CURRENT SUPPLY SYSTEM FOR ELECTROLYTIC CELLS

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FIG. 1

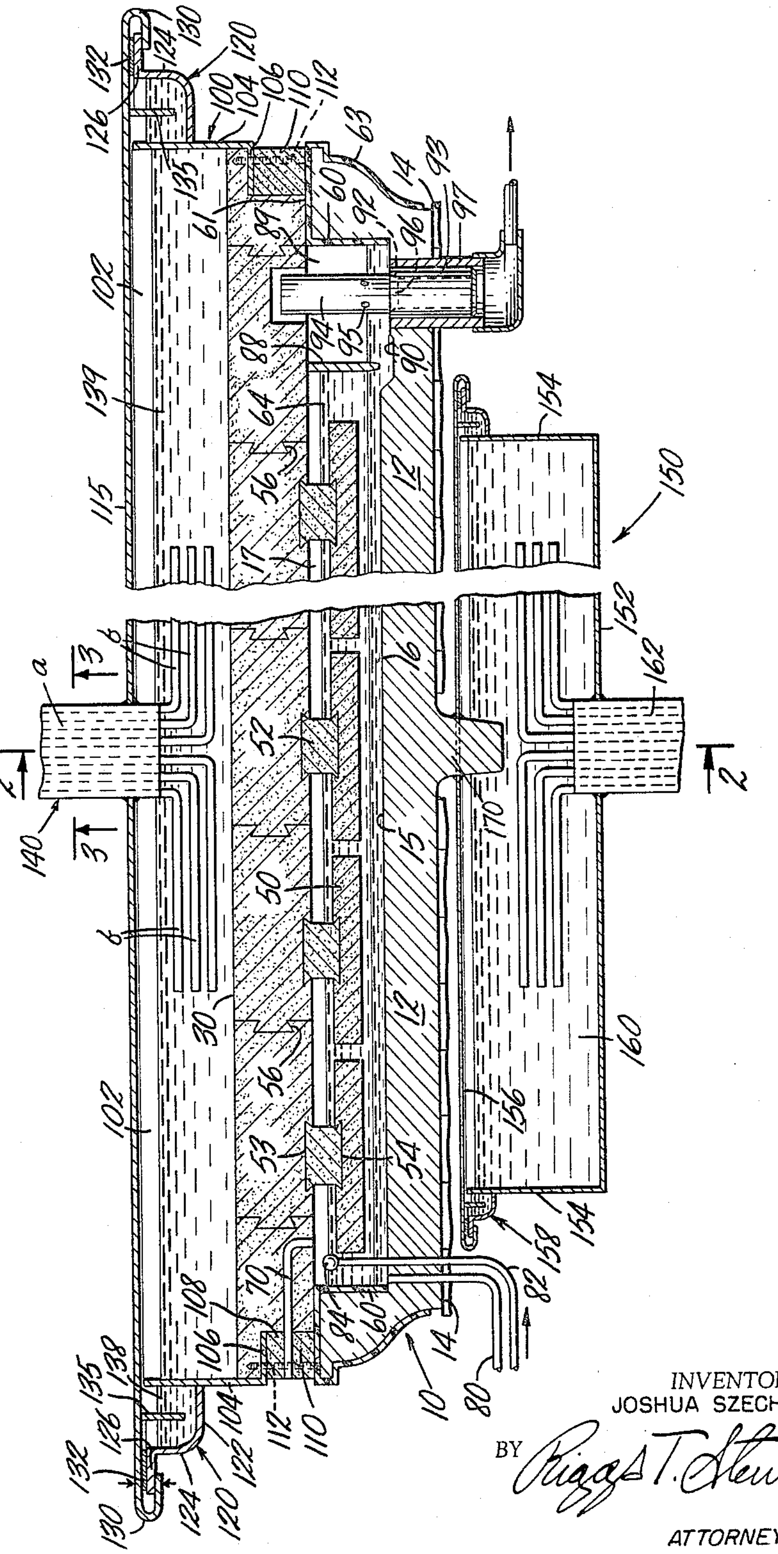

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FIG. 2

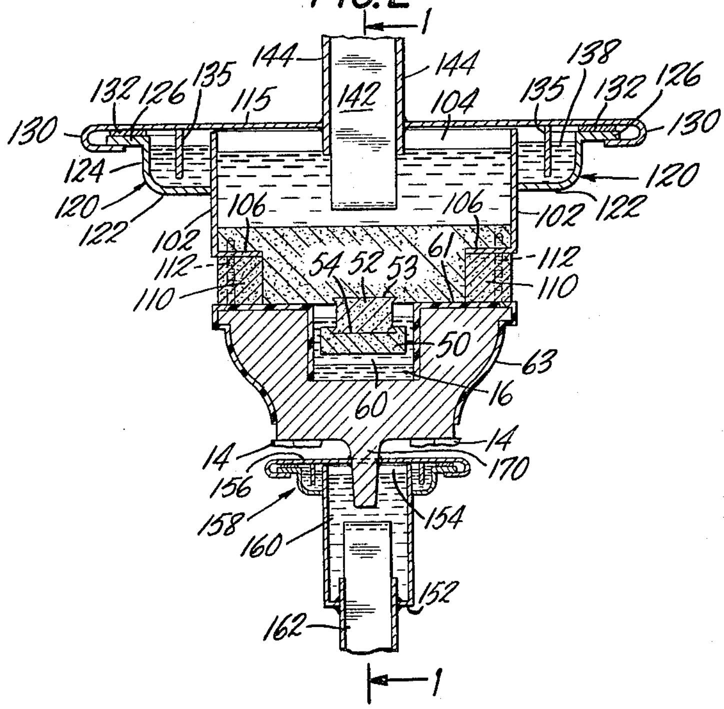
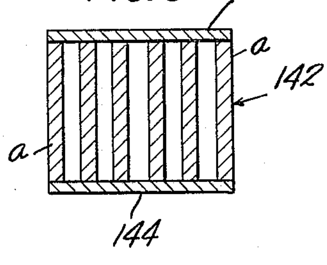


FIG. 3



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CURRENT SUPPLY SYSTEM FOR ELECTROLYTIC CELLS

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14 Claims. (Cl. 204—219)

This invention relates to electrolytic cells of the type employed for the decomposition of salts, such as alkali metal chlorides and alkaline earth metal chlorides, and is more particularly concerned with a current-conducting construction for such cells which is effective to co-operate with the cell to connect the cell in a current circuit, e.g. to connect the anodes with a source of electrolysis current and to lead the current from the cell cathode.

Electrolytic cells of the horizontal type are known for the electrolysis of salts such as alkali metal salts and alkaline earth metal salts. In my co-pending application Serial No. 699,979, filed December 2, 1957, now Patent No. 3,104,213, issued September 17, 1963, I have described a cell which is suitable for high-temperature electrolysis of molten salts, using a molten lead cathode. In this cell, electrolysis current is supplied to the anodes through the cell cover and the current flows from the sole of the cell upon which the lead cathode is supported. The operation of an electrolytic cell at elevated temperatures naturally involves thermal expansion and contraction of the cell, and a problem arises with regard to the connection of the cell to the electrolysis current conductors.

Flexible conductors, generally in the form of multiple strands, can be used. However, when very large currents are involved, such flexible conductors do not give the optimum results that can be achieved with rigid conductors. Rigid conductors, however, have not heretofore been used in a manner which effectively solves the problems created by the above-mentioned thermal expansion and contraction.

It is, accordingly, an object of the present invention to provide a construction for an electrolytic cell which permits the electrically-conductive connection of rigid conductors to the cell in a manner which will compensate for any expansion and contraction of the cell itself.

It is a further object of the invention to provide a cell cover construction by means of which positive electrolytic current can be supplied to the anodes from rigid bus bars.

It is another object of the invention to provide a cell body construction which permits the negative sole of the cell to be connected to rigid conductors.

It is a still further object of the invention to provide an electrolytic cell construction wherein the cell may be flexibly connected in a current circuit composed of rigid conductors.

The invention is concerned with an electrolytic cell having a cover which is formed from a material which will conduct electricity, more specifically graphite, and with a sole or bottom formed from an electrically-conductive metal, e.g. iron, and formed with a conductive extension. The anodes are electrically connected to the cover without passing through it as described, for example, in my said co-pending application Serial No. 699,979. Thus, the anodes may be supported from the cover by means of stems which are connected to the cover by direct attachement to its lower side or the anodes may be directly connected to the cover, or the lower surface of the graphite cover may itself serve as the anode. The anode stems are in electrically-conducting

relationship with the cover and with the anodes so that when electrolytic current is fed to the cover, it passes directly through the anode stems to the anodes. Similarly, the cell sole and the sole extension are in direct electrically conductive relationship so that electrolytic current flows from the sole through the extension.

In accordance with the invention, the cover, or at least part of it, is enclosed by a covered container adapted to containing a body of an electrically-conductive metal which is molten at the operating temperature of the cell, the container including a cover which is relatively movable in relation to the container walls, and the rigid conductor means extend into the container for immersion in the body of metal contained therein. More specifically, the rigid conductor is advantageously connected to the container cover, i.e. the part of the container which is not directly connected to the cell itself.

In similar manner, the portion of the cell sole defined by the sole extension is at least partly enclosed by a second covered container adapted to contain a body of an electrically-conductive metal which is molten at the operating temperature of the cell, the container including a cover which is relatively movable in relation to the container walls, and the rigid conductor means is positioned for electrically conductive relationship with the body of electrically-conductive metal. More specifically, the container cover is connected to the sole extension, and the rigid conductor means extends into the container for immersion in the body of metal contained therein.

It is a feature of the construction of this invention that the molten metal provides the principal conductive path between the rigid conductor means and the cell and thus absorbs any movement between the cell and the rigid conductor means so that an effective connection is achieved at all times, regardless of the extent of thermal expansion and contraction of the cell.

Other objects and features of this invention will be apparent from the following detailed description of an illustrative embodiment thereof, and from the accompanying drawing, wherein,

FIG. 1 is a longitudinal cross-sectional view of an electrolytic cell construction embodying features of the present invention, as seen generally along the line **1—1** of FIG. 2;

FIG. 2 is a transverse sectional view of the cell shown in FIG. 1, taken generally along the line **2—2** of FIG. 1; and

FIG. 3 is a transevrse sectional view of a conductor assembly as seen generally along the line **3—3** of FIG. 1.

Referring to the drawing, the cell body **12** of the cell **10** is suitably formed from metal, e.g. iron, and is supported upon an insulating support **14**, indicated in the drawing as refractory blocks or bricks, but it will be understood that any other convenient insulating base may be employed. As seen in FIG. 1, the cell **10** defines a sole sursurface **15** upon which the liquid cathode **16**, e.g. molten lead, is adapted to rest and to flow from left to right. Thus, the elongated cell body **12** is formed with an elongated channel of which the sole **15** is the bottom and which provides the electrolysis chamber **17**. The sole **15** may be horizontal or it may slope slightly toward the right. The slope of the sole may vary but a slope of 1° or less is preferred. Since the cell is adapted to operate at elevated temperatures for the electrolysis of molten salts, e.g. temperatures of 810° to 850° C. which are suitable for the electrolysis of molten sodium chloride, any convenient means for heating the cell body and maintaining it at an elevated temperature may be employed.

Closing the cell is a cover **30** which extends completely across the cell body **12** and also extends from one end of the cell body to the other. This cover is formed from an electrically-conductive material and, most suitably, it is formed from graphite. The cover **30** directly supports the anodes **50** and such support is suitably effected by means of anode stems **52**.

Thus, as seen in FIGS. 1 and 2, the stems **52** are received in slots **53** and **54** formed in the cover **30** and in the anode blocks **50**, respectively, so that these parts are removably interconnected, or the stems may be removably connected only with the cover, or only with the anodes, or all parts may be integrally interconnected. Indeed, all of the above-mentioned parts may be formed as a single unified body so that, in effect, the lower surface of the cover serves as the anode. Further, while the cover **30** is shown as an integral body extending over the entire cell, it is advantageously formed from a plurality of sections extending across the cell body **12**, the sections being interconnected by means of dove-tail joints such as shown between the anode stems and the associated cover and anodes, and indicated at **56**. As described in my co-pending application Serial No. 669,979 and, as seen in FIGS. 1 and 2, a continuous refractory lining **60** is provided along the entire interior walls of the electrolysis chamber **17** of the cell, the lining **60** serving as an electrical insulator and also as a protector of the walls against chemical attack by the chemical contents within the chamber. Since the cover must be electrically insulated from the body of the cell, because it is a conductor of electrolysis current, an insulating sheet **61** completely overlies the top edges of the walls of the cell body **12**. The exterior of the cell body is suitably provided with a tight heat-insulating covering **63**. The weight of the cover upon the cell body together with the insulating sheet **61** is generally sufficient, but if a tighter relationship is desired, a plurality of spaced-apart clamps (not shown), can be used to secure the cover to the cell body. Such clamps must, of course, be insulated from the cell body in order to prevent electrical contact between cover **30** and cell body **12**. Furthermore, the exterior insulating cover effects not only heat-insulation but electrical-insulation as well.

An outlet channel **70**, is suitably provided in cover **30** to permit venting of the electrolysis chamber of gases evolved above the level of the electrolyte.

The manner in which the electrolyte and the liquid cathodes are introduced into and removed from the cell form no part of the present invention and the manner described in my copending application Serial No. 699,979 is particularly suitable, especially since it insures against entrance of air or oxygen with the electrolyte and the cathode into the electrolysis chamber. Thus, as seen in FIG. 1, the liquid cathode, e.g. molten lead, and the electrolyte, e.g. molten alkali metal chloride or alkaline earth metal chlorine, are introduced at the left-hand end of the cell body, the molten lead suitably being introduced through a conduit **80** and the electrolyte being introduced through a conduit **82**. The conduit **82** extends upwardly into the electrolysis chamber **17** and discharges through a self-regulating float valve, indicated diagrammatically at **84**, of the type described in FIG. 5 of my copending application Serial No. 699,979. At the right-hand end of the cell body **10**, there is provided a transverse wall **88** extending between the side walls of the cell body and engaged by the cover **30** to define the downstream end of the electrolysis chamber proper and to define an end compartment **89**. The cell bottom slopes downwardly in the vicinity of the transverse wall in order to form a well **90** into which the wall can extend to form a liquid seal against passage of the lighter electrolyte into the end compartment as long as the liquid level of the cathode is maintained.

The end compartment **89** is formed with an outlet opening **92**. A tall cylindrical sleeve **94** is provided with apertures **95** and with a nose **96** normally disposed in outlet opening **92** at the top of a sleeve **93**, the cathode level being maintained by the apertures **95** through which the alloy formed in the cell is discharged. The upper end of the sleeve **94** extends into a recess in cover **30** and it may be lifted, e.g. by electromagnetic means, to permit emptying of the cathode from the cell, as described in my co-pending application Serial No. 699,979. Suitable electrical insulation (not shown) prevents contact between sleeve **94** and cover **30**. Adjustment of the anode-cathode gap may be effected in any convenient manner but it is most suitably effected in the manner described in my co-pending application Serial No. 89,943, filed February 17, 1961, now abandoned, wherein the sleeve **93** is threadedly engaged with the insulating tube **97** and the level of the apertures is adjusted by rotating sleeve **93**.

In accordance with the invention, rigid current conductors are connected to the anodes and the cathode of the cell in a manner which eliminates any problem of thermal expansion or contraction of the cell, or any part of it, by providing a construction in which the conductors are adapted to be immersed in a molten current-conducting metal. Referring more particularly to FIG. 1, the top of the cell cover **30** is enclosed by a receptacle **100** defined by side walls **102** and end walls **104**, with the cell cover itself serving as the bottom for the receptacle. The bottom ends of the side walls and end walls are formed with an inwardly-directed flange **106** which is received within a peripheral recess **108** formed in the lower portion of the cell cover **30**. The recess **108** is filled with removable graphite blocks **110** which are joined to the remainder of the cover and serve to clamp the flange **106** in fluid-tight relationship. The blocks **110** are secured in place by any convenient means, and most suitably by graphite bolts **112** which pass through the blocks from their lower surfaces, which rest upon the insulating sheet **61**, and then pass through suitable apertures in the flange **106** and are threadedly engaged in the upper portion of the cell cover. As seen at the left of FIG. 1, the gas outlet **70** suitably extends from the main cover body into the adjacent block and then to the exterior of the cell, where it is suitably connected to an outlet conduit (not shown). It will be understood that other means of securing the side walls **102** and the end walls **104** to the cell cover may be employed, if desired.

Overlying the top edges of the side and end walls of the receptacle **100** is a cover **115**. In accordance with the invention, relative mobility with concurrent fluid-tightness between the walls of the receptacle and the cover **115** is provided by the peripheral sealing and sliding construction shown at the upper ends of FIG. 1. This construction has been exaggerated in size in order to show the relative relationships more clearly. Thus, the upper ends of the walls **102** and **104** are formed with a continuous trough **120** having a bottom wall **122**, secured, as by welding, to the walls **102** and **104**, and a side wall **124** having a peripheral flange **126**. The cover **115** is dimensioned to extend outwardly over the trough, and its end portions are retroverted as indicated at **130** to define a slot in which the flange **126** is received. To insure tightness but to allow relative sliding movement between the cover and the trough flange, a sliding seal member **132** overlies the flange **126** and supports the cover. This seal member may be of any suitable type and formed of a material resistant to the elevated temperatures and to the materials with which it may come in contact, but most advantageously it is formed from a soft copper enveloped within mica. The retroverted portion **130** is crimped over the flange **126** and the seal so that a close sliding fit is provided and, if desired, the connection can be made even tighter by applying clamps (not shown) to bear in the directions indicated by the arrows in FIG. 1.

The relatively movable but sealing construction described above is completed by the provision of a continuous dam **135** depending from the cover **115** and positioned to be received in the trough **120**, with the trough being filled with a hydraulic sealing fluid **138**, which is suitably molten lead. The receptacle **100** is adapted to be filled with a current-conducting fluid **139**, and this is most suitably molten sodium. The above-described seal prevents the escape of sodium vapors into the atmosphere and the seal member **132** prevents the escape of vapors from the trough **120**.

In accordance with this invention, current is supplied from rigid conductors in a manner which is completely free from conflict with any expansion or contraction which the cell, or any part of it, may undergo, by bringing the conductors through the cover **115** and into the interior of receptacle **100** so that they will be immersed in conducting liquid **139**. A typical, particularly suitable, rigid conductor assembly is illustrated in FIG. 1 and is also seen in FIG. 2. This conductor assembly, which is indicated generally at **140**, is formed from a plurality of rigid L-shaped copper strips **142** nested together and secured at their sides by connecting strips **144**. Thus, as seen in FIGS. 1 and 3, the vertical legs *a* of the strips **142** extend downwardly through the cover in spaced apart relationship and are then bent at right angles to define the horizontal legs *b* which extend through the receptacle substantially parallel to the cell cover. The side connecting strips **144** hold the assembly together and maintain the strips **142** in their spaced-apart relationship. These connecting strips and the outermost strips **142** are brazed or otherwise rigidly secured to the cover **115**. Thus, if expansion or contraction of the cell should occur, such expansion or contraction will not be transmitted to the rigid conductors because the cover **115**, to which they are connected, will not follow the movements of the receptacle **100** by reason of the sliding connection between the cover and the receptacle described above. While these two components are described as being crimped and clamped together at their edges, it is always to be understood that such crimping or clamping does not prevent relative movement such as would occur as a result of thermal expansion or contraction.

While a single conductor assembly has been illustrated, it will be understood that a plurality of such assemblies may be provided, e.g. four, or more, depending upon the current requirements of the cell and the size of the conductor assemblies. One of the advantages of the conductor assembly construction illustrated is that the bottom ends of the vertical spaces between the conductor strips seen in FIG. 3 can be closed off, and these spaces filled with a cooling fluid, suitable aperatures in the conductors being provided to permit circulation. It is a further advantage of the conducting construction illustrated that the body of sodium **139** overlying the cover serves to seal the large top surface of the cover and thus to prevent ingress of air should the cell be operated under vacuum. In addition, the construction of the invention insures ample supply of current to the cell, whatever the current requirements may be, from rigid conductors without concern for thermal expansion or contraction.

In accordance with a further feature of the invention, the sole or negative side of the cell is also suitably connected to rigid conductors in a manner which insures adequate current flow and complete freedom from any conflict with the thermal expansion or contraction of the cell. In this connection, reference is made to the lower portion of FIG. 1. A receptacle **150** defined by a bottom **152** and side and end walls **154** extends under the cell body **12** and is provided with a cover **156**. The cover **156** is associated with the walls of receptacle **150** in a fluid-tight yet relatively movable manner by a seal construction, indicated generally at **158**, which is suitably exactly like that described above comprising elements **120–138**. The interior of the receptacle **150** is adapted to receive a body **160** of a current-conducting fluid, such as molten sodium, and the rigid current conductor assembly **162** which is immersed in the fluid **160**, and which extends upwardly through the bottom **152** of the receptacle **150**, suitably has the same construction as the current conductor unit **140** described above and, as in the case of the positive side of the cell, a plurality of assemblies **162** may be employed. Since space requirements may limit the width of the assemblies **162**, it may be necessary to have more assemblies **162** than assemblies **140**, e.g. twice as many. Current flows from the sole of the cell into the conducting body **160** through an extension **170** which is formed integrally with the cell bottom, e.g. it is cast as a unit with the cell body. The extension **170** passes through the cover **156** and is rigidly secured to it, e.g. by brazing.

Thus, a highly-effective connection is provided between the negative side of the cell and rigid conductor means comparable to that provided for the positive side of the cell. It will be understood, however, that if the thermal expansion and contraction encountered are not too great, one or the other of the conductor-connecting constructions may be eliminated and the related rigid conductor means directly connected to the cell. As is known, in electrolytic cell installations, the several cells are connected in series so that the conductors leading from the negative side of one cell are connected to the positive side of a succeeding cell. Thus, if each cell were provided with a construction of the type described above for feeding the anodes of the cells, these constructions would be effective to compensate not only for expansions and contractions between the parts of the cell and the rigid conductors supplying current to the anodes, but also relative expansion and contraction between the two succeeding cells. Preferably, however, a conductor-connecting construction in accordance with the invention is provided both for the anodes and for the cathode of each cell in the series. In the construction shown in FIG. 1, for example, the conductor strips of the conductor assemblies **140** are connected with the conductor strips of the conductor assemblies **162** of a preceding cell, and similarly the assemblies **162** of the cell illustrated are connected to the assemblies **140** of a succeeding cell.

In the foregoing, it will be understood that thermal and electrical insulation may be provided whenever desirable, e.g. on the receptacles **115** and **150**, and associated parts, and that heating means, e.g. strip heaters, may be applied to the receptacles, conduits, and other parts, where desired, e.g. to maintain the molten metals and other fluids in molten form. Such insulation and heating means have not been shown in the drawings in order to facilitate illustration of the invention. It will also be understood that relative dimensions and other relative relationships shown are for illustrative purposes only and can be varied freely.

Furthermore, the conductor-connecting constructions of this invention may be used with cells other than those of the specific construction to which reference has been made above. In addition, the construction of this invention may be combined with the flexible outlet construction described and claimed in my concurrently-filed application entitled "Outlet System for Electrolytic Cells."

It will also be understood that various other changes and modifications may be made in the embodiments described and illustrated 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 only and not as limitative of the invention.

I claim:

1. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-

conductive contact with said cover, first bus bar means extending into said first receptacle for at least partial immersion in said metal, whereby said first bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal confined in said first receptacle, first cover means for covering said first receptacle, means for connecting said first cover means to said receptacle in relatively slidable but fluid-tight relationship, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means extending into said second receptacle for at least partial immersion in said metal, whereby said second bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal confined in said second receptacle, second cover means for covering said second receptacle, and means for connecting said second cover means to said second receptacle in relatively slidable but fluid-tight relationship.

2. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-conductive contact with said cover, first bus bar means extending into said first receptacle for at least partial immersion in said metal, whereby said first bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal confined in said first receptacle, first cover means for covering said first receptacle, means for connecting said first cover means to said receptacle in relatively slidable but fluid-tight relationship, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means extending into said second receptacle for at least partial immersion in said metal, whereby said second bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal confined in said second receptacle, second cover means for covering said second receptacle, said first and said second receptacle each having means defining a trough at the upper periphery thereof adapted to contain a liquid and said first cover means, and said second cover means each having a flange depending into the associated trough.

3. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-conductive contact with said cover, first bus bar means extending into said first receptacle for at least partial immersion in said metal, whereby said first bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal confined in said first receptacle, first cover means for covering said first receptacle, means for connecting said first cover means to said receptacle in relatively slidable but fluid-tight relationship, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means extending into said second receptacle for at least partial immersion in said metal, whereby said second bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal confined in said second receptacle, second cover means for covering said second receptacle, and means for connecting said second cover means to said second receptacle in relatively slidable but fluid-tight relationship, said first bus bar means and said second bus bar means each extending through the associated cover means and being connected thereto.

4. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-conductive contact with said cover, first bus bar means extending into said first receptacle for at least partial immersion in said metal, whereby said first bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal confined in said first receptacle, first cover means for covering said first receptacle, means for connecting said first cover means to said receptacle in relatively slidable but fluid-tight relationship, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means extending into said second receptacle for at least partial immersion in said metal, whereby said second bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal confined in said second receptacle, second cover means for covering said second receptacle, and means for connecting said second cover means to said second receptacle in relatively slidable but fluid-tight relationship, each of said bus bar means comprising a plurality of parallel rigid strips secured together to form a bus bar unit including vertical portions extending into the associated receptacle and horizontal end portions.

5. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-conductive contact with said cover, first bus bar means extending into said first receptacle for at least partial immersion in said metal, whereby said first bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal confined in said first receptacle, first cover means for covering said first receptacle, means for connecting said first cover means to said receptacle in relatively slidable but fluid-tight relationship, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means extending into said second receptacle for at least partial immersion in said metal, whereby said second bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal confined in said second receptacle, second cover means for covering

said second receptacle, and means for connecting said second cover means to said second receptacle in relatively slidable but fluid-tight relationship, said sole having an integral downwardly-extending extension to effect said electrically-conductive contact with said metal.

6. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperature above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conductive relationship with said anodes and supporting said anodes with all parts of the anodes lying below the top surface of said cover, means for connecting said cover in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said cover, bus bar means free from direct contact with said anodes but in electrically-conductive relationship with said metal whereby said bus bar means are in electrically-conductive relationship with said anodes through said metal and said cover when said body of metal is in electrically-conductive contact with said cover, said receptacle being closed to exclude the surrounding atmosphere and said cover being relatively movable in relation to said bus bar means, whereby the thermal expansion and contraction of said cover are not transmitted to said bus bar means.

7. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conductive relationship with said anodes and supporting said anodes with all parts of the anodes lying below the top surface of said cover, means for connecting said sole and said cover in an electric circuit, said means comprising means defining a first receptacle, a body of a metal molten at the temperature of operation of said cell confined in said first receptacle in electrically-conductive contact with said cover, first bus bar means free from direct contact with said anodes but in electrically-conductive relationship with said metal whereby said first bus bar means are in electrically-conductive relationship with said anodes through said metal and said cover, said first receptacle being closed to exclude the surrounding atmosphere and said cover being relatively movable in relation to said first bus bar means, whereby the thermal expansion and contraction of said cover are not transmitted to said first bus bar means, means defining a second receptacle, a body of a metal molten at the temperature of operation of said cell confined in said second receptacle in electrically-conductive contact with said sole, second bus bar means free from direct contact with said sole but in electrically-conductive relationship with said metal in said second receptacle whereby said second bus bar means are in electrically-conductive relationship with said sole through said metal, said second receptacle being closed to exclude the surrounding atmosphere and said sole being relatively movable in relation to said second bus bar means, whereby the thermal expansion and contraction of said sole are not transmitted to said second bus bar means.

8. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said sole in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said sole, and bus bar means extending into said receptacle for at least partial immersion in said metal, cover means for covering said receptacle, whereby said bus bar means are free from direct contact with said sole but are in electrically-conductive relationship with said sole through said metal when said body of metal is in electrically-conductive contact with said sole, and means for connecting said cover means to said receptacle in relatively slidable but fluid-tight relationship.

9. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said cover in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said cover, and bus bar means extending into said receptacle for at least partial immersion in said metal, cover means for covering said receptacle, whereby said bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal and said cover when said body of metal is in electrically-conductive contact with said cover, and means for connecting said cover means to said receptacle in relatively slidable but fluid-tight relationship.

10. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said cover in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said cover, and bus bar means extending into said receptacle for at least partial immersion in said metal, whereby said bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal and said cover when said body of metal is in electrically-conductive contact with said cover, cover means for covering said receptacle, and means for connecting said cover means to said receptacle in relatively slidable but fluid-tight relationship, said receptacle having means defining a trough at its upper periphery adapted to contain a liquid, and said cover means having a flange depending into said trough.

11. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said cover in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said cover, and bus bar means extending into said receptacle for at least partial immersion in said metal, whereby said bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal and said cover when said body of metal is in electrically-conductive contact with said cover, cover means for covering said receptacle, and means for connecting said cover means to said receptacle in relatively slidable but fluid-tight relationship, said bus bar means extending through said cover means and being secured thereto.

12. In combination with an electrolytic cell of the horizontal type constructed to operate at elevated temperatures above the melting point of sodium chloride and having a sole adapted to support a liquid metal cathode, a plurality of anodes, and a cover in electrically-conducting relationship with the anodes of the cell, means for connecting said cover in an electric circuit, said means comprising means defining a receptacle, a body of a metal molten at the temperature of operation of said cell confined in said receptacle in electrically-conductive contact with said cover, and bus bar means extending into said receptacle for at least partial immersion in said metal, whereby said bus bar means are free from direct contact with said anodes but are in electrically-conductive relationship with said anodes through said metal and said cover when said body of metal is in electrically-conductive contact with said cover, cover means for covering said receptacle, and means for connecting said cover means to said receptacle in relatively slidable but fluid-tight relationship, said bus bar means comprising a plurality of parallel rigid strips secured together to form a bus bar unit including vertical portions extending into said receptacle and horizontal end portions.

13. The combination as set forth in claim **6**, wherein said body of molten metal is sodium.

14. The combination as set forth in claim **7**, wherein said body of metal molten in said first receptacle is sodium and said body of a metal molten in said second receptacle is sodium.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,282,820 November 1, 1966

Joshua Szechtman

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 49, for "transevrse" read -- transverse --; line 56, for "sur- surface" read -- surface --; column 3, line 20, for "669,979" read -- 699,979 --; line 45, for "cathodes" read -- cathode --.

Signed and sealed this 22nd day of August 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents