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ELECTROLYTIC CELL COVER

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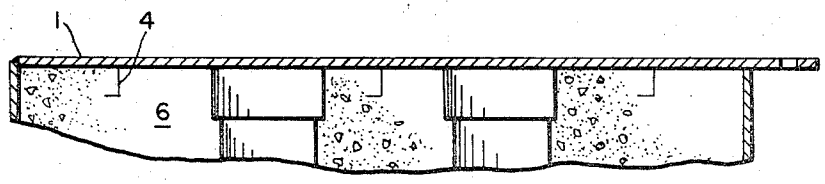


FIG. 1

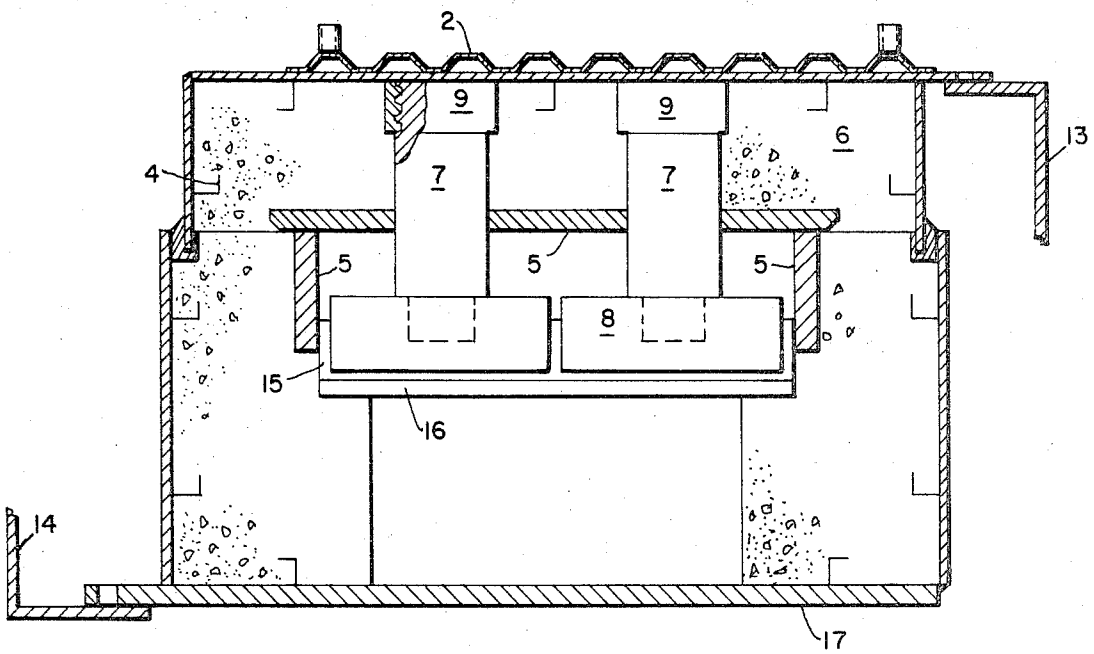


FIG. 2

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ELECTROLYTIC CELL COVER

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ABSTRACT OF THE DISCLOSURE

An electrolytic cell is provided having a cover of a material which will conduct an electric current, the undersurface of such cover being formed of a refractory material substantially entirely except for allowing contact of the anodes or anode stems with the current carrying material. A cover of such construction allows for substantially less loss of heat from the electrolytic cell and substantially less wear and mechanical failure due to excessively high temperatures of the cover material.

The present invention relates to an improvement in the construction of electrolytic cells and the cover thereof in particular; and more particularly, the present invention relates to a new construction of the cover of the anode section of an electrolytic cell of the horizontal type useful in the electrolysis of fused salts wherein said cover comprises an electric current conducting material, the inner surface thereof being covered with a refractory composition.

The present invention is particularly applicable to the construction of cells which provide for the electrolysis of molten inorganic compounds at high temperatures wherein a molten metal is employed as a cathode. Cells of this type operating with an electrolyte of fused salts have been known for some time. Thus, the examples of such cells include the Acker cell e.g., as described in U.S. Pat. 674,691, the Ashcroft cell e.g., as disclosed in U.S. Pat. 1,159,154, the Hamprecht cell used in Germany during World War II and described in FIAT Report No. 830, as well as the early Szechtman cell as represented by U.S. Pat. 3,104,213. In cells of this type, the top or cover is necessarily subjected to substantially the same temperature as that of the molten inorganic compound employed as the electrolyte. Generally, temperatures in excess of 1300° F. and sometimes in excess of 1800° F. are employed, such temperatures being necessary to keep the electrolyte in a molten state. Accordingly, the top or cover of such horizontal electrolytic cells are subjected to stress at the high temperatures to which they are subjected, such stress generally resulting in a shortened life of the cover or top due to failure. Thus, the conventional cover materials tend to become mechanically weak and lose the dimensional stability. In a recent patent to Szechtman e.g., U.S. Pat. 3,235,479, it is proposed to employ graphite as the cell cover of the horizontal electrolytic cell as the type discussed above. While the graphite cover of such patent does conduct an electric current, it is not a good conductor. Moreover, however, such graphite is an excellent conductor of heat thereby providing for a great loss of heat through the cover of the electrolytic cell. On an industrial scale therefore, the use of graphite as the cover for the horizontal electrolytic cell is disadvantageous in that it provides for poor conduction of an electrical current while providing an expensive loss of heat to the surround ang atmosphere. Accordingly, such use of the graphite cover has not solved the problem associated with the inherent disadvantages and deficiencies of cover and top materials employed in horizontal electrolytic cells such as embodied by the present invention, but, in fact, has tended to compound the same. Accordingly, it has still been the desire of the industry to provide a simple and efficient cover for horizontal electrolytic cells employing high temperatures in an electrolytic process especially adapted for the electrolysis of molten electrolytes utilizing a molten metal cathode.

Such inherent disadvantages and deficiencies of the prior art have been overcome in accordance with the present invention wherein a cover for the electrolytic cell is provided comprising a metal shell with a refractory lining, such refractory lining carrying connections therethrough to electrically conducting cover from the anodes. The use of such a cover allows for the utilization of a metal shell capable of carrying the electric current necessary for operation of the electrolytic cell, while the refractory lining present on the inner surface of the metal shell provides protection against excessive heat and heat loss to the atmosphere.

Accordingly, it is the principal object of the present invention to provide an improvement in the production of covers for electrical cells, particularly of the horizontal type wherein a molten electrolyte is employed in conjunction with the flowing molten metal cathode, such improvement eliminating the inherent deficiencies and disadvantages associated with the employment of prior art apparatus.

A further object of the present invention comprises an improvement in the cover for a horizontal electrolytic cell wherein such cover comprises an electrically conducting metal shell containing a refractory lining, such refractory lining allowing contact between the anodes or anode stems and the metal shell.

A still further object of the present invention comprises a cover for the electrolytic cell which eliminates the problem of fatigue and mechanical weakness and loss of dimensional stability associated with the high temperatures developed in the electrolysis process as well as an excessive loss of heat to the atmosphere, the elimination of such problems being associated with the provision of a cover comprising a metal shell capable of conducting electricity necessary for the operation of the electrolytic cell and as a lining therefore, a refractory material which resists degradation or deformation due to high temperature and resists the passage of heat therethrough.

Still further objects and advantages of the novel improved electrolytic cell cover of the present invention will become more apparent in the following more detailed description thereof in conjunction with the accompanying drawings: wherein,

FIG. 1 is a side cross-sectional view of the cover of the present invention;

FIG. 2 is a cross-sectional view of an electrolytic cell having in place the cover of the present invention.

In the figures, like numerals represent like elements.

In FIG. 1, the electrolytic cell cover of the present invention is shown as comprising a metal shell **1**, containing a refractory liner **6**, generally comprising a depth of 6 to 8" or more below the metal shell. The refractory liner **6**, is generally of a castable or monolithic refractory, such refractory liner **6** underlying approximately 60 to 90%, preferably 80–85% of the total cover area. The remainder of the cover area i.e. 10–40%, preferably 15–20% is not covered by the castable or monolithic refractory liner **6**, so as to provide contact with the anode stems **7**, of the electrolytic cell as will be discussed in more detail in reference to FIG. 2. Thus, while the heat from the electrolytic cell will be conducted through that portion of the cover area not underlayed by the refractory lining, since such area comprises only a very minor amount of the total cover area i.e. only about 15–20% of the total area, the heat conducted through this

area will not be appreciable, in this respect, since the refractory lining **6**, is a poor conductor of heat, comparatively little heat will be conducted through this area which underlays the major portion of the total cover area i.e. from about 60–90% of the total cover area. It is pointed out with respect to the percentages of area covered and uncovered by the refractory lining **6** as set forth above that such percentages are merely exemplary of a typical electrolytic cell embodying the present invention. Of course, where desired for particular purposes it may be desirable to underlay more or less of the total cover area with the refractory lining depending in part on the area necessary for the contact of the anode stem and bushings with the electrically conducting metal shell and, the amount of heat which can be tolerated by the metal shell itself. Since the heat transmitted through the area of the cover above the anodes i.e. that area not underlayed by the refractory lining **6**, together with the comparatively small amount of heat transmitted through the refractory lining **6** itself, will be dissipated over the whole area of the cover, the cover material i.e. the metal shell will be generally maintained at a moderate temperature which can be tolerated by any and all of the metals employed which are capable of conducting the electric current necessary for operation of the electrolytic cell.

While any material having the requisite characteristics of ability to conduct electricity and resistance to the temperatures to which the metal shell is heated can be employed, it is preferred that the metal shell **1** of the cover comprise a nickel-clad mild steel with the nickel-clad surface facing downward. The nickel-clad mild steel is preferred since nickel most effectively resists the action of dry chlorine gas up to a temperature of about 1000° F. whereas straight steel resists such dry chlorine gas up to a temperature of about 300° F. Thus, although this is a consideration in selecting the metal for use in the cover of the elctrolytic cell of the present invention, it is pointed out that contact with the chlorine gas and other products and reactants of the electrolysis reaction is minimized by the fact that a substantial proportion of the undersurface of the metal shell is underlayed with a fairly substantial refractory liner **6**. However, while various alloys of steel etc. have the requisite characteristics for use in accordance with the present invention, the use of the nickel-clad mild steel is preferred for the reasons set forth above.

Again, it is pointed out that in view of the fact that the metal shell of the cover does not achieve an extremely high temperature and is not contacted by the reactants and products of the electrolysis because of the refractory liner **6**, the most essential characteristic of the metal employed for the shell is that it be a good conductor of electricity.

As indicated previously, the refractory lining preferably comprises a cast or monolithic refractory material. Such materials generally are fairly inert to the environment of the electrolytic cell and in addition, possess the necessary property of not allowing passage of substantial amounts of heat. In other words, the refractory linings employed in accordance with the present invention are poor conductors of heat, this common characteristic of all applicable and conventional refractories allowing the same to be operably employed in the electrolytic cell cover of the present invention. Thus, suitable refractories having the requisite relatively low co-efficient of heat transfer include those which have a high percentage of alumina or magnesia. Thus, a cement refractory composition may suitably employ calcium aluminate as a binder. High silicate content refractories are not preferred since, especially when a sodium salt e.g., sodium chloride is electrolized in the electrolytic cell, the sodium present has the effect of reducing the silica content. In addition to the alumina and/or magnesia content or other refractory materials, the refractory lining of the electrolytic cell cover of the present invention can include a suitable filler material e.g., vermiculite, crushed firebrick, etc.

As indicated previously, almost any conventional refractory material can be employed with the present invention, the sole requirement for suitability being a relative inertness to the atmosphere of the electrolytic cell and, a fairly low coefficient of heat transfer, so as to be a poor conductor of heat.

The cover of the present invention, comprising the metal shell **1** and refractory liner **6**, is shown in FIG. 2 in a conventional elctrolytic cell. The inside surface of the metal shell **1** of the cover is provided with anchors or studs **4** extending into the body of the refractory liner to provide a mechanical bond between the refractory liner **6** and metal shell **1**. While such anchors or studs **4** are not essential since both the refractory liner **6** and metal shell **1** can be adequately supported by the sides of the electrolytic cell, the use of such anchors or studs **4** provides a more cohesive structure by providing the mechanical bond between the portions of the cover.

As shown in FIG. 2, the electrolytic cell can also contain atop the cover a water jacket of any conventional design. The water jacket **2** assists in lowering the temperature of the cover still further than possible by the use of the refractory liner alone.

In the electrolytic cell represented in FIG. 2, graphite anode stems **7** are screwed into nickel bushings **9** which are connected to the metal shall **1** of the cover but do not pass therethrough. The anodes **8** of the type similar to those employed in mercury-alkali chloride cells, e.g., graphite anodes, are pressed onto the lower ends of the anode stems **7**. Generally the nickel bushings **9** with internal threads so as to be receptive to the anode stems **7** are welded to the metal shell **1** of the cover of the electrolytic cell in any suitable manner.

As shown in FIG. 2, the interior of the electrolytic cell may be lined with carbon or graphite slabs **5**, which slabs provide additional protection of the cell construction against the action of chlorine gas.

In the operation of the electrolytic cell the current enters the cell from a bus (not shown) connected to lead **13** which is bolted or otherwise fastened to the metal shell **1** of the cover, preferably extending beyond the exterior of the electrolytic cell as shown in FIG. 2. The current travels through the metal shell **1**, through the nickel bushings **9**, through the anode stem **7** to the anode proper **8**. From the anode **8** the current passes through the fused salt electrolyte **15** to the cathode **16**, generally a molten metal such as lead, tin or an alloy, for example, a lead-sodium alloy. The current passes from the cathode **16** to the cell bottom **17** and then to connection **14** leading to the negative bus (not shown).

While not illustrated in FIG. 2, the cell bottom of the electrolytic cell to which the improved cell cover of the present invention is most applicable is preferably of the type disclosed in co-pending application Ser. No. 542,002, filed Apr. 12, 1966, now U.S. 3,468,786. Such cell bottom as defined in such co-pending application comprises a metal base and a relatively fixed refractory overlayer disposed on top of the base, the refractory overlayer having at least one recess extending fully through its thickness so as to permit direct contact between the metal base and the flowing molten cathode. As is the case with the refractory underlayer employed in accordance with the improved cell of the present invention the refractory employed in conjunction with the cell bottom as illustrated in applicant's co-pending application is characterized by having a low co-efficient of heat transfer.

As indicated previously, the improved cell cover of the present invention is most applicable to a horizontal cell adapted for the electrolytic decomposition of inorganic compounds at highly elevated temperatures. Such inorganic compounds comprising the electrolyte employed in the electrolysis process generally comprise fused halides of alkali metals, e.g., sodium chloride, potassium chloride and lithium chloride as well as the

halides of alkaline earth metals, etc., e.g., calcium chloride, etc.

Such a horizontal cell to which the improved cell cover of the present invention is most applicably adapted generally comprises as shown in FIG. 2 a substantially horizontal bottom surface, side walls, anodes in space relationship to and disposed above the bottom and means separately electrically connected to the anodes from the cell cover and to the bottom of the electrolytic cell adapted to pass electric current from the anodes to the bottom through a flowable molten metal cathode, generally molten lead. In such an electrolytic cell the molten inorganic compound, e.g., electrolyte floats on the cathode in contact with the anodes. Generally in such electrolytic cells the cell bottom has a slight slope so as to permit the molten metal cathode, e.g., lead, to flow across the bottom from one end of the cell to the other.

As noted previously, such an electrolytic cell is shown in a recently issued patent to Szechtman, U.S. Pat. 3,235,479. In accordance with such patent, however, the cell cover is prepared from a material which conducts electricity, e.g., graphite. The structure illustrated in that patent, however, has been greatly improved in accordance with the present invention by providing a cell cover which comprises in combination a metal shell capable of conducting electricity and a relatively thick underlayer of a refractory material having a relatively low coefficient of thermal conductivity and allowing direct contact of the anodes with the metal shell through anode stems and bushings, e.g., preferably nickel bushings.

Thus, while the present invention has been described in respect to the foregoing exemplification as embodied by FIGS. 1 and 2, it is to be understood that the present invention is in no way to be limited thereto but must be construed as broadly as are any equivalents thereof.

I claim:

1. In a horizontal electrolytic cell adapted for electrolytic decomposition of inorganic salt electrolytes at high temperatures comprising a substantially horizontal bottom surface, side walls, current-carrying cover, anodes in spaced relationships and connected to said cover to receive electric current therefrom, said bottom surface being adapted to support said inorganic salt electrolyte floating on a molten metal cathode, said electrolyte being in contact with said anodes so that electric current passes through said electrolyte to said cathode, the improvement which comprises a cover comprising a metal shell capable of carrying an electric current and a relatively thick refractory underlayer thereof, said refractory underlayer comprising a substantial portion of the underside of said metal shell but allowing electrical contact between said metal shell and anodes, said refractory being characterized by a relatively low coefficient of heat transfer.

2. The horizontal electrolytic cell of claim 1 wherein said refractory underlays from about 60–90% of said metal shell.

3. The horizontal electrolytic cell of claim 1 wherein anchorages provide mechanical adhesive between said metal shell and refractory underlayer.

4. The horizontal electrolyte cell of claim 1 where said refractory underlayer comprises predominantly alumina.

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