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ELECTROLYZER FOR PRODUCTION OF MAGNESIUM

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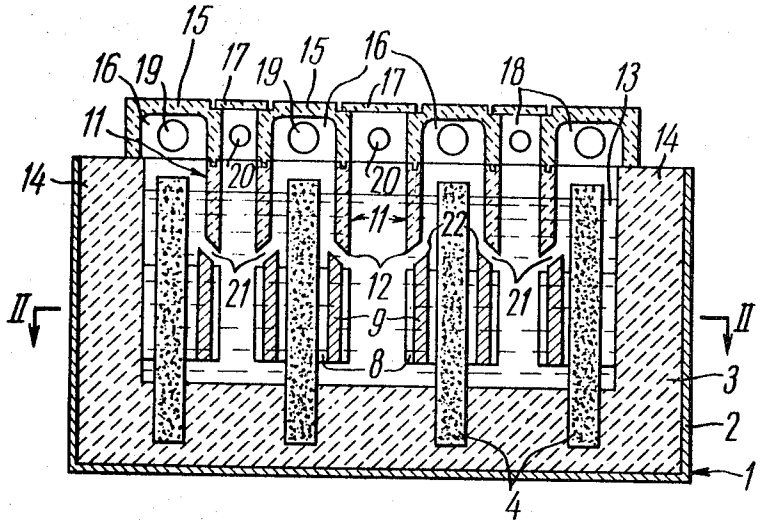


FIG. 1

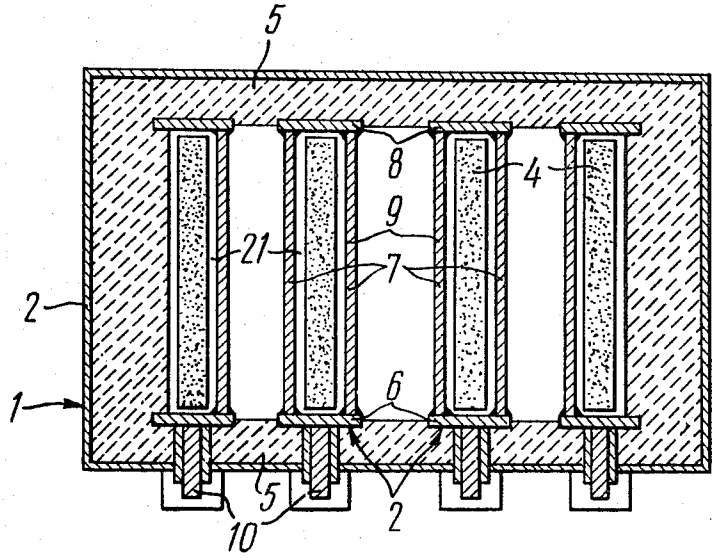


FIG. 2

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ELECTROLYZER FOR PRODUCTION OF MAGNESIUM

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ABSTRACT OF THE DISCLOSURE

The present invention relates to electrolyzers for production of magnesium, having cathodes completely immersed in the electrolyte bath. In accordance with the invention, each of the cathodes, with the exception of the outermost two, encloses the associated anode thereinside, the internal surface of the cathode being congruent with the surface of the anode. With the cathodes constructed in this manner, the yield of electrolyte per unit of the surface of the electrolyzer is increased by 10 to 12 percent, and even higher.

The present invention relates to electrolyzers for production of magnesium.

There is commonly known an electrolyzer for production of magnesium, comprising a bath having its walls lined from inside with a refractory material. Graphite anodes are partially embedded in the bottom portion of said bath and thus are mounted therein, whereas steel cathodes are mounted in a cantilever fashion on the side walls of the bath and are disposed in pairs at both sides of each anode, with the exception of the two outermost anodes which are associated each with a single cathode mounted adjacent to one side thereof. The cathodes and the anodes are completely immersed in the electrolyte.

Mounted at the top of the bath, above each one of the cathodes, is a partition immersed in the electrolyte to at least 100 mm. to 150 mm. of its vertical extent, the partition separating the cell for accumulation of chlorine from that for accumulation of magnesium. The bath is closed from above with lids sealingly engaging one another. The lids have openings made therethrough for withdrawal of the gases with the help of a suction pump. The lower edge of each of the partitions is curvilinear while the upper edge thereof is flat, parallel to the bottom of the bath.

Practical operation of electrolyzers of this known type involves certain difficulties, one of them being the fact that only those surfaces of each anode are engaged in the process, which are facing the adjacent cathode. Thus, non-operating portions of the surface of each anode amount to 10 to 12 percent of the total surface thereof. Consequently, the size of the electrolyzer becomes greater than it could have been if the entire surface of the anodes had been utilized.

In addition, in the areas where the cathodes contact the refractory lining of the bath, silicon oxide contained in the lining enters into a chemical reaction with the magnesium extracted from the electrolyte at the surface of the lining. The reaction yields magnesium silicides which adhere to the lining but poorly, whereby the magnesium silicides are apt to leave the lining for the electrolyte; as a result the lining in these areas is gradually destroyed.

The elevated temperatures of the process of electrolysis brings about deformation of the cathodes that are secured, as it has been stated, in a cantilever fashion. Thus, the spacing between the cathodes and the respective anodes is apt to vary in the course of the service life of the electrolyzer, which fact impedes normal operation of the electrolyzer; in some cases this deformation results in a cathode contacting the adjacent anode, which means a breakdown.

Also, the shape of the adjacent edges of a partition and of the respective one of the cathodes does not provide for sufficient hydraulic resistance to the flow of the electrolyte containing the bubbles of gaseous chlorine and trying to find its way from the respective anode into the space between the cathodes, i.e. into the cell where magnesium is accumulated. Consequently, it becomes necessary to install additional equipment for neutralization of the chlorine carried by the gases withdrawn from the magnesium accumulation cells.

It is an object of the present invention to eliminate these difficulties.

It is the main object of the present invention to improve the structure of the cathodes of an electrolyzer, to increase the active surface of the cathodes and to ensure a greater stability of the position of the cathodes relative to the respective anodes.

This object is accomplished in an electrolyzer for production of magnesium, wherein each of the cathodes, at least with the exception of the two outermost cathodes, includes an annular member enclosing thereinside the respective anode, the internal surface of said cathode being congruent to the surface of said anode.

With this novel structure of the cathodes, the active surface of each of the cathodes is increased, which provides for an increased active surface of the associated anodes. The rigidity of the cathode is increased, too, and, consequently, its position relative to the respective anode becomes more stable. Moreover, the area of the lining which is destroyed on account of magnesium being produced at the surface of the lining is substantially reduced, because with the novel structure of the cathodes it is at the cathodes where the maximal amount of magnesium is produced and not at the surface of the refractory lining.

In accordance with the present invention, it is further preferred, in order to prevent access of chlorine into the magnesium accumulation cells of the electrolyzer, for the upper edge of each cathode of such electrolyzer and the lower edge of the adjacent one of the partitions, facing each other, to be parallel to each other and to have their respective planes extending at an angle to the longitudinal axis of the respective anode, the apex of this angle being at a point disposed above these edges. In this case the hydraulic resistance of the gap formed between these adjacent edges of the cathode and of the partition is substantially increased. The flow of chlorine gas bubbles together with magnesium, which ascends along the surface of the anode, maintains its upward direction, when it passes such gap. After the chlorine has flowed out at the top surface of the electrolyte in the chlorine accumulation cell, the descending flow of the electrolyte with magnesium finds its way into the gap the shape of which promotes passage of this descending flow into the respective magnesium accumulation cell.

Therefore, the amount of chlorine passing into the magnesium accumulation cells is reduced to about one-tenth, as compared with the commonly known electrolyzers, and the yield of magnesium is correspondingly increased.

The hydraulic flow resistance of said gap can be increased still further, if the lowermost point of the lower edge of the partition and the topmost point of the adjacent upper edge of the cathode are disposed substantially at the same vertical level.

In order to prevent positively the possibility of a cathode contacting the adjacent anode, it is further preferred for each cathode to have the opposite ends thereof supported by the respective opposite walls of the refractory lining defining the bath with the electrolyte.

A considerable advantage offered by an electrolyzer constructed in accordance with the present invention, over the previously known electrolyzers is that a new electrolyzer of the same size as the previously known one yields 10 to 12 percent more magnesium per unit of the electrolyte surface, and even more.

Given hereinbelow is a detailed description of an electrolyzer constructed in accordance with a preferred embodiment of the present invention, with reference being had to the accompanying drawings, wherein:

FIG. 1 is a schematic longitudinal sectional view of an electrolyzer, constructed in accordance with the present invention; and

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

Referring now in particular to the appended drawings, an electrolyzer for production of magnesium comprises an electrolysis bath **1** (FIG. 1) having a casing **2** lined from inside with a refractory material **3**.

Embedded by their bottom portions into the bottom of the bath **1** are anodes **4** made of graphite, the anodes **4** being rectangular in cross section. The length of each anode is such that the upper portion thereof projects by about 100 to 150 mm. above the working level of the electrolyte in the bath **1**. Mounted intermediate of the vertical limits of each of the two longitudinal walls **5** (FIG. 2) of the bath **1**, nearer to the bottom thereof, are the end portions of steel cathodes **6**, each said cathode, except the outermost two, being shaped as an annulus **7** enclosing thereinside the respective one of the anodes **4**, the internal surface of each said cathode **6** being congruent with the external surface of the respective anode **4**. Each cathode **6** is a welded structure including a pair of opposing short rectangular plates **8** and a pair of opposing elongated rectangular plates **9**. Welded to the structure of each one of the cathodes **6** is one end of the respective plate **10** serving as current supply conduits, the plates **10** having their respective free ends projecting beyond the confines of the bath **1**.

Each one of the two outermost cathodes **6** includes a pair of opposing short plates **8** and a single elongated plate **9**, welded together so that the elongated plate **9** is facing the adjacent one of the innermost cathodes **6**.

Mounted in the upper portion of the bath **1**, immediately above each one of the elongated plates **9** of the cathodes **6**, are respective partitions **11** (FIG. 1) made of a refractory material. The vertical extent and arrangement of the partitions **11** are such that the lowermost edges **12** of the partitions **11** are immersed into the electrolyte **13** by no less than 100 to 150 mm. beneath the working level thereof. Disposed above each pair of the adjacent ones of the partitions **11** and above each outermost partition **11** and the adjacent lateral wall **14** of the bath **1** are the respective box-like structures **15** of a refractory material, these box-like structures engaging by the base portions thereof the top edges of the partitions **11** and of the lateral walls **14** of the bath **1** and forming therewith the respective cells **16** for collection of chlorine. Supported between the adjacent pairs of the box-like structures **15** are removable lids **17** also made of a refractory material, these lids **17** closing from above the respective cells **18** for collection of magnesium. Each box-like structure **15** has an opening **19** therethrough for connection of the respective cell **16** with an apparatus (not shown) adapted to withdraw the chlorine accumulating in the cell **16** and to supply this chlorine to any suitable utilization or dispensing apparatus. Each cell **18** for collection of magnesium has an opening **20** in one of its external walls, through which opening the cell **18** communicates with an apparatus (not shown in the drawings) adapted to withdraw the gases accumulating in this cell and to supply them into an apparatus (not shown) for neutralization of these gases.

The herein described electrolyzer has its electrolysis bath **1** filled with the electrolyte **13** containing molten chlorides of alkaline and alkaline earth metals.

In operation of the herein described electrolyzer, when direct electric current flows through the electrolyte **13**, chlorine gas is produced across the entire longitudinal and lateral surfaces of the anodes **4**, whereas magnesium is produced across the entire internal, i.e. facing the respective anodes **4**, surfaces of the cathodes **6**. In this manner the entire vertical extent of each anode **4**, immersed in the electrolyte **13**, is utilized in the operation. Chlorine in the form of gas bubbles rises along the surfaces of each one of the anodes **4**, dragging therealong portions of electrolyte and magnesium produced at each one of the cathodes **6**. When the chlorine gas bubbles reach the upper level of the electrolyte **13**, they accumulate in the respective cells **16** from which the gas is removed through the respective openings **19**, as has been already mentioned. The electrolyte, now relieved from the chlorine gas bubbles and retaining the magnesium, flows downwardly through gaps **21** into the areas of the cells **18** for accumulation of magnesium. The partitions **11** which are, as has been explained, immersed by their bottom portions into the electrolyte **13**, prevent mixing of the two products of the electrolysis, i.e. of chlorine and magnesium.

Magnesium accumulates on the surface of the electrolyte in each one of the cells **18**, the specific gravity of magnesium being less than that of the electrolyte.

A relatively small amount of chlorine that has not separated itself from the electrolyte in the chlorine accumulation cells **16** is taken along by the downward stream of the electrolyte and thus finds its way into the magnesium accumulation cells **18**, where the chlorine rises off the surface of the electrolyte **13** and is removed through the openings **20** together with the air that has got into these cells **18**.

The cathodes **6** and the partitions **11** of the herein described electrolyzer are so arranged that the upper edge **22** of the elongated plate **9** of each one of the cathodes **6** and the adjacent lower edge of the partition **11** are facing each other, are parallel to each other and have their respective planes extending at an acute angle to the vertical axis of the adjacent anode **4**, the apex of this angle lying above the gap **21** formed between the two edges. Moreover, the lowermost point of the edge **12** of the partition **11** and the topmost point of the upper edge **22** of the elongated plate **9** of the cathode **6** adjacent thereto are disposed approximately at the same vertical level. Thus, the gap **21** formed between the adjacent edges, i.e. the edge **12** of the partition **11** and the edge **22** of the plate **9** of the cathode **6** features relatively high hydraulic flow resistance, whereby the access of the electrolyte saturated with the chlorine gas bubbles, rising along the surface of the anode **4**, into the respective magnesium accumulation cell **18**, is substantially prevented. It is only after the chlorine has flowed out on the surface of the electrolyte **13** within the chlorine accumulation cell **16**, that the electrolyte is able to flow down through the gap **21** into the respective magnesium accumulation cell **18**. As it has been mentioned, a minimal amount of chlorine flows out from the electrolyte **13** in the magnesium accumulation cell **18**, this being the amount that has not managed to exude on the surface of the electrolyte **13** in the chlorine accumulation cell **16**, but the amount is so small that the cost of its neutralization is minimal.

The amount of magnesium extracted from the electrolyte at the surface of the refractory material is substantially reduced, as compared with the above-specified known apparatus, on account of a comparatively great amount of magnesium being extracted at the respective surfaces of the short plates **8** of the cathodes **6** (FIG. 2). Consequently, destruction of the refractory material in the zones **23**, where the cathodes **6** enter the body of the electrolyte, on account of reaction between magnesium and silicon oxide, is considerably reduced.

In the course of operation the cathodes **6** which are shaped as annular members **7** and supported between the opposite walls **5** of the lining **5** do not undergo deformation, and thus throughout the operation of the electrolyzer the spacing between the adjacent surfaces of the cathodes **6** and the anodes **4** is maintained substantially constant, whereby the parameters of the process of electrolysis become more stable than is the case with the previously known electrolyzers.

Although in the hereinabove described embodiment of the present invention the anodes **4** are embedded in the bottom of the bath **1**, the anodes may, alternatively, be introduced into the bath from above, through openings provided for the purpose in the top walls of the box-like structures **15**.

What is claimed is:

1. An electrolyzer for the production of magnesium comprising a vessel, a plurality of anodes attached to the interior portion of said vessel, a plurality of cathodes attached to the interior portion of said vessel, each cathode with the exception of the two outermost cathodes being in the form of a closed loop encompassing the respective

anode, the inner surface of each of said cathodes being congruent to the surface of the respective anode, a plurality of partitions being disposed between said cathodes and said anodes to prevent the mixing of the products of electrolysis.

2. An electrolyzer for the production of magnesium according to claim **1**, wherein the top edge of each said cathode and the bottom edge of each adjacent one of said partitions are facing each other, are parallel to each other and have their respective planes disposed at an acute angle to the longitudinal axis of the adjacent one of said anodes, the apex of said angle being directed upwards.

3. An electrolyzer for the production of magnesium according to claim **2**, wherein the lower edge of said partition and the topmost point of the upper edge of the adjacent cathode are disposed substantially at the same vertical level.

4. An electrolyzer for the production of magnesium according to claim **1**, wherein each said cathode has its opposite end portions secured in the opposite walls of said vessel.

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