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(54) **COVER FOR AN ELECTROLYSIS CELL FOR PRODUCING ALUMINIUM**

(57) The invention relates to non-ferrous metallurgy, more particularly to producing aluminium by electrolysis, and even more particularly to a structural element for covering the space above a melt in an electrolysis cell for producing aluminium by the electrolysis of cryolite-alumina melts. In a cover for an electrolysis cell for producing aluminium, which is in contact with a vapour-gas phase when the electrolysis cell is in operation and which is in the form of central and peripheral sections which are movably arranged relative to each other, the central and peripheral sections are made from a corrosion-resistant and erosion-resistant material which comprises 80.0-99.0 wt% of fluorophlogopite and 20.0-1.0 wt% of a refractory filler. The central sections of the cover may be permanently fixed on each anode rod, and the peripheral sections may be configured as convex panels rigidly and removably fixed on the top surface of a cathode and supported by the central section of the cover. Moreover, the refractory filler may be chosen from the following chemical substances: clay, calcium fluoride, rutile, sodium aluminosilicate, fluorapophyllite, nepheline, olivine, magnesium fluoride, and spinel. The end and side joints of the central and peripheral covers may be coated with a sealant layer in the form of a layer of alumina, and the central section of the cover may be provided with

apertures. The use of this invention provides for the hermetic sealing of the cover, the reliability and safety of the structure, and a reduction in energy consumption.

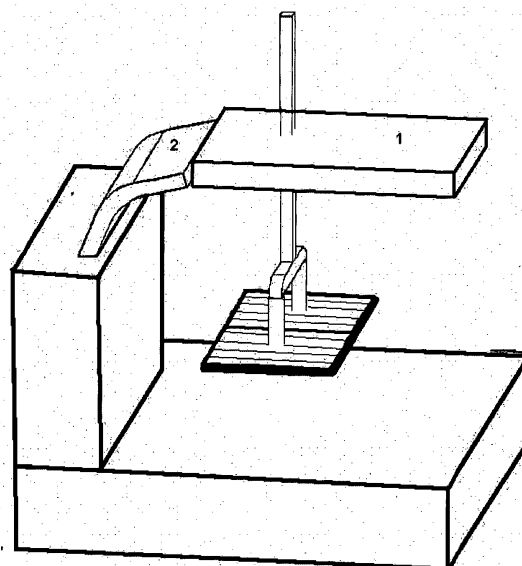


Fig. 1

Description

[0001] The invention relates to non-ferrous metallurgy, more particularly to producing aluminium by electrolysis, and even more particularly to a structural element for covering the space above a melt in an electrolysis cell for producing aluminium by the electrolysis of cryolite-alumina melts.

[0002] The most important factor defining electrolysis cell performance is the hermetic sealing of a cover above a melt. The hermetic sealing of the electrolysis cell cover is directly associated with aluminium production costs because of its impact on heat and energy balance, raw material consumption and environment.

[0003] The primary electrolysis cell cover has following main purposes:

- 1) It provides heat balance,
- 2) It minimizes gaseous emissions,
- 3) It stabilizes operating modes,
- 4) It minimizes raw material losses.

[0004] The surface area of a cryolite-alumina crust for covering the operating space of electrolysis cell having inert anodes is three times more than that of a standard bath. The cryolite-alumina crust cannot hermetically seal the electrolysis cell across such big surface area because of strength, porous structure, occurring chemical reactions and instability of the surface integrity.

[0005] Taking into account mentioned above factors, it is required to hermetically seal an electrolysis cell having inert anodes using a primary cover made of a material which is resistant to a corrosive atmosphere and gaseous fluorine-containing compounds, melt droplets and mechanical loads. Such cover should ensure lower gas permeability, integrity, heat insulation, and strength. A cover material and a schematic diagram of cover fixturing should be applicable to all types of electrolysis cells.

[0006] US Patent 5582695, IPC C04B 7/32, C04B 14/04, C04B 14/02, C04B 14/30 published on 10.12.1996 is known. The invention relates to structural elements of aluminium electrolysis cells contacting a gaseous phase, in particular, it relates to covers and anode casings. The aim of this patent is, as disclosed in the specification, to address the problem of hermetic sealing of the space between side boards and anodes of an electrolysis cell having a self-baking anode, in particular it is related to the replacement of a current cryolite-alumina cover consisting of a cast-iron (steel) gas-collecting bell and a cryolite-alumina crust with an "artificial" cover. The suggested «artificial» cover is made as one piece or as a combined piece made of the refractory concrete having following composition: 15-30 wt% of hydraulic concrete, 5-10 wt% of microsilica, 65-80 wt% of alumina.

[0007] This solution has the following main drawback:

According to this patent, during operation the cover material contacts with the electrolysis cell gas-vapour phase comprising not only fluorine and sulphur-containing compounds. The cover material of the electrolysis cell has to be corrosion resistant to the electrolysis cell gas-vapour phase containing fluorine and sulfur compounds in the presence of oxidants CO, CO₂, O₂, HF, which will enable the usage of the cover for electrolysis cells having a Soderberg anode and backed and inert anodes. The suggested material is not totally inert, and during operation, due to material porosity, this material is soaked with electrolyte vapors. When concrete is soaked, crystal and concrete bounds are destructed resulting in product destruction.

[0008] In addition, a method for structural electrolysis cell cover from US Patent No 2006124471 A1, IPC C25C3/14 published on 15.06.2006 is known. The invention relates to structural elements of a cover and a supply system of aluminium electrolysis cells, in particular to the creation of a sealing cover above electrolyte of the aluminium electrolysis cell at low-temperature operation. One of the conditions of the manufacturing technology is the creation of a gel-like layer on the electrolyte surface, which is provided by electrolyte surface isolation with an «artificial» cover structure of enhanced heat insulation properties. The electrolysis cell cover consists of a central section arranged in a central space between anodes along the entire length of a bath. The central section of the cover is secured to a gas pipe beam and is fixed against movement, can comprise several sections, the cover movement is not envisaged. Lateral sections of electrolysis cell cover are movable, can be provided in the form of several lateral sections, which are movable independently from each other and from the central cover. The electrolysis cell cover is made from a ceramic material (e.g., alumina).

[0009] This solution has the following main drawback:

The central section of the cover is not adapted for changing its own position, and a disassembling method can be performed only with changing operating position of anodes. Further, alumina suppliers are required to be disassembled prior to disassembling the central section.

[0010] Another significant drawback is a cover material:

- ceramics - can be damaged when subjected to temperature difference and mechanical damages.

[0011] US Patent No 2005230265, IPC C25C3/08, B01D59/40, B01D59/00, C25C3/00, C25C5/04, C25C7/00 published on 20.10.2005 is known. This invention relates to structural elements of aluminium electrolysis cells contacting a vapour-gas phase of an electrolysis cell, in particular to a cover structure of the upper part of electrolysis cells having backed or inert anodes.

The aim of this patent is to eliminate heat losses of an electrolysis cell, namely, to reduce heat transfer from a cover to an environment, to reduce heat consumption for dissolution of the cover fallen into a melt, to reduce heat losses by means of heat balance stabilization and maintaining the operation space shape. In this patent, as well as in the previously described solution, an artificial cover for an electrolyte melt is made in the form of sections movable separately.

[0012] Because of its technical specs and the number of similar essential features, the known technical solution is selected as the closest analog (prototype).

[0013] According to the prototype solution, sections of an "artificial" cover above an electrolyte melt are made in the form suspended structures. Based on their location, covers are peripheral and central. Peripheral cover sections are made in the form of suspended elements movable separately from each other, from the cover central section and from anodes. A cover section for the electrolysis cell central space is made in the form of the one-piece element or in the form of several sections. The central cover is extended along the entire length of the electrolysis cell; cover sections are fixed by means of suspended fasteners and are movable with respect to the melt separately from anodes. The central cover structure is provided with operational doors and apertures, thus, allowing for production operations, bath feeding with raw material, and work with an anode assembly. The peripheral and central covers are made so that cover lifting and replacement can be done in compliance with the anode horizontal arrangement, in other words, actions with the cover wouldn't impact the stability of the current load. Materials resistant to oxygen and fluoride, e.g., ceramics or composite materials of a casing based on the nickel-titanium alloys and a heat insulator are suggested for use as the cover material.

[0014] This solution has the following main drawback:

This «artificial» cover has the same structure and cannot be considered as versatile for usage in electrolysis cells having backed anodes and a Soderberg anode.

[0015] The central cover is secured in the way that makes the cover movable independently from anodes; it inhibits replacement of a failed cover without affecting anodes and stability of electrolysis cell operation. Taking into account the cover section material, the need for periodic replacement of cover section arises. Another significant drawback is a cover material:

- ceramics - can be damaged when subjected to temperature difference and mechanical damages,
- composite material - is subjected to oxidation under the fluorine-oxygen atmosphere.

[0016] The object of the invention is to provide a multifunctional sectional «artificial» cover above electrolyte

melt in electrolysis cells having an inert, backed anode and a Soderberg anode, which shows corrosion and erosion resistance to an aggressive vapour-gas environment of electrolysis cells.

[0017] The technical effect of the present invention is to provide a hermetically sealed cover, a reliable and safe structure, and a reduction in energy consumption.

[0018] Such technical result is achieved by that in a cover for an electrolysis cell for producing aluminium, which is in contact with a vapour-gas phase when the electrolysis cell is in operation and which is in the form of central and peripheral sections which are movably arranged relative to each other, the central and peripheral sections are made of a corrosion and erosion-resistant material which comprises 80.0-99.0 wt% of fluorophlogopite and 20.0-1.0 wt% of a refractory filler.

[0019] The central sections of the cover may be permanently fixed on each anode rod, and the peripheral sections may be configured as convex panels rigidly and removably fixed on the top surface of a cathode and supported by the central section of the cover. Moreover, the refractory filler may be chosen from the following chemical substances: clay, calcium fluoride, rutile, sodium aluminosilicate, fluorapophyllite, nepheline, olivine, magnesium fluoride, and spinel.

[0020] The end and side joints of the central and peripheral covers may be coated with a sealant layer in the form of a layer of alumina, and the central section of the cover may be provided with apertures.

[0021] The subject matter of the present invention is as follows:

a cover is manufactured in the form of large-sized products in the form of plates (Fig.1). The cover is arranged above the top surface of the anode so that it doesn't contact with the electrolyte melt and consists of sections. One complete cover section consists of a central section 1 and a peripheral section 2. The central section 1 of the cover is directly fixed on an anode rod by means of protrusions, wherein the distance from the cover surface to the electrolyte melt is selected based on the electrolysis cell type and specifications. This selected distance makes allowance for the likelihood of brief exposure to electrolyte run-ups onto the cover working surface when changing anode-to-cathode distance in the electrolysis cell. Cover central sections are provided with apertures for alumina dispensers arranged in accordance with an electrolysis cell feeding scheme. The peripheral section 2 of the cover is mounted so that one of its sides is supported by the cover central section, and another side is supported by the top surface of the cathode (such as a flange, an edge, a lining). The width of the peripheral section is equal to that of the central section and is a parabola in shape, thus enabling quick cover removal from the bath for technological operations to be performed. In this way, central and peripheral sections of the

cover define a cover section for one anode on the blank or front side, and the number of cover sections corresponds to the number of anodes. Each cover section is movable together with the anode and can change own position separately from neighbor cover sections and neighbor anodes. The electrolysis cell cover permanently contacts the gas-air environment of the electrolysis cell and periodically contacts the electrolyte melt, that is why the cover is manufactured of the corrosion and erosion resistant material, proof to the aggressive vapour-gas environment of electrolysis cells having backed, self-baking, or inert anodes. The used cover material is not soaked and wetted with the cryolite-alumina melt. For cover manufacturing, fluorophlogopite or alumina slurries can be used. Independent movement of the cover allows for hermetic sealing of the operation space of the electrolysis cell having inert anodes and makes technological operations simple and mobile. Any cover section can be disassembled independently from the others and replaced with a new part.

[0022] One of the factors of variance for a fluorophlogopite cover is a chemical composition of an agglomerate in terms of the main component $KMg_3(Si_3Al)O_{10}F_2^*$, because the change of material chemical purity results in the change of physical and chemical properties of the material, and consequently, its mechanical strength, heat conductivity, and corrosion and erosion resistance. When fluorophlogopite is used as the cover material, it is required to use the material containing the main component, fluorophlogopite, in the range of 80-99%, which will allow flexible usage of materials for different types of electrolysis cells. In addition to hermetic sealing, heat insulation of the operation space above a melt in an electrolysis cell, fluorophlogopite ensures melt and aluminium purity. Operational apertures in the central section of the cover allow using the cover for electrolysis cell feeding, cover installation and disassembling, and maintenance operations. To seal the joints of cover sections alumina is used, which is chemically similar to the fluorophlogopite material. Operational through-apertures in the ends of the cover central section in the electrolysis cell center provide removal of the gas-air mixture from the electrolysis cell to a gas removal system.

[0023] The procedure for preparation of the electrolysis cell having the claimed cover includes following steps:

Central and peripheral cover sections are produced from the machined blanks. Then, appropriate apertures are made in the produced sections according to location and position markings in the electrolysis cell. Next, these cover sections are placed on anodes mounted or being mounted in the following sequence: at first, the central section and then the peripheral section. The cover made of fluorophlogopite can be placed in an active electrolysis cell because

this material is resistant to thermal shocks.

[0024] The electrolysis cell cover according to the suggested solution features improved reliability, provided by not only the corrosion and erosion resistance of a cover material but also by an independent structural feature of the sectional cover allowing access to any part of the electrolysis cell in a short time without significant intervention in the process. In addition, thermal expansion of the cover material is prevented due to the material properties, allowing free movement of the cover along adjacent covers.

[0025] The ease of the suggested cover manufacture process is ensured by the processability of the inventive cover material (fluorophlogopite) and the simplicity of a fastening system on an anode rod allowing for section functionality ensured by means of the product strength and the shape of fastening surface and by supporting the central cover.

[0026] Recently conducted long-term laboratory and pilot-scale tests of the claimed fluorophlogopite cover according to the suggested technical solution have shown its functional ability and efficiency.

Claims

1. A cover for an electrolysis cell for producing aluminium, which is in contact with a vapour-gas phase when the electrolysis cell is in operation and which is in the form of central and peripheral sections which are movably arranged relative to each other, **characterized in that** the central and peripheral sections are made from a corrosion-resistant and erosion-resistant material which comprises 80.0-99.0 wt% of fluorophlogopite and 20.0-1.0 wt% of a refractory filler.
2. The cover according to claim 1, **characterized in that** central sections of the cover are permanently fixed on each anode rod.
3. The cover according to claim 1, **characterized in that** peripheral sections are configured as convex panels rigidly and removably fixed on the top surface of a cathode and supported by the central section of the cover.
4. The cover according to claim 1, **characterized in that** the refractory filler may be chosen from the following chemical substances: clay, calcium fluoride, rutile, sodium aluminosilicate, fluorapophyllite, nepheline, olivine, magnesium fluoride, and spinel.
5. The cover according to claim 1, **characterized in that** the end and side joints of the central and peripheral covers are coated with a sealant layer in the form of a layer of alumina.

6. The cover according to claim 1, **characterized in that** the central section of the cover is provided with apertures.

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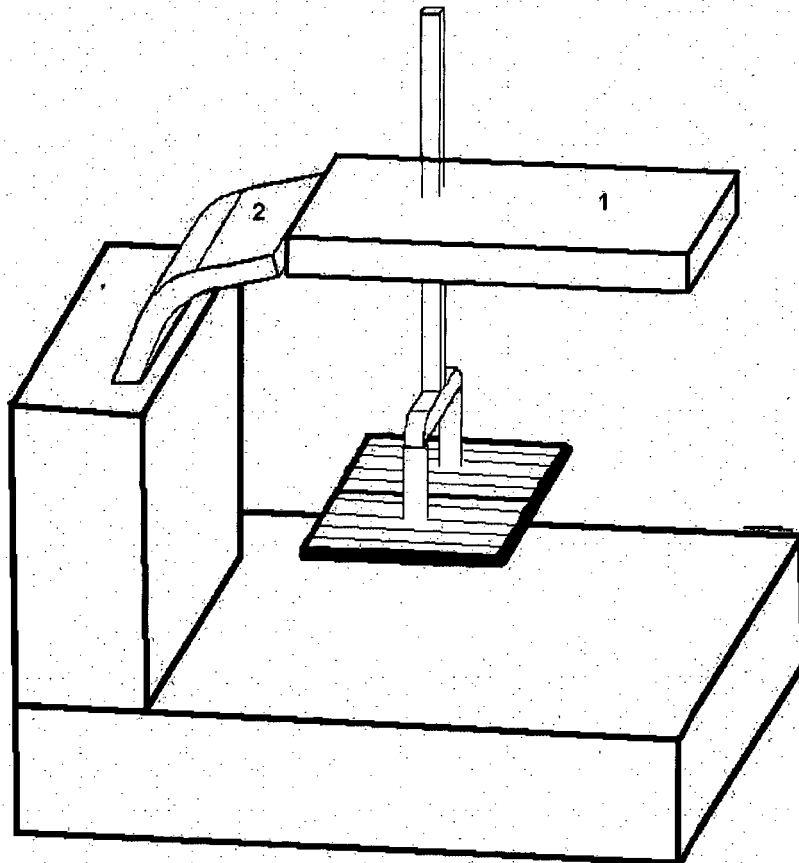


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2015/000716

A. CLASSIFICATION OF SUBJECT MATTER

C25C 3/10 (2006.01) C25C3/22 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25C 3/06-3/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, D	US 2005/0230265 AI (VITTORIO DE NORA et al) 20.10.2005	1-6
A, D	US 2006/0124471 AI (NGUYEN THINH T, DE NORA VITTORIO) 15.06.2006	1-6
A, D	US 5582695 A (ELKEM ALUMINIUM ANS) 10.12.1996	1-6
A	RU 2361017 C2 (ZAKRYTOE AKTSIONERNOE OBSHCHESTVO "UNIKHIMTEK") 10.07.2009	1-6
A	RU 2375504 C2 (OBSHCHESTVO S OGRANICHENNOI OTVETSTVENNOSTIU "RUSSKAIYA INZHINIRINGOVAYA KOMPANIYA") 10.12.2009	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search

05 February 2016 (05.02.2016)

Date of mailing of the international search report

03 March 2016 (03.03.2016)

Name and mailing address of the ISA/

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Patent documents cited in the description

- US 5582695 A [0006]
- US 2006124471 A1 [0008]
- US 2005230265 A [0011]