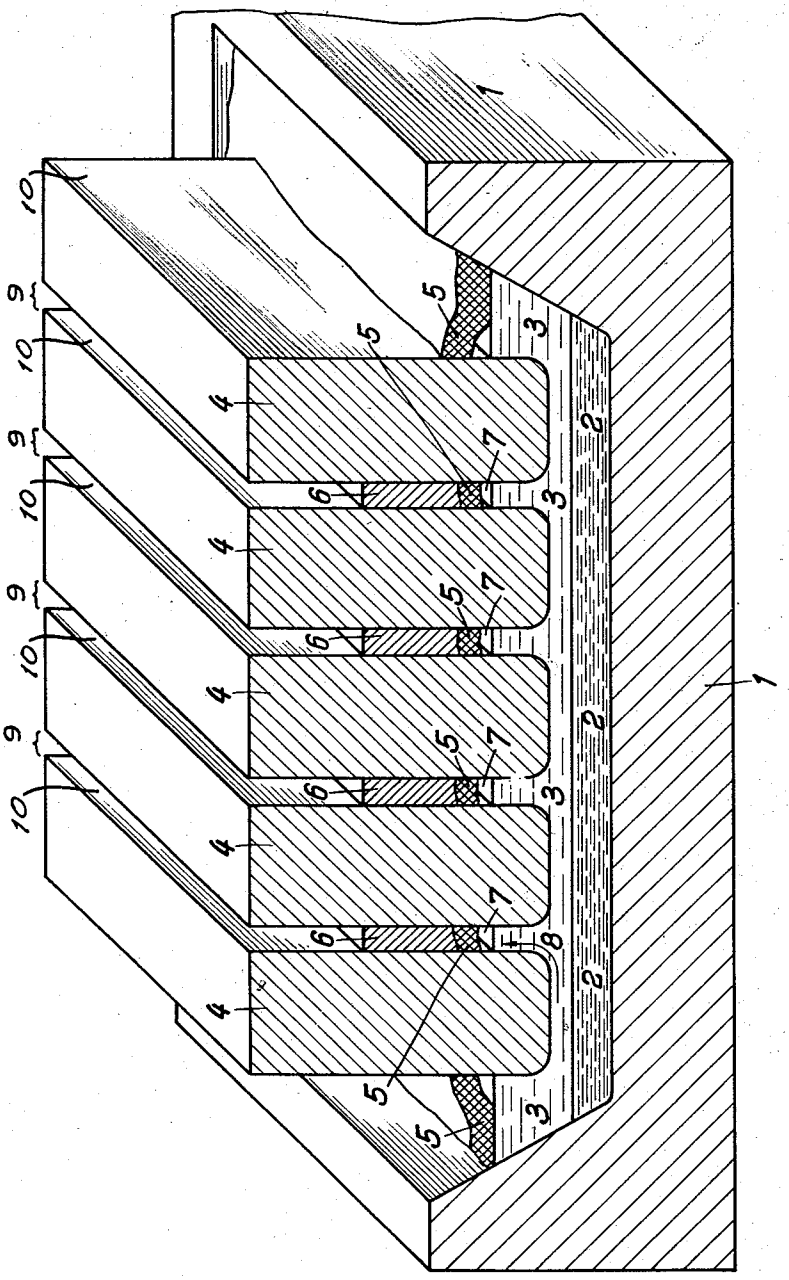
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ELECTROLYTIC CELL FOR PRODUCING ALUMINUM

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ELECTROLYTIC CELL FOR PRODUCING ALUMINUM

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The present invention relates to an electrolytic cell for producing aluminum, and more particularly to an electrolytic cell for producing aluminum of high purity.

Aluminum is technically produced by electrolysis of a molten mass, consisting of alumina and cryolite, at a temperature of about 1000° C. The cathode is formed by a tank-shaped, carbon lined container, in which liquid aluminum is separated and forms a layer on the bottom of the container. The liquid aluminum layer is formed underneath a molten mixture of alumina and cryolite. The anode consists of carbon blocks which are partially immersed into the molten mixture from above. The anode is continuously used up and has to be correspondingly replenished. The anode is used up by being oxidized by the oxygen formed thereon. The resulting carbon dioxide and carbon monoxide escape from the electrolytic cell. The alumina contained in the molten mixture must also be replenished from time to time since the same too is used up during the electrolytic process. Theoretically for each part by weight of aluminum which is produced at least 1.89 parts by weight of alumina and 0.33 part by weight of anode carbon are consumed. Practically, the figures of use of alumina and carbon are greater since losses occur for a variety of reasons. The use of anode carbon varies in actual operation between 0.50 and 0.80 part by weight. There is also a small loss of cryolite amounting to about 0.05 part by weight for each part by weight of aluminum produced. During the electrolytic process practically all impurities of the consumed materials are included in the produced aluminum. Consequently the electrolytic production of aluminum requires a high degree of purity of the starting materials. It has already been proposed to improve the purity of the starting materials by various chemical and physical means and to prevent the dissolution of metal from tools which come in contact with the molten mixture or the molten aluminum. Using all these known precautions a purity of 99.7% can be obtained in the electrolytic production of aluminum. The impurities consist mainly of iron, silicon and small quantities of a number of other metals.

In order to obtain aluminum of greater purity, a separate electrolytic refining process has to be added. Thereby it is possible to obtain aluminum of the highest purity such as 99.99%, however, the costs of producing aluminum of higher purity than 99.7% are very great. On the other hand, the technological importance of high purity aluminum is increasing rapidly. For many technical purposes aluminum of a purity of 99.8% or 99.9% can be used successfully while aluminum having a purity of only 99.7%, such as is obtained by the regular electrolytic process, cannot be used.

It is therefore an object of the present invention to provide an electrolytic cell in which aluminum of higher purity than 99.7% can be directly produced.

It is another object of the present invention to provide an electrolytic cell in which high purity aluminum can be produced in a simple and economical manner.

Other objects and advantages of the present invention will become apparent from a further reading of the description and the appended claims.

With the above objects in view, the present invention mainly comprises in an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte, and a series of carbon anodes of substantially rectangular cross-section and of substantially the same dimensions arranged in the container adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, the adjacent anodes being spaced from each other a maximum of 150 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as flue for rapid withdrawal of gases reaching the channels during operation of the cell.

The present invention also comprises in a method of electrolytically producing aluminum from aluminum-containing material, the steps of placing in a cathode container adapted to hold a molten mixture of aluminum producing electrolyte a series of elongated carbon anodes of substantially rectangular cross-section and of substantially the same dimensions in a row extending in one direction, adjacent and spaced from each other at a distance of between 15 and 150 millimeters, passing current between the anodes and the cathode thereby electrolytically producing aluminum from the molten mixture and forming between adjacent anodes spaced from the upper level of the molten mixture a frozen crust of the mixture of aluminum producing electrolyte, and tightly packing upwardly of the frozen crust in the space between adjacent carbon anodes at least one pulverulent substance belonging to the group consisting of cryolite, alumina and sodium carbonate, the packing contacting adjacent portions of adjacent anodes thereby preventing the access of air to and oxidation of the portions.

It has been found that the gases formed at the anodes and escaping from the electrolytic cell, which mainly comprise carbon monoxide and carbon dioxide also contain small varying quantities of iron and silicon as well as traces of titanium, chromium, vanadium and of other metals or metal compounds either in gaseuos state or in finely dispersed solid state in the form of smoke. The larger portion of these metals remains in the electrolytic cell and also finds its way into the molten aluminum.

Surprisingly, it has been found that a very considerable portion of these impurities can be removed from the cell and simultaneously prevented from contaminating the molten aluminum, by increasing the speed of flow of the gases escaping from the cell and by shortening the path of these gases within the cell, especially in contact with the molten mixture. It has also been found advantageous according to the present invention to maintain the pressure of these gases above atmospheric pressure while the same are escaping from the cell.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which the figure shows in cross-section a schematic view of an electrolytic cell according to the present invention.

Referring now to the drawing, reference numeral 1

denotes the carbon-clad container-shaped cathode, on the bottom of which a layer 2 of liquid aluminum has been formed. The trough-like interior of the cathode contains also floating on top of the liquid aluminum layer 2, the molten mixture 3 consisting of cryolite and alumina. The individual anodes 4 of substantially rectangular cross-section and elongated shaped are shown arranged in a row extending in one direction and with their lateral elongated faces 10 adjacent and spaced from each other. The anodes are so arranged that the distance 9 between adjacent faces of adjacent anodes is not greater than 150 millimeters. The length of the anodes is preferably kept between 1400 and 3000 millimeters and their width is preferably kept between 200 and 700 millimeters. During operation of the cell a frozen crust 5 is formed of the molten mixture of electrolyte material. Crust 5 is so located that an intervening space 7 is formed between the lower level of crust 5 and the upper level of the molten electrolyte mixture. Intervening space 7 is limited to a width of between 15 and 150 millimeters by portions of the lateral elongated faces 10 of adjacent electrodes 4. According to a preferred embodiment of the present invention, a packing 6 consisting of tightly packed or compressed pulverulent material, preferably having a particle size not exceeding 200μ, is arranged between the lateral elongated faces of adjacent anodes. It is the purpose of packing 6 to prevent oxidation of the portions of the lateral elongated faces of the carbon anodes which otherwise would be exposed to the oxidizing influence of the oxygen of the air. In view of the narrowness of the space between adjacent anodes, the heat emanating from the molten electrolyte mixture which is kept at a temperature of about 1000° C. dissipates very slowly, and consequently the carbon anodes and the surrounding air are of such high temperature that contact between the surface of the hot portions of the anodes and the air would result in considerable loss of carbon due to oxidation. Such oxidation losses are prevented by the packing 6 as will be explained in detail further below. Arrow 8 indicates the path of the gases formed on the portion of the anode which is submerged in the molten electrolyte mixture. This path which in accordance with the present invention is kept as short as possible, leads the gases to channel 7 through which the same escape from the electrolytic cell.

In the schematic showing of the electrolytic cell, electric bus bars, means for suspending the anodes and other conventional parts have been omitted. Five anodes 4 are shown in the schematic drawing, however, the actual number of anodes may differ from the number shown and, depending on the size of the cell, is preferably greater than five.

The distance between the carbon anodes and the cathode is preferably kept at between 300 and 600 millimeters, depending on the dimensions of the individual carbon anodes and the capacity of the entire cell. However, the present invention is not limited to any specific distance between anodes and cathode vessel.

In accordance with the present invention, the formation and passage of the impurities-containing carbon monoxide and carbon dioxide gases is favored, and the removal of gases and impurities from the cell is accomplished by keeping the speed of flow of these gases within the cell, and until the same leave the cell, as high as possible. This is accomplished by shortening the path of the gases within the cell and by keeping the gases under superatmospheric pressure until the same leave the cell. According to the present invention, and especially by keeping the dimensions of the carbon anodes and their distance from each other within the limits referred to above, the gases escaping from the cell are kept under superatmospheric pressure amounting to between 10 and 100 millimeters, preferably about 20 millimeters water pressure.

Thus, preferably the individual carbon anodes possess

a width of between 200 and 700 millimeters, a length of at least 1400 millimeters, and it is also preferred to keep the electric current charge of each individual anode below 10,000 amperes, preferably between 5000 and 8000 amperes. The width of the space 7 between adjacent anodes is not to exceed approximately 150 millimeters, and preferably is kept between 40 and 50 millimeters. Thereby, during operation of the cell, channels are formed between adjacent anodes limited by the upper level of the molten electrolyte 3 and the lower level of the crust 5 consisting of frozen electrolyte. This crust 5 is formed approximately 30 millimeters above the upper level of the molten electrolyte and has a thickness of about between 50 and 200 millimeters. Thus, the channels between adjacent carbon anodes through which the impurities such as metals and metal oxides-containing gases flow from the cell have a width of between 15 and 150 millimeters and a height of approximately 30 millimeters. These channels are gas-tight and in order to permit the gases to leave the channels and the cell, it is necessary to keep the channels open for instance by breaking the frozen crust near one or both front ends of the anodes. Through thus-formed holes in the frozen crust the gases then escape into the surrounding atmosphere. Accordingly, the path of the gases and impurities, in contact with the molten electrolyte is kept very short. As indicated in the drawing by arrow 8, the longest path of the gases prior to reaching the channels will be equal to half the width of the individual carbon anodes plus the depth to which the anodes are submerged in the molten electrolyte mixture. Customarily the anodes are submerged in the electrolyte mixture to a depth of about 250 millimeters. In accordance with the present invention, decomposition and deposition of the impurities contained in the reaction gases will not take place within the cell in any appreciable amount, due to the high speed and the superatmospheric pressure with which the gases leave the cell. In this connection it is important to note that in accordance with the present invention the mixing of the gases with air is prevented by pushing the gases out of the cell under superatmospheric pressure instead of sucking-off of the gases. The channels which are formed between adjacent carbon anodes and which are downwardly defined by the upper level of the molten electrolyte, are maintained in gas-tight condition throughout the operation of the cell, not withstanding the lowering of the anodes into the molten electrolyte mixture which slowly takes place corresponding to the consumption of the anode. The frozen crust of electrolyte which limits the channels in upward direction is kept at a distance of approximately 30 millimeters upwardly from the upper level of the molten electrolyte by the pressure of the gases passing through the channels.

By arranging a plurality of carbon anodes in close proximity from each other, so that in accordance with the present invention the distance between adjacent anodes is kept between about 15 and 150 millimeters, preferably between 40 and 50 millimeters, heat accumulates between adjacent anodes and the danger exists that the lateral portions of adjacent anodes facing each other and extending upwardly from the crust of frozen electrolyte will be severely attacked by the oxygen of the air flowing between adjacent electrodes. This would lead to great losses of anode material and consequently also to a considerable reduction in the cross-section of the anode portions which are eventually lowered into the molten electrolyte mixture. Thereby not only an uneconomical operation would result, but the current density within the anode would also be effected and eventually lead to conditions which would not permit successful operation of the cell. It is therefore important to prevent excessive oxidation of adjacent lateral faces of the anodes which extend upwardly from the frozen crust.

According to the present invention, oxidation of the lateral anode faces is prevented by arranging a packing between adjacent anodes on top of the frozen crust which

completely fills the space between and covers adjacent lateral anode faces, either up to the top of the anodes, or at least up to the height to which elevated temperature would cause excessive oxidation of the lateral anode faces.

The packing according to the present invention preferably consists of cryolite, alumina or sodium carbonate, or of a mixture of these substances. According to a preferred embodiment of the present invention, a mixture of 10 parts by weight cryolite, 10 parts by weight of alumina and 1 part by weight sodium carbonate is used. The individual particle size of the packing material is preferably kept below 200. The packing preferably extends upwardly from the upper level of the frozen crust for between 400 and 900 millimeters, most preferably for about 700 millimeters. The packing material has to be tightly packed between the adjacent lateral anode faces and on top of the frozen crust, for instance by pounding the same into the space between adjacent anodes while providing temporary or permanent frontal end walls limiting the space defined between adjacent anodes and preventing the loose packing material from escaping. Once the packing material has been tightly compressed in the space between adjacent anodes, the same will remain in place and will prevent contact between air and the lateral faces of adjacent anodes. Consequently, oxidation of adjacent anode faces and concomitant loss of anode material will be prevented. It is to be noted that the packing material consists of substances which also form at least part of the molten electrolyte mixture, so that the electrolyte mixture will not be contaminated by the packing material. The entire height of the anodes is preferably between 1000 and 1500 millimeters. To the extent that the anodes are lowered into the molten mass (and new anode portions are added on top of the anodes), the height of the packing will be reduced by melting and dropping into the molten electrolyte and it will become necessary to add packing material and to pound the same into tightly packed condition on top of the remaining layer of the packing.

According to a preferred embodiment of the electrolytic cell of the present invention, and of the method of operating the same, the cathode portion of the electrolytic cell consists of an iron tub which is covered on its inner surface with carbon stones. Between the carbon stones or bricks and the iron tub a heat-insulating layer of fireproof material is provided. Iron bus bars are inserted in the carbon cover and serve for leading off current. The liquid aluminum which is formed by the electrolytic process in the cell is collected on the bottom of the cell on top of the carbon cover. The molten electrolyte mixture, consisting of cryolite with alumina dissolved therein, floats because of its lesser specific gravity on top of the liquid aluminum layer. The anodes are immersed into the molten electrolyte to a depth of about 200 to 250 millimeters. In an oven of 70,000 ampere capacity, preferably 9 anodes of 1900 millimeter length, 630 millimeter width and consisting of baked carbon blocks of 500 millimeter height are arranged, spaced from each other at a distance of about 50 millimeters. Two or three carbon anode blocks each having a height of about 500 millimeters, are placed on top of each other so that the entire height of each anode is between 1000 and 1500 millimeters. From time to time, corresponding to the consumption of the anodes in the molten electrolyte mixture, and to the consequent reduction in height of the anodes, new anode blocks of about 500 millimeters height are placed on top of the remaining anode portions. The space between adjacent anodes on top of the frozen crust of electrolyte mixture is filled with a packing of alumina or preferably with a mixture of equal quantities of alumina and cryolite to which a small quantity, about 5% by weight of the entire mixture of sodium carbonate has been added. This packing material is then compressed into a solid mass which protects the adjacent

anode faces from contact with air. The current load of each anode is preferably between 6000 and 9000 amperes, most preferably at about 8000 amperes. The temperature of the gases in the cell is about 900° C. A 70,000 ampere cell as herein described produces within 24 hours about 500 kilograms of aluminum of a purity of 99.9%.

The consumption of anode carbon material is reduced according to the present invention by carefully pounding or compressing the packing material so that the individual particles, having a size of preferably less than 200μ, are compressed into a dense and solid packing. The reduction in the consumption of carbon anode material is thus directly related to the care taken in preparing the compressed packing. It is possible according to the present invention to reduce the consumption of anode carbon to between about 430 and 500 kilograms per thousand kilograms of aluminum produced. A low consumption of about 430 kilograms of carbon per thousand kilograms of aluminum produced is obtained when oxidation by air of the adjacent lateral faces of the carbon anodes is practically completely prevented.

Due to cooling off at the surface of the molten electrolyte mixture, a frozen crust is formed having a thickness of between 50 and 200 millimeters, and consisting of cryolite with about 5% alumina dissolved therein. This crust is pushed upwardly about 30 millimeters by the escaping gases. To the extent that holes permitting gas escape are not automatically formed in this crust, the same has to be crushed with a chisel or the like, preferably in the vicinity of the frontal ends of the anodes, in order to permit the gases to escape from the channels formed by the upper level of the molten electrolyte mixture, the lower level of the frozen electrolyte crust and portions of the lateral faces of adjacent anodes.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of electrolytic cells differing from the types described above.

While the invention has been illustrated and described as embodied in an electrolytic cell for producing aluminum, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptions should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; and a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions each having a capacity of 10,000 amperes, a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters, said carbon block being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other a maximum of 150 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell.

2. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions each having a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other; and means for supplying a current of between 5000 and 10,000 amperes to each of said baked carbon block anodes, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of between 15 millimeters and 150 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell.

3. In an electrolyte cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions each having a capacity of 10,000 amperes a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters, said carbon block being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of between 15 millimeters and 150 millimeters so that the channels defined between adjacent anodes by the upper level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell; and a packing essentially consisting of at least one tightly packed pulverulent substance belonging to the group consisting of cryolite, alumina and sodium carbonate located between the lateral elongated faces of adjacent anodes, said packing being spaced from the lower edges of said anodes and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

4. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions each having a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of between 15 millimeters and 150 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell; means for supplying a current of between 5000 and 8000 amperes to each of said baked carbon block anodes and a packing consisting of tightly packed material located between the lateral elongated faces of adjacent anodes, said packing being spaced from the upper and lower edges of said anodes and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

5. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions each having a capacity of 10,000 amperes, a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters, said carbon block anodes being arranged in said container adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of between 15 millimeters and 150 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during the operation of the cell; and a packing essentially consisting of at least one tightly packed pulverulent substance belonging to the group consisting of cryolite, alumina and sodium carbonate located between the lateral elongated faces of adjacent anodes, said packing being spaced from the lower edges of said anodes and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

6. In a method of electrolytically producing aluminum from aluminum-containing material, the steps of placing in a cathode container adapted to hold a molten mixture of aluminum producing electrolyte a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section and of substantially the same dimensions, each having a width of between 200 and 700 millimeters and a length of between 1400 and 3000 millimeters, in a row extending in one direction, adjacent and spaced from each other at a distance of between 15 and 150 millimeters; passing a current of between 5000 and 10,000 amperes between each of said anodes and said cathode thereby electrolytically producing aluminum from said molten mixture and forming between adjacent anodes spaced from the upper level of said molten mixture a frozen crust of said mixture of aluminum producing electrolyte, thereby forming between said molten mixture, said frozen crust and adjacent carbon anodes channels of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during the production of aluminum; and tightly packing upwardly of said frozen crust in the space between adjacent carbon anodes at least one pulverulent substance belonging to the group consisting of cryolite, alumina and sodium carbonate, said packing contacting adjacent portions of adjacent anodes thereby preventing the access of air to and oxidation of said portions.

7. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; and a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section each having a capacity of 10,000 amperes, a width of approximately 630 millimeters and a length of approximately 1900 millimeters, said carbon block anodes being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of approximately 50 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal

of gases reaching said channels during operation of the cell.

8. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section each having a capacity of 10,000 amperes, a width of approximately 630 millimeters and a length of approximately 1900 millimeters, said carbon block anodes being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of approximately 50 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell; and a packing essentially consisting of at least one tightly packed pulverulent substance belonging to the group consisting of cryolite, alumina and sodium carbonate located between the lateral elongated faces of adjacent anodes, said packing being spaced from the lower edges of said anodes so as to extend upwardly from the channel defined between adjacent anodes and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

9. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of continuous baked elongated carbon block anodes of substantially rectangular cross-section each having a capacity of 10,000 amperes a width of approximately 630 millimeters and a length of approximately 1900 millimeters, said carbon block anodes being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of approximately 50 millimeters so that the channels defined between adjacent anodes by the upper level of the molten electrolyte and the lower level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell; and a packing essentially consisting of a tightly packed pulverulent mixture of approximately 10 parts by weight cryolite, 10 parts by weight alumina and 1 part by weight sodium carbonate located between the lateral elongated faces of adjacent anodes, said packing edges and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

10. In an electrolytic cell for producing aluminum, in combination, a container for holding molten aluminum-producing electrolyte; a series of elongated carbon anodes, each of said anodes consisting essentially of a plurality of superposed baked carbon blocks, each carbon block having a height of about 500 millimeters, a length of about 1,900 millimeters and a width of about 630 millimeters, the capacity of each of said elongated carbon anodes being between 6,000 and 9,000 amperes and said elongated carbon block anodes being arranged in said container in a row extending in one direction with their lateral elongated faces adjacent and spaced from each other, whereby upon operation of the cell a frozen crust of the electrolyte is formed between adjacent anodes and spaced from the molten electrolyte in the cell, said adjacent anodes being spaced from each other at a distance of about 50 millimeters so that the channels defined between adjacent anodes by the upper level of the frozen crust are of sufficiently small cross-section to act as discharge passages for rapid withdrawal of gases reaching said channels during operation of the cell; and a packing consisting essentially of a mixture of about equal quantities of alumina and cryolite and about 5% of said mixture of sodium carbonate, located between the lateral elongated faces of adjacent anodes, said packing being spaced from the lower edges of said anodes and contacting portions of said elongated faces of adjacent anodes thereby substantially preventing oxidation of said contacted portions of said anodes.

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