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METHOD FOR STARTING ALUMINUM ELECTROLYTIC CELLS WITH SELFBAKING ANODE AND CURRENT SUPPLYING STUDS

Filed May 25, 1959 2 Sheets-Sheet 1

Fig. 1.

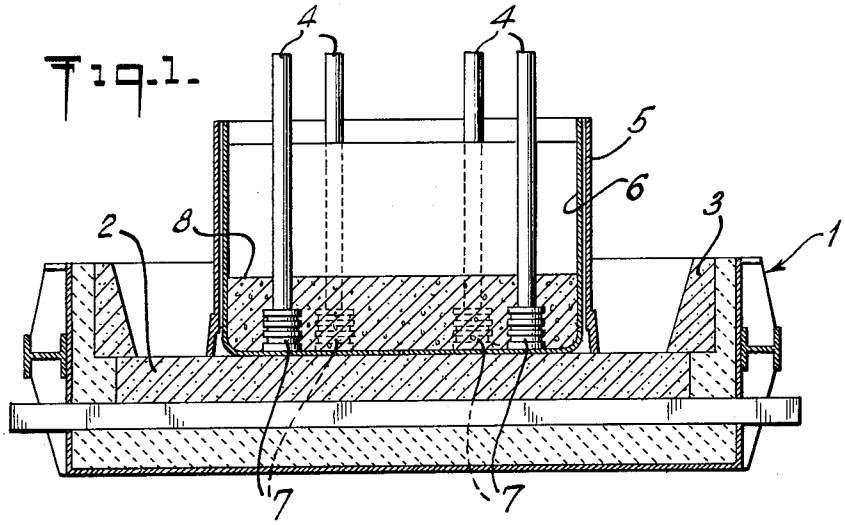
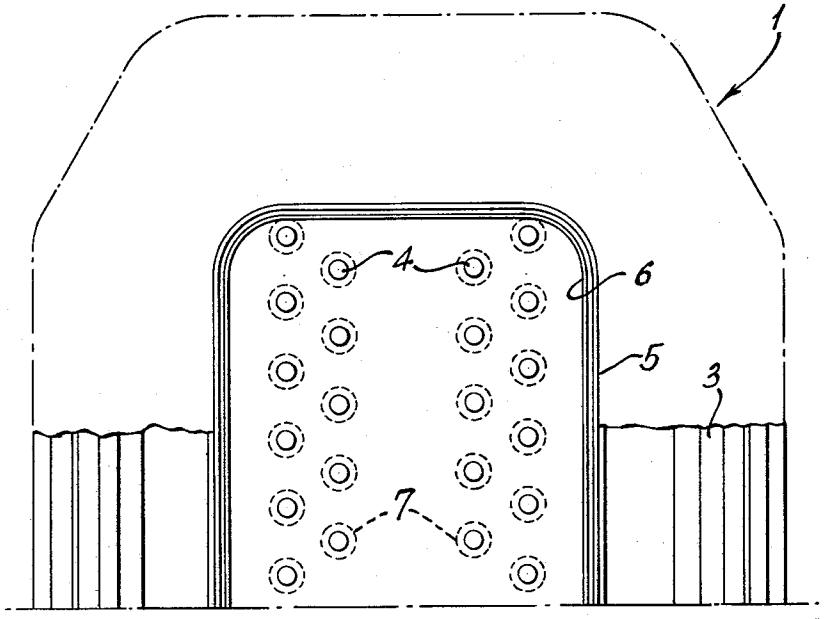


Fig. 2.



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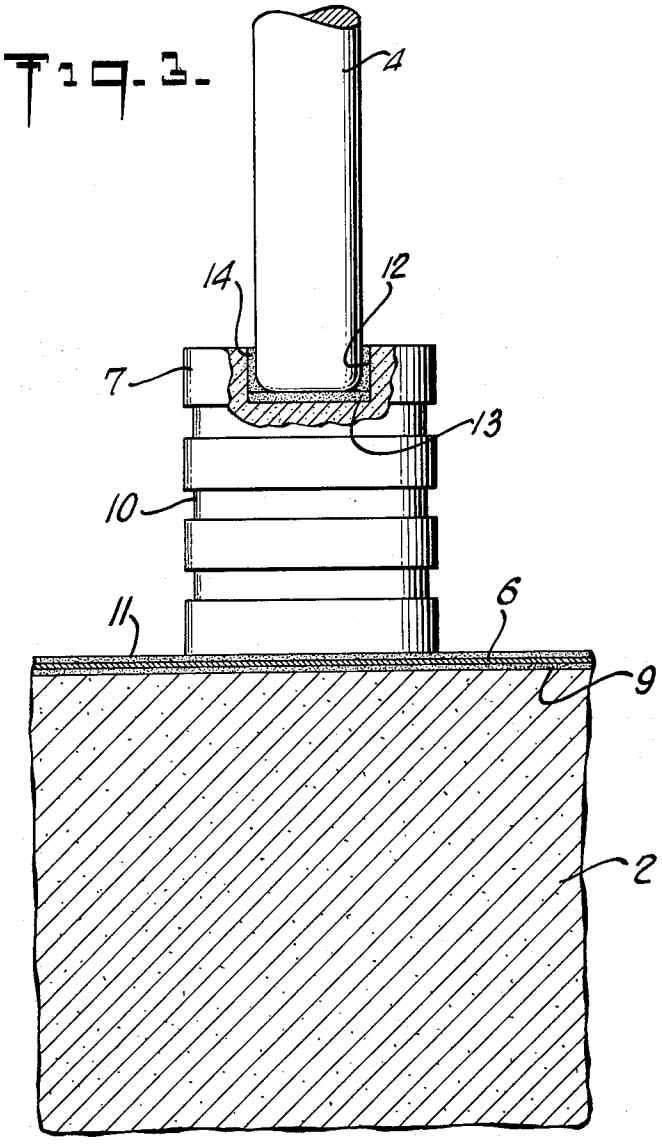
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Filed May 25, 1959 2 Sheets-Sheet 2

Fig. 3.



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METHOD FOR STARTING ALUMINUM ELECTROLYTIC CELLS WITH SELFBAKING ANODE AND CURRENT SUPPLYING STUDS

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In order to obtain a good operation of aluminum electrolytic cells with selfbaking anodes (so-called Soederberg-cells) and advantageous results, one has to take care that already when switching on the cell at the beginning of its operation, the coking of the still unbaked parts of the carbonaceous cathode and of the still unbaked anode takes place without any troubles. The temperature rise especially in the anode as a result of the current flow through the lower zones of the still unbaked carbonaceous material should not be too abrupt and the gradual coking of the anodic mass has to take place uniformly over the whole cross-section of the anode.

Only when starting in this way Soederberg cells with new anodes, one has the certainty that also the bottom of the cell will be baked uniformly and not damaged by local overheating just after being put into operation, that the beginning of the fusion operation (that is to say charging the cryolite- or chiolite-flux in solid and/or liquid state into the cell and simultaneously lifting the anode and pouring liquid aluminum into the cell) may be performed without any trouble, that the further uniform coking of the Soederberg-anode during the operation of the cell will be secured and that the cell works satisfactorily.

Generally the starting state of Soederberg-cells with new anodes is the following:

The anode consisting in still unbaked carbonaceous Soederberg-mass is placed directly on the bottom of the cell vat which is usually lined with rammed carbonaceous mass or with carbon blocks and has rammed carbonaceous walls. As the Soederberg mass is still soft and as the frame of the anode is not lowered down to the bottom of the vat, one must insert into the frame a kind of cup made from sheet metal, which cup rests with its bottom on the bottom of the cell vat and prevents the lower part of the unbaked anode from losing its shape.

Between the bottom of the protecting cup and the carbon vat there is disposed a layer of fine coke thus improving the electric contact between the cup and the vat.

Contact studs are introduced into the still unbaked Soederberg mass of the anode; they serve to conduct the current from anodic current supply conductors to the carbonaceous mass of the anode.

After switching in the cell in the as-described state, that is to say with the anode resting on the vat, the current flows from the anodic current supply conductors through the Soederberg mass into the bottom of the cell and then through the cathodic conductors out of the cell into the next cell.

By the joulean heat the coking process begins in the Soederberg mass. As soon as the lower part of the anode block is baked (coked), one can fill the cell with cryolite fiux and molten aluminum and rise simultaneously the anode to such a height that the necessary distance is adjusted between the lower surface of the anode and the layer of molten aluminum, thus starting the electrolytic process.

In the first stage of development of the Soederberg cells the starting of such cells with new anodes was performed frequently in the following way: the contact studs were driven into the unbaked Soederberg mass of the anode and no electric connection was between the

lower ends of the contact studs and the bottom of the protective sheet-metal cup respectively the bottom of the furnace vat. As the unbaked Soederberg-mass is not yet electrically conducting, it was necessary to dispose outside of the anode metallic connections between the heads (tops) of the contact studs and the bottom of the sheet-metal cup. In this way the anode was heated from below and the coking process was started at individual spots of the still unbaked lower part of the anode; in this way the current flow through the lower part of the anode was initiated.

This method has proved rather unsatisfactory, as in this way individual contact studs take up more and more electric current, with the result that the carbonaceous mass surrounding the contact studs become too quickly coked and often even overheated, whereas other zones of the anode remain at first wholly unbaked. As a consequence the anode becomes irregularly coked (baked) and there are created zones of badly coked and porous mass as well as heat cracks, which have a disadvantageous effect during the whole subsequent operation of the cell.

In order to obtain a uniform baking of the anode when switching in the same, one has therefore later disposed electrically conducting pieces between the contact studs and the sheet-metal cup before filling in the unbaked Soederberg mass. For instance, one disposed between the tips of the contact studs and the sheet-metal cup on the bottom of the carbonaceous cell-vat electric conductors made of strips or spirals; then the unbaked Soederberg mass was filled into the anode frame respectively into the sheet-metal cup. Instead of metallic conductors one used also sometimes thin graphite rods which were disposed between the tips of the contact studs and the sheet-metal cup.

When electrically conducting pieces are disposed in the above described way, the electric current flows after switching in the electrolytic cell at first through these pieces between the contact studs and the sheet metal cup respectively the bottom of the cell; these electrically conducting pieces become hot through the joulean heat and heat therefore the unbaked carbonaceous mass surrounding these conducting pieces and the contact studs, so that the coking process becomes initiated in these zones.

But also the above mentioned method has proved not quite satisfactory, as the coking of the unbaked carbonaceous mass starts in this way from relatively small zones and as in these zones current overloads take place which cause an irregular coking of the carbonaceous anode. The use of graphite rods presents the further disadvantage that they become not bounded to the surrounding carbonaceous mass and are not consumed in the same manner as the latter in the molten cryolite electrolyte. As a result, the graphite rods fall out of the anode during its consumption, enter the fused electrolyte and disturb the operation of the furnace.

My present invention relates to a method for starting aluminum electrolytic cells with selfbaking anodes (Soederberg-anodes), by which method the drawbacks mentioned above do not occur.

According to my invention, slightly coked, preferably cylindrical bodies made from carbonaceous mass are disposed vertically between the free ends of the contact studs and the sheet metal cup before introducing the unbaked carbonaceous (Soederberg) mass; these bodies, which have nearly the same composition as the unbaked Soederberg mass, are so disposed that the contact studs rest with a slight pressure on the top of these carbonaceous bodies and that the carbonaceous bodies themselves rest with a slight pressure on the bottom of the sheet-metal cup. Suitably a thin layer of fine coke is disposed between the lower surface of the carbonaceous

bodies and the bottom of the sheet metal cup. In the following description these carbonaceous bodies are designated as "carbon cylinders."

If the selfbaking anode is provided with vertical contact studs, for which the carbon cylinders according to my invention are very suitable, it is the best to choose carbon cylinders the diameter of which is suitably 1.2 to 3 times as great as the diameter of the lower end of the contact studs. The carbon cylinders are made by ramming a carbonaceous mass into a suitable mold or by means of a block or extrusion press, or by vibrating the carbonaceous mass in a suitable mold on a jarring table. Advantageously grooves are disposed round the carbon cylinders in order to improve the contact surface with the carbonaceous mass of the anode. One may also advantageously rough the carbon cylinders on their periphery by mechanical means.

The carbon cylinders may have for instance the following composition:

15% pitch coke with a particle size of 1.68 to 3.36 mm.
52% pitch coke with a particle size of 0.21 to 1.68 mm.
33% pitch coke with a particle size of 0 to 0.21 mm.

The size of the particles has been measured by means of the Tyler sieve.

One adds to this dry mixture such a quantity of middle hard pitch that the pitch content of the whole mass amounts for instance to 16.5%. The pitch addition may for instance vary between 13 and 25%. However, in order to get a good bond between the carbon cylinders and the surrounding carbonaceous mass of the anode, the pitch content should be at least 3%, preferably 10% lower than the pitch content of the carbonaceous mass of the anode (the pitch content of the carbonaceous mass of the anode amounts generally to 25–35% depending on the grain composition and the kind of the dry material used). The carbon cylinders are previously baked outside the Soederberg cell in suitable baking chambers at a relatively low temperature and then disposed in the Soederberg cell in a slightly coked state. I have found that a suitable coking temperature range lies between 500 and 1000° C., preferably between 600 and 750° C. The carbon cylinders are exposed to such a temperature during 12 to 48 hours. The whole process of coking lasts 1 to 10, preferably about 3 to 4 days. For determining the duration of the coking process, I measure the time which elapses from the moment when a temperature of 300° C. is reached during the heating of the carbon cylinders till the moment when the same temperature of 300° C. is reached during the cooling of the carbon cylinders.

Suitably the top end of the carbon cylinders, where the contact stud will rest, is provided with a recess conformed to the tip of the stud. One introduces then the tip of the stud with some clearance into the recess and suitably fills the space between the stud and the wall of the recess with a carbonaceous ramming mass after having disposed a layer of graphite powder on the bottom of the recess.

The drawing shows an embodiment of my invention with an aluminum electrolytic cell having vertical contact studs. FIG. 1 represents schematically in vertical section and FIG. 2, also schematically, a top view of a part of the cell without the conductors for the anodic current supply, the conductors for the cathodic current supply and the suspension parts for the anode; both FIGURES 1 and 2 show the cell before switching in the electric current.

FIG. 3 represents on a greater scale a carbon cylinder between the lower part of the contact stud 4 and the bottom of the carbonaceous vat.

1 designates the pot of the aluminum electrolytic reduction cell, 2 the carbonaceous bottom and 3 the carbonaceous side walls. 4 designates the vertical contact studs, 5 the anode casing and 6 the sheet metal cup necessitated for the starting of the cell. The cup is made from 1 to 2 mm. thick iron sheet. A vertical mantle made from aluminum sheet of a thickness of 1 to 2 mm. is riveted on the rim of the cup; this aluminum mantle surrounds the anode laterally and slides in the anode casing 5. Carbon cylinders 7, according to my invention, are disposed between the sheet-metal cup and the contact studs. 8 is the Soederberg mass poured into the cell in the molten state.

In FIG. 3, there is a thin layer 9 of fine coke spread uniformly between the bottom of the sheet-metal cup 6 and the carbon bottom 2 of the cell pot 1; the sheet-metal cup is pressed on the said layer. The slightly coked carbon cylinder 7 is provided on its periphery with grooves 10, which enlarge their surface, and pressed into a layer 11 of fine coke (coke fines) which covers the bottom of the sheet-metal cup 6. In its top part there is provided a round recess 12 into which the contact studs 4 are introduced under pressure. On the bottom of the recess there is spread a layer 13 of graphite powder, which improves the electric contact between the stud 4 and the carbon cylinder 7. The diameter of the recess is somewhat greater than the diameter of the lower part of the contact stud. Carbonaceous ramming mass 14 has been tamped into the lateral clearance between the contact stud and the wall of the recess.

The carbon cylinder disposed in this manner gives a good electric connection between the contact studs and the bottom of the cell pot. After having disposed all the carbon cylinders between the contact studs and the sheet-metal cup one fills in the unbaked carbonaceous (Soederberg) mass, and that up to a height at least 5 centimeters over the top of the carbon cylinders, so that the latter are well covered through the unbaked carbonaceous mass.

The advantages which result from the use of these carbon cylinders for the switching in of Soederberg anodes are the following:

Contrary to metallic connections or graphite rods as electric conductors between the contact studs and the sheet-metal cup these slightly coked carbon cylinders have a relatively high resistivity, which may be between about 80 and about 150 ohms.cm.$^{-1}$.cm.^{2} at 20° C. However, in spite of this higher electric resistance, there is still a rather good electrical connection between the contact studs and the bottom of the cell vat. But, owing their higher resistivity in comparison to the above mentioned connecting pieces, the carbon cylinders represent a kind of barrier resistance which causes a good equalization of the current intensity in all contact studs, so that a uniform current distribution in the anode results when the operator switches in the anode.

According to another, still unpublished invention I made, one uses slightly coked carbon plugs for filling the holes formed in Soederberg anodes when the contact studs are pulled out during the operation of the cell; these slightly coked carbon plugs give a mechanically and electrically good bond with the more coked Soederberg mass surrounding the plugs. It could not be foreseen that slightly coked carbon cylinders according to my invention would also give a good mechanical and electrical bond with the unbaked Soederberg mass during the passage of the electric current, as it is not the same to force slightly coked carbon bodies into a more coked carbonaceous mass as when slightly coked carbon bodies are surrounded by molten Soederberg mass which does not stand under higher pressure. Moreover, the relation between the values of the thermal expansion and the relation between the values of the conductivity are in both cases quite different, as well as the relation of values of the thermal capacity (specific heat) between the carbon bodies and the surrounding mass.

My systematic investigations and trials have shown surprisingly that the slightly coked carbon cylinders according to my invention give a remarkably good mechanical and electrical bond with the surrounding carbonaceous

mass during the coking process. This bond is improved by grooves or by roughening the carbon cylinders.

Furthermore, I have found that the diameter of the carbon cylinders, as already stated, must be substantially greater than the diameter of the lower part of the contact studs. It results therefrom that the surrounding unbaked carbonaceous mass, as soon as the carbon cylinders take up the electric current, becomes baked in such a broad zone round the carbon cylinders that the coking zones round the individual carbon cylinders interflow and that a quite uniform coking is obtained over the whole cross-section of the anode. During the passage of the electric current, the carbon cylinders introduced into the cell in a slightly coked state are of course submitted to a further coking process through which their resistivity is gradually lowered to the final value of the completely coked Soederberg mass.

With the above mentioned size and arrangement of the carbon cylinders, the said coking process proceeds so slowly that the coking of the surrounding Soederberg mass keeps up with it; it results that no local overheating can take place, neither an overheating of the carbon cylinders nor an overheating of the zones of the carbonaceous mass surrounding the carbon cylinders in the anodes.

The method according to my invention may also be applied with selfbaking anodes having lateral contact studs. Furthermore, its use is not restricted to selfbaking anodes where the carbonaceous mass is supplied in a molten or pasty state; my method may also be applied with anodes which are built up from blocks of unbaked carbonaceous mass.

While I have described a preferred embodiment of my invention, it will be recognized that modifications may be made without departing from the principle thereof. These modifications are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

What I claim is:

1. The method of putting into operation an aluminum electrolytic reduction cell having a self-baking anode and having a carbon bottom, which method comprises assembling in the cell before putting the cell into operation an embryo anode unit comprising a sheet metal cup which contains an unbaked carbonaceous mass adapted to form the anode upon baking and which rests initially on the carbon bottom of the cell, current supply contact studs extending into said carbonaceous mass, and partially coked carbon bodies made of a material compatible with the carbonaceous mass to insure a strong bond between said mass and said carbon bodies upon baking, and disposed between the lower ends of the contact studs and the bottom of the sheet metal cup, said carbon bodies having a diameter substantially greater than that of the lower part of the contact studs, and in the initial stages having high resistance but nevertheless forming good electrical connections between the studs and the bottom of the metal cup, and passing an electric current in series through the contact studs, through said partially coked carbon bodies, through the bottom of the sheet metal cup and through the carbon bottom of the electrolytic cell to cause the carbon bodies and at the same time the carbonaceous mass to be baked and coked into an intimately bonded integrated unit.

2. The method as described in claim 1, wherein the current supply contact studs extend vertically in said carbonaceous mass.

3. The method as described in claim 1, wherein the unbaked carbonaceous mass contains pitch and the carbon bodies are made of a carbonaceous material having a pitch contents which is at least 3% lower than the pitch contents of the unbaked carbonaceous mass.

4. The method as described in claim 1, wherein the unbaked carbonaceous mass has a pitch contents of about 25–35% and the carbon bodies are made of a carbonaceous material having a pitch contents of between 3% and 15% lower than the pitch contents of the unbaked carbonaceous mass.

5. The method as described in claim 1, wherein the carbon bodies before the start of operation have been coked at a temperature between 500° and 1000° C.

6. The method as described in claim 1, wherein the carbon bodies before the start of operation have been coked at a temperature between 500° and 1000° C. for from one to ten days.

7. The method as described in claim 1, wherein the carbon bodies are of generally cylindrical form having external conformations presenting peripheral areas substantially greater than the areas presented by smooth regular cylinders of equal diameter.

8. The method as described in claim 1, wherein the carbon bodies have their peripheral surfaces substantially enlarged by roughening.

9. The method as described in claim 1, wherein the carbon bodies have their peripheral surfaces substantially enlarged by the provision of circumferential grooves around said bodies.

10. The method as described in claim 1, wherein the carbon bodies have respective recesses at the top, and wherein the contact studs extend into said recesses with clearance but have electrical connections to said bodies through the recesses.

11. The method as described in claim 1, wherein a layer of fine coke is disposed between the bottom of the sheet metal cup and the carbon bodies as well as between the bottom of the sheet metal cup and the carbon bottom of the cell.

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