United States Patent

Huwyler et al.

[15] **3,688,559**

[45] **Sept. 5, 1972**

[54] **METHOD FOR TESTING HEAT INSULATING LINING MATERIALS FOR ALUMINUM ELECTROLYSIS CELLS**

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[22] Filed: **July 6, 1971**

[21] Appl. No.: **160,048**

[30] **Foreign Application Priority Data**

July 17, 1970 Switzerland 10907/70

[52] **U.S. Cl.** **73/15.6**, 204/243

[51] **Int. Cl.** **G01n 3/18**

[58] **Field of Search** 73/154, 156; 204/67, 243

[56] **References Cited**

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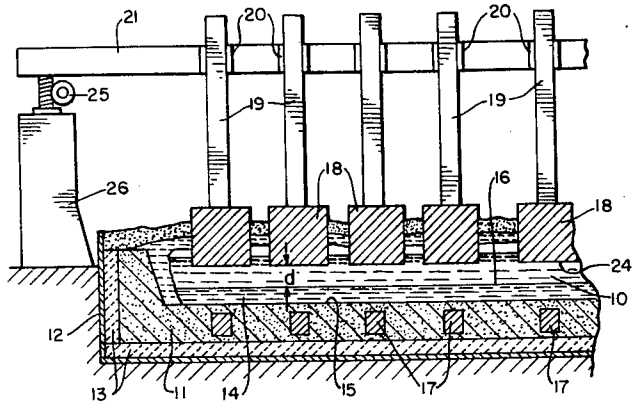
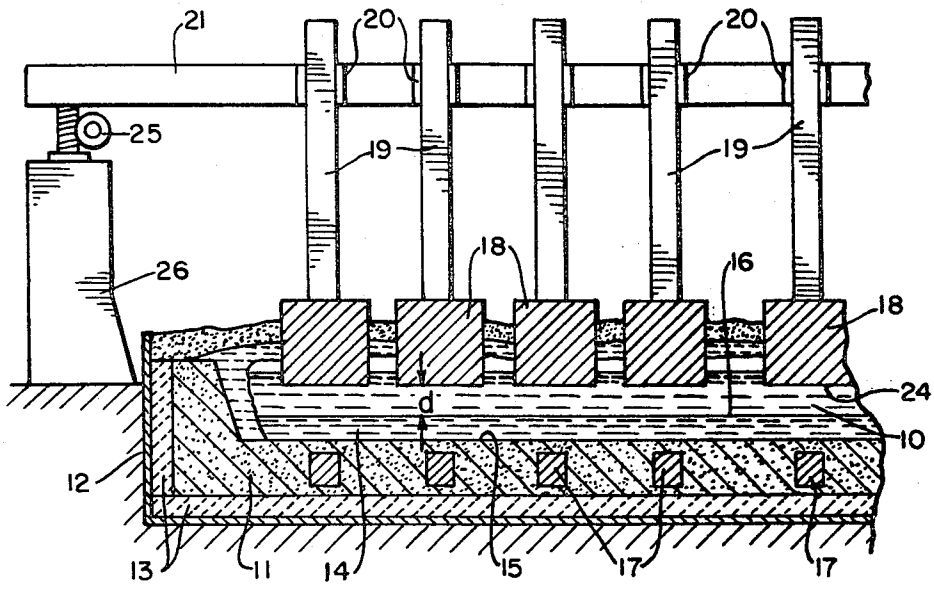
[57] **ABSTRACT**

Samples of inoxidizable heat insulating lining materials for aluminum electrolysis cells are tested after heating at high temperatures, some samples bare, some others packed in cryolite, whereupon the compression strength at room temperature, the apparent density and the dimensions are compared with the corresponding values of the untreated samples.

1 Claim, 1 Drawing Figure





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METHOD FOR TESTING HEAT INSULATING LINING MATERIALS FOR ALUMINUM ELECTROLYSIS CELLS

To obtain aluminum by electrolysis aluminum oxide (AL_2O_3, alumina) is dissolved in a fluoride melt. Electrolysis is done in a temperature range of approximately 940° to 975° C. The cathodically deposited aluminum collects under the fluoride melt on the bottom of the cell. Anodes of amorphous carbon are dipped from above into the melt. The electrolytic decomposition of the aluminum oxide causes oxygen to form on the anodes and this combines with the carbon of the anode to produce CO and CO_2.

A typical aluminum electrolysis cell is shown diagrammatically in the Figure in a longitudinal section. The fluoride melt **10** (the electrolyte) is contained in a carbon lined **11** steel pot **12** provided with an insulation **13** of heat resistant, heat insulating material. The cathodically deposited aluminum **14** collects on the bottom **15** of the cell. The surface **16** of the liquid aluminum acts as the cathode. Iron cathode bars **17** are embedded in the carbon lining **11** so as to conduct the current from the cell bottom outwards.

Anodes **18** of amorphous carbon dip into the fluoride melt from above for the purpose of conducting the d.c. current to the electrolyte. They are fixed to current conductive beams **21** by means of rods **19** and locks **20**. The electrolyte **10** is covered with a crust **22** of solidified melt and on the top of this is a layer of alumina. The distance *d* from the underside of an anode **24** to the surface **16** of the aluminum (also called the interpolar distance) can be varied by raising or lowering the beam **21** through hoisting units **25** mounted on columns **26**.

Due to the attack by the oxygen released during electrolysis the anodes are consumed at their underside to an extent of about 1, 5 to 2 cm of their length each day in accordance with the particular construction of the cell.

From the fluoride melt **10** to the steel pot **12**, in order of sequence, the heat insulation **13** mostly consists of one or more layers of high temperature-resistant and heat insulating materials to further layers of lesser heat resistance but with good heat-insulating properties.

During the life of a cell, both liquid and gaseous bath components seep through the carbon lining **11** into these heat insulating layers. Chemical reactions can arise between the bath components and the heat insulating materials with the result that these materials are attacked. This can cause disintegration, shrinking or volume increase of the insulating materials, All these effects reduce the strength of the heat insulating layer **13** and consequently the durability of the electrolysis cell is shortened. This leads to premature and costly repairs and therefore to a production loss. Furthermore the voltage drop in the carbon bottom **11** is increased which impairs the specific electrical energy consumption (kWh/KgAl).

The described problems can be considerably diminished or totally avoided by using cryolite resistant materials for the thermic insulation **13**.

It is therefore necessary to test the lining materials as to their cryolite resistance before insertion into the cell.

The invention relates to a method for testing the inoxidizable heat insulating lining materials as to their resistance to cryolite. This method enables to determine the resistance to cryolite by means of the laboratory test described below.

The long-term changes which the lining materials in the cells undergo, due to the attack by the bath components, appear simply and speedily by the laboratory test.

The method according to the invention consists of preparing a sample of the lining material, one part therefrom remaining untreated, one part heated to and maintained at 800°±20° C for at least 1 day, one part packed in cryolite and maintained at a temperature of 500° ± 10° C for at least 1 day and a further part packed in cryolite powder and maintained at 800° ± 20° C for at least 1 day, whereupon the cold compression strength (compression strength at room temperature), the apparent density and the dimensions of the treated samples are compared with the corresponding values of the untreated samples.

For the purpose of carrying out the test, samples of approximately 35 × 35 × 65 mm are cut from the lining materials to be tested, sizes which proved easy to handle. Other sizes can of course be chosen. The apparent density and the cold compression strength were first ascertained.

Samples were heat 800°±20° C and maintained at this temperature for at least 1 whole day; the cold compression strength was then determined. A drop in the cold compression strength after subsequent heating already would give evidence of a weakening of the structure, this being purely effected by temperature reaction.

Further samples were packed in cryolite powder (preferably in a graphite crucible), heated to 500°±10° C and maintained at this temperate for at least 1 day. The samples were then cooled, cleansed of any adherent cryolite and tested as to shrinkage or volume increase; the samples were also examined for any change of weight. Materials well suitable for use in electrolyte cells should not show shrinkage nor volume increase, nor change in weight to any extent. The test is complemented by determining the cold compression strength of the samples heated in cryolite. For the usability of these materials the cold compression strength of the samples heated in cryolite compared to the compression strength of those which are not heated in cryolite should show no worth mentioning difference. It can happen that after temperature reaction — with or without cryolite — a higher compression strength occurs; this points to an undesired embrittlement of the material. On the other hand, a reduced compression strength points to an attack by the cryolite. Such materials which during the test have undergone a noteworthy change are not suitable for lining aluminum electrolysis cells. On the other hand, materials which have shown no change to any extent during the test are suitable to use in cell regions of lower temperatures.

The same test was carried out in cryolite but at a temperature of 800°±20° C — again for at least 1 day. The judgement criterions were the same as after heating to 500°±10° C. Materials which have endured this stress without undergoing any noteworthy change are suitable to use in aluminum electrolysis cells without limitations, — as far as their absolute values for strength and heat conductivity allow it.

It has been shown that a good correlation exists between the results of these tests and the behavior of the materials in the electrolysis cells. Thereby the risk which especially exists in the utilization of new, not previously used materials is considerably minimized. The increased life of the cells which is made possible by testing the materials in this way allows a considerable reduction in aluminum production costs.

What is claimed is:

1. Method of testing inoxidizable heat insulating lining materials for aluminum electrolysis cells in which samples of lining material are prepared, from which one part remains untreated, one part heated to 800° ± 20° C and maintained at that temperature for at least 1 day, one part packed in cryolite and held at a temperature of 500°±10° C for at least 1 day, another part packed in cryolite and held at a temperature of 800° ± 20° C for at least 1 day, whereupon the cold compression strength (compression strength at room temperature), the apparent density and the dimensions of the treated samples are compared with the corresponding values of the untreated samples.

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