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D. H. TILSON

GAUGING DEPTHS IN AN ELECTROLYTIC CELL

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Fig. 1

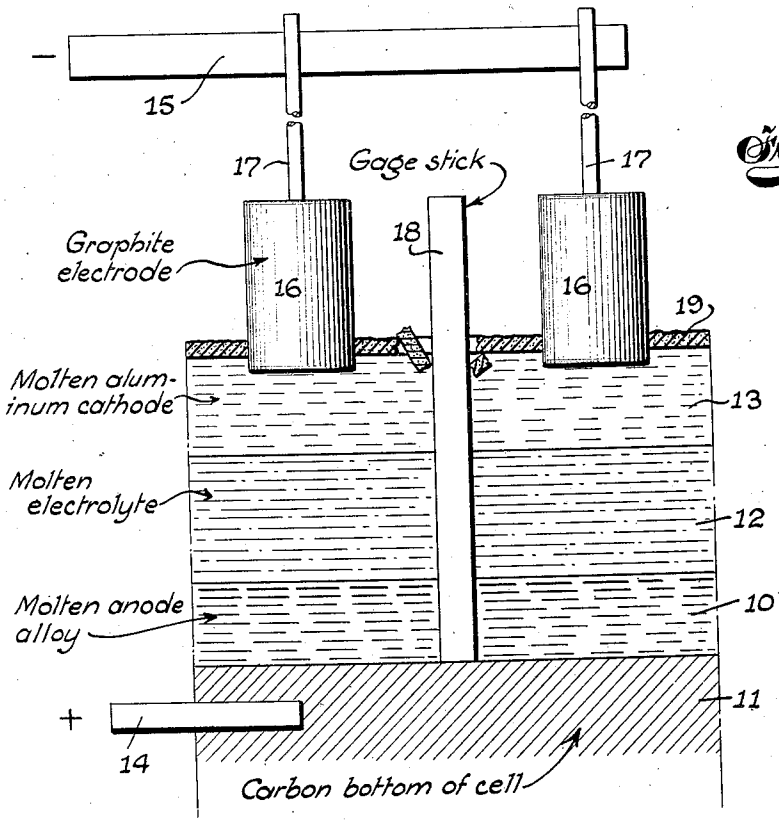
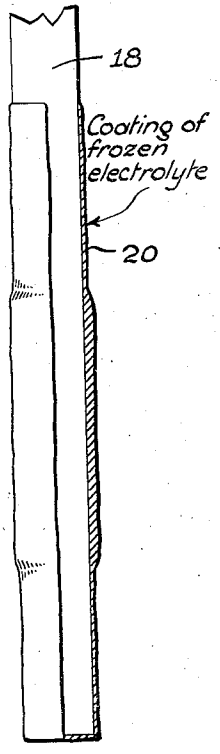


Fig. 2



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GAUGING DEPTHS IN AN ELECTROLYTIC CELL.

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To all whom it may concern:

Be it known that I, DONALD H. TILSON, a citizen of the United States of America, residing at Badin, in the county of Stanly and State of North Carolina, have invented certain new and useful Improvements in Gauging Depths in Electrolytic Cells, of which the following is a full, clear, and exact description.

In electrolytic processes which employ molten baths or electrolytes it is generally desirable and often essential to have a simple, convenient and accurate method of gauging the exact depths of electrolyte and molten metal or metals, which may be present in the cell. This is particularly the case in processes for the electrolytic refining processes for aluminum described in the copending applications of William Hoopes et al., Serial Nos. 608,284, 608,285, 608,286, and 608,287, filed December 21, 1922, in which there are employed gravitatively separated molten layers comprising a pure aluminum cathode, a suitable electrolyte and a suitable anode alloy containing aluminum, the whole being enclosed within an electrolytic cell.

In the control of such a process of electrolytic refining, it has been found highly advantageous to know, and to keep accurate records of, the depth or thickness of each of the above mentioned layers in the cell. During the progress of the refining operation, the extraction of aluminum reduces the thickness of the anode alloy to the extent of one-third to one-half, with a corresponding increase in the thickness of the cathode layer of pure metal. The thickness of the bath or electrolyte layer should remain substantially constant, in order to maintain constant conditions in the cell. But the formation of side crust and top crust by freezing of electrolyte on the cell walls and above the cathode may at times introduce undesirable variations in the thickness of the bath layer, so that it is desirable to observe and record this thickness carefully in order to be able to interpret and properly control the behavior of the cell. If the bath layer becomes too thick, that is, too deep, the ohmic resistance between the floating metal cathode and the molten metal anode becomes too great and the cell absorbs too much power, with the result that it becomes overheated and its efficiency drops, while the decomposition and volatilization of the electrolyte or constituents thereof are accelerated. If, on the other hand, the bath layer becomes too shallow, the voltage and power input drop, the cell runs too cold, and there is great danger of contamination due to tendency of the bath to partially freeze and become mushy in spots, which causes a concentration of the current in other spots, thus producing magnetic disturbance and swirling in the cathode and in the anode alloy, which, with the reduced thickness of the bath layer, can easily bring about contamination of the floating cathode by materials mechanically carried over from the anode.

It is evident that no ordinary type of gage or measuring apparatus would be applicable under the conditions obtaining in the electrolysis of fused salts. Before my invention of the means herein described, the only method known to me comprised the measuring of the thickness of the top metal by the use of a small ladle which was carefully dipped into the cell contents for a definite depth, and withdrawn. If the ladle was found to be full of metal, the operation was repeated, increasing the depth of immersion, until the ladle brought up a mixture of bath and metal, which indicated that it had passed through the floating top layer of molten aluminum, and the depth of that layer could then be estimated from the depth to which the ladle had been immersed. This method was inaccurate, slow, and, on account of the high temperatures encountered, was very unpleasant for the workmen.

I have discovered that an accurate determination of the thickness of all three of the molten layers may be accomplished in one operation in a very short space of time by the following gauging method. As a gage, I select a piece of some suitable conducting refractory material which is not attacked by the molten bath or metal layers, such, for example, as a piece of carbon or graphite. A convenient size for such piece is 20 inches by 2 inches by ½ inch, but it is apparent that other sizes may be used if desired, the only requirement being that the piece be long enough so that it may be conveniently held

in a vertical position while one end of it is made to rest upon the bottom of the cell, and that it be of sufficient cross section to have the necessary mechanical strength and thermal capacity.

In using my gauging method, I lower this gauging stick in a vertical position through the three molten layers until it comes to rest on the bottom of the cell. Contrary to expectation, I have found it inadvisable to cut the current from the cell during the gauging operation, as the amount of current which is short-circuited by the gauging stick is not sufficient to produce injurious mechanical or other effects, and the passage of the current through the stick makes more definite and distinct the marks which reveal the thickness of the different layers. I allow the gauging stick to remain in the position described for a suitable time, which is determined by trial, but which for the above described stick may be from 5 to 20 seconds, and then quickly withdraw the stick. Upon examination, it will now be found that there are three distinct marks visible upon the gauging stick, which show exactly the depths of the three layers above referred to.

On being introduced into the cell, the cold gauging stick becomes coated with a thin layer of molten electrolyte, which freezes upon it. During the time of immersion the coating of frozen electrolyte thickens in the electrolyte region, and remains thin over the portions which are immersed in the anode alloy and the cathode metal. This layer of electrolyte, due to the phenomenon of capillary attraction, or, more generally, surface tension, extends up the gage just to the top of the molten floating cathode layer, so that the length of the gage which is coated with bath gives the total thickness of the three layers. At the bottom of the floating cathode layer the current enters the carbon stick, and there are bright marks visible on the gage at that point when it is first removed. These make more definite the line of demarcation between the portions of the gage which were immersed in the top metal and electrolyte, respectively. There will always be found a very definite line of demarcation between the portion of the gage which was immersed in the anode alloy and the portion which was immersed in the electrolyte, since the portion in the anode alloy is much thinner, and on account of passage of current between the alloy and the stick it usually appears to be considerably hotter. By measuring the distances between the bottom end of the gage and the various marks described, I am able to obtain accurate knowledge of the depths of the various molten layers.

The knowledge of the depth of the molten anode alloy present is very valuable during the operation of tapping out the impoverished alloy, as it enables me to know the amount remaining in the cell at any instant, and to determine when the desired amount has been withdrawn or when the bottom has been drawn practically clean of alloy, thus avoiding the tapping out of bath from the cell. Moreover, the amount of metal produced by the cell in the interval between two tapping periods may thus be accurately gaged, and consequently the amount of new aluminum alloy may be suitably chosen when the thicknesses of the anode and cathode layers at each tapping time are known.

Referring to the accompanying drawing,

Fig. 1 is a vertical sectional view, somewhat diagrammatic in character, showing the gage stick thrust through the three molten layers to the bottom of the cell.

Fig. 2 is a view of the gage stick after withdrawal from the cell, showing the frozen coating, partly in section.

In Fig. 1, 10 represents the layer of molten anode alloy, on the bed 11 of carbon which forms the bottom or the bottom-lining of the preferred cell. The fused electrolyte layer is indicated at 12. It is of less density than the anode alloy, so as to float thereon. The aluminum layer constituting the cathode, of less density than the bath or electrolyte so as to float on the latter, is represented at 13. The carbon bed 11 serves as an electrode by which the anode alloy is connected to the positive terminal of the external circuit, represented by the conductor 14. The cathode layer 13 is connected to the negative bus-bar 15 by means of one or more connectors which may consist of carbonaceous cylinders 16 and copper rods 17; the latter being suitably fastened to the cylinders, and clamped to the bus-bar by any convenient and suitable means not shown.

In Fig. 1 the carbon gage stick 18 is shown as thrust vertically into the cell, through the three molten layers, with its lower end resting on the carbon bottom. For convenient manipulation of the stick it may be grasped at the top by means of tongs or other suitable device, not shown. If a top crust, as 19, has been formed above the cathode it may be necessary to break a hole in the crust to permit introduction of the stick.

In Fig. 2, which shows the gage stick withdrawn from the cell after an immersion of, say, 15 to 30 seconds, the coating of frozen electrolyte is represented at 20, the thicker portion indicating clearly the depth of the electrolyte layer and the thinner portions, above and below, indicating the depth of the cathode layer and anode layer re-

spectively. After the three have been measured the coating can be cracked or melted off to permit re-use of the stick.

It is to be understood that the invention is not limited to the specific details herein described but can be carried out in other ways without departure from its spirit as defined by the following claims.

I claim:

1. The method of gauging the thicknesses of superimposed metallic and non-metallic molten layers in an electrolytic cell, comprising introducing into the cell through the layers to be gaged a relatively cold rod or stick composed of thermally and electrically conducting refractory material, allowing the stick to remain until it has acquired a solid non-metallic coating having characteristics indicative of the depths of the layers penetrated, and withdrawing the stick for examination.

2. The method of gauging the thicknesses of superimposed metallic and non-metallic molten layers in an electrolytic cell, comprising introducing into the cell through the layers to be gaged a relatively cold rod or stick composed of carbon, allowing the stick to remain until it has acquired a solid non-metallic coating having characteristics indicative of the depths of the layers penetrated, and withdrawing the stick for examination.

3. The method of gauging the depths of gravitatively arranged molten layers consisting of a body of cathode metal, a body of anode alloy, and an intermediate body of fused salt, in an electrolytic cell, comprising introducing vertically through such layers to the bottom of the cell a carbon rod or stick in a relatively cold condition, allowing the stick to remain momentarily, until it has acquired on its submerged portion a solid non-metallic coating having characteristics, including varying thickness, indicative of the depths of the several layers, and withdrawing the stick for examination.

In testimony whereof I hereto affix my signature.

DONALD HEATH TILSON.