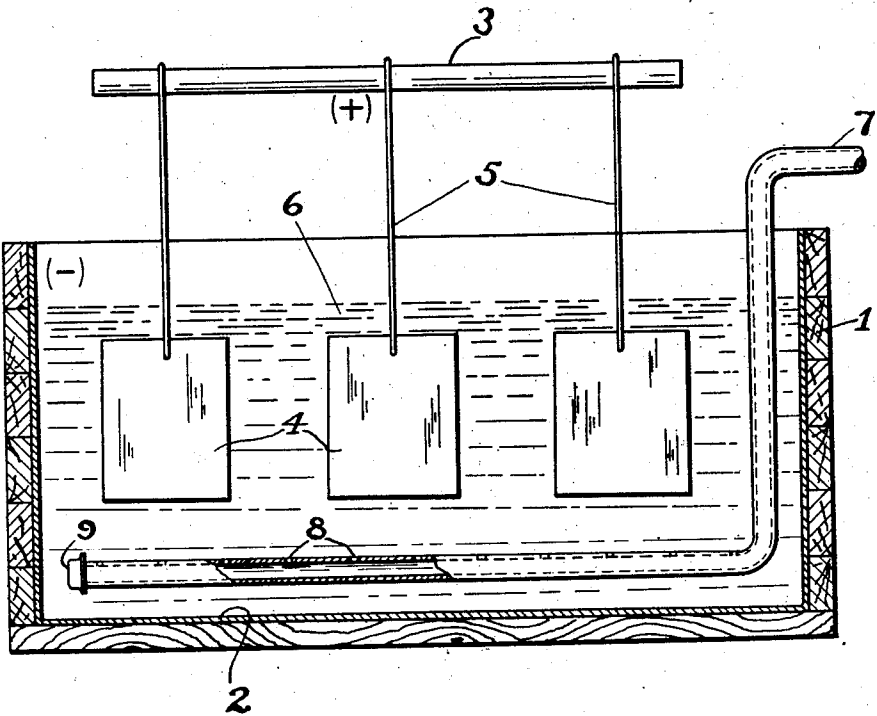


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H. BENGSTON
METHOD OF COATING
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METHOD OF COATING

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This invention relates to the coating of aluminum or aluminum base alloys, herein and in the appended claims comprehended by the term "aluminum", with a hard surface coat composed in more or less substantial part of aluminum oxide and generally termed "oxide coating". The invention particularly relates to a method of anodically forming on aluminum surfaces an oxide coating which is uniform in properties.

Oxide coatings may be formed on aluminum surfaces by making the aluminum the anode of an electrolytic cell in which the electrolyte is a solution of sulfuric acid, chromic acid, organic acids or the like. In the practice of this method a suitable cell is provided with an aluminum anode and preferably a metal cathode such as a lead cathode. The cell is filled with the proper coating-forming electrolyte and the circuit is closed. After a period of time, which may vary, the aluminum anode, by reason of the treatment, is coated with a hard, usually dense and adherent coating which is composed to a large part of aluminum oxide but which may be composed in part, by reason of the electrolyte used, of other substances. In the operation of these anodic processes, it has been difficult to produce a coating on the aluminum anode which is, over its entire surface, uniform in properties.

It is an object of this invention to provide a method by which an aluminum article may be coated with an oxide coating which is entirely uniform in properties over its entire surface. It is a further object of this invention to provide a new and useful method of treatment, particularly adapted to commercial operation, by which aluminum may be provided with an oxide coating. These and other objects will more fully appear upon reference to the following description and the drawing therein referred to.

In order to conveniently explain my invention, I have chosen to describe it with reference to that anodic process of producing oxide coatings on aluminum which comprises the use of sulfuric acid as the electrolyte, but it will be understood that the in-

vention relates broadly to anodic processes regardless of the electrolyte used.

The drawing illustrates in cross sectional elevation a schematic outline of a coating apparatus.

Referring to the drawing, the electrolytic cell in which the anodic treatment of the aluminum takes place is usually formed of a tank 1 conveniently lined, particularly where sulfuric acid is the electrolyte employed, with a lead lining 2. This lead lining may conveniently be used as the cathode and is herein designated as such. Above the tank 1 is conveniently disposed a rack, herein indicated by the line 3, from which the specimens 4 are suspended, by means of wires 5, in the electrolyte 6. The lining 2 and the rack 3 are energized by any convenient source of direct current, herein not shown, the lining 2 being made the cathode and the rack 3 and the specimens 4 the anode. Disposed within the tank and along the bottom thereof is an air line 7 having suitably located therein the air outlets or holes 8. The air line is sealed at its end 9 and at its open end connected to a convenient source of compressed air.

In processes of anodic coating as heretofore practiced, it has been observed that that part of the aluminum anode which is nearest the surface of the electrolyte is, by the process, provided with a coating of different properties than is that part of the aluminum anode surface which is more deeply immersed in the electrolyte. This difference in coating characteristics and properties is particularly noticeable when the oxide coating formed is later treated with an organic dye to color it, in which case the coloring is not uniform.

As a result of considerable experimentation I have determined that in order to anodically produce on aluminum surfaces a coating which is thoroughly uniform in properties, it is necessary that the temperature conditions at the interface between the coat-forming electrolyte and the anode surface be constant; that is to say, the temperature at any given point on said interface should be substantially equal to the temperature at any other given point on said interface. I have further determined that

although the temperature value may affect the properties of the coating formed, it is temperature uniformity over the entire anode surface-electrolyte interface that determines whether the coating formed will, as regards its entire area, have uniform properties.

Although aluminum and its alloys are good conductors of heat and it would be expected that, under normal conditions of operation, there would be no material variance in temperature from one portion of the anode surface to another, I have determined that such is not the case, and in some instances the variation in temperature over the anode surface will be as much as 8° centigrade or more. I have further determined that a very small variation in temperature may be sufficient to materially alter coating properties, particularly the property of uniformly taking a color from an organic dye solution.

The reasons for such temperature differential between different points on the anode surface-electrolyte interface lie in the peculiar conditions under which the coatings are formed. The electrolyte in the anodic treatment herein described increases in temperature as the process continues. Since, however, the larger portion of the resistance of the cell to the passage of current is not offered by the electrolyte but rather in the coating at the anode surface, the total effect is that the electrolyte is not uniformly heated; the heating being similar to that effected by placing a small unit heater in a large body of water. As a result, the first heated portion of the electrolyte rises to the surface, thereby producing a body of solution which varies considerably in temperature from its upper surface to the bottom of the receptacle in which it is contained. The anode suspended in this electrolyte extends, therefore, through an electrolyte which varies in temperature from top to bottom with the result that the temperature at the anode surface-electrolyte interface varies from the top to the bottom of the anode, being higher at the top.

My invention comprises, therefore, a process of anodically coating aluminum with oxide coating by making the aluminum an anode in an electrolytic cell, the electrolyte of which is a coating-forming solution, and, during the anodizing, maintaining all points in the aluminum anode-electrolyte interface at a substantially constant temperature. The maintenance of this constant temperature may be accomplished in various ways as for instance by mechanical stirring of the electrolyte, or by recirculation of the electrolyte, or by similar methods. Having in mind, however, the limitations of commercial operation, I have preferred to agitate the electrolyte adjacent the anodes with a gas such as air. Referring to the drawing, one convenient and simple method of accomplish-

ing such agitation is to dispose within the electrolytic cell one or more air lines 7 which may be closed at their end 9 and provided, along so much of their length as lies beneath or adjacent the anode, with outlet holes 8. Air is fed through the line from a convenient source and the bubbles of air passing upwards through the electrolyte agitate the same sufficiently to obtain the desired result. Using this type of air agitation in connection with the commercial coating of large quantities of articles which are to be thereafter colored by treatment in organic dye solutions I have been enabled to consistently produce aluminum articles having disposed on their surface a coating of uniform characteristics. So uniform, in fact, that when the coating is thereafter colored, all portions of it take the same color shade. I have accomplished this result even when the aluminum anode has extended from immediately below the surface of the electrolyte to the bottom thereof, and I have accomplished all this simply and inexpensively and without detriment to the anodizing process.

It will be apparent, from a consideration of the above description of my invention and the problems which it solves, that the invention is not limited to the electrolyte employed, to the means of maintaining constant temperature at the anode-electrolyte interface or to the particular temperature at which anodizing may take place, and I do not desire to be so limited except in so far as such limitations may appear in the appended claim.

I claim:

A process of anodically coating aluminum with an oxide coating which comprises making the aluminum an anode in an electrolytic cell, the electrolyte of which is a coating-forming solution and, during the coating process, maintaining all points at the aluminum anode surface-electrolyte interface at a substantially constant temperature.

In testimony whereof I affix my signature.
HELMER BENGSTON.