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2,873,237 2/1959 Lamberton et al. 204/219 X
3,254,004 5/1966 Jackson et al. 204/15

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[54] **ELECTROCOATING**
7 Claims, 2 Drawing Figs.
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204/250
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181, 219, 56, 58, 23, 250
[56] **References Cited**
UNITED STATES PATENTS
2,745,803 5/1956 Leveque 204/195

ABSTRACT: Methods and apparatus for electrocoating a conductive article from an aqueous coating bath by means of a direct current potential applied to the article to be coated through a liquid metal such as mercury. The mercury is contained at the bottom of an electrocoating vessel wherein an intermediate layer of insulating liquid between the liquid metal and the aqueous coating bath prevents direct contact of the bath with the liquid metal. The article to be coated extends through the intermediate layer to establish electrical contact with the liquid meal and an electrodeposited coating is applied to that portion of the article in contact with the aqueous coating bath. This process is useful for applying coatings to metals by electrolytic plating of metals, electrophoretic deposition of resins and by anodizing a metal article.

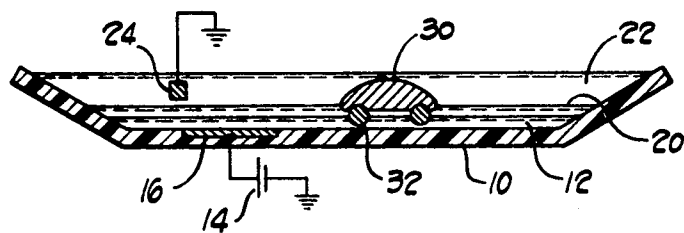


Fig. 1

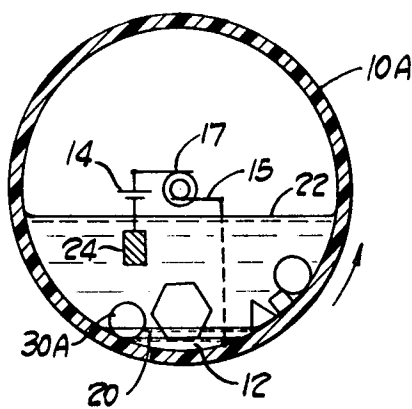


Fig. 2

ELECTROCOATING

BACKGROUND OF THE INVENTION

In the conventional electrocoating processes an electrically conductive article, usually a base metal, is immersed in a coating bath and biased with a direct current potential to create a coating on the surface of the article. In such processes, an electrical circuit is needed which is capable of conducting current from the source of power to the article to be coated, through the coating bath and back to the power source. This circuit is usually made by contacting the article with a solid electrical conductor and an electrode of opposite polarity is contacted with the coating bath. In the usual process, the article is suspended in the coating bath by a rack and the temporary electrical contact to the article is made through such rack. This arrangement requires some means of attaching the article to the rack, and the material handling problems in achieving this support and circuit function consumes considerable manpower. The racking is frequently performed by manual labor, and the coating process is sometimes interrupted by dirt or coating material at the point of connection which prevents proper electrical contact with the wire to the coated. One approach to this problem has been the use of a mercury pool which becomes a part of the electrical circuit for contacting the wire. In U.S. Pat. No. 3,254,004, a relatively complex system for handling small articles to be coated with metal oxides by electrophoresis is described. In this process, the mercury contacts both the ware and the coating bath. This arrangement limits the number of electrocoating processes in which liquid metal contact means can be used due to the interaction between the liquid mercury and the components of the coating bath. For instance, electrolytic plating of metals from an ionic solution is not feasible with a mercury electrode because the metal ions are discharged at the mercury surface as well as the surface of the article to be coated, thereby destroying the liquid characteristics of the mercury.

SUMMARY OF THE INVENTION

In this invention, a liquid metal contact means, such as liquid mercury or gallium, is contained in an electrocoating vessel and connected to a source of DC electrical power. A liquid heavier than the aqueous coating bath and having high resistance to the passage of electrical current forms a covering layer over the liquid metal to insulate the liquid metal from the coating bath. An article to be electrocoated is immersed in the aqueous bath with an electrical path extending through the intermediate insulating liquid layer to make electrical contact with the liquid metal. An electrode of opposite polarity is immersed in the coating bath and connected to the power source to complete the circuit. The intermediate insulating liquid forms a continuous layer between the liquid electrode and the coating bath, preventing chemical or electrochemical interaction between these phases. That portion of the ware which contacts the coating bath is coated anodically or cathodically while the portions of the ware in contact with the liquid metal and insulating liquid remain uncoated. By shifting the position of the ware, the uncoated portions can contact the coating bath and uniform coating can be obtained in some systems.

THE DRAWING

FIG. 1 is a vertical cross section view of an electrocoating tank showing an electrical circuit schematically; and

FIG. 2 is a vertical cross section view of a rotary coating vessel.

DESCRIPTION

In FIG. 1, an electrocoating tank 10 contains a layer of liquid mercury metal 12, which is electrically connected to a source of direct current potential, such as power source 14, through a solid metal plate 16. A thin layer of insulating liquid 20 is laid over the mercury 12 and the aqueous electrocoating bath 22 is contained in the vessel 10 over the insulating layer

20. A second electrode 24 is immersed in the electrocoating bath 22 and connected to the DC power source 14.

The circuit is completed when an article 30 to be coated from the bath 22 is placed in electrical contact with the liquid mercury 12, extending through the intermediate insulating layer 20, the portion 32 of the article below the interface between the insulating layer and coating bath is not electrocoated in this position. The portion of the article extending through the insulating layer into the liquid mercury may be formed integrally with the article 30 or may be a separate conductor attached to the portion being coated. The electrocoating vessel 10 can be constructed on an insulating material or a metal tank can be provided with a layer of insulation in those portions exposed to the electrocoating bath 22. The article to be coated can be carried through the tank 10 by a conveyor or other suitable handling equipment.

A second embodiment of the invention, especially adapted for coating smaller articles is shown in FIG. 2. A rotary electrocoating vessel 10A in the shape of a cylindrical drum contains a body of liquid metal 12, an insulating liquid layer 20 and an electrocoating bath 22. Electrical contact is made from the liquid metal 12 to the power source 14 through an insulated conductor 15 and a movable brush device 17. An electrode 24 is suspended in the bath 22. Articles 30A to be electrocoated are placed in the bath, with some portions extending through the insulating layer 20 to establish electrical contact. The relative positions of the articles 30A are shifted by rotation of the coating vessel 10A. After the desired coating is obtained, the articles are removed.

The insulating liquid can be chosen from a variety of chemical compounds or mixtures of different compounds. This liquid should be substantially inert to the components of the aqueous coating bath as well as the liquid metal phase. A desirable insulating liquid is insoluble in the other liquids and has a specific gravity greater than the aqueous electrocoating bath under the conditions of operation. Its boiling point must be higher than the operating temperature of the electrocoating process and the preferred insulating liquids have a boiling point greater than 70° C. To assure complete separation of the coating bath and insulating liquid, the latter should have a specific gravity greater than 1.1 g./l. High electrical resistivity is needed and those insulating liquids having an electrical resistivity greater than about 10^7 ohm-cm. are suitable. The preferred insulating liquids include the halogenated hydrocarbons such as bromobenzene, carbon tetrachloride, 1,2-dichloroethane, 1,1,1-trichloroethane and n-propyl bromide. Other insulating liquids include the nitro-substituted compounds and carbon disulfide, if compatible with the overall system. The thickness of the insulating layer should be sufficient to prevent electrical contact between the liquid metal and electrocoating bath. Ordinarily this layer can be less than a millimeter; but if the lower portion of the article is to be masked to prevent deposition of coating material, the insulating layer can be thicker. At high DC potential, the electrical breakdown of a very thin layer can become a problem and dielectric properties should be considered for such applications.

The preferred liquid metal is mercury, although gallium can be used at higher temperatures. The amount of liquid metal is not critical. If a metal bottomed vessel is used, a thin film can be sufficient for many systems. The high specific gravity of these metals will float many metal articles being electrocoated.

As examples of electrocoating baths which can be used in the practice of this invention, three types of aqueous baths will be discussed. One typical system is the electrolytic plating of metals, such as copper, from an aqueous solution of the metal salt, such as copper sulfate or cyanide. In these systems, the article to be coated is biased cathodically and the metal cations discharge at the surface of the article to form the metal coating.

If the article to be coated is an oxidizable metal such as aluminum or tantalum, an oxide coating may be deposited by ap-

plying a positive potential to the article and contacting the metal surface with an aqueous anodizing solution containing oxygen-forming anions, such as hydroxyl, sulfate or oxalate ions.

Another electrocoating bath which can be used is a water-dispersion of a polycarboxylic acid resin having an acid value greater than about 30 and being at least partially neutralized with a base. Such resins are disclosed in U.S. Pat. No. 3,230,162.

While the invention has been described by reference to specific examples, there is no intent to limit the inventive concept except as set forth in the following claims.

1. A process for coating an electrically conductive article with coating material from an aqueous electrocoating bath comprising the steps of:

containing a liquid metal in an electrocoating vessel, said liquid metal comprising mercury or gallium;
maintaining a layer of high-resistivity inert liquid in contact with the liquid metal electrode and an aqueous electrocoating bath to electrically insulate the liquid metal electrode from the aqueous electrocoating bath with an intermediate layer, said high-resistivity liquid having a specific gravity greater than the aqueous electrocoating bath and less than the liquid metal;

immersing the article to be coated in the aqueous electrocoating bath while providing an electrical contact between the liquid metal electrode extending through the intermediate insulating layer; and biasing the liquid metal electrode and article to be coated with a direct current potential to produce an electrochemically deposited coating on the article.

2. The process of claim 1 wherein the liquid metal consists essentially of mercury and the high-resistivity liquid consists

essentially of halogenated hydrocarbons having a specific gravity greater than 1.1 g./l., a boiling point higher than 70° C. and an electrical resistivity greater than 10⁷ ohm-cm.,

3. The process of claim 1 wherein the metal electrode is biased anodically and the aqueous electrocoating bath comprises a dispersion of a polycarboxylic acid resin having an acid value greater than about 30 and being at least partially neutralized with a base.

4. The process of claim 1 wherein the liquid metal electrode and article are biased anodically and the aqueous coating bath consists essentially of an electrolytic solution containing oxygen-forming anions.

5. The process of claim 1 wherein the liquid article comprises aluminum and the electrochemically deposited coating consists essentially of aluminum oxide.

6. The process of claim 1 wherein the liquid metal electrode and article are biased cathodically and the aqueous electrocoating bath consists essentially of an electrolytic solution of metal ions.

7. In electrocoating apparatus wherein an electrically conductive article in contact with an aqueous coating bath is biased with a direct current potential through electrical contact with a liquid mercury contact means, the improvement which comprises:

a high-resistivity liquid disposed in a continuous intermediate layer between the aqueous coating bath and the liquid mercury contact means whereby an electrical path is provided from the liquid mercury to the aqueous bath through the conductive article extending through the high-resistivity liquid and whereby liquid mercury is electrically insulated from direct contact with the aqueous coating bath by the layer of high-resistivity liquid.

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