

UNITED STATES PATENT OFFICE

1,946,150

COATING OF ALUMINUM

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No Drawing. Application May 15, 1931
Serial No. 537,754

13 Claims. (Cl. 204—1)

This invention relates to the treatment of aluminum and aluminum alloy surfaces to produce thereon a dense white coating. The term "aluminum" as used herein and in the appended claims includes that metal in every degree of purity and alloys thereof containing sufficient aluminum to permit the formation of a suitable oxide coating on the surface of the article as explained hereinafter.

The many uses of aluminum in the decorative arts have made very desirable the development of suitable processes by which a permanent white color may be imparted to the aluminum surface, and the provision of such a process is one of the objects of my invention. A further object is to provide a process which is simple and effective in operation and which may be practiced on a large scale at a reasonable cost and with a minimum of difficulty.

In the course of an extensive investigation directed toward the development of suitable processes and methods for coloring the surface of aluminum and its alloys, I have discovered that a white color is particularly difficult to obtain in a coating which is adherent and substantially permanent. Such white coatings can, however, be readily obtained by my present invention which, briefly stated, comprises first treating the aluminum article to produce on its surface an adherent oxide coating and thereafter treating this coating with a reagent capable of removing colored impurities from such coating to leave a pure white aluminum oxide film in a dense adherent form as a coating on the aluminum surface.

The term "oxide coating" as used herein is a well known designation in the art to describe a layer of aluminum oxide artificially produced on the aluminum surface by chemical treatment, with or without the use of externally applied electrical energy, but the term does not include the thin film of aluminum oxide which is naturally formed upon the metal by contact with the air.

For the purpose of my invention, oxide coatings may be produced on aluminum or aluminum alloy surfaces by any one of several methods. For example, the aluminum surface may be treated with a solution of an alkali carbonate and a soluble dichromate in any suitable manner, such as by immersion, or the oxide may be produced by the anodic oxidation of the aluminum surface in a sulphuric acid solution or an oxalic acid solution.

When the oxide coating is produced upon the

aluminum surface by treatment with an alkali carbonate and soluble dichromate as the reagents, a variety of solutions of an alkali carbonate and soluble dichromate may be used, but I prefer a solution of sodium carbonate and potassium dichromate containing about 0.5 to 6.0 per cent of carbonate and about 0.1 to 1.0 per cent of dichromate, and I have obtained particularly good results with about 2 per cent of the former and about 0.5 per cent of the latter. Simple immersion of the piece to be coated in the treating solution is generally sufficient to produce a satisfactory oxide coating, but any suitable method of applying the solution to the surface may be used. It is preferred that the treatment be made in a hot solution as there is thereby obtained a coating of greater thickness and density which is more satisfactory for my purpose. The oxide coating obtained by this method is dense and adherent and is characterized by a dull gray color.

In the anodic oxidation of aluminum or aluminum alloy surfaces by the use of sulphuric acid solutions, the concentration of the acid may range from about 1 to 70 per cent. The metallic article to be coated is placed in the bath and made the anode in an electric circuit. When a solution of 7 per cent sulphuric acid is used, a current of about 0.01 to 0.4 amperes per square inch is impressed upon the aluminum article and the action of the acid solution on the aluminum or aluminum alloy is allowed to continue for about 30 minutes. When lower concentrations of acid are used, heating of the solution is preferred to increase the rapidity of the action. With high concentrations of acid, lower current densities are preferably impressed on the anode.

Suitable oxide coatings may also be produced by anodically coating the aluminum article in an oxalic acid solution. An aqueous solution of oxalic acid is used, the concentration of the acid ranging from about 1 to 10 per cent. When a solution of 5 per cent oxalic acid is used, a current of 0.01 to 0.1 amperes per square inch is impressed upon the article for about 30 minutes.

After the oxide coating has been formed on the aluminum surface, I treat the metal, preferably by immersion, with a reagent which will act upon the oxide coating to remove the colored constituents therefrom and to leave a dense white surface. For this purpose, I have found a solution of nitric acid, a solution of sulphuric acid, or a mixture of nitric and sulphuric acids, or a solution of hydrofluoric acid to be satisfactory. I have found also that while white coatings may be

obtained by treatment of an oxide coating produced in any one of the above described methods, with any one of these acids or acid mixtures, there are certain of these acids which are to be preferred for the treatment of coatings produced in certain ways. For example, I prefer to treat coatings produced by immersion of the aluminum in a sodium carbonate-potassium dichromate solution with a solution of nitric acid or a mixture of nitric and sulphuric acids, while I prefer to treat an anodic coating produced in sulphuric acid or oxalic acid with a solution of hydrofluoric acid to produce the white color desired.

The concentration of the acid solution used does not appear to be a critical factor when nitric or sulphuric acids or mixtures of these two are used, although I have found that when sulphuric acid is used more concentrated solutions are generally required than when nitric acid is used to obtain similar results. Considerably weaker solutions of hydrofluoric acid are required, however, and the concentration of such solutions should not exceed about 10 per cent by weight of hydrofluoric acid, and I prefer to use solutions containing about 5 per cent of acid. When using nitric acid solutions, I prefer to use a solution containing at least about 30 per cent by weight of acid, and I have obtained particularly good results with a 35 per cent solution. Solutions containing about 60 to 80 per cent by weight of sulphuric acid have been found satisfactory. When I use a mixture of nitric and sulphuric acids, I prefer to use a solution containing about 50 per cent by weight of acid in proportions of 1 part of nitric acid to 1 part of sulphuric acid.

The length of time of treatment of the oxide coating with the acid solution varies with the type of oxide coating treated, the type and concentration of the acid solution used, and the temperature of the acid solution. In general, I have found a shorter treatment with acid is required for sodium carbonate-potassium dichromate coatings than for sulphuric acid or oxalic acid anodic coatings to obtain good results. I have found also that when using hydrofluoric acid as the treating agent, a considerably shorter period of treatment is required, regardless of what type of coating is being treated. When using nitric acid solutions, I may use either hot or cold solutions and I prefer to use a hot solution when using the acid in a concentration of about 30 to 35 per cent. When using sulphuric acid solutions, however, or solutions of sulphuric and nitric acid, I prefer to use cold solutions because of the solvent action of such solutions on the oxide film. Hydrofluoric acid solutions should also be used cold.

I have found also that the intensity of the white coating produced on the aluminum or aluminum alloy surface may be regulated by varying the thickness of the oxide coating which is originally produced on the aluminum surface. If the aluminum in the oxide coating process is immersed in the solution for a brief period, a thin film of oxide coating will be obtained. With longer immersion, the thickness of this oxide coating increases and in this way a satisfactory, adherent coating of the desired thickness will be produced. A more intense white color is in general produced with a heavy oxide coating than with a thin coating on treatment with the acid solution.

As a specific example of the method by which my invention may be practiced, an aluminum article was immersed for 20 minutes in a hot

aqueous solution containing 20 grams per liter of sodium carbonate and 5 grams per liter of potassium dichromate. At the end of this time, the metal was removed from the solution, washed, and immersed in a hot 35 per cent nitric acid solution. The article, after removal from the nitric acid solution, had on its surface an intense white coating which was dense and adherent and substantially permanent.

As a further example of the method by which my method may be practiced, an aluminum article was anodically coated in 7 per cent sulphuric acid solution for 30 minutes. At the end of this time, the metal was removed from the coating bath, washed, and immersed in a 5 per cent solution of hydrofluoric acid for one minute. There was produced upon the surface of the article by this treatment a dense white coating which was adherent and substantially permanent.

It is to be understood that this invention is not limited to the specific details herein described but may be carried out in other ways without departure from its spirit.

I claim:

1. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of an acid.

2. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of an acid having a solvent action on the colored constituents contained therein.

3. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of nitric acid.

4. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of sulphuric acid.

5. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of nitric and sulphuric acids.

6. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of hydrofluoric acid.

7. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating by treating the metal surface with a solution containing an alkali carbonate and a soluble dichromate and subjecting the oxide coating to a non-electrolytic treatment with a solution of an acid.

8. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating by making such article the anode in an electrolytic cell containing a sulphuric acid electrolyte and impressing a current thereon and

subjecting the oxide coating to a non-electrolytic treatment with a solution of an acid.

ble dichromate to form thereon an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of nitric and sulphuric acids.

9. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating by making such article the anode in an electrolytic cell containing an oxalic acid electrolyte and impressing a current thereon and subjecting the oxide coating to a non-electrolytic treatment with a solution of an acid.

12. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating by making such article the anode in an electrolytic cell containing a sulphur acid electrolyte and impressing a current thereon and subjecting the oxide coating to a non-electrolytic treatment with a solution of hydrofluoric acid.

10. The method of producing white coatings on aluminum or aluminum alloy articles comprising treating the metal surface with a solution containing an alkali carbonate and a soluble dichromate to form thereon an adherent oxide coating and subjecting said coating to a non-electrolytic treatment with a solution of nitric acid.

13. The method of producing white coatings on aluminum or aluminum alloy articles comprising forming on the metal surface an adherent oxide coating by making such article the anode in an electrolytic cell containing an oxalic acid electrolyte and impressing a current thereon and subjecting the oxide coating to a non-electrolytic treatment with a solution of hydrofluoric acid.

11. The method of producing white coatings on aluminum or aluminum alloy articles comprising treating the metal surface with a solution containing an alkali carbonate and a solu-

MARTIN TOSTERUD.

CERTIFICATE OF CORRECTION.

Patent No. 1,946,150.

February 6, 1934.

MARTIN TOSTERUD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 84, claim 12, for "sulphur" read sulphuric; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of March, A. D. 1934.

F. M. Hopkins

(Seal)

Acting Commissioner of Patents.

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