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COATING

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This invention relates to aluminum alloys and products thereof and more especially to the art of producing aluminum coatings thereon.

A principal object of the present invention is to provide a method of producing die cast aluminum alloys having a uniform lustrous surface.

Another object of the present invention is to provide an anodized coating, the shade of which is not only reproducible but independent of the aluminum alloy used.

Another object of the present invention is the provision of aluminum die-cast products and articles having a high quality anodized coating for the purpose of increasing resistance to corrosion, of insulation, of dyeing or for other usual purposes of such type treatment.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

Since pure aluminum metal cannot be die cast, as is well known in the art, aluminum alloys have been utilized to overcome this difficulty. Aluminum alloys, however, are extremely difficult, if not impossible, to anodize satisfactorily. It is oftentimes desirable to provide oxide coatings on aluminum alloys for the purpose of increasing resistance to corrosion, abrasion or insulation for example. Equally important, however, is the necessity of providing a surface which may be dyed to produce various colors.

Accordingly, many methods have been proposed for the treatment of aluminum alloys involving generally the formation on the aluminum alloy surface of a hard film of oxide which is resistant to abrasion and also serves, to a reasonable degree, to prevent chemical corrosion of the aluminum alloy.

Among such methods are the sulfuric acid and chromic acid anodizing baths and variations thereof. When using such methods, the aluminum alloy article such as die castings is brought into contact with the anodizing solution. Such factors as concentration and temperature of the anodizing bath must be rigidly controlled in order to achieve consistent results. However, no method of providing anodized coatings has been presented which is satisfactory for all aluminum alloys and which provides for an anodized article having a smooth, uniform, lustrous surface, in addition to being resistant to corrosion and abrasion.

When presently known methods of anodizing are applied to aluminum alloy articles, such as die cast products, there results an anodized surface which is dull in appearance, ranging from grey to black in color, pitted and generally non-uniform (exception is noted where the purest forms of aluminum are used). This results primarily from the action of the anodizing bath on impurities and/or aluminum alloying ingredients. Such surfaces, in addition to being undesirable in appearance, present serious restrictions when the anodized article is to be subsequently color dyed.

For example, the type of aluminum alloy has a pronounced effect on shade, especially with certain dyes. The brightest and clearest anodic films are produced on the purest form of aluminum, the coatings becoming duller as the amount of alloying constituents are increased. Aluminum alloys containing copper, although forming a thinner and less durable coating than the purer forms, produce a heavier and duller shade. Magnesium has a similar effect although not as pronounced. The presence of silicon imparts a grey to black color to the

anodized coating. Alloys containing more than 5% silicon are not recommended for use with bright dye colors. In view of the fact that the majority of aluminum casting alloys contain appreciable amounts of silicon, ranging as high as 13%, dyeing of such anodized surfaces is greatly limited.

In accordance with the present invention there is provided a novel method of producing anodized aluminum die cast articles which eliminate the difficulties heretofore mentioned.

Briefly stated, the invention comprises vacuum depositing an adherent layer of aluminum metal on the surface of the aluminum alloy die-cast article and then subjecting the aluminum coated article to the anodizing process.

The invention may be better understood by reference to the following detailed description thereof.

Aluminum die cast articles can be used. These alloy castings may contain appreciable amounts of an allyoing element such as silicon, copper, magnesium, iron, manganese, nickel, zinc, chromium, titanium, boron and mixtures thereof which restricts anodizing the aluminum alloy die-casting to a lustrous finish. Whether the castings are used in the "as cast" condition or buffed before coating, all surface contaminants such as oil, grease, dirt and other material must be removed in order to obtain an adherent continuous film of aluminum. Any such contaminants can be removed by means of solvent or vapor degreasing. Suitable organic solvents such as acetone, hexane may be used.

The aluminum die cast articles are preferably polished by buffing before being coated with aluminum. The castings are then placed in a vacuum chamber. The vacuum chamber is evacuated to a pressure of approximately 0.1 to 1 micron Hg abs. The die castings are then heated by radiation to a temperature above 300° C. and below 400° C. The exact temperature is limited by the softening temperature of the castings. This preheating serves not only to activate the die-cast surfaces but also removes volatile surface contaminants not previously removed. Aluminum metal which is substantially free of impurities and alloying elements which restrict anodizing to a lustrous finish is then vaporized and condensed on the surface of the castings. Means are provided for rotating the castings to insure uniform coating. When a film thickness of between 0.75 and 2 mils is obtained the coating process is discontinued. The aluminum coated castings are removed from the vapor chamber and polished by buffing before being subjected to the anodizing process.

The anodizing process used is the sulfuric acid bath type which is well known in the art. The bath consists of 15–25% sulfuric acid by weight at room temperature or at 32° F. A direct current of 12–25 amp./ft.^{2} (14–18 volts) is passed through the bath for 15–30 minutes. It is understood that the anodizing conditions may be varied to change the anodized surface characteristics.

In connection with the anodizing process, the present invention provides the advantage of enabling aluminum oxide films of predetermined thickness to be formed on all alloys of aluminum. Previously, uniform thicknesses of anodized stratum could not be obtained because of the action of the anodizing bath on impurities and alloying ingredients as pointed out above. Now, however, by means of the present process the aluminum metal coating may be substantially completely oxidized where, for example, a hard brittle surface is desired. Similarly, the aluminum metal coating can be only slightly anodized to produce a surface which is flexible.

The invention will now be described by way of specific examples.

Example I

In this example the aluminum die castings consisted of

commerical boat hardware articles and drawer handles both of which were in a polished condition and contained over 5% silicon. These die castings were cleaned of grease and other surface contaminants by washing in acetone. The castings were then placed on a "jig" within the vacuum chamber. The vacuum chamber was then evacuated to a pressure of approximately 0.1 to 1 micron Hg abs. The castings were then heated by radiation to a temperature of about 350° C. The aluminum for coating which is contained in a "Graphitar" crucible was heated to about 1200 to 1250° C. to vaporize the aluminum. When a suitable vaporization rate was obtained, the castings were moved into the coating area. The coating was continued for about 10 minutes to provide a film thickness of 1 mil. The aluminum coated articles were then removed from the vacuum chamber and polished by buffing before being subjected to the anodizing process.

The anodizing bath was at room temperature and contained approximately 15% by weight sulfuric acid. The process was carried out for approximately 15 mintues at a current density of about 12 amp./ft.^{2}, at 10–12 volts.

The resulting anodized articles had a luster equal to or better than the polished die cast starting material.

The articles were then subjected to conventional dyeing methods to provide, for example, pink and gold colors of high quality.

Example II

This example was similar to Example I in all respects except that one-half of each aluminum die casting was coated with aluminum, the other half remaining uncoated. The uncoated section after anodizing had a surface which was black in appearance, uneven and pitted. The coated section, however, after anodizing, had a smooth, uniform, lustrous surface similar to that of Example I.

The anodized coating produced according to the present invention are not only adherent and uniform but also have a bright appearance heretofore not obtainable on aluminum alloys in general and especially high silicon containing aluminum alloys. Moreover, coatings produced according to this invention are easily reproducible notwithstanding the type of aluminum alloy employed. Additionally, since the anodized coating is bright in appearance, conventional dyeing methods may be used to produce colors ranging from light to dark.

Since many possible embodiments may be made of this invention and since many changes may be made in the embodiment hereinbefore set forth, it will be understood that all matter described herein is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A shaped body of die-cast aluminum alloy containing at least one alloying element selected from the group consisting of silicon, copper, magnesium, iron, manganese, nickel, zinc, tin, chromium, titanium and boron which restrict anodizing said body to a lustrous finish, and a smooth lustrous adherent coating of aluminum metal and aluminum oxide on said die-cast body, said coating of aluminum metal and aluminum oxide being substantially free of said alloying elements which restrict anodizing said body to a lustrous finish, said aluminum oxide forming the outer surface of said coating.

2. A shaped body of die-cast aluminum alloy containing at least one alloying element selected from the group consisting of silicon, copper, magnesium, nickel, zinc, tin, chromium, titanium and boron which restrict anodizing said body to a lustrous finish and a smooth lustrous adherent film of aluminum metal and aluminum oxide on said die-cast body, said film of aluminum metal and aluminum oxide being substantially free of said alloying elements which restrict anodizing said body to a lustrous finish and having a thickness of between about .75 to 2 mils, said aluminum oxide forming the outer surface of said film and being substantially resistant to corrosion and abrasion.

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