

[54] **ALUMINUM ELEMENT HAVING
INTEGRAL SEPIA SURFACE AND METHOD
THEREFOR**

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[51] **Int. Cl.**..... **C23f 7/00**

[58] **Field of Search**..... **148/6.14 R, 6.27; 117/75**

[56] **References Cited**

UNITED STATES PATENTS

2,393,663 1/1946 Thomas et al. 148/6.2

2,550,328	4/1951	Cohn	148/6.2
2,927,872	3/1960	Cohn	148/6.27 X
3,607,452	9/1971	Marosi	148/6.27 X

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[57] **ABSTRACT**

Sepia-tone conversion/organic coatings on aluminum structural elements are obtained by altering the element surface by reaction with alkaline sodium formate solution, and coating the altered surface with a clear polymeric coating.

13 Claims, No Drawings

ALUMINUM ELEMENT HAVING INTEGRAL SEPIA SURFACE AND METHOD THEREFOR

BACKGROUND OF THE INVENTION

This invention has to do with structural aluminum elements useful in automotive, architectural and decorative applications. More particularly the invention is concerned with a method of providing such aluminum elements with a sepia tone surface of great beauty. This method produces a surface treatment on aluminum which because of its superior toughness and durability in handling and weathering is functionally advantageous and which because realized without electrochemical processing is lower in cost, and commercially more attractive than older, still widely practiced methods, such as anodizing.

Prior Art

The art and science of contributing color to aluminum have been highly developed. Primary among such techniques are painting which is broadly inclusive of organic, pigmented coatings, and anodizing, either of which techniques may give a wide variety of color. Paint, however is subject to deterioration over time, and anodizing is costly. Conversion coatings on aluminum are known e.g., see my earlier patent U.S. Pat. No. 2,836,526, in which chemical reaction at the aluminum element surface is used to improve the performance of the element against weather, or to improve the bonding of organic coatings to the element, or to contribute a particular, desired, aesthetic effect, or all three purposes may be realized.

A popular architectural color is a metallic brown, which is imposing and rich in interior decor and quite striking when used as the exterior facing of a building. Indeed, the future of aluminum, as an architectural metal depends on satisfactory resolution of the need of obtaining rich, uniform color, especially browns or sepias and retention of this richness and uniformity despite subjection to atmospheric contaminants, salt, moisture and radiation. Thusfar, anodizing has not been able to provide a completely satisfactory sepia surface colored, aluminum, structural, e.g., architectural element. One manner of achieving a brown to black coating is described in my earlier patent, U.S. Pat. No. 3,607,452, wherein an acrylic polymer and iron is used to form the color layer and a clear acrylic polymer overcoat is superadded.

SUMMARY OF THE INVENTION

The invention to be described hereinafter employs a different reagent: sodium formate, and no resin in the initial step. It is accordingly an objective of the present invention to provide a sepia-tone structural, e.g., architectural aluminum element. It is an object of the invention to provide such elements by chemical means, at lower operating expense and investment cost, and with greater permanence, uniformity, depth and richness of tone than heretofore achieved. Other objects will become apparent hereinafter.

In general the foregoing purposes are realized by the present method of forming sepia-tone coatings on aluminum structural elements which comprises briefly surface reacting the element in a highly dilute, alkaline, elevated temperature, aqueous solution of sodium formate, or other alkali metal formate, and once reacted,

overcoating the surface with a clear colorless, resinous film.

PREFERRED EMBODIMENTS

More particularly the invention contemplates a first step of surface reacting the aluminum metal element to be treated to alter the optical properties of the surface in a special way distinctively conducive to sepia-toning of the surface, and thereafter realizing the sepia tone through over-coating the treated, altered surface with a clear, nonpigmented resinous film.

The operating parameters for the initial treating step are narrowly critical, but the resinous overlayer may generally be any film forming material, not contributing a color of its own, and suitably weathering resistant, per se, where exposure to sun and salt is envisioned, as in building exterior applications.

In carrying out the method, an aluminum element is cleaned of oil, grease and the like with a dilute detergent solution, deoxidized if necessary with a light treatment in dilute caustic e.g., 5-15 percent by weight NaOH at elevated temperatures, and thus cleaned is subjected to the novel treatment now to be described.

A bath is prepared by dissolving in water an alkali metal formate, e.g., potassium formate, cesium formate, or, and particularly, sodium formate which is the least costly and most effective and which will be used for illustrative purposes hereinafter. The solution is highly dilute. Typical concentrations are 0.1 to 3 percent by weight sodium formate, with 0.5 to 1.5 percent by weight being highly satisfactory, and about 1 percent being the most highly preferred concentration of sodium formate. The pH of the bath is to be between 9 and 10, and caustic or other base may be added as necessary to bring the bath into this range. The bath temperature is elevated, but well below boiling. A temperature range of 170° to 190°F is generally used.

After preparation of the bath, the aluminum element is immersed therein as the most effective technique for ensuring the duration and intimacy of contact necessary for the reaction to take place, although flushing or heavy spraying of the surface might be used in some circumstances. As noted the aluminum surface is pre-cleaned to be free of oxide and contaminants prior to immersion in the bath. Times of immersion are brief, e.g., 10 to 15 or 30 minutes with times as little as 5 minutes being suitable only for light treatment and times up to 1 hour or more being useful but conferring no particular advantage over the 30 minute maximum in the range given.

Following immersion in the bath for the requisite time, the element is removed and water rinsed before the over-coating step, to prevent contamination of the overcoating system and to enhance the bonding of the resinous coating to the treated substrate. After one or two water rinses, e.g., by dipping, the element is ready for the sepia tone producing step.

Surprisingly, the sepia tone is produced by the application of a clear, nonpigmented, undyed, resinous film over the sodium formate treated surface, without more. The sodium formate treatment chemically alters the aluminum surface in such wise that a physical change in the crystalline structure forming the element surface occurs, in a presently undetected manner. The effect of the change is seen in the production of a sepia tone

upon the second important step in the method: application of the resinous film overcoating.

The optical and chemical mechanisms to account for the obtaining of a sepia tone surface on aluminum according to the invention are not fully understood, nonetheless, and without wishing to be bound to any particular theoretical explanation of the phenomenon observed in practice of the method herein, it may be theorized that the usual refractive, absorptive and/or reflectivity properties of the elemental aluminum metal surface are first chemically altered to be different in optical response by the reaction therewith of the sodium formate in solution, under alkaline conditions. The thus chemically altered surface, still not apparently sepia in tone, is then coated with a clear resinous, film forming coating having its own refractive, absorptive and reflective qualities, which are different from either the elemental aluminum or the chemically altered aluminum surface in this respect. The juxtaposition of the resinous, film coating with its refractive properties and the chemically treated aluminum surface with its refractive, absorptive and reflective properties altered from the elemental aluminum properties then causes a combination of refractive, reflective and absorptive modifications to the incident light radiation which results in the surface having a sepia-tone to the eye.

In any case, to obtain the sepia tone, the sodium formate pretreated element surface is coated with from 0.1 to 10 or more mils of resinous film. Lacquers may be used as the resinous coating, but the superior handling abilities and tailored weathering properties of now available synthetic organic polymers dictates the use of these latter resinous products as the film forming resin.

Many resins will be useful if clear and film forming and of course adherent to the chemically altered, treated surface.

Preferred resins are the acrylic and methacrylic polymers and copolymers, which have the advantages of outstanding weatherability, clarity, and availability in water emulsion form. Particularly useful are copolymers of acrylic acid, or methacrylic acid with an ethylenically unsaturated hydrocarbon e.g., having two carbon atoms, i.e., ethylene-acrylic acid, or ethylene-methacrylic acid copolymers; copolymers of alkyl esters of these acids particularly the methyl and ethyl acrylate esters with ethylene and aromatic ethylenically unsaturated hydrocarbons such as and particularly styrene. Styrene-acrylic, styrene-methacrylic and ethyl acrylate ester and methyl methacrylate ester forms of these acids are highly preferred copolymers, particularly those containing from 10 to 70 parts of the acid, or acid ester and the balance styrene. Generally then, it is preferred to employ as the resinous overcoat an acrylic or methacrylic acid, or acid methyl or ethyl ester of such acid copolymer with an ethylenically unsaturated hydrocarbon having up to and including eight carbon atoms.

Following coating with the resin, the water if an emulsion, or solvent if a solution, is driven off by heating, to bake the overcoating onto the chemically altered aluminum surface, as a continuous film; which element thus has a sepia-tone.

In some embodiments of the method a stabilizer may be added to the chemically altered element surface, and prior to application of the resinous overcoating. This is accomplished by diffusing nickel ion into and

through the atomic structure on the element surface following, or simultaneously, with the chemical alteration treatment with sodium formate. A separate, or conjoint highly dilute e.g., 0.5 to 5 percent and particularly 1 percent by weight solution at ambient temperature of a water soluble nickel salt, e.g., nickel sulfate immersion of the surface altered, uncoated element for 15 to 30 minutes will be satisfactory. Other nickel salts including nickel chloride, nickel fluoride, nickel bromide, nickel nitrate and the like nickel salts may be employed where the chemical alteration of the aluminum element surface by the sodium formate is not adversely affected thereby.

EXAMPLE

An aluminum window frame section is washed in an agitated 1 percent detergent solution, dipped in 5 percent aqueous caustic at an elevated temperature less than 100°F for five minutes, then immersed in a 1 percent solution (pH 9-10) of sodium formate at a temperature of 180°F for 10 minutes. After rinsing the sodium formate from the part, the part is immersed in a commercial acrylic copolymer emulsion and after less than five minutes is withdrawn, dripped briefly and force dried in an oven.

A uniformly sepia-tone section is obtained. This section may be bent back on itself without chipping, cracking or flaking off of the coating, illustrating a further important advantage of the sepia-tone coating method hereinabove disclosed.

I claim:

1. Method of forming sepia-tone coatings on aluminum structural elements comprising surface reacting the element for 10 to 30 minutes in a bath at a temperature between 170° and 190°F, said bath having a pH of between 9 and 10 and consisting essentially of 0.1 to 3 percent by weight alkali metal formate and water; rinsing the surface, and thereafter overcoating with a clear, colorless resinous film.

2. Method according to claim 1 including also subjecting the surface reacted element to immersion in highly dilute aqueous nickel ion solution, prior to said overcoating step.

3. Method according to claim 2 in which said element is immersed in a 1 percent by weight solution of a nickel salt.

4. Method according to claim 1 in which the element surface is immersed in said bath for 10 minutes.

5. Method according to claim 1 in which the alkali metal formate is sodium formate.

6. Method according to claim 5 in which the concentration of sodium formate in the bath is between 0.5 and 1.5 percent by weight.

7. Method according to claim 6 in which the element surface is immersed in said bath for 10 to 15 minutes.

8. Method according to claim 7 in which the resinous film overcoating comprises synthetic organic polymer.

9. Method according to claim 8 in which the synthetic organic polymer comprises an acrylic or methacrylic acid or acid methyl or ethyl ester copolymer with an ethylenically unsaturated hydrocarbon containing up to eight carbon atoms.

10. Method according to claim 9 in which said element surface is immersed in an aqueous emulsion of

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said copolymer and dried with heating, to coat the surface.

11. Method according to claim 10 in which the sodium formate reacted surface is subjected to immersion in a 1 percent by weight nickel sulfate solution prior to overcoating with said copolymer.

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12. Aluminum structural element having a sepia tone surface prepared by the method of claim 1.

13. Aluminum structural element having a sepia tone surface prepared by the method of claim 11.

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