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PROCESS FOR DECORATING ALUMINUM

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This invention relates to a process for decorating products formed of aluminum and has particular reference to the production of variegated designs on oxide-coated surfaces of such products.

The term "aluminum" as used herein includes this metal in every degree of purity as well as metallic alloys whose compositions have a content of aluminum sufficient to permit the formation of a substantial thickness or coating of porous aluminum oxide thereon by conventional anodizing or chemical conversion techniques.

An object of the present invention is to provide a process for decorating oxide-coated surfaces of aluminum which, with considerably less than the usual complication in this field, will yield variegated designs of prescribed patterns on a reliably repetitive basis.

Another object is to provide for the production of designs of unlimited configurations which display a natural-appearing pleasing blend of coloring rather than the usual mechanical appearance.

A further object is to achieve multi-coloring of oxide-coated aluminum in a single step; and

A still further object is to achieve all of the foregoing objectives in an unusually simple and economical manner.

In order to attain the aforesaid objects and others which may appear from the following description in accordance with principles of this invention, we have devised a process wherein a carrier which supports but does not dissolve dyestuffs is used to locate such colorant in a specified area of an oxide-coated surface intended to be decorated. Once located in a prescribed pattern on the oxide-coated surface, the carrier and suspended colorant are simultaneously dissolved to release the colorant immediately into the oxide coating. The carrier supports without dissolution any desired number or combination of differently colored dyestuffs so that variegated coloring of the oxide coating may be effected with a single application of the carrier-colorant combination or "printing ink" as it will be referred to hereinafter.

Any desired design or prescribed pattern of coloring may be achieved by stenciling, silk screening, rubber stamping, offset printing or hand-applying the printing ink to the oxide-coated surface. All such techniques of applying the printing ink will be termed as "printing" in the following description and the use of this term hereinafter is intended to include any one or all thereof. The design work may also be applied over background coloring previously applied to the subject surface.

As a corollary feature of the present process, slight bleeding of the colorants during their penetration into the oxide coatings produces a blending of colors which renders the decoration peculiarly non-mechanical in appearance and, accordingly, aesthetically pleasing in that designs may be made to closely resemble the natural coloring of marble, for example, or other blends and forms of designs and coloring found in nature.

The present invention will be mode fully understood by

reference to the following detailed description of our process:

As already mentioned, the invention relates more particularly to the treatment of oxide coatings on aluminum whether such coatings are formed by anodizing, chemical conversion or other recognized processes. It should be understood, however, that the coatings need be of a porous nature, i.e. unsealed and of appreciable thickness so as to readily absorb a substantial quantity of the dyestuffs applied thereto. Accordingly, the thin film of aluminum oxide which is normally formed upon such metal by exposure to air is generally unsuitable. Our process relates more particularly to the treatment of artificially-produced aluminum oxide coatings. Such oxide coatings may be formed by making a piece of aluminum the anode in an electrically-charged electrolytic cell containing an electrolyte such as sulfuric acid or they may be formed without the use of electrical energy by immersion of the piece in a suitable, generally alkaline, solution. Anodizing and chemical conversion processes for producing artificial oxide coatings on aluminum are well-known in the art and, accordingly, should not require detailed discussion herein.

In the matter of the present invention, it is only necessary that the subject process begin with the provision of a piece of aluminum having a suitable surface coating of porous aluminum oxide. The coating, however, should be rendered free of acids or other residues of solutions used to form the same and dried. This may be accomplished in conventional fashion by neutralizing the oxide-coated piece in a mild solution of sodium carbonate and rinsing same with water. Thereafter, the piece may be air-dried or baked at a moderate temperature if acceleration of the drying time is desired.

Decoration of the cleansed and dried oxide-coated piece according to principles of the invention is accomplished as follows:

A design of any desired configuration or prescribed pattern is printed on the surface of the dry, unsealed oxide coating with a printing ink containing a suspension of one or any desired larger number or combination of differently colored dyestuffs in a carrier in which the dyestuffs are insoluble. The printing is allowed to air-dry to facilitate handling of the aluminum piece and then is immersed in a solvent for both the dyestuffs and carrier. Upon immersion in the solvent, the dispersed dyestuffs in the printing ink immediately penetrate into pores of the oxide coating in substantially the same pattern as was printed thereon. Agitation of the solvent and/or of the piece placed therein is minimized so as to prevent undue mixing of the dyestuffs during dissolution thereof and possible disruption of the printed pattern. In multi-color applications, slight bleeding of one colorant peripherally into another during their penetration into the oxide coating produces a unique blending of all of the colors within the design and a feathering or blending of the edges of the pattern per se into its background. Thus, a colored design of prescribed pattern but of non-mechanical appearance is established in the oxide coating. The coating may then be sealed in the usual manner such as by immersion in hot water or a hot nickel acetate bath to prevent subsequent staining and/or fading of the design.

It should be understood that if background coloring is desired, the oxide-coated piece may be uniformly dyed prior to the above-described printing thereof. Background coloring may be applied by immersing the piece in a water bath containing a preselected monochromatic water-

soluble azo or other suitable dye. Following such treatment, however, the piece should be rinsed with clear water and thoroughly dried before proceeding with the design work.

The invention will be better understood from the following examples of printing inks, dyes and procedures applicable to actual practice of the invention. These examples, however, are to be considered only as being illustrative and not as limitative of such broader aspects of the invention as may come within the scope of the appendant claims.

Colorants or dyestuffs used in the aforementioned printing ink may comprise any of those heretofore employed in coloring aluminum oxide. For example, the azo dyes and/or materials such as ferric ammonium oxalate may be used.

According to one aspect of the invention, the printing ink comprises water-soluble dyestuffs dispersed in a carrier consisting of a water-soluble polymer dissolved in an organic solvent such as a glycol or alcohol in which the dyestuffs are not soluble.

A typical printing ink may comprise as its carrier, carrier solvent and dyestuffs respectively:

	Grams
50% solids solution of a copolymer of vinyl pyrrolidone and vinyl acetate	100
Ethylene glycol or isopropyl alcohol	12
Water-soluble dyes of one or any desired greater number of colors	5

The ratio of vinyl pyrrolidone to vinyl acetate in the above-given copolymer may be varied, for example, to include from 75% to 90% vinyl pyrrolidone. The percentage by weight of the carrier solvent and/or dyestuffs need be controlled only by their effect on the viscosity of the total mixture according to the suitability of such as a printing ink for silk screening, printing or whatever technique is employed in forming the aforementioned designs. Other suitable carriers are polyvinyl alcohol or a copolymer of methyl vinyl ether and maleic anhydride.

One mode of practicing the invention is as follows:

A piece of aluminum is anodized in a conventional manner such as forty minutes at 12 amperes per square foot in an electrolyte containing about 15% sulfuric acid at 70° F. to provide thereon an aluminum oxide coating of approximately 0.0006 in thick;

The piece is rinsed in water and neutralized in a mild solution of sodium carbonate to remove all acid;

It is next dyed for background coloring by immersion in a water bath containing approximately 0.25 gram per liter of a water-soluble dye such as that known commercially as Sandoz gold EA, manufactured by Sandoz, Inc.;

The piece is then rinsed with clear water and dried;

A design of prescribed pattern is printed on a preselected area of the dyed oxide coating using the aforementioned printing ink containing, for example, 3 grams of bronze dye and 2 grams of green dye such as those known commercially as Bronze G and Aluminum Green LWN, manufactured by American Hoeschst Corp.;

The printed design is allowed to air-dry to facilitate handling of the piece and then is immersed in a water bath in which the temperature and pH are controlled at approximately 140° F. and 4.5 respectively. The printing ink including its dyestuffs is dissolved by the water bath causing the dyestuffs to penetrate into the pores of the oxide coating in substantially the same pattern as was originally printed thereon. This develops a multicolored design in green and brown on a gold background.

The piece is then rinsed with clear water and sealed in hot water or a 0.5% nickel acetate bath at or near the boiling point to lock the color in the oxide coating and prevent subsequent fading and/or staining thereof.

While the foregoing examples of printing inks have dealt with the use of water-soluble dyes and carriers, it should be understood that water-insoluble dyestuffs and/or carriers may also be used according to principles of our invention.

In this regard, a printing ink may consist of either the copolymer of vinyl pyrrolidone and vinyl acetate, methyl vinyl ether and maleic anhydride or polyvinyl alcohol dissolved in water rather than in the aforementioned organic solvent and have added thereto a preselected amount of azoic azo dyes and/or other water-insoluble dyestuffs. A specific example of a suitable water-insoluble dye would be that commonly known in this art as "Sudan I." For simultaneous dissolution of the foregoing dyestuffs and carrier, following the printing of an aluminum piece therewith, the piece would be immersed in an alcohol, e.g. methanol.

A printing ink wherein both the dyestuffs and carrier are water-insoluble may also be employed in carrying out the process of our invention. This may, for example, consist of a spirit soluble dyestuff such as the well-known and commercially available "Blue II" (manufactured by Farbwerke Hoeschst AG) suspended in a carrier of petroleum jelly or a similar high molecular weight petroleum fraction. Following printing therewith, simultaneous dissolution of both the dyestuff and carrier may be accomplished by soaking same in mineral spirits or a similar hydrocarbon solvent blend.

Prior to the use of any one of the printing inks which incorporate water-insoluble dyes, the earlier-described procedure for providing background coloring may be employed. Also, final sealing of the design work in a subject oxide coating may be accomplished by placing the coating in a hot aqueous or nickel acetate bath as mentioned in the first described mode of the invention.

It should be understood that prior to the final sealing step in any one of the aforementioned exemplary procedures, the steps of printing and "developing" (i.e. simultaneous dissolution of the dyestuffs and carrier) may be repeated any number of times when it is desired to superimpose one or more designs of different configuration and/or coloring upon a previously printed and developed design. Each repetition, however, should be preceded by the already-described step of rinsing the oxide coating in clear water and drying same.

We claim:

1. In a process of decorating a porous oxide coating on aluminum, the improvement which comprises printing on the surface of said oxide coating a design of prescribed pattern in a printing ink comprised of a number of dyestuffs dispersed in a carrier in which the dyestuffs are insoluble, subjecting the printed oxide coating to a solvent for both the dyestuffs and carrier to cause said dyestuffs to penetrate into said coating in a pattern substantially identical to that of said printing and sealing the pores of said oxide coating.

2. The process as recited in claim 1 wherein said dyestuffs are multicolorous.

3. The process as recited in claim 1 wherein said dyestuffs and carrier are both soluble in water.

4. The process as recited in claim 1 wherein said dyestuffs and carrier are both water-insoluble.

5. The process as recited in claim 1 wherein said dyestuffs and said carrier are one, water-soluble and the other, water-insoluble.

6. The process as recited in claim 1 including the step of dyeing said porous oxide coating prior to said step of printing said design.

7. The process as recited in claim 1 wherein said steps of printing on said coating and subjecting said printed coating to said solvent are repeated a number of times prior to the sealing of the pores of said oxide coating.

8. The process as recited in claim 7 wherein the configuration of said design of prescribed pattern is varied during at least one repetition of said steps of printing and subjecting said printed coating to said solvent.

9. The process as recited in claim 6 wherein dyestuffs of different colors than those initially used are substituted

in at least one of said repetitions of said steps of printing and subjecting said printed coating to said solvent.

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204—35, 38