Jan. 22, 1957 C. J. SOBOL 2,778,790

DECORATING ANODIZED ALUMINUM

Filed June 30, 1953

Fig. 1.

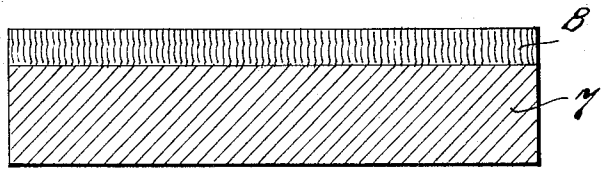


Fig. 2.

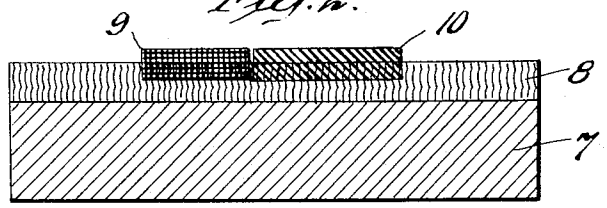


Fig. 3.

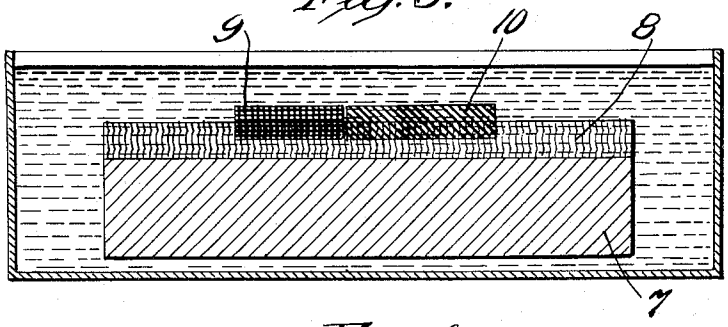


Fig. 4.

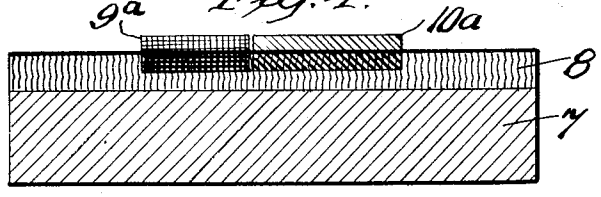
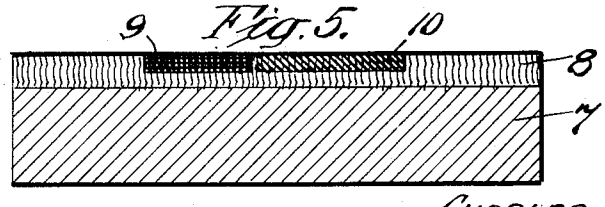


Fig. 5.



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DECORATING ANODIZED ALUMINUM

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4 Claims. (Cl. 204—58)

The invention herein disclosed relates to the decoration of anodized aluminum.

The objects of the invention primarily are to accomplish the decoration or coloration of aluminum objects at low cost and in commercially practical, high production operations.

Particular objects of the invention are to accomplish accurate, uniform, highly artistic and decorative results in single or multiple colors and in simple or complex designs or configurations.

Basically the invention involves printing in any manner, desired designs on the unsealed anodized surface of aluminum with a dye and vehicle, both of which are insoluble in water but in which the vehicle is permeable by water, then hot water sealing all portions of the anodized sheet, including and through the printed design, without dispersion, reduction of color intensity or bleeding into adjacent areas, and finally removing the degraded surface carrier film.

Other important features of and objects attained by the invention are set forth and will appear in the course of the following specification.

The drawing accompanying and forming part of the specification illustrates successive steps in the performance of the invention. These views are diagrammatic in character and are presented primarily as a matter of disclosure and to make it clear that there is no color loss or dispersion in accomplishing the permanent incorporation of the outlined color designs in the surface film of the metal.

In the drawing, Fig. 1 is a cross sectional diagrammatic representation of a piece of unsealed anodized aluminum sheet having a surface film made up of a network of sub-microscopic absorbent capillaries;

Fig. 2 is a similar view of the same showing adjacent areas upon which have been applied dyes of different colors dissolved in a vehicle non-soluble in but permeable by water, and showing the dyes as penetrating the absorbent capillaries of the unsealed aluminum oxide film;

Fig. 3 is a diagrammatic sectional view illustrating the printed article immersed in boiling water and showing the water penetrating not only the undyed portions but also permeating the surface carrier film and hydrating the aluminum oxide beneath that film, rendering the anodic film non-absorbent by closing the capillaries and thereby sealing the dyes in place and making the adjacent areas incapable of absorbing dye;

Fig. 4 is a sectional diagram showing the article after removal from hot water processing and illustrating the point that the amount of absorbed dye has not been reduced by the hot water sealing;

Fig. 5 is a sectional view illustrating the finished article after the surface layer of vehicle containing surplus unabsorbed dye has been removed. This further demonstrates that the amount of dye originally absorbed has not been changed and the adjacent areas have been left free of dye.

Referring to the drawing in detail, a sheet of aluminum, and that is intended to include aluminum alloys, is indicated at 7 in Fig. 1, anodized to provide the unsealed capillary surface film 8.

Fig. 2 illustrates the effect of printing on the sheet in different colors at 9 and 10, showing the dyes penetrating and absorbed by the capillary film and leaving a film of the vehicle carrying some unabsorbed dyes on the surface of the anodic film.

The printing may be effected by any known means capable of applying the color or colors in definite designs or contours or over the entire area.

The different colors may be printed in immediately adjoining and, in fact, in contacting relation, without overlapping, or may be printed in fully separated relation or with fine lines of separation or lines of any width between the same. This is possible because the inks employed are of a non-flowing type and of proper consistency to hold to a definite outline.

The printing may be such as to effect desirably accurate results, such as lithographic, stencil spray, silk screen or the like.

The inks employed are of special composition in that they are made up of dyes and vehicles which are insoluble in water but, and this is of particular importance, the vehicles are permeable by water.

By way of example, oil soluble dyes classified by the manufacturer, Ciba Company, as "Orasol" and "Oracet," have been used with ethyl cellulose or cellulose nitrate as a vehicle, the percentage of dye controlled according to depth of color desired.

Fig. 3 illustrates the hot water sealing step, in which the printed anodized aluminum is immersed in hot water for a period sufficient for the water to penetrate the water permeable vehicle and seal the dyes absorbed in the anodic film while at the same time sealing the undyed portions of the film.

The water penetrable vehicle thus acts as a control for the dyes, preventing loss or dispersion or reduction in intensity, permitting complete sealing of the dyes as situated and absorbed in the anodic film.

The temperature of the sealing water may be in the range of 200 to 212° F., and the time of immersion may run from about ten to twenty minutes.

Fig. 4 shows the completely sealed article removed from the hot water bath and left with degraded surface films *9a*, *10a*, more or less denuded but containing some unabsorbed dyes.

Fig. 5 illustrates the finished article with the surface carrier films washed off the sealed anodized surface of the aluminum.

This cleaning away of the degraded carrier may be effected by washing with a suitable solvent, in the present example such as trichlor ethylene.

In this finished state the article has a hard, wear resisting, glossy, smooth surface in which the colors are permanently incorporated, and does not require burnishing or other more or less usual finishing operations. Burnishing and such steps, however, have no injurious effect.

The complete series of manufacturing steps may be considered as comprising—

First, anodizing aluminum in one of the several available electrolytes such as sulphuric acid, to produce an unsealed surface film of absorbent aluminum oxide;

Second, rinsing in cold water;

Third, air drying;

Fourth, printing, in the sense of applying water insoluble but water permeable vehicle, such as ethyl cellulose containing oil soluble but water insoluble dye such as "Orasol" or "Oracet," in desired design to the anodic film;

Fifth, allowing to dry thoroughly, as by air drying;

Sixth, immersing in hot, approximately boiling water for from ten to twenty minutes to seal the embedded and absorbed dye through the water penetrable vehicle film into the anodized surface while at the same time sealing the surrounding undyed and uncovered portions;

Seventh, removing the more or less denuded and degraded ethyl cellulose or other such vehicle from the sealed anodized surface with a suitable solvent such as trichlor ethylene.

For multicolor printing the foregoing steps would be varied by applying the second color or colors to the selected areas after the drying stage, step 5 above, and then after a second drying, continuing with the sealing and washing steps 6 and 7.

An important aspect of the process is that the dye is sealed in place through the water permeable vehicle, thus preventing and avoiding any loss or reduction in color intensity or in bleeding or flow into adjacent dyed or undyed areas.

The hot water seal degrades the dye carrier such as ethyl cellulose, which then has performed its function as a selective dyeing vehicle. In this condition it may be removed without in any way affecting the colors absorbed and sealed in the anodic film.

The amount of dye absorbed is proportional to the ratio of vehicle to dye. By permanently sealing through the applied film, reduction in color intensity is avoided, thus insuring accurate and constant reproducibility of dye coloring of the anodic film.

With the invention carried out as above, there is no smearing, spreading or straying of colors, as in methods heretofore proposed where, because of the use of water impermeable vehicles, it was necessary to first wash off the surplus impenetrable vehicle before sealing. In washing thus before sealing the colors were smeared, producing blurred outlines and loss of color intensity in the absorbed areas.

These faults are avoided in the present process by accurately controlling the dye in pattern with a non-soluble but water permeable vehicle and sealing the dye in place through and without disturbing the vehicle, and removing the vehicle and dye residue only after the sealing has been completed.

The process is an economical one and may be performed at a high speed production rate, at reasonable cost for labor and materials. The products are of a uniform, high grade character and are ready for use immediately on drying after washing away the dye applying and controlling vehicle containing any remaining dye residue not previously absorbed in the originally unsealed anodic film. In the action described it appears that the molecular structure of the vehicle is such that it is not fine enough to penetrate the capillary openings in the unsealed anodized aluminum film, whereas the dye does so. Consequently the whole or main portion of the dye is contained within the sealed surface film, leaving only the vehicle and possibly some small residue portion of the dye to be removed from the sealed surface.

What is claimed is:

1. The method of decorating unsealed anodized aluminum comprising printing on the unsealed anodized surface with water insoluble but water permeable vehicle and water insoluble dye, then, before removing excess vehicle from the printed surface, hot water sealing through the water permeable, insoluble vehicle left on the sealed surface of the aluminum and then after sealing, removing the vehicle.

2. The method of decorating unsealed anodized aluminum comprising printing on the unsealed anodized surface of the aluminum with a water insoluble but water permeable vehicle and water insoluble dye, then, before removing excess vehicle from the printed surface, hot water sealing the printed portion through the water insoluble but water permeable vehicle and the non-printed portions of the anodized surface, drying and then after sealing the dye in the anodized surface, washing away water penetrated denuded vehicle from the underlying sealed anodic surface.

3. The herein disclosed method including the anodizing of an aluminum surface, printing on the unsealed anodized surface of the aluminum with a water insoluble but water permeable vehicle and water insoluble dye, drying the printed matter, then before removing excess vehicle from the printed surface, passing boiling hot water through the vehicle to the anodized surface underneath and thereby sealing dye absorbed from the overlying vehicle in the anodized film of the metal and thereafter removing vehicle remaining on the sealed anodized film of the aluminum.

4. The method of decorating aluminum comprising anodizing the surface of the aluminum into a porous, capillary, unsealed surface film, rinsing in cold water and then drying the unsealed anodic surface film, applying to the dry, unsealed anodic film a water insoluble but water permeable vehicle impenetrable to the surface film, in the nature of ethyl cellulose, containing oil soluble but water insoluble dye penetrable to the surface film, and thereby impregnating the unsealed film with dye and leaving the vehicle on the surface of the film, drying thoroughly, then, before removing excess vehicle from the printed surface, immersing in hot, approximately boiling water for about ten minutes and thereby sealing the dye embedded in the film through the water penetrable vehicle and finally freeing the dyed and sealed aluminum of hot water and removing the vehicle from the sealed surface with a solvent in the nature of trichlor ethylene.

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