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WOOD STAIN METHOD OF INCREASED LIGHTFASTNESS

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This invention relates to a method of finishing wood and, more particularly, to the staining of wooden surfaces with new stains of greatly improved lightfastness.

The procedures of finishing wood comprise, in general, after a sanding and bleaching operation (provided the latter is called for), the steps of staining, filling (with the exception of several woods such as cedar, cypress, Douglas fir, hemlock and others which do not require filling) and coating the wooden surface with a varnish or lacquer, which is usually followed by rubbing and polishing.

Of the various staining media, the older stains, such as (1) the water-soluble stains, (2) the oil stains and (3) the spirit soluble stains have been largely abandoned, because they either have a tendency to raise the grain and to roughen the surface (1), which requires a subsequent wash-coating and careful sanding, or they bleed into the filler or top coat (2, 3), which necessitates a varnish or shellac sealer, or they are fugitive and of inferior lightfastness (2, 3), notwithstanding the protection of the top coat.

Modern stains showing the afore-described shortcomings to a lesser degree comprise water-soluble aniline dyes, dissolved in an alcohol or glycol ether and having one or several low boiling organic solvents such as methanol and toluol added thereto. Due to the use of solvents of the type mentioned, these stains are characterized by non-grain raising properties. Moreover, these stains do not bleed into lacquer and varnish top coats and have a lightfastness which is about equal to that of the water-soluble stains and better than that of the spirit- and oil-soluble stains.

I have discovered a new method of wood staining which does not raise the grain and which, aside from producing non-bleeding stains, results in a greatly increased lightfastness.

The modern, non-grain raising and non-bleeding stains above mentioned as a rule comprise the alkali (sodium) salt of a sulfonic acid-azo dyestuff as the coloring material. The same type of dyestuffs is used in the production of color lakes, whereby the soluble sodium salt of the dyestuff is changed into an insoluble heavy metal salt. Heavy metal compounds useful for this purpose comprise, for example, the salts of barium, calcium, strontium, manganese and aluminum. Other heavy metal salts, such as the salts of iron, nickel, copper and cobalt will insolubilize dyestuffs of the type mentioned, but they are not used, as a rule, because of the resulting differences in color shade. Moreover, lakes are usually formed in the presence of a substrate, such as aluminum hydrate. One of the reasons for the use of a substrate is that it adsorbs that amount of dyestuff which has not been completely precipitated as lake and thus aids in the reduction of water bleed, for instance. It is important that, probably due to an increase in particle size, the lakes, as a rule, have much greater lightfastness than the dyestuffs from which they are made.

In view of what had been known about color lakes, it

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was not unreasonable to presume that, if a lake could be formed in the grain of wood by precipitating the soluble dyestuff from a solution which had penetrated into the wood surface, such a laking operation would result in a stain of greater lightfastness than that of the non-grain raising dye stains now in use. On the other hand, it seemed questionable that an adequate lake formation would occur within the fiber of the wood, in view of the fact that a substrate such as aluminum hydrate is normally necessary to obtain proper precipitation or lake formation of the acidic dyestuff.

Aside from these theoretical considerations, it seemed more than doubtful, however, that a piece of wood stained in the usual manner with a non-grain raising dye solution could be treated with the solution of a heavy metal salt and any practical result be obtained thereby. Even if proper laking should take place, the purpose would be defeated, in all probability, by the crystallization of a large quantity of inorganic salt on the surface of the wood. Presumably, such crystallization would occur not only from the salt left on the surface of the wood after evaporation of the solvent, but salt having penetrated into the subsurface of the fibrous base, would be carried back to the surface as the solvent was evaporating from within the wood. Thus, instead of improving the stain, a method causing such salt crystallization on the surface would result in deleterious effects such as hazing, cloudiness and graying, because of the diffusion of light by salt crystals on the wood surface. It was, therefore, entirely unexpected that, upon a carefully adjusted application of solvent solutions of heavy metal salts on stained wood surfaces, no hazing, clouding or graying of the surface was noticed, regardless of whether or not the application was followed by the customary finishing and top coating. In fact, contrary to expectations, a clearer and brighter finish was obtained than without the use of such heavy metal salts. As predicted, the lightfastness of stains treated with these heavy metal salts was much improved. Apparently, the fibers of the wood are entirely capable of acting as a substrate, the same as aluminum hydrate.

My discovery provides the trade with wood stains of remarkably higher lightfastness, without any undue increase in the cost of labor and material.

In practicing my invention, I use acidic dyestuffs, such as the sodium salts of sulfonic acid-azo dyes which are capable of forming color lakes. Typical of such dyestuffs, identified by their color index number, are: Nigrosine (C. I. 865), Resorcin Brown (C. I. 234), Brilliant Croceine M (C. I. 252), Orange II (C. I. 151), Naphthol Blue Black (C. I. 246), Fast Light Yellow (C. I. 636), Metanil Yellow (C. I. 138), Tartrazine (C. I. 640). Ordinarily, I dissolve one to eight parts of one of these dyestuffs, or of a mixture of dyestuffs of this type, in 100 parts of a solvent mixture consisting of 90% methanol and 10% Cellosolve (glycol ethyl ether). In the manner of preparing the known "non-grain-raising" stains, for reasons of economy the foregoing solvents can be partly replaced by cheaper hydrocarbons, such as toluene, up to the amount at which the replacement begins to impair the solubility of the dyestuff in the solvent mixture.

After the wood has been stained with one of the foregoing solutions in the usual manner, it is treated, preferably but not necessarily before drying, with a heavy metal salt solution in the identical or a similar solvent mixture as used for the dyestuff. A list of heavy metal salts which I found useful for the herein disclosed purpose includes: aluminum chloride, aluminum nitrate, aluminum orthophosphate, aluminum sulfate, aluminum bromide, basic aluminum acetate, barium chloride, barium bromide, calcium chloride, calcium bromide, calcium nitrate. As disclosed by appropriate tables, these heavy metal salts as a

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rule are sufficiently solvent soluble to allow the preparation of solutions having a strength from 2 to 10 percent, even at room temperature. As in the case of the dyestuff solutions, the methanol can be replaced, in part, by a cheaper hydrocarbon. It should be noted, however, that the solubility of the heavy metal salts decreases with an increase in the proportion of, say, toluene in the solvent mixture.

In a first series of tests, plywood panels made from Honduras mahogany were treated, in the usual manner, by spraying with a "light mahogany" staining solution consisting of, say, 43.40 parts Brilliant Croceine M, 18.24 parts Resorcin Brown, 9.14 parts Naphthol Blue Black, 438.00 parts Cellosolve and 2,600.00 parts methanol. (All parts being parts by weight.) Some of the panels were left without further treatment after staining to provide standards, others were treated with ten percent solutions of heavy metal salts in a solvent mixture consisting of 90% methanol and 10% Cellosolve, while still others were lacquered in the usual manner after staining and treatment with the heavy metal salt solution. These panels were then placed into a fadometer (Twin Arc Weather-Ometer, Atlas Electric Devices Co., Chicago, Ill.) and, after an exposure of 50 hours, checked for fading. The results are given in the tabulation below:

Fadometer test

Sample	Treatment after Staining	(exposure time: 50 hours) Fading
1-----	control, no treatment	90%.
2-----	basic aluminum acetate	50%.
3-----	calcium bromide	none (trace of darkening). Do.
4-----	calcium bromide, lacquer coating	20%.
5-----	basic alum. acetate, lacquer coating	

In a second series of tests, plywood panels made from Honduras mahogany were treated in the usual manner, with the afore-mentioned "light mahogany" stain. Some of the panels were treated immediately, while the stain was still wet, with one of the afore-mentioned heavy metal salt solutions, while others were treated after the stain was dry. All panels were lacquer coated before exposure.

Fadometer test

Sample	Treatment after Staining	Exposure Time		
		23 hrs.	51 hrs.	72 hrs.
		Fading in percent		
1-----	control, no treatment	20-----	50-----	70-----
2-----	solvent only, no heavy metal salt treatment.	20-----	50-----	70-----
3-----	wet stain, treated with basic alum. acetate soln.	5-10-----	20-----	30-----
4-----	dry stain, treated with basic alum. acetate soln.	5-10-----	30-----	50-----
5-----	wet stain, treated with alum. chloride-6H ₂ O soln.	trace-----	10-----	20-----
6-----	dry stain, treated with alum. chloride-6H ₂ O soln.	slightly darkened.	trace-----	20-----
7-----	wet stain, treated with calcium bromide soln.	do-----	do-----	20-----
8-----	dry stain, treated with calcium bromide soln.	do-----	no change.	10-----

It is obvious that, in forming these color lakes within the wood surface, theoretically there should be a stoichiometric balance between the amount of acid dyestuff in the stain applied to the wood and the amount of heavy

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metal salt required to completely precipitate the dye. It is also obvious that the latter amount will vary with the concentration of dyestuff in the stain as well as with the amount of stain actually applied to the wood. If the concentration of the heavy metal salt solution is too low or if an insufficient amount of the solution is applied, the laking will be incomplete. On the other hand, a very large excess may lead to crystallization on the surface. In view of the nature of these operations, the stoichiometric amounts of stain and of heavy metal salt cannot be determined for or during a single operation. Moreover, they will vary from shop to shop. But the concentrations of the heavy metal salt solution may be readily determined and adjusted by each particular shop over a period of time such as a week in which time the amount of stain actually used can be measured. Generally, until such data are available, it is advisable to apply, by means of spraying or brushing, an amount of heavy metal salt solution which contains an excess of the heavy metal salt over that needed for completely laking the dyestuff. However, it should be carefully observed that, at whatever concentration the heavy metal salt solution is used, no uncalled for excess should be applied so as to flood or soak the stained wood surface. In the absence of this precaution, upon the evaporation of the solvent such excess salt accumulates on the surface and forms a cake there which, particularly in the case of hygroscopic salts, leaves an unsatisfactory wood finish. Still, it was entirely unexpected that, when using heavy metal salt solutions up to 30 percent in concentration and spraying amounts thereof which would exceed the volumes normally used or applied by means of spraying, but be restricted to below the amounts required for flooding or soaking the surface, no crystallization of salt on the wood surface was found. As a practical rule I found that, by spraying onto a given surface area of wood a volume of heavy metal salt solution which was about equal to the volume of staining solution used, provided that the salt solution ranges from 5 to 10 percent in concentration, there is a sufficient excess of heavy metal salt to completely lake the dyestuff, but still not such an excess of heavy metal salt to impair the surface characteristics of the wood.

Although satisfactory results in improving the light-fastness of wood stains can be obtained by applying the heavy metal salt solution prior to the staining solution, I prefer the practice of staining the wood first. In this preferred method there is no possibility of a partial precipitation of the color lake immediately at or near the surface. By applying the dyestuff solution first, there is no agent present which may react with the dyestuff and thereby prevent the normal penetration of the stain into the fibers of the wood.

Having described my invention, I claim:

1. In the method of staining wood consisting of applying to the wood a solution of the alkali salt of at least one sulfonic acid-azo dyestuff in a penetrant vehicle consisting of a mixture of ethyl ether of ethylene glycol and methanol, the improvement which consists in applying to the stained surface a solution consisting of 5 to 10% by weight, of a heavy metal salt of the group consisting of the salts of barium, calcium, strontium, manganese and aluminum, dissolved in a solvent consisting of a mixture of ethyl ether of ethylene glycol and methanol.
2. The method according to claim 1; the heavy metal salt being calcium bromide.

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