March 25, 1969 H. T. PRATT 3,434,793

METHOD FOR SCREEN PRINTING PILE STRUCTURES

Filed Nov. 2, 1964

FIG. 1

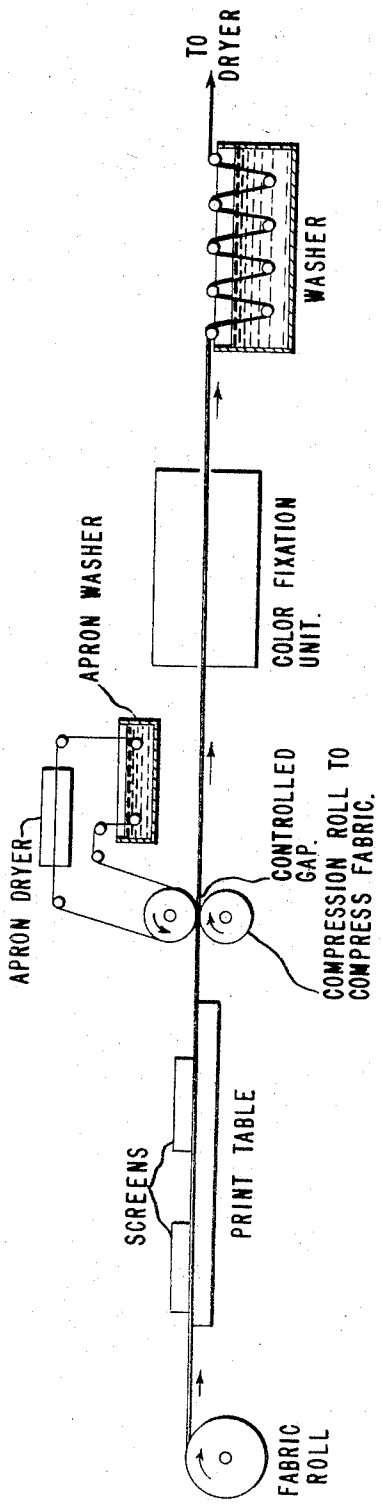
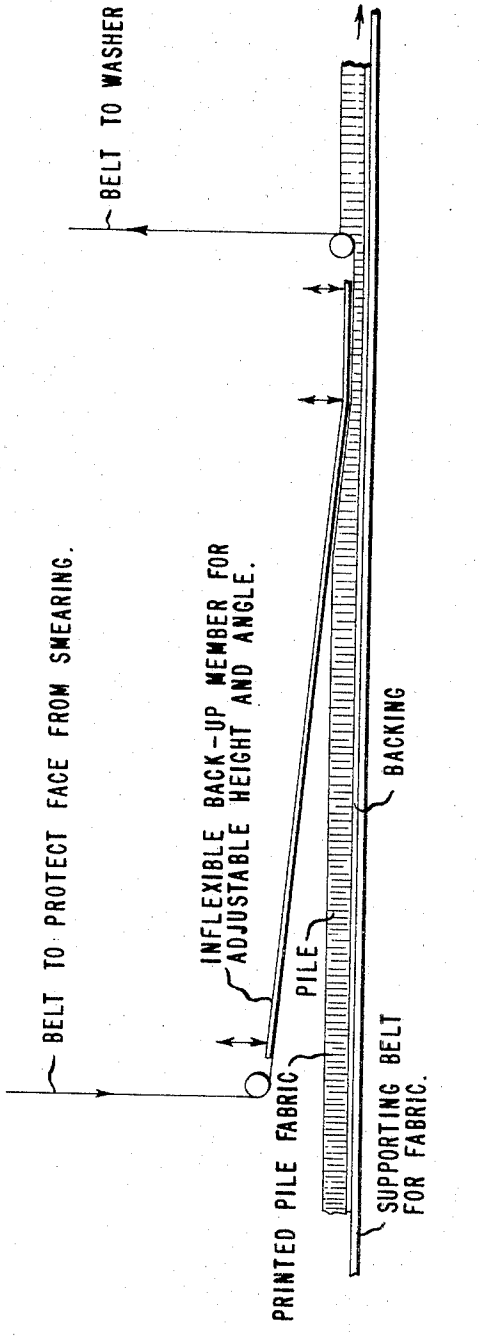


FIG. 2



INVENTOR
HERBERT THOMAS PRATT

BY Donald A. Hoes

ATTORNEY

United States Patent Office 3,434,793
Patented Mar. 25, 1969

3,434,793

METHOD FOR SCREEN PRINTING PILE STRUCTURES

Herbert Thomas Pratt, New Castle, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del.

Filed Nov. 2, 1964, Ser. No. 408,094
Int. Cl. D06p 5/00, 7/00
U.S. Cl. 8—62
3 Claims

ABSTRACT OF THE DISCLOSURE

In screen printing pile structures having fiber ends in the pile surface improved print definition and ink penetration are obtained by compressing the pile, after printing but while the dye composition is still liquid, to reduce its thickness to between 1 and 40% of its uncompressed thickness.

This invention relates to improvements in the screen printing of textiles and particularly to an improved process for screen printing certain pile-like textile products having fiber ends in the pile surface.

Screen printing of textiles has already been developed to a point where it is a highly advantageous technique for printing intricate designs having fine lines with good definition. Normally a dye paste is forced through a mesh screen that has been coated in certain areas with an impervious material to form a pattern. Penetration of the dye through the screen is accomplished with a rubber squeegee or other squeeze device which distributes pressure over the whole area of the patterned screen. This printing technique works satisfactorily when applied to flat fabrics, but is not effective when applied to pile fabrics in general because the thickness of the pile is so great that sufficient pressure cannot be exerted with the squeeze device to force the dye paste completely into or through the structure. Thus, a print is formed at the surface of the pile that is readily distorted and misshaped when the pile fibers are moved, which causes a very unattractive appearance because of loss of pattern definition and white fibers showing through the prints. Changing the conditions of dye paste, viscosity, screen mesh, or pressure of the squeeze device have not produced any substantial improvement in the screen printing of pile fabrics.

It is therefore an object of this invention to provide a satisfactory means for screen printing of certain pile structures. Another object is to provide a method for screen printing compressible pile structures having fiber ends at the surface of the structure. Other objects will be apparent from a description of the invention given below.

In accordance with the invention there is provided an improved method for screen printing upon a pile structure comprising a backing and adhered thereto a porous assembly of short crimped substantially parallelized fibers upstanding from said backing, said fibers throughout the porous assembly being attached to one another at a plurality of contact points and creating a pile surface composed essentially of fiber ends; the improvement, for achieving outstanding print definition and greater ink penetration, comprising applying a liquid dye composition to said pile surface in a predetermined pattern by forcing said dye composition through a screen in contact with said pile surface, removing said screen from said pile surface and thereafter, while said dye composition is still liquid, compressing said pile surface against a generally inflexible surface to reduce the thickness of said porous assembly to between 1 and 40% of its uncompressed thickness, and

then releasing the compressive force and drying and fixing said dye composition.

The invention will be more fully understood by reference to the attached drawings. Therein:

FIGURE 1 shows schematically one embodiment of the invention for screen printing upon a pile structure. As shown the process comprises consecutive steps of unwinding, printing, compressing between rolls, color fixation, washing and drying. It will be apparent that the compression rolls could, if desired, be replaced by a hydraulically loaded platen or other means.

FIGURE 2 illustrates an alternative pressure device, employing a pair of belts to sandwich the pile structure therebetween, that can be substituted in the arrangement of FIGURE 1.

It has been discovered that by compressing the pile to a proper extent while the liquid dye composition is on the surface, pile structures of this invention having attractive well-penetrated screen prints can be obtained. In operating the process, conventional dyestuffs which are normally used in screen printing may be employed; such as disperse, vat, acid, and direct dyes. The viscosity of the dye composition will, of course, be dependent on the screen porosity, but conventional dye paste formulations and conventional viscosities may be employed. As is well known, the viscosity of the dye compositions may be adjusted by regulating the amount of thickener, such as kelp, carboxymethyl cellulose, and the like. Also conventional screen porosities are useful, such as those varying from 400 to 48,125 openings per square inch. The screen printing is normally carried out at room temperature. In applying the dye composition to the surface of the pile structure the squeeze device or other applicator may be applied one or more times over the screen to regulate the amount of dye paste going into the print. Also the dye applicator may be made of rubber, wood, plastic, or other material which may be selected to have different degrees of hardness and different shapes for different applications. The particular pile structures which are suitable for screen printing in accordance with this invention are normally porous bonded fibrous pile structures having one surface composed substantially of fiber ends and the other surface adhered to a backing material for stabilizing the pile structure so that it has sufficient integrity to receive the screen printing. A highly preferred form of pile structure for use in the present invention is described by Koller U.S. Patent 3,085,922, the disclosure of which is incorporated herein by reference. The fiber density of the pile structures to be printed should normally be less than about three pounds per cubic foot, and preferably between 0.5 and 1.5 pounds per cubic foot. The thickness of pile in the product to be printed will normally be between about 3/32 inch and ½ inch, although for some special applications it may be possible to print structures having a pile thickness as great as one inch.

The porous bonded pile structures to be printed in accordance with this invention may be made according to the methods described in the Koller patent mentioned above. The pile fibers may be composed of suitable synthetic fiber compositions such as polyamides, polyesters, acrylonitrile polymers and copolymers, vinyl polymers and copolymers, olefin polymers and copolymers such as linear polyethylene and linear polypropylene, polyurethanes, polycarbonates, polyesteramides, cellulose derivatives, bicomponent polymers, such as those described by Breen in U.S. 3,038,236 and Taylor in U.S. 3,038,237. Mixtures of synthetic fibers with natural fibers such as regenerated cellulose, cotton, wool, and the like can often be used to advantage. The fibers in the pile structure may

be bonded together by a small amount of a binder composition, such as at least 0.5% binder based on the weight of pile fibers, or the fibers may be bonded by means of softening with a fiber solvent or by softening with steam or other means of heat. The fibrous pile layer of the pile structure to be printed should normally have a porosity of at least 50% by volume, and preferably at least 90% by volume.

As already stated, the amount of pile compression while the liquid dye composition is on the surface of the pile is critical to achieving a satisfactory print. This compressive force is usually applied in a direction substantially perpendicular to the backing of the pile structure to be printed and the lower the fiber density of the material, the greater the degree of compression that is needed. Too much pile compression will result in spreading and diffusing the dye and making the design run and cause indistinctive prints, whereas too little compression will merely result in a printed surface of the pile which is unsatisfactory because it gives a distorted appearance and white fibers will tend to show from underneath the print when the pile fibers are separated or bent. It has been found that the amount of pile compression should be within the range down to 1%–40% of the original or uncompressed thickness of the pile. The optimum amount of compression is achieved by compressing the pile down to 5%–15% of the original pile thickness.

The pile structure selected for screen printing in this invention should have a backing material attached to one surface of the pile to provide sufficient stabilization for the printing process. The backing material may be a woven, knitted or nonwoven fabric, a continuous film such as polyethylene or polyethylene terephthalate, or polypropylene, a layer of an adhesive composition applied to the surface either continuously or sprayed on the surface to give a discontinuous adhesive in the form of small particles, a layer of rubber composition or other elastomeric composition, a foam or sponge layer, or any other material which will stabilize the pile structure. The backing material may be attached to the pile fibers by means of cementing or by mechanical means, such as tufting, sewing, needling, and the like.

The chief advantage of this invention is that it provides a satisfactory process for the screen printing of pile structures. By means of the technique described herein, at least 3 to 10 times the pile thickness may be penetrated by dye composition in comparison with the normal penetration of dye that is obtained by conventional screen printing methods that are used for flat fabrics. Also the process improves the color value of the dyed areas of the fabric. In addition, the improved process provides flexibility in styling, designing, and coloring of porous bonded fibrous pile articles, which has not been possible in the past.

The process of this invention may be applied to the screen printing of any of the porous bonded pile structures mentioned above for the purpose of preparing blankets, apparel outerwear, interlinings for coats, dresses, and suits, bath mats, carpets, tiles and other floor coverings, bathrobes, bedspreads, cushioning materials, upholstery, bath sponges, heat, sound and electric insulation, and other apparel and industrial textile applications.

The following examples illustrate specific embodiments of this invention, but are not intended to limit the scope of the invention.

Examples

A fiber block was prepared starting from a blend of crimped, staple fibers of polyethylene terephthalate polymer. The blend was composed of 60 parts by weight of 4 denier per filament, 2 inch long staple fibers having a three-dimensional curvilinear crimp and 40 parts of 1.5 denier per filament, 1.5 inch long staple fibers having a stuffer-box type of crimp. This blend was carded to form a 200 grains-per-yard sliver. A steel mold measuring approximately 6 feet square and 6 inches deep was arranged to receive the sliver element which were packed vertically in the mold in parallel rows. The lengths of sliver elements were cut off even with the top of the mold and the rows were compressed against the sides of the mold by a ram to produce a fiber block having a fiber density of 1.25 pounds per cubic foot. After filling the mold with parallel rows of sliver elements, the top of the mold was covered by a plate and the perforated mold was then lowered into a dipping tank containing a solution of binder. The mold was completely immersed in the binder solution and then removed and allowed to hang suspended in air over the tank to allow excess binder to drain from the fiber block for one hour. The binder solution consisted of a 3½% by weight solution in trichloroethylene solvent of a heat-curable polyurethane formed of 2,4-toluene diisocyanate and a polyester of ethylene glycol and adipic acid. The drained block was placed in an air oven for four hours at 120° C. in order to cure the polyurethane binder. The resulting porous, bonded fiber block was removed from the mold and sliced into thin sheets, ⅜ of an inch thick, from the block perpendicular to the fiber direction with a cutting knife. One face of the sheet was sprayed lightly with one ounce per square yard of an adhesive composition freshly prepared from the same ingredients as those in the binder solution given above. The sprayed face of the sheet was then placed against the face of a light-weight woven cotton fabric, and the laminated assembly held together with light pressure while cured in an oven for 1.75 hours at 149° C. to produce a soft, drapable pile fabric.

The pile fabric prepared above was screen printed using the following dye paste formulation, in which the ingredients are expressed in parts by weight:

Blue pigment	0.5
Ammonium hydroxide (conc.)	2.5
Water	115
Kelp solution	285
Acrylic emulsion	50
Total parts	453

The kelp solution was an aqueous solution of 4% by weight solids of modified kelp (commercially available as "Keltex" used for printing pastes), whereas the acrylic emulsion was a commercially available polyacrylic resin emulsion composed of about 25% by weight resin solids. Three identical samples of the above pile fabric were selected for the screen printing experiments. Dye paste was applied to each sample using a rubber squeegee to apply the paste through the screen pattern onto the fabric. After one application of dye paste, each sample was cut in half and one half compressed with a heavy rubber surfaced roller to collapse the pile to approximately 10% of its original thickness. This rubber compression roll was applied to the fabric surface after removal of the pattern screen while the dye paste was still in liquid condition. After the compression was removed from the fabric and the latter allowed to regain original thickness, both the compressed samples of fabric, as well as those which had not been compressed, were then subjected to a standard drying treatment, followed by a color fixation treatment by heating the printed fabric at 205° C. for 45 seconds, and then washing and another drying treatment. It will be apparent from the table given below that the effect of compressing the pile after applying the liquid dye paste was to increase the penetration of the dye paste into the pile structure. In addition to this increase in penetration being quantitative, it was also quite apparent to the naked eye that the printed fabrics which were not compressed showed many white fibers and a distorted pattern when the fabric was bent or wrinkled, whereas the compressed samples showed uniform color value in the printed areas of the fabric even when the fabric was bent. In Example 1 the dye penetrated completely through the backing.

TABLE

Example	Screen Porosity (Openings/ square in.)	Print Paste Penetration (mm.)		Approximate Increase in Penetration
		Not compressed	Compressed	
1	6,084	3	9.5	3 Times.
2	2,500	1.5	9.5	6 Times.
3	576	1	7.0	7 Times.

What is claimed is:

1. In a method for screen printing upon a pile structure comprising a backing and adhered thereto a porous assembly of short crimped substantially parallelized fibers upstanding from said backing, said fibers throughout the porous assembly being attached to one another at a plurality of contact points and creating a pile surface composed essentially of fiber ends; the improvement, for achieving outstanding print definition and greater ink penetration, comprising applying a liquid dye composition to said pile surface in a predetermined pattern by forcing said dye composition through a screen in contact with said pile surface, removing said screen from said pile surface and thereafter, while said dye composition is still liquid, compressing said pile surface against a generally inflexible surface to reduce the thickness of said

porous assembly to between 1 and 40% of its uncompressed thickness, and then releasing the compressive force and drying and fixing said dye composition.

2. Method according to claim 1 wherein the porous assembly is reduced to a thickness between 5 and 15% its uncompressed thickness.

3. Method according to claim 1 wherein said porous assembly has a fiber density of less than about 3 lbs./ft.^{3} and comprises polyethylene terephthalate fibers bonded together by a polyurethane adhesive.

References Cited

UNITED STATES PATENTS

2,816,811	12/1957	Tillett et al.	8—148
2,984,540	5/1961	Tillett et al.	8—148
2,997,952	8/1961	Horrocks et al.	101—181
3,129,442	4/1964	Leckie	101—129 XR

NORMAN G. TORCHIN, *Primary Examiner.*

T. J. HERBERT, JR., *Assistant Examiner.*

U.S. Cl. X.R.

8—148