United States Patent Office 3,304,195 Patented Feb. 14, 1967

3,304,195

PROCESS FOR TONAL COLORING OF FABRICS

Joseph I. Ackerman, Jr., Arlington, Mass., assignor to United Merchants and Manufacturers, Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed Apr. 11, 1963, Ser. No. 272,203
15 Claims. (Cl. 117—37)

This invention relates to the dyeing or coloring of textiles having different surface structures or characteristics to obtain contrasting or different tonal effects. More particularly, this invention relates to the dyeing of glass fiber fabrics having loosely woven yarn sections such as bulked, boucle, taslan, nubs or floats, constituting the loosely woven areas, on the more tightly woven background areas.

In this specification all percentages and parts are given on a weight basis.

Among the fabrics which can be dyed or colored by the present invention, in addition to the preferred glass fiber fabrics, are fabrics made from fibers and/or filaments of cellulosic material, particularly spun and/or filament rayon; and synthetics such as the acrylic (e.g., Orlon, Creslan, Acrilan, Varel, Zefran, Darvan and Dynel); polyester (e.g., ethylene glycol terephthalic acid condensation polymers such as Dacron); polyamide (nylon); vinyl and vinylidene (e.g., Saran); polyolefin, e.g., polyethylene and polypropylene; polyurethane; and blends of two or more of any of the fibers and/or filaments enumerated above.

Fabrics of different surface structure or characteristics may be produced by any known procedure. For example, the fabrics may be woven from textured, nubbed, loop, knot, slub, bulked, boucles, taslan, or filament-type yarns to produce loosely woven areas and tightly woven areas. The fabrics may be woven to produce a base having throws, loops or nubs thereon and thus provide two different surface structures or characteristics, one the tightly constructed base, an the other the throws, loops or nubs thereon, constituting the loosely constructed surfaces. Fabrics may be woven in a conventional manner to provide a uniformly woven fabric and then napped to produce relatively tight and loosely constructed surfaces.

Still another example of fabrics having different surface characteristics are flocked fabrics in which the flocking is applied to produce design or pattern effects. In such fabrics, the unflocked base fabric has one surface characteristic, and the flocked areas another surface characteristic provided by the flocking.

As noted, this invention is particularly concerned with the dyeing of glass fiber fabrics. The expression dyeing is used herein in the broad sense of imparting color to the fabric. The description hereinafter will therefore be largely confined to the dyeing of glass fiber fabrics but it will be understood that this invention is not limited thereto but includes the dyeing of other fabrics having different surface characteristics to obtain contrasting tonal effects. Heretofore, to produce glass fiber fabrics having dyed pattern effects, bulked yarns have been pre-dyed in two or more colors and woven in the desired pattern. This requires several time-consuming operations including the steps of pre-dyeing the yarn, weaving and finishing the pre-dyed yarn. These operations require the production of different batches of selected dyed yarns for each fabric pattern or style, which unnecessarily complicates the weave mill operations with consequent increased cost of producing the finished fabrics.

The dyeing of glass fiber fabrics by conditioning the dye bath to impart a positive charge to the dye particles, by adding metallic ions to accomplish this end and applying the thus conditioned dye bath to glass fiber fabrics in

which the loosely constructed areas are charged anionically so that the positively charged dye particles will adhere thereto, has been suggested. Another suggested procedure to effect selective dyeing of the background or tightly woven areas is to add hydroxyl ions to the dye bath to impart a negative charge to the dispersed dye particles and pass the fabric through this bath so that the negatively charged dye particles are attracted preferentially to the less negatively charged background areas than to the more negatively charged loosely constructed areas. These procedures obviously involve the maintenance of different charges on the fabric during the application of the charged dye particles thereto, the addition of the necessary materials to the dye bath to create the desired charges on the dye particles and the problems and difficulties inherent in such procedure in obtianing relatively sharply delineated contrasting tonal effects.

It is a principal object of the present invention to provide a process for selectively coloring or dyeing fabrics having loosely and tightly constructed areas, particularly glass fiber fabrics having loosely and tightly woven yarns, to selectively dye the loosely constructed areas in preference to the tightly constructed areas, usually the background areas.

Another object is to provide such process in which the entire fabric is first dyed any desired color or color blend and thereafter only the loosely constructed areas are dyed a different color to produce sharply delineated, pleasing contrasting color effects.

Other objects and advantages of the present invention will be apparent from the following detailed description thereof.

In accordance with this invention the fabric having loosely and tightly constructed areas is first treated with a liquid vehicle to thoroughly wet the fabric and substantially completely saturate all of the capillaries, interstices, and surface active areas of the fabric. The fabric can be soaked in water to accomplish this end, but preferably is treated with a solution or dispersion containing one or more of (1) binder, (2) fiber protectant including protectants which act as fiber lubricants, (3) material which imparts abrasion resistance to the fabric, (4) water repellents, (5) delusterants, and (6) where it is desired to produce a base color on the fabric, solutions of dyes or pigments or dispersions of dyes or pigments having a particle size of less than 1 micron, preferably less than 0.5 micron. After this initial treatment the fabric while still wet is treated with a dispersion of pigment or dye particles having a particle size of from 1 to 1500 microns, preferably from 10 to 500 microns, which are effectively neutral, i.e., carry substantially no electrical charges and when applied are maintained in suspension by agitating the bath through which the fabric is passed to effect the application or by spraying under pressure. After application the fabric is padded, i.e., passed through press rolls which as the fabric enters the nip and passes through the press rolls squeeze out the excess dye or pigment dispersion, the liquid thus expressed from the fabric flowing over the fabric on both sides thereof and "washing" the fabric.

The second step is carried out using a dispersion of the dyestuff or pigments having the particle size noted, with these pigments in an effectively neutral condition, i.e., carrying no appreciable electrical charge and with the fabric also effectively neutral. By effectively neutral is meant that the charge, if any, on the fabric or on the pigment or dye particles is so small as to have no noticeable or appreciable effect from the standpoint of the pigment or dye particles being attracted to or repelled by the fabric, or different portions thereof or to or from each other.

It is important that the dispersion applied during the second step be free of resin binder, fiber protectant and other such additives.

The successive steps result in the loosely constructed areas selectively absorbing the dye or pigment particles in the dispersion applied in the second step, this end being furthered by the substantially complete saturation of the fibers effected during the preceeding step so that the absorptive capacities of the interstices of the yarns and the fabric as a whole, as well as the surface active points thereof, are satisfied by the treating solution applied to the fabric in the first step. This order of procedure eliminates smearing, staining and blotching of dye particles intended only for the loosely constructed areas; the dye particles applied in the second step adhere substantially entirely to the loosely woven areas and are washed off and removed from the tightly woven or background areas by the liquid squeezed out of the fabric in the padder, which liquid washes off the surfaces of the fabric and removes the dye or pigment particles which are not caught by the loosely woven areas or yarns; the latter act as traps, in a physical sense, for the dye or pigment particles causing them to adhere thereto. This washing off is facilitated by the effective electrical neutrality of the dye or pigment particles and the fabric; both being effectively neutral no electrical attractive forces have to be overcome to effect the washing off or removal of any dye or pigment particles from the tightly woven areas.

Following the second step the fabric is dried and then treated with a solution or dispersion of a wash-fastness agent such as the conventional organic chromic chloride employed to impart wash-fastness to glass fiber fabrics. Binder and fiber protectant are applied in this treatment, if not in the first step. If desired, the binder and fiber protectant can be applied during both the first step and this step, which will hereinafter be referred to as the wast-fastness step.

Thereafter the fabric is subjected to heat curing, desirably at a temperature of from 250° F. to 375° F. for from 1 to 10 minutes. The longer times are used when heating at the lower temperatures and the shorter heating times at the higher temperatures, within the range of from 250° F. to 375° F.

Water is the preferred liquid medium for application to the fabric in the first step for reasons of economy, ready availability and ease of handling. However, organic solvents can be used in place of or along with water. Examples of suitable organic solvents are alcohols, particularly the lower aliphatic alcohols, methanol, ethanol, isopropyl alcohol, ketones, e.g., acetone, esters, aliphatic and/or aromatic hydrocarbons, glycols, and glycol ethers. The liquid medium is applied by passing the fabric through a bath and then through a padder to remove the excess and give the desired pick up of at least 10% based on the dry weight, preferably from 20% to 40% by weight, or by spraying the liquid on the fabric to give the desired pick up. An excess can be sprayed onto the fabric and the fabric containing such excess subjected to pressure as by passage through press rolls to remove the excess.

The liquid applied in the first step can contain one or more of: (1) a binder for the dye or pigment particles; (2) fiber protectant including protectants which act as fiber lubricants; (3) material which imparts abrasion resistance to the fabric; (4) water repellents; (5) delusterants; (6) solutions or dispersons of dyes or pigments; and (7) other concentrated additives such as sizes and softeners which facilitate handling of the fabric and impart desirable properties thereto, such as starches, dextrins, water soluble gums, sorbitol, glycerine and glycols. It will be understood that one and the same material can have the necessary properties to supply two or more of the above indicated functions. Thus, for example, certain polymers or resins such as the silicones serve as protectants, water repellents and improve abrasion resistance.

The binder can be any of the know resin or polymer additives used in the finishing of glass fiber fabrics. Preferred binders are the acrylic resins (Rhoplexes), butadiene-acrylonitrile copolymers (Hycars), polymethacrylates, polyethylenes, polypropylenes, polybutadiene, polyisoprene, polystyrene, butadiene-styrene copolymers, silicones and silicone resins, polyvinyl acetates, polyvinyl chlorides, vinyl acetate and vinyl chloride copolymers, polyamides such as nylon 6, 66 and 610, urea formaldehyde precondensates, melamine formaldehyde precondensates, polyurethanes, epoxy resins, phenolicaldehyde precondensates. The amount of binder used and this applies also to the other additives to the treating composition used in the first step can be varied and depends upon the desired weight of the fabric, types of yarns and weave, and whether or not the additive in question is applied only in the first step or both in the first step and the wash-fastness step. In general the amount can vary from 0.5% to 10%, preferably from 0.3% to 3% based on the total weight of the treating compositions. Where the binder is applied in both the first step and the wash-fastness step from .2% to 2% can be applied in the first step and from 2% to 4% in the wash-fastness step.

The glass fiber protectant used can be chosen to supply oiliness or lubricity to reduce friction thus reducing breaking or cracking due to strains or to "sheath" the fibers and thus protect them during bending, twisting and compression or to protect the fibers in both ways. Preferred protectants are the polytetrafluoroethylenes (Teflons), and silicones (e.g., Drusil 60). They are used in the first step in amount of 0.5% to 10%, preferably 0.3% to 3%. When employed in both the first step and the wash-fastness step from 0.2% to 1% can be used in the first step and about 2% used in the wash-fastness step.

The Teflons and silicones not only have protective properties but also improve abrasion resistance; many of the resin binders also have the property of improving abrasion resistance.

Preferred water-repellents, e.g., materials which impart water-repellent properties to the finished fabric, are the silicones, waxes and polyolefins such as polyethylene and polypropylene. The amount used can be in the range of from 0.3% to 10%, preferably 0.5% to 3%.

A preferred delusterant is titanium dioxide (Ti-Pure) in amount of from 0.5% to 4%, preferably 0.75% to 1.5%. Silica dispersions, such as Syton, may also be used.

Soluble or dispersible dyes or pigments in a concentration to produce the desired color is employed in the liquid composition used in the first step when it is desired to dye the fabric a base or ground color. The amount of dye or pigment used can be from 0.05% to 10% depending on the toning power of the dye or pigment used and the tone depth desired; preferably from about 0.2% to 2% dye or pigment is used. Examples of dyes and pigments which can be used are the phthalocyanines, indanthrenes, anthroquinone vat dyes, azo dyes, and pigments such as the metal selenides, molybdates, oxides and carbon black. When a soluble dye or dye solution is used, a precipitant may also be employed to precipitate the dye in the form of finely divided water-insoluble dispersed particles having a particle size of less than 1 micron.

The treating composition used in the first step is formulated to completely saturate the capillaries, absorptive capacities and surface active areas of the fabric including the interstices between the fibers and between the contacting regions of the different yarns and which in combination with the constituents used in the wash-fasness step imparts to the fabric the desired properties such as wash-fastness and light-fastness of the colors, hand or drape, abrasion resistance, good sewing properties, crack resistance, weave setting, and soft light reflection.

Preferred treating compositions for the first step can contain from 2% to 5% acrylic resin (Rhoplex HA–4), from 0.5% to 4% tetrafluoroethylene polymer (Teflon #30), 0.5% to 3% titanium dioxide (Ti-Pure) and/or 0.5% to 6% silica and the rest water. When it is desired to color the fabric from 0.2% to 2% non-white pigment or dye is used instead of the titanium dioxide. Preferable the total solids content of this treating composition should not exceed 35% and the liquid content, preferably water, should be at least 65%, desirably from 90% to 98%. Treating compositions containing relatively high solids content are employed when producing relatively stiff fabrics for wall or ceiling decor, table pieces, etc. The amount used of each ingredient within its specified range depends on the particular fabric qualities desired, the desired weight of the finished fabric, the type of weave and the padding pressures used in treating the fabric.

Preferably the glass fiber fabric before treatment with the treating composition in the first step is effectively neutral, i.e., carries no appreciable electrical charges. The glass fiber fabric before application of the treating composition can have both its face and back grounded by passage over metal bars or rollers which are electrically grounded to render the glass fibers electrically neutral and substantially static free; the same result can be obtained by passing the fabric over a bar or rollers having a potential of opposite polarity to neutralize the charge on the fabric. If desired the bath and the submerged bath rollers can be grounded to dissipate any electrical charges upon the fabric immediately upon entering the bath. With grounded baths of poor electrical conductivity an inorganic salt can be added to make the contents of the bath adequately conductive.

While still wet the fabric is treated with a dispersion of dye particles having a particle size of from 1 to 1500 microns, preferably 10 to 500 microns, in amount of from 0.1% to 10%, preferably 0.5% to 5%, depending on the toning powder of the dyestuff or pigment and the depth of color desired on the loosely constructed areas of the fabric. The treating composition for the second step can contain from 0.05% to 5%, preferably 0.5% to 2%, of a dispersing agent and the rest liquid, preferably water. Hence the liquid content of the dispersion is at least 85% and can be as much as 99%.

The dyestuff or pigment used in the second step must be insoluble in the liquid medium in which it is applied and have a particle size of from 1 to 1500 microns, preferably 10 to 500 microns. Employing dispersions having a smaller particle size, a flocculating or agglomerating agent can be added thereto to form agglomerates having the necessary particle size. Preferred flocculating agents are the polyalkylpolyamines (Sandofix WE–51) although other flocculating agents can be used such as deacetylated chitin; polyalkyl-polyamine fatty acid reaction products; amino aldehyde condensate dye-fixatives; methylchloride quaternary of the stearic acid amide of 1-(2-aminoethyl)-2-heptadecenyl-2-imidazoline; fluid oil in water type emulsions of low molecular weight polyethylene chemically stabilized with a cationic amine acetate derivative of a long chain fatty compound; dicyandiamide formaldehyde dye fixatives; colloidal cationic thermo-setting resinous reaction products of straight chain poly-functional amines and an aldehyde; fatty acid chromic chloride complexes; or a mixture of such agents. Any insoluble dye or pigment can be used, including indanthrene, phthalocyanine, anthraquinone vat, and azo dyes and metal oxide, sulfide and sulfate pigments.

The dyestuff or pigment can be absorbed from a solution or colloidal state onto small particles of an adsorbent carrier material, such as silica, insoluble metal oxides, an insoluble powdered resin, insoluble cellulosic material and flour or other insoluble meals. Such carriers are dispersed in the liquid vehicle applied to the fabric in the second step forming the particles of from 1 to 1500 microns trapped by the loosely woven areas and washed off the background areas. In the subsequent processing the dye or pigment on the carrier particles are bonded to the loosely woven areas, as disclosed more fully hereinafter.

The preferred procedure, however, is to precipitate the dye or pigment or to agglomerate dye or pigment particles in a dispersion thereof having a particle size of less than 1 micron, by adding a precipitating or agglomerating agent, disclosed above, which results in suspended pigment or dye particles having a particle size of from 1 to 1500 microns.

The second step is carried out with both the glass fabric and the dye or pigment particles carrying no appreciable electrical charges, i.e., effectively neutral. For this purpose the glass fabric before entering the dye bath used in the second step can be contacted on both face and back surfaces with electrically grounded bars or rollers to render the glass fibers throughout the fabric electrically neutral or substantially free of static electricity, i.e., electrostatic charges. For example, where the wet fabric from the first step travels over a number of rollers and in so doing acquires a static charge this charge is dissipated in any of the manners hereinabove described before application of the dispersed dye or pigment particles in the second step.

By having both the glass fiber fabric and the dye particles effectively neutral, the removal of dye particles from the background area is facilitated in that the washing off of such dye particles is not prevented or retarded by electrical attraction between the dye particles and the background areas of the fabric. The loosely constructed areas on the other hand retain the dye or pigment particles applied in the second step by entrapment. Selective deposition of the dye particles, so that they are trapped by the loosely woven yarns and do not adhere to the tightly woven areas results from the particle size or mass of these dye or pigment particles (they are large enough to be trapped by the loose yarns and to be washed off the tightly woven areas and yet not too large), and the relatively high speed of motion of these dye or pigment particles due to agitation of the bath, spraying of dispersions, when a spray procedure is used and the padding which expresses the dispersion so that it washes over the fabric entering the nip of the padding rollers. Since the selective deposition of the color in the second step is obtained in this manner, with high speed of motion of the dye or pigment particles, the process of this invention can be used effectively at the highest speeds currently employed in glass fiber fabric finishing operations with excellent results.

That the dispersion of pigment or dye particles used in the second step is effectively neutral can readily be determined by any one of the following tests:

(1) Place a specimen of the fabric in water and close to a settled body of the pigment or dye particles in water in an electrically insulated glass container so as to avoid any motion of the particles. The absence of motion of the particles shows they are effectively neutral; if they bear a charge they will either be attracted to or repelled from the test fabric specimen.

(2) Pour some of the dispersion of pigment or dye-particles onto the tightly woven areas of a previously wetted fabric carrying no electrical charges and then gently pass water over the fabric. Ready removal of the dye or pigment from the background areas by the water is good evidence that there is practically no electrostatic attraction between the fabric and the pigment particles, and hence the pigment particles are effectively neutral.

(3) Leave the dispersion standing without agitation for 15 seconds or longer, say up to about 30 minutes. If the dye or pigment particles settle out and leave a clear supernatant liquid on standing, they are effectively neutral. Pigment particles which bear a charge (since

the pigment particles in any given dispersion are the same, they bear a charge of the same polarity) repel each other.

Test (3) is a convenient means of determining how much precipitating or agglomerating agent to use with any particular dye or pigment. The amount used should be such that the pigment particles are effectively neutral and hence settle out on standing to produce a substantially clear supernatant liquid. If an insufficiency is used, some of the dispersed particles will remain dispersed. The use of such dispersion would result in coloration of the background as well as the loosely woven yarns and would not give the desired selective coloration. Employing an excess of precipitant or agglomerating agent results in the formation of particles of excessive size—greater than 1500 microns—or in the formation of particles acquiring a charge which causes redispersion in finely divided form, so that they do not settle out and because of too small a particle size will not dye the loosely woven yarns, at least not selectively to the tightly woven yarns. The use of dispersion in which the average size of the agglomerates of dye or pigment particles are of excessive size or too large results in poor dyeing of the loosely woven yarns, or the squeezing of these large dye particles onto the background or tightly woven yarns during the padding with consequent spoilage of the desired well delineated contrasting tonal effects.

After drying the fabric it is treated with a solution or dispersion containing a stearatochromyl chloride (Quilon S) or myristylchloromyl chloride (Quilon M) or other Werner complex in which the acids group coordinated with the chromium atom has more than 10 carbon atoms, as described in United States Patents No. 2,273,040 and No. 2,356,161. The water-repellent is applied by passing the fabric through a bath containing from 0.2% to about 4% or 5% by weight chrome complex or by spraying the fabric with the water-repellent composition and then drying at 250° F. to 375° F. to set the water-repellent on the fabric. The water-repellent composition can also contain the binder and/or fiber protectant in the amounts above disclosed.

The following examples are given to illustrate specific embodiments of the invention. It will be appreciated that the invention is not limited to these examples.

In the examples which follow:

Ti-Pure is the E. I. du Pont de Nemours trademark for its titanium dioxide power easily wettable with water.

Rhoplex HA–4 is the Rohm & Haas Company trademark for its acrylic resin in the form of a non-ionic colloidal emulsion containing about 45% solids.

Drusil 60 is the E. F. Drew & Company Inc. trademark for a silicone emulsion containing about 60% solids.

Teflon is the E. I. du Pont de Nemours trademark for a polymer of tetrafluoroethylene; Teflon #30 is a dispersion of this polymer containing 60% polymer solids.

Sandofix WE–51 is the Sandoz, Inc., trademark for a polyalkylpolyamine dye fixative having cationic properties.

Quilon is the E. I. du Pont de Nemours trademark for organo chromic chloride complexes; Quilon S is the stearylato chromic chloride; Quilon M is the myristylato chromic chloride.

The four dyestuffs or pigments disclosed below, used in the examples, are all products of the Inter-Chemical Corporation.

Blue 2G No. 9750 is a phthalocyanine dye dispersion containing 12% pigment solids.

Violet 4B No. 9652 is an indanthrene vat dye dispersion having 7.2% pigment solids.

Yellow K No. 9850 is an iron oxide yellow dispersion having 45% pigment solids.

Orange 2R No. 9800–16 is a molybdate orange dispersion having 60% pigment solids.

The fabric employed in all examples was a decorative glass fiber boucle fabric having tightly woven background areas and loosely woven boucle yarns, weight of 4.4 ounces per square yard and contained 56 warp picks and 54 fill picks per inch. In all examples the baths used for the first and second steps were electrically grounded to insure that the contents were effective neutral.

Example I

The bath used for the first step had the following composition:

Ti-Pure	percent	1
Teflon #30	do	3
Rhoplex HA–4	do	3
Water	do	93
Total volume	gals	[1] 30

[1] Approximately.

The glass fiber fabric was immersed in this bath and passed therethrough while the contents of the bath was agitated by means of a mechanical agitator to maintain the solids dispersed. The residence time within the bath was approximately 3 seconds. The fabric exiting from the bath passed through a pair of padding rollers, the wet pick-up was 25%.

The wet fabric was sprayed with a treating composition prepared by mixing:

Yellow K	lbs	34
Orange 2R	lbs	12
Sandofix WE–51	lbs	5.8
Water to 130 gallons total treating composition.		
Total volume	gals	Approx. 130

This treating composition was prepared by dissolving the Sandofix in water with slight warming to produce a clear solution to which was added the Yellow K and Orange 2R. A dispersion of effectively neutral particles of pigment was thus produced having particle sizes within the preferred range herein disclosed. The effective neutrality of this dispersion was ensured not only by the use of industrial water containing ionic impurities and thus electrically conductive but also by employing spraying equipment which was grounded. The sprayed fabric was passed through a pair of padding or press rollers to remove the excess dispersion which washed over the fabric as it entered the bite of the padding or press rollers.

From this second step the fabric was passed through an oven maintained at a temperature of about 350° F. for a residence time of 1 minute and thereafter treated in a bath containing 2% of Quilon S. This treatment involved immersion in the bath for 3 to 4 seconds and passage of the thus treated fabric through a pair of padding rollers so that the wet pick-up of the treated fabric on leaving the padding rollers was 15% to 22%.

The Quilon treated fabric was passed through an oven maintained at 350° F. for a residence time of 1 minute.

The boucles or loosely woven yarns were dyed a persimmon color sharply contrasting with the off-white background or tightly woven areas. The fabric thus produced met existing specifications for abrasion resistance, anticracking, wash-fastness and hand or drape and was considered an eminently satisfactory commercial fabric.

Example II

The composition used for the first step was:

	Percent
Ti-Pure	4.5
Rhoplex HA–4	3.4
Drusil 60	3.8
Water	88.3

For the dye bath used in the second step, the first part (part A) of the bath was prepared by mixing 39.4 parts of Violet 4B with 500 parts of water. A second part

(part B) was prepared by dissolving 2.15 parts Sandofix WE in 120 parts of water with slight warming to produce a clear solution to which was added part A forming a dispersion of the solid dye particles in the water. The dispersed dye particles had particle sizes within the range herein disclosed.

The treatment of the glass fiber fabric was substantially the same as in Example I except that the above indicated treatment composition was used for the first step and dye dispersion was used for the second step, and the dye dispersion in the second step instead of being sprayed onto the wet fabric leaving the first step was padded with the dye dispersion employing a bath with a flooded nip in the bite between the padding rollers.

There was thus produced a glass fiber fabric having the loosely woven or boucle yarns dyed violet with the background of more tightly woven yarns of delustered off-white with no staining, smearing or blotching due to the particles of the dyestuff adhering to the background areas.

Example III

	Percent
Ti-Pure	1
Drusil 60	5
Rhoplex HA–4	5
Water	89

This composition was applied in the same manner as in Examples I and II.

The dye bath used for the second step was prepared by first dissolving 2.44 parts of Sandofix WE–51 in 120 parts of water to produce a clear solution and adding to this solution a dispersion of 2.85 parts of Blue 2G, 19.7 parts of Violet 4B and 250 parts water thus forming a dispersion containing precipitated dye particles having particle sizes within the preferred range herein disclosed.

The treatment of the fabric was the same as described in Example II using, of course, the above disclosed treatment composition for the first step and dispersion of agglomerated dye particles for the second step.

The resultant glass fiber fabric had the loosely constructed or boucle areas sharply dyed a deep lilac tone contrasting with the nearly white delustered background or tightly woven areas and with no stains, smears or blotches on the tightly woven areas.

Example IV

The treating composition employed in the first step contained 5% Rhoplex HA–4 and the rest water.

Except for the substitution of this treating composition for the treating composition in step one of Example III the treatment was otherwise the same as in Example III.

The results were similar.

Example V

The treating composition used for step one was as follows:

	Percent
Ti-Pure	1
Teflon	3
Rhoplex HA–4	5
Water	91

The dye bath used for the second step of this Example was prepared by dissolving 28 parts by weight of Sandofix WE–51 in 188 parts water to produce a clear solution to which was added a dyestuff dispersion containing 34 parts Yellow K, 11.2 parts Orange 2R in 188 parts water. Upon addition of this dispersion to the clear solution of Sandofix agglomeration of the dispersed dye particles took place with the formation of agglomerates having particle sizes within the range herein disclosed.

This dispersion of these agglomerates was maintained with these agglomerates uniformly dispersed in the aqueous medium by agitating the bath during the passage of the glass fabric therethrough employing mechanical agitation for this purpose.

The treatment was otherwise the same as in Example II.

The product had heavily toned persimmon boucles or loosely woven areas on an evenly toned slightly delustered off-white background areas, free of stains, smears and blotches.

For comparative purposes the above described procedure was duplicated with another specimen of the same fabric, except that about 5 parts of a 10% solution of ammonia was added to the dispersion of dyestuff employed in the second step to increase the pH of this dispersion to about 10, thus imparting an anionic charge to the agglomerated dye particles. Upon passage of the fabric through this dye bath and treating it otherwise as in Example V the background contained smears, stains and blotches and the fabric was dyed unevenly, so much so that it was completely unacceptable. This comparative test demonstrates the importance of having the dispersed dye particles effectively neutral.

Example VI

This example differs from Example V in that the bath used for the first step contained in addition to the constituents above mentioned about 4% by weight of a 10% dispersion of Yellow K and Orange 2R, having a particle size less than 1 micron. The dispersion of these dyestuffs when added to the other constituents of the bath employed for the first step remained dispersed, i.e., did not settle, the dispersed condition being maintained by agitation of the bath.

The treatment was otherwise the same resulting in a glass fiber fabric in which the background had a uniform light persimmon color and the boucle or loosely woven areas had a dark persimmon color with no smears, stains or blotches on the fabric.

The treatment of fabrics having loosely and tightly constructed areas, such as nylon, acrylic, polyester, vinyl, vinylidene, polypropylene, polyurethane and other synthetic fabrics including rayon employing the bath of the first step of Example I, following the same processing treatment for the first step, the subsequent spraying treatment of the second step, the drying and Quilon S treatment produces tonal effects similar to those obtained in Example I on glass fiber fabrics. The loosely constructed areas, employing the Example I procedure, are colored a persimmon color sharply contrasting with the off-white tightly constructed areas.

Similarly the treatment of such synthetic fabrics employing the two baths of Example II and Example III followed by treatment in a bath containing from 0.2% to 5% Quilon as in these two examples and then through an oven maintained at about 350° F. for a residence time of one minute gives the tonal effects on the synthetic fabrics substantially the same as hereinabove pointed out for the glass fiber fabrics.

The present invention, it will be noted, results in the production of multiple colored or toned glass fiber fabrics in which the tightly woven areas or yarns are free of dyestuff smears, stains and blotches and the loosely woven areas or yarns are colored a desired color contrasting with that on the tightly woven areas which can, if desired, be delustered or uncolored, i.e., white or off-white. The process of the present invention is versatile, it can be used on all types of weaves having tight or loosely woven yarns or areas. The process is adaptable to the high speeds employed in finishing glass fiber fabrics and results in such fabrics of excellent wash-fastness, hand and drape and of desired contrasting color or tonal effects in the respective loosely and tightly woven yarn sections or areas.

An important feature of the process of this invention is that the glass fiber fabric when treated with the dispersion of dye or pigment particles having a particle size of from 1 to 1500 microns, preferably 10 to 500 microns, the fabric and the dispersed dye particles are effectively neutral, i.e., neither carries an electrical charge, and the fabric is wet and has substantially all of its capillaries,

interstices and surface active areas saturated with the treating liquid used in the first step. These features, it is believed, are largely responsible for the sharp delineation of color contrast between the tightly and loosely constructed areas of the fabrics and the non-formation of smears, stains or blotches on the tightly woven areas. The latter being neutral and the dye or pigment particles applied to the loosely woven areas also being neutral, the removal of any such dye particles from the tightly woven areas, as the liquid content of the dispersion washes thereover, is facilitated and insured. In other words, the washed liquid obtained by the expressing of the excess dispersion from the fabric in the second step of the process as the fabric passes through the padding or press rollers effectively removes any dye or pigment particles on the background areas and in so doing does not have to overcome the attraction between the dye particles and the tightly woven or background areas because both are neutral and there are therefore not attractive forces that have to be overcome to effect the removal of such dye particles. On the other hand, the loosely woven areas effectively trap the dye particles which are of such size as to facilitate the entrapment and upon subsequent processing of the fabric, i.e., during the curing stage, the binder applied either in the first step or in the subsequent wash-fastness step, and, if desired, during both steps, effects the bonding of the dye particles to the loosely woven areas.

A further important feature responsible for the improved results and particularly the sharp delineation of the colored loosely woven yarns and the tightly woven yarns or areas is the factor that the dispersion of dyestuffs employed in the second step is free of binder resin or other constituents employed in the finishing of glass fiber fabrics such as fiber treating agents, including lubricants, delusterants, abrasion resistant agents, etc. This results in the deposition by entrapment of dye or pigment particles in a highly concentrated form with consequent attainment of better color value from the amount of dye or pigment used and also facilitates removal of unwanted dye or pigment from the background areas.

In the claims the expression pigment is used in a broad sense to include dyes as well as pigments.

Since different embodiments of the invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A process for coloring fabrics having loosely and tightly constructed areas which comprises
   (1) treating the fabric with liquid to substantially completely saturate the capillaries, interstices and surface active areas of the fabric;
   (2) treating the fabric from step 1, while still wet with the liquid applied in step 1, with a dispersion consisting essentially of dispersed pigment particles having a particle size of from 1 to 1500 microns, while maintaining the dispersed pigment particles and the fabric effectively electrically neutral, and padding the thus treated fabric to remove excess liquid which excess liquid washes over the fabric entering the padder thus removing pigment particles from the tightly constructed areas while leaving said pigment particles trapped within the loosely constructed areas; and
   (3) applying a binder for the pigment to the thus treated fabric to bond the pigment particles to the loosely constructed fabric area.

2. The process as defined in claim 1 in which the liquid employed in step 1 contains pigment particles having a particle size of less than 1 micron and the fabric when treated in step 1 with said liquid is thus colored with said pigment forming the background color of said fabric.

3. The process as defined in claim 1 in which the liquid employed in step 1 contains from 0.5% to 10% binder for pigment particles employed in step 2.

4. The process as defined in claim 1 in which the liquid applied in step 1 contains from 0.5% to 4% delusterant, from 0.05% to 10% pigment binder and from 0.5% to 10% of a material which imparts abrasion resistance to the fabric.

5. A process for coloring glass fiber fabrics having loosely and tightly woven yarns which comprises
   (1) treating the fabric with a liquid to substantially completely saturate the capillaries, interstices and surface active areas of the fabric;
   (2) treating the fabric from step 1, while still wet with the liquid composition applied in step 1, with a dispersion consisting essentially of dispersed pigment particles having a particle size of from 1 to 1500 microns, while maintaining the said dispersion and the fabric effectively electrically neutral, and padding the thus treated fabric to remove the excess liquid dispersion, which excess liquid dispersion removed by the padder washes over the fabric thus removing from the tightly woven yarns the pigment particles thereon while leaving pigment particles trapped within the loosely woven yarns;
   (3) drying the fabric from step 2; and
   (4) treating the fabric from step 3 with a wash-fastness agent and a binder for the pigment particles and thereafter heating the fabric to set the binder and thus bond the pigment particles to the loosely woven yarns.

6. The process as defined in claim 5 in which the liquid employed in step 1 consists essentially of an aqueous dispersion of a whtite delusterant.

7. The process as defined in claim 5 in which the liquid employed in step 1 consists essentially of an aqueous dispersion of a fiber lubricant.

8. The process as defined in claim 5 in which the liquid composition employed in step 1 consists essentially of an aqueous dispersion of a pigment having a particle size of less than 1 micron.

9. The process as defined in claim 5 in which the liquid composition employed in step 1 consists essentially of an aqueous dispersion containing a binder for the pigment applied in step 2, a fiber lubricant and a delusterant.

10. The process as defined in claim 5 in which the liquid employed in step 1 consists essentially of water.

11. A process as defined in claim 5 wherein the fabric is neutralized as to electrical charges by contacting the fabric on both sides with electrically grounded members before treatment with the liquid composition employed in step 1.

12. A process as defined in claim 5 wherein the fabric is neutralized as to electrical charges by contacting the fabric on both sides with electrically grounded members before treatment with the liquid composition employed in step 1 and also before the step 2 treatment.

13. A process as defined in claim 5 in which in step 1 a bath of liquid is employed in which the fabric is immersed, and in step 2 a bath of liquid is employed in which the fabric is immersed and in which both of said baths are electrically grounded.

14. A colored fabric having loosely and tightly constructed areas produced by the process of claim 1.

15. A colored glass fiber fabric having loosely and tightly constructed yarns produced by the process of claim 5.

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ALFRED L. LEAVITT, *Primary Examiner.*

W. L. SOFFIAN, *Assistant Examiner.*