Nov. 22, 1966 C. R. KOLLER 3,287,196

METHOD OF STYLING TEXTILES BY CONTOUR SCULPTURING

Filed Nov. 23, 1962

FIG. 1

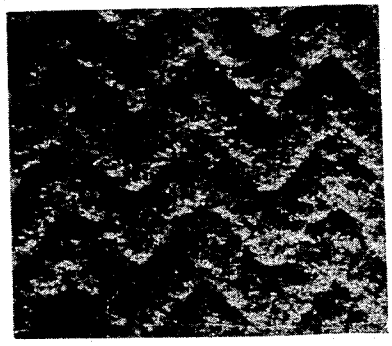


FIG. 2

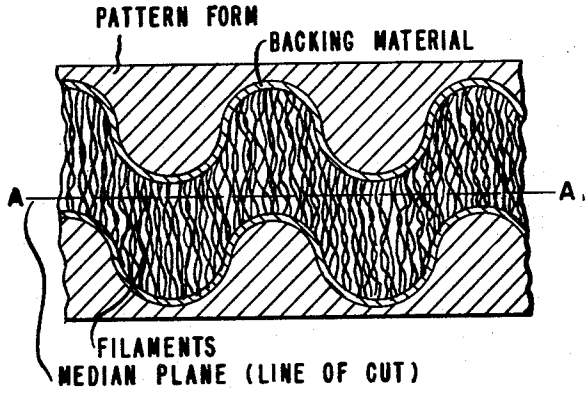


FIG. 3

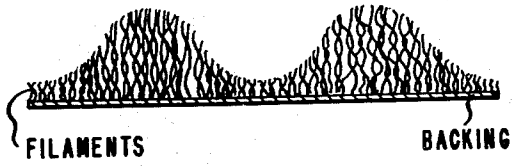
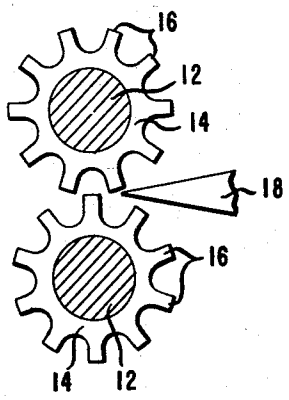


FIG. 4



INVENTOR
CHARLES RICHARD KOLLER

BY Donald A. Hoes

ATTORNEY

United States Patent Office 3,287,196
Patented Nov. 22, 1966

3,287,196

METHOD OF STYLING TEXTILES BY CONTOUR SCULPTURING

Charles Richard Koller, Wilmington, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Nov. 23, 1962, Ser. No. 239,698
6 Claims. (Cl. 156—254)

This invention relates to the styling of textile articles and, more particularly, to improved methods of contour sculpturing and the resulting products.

Techniques are available for styling pile fabrics such as carpets by sculpturing. Normally these techniques involve the feature of cutting out fiber sections to different depths in the pile surfaces. The severed portions of the pile are then commonly discarded as waste and as a result the technique is inefficient and excessively expensive.

One of the objects of this invention is to provide an improved process for styling pile textile articles. Another object is to provide a technique for obtaining a repetitive contoured pattern in the pile surface of textiles without wasting any of the pile fiber. A further object is to provide a sculpturing process particularly adapted for styling fiber-on-end textiles. Another object is to provide a group of novel pile fabrics having a wide variety of sculptured patterns. Other objects will be apparent from a further description of the invention given below.

The above objects are accomplished by a process for making a styled pile article having a sculptured surface. According to the process there is first provided a resilient porous, self-supporting material having a body formed of a plurality of contorted filamentary structures which are overlapping and are aligned in generally the same direction. The body is further characterized as constituting a network wherein at least a major proportion of the filamentary structures contact each other throughout the three dimensions of the body. Also the fiber density of the body should be below 25 lbs./ft.^{3} and the material should have two substantially parallel planar surfaces, the planes of which would be intersected by the average direction of filament alignment by an angle at least 30°. In one embodiment the self-supporting material is composed of such filamentary structures which are interconnecting, as by means of a binder composition, throughout the three dimensions. In another embodiment, the self-supporting material is composed of such filamentary structures which are attached to one or two backing layers which define the planar surfaces. In the latter embodiment, a binder for purposes of interconnecting the filamentary structures can also be provided. Isolated volumes of the material are then displaced such that the two previously planar surfaces become patterned undulating surfaces which are non-intersecting with the median plane defined thereby and which are separated by a substantially constant thickness dimension as measured in a direction perpendicular to the median plane. Subsequently the resulting material is sliced along the median plane to form two nearly identical pile bodies which each have one planar surface and one sculptured surface.

The invention is illustrated in the accompanying drawings. FIGURE 1 represents a photograph of the pile surface or top view of a typical carpet made in accordance with the invention. FIGURE 2 represents a schematic diagram of a cross section of a filamentary body having a backing on each of two opposite faces and in which isolated volumes of filaments have been displaced by differential distances in the thickness direction of the body. The body, originally with backings forming two substantially parallel planar surfaces, has been displaced in conformity with the pattern form or molding means such that the surfaces take on an undulating curved character. The

thickness, in a direction perpendicular to the median plane illustrated by line A–A′, remains essentially constant. Necessarily the median plane is not intersected by the curved surfaces (defined by the backing layers) to prevent the assembly from separating at various locations upon slicing. FIGURE 3 represents a schematic diagram of a cross section of a resulting textile after a transverse flat cut has been made in the median plane shown by the line A–A′ in FIG. 2 between the two displaced faces of the body to provide a textile article having a single sculptured surface. As shown, the planar surface defined by freshly cut filament ends has become the exposed contoured surface. FIGURE 4 depicts the side view of a portion of a suitable profile cutting mechanism.

A suitable method for carrying out the present invention involves first preparing a bonded block of filaments by arranging a group of continuous filaments, each having a three dimensional crimp, so that the filaments are aligned generally in the same direction and are overlapping when they are placed in a mold. Next the block is sliced at two locations traversely to the direction of the filaments to provide two, preferably parallel, faces of cut filament ends. Next a suitable flexible backing material is attached to both faces of the block by first applying a suitable adhesive to the two faces made up of filament ends and then pressing the backing onto each face. The resulting block is then fed into a contour slitter which displaces under pressure isolated volumes of filaments in the thickness direction of the body by differential distances by means of a series of presser feet on matching patterning rolls. A side view of such a mechanism shown in FIG. 4 wherein two parallel cores **12** have each mounted thereon a series of annularly shaped forming elements or rings **14**. Each such ring has a plurality of presser feet or flat faces **16** distributed about its periphery and which alternate with parabolic shaped recesses. The presser feet of the rings mounted on the core, being driven in the same direction with the same surface speeds, intermesh to engage the block there between and thereby displace isolated volumes of the material. The same mechanism then makes a complete slice by means of knife **18** between the two backed faces of the body in a fixed plane while the isolated volumes of filaments are in the displaced state from this plane. The plane or median plane effectively divides the volume of the backed block into equal halves. Upon emerging from the contour slitter, the filaments and backings, being resilient, recover from their displaced state to yield two individual backed pile fabrics, each having a sculptured pattern in the pile surface. The pile surfaces of these two articles have matching sculptured patterns. Variations in the number and relative position of the rings **14** make possible a wide variety of designs. For example, an arrangement whereby the presser feet of every other ring about a core are in longitudinal alignment produces a zig-zag pattern. If desired, the binder present in the pile layer of the pile fabric can be removed by washing to give a pile fabric such as a carpet having a soft, sculptured pile surface made up of a plurality of areas having differential pile height.

The pile fiber density or simply "fiber density" reported in pounds per cubic foot is a measure of the density of the fibers in the pile layer of the backed carpet or other specimen from which layer the binder has been removed, or in other words the density of the shearable fiber above the adhesive line. The pile fiber density is calculated by dividing the effective pile weight of the fibers in the pile layer by the volume these fibers occupy when the specimen is under a load of 0.1 p.s.i. This volume is determined by multiplying the average width by the average length of the conditioned carpet specimen by the effective pile height, and then applying suitable conversion factors to obtain the volume in units of cubic feet.

A full description of the filamentary materials employed in accordance with this invention for the production of styled pile fabrics is set forth in C. R. Koller U.S. application Serial No. 787,662, filed January 19, 1959, now U.S. Patent 3,085,922. These materials are of a porous character and have a plurality of contorted e.g. crimped, filamentary structures which overlap, are aligned generally in the same direction, are intercontacting or interconnected throughout the three dimensions of the material and the material has a fiber density below 25 lbs./ft.^{3}. Although a description of these materials including definitions of the terms used in connection therewith is fully set forth in the above Koller application, the disclosure of which is specifically incorporated herein by reference, they will be briefly mentioned herein. By "contorted" it is meant that the profile (i.e. side elevation) of an individual filament is irregular (i.e. not straight) when the filament is viewed from at least one side. In addition to being contorted, it is necessary that such filamentary structures overlap adjacent structures throughout the three dimensions of the article. By the term "overlap" is meant that in at least one view, a filamentary structure crosses over, with or without touching or attachments, an adjacent filamentary structure. Furthermore, it is critical to such structures that the contortion and overlapping of the filamentary structures do coact or are allowed to coact with one another. By "coact" is meant that the contortion and relative placement of the filamentary structures are such that they assist one another in producing and maintaining the claimed structures both with respect to the general alignment of the filamentary structures and their spacing with respect to each other to achieve the desirable densities contemplated.

The initial filamentary material may be in any of a variety of forms, for example, carded webs of substantially aligned staple fibers or bodies of substantially aligned filamentary structures prepared from a warp of sliver, top, roping, roving, tow stuffer box crimped tow, steam bulked tow, steam crimped continuous filament yarn, gear crimped continuous filament yarn, twist set-back twisted continuous filament yarn, knife edge crimped continuous filament yarn, two-component bulky continuous filament yarn, spun yarns, and many others. Any of the above procedures may then be followed to prepare the layer of material for use in this machine.

In preparing a block sheet material of contorted fibers a wide variety of polymeric compositions may be employed. Typical of the fibers and filaments which may be employed are those made of polyamides, such as poly(hexamethylene adipamide), poly(meta-phenylene isophthalamide), poly(hexamethylene sebacamide), polycaproamide, copolyamides and irradiation grafted polyamides, polyesters and copolyesters such as condensation products of ethylene glycol with terephthalic acid, ethylene glycol with a 90/10 mixture of terephthalic/isophthalic/5-(sodium sulfo)-isophthalic acids, and trans-p-hexahydroxylylene glycol with terephthalic acid, self-elongating ethyleneterephthalate polymers, polyacrylonitrile, copolymers of acrylonitrile with other monomers such as vinyl acetate, vinyl chloride, methyl acrylate, vinyl pyridine, sodium styrene sulfonate, terpolymers of acrylonitrile/methylacrylate/sodium styrene sulfonate made in accordance with U.S. Patent 2,837,501, vinyl and vinylidene polymers and copolymers, polycarbonates, polyacetals, polyethers, polyurethanes such as segmented polymers described in U.S. Patents 2,957,852 and 2,929,804, polyesteramides, polysulfonamides, polyethylenes, polypropylenes, fluorinated and/or chlorinated ethylene polymers and copolymers (e.g., polytetrafluoroethylene, polytrifluorochloroethylenes), cellulose derivatives, such as cellulose acetate, cellulose triacetate, composite filaments such as, for example, a sheath of polyamide around a core of polyester as described in U.S. Patent 3,038,236, and self-crimped composite filaments, such as two acrylonitrile polymers differing in ionizable group content cospun side by side as

described in U.S. Patent 3,038,237 regenerated cellulose, cotton, wool, glass, metal, ceramic and the like. Blends of two or more synthetic or natural fibers may be used, as well as blends of synthetic and natural. Other fibers such as silk, animal fibers such as mohair, angora, vicuna are also suitable.

The self-supporting material may be prepared from a wide variety of forms of fibers and filaments having any of the above-mentioned compositions, such as, for example, continuous monofilaments, continuous multifilaments, carded webs, warp, sliver, top, roping, roving, tow, bulked tow, bulked continuous filament yarn, spun yarn, batts, felts, papers and other non-woven webs, and the like. The fibers and filaments used as raw material may be either crimped or uncrimped, bulked or unbulked, drawn or undrawn or twisted or untwisted. The denier of the filaments is not critical and may vary from about 0.5 to about 50 denier or even higher.

The use of a binder is preferred to interconnect the filamentary structures at a plurality of points along their length. Depending upon the use desired, these may be either soluble or insoluble, and may be either thermoplastic in nature or may be thermosetting for subsequent reaction with a curing agent to form a cured polymer. By "binder" is meant the additional material used to attach the filaments to each other. Normally these materials will be used in an amount of at least about 0.5% by weight based on the filamentary structures. If it is desired to remove the binder after attaching to a backing or after slicing the material in displaced form a soluble binder will be employed which may be either organic-soluble or water-soluble. Suitable organic-soluble binders include natural rubber or synthetic elastomers (e.g., chloroprene, butadienestyrene copolymers, butadiene-acrylonitrile copolymers), which may be used in the form of a latex dispersion or emulsion or in the form of a solution, vinyl acetate polymers and copolymers, acrylic polymers and copolymers such as ethyl acrylate, methyl acrylate, butyl acrylate, methyl methacrylate, acrylic acid/acrylic and methacrylic ester copolymers, cellulose nitrate, cellulose acetate, cellulose triacetate, polyester resins such as ethylene terephthalate/ethylene isophthalate copolymers, polyurethanes such as the polymer from piperazine and ethylene bis-chloroformate, polyamide polymers, and copolymers, methoxymethyl polyamides, vinyl chloride polymers and copolymers such as vinyl chloride/vinylidene chloride copolymer latices. Alcohol soluble polyamide resins are also suitable organic-soluble binders. Suitable water-soluble binders include materials such as polyvinyl alcohol, sodium alginate, acrylic acid polymers and copolymers such as polyacrylic acid, carboxymethyl cellulose, hydroxyethyl cellulose, dextrins, animal glue, soybean glue and sodium silicate. Suitable binders which are insoluble in organic solvents include polytetrafluoroethylene and ureaformaldehyde resin latices.

Additional suitable binder compositions include chlorosulfonated polyethylene; butyl rubbers, such as isobutylene/isoprene copolymers; polyhydrocarbons, such as polyethylene, polypropylene and the like and copolymers thereof; high molecular weight polyethylene glycols sold under the trade name of Polyox; epoxide resins, such as the diepoxide of bisphenols and glycols; polystyrene; alkyd resins, such as polyesters of glycerol with phthalic or maleic acid; polyester resins such as from propylene glycol-maleic anhydride-styrene; phenol-formaldehyde resins; resorcinol-formaldehyde resins; polyvinyl acetals, such as polyvinyl butyral and polyvinyl formal; polyvinyl ethers, such as polyvinyl isobutyl ether; starch, zein, casein, gelatine, methyl cellulose, ethyl celluose, poyvinyl fluoride, natural gums, polyisobutylene, shellac, terpene resins and rosin soaps. Segmented polymers, such as spandex polymers, polyether amides, polyether urethanes (e.g. those in U.S. 2,929,800) and polyester/urethanes are also suitable.

The adhesives which may be used when applying the

backing are varied. By "adhesive" or "glue" is meant the material used to cause the filamentary structures and sheet materials to adhere to the backing or is meant the material used to constitute the backing. Illustrative adhesives are: chloroprene rubber, elastomeric foams and sponges, butadienestyrene rubber, polyvinyl chloride resin (e.g. those in combination with either a polymeric plasticizer or a monomeric plasticizer curable after application of the adhesive), polyurethane resins, polyamide copolymer of hexamethylene diamine and adipic and sebacia acids, casein resin, and epoxy resins such as the diepoxide of 2,2-bis(parahydroxyphenyl)propane. Illustrative backings are: woven fabrics such as burlap, canvas, and nylon scrim fabrics, knit fabrics such as nylon tricot, nonwoven fabrics such as polyethylene or polypropylene fiber webs, resin bonded polyethylene terephthalate fiber webs, papers of cellulosic and/or synthetic fibers, paper felts such as asphalt impregnated cellulose, elastomeric foams and sponges, plastic films such as from polyethylene terephthalate, polypropylene and polyvinyl chloride polymers, metal foils and rigid sheets such as fiber glass reinforced polyester resins, metals, ceramics and wood, elastic, stretchable or shrinkable fabrics and films, and the like. Necessarily the backing must be of a flexible nature if it is to be applied to the block or sheet material prior to the displacement of isolated portions of the material.

Reference is made herein to the terms "body," "block," and "sheet." The term "block" is usually applied to a body having a relatively large thickness in the direction of the filament length, whereas the "sheet" in usually applied to a body having a relatively small thickness in the direction of the filament length. For purposes of practicing this invention, the porous body of aligned filaments may be of any convenient size depending upon the nature of the final textile article desired. However, the block or sheet material should be readily compressible and resilient to permit controlled displacement of filaments by isolated forces applied to the faces of the body. This means that the selection of the backing layer and adhesive composition should be judicious so that the properties of these materials do not interfere with the compressibility of the porous body. In addition, the porous filamentary body should be composed of resilient filaments and/or resilient binder, so that the filaments achieve substantially complete recovery on release of the displacing force. In addition, the pile fiber density and the composition of the binder if left in the body should be selected to provide sufficient compressibility in the body, so that the displacement of filaments may be accomplished. The step of displacing the isolated volumes of filaments in the thickness direction of the body may be carried out on a porous bonded filamentary body containing no backing layer on either face; or the displacing step may be carried out on a bonded filamentary body having a backing layer on one or both faces made up of filament ends; or the displacing step may be carried out on a porous body of aligned filaments which are kept in the aligned position by having been attached to a backing on both faces of the body and then removing the binder from between the filaments. A preferred method for carrying out the invention is one in which the displacing step is applied to a porous filamentary body containing only a small amount of binder holding the filaments in the aligned direction. In addition, it is preferred to employ a porous bonded filamentary body having a pile fiber density of less than 5 lbs./ft.^{3} since the degree of resiliency afforded is greater. For most purposes and particularly in the case of carpets it is desirable that the thickness dimension of the material to have isolated volumes displaced is not in excess of 2 inches.

The step of displacing isolated volumes of filaments in the thickness direction of the filamentary body by differential distances with respect to the median plane of a predetermined transverse flat cut through the body may be carried out by any convenient means or apparatus. One suitable apparatus for accomplishing the displacing step and slicing step is a Fechen-Kirfel contour slitter, available from Fechen-Kirfel Maschinenfabrik of Aachen, Germany. Though the displacement of isolated volumes of filaments by differential distances will normally be made by displacing a volume of fibers while the volume remains constant, the invention includes the optional provision of displacing some of the isolated volumes of filaments within the filamentary body by compression of a volume of the filaments to obtain a volume of higher fiber density and lower fiber volume. The phrase "patterned undulating surface" refers to the wavy outline or appearance of the self-supporting material having isolated portions displaced. The undulations need not be wholly continuous or fully repetitive throughout a given surface but need only be sufficient to provide a predetermined pattern or design by means of a plurality of isolated areas of contrasting pile thickness.

Any suitable sharp knife, blade or other cutting means may be used to carry out the step of slicing the filamentary body provided the slice is flat, is transverse to the direction of the filaments and is essentially in the median plane between the two distorted faces of the body made up of filamentary ends and, most importantly, provided the slicing is done while the isolated volumes of filaments are held in their displaced state. The body of displaced filaments may be held fixed while the slicing or cutting means is moved transversely through the body, or the cutting means may be held stationary while the body and its displaced volumes of filaments move with respect to the cutting means.

The primary advantage of this invention resides in the economics involved since, in contrast to most existing sculpturing methods for making pile fabrics, there is no loss of pile fiber and the process can be carried out continuously and at relatively high speeds. Another advantage lies in the fact that a wide variety of texturing and patterning effects may be easily obtained by variations in the patterning rolls employed, as well as variations in the amount of filament displacement before slicing. The process of this invention may be applied to either unbacked bonded filamentary bodies or backed filamentary bodies with or without binder.

The present invention is useful for preparing a variety of textile articles, particularly pile fabrics, in the form of floor coverings such as carpets and tiles, furs and fleeces, upholstery fabrics, garment interliners, blankets, cushions, mattresses, fibrous laminated structures, sponges, insulating materials, filters for gases, liquids and solids, and the like.

The following example illustrates a specific embodiment of this invention, but is not intended to limit the scope of the invention.

Example

A fiber-on-end block is prepared from a tow of steam-bulked continuous filament nylon yarn using the procedure, type of yarn and binder described in Example I of U.S. application, Serial No. 787,662, filed January 19, 1959. The bonded block has a fiber density of 2.94 lbs./ft.^{3} and binder content of about 4% (based on the weight of fiber). The bonded fiber-on-end block is sliced transversely to the fiber direction and in a plane parallel with the face of the block to give a 27" x 27" x 1" thick fiber-on-end self-supporting sheet. The fibers in this sheet are oriented in the same direction with their ends directed towards the cut faces of the sheet, i.e. the 27" x 27" faces. Burlap fabric is then attached by means of neoprene adhesive to the two cut faces of the bonded fiber-on-end sheet.

The double-backed bonded fiber sheet is then passed through a Fechen-Kirfel Bandknife Profile Cutting Machine (Model 69KP, 48" wide, Fechen-Kirfel Machinenfabrik, Aachen, Germany) so as to cut the fibers transversely between the two backing fabrics. The two pro-

file forming rolls of this machine were fitted with a series of annularly shaped forming elements or rings each with ten square (0.4" x 0.4") pressure faces evenly distributed around their periphery. (Each annularly shaped forming element being 0.4" wide, 4.8" in diameter.) The forming elements are arranged so as to give a transversal zig-zag ribbed pattern. The roll settings on both the top and bottoms is 2.44 inches (distance from knife edge to center of profile forming roll).

Two backed bonded pile fiber assemblies are thus produced in which the height of the pile members varies from about ¼" to about ¾" in a contoured transversal zig-zag ribbed pattern. The binder is removed from the pile members by washing with an ethanol/water (80/20 by vol.) solvent and the sample is then dried. There is obtained a soft backed pile fabric with an attractive sculptured pile pattern that is suitable for a use as a carpet.

What is claimed is:

1. Method for the production of surface styled pile articles which comprises:

(a) providing a resilient porous, self-supporting material having a body formed of a plurality of contorted filamentary structures which are overlapping and are aligned in generally the same direction, said body constituting a network wherein at least a major proportion of the filamentary structures contact each other throughout the three dimensions of the body, the fiber density of the body being below 25 lbs./ft.^{3}, said material having two substantially parallel planar surfaces, the planes of which would be intersected by the average direction of filament alignment by an angle of at least 30°,

(b) displacing isolated volumes of said material such that said planar surfaces become patterned undulating surfaces which are non-intersecting with the median plane defined thereby and which are separated by a substantially constant thickness dimension as measured in a direction perpendicular to said median plane at the point of maximum displacement, and

(c) slicing the resulting material along said median plane.

2. Method of claim 1 wherein said body has a fiber density of less than about 5 lbs./ft.^{3}.

3. Method of claim 1 wherein at least one of said two substantially parallel planar surfaces is defined by a backing in adherent contact with said body.

4. Method of claim 1 wherein said two substantially parallel planar surfaces are defined by respective backings in adherent contact with said body and wherein that portion of said body intermediate said two substantially parallel planar surfaces is essentially free of interconnections.

5. Method of claim 1 wherein said two substantially parallel planar surfaces are defined by cut filamentary ends and wherein said filamentary structures are interconnected by means of a binder composition.

6. Method of claim 5 wherein the binder composition is at least about 0.5% based on the weight of filamentary structures.

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EARL M. BERGERT, *Primary Examiner.*

DOUGLAS J. DRUMMOND, *Examiner.*