United States Patent

Crowley

[15] **3,694,873**

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[54] **METHOD OF PREPARING A TUFTED RUG WITH CELLULAR FIBERS**

[72] Inventor: **Richard P. Crowley,** 125 High St., Wellesley Hills, Mass. 02110

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 872,498, Oct. 30, 1969.

[52] **U.S. Cl.** ....**28/72 P,** 156/72, 112/266, 112/410

[51] **Int. Cl.** **D05c 15/00,** D06c 7/00

[58] **Field of Search**.....28/72 P, 75, 72.2; 139/420 R; 156/72; 112/266, 410

[56] **References Cited**

UNITED STATES PATENTS

2,960,750	11/1960	Matthews	28/72 P X
3,017,847	1/1962	Keen	28/72 P X
3,091,017	5/1963	Wetterau	28/75 R
3,506,530	4/1970	Crosby	28/72.2 R X
3,100,926	8/1963	Richmond	28/75 R
3,244,545	4/1966	Marzocchi et al.	139/420 R X
3,554,824	1/1971	Callahan	112/410

FOREIGN PATENTS OR APPLICATIONS

977,513	12/1964	Great Britain	139/420 R

Primary Examiner—Henry S. Jaudon
Attorney—Richard P. Crowley and Richard L. Stevens

[57] **ABSTRACT**

A sheet material, such as a needle-punched or tufted fabric, is prepared employing gas-expandable polymeric fibers, such as a polypropylene resin containing an undecomposed blowing agent, and, thereafter, expanding the diameter of the polymeric fibers by heating the fibers to form cellular polymeric fibers, the expansion locking such cellular fibers into the sheet material. The gas-expandable polymeric fibers may be employed either in the backing sheet or as the face fabric.

13 Claims, No Drawings

METHOD OF PREPARING A TUFTED RUG WITH CELLULAR FIBERS

REFERENCE TO PRIOR APPLICATION

This application is a continuation-in-part application of my prior copending application U.S. Ser. No. 872,498, filed Oct. 30, 1969.

BACKGROUND OF THE INVENTION

Pile fabrics are typically prepared by tufting, needle punching, weaving or otherwise working a fibrous material into and through a sheet backing material, such as a jute fabric. Pile fabrics may be usefully employed as rugs and carpets for wall covering upholstery and for personal clothing, such as coats, boots, inner-lining of garments and the like. The fibrous material is often secured to the backing material which typically comprises a woven inexpensive sheet material of jute, sisal, paper or other sheet material through the use of adhesives. Adhesives, such as latex, vinyl and urethane resins and other polymeric materials of both natural and synthetic types are coated on the back of the backing material after the needle punching, tufting or woven or forming operation and thereafter hardened, such as by curing, heating, cross-linking in order to secure the fibers to the backing material and prevent them from being removed from the fabric face during use.

U.S. Pat. No. 3,091,017 prepares textile fabrics containing cellular plastic fibers by incorporating a composite strand comprising a fiber core surrounded by a smooth foam plastic composition into a textile fabric. U.S. Pat. No. 2,964,799 relates to a method of making plastic foam sheet laminates by calendering a thin film of a thermoplastic material containing a blowing agent onto a backing sheet, and subsequently blowing or expanding the film.

SUMMARY OF THE INVENTION

My invention concerns novel synthetic fibers and in particular the method of employing such fibers to prepare a sheet material characterized by having fibers secured to a backing sheet. My invention concerns in particular the use of synthetic gas-expandable fibrous material to prepare a tufted, needle-punched, woven, or otherwise formed material to a backing sheet wherein the fibers are secured to the backing sheet and locked through the subsequent expansion of the diameter of the fibers in the backing sheet and/or the pile fabric.

In one embodiment, my method comprises forming of a synthetic fiber which is gas-expandable and contains a blowing agent, the forming operation taking place at a temperature less than the temperature at which the blowing agent would decompose, and thereafter, using the gas-expandable polymeric fibers to form a pile fabric by inserting the gas-expandable fibers into a backing sheet of either a solid nature or having relatively small interstitial areas therein and subsequently heating the fibers, whereby the fibers will expand in diameter and thereby become locked into the backing sheet.

In another embodiment, the gas-expandable fibers are employed in the backing sheet so that on heating and expansion of the fibers, the fibers needle-punched into the backing sheet will be secured thereto. My method may be used in conjunction with adhesives in order to secure the fibers to the sheet material. My method has particular utility where it is desired to have good tuft lock of the fibers to the backing sheet and where the backing sheet has interstitial areas such that the expansion of the fibers provides a locking action against the fibers or material of the backing sheet.

The product produced by my method is unique in that the use of hardened adhesives may be avoided while the face fabrics, by being gas-expandable and having a foam density of the desired weight, provide a softness, cushioning and resiliency effect where the product is employed as a carpet or rug. The products produced by my method are particularly useful in recreation or artificial turf applications, such as for tennis courts, football fields or swimming pool patios and provides an inexpensive and efficient method of producing such products.

The polymeric material used in forming the gas-expandable fibers in my invention may comprise a variety of natural and synthetic resinous material, both thermoplastic and thermosetting, such as natural and synthetic elastomeric material as well as thermoplastic material, the selection of the particular fiber based on the ultimate use of the product. Typical materials include any polymeric material which is capable of being expanded into a cellular product by the use of a blowing agent. Such materials would include but not be limited to those organic thermoplastic materials, such as vinyl resins like vinyl halide resins, such as vinyl chloride resins to include polyvinyl chloride and vinyl chloride copolymers with the esters of short-chain fatty acids, such as vinyl acetate as well as with vinylidiene chloride, olefinic resins, such as C_2–C_4 olefinic resins like polypropylene, polyethylene, copolymers of ethylene, propylene, butylene and the like as well as elastomeric polymers subjected to curing such as butyl rubber, neoprene, polybutadiene, styrene-butadiene, styrene-acrylonitrile-butadiene and the like.

The polymeric materials may be formed into small diameter fibers through conventional techniques such as by extruding through a die or spinerette. The fibers may be employed alone or with other natural or synthetic materials in multiple strands. The diameter of the fibers may vary and where desired, the fibers may be of round, elliptical, flattened or other shape. For example, a typical flat or ribbon-like fiber and use of such fibers which may be made gas-expandable are set forth in U.S. Pat. No. 3,110,905. The formation of the fibers containing a blowing agent and other additives as required should take place at a temperature insufficient to decompose or to substantially decompose the particular blowing agent being used, with the temperature so selected depending on the blowing agent and stabilizers employed in the polymeric mixture.

Further, in another embodiment of my invention, the synthetic polymeric material containing a blowing agent may be extruded, coated, cast or otherwise employed over one or more materials employed in single or multiple strands as an inner core material of either natural or synthetic origin. The core material may, for example, be a fiber of cotton, rayon, wool, jute, cellulose, nylon, polyester, acrylic, vinyl resin, olefinic resin, and the like. The inner core fiber typically would be solid; that is, nongas-expandable, but if desired, may also, where it is synthetic, be gas-expandable to the same or different density than that employed for the outer coating. The gas-expandable material may be formed over a cellular core material or over a gas-expandable material so that on subsequent heating, the core and coating form a cellular product. The use of a single monofilament or a strand of monofilament as an inner core material may be used where it is desired to impart additional mechanical strength to the fibers employed, such as the use of an olefinic, polyester, nylon or acrylic resin, glass fibers or steel fibers or where, for example, to use an inexpensive material, such as cotton where it is desired to reduce the amount of the gas-expandable polymer employed as the outer coating. The thickness of the outer coating may vary from 2 to 100 mils, depending on the depth and size of the ultimate fiber product desired.

The synthetic polymeric material to be employed in the fibers may typically include those plasticizers, stabilizers, curing agents, accelerators, pigments, dyes, oils, fillers and other additives desired and should also contain one or more blowing agents. Typically, the blowing agents would be used in the amount of from 0.1 to 25 parts of the blowing agent per 100 parts of the resin; for example, 1 to 15. A wide variety of blowing agents may be employed including those blowing agents which decompose in the application of heat to give an inert gas such as nitrogen, hydrogen or carbon dioxide and the like or may also include those liquid blowing agents such as the fluorocarbons which on the application of heat vaporize to form a cellular product. The selection of a particular blowing agent is based on a melt viscosity of the polymeric material to be used and the temperature at which the material must be formed into the fiber and the decomposition characteristics and temperature of the blowing agent. Typical blowing agents which could be employed would include azodicarbonamide for the vinyl chloride resins, oxybisbenzenesulphonylhydrazide for other thermoplastic resins and dinitrosopentamethylenetetramine for the neoprene, butyl rubber, ABS resins and polybutadiene and the like. Other blowing agents may be selected from the Encyclopedia of Polymer Science and Technology, Volume 2, pages 532–565 by Henry R. Lasman, 1965.

The gas-expandable synthetic polymeric fibers may be employed in typical rug, carpet or pile fabric techniques in order to secure them to a sheet material used as a backing material. Of course, the fibers may be employed alone or with the other adhesive materials to aid in securing onto the backing sheet with my technique employed to provide greater lock to the sheet material. The extrusion or forming of the fibers as well as the placing the fibers into contact with or at least partially through if not entirely through the backing sheet should be done at a temperature below the decomposition temperature of the blowing agent. After the tufting, needle punching or weaving process, the product may then be exposed to a higher temperature and a decomposition agent in order to decompose the blowing agent and thereby selectively expand the fibrous material to the formation of a foam fiber. On decomposition, the fibrous material will expand in diameter, pushing against the surrounding material of the backing sheet or the pile fibers and thereby provide a greater lock of the fabric to the backing sheet. The foam density of the polymeric material should be selected to provide the cushioning effect desired together with what wear-resistant properties are needed. For example, high foam density material may be desirable, for example, from 20 to 50 pounds per cubic foot may be desirable where high wear resistance is necessary, such as in outdoor carpet, while lower foam density material where wear resistance is not important, such as from 2 to 15 pounds per cubic foot, may be desirable where cushioning effect and wear resistance is not the primary objective.

The backing material employed in preparing my products may comprise any sheet material either woven or nonwoven of natural or synthetic origin. Typically, however, the sheet material should be fairly solid or have a woven fabric having a low interstitial area so that upon expansion of one or more fibers, that the fibers will properly lock. Of course, with thermoplastic resins, an additional advantage of my invention is that the application of the higher temperatures to decompose the blowing agent will also provide for the thermoplastic resin to flow and adhere to the surrounding backing sheet or pile fibers, thereby also providing an adhesive effect to hold the fibers in place. Typical sheet backing material which may be employed would include paper or woven yarns composed of jute, sisal, resin-reenforced papers or even resinous sheet material, such as a gas-expandable thermoplastic resinous material such as a gas-expandable vinyl chloride sheet material so that upon the application of the higher temperature, both the backing sheet and the yarns will expand to form a unitary product having a cellular backing sheet with cellular yarn secured directly thereto. Of course, the cellular foam formed either on the backing sheet or the fibers may be of the open or closed cell as desired, although typically, the fibers formed will have a thin-skin outer coating to prevent the absorption of liquid spilled thereon. Other sheet materials would include screens of fiber glass, asbestos sheets, knitted, braided or other fabrics such as stretch fabrics and the like. My gas-expandable fibers may be woven or formed into the backing material alone or with other natural or synthetic fibers. The gas-expandable fibers may be woven at spaced intervals through a jute backing. It is preferred that the same synthetic polymer be used in the backing and pile face.

A vinyl chloride tufted pile fabric is employed in the practice of my invention by extruding a vinyl chloride resin through a spinerette die to form a fine diameter continuous fibrous material. The vinyl chloride resin may comprise a vinyl resin together with an ester-type plasticizer such as dioctylphthalate ranging from 10 to 50 parts per hundred parts of the resin, a zinc-cadmium organic soap stabilizer in amounts of 4 parts per hundred parts of resin, a pigment, such as titanium dioxide at 5 parts per 100 parts resin, and about 2 parts per hundred parts of resin of a blowing agent such as azodicarbonamide. This mixture may be rolled into a substantially dry extrudable form on a roller mill and then extruded into fiber form at a temperature of approximately below 170°C, such as 160°C. This vinyl chloride resin, if desired, may also be extruded around a nylon core, the nylon employed for strength with the nylon inner core representing about half of the diameter of the fabric so formed. The gas-expandable vinyl resin is then tufted onto a closely woven fabric sheet material in typical manner; for example, as set forth in U.S. Pat. No. 3,110,905, either the prior art or the method proposed therein. The tufted product containing polymeric fibers as the pile fabric is then subjected to a temperature, for example, in a hot air oven or infrared heaters directed to one or both surfaces greater than about 175°C, for example, 190° to 200°C, in order to more fully fuse the vinyl resin and to provide for the decomposition of the azodicarbonamide to form a cellular product. Prior to such decomposition, it may be desirable to secure a gas-expandable vinyl chloride sheet material to the backing material so that upon heating to this temperature, the backing material will also decompose so that the product will ultimately have a vinyl foam backing secured to one side of the backing material and a cellular vinyl foam face as the pile fabric.

Of course, where desired, my gas-expandable polymeric fabrics may be woven into a particular shape and then expanded in order to secure and form a sheet material without a backing material and which contains a flexible interwoven cellular fibrous material. Where a solid flexible thermoplastic backing sheet is used, the product produced is suitable for use as floor tiles with the cellular synthetic fibers secured to the backing sheet. The heating to expand the face fibers in such case where the backing material is a vinyl chloride resin also serves to fuse the resin and the fibers into a unitary product of a solid vinyl chloride back with a cellular vinyl chloride resin fibrous pile face. Other techniques and modifications of my invention will be apparent to those people skilled in the art, and accordingly, it is intended to be bound only by the scope of the claims appended hereto.

What is claimed is:

1. The method of preparing a tufted product, which method comprises:

a. extruding a polymeric composition containing a polymer and a blowing agent into a fiber, the temperature of extrusion being below the decomposition temperature of the blowing agent to provide a solid gas-expandable polymeric fiber;

b. tufting the gas-expandable solid polymeric fiber into or through a base sheet to provide a sheet material having a fibrous face containing such gas-expandable polymeric fibers; and

c. heating the gas-expandable polymeric fibers to a temperature above the decomposition temperature of the blowing agent to expand the diameter of the fibers and to form cellular polymeric fibers, the expansion of the diameter of the fiber locking the fiber to the base sheet.

2. The method of claim 1 wherein the base sheet comprises a solid, flexible nonexpandable polymer sheet material.

3. The method of claim 1 wherein the polymeric composition comprises an olefinic resin or vinyl chloride resin.

4. The method of claim 1 wherein the polymeric composition is extruded about a solid high strength inner core material to form a composite fiber.

5. The method of claim 4 wherein the inner core comprises a different material than the outer gas-expandable polymeric material.

6. The method of claim 4 wherein the inner core is formed of nylon.

7. The method of claim 1 wherein the base sheet comprises a gas-expandable thermoplastic material, and after tufting the gas-expandable polymeric fibers into or through the base sheet, heating the base sheet to a temperature sufficient to cause the expansion of the thermoplastic material of the base sheet, thereby providing expansion of the base sheet and fibers so as to lock the fibers to the base sheet.

8. The method of claim 7 wherein the thermoplastic base sheet comprises a vinyl chloride resin.

9. The method of claim 1 wherein the base sheet comprises nonwoven gas-expandable polymeric fibers containing an undecomposed blowing agent, and after tufting the polymeric fibers into or through the nonwoven base sheet, heating said base sheet to a temperature above the decomposition temperature of the blowing agent in the fibers of the base sheet to expand the diameter of the fibers, whereby the expansion of the diameter of all fibers locks the cellular face fibers to the cellular base sheet.

10. The method of claim 1 which includes the steps of:

a. securing a backing gas-expandable vinyl chloride sheet material to the base sheet prior to heating the gas-expandable polymeric face fibers; and, thereafter,

b. heating said backing material so as to effect gas expansion of the vinyl chloride sheet, thereby providing a tufted rug having a vinyl foam backing secured to one side of the base sheet and a cellular fiber face.

11. The method of preparing a synthetic tufted product such as a tufted rug or floor tile product, which method comprises:

a. extruding a vinyl chloride resin or an olefinic resin containing a blowing agent into a fiber over an inner core material, the temperature of extrusion being below the decomposition temperature of the blowing agent to provide a solid gas-expandable polymeric fiber;

b. tufting the gas-expandable solid polymeric fiber into or through a base sheet comprising a thermoplastic resin material; and

c. heating the gas-expandable polymeric fibers to a temperature above the decomposition temperature of the blowing agent to expand the diameter of the fibers and to form cellular polymeric fibers, the expansion of the diameter of the fibers locking the fibers to the base sheet.

12. The method of claim 11 wherein the same polymer is employed in the base sheet and the fibers.

13. The method of claim 11 wherein the temperature of extrusion is below about 170° C.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,694,873 Dated October 3, 1972

Inventor(s) Richard P. Crowley

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet [72] "Richard P. Crowley, 125 High St., Wellesley Hills, Mass. 02110" should read -- Richard P. Crowley, Wellesley Hills, Mass. (125 High Street, Boston, Mass. 02110) --.

Signed and sealed this 3rd day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents