Feb. 29, 1944. C. H. MASLAND, 2D 2,342,746

PROCESS FOR MAKING PILE FABRIC

Filed Aug. 23, 1941

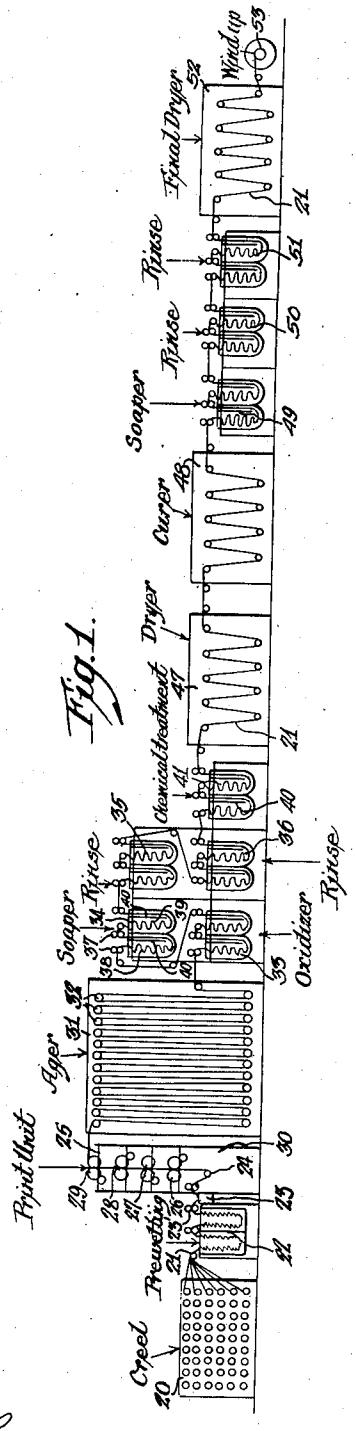


Fig. 1.

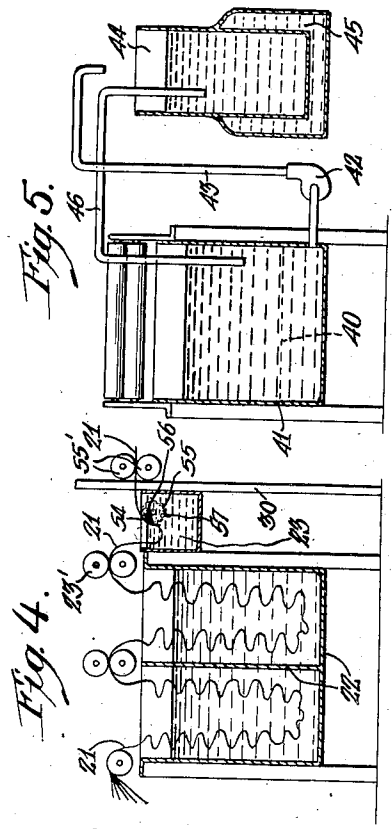


Fig. 5.

Fig. 4.

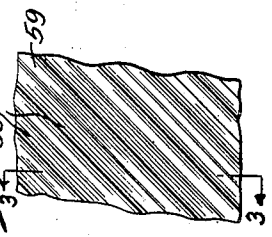


Fig. 2.

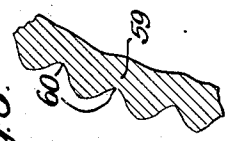


Fig. 3.

Witness:
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Patented Feb. 29, 1944

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UNITED STATES PATENT OFFICE

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PROCESS FOR MAKING PILE FABRIC

Charles Henry Masland, 2nd, near Carlisle, Pa.

Application August 23, 1941, Serial No. 408,122

4 Claims. (Cl. 28—75)

The present invention relates to processes for treating, drying, curing and/or manipulating textile fiber, and producing pile fabric therefrom.

The present application is a continuation in part of my copending application Serial No. 366,354, filed November 20, 1940, for Textile dyeing and finishing method, apparatus and product.

A purpose of the invention is to create a loftier pile in a pile fabric such as a carpet or rug, and to produce a pleasing effect more economically.

A further purpose is to apply a resinous size to the fibers to be used for making the piles of pile fabrics such as carpets or rugs prior to spinning, cure the resinous size, spin the sized fibers into pile yarn and employ the yarn in the pile of a pile fabric, thus using the tendency of the sized fibers to return to their unspun condition to give increased loftiness to the pile.

A further purpose is to form artificial textile fiber of average diameter between 27 and 75 microns into an unspun band, continuously size the band with a resinous size such as urea formaldehyde or acrylate resin, continuously cure the resinous size, spin the fiber into yarn, and form the yarn as the pile yarn of a cut pile fabric, the fiber in the cut pile having a tendency to return to its unspun condition due to the action of the resinous size, and thereby giving improved loftiness to the pile.

A further purpose is to size artificial textile fiber continuously and/or render it water-repellent by handling the fiber as an unwoven band.

A further purpose is to progress artificial textile fiber in band form through an aqueous solution of urea formaldehyde, desirably maintained hot and uniform by recirculation from a heated reservoir, and subsequently to dry, cure and wash the fiber, all as a continuous process.

A further purpose is to terminate the drying of artificial textile fiber which has been subjected to treatment with a resinous sizing, at a moisture level of at least 12%, and preferably at least 15% of the dry weight of the fiber, in order to facilitate the spinning of the fiber into yarn.

A further purpose is to apply sizing, desirably urea formaldehyde, prior to spinning, to crimped artificial textile fiber of large diameter in order to assist in maintaining the crimp during spinning and to obtain greater covering power.

Further purposes appear in the specification and in the claims.

In the drawings no attempt has been made to illustrate all forms of the present invention. The single form shown has been chosen because of its convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a diagrammatic front elevation of the preferred form of my novel sizing process.

Figure 2 is an enlarged fragment of the surface of the intaglio-engraved printing roll.

Figure 3 is a fragmentary section of Figure 2 on the line 3—3 thereof.

Figure 4 is a diagrammatic side elevation showing the pick-up mechanism 23 which is desirably attached to the pre-wetting box.

Figure 5 is a diagrammatic illustration of the chemical treatment box and reservoir with associated circulating means. The mechanism of Figure 5 is duplicated with respect to each of the compartments of the chemical treatment box.

In the drawing similar numerals indicate like parts.

Fibers which are spun into pile yarn for pile fabrics such as carpets and rugs produce piles of varying loft, depending upon many facts, such as the inherent resilience of the fiber. I have discovered that the loft of such piles may be increased by applying resinous size to such pile fiber and curing the resinous size before spinning, so that the stable condition of the fibers is the condition reached after the resinous sizing is fixed on the fiber. The fibers after spinning tend to return to their unspun condition in the cut pile to a much greater extent than when the fibers are untreated or treated by any other method, thus assuring increased loftiness in the pile.

This invention is particularly useful in increasing the loft in a pile consisting wholly or in part of artificial textile fibers of large diameter, and especially those of average diameter between 27 and 75 microns, which are specially suited for house furnishing fabrics of the type of floor coverings and upholstery fabrics. The invention is particularly useful for rayon fibers such as regenerated cellulose (viscose or cuprammonium) although it may also be applied to cellulose ester fibers such as the acetate. Without the resinous sizing treatment of the present invention, many of these synthetic fibers tend to produce a pile yarn having less loft than one made from carpet wool.

It is contemplated that the application of resinous size to the fiber in band form will follow printing of color on both sides of the band. During the printing, the steaming in the ager and the treatment in the fixing baths, certain opportunities develop for crimping forces to become effective. Also in many cases the fiber ini-

tially supplied to the printing machine will have been previously crimped, for example by the rayon manufacturer. Whatever the source of the crimping, whether previously deliberately applied or incidental to the operations performed herein, it is very desirable that crimping be preserved for its advantages during spinning and for its effect upon the final yarn and fabric.

Application of sizing prior to spinning assures that the effect of the sizing or finish coating will be present during spinning to maintain the crimp, whereas this is not true if the sizing is not applied until after the spinning of the fiber into yarn.

As already explained, resinous sizing applied before spinning will increase the covering power by setting the fiber in unspun condition, so that after spinning the fibers will tend to untwist, thus forming a loftier yarn of greater covering power.

The drafting incident to spinning has the desirable effect of removing any slight unevennesses in color level which may remain in spite of the print dyeing, and also make it possible to combine with the lot, after color correction, a sample which has been run for color test purposes before color correction.

The term "band" is used herein to designate unspun fiber in continuous strip form. The band may either consist of artificial textile fiber in the form of a rope or bundle obtained from the filament extrusion machine after suitable treatment such as desulphurizing, bleaching and washing, or it may consist of a sliver coming from a raw preparation process such as carding, combing or gilling. The rope, bundle or sliver may come directly and continuously from the mechanism on which it was prepared or it may come rolled into a spool, ball, cake, roll or cheese.

It is considered that the best application of the invention will be to ropes or bundles of substantive continuous filament (that is, filament having substantivity) which are not to be converted into staple fiber until after treatment by the present process.

For the above reasons it is very desirable to proceed directly with the sizing or other desired chemical treatment as a step following the print dyeing during the continuous travel of the band. Less advantageously, however, the sizing or other chemical treatment can precede the print dyeing. It will also be understood that even where print dyeing is not being employed, continuous sizing or chemical treatment in accordance with the present processes may desirably be used.

In the present invention it is preferred to employ urea formaldehyde, although any other suitable resinous sizing such as thiourea formaldehyde, acrylate, phenol formaldehyde, or the like might be employed and the disclosure of resinous sizing herein is generic. Urea formaldehyde is much superior to other resinous sizings.

The resinous sizing, for example urea formaldehyde, desirably serves to maintain crimp as previously explained. The urea formaldehyde also tends to make the pile fibers of cut pile fabrics return to or approach their unspun condition as previously explained, imparting loftiness.

Unless precautions are taken in applying the urea formaldehyde, it will penetrate the fibers and markedly increase the brittleness. To prevent such increase in brittleness, I will preferably use only urea formaldehyde in an advanced stage of polymerization, in which condition the resin will not penetrate but merely coat the fibers, and will not increase the brittleness.

Example 1

Urea formaldehyde may desirably be applied to the fiber in an aqueous treating bath by passing the band of fiber through the bath. The preparation of the liquid resin (or the unpolymerized liquid mixture of resin ingredients) will preferably be as follows:

Formaldehyde and urea in proportions of about 1.8 molecular quantities of formaldehyde to 1.0 molecular quantity of urea are brought together at about 130° F. in a suitable quantity of water and in the absence of a catalyst. A pH of about 9 is maintained. When the product is condensed to the desired degree, a suitable catalyst such as ammonium acid phosphate is added and the resultant product is ready for application to the textile fiber. A treating temperature of 90 to 110° F. is recommended.

It is not ordinarily desirable to employ more than 5% of urea formaldehyde on the weight of the fiber. Up to 5% of urea formaldehyde on the weight of the fiber may be employed without embrittlement if care is taken to see that the urea formaldehyde coats without penetration.

In addition to the sizing, other suitable chemical treatments may be applied in the same bath or in a separate bath, such as finish coating, delustering, lubricating and waterproofing.

A special after treatment is employed to fix or "cure" the urea formaldehyde. The after treatment used will ordinarily be as follows:

1. Drying	3. Washing
2. Curing	4. Drying

The initial drying will desirably be accomplished at a wet-bulb temperature not in excess of 120° F. (the temperature of the moisture on the fiber). In the initial drying, the fiber should reach practical dryness, that is 3% moisture or less of the weight of the fiber. The curing temperature should range between 270° and 300° F., with the time in inverse ratio. About 10 minutes curing at 270° F. or 5 minutes curing at 300° F. gives satisfactory results.

The reasons for having the fiber practically dry before elevating the temperature for curing are to avoid fiber degradation effects of the acid and also to remove excess formaldehyde which, if present on the fiber at high temperature, tends toward an embrittling effect.

After curing, the fiber is washed with water to remove products of decomposition resulting from the curing. The washed product is then dried at the most economical temperature, preferably about 212° F. wet bulb and 250° F. dry bulb.

Where the product under treatment is unspun fiber, the moisture content at the completion of the final drying operation is a matter of importance. When the product comes from the drier in substantially dry form and is subsequently converted into yarn by cutting into staple fiber lengths, if not already cut, drafting and spinning, it has been found that the fiber produced in accordance with the invention is difficult to manipulate. Where the treatment with urea formaldehyde or other resin size as above described has been used, the fiber, if substantially dry, behaves like wire in carding and is practically unspinnable in that form. Lubrication with oil or with emulsion, and ordinary types of moisture treatment such as sprinkling or exposure to moisture for a few hours are of no benefit.

This condtion can be corrected by exposure to moisture at room temperature for 36 to 48 hours, wiith some reduction in time if elevated temperatures are used. The present inventor has discovered, however, that the whole difficulty can be avoided and the material rendered immediately and normally spinnable on either the woolen or the worsted system, if the drying operation be terminated when the moisture content has been reduced to not less than 12%, and preferably not less than 15% of the dry weight of the fiber. The upper limit of moisture content will normally be 30% and preferably 25% of the dry weight of the fiber.

Instead of urea formaldehyde resin, acrylate resin may be used. Any suitable form of acrylate resin may be employed, for example polymers of alkyl acrylates such as the methyl, ethyl, propyl, butyl, isobutyl and higher esters of acrylic acid; polymers of alkyl alkacrylates such as the methyl, ethyl, propyl, butyl, isobutyl, and higher esters of methacrylic acid, ethacrylic acid, or the like; polyhydric alcohol esters of these acids such as diglycol methacrylate; and polymers of acrylonitrile or methacrylonitrile.

The acrylate resins may desirably be applied to the fiber in the form of dispersions in water or other mediums. It is desirable to employ dispersing agents such as alkyl naphthalene sulphonic acids or their alkali metal or ammonium salts, alkali metal or ammonium soaps, Turkey red oil, sodium petroleum sulphonate, Marseilles soap or the like. Protective colloids such as casein, gelatin, glue, soluble starch, gum tragacanth, gum acacia, gum tragon, sodium alginate, agar agar or the like may be used also. Catalysts such as example benzoyl peroxide, hydrogen peroxide and the like may be used.

Example 2

Vigorously mix 100 parts by weight of monomeric methyl methacrylate containing one part of benzoyl peroxide catalyst, with 500 parts of water containing 2% of dissolved gum tragacanth and a suitable dispersing agent such as alkyl naphthalene sulphonic acid.

A fiber band is passed through this dispersion held at room temperature, after which the band is squeezed, and dried and cured (polymerized) at about 212° F. in ovens 47 and 48.

If desired, the dispersion may be maintained at any temperature between 68° F. and 150° F. for a time up to 48 hours or longer before use to cause partial polymerization of the dispersed resin.

Example 3

Vigorously mix 100 parts by weight of monomeric methyl acrylate with 400 parts of water containing 0.3 per cent of Marseilles soap, 0.5 per cent of propyl naphthalene sulphonic sodium salt and 2 per cent of 30% aqueous hydrogen peroxide catalyst. The fiber band is passed through the dispersion held at any desired temperature between 68° F. and 195° F., depending upon the desired degree of polymerization, before drying and curing in the ovens at about 212° F.

Example 4

Vigorously mix 100 parts by weight of monomeric acrylonitrile with 400 parts of an aqueous solution of 0.5 per cent of the sodium salt of palmitic sulphonic acid, 0.6 per cent of Marseilles soap, and 1.5% of a 30% aqueous hydrogen peroxide solution. This emulsion may be used as in Examples 2 and 3.

Instead of applying the acrylic resin as a dispersion, it may less desirably be used as a solution in any suitable solvent, such as toluene or acetone.

Example 5

The fiber band is passed through a 5% solution of polymerized methyl methacrylate in acetone, and the fiber band is dried in the air and then, with further curing of the resin, in the oven at 212° F.

The advantages concerning sizing with resin given in this application would in general apply not only to the artificial fibers for which it is chiefly intended, but, to a less pronounced extent, to comparable fibers of wool, jute, etc. The method of sizing with resin for the natural fibers would be similar.

The fiber band after completion of the print dyeing and sizing as continuous steps, may be subsequently manipulated in any manner desired. If the fiber is in the form of a bundle or rope of continuous filament, it will normally be cut into staple lengths, drafted and spun. If the fiber already is in the form of a sliver or roving of staple fiber, it will be drafted and spun. The fiber treated herein may be blended with any other suitable fiber as desired. If the fiber is in the form of a warp or warp unit, it may be used directly for weaving or other procedure of producing fabric (for example, by cementing to a backing for production of a cemented pile fabric). The yarn may also be plied to combine several ends.

In the apparatus as shown in Figure 1, the material undergoing treatment is drawn from any suitable source here illustrated as a creel 20. The raw material is drawn off in the form of a band and may, as already explained, actually be a rope, bundle, roving, sliver, or the like. The band 21 may be printed dry but will ordinarily undergo prewetting in the treatment box 22 from which it is withdrawn by a pick-up mechanism 23, later to be described, which assists in forming a flat band. A considerable quantity of band will normally remain fanfolded in the treatment box 22, being drawn out at a rate determined by the speed of movement of the rolls 23', which are operated by means not shown synchronized with the printing rolls. The prewetting box in the case of rayon will normally merely contain water, but in the case of wool a scouring agent followed by a suitable rinse may be employed at this point. From the treatment box 22 the flat band 21 is carried over an idler 24 to the printing mechanism 25 consisting of printing units 26, 27, 28, and 29 arranged one above another on a frame 30.

The printing units 26 and 28 print on the right-hand side of the upwardly directed span of fiber band shown in Figure 1, while the printing units 27 and 29 print on the left-hand side of this span.

The printing units are described in detail in application Serial No. 366,354, filed November 20, 1940, for Textile dyeing and finishing, method, apparatus and product, which is incorporated herein by reference, and no further detail of them will be given herein, as it is not important to the present invention.

Suffice it to say that each printing unit includes an intaglio engraved printing roll 59, suitably of copper, which contacts the fiber band. The roll 59, as seen in Figures 2 and 3, has channels 60 extending over its entire surface. These

channels are preferably set at an angle of approximately 45° to the axis of the roll as shown. Each channel is substantially identical and when the depressions of the printing roll are supplied with color to the level of the circumference of the roll in any desired manner, each channel 60 contains substantially the same measured quantity of color. In printing artificial textile fiber of large diameter, it has been found to be desirable to employ channels approximately 0.01 inch deep, and to use twenty-eight channels per inch on the circumference of the roll. This is merely suggestive and not stated as a limitation.

After the printing of color upon the fiber band, the color will be desirably immediately fixed, the method of fixing depending upon the particular dye used. Ordinarily the fiber band will pass directly through an ager or steamer in which it will be exposed to steam at a temperature depending upon the dyestuff, suitably 212° to 215° F. for a time of 4 to 5 minutes in the case of a vat dye, and at a somewhat lower temperature for a longer time, for instance 180° to 190° F. for 8 to 10 minutes, in the case of a direct or acid dye. The finishing treatment of the dye will vary with the dyestuff as well known in the art. For example, with a vat dyestuff the treatment may consist of oxidizing with an oxidizing agent such as hydrogen peroxide and then passing through hot soap solution while in the case of a direct or acid dye there would normally be treatment with cold neutral soap solution followed by a rinse.

From the printer 25 the fiber band proceeds to dye-fixing mechanism starting with an ager or steamer 31 of any suitable manner, and normally supplied with steam by means not shown.

As already explained the character of the fixing treatment will depend upon the dye used. In this example the fiber band passes from the ager successively through an oxidizer 33, a soaper 34, and rinses 35 and 36. Each of these treatment boxes 33 to 36 may be of any well-known type, and here are provided with feed rolls 37, driven in any suitable manner and carrying the fiber band between compartments 38 and 39, each of which has a partition 40 separating the outgoing from the incoming portions of the fiber band.

From the dye-fixing mechanism the fiber band is progressed to the sizing box 41 in which a resin size, preferably urea formaldehyde is contained in solution or suspension. The most efficient temperature of operation in the treatment box 41 is from 90 to 110° F. To maintain this temperature and to maintain uniformity of the treating liquor, the treating liquor in each compartment of the treatment box 41 is continuously drawn off at a pump 42 (Figure 5) and connections 43 to a reservoir 44, jacketed at 45 by hot water. The reservoir 44 contains urea formaldehyde of the same composition as that in the treatment box. Treating liquor continuously flows through the pipe connection 46 to the compartments of the treating box. The fresh treating liquor from the reservoir 44 is introduced by the pipe 48 on the outgoing side of each compartment of the treatment box 41, thus applying the countercurrent principle.

From the treating box 41 the fiber band desirably passes through a drier 47 of any suitable type and heated by any suitable means, not shown. The drier will normally operate at a temperature not exceeding 120° F. wet bulb. From the drier 47 the fiber band progresses to a curer 48 maintained at a more elevated temperature, suitably between 270° F. and 300° F. dry bulb. From the curer 48 the fiber band passes through suitable washing units, desirably consisting of a soaper 49 and rinsing boxes 50 and 51. From the washing units the fiber band is carried to a drier 52 operated at the most economical temperature, preferably about 212° F. wet bulb and 250° F. dry bulb. The fiber is withdrawn from the drier 52 before its moisture content has dropped below about 12% and preferably before it has dropped below 15% of the dry weight of the fiber. From the drier 52 the fiber band passes to any suitable take-up mechanism, here shown as a windup 53, or directly to a preparation or spinning apparatus.

Special precautions are taken to insure that the fiber band which comes to the printing mechanism is substantially of uniform thickness. If the fiber band were withdrawn from the liquid without taking any precaution in this respect, the effect of the surface tension of the liquid would result in producing a circular or oval cross section of the band and the flattening action of the flattening rolls would produce a band much denser or thicker at the center than at the edges. To prevent this a pick-up mechanism 23 is employed, best seen in Figure 4. Beneath the surface of the liquid in the pick-up mechanism 23, the fiber band is carried into contact with the moving surface 54 of a drum 55. It will be noted that the point of contact 56 with the drum 55 is below the surface of the liquid. At the time contact between the fiber band and the surface of the drum is made, the fiber band is relatively spread out due to the action of the liquid. The spread fiber band is then carried up on the surface of the drum until it is above the surface of the liquid, adhesion to the surface of the drum overcoming the tendency of the fiber band to assume a circular or oval cross section when leaving the liquid. The drum surface is desirably of metallic screen wire 57 or other foraminated material so that liquid from the fiber band will drain through the drum as the band travels with the drum. The point at which the fiber band leaves the drum is well above the surface of the liquid. After leaving the drum the fiber band is flattened by pinch rolls 55', and then is printed on both sides by the printing mechanism.

It will be evident that the present invention produces pile fabrics with greater economy because of the greater covering power of the pile fiber and with improved appearance because of the increased loft of each pile tuft. These features are especially pronounced in cut pile fabrics and find their greatest utility in carpets and rugs.

When reference is made herein to curing of a resinous size, it is intended to designate any curing operation, for example condensing or polymerizing the resin ingredients.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process shown.

Having thus described my invention, what I claim is new and desire to secure by Letters Patent is:

1. The process of producing improved pile fabrics, which comprises forming artificial textile fiber of average diameter between 27 and 75 microns into an unspun band, continuously sizing the band with a resinous size while progressing the band lengthwise, continuously curing the resinous size while continuing the lengthwise

progression of the unspun band, spinning the fiber into yarn, and forming the yarn as the pile yarn of a cut pile fabric, the fiber in the cut pile having a tendency to return to its unspun condition due to the action of the resinous size, and thereby giving improved loftiness to the pile.

2. The process of producing improved pile fabrics, which comprises forming artificial textile fiber of average diameter between 27 and 75 microns into an unspun band, continuously sizing the band with urea formaldehyde while progressing the band lengthwise, continuously curing the urea formaldehyde while continuing the lengthwise progression of the unspun band, spinning the fiber into yarn, and forming the yarn as the pile yarn of a cut pile fabric, the fiber in the cut pile having a tendency to return to its unspun condition due to the action of the urea formaldehyde, and thereby giving improved loftiness to the pile.

3. The process of producing improved pile fabrics, which comprises forming artificial textile fiber of average diameter between 27 and 75 microns into an unspun band, continuously sizing the band with acrylate resin while progressing the band lengthwise, continuously curing the acrylate resin while continuing the lengthwise progression of the unspun band, spinning the fiber into yarn, and forming the yarn as the pile yarn of a cut pile fabric, the fiber in the cut pile having a tendency to return to its unspun condition due to the action of the acrylate resin, and thereby giving improved loftiness to the pile.

4. The process of producing improved pile fabrics, which comprises forming artificial textile fiber of average diameter between 27 and 75 microns into an unspun band, continuously sizing the band with methyl methacrylate while progressing the band lengthwise, continuously polymerizing the methyl methacrylate while continuing the lengthwise progression of the unspun band, spinning the fiber into yarn, and forming the yarn as the pile yarn of a cut pile fabric, the fiber in the cut pile having a tendency to return to its unspun condition due to the action of the methyl methacrylate, and thereby giving improved loftiness to the pile.

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