METHOD OF MAKING PILE YARNS

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This invention relates to pile fabrics intended for hard wear and wherein the pile is cut and formed from pile yarns that have sufficiently high plying twists to impart a knobby or curly texture to the cut pile as contrasted to the soft plush-like appearance of cut pile obtained from pile yarns with low plying twists. More particularly, it relates to floor coverings and upholstery fabrics wherein the cut pile is formed from highly twisted yarns of stock dyed wool and in which the twist is fast to withstand aqueous treatments, such as commercial shampooing, and to the method of producing such pile yarns.

Hard twist frieze carpets and rugs have been woven from pile yarns that have sufficiently high plying twists to give a knobby or curly texture to a cut pile as contrasted to the soft plush-like appearance of a cut pile obtained from pile yarn of low plying twists. Floor coverings having high twist piles possess many advantages over floor coverings having low twist pile. These hard twist frieze carpets and rugs have been particularly popular in plain colors and have attained considerable commercial success in this country, especially during the past decade or so. The highly twisted pile has a higher resistance to crushing than low twist pile. Consequently, in floor coverings having a highly twisted pile, footprints do not show and shaded areas of contrasting appearance do not develop as readily where the traffic and wear are concentrated as in the case of floor coverings having low twist piles. The high twist binds the fibers more tightly in the yarns, thereby reducing shedding and fluffing to a minimum. For equal quantities of pile yarn, floor coverings having highly twisted piles possess a somewhat higher resistance to abrasive wear than floor coverings having low twist piles.

In one of the methods most generally employed in the production of large yardages of plain shade carpet free from color streaks and bands and of uniform shade, loose wool is dyed prior to the carding, spinning and twisting processes of woolen yarn manufacture. This process of dyeing the loose wool is known in the art as "stock dyeing," and by such procedure very large quantities of wool can be dyed and thoroughly blended prior to yarn manufacture so that the resulting yarn is very uniform in color and of sufficient amount to supply numerous looms of all widths. This enables large lots of carpet of uniform shade to be produced in many widths and constructions, free from streaks and color bands, and which can be laid side by side without color contrast.

After the wool has been stock dyed, it is carded, spun and given a hard twist. Since wool is an elastic material, if the twist were not set prior to weaving, it would unwind when the tufts were cut to form the cut pile. Accordingly, after producing the highly twisted pile yarns and prior to weaving, it has been common practice to set the twist by steaming the highly twisted yarn with dry steam in "cottage" steamers at a few pounds pressure for times ranging up to several hours.

In such procedure, the moisture content of the yarn was in equilibrium with the atmospheric relative humidity and contained from approximately 6% to 10% of moisture.

During a floor covering's service, it becomes dirty or soiled. One of the most common procedures for cleaning a floor covering is by shampooing. In a commercial shampooing, the floor covering is placed on a cement floor, with the pile down, and the back hosed with water. The back is then scrubbed with a power-driven rotary brush, a gel soap being fed onto the back during this operation. Thereafter, the back is hosed with cold water to remove the soap (rinsing). The floor covering is reversed and the foregoing operations performed in the same sequence on the pile face. Finally, the fabric is passed between squeeze rollers and dried.

Floor coverings in which the pile is formed from highly twisted yarn in which the twist was set by dry steaming as above described do not possess an adequate fastness of twist to aqueous treatments, such as commercial shampooing above described. As a result, when such floor coverings were shampooed by commercial cleaners, the pile lost a considerable amount of twist and the cleaned floor coverings lost their original texture and virtually all of the characteristics of a highly twisted yarn. The inadequate twist-fastness to aqueous treatment also has resulted in widespread consumer dissatisfaction, in many claims and complaints against manufacturers, and has been a problem of considerable magnitude to commercial rug cleaners. The latter have resorted to certain expedients, as surface cleaning methods using solvents, solvent-impregnated powders, or using froths which wet only the surface of the pile. These techniques do not thoroughly cleanse the whole fabric as does the usual rug shampooing procedure and therefore give the consumer a choice of two evils, i.e., poor cleaning or loss of the original texture. In some cases, the twist fastness obtained by the prior art procedure previously mentioned has been so poor as to allow substantial twist loss from spillage or wet footwear.
An object of this invention is to provide a highly twisted pile yarn of stock dyed wool which, when formed into a cut pile of a pile fabric, possesses improved properties.

Another object of this invention is to provide a highly twisted pile yarn of stock dyed wool and which, when formed into a cut pile of a pile fabric, will be substantially fast to aqueous treatments.

A further object of this invention is to provide a method of making highly twisted pile yarn of stock dyed wool whereby, when said yarn constitutes the cut pile in a pile fabric, the twist will be substantially fast to aqueous treatments.

Other and additional objects will become apparent hereinafter.

The objects of the invention are accomplished, in general, by forming a highly twisted stock dyed wool yarn containing preferably at least 30%, by weight, of moisture and setting the twist by steaming with saturated steam whereby the moisture content in the yarn is maintained at preferably at least 30% during the steaming operation.

In the preferred embodiment of the invention, at some stage in the process subsequent to stock dyeing of the wool and prior to the twist setting operation, the yarn is neutralized or rendered alkaline, i.e., the pH of the stock dyed wool is adjusted to approximately 6 to 8, or even up to 10.

Optimum results, i.e., fastness of the twist to a degree that the pile will successfully withstand multiple commercial shoo machines without serious loss of twist, are obtained when after the neutralized highly twisted yarn has been subjected to steaming at high moisture levels such yarn is treated with an aldehyde.

The details and manner of practicing the invention will become apparent by reference to the following specific examples, it being understood that these examples are merely illustrative embodiments of the invention and that the scope of the claims is not limited thereto.

**Example I**

The wool which is to be formed into the pile yarn is opened up and scoured in the usual manner. Thereafter, the wool is dyed in a known acid dye bath at a pH of about 4.2. At the end of the dyeing operation, the pH of the wool will be in the neighborhood of 4.2. The dyed wool is sprayed with a mineral oil emulsion, and various lots thereof are blended to make a large lot of uniform shade. The wool is carded and spun on the woolen system to give a singles woolen yarn weighing 207 grams per 50 yards with 175 turns of the S-twist per yard. Two of such singles yarns are plied together to form a two-ply yarn, the plying twist being 350 turns per yard Z-twist and the weight of the plied yarn being 456 grams per 50 yards.

The plied yarn is neutralized by treatment with an alkaline substance, such as an aqueous solution containing 0.5% sodium carbonate, whereby the pH of the yarn is adjusted to approximately 6.5. After washing the yarn with water, it is centrifuged to a substantially uniform moisture content of 35%, by weight. The highly twisted yarn containing 35% moisture is steamed for 2 hours at 220°F in a closed "cottage" steamer with saturated steam whereby the moisture content of the yarn is maintained at substantially 35%.

The pile yarns are then woven into floor coverings by any of the well-known procedures for producing floor coverings with cut piles.

**Example II**

The procedure is the same as in Example I, except that the yarn containing 35% moisture is steamed with saturated steam for 1 hour at 220°F. In the closed "cottage" steamer and the moisture content of the yarn is maintained at substantially 35% during steaming. The steamed yarn is then soaked in a 4% aqueous solution of formaldehyde at 100°F. for 3 hours. Upon removal from the formaldehyde solution, the yarn is rinsed twice with cold water, extracted, and finally dried.

The pile yarns are then woven into a fabric as described in Example I.

The invention can be used with any of the wools or blends of wool commonly used in the production of pile yarns for carpets, rugs and upholstery fabrics. Wools of the cross-bred type, such as South American B. A., South American Cordova, South American Montevideo, New Zealand fleeces and English Devon, are comparatively easy to set, while carpet type wools, such as India Vicenee, India Sind and Iraq, have been found difficult to set. In the preferred embodiment of the invention, a blend comprising 40% to 75% of cross-bred wools and 60% to 25% of carpet wools, the proportions being by weight and based on the clean wool, is employed. It is to be noted that in floor coverings having low twist piles, cross-bred wools or blends of wool containing a high percentage of cross-bred wools are undesirable since they do not fill out and cover as well as carpet wools and, due to their softness, crush very readily.

The invention is not restricted to the pile yarns of the precise weight and construction set forth in the examples. The pile yarn can be formed of more than two singles yarns and the singles twist can be greater or smaller than that of the examples. In all cases the plying twist is sufficient to give a knobby or curly appearance or texture to the cut pile resulting therefrom. Preferably, the twists in the respective singles yarns are in the same direction and the plying twist is in the direction opposite to the direction of the singles twist.

In this specification, the terms "hard twist" and "high twist," or similar terms, are used as is well known in the art to denote that amount of twist in a pile yarn which is sufficient to give a knobby or curly appearance or texture in a cut pile formed therefrom.

Hereinafter are set forth several illustrative examples of yarn constructions which can be used in accordance with this invention in connection with frieze carpets:

<table>
<thead>
<tr>
<th>Singles Twist</th>
<th>Singles Weight</th>
<th>Plied Twist</th>
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<tr>
<td>Two-ply Frieze</td>
<td>175</td>
<td>207</td>
<td>350</td>
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<tr>
<td>Three-ply Frieze</td>
<td>176</td>
<td>146</td>
<td>250</td>
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<tr>
<td>Two-ply Knobby Yarn</td>
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<td>150</td>
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(Twists given in turns per yard.)

(Weights given in grams per 50 yards.)

In Examples I and II, the highly twisted yarn has a uniform moisture content of approximately 35% prior to steaming. It is to be understood that the invention is not restricted to such precise moisture content. In general, the minimum critical moisture content is that which will saturate the pores of the wool, the intermicellar spaces and the micellar structure. The preferred minimum moisture content is approximately at least 30%, by weight, of the wool. A moisture content
in excess of the minimum amount, such as up to 100%, by weight, of the wool, can be used with success in this patent. The addition of moisture to the yarn prior to steaming is preferably accomplished by the method shown in the specific examples, though it will be apparent to a person skilled in the art that other procedures can be used.

The high twist is set by steaming at high moisture levels whereby the moisture content in the yarn is maintained during steaming at least 30% or higher. In the preferred embodiment, this is accomplished by subjecting the highly twisted yarn containing at least 30% moisture to saturated steam. One procedure which has been found satisfactory for producing saturated steam, using present equipment, is to desuperheate the steam after throttling it down from a high pressure, such as 80 pounds per square inch gauge pressure, to 2½ pounds per square inch gauge pressure before introducing it into the "cottage" steamer.

The usual practices for stock dyeing wool for carpets and rugs utilize so-called acid or chrome dyes, which leave the wool in an acid state, i.e. the wool has a pH of from 2 to 5. Experimental research has shown that when the yarn is rendered approximately neutral by adjusting the pH of the yarn to between 6 and 8, or even alkaline by adjusting the pH up to 10, the setting reaction is improved and proceeds more rapidly than when the pH is from 2 to 5. The pH adjustment of the yarn can be accomplished by various methods, such as treatment with aqueous solutions of alkaline substances followed by rinsing with water to remove excess materials. The pH adjustment can be the final step of the dyeing operation. It can be carried out during yarn manufacture or it can be accomplished after the yarn has been spun. In the latter instance, it can be part of an alkaline scouring designed to brighten the color and remove oil and grease. Sodium carbonate is the preferred alkaline substance, and the concentration thereof in the aqueous solution depends on the pH of the wool to be neutralized. In general, aqueous solutions containing 0.25% to 1% of sodium carbonate can be used, though other concentrations can be used.

In neutral wool dyeing processes, it is customary to conclude the dyeing operation by the addition of sufficient acid to exhaust the dye. This produces a wool which contains sufficient acid to inhibit setting. Thus, even when the wool is dyed by the so-called neutral dyeing processes, the pH of the yarn resulting therefrom should be adjusted, as hereinbefore set forth.

The time of the steaming operation can vary within limits depending, in part, on the wool constituting the yarn, the pH of the wool, the moisture content, and the temperature, and can be determined by simple empirical experiment. In no case should the steaming operation be for such period of time that will seriously deleteriously affect the yarn.

Yarn resulting from Example I possesses improved twist fastness to aqueous treatments and commercial shampoos as compared to the yarns resulting from the prior art procedures, i.e. steam treatments. The treatment with formaldehyde, as disclosed in Example II, improves the twist fastness so that the carpet will successfully withstand multiple commercial shampoos without serious loss of twist. Additionally, the treatment with the formaldehyde enables a high level of twist-set fastness to be obtained with a reduced time of wet steaming and therefore minimizes the loss of abrasive wear resistance caused by long periods of steaming.

The invention is not restricted to the specific formaldehyde solution or the time and temperature conditions under which the steamed yarn is treated in Example II. The concentration of the aqueous solution of formaldehyde may vary. For example, an aqueous solution containing as low as 0.1% of formaldehyde and as high as 10% of formaldehyde has been found to give satisfactory results. The temperature of the formaldehyde treatment depends on the concentration of the formaldehyde. The higher the concentration, the lower the temperature. Thus, for example, when the formaldehyde solution contains 0.1% of formaldehyde, satisfactory results are obtained with a temperature of 212°F. Likewise, the period of immersion varies with the concentration and temperature and may be, depending on the temperature and concentration, a few minutes to several hours. In all cases, the formaldehyde reaction condition depends also on the type of wool, the steaming conditions, and the fastness of the dyes used in the formaldehyde.

Instead of an aqueous solution of formaldehyde, monomeric formaldehyde gas, which would dissolve in the moisture content in the yarn, can be used. Alternatively, the yarn can be impregnated with a substance that yields formaldehyde upon heating.

Though formaldehyde is preferred, manifestly aldehydes other than formaldehyde can be employed. Acetaldehyde and glyoxal are illustrative examples of additional aldehydes which can be used. If desired, an acid or acid salt catalyst can be used in conjunction with the aldehyde treatments.

Wool that has been steamed in a neutral condition at a high moisture level in accordance with the instant invention reacts more completely with formaldehyde than does wool steamed in an acid condition at low moisture levels. In one instance, yarn steamed equal length of time by the two methods and treated with formaldehyde in the same manner analyzed 0.3% combined formaldehyde when steamed in the normal fashion and 1% combined formaldehyde when steamed in the neutral wet manner.

Though the invention has been described specifically in connection with floor coverings having cut piles it is to be understood that the invention is not restricted thereto. In general, the invention is applicable to pile yarns which are to constitute cut pile in fabrics subjected to hard wear, such as floor coverings, upholstery fabrics, etc.

Since it is obvious that various changes and modifications may be made in the above description without departing from the nature of spirit thereof, this invention is not restricted thereto except as set forth in the appended claims.

I claim:

1. A process for preparing highly twisted wool yarns which when formed into a cut pile of a pile fabric intended for hard wear the twist will be substantially fast to aqueous treatment, which comprises forming a highly twisted stock of wool yarn in which the pores, the intercellular spaces and the micellar structure of the wool are at least saturated with moisture, setting the twist by steaming said yarn, during the steaming treatment maintaining the moisture content in the yarn at least that which saturates the pores, the intercellular spaces and the micellar struc-
ture of the wool, and reacting the steamed yarn with an aldehyde.

2. A process for preparing highly twisted wool yarns which when formed into a cut pile of a pile fabric intended for hard wear the twist will be substantially fast to aqueous treatment, which comprises forming a highly twisted stock dyed wool yarn having a pH of from 6 to 10 and in which the pores, the intermicellar spaces and the micellar structure of the wool are at least saturated with moisture, setting the twist by steaming said yarn, during the steaming treatment maintaining the moisture content in the yarn at at least that which saturates the pores, the intermicellar spaces and the micellar structure of the wool, and reacting the steamed yarn with an aldehyde.

3. A process for preparing highly twisted wool yarns which when formed into a cut pile of a pile fabric intended for hard wear the twist will be substantially fast to aqueous treatment, which comprises forming a highly twisted stock dyed wool yarn containing at least 30% by weight of moisture, setting the twist by steaming said yarn, maintaining the moisture content in the yarn at at least 30% during the steaming treatment, and reacting the steamed yarn with an aldehyde.

4. A process for preparing highly twisted wool yarns which when formed into a cut pile of a pile fabric intended for hard wear the twist will be substantially fast to aqueous treatment, which comprises forming a highly twisted stock dyed wool yarn having a pH of from 6 to 10 and containing at least 30% by weight of moisture, setting the twist by steaming said yarn, maintaining the moisture content in the yarn at at least 30% during the steaming treatment, and reacting the steamed yarn with an aldehyde.

5. A process for preparing highly twisted wool yarns which when formed into a cut pile of a pile fabric intended for hard wear the twist will be substantially fast to aqueous treatment, which comprises forming a highly twisted plied yarn of stock dyed wool having a pH in the neighborhood of 4.2, adjusting the pH of said yarn to approximately 6.5, reducing the moisture content of said yarn to 35%, and steaming said yarn in a closed steamer with saturated steam to set said twist and soaking the steamed yarn in a 4% aqueous solution of formaldehyde at 100°F for 3 hours.

ROBERT C. ALLISON.

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The following references are of record in the file of this patent:

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