PERMANENT CRIMPING PROCESS
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This invention is directed to the manufacture of bulked fabrics by a "K-set" process described below. It is more particularly concerned with increasing the permanence of crimp in cellulosic textile yarns so that the crimp will be retained when the yarn is fabricated into a textile and will withstand numerous washings without losing its characteristics.

It is well known in the prior art that a crepe-like or bulked fabric can be produced by crimping a yarn beforehand, setting the crimp, straightening the yarn so that it can be woven into a fabric by conventional means, and then permitting the crimp to become reactivated in the finished fabric so as to give it a loosely-woven appearance. This can be done in many ways in the case of thermoplastic fibers such as nylon, polyvinyl chloride, Vinyon, Suran, etc., since the crimp can be set in these yarns by heating sufficiently to plasticize the crimped yarn, followed by cooling to solidify it. This is the principle employed in Ban-Lon, Taslon, Helanca, etc. The latter involves a superwarp and is described in U.S. Patent Nos. 2,019,183, 2,019,185, 2,564,245 and others. U.S. Patent No. 2,601,451 discloses forming a crinkled nylon stocking by first knitting the yarn into a fabric, unrolling the fabric, and reknitting it into a stocking. The crimp recurs in the stocking to give it a crepe-like elastic texture. However, such means of mechanical crimping are unsuccessful with rayon yarns since the resulting crimp in this case is lost during washing, which causes its bulling and resilience to vanish.

The K-set process of this invention provides a permanent crimp or loop set in the yarn and the high bulling characteristics and elasticity are maintained regardless of wetting out or laundering.

The present invention has as its object to control the type of crimp in cellulosic yarns and to render the crimp permanent to the extent that it withstands repeated commercial laundering. A further object is to produce rayon yarns having permanent resilience and mechanical elasticity along with high bulk with light weight. A further object is to prepare a rayon yarn with characteristics capable of entering into competition with Helanca, Ban-Lon, Tycora, Taslon and other textured yarns.

The present invention which will be designated herein as K-set is a process by which a crimp or a like distortion is held in a cellulosic yarn to which a thermoplastic finish has been applied and in this form it is thermally cured. Once this is done, the yarn is permanently crimped and will always have a strong tendency to maintain the crimp or loop or whatever deformation is was given. This tendency is greatly strengthened by introducing heat and water. With this in mind, it is necessary to allow enough room or looseness in knitting or weaving K-set yarn into fabric if full effect of texture, bulk and resilience is desired after scouring. The K-set yarn may be processed into fabric by such means as knitting, weaving, tufting, braiding, etc. The final effect may be varied according to looseness or tightness of fabric construction. This process is less expensive than twisting, setting, detwisting, and plying.

The K-set process permits many physical approaches. In all cases adequate yarn chemical preparation is necessary. One of the procedures might be described in detail as follows: a rayon yarn is knitted into sleeves or tubes, large diameter preferred. The knitting machine requirements are only that the gauge of the machine must be suitable for the size (count or denier) of the yarn. Any type of knitting machine may be used so long as an end of the yarn may be easily and quickly unravelled from the fabric after it is knitted and chemically treated. To explain this phase further, the crimp which is actually a loop formation is mechanically held in place in the form of a knitted fabric. This fabric is then chemically treated with a special finish and cured. This is the most important phase because in chemically stabilizing the knitted fabric, the crimp or loop becomes a permanent deformation in the yarn and remains so when the yarn is taken from the fabric and restored to single end yarn which is packaged for reworking into final fabric. It is essential that the loop be rigidly held during setting so that the fibers will lie in parallel, giving a uniform crimp along the full length of the yarn rather than a random crimp. In this way the silhouette of each filament will parallel that of other filaments throughout the full yarn length, giving a crimped or looped formation or distortion to the yarn.

After the knitted fabric is permanently stabilized the fabric is put into containers or any other means of support and positioned on a combing machine. An end of yarn is unravelled from the fabric and passed through the combing machine to the paper cone. The combing machine will then continue to unravel the yarn from the fabric and produce a cone of yarn of desired size or weight. In packaging on cones, the yarn is straightened out considerably but by contacting the yarn in textile form with heat and water the latent crimp in the yarn is released so that the yarn regains the crimp or loop formation and creates a very effective bulked textile. Any knitting machine of proper gauge for the desired yarn size may be used for crimping so long as the knitting permits the yarn to be unravelled out of the fabric easily and fast.

Yarns responding to this process are rayon in the form of continuous filament, spun, tow or carpet yarn and fiber blends of infinite variety. Steaming, scouring and dyeing or any combination of these may be applied for various degrees of bulk effect.

Other mechanical devices for crimping the yarn would include the crimp box, stuffer box, crimping cylinder, crimping wheels, and mock twist or variations thereof. These units can be modified to process multiple yarn ends as well as a single end and will not only impress the yarn or sheet of yarn with crimp, but will permit varying the shape of crimp and its quantity. In these devices, as with knitting, the crimping or impressing of the chemically coated yarn must be maintained while the yarn is being cured before it travels to a packaging unit. The chemical action must take place while the yarn is in crimped or impressed form and the chemical setting agent must be on the yarn while it is cured in crimped form regardless of whether the chemical is applied before the crimp or afterward. The type of heat for drying and curing may be dry heat or wet heat, so long as sufficient temperatures are reached for the particular chemical formulas being used. Best results are achieved when the yarn is processed with 15% to 20% moisture content before entering the crimping device so that the molecular construction of the yarn is set before it is deformed by crimping.

To conduct the crimping operation in a continuous...
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Example I

Five yards of knitting tubing made from rayon yarn was padded twice with an aqueous solution containing the following composition in parts by weight:

*Avcoset WS* (water-soluble hydroxyethyl cellulose) - 5
*Formaldehyde* - 10
*Avcosol 20* (50% sorbitan monopalmitate-50% sorbitan tristearate) - 0.5
*NH4SO4* - 2

In the next step the sleeve was dried at 270° F., cured at 315° F. for five minutes in a suction dryer, and washed in a rope-washer at 120° F. for 15 minutes. The washing solution was a neutralizing bath adjusted to a pH of 9-9.5 with soda ash and detergent. After neutralizing the sleeve was rinsed with warm and cold water. It was then dried in relaxed form to a temperature of 270° F.

The yarn in the sleeve was then unravelled, wound on a bobbin, and then punched or tufted through a backing to form a tufted pile fabric. This was moistened to bring out the crimp.

Example II

The process of Example I was repeated, but with the following finish formula:

*Avcoset WS* - 5
*Formaldehyde* - 10
*Avcosol 20* - 0.5
*MgCl2* (catalyst) - 10

Example III

The process of Example I was repeated using the following formula:

*Rhonite R-1* (ethylene urea-formaldehyde) - 20
*Avcosol 20* - 0.5
*Catalyst G-8* (the heterogeneous reaction product of 0.9 mols monoethanolamine, 1.0 mols HCl and 2.0 mols formaldehyde) - 1

Example IV

The process of Example I was repeated using the following formula:

*Rhonite 610* (urea-formaldehyde resin) - 36
*Avcosol 20* - 0.5
*Catalyst G-8* - 0.9

Example V

The process of Example I was repeated using plain water as a control.

To test the ability of the above samples to retain the initial appearance of loop or crimp formation all samples were given five consecutive washings in ordinary household laundry equipment. Samples were dried either in a tumble dryer or air dried, alternating tumble drying with air drying. Carpet samples subject to the procedure as above outlined were then classified according to appearance, cover, and fullness due to retention of the effective loop or crimp formation. Indications were clearly to the effect that the formula providing the greatest degree of permanence or retention of the loop or crimp formation is the one outlined in Example I. Sample #1 stands out for its ability to retain its initial excellent appearance. Samples #2, #3, and #4 are next in line. All show quite a difference when compared to #1, but not a great difference when compared among themselves. Sample #5, treated with water only, was inferior to all. It is evident that the cellulose ether-formaldehyde composition is superior to urea-formaldehyde and that both are superior to water treatment alone.

It is felt that the yarns having the aforesaid qualifications will create a great demand in all textile fields by adding new and different characteristics to the yarn which will make it superior to existing rayon yarns for end uses which rayon has been incapable of filling into. Up to this time, yarns such as Helanca, Ban-Lon, Tylan and other such textured yarns have enjoyed wide usage without interference from rayon producers. It is felt that K-set yarns can now enter in competition with above mentioned yarns for end uses such as sweaters, half-hose, sport shirts, blouses, fabrics, dress fabrics, panties, industrial fabrics, vinyl laminated fabrics, coated fabrics, carpets and many other end uses yet to be investigated.

To recapitulate, the advantages of the fabrics produced from the K-set yarns of this invention are:

1. Permanence of crimp or deformations.
2. High resilience.
3. Ability to yield or recoil.
4. Permanence of characteristics to repeated launderings.
5. Production cost greatly lower than via the twisting, devissing, curing, etc., method.

We claim:

1. The process of producing a bulked fabric including in the order named the steps of mechanically crimping a regenerated cellulose yarn, impregnating the yarn with an aqueous solution of a thermosetting finish the essential components of which are a cellulose ether, an aldehyde, and a cross-linked catalyst, thermally curing the impregnated yarn to set the crimp therein, mechanically straightening the yarn, processing the straightened yarn into a fabric and wetting the fabric to restore the crimp to the yarn.
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2. Process of claim 1 wherein the yarn is mechanically crimped by knitting, and the finish consists essentially of an aqueous solution of about 5% by weight of the cellulose ether, about 10% formaldehyde, and 2–3% of an acidic cross-linking catalyst.

3. Process of claim 1 wherein the finish is applied to the yarn prior to the mechanical crimping step, and the curing is effected simultaneously with the crimping step.

4. Process of claim 1 wherein the finish is applied to the yarn during crimping.

5. The method of producing a bulked fabric comprising knitting a regenerated cellulose yarn to form a sleeve, thermally curing said sleeve while it is impregnated with an aqueous solution of a thermosetting finish whose essential components are a cellulose ether, an aldehyde, and a cross-linking catalyst, thereby imparting a set to the yarn which provides permanent crimps corresponding to the loops of the knitted sleeve, unravelling the yarn from said sleeve, processing said permanently crimped yarn into a fabric, and moistening the fabric to release the latent crimp therein so as to form crimps in the fabric which are similar to those imparted in the sleeve.

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