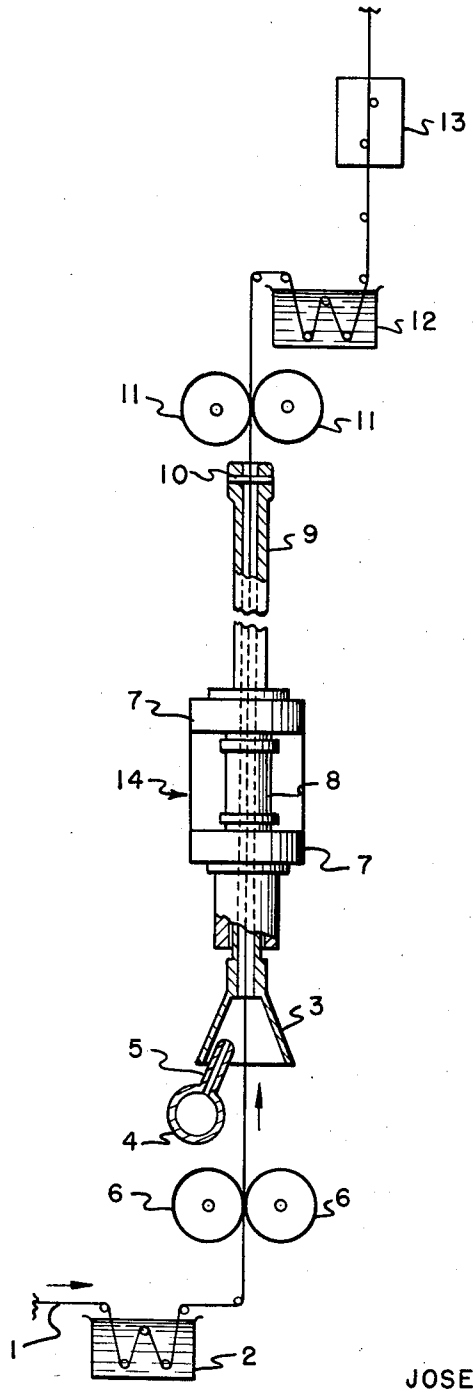
Oct. 6, 1964 J. H. DUSENBURY 3,151,439

PROCESS FOR MAKING ELASTIC KERATINOUS YARNS

Filed July 9, 1962



INVENTOR.
JOSEPH H. DUSENBURY
BY
ATTORNEY

United States Patent Office 3,151,439 Patented Oct. 6, 1964

3,151,439 PROCESS FOR MAKING ELASTIC KERATINOUS YARNS

Joseph H. Dusenbury, Spartanburg, S.C., assignor to Deering Milliken Research Corporation, Spartanburg, S.C., a corporation of Delaware

Filed July 9, 1962, Ser. No. 208,440
11 Claims. (Cl. 57—164)

This invention relates to a method for the preparation of an all-textile yarn having elastic characteristics and more specifically to a false twisting method for the preparation of an all-textile yarn containing keratinous fibers having extensibility and recovery properties.

Elastic yarns are well-known in the textile field. Elastic yarns of man-made polymeric fibers have been produced in a variety of forms which have found wide acceptance. Naturally-occurring fibers, however, have generally been limited to use as a cover material for yarns employing a man-made elastomeric core or to use as blends in man-made elastic monofilament yarns. Certain natural fibers, such as keratinous fibers, have inherent properties of extensibility and recovery. The term "keratinous fibers" as used herein is meant to include any naturally-occurring filamentary material or regenerated filamentary material containing major proportions of corresponding long chain fibrous proteins. The development of extensibility and recovery properties of keratinous fibers, if of sufficient intensity, could result in an elastic yarn the elastic properties of which are provided by the keratinous fiber. It should be understood that the term "elastic" when used with reference to the yarn of this invention is meant to define a mechanical extensibility rather than a rubber-like condition.

An elastic yarn wherein the elasticity is provided by the fibers making up the yarn will usually have superior bulking qualities. A fiber which has the tendency to contract upon its own axis will, when spun into a yarn, have a tendency to extend at right angles to the longitudinal axis of the yarn thereby giving the yarn bulking qualities. While all elastic yarns do not have bulking qualities, the coexistence of these two features is quite common.

It is therefore an object of this invention to provide a method for the preparation of an elastic keratinous yarn by means of a false twisting process.

It is another object of this invention to provide a method for the preparation of an elastic keratinous fiber containing yarn by means of a false twisting process.

It is a further object of this invention to provide a bulked keratinous yarn by means of a false twisting process.

In accordance with this invention, a method has now been discovered for imparting increased elastic recovery properties to the keratinous fibers of a preformed yarn by false twisting a travelling yarn and applying a set to the yarn over that part of the yarn length which is actually receiving twist. A false twisting operation of this type will result in a twist being imposed on the yarn, the imposed twist being set and then at least all of the imposed twist being removed. The yarn is preconditioned by immersion in an aqueous solution of reducing agent capable of splitting the characteristic cystine linkage of keratin prior to subjecting the yarn to false twisting operations. The setting operation which takes place while the yarn is actually receiving twist is accomplished by subjecting the moving yarn to a heating medium such as for instance, hot air, steam and the like. The yarn employed may be a yarn consisting entirely of keratinous fibers, or may be a blended yarn containing less than 100% but more than 50% of keratinous fibers with the remainder of the blend being either man-made or naturally-occurring non-keratinous fibers. Specific keratinous fibers which are suitable for purposes of this invention are fibers such as for instance, sheepwool, lambwool, mohair, camelhair, alpaca, cashmere, vicuna, llama, angora wool and the like.

Any reducing agent capable of rupturing the desired level of the disulfide linkages is suitable for use in accordance with this invention. Among the suitable reducing agents there are included lower alkanolamine sulfites, such as monoethanolamine sulfite and isopropanolamine sulfite, and others containing up to about 8 carbon atoms in the alkyl chain, such as n-propanolamine sulfite, n-butanolamine sulfite, dimethylbutanolamine sulfite, dimethylhexanolamine sulfite and the like; metallic formaldehyde sulfoxylates, such as zinc formaldehyde sulfoxylate, the alkali metal sulfoxylates, such as sodium formaldehyde sulfoxylate; the alkali metal borohydrides, such as sodium borohydride, potassium borohydride and sodium potassium borohydride; alkali metal sulfites, such as sodium or potassium bisulfite, sulfite, metabisulfite, or hydrosulfite; ammonium bisulfite, sodium sulfide, sodium hydrosulfide, cystine hydrochloride, sodium hypophosphite; sodium thiosulfate, sodium dithionate; titanous chloride; sulfurous acid; mercaptan acids, such as thioglycollic acid and its water-soluble salts, such as sodium potassium or ammonium thioglycolate; mercaptans, such as hydrogen sulfide, and sodium or potassium hydrosulfide; alkyl mercaptans, such as butyl or ethyl mercaptans and mercaptan glycols, such as β-mercapto ethanol; and mixtures of these reducing agents.

Beneficial results are often obtained if the reducing agent is employed in conjunction with a swelling agent or a "low molecular weight polyhydroxy compound." Urea constitutes the most readily available and desirable swelling agent, although any other material which will swell wool fibers in an aqueous medium is suitable. For example, guanadine compounds such as the hydrochloride, formamide, N,N-dimethylformamide, acetamide, thiourea, phenol, lithium salts, such as the chloride, bromide, and iodide and the like are similarly useful.

By the term "low molecular weight polyhydroxy compound" is meant a compound containing more than one hydroxy group and having a molecular weight no greater than about 4000. Of these compounds the most readily available and desirable compound, from the standpoint of ease of application, comprises ethylene glycol. A particularly preferred group of glycols includes the polyfunctional glycols having terminal hydroxyl groups separated by 2 to 10 methylene groups, including, of course, the preferred ethylene glycol as well as trimethylene glycol, tetramethylene glycol, pentamethylene glycol, hexamethylene glycol, heptamethylene glycol, octamethylene glycol, nonamethylene glycol, and decamethylene glycol, or such glycols as 1,2-propylene glycol, dipropylene glycol, 1,3-butylene glycol, diethylene glycol, polyethylene glycol or the like.

Polyfunctional compounds containing more than 2 hydroxyl groups include the polyfunctional alcohol glycerols such as glycerin, quintenyl glycerin, diethyglycerol and mesicerin, as well as trimethylol ethane, trimethylol butane, tris-hydroxymethyl-amino methane and others. Glycol ethers, such as the water-soluble or dispersible polyethylene glycols or polypropylene glycols having molecular weights no greater than about 4000 also provide satisfactory results when utilized in accordance with this invention.

The reducing agent with or without the swelling agent or polyhydroxy compound is applied to the yarn at concentrations sufficient to produce the desired degree of reduction, the concentration being dependent, of course, on the length of time the yarn remains in the reducing

agent. In general, satisfactory results are obtained with aqueous concentrations of from about 10% by weight to the solubility limit of the reducing agent. Preferably, concentrations of from 20% by weight to the solubility limit of the reducing agent are employed. The swelling agent or polyhydroxy compound if employed may be applied to the yarn by addition to the aqueous solution of reducing agent of amounts of from about 3 to about 50% and most preferably from about 5 to about 20% by weight. Higher concentrations may be utilized where the method of applying the reagents necessitates, e.g., when the reagents are applied by techniques other than by immersion in an aqueous medium containing the reagents.

The reducing agent which splits the cystine linkage of keratinous fibers does not produce a permanent split. The split linkages are easily reoxidized, by operations such as for instance, atmospheric exposure to reform the disulfide bonds. While the keratinous fiber remains substantially unchanged chemically by the reduction and oxidation operations, a physical reformation of the cystine linkages takes place probably with some changes in hydrogen bonding which will under proper conditions produce a reformed fiber with an elastic memory. Elastic memory is the feature which gives the individual keratinous fibers of this invention their extensibility and recovery properties. The extensibility and recovery properties of the keratinous fibers of this invention should not be confused with the rubber-like condition of a fiber whose polymeric structure has been extensively degraded.

The process can be applied to any yarn ply or any yarn consisting of a plurality of plies, the only limiting feature being that the singles yarn should usually not go through zero twist. The process is carried out by immersing a running length of yarn in a reducing agent, passing the treated yarn through a false twisting operation and simultaneously setting the twist, and then, if desired, washing and drying the running length of yarn. The twist setting operation which is conducted simultaneously with the false twisting operation is carried out in a time interval of from about 0.5 second to about 5 seconds, the time interval varying according to the degree of reduction effected by treatment in the reducing agent bath and according to the temperature of the setting medium employed in the twist setting operation. It should be understood that the time of the false twisting operation and the time of the twist setting operation are substantially identical.

The elasticized yarn obtained by the process of this invention and consisting wholly or partially of keratinous fibers may then be plied with other elasticized yarns consisting wholly or partially of keratinous fibers or may be plied with nonelastic yarns consisting wholly or partially of keratinous fibers or may be plied with nonelastic yarns consisting of non-keratinous natural fibers, synthetic fibers and mixtures thereof. By varying the type of plies twisted into the finished yarn, a variety of yarns having various elastic and bulking characteristics may be obtained.

In performing the elasticizing operation, there are a number of possible approaches. First, the initial twisting may be either in the same direction or in the opposite direction to the twist in the single yarn. In the former case a hard yarn is obtained, and in the latter case a soft yarn is produced. The result may be explained by the fact that the initial imposed twist is only placed in the yarn temporarily and that after setting the yarn in this configuration the imposed twist is taken out and an additional twist may be placed in the opposite direction so that in fact the resulting twist may be opposite to the initial imposed twist. An additional factor is that in a plied yarn each singles yarn may have different twist direction and different twist levels. When different twist directions and different twist levels are present in a plied yarn, a sharp distinction between hard and soft yarns may not always be obtained by varying the direction of the imposed twist. A general division may be made in the type of products obtained according to whether a helical or a random curling effect is produced.

A better understanding of the process of this invention may be had from a description of the accompanying drawing.

The drawing is a diagrammatic view partially in section of one type of apparatus which may be employed in carrying out the process of this invention. In the drawing, a keratinous fiber containing yarn 1 is passed through a reducing agent bath 2 into the nip of a pair of rollers 6 and then into a false twisting device 14, the false twisting device comprising a rotatable tube 9 mounted on bearings 7 and driven by means of a wheel 8, said rotatable tube 9 being provided with a funnel member 3 said funnel member being suitable for receiving a heating medium ejected from a header 4 provided with a nozzle 5. The rotatable tube 9 has a pin member 10 whereby the yarn is looped about said pin member 10 and subjected to a false twisting operation, setting of the yarn in the twisted configuration being accomplished by the heating medium ejected from the nozzle 5. The yarn emerging from the rotatable tube 9 is passed into the nip of a pair of rollers 11 and then into a washing tank 12 and from thereinto a drying box 13.

The heating medium may be a medium such as for instance, steam, hot air, inert organic heat-transfer liquids and the like. Steam is the preferred heating medium in that the presence of additional moisture aids the chemical reaction which takes place in setting the imposed twist. Inert organic heat-transfer mediums such as as Dowtherm E (treated o-dichlorobenzene produced by the Dow Chemical Company) are beneficially employed where temperatures in the range of from 300° to 500° F. are required in false twisting cycles of short time duration. It should be understood that the use of heating mediums other than steam necessitate a high moisture pick-up on the yarn coming into the false twisting operation.

As previously stated, the finished yarn may contain fibers other than keratinous fibers. These fibers may be present as a blend in the keratinous fiber containing plies prior to elasticizing treatment or may be present as a homogeneous non-keratinous ply which is twisted with the keratinous fiber containing ply. The non-keratinous fibers may be fibers such as for instance, cellulosics, such as cotton, rayon, cellulose acetate, cellulose triacetate, vinyl fibers, acrylic fibers, polyamide fibers, polyester fibers and the like. Regardless of how the non-keratinous fibers are blended into the finished yarn, the only elasticizing effect is that furnished by the keratinous fibers. The non-keratinous fibers, however, furnish substantial bulk to the finished yarn. The shrinkage of the keratinous fibrous elements tends to crimp, loop and pucker the non-keratinous fibers, thereby furnishing bulk to the finished yarn.

The elastic properties of the yarn of this invention are quite durable. It has been found that the elasticized yarns of this invention will tolerate steaming and mild soaping while in the relaxed form. The elasticized yarn, when stretched and placed on a bobbin for an extended period of time, has relatively little tendency to retract on being relaxed, but upon steaming or wetting, the elasticity of the yarn is immediately realized. This phenomenon is an asset, since knitting in this stretched state will be much less troublesome than knitting a yarn which tends to contract. For example, a fabric may be knitted and then steamed to produce a bulky fabric.

The various embodiments of this invention will be readily seen from the following examples. The examples, however, are given for purposes of illustration and should not be considered as limiting the spirit or scope of this invention.

Example I

A single 27's wool yarn having an original twist of 14 turns of "Z" twist per inch is immersed in a 50% by weight aqueous solution of normal propanolamine sulfite. The running length of yarn is then sent through a false twisting operation, false twisting being carried out for a period of 3 seconds imparting additional turns of "Z" twist to the yarn. The additional turns of implied "Z" twist are set simultaneously with the false twisting operation by means of the injection of steam at temperatures of 120° C. The running length of yarn is then taken from the false twisting operation into a washing bath and then into a drying box. The resultant finished yarn is characterized by a high degree of bulking and elasticity and is a relatively hard yarn.

Example II

A single 27's yarn having 14 turns of "S" twist is immersed in a 70% aqueous solution of isopropanolamine sulfite. The running length of yarn is then sent through a false twisting operation, false twisting being carried out in a manner such as to impose "Z" twist on the yarn. The imposed "Z" twist is set simultaneously with the false twisting operation by the application of superheated steam at temperatures of about 120° C. The running length of yarn is then passed through a washing tank and then into a dry box. The finished yarn is a relatively soft yarn having a high degree of bulk and elasticity.

Example III

A single end of single 27's yarn composed of a blend of 90% wool and 10% Dacron (polyester fiber produced by E. I. du Pont de Nemours and Company) and having an original twist of 14 turns of "Z" twist per inch is immersed in a saturated solution of monoethanolamine sulfite. The running length of yarn is then sent through a false twisting operation where additional turns of "Z" twist are imposed on the yarn, the imposed twist being set simultaneously with the false twisting operation by the application of superheated steam at temperatures of about 110° C. The running length of yarn is then passed through a washing tank and then into a dry box. The finished yarn is characterized by a high degree of bulking and elasticity, the yarn being relatively hard yarn.

Example IV

A two-ply yarn consisting of 2 single 27's wool yarn having 14 turns of "S" twist per inch plied and twisted to 25 turns of "S" twist per inch is immersed in a saturated aqueous solution of dimethylhexanolamine sulfite. The running length of yarn is then passed through a false twisting operation wherein additional turns of "S" twist are imposed upon the yarn, the imposed twist being set simultaneously with the false twisting operation by the application of hot air at temperatures of about 150° C. The running length of yarn is then passed through a washing step and then through a dry box. The finished yarn is characterized by a high degree of bulking and elasticity and is a relatively hard yarn.

Example V

A single end of single 27's wool yarn having an original twist of 14 turns of "S" twist per inch is immersed in a 20% aqueous solution of isopropanolamine sulfite. The running length of yarn is then sent through a false twisting operation wherein additional turns of "S" twist are imposed on the yarn, the imposed twist being set simultaneously with the false twisting operation by the application of superheated steam at temperatures of 110° C., the false twisting operation lasting about three seconds. The running length of yarn is then sent through a washing step and then through a dry box. The finished yarn is characterized by a high degree of bulking and elasticity and is a relatively hard yarn.

Example VI

A single end of single 27's wool yarn having an original twist of 14 turns of "S" twist per inch is immersed in a 20% aqueous solution of isopropanolamine sulfite. The running length of yarn with high moisture retention is then sent through a false twisting operation wherein additional turns of "S" twist are imposed on the yarn, the imposed twist being set simultaneously with the false twisting operation by the application of Dowtherm E (treated ortho-dichlorobenzene produced by the Dow Chemical Company) at temperatures of 400° C., the false twisting operation lasting about one-half second. The running length of yarn is then sent through a washing step and then through a dry box. The finished yarn is characterized by a high degree of bulking and elasticity and is a relatively hard yarn.

Example VII

A four-ply yarn consisting of three single 27's wool yarn having 14 turns of "S" twist per inch and one ply of single 27's Dacron (polyester fiber produced by E. I. du Pont de Nemours and Company) having 14 turns of "S" twist per inch plied and twisted to 25 turns of "S" twist per inch is immersed in a 10% by weight aqueous solution of dimethylhexanolamine sulfite. The running length of yarn is then passed through a false twisting operation wherein additional turns of "S" twist are imposed upon the yarn, the imposed twist being set simultaneously with the false twisting operation by the application of superheated steam at temperatures of about 110° C., the false twisting operation lasting about 5 seconds. The running length of yarn is then passed through a washing step and then through a dry box. The finished yarn is characterized by a high degree of bulking and elasticity and is a relatively hard yarn.

What is claimed is:

1. A method for the preparation of an elastic yarn comprising immersing a length of yarn containing at least some keratinous fibers in a reducing agent, imposing a twist on said yarn by passage through a false twisting operation having a time duration of from about 0.5 second to about 5 seconds and simultaneously setting the imposed twist by the application of heating mediums at temperatures of from about 110° C. to about 500° C.

2. The method of claim 1 wherein said yarn contains all keratinous fibers.

3. A method for the preparation of an elastic yarn containing at least some keratinous fibers comprising immersing a running length of yarn in a reducing agent, imposing a twist on said yarn in the same direction as said single ply yarn's initial twist by passing said yarn through a false twisting operation having a time duration of from about 0.5 second to about 5 seconds and simultaneously setting the imposed twist by the application of a heating medium having a temperature of from about 110° C. to about 500° C.

4. The method of claim 3 wherein said yarn contains all keratinous fibers.

5. A method for the preparation of an elastic yarn containing at least some keratinous fibers comprising immersing a running length of yarn in a reducing agent, imposing a twist on said yarn in the opposite direction as said single ply yarn's initial twist by passing said yarn through a false twisting operation having a time duration of from about 0.5 second to about 5 seconds and simultaneously setting the imposed twist by the application of a heating medium having a temperature of from about 110° C. to about 500° C.

6. The method of claim 5 wherein said yarn contains all keratinous fibers.

7. A method for the preparation of an elastic yarn comprising immersing a running length of yarn containing at least some keratinous fibers in a reducing agent, imposing a twist on said yarn by passage through a false twisting operation and simultaneously setting the imposed twist

by subjecting the yarn for a period of from about 0.5 second to about 5 seconds to a heating medium selected from the group consisting of hot air, steam and inert organic heat-transfer liquids said heating medium having a temperature in the range of from about 110° C. to about 500° C.

8. The method of claim 7 wherein said yarn contains all keratinous fibers.

9. A method for the preparation of a plied elastic yarn, at least one ply containing at least some keratinous fibers comprising immersing a length of yarn in a reducing agent, imposing a twist on said yarn by passage through a false twisting operation having a time duration of from 0.5 second to about 5 seconds and simultaneously setting the imposed twist by the application of a heating medium at a temperature of from about 110° C. to about 500° C.

10. The method of claim 9 wherein said keratinous fiber containing ply is an all-keratinous fiber containing ply.

11. A method for the preparation of an elastic yarn comprising immersing a running length of yarn containing at least some keratinous fibers in an aqueous solution of a reducing agent and a swelling agent said reducing

agent being capable of splitting the characteristic cystine linkage of keratin and being present in concentrations of from about 10% by weight to the solubility limit of the reducing agent, imposing a twist on said yarn by passage through a false twisting operation and simultaneously setting the imposed twist by subjecting the yarn for a period of from about 0.5 second to about 5 seconds to a heating medium selected from the group consisting of hot air, steam and inert organic heat-transfer liquids, said heating medium having a temperature in the range of from about 110° C. to about 500° C.

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