Feb. 13, 1945. K. HEYMANN 2,369,395

YARN-LIKE STRUCTURE

Filed Jan. 21, 1942

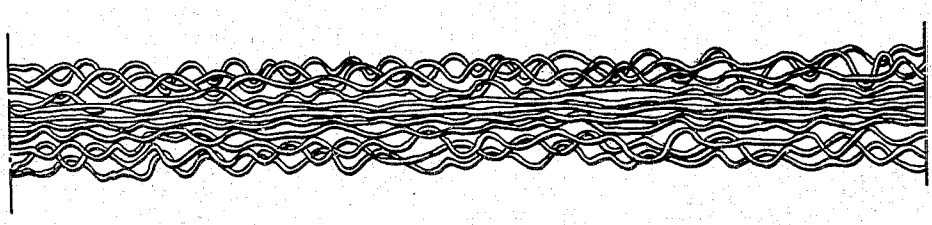


Fig. 2.



Fig. 1.

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Patented Feb. 13, 1945 2,369,395

UNITED STATES PATENT OFFICE

2,369,395

YARNLIKE STRUCTURE

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Application January 21, 1942, Serial No. 427,563

7 Claims. (Cl. 28—81)

This invention relates to yarn-like structures of artificial filaments exhibiting a wooly, fluffy character and to processes of making them.

The natural wools are composed of short fibers, which are formed into fabrics by felting, spinning, weaving, and fulling processes. Such fabric materials, being composed of fibrous masses having numerous ends, cause a scratching or an itching sensation when they come into contact with the skin of the wearer. The woolen fabrics, such as flannels, blankets, and certain suitings which have been fulled commonly have this effect, and the free fiber ends in combination with the high resiliency and elasticity of the crimped fibers are largely accountable for this sensation which is at times extremely annoying to the wearer. It has heretofore been proposed to make artificial wool-like masses by imparting a crimp or curl to fibers of certain synthetic materials having staple lengths and spinning the crimped fibers to form a yarn. Such known yarns as have yielded somewhat improved skin sensations have done so, with but few exceptions, only with the sacrifice of resiliency and elasticity of the fibers making up the substitutes. Such a sacrifice is inconsistent with the obtention of the most desirable wool-like properties, such as the retention through long periods of hard wear and usage of a loose, fluffy fibrous mass which is necessary to impart the desired heat insulation capacity.

Figure 1 is a somewhat enlarged view of a fluffy yarn-like structure made in accordance with the invention, showing its general external appearance, and

Figure 2 is a greatly enlarged view showing the disposition of the filaments in a given plane within a yarn having substantially no twist, illustrating one embodiment of the invention.

In accordance with this invention, it has been found that a textile material in yarn-like form and having extremely wool-like properties may readily be obtained from continuous filaments of polyvinyl resins, such as polyvinyl chloride and more particularly the co-polymers of vinyl chloride and vinyl acetate described in the Rugeley Patent 2,161,766, halogenated polyvinyl resins, such as chlorinated polyvinyl chloride and the chlorinated co-polymers of vinyl chloride and vinyl acetate described in the Lytton and Taylor application Serial No. 403,530 filed July 22, 1941 patented October 26, 1943, No. 2,332,974. It has been found that when continuous filaments of these resins which have been stretched, either during their spinning or after their coagulation whether they are manufactured by the evaporative or the coagulative spinning processes, are subjected, in the form of a bundle or group, to a certain degree of heat, preferably in an indifferent medium, while limply suspended, a shrinkage occurs and that this shrinkage is accompanied by the production of a crimpyness or curlyness in the filaments which is highly irregular and of such a fine degree that it imparts to the filaments an appearance and fluffiness similar to that of natural wool without the fuzziness thereof associated with fiber ends. The fine and delicate yet permanent crimp obtainable by the process of the invention should not be confused with the comparatively coarse crimp heretofore imparted to other filamentary materials by such unrelated means as mechanical working which has the serious disadvantage of reducing the elasticity of the filaments, particularly at the places of bending. It has been found that such shrinkage and crimping as is produced in accordance with the invention is accompanied by substantially no loss of elasticity so that fabricated materials made from such filaments are found to exhibit and maintain through hard usage a loose, fluffy character and heat insulating qualities of the same order as those exhibited by woolen fabrics.

Resin filaments having any amount of stretch may be employed. For example, filaments which have been stretched to several hundred per cent of their original length as well as those which have been stretched to less than one hundred per cent of their original length may be heated to impart a partial or a complete shrinkage thereof. When highly stretched filaments are employed, however, it may be desirable not to effect complete shrinkage because of the concomitant excessive decrease in length which, being accentuated by virtue of the crimping, may make the material too expensive from a commercial standpoint to be practical for certain purposes. Inasmuch as the degree of shrinkage of any of the resins may be controlled merely by controlling the temperature of heating, it is possible and preferable to impart the desired crimp without imparting excessive shrinkage or decrease in length of the filaments. However, the temperature employed in the crimping or shrinkage process is preferably selected so that it will be at least as high as the highest temperature or temperatures to which the fabric to be made of the crimped filaments would ordinarily be subjected in subsequent use or cleaning. By so selecting the shrinkage temperature, complete sta-

bility of the fabric throughout ordinary usage and cleaning processes is assured.

By starting from filaments which have been stretched to a degree less than one hundred per cent of original length during their manufacture, complete shrinkage is permissible and is consistent with the obtention of the above-stated wool-like properties. In addition, the filaments which have been completely shrunk and fabrics made therefrom are substantially unaffected by heat through a greater range of temperatures than is the case where only partial shrinkage is employed.

However, by selecting a filament or filaments made of a resin having an inherently high shrinkage temperature well above the temperatures that are encountered during customary use of the fabrics to be made therefrom, the filaments of such resins may be made with any desired degree of stretch and may be crimped with either a complete or a partial shrinkage without encountering the danger that the yarns or fabrics made therefrom will undergo shrinkage in subsequent use. For example, stretched filaments of the chlorinated co-polymers of vinyl acetate and vinyl chloride disclosed in the Lytton and Taylor patent cited above as well as of chlorinated polyvinyl chloride having shrinkage temperatures of at least about 100° C. may be subjected to heat such as to impart only a partial shrinkage to the filaments. Because of the elevated shrinkage and softening temperature ranges of these resins relative to the corresponding ranges of the unmodified co-polymers, a correspondingly higher temperature must be employed in order to effect the desired crimping. While temperatures between about 70° to 100° C. are suitable for the unchlorinated co-polymers, temperatures ranging from 100 to 200° C. should be employed with the chlorinated polymers and co-polymers having the elevated shrinkage temperatures.

The crinkling effect is obtained regardless of whether or not the filaments in the bundle are twisted. However, a certain amount of twist enhances the fluffiness and crimpiness of the resulting yarn-like structure and imparts additional advantageous characteristics to the resultant product as pointed out more particularly hereinbelow.

The crimping treatment may also be imparted to yarns made up of several multifilament ends twisted or doubled together to form a plied continuous thread. The several ends so doubled may comprise filaments having the same amount of stretch and made of the same resin or the several ends may comprise filaments, one or more of which may have a different amount of stretch and/or may be made of different resins. The net result of such a combination of filaments having different amounts of stretch and/or of different resins is to enhance the loose and fluffy appearance as well as the crimping and curling of the entire yarn. Upon treating such a combined yarn at a given temperature, at least some of the filaments in the composite yarn may be given different amounts of shrinkage thereby enhancing the wool-like appearance of the resulting products. The yarn to be treated, whether singles or plied, may have any degree of twist at the time of treatment, but a relatively low twist is preferable. For example, fine yarns preferably have from 0.5 to 4 turns of twist per inch while heavy yarns preferably have 1½ to 2 turns per inch. Where the yarns to be treated are plied of singles yarns having different shrinkage capacities under the conditions of subsequent treatment, the individual singles yarns preferably have different amounts of twist selected to prevent any one or more of the singles yarns from slubbing off those which undergo the greatest shrinkage upon subsequent treatment.

By varying the amount of shrinkage or by varying the denier of the individual filaments of which the filament-bundle or yarn is constituted, it is possible to produce yarn resembling any grade of wool from the coarsest to the finest Shetland. The effects may further be varied by varying the amount of stretch and controlling the relation between the amount of stretch and the temperature of treatment and either or both of these factors may also be employed in combination with any of the above-mentioned modifications in which several filaments made of different resins or having a different amount of stretch are combined into a composite yarn by doubling with or without an additional amount of twist applied to the doubled yarn. The single ends of which such plied thread is made may each comprise filaments having the same constitution and the same amount of stretch; or one end comprising only filaments of one resin stretched to a certain extent may be combined with one or more other ends which are made of a different resin or of the same resin but stretched to a different degree than the filament in the first end, or each individual end in the composite yarn may comprise a mixture of filaments made of different resins and/or having a different amount of stretch. Furthermore, the individual ends of which the composite yarn is composed may have the same or a different amount of twist and the several ends may be doubled in the composite yarn in such a manner as to oppose or favor the snarling tendency of the individual ends resulting from their twist.

Depending upon the character of the initial filament-bundle, the twist therein, the extent of treating and the other factors mentioned above, various forms of yarn-like structures are obtained. In treating a multifilament singles yarn having a relatively low twist, there results in general a yarn-like structure along the length of which each filament winds in and out among the remaining filaments so that at one point it may be near the surface of the yarn while at a short distance therefrom it may run more or less deeply within the interior of the yarn. In general, it has been found that the core of the yarn-like structure, whether the yarn is originally twisted or not, has a somewhat lesser crimpiness than the exterior and that the average crimpiness progressively increases from the center to the surface of the structure, which results in a remarkably soft and fluffy exterior. See Figure 2 of the drawing which illustrates this characteristic in a crude way. The reduced crimpiness of the core causes it to resist excessive straightening of the highly crimped filaments upon the exterior when the yarn-like structure is placed under tension. In addition, where a slight or any amount of twist is present in the structure, the several filaments weave in and out within the body of the structure so that each filament has various degrees of crimping along its length depending upon the position it occupies within the body of the structure at the various points, and this structural relationship of the several filaments making up the yarn prevents the external layers

from slubbing off the less highly crimped central core of the structure. This novel structure is therefore highly useful in that the fluffy character of the exterior of the yarn is maintained without slubbing and with but small diminution under all conditions of tension occurring in ordinary usage.

Composite or singles yarns may be subjected to the desired temperature to effect shrinkage and crimping as they are wound limply from one carrier to a second carrier or package. The actual winding of the treated yarn upon the second carrier preferably should not occur until after the heated yarn has been allowed to cool so that the bending involved in winding the yarn upon the carrier will effect a tearing apart of any individual filaments which may have been lightly fused together at points of their surfaces during the heating. For example, the several ends may be plied upon any form of downtwisting equipment, such as by ring spinning, and the plied yarn may be withdrawn from the package upon which it was wound during plying in such a manner as to allow a loose length to dip limply into and pass through a bath of water heated to the desired temperature and then the crimped yarn may be wound upon a spool or other package arranged sufficiently far from the point of emergence of the yarn from the heating bath to permit it to cool until it loses any tackiness before it is wound upon the spool. Alternatively, the doubled yarn may be put into skein form and may then be subjected to heat by immersion in hot water or by placing it in a heated atmosphere. When the water employed in the treatment is at a relatively high temperature, a rather hard cake is obtained. However, this is readily broken up by mechanical action, such as by hand kneading, by passing the yarn between pressure rolls or by winding on spools. A softer yarn is produced by immersion of the skein in water of somewhat lower temperature or in hot air. The hot air treatment produces a bright yarn while the wet treatment causes a dulling of the fibers.

Whereas in the above described procedures heat alone has been employed to shrink and crimp stretched yarns made from polyvinyl resins it is likewise possible to arrive at the same effect but at lower temperatures with the help of swelling agents for the polyvinyl fibers. In the swollen fibers the contracting forces are released at lower temperatures. Such swelling agents may be liquid or solid chemical compounds, for instance, ethyl acetate, diethyleneglycol dipropionate, dibutylphthalate, triphenylphosphate or p-dimethylamino benzaldehyde, phenol, and o-hydroxydiphenyl. These compounds are best applied in the form of concentrated solutions or in the form of aqueous emulsions or dispersions and the yarns are treated in these baths for a certain time but at lower temperatures than would be required if no swelling agents were present. By adding suitable dyestuffs to these baths, it is possible to combine the crimping and dyeing of the yarns in a single operation.

Example 1

A filamentary yarn of a co-polymer comprising 90% of vinyl-chloride and 10% of vinyl acetate was subjected to stretching by leading the yarn about two godet wheels having their circumferential speeds differing by 75% immediately after the filaments left the spinning tube. The resulting singles yarn had a titer of 220 denier and was composed of 54 filaments. It had a total shrinkage capacity of 40%. Four ends of this yarn were doubled with four ends of filaments composed of the same resin but spun only with the stretch due to normal spinning tension, having a titer of 190 denier for 54 filaments and having a shrinkage capacity of only 25%. The plied yarn had a twist of one and one half turns per inch. The yarn was subjected to a bath of hot water at about 90° C., was removed from the bath and was then wound upon a suitable package with a certain amount of mechanical working to soften or loosen the structure. The yarn was fluffy and resembled wool.

Example 2

Continuous filaments were wet-spun with 200% stretching from a chlorinated co-polymer comprising 90% vinyl chloride and 10% of vinyl acetate having a chlorine content of 60%. Three ends of such filamentary material were doubled and the doubled yarn was subjected to hot air at 110° C. The resulting yarn was loose and fluffy and had an extremely close resemblance to wool.

Example 3

A composite yarn as described, for instance, in Example 1 was treated in skein form in a bath of water containing in finely divided form 10% by weight of o-hydroxy-diphenyl calculated on the weight of the yarn. The ratio of yarn to bath was 1:30 by weight. After treatment of the yarn for one half hour at 55° C., the bath was brought to a temperature of 70° C. and the skein was then removed. It had shrunk to a fluffy, woolly yarn.

Example 4

Two ends of a yarn spun from chlorinated polyvinyl chloride and having a shrinkage capacity of 60% at 165° C. and a titer of 250 denier for 50 filaments were doubled with two ends of a similar yarn having a shrinkage capacity of 75% at 165° C. and a titer of 230 denier for 50 filaments. The plied yarn carried two turns twist per inch. It was immersed for a few minutes in a mixture consisting of 50 parts per volume of grain alcohol and 50 parts per volume of ethyl acetate. After drying of the treated yarn, it was fluffy and resembled wool.

The strength and extensibility characteristics of the yarn may be improved by plying singles yarns of such polymers or co-polymers or their chlorinated derivatives with an end of such materials as wool, cotton, silk, rayon or other synthetic filaments, such as stretched Vinyon, particularly of the chlorinated type, nylon or fiber glass. Furthermore, a yarn may be made by combining in any proportion filaments of the polyvinyl polymers, co-polymers or their chlorinated derivatives with fibers or filaments of other materials, such as wool, cotton, silk, rayon or other synthetic fibers, such as nylon or fiber glass. Preferably, in all these combinations, materials of continuous filaments are employed in order to minimize the danger of itching or scratching by fabrics made of such materials.

The wool-like material produced in accordance with this invention is water-resistant and mothproof. Besides having less tendency to produce an itching or scratchy sensation upon the wearer, the material serves as an excellent substitute for wool, especially for persons who are allergic to wool or similar synthetic wools of proteinous constitution. Besides being adaptable to weaving, fulling, and similar processes, the yarn obtained in accordance with the invention is particularly

adapted for knitting. Because of its softness and reduced tendency to provoke irritation upon the skin of the wearer, fabrics made from this material are adaptable to the manufacture of infant clothing. When combined with filaments of other materials, cross-dyeing effects may be used with advantage to enhance esthetic appeal. Fabrics made from the wool-like material produced in accordance with this invention are also readily laundered and dry rapidly. The crinkled singles yarns may also be doubled with other yarns to produce special effect yarns in manners heretofore known to the art.

In the claims the word "filamentary" is intended to refer to both filaments (continuous lengths) and fibers (short filamentary lengths). The expression "internally stressed" is intended to refer to the internal condition acquired by the filamentary material upon being stretched during manufacture as hereinabove described.

The description is intended to be merely illustrative, and various modifications and changes may be made within the spirit and scope of the following claims.

I claim:

1. A yarn structure comprising a plurality of filaments of a polyvinyl resin, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

2. A yarn structure comprising a plurality of filaments of a co-polymer of vinyl chloride and vinyl acetate, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

3. A yarn structure comprising a plurality of filaments of an after-chlorinated polyvinyl resin, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

4. A yarn structure comprising a plurality of filaments of a polyvinyl resin twisted together so that the filaments weave in and out among each other along the length of the structure, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

5. A yarn structure comprising a plurality of filaments of a co-polymer of vinyl chloride and vinyl acetate twisted together so that the filaments weave in and out among each other along the length of the structure, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

6. A yarn structure comprising a plurality of filaments of an after-chlorinated polyvinyl resin twisted together so that the filaments weave in and out among each other along the length of the structure, the filaments being in a crimped or crinkled condition substantially throughout said structure, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

7. A yarn structure comprising a plurality of filaments in a crimped or crinkled condition, the average degree of crimpiness generally increasing from the central to the exterior portions of said structure.

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