

## UNITED STATES PATENT OFFICE

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TEXTILE YARN AND PROCESS FOR  
PRODUCING IT

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This invention relates to improvements in textile yarns and processes for producing them, and is more particularly concerned with increasing the permanence of crimp or crinkle in textile yarns.

When an artificial crimp is imparted to textile yarns by passing the yarns through crimping rollers which may be heated, in most cases the crimp obtained is of a relatively impermanent character and is very much reduced or removed altogether in washing operations. This is particularly so with yarns of natural or regenerated cellulose. With yarns of cellulose acetate or other organic derivative of cellulose or other thermoplastic substances, the crimp may be more permanent than with natural or regenerated cellulose yarns, particularly if the temperature and pressure at which the crimp is applied is sufficient to render plastic the substance composing the filaments or fibres of the yarn. The same is also true to a less extent of crimp imparted to natural silk yarns. However, even here there is the disadvantage that if the temperature and pressure are raised with the object of rendering the crimp entirely resistant to washing, there is a danger of damaging the yarn.

The present invention has as its object to render crimp, crinkle or like deformation of the fibres or filaments of a textile yarn permanent, or more resistant to washing. According to the present invention, after the insertion of the crimp, crinkle or similar deformation in the fibres or filaments which constitute or which are to constitute the yarn, a condensation or polymerisation is brought about in the fibres or filaments so as to fix the crimp, crinkle or the like.

Condensation to produce synthetic resins may be brought about in the fibres or filaments either by interaction of suitable reagents in the material or by carrying out at least the last stages of the condensation necessary to produce the synthetic resin in the material.

Preferably the fibres or filaments are impregnated with the reagents necessary for the condensation or polymerisation or with an intermediate condensation or polymerisation product before applying the crimping, crinkling or like process, especially when, as is desirable, the reagents or intermediate products are applied from an aqueous solution or emulsion. The material may, for example, be impregnated with the reagents or the intermediate product, excess removed by heavy squeeze rollers, the material dried or substantially dried, and then subjected to the crimping, crinkling or like process. Further,

where one of the reagents for the formation of the condensation or polymerisation product, for example formaldehyde, is to be applied in gaseous or vaporous form, such application may take place after the insertion of the crimp, crinkle or similar deformation.

A wide variety of condensation or polymerisation products is available for use according to the invention, for example synthetic resins of the phenol-formaldehyde type, of the phenol-ketone-aldehyde type, of the ketone-aldehyde type, and of the urea- or thiourea-aldehyde type. For example, phenol, cresols, diphenylol propane, resorcinol or the like, or acetone or methyl ethyl ketone may be condensed with formaldehyde or other aldehyde. For nitrogenous resins, aliphatic or aromatic amines or amides generally, for example urea, thiourea, guanidine and their derivatives, dicyandiamide, aniline, methyl aniline, diphenylamine, benzyl aniline,  $\beta$ -naphthylamine, para-toluene-sulphonamide or other aromatic sulphonamides or N-alkyl or other derivatives thereof, may be employed and condensed with formaldehyde, acetaldehyde, or other reactive aldehyde.

Another group of compounds available is the vinyl compounds capable of producing the synthetic resins by polymerisation. For example the vinyl resins may be polymerised vinyl acetate, polymerised vinyl chloracetate, polymerised acrylic methyl or ethyl ester, polymerised methacrylic methyl or ethyl ester, and their homologues and substitution products. As with the synthetic resins obtainable by condensation, the vinyl and other unsaturated resins may be applied to the material in the monomeric state or in an intermediate stage of polymerisation in which they are readily soluble, and the polymerisation or further polymerisation carried out on the material.

As described in U. S. application S. No. 57,452 filed January 3, 1936, formaldehyde or other aldehyde or substances yielding aldehydes may be brought to reaction in the materials in the presence of oils, plasticisers or other softening agents, and especially substances containing a chain of at least eight carbon atoms and preferably twelve or more carbon atoms in length. Reference is made to the specification of this application for examples of suitable substances.

As previously indicated, it is preferable to apply the reagents or intermediate products to the materials from aqueous solution. Organic solvents may, however, be employed, either in the anhydrous or substantially anhydrous condition or

mixed with water, as media for applying the reagents or intermediate products and their use may, especially with textiles which are soluble or become swollen by the organic media, e. g., cellulose derivatives, assist penetration. Organic media are also useful where the reagents or intermediate products are applied after the crimping, crinkling or like process.

It is particularly desirable that the reagents or intermediate products should penetrate the filaments or fibres and that no substantial quantity should be left adhering to the outside. To this end excess should be removed under heavy pressure, applied for instance by means of calender rolls. The use of dilute solutions also assists in reducing the quantity of reagents adhering to the exterior of the filaments or fibres.

The crimp, crinkle or the like may be imparted as previously described by means of crimping rollers which may be heated, or steam may be applied to the material during passage through the crimping rollers, this latter mode of operation being particularly suitable for use on yarns of cellulose acetate or other organic derivative of cellulose. A further method of inserting a crimp or crinkle consists in applying a twist, and preferably a high twist, to the yarn and subsequently untwisting. The condensation or polymerisation is preferably effected after the insertion of the twist to produce the crimp or crinkle and before the removal of this twist. However, if desired the crimp or crinkle due to the insertion of the twist may be temporarily fixed in the yarn by treatment with steam, hot water or the like before the untwisting, and the condensation or polymerisation effected after the untwisting.

The present invention further includes treatment of the yarns so as to "break up" the crimp or crinkle in the yarn, or, so to speak, render the crimp or crinkle in some of the filaments or fibres constituting the yarn out of phase with the crimp or crinkle in other filaments or fibres in the yarn. By this means, a voluminous yarn of very wool-like character is produced. In some cases the "breaking up" of the crimp or crinkle may be effected very simply by the insertion of twist. For example where crimp has been inserted by means of crimping rollers acting upon a yarn having very low twist or no twist at all, the crimp may be broken up by the subsequent insertion of twist. If the yarn before the insertion of crimp or crinkle has an ordinary or high degree of twist, it is preferable in order to "break up" the crimp or crinkle to twist the yarn in the reverse direction so that it passes through the neutral point of no twist. Such a process is applicable in particular to continuous filament yarns.

Another process which assists in "breaking up" the crimp or crinkle is to cut the filaments of a continuous filament yarn into comparatively short lengths while retaining the continuity of the yarn. Processes for effecting such cutting are described in U. S. applications S. No. 726,264 filed May 18, 1934, and S. Nos. 66,866, 66,867, and 66,868 all filed March 3, 1936. If the yarn which has undergone crimping or crinkling and subsequent conversion into a staple fibre yarn has initially a comparatively low twist, the subsequent insertion of twist also assists in "breaking up" the crimp or crinkle. With a staple fibre yarn, a simple drawing operation applied to the already crimped or crinkled material is usually sufficient to "break up" the crimp or crinkle. Thus, a drawing operation may

be applied to a crimped or crinkled yarn initially made up of staple fibre, or to a yarn which was initially a continuous filament yarn and is subsequently converted into a staple fibre yarn as described. When, after the crimping or crinkling process, or after the fixation of the crimp or crinkle according to the invention, the yarn is in a condition of substantially no twist, a blast of air applied to the running yarn also assists in "breaking up" the crimp or crinkle.

The process may be applied to the staple fibre itself which is subsequently to constitute the yarn, in which case the ordinary spinning operation including a drawing process will effect the desired "break up" of the crimp or crinkle. The staple fibre may, for example, be treated in the form of a sliver.

The condensation or polymerisation to fix the crimp or crinkle in the material may be carried out before or after the operation designed to "break up" the crimp or crinkle. Preferably the reaction conditions are such that the condensation or polymerisation product is produced in the desired water-insoluble state in as short a time as possible, for example a period under five minutes. For example a three minute treatment of the textile material at a temperature of 150-180° C. is usually sufficient for condensation in the case of the phenol-aldehyde or urea- or thiourea-aldehyde type of resin in presence of appropriate catalysts.

The following examples illustrate the invention but are not to be considered as limiting it in any way.

#### Example 1

A urea/formaldehyde solution is prepared as follows:

|                       | Parts by weight |
|-----------------------|-----------------|
| Urea.....             | 40              |
| 40% formaldehyde..... | 80              |

The mixture is made alkaline, brought to the boil, and 5 parts by weight of magnesium chloride added. The solution is cooled and poured into 240 parts by weight of water containing 15 parts by weight of magnesium chloride. A viscose yarn is soaked in this solution for 5 minutes, squeezed and dried at 50° C. The yarn is then placed for 5 minutes in a 5% solution of ethyl stearate or dibutyl phthalate in methyl alcohol, squeezed, then dried at 50° C. The yarn is thereafter twisted so as to insert a high degree of twist, for example 50-60 turns per inch, and in the highly twisted state is heated for 5 minutes at 140° C. The yarn is thereafter untwisted so as to pass the neutral point of twist and to insert a twist of about 5 turns per inch in the reverse direction. In this manner a very woolly yarn is produced.

#### Example 2

A cotton yarn is swollen by allowing it to stand for 5 minutes in caustic soda at 20° Tw., is then washed in warm water and soaked for 15 minutes in a resin-forming solution made up as follows:

|                       | Parts by weight |
|-----------------------|-----------------|
| Phenol.....           | 50              |
| 40% formaldehyde..... | 50              |

The yarn is then centrifuged, dried at 50° C., immersed in 40% formaldehyde for 1 minute, and again dried at 50° C. The yarn is then passed through crimping rollers which may, if desired, be enclosed in a steam chamber, and is finally heated to 180° C. for 3 minutes.

*Example 3*

A viscous yarn is crimped or crinkled by the process and apparatus described in U. S. applications S. Nos. 727,609, filed May 26, 1934, and 21,376 filed May 14, 1935. It is thereafter padded with a solution of 5% Brilliant Aviol in 20% formaldehyde with or without a small quantity of concentrated hydrochloric acid. The yarn is squeezed and dried, care being taken to apply as small a tension as possible. The yarn is finally heated for 5 minutes at 140° C. The yarn may then be converted into a staple fibre yarn by any of the processes described in U. S. applications S. No. 726,264 filed May 18, 1934, and S. Nos. 66,866, 66,867, and 66,868, all filed March 3, 1936.

*Example 4*

A cellulose acetate yarn saponified to a loss in weight of 5 to 20 or 25% is treated according to the process of any of the preceding examples, a swelling in aqueous acetone (46.5% acetone by volume) being interposed before the impregnation with the reagents for condensation or polymerisation.

Having described my invention, what I desire to secure by Letters Patent is:

1. In a process for the production of filaments, fibres, yarns and like materials displaying a crimped or crinkled effect and wherein the curl in some of the filaments or fibres is out of phase with the curl in other filaments or fibres in the yarn, the step which comprises fixing the crimp or crinkle in the fibres or filaments by effecting a condensation or polymerization in the fibres or filaments.

2. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments, fibres, yarns and like materials, treating the crimped or crinkled materials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter forming a polymerization or condensation product within the materials.

3. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments, fibres, yarns and like materials carrying reagents capable of polymerization or condensation, treating the crimped or crinkled materials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter polymerizing or condensing the reagents.

4. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect which comprises crimping or crinkling filaments, fibres, yarns and like materials, treating the crimped or crinkled materials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter forming a resinous polymerization or condensation product within the materials.

5. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments, fibres, yarns and like materials carrying reagents capable of polymerization or condensation to form a resinous product, treating the crimped or crinkled mate-

rials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter polymerizing or condensing the reagents.

6. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments or fibres, thereafter forming a polymerization or condensation product within the filaments or fibres, and subjecting yarn containing the filaments or fibres to a finishing operation which breaks up the crimp or crinkle so that the curl in some of the filaments or fibres is out of phase with the curl in other filaments or fibres in the yarn.

7. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments or fibres, thereafter forming a resinous polymerization or condensation product within the filaments or fibres, and subjecting yarn containing the filaments or fibres to a finishing operation which breaks up the crimp or crinkle so that the curl in some of the filaments or fibres is out of phase with the curl in other filaments or fibres in the yarn.

8. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments or fibres carrying reagents capable of polymerization or condensation to form a resinous product, thereafter polymerizing or condensing said reagents, and subjecting yarn containing the filaments or fibres to a finishing operation which breaks up the crimp or crinkle so that the curl in some of the filaments or fibres is out of phase with the curl in other filaments or fibres in the yarn.

9. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling staple fibres, thereafter forming a polymerization or condensation product within the staple fibres, and subjecting yarn containing the staple fibres to a drawing operation whereby the curl in some of the fibres is caused to be out of phase with the curl in other fibres in the yarn.

10. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling continuous filaments, thereafter forming a resinous polymerization or condensation product within the filaments, and converting yarn containing the filaments to staple fibre yarn whereby the curl in some of the filaments in the staple fibre yarn is caused to be out of phase with the curl in other filaments of said yarn.

11. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling continuous filaments, thereafter forming a resinous polymerization or condensation product within the filaments, and converting yarn containing the filaments to staple fibre yarn while retaining the continuity of the yarn whereby the curl in some of the filaments in the staple fibre yarn is caused to be out of phase with the curl in other filaments of said yarn.

12. Process for the production of improved yarns displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments or fibres, thereafter forming a resinous polymerization or condensation product within the filaments or fibres, and breaking up the crimp or

crinkle in yarn containing the filaments or fibres by changing the degree of twist in the yarn.

13. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments fibres, yarns and like materials, treating the crimped or crinkled materials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter forming a water-insoluble polymerization or condensation product within the materials.

14. Process for the production of improved filaments, fibres, yarns and like materials displaying a crimped or crinkled effect, which comprises crimping or crinkling filaments, fibres, yarns and like materials carrying reagents capable of polymerization or condensation to form a water-insoluble product, treating the crimped or crinkled materials to cause the curl in some of the filaments or fibres thereof to be out of phase with the curl in other filaments or fibres thereof, and thereafter polymerizing or condensing the reagents.

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