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METHOD OF MANUFACTURING ARTIFICIAL FILAMENTS

Original Filed May 13, 1943

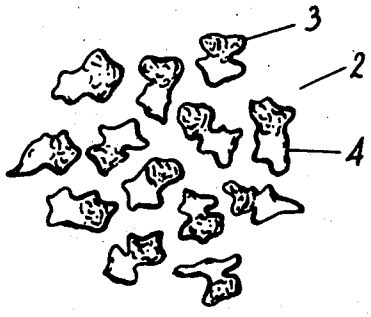


Fig-1-

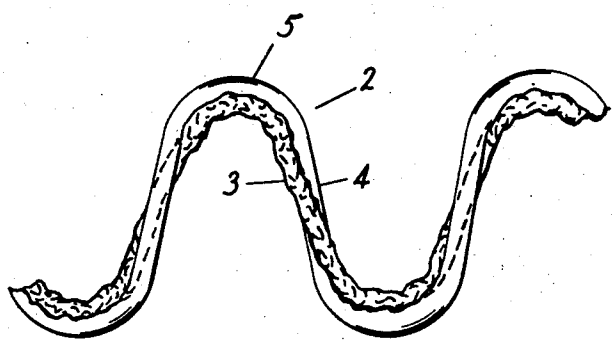


Fig-2-

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METHOD OF MANUFACTURING ARTIFICIAL FILAMENTS

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8 Claims. (Cl. 18—54)

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This invention relates to processes for the production of novel filaments of composite character, and particularly to filaments of this character having a substantially permanent crimp. This application is a division of Serial No. 486,773, filed May 13, 1943, now Patent No. 2,439,814, April 20, 1948.

In accordance with this invention, two or more different spinning materials are spun into filaments in such a manner that the individual filaments comprise two or more longitudinal sections joined in side by side relationship. This, in its most elementary aspect, may be accomplished by arranging an orifice in one spinneret in close juxtaposition to that in another, feeding the different spinning materials to them and withdrawing the single filament produced by the conversion to a plastic condition in the setting medium of the single-liquid stream resulting from the joining of the two streams of material issuing from the orifices. By similarly arranging in proximity three or more orifices in a corresponding number of spinnerets which may be fed a corresponding number of different spinning materials, a correspondingly more complex conjugate filament results. Other arrangements may be utilized to produce the filaments, it being necessary only that the separate streams of the different spinning materials be united at the point of entrance into the setting or coagulating medium, or shortly before or after reaching this point.

In accordance with one such arrangement shown in the application of Kulp et al., Serial No. 486,774, filed May 13, 1943, now Patent 2,386,173, two or more filament-forming materials of different properties, in a fused or plasticized state or in the form of solutions thereof, are extruded in separate or only partially intermingled phases through a common orifice or a plurality thereof, where they are joined together in eccentric or side by side relation, into a setting medium which may be either gaseous or liquid and may function either by a cooling, precipitating or evaporative effect to produce or form unitary filaments in each of which the different materials form separate portions of the body of the filament.

A certain amount of mixing is permissible provided only that the mixing does not become so great as to render the final filament homogeneous in cross-section. Preferably, mixing between the two streams of filament-forming material occurs at the boundary of the juncture to the extent needed to obtain a strong bond in the final filaments.

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Any of the filament-forming materials or solutions including viscoses, proteins, such as caseins and soya bean proteins, cellulose derivatives such as cellulose acetate and ethyl celluloses, and resins such as nylons, the vinyl resins, especially the copolymers of vinyl chloride and vinyl acetate and the vinylidene halides, may be employed. When different cellulose xanthates or viscoses are used, they may differ as to either age, cellulose content, sodium hydroxide content, carbon disulphide content, as to the type of cellulose from which they are made, such as wood pulp or cotton pulp, or as to any two or more of these factors. When other cellulose derivatives, such as the esters, or ethers are used they or their solutions may differ as to viscosity, cellulose content, or as to degree of polymerization or substitution of the cellulose chains therein. When resin solutions are used, the solutions may differ as to kind of resin, viscosity, and the degree of polymerization of the resin. Two spinning materials of different classes may be combined, such as a protein with a viscose, a protein with a cellulose acetate, or a cellulose acetate with a vinyl resin. It is only necessary that the materials in the form employed (fused or in solution) do not mutually precipitate each other and that they adhere together in the final filaments.

The filaments may be extruded into either a liquid or gaseous setting or precipitating medium depending upon the solutions that are used. For instance, viscose solutions may be extruded into an acid precipitating bath and other cellulose derivatives and resins or their solutions may be extruded into either a liquid or a gaseous medium.

After production of the filaments by the conversion of the joined liquid streams to a plastic conditioning during their passage from the orifices through the setting medium, they are subjected to an after-stretch while plasticized or not, thereafter relaxed in a plasticized condition and the plasticizer is removed while in relaxed condition to set the crimp therein. The plasticizer employed depends on the materials of which the filaments are composed. Water, whether hot or cold, is adequate for regenerated cellulose. Heat or swelling agents may be employed with thermoplastics such as the cellulose esters and ethers, vinyl resins, nylons, and the like. One particularly advantageous method of producing crimped filaments from thermoplas-

tic components is to use two such components which have different shrinkage temperatures or which have different shrinkage characteristics at a given temperature. Merely by subjecting the final composite filaments of such character to the given temperature, a differential shrinkage occurs, one component of the filament either not shrinking at all or much less than the other with the result of a substantially permanent crimp therein. This is specifically claimed in my copending application Serial No. 586,451, filed April 2, 1945, now Patent No. 2,439,815, April 20, 1948.

Figure 1 shows the filaments in cross-section, and Figure 2 shows the crimpiness of the filaments.

While the description which follows hereinafter more completely illustrates the invention as applied to composite regenerated cellulose filaments, it is to be understood that it is applicable generally to filaments of any component materials, at least one of the components of which is plasticizable. Generally stated, the process of the invention comprises stretching the composite filament while plasticized or while at least one of its components is plasticized, subsequently relaxing and, if not already at least partially plasticized, plasticizing at least one or more or all of the components of the filament, and then restoring the filament to unplasticized condition while maintaining it under relaxation.

When viscose solutions are spun, any conventional spinning arrangement may be used for coagulating, collecting and wet-processing the filaments. For example, the filaments proceeding from the coagulating bath may be guided by a series of godets or rotating guides to a collecting device in the form of a bobbin, spinning bucket, or a twisting device. If desired, a certain amount of stretch may be imparted to the filaments as they proceed between one or more pairs of the godets by virtue of differences in linear peripheral speeds thereof. The collected filament package is subjected to the conventional wet-processing treatments, such as washing, desulfurizing, bleaching, soaping, dressing, and finally drying. Alternatively, the filaments may be made by a continuous process in which they travel continuously, such as in the form of helices, through subsequent liquid-treating baths directly from the coagulating or the stretching bath if the latter is used, in which arrangement, the filaments as finally collected are in a dry condition.

In accordance with my invention, the composite filaments are subjected to an after-stretching which may be performed, in the case of regenerated cellulose filaments, while the filaments are still in a wet or plasticized condition as they come from any stage of the liquid processes to which the artificial filaments are subjected, generally without drying, after formation or production by spinning into the setting medium. The after-stretching may be performed upon the filaments after the final drying stage of after-treatment. The after-stretching may then be performed on the dry filaments, but preferably, the filaments are wetted before being subjected to the after-stretching procedure. The stretching should be sufficient to go beyond the elastic limit of at least one component (and preferably beyond that of all components if this is possible without rupture) of the filaments under the conditions of the stretching (that is, the elastic limit for the wet or the dry condition). In terms of the percentage elongation, a stretch of from about

20 to 50% and preferably of 35 to 50% of the original length is generally suitable. In any event, the percentage of stretching that can be imparted to the filaments depends upon the extensibilities of the component portions of the individual filaments, that component having the lower extensibility controlling the limit of elongation before rupture.

After the stretching, the filaments are allowed to relax while wet or plastic and to dry in the relaxed condition. If the after-stretching is performed on the dry filaments, they are wetted and relaxed and allowed to dry while in the relaxed condition.

The after-stretching procedure, whether performed wet or dry, imparts a decided crimp of substantially permanent character to the filaments. When the filaments before being subjected to after-stretching already posses a crimp, it is markedly improved by the after-stretching procedure. Generally, a much greater improvement in crimp or degree of crimpiness is obtained by performing the after-stretching while the filaments are wet.

The difference in viscoses that can be used may be comprised of any one or more of several factors including the type of pulp (whether cotton or wood), salt test (old or young), percentage sodium hydroxide, percentage cellulose, percentage carbon disulfide, percentage sulfite, viscosity, surface tension, as well as the presence or absence of pigments, delustrants, and so forth. For the purposes of obtaining a crimp, differences in the viscoses which manifest themselves in differences in shrinkage in the final product are of the greatest importance. To obtain a crimp, it is sufficient to utilize viscoses made of different pulp, especially of wood pulp with cotton pulp; viscoses of different salt tests or ages, different percentages of cellulose, different percentages of carbon disulfide, different amounts of sulfite and the like. The two viscoses used may differ not only as to type of pulp but also as to salt test and/or as to any one or more of the other factors specified. By taking into consideration the differences in shrinkage characteristics of any two viscoses, it is possible to combine predetermined qualities into the two components of the filaments and obtain any desired crimpiness in the product ranging from 5 to 50 or more crimps per inch. Thus, by combining a viscose which shows relatively little shrinkage when subjected to the conditions under which the processing of the composite filaments is to be performed with a viscose having a high degree of shrinkage under such conditions, an extremely crimpy filament is obtained. Conversely, if the shrinkage characteristics of the two component viscoses are very little different when subjected to the processing conditions as individual filaments, composite filaments made of such a pair of viscoses would show relatively little crimping. Thus, simply by the selection of the two viscoses from which the composite filaments are to be produced, any desired predetermined crimpiness can be obtained in the final composite filament. This makes it possible to produce "tailor-made" continuous filaments and staple fibers.

Referring to Figures 1 and 2 of the drawing in which views are shown of filaments made in accordance with the invention, reference character 2 indicates a filament generally and reference characters 3 and 4 indicate the component portions of the filament which are constituted of different materials. In Figure 2 of the draw-

ing in which the crimp of the filament is shown, reference character 5 indicates one bend of the crimp. Reference character 4 indicates the portion of the filament that is made of the material having the lesser tendency to shrink or less recovery and reference character 3 indicates the portion of the filament that is made of the material having the greater shrinkage tendency or greater elastic recovery. The portion 4 being, in effect, shrunk less than portion 3, portion 4 is of greater length and forms the outside of the bends of the crimp and portion 3 forms the inside of the bends of the crimp. It is to be understood that the crimp is actually of a three-dimensional character (that is, the crimps extend or lie at random in three dimensions) and that Figure 2 shows the filament in a single plane.

The individual filaments produced in accordance with this invention have a unitary structure having a cross-section at all points of the filament length which comprises two or more substantially distinct areas each of which has a different composition or state of physical aggregation than that of the others and at least one of which is eccentrically disposed with respect to the filament cross-section. The components of the composite fibers exhibit therein differences in shrinkage, swelling, extensibilities, strength, orientations, dye absorptions, chemical reactivity, crenulation, and they show different skin thicknesses which is readily observable as a differential dye absorption phenomenon when they are stained with certain dyes.

The crimped filament takes the form of a regular or irregular helical coil which may reverse itself in direction at more or less frequent intervals of regular or irregular occurrence, the eccentric components of the filament following a helical path about the longitudinal axis of the filaments, which path may reverse itself at more or less frequent irregular or regular intervals. Thus, a three-dimensional crimp with the crimps out of phase is present in the composite filaments.

The individual composite filaments produced in accordance with this invention in their state of normalcy are characterized by a stabilized condition having an inherent distortion which imparts a permanently recoverable crimp. The only condition under which it loses its crimp, and in this case the loss is temporary, is that prevailing when the crimped filament is wetted and caused to dry while under a tension. It can be repeatedly wet and dried without an appreciable loss in crimpiness as long as it is permitted to dry in a relaxed condition. If dried under tension, the crimp can be recovered merely by wetting and drying while relaxed.

No completely satisfactory tests have been devised to evaluate the degree of permanency of a crimp. However, the crimped composite filaments of this invention have been found to possess a "crimp retentivity" ranging from about 60% up to a value approaching 100% when tested in accordance with the procedure outlined in the Hardy et al. Patent 2,287,099, issued June 23, 1942. Individual filaments when subjected to that test, not merely after a single immersion but after as many as 20 or more immersions, have been found to show crimp retentivities as high as substantially 100% and relatively few of the filaments made in accordance with this invention have been found to have crimp retentivities as low as 60%. The crimp retentivity test as outlined in Patent 2,287,099 is performed in water at 60° C. It has been found that for the composite filaments of this invention, crimp retentivity is fully as high when cold or boiling water is used in the test. Thus, the composite filaments of the present invention show a corresponding excellence (that is from about 60 to 100%) when measured by the "crimp recovery from stretch" test outlined in the above mentioned Patent 2,287,099.

Thus, the composite filaments and staple fibers of the present invention do not appreciably lose their crimp during the ordinary conditions of wear in either of which temperatures ranging from the neighborhood of the freezing point and the boiling point of water are encountered. Fabricated products made from these filaments and fibers thus have properties which may be made to approach those of natural wool in some respects.

While it is preferred that the unitary filaments comprise approximately equal portions of the different types of material, various proportions of the different types of spinning solutions may be used by adjusting the pumps to control the proportionate amounts of the different types of spinning material that are delivered to form a single filament.

It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A method of making artificial filaments comprising extruding into a setting medium at least two differing liquid spinning materials, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament stretching the composite filaments in plastic condition at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components, relaxing them, and bringing them into unplasticized condition while retaining them in relaxed condition.

2. A method of making artificial filaments comprising extruding into a setting medium at least two differing liquid spinning materials, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, stretching the composite filaments at some stage after conversion by the setting medium to plastic

condition beyond the elastic limit of at least one of their components, plasticizing them, relaxing them, and restoring them to unplasticized condition while retaining them in relaxed condition.

3. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing liquid cellulosic spinning materials, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, stretching the composite filaments at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components, relaxing the filaments and wetting them.

4. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing viscose spinning solutions, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, stretching the composite filaments at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components, relaxing the filaments, wetting them and drying them while in relaxed condition.

5. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing viscose spinning solutions, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, stretching the composite filaments at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components while wet, relaxing the stretched wet filaments, and drying them in relaxed condition.

6. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing viscose spinning solutions, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, at least one of the components being derived from a viscose made from cotton and at least one other being derived from a viscose made from wood pulp, stretching the composite filaments at some stage after conversion by the setting machine to plastic condition beyond the elastic limit of at least one of their components while wet, relaxing the stretched wet filaments, and drying them in relaxed condition.

7. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing viscose spinning solutions, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, at least one of the components being derived from a viscose having a higher carbon disulfide content than that from which at least one other component is derived, stretching the composite filaments at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components while wet, relaxing the stretched wet filaments, and drying them in relaxed condition.

8. A method of making artificial filaments comprising extruding into a cellulose regenerating setting medium at least two differing viscose spinning solutions, capable of imparting different shrinkage characteristics to equally stretched filaments thereof, simultaneously in side-by-side relation through each of a plurality of orifices, passing the materials from the orifices side-by-side through the setting medium to convert them from a liquid to a plastic condition to form a plurality of unitary filaments each having at least two eccentrically arranged components of regenerated cellulose joined side-by-side the entire length of the filament by intermingled portions of the materials making up the adjoining components and disposed with a portion of the

peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament, at least one of the components being derived from a viscose of greater ripeness than that from which at least one other component is derived, stretching the composite filaments at some stage after conversion by the setting medium to plastic condition beyond the elastic limit of at least one of their components while wet, relaxing the stretched wet filaments, and drying them in relaxed condition.

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