April 22, 1941. W. T. JACKSON ET AL 2,238,977

PRODUCTION OF CELLULOSE DERIVATIVE CUT STAPLE FIBERS

Filed Sept. 16, 1937

FIG. 1

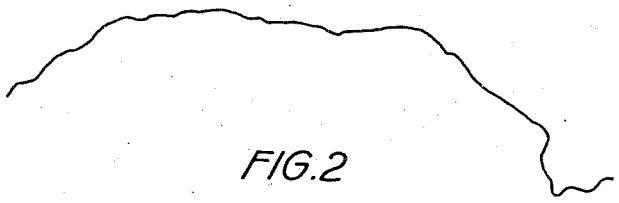


FIG. 2



FIG. 3

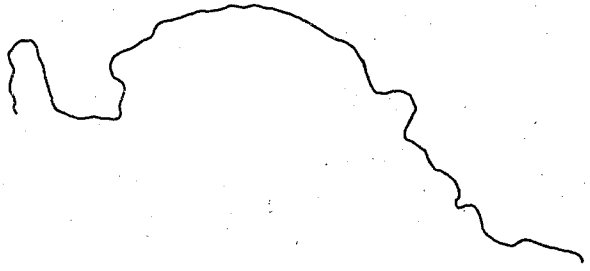


FIG. 4



FIG. 5



FIG. 6



Wallace T. Jackson
Henry R. Childs
INVENTORS
N. M. Perrins
BY Daniel J. Mayne
ATTORNEYS

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PRODUCTION OF CELLULOSE DERIVATIVE CUT STAPLE FIBERS

Wallace T. Jackson and Henry R. Childs, Kingsport, Tenn., assignors to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

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11 Claims. (Cl. 18—54)

This invention relates to cellulose derivative cut staple fibers and to the production thereof, and more particularly to the production of crimped cut staples having an appearance closely simulating natural wool.

This application is in part a continuation of our application, Serial No. 114,078, filed December 3, 1936.

As is well-known, synthetic filaments or fibers produced from cellulose derivatives, particularly cellulose organic derivatives such as cellulose acetate, cellulose acetate propionate, the cellulose ethers and others, have a smooth exterior surface. Natural wool fibers, on the other hand (and cotton fibers to a lesser degree) are characterized by irregularity of surface formation and cross-section and a natural kinkiness which gives them their characteristic woolly appearance and feel and a high degree of resiliency. This kinkiness or wooliness renders such fibers especially well adapted for the manufacture of various types of yarns and fabrics, especially those which are subjected to hard wear, because of the fact that it enables them to be readily spun into strong threads by virtue of the interlocking of the individual fibers. As indicated, synthetic fibers are ordinarily lacking in this natural wooliness or kinkiness and therefore, as ordinarily produced, are inherently unadapted for the same uses to which natural wool and cotton fibers can readily be applied.

Workers in the synthetic silk industry, recognizing these inherent defects of synthetic materials, have made numerous but unsuccessful attempts to simulate natural wool fibers, but none of the expedients thus far suggested have resulted in a practical, satisfactory wool substitute. The prior art contains numerous references to "artificial wool or cotton," "wool-like fibers," "staple fibers having a crinkled cotton-like structure," "wool substitute," and the like, but the fact remains that the art does not disclose, nor has anyone, until the advent of the present invention come forward with, synthetic staple which actually simulates natural wool and is capable of being spun or woven into fabrics closely resembling fabrics produced from the natural product.

It is noteworthy that practically all of the methods thus far suggested for the production of synthetic staples had been based, either upon the principle of subjecting the fibers to drastic external physical modification, as by cutting under tension, molding and then cutting, stretching, pressing, and the like or upon the principle of applying to fibers externally a chemical crimping agent or bath. In other words, all of the prior art methods have been based upon the idea of treating the fibers externally as distinguished from the method more fully set forth hereinafter.

The principal object of the present invention is to provide a process of producing a wholly new and improved type of cellulose derivative cut staple fiber of irregularly rounded cross-section closely resembling natural wool in appearance and in its ability to be spun into yarn and woven into fabrics closely resembling fabrics produced from natural wool. A further object is to provide a process whereby cellulose organic derivative filaments, particularly those produced from cellulose acetate may be converted into a form closely simulating natural wool fibers. A still further object is to provide a process of making cellulose organic derivative filaments of such character as to be readily convertible into a kinky or wool-like condition. Another and more specific object is to provide a new type of wool substitute in which the individual fibers are characterized by a unique external configuration and unique physical and chemical properties, particularly a high degree of resiliency and the ability to retain their resiliency, natural luster and characteristic wool-like condition, even when subjected to repeated scouring in hot aqueous baths. A further specific object is to provide a new and improved type of spun yarn suitable for a wide variety of purposes, including knitting, weaving and the like, and particularly adapted for the manufacture of suitings, blankets and many other textile materials. A still further specific object is to provide a new type of fabric characterized by the presence therein, in whole or in part, of a new and improved type of synthetic wool staple yarn herein described. Other objects will appear hereinafter.

These objects are accomplished by the following invention, which, in its broader aspects, comprises incorporating in the cellulose derivative solution or dope from which the filaments are to be spun, a crimping, crinkling, or kinking agent which gives the filaments the property of becoming crimped, kinky or wool-like in appearance when they are subsequently treated with a non-solvent for the cellulose derivative filament material at a moderately elevated temperature; spinning the dope into filaments in the usual manner, cutting the filaments into staple lengths and subjecting the cut staple to the action of a non-solvent in liquid or vapor form at a temperature of about 100° C. or over. The fibers even when subjected to this rather drastic treatment,

do not, under the conditions of operation described herein, appreciably lose their characteristic luster or strength.

In the accompanying drawing, constituting a part hereof, Figs. 1, 2, and 3 depict three different filaments (upon an enlarged scale) of wool-like cut staple filaments selected at random from a batch made in accordance with our invention.

Figs. 4, 5, and 6 illustrate cross-sections of typical filaments also selected at random from a batch of the same type of filaments as illustrated in Figs. 1, 2, and 3.

We have found that a rather wide range of substances may be employed as the crimping or crinkling agent in accordance with our invention. We have found it somewhat difficult to define the exact physical properties of those compounds which we define as crimping or crinkling agents. Apparently there is some unusual relationship between the cellulose organic derivatives and certain compounds which may be incorporated therein which causes crinkling, upon subsequent treatment of the fibers as herein defined. Obviously the agent must cause crinkling but not with any substantial delustering or weakening of the fiber. We have demonstrated that another characteristic of the crinkling agent is the fact that the subsequent non-solvent treatment does not remove the crinkling agent from the fiber, although a substantial percentage of the agent normally is removed. The crinkling agent must, of course, be substantially compatible with the cellulose organic derivative; we have found that the agent may fall under the classification of a solvent, semi-solvent, plasticizer or merely a conditioning component for the cellulose organic derivative. To be considered a crinkling agent within the scope of this application, the agent must be capable of producing greater than about 10 crimps per inch in the cellulose organic derivative fiber as we do not regard a fiber with a lesser number of crimps per inch as simulating wool in appearance. Among the many compounds which we have found eminently satisfactory as crinkling agents are high boiling plasticizers such as glycerol tripropionate, glycerol tributyrate, dimethyl phthalate, dibutyl phthalate, dibutyl tartrate and mixtures of these plasticizers, such for example, as a mixture of ortho- and paratoluene ethyl sulfonamides, sold under the trade name "Santicizer 8." Ethyl phthalyl ethyl glycollate, sold under the trade name "Santicizer E–15," has also been found to be satisfactory. While any of the aforementioned plasticizers may be successfully employed in connection with cellulose acetate and other cellulose organic derivative filaments, we prefer the use of glycerol tributyrate as this compound appears to be outstanding in its ability to bring about the above-mentioned crimping action under the conditions of our process.

In addition to compounds which are generally regarded specifically as plasticizers, we have found that certain other agents which may be regarded as solvents or semi-solvents for cellulose acetate and other cellulose organic derivatives give highly satisfactory results as crimping and crinkling agents when employed in accordance with our invention. Among those we may mention those aliphatic ketones having a boiling point of over approximately 100° C., such as diethyl ketone, dipropyl ketone, diamyl ketone, methyl isopropyl ketone, methyl isobutyl ketone, methyl ethyl ketone, methyl amyl ketone, and diacetone alcohol. In addition to these ketonic compounds, we have found that methyl cellosolve (the monomethyl ether of ethylene glycol) and carbitol acetate (the acetate of diethylene glycol monoethyl ether) may be used.

So far as the production of the yarn itself is concerned, it may be made according to standard acetate yarn practice. For example, we may employ a process broadly similar to that disclosed in the Stone U. S. Patent 2,000,047 or the Stone U. S. Patent 2,000,048. In such a process a cellulose acetate spinning dope of suitable composition may be prepared in accordance with known technique. Preferably the dope is a triple filtered bright luster dope to which a crimping agent has been added in an amount corresponding to 1 to 15% on the dry weight of the cellulose acetate. The dope is then extruded through a spinneret having the type of extrusion orifices to give filaments of the proper denier. For example, if a 10 denier filament is desired, a spinneret having extrusion orifices of .1 mm. in diameter will be suitable. The dope passes through a candle filter heated to about 69° C. and is extruded downwardly, the filaments being carried through a body of evaporative medium such as air which passes countercurrently to the filaments and upwardly through the spinning cabinet. The air temperature may vary as desired, an appropriate temperature in the cabinet being represented by an inlet temperature of somewhere in the neighborhood of 100 to 110° C. and an outlet temperature of about 78° C. The air may pass through the cabinet, which may range in length from 10 to 20 feet in height, the air passing out of the cabinet at a point somewhere about ⅓ of the way from the top as disclosed in the above-mentioned Stone patents, at a speed corresponding to about 23 cubic feet per minute.

Due to the fact that the agents which we prefer to employ in our invention have relatively high boiling points, that is, above 100° C., the yarn emerges from the spinning cabinet carrying the main body of the agent entrained therein. The filaments, either before or after they leave the cabinet may, if desired to facilitate winding, be subjected to a lubricating treatment. This may be done by conducting the yarn as it emerges from the cabinet through a bath of the lubricant or in contact with an applicator roll dipping in a lubricant bath. The yarn may then be wound on bobbins and stored for future treatment or it may pass directly to the stapling operation. In either case, a plurality of yarn strands or threads are warped together to form a high denier roving of a convenient size, for example, a roving of 1,000,000 denier, this being passed to a stapling machine where the filaments are cut to the desired length. In making so-called short wool type staple we may employ three denier filaments and cut to a staple length of 2½–4 inches, while in making the long wool type staple we may employ 5–20 or even 25 denier filaments and cut from 4–7 inches. These figures are of course merely illustrative as we may employ filaments of a greater or less denier and cut to other lengths, this depending upon the particular type of product required.

At this point, it may be well to state that, although the more important aspect of our invention is the production of wool type cellulose derivative staple, nevertheless the broad scope of our invention includes the production of a type of staple somewhat resembling natural cotton fibers, particularly as regards its ability to be spun into yarn on the cotton system. Broadly

considered, the cotton type staple produced in accordance with our process differs from the wool type only in a matter of staple length, the cotton type staple being cut to a length of 1–1¾ inches as compared to a length of 2½–7 or more inches for the wool type staple.

After the cutting operation the staple yarn is preferably, although not necessarily, subjected to a mechanical opening treatment, such as by subjecting it to a blast of air or mechanically equivalent treatment.

This mechanical opening treatment is desirable for the reason that it permits the crinkling action upon each cut filament to take place with greater facility and furthermore permits us to further dry the cut filaments to remove the residual acetone (some 5 to 10% being contained therein) from the filaments. This further drying is accomplished by merely conducting the opened filaments through a tunnel dryer by means of a conveyor, the dryer being heated to approximately 105° C. at the hottest point, the hot air being conducted slowly through the dryer countercurrent to the movement of the fibers. The cut staple is then subjected to the crimping operation per se which consists in subjecting it to the action of a boiling or hot vaporous non-solvent bath. The bath is preferably first brought to a temperature of approximately 95 to 105° C. and the staple is immersed into it in such amount that there will be present enough non-solvent to easily wet the staple. The material is allowed to remain in the bath for a sufficient length of time to bring out the crimping effect which, under ordinary circumstances, is about 5 to 30 minutes. During the non-solvent treatment a considerable proportion of the crimping agent originally incorporated in the dope is removed from the staple and, in some manner, the explanation of which is not entirely clear, the simultaneous action of the crimping agent and the hot non-solvent result in imparting a pronounced crimp to each of the individual fibers. Although a rather wide range of non-solvents may be employed in or as the crimping bath, we prefer to employ compounds characterized by the presence therein of one or more hydroxyl groups, which compounds, although generally to be regarded as non-solvents, nevertheless presumably have a latent solvent or softening action on the cellulose derivative material of the filaments. In general, mono- or polyhydric alcohols are suitable. Examples of compounds of this nature which we have found particularly satisfactory for the purposes of our invention are glycerol, diethylene glycol, amyl alcohol and water.

The staple may then be removed from the crimping bath and treated to give it antistatic properties by immersion in a suitable antistatic bath. Such baths and the methods of using them are described and claimed in the copending application of W. T. Jackson and W. G. Faw, Serial No. 114,077, filed December 3, 1936 and corresponding to U. S. Patent 2,197,930 and the application of J. R. Caldwell, Serial No. 114,085, filed December 3, 1936. The staple after removal from the antistatic bath is dried by any suitable means such as a current of moderately warm air and is then ready for working up on the usual textile machines.

The crimp imparted to the staple by the above described process gives it a decided woolly appearance and feel. Not only does the product bear a striking resemblance to natural wool in appearance and feel, but also possesses to a high degree the resiliency and kinkiness peculiar to wool fibers. It should also be noted that the crimp or kinkiness and resiliency of fibers produced in accordance with our invention is permanent and is not subsequently lost in further processing of the staple or the spun yarns and fabrics produced therefrom for the reason that cellulose organic derivatives have high tensile strength at atmospheric temperatures and do not lose their resiliency until a temperature is reached which causes the cellulose organic derivative to flow, due to its thermoplasticity. At the same time this thermoplasticity is of value in that fabrics, such as suitings, made from or containing our improved fibers can be pressed with a hot iron and, because of the thermoplasticity of the cellulose organic derivative, cause a crease to be taken by the cloth much more readily and permanently than natural wool. At the same time the resistance of the cellulose organic derivative fiber to deformation at atmospheric temperature contributes to the fabric an ability to resist mussing or wrinkling to even a greater extent than natural wool fabrics.

Another feature of our staple filaments and one which additionally distinguishes them from any other products of the prior art is the fact that they have a characteristic irregularly rounded, or "potato-shaped" cross-section. Reference to Figs. 4, 5, and 6 of the drawing illustrating cross-sections of typical crimped staple filaments produced in accordance with our invention will clearly show that the cross-section of each filament is distinguished by the presence of a plurality of rounded cusps projecting from the more or less round main body structure of the filaments. It will thus be clear that the crinkled or crimped appearance of the filaments of our invention is not due to any effect such as that obtained when flattened or ribbon-like filaments are twisted or otherwise mechanically distorted.

As will be evident from a consideration of Figs. 1, 2, and 3 of the accompanying drawing, it is a further characteristic of the staple fibers of our invention that they have, normally, considerably more than 10 kinks per inch, and on the average more than 20 kinks per inch, many fibers produced by our invention having as many as 30 to 40 or even more kinks per inch. It will be observed that these kinks do not occur in one plane—which is a very useful characteristic of such fibers. The kinks per inch are easily counted by inspecting the fiber under a microscope with a black background, by the use of a one inch field. The kinks per inch in several fibers (say ten) are counted and the average taken as representative of the number of kinks per inch of the fibers in that batch. Because of the high resistance of these fibers to deformation, the resistance of the fiber to loss of kink when a fiber is placed under tension is quite remarkable, i. e. when a single fiber is placed under tension, the tension must be quite high—relatively—before there is appreciable loss of kink and permanent straightening of the fiber. When our new fibers are made into a roving and the roving drawn into a yarn, the yarn—for the above reasons—has a tensile strength in excess of that of natural wool yarn.

The crimped cut staple fibers herein described are identical in all respects with the material referred to in our co-pending application Serial No. 114,078, filed December 3, 1936, of which the present application is in part a continuation.

Our invention will be more fully understood

by reference to the following examples and description in which we have set forth several of the preferred embodiments of our invention which are included merely for purposes of illustration and not as a limitation thereof.

Example I.—A cellulose acetate spinning dope was prepared containing 26.07% cellulose acetate, 64.63% acetone, 6.68% water, and 2.62% (representing 10% based on the weight of the cellulose acetate) of dipropyl ketone (boiling point 144° C.). This dope after triple filtration was passed to a candle filter maintained at a temperature of 69° C. and thence through a spinneret having extrusion orifices of about .1 mm. in diameter and mounted in a spinning cabinet of about 20 feet in height, of the type referred to in Stone U. S. Patent 2,000,048. The filaments were spun downwardly at a linear speed of about 330 feet per minute, the filaments passing countercurrently to a body of heated air passing through the cabinet at a speed of approximately 23 cubic feet per minute, the air inlet temperature being about 110° C. and the air outlet temperature being about 78° C. The draft (peripheral roll velocity divided by the linear velocity of extrusion) was 1.5. These spinning conditions give an 8 denier filament.

The filaments emerging from several cabinets operated as above described were lubricated by application thereto of an antistatic lubricant composed of a mixture of mineral oil and the diethyl cyclohexylamine salt of a sulfated higher fatty alcohol and warped into a roving of about 1,000,000 denier, this being done by feeding the filaments from a plurality of spinning cabinets to a converging point where the roving is formed, the filaments in the roving being in substantially parallel relationship to one another. This roving was then fed to a stapling machine of standard construction and cut into staple lengths of 3 to 4 inches after which the cut material was opened by means of pickers and further dried. The staple was then entered into a bath of boiling water in such amount as to have present in the bath one part by weight of staple to about 30 parts by weight of water and boiled for 5 to 30 minutes (depending on the extent of crimping desired), removed, centrifuged, and dried in a current of warm air maintained at a temperature of about 95° C.

The resulting product was a cut staple having a high degree of crimp or kinkiness and resiliency, an irregularly rounded, "potato-shaped" cross-section and closely resembling natural wool in appearance and physical properties. The individual staples possessed a high degree of luster, notwithstanding the fact that they had been exposed to the action of boiling water which would ordinarily be expected to bring about marked delustering. About twenty crimps per inch were found to have been imparted to the staples.

Example II.—The same procedure as that of Example I was followed, except that the spinning dope contained 7%, based on the weight of the cellulose acetate, of methyl amyl ketone. As in Example I, a product having a pronounced crimp and resiliency, an irregularly rounded cross-section and closely simulating natural wool was produced.

Example III.—A cut staple cellulose acetate yarn closely resembling natural wool was produced by following the procedure of Example I, except that 8%, based on the weight of the cellulose acetate, of diacetone alcohol was added to the spinning dope prior to extrusion of the filaments. A crimped wool-like product was produced.

Example IV.—The procedure of Example I was employed to produce a crimped cut staple, except that about 10%, based on the weight of the cellulose acetate, of diamyl ketone was employed in the spinning dope. As in the previous examples, a crimped, woolly product adapted for the manufacture of spun yarns was obtained.

Example V.—A spinning dope was prepared containing 27.3% by weight cellulose acetate propionate, 7% water and 65.7% acetone. Into this dope there was incorporated about 1.3% based on the dry weight of the cellulose acetate propionate of glycerol tributyrate. This dope after triple filtration was passed to a candle filter maintained at a temperature of 69–71° C. and thence through a spinneret having extrusion orifices of about .06–08 mm. in diameter and mounted in a spinning cabinet of about 20 ft. in height of the type referred to in the Stone Patent 2,000,048. The filaments were spun at a linear speed of about 300–600 ft. per minute, the filaments passing countercurrently to a body of heated air passing through the cabinet at a speed of approximately 20–23 cubic feet per minute, the air inlet temperature being about 105° C. and the outlet temperature being about 80° C. The draft was 1–1.7. These spinning conditions gave 9–5 denier filaments.

Yarn from a plurality of cabinets operated as described in the previous paragraph was fed directly to a rotary staple cutting machine and cut to a staple length of 5–7 inches. The cut staple fibers were then immersed in a crimp-inducing bath of boiling water and thereafter treated as described in Example I. As in the previous examples, the product was a crimped, cut staple of irregularly rounded, bulbous or "potato-shaped" cross-section closely resembling natural wool in appearance and physical properties. In this particular case there were about 25 to 30 crimps per inch imparted to the staple.

We may produce a cut staple having even a higher number of crimps per inch by employing a somewhat higher viscosity cellulose acetate than what is regarded as normal in the industry. By the use of such cellulose acetate and the use of glycerol tributyrate as the crimping agent we have been able to obtain under the approximate conditions set forth under Example V, cut staple having as many as 40 or even more crimps per inch.

While the foregoing examples have been based upon the use of substantially boiling water as the non-solvent for our process it has been pointed out elsewhere herein that other non-solvents may be employed. For instance, instead of water we may employ such non-solvents as glycerol, diethylene glycol, amyl alcohol and the like so long as they are non-solvents for the filaments at the temperatures employed, or at least do not have anything more than a latent solvent or softening action thereon.

In addition, instead of immersing the filaments in a non-solvent liquid we may vaporize the non-solvent liquid at a temperature of approximately 100° C. and cause the vapors to pass through the cut filaments until the desired crimping action is obtained.

Although we have found it convenient to illustrate our invention by reference to certain specific examples and to certain conditions of operation, it will be apparent that many modifications are possible within the scope of our invention. For

example, we may employ cellulose acetates, cellulose propionates, cellulose acetate propionates and other single or mixed organic acid esters of cellulose of varying degrees of acylation dissolved in varying solvent combination in making up the spinning dope. However, all of such solutions or dopes are, in accordance with our invention, characterized by the presence therein of a high boiling compound boiling at or above approximately 100° C.

The amount of the high boiling crimping compound may vary within rather wide limits, depending, not only upon the particular cellulose derivatives employed in the spinning dope, but also upon the degree and kind of crimping effect desired in the finished staple fiber. For example, when employing cellulose acetate or other cellulose organic derivative as the filament material, we may use as little as about 1%, based on the dry weight of the cellulose derivative material, of the crimping compound. On the other hand, we may employ as much as 25% or more of the crimping compound. As indicated in Example V, one of the most satisfactory compositions which we have employed for the manufacture of wool-type staple in accordance with our invention is one containing .36 part by weight of plasticizer to 27.3 parts by weight of cellulose acetate, representing about 1.3% of the plasticizer, based on the weight of the acetate.

The preferred range for most crimping agents is about 1 to 15%. In general, it may be said that the higher the concentration of the crimping agent in the filaments before treatment in the hot crimping bath, the more intense will be the crimping effect. However, the greater the amount of plasticizer the lower will be the tensile strength of the filaments, and it is therefore a question of balancing the maximum crimp desired against the minimum decrease in tensile strength permissible.

Likewise, the temperature of the spinning dope, speed of spinning, temperatures of the evaporative medium in the spinning cabinet, speed of the evaporative medium passing through the cabinet, draft and the like, may vary rather widely to meet varying conditions or to meet the requirements of particular types or denier of staple it is desired to produce. In producing the longer wool type staple it is desirable to employ a rather high denier yarn. Under such circumstances, the spinning speed will be relatively lower than the spinning speeds employed for the lower denier staples, and the various conditions of spinning such as air temperatures, air speed, draft and other factors will be adjusted accordingly.

As indicated above, we have succeeded in producing an entirely new type of cellulose derivative staple which, in its physical properties and appearance and its ability to be woven into spun yarn and employed in the manufacture of many different types of textile fabrics is absolutely unique. While we do not confine ourselves to any particular theory to explain the unusual results obtained by the process of our invention, it appears that the development of the characteristic configuration of the staple is due to the combined action of the high boiling crimping agent employed in the spinning dope and the action of the hot non-solvent thereon. It appears that, due to some action of the crimping agent on the cellulose derivative material, the explanation of which is not clearly understood, the filament material is brought into a condition in which the non-solvent causes it to crimp, crinkle or, in a sense, shrivel and assume the characteristic wool like condition. This crimping action may conceivably be due to a heterogeneous disposition of the agent in the cellulose derivable material which gives rise to some sort of micellar re-arrangement of the cellulose derivative material such that, under the influence of the hot non-solvent, certain strains are released, equalized or created throughout the body of the filament material. Whatever the explanation may be, the crimping action is exclusively induced by the presence in the interior of the filament of the crinkling rather than by exclusively external means. Although, according to our invention the crimping effect is finally induced by the application of an external agent, namely, the hot non-solvent, the desired results are obtained only by employing a high boiling compound as an ingredient of the spinning dope as set forth above. This clearly distinguishes our process from all of the prior art processes referred to above, which depend exclusively upon the external application of crimping agents of various kinds or upon the application of external molding, stretching or other mechanical forces to the surface of the fiber. It appears that inducing the crimping action from the interior of the fiber is the necessary condition for the production of a truly wool-like staple. In any event, the fact remains that until the advent of the present invention, the prior art has never brought forward a satisfactory wool substitute, nor so far as we are aware, has any satisfactory synthetic wool fabric been produced prior to our invention.

A further and definitely distinguishing characteristic of our invention is the fact that the resiliency, strength and luster of our staple fibers is substantially uneffected by treatment with hot water or other cellulose derivative non-solvent. Quite contrary to what would be expected by subjecting such plastic material as cellulose acetate, for example, to the action of hot water, no incipient precipitation with consequent delustering occurs and the fibers retain their original luster. In addition, the original strength and resiliency of the fibers is substantially preserved.

Another outstanding characteristic of the wool-like staple fibers produced in accordance with our invention is the fact that the crimping is permanent and is not removed, either in processing on the various types of textile machinery involved in the manufacture of spun yarns and the manufacture of such yarns into textile fabrics, or by repeated washing in aqueous scour baths. In fact, even after repeated scouring in relatively strong soap solution, our staple retains its original wool-like configuration, resiliency, brilliance and luster, and fabrics such as "wool" blankets and other fabrics produced from our material may be repeatedly washed and cleansed in accordance with standard laundering practice without shrinkage or other adverse effect thereon. Furthermore, the material is completely moth-proof, a feature which places fabrics produced from this type of staple definitely in a class by themselves.

It will be evident from a consideration of the properties of our new wool type staple that it is susceptible of a wide variety of uses. For example, it may be employed in the manufacture of spun yarns according to accepted standard practice and with standard machinery. As

a matter of fact, it is one of the outstanding characteristics of our product that it so nearly simulates natural wool that it may be processed in accordance with standard practice and without any alteration of conditions or equipment. However, we should point out that our product is in many respects outstandingly superior to natural raw wool, since it may be employed directly in the various processing operations and spun into yarn without the necessity of removing foreign substances which are always present in the natural product. As is well-known, in the processing of natural wool it loses in some instances anywhere from 15 to 30% or more of its weight in processing, this loss being represented by sticks, burrs, dirt, grease and other foreign substances, as well as the combing out of fibers having too short a length to be useful in the manufacture of yarns. The scouring of grease from wool requires large machines and considerable labor, adding to the cost of processing. De-burring operations require large machines or carbonizing. Either the mechanical or chemical de-burring operations add to the cost of processing natural wool. It will be readily understood that none of these inherent defects are present in the wool type staple of our invention.

Not only is it possible to obtain much higher yields of finished product when employing our wool type staple than is possible with the natural product, but we are enabled to definitely control the length of the various staples entering into a given yarn product. Whereas natural wool contains fibers varying in length, our product can be produced so that all of the staples are of substantially equal length and denier. However, and as is well-known it is desirable to employ a blend of different staples for the production of various types of spun yarn. For instance, it may be desired to use a mixture of short and long staples. In such a case, we may use a mixture of wool type staples varying in length all the way from about three inches to about seven inches or more. Due to the fact that we have direct control over the staple length, we can readily and exactly control the composition of a given blend. In general, if various denier staples are used, the best covering power is obtained if the smaller filaments are in the shorter lengths and the larger denier staples are in the longer lengths. By using a blend of the various lengths of staples and varying the filament denier it is easily possible to duplicate the real wool blends now commonly employed in the production of wool yarns.

The wool type cellulose derivative staples of our invention may, as indicated above, be employed in the manufacture of spun yarn and also yarns employed for ordinary knitting purposes. These spun yarns may be employed in the manufacture of suitings, blankets, and many other types of fabrics. One of the most important uses of our product is in the manufacture of mohair. In fact, our product may be employed as a substitute for all or part of the natural wool now employed in making this type of fabric.

Our wool type staple may also be employed in the manufacture of so-called mixed or composite yarns by mixing the wool type staple with cotton, silk, natural wool or other types of textile fibers and spinning in the usual manner. Yarns spun wholly or partly from our product may also be used in the manufacture of composite fabrics in which a cotton warp and a wool filling is employed or vice versa. All of the above types and combinations of yarns and fabrics are included within the scope of our invention. In using both the composite yarn and the type of cloth construction just referred to, numerous attractive cross-dyeing effects may be obtained.

It will thus be apparent that our invention represents an outstanding advance in the art of producing artificial textile materials, especially in that it enormously extends the field of application of cellulose organic derivative filaments. In fact, our work leads us to the conclusion that the wool type staple produced in accordance with our invention may be employed in practically all cases where natural wool fibers are now used. Not only is our material a practical substitute for natural wool, but in many respects it is vastly superior thereto, especially as regards its luster, brilliance, purity and other characteristics.

What we claim is:

1. The method of making crimped cellulose organic derivative cut staple fibers having a high resiliency and capable, when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool, which comprises forming filaments of irregularly rounded cross-section from a cellulose organic derivative dope containing a glycerol ester of an aliphatic acid having three to four carbon atoms, removing the solvent therefrom but substantially retaining the glycerol ester therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

2. The method of making crimped cellulose acetate cut staple fibers having a high resiliency and capable, when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool, which comprises forming filaments of irregularly rounded cross-section from a cellulose acetate dope containing a glycerol ester of an aliphatic acid having three to four carbon atoms, removing the solvent therefrom but substantially retaining the glycerol ester therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

3. The method of making crimped cellulose organic derivative cut staple fibers having a high resiliency and capable when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool, which comprises forming filaments of irregularly rounded cross-section from a cellulose organic derivative dope containing glycerol tributyrate, removing the solvent therefrom but substantially retaining the glycerol tributyrate therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

4. The method of making crimped cellulose acetate cut staple fibers having a high resiliency and capable, when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool, which comprises forming filaments of irregularly rounded cross-section from a cellulose acetate dope containing glycerol tributyrate, removing the solvent therefrom but substantially retaining the glycerol tributyrate therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

5. The method of making crimped cellulose organic derivative cut staple fibers having a high

resiliency and capable, when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool which comprises forming filaments of irregularly rounded cross-section from a cellulose organic derivative dope containing glycerol tripropionate, removing the solvent therefrom but retaining the glycerol tripropionate therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

6. The method of making crimped cellulose acetate cut staple fibers having a high resiliency and capable, when fabricated into textile products, of retaining their resiliency and crimp under normal conditions of use resembling that of natural wool which comprises forming filaments of irregularly rounded cross-section from a cellulose acetate dope containing glycerol tripropionate, removing the solvent therefrom but retaining the glycerol tripropionate therein, cutting the filaments into staple lengths and subjecting the cut staples to the action of boiling water.

7. Permanently crimped synthetic staple fibers of high resiliency consisting of relatively short filaments composed of a cellulose organic derivative containing a glycerol ester of an aliphatic acid having three to four carbon atoms, said filaments having more than ten crimps per inch of filament length and an irregularly rounded cross section and capable, when fabricated into textile products, of retaining their original resiliency under normal conditions of use.

8. Permanently crimped synthetic staple fibers of high resiliency consisting of relatively short filaments composed of a cellulose organic derivative containing tributyrin, said filaments having more than ten crimps per inch of filament length and an irregularly rounded cross section and capable, when fabricated into textile products, of retaining their original resiliency under normal conditions of use.

9. Permanently crimped synthetic staple fibers of high resiliency consisting of relatively short filaments composed of a cellulose organic derivative containing tripropionin, said filaments having more than ten crimps per inch of filament length and an irregularly rounded cross section and capable, when fabricated into textile products, of retaining their original resiliency under normal conditions of use.

10. Permanently crimped synthetic staple fibers of high resiliency consisting of relatively short filaments composed of cellulose acetate containing tributyrin, said filaments having more than ten crimps per inch of filament length and an irregularly rounded cross section and capable, when fabricated into textile products, of retaining their original resiliency under normal conditions of use.

11. Permanently crimped synthetic staple fibers of high resiliency consisting of relatively short filaments composed of cellulose acetate containing tripropionin, said filaments having more than ten crimps per inch of filament length and an irregularly rounded cross section and capable, when fabricated into textile products, of retaining their original resiliency under normal conditions of use.

WALLACE T. JACKSON.
HENRY R. CHILDS.