Oct. 14, 1941. H. R. CHILDS ET AL 2,259,150

PRODUCTION OF CRIMPED CELLULOSE DERIVATIVE STAPLE FIBERS

Filed Feb. 29, 1940 2 Sheets-Sheet 1

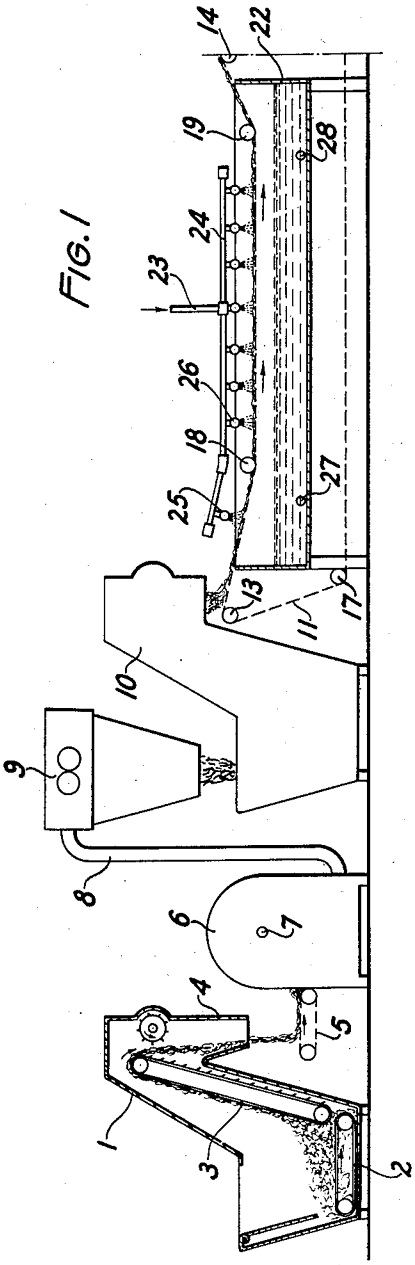
FIG. 1

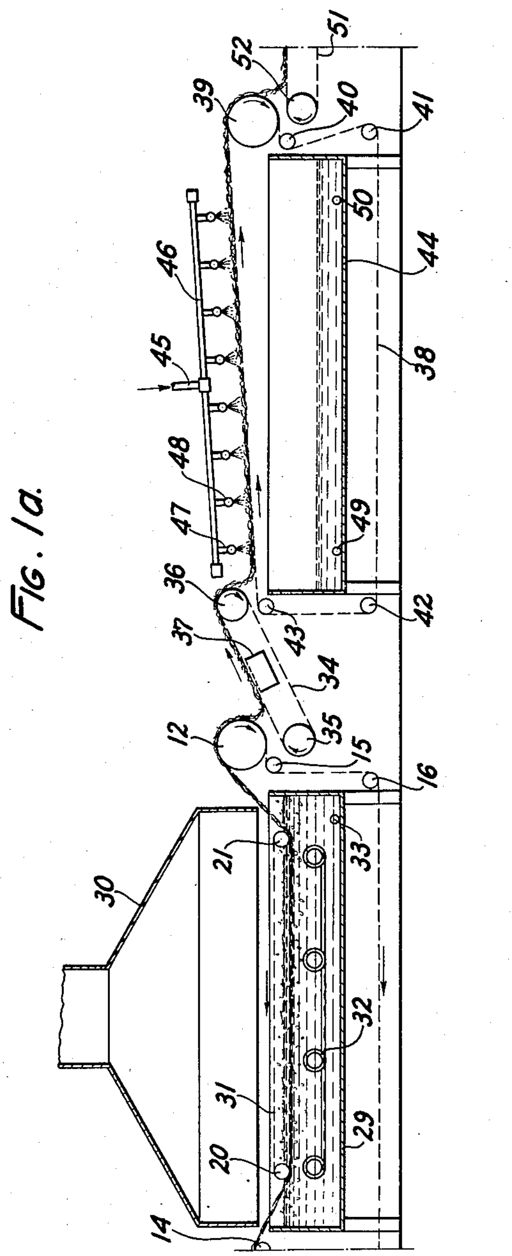
FIG. 1a

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Filed Feb. 29, 1940 2 Sheets-Sheet 2

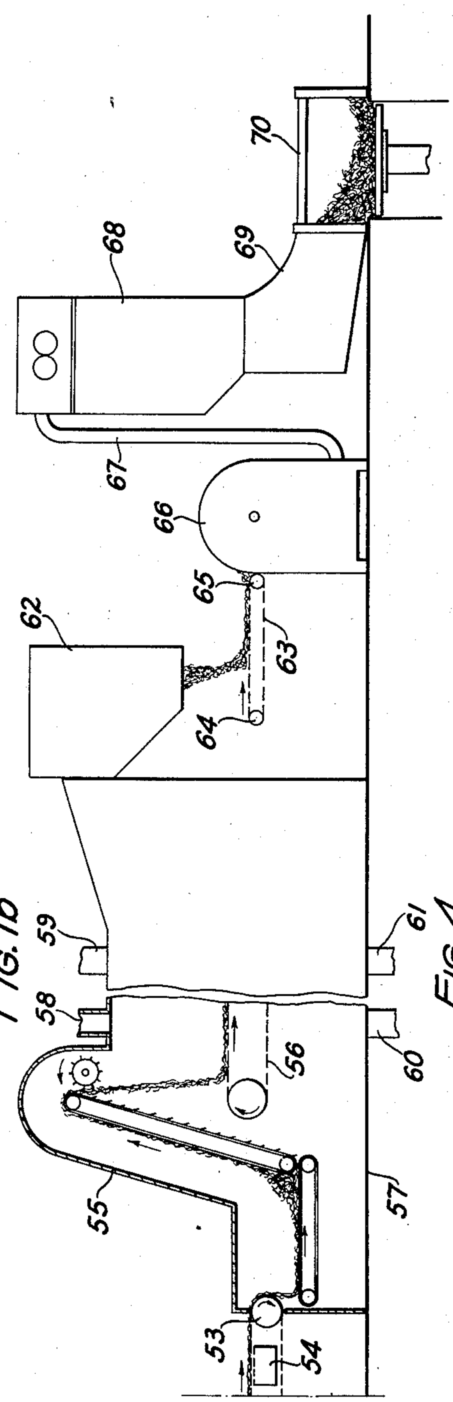

FIG. 1b

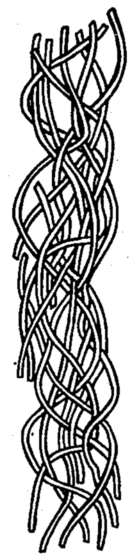

FIG. 2

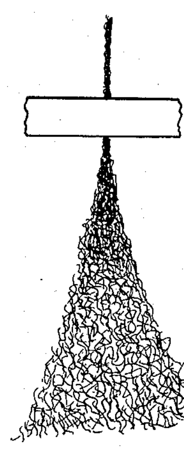

FIG. 4

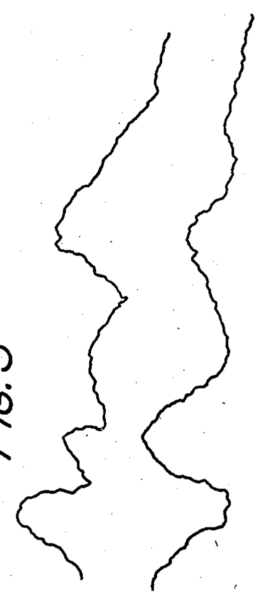

FIG. 3

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2,259,150

PRODUCTION OF CRIMPED CELLULOSE DERIVATIVE STAPLE FIBERS

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Application February 29, 1940, Serial No. 321,540

4 Claims. (Cl. 19—66)

This invention relates to the production of crimped staple fibers, and more particularly to the production of crimped cellulose derivative staple fibers closely simulating natural wool in physical properties and appearance and in addition possessing distinctive properties not possessed by wool or other natural fibers.

As is well known, wool fibers, and cotton fibers to a less degree, are characterized by a certain natural crimpiness or kinkiness and irregularity of surface formation which gives them their characteristic appearance and feel, and a high degree of resiliency. Because of the presence of numerous kinks or crimps in these fibers which permits interlocking or matting, they can be satisfactorily spun into strong yarns and threads. Synthetic filaments or fibers produced from cellulose derivatives, particularly cellulose organic acid derivatives such as cellulose acetate, cellulose acetate propionate, the cellulose ethers and the like, as ordinarily produced, are completely devoid of any crimpiness and are therefore inherently unadapted for many uses for which natural wool and cotton fibers are perfectly adapted. Workers in the synthetic silk industry, recognizing the inherent defects of artificially produced materials, have made many attempts to simulate natural wool fibers. In fact, the technical and patent literature contains numerous references to "artificial wool or cotton," "wool-like fibers," "staple fibers having a crinkled cotton-like structure," "wool substitutes" and the like. However, the fact remains that the expedients thus far suggested have not resulted in products which are structurally sufficiently close to natural wool fibers as to be susceptible of large-scale commercial application in the various spun yarn systems.

It is noteworthy that the methods thus far suggested for the production of crimped staple fibers have been based primarily upon two expedients. The first of these is the use of treatments involving some type of chemical action upon the fiber material. Included in this classification are many processes in which so-called "crimping agents," that is, chemical agents of one kind or another, are either added to the spinning solution from which the filaments are formed, or are applied externally to preformed filaments from a bath in which the material is immersed after cutting into staple lengths. Also included in this class of crimping treatments is the use of hot aqueous solutions of "crinkling and delustering agents." In all of these external treatments reliance is had primarily upon the chemical action of the crimping or crinkling agent present in the bath, although doubtless some slight shrivelling or shrinking of the material takes place through the agency of the hot water itself. However, experiments have shown that this shrinking or shrivelling because of hot water as applied in accordance with these prior art teachings is negligible so far as producing a true crimp is concerned.

The second expedient has been the application to the yarn, either in continuous filament or cut staple form, of a positively applied external mechanical force, such as by giving the yarn an extremely high twist before or during immersion in some type of softening bath or by passing the softened material between the nip of corrugated rolls. As will be apparent from the following discussion, the process herein described is clearly distinguished from both of these chemical and mechanical treatments.

The principal object of the present invention is to provide a process of producing a new and improved crimped cellulose derivative staple fiber closely resembling natural wool in appearance, in physical properties, and in its ability to be spun into yarn and woven into fabrics closely resembling fabrics made from natural wool. A further object is to provide a process whereby cellulose organic derivative staple fibers, particularly those produced from cellulose acetate, may be converted into a form closely simulating natural wool fibers, yet possessing certain peculiar and characteristic properties which distinguish them, not only from natural wool fibers, but from all other known synthetic or natural materials. A still further object is to provide a process for producing such crimped fibers which is independent of the use of internal or external chemical crimping or crimp-inducing agents, and of the use of externally applied mechanical force. Other objects will appear hereinafter. Another object is to provide an entirely new type of wool substitute in which the individual fibers are characterized by a unique external configuration and unique physical 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 and by the ability to be satisfactorily carded, drawn, and spun on ordinary textile machinery into a yarn capable of being woven into a commercially acceptable fabric.

A further object is to provide an improved type of synthetic staple fiber and yarn material having an inherently low natural moisture content, yet a high permeability without excessive absorption or retention of moisture, a heat transfer (insulating ability) comparable to natural wool, an improved ability to acquire crease at ordinary ironing temperatures, and an improved crease retentivity due to low moisture absorption or retention. Other objects will appear hereinafter.

These objects are accomplished by the following invention which, in its broader aspects, comprises forming a relatively loose mat or mass of cut staple cellulose derivative fibers in an open condition such that the fibers are heterogeneously disposed or arranged in a random or helter-skelter fashion in a multitude of different planes and such that substantially each individual fiber is in contact with one or more of its associated fibers at a plurality of points of contact or support, rendering the fibers plastic under the influence of heat, preferably by treatment with hot or boiling water, allowing the fibers to crimp and deform while in a plastic condition by virtue of their own weight, the weight of other fibers bearing thereon, and the shifting effect of ebullition, and then causing the fibers to set in their crimped or deformed condition by cooling.

Preferably we subject the staple fiber material as it comes from the cutter, first to a thorough opening treatment in a picker to break up the relative compactness of the fiber bundles and to disrupt the parallelism of the individual fibers. The action of the picker is such that the fibers are thrown about, their original positional relationships destroyed, and they are caused to be heterogeneously disposed in a multitude of different planes in a random, helter-skelter fashion. In this condition any given fiber, and, in fact, each individual fiber, is caused to assume contact at a plurality of points with one or more of its associated fibers. Assuming a fiber after this opening operation to be lying across, and supported at, a plurality of points by several of its associated fibers, each of which has in turn been opened or separated with respect to the others, it will be seen that as the fiber becomes plastic under the influence of heat, those portions of the fiber lying between the points of support will sink down under their own weight, or by the pressure due to the weight of overlying fibers, thus forming undulations or crimps along the fiber length.

In addition to the crimping effect obtained by deformation of the fibers in the manner just indicated, a further crimping effect results from the fact that the fibers in their open, helter-skelter arrangement, tend to wrap slightly one around the other in regular or irregular conformations. However, in general, in no case does this wrapping tendency result in a looping or tangling of the fibers, but rather in an infinite variety of conformations of individual fibers with respect to one another. The crimping or deformation of the fibers is also augmented by the shifting of the fibers under the influence of ebullition in the crimping bath. It will be understood that when boiling takes place, the fibers tend to be stirred or pushed around at random in the bath and, since they are in a thermoplastic condition, tend to be further deformed, either by pressure against their associated fibers or by displacement of portions of the fibers by bubbles or by moving masses of the boiling bath.

We wish at this point again to emphasize that the success of our process depends upon the attainment of a thoroughly opened condition of the fiber mass, that is, a condition in which the fibers are heterogeneously disposed utterly at random in a multitude of planes throughout the mass and yet in which substantially each fiber contacts one or more of its fellows and is thus subjected to deformation when the material becomes plastic.

The crimping step per se, that is the deformation of the fiber mass in a plastic condition, is preferably carried out by subjecting the opened mass to the action of a bath of hot and preferably boiling water for a short time—on the average 5–10 minutes. The time of immersion will of course vary with the material dealt with, the denier per filament, staple length, etc., and no set rule for this can be stated. At ordinary atmospheric pressures we have found that a temperature of 90–100° C. is satisfactory. When using pure water a temperature of 100° C., will of course suffice to obtain boiling, but if other agents are added to the bath, higher temperatures will be necessary.

As soon as the deformed or crimped fiber mass is permitted to cool below the softening or plastic point of the material, the fibers set and the crimps or deformations therein become a permanent characteristic of the material.

It will of course be understood that in commercial practice, following the hot water crimping, the fiber is given an anti-static treatment, dried, preferably open again and finally baled for shipment.

In a process of this type, it will be readily appreciated that, in general, no hard and fast quantitative rules can be laid down as to the degree or nature of the crimping or deformation to be obtained. The actual number of crimps per inch will, however, vary with the particular cellulose derivative dealt with, the denier per filament, staple length, and other factors. Thus the number of crimps per inch or the particular form or nature of the crimps is not to be regarded as critical.

On the other hand, a more definite and practical, though somewhat empirical, test of the operability of our product, is what may be termed its textilability, that is, its ability to be successfully converted into a practical spun yarn capable of being woven into a commercially acceptable fabric. Specifically, its ability to be properly carded on an ordinary cotton card or similar machinery, is the best practical test of our product. We have found that, unlike other synthetic staple fibers, the product produced in accordance with our process is admirably suited for carding according to standard textile practice and on standard machinery. The one feature of control in our process which can be used to regulate proper quality of product (assuming that the fibers are made sufficiently plastic by the hot bath) is the substantially complete helter-skelter arrangement of the fibers in a multitude of different planes. If too many of the fibers are in parallelism or too many lie in one plane there will be insufficient crimping. If, on the other hand, the fibers are too widely separated, there is a tendency toward insufficient crimping. In this connection, it may be pointed out that, in general, the longer the staple length, the less will be the number of crimps required to give a product which can be properly carded, drawn, and spun into a satisfactory yarn. Thus satisfactory carding is a rather accurate gauge of the degree of openness required of the fiber mat before crimping.

In the accompanying drawings:

Figs. 1, 1a and 1b are diagrammatic illustrations of the various steps employed in a preferred embodiment of the invention and illustrating one type of apparatus suitable for practicing the process.

Fig. 2 is an illustration in greatly exaggerated proportions illustrating the manner in which the fibers are disposed in the crimping bath and undergoing the development of their irregular or crimped form.

Fig. 3 is an illustration of typical staple fibers which have been crimped in accordance with the invention.

Fig. 4 illustrates the formation of a card sliver from staple fibers crimped in accordance with the invention.

In the following examples and description, we have set forth a preferred embodiment of our invention, but it is to be understood that it is included merely for purposes of illustration and not as a limitation thereof.

Our invention will be more readily understood by reference to Figs. 1, 1a and 1b which are diagrammatic illustrations in the nature of a flow sheet showing the steps employed in a typical process carried out in accordance therewith. The numeral 1 designates a raw stock feeder such as is commonly employed in the woolen and worsted industries for the handling of wool and other fibers. Cellulose acetate fibers previously cut to an appropriate staple length, depending upon the ultimate use to which the product is to be put, are placed in the hopper of this feeder as illustrated. By means of conveyor belts 2 and 3 operating as indicated by the arrows, the material is conveyed through the device, emerging therefrom through chute 4 and dropping by gravity onto the conveyor mechanism 5 of a rayon opener or picker. Before reaching the picker, the material is in the form of more or less compact masses of parallel fibers, that is, it is in the same more or less compact condition in which it comes from the cutter.

The material is fed into the picker which, as is well known, consists essentially of a drum rotating upon a shaft such as 7 mounted in suitable bearings (not shown) within the casing 6. The surface of the drum is provided with a large number of rows of protruding teeth which catch up the compacted masses of fibers, disrupt their parallelism, separate or pull them apart and, in general, bring the material into a condition such that the individual fibers are heterogeneously disposed in a multitude of different planes in an utterly random, helter-skelter fashion as described above.

The opened material then passes from the picker through conduit 8 to condenser 9, being impelled through the conduit partly by pressure built up by the rotating drum in the picker and by suction applied thereto by a suction fan or other appropriate means (not shown). The condenser which, as is known, consists of a perforated drum (not shown) is mounted inside of a casing in suitable bearings and provided with actuating means for rotation. Part of the perforated surface of the drum is blocked off by a damper and the ends of the drum are connected to an exhaust fan. The opened staple material coming in contact with this drum tends to cling thereto due to the passage of air through the perforations, but when it reaches the portion covered by the damper it is released and allowed to fall away from the drum into the stock feeder 10 as shown. The condenser thus serves to separate the fiber material from the relatively large volume of air which it has picked up in its passage through the picker.

The fiber material, still in its opened condition, is fed by the stock feeder 10, which is in all respects similar to feeder 1, to an endless screen belt 11, driven in known manner by means of roll 12, in the direction indicated by the arrows. This belt is similar to, but somewhat coarser in mesh than, the Fourdrinier screens commonly employed in the paper-making industry. As shown, the belt is carried over guide rolls 13, 14, 15, 16 and 17. Rolls 18 and 19, as well as 20 and 21, which also act as guide rolls, serve to depress the path of the belt so that it runs within but well below the top of the respective tanks as shown.

The numeral 22 designates what may, for convenience, be called a leaching tank. The tank is provided with a spray system 23 composed essentially of manifold 24 which supplies water under pressure to branch pipes 25, 26, etc., arranged substantially at right angles thereto and extending horizontally across the tank, as illustrated. Each of these pipes has a number of perforations in its under side for passage of water therethrough. Tank 22 is also provided with suitable drainage conduits 27 and 28 for conveying away the accumulated liquid. As the fiber material is conveyed over the tank in the direction indicated by the arrows, the water plays thereon and serves to leach out residual solvent which may be present in the fiber. The water containing the dissolved or otherwise accumulated materials passes into the tank and is drained off by means of conduits 27 and 28.

The thoroughly leached staple fiber material, still in its open condition, is conveyed by screen 11 over the roll 14 and into the crimping tank 29. This tank is conveniently provided with a hood or other suitable enclosure 30 for confining and conveying away the steam or vapor rising therefrom. Rolls 20 and 21 carry endless screen belt 31, this belt being driven by one of these rolls in known manner at approximately the same linear speed as screen belt 11. Belt 31 is of the same type as belt 11 and is so positioned as to be substantially parallel therewith. Due to some natural sagging of belt 11, particularly at the center, there is a small space of the order of an inch or two between these two parallel belts. The function of the belt 31 is primarily to keep the fiber material from wandering in the bath under the influence of ebullition or other forces.

Tank 29 is also provided with a series of heating coils 32 through which steam at an appropriate temperature is supplied. The tank is completely filled with water by means of an inlet conduit 33, the level being such that the surface of the water will be preferably just above the lower run of the superposed screen 31, that is, a level such that the open staple fiber material passing between roll 20 and roll 21 will always be submerged. The water level may be maintained by constant level devices or other well-known equivalent means. The water is heated to boiling by the steam coils so that as the fiber mass is conveyed along by the screen 11, it is subjected for a period of several minutes to the action of the boiling water. It is at this stage of the process that the principal crimping action takes place. In other words, each staple fiber in its open, random, helter-skelter arrangement, is rendered plastic and assumes a crimped form under the softening influence of heat. This is due, partially to the sinking down of suspended portions of the material, partially to the wrapping around or other contact of fiber against fiber and partially to the deforming effect of moving masses of water which impinge thereon in the boiling bath.

As the crimped material is carried along by the belt 11, it eventually passes over roll 12 and falls upon another conveyor belt 34 carried by rolls 35 and 36, one of which is a drive roll. This belt is also provided with suction box 37, which operates in a manner similar to that of a suction box employed on a paper machine and serves to remove the excess water from the crimped material.

The material then drops by gravity from the screen as it passes over roll 36 onto another endless screen belt 38 driven by roll 39 and passing around guide rolls 40, 41, 42, and 43 in the manner illustrated, the upper run of the belt being over tank 44. This tank is provided with a spraying device 45 somewhat similar to that provided for tank 22, and composed essentially of manifold 46 and provided with branch pipes 47, 48, and so on, positioned at right angles thereto and perforated in such fashion as to spray liquid onto the surface of the material carried along by belt 38. This spray system is fed with a suitable anti-static, lubricating emulsion. The excess emulsion falls by gravity into the tank 44 and is drained off by means of conduits 49 and 50.

The crimped and lubricated staple fiber material as it passes over roll 39 falls therefrom by gravity onto the surface of another endless screen belt 51 carried by rolls 52 and 53, one of which rolls provides a drive therefor. This belt is also provided with a suction box 54 so positioned with respect to the screen as to remove excess lubricant from the crimped fiber material carried thereby.

After removal of excess lubricant from the material it drops by gravity from roll 53 into a feeder 55 similar to feeder 1 and this conveys the material onto the surface of another endless screen belt 56 operating as shown within an extended apron drier 57. The material is dried by means of heated air passed into the drier through a series of conduits 58, 59, the moisture-laden air being conveyed from the drier by appropriate suction means through outlet conduits 60 and 61. The drier is conveniently provided at its delivery end with another feeding device (not shown) and also with a discharge chute or bin 62, which conveys the material onto conveyor belt 63, carried by rolls 64, and 65, of a second picker 66. This picker serves to loosen or fluff up the crimped material and give it what may be referred to as uniform consistency. From the picker, the material then passes by conduit 67 to condenser 68 and finally through chute 69 to baler 70.

It will of course be understood that the process may be varied rather widely within the scope of our invention and that, in general, no hard and fast rules can be laid down with respect to the specific conditions of operation.

While other non-solvent liquids may be employed for the crimping bath, we prefer to use plain water. While we do not limit ourselves thereto, we prefer to employ boiling water for this purpose.

The duration of immersion of the fibers in the crimping bath may vary within wide limits depending upon the particular cellulose derivative material dealt with, the temperature of the bath and various other considerations. In most cases, the linear speed of the belt is so adjusted with respect to the length of the crimping tank as to provide for an immersion of about 5–10 minutes when boiling water is employed.

Similarly, the temperature of the drying air used in the apron drier may vary considerably, depending upon the particular material dealt with. In general, the inlet temperature of the air may be about 90° to 150° C.

Likewise, certain other details of the process may be varied. For example, the leaching step in which residual solvent such as acetone is removed from the material before crimping is desirable, but not vital to the success of the process so far as obtaining satisfactory crimp is concerned. Other details such as the amount of suction employed on the suction boxes to remove excess liquid from the material may be varied considerably. Since these are largely matters of plant practice well within the knowledge of those skilled in the art no specifications with respect thereto need be given.

The nature of our crimping process may be further explained by reference to Fig. 2 of the drawings which illustrates in general the condition of the material during the actual crimping operation. It will be seen from this figure that the fibers in the crimping bath are in a completely heterogeneously disposed condition, that is, there is complete absence of parallelism between the fibers which are disposed utterly at random in a completely helter-skelter fashion. Each of the fibers is thus, either supported by, or otherwise in contact with, one or more of its associated fibers. It will also be understood that under the influence of ebullition, moving masses of the water will penetrate up through the fiber mass and further serve to displace and deform the individual fibers while in their plastic condition. It is, as previously pointed out, this utterly random or helter-skelter disposition of the fibers while undergoing the action of the hot water which presumably accounts for the satisfactory and permanent crimp imparted to the material, once it has set or lost its plasticity under the influence of a lower temperature.

The finished product will be more clearly understood by reference to Fig. 3 which is an illustration of typical staple fibers crimped in accordance with our invention. It will be seen that the crimps are disposed along the fiber length utterly at random as might be expected from a consideration of the fibers prevailing in the crimping bath as illustrated in Fig. 2. While the chief crimps are the larger ones appearing in the illustration of Fig. 3, there may be smaller secondary crimps or irregularities present along the major crimp segments. While two or more of the major or minor crimps may lie in the same plane, the majority of the crimps are found to lie in an indefinite number of different planes. Thus the crimps may actually assume the form of irregular spirals or similar irregular conformations. It is this utterly random disposition or orientation of the crimps in the individual fibers which gives them their very close similarity to natural fibers, particularly wool, especially in their ability to be carded, drawn and spun into commercially satisfactory yarn and thread, or in other words, their "textilability."

In view of the extremely random distribution of the crimps in the material, no hard and fast rule can be laid down with respect to the number of crimps per inch which may be required for a given purpose, although for most purposes 5–20 crimps per inch will be satisfactory. However, in general, it may be said that for the longer staple fibers, such as those employed for the woolen system, for example, a fewer number of crimps per inch or crimps per fiber are required to give a satisfactory product. Conversely, with the shorter staple lengths, such as in the case of material designed for use on the cotton system, a larger number of crimps per inch, that is, a higher degree or intensity of crimping, will be required.

The practical test of whether or not a given crimped staple fiber product produced in accordance with our invention has a satisfactory degree of crimp is, as stated, its textilability, that is, its ability to be carded and formed into slivers, rovings and the like, which may subsequently be drawn, spun and so forth, into threads and yarn suitable for weaving into a commercially satisfactory fabric. In the final analysis, it is particularly the ability of the crimped material to withstand the drastic action of the card (and still retain sufficient matting or interlocking ability to give a card sliver capable of holding together) which is the real practical test. This is, at best, a somewhat empirical, but nevertheless, a very valuable test. In any event, so far as we are informed, we are the first to produce a commercially satisfactory crimped staple fiber, that is, a fiber which is susceptible of carding and subsequent conversion into a commercially satisfactory spun yarn.

While no very exact statement may be made as to the relation between the openness of the material and the degree of crimping, it may be stated, as a general proposition, that the more preopened the material, the greater the number of crimps per fiber or crimps per inch will be inserted in the material. For a staple fiber material of any given specifications (denier, filament, length, etc.), there will be an optimum degree of crimping which will reveal itself in the cardability (textilability) of the material. For a given material, it will be readily understood that, on the one hand, if the material is in too open a condition it may receive excessive crimp for the product in question, while on the other hand, too low a degree of preopenness of the material may also result in unsatisfactory crimping because of the fact that the fibers tend to lie too close together and too parallel and thus cannot assume the open, random, helter-skelter orientation above referred to. In general, it may be stated that yarn having insufficient crimp will give trouble in the subsequent textile operations such as drawing and spinning. Likewise, over-crimped yarn gives trouble due to an excessive amount of fly and low tensile strength of the product.

Fig. 4 illustrates diagrammatically the formation of a card sliver such as referred to above. As the fiber mass leaves the delivery side of the card, it is in the form of a light, tenuous, filmy mass or web of interlocked fibers. It is only by this interlocking, matting or felting of the fibers that the sliver can hold together. If there is an insufficient degree of crimping, the individual fibers will tend to slide one over the other and the sliver will tend to fall apart by its own weight or by a slight strain placed thereon. With fibers which have been sufficiently crimped, on the other hand, the sliver has sufficient strength to hold together and to withstand the slight strain necessary to impart to it the low twist customarily employed. The formation of a card sliver from fibers which have been satisfactorily crimped in accordance with our invention is illustrated in Fig. 4.

It will of course be apparent our process is not limited to the manufacture of any particular type of staple fiber, but is applicable generally to the manufacture of crimped staple fiber adapted for use on any of the standard cotton, woolen and worsted systems. While filaments or staples of the so-called bulbous or potato-shaped cross-section may be readily crimped by the process, filaments of other cross-sectional characteristics may be employed with equally satisfactory results. Under some circumstances, the use of filaments of flat cross-section are to be preferred, since this type of filament is more subject to deformation and therefore more readily crimped than the rounded cross-section type.

While our process has proved to be particularly efficacious in the crimping of staple fibers composed of cellulose acetate, it may be applied with equal facility to the crimping of fibers composed of other cellulose esters, such as cellulose propionate, cellulose butyrate, cellulose acetate propionate, cellulose acetate butyrate, and similar single and mixed organic acid esters of cellulose, the cellulose ethers such as methyl cellulose, ethyl cellulose, and hydroxy ethyl cellulose, viscose, cuprammonium cellulose, vinyl resins such as polyvinyl acetate, polyvinyl acetals and other materials. It will of course be obvious that the particular conditions of operation, such as the nature of the bath, duration of crimping treatment and various other factors will be selected, in accordance with our invention, upon the basis of the particular solubility, thermoplasticity, and swelling or softening properties of the particular material dealt with. It goes without saying that the crimping bath should preferably have no or little solvent action upon the staple fiber material and also that, following the plastic deformation of the fibers, they will in any case recover their natural rigidity in the deformed condition, thereby producing a permanent crimp.

What we claim is:

1. The method of producing crimped cut staple fibers closely simulating wool and other natural fibers which comprises subjecting thermoplastic fibers free from crimp-inducing agents and of the desired staple length to the following series of continuous operations: (1) disposing the fibers in a loose, open condition in which the fibers are positioned in an utterly random relationship with respect to one another in an indefinite number of different planes and in which condition contact is made by any given fiber with one or more of its associated fibers at a plurality of points, then (2) heating the fibers until they become soft and plastic and maintaining them in such soft and plastic condition until the fibers assume an irregular, undulated, crimped form due to the sagging of the suspended fibers and to pressure upon the various fibers by the other fibers with which they are in contact, and then (3) allowing the fibers to set in

substantially the irregular, undulated, crimped form so assumed.

2. The method of producing crimped cut staple fibers closely simulating wool and other natural fibers which comprises subjecting thermoplastic fibers free from crimp-inducing agents and of the desired staple length to the following series of continuous operations: (1) disposing the fibers in a loose, open condition in which the fibers are positioned in an utterly random relationship with respect to one another in an indefinite number of different planes and in which condition contact is made by any given fiber with one or more of its associated fibers at a plurality of points, then (2) heating the fibers with a hot liquid medium until they become soft and plastic and maintaining them in such soft and plastic condition until the fibers assume an irregular, undulated, crimped form due to the sagging of the suspended fibers and to pressure upon the various fibers by the other fibers with which they are in contact, and then (3) allowing the fibers to set in substantially the irregular, undulated, crimped form so assumed.

3. The method of producing crimped cut staple fibers closely simulating wool and other natural fibers which comprises subjecting thermoplastic fibers free from crimp-inducing agents and of the desired staple length to the following series of continuous operations: (1) disposing the fibers in a loose, open condition in which the fibers are positioned in an utterly random relationship with respect to one another in an indefinite number of different planes and in which condition contact is made by any given fiber with one or more of its associated fibers at a plurality of points, then (2) heating the fibers with boiling water until they become soft and plastic and maintaining them in such soft and plastic condition until the fibers assume an irregular, undulated, crimped form due to the sagging of the suspended fibers, to pressure upon the various fibers by the other fibers with which they are in contact and by the distortion of the fibers by the ebullition of the water, and then (3) allowing the fibers to set in substantially the irregular, undulated, crimped form so assumed.

4. The method of producing crimped cut staple fibers closely simulating wool and other natural fibers which comprises subjecting cellulose acetate fibers free from crimp-inducing agents and of the desired staple length to the following series of continuous operations: (1) picking a mass of the fibers to form an open fiber mass in which the fibers are positioned in an utterly random relationship with respect to one another in an indefinite number of different planes and in which condition contact is made by any given fiber with one or more of its associated fibers at a plurality of different points, then (2) heating the fibers in boiling water for about 5–10 minutes until they become soft and plastic and maintaining them in such soft and plastic condition until the fibers assume an irregular, undulated, crimped form due to the sagging of the suspended fibers, to pressure upon the various fibers by the other fibers with which they are in contact and by the distortion of the fibers by the ebullition of the water, and then (3) allowing the fibers to set in substantially the irregular, undulated, crimped form so assumed.

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