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STAPLE FIBERS AND PRODUCTION THEREOF

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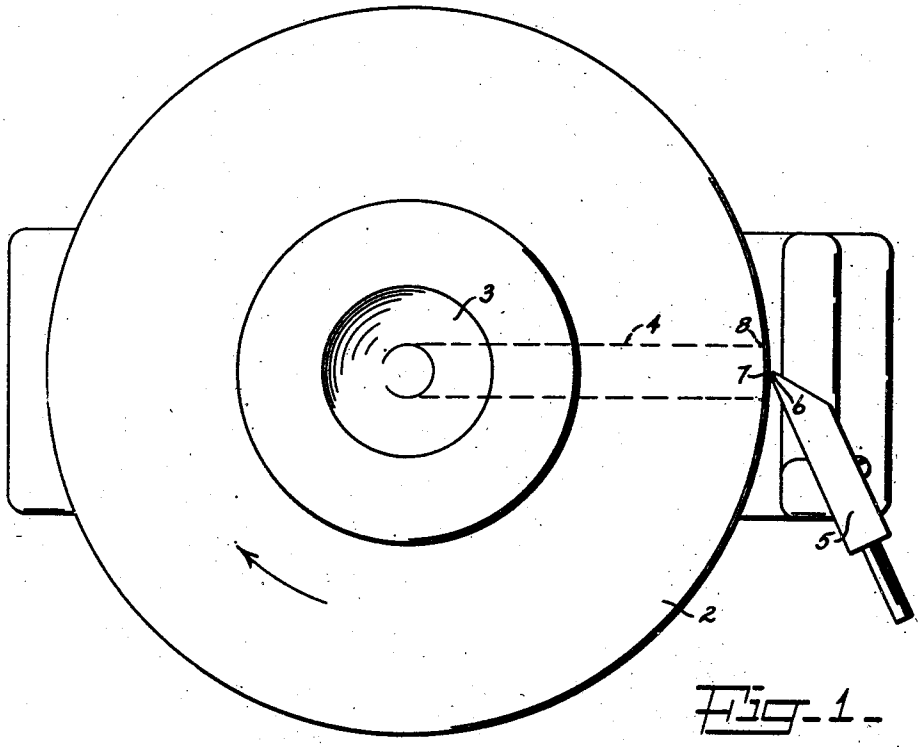


Fig. 1.

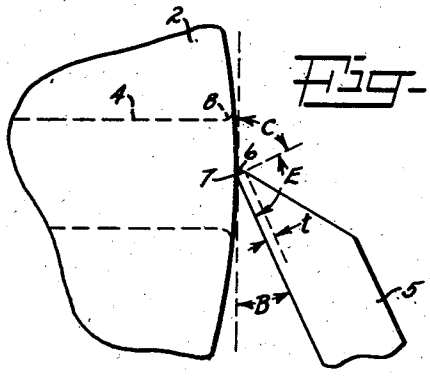


Fig. 2.

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STAPLE FIBER AND PRODUCTION THEREOF

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13 Claims. (Cl. 164—36)

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This invention relates to a novel staple fiber product and a process and apparatus for producing it.

It is well recognized that the tendencies of staple fibers to cohere is a highly desirable property for improving the strength and handle of the textile materials made therefrom such as yarns, felts, and the like, and that this property of coherence of the fibers has a great influence upon subsequent textile processing, such as carding, spinning, and the like. In order to enhance this tendency of staple fibers to cohere, it has been the practice heretofore to impart a crimpiness to the entire length of the continuous filamentary material from which the fibers are cut or to the entire length of the fibers after they are cut from a continuous filamentary tow of little or no crimp. Such treatments involve a special step of mechanical or chemical processing of the tow or fibers. It has now been found possible to obtain much of the desired coherence and concomitant properties by a novel procedure of cutting which imparts an irregular condition to the ends of a portion of the fibers. This irregular condition comprises any one or more or all of a number of characteristics consisting of irregularly-spaced microscopic corrugations extending partially or completely around the fiber, mangled and torn portions having irregular barb-like projections or a crimpiness along the end portions of the fibers. It has been found that the presence of such irregularities along a minor portion of the lengths of the fibers even where present in but a minor proportion of the entire lot of fiber to be spun or otherwise processed, imparts a marked improvement in their properties, and especially in their coherence.

Accordingly, it is the object of this invention to provide a novel staple fiber product having improved cohesive properties by virtue of the presence of a crimpiness, barb-like projections, or irregular corrugation or a combination of these characteristics in a minor portion of the length of the individual fibers. A further object of the invention is to provide a process for producing such fibers, such process involving the exertion of compressive forces generally transverse of a somewhat softened tow of continuous filamentary material an appreciable distance along the ends of the fibers as they are being cut to staple lengths. A further object of the invention is to provide a cutting apparatus for producing the improved staple fiber product from a somewhat softened tow of continuous filamentary material such apparatus having cutting edges constructed

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and arranged to compress a substantial length of the continuous filamentary tow adjacent the position of cutting simultaneously with the cutting. Further objects and advantages of the invention will appear from the drawing and the description thereof hereinafter.

In the drawing, illustrative of the invention,

Figure 1 is a plan view of one form of cutting device capable of accomplishing the invention, and

Figure 2 is an enlarged view of a portion of the device of Figure 1 showing more clearly the relationship of the cutting elements.

In general, the process of this invention involves the application of both compressive and shear forces transversely of a bundle of continuous filamentary material which is in a somewhat softened or plastic condition. The bundle of filamentary material may have any cross-section, such as round, elliptical, or generally rectangular. The application of such combined forces causes a crowding of the filaments for a considerable distance along the length of the bundle in the neighborhood of the application of the forces. This crowding causes irregular distortions in the individual filaments which become set upon subsequent drying of the filamentary material. The resulting staple fiber product which is sheared from the continuous filamentary bundle simultaneously with the application of the compressive forces comprises individual fibers at least some of which have a minor portion of their length in a crimped, barbed, or corrugated condition or in a combination of these conditions and the remainder of their length in a substantially undistorted or less severely distorted condition. The somewhat softened or plastic condition of the continuous filamentary bundle may be obtained by suitable treatment of the filamentary bundle before it is subjected to the compression-cutting. Instead of applying a special softening and plasticizing agent for the particular material, a recently spun continuous filamentary tow coming from the spinning machine in a still plastic condition may be subjected directly to the compression-cutting. For example, a continuous filamentary material obtained from viscose still in a somewhat gelatinous condition as it comes from the preliminary washing baths, or a dry-spun cellulose acetate tow still containing a small residue of solvent therein, may be directly subjected to the compression-cutting. With such materials as regenerated cellulose or cellulose acetate, the softened condition may be obtained merely by application of moisture or steam.

A cutter arrangement capable of imparting the combined compressive and shearing forces is illustrated in Figures 1 and 2 where it is associated with a Beria type of staple fiber cutter. As shown, the cutter comprises a rotatable disc 2 having the centrally located axial channel 3 communicating with the radial channel 4, the filamentary bundle being fed into the rotatable disc by way of the axial channel and being conducted through the radial channel by virtue of centrifugal force set up by rotation of the disc or by a jet of fluid, such as air or water, directed into the axial channel. Suitable means, not shown, are provided to rotate the disc. A knife 5 having a leading face 6 is supported so that its cutting edge 7 cooperates with the periphery of the disc to sever the filamentary material extending therefrom upon each revolution thereof.

Referring to Figure 2, the various angular relationships of the cutting device will be defined as follows:

Angle B, hereinafter called the "back angle," is the angle between the tangent and the back face of the knife.

Angle C, hereinafter called the "cutter angle," is the angle between the tangent to the disc and the leading face of the knife. In the claims the line of the tangent to the disc is referred to as the "line of shear."

Angle E, hereinafter called the "edge angle," is the angle between the back of the blade and the leading face 6 of the blade.

In accordance with the invention the cutter angle C is preferably less than 90° and falls preferably within a range of about 55° to about 85°. The back angle B may vary from 0 to 30° and the edge angle E makes up the balance of 180°. From a practical standpoint, back angle B is preferably made about 23° to 25° and edge angle E would therefore vary from about 61 to 102° depending on the values of cutter angle C and of back angle B desired. The thickness of the leading face 6 of the knife designated *t* in Figure 2 is preferably on the order of $1/64$ to $3/16$ of an inch. Giving the thickness of the leading face dimensions of the order of $3/16$ inch and larger makes cutting somewhat more difficult but has the advantage of increasing the length of the crimped and/or corrugated portion of the fibers.

It will be observed that the cutter angle C is such that the leading face 6 tends to compress the filaments in the neighborhood of cutting. While it is not absolutely essential, it is preferred to bevel, roughen or otherwise blunt the edge 8 which the radial channel makes with the disk periphery and with which the edge 6 of the knife cooperates to effect cutting. This beveling and roughening has the effect of assuring the production of crimpiness and/or irregular corrugation on the leading ends of the filamentary tow so that the fibers cut upon the next revolution of the disc will have both ends crimped and/or irregularly corrugated. Occasionally, bushings are employed within the radial channel of the disc and present the edge against which the knife operates. In such event, the edge of the bushing corresponding to edge 8 is preferably beveled or roughened or both as in the case shown where no bushing is employed.

A preferred embodiment uses a beveled and roughened operating edge 8 of the radial channel or bushing therein, and a knife having its cutter angle C 75°, edge angle E 80°, back angle B 25° and the edge thickness *t* $1/32$ inch.

For all practical purposes, one may start with a knife presenting a cutter angle as above defined of 90° or of even greater size and allow the knife to become blunt during operation so that it then presents a cutter angle of less than 90° and preferably between about 55° to 85°. Whereas it has heretofore been customary to maintain the knives of a staple cutting machine in a sharpened condition, the discovery upon which my invention is based makes it desirable to avoid the condition of sharpness as hitherto understood.

Instead of having the blunt leading face 6 of the knife extending clear across the width thereof, an ordinarily sharp knife may be dulled or blunted along that portion of its width which cooperates with the radial channel to cut the staple fibers. The blunting should be such as to provide a leading face having a thickness preferably of the order of $1/64$ to $3/16$ inch extending at an angle within the range of 55° to 85° specified above for cutter angle C. Where such a dulled or blunted knife is employed, it may be desirable to grind down the remaining sharp width of the blade in order to assure better contact of the dulled portion with the cooperating edge 8 of the annular channel though it is not essential that absolutely perfect contact nor in fact that even reasonably good contact be made between these cooperating edges since the compressive forces are enhanced by avoiding perfect contact.

The leading face 6 of the blade, instead of being constituted by a relatively flat surface, as shown, may be rather irregular and may in fact be constituted of small serrations or undulations, the grooves between which extend generally in the direction of the thickness of the leading face 6.

Although the invention has been specifically described and shown in connection with a Beria type of cutter in which a knife cooperates with a rotating disc as a co-operating shear member, other types of cutters may be employed, such as one comprising, as a co-operating shear member a fixed table across which a bundle of filamentary material is passed and a knife reciprocable or otherwise swingable with respect to a cutting edge of the table and having a leading face for cooperation therewith set at an angle corresponding to that of cutter angle C of Figure 2. In such embodiments, the companion cutting edge of the fixed table is preferably beveled or roughened or both in a manner similar to that of the edge 8 of the annular channel in the disc as shown in Figures 1 and 2.

The cutting operation described above may impart the above-described irregularities to but a small proportion of the fibers produced at each cut or to a much larger part thereof and, if desired, even to substantially all of them, depending upon such conditions as the volume of the filamentary bundle being cut, and the extent of plasticity of the filaments in the bundle. However, the employment of blunt knives in the manner hereinabove described assures that at least some portion of the fibers will have the desired irregularity along one or both of their ends regardless of the volume or extent of plasticity of the filamentary bundle. The character of the irregularity may be varied by variation of the several factors. For example, by operating upon filaments in a softer condition, the fibers produced show an increase in the microscopic cor-

rugations and barb-like projections. On the other hand, by operating upon filaments which are completely set up so that they are subject to little or no plastic flow, the fiber product shows few or no fibers having the corrugated or barbed condition, the crimped condition being present instead. By mixing filaments in a somewhat plastic condition with others completely set up, it is possible to obtain cut fibers comprising some that are only crimped and others which exhibit the microscopic corrugations.

Fibers which have the microscopic corrugations or a barbed condition superimposed on the crimping show improved spinning capabilities and particularly an enhanced cohesiveness as compared with those having only a crimpiness or only the corrugated or barbed condition. It is to be understood that my invention contemplates a fiber product comprising any proportion of fibers one or both of whose ends have been crimped, barbed and/or corrugated whether produced directly by the cutting procedures herein disclosed or whether obtained by mixing a portion of a fiber product so obtained with any proportion of one or more staple fiber products produced by other procedures. It also contemplates applying the novel cutting operation to bundles of crimped as well as to uncrimped continuous filaments and also to bundles of filaments in a condition such that after cutting they set up to a crimped condition along their entire length.

While preferred embodiments have been disclosed, the description is intended to be illustrative only, and 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. In apparatus for producing staple fibers, means for cutting a bundle of continuous filamentary material to discontinuous lengths comprising a blunt knife and a co-operating shear member, said knife and shear member being provided with effective shearing edges and being relatively movable in opposite directions to cause said edges to become opposed and then to pass each other in the line of shear direction, said blunt knife having a leading face arranged to present a cutter angle of less than 90° with respect to the line of shear.

2. In apparatus for producing staple fibers, means for cutting a bundle of continuous filamentary material to discontinuous lengths comprising a blunt knife and a co-operating shear member, said knife and shear member being provided with effective shearing edges and being relatively movable in opposite directions to cause said edges to become opposed and then to pass each other in the line of shear direction, said blunt knife having a leading face of a thickness of the order of 1/64 to 3/16 of an inch and arranged to present a cutter angle of less than 90° with respect to the line of shear.

3. In apparatus for producing staple fiber, means for cutting a bundle of continuous filamentary material to discontinuous lengths comprising a blunt knife having a leading face arranged to present a cutter angle of less than 90° with respect to the line of shear and a companion blunt edge with which the blunt knife is arranged to cooperate.

4. In apparatus for producing staple fiber, means for cutting a bundle of continuous filamentary material to discontinuous lengths comprising a blunt knife having a leading face arranged to present a cutter angle with respect to the line of shear and a companion blunt edge with which the blunt knife is arranged to cooperate.

5. In apparatus for producing staple fiber, means for cutting a bundle of continuous filamentary material to discontinuous lengths comprising a blunt knife having a leading face of a thickness of the order of 1/64 to 3/16 of an inch and presenting a cutter angle between about 55° to 85° with respect to the line of shear and a companion blunt edge with which the blunt knife is arranged to cooperate.

6. In apparatus for producing staple fiber, a rotatable member having a channel therethrough for guiding filamentary material outwardly therefrom, a blunt knife having its cutting edge arranged for cooperation with the rotatable member, and means for rotating said member to effect periodic cutting of the filamentary bundle by said knife and simultaneous compression by said knife of the filamentary bundle in the neighborhood of the position of cutting.

7. In apparatus for producing staple fiber, a rotatable member having a channel therethrough having a radially extending portion opening into the periphery thereof for guiding filamentary material outwardly therefrom, and a blunt knife having a leading face arranged to present a cutter angle of less than 90° with respect to a tangent to the periphery of the rotatable member through the knife edge.

8. In apparatus for producing staple fiber, a rotatable member having a channel therethrough having a radially extending portion opening into the periphery thereof for guiding filamentary material outwardly therefrom, and a blunt knife having a leading face arranged to present a cutter angle with respect to a tangent to the periphery of the rotatable member through the knife edge.

9. In apparatus for producing staple fiber, a rotatable member having a channel therethrough having a radially extending portion opening into the periphery thereof for guiding filamentary material outwardly therefrom, a blunt knife having a leading face of a thickness of the order of 1/64 to 3/16 of an inch and presenting a cutter angle between about 55° to 85° with respect to a tangent to the periphery of the rotatable member through the knife edge cooperating therewith.

10. In apparatus for producing staple fiber, a rotatable member having a channel therethrough having a radially extending portion opening into the periphery thereof for guiding filamentary material outwardly therefrom, a blunt knife having a leading face of a thickness of the order of 1/64 to 3/16 of an inch and presenting a cutter angle between about 55° to 85° with respect to a tangent to the periphery of the rotatable member through the knife edge cooperating therewith, the edge of the opening of said radial channel in the periphery of the rotatable member being blunt.

11. In a method of producing staple fibers, the steps of cutting a bundle of continuous filamentary material in a somewhat plastic condition into discontinuous lengths, presenting a blunt knife against said bundle of filaments and causing said knife to coact with a companion blunt edge to provide a line of shear and causing a leading face of said knife to present an angle of less than 90° to said line of shear.

12. In a method of producing staple fibers, the steps of cutting a bundle of continuous filamen-

tary material in a partially plastic condition to discontinuous lengths by subjecting the material to transverse compression along a substantial portion thereof immediately adjacent the cutting position between opposed offset surfaces extending transversely of the bundle and relatively moving toward and through the bundle of material from opposite sides thereof in adjacent tangentially related paths to effect shearing thereof while simultaneously feeding the material at high velocity to the cutting position, one of said surfaces being inclined at an acute angle from the line of shear.

13. In a method of producing staple fiber, the steps of cutting a bundle of continuous filamentary material in a partially plastic condition to discontinuous lengths by subjecting the material to transverse compression along a substantial portion thereof immediately adjacent the cutting position, between opposed offset surfaces extending transversely of the bundle and relatively moving toward and through the bundle of material from opposite sides thereof in adjacent tangentially related paths to effect shearing thereof while simultaneously feeding the material at high velocity to the cutting position, both of said surfaces being inclined at an acute angle from the line of shear.

NORMAN S. WELTON.