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TOW SPREADING AND WIDTH CONTROL DEVICE

Filed July 5, 1966

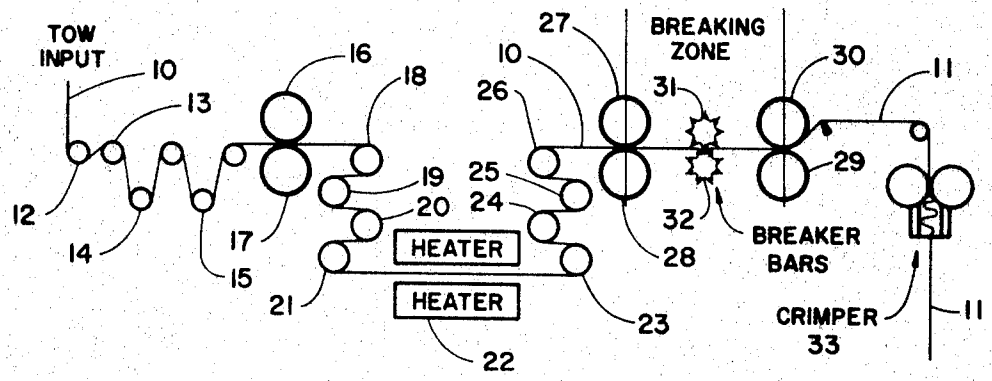



FIGURE 1

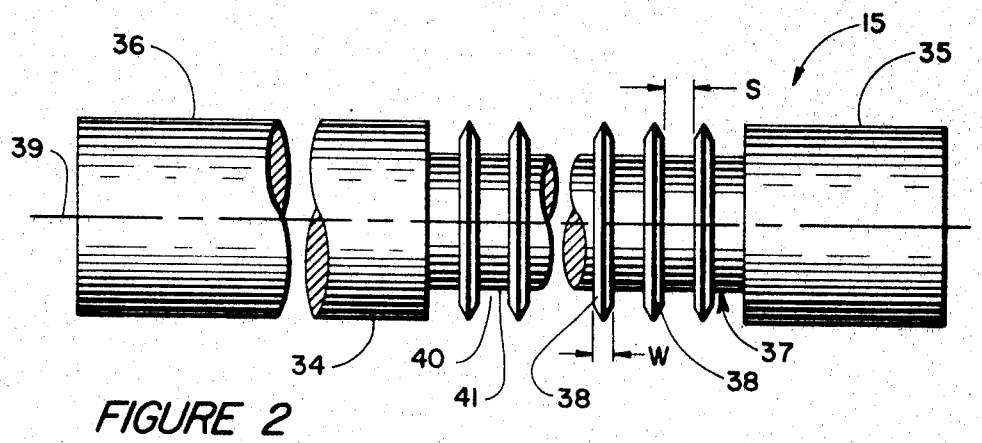



FIGURE 2

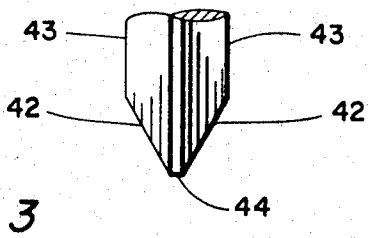



FIGURE 3

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3,439,385

# TOW SPREADING AND WIDTH CONTROL DEVICE

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U.S. Cl. 19—.35 1 Claim

## ABSTRACT OF THE DISCLOSURE

An apparatus and method for controlling the width of continuous filament tow being fed to a continuous filament to staple conversion apparatus to thereby more uniformly control the width and thickness of the tow in the conversion apparatus.

This invention relates to a novel device or guide means for separating a tow or bundle of continuous filaments during the processing thereof into a plurality of subdivided bundles for handling in various textile operations. It particularly relates to a profiled device, e.g., a roll having alternating grooves and fins thereon for maintaining uniform the width of a relatively flat ribbon of tow.

In contrast to natural fibers which are of staple length and which require parallelization and purification as the first step toward yarn manufacture, man-made fibers first appear as continuous, perfectly uniform, parallel filaments, free from all impurities. However, in order to produce a man-made fiber yarn having the desirable properties of natural staple fiber yarn, while still maintaining the advantages of man-made fibers, continuous filaments are often cut or broken into staple fiber lengths and thereafter processed on various staple fiber processing apparatus to form man-made staple fiber yarns. Such processes, however, because of their very nature introduce contaminants, fly, other fibers, etc., into the man-made staple fiber yarns and therefore destroy the above-mentioned advantageous uniformity and purity of the man-made fibers in their initial form. In addition, the man-made parallel filaments after being cut into staple fiber lengths are disarranged from their parallel arrangement during subsequent handling, e.g., baling or the like. Often the disarrangement is intentionally done. The disarranged staple fibers, as is common practice, must then be rearranged, i.e., made parallel, during staple processing, in order to be subsequently spun into usable yarns.

It is because of the above-mentioned disadvantages, and others, of processing man-made staple fibers in the conventional staple systems that various "tow-to-top" processes and apparatus have come into relatively wide acceptance in the textile industry. Tow, i.e., a bundle of man-made continuous filaments without twist, often 200,000 total denier and up, is processed according to various well-known techniques whereby the individual filaments within the tow bundle are either broken as on the Turbo Stapler or cut as on the Pacific Converter into predetermined staple fiber lengths comparable to those found in various natural fibers. This loose rope-like bundle of man-made staple fibers, or as it is commonly referred to, top or sliver, is then drafted, twisted, etc. to form a man-made staple fiber yarn.



To provide a better and more complete understanding of my invention, the conversion of tow-to-top on the Turbo Stapler will be hereinafter more fully described. Tow in the shape of a relatively flat band or ribbon is fed under tension to a breaking zone wherein the tow is deflected from its normal straight line path of travel by a pair of breaking bars. This combined action, tension on the tow band and deflection of the filaments therein, causes each filament in the tow band to break; however, because there is a relatively large number of individual filaments, often 100,000 or more, and the breaking action takes place continuously, the breaks in the individual filaments occur at different times and places along the length of the tow bundle and the continuity of the tow ribbon is not destroyed.

Although the variable staple fiber array from the Turbo Stapler generally gives quite even yarns, undesirably short fibers are sometimes produced, i.e., shorter than desired in the particular array. Such short fibers are prone to create fly in the mills and can even cause neps, i.e., small, tightly tangled masses of fiber, in the yarn. Proper adjustment of the width of the tow band and the breaker bar depth is deemed essential in order to keep short fibers, hence, fly, to a minimum. However, with the width control device currently used on the conventional Turbo Stapler, a mere curved bar spreader, the tow is often unevenly spread. In some instances, depending on the relative position of the curved bar spreader with respect to the traveling tow ribbon, i.e., whether the tow ribbon is riding on the convex or concave surface of the bar, the filaments in the tow ribbon have a tendency to spread out more to either side of the curved bar spreader than to the center thereof. This results in a tow ribbon having a thin center and relatively thick edges. At other times, the filaments in the tow ribbon tend to bunch-up, thus resulting in thin edges and a relatively thick center. Moreover, if the air spreader is out of adjustment and is, for example, providing a tow ribbon wider than that desired, the curved bar spreader, in contrast to the inventive device hereinafter described, is unable to compensate for the lack of width control. In fact, such lack of width control may even be enhanced by the curved bar spreader. It has also been observed that with meandering filaments, i.e., filaments within the tow band which are not parallel to the direction of travel thereof, but which traverse back and forth across the width of the ribbon along its length, such filaments tend to cause the rest of the filaments within the ribbon to be bunched together. Such results in density variations, i.e., uneven density, regions of high and low density being indiscriminately produced laterally across the tow band, as well as width variations, i.e., the tow band varies in width along its length. In a dense tow band the continuous filaments comprising such band tend to be chopped or cut rather than randomly broken, as is desired. Moreover, density variations laterally of the tow and cause non-uniform breaking and a different staple fiber pattern array, other than that desired, to be produced in different parts of the tow band. As abovementioned, production of short fibers should be kept to a minimum because of their tendency to cause formation of neps. Moreover, the production of extra long fibers should also be kept to a minimum because such often results in roll wraps around the front or output rolls of the Turbo Stapler. Quite desirably,

the staple array is such that the short fibers are not more than about three inches shorter than the longer fibers. For example, the minimum staple fiber length produced on the Turbo Stapler is about three inches and the maximum length is about 14 inches. Desirably, with either such fiber length being produced the staple fiber array should range from about 3–5 inches and from about 11–14 inches, respectively. The undesirably non-uniform breaking results in a lack of cohesion between the fibers within the sliver, i.e., it is pulled apart during subsequent drafting thereof, and formation of slubs, i.e., thick and thin places in the top or sliver. These defects, e.g., neps and slubs, are carried forth in the subsequent processing of sliver to yarn. Even if the sliver is not pulled apart during drafting thereof at a region of low density (thin place), the neps and slubs adversely influence the dyeing characteristics of the yarn. Thick and thin places within the yarn result in non-uniform dyeing, i.e., a thin place is dyed to a darker shade than is a thick place.

To compound the problems created by the curved bar width control device conventionally used, as above-mentioned, tow bundles received from the man-made fiber manufacturer are often non-uniform in width or thickness or both. Thus, the curved bar spreader conventionally used is often called upon to make a non-uniform tow uniform when in most instances it cannot adequately ever retain a uniform tow band in such state, as is above discussed fully.

It is, therefore, the primary object of my invention to avoid the numerous disadvantages and problems above-mentioned.

It is another object of my invention to provide improved man-made staple fiber yarn having fewer neps and slubs.

It is a further object of my invention to provide an improved apparatus for processing tow-to-top.

It is an additional object of my invention to provide a novel device for subdividing a tow band into a plurality of subdivisions and for maintaining uniform the width of a ribbon or band of continuous filaments.

It is still an additional object of the invention to provide an improved process for manufacture of sliver.

Other objects of the invention will become more apparent after reading the following detailed description and examining the drawing wherein:

FIGURE 1 is a schematic diagram of a tow-to-top process and apparatus for manufacture thereof;

FIGURE 2 is a side elevation of a device according to my invention; and

FIGURE 3 is a greatly enlarged view of a segment of one of the fins of the width control device shown in FIGURE 2.

In accordance with the general aspects of my invention, I provide a width control device comprising a body having a plurality of evenly spaced fins thereon defining a plurality of evenly spaced grooves for spreading and retaining a band or ribbon of continuous filaments as they pass over the device whereby the width and thickness of the band is maintained uniform during processing.

As used herein, the term "fin" includes not only fins, ridges, circular rings or the like which are cut into a body, much like the threads cut into a bolt but the term "fin" also includes those fins, ridges or rings which are additionally placed on a body and secured thereon to form a more or less integral unit, as by welding, adhesive bonding or the like.

Referring now to the drawing, there is shown in FIGURE 1 a schematic presentation of a conventional Turbo Stapler, with the width control device of this invention in combination therewith, for converting a tow band or ribbon of man-made continuous filaments **10** into a sliver **11** of man-made staple fibers. Tow is forwarded as a ribbon or band **10** from a bale of tow (not shown) over a conventional air spreader (also not shown) whereby the tow ribbon is spread laterally to from about 1.5 to 3 times its width in the bale, i.e., the ribbon is spread from a width of about 2 inches to a width of from about 3 to 6 inches, preferably about 3½ inches.

Tow ribbon **10** is then passed over snubbing bars **12** and **13**, and centering control bar **14**, all of which are of conventional design. After leaving centering control bar **14**, the tow ribbon **10** is then passed over width control device **15** according to my invention and thence to the nip of rolls **16, 17** in the infeed section of the Turbo Stapler.

The tow ribbon **10** is then passed over a first set of snubbing bars **18, 19, 20, 21** in the infeed section, through heater **22** (optional) and over a second set of snubbing bars **23, 24, 25, 26** before entering the nip formed by intermediate rolls **27, 28**. In the draw zone, created by the fact that rolls **27, 28** operate at from about 1.5 to about 6 times the peripheral speed of rolls **16, 17**, the tension on the ribbon **10** of continuous filaments serves to further provide an even feed to the breaking zone, which is hereinafter described. In certain instances, and if desired, the continuous filaments in the tow band can actually be stretched in the presence of heat for particular effects. Merely by way of example, polyester filamentary tow when heat stretched at about 350° F. before entering the breaking zone results in the production of less fly than when entering the breaking zone after being cold stretched.

Tow band **10**, containing a multitude of individual, continuous filaments, i.e., in the unbroken state, is then passed under an increased tension into the breaking zone defined by intermediate rolls **27, 28**, front pressure rolls **29, 30** and breaking bars **31, 32**. By way of example, a draft of from about 2.5 to 7.5, preferably about 3.0 in the case of polyethylene terephthalate filaments having a filament denier of about 5 and a total denier of about 200,000 is used in the breaking zone. Each filament, as the tow ribbon is gripped by the front rolls **29, 30**, is subjected to an increasing tension by this draft. At the same time, the filaments in the tow band **10** are deflected from the normal straight line path between the nips of the intermediate rolls **27, 28** and front rolls **29, 30**, as is shown in FIGURE 1 of the drawing, by the edges of the breaker bars **31, 32**. This combined action on the tow ribbon, i.e., the tension thereon and the deflection thereof causes each filament in the tow ribbon to break, but since there are upwards of 100,000 filaments or more in a tow ribbon **10** and because the action takes place continuously, these filament breaks occur at different times and places with respect to the individual filaments and the continuity of the tow band is therefore not destroyed. Sliver **11**, i.e., a bundle of loosely assembled staple fibers, is discharged from front rolls **29, 30** in the form of a web about 3 to 6 inches in width, depending upon the width of the tow ribbon presented to the infeed section, and which in the case of polyester staple fibers weighs about 110 grains/yd. The sliver **11** is then folded, rolled, bunched together, or otherwise condensed into a ropelike strand approximately uniform along its length in cross-sectional area of loosely assembly fibers without twist having a diameter of about 1 inch. It is then crimped in a conventional stuffing box crimper **33** and is dropped into cans (not shown in the drawing), where it is retained until being further processed, according to usual techniques, into a suitably desired spun yarn.

The structure and operation of my novel width control device **15**, as is more clearly shown in FIGURE 2, will now be more fully described. Width control device **15** preferably comprises an elongated body **34** having the general shape of a right cylindrical shaft or rod. The ends **35, 36** thereof are preferably adapted for fixedly supporting the width control device. If desired, however, the width control device may be also either positively driven according to usual techniques or merely freely rotatable. Quite obviously, if positively driven, the end portions **35, 36** of the device should preferably be square-

shaped, hexagonal or other polygonal shape, roughened or the like to reduce the likelihood of slippage and make for more positive rotation thereof. Intermediate ends **35, 36** there is provided an elongated body **34** a portion thereof designated generally by reference numeral **37** of lesser diameter for a purpose hereinafter described. A plurality of fixed spaced-apart fins or ridges **38**, which preferably are evenly spaced with respect to one another, are located in series axially along reduced body portion **37**. The fins **38** can be cut into body **34** as are threads on a bolt or the like or otherwise placed on the body portion **37**. For example, circular rings or fins of the required shape and diameter may be prepared by conventional cutting and grinding techniques, positioned on body portion **37** and then secured thereto as by welding, adhesive bonding or the like. The fins **38** extend continuously around the periphery of body portion **37** as a circular ring and are parallel with respect to one another. Moreover, they extend in planes which are perpendicular to the axis **39** of the cylindrical body **34**. The fins **38**, as seen in FIGURE 2 of the drawing, have the same outside diameter as do ends or shoulders **35, 36** of body **34**. Such diameter is not deemed critical but by way of example quite suitably can be from about ½ inch to about 3 inches or more. Preferably, however, and from an obviously practical standpoint, the outside diameter of fins **38** is from about 1–2 inches, even more preferably about 1¼ inches in diameter. Each adjacent pair of fins **38** defines a groove **40** in which is carried and retained during its forward movement through the Turbo Stapler a portion of the continuous filaments of tow ribbon **10**.

The grooves **40** defined by fins **38** have a flat bottom or base **41** thereto which is formed by the body portion **37** extending between adjacent fins **38**. Groove **40**, as seen in FIGURE 2, is wider at the top than at the bottom thereof because of tapered sidewalls **42** of fins **38**. Such configuration permits the filaments in the tow ribbon **10** to more easily slip into their respective grooves, and allows meandering filaments to redistribute themselves with the tow ribbon **10** without breakage thereof. Moreover, with such configuration, and apparently because the grooves are relatively shallow, the tow ribbon is presented to the infeed section of the Turbo Stapler as a single ribbon and not as a plurality of bundles of fibers. Moreover, as more clearly shown in FIGURE 3, fin **38** has flat annular sidewalls **43**, which are parallel with respect to one another and which connect respectively with tapered sidewalls **42**. The flat sidewalls **43** are, as above-mentioned, perpendicular with respect to axis **39** of elongated body **34**. The tapered sidewalls **42**, which may have an angle of taper with respect to sidewalls **43** of from about 30 to 75 degrees, preferably about 60 degrees, joint relatively flat annular surface **44** which forms a flattened top for ridges or fins **38**. The relatively flat annular surface **44** is provided by bringing the tapered edge formed by the function of tapered sidewalls **42** to a relatively sharp point with a radius of at least 0.003 inches. Conveniently, annular surface **44** is from about 0.001 inch to about 0.008 inch width. Such flattened tops permit stray filaments, i.e., filaments which are not parallel to the direction of travel of tow band or ribbon **10** to pass thereover without breakage.

While the dimensions of width control device **15** are not deemed critical and may be determined to some extent by the particular use to which the device is put, other uses being hereinafter referred to, it has been found that the width $w$ of fin **38** should be relatively small compared to the spacing $s$ between any two adjacent fins **38**. Quite preferably, the ratio of spacing $s$ to width $w$ (both in inches) should be at least 2:1 or even greater. Merely by way of example, satisfactory results have been obtained when $s$=¼ inch and $w$=⅛ inch. As above mentioned, body portion **37** is of lesser diameter than ends **35, 36** of body **34**. It is therefore obviously also of lesser diameter than fins **38**, thereby providing some depth to groove **40**, which depth can be from as little as about ⅛ inch to as much as about ¾ inch, depending upon the particular use to which the device is put. Preferably, however, the groove should be at least about ¼ inch deep. Fins **38**, as is more clearly shown in FIGURE 3, are tapered at the outer periphery thereof, the tapered sidewall **42** beginning at about the midpoint of the groove depth dimension. For example, if groove **40** is ¼ inch deep, then tapered sidewall **42** begins ⅛ inch from groove bottom **41**.

In use, tow ribbon **10** is relatively uniformly spread by hand over the width control device **12** so as to be subdivided into approximately equal portions into grooves **40**. Tow ribbon **10** is thus presented to the infeed section of the Turbo Stapler with a relatively more uniform depth or thickness and is retained by the grooves in a uniform width. It is deemed quite apparent that by maintaining the ribbon of substantially uniform thickness and width that a tow ribbon is presented to the breaker bars of substantially uniform density, thereby avoiding the problems and disadvantages above-mentioned. Slight tension on tow band **10**, as provided by rolls **16, 17**, tends to maintain the individual portions of the tow band **10** in grooves **40**. Moreover, the tow band tends to keep the original dimensions and shape resulting from passing over the width control device hereinabove described.

The following example is given to further illustrate the present invention but is not intended to be limiting thereof.

## EXAMPLE

A tow ribbon or bundle of 120,000 continuous filaments about 2 inches wide comprising polyethylene terephthalate having a total denier of about 240,000 and a filament denier of 2 is withdrawn from a bale thereof. The tow ribbon, having previously been crimped, is threaded into a Turbo Stapler according to the usual techniques and as is described more fully above with respect to the detailed description of FIGURE 1. The tow ribbon is passed over a conventional air spreader (not shown) to expand it to a ribbon or web **10** thereof of about 3½ inches in width. The air spreader comprises a pair of spaced-apart plates provided on their opposed faces with longitudinal slits through which compressed air is directed against the tow. Ribbon **10** is then spread by hand over tow spreading and width control device **15** and is thereby divided into a number of bundles of filaments of approximately equal portions corresponding to the number of grooves in the width control device. The filaments in the tow ribbon are more or less evenly distributed to give a ribbon of about uniform density laterally thereof. With the aid of fins **38** and grooves **40** the tow ribbon feeding into the infeed section of the Turbo Stapler is maintained at a uniform width corresponding to the distance between the outside grooves of the width control device.

Width control device **15** comprises an elongated circular body **34** about 20⅞ inches long having a diameter at the ends **35, 36** thereof of about 1¼ inches. About 1½ inches in from the right end **35** of the body **34** as viewed looking at the body located in the support mechanism therefor, there are provided a plurality of circular fins **38** of about ⅛ inch thickness which are spaced ¼ inches apart, i.e., measured at the flat base **41** of the groove **40** which is defined by adjacent fins **38**. At the other end of the body **34** is provided a longer axis of about 11½ inches in length. The fins **38** are concentric with circular body **34** and of equal diameter, namely, 1¼ inches. Each fin **38** has a flat top surface **44** of about 1/32 inch which is centered between the two flat sidewalls **43** thereof. The sidewalls **43** are in two spaced-apart planes perpendicular to the longitudinal axis **39** of the elongated cylindrical body **34**. The top surface **44** and sidewalls **43** are connected together by flat tapered surfaces **42** which form an angle of about 64 degrees with respect to sidewalls **43**.

The groove **40** defined by each pair of adjacent fins **38** has a depth of about ¼ inch. Although the groove is ¼ inch in width at the bottom thereof, it fans out at the top, i.e., ⅛ inch from groove bottom **41**, because of tapered surface **42** to a width of about 3/16 inch.

Slight tension on the tow ribbon **10**, provided by rolls **16, 17**, tends to maintain the individual portions or divisions of the tow band **10** in the grooves **40** and to maintain the configuration of the tow band, as above-discussed. Stray filaments within the tow ribbon **10** which are not parallel longitudinally to the direction of ribbon travel are engaged by the tapered surfaces **42** of the fins and tend to redistribute themselves within the ribbon. In this attempt to uniformly distribute themselves individual filaments, or small groups thereof, meander back and forth across width control device **15** without filament breakage. Apparently breakage is precluded because of the tapered sidewalls and slippage between the filaments engaging the surfaces of the fins **38**. Other stray filaments which pass over the tops of the fins are not broken and tend to maintain band integrity.

Intermediate rolls **27, 28** are operated at a slightly greater surface speed than rolls **16, 17**, e.g., about 10% greater in order, to maintain a slight degree of tension on the tow ribbon **10** entering into the breaking zone. Front rolls **29, 30** are operated at a peripheral speed of 600 f.p.m. in order to provide a draft of about 3 on the filaments of the tow ribbon. Breaker bars **31, 32** are positioned ahead of front rolls **29, 30** in accordance with the usual techniques whereby a staple fiber array of from about 3 to 5 inches is provided. Sliver **11**, about 3½ inches wide, is folded and rolled so as to provide a generally circular bundle of loosely assembled staple fibers about 1 inch in diameter after which it passes through the crimper **33** and is collected into cans for further processing into staple yarn according to usual techniques.

While only a single width control device **15** has been shown in the drawings and described above, it is understood, of course, by those skilled in the art, that a number of such devices can be used in series to control the width of tow ribbon **10** in the Turbo Stapler. Moreover, such a device can either be used in place of the conventional curved bar spreader or in addition thereto, as desired.

The tow spreading and width control device **15** can be made of any suitable material, e.g., metal, plastic, rubber or fibrous material, or any combination of the same. If the cylindrical body is entirely of metal, plastic, or the like, i.e., a solid body of the same, then alternating fins and grooves may be cut therein according to conventional cutting techniques or the like. Where the roll exterior is not metallic the roll may have a metallic cylindrical core body coated with a layer of rubber or like elastic material. The configuration of alternating fins and grooves may then be created by forming angular threads or rings in such elastic by cutting, molding or other such conventional techniques.

While for purposes of illustration the width control device is shown having circular grooves, it will be understood, of course, that this configuration is desirable from ease of machining and an economical standpoint. An arcuate groove is preferred, although not necessarily circular, over a longitudinal type groove for the reasons that contact of filaments with a round or arcuate surface may be tangential and offers less frictional contact than would a parallel contact of the filaments with the surfaces of a longitudinal groove.

While the tow in the example given is composed of a plurality of polyethylene terephthalate continuous filaments, it is, of course, understood by those skilled in the art that tows of any continuous filamentary material are included herein. Merely by way of example, the filamentary material may be an organic derivative of cellulose, e.g., esters or ethers of cellulose such as cellulose acetate and triacetate, rayon (regenerated cellulose), linear superpolyamides such as nylon 6 and nylon 66, acrylonitrile polymers and copolymers, and the like. The number of filaments and the total denier can vary within wide limits, e.g., the number of filaments generally ranges between about 10,000 and 200,000 and the total denier ranges from 40,000 to 450,000, computed on uncrimped tow.

Although the invention is more particularly described hereinabove with respect to producing staple sliver from a filamentary tow bundle, it is, of course, not deemed to be so limited. The novel guide means of my invention may be used wherever it is desirable to maintain uniform the width, and additionally, in some instances, the depth or thickness, of a band or ribbon of tow. For example, my novel guide means may be used in combination with a crimping apparatus such as a stuffing box crimper whereby a tow ribbon of uniform width and depth is provided to the crimping chamber. To secure uniform crimp, it is important that the tow be presented to the crimper as a flat band of uniform width and thickness. Contrary to the "shoestring" effect, i.e., individual strands being discernible in the crimped tow, such as is formed by reeds in forming tow into a ribbon of uniform width and thickness, the tow ribbon made uniformly wide according to the invention is presented to the crimper as one composite group of parallel filaments.

Another application of the inventive device is in splitting crimped tow into bulky yarns which can be used, for example, in carpets. The device acts both as a guide for the individual yarns and also as a divider for the individual yarns so that the ends thereof may be leased at certain intervals for subsequent separation or treatment. The device may be used in a process for manufacturing crimped continuous filament yarns by combining yarns, crimping, and separating the crimped yarns. Using the finned guide roll, acetate tow, e.g., separates easily into the original yarn components combined to form the tow before crimping. The yarns are maintained substantially separate and parallel with each other before they pass to the crimper. After separation, generally after a crimp setting operation, the continuous filament yarns are wound upon bobbins ready for subsequent twisting, winding, and fabrication. Such a process has certain economical advantages because many yarns can be crimped simultaneously, at the metier, for example, and tow, since it can be easily separated into crimped yarns, instead of packages, can be shipped to customers.

It is deemed readily apparent from the above that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore, is not intended to be limited except as indicated in the appended claims.

What is claimed is:

**1.** In combination with an apparatus for converting a bundle of continuous filaments into discontinuous fibers of varying predetermined lengths including means for forming said continuous filaments into discontinuous fibers, and means for feeding the continuous filament bundle to said forming means, a device for separating said bundle of continuous filaments into a plurality of subdivisions and for controlling the width of the bundle of continuous filaments presented to the forming means, said device being positioned prior to said feed means and comprising a body having a plurality of fins thereon concentrically positioned around a common axis, said plurality of fins defining a pluarlity of grooves for supporting and retaining the bundle of continuous filaments as said bundle passes over the device wherein adjacent fins are spaced-apart from ⅜ inch center-to-center thereby defining a groove of about ¼ inch wide, the annular surface of each fin being about 0.001 inch wide and being interconnected to the sidewalls at a point about

midway thereof to provide a tapered edge to the fin and to thereby provide each groove with a depth of about ¼ inch.


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