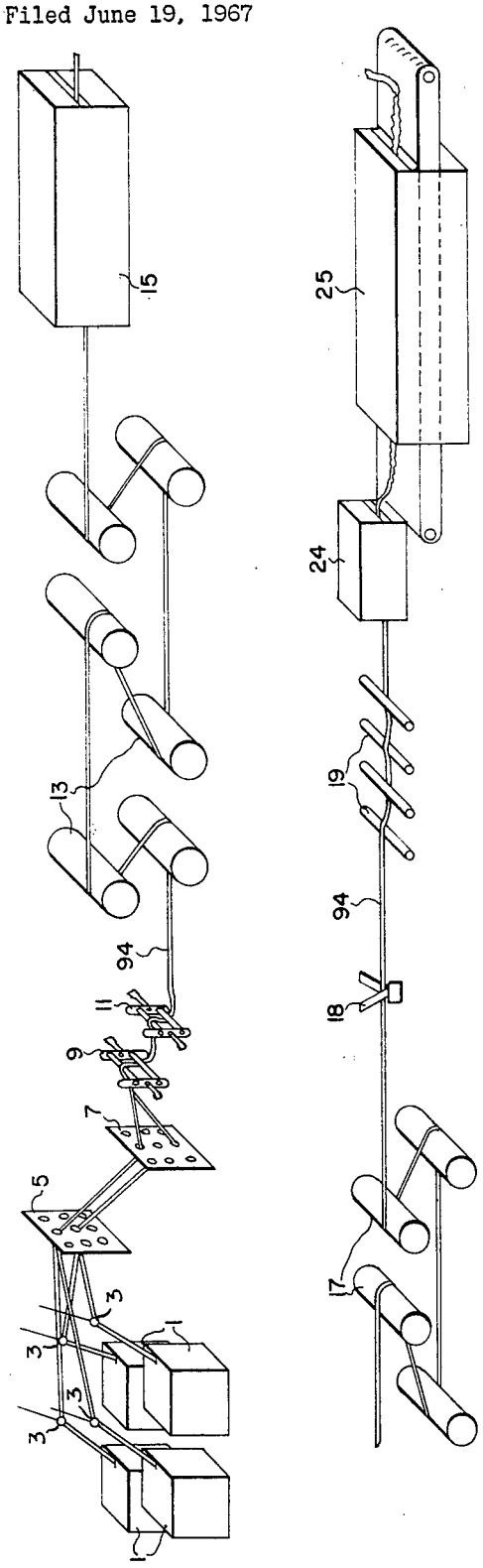
March 31, 1970 T. W. GLYNN III, ET AL 3,503,100

METHOD OF PROCESSING LARGE DENIER TOW

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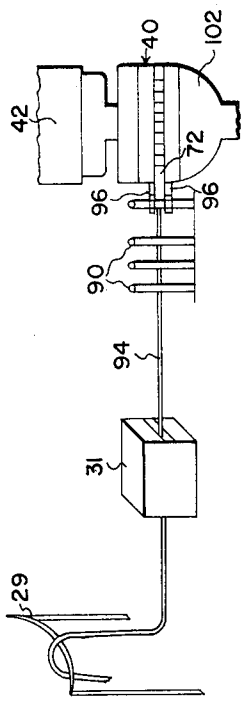


FIG. 1

Garland B. Keith
Theodore W. Glynn III
INVENTORS

BY William J. French
William P. Heath Jr.
ATTORNEYS

March 31, 1970 T. W. GLYNN III, ET AL 3,503,100

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FIG. 2

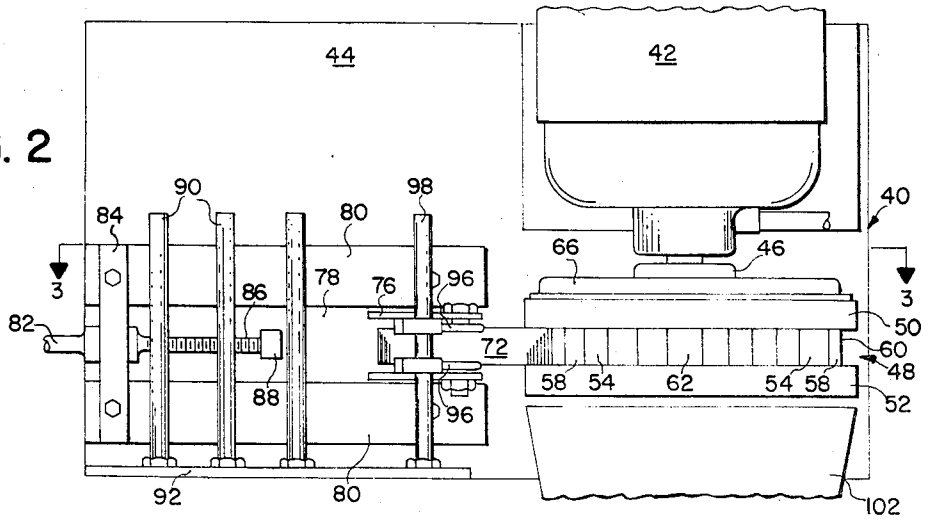
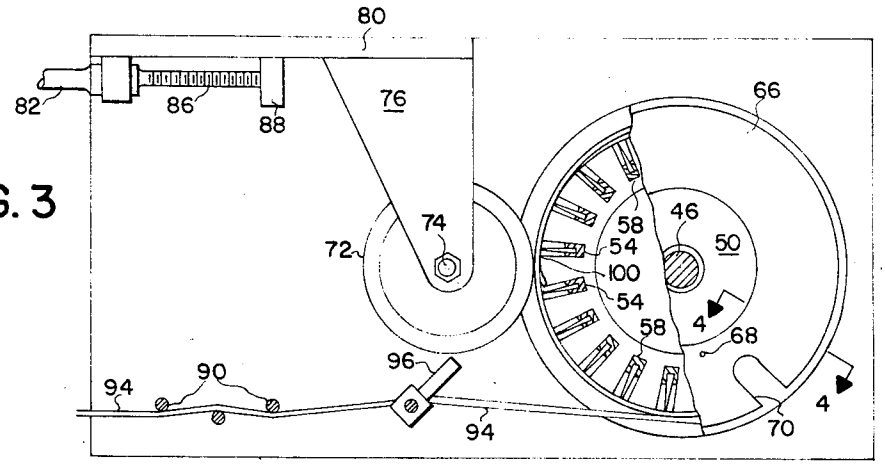


FIG. 3



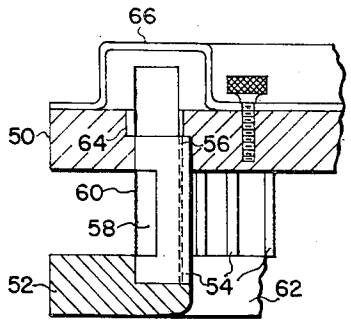


FIG. 4

Garland B. Keith
Theodore W. Glynn III
INVENTORS

BY William J. French
William P. Heath Jr.
ATTORNEYS

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Patented Mar. 31, 1970

3,503,100

METHOD OF PROCESSING LARGE DENIER TOW

Theodore W. Glynn III, and Garland B. Keith, Kingsport, Tenn., assignors to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

Continuation-in-part of application Ser. No. 577,930, Sept. 8, 1966. This application June 19, 1967, Ser. No. 646,855

Int. Cl. D01g 1/00

U.S. Cl. 19—.32

6 Claims

ABSTRACT OF THE DISCLOSURE

Method of continuously processing a tow of at least 800,000 total denier at speeds of at least 70 meters per minute. The process includes drafting, crimping, heat setting, lubricating and cutting the tow into predetermined lengths.

This application is a continuation-in-part of application Ser. No. 577,930, filed Sept. 8, 1966.

This invention relates to a novel method for processing large denier tows of filamentary material. More particularly this invention relates to a novel method for processing a tow of at least 800,000 total denier including drafting, crimping, heat-setting and cutting the tow into desired lengths at a rate of production of at least 70 meters per minute.

Prior art methods for processing single large denier tows were severely limited as to the rate of feed of the tows onto the processing line and as to the total denier of tow that could be satisfactorily drafted, crimped and cut in a continuous manner. When dealing with large denier tows being processed at high speeds it is obvious that problems which were merely annoying with smaller denier tows and slow production rates become major problems. For example, when as large a tow as 800,000 to 1,000,000 total denier is being fed onto the line it becomes very important that twist is removed. The tow must be laid on the feed rolls in a band that is not tangled or twisted and it must be of uniform thickness and width to insure a constant quality finished product.

Other problems which are generated by the large tow is that the tow must be fed to the crimper in the form of a highly uniform band if proper crimping is to be effected. Poor uniformity will cause the crimper to jam and as a result cause a shutdown of the line. As the tow leaves the crimper it must be heatset. This tends to cause folds in the tow which must be removed before the tow is passed through a lubricating both to insure uniform lubrication of the tow. After the tow leaves the lubricating booth and before it is moved into the cutting operation it is necesary that means be provided to reform the tow into a uniform band before it is fed into the cutting apparatus.

Prior methods of processing a single large denier tow have been severely limited by the operational inability of existing cutting apparatus to satisfactorily cut the tow into staple lengths or flock lengths when the processing line is being run in excess of 70 meters per minute. Many types of cutting devices and methods for dividing elongated material into short lengths are known. While some of these devices perform with a reasonable degree of satisfaction at lower speeds, they all have inherent faults when run at higher production rates and especially when the cutting of continuous filamentary material into staple fibers is involved. For example, in these prior art devices there is at some time during the cutting cycle, a movement of the cutting surface longitudinally of the fiber. Such longitudinal movement, although of short duration, occurs with great impact and at very high rates

of speed. This noncutting contact between the fiber and the cutting edge is highly undesirable since the lengthwise motion of filaments with the respect to the knife edge causes dulling of the edge and, hence, short knife life.

An undesirable result of dull cutter edges is the generation by friction of higher than usual amounts of heat. Oftentimes the amount of heat generated is sufficient to cause the ends of the adjacent fibers to fuse together, a condition which from a quality control standpoint is highly undesirable.

Some efforts have been made to overcome the shortcomings of prior art cutters. For example, in order to alleviate the welding or fusing of fibers to a degree, the tow is cut while wet. Thus, excess frictionally produced heat is dissipated by evaporation of the wetting agent. This solution, however, adds additional problems in that the wet staple produced is expensive to dry and requires the addition of equipment and processing steps to the production line.

Therefore, it is apparent that the development of a method by which tows of at least 800,000 total denier can be successfully drafted, crimped, heatset and cut into staple or shorter lengths at speeds of 70 meters per minute and higher represent a major advance in the manufacture of staple length synthetic fibers.

This invention has for one object to provide a method for use in the processing tows of filamentary material having a total denier of at least 800,000 at speeds in excess of 70 meters per minute. A further object is to provide a method to control the tow sufficiently to maintain a uniform band which is free of twist and folds during processing. A particular object is to provide a method to continuously draft, crimp, heatset and cut into staple lengths tows which are processed at a rate of at least 70 meters per minute and that are of at least 800,000 total denier.

For a more complete understanding of our invention reference is made to the attached drawings forming a part of the present invention.

FIGURE 1 is a diagrammatic view of apparatus which may be used to carry out our novel method of processing large denier tows at high speeds;

FIGURE 2 is a side elevational view of a cutting apparatus which may be used in our novel process; and

FIGURE 3 is a view taken along line 3—3 of FIGURE 2 showing the specific relationship between the cutting reel, the pressure applicator and the material being severed;

FIGURE 4 is an enlarged, detailed, fragmentary view taken along line 4—4 of FIGURE 3 showing the manner in which the blades are secured in the cutting reel.

Reference is now made to FIGURE 1 schematically showing the equipment necessary for running a tow of at least 800,000 denier at speeds of at least 70 meters per minute. The creeling equipment for the processing production line includes a plurality of puddling boxes **1**, tow guides **3**, and eyeboards **5** to guide the puddled ends from the boxes **1** to the second eyeboard **7** near the feed rolls **13**. The number of puddling boxes used in a creel of yarn depends upon: (1) The denier per cabinet end, (2) The number of cabinet ends per puddling box or denier per puddled end, and (3) The total denier that is being processed.

Above each box the puddled end passes through creel guides **3**, located over each box. Each end is run through an eyeboard **5** and then through a second eyeboard **7**. As illustrated, the two eyeboards are angularly offset relative to each other in such a manner that each end is drawn through the eyeboard **7** at an angle rather than straight through the eye. The purpose of this angle is to

remove folds and false twist which may occur as the ends are pulled from the puddling boxes.

After the ends pass through the last eyeboard **7**, they are run through a set of leveling bars **9**, **11**, which operate to finish the process of tensioning and forming the tow into a band of ends which are substantially parallel, free of folds and entanglement, the band thereby being uniform in width and thickness. This thickness and width control is critical since anything less will interfere with the drafting and further processing due to lack of uniformity of the drafted tow. The leveling bars may be made as a pair of parallel rods spaced several inches from each other in such a manner that the tow runs over one bar and under the second bar along a generally S-shaped path. This bar arrangement functions to flatten the tow band and to apply some tension thereto as it is drawn around the bars.

After the tow is properly banded it is then fed onto a series of feed rolls **13**. Any desired number of feed rolls may be used so long as they are sufficient in number to prevent slippage as the tow is fed into the drafting zone of the process. In drafting the tow the feed rolls **13** feed the tow into a steam chest **15** or the like where the tow is heated to enhance drafting. The drafting rolls **17** are normally run at surface speeds which are about 200% to 600% faster than the surface speeds of the feed rolls. This difference in surface speed of course determines the draft ratio. As the drafted tow leaves the drafting rolls it is fed into a crimper. It is desirable that the tow leaving the drafting rolls have a uniform thickness before it is fed into the crimper. Therefore, we provide a guide **18** for condensing the tow as it leaves the drafting rolls.

The guide **18** may be constructed as a V-shaped member with the arms thereof being adjustable relative to each other. This adjustment makes possible the control of the tow width within desired ranges.

The tow band of 800,000 denier or larger is condensed by guide **18** and then is passed through snubbing bars **19** for flattening and then it is fed into the crimper **24** for crimping. The crimper **24** may be of the stuffer box type where two opposing rolls under pressure force the tow into a chamber with a constricted exit causing the tow to be folded and packed upon itself to form a crimp. Normally, steam is admitted into the crimper at a rate sufficient to obtain a sharply defined crimp suitable for tow processing of for filling type staple. If the tow band is not properly condensed and shaped before it is fed into the crimper the crimper tends to jam and cause shutdowns to repair the equipment.

After the tow leaves the crimper **24** it is puddled again on a conveyor which carries it into a heatsetting oven to set the crimp and to rid the tow of residual moisture remaining after crimping. As the tow comes out of the dryer it is permitted to cool before it is removed from the apron of the conveyor **25** to prevent removal or reduction in the crimp as it is subsequently lubricated and cut into staple length. The tow as it is picked up from the apron of conveyor **25** is pulled over a guide bar **29** which is elevated and which will remove any twist or folds in the puddled tow as it is picked up from the apron.

As the tow enters the lubrication booth **31**, it passes over suitable guides, and as it passes through the booth a fiber lubricant is applied to evenly coat the fiber at a uniform level. This lubricant is applied to control static in subsequent operations without causing loading of carding machines or roll wrapping due to excessive lubricant. The lubricant is normally an oil, but emulsions may also be used if properly handled to prevent separation.

After the tow leaves the lubricating booth it is run through a series of finger guides (as seen in FIGURES 2 and 3) to shape the incoming tow into a flattened tape or band. From the finger guides the filamentary material or tow passes through rounded edge guides (as shown in FIGURES 2 and 3), These guides serve the dual function of controlling the width of the tow tape or band so that it may be wound snugly upon the blades of the cutter (hereinafter described) and to act as a friction brake to place the tow under tension sufficient to temporarily straighten the crimped tow to be wound onto the blades of the cutting apparatus. As the tow is wound on the cutting apparatus in touch contact with the blades a light but firm pressure is applied radially inwardly of the cutting reel to cause the tow to be severed into predetermined lengths. As each wrap or layer of tow is cut another wrap or layer is wound on the outermost layer of uncut tow remaining on the cutting apparatus.

The cutter used in our invention is fully described in copending U.S. application Ser. No. 577,930, filed Sept. 8, 1966. However, for the sake of completeness a general description of one embodiment of the cutter follows. In FIGURE 2, reference numeral **40** designates generally a cutting apparatus including a driving motor **42** mounted on a base **44** with its output shaft **46** connected in a suitable manner to a cutting reel or assembly designated generally by reference numeral **48**. While the means for supplying driving power to the cutter is described as a motor it may as well consist of a gearbox receiving power from a rotating shaft common to several machines.

The cutting reel or assembly **48** consists of a mounting member including a disc **50**, to which the output shaft **46** is removably connected, and a mounting ring **52** both of which are formed of generally flat plates of suitable material. As best shown in FIGURE 4, the mounting disc **50** and the mounting ring **52** are secured together in spaced, parallel relationship by a plurality of U-shaped connector lengths **54** which are secured in position by any of a number of well known expedients such as, for example, furnace brazing. A narrow slot **56** extends through both mounting disc **50** and mounting ring **52** as well as each connector length **54** for a purpose to be hereinafter more fully described. As shown in FIGURE 3, the connector lengths **54** are normally secured between the mounting disc **50** and the mounting ring **52** at equal distances radially outwardly from the shaft **46**, which also defines the axis of rotation of the cutting reel **48**. The circumferential spacing between connector lengths **54** is determined by the staple length desired as will be fully discussed hereinafter. While the device described above is a preferred construction, a configuration in which the ring **52** is not secured to mounting disc **50** by connectors **54** can be successfully utilized when the material to be cut is not excessively heavy wherein the clamped knife blades **58** are the sole structural tie between disc and ring.

A manner of mounting the knife blades **58** is illustrated in FIGURES 2–4. As shown therein the knife blades **58** are removably mounted or inserted in slots **56** in connector lengths **54** with the cutting edge **60** extending radially outward. Since the connector lengths are disposed radially from the output shaft **46** and the axis of rotation of the cutting assembly **48**, the knife blades **58** are likewise disposed. The width of blades **58** from cutting edge **60** to back is substantially less than the radial distance from the axis of rotation of the cutting reel **48** to the edge **60**. Thus, the mounting disc **50**, the mounting ring **52**, and connector lengths **54** in which blades **58** are supported form an open ended compartment **62** within the cutting reel **48**. The purpose and function of the compartment **62** will be described hereinafter in connection with the discussion of the mode of operation of this novel cutting apparatus.

As the knife blades **58** are of such a length usually slightly more than twice the distance between disc **50** and ring **52** so that they will extend through a plurality of radially extending slots **64** formed in the mounting disc **50** to a point above its surface. Thus, blades **58**, which simply rest within slots **56** in connector lengths **54** are readily removable from the cutting reel **48**. An annular cap **66** protects the upper end of blades **58** as well as the operator attending the apparatus. The cap **66** is secured to the mounting

disc 50 by suitable means such as thumb screws 68. When screws 68 are removed the cap 66 can be rotated relative to disc 50 so that individual blades 58 can be removed from the cutting reel 48 by aligning them with a slot 70 formed in the side of cap 68. Thus, as the knife edge 60 on a blade 58 becomes dulled through usage it can be easily replaced or, if the upper end has not yet been utilized, turned end for end to present a fresh, sharp cutting surface.

As best shown in FIGURES 2 and 3, a pressure applicator 72 of the rotatable type such as a wheel or roller is mounted on a shaft 74 secured to a bifurcated bracket 76 which in turn is supported on a movable slide 78 fitted into elongated ways 80 secured to the base 44. Regulated movement of the slide 78 is accomplished by a lead screw 82 rotatably secured in a pillow block 84 fixed in position relative to elongated ways 80 and thus to the base 44. One end 86 of lead screw 82 is threaded into an appendage 88 integral with or otherwise fixed on the surface of the movable slide 78 to move relative to elongated blocks 80 and base 44. This structure, a lead screw actuated slide and ways assembly well known in the art, provides for movement of pressure roll 72 relative to cutting reel 48 and minute adjustment of the space between it and cutting edges 60. The reason for such a minute adjustment will become more apparent hereinafter in connection with the discussion of the mode of operation of this device.

A plurality of finger guides 90 or others well known in the art extend outwardly from a plate 92 secured at right angles to the base 44. The finger guides 90 shape the incoming filamentary tow 94 into a flattened tape or band. From the finger guides 90 the filamentary material or tow passes through rounded edge guides 96 which are pivotally mounted on an elongated rod 98 secured, as are finger guides 90, to place 92. Guides 96 serve to control the width of the flattened tape band 94 so that it will wind snugly between mounting disc 50 and mounting ring 52 of the cutting reel 48. In addition to flattening the incoming tow 94, the finger guides 90 also serve as a friction brake to place the tow under a controlled amount of tension as it is fed into the cutting reel 48.

In operation of this cutting apparatus, the incoming filamentary tow which has been flattened into a tape on finger guides 90 and shaped by the edge guides 96 is fed into the rotating cutting reel 48 and wrapped therearound between mounting disc 50 and mounting ring 52. Thus, as shown in FIGURE 3, the tow is in touch contact with cutting edges 60 or knife blades 58 which form the bottom of reel 48. The tow 94 is wrapped upon itself in layers until the distance between knife edges 60 and pressure roll 72 is filled. As the cutting reel 48 rotates under the influence of motor 42 or other drive means, the feed of filamentary tow 94 continues causing pressure to build up within a chamber defined by the pressure roll 72, mounting disc 50, mounting ring 52, and the adjacent knife blade 60 which, at a point in time, is closest to the pressure roll 72. This pressure chamber is clearly shown in FIGURE 3 and identified by reference numeral 100. It is to be understood, however, that this pressure chamber 100 is formed with any knife blade 60 as the cutting reel 48 rotates, not just the particular chamber identified in FIGURE 3. The pressure continues to mount in magnitude until some of the filaments will be forced to escape the pressure chamber at the point where the highest unit pressure exists between the chamber confines and the filamentary pack itself. Obviously, the escape route is not through the gently radiused pressure roll surface or the flat walls of mounting disc 50 or mounting ring 52, but past the minutely small area of the cutting edge 60 itself. Hence an inward portion of the filamentary pack approximately equal to the feed of the oncoming band of tow 94 will be cut as each succeeding cutting edge 60 passes under the pressure roll 72. The remainder of the pack formed by the several layers will be held firmly against the cutting edges 60 trapped by several tensioned outer layers, to be cut in turn as the pressure again rises in the before described chamber. As the tow is severed the staple fibers pass between the knife blades 60 into the open ended compartment 62 and pass therefrom through the aperture in mounting ring 52 urged by air jet, vacuum, gravity, or other suitable means into a collecting funnel 102.

Generally speaking it is preferred that the cutting edges be spaced at equal radial distances from the axis of rotation of the reel 48 so that the innermost layer will be completely divided into a number of lengths during one rotation. This distance can be staggered, however, so that the blades form some closed geometrical figure other than a circle. In this manner, a particular layer will be severed into a plurality of lengths during one rotation with these lengths being themselves divided into a plurality of lengths during subsequent reel rotations.

A still further understanding of our invention will be had from a consideration of the following example which is set forth to illustrate a preferred embodiment.

The starting material for this run is a polyester tow of 1,000,000 denier made up of 1,000 spinning cabinet ends, each end being 1,000 denier. This tow is pulled from puddling boxes, through guides and offset eyeboards to remove folds and twist. The tow is then fed onto feed rolls at the rate of 58 meters per minute and through a steam cabinet which is heated to a temperature of about 200° C. to soften the polyester tow. The drafting rolls are set to run at a surface speed of 175 meters per minute and therefore will draft the tow about 300%. The drafted tow is fed into a stuffer box crimper in which about six crimps per inch are put into the filaments of the tow. The crimped tow is then passed through a heatsetting oven for five minutes to set the crimp. The temperature in the oven is about 220° C. The tow is then cooled to ambient temperature and is then run through a lubricating booth where an oil-type lubricant is applied by spray guns. The tow is then tensioned to temporarily remove the crimp from the tow and is wound around and into touch contact with the blades of a reel type cutter. Pressure is applied to the wound tow as the cutter reel rotates to cut the tow into 1½" staple lengths. This method can be used to continuously run a tow of 1,000,000 denier at speeds of 175 meters per minute.

The method and apparatus of this invention is particularly useful in processing polyester tow of a total denier of 1,000,000 and above when it is run at speeds of about 175 meters per minute. However, the present invention may be used on other manufactured fibers such as for example continuous filament polyamide yarns, modacrylic yarns, acrylic yarns, polyolefin yarns, and cellulose ester yarns.

Although the invention has been described in considerable detail with particular reference to certain preferred embodiments thereof, variations and modifications can be effected within the spirit and scope of the invention as described hereinabove, and as defined in the appended claims.

We claim:

1. Method of continuously processing multifilament tow of at least 800,000 total denier at the rate of at least 70 meters per minute, said method comprising the steps of:

(A) continuously removing twist and folds from a predetermined number of spinning cabinet ends and bringing said ends together to form a tow of at least 800,000 total denier;

(B) continuously leveling and forming said tow into a band of uniform width and thickness;

(C) moving the tow by means of feed rolls into heating means to soften the tow;

(D) withdrawing the tow from said heating means at speeds of at least 70 meters per minute by means of drafting rolls;

(E) feeding the drafted tow into a crimper and crimping said tow;

(F) conveying the crimped tow into a heatsetting oven to set the crimp therein;

(G) removing folds and twist from the heatset tow and lubricating it;

(H) shaping the lubricated tow into a flat uniform band;

(I) placing the uniform band of tow under tension sufficient to temporarily remove a portion of the crimp therein and placing said tensioned tow in touch contact with a plurality of cutting blades arranged on a rotating reel; and

(J) applying pressure to the tow radially inwardly toward the cutting blades to sever the tow into predetermined lengths having substantially square cut ends.

2. Method of claim **1** wherein the tow is maintained in touch contact with said plurality of cutting blades with substantially no relative movement therebetween.

3. Method of claim **1** wherein said tow is continuously wrapped around the reel of cutting edges at a speed of at least 70 meters per minute.

4. Method of claim **1** wherein the pressure is applied to said tow over one cutting edge at a time.

5. Method of claim **1** wherein the tow is wrapped in at least two layers about said reel of cutting edges, and said tow and reel of cutting edges is rotated about an axis as a unit.

6. Method of claim **1** wherein said tow is at least 1,000,000 denier and is processed at a speed of 175 meters per minute.

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DORSEY NEWTON, Primary Examiner

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