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R. T. CRAWFORD ETAL

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PROCESS FOR THE MANUFACTURE OF UNIFORMLY CRIMPED FILTER TOW

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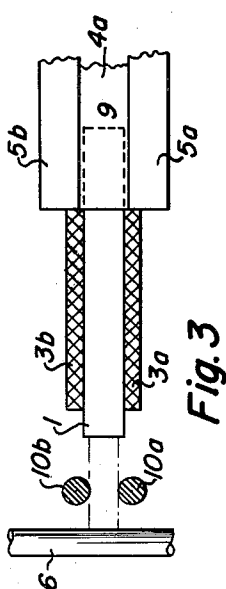


Fig. 3

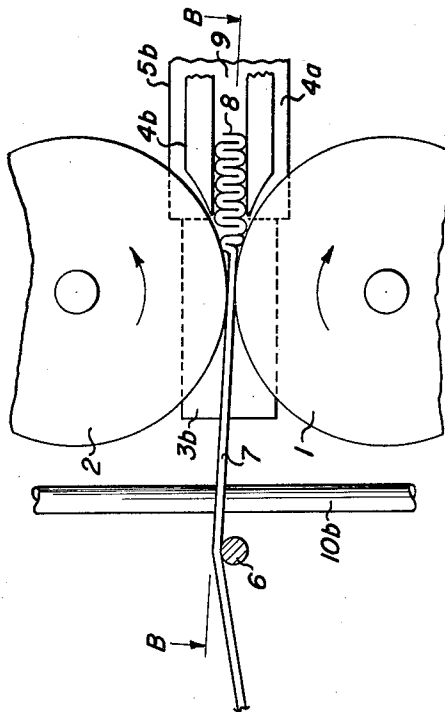


Fig. 2

Fig. 1

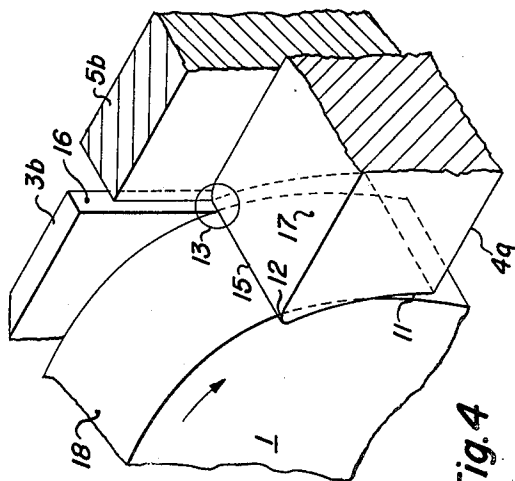
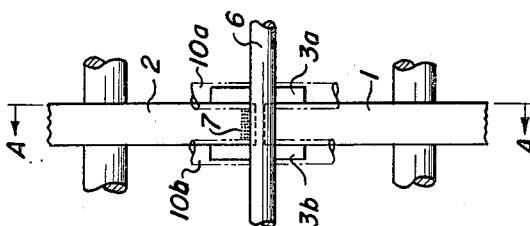


Fig. 4

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1

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PROCESS FOR THE MANUFACTURE OF UNIFORMLY CRIMPED FILTER TOW

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This invention relates to the manufacture of a special tow of cellulose ester continuous filaments. More particularly, this invention concerns the manufacture of a tow particularly adapted for use in the production of tobacco smoke filters.

This application is a continuation-in-part of our earlier U.S. applications Serial No. 435,544 (now U.S. Patent 2,900,988) and Serial No. 699,164, now U.S. Patent 2,953,838. In our U.S. Patent No. 2,794,239, of June 4, 1957, we have described a cellulose acetate tow useful for making cigarette filters. Also, we have described in detail how said tow may be manufactured into the cigarette filters. We have described the functioning of such a filter in taking out nicotine, tar and the like components from tobacco smoke.

We have now discovered how tow of the aforementioned type may be further improved to render the tow more useful in making filters.

This invention has for one object an improved method for manufacturing cellulose ester tow particularly adaptable for use in the production of tobacco smoke filters. Another object is to provide a cellulose acetate tow that is especially uniform both lengthwise and across the tow. Still another object is to provide a tow of the class described from which tobacco smoke filters may be prepared free of soft spots and fuzzy ends. Another object is to provide a tow that is treated with certain filament treating agents which, while lubricating the tow, still permit some static charge to build up on the filaments. Other objects will appear hereinafter.

Crimped tows of textile fibers have been known in the textile industry for a number of years. However, such textile tow is unsatisfactory as such for tobacco smoke filters as filters made therefrom have soft spots and otherwise present disadvantages. In our earlier applications and patents aforementioned we have described a tow comprised of cellulose acetate filaments having an acetyl content of 38-41%, said filaments being of about 3 to 16 denier per filament. The total denier of the aforesaid tow is within a range corresponding to about 80,000 to 160,000. This tow has a crimp of about 4-15 crimps per inch.

We have now found that filters with improved filtering efficiency can be produced using filaments with a wider range of denier as, for example, deniers that are less than 3 and that improved crimping and filter processing techniques of the present invention also permit the use of tows of lower total denier. We have found, for example, that tows of 50,000 total denier will produce firm rods suitable for use on the usual cigarette (24.5-25.5 mm. circumference). Further, 100,000 total denier is in most instances the upper limit for filter tips of the usual commercial length (11-17 mm.). This capability of reduction in tow denier results in a substantial saving in material for the filter manufacturer.

In the broader aspects of the instant invention, in addition to the aspect of improving the finish on the filaments and certain associated features, as will be described hereinafter, we have found that a much improved tow may be obtained by carefully controlling the uniformity of crimp as will now be discussed.

The crimp of the usual textile tow may vary in several ways without seriously affecting the textile end product

2

which is usually a spun thread of short fibers. For example, in the usual textile tow variations in crimp are common. We define crimp as the number of "peak" or "valley" points in a 1-inch length of straight filaments. Thus, an 8-crimp tow would measure $\frac{1}{16}$ -inch along each straight portion or $\frac{1}{8}$ -inch for a complete crimp cycle.

In the usual prior art crimped tow for textile use, "skips" are frequently observed. That is, short lengths of $\frac{3}{16}$ to $\frac{3}{4}$ of an inch appear in the tow without any crimp. Also the crimp may vary at least plus or minus two crimps from the average or nominal value. This prior art variation may occur from length to length or it may be that the crimp will vary across the width of the tow. We have also found that it is quite common to find prior art tow with a higher crimp in the center of the tow band than on one or both edges.

We have found that in the case of tow for cigarette filters uniform crimp is of great importance. We have found that a long skip will cause a soft spot in the finished filter rod. Furthermore, in our process for converting tow to filters, as described in detail in our above-identified earlier applications and patents, the tow is stretched close to its breaking point to open and bloom the filaments. This opening operation, which is used in making filters, we have found is not dependent upon ultimate strength but upon uniformity. The action is such that a stronger tow must be tensioned more than a weaker one. Therefore, since the crimp affects the strength of the filaments it follows that uniform crimp is a prerequisite to uniform strength. Accordingly, when the crimp varies along the tow, low crimp areas are not properly bloomed or high crimp areas break. It depends on which crimp level has been used to adjust the machine which is being used to convert the tow into a filter. Likewise, variations in crimp across the tow affect the blooming and result in a filter rod which is fuzzy on the end.

Accordingly, it is believed apparent that the tow for use in manufacturing tobacco smoke filters represents a specialized product. Hence, the present invention which provides such a product represents a highly desirable result.

In accordance with the present invention, in order to prepare an improved tow that is substantially uniform and free of the above discussed types of variations, we proceed as follows. A spinning composition of cellulose acetate having a 38-41% acetyl content in acetone or other suitable solvent is made up. If round or cloverleaf shaped filaments are desired, the spinning solution is spun in accordance with the methods described in H. G. Stone U. S. Patents Nos. 2,000,047 and 2,000,048, of May 7, 1935. If on the other hand filaments of a special cross section such as a Y cross section are desired, the solution may be spun in accordance with the method described in Reynolds et al. U. S. patent application Serial No. 400,564 (now U. S. Patent No. 2,829,027).

The filaments of whatever configuration, produced as aforesaid, after removal of solvent and setting up in a spinning cabinet are conducted out of the cabinet around a godet roll.

Prior to or beyond the godet roll the filaments are treated with one or more of the finishing agents of the present invention which imparts a low ratio of static to kinetic friction between the tow and the surfaces of the crimper stuffing box. This relationship, commonly called "slip-stick," has an effect on crimp uniformity. With a high slip-stick ratio, the tow column in the stuffing box moves intermittently. With a low slip-stick ratio the column of tow moves more uniformly. This more uniform movement of the tow column is easily seen as is the improved uniformity of crimp. These finishing agents are pharmaceutical or edible grades of the following chemicals:

Esters of monohydric alcohols and fatty acids such as isobutyl palmitate and butyl oleate.

Naturally occurring or synthetic esters of polyhydric alcohols or their hydrides with fatty acids, such as glycerol monostearate, glycerol trioleate, peanut oil, coconut oil and glycerol monooleate-diacetate.

High molecular weight monohydric alcohols such as lauryl alcohol, oleyl alcohol and ethylene oxide condensates comprising monohydric alcohols of 300 to 15,000 molecular weight.

Di- or polyhydric alcohols, such as glycerine and 2-ethylhexanediol.

Ethylene oxide-polyhydric alcohol (or anhydride) ester condensates, such as polyoxyethylene glycerol monooleate.

Mixtures containing materials from the above groups with or without mineral oil, the mixtures blended in such fashion as to provide emulsifiable compositions suitable for aqueous emulsion application.

We have found that the above agents lubricate the tow filaments satisfactorily and while imparting some antistatic effect, do permit a reasonable static charge to develop on the tow during the tow processing in filter manufacturing. Such static charge aids in blooming and separating the filaments during filter manufacturing operations as described in our parent application above-identified. In addition, the aforementioned agents are non-toxic, free from organoleptic effects and either do not impair the tobacco smoke taste and odor or in some instances may enhance the flavor of the tobacco smoke.

In further detail, the yarn may be prepared and the aforementioned finishes may be applied to the tow by several methods such as the following:

(A) Cellulose acetate is produced by a suitable dry spinning process. Immediately after the yarn from one spinning cabinet is withdrawn therefrom and before it wraps the godet roll, it is passed across the surface of a rotating cylindrical applicator roll. The finish is picked up on the roll by partial immersion in a trough containing the finish. If desired a doctor blade can be used on the applicator roll to control the film thickness of the finish although generally the film thickness is sufficiently uniform to make this unnecessary. The thread of filaments is slightly deflected from a straight line by the roll, preferably no more than 3°. The amount of finish applied can be controlled by varying this arc of contact or preferably by varying the speed of the roll. The roll may be rotated so that the surface in contact with the thread moves in the same direction as the thread or in the reverse direction. In either case the surface speed of the roll is much less than the linear speed of the thread. The roll speed is generally between 0.1 and 3.0% of the yarn speed. This depends on viscosity and also on the presence of water or other volatile diluent. The roll is generally a ceramic although metals and other suitable materials may be used. Preferably the surface is roughened to insure the adherence of a uniform film of finish. If desired, the thread may be guided to run in a suitable groove cut in the roll, providing better opportunity for all the filaments in the thread to pick up finish.

(B) Another method of applying the finish is to pass the thread across a wick which picks up finish from a reservoir by capillary action.

(C) Still another method is to meter the required amount of finish to the wick or to a surface from which the thread can pick it up.

(D) If the finish applied consists of two or more components which are not miscible and which cannot be readily combined by emulsification, two or more lubricant applicators can be used. These may be between the spinning cabinet and the godet roll as described or one or more may be beyond the godet roll but ahead of the crimper.

After the filaments are suitably treated as just described to apply a finish thereto, 5,000 to 40,000 of the

filaments are formed into a tow and have imparted thereto the uniform and critical crimp referred to above. This may be accomplished as follows:

Generally the number of filaments and the size tow are such that it is not practical to produce the tow from a single large spinnerette and the preferred practice is to combine the threads from a number of spinning cabinets. 1,000 to 5,000 denier is an advantageous size to produce from a single cabinet so 15 to 100 cabinets are combined to form a composite tow of 50,000 to 100,000 denier. The spinning capacity of the cabinet and the arrangement of the cabinets will together determine the number which can readily be combined to form the desired tow. Since the linear speed of all cabinet threads should be the same, the godet rolls are driven from a common power source. So that each cabinet will produce its proportionate share of the total denier, each spinnerette is supplied spinning solution from its own metering pump and these are also driven from a common power unit. The godet rolls and metering pumps may both be driven from a common power unit. The godet rolls and metering pumps may both be driven by the same motor or separate power units may be used in which case they should be interconnected, electrically, hydraulically or mechanically. The threads from the required number of cabinets are drawn together to form the tow which is fed to a stuffing-box type crimper. If desired, additional finish can be applied to the filaments between the godet roll and crimper as discussed above. For example, the finish required on the filaments for good processing into cigarette filters should possess low antistatic properties as disclosed in our earlier U.S. Patent 2,900,988. In the manufacture and packaging of the tow, static is detrimental. Therefore, it is advantageous to apply a temporary antistatic and softening agent prior to crimping. Water is satisfactory for this purpose.

To secure uniform crimp, it is important that the tow be presented to the crimper as a flat band of uniform width and thickness. Variations cannot be tolerated and it is equally important that the band width as the tow enters the crimper be properly correlated to the width of the rolls. Too narrow a band causes low crimp on the edges. Too wide a band results in what is termed "crimper harsh." This occurs when a few filaments are trapped between the sides of the rolls and the side plates which form the stuffing box. The filaments are chewed up and pressed into small, flat flakes of the material from which the filaments were spun.

The preferred method of guiding the tow to the crimper and certain details of the crimper configuration are best understood by reference to the attached drawing forming a part of this application. FIGURE 1 is a front elevation view showing the tow band in cross section. FIGURE 2 is a partial side elevation view taken generally on line A—A of FIGURE 1. FIGURE 3 is a sectional plan view taken on line B—B of FIGURE 2 but with the tow omitted. FIGURE 4 is a partial isometric of a critical portion of the stuffer box. The important elements are indicated by numerals with a given numeral indicating the same element in all figures.

Items 1 and 2 represent the coacting rolls of a stuffing box crimper. These are supported on suitable shafts and bearings and both are positively driven in the direction indicated in FIGURE 2. One roll, as the roll designated 1, is supported with its axis rigidly fixed. The other roll 2, is supported so that its axis may move generally toward or away from roll 1 to accommodate different amounts of material fed through the nip of the rolls. Roll 2 is urged toward roll 1 by a weight, spring or fluid pressure so that the tow is gripped in the nip of the two rolls and forced into the stuffing box 9.

The stuffing box is formed by a front plate 5a, a back plate 5b, a bottom doctor blade 4a and a top doctor blade 4b. As indicated in FIGURE 3, the front and back plates 5a and 5b are spaced apart somewhat more than the

5

thickness of rolls 1 and 2. This spacing is accomplished by clamping the bottom doctor blade 4a securely between the front and back plates. These three members are bolted securely to the frame of the machine to maintain the indicated relationship with roll 1. The top doctor blade 4b is a slip fit between the front and back plates. It is secured to neither but is supported by the movable portion of the frame which carries roll 2.

As shown in FIGURE 2, portions of the top and bottom surfaces of the stuffer chamber are formed by the faces of rolls 1 and 2. To enclose the sides of this portion of the chamber, plates 3a and 3b are supported adjacent to the sides of the rolls. These plates are lightly urged against the sides of the rolls. Plates 3a and 3b are best supported in the desired positions by extended portions of front and back plates 5a and 5b. To minimize wear, generally the plates are made of a hard, ceramic material. Furthermore, a liquid lubricating and cooling medium may be applied to the sides of the rolls to reduce friction and wear. Water applied as a spray is preferred but other liquids or gaseous mediums may be employed.

Referring now to FIGURE 4, it will be seen that the leading edge 15 of the bottom doctor blade 4a butts against the end 16 of plates 3b. Edge 15 is also nearly in contact with the cylindrical face 18 of roll 1. The arcuate surface 11 of bottom doctor blade 4a is formed on a curve such that the clearance between said surface and the roll increases. The end 16 of plate 3b also bears against the end of back plate 5b. Item 13 depicts the increase in width of the stuffer box at the butting ends of 3b and 5b. Surfaces 11 and 17 of bottom doctor blade 4a do not extend to form a knife edge at 15. Instead a rounded bevel is formed where surface 17 meets the cylindrical surface 18. This is indicated at 12. The beveled edge provides additional strength to "doctor" the crimped tow away from the roll and it prevents the tow from being cut as would be the case with a knife edge. Plates 3a and 5a are similarly positioned. Doctor blade 4b occupies a similar position with respect to roll 2 except that 4b can move between 5a and 5b.

Referring again to FIGURE 2, note that the movement of roll 2 is preferably in a direction parallel to the line joining the centers of rolls 1 and 2. If such is not the case, the ends of the tip of doctor blade 4b will move into or away from plates 3a and 3b. A small amount of lateral movement is permissible especially if the end surface 16 of plate 3b (and 3a) is formed to accommodate this movement.

If desired for ease of operation, one ceramic plate (as 3a) can be made easily removable. The corresponding side plate (5a) of the stuffer chamber can be formed in two parts, leaving a continuous narrow slot parallel to the common tangent between rolls 1 and 2. This facilitates threading tow into the crimper and is not detrimental to the quality of the product.

Two opposite sides of the crimp chamber (most conveniently doctor blades 4a and 4b) are positioned so that their tow-contacting surfaces are not parallel but diverge slightly. Not shown, but included in the crimp chamber, is a movable gate pivotally mounted to restrict the discharge of the crimp chamber. This gate may be placed in back plate 5b or in either doctor blade 4a or 4b. The gate is urged inwardly by a pneumatic bellows or alternatively by a spring or by a weight operating through levers. The design and operation of such gates are well known to those skilled in the art.

Feeding the tow to the nip of rolls 1 and 2 is a critical feature of the invention and will be discussed in detail. The strands forming the tow must be arranged to form a flat ribbon of uniform width and thickness as indicated at 7. Formation of such a ribbon is facilitated by directing the strands of the tow across a guide 6. Although only one such guide is shown, it is frequently desirable to use a series of guides, breaking the tow slightly under or

6

over the guides in alternating order. Also one or more pairs of guides 10a and 10b may be placed perpendicular to the edges of the ribbon to define its width. As shown in FIGURE 1, the width of the ribbon as it enters the nip of the rolls should be slightly less than the width of the rolls. If desired, a raised surface may be added to plates 3a and 3b to define this reduced width. In any event, the width of the tow band should not be unduly reduced by guides close to the rolls as such procedure does not result in uniform band thickness. Preferably the pair of edge guides closest to the nip of the rolls serve to prevent occasional increases in band width rather than to continuously decrease the width.

It is noteworthy that it is not desirable to use a reed to form the tow into a ribbon of uniform width and thickness. The use of a reed results in a crimped tow characterized by a "shoe-string" effect; that is the individual strands are discernible in the crimped tow. Likewise it is detrimental to have any twist in the tow or to have groups of filaments wander across the width of the ribbon. The goal is to present the ribbon of tow to the crimper as one composite group of parallel filaments. Such precise control of the tow has heretofore not been necessary as previously crimped tow was cut into staple fiber directly or was randomized and broken by a tow-to-top process. The controlled tow feed of the present invention results in a uniform crimping action in the stuffer chamber and this uniform crimp is essential in the production of uniform, high quality cigarette filter tips.

Referring again to the width of the ribbon of tow entering the nip of the rolls, control of this dimension is essential for the production of a tow with a uniform crimp across the width of the tow. In the production of crimped tow for staple it is permissible and frequently the practice not to "fill the crimper." In other words, relatively large spaces are left between the edges of the band and the sides of the crimper. This permits relatively large tolerances and clearances in the design and assembly of the crimper but results in a tow which has a low crimp on the edges. We have found that by precise design and assembly of the crimper as above described, it is possible to have the tow band almost as wide as the nip rolls. It is not desirable to have the width of the entering tow band as wide as the rolls as in such case a few filaments might be trapped between the sides of the rolls and plate 3a or 3b. This breaks the filaments or grinds them up to form small, flat flakes of material.

In our crimper it is preferred that the two rolls be of equal thickness and that corresponding sides form a single plane. The working faces of plates 3a, 3b and 5a and 5b are in or parallel to these planes. Likewise it is preferred that the edges of the entering tow band be parallel to these planes.

By adhering to the designs and practices described above, we can produce a crimped tow wherein the crimp is uniform along and across the tow. Such a tow performs in a superior manner when processed on the apparatus disclosed in our U.S. Patent 2,794,480 and results in the production of filter rods having uniform properties.

The drawings and description referred to herein have been based on the premise that the tow band enters the crimper in a horizontal plane and that the nip rolls are positioned one above the other. While this is preferred, other positioning can be utilized.

For a still further understanding of our invention, reference will be made to the following detailed examples which are set forth primarily for illustrating our preferred embodiment.

Example I

In accordance with this example a round or conventional type of filament was produced. That is, a spinning solution of about 28% of cellulose acetate, 0.4% of titanium dioxide, 2% of water, balance acetone solvent was made up in a conventional manner. This solution was

spun in accordance with usual dry spinning methods through spinnerettes having 250 holes of a 0.07 mm. diameter per spinnerette. The filaments were withdrawn from the spinning cabinet around a godet roll at approximately 10 feet per second.

The withdrawn filaments were then treated with one of the special filament finishes described above, namely, peanut oil. This finish was applied by applicator roll in an amount of 0.5% of the weight of the filament.

A suitable number of filaments thus finished to give a tow of a denier of 75,000 was uniformly crimped to 8.0 crimps per inch with a stuffing box crimper having rolls one inch wide and seven inches in diameter as described above.

The resultant tow was then formed into cigarette filters in accordance with the method described in detail in our Patent No. 2,794,239. In forming the filters it was observed that static developed on the tow during its passage over the rollers and thereby facilitated the opening and blooming of the tow. Filters made in accordance with this example were tested by procedures as follows:

Hardness was measured by observing the deformation of the rod when subjected to a suddenly applied load, crushing the rod transversely between a stationary base plate and an anvil.

Pressure drop was measured by determining the differential pressure necessary to pass 17.5 ml. of air per second through the filter.

The weight of individual rods was measured.

These tests indicated that the filter rods formed from our improved tow were of good, uniform quality. In addition, visual examination indicated that the filaments were uniformly bloomed and the rod ends were cut smoothly and without any fuzziness.

Example II

In accordance with this example, the spinning solution used was of a somewhat different composition than that used in Example I and comprised the following: cellulose ester—27.00%, titanium dioxide—0.15%, water—1.55%, acetone—71.30%. Reasonable tolerances were permitted on the percentage of each component.

This solution was extruded through a spinnerette containing 0.04 mm. openings to obtain a yarn made up of 600 filaments. This yarn was treated with a special finishing agent composed of lauryl alcohol—5 parts, glycerine—5 parts, water—90 parts. This solution was applied so that the yarn contained 0.5% of the alcohol-glycerine mixture.

The yarn thus treated was formed into a tow of 90,000 denier, uniformly crimped as in the preceding examples and formed into filters. The improvement by the use of this special treating agent was evidenced by the following: The water content of the tow softened the filaments so that the crimping required less stuffing box pressure and the filaments were not weakened appreciably at the points of bending. Subsequently, the tow had more resilience and retained a higher amplitude of crimp after stretching and relaxing.

The filters thus formed were tested and the filters were found to be firmer than when made from a comparable tow lubricated with mineral oil due to the improved crimp retention of the filaments.

While in the above examples we have shown the use

of finishing agent in the amount of 0.5%, the finishes of the present invention may be applied in amounts ranging from 0.1% to 3.0%. In regard to holding the crimp uniform in the present invention, we maintain any crimp variation within the range of about a plus or minus one crimp from the nominal and in our preferred operations our product is within closer limits.

It is believed apparent from the foregoing that we have provided a new tow in that it has a greater uniformity and carries certain filament finishes not heretofore used on crimped tow for tobacco smoke filters. As established above the filters made from our improved tow are advantageous in being more firm and otherwise exhibit advantages.

We claim:

1. The process of manufacturing tow particularly adapted for use in the preparation of tobacco smoke filters, which comprises spinning filaments in 15 to 100 spinning cabinets from a spinning solution supplied from metering pumps driven by a common power unit, withdrawing the spun filaments from all of said cabinets and conducting the filaments around godet rolls driven from a common power source whereby better uniformity of spinning and withdrawal are obtained, treating all of said filaments with a non-toxic finishing agent which imparts a low slipstick ratio to the filaments, gathering all of the filaments together in the form of a band of filaments of substantially uniform width and thickness, applying a temporary antistatic and softening liquid to said uniform band, feeding the uniform band to and through a stuffing box crimper whereby at least four crimps per inch is imparted to said filaments, said crimped tow resulting from the aforesaid process being characterized in that it is free of skips and is uniform across the tow and withdrawing and packing said crimped tow.

2. A process of manufacturing crimped tow for use in the preparation of tobacco smoke filters, which tow is characterized in that the crimp is uniform and free of skips, any variation in crimp being less than two crimps from the nominal, which comprises spinning the filaments to be formed into the tow, treating said filaments with a finishing agent which lubricates without eliminating all of the static on the filaments, also applying a temporary softening liquid to the filaments which temporarily reduces the static, feeding a band of said filaments to a stuffing box type crimper which has rolls at the entrance thereof, maintaining said band of a width slightly less than the width of said rolls, processing the filaments in said crimper to apply a uniform crimp to said filaments and withdrawing said uniformly crimped tow filaments from the apparatus.

3. A process in accordance with claim 2 wherein the temporary softening liquid is largely comprised of water.

4. The process of claim 2 wherein the band fed to the crimper consists of flat, parallel filaments free of twist.

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