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2,953,838

**TOW FOR USE IN THE PRODUCTION OF  
TOBACCO SMOKE FILTERS**

Robert T. Crawford and Joel B. Stevens, Kingsport, Tenn., assignors to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

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This invention relates to a special tow of cellulose ester continuous filaments. More particularly, this invention concerns 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. application Serial No. 435,544, filed June 9, 1954, and now U.S. Patent No. 2,900,988. 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 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 application aforementioned we have described a special 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 with 2 denier filaments and that improved crimping and filter processing techniques permit the use of tows of lower total denier. We have found 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 the practical upper limit for filter tips of the usual commercial length (11–17 mm.). This 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, as will be described in detail hereinafter, we have now found that a much improved tow may be obtained by carefully controlling the uniformity of crimp as will now be discussed.

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The crimp of the usual textile tow may vary in several ways without seriously affecting the textile end product 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" and "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 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 application, 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 weak 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. By bloomed or blooming it is meant the property of the tow filaments opening up or separating from one another. Since the finishing agents of the present invention to be described hereinafter do not completely dissipate all of the static on the tow filaments, the blooming of the filaments and their separation from one another may be caused to some extent by the mutual repulsion of the static charge on the individual filaments.

Accordingly, it is believed apparent that 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 No. 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. 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 anti-static 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 nontoxic, 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 the conventional 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 good 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. 1000 to 5000 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 anti-static properties as disclosed in our earlier U.S. Patent No. 2,900,988. In the manufacture and packaging of the tow, static is detrimental. Therefore, it is advantageous to apply a temporary anti-static 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 by 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.

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 the methods described in the aforementioned Stone patents 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 80

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crimps per inch with a stuffing-box crimper having rolls 1 inch wide and 7 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 evidence 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. In an article of manufacture comprising an inter-

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mediate product for use in the manufacture of tobacco smoke filter tip elements in which substantially all the filaments of the element are coextensive, said intermediate product consisting essentially of a substantially untwisted, elongated, continuous filament filter tow of which the filaments in the aggregate are substantially parallel, said tow being made up of filaments of a plasticizable spun cellulose ester, said filaments being of a denier of not greater than about 16 denier per filament and the total denier of the tow being below 160,000, the tow carrying 0.1%–3% by weight of the tow of a filament finishing agent which is nontoxic and of edible grade and which does not impair the tobacco smoke taste and odor and in some instances may enhance the flavor of the tobacco smoke, the aforesaid tow being particularly characterized in that the individual filaments of the tow contain a degree of crimp greater than 4 crimps per inch and this crimp is particularly characterized in that it is substantially uniform and free of skips both longitudinally of the tow and across the tow.

2. In an article of manufacture comprising an intermediate product for use in the manufacture of cigarette filter tip elements in which substantially all the filaments are coextensive, said intermediate product consisting essentially of a package of substantially untwisted, elongated, continuous filament filter tow of which the filaments in the aggregate are substantially parallel, said tow being made up of filaments of a plasticizable dry-spun cellulose acetate having an acetyl content of about 38–41%, said filaments being of a denier not greater than 16 denier per filament and the total denier of the tow being within the range of 15,000–100,000, said tow carrying from 0.1%–3% by weight of the tow of a filament finishing agent which is nontoxic and of an edible grade and which does not impair the tobacco smoke flavor and in some instances may enhance the flavor of the tobacco smoke, said tow being in particular characterized in that the individual filaments contain a high degree of crimp of the order of at least 8 crimps per inch and this crimp is particularly characterized in that it is substantially uniform and free of skips, said uniformity of crimp being controlled within the range of  $\pm 1$  crimp from the nominal.

3. An article of manufacture in accordance with claim 2 wherein the tow carries a filament finishing agent from the group consisting of esters of monohydric alcohols and fatty acids, esters of polyhydric alcohols, high molecular weight monohydric alcohols, polyhydric alcohols, and ethylene oxide-polyhydric alcohol ester condensates, the finishing agent being further characterized in that it is of pharmaceutical or edible grade.

4. An article of manufacture in accordance with claim 2 wherein the denier per filament is about 2 and the total denier is about 50,000.

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