METHOD FOR THE MANUFACTURE OF FILTERS COMPOSED OF CELLULOSE ACETATE

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FIG. 4.

FIG. 3.
METHOD FOR THE MANUFACTURE OF FILTERS COMPOSED OF CELLULOSE ACETATE

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This invention generally relates to tobacco smoke filters which may be employed as cigarette or cigar filter tips or as filters for use with cigarette or cigar holders or with pipes. More particularly the present invention relates to an improved and inexpensive process for making such tobacco smoke filters from a plurality of cellulose acetate fibers initially in the form of relatively highly crimped continuous filament tow in which the filaments are in substantially aligned relationship.

The processes which were employed prior to our invention for the conversion of such a continuous filament tow of cellulose acetate into tobacco smoke filtering material did not provide the quality and character of product which was desired by the tobacco industry.

The tobacco industry desires a uniformly constructed cellulose acetate filter which can be made rapidly and easily, and of a uniformity within close tolerance limits, from crimped continuous filament cellulose acetate tow as received from the tow manufacturer. The desired filter should be distinctive as respects such characteristics as compactness, size, weight, density, fiber distribution, air pressure drop, resiliency, body, rigidity, fiber loss, porosity and integrity. These distinctive characteristics should be combined in a manner so that the resulting filter not only does not detract from the smoker’s pleasure, but gives the assurance that the filter is functioning properly to remove any harmful ingredients present in the tobacco smoke. In the cigarette manufacturing industry, an economic requirement is that the completed filter be so constructed as to be easily assembled with the cigarette in processing apparatus conventionally used in the industry for cigarette manufacture and packaging.

An object, therefore, of the present invention is to provide a high speed, efficient process suitable for carrying out the conversion of crimped continuous filament tow in the compressed condition it is received from the producer, into filter units of substantially uniform characteristic which are excellent as tobacco smoke-filters.

Another object of the present invention is to provide a novel process for the conversion of crimped continuous filament cellulose acetate tow into a compact homogeneous unit of cellulose acetate filaments from which improved tobacco smoke filters can be made.

Another object of the present invention is to provide a novel process for the conversion of crimped continuous filament cellulose acetate tow into a compact homogeneous unit of cellulose acetate filaments from which improved tobacco smoke filters can be made.

The cellulose acetate from which the tow is manufactured may have an acetyl value of 38 to 41%, preferably 38.8 width considerably greater than that of the expanded tow;

(4) Treating the ribbon-like band with a bonding medium;

(5) If required, adding finely divided powder-like filtering material to the ribbon-like band;

(6) Condensing the treated tow to a firm, compact, rod-like form having a diameter slightly smaller than that of a cigarette;

(7) Wrapping and sealing the condensed tow in a suitable wrapper;

(8) Heat-treating the wrapped rod of condensed tow so that the bonding medium is caused to stiffen on the wrapped rod;

(9) Cutting the stiffened wrapped rod into lengths suitable for filter units.

The filter unit may then be assembled in the cigarette by a standard process.

Our novel process as indicated above preferably employs as a starting material a relatively high crimped continuous filament cellulose acetate tow. The term tow describes a large number of aligned, continuous filaments which are associated in a somewhat loose form flat band-like structure. When this tow is crimped the product is crimped tow. This type of crimped tow is now available on the market as Estron Tow. The size of the filaments in the tow is designated by the term “denier.” Denier is the weight in grams of a 9,000 meter length of yarn. For example, a filament 9,000 meters long which weighs 1 gram is designated 1 denier. The size of the tow is given in total denier. Total denier is the product of the denier per filament (d./f.) times the number of filaments contained in the tow. Thus, a 5 d./f., 80,000 denier tow would contain 16,000 filaments and would weigh 80,000 grams per 9,000 meters.

The preferred crimped continuous tow is also one which has been treated to impart desirable density characteristics thereto. The crimped continuous filament cellulose acetate tow most suitable for use in the process of the instant invention is one that has been conditioned with a lubricant which imparts additional density and lubricating properties to the tow but without giving the tow additional anti-static properties. Thus, the crimped cellulose acetate tow although lubricated so that it may pass easily through the steps of the process preferably carries a static charge which, due to electrostatic repulsion between filaments, assists in the step of filament separation and distribution which, as is described hereinafter, is carried out primarily by other means. A preferred lubricant is a neutral, non-toxic material. Most advantageously we employ about 0.5% of pharmaceutical grade mineral oil by weight of the fibers.

Tows suitable for cigarette filters range from 45,000 to 160,000 total denier. The filament sizes normally available are 1.5, 3, 5, 8, 12, 16, 20 and 35 denier per filament and the tow may be made up between 5,000 and 100,000 filaments (preferably 20,000) of about 1.5 d./f. (preferably about 5) denier per filament or a total denier within the range of 80,000 to 250,000 (preferably 100,000). The crimps in the tow should range from 4 to 18 crimps per inch and 9 crimps per inch are preferable.

The preferred Estron Tow comprises continuous filaments of cellulose acetate which have been spun from a spinnerette, having a plurality of orifices therein, by the well-known dry spinning process and loosely drawn together in more or less parallel band-like association to form a continuous band which is termed a “tow” in the spinning industry. Such a cellulose acetate tow can be made, for example, by the dry spinning process described in U.S. Patents 2,000,047 and 2,000,048. The cellulose acetate from which the tow is manufactured may have an acetyl value of 38 to 41%, preferably 38.8
8,017,309 3 to 39.2%. The tow may be crimped by any suitable crimping process which can give the desired highly crimped filament tow. The tow may be advantageously supplied for use in our process in the form of a bale about 40 inches high, 25 inches wide, and 50 inches long which weighs 600 to 800 pounds. Such a bale contains a continuous tow of about 91,000 feet in length which is normally enough to supply the process for about 8 hours when making 1,000 filter tips per minute.

The various steps in the process may be carried out in any suitable device. A very satisfactory device for this purpose is shown in the accompanying drawings in which:

FIG. 1 is an isometric drawing of apparatus which may be employed for carrying out our method of processing tow up to the point where the processed tow is fed to the machine for forming it into a round wrapped rod;

FIG. 2 is an isometric drawing of the apparatus for wrapping the processed tow into a continuous wrapped rod and cutting the rod into filter units;

FIG. 3 is a vertical section showing the interior construction of the banding jet taken on the lines 3—3 of FIG. 4;

FIG. 4 is an enlarged longitudinal section through a portion of a tipped cigarette assembled with a filter made by the instant process.

Referring to FIG. 1, there is shown one form of apparatus suitable for carrying out our improved method for processing cellulose acetate tow into filter units for use with cigarettes. As shown in this drawing, a bundle of crimped continuous filament tow 10 is positioned so that the tow 11 may be continuously supplied to the smoke filter making process. The tow in the bale is in a relaxed condition so that it retains all the crimp, thus giving greater bulkiness to the tow. Tow 11 passes over two pairs of coating rolls 16 and 17 which are preferably rubber covered so as to improve the traction on the tow passing therebetween. The tow 11 passes between the rolls of each pair. Rolls 17, which are positively driven by drive means 18, are driven at a faster rate than rolls 16 so that the above-described step of temporary stretching of tow 11 takes place in the zone between the respective nips of rolls. A tension of 20 to 250 pounds may be advantageously imparted to the tow 11 during the stretching step. A mechanical vibrator 19 actuated by means, not shown, is positioned below the tow 11, and while the tow is under tension it may, if desired, be struck by the vibrator 19 at a frequency, for example, of 1800 times per minute. As shown in the drawing, the rolls 16 and 17, drive means 18 and vibrator 19 may be suitably mounted on member 21.

The next step of the process takes place as the stretched tow leaves the nip of the pair of rolls 17. The tow at this point is relaid and coated in a considerably less tension and this results in permitting the crimps which were stretched by the previous step of our process suddenly to reform. This sudden relaxation of the tension with the accompanying spring-like action of the reforming crimps permits an "explosive expansion" within the somewhat flattened tow to restore it to a more cylindrical shape. This advantageously results in arranging the fibers to give a tow of substantially homogeneous cross-section.

By these two consecutive steps of stretching the crimped tow and then permitting the crimps suddenly to be restored, any filaments which previously may have been associated here and there within the tow in heterogeneous bundles are separated and the bundles are thus eliminated.

This elimination of the bundle-like perforce also eliminates undesired channels which often occur within the tow cross-section adjacent to the unwanted bundles of filaments. A tobacco filter containing such random positioned bundles and channels obviously will not have the desirable uniform filtering characteristics previously described in the above paragraphs.

The tow which now has the plurality of crimped continuous filaments homogeneously distributed in parallel relationship continues to the next step of our process. This next process step comprises acting on the expanded tow to spread it into a substantially flat band. This spreading step may be conducted in any suitable manner. We have found, however, that carrying out this step of our process in a banding jet device such as described below is advantageous. Therefore, as shown in FIG. 1, the expanded tow 11 proceeds to such a banding jet device 22.

As shown more clearly in the sectional view of FIG. 3, the banding jet 22 is in the form of a hollow box-like member 23 having a plenum chamber 24 therein which is connected by pipe 25 to a source of air under pressure. The top of the chamber 24 is defined by slotted plate 26 having a plurality of air jet slots 27 therein. The end walls of this banding jet 22 extend above plate 26 and a solid cover plate 28 is fitted thereon. The side walls, not shown, merely enclose chamber 24. Thus a slot-like chamber 29 is formed between slotted plate 26 and cover plate 28. Slots 31 and 32 shown in FIG. 1 are positioned in the respective side walls of banding jet 22 to permit the tow 11 to move through chamber 29.

The air from jets 27 strikes the tow substantially perpendicularly to its path of movement and acts to flatten the tow and to spread apart the filaments, thereby forming a band. We have found it desirable that this band be of approximately eight times the original tow width and be also of a minimum thickness commensurate with such a width. In this thin, spread out condition the several filaments of the tow are accessible to treatment with fluids which are applied thereto by the next step of our process.

In the next step, the moving tow now in the form of the flat band of parallel disposed crimped filaments is continuously sprayed on each side with a solution of a plasticizing medium. Most advantageously the spray is a liquid plasticizer which will produce a tackiness in the filaments through surface solution thereof at points of contact therewith. While various devices may be employed to apply the plasticizer to the band, the apparatus shown in FIG. 1 is quite effective. As there shown, the tow 11, on leaving the banding jet apparatus 22 enters spray chamber 33 which may be glass enclosed and be provided with an exhaust flue 34. In the spray chamber 33 a fluid plasticizing binding medium is applied by oppositely disposed spray guns 35 and 36 to cause the filaments to be capable of bonding to an adjacent filament wherever contacted by the spray.

The plasticizer is sprayed so as to form minute droplets at random points along the top and bottom surfaces of substantially each of the filaments of the two in sufficient quantity so that substantially each of the filaments will have a plurality of bonding points along any length corresponding to the length of the smoke filtering unit which is to be the ultimate product. Most advantageously, a plasticizing agent such as methyl phthalyl ethyl glycolate (carbethoxymethyl) methyl phthalate) is employed. Other suitable nontoxic plasticizers which have nontoxic decomposition products and which adversely affect the taste of tobacco smoke filtered through elements of the invention, are dibutyl phthalate, tributyl phylal, and acetyl triethyl citrate. The plasticizing agent preferably is sprayed on until the fibers contain 4 to 30% (preferably about 6-15%) by weight of plasticizer.
desired, the temperature at which the fluid treatment takes place may be controlled by means, not shown.

The tow now having the plasticizer therein may be conducted directly to the apparatus shown more completely in FIG. 2 for wrapping the tow into continuous filter rods and for other processing to be described subsequently.

However, in certain instances it may be desired to apply one or more additions to the plasticized tow. The plasticized tow is an excellent carrier for a number of materials which may be added to the tow to vary the filtration characteristics. Therefore, as shown in FIG. 1, the spread-out tow which has been given the sprayed plasticizer treatment in chamber 33, on leaving that chamber is conducted into a dusting process which may be suitably conducted in dusting apparatus 37. The dusting apparatus 37 comprises an enclosed chamber 38, the bottom of which comprises a hopper 39 into which the powder to be added to the plasticized tow is fed from bin 41 by screw 42. The powder is supplied to the underside of the plasticized tow by blower 43 and 44 to nozzle 45, and to the upper side of the tow by blower 46, duct 47 and nozzle 48. The blowers are operated by electric motors, one of which is shown at 49. The powder spray is shown at 51. The upper wall of the closed chamber 38 is formed by a pressure rupturable foil, the edge of which is shown at 52. A pressure sensitive adhesive is positioned about the foil seal 52 and chamber 38 which is closed thereby. The side walls of the chamber, one of which is shown broken away at 54, may be of metal or glass.

To prevent dust from leaving the dusting chamber 38 through the slots by which the tow 11 enters and leaves the chamber 38, suction devices 55 and 56 are provided. These suction devices are affixed respectively to the end walls of the dust chamber 38 and comprises elongated suction chambers in fluid communication with chamber 38. The tow 11 enters one side of suction device 55 through a slot having a length substantially equal to the width of the slot, and a width substantially equal to the thickness of the tow and leaves through a similar slot which is positioned against a similar slot in the adjacent wall of chamber 38. As is apparent from FIG. 1, scavenging ducts 57 and 58 respectively produce a suction in ducts 55 and 56. Thus any dust particles which travel outwardly through the slots through which the tow enters or leaves chamber 38 will be drawn into ducts 57 or 58 and be removed from the vicinity of the process. A filter, not shown, can be installed in the exhaust system to reclaim this material. Since many powders in air give combustible mixtures that can cause violent explosions, care must be taken in the operation of this process. One method of operating is to use an inert atmosphere such as nitrogen in the dust chamber.

Such materials as powdered cornstarch, rice starch, hydroxyethyl cellulose, and calcium stearate may be employed as additives.

On leaving the dusting chamber 38 the tow passes between delivery rolls 59 and 61 which are turned by driving means 60. It will now be apparent that driven rolls 17 cause the tow to unwrap from hale 10 and that rolls 59 and 61 provide the drawing for pulling the tow 11 through the plasticizing and powder applying stations.

The treated continuous filament cellulose acetate tow is now in condition to be formed into cigarette filter units. The tow 11 is therefore introduced into the filter forming devices through condensing trumpet 62 which serves to position the flat tow 11 to a round multiple filament strand 63.

A device suitable for carrying out the wrapping of the round strand 63 into a filter unit is shown in FIG. 2. In addition to the above-mentioned tow condensing trumpet 62, the device comprises an endless belt 64 which revolves around drums 65 and 66 and is maintained taut by drums 67. The belt is driven by means, not shown. The wrapper 69, which may be filter paper, is continuously unwound from roll 68 and passes over guide roll 71 and is carried by endless belt 64 through a wrapper forming device 72 which bends the wrapper into a U-shaped form just before it comes into contact with the strand 63. The U-shaped wrapper containing the strand 63 is now carried by endless belt 64 through a second forming device 73 in which the wrapper is lapped around the strand 63 leaving one edge 74 of the paper extending upward.

The standing edge 74 of the paper then moves along to contact rotating wheel 75 which applies a suitable adhesive to the inner side of the standing edge 74. The source of the adhesive is not shown. The standing edge 74 is now smoothed down over the adjacent paper edge by forming member 76 and then is heat sealed into a permanent adhesive bond by electric heating shoe 77.

The product therefore at this point in the process is a continuous round and compact filter rod 78 having a diameter slightly less than that of the cigarette with which the filter is to be assembled. If desired, the filter rod 78 may be stiffened by heat treatment as by being passed through an electrically heated die 79. The heat treatment may be conducted at 160° F.

The continuous heat treatment of the paper-covered rod may be replaced by subjecting the severed rods to heat treatment such as by storage in a chamber heated to 200° F. for a period of about two hours. In such case, we have found it satisfactory to subject the finally wrapped rods of cellulose acetate filaments to a temperature of 160° F. for four hours where solvation has been accomplished with a plasticizer such as Monsanto Santicizer M-17 (believed to be carboxyethyl methyl pthalate), although the treating time may be varied from 1/2 to 24 hours depending on the temperature and the particular plasticizing agent employed. A temperature within the range of 125° F. to 300° F. may be found satisfactory.

It sometimes may be satisfactory to forego a final heat treatment and merely to allow the paper-wrapped rod to age for a period of 24 hours to allow the plasticizer to penetrate and the bonding to become thorough and complete.

The heat treatment causes setting of the fluid portions of the filaments and/or plasticizer or adhesive thereon. The heat treatment may promote the removal of volatile solvents or homogenization of filament composition by promoting migration of localized plasticizer through the mass, thereby reducing the fluidity and increasing stiffness and resilience at such localized points and the setting of a firm bond at these bonding points. In any event, the heat treatment or aging steps insure final bonding and welding when practiced according to the preferred procedure and give a more rigid structure to the fiber mass which facilitates handling and assembly operations.

On leaving heated die 79, the filter rod 78 is cut into appropriate lengths by cutter 81 which is rotated by means, not shown.

After the paper-covered rod has been severed into elements of appropriate length and preferably stiffened as by the heat treatment, the elements may be employed as the final product for use in pipes and cigarettes and cigar holders. If the filter material is to be used as a tip for cigarettes, known procedures for manufacturing filter tip cigarettes may be used. That is to say, elements of appropriate length may be fed to a joiner or other machine which serves to position the filter elements adjacent to tobacco bodies, join them and cut the joined pieces at the proper points.

The product produced in accordance with the present invention is an article of manufacture or smoking device containing the same, the article comprising a rod, normally cylindrical in form and customarily substantially
the size of a cigarette in circumference and diameter, the rod being a compact, rigid, structurally unitary debund- dized mass of cramped cellulose acetate filaments and a wrapper encircling the mass, each filament of the mass being substantially coextensive therewith. The filaments as a whole are in substantial alignment longitudinally of the mass but substantially each of the individual filaments has non-oriented short portions thereof disposed randomly in diverging and converging relationship to the main filaments so that substantially all of the filaments of the mass are positively bonded to contiguous filaments within said structurally unitary rod by means of surface solvation bonds at random points of contact of the filaments. The filaments of the mass are uniformly distributed throughout the transverse section of the mass thereby providing uniform filtering. FIG. 4 shows the filter unit assembled in normal position with a cigarette. The filters are usually 25 mm. in circumference and 13 mm. long.

While our process can be carried out on the apparatus disclosed in the foregoing paragraphs, it should be mentioned that our process can be carried out with different apparatus. For instance, in the step of filament separation, the ovens may be accompanied by use in cooperation with a pair of drive rolls of a trap box having a weighted tongue to produce a braking action. The trap box would be a substitute for the pair of braked idler rolls 16. In other words, an opening device instead of two pairs of tension rolls might comprise a pair of drive rolls and a retarding device such as a tongued-trap box. Banding might be accomplished successfully through the use of an expander bar as known in the art or as suitably modified. Thus one might employ a banding device comprising a surface presenting a portion of a cylinder and provided with two diverging sets of tow contacting ribs at an angle to each other of, e.g., 60°. With such a de- vice it is contemplated that tow passing over the bar and in frictional engagement therewith will be banded in a manner similar to that occurring in the banding jet in that filaments are moved apart from each other, particularly in regions of high filament density to produce a tow structure having a greatly increased uniformity of cross-sectional fiber distribution.

This application is a continuation-in-part of our co- pending application Serial No. 374,168, filed August 14, 1953, now Patent No. 2,794,480 of June 4, 1957, and entitled "Apparatus for the Manufacture of Filters Composed of Cellulose Acetate."

We claim:

1. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament tow, the filaments of which have a plurality of crimps therein, stretching the tow under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow to a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit and cutting the rod-like unit into individual filter elements.

2. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow, the filaments of which have a plurality of crimps therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

3. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow, the filaments of which have a plurality of crimps therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, adding a powder-like filter aid to the surface of the spread-out tow, straightening out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit and cutting the rod-like unit into individual filter elements.

4. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow the substantially parallel filaments of which have from 4 to 18 crimps per inch therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

5. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow, the substantially parallel filaments of which have approximately nine crimps per inch therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a non-toxic bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

6. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow, the substantially parallel filaments of which have from 4 to 18 crimps per inch therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sideadise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

7. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multifilament cramped tow, the substantially parallel
filaments of which have approximately nine crimps per inch therein, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sidewise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, adding a powder-like filter aid to the surface of the spread-out tow, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

10. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multi-filament crimped tow, the substantially parallel filaments of which have approximately nine crimps per inch therein, placing a static charge on the tow, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension and permitting the static charge on the tow to separate the relaxed filaments thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sidewise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

12. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multi-filament crimped tow, the substantially parallel filaments of which have approximately nine crimps per inch therein, placing a static charge on the tow, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension and permitting the static charge on the tow to separate the relaxed filaments thereby permitting said crimps freely to reform, spreading the thus expanded tow in a sidewise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.
multi-filament cellulose acetate crimped tow, the substantially parallel filaments of which have from 4 to 18 crimps per inch therein, placing a static charge on the tow, stretching the tow lengthwise under a tension sufficient to straighten out temporarily said crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting the static charge on the tow to separate the relaxed filaments while permitting said crimps freely to reform, spreading the thus expanded tow in a sidewise direction to form a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium, adding a powder-like filter aid to the surface of the spread-out tow, condensing said treated tow to a substantially round rod-like unit, wrapping and sealing the rod-like unit in a thin wrapper, heat treating the wrapped rod-like unit to stiffen the unit, and cutting the rod-like unit into individual filter elements.

16. A continuous process for forming unitary rod-like filter elements which comprises providing a continuous multi-filament tow, the filaments of which have a plurality of crimps therein, stretching the tow under a tension sufficient to straighten out temporarily the crimps, expanding the cross-sectional dimensions of the tow by abruptly relaxing said tension thereby permitting said crimps to reform, spreading the thus expanded tow to a ribbon-like band having a width considerably greater than that of said expanded tow, treating the thus spread-out tow with a bonding medium comprising a glyceryl tri-ester of a lower fatty acid, condensing said treated tow to a substantially round rod-like form and wrapping and sealing the condensed tow in a thin wrapper.

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