

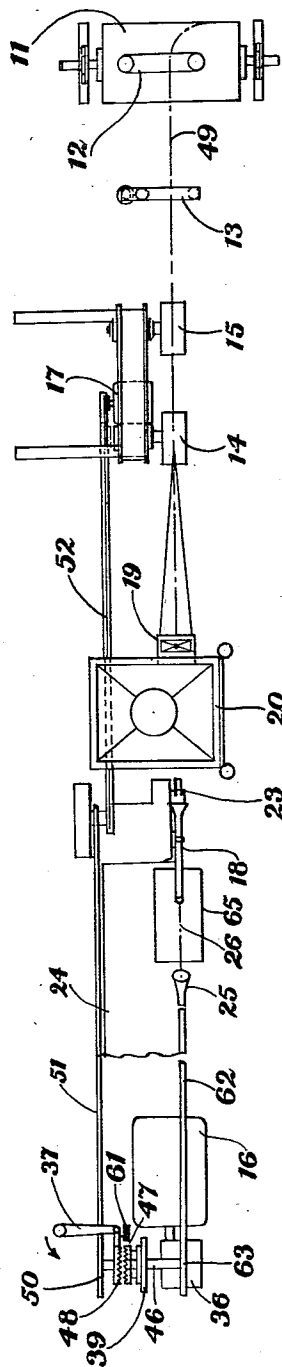
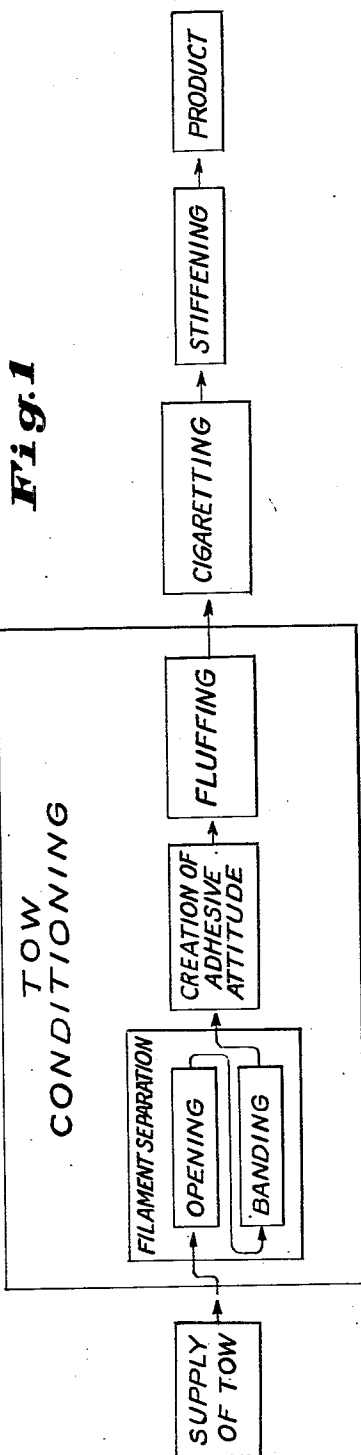
June 4, 1957

R. T. CRAWFORD ET AL
APPARATUS FOR THE MANUFACTURE OF FILTERS COMPOSED
OF CELLULOSE ACETATE

2,794,480

Filed Aug. 14, 1953

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

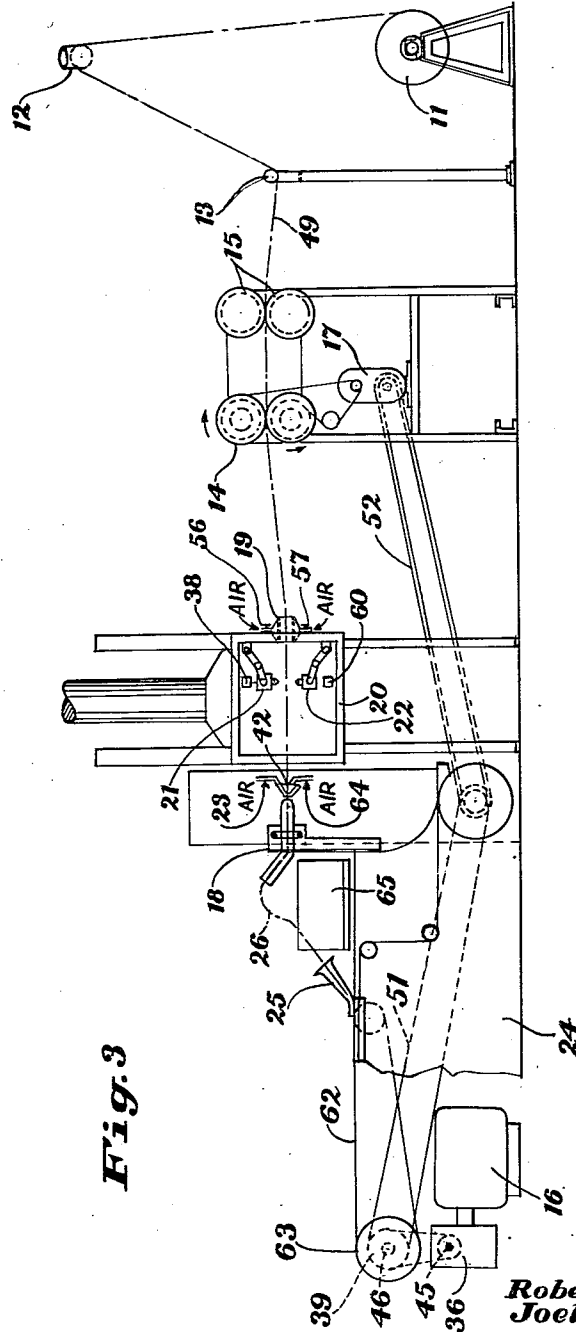


Fig. 3

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Fig. 4

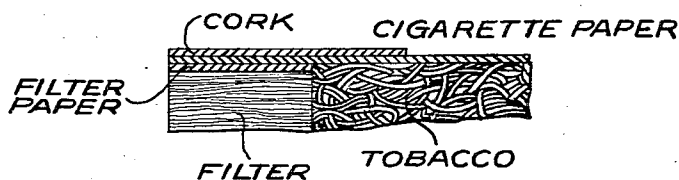


Fig. 7

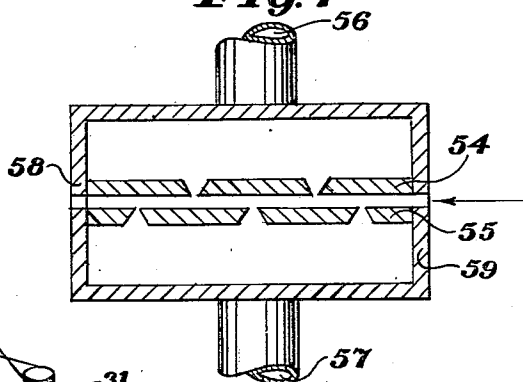


Fig. 5

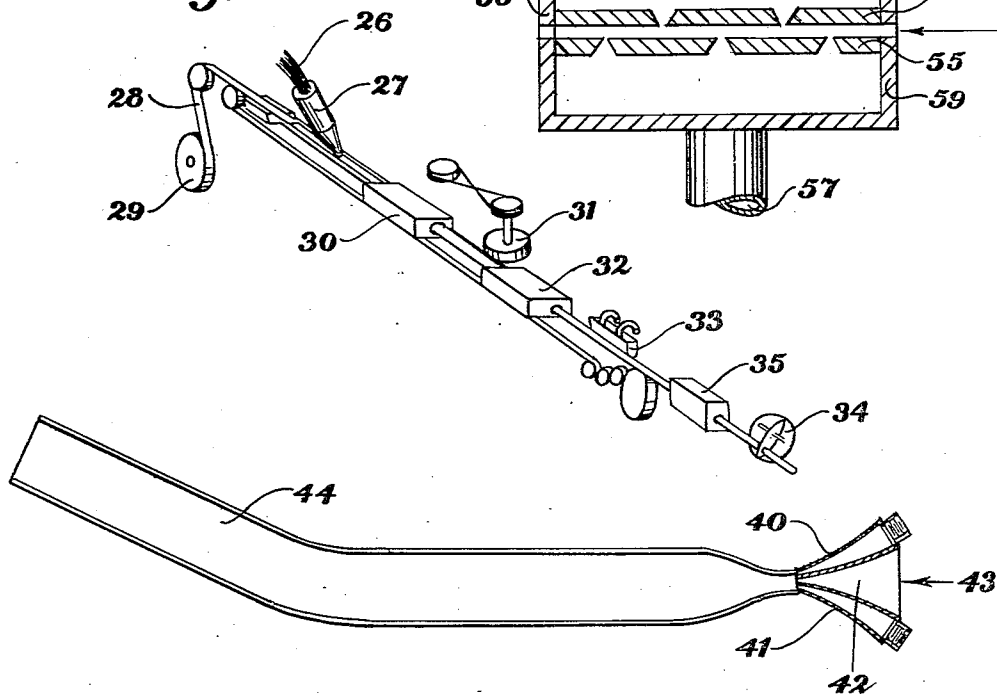


Fig. 6

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2,794,480

APPARATUS FOR THE MANUFACTURE OF FILTERS COMPOSED OF CELLULOSE ACETATE

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Application August 14, 1953, Serial No. 374,168

6 Claims. (Cl. 154—1.7)

This is a continuation-in-part of our U. S. patent application Serial No. 324,342, filed December 5, 1952.

In Cobb and Hargrave U. S. patent application Serial No. 324,284, filed December 5, 1952, there is disclosed a method and means for the preparation of a novel tobacco smoke filtering material. Cobb and Hargrave disclose a filtering element comprising a structurally unitary rod-like mass of crimped cellulose acetate fibers and a wrapper encircling the mass, each fiber of the mass being substantially coextensive therewith, the fibers as a whole being in substantial alignment longitudinally of the mass but substantially each of the individual fibers having non-oriented short portions thereof disposed randomly in diverging and converging relationship to the main fiber axis, a plurality of the fibers having surface solvation bonds to contiguous fibers at random points of contact.

As indicated by Cobb and Hargrave, the material taught by them provides an improvement in the art and is of particular utility since it is designed for fabrication from a running length of continuous filament tow. However, it has been found that in the conversion of a filamentary tow of cellulose acetate into tobacco smoke filtering material according to the Cobb and Hargrave method, there is not provided the quality and character of product which is required by the tobacco industry. In order that a filter material formed from cellulose acetate tow be acceptable to the cigarette industry in all respects, the filter material first of all must be produced with quite a distinct character as respects compactness, size, weight, density, cross-sectional fiber distribution, air pressure drop, resiliency, body, feel, rigidity, fiber loss, porosity, integrity and the like. These properties must be present in such quantity, and relationship that the material not only is pleasing as a cigarette component but is susceptible of handling with processing apparatus normally used for cigarette manufacturing and packaging. A second and equally important requirement is that in any given operation all of the filamentary filter material produced must exhibit these characteristics uniformly within close tolerance. Another requirement is that any method for conversion of continuous filament tow to a smoke filtering material be adapted for conversion at high speed.

The present invention relates to an improved cellulose acetate tobacco smoke filtering element, a method for the preparation of the same, a starting material for use in the method, and particularly apparatus for carrying out the method. The filter element is adaptable to use as a cigarette or cigar filter tip or a filter for use with cigarette or cigar holders or pipes.

We have discovered a method for the conversion of tow into a cigarette smoke filtering material which will exhibit the necessary properties as required by the tobacco industry. We have further found an apparatus capable of accomplishing the novel process at a high speed and in such a manner that the required uniformity is obtained. The product resulting from our improved method is novel in that it comprises, as a result of a preliminary condi-

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tioning of the tow, a dechannelized, debundled, mass of filaments having a uniform cross-sectional filament distribution and having improved body, affording compactness, rigidity and resiliency.

A primary object of the present invention is to provide a high speed apparatus suitable for carrying out the conversion of tow into filter elements in accordance with the improved method of the invention. A second object is to provide apparatus which will operate on tow with sufficient exactness to provide a product of uniform properties. Another object of the invention is to provide a novel method for the conversion of cellulose acetate tow into a compact, rigid, structurally unitary mass of cellulose acetate filaments suitable for use as a tobacco smoke filtering material. A still further object of the invention resides in the provision of a filamentary cellulose acetate tobacco smoke filtering material suitable for use as a cigarette filter tip or as a filter for a cigarette or cigar holder or pipe and having a structure which is improved in the respect that it is dechannelized and debundled, i. e., having a uniform cross-sectional fiber distribution. Still another object of the invention is to provide an article of manufacture comprising a cellulose acetate tow having characteristics which make it unusually satisfactory for conversion into tobacco smoke filtering material in accordance with the invention.

The invention will be described herein in terms of operations conducted with continuous filament cellulose acetate tow which is most advantageous with the method of the invention. We have found it preferable to employ a textile yarn-type acetate having an acetyl value of 38–41% (preferably 38.8–39.2%) in the form of a continuous filament tow having between 5,000 and 100,000 filaments (preferably 20,000) of about 1.5 to 16 (preferably about 5) denier per filament or a total denier within the range 80,000 to 250,000 (preferably about 100,000), all filaments having about 4 to 18 (preferably 9) crimps per inch and being conditioned with a "semi-lubricant." Modern textile lubricants furnish both lubricating and anti-static action. By a "semi-lubricant" we mean a lubricant which furnishes lubrication only, thereby producing a tow carrying a static charge to assist in filament separation and distribution. 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 fiber. While the invention is described in terms of continuous filament yarn-type cellulose acetate tow, it will be understood that the utility of the invention is by no means limited thereto, and those skilled in the art will recognize that other fibrous or filamentary material may be employed. Thus the terms "strand" and "tow" as used herein are intended to be applicable to any suitable type of material in the form of an elongate continuous mass of fibers substantially oriented in a longitudinal direction. However, it will be understood that the continuous filament tow which we have found to be most advantageous is the specific material which results when filaments spun from a plurality of spinnerette holes are brought together and combined, preferably with filaments from other spinnerettes to form a strand or bundle of parallel filaments.

The various phases of the invention can best be described by a detailed explanation of the most advantageous embodiment of starting material, apparatus, method and product. The best mode known to us for carrying out the invention is illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of the steps of our method,

Fig. 2 is a top plan view, partially cut away, of a pre-

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ferred form of apparatus for conducting the method of the invention,

Fig. 3 is a side elevation, partially cut away, of the apparatus of Fig. 2,

Fig. 4 is an enlarged longitudinal section through a portion of a tipped cigarette assembled with a filter of the invention,

Fig. 5 is a diagrammatic representation of a suitable cigaretting device,

Fig. 6 is a longitudinal vertical section through a tow fluffing means of the type forming part of the apparatus of Figs. 2 and 3, and

Fig. 7 is a vertical section along the path of tow movement through a banding jet.

With reference to Fig. 1 it will be noted that the method of our invention, as a broad concept, involves the principal steps of "cigaretting" a tow of cellulose acetate filaments after first conditioning the tow. By "cigaretting" as used in the present specification and claims we mean the steps of forming (of a conditioned tow) into a rod having the approximate transverse size and shape of a cigarette, covering the rod with a wrapper, e. g. cigarette paper, and severing the rod to appropriate lengths as desired. "Cigaretting" is a standard step in cigarette manufacture and is accomplished on the conditioned tow by means of any suitable standard cigarette manufacturing equipment which wraps the tow in paper, seals and cuts the wrapped material into lengths. That is to say, in regular cigarette manufacture, shredded tobacco is metered from a hopper onto a moving paper ribbon carried by a flax tape. The tobacco and the paper then go through one or more dies thus forming the tobacco into a cylinder and lapping the paper over itself. Then glue is applied along the overlapping edge, the edge is smoothed down and the joint is heat-sealed, forming a continuous cigarette. A cutter knife cuts the tube into desired lengths. Thus our invention in the cigaretting step involves passing a properly conditioned tow of cellulose acetate filaments in a continuous manner through a cigarette manufacturing machine, i. e. the garniture of a cigarette manufacturing machine in which the tow is formed and shaped into a cylindrical section having the approximate diameter of a cigarette body, wrapped in paper with the paper joint being sealed, and severed into the paper covered rods of appropriate length.

The step of tow conditioning which we have found to be necessary to the procurement of the desired properties, regardless of the nature of the tow starting material, consists essentially of three operations: (1) filament separation, (2) creation of an adhesive attitude in the separated filaments and (3) fluffing of the adhesive filaments. A final step after cigaretting, necessary to take full advantage of the conditioning of the tow, is the operation of stiffening the rods formed by the cigaretting operation, but as will be noted from the following, the final step, depending on the type of adhesive attitude in the fibers, may be dispensed with or may be possible merely through storage of the product for a sufficient period of time.

A highly useful method in accordance with the invention comprises as the step of creation of an adhesive attitude in the fibers the application of a spray of liquid adhesive or a liquid which will cause the filament surfaces to become adhesive. In the most advantageous embodiment of the invention in which a yarn type cellulose acetate continuous filament tow is employed, the step of creating an adhesive attitude is conducted in terms of a spray of a liquid plasticizer effective to produce a surface solvation in those portions of the acetate filament surfaces contacted by the plasticizer. The plasticizer partially dissolves or softens the fiber which it reaches and produces therein a sticky attitude sufficient to subsequently produce bonding between filaments having adjacent contacting areas affected by plasticizer. Thus, by the term "surface solvation" of the fibers as used herein is meant the creation, by the action of a solvent or plasticizer and/or heat,

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of an adhesive, tacky or readily bonding condition of the fibers by solution or incipient solution of surface portions of the filament material. By this means there is produced a welding and adhesion between adjacent filaments contacting at such portions. By "coalescence" we mean the situation caused by partial or incipient solvation of surface portions of the filaments and resulting in a condition within those portions under which the portions will flow into or unite with similar portions of dissolved or plastic material in contiguous filaments.

The step of filament separation has been found to provide two requisite qualities to the tow. First, filament separation amounts to an opening of the tow in the respect that small compact bundles of filaments within the tow are broken up to give a more uniform cross-sectional distribution of filaments throughout the entire tow. Uniformity manifests itself in the final product primarily through reduction in the normal tendency of the filtering material to cause channeling of the smoke through areas in which the fiber density, i. e. distribution of fibers is less than in other areas. Uniformity also manifests itself in an improved compactness, rigidity and resiliency of the product. The second characteristic imparted to the tow in filament separation is the susceptibility, i. e., exposure of all or a large percentage of the individual filaments to treating materials in the subsequent step of the conditioning, i. e. in the creation of the adhesive attitude of the filaments. In other words, the step of filament separation results in the individual filaments being more vulnerable to a fluid treatment as well as assuming a more uniform and dechannelized (debundled) transverse distribution of fibers. Exposure and susceptibility are manifested in the final product through an improved retention of uniformity, and through improved rigidity, resiliency and integrity.

It has been our experience that filament separation is best accomplished through at least two distinct operations on the tow, each of which promotes both uniformity of distribution (debundling) and exposure, but the first achieving primarily distribution and the second achieving primarily exposure. Thus we have found it advantageous to conduct filament separation by means of the successive steps termed tow opening and tow banding, respectively.

By "banding," we mean opening and widening at the expense of thickness. Thus, a "banded" tow is one which has been converted to a web-like, i. e. ribbon-like conformation being, for instance, five to ten (usually about eight) times its original width and having little thickness so that all or at least a substantial majority of the individual filaments are directly exposed and vulnerable to a spray from above and/or below. In other words, "banding" may be described as the operation of greatly increasing the dimension of the tow in a first plane while maintaining a substantially uniform distribution of fibers in that plane and greatly reducing the dimension of the tow in a second plane perpendicular thereto. Banding is accomplished by means tending to move the filaments apart by movement more or less confined to a single plane and therefore banding assists in the dechannelizing (debundling) of the tow.

As noted above, however, dechannelizing is largely accomplished by the prior operation of tow opening. Opening is nicely accomplished by the use of tensional forces which take advantage of the inherent springiness of the tow to restrict it to an extent from which its reaction upon release of tension is to open or expand. Thus opening also facilitates banding but primarily promotes uniformity of filament distribution in the tow. Opening thus is important in providing a debundled and dechannelized structure in the final product. In accordance with the terminology used herein, a "dechannelized" tow is one from which there has been removed the tendency for smaller groups of adjacent filaments to become associated as distinct compacted smaller bundles within the larger mass or bundle of filaments. Such a tendency of

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course inherently includes a tendency toward formation of channels. It is necessary to remove and break up such grouping in order that there be no small fiber bundles present in the final product.

Therefore, our preferred method for the conversion of cellulose acetate tow into tobacco smoke filter elements comprises the successive steps of (1) conducting filament separation by (a) opening, i. e. enlarging the diameter of a crimped tow supplied continuously, and (b) banding the thus opened tow to form a ribbon-like web of relatively large width and small thickness, (2) creating an adhesive attitude of the filaments of the banded tow by subjecting the latter to a spray of liquid plasticizer, (3) fluffing the liquid treated tow to provide a lofted open structure and to maintain the condition of filament separation achieved in the first step, (4) cigaretting the thus conditioned fluffed tow by condensing, shaping, wrapping, sealing and severing the conditioned tow, and (5) stiffening the elements severed from the continuous length of material so produced. The stiffened element in suitable length may be joined to the tobacco body of a cigarette as a filter tip or it may be employed in a suitable length as a filter unit in a cigarette or cigar holder or pipe.

Basically, the apparatus of the invention comprises the combination with a cigaretting machine of means operated synchronously therewith for conditioning the tow, the conditioning means comprising a plurality of cooperating means positioned successively along and forming a path for the tow and including a filament separation means disposed to withdraw tow from a source of supply, means adjacent the separation means for applying a fluid medium to the separated tow, and means positioned between the fluid applying means and the cigaretting machine for fluffing the fluid treated tow and presenting it to the cigaretting machine. More specifically, a highly useful conditioning means comprises a group of successively positioned cooperating apparatus members comprising a tow opening apparatus, a tow banding apparatus, a fluid treating apparatus, and a fluffing apparatus.

The most advantageous assembly of apparatus which we have found to be suited for providing uniformity of product in a high speed tow conditioning and filter forming method (e. g., a method operated at 100 to 200 feet of tow per minute) is illustrated in Figs. 2 and 3 in which the tow is represented diagrammatically only. With reference to these figures the apparatus comprises an assembly of cooperating means successively positioned along and forming a path for tow 49 supplied from a ball warp 11 mounted for free rotation. Smooth arc-like metal members 12 and 13 serve as stationary friction fingers to remove slack from tow withdrawn from the ball warp 11. Proper slack removal prior to the filament separation operation helps avoid false twist in the tow and facilitates the conduct of the separation step. For best results we have found that the tow should be delivered to the filament separating means under a fairly constant tension.

A filament separation means comprising a tow opening apparatus consisting of a tensioning device having a pair of driven rolls 14 and a pair of frictionally braked idler rolls 15 serves to pull the tow from the ball warp and subject it to a predetermined tension for the distance of the ratch, i. e. the distance between the nips of the roll pairs 14 and 15. The tensioning device is powered from a prime mover 16 through a speed reduction gear box 36, shaft 45, and a chain and sprocket arrangement to sprocket 39 which is free to turn on a shaft 46 which normally is free to remain stationary relative to the sprocket 39. Integral with the sprocket 39 is a clutch plate 47. A cooperating clutch plate 48 is keyed to the shaft 46 and its position on the shaft 46 controlled by a bell crank 37 adapted for manual operation. Movement of the bell crank handle in the direction indicated by the arrow in Fig. 2 results in engagement of the clutch

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plates 47 and 48 and thereby provides actuation of the shaft 46 keyed to clutch plate 48. Rotating with the shaft 46 is a sprocket 50 through which power is transmitted to the roll tensioning device by means of chain drives 51 and 52, a variable speed transmission 17, and a chain and sprocket drive between the latter and the pair of rolls 14. The upper roll is powered from the same source to rotate in a direction counter to the lower roll of the pair 14 in the direction as indicated by the arrows in Fig. 3. The action of these rolls through the nip provided therebetween serves to pull tow from and through the braked rolls of the pair 15. The rolls of the pairs 14 and 15 have elastic cushioning surfaces to provide sufficient traction on the tow. The rolls of the idler pair 15 are spaced sufficiently close to deform the cushion surface and introduce resistance through the friction of deforming. This provides a braking action by means of which a predetermined amount of tension, for example, of the order of 20 to 250 pounds, is imparted to the tow in the ratch between the two pairs of rolls. During the application of tension the crimp in the tow is straightened out and upon emergence of the tow from the nip of the drive rolls 14 into a relatively relaxed state, the tow undergoes an expansion, i. e. enlargement of diameter and circumference and reduction of fiber density transversely, through the puffing action or spring-like action of the filaments in returning to their normal crimped condition. That is to say, a type of "explosive expansion" occurs within the tow to provide bundle breaking, i. e. disintegration of any individual compact bundles of filaments which may exist within the larger bundle forming the tow.

In other words, the tensioning apparatus of the invention subjects the tow to sufficient tension to produce (as noted above) a restriction of the strand which results, upon emergence of the strand from the nip of the positively driven rolls into a zone of relative relaxation, in a more uniform distribution of filaments within the strand as a result of inherent and elastic forces within the filaments of the strand. These forces are exerted transversely of the strand and are more intense where filament density, i. e. the concentration of filaments is greatest. Therefore, the lateral force causes transverse displacement of filaments from zones of high filament density. Thus, action herein termed "tow opening" or "bundle breaking" obviously is dependent upon the use of both (a) satisfactorily crimped or otherwise springy tow and (b) zones of definite tension differential. In the latter respect, the action of the tensioning apparatus is dependent upon the existence of an adjacent zone in which the tow is subject to relatively little tension. In practice, the apparatus of the invention provides a condition almost of relaxation within the filaments adjacent to the tensioning zone. This is brought about by the use, more fully explained below, of an aspirating action of a fluid fluffing jet in moving the tow away from the tensioning means. Thus, it may be said that movement of the tow between the tensioning device and the fluffing device is a matter of little more than removal of the slack existing therein adjacent the tensioning means.

In any event, the operation of opening (together with banding) produces a satisfactory filament separation and results in a filament mass having the character or condition herein identified as debundled or dechannelized. A dechannelized tow in accordance with the invention has a uniform and homogeneous distribution of filaments, and the method of the invention provides dechannelization in such a way that the product will be found to comprise rods of filaments in which the filaments as a whole are longitudinally aligned and in the aggregate in parallel orientation, but with distinct short portions of individual fibers running more or less at random in non-parallel unoriented diverging and converging directions.

From the point of emergence from drive rolls 14 of the tow opening apparatus the tow is pulled under the

relatively little tension afforded by means of the aspirating action in fluffing unit 18, through the second unit of the filament separation means which is an adjacent banding apparatus in the form of an air jet banding device 19. The air banding device is spaced from the opening device a suitable distance, preferably at least about four times the banded width of the tow, to provide for gradual widening of the tow. The banding device 19, as illustrated in Fig. 7, comprises a banding jet having two oppositely disposed flat plates 54 and 55 providing a slot-like aperture for passage of tow there-through, as indicated by the arrow, the plates each being provided with openings for forming jets of air or other gas under pressure. Air is fed under pressure through the lines 56 and 57 into plenum chambers of which the apertured plates 54 and 55, form parts respectively of the walls thereof. The slot provided between the plates 54 and 55 is shallow and sufficiently wide to accommodate the tow in the widest condition desired. The outer boundaries of the slot are formed by imperforate side walls 58 and 59 of the banding jet. The banding jet device preferably is of the type disclosed and claimed in Jackson U. S. patent application Serial No. 356,983, filed May 25, 1953, now Patent No. 2,737,688, issued March 13, 1956. The action of the jets of the banding jet device is to strike the tow perpendicularly to its path of movement and force the filaments apart, thereby forming a ribbon-like web having approximately eight times the original tow width with a minimum of thickness. In this condition the filaments of the tow are accessible to fluids which are applied by the next member of the conditioning assembly.

From the banding apparatus 19 the tow emerges into a spray chamber 20 which is illustrated as having a slidable glass window and an exhaust hood and flue. In the spray chamber, a fluid bonding medium is applied by means of oppositely disposed spray guns 21 and 22 to produce an adhesive attitude in the filaments. Most advantageously the spray is a liquid plasticizer which will produce a tackiness in the filaments through surface solvation thereof at points of contact therewith.

The plasticizer is fed to the spray guns 21 and 22 from a supply tank (not shown) and lines leading through solenoid valves 38 and 60. These valves are opened to admit plasticizer to the guns by energization of a circuit controlled by a suitable switch such as a spring-biased single throw switch or micro switch 61. The switch remains open when the apparatus is inoperative. When the clutch plates 47 and 48 are brought into engagement by movement of the bell crank handle in the direction indicated, the arm of the lever moving the clutch plate 48 contacts the switch and moves it into a position closing the circuit and thereby supplying plasticizer to the spray guns. This cooperation of elements prevents the application of an excessive amount of plasticizer to the banded tow if operation of the machine must be temporarily halted. The supply of pressure air to the spray guns may be controlled in a similar way but this is not necessary.

The plasticizer forms minute droplets at random points along the surface of substantially each of the filaments of the tow in sufficient quantity so that substantially each of the filaments will have a plurality of points of surface solvation along any length corresponding to the length of the smoke filtering unit which is to be the ultimate product.

In the fluid treatment of the ribbon-like tow, it is best to utilize a plurality of atomizers to produce intimate spraying among and onto the filaments throughout the body of the tow whereupon the tow becomes more or less evenly coated with the treating liquid. Theoretically, all or substantially all of the individual filaments are wet at at least one or preferably a plurality of points along any given length corresponding to the extent of a single filter element. Most advantageously, a plastic-

izing agent such as methyl phthalyl ethyl glycolate (carboethoxymethyl methyl phthalate) is employed. Other suitable nontoxic plasticizers which have nontoxic decomposition products and do not adversely affect the taste of tobacco smoke filtered through elements of the invention are dibutyl phthalate, tripropionin 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. If desired, the temperature at which the fluid treatment takes place may be controlled.

In the course of its continuous movement the tow, wet with plasticizer, passes out of the spray cabinet 20 through a slot in the side wall thereof and is received into the mouth of an adjacently disposed tow fluffing means. The fluffing means specifically illustrated in Fig. 6 is a fluffing jet device through which air under pressure or at least in relatively high velocity is supplied to the liquid treated tow in such a manner as to fluff up the tow and enhance its loftiness. The fluffing means has a second function obtained through its aspirator action in serving to move the tow from the tow opening means through the remainder of the conditioning apparatus to a forming horn of the cigaretting means. Thus in the illustrated embodiment air is supplied through valves 23 and 64 in a predetermined amount preferably 20 to 40 pounds per square inch gauge, sufficient to coordinate movement of the tow through the banding jet and spray chamber with movement achieved through the drive rolls of the tensioning device and through the cigaretting machine 24. The fluffing means illustrated is provided with a band-like jet formed by orifices in the nozzles 40, 41 above and below the mouth 42 through which the tow enters in the direction indicated by arrow 43. Upon entry into the mouth 42 of the fluffing device the tow passes between the discharge of the two jets and is carried with the high velocity air stream through an elongated restricted tubular passageway 44 having a bend intermediate its ends whereby to ensure passage of the air blast completely through the tow.

We have discovered that the fluffing results in further bundle breaking and is a procedure that will provide for suitable restoration of the filament mass into a springy, resilient condition and prevention of group bundling and matting of the wetted filaments. In other words, it maintains proper filament distribution and filament separation. The elongated tube of Fig. 6 may employ, instead of flat, sheet-like air streams, an annular blast of air under a pressure of 10 to 100 lbs. gauge, preferably 45 to 50 pounds gauge.

The illustrated fluffing means, i e. the fluffing jet may be satisfactorily replaced with other fluffing means, most advantageously one which also provides an aspirator action. Thus the fluffing may be accomplished with a type of banding jet modified as to jet direction so as to produce movement of the tow. Likewise, it may be suitable to modify and use a well-known scutcher suitably modified or doffing aspirators of the art. Accordingly, the fluffing step most advantageously takes the form of any lofting procedure accomplished by passing the liquid treated tow concurrent with a relatively confined stream of high velocity gas such as air so that it both lofts and moves the tow.

Tow emitted in the air stream from the fluffing device is then drawn into a cigaretting means such as the garniture 24 of the cigarette-making machine. The horn or die 25 of the garniture condenses and shapes the fluffed wet tow and discharges it onto a moving strip or ribbon of cigarette paper carried on an endless belt conveyor.

The operation of one suitable type of garniture is indicated diagrammatically in Fig. 5 in which conditioned tow 26 is shown entering a condensing horn 27 and being discharged therefrom onto paper web 28 fed from a roll 29. The paper is lapped around the rod of acetate filaments in the shaping member 30 and a standing edge of

paper has adhesive continuously applied to it by a rotating disc 31. The standing paper edge is smoothed down over the adjoining edge by member 32 and heat-sealed into a permanent adhesive bond by member 33. A rotating knife 34 severs the paper-covered rod into appropriate lengths.

The garniture or cigaretting machine is powered by the prime mover 16 through the clutch plates 47 and 48 in a manner as explained above in connection with the tensioning device. The continuous conveyor belt 62 (Figs. 2 and 3) is driven through the action of pulley 63 which is keyed to the shaft 46. Other separate parts of the garniture may be synchronously driven by any convenient arrangement of shafts (not shown) geared to the shaft 46. In any event the driving arrangement is such that movement of the tow through the entire apparatus and application of plasticizer are both controlled by means of the operation of the bell crank lever 37. Movement of tow and spray application thus are started and stopped in unison. It is necessary that sufficient air always be supplied to keep the tow moving through the fluffing jet and to avoid slack in the tow. However, as relatively little force can be applied to the tow by the fluffing jet, the air supply thereto need not be stopped when the operation of the garniture and spray is halted. However, when air supply to the fluffing device is cut off, the tow will sag from the position indicated by the dotted line in Fig. 3. A tray 65 consisting of a bottom and side walls is mounted on the garniture to support and protect tow falling thereon.

If desired, the paper covered rod formed by the cigaretting operation may be stiffened by a heat curing treatment accomplished during passage of the rod through a heated member 35 prior to severance. The same results may be obtained by subjecting the severed rods to heat treatment such as for instance storage in a chamber heated to 200° F. for a period of about two hours.

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 carbethoxymethyl methyl phthalate), although the treating time may be varied from ½ to 24 hours depending on the temperature and the particular plasticizing agent employed. Any 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, for instance, 24 hours to allow the plasticizer to penetrate and the bonding to become thorough and complete.

The term "stiffening" as applied to the generic step disclosed herein means treating, as by curing, to cause a setting of the fluid portions of the filaments and/or plasticizer or adhesive thereon. It may amount to the removal of volatile solvents or homogenization of filament composition brought about by promoting migration of localized plasticizer through the mass, thereby reducing the fluidity and increasing stiffness and resiliency at such localized points and the setting of a firm bond at these bonding points. In any event, the stiffening step insures final bonding and welding when practiced according to the preferred procedure and gives a more rigid structure to the fiber mass which facilitates handling and assembly operations, results in a better feel and prolongs uniformity of filament distribution.

After the paper-covered rod has been severed into elements of appropriate length and preferably stiffened, 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 posi-

tion 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 debundled mass of crimped cellulose acetate filaments and a wrapper encircling the mass, each filament of the mass being substantially coextensive therewith, the filaments as a whole being in substantial alignment longitudinally of the mass but substantially each of the individual filaments having non-oriented short portions thereof disposed randomly in diverging and converging relationship to the main filament axis, substantially all of the filaments of the mass being 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 being uniformly distributed throughout the transverse section of the mass thereby providing a dechannelized condition within the mass.

Thus a "rod" in accordance with our terminology comprises a filter mass, regardless of length or diameter, which results from conditioning and cigaretting a tow according to the invention and which is structurally unitary or substantially so, and capable independently of substantially retaining its size and shape. The rods of the invention, though endowed with compactness and rigidity, are resilient and to a certain extent flexible. The rigidity of the rod may be emphasized almost to the point of inflexibility by means of a final stiffening (curing) treatment of proper intensity.

The condition and disposition of the filaments within the product is one in which the filaments, though members of the same strand and coextensive, are in less than exact longitudinal alignment due to the filament separation and fluffing operations. The individual diverging and converging portions include portions at which crimp has taken place and portions with exaggerated displacement as a result of fluffing operations. Furthermore, the porosity and perviousness of the rod-like mass is preferably such that in passing longitudinally through the mass any given amount of tobacco smoke is split into numerous small streams and each stream guided through small channels formed by the surfaces of surrounding filaments, channel size being such that good contact is thereby afforded between the filament surfaces and all portions of the smoke.

While the apparatus disclosed in the foregoing paragraphs has been found to be most advantageous for reproduction of uniformity in products produced according to our novel method it should be mentioned that some alternatives for individual elements are possible within the scope of invention. For instance in the step of filament separation, tow opening may be accomplished 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 15. In other words, an opening device instead of two pairs of tension rolls might comprise a pair of driven 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 device 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 would be transversely moved apart from each other, particularly in regions of high filament density to produce a tow structure having a great-

ly increased uniformity of cross-sectional fiber distribution.

We claim:

1. Apparatus for conditioning a continuously supplied crimped continuous filament tow preparatory to conversion of the tow into compact, firm, resilient, rod-like segments of a predetermined size and shape suitable for use as filter elements and in which the filaments in the aggregate are in substantial parallelism with the longitudinal axes of the segments, said apparatus comprising a pair of driven rolls for continuously drawing tow from a supply source, a tow retarding device forming a bite for tow passing from the supply source toward the driven rolls, said retarding device cooperating with said driven rolls to place tow in the zone between the retarding device and the driven rolls under a relatively high longitudinal tension, a slotted air blasting device positioned to receive the tow under relatively low tension from the driven rolls and adapted to spread the tow into a wide flat band substantially wider than the tow at the supply source, spray means adjacent the tow spreading device for uniformly projecting droplets of a liquid spray onto a large number of filaments of the wide, flat tow band discharged from the tow spreading device, means for moving the tow from the driven rolls through the air blasting device and the spray means, said moving means cooperating with said driven rolls to maintain tow in the zone between the driven rolls and the moving means relatively relaxed and under a relatively low longitudinal tension substantially lower than said relatively high tension, and a condensing funnel positioned to receive tow from the tow moving means and adapted to condense the tow into a firm, compact, rod-like form.

2. Apparatus for conditioning a continuously supplied, crimped, continuous filament tow for conversion of the tow into firm, compact, rod-like segments of a predetermined size and shape suitable for use as cigarette filter tips, said apparatus comprising a pair of driven rolls for continuously drawing tow from a supply source, a second pair of rolls forming a bite for tow passing from the supply source toward the driven rolls, the second pair of rolls cooperating with the driven rolls to exert a high longitudinal tension of at least twenty pounds on tow therebetween, an air-blasting tow spreader positioned to receive tow from the driven rolls and adapted to spread the tow into a wide, thin band substantially wider than tow at the supply source, spray means adjacent the spreader for uniformly projecting droplets of a liquid spray onto a large number of filaments of the wide, thin tow band discharged from the spreading device, means for moving the tow from the driven rolls through the spreader and the spray means, said moving means cooperating with said driven rolls to maintain tow in the zone between the driven rolls and the moving means relatively relaxed and under a relatively low longitudinal tension of less than twenty pounds, and means for condensing the sprayed tow into a compact, rod-like form.

3. Apparatus as defined in claim 1 wherein the tow moving means comprises an aspirator tube.

4. Apparatus for the conditioning of a continuously supplied, crimped, continuous filament tow for conversion into firm, compact, rod-like segments of a predetermined size and shape suitable for use as filter elements and having filaments which in the aggregate are in substantial parallelism with the longitudinal axes of the segments, said apparatus comprising a plurality of cooperating means positioned successively along and forming a path for continuous longitudinal movement of the tow, said means being driven under timed relationship con-

ditions, the means including a pair of driven rolls for continuously drawing tow from a supply source, a second pair of rolls forming a bite for tow passing from the supply source toward the driven rolls, the second pair of rolls cooperating with the driven rolls to exert a high longitudinal tension of at least twenty pounds on tow therebetween, a slotted, air-blasting tow spreader positioned to receive tow from the driven rolls and adapted to spread the tow into a wide, thin band substantially wider than tow at the supply source, spray means adjacent the spreader for uniformly projecting droplets of a liquid spray onto a large number of filaments of the wide, thin tow band discharged from the tow spreading device, means for moving the tow from the driven rolls through the spreader and the spray means, said moving means cooperating with said driven rolls to maintain tow in the zone between the driven rolls and the moving means relatively relaxed and under a relatively low longitudinal tension of less than twenty pounds and means for condensing the sprayed tow into a compact, rod-like form.

5. Apparatus for the conversion of a continuously supplied, crimped, continuous filament tow into firm, compact, rod-like segments of a predetermined size and shape suitable for use as filter elements and having filaments which in the aggregate are in substantial parallelism with the longitudinal axes of the segments, said apparatus comprising a plurality of cooperating means positioned successively along and forming a path for continuous longitudinal movement of the tow, said means being driven under timed relationship conditions, the means including a pair of driven rolls for continuously drawing tow from a supply source, a second pair of rolls forming a bite for tow passing from the supply source toward the driven rolls, the second pair of rolls cooperating with the driven rolls to exert a high longitudinal tension of at least twenty pounds on tow therebetween, a slotted, air-blasting tow spreader positioned to receive tow from the driven rolls and adapted to spread the tow into a wide thin band substantially wider than tow at the supply source, spray means adjacent the spreader for uniformly projecting droplets of a liquid spray onto a large number of filaments of the wide, thin tow band discharged from the tow spreading device, means for moving the tow from the driven rolls through the spreader and the spray means, said moving means cooperating with said driven rolls to maintain tow in the zone between the driven rolls and the moving means relatively relaxed and under a relatively low longitudinal tension of less than twenty pounds, means for condensing the sprayed tow into a firm, compact, rod-like form, means for wrapping the rod-like tow in paper, and means for cutting the wrapped tow rod into said segments.

6. Apparatus as defined in claim 5 wherein the second pair of rolls is braked.

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