

Aug. 25, 1959

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2,900,988

TOBACCO SMOKE FILTER ELEMENTS

Original Filed Dec. 5, 1952

2 Sheets-Sheet 1

Fig. 1

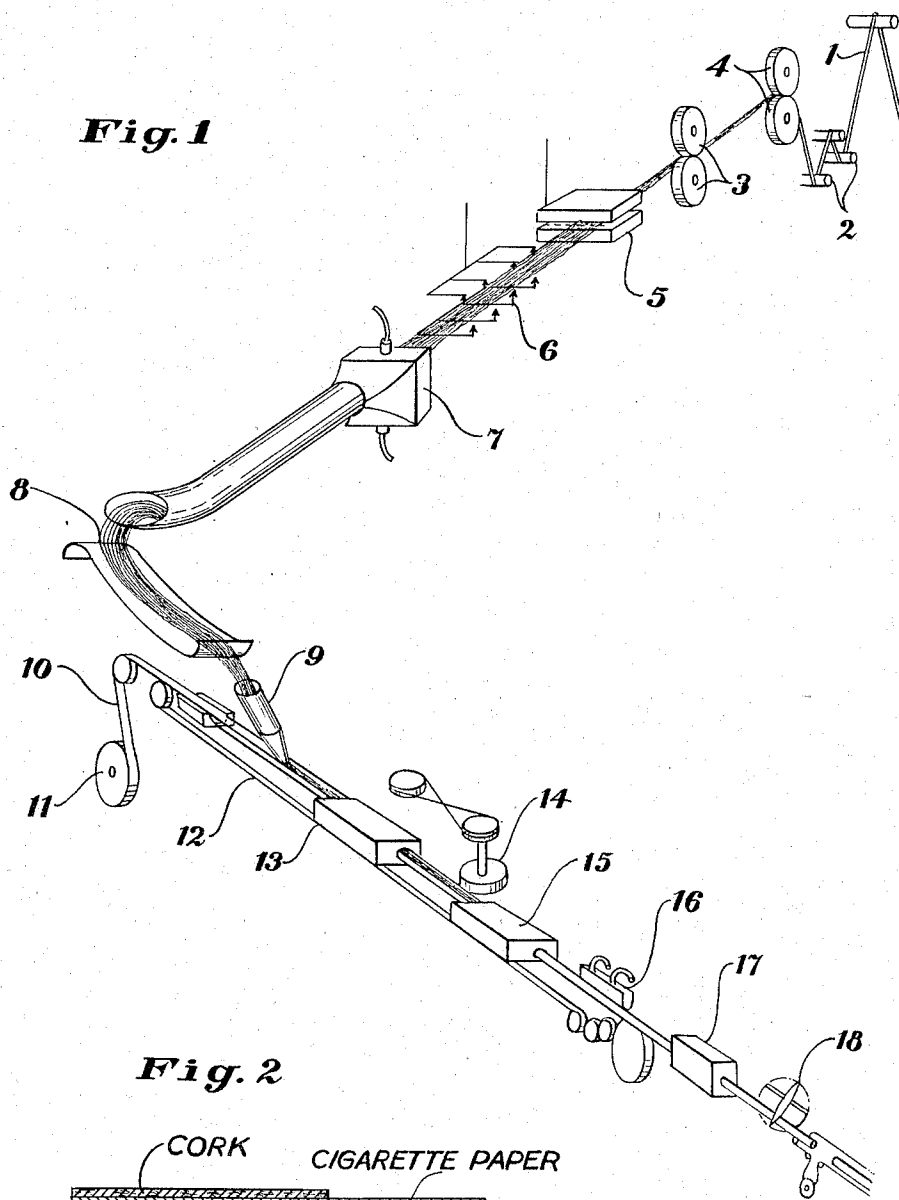
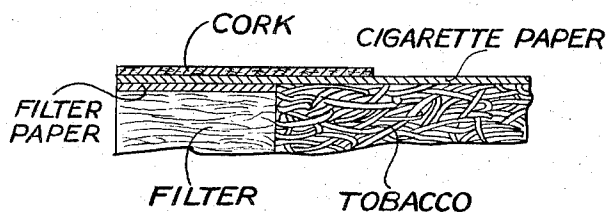


Fig. 2



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2 Sheets-Sheet 2

Fig. 3

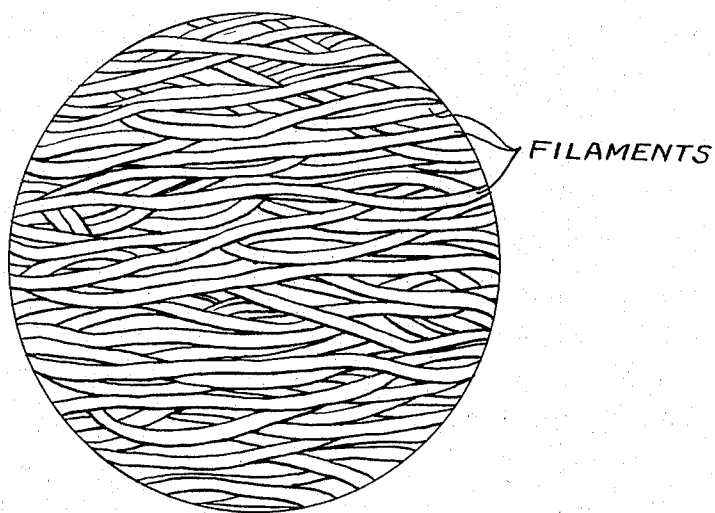
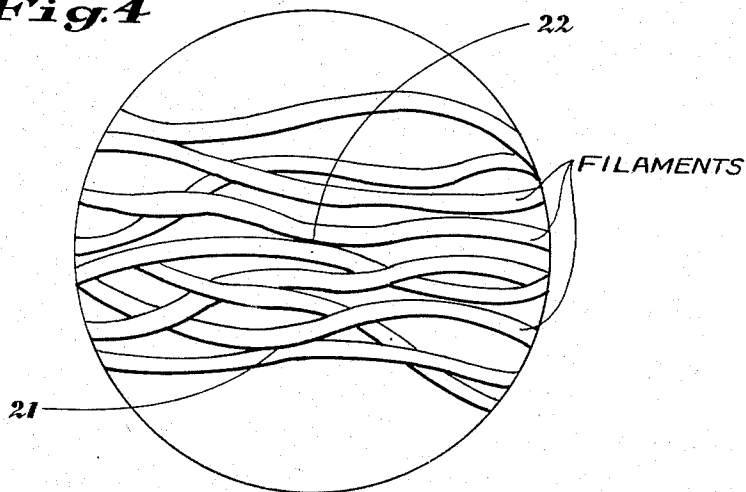


Fig. 4



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2,900,988

TOBACCO SMOKE FILTER ELEMENTS

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Original application December 5, 1952, Serial No. 324,342. Divided and this application June 9, 1954, Serial No. 435,544

8 Claims. (Cl. 131—208)

This application is a division of our U.S. patent application Serial No. 324,342 filed December 5, 1952, which together with our application Serial No. 374,168 filed August 14, 1953, contains claims to certain subject matter disclosed in the instant application.

The present invention relates to tobacco smoke filtering elements comprising fibrous cellulose esters, particularly cellulose acetate of the yarn-type. More particularly the invention is concerned with a method for the preparation of structurally unitary elongated rod-like masses of cellulose acetate fibers contained within an outer surrounding wrapper of paper and suitable in appropriate lengths for use as cigarette filter tips and as filter elements for pipes and for cigar and cigarette holders.

The problems associated with production of a filtering element acceptable to the cigarette manufacturing industry have been numerous. Requirements for a satisfactory cigarette filter tip are stringent in that the tip must be of proper density, weight, body, resiliency, rigidity, etc., for use in manufacturing and packaging machinery commonly employed in cigarette factories. Furthermore, the industry has high standards as regards uniformity of composition and structure in filter tip elements and demands that draw-backs such as result, for example, from occasional loss of one or more fibers or filaments from the filtering elements be entirely eliminated. It is a particularly difficult problem to produce a satisfactory filter element of cellulose acetate fibers which will conform to the above-stated requirements and yet meet the other demands in structural uniformity of its transverse section and particularly uniformity as regards air pressure drop from one end to the other of the element. It is also a difficult problem to provide a fibrous filter wherein optimum density and body for manufacturing and packaging purposes and optimum air pressure drop for smoking purposes are both simultaneously maintained, especially where these goals must be achieved in the absence of any tendency exhibited in the filter element toward formation of passages which would lead to channeling of the smoke. A filter element must be rejected if it contains passages which lead to channeling of the smoke since in such case inadequate filtering will result. On the other hand, where compaction of the fibers transversely is increased to avoid the possibility of channels, either the drawing properties of the cigarette are so affected that the filter element again is considered not serviceable or the density, weight or body become intolerable to the manufacturing procedures.

We have discovered a method leading to the preparation of filter elements composed of yarn-type cellulose acetate fibers wherein the filter produced is of superior quality as regards all of the above-identified requirements. The novel elements of the invention utilize all of the known capabilities of cellulose acetate tobacco filters and yet are uniform and adequate as respects the other requirements of the cigarette manufacturing industry.

Accordingly, it is an object of the invention to overcome in toto the problems enumerated above and to meet all

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the requirements outlined in respect to tobacco smoke filtering elements, especially cigarette filter tips and procedures for the preparation thereof. Thus it is a primary object of the invention to produce improved rod-like tobacco smoke filtering elements from yarn-type cellulose acetate fibers. Another object is to provide a commercial method for the preparation of such filter elements in a continuous mass production procedure in which continuous running lengths of tow are employed to produce continuous running lengths of rod-like filter material which may be cut into elements of any desired length. A further object of the invention is to provide a filter element in which the fibers have been dechannelized, so to speak, wherein there are present within the larger fiber mass no smaller distinct fiber bundles which will result in channeling of the smoke through the filter because of improper cross-sectional distribution of the fibers. Still another object is to provide an elongated paper-wrapped cellulose acetate fiber rod in which the fibers are randomly oriented primarily in a longitudinal direction to produce a fiber rod of uniform cross-sectional fiber distribution, and thus uniform cross-sectional air pressure drop. A further object of the invention is to provide a method for the preparation of elements of the described character. A still further object is the preparation of structurally unitary fibrous filters in which substantially each and every fiber is positively bound to the structural unit and from which, therefore, the removal of fibers will not accidentally occur when the filter element is in use. Other objects will be apparent from the present specification and claims.

In the foregoing, the expression "randomly oriented primarily in a longitudinal direction" is intended to describe the condition of the fibers within the filters of the present invention in which the fibers are as a whole longitudinally aligned and are in the aggregate in a parallel orientation, but in which distinct short portions of individual fibers may run more or less at random in non-parallel diverging and converging directions.

The term "strand" as employed in the present specification and claims is intended to mean an elongate continuous relatively loose and uncompacted mass of fibers substantially oriented in a longitudinal direction and the term is generic to both continuous filament tows and continuous slivers of carded staple fiber. By continuous filament tow we mean the material which results when filaments spun from a plurality of spinneret holes are brought together and combined, preferably with filaments from other spinnerets to form a tow of parallel filaments. By carded sliver we refer to the untwisted continuous strand or rope comprised of cut fibers which results from the passage of said fibers through a conventional carding machine e.g. a cotton, woolen or worsted card. In the process of the invention, a strand is subjected to a number of conditioning treatments during which the strand is opened and dechannelized. During the strand treating period the strand more or less loses its identity as such in that it is converted into a quite open and loose form with the filaments in indeterminate relationship, subsequently assuming web-like and ribbon conformations. Therefore the fiber mass is more aptly identified during the treating period as a fiber bundle rather than a strand. The treated dechannelized strand or fiber bundle finally is run through a tapered condensing tube and becomes thereby reformed and condensed as a compacted dechannelized strand. The structurally unitary product resulting from shaping and heat treatment of the condensed strand will be referred to as a "rod."

While in our parent application Serial No. 324,342 we have discussed the preparation of tobacco filter rods from yarn-type spun cellulose acetate filaments in either tow or sliver form, heat- or solvent- or plasticizer-treated

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to produce structurally unitary aligned fiber masses of various types, we propose to take advantage of one species best adapted to standard paper-wrapped cigarette filter and cigarette production methods and further to take advantage of the continuous and uniform properties of spun cellulose acetate at its stage of manufacture when it is in the form of a crimped continuous filament tow. In a method including a specific and critical procedure for pretreatment of the strand, we form the strand into a structurally unitary rod-like condition only after the special novel pretreatment thereof. The treated and formed strand is shaped to the transverse section of a cigarette body and paper is subsequently closed around the compacted strand and sealed in place as an outer retaining skin, the paper-covered fiber rod thus produced subsequently being cut into appropriate lengths. The special objects of the present invention thus are accomplished particularly by the preliminary treatment of the strand. As will be observed from the following description, the invention is designed primarily for use with a strand consisting of a continuous filament tow of cellulose acetate fibers.

In accordance with our invention which seeks especially to achieve a structurally unitary elongated rod-like element comprising an opened and dechannelized mass of fibers uniformly distributed throughout the transverse section of the rod and randomly oriented primarily in a longitudinal direction, the strand is brought to an open relaxed form whereby the extent of fiber orientation is reduced and in its opened, relaxed form the strand is subjected to a treatment with a fluid chemical which subsequently results in bonding of the fibers at random points of contact. A lofting or second opening operation follows the chemical treatment. We have found that such procedure results in uniform cross-sectional distribution of fibers and in a fiber bonding which insures that fibers will be positively retained in place within the body of the filter elements. In brief, a preferred embodiment of the invention resides in a method comprising carrying out the above-listed sequential steps upon a crimped continuous filament tow from which the slack has been removed and subsequently condensing and forming the moving treated strand into desired size and shape by means of a condensing tube, laying the condensed strand into a moving ribbon of paper which then is closed about the periphery of the condensed strand and which serves as a retaining shell for the latter, and finally heat treating the paper covered compacted strand and thereby forming a structurally unitary rod-like article.

A preferred method of the invention is illustrated in the drawings in which Figure 1 is a schematic diagram, in perspective, of the various phases of treatment required to convert the initial strand into final rod-like filter elements; Figure 2 is a vertical longitudinal section through the tip end portion of a cigarette provided with a filter element of the invention; Figure 3 represents a photomicrograph of a portion of the interior of the filter mass shown in Figure 2 (side elevation of the portion); and Figure 4 is a still more highly magnified view of a portion of the mass of Figure 3 particularly showing surface solvation bonds between adjacent filaments.

With reference to Figure 1, a strand, most advantageously a previously preferably mechanically crimped tow 1, is passed through a series of tension fingers 2 to remove slack. The tow from which the slack has been removed is passed to a variable drafting arrangement comprising a pair of positively driven rolls 3 and a pair of rolls 4 which either are positively driven at a slower rate than the rolls 3 or are held from free turning by a braking or friction action so that they are resistively turned by the action of rolls 3 in positively pulling through the tow 1. In the drafting device the strand is subjected to sufficient tension to produce a restriction of the strand which results, upon emergence of the strand from the nip of the positively driven rolls into a zone

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of relaxation, in a more random distribution of the filaments, to produce a fiber mass or bundle from which smaller individual bundles are eliminated. The action is a result of inherent elastic forces within the filaments of the strand. The strand, which as a result of the drafting and relaxation has become somewhat webbed, opened or bloomed, next is sent through a further opening or banding device 5 provided with a plurality of air jets which move the filaments apart and produce a ribbon-like fiber mass which has a still more web-like nature. From the air opening device the bundle passes then to chemical treating apparatus 6 which preferably is composed of a multiplicity of atomizing sprays directed at the ribbon-like bundle from all points around the latter. Here a plasticizer or the like which serves to partially dissolve or soften the fiber which it reaches and which will produce in the fibers a sticky attitude sufficient to subsequently produce fiber bonding is injected into and throughout the fiber bundle. From the chemical treating apparatus the moistened fiber moves next to a lofting device 7 which serves further to fluff up and improve the loftiness of the fiber mass. From the outlet end of the lofting device the lofted moving bundle is led over an apron 8 where it collects and dwells for a short period of time in a relaxed condition. Subsequently the bundle is withdrawn from the apron and passed into a suitable funnel-like horn 9 which serves as a condenser. Within the horn 9 the strand is reformed as a condensed dechannelized mass, i.e. the bundle is shaped into a partially compacted mass of approximately desired transverse section which normally will be circular.

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 several dies thus forming the tobacco into a cylinder and lapping the paper over itself. The glue on the paper is heat sealed forming a continuous cigarette. A cutter knife cuts the tube into desired lengths. With very minor modifications the partially compressed dechannelized strand of a continuous nature is substituted for the stream of tobacco fed onto the paper in the remainder of the process of the present invention to form the cigarette filter which we propose as new and novel. Thus, the compacted dechannelized strand from the condenser, is passed onto a moving ribbon 10 of cigarette paper fed from a supply roll 11 and carried by an endless conveyor belt 12. From this point the condensed reformed strand and the paper with which it is associated are treated in a manner similar to that which results in the garniture of an ordinary cigarette manufacturing machine. That is to say, the web of paper ribbon and the condensed strand associated therewith maintain a fixed relation as regards longitudinal, horizontal and transverse motion and pass into a preliminary forming die 13, thence past a pasting wheel 14 which applies paste along the edge of the paper, next to a final forming die 15 which completes positioning of the paper around its associated strand, thence to a sealing device such as an electric heating shoe 16 which serves to seal closed the pasted paper. Finally the paper enclosed strand may be subjected to a treatment with a heated die 17 which insures satisfactory fusion and welding of the fibers at random points of contact and thereby results in rod formation. The rod thence is passed to a cutting device 18 which is adjusted to sever the paper covered rod into filter elements of desired length. An alternate method is to cut the rod before complete bonding action occurs and complete the process by storing the severed elements in an oven.

Normally the strand should be treated with a lubricant prior to being subjected to the various phases of the process. Thus it may be stated that the process of the invention employs as a starting material a crimped lubri-

cated strand of synthetic filaments or fibers. The lubricant may be any one of a number of neutral, nontoxic materials. It has been found advantageous to employ on the fiber approximately 0.5% of pharmaceutical grade mineral oil.

The so-called yarn-type cellulose acetate is a preferred material for use and is an acetate having an acetyl value in the range of 38-41%, most advantageously 38.8-39.2%. However, the term cellulose acetate is used generically herein to include, not only cellulose acetate having an acetyl value of 38-41%, but also cellulose triacetate, acetate-propionate and acetate-butyrate. While it is not necessary to use plasticized fibers it is possible to practice the invention with a strand which constitutes a fiber mixture having some plasticized fibers. If plasticized fibers are to be employed, it will be possible under suitable conditions to use 100% plasticized fiber if a low percentage of plasticizer has been put in the fiber. With a blend of plasticized and unplasticized fibers, plasticized fibers containing 33% of a suitable plasticizer such as triethyl citrate have been found best. It is to be remembered, however, that even totally unplasticized acetate fibers will fuse with proper heat control and that in accordance with advantageous procedure of the invention, plasticizer is applied to all the fibers. The fibers employed might perhaps satisfactorily be in the form of a strand comprising 100% yarn-type unplasticized cellulose acetate such as results from the dry spinning of a cellulose acetate acetone dope. The strand is suitably crimped and contains in accordance with the invention 4-15 crimps per inch, most advantageously 10-15 crimps per inch. A crimped tow proves most advantageous in that it offers continuously uniform properties. The tow employed may be in form of a ball wrap, i.e., a continuous crimped tow as taken from crimping machines and wrapped on a core.

The acetate filaments should have a weight within the range of 3 to 16 denier per filament and a total denier of the tow within the range of 80,000 to 160,000 denier. An advantageous starting material is a yarn-type dull cellulose acetate continuous filament tow of 5 denier per filament with 90,000 total denier. Where plasticized fibers are to be used in mixture with unplasticized fibers a continuous filament tow may be made up with one or more filaments of plasticized yarn which plasticized yarn may have a maximum total denier of 80,000. If a carded sliver is to be employed rather than a continuous filament tow, the sliver may have a weight of 100 to 300 grains per yard.

As an example, good filters were made from a 5 denier per filament, 160,000 denier tow of spun cellulose acetate with crimps varying from 5 to 7 per inch. This tow was subjected to the special opening and liquid treatment and the resulting bundle was presented to a regular Molins cigarette making machine where it was compressed, wrapped with paper and severed into suitable lengths.

The first step of slack removal provides an evened-out strand and requires merely that sufficient tension be applied to the tow to remove the slack in any of the filaments. Such a procedure is well known to those familiar with the textile art and may be accomplished with any suitable arrangement of a series of tensioning bars or spools.

The drafting step employing a double set of rolls to produce variable draft serves to enhance the bloom or loftiness of the tow. As the tow relaxes upon emerging from the nip of the front rolls the elastic forces inherent in the fibers cause reactions in all planes and result in a more opened tow. The actual degree of initial crimp and the following controlled drafting, relaxing, etc. is subject to variation over a wide range depending upon the various deniers per filament, total deniers, lubricant, and such changes as may be developed from time to time.

The air opening procedure, which might more properly

be termed "banding" uses high velocity air or other gas and should be provided with variable air pressure. The expressions "dechannelizing" and "dechannelized," etc., as employed in the present specification have reference respectively to the procedure of strand opening and the character of the resulting fiber mass as explained in the instant paragraph. In accordance with the defined terminology, a dechannelized fiber strand is one from which there has been removed the tendency for smaller groups of adjacent fibers or filaments to become associated as distinct compacted smaller bundles within the larger mass or bundle of filaments. Such a tendency of course inherently includes a tendency toward formation of channels. The multitude of orifices in the air-jet strand bander produces a high degree of separation and the filament strand is well opened resulting in a large percentage of the fibers being directly exposed to the spray in the subsequent chemical treatment. The bundle breaking and opening operations reduce interior filament marriage resulting from the crimping operations. It is necessary to remove and break up such grouping in order that there be no small fiber bundles present in the final product. The air jet banding procedure preferably is accomplished with jets provided by approximately 600 holes of 0.3 mm. diameter and air pressure at 15 to 20 pounds gauge. Obviously these conditions can be varied within relatively wide limits as can the spacing and positioning of the air jets.

The chemical treatment of the air opened ribbon-like fiber web utilizes a battery of air atomizers to produce intimate spraying among and onto the fibers throughout the bundle body whereupon the fiber mass becomes more or less saturated with the treating liquid. Theoretically, all or substantially all of the individual fibers are wet at a plurality of points along any given length corresponding to the extent of a single filter element. Most advantageously a plasticizing agent such as methyl phthalyl ethyl glycolate is employed although varying situations may make it equally feasible to use semi-solvents, oils, etc., which will serve to bond the fibers together and produce subsequent consolidation of the strand. 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 5 to 30% by weight of plasticizer, more preferably 10 to 15%. If desired, the temperature at which the chemical treatment takes place may be controlled.

For lofting, one may use an elongated tube into the leading end of which is directed an annular controlled blast of air of varying turbulence under a pressure of 10 to 100 lbs. gauge, preferably 45 to 50 pounds gauge. The annular blast creates an aspirating effect to move the tow and additional air through the annulus and the remaining portion of the tube. All of the entering air, and of course the tow, pass out of the tube at the opposite end. Since the fiber bundle entering the lofting tube advantageously is in the form of a ribbon-like web, we prefer to employ an air blast in the form of two flat jets disposed respectively above and below the web. Sufficient turbulence is thereby produced to restore the bundle to its previously existing well opened state and the loftiness of the fiber strand in its subsequently applied paper wrapper. The lofting operation increases the filtering efficiency of the fiber rod and adds body to the final filter assembly.

The step in which the treated fiber mass passes over the apron permits relaxing and eases the strains produced by the straight-line tension to which the fiber previously has been subjected and prevents extension of the fiber to the point where decrimping or breaking occurs from excessive tensile forces. In addition, the apron serves as a bin or reservoir.

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At this stage of the procedure the opened, sprayed and lofted relaxed fiber bundle is passed into the funnel-like condensing nozzle and thence into the shaping end thereof wherein the lands consolidate the mass reforming the dechannelized strand in a compacted condition and shaping it to suitable size and transverse section for laying into the advancing cupped paper ribbon. Normally the transverse section will be circular, but it may be oval, triangular, square, or any special shape as desired. For most standard brands of cigarettes made in the United States, a final circular section of 0.32" diameter is desired in the filter elements. It should be noted in this connection, however, that variation in circumference or diameter ordinarily is more critical than variation in weight of elements prepared for use as cigarette filter tips as regards problems encountered in using the tips in standard cigarette manufacturing and packing procedures.

The remaining steps of the process are generally old in the art of cigarette manufacture and may be suitably varied as will be known to those familiar with the art. Essentially the process is carried out as if the paper carried a charge of tobacco rather than fibrous filtering material. A possible distinction is that a heat treating station may be inserted into the path of movement of the fiber strand subsequent to the point at which the paper wrapper has been sealed. Such an after treatment of the continuous rod in its paper wrapper may be conducted in a heated die in order to accomplish final bonding and welding of the fibers sufficient to insure against their displacement.

We have found it satisfactory to subject the finally wrapped rods to a temperature of 160° F. for four hours although the treating time may be varied from ½ to 24 hours depending on the particular plasticizing agent employed. Any temperature within the range of 125° F. to 300° F. may be found satisfactory. It sometimes may be preferable 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.

After the paper-covered rod has been severed by the cutting apparatus into elements of appropriate length, these 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 the two and sever the joined pieces at the proper points.

The product produced in accordance with the present invention is an elongated rod, normally cylindrical in form and customarily substantially the size of a cigarette in circumference and diameter, the rod being a structurally unitary element composed of a dechannelized mass of randomly but primarily longitudinally oriented and transversely uniformly distributed crimped yarn-type cellulose acetate fibers severed from a condensed reformed treated strand prepared from a continuous filament tow, or carded sliver, and a cylindrical paper retaining shell surrounding said mass at the periphery thereof, substantially all of the fibers of the mass being positively bonded within said structurally unitary rod. In other words, the filter elements comprise paper encased rods of cellulose acetate fibers having the individual fibers thereof "tack welded" to each other, the rods being pervious to air long their longitudinal axes. That is to say, the bonding is not sufficiently complete to give anything approaching a solid material with longitudinal passages but is rather a matter of "spot bonding" each filament at various points so as to give a material which has approximately the same physical characteristics as a plain, wrapped strand, but is yet suf-

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ficiently unitary to prevent individual filaments being pulled out.

The invention is further illustrated in the following example:

Example 1

A continuous filament tow of yarn-type unplasticized dull cellulose acetate containing 0.5% mineral oil lubricant and having 12 crimps per inch produced by a crimping machine, 5 denier per filament and 90,000 total denier was passed through a tension device and slack was removed from the tow. The tensioned tow next was passed through two pairs of controlled drafting rolls as illustrated in the drawings for the purpose of opening the tow and breaking up bundles therein. The opened tow was thence directed to an air jet bundle breaking and banding device of a type such as that illustrated in the drawing. Air jets from above and below the tow operating at a pressure of 15 to 20 pounds gauge and having a total of 600, 0.3 mm. holes were directed against the tow and succeeded in further breaking any individually formed bundles therein and opening or banding the tow to provide a fiber mass of web-like form. Thence the opened and banded fiber mass was sent to a chemical conditioning station where it was continuously sprayed with 10 to 15% of methyl phthalyl ethyl glycolate plasticizer. The sprayed, webbed fiber bundle next was passed to a lofting tube in which it was subjected to a blast of air at 45 to 50 pounds gauge and ejected onto an apron. From the apron the lofted fiber bundle was passed through a guide horn which tapered to an orifice of ¼" diameter and the fiber bundle was pulled therefrom as a shaped, organically wetted strand cylindrical in shape. The strand was passed onto a moving paper tape with which it subsequently was sized, covered and sealed in a fashion as described above. The product was severed into short lengths as cylindrically shaped rod-like filter elements of desired body, size, draw, resiliency, rigidity, weight, and transverse fiber distribution. By after treatment in an oven for approximately four hours at 150° F. the bonding action of the plasticizer was completed. The elements contained no individual fiber bundles and no perceptible channels. The elements did not lose fibers inadvertently. An element prepared as described was formed into a filter-tipped cigarette on a conventional cigarette making machine and the cigarette produced gave a highly satisfactory filtered smoke, i.e., satisfactory removal of tars and nicotine, and physical characteristics that were good for the reason that dechannelization caused the smoke to pass through uniformly and no small bits of the filter passed into the smoker's mouth. It was particularly noticeable that no fibers from the filter were plucked out by the tongue of the smoker in trials under normal conditions.

It should be borne in mind that among the special reasons why the instant process is ably adapted to the manufacture of improved cigarette filter tips are the advantages obtained in the use of continuous fiber strand, e.g., tow, without sacrifice of filter quality or standardization. The invention thereby achieves not only an adequate filter of a character which meets all the requirements of the tobacco industry as set forth above, but also a method adapted to the established manufacturing and packaging procedures of the industry.

The condition and relative arrangement of the fibers which results from various treatments to which the fiber strand and bundle are subjected is variously described in the present specification as one in which, so to speak, a regular irregularity has been produced. Thus the rod may be described as consisting of randomly but primarily longitudinally oriented fibers. The various expressions employed obviously are intended to define that condition which exists when a tow in which all fibers are substantially longitudinally aligned and therefore mostly parallel are subjected to the various opening and dechannelizing treatments. In other words, the rods produced in ac-

cordance with the invention are composed of fibers which in the aggregate are parallel and longitudinally aligned but which have short portions divergent from the main fiber axis. Thus a strand which has been treated in accordance with the invention will consist of a fiber mass in which the fibers may be said to lie randomly but primarily in longitudinal orientation.

As indicated in the foregoing description, tobacco smoke filtering elements may be produced in accordance with our invention from a wide variety of thermoplastic filamentary material. While a preferred material is cellulose acetate of the so-called yarn type, many other cellulose derivatives may be employed such as cellulose acetates of varying degrees of acetylation, cellulose propionates, cellulose butyrate, cellulose acetate butyrate and other organic acid esters of cellulose. Likewise, filamentary or fibrous material composed of synthetic thermoplastic material such as the various polyamides, polyacrylic and polyester materials typified by materials sold under trade names such as nylon, Orlon, Acrilan, Dacron, and similar materials may be employed. In fact, any non-inflammable or slow burning synthetic thermoplastic material which is susceptible of surface or partial solvation may be used.

By the term "solvation" as employed in the present specification and claims is meant the formation, by the action of a solvent or plasticizer and/or heat, of an adhesive condition in surface portions of fibers whereby there is produced a welding and adhesion between adjacent fibers contacting at such portions.

The products of this invention may be employed in suitable size and shape for a variety of useful purposes other than the filtration of tobacco smoke as will be obvious to those skilled in the various arts. For instance, the products may be utilized for the filtration of other gases or of liquids or they may be used as packing, wadding, or cushioning materials or the like.

We claim:

1. A tobacco smoke filter adapted to remove certain undesirable components from tobacco smoke, said filter being essentially comprised of a bundle of continuous longitudinally aligned, crimped uncoated filaments of a material consisting essentially of cellulose acetate and plasticizer therefor, said plasticizer being present in the amount of 5-30% by weight of the filaments and being so associated with said filaments that the removal properties of the cellulose acetate for the undesired components in the tobacco smoke is not substantially impaired and a paper wrapper, the filter being further characterized in that: (a) the bundle is made up of at least several thousand individual filaments in which substantially all of the filaments extend from end to end of the filter; (b) the denier per filament is less than 16; (c) the crimp in the filaments is greater than 4 per inch; (d) the filaments are substantially uniformly distributed across the transverse section of the bundle and joined to one another at random points of contact to a substantial extent from the action of the aforesaid plasticizer, the bundle being pervious along its longitudinal axis; and (e) said paper wrapper surrounds the bundle at the circumference thereof.

2. A filter in accordance with claim 1 wherein the acetyl content of the cellulose acetate is from 38-41%.

3. A tobacco smoke filter adapted to remove certain undesirable components from tobacco smoke, said filter being essentially comprised of a bundle of continuous longitudinally aligned, crimped filaments of a material consisting essentially of a cellulose ester and plasticizer therefor, said plasticizer being so associated with said filaments that the removal properties of the cellulose ester for the undesired components in the tobacco smoke is not substantially impaired and a paper wrapper, the filter element being further characterized in that: (a) the bundle is made up of at least several thousand individual filaments in which substantially all of the fila-

ments extend from end to end of the filter; (b) the denier per filament is less than 16; (c) the crimp in the filaments is greater than 4 per inch; (d) the plasticizer is a chemical compound derived from the reaction of a polyhydroxy alcohol and an organic acid, the decomposition products of which plasticizer are non-toxic and do not adversely affect the taste of the smoke filtered through the filter; (e) the filaments are joined to one another at random points of contact, the bundle being pervious along its longitudinal axis; and (f) said paper wrapper surrounds the bundle at the circumference thereof.

4. A filter in accordance with claim 3 wherein the plasticizer is a glyceryl ester of a lower fatty acid.

5. A filter adapted to remove certain undesirable components from tobacco smoke, said filter being essentially comprised of a bundle of continuous longitudinally aligned, crimped uncoated filaments of a material consisting essentially of a thermoplastic composition adapted to be plasticized and a plasticizer therefor, said plasticizer being present in the amount of 5-30% by weight of the filaments and being so associated with said filaments that the removal properties of the thermoplastic composition for the undesired components in the tobacco smoke is not substantially impaired and a paper wrapper, the filter being further characterized in that: (a) the bundle is made up of several thousand individual filaments in which substantially all of the filaments extend from end to end of the filter; (b) the denier per filament is less than 16; (c) the crimp in the filaments is greater than 10 per inch; (d) the filaments are substantially uniformly distributed across the transverse section of the bundle and joined to one another at random points of contact to a substantial extent from the action of the aforesaid plasticizer, the bundle being pervious along its longitudinal axis; and (e) said paper wrapper surrounds the bundle at the circumference thereof.

6. An filter adapted to be attached to the ends of cigarettes, said filter being essentially comprised of a cylindrical bundle of continuous longitudinally aligned, crimped filaments of a material consisting essentially of cellulose acetate and plasticizer therefor, said plasticizer being present in the amount of 5-15% by weight of the filaments and being so associated with said filaments that the removal properties of the cellulose acetate for certain undesired components in the smoke from the cigarette is not substantially impaired and a paper wrapper, the filter element being further characterized in that: (a) the bundle is made up of several thousand individual filaments in which substantially all of the filaments extend from end to end of the filter; (b) the denier per filament is less than 16; (c) the crimp in the filaments is greater than 10 per inch; (d) the filaments are substantially uniformly distributed across the transverse section of the bundle and joined to one another at random points of contact, by a cellulose acetate to cellulose acetate plasticizer bonds, the bundle being pervious along its longitudinal axis; and (e) said paper wrapper surrounds the bundle at the circumference thereof.

7. A filter in accordance with claim 6 wherein the several thousand individual filaments do not exceed a total denier greater than 160,000 denier.

8. A tobacco smoke filter adapted to remove certain undesirable components from tobacco smoke, said filter being essentially comprised of a bundle of continuous longitudinally aligned, crimped filaments of a material consisting essentially of cellulose acetate and plasticizer therefor, said plasticizer being essentially composed of a glyceryl triester of a lower fatty acid and present in the amount of 5-30% by weight of the filaments, said plasticizer being so associated with said filaments that the removal properties of the cellulose acetate for the undesired components in the tobacco smoke is not substantially impaired and a paper wrapper, the filter element being further characterized in that: (a) the bundle is

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made up of several thousand individual filaments in which substantially all of the filaments extend from end to end of the filter, but insufficient to give a total denier greater than 160,000; (b) the denier per filament is less than 16; (c) the crimp in the filaments is greater than 4 per inch; (d) the filaments are substantially uniformly distributed across the transverse section of the bundle and joined to one another at random points of contact, the bundle being pervious along its longitudinal axis; and (e) said paper wrapper surrounds the bundle at the circumference thereof.

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