

March 12, 1963

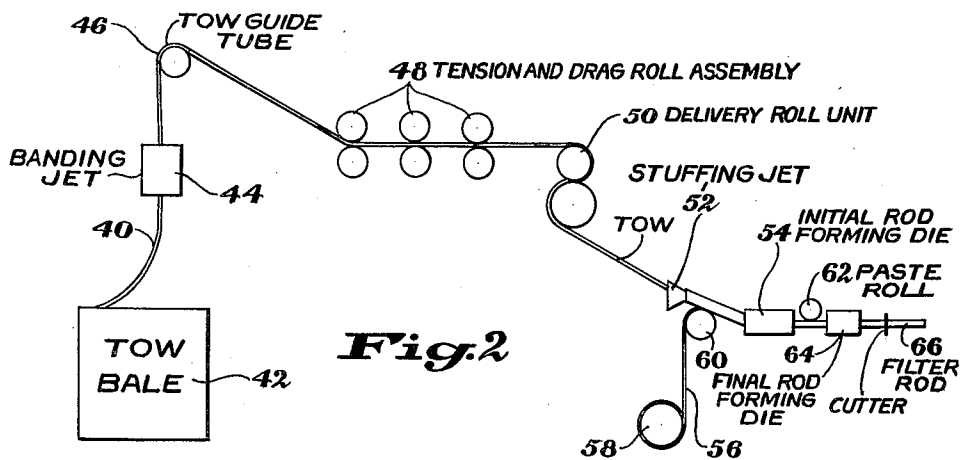
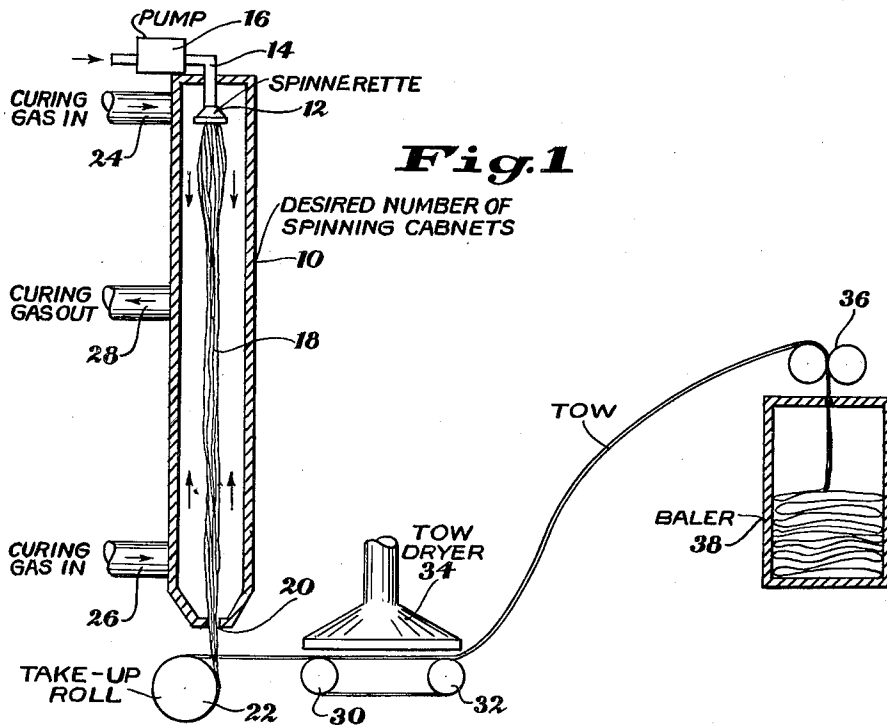
C. A. JARRETT ET AL

3,080,611

METHOD FOR THE PRODUCTION OF CIGARETTE FILTERS

Filed Nov. 8, 1960

2 Sheets-Sheet 1



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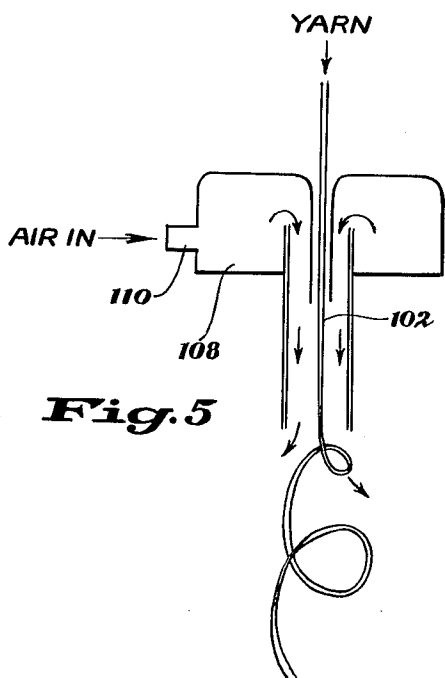
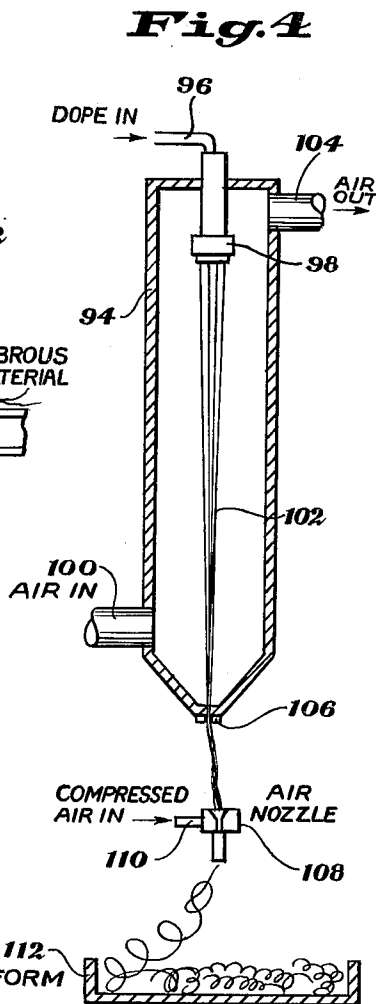
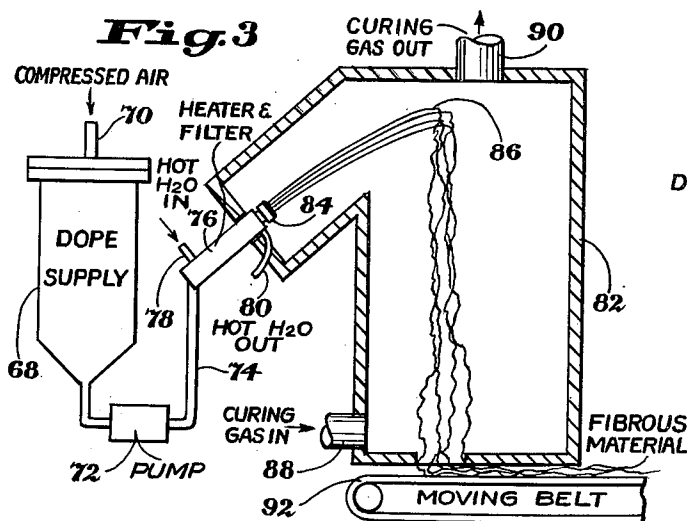
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METHOD FOR THE PRODUCTION OF CIGARETTE FILTERS

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2 Claims. (Cl. 18—47.5)

This invention relates to a method of manufacturing highly crinkled, self-crimped filaments with a roughened surface and the novel filaments or yarn and other products resulting therefrom. More particularly, this invention concerns cellulose ester filaments having a highly irregular surface and finely crimped or looped and entangled form and tobacco-smoke filters prepared therefrom.

Highly crinkled or crimped filaments with roughened or delustered surfaces have many varied uses in industry and are particularly desirable because of their ability to enhance tars removal efficiency when used in cigarette filters. There are also other uses for filaments with suitably roughened surfaces and crinkled form. For instance, the slippage in seams of garments made from roughened, highly-crinkled filaments may be minimized by proper roughening of the surface, and the attractive appearance and durability of fabrics manufactured therefrom is greatly improved.

Prior to the present invention one way of approaching the degree of roughness desired has been to add a delustering agent to the spinning solution prior to the extrusion operation, and then the filaments produced were substantially straight instead of crinkled. Mechanical crimping gave an artificial rather than a true crinkled appearance, and the addition of bonding agents or plasticizers tended to return a considerable amount of luster. In such a prior-art process the spinning solution was extruded at a draft ratio or ratio of take-up velocity to extrusion velocity of unity or higher.

Therefore, it is apparent that providing a procedure for making filaments with roughened surfaces and highly-crinkled, self-crimped form as well as producing novel filaments and filament products of such nature without adding a delustering agent and a bonding agent or plasticizer and without the necessity of a mechanical crimping operation after extrusion represents a highly desirable result. After extended investigation we have discovered such a method and product.

One object of this invention is to provide a process for making filaments with a roughened surface and a highly-crinkled form. Another object is to provide filaments which are useful in the production of cigarette filters which have a high percent tar removal coupled with a moderate pressure drop. A further object of the invention is to provide filaments of highly irregular or roughened surface and a disoriented, spiral, self-crimped appearance. Still another object is to provide synthetic fibers which prevent slippage in the seams of garments made therefrom and similar usages. Another object is to provide filaments with increased surface area for use as filters. Another object is to provide a method for the production of filaments whereby said filaments can be converted substantially directly into cigarette filters without requiring crimping or the addition of bonding agents or plasticizers thereto. Still another object of the invention is to provide a method for the production of filaments which eliminates the necessity of adding a delustering agent to the spinning solution. Other objects will appear hereinafter.

In the broader aspects of the present invention, the above objects are accomplished by extruding a spinning solution of polymer dope at a relatively high velocity into an evaporative atmosphere which removes the solvent

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from the filaments formed, and by removing the yarn from the spinning cabinet at a relatively low velocity such that the preferred ratio of take-up velocity to extrusion velocity, otherwise known as the draft ratio, is below about 0.15 and preferably about 0.1 or lower. The filaments thus produced are self-crimped, having such a crinkled shape and roughened texture that they can be converted substantially directly into tobacco smoke filters having a high tar removal and a moderate pressure drop or into other fibrous materials, such as pill bottle stuffing. The roughened surface of the yarn allows the conversion substantially directly into tobacco smoke filters or fibrous fabrics without any delustering step such as the addition of a delusterant to the spinning solution. Also, the heretofore-used mechanical crimping and bonding steps of the prior art, the latter involving the addition of a bonding agent or plasticizer subsequent to spinning, may be entirely eliminated. Apparently the yarn is bonded together by solvent remaining in the filaments as they touch one another. By varying the solids concentration in the spinning solution and the size of the orifices in the spinning cabinet, a yarn ranging in size from about 10 deniers or more per filament to 1 denier per filament can be produced. The yarn of our invention is characterized by such a typically low denier of less than about 10 per filament. Denier per filament will hereinafter be represented by d./f.

According to a preferred embodiment, to obtain the lower draft ratio we increase the extrusion velocity. We have also found that by a proper control of the curing medium introduced into the spinning cabinet from one side that the solvent evaporates more rapidly on this side than on the other. The curing medium may be air, nitrogen, carbon dioxide, or similar substance. The side from which the curing medium is introduced, being the first side struck by the curing medium, shrinks and cools more rapidly, thus placing the other side in tension and producing a uniform crimping effect. As the extrusion velocity increases, the extrusion pressure and drying rate increase, causing the yarn to become looped and entangled. Also, since the spinning solution is extruded at a high velocity, the friction force produced by the fast-moving dope and the slow-moving air tends to slow the filaments before they are completely cured. The filaments assume a roughened, highly-crinkled, self-crimped form after being extruded and struck by the incoming curing medium. Thereafter they fall in a controlled floating manner and pile up as the momentum decreases as they approach the bottom of the spinning cabinet. The self-crimping may be further aided by passing the filaments as they continue their fall through a compressed air zone such as an air jet. When this is done using a traversed air nozzle, the filaments may be built up directly and evenly into self-crimped, self-bonded air filters.

According to another embodiment of our invention filaments may be extruded at an angle between vertical and horizontal, e.g., 45°, such that the filaments, after reaching their maximum projected distance, fall freely through the evaporative medium onto a moving belt or other suitable collecting device such as a revolving drum, revolving roll, windup mechanism, form, bin, or the like.

Although other polymers which are capable of being spun into filaments forming a solvent dope may be used in the process of this invention, we have found cellulose esters to be most effective, particularly cellulose acetate. In one embodiment of our invention, the curing medium is introduced on one side of the spinning cabinet at two different locations, one near the top and one near the bottom. It may be conveniently channeled out of the spinning cabinet somewhere near the middle of the same side on which it enters. We have found that one of the most effective formations of our roughened, highly-crinkled

filaments takes place when the amount of curing medium coming in from below is substantially equal to the amount coming in from above. The filaments are thus allowed, after after being substantially set in their typical roughened, self-crimped form, to proceed downward in the abovementioned floating manner to the bottom of the cabinet, from which they may be removed in continuous form on a take-up roll. The general effect may be described as producing a negative tension as contrasted with the customary positive tension of the prior art.

Upon the filaments being formed, thus a roughened, self-crimped effect is brought about. A rather close control of the extrusion temperature of the spinning solution is important in our invention, for with temperatures under about 60° C. the filaments tend to straighten out and with temperatures over about 150° C. they tend to rupture. Acetone is an appropriate solvent, although other solvents such as methyl ethyl ketone, or methylene chloride when the polymer is cellulose triacetate, may be used. According to our invention, the extrusion velocity should be at least about 500 meters per minute (hereinafter referred to as m./m.), the spinnerette orifices should have a diameter of less than about 0.15 mm., and a draft ratio of less than about 0.15, preferably less than about 0.1, should be used. Thus, a strategic combination of factors produces the highly-crinkled, spiral-shaped, disoriented filaments which may be taken up from the bottom of the spinning cabinet in continuous form as yarn by a take-up roll or other suitable means, from which they may be assembled in dry form in bales of tow. A feature of our invention is that, if desired, the filaments may be conducted substantially directly from the take-up roll into a garniture or filter packing machine in which they are converted into a highly compact cigarette filter having a moderate pressure drop across its length as well as a high efficiency. In the art of cigarette filter manufacture, the efficiency is indicated by the ratio of the percent tars removal to pressure drop across the filter. By high efficiency we means about 10% or greater. As high a percent of tobacco tars removal as possible coupled with as low a pressure drop as possible is highly desirable. Since the pressure drop is an indication of the resistance to draw, in general the lower the pressure drop, the easier the cigarette to smoke. A high percent tars removal is characteristic of cigarette filters produced from tow prepared by the process of the invention, as is a moderate pressure drop. By high percent tars removal we means in excess of about 15% for filters of moderate pressure and by moderate pressure drop we mean less than about a 6-inch pressure drop across the filter. The manner of conducting tests to obtain these values will be explained hereinafter.

We have found that in a preferred embodiment of producing our roughened, highly-crinkled filaments, the extrusion velocity should be kept within the range of from about 500 to about 2,000 m./m., the extrusion temperature between about 60° C. and about 150° C., the solution concentration in percent of cellulose ester between about 15 and about 35, the spinnerette orifice diameter between about 0.02 mm. and about 0.15 mm., the draft ratio between about 0.05 and about 0.15 and the extrusion pressure between about 200 p.s.i.g. and about 2,000 p.s.i.g.

In our work involving preparation of filter rods, the rods were prepared from the highly crimped, roughened-surface yarn of our invention, were cut to 90-mm. lengths, analyzed for pressure drop with a U-tube manometer, cut into 15-mm. tips and again analyzed for pressure drop. The pressure drop was measured and is reported in the filter-rod examples of this invention to follow in inches of water required to obtain an air flow of 1050 cc. of air per minute through 15-mm. filter tips or rods. To determine percent tars removal the tips were attached to king-size cigarettes of a standard brand available on the retail

market in the United States by means of an adhesive tape, and the cigarettes were smoked on a smoking machine, as described in our co-workers' patent, U.S. 2,881,769. The smoking machine was similar in design and operation to the smoking machine described by J. A. Bradford, W. R. Harlan, and H. R. Hammer in *Industrial and Engineering Chemistry*, vol. 28, pp. 836-9 (1936). Similar tests were made on the same king-size cigarettes containing no filter tips. A 2-second puff was made at intervals of one minute. The tars and nicotine passed by the cigarettes were trapped by glassware and weighed. The percent tars removal is the ratio of the weight of tars and nicotine passed by the standard brand cigarettes without filter tips minus the weight passed by the cigarettes containing the filter tips to the weight of tar and nicotine passed by the standard-brand cigarettes without filter tips.

A better understanding of our invention may be obtained by reference to the attached drawings forming a part of this application and which illustrate certain of the preferred embodiments of the present invention.

FIGURE 1 is a semi-schematic drawing of one embodiment of the process for the preparation of filaments of this invention from a spinning solution.

FIGURE 2 is a semi-schematic drawing of the manufacture of cigarette filters from a bale of filaments known to the art as a tow bale containing filaments prepared by our low draft-ratio method.

FIGURE 3 is a semi-schematic drawing of an embodiment of the process of this invention wherein the dope is extruded at an angle of approximately 45° from the horizontal and the continuous filaments are collected on a moving belt.

FIGURE 4 is a semi-schematic drawing of a further embodiment of the process of this invention showing the application of an additional air stream after extrusion of the dope into an evaporative medium.

FIGURE 5 is an enlarged semi-schematic view of the air nozzle 108 depicted in FIGURE 4.

Referring first to FIGURE 1, shown schematically is a view of a spinning cabinet 10 and its associated apparatus by which the novel tow or continuous-filament yarn of the instant invention may be manufactured. In a preferred embodiment of this invention, a series of such spinning cabinets and associated apparatus is used. Mounted at the top of the cabinet 10 is a spinnerette 12 which may be uniformly heated by heating coils, not shown. Through these coils may be circulated an appropriate heat exchange medium such as water maintained at the desired temperature. A spinning solution of the compounds described herein is introduced through conduit 14 by means of pump 16. The filaments fall downwardly in the cabinet 10 in the form of tow 18, progressively losing solvent and curling up until they take the form in a substantially solidified dried condition of self-crimped, spiral-shaped, disoriented, rough-surfaced filaments which pass through an opening 20 in the bottom of the cabinet 10 in the form of a continuous filament yarn or tow onto a take-up roll 22. The proper degree of curling up or self-crimping of the filaments as they fall is secured by passing curing gas in through an inlet 24 near the top of the cabinet and an inlet 26 near the bottom and allowing the proper amount of gas to pass out through outlet 28, which may be conveniently located near the center of the spinning cabinet on the same side as inlets 24 and 26. In general, we have found that the best results are secured when the gas flow through the upper and lower inlets, 24 and 26 respectively, is approximately the same, thus causing the filaments to fall to the bottom of the cabinet in a floating manner, curling up in highly crinkled, self-crimped, and roughened form as they fall. It is important that the velocity at which the dope is extruded through spinnerette 12 be maintained at a high enough rate that the draft ratio or ratio of this velocity to that of the take-up roll 22 be 0.15 or

less in order for the tow to attain the proper crinkled, roughened appearance.

The yarn is then passed over rolls 30 and 32 through a tow drier 34, from which it is conveyed between rolls 36 into a baler 38. The drawing of the tow into a bale is only an illustrative method of collection. An important advantage of the tow of this invention prepared in this manner is the elimination of the necessity of both the mechanical crimping and bonding agent application steps of the prior art. The tow may, if desired, be conveyed substantially directly through a stuffing jet to a garniture where it may be formed into cigarette filters.

Referring next to FIGURE 2, which represents a method of converting the tow prepared in accordance with the instant invention into filter rods, the tow 40 is drawn from tow bale 42 through banding jet 44 and under tow guide tube 46 to a tension and drag roll assembly 48. From the tension and drag roll assembly 48 it is conveyed by a delivery roll unit 50 to a stuffing jet 52 and on into an initial rod-forming dye 54, wherein it is surrounded by cigarette paper 56 supplied by means of rolls 58 and 60. At this point paste is applied from paste roll 62 to the paper, and the tow, now in a loose rod form, is passed through a final rod-forming die 64, from which it issues in a compact continuous filter rod form 66. The filter rod material 66 may be conveniently cut into filter rods of the proper shape by cutting apparatus not shown. If desired, the tow may be drawn directly from the tow drier to the banding jet without being packaged first in the form of a tow bale.

Referring next to FIGURE 3, compressed air enters dope supply tank 68 via line 70 and the dope is pumped by pump 72 through line 74 to a heater and filter unit 76, to which hot water is supplied by way of line 78 and from which water leaves through line 80. The heated dope is then extruded into the spinning cabinet 82 from spinnerette 84 at an upward angle of about 45°. The filaments 86 then fall freely without the application of tension, crinkling or becoming self-crimped as they fall and as they are cured by curing medium entering at line 88 and in this particular embodiment leaving from the top of the cabinet at line 90. The filaments are collected as continuous filament yarn on moving belt 92.

Referring now to FIGURE 4, the dope enters spinning cabinet 94 via line 96 and is extruded downward from spinnerette 98. Curing medium enters the cabinet 94 near the bottom via line 100, giving a floating or free-fall effect to the filaments 102, and in this embodiment leaves near the top on the opposite side via line 104. After passing through an opening 106 in the bottom of the spinning cabinet 92, the filaments 100 pass through an air nozzle 108 to which compressed air is introduced through line 110 to assist in the crinkling or self-crimping. The continuous filament yarn is collected in a suitable collecting device 112.

Referring now to FIGURE 5, the crimping of the filaments 102 is depicted in a more detailed manner, compressed air entering air nozzle 108 via line 110.

A further understanding of our invention may be had from a consideration of the following examples, which illustrate certain of our preferred embodiments.

Example I

Cellulose acetate in acetone solution at 27% solids and a viscosity of 2100 poises at 30° C. was extruded at 1240 m./m. and 1165 p.s.i.g. through a 230-hole, 0.035-mm., round-hole spinnerette similar to that illustrated in FIGURE 1 at 80° C. and at a draft ratio of 0.085. The yarn produced had an average d./f. of somewhat greater than 10 and produced a firm filter rod without the application of a bonding agent. The filter rod gave a tars removal of 19% when measured in accordance with the procedure given hereinabove, the pressure drop across the filter tip being 1.32 inches as determined by the abovementioned U-tube manometer procedure.

Example II

Cellulose acetate in acetone solution at 17.5% solids without TiO₂ having a viscosity of 70 poises at 30° C. was extruded at 1250 m./m. and 250 p.s.i.g. through a 230-hole, 0.035-mm. diameter, round-hole spinnerette at 110° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 3.3 and when made into a filter rod gave a 40% tars removal and a 3-inch pressure drop across the filter tip.

Example III

Cellulose acetate in acetone solution at 17.5% solids without TiO₂ having a viscosity of 70 poises at 30° C. was extruded at 1550 m./m. and 300 p.s.i.g. through a 230-hole, 0.025-mm. diameter, hole spinnerette at 110° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 2.5 and when made into a filter rod gave a 55% tars removal and a 3.2-inch pressure drop across the filter tip.

Example IV

Cellulose acetate in acetone solution at 17.5% solids without TiO₂ having a viscosity of 70 poises at 30° C. was extruded at 1590 m./m. and 390 p.s.i.g. through a 230-hole, 0.02-mm. diameter, hole spinnerette at 110° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 1.0 and when made into a filter rod gave a 67% tars removal and a 4.3-inch pressure drop across the filter tip.

Examples V and VI show the effect of varying the amount of curing gas entering the spinning cabinet. In both examples air was admitted at top and bottom channels in apparatus similar to that illustrated in FIGURE 1. In Example VI the effect of increasing the draft ratio above the about 0.15 maximum of this invention is also illustrated.

Example V

Cellulose acetate in acetone solution at 27% solids without TiO₂ having a viscosity of 2100 poises at 30° C., was extruded at 1240 m./m. and 1100 p.s.i.g. through a 230-hole spinnerette having hole diameters of 0.035 mm., the spinning solution being extruded at 80° C. into a curing atmosphere of air at 100° C. moving down the cabinet column at approximately 52 m./m. A short distance down the column the filaments were struck by another current of air at 100° C. moving up the column at approximately 40 m./m., this current floating the solidified filaments slowly to the bottom of the cabinet, where they were removed by a take-up roll such as that illustrated in FIGURE 1. This yarn had an average d./f. of about 10, produced a firm filter rod without use of a bonding agent, and gave a tars removal of 16% and a tip pressure drop of 1.2 inches.

Example VI

Cellulose acetate in acetone solution at 30% solids, having a viscosity of 3000 poises at 30° C., was extruded at orifice velocities of 600–1600 m./m. and draft ratios of 0.29–0.11 through a 230-hole spinnerette having hole diameters of 0.035 mm., the spinning solution being extruded at 80° C. into 85 c.f.m. (cubic feet per minute) of air moving down the column at 33 m./m. A short distance down the column the filaments were struck by 85 c.f.m. of air at 100° C. moving up the column at 33 m./m., this current floating the filaments slowly down the column. The spinning pressure for these tests ranged from 600 to 1500 p.s.i.g. The amount of crimp in the yarn diminished at draft ratios above 0.15–0.175, and the yarn d./f. increased as the extrusion velocity increased at draft ratios above 0.175, whereas it decreased as the extrusion velocity increased at draft ratios below 0.15. These tests were repeated at a draft ratio of 0.125, and it was found that the yarn d./f. decreased as the extrusion velocity increased from 800–1600 m./m. Thus it can be readily seen that a decrease in yarn d./f. with an increase in extrusion velocity is a distinguishing feature of the

low-draft spinning process which occurs at draft ratios below about 0.15.

Example VII through X illustrate that although the process of this invention can be performed without the addition of a delustering agent such as titanium dioxide (TiO_2) or other delusterant, such a delustering agent may be used in the spinning solution as in prior art processes.

Example VII

Cellulose acetate in acetone solution at 30% solids with TiO_2 , having a viscosity of approximately 3000 poises at 30° C., was extruded at 1210 m./m. through a 230-hole, 0.035-mm., round-hole spinnerette at 80° C. and 1200 p.s.i.g. pressure. The draft ratio was 0.086. The yarn had an average d./f. of somewhat above 10 and produced a firm filter rod without a bonding agent that gave a tars removal of 19% at a 1.2-inch pressure drop across the filter tip.

Example VIII

Cellulose acetate in acetone solution at 30% solids with TiO_2 , having a viscosity of 3000 poises at 30° C., was extruded at 1200 m./m. and 1380 p.s.i.g. through a 400-hole, 0.033 equivalent diameter, square-hole spinnerette at 70° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 10.3 and when formed into a filter rod without a bonding agent gave a 23% tars removal and a 1.3-inch pressure drop across the filter tip.

Example IX

Cellulose acetate in acetone solution at 30% solids with TiO_2 , having a viscosity of 300 poises at 30° C., was extruded at 1300 m./m., and 1500 p.s.i.g. through a 400-hole, 0.033-mm. equivalent diameter, square-hole spinnerette at 80° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 9.0 and when formed into a filter rod without a bonding agent gave a 28% tars removal and a 1.4-inch pressure drop across the filter tip.

Example X

Cellulose acetate in acetone solution at 21% solids with TiO_2 , having a viscosity of 160 poises at 30° C., was extruded at 1500 m./m. through a 230-hole, 0.025-mm. diameter, round-hole spinnerette at 130° C. and a draft ratio less than 0.1. The yarn had an average d./f. of 2.5 and when made into filter rods gave a 55% tars removal and a 3.1-inch pressure drop across the filter tip.

Example XI is illustrative of the production of an air filter by our process. In this example and in Examples XII, XIII, and XIV to follow, the filaments were passed through a supplemental compressed air zone such as that of FIGURE 4.

Example XI

Cellulose acetate dissolved at 28.5% solids in acetone was extruded at a 45° angle upward, using a .13 mm. one-hole spinnerette at 800 p.s.i., into an evaporative medium. The resulting filament was passed through an air nozzle and was directed at a conventional air filter form. The filament was blown into the filter form from the air used in the air nozzle and was accompanied by a great deal of swirling. The air nozzle was traversed to provide an even buildup of material in the filter form. The extrusion rate and filament size was such that enough solvent remained in the fibers to allow bonding together wherever the fibers touched. The resulting air filter performed very much like representative spun glass air filters known to the art. The material was well bonded together by the fusing of individual fibers.

Example XII

Dope of cellulose acetate at 30% solids was extruded through a 10-hole .13 mm. spinnerette in a downward direction into an evaporative medium. The filaments were then passed through the air nozzle, and after vigorous swirling were directed to a moving belt. The air

nozzle was traversed so as to provide an even buildup of the layer of batting. Enough solvent remained in the yarn to provide bonding of the filaments as they touched one another. The layer of material was then passed through hot calendering rolls and made into a non-woven fabric.

Example XIII

A dope of 30% cellulose acetate in acetone was extruded through a .05 mm. 100-hole spinnerette into an evaporative medium in a downward direction. The filaments were passed through the air nozzle and were spun into a collector-bin. The fibers were sufficiently cured so that they did not bond together as they touched. The resulting material was an entangled mass of fibers suitable for stuffing or padding.

Example XIV

A dope of 28.5% cellulose acetate in acetone was extruded through a .13 mm. one-hole spinnerette into an evaporative medium. The filament was then passed through an air nozzle and directed to a revolving drum. Enough solvent was left in the fibers so that they bonded wherever they touched each other. The air nozzle was traversed as the drum revolved, resulting in a uniform buildup of material on the drum. This layer of material could thus be continuously removed, calendered and made into a non-woven fabric.

Examples XV, XVI, XVII, XVIII, and XIX illustrate the production of self-crimped filaments from dope which was extruded upwardly at an angle between horizontal and vertical. Apparatus such as that of FIGURE 3 was used in these examples.

Example XV

Cellulose acetate in acetone solution at 28% solids having a viscosity of approximately 1500 poises when measured at 30° C. was supplied to a gear dope-metering pump by the use of compressed air on a blowcase, at a solids rate of approximately $\frac{1}{10}$ lb. per hr. and a dope heater temperature of 70° C. The dope was extruded upward through a one-hole .045 mm. spinnerette at 1200 p.s.i. at an angle of 45° from the vertical into an enclosed cabinet in which the air was turned over rapidly. The filaments extruded about two feet from the face of the spinnerette and were then allowed to fall freely a distance of about 20 inches onto a board. The fibrous mass was collected on the board and the board was traversed so as to give the effect of a moving belt. In this example yarn was sufficiently cured so as not to plaster together; however, the mass was completely entangled. The above process was repeated using a 10-hole spinnerette at increased rates. The specific volume of the resulting mass in each case was about 1200 in.³ per lb.

Example XVI

Cellulose acetate at 28.5% solids in acetone solution having a viscosity of 1500 poises at 30° C. was extruded at .3 lb. per hr. and 60° C. through a 1-hole .13 mm. spinnerette at 800 p.s.i. The spinnerette assembly was at an angle of 45° with the vertical. The filaments extended about one foot from the face of the spinnerette and fell freely for a distance of about 12 inches onto a board which was traversed to allow even build-up. Fibers extruded from an orifice of this size, with the evaporated medium at room temperature, contained sufficient acetone so that the fibers bonded together wherever they touched. The resulting pile, in addition to containing the completely curled fibers, was further bonded together by the fusing together of individual filaments.

Example XVII

A cellulose acetate dope was extruded at 70° C. through a spinnerette having 400 holes of .045 mm. at an angle of 45° upward into an evaporative medium of air at 80° C. The extruded filaments were allowed to

fall freely onto a board which was traversed to give the desired build-up of material.

Example XVIII

A dope of cellulose acetate in acetone was extruded through a 100-hole spinnerette having .05 mm. holes into the top opening of a standard staple dry spinning cabinet. The spinnerette was pointed upward at a 45° angle. The yarn was then allowed to fall freely through the heated cabinet and was withdrawn on a roll and wound on a parallel package.

Example XIX

A cellulose acetate dope was extruded through a 100-hole .045 mm.-hole spinnerette at an angle of 45° upward. The resulting filaments were allowed to fall freely through an evaporative medium into a V-shaped trough with a slot in the bottom, then through the slot and onto a moving belt. The trough caused the fibers to bond together into a narrow continuous strip. This strip was removed from the moving belt continuously as a tow.

It is believed that it may be seen from the above description and examples that we have provided a novel method for the preparation of self-crimped, roughened-surface filaments whereby the necessity of mechanical crimping and delustering is eliminated. However, the present invention will function with filaments on which a delusterant is used. It is also believed that it may readily be seen that we have provided a new composition comprising yarn or tow loose or in bales characterized by substantially disoriented, highly-crinkled, roughened-surface, self-crimped filaments which can be processed substantially directly into filters, fabrics, or other filamentous products of highly desirable properties or used substantially as is as certain forms of filters such as air filters without further processing. It is further apparent from the above description that we have provided novel cigarette filters having a combination of efficient tars and nicotine removal coupled with a moderate pressure drop or ease of draw and a method for the preparation thereof.

Although the invention has been described in detail with reference to certain embodiments thereof, it will be understood that variations and modifications can be effected within the scope and spirit of the invention as described hereinabove and as defined by the appended claims.

We claim:

1. A method for the production of cigarette filters which comprises extruding a solution of cellulose acetate in acetone with a solids content of from about 15% to about 30% at a draft ratio of less than about 0.15 under a pressure of from about 200 p.s.i.g. to about 2,000 p.s.i.g., at a temperature of between about 70° C. and about 150° C., at an extrusion velocity of from about 500 m./m. to about 2000 m./m., and through orifices having diameters

of from about 0.02 mm. to about 0.06 mm. into an atmosphere of warm air, said warm air being introduced in substantially equal amounts from above and below the point of extrusion, thereby crimping the filaments formed by the extrusion of said solution of cellulose acetate in acetone and fashioning them into highly-crinkled and roughened surface form while floating them downwardly, and converting said filaments substantially directly into cigarette filters having a tars removal of greater than about 15%, a pressure drop of less than about 5 mm., and an efficiency of at least about 10%.

2. A method for the production of cigarette filters which comprises extruding a solution of cellulose acetate in acetone having a solids content of about 25% at an extrusion velocity of about 1200 m./m. and a pressure of about 1100 p.s.i.g. through a 230-hole, 0.055-mm. diameter, round-hole spinnerette at a temperature of about 80° C. and a draft ratio of less than about 0.1 into a curing atmosphere of air at about 100° C., said air being introduced in two separate streams, the first of said two streams entering from above and moving downwardly at approximately 50 m./m. and the second of said two streams entering from below and moving upwardly at about 40 m./m. floating the filaments slowly downward, collecting said filaments in finely crinkled, self-crimped, roughened-surface form as continuous tow, drying said tow to an acetone concentration of about 0.01%, baling said tow, pulling said tow from the bale through a banding jet, thereby opening said tow and providing a filament mass of web form, conducting said filament mass through a tension and drag-roll assembly, thereby removing slack from said filament mass and further opening said filament mass, diverting said filament mass to a stuffing jet, feeding said filament mass together with cigarette-filter paper into a die and cutter assembly, and there-in cutting said filament mass into the form of short-length, roughened-surfaced, cylindrical-shaped, rod-like tobacco-smoke filters containing compact filaments of disoriented, finely crinkled, self-crimped, spiral-shaped form, said filters having a tars removal of greater than about 15%, a pressure drop of less than about 5 mm., and an efficiency of at least about 10%.

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