

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Tow and Tobacco Smoke Filters and Method for their Production

We, EASTMAN KODAK COMPANY, a company organized under the laws of the State of New Jersey, United States of America, 343, State Street, Rochester 4, New York, United States of America, (Assignees of JOHN WINSTON SMITH), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improved crimped continuous filament tow, such as cellulose acetate tow, which is particularly useful in preparing tobacco smoke filters and especially cigarette filters and to the filters made therefrom.

The term tow describes a large number of aligned, continuous filaments which are associated in a somewhat loose form in a flat band-like structure. When this tow is crimped the product is crimped tow.

Tows suitable for cigarette filters range from 20000 to 250,000 total denier and preferably 40000 to 160,000 total denier. The filament sizes normally available are usually in the range of 2 to 16 denier per filament and the tow may be made up of between 5000 and 50000 filaments (preferably 20000) of from 2 to 16 (preferably not greater than 5) denier per filament or a total denier not greater than 100,000. The crimps in the tow should be greater than 4 crimps per inch and preferably greater than 8 crimps per inch.

Denier is defined as the weight in grams of a 9000 meter length of yarn. Thus, a filament 9000 meters long which weighs 1 gram is designated 1 denier. The size of the tow is given in total denier. Total denier is the product of the denier per filament (D/F) times the number of filaments contained in the tow. Thus, a 5 D/F, 80000 denier tow would contain 16000 filaments and

would weigh 80000 grams per 9000 meters. 45

The preferred cellulose acetate tow comprises continuous filaments of cellulose acetate of the specified deniers which have been spun from one or more spinnerettes, having a plurality of orifices therein, by the well-known dry spinning process and loosely drawn together in more or less parallel band-like association to form a continuous band or tow. The cellulose acetate from which the tow is manufactured may be an acetyl value of 38 to 41%, preferably 38.8 to 39.2% and is available commercially. The tow is crimped by any suitable crimping process which can give the desired highly crimped filament tow. The tow may be advantageously supplied for use in the apparatus and process according to the present invention in the form of a bale about 40 inches high, 25 inches wide, and 50 inches long which weighs 600 to 800 pounds. Such a bale contains a continuous tow of about 91000 feet in length which is normally enough to supply the process for about 8 hours when making 1000 filter tips per minute. 50 55 60 65 70

The crimped continuous filament cellulose acetate tow particularly suitable for use in the apparatus and process of the present invention is one that has also been conditioned with a lubricant which imparts additional density and lubricating properties to the tow but without giving the tow additional antistatic properties. Thus, the crimped cellulose acetate tow although lubricated so that it may pass easily through the steps of the process preferably carries a static charge which, due to electrostatic repulsion between filaments, assists in the step of filament separation and distribution which, as is described hereinafter, is carried out primarily by other means. The static charge is placed on the tow by movement of the tow through the apparatus described herein. A preferred 75 80 85

[Price 4s. 6d.]

lubricant is a neutral, non-toxic material. Most advantageously one may employ about 0.5% pharmaceutical grade mineral oil by weight of the filaments.

5 There are numerous processes available commercially for imparting crimp to the tow. However, such crimping operations cause the filaments adjacent to each other to have the same identical crimp configuration. This results frequently in forming bundles of filaments here and there in the continuous tow that cling together and are difficult to separate in subsequent processes. These married filaments or shiners as they are called in the industry are also not easily separated when the tow is being made into cigarette filters. The presence of these filament bundles in the tobacco filter is undesirable since they give an uneven passage for the tobacco smoke and hence, substantially reduce the efficiency of the filter.

The present invention provides a tow comprising a plurality of crimped, continuous filaments, the crimps in any one filament being out of register with the crimps of adjacent filaments. This tow is particularly suitable for manufacturing into cigarette filter tips.

According to the invention there is provided a method for continuously opening a crimped continuous multi-filament tow which comprises subjecting substantially equal lengths of the filaments in the tow to a first amount of tension which is sufficient to stretch the filaments and temporarily straighten out the crimps therein, subjecting the filaments to a second tension which is sufficient to maintain the crimps in the straightened condition and is applied to adjacent filaments of the tow at different lengths thereof whereby the crimps in adjacent filaments are drawn out of registry with one another and restoring the crimps in the tow in the out-of-registry position by relaxing the second tension.

10 In accordance with the present invention there is also provided an apparatus for opening continuous multi-filament crimped tow comprising three spaced pairs of rubber-covered rollers, between the nip of each pair of which the tow is conducted, breaking means for the first pair of rollers and driving means for the second pair of rollers so that the tow in the ratch therebetween is subjected to a tension which is sufficient to stretch the filaments and temporarily straighten out the crimps therein, driving means for the third pair of rollers for maintaining the tension on the tow in the ratch between the second and third pairs of rollers, the third pair of rollers being positioned to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimps in adjacent filaments are drawn out of registry with one another, and means for releasing the tension thereby permitting the

crimps to reform in the filaments in the out-of-registry position.

In the accompanying drawings:—

Fig. 1 is an elevation of an apparatus constructed in accordance with one form of the invention for carrying out the method of opening continuous crimped cellulose acetate tow in accordance with the invention;

Fig. 2 is a plan of the apparatus shown in Fig. 1;

Fig. 3 is a rear elevation, to an enlarged scale, of the two pairs of rubber-covered rolls showing their mounting means and the driving means for the driven pair of rolls;

Fig. 4 is a view of the gearing and pulley assembly which coacts with other elements to drive portions of the apparatus;

Fig. 5 is a diagrammatic lay-out of the apparatus for wrapping the processed tow into a continuous wrapped rod and cutting the rod into filter units;

Fig. 6 is a vertical section along the path of tow movement through the banding jet; and

Fig. 7 is an enlarged representation showing the filter rod with the crimps in the filaments in out-of-registry position.

Referring to Fig. 1 there is shown an apparatus suitable for use in accordance with the present invention for continuously opening continuous filament tow such as cellulose acetate tow. The tow 15 is drawn upwardly from the tow bale and passes through a preliminary tow opener 16 comprising a box-like structure having a passage 161 therethrough for the tow and a wall 162 containing a number of openings 163 through which jets of air impinge on the tow, the lower end of the device having a pipe 164 secured thereto for attachment to an air supply. The tow 15 then continues over roller 17 which is a fixed guide, the tow opener 16 and roller 17 being mounted on a support 18. The tow then continues to the nip between rubber-covered rollers 19 and 21 and thence to the nip between the rubber-covered rollers 22 and 23. These pairs of rollers are mounted on respective supports 24 and 25 and as shown more clearly in Fig. 2, are spaced from each other.

The rollers 19 and 21 are braked rollers which grip the tow 15 passing therebetween and restrain its forward movement. The braking means, represented in part by member 20, may be of any known construction, such as a conventional hydraulic operated brake adapted to be adjusted to retard the rotation of the rollers to the required amount. The rollers 22 and 23 are positively driven, by means described hereinafter, and are rotated at a rate sufficient to stretch the crimped tow 15 until the crimps are straightened to a considerable extent.

On leaving the nip of rollers 22 and 23, the tow continues to a pair of rubber-covered

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rollers 26 and 27 and passes through the nip therebetween. The rollers 26 and 27 are driven at a rate sufficient to maintain tension on the tow which has been placed thereon by the rollers 22 and 23 and are mounted on a support 28. As shown more clearly in Fig. 2, the first and second pairs of rollers are positioned at an angle to the third pair of rollers. Thus, while substantially equal lengths of the tow are stretched in the ratch between the first and second pairs of rollers, because of the angular relationship of the third pair of rollers to the second pair of rollers, adjacent filaments in the continuous filament tow are stretched at unequal lengths across the width of the tow. The angle between the second pair of rollers and the third pair of rollers may be within the range of 5 to 65 degrees but 30 degrees appears to be the preferred angular displacement when processing 100,000 denier tow of 5 denier per filament. The tow is withdrawn from the nip of rollers 26 and 27 at a relaxing tension which permits the crimps in the filaments to reform.

This equal and unequal stretching of the tow substantially completely eliminates married filament or filament bundles. The equal length stretching of the filaments accomplished by the coaction of the first and second pairs of rollers separates into a parallel relationship the majority of the filaments in the tow but the crimps across the width of the tow are substantially still in registry. The unequal stretching accomplished by the second and third pairs of rollers operates to unsnarl any remaining married filaments and break up any remaining filament bundles, due to the crimps being in registry, by drawing the crimps out of registry. Therefore, when the tow leaves the third pair of rollers the plurality of filaments while still in a parallel relationship are substantially out of registry as regards crimps in adjacent filaments.

Thus, when this double stretched tow is suddenly relaxed as it passes through the third pair of rollers, the crimps spring back into their original shape, but are in out-of-registry positions and the filament bundles and married filaments cannot reform. The tow at this point is of the form as shown in Fig. 7, in which the crimps in any one of the parallel filaments are out of register with the crimps in adjacent filaments.

The tow now continues at the relaxing tension through a guide 29 to another air-operated tow opener 31 which is similar in operation to that shown at 16. This spreads out the filaments so that the tow is substantially at its maximum width, the adjacent filaments touching only a horizontal plane.

From this point, the moving tow in the form of a flat band of parallel disposed filaments with the crimps out of register is con-

ducted through a spray chamber 34 where a fluid plasticizing bonding medium is applied on each side of the tow by spray guns, not shown, to cause the filaments to be capable of bonding at a subsequent stage in the process to an adjacent filament wherever contacted by the spray.

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

The tow having the plasticizer therein is conducted between delivery rollers 35 and 36 and thence into the filter forming device shown in Fig. 5 through a condensing trumpet 37 which forms the flat tow into a round multi-filament strand 38.

The means for rotating the three pairs of rubber-covered rollers and the delivery rolls are shown in Figs. 1, 2, 3 and 4. As shown, particularly in Fig. 3, the first two pairs of rollers are mounted to turn respectively on shafts 60, 61, 62, 63 which are supported by members 64 and 65. The lower rollers of each pair may be brought into engagement with the upper rollers of each pair by adjustment of members 50 as will be apparent from Fig. 3. The roller 22 is positively driven by means of a belt 66 which engages pulleys 67 and 68, the pulley 68 being driven by a belt 69 from a driven pulley 71 which, as shown in Fig. 4, is mounted on a shaft 72 and is driven through level gears 73 and 74 and a shaft 75 which is driven by a pulley 76. These various elements are conventionally mounted on a supporting frame 78.

Referring again to Fig. 1, it will be seen that pulley 76 is driven by a belt 77 which is associated with a transmission box 81 which is operated by a pulley 84, belt 88 and a pulley 89 which is rotated by means of a transmission 90, the latter being operated by a motor (not shown). A pulley 80 mounted on the shaft of pulley 84 and a belt 83 drive a pulley 82 which operates a pump (not shown) for forcing the bonding medium through the above-mentioned spray nozzles which are positioned on either side

of the tow as it passes through chamber 34. A pulley 92 forming part of the transmission 90 and a belt 93 drive a pulley 94 and furnish power to the device shown in Fig. 5 for forming the tow into a continuous filter rod.

A device suitable for wrapping the round strand 38 of continuous filaments into a filter unit is shown in Fig. 5. In addition to the tow condensing trumpet 37, the device comprises an endless belt conveyor 39 which revolves around drums 41 and 42 and is maintained taut by rollers 40, the belt being driven by means not shown. A wrapper 43, which may be filter paper, is continuously unwound from a roller 44 and passes over a guide roller 45 and is carried by the endless belt 39 through a wrapper forming device 46 which bends the wrapper into a U-shaped form just before it comes into contact with the now round strand of filaments 38. The U-shaped wrapper containing the strand 38 is carried by the endless belt 39 through a second forming device 47 in which the wrapper is lapped around the strand 38 leaving one edge 48 of the paper standing upwardly.

The standing edge 48 of the paper is moved into contact with a rotating wheel 49 which applies a suitable adhesive to the inner side of standing edge 48. The source of the adhesive may be conventional and is not shown. The standing edge 48 is then smoothed down over the adjacent paper edge by a forming member 51 and is heat sealed into a permanent adhesive bond by an electric heating shoe 52. The product at this point in the process is a continuous round and compact filter rod 53 having a diameter approximately the same as that of the cigarette with which the filter is to be assembled.

The filter rod 53 is passed through an electrically heated die 54. The heat treatment may be conducted at 160° F. and, as described above, stiffens the filter rod. On leaving the heated die 54 the filter rod 53 is cut into appropriate lengths by means of a cutter 55 which is rotated by driving means (not shown), the filter elements being removed by means of a conveyor 55.

The end product is a filter element of circular cross-section having an external paper wrapper containing a compact, rigid mass of crimped cellulose acetate filaments, each filament of the mass being substantially co-extensive therewith. The filaments as a whole are in substantial alignment longitudinally of the mass but substantially each of the individual filaments has nonoriented short portions thereof disposed randomly in diverging and converging relationship to the main filament axis. Substantially all of the filaments of the mass are positively bonded to contiguous filaments within said structurally unitary rod by means of surface solvation bonds at random points of contact of the

filaments. The filaments of the mass are uniformly distributed throughout the transverse section of the mass thereby providing uniform filtering and the crimps in the filaments are in an out-of-registry position. The filters are usually 25 mm in circumference and 13 mm long.

While the invention has been described in connection with cellulose acetate tow, it will be understood that tows of other suitable synthetic filaments may be made into tobacco smoke filters in accordance with the invention.

WHAT WE CLAIM IS:—

1. A method for continuously opening a crimped continuous multi-filament tow which comprises subjecting substantially equal lengths of the filaments in the tow to a first amount of tension which is sufficient to stretch the filaments and temporarily straighten out the crimps therein, subjecting the filaments to a second tension which is sufficient to maintain the crimps in the straightened condition and is applied to adjacent filaments of the tow at different lengths thereof whereby the crimps in adjacent filaments are drawn out of registry with one another restoring the crimps in the tow in the out-of-registry position by relaxing the second tension.

2. Method for continuously opening a crimped continuous multi-filament tow according to Claim 1, wherein the second tension is applied at an angle to the first tension.

3. Method for continuously opening a crimped continuous multi-filament tow according to Claim 2, wherein the second tension is applied at an angle of between 5 to 65 degrees, preferably 30 degrees, to the first tension.

4. Method of continuously opening a crimped continuous multi-filament tow substantially as hereinbefore described.

5. A tow of crimped, continuous filaments, the crimps in any one filament having been displaced out of register with the crimps of adjacent filaments by the method according to Claim 1, 2, 3 or 4.

6. A tow according to Claim 5, comprising crimped, continuous filaments of cellulose acetate.

7. A tow according to Claim 6, wherein the filaments of cellulose acetate have an acetyl content within the range of 38—41%, each filament has the same denier within the range of 2 to 16, the total denier of the tow is within a range of 20000 to 250,000, and the individual filaments contain a high degree of crimp greater than 4 crimps per inch.

8. A cigarette filter tip made from tow according to Claim 5, 6 or 7.

9. An apparatus for opening continuous multi-filament crimped tow comprising three



of the tow as it passes through chamber 34. A pulley 92 forming part of the transmission 90 and a belt 93 drive a pulley 94 and furnish power to the device shown in Fig. 5 for forming the tow into a continuous filter rod.

5 A device suitable for wrapping the round strand 38 of continuous filaments into a filter unit is shown in Fig. 5. In addition to the tow condensing trumpet 37, the device comprises an endless belt conveyor 39 which
10 revolves around drums 41 and 42 and is maintained taut by rollers 40, the belt being driven by means not shown. A wrapper 43, which may be filter paper, is continuously
15 unwound from a roller 44 and passes over a guide roller 45 and is carried by the endless belt 39 through a wrapper forming device 46 which bends the wrapper into a
20 U-shaped form just before it comes into contact with the now round strand of filaments 38. The U-shaped wrapper containing the strand 38 is carried by the endless
belt 39 through a second forming device 47 in which the wrapper is lapped around the
25 strand 38 leaving one edge 48 of the paper standing upwardly.

The standing edge 48 of the paper is moved into contact with a rotating wheel 49 which
30 applies a suitable adhesive to the inner side of standing edge 48. The source of the adhesive may be conventional and is not shown. The standing edge 48 is then
smoothed down over the adjacent paper edge by a forming member 51 and is heat sealed
35 into a permanent adhesive bond by an electric heating shoe 52. The product at this point in the process is a continuous round and compact filter rod 53 having a diameter
40 approximately the same as that of the cigarette with which the filter is to be assembled.

The filter rod 53 is passed through an electrically heated die 54. The heat treatment may be conducted at 160° F. and, as
45 described above, stiffens the filter rod. On leaving the heated die 54 the filter rod 53 is cut into appropriate lengths by means of a cutter 55 which is rotated by driving
means (not shown), the filter elements being removed by means of a conveyor 55.

50 The end product is a filter element of circular cross-section having an external paper wrapper containing a compact, rigid mass of crimped cellulose acetate filaments, each filament of the mass being substantially co-
55 extensive therewith. The filaments as a whole are in substantial alignment longitudinally of the mass but substantially each of the individual filaments has nonoriented short portions thereof disposed randomly in diverging and converging relationship to the main
60 filament axis. Substantially all of the filaments of the mass are positively bonded to contiguous filaments within said structurally unitary rod by means of surface solvation
65 bonds at random points of contact of the

filaments. The filaments of the mass are uniformly distributed throughout the transverse section of the mass thereby providing uniform filtering and the crimps in the filaments are in an out-of-registry position. The
70 filters are usually 25 mm in circumference and 13 mm long.

While the invention has been described in connection with cellulose acetate tow, it will be understood that tows of other suitable
75 synthetic filaments may be made into tobacco smoke filters in accordance with the invention.

WHAT WE CLAIM IS:—

1. A method for continuously opening a
80 crimped continuous multi-filament tow which comprises subjecting substantially equal lengths of the filaments in the tow to a first amount of tension which is sufficient to stretch the filaments and temporarily straighten
85 cut the crimps therein, subjecting the filaments to a second tension which is sufficient to maintain the crimps in the straightened condition and is applied to adjacent filaments of the tow at different lengths
90 thereof whereby the crimps in adjacent filaments are drawn out of registry with one another restoring the crimps in the tow in the out-of-registry position by relaxing the
95 second tension.

2. Method for continuously opening a crimped continuous multi-filament tow according to Claim 1, wherein the second tension is applied at an angle to the first tension.

3. Method for continuously opening a
100 crimped continuous multi-filament tow according to Claim 2, wherein the second tension is applied at an angle of between 5 to 65 degrees, preferably 30 degrees, to the first tension.
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4. Method of continuously opening a crimped continuous multi-filament tow substantially as hereinbefore described.

5. A tow of crimped, continuous filaments, the crimps in any one filament having been
110 displaced out of register with the crimps of adjacent filaments by the method according to Claim 1, 2, 3 or 4.

6. A tow according to Claim 5, comprising crimped, continuous filaments of cellulose
115 acetate.

7. A tow according to Claim 6, wherein the filaments of cellulose acetate have an acetyl content within the range of 38—41%, each filament has the same denier within the
120 range of 2 to 16, the total denier of the tow is within a range of 20000 to 250,000, and the individual filaments contain a high degree of crimp greater than 4 crimps per inch.
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8. A cigarette filter tip made from tow according to Claim 5, 6 or 7.

9. An apparatus for opening continuous multi-filament crimped tow comprising three

- spaced pairs of rubber-covered rollers, between the nip of each pair of which the tow is conducted, braking means for the first pair of rollers and driving means for the second pair of rollers so that the tow in the ratch therebetween is subjected to a tension which is sufficient to stretch the filaments and temporarily straighten out the crimps therein, driving means for the third pair of rollers for maintaining the tension on the tow in the ratch between the second and third pairs of rollers, the third pair of rollers being positioned to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimps in adjacent filaments are drawn out of registry with one another, and means for releasing the tension thereby permitting the crimps to reform in the filaments in the out-of-registry position.
10. An apparatus according to Claim 9, wherein the third pair of rollers is positioned at an angle to the second pair of rollers, preferably at an angle of between 5 and 65 degrees.
11. An apparatus according to Claim 10, wherein the tow is subjected to gas under pressure after passing through the nip of the third pair of rollers to assist the further opening of the tow.
12. An apparatus for opening continuous multi-filaments crimped tow constructed substantially as hereinbefore described with reference to, and as shown in, Figs. 1 to 4 of the accompanying drawings.
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