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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Opening Crimped Filamentary Tow

5 We, CELANESE CORPORATION OF AMERICA, of 522 Fifth Avenue, New York 36, State of New York, United States of America, a company incorporated in accordance with the laws of the State of Delaware, United States of America, 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:—

10 This invention relates to the opening of filamentary material in the form of a crimped tow, i.e. a bundle of filaments which has been subjected to a crimping treatment, for instance by passage through gear wheels or a stuffing box crimper.

15 According to the invention, a crimped tow of artificial filaments is opened and the crimps in individual filaments moved out of registration with the crimps in adjacent filaments by passing the running tow between a pair of rolls the surface of at least one of which is made up of grooves and ridges, the grooves encircling the roll in the form of one or more helices or a large number of parallel and endless grooves, so that filaments are only gripped between the rolls at the ridges and little or no grip is applied to the remaining filaments and the particular filaments which are gripped and released change with the rotation of the grooved roll or rolls and, at the same time, some filaments are caused to undergo lateral movement relative to other filaments.

20 By the process of the invention a remarkably well opened tow in which a thorough de-registration of the crimps in the filaments is apparent can be obtained. A crimped tow of many thousands of filaments when thus treated yields cigarette filter plugs which are characterised by unusual uniformity not only as regards density from plug to plug, but also as regards porosity over the cross-section of each plug. The invention is of particular im-

portance regarded as a step in the manu-
45 facture of such filter plugs, but may be employed in other connections, for instance in making the so-called non-woven fabrics by causing a mat of filaments to adhere to each other in the form of a thin sheet; the mat of filaments may be made by opening the tow in accordance with the invention and forming it into a thin sheet the thickness of which can be built up by cross-laying several layers of the opened tow. Moreover, the novel process may be applied to a crimped tow containing fewer filaments, such as may be used for weaving or knitting into a textile fabric, so as to obtain a bulky yarn of attractive properties and appearance. In general, the opened tow may be used wherever webs of staple fibre have heretofore been employed, bonding of the filaments at contacting points being employed if desired.

50 The effectiveness of the process of the invention in producing a well opened tow of uniform low density appears to result from relative longitudinal movement of alternate sections of the tow, differently timed gripping and release of different sections of the tow with the accompanying opening action of the filaments as they re-assume their full crimp and the lateral movement imparted to filaments as the sections of the grooved roll between the grooves come into contact with, grip and then release the filaments.

55 The progress of the tow to and between the rolls may be effected by independent tow feeding means but is most simply performed by driving one or both of the rolls. Preferably one of the rolls has a smooth surface and is driven while the other roll, having a grooved surface, is biased towards it and is rotated by its contact with the smooth roll or the tow passing between the rolls.

60 However, both rolls may be grooved, in which case it is best for helical grooves in the two rolls to run in the same direction so

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that with the rolls rotating in opposite directions the ridges on one roll do not mesh with the grooves on the other and sections of the tow are always gripped between meeting ridges on the rolls. Oppositely rotating rolls having opposing grooves cut in opposite directions can, however, be used if precautions are taken to avoid registry, or at least permanent registry, between the grooves in one roll and the opposing ridges in the other. This may be achieved, for instance, by using rolls of different diameter, by ensuring that opposed rolls rotate at different superficial speeds or by arranging to reciprocate axially one or both of the opposing rolls. In general, however, it is preferred to use a grooved roll paired with a driven plain surface roll.

The grooved roll or rolls may be provided with one or more helical grooves or the grooves may be parallel and endless. Preferably each grooved roll is provided with two helical grooves, or two sets of helical grooves, of opposite sense, the groove or grooves of one sense running from the centre of the roll to one end thereof and the groove or grooves of the opposite sense also starting from the centre of the roll and running to the opposite end. With proper direction of rotation such a roll causes the filaments to be spread apart.

The rolls may be made of any suitable material, e.g. metal, plastic, rubber or fibrous materials, or may be made from a combination of materials, for instance a metallic cylindrical core body may be provided with an outer layer of rubber or like elastic material; the desired arrangement of grooves and ridges is preferably produced in the covering layer of such a roll. Advantageously one of the pair of rolls is of rubber and the other of steel; preferably the rubber roll is smooth and below a steel roll carrying the grooves.

In an important embodiment of the invention, a plurality of pairs of rolls are arranged in tandem, each pair of rolls being spaced from the next by, for instance, 10 to 50 inches. With such an arrangement it is preferred to arrange that one roll of each pair is plain surfaced and is driven. The peripheral speeds of the rolls of the several pairs need not all be the same. In the event that the tow is placed under a small amount of tension in moving from the bale to the first pair of rolls, the tension being sufficient to distend the crimp slightly without effecting opening or de-registry, successive pairs of rolls can operate at slower peripheral speeds to effect opening while permitting relaxation of the tow. Alternatively, successive pairs of rolls may operate at peripheral speeds as much as 50% or more greater than the preceding pair. If successive pairs of rolls are driven at substantially increasing speeds, this will be evidenced visually in the shape of the tow passing between the rolls, i.e. the tow is taut and the crimps are straightened out. If an

operator attempts to deflect the running tow between roll pairs, he will encounter a considerable resistance to such deflection as a result of the tension in the tow.

In a preferred embodiment of the invention successive pairs of rolls are run faster than the preceding rolls but insufficiently fast to put the tow under substantial tension so that the crimp in the filaments is noticeable even between roll pairs while the tow can be manually deflected out of its normal running path with ease. In practice it has been found that if all the roll pairs are operated at the same speed or at falling speeds, there is a tendency to develop slack in the tow and if this is permitted to continue without correction the slack tow may lap around the rolls and necessitate interruption of the processing. The successive roll pairs are best run just sufficiently faster to compensate for this spontaneous lengthening. This can be effected without placing the tow under tension, although the slack will also be avoided if the tow is put under tension. Tension can be introduced into the tow not only by running successive roll pairs at substantially increasing speeds but also by the use of tension rolls which are either idly mounted or driven slower than the opening rolls or by the use of tension bars or the like; two or more of these expedients may be employed simultaneously. The speed differentials necessary to eliminate slack will depend upon the spacing between roll pairs and the degree of opening desired. The actual number of roll pairs employed will depend on the type of tow being processed, and on such factors as its denier per filament, crimp level and uniformity, stretch recovery properties and static characteristics.

The tow may be composed of a plurality of crimped continuous filaments of an organic derivative of cellulose, e.g. esters or ethers of cellulose such as cellulose acetate, cellulose propionate and cellulose acetate propionate, highly esterified cellulose containing less than 0.29 free hydroxyl groups per anhydro-glucose unit such as cellulose triacetate and the like. Other filamentary materials such as rayon (regenerated cellulose), linear super-polyamides such as nylon-6 and nylon-66, linear polyesters, acrylonitrile polymers and copolymers and the like, can also be employed. The number of filaments and the total denier can vary within wide limits, but in preparing filters for conventional cigarettes which are approximately 25 to 26 mm in circumference, the number of filaments generally varies between about 5,000 and 33,000, and the total denier ranges from about 35,000 to 160,000, computed on uncrimped tow. The number of crimps per inch in the tow can range up to about 30 to 40 but preferably averages between about 4 and 25.

The accompanying drawings illustrate novel

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apparatus according to the invention. In the drawings

Figure 1 is a schematic side elevational view of a tow opening apparatus embodying the present invention.

Figure 2 is a diagrammatic side elevational view of the tow opening roll system of the apparatus of Figure 1.

Figure 3 is a top plan view of the said roll system, the view being taken along the line 3—3 in Figure 2.

Figure 4 is a sectional view taken along the line 4—4 in Figure 3.

Figure 5 is a fragmentary elevational view of one pair of rolls of the tow opening roll system, the view being taken along the line 5—5 in Figure 3.

Figure 6 is a schematic elevational view of a modified tow opening roll system.

Referring now more particularly to Figure 1 of the drawings, it will be seen that a multi-filament tow 11 is taken from a bale 12 thereof and fed through a straightening device 13 and a banding jet 14, both of conventional construction. The device 13 functions to remove folds from and prevent twisting of the tow as it is drawn off the bale 12 and the jet 14, which is composed essentially of a pair of spaced parallel plates pierced by a plurality of slots connected with a compressed air line, functions to provide a flat band of tow which can be fed uniformly into the tow opening mechanism of the system.

After leaving the banding jet 14, the tow is fed around a guide member 15 and then about a guide bar 16 to the opening mechanism G which, in the illustrated embodiment of the invention, comprises three pairs of opening rolls 17—18, 19—20 and 21—22. The location of guide bar 16 relative to roll 18 may be changed so as to change the amount of contact between the tow 11 and the surface of roll 18. As clearly shown in Figures 2 and 3, the three pairs of rolls are arranged in tandem within a rectangular framework consisting of a base 23 to the top and at the opposite sides of which are connected three pairs of vertical mounting members 24—25, 26—27 and 28—29, which in turn are interconnected by struts 30 to ensure rigidity of the frame. The pair of rolls 17—18 is journaled in the members 24—25, the pair of rolls 19—20 in the members 26—27 and the pair of rolls 21—22 in the members 28—29. If desired, the mounting members 24 to 29 may be displaceable relative to the base 23 and to one another to permit adjustment of the distances between the roll pairs. The two rolls of each pair are resiliently biased toward one another, either mechanically or hydraulically.

A drive mechanism 31, provided with any suitable type of output speed control 31a, is arranged to drive one roll of each pair of rolls. The output shaft 32 of the mechanism

31 carries a sprocket wheel 33 about which passes a sprocket chain 34 which also passes about a sprocket wheel 35 mounted on the axle 18a of the roll 18. The axle 18a carries a second sprocket wheel 36 about which passes a chain 37 which also passes about a sprocket wheel 38 carried by the axle 20a of the roll 20. Mounted on the axle 20a is yet another sprocket wheel 39 about which passes a chain 40 which also passes about a sprocket wheel 41 carried by the axle 22a of the roll 22. Thus, all of the rolls 18, 20 and 22 are driven by a single drive mechanism although individual drives may, of course, be employed. Any desired differences in the peripheral speeds of the rolls may be provided for by selection of suitable characteristics of the transmission, e.g. by variation of the numbers of teeth of the respective sprocket wheels or by employing rolls of different diameters.

The three pairs of rolls 17—18, 19—20 and 21—22 are similar in construction and thus only one of these pairs of rolls will be described in detail. Referring in particular to Figures 3, 4 and 5, it will be seen that the top roll 21 of the third pair of opening rolls comprises a cylindrical core body 42 to the opposite ends of which are secured end plates 43 and 44. The axles 21a and 21b by means of which the roll 21 is journaled in the mounting members 29 and 28, respectively, are carried on the outer faces of the end plates 43 and 44. About the exterior surface of the core body 42 of the roll 21 there is provided a layer 45 of steel which may, by way of example, be about 1 inch thick. The outer peripheral surface of the covering 45 is provided with a pair of helical threads 46 and 47 which start at the centre of the roll and advance toward the opposite ends thereof, the thread 46 advancing in a counter-clockwise sense (as seen from the centre of the roll) and the thread 47 in a clockwise sense (likewise as seen from the centre of the roll). As clearly shown in Figure 4, the threads 46 and 47 are composed, respectively, of helical grooves and ridges 46a—46b and 47a—47b, with the ridges 46b and 47b having flat faces or peaks to provide good gripping surfaces; the bottoms of the grooves 46a and 47a may be flat or V-shaped, as desired.

The associated roll 22 which is located below the roll 21 is likewise composed of a cylindrical core body 48 closed at its opposite ends by plates 49 and 50 which carry the axles 22a and 22b by means of which the roll 22 is journaled in the members 29 and 28. The body 48 of the roll 22 is provided with an exterior covering 51 of rubber or like elastic material which has a smooth outer peripheral surface.

From the foregoing it will, therefore, be understood that at the nip between the two rolls of each of the three pairs of rolls 17—18, 19—20 and 21—22 there are provided a

plurality of grooves and a plurality of ridges alternating with one another. Accordingly, when the tow passes between the rolls 17 and 18 of the first pair it will be differentially gripped thereby, i.e. some sections of the tow will be gripped firmly between the smooth surface of the bottom roll 18 and the flat faces of the ridges 46b and 47b of the associated threaded top roll 17, while other sections of the tow alternating with the gripped sections will be located within the confines of the grooves or spaces 46a and 47a between the ridges 46b and 47b and thus will be gripped not at all or at most only very slightly.

As a consequence of the helical threads the gripped sections of the tow will be displaced laterally relative to the ungripped sections of the tow so as to bring about a separation of these filaments and a de-registration of the crimps in the adjacent filaments. This will occur not only with respect to filaments lying in the same horizontal plane between the rolls, but also with respect to vertically coplanar filaments between the rolls, due to the fact that there will be some slippage between the filaments engaging the faces of the ridges of the driven top roll 17 and the filaments engaging the smooth surface of the bottom roll 18 which is not positively driven. At the same time, of course, the opposed helical arrangement of the grooves 46a—47a and ridges 46b—47b at opposite ends of the rolls 17—18 causes one half of the tow 11 to be shifted toward one end of the pair of rolls 17—18 and the other half of the tow to be shifted toward the other end of the pair of rolls 17—18. Again, this occurs not only with respect to horizontally coplanar sections of the tow, but also with respect to vertically coplanar sections of the tow. Thus, the filaments are also separated laterally in every stratum of the tow, with the accompanying result of a further de-registration of the crimps of adjacent filaments.

Substantially similar actions occur when the tow 11 passes between the second pair of rolls 19—20 and the third pair of rolls 21—22.

Figure 6 shows an apparatus for opening tow similar to that of Figure 1 except for the addition of a pair of tension rolls 52 and 53 which are journaled in any suitable supporting structure (not shown) and are preferably provided with smooth surfaces of an elastic material such as rubber. These rolls may consist entirely of rubber or of a metallic or other core body carrying a peripheral covering of rubber. The rolls 52 and 53, which may be positively driven or adapted to be rotated by the drag of the tow passing between them, are biased toward one another by any suitable hydraulic or mechanical means (not shown) and function as retarding means for the tow being fed through the apparatus. The magnitude of the biasing force is so selected that the rolls 52 and 53 also function to iron out

possible crimp variations while at the same time aiding in the maintenance of a predetermined tension on the tow being processed.

From the tension rolls 52 and 53 the tow 11 passes to the three pairs of opening rolls 17—18, 19—20 and 21—22. In this embodiment roll 22 is driven 20% faster than roll 20 which, in turn, is driven 20% faster than roll 18. As a consequence, the tow 11 is tensioned immediately upon leaving the nip of rolls 52 and 53, and this tension is maintained until the tow passes from between rolls 21—22, as is shown by the taut appearance of the tow. The tow which is now open relaxes beyond rolls 21—22, as can be seen from the reappearance of the crimp.

It is to be noted that the process of the invention is operated so as to avoid excessive stretching of the tow such as would bring about a permanent deformation of the filaments, i.e. a permanent straightening out of the crimps; the actual degree of stretch permissible is, of course, determined by the elongation and recovery characteristics of the tow being opened. With apparatus such as is shown in Figure 6 the loading of the tension rolls is adjusted accordingly.

Although the tow opening system of the present invention has been particularly described as employing three pairs of opening rolls, the invention is not limited in this respect. Large variations from normal or average values of total tow denier and number of filaments may necessitate the use of a greater number of pairs of rolls or permit the use of less than three pairs. Thus, for example, acetate tow with a denier per filament of 17 can be opened by a single pair of opening rolls acting in conjunction with a pair of tensioning rolls (52—53), while for acetate tow with a denier per filament of about 2 or 3, two or more pairs of opening rolls without tensioning rolls will achieve the same degree of opening.

As contrasted with conventional braked roll tow opening systems, the novel system enables opening to be effected without excessive pulling out of crimp. Because opening is associated with pulling out crimp in the conventional system, there is relatively little latitude possible in the weight per unit length of opened tow, i.e. about a 4% range of weights. By means of the invention a tow can be processed to give a product whose weight, at will, can be varied over a range of 12%. Moreover, once a particularly target weight has been set the novel system will produce opened tow of marked uniformity so that filter tips produced therefrom will all be of substantially the same weight, whereas a tow opened in conventional manner will yield filter tips varying considerably from one another in weight.

The superior opening of the novel system shows itself in more firm plugs or plugs of conventional firmness at lower weight which in

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turn reduces the amount of plasticiser needed in the plug-forming operation for bonding the filaments. Less filamentary material is required to meet particular smoke removal and pressure drop specifications than with conventional opening systems and, in addition, a particular smoke removal efficiency can be achieved at a lower pressure drop, i.e. with greater ease of draw.

The following examples illustrate the invention, all parts being by weight:—

EXAMPLE 1

A crimped tow composed of 16,675 secondary cellulose acetate filaments of 3.2 denier is processed through the apparatus shown in Figure 1 with the rolls 19, 20 separated so as not to operate on the tow and the nip of rolls 17, 18 spaced eighteen inches from the nip of rolls 21, 22. Rolls 18 and 22 are rubber covered and driven at peripheral speeds of 145 and 170 feet per minute; since the crimp in the tow is of such magnitude that it could be pulled by roll 22 up to 200 feet per minute without removing the crimp, the tow is not under any significant tension between rolls 18 and 22. Rolls 17 and 21 are made of steel and helically threaded from their centre lines to their ends in opposite directions. They are idly mounted and rotate through contact with their associated driven rolls 18 and 22.

As a result of the operation a well opened tow of uniform density is obtained. The quality of this product can be demonstrated by converting it into cigarette filter plugs by the conventional procedure using dimethoxy ethyl phthalate as plasticiser sprayed on in quantity equal to approximately 7% of the tow weight. When tested by the methods usually employed the plugs exhibit a pressure drop of 54 mm of water and a smoke removal efficiency of 39%. To obtain a plug exhibiting a comparable pressure drop and smoke removal efficiency from a tow opened by the methods commonly employed, it is necessary to use a tow of 60,000 total denier and the plug obtained is less firm (compressibility 29%) than that made from the tow opened as described in the Example (compressibility 22%). On the other hand, if, in the Example, rolls 17 and 21 are replaced by smooth surfaced rolls, the tow is not sufficiently opened to produce a commercially useful filter plug.

EXAMPLE 2

The apparatus of Figure 1, except for inclusion of tensioning rolls 52—53 of Figure 6, is used to process a tow composed of 35,000 continuous filaments of cellulose acetate, having a total denier of 70,000 and an average of 12 crimps per inch. The rolls 17 to 22 are five inches in diameter, which includes a one-inch layer of rubber having a hardness value of about 60 Durameter, and

approximately fourteen inches long. The pairs of rolls are spaced about fifteen inches apart and each of the rolls 17, 19 and 21 has opposite helical threads of fourteen turns per inch cut about one-sixteenth inch deep into its outer surface from the centre of each roll to its end. The roll 18 is driven at a surface speed of 36.0 yards per minute, the roll 20 at a 5% greater speed of 37.8 yards per minute and the roll 22 at a 5% greater speed still of 39.7 yards per minute. The tensioning rolls 52—53 are idly mounted for rotation and are biased toward each other so strongly as to require a pull of ten pounds to advance the tow between them. The opened tow produced shows no signs of being overstretched and is characterised by uniformity of openness throughout, by thorough de-registration of crimps and by a negligible percentage of broken filaments.

EXAMPLE 3

A 50,000 denier tow of 3.3 denier secondary cellulose acetate filaments crimped to the extent of 10 crimps per inch is opened by the apparatus of Figure 6 to give a web weighing 0.45 ounces per square yard of exceptional uniformity of thickness and porosity.

WHAT WE CLAIM IS:—

1. Method of opening a crimped tow of artificial filaments while moving the crimps in individual filaments out of registration with those in adjacent filaments, which comprises passing the running tow between a pair of rolls the surface of at least one of which is made up of grooves and ridges, the grooves encircling the roll in the form of one or more helices or a large number of parallel and endless grooves, so that filaments are only gripped between the rolls at the ridges and little or no grip is applied to the remaining filaments and the particular filaments which are gripped and released change with the rotation of the grooved roll or rolls and, at the same time, some filaments are caused to undergo lateral movement relative to other filaments.

2. Method according to Claim 1, wherein the tow is passed between a pair of rolls one of which is provided with the grooves in its surface and the other of which has a smooth surface and is driven.

3. Method according to claim 1 or 2, wherein the tow is passed between a plurality of pairs of rolls arranged in tandem.

4. Method according to Claim 3, wherein the peripheral speeds of the rolls are successively higher in the direction of travel of the tow.

5. Method according to any of the preceding claims, wherein the tow, before being passed between any pair of rolls at least one of which has a grooved surface, is drawn between a pair of tensioning rolls biased towards each other whereby the tow leaves the tensioning rolls under tension.

turn reduces the amount of plasticiser needed in the plug-forming operation for bonding the filaments. Less filamentary material is required to meet particular smoke removal and pressure drop specifications than with conventional opening systems and, in addition, a particular smoke removal efficiency can be achieved at a lower pressure drop, i.e. with greater ease of draw.

The following examples illustrate the invention, all parts being by weight:—

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As a result of the operation a well opened tow of uniform density is obtained. The quality of this product can be demonstrated by converting it into cigarette filter plugs by the conventional procedure using dimethoxy ethyl phthalate as plasticiser sprayed on in quantity equal to approximately 7% of the tow weight. When tested by the methods usually employed the plugs exhibit a pressure drop of 54 mm of water and a smoke removal efficiency of 39%. To obtain a plug exhibiting a comparable pressure drop and smoke removal efficiency from a tow opened by the methods commonly employed, it is necessary to use a tow of 60,000 total denier and the plug obtained is less firm (compressibility 29%) than that made from the tow opened as described in the Example (compressibility 22%). On the other hand, if, in the Example, rolls 17 and 21 are replaced by smooth surfaced rolls, the tow is not sufficiently opened to produce a commercially useful filter plug.

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approximately fourteen inches long. The pairs of rolls are spaced about fifteen inches apart and each of the rolls 17, 19 and 21 has opposite helical threads of fourteen turns per inch cut about one-sixteenth inch deep into its outer surface from the centre of each roll to its end. The roll 18 is driven at a surface speed of 36.0 yards per minute, the roll 20 at a 5% greater speed of 37.8 yards per minute and the roll 22 at a 5% greater speed still of 39.7 yards per minute. The tensioning rolls 52—53 are idly mounted for rotation and are biased toward each other so strongly as to require a pull of ten pounds to advance the tow between them. The opened tow produced shows no signs of being overstretched and is characterised by uniformity of openness throughout, by thorough de-registration of crimps and by a negligible percentage of broken filaments.

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WHAT WE CLAIM IS:—

1. Method of opening a crimped tow of artificial filaments while moving the crimps in individual filaments out of registration with those in adjacent filaments, which comprises passing the running tow between a pair of rolls the surface of at least one of which is made up of grooves and ridges, the grooves encircling the roll in the form of one or more helices or a large number of parallel and endless grooves, so that filaments are only gripped between the rolls at the ridges and little or no grip is applied to the remaining filaments and the particular filaments which are gripped and released change with the rotation of the grooved roll or rolls and, at the same time, some filaments are caused to undergo lateral movement relative to other filaments.

2. Method according to Claim 1, wherein the tow is passed between a pair of rolls one of which is provided with the grooves in its surface and the other of which has a smooth surface and is driven.

3. Method according to claim 1 or 2, wherein the tow is passed between a plurality of pairs of rolls arranged in tandem.

4. Method according to Claim 3, wherein the peripheral speeds of the rolls are successively higher in the direction of travel of the tow.

5. Method according to any of the preceding claims, wherein the tow, before being passed between any pair of rolls at least one of which has a grooved surface, is drawn between a pair of tensioning rolls biased towards each other whereby the tow leaves the tensioning rolls under tension.



6. Method of opening a crimped tow of artificial filaments while moving the crimps in individual filaments out of registration with those in adjacent filaments, substantially as hereinbefore described. 30
- 5 7. Method of opening a crimped tow of many thousands of artificial filaments, substantially as described in any of the Examples. 35
- 10 8. An opened tow of crimped artificial filaments whenever produced by any of the processes claimed in the preceding claims and filter plugs, non-woven fabrics and other articles made therefrom. 40
- 15 9. Apparatus for use in opening a crimped tow of artificial filaments comprising a pair of rolls the surface of at least one of which is made up of grooves and ridges, the grooves encircling the roll in the form of one or more helices or a large number of parallel and end- 45
- 20 less grooves, one roll being driven and the rolls being biased towards each other so as to grip crimped filaments passing between them only at the ridges, and means for causing a tow to pass between the rolls.
- 25 10. Apparatus according to Claim 9, wherein one roll is grooved and the other is smooth surfaced and means are provided for driving the smooth surfaced roll.
11. Apparatus according to Claim 9 or 10 and comprising a plurality of such pairs of rolls.
12. Apparatus according to Claim 11 and comprising means for driving one of each of the successive pairs of rolls at peripheral speeds which increase in the direction of travel of a tow passing between all the roll pairs.
13. Apparatus according to Claim 11 or 12 and comprising a pair of smooth surfaced tensioning rolls biased towards each other so as to grip a tow passing between them, said tensioning rolls being arranged to receive a tow and apply tension to it as it is drawn between them by a first pair of said rolls of which one has grooves in its surface.
14. Apparatus for use in opening a crimped tow of artificial filaments, substantially as illustrated in and described with reference to the accompanying drawings.

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