Jan. 16, 1962 J. W. SMITH 3,016,581

APPARATUS FOR OPENING CONTINUOUS MULTIFILAMENT CRIMPED TOW

Filed Nov. 7, 1957 4 Sheets-Sheet 1

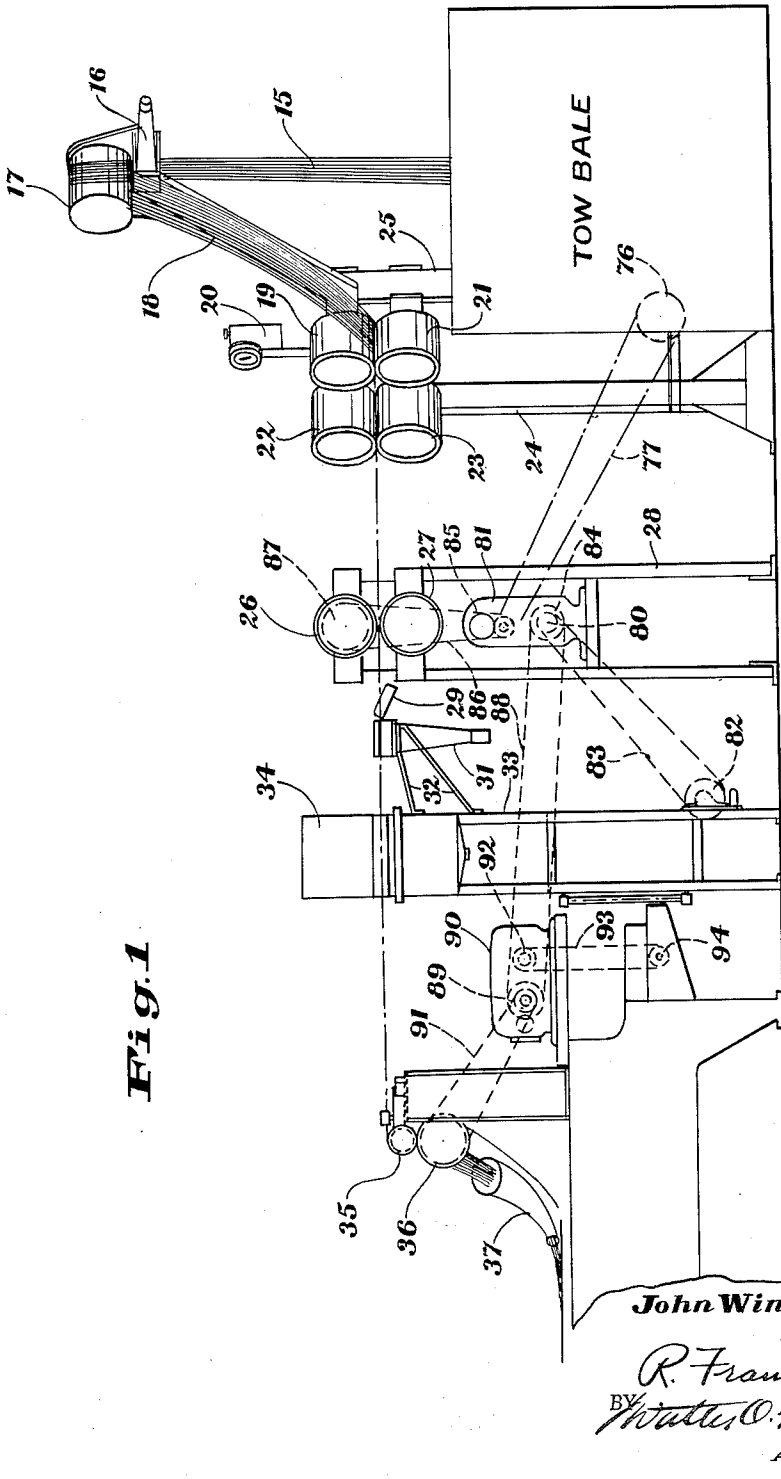


Fig. 1

John Winston Smith
INVENTOR.

R. Frank Smith
BY Walter O. Hodson

ATTORNEYS

Jan. 16, 1962 J. W. SMITH 3,016,581

APPARATUS FOR OPENING CONTINUOUS MULTIFILAMENT CRIMPED TOW

Filed Nov. 7, 1957 4 Sheets-Sheet 2

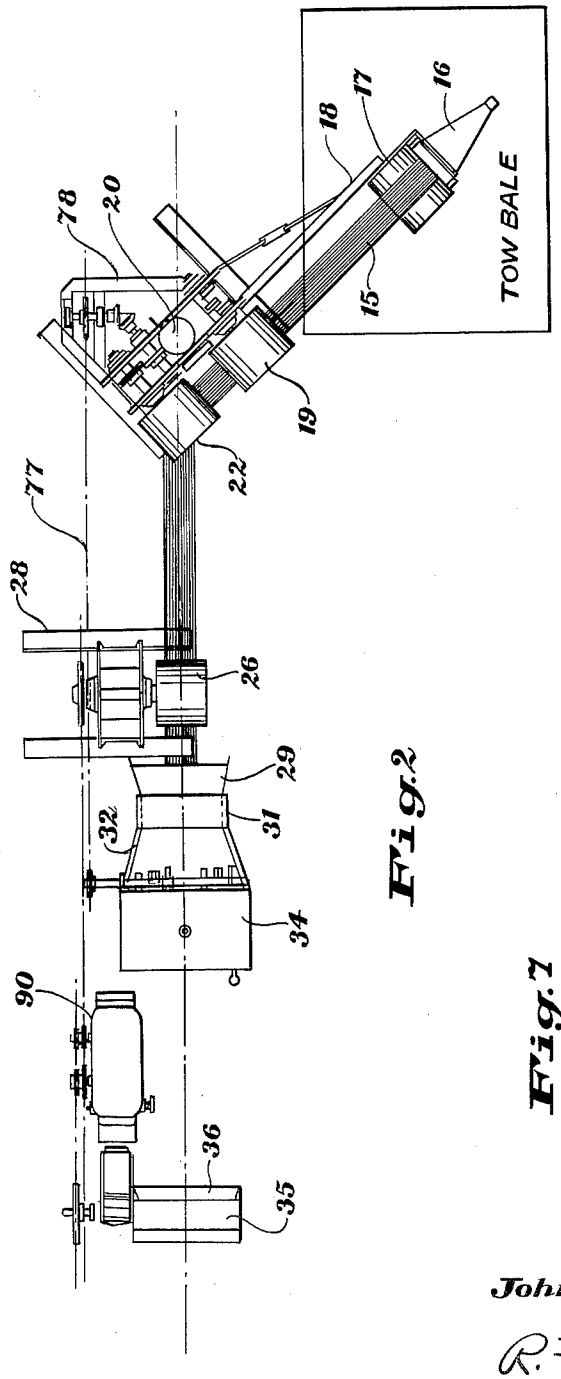


Fig. 2

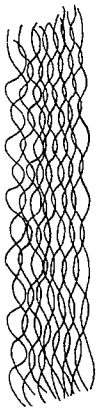


Fig. 7

John Winston Smith
INVENTOR.

BY R. Frank Smith
Walter O. Hodsden
ATTORNEYS

Jan. 16, 1962 J. W. SMITH 3,016,581

APPARATUS FOR OPENING CONTINUOUS MULTIFILAMENT CRIMPED TOW

Filed Nov. 7, 1957 4 Sheets-Sheet 3

Fig. 3

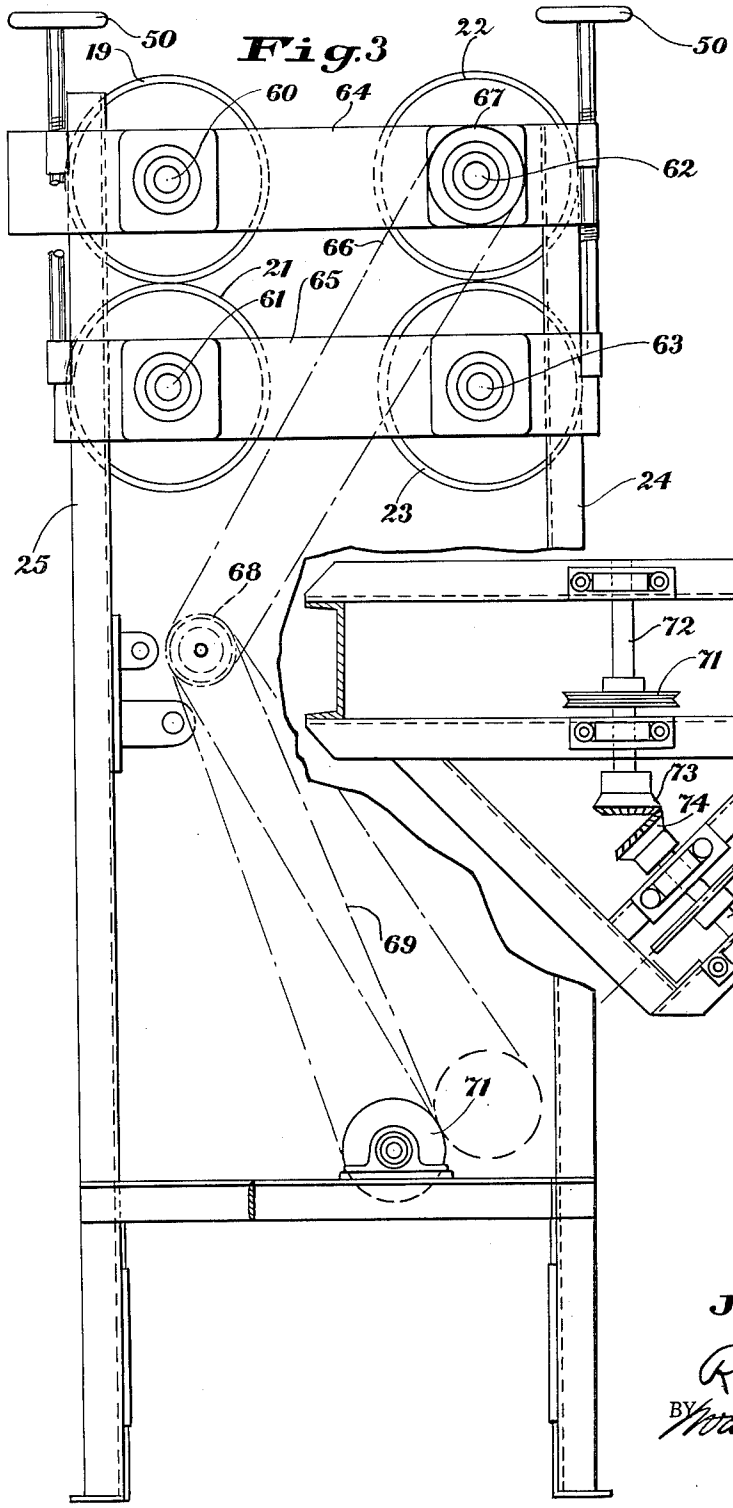


Fig. 4

John Winston Smith
INVENTOR.
R. Frank Smith
BY Walter O. Hodsdon
ATTORNEYS

Jan. 16, 1962 J. W. SMITH 3,016,581

APPARATUS FOR OPENING CONTINUOUS MULTIFILAMENT CRIMPED TOW

Filed Nov. 7, 1957 4 Sheets-Sheet 4

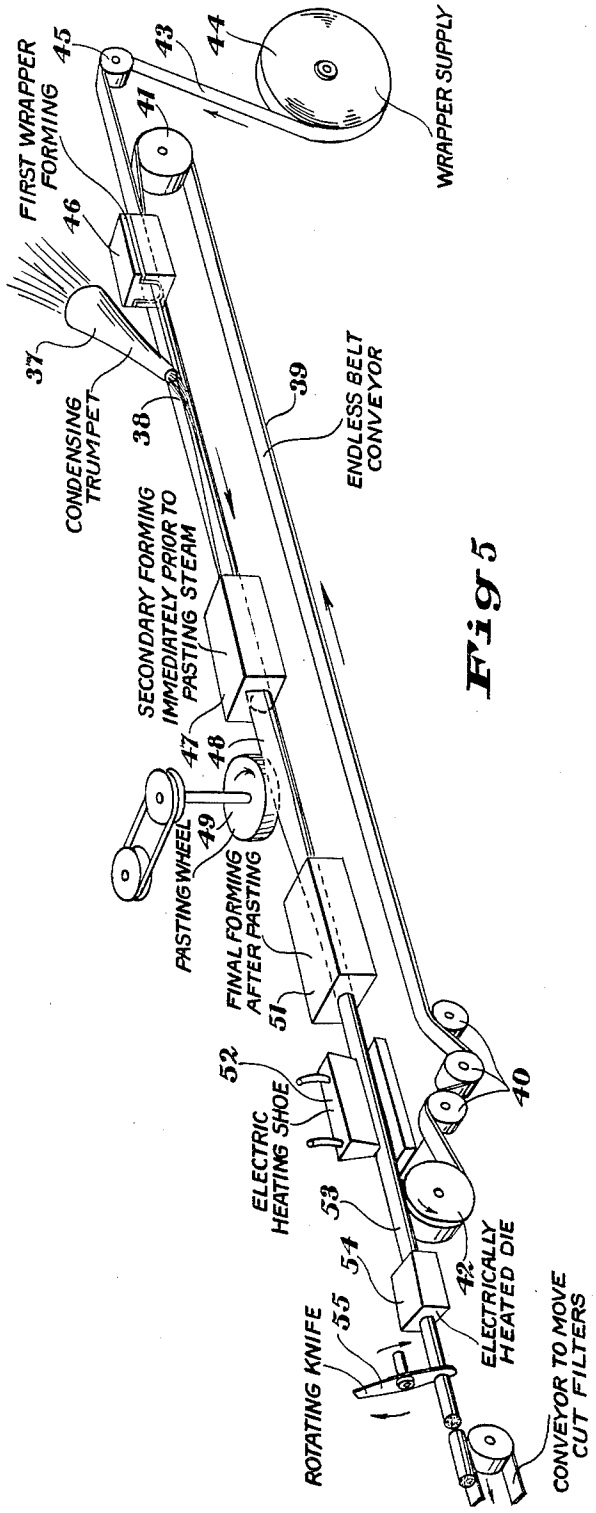


Fig 5

Fig. 8

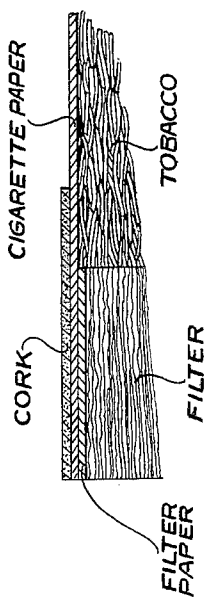
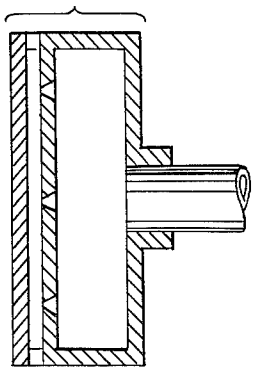


Fig. 6



John Winston Smith
INVENTOR.
R. Frank Smith
BY Walter O. Hodsdon
ATTORNEYS

United States Patent Office 3,016,581 Patented Jan. 16, 1962

3,016,581

APPARATUS FOR OPENING CONTINUOUS MULTIFILAMENT CRIMPED TOW

John Winston Smith, Kingsport, Tenn., assignor to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey

Filed Nov. 7, 1957, Ser. No. 695,080
5 Claims. (Cl. 19—65)

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. This invention is also concerned with novel apparatus and process for the opening of continuous filament tow to increase the cross-sectional area of the tow and the uniformity of filament distribution within the tow, and is moreover directed to the efficient elimination of shiners, married fibers and bundles of fibers within the tow.

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 45,000 to 160,000 total denier. The filament sizes normally available are usually in the range of 2 to 75 denier per filament and the tow may be made up of between 5,000 and 100,000 filaments (preferably 20,000) of from 2 to 16 (preferably 5) denier per filament or a total denier within the range of 80,000 to 250,000 (preferably 100,000). The crimps in the tow should range from 4 to 18 crimps per inch and 9 crimps per inch are preferable.

Denier is defined as the weight in grams of a 9,000 meter length of yarn. Thus, a filament 9,000 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., 80,000 denier tow would contain 16,000 filaments and would weigh 80,000 grams per 9,000 meters.

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. Such a cellulose acetate tow can be made, for example, by the dry spinning process described in H. G. Stone Patents 2,000,047 and 2,000,048. 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 my apparatus and process 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 91,000 feet in length is normally enough to supply the process for about 8 hours when making 1,000 filter tips per minute.

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. Such a tow is the subject of Crawford and Stevens Patent 2,794,239 of June 4, 1957. 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 lubricant is a neutral, non-toxic material. Most advantageously one may employ about 0.5% pharmaceutical grade mineral oil by weight of the fibers.

There are numerours processes available commercially for imparting crimp to the tow. However, such crimping operations causes 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 reduces the efficiency of the filter.

Heretofore, it has often been the practice to remove shiners from yarn for textile uses by processing the yarn two or more times through opening devices, such as pickers. This is costly and results in low machine efficiency.

More effective methods and means of opening tow to eliminate fiber bundles in the crimped continuous cellulose acetate tow to be used in making cigarette filters are described in the copending Wallace T. Jackson U.S. application, Serial No. 403,131, filed January 11, 1954, now Patent 2,926,392 of March 1, 1960, and entitled "Method and Apparatus for Opening Crimped Tow"; and in John Winston Smith Patent 2,790,208 of April 30, 1957, entitled "Method and Means for Opening Crimped Continuous Filament Tow."

These inventions have been successfully employed in the trade to open crimped continuous filament cellulose acetate tow for processing into cigarette filters. However, the resulting filter plugs may now and then contain filament bundles due to the crimps reforming in registry in several adjacent filaments. The present apparatus and method further eliminate such undesired structures.

An object, therefore, of the present invention is to provide an improved method and apparatus for continuously opening crimped continuous cellulose acetate tow, whereby the bulk and uniformity of filament distribution is increased and more effective elimination from the tow of shiners and married filaments occurs.

Still another object is to provide a process and apparatus whereby the tow can be opened more efficiently while under less tension than has been employed in previous processes.

Yet another object is to provide a process and apparatus whereby the crimps in any one of the filaments making up the crimped tow can be positioned and maintained out of registry with the crimps in the adjacent filaments.

Another object is to provide a multi-filament crimped tow in which the crimps in any one of the filaments are out of registry with the crimps in the adjacent filaments.

Still another object of the present invention is a tobacco smoke filter unit comprising aligned crimped continuous filaments in which the crimps in any one of the filaments are out of registry with the crimps in the adjacent filaments.

Other objects will appear herein.

In accordance with the present invention a crimped, continuous multi-filament tow, of relatively narrow cross-section, in which the crimps are substantially in registry

and which contains married filaments or filament bundles is withdrawn from a source of supply such as a tow bale and passed through a preliminary tow opener device in which air under pressure is blown against the tow substantially at right angles to the direction of movement of the tow in order to give a preliminary separation to the filaments.

The tow at this point is substantially wider and thinner than that still in the bale and is now conducted through the nip of a first pair of braked coacting rubber-covered rolls and thence through a ratch and through the nip of a second pair of driven coacting rubber-covered rolls. By "ratch" is meant the distance between the nips of the adjacent pairs of the coacting rubber-covered rolls. The braked rolls restrain the forward movement of the tow somewhat and the driven rolls are operated to stretch the tow in the ratch between the pairs of rolls until the crimps in the filaments are straightened to a considerable extent but not sufficient to overcome the tendency of the crimps to reform.

The stretched tow is conducted under substantially the same tension to a third pair of driven coacting rubber-covered rolls and through the nip therebetween.

A particular feature of the present invention is occasioned by the angular arrangement of the first and second pairs of rolls with respect to the third pair. This may be comprehended by reference particularly to FIG. 2 of the related drawings.

While passing between the first and second pair of rolls the respective filaments in the tow are stretched at substantially equal lengths and parallel to the length of the filaments. However, as the tow continues from the second pair of rolls to the third pair of rolls the individual filaments are stretched at progressively different lengths across the tow because of the angular relationship of the second and third pairs of rolls. This angular stretching of the filaments draws the crimps, which up to this point are in registry across the width of the tow, out of registry so that the crimps in any given filament are out of registry with the crimps in adjacent filaments in the tow.

The tow is conducted away from the nip of the third pair of rolls at a relaxing tension so that the crimps are suddenly restored in each filament of the tow. The sudden release of the tension on the spring-like stretch, crimped filaments plus the repelling effect of the static charge which is placed on the filaments by contact with the various rubber-covered rolls results in an "explosive expansion." Since the filaments have been pulled out of registry they are restored in the out-of-registry position. The cumulative effect of the longitudinal plus the angular stretching is to eliminate substantially completely all married filaments or filament bundles in the crimped, continuous filaments of the tow.

The tow is preferably passed through another air-operated tow opener device similar to that mentioned above to widen the tow still further and through a chamber in which a bonding medium is placed on each side of the tow.

The continuous filament cellulose acetate tow is now in condition to be formed into cigarette filter units. The tow is therefore introduced into the filter forming device through a condensing trumpet which reforms the flat tow into a round strand, a paper wrapper is then placed around the continuously moving condensed rod of tow.

The product at this point is a continuous round and compact paper-covered filter rod in which the crimped filaments are also in substantial parallel alignment and with the crimps in said out-of-registry condition. This rod has a diameter the same or slightly less than that of the cigarette with which the filter is to be assembled.

The continuous rod is then subjected to a heat treatment for purposes of stiffening the rod. The heat causes the bonding of the filaments to each other where they contact within the filter structure and gives a more rigid structure to the rod which facilitates handling and assembly operations.

Subsequent to the heat treatment the moving filter rod is periodically cut into lengths suitable for use in filter cigarette manufacture or for use in pipes and cigar holders.

The present invention will be further understood by reference to the following detailed description and accompanying drawing in which:

FIG. 1 is an elevational view of my novel apparatus which may be employed for carrying out my novel method of opening continuous crimped cellulose acetate tow;

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

FIG. 3 is a rear view in elevation 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 an isometric drawing 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;

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

FIG. 8 is an enlarged longitudinal section through a portion of a tipped cigarette assembled with a filter made by the instant process.

Referring to FIG. 1 there is shown 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** which is generally similar to that shown in Jackson Patent 2,737,688 of March 13, 1956. The tow **15** then continues over roll **17** which is a fixed guide. Tow opener **16** and roll **17** are suitably mounted on support **18**. The tow then continues to the nip between rubber-covered rolls **19** and **21** and thence to the nip between the rubber-covered rolls **22** and **23**. These pairs of rolls are suitably mounted on respective supports **25** and **24** and as shown more clearly in FIG. 2, are spaced from each other.

Rolls **19** and **21** are the braked rolls which grip the tow **15** passing therebetween and restrain its forward movement somewhat. The braking means, represented in part by member **20**, may be of any suitable construction such as a conventional hydraulic operated brake adapted to be adjusted to retard the rotation of the rolls to the desired amount. Rolls **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.

The tow on leaving the nip of rolls **22** and **23** continues to the pair of rubber-covered rolls **26** and **27** and passes through the nip therebetween. Rolls **26** and **27** are also driven rolls and are driven at a rate sufficient to maintain tension on the tow which has been placed thereon by rolls **22** and **23**. These rolls are suitably mounted on support **28**. As shown more clearly in FIG. 2, the first and second pairs of rolls are positioned at an angle to the third pair of rolls. Thus, while substantially equal lengths of the tow are stretched in the ratch between the first and second pairs of rolls, because of the angular relationship of the third pair of rolls to the second pair of rolls, 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 rolls and the third pair of rolls may be within the range of 5 to 65 degrees. 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 rolls 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 fibers or filter bundles. The equal length stretching of the filaments accomplished by the coaction of the first and second pairs or rolls 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 rolls 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 rolls the plurality of filaments while still in a parallel relationship are substantially out of registry as respects crimps in adjacent filaments.

Thus, when this double stretched tow is suddenly relaxed as it passes through the third pair of rolls, the crimps spring back into their original shape, but are now in the out-of-registry positions and the filament bundles and married filaments cannot reform. The tow at this point is therefore of novel structure as shown in FIG. 7, having the crimps in any one of the parallel filaments out of registry 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.

The moving tow now in the form of the flat band of parallel disposed filaments with the crimps out of registry is conducted 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 phtyalyl 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 filtered through elements of the invention, are dibutyl phthalate, tripropionin and acetyl triethyl citrate. The plasticizing agent preferably is sprayed on until the fibers contain 4 to 30% (preferably 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 now having the plasticizer therein is conducted between delivery rolls 35 and 36 and thence into the filter forming device shown in FIG. 5 through 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 rolls and the delivery rolls are shown in FIGS. 1, 2, 3 and 4.

As shown particularly in FIG. 3 the first two pairs of rolls are mounted to turn respectively on shafts 60, 61, 62, 63 which are suitably supported by members 64 or 65. The lower rolls may be brought into engagement with the upper rolls by suitable adjustment of members 50 as is apparent from the drawing. Roll 22 is positively driven by belt 66 which engages pulleys 67 and 68. The latter pulley 68 is turned by belt 69 from driven pulley 71 which, as shown in FIG. 4, is mounted on shaft 72 and is driven through gears 73 and 74 and shaft 75 which is turned by pulley 76. These various elements are conventionally mounted on a supporting frame 78.

Referring again to FIG. 1, it will be seen that belt 77 is turned by pulley 76 which is associated with a transmission box 81 which is operated by pulley 84 which is turned by belt 88 by means of pulley 89 which is rotated by transmission 90. The latter is operated by a motor, not shown. Pulley 89 and belt 83 turns 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. Pulley 92 and belt 93 turn 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 39 which revolves around drums 41 and 42 and is maintained taut by drums 40. The belt is driven by means not shown. The wrapper 43, which may be filter paper, is continuously unwound from roll 44 and passes over guide roll 45 and is carried by 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 now carried by 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 then moves along to contact 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 now smoothed down over the adjacent paper edge by forming member 51 and is then heat sealed into a permanent adhesive bond by electric heating shoe 52.

The product therefore 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 is then 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 cutter 55 which is rotated by means, not shown.

The end product is a round filter element having an external paper wrapper containing a compact, rigid structurally unitary debundlized mass of crimped cellulose acetate filaments, each filament of the mass being substantially coextensive therewith. The filaments as a whole are in substantial alignment longitudinally of the mass but substantially each of the individual filaments has non-oriented short portions thereof disposed randomly in diverging and converging relationship to the main filament axis.

Substantially all of the filaments of the mass 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. FIG. 8 shows the filter unit of the present invention assembled in normal position with a cigarette. 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 by employing my novel apparatus and process.

I claim:

1. In a device for opening continuous multi-filament

crimped tow, in combination, a first pair of rubber-covered rolls, a second pair of rubber-covered rolls, a third pair of rubber-covered rolls, said pairs of rolls being adjustably positioned to form a nip between the rolls of each pair and positioned to form a ratch between each of the adjacent pairs of rolls, means for conducting said tow between said pairs of rolls and through the ratches between the first and second and the second and third pairs of rolls, driving means for driving said second and third pairs of rolls, braking means for braking said first pair of rolls, the driving means for said second pair of rolls and said braking means cooperating to exert a tension by means of said rolls on the tow in the ratch between said rolls sufficient to stretch the filaments and temporarily straighten out the crimps, means comprising said driven third pair of rolls for maintaining the tension on said tow in the ratch between said second and third pairs of rolls, said third pair of rolls being positioned to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimp in adjacent filaments are drawn out of registry with one another, and means for abruptly releasing the tension thereby permitting the crimps to reform in the tow in the out-of-registry position.

2. In a device for opening continuous multi-filament crimped tow, in combination, a first pair of rubber-covered rolls, a second pair of rubber-covered rolls, a third pair of rubber-covered rolls, said pairs of rolls being adjustably positioned to form a nip between the rolls of each pairs and positioned to form a ratch between each of the adjacent pairs of rolls, means for conducting said tow between said pairs of rolls and through the ratches between the first and second and the second and third pairs of rolls, driving means for driving said second and third pairs of rolls, braking means for braking said first pair of rolls, the driving means for said second pair of rolls and said braking means cooperating to exert a tension by means of said rolls on the tow in the ratch between said rolls sufficient to stretch the filaments and temporarily straighten out the crimps, means comprising said driven third pair of rolls for maintaining the tension on said tow in the ratch between said second and third pairs of rolls, said third pair of rolls being positioned at an angle to said second pair of rolls and being adapted to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimp in adjacent filaments are drawn out of registry with one another, and means for abruptly releasing the tension thereby permitting the crimps to reform in the tow in the out-of-registry position.

3. In a device for opening continuous multi-filament crimped tow, in combination, a first pair of rubber-covered rolls, a second pair of rubber-covered rolls, a third pair of rubber-covered rolls, said pairs of rolls being adjustably positioned to form a nip between the rolls of each pairs and positioned to form a ratch between each of the adjacent pairs of rolls, means for conducting said tow between said pairs of rolls and through the ratches between the first and second and the second and third pairs of rolls, driving means for driving said second and third pairs of rolls, braking means for braking said first pair of rolls, the driving means for said second pair of rolls and said braking means cooperating to exert a tension by means of said rolls on the tow in the ratch between said rolls sufficient to stretch the filaments and temporarily straighten out the crimps, means comprising said driven third pair of rolls for maintaining the tension on said tow in the ratch between said second and third pairs of rolls, said third pair of rolls being positioned at an angle of 5 to 65 degrees to said second pair of rolls and being adapted to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimp in adjacent filaments are drawn out of registry with one another, and means for abruptly releasing the tension thereby permitting the crimps to reform in the tow in the out-of-registry position.

4. In a device for opening continuous multi-filament crimped tow, in combination, a first pair of rubber-covered rolls, a second pair of rubber-covered rolls, a third pair of rubber-covered rolls, said pairs of rolls being adjustably positioned to form a nip between the rolls of each pairs and positioned to form a ratch between each of the adjacent pairs of rolls, means for conducting said tow between said pairs of rolls and through the ratches between the first and second and the second and third pairs of rolls, driving means for driving said second and third pairs of rolls, braking means for braking said first pair of rolls, the driving means for said second pair of rolls and said braking means cooperating to exert a tension by means of said rolls on the tow in the ratch between said rolls sufficient to stretch the filaments and temporarily straighten out the crimps, means comprising said driven third pair of rolls for maintaining the tension on said tow in the ratch between said second and third pairs of rolls, said third pair of rolls being positioned to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimp in adjacent filaments are drawn out of registry with one another, and means for withdrawing the tow from the nip of said third pair of rolls at a relaxing tension whereby the tension is abruptly released thereby permitting the crimps to reform in the tow in the out-of-registry position.

5. In a device for opening continuous multi-filament crimped tow, in combination, a first pair of rubber-covered rolls, a second pair of rubber-covered rolls, a third pair of rubber-covered rolls, said pairs of rolls being adjustably positioned to form a nip between the rolls of each pairs and positioned to form a ratch between each of the adjacent pairs of rolls, means for conducting said tow between said pairs of rolls and through the ratches between the first and second and the second and third pairs of rolls, driving means for driving said second and third pairs of rolls, braking means for braking said first pair of rolls, the driving means for said second pair of rolls and said braking means cooperating to exert a tension by means of said rolls on the tow in the ratch between said rolls sufficient to stretch the filaments and temporarily straighten out the crimps, means comprising said driven third pair of rolls for maintaining the tension on said tow in the ratch between said second and third pairs of rolls, said third pair of rolls being positioned to exert a tension on adjacent filaments of the tow at different lengths thereof whereby the crimp in adjacent filaments are drawn out of registry with one another, means for withdrawing the tow from the nip of said third pair of rolls at a relaxing tension thereby permitting the crimps to reform in the tow in the out-of-registry position, and means employing a gas under pressure positioned between said withdrawing means and said third pair of rolls to assist the further opening of the tow.

References Cited in the file of this patent

UNITED STATES PATENTS

2,413,969	Hardy	Jan. 7, 1947
2,427,955	Furness	Sept. 23, 1947
2,623,266	Hemmi	Dec. 30, 1952
2,765,515	Knudson	Oct. 9, 1956
2,794,239	Crawford et al.	June 4, 1957
2,794,480	Crawford et al.	June 4, 1957
2,807,863	Schenker	Oct. 1, 1957
2,822,582	Hayward et al.	Feb. 11, 1958
2,843,881	Bishop et al.	July 22, 1958

FOREIGN PATENTS

694,789	Great Britain	July 29, 1953