Oct. 14, 1969 D. D. GREY 3,471,901

TOW PROCESSING

Filed Sept. 12, 1966 3 Sheets-Sheet 1

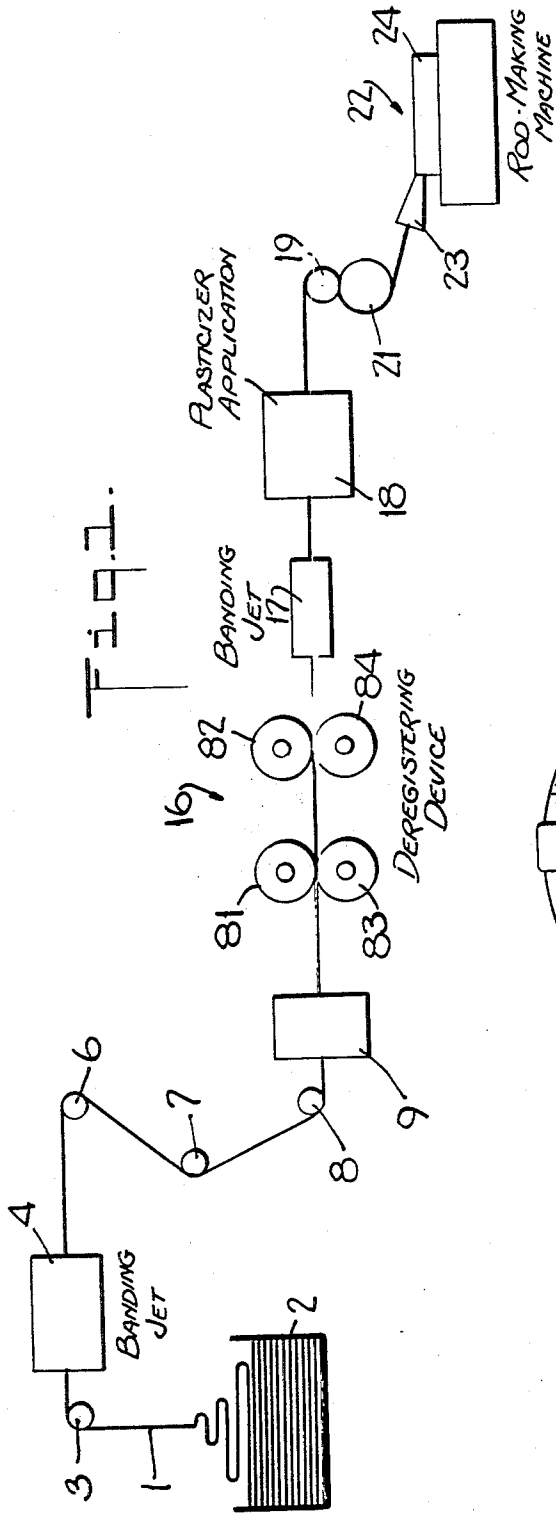

Fig. 1.

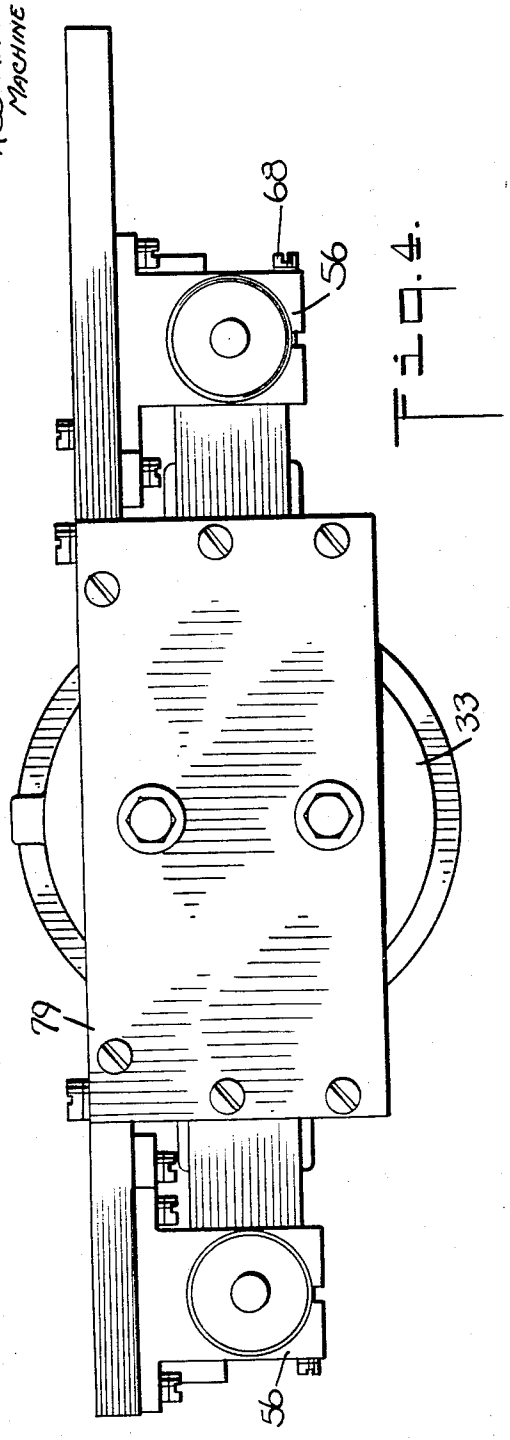

Fig. 4.

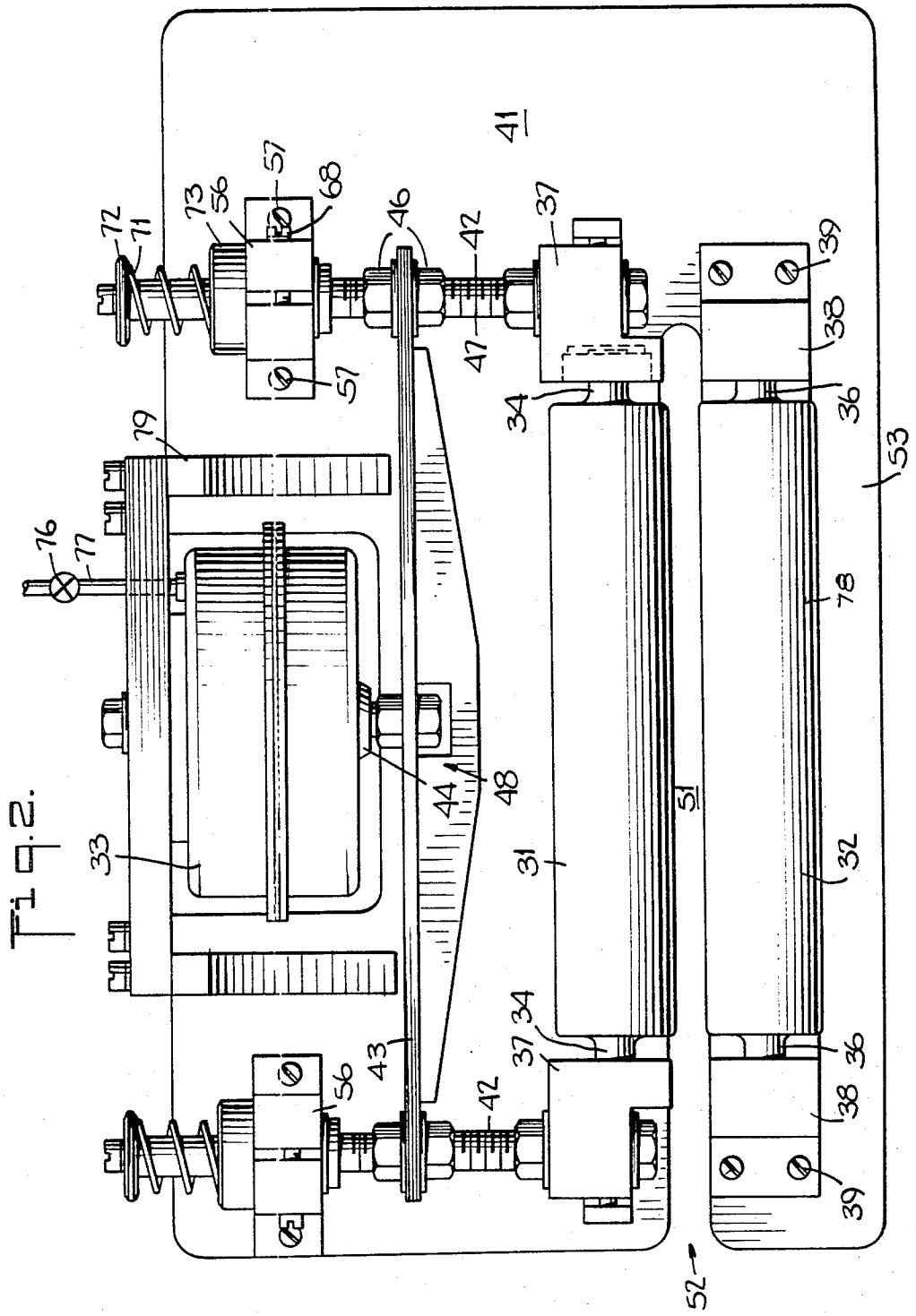
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Fig. 2.

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Fig. 5.

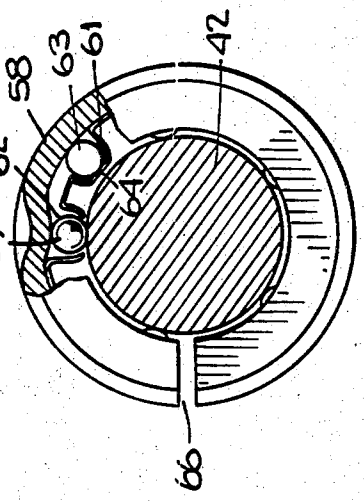


Fig. 6.

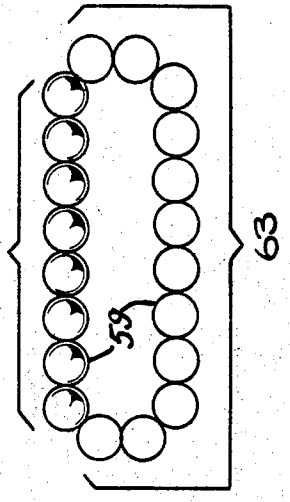
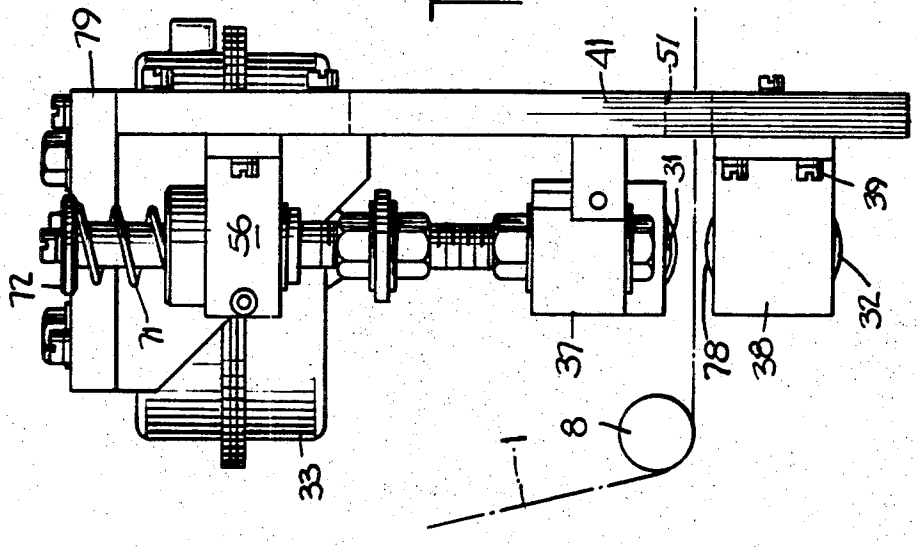


Fig. 7.



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3,471,901

TOW PROCESSING

Donald D. Grey, Matthews, N.C., assignor to Celanese Corporation, New York, N.Y., a corporation of Delaware

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U.S. Cl. 19—66 2 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus is described for the manufacture of opened deregistered tow by passing a crimped multifilament tow having crimps in registry through a banding jet and a differential gripping device for deregistering the crimps and moving the tow longitudinally, the improvement in the apparatus comprising tow gripping means in the path of the tow just upstream of the differential gripping device, said tow gripping means comprising a pair of low inertia elongated rolls.

This invention relates to the production of opened tows and relates, more particularly, to the production of cigarette filter tips.

Cigarette filter tips are usually made from crimped continuous artificial filaments combined into a tow or bundle consisting or several thousands of such filaments. Typically, the filaments are produced by dry-spinning a solution of cellulose acetate into an evaporative atmosphere to form a relatively small bundle of a number substantially parallel filaments and a number of these smaller bundles are combined to make a tow, which may contain, for example, about 5,000 to 30,000 filaments of about 1 to 20 denier per filament. The tow is then generally mechanically crimped to the extent desired so that the filaments are more or less adhered to each other in a wavy band or ribbon-like form, with the crests and vales of the crimp in adjacent filaments being in registry. This ribbon is then packed as a bale (usually by traversing it back and forth in a carton) which is shipped to the cigarette manufacturer, or to a manufacturer of filter rods who reships the rods to the cigarette maker.

In one method of making cigarette filter rods from cellulose acetate tow, the tow band is drawn from the bale through a banding jet where it is subjected across its width to one or more streams of air which help to spread the tow into a flattened band. The flattened tow then passes to a driven differential gripping device whose driven rolls serve, inter alia, to deregister the crimped filaments of the tow, as well as to draw the tow through the banding jet. The resulting opened tow then preferably passes through a second banding jet to a plasticizer-applying device, then to driven delivery rolls, and from there to a rod-making machine, which typically includes a stationary, circular funnel-like trumpet (where the tow band is shaped to a circular cross-section) and a garniture at which the circular bundle is then covered with a wrapping (e.g. cigarette paper) and cut to the desired length, for example to a length of 4 inches. The resulting rods are later cut transversely to form the shorter lengths (e.g. ⅔ inch lengths) used in cigarette filter tips.

In attempting to operate a system of this type at a high rate of speed (such as a speed above 800 feet per minute, e.g. about 1000 feet per minute corresponding to the production of about 3000 rods per minute), it is found that the resulting rods are not as uniform as desired. They vary in weight and circumference, for example, to a considerably greater degree than rods produced at lower speed. Thus, there will be correspondingly undesirable large variations in the smoking qualities of

the individual filter tip cigarettes made from the rods produced at high speeds.

In accordance with one aspect of this invention, I have discovered that the variability resulting from high speed operation can be reduced considerably by the use of a novel tow-gripping mechanism positioned upstream of the differential gripping device.

One embodiment of the improved tow-gripping unit is illustrated in the accompanying drawings, in which:

FIG. 1 is a schematic side view of the overall operation;

FIG. 2 is an end view of the tow-gripping mechanism looking in the direction of movement of the tow;

FIG. 3 is a side view of the tow-gripping mechanism, and

FIG. 4 is a top view;

FIG. 5 is a cross-sectional view of a ball bushing used in the tow-gripping mechanism and

FIG. 6 is a detailed view of a ball circuit of the bushing of FIG. 5.

As indicated in FIG. 1, the tow band **1** is drawn from the bale **2** over a stationary guide rod **3**, through a banding jet **4** where it is subjected across its width to one or more streams of air which help to spread the tow into a flattened band. For example, the tow band may have a width of about 3–4 inches before entering the banding jet **4** and a width of 6 inches on leaving that jet. The flattened tow then passes around stationary guide rods **6** and **7**, and under stationary guide rod **8**, to the tow-gripping mechanism **9**. From there, it passes to a driven differential gripping device **16** whose driven rolls serve to draw the tow through the tow-gripping mechanism **9** and banding jet **4** as well as to deregister the crimped filaments of the tow, as more fully described below. The resulting opened tow then preferably passes through a second banding jet **17** (being thereby spread, for example, from a width of about six inches, on leaving the differential gripping device **16**, to a final width of about 12 inches), to a plasticizer-applying device **18**, then to driven delivery rolls **19**, **21** and from there to a rod-making machine **22**, which may be of conventional construction having a trumpet **23** and garniture **24**. If desired, the plasticizer need not be applied before the tow reaches the delivery rolls; instead, a film of plasticizer may be placed on these rolls for application thereby to the tow passing over them.

The tow-gripping mechanism **9** includes a pair of elongated freely rotatable upper and lower rolls **31** and **32**, each having a uniform smooth cylindrical outer surface for contacting the flattened tow **1** which, in passing between these rolls, is squeezed between them, the upper roll **31** being pressed resiliently downward as by the action of a pneumatic diaphragm device **33**, while the lower roll **32** is mounted with its axis stationary. More particularly, the end shafts **34**, **36** of the rolls **31**, **32**, respectively, are supported on roller bearing **37** and **38**. The two lower bearings **38** are fixed (as by screws **39**) to a stationary vertical foundation plate **41**, while each of the two upper bearings **37** is mounted at the ends of a vertical guide bar **42**. These guide bars **42** extend through and are adjustably fixed to the ends of a rigid cross bar **43** which is, in turn, engaged at its center portion by a stem **44** extending downward from the pneumatic diaphragm device **33**. The vertical guide bars **42** may be fixed to the cross bar **43** by means of nuts **46** engaging screw threads **47** on the lower ends of the guide bars; a similar nut and screw arrangement **48** may be used for adjustably fixing the stem **44** to the cross bar.

The foundation plate **41** has a long slot **51**, aligned with the nip of the rolls **31**, **32** for the passage of the tow through the plate. This slot **51** is open at one end **52** to permit easy insertion of the tow band, through said open end **52**, into the desired position between the rolls **31**, **32**.

Thus, in effect, the lower roll **32** is mounted on an arm **53** extending from the lower part of the plate **41**.

The smooth circular upper portions of the guide bars **42** are laterally supported and aligned (so that these bars, and the upper roll **31** carried thereby, move in a precise vertical path) by means of ball bushings **56** fixed (as by screws **57**) to the foundation plate **41**. Each of these ball bushings (see FIGS. 5 and 6) comprises a generally cylindrical sleeve **58** carrying a large number of recirculating bearing balls **59** which are in rolling contact with the inner wall of the sleeve and with the outer surface of the guide rod **42** which passes through the sleeve. A retainer **61** within the sleeves holds the balls in place and separates them into three or more sets, establishing a corresponding number of oblong circuits for the balls. FIGS. 5 and 6 show details of one such circuit. In the load-carrying portion **62** of a circuit, the balls roll freely in a straight line path parallel to the axis of the sleeve (and to the axis of the guide rod). In the remaining, recirculating portion **63** of a circuit, the balls do not make contact with the guide rod but, instead, roll freely between the inner surface of the sleeve and a runway **64** provided by the retainer **61**. Preferably, an adjustable ball bushing is used; in one form of adjustable bushing, the sleeve **58** is not a complete cylinder but has a slot **66** running its full length parallel to the axis and is housed in a split pillow block **56** (FIGS. 2 and 4) having an adjusting screw **68**, which generally is tightened only enough to make the balls just grip the guide rod **42**, to give a line-to-line or slight preload fit.

The apparatus may include means for returning the upper roll **31** to its upper position, such as helical springs **71** which are compressed between collars **72** (at the tops of the guide rods **42**) and spring retainers **73** resting on the ball bushings **56**. For example, when it is necessary to insert, or remove, the tow band from the tow-gripping mechanism, e.g. during start-up, the air supply to the pneumatic diaphragm device **33** may be shut off or vented (e.g. from a suitable valve **76** leading to the air supply tube **77** of the diaphragm device) so that the upper rod can rise under the influence of the springs **71** to a position permitting free passage of the tow between the rolls **31, 32**.

The rolls **31, 32** have a relatively small mass and, therefore, a low inertia, so that they will respond quickly to changes in the tension in the tow and will permit start up without so loading the tow as to cause undesirable stretching or breaking of the tow. In a preferred embodiment, illustrated in the drawing, the upper and lower rolls are each 8 inches long (plus the stub shafts, at each end, which are each about ¾ inch long) and are each less than 2 (e.g. 1½) inches in diameter; the upper roll is of solid steel while the lower roll is similar but includes a rubber surface layer **78** (e.g. of Shore 80 hardness, ⅛ inch thick); each roll weighs less than 5 pounds (e.g. about 3 to 4 pounds).

The pneumatic diaphragm device **33** is of known type having an air chamber, one wall of which is a flexible diaphragm (not shown) attached to the stem **44**; air under adjustably controlled pressure is supplied to the air chamber through the tube **77**. The diaphragm device is rigidly supported on the foundation plate **41** by means of a mounting bracket **79**.

In operation, the tow is threaded through the apparatus while the upper roll **31** is in its upper, inactive, position and, with all the driven rolls in operation, the pressure in the diaphragm device is gradually increased so as to force the upper roll down against the tow thus increasing the tension in the tow band running between the nip of rolls **31, 32** and the differential gripping device **16** until that tension is just below that which would cause breakage of individual filaments; undesirably high tensions which can result from the use of too high a pressure at the nip, evidence themselves by the appearance of broken filament ends projecting slightly from the tow, like little hairs, so that the tow leaving the pretensioning device has a rough, unshaven appearance. When the air pressure is adjusted to the most desirable level for the particular tow, the tow band leaving the nip of the rolls **31, 32** has no visible broken filament ends and the crimp in its individual filaments is clearly visible.

Particularly suitable types of differential gripping devices **16** are described in Dunlap et al., U.S. Patent 3,156,-016, whose disclosure is incorporated herein by reference, in which the tow is opened by subjecting it, while moving in a predetermined path, to a differential gripping action between a plurality of points spaced from one another both longitudinally and transversely of the path, so that certain laterally spaced sections of the tow are positively gripped relative to other laterally spaced sections of the tow, alternating with the said gripped sections, which are not gripped at all or are gripped at different relative points. In this manner, there is produced, as a function of the differential positive gripping of the tow, a relative shifting of adjacent filaments longitudinally of the tow, whereby the crimps are moved out of registry with one another. Preferably, although not necessarily, the differential gripping action is such that a relative lateral displacement between adjacent filaments of the tow is also effected, so that the combination of two transverse filament movements brings about the complete opening of the tow.

The differential gripping action may be achieved by the provision of at least one pair of rolls, one of which is smooth-surfaced and the other of which is grooved over its entire periphery; if desired, there may be a plurality of such pairs of rolls arranged in tandem. On each grooved roll, the grooves and the ridges alternating therewith may extend obliquely or helically in opposite senses from its center to its opposite ends. Thus, when the tow passes between the two rolls of any given pair of one grooved and one smooth-surfaced roll, some of the tow sections are gripped between the peaks of the ridges of the grooved roll and the outer peripheral surface of the opposed smooth-surfaced roll, while other sections of the tow which are at that time located in registry with the spaces between the ridges of the grooved roll are not gripped between the latter and the smooth-surfaced roll. Generally, only one roll of each pair is positively driven while the other is yieldably biased toward it and rotates due to the passing of the tow between the rolls.

I prefer to use two sets of differential gripping rolls, rather than the three sets specifically illustrated in the drawing of the previously mentioned Dunlap et al. patent. In a preferred embodiment, each set of rolls comprises an upper patterned-surface roll **81, 82** and a lower positively driven rubber-surfaced roll **83, 84**, each upper roll being mounted for free rotation and being driven by the rotation of the corresponding driven lower roll. In one specific form, the rolls **81, 82, 83, 84**, are each about 6½ inches in diameter and the upper rolls are of steel helically threaded with about 14 threads per inch, the thread being about 1/20 inch deep; the upper delivery roll **19** is about 3 inches in diameter, the lower delivery roll **21** is about 8 inches in diameter, both delivery rolls being of steel and the lower one being positively driven, the tow making an S-wrap about the rolls **19, 21**; the roll **84** is driven at a surface speed greater than that of the roll **83** while the delivery roll **21** is driven about the same speed as the roll **83**; thus when rolls **83** and **21** are driven at a surface speed of about 1000 feet per minute, the surface speed of roll **84** is, for example, about 1600 feet per minute. The distance between the nip of rolls **81, 83** and the nip of rolls **31, 32** is typically about one foot.

Even at high tow speeds the tow band approaching the rolls **81, 83** is much flatter, smoother, and more free of random splits when our novel tow-gripping mechanism **9** is employed.

By the use of the ball bearing slide arrangement, the roll **31** is maintained in parallel alignment with roll **32**

at all times despite vibrations and stresses resulting from high speed operation; its axis can move freely (in a fixed path in such parallel alignment), against the pressure exerted by the diaphragm device, in response to the forces accompanying such operation. When this ball bearing slide arrangement is used with rolls of low inertia, which respond quickly to changes in the tension in the tow, particularly good results are obtained.

It is within the broader aspects of this invention to use patterned-surface rolls having other configurations, such as the specific configurations illustrated in U.S. Patent 3,255,506, in the differential gripping device.

The banding jets **4** and **17** may be of well known type, in which the tow passes between a pair of spaced parallel plates (placed, for example, $\frac{1}{10}$ inch apart), one or both of which have a plurality of slots leading from a compressed air plenum chamber, so that streams of air are blown at the tow through the slots. The degree of uniformity of the filter rod may be gauged, as the machine is running, by observing the variability of the width of the tow band leaving the second banding jet; this variability is much lower when the tow-gripping mechanism of the present invention is used.

In the plasticizer applying device **18**, the plasticizer may be delivered by means of a conventional spray head, but more preferably by means of a plurality of rapidly whirling disks which centrifugally project fine droplets of the plasticizer onto both sides of the tow band.

A plasticizer, when employed, will be selected, of course, according to the nature of the filaments. When the preferred cellulose acetate filaments are used, the plasticizer may be triethyl citrate, dimethoxy ethyl phthalate, or methyl phthalyl ethyl glycoate among others; desirably, however, glycerol triacetate (triacetin) is employed. Ordinarily, about 2 to 30% by weight of the plasticizer—and preferably about 4 to 15%—will be applied to the filaments.

For the manufacture of cigarette filter tips for use in cigarettes of conventional cross section (i.e. cigarettes having a periphery of about 25 to 26 mm.) the denier per filament will range from about 1 to 50 and preferably from about 1½ to 16, and the total denier of the tow supplied will range from about 20,000 to 160,000, and preferably from about 20,000 to 80,000. The number of crimps per inch will generally be in the range of about 4 to 20, e.g. about 12 to 16.

While the invention finds its greatest utility in the manufacture of cigarette filter rods, it may also be employed in the manufacture of other articles from deregistered crimped tows, e.g. in processes in which a deregistered tow of, say, polyethylene terephthalate filaments, is spread to a wide width (e.g. 3 or 4 feet or more) and then cross-lapped to form a batting material which may be used, for example, for the stuffing of pillows.

The filaments of the tow may be made of an organic derivative of cellulose including, particularly, cellulose esters such as the preferred secondary cellulose acetate (e.g. containing about 2½ acetyl groups per anhydroglucose unit), as well as cellulose triacetate, cellulose propionate, cellulose acetate propionate, and other cellulose organic acid esters or ethers. Other filamentary materials which may be used include rayon (regenerated cellulose), and filaments of linear superpolyamides such as nylon-6 and nylon-66, linear polyesters (e.g. polyethylene terephthalate), polyolefins (e.g. polypropylene or polyethylene), acrylics (e.g. polyacrylonitrile and known acrylic fibers comprising copolymers of high acrylonitrile content), oxymethylene polymers, polyvinyl chloride (including vinyl chloride copolymers), polyvinylidene chloride (including vinylidene chloride copolymers), nitrile fibers (e.g. vinylidene cyanide-vinyl acetate copolymers), etc.

It is to be understood that the foregoing detailed description is given merely by way of illustration, and that variations may be made therein without departing from the spirit of the invention.

What is claimed is:

1. In an apparatus for the manufacture of cigarette filter tip rods by passing a crimped multifilament tow having crimps in registry through a banding jet, a differential gripping device for deregistering the crimps and for moving said tow longitudinally, and a rod-making machine having a condensing trumpet and garniture, the improvement comprising tow-gripping means in the path of the tow just upstream of the differential gripping device, said tow-gripping means having a first elongated low inertia roll and a second elongated low inertia roll, said first and second rolls being mounted for free rotation, being adapted to engage opposite sides of said tow and to be rotated by the movement of said tow, and having smooth, cylindrical tow-engaging surfaces, a stationary mounting for the first roll, a movable rigid mounting for the second roll, said movable mounting comprising a member carrying spaced bearings at its ends for rotatably supporting said second roll, means for resiliently urging said movable mounting with a predetermined force in a direction to press said second roll toward the first roll, guide means for constraining said movable mounting to maintain said first and second rolls parallel while said second roll is urged toward said first roll, said guide means including guide rods secured to said member and projecting from said ends, in a direction perpendicular to said rolls, and stationary bushings for receiving said guide rods, each of said bushings carrying a plurality of circuits of recirculating ball bearings, said urging means having an air chamber supplied with compressed air and a diaphragm forming a wall of said chamber and operatively connected to said movable mounting, said differential gripping device having a patterned-surface roll.

2. The apparatus of claim **1** wherein said rolls each have a diameter less than about 2 inches and a weight less than about 5 pounds.

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DORSEY NEWTON, Primary Examiner

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