March 1, 1960 W. T. JACKSON 2,926,392

METHOD AND APPARATUS FOR OPENING CRIMPED TOW

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Fig. 1

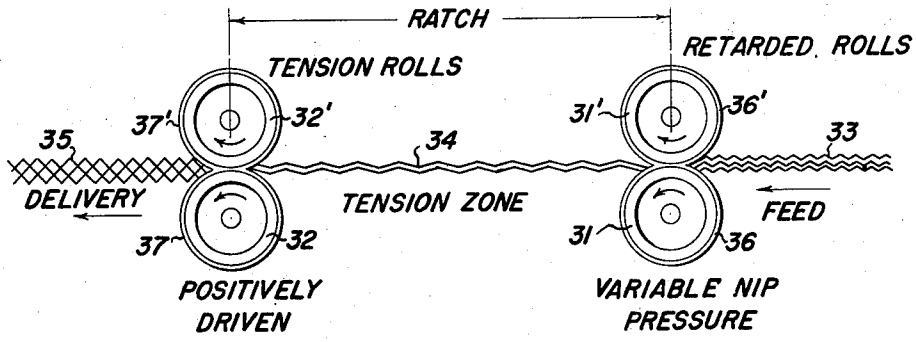


Fig. 2

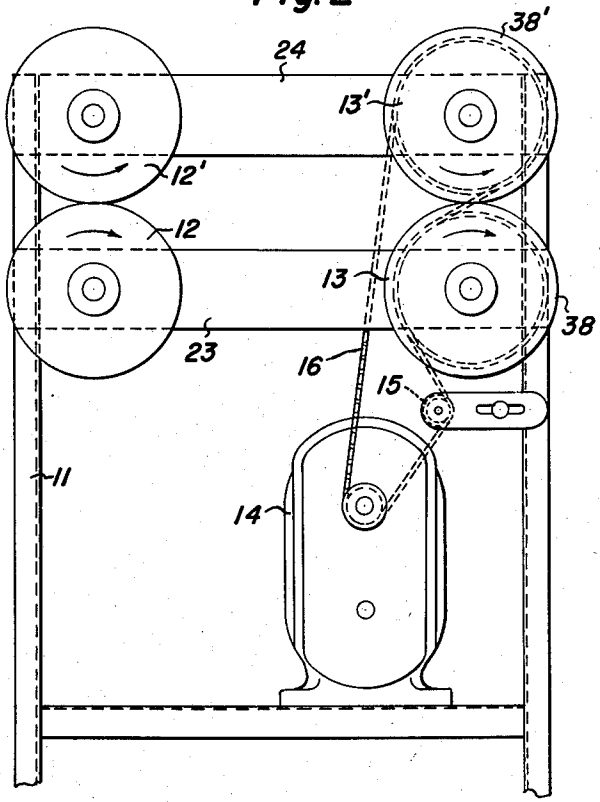
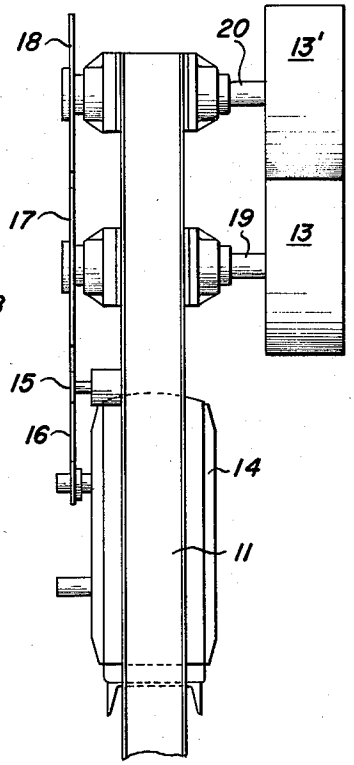


Fig. 3



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Fig. 4

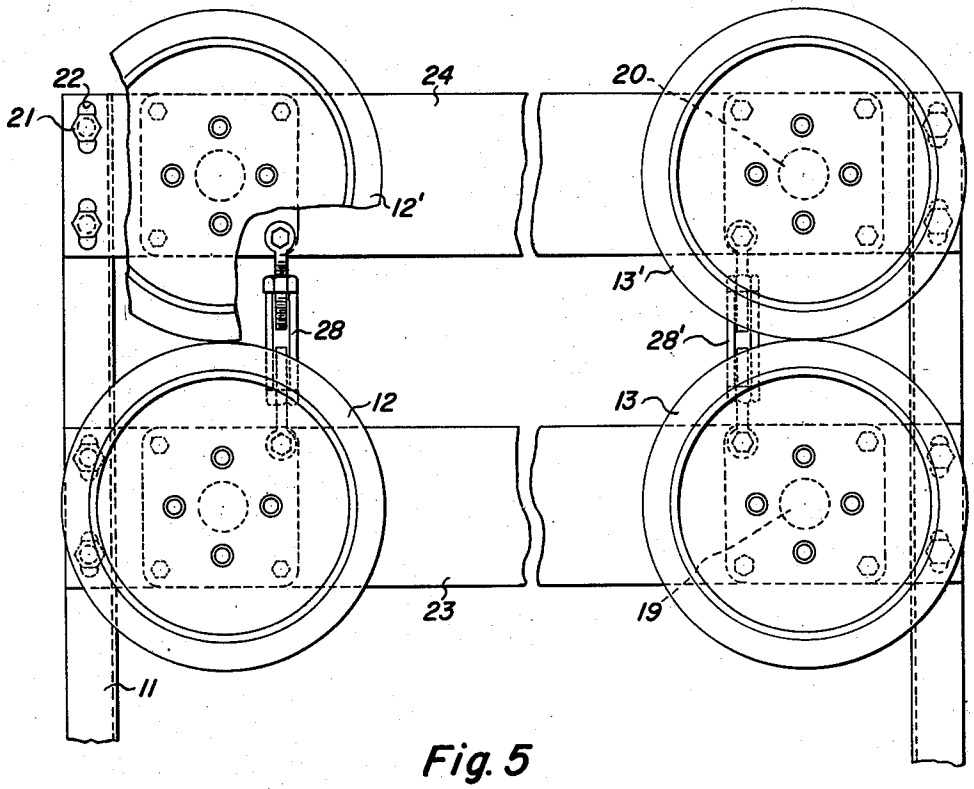
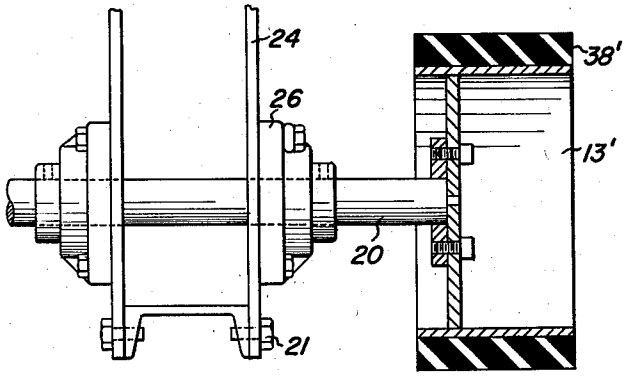


Fig. 5



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METHOD AND APPARATUS FOR OPENING CRIMPED TOW

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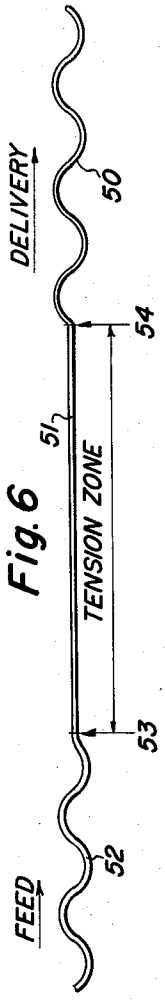


Fig. 6

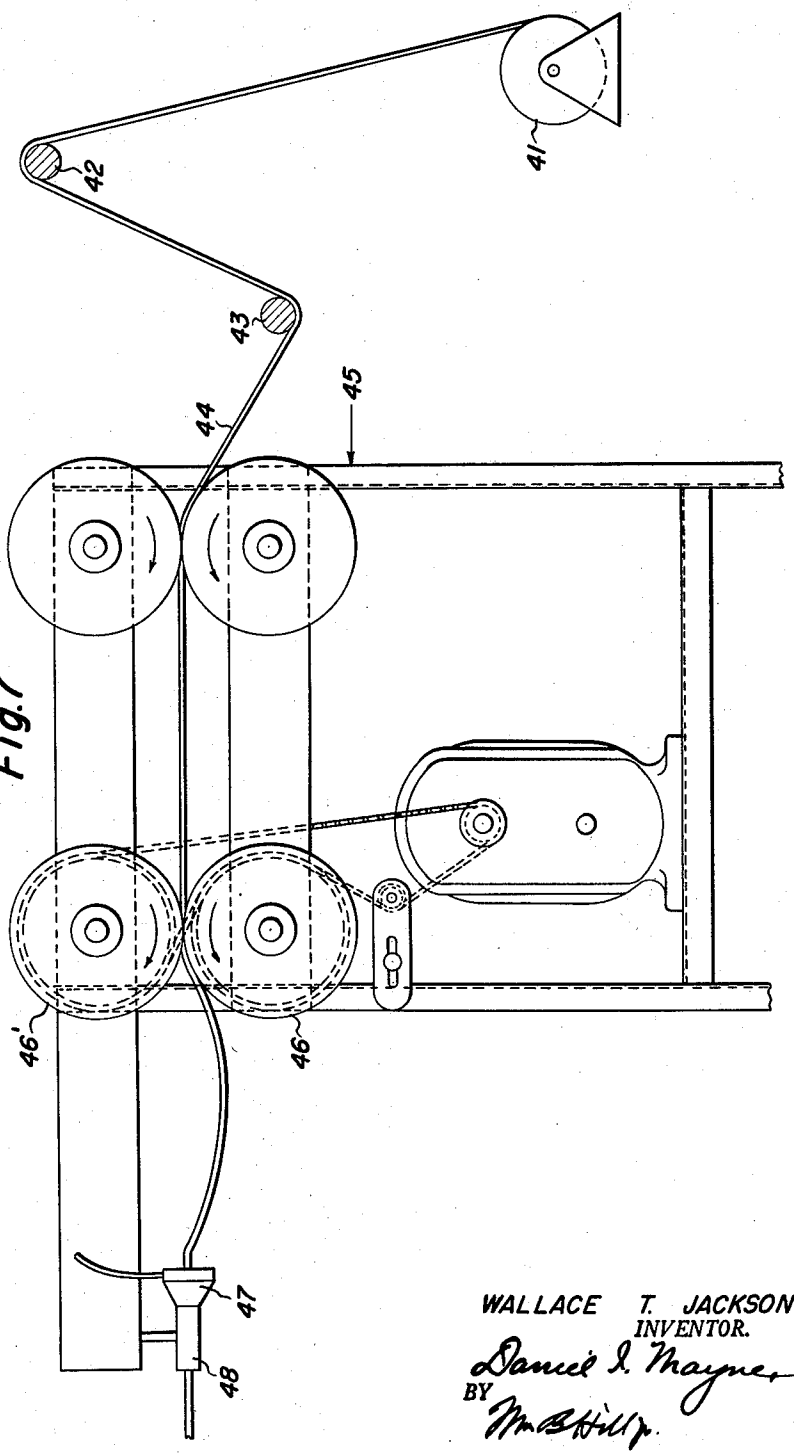


Fig. 7

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2,926,392

METHOD AND APPARATUS FOR OPENING CRIMPED TOW

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Application January 11, 1954, Serial No. 403,131

2 Claims. (Cl. 19—66)

The present invention relates to the improvement of continuous filament tow. More particularly, the invention is concerned with opening of tow to increase the cross-sectional area of the tow and the uniformity of fiber distribution within the tow and to remove shiners, married fibers and concentrated bundles of filaments within the tow.

In the handling and treatment of tow, difficulties are experienced due to the fact that generally the filaments occur in small bundles, i.e. they are accumulated into bundles easily identifiable as such within the tow itself. Also, many of the filaments tend to adhere to adjacent filaments causing a condition variously termed "shiners," and "married fibers." To facilitate the working of the fibrous material in the tow, either before or after it has been converted into staple fiber, it is desirable to remove shiners, that is, to separate adhering fibers, in order to increase the openness of the tow and of staple formed therefrom. It is also often sought to increase the openness or bulk of the tow by disintegration of smaller groups or bundles of filaments therein and by enlargement of the cross-sectional area of the tow. That is to say, it is often desired to achieve enlargement of tow diameter and increase in uniformity of fiber distribution in the tow.

I have found a method and apparatus which provides for a continuous opening operation on a longitudinally moving crimped continuous filament tow. My invention takes advantage of the inherent springiness of crimped tow and its ability, when stretched into a condition in which the crimps are substantially straightened out, to retract or spring back to its original length, and the invention is specific to tow having this characteristic in the absence of any substantial tendency toward permanent elongation of the filaments themselves.

Therefore, it is an object of my invention to provide a method and means for continuously operating on a longitudinally moving essentially non-stretchable crimped continuous filament tow to open the tow, increase the bulk and uniformity of fiber distribution thereof, and to remove adhered shiners and married filaments from the tow. The operation in accordance with my invention sometimes is referred to as "blooming," and the invention thus has as additional objects the provision of means for producing a bloomed tow and an improved openness of staple fiber prepared therefrom. A further object is to provide a tow treatment which reduces the tangles in the tow and results in a condition making the tow more suitable for subsequent processing in various types of converters, drafters and the like. Still another object is to provide means for the opening of tow in connection with conditioning of the tow for conversion into tobacco smoke filter elements of the type disclosed in copending U.S. patent applications of Crawford and Stevens, Serial No. 324,342, filed December 5, 1952, now U.S. Patent No. 2,794,239, and Serial No. 374,168, filed August 13, 1953, now U.S. Patent No. 2,794,480.

Other objects will be obvious from the accompanying specification and claims.

In accordance with my invention a longitudinally moving tow of crimped continuous filaments is subjected to a continuous longitudinal tension at one zone in the path of its movement and the tension is suddenly released in an immediately adjacent zone downstream of the tension zone. In a most advantageous embodiment of the invention, an apparatus for continuously opening a crimped continuous filament tow comprises two cooperating pairs of rolls positioned to form a path for longitudinally moving tow, one pair of the rolls being downstream of the other, the downstream rolls being positively driven tension rolls for exerting a pulling force on the tow, and the upstream rolls being retarded rolls adapted to exert a holding back effect on the tow against the pulling force of the tension rolls.

The invention is illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of the functioning of the invention on a crimped tow,

Fig. 2 is a side elevation of an apparatus of the invention,

Fig. 3 is an end elevation of the apparatus shown in Fig. 2,

Fig. 4 is an enlarged and detailed side elevation, in part cut away, showing means for mounting the rolls,

Fig. 5 is a plan view, partly in section, showing mounting details of a single roll,

Fig. 6 is a diagrammatic representation of the change in condition of a single filament in a tow being conditioned by means of the invention, and

Fig. 7 is a diagrammatic representation of means for using an air aspirator to provide proper tension adjacent the tension zone, i.e. at the discharge of the tension rolls.

With reference to the drawings, Fig. 1 shows a crimped continuous filament tow **33** being put under tension in a tension zone formed between the bite of rolls **31**, **31'** and the bite of rolls **32**, **32'**, the two spaced pairs of rolls forming a path for longitudinal movement of the tow. In accordance with the invention sufficient tension is placed on the tow in the tension zone to substantially straighten out the crimp in the filaments of the tow and produce a condition in the tow as indicated at **34**. While the tow is temporarily "stretched," the filaments undergo no permanent stretch or elongation. The proper tension in the tension zone, i.e. the ratch between the roll pairs, is created by the pull of the front rolls **32** and **32'**, which are positively driven tension rolls, in tending to overcome the retarding force on the tow created by the back rolls **31** and **31'** which are retarded rolls. The back rolls may be retarded in any suitable manner and thus may be positively driven at a slower rate than the front rolls, but preferably the retarded rolls are under the influence of a frictional braking effect.

As illustrated, all the rolls preferably are equipped with deformable elastic surfaces **36**, **36'** and **37**, **37'** which provide a sufficient bite on the tow to avoid slippage. The retarded rolls **31**—**31'** preferably are so spaced that the deformation of the elastic surfaces **36** and **36'** requires just sufficient work to provide the proper retarding or holding back force on the tow to produce the desired amount of tension in the tension zone. As illustrated in Fig. 1, tow delivered from the bite of the tension rolls **32**—**32'** automatically opens and blooms under forces inherent in the tow to provide an increased bulk, i.e. enlargement of the diameter of the tow. The operation also results in the breaking up of separate fiber bundles within the tow and improvement in the uniformity of cross-sectional fiber distribution.

The invention is further illustrated in Fig. 2 in which the apparatus comprises a frame 11 supporting a pair of retarded rolls 12, 12' forming a bite therebetween and a pair of driven tension rolls 13—13'. The tension rolls are powered to turn in opposite directions by means of a chain 16 engaged on sprockets of a prime mover 14, idler 15 and sprockets 17 and 18 keyed to shafts 19 and 20 on which are mounted the rolls 13 and 13' respectively.

The rolls are mounted for variable positioning so that the pressure of the bite between the rolls of each pair may be varied. This allows for change to accommodate tows of varying size in the bite of both pairs of rolls. It is even more important in the case of the retarded rolls since it allows variation in the amount of friction which must be overcome in order to turn the retarded rolls, thereby facilitating control of the amount of tension to be applied to the tow in the tension zone. That is, the amount of pulling force exerted on the tow by the tension rolls to overcome the opposing force of the retarded rolls and to move the tow through the tension zone is adjusted as desired.

As illustrated in Fig. 4, the frame 11 includes a horizontal mounting member 23 supporting the two lower rolls 12 and 13 and a horizontal mounting member 24 supporting the two upper rolls 12' and 13'. The horizontal members are vertically adjustable relative to each other through relative positioning of bolts, e.g. 21 and elongated slots, e.g. 22. Proper degree of movement of the horizontal members when the bolts, e.g. 21 are loosened is achieved through manipulation of turnbuckles 28 and 28'. A resilient, elastic roll surface as shown more clearly in the enlarged detail of Fig. 5 as 38', allows for a considerable amount of relative positioning of the two rolls of each pair. The individual rolls may be mounted in any suitable way such as is illustrated in Fig. 5 wherein roll 13' is shown as secured to shaft 20 journaled in housing 26 which is fixed to horizontal member 24.

In Fig. 6 the functioning of the invention is shown in terms of change in character of a single filament. The filament in its normally crimped condition (52) is straightened into the form 51 in the tension zone indicated between the arrows 53 and 54. When the filament emerges from the tension zone into a zone of substantially reduced or relatively little tension, it retracts or springs back to its original length and crimped condition as indicated at 50. In so doing, the filament exerts forces radial to the axis of its path. When acting in concert with closely adjacent and contiguous filaments, the action in springing back is emphasized and exaggerated and the cumulative effect of the forces exerted by each filament acting upon the others surrounding it is what might be described as an "explosive" blooming action.

Obviously it is a requisite to proper practice of the invention that a condition of substantially reduced tension be maintained within the tow in the zone immediately adjacent to the tension zone, i.e. at the discharge from the tension rolls. The zone of reduced tension may be aptly described as a "relaxation" zone. In other words, the tow, after tensioning, is suddenly released from substantially all tension in order that the inherent elastic forces in the filament of the tow may manifest themselves.

Any suitable means may be used for moving the tow away from the tension zone through the relaxation zone, for example, rolls driven at the same speed as the retarded rolls. Obviously, some slack should be maintained in the tow in the relaxation zone. A preferred means for maintaining relatively reduced tension on the tow in the relaxation zone immediately downstream of the bite of the tension rolls is an air jet tow mover operating on the principle of aspiration. Such an element is illustrated in the combination of Fig. 7 in which a tow 44 is shown being pulled from a ball warp 41 on which it is initially wound. From the ball warp the tow is led over guides 42 and 43, thence into a tensioning device indicated generally by the numeral 45. The tow is delivered from the tension zone at the discharge of tension rolls 46—46' into an immediately adjacent relaxation zone in which the tow is under relatively less tension. Tension applied in the relaxation zone is maintained at a low value, normally only as much tension as is necessary to move the tow away from the tension zone as it is delivered from the bite of the rolls 46—46'. This is done with an aspirator 47 such as is well known in the art. As illustrated, the aspirator 47 comprises a tube having a tapered inlet for the tow and provided with an annular air nozzle surrounding the tow and arranged to deliver air into the tube 48 in the direction of tow movement under a predetermined pressure and velocity.

Since the size of the filaments in the tow, the number of crimps initially present in each filament, and the total number of filaments in the tow may be widely varied, it will be understood that the conditions under which the method and apparatus of the invention are operated may likewise be varied within relatively flexible limits. Normally a tension of 20 to 250 pounds may be developed in the tension zone using rolls about 10.5 inches in diameter. Obviously, the tension should be sufficient to temporarily remove substantially all kinks and crimps from most of the filaments in the tow, but should not be so great that any or at least a substantial number of filaments will be broken under the strain.

The elastic surfaces of the rolls may be a natural rubber compound of a 50–55 durometer. The exact spacing between the pairs of rolls is not important but conveniently may be approximately 2½ to 3½ times the roll diameter. When the equipment is functioning properly, the speed of movement of the tow is not important, and good results normally may be obtained with a linear speed of 150 to 1700 feet per minute. The spacing of the two cooperating rolls comprising the pair of driven tension rolls for most conditions will be proper when in the absence of a tow between the rolls the elastic surfaces are just tangent to each other. Somewhat closer spacing between the rolls of the cooperating pair of retarded rolls generally is necessary so that some deformation of the elastic surfaces is had even before the tow is run through the bite of the rolls.

The prime mover employed for driving the tension rolls may be a variable speed motor or any other suitable apparatus such as a variable speed transmission receiving power from a motor located elsewhere. If the retarded rolls are positively driven, they may be geared to a separate prime mover or may receive their power in a stepped-down speed ratio from a prime mover common to the drive of the tension rolls. While preferred apparatus embodiments have been specifically disclosed, it is apparent that certain changes in the nature of the tension zone and retarding rolls will be possible. For example, the tension zone illustrated in Fig. 7 may be lengthened to include the ball warp if the latter is re-retarded in unwinding. That is to say, the function of the retarded rolls may be supplied by other means for retarding movement of tow under tension of the driven tension rolls. If the ball warp is by means known in the art braked or positively driven at a slower rate than the tension rolls, it becomes a means for retarding longitudinal movement of the tow against the pulling force of the tension rolls and in this event the retarded ball warp may completely replace the retarded rolls.

The invention is illustrated in the following examples.

Example 1

A cellulose acetate tow of 5 denier per filament and 200,000 total denier was formed in the normal way by spinning and crimping with a normal crimp of e.g. 7.0

crimps per inch. After passing from the crimper through a tow dryer, the tow was sent through an arrangement of tension rolls and retarded rolls as described above, thence to a ball warper for winding to a shipping package. The retarded rolls were driven at a surface speed 99.5% of the surface speed of the tension rolls. The stretching and relaxing imparted by the tension rolls broke up the married fibers and shiners so that a better product was obtained from this tow after conversion to a textile sliver by means of a converter and pin drafter.

Example 2

A cellulose acetate tow of 3 denier per filament and 120,000 total denier was formed in the normal way by spinning and crimping with a crimp of 7.5 crimps per inch. After passing from the crimper through a tow dryer, it was sent through a set of tension rolls and braked retarded rolls as described above at 1400 feet per minute, thence to a cutter for conversion into staple form, and finally to a baler for packaging for shipment. The stretching and relaxing imparted by the draw rolls broke up the married fibers and shiners so that the final opening performed at the cutter was improved. The end result was a staple with good opening quality and a reduced number of neps and tangles. The product product produced a cleaner, more uniform yarn.

Example 3

A cellulose acetate tow of 5 denier per filament and 100,000 total denier was spun with a special pharmaceutical grade mineral oil and crimped to a high crimp of 9.0 crimps per inch. It was wound into a ball warp package, which package subsequently served as a supply for a cigarette filter making machine. The tow was run from the ball warp through the filter making machine including a tension roll and braked retarded roll device as shown in the drawings. The stretch-relaxing action of the tension rolls bloomed the tow to such an extent that an air banding jet was able to maintain a very uniform band of tow. The combination of draw rolls and banding jet enabled a band of substantially separated individual filaments to be presented to plasticizer sprays without the presence of shiners or groups of filaments. This greatly improved the uniformity of plasticizer application and consequently the uniformity of the completed filter.

From the foregoing examples it will be appreciated that the precise character of the tow is unimportant, and it is contemplated that the invention will be useful with tows generally which may be defined as material resulting when filaments spun from a plurality of spinnerette holes are brought together and combined, preferably with filaments from other spinnerettes to form a strand or bundle of e.g. 500–5,000,000 parallel filaments. The filaments may be of various sizes, e.g. 1.0 to 50 denier, and

the nature of the invention is such that its efficiency increases with increased tow density and compactness.

Thus it will be understood that the invention will be operative with any crimped tow which has the described requisite inherent properties of extensibility under fairly strong tension without excessive filament breakage or substantial permanent filament elongation, and the invention may be practiced on suitable tows of cellulose acetate, saponified cellulose acetate, regenerated cellulose, acrylic fiber, polyester polyamide, or protein type fibers.

The operating range of crimp will vary with the type fiber and its denier per filament. For instance, with a cellulose acetate tow of 2 D./F. the crimp would be in the order of 12 to 14 crimps per inch; for 10 D./F. 7 to 8 crimps per inch; and for 50 D./F., 3 to 4 crimps per inch.

I claim:

1. A method for continuously opening a longitudinally moving crimped tow of continuous filaments comprising (1) continuously applying to the moving tow at a point in its path of movement a force tending to retard movement of the tow longitudinally while simultaneously longitudinally moving the tow away from the point of retardation by means of a force opposing and overcoming the retardation, thereby placing the tow under tension, the tension being sufficient to substantially straighten the crimped tow, and (2) continuously passing the tensioned and straightened tow into a zone of substantially less tension thereby providing for sudden relaxation of the tow whereby the inherent elasticity of its crimped fibers results in blooming of the tow.

2. Method for use in continuously opening crimped continuous filament tow comprising the steps of moving the tow longitudinally into, across, and out of a tension zone, applying a longitudinal stretching tension to the tow while it is in the tension zone, the stretching tension being sufficient to temporarily remove the crimps from and substantially straighten the tow but insufficient to cause any substantial breaking of filaments of the tow, and finally suddenly releasing substantially all tension from the tow by discharging the tow from the tension zone whereby inherent elastic forces in the filaments of the tow manifest themselves, upon return of the crimped condition of the tow, in a uniform enlargement of the diameter and periphery of the tow bundle.

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