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PROCESS AND APPARATUS FOR TREATING ARTIFICIAL FILAMENTS

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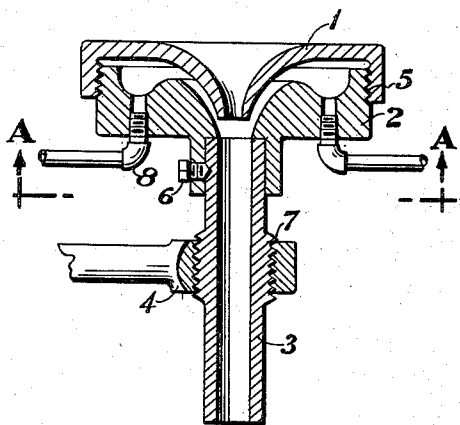


Fig. 1

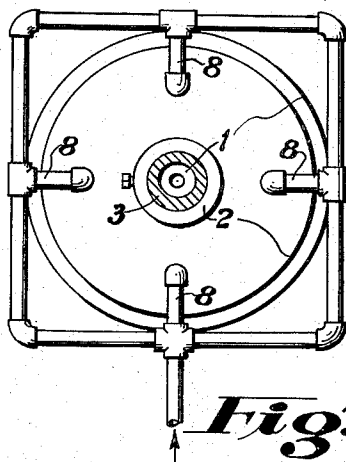


Fig. 2

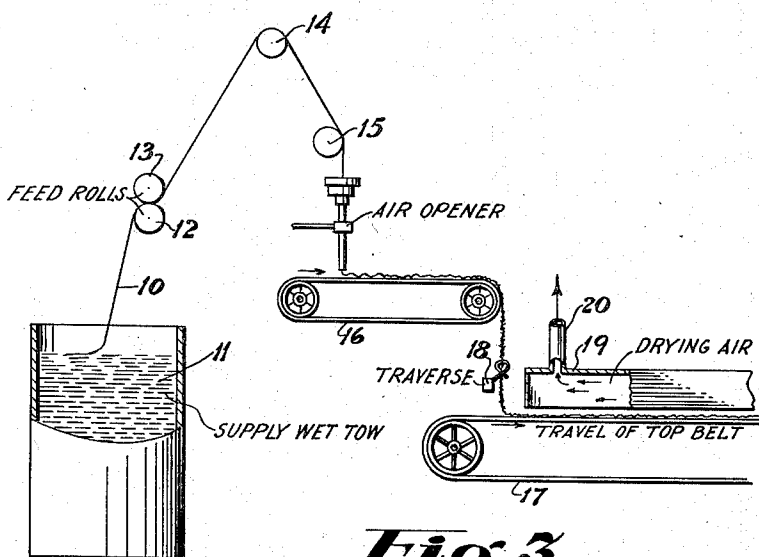


Fig. 3

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PROCESS AND APPARATUS FOR TREATING
ARTIFICIAL FILAMENTS

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10 Claims. (Cl. 34—12)

This invention is concerned with the opening of a relatively compact bundle or tow of continuous artificial filaments.

Continuous filament tow produced by the viscose process according to known methods possesses certain inherent disadvantages. The dried tow is very compact, that is, the filaments adhere tightly to each other and this compact material cannot subsequently be converted to a useful textile article without being subjected first to drastic and expensive opening treatments such as scutching, picking or carding.

It is desirable also that the continuous filament tow be given a satisfactory crimp. However, to impart a crimp to the filaments, whether in the gel or dry state, requires special treatment which, in general, imparts an inferior crimp and which, furthermore, tends to pack the filaments tightly together, necessitating an opening treatment to separate the fibers.

Continuous filament tow has the further disadvantage that, when dried under tension, for example, after having been wound on a core, the filaments of the tow have low elongation and high residual shrinkage. Also, the tow cannot be directly converted into a top, as by a drawing treatment involving breaking of the filaments into staple lengths since, due to the compactness of the filament bundles, the drafting of the bundle is non-uniform and the filaments do not overlap properly to give the desired uniformity of fiber cohesion needed to produce good quality staple yarn.

The development of a method for producing gel regenerated cellulose continuous filament tow in which the filaments do not adhere to each other and have the desired physical properties represents a great benefit to the industry since such material can be directly converted to top, thereby eliminating the expensive steps of stretching, carding, picking and otherwise opening the dried tow of continuous filaments preparatory to conversion into a suitable top.

An object of this invention pertains to a novel method and means of opening relatively large and relatively compact bundles of continuous filaments. A further object is concerned with the opening of such bundles, while they still contain a substantial amount of moisture, and drying the bundle of separated filaments under such conditions as to impart to the filaments a desirable curl, crimp or crinkle. An additional object relates to the production of tow comprising separated and non-adherent continuous filaments having an increased elongation prior to breaking

and a decreased residual shrinkage. Other objects will be apparent from the following description.

The objects of the invention are, in general, attained by passing a tow of continuous filaments containing a substantial amount of moisture and adhering closely to each other, at a regulated speed, through a confining tube, while simultaneously introducing into said tube a gas under pressure, maintaining the contact of gas and filaments through a path sufficiently long to permit an adequate distribution of the gas throughout the mass of the filaments and ejecting the filaments with simultaneous expansion of the gas due to a rapid decrease in pressure so as to fluff out and separate the filaments, and impinging the filaments against a surface adjacent the point of ejection from the tube.

The invention will be more fully comprehended by reference to the accompanying drawing, of which:

Figure 1 is a cross-sectional elevation of a preferred form of jet opener;

Figure 2 is a view taken along the line A—A of Figure 1; and

Figure 3 is a diagrammatic showing of a suitable arrangement for feeding, opening and conveying continuous filament tow in accordance with the invention.

Referring to Figures 1 and 2, the jet opener comprises a trumpet-like, or inwardly flared element 1, adjustably fastened by a screw thread connection 5 to a supporting element 2, the screw connection permitting an adjustment in the spacing of elements 1 and 2 so as to vary the space for fluid passage formed therebetween. Air or other readily expansible fluid is introduced through pipes 8 under suitable pressure into this space formed between members 1 and 2. Any number of air inlets may be provided, for instance one, two, three, four or more, but it has been found desirable to introduce air into this space at multiple points, and in the instant case, four inlets have been provided as shown. The upper portion of the assembly is fastened to a tail pipe 3 of uniform diameter throughout its length by means of a set screw 6 tapped through the lower annulus of member 2 and the entire assembly is adjustably supported on a fixed arm 4 by means of a screw connection 7.

Referring to Figure 3, gel regenerated cellulose tow 10 is drawn from a supply container 11 by means of positively driven feed rolls 12 and 13 rotating at a predetermined, constant speed. The tow then travels over guide rolls 14 and 15,

also positively rotated, preferably at the same or somewhat greater surface speed than that of feed rolls 12 and 13, and the tow is given a substantial, free travel between rolls 12 and 13 and the jet opener so as to permit any temporary or false twist that may be present in the tow to run out before delivering it to the jet opener. The tow then passes into the trumpet 1 of the jet opener and air or other suitable gas, under substantial pressure, is introduced into the opener through pipes 8. The air and tow are both ejected against a belt 16, traveling in the direction indicated by the arrow (although a stationary belt or other surface could be used if desired), the belt 16 being positioned relatively close to the point of ejection from tube 3 for optimum results. It is preferred that a moving belt 16 be used since the speed of such a belt can be regulated, for example, to 60% to 90% of the peripheral speed of feed rolls 12 and 13 in order to initiate drying of the opened tow in a relaxed condition. The tow of opened and relaxed filaments is preferably only partially dried on belt 16 which is relatively short, and is then distributed on to a second slowly traveling belt 17, being traversed across the belt by means of any suitable traverse mechanism 18. The second traveling belt 17 passes through a tunnel drier 19 or other suitable drier supplied with drying air which passes counter-current to the travel of the material being dried and is exhausted through a vent 20. The tow is laid down crosswise on the belt 18 in order that it may remain in a relaxed state throughout the drying period.

The following specific example describes a preferred mode of applying the invention and is intended to be illustrative rather than limitative:

Example

A tow of regenerated cellulose continuous filaments produced by the viscose process and comprised of 46,500 filaments, each filament being about 5.5 denier after washing and desulfuring, is passed through the jet opener in the manner described above. The tow, as it is drawn from the supply can 11 may contain about 160% moisture based on its dry weight. The feed rolls 12 and 13 are adjusted to draw the tow from the can, and at the same time, to hold the tow back against advancement due to the action of the air jet in the opener, at a peripheral speed of 30 feet per minute. From the feed rolls, the tow travels about 20 feet to the upper guide roll 14 to insure the removal of any false twist that might be contained in the tow. For this size tow which is a little over 255,000 denier, a trumpet is used having a minimum diameter at the discharge point of $\frac{3}{8}$ inch, the inside diameter of the tail pipe 3 being $\frac{1}{2}$ inch. Compressed air is fed into the opener through the pipes 8 under a gauge pressure of between 30 and 40 pounds per square inch. The exit end of the tail pipe is spaced 4 inches from the upper surface of a slowly moving belt 16. The speed of this belt is adjusted to 25 feet per minute which is about 84% of the peripheral speed of the feed rolls. After a travel on this belt of a few feet, the tow is discharged through a suitable traversing guide where it is laid back and forth across the upper surface of the drying belt 17 which is advanced through the tunnel air drier 20 at the rate of about 3 feet per minute. The dry tow of continuous filament obtained at the other end of the drier is voluminous and woolly and each filament

thereof is substantially free and without any substantial adherence to adjacent filaments. Each of the filaments have a slight curl or crinkle due to the expansion of the gas that took place on its ejection from the opener and due to the slower take-up and subsequent drying substantially free of tension. A certain amount of shrinkage has also taken place and the filaments have considerably higher breaking elongation as well as considerably less residual shrinkage as compared to similar filaments that have been dried without passing through the opener.

If more intense crinkle is desired, the speed of the take-up surface at the discharge end of the opener may be slowed down so that it is but 70% or even 60% or less that of the feed roll speed. Together with the increased intensity of the crinkle, elongation of the filaments will be increased still further and residual shrinkage of the filaments will be lowered an additional amount. If substantially no crinkles are desired, the speed of the take-up surface at the opener with respect to the rate of feed of tow may be as much as 90% or even more, but if this speed is substantially above 90% of the feed speed, the filaments will not have sufficient opportunity to relax and thus gain improved properties and the voluminosity and openness of the dried tow may also be somewhat reduced.

With other size tows, the area of the trumpet opening and of the tail pipe opening of the opener should be changed in size substantially in proportion to the change in cross-sectional area of the tow. The air pressure on the air feed lines of the opener may be used over a fairly wide range of pressures, such as from 20 pounds up to 100 pounds per square inch (gauge pressure) with good results. As has previously been stated, the distance of the collector from the opener should not be too great and preferably, this distance should be in the range of from 2 to 8 inches.

Without any intention of being limited or restricted by this explanation, the following is given to provide a better understanding of the invention. It is believed undesirable to have any excessive amount of air flow through the confining tube. It is not the velocity of the air through the tube that is believed to effect the crinkling and opening of the structure, but rather the compression of the gel structure in the tube due to the presence of the gas in, around and between the numerous filaments under substantial pressure which forms numerous gas pockets and when discharged, immediately expand to "explode" the filaments apart. Accordingly, it is believed desirable to have the cross-sectional area of the tail pipe of the opener no more than about 20% greater than the uncompressed cross-sectional area of the wet tow. In some cases, the inside diameter of the tail pipe may even be substantially equal to the uncompressed average diameter of the wet tow. If the cross-sectional areas are substantially the same, the air pressure within the opener will compact the tow somewhat and, protected by compressed air layers from undesirable frictional contact with the tube, the tow will pass through satisfactorily. The opening must not be too small however for if the resistance to the passage of the tow becomes too great, then a poor opening of the tow may result because the air pockets are insufficient to properly expand the tow at the point of its discharge, or the tow may jam in the tube and even fail to pass through at all. This optimum relationship between the size of the tow and the size of the

opening in the tail pipe, as well as the opening in the trumpet, can best be determined experimentally.

While this invention has been described in terms of air as the readily expansible fluid medium for opening the tow, other gases and even vapors in some instances may be used with good results. It may be considered desirable in some cases to impregnate the filaments simultaneously with opening, in which case impregnating materials in the form of a gas or vapor, or mixed with a gas or vapor may be used. Dry or superheated steam may be found advantageous under certain conditions. Again, the air may be heated so as to effect a substantial drying of the filaments simultaneously with the opening and crimping thereof.

Although the preferred method of drying the opened tow has been described above, it is to be understood that any other suitable method of drying may be used. For example, the initial collecting surface, illustrated by traveling belt 16, can be of a length sufficient to permit complete drying of the filaments. It is preferred, in order to attain the most satisfactory results, that drying be effected while the tow is substantially free of tension. Another way of accomplishing this result being to festoon the opened tow over a series of rods while contacting it with any proper drying medium.

The invention has its greatest value in the treatment of continuous filament tow produced by the viscose process, while it is in the gel state, i. e. while it contains at least 25% moisture although the moisture content may be as high as 300% or somewhat more, based on the bone dry weight of the regenerated cellulose. However, the invention is also applicable to the treatment of gel continuous filament tow having a similar moisture content and produced by other processes, e. g. regenerated cellulose produced by the cuprammonium cellulose process, cellulose esters and ethers containing a low degree of substitution, i. e. $\frac{1}{4}$ to $\frac{3}{4}$ mols of substitution per mol of cellulose, casein or other similar fibers produced by the wet spinning process.

By the practice of this invention, it is not only possible to produce a well opened tow of continuous filaments, but additionally, the filaments have also attained a desirable curl, crimp or crinkle which makes the product eminently suited for direct conversion into top or other similar fibrous structures by known methods. Thus, it is possible to accomplish in a single step that which has not heretofore been satisfactorily accomplished in two or more steps. In addition, the dried continuous filaments produced in accordance with this invention have much more desirable properties in the way of increased elongation and lower residual shrinkage.

The gel continuous filament tow treated in accordance with the present invention is composed of a large number of filaments and has a large total denier. Generally speaking, such a tow will be of the order of 100,000 to 300,000 denier, more or less, and will have 25,000 to 50,000 filaments, more or less.

I claim:

1. A process which comprises subjecting a compact bundle of continuous filaments to contact with a gas under pressure in an elongated, confined zone having a cross-sectional area no more than about 20% greater than the uncompressed cross-sectional area of the compact bundle, passing said filaments and said gas into a second zone

having a pressure considerably lower than that of the first-named zone so as to obtain a rapid expansion of said gas and separation of said filaments.

2. A process which comprises subjecting a compact bundle of continuous filaments to contact with a gas under pressure in an elongated, confined zone having a cross-sectional area no more than about 20% greater than the uncompressed cross-sectional area of the compact bundle, passing said filaments and said gas into a second zone having a pressure considerably lower than that of the first-named zone so as to obtain a rapid expansion of said gas and separation of said filaments, and impinging said bundle of separated filaments on to a surface disposed in relatively close proximity to the end of said first-named zone.

3. Apparatus for the opening of compact bundles of continuous filaments comprising a confining tube having a cross-sectional area not more than about 20% greater than the uncompressed cross-sectional area of said compact bundles, means for introducing into said tube a compact bundle of continuous filaments at a controlled rate, means for introducing into said tube a gaseous fluid under pressure, said tube being open at one end to permit the exit of said gas and said filaments whereby to effect rapid expansion of said gas and said bundle when subjected to lower pressure conditions outside of said tube, a collecting member adjacent said tube for receiving said filaments, and means for moving said collecting member across the path of said filaments issuing from said tube.

4. Apparatus for the opening of wet, compact bundles of continuous filaments comprising a confining tube, means for introducing into said tube a compact bundle of continuous filaments at a controlled rate, means for introducing into said tube a gaseous fluid under pressure, said tube being open at one end to permit the exit of said gas and said filaments whereby to effect rapid expansion of said gas and said bundle when subjected to lower pressure conditions outside of said tube, a collecting member adjacent said tube for receiving said filaments, means for moving said collecting member across the path of said filaments issuing from said tube, a second moving collecting member positioned to receive the filaments passing from said first collecting member, and means for drying said filaments in an untensioned condition on said second collecting member.

5. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at least 20 pounds per square inch into an elongated confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other.

6. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at least 20 pounds per square inch into an elongated confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other, and impinging said bundle of separated filaments against a surface disposed in close proximity to said confined zone.

7. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at

least 20 pounds per square inch into an elongated confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other, and drying said filaments while they are substantially free from tension.

8. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at least 20 pounds per square inch into an elongated confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other, impinging said bundle of separated filaments against a surface disposed in close proximity to said confined zone, and drying said filaments while they are substantially free from tension.

9. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at least 20 pounds per square inch into an elongated

confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other, impinging said bundle of separated filaments onto a collecting surface, and drying said filaments while they are substantially free from tension on said collecting surface.

10. A process which comprises simultaneously passing a wet compact bundle of continuous filaments and a gas having a gauge pressure of at least 20 pounds per square inch into an elongated confined zone, and passing said bundle of filaments and gas from said confined zone into the atmosphere, whereby the gas rapidly expands and separates the filaments from each other, and impinging said bundle of separated filaments onto a moving collecting surface disposed in close proximity to said confined zone, the linear speed of said collecting surface being less than the linear speed of the impinging filaments.

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