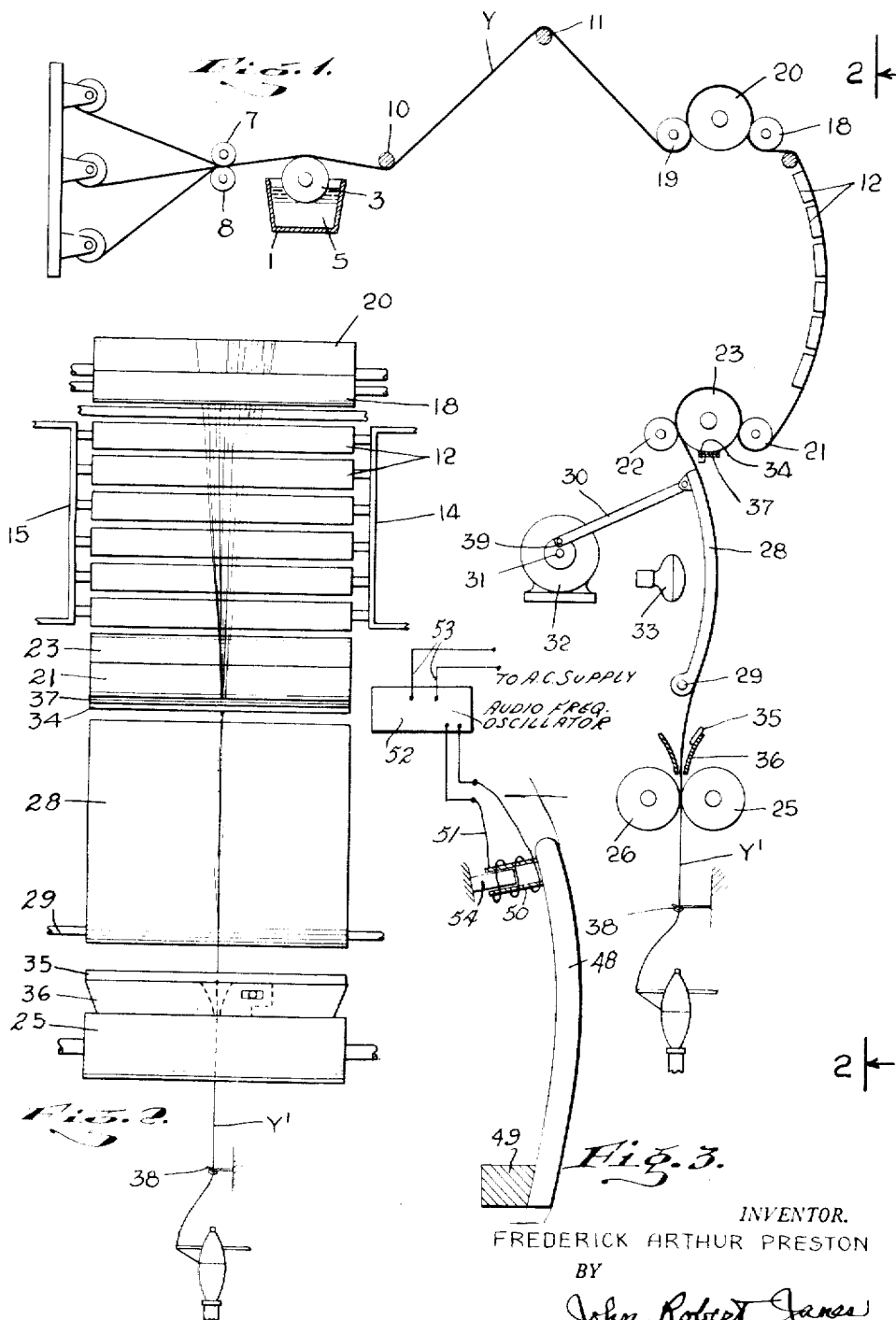


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PROCESS AND APPARATUS FOR CONVERTING CONTINUOUS FILAMENTARY
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PROCESS AND APPARATUS FOR CONVERTING CONTINUOUS FILAMENTARY MATERIAL INTO FILAMENTS OF STAPLE LENGTH

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This invention relates to a process for the conversion of continuous filamentary material into filaments of staple length and to apparatus adapted to carry out this process.

Although stretch-breaking continuous filament viscose rayon tow is now a familiar textile operation, it has been found to be extraordinarily difficult to convert continuous filament nylon to staple length by this process.

In the first place, it is impractical to stretch-break undrawn continuous filament nylon, because nylon in this form is capable of stretching as much as seven times its original length before its elastic limit is reached. As nearly as can be ascertained, this is what occurs: In starting up the apparatus, individual filaments are drawn into the nip of the bottom rolls, and as soon as this occurs, they start to stretch, but do not break promptly thereafter. Thus, as more and more filaments are drawn into the nip, and are stretching, a thick mass of filaments is created at that point. Then suddenly the elastic limit of a large number of the filaments in the mass is reached, and the whole mass passes through the nip as a slub, producing uneven yarn. This cycle of a finite interval during which stretching occurs, followed by an interval during which breaking occurs, then is repeated. Therefore, it is impossible to get uniform stretch-breaking started. Even drawn nylon stretches up to 20%, and so the same problem exists.

Thus it has been difficult to obtain stretch-broken nylon yarn of uniform thickness. For this reason it has been impossible to stretch-break and draft continuous filament nylon to less than 110 denier yarn (48 count on the cotton system). When such non-uniform yarn is woven as filling in a plain weave fabric the differences in thickness at various points of the yarn become apparent as bands and slubs, which defects limit the marketability of the fabric.

It has been determined that these difficulties may be avoided, and nylon successfully stretch-broken, in any of three ways: by stretch-breaking and drafting the filaments at a temperature in excess of 125° C. (258° F.), or while subjecting the filaments to a transverse oscillation, or while subjecting the filaments to a transverse oscillation and heating them at an elevated temperature, preferably in excess of 100° C. (212° F.). The yarn obtained by any of these methods is of uniform diameter, and may be drafted to as fine a diameter as 66 denier (80 count on the cotton system), considerably finer stretch-broken nylon yarn than has ever before been produced.

It has also been found that undrawn continuous filament zero twist nylon yarn may be stretch-broken by this process if the yarn is first subjected to a draft of

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approximately 2 to 4 times at a temperature between 25 and 250° C. The drawn yarn may immediately be stretch-broken and drafted as described above. Further, the continuous filament nylon yarn may be treated with softening agents, lubricants and anti-static agents prior to being subjected to stretch-breaking and/or drafting.

In accordance with the invention an improved stretch-breaking and drafting apparatus is provided, including a set of feed rollers and a set of drafting rollers spaced therefrom, defining a ratch therebetween, the drafting rollers being adapted to be driven at a speed greater than the feed rollers so as to break and draft at least some of the filaments, and means disposed in the ratch for subjecting the filaments to a transverse oscillation, comprising a plate mounted for reciprocatory movement and means for reciprocating said plate. In one embodiment, one end of the plate is rotatably mounted on a fixed shaft, and said means for reciprocating the plate comprises a rod affixed at one end to the plate and at the other end to an eccentric mounted on a driven shaft; thus the plate may be caused to rock upon the shaft by reciprocation of the rod.

The apparatus also provides means in association with the set of feed rollers for stretching the material. This means comprises a set of retaining rolls adapted to be operated at a lower speed than the feed rolls. Means for heating the yarn in the ratch between the retaining and feed rolls and means for applying liquid treating material to the yarn prior to stretching and/or stretch-breaking also may be provided.

It has been determined that the process and apparatus of the invention may be employed for stretch-breaking continuous filament yarn of materials other than nylon, for example, cellulose acetate, viscose rayon, Vinyon (polyvinyl chloride) Saran (copolymers of polyvinyl chloride and polyvinylidene chloride) Vinyon N and Orlon (polyacrylonitrile) and Terylene (polymers of a dibasic acid, such as terephthalic acid, and a glycol, such as ethylene glycol).

In stretch-breaking viscose rayon and cellulose acetate it has been found desirable to stretch the yarn approximately 10 to 20 percent prior to stretch-breaking and then to carry out the stretch-breaking as set forth above. Vinyon N, Vinyon, Saran, Orlon and Terylene may be handled much in the same manner as nylon.

Fig. 1 is a diagrammatic side view showing the steps of the process and the sequential arrangement of the various parts of the apparatus of the invention;

Fig. 2 is a view taken along the line 2—2 of Fig. 1;

Figure 3 is a diagrammatic side view, partially in section, of the vibrating plate portion of the apparatus of the instant invention, depicting a modified means for vibrating the plate.

The means for applying liquid softening, antistatic or lubricating material to the continuous filamentary material Y comprises a storage reservoir or tank 1 in which dips a driven roll 3. The roll carries liquid treating material 5 contained in the tank by surface tension to the filamentary material, and ordinarily is driven in a direction opposite to the direction of travel of the filamentary material. Associated with the tank are a set of guide rolls 7 and 8 and a stationary guide bar 10, which are so positioned that filamentary material passing between the rolls 7 and 8 and beneath the guide bar 10 is forced to

contact a portion of the exposed upper surface of the roll 3 and receive a coating of liquid material 5 therefrom.

The stretching means of the invention comprises a set of retaining and a set of feed rolls, the first comprising two parallel pressure rolls 18 and 19 which are rotated by driven roll 20 therebetween, and the second comprising a pair of pressure rolls 21 and 22 rotated by the driven roll 23 therebetween. The retaining rolls draw the filamentary material through the first described portion of the apparatus, and impart the drag to the filaments necessary to stretch them when the latter rolls are operated at a greater surface speed than the former. Any desired amount of stretching may be imparted to the filamentary material while it is being passed therebetween.

A number of electric resistance strip heaters, indicated generally at 12, are disposed in the ratch between the rollers on curved support arms 14 and 15, so that the strip heaters taken together form a wide arc. Other heating means, such as infra-red lamps, may be employed instead of the strip heaters.

The stretch-breaking means comprises the back or top rolls 21, 22 and 23 and the front or bottom rolls 25 and 26. Rolls 21 and 22 are pressure rolls, rotated by the driven roll 23. The bottom rolls are operated at a considerably higher surface speed than the top rolls, so that the yarn is stretched, broken and drafted during passage therebetween. A smooth curved plate 28 is disposed in the ratch in the path of travel of the filaments and is traversed thereby. This plate is made of stainless steel, but it may also be made of nickel, zinc-coated steel, or like electric conductor that does not tarnish or corrode. An infra-red lamp 33 heats the plate to the temperature at which it is desired to stretch-break the filaments that contact it, in this case, 150° C. (300° F.). The lower end of the plate is rotatably mounted on the shaft 29, while to the upper portion of the plate is affixed one end of the shaft 30. The other end of the shaft 30 is affixed to an eccentric 39 mounted on the shaft 31 of the electric motor 32. The speed of the motor and the position of the rod 30 on the eccentric 39 are so adjusted that the plate 28 is vibrated by reciprocations of the shaft 30 at approximately 60 cycles per second and an amplitude of approximately 0.07 inch. It will be understood that a different rate of vibration and a different amplitude may be used, as desired, as set forth hereinafter. For example, instead of an electric motor, an electric oscillator of the usual type may be employed, and is in fact essential if oscillations of the order of 1,000 to 2,000 cycles per second are desired.

Figure 3 schematically illustrates an electrically oscillated plate capable of achieving the higher frequencies of vibration. In this figure, the plate 48 is fixed at one end thereof as at 49. To the other end is attached a tube 50 formed from Bakelite phenolic resin or other suitable material and about which is coiled several turns of a conductor 51, connected at its ends to an audio frequency oscillator 52 to which A. C. current is supplied from any suitable source, not shown, through leads 53. A bar of permanently magnetic material 54, fixed at one end at a point spaced from said plate, extends into the tube 50. When the oscillator is energized, an alternating field of electromagnetic attraction is set up between the bar 54 and the coil, thus vibrating the plate at a high frequency.

In order to reduce static, two strips of metal 34 and 35 coated with a radium salt or like radioactive substance are placed adjacent the path of travel of the filaments, but are not contacted thereby. Strip 34 is affixed to the clearer 37, and strip 35 to the trumpet 36. The trumpet 36 guides the stretch-broken filaments Y' into the nip of the bottom rolls 25 and 26 and condenses the fibers to enable them to be twisted into yarn.

The stretch-broken filaments are then passed through the eye 38, twisted and wound on a bobbin.

The following are the preferred conditions for stretch-

breaking continuous filamentary material in accordance with the invention:

Treatment	Group I	Group II
1. Application of solution or dispersion of softener, anti-static or lubricating agent.	Optional.	Optional.
2. Stretching and drying of treated filamentary material.	Optional if drawn filaments are used.	Do.
(a) draft	If undrawn, 200 to 400%. If drawn, 5 to 25%.	5 to 25%.
(b) temperature range	25 to 250° C.	25 to 250° C.
Groups I and II		
3. Stretch-breakium:		
(a) draft	5 to 300 times.	
(b) length of ratch	1 to 10 ft.	
(c) vibration (if used):		
(1) frequency	10 to 2,000 cycles/second.	
(2) amplitude	0.005 to 0.25 inch.	
(d) temperature:		
(1) if vibration is used	room temperature to 250° C.	
(2) if no vibration is used	125 to 250° C.	

Group I filaments are nylon, Vinyon, Saran, Vinyon N, Orlon, and Terylene.
Group II filaments are viscose rayon and cellulose acetate.

Anti-static, softening and lubricating agents which may be employed are usually used in the form of aqueous solutions and dispersions, and include fatty acid esters, such as polyoxyalkylene stearate (Atlas G 2149), mixed cationic and anionic aqueous dispersions of paraffin hydrocarbons (Aerotex Softener H) and Sodium Stymer (an aqueous dispersion of sodium salt of polystyrene). Such agents are particularly recommended for stretch-breaking undrawn nylon.

Following application of such an agent, it is necessary to dry the filamentary material. This step may be combined with the stretching step, if the filaments are to be stretched, since this step usually is best carried out at an elevated temperature. The amount of draft and the temperature will obviously depend upon the chemical and physical properties of the material, and whether it has previously been drawn to orient the fibers; in general, the material should be so handled in this step that at the time it is stretch-broken it is dry, that is, in equilibrium with atmospheric relative humidity, and at the approximate limit of its extensibility, so that it breaks almost instantly under the draft of the bottom rolls of the stretch-breaking apparatus.

As has been stated, stretch-breaking is carried out on dry material, preferably at temperatures between 125 and 250° C., and with or without vibration.

Ordinarily, vibration should be employed. It is believed that this operation gives improved results because when each individual filament is set in motion the filaments as a whole are spread out, and prevented from lying against and adhering to one another, thus reducing inter-fiber static friction. As a result, more even drafting and more uniform yarn is obtained. For this reason, it is preferred to employ filamentary material of zero twist. A small amplitude and relatively high frequency of vibration have been found to be most effective.

In order to expedite free flow of the filaments across the vibrating plate, it is desirable that the plate be heated to 100° C. or over, preferably in excess of 125° C. The filaments of course acquire the same temperature as they pass over the plate. This prevents condensation of moisture on the plate, so that there is no mono-layer of water vapor between the filaments and the plate.

Because positive prevention of formation of this mono-layer cannot be assured below 100° C., and in fact its formation is not readily inhibited below 125° C., it is difficult to stretch-break the filaments with application of vibration below 100° C. when a plate is used as the vibrator.

It has been found that even in the absence of vibration, if the dry filaments be stretch-broken at temperatures in excess of about 125° C., improved yarn is obtained. This improvement has been especially noted with the thermoplastic filaments, such as nylon, and possibly is a result in part of the effect of elevated temperatures upon the elasticity and extensibility of these filaments. This, perhaps, explains why little or no improvement is noted if the filaments be stretch-broken at temperatures below 125° C., although if vibration be applied, considerably lower temperatures, down to room temperature (25° C.), may be employed.

The longer the ratch, the higher the tensile strength and elongation of the stretch-broken yarn obtained. Thus ratches up to 10 feet in length or even longer are desirable. The speed of the bottom rolls is set at that required to give a draft of 5 to 300 or more times. Drafts of 200 or more are desirable from an economic standpoint.

The following is a typical run made using the apparatus of Figs. 1 and 2.

Ten ends of undrawn 900 denier 220 filament zero twist type 200 continuous filament nylon yarn were drawn from bobbins and combined between the guide rolls 7 and 8 over the kissing roll 3 and thereby coated with a 1½% aqueous Aerotex Softener H solution contained in the tank 1. The treated filaments were passed beneath the guide bar 10 and over the guide bar 11 and then under and over the upper drawing rolls 18, 19 and 20. The filaments were heated to 205° C. (400° F.) by passage over the electrical resistance strip heaters 12 so that the filaments were dried while at the same time drawn 360%, because the lower drawing rolls 21, 22 and 23 were operated at a speed 3.6 times the speed for the upper rolls.

Next the dry filaments were run over the surface of the vibrating plate 28 where they were heated to a temperature of 150° C. (300° F.) while being stretch-broken. The plate 28 was vibrated at 60 cycles per second and an amplitude of 0.07 inch. The bottom rolls 25 and 26 were operated at such a speed that a draft of 25.5 times was obtained, so that the ten ends of stretch-broken nylon were reduced over all to one 98 denier (54 count on the cotton system) yarn. The total draft to which the yarn had been subjected during passage through the apparatus was 92. The stretch-broken yarn was then wound on bobbins.

The yarn was observed to be very uniform in diameter. When rewound on quills and woven as filling in a plain weave fabric with a warp of cellulose acetate yarn, no banding or marked slubs were observed. When, however, ordinary drawn stretch-broken nylon yarn was woven as filling in such a fabric severe bands and gross slubs, a result of unevenness in the yarn, were noted.

The following is claimed:

1. A process which comprises applying a softening agent to a continuous filament yarn to plasticize and soften the filaments thereof, and thereafter drafting and stretch-breaking the plasticized and softened filaments while simultaneously subjecting them to a transverse oscillation, at a frequency within the range of from 10 to 2,000 cycles per second, without substantial bending thereof.

2. A process of converting undrawn continuous filament nylon into filaments of staple length which comprises applying a softening agent to the filaments, stretching the filament while heating them at a temperature of about 400° F. and then stretch-breaking and drafting the filaments while subjecting them to a transverse oscillation at a frequency within the range from 10 to 2,000 cycles per second and heating them to a temperature of about 300° F.

3. A process of converting continuous filamentary man-made textile materials into filaments of staple length which comprises heating the filamentary material to a temperature in excess of about 125° C. while simultaneously stretch breaking and drafting the filaments, and

at the same time subjecting them to transverse oscillation at a frequency within the range of from 10 to 2,000 cycles per second.

4. A process of converting continuous filaments into filaments of staple length which comprises stretching the filaments while subjecting them to a temperature in excess of 125° C., and thereafter subjecting the filaments to a transverse oscillation, at a frequency within the range of from 10 to 2,000 cycles per second, without substantial bending thereof while simultaneously stretch breaking and drafting the filaments.

5. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments in the ratch; of means positioned in the ratch for heating said guide means.

6. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments in the ratch; of means for guiding the continuous filaments to said feed rollers and means for heating said last mentioned means to thereby heat the continuous filaments prior to the passage of said filaments through said feed rollers.

7. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments in the ratch; of a set of retaining rollers adapted to cooperate with said feed rollers to stretch said continuous filaments prior to stretch breaking, and means positioned between said retaining rollers and said feed rollers for heating said filaments during stretching thereof.

8. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments in the ratch; of means for applying a treating agent to the continuous filaments, prior to passage thereof through said feed rollers, said last named means comprising a tank and a kissing roll associated with said tank, the lower surface of said kissing roll being positioned to contact a supply of treating solution disposed in said tank and the upper surface of said kissing roll being positioned to contact the continuous filaments to be stretch broken.

9. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch

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therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments in the ratch; of at least one strip having a radioactive coating thereon disposed in the ratch adjacent the path of travel of said filaments.

10. The combination with apparatus for converting continuous filaments into filaments of staple length, said apparatus including a set of feed rollers, a set of drafting rollers spaced from said feed rollers to define a ratch therebetween, said drafting rollers being adapted to be driven at a speed greater than said feed rollers so as to break and draft at least some of the filaments, filament guide means disposed in the ratch for passage of the filaments thereover and means for reciprocating said guide means to impart transverse oscillations to the filaments

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in the ratch; of trumpet-shaped means for receiving and condensing stretch broken and drafted filaments prior to passage thereof through the nip of said drafting rollers.

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