United States Patent [19]

Stanley

[11] **3,753,275**

[45] **Aug. 21, 1973**

[54] **DRAW-CRIMPING TEXTILE FILM STRANDS**

[76] Inventor: **Robert K. Stanley,** 620 Meadowvale Ln., Media, Pa.

[22] Filed: **Mar. 15, 1971**

[21] Appl. No.: **124,213**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 822,429, May 7, 1969, Pat. No. 3,570,083, which is a continuation-in-part of Ser. Nos. 678,428, , Pat. No. 3,462,814, and Ser. No. 302,758, , Pat. No. 3,376,622, Continuation-in-part of Ser. No. 846,457, July 31, 1969, which is a continuation-in-part of Ser. No. 835,883, June 9, 1969, Pat. No. 3,551,254, which is a continuation-in-part of Ser. No. 650,762, July 3, 1967, abandoned, which is a continuation-in-part of Ser. No. 349,338, March 8, 1964, Pat. No. 3,348,283.

[52] **U.S. Cl.** **28/72.14,** 28/DIG. 1

[51] **Int. Cl.** **D02g 1/12**

[58] **Field of Search** 28/DIG. 1, 1.6, 72.14

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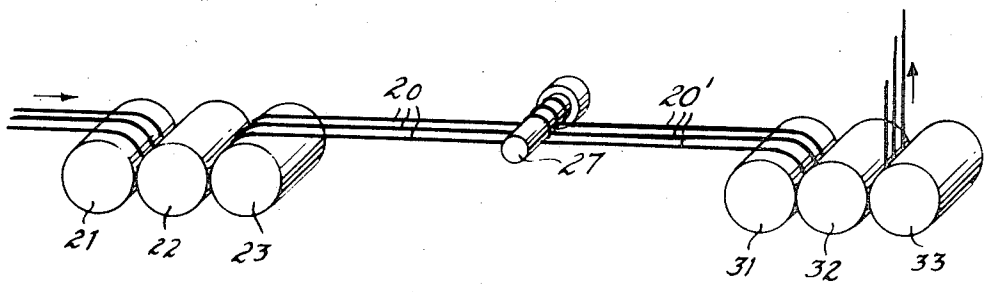
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[57] **ABSTRACT**

Drawable textile film strands are treated by drawing the same to increased length and compressively crimping the drawn material, both steps being carried out in essentially continuous manner with a minimum of time and space therebetween.

9 Claims, 8 Drawing Figures



Patented Aug. 21, 1973 3,753,275

2 Sheets-Sheet 1

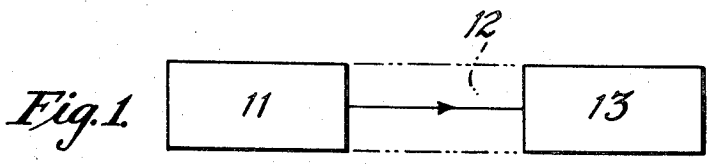


Fig. 1.

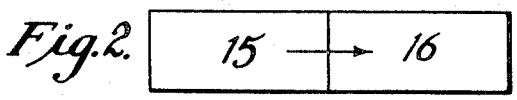


Fig. 2.



Fig. 3.

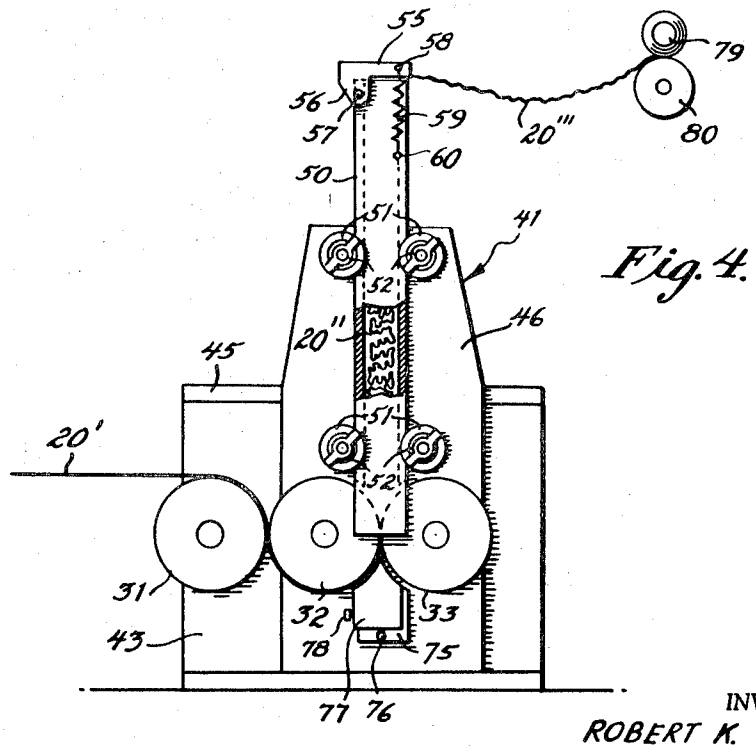


Fig. 4.

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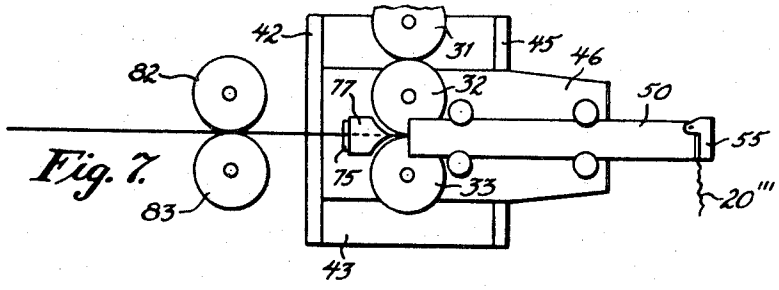


Fig. 7.

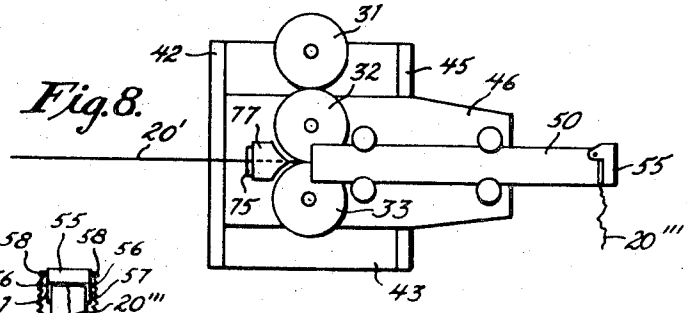


Fig. 8.

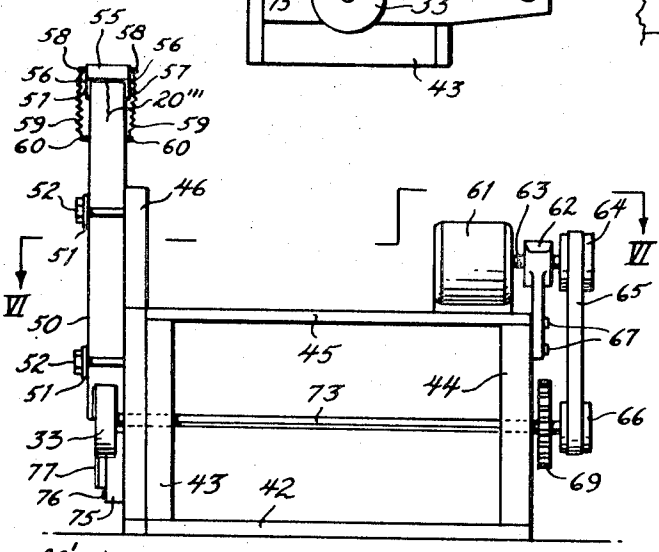


Fig. 5.

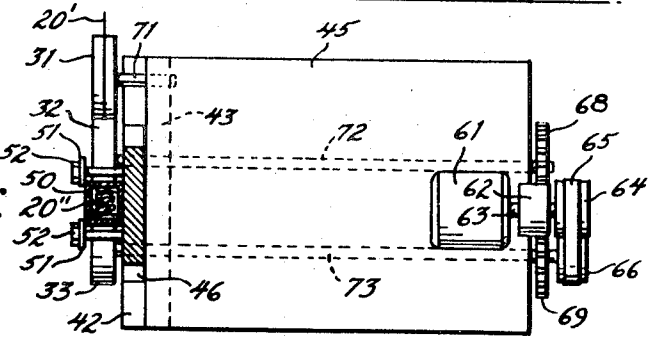


Fig. 6.

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DRAW-CRIMPING TEXTILE FILM STRANDS

This application is a continuation-in-part of my copending patent application for strand-treating apparatus, Ser. No. 822,429 filed 7 May 1969 and scheduled to issue as U.S. Pat. No. 3,570,083. The latter was a continuation-in-part of my prior applications, Ser. No. 678,428 (now U.S. Pat. No. 3,462,814) and Ser. No. 302,758 (now U.S. Pat. No. 3,376,622). Reference is also made to my prior application Ser. No. 216,525, filed 13 August 1962 and subsequently abandoned, upon which the last named patent was based at least in part.

The present application also is a continuation-in-part of Ser. No. 846,457 filed 31 July 1969, which in part was a continuation-in-part of Ser. No. 835,883 filed 9 June 1969, now U.S. Pat. No. 3,559,254 as a continuation-in-part of Ser. No. 650,762 filed 3 July 1967 (which was abandoned upon the filing of S.N. 846,457), which was in pertinent part a continuation of Ser. No. 349,338 filed 8 March 1964 and now Pat. 3,348,283.

Textile film strands can be produced by extrusion of film-forming composition through a suitable slot into sheet form, slitting the sheet lengthwise, usually after some drawing thereof to increased length, and collecting the resulting strands, which are more or less ribbon-like in configuration but often so narrow as to be substantially identical to strands extruded in filamentary form. Many polymeric film-forming compositions so treated produce strands of relatively low tensile strength because of relatively low macromolecular orientation with respect to the longitudinal axis. In most such compositions the orientation and tensile strength can be increased readily because the strand components are drawable (or further drawable) to an attenuated and extended condition of high orientation from which there is little or no tendency to return to the original condition. The strand temperature normally increases during drawing because of intermolecular friction and friction with any snubbing pin or similar means employed to restrict the drawing location. In actual practice the strand, regardless of composition, may be heated to facilitate and to localize the drawing operation.

Textile film strands, whether oriented or unoriented, are inappropriate for many uses because of their rectilinearity, which is conductive to slickness, translucency, and low bulk, all of which can be eliminated or modified by any of a variety of processes usually called "crimping" or "texturing". Nearly all of those processes (e.g., edge-crimping, gear-crimping, jet-crimping, and twist-crimping) tend to extend the strand axially while deforming it transversely of the longitudinal axis and, therefore, may be expected to be compatible with an immediate predrawing operation. Longitudinally compressive crimping, such as stuffer-crimping, of drawn textile film strands may be expected to be separated from the drawing process in location or time (the drawing being prior, usually long prior) rather than adapted to follow immediately upon an attenuation of the strand to increased length.

A primary object of the present invention is novel drawing and crimping of textile film strands.

Another object is provision of means for crimping textile film strands by longitudinal compression along the strand axis immediately following permanent extension therealong.

A further object is continuous draw-crimping of a plurality of textile film strands simultaneously.

Other objects of this invention, together with means and methods for accomplishing the various objects will be apparant from the following description and the accompanying drawings.

FIG. 1 is a schematic representation of drawing and crimping steps with intervening time period;

FIG. 2 is a schematic representation of a continuous draw-crimping process without intervening time period;

FIG. 3 is a perspective view (somewhat stylized) of a drawing system with a plurality of textile film strands according to this invention;

FIG. 4 is a front elevation of a stuffer-crimper for use therein according to this invention;

FIG. 5 is a side elevation of the stuffer-crimper of FIG. 4;

FIG. 6 is a sectional plan of the same stuffer-crimper taken at VI—VI of FIG. 5;

FIG. 7 is a front elevation of a modification of apparatus according to this invention; and

FIG. 8 is a front elevation of a further modification of apparatus according to this invention.

In general, the objects of the present invention are attained by attenuating one or preferably a plurality of polymeric textile film strands to increased length in a drawing zone and by compressing the strands axially in a crimping zone immediately thereafter to buckle successive length increments thereof into crimped configuration. Preferably the means defining the beginning of the crimping zone and the means defining the end of the crimping zone are located close together, or even coincident or overlapping.

FIG. 1 shows schematically zone **11** wherein one or more strands are attenuated to increased length or "drawn" and zone **13** wherein the drawn product is crimped, as by any conventional system. Intervening zone **12,** shown in broken lines and traversed by an arrow leading from zone **11** to zone **13,** represents the period (conventionally excessive) of time intervening between drawing and crimping. FIG. 2 shows schematically drawing zone **14,** wherein textile film strands are treated as in zone **11,** and compressive crimping zone **16** contiguous therewith according to this invention. The arrow indicates the passage of the strands immediately to the crimping zone from the drawing zone without appreciable time intervening. The meaning of this limitation will be apparent from the following details of the apparatus and process of this invention.

FIG. 3 shows, in perspective (stylized by omission of supporting, heating, driving, or other elements), rolls **21, 22,** and **23** at the input end of a drawing zone, useful according to this invention, and rolls **31, 32,** and **33** at the output end of the zone. Located in the space between the two sets of rolls is draw pin **27,** use of which is optional. Strands **20,** whose direction of travel is indicated by arrows, proceed generally from left to right, passing about a quadrant of roll **21,** downward through the nip of rolls **21** and **22,** about the lower half of roll **22,** upward through the nip of rolls **22** and **23,** and over a quadrant of roll **23.** The strands make a single turn about draw pin **27,** after which they are denoted as **20'**. After leaving the draw pin the strands proceed about a quadrant of roll **31,** downward through the nip between rolls **31** and **32,** about the lower half of roll **32,** and then upward through the nip between rolls **32** and **33.**

The three strands illustrated side-by-side in FIG. 3 are exemplary of a multiplicity of such strands as may be formed by conventional slitting of a film sheet. It will be understood that such strands may be fibrillated to an appreciable extent, either before or after slitting and that compressive crimping of them, as by stuffer-crimping, is conductive to fibrillation whether or not already partially fibrillated.

It will be understood that at least one of the rolls in each of these two sets is driven directly by the motive means or indirectly by contact (essentially non-slipping) with one another. The surface speed of the rolls in the second or forwarding set (**31, 32, 33**) is greater than the speed of the rolls in the first or input set, thereby determining the extent to which the strands are drawn therebetween. The draw pin does not rotate but is fixed so as to snub the strands passing about it, thereby frictionally heating the strands, which also are heated by the drawing step itself, as by reason of internal or intermolecular friction. The pin may, but need not, be heated by any conventional means (e.g., electrically or by steam, preferably supplied internally) as is customary in the art of strand drawing.

With some strand compositions it may be helpful to heat one or both sets of rolls (in addition to, or instead of, the draw pin). Heating the first set of rolls preheats the strands for drawing, possibly rendering them easier to draw, and incidentally preheating them for crimping—as may the drawing itself. Heating the second set of rolls at least sufficiently to prevent the drawn strands from cooling in the interim (however brief) is conducive to a steady and high degree of crimping. Although not illustrated, methods and means for heating the rolls, preferably internally, will come readily to the mind of a person skilled in the art; e.g., circulation of heated fluid therein, or by electrical means as disclosed in my U.S. Pat. No. 3,111,740. The herein illustrated arrangement of three rolls in each set, with their axes in a common plane, two of the rolls flanking and being contiguous with the other roll is a useful arrangement, but it is not imperative for the practice of this invention, as will be apparent hereinafter.

FIGS. **4, 5,** and **6** show, in front and side elevation and sectional plan, respectively, stuffer-crimper **41** useful according to this invention. Rolls **31, 32,** and **33** are shown incorporated in this apparatus, the latter two functioning also as stuffing feed rolls. The supporting frame comprises base plate **42,** front plate **43,** back plate **44,** and top plate **45,** all secured together by suitable means (not shown). Upstanding facade **46** is secured similarly to the front plate. Tubular stuffing chamber **50,** which is nearly square in cross-section, is held in place against the front of the facade by four washers **51** overlapping the side edges of the front of the chamber and supported on four wing screws **52** threaded into suitable apertures in the facade. The front wall of the chamber overlaps portions of rolls **32** and **33,** and the rear wall does likewise, down to the roll nip, while the side walls terminate adjacent the rolls, thereby forming a closefitting entrance to the chamber for strand stuffed thereinto by the rolls. The upper end of the chamber is covered by cap **55,** which has ears **56** overlapping the front and back walls of the chamber and pivoted thereto by pintles **57.** Extension springs **59** stretched from pins **58** on the cap to pins **60** on the chamber walls bias the cap closed against the otherwise open top of the chamber.

Motor **61** affixed to the top surface of top plate **45** has shaft **63** extending to the rear through journal **62** upstanding from and secured by bolts **67** to the rear face of back plate **44.** Affixed to the end of the motor shaft is pulley **64** interconnected by belt **65** to pulley **66** on the end of shaft **73,** which carries roll **33** at its front end and extends through the front and back plates and also carries gear **69.** Meshing wih this gear is gear **68** on the end of shaft **72,** the other end of which carries roll **32.** Stub shaft **71** journaled in front plate **43** carries roll **31.**

Located below rolls **32** and **33** are several components not being used as stuffer-crimper **41** is shown in FIGS. **4, 5,** and **6.** They are guide block **75,** affixed to the facade by screw **76,** and overlying guide clip **77,** which is secured to the guide block by bolt **78** at the side. Both the guide block and clip extend arcuately toward the nip of the rolls. Use of these guide elements (and non-use of roll **31**) appears in the embodiment shown in FIGS. **7** and **8,** which are described hereinafter.

In the embodiment already described, strands **20** are attenuated to become strands **20'** in the drawing zone between first set of rolls **21, 22, 23** and faster running second set of rolls **31, 32, 33,** the strands passing in essentially nonslipping contact with the rolls in each group. Immediately after having been drawn to increased length and thereby molecularly oriented, strands **20'** are fed upward through the nip of rolls **32** and **33** and thus stuffed into the entrance of chamber **50.** Although the strands previously shown were drawn in the same zone by a single drawing arrangement, the strands need not be fed into a single crimper but may be fed singly or in pairs, with appropriate lateral separation such as may be assured by combs or other separator guides (not shown) to like crimpers. Where treated together in a single crimper the respective strands may be combined into a single strand in the output therefrom or may be wound up singly, whichever is preferred.

In the simple arrangement where the surface speed of the rolls feeding the strand or strands into the crimper or crimpers is the same as the speed at which the strand leaves the drawing zone, i.e., neither an overfeed nor an underfeed according to roll speed, the tendency of the recently drawn strand to retract in length produces in effect an under-feed, be it ever so slight, to the crimping chamber. The chamber itself is filled with accumulation **20''** of crimped strand, shown (stylized, for clarity) in FIG. 4 by a cutting away of part of the front wall of the chamber, and is otherwise unheated and may be positively cooled (e.g., by circulation of a coolant—not shown—between the exterior and interior walls thereof) as in my U.S. Pat. No. 3,111,740.

Because the stuffing chamber is always full during crimping operations each straight-length increment of strand entering the chamber is compressed axially (i.e., longitudinally) and is forced to buckle, much as an overloaded structural column buckles. Continual buckling of successive length increments at the chamber entrance produces a crimping of the strand. Of course, the continued stuffing of the strand into the chamber forces the terminal part of the strand accumulation therein to emerge gradually therefrom between the spring-loaded cap and the upper end of the chamber. Such spring-loaded cap may be replaced by alternative types of back-pressure or strand-impeding devices,

such as those disclosed in the following U.S. patent No., for example: serrated wheel, 3,027,619 and 3,174,206; plunger, 2,758,357 and 2,760,252; or spheroids, 2,949,659 and my 3,440,669. Alternatively, lateral confinement alone may be employed, as in my 3,279,025.

It will be understood that the term "strand" as used herein includes not only a monofilament strand but also a multifilament strand and that shorter lengths (e.g., staple) than usually termed "continuous" may be present. Suitable strand compositions will come readily to the mind of a person skilled in the textile arts. Prominent among the suitable compositions are thermoplastic film-forming materials, such as polyhydrocarbons (e.g., polyethylene, polypropylene), and polyesters (e.g., polyethylene terephthalate). This list is simply exemplary and is not intended to be exhaustive of suitable compositions.

If a heated draw pin is used the appropriate temperature for it will depend upon the characteristics of the strand composition and the speed of the strands over the draw pin. Appropriate processing speeds lie in the range of from 100 to 1,000 yards per minute (ypm), but somewhat slower or faster speeds may be employed. The speed at which the strands are fed into the stuffer-crimper (or stuffer-crimpers) correlates with the output speed from the drawing zone, of course, and the roll temperature preferably prevents the strands from cooling before entering. Such crimpers preferably are constructed to maintain the strand temperature while under crimping compression, as in my U.S. Pat. No. 3,348,283.

FIGS. 7 and 8 show (in front elevation, but rotated 90° clockwise) the crimper of FIGS. 4, 5, and 6 but with the strand passing therethrough being fed directly by and between rolls 32 and 33 in line with their common tangent (through the roll nip). Additional rolls ahead of rolls 32 and 33 may prove useful in attaining essentially non-slipping contact at a pressure that will not damage the strands. Thus, in FIG. 7, added pair of nip rolls 82 and 83 are so located, and one or more strands 20' pass therebetween. As shown in FIG. 8, the nip of rolls 32 and 33 may be utilized to constitute a junction of the drawing and crimping zones by deleting the portion of strand path about illustrated roll 31 (which may then be deleted), a modification that is most useful with monofilament or small multifilament strands because of the likelihood of slippage with other strands by reason of reduced roll surface contact therewith. The rate of strand travel in such intervening portion of the strand path may be substantially the same as at the end of the drawing zone; it should not be less and may be more, thereby tensioning the strands further and, if desired, actually drawing them further.

Enhanced underfeed is accomplished conveniently according to the arrangement of FIG. 7, for example, by regulating the surface speeds of the various sets of rolls in any suitable manner, which may be conventional in itself, so that rolls 82, 83 have a speed intermediate that of slower rolls 21, 22, 23 at the beginning of the drawing zone and faster stuffer rolls 32, 33 at the crimper input. The latter rolls may run anywhere from several percent to perhaps ten percent, or somewhat more, faster than rolls 82, 83 while merely tensioning the strands, already drawn to increased length between rolls 21, 22, 23 and rolls 82, 83. An integrally contained drawing arrangement preceding a stuffer crimper, as in FIG. 7, permits modification of the crimper itself, such as by substitution of other stuffing means (e.g., fluid jets) for the more conventional stuffing rolls to feed the strand thereinto. Of course, conventional godets may be substituted for those nip rolls at either end (or both ends) of the drawing zone, regardless of the type of crimper infeed.

At greater than about ten percent roll overspeed, corresponding to strand underfeed, the strands probably will be drawn to further increased length, unless a maximum draw for the particular strand composition already had been imposed, and such further draw may equal or even exceed the previous draw if desired. It is preferred, although not necessary, that the strands not have been drawn significantly at a remote previous time, although appreciable benefit from the present invention may be attained if such previous draw did not exceed about half the total drawability of the undrawn material, thereby leaving it still substantially drawable. It is preferred to limit the degree of underfeed from rolls 82, 83 to the crimper to at most half the total drawing underfeed, or usually to not much more than about 200 percent. A range of from about 5 to 50 percent underfeed is preferred when little or no added draw is desired, and a range of from about 100 to 200 percent when substantial added draw is desired at the crimper input.

FIG. 8 also shows the same stuffer crimper with straight-in feed of the strands into the stuffing chamber but without added intermediate rolls 82, 83. In both FIGS. 7 and 8 the strands pass between guide block 75 and overlying clip 77 for centering along the nip of rolls 32 and 33. When using all three rolls, as in FIGS. 4 to 6, it may be desirable to locate a pigtail or other guide ahead of the first roll and centered from end to end thereof for a like purpose.

Other variations in or modifications of the described apparatus and process may be made without involving a departure from the inventive concept. Although textile film strands are emphasized, strands extruded in filamentary form may be treated likewise with good effect. Any similarly useful compressive crimping device may replace the illustrated stuffer-crimper, which is merely exemplary, as is the spring-loaded cap as the device for applying back-pressure to the strand accumulation in that crimper. Except when using the last previously mentioned type of stuffer crimper, windup of the crimped textile film strands expelled from the chamber preferably should be synchronized without, however, withdrawing any thereof from ahead of the back-pressure device. The portion of the cap covering the chamber illustrated herein may be used to control the windup rate, or a sensing device may be employed inside the chamber, such as disclosed in my U.S. Pat. No. 3,280,444, which is well adapted to use with a stuffer-crimper of the type disclosed in U.S. Pat. No. 3,027,619.

Strands crimped according to the present invention are characterized by excellent crimp stability, despite absence of conventional strain-relieving features, which have been customary despite the complication and expense attendant thereon. Control of the travelling strands, especially at high rates of travel, such as in the vicinty of 1,000 yards per minute, is comparable to that obtainable with overfed strands at lower rates, such as several hundred yards per minute. Other benefits and advantages of this invention, which produces

crimped textile film strands of exceptional bulk, will become apparent and accrue to those who undertake to practice it as defined in the following claims.

I claim:

1. Continuous draw-crimping process for textile film strands, comprising forwarding a textile film strand, tensioning the strand sufficiently to draw it to increased length in a drawing step, maintaining the drawn strand under tension by underfeeding it to a crimping step, and stuffer-crimping the so tensioned strand in the crimping step.

2. Draw-crimping process according to claim 1, wherein a plurality of such strands are drawn together in the drawing step.

3. Draw-crimping process according to claim 1, wherein a plurality of such strands are stuffer-crimped together in the crimping step.

4. Draw-crimping process according to claim 1, wherein a plurality of such strands are drawn side-by-side in the drawing step and are stuffer-crimped together in the crimping step.

5. Draw-crimping process according to claim 1, wherein the strand is underfed from the drawing step to the crimping step under tension sufficient to extend the strand but insufficient to draw it to permanently increased length.

6. Draw-crimping process according to claim 1, wherein the strand is underfed from the drawing step to the crimping step under tension sufficient to extend the strand and thereby to draw it to permanently increased length.

7. Continuous draw-crimping process for textile film strands comprising tensioning a plurality of drawable textile film strands and thereby simultaneously drawing them to increased length in a drawing step, forwarding the drawn strands directly to a stuffer-crimping step, and simultaneously stuffer-crimping them in such step, wherein the strands are underfed from the drawing step to the crimping step and are thereby subjected to an increase in tension therebetween.

8. Draw-crimping process according to claim 7, wherein the strands are heated for drawing and are maintained in such heated condition for stuffer-crimping.

9. Draw-crimping process for textile film strands comprising forwarding a multifilament strand comprising at least one textile film strand to a drawing zone and therefrom to a crimping zone, drawing the strand to increased length and thereby orienting it in the drawing zone, feeding the strand into the crimping zone at a rate higher than the rate at which it was forwarded out of the drawing zone, and then longitudinally compressing the strand and thereby crimping it in the crimping zone.

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