April 9, 1968 R. K. STANLEY 3,376,622

STRAND TREATMENT

Filed July 31, 1963 3 Sheets-Sheet 1

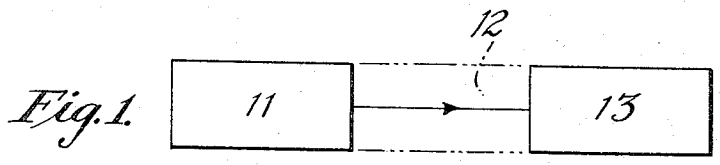


Fig. 1.

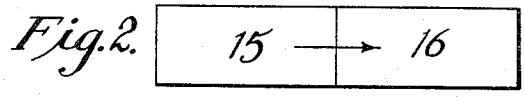


Fig. 2.

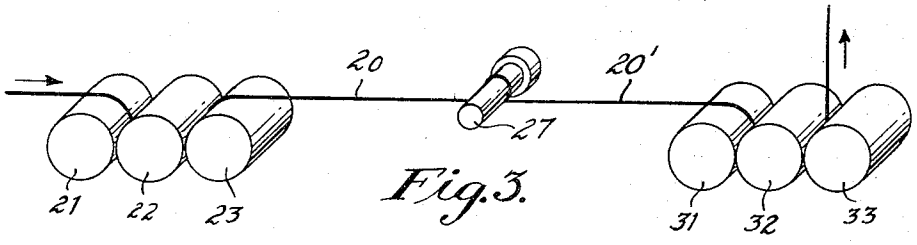


Fig. 3.

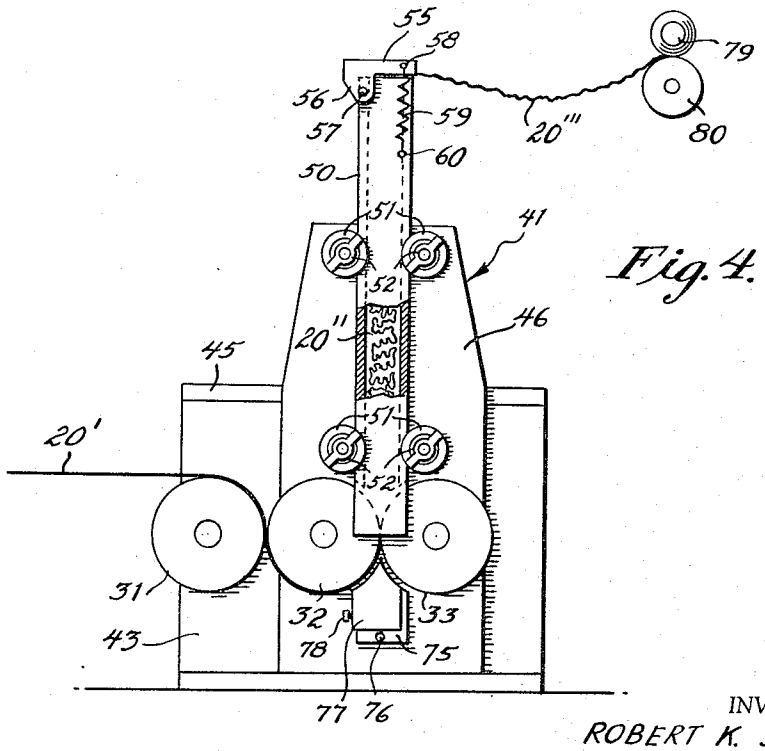


Fig. 4.

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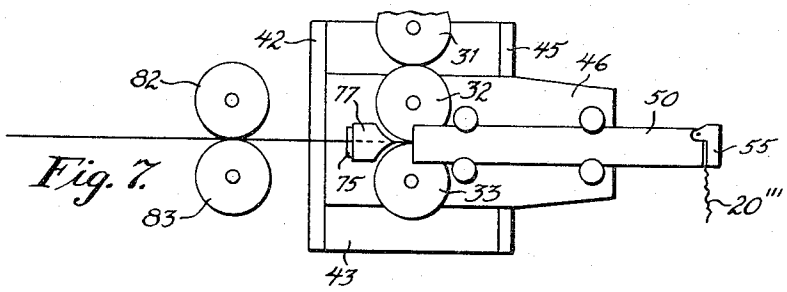


Fig. 7.

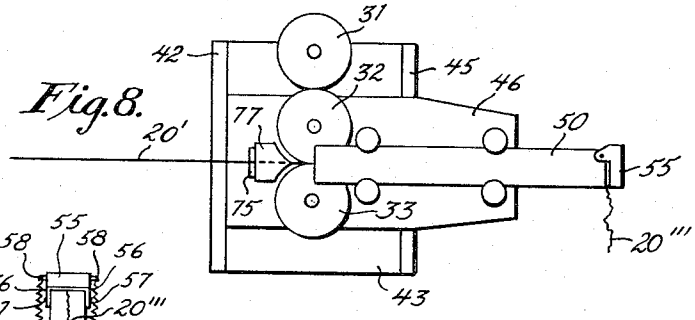


Fig. 8.

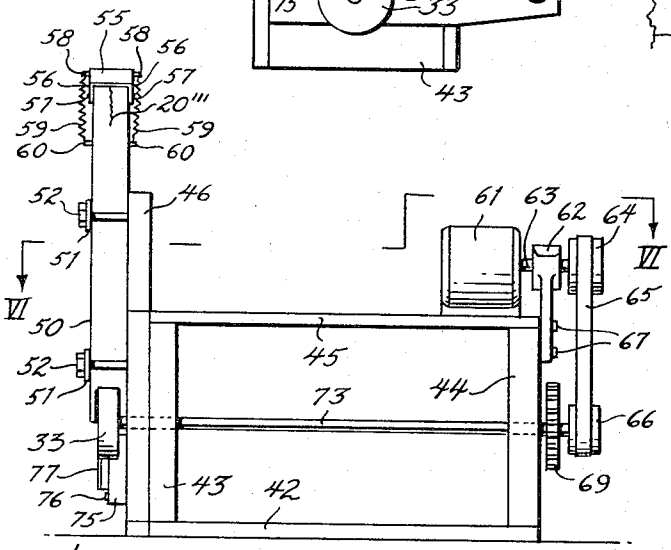


Fig. 5.

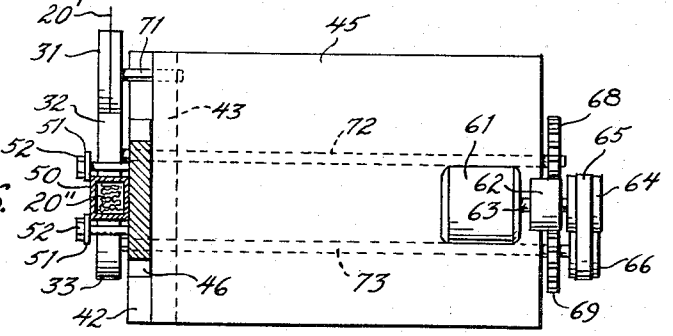


Fig. 6.

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STRAND TREATMENT

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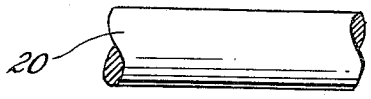


Fig. 9.

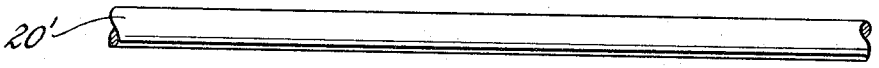


Fig. 10.

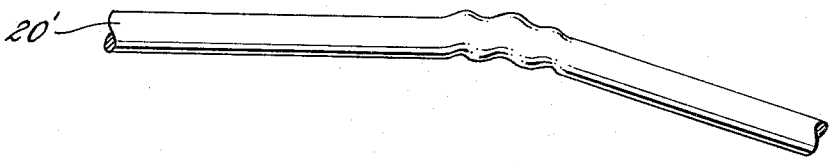


Fig. 11.

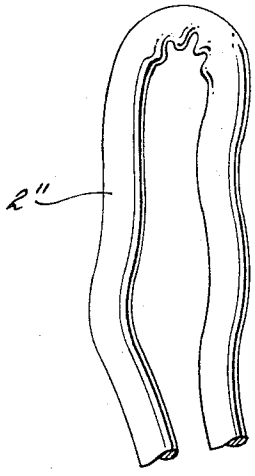


Fig. 12.



Fig. 13.

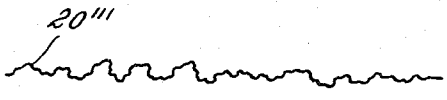


Fig. 14.

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United States Patent Office 3,376,622 Patented Apr. 9, 1968

3,376,622

STRAND TREATMENT

Robert K. Stanley, Middletown Township, Delaware County, Pa., assignor to Techniservice Corporation, Lester, Pa., a corporation of Pennsylvania

Continuation-in-part of application Ser. No. 216,524, Aug. 13, 1962. This application July 31, 1963, Ser. No. 302,758

5 Claims. (Cl. 28—72)

This invention is a continuation-in-part of Ser. No. 216,524, filed Aug. 13, 1962, now abandoned, and relates to treatment of textile strands, concerning especially crimping thereof by successive extension and compression along the strand axis.

Textile strands can be produced by extension of fiber-forming compositions through spinneret orifices and collection of the resulting filaments or fibers. Many polymeric fiber-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 (usually continuous filaments) are drawable to an attenuated and extended condition of high orientation from which there is little or no tendency to return to the original condition. Nylon strands, for example, can be drawn so readily at room temperature that they are commonly indicated as being "cold-drawable." In actual practice the strand, regardless of composition, may be heated to facilitate and to localize the drawing operation.

Strands of continuous filaments, whether oriented or unoriented, are inappropriate for many uses because of their rectilinearity, which is conducive 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 pre-drawing operation. Stuffer-crimping, however, which orients the strands by longitudinal compression thereof, may be expected to be separated from the crimping process in location or time (except for being prior, usually long prior) rather than adapted to follow immediately upon an attenuation of the strand to increased length. Attempts to crimp thermoplastic textile strands within a short time following drawing thereof have required that the strands be heated or wet during both steps or both heated and wet during one or both steps. There is a considerable need for improved apparatus, technique, and results.

A primary object of the present invention is provision of a novel drawing and crimping process for textile strands.

Another object is crimping of textile strands by compression along the strand axis immediately following permanent extension therealong.

A further object is elimination of the customary requirement that thermoplastic strands be heated or wet (or both) during drawing and crimping.

Other objects of this invention, together with means and methods for accomplishing the various objects, will be apparent 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 useful according to this invention;

FIG. 4 is a front elevation of a stuffer-crimper for use 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;

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

FIG. 9 is a side elevation of a length increment of monofilament textile strand in unoriented or only partly oriented condition;

FIG. 10 is a side elevation of the same increment of the strand of FIG. 9 after attenuation to increased length to orient it;

FIG. 11 is a side elevation of the oriented length increment of the strand of FIG. 10 buckling under axially compressive stress;

FIG. 12 is a side elevation of the same strand length increment crimped into a generally U-shaped configuration;

FIG. 13 is a side elevation (on reduced scale and somewhat stylized) of successive length increments crimped as in FIG. 12; and

FIG. 14 is a side elevation (on a much further reduced scale and also somewhat stylized) of a considerably greater length of crimped strand than shown in FIG. 13.

In general, the objects of the present invention are attained by attenuating a polymeric textile strand to increased length and immediately thereafter compressing the strand axially to buckle succesive length increments thereof, without necessity for the strand to be heated or wet (or both). The invention comprehends particularly such process as an improvement in stuffer-crimping. Certain apparatus for drawing and immediately stuffer-crimping textile strands comes within the purview of this invention, as indicated below.

FIG. 1 shows schematically zone **11** wherein a strand is attenuated to increased length or "drawn" and zone **13** wherein the strand 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 (excessive) of time intervening between drawing and crimping. FIG. 2 shows schematically drawing zone **15**, wherein the strand is treated as in zone **11**, and compressive crimping zone **16** contiguous thereto according to this invention. The arrow indicates the passage of the strand 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. Strand **20**, whose direction of travel is indicated by arrows, proceeds 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**. It then makes a single turn about draw pin **27**, after which it is denoted as **20'**. After leaving the draw pin the strand proceeds 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**.

It will be understood that at least one of the rolls in each of these two sets is driven by suitable motive means (not shown) and that all the rolls within each set rotate at constant speed, whether 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. The draw pin does not rotate but is fixed so as to snub the strand passing about it. 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 strand for drawing, possibly rendering it easier to draw, and incidentally preheating it for crimping—as may the drawing step itself. Heating the second set of rolls at least sufficiently to prevent the drawn strand 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 patent application Serial No. 790,658 filed February 2, 1959 for Strand Crimping now Patent 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 preferred 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 close-fitting 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 with 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 embodiments shown in FIGS. 7 and 8, which are described hereinafter.

In the preferred embodiment already described, strand **20** is attenuated to become strand **20'** in the drawing zone between first set of rolls **21, 22, 23** and faster running second set of rolls **31, 32, 33**, the strand passing in essentially non-slipping contact with the rolls in each group. Immediately after having been drawn to increased length and thereby molecularly oriented, strand **20'** is fed upward through the nip of rolls **32** and **33** and thus stuffed into the entrance of chamber **50**. The chamber itself is filled with accumulation **20''** of crimped strand, shown (stylized, for clarity) in FIG. 4 by 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 disclosed in my patent application Serial No. 790,658 filed Feb. 2, 1959 for Method and Apparatus for Strand Crimping now Patent 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. Emergent crimped strand **20'''** is in relaxed condition and is wound up onto cone **79** driven by contact (through the layers of strand on it) with drive roll **80**.

FIG. 9 shows, from the side, a short length of unoriented (or only partly oriented) monofilament strand **20**. In transverse cross-section it is round, although that is not essential. FIG. 10 shows a like amount of strand **20'**, attenuated to increased length and thereby oriented. FIG. 11 shows the same length increment of strand **20'** at an early stage of buckling under axially compressive stress. FIG. 12 shows the same length increment, now designated **20''**, completely buckled into a generally U-shaped configuration such as exists inside the confining chamber. FIG. 13 shows, on a much smaller scale, a longer length of strand **20''**, including several buckled length increments, showing the generally curved arms of the U-shaped configurations (or crimps) stylized to the extent of being shown apart or separated although in the chamber there is little or no such separation. FIG. 14 shows, on an even smaller scale, relaxed crimped strand **20'''** such as is produced according to this invention.

Although the drawings illustrate only a monofilament strand, it will be understood that the term "strand" as used herein includes 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 the nylons (polycarbonamides), e.g., 66-nylon (i.e., polyhexamethylene adipamide), also 6-nylon, 11-nylon, 610-nylon, and fiber-forming copolymers thereof, including terpolymers. Other suitable polymeric materials for strands to be treated according to this invention include most of the thermoplastic fiber-forming materials, such as polyhydrocarbons (e.g., polyethylene, polypropylene), polyesters (e.g., polyethylene terephthalate), polyacrylonitrile and copolymers of acrylonitrile with other vinyl compounds, also copolymers of vinyl chloride and vinylidene chloride, and polyurethanes. This list is simply exemplary and is not intended to be exhaustive of suitable compositions, most or all of which are thermoplastic.

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 strand over the

draw pin. Appropriate processing speeds lie in the range of from one hundred to one thousand yards per minute (y.p.m.), but somewhat slower or faster speeds may be employed. For 66-nylon at an input of 100 y.p.m. and output of 400 y.p.m. (draw of 4X) the draw pin temperature may conveniently be between 150° and 250° C. The speed at which the strand is fed into the stuffer-crimper coincides with the output speed from the drawing zone, of course, and the roll temperature preferably prevents the strand from cooling before entering the crimper.

As previously indicated, preheating of the strand is not required for crimping according to this invention and may not be required for drawing. The moisture content of the strand, if appreciable, may have a deleterious effect upon the desired treatment or its results. In general, therefore, the strand should not be wet, the preferable content of water (and/or any lubricant or softening, swelling, or plasticizing agent or solvent, all of which may be collectively referred to as "moisture") being less than about 10%. A strand at such low moisture content may be considered as essentially dry or moisture-free for the purpose of the present invention. The relative humidity in and about the chamber should not exceed about 20% for the usual textile strand compositions, the upper limit of humidity varying somewhat according to the moisture content and sensitivity of the composition.

While the illustrated three-roll arrangement is preferred at each end of the drawing zone, it is possible to use other roll arrangements, such as godets, if desired. The nip of rolls **32** and **33** may constitute a junction of the drawing and crimping zones, thereby effectively reducing to zero the length of the otherwise intervening path portion mentioned above. 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). Inasmuch as essentially non-slipping contact may be difficult to attain at a pressure that will not damage the strand, additional rolls ahead of rolls **32** and **33** may prove useful. When, as illustrated, the compressive crimping is accomplished by means of a stuffer-crimper, the end of the drawing zone should not be further from the beginning of the crimping zone than about three diameters (measured along the strand path) of the suffing rolls. Thus, in FIG. 7, added pair of nip rolls **82** and **83** are so located, and strand **20'** passes therebetween. 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. In both FIGS. 7 and 8 the strand passes between guide block **75** and overlying clip **77** to center it 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. 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. Such a crimper may have a stuffing chamber with a round bore and a plunger therein as the back-pressure element, for example; also useful is a stuffer-crimper having a frictionally retarded back-pressure device of wheel-like or gear-like configuration, as disclosed in U.S. Patent 3,027,619. Windup of the crimped yarn expelled from the chamber preferably should be synchronized to accommodate the yarn so expelled without, however, withdrawing yarn from ahead of the back-pressure device;

the portion of the cap covering the chamber may be used to control the windup rate, or a sensing device inside the chamber, such as is disclosed in my patent application Serial No. 294,035, filed July 10, 1963, for Strand Crimping, which is well adapted to use with a stuffer-crimper of the type disclosed in U.S. Patent 3,027,619, may be employed.

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. Other benefits and advantages of this invention, which produces crimped textile strands of exceptional bulk and crimp doubtless will become apparent and accrue to those who undertake to practice it as defined in the following claims.

The claimed invention:

1. A process for drawing and bulking yarns of synthetic continuous filaments, comprising the steps of
forwarding an undrawn yarn of synthetic continuous filaments at a predetermined linear rate to the nip of rolls of a stuffer-box crimper;
rotating said nip rolls at a predetermined peripheral rate at least twice as great as said linear rate;
drawing said yarn by the nip of said rolls;
immediately thereafter crimping said drawn yarn within said crimper;
and discharging the crimped yarn from said crimper at a linear rate less than said peripheral rate.

2. Process according to claim **1**, wherein the peripheral rate is about four times as great as said linear rate.

3. Process according to claim **2**, wherein the yarn is composed of nylon filaments.

4. A process for drawing and bulking yarns of synthetic continuous filaments, consisting of the steps of
forwarding a drawable yarn of synthetic continuous filaments at a predetermined linear rate to the nip rolls of a stuffer-box crimper;
rotating said nip rolls at a predetermined peripheral rate at least twice as great as said linear rate;
locating the point of draw at a friction means positioned up-stream of the nip rolls;
drawing said yarn by the nip of said rolls;
immediately thereafter crimping said drawn yarn within said crimper;
and discharging the crimped yarn from said crimper at a linear rate less than said peripheral rate.

5. A process for drawing and bulking synthetic continuous-filament, yarns consisting of the steps
forwarding an at least partially undrawn yarn synthetic continuous filaments at a predetermined linear rate to the nip rolls of a stuffer-box crimper;
rotating said nip rolls at a peripheral rate at least twice as great as said linear rate;
drawing said yarn by the nip of said rolls;
immediately thereafter crimping said drawn yarn within said crimper;
discharging the crimped yarn from said crimper at a linear rate less than said peripheral rate;
and controlling said linear rate of discharge to maintain the frequency of crimp uniform.

References Cited

UNITED STATES PATENTS

2,419,320	4/1947	Lohrke	28—72
3,167,846	2/1965	Iwnicki et al.	28—1
3,177,556	4/1965	Van Blerk	28—1
2,686,339	8/1954	Holt	28—72
2,917,806	12/1959	Spence et al.	19—66
3,111,740	11/1963	Stanley	28—1

LOUIS K. RIMRODT, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,376,622 April 9, 1968

Robert K. Stanley et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 11, "invention" should read -- application --; lines 44 and 45, "crimping" should read -- drawing --; line 45, after "for" insert -- such drawing --. Column 3, line 27, and column 4, line 19, after "Crimping", each occurrence, insert a comma. Column 4, lines 18 and 19, cancel "for Method and Apparatus". Column 5, line 46, "suffing" should read -- stuffing --. Column 6, line 49, ", yarns" should read -- yarns, --; same line 49, after "steps" insert -- of --; line 50, after "yarn" insert -- of --.

Signed and sealed this 11th day of August 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents