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MOVING SIDE WALL CRIMPING PROCESS AND APPARATUS THEREFOR

Filed March 31, 1966

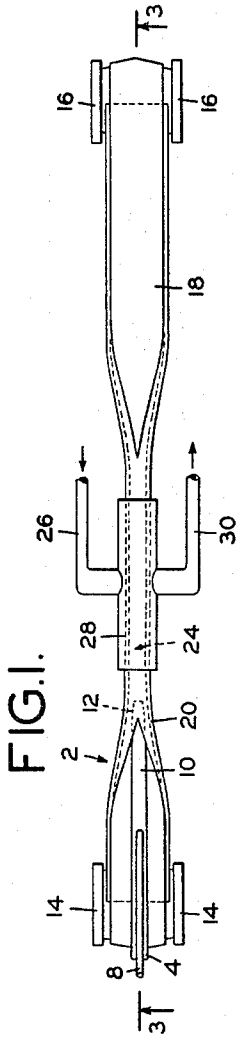


FIG. 1.

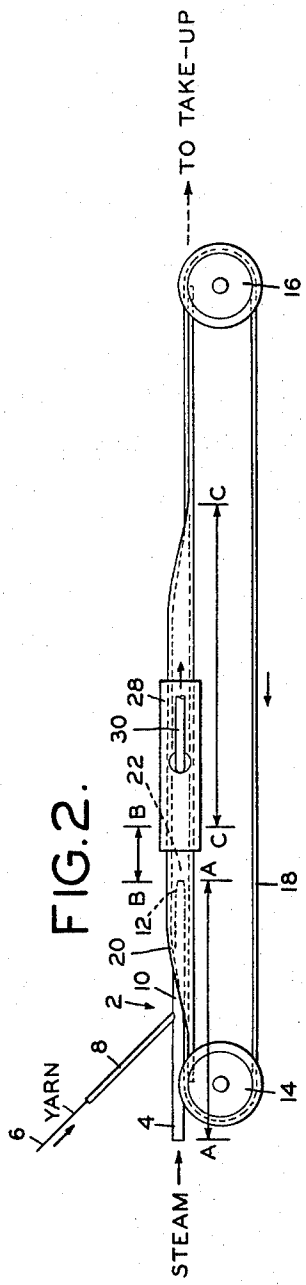


FIG. 2.

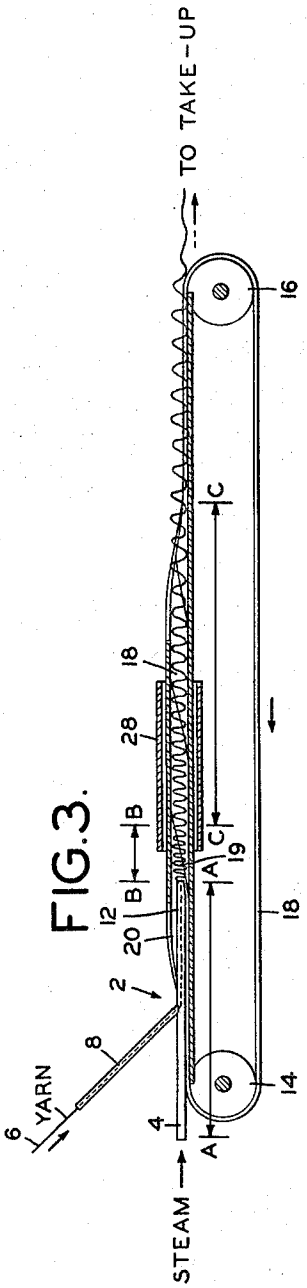


FIG. 3.

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MOVING SIDE WALL CRIMPING PROCESS AND APPARATUS THEREFOR

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ABSTRACT OF THE DISCLOSURE

A process and apparatus for texturing continuous yarns using a fluid medium such as steam to heat plasticize and advance the yarn into a tubular enclosure which is formed by a circular member employed to converge a moving conveyor-type foraminous belt until the edges thereof meet to form said tubular enclosure wherein a jet is positioned to aspirate the plasticized yarn into the tubular enclosure at a rate faster than the removal rate thereof to cause the yarn to accumulate in the form of a plug to impart a helical crimp to the yarn when in said plug. The crimped yarn is advanced from the crimping zone upon the belt and taken up by conventional means.

Several basic methods of texturizing yarn, particularly synthetic yarn, e.g. nylon, are known. These methods include drawing the yarn over a knife edge, passing the yarn through the meshing teeth of driven gears, and the like. For reasons known in the art, these methods have been largely discarded since they do not give random woollike crimp economically. The most common method for crimping synthetic thermoplastic yarn resides in use of a stuffer box or similar device for stuffing yarn. The yarn is crimped using this apparatus by feeding the yarn through nip rolls into a zone of compaction or stuffer box wherein the yarn is compacted by being randomly forced into a plug. The yarn is withdrawn from the stuffer box at a rate less than the feed rate of the yarn to the stuffer box through the nip rolls.

It has also been proposed to texturize or crimp yarn using a fluid or jet texturizing device. One of the earliest patents in this field is U.S.P. 2,852,906 to A. L. Breen, Sept. 23, 1958 entitled: "Method and Apparatus for Producing Bulky Continuous Filament Yarn." According to the process therein disclosed, a stream of air or other compressible fluid is fed rapidly from a confined space to form a turbulent region. The yarn to be treated is then fed into a fluid stream so that the yarn is supported by it and the individual filaments of the multi-filament yarn are separated from each other and whipped about violently in the turbulent region. The yarn so formed has loops or other convolutions at random intervals along each filament and are irregularly spaced on different filaments. The yarn so texturized or bulked is suitable for use as carpet yarn or in garments wherein a good "hand" is required.

Neither of the old processes above discussed provides a random helical crimp which gives an even better hand to carpets or garments made from the yarn so texturized. The yarn from the jet process tends to have loops on the surface whereas the yarn crimped by use of the stuffer box tends to have a "V" or "N" crimp i.e. crimp in one plane. The best crimp is one having both of these features i.e. wherein the crimp is three-dimensional.

It is an object of this invention, therefore, to provide a process for texturizing yarn, e.g. synthetic thermoplastic yarn, especially nylon, to impart thereto a random helical crimp in three-dimensions, the yarn characterized by exceptionally good bulk.

It is still another object of this invention, therefore, to provide a process and apparatus therefor, for crimping nylon or other thermoplastic synthetic yarn which can be performed in one simple operation at high speeds without any sacrifice in yarn properties.

Broadly, this invention contemplates a process for texturizing yarn which comprises crimping said yarn by aspirating said yarn through a zone or jet with a compressible fluid into a tubular zone defined by a moving foraminous material, said material being sufficiently foraminous to permit escape of a sufficient amount of fluid to decrease the pressure on said yarn sufficiently to form a yarn plug in said tubular zone, and taking up the yarn at a rate less than the feed rate to said moving tubular zone, the feed rate and take-up rate being correlated so that a yarn plug of at least ½ inch in length is formed in said tubular zone.

In a particularly desirable embodiment, this invention contemplates a process for texturizing thermoplastic yarn which comprises passing said thermoplastic yarn through a steam jet maintained at sufficient temperature to plasticize said thermoplastic yarn sufficient to be receptive to a crimp, and at a feed rate of at least 500 feet per minute into a moving tubular zone defined by a moving foraminous material, said foraminous material moving at a rate of at least 7.5 ft. per minute and being sufficiently foraminous to permit escape of a sufficient amount of fluid to decrease the pressure on said yarn sufficiently to form a yarn plug in said tubular zone, taking up said thermoplastic yarn from said zone at a rate less than the feed rate of said yarn to said zone, the take-up rate and feed rate being so correlated that a yarn of at least ½ inch in length is formed in said zone.

In a still more desirable embodiment, the invention contemplates a process for texturizing nylon i.e. long chain synthetic polymeric amide which has recurring amide groups as an integral part of the main polymer chain and capable of being formed into a filament in which the structural elements are oriented in the direction of the axis which comprises aspirating said yarn through a steam jet, said steam being at a temperature of 100°–110° C., at rate of 500 feet per minute to 8000 feet per minute into a tubular zone of inside diameter between 3/16 inch and ½ inch and defined by a moving foraminous belt folded over upon itself lengthwise and moving at a rate of between 7.5 feet per minute and 750 feet per minute, said belt being sufficiently foraminous to permit escape of a sufficient amount of fluid to decrease the pressure on said yarn sufficiently to form a yarn plug in said tubular zone, taking up said yarn from said zone at a rate less than the feed rate of said yarn to said zone, the take-up rate and feed rate being so correlated that a yarn plug of at least ½ inch in length is formed in said zone.

The invention further contemplates an apparatus for texturizing yarn comprising a compressible fluid jet having a nozzle of sufficient dimension to jet therethrough, yarn to be texturized, the nozzle of said jet communicating with a tubular zone defined by foraminous material, and means for moving said foraminous material in a longitudinal direction away from said nozzle.

In a particular embodiment of the apparatus of this invention the foraminous material is a porous endless conveyor belt driven by a pair of wheels and wherein there is provided adjacent the nozzle of the jet circular guide means of diameter less than the width of the conveyor belt passing therethrough and by virtue of which the belt folds over upon itself lengthwise to form the tubular zone.

The invention can be more clearly understood by reference to the accompanying drawings in which:

FIGURE 1 is a plan view of an apparatus of my invention;

FIGURE 2 is a side view of an apparatus of my invention;

FIGURE 3 is a section taken along lines 3—3 of FIGURE 1.

Referring to the drawings, **2** is the over-all compressible fluid jet, e.g. steam jet, **4** is the fluid inlet, **6** is the yarn passing into yarn inlet **8** joining the steam in tube **10** which, in the embodiment shown, is a continuation of the fluid inlet or tube **4**. The yarn is aspirated with the steam at a pressure of say 100–120 p.s.i. through nozzle **12**. Wheels **14** and **16** driven by motors not shown, move endless foraminous conveyor belt **18** through the predetermined path. Circular guide means **20** having a diameter less than width of belt **18** causes the belt **18** to fold over upon itself lengthwise as shown in FIGURE 3 forming a tubular zone. The belt unfolds by itself as it moves and approaches wheel **16**. The length of the tubular zone is governed by the type of material comprising the foraminous belt and the type of circular guide forming the belt into a tube. The nozzle **12** communicates with the tubular zone **22** so formed at cooler **24**.

In operation, yarn **6** is fed through yarn inlet **8** and steam or other compressible fluid enters fluid inlet **4** of the compressible fluid jet **2**. The yarn meets the steam in tube **10** and is aspirated through tube **10** into the crimping zone **19** bounded or defined by the moving foraminous belt **18** after passing out of the nozzle **12**. Due to the porosity of belt **18**, the steam escapes therethrough and advancement of the yarn through crimping zone **19** ceases. The yarn forms a plug of compaction in zone B—B as shown in FIGURES 2 and 3 and the yarn is crimped by this compaction. The yarn may then be cooled in cooler **24** comprising cooling gas inlet **26**, cooler body **28** and cooling gas outlet **30**. Cooling gas is passed through cooling gas inlet **26** through to the cooler body **28** which restricts lateral movement of lengthwise folded foraminous belt **18** continuing newly crimped yarn **6**. The cooling gas e.g. air is then taken out of the cooling gas outlet **30**. In zone C—C the yarn is begun to be taken up due to tension applied thereto from winders (not shown) revolving bobbins onto which the yarn is placed. Instead of employing the cooling system as shown in FIGURES 1–3, there can be employed additional or alternate means for introducing chemicals e.g. sizing agents or dyes to treat the yarn immediately after crimping. Subsequent treatment of the yarn will depend upon several factors not the least of which is the use intended for the newly crimped yarn. In operations where the yarn is aspirated through the aspiration zone A—A at a slow speed so as to be under the influence of high temperature for a relatively long period of time and wherein the yarn is aspirated into a slowly moving belt thus increasing the yarn exposure to the temperature, it may be desired to utilize a cooling means such as illustrated in the drawings instead of employing slow cooling as by exposure to the atmosphere at room temperature. It is known that it is not desirable to expose yarn to high temperatures for a period of time since degradation of the polymer constituting the synthetic yarn may occur to a sufficient extent to cause weak spots in the length of the yarn.

It should be realized that the crimp obtained by using the process of the instant invention will vary depending upon certain parameters such as the diameter of the tube **10**; the diameter of the crimping zone **19** defined by the foraminous belt **18**; the temperature of the steam; the rate at which the yarn is aspirated into the crimping zone **19**; the rate of forward movement of the moving foraminous belt **18**; and the speed of take-up of the yarn on conventional winding apparatuses. Generally, utilizing the apparatus shown in the accompanying drawings wherein tube **10** has a inside diameter of ⅛ inch and the crimping zone **19** has a diameter of ¼ inch when yarn is aspirated through tube **10** at a slow rate say 500–600 feet per minute and is aspirated into crimping zone **19** wherein the belt is moving at a slow rate say 7.5 feet per minute, only a moderate crimp is imparted to the yarn. On the other hand, where the feed rate of aspirated yarn into crimping zone **19** is substantially greater say 2000 to 3000 feet per minute at about the same belt speed of about 7.5 feet per minute, a substantially more severe crimp is imparted to the yarn and the yarn is characterized by a higher crimp frequency in terms of crimps per inch. When the foraminous belt is moved forward at a substantially greater rate say 65 to 75 feet per minute and the feed rate of aspirated yarn through tube **10** into crimping zone **19** is say 500–600 feet per minute, a very moderate crimp is observed in the yarn and the yarn so crimped has a low crimp frequency in crimps per inch. Under these same conditions, when the aspiration rate of the yarn through tube **10** is increased substantially to a rate of between say 2000 and 3000 feet per minute, a moderately good crimp is observed and the yarn is characterized by a relatively high crimp frequency in terms of crimps per inch. It should be realized that in all cases the yarn is helically crimped but the degree of 3 dimensional displacement of the yarn in helical form will depend upon the specific process parameters chosen. Generally, when process conditions imparting high crimp frequency are employed, a greater degree of helical crimping is observed than when crimping conditions imparting only a moderate crimp in terms of crimp frequency are employed. In carrying out a process using an aspirating device having a nozzle of ⅛ inch diameter using steam at a temperature of 110° C. wherein the yarn is aspirated into a crimping zone having a diameter of ¼ inch. I prefer to operate the process such that the aspiration rate of the yarn into crimping zone **19** is between 500 ft./min. and 8,000 ft./min. and the forwarding speed of the tube composed of belt **18** is between $\frac{1}{40}$ and $\frac{1}{50}$ of the aspiration rate (feed rate) of the yarn into the crimping zone.

In order to more fully illustrate the nature of my invention and the manner of practicing the same, the following example is set forth. Unless otherwise stated, all speeds are in feet per minute and temperature is in degrees centigrade.

Example I

Using the apparatus shown in the drawings wherein tube **10** had an inside diameter of ⅛ inch and outside diameter of $\frac{3}{16}$ inch 2400 denier, 140 filament nylon 6 yarn was aspirated through tube **10** into the crimping zone 19 of ¼ inch diameter defined by foraminous belt **18** thereby forming a plug having ¼ inch diameter. The yarn was aspirated in zone A—A using steam at a temperature between 100–110° C. at a pressure of 100–120 p.s.i.g. The yarn subsequently advanced was crimped by compaction against the plug formed in zone B—B by virtue of the steam escaping through the pores of the foraminous belt **18**. The yarn was taken up downstream in zone C—C at a rate less than the feed rate of the yarn to the crimping zone **19**. Throughout the process the feed rate of the yarn was varied from about 500 ft./min. to about 2,000 ft./min. The take-up rate was always less than the feed rate and generally coordinated to maintain a plug having a length of about 12–15 inches. A helical crimp was imparted thereto having a crimp elongation after boil of about 20%.

It is readily seen therefore, that I have provided a significant advance in the art of producing bulky filaments by jet texturizing within a zone of compaction providing an industrially suitable process for producing yarn having a helical crimp. Other advantages e.g. use of lower temperatures than generally advocated will be observed by those skilled in the art.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but it is recog-

nized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A process for texturizing yarn, which comprises:
(a) advancing a continuous yarn at a constant feed rate onto a moving foraminous material,
(b) converging the foraminous material to form a moving tubular zone which substantially surrounds the yarn,
(c) introducing a source of fluid into the tubular zone under sufficient pressure to produce a yarn plug therein, and
(d) removing the yarn from the tubular zone at a rate less than the feed rate whereby a yarn plug at least ½ inch in length is maintained in said tubular zone.

2. A process for texturizing yarn according to claim 1 wherein the yarn is thermoplastic.

3. A process for texturizing yarn according to claim 1 wherein the fluid is steam maintained at sufficient temperature to plasticize said yarn to impart crimp thereto.

4. A process for texturizing nylon according to claim 3 wherein said steam is at a temperature of 100–110° C., said feed rate is at a linear speed of 500–8000 feet per minute, said tubular zone has an inside diameter between 3/16 and ½ inch, said moving foraminous material is a moving foraminous belt lengthwise folded over upon itself and moves at a rate of between 7.5 and 750 feet per minute.

5. A process according to claim 4 wherein said belt is moved at a rate of between 65 and 75 feet per minute and the feed rate of the yarn into the tubular zone is 500–600 feet per minute.

6. A process according to claim 4 wherein the yarn is aspirated into the said tubular zone at between 500 and 600 feet per minute and said belt is moved at a rate of about 7.5 feet per minute.

7. A process according to claim 4 wherein the feed rate of said yarn into said zone is between 2000 and 3000 feet per minute and said belt moves at a speed of about 7,5 feet per minute.

8. A process according to claim 4 wherein said yarn is aspirated into said zone between 500 feet per minute and 8000 feet per minute and said belt is moved forward at a rate of between 1/40 and 1/50 of the feed rate of said yarn into said zone.

9. An apparatus for texturizing yarn, which comprises,
(a) a compressible fluid jet positioned in close proximity to a movable foraminous belt,
(b) means positioned intermediate the length of the belt for converging the edges of said belt together to form a tubular section therefrom, said jet extending into said tubular section,
(c) an inlet for introducing a continuous yarn into the backside of the jet,
(d) a second inlet for introducing a pressurized fluid into the jet to force said yarn through said jet into the tubular section, and
(e) means for advancing the foraminous belt to remove the yarn from the tubular section.

10. Apparatus according to claim 9 wherein the foraminous belt is an endless conveyor belt driven by a pair of wheels.

11. Apparatus according to claim 10 wherein the converging means is a circular-shaped member having an inlet and outlet in the sides thereof for passing a gaseous medium through said circular-shaped member transverse to the travel of yarn therein.

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LOUIS K. RIMRODT, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,389,445 June 25, 1968

Robert Z. Schreffler

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

Column 5, line 18, the claim reference numeral "1" should read -- 2 --.

Signed and sealed this 27th day of January 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents