March 13, 1962 J. E. BROMLEY ETAL 3,024,517

METHOD OF TREATING FILAMENT YARN

Original Filed May 18, 1959 3 Sheets-Sheet 1

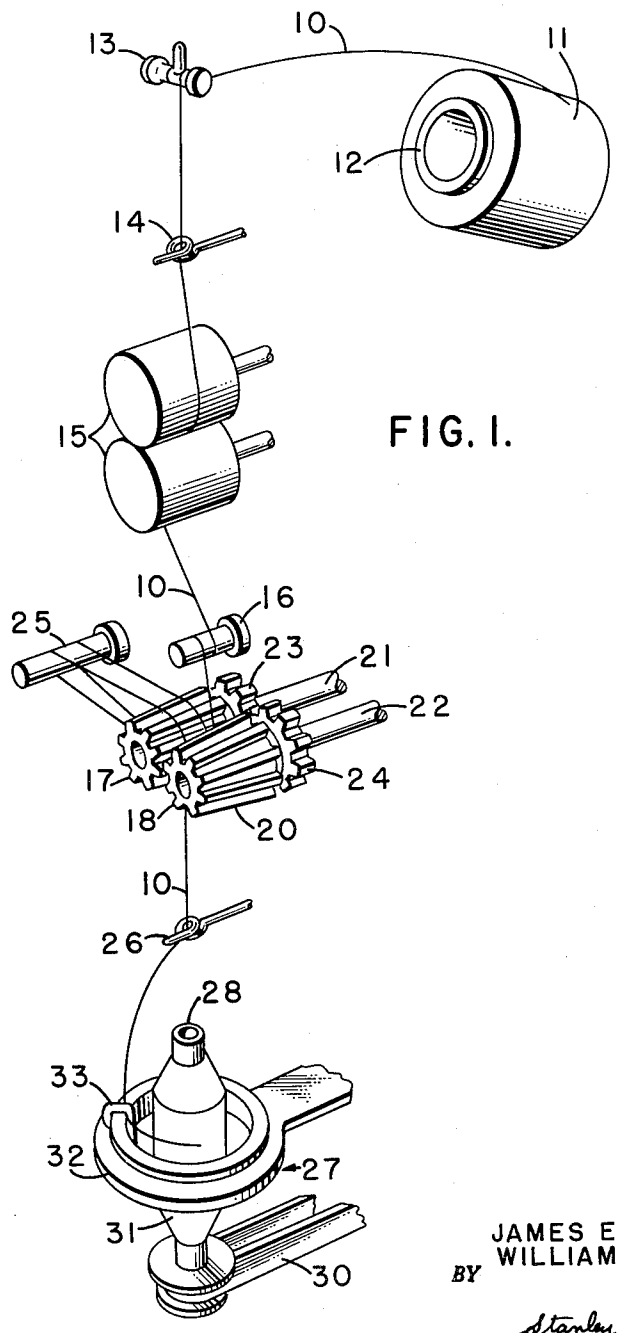

FIG. 1.

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Original Filed May 18, 1959 3 Sheets-Sheet 2

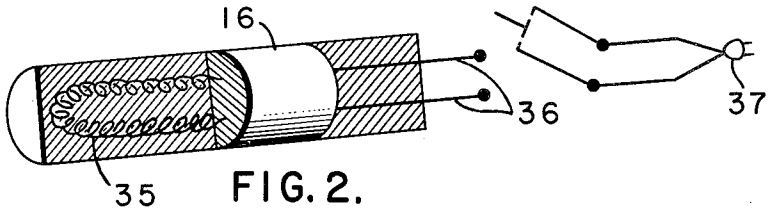

FIG. 2.

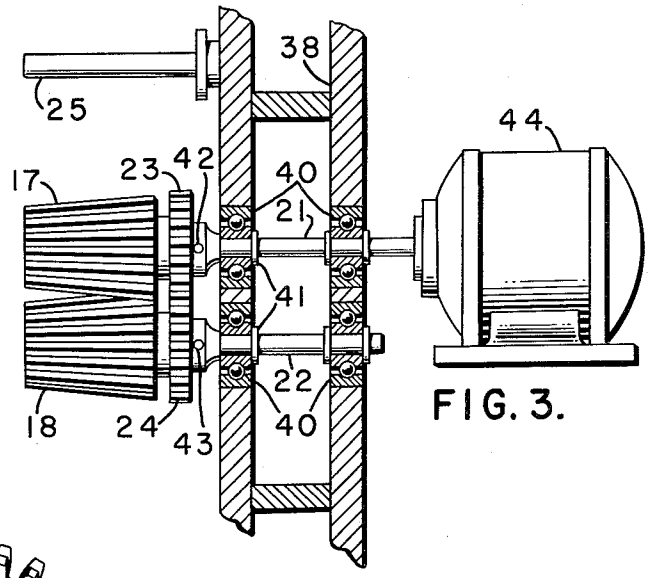

FIG. 3.

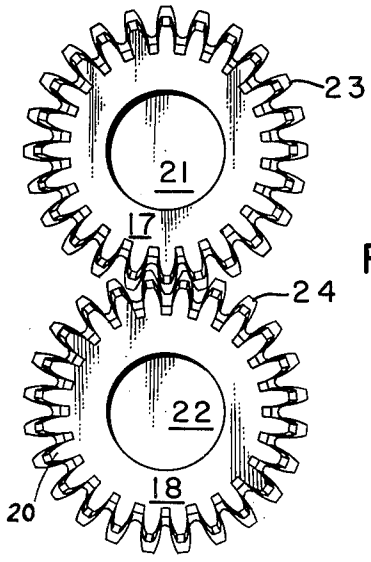

FIG. 4.

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Original Filed May 18, 1959 3 Sheets-Sheet 3

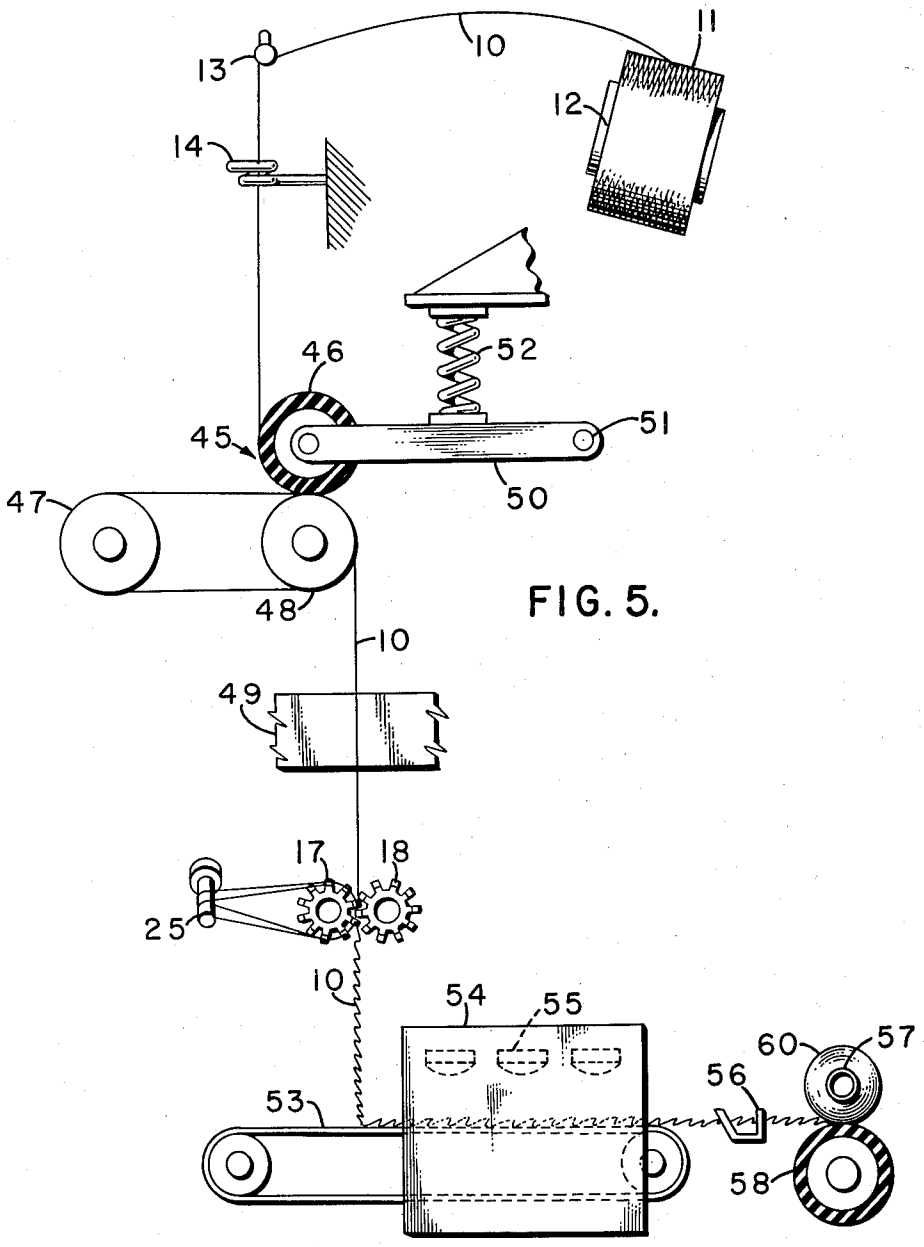

FIG. 5.

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3,024,517

METHOD OF TREATING FILAMENT YARN

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Original application May 18, 1959, Ser. No. 813,902. Divided and this application Sept. 19, 1960, Ser. No. 56,983

6 Claims. (Cl. 28—72)

This invention relates to a method and apparatus for processing cold-drawable textile filaments formed from a thermoplastic polymer. More particularly, this invention relates to a method and apparatus for continuously stretching and continuously deforming substantially parallel synthetic continuous textile filaments of the nylon type, whereby such filaments are rendered potentially crimpable.

This application is a division of application Serial No. 813,902, filed May 18, 1959.

Continuous synthetic cold-drawable filaments can be formed from nylon polymers and the like by the wet, dry, or melt spinning processes, the last mentioned process being employed in the commercial production of most, if not all, of the nylon filaments made today. The freshly formed nylon filaments generally are not highly oriented and have relatively low tensile strengths as compared to highly oriented nylon filaments in which the molecules are aligned or oriented in the direction of the filament axis. To orient nylon filaments and thereby to increase greatly the strength thereof, they may be stretched to a desired extent by attenuating them by means of thread advancing devices such as two godets or two other thread advancing means operated at a predetermined peripheral speed differential therebetween. In the cold-drawing of continuous filaments of nylon it is known that stretching is accomplished advantageously when the point at which stretching occurs is fixed or localized by mechanical or thermal means. The localization of the stretch point is carried out ordinarily with the employment of a yarn braking device or the like located between two stretching roll devices.

Unlike wool, synthetic filaments are relatively straight and have a smooth, slick surface, thereby not being particularly adapted for spinning into spun yarn by the conventional spinning systems. To facilitate the carding and/or combing and drafting operations to which synthetic staple fibers are subjected in connection with spinning them into spun yarn, it is essential to crimp them so that they will have a satisfactory contour or pattern to permit spinning thereof into spun yarn by means of conventional textile processing equipment. Numerous devices and processes have been proposed to impart this desired crimp or crinkle to synthetic continuous filaments. One known form of a crimping device uses toothed gearing or serrated engaging wheels that are heated and adapted to receive the straight continuous filaments and to shape same by compressive forces into a crimped configuration.

While continuous filament yarns have the advantage of greater evenness and superior strength, they have several undesirable properties including low heat insulating values, lack of bulkiness desired for some end uses, and low covering power. Many attempts have been made in the past to impart some of these desirable properties of spun yarn to continuous filament yarn. In addition to the fact that the expense of manufacturing the yarn is increased considerably, there are unfortunately certain well recognized disadvantages associated with the prior devices and methods for imparting bulk to continuous filament yarn.

An object of this invention therefore is to provide a simple, rapid, and economical method for commercially producing a thermoplastic continuous multifilament or

monofilament yarn having a fluffy, stretchable character and possessing many properties associated with spun yarn while retaining many properties associated with filament yarn such as strength and freedom from pilling. Another object of this invention is to provide a continuous method for drawing and deforming nylon filaments in a single operation so as to render same potentially highly crimpable. Still another object of this invention is to provide a method for simultaneously deforming and cooling nylon filaments immediately after said filaments are oriented by a drawing operation. A further object of this invention is to provide a method for producing oriented nylon filaments having potential crimpability. A still further object of this invention is to provide an improved stretching and deforming apparatus for processing nylon or the like. A yet further object of this invention is to provide an apparatus for processing cold-drawable synthetic filaments with which unstretched or unoriented continuous filaments are fed by a power driven feed roller through a heat-stretch zone wherein the filaments are heated and stretched and from which the filaments are fed between positively driven intermeshing toothed wheel members, the teeth of which are in closely spaced adjustment, and a desired number of times around one of said members in such a manner to provide reduced tensioning with each wrap and a separator bar or roller in spaced relationship therewith and axially askew with respect to the axes of said members.

Other objects and advantages of the present invention will become apparent from a study of the following specification, claims, and drawing. Preferred embodiments of the apparatus of this invention will now be described with reference to the accompanying drawing wherein:

FIGURE 1 is a schematic view in perspective with principal parts in location illustrating one arrangement of apparatus suitable for preparing the potentially crimpable thermoplastic filaments of this invention;

FIGURE 2 is a fragmental view on a larger scale in perspective partly in axial section illustrating with more particularity the yarn heating device of the apparatus herein disclosed;

FIGURE 3 is a detailed fragmental plan view illustrating an organization of two tapered crimping toothed wheel members and a fixed spacer bar, as well as two externally contacting spur gears operatively associated with said members to drive same;

FIGURE 4 is an elevational view in section illustrating the teeth of the wheel members in closely spaced engagement and the teeth of the spur gears in working contact; and

FIGURE 5 is a schematic view in front elevation with principal parts in location illustrating another arrangement of apparatus of the present invention with which the stretched and deformed filaments can be subjected to an additional heat treatment while relaxed to develop the potential crimpability therein.

In these various figures the same reference numerals designate like parts.

In accordance with this invention there is provided an improved stretching and deforming machine for processing nylon or like synthetic continuous filament yarn, the machine being constructed for highly efficient and economical operation. This is made possible by the novel construction and arrangement of a feed roll assembly and a set of drawing and deforming toothed wheel members, together with means for heating the yarn such as a heated draw or stretch pin, a heated plate, a heated tube, and the like interposed between the said roll assembly and said members. From a suitable source the yarn is fed to the said feed roll assembly after being passed around or through a suitable tensioning device. At least one of the rolls is positively driven. The objectives of

the roll assembly are the provision of a supply of yarn at a predetermined rate and the provision that the yarn will not slip therethrough or therearound due to the stretch tension subsequently applied. In the yarn path forward with respect to the roll assembly and the heating means there are disposed a pair of toothed wheel members driven in unison and intermeshing in close relationship without coming in contact with each other. At least one of said members is positively driven at a predetermined increased speed relative to the delivery speed of the roll assembly such that a stretch is imparted to the yarn between the said roll assembly and said members. The yarn normally advancing in the heat-stretch zone defined by the roll assembly and the members and in which the yarn heating means is disposed ordinarily contacts the surface of said heating means to heat the yarn as desired with stretching of the filaments occurring continuously between the roll assembly and the members, including when the filaments are in contact with the yarn heating means where most of the attenuation of the filaments is localized. The yarn is directed in operation between said members and preferably around part of the periphery of one of the members and thence around part of the periphery of a spaced apart roller or separator bar for a desired number of times with the yarn taking a path that is progressively longitudinally forward with respect to the point where said yarn initially is passed between the toothed wheel members. By proper spacing of the roller or separator relative to the wheel members, the yarn is intermittently engaged and disengaged between the members either in a random or definite pattern. The members not only serve to deform the filaments of the yarn but also function to cool rapidly or to quench and thereby to harden them as they pass therebetween. Hence, the members are made preferably of heat conductive material. After being stretched and deformed in such manner, the yarn is taken up by suitable means in an orderly form. In accordance with an added feature of this invention the yarn after being stretched and deformed by the toothed wheel members but before collection thereof is subjected to an elevated temperature while little or no tension to develop substantially the potential or latent crimp formed therein by the preceding treatment. In such an arrangement nylon yarn may be stretched at a draw ratio between 1.0 to 1.1 and 1.0 to 6.0 and deformed in accordance with the present invention without difficulty at filament through-put speeds up to and above 1000 yards per minute.

In the continuous filament yarn treating apparatus shown schematically in FIGURE 1 to which reference is made now in particular the thermoplastic cold-drawable yarn indicated by numeral **10**, such as nylon and the like and composed of a bundle of smooth substantially parallel filaments that have not been fully oriented is supplied from a yarn source. Since the yarn is not completely oriented, it is necessary to extend the yarn to be process in order to obtain the optimum degree of molecular orientation therein. The yarn source can be, for example, yarn package **11** previously doffed from a conventional spinning machine. While the invention will be described primarily in connection with an apparatus which employs a yarn package so-doffed, it is to be borne in mind that this is merely for the purpose of convenient illustration and in no sense of limitation since apparatus in accordance with the present invention likewise may be employed readily for processing continuous yarn which has not been doffed previously from a spinning machine.

In operation, as shown, yarn **10** is passed over and around one end of bobbin **12** or other yarn holder, such as a pirn or cone holding a yarn source. The yarn **10** is threaded conventionally around snubbing bar **13** which functions as a simple, uncomplex tensioning device to assist in maintaining an orderly and uniform supply of yarn. It will be perceived readily that other tensioning devices such as the gate type can be used instead of the tensioning device shown or that the need of a tensioning device may be eliminated entirely. From the tensioning device or bar **13** the yarn **10** is passed through a yarn guide **14**, if needed, and then to a rotatably arranged thread advancing means **15** that withdraws the yarn from bobbin **12** and supplies same at a controlled supply rate and that is operated at a first delivery speed. As shown, means **15** comprises a pair of suitably mounted feed rolls, at least one of which is positively driven. The rolls have parallel axes and engage each other in operation to nip sufficiently the yarn passing therethrough so that slippage or free-flight of the yarn between the rolls is prevented.

From thread advancing means **15** the yarn **10** is led downwardly and around heated stretch or draw pin **16** where the majority of the attenuation of the yarn occurs. The pin is mounted to be stationary and axially askew with respect to the axes of the feed rolls and has a smooth yarn contact surface, details of the pin being shown with more particularity in FIGURE 2. After being passed around pin **16** a desired number of times, the yarn **10** is directed downwardly between rotatably mounted and axially parallel wheel members **17** and **18** having a plurality of uniformly circumferentially spaced and longitudinally extending teeth **20** that mesh in closely spaced adjustment, said members being spaced a short distance below pin **16**. Members **17** and **18** are keyed to shafts **21** and **22** respectively or are integral therewith. To drive said wheel members in unison there are provided external contacting spur gears **23** and **24** having horizontally parallel axes, that mesh and are fixedly mounted on shafts **21** and **22**. As the teeth **20** mesh, the yarn is subjected to laterally applied strains increasing and decreasing in intensity as the yarn approaches and leaves the horizontal plane in which the axes of said wheel members lie and where said teeth engage the notches defined by said teeth to the greatest extent. After being directed around part of the periphery of one of the members, the yarn is directed tangentially therefrom and then around part of the periphery of a roller **25** mounted on a supporting frame for free rotation and positioned adjacent roll **17**. A spacer bar fixedly mounted to a frame may be a suitably equivalent spacing means for roller **25**. The yarn **10** is wound around member **17** and roller or spacing means **25** a plurality of times as shown in FIGURE 1. The axis of said roller **25** is positioned at a slightly inclined angle with respect to the axes of members **17** and **18** so as to insure proper longitudinal distribution on and advancement along the peripheries of member **17** and roller **25**, thus preventing superposition of the wraps thereon. In other words, the yarn wrapped around said members and the horizontally spaced roller associated therewith assumes generally the shape of a flattened helix, the convolutions of which are spaced apart, whereby the yarn advances along wheel member **17** from the inboard end thereof to the outboard end thereof during rotation of the members **17** and **18**.

By correct positioning of the spacing means **25** with relation to the toothed wheel members **17** and **18**, the moving yarn is periodically engaged and disengaged between the wheels either in a random or definite pattern. Where there is random reengagement, the segments of the filaments forming the ridges of the corrugations induced during initial deformation do not form ordinarily the same part of the corrugations previously formed, whereby the distortion and deformation occurring during the operation fortuitously are induced. It is seen further that the temperature at which the yarn is directed between the wheel members progressively diminishes as the yarn moves longitudinally forward on wheel members **17**. Stated another way, where the yarn is passed a plurality of times between the toothed wheel members **17** and **18**, the temperature at which the first deformation is conducted is more elevated than during subsequent reengagements of the yarn between the said wheels. Next, the yarn after

forming the outermost convolution is fed vertically downwardly through yarn pigtail guide **26** or the like, if needed, which is suitably mounted and located below said wheel members.

The yarn is then taken up in an orderly arrangement in a conventional manner by a suitable form of package building apparatus. As shown in FIGURE 1, the yarn **10** is taken up by a ring twisting assembly generally denoted by reference number **27** which comprises a bobbin **28** adapted to be rotated by driven belt **30** in a conventional manner to collect a supply of the yarn indicated by numeral **31**. The assembly further comprises a conventional vertically reciprocatable spinning ring **32** carrying a ring traveller **33** adapted to revolve freely about the bobbin **28** as the yarn is twisted a desired amount and wound on the bobbin.

It may be desirable in accordance with an important feature of this invention to provide a uniform taper or bevel to at least one of the toothed wheel members, as illustrated, while maintaining the axially parallel relationship thereof for more even operation and, among other things, to assist in preventing possible jamming of the wheels due to breakage of the yarn **10**. Hence, when yarn breakage occurs, the yarn will tend to move outboard along said wheel instead of perhaps becoming accumulated and entangled thereon. Where the wheel members **17** and **18** are tapered and the yarn progresses longitudinally along these members in the converging direction, the extent to which the yarn is deformed into a corrugated shape as it passes between the members from the normally unbent shape will diminish with the frequency of the corrugations remaining the same. Hence, it will be observed that as a result of employing tapered wheel members, the yarn is subjected to a reduced tension between each successive engagement of the yarn and the wheel members. When tapered, the wheel members have the shape of a truncated cone instead of being cylindrical. It should be understood that the reduced tensioning may be attained by other means.

Reference is made now to FIGURE 2 where one form of a yarn braking device or stretch pin **16** which is called sometimes a snubbing pin is shown in more detail and which is employed according to the present invention, said pin being non-rotatably mounted, preferably in the position indicated in FIGURE 1. The cross-section of the pin for best results is preferably circular but also may be elliptical or have any other suitable cross-sectional design. Since the yarn **10** frictionally engages the surface of the pin as it travels therearound, the surface of yarn contact area thereof for best results is smooth or moderately smooth and is made of a mechanically very resistant-to-wear material. The stretch pin **16** can be made of a wide variety of wear resistant materials including stainless steel, chromium plated steel, aluminum, a bonded ceramic and the like. Preferably, it is made of aluminum flame-plated with aluminum oxide or flame-plated with sintered tungsten carbide which is extremely resistant to wear and performs efficiently at the temperatures employed. The stretch pin **16** is provided with heating means **35** so that the yarn passed therearound is heated to a predetermined elevated temperature. The heating of the pin can be achieved in a suitable manner, e.g., by heated fluid inside thereof or by internal electric resistant heating which is preferred in view of its convenience in operation. It is also contemplated within the purview of the invention to provide a stretch pin with a high frequency heating means. As shown in FIGURE 2, stretch pin **16** is provided with an electrically energizable heater element **35**, electrical power being supplied thereto through conductive lines **36** having a terminal plug **37** adapted for reception in a power outlet source. The heater element may be embedded in the pin as shown or it may be part of a removable cartridge or insert. While there seems to be no theoretical limit for the diameter of pin **16**, it is desirable to stay within a reasonable range from a practical standpoint.

Reference is now made to FIGURE 3 where there is shown a frame **38** or mounting wall being adapted for suitable journalling of shafts **21** and **22** therein. In the frame are bearings **40** for supporting shafts **21** and **22** and for permitting free rotation thereof, the rings **41** of which are adapted to register with said frame to prescribe the axial movement of said shafts. Members **17** and **18**, together with a pair of externally contacting spur gears **23** and **24**, are mounted on shafts **21** and **22**, said members being keyed fixedly thereto at **42** and **43**. At least one of said shafts is driven positively by a suitable drive mechanism, such as by an electric motor **44** (as shown), gearing, belts, and the like.

As can be seen in FIGURE 4, gears **23** and **24** contact during operation, but teeth **20** extending longitudinally of wheel members **17** and **18** are in close but spaced adjustment. To be effective for the purpose of the invention, the lateral pressure applied to the yarn **10** passing between members **17** and **18** to deform same into a corrugated shape is applied mostly along the apices of teeth **20** and not in the grooves therebetween. This is accomplished by proper selection of the height and slope of the teeth. The amplitude of the corrugations formed in the yarn is controlled as a function of the height of the teeth **20**, as well as the extent to which the teeth engage in the grooves. The frequency of the corrugations, that is the number of alternate ridges and grooves formed in a given length of yarn, is of course controlled as a function of the number of teeth disposed along a given segment of the circumference of the wheel members **17** and **18**.

With reference now to FIGURE 5 where one complete yarn treating installation is shown, including means for developing the potential or latent crimpability in the yarn, thermoplastic continuous filament yarn **10** which is not fully oriented is withdrawn from a yarn package **11** and is passed over one end of bobbin **12** or other yarn holder. The yarn is passed around snubbing bar **13** and through a pigtail guide **14**, after which it is led through a rotatably mounted feed roll assembly designated generally by numeral **45**, said assembly comprising idler roll **46** having a rubber cot and idler roll **47** associated with driven roll **48**. Shaft **50** is attached at an end of roll **46** and is mounted at the other end at point **51** for pivotal movement of roll **46** about **51**. Coiled spring **52** is fixed at one end with the other end being attached to shaft **50** as indicated so as to bias swingable idler **46** into frictional engagement with roll **48**. The yarn is passed helically around driven feed roll **48** and idler roll **47** and then contacts heater plate **49**, the surface of which is stationary and maintained at a suitable temperature by internal electrically energizable means. The number of laps of the yarn around these rolls is sufficient to prevent slippage of the yarn through the roll assembly **45**. The yarn then is passed through the toothed wheel members **17** and **18** which are rotated normally at a greater peripheral speed than the peripheral speed of the driving roll **48**, thereby tensioning and stretching the yarn between said feed roll assembly and said members. The drawn yarn is passed helically about wheel **17** and separator roll **25**.

In accordance with an embodiment of the present invention, the drawn, deformed thermoplastic filament yarn is subjected to a final heat treatment in a hot aqueous medium such as steam or by dry or combination of both in a relaxed or substantially relaxed condition. This operation as mentioned above develops the potential crimpability induced in the yarn by the prior operation and simultaneously sets the thus-developed crimp, thereby imparting enhanced bulkiness, crimpiness, and stretchability to the yarn. As shown, the yarn is permitted to fall onto a conveying means **53**, as for example an endless driven belt. For more efficient operation, the yarn may be layed onto such a belt in a zig-zag pattern by means of a traverse piddler (not shown). Belt **53** carrying the yarn is passed through a heating zone in cabinet

54 having a radiant heat applicator means 55, such as an array of heating lamps, thus developing the crimpiness in the yarn. It is to be understood, of course, that other apparatus arrangmeents can be employed for subjecting the yarn to an elevated temperature while under little or no tension. Without being excessively tensioned the yarn is cooled. This may be accomplished by passing the yarn without undesirable tensioning for a short distance through the air, excessive tension being avoided because the developed crimpiness may be destroyed thereby. Thereafter, the yarn is taken up in an orderly manner. As illustrated, traverse guide 56 lays the treated yarn on a bobbin 57 surface driven by roller 58 to form a yarn package 60. It will be appreciated that the speed of yarn take-up on bobbin 57 will be coordinated properly with the delivery speed of the yarn on means 53 so that undue tensioning therebetween and excessive yarn accumulation on means 53 are prevented.

In accordance with this invention, it has been discovered that filament yarn of a thermoplastic polymer which is not fully oriented can be advantageously treated to render same potentially crimpable, and capable of being easily transformed in a yarn having increased elasticity or stretchability and improved bulkiness, this being accomplished in a useful, rapid, and economical method. More particularly, the method of this invention comprises providing a source of not fully oriented continuous filament yarn in the form of a monofilament or bundle of filaments having little or no twist, the filaments being nylon or the like. The yarn is continuously passed through a stretching zone wherein the filaments are heated to an elevated temperature, such as by passing same around a heated stretch pin or heated plate interposed in said zone. Immediately after leaving the stretching zone, the filaments are deformed into a corrugated shape having alternate ridges and grooves while being cooled by passing between the engagements of toothed wheels, the teeth of which are fitted together in closely spaced adjustment. The filaments are redeformed intermittently into a corrugated shape a number of times by being passed between said wheels a corresponding number of times, each subsequent redeformation occurring at a somewhat lower temperature. Where tapered wheels are employed, the tension to which the yarn is subjected between each successive engagement of the yarn and the wheels is decreased. The yarn which is markedly potentially crimpable thereafter is collected. An additional operation whereby the crimp is developed includes subjecting the yarn while relaxed to another heat treatment as above described.

The method of the present invention is applicable to a wide variety of continuous filament yarns, the requirement being that the yarn is made from a thermoplastic fiber-forming resin and which can be extended by drawing and then show increased molecular orientation along the filament axis. The yarns may be formed by known techniques from these resins, including melt extrusion, wet spinning processes, and dry spinning processes. As examples of fiber-forming synthetic polymers which are included in the thermoplastic fiber-forming resins may be mentioned polyethylene; polypropylene; polyurethane; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of mono-olefinic compounds copolymerizable therewith, such as, for example, vinyl chloride; homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefinic compound copolymerizable therewith and polymer blends containing combined acrylonitrile in a major proportion; copolymers of vinyl chloride and acrylonitrile; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polyethylene terephthalate and the polyester derived from terephthalic acid and bis-1,4-(hydroxymethyl) cyclohexane; linear polycarbonamides such as, for example, polyhexamethylene adipamide, polyhexamethylene sebacamide, polymeric monoaminomonocarboxylic acids, such as polymeric 6-amino caproic acid; and other fiber-forming thermoplastic polymers. Mixtures of such fiber-forming synthetic polymers also can be used. The process of this invention is applicable particularly for the treatment of yarn generically referred to as nylon, including nylon 66, nylon 4, nylon 6, nylon 610, nylon 11, and their fiber-forming copolymers thereof e.g., 6/66, 6/610/66, 66/610, etc.

While the present process is suitable for treatment of yarn whose filaments have a normal cross-section such as that produced where a spinneret having circular shaped orifices is employed during the manufacture thereof, unusual effects may be obtained by processing yarns having a non-circular cross-section or having an axial passage in accordance with the present invention. For example, when yarn composed of a plurality of continuous filaments having a body section and a plurality of finned sections or legs integrally joined to said body and radially disposed upon the surface of and extending longitudinally of the body, such as yarn of X- or Y-shaped cross-section, is subjected to the treatment in accordance with the instant invention, the resulting yarn has increased covering power, resiliency, and a crisp feel. The number of fins may be two, three, four, or more; and yarns having the fins are prepared by conventional methods, such as by employing during spinning a spinneret adapted to produce filaments having the desired number of fins or legs. It has been found that the yarn having the non-circular cross-section and whose bulk has been enhanced by the method and apparatus of the present invention is excellent for rugs and the like.

Twisted yarn can be processed as well as untwisted yarn, the requirement being that the yarn is not fully oriented. However, it is preferred to start with a source of yarn having zero twist or substantially no twist. Pretwisting of the yarn is generally unnecessary and for economic consideration is preferably avoided. The denier of the thermoplastic yarn can vary considerably, as well as the denier of the individual filaments, the ordinary deniers of commercially available yarns being completely suitable. Yarns having different compositions and deniers can be combined before being processed to produce novelty effects.

The temperature at which the yarn heating means is operated depends upon many factors including the type of yarn, the yarn linear speed, and the construction thereof. The temperature of the yarn should be elevated preferably to a temperature below the temperature at which adjacent filaments will stick during the process. However, the temperature should be sufficient so that the yarn will be deformed or distorted by the intermeshing of the teeth of the stretching wheels without undue filament breakage. The temperature to which the yarn is subjected may be in the range of 150° C. to 250° C. when nylon 66 is processed. The surface temperature of the yarn heating means will depend on the many factors, such as the denier of the yarn and the speed of the yarn.

By employing the above-described apparatus and process, one produces a potentially or latently crimpable yarn which can be changed easily into a bulked, highly crimped, stretchable continuous filament yarn. "Bulk" refers to the relative volume occupied by a given weight of yarn. Hence, yarn having increased bulk, such as that produced in accordance with the present invention, has greater covering power and warmth. "Crimped" refers to the fact that the filaments contain many crimps, crinkles, curls, and the like which bend in and out in a sinuous pattern along the length of the filaments and which may be in one or more planes. "Stretchable" refers to the fact that the yarns produced in accordance with this invention are elastic and have the ability to accept a slight longitudinally applied stress and thereby to become easily extended a considerable length without permanent elon-

gation thereof. For example, the yarn can be elongated 10 to 100 percent or more from its untensioned or relaxed length and immediately recover from this elongation in the nature of the so-called "stretch-yarn." It is preferred for some end uses to develop the potential crimpability of the yarn after same has been converted into a textile article. For instance, the stretched and deformed yarn prior to the final heat treatment advantageously may be tufted into a carpet after which the heat treatment is applied. The tufts of yarn disposed on the face of the carpet will bulk to a notable extent, thereby imparting more luxurious appearance to the carpet. In such a manner the potential crimpability in the yarn which is on the back of the carpet and in the backing material, since it is tightly held at these points, will not be developed, thereby providing an overall more economical utilization of the yarn. It will be noted also that the tufting operation is made more convenient when the crimp is subsequently developed.

The following is an example of the above-described method of treating yarns and filaments of this invention.

Example

The filaments used as a yarn source were prepared by melt spinning polyhexamethylene adipamide, the cross-section of which was Y-shaped. A yarn composed of 68 of these undrawn filaments, each of which had a denier of 60 and a twist of zero turns per inch, was wound (from a spinning machine) onto a bobbin for treatment.

Apparatus corresponding to that in FIGURE 1 was used to treat the yarn. The yarn was unwound for treatment from the bobbin by passing same through a pair of positively driven feed rolls, the rate of withdrawal being about 100 yards per minute. From the feed rolls the yarn was led onto and around a stationary stretch pin one time, the yarn movement describing a helical path therearound. The surface temperature of the pin was maintained at 210° C. by an electric resistant heater located inside the pin and controlled by a thermistor temperature sensing control device. The yarn was fed between two metal toothed wheels meshing but not having contacting teeth. The wheels were driven in unison at a predetermined speed so that a stretch of about 400 percent occurred in the yarn between the feed rolls and withdrawal from these wheels. The yarn was passed through the wheels for an additional three times; before each pass the yarn was directed around a spaced roller. Thereupon the yarn was collected on a conventional ring twister assembly.

A tufted carpet was produced from the yarn so treated. The carpet was subjected to live steam at an elevated temperature of 130° C., thereby developing the potential crimpability therein. The resulting carpet had a fluffy, bulky appearance and possessed an aesthetic appeal.

From the foregoing it is seen that the advantages of the present invention are many. The method results in the production of yarns having desirable bulk and is broadly applicable to produce such yarns from a wide range of cold-drawable filaments manufactured from thermoplastic resins. The improved device for processing continuous filaments, for example, of the nylon type, which may be run at a high speed and high efficiency requires little operator attention. The construction and arrangement of the device make it possible to convert at moderate expense existing textile processing equipment such as a draw twister adapted for nylon processing into a machine of the type disclosed and claimed herein. By relatively simple adjustment the apparatus of the present invention can be adapted easily for the production of yarn having a low crimpability to a high crimpability. The inherent properties of the treated yarn are such that they impart numerous and desirable properties in woven, non-woven, and knitted fabrics. Yarns composed of non-circular cross-sections and processed in accordance with the present invention have increased resiliency and enhanced covering power eminently suitable for rugs, carpets, and the like.

The term "yarn" is used in the specification and in the claims as referring to continuous multifilaments, as well as to a continuous monofilament.

Many different embodiments of the invention may be made without departing from the spirit and scope thereof. For example, while one yarn treating unit is illustrated in the annexed drawing, it will be appreciated readily that the apparatus of the instant invention may be provided with a plurality of identical yarn processing units along its length or having two banks of such points in back to back relationship. Moreover, novelty effects of various sorts may be imparted to the yarn by irregular or regular variations in the yarn speeds and stretches. Furthermore, it will be appreciated that an undrawn thermoplastic yarn may be treated together with a drawn yarn or with a yarn which is not thermoplastic such as regenerated cellulose yarn. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments shown and described herein, except as defined in the appended claims.

What is claimed is:

1. A method for texturing a continuous filament yarn made from a thermoplastic polymer whereby potential crimpiness is imparted thereto comprising the steps of providing a source of a molecularly orientable continuous filament yarn made from a thermoplastic polymer, continuously passing said orientable yarn through a heat-stretch zone, heating the yarn in said zone to an elevated temperature and attenuating the yarn in said zone a predetermined extent thereby to increase the molecular orientation thereof, the majority of the attenuation being localized in the area where said yarn is heated, thereafter continuously deforming the heated and stretched yarn into a corrugated shape simultaneously while same is being cooled by continuously passing the yarn between the intermeshing engagement of toothed wheels, successive portions of the yarn being subjected to forces laterally applied by the teeth of said wheels alternately in one direction and then in the opposite direction to cause deformation of the yarn mostly along the apices of the teeth, then intermittently redeforming the yarn into a corrugated shape a plurality of times by passing same between said wheels a corresponding number of times, and collecting said yarn in an orderly manner.

2. A method for treating a continuous filament yarn made from a nylon polymer whereby potential crimpiness is imparted thereto comprising the steps of providing a source of a molecularly orientable nylon continuous filament yarn, continuously passing said orientable yarn through a heat-stretch zone, wherein the yarn is heated to an elevated temperature and is attenuated a predetermined extent thereby to increase the molecular orientation thereof, the majority of the attenuation being localized in the area where said yarn is heated, thereafter continuously deforming the heated and stretched yarn into a corrugated shape simultaneously while same is being cooled by continuously passing the yarn between the engagement of toothed wheels, then intermittently redeforming the yarn into a corrugated shape a plurality of times by passing same between said wheels a corresponding number of times, reducing the tension on the yarn between each successive engagement of the yarn and said wheel, and collecting said yarn in an orderly manner.

3. The method as defined in claim 2 wherein said nylon filament yarn is composed of polyhexamethylene adipamide polymer and has a non-circular cross-section, the temperature to which said yarn is subjected in said heat-stretch zone being in the range of 150° C. to 250° C.

4. A method for texturing a continuous filament yarn made from a nylon polymer comprising the steps of providing a source of a molecularly orientable nylon continuous filament yarn, continuously passing said orientable yarn through a heat-stretch zone, heating the yarn in said

zone to an elevated temperature and attenuating the yarn in said zone a predetermined extent thereby to increase the molecular orientation thereof, the majority of the attenuation being localized in the area where said yarn is heated, thereafter continuously deforming the heated and stretched yarn into a corrugated shape simultaneously while same is being cooled by continuously passing the yarn between the engagement of toothed wheels, successive portions of the yarn being subjected to forces laterally applied by the teeth of said wheels alternately in one direction and then in the opposite direction to cause deformation of the yarn mostly along the apices of the teeth, intermittently redeforming the yarn into a corrugated shape a plurality of times by passing same between said wheels at predetermined intervals a corresponding number of times, permitting the yarn to relax, subjecting the yarn while relaxed to an elevated temperature thereby to develop the potential crimpiness induced in the yarn and to set the thus-developed crimpiness, cooling the yarn without excessive tensioning thereof, and then collecting said yarn in an orderly manner.

5. A method for treating a continuous filament yarn made from a nylon polymer comprising the steps of providing a source of a molecularly orientable nylon continuous filament yarn, continuously passing said orientable yarn through a heat-stretch zone, wherein the yarn is heated to an elevated temperature and is attenuated a predetermined extent thereby to increase the molecular orientation thereof, the majority of the attenuation being localized in the area where said yarn is heated, thereafter continuously deforming the heated and stretched yarn into a corrugated shape simultaneously while same is being cooled by continuously passing the yarn between the engagement of toothed wheels, intermittently redeforming the yarn into a corrugated shape a plurality of times by passing same between said wheels at predetermined intervals a corresponding number of times, reducing the tension on the yarn between each successive engagement of the yarn and said wheels, permitting the yarn to relax, subjecting the yarn while relaxed to an elevated temperature thereby to develop the potential crimpiness induced in the yarn and to set the thus-developed crimpiness, cooling the yarn without excessive tensioning thereof, and then collecting the said yarn in an orderly manner.

6. The method as defined in claim 5 wherein said nylon yarn is composed of polyhexamethylene adipamide polymer and has a non-circular cross-section, the temperature to which said yarn is subjected in said heat-stretch zone being in the range of 150° C. to 250° C.

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