June 23, 1964 J. E. BROMLEY 3,137,911

APPARATUS FOR TREATING FILAMENT YARN

Filed Jan. 3, 1961 5 Sheets-Sheet 1

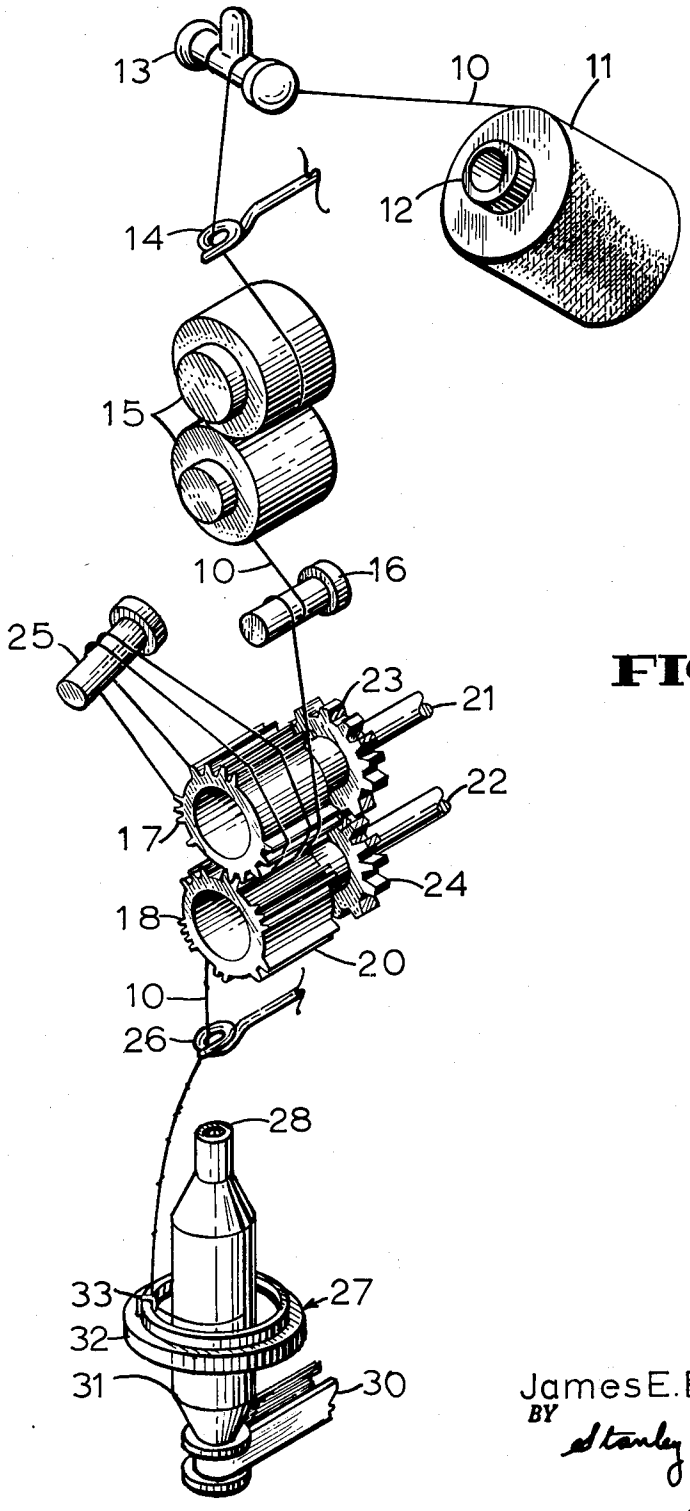

FIG. 1

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APPARATUS FOR TREATING FILAMENT YARN

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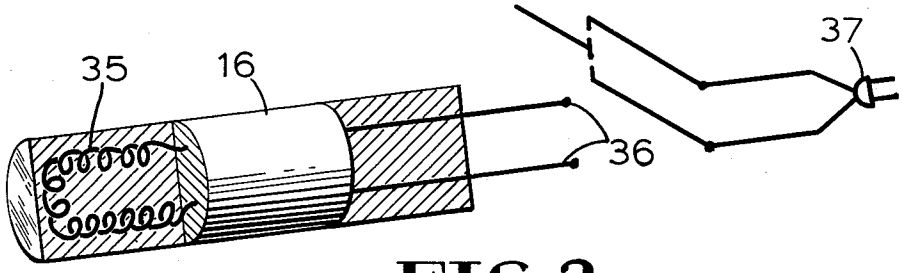

FIG. 2

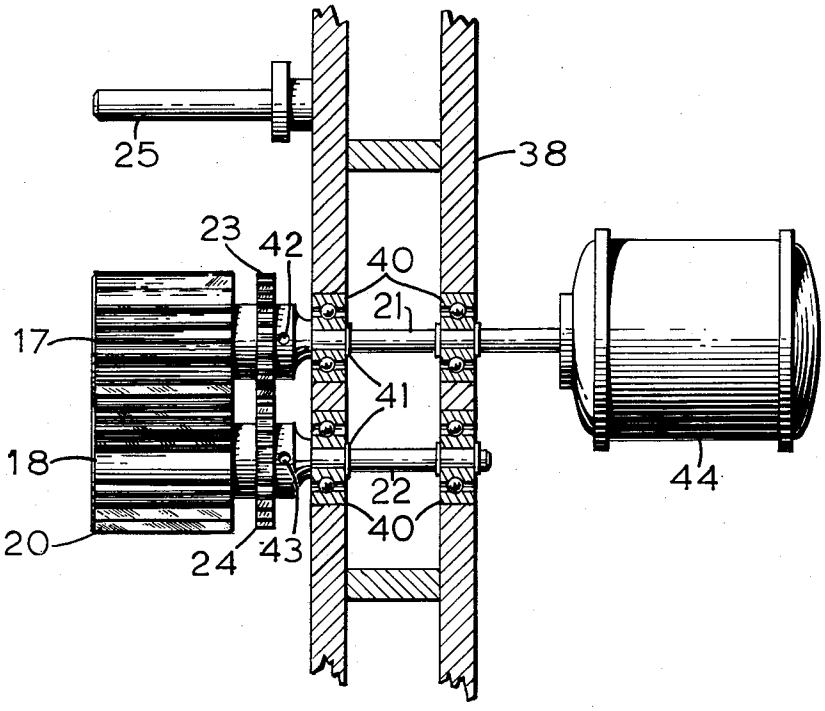

FIG. 3

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APPARATUS FOR TREATING FILAMENT YARN

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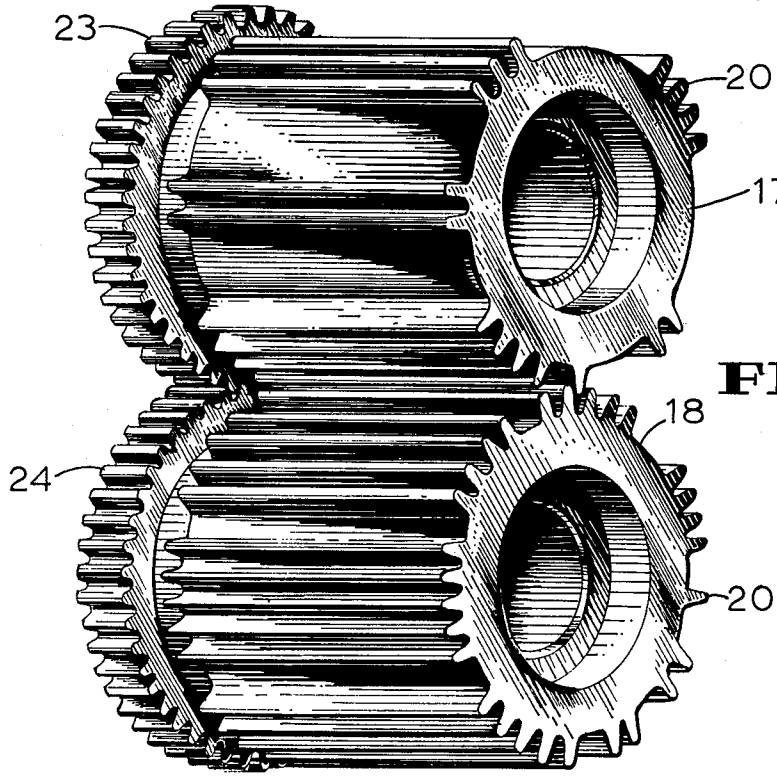

FIG. 4

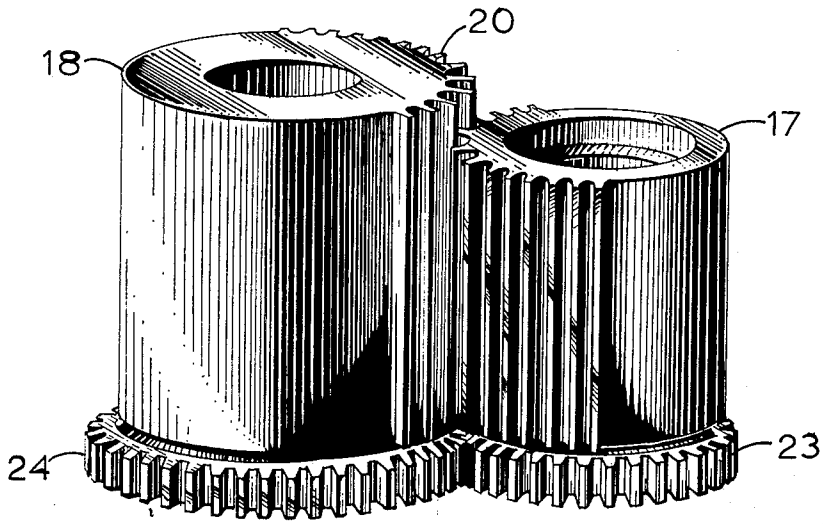

FIG. 5

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APPARATUS FOR TREATING FILAMENT YARN

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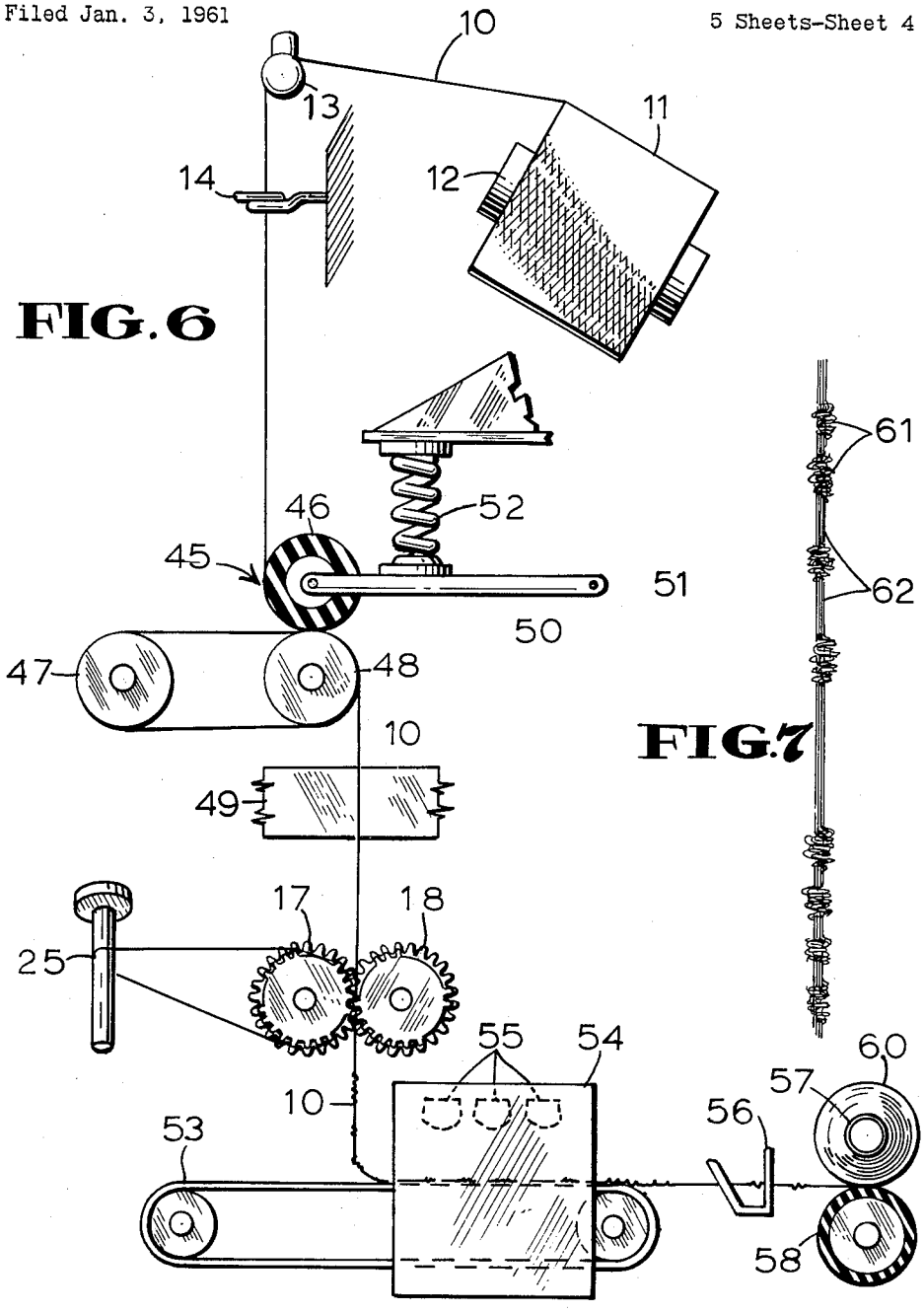

FIG. 6

FIG. 7

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APPARATUS FOR TREATING FILAMENT YARN

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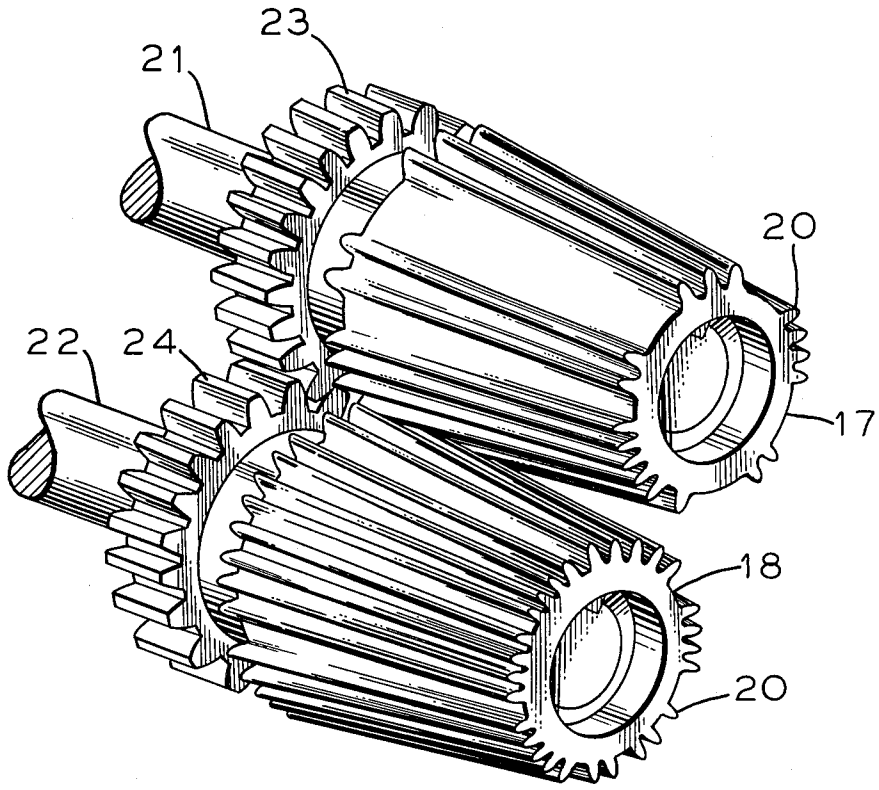

FIG. 8

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United States Patent Office 3,137,911 Patented June 23, 1964

3,137,911

APPARATUS FOR TREATING FILAMENT YARN

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Filed Jan. 3, 1961, Ser. No. 80,341
20 Claims. (Cl. 28—1)

This invention relates to a method and apparatus for processing cold-drawable textile filaments formed from a thermoplastic polymer to impart intermittent and random bulkiness thereto. More particularly, this invention relates to a method and apparatus for continuously stretching and continuously deforming parallel synthetic continuous textile filaments of the nylon type whereby such filaments are rendered bulky at intermittent and random points along the length thereof.

Man-made textile yarns are classified generally into two distinct types, each having its own properties and advantages over the other. One type known as spun yarn is produced by cutting continuous filaments into staple lengths and spinning the resulting staple fibers into yarn by conventional processes in a manner similar to that used in spinning cotton and wool. Among other things the spun yarns have the disadvantage of relatively low strength, and fabrics produced therefrom have a tendency to pill. However, some of the advantages associated with spun yarns include enhanced capacity to adsorb moisture, greater insulating power, a softer hand, a toned-down luster. The outer distinct type of man-made textile yarn is composed of filaments of extreme lengths and is known as continuous filament yarn. While continuous filament yarns have the advantage of greater evenness, superior strength, etc., they have several undesirable properties including low heat insulating values, lack of bulkiness, low covering power, etc.

Many methods and devices are known for imparting some of the desirable properties of spun yarn to continuous filament yarn by modifying the texture thereof. As a result, numerous end uses formerly dominated by spun yarns have been opened to continuous filament yarn. Continuous filament yarn which has been modified in some manner to increase its bulk, stretch, or both of these properties has become known as a textured yarn.

Recently a method and apparatus have been invented whereby cold-drawable synthetic filaments are textured in a most advantageous manner. This treatment includes simultaneously deforming and cooling the yarn immediately after the filaments are oriented by a hot drawing operation. In such treatment the filament yarn is fed continuously through a heat-stretch zone wherein the yarn is heated and stretched and from which the filaments are fed between intermeshing toothed wheel members. In such a procedure the treated yarn is essentially uniformly textured throughout its length. Often, however, it is desirable to produce yarns of variable texture whereby to impart novelty effects to fabrics having aesthetic appeal in such end uses as dress goods, draperies, upholstery and the like.

Heretofore, the prior art procedures for imparting intermittent bulk to filament yarn have been fraught with difficulties. One such difficulty is that truly random bulk can not be accomplished readily. Moreover, the known apparatus are complex and the yarn can not be bulked intermittently at economically feasible speeds.

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 exhibiting a random and intermittent bulk along its length.

Another object of this invention is to provide a simple and effective apparatus for producing randomly and intermittently textured yarns.

FIGURE 1 is a schematic view in perspective with principal parts in location illustrating one arrangement of apparatus suitable for preparing the intermittently bulked yarns of this invention;

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

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

FIGURE 4 is a perspective view illustrating a peripheral denticulation occurring in a random and interrupted sequence on the wheel members which are in closely spaced engagement;

FIGURE 5 illustrates a second pair of wheel members exhibiting a different peripheral denticulation;

FIGURE 6 is a schematic view in front elevation with principal parts in location illustrating another arrangement of the apparatus of the present invention in which the stretched and deformed filaments can be subjected to an additional heat treatment while relaxed to enhance the texture therein;

FIGURE 7 is a drawing illustrating continuous multifilament yarn textured in accordance with the present invention, and

FIGURE 8 illustrates a pair of tapered wheel members.

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 randomly deforming toothed wheel members, together with means for elevating the temperature of the yarn such as a heated draw or stretch pin, or heated plate, a heated tube, frictional heater, and the like interposed between the said roll assembly and the said members. From a suitable source the yarn is fed to said feed roll assembly after being passed around or through a suitable tensioning device, if desired. 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 recurrently toothed wheel members driven in unison and intermeshing from time to time in close relationship without coming in contact with each other. The wheel members have peripheral denticulations interrupted at intervals by smooth peripheral areas. 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 the yarn is stretched between the said roll assembly and the 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 the said heating means to raise the temperature of 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 the attenuation of the filaments tends to be localized. The yarn is directed in operation between the said members and, if desired, 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 numer of times with the yarn taking a path that is progressively longitudinally forward with respect to the point where the said yarn initially is passed between the toothed wheel members. The members not only serve to deform the filaments of the yarn in a random sequence 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 randomly deformed in such manner, the yarn may be taken up in an orderly manner by suitable means. In accordance with a concomitant 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 under little or no tension to cause the textured segments of the yarn to blossom into their full bulkiness. In such an arrangement commercial 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 in FIGURE 1 a thermoplastic cold-drawable yarn indicated by reference 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 processed 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 filament-forming 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 filament-forming machine.

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 guiding bar **13** which functions as a simple, uncomplex tensioning device to assist in maintaining an orderly and uniform supply of yarn. It will be preceived readily that other tensioning devices such as a gate type can be used instead of the bar **13** 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 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 or minimized.

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 irregularly circumferentially spaced and longitudinally extending teeth or denticles **20** that randomly mesh in closely spaced adjustment, said members being spaced a short distance below pin **16**. The yarn preferably should be cooled and deformed by said members as soon as and as rapidly as practicable after it is hot-stretched. 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, various segments of the traveling yarn are subjected to laterally applied strains increasing and decreasing in intensity as the yarn approaches and leaves the horizontal plane in which the axes of the said wheel members lie and where the said teeth engage in random, periodic fashion the narrow depressions between adjacent 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 suitable supporting frame for free rotation and positioned adjacent to roll **17**. A spacer bar fixedly mounted to a frame would be a suitable equivalent spacing means for roller **25**. The yarn **10** is preferably wound around member **17** and roller or spacing means **25** a plurality of times as shown in FIGURE 1, although good bulked yarn has been obtained by passing the hot-stretched yarn only one time between members **17** and **18** in which case roller **25** becomes redundant structure and, hence, may be omitted. 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 axial advancement along the peripheries of member **17** and roller **25**, thus preventing superposition of the wraps thereon.

Care should be taken that the yarn does not pass through the said members so many times that the resulting yarn is uniformly textured throughout its length. The number of permissible passes will be determined by the particular pattern of peripheral denticulation and smooth areas chosen, the objective being to texture only segments of the length of the yarn so that a yarn of variable texture is produced.

It is seen that the temperature at which the yarn is directed between the wheel members progressively diminishes as the yarn moves longitudinally forward on wheel member **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 the 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 a driven belt **30** in a conventional manner to collect a package of yarn **31**. The assembly further comprises a conventional vertically reciprocatable spinning ring **32** carrying a ring traveller **33** adapted to revolve freely about bobbin **38** 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 in FIGURE 8, while maintaining the axially parallel relationship thereof for permitting relaxation of the yarn 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 wheels instead of becoming accumulated and entangled thereon. Where the wheel members 17 and 18 are tapered, the yarn progresses longitudinally along these members in the direction of taper, the extent to which the yarn is deformed intermittently into corrugated shapes along its length as it passes between the members from the normally unbent shape will diminish. Moreover, it will be observed that as a result of employing tapered wheel members, the yarn being treated is subjected to a reduced tension between each successive engagement of the yarn and the wheel members. It should be understood that the reduced tensioning may be attained by other means, such as by positioning the wheel members with respect to each other so that their axes slightly converge toward the direction of longitudinal movement of the yarn along the members.

Reference is made now to FIGURE 2 where one form of a yarn braking device or stretch pin 16 which is sometimes called 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 means 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. Rings 41 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 this purpose of the invention, the lateral pressure applied to the yarn 10 passing between members 17 and 18 to deform same into a random and interrupted sequence of corrugated shape is applied mostly along the apices of teeth 20 and not in the grooves between the teeth or in the smooth peripheral areas separating the area of peripheral denticulations. This is accomplished, inter alia, by proper selection of the height and slope of the teeth, as well as the spacing of adjacent teeth relative to the area of peripheral denticulation and the spacing of the smooth peripheral areas. The amplitude of the corrugation formed in the yarn is controlled, among other things, as a function of the height of teeth 20 and the extent to which the teeth engage the grooves. The frequency of the corrugations and the sequence of the interrupted denticulations are controlled as a function of the number and particular arrangement of teeth disposed along the circumference of wheel members 17 and 18.

FIGURE 5 illustrates the employment of two wheels of different diameter and a denticulation pattern different from that shown in FIGURE 4. In this illustration the denticulated area is less than half of the periphreal area of each wheel. Larger spacing of the textured yarn portions may be produced with such arrangement.

With reference now to FIGURE 6 where one complete yarn treating installation is shown including means for fully developing the potential or latent texturability in the treated 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 randomly 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 heat or combination of both in a relaxed or substantially relaxed condition. This operation as mentioned above fully develops the potential texturability induced in the yarn by the prior operation and simultaneously sets the thus-developed texture, thereby imparting enhance 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 plaiting device (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 arrangements 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 pasing the yarn without undesirable tensioning for a short distance through the air, excessive tension being

avoided because the developed texture 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.

FIGURE 7 illustrates an intermittently textured yarn of the present invention having textured portions **61** and untextured portions **62**.

In accordance with this invention, it has been discovered that filament yarn of a thermoplastic fiber-forming polymer which is not fully oriented can be advantageously treated to impart a variable texture therein and to render same capable of exhibiting an even greater texture, this capability being known as texturability. 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 preferably 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 interposed in a zone. Immediately after leaving the heat-stretch zone, portions of the filaments are deformed into a corrugated shape while being cooled by passing between the engagement of wheels having peripheral denticulations randomly interrupted by smooth peripheral areas. Portions of filaments may be redeformed into corrugated shapes a number of times by being passed between said wheels a corresponding number of times, each subsequent deformation occurring at a somewhat lower temperature. The tension to which the yarn is subjected between each successive engagement of the yarn and the wheels may be decreased. The yarn which has a variable texture and which possesses a markedly potential texturability is collected. An additional operation whereby the texture may be developed fully includes subjecting the yarn while relaxed to a subsequent and additional 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; polyurethanes; polycarbonates; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of mono-olefinic compounds copolymerized therewith, such as, for example, vinyl chloride; homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefinic compound copolymerized 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 apparatus and process are 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 and/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, the speed of the yarn, etc.

By employing the above-described apparatus and process, one produces a variably textured yarn. The yarns may possess a potential or latent texturability capable of being fully developed by a heat treatment while the yarn is relaxed. The textured portions are highly bulked and highly crimped and the yarn is stretchable. "Bulk" refers to the relative volume occupied by a given weight of yarn. Hence, yarn having increased bulk has greater covering power and warmth. "Crimped" refers to the fact that in the textured portions the filaments contain many crimps, crinkles, curls, and the like which bend in and out in a sinuous pattern 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 to some extent and have the ability to accept a slight longitudinally applied stress and thereby to become easily extended without permanent elongation thereof. The extent of such elongation depends on what proportion of the length of yarn that is textured. It is preferred for some end uses to develop fully the potential texturability of the yarn after same has been converted into a textile article.

A novel characteristic of the yarn treated in accordance with the present invention is the fact that the yarn when

dyed with certain types of dyes exhibit a variable dye-pick-up along segments of the yarn. A most novel effect is obtained in dyed fabric made from the yarn. The deeper dyed portions of the yarn contrasted with lighter portions of the yarn imparts a truly speckled or mottled color to the fabric. There are no definite patterns of the mottled effect and no undesirable geometric design in the fabric due to the uneven dyeing which occurs in fabric made from yarn having regularly spaced variations. The exact reason or reasons for this uneven dyeability are not known with certainty. But it is known that the portions of yarn deformed by the teeth are stretched to a slight degree more than the portions that are not so-deformed. This is believed at least to contribute to the uneven dyeing of the yarns treated in accordance with the present 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, was withdrawn from a source at 100 yards per minute by means of a pair of feed rolls. The yarn was led onto and around a stationary stretch pin one time. The surface temperature of the pin was maintined 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 teeth were not uniformly spaced around the circumference of the wheel but smooth areas randomly separated the denticulated areas defined by the 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 take-up.

A fabric was woven from the yarn so treated. The fabric was dyed with a dasic dye in a conventional manner. The resulting fabric exhibited variable texture and a mottled color which were in every respect random in appearance. The fabric 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 intermittent 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 may be run at a high speed and 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 random low texture to a random high texture. The inherent properties of the treated yarn are such that they impart numerous and desirable effects in woven, non-woven, and knitted fabrics made therefrom.

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, additional novelty effects of various sorts may be imparted to the yarn by irregular or regular disengagement and reengagement of the toothed wheel members and by 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 rayon. 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. An apparatus for producing a novelty filament yarn made from a thermoplastic polymer whereby portions of the yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, means for supplying a molecularly orientable synthetic continuous filament yarn made from a thermoplastic polymer from a source at a first rate, denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageably arranged in closely spaced adjustment, the pattern of denticulated interruptions of each of the wheel members being random with respect to the pattern of denticulated interruptions of the other wheel members said members being adapted to receive said yarn and to advance same at an increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said yarn supply means and said wheel members is attenuated thereby to increase the molecular orientation thereof, means between the supply means and said wheel members for elevating the temperature of said yarn, thereby to localize the attenuation of said yarn in its travel between the yarn supply means and said wheel members, and means for taking up said yarn in an orderly manner after it has passed between said wheel members.

2. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of the yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, a rotatably mounted thread advancing means adapted to supply a molecularly orientable synthetic continuous filament yarn made from a thermoplastic polymer from a source at a first rate, rotatably mounted denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageably arranged in closely spaced adjustment, the pattern of denticulated interruptions of each of the wheel members being random with respect to the pattern of denticulated interruptions of the other wheel members, said members being adapted to receive said yarn and to advance same at an increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing means and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, a yarn heating device for heating said yarn to a predetermined elevated temperature in the filament path between said thread advancing means and said wheel members provided with internal heating means, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing means and said wheel members, a separator mounted adjacent to said wheel members in spaced relation therewith and positioned so that its axis is disposed at a slight angle with respect to the axis of one of the wheel members, and means for taking up said yarn in an orderly manner after said yarn has passed between said wheel members and around said separator a plurality of times.

3. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of said yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable synthetic continuous filament yarn from a source at a predetermined first rate, rotatably mounted denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas,

the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of each of the wheel members being random with respect to the pattern of denticulated interruptions of the other wheel members, said members being adapted to receive said yarn and to advance same at a predetermined increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, a yarn heating device in the filament path between said thread advancing rolls and said wheel members provided with internal heating means and which said yarn contacts in operation at least once, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relation therewith and positioned so that its axis is disposed at a slight angle with respect to the axis of one of the wheel members, and means for taking up said yarn in an orderly manner after said yarn has passed between said wheel members and around said separator roll a plurality of times.

4. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of said yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable synthetic continuous filament yarn from a source at a predetermined first rate, rotatably mounted denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of each of the wheel members being random with respect to the pattern of denticulated interruptions of the other wheel members, said members being adaped to receive said yarn and to advance same at a predetermined increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, a nonrotatably mounted yarn stretch pin in the filament path between said thread advancing rolls and said wheel members having a smooth wear resistant filament contact surface and around which said yarn is wrapped in operation, electrically energizable means for heating said pin internally, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relation therewith and positioned so that its axis is disposed at a slight angle with respect to the axis of one of the wheel members, and means for taking up said yarn in an orderly manner after said yarn has passed between said wheel members and around said separator roll a plurality of times.

5. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of said yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable nylon continuous filament yarn from a source at a predetermined first rate and to nip yarn therebetween, a pair of rotatably mounted denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of one wheel member being random with respect to the pattern of denticulated interruptions of the other wheel member, said members being adapted to receive said yarn and to advance same at a predetermined increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, means to drive said pair of wheel members in unison, a yarn heater plate in the filament path between said thread advancing rolls and said wheel members which said yarn contacts in operation, electrically energizable means for heating said plate internally, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relationship therewith and positioned so that its axis is disposed at a slight angle with respect to the axes of said wheel members in order that the yarn normally progressing around one wheel member and said separator roll will describe generally a helix, the convolutions of which are spaced apart, said pair of wheel members being positioned adjacent said yarn heater plate in spaced relation therewith so that said wheel members are adapted to receive the heated yarn forthwith from said yarn heater plate, and means for taking up said yarn in an orderly manner after said yarn has passed between said pair of wheel members and around said separator roll a plurality of times.

6. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of said yarn have potential texturability of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable nylon continuous filament yarn from a source at a predetermined first rate, a pair of denticulated wheel members having horizontally disposed parallel axes and peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, each member being fixedly mounted on separate shafts journaled in a supporting frame, the denticles of said wheel members being engageable in closely spaced adjustment, the pattern of denticulated interruptions of one wheel member being random with respect to the pattern of denticulated interruptions of the other wheel member, said members being adapted to receive said yarn and to advance same at a predetermined increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, means to drive said pair of wheel members in unison, a non-rotatable stretch pin mounted at one of its ends in the filament path between said thread advancing rolls and said wheel members and having a smooth wear resistant filament contact surface around which said yarn is wrapped in operation at least once and describes a helical path extending longitudinally forward with respect to the mounted end of said pin, electrically energizable resistant heater inside said pin to heat same internally, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relationship therewith and positioned at a slight angle with respect to the axes of said wheel members in order that the yarn normally progressing around one wheel member and said separator roll will describe generally a helix, the convolutions of which are spaced apart, whereby the yarn advances along the one wheel member from the inboard end thereof to the outboard end thereof during rotation of said wheel members, said pair of wheel members being positioned adjacent said stretch pin in spaced relation therewith so that said wheel members are adapted to receive the heated yarn forthwith from said stretch pin, and means for taking up said yarn in an orderly manner after said yarn

has passed between said pair of wheel members and around said separator roll a plurality of times.

7. The apparatus as set forth in claim 6 further characterized in that at least one of said pair of toothed wheel members has a uniformly tapered surface converging in the direction away from said supporting frame.

8. The apparatus as set forth in claim 6 further characterized in that said thread advancing rolls comprise a pair of rolls having horizontally disposed parallel axes, at least one of said rolls being positively driven.

9. The apparatus as set forth in claim 6 further characterized in that said means for taking up said yarn comprises a ring twisting assembly.

10. The apparatus as set forth in claim 6 further characterized in that a pair of external spur gears having parallel axes are fixedly mounted on said shafts and adapted for working contact to provide unison rotation of said pair of wheel members.

11. The apparatus as set forth in claim 10 further characterized in that the apparatus includes means for imparting rotation to at least one of said shafts.

12. The apparatus as set forth in claim 6 further characterized in that said thread advancing rolls comprise three rolls, one of which is adapted to be positively driven with the other two being idler rolls mounted for free rotation, one of said idler rolls being pivotally mounted about a point and spring biased into rotating engagement with the driven roll.

13. The apparatus as set forth in claim 6 further characterized in that said separator roll is mounted on a frame for free rotation.

14. The apparatus as set forth in claim 6 further characterized in that said separator roll is non-rotatably mounted.

15. An apparatus for producing novelty filament yarn made from a thermoplastic polymer whereby portions of said yarn have enhanced texture of varying lengths randomly disposed along the length thereof comprising, in combination, means for supplying a molecularly orientable synthetic continuous filament yarn made from a thermoplastic polymer from a source at a first rate, denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of each of the wheel members being random with respect to the pattern of denticulated interruptions of the other wheel members, said members being adapted to receive said yarn and to advance same at an increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said yarn supply means and said wheel members is attenuated thereby to increase the molecular orientation thereof, means between said yarn supply means and said wheel members for elevating the temperature of said yarn, thereby to localize the attenuation of said yarn in its travel between said yarn supply means and said wheel members, means for subjecting said yarn in a relaxed condition to a heat treatment thereby to develop the potential crimpiness induced in the yarn, and means for taking up said yarn in an orderly manner after said heat treatment.

16. An apparatus for producing novelty filament yarn made from a nylon polymer whereby portions of said yarn have enhanced texture of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable nylon continuous filament yarn from a source at a predetermined first rate, a pair of rotatably mounted denticulated wheel members having peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of one wheel member being random with respect to the pattern of denticulated interruptions of the other wheel member, said members being adapted to receive said yarn and to advance same at a predetermined increase rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, means to drive said pair of wheel members in unison, a yarn heating device for heating said yarn to an elevated temperature in the filament path between said thread advancing rolls and said wheel members, electrically energizable means for heating said yarn heating device internally, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relationship therewith and positioned so that its axis is disposed at a slight angle with respect to the axes of said wheel members, said pair of wheel members being positioned adjacent said yarn heating device in spaced relation therewith so that said wheel members are adapted to receive the heated yarn forthwith from said yarn heating device, and means for subjecting said yarn in a relaxed condition to a heat treatment thereby to develop the potential crimpiness induced in the yarn and to set the thus-developed crimpiness prior to taking up said yarn in an orderly manner.

17. The apparatus as set forth in claim 16 further characterized in that at least one of said pair of denticulated wheel members has a uniformly tapered surface.

18. An apparatus for producing novelty filament yarn made from a nylon polymer whereby portions of said yarn have enhanced texture of varying lengths randomly disposed along the length thereof comprising, in combination, rotatably mounted thread advancing rolls adapted to supply a molecularly orientable nylon continuous filament yarn from a source at a predetermined first rate, a pair of denticulated wheel members having horizontally disposed parallel axes and peripheral axially-extending denticulations interrupted at random intervals by smooth peripheral areas, the denticles of which are engageable in closely spaced adjustment, the pattern of denticulated interruptions of one wheel member being random with respect to the pattern of denticulated interruptions of the other wheel member, each member being fixedly mounted on separate shafts journaled in a supporting frame, said members being adapted to receive said yarn and to advance same at a predetermined increased rate as compared to the supply rate of said yarn, whereby the yarn normally advancing between said thread advancing rolls and said wheel members is attenuated to a predetermined extent thereby to increase the molecular orientation thereof, means to drive said pair of wheel members in unison, a non-rotatable yarn stretch pin mounted at one of its ends in the filament path between said thread advancing rolls and said wheel members and having a smooth wear resistant filament contact surface around which said yarn is wrapped in operation and describes a helical path extending longitudinally forward with respect to the mounted end of said pin, electrically energizable resistant heater inside said pin to heat same internally, thereby to localize the attenuation of said yarn and to impart heat to said yarn in its travel between said thread advancing rolls and said wheel members, a separator roll mounted adjacent said wheel members in spaced relationship therewith and positioned at a slight angle with respect to the axes of said wheel members in order that the yarn progressing around one wheel member and said separator roll will describe generally by a helix, the convolutions of which are spaced apart, whereby the yarn normally advances along the one wheel member from the inboard end thereof to the outboard end thereof during rotation of said wheel members, said pair of wheel members being positioned adjacent to said stretch pin in spaced relation therewith so that said wheel members are adapted to receive the heated yarn worthwith from said stretch pin,

means for conveying said yarn adapted to receive same after said yarn has passed between said pair of wheel members and around said separator roll a plurality of times and to move said yarn continuously through a heating zone thereby to develop the potential crimpiness in the yarn and to set the thus-formed crimpiness prior to taking up said yarn.

19. The apparatus as set forth in claim 18 further characterized in that at least one of said pair of denticulated wheel members has a uniformly tapered surface converging in the direction away from said supporting frame.

20. The apparatus as set forth in claim 18 further characterized in that a pair of external spur gears having parallel axes are fixedly mounted on said shafts and adapted for working contact to provide unison rotation of said wheel members.

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