United States Patent

Binford et al.

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[54] APPARATUS FOR BULKING YARN

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[52] **U.S. Cl.** **28/1.3**

[51] **Int. Cl.** **D02q 1/20**

[58] **Field of Search** 28/1.5, 1.4, 1.8, 72.11, 72.12, 28/72.15

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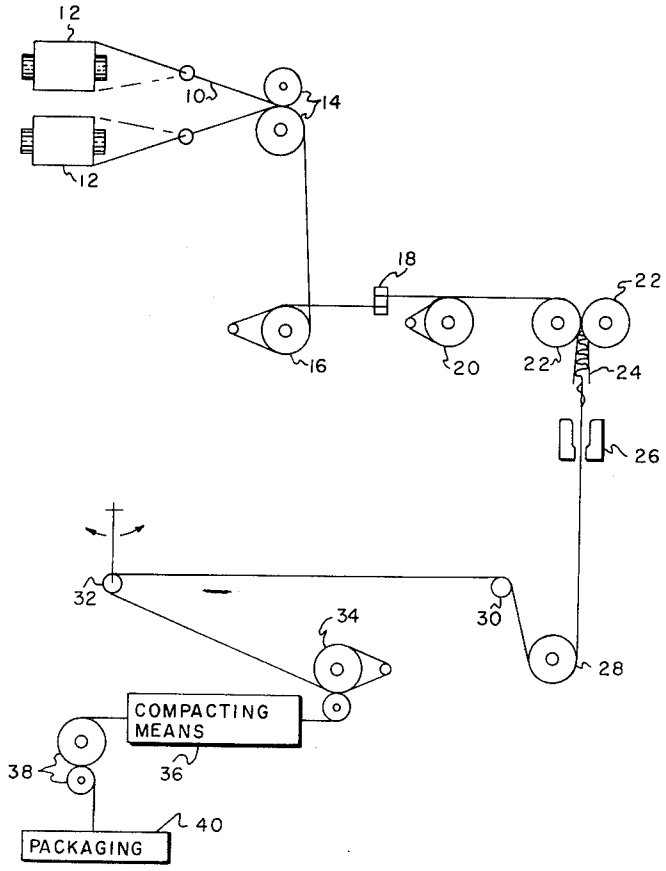
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[57] **ABSTRACT**

A method for producing a yarn having latent bulking characteristics and the apparatus therefor is described. The yarn is composed of multifilament synthetic fibers which have been crimped and subjected to a constant tensioning process. The process involves subjecting a drawn yarn, preferably freshly drawn, to a crimping process which can be any of a number of crimping methods including stuffer box crimping, gear crimping, steam jet crimping and the like. The yarn is withdrawn from the crimping step under a low, substantially uniform tension, tensioning the yarn under a higher constant tension to at least partially extend the crimps, entangling or twisting the yarn and taking the yarn up on a package. The bulk characteristics of the yarn are preferably developed after incorporation into the end product such as a carpet by subjecting to heat and moisture.

11 Claims, 7 Drawing Figures



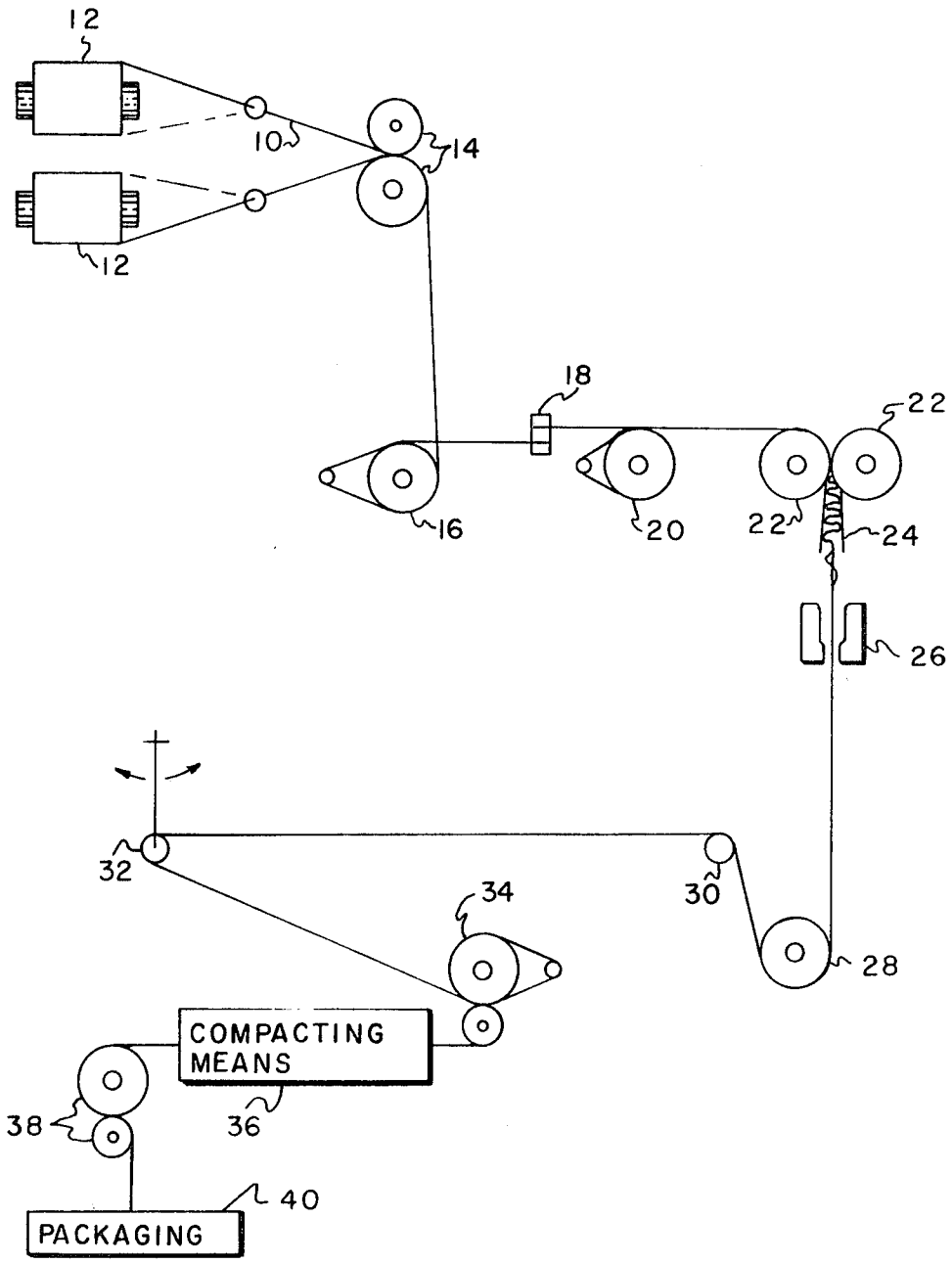


FIG 1

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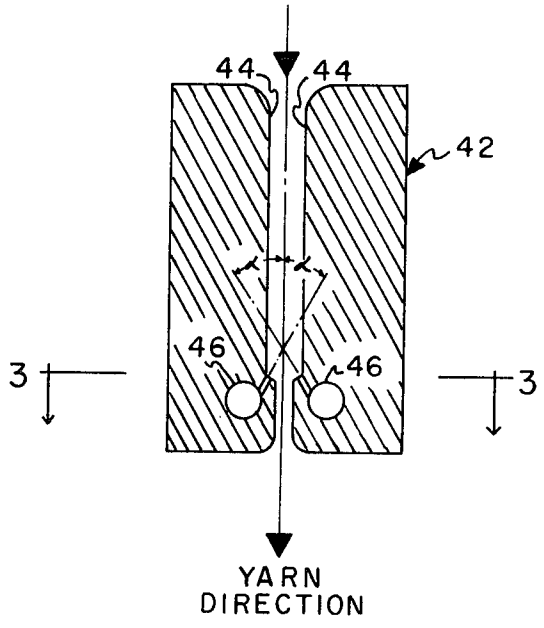


FIG 2

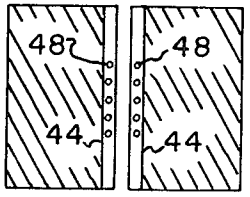


FIG 3



FIG 4



FIG 5 PRIOR ART

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FIG. 6

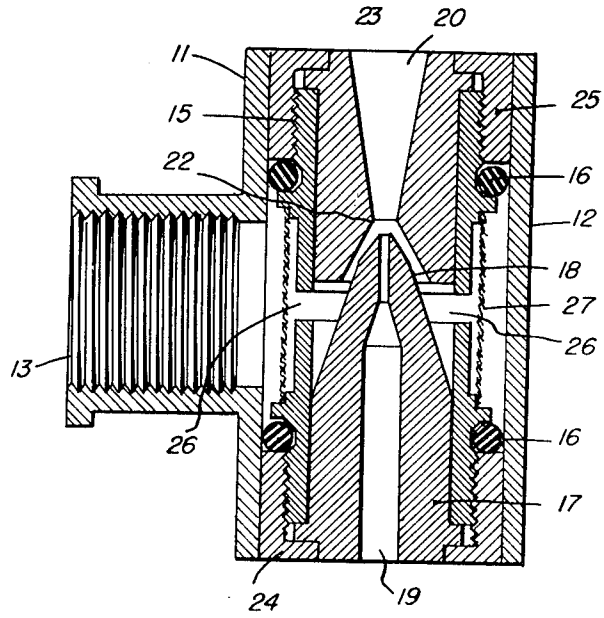
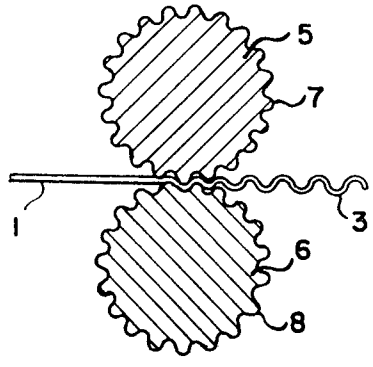


FIG. 7



APPARATUS FOR BULKING YARN

BACKGROUND OF THE INVENTION

This invention relates to production of a crimped yarn which has latent bulking characteristics and more particularly to the production of a crimped yarn under conditions which lead to improved uniformity of bulking characteristics and dyeability in the end product. In particular, the invention is directed to carpet yarns, and more particularly, nylon carpet yarns, although other yarns and other uses are also contemplated as will be evident from the descriptions set forth herein.

Numerous methods have been proposed for the production of crimped yarns. Many of these processes provide useful yarns which can be used in many applications without difficulty. However, in the production of carpet yarns and certain fabric yarns wherein a great number of yarn ends or yarn packages go into a single strip of carpet or fabric, the uniformity from package to package and from end to end must be extremely good in order to provide a yarn which is useful for the piece dyeing of the end product. Yarns which do not have the required uniformity have to be package dyed and the yarn shades matched to obtain the desired uniformity or space dyed prior to producing the end product. Because it is more preferred in most instances to produce the end product, such as a carpet, and then dye the end product in its entirety, yarns which do not have the required degree of uniformity are considered to be of reduced value.

It is therefore an object of the present invention to provide a method for reducing, and in many instances eliminating, yarn imperfections by reducing yarn tension variations to a minimum. It is another object of the present invention to provide a method for closely controlling the process history of the yarn yarn from the drawing step through the crimping and final packaging of the yarn, thereby controlling the tensions applied to the yarn in a manner whereby tension fluctuations are maintained at an absolute minimum. It is a further object of the present invention to provide an apparatus for the application of tensions to the yarn and a total process apparatus for applying and controlling the history of yarn tensions from the drawing step through the packaging of the crimped yarn. These and other objects will become apparent to those skilled in the art from the description which follows.

THE INVENTION

In accordance with the invention, a process is provided for producing a crimped yarn having latent bulking characteristics comprising feeding a drawn, pretensioned, multifilament yarn to a crimping zone, crimping said yarn, withdrawing crimped yarn from said crimping zone under a low, substantially constant tension and at a substantially uniform speed, cooling said yarn, increasing the tension on said yarn to a substantially constant tension between 0.03 to 0.8 grams per denier to at least partially reduce the amplitude of said crimps and compacting said yarn to facilitate further processing.

In accordance with a further aspect of the invention, an apparatus is provided for treating said yarn comprising yarn drawing means, yarn crimping means, yarn tensioning means and yarn compacting means, said means being consecutively, operatively connected, said yarn drawing means comprising a feed roll and a draw roll having a draw pin position therebetween to draw yarn, said crimping means being positioned in relationship to said drawing means for the receipt with a minimum delay of freshly drawn yarn, said yarn tensioning means being positioned for the receipt of freshly crimped yarn from said crimping means and for the application of tension to said yarn thereby increasing the force of yarn contact with further yarn tensioning means, said yarn further tensioning means comprising a braked wheel and a withdrawal roll having thereinbetween a tension leveler wherein the yarn is passed from said braked wheel across said tension leveler through said withdrawal roll to said compacting means.

DETAILS OF THE INVENTION

The invention will be described more clearly by reference to the drawings wherein:

FIG. **1** is a schematic flow sheet representing a preferred embodiment of the present invention;

FIG. **2** is an enlarged sectional view of a preferred pretensioning jet illustrated in FIG. **1**;

FIG. **3** is a sectional view along line **3—3** of FIG. **2** further illustrating a preferred tensioning jet;

FIG. **4** is a tension trace indicating the recorded tensions of running yarn in accordance with the present constant tensioning process;

FIG. **5** is a tension trace of recorded tensions of yarns in accordance with the prior art constant elongation stretch method;

FIG. **6** is a cross section of a steam bulking jet suitable for use as the crimping means of the invention; and

FIG. **7** is a cross section of a pair of gear crimper wheels suitable for use as the crimping means of this invention.

Referring to FIG. **1**, yarn **10** is drawn from one or more packages **12** to produce the yarn of the desired total denier by nip rolls **14**. Yarn **10** then proceeds to feed roll **16** and across draw pin **18** to draw roll **20**. Draw roll **20** operates at a higher linear speed than feed roll **16**, thereby effecting a drawing of the yarn at pin **18** in the desired draw ratio. Such ratio is determined by the relative roll speeds which are selected in accordance with the particular yarns being treated and the particular properties desired in the drawn yarn. Normally the draw ratio is between about 3:1 to 6:1, while for nylon 6,6, a draw ratio of about 3.5:1 to 4.5:1 is preferred.

Yarn **10** proceeds from the drawing means through the crimping means which can be any of a number of well known crimping means including a steam jet bulking means such as is described in U. S. Pat. No. 3,380,242, stuffer box crimping means, particularly utilizing a stuffer box crimper of the type described in copending application Ser. No. 848,495, filed Aug. 8, 1969 entitled "Stuffer Box Crimper and Method Therefor" in the name of Jack Binford et al., commonly assigned to the same assignee as the present application and filed on even date herewith, which application is hereby incorporated by reference into this application. A further method of crimping which can be used is by means of intermeshing geared wheels which crimp the yarn thereinbetween as is well known in the art.

The preferred method of crimping is by stuffer box crimping wherein crimping rolls **22** feed yarn **10** into stuffer box **24** thereby setting the crimps into the yarn. Crimped yarn **10** is preferably extruded from stuffer box **24** or otherwise extracted under a low tension of 0 to 0.05 grams per denier and passed through quenching and pretensioning means **26** which causes a tension increase on the yarn by impeding yarn travel and enables the yarn to make low slippage contact with braked roll **28**. Braking action in roll **28** restrains the rotation thereof relative to withdrawal roll **34** and provides a further increase in yarn tension to the desired 0.03 to 0.8 grams per denier level which is below the drawing force of the yarn. Alternative pretension means **26** can include nip rolls or other holding means which impede the forward motion of the yarn sufficiently to engage the yarn against braked roll **28**. Thus, yarn **10** travels from braked roll **28** across idler roll **30** and tension leveler **32** to withdrawal roll **34** the latter of which exerts a pulling force on the yarn to the desired tension level, which level is below the drawing force of the yarn.

A particularly significant aspect of the present invention resides in the maintenance of a substantially constant pretension, draw tension, crimp amplitude reduction tension and windup tension which is not allowed to vary significantly even with fluctuations in the feed of yarn between braked roll **28** and withdrawal rolls **34**. Thus tension leveller **32** is preferably a spring loaded movably mounted means which varies the distance between braked roll **28** and withdrawal roll **34**, thereby keeping the tension substantially constant. Suitable tension leveler means include spring loaded dancer arms,

reciprocal spring mounted rollers or the like means, e.g. tension controlled roll speeds, of leveling out an applied tension.

From withdrawal roll **34**, the yarn proceeds through compacting means **36** coupled with a preferred relaxation of the yarn in the range of 1 to 10 percent of the applied stretch. The compacting means utilized include conventional twisting or twist substitutes including air entanglement or the application of an adhesive material. From the compacting means **36**, yarn **10** is passed through feed rolls **38** to packaging **40** or directly to the end use.

Referring more particularly to the more specific preferred embodiments of the present invention, it is often preferred to have a slight overfeed of yarn between draw roll **20** and the crimping means such as in the range of 0.1 to about 3 percent. Such a small degree of overfeed has been found to be particularly advantageous in the development of crimp which produces a particularly desirable bloom in the end product.

The crimping means utilized preferably extrudes the crimped fibers under substantially zero tension or a very low tension, e.g. 0 to 0.05 grams per denier and more preferably 0 to 0.01 grams per denier. It has been found that the application in any greater amount of tension, introduces variations into the yarn which subsequently shows up in the bulking properties of the yarn and/or the dyeability thereof as streaks, "-worms" or other undesirable imperfections. This is believed to occur because of the periodic or sporadic requirement of increased tensions to extract such yarns. Therefore, the extrusion of the yarn from the crimping means is under tensions which do not exceed **0.05** grams per denier.

Normally, yarn coming from the crimping zone is in a heated condition either because of the application of heat in the setting of the yarn or the heat of friction developed in the crimping process or other added heat. Thus, temperatures of about 40° to 180° C. or higher are preferably developed in the crimping zone, depending on the particular crimping process. The higher temperatures are normally used with steam jet crimping and the lower temperatures with stuffer box and gear crimping means. As such, it is preferred to quench the yarn as it comes out of the crimping means.

A particularly desirable manner of quenching the yarn while at the same time applying the initial pretensioning to the yarn is accomplished by the apparatus illustrated in FIG. **2** and **3**. Because the yarn exiting from the crimping area preferably is under a very low tension, a pretension is preferably applied so as to aid in the further processing of the yarns in the subsequent tensioning step. As such, quenching jet **42** is preferably utilized. Quenching jet **42** utilizes two opposed sidewalls **44** having in each wall a plenum chamber **46** for the distribution of pressurized gas to exit ports **48**. Exit ports **48** preferably are slots or a plurality of holes or a combination thereof, which are preferably positioned in a parallel relationship with respect to each other. Exit ports **48** are aimed at the opposing wall of the quench jet in an angled relationship to sidewall **44** and the line of yarn travel. As yarn is passed through the gaseous jet stream, the gas impinges against the yarn, thereby inhibiting the forward motion of the yarn and creating a tension on the yarn exiting from the jet area. To establish the desired tension, it is preferred to have the jets aimed at an angle of α of about 5° to 70° with respect to sidewall **44** or running line of the yarn, and more preferably 5° to 45°, thereby exerting the desired back pressure and pretensioning of the yarn as the yarn passes therethrough. Thus, the quenching jet accomplishes both the cooling of the yarn and the pretensioning thereof in an amount of 0.003 to about 0.06 grams per denier and more preferably 0.005 to 0.03 grams per denier. Because of the desire to cool the yarn, any non-reactive gas can be used, with air being preferred. Special cooling of the air is normally not required. Thus ambient gas temperatures are generally quite suitable.

While the exit ports can be so arranged to induce a twisting action in the yarn, it is preferred that the exit ports are positioned to avoid a twisting effect. The amount of tension applied to the yarn in the pretensioning is controlled by controlling the gas pressure, the angle at which the gas impinges against the yarn, the gas flow rate, the positioning of the sidewalls, and the like. Further, it is desirable to effect at least some entanglement of the yarn so as to aid in the further processing of the yarn by containing broken or projected filaments. The described apparatus readily accomplishes this, particularly at the preferred gas impingement angles and back pressure producing velocities.

The particular gas used in the quenching jet is preferably air, but can be any cooling gas such as nitrogen, various inert gases and the like as is well known to those skilled in the art. The gas pressure utilized is dependent upon the number of exit ports used, the shape thereof, the cross-sectional area and the desired degree of pretensioning. Thus, it is preferred to adjust the air pressure in accordance with the desired pretensioning.

Brake wheel **28** can be a number of different known braking wheels such as frictionally impeded channeled wheels. A particularly preferred brake clutch is a magnetic particle clutch in which the braking tension can be readily adjusted to correspond to the subsequently applied tensioning. Other means of frictional braking such as fluid clutches, eddy current braking and the like are used with correspondingly good results.

Between brake roll **28** and withdrawal roll **34**, a substantial constant tension is applied to the moving yarn. This tension is below the tension required to draw the yarn, but is sufficient to partially remove the crimps in the yarn by reducing their amplitude without permanently removing the crimp. Such stretching takes the crimps out of registry with each other and induces a latent effect to the crimp which enables easier fabrication of the end product with the yarn as well as improving the development of bulkiness in the end product. Thus, the amount of stretch applied is in the range of about 0.03 to 0.8 grams per denier and more preferably about 0.05 to 0.5 grams per denier. Tension leveler **32** is adjusted for the applied tension to smooth out tension variations as may occur due to periodic sporadic variations in the feed of the yarn across brake roll **28**.

FIG. **6** shows in cross section a jet which can be used as the crimping means of the invention when it is desired to produce a steam jet crimped or bulked yarn. The jet unit comprises a T-piece **11**, the double limb **12** of which communicates at each end with the atmosphere, while the third limb **13** is connected to a steam header for the supply of steam to the unit. Within the double limb **12** is slipped a cylindrical member **15** which is circumferentially grooved about one-quarter and three-quarters way along its length for the reception of rings **16** of suitable packing material adapted to make a tight joint against the wall of the double limb. Into one end of the cylindrical member is slipped a tubular yarn inlet member **17**, the tip **18** of which is of double-conical form, having conical angles of 47° near the tip and 33° a short distance behind the tip. The inlet has an entry bore **19** of one-eighth inch, which tapers to one thirty-second inch at the tip. At the other end of the cylindrical member **15** is inserted a venturi tube **20** having an inlet cone **21** of 40° angle, a throat diameter **22** of one-sixteenth inch, and an outlet cone **23** of 10° angle, the tip **18** of the inlet jet entering into the inlet cone **21** of the venturi. Both the inlet jet **17** and the venturi tube **20** are externally flanged to engage against the ends of the cylindrical member **15** and are held in place by two collars **24, 25** internally flanged to engage over the external flanges of the inlet jet **17** and venturi **20** respectively, and internally screw-threaded to screw over the cylindrical member **15**. The inner edges of the collars **24, 25** engage the packing rings **16** and compress them against the wall of the double limb **12** of the T-piece **11**, so holding the whole assembly in place. Mid-way along its length the cylindrical member **15** is bored with diametrically opposite holes **26** for the admission of steam entering from the steam main **14** through the third limb **13** of the T-piece **11**. A gauze collar **27** may be provided surrounding the middle portion of the cylindrical member **15**.

FIG. **7** illustrates a gear crimper comprised of rotatable wheels **5, 6**, each carrying a plurality of teeth illustrated individually by **7,8**, to crimp yarn **3** passing therebetween.

FIG. 4 represents a tension trace showing the substantially constant tension applied by the present method in the area between idler roll 30 and tension leveler 32. FIG. 5 represents a tension trace showing the fluctuations in tension as occur in the prior art constant elongation stretching process.

The particular yarn treated by the present process can be any of the synthetic continuous filament yarn including nylon, polyester, acrylic, modacrylic, polypropylene, polyvinyl chloride, polyvinylidene chlorides, Darvan, Spandex, and the like as are well known in the art. The particular fiber denier can be any fiber denier within the range of about 0.5 to 200 denier per filament but particularly those in the textile range of about 0.5 to 10 denier per filament and those in the industrial and carpet yarn range of about 8 to 30 denier per filament. Accordingly, the total yarn denier can vary substantially depending upon the particular use to which the processed yarn is to be put. Carpet yarn total deniers are in the range of about 700 to about 5,000, more preferably about 800 to 4,000 total denier. Textile yarns may conveniently have lower total denier ranges such as from about 100 to 800. Of course, greater and lesser total denier yarns can be readily processed, but the best applications are effected in the production of carpet yarns which are particularly sensitive to texturing variations.

The invention will be described more particularly with reference to the following example which illustrates certain preferred embodiments of the present invention.

EXAMPLE

Nylon 6,6, polyhexamethylene adipamide fiber, was processed in accordance with the present invention and particularly in accordance to the schematic shown in FIG. 1 of the drawing and the apparatuses illustrated therein. Undrawn yarn was fed to a drawing means comprising a pin and draw roll wherein it was drawn at the rate of 1,620 feet per minute at a total draw ratio of 3.82. The freshly drawn yarn was directly fed to a stuffer box crimper at a feed input of 1,613 feet per minute to the crimper rolls. The stuffer box crimper utilized was that described in copending Docket No. 4712 (previously described).

A crimped yarn of generally saw-tooth crimps at a temperature of about 80° C. exited under zero tension from the stuffer box and was passed through the quenching jet of FIG. 2 and 3 which was operated at an air pressure of 30 pounds per square inch gauge. The angle of impingement of the gas jet stream against the yarn formed an angle of 30° between the yarn and the axes of the jet exit port. This pressure and angle of impingement applied a tension of 50 to 75 grams of tension to the yarn, which tension equaled about 0.019 to 0.029 grams per denier. The pretensioned yarn from the quench jet engaged a magnetically braked particle clutch and traveled across a spring loaded dancer arm to a withdrawal roll which applied a 400-gram tension to the running yarn between the clutch roll and the stretch roll. This tension equaled about 0.154 grams per denier. The consistency of the tension is illustrated in FIG. 4.

From withdrawal rolls 34, the yarn was relaxed 5 percent of the tensioned length and passed through a yarn entangling jet. The yarn was then wound on a package as a 2600/136 nylon 66 carpet yarn. This yarn had a skein length of about 14½ inches and about 15 to 19 crimps per inch. The skein length was measured with meter length raps and subsequently submerged in 60° C. water for 3 minutes prior to determining the length.

The yarn produced in accordance with this method was made into a continuous filament carpet and piece dyed. Examination of the piece dyed product indicated that it was substantially free of bulk and dye variations. This is indicative of package to package uniformity of the yarn as well as within package uniformity.

The yarn produced would be varied in the number of crimps per inch and the skein length of the resulting yarn. Using a stuffer box crimper, a generally saw tooth crimp of primary and secondary crimp amplitudes is produced in the yarn. The number of crimps per inch can be adjusted between about three to 30 crimps per inch or more while about five to 20 crimps per inch is generally most preferred. Also, the skein length of the crimped yarn can be varied from about 10 inches to about 19 inches as may be desired in the particular end use by changes in the crimping temperature, the after tension and the like adjustments. The preferred range for carpet yarns of this type is a skein length of about 11 to 15 inches.

In the same manner, other crimping processes such as gear crimping or steam jet bulking are substituted for stuffer box crimping whereby similar results are obtained. The particular type of crimp is varied with the particular crimping method utilized.

While the invention has been described more particularly with respect to nylon, correspondingly good results are obtained with the other enumerated synthetic continuous filaments. Also, filaments of greater and lesser total denier and denier per filaments can be processed accordingly with correspondingly good results.

What is claimed is:

1. An apparatus for treating yarn comprising yarn drawing means, yarn crimping means, yarn constant tension tensioning means and yarn speed control means, said means being consecutively operatively connected, said yarn drawing means comprising a feed roll and a draw roll to draw yarn, said crimping means being positioned in relationship to said drawing means for the receipt with a minimum delay of freshly drawn yarn, said yarn constant tension tensioning means being positioned for the receipt of freshly crimped yarn from said crimping means and for the application of a constant tension to said yarn and said yarn speed control means being positioned for the receipt of the tensioned yarn prior to further yarn processing or yarn packaging.

2. The apparatus of claim 1 wherein said constant tensioning means is a fluid quenching jet.

3. The apparatus of claim 1 including yarn compacting means operatively connected for receipt of yarn from said yarn speed control means.

4. The apparatus of claim 3 wherein the crimping means is a stuffer box crimper.

5. The apparatus of claim 3 wherein the crimping means is a steam jet crimper.

6. The apparatus of claim 3 wherein the crimping means is a gear crimper.

7. The apparatus of claim 3 wherein the compacting means is a yarn twister.

8. The apparatus of claim 3 wherein the compacting means is an entangling jet.

9. An apparatus for treating yarn comprising yarn drawing means, yarn crimping means, yarn constant tension tensioning means and yarn compacting means, said means being consecutively operatively connected, said yarn drawing means comprising a feed roll and a draw roll having a draw pin positioned therebetween to draw yarn, said crimping means being positioned in relationship to said drawing means for the receipt with a minimum delay of freshly drawn yarn, said yarn tensioning means being positioned for the receipt of freshly crimped yarn from said crimping means and for the application of a tension to said yarn by means comprising a braked roll and a withdrawal roll having thereinbetween a tension leveler wherein yarn is passed from said braked roll across said tension leveler through said withdrawal roll to said compacting means, and wherein the tensioning means includes pretensioning means comprising an air quenching jet positioned for the application of a jet of air against the running line of the yarn.

10. The apparatus of claim 9 wherein the air jet is positioned to impinge against at least two opposite sides of the yarn at an angle of about 5° to 70° against the direction of the running line of the yarn.

11. The apparatus of claim 10 wherein the jet is an entangling, non-twisting air jet.