Oct. 26, 1971 F. B. SATTERWHITE 3,614,818

YARN TREATING APPARATUS AND METHOD

Original Filed March 8, 1966 4 Sheets-Sheet 1

Fig. 1. (PRIOR ART)

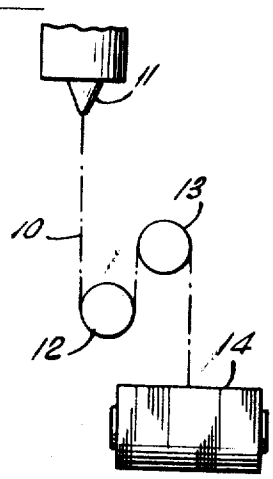


Fig. 2.

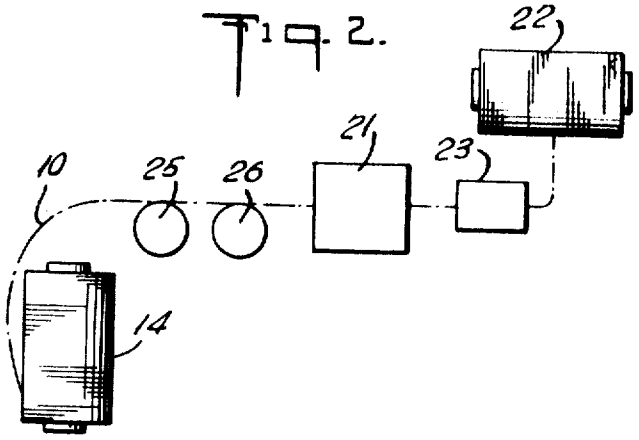
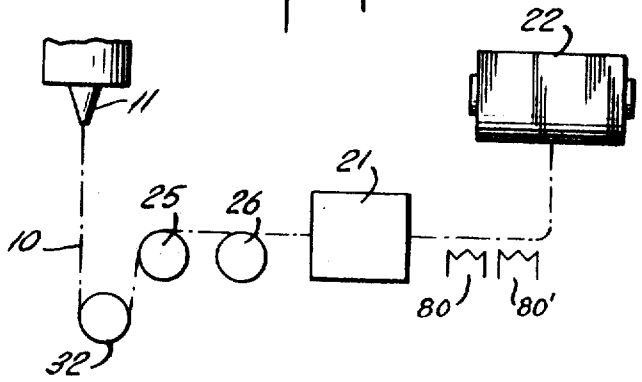


Fig. 3.



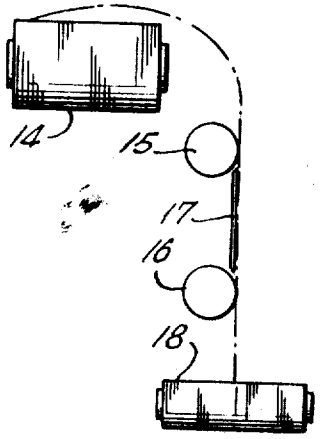
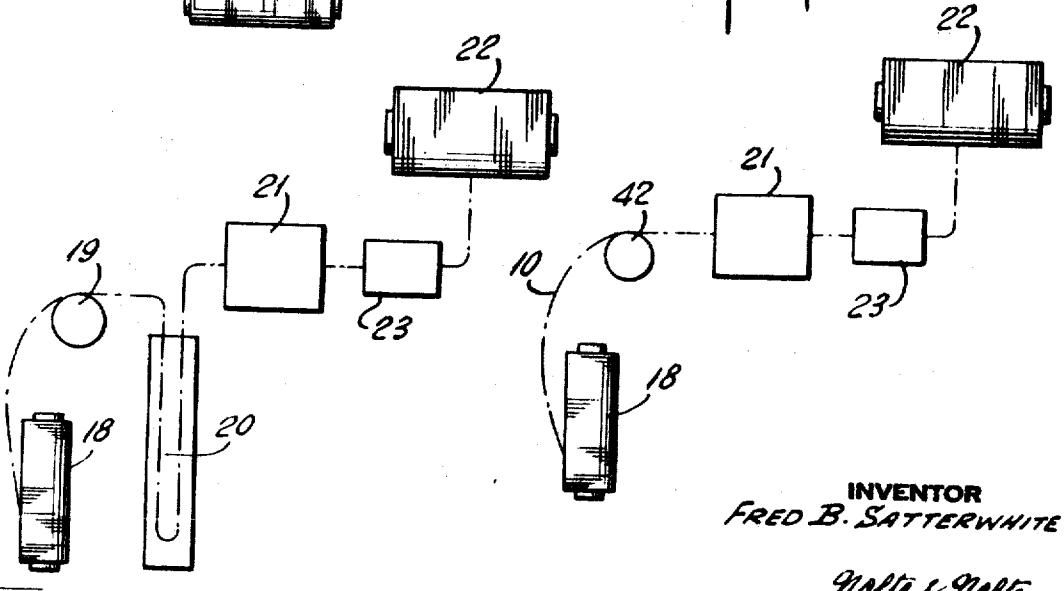


Fig. 4.



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YARN TREATING APPARATUS AND METHOD

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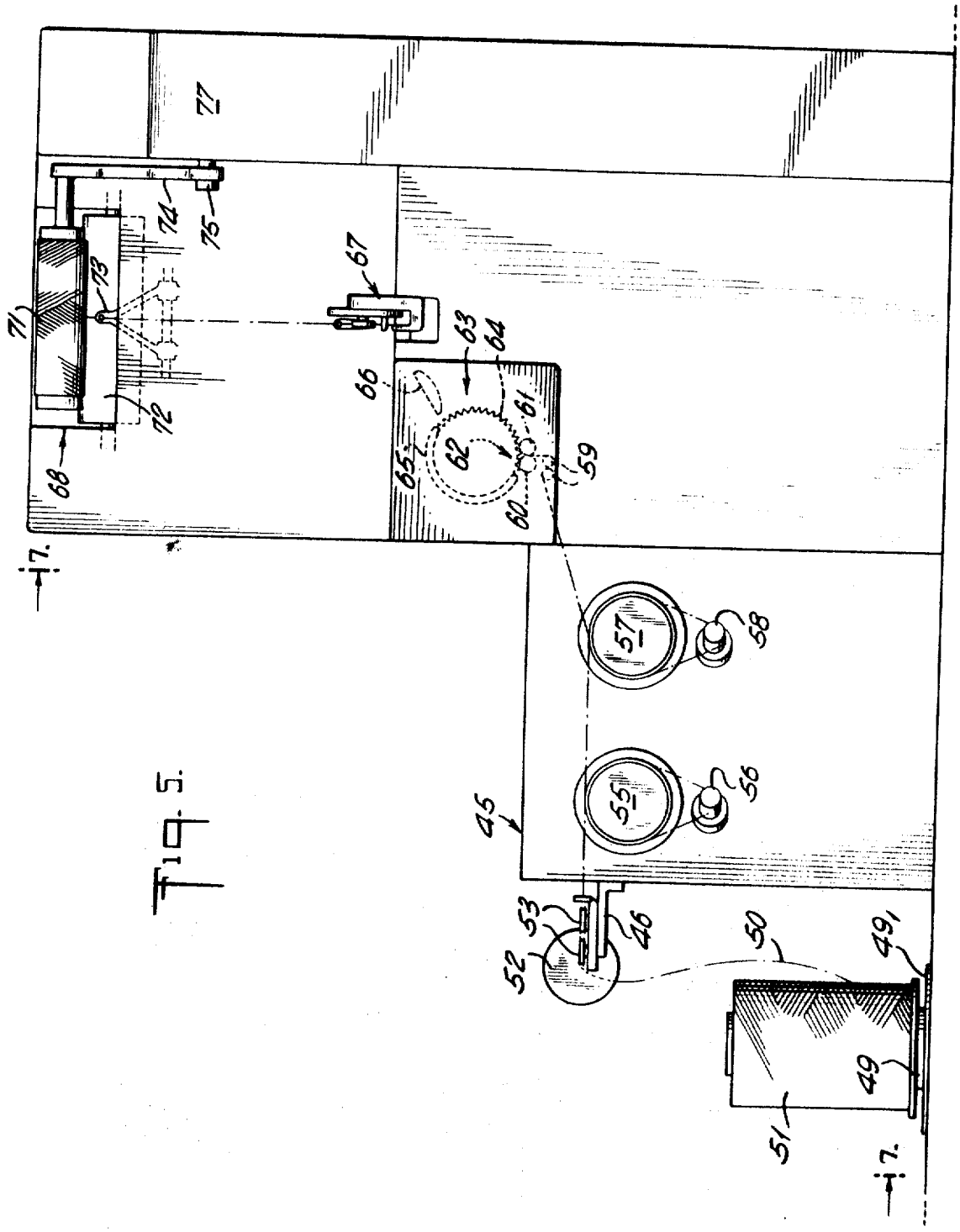


FIG. 5.

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YARN TREATING APPARATUS AND METHOD

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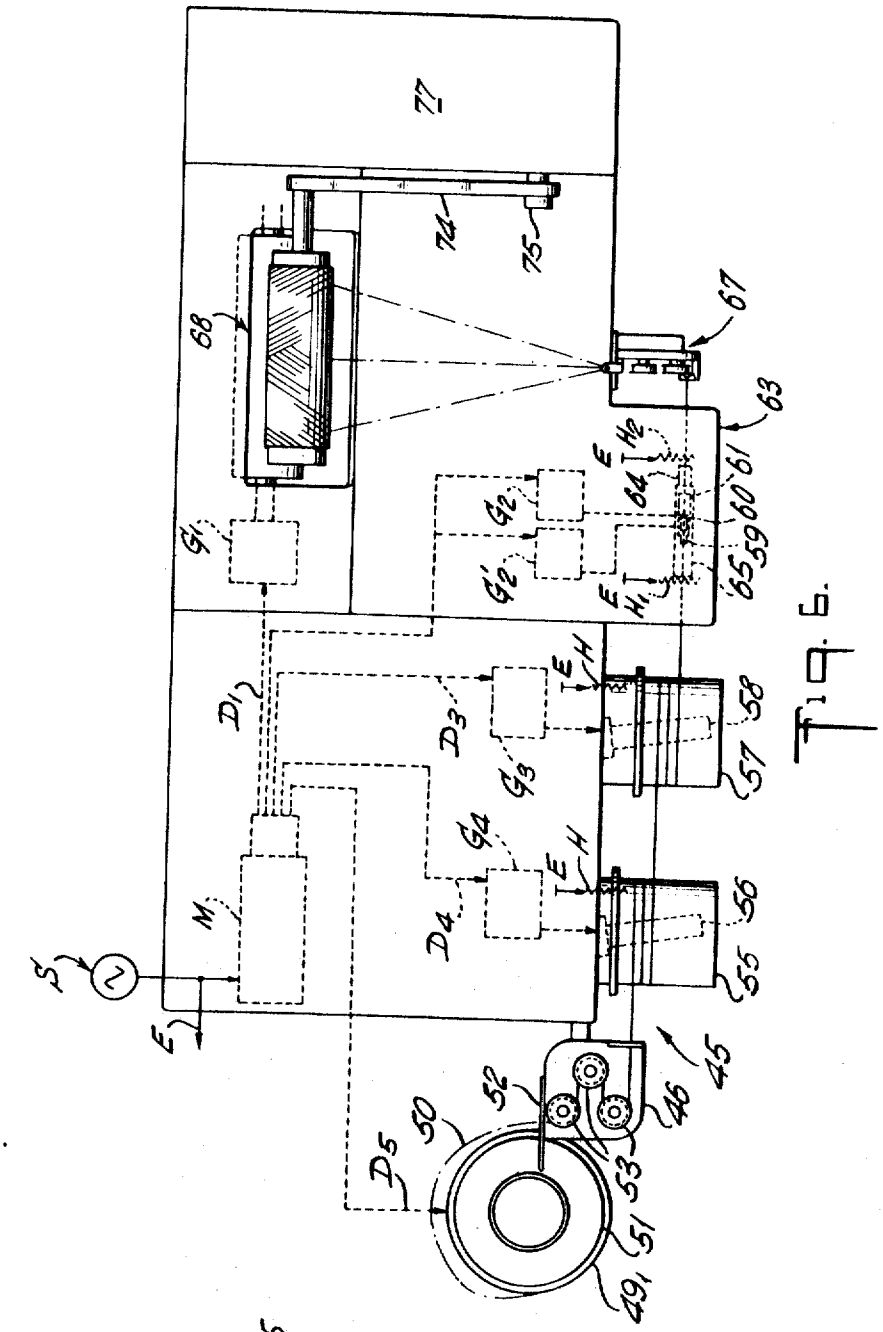


Fig. 6.

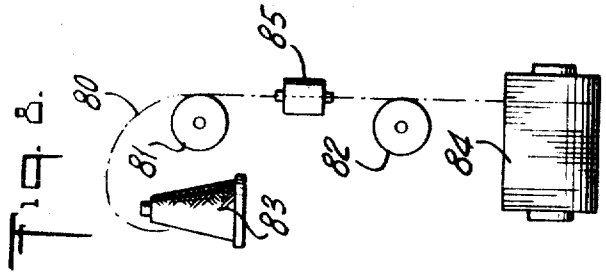


Fig. 8.

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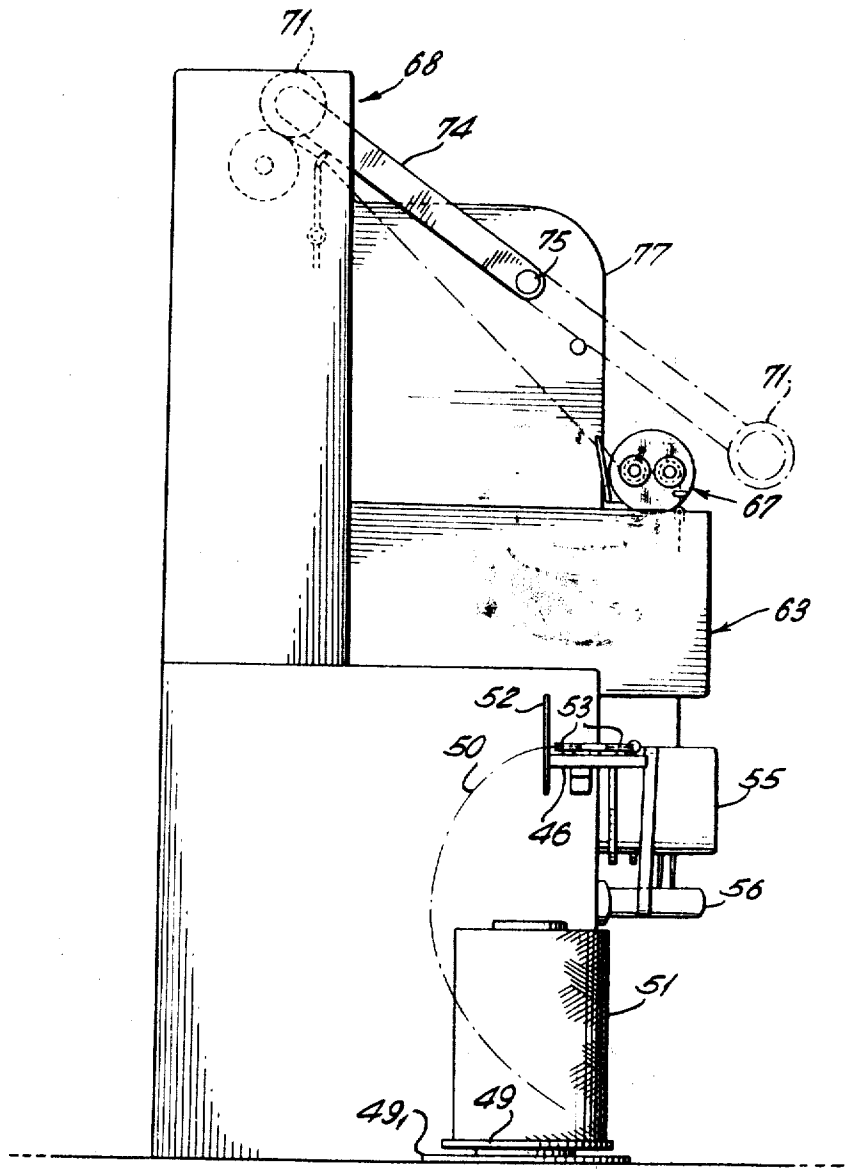
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Fig. 7.



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3,614,818

YARN TREATING APPARATUS AND METHOD

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Continuation of application Ser. No. 532,642, Mar. 8, 1966, now Patent No. 3,454,998, dated July 15, 1969.
This application May 2, 1969, Ser. No. 821,229
The portion of the term of the patent subsequent to July 15, 1986, has been disclaimed
Int. Cl. D02g 1/12
U.S. Cl. 28—1.6 30 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat the advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by the said one roller arrangement to thereby draw the yarn while in a heated condition from the said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

This application is a continuation of application Ser. No. 532,642, filed Mar. 8, 1966, now U.S. Pat. 3,454,998, granted July 15, 1969.

This invention relates generally to improvements in a method and apparatus for drawing and crimping thermoplastic yarn, such as, for instance, yarn made of polypropylene, polyester and the nylons, and in particular to an improved method and apparatus for drawing, crimping and treating yarn.

In the known methods of preparing thermoplastic materials for use as yarn, the yarn is first extruded and formed onto a supply package. This package of yarn is then drawn to establish the desired denier of the yarn, by passing the yarn over a heater between a pair of drawing rollers onto a take-up package. To crimp this drawn yarn, it is then further processed by feeding it over a heating element from whence it is crimped in crimping apparatus, such as that described in U.S. Pat. No. 3,212,157. (Such crimping apparatus in combination with the heating and drawing technique and apparatus to be described, results in high-speed operations for even the very heavy denier yarns.)

One of the problems in these various prior art steps is that it is difficult when thermoplastic yarn is heated, to accurately control the temperature of the heated yarn both internally and externally. In known crimping apparatus, the interior of the thermoplastic yarn is often not heated uniformly at the proper temperature just prior to crimping. Resultingly, non-uniform crimping occurs.

Another disadvantage in presently known crimping apparatus, where a drawing step is incorporated in the over-all process, is that it is difficult to keep the yarn drawing rate uniform. Furthermore, the range of available drawing rates is limited.

Yet another disadvantage in conventional drawing and crimping apparatus arises from yarn-heater contact where friction between the yarn and heater damages the yarn at least to the extent that non-uniform crimp may result.

It is, therefore, an object of the present invention to provide improved yarn processing apparatus which is simpler, less expensive, and more reliable and by means of which an improved quality of yarn may be obtained.

It is a further object of the present invention to provide a novel combination of drawing and crimping apparatus for processing thermoplastic yarn and in which is provided improved temperature control of the yarn, a more uniform heating and drawing of the yarn prior to the crimping thereof, and with a minimum of yarn-surface friction.

It is a further object of the invention to provide such apparatus in which the rate of drawing can, if desired, be varied over a wide range for processing a wide range of yarn denier, and which may also be varied during the drawing process for special dying and crimping results.

It is yet another object of this invention, in one embodiment thereof, to provide drawing and crimping apparatus which obviates the need for separate predrawing processes after the initial extrusion of the yarn and before crimping thereof.

According to one embodiment of the invention, extruded but otherwise unprocessed yarn is passed over the surface of two driven rollers one or both of which being internally heated, by electrical means for example. The rollers are caused to rotate at different rates to draw the yarn and establish the desired denier of the yarn. The drawn yarn is then fed into the crimping chamber of a high-speed crimping apparatus from whence it is formed onto a take-up package. One immediate advantage here is that separate positive drive means for passing yarn frictionally over stationary heated surfaces is eliminated as is yarn-heater surface frictional engagement.

The rates of rotation of the two rollers may be set to produce a desired denier of the yarn, or the rate may be continually or intermittently varied during the drawing process to obtain variable deniers along the yarn if so desired. To assure uniform internal as well as external heating at uniform speed of drawing, the number of turns of yarn around the heated roller or rollers can be calculated and varied for different yarn applications.

In another embodiment of this invention, the yarn is guided directly from the extruder onto the heated drawing rollers and then to the crimping apparatus in one continuous operation.

In yet another embodiment of this invention, the yarn after first being extruded and then drawn in a conventional manner may be then passed over a single heated roll which heats the yarn in an improved, uniform manner prior to the yarn entering the crimping chamber.

One aspect of the invention also lends itself to utilization in false twisting apparatus, in which the improved means of drawing and heating the twisted yarn is provided and in which the heated rollers preheat and postheat the yarn while simultaneously feeding the yarn through the false twisting apparatus. This method also eliminates the need for separate positive feed rollers in the heating areas of such apparatus.

Inasmuch as the speed of the heated roller or rollers of the invention can be controlled and varied, it is still a further object of this invention to utilize this principle to provide an improved method for varying the denier of the yarn for special dyeing effects. Also, because of the use, in the inventive combination, of the high-speed crimping apparatus and because of the desirable speed and uniform heating and drawing achieved via the invention, various functional portions of the crimping apparatus may be used in varying the dyeing and crimping character-

istics of the crimped yarn while taking advantage of the improved performance of the heated rollers of the invention.

In another aspect of the invention, where the yarn is being drawn and crimped for tufting in carpet manufacture processing, the apparatus of the invention provides for imparting a slight twist to the yarn just prior to the drawing operation from whence it is crimped, the slight twist being retained in the taken-up crimped yarn for facilitating tufting.

Yet another aspect of the invention contemplates the drawing and crimping of various untreated yarns and in this respect, means for coating the yarn with oil and the like are provided in the apparatus of the invention.

In accordance with another aspect of the invention the rollers and other yarn contacting surfaces of the apparatus including the crimping chamber are coated in Teflon so that snagging of the yarn being processed at high speeds is reduced; sticking of decomposed polymers is substantially eliminated; and the fumes from and direct contact with oils on the yarn will not coat the yarn contacting surfaces to adversely affect a next package of yarn to be processed.

The use of heated rollers in the drawing of yarn also lends itself to drawing combined yarns of different polymers and/or yarns with different heat histories, orientations, molecular weights, crystallizations, etc. to produce multi-filament yarn composed of yarns having various levels of crimp.

Further features and objects of the present invention will be derived from an examination of the specification below studied in conjunction with the drawings in which:

FIG. 1 is a schematic diagram showing a conventional method for drawing and crimping yarn as known in the prior art;

FIG. 2 is a schematic diagram showing of a method and apparatus for drawing and crimping yarn according to the invention;

FIG. 3 is a schematic diagram of another embodiment of the inventive improvement to a yarn drawing and crimping apparatus;

FIG. 4 is a schematic diagram of yet another embodiment of an improvement in a yarn crimping apparatus according to the present invention;

FIG. 5 is a front elevational view of a preferred embodiment of a yarn drawing and crimping apparatus employing a heated roller according to the present invention;

FIG. 6 is a plan view of the apparatus of FIG. 5;

FIG. 7 is a side elevation of the apparatus of FIG. 5 when viewing in the direction of the arrows 7—7; and

FIG. 8 is a schematic diagram showing the use of the invention in false twist apparatus.

To better understand the improvements derived by use of the present invention, it will be useful to give a brief discussion of a presently known yarn drawing and crimping apparatus having reference to FIG. 1.

The thermoplastic yarn **10** is first extruded from an extruder **11** and after setting during its vertical travel is passed around guide rollers **12** and **13** from which the yarn is taken up on a supply package **14**.

The yarn **10** from the supply package **14** is subsequently subjected to a drawing process in which the yarn is stressed under heat to cause a re-orientation of the molecular structure of the thermoplastic yarn in order to increase the tenacity of the yarn. The extent of the drawing process, which may be varied, causes the final length of the yarn to be several times that of the original length and may be varied according to the desired characteristics and denier of the drawn yarn.

In the known process, the yarn **10** is drawn between two driven cold rollers **15** and **16** around which the yarn is made to travel through a few turns. The rate of rotation of roller **16** is caused to be greater than that of roller **15**. This difference in rotational speed of the two drawing rollers **15**, **16**, effectuates the drawing process.

To facilitate the drawing of the yarn, the yarn is softened by drawing the yarn over a heating plate **17** between the drawing rollers **15** and **16**. From the rollers, the yarn is taken up on package **18**. The yarn on package **18** is then ready to be crimped. For this purpose, the yarn from package **18** is passed over a positive drive roller **19**, over the heating surfaces of an elongated heating element **20** where the yarn is once again heated prior to being guided to a crimping apparatus **21** where the yarn is crimped. The crimped yarn is then formed onto a take-up package **22**. Intermediate the crimping chamber **21** and takeup package **22**, an oiler **23** may be provided, to provide the crimped yarn with a coating of oil for subsequent processing unless the oil coating step was performed prior to crimping.

Having explained the conventional apparatus and method for processing thermoplastic yarn, the improvements derived by the present invention can now be more readily understood. For the sake of clarity, corresponding components in the various embodiments will be identified by corresponding reference numerals.

In FIG. 2 is shown one embodiment of the present invention. Undrawn yarn **10** from a supply package **14** is drawn between two rollers **25** and **26**, either the front one **25** of which must be, or both of which may be, heated and around both of which the yarn travels through several turns. Again, the rollers are rotated at different rates of rotation in order to drawn the yarn **10** to the desired denier.

It is apparent that the provision of a heated roller does away with the requirement of both heating plates **17** and **20** in the prior art embodiment shown in FIG. 1.

Also provided by the use of the heated roller because of constant yarn-heater contact, is a greater uniformity of heating throughout the entire length of the thermoplastic yarn, and this with a reducton in expense, and complexity of equipment. Other significant advantages derived by the use of the heated roller to replace the known heating plate, are that sharp bends in the heated yarn path are eliminated, frictional drag between the yarn and heater is completely eliminated, and uniform heating of the interior as well as the exterior of the yarn is assured by the simple expedient of calculating the turns of yarn relative to the speed of the roller.

Due to the above-mentioned advantages, of the apparatus more fully described below, a very high drawing speed, such as up to 500 meters per minute off the second roller **26** may be obtained. At such speeds, the yarn may be passed directly from the extruder **11** to the drawing rollers **25–26** as shown in FIG. 3, thus eliminating the step of taking up extruded yarn onto a take-up package **14** as shown in FIG. 1.

From the drawing roller **26**, the heated, drawn yarn is passed to a crimping chamber **21**, where it is crimped and is then formed onto a take-up package **22**.

Frequently, in the pre-processing of drawing yarn as in the prior art, the yarn is coated with oil and/or other compositions to finish or, for instance, predispose the yarn for later processes, such as dyeing or tufting. The present invention, in eliminating such preprocessing steps, may provide, for instance, after the crimped yarn leaves the crimping chamber **21**, on the way to the take-up package **22**, an oiler **23** in which a coating of oil is applied to the yarn **10**, to make it more amenable to a subsequent dyeing process. Due to the more uniform heating of the yarn by the heated rollers, the oil is more uniformly distributed over the surface of the yarn and consequently the dyeing process is also more uniform.

It is also within the scope of the invention to vary the rate of rotation of the drawing rollers either continually or intermittently to create an uneven denier in the yarn so that when the yarn is dyed, the yarn will receive various levels of dye forming various shades of coloring thereon, to provide an aesthetically pleasing effect in the finished product. The lesser drawn areas will dye darker than

those portions of the yarn which are drawn to a greater extent.

FIG. 4 shows another application of the invention concept in which the yarn **10** is first drawn, such as by the prior art means, shown in the embodiments of FIG. 1, the drawn yarn being formed onto packages **18**. The yarn **10** is taken from package **18** and passed around a single driven heated roller **42** which provides a uniform heating of the yarn, without drawing, before the yarn is led to the crimping chamber **21**. After the crimping operation, the yarn is guided through oiler **23** and then is formed onto take-up package **22** as in the previously described embodiments.

FIGS. 5, 6 and 7 illustrate yarn processing apparatus made in accordance with and performing the methods of the invention.

The yarn **50** is unwound from a supply roll **51** through guide disc **52** around rotatably mounted guide and tensioner wheels **53**, the disc and wheels being mounted on shelf **46** extending from housing **45**, onto driven rollers **55** and **57** and their associated separating rollers **56** and **58**.

The yarn **50** is first passed over the first driven roller **55**, which is heated, and separating roller **56** through the desired number of turns, the separating roller **56**, extending at an angle relative to the plane of the axis of roller **55** (see FIG. 6, assisting in distributing the yarn in a spiral path across the face of the roller **55**. The yarn is then passed from roller **55** to the second driven roller **57**, which may or may not be heated, as desired, and separating roller **58**, through the desired number of turns, again, separating roller **58** serving to assist in distributing the yarn in a spiral path across the face of the roller **57**.

The drawn rollers **55** and **57** grip the yarn and are so driven, by conventional driving means (not shown) contained within the housing **45**, that the roller **57** is caused to have a greater rotational speed than that of roller **55**. As a result of the differential in the rates of rotation of the two rollers, the yarn is stretched or drawn.

Standard heated godet rolls, 12 inches in circumference with 2 to 5 inch wide faces, rated at 500 to 1000 watts at 12 to 24 volts for temperatures 225° C. have been used as heated rollers **55** and **57** with exceptionally good results. Surface temperature in such rolls is maintained and varied by integral heaters and thermistors. Rheostat controls such at rotating controllers put out by Barber-Colman Company, specifically made for use as a surface heat controller for standard godet rollers, will act to further assure close and constant temperature control.

It has been found advisable to work with temperatures within the 85° C. to 185° C. for the first roller **55** for processing the various currently used thermoplastic yarns for carpeting.

The actual temperature to which the roller surface is raised is determined by the type of yarn being treated, upon the desired degree of crimping, and other considerations which arise in the subsequent processing of the yarn. The roller surface temperature will also depend upon the polymer of the thermoplastic yarn.

In a typical operation, which will produce yarn having a denier of between 1000 and 4000, the rotational rate of roller **57** will vary around approximately 500 meters per minute, while the peripheral speed of roller **55** will be approximately two and one-half to five times slower than that of roller **57**.

As noted previously, it is not essential that the surface of roller **57** be heated, but in some applications, to increase the over-all heating of the yarn, it is conceivable that roller **57** will be heated.

It is also within the scope of this invention to supply heating means to separator roll **56** and/or **58** if required by any particular operating or processing considerations.

After the yarn is drawn, it is then passed in a heated condition from roller **57** around guide rolls **59** through the nip of driven rollers **60**, **61**, which are rotated at the same peripheral speed as the second roller **57**. The rollers **60**, **61**, pass the heated and drawn yarn into the crimping area or chamber **62** of a stuffer box crimper **63**, the details of construction of which are fully set forth in U.S. Pat. No. 3,212,157.

The yarn is bunched and crimped in the stuffer box area **63** and in such condition is engaged by the toothed periphery (FIG. 5) of wheel **64** which is rotated, clockwise in FIG. 5, in timed relation with the nip rollers **60**, **61**, the peripheral speed of wheel **64** being less than the peripheral speed of the rollers **60**, **61** at a ratio of between one to one hundred and twenty and one to four hundred and twenty and one to four hundred and sixty according to the nature of the yarn and the form required, where the hole (not shown) into the crimping area is about 5/16 of an inch.

The toothed periphery of the wheel gathers up the bunched yarn moving it along the groove (not shown) in the arcuate element **65** which encloses the bunched yarn and may be heated if required to bring the yarn to a final required state.

After leaving the wheel **64**, the yarn passes under tensioning device **66** through guide **67** to winding apparatus **68** which is driven at a constant speed with respect to the rate at which bunching of the yarn takes place.

The crimped yarn is formed onto take-up bobbin **71**, which is driven by a roller **72** which contacts the periphery of the bobbin **71**. The yarn is laid on the bobbin, in a well-known manner, by reciprocating guide means **73** adjacent the nip of the bobbin and the drive roller. In this manner a package of crimped yarn is uniformly formed over the entire surface of take-up bobbin **71**.

To remove the completed package **71**, an arm **74**, from which bobbin holder **76** extends, is pivoted via shaft **75**, (FIG. 7), which is pivotally mounted on a housing **77**.

Inasmuch as the crimping apparatus, just described is capable of accepting yarn at the high rate of speed from rollers **55** and **57**, such apparatus in combination with rollers **55** and **57** results in the provision of a continuous operation including, if desired, extruding, as well as drawing, heating and crimping with all intermediate yarn take-up and supply steps eliminated.

As noted, the drive means for the various parts described may be conventional, including a source of supply S connecting a motor means M, heaters H in the rollers **55** and **57** as well as heater H_1 in the arcuate element **65** and H_2 for heating the teeth of wheel **64**, if desired, through appropriate circuitry E.

The motor means M drives drive means D_1, D_2, D_3 and D_4 for operating gear boxes or other transmission means G_1, G_2, G_3 and G_4 properly set or variable for rotating the winding mechanism **68**, toothed wheel **64**, nip rollers **60**, **61** and rollers **55** and **57** at desired speeds.

It is also within the scope of the invention to vary the rate of rotation of the drawing rollers to create an uneven denier in the yarn, by providing variable transmission characteristics to G_3 and G_4, so that when the yarn is dyed, the yarn will receive various levels of dye reception, forming various shades of coloring thereon. The lesser drawn areas will dye darker than those portions of the yarn which are drawn to a greater extent.

It is also within the scope of this invention to place movable electrically heated elements, such as wires, along the path of the yarn, for instance, between the crimping and take-up apparatus, the wires being driven and disposed relative to the yarn so as to periodically contact the yarn at predetermined intervals. That portion of the yarn which is contacted by the heated wires accepts less dye than those portions not contacted, so that a yarn is produced having various levels of dye acceptance. This optional feature is illustrated, as an example, in FIG. 3, where electrically heated wires **80** and **80'** are arranged to be intermittently moved into contact with the yarn.

It is also within the scope of this invention to pad a resist dye onto the yarn during the texturing process, so that the yarn will be produced with various levels of dye.

Color variations in the dyeing process can also be achieved by heating the tips of the toothed wheel, by suitable heating means such as a contact heater externally of the arcuate element **65** or by direct heat, via electric heating elements, for instance, to selected teeth within the arcuate element.

Because of the speed at which the yarn is being drawn and then immediately crimped, it may also be advantageous to coat the heated rollers **55** and **57** and the crimping chamber elements such as the toothed wheel **64** and the crimping area **63** with a coating of Teflon, which because of its resistance to high temperatures and smooth surface characteristics, reduces snag areas in the apparatus; the decomposed polymer from the yarn will not stick to the Teflon surfaces; and the fumes from the oiling process will not form a coating on the Teflon surfaces in the apparatus.

In the process of manufacturing rugs and similar items from crimped yarn, it is necessary to tuft the yarn. To prepare the yarn for tufting, it has been found desirable to form a twist in the yarn prior to the tufting operation. In the crimping apparatus as shown, twist is imparted to the yarn in a simple manner, by continually rotating the supply package **51** while the yarn is being passed from the supply package **51** to the drawing and heating rolls **55** and **57**. The supply package **51** is rotated about a vertical axis in FIG. 5 by providing a rotatable support **49** for the package **51** on base 49_1 and by imparting rotational movement by an conventional means including drive means D_5 from motor means M. The yarn retains the twist through the subsequent processing to the bobbin package **71**.

As can be appreciated, the apparatus of the invention lends itself to combining yarns of various characteristics, such as yarns of different polymer and/or yarns of different heat histories, differing molecular weights, differing orientations and yarns of different crystallizations. Any one of these combinations of yarn may be processed by the apparatus shown in FIGS. 5–7 by providing a second, third, etc. supply package and passing the yarn therefrom simultaneously over the rollers **56, 58** through the crimper **65** and onto the windup or take-up apparatus **68**.

The guides **53, 59** and **67**, as well as the rollers and crimper may readily, accept the yarns either physically combined or, be modified to accept the yarns in parallel relation.

When the yarn leaves the drawing rollers, loose fibers often are found which hang from the surface of the yarn, thereby creating problems in some subsequent processing. The application of a "weld" or oil on the yarn from oiler, such as shown at **23** in FIG. 2, causes the fibers to cling to the surface of the yarn forming a smooth surface.

Yet another embodiment of this invention is shown in FIG. 8 in which a heated roller is used in a false twist apparatus.

In the known false twist apparatus the yarn is passed from a supply package onto a positive feed roller and then onto a heating plate on which the yarn is softened. After leaving the heating plate, the yarn is passed through a false twist head from which it is then passed to another positive feed roller and then to a take-up package.

In the improved embodiment shown in FIG. 8, the two positive feed rollers and the heating plate are replaced by rollers **81** and **82**, one or both of which may be heated by electrical heating means disposed within each roller. The rollers thereby serve to heat the yarn and also operate as a positive feed means, so that the yarn **80** is passed from supply package **83** onto the first heated roller **81**, and is then passed through a false twist head **85**.

The yarn is softened by being passed several turns over heated roller **81** to achieve a uniform heating so as to better prepare the yarn for the twisting operation. After passing through false twist head **85**, the yarn **80** is passed over driven roller **82**, which may or may not be heated by internal heating means, onto a take-up package **84**.

The invention is not limited by the embodiments shown, but rather by the scope of the claims which are appended below.

What is claimed is:

1. Apparatus for treating thermoplastic yarn comprising means for supporting a supply package of at least partially undrawn yarn, a first heatable roller being rotatable about a first axis and around which yarn from the supply package passes, a second heatable roller being rotatable about a second axis, said second axis lying outside a vertical plane in which the first axis lies, said second roller being rotatable at a higher peripheral speed than said first roller whereby the yarn passing from the first roller is caused to be drawn by the second roller, associated with each of said heatable rollers a respective spacing roller around and in contact with which the yarn passes an conjunction with the heatable roller, means for crimping the drawn yarn by longitudinal compression thereof comprising a crimping chamber and a pair of nip rollers for feeding the drawn yarn into the crimping chamber, said nip lying outside a vertical plane in which the second axis lies, said crimping means being positioned to receive the drawn yarn from the second heatable roller while still hot.

2. Apparatus according to claim **1**, in which the first axis, the second axis and the nip are parallel.

3. Apparatus according to claim **1**, in which the first axis and the second axis lie in a horizontal plane.

4. Apparatus according to claim **1**, including winding means arranged to wind the crimped yarn into a package at a higher level than said crimping means.

5. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means, each of said roller arrangements including a driven roller and a spacing roller for spacing axially along the driven roller turns of yarn wound around both said driven roller and the spacing roller and said apparatus further comprising means associated with at least one of said spacing rollers for heating the periphery thereof.

6. Apparatus for treating thermoplastic yarn comprising means for supporting at least one yarn supply package, said supporting means including means for rotation of the yarn supply package about an axis substantially parallel to the general direction of feed therefrom, means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and

advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

7. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangements being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said apparatus further comprising means for tensioning the yarn as it travels to said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

8. The apparatus of claim 7 wherein said means for tensioning the yarn includes rotatably mounted guide and tensioning wheels.

9. Apparatus for treating thermoplastic yarn comprising means for supporting at least one yarn supply package, a first feed roller around which the yarn is wound for heating and linearly advancing the yarn; a second feed roller for advancing and drawing the yarn as it leaves the first feed roller; tensioning means provided in the path of the travelling yarn in a position between said supporting means and said first feed roller; and means for imparting a false twist to yarn interposed between said first and second roller, at least one of said rollers comprising internal heating means constituting the sole means for heating the yarn in the drawing and twisting operation.

10. Apparatus for treating thermoplastic yarn, comprising means for supplying at least one continuous length of a yarn; means for drawing the yarn; and means for crimping the drawn yarn by longitudinal compression, said drawing means comprising a roller arrangement, having a roller comprising a peripheral surface around which the yarn is wound, means for heating the yarn while it is contained on said peripheral surface; means for advancing the heated yarn away from said roller arrangement at a rate faster than the rate at which the yarn travels on said peripheral surface; said crimping means including a chamber defining a yarn bunching zone for forming a plug of crimped yarn; means for driving the drawn yarn into said chamber while the yarn is still in a heated condition from said drawing means; and means for advancing said plug of crimped yarn away from said bunching zone; said apparatus comprising furthermore tensioning means in a position between said yarn supplying means and said heated roller, so as to provide controlled tension to the yarn as it is fed to and wound around said periphery of said roller.

11. The apparatus of claim 10, wherein said tensioning means includes rotatably mounted guide and tensioning wheels.

12. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, at least one of the roller arrangements comprising means for intermittently varying the relative rate of rotation of said roller arrangements, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

13. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means, the surfaces of the apparatus which come in direct contact with the traveling yarn, including the peripheral surfaces and the chamber, being coated with a fluorinated ethylene polymer.

14. Apparatus for treating thermoplastic yarn comprsing means for supporting a plurality of independent yarn supply packages, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for windingup the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

15. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, means for applying a liquid to the traveling crimped yarn ,and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements

having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

16. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangements having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming a plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means, said crimping means including a crimping chamber, said chamber communicating with a passage for receiving the plug of crimped yarn, said passage including heating means for heating the plug of yarn.

17. Apparatus for treating thermoplastic yarn comprising means for heating and drawing the yarn while advancing the yarn, means for crimping the yarn by longitudinal compression directly after drawing while the yarn is still in a heated condition from the heating and drawing means, movable heating means for intermittent contact with the yarn, and means for winding up the drawn and crimped yarn, said heating and drawing means comprising a pair of roller arrangements, each of said roller arrangemnets having a peripheral surface with which the yarn is contacted, one of said roller arrangements being heatable and rotatable to heat and advance yarn from the supply to the other of said roller arrangements, said other roller arrangement being heatable and rotatable to advance the yarn at a rate greater than the rate at which the yarn is advanced by said one roller arrangement to thereby draw the yarn while in a heated condition from said one roller arrangement, said crimping means comprising a chamber defining a yarn bunching zone for forming plug of crimped yarn and means for driving the drawn yarn into the chamber while the yarn is still in a heated condition from the heating and drawing means.

18. The apparatus of claim **17**, wherein said movable heating means are heated elements, which are positioned, in relation to the travel of the yarn, behind said crimping means.

19. A method for treating thermoplastic yarn, including the steps of taking yarn from a supply, guiding the yarn to and winding the yarn around an internally heated roller having a peripheral surface, restraining the travel of the supplied yarn prior to its winding around the periphery of said roller, so as to wind the yarn onto the periphery of said heated roller with a controlled tension, rotating the roller in the direction of the winding of the yarn therearound, heating the yarn by means of the roller as it travels in contact with the roller, drawing the yarn off the roller at a greater speed than the peripheral speed of the roller, and directly crimping the drawn yarn while said yarn is still in a heated condition from said heating step.

20. The method of claim **19**, further comprising feeding the yarn from the roller onto and around a second roller, rotating the second roller at a peripheral speed greater than that of the first named roller and guiding the yarn from the second roller into crimping apparatus.

21. The method of claim **19**, in which the yarn is taken from a supply package and said supply package is rotated around its length axis.

22. The method of claim **19**, in which a plurality of yarns is taken from a plurality of individual yarn packages.

23. The method of claim **19**, wherein a coating of liquid is applied to the yarn.

24. The method of claim **23**, wherein the application of the liquid coating is intermittent and spaced along the length of the yarn.

25. A method for treating thermoplastic yarn, including the steps of taking yarn from at least one supply package having a rotational length axis, guiding the yarn to and winding the yarn around the periphery of an internally heated roller, rotating the roller in the direction of the direction of the winding of the yarn therearound, heating the yarn by means of the roller as it travels in contact with the periphery of the roller, drawing the yarn off the roller at a greater speed than the peripheral speed of the roller, and directly crimping the drawn yarn while said yarn is still in a heated condition from said heating step, wherein the yarn is taken off the supply package in a direction generally parallel to the rotational length axis of the supply package, and wherein the package is rotated during take off the yarn around its length axis.

26. A method for treating thermoplastic yarn including the steps of taking a plurality of yarns of different characteristics, simultaneously guiding said yarns directly to and winding said yarns around an internally heated roller, rotating the roller in the direction of the winding of said yarns therearound, heating said yarns by means of the roller as said yarns travel in contact with the roller, drawing said yarns off the roller at a greater speed than the peripheral speed of the roller, and directly crimping the drawn yarns while said yarns are still in a heated condition from said heating step.

27. The method of claim **26**, in which the yarns are in the form of a physically combined yarn bundle.

28. The method of claim **26**, in which the yarns are physically independent and disposed in mutually parallel relation.

29. A method for treating thermoplastic yarn including the steps of taking yarn from a supply, guiding the yarn directly to and winding the yarn around the periphery of an internally heated roller, rotating the roller in the direction of the winding of the yarn therearound, heating the yarn by means of the roller as it travels in contact with the roller, drawing the yarn off the roller at a greater speed than the peripheral speed of the roller, and directly crimping the drawn yarn while said yarn is still in a heated condition from said heating step, said method comprising the further step of varying the physical and dyeing characteristics of the yarn along its length by applying one or more of the steps of intermittently contacting the travelling yarn with a heated body, intermittently varying the rate of withdrawal of the yarn from the roller, applying a dye resist to selected portions of the traveling yarn.

30. A method for treating thermoplastic yarn including the steps of taking yarn from a supply, guiding the yarn directly to and winding the yarn around the periphery of an internally heated first roller, rotating the roller in the direction of the winding of the yarn therearound, heating the yarn by means of the roller as it travels in contact with the roller, feeding the yarn from the first roller onto

and around the periphery of the second roller, rotating the second roller at a peripheral speed greater than that of the first roller, and intermittently varying the peripheral speed of one or of both of the rollers to produce an intermittently varied rate of draw of the yarn.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,614,818 Dated October 26, 1971

Inventor(s) F. B. SATTERWHITE

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

Column 8, line 20, change "an" to --in--.
Renumber claims 5 to 24 as 7 to 26, respectively. Insert after claim 4 the following claims:
--5. Apparatus according to claim 4 in which at least the first of said heatable rollers includes means for heating the roller which means are located internally of the roller.--
--6. Apparatus according to claim 5, in which said heatable rollers and said spacer rollers constitute the sole means heating or contacting the yarn during the drawing of the yarn.--
Renumber claims 25 to 30 as 29 to 34, respectively. Insert after claim 26, the following claims:
--27. A method according to claim 19, in which as the yarn passes around and in contact with the internally heated roller the yarn also passes around and in contact with a spacer roller associated with the internally heated roller.--
--28. A method according to claim 27, in which only said spacer rollers heat or contact the yarn as the yarn is drawn.--
Column 9, line 35, change "7" to --9--. Column 9, line 70, change "10" to --12--. Column 11, line 62, change "17" to --19--. Column 12, each of lines 5, 10, 13, 16, change "19" to --21--. Column 12, line 18, change "23" to --25--. Column 12, each of lines 47 and 49, change "26" to --30--.

Signed and sealed this 6th day of June 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents