This invention relates to a process and apparatus for preparing novelty yarns from artificial thermoplastic material. More specifically, it relates to an improved method and apparatus for preparing thick-and-thin novelty yarns wherein the denier variations are arranged in a random fashion.

It is known that a textile yarn having abrupt changes in denier along its length is capable of producing a fabric possessing novel visual and tactile properties. Several methods have heretofore been proposed for producing such yarn. For example, thick-and-thin cellulose acetate yarns have been prepared by passing the yarn around a driven heated roller having its surface indented with longitudinal channels so that intermittent sections of the yarn are heated, and thereafter applying a uniform drawing tension to the yarn. Thick-and-thin yarns of other artificial thermoplastic materials such as polyethylene terephtalate may also be prepared in this manner if one starts with undrawn yarn and adjusts the drawing ratio so that the final yarn has alternate drawn and undrawn sections.

However, the yarns heretofore prepared in this manner have a more or less regularly arranged series of denier variations which give a discernible pattern when woven or knitted into fabric. This discernible pattern is objectionable in many end uses of the finished material.

Methods have been proposed to eliminate this "patternizing" effect by imparting a random variation to the yarn denier variations. In general, however, these methods have required complicated apparatus, for example, electronic controls actuated by cosmic rays such as those described by Hare in U.S. Patent 2,622,282.

It is, therefore, an object of this invention to provide an improved process for preparing novelty yarns of thermoplastic artificial material comprised of alternately disposed and sharply defined large and small denier sections wherein the denier variations are spaced in a truly random manner. A further object is to provide a process for preparing thick-and-thin yarns which do not give a discernible pattern when woven or knitted into fabric form. A still further object of this invention is to provide improved apparatus for preparing novelty yarns having random thick-and-thin sections. Other objects will be apparent from the following description.

The objects of this invention are attained by a process which comprises passing yarn of an artificial thermoplastic material over a roller having randomly spaced, heated and unheated portions while simultaneously traversing the yarn back and forth across the surface of the roller at a rate at which the path of the yarn forms an angle greater than about 60° but less than about 90° with a line parallel to the axis of the roller. The yarn is withdrawn from the roller at a rate at least about two times greater than the rate at which it is fed to the roller, thereby drawing the heated portions from about two to twenty times their original length. Single filaments as well as a plurality of filaments are intended to be included within the term "yarn."

The process of this invention may be practiced using yarn-drawing apparatus comprised of means for supplying an undrawn yarn at a uniform rate to a roller having randomly spaced abrupt changes in its radial contour so that the pattern along the contour described by a given helical path around the roller is significantly different from the pattern described by any other helical path parallel to but displaced along the axis of said roller from the first path, means for driving said roller, means for heating said roller, means for traversing the yarn back and forth across the surface of said roller, and means for applying a uniform drawing tension to the yarn leaving said roller.

The invention will be more clearly understood by reference to the following description and accompanying drawings.

In the drawings,

Figure 1 is a perspective illustration of one embodiment of the present invention;

Figure 2 is a perspective illustration of another embodiment of the invention;

Figures 3, 4, and 5 are perspective views of suitable rollers; and

Figure 6 is a perspective view of a suitable traversing mechanism.

With reference to Figure 1, a thermoplastic yarn 1 is passed from a source of supply, not shown, under a guide pin 2, between feed rollers 3 and 4, through yarn guide 5 of a reciprocating bar 6, around heated, grooved roller 7, and finally around draw roller 8. The rollers rotate on shafts 9 in the direction shown by the arrows, rollers 3, 5, 6 and 8 rotating at the same uniform peripheral speed and roller 7 rotating at a higher peripheral speed, preferably at least twice the peripheral speed of rollers, 3, 4 and 7. The yarn is wrapped around draw roller 8 a number of times to prevent slippage. After leaving roller 8, the yarn is wound up using a device not shown. Rollers 3, 4, and 8 are unheated, while grooved roller 7 is heated to a suitable temperature. Heating may be accomplished in any suitable manner, for example, by electrical means or by stem or other hot fluid which may be circulated through the roller.

The yarn 1 is passed around and the heated grooved roller 7, usually making contact for at least about 90° of arc, during which time those portions of the yarn which contact the peripheral areas 10 of the roller become heated. The amount of wrap on the roller will, of course, depend somewhat on the diameter of the particular roller being used. The differential speed between rollers 7 and 8 cause the heated portions of the yarn to be drawn as the yarn leaves the grooved roller. The portions of the yarn which have passed around the roller above the depressed zones or grooves 11 of the roller are unheated and remain substantially undrawn, providing sharply defined sections of the yarn which are substantially the same denier as the original yarn.

Yarn guide 5 is attached to a reciprocating bar 6 which traverses the yarn back and forth, preferably with non-uniform motion, over the surface of the heated roller. In the preferred method of operation the yarn is traversed rapidly, one complete cycle being completed in a period slightly less or greater than the time required for one revolution of the heated roller. The yarn thus starts each successive traverse at a different point on the heated roller. Operated in this manner, a large number of cycles are completed before a pattern is repeated. For example, if the speed of the traverse is such that the first reversal point progresses around the hot roller at the rate of 6% of the roller circumference per cycle, a total of 63 revolutions will be made before a reversal point is repeated.

An alternative embodiment of apparatus for practicing this invention is shown in Figure 2 in which a thermoplastic yarn 1 is passed from a source of supply, not
shown, by means of suitable guides to a grooved traverse roller 12, around heated grooved roller 7, and finally around draw roller 8. The rollers roller 8, 12, 17, 34, 35, and 36 shown in the direction shown by the arrows, roller 8 rotating at a higher peripheral speed than roller 7 in order to give the desired drawing ratio. Rollers 8 and 12 are unheated, while grooved roller 7 is heated to a suitable temperature. As the yarn passes around the heated grooved roller 7, those portions of the yarn which contact the peripheral areas 10 of the heated roller become heated. The heated portions of the yarn are drawn as they leave the grooved roller because of the tension exerted by draw roller 8. However, portions of the yarn which have passed around the roller above the depressed zones 11 of the roller are unheated and remain substantially undrawn, providing sharply defined sections of the yarn which are still substantially the same denier as the original yarn. After leaving roller 8, the yarn is wound up or packaged in any suitable manner.

The grooved traverse roller 12 is operated at such a speed that the yarn falling in groove 13 is traversed rapidly over the surface of roller 7, completing one traverse cycle in somewhat more or less time than required for one revolution of the heated roller. The yarn thus starts each successive traverse at a different point on the heated roller so that a large number of cycles are completed before a pattern is repeated.

A corrector mechanism for adjusting the relative speeds of traverse roller 12 and heated roller 7 of Figure 2 is to mount two drive wheels on the shafts of the two rollers and bring the peripheries of the two wheels into frictional contact so that one wheel may drive the other, i.e., to have in effect the traverse roller shaft is driven by the heated roller shaft. With such an arrangement the ratio of the rotational speeds of the traverse roller and heated roller is in the inverse of the ratio of the diameters of the respective driving wheels. Therefore, the speed ratio may be adjusted by appropriate change in the diameters of the driving wheels. The number of revolutions the rollers must make before exactly repeating a given configuration may be found mathematically by setting up the ratio of diameters of the two driving wheels in the form of a fraction and dividing both numerator and denominator by their largest common factor, or, if one or the other is a fraction, multiplying both numerator and denominator by the smallest number necessary to convert both to integers. With the ratio in its revised form, the larger number (numerator or denominator) gives the number of revolutions required of the faster roller, and the smaller number gives the number of revolutions required of the slower roller, before a given configuration is exactly repeated. For example, if the diameter of the driving wheel on the heated roller shaft is 6.43 inches, and that of the driving wheel on the traverse roller shaft is 7.50 inches, their ratio is

\[ \frac{6.43}{7.50} \]

or

\[ \frac{643}{750} \]

Since 643 is a prime number, the fraction is now in its simplest form. Therefore, the number of revolutions required of the heated roller before the set of rollers repeats a given configuration is 750. Likewise, the number of revolutions required of the traverse roller is 643. In light of the above discussion, it will be obvious that the number of revolutions required before a given configuration is repeated may be varied within wide limits by picking appropriate driving wheel diameters with the aid of a table of primes and factors.

The optimum number of traverse cycles per revolution of the heated roller may be illustrated in terms of the minimum angle attained during the traverse cycle between the yarn path on the surface of the roller and a line parallel to the axis of the roller. For best results the yarn path during the traverse cycle is such that the angle between the yarn path on the surface of the roller and a line parallel to the axis of the roller is greater than about 60° but less than about 90°. A fast traverse which gives an angle appreciably below this range leads to sidewise slippage of the yarn because of the stretching tension by the yarn which leaves the roller.

The number of cycles will also depend on the type of fabric which is to be prepared from the novel yarns. Generally from about 10 to 700 cycles, before a repeat, are required to eliminate objectionable patterning. The lower figure represents the number of cycles required to produce an average of one randomly spaced change in denier per inch, and the upper figure represents the number of cycles required to produce an average of one randomly spaced change in denier for each twenty inches of yarn. It may seem surprising that such a large number of cycles are required to produce an average of one change in denier per twenty inches. However, experience has proved that accomplishing a truly random spacing of the changes in denier in such cases is extremely difficult with patterning being more readily detected when such large spacings are used.

The traversing mechanism may also be operated with a non-uniform or random motion. A suitable random traverse mechanism is shown in Figure 6 in which the traverse bar 14, bearing yarn guides 15, is moved back and forth by arm 16 which is pivoted on shaft 17 supported by bearing 18. The movement of arm 16 is controlled by the cooperative action of spring 19 and cam follower assembly 20 which rides on the outer edge of the non-uniform mult-lobe cam 21. Cam 21 is driven by shaft 22 which is the output shaft of speed reducer 23. The input shaft 24 of speed reducer 23 is driven by variable speed transmission 25 which in turn is driven by constant speed motor 26. Pulley 27, mounted on shaft 22 along with cam 21, drives pulley 28 on shaft 29 by means of belt 30. Shaft 29 passes through bracket 39 and drives eccentric 31 which, through arm 32, causes member 33 to oscillate back and forth. This oscillatory motion is carried by shaft 34 and arms 35, 36 and 37 to shaft 38. Shaft 38 is the actuating member for varying the speed of variable speed transmission 25. The non-uniform variation in rotational speed of the non-uniform cam 21 imparts random reciprocating translational motion to guide rod 14, and the yarn traversing through guides 15 mounted on roller 12 are traversed across the surface of slotted roller 40 in truly random fashion.

Figures 3, 4 and 5 illustrate rollers having varying surface contours which may be substituted for roller 7 in Figures 1 and 2. Figure 3 shows a roller having a plurality of indentations consisting of peripheral slots or holes. The slots are spaced in an uneven and random fashion so that no two helical paths are the same. Figure 4 shows a roller on the surface of which are a plurality of raised vanes which hold the yarn away from the hot roller surface and thereby leave unheated sections in the yarn which do not stretch or draw. The length of the undrawn portion of yarn may be varied by varying the height of the vane above the hot surface of the roller. The vanes may be arranged in any suitable manner.

Figure 5 shows a roller which has a grooved surface similar to that shown in Figure 1 except that the grooves are introduced in a zigzag fashion. The grooves may also be arranged in other geometrical patterns such as arcs or circles.

It will be apparent that the length of the thick or un-
drawn portion of the product yarn depends upon the length of unheated yarn which is primarily controlled by the width of the groove, slot, or hole, or the height of the raised portion at the heated roller surface. The distance between thick sections of the yarn is determined by the length of hot roller surface contacted by the yarn between grooves, slots, holes, or raised elements and the drag ratio imposed by the differential speed of draw roller and the feed rollers.

The invention will be further described but is not intended to be limited by the following examples.

**EXAMPLE I**

Apparatus for drawing yarn is arranged as shown in Figure 1, the grooved roller being constructed similarly to roller 7 shown in the figure. The body of the roller, a right circular cylindrical chrome-plated steel roller four and one-half inches in diameter and two inches wide, is machined to convert the cylindrical surface of the roller into a grooved surface roller. The grooves are spaced on the surface is indicated in Table 1 which follows, where angle A, which is measured clockwise, gives the location of the groove around the periphery of the roller and angle B gives the inclination of the groove from a line parallel to the axis of the roller.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>4</td>
<td>19</td>
<td>100</td>
<td>-12</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>4</td>
<td>29</td>
<td>200</td>
<td>+4</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>4</td>
<td>39</td>
<td>300</td>
<td>+12</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>4</td>
<td>49</td>
<td>400</td>
<td>-12</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>4</td>
<td>59</td>
<td>500</td>
<td>-12</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>4</td>
<td>69</td>
<td>600</td>
<td>+4</td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>8</td>
<td>79</td>
<td>700</td>
<td>-4</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>12</td>
<td>89</td>
<td>800</td>
<td>-4</td>
</tr>
<tr>
<td>9</td>
<td>90</td>
<td>16</td>
<td>99</td>
<td>900</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>8</td>
<td>100</td>
<td>1000</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>110</td>
<td>12</td>
<td>110</td>
<td>1100</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>120</td>
<td>16</td>
<td>120</td>
<td>1200</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>130</td>
<td>20</td>
<td>130</td>
<td>1300</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>140</td>
<td>24</td>
<td>140</td>
<td>1400</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>150</td>
<td>28</td>
<td>150</td>
<td>1500</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>160</td>
<td>32</td>
<td>160</td>
<td>1600</td>
<td>0</td>
</tr>
</tbody>
</table>

The grooves are 0.060 inch in width and 0.090 inch deep. Means for heating the roller consist of three 50-watt cartridge heaters mounted in a stationary heater block about which the roller rotates, the clearance being 36a inch.

Polyethylene terephthalate polymer, having an intrinsic viscosity of 0.63, is melt-spun into a yarn, comprising 27 filaments, having a total undrawn denier of 135 and a birefringence of 0.0090. In drawing the yarn in the apparatus described above, the feed rollers and the grooved roller are operated to give a yarn speed of 141 yards per minute, and the yarn is passed around the draw roller at 375 yards per minute. The speed of the traverse is arranged so that one traverse cycle is completed in slightly less than one revolution of the heated roller, the yarn starting the second traverse at a point about 6%4 inch from the start of the preceding traverse. The minimum angle during one traverse cycle between the yarn path on the surface of the roller and a line parallel to the axis of the roller is about 70°. The grooved roller is maintained at 108°C. The drawn yarn, when examined under magnification, shows abrupt changes in denier with the thick portions having a diameter approximately 1.7 times that of the intervening smaller denier segments.

Yarn prepared as described above is woven into a filling-faced satin fabric six inches in width. After finishing, the fabric is found to have the novel appearance associated with thick-and-thin yarns with no discernible evidence of patterning.

Yarn prepared as described above is woven into a 48-inch taffeta fabric. The fabric is scoured one-half hour at 160°F, heat-set eight seconds at 325°F, and dyed with a dispersed dye for one hour at 205°F. The resulting fabric has the appearance and feel expected of a fabric prepared from a thick-and-thin yarn with no discernible evidence of patterning.

Another sample of yarn prepared as above is knit into a two-bar jersey tricot fabric (12 inches per rack). After scouring at the boil for thirty minutes, the fabric assumes an appealing dry, crepe-like hand with no visible pattern formation.

**EXAMPLE II**

Apparatus for drawing yarn is set up as shown in Figure 1 except that a roller with raised vanes similar to that shown in Figure 4 was substituted for the roller shown in Figure 1. The roller, originally a right circular cylinder four and one-half inches in diameter and two inches wide, is equipped with vanes protruding perpendicularly from the surface. The vanes are made of wire appropriately bent and inserted into holes in small curved plates which form the outside surface of the roller.

The roller is heated as described in Example I.

The height of the vanes is varied with some of the vanes high at one end and low at the other. The higher vanes hold more yarn off the hot roller surface than the lower vanes, thereby producing thick-and-thin yarn sections of varying lengths.

The vanes are mounted at an angle equal to the helix angle of the traversed yarn so that the yarn will pass over the vane when traversed in one direction but will lie beside it when traversed in the opposite direction. Also, some vanes are spaced in such a fashion that occasionally the yarn will pass over two or more vanes without touching the hot roller surface between vanes to form very large, thick sections.

Undrawn polyethylene terephthalate yarn prepared as in Example I is drawn on the apparatus described above at a windup speed of 375 yards per minute and a draw ratio of 2.9. The speed of the traversing mechanism is adjusted so that one traverse cycle is completed in about 0.81 revolution of the heated roller. The actual cycle is such that the heated vaned roller rotates approximately 2000 times before the traverse cycle is exactly repeated. The angle between the yarn path on the surface of the roller and a line parallel to the axis of the roller is about 70°. The vaned roller is maintained at a temperature of 108°C. The drawn yarn, when examined under magnification, shows randomly arranged, abrupt changes in denier.

Yarn prepared as described above is woven into a 30-inch wide taffeta fabric and found to give the novel appearance associated with thick-and-thin yarns with no discernible evidence of patterning.

**EXAMPLE III**

A 600-denier, 30-filament cellulose acetate yarn (about 54% combined acetic acid) possessing no twist is stretched using the process described in Example I. The peripheral speed of the hot roller is 248 inches per minute while the peripheral speed of the take-up roller is 620 inches per minute. The angle between the yarn path on the surface of the roller and a line parallel to the axis of the roller is 75°. The width of the grooves in the grooved roller is one-eighth inch and the roller temperature is maintained at approximately 245°C. The over-all denier of the stretched yarn is 240, but abrupt changes in denier are visible along its length. When this yarn is woven into a 36-inch taffeta fabric, the characteristic appearance expected of a thick-and-thin yarn is obtained, with no discernible evidence of patterning.

When yarn prepared by the above process is woven
as filling in a 6-inch wide filling-faced satin fabric, the novel appearance of a thick-and-thin yarn is obtained with no evidence of pattern formation.

**EXAMPLE IV**

An apparatus for drawing yarn is set up as described in Example I with the exception that a heated roller four inches wide having parallel grooves spaced apart in an irregular pattern is used to draw a polyethylene terephthalate yarn. The traverse mechanism is adjusted so that the traverse guide completes a trip across the face of the heated roller in one direction in 0.400 revolution of the roller, remains stationary for 0.200 revolution of the roller, makes the return trip in the opposite direction in 0.460 revolution of the roller, and then remains stationary for 0.247 revolution of the roller before beginning the traverse cycle over again. Thus, the full traverse cycle is completed in 1.307 revolutions of the heated roller, thereby progressing around the heated roller at the rate of slightly less than \( \frac{1}{4} \) of the circumference of the roller per cycle. The heated roller makes 1307 revolutions before a given traverse cycle starting point is again encountered.

The yarn produced is woven into a 48-inch taffeta fabric which is scoured, heat-set, and dyed as in Example I. The woven fabric has the appearance and handle expected of a fabric prepared from a thick-and-thin yarn, with no discernible evidence of patterning.

Another sample of yarn prepared as above is woven into a 36-inch filling-faced satin fabric. The resulting fabric has the appearance and handle expected of a fabric prepared from thick-and-thin yarn, with no discernible evidence of patterning.

In addition to preparing thick-and-thin yarns from the materials described in the foregoing examples, this invention may be advantageously used to prepare yarns from a variety of other fiber-forming materials. Such materials include both natural and synthetic polymers which are capable of being drawn when heated and placed under tension. Although yarns which have not been drawn are preferred, drawn yarns which may be further drawn upon heating may be used. Yarns prepared from polyanilides, polyanilideacids, polyeysters, polyurethanes, polyureas, polyacrylonitrile, polyhydrocarbons, e.g., polyethylene, polypropylene, polyvinyl chloride, cellulose esters, cellulose ethers, as well as many others may be drawn by the process of this invention.

The temperature of the heated roller and tension, will, of course, be determined to a large extent by the nature of the material being drawn and the amount of drawing desired. The speed of drawing will also depend primarily on these factors. However, as previously indicated, the relative speed of traverse and the speed of the heated roller should be selected to give maximum random spacing of the thick-and-thin sections. Also, the traversing should be accomplished at a speed at which the angle formed between the yarn path on the surface of the roller and a line parallel to the axis of the roller is greater than 60° but less than 90°.

Accordingly, the apparatus of this invention may be modified in various ways. For example, the heated roller may have solid vanes which are heat conducting instead of grooves, or the vanes may be made from a thermal insulating material. A plurality of yarn guides, heated rollers, and drawing rollers may be used to draw a number of yarns simultaneously.

The traversing apparatus shown in Figure 6 is also susceptible of various modifications. For example, a suitable arrangement of gears may be substituted for belt 36 and pulleys 27 and 28 in transmitting motion to variable speed transmission 25. Also, a cam and spring arrangement operating directly from shaft 22 could be used to cause shaft 38 to oscillate, thereby varying the gear ratio in variable speed transmission 25. Other modifications will be apparent to those skilled in the art.

The outstanding advantage of the present invention resides in the fact that variable denier yarns having truly randomly spaced thick-and-thin sections are produced. The yarns may be used in many widely different types of woven and knitted fabrics without objectionable pattern formation.

It will be apparent that many more different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

1. The process for preparing yarns having randomly spaced thick-and-thin sections which comprises withdrawing a yarn prepared from an artificial thermoplastic material from a supply source at a uniform rate, heating said yarn at randomly spaced intervals by passing said yarn over a roller having randomly spaced heated portions, simultaneously traversing said yarn back and forth across the surface of said roller at a rate at which the path of said yarn during said traversing forms an angle of at least 60° but less than 90° with a line parallel to the axis of said roller, withdrawing said yarn from said roller under uniform tension at a uniform rate at least about two times greater than the rate at which said yarn is fed to said roller whereby the sections of said yarn passing in contact with said heated portions of said roller are drawn from about two to about twenty times their original length.

2. The process of claim 1 wherein said roller makes a plurality of revolutions before the original path on the roller is repeated.

3. The process of claim 1 wherein a plurality of yarns are drawn simultaneously.

4. The process of claim 1 wherein said yarn is caused to traverse the surface of said roller during less than one revolution of said roller.

5. The process of claim 4 wherein said traversing is intermittent.

6. The process for preparing yarns having randomly spaced thick-and-thin sections which comprises withdrawing an undrawn yarn prepared from an artificial thermoplastic material from a supply source at a uniform rate, heating said yarn at randomly spaced intervals passing said yarn over a roller having randomly spaced heated portions, simultaneously traversing said yarn back and forth along the drawing condition, the angle changing rate at the path of said yarn during said traversing forms an angle of at least about 60° but less than 90° with a line parallel to the axis of said roller, withdrawing said yarn from said roller under uniform tension at a uniform rate at least about two to about twenty times greater than the rate at which said yarn is fed to said roller whereby the sections of said yarn passing in contact with said heated portions of said roller are drawn from about two to about twenty times their original length.

7. The process of claim 6 wherein a plurality of yarns are drawn simultaneously.

8. Apparatus for producing novelty yarns having randomly spaced thick-and-thin sections comprising in combination means for supplying a plurality of artificial thermoplastic yarns at a uniform rate to a driven roller, said roller having abrupt changes in its radial contour whereby the pattern along the contour described by a given helical path around the roller is significantly different from the pattern described by any other helical path parallel to but displaced along the axis of said roller, means for heating said roller, a plurality of yarn guides in advance of said roller mounted on a common member for traversing said yarns back and forth along the surface of said roller, means operatively connected to said member for imparting a non-uniform reciprocating trans-
9. Apparatus for producing novelty yarn having randomly spaced thick-and-thin sections comprising in combinations means for delivering an artificial thermoplastic yarn at a uniform rate to driven roller having a plurality of angularly displaced, randomly disposed slots across its surface, said slots being so disposed across the surface of said roller that a pattern defined by a given helical path around the roller is significantly different from the pattern defined by any other helical path parallel to but displaced along the axis of said roller, means for forward ing an artificial thermoplastic yarn at a uniform rate to said driven roller, traversing means immediately in advance of said roller for traversing said yarn back and forth across the surface of said roller, means for heating said elevated sections of said roller and means for withdrawing said yarn from said roller under uniform tension.

**References Cited in the file of this patent**

**UNITED STATES PATENTS**

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor(s)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,898,085</td>
<td>Dreyfus et al.</td>
<td>Feb 21, 1933</td>
</tr>
<tr>
<td>2,156,923</td>
<td>Picard</td>
<td>May 2, 1939</td>
</tr>
<tr>
<td>2,278,888</td>
<td>Lewis</td>
<td>Apr. 7, 1942</td>
</tr>
<tr>
<td>2,296,394</td>
<td>Meloon</td>
<td>Sept. 22, 1942</td>
</tr>
<tr>
<td>2,622,282</td>
<td>Haro</td>
<td>Dec. 23, 1952</td>
</tr>
<tr>
<td>2,854,802</td>
<td>Braunlich</td>
<td>July 14, 1959</td>
</tr>
</tbody>
</table>
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,975,474
March 21, 1961

James G. Smith

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 39, for "stem" read -- steam --; column 3, line 31, for "peripheries" read -- peripheries --; column 5, line 21, for "is" read -- as --; column 8, line 23, after "least" insert -- about --; line 45, after "intervals" insert -- by --; column 9, lines 4 and 5, for "combinations" read -- combination --; line 6, after "to" insert -- a --.

Signed and sealed this 2nd day of January 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents
USCOMM-DC