

[54]	PROCESS FOR TEXTURING YARN BY GEAR CRIMPING	3,293,843	12/1966	Bibby et al.....	28/1.8
		3,417,446	12/1968	Fairclough et al.....	28/1.8
[75]	Inventors: Stanley Robert Cochran, Martinsville, Va.; Melvin Harry Johnson, Wilmington, Del.	Primary Examiner—Louis K. Rimrodt			
[73]	Assignee: E. I. du Pont de Nemours and Company, Wilmington, Del.				
[22]	Filed: Dec. 20, 1972				
[21]	Appl. No.: 316,744				
[52]	U.S. Cl.	28/72.15			
[51]	Int. Cl.....	D02g 1/14			
[58]	Field of Search.....	28/1.8, 72.15			
[56]	References Cited				
	UNITED STATES PATENTS				
	3,024,517	3/1962	Bromley et al.	28/72.15	
	5 Claims, 8 Drawing Figures				

[57] ABSTRACT

A continuous process for imparting crimp to synthetic yarn includes the steps of drawing the yarn, heating the drawn yarn, then passing the yarn through the nip of a pair of crimper gears. An essential feature of the process is operation of the crimper gears to avoid further drawing of the yarn in the nip of or upstream of the gears.

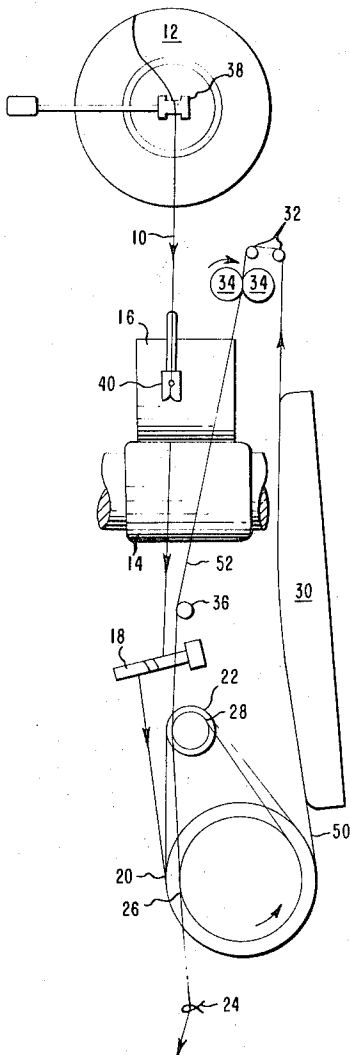


FIG. 1

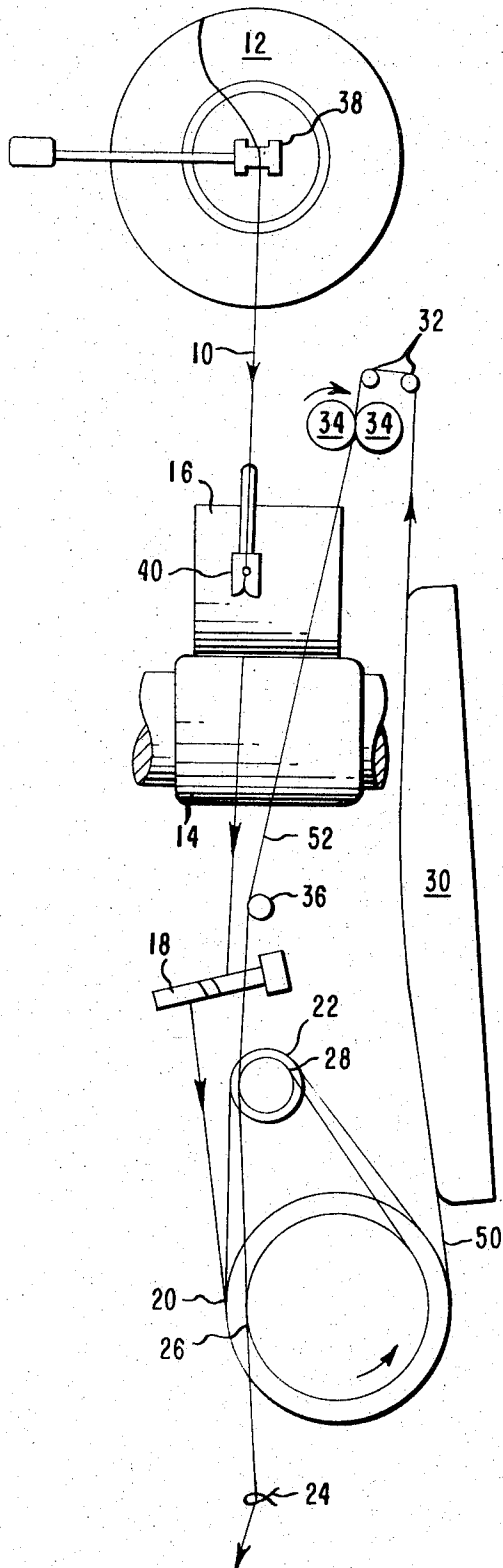


FIG. 2

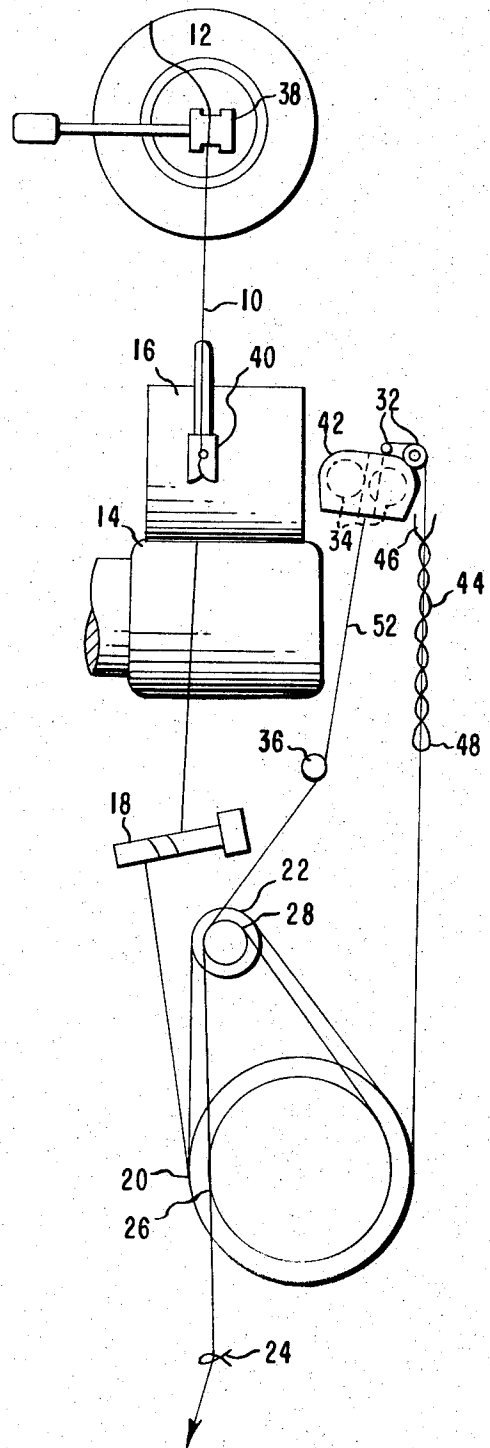


FIG. 3

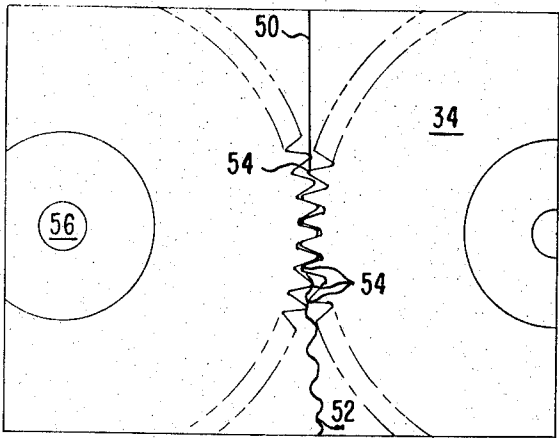


FIG. 4

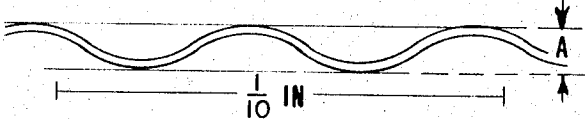


FIG. 5

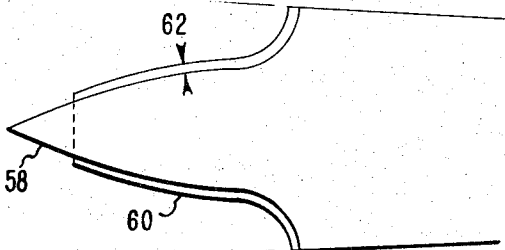


FIG. 6

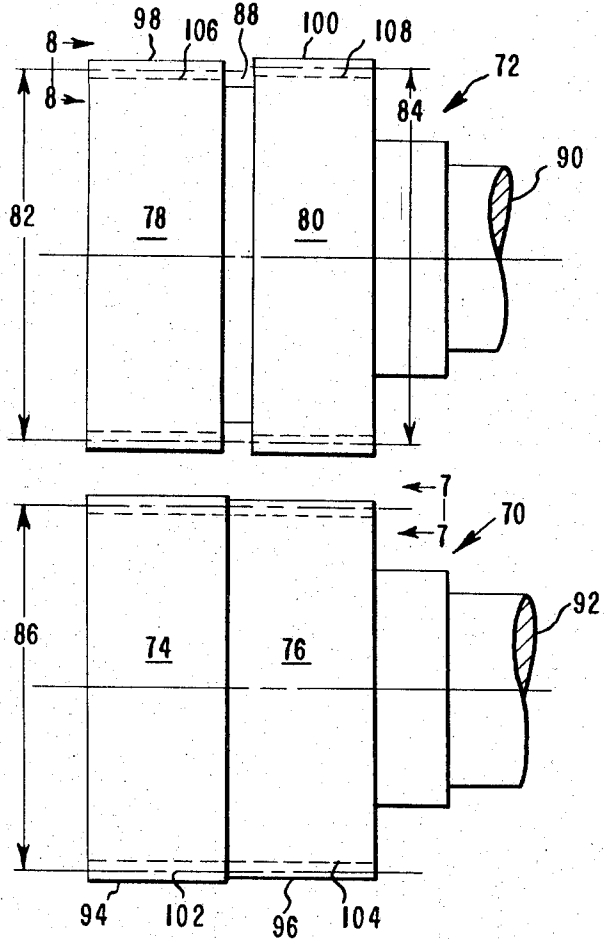


FIG. 7

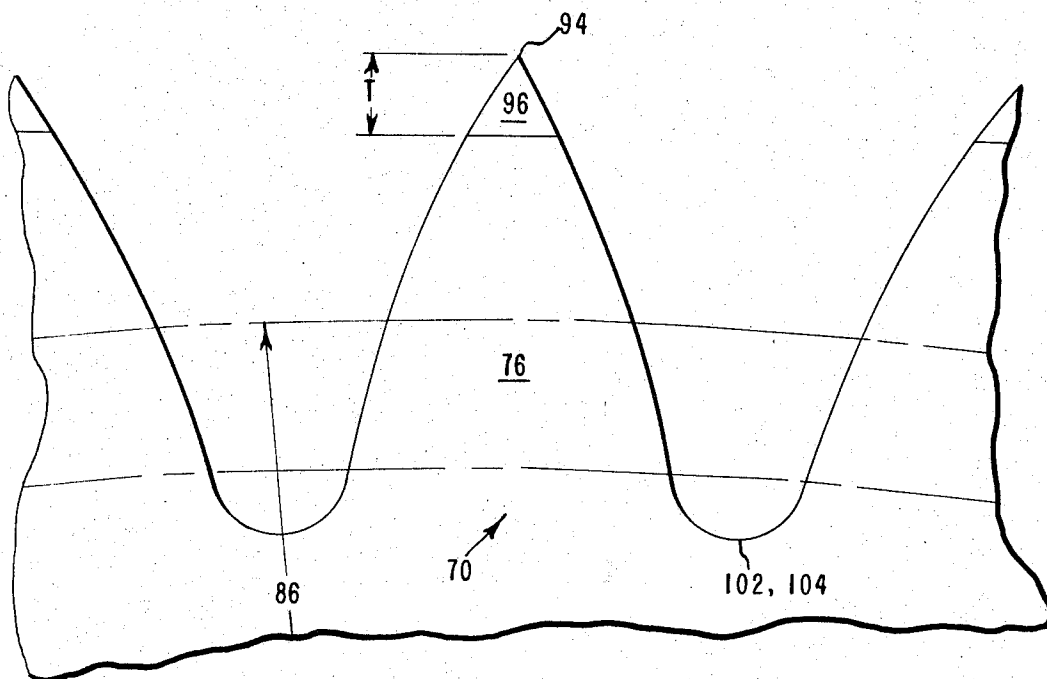
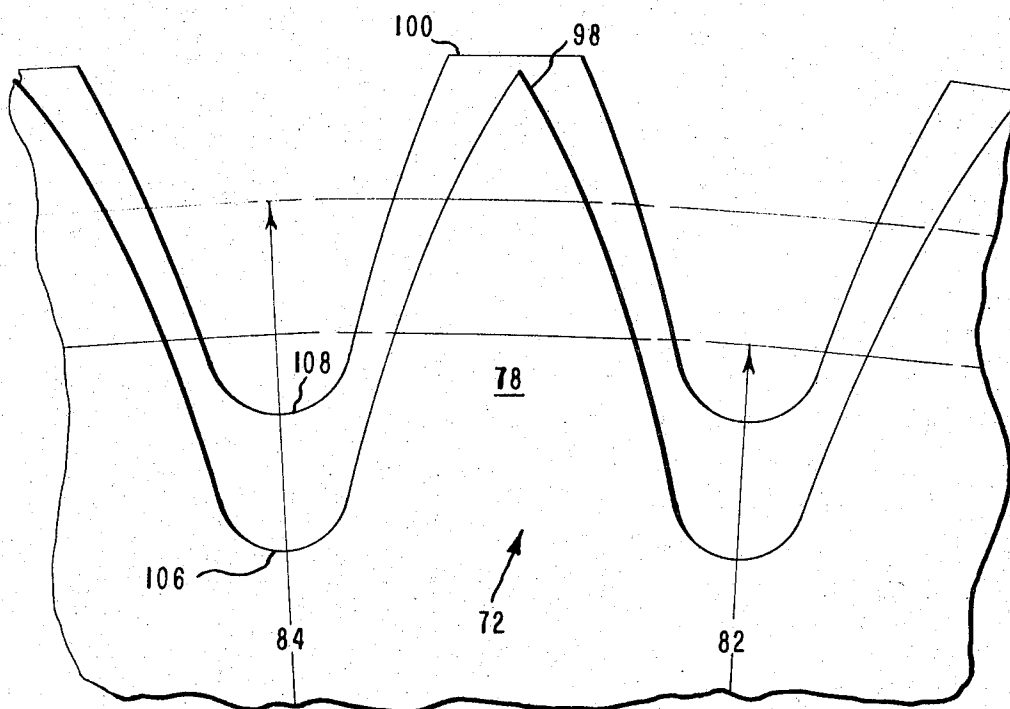


FIG. 8



PROCESS FOR TEXTURING YARN BY GEAR CRIMPING

BACKGROUND OF THE INVENTION

This invention relates to the texturing of yarn by gear crimping and more especially to the gear crimping of continuous monofilament for use in the backbar of crepe tricot.

Gear crimping as a means for texturing synthetic yarns, is old in the textile art. The utility of gear crimped yarns is not restricted to any one use, but gear crimped monofilaments are especially useful in the backbar of crepe tricot fabrics. A commercially attractive gear crimping process should operate at yarn speeds exceeding 500 yd./min. and preferably is carried out on modified existing yarn handling equipment, e.g., drawtwisters to provide a continuous process performing both drawing and crimping which results in superior crimp. C. M. Rice in U.S. Pat. No. 3,256,134 describes a crimping process said to be operable at speeds up to 1,000 yd./min. or more. Unfortunately, the crimping device used to attain such high speeds is complicated and costly. Direct substitution of gear crimping in this process is unreliable because the use of a gear pair as a draw roll to cause drawing upstream also results in further drawing within the nip between the gears which in turn results in frequent yarn breaks at the desirably high rates of yarn passage through the nip.

DEFINITION OF THE INVENTION

According to this invention, cold drawing and gear crimping occur in one continuous process but occur in separate zones. It is essential that the gears be oriented and operated such that no cold drawing of the yarn occurs either in the nip of the gears or in the immediate upstream zone thereof. Stated differently, the cross-sectional area of crimped yarn exiting the gears should always be at least as large as that of drawn and heated yarn entering the gears.

More particularly, the invention involves a continuous process for crimping an undrawn synthetic yarn including the steps of drawing the yarn in a first zone, heating the drawn yarn to a heat setting temperature, crimping the yarn in a second zone separate from said first zone by passing the heated yarn through the nip between interdigitating driven gears with the total change of direction of the yarn between the gears being less than 20 radians and without further drawing the yarn in the crimping step and forwarding the yarn while cooling it from said second zone at low tension to a collecting location.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically represents the process of this invention being carried out on a modified drawtwister.

FIG. 2 is an alternative arrangement of FIG. 1 using a particularly preferred type of yarn heater.

FIG. 3 is a drawing copied from a photograph of the gear crimping step and taken while the process is temporarily stopped.

FIG. 4 shows in magnified scale a typical 25 denier gear crimped nylon monofilament after relaxed steaming.

FIG. 5 shows aligned profiles of the crimping and driving sections of a preferred gear tooth.

FIG. 6 shows a pair of 2 section crimping gears particularly suitable for use in crimping according to this invention.

FIG. 7 is a view of gear 70 taken at 7—7 of FIG. 6.

FIG. 8 is a view of gear 72 taken at 8—8 of FIG. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 the process of this invention is being carried out on one position of a modified drawtwister. Cold drawable synthetic filament yarn 10 is withdrawn from its spin bobbin 12 via guide 38 and traverse guide 40 to and through the nip between cott roll 16 and driven feed roll 14. A stepped draw roll has major step 20 and minor step 26 (the associated separator roll has corresponding steps 22 and 28). Passing via a draw pin 18 (for localizing the draw point) yarn 10 takes several wraps around draw roll 20 which, by being driven at a peripheral velocity greater than that of feed roll 14, causes yarn 10 to become fully drawn in a first zone, i.e., between feed roll 14 and draw roll 20. Drawn yarn 50 is heated to a heat setting temperature on passage over hot plate 30 and immediately thereafter, via guides 32, passes once only through the nip between unheated driven interdigitating gears 34, i.e., a zone separate from the draw zone. As more fully discussed hereinafter, gears 34 are arranged and operated so that no further drawing of yarn 50 occurs either in the nip of gears 34 or upstream in the heating zone. Exiting the nip of gears 34, crimped yarn 52 passes via suitable guide 36 to several wraps around roll 26 and thence via pigtail guide 24 to packaging via a conventional ring-and-traveler windup (not shown).

The preferred process of FIG. 2 is entirely analogous to FIG. 1 with the exceptions that hot plate 30 is replaced with double helix hot wire heater 44 and that a safety shield 42 encloses gears 34. Ends 46 of heater 44 are attached (not shown) to a regulated supply of electricity (for safety, preferably of low voltage) whereby heater 44 raises yarn 50 to a heat setting temperature. A typical heater 44 is of 40 mil diameter bare Nichrome wire (Nichrome is a registered trademark of the Driver-Harris Company for certain Ni-Cr alloy electrical resistance wires) doubled at the end 48 so that its two legs are helically wound together about a common axis to leave a uniform 12 mil diameter yarn passage along its axis and lateral spacing between adjacent coil portions of about the same 12 mil dimension. Heater 44 is preferably positioned close to gears 34 to prevent appreciable cooling before crimping.

FIG. 3 is a drawing prepared from a photograph of a temporarily interrupted gear crimping operation according to this invention. Fully drawn monofilament 50 enters the nip between intermeshing gears 34 and emerges as crimped yarn 52. In this case the gears 34 are driven by an extension 56 of one of the gear shafts. A belt drive (not shown) to shaft 56 from the drive system of the drawtwister has the advantage that feeding, drawing and crimping rates are always in constant preselected ratios.

FIG. 4 is an enlarged view of a portion of a typical 25 denier monofilament gear crimped according to this invention and subsequently steamed with saturated atmospheric steam in relaxed condition. By "zig-zag" crimping is meant herein that the crimping displace-

ments of yarn portions occur in a single plane through the longitudinal axis of the crimped yarn.

Any continuous filament yarns of synthetic polymeric thermoplastic material are suitable for crimping according to this invention providing only that they are not fully cold drawn as supplied. "Cold-drawn," as used herein, means that the yarn is elongated by applying tensions exceeding the yield point while the yarn is in its solid state. Thus, cold drawing does not preclude the application of heat so long as no melting occurs. Yarns which have not previously been cold drawn at all are preferred in this invention. In any event, the yarns should become fully drawn in the draw zone, i.e., they are drawn about as much as possible without introducing an undesirable frequency of draw breaks. This level of drawing depends somewhat on the polymer substrate involved but for common substrates and in particular polyhexamethylene adipamide, yarns are considered fully drawn when the ratio of drawn to undrawn lengths is between about 3.5 and about 4.5. This process is particularly desirable because yarn speeds on draw roll 20 readily exceed 500 yd./min. and preferably exceed 1,000 yd./min.

Although the double-helix hot wire heater 44 is the preferred means for raising the yarn to a heat setting temperature, the process of this invention is in no way limited to any particular means. Dry heat is preferred including, among other well-known devices hot plates, heated tubes, radiant ovens and the like. Heat setting temperatures are well known for commercially available polymeric substrates. For polyhexamethylene adipamide yarns, the yarn temperature leaving the heater should be at least about 135°C. and up to about 200°C. The maximum yarn temperature should be at least as high as any anticipated in subsequent operations involving tension on the yarn before, during or after fabric construction. If the yarn is tensioned later at a higher temperature, some or all of the crimp will be removed.

According to this invention, then, cold drawing and gear crimping occur in one continuous process but occur in separate zones. It is essential that the gears be oriented and operated such that no cold drawing of the yarn occurs either in the nip of the gears or in the immediate upstream zone thereof. Stated differently, the cross-sectional area of crimped yarn 52 exiting the gears 34 should always be at least as large as that of drawn and heated yarn 50 entering the gears and the latter should be at least as large as that of drawn yarn 50 immediately after leaving draw roll 20.

With reference to FIG. 3, it is apparent that as yarn 50 enters and passes through the nip, it contacts a series of tips of gear teeth 54, these tips alternating from one to the other of the gears. The incremental length of yarn between adjacent gear tips increases from first contact to a maximum where radii of the two gears fall on the same straight line. Assuming, as is necessary for this particular geometrical analysis, that yarn 52 exits along a projection of the line of entry of drawn yarn 50, the remaining incremental lengths decrease symmetrically as the yarn continues to its last contact with a tip of a gear tooth. It is apparent, then, that if no drawing of the yarn is to occur within the nip, the yarn must be free to slip across tooth tips while still providing sufficient forwarding force to lead the yarn 50 into the nip without allowing upstream slack to develop.

One of the requirements allowing adequate slip is that the parallel axes of rotation of the two gears be spaced apart so that all along the yarn path through the nip there is sufficient clearance between gear surfaces that the yarn's full diameter can be accommodated without deforming its cross section. Even with this clearance, some flattening of the cross section occurs on the underside of each crimp peak due to slippage across tooth tips as described hereinabove.

The extent of frictional contacts of the yarn within the nip must be restricted if drawing within the nip is to be avoided. The size of each gear tooth is dictated within reasonably restricted limits, as is well understood, by the frequency and amplitude of the desired crimping. In general, in order to limit extent of frictional contacts, it is necessary that at least one, and preferably both, of the gears have a small pitch diameter, i.e., usually less than 1 inch. This dimension cannot be specified rigorously. It is found, however, that satisfactory results are obtained if, in passing through the nip, the yarn undergoes less than 20 radians of change in direction summed over all teeth contacted. Preferably for customary gear tooth sizes, the number of teeth simultaneously contacted in the nip is no more than 15, but slightly larger numbers can be accommodated if only small crimp amplitudes are to be provided. These criteria, together with a selected size of gear tooth, dictate the maximum suitable gear diameters. These limits apply to the assumption only for design and calculation purposes that the yarn downstream of the point of maximum interpenetration of gear teeth is held tightly against the tooth tips exactly as it is held upstream thereof.

Although cooling of crimped yarn 52 occurs somewhat during passage through the nip of the unheated gears 34, it is essential that yarn 52 be withdrawn from the nip under very low tension while being further cooled along a path in ambient air. In general, the lower the operable tension the better is the crimp retained. Tensions lower than 0.05 gm./den. are found effective, preferably the tension is less than 0.02 gm./den. As shown in FIGS. 1 and 2, the provision of this low tension is easily accomplished on lower diameter step 26 of a stepped draw roll.

Departing step roll 26, yarn 52 may be wound up in any conventional fashion either visibly crimped in its package or tensioned so as to straighten the crimps. In either event, subsequent relaxed heat treatment (e.g., steaming) restores the originally imparted crimp.

Two single section gears may be used to perform the crimping and the driving of one gear by the other. In preferred crimping gears, however, each gear has 2 sections on the same shaft, a drive section and a crimping section with the respective pairs of sections mating in operation. FIG. 5 shows a single gear tooth as viewed from the end with the crimping section of one of 2 identical gears. The crimping portion of the tooth has the narrow pointed profile 58 while the drive section has the wider blunt profile 60. The added width 62 of each drive tooth allows zero backlash operation of the driver sections while preventing maximum penetration of tooth 58 to the bottom of its opposite tooth space. Thus, a yarn passage always at least as wide as the yarn's diameter is always left in the crimping section when the two gears are in parallel maximum intermeshing alignment. With single section gears, any variations in friction of their shaft bearings or sharp changes in ro-

tary velocity tend to cause yarn breaks. The use of aligned two section gears, as described, substantially eliminates yarn breakage.

FIGS. 6, 7 and 8 present in greater detail another pair of crimping gears 70, 72 particularly suited to crimping according to this invention. Gear 70 is preferably the driven gear, being mounted and driven via shaft 92. Follower gear 72 is mounted for rotation via its shaft 90. Their axes are separated for clarity in FIG. 6, but in operation they are in fully intermeshing parallel engagement. Gear 70 has crimping section 74 and drive section 76, preferably integral therewith, aligned on shaft 92. FIG. 7 shown as indicated at 7-7 of FIG. 6 shows one complete gear tooth of the aligned sections of gear 70. All teeth in this instance have the same pitch diameter 86 and dedenda 102 and 104. The tooth tip 94 of the crimping section 74 is pointed; it is turned to a radial depth T at 96 in the drive section 76. FIG. 8, shown as indicated at 8-8 of FIG. 6, shows one complete gear tooth of the aligned sections of gear 72. The teeth of driver section 80 have blunt tips 100 and dedenda 108 formed at pitch diameter 84. The teeth of crimping section 78 have pointed tips 98, roots 106 and pitch diameter 82 smaller than pitch diameter 84. Pitch diameter 86 preferably matches pitch diameter 84. Gear 72 has a recessed separation 88 between sections 78 and 80 to prevent running interference with what is otherwise a transition zone between the two. In one useful embodiment of gear pair 70 and 72, the pair of identical crimping sections 74 and 78 used fits the following specifications:

1. 60 involute gear teeth
2. 16.70 mm. outside (maximum) diameter
3. 15.87 mm. pitch diameter (defines "pitch circle")
4. 20° tooth pressure angle (at pitch circle)
5. 0.8312 mm. circular pitch (center-to-center distance between adjacent teeth measured along pitch circle)
6. 0.4156 mm. tooth width at pitch circle
7. 0.82 mm. height (difference in radius of 2 circles, one coincident with all tooth tips and the other

with all valleys).

Drive section 76 of gear 70 is identical to the crimping sections except that tooth tips 94 are turned to an outside diameter of 16.50 mm at 96.

Drive section 80 of gear 72 has the same number of teeth precisely aligned angularly with the teeth of crimping section 78. The teeth of drive section 80 are first contoured precisely like those of crimping section 78 but with corresponding points spaced radially outward by 0.31 mm. to provide an effective pitch diameter 84 of 16.49 mm. Finally, drive section 80 is turned down to an outside diameter of 16.86 mm. to form blunt tips 100.

With the pair of gears mounted for operation, the intermeshing distance (or working depth) is 0.61 mm. measured along a line through the centers of both crimping sections as the overlap of 2 circles coincident with the 2 sets of tooth tips. This geometry provides a total change in direction of yarn passing through the nip of 17.1 radians.

What is claimed is:

1. A continuous process for crimping an undrawn synthetic yarn comprising: drawing said yarn in a first zone; heating the drawn yarn to a heat setting temperature; crimping the yarn in a second zone separate from said first zone by passing the heated yarn once through the nip between interdigitating driven gears without drawing the yarn by means of the crimping step; and forwarding the yarn from said second zone at low tension to a collecting location.

2. The process as defined in claim 1, the total change of direction of the yarn between the gears being less than 20 radians.

3. The process as defined in claim 1, said yarn being nylon, said heat setting temperature being in the range of from about 135°C. to about 200°C.

4. The process as defined in claim 1, said low tension being less than 0.05 gram per denier.

5. The process as defined in claim 4, said tension being less than 0.02 gram per denier.

* * * * *

45

50

55

60

65