

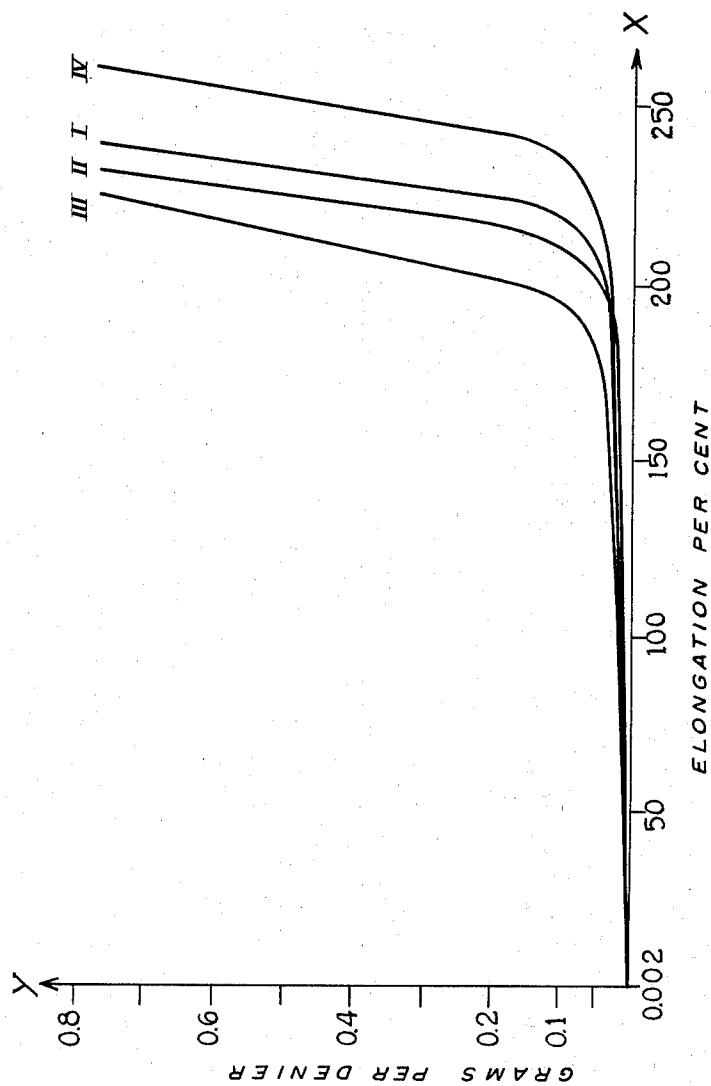
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PROCESS FOR PRODUCING CRIMPED YARNS

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PROCESS FOR PRODUCING CRIMPED YARNS

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This invention relates to a process for making permanent crimped yarn of synthetic polymerized organic material.

Processes for producing crimped yarn by high twisting, setting and detwisting are known. Yarns treated by these known methods have been found to have varying physical characteristics.

The principal object of the present invention is to control the characteristics of such yarns and to produce yarns which shall possess characteristics desired for knitting and otherwise.

The invention comprises the novel products as well as the novel processes and steps of processes according to which such products are manufactured, the specific embodiments of which are described hereinafter by way of example and in accordance with which we now prefer to practice the invention.

It has been found in accordance with the present invention that crimped yarns will vary in accordance with the amount of high twist given the yarn, but when the yarn is twisted in accordance with the equation given below, a superior crimped yarn is produced which is relatively permanent, is voluminous and has generally pleasing appearance. It also has a relatively high "total percentage elongation" and a low "percentage tension," the latter being referred to hereinafter as "fiber elongation." Under "total percentage elongation" we understand the elongation of the yarn on applying a defined stress, this elongation being composed of the stretching out of the crimp and of the strain of the fibrous material itself. Under fiber elongation we understand the strain of the fibrous material itself. These last-mentioned and quoted characteristics are further determined in connection with formulae which will be given below.

The above-mentioned equation is as follows:

$$T = \frac{275,000}{D + 60} + 800$$

whereby T means the optimum number of twists and D the denier number of the yarn. By means of this simple technical equation the optimum number of twists for different yarn titres can be easily obtained with the necessary accuracy, whereby the wearisome empiric determination of the number of twists is avoided. It has been found in employing this equation that it is particularly effective in establishing the proper number of twists to be given the yarn for yarns of 20 to 450 denier.

The present invention refers especially to fibers of polyamides, as for instance polyhexamethylene adipamide or the polymerisation product of epsilon-caprolactam. It, however, may be employed also with other synthetic polymerized organic textile fibers, filaments or yarns such as polyesters or polyvinyl compounds.

Yarns made in accordance with the present process are permanently crimped, have a round cross section and are voluminous. They possess a high "total percentage elongation" and a low fiber elongation. The "total per-

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centage elongation" is obtained by use of the following equation:

$$\frac{b-a}{a} \times 100 = \text{up to } 400\%$$

where (a) is the yarn length measured at a load of .002 gram/denier, and (b) is the yarn length measured at a load of 0.8 gr./den. The fiber elongation is calculated as follows:

$$\frac{b_2 - b_1}{b_2} \times 100 = 5 - 20\%$$

for the most suitable twists as a rule about 5-12% where b_1 is the yarn length measured at a load of 0.1 gr./den. and b_2 is the yarn length measured at a load of 0.8 gr./den.

The following are examples of the process as it is now desired to practice it in accordance with the invention.

(1) As a starting material a yarn made of the linear poly condensation product hexamethylenedipamide is used, which is well known in the market under the name of nylon. It consists of 10 filaments and shows a total titre of 30 denier. According to the above equation the optimum twist for the high-twisting can be obtained as follows.

$$\frac{275,000}{30 + 60} + 800 = 3860 \text{ T/m}$$

$\frac{2}{3}$ of the yarn quantity are high-twisted to 3860 T/m S, $\frac{1}{3}$ to 3860 T/m Z. Then it is steamed to set it for half an hour at 2.7 atmospheres. The yarn which is high twisted in the S-direction is detwisted to 150 T/m Z, the yarn which is high twisted in the Z-direction is detwisted to 150 T/m S, and finally the two yarns of 150 T/m Z, plus one yarn of 150 T/m S are twisted together to 100 T/m S. In order to facilitate the mechanical workup, the twist of three-ply yarns usually are sized afterwards with an aqueous solution of polyvinyl alcohol plus glycerine. After washing out the sizing, the fiber material has an intensive, uniform crimp or curliness, the thread becomes considerably more voluminous and is very elastic. The "total percentage elongation" is of the order of 400% and the fiber elongation is of the order of 12%. Knitted and woven goods of this yarn show a completely new character in textiles and an outstanding heat retention capacity.

(2) Nylon yarn according to example 1 of a total titre of 70 den., consisting of 23 filaments, is high-twisted to

$$\frac{275,000}{70 + 60} + 800 = 2900 \text{ T/m}$$

half of the quantity each in Z and S direction. The high-twisting is carried out on a ring twisting frame, and the yarn is then wound onto aluminum tubes. The high-twisted yarn is steamed on the rigid aluminum tubes for 45 minutes at 2 atmospheres. Then the yarn is detwisted to 100 T/m S resp. to 100 T/m Z and thereafter one yarn each of S and Z direction is twisted together to 100 T/m Z, and finally reeled. After a short steaming without pressure there results an extraordinary and very uniform, crimped, voluminous twist of a soft and wool-like hand of high elasticity and of an outstanding warmth retention. The crimp is washproof. The "total percentage elongation" was 225% and the fiber elongation was 9.8%.

(3) A polyamide yarn of type "Perlon" L or "Grilon," made of a spun polycondensation product of epsilon-caprolactam, of a total titre of 300 den., is high-twisted to

$$\frac{275,000}{300 + 60} + 800 = 1560 \text{ T/m}$$

and wound on rigid tubes in Z-direction. Then the yarn is steamed on tubes for 30 minutes at 1.2 atmospheres, detwisted to 80 T/m S, reeled and treated in hank form with aqueous steam for a short time. A very intensive and equal crimp of the fiber material will be obtained under heavy contraction. The yarn becomes very voluminous and elastic and shows an extraordinary soft and agreeable hand. The "total percentage elongation" is more than 200% and the fiber elongation is about 11%.

Yarns made in accordance with the above examples have a pleasing appearance and their properties with respect to the "total percentage elongation" and fiber elongation along with their rounded across section render them highly desirable for processing into knit wear.

The properties in the yarns are illustrated on the attached drawing forming part of this application. In this drawing the course of the elongation as compared with the load applied is shown for yarns of various titres. The load in grams per denier is shown as the ordinate y and the values of the abscissa x show the elongation percent. For each of the yarns shown a basic load of .002 gr./den. is chosen which corresponds with an elongation of 0%. Curves I-IV shown yarns of fibers made of the linear polycondensation product of hexamethylene adipamide (nylon), each consisting of double twists of yarns of various titres made in accordance with the above examples. Curve I refers to a 30/2 S-yarn (twist in S-direction of two single yarns of 30 den. each), curve II to a 40/2 S-yarn, curve III to a 70/2 S-yarn and curve IV to a 200/2 S-yarn.

From this drawing, as well as from the following chart which shows the single elongation values at the various loads for each yarn, it is evident that the new product shows a remarkably high elongation.

30/2 S-yarn		40/2 S-yarn		70/2 S-yarn		200/2 S-yarn	
load, gr./den.	elong.	load, gr./den.	elong.	load, gr./den.	elong.	load, gr./den.	elong.
0.002	0	0.002	0	0.002	0	0.002	0
0.017	106	0.019	140	0.021	121	0.025	166
0.033	184	0.037	190	0.036	165	0.050	221
0.083	216	0.075	206	0.072	188	0.075	232
0.166	223	0.150	214	0.143	198	0.150	240
0.330	240	0.310	232	0.290	225	0.290	261

All elongations in the above table are expressed in percents.

Furthermore, if we figure out the strain of the fibrous material, i.e. fiber elongation, which means the propor-

tionate elongation within 0.1 and 0.8 gr./den. load, expressed in percents of the total length of the yarn loaded with 0.8 gr./den., we get the following values:

	Percent
30/2 S-yarn	6.2
40/2 S-yarn	6.9
70/2 S-yarn	9.8
200/2 S-yarn	7.2

From these numerical values, we learn that the fiber elongation for the new product is comparatively small.

What we claim is:

1. A process for producing a voluminous, permanently and uniformly crimped synthetic organic textile yarn having a high total elongation and a low fiber elongation, which consists of the steps of twisting in a single operation a yarn of a denier of 20 to 450 in accordance with the following equation:

$$T = \frac{275,000}{D + 60} + 800$$

where T is the number of turns per meter twist and D is the denier of the yarn, setting the yarn, then untwisting the same to a normal twist, and plying said yarn with another similarly but oppositely twisted, set and untwisted yarn, the extent of twisting, setting and untwisting being such as to produce a plied yarn having a total elongation between 150 and 400% and a fiber elongation between about 5 and 20%.

2. A process as set forth in claim 1 wherein the yarn is so twisted, set and untwisted as to produce a plied yarn having a total elongation between 150 and 400% and a fiber elongation of 5 to 12%.

3. A process as set forth in claim 1 wherein the yarn is a polyamide yarn.

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