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[54] **PROCESS FOR THE MANUFACTURE OF CRIMPED FIBERS AND FILAMENTS OF LINEAR HIGH MOLECULAR WEIGHT POLYMERS**

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[51] **Int. Cl.** **D01d 5/22**

[58] **Field of Search** .... 264/176 F, 168, 210 F

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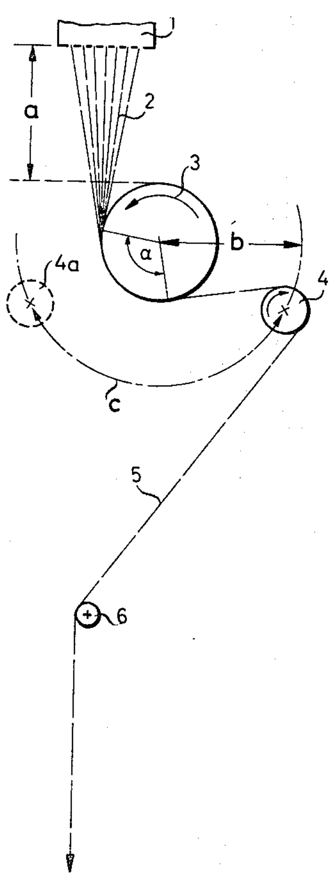
[57] **ABSTRACT**

Fibers and filaments of linear high molecular weight polyesters and copolyesters having a latent three-dimensional crimp are produced by passing the spun filaments after their exit from the spinneret, over a rotating cooled cylinder at a temperature at which they do no longer stick on to the cylinder but are not fully cooled down. The cylinder has a temperature in the range of from 15° to 90°C and rotates at a circumferential speed U of from $V_f/50$ to $V_f-V_f/90$, V_f being the draw off speed of the filaments. The filaments are in contact with a surface section of the cylinder the length of which is determined by a contact angle of 10° to 150°.

7 Claims, 3 Drawing Figures



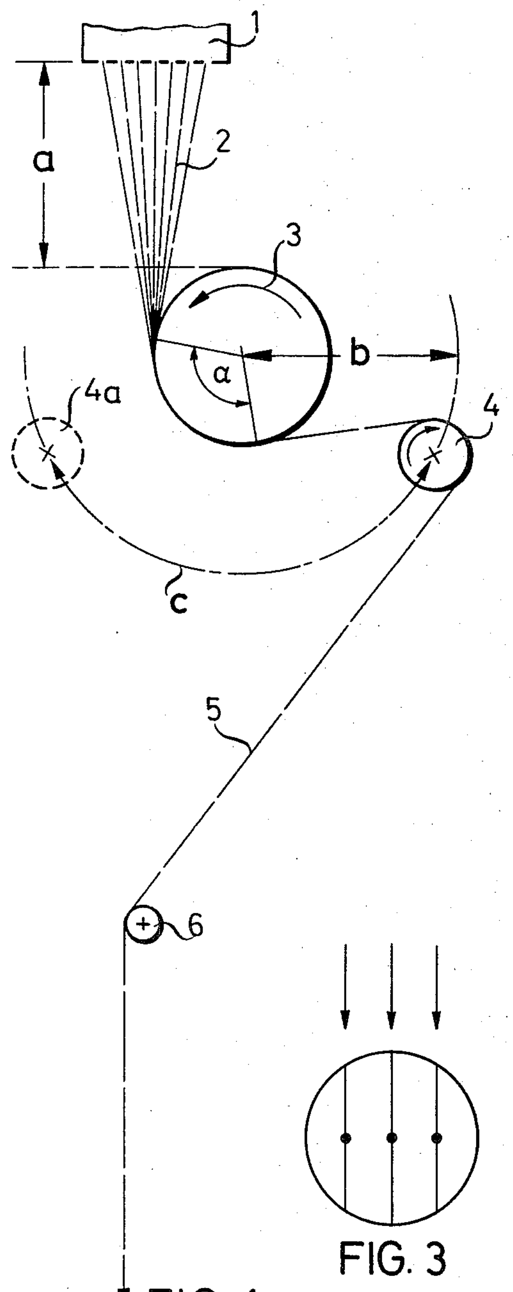


FIG. 1

FIG. 3

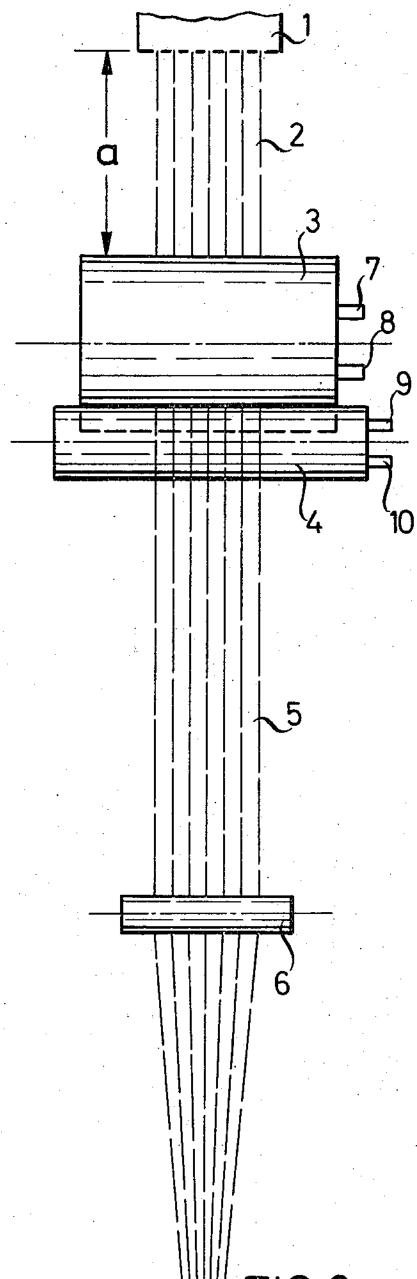


FIG. 2

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PROCESS FOR THE MANUFACTURE OF CRIMPED FIBERS AND FILAMENTS OF LINEAR HIGH MOLECULAR WEIGHT POLYMERS

The present invention relates to a process for the manufacture of fibers and filaments of linear, high molecular weight polyesters and copolyesters having a latent, three-dimensional crimp and to a device suitable for carrying out the said process.

It is especially easy to influence the crystallization and orientation of melt spun filaments of linear, high molecular weight polymers after they have left the spinneret and as long as they have not yet completely solidified. When the spun filament is unilaterally quenched or heated, the degree of orientation and crystallization varies over the cross section of the filament, which can be determined by measuring the different birefringence values on the opposite sides of the filament. In a later shrinking process the differences in orientation and crystallization thus produced cause the filament to shrink to different extents on the opposite sides of its cross section whereby a helical or spiral crimp of the filament is obtained.

It has been proposed to produce such an asymmetric crystallization and orientation by unilaterally heating the filament (cf. British Patent 1,016,100). An analogous effect may be obtained by unilateral quenching, for example by means of a liquid film on a porous support, into which film the filament immerses with part of its diameter only (cf. French Patent 1,145,727). Furthermore, it is possible to cool freshly spun filaments on one side by a gas current just below the spinneret (cf. French Patent 1,257,932). A three-dimensional crimp may also be brought about with the aid of a cooling body installed in the spinning shaft so as to be in contact with one side only of the filament (cf. French Patent 1,559,751).

It is known that in the manufacture of filaments from high melting substances, for example glass, a quenching below the spinneret by 1,000 to 1,500 centigrade sets the curvature produced thereby so that a strong visible crimp is obtained. To quench the glass filaments, thin cooling rods as well as two air currents directed one against the other are used (cf. British Patent 769,876). This process used for glass filaments is unsuitable in the manufacture of filaments from organic linear polymers of high molecular weight because the considerably smaller temperature difference between the plastic and the solid state is not sufficient to stabilize the geometric shape taken at the moment of quenching. Moreover, polyester filaments which have not been drawn after quenching, have too low a tensile strength and a poor elasticity, contrary to glass filaments.

The known methods permit, with more or less success, the manufacture of low titre, melt-spun filaments of linear, high molecular weight polymers having a spiral or helical crimp. With high titres, these methods do not yield filaments with satisfactory crimp.

The known modes of operation are not suitable to produce a sufficient gradient of birefringence over the cross section of the filament because the contact between the filament and the cooling device is not intense and effective enough.

The present invention provides a process and a device for the manufacture of fibers and filaments of high molecular weight polyesters and copolyesters, especially polyethylene terephthalate, which fibers and filaments have a latent three-dimensional crimp and a final titre in the range of from 4 to 300 dtex. Dtex is the weight of 10,000 m. of filament.

Fibers and filaments of this type are produced by passing the spun filaments, after they have left the spinneret, over a rotating cooled cylinder having a temperature of from 15 to 90°C, preferably 20° to 40°C and a circumferential speed U in the range of from

$U = V_f/50$ to U $U = V_f - V_f/90$,

preferably

$U = V_f/10$ to $U = 6V_f/10$

V_f being the draw off speed of the spun filaments, while being in contact with the cooled cylinder on a surface section the length of which is determined by a contact angle of 10° to 150°, preferably 30° to 115°.

To carry out the process of the invention a device is used comprising a first cooled, driven cylinder, and a second cooled driven cylinder which can be displaced on a semi-circular orbit preferably concentric with respect to the jacket of the first cylinder and locked at any point of this orbit, the distance in meters between the centers of the two cylinders being not larger than $b = R_3 + R_4 + 1 + 10 \cdot \cos \alpha$ in which R_3 is the radius of the first cylinder, R_4 is the radius of the second cylinder in meters and α indicates the contact angle.

According to a preferred variant of the device of the invention the first cooled cylinder has a diameter of $0.3 \cdot 10^2$ to $20 \cdot 10^2$ mm, preferably $1.7 \cdot 10^2$ to $4.0 \cdot 10^2$ mm and the second cylinder has a diameter of $0.3 \cdot 10^2$ to $1 \cdot 10^3$mm, preferably $0.3 \cdot 10^2$ to $0.9 \cdot 10^2$ mm. The circumferential speed of the second cylinder is preferably in the range of from 0 to $1 \cdot 10^3$ m/min, more preferably 0 to $0.9 \cdot 10^2$ m/min.

The process of the invention yields especially valuable fibers and filaments from a high molecular weight linear polyester having a specific viscosity above 0.5, preferably above 0.8, measured with a 1 percent by weight solution of the polymer in phenol/tetrachloroethane in a weight ratio of 3 : 2. After drawing, the polyester filaments have a final titre of 4 to 300 dtex.

The manufacture of the filaments having a latent crimp according to the process of the invention is now described with reference to the accompanying drawing in which

FIG. **1** is a side view of the device according to the invention,

FIG. **2** is a front view of the device and,

FIG. **3** is a cross sectional view of a filament with different zones of orientation and crystallization.

The polyester is melted in known manner with the aid of a melting grate or on an extruder and the melt is passed through a spinneret having such a number of orifices that the filaments **2**, after having left the spinneret **1**, lie side by side on cylinder **3** without disturbing each other, so that they cannot stick together while they travel over the surface of the cylinder. To this effect the orifices are preferably displaced with respect to one another. Their number thus depends on the diameter of the spinneret and the width of the cylinder. Further definitions are given in the examples.

Cylinder **3** is installed below spinneret **1** at such a distance (a) that the spun filaments **2** when striking the surface of cylinder **3** are cooled at a temperature at which they are no longer sticky but at which orientation and crystallization can still be influenced by quenching. As these two conditions do not always agree with one another, the cylinder should have a surface such that a good contact with the filaments is ensured as long as they are on the cylinder but that they readily detach when leaving it. For this purpose the cylinder preferably has a mat chromium plated surface. Distance (a) depends on the titre, the spinning temperature and the circumferential speed U of cylinder **3** in the manner described in the paragraph dealing with the influence of the spinning parameters and it can easily be adjusted empirically. It should be as small as possible.

To adjust the temperature of cylinder **3** a cooling medium is passed through which may be either liquid or gaseous. In most cases tap water or desalted water will be used, which is supplied and withdrawn centrically **7,8.**

Cylinder **3** rotates in the direction indicated by the arrow in FIG. **1** and has a drive of its own. The circumferential speed U is adjusted to a value in the range of from

$U = V_f/50$ to $U = V_f - V_f/90$,

preferably

$U = V_f/10$ to $U = 6V_f/10$, V_f being the draw off speed or the spun filaments.

An intense contact of the large cylinder **3** with the spun filaments **2** is brought about by a smaller cooled and driven cylinder **4.** At the beginning of the spinning operation, small cylinder **4** the diameter of which is preferably in the range of from $0.5 \cdot 10^2$ to $0.7 \cdot 10^2$ mm is situated in position **4a.** It can be displaced along a semi-circular orbit *c* which is preferably concentric with respect to cylinder **3.** After the beginning of spinning it is swung into a position **4.** Owing to the fact that it can be locked at any point of orbit *c*, contact angle α defined above of the spun filaments can be adjusted on cylinder **3** as desired. In FIG. **1**, the contact angle α is shown as a sector of cylinder **3.**

Cylinder **4** preferably has the same mat chromium plated surface as large cylinder **3** and is cooled by a cooling medium supplied and discharged centrically **9, 10.** Cylinder **4** advantageously has approximately the same surface temperature as cylinder **3**, is driven by its own drive in the direction of the arrow indicated in FIG. **1.** In the preferred variant it has a circumferential speed of 0 to $1 \cdot 10^3$, preferably 0 to $0.9 \cdot 10^2$ m/min.

Distance *b* between the centers of the two cylinders in meters should not be larger than

$b = R_3 + R_4 + 1 + 10 \cos \alpha$,

R_3 and R_4 being the respective radii of large cylinder **3** and small cylinder **4** in meters and α representing the contact angle. The distance is defined by the fact that with a position of cylinders **3** and **4** with respect to one another with a contact angle α of 90° a distance *b* which is larger as defined above causes the filaments to break. The distance between the two cylinders may be the larger the closer the direction of the filaments between the two cylinders comes to the perpendicular ($\alpha = 0°$).

After having left small cylinder **4** the bundle of cooled filaments **5** is passed over a guide **6** or another deflection roll and wound up or laid down in a spinning pot without having passed a draw off shaft within a length of 10 to 15 meters as otherwise necessary with coarse filaments, suitably after having been treated with a known antistatic and antiadhesive preparation.

The spinning tow obtained in this manner can be drawn as usual, for example between drawing elements with the aid of saturated vapor or superheated steam, warm water or hot air. It is also possible to heat part or all of the godets of the intake unit.

The three-dimensional crimp can be released either in the tow or in the cut fibers in the apparatus used in the manufacture of synthetic fibers for setting the crimp in the stuffing chamber and eliminating too large a shrinkage. The tow (with an advance of about 1 : 7) or the flock can be passed, for example, on a conveyor belt through a zone of hot air or superheated steam. As in the case of conventional processes for crimping fibers in the stuffing chamber, the heat treatment is carried out to avoid too large a shrinkage by anticipation, whereby asymmetrically oriented fibers acquire a spiral crimp.

The heat treatment is carried out at a temperature in the range of from 70° to 230°C, preferably 90° to 160°C. For the transmission of heat, air, steam, liquids or heated surfaces may be used.

In the process of the invention the various spinning parameters decisively influence the properties of the crimped fibers obtained. There must be taken into consideration not only the specific viscosity of the starting material, the number of orifices of the spinneret, the conveyed amount of spinning mass and the draw off speed of filaments, but also the distance *a* of large cylinder **3** from spinneret **1**, the circumferential speed U of cylinder **3**, the contact angle α of the spun filament around cylinder **3** and the circumferential speed Z of small cylinder **4.**

Influence of the specific viscosity of the starting material

A high specific viscosity of the starting material means a high melt viscosity and simultaneously a higher spinning tension (measured between guide **6** and the pull-off godet before the winding up. A higher spinning tension reduces the danger of sticking of the spun filaments on the cylinder **3** and thus permits a reduction of the distance *a* whereby, on the one hand, the filaments are quenched by cooling cylinder **3** while having a higher temperature so that the difference in temperature between the cooled and the uncooled side of the filament is greater and, on the other, the filaments are quenched at a earlier stage of pre-orientation, whereby the gradient of birefringence over the cross section of the filament becomes larger, i.e. a stronger crimp is formed after release.

In the following Table 1 are compared the crimping properties of two types of filaments spun under identical conditions from two starting materials having different specific viscosities (the other parameters not mentioned are kept constant in this and the following experiments).

The abbreviations used in the table have the following meaning:

K_E (crimp) $= l - l_e/l_e \cdot 100$ percent

wherein

l is the length of a crimped fiber loaded with a preliminary load of 1.8 mg/dtex,

l_e is the length of the same fiber in a de-crimped state.

The force necessary for de-crimping is determined with the aid of a force/elongation diagram of the respective fiber type to be tested.

K_R (residual crimp) $= l_R - l_{Re}/l_{Re} \cdot 100$ percent wherein

l_R is the same length of a crimped fiber loaded with a preliminary load of 1.8 mg/dtex as with l, with the sole difference that fiber R is loaded prior to the test for 1 minute with a load of 0.45 p/dtex and the measurement is carried out after a subsequent recovery of 1 minute,

l_{Re} is the length of the fiber R in the de-crimped state (cf. l_e)

Table 1

Experiment No.	specific viscosity	K_E (%)	K_R (%)	bends/cm
1	0.8	42.9	31.0	6.4
2	0.98	53.0	34.9	10.4

Influence of the number of orifices in the spinneret

With too high a number of orifices in the spinneret the distance between the spun filaments on the cooled cylinder 3 and on the path from the spinneret 1 to said cooled cylinder is very small so that the individual filaments may stick together owing to vibration of the apparatus or a draft, whereby processing troubles arise as in conventional spinning and drawing processes.

Influence of the conveyance of spinning mass

Under constant conditions but with a higher amount of spinning mass conveyed the titre of the spun filaments naturally increases.

With a low titre the spun filaments often come into contact with the large cylinder after they have substantially cooled down, since otherwise they do not support the tension exerted thereon.

If too large a contact angle α is chosen, filaments of very low titre are cooled down over their entire cross section so that crimping is not possible.

Under identical conditions filaments having different final titres are cooled to a different extent over their cross section. In Table 2 there are indicated the differences in the birefringence as a measurement for the asymmetry of the spun filaments with respect to crystallization and orientation in different sections of their cross section in filaments of two different titres. FIG. 3 of the accompanying drawing illustrates the sections where the measurements were taken. The final titre is the titre of the filaments and fibres after drawing and development of the crimp.

Table 2

Exp. No.	final titre (dtex)	birefringence 10^3 in 1st quarter	in center	in 3rd quarter	difference ΔD between 1st and 3rd quarter
		of the cross section of the spun filament			
3	35	42.6	46.2	62.5	19.9
4	100	11.7	12.7	17.2	5.5

The influence of the difference in the birefringence (ΔD) on the crimp is shown in the following Table 2*a*).

Table 2*a*

Experiment No.	final titre (dtex)	ΔD	K_E (%)	K_R (%)	bends (cm)
3	35	19.9	41	28.7	8.2
4	100	5.5	26	19.1	4.5

Influence of the draw off speed

An increase in the draw off speed mainly increases the spinning tension whereby, as pointed out above in connection with the specific viscosity, the distance *a* between cooling cylinder 3 and spinneret 1 can be reduced and a more pronounced crimp can be produced (cf. Tables 3 and 4).

Table 3

Exp. No.	final titre dtex	supply of spinning mass g/min	draw off speed m/min	distance *a* mm	draw ratio	K_E %	K_R %	bends/cm
5	41.9	245	1,000	600	1 : 1.59	35	27.4	5.6
6	42.4	305	1,250	300	1 : 1.30	40.5	30.9	7.6

Table 2 shows that spun filaments which have been asymmetrically quenched according to the process of the invention have a relatively high degree of preorientation. The degree of preorientation may be further increased by a high draw off speed and a high specific viscosity of the starting material. By an increasing degree of preorientation, the difference in orientation caused by quenching is likewise increased, this being desirable. The high degree of preorientation yields filaments which can be drawn to a small extent only. A draw ratio of 1 : 4 or there above, as generally used with polyester filaments, would cause the filaments to break and form laps on the drawing godets. Care should be taken, however, that the highest possible draw ratio is used as the degree of shrinkage, the difference in shrinkage between the cooled and the uncooled side of the filaments and consequently the crimp depend thereon.

Influence of distance *a* between spinneret 1 and cooled cylinder 3

It is obvious that the greater the distance *a* between spinneret 1 and cooled cylinder 3, the smaller the difference in the birefringence ΔD in the opposite sides of the cross section of the filament. The lower the temperature of the filament at the moment it strikes cooled cylinder 3, which depends on the distance between the spinneret and the cylinder, the smaller the temperature difference in the opposite sides of the filament after quenching. Hence, the intensity of the crimp diminishes, while the draw ratio possible without breaking the filaments, and consequently the tensile strength and the bending-breaking-stress stability increase (cf. Table 4). Therefore, the smallest distance yields the best crimp. In consideration of the above statements, this smallest distance must be greater with higher titres, higher spinning temperatures and a higher circumferential speed U of cylinder 3 than with a fine titre, a lower spinning temperature and a slower speed of rotation of cylinder 3. The most favorable distance *a* for the chosen combination of the other parameters is the distance at which the filaments just run off cylinder 3 without sticking together or being entrained.

Table 4

Experiment No.	7	8	9
distance a (mm)	400	600	900
tensile strength (p/dtex)	22.7	30.1	39.2
elongation at break (%)	40.3	39.5	40.2
K_E (%)	39.3	35.5	33.0
K_R (%)	28.4	27.4	24.3
bends/cm	6.4	5.6	4.8
chafing-bending turns until break	960	1360	1500

The tensile strength and elongation at break were measured on a Fafegraph fiber breaking apparatus of Messrs. Textechno and the bending-breaking-stress stability was determined on a testing device as described in "Chemiefasern", No. 12 (1962), page 853 by K.H. Grunewald.

Influence of the circumferential speed U of cylinder 3

The smaller the circumferential speed U of cylinder 3 with respect to the draw off speed V_f of the spun filaments, the higher the friction and the lower the degree of orientation of the molecules on the cooled side of the surface. On the other hand, by the friction a tension is built up towards the large cylinder which results in a higher preorientation and hence a lower draw ratio.

The above experiments show that with a circumferential speed U of cylinder 3 of less than $V_f/10$, fibers are obtained which have a poor tensile strength and abrasion resistance and are, therefore, not very suitable for practical purposes. With a circumferential speed higher than 6 $V_f/10$, fibers having large bends are obtained which are not very voluminous and of minor interest only.

Table 5

Experiment No.	10*a*	10*b*	11	12*a*	12*b*
pull off V_f (m/min)	1000	1000	1000	1000	1000
U (m/min)	50	200	270	340	700
final titre (dtex)	51	46	39	34	25
ΔD	73	60	32	18	4
draw ratio	1:1.26	1:1.39	1:1.64	1:1.89	1:2.47
tensile strength (p/tex)	9.1	17.0	33.0	34.6	37.1
elongation at break (%)	23.2	31.9	34.6	39.6	38.9
K_E (%)	69.4	61.5	32.0	28.0	22.3
K_R (%)	47.7	45.4	25.3	19.8	15.6
bends/cm	11.6	10.3	5.6	4.8	2.1
chafing-bending turns until break	7	130	1200	2070	2340

When in the spinning process the circumferential speed of cylinder 3 is below $V_f/50$ or above $V_f - V_f/90$ with a contact angle within the indicated range, considerable spinning difficulties are encountered or uncrimped fibers are obtained.

Influence of the circumferential speed Z of cylinder 4

By the circumferential speed Z of cylinder 4 the tension of the spun filaments after cooling can be varied and, owing to the possible variation of the preorientation, it influences mainly the draw ratio after spinning and thus the tensile strength and elongation at break.

Table 6

Exp. No.	circumferential speed Z m/min	draw ratio	final titre (dtex)	tensile strength (p/tex)	elongation at break (%)
13	0	1:1.44	42.1	28.0	43.0
14	1.32	1:1.52	40.0	29.2	42.8
15	2.65	1:1.64	39.2	33.2	34.6

Influence of the contact angle α

A larger contact angle α of the filaments round cylinder 3 results in a longer residence time of the filaments on the cooled surface. Hence, a larger portion of the cross section of the filament is cooled, the crimp becomes more stable (as the portion causing the crimp is greater) but the fineness of the bends is a little reduced. The difference in birefringence increases with an increasing angle while the draw ratio decreases to a small extent.

Table 7

Exp. No.	α	D	draw ratio	K_E (%)	K_R (%)	crimp stability (%)*	bends/cm
16	70	23.2	1:1.72	41.3	30.4	74	7.2
17	90	27.4	1:1.66	42.4	32.6	77	6.4
18	110	31.7	1:1.64	31.0	24.1	78	5.6

*)defined in Example 1 below

The following examples described fibers and filaments produced with the aid of the device of the invention. The indicated titres do not represent limits of the process of the invention, fibers and filaments having a finer or larger titre and a more intense latent three-dimensional crimp can also be produced.

The filaments and fibers produced by the process of the invention and having medium or large titres have an excellent three-dimensional crimp of good stability. They are very suitable as upholstery filling or for the manufacture of tufted felt carpets.

EXAMPLE 1

Polyethylene terephthalate having a specific viscosity of 1.005, measured with a 1 percent by weight solution of the polymer in a 3 : 2 parts by weight mixture of phenol and tetrachloroethane, was spun as described above through a spinneret having 25 orifices in a line at a spinning temperature of 285°C under the following spinning conditions:

conveyance of spinning mass	240 g/min
draw off speed of filaments	550 m/min
distance a of cylinder (3) from spinneret (1)	650 mm
contact angle (α)	110°
circumferential speed U of cylinder (3)	140 m/min
circumferential speed Z of cylinder (4)	2.65 m/min
diameter of cylinder (3)	19 cm
diameter of cylinder (4)	7 cm
temperature of cylinder (3)	27°C
temperature of cylinder (4)	27°C

The tow was drawn in a ratio of 1 : 1.94 by blowing saturated steam onto it between godets having room temperature and the crimps in the tow were developed in the setting tube by means of hot air (300°C). The filaments obtained had the following properties:

individual titre	dtex	103
tensile strength	p/tex	21.8
elongation at break D	%	38.7
crimp	K_E %	48.1
residual crimp	K_R %	34.4
crimp stability	%	71.6
bends/cm		5.2
(crimp stability	$= K_R/K_E \cdot 100$)	

EXAMPLE 2

Polyethylene terephthalate as defined in Example 1 was spun at 285°C through a spinneret with 120 orifices in a row. With a conveyed amount of spinning mass of 205 g/min and a draw off speed of 1,800 m/min the following conditions were observed:

distance a of cylinder (3) from spinneret	150 mm
circumferential speed U of cylinder (3)	440 m/min
contact angle (α)	100°

The remaining conditions such as Z, diameter of cylinders and temperatures thereof were the same as in Example 1.

After drawing in a ratio of 1 : 1.41 and development of the crimp in the manner described in Example 1, fibers having the following properties were obtained:

individual titre	dtex	9.0
tensile strength	p/tex	25.3
elongation at break	%	28.8
crimp	%	33.1
residual crimp	%	23.9
crimp stability	%	72.3
bends/cm		20.5

EXAMPLE 3

The polyethylene terephthalate used had a specific viscosity of 0.85. The polymer was spun through a plate nozzle having 43 orifices and a diameter of 134.5 mm at a temperature of 287°C.

conveyance of spinning mass	245 g/min
draw off speed of filaments	1,000 m/min
distance a of cylinder (3) from spinneret (1)	450 mm
contact angle (α)	110°
circumferential speed U of cylinder (3)	270 m/min
circumferential speed Z of cylinder (4)	0.9 m/min
radius of cylinder (3)	8.5 cm
temperature of cylinder (3)	36°C

The other conditions were identical with those of Example 1. The fibers obtained after drawing in a ratio of 1 : 1.52 and a heat treatment under the conditions specified in Example 1 had the following properties:

individual titre	dtex	45.1
tensile strength	p/tex	28
elongation at break D	%	32.1
crimp	K_E %	42.9
residual crimp	K_R %	31.1
crimp stability	%	72.6
bends/cm		6.4

Fibers which had been spun from the same polymer by a conventional process, i.e., without the cooled cylinder, with a conveyance of 300 g/min and a draw off speed of 425 m/min and drawn in a ratio of 1 : 4.03 had the following properties:

individual titre	dtex	46.8
tensile strength	p/tex	30.8
elongation at break D	%	64.4
crimp	K_E %	23.5
residual crimp	K_R %	8.4
crimp stability	%	35.8
bends/cm		4.8

The above values shown that fibers of high titre spun according to the process of the invention have an initial crimp and residual crimp that are considerably higher than the crimp obtained in a conventional stuffing chamber for two-dimensional crimps.

EXAMPLE 4

Polyethylene terephthalate having a specific viscosity of 1.05 was spun through a spinneret with 43 trilobal orifices at a temperature of 291°C. The cooled cylinder 3 had a diameter of 21 cm. In the present and in all following examples cylinder 4 had a diameter of 70 mm and was kept at a temperature of 25° to 35°C.

conveyance of spinning mass	126 g/min
draw off speed of filaments	1,100 m/min
distance a of cylinder (3) from spinneret (1)	250 mm
contact angle (α)	80°
circumferential speed U of cylinder (3)	400 m/min
circumferential speed Z of cylinder (4)	0
temperature of cylinder (3)	30°C
temperature of cylinder (4)	30°C
cooling medium	tap water

The lobed fibers obtained were drawn in a ratio of 1 : 2.18 and the crimp was developed as described in Example 1. The fibers obtained had the following properties:

individual titre	dtex	14
tensile strength	p/tex	36.3
elongation at break D	%	23.8
crimp	K_E %	29.4
residual crimp	K_R %	17.9
crimp stability	%	68.8
bends/cm		6.6

EXAMPLE 5

Polyethylene terephthalate having a specific viscosity of 1.0 was spun as described in Example 1 under the following conditions:

number of orifices	25
conveyance of spinning mass	240 g/min
draw off speed of filaments	180 m/min
distance *a* of cylinder (3) from spinneret (1)	310 mm
contact angle (α)	110°
circumferential speed U of cylinder (3)	74 m/min
circumferential speed Z of cylinder (4)	2.7 m/min
radius of cylinder (3)	105 mm
temperature of cylinder (3)	25°C
temperature of cylinder (4)	25°C

The fibers were drawn in a ratio of 1 : 3.53 and the crimp was developed as described in Example 1. The fibers obtained had the following properties:

individual titre	dtex	198.0
tensile strength	p/tex	30.4
elongation at break	%	51.5
crimp	K_E %	43.2
residual crimp	K_R %	31.0
crimp stability	%	71.5
bends/cm		3.8

EXAMPLE 6

A copolyester (as described in DOS 1,495,625 (German Application as laid open to public inspection)) consisting of ethylene glycol terephthalate units and 5 percent of 2,2-dimethyl-propanediol-1,3 units, calculated on dimethyl terephthalate, and having a specific viscosity of 0.625 was spun under the following conditions:

spinning temperature	280°C
number of orifices in spinneret	120
conveyance of spinning mass	225 g/min
draw off speed of filaments	1,800 m/min
distance *a* of cylinder (3) from spinneret (1)	450 mm
contact angle (α)	55°
circumferential speed U of cylinder (3)	470 m/min
circumferential speed Z of cylinder (4)	1.5 m/min
radius of cylinder (3)	8.5 cm
temperature of cylinder (3)	32°C
temperature of cylinder (4)	30°C

After drawing in a ratio of 1 : 1.58 and development of the crimp in the manner described in Example 1, fibers having the following properties were obtained:

individual titre	dtex	6.7
tensile strength	p/tex	31.1
elongation at break	%	29.6
crimp	K_E %	26.6
residual crimp	K_R %	18.0
bends/cm		8.0

What is claimed is:

1. A process for the manufacture of filaments of linear high molecular weight polyesters and copolyesters having a latent, three-dimensional crimp by asymmetrical cooling and a final titer of from about 4 to 300 dtex after drawing, which comprises passing the melt spun filaments, substantially immediately after they have left the spinneret when just cool enough to avoid sticking over a substantially dry smooth rotating cooled cylindrical zone having a temperature of from 20° to 40°C and a circumferential speed U in the range of from $U = V_f/50$ to $U = V_f - V_f/90$ with U ranging from about 74 m/min. to 470 m/min., V_f being the draw off speed of the spun filaments from the cylindrical zone, whereby the filaments are in contact with the cylindrical zone on a surface section, the length of which is determined by a contact angle of 10° to 150°.

2. The process of claim **1**, wherein the polyester is polyethylene terephthalate.

3. The process of claim **1**, wherein the cooled cylindrical zone rotates at a circumferential speed $U = V_f/10$ to $U = 6V_f/10$

4. The process of claim **1**, wherein the contact angle determing the length of the filaments in contact with the cooled cylindrical zone is in the range of from 30° to 115°.

5. The process of claim **1**, wherein the polyester has a specific viscosity above 0.5.

6. The process of claim **1**, wherein the polyester has a specific viscosity above 0.8.

7. A process as set forth in claim **1** wherein the circumferential speed U ranges approximately from 200 to 340 m/min.

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