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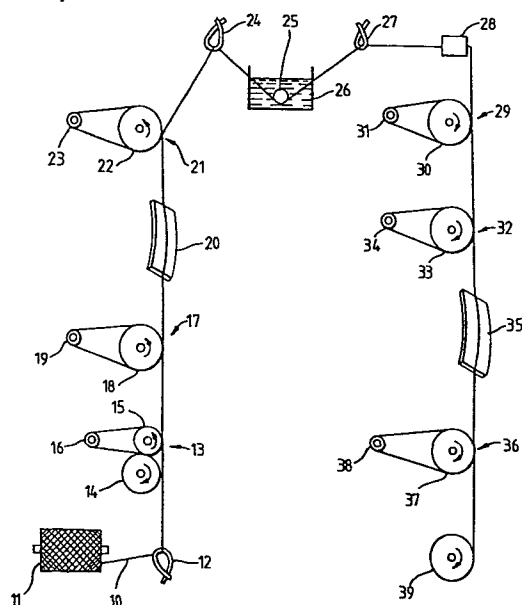
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54 **Air jet-texturing process for production of low-shrinkage polyester yarn.**

57 A process is disclosed for producing an air jet textured polyester yarn having a low dry heat shrinkage. The process comprises the steps of: (a) cold drawing a spin-oriented polyester yarn at a draw ratio of from 1.3 to 2.0; (b) preheating the drawn yarn at substantially constant length; (c) feeding the yarn to an air jet at a 10% to 40% overfeed; (d) jet-texturing the yarn with the air jet; (e) drawing the jet-textured yarn at a draw ratio of 1.04 to 1.12; (f) winding up the resulting air jet-textured yarn. In an embodiment of the process a step of post-heating the jet-textured yarn is included between step (e) and step (f) in order to reduce the size of the surface loops and to improve the stability of the jet-textured yarn. In the illustrated embodiment step (a) is performed between roll assemblies (13) and (17), step (b) by heater plate (20). Passing through a water bath (26) the yarn is fed to the air jet bulking device (28) at an overfeed regulated by roll assemblies (21) and (29). Step (e) is performed between roll assemblies (29) and (32), after which the jet-textured yarn is post-heated by heater plate (35). The yarn is wound on package (39).



- 1 -

AIR JET-TEXTURING PROCESS FOR PRODUCTION
OF LOW-SHRINKAGE POLYESTER YARN

5 This invention relates to the production of air jet-textured bulked polyester yarn from spin-oriented polyester yarn and more particularly to the production of such air jet-textured yarn having a low dry heat shrinkage.

10 The term "spin-oriented polyester yarn" as used herein means such yarn prepared by melt-spinning polyethylene terephthalate into yarn while withdrawing the yarn from the spinneret at a take-off speed of 3000 to 4000 yards/minute (2740 to 3660 metres/minute) as described by Gorrafa in United States Patent No. 3 973 386 issued 1976 August 10.

15 Measurements of "dry heat shrinkage" as used herein are obtained by (a) suspending a weight from a skein of yarn to produce a 0.1 g/denier (0.0883 dN/tex) load on the yarn and measuring its length (L_0), (b) replacing the weight by a lighter weight generating a 0.005 g/denier (0.00441 dN/tex) load and placing the loaded yarn in an oven
20 at $250 \pm 5^\circ\text{F}$ ($121 \pm 2.8^\circ\text{C}$) for 5 minutes, (c) removing the yarn, cooling it to room temperature, loading it again with the original weight, and recording its new length (L_f), and (d) calculating the shrinkage as follows:

25
$$\text{Dry heat shrinkage (\%)} = (L_0 - L_f) / L_0 \times 100$$

A prior art process for producing air jet-textured yarn from spin-oriented polyester yarn involves the following steps: (a) hot-drawing the spin-oriented polyester yarn e.g. over a heated draw pin at a draw ratio in the range of
30 from 1.3 to 2.0; (b) feeding the yarn to an air jet at 10% to 40% overfeed; (c) jet-texturing the yarn with the air jet; (d) drawing the jet-textured yarn at a draw ratio of 1.04 to 1.12 to reduce the size of large loops produced during the jet-texturing step; (e) post-heating the jet-textured yarn; and (f) winding up the resulting jet-textured
35 yarn.

The jet-textured polyester yarn produced by the

- 2 -

above prior art process has a relatively high dry heat shrinkage e.g. about 4.1% to about 4.5% for 400 dtex to 600 dtex yarn; about 4.8% to about 6.4% for 800 dtex to 1200 dtex yarn; and even higher for yarn above 1200 dtex. While
 5 such dry heat shrinkages are satisfactory in many end uses for the jet-textured polyester yarn, they are a disadvantage when it is desired to use the yarn for applications which require yarns having lower dry heat shrinkages.

Surprisingly it has now been found that by replacing
 10 ing the hot drawing step in the above prior art process by a cold drawing step followed by a preheating step at constant yarn length, optionally without the post-heating step, jet-textured yarns may be produced which have significantly lower dry heat shrinkages e.g. about 2.2% to about 2.8% for
 15 400 dtex to 600 dtex yarn; about 3.1% to about 3.5% for 800 dtex to 1200 dtex yarn; and about 3.5% to about 3.9% for 1200 dtex to 2000 dtex yarn.

Accordingly the present invention provides a process for producing an air jet-textured polyester yarn
 20 having a low dry heat shrinkage, the process comprising the steps of: (a) cold drawing a spin-oriented polyester yarn at a draw ratio in the range of from 1.3 to 2.0; (b) preheating the drawn yarn at substantially constant yarn length; (c) feeding the yarn to an air jet at a 10% to 40%
 25 overfeed; (d) jet-texturing the yarn with the air jet; (e) drawing the jet-textured yarn at a draw ratio of 1.04 to 1.12; and (f) winding up the resulting jet-textured yarn.

The term "overfeed" to the air jet as used herein means:

30

$$\frac{\text{Feed speed to air jet} - \text{Removal speed from air jet}}{\text{Removal speed from air jet}} \times 100\%$$

In one embodiment of the process of the present invention a step of post-heating the jet-textured yarn is included between step (e) and step (f).

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In another embodiment of the process of the present invention the step of preheating the drawn yarn and

- 3 -

the step of post-heating the jet-textured yarn are each carried out on a contact heater plate operating at a surface temperature in the range of from 180°C to 220°C.

5 In yet another embodiment of the process of the present invention the yarn is fed to the air jet at a 20% to 30% overfeed.

In yet another embodiment of the process of the present invention the jet-textured yarn is drawn at a draw ratio of 1.06 to 1.10.

10 In yet another embodiment of the process of the present invention the step of preheating the drawn yarn and the step of post-heating the jet-textured yarn are each carried out on the surface of a contact heater plate operating at a surface temperature in the range of from 205°C to
15 215°C.

In yet another embodiment of the process of the present invention the yarn is fed to the air jet at a 23% to 27% overfeed.

20 In a further embodiment of the process of the present invention the spin-oriented polyester yarn is cold drawn at a draw ratio of from 1.6 to 1.8.

In a still further embodiment of the process of the present invention the cold drawing step is carried out at a draw ratio of from 1.6 to 1.8 on a draw roll operating
25 at a surface speed of at least 375 metres/minute and the resulting air jet-textured yarn has a linear density in the range of from 400 dtex to 600 dtex and has a dry heat shrinkage in the range of from about 2.2% to about 2.8%.

30 In a still further embodiment of the process of the present invention the cold drawing step is carried out at a draw ratio of from 1.6 to 1.8 on a draw roll operating at a surface speed of at least 375 metres/minute and the resulting air jet-textured yarn has a linear density in the range of from 600 dtex to 1200 dtex and has a dry heat
35 shrinkage in the range of from about 2.8% to about 3.5%.

In a still further embodiment of the process of the present invention the cold drawing step is carried out at a draw ratio of from 1.6 to 1.8 on a draw roll operating

- 4 -

at a surface speed of at least 375 metres/minute and the resulting air jet-textured yarn has a linear density in the range of from 1200 dtex to 2000 dtex and has a dry heat shrinkage in the range of from about 3.5% to about 3.9%.

5 In a still further embodiment of the process of the present invention the cold drawing step is carried out at a draw ratio of from 1.6 to 1.8 on a draw roll operating at a surface speed of at least 240 metres/minute and the resulting air jet-textured yarn has a linear density in the
10 range of from 2000 dtex to 3500 dtex and has a dry heat shrinkage of less than about 3.0%.

 An embodiment of the present invention will be described in greater detail with the aid of the accompanying drawing which is a schematic representation of apparatus
15 suitable for carrying out the process of the present invention.

 In the drawing, spin-oriented polyester yarn 10 is pulled from a supply package 11 over a yarn guide 12 by feed roll assembly 13, comprising a feed roll 14, a cot roll 15
20 and a separator roll 16. Yarn 10 is passed about cot roll 15 and separator roll 16 for a plurality of wraps. From the feed roll assembly 13 the yarn 10 passes to a draw roll assembly 17, comprising draw roll 18 and separator roll 19. The yarn 10 is passed about draw roll 18 and separator roll
25 19 for a plurality of wraps. Draw roll assembly 17 runs at a faster speed than feed roll assembly 13 to draw the yarn at a draw ratio in the range of from 1.3 to 2.0 and preferably in the range of from 1.6 to 1.8. From draw roll assembly 17, the drawn yarn passes over a heater plate 20,
30 which operates at a temperature in the range of from 180°C to 220°C and preferably in the range of from 205°C to 215°C, to roll assembly 21, comprising driven roll 22 and separator roll 23. The drawn yarn is passed about driven roll 22 and separator roll 23 for a plurality of wraps. Preferably roll
35 assembly 21 runs at the same speed as draw roll assembly 17. From roll assembly 21, the yarn passes over yarn guide 24 under guide pin 25 which is immersed in a bath 26 containing water at room temperature. It then passes over yarn guide

- 5 -

27, through air jet bulking device 28, to roll assembly 29, comprising driven roll 30 and separator roll 31. The jet-textured yarn is passed about driven roll 30 and separator roll 31 for a plurality of wraps.

5 The air jet bulking device 28 produces crunodal surface loops. A preferred jet is disclosed by Agers in United States Patent No. 4 157 605 issued 1979 June 12 (see particularly Figures 6 and 7). The yarn is immersed in water bath 26 in order to improve the efficiency of air jet
10 bulking device 28. Water bath 26 and air jet bulking device 28 may both be placed in an enclosed air jet-texturing chest as disclosed by Wirsig in European Patent Application No. A 0 004 781 published 1979 October 17. The overfeed of yarn to the jet, which may be determined by
15
$$\frac{\text{Speed of roll assembly 21} - \text{Speed of roll assembly 29}}{\text{Speed of roll assembly 29}} \times 100\%$$
 may be set as desired in the range of from 10% to 40%, but is preferably in the range of from 20% to 30%, especially in the range of from 23% to 27%.

20 From the roll assembly 29, the jet-textured yarn passes to draw roll assembly 32, comprising draw roll 33 and separator roll 34. The jet-textured yarn is passed about draw roll 33 and separator roll 34 for a plurality of wraps. Draw roll assembly 32 runs at a faster speed than roll
25 assembly 29 to draw the jet-textured yarn at a draw ratio in the range of from 1.04 to 1.12 and preferably in the range of from 1.06 to 1.10. This post drawing step tends to reduce the number of large and poorly formed crunodal surface loops produced by the air jet bulking device 28 and
30 hence to improve the handling characteristics of the jet-textured yarn. From draw roll assembly 32, the jet-textured yarn passes over a heater plate 35, which operates at a temperature in the range of from 180°C to 220°C and preferably in the range of from 205°C to 215°C, to
35 roll assembly 36, comprising driven roll 37 and separator roll 38. The jet-textured yarn is passed about driven roll 37 and separator roll 38 for a plurality of wraps. Preferably roll assembly 36 runs at the same speed as draw

- 6 -

roll assembly 32. This post-heating step at substantially constant yarn length tends to reduce the size of the surface loops and to improve the stability of the jet-textured yarn. The term "stability" as used herein means a measure of the load carrying capacity of the jet-textured yarn before the loops begin to straighten out throughout the yarn bundle.

It will be appreciated that the post-heating step may be omitted if it is desired to produce jet-textured yarn having larger surface loops. From roll assembly 36 the jet-textured yarn is wound up on package 39.

The apparatus for carrying out the process shown schematically in the drawing and described above may be provided on two adjacent positions of a conventional draw twister e.g. a Model 14S drawtwister manufactured by Zinser Textilmaschinen GmbH by making the following modifications:

- (a) adding separator roll 16 to the feed roll assembly of the first position;
- (b) converting the draw roll in each position to a stepped draw roll by adding a smaller diameter roll and adding an associated separator roll in the first position;
- (c) adding a heater plate above the draw roll in the first position;
- (d) adding a jet-texturing chest (containing water bath 26 and air jet bulking device 28 as described in aforementioned European Patent Application No. A 0 004 781) above the draw roll in the second position;
- (e) adding two change-of-direction rolls and several yarn guides; and
- (f) modifying the wind-up device.

With the above modifications to two adjacent positions on a Model 14S Zinser drawtwister: (1) feed roll assembly 13 comprises the feed roll assembly of the first position; (2) draw roll assembly 17 comprises the larger diameter roll of the stepped draw roll of the first position and its associated separator roll; (3) heater plate 20 comprises the heater plate added above the draw roll of the

- 7 -

first position; (4) roll assembly 21 also comprises the larger diameter roll of the stepped draw roll of the first position and its associated separator roll; (5) water pan 26 and air jet bulking device 28 are contained in the jet-texturing chest added above the draw roll of the second position; (6) roll assembly 29 comprises the smaller diameter roll of the stepped draw roll of the second position and the separator roll of the second position; (7) draw roll assembly 32 comprises the smaller diameter roll of the stepped draw roll of the first position and its associated separator roll; (8) heater plate 35 also comprises the heater plate added above the draw roll of the first position; and (9) roll assembly 36 also comprises the smaller diameter roll of the stepped draw roll of the first position and its associated separator roll.

The present invention is illustrated by the following examples.

EXAMPLE I

A composite 590 dtex, 68 filament, spin-oriented polyester yarn was cold drawn in a drawing zone, preheated on a heater plate, jet-textured with an air jet, drawn in a post drawing zone, post-heated on a heater plate and wound up on a package. The spin-oriented polyester yarn had been prepared by melt spinning polyethylene terephthalate into yarn while withdrawing the yarn from the spinneret at 3110 metres/minute. The apparatus used, which is shown schematically in the drawing, was provided on two adjacent positions of a Model 14S drawtwister (manufactured by Zinser Textilmaschinen GmbH) by making the modifications described hereinabove. The air jet bulking device 28 was substantially the same as that shown in Figures 6 and 7 of aforementioned United States Patent No. 4 157 605. The feed rate of spin-oriented polyester yarn 10 provided by feed roll assembly 13 was 237 metres/minute. Draw roll assembly 17 was operated at a speed of 391 metres/minute to give a draw ratio of $\frac{391}{237} = 1.65$. Heater plate 20, which was 63.5 cm in length, was operated at a temperature of 210°C and roll

- 8 -

assembly 21 was operated at 391 metres/minute so that the yarn was preheated at constant length. Air jet 28 was operated with an air pressure of 1146 kPa (150 psig). Roll assembly 29 was operated at a speed of 312.8 metres/minute so that the overfeed of the yarn to the air jet 28 was

5 $\frac{391 - 312.8}{312.8} \times 100\% = 25\%$. Draw roll assembly 32 was operated at a speed of 336.3 metres/minute so that the jet-textured yarn was drawn at a draw ratio of $\frac{336.3}{312.8} = 1.075$.

10 Heater plate 35, which was 63.5 cm in length, was operated at a temperature of 210°C and roll assembly 36 was operated at a speed of 336.3 metres/minute so that the jet-textured yarn was post-heated at constant length. The jet-textured

15 yarn was wound up on a surface driven package 39 by a driver roll (not shown). The surface speed of the driver roll was 344 metres/minute; however, slippage between the driver roll and the package 39 may have occurred. The linear density of the air jet-textured yarn on package 39 was found to be

20 404.0 dtex and the dry heat shrinkage thereof (obtained by the method described hereinbefore) was found to be 2.19%.

EXAMPLE II

A composite 885 dtex, 102 filament, spin-oriented polyester yarn was treated on the same apparatus and in the

25 same manner as the yarn in Example I. The spin-oriented polyester yarn had been prepared under the same conditions as that of Example I. The linear density of the resulting jet-textured polyester yarn on package 39 was found to be 600.5 dtex and the dry heat shrinkage thereof was found to be

30 2.86%.

EXAMPLE III

A composite 1180 dtex, 136 filament, spin-oriented polyester yarn was treated on the same apparatus and in the

35 same manner as the yarn in Example I. The spin-oriented polyester yarn had been prepared under the same conditions as that of Example I. The linear density of the resulting jet-textured polyester yarn on package 39 was found to be 802.8 dtex and the dry heat shrinkage thereof was found to be 3.06%.

- 9 -

EXAMPLE IV

A composite 1770 dtex, 204 filament, spin-oriented polyester yarn was treated on the same apparatus and in the same manner as the yarn in Example I. The spin-oriented polyester yarn had been prepared under the same conditions as that of Example I. The linear density of the resulting jet-textured polyester yarn on package 39 was found to be 1209.5 dtex and the dry heat shrinkage thereof was found to be 3.52%.

EXAMPLE V

A composite 2950 dtex, 340 filament, spin-oriented polyester yarn was treated on the same apparatus and in the same manner as the yarn in Example I. The spin-oriented polyester yarn had been prepared under the same conditions as that of Example I. The linear density of the resulting jet-textured polyester yarn on package 39 was found to be 2014.5 dtex and the dry heat shrinkage thereof was found to be 3.85%.

EXAMPLE VI

A composite 4720 dtex, 544 filament, spin-oriented polyester yarn was treated on the same apparatus and in the same manner as that of Example I except that the operating yarn speeds were slower. The spin-oriented polyester yarn had been prepared under the same conditions as that of Example I. The feed rate of spin-oriented polyester yarn provided by feed roll assembly 13 was 146.5 metres/minute. Draw roll assembly 17 was operated at a speed of 252 metres/minute to give a draw ratio of $\frac{252}{146.5} = 1.72$. Roll assembly 29 was operated at a speed of 201.6 metres/minute so that the overfeed of yarn to the air jet was $\frac{252 - 201.6}{201.6} \times 100\% = 25\%$. Draw roll assembly 32 was operated at a speed of 216.7 metres/minute so that the jet-textured yarn was drawn at a draw ratio of $\frac{216.7}{201.6} = 1.075$. Roll assembly 36 was operated at a speed of 216.7 metres/minute so that the jet-textured yarn was post-heated at constant length. The jet-textured yarn was wound up on a surface driven package 39 by a driver roll (not shown). The surface speed of the

- 10 -

driver roll was 230 metres/minute; however, slippage between the driver roll and the package 39 may have occurred. The linear density of the air jet-textured yarn on package 39 was found to be 3206 dtex and the dry heat shrinkage thereof (obtained by the method described hereinbefore) was found to be 2.68%.

EXAMPLE VII

For comparative purposes five tests (A to E) were run with the same composite spin-oriented polyester yarns as in Examples I to V respectively. However, these tests (A to E) were run according to a prior art process by modifying the apparatus shown in the drawing as follows: (1) a hot draw pin was inserted between feed roll assembly 13 and draw roll assembly 17 and (2) the heater plate 20 and the roll assembly 21 were removed. In each test the hot draw pin was operated at 125°C with a 360° yarn wrap about the pin and the hot draw ratio was 1.65. Other conditions were maintained substantially the same as those for Examples I to V. The results are summarized below in the Table, which also includes the results for Examples I to V.

TABLE

AIR JET TEXTURED YARN PRODUCED		
Test	Linear Density (dtex)	Dry Heat Shrinkage (%)
A	401.5	4.15
B	608.2	4.58
C	814.6	4.77
D	1227.3	6.41
E	2024.2	15.17
Example I	404.0	2.19
Example II	600.5	2.86
Example III	802.8	3.06
Example IV	1209.5	3.52
Example V	2014.5	3.85

- 11 -

The dry heat shrinkages of the air jet-textured yarn produced in tests A to E (prior art process) are much higher than the dry heat shrinkages of the air jet-textured yarn produced in corresponding Examples I to V (process of present invention).

EXAMPLE VIII

In order to determine the effect of omitting the step of post-heating the yarn at substantially constant yarn length, EXAMPLE VI was repeated with the exception that heater plate 35 and roll assembly 36 were not utilized i.e. the jet-textured yarn was wound up on package 39 directly from draw roll assembly 32. The linear density of the air jet-textured yarn on package 39 was found to be 3242 dtex and the dry heat shrinkage thereof was found to be 2.57%. The comparative figures for EXAMPLE VI were a linear density of 3206 dtex and a dry heat shrinkage of 2.68%.

From the above, it is apparent that the dry heat shrinkage of the air jet-textured yarn was just as low when the step of post-heating the yarn at substantially constant yarn length was omitted as it was when the step was included. A visual examination of the air jet-textured yarn, however, indicated that the surface loops in the yarn produced in EXAMPLE VIII i.e. with the post-heating step omitted, were considerably larger in size than the surface loops in the yarn produced in EXAMPLE VI i.e. with the post-heating step included.

- 12 -

CLAIMS :

1. A process for producing an air jet-textured polyester yarn having a low dry heat shrinkage, the process comprising the steps of :
 - 5 (a) cold drawing a spin-oriented polyester yarn at a draw ratio in the range of from 1.3 to 2.0;
 - (b) preheating the drawn yarn at substantially constant yarn length;
 - (c) feeding the yarn to an air jet at a 10% to 40% overfeed;
 - 10 (d) jet-texturing the yarn with the air jet;
 - (e) drawing the jet-textured yarn at a draw ratio of 1.04 to 1.12; and
 - (f) winding up the resulting jet-textured yarn.
2. The process according to Claim 1 wherein a step
15 of post-heating the jet-textured yarn is included between step (e) and step (f).
3. The process according to Claim 2 wherein the step of post-heating the jet-textured yarn is carried out at substantially constant yarn length.
- 20 4. The process according to Claim 2 or Claim 3 wherein the step of preheating the drawn yarn and the step of post-heating the jet-textured yarn are each carried out on the surface of a contact heater plate operating at a surface temperature in the range of from 180°C to 220°C.
- 25 5. The process according to Claim 4 wherein the step of preheating the drawn yarn and the step of post-heating the jet-textured yarn are each carried out on the surface

- 13 -

of a contact heater plate operating at a surface temperature in the range of from 205°C to 215°C.

6. The process according to any one of the preceding claims wherein the yarn is fed to the air jet at a 20%
5 to 30% overfeed.

7. The process according to Claim 5 wherein the yarn is fed to the air jet at a 23% to 27% overfeed.

8. The process according to any one of the preceding claims wherein the jet-textured yarn is drawn at a draw
10 ratio of 1.06 to 1.10.

9. The process according to any one of the preceding claims wherein the spin-oriented polyester yarn is cold drawn at a draw ratio of from 1.6 to 1.8.

10. The process according to Claim 9 wherein the cold
15 drawing step is carried out on a draw roll operating at a surface speed of at least 375 metres/minute and wherein the resulting air jet-textured yarn has a linear density in the range of from 400 dtex to 600 dtex and has a dry heat shrinkage in the range of from about 2.2% to about
20 2.8%.

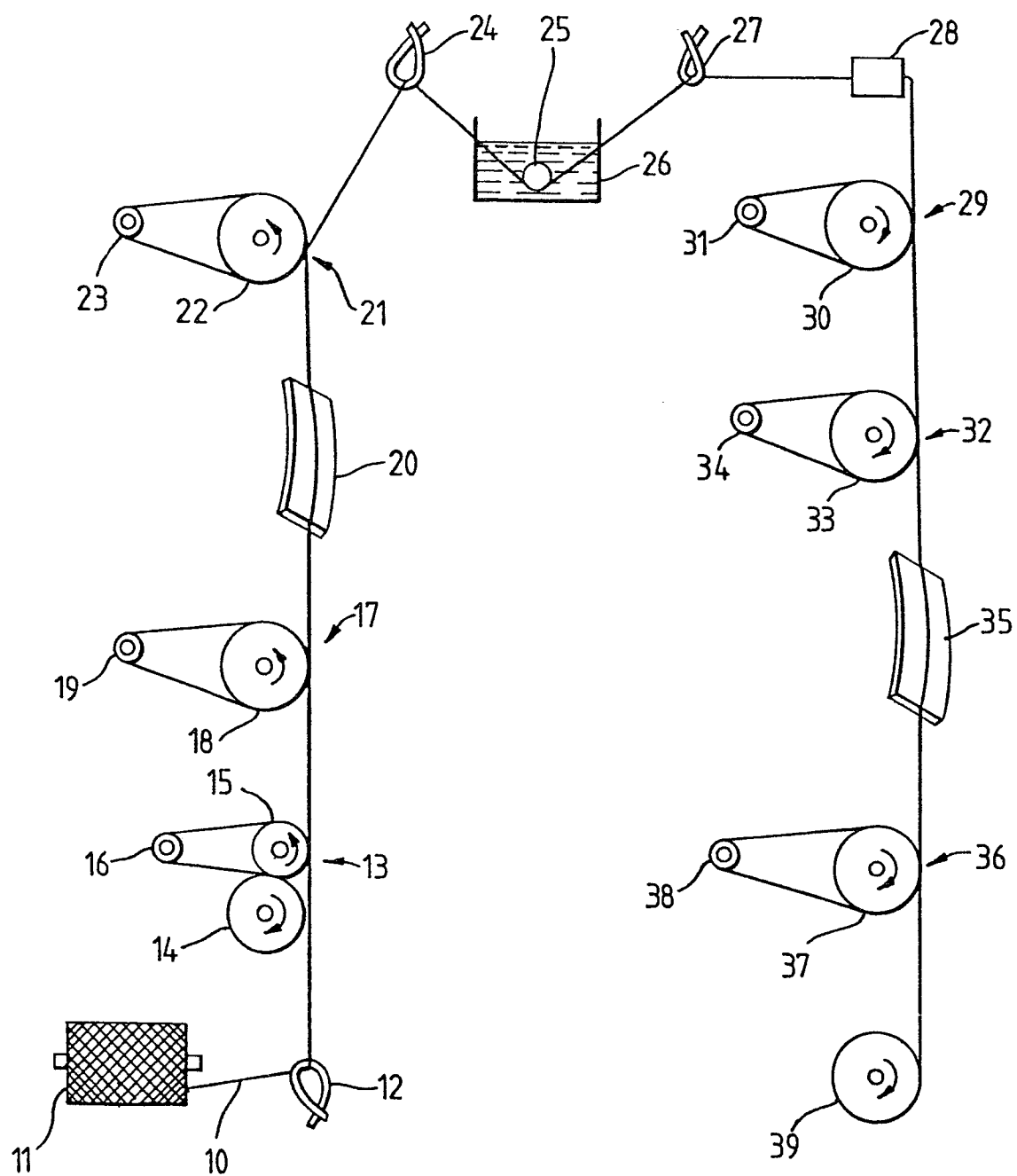
11. The process according to Claim 9 wherein the cold drawing step is carried out on a draw roll operating at a surface speed of at least 375 metres/minute and wherein the resulting air jet-textured yarn has a linear density
25 in the range of from 600 dtex to 1200 dtex and has a dry heat shrinkage in the range of from about 2.8% to about 3.5%.

- 14 -

12. The process according to Claim 9 wherein the cold drawing step is carried out on a draw roll operating at a surface speed of at least 375 metres/minute and wherein the resulting air jet-textured yarn has a linear density
5 in the range of from 1200 dtex to 2000 dtex and has a dry heat shrinkage in the range of from about 3.5% to about 3.9%.

13. The process according to Claim 9 wherein the cold drawing step is carried out on a draw roll operating at a
10 surface speed of at least 240 metres/minute and wherein the resulting air jet-textured yarn has a linear density in the range of from 2000 dtex to 3500 dtex and has a dry heat shrinkage of less than about 3.0%.

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European Patent
Office

EUROPEAN SEARCH REPORT

0032067

Application number

EP 80 30 4778.6

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	CH - A - 547 879 (PLATT INTERNATIONAL) ---		D 02 G 1/00
A	FR - A1 - 2 278 807 (RHONE-POULENC-TEXTILE) ---		
A,P	GB - A - 2 043 718 (DU PONT DE NEMOURS) ---		
A	US - A - 3 680 301 (MICHEL) ---		TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
D,A	US - A - 3 973 386 (GORRAFA) ----		D 02 G 1/00
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
☒ The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search Berlin		Date of completion of the search 10-03-1981	Examiner KLITSCH