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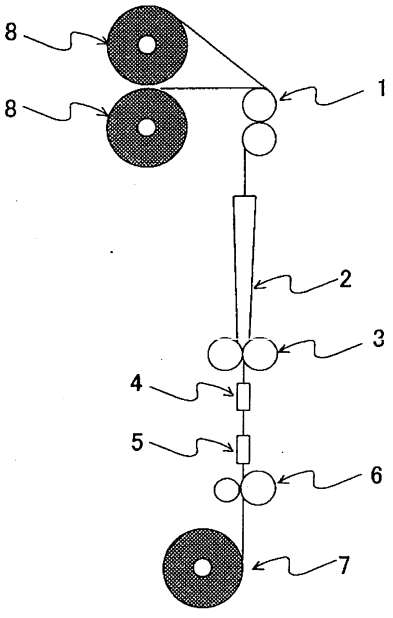
(54) HIGH-STRENGTH YARN MADE THROUGH STRETCH BREAKING AND PROCESS FOR PRODUCING THE SAME

(57) A spanized yarn constituted by a high strength short fiber containing at least one polymer selected from the group consisting of poly-p-phenylene terephthalamide, poly-p-phenylene benzoxazole, polyethylene, polyvinyl alcohol and wholly aromatic polyester and having a strength of 14 cN/dtex or more, and the high strength short fiber has an average single yarn length of from 50 to 90 cm and a coefficient of variation (CV) in average single yarn length of 50% or less.

Fig. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a spanized yarn and a method for producing the same. More specifically, it relates to such a spanized yarn that has a high strength maintenance rate of a base yarn and suffers less fluctuation in strength, and such a method that is capable of producing the spanized yarn stably.

BACKGROUND ART

[0002] A high-strength fiber represented by a para-type wholly aromatic polyamide fiber is applied to a spun yarn for a protective clothing material in the field of clothing materials owing to the high heat resistance and the high incision resistance. However, a spun yarn using the conventional high-strength fiber such problems that it suffers considerable decrease in strength of the processed yarn as compared to the base yarn before processing (i.e., low in strength maintenance rate), and causes a large amount of surface fluff specific to a spun yarn. Accordingly, it is difficult to apply to such a purpose that requires a spun yarn having a high strength and causing a less amount of surface fluff.

[0003] The strength of a spun yarn is generally in proportion to the strength of the single yarn (base yarn) constituting the spun yarn and the average yarn length of the single yarn. It is preferred that the strength maintenance rate is improved by increasing the average yarn length of the constitutional single yarn since there is a limitation in improving the strength of the base yarn, but the single yarn length in the conventional spun yarn is generally 100 mm or less, and the strength maintenance rate of a spun yarn constituted by such a short fiber is 50% or less at most.

[0004] However, the use of a single yarn (short fiber) having a length larger than the above encounters not only difficulty in production of a spun yarn, but also such a problem that the simple prolongation in single yarn length brings about stiffness specific to a high-strength fiber to make uniform orientation difficult, and thus the strength maintenance rate is rather decreased.

[0005] In order to solve the problem, JP-B-1-16932 proposes a thread that is like a wholly aromatic polyamide spun yarn that is applied with conjugation property and is formed of a fiber having an average single yarn length of from 130 to 600 mm, which is obtained by tearing a continuous thread into a short fiber. However, according to investigations made by the present inventors, upon producing a thread that is like a spun yarn of, for example, a poly-p-phenylene terephthalamide fiber under the conditions described in the publication, it has been found that such a problem arises that the strength maintenance rate and the amount of surface fluff are liable to fluctuate. That is, in the case where a poly-p-phenylene terephthalamide fiber is used as the wholly aromatic polyamide fiber, the tow is considerably expanded upon spanizing due to static charge formed by friction of the single yarns and causes turbulence on a roller to make uniform spanizing difficult. As a result, the fluctuation in single yarn length is increased to decrease the strength maintenance rate, and thus even though a high strength fiber is used, such problems occur that the spanized yarn is decreased in strength, the fluctuation in strength is increased, and the amount of surface fluff is significantly increased.

[0006] The problem of decrease in strength maintenance rate can be improved by increasing the average single yarn length, but it is necessary therefor to increase the spanizing length, which brings about such a problem that the tow is further liable to expand between rollers to make the yarn liable to twist around the feeding roller and the spanizing roller, and thus the spanizing process cannot be stably carried out.

[0007] As having been described, it is the current situation that there have not been proposed such a high strength spanized yarn having high quality and a method for producing the same that is produced with a fiber liable to cause static charge due to friction of single yarns, such as a poly-p-phenylene terephthalamide fiber, to have a large average single yarn length with a small fluctuation in single yarn length.

DISCLOSURE OF THE INVENTION

[0008] An object of the invention is to solve the problems associated with the conventional art to provide such a high strength spanized yarn having high quality and a method for stably producing the spanized yarn that has a high maintenance rate in strength of a base yarn and a small fluctuation in single yarn length.

[0009] As a result of cumulative investigations for solvinq the problems made by the inventors, the invention has been completed.

[0010] Accordingly, the object of the invention is attained by a high strength spanized yarn constituted by a high strength short fiber containing at least one polymer selected from the group consisting of poly-p-phenylene terephthalamide, poly-p-phenylene benzoxazole, polyethylene, polyvinyl alcohol and wholly aromatic polyester and having a strength of 14 cN/dtex or more, characterized in that the high strength short fiber has an average single yarn length of from 50 to 90 cm and a coefficient of variation (CV) in average single yarn length of 50% or less; and a method for producing a high strength spanized yarn characterized by containing steps of tearing a high strength fiber containing at

least one polymer selected from the group consisting of poly-p-phenylene terephthalamide, poly-p-phenylene benzoxazole, polyethylene, polyvinyl alcohol and wholly aromatic polyester and having a strength of 14 cN/dtex or more, between a pair of a feeding roller and a spanizing roller with a distance between the rollers of from 100 to 200 cm, to which a moistening fluid having a humidity of 80% or more is applied, and withdrawing the fiber with conjugation through a fluid nozzle.

BRIEF DESCRIPTION OF THE DRAWING

[0011]

Fig. 1 is a side elevational view showing an example of a spanizing apparatus used for producing a high strength spanized yarn according to the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] An embodiment of the invention will be described in detail below.

[0013] The high strength short fiber constituting the spanized yarn of the invention necessarily has a strength of 14 cN/dtex or more, and preferably from 18 to 50 cN/dtex. In the case where the strength is less than 14 cN/dtex, the strength as the spanized yarn becomes insufficient to fail to attain the object of the invention. Examples of the high strength short fiber that is preferably used include a poly-p-phenylene terephthalamide short fiber, a poly-p-phenylene benzoxazole short fiber, a high strength polyethylene short fiber, a high strength polyvinyl alcohol short fiber and a wholly aromatic polyester short fiber, which may be used as a mixture of two or more kinds thereof. Among these, a poly-p-phenylene terephthalamide short fiber is preferred.

[0014] In the case where the single yarn fineness of the high strength short fiber is too large, the number of single yarns constituting the spanized yarn is decreased to lower the strength of the spanized yarn due to the reduced entanglement of the single yarns, and therefore, it is desirably 2.5 dtex or less, preferably 1.1 dtex or less, and more preferably 0.8 dtex or less.

[0015] The average single yarn length of the high strength short fiber constituting the spanized yarn of the invention is necessarily in a range of from 50 to 90 cm, and particularly in a range of from 60 to 80 cm. In the case where the average single yarn length is less than 50 cm, the strength maintenance rate (strength of spanized yarn/strength of short fiber) of the spanized yarn with respect to the strength of the short fiber (base yarn) is decreased to fail to exhibit the strength of the base yarn sufficiently. In the case where the average single yarn length exceeds 90 cm, on the other hand, the spanizing length upon spanizing is necessarily 2.0 m or more for obtaining such spanized yarn, and as a result, the tow at the spanizing portion is considerably unraveled to cause winding on a roller frequently, which impairs stable spanizing.

[0016] The high strength spanized yarn of the invention necessarily has a coefficient of variation (CV) in single yarn length of 50% or less, and particularly 40% or less. In the case where the coefficient of variation (CV) exceeds 50%, the fluctuation in single yarn length becomes too large the strength of the spanized yarn fluctuates, that is, the standard deviation of the strength becomes large because thereby failing to attain the object of the invention, i.e., the provision of a uniform spanized yarn with high quality.

[0017] The high strength spanized yarn of the invention preferably has a strength maintenance rate of 70% or more. In the case where the spanized yarn is constituted by plural kinds of short fibers, the strength maintenance rate referred herein is a maintenance rate with respect to the strength of the short fiber having a lower strength. In the case where the maintenance rate is less than 70%, not only the strength of the short fiber (base yarn) cannot be effectively exhibited, but also the amount of surface fluff is increased due to the short constitutional single yarn length, which restricts the application of the spanized yarn.

[0018] A preferred method for producing the spanized yarn of the invention will be described in detail with reference to the drawing. Fig. 1 shows a spanizing apparatus that is preferably used for producing the high strength spanized yarn according to the invention. Numeral 1 denotes a feeding nip roller, 2 represents a shooter, 3 denotes a spanizing nip roller, 4 denotes a suction air nozzle, 5 denotes a revolving conjugation nozzle, 6 denotes a delivery roller, 7 denotes a wound spanized yarn, and 8 denotes a high strength fiber.

[0019] A prescribed number of the high strength fibers are arranged before the feeding nip roller, and after superposing while passing through the feeding nip roller, they are spanized (tearing process) in the shooter. At this time, a moistening fluid having a humidity of 80% or more, such as damp air, is fed into the shooter to apply to the high strength fibers. Subsequently, the fibers are drawn off through the spanizing nip roller with the suction air nozzle, and applied with conjugation property with entanglement and fluff winding through the revolving conjugation nozzle, followed by withdrawing with the delivery roller.

[0020] The high strength fiber is formed into the short fiber through spanizing as having been described, and the

strength thereof is necessarily 14 cN/dtex or more, and preferably from 18 to 50 cN/dtex or more. In the case where the strength is less than 14 cN/dtex, the strength of the short fiber after spanizing becomes insufficient to fail to provide the spanized yarn of the invention. Examples of the high strength fiber that is preferably used include, as having been described, a poly-p-phenylene terephthalamide fiber, a poly-p-phenylene benzoxazole fiber, a high strength polyethylene fiber, a high strength polyvinyl alcohol fiber and a wholly aromatic polyester fiber, which may be used as a mixture of two or more kinds thereof. Among these, a poly-p-phenylene terephthalamide fiber is preferred.

[0021] In the invention, the high strength fiber is preferably attached with an oily agent in an amount of from 0.05 to 0.5% by weight based on the weight of the fiber, and the attached oily agent preferably has a water content of 7.0% by weight or less. In the case where the attached amount of the oily agent is less than 0.05% by weight, the fiber is liable to be statically charged in the tearing process described later, whereby the tow is unfastened with repulsion due to static charge to cause breakage of yarn frequently, and thus it is difficult to carry out spanizing stably. In the case where the attached amount of the oily agent exceeds 0.5% by weight, the tow is not sufficiently unraveled due to the effect of the oily agent of unspreading the fiber, which might bring about large fluctuation in length of the single yarns constituting the spanized yarn. In the case where the water content of the attached oily agent exceeds 7.0% by weight, the similar phenomenon might occur as in the case where the attached amount of the oily agent exceeds 0.5% by weight, due to the effect of the water content of unspreading the fiber.

[0022] In the invention, after forming the short fiber by tearing the high strength fiber between the feeding roller and the spanizing roller, it is necessary that the yarns of the short fibers are withdrawn with conjugation by the fluid nozzle to prevent the yarns from being drawn out in the longitudinal direction (withdrawing direction) while preventing disturbance in arrangement of fibers from occurring. In the tearing process, in order to prevent as much as possible the arrangement of the torn short fibers from being disturbed, it is preferred that, for example, the short fibers are covered with a guide having a funnel shape.

[0023] It is important in the invention that in the tearing process, a moistening fluid, and preferably damp air, having a humidity of 80% or more, preferably 90% or more, and particularly preferably 95% or more, is applied to the high strength fiber. In the case where the humidity of the moistening fluid is less than 80%, it is not preferred since the effect of discharging static charge on the surface of the fiber is reduced, whereby the tow is unfastened with repulsion among the fibers to make the single yarns liable to twist around the feeding roller and the spanizing roller, and thus it is difficult to carry out spanizing stably. In order to reduce fluctuation in spanizing length, it is necessary that the fiber is uniformly unraveled on the surface of the spanizing roller, but excessive unraveling brings about the single yarns twisting around the feeding roller and the spanizing roller, and therefore, the application of the moistening fluid is important.

[0024] The distance (spanizing length) between the pair of the feeding roller and the spanizing roller is necessarily in a range of from 100 to 200 cm, and preferably in a range of from 120 to 175 cm. In the case where the spanizing length is less than 100 cm, the average single yarn length of the resulting spanized yarn is less than 40 cm, and the strength maintenance rate of the base yarn becomes less than 70%, so as to fail to attain the object of the invention. In the case where the spanizing length exceeds 200 cm, on the other hand, it is not preferred since the tow width between the feeding roller and the spanizing roller is extremely expanded to make the single yarn liable to twist around the spanizing roller, and thus it is difficult to carry out spanizing stably.

[0025] The spanized yarn of the invention having been described hereinbefore may be suitably twisted and woven as a warp yarn and/or a weft yarn into a desired density, followed by subjecting to refining, heat setting, relaxing, calendering and the like, to obtain a fabric.

EXAMPLE

[0026] The constitution and advantage of the invention will be described in more detail with reference to examples below. The properties in the examples were obtained in the following manner.

(1) Fineness, Breaking Strength, Breaking Elongation and Elastic Modulus
The parameters were measured according to JIS L1013, where the twisted number was 250 t/m.
(2) Single Yarn Length
120 threads of the single yarns were randomly withdrawn from the spanized yarn while preventing breakage, and an average value of the lengths of the extended single yarns was obtained.
(3) Coefficient of Variation (CV) in Single Yarn Length
The coefficient of variation was obtained by calculating from the standard deviation (σ) and the average yarn length (X) of the 120 threads of the single yarns obtained in the aforementioned manner, according to the following equation.

$$\text{Coefficient of variation (CV) in single yarn length (\%)} = \sigma / X \times 100$$

(4) Number of Breakage of Yarn
As an index of the process conditions, a number of breakage of the yarn (breakage by twisting around the feeding roller or the spanizing roller) upon carrying out the spanizing process for 8 hours was measured.

(Examples 1 to 3 and Comparative Examples 1 to 3)

[0027] By using the apparatus shown in Fig. 1, two threads of poly-p-phenylene terephthalamide fibers (Twaron, produced by Teijin Twaron B.V.) each having a total fineness of 1, 100 dtex and a strength of 21 cN/dtex with the single yarn fineness and the oily agent attached amount as shown in Table 1 were arranged and torn among the feeding nip roller, the shooter and the spanizing nip roller at a speed of 300 m/min with damp air applied thereto to make a spanizing rate of about 10 times with variation of the distance between the roller (spanizing length) and the humidity of the damp air as shown in Table 1, so as to obtain a bundle of short fibers.

[0028] Subsequently, the short fibers were passed through the suction air nozzle and the revolving conjugation nozzle to make a speed ratio between the spanizing nip roller and the delivery roller of 100/99.5 to apply entanglement and to wind fluff of short fibers randomly, so as to obtain a spanized yarn of about 220 dtex. The physical properties of the spanized yarn are shown in Table 1.

(Comparative Example 4)

[0029] By using the apparatus shown in Fig. 1, two threads of copoly-p-phenylene-3,4'-oxydiphenylene terephthalamide fibers (Technora, produced by Teijin Techno Products, Ltd.) each having a single yarn fineness of 0.84 dtex, a total fineness of 1,100 dtex, a strength of 25 cN/dtex and an oily agent attached amount of 0.2% by weight were arranged and torn among the feeding nip roller, the shooter and the spanizing nip roller with a distance between the rollers (spanizing length) of 120 cm at a speed of 300 m/min with damp air having a humidity of 50% applied thereto to make a spanizing rate of about 10 times, so as to obtain a bundle of short fibers.

[0030] Subsequently, the short fibers were passed through the suction air nozzle and the revolving conjugation nozzle to make a speed ratio between the spanizing nip roller and the delivery roller of 100/99.5 to apply entanglement and to wind fluff of short fibers randomly, so as to obtain a spanized yarn of about 220 dtex. The physical properties of the spanized yarn are shown in Table 1.

Table 1

		Unit	Example 1	Example 2	Example 3
Base yarn	Kind of base yarn		Twaron	Twaron	Twaron
	Fineness of single yarn	dtex	1.1	1.1	1.1
	Oily agent attached amount	% by weight	0.2	0.2	0.2
Spanizing condition	Spanizing length	cm	120	150	175
	Humidity of damp air	%	95	95	95
Spanized yarn	Fineness	dtex	221	222	220
	Strength	cN/dtex	15.4	16.1	16.8
	Average single yarn length	cm	51	61	75
	Coefficient of variation in single yarn length	%	34	35	39
	Strength maintenance rate	%	73	77	80
	Standard deviation of strength	cN/dtex	1.1	1.2	1.5
	Number of breakage of yarn (8h)	per hour	0	0	0

Table 1 (continued)

		Unit	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Base yarn	Kind of base yarn		Twaron	Twaron	Twaron	Technora
	Fineness of single yarn	dtex	1.1	1.1	1.1	1.1
	Oily agent attached amount	% by weight	0.2	0.2	0.2	0.2
Spanizing condition	Spanizing length	cm	40	80	150	120
	Humidity of damp air	%	95	95	50	50
Spanized yarn	Fineness	dtex	222	223	218	221
	Strength	cN/dtex	11.1	12.1	15.9	19.8
	Average single yarn length	cm	19	42	55	50
	Coefficient of variation in single yarn length	%	30	31	63	34
	Strength maintenance rate	%	44	48	76	79
	Standard deviation of strength	cN/dtex	1.3	1.1	3.5	1.3
	Number of breakage of yarn (8h)	per hour	0	0	3	0

INDUSTRIAL APPLICABILITY

[0031] According to the invention, such a spanized yarn can be obtained that has a high strength maintenance rate of the spanized yarn with respect to the strength of the high strength short fiber as compared to the conventional spanized yarn with small fluctuation in single yarn length thereof, so as to provide, for example, a protective clothing material of high quality in the field of protective clothing material. According to the production method of the invention, the high strength spanized yarn can be stably produced.

Claims

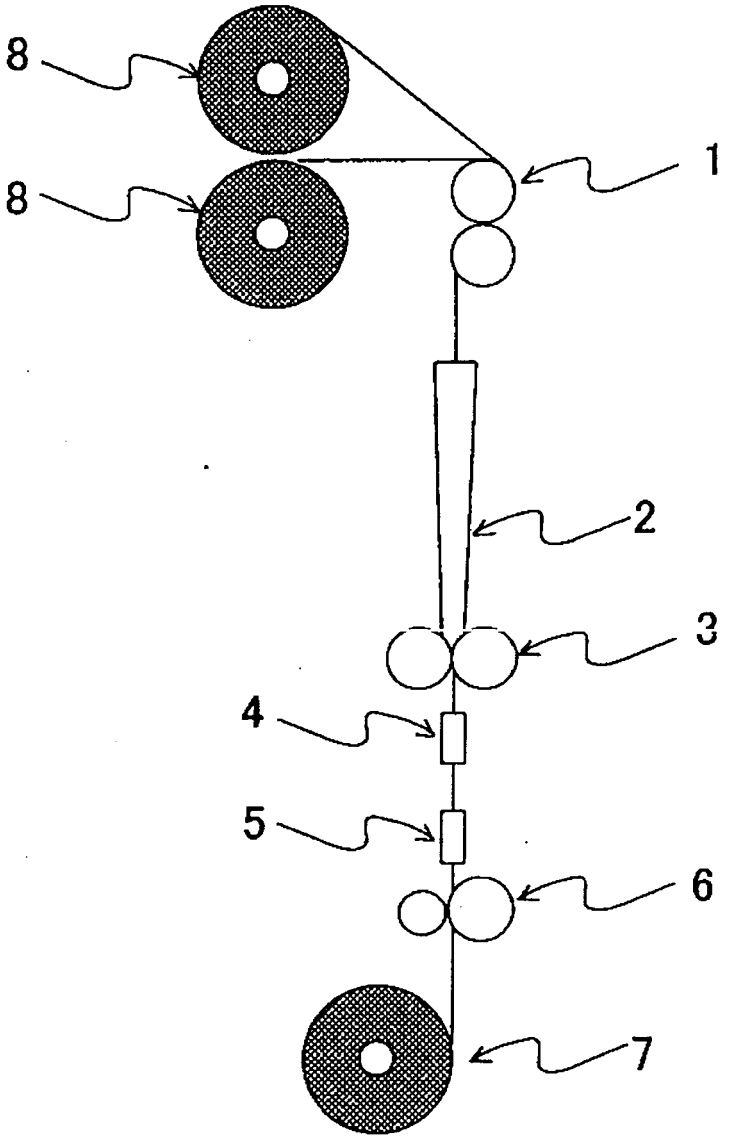
1. A high strength spanized yarn comprising a high strength short fiber comprising at least one polymer selected from the group consisting of poly-p-phenylene terephthalamide, poly-p-phenylene benzoxazole, polyethylene, polyvinyl alcohol and wholly aromatic polyester and having a strength of 14 cN/dtex or more, **characterized in that** the high strength short fiber has an average single yarn length of from 50 to 90 cm and a coefficient of variation (CV) in average single yarn length of 50% or less.

2. The high strength spanized yarn according to claim 1, wherein the high strength spanized yarn has a strength maintenance rate of 70% or more with respect to the high strength short fiber.

3. A method for producing a high strength spanized yarn **characterized by** comprising steps of: tearing a high strength fiber comprising at least one polymer selected from the group consisting of poly-p-phenylene terephthalamide, poly-p-phenylene benzoxazole, polyethylene, polyvinyl alcohol and wholly aromatic polyester and having a strength of 14 cN/dtex or more, between a pair of a feeding roller and a spanizing roller with a distance between the rollers of from 100 to 200 cm, to which a moistening fluid having a humidity of 80% or more is applied; and withdrawing the fiber with conjugation through a fluid nozzle.

4. The method for producing a high strength spanized yarn according to claim 3, wherein the high strength fiber is attached with an oily agent in an amount of from 0.05 to 0.5% by weight.

Fig. 1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/008083

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D02G3/02, 1/16, D02J1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D02G3/02, 1/16, D02J1/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2003/014446 A1 (Teijin Ltd.), 20 February, 2003 (20.02.03), Full text (Family: none)	1-4
A	JP 4-361636 A (Teijin Ltd.), 15 December, 1992 (15.12.92), Full text (Family: none)	1-4
A	JP 6-299468 A (Teijin Ltd.), 25 October, 1994 (25.10.94), Full text (Family: none)	1-4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
26 August, 2005 (26.08.05)	13 September, 2005 (13.09.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/008083

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 5-272010 A (Teijin Ltd.), 19 October, 1993 (19.10.93), Full text (Family: none)	1-4
A	JP 4-361633 A (Teijin Ltd.), 15 December, 1992 (15.12.92), Full text (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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