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TRANSLATION CERTIFICATION

Date: March 17, 2025

To whom it may concern:

This is to certify that the attached translation is an accurate representation of the documents received by this office. The translation was completed from:

- Korean

To:

- English (USA)

The documents are designated as:

- 2022.04.13 Hyosung Invalidation Trial Petition (p8~64)

Emily Paras, Project Manager in this company, attests to the following:

"To the best of my knowledge, the aforementioned documents are a true, full and accurate translation of the specified documents."

Signature of Emily Paras

Kolon Industries, Inc.
Exhibit 2006
HS Hyosung v. Kolon
IPR2025-00664
Ex. 2006-001

Shipment Number: 7-7-2022-001865673
Shipment Date: 04/13/2022
Submission Date: 05/10/2022

Received by: 110 Magokdong-ro, Gangseo-gu, Seoul (Magokdong)
Kolon Industries Co., Ltd. Dear (Precious)

07793

Patent Trial and Appeal Board
74th Division
Trial Request Sub-Delivery Form

Trial number		2022Dang969
Case indication		Patent No. 1580352 invalidation
Claimant name		Hyosung Advanced Materials Co., Ltd.
	Address	119 Mapo-daero, Mapo-gu, Seoul (Gongdeok-dong)
Agent name		Jeil Patent Corporation (Ltd.)
	Address	60 Mabang-ro, Seocho-gu, Seoul (Yangjae-dong, Dongwon F&B Building)
Designated patent attorney		Chan-young Kim and 2 others
Respondent name		Kolon Industries, Ltd.
	Address	110 Magokdong-ro, Gangseo-gu, Seoul (Magokdong)

1. Regarding the above trial case, [A copy of the trial request has been delivered, so please submit a response (or opinion) by the above submission deadline.
(Related laws, etc.: Patent Act Article 147, Utility Model Act Article 33, Design Protection Act Article 134, Trademark Act Article 133)

2. In the case of invalidation trials pursuant to Article 133 Paragraph 1 of the Patent Act, Article 137 Paragraph 1 of the same Act, and Article 31 Paragraph 1 of the Utility Model Act, a request for correction may be made within the above-mentioned response submission period. In addition, in the case where the claimant submits new invalidation evidence through an opinion, a copy of the request for an invalidation trial is delivered to the respondent, and an opportunity to request correction is given. (Related laws.: Patent Act Article 133-2 Paragraph 1, Article 137 Paragraph 3 of the same Act, Utility Model Act Article 33)

3. In the case of wishing to extend the above-mentioned submission deadline, please submit an “Application for Extension of Designated Period” along with attached documentation explaining the unavoidable reason for the extension. However, only for the first extension request for the response submission period, the period may be extended by up to one month without attaching supporting documents.

Attachment: One copy of the request for trial.

04/13/2022

Presiding Judge Jeon-gwan Kang

[Stamp] (Patent Trial and Appeal Board Chief Judge)

« Guide »

※ If you have any questions about the contents of this notice, please contact the Patent Customer Service Center at ☎1544-8080 for the form or procedure, or the Trial Policy Division at ☎042-481-5850 (Contact: Yoon Ga-young) for inquiries about the contents of the notice.

※ If you visit the Patent Trial and Appeal Board (www.kipo.go.kr/ipt) or Patent Office (www.patent.go.kr) website, you can get more information about the trial progress, online trial document submission, and patent trial procedures.

※ In order to support the socially and economically disadvantaged, the Patent Trial and Appeal Board appoints a public defender upon the request of a trial party without a representative. After confirming your eligibility, please submit the "Application for Appointment of Court-appointed Attorney" before the end of the trial. For more information, please visit the Patent Trial and Appeal Board website (www.kipo.go.kr/ipt).

※ The Korean Intellectual Property Office operates the Public Interest Patent Attorney Patent Consultation Center (www.pcc.or.kr) to support representation in trials and appeals in cases where disputes arise between socially disadvantaged persons holding industrial property rights. For more information, please contact the Public Interest Patent Attorney Patent Consulting Center (☎02-6006-4300).

※ The Korean Intellectual Property Office operates the Industrial Property Rights Dispute Mediation Committee (www.koipa.re.kr) to resolve industrial property rights disputes quickly and inexpensively through agreements between the parties in addition to trials and lawsuits. For more information, please contact the Industrial Property Rights Dispute Mediation Committee Secretariat (☎1670-9779).

※ If you apply for the notification service on the Patentro (www.patent.go.kr) homepage - Customer Center - Notice Service, you will be notified by email or mobile phone of the parties or their representatives regarding the dispatch of the trial notice/decision, etc.

Opinion (Response, Explanation) Form - Example

(Front)

[Document Classification**]** □ Opinion according to notice of reasons for rejection, etc. □ Opinion on ex officio correction

[X] Trial case response □ Trial case opinion

□ Objection response □ Objection opinion

□ Re-objection response □ Explanation in accordance with the notice of reasons for rejection

[Submitter**]**

[Name (Title)] **Sim-pan Kim**

[Patent customer number] **4-2014-031378-7**

[Relationship to the Case] **Defendant**

[Case Description]

[Trial Number] **2015-Dang-123456**

[Opinion (Response, Explanation) Contents] **Same as attached** ☞ Describe the reason for the opinion and its contents in detail, and if this column is insufficient, it can be written on a separate sheet and attached.

([Method of Evidence])

Submit it to the Commissioner of the Korean Patent Office (Chairman of the Patent Trial and Appeal Board, Chief Trial Officer) as above.

Submitter (Agent): **Sim-pan Kim** (Signature or stamp)

[Attached Documents] 1 copy of each document stipulated by law (Refer to Description Guideline No. 8)

* Please refer to the notes on preparation in the description guideline No. 9

210mmX297mm[White paper 80g/m3]

[Appendix 10 Format] Application for Extension of Period (Shortening of Period, Relief from Expiration of Period, Continuation of Procedure) <Revised 9/22/2017>

■ Patent Act Enforcement Regulations You can submit online at Patentro (www.patent.go.kr).

Application for Extension of Period (Shortening of Period, Relief from Expiration of Period, Continuation of Procedure)

[Application Category]	[x] Statutory (designated) period extension	□ Shortening of designated period
	□ Extension of design secrecy period	□ Extension of design secrecy period
	□ Relief for lapse of period	□ Shortening of design secrecy period

[Submitter]

[Name (Title)] **Sim-pan Kim**

[Patent customer number] **4-2014-031378-7**

[Relationship to the Case] **Defendant**

[Agent]

[Name (Title)]

[Agent number]

([Comprehensive Power of Attorney Registration Number])

[Application Number (Technology Evaluation Request Number*, International Registration Number*, Objection Application Number*, Application for Reclassification of Product Classification, Cancellation Application Number, Trial Number)] **2019-Dang-123456**

([Design Serial Number])

[Extension of Period (Shortening of Period, Relief from Expiration of Period), Indication of Continuation of Trademark Procedure (Submission of Opinion)]

([Documents to be Submitted]) **Trial Case Response**

([Receipt (Shipment) Number]) **7-7-2019-1234567-01**

[Reason for Extension (Reason for Shortening, Reason for Period Expiration)] **According to the circumstances of the Respondent**

([Number of extension application submissions]) **1 time**

([Desired period for extension (shortening of confidentiality period) (date of expiration of reason for lapse)]) **1 month**

Submit it to the Commissioner of the Korean Patent Office (Chairman of the Patent Trial and Appeal Board, Chief Trial Officer) as above.

Submitter (Agent): **Sim-pan Kim** (Signature or stamp)

[Fees] KRW (Refer to description instructions No. 6)

([Automatic fee payment number])

[Attached Documents] 1 copy of each document stipulated by law (Refer to Description Guideline No. 8)

*Please refer to the notes when writing Instructions for Writing No. 9

210mmX297mm[White paper 80g/m3]

Ex. 2006-005

[Bibliographic information]

[Document title] Trial request form

[Claimant]

[Name] Hyosung Advanced Materials Co., Ltd.

[Patent customer number] 1-2018-034869

[Agent]

[Name] Jeil Patent Corporation (Ltd.)

[Agent number] 9-2010-100081-2

[Designated patent attorney] Chan-young Kim, Ha-na Jo, Woo-ram Lee

[Respondent]

[Name] Kolon Industries, Ltd.

[Patent customer number] 1-2010-000846-1

[Case Description]

[Type of trial] Invalidation trial

[Patent (registration) number] 10-1580352-00-00

[Purpose of claim] Same as attached

[Reason for claim] Same as attached

[Purpose] Submit to the Director of the Patent Trial and Appeal Board as above

Agent: Jeil Patent Corporation (Ltd.) (Signature or stamp)

[Fees]

[Basic trial claim fee] 9,150,000 KRW

[Additional trial claim fee]	135,000 KRW
[Total]	285,000 KRW
[Attached Documents]	1. Contents of claim (purpose and reason)_1 copy 2. Power of attorney_1 copy 3. Evidence [Party A - Evidence No. 001]_1 copy 4. Evidence [Party A - Evidence No. 002]_1 copy 5. Evidence [Party A - Evidence No. 003]_1 copy 6. Evidence [Party A - Evidence No. 004]_1 copy 7. Evidence [Party A - Evidence No. 005]_1 copy 8. Evidence [Party A - Evidence No. 006]_1 copy 9. Evidence [Party A-No. 007]_1 set 10. Evidence [Party A-No. 008]_1 set 11. Evidence [Party A-No. 009]_1 set 12. Evidence [Party A-No. 010]_1 set 13. Reference material [Reference-No. 001]_1 set 14. Reference material [Reference-No. 002]_1 set 15. Reference material [Reference-No. 003]_1 set 16. Reference material [Reference-Evidence No. 004]_1 copy 17. Reference material [Reference-Evidence No. 005]_1 copy 18. Reference material [Reference-Evidence No. 006]_1 copy 19. Reference material [Reference-Evidence No. 007]_1 copy

[Purpose of claim]

Same as attached

[Reason for claim]

Same as attached

Purpose of Claim

1. Claims 1 to 9 of Patent No. 1580352 are invalidated.
2. The costs of the trial shall be borne by the defendant.

The above decisions are requested.

Reason for Claim

I. Registration background of Patent No. 1580352

Patent No. 1580352 (hereinafter referred to as the "patent in this case"), entitled "Hybrid Fiber Cord and Manufacturing Method Thereof," was applied for with the Korean Intellectual Property Office on December 27, 2012 (Application No. 2012-0154933), and was announced for registration on December 23, 2015, and is currently valid as of the date of the request for invalidation trial in this case (Exhibit A No. 1: Patent Registration Book; Exhibit A No. 2: Registered Patent Gazette).

II. Interests of the Claimant

The claimant in this case, "Hyosung Advanced Materials" (hereinafter referred to as "claimant"), manufactures and sells tire cords used as tire reinforcement materials (see Exhibit A No. 3: Claimant's website). On the other hand, the mixed fibers described in the scope of claims of the patent in this case are used as tire cords (see paragraph [0004] of Exhibit A No. 2).

Therefore, the claimant in this case has a direct and practical interest in the validity of the patent in this case, and is therefore qualified to request an invalidation trial of the patent in this case pursuant to Article 133, Paragraph 1 of the Patent Act.

III. Summary of the Patent in This Case

1. Technical Field

The patent of this case relates to a hybrid fiber cord comprising nylon filaments and aramid filaments and a manufacturing method thereof (Exhibit A No. 2, paragraph [0001]).

2. Tasks to Be Solved and Purpose of the Invention

The patent in question points out that the prior art of a hybrid structure using nylon and aramid together has problems such as "limited manufacturing possibilities with low productivity using an old ring yarn twister or a special yarn twister due to the use of different twists, and increased property fluctuations and higher defect rates due to unstable structures" (Exhibit Gap No. 2, paragraph [0007]).

In addition, the patent in question states that, in relation to the problem to be solved, it seeks to "provide a hybrid fiber cord including nylon filaments and aramid filaments that is not only easy to manufacture but also has more uniform properties and improved strength and fatigue characteristics, making it applicable to ultra-high-performance tires" (paragraphs [0010] to [0013] of Exhibit A No. 2).

3. Means for Solving the Task

As a means to solve the above problem, the patent in question proposes a hybrid fiber cord in which nylon overtwisted yarns and aramid overtwisted yarns are spun together with the same twists and the same structure (paragraphs [0014] and [0015] of Exhibit A No. 2).

In addition, the patent in this case states that "the hybrid fiber cord of the present invention provides the same number of twists in the lower and upper twists in the yarn process" (paragraph [0059] of the second document of the Gap).

4. Claims of the Patent in This Case

The claims of the patent in this case consist of (i) claims 1 to 5 regarding the hybrid fiber cord, and (ii) claims 6 to 9 regarding the method for manufacturing the hybrid fiber cord, and the contents thereof are as follows (Claims of Exhibit A No. 2).

Claim 1

A hybrid fiber cord comprising a nylon filament having a first twist number and an aramid filament having a second twist number, wherein the first twist number and the second twist number are the same, and the nylon filament and the aramid filament are twisted together with the same structure and the same twist number as the first and second twist numbers.

Claim 2

The hybrid fiber cord according to claim 1, characterized in that the first and second twist numbers are 300 to 500 TPM.

Claim 3

The hybrid fiber cord according to claim 1, characterized in that the weight ratio of the nylon filament and the aramid filament is 20:80 to 80:20.

Claim 4

A hybrid fiber cord characterized in that, according to claim 1, the breaking strength and the elongation at break measured by ASTM D885 are 8.0 to 15.0 g/d and 7 to 15%, respectively, and the strength retention rate after a disk fatigue test conducted according to the JIS-L 1017 method of the Japanese Standard Association (JSA) is 80% or more.

Claim 5

According to claim 4, a hybrid fiber cord having a dry heat shrinkage rate of 1.5 to 2.5%.

Claim 6

The first step of producing a nylon filament by twisting a nylon filament;

The second step of producing an aramid twisted yarn by twisting aramid filaments;

The third step of producing a double twisted yarn by twisting the nylon twisted yarn and the aramid twisted yarn together in the same structure, characterized in that the same number of twists is applied when performing the twisting of the first and second steps and the twisting of the third step.

Claim 7

A method for manufacturing a hybrid fiber cord, characterized in that, according to claim 6, the first to third steps are performed simultaneously and continuously.

Claim 8

A method for manufacturing a hybrid fiber cord, characterized in that according to claim 6, the method further comprises: a step of immersing the compound yarn in an adhesive solution;

a step of drying the compound yarn impregnated with the adhesive solution by the immersion process;

and a step of heat-treating the dried compound yarn.

Claim 9

According to claim 8, a method for manufacturing a hybrid fiber cord, characterized in that the adhesive solution comprises a resorcinol-formaldehyde-latex (RFL) adhesive.

IV. Invalidity Grounds of the Patent in This Case

(i) The invention described in claims 1 to 6, 8 and 9 of the patent in this case lacks novelty or progressiveness due to prior invention 1 published before the filing date, and thus violates Article 29, Paragraph 1, Subparagraph 2 or Article 29, Paragraph 2 of the Patent Act.

(ii) The invention described in claims 1 to 6, 8 and 9 of the patent in this case lacks novelty or progressiveness due to prior invention 2 published before the filing date, and thus violates Article 29, Paragraph 1, Subparagraph 2 or Article 29, Paragraph 2 of the Patent Act.

(iii) The invention described in claims 1 to 6, 8 and 9 of the patent in this case lacks novelty or progressiveness due to prior invention 3 published before the filing date, and thus violates Article 29, Paragraph 1, Subparagraph 2 or Article 29, Paragraph 2 of the Patent Act.

(iv) The invention described in claims 1, 3, and 6 to 8 of this patent lacks novelty or progressiveness due to prior invention 4 published prior to the filing date, and thus violates Article 29, Paragraph 1, Subparagraph 2 or Article 29, Paragraph 2 of the Patent Act.

(v) The invention described in claims 2, 4, 5, and 9 of this patent lacks progressiveness due to prior invention 4 or the combination of prior inventions 4 and 5 published prior to the filing date, and thus violates Article 29, Paragraph 2 of the Patent Act.

(vi) The invention described in claim 7 of this patent lacks progressiveness due to the combination of prior inventions 1 and 5, the combination of prior inventions 2 and 5, or the combination of prior inventions 3 and 5 published prior to the filing date, and thus violates Article 29, Paragraph 2 of the Patent Act.

(vii) The invention described in claim 7 of this patent lacks novelty due to the combination of prior inventions 1 and 7, the combination of prior inventions 2 and 7, or the combination of prior inventions 3 and 7 that were published prior to the filing date, and thus violates Article 29, Paragraph 2 of the Patent Act.

(viii) Claims 1 to 5 of this patent are not supported by the description of the invention of this patent, and therefore do not satisfy the description requirement (support requirement) of Article 42, Paragraph 4, Subparagraph 1 of the Patent Act.

(ix) Claims 1 to 9 of this patent do not clearly describe the composition of the invention, and therefore do not satisfy the description requirement (clarity requirement) of Article 42, Paragraph 4, Subparagraph 2 of the Patent Act.

Therefore, this patent should be invalidated pursuant to the provisions of Article 133, Paragraph 1, Subparagraph 1 of the Patent Act, which will be explained in detail below.

(x) Grounds for Invalidation Due to Lack of Novelty

1. The filing date of this patent (12/ 27/2012) Technical status at the time

The patent in this case relates to a hybrid fiber cord for tire cord (rubber reinforcing material of tire) containing nylon filaments and aramid filaments and a method for manufacturing the same (paragraphs [0001], [0011] and [0012] of Exhibit A No. 2).

As described in the [Background Technology] section of the specification of the patent in this case, even before the filing date of the patent in question, a hybrid structure tire fiber cord using both nylon and aramid yarns as a means for maintaining the stability and durability of tires had already been developed and put into use (paragraphs [0003] to [0007] of Exhibit A No. 2).

In addition, as an improvement measure for the problems of the prior art described in the [Background Technology] section of the patent specification of this case (i.e., problems occurring when the twist numbers of nylon yarn and aramid yarn are different, paragraphs [0007] to [0009] of Exhibit Gap No. 2), the technical configuration of twisting nylon yarn, aramid yarn, and their combined yarn with the same twist number was also already in general use at the time of the filing date of the patent of this case. Specifically, European Patent Application Publication No. 1 878 591 A2 (published on Jan. 16, 2008; Exhibit A No. 9; corresponding to prior invention 6), U.S. Patent Publication No. 3,977,172 (published on Aug. 31, 1976; Exhibit A No. 5; corresponding to prior invention 2), and U.S. Patent Publication No. 6,533,012 (patent date: Mar. 18, 2023; Exhibit A No. 7; corresponding to prior invention 4), which were published prior to the filing date of the patent in this case, teach a technique of applying the same number of twists to nylon yarn, aramid yarn, and a plied yarn thereof in order to manufacture a tire cord that is easy to manufacture and has good flexibility and fatigue resistance.

[Paragraph [0012] of Exhibit A No. 9]According to an advantageous embodiment of the present invention, the hybrid cord is symmetrically constructed. That is, the initial twists of the first and second yarns are substantially the same with a maximum error of 7%, both yarns are twisted in the Z-direction and the cords are twisted together in the S-direction and the final twists are substantially the same as the initial twists. The initial and final twists are 380 to 500 T/m. Of course, both yarns can be twisted in the S-direction and the cords can be twisted in the Z-direction. In this way, a cord which is particularly easy to manufacture and which has excellent flexibility and fatigue resistance is obtained.

Paragraph [0016] In order to obtain a cord that is as uniform as possible, which can be manufactured well and which has good residual strength after fatigue, the difference in the (twist) between the high modulus yarn and the low modulus yarn should be selected as small as possible. A hybrid cord made of 840 dtex aramid yarn and 940 dtex nylon yarn has been shown to be particularly advantageous due to its excellent residual strength in fatigue and at the same time being inexpensive.

Exhibit A No. 5, Column 1, Lines 34 to 52 According to the present invention, the cord is formed by cabling together a continuous filament PPD-T yarn (twisted yams) and a continuous filament nylon or polyester yarn. The PPD-T yarns are used in a ratio of 1 or 2 yarns per 1 nylon or polyester yarn. It is preferred that each of the twisted yarn strands has a denier in the range of 500 to 3000. As is well known in the art, the sizes of the strands should be approximately equal in order to obtain a balanced cord. Each strand is twisted in the same direction and the combined strands are twisted approximately the same amount in the opposite direction, providing a twist factor in the range of 6 to 10. It has been found that the cabled yarn has a much lower disk fatigue loss than would be expected from the components that make up the cabled yarn. In addition, the cable yarn exhibits good shrinkage, suitable for preventing wavy cords and loose bead turn-ups in bias-type tires.
Exhibit A No. 7, Column 467 to Column 518 In order to make the reinforcing material of the present invention, an overtwist of the number of turns per meter indicated by Z is applied to each of the basic fibers constituting the final reinforcing material in the first step. Then, the twist is simultaneously applied to all the fibers so that they are overtwisted in the opposite direction with an overtwist of the number of turns per meter indicated by S. The twist S value (numbers per meter) of the yarn of the present invention is such that the twist coefficient is greater than 2500 and less than 7000. Ti is the coefficient of high modulus fibers (indicated by tex) introduced into the yarn, and n is the total number of fibers contained in the yarn. Preferably, the overtwist (numbers per meter) of the basic fiber Z is such that Z/S=1.

In summary, it can be seen that those skilled in the art in the field of composite fibers for tire cords were already aware of the problem that this patent was attempting to solve (deterioration of productivity and properties of hybrid fiber cords due to different twist counts of the lower yarns), and that they had already been using nylon and aramid fibers with the same twist count as a means of solving the above problem prior to the filing date of this patent.

2. Disclosure of Prior Art 1 to 6

(a) Prior Invention 1 (Exhibit A 4: Japanese Patent Laid-Open No. 2009-68549)

Prior Invention 1, which was published on April 2, 2009, prior to the filing date of this patent (December 27, 2012), relates to a "large-diameter rubber hose", and the contents related to the grounds for invalidation of this patent are as follows.

[Abstract]

[Task] To provide a large-diameter rubber hose in which the adhesive strength between the rubber layer and the reinforcing layer is maintained even after long-term vulcanization of 500 to 1,000 minutes, the rubber layer and the reinforcing layer do not peel off during use, and also in which the change in hose diameter due to fluid pressure is small even when transporting fluid, and which has excellent durability and dimensional stability.

[Solution] A large-diameter rubber hose formed using vulcanized rubber reinforced by compositely combining fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord are composed of composite fibers of aramid fiber and nylon fiber.

[Claim 1] A large-diameter rubber hose formed using vulcanized rubber reinforced by composite fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord is composed of composite fibers of aramid fiber and nylon fiber.

[Claim 6] A large-diameter rubber hose, according to any one of claims 1 to 5, wherein the composite fibers are each formed by twisting aramid fibers and nylon fibers, and have a twist coefficient of 1440 to 2400.

[Claim 7] A large-diameter rubber hose, according to any one of claims 1 to 6, wherein the composite fibers are each formed by twisting aramid fibers and nylon fibers, and the number of twists is 0.5 to 1 times the number of twists.

[0018] In the present invention, the aramid fiber and the nylon fiber are composited to form an aramid/nylon composite fiber cord and a composite fiber fabric. The composite fiber cord is obtained by individually twisting a plurality of aramid fibers and nylon fibers and twisting them in a predetermined number, and the composite fiber fabric is obtained by using the composite fiber cord to make a fabric according to a conventional method.

[0020] In addition, it is preferable that the ratio of the fineness of the aramid fiber to the fineness of the entire aramid/nylon composite fiber cord (the fineness of the aramid fiber/the total fineness of the entire composite fiber X 100 (%)) is usually 35 to 80%, and particularly 44 to 71%. When the fineness ratio is less than 35%, there is a concern that a decrease in strength or an increase in creep may occur, and when it exceeds 80%, there is a concern that a decrease in the bending fatigue resistance of the hose may occur.

[0023] Also, the number of times of the lowering is usually the same as the number of times of the uppering, but it does not necessarily have to be the same, and can be appropriately determined according to the required characteristics of the composite fiber. For example, by reducing the number of times of the lowering of the nylon fiber relative to the number of times of the uppering, the elongation of the entire composite fiber can be greatly increased. In the present invention, the number of times of the lowering is preferably in the range of 0.5 to 1 times the number of times of the uppering.

[0031] Before covering both sides of the composite fiber fabric and/or the composite fiber cord with adhesive rubber as described above, the method is not particularly limited, but in the present invention, a method of immersing the composite fiber fabric and/or the composite fiber cord in an adhesive, drying, and heat-treating can be adopted. For example, as an adhesive-heat treatment process, a method of immersing, drying, and heat-treating in a solution of an epoxy compound (such as Denacol EX313, EX314, or EX421 manufactured by Nagase Sangyo Co., Ltd.) in bath 1 according to a conventional method, and then similarly immersing, drying, and heat-treating in an RFL solution (resorcin, formalin, or latex solution) in bath 2 to attach the adhesive can be suitably used.

[0034]

(1) Strength (N/unit) and elongation (%)

In accordance with JIS L1017, a test was conducted on one fiber cord under the conditions of a gripping interval of 25 cm and a tensile speed of 30 cm/min, and the strength and elongation at break were measured.

(2) Dry heat shrinkage (%)

In accordance with JIS L1017 (Method B), the fiber cord whose yarn length was accurately measured was left in a dryer at a set temperature of 180°C for 30 minutes, then taken out of the dryer and left for 30 minutes, and the yarn length was measured to calculate the dry shrinkage rate.

(3) Strength (g/d)

The strength value measured in (1) was converted from N to g, and calculated by dividing it by the total denier of the fiber cord (0.9d (denier) = 1.0dt (decitex)). (omitted)

[0036] [Table 1]

		Fiber Material						Aramid Fiber Denier Ratio (%)	Total Denier (dt)	Twist Count (turns/10cm)				Twist Multiplier	Warp Thread Count (pieces/5cm)
		Aramid Fiber		N66		PET				S-twist	Z-twist				
		(dt)	(pcs)	(dt)	(pcs)	(dt)	(pcs)				Aramid Fiber	N66	PET		
Comparative Example	1			1400	2			0	2800	39		39		1958	50
	2					1670	2	0	3340	39			39	2138	50
Example	1	1670	1	1400	1			54.4	3070	**36**	**36**	**36**		1892	50
	2	1670	1	1400	1			54.4	3070	**31**	**31**	**31**		1629	50
	3	1670	1	1400	1			54.4	3070	31	31	23		1629	50
	4	1670	1	2100	1			44.3	3770	**32**	**32**	**32**		1864	50
	5	1670	1	1400	2			37.4	4470	**30**	**30**	**30**		1903	50
	6	1670	2	940	1			78.0	4280	**30**	**30**	**30**		1862	40
	7	1670	2	1400	1			70.5	4740	**29**	**29**	**29**		1894	40
	8	1670	2	1400	1			70.5	4740	**36**	**36**	**36**		2351	40
	9	1670	2	2100				61.4	5440	**27**	**27**	**27**		1889	40
Comparative Example	3	1670	2		2			100	3340	26	26			1426	50
	4	1670	1	2100				28.4	5870	26	26	26		1890	40
	5	1670	1		1	1670	1	50.0	3340	39	39		30	2138	50
	6			1400		1670	1	0	3070	36		36	36	1892	50

[0037] [Table 2]

		Characteristics of Adhesive Heat Treatment Yarns					Characteristics After Vulcanization				
		Strength (N/piece)	Elongation at Break (%)	Dry Heat Shrinkage (%)	Tenacity (g/d)	Creep (%)	Strength Retention Rate After Flexing	Adhesion (Peel Test)			Strength Retention Rate (%)
								Adhesion Strength (N/25mm)		Adhesion Strength Retention Rate (%)	
								30분	1440분		
Comparative Example	1	216	21.0	5.8	8.7	4.8	96	295	300	102	98
	2	216	17.7	6.1	7.3	1.9	87	275	100	36	49
Example	1	325	10.5	2.5	12.0	0.5	90	320	310	97	90
	2	326	8.5	2.4	12.0	0.5	88	310	310	100	89
	3	328	10.0	2.6	12.1	0.6	91	310	300	97	87
	4	364	10.7	3.0	10.9	0.6	91	330	330	100	90
	5	390	11.5	3.2	9.9	1.0	90	320	300	94	93
	6	556	7.0	2.0	14.7	0.5	90	350	330	94	87
	7	581	8.6	2.1	13.9	0.4	90	340	340	100	87
	8	539	8.6	2.1	12.9	0.5	94	330	340	103	89
	9	615	8.8	2.0	12.8	0.5	92	360	350	97	88
Comparative Example	3	523	5.2	0.0	17.7	0.2	39	320	300	94	85
	4	462	12.0	4.0	8.9	1.6	89	340	320	94	92
	5	319	9.5	3.1	10.8	0.5	82	310	210	68	71
	6	206	17.5	6.0	7.6	3.1	90	320	220	69	63

b. Prior Art 2 (Exhibit A No. 5: U.S. Patent Publication No. 3,977,172)

Prior Art 2, which was registered with the U.S. Patent Office on August 31, 1976, before the filing date of this patent, relates to "Reinforced Cord," and the content related to the grounds for invalidation of this patent is excerpted as follows.

[Abstract] A cord useful for mechanical rubber products (e.g., tires, V-belts, conveyor belts) composed of twisted yarn of poly(p-phenylene terephthalamide) continuous filaments and nylon or polyester continuous filaments.
[Column 1, lines 23 to 31] This invention is an improved cord for mechanical rubber products comprising one or two ends (also called plies) of continuous filament poly(p-phenylene terephthalamide) (hereinafter PPD-T) yarn and one end of continuous filament nylon or polyester (for example, polyethylene terephthalate) yarn. Each end has a denier of 500 to 3000, and the cord has a twist multiplier in the range of about 6 to 10.
[Column 1, lines 34 to 52] According to the present invention, the cord is formed by cabling together twisted yarns of continuous filament PPD-T and twisted yarns of continuous filament nylon or polyester. The PPD-T yarn is used in a ratio of 1 or 2 ends per 1 end of nylon or polyester yarn. Each of the twisted yarn ends preferably has a denier in the range of 500 to 3000. As is well known in the art, the size of the ends should be nearly the same to obtain a balanced cord. Each end is twisted in the same direction and the combined ends are twisted in the opposite direction by nearly the same amount to provide a twist multiplier in the range between 6 and 10. The cabled yarn has been found to have a much lower disc fatigue loss than would be expected from the components that make up the cabled yarn. Also, the cabled yarn exhibits good shrinkage, which is appropriate for preventing wavy cords and loose bead turn-ups in bias-type tires.
[Column 2, lines 5 to 7] Cord characteristics were measured by A.S.T.M. test number D-885. Shrinkage was measured after exposure at 160°C for 15 minutes.
[Column 2, lines 21 to 26] Tire cord (A) was manufactured with three ends of PPD-T yarn (each 1500 denier). A second tire cord (B) was manufactured with two ends of PPD-T yarn (each 1500 denier) and one end of nylon yarn (1260 denier). The cords were made, dipped, cured in rubber blocks, and tested for disc fatigue.

[Column 2, lines 34 to 48] Table 1

Cord	A	B
Twist, Ply × Cord	8.8 × 8.8	8.8 × 8.8
Dipped Cord*		
Tenacity – gpd	18.3	13.6
Breaking Elongation - %	6.7	7.5
Modulus - %	221	137
Shrinkage - %	0.14 growth	1.24
Denier **	4829	4621
Disc Fatigue		
Control Breaking Strength	188.3	133.9
Breaking Strength After Fatigue	165.3	130.5
% Loss	12.2	2.6
Twist Multiplier	8.4	8.2

*Dipped in epoxy adhesive and dried and processed with 7 lbs tension for 1 minute at 475°F, then dipped in resorcinol-formaldehyde latex, dried and processed with 2 lbs tension at 475°F.
**Adjusted by dip pick-up.

c. Prior Art 3 (Exhibit A No. 6: Japan Published Patent Publication Sho 61-71204)

Prior Art 3, published on April 12, 1986, before the filing date of this patent, relates to "Pneumatic Radial Tire Carcass Ply," and the content related to the grounds for invalidation of this patent is excerpted as follows.

[Claim 1] A pneumatic radial tire carcass ply characterized by embedding a cord having a strength of 8.5g/d or more, after applying an adhesive by conventional method followed by heat treatment at high temperature (typically 230-260°C), in rubber having a dynamic modulus in the range of 3×10^7-10×10^7dyn/cm^2 when measured under conditions of 30°C, 50Hz, 1% deformation, wherein the cord is formed by: applying a Z-twist in the range of 0.40-0.60 for the twist coefficient NT given by formula (1) below to filament bundles of polyester or nylon having a strength of 7g/d or more; adding a Z-twist in the same direction as the Z-twist in the filament bundles of polyester or nylon within the limit expressed by formula (3) below for the twist coefficient NT2 given by formula (2) below to filament bundles of all-aromatic polyamide having a strength of 12g/d or more; and using 1-3 filament bundles of polyester or nylon and 1-4 filament bundles of all-aromatic polyamide, applying an S-twist in the opposite direction to the Z-twist within the limit of formula (5) for the twist coefficient NT3 given by formula (4) below.

[Claim 3] The ply as described in claim 1 or 2, wherein the denier ratio of polyester or nylon to all-aromatic polyamide in the embedded cord is in the range of 15 to 85%.
[Page 4, upper left, lines 6 to 15] The purpose of this invention is to approximate the twist (Z-twist) of polyester or nylon filament bundles and the twist (Z-twist) of aramid filament bundles to utilize the excellent creep properties of aramid as a cord material for radial tires, and to optimize the twist range and approximate the aramid filament twist and cord twist (S-twist) to improve flex fatigue resistance. It was decided to express this in terms of twist coefficient, taking into account the denier of the cord used here and the twisting state of the filaments.
[Page 4, lower left, lines 3 to 7] Next, regarding the twist coefficient, it is basically preferable that the twist coefficient (Z-twist) of polyester or nylon filaments, the twist coefficient (Z-twist) of aramid, and the twist coefficient of their combination cords approximate each other.
[Page 5, upper right, lines 7 to 13] Next, for the heat-treated cord, Z-twist was applied to each filament bundle as described earlier, and the cord was made by adding S-twist to the Z-twisted yarn bundles, then a two-bath treatment was performed with an epoxy (isocyanate is also acceptable) compound/RFL dipping solution in the range of 160-240°C, and the following various physical properties were measured.
[Page 6, bottom]

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Comparative Example	Comparative Example	Example	Example	Comparative Example	Comparative Example	Comparative Example	Comparative Example	Comparative Example	Comparative Example	Comparative Example	Example	Comparative Example	Comparative Example
Polyester Characteristics	Intrinsic Viscosity (IV)	0.89	-	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	-	-	-
	Terminal COOH Number (equivalent/ton)	20	-	20	20	20	20	20	20	20	20	20	-	-	-
Tenacity (g/d)	PET (1500 denier)	9	-	9	9	9	9	9	9	9	9	9	-	-	-
	Nylon (1260 denier)	-	-	-	-	-	-	-	-	-	-	-	9.5	9.5	9.5
	Aramid (1500 denier)	-	17	17	17	17	17	17	17	17	17	17	17	17	17
Z-twist Coefficient	PET NT1 (twist number)	0.49 (40)	-	0.49 (40)	0.48 (38)	0.88 (51)	0.32 (26)	0.49 (40)	0.49 (40)	0.49 (40)	0.49 (40)	0.49 (40)	-	-	-
	Nylon NT1 (twist number)	-	-	-	-	-	-	-	-	-	-	-	0.47 (40)	0.31 (28)	0.61 (52)
	Aramid NT2 (twist number)	-	0.48 (40)	0.48 (40)	0.51 (42)	0.55 (48)	0.31 (28)	0.89 (82)	0.60 (60)	0.48 (40)	0.48 (40)	0.48 (40)	0.48 (40)	0.31 (28)	0.48 (40)
Cord Denier	PET or Nylon/Aramid	1500/2/-	1500/2	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500	1260/1500	1260/1500	1260/1500
S-twist Coefficient	Cord NT3 (twist number)	0.49 (40)	0.48 (40)	0.48 (40)	0.51 (42)	0.55 (48)	0.32 (26)	0.41 (34)	0.49 (41)	0.36 (30)	0.48 (40)	0.48 (40)	0.48 (40)	0.30 (28)	0.48 (40)
Cord Characteristics After Heat Treatment	Tenacity (g/d)	7.1	14.6	9.1	6.9	8.2	12.7	10.8	6.2	6.5	9.1	9.1	9.8	12.3	9.2
	Strength (kg)	28.0	47.0	29.0	29.5	27.0	39.0	38.0	28.0	28.0	29.0	29.0	28.0	35.0	27.5
	Elongation at 6.75K (%)	5.5	2.0	8.8	8.8	4.1	3.0	3.5	4.5	4.0	3.8	3.8	5.5	4.2	5.0
	Breaking Elongation (%)	19.0	6.0	11.0	9.8	12.5	7.0	9.0	14.0	10.0	11.0	11.0	15.6	18.1	14.8
	Breaking Energy	2.19	1.41	1.8	1.45	1.89	1.37	1.49	1.82	1.4	1.6	1.6	2.19	2.29	2.04
	Fatigue Resistance (%)	4.2	0.8	3.6	3.8	3.9	2.2	3.0	4.1	4.0	3.5	3.5	4.5	3.9	4
		100	5	74	67	78	15	40	78	45	88	66	78	48	79

d. Prior Art 4 (Exhibit A No. 7: U.S. Patent Publication No. 6,533,012)

Prior Art 4, which was registered with the U.S. Patent Office on March 18, 2003, before the filing date of this patent, relates to "Tire with Circumferential Reinforcement," and the content related to the grounds for invalidation of this patent is excerpted as follows.

[Column 1, lines 37 and 38] This invention relates to a tire with improved running noise performance and high running speed resistance.
[Column 1, lines 56 to 67] "Plied yarn" or "folded yarn" refers to reinforcement formed by twisting and combining two or more fibers (single yarns). Generally, fibers formed from multifilament yarns are first individually twisted in one direction (twist direction S or Z) in the first twisting step, then twisted together in the opposite direction (twist direction Z or S respectively) in the process of the second twisting step. "Adhesive reinforcement" refers to reinforcement that has undergone appropriate coating treatment called sizing or adhesion, which can allow the reinforcement to adhere to the intended matrix after appropriate heat treatment.
[Column 2, line 63 to Column 3, line 5] Initial modulus means the secant modulus measured in the reinforcement under the same conditions as the preconditioning under 0.7% deformation after applying an initial tension equal to half the titer of each basic fiber (i.e., initial tension of 0.5 cN/tex). The initial length of the sample is 400mm and the speed is 200mm/min (or 50mm/min if the breaking elongation does not exceed 5%), and it is understood that the measurement of modulus and stress includes the average of 10 samples.
[Column 3, lines 6 to 13] This reinforcement consists of at least one fiber of at least one material having a high modulus (preferably aramid, but without departing from the spirit of the present invention, for example, paraphenylene benzobisoxazole (PBO)) and at least one material having a low modulus (preferably nylon, but also polyethylene terephthalate).

[Column 4, line 67 to Column 5, line 22] To make the reinforcement of this invention, overtwist of a number of turns per meter designated as Z is applied to each basic fiber constituting the final reinforcement in the first step. Then twisting is simultaneously applied to all fibers to be twisted together with overtwist of a number of turns per meter designated as S in the opposite direction. The twisting S value (number per meter) of the yarn of this invention is a value that makes the twist coefficient greater than 2500 and less than 7000. Ti is the titer of the high-modulus fiber (expressed in tex) introduced into the yarn, and n is the total number of fibers included in the yarn. Preferably, the overtwist Z of the basic fiber (number per meter) is such that Z/S≒1. The reinforcement can be sized in a series of steps by passing through state-of-the-art adhesive baths and heat-treated under tension to provide the required level of shrinkage potential (CS) to the reinforcement.
[Column 6, lines 60 to 66] Tire C includes a ply having a bimodulus reinforcement according to the present invention. The reinforcement is an adhesive yarn with an equivalent titer of 521 tex made of two identical aramid fibers of 167 tex individually twisted at 280 t/m and a nylon fiber of 140 tex twisted at 280 t/m, and these three fibers are simultaneously twisted again at 280 t/m in the opposite direction.

e. Prior Art 5 (Exhibit A No. 8: Republic of Korea Published Patent Publication No. 2006-0126101)

Prior Art 5, published on December 7, 2006, before the filing date of this patent, relates to "Hybrid Tire Cord and Manufacturing Method Thereof," and the content related to the grounds for invalidation of this patent is excerpted as follows.

[Abstract] The present invention relates to a hybrid tire cord and manufacturing method thereof, more particularly to a hybrid tire cord and manufacturing method thereof wherein nylon filament and aramid filament are plied together at a weight ratio of 10:90 to 90:10, and then 2-plied or 3-plied at a weight ratio of 2:1 to 1:2. The hybrid tire cord has uniform denier, improved physical properties such as tensile strength due to the use of aramid filament, and reduced production cost due to the use of nylon filament, making it preferably applicable as a cap ply for ultra-high performance automobile tires suitable for high-speed driving.
[Claim 1] A hybrid tire cord characterized by comprising nylon filament and aramid filament, wherein said nylon filament and aramid filament are included at a weight ratio of 10:90 to 90:10.

[Claim 4] The hybrid tire cord according to claim 1, characterized in that said nylon filament has a tensile strength of 8 g/d or more and a breaking elongation of 17% or more.
[Claim 5] The hybrid tire cord according to claim 1, characterized in that said aramid filament has a tensile strength of 20 g/d or more and a breaking elongation of 3.0% or more.
[Claim 6] The hybrid tire cord according to claim 1, characterized in that said hybrid tire cord has the following physical properties: (i) Tensile strength of 8.0 to 15.0 g/d measured by ASTM D885: (ii) Breaking elongation of 10 to 20 measured by ASTM D885: (iii) Dry heat shrinkage of 2.0 to 5.0 measured at 180°C.
[Claim 9] A method for manufacturing a hybrid tire cord comprising: a) manufacturing Z-twisted yarn by Z-twisting nylon filament and aramid filament, b) manufacturing S-twisted yarn after plying 2 to 3 strands of Z-twisted yarn, and c) dipping the S-twisted yarn in adhesive solution followed by drying and heat treatment.
[Page 5, lines 14 to 18] Furthermore, the appropriate twist count is selected for the hybrid tire cord to maximize the physical properties of each filament. Generally, when the twist count of a fiber is high, strength decreases but fatigue performance increases, and conversely, as the twist count decreases, strength increases while fatigue performance decreases. Since the two types of filaments in the hybrid tire cord of the present invention have similar structures, they exhibit similar strength and fatigue performance according to twisting, so the twist count of the hybrid tire cord follows the denier of nylon.
[Page 5, lines 20 to 22] For example, when the total denier of nylon filament is 840, the appropriate twist count is 470 TPM (Twist Per Meter), and when it is 1890 denier, 300 TPM is appropriate, so the hybrid tire cord according to the present invention has a twist count in the range of 300 to 500 TPM. At this time, it is preferable that the denier of the aramid filament also has the same or similar range as the nylon filament.
[Page 5, lines 50 to 54] The twisting process of the present invention shows a significant difference from the conventional method of performing the S-twisting process after manufacturing Z-twisted yarn with each filament. That is, if Z-twisted yarn is made with filaments of each material and then S-twisted yarn is manufactured with these two Z-twisted yarns, the ratio of the two materials must be maintained at 1:1, otherwise manufacturing becomes impossible due to twisting defects in the S-twisted yarn. Moreover, even if a 1:1 ratio is maintained, when materials with clearly different strength and modulus are used, the possibility of twisting defects increases again.

[Page 6, lines 1 to 6] However, in the present invention, by going through a plying process before or simultaneously with the Z-twisting process to ply nylon filament and aramid filament and then performing the Z-twisting process, or by performing the Z-twisting process simultaneously with plying, the Z-twisted yarn obtained after the Z-twisting process has the same denier. Accordingly, the S-twisted yarn obtained by performing the S-twisting process with the Z-twisted yarn not only has the same denier but also has identical physical properties for each S-twisted yarn, resulting in no twisting defects. As a result, the physical properties such as strength and modulus of the final hybrid tire cord are greatly improved, and productivity is increased as twisting defects rarely occur. Moreover, by using this method, the final tire cord can be easily manufactured by adjusting the ratio according to the physical property level required by the final tire.

[Page 6, lines 45 to 51] Nylon 66 filament and p-aramid (p-aramid, Kevlar) filament having the physical properties shown in Table 1 below were passed through guides, plied together, and then Z-twisted to manufacture Z-twisted yarn.
Two strands of the Z-twisted yarn were subjected to an S-twisting process with a twist count of 360 TPM to manufacture S-twisted yarn.
The obtained S-twisted yarn was passed through an RFL adhesive bath, then dried and heat-treated for 60 seconds each at 150°C and 240°C to manufacture the hybrid tire cord.

[Page 7, top] [Table 1]

Category		Example 1	Example 2	Example 3	Example 4
Nylon/p-aramid (weight %)		50/50	60/40	40/60	85/15
Twisting Method		Plying before Z-twisting	Plying before Z-twisting	Plying before Z-twisting	Plying before Z-twisting
Nylon Filament	Tensile Strength	9.1	9.1	9.1	9.1
	Breaking Elongation	20.5	20.5	20.5	20.5
p-aramid Filament	Tensile Strength	21	21	21	21
	Breaking Elongation	3.5	3.5	3.5	3.5
Twist Count (TPM)		360	360	360	360

f. Prior Art 6 (Exhibit A No. 9: European Patent Application Publication No. 1 878 591 A2)

Prior Art 6, published on January 16, 2008, before the filing date of this patent, relates to "Pneumatic Vehicle Tire with Layer Having Rigid Supports Embedded in Rubber Compound and Belt Bandage," and the content related to the grounds for invalidation of this patent is excerpted as follows.

[Claim 1] A layer including reinforcement in an unvulcanized rubber compound for a belt bandage of a pneumatic vehicle tire, wherein the strength members in the layer are essentially parallel to each other and are hybrid cords made of a first twisted yarn having a high elastic modulus of at least 25000 N/mm2 and a second twisted yarn having a low elastic modulus of 100 or less, at least 15000 N/mm2, with ends twisted and stacked together, wherein the yarn having a high elastic modulus has a fineness of < 840 dtex, and the yarn having a low elastic modulus has a fineness of ≤ 940 dtex.
[Claim 4] The layer according to any one of Claims 1 to 3, characterized in that the yarn having a high elastic modulus is an aramid yarn.
[Claim 5] The sheet according to any one of Claims 1 to 3, characterized in that the yarn having a low elastic modulus is a nylon yarn.
[0012] According to an advantageous embodiment of the present invention, the hybrid cord is configured symmetrically. That is, the initial twist count of the first and second yarns is substantially identical with a maximum error of 7%, both yarns are twisted in the Z-direction, the cord is twisted together in the S-direction, and the final twist count is substantially the same as the initial twist count. The initial and final twist counts are 380 to 500 T/m. Of course, both yarns can be twisted in the S-direction and the cord can be twisted in the Z-direction. In this way, a cord that is particularly easy to manufacture and has excellent flexibility and fatigue resistance is obtained.
[0016] In order to obtain a cord that is as uniform as possible, can be well manufactured, and has good residual strength after fatigue, the difference in (twist) count between the high-modulus yarn and the low-modulus yarn should be selected to be as small as possible. A hybrid cord made of 840 dtex aramid yarn and 940 dtex nylon yarn has proven to be particularly advantageous as it has excellent residual strength during fatigue while being inexpensive.

g. Prior Art 7 (Exhibit A No. 10: U.S. Patent Application Publication No. 2003/0200739)

Prior Art 7, published on October 30, 2003, before the filing date of this patent, relates to "Apparatus and Method for Making Hybrid Cord," and the content related to the grounds for invalidation of this patent is excerpted as follows.

Paragraph [0002] This invention relates to an apparatus for manufacturing cord structures for use in reinforcing pneumatic tires, hoses, belts, and other articles generally known as mechanical rubber products. The invention also relates to a method of operating such equipment to form hybrid yarns.
Paragraph [0006] Twenty years ago, ring twisters were the conventional equipment used to first twist yarn filaments and then twist these twisted yarns (2 or 3) together to form a cord. Ring twisters performed two operations, namely flying (yarn twisting) and cabling (twisted yarn twisting). Then in the early 1990s, commercially available cabling machines entered the market, twisting two yarn filaments together to form a cord in a single operation. Cabling machines became more widespread because they eliminated one step in the ring twister process. Three-filament cords are still made with ring twister devices.
Paragraph [0021] The direct cabling system of the present invention functions with various types of yarns including fiberglass, aramid, nylon, polyester, and rayon.

3. Lack of Novelty and Inventive Step of the Patent in Suit

a. Claims 1 to 6, 8, and 9: Lack of Novelty or Inventive Step by Prior Art 1

(1) Lack of Novelty or Inventive Step of Claims 1 to 3 regarding Hybrid Fiber Cord

Claims 1 to 3 of the patent in suit relate to a hybrid fiber cord comprising a nylon Z-twisted yarn having a first twist count and an aramid Z-twisted yarn having a second twist count, wherein the first twist count and the second twist count are identical, and the nylon Z-twisted yarn and the aramid Z-twisted yarn are S-twisted together with the same twist count as the first and second twist counts in the same structure.

Meanwhile, Prior Art 1 discloses a composite fiber formed by S-twisting Z-twisted aramid fiber and nylon fiber, and teaches a configuration of S-twisting aramid fiber and nylon fiber having the same twist count with the same twist count (Exhibit A No. 4 Claims 1, 6, 7 and Table 1).

Below, we will compare each component of Claims 1 to 3 of the patent in suit with the disclosure of Prior Art 1.

[Table 1]

The Patent in Suit	Prior Art 1 (Exhibit A No. 4)
[Claim 1] Comprising a nylon Z-twisted yarn having a first twist count and an aramid Z-twisted yarn having a second twist count,	Fiber fabric and/or fiber cord consists of composite fiber of aramid fiber and nylon fiber (Claim 1)
wherein the first twist count and the second twist count are identical,	In fiber cords of Examples 1, 2, and 4 to 9, aramid fiber and nylon fiber (N66) have the same twist count (paragraph [0036], [Table 1])
and the nylon Z-twisted yarn and the aramid Z-twisted yarn are S-twisted together with the same twist count as the first and second twist counts in the same structure,	Composite fiber is formed by S-twisting Z-twisted aramid fiber and nylon fiber, and the Z-twist count is 0.5-1 times the S-twist count (Claim 7) In fiber cords of Examples 1, 2, and 4 to 9, the Z-twist count and S-twist count are identical (paragraph [0036] and [Table 1])
hybrid fiber cord.	composite fiber cords ([0018]).
[Claim 2] According to Claim 1, hybrid fiber cord characterized in that the first and second twist counts are 300 to 500 TPM.	In fiber cords of Examples 1, 2, and 4 to 9, the Z-twist count is 27 to 36 turns/10cm (when converted, 270 to 360 TPM) (paragraph [0036] and [Table 1]).

[Claim 3] According to Claim 1, hybrid fiber cord characterized in that the weight ratio of the nylon Z-twisted yarn and the aramid Z-twisted yarn is 20:80 to 80:20.	It is preferable to make the ratio of the denier of the aramid fiber to the total denier of the aramid/nylon composite fiber cord typically 35-80% (paragraph [0020]).

As confirmed from the above [Table 1], all components described in Claims 1 to 3 of the patent in suit are disclosed as they are in Prior Art 1, so these claims lack novelty by Prior Art 1. Or, since a person of ordinary skill in the art could easily derive the invention of Claims 1 to 3 of the patent in suit from the disclosure of Prior Art 1, these claims lack inventive step by Prior Art 1.

(2) Lack of Novelty or Inventive Step of Claims 4 and 5 regarding Hybrid Fiber Cord

Claims 4 and 5 of the patent in suit are dependent claims of Claim 1, stating that the hybrid fiber cord has a breaking strength and breaking elongation measured by ASTM D885 of 8.0 to 15.0 g/d and 7 to 15%, respectively, and a strength retention rate after disk fatigue test conducted according to JIS-L 1017 method of the Japanese Standards Association of 80% or more (Claim 4), or has a dry heat shrinkage of 1.5 to 2.5% (Claim 5).

Regarding the physical properties stated in Claims 4 and 5, the specification of the patent in suit states that "the hybrid fiber cord of the present invention manufactured by the above method has a breaking strength of 8.0 to 15.0 g/d measured by ASTM D885,

a breaking elongation of 7 to 15%, and a dry heat shrinkage of 1.5 to 2.5% measured at an initial load of 0.01g/De' for 2 minutes at 180°C" (Exhibit A No. 2, paragraph [0060]), but does not explain or mention at all any technical means that should be separately selected to obtain these property values beyond the components described in Claim 1.

Therefore, the properties described in Claims 4 and 5 of the patent in suit are merely a simple statement of inherent characteristics of the hybrid fiber cord described in Claim 1.

Considering that the fiber cord disclosed in Prior Art 1 has the same configuration as the hybrid fiber cord described in Claim 1 of the patent in suit, if the fiber cord of Prior Art 1 is evaluated according to the measurement and evaluation method described in the specification of the patent in suit, the property values described in Claims 4 and 5 would naturally be obtained. Therefore, the invention described in Claims 4 and 5 lacks novelty or inventive step compared to Prior Art 1.

Furthermore, Prior Art 1 describes data on breaking strength and elongation, dry heat shrinkage rate, and strength retention rate after flexing of reinforcing fiber cord measured and evaluated according to JIS L1017 (Exhibit A No. 4, paragraphs [0034] to [0037] and [Table 2]). A specific comparison of the components of Claims 4 and 5 of the patent in suit with the disclosure of Prior Art 1 is as follows.

[Table 2]

<table>
<tr><td>The Patent in Suit</td><td>Prior Art 1 (Exhibit A No. 4)</td></tr>
<tr><td>[Claim 4]
According to Claim 1,
hybrid fiber cord characterized in that the breaking strength and breaking elongation measured by ASTM D885 are 8.0 to 15.0 g/d and 7 to 15%, respectively, and the strength retention rate after disk fatigue test conducted according to JIS-L 1017 method of the Japanese Standard Association (JSA) is 80% or more.</td><td rowspan="2">When measured according to JIS L1017, the fiber cords of Examples 1, 2, and 4 to 9 have a breaking strength of 9.9 to 14.7 g/d, a breaking elongation of 7.0 to 11.5%, a strength retention rate after flexing of 88 to 94%, and a dry heat shrinkage of 2.0 to 3.2% (paragraphs [0034] to [0036] and [Table 2])
[Table 2] Excerpt
<table>
<tr><td></td><td></td><td>Breaking Elongation (%)</td><td>Dry Heat Shrinkage (%)</td><td>Strength (g/d)</td><td>Strength Retention Rate After Flexing (%)</td></tr>
<tr><td rowspan="9">Example</td><td>1</td><td>10.5</td><td>2.5</td><td>12.0</td><td>90</td></tr>
<tr><td>2</td><td>8.5</td><td>2.4</td><td>12.0</td><td>88</td></tr>
<tr><td>3</td><td>10.0</td><td>2.6</td><td>12.1</td><td>91</td></tr>
<tr><td>4</td><td>10.7</td><td>3.0</td><td>10.9</td><td>91</td></tr>
<tr><td>5</td><td>11.5</td><td>3.2</td><td>9.9</td><td>90</td></tr>
<tr><td>6</td><td>7.0</td><td>2.0</td><td>14.7</td><td>90</td></tr>
<tr><td>7</td><td>8.6</td><td>2.1</td><td>13.9</td><td>90</td></tr>
<tr><td>8</td><td>8.6</td><td>2.1</td><td>12.9</td><td>94</td></tr>
<tr><td>9</td><td>8.8</td><td>2.0</td><td>12.8</td><td>92</td></tr>
</table></td></tr>
<tr><td>[Claim 5]
According to Claim 4,
hybrid fiber cord having a dry heat shrinkage of 1.5 to 2.5%.</td></tr>
</table>

As confirmed from the above [Table 2], the physical characteristics of the hybrid fiber cord described in Claims 4 and 5 of the patent in suit are substantially identical to the property values (breaking strength and elongation, dry heat shrinkage rate, and strength retention rate after flexing) of the fiber cord described in Prior Art 1. Therefore, these claims lack novelty or inventive step compared to Prior Art 1.

(3) Lack of Novelty or Inventive Step of Claims 6, 8, and 9 regarding Manufacturing Method of Hybrid Fiber Cord

Claims 6, 8, and 9 of the patent in suit relate to a method for manufacturing a hybrid fiber cord, including the steps of manufacturing nylon Z-twisted yarn and aramid Z-twisted yarn,

and manufacturing plied yarn by S-twisting the nylon Z-twisted yarn and the aramid Z-twisted yarn together in the same structure.

Meanwhile, Prior Art 1 discloses a method of manufacturing aramid/nylon composite fiber cord by S-twisting Z-twisted aramid fiber and nylon fiber (Exhibit A No. 4, paragraph [0018]).

A comparison of the components of Claims 6, 8, and 9 of the patent in suit with the disclosure of Prior Art 1 is shown in [Table 3] below.

[Table 3]

The Patent in Suit	Prior Art 1 (Exhibit A No. 4)
[Claim 6] A first step of manufacturing nylon Z-twisted yarn by Z-twisting nylon filament;	In this invention, aramid fiber and nylon fiber are combined to form an aramid/nylon composite fiber cord. The composite fiber cord is obtained by S-twisting a predetermined number of aramid fibers and nylon fibers that have been individually Z-twisted in multiple numbers (paragraph [0018]).
a second step of manufacturing aramid Z-twisted yarn by Z-twisting aramid filament; and	
a third step of manufacturing plied yarn by S-twisting the nylon Z-twisted yarn and the aramid Z-twisted yarn together in the same structure,	
wherein the method for manufacturing a hybrid fiber cord is characterized in that the same twist count is applied when performing the Z-twisting of the first and second steps and the S-twisting of the third step.	The Z-twist count is often the same as the S-twist count in common practice, and it is preferable that the Z-twist count is in the range of 0.5 to 1 times the S-twist count (paragraph [0031]). In the fiber cords of Examples 1, 2, and 4 to 9, the Z-twist count of aramid fiber and nylon fiber (N66) and the S-twist count are identical (paragraph [0036], [Table 1])

[Claim 8] According to Claim 6, a method for manufacturing a hybrid fiber cord further comprising: a step of immersing the plied yarn in an adhesive solution; a step of drying the plied yarn in which the adhesive solution is impregnated by the immersion process; and a step of heat-treating the dried plied yarn.	A method of immersing, drying, and heat-treating the composite fiber cord in an adhesive can be employed (paragraph [0031]).
[Claim 9] According to Claim 8, a method for manufacturing a hybrid fiber cord characterized in that the adhesive solution comprises a resorcinol-formaldehyde-latex (RFL) adhesive.	A method of attaching adhesive by immersing, drying, and heat-treating in an RFL solution (resorcinol, formalin, latex solution) can be suitably used (paragraph [0031]).

As described in the above [Table 3], all components described in Claims 6, 8, and 9 of the patent in suit are disclosed as they are in Prior Art 1, so these claims cannot be recognized as having novelty in light of Prior Art 1. Furthermore, since a person of ordinary skill in the art could easily derive the invention of Claims 6, 8, and 9 of the patent in suit from Prior Art 2, Claims 6, 8, and 9 cannot be recognized as having inventive step by Prior Art 2.

b. Claims 1 to 6, 8, and 9: Lack of Novelty or Inventive Step by Prior Art 2

(1) Lack of Novelty or Inventive Step of Claims 1 to 5 regarding Hybrid Fiber Cord

Prior Art 2 relates to a cord composed of twisted yarn of poly(p-phenylene terephthalamide) (hereinafter, PPD-T) continuous filaments and nylon continuous filaments,

and discloses a configuration applying the same twist count to filament twisted yarn and cord (Exhibit A No. 5 Abstract, Column 1 lines 41 to 46 and Table 1).

Meanwhile, the description of the invention of the patent in suit describes poly(p-phenylene terephthalamide) as an example of an aramid polymer compound (Exhibit A No. 2 paragraphs [0037] and [0038]). That is, PPD-T disclosed in Prior Art 2 is a sub-concept of aramid polymer and corresponds to the aramid component of the patent in suit.

A comparison of the components of Claims 1 to 5 of the patent in suit with the disclosure of Prior Art 2 is shown in [Table 4] below.

[Table 4]

The Patent in Suit	Prior Art 2 (Exhibit A No. 5)
[Claim 1] Comprising a nylon Z-twisted yarn having a first twist count and an aramid Z-twisted yarn having a second twist count,	Composed of twisted yarn of poly(p-phenylene terephthalamide) continuous filaments and nylon or polyester continuous filaments (Abstract)
wherein the first twist count and the second twist count are identical,	To obtain a balanced cord, the size of the strands should be nearly the same. Each strand is twisted in the same direction, and the combined strands are twisted in the opposite direction by nearly the same amount (Column 1, lines 41 to 45).[1)] In tire cord (B), the twist count of PPD-T yarn and nylon yarn is 8.8 tpi, and the twist count of the cord is also identical at 8.8 tpi (Table 1)
and the nylon Z-twisted yarn and the aramid Z-twisted yarn are S-twisted together with the same twist count as the first and second twist counts in the same structure,	
hybrid fiber cord.	Cord composed of PPD-T yarn and nylon yarn (Abstract and Column 1, lines 23 to 31)

1) As stated in Prior Art 2, if two strands with nearly the same size are twisted in the same direction with the same amount of twist, the two strands will eventually have the same structure with each other.

[Claim 2] According to Claim 1, hybrid fiber cord characterized in that the first and second twist counts are 300 to 500 TPM.	In tire cord (B), the twist count of PPD-T yarn and nylon yarn is 8.8 tpi (twists per inch) (Table 1) When converting units, this corresponds to 346 TPM
[Claim 3] According to Claim 1, hybrid fiber cord characterized in that the weight ratio of the nylon Z-twisted yarn and the aramid Z-twisted yarn is 20:80 to 80:20.	Tire cord (B) was manufactured with two strands of PPD-T yarn (each 1500 denier) and one strand of nylon yarn (1260 denier) (when calculated, the weight ratio of nylon yarn to PPD-T yarn in tire cord (B) corresponds to 30:70) (Column 2, lines 22 to 24).
[Claim 4] According to Claim 1, hybrid fiber cord characterized in that the breaking strength and breaking elongation measured by ASTM D885 are 8.0 to 15.0 g/d and 7 to 15%, respectively, and the strength retention rate after disk fatigue test conducted according to JIS-L 1017 method of the Japanese Standard Association (JSA) is 80% or more.	Cord characteristics were measured by A.S.T.M. test number D-885. Shrinkage was measured after exposure for 15 minutes at 160°C (Column 2, lines 5 to 7). Tire cord (B)'s breaking strength is 133.9 lbs (=60.7 kg), breaking elongation is 7.5%, breaking strength after disk fatigue is 130.5 lbs (=59.2 kg), shrinkage is 1.24%, and total denier is 4621 denier (Column 2, lines 5 to 7 and lines 34 to 48, Table 1) When calculated, the breaking strength of tire cord (B) corresponds to 13.1 g/d (=60.7 kg/4621d), and the strength retention rate after disk fatigue test corresponds to 97.4% (=130.5/133.9)
[Claim 5] According to Claim 4, hybrid fiber cord having a dry heat shrinkage of 1.5 to 2.5%.	

As confirmed from the above [Table 4], all components described in Claims 1 to 4 of the patent in suit are disclosed as they are in Prior Art 2, so these claims cannot be recognized as having novelty by Prior Art 2. Furthermore, since a person of ordinary skill in the art could easily derive the invention of Claims 1 to 4 of the patent in suit from Prior Art 2, Claims 1 to 4 cannot be recognized as having inventive step by Prior Art 2.

Meanwhile, there is a slight difference in that the hybrid fiber cord described in Claim 5 of the patent in suit has a dry heat shrinkage of 1.5 to 2.5%, while the shrinkage of tire cord (B) disclosed in Prior Art 2 is 1.24%. However, the specification of the patent in suit does not describe the technical significance of the lower limit value of 1.5% of the numerical range stated in Claim 5, and does not disclose at all any difference in effect inside and outside the lower limit value of 1.5%, so the lower limit value of 1.5% cannot be a component that guarantees inventive step.

Rather, the shrinkage of tire cord (B) disclosed by Prior Art 2 was measured after exposure for 15 minutes at 160°C, and its measurement conditions differ from the measurement and evaluation methods of the patent in suit. Therefore, if the dry heat shrinkage of tire cord (B) of Prior Art 2, which satisfies all the components described in Claim 1 of the patent in suit, is measured according to the measurement and evaluation method described in the specification of the patent in suit, it would satisfy the numerical range described in Claim 5.

Therefore, Claim 5 of the patent in suit cannot be recognized as having inventive step in light of Prior Art 2.

(2) Lack of Novelty or Inventive Step of Claims 6, 8, and 9 regarding Manufacturing Method of Hybrid Fiber Cord

Prior Art 2 discloses a method of forming a tire cord by cabling together twisted yarn of PPD-T and twisted yarn of nylon.

(Exhibit A No. 5, Column 1, lines 34 to 37).

A comparison of the components of Claims 6, 8, and 9 of the patent in suit with the disclosure of Prior Art 2 is shown in [Table 5] below.

[Table 5]

The Patent in Suit	Prior Art 2 (Exhibit A No. 5)
[Claim 6] A first step of manufacturing nylon Z-twisted yarn by Z-twisting nylon filament;	The cord is formed by cabling together twisted yarns of continuous filament PPD-T and twisted yarns of continuous filament nylon or polyester (Column 1, lines 34 to 36) To obtain a balanced cord, the size of the strands should be nearly the same. Each strand is twisted in the same direction, and the combined strands are twisted in the opposite direction by nearly the same amount (Column 1, lines 41 to 46) In tire cord (B), the twist count of PPD-T yarn and nylon yarn is 8.8 tpi, and the twist count of the cord is also identical at 8.8 tpi (Table 1)
a second step of manufacturing aramid Z-twisted yarn by Z-twisting aramid filament; and	
a third step of manufacturing plied yarn by S-twisting the nylon Z-twisted yarn and the aramid Z-twisted yarn together in the same structure,	
wherein the method for manufacturing a hybrid fiber cord is characterized in that the same twist count is applied when performing the Z-twisting of the first and second steps and the S-twisting of the third step.	

[Claim 8] According to Claim 6, a method for manufacturing a hybrid fiber cord further comprising: a step of immersing the plied yarn in an adhesive solution; a step of drying the plied yarn in which the adhesive solution is impregnated by the immersion process; and a step of heat-treating the dried plied yarn.	The dipped cord is dipped in epoxy adhesive and dried and processed with 7 lbs tension for 1 minute at 475°F, then dipped in resorcinol-formaldehyde latex, dried and processed with 2 lbs tension at 475°F (Column 2, lines 34 to 48)
[Claim 9] According to Claim 8, a method for manufacturing a hybrid fiber cord characterized in that the adhesive solution comprises a resorcinol-formaldehyde-latex (RFL) adhesive.	

As described in the above [Table 5], all components described in Claims 6, 8, and 9 of the patent in suit are disclosed as they are in Prior Art 2, so these claims cannot be recognized as having novelty or inventive step by Prior Art 2.

c. Claims 1 to 6, 8, and 9: Lack of Novelty or Inventive Step by Prior Art 3

(1) Lack of Novelty or Inventive Step of Claims 1 to 5 regarding Hybrid Fiber Cord

Prior Art 3 discloses a cord formed by S-twisting nylon filament Z-twisted yarn and all-aromatic polyamide (hereinafter, aramid) filament Z-twisted yarn, and states that it is preferable to approximate the twist of nylon filament and the twist of aramid filament, and to approximate the aramid filament twist and the cord twist.

(Exhibit A No. 6, Claim 1, Page 4, upper left, lines 6 to 15).

A comparison of the components of Claims 1 to 5 of the patent in suit with the disclosure of Prior Art 3 is shown in [Table 6] below.

[Table 6]

The Patent in Suit	Prior Art 3 (Exhibit A No. 6)
[Claim 1] A nylon Z-twisted yarn having a first twist count and an aramid Z-twisted yarn having a second twist count,	Nylon filament bundle Z-twist and aramid filament bundle Z-twist (Claim 1)
wherein the first twist count and the second twist count are identical,	The purpose of this invention is to approximate the twist (Z-twist) of nylon filament bundle and the twist (Z-twist) of aramid filament bundle, and to approximate the aramid filament twist and cord twist (S-twist) (Page 4, upper left, lines 6 to 13). In Example 12 cord, the Z-twist count of nylon, the Z-twist count of aramid, and the S-twist count of the cord are all identical at 40 turns/10cm (Table at the bottom of Page 6) Cord formed by S-twisting Z-twisted nylon filament bundle and Z-twisted all-aromatic filament bundle (Claim 1)
and the nylon Z-twisted yarn and the aramid Z-twisted yarn are S-twisted together with the same twist count as the first and second twist counts in the same structure,	
hybrid fiber cord.	Composite cord (Page 2, lower right, line 8)
[Claim 2] According to Claim 1, hybrid fiber cord characterized in that the first and second twist counts are 300 to 500 TPM.	Example 12 cord has a Z-twist count of nylon and a Z-twist count of aramid of 40 turns/cm (Page 6, bottom table) (When converting units, this corresponds to 400 TPM)

<table>
<tr><td>[Claim 3]
According to Claim 1,
hybrid fiber cord characterized in that the weight ratio of the nylon Z-twisted yarn and the aramid Z-twisted yarn is 20:80 to 80:20.</td><td>The denier ratio of nylon to all-aromatic polyamide in the embedded cord is in the range of 15 to 85% (Claim 3)</td></tr>
<tr><td>[Claim 4]
According to Claim 1,
hybrid fiber cord characterized in that the breaking strength and breaking elongation measured by ASTM D885 are 8.0 to 15.0 g/d and 7 to 15%, respectively, and the strength retention rate after disk fatigue test conducted according to JIS-L 1017 method of the Japanese Standard Association (JSA) is 80% or more,</td><td rowspan="2">When measured by a specified measurement method, Example 12 cord has a strength of 9.8g/d, breaking elongation of 15.6%, fatigue resistance of 78% (relative value), and thermal shrinkage of 4.5%
(Excerpt from table at the bottom of Page 6)
<table>
<tr><td></td><td></td><td>Example 12</td></tr>
<tr><td>Strength (g/d)</td><td>Nylon (1,260 denier)
Aramid (1,500 denier)</td><td>9.5
17</td></tr>
<tr><td>Z-twist Coefficient</td><td>Nylon NT1 (twist number)
Aramid NT2 (twist number)</td><td>0.47 (40)
0.48 (40)</td></tr>
<tr><td>Cord Denier</td><td>Nylon/Aramid</td><td>1260/1500</td></tr>
<tr><td>S-twist Coefficient</td><td>Cord NT3 (twist number)</td><td>0.48 (40)</td></tr>
<tr><td>Cord Characteristics After Heat Treatment</td><td>Strength (g/d)
Tensile Strength (kg)
Breaking Elongation (%)
Thermal Shrinkage (%)
Fatigue Resistance (%)</td><td>9.8
28.0
15.6
4.5
78</td></tr>
</table></td></tr>
<tr><td>[Claim 5]
According to Claim 4,
hybrid fiber cord having a dry heat shrinkage of 1.5 to 2.5%.</td></tr>
</table>

As described in the above [Table 6], all components described in Claims 1 to 3 of the patent in suit are substantially disclosed in Prior Art 3, so these claims cannot be recognized as having novelty or inventive step in light of Prior Art 3.

Meanwhile, the physical properties described in Claims 4 and 5 have some differences from Prior Art 3, but as mentioned earlier, the physical properties of Claims 4 and 5 have no special technical significance and can be easily derived by a person of ordinary skill in the art through simple repetitive experiments. For example, Prior Art 3 substantially discloses a fiber cord (Example 12 cord) identical to the hybrid fiber cord of Claim 1 of the patent in suit,

and if the strength, breaking elongation, fatigue resistance, and thermal shrinkage of Example 12 cord are measured using the measurement method described in the specification of the patent in suit, the physical property values described in Claims 4 and 5 would be derived.

Therefore, the invention described in Claims 4 and 5 of the patent in suit also cannot be recognized as having inventive step compared to Prior Art 3.

(2) Lack of Novelty or Inventive Step of Claims 6, 8, and 9 regarding Manufacturing Method of Hybrid Fiber Cord

Prior Art 3 discloses a method of manufacturing a composite cord by applying Z-twist to nylon filament bundles, applying Z-twist to all-aromatic polyamide filament bundles, and S-twisting them together (Exhibit A No. 6, Claim 1).

A comparison of the components of Claims 6, 8, and 9 of the patent in suit with the disclosure of Prior Art 3 is shown in [Table 7] below.

[Table 7]

The Patent in Suit	Prior Art 3 (Exhibit A No. 6)

[Claim 6] A first step of manufacturing nylon Z-twisted yarn by Z-twisting nylon filament;	While applying Z-twist to nylon filament bundles, adding Z-twist to all-aromatic polyamide filament bundles, and using them to perform S-twist in the opposite direction to the Z-twist (Claim 1)
a second step of manufacturing aramid Z-twisted yarn by Z-twisting aramid filament; and	
a third step of manufacturing plied yarn by S-twisting the nylon Z-twisted yarn and the aramid Z-twisted yarn together in the same structure,	
wherein the method for manufacturing a hybrid fiber cord is characterized in that the same twist count is applied when performing the Z-twisting of the first and second steps and the S-twisting of the third step.	The purpose of this invention is to approximate the twist (Z-twist) of nylon filament bundle and the twist (Z-twist) of aramid filament bundle, and to approximate the aramid filament twist and cord twist (S-twist) (Page 4, upper left, lines 6 to 13). In Example 12 cord, the Z-twist count of nylon, the Z-twist count of aramid, and the S-twist count of the cord are all identical at 40 turns/10cm
[Claim 8] According to Claim 6, a method for manufacturing a hybrid fiber cord further comprising: a step of immersing the plied yarn in an adhesive solution; a step of drying the plied yarn in which the adhesive solution is impregnated by the immersion process; and a step of heat-treating the dried plied yarn.	Going through heat treatment at high temperature (typically 230-260°C) after adhesive coating by a conventional method (Claim 1)
[Claim 9] According to Claim 8, a method for manufacturing a hybrid fiber cord characterized in that the adhesive solution comprises a resorcinol-formaldehyde-latex (RFL) adhesive.	The cord is treated in a two-bath process with an RFL dipping solution in the range of 160-240°C (Page 5, upper right, lines 7 to 13)

As described in the above [Table 7], all components described in Claims 6, 8, and 9 of the patent in suit are substantially disclosed in Prior Art 3,

so these claims cannot be recognized as having novelty or inventive step in light of Prior Art 3.

d. Claims 1, 3, and 6 to 8: Lack of Novelty or Inventive Step by Prior Art 4

(1) Lack of Novelty or Inventive Step of Claims 1 and 3 regarding Hybrid Fiber Cord

Prior Art 4 discloses fibers formed from multifilament yarns consisting of individually twisted aramid yarn and nylon yarn in one direction and then twisted together in the opposite direction (Exhibit A No. 7, Column 1, lines 56 to 67 and Column 3, lines 6 to 13).

A comparison of the components of Claims 1 and 3 of the patent in suit with the disclosure of Prior Art 4 is shown in [Table 8] below.

[Table 8]

The Patent in Suit	Prior Art 4 (Exhibit A No. 7)
[Claim 1] Comprising a nylon Z-twisted yarn having a first twist count and an aramid Z-twisted yarn having a second twist count,	Aramid fiber and nylon fiber individually twisted in one direction (twist direction S or Z) (Column 1, lines 56 to 63 and Column 6, lines 60 to 66)
wherein the first twist count and the second twist count are identical,	That reinforcement is an adhesive yarn with an equivalent titer of 521 tex made of two identical aramid fibers of 167 tex individually twisted at 280 t/m and nylon fibers of 140 tex twisted at 280 t/m, and these three fibers are simultaneously twisted again at 280 t/m in the opposite direction (Column 6, lines 61 to 66).[2)]
and the nylon Z-twisted yarn and the aramid Z-twisted yarn are S-twisted together with the same twist count as the first and second twist counts in the same structure,	

hybrid fiber cord.	Fibers formed from multifilament yarns (Column 1, lines 56 to 59)
[Claim 3] According to Claim 1, hybrid fiber cord characterized in that the weight ratio of the nylon Z-twisted yarn and the aramid Z-twisted yarn is 20:80 to 80:20.	The reinforcement of tire C is an adhesive yarn made of two aramid fibers of 167 tex and one nylon fiber of 140 tex (when converted, the weight ratio corresponds to 30:70) (Column 6, lines 60 to 66)

As described in the above [Table 8], all components described in Claims 1 and 3 of the patent in suit are substantially disclosed in Prior Art 4, so these claims cannot be recognized as having novelty or inventive step in light of Prior Art 4.

(2) Lack of Novelty or Inventive Step of Claims 6 to 8 regarding Manufacturing Method of Hybrid Fiber Cord

Prior Art 4 discloses manufacturing multifilament yarn by simultaneously twisting together aramid yarn and nylon yarn, which are individually twisted in one direction, in the opposite direction (Exhibit A No. 7, Column 1, lines 56 to 67 and Column 3, lines 6 to 13).

A comparison of the components of Claims 6 to 8 of the patent in suit with the disclosure of Prior Art 4 is shown in [Table 9] below.

2) As disclosed in Prior Art 4, if aramid fiber and nylon fiber are twisted simultaneously in one direction with one twist amount, the aramid fiber and nylon fiber will have the same structure.

[Table 9]

The Patent in Suit	Prior Art 4 (Exhibit A No. 7)
[Claim 6] A first step of manufacturing nylon Z-twisted yarn by Z-twisting nylon filament;	Fibers formed from multifilament yarns are first individually twisted in one direction (twist direction Z) in the first twisting step, then twisted together in the opposite direction (twist direction S) in the process of the second twisting step (Column 1, lines 56 to 63) The reinforcement is an adhesive yarn with an equivalent titer of 521 tex made of two identical aramid fibers of 167 tex individually twisted at 280 t/m and a nylon fiber of 140 tex twisted at 280 t/m, and these three fibers are simultaneously twisted again at 280 t/m in the opposite direction (Column 6, lines 60 to 66)
A second step of manufacturing aramid Z-twisted yarn by Z-twisting aramid filament; and	
a third step of manufacturing plied yarn by S-twisting the nylon Z-twisted yarn and the aramid Z-twisted yarn together in the same structure,	
wherein the method for manufacturing a hybrid fiber cord is characterized in that the same twist count is applied when performing the Z-twisting of the first and second steps and the S-twisting of the third step.	
[Claim 7] According to Claim 6, method for manufacturing a hybrid fiber cord characterized in that the first to third steps are performed continuously simultaneously.	Overtwist of a number of turns per meter designated as Z is applied to each basic fiber in the first step, and then twisting is simultaneously applied to all fibers to be twisted together with overtwist of a number of turns per meter designated as S in the opposite direction (Column 5, lines 1 to 6)
[Claim 8] According to Claim 6, method for manufacturing a hybrid fiber cord further comprising: a step of immersing the plied yarn in an adhesive solution; a step of drying the plied yarn in which the adhesive solution is impregnated by the immersion process; and a step of heat-treating the dried plied yarn.	"Adhesive reinforcement" refers to reinforcement that has undergone appropriate coating treatment called sizing or adhesion, which can allow the reinforcement to adhere to the intended matrix after appropriate heat treatment (Column 1, lines 64 to 67). The reinforcement can be sized in a series of steps by passing through state-of-the-art adhesive baths and heat-treated under tension to provide the required level of shrinkage potential (CS) to the reinforcement (Column 5, lines 18 to 22).

As described in the above [Table 9], all components described in Claims 6 to

8 of the patent in suit are disclosed as they are in Prior Art 4, so these claims cannot be recognized as having novelty or inventive step in light of Prior Art 4.

e. Claims 2, 4, 5, and 9: Lack of Inventive Step by Prior Art 4, or Combination of Prior Arts 4 and 5

(1) Lack of Inventive Step of Claim 2 regarding Hybrid Fiber Cord

Claim 2 of the patent in suit is a dependent claim of Claim 1, limiting the first twist count of the nylon Z-twisted yarn and the second twist count of the aramid Z-twisted yarn to a numerical range of 300 to 500 TPM.

However, the specification of the patent in suit does not state anything that can support that there is critical significance in the numerical range of the twist count, and in the examples, only twist counts of 300 TPM or 350 TPM are used (Exhibit A No. 2, [Table 1]).

In addition, the specification of the patent in suit states that "the twist count of the nylon Z-twisted yarn (110) and the aramid Z-twisted yarn (120) is determined based on the denier of nylon" and explains as follows (Exhibit A No. 2, paragraph [0045]):

[0046] The Nylon Ply twist Yarn (110) and Aramid Ply twist Yarn (120) of the hybrid fiber cord according to this invention have the same twist number in the range of 300 to 500 TPM. For example, in the case that the nylon filament's total denier is 840 denier, the proper twist number for the Nylon Ply twist Yarn (110) and Aramid Ply twist Yarn (120) is 470 TPM (twists per meter), and in the case that the nylon filament's total denier is 1890 denier, the proper twist number of the Nylon Ply twist Fiber (110) and Aramid Ply twist Fiber (120) is 300 TPM.

That is, a person skilled in the art can easily deduce the numerical range of twist numbers 1 and 2 written in Claim 2 of the patent in this case by only considering the fiber of the nylon filament and performing a simple repeated experiment.

In addition, regarding the hybrid tire cord, given that Prior Art 5 also discloses that the hybrid tire cord has a twist number in the range of 300 to 500 TPM (Document No. 8, page 5, lines 20 through 22), a person skilled in the art can easily deduce the numerical range of Claim 2 of Prior Art 5.

Furthermore, by examining the disclosure details[4)] of Prior Arts 1 through 3 and 6, it can be seen that the twist number range written in Claim 2 of the patent of this case would be well known to a person skilled in the art of this technical field as of the filing date, and it can be confirmed that this twist number has been frequently used among conjugate fibers of nylon and aramid.

[4]) **Prior Art 1** discloses an aramid/nylon mixed fiber cord with a twist number of 27 to 36 twists/cm (270 through 360 TPM) (Document No. 4 [Table 1]), **Prior Art 2** discloses a tire cord of PPD-T yarn and nylon yarn twisted to a twist number of 8.8 tpi (346 TPM) (Document No. 5, Table 1), **Prior Art 3** discloses a nylon filament and aramid filament with ply twist yarn of 40 twists/cm (400 TPM) (Document No. 6, page 6, bottom table), and **Prior Art 6** discloses a hybrid cord made with aramid yarn and nylon yarn with initial and final twist numbers of 380 through 500 T/m (Document No. 9, paragraphs [0012] and [0016]).

Therefore, for Claim 2 of the patent of this case, non-obviousness is not recognized on the basis of Prior Art 4 or the combination of Prior Arts 4 and 5.

(2) Lack of non-obviousness of Claims 4 and 5 regarding the hybrid fiber cord

As for Claims 4 and 5 of the patent of this case, the breaking strength and breaking elongation of the hybrid fiber cord measured in accordance with ASTM D885 are 8.0 to 15.0 g/d and 7 to 15%, the strength retention rate following a disc fatigue test conducted in accordance with method JIS-L 1017 of the Japan Standards Association is over 80% (Claim 4), or on the other hand limits it to having a dry heat shrinkage rate of 1.5 to 2.5%, there is a difference in that such physical properties of the fiber cord are not disclosed in Prior Art 4.

However, for the physical properties written in Claims 4 and 5, as the inherent properties of the hybrid fiber cord written in Claim 1 are simply written, the hybrid fiber cord being drawn in Prior Art 4 or the combination of Prior Art 4 and 5 also presents the physical properties written in Claims 4 and 5.

Not only this, given that the physical properties written in Claims 4 and 5 can be easily deduced with reference to the disclosure details of Prior Art 5 by a person skilled in the art, a detailed explanation is provided below.

First, for Prior Arts 4 and 5, as both regard hybrid tire cords of nylon and aramid, they are within the same technical field and have the same objective of providing ultra-high performance car tires appropriate

for high-speed driving (Document No. 7, column 1, lines 6 through 10 and the summary of Document No. 8). Therefore, a person skilled in the art would have no technical difficulty in combining Prior Arts 4 and 5.

On the other hand, Prior Art 5 discloses a hybrid tire cord comprising nylon filament and aramid filament having the physical properties of (i) a tensile strength of 8.0 to 15.0 g/d measured in accordance with ASTM D885, (ii) an elongation at break of 10 to 20 measured in accordance with ASTM D885 and (iii) a dry heat shrinkage rate of 2.0 to 5.0 measured at 180° (Document No. 8, Claims 1 and 6, paragraph [0043]), and explains that "The above hybrid tire cord among tire cords, especially those preferably to be applied to the cap ply to sufficiently prevent deformation of the tire belt area that occurs in the case of high-speed driving, can effectively improve the flat-spotting phenomenon that occurs with tires applying existing nylon-based tire cords" (Document No. 8, paragraph [0044]).

However, for Prior Art 4, the objective shall be providing tires with improved high rolling speed resistance, and for this, as the tire reinforcement oriented in the circumferential direction is composed of a combination of aramid fiber and nylon fiber (Document No. 7, column 1, lines 37 and 38, column 3 lines 6 through 13), a person skilled in the art can attempt to limit the above fiber reinforcement's strength, elongation at break and dry heat shrinkage to a specific numerical range following the instructions in Prior Art 5 on further improving the tire reinforcement's effect of preventing deformation of the tire belt area written in Prior Art 4.

Therefore, to the fiber reinforcement disclosed in Prior Art 4, through a simple attempt to apply the physical properties of the hybrid tire cords disclosed in Prior Art 5, the invention described in Claims 4 and 5 of the patent of this case can be easily deduced.

Moreover, as can be seen in Prior Arts 1 through 3 and 6,[5)] as of the filing date of the patent in this case, it is well known in the technical field of hybrid fiber cords that the strength, breaking elongation, dry heat shrinkage and fatigue resistance (for example, strength retention rate following a disc fatigue test) of tire cords used for tire rubber reinforcement must fall within a certain range, and when considering that these physical properties have been repeatedly measured and evaluated using a fixed method, a person skilled in the art would have no technical difficulty limiting the fiber reinforcement of Prior Art 4 to the physical properties written in Claims 4 and 5 of the patent of this case.

Therefore, in view of Prior Art 4 or a combination of Prior Arts 4 and 5, the invention described in Claims 4 and 5 of the patent of this case cannot be recognized as non-obvious.

(3) Lack of non-obviousness of Claim 9 regarding the manufacturing method of the hybrid fiber cord

[5)] **Prior Art 1** discloses a reinforcement fiber cord with a strength when cut of 9.9 to 14.7 g/d, and elongation when cut of 7.0 to 11.5%, a strength retention rate of 88 to 94% and a dry heat shrinkage rate of 2.0 to 3.2% (Document 4, paragraphs [0034] through [0036] and [Table 2]), **Prior Art 2** discloses the breaking strength (13.1 g/d), breaking elongation (7.5%), strength retention rate following a disc fatigue test (97.4%) and shrinkage rate (1.24) of the tire measure by A.S.T.M. test No. D-885 (Document No. 5, column 2, lines 5 through 7 and 34 through 48, Table 1), **Prior Art 3** discloses physical property data of the strength, elongation at break, fatigue resistance, heat shrinkage rate, etc., of the nylon/aramid cords (Document 6, page 6, bottom table), and **Prior Art 6** discloses the residual strength and shrinkage of the hybrid cord following fatigue (Document No. 9, paragraph [0016] and Table 1).

Citing Claim 8, Claim 9 of the patent of this case states that the adhesive solution mentioned in Claim 8 is an adhesive that includes resorcinol-formaldehyde-latex (RFL).

Prior Art 4 discloses that sizing is done through the series of steps involved in passing the reinforcement fiber composed of nylon fiber and aramid fiber through the adhesive dip, but as it does not disclose that the above adhesive dip includes resorcinol-formaldehyde-latex (RFL) adhesive, there is a difference in Claim 9 of the patent of this case.

However, as written in the specification of the patent of this case, as of the filing date of the patent of this case, RFL solution is generally used as an adhesive solution for tire cords (Document No. 2, paragraph [0055]), and therefore no technical difficulty can be seen in a person skilled in the art choosing an adhesive that contains RFL adhesive for the adhesive bath disclosed in Prior Art 4.

In addition, Prior Art 5 also discloses passing the cable twist yarn of nylon filament ply twist yarn and aramid filament ply twist yarn through an RFL adhesive tank (Document No. 8, page 6, lines 45 through 51).

Therefore, in view of Prior Art 4 or a combination of Prior Arts 4 and 5, the invention described in Claim 9 of the patent in this case cannot be recognized as non-obvious.

F. Claim 7: Lack of non-obviousness based on a combination of one of Prior Arts 1 through 3 and Prior Art 5

Citing Claim 6 regarding the manufacturing method of the hybrid fiber cord, Claim 7 of the patent of this case limits steps 1 through 3 written in Claim 6 to being performed simultaneously and in a continuous manner.

That is, Claim 7 states that step 1 for manufacturing nylon ply twist yarn, step 2 for manufacturing aramid ply twist yarn and step 3 for manufacturing ply yarn by twisting these into a single high-twist configuration are performed simultaneously and in a continuous manner.

However, as described in section VI.2.B. below, for the invention described in Claim 7 of this case, the meaning of "being performed simultaneously in a continuous manner" is ambiguous and it is impossible to clearly understand the invention of Claim 7. Specifically, in order to high-twist the nylon ply twist yarn and aramid ply twist yarn together in step 3, the nylon ply twist yarn and aramid ply twist yarn to be used for the ply yarn (cable twist) must, of course, already exist prior to the ply yarn manufacturing process that step, so it's difficult to understand how steps 1 through 3 can be performed simultaneously.

However, the configuration of Claim 7 will be interpreted as both steps 1 and 2 of the ply twist yarn manufacturing process being performed simultaneously, followed by the manufacturing process for the ply yarn, which is performed in a continuous manner by high-twisting the above two ply twist yarns together, and the following will compare this with the disclosure details of Prior Art 5.

In detail, Prior Art 5 discloses that when the nylon filament and aramid filament are blended to make the hybrid tire cord, the method of manufacturing the nylon ply twist yarn and aramid ply twist yarn involves a ply twist process performed after the braiding or simultaneous with the braiding of each filament (Document No. 8, page 6, lines 1 through 6), which means that the ply twist process of the nylon filament and the ply twist process of the aramid filament are performed simultaneously. In addition, Prior Art 5 also discloses the configuration of performing the cable twist process after the above simultaneous ply twist process using the ply twist yarn produced therein. Thus, the configuration of Claim 7 is substantially disclosed in Prior Art 5.

Therefore, through comparison with a combination of Prior Arts 1 and 5, a combination of Prior Arts 2 and 5 or a combination of Prior Arts 3 and 5, the invention described in Claim 7 of the patent of this case cannot be recognized as non-obvious.

7. Claim 7: Lack of non-obviousness based on a combination of one of Prior Arts 1 through 3 and Prior Art 7

On the other hand, by interpreting the configuration of Claim 7 (performing steps 1 through 3 simultaneously in a continuous manner) as meaning one of either the ply twist or cable twist steps being performed in a cable machine, as of the filing date of the patent of this case, the configuration of Claim 7 is no different from what has generally been frequently used in this technical field and therefore is not a configuration for which non-obviousness can be assured.

For instance, Prior Art 7 (U.S. Patent Application Publication No. 2003/0200739; Document No. 10), published prior to the filing date of the patent of this case, discloses a tire cord manufacturing method where the ply twist step and cable twist step are performed in one cable machine: a direct cable machine. In addition, as there are a number of patent documents showing that the above direct cable machine has been generally used in this technical field since prior to the filing date of the patent of this case, these patent documents have been submitted as reference materials 3 through 7.

Document No. 10 (Prior Art 7; publication date: 2003. 10. 30.)

Paragraph [0002] This invention concerns equipment for manufacturing a cord structure for use in the reinforcement of air tires, hoses, belts and other items generally known as mechanical rubber goods. The invention also concerns the method of operating this equipment for the production of hybrid yarn.

Paragraph [0006] 20 years ago, ring twisters were basic equipment used to first twist yarn filaments, and then twist these yarns (2 or 3) together to form a cord. Ring twisters performed two operations, called plying and cabling. Later, in the early 1990s, cabling machines for commercial use entered the market, and these could twist two filaments together to form a cord in a single operation. Because cabling machines eliminated one step from the ring twister process, they became more common. Cords composed of three filaments were still made with ring twisters.

Paragraph [0021] The direct cabling system of this invention works for various types of yarn, including fiberglass, aramid, nylon, polyester, and rayon.

Reference Material 3 (U.S. Patent Publication No. 6,601,378; patent date: 2003. 8. 5.)
[Column 2, lines 39 through 44] This invention also concerns a method for producing hybrid cable cords that includes one step of supplying a direct cabler with two or more yarns of different properties and one step of cabling the two or more yarns using the direct cables in order to produce a hybrid cable core with a coring level other than zero.

[Column 3, line 64 through column 4 line 15] Cable cords with an unbalanced structure are obtained by using a direct cabling machine. This machine

is designed to use a roll and brake to control the tension of the ends of two yarns in order to obtain a balanced cord composition, and generates a balanced structure with the balanced composition intended. Direct cablers have the advantage of operating at a much higher speed (30-50% higher) than existing ring twisters. In addition, unlike direct cablers, which generate cable cords in one step, ring twisters require two steps to form cable cords, first twisting the yarns individually (i.e., in the Z direction), and then twisting these twisted yarns together (i.e., in the S direction). The benefit of direct cablers is that they form cable cords by performing cabling directly when supplied with two yarns.

[Column 5, lines 31 through 36] Usable polymer yarns for the method and product of this invention include all yarns for use in industry and fibers. Examples are not limited to polyesters such as polyethylene terephthalate (PET) and polyethylene naphthalate (PEN); they also include polymers such as aramid, nylon-6, nylon-6,6 and nylon-4,6, and more.

Reference Material 4 (U.S. Patent Publication No. 2003/0060540; publication date: 2003. 3. 27.)
Paragraph [0004] However, using an appropriate twist structure remains the main reinforcement method for tire cords manufactured with rayon, nylon, aramid and polyester, as well as with organic fibers of a similar high strength.

Paragraph [0006] Recent industrial development has brought changes to this production process for traditionally treated tire cords. For example, in many cases in the fabrication industry old ply and twist equipment are being replaced with direct cable machines. These machines combine the ply and twisting steps into one operation, creating a more efficient and economical tire core production process. In addition, these machines produce larger packages and improve quality by reducing knots and splices in in the final cord products.

Reference Material 5 (Korean Published Patent Application No. 2009-0114609; publication date: 2009. 03. 04)

Paragraph <44> Using a Cable & Cord 3 twister (C.C Twister, Allma Co.), the above Lyocell multi-filament is given Z twisted and S twisted to 400 TPM each to manufacture Lyocell ply yarn with 2 ply.

Reference Material 6 (Korean Published Patent Application No. 2009-0022461; publication date: 2009. 11. 4.)
Paragraph <29> According to the example of the manufacturing method for aramid tire cords according to this invention, to manufacture the ply yarn, first a cable machine suitable for tire cords is used to give the aramid multi filament with the above physical properties a cable twist (Z twist) in the counter-clockwise direction as shown in Diagram 2, then the two high-twisted strands are braided while giving them a ply twist (S twist) in the clockwise direction as shown in Diagram 3.
Paragraph <89> To manufacture cord fabric, a Cable & Cord 3 twister (C.C Twister, Allma Co.) is used to high-twist (Z twist) the aramid multifilament manufactured above

to a twist number of 30 twists/10 cm, then two cable twisted strands are low-twisted (S twist) to a twist number of 30 twists/10 cm to create ply yarn.

Reference Material 7 (Korean Published Patent Application 2012-0069340; publication date 2012 6. 28.)

Paragraph [0032] To explain the twisting process of this invention in greater detail, polyethylene terephthalate drawing yarn manufactured according to the above method is twist-spun using a direct cable machine that can perform false twisting and plying of two spooled yarns at the same time to manufacture the raw cord used for tire cords. For the raw cord, manufacturing is done by ply twisting followed by cable twisting of the polyethylene terephthalate yarn for use in tire cords to twist the yarns together, and generally the twist count is the same for the ply twist and the cable twist, so different twist counts can be applied as needed.

Paragraph [0033] One important effect of this invention is that physical properties of the cord such as tenacity, core filaments, internal fatigue rate, etc., vary according to the level (twist count) of twist applied to the polyethylene terephthalate yarn. Generally, in the case of a high number of twists, there is a tendency for the cord's tenacity to increase and its core filaments and bent cores to decrease. Also for the internal fatigue rate, an improvement trend can be seen with increased twisting. As for the twist count of the polyethylene terephthalate tire cords manufactured with this invention, 300/300 TPM to 500/500 TPM was achieved with simultaneous high/ply twisting, providing equal high and ply twist numbers, revealing the excellent physical properties of no turning, twisting, etc., of the manufactured tire cord was evident, making it easy to maintain a straight line. At this time, in the case of a TPM of less than 300/300, bent cores in the raw cord and the internal fatigue rate can be easily reduced, while in the case of a TPM of greater than 500/500, the reduced tensile strength makes it inappropriate for use in tire cords.

In detail, Prior Art 7 discloses the formation of hybrid cord in a single operation using a direct cabling machine to twist two yarn filaments together. Specifically, Prior Art 7 discloses a configuration for manufacturing hybrid yarn by performing plying (corresponding to the ply twist step) and cabling (corresponding to the cable twist step) with one cable machine (direct cabling machine), and discloses aramid and nylon as being included in the above hybrid yarn.

Furthermore, prior art references 1 and 3, as well as prior art reference 7, belong to the same technical field in that they relate to a hybrid cord used for reinforcing tire products.

Thus, there is no technical difficulty in fully aligning and combining them. Moreover, prior art reference 7 discloses the use of materials such as aramid and nylon in a direct cabling system, thereby providing sufficient motivation for one skilled in the art to combine the structural elements of the direct cabling system from prior art reference 7 with the embodiments of prior art references 1 and 3.

Moreover, by reviewing prior art references 3 and 4, it can be seen that manufacturing a hybrid cord by combining individual yarns and ply yarns using a single direct cabling machine was already common practice before the filing date of this patent application. Additionally, prior art references 5 to 7 also disclose manufacturing cords with an equal number of upper and lower twists using a direct cabling machine.

Lastly, the invention of Claim 7 simply uses a single cabling machine to perform both upper and lower twisting processes to improve productivity, and thus, its effects could reasonably be anticipated based on prior art.

Therefore, even if it is considered that performing the steps of upper and lower twisting with a single cabling machine in Claim 7 is disclosed by prior art, the invention of Claim 7 lacks an inventive step compared to combinations of prior art references 1 and 7, prior art references 2 and 7, or prior art references 3 and 7.

Summary

As described above, Claims 1 to 6, 8, and 9 of this patent application lack novelty or inventive step compared to prior art references 1 through 3, respectively. In addition, the inventions described in Claims 1, 3, and 6 through 8 lack novelty or inventiveness compared to prior art reference 4. Furthermore, the inventions of Claims 2, 4, 5, and 9 lack inventiveness in comparison with prior art reference 4 or a combination of references 4 and 5. Lastly, the invention of Claim 7 lacks inventiveness compared to either a combination of any of prior art references 1 through 3 with prior art reference 7.

VI. Reasons for Rejection of the Present Patent Application

1. Grounds for Rejection under Article 42, Paragraph 4, Item 1 of the Patent Act (Violation of Support Requirement)

A. Content regarding Article 42, Paragraph 4, Item 1 of the Patent Act and Examination Standards of the Korean Intellectual Property Office:

"Claims must be supported by the description of the invention."
The description serves as a technical disclosure; thus, granting a patent for claims that extend beyond what is disclosed in the description would result in unjustified protection for undisclosed aspects of the invention.

Regarding Article 42, Paragraph 4, Item 1 of the Patent Act (support requirement), the Examination Guidelines for Patents and Utility Models issued by the Korean Intellectual Property Office state the following (See Reference 1, pages 2403 and 2404):

"Determining whether a claim is supported by the description involves not only checking textual identity between the claim and the description, but primarily examining whether a person skilled in the art can reasonably recognize, from the description, that the claim does not exceed what has been disclosed, considering the purpose of Article 42, Paragraph 4, Item 1."

B. Hybrid fiber cords as defined in Claims 1 to 5 of this patent application:

Claim 1 of this patent describes a structure in which a nylon lower-twist yarn (first twist number) and an aramid lower-twist yarn (second twist number) are twisted together with upper twists equal to the lower twists (hereinafter referred to as upper twist number). This configuration was added to claim 1 during the examination process as a response to the Office Action dated May 27, 2015 (See Reference 2: Opinion submitted during the examination of this patent application on August 24, 2015).

However, the specification of this patent application does not disclose a case where the hybrid fiber cords having identical lower and upper twist numbers (particularly the hybrid fiber cords as defined in Claims 1 to 5) are impregnated and dried in an adhesive solution. This will be further explained below.

Regarding the structure in claim 1 of this patent, which specifies identical lower and upper twist numbers, the relevant contents disclosed in the specification of this patent are reviewed as follows:

[0059] Meanwhile, the hybrid fiber cord of the present invention is given identical numbers of lower and upper twists in the cabling process; however, during the process of impregnating in an adhesive solution and subsequent drying, twisting and untwisting phenomena may occur, resulting in a difference of up to 15% between lower and upper twist numbers.
[0067] Hybrid yarn was produced by simultaneously performing lower twisting in the counterclockwise direction and upper twisting in the clockwise direction using a Cable Corder machine, with 1260 De nylon filament and 1500 De aramid filament. At this time, the twist number was set at 300 TPM.

Apart from the above disclosures, there is no further mention regarding identical lower and upper twist numbers in the specification. The specification only discloses that the lower and upper twist numbers were "given" or "set" identically during the cabling process. However, there is no explicit disclosure verifying whether the lower and upper twist numbers of the final hybrid fiber cord product remain identical in practice.

Rather, paragraph [0059] of the specification in this patent explicitly discloses that even if identical lower and upper twist numbers are initially set during the cabling process, due to the twist relaxation phenomenon occurring during the adhesive impregnation and drying process (where fewer twists remain compared to those initially set), the final hybrid fiber cords produced will eventually have different lower and upper twist numbers.

Therefore, if the hybrid fiber cords described in Claims 1 to 5 of this patent refer specifically to final products that have undergone adhesive impregnation and drying processes, such hybrid fiber cords are not supported by the disclosure of the specification, which explicitly states that the final hybrid fiber cord will have different upper and lower twist numbers.

2. Grounds for Rejection under Article 42, Paragraph 4, Item 2 of the Patent Act (Violation of Clarity Requirement)

The inventions claimed in Claims 1 to 9 of this patent application do not satisfy the clarity requirement stipulated in Article 42, Paragraph 4, Item 2 of the Patent Act. This will be explained in detail below.

A. Lack of clarity in claims 1 and 6

Claim 1 of this patent describes hybrid fiber cords twisted together from nylon yarns and aramid yarns in an identical structure, and Claim 6 also describes a step of manufacturing yarns twisted together from nylon and aramid yarns in an identical structure. However, the meaning of the term "identical structure" is unclear.

Regarding this terminology, the specification of the present invention discloses that:

"By adjusting the tension during the cabling process, nylon yarns and aramid yarns with different modulus characteristics can form an identical and stable structure, twisted at equal ratios, rather than being manufactured in a covering-type form."
(See paragraph [0018] of the specification).

However, even considering the above explanation, the meaning of the term "identical structure" remains unclear. It is not explicitly clear whether this term means:

(i) emphasizing that the twist number of the nylon yarn (first twist number) and aramid yarn (second twist number) are identical,
(ii) that nylon and aramid yarns are twisted together at equal weights or equal volumes, rather than being manufactured in a covering form,
(iii) that nylon and aramid yarns twisted together within the hybrid fiber cord have identical shapes and/or dimensions,
(iv) or whether it has some other meaning entirely.

Therefore, the phrase "identical structure" used in Claims 1 and 6 of this patent lacks clarity, and thus the invention claimed in these claims, as well as any other claims dependent thereon, violates the clarity requirement of Article 42, Paragraph 4, Item 2 of the Patent Act.

B. Lack of clarity in Claim 7

Claim 7 of this patent refers to the manufacturing method of hybrid fiber cords, citing Claim 6, and describes steps 1 to 3 of Claim 6 as being performed simultaneously and continuously. However, the exact meaning of the expression "simultaneously and continuously" is unclear.

Claim 6 states the following: "Step 1: Manufacturing nylon yarns using nylon filaments; Step 2: Manufacturing aramid yarns using aramid filaments; and Step 3: Manufacturing twisted yarns by twisting together the nylon and aramid yarns in an identical structure."

According to Claim 6, the twisted yarns are produced by twisting previously manufactured nylon yarns and aramid yarns. Therefore, if the nylon and aramid filaments have not yet been twisted into yarns, it would be impossible to twist them together. Consequently, a person skilled in the art would not clearly understand the invention as claimed in Claim 7.

Thus, Claim 7 also violates the clarity requirement of Article 42, Paragraph 4, Item 2 of the Patent Act due to the unclear definition of the invention.

VII. Conclusion

As described above, this patent should be invalidated based on Article 133, Paragraph 1, Item 1 of the Patent Act. Therefore, we respectfully request a decision in accordance with the petitioner's claims.

Method of Proof (Exhibits)

1. Exhibit 1: Patent Registration (Patent No. 1580352, this patent case)

1. Exhibit 2: Published Patent Gazette (Patent No. 1580352, this patent case)

1. Exhibit 3: Petitioner's website (http://www.hyosungadvancedmaterials.com/kr/business/tire_rein_forcement.do)

1. Exhibit 4: Japanese Published Patent Application No. 2009-68549 (Prior Art 1)

1. Exhibit 5: U.S. Patent No. 3,977,172 (Prior Art 2)

1. Exhibit 6: Japanese Published Patent Application No. Sho61-71204 (Prior Art 3)

1. Exhibit 7: U.S. Patent No. 6,533,012 (Prior Art 4)

1. Exhibit 8: Korean Published Patent Application No. 2006-0126101 (Prior Art 5)

1. Exhibit 9: European Published Patent Application No. 1 878 591 A2 (Prior Art 6)

1. Exhibit 10: U.S. Published Patent Application No. 2003/0200739 (Prior Art 7)

References

1. Reference 1: Pages 2403 and 2404 of Patent and Utility Model Examination Guidelines

1. Reference 2: Opinion submitted on August 24, 2015, regarding this patent case

1. Reference 3: U.S. Patent No. 6,601,378

1. Reference 4: U.S. Published Patent Application No. 2003/0060540

1. Reference 5: Korean Published Patent Application No. 2009-0022461

1. Reference 6: Korean Published Patent Application No. 2009-0114609

1. Reference 7: Korean Published Patent Application No. 2012-0069340

Patent No.: 1580352

[Rights Information]

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[Patent Fee Payment History]

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[Patent Holder Information]

(Final Rights Holder)
Kolon Industries, Inc. (135311-*******)
110 Magokjungang-ro, Gangseo-gu, Seoul (Magok-dong)

Order No.	Registration Details	
1	(Registered Rights Holder) Kolon Industries, Inc. (135311-*******) 110 Magokjungang-ro, Gangseo-gu, Seoul (Magok-dong)	December 18, 2015
Supplement 1	(Unified management of registered rights holder) Application Date: October 10, 2016 Application No.: 2016-5143745 Changed Rights Holder: Kolon Industries, Inc. (135311-*******) 11 Kolon-ro, Gwacheon-si, Gyeonggi-do (Byeolyang-dong, Kolon Tower) Details of Address Change: - Before Change: 11 Kolon-ro, Gwacheon-si, Gyeonggi-do (Byeolyang-dong) - After Change: 11 Kolon-ro, Gwacheon-si, Gyeonggi-do (Byeolyang-dong, Kolon Tower)	October 10, 2016
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(73) Patent Holder
Kolon Industries, Inc.
11 Kolon-ro, Gwacheon-si, Gyeonggi-do (Byeolyang-dong)

(72) Inventors

Lee Min-ho: 202-dong, Apt. 804, 186-19 Gumidae-ro, Gumi-si, Gyeongsangbuk-do (Gwangpyeong-dong, Gumi Gwangpyeong Prugio 2nd)

Jin Wook-hwa: 705-dong, Apt. 209, 26 Seobyeon-ro, Buk-gu, Daegu (Seobyeon-dong, Dongseo Byeonwon The Meridian Apartment)

Jung Il: Apt. 1603, 105-dong, 135 Dongwon-ro, Suseong-gu, Daegu (Manchon-dong, **Metro Palace 1 Danji Apt.)**

(74) Patent Attorney

Patent Firm Incheon Moon

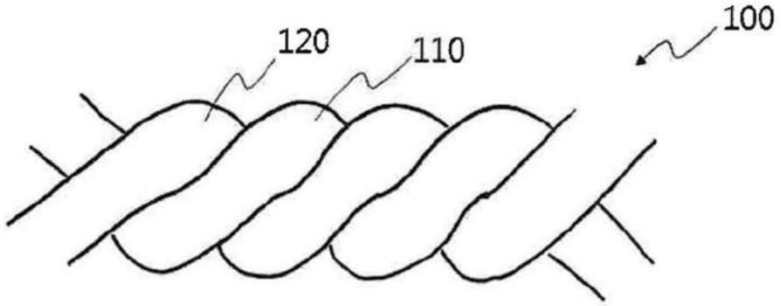
Total number of claims: 9

Examiner: Park Young-min

(54) Title of the invention:
Hybrid fiber cord and manufacturing method thereof

(57) Abstract
Compared to conventional hybrid fiber cords, the invention not only simplifies the manufacturing process but also provides hybrid fiber cords, including nylon filaments and aramid filaments, having superior uniformity, improved sound characteristics, enhanced strength, and excellent fatigue properties, making them suitable for ultra-high-performance tire applications. Specifically, the hybrid fiber cord comprises nylon lower yarns having a first twist number and aramid lower yarns having a second twist number, where the nylon and aramid yarns are twisted together into an identical structure having equal first and second twist numbers.

Representative Drawing: Figure 2



Claims

Claim 1

A hybrid fiber cord comprising:
a nylon lower yarn with a first twist number; and
an aramid lower yarn with a second twist number,
wherein the first and second twist numbers are identical,
and wherein the nylon yarn and the aramid yarn are twisted together in an identical structure having an upper twist number id entical to said first and second twist numbers.

Claim 2

The hybrid fiber cord according to Claim 1, wherein the first and second twist numbers are each from 300 to 500 TPM.

Claim 3

The hybrid fiber cord according to Claim 1, wherein the weight ratio of nylon yarn to aramid yarn is from 20:80 to 80:20.

Claim 4

The hybrid fiber cord according to Claim 1, wherein the tensile strength and modulus measured by ASTM D885 are from 8.0 to 15.0 g/d and from 7 to 15%, respectively, and wherein strength retention after a disk fatigue test according to JIS-L 1017 (Japanese Standard Association: JSA) is 80% or higher.

Claim 5

The hybrid fiber cord according to Claim 4, wherein the elongation at break is from 1.5% to 2.5%.

Claim 6

A method of manufacturing a hybrid fiber cord, comprising:
Step 1: manufacturing nylon yarn from nylon filaments;
Step 2: manufacturing aramid yarn from aramid filaments; and
Step 3: twisting the nylon yarn and aramid yarn from steps 1 and 2 together in an identical structure,
wherein the twist numbers applied during steps 1, 2, and 3 are identical.

Claim 7

The method according to Claim 6, wherein the steps 1 to 3 are performed simultaneously and continuously.

Claim 8

The method according to Claim 6, further comprising:

impregnating the twisted yarn with an adhesive solution;

drying the impregnated twisted yarn to cure the adhesive; and

heat-treating the dried twisted yarn.

Claim 9

The method according to Claim 8, wherein the adhesive solution comprises a resorcinol-formaldehyde-latex (RFL) adhesive.

Description of the Invention

Technical Field

[0001]
The present invention relates to a hybrid fiber cord comprising nylon filaments and aramid filaments and a method of manufacturing the same. More particularly, it relates to hybrid fiber cords suitable for ultra-high-performance tires, characterized by simplified manufacturing processes, superior uniformity, improved dimensional stability, fatigue properties, and strength compared to conventional hybrid fiber cords. Specifically, the invention relates to hybrid fiber cords containing nylon and aramid filaments, as well as methods for manufacturing the same.

Background Art

[0002]
Fiber cords are commonly used as reinforcing materials in rubber products such as tires, conveyor belts, V-belts, and hoses. Particularly, adhesive-treated fiber cords are widely employed. Typical materials for manufacturing fiber cords include nylon fibers, polyester fibers, rayon fibers, and the like. Enhancing the properties of fiber cords used as reinforcements is one of the critical ways to improve the final product's performance.

[0003]
As automobile performance and road conditions continually improve, driving speeds are gradually increasing. As a result, tire safety and durability requirements at high speeds have intensified, and active research is ongoing for tire cords used as reinforcing materials in rubber tires.

[0004]
Tire cords vary depending on their position and role in the tire. Generally, these include the carcass, which supports the entire tire; the belt, which prevents deformation of the tread; and the bead, which prevents rim deformation. Particularly, as automobile performance has improved and vehicles frequently accelerate or brake sharply, deformation issues related to the belt section have become significant. Therefore, preventing the deformation of the belt part is increasingly important.

[0005]
Currently, materials predominantly used in cap-ply cords include nylon and aramid. Among these, nylon is widely employed in tire construction due to its relatively low modulus, excellent adhesion to rubber, and superior abrasion resistance. Nylon is also extensively used as cap-ply cords for steel belts because it prevents structural separation and enhances tire durability. However, nylon’s drawback is that its modulus is low, causing dimensional instability during high-temperature curing processes. This results in increased non-uniformity and compromised performance.

[0006]
Aramid fibers, in contrast to nylon, have lower elongation, superior creep characteristics, and higher modulus, providing excellent dimensional stability and high tensile strength. However, due to their excessively high modulus, aramid fibers lack ride comfort and flexibility, thus they are rarely used independently in ordinary passenger tires. Aramid fibers are mostly utilized in high-performance tires or run-flat tires designed for special applications. Moreover, aramid fibers are significantly more expensive than nylon fibers, limiting their broader usage. Consequently, hybrid cords consisting of nylon and aramid fibers have been developed. However, due to substantial differences in modulus and elongation between nylon and aramid fibers, maintaining uniformity in hybrid cord structures has remained challenging.

[0007]
To address these issues, hybrid cords combining nylon and aramid have been developed. However, due to the significant differences in physical properties such as modulus between nylon and aramid yarns, issues frequently occur, including differences between the lower and upper twist numbers in the cords, structural instability during manufacturing, and dimensional instability due to yarn slippage. This has caused problems such as non-uniform elongation, limiting their broader practical use.

To address these issues, hybrid cords combining nylon and aramid have been developed. However, due to the significant differences in physical properties such as modulus between nylon and aramid yarns, issues frequently occur, including differences between the lower and upper twist numbers in the cords, structural instability during manufacturing, and dimensional instability due to yarn slippage. This has caused problems such as non-uniform elongation, limiting their broader practical use.

[0008]
Specifically, conventional hybrid cords have different twist numbers for nylon and aramid yarns, causing them to untwist or over-twist when twisted together. Such irregular twisting prevents uniform distribution of twist numbers across the hybrid cord, making it difficult to effectively utilize the strength of the entire hybrid fiber cord.

[0009]
Additionally, as shown in the general prior art (Fig. 1), conventional hybrid cords are typically manufactured by twisting nylon lower yarns (11) and aramid lower yarns (12) individually, and then covering the nylon yarn (11) with the aramid yarn (12). During adhesive impregnation and drying of the cord (10), the aramid yarn (12) slips due to frictional differences with the guide and pulley, resulting in the separation of the covered structure of nylon yarn (11) and aramid yarn (12). Consequently, this produces hybrid fiber cords having irregular elongation. This irregular twisting and covered structure results in non-uniform properties, causing production instability and reduced quality.

Disclosure of Invention

Technical Problem

[0010]
Therefore, the present invention provides hybrid fiber cords and their manufacturing methods capable of overcoming the limitations and drawbacks of the prior art mentioned above.

[0011]
Specifically, the present invention provides hybrid fiber cords that simplify manufacturing processes, provide enhanced uniformity, improved dimensional stability, fatigue resistance, and higher strength compared to conventional hybrid fiber cords, suitable for ultra-high-performance tires.

[0012]
Additionally, the present invention provides a manufacturing method for hybrid fiber cords, which simplifies the manufacturing process, ensures uniformity, and improves dimensional stability and fatigue properties compared to conventional hybrid cords, making them suitable for ultra-high-performance tires.

[0013]
Other objectives, features, and advantages of the invention will become apparent through the following detailed description or through partial implementation of the invention. The purposes and other advantages of the invention can also be realized through structures specifically defined in the claims and their combinations.

Solution to Problem

[0014]
To achieve the objectives mentioned above, the invention provides a hybrid fiber cord comprising nylon lower yarns with a first twist number and aramid lower yarns with a second twist number, wherein the first and second twist numbers are identical, and the nylon and aramid yarns are twisted together into an identical structure having the same upper twist number as the lower yarns.

[0015]
According to another aspect, the invention provides a method for manufacturing hybrid fiber cords, comprising a first step of manufacturing nylon yarns from nylon filaments; a second step of manufacturing aramid yarns from aramid filaments; and a third step of twisting the nylon yarns and aramid yarns from the first and second steps together into an identical structure, wherein the twist numbers during each step are identical.

[0016]
Other features and details of the invention will become apparent through the detailed description and examples provided below. Particular advantages of the invention can be recognized clearly through these examples.

Effects of the Invention

[0017]
The present invention, by having identical lower twist numbers for nylon and aramid yarns, simplifies the manufacturing processes of hybrid fiber cords and enhances production efficiency.

[0018]
Additionally, by adjusting tension during the cabling process, nylon yarns and aramid yarns with significantly different moduli can form an identical structure, without one yarn covering the other. Thus, it is possible to achieve a uniform, stable structure with nylon and aramid yarns twisted at equal ratios. Consequently, hybrid fiber cords produced according to the invention exhibit not only reduced dimensional instability but also improved strength, fatigue resistance,

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and suitability for use in ultra-high-performance tire caps.

Brief Description of Drawings

[0019]
The attached drawings are included to facilitate understanding of the invention and form part of the specification. They illustrate the detailed description along with the principles of the invention:

Figure 1: Schematic view illustrating a conventional hybrid fiber cord.

Figure 2: Schematic view illustrating a hybrid fiber cord according to the present invention.

Detailed Description of the Invention

[0020]
The invention may be embodied in various forms without departing from its spirit and essential characteristics. Therefore, it should be understood that the invention is not limited by the following detailed embodiments but includes variations and equivalents within the scope of the claims and patent law.

[0021]
In this specification, "twisting yarn" refers to twisting filaments in the Z-direction (clockwise direction), and "untwisting yarn" refers to twisting filaments in the S-direction (counter-clockwise direction).

[0022]
"Single yarn" refers to yarn formed by twisting multiple filaments together in a single direction.

[0023]
"Cabled yarn" refers to yarn formed by twisting two or more single yarns together in one direction, also known as "raw cord."

[0024]
In the specification, "fiber cord" refers to fibers twisted and treated with adhesives for direct application in rubber products, also known as a "dipped cord," while "hybrid cord" refers to a cord made by twisting two or more different types of yarn together.

[0025]
"Twist number" refers to the number of twists per unit length applied to yarn or cords, measured in TPM (Twists Per Meter).

[0026]
The invention provides hybrid fiber cords comprising nylon and aramid filaments, wherein the weight ratio of nylon to aramid filament ranges from 20:80 to 80:20.

[0027]
In the invention's hybrid fiber cord, nylon filaments and aramid filaments are each twisted into yarns with identical lower twist numbers and then twisted together with an identical upper twist number, with the upper and lower twist numbers being the same.

[0028]
Hybrid fiber cords of the invention have tensile strengths measured according to ASTM D885 ranging from 8.0 to 15.0 g/d, modulus from 7% to 15%, and elongation at break ranging from 1.5% to 2.5%.

[0029]
Additionally, the hybrid fiber cords have a minimal difference between their highest and lowest elongations, showing an elongation uniformity within ±3% based on their elongation at break.

[0030]
The hybrid fiber cords maintain strength retention of 80% or greater in disk fatigue tests performed according to JIS-L 1017 (Japanese Standard Association: JSA).

[0031]
According to an embodiment, hybrid fiber cords of the invention are manufactured using equipment such as a Cable Corder, simultaneously conducting lower twisting of nylon and aramid yarns with identical twist numbers and then simultaneously upper twisting these yarns, followed by impregnating and drying the cords in an adhesive solution.

[0032]
This invention is explained in detail below through examples.

[0033]
The hybrid fiber cords according to the invention provide excellent adhesive properties and fatigue characteristics suitable for tire cap-ply, combining nylon filaments and aramid filaments. The hybrid combination compensates for nylon filaments' lower modulus with aramid's higher modulus, and aramid's low elongation is complemented by nylon's higher elongation, improving price competitiveness due to the reduced use of expensive aramid.

[0034]
Hybrid fiber cords of the present invention serve as special cords applied onto the steel wire or textile-reinforced belts of tire cap-plies. They improve vehicle performance, prevent belt separation phenomena, and consider various process factors such as filament properties, modulus, twist numbers, and twisting order to ensure balanced performance.

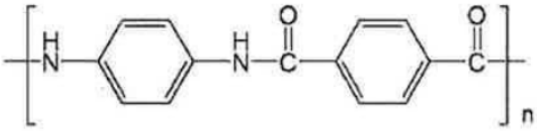
[0035]
Nylon refers to polyamide fibers having amide groups with strong polarity and crystalline structure with regularity and symmetry. Nylon filaments suitable for fiber cord manufacturing in this invention are not specifically limited, provided they have adequate physical properties such as tensile strength of at least **8 g/d** and elongation at break of **17% or more**. However, filaments not meeting these conditions require larger cord quantities due to lower strength, resulting in heavier tires and insufficient control of belt deformation during driving. Additionally, lower-quality filaments suffer significant strength reduction due to fatigue during complex tire movements.

[0036]
Examples of suitable nylon filaments include typical nylons such as **Nylon 6**, **Nylon 66**, and **Nylon 6,10**, among which **Nylon 66** is particularly preferred.

[0037]
Aramid refers to aromatic polyamide fibers and is a polymer with phenyl groups directly linked to the amide groups in all main chains except the amide group itself, exhibiting a modulus **10 times higher** than nylon. Aramid fibers include para-type (**p-type**) and meta-type (**m-type**), depending on how phenyl groups are connected. In the present invention, preferred aramid fibers are para-type poly(p-phenylene terephthalamide), as shown in **Chemical**

Formula 1.

[0038] <화학식 1>



[0039]

[0040]
In Chemical Formula 1, “n” represents the degree of polymerization of aramid, and is not particularly limited in the present invention.

[0041]
The aramid filaments having the structure shown in Chemical Formula 1 possess high crystallinity due to the planar connection of phenyl groups, resulting in excellent thermal stability and very high modulus. These aramid filaments preferably have a tensile strength of at least 20 g/d and elongation at a break of 3.0% or greater for use in fiber cords. However, due to their rigid molecular structure, they exhibit low fatigue resistance and poor internal stress distribution, making it difficult to sufficiently compensate for the low modulus of nylon filaments proposed in the invention if used alone.

[0042]
The physical properties of hybrid fiber cords according to the invention can be optimized by adjusting the mixing ratios of nylon and aramid filaments. The mixing ratios are selected within a range sufficient to satisfy required water-level characteristics and to complement the disadvantages of each filament type. Generally, aramid filaments exhibit approximately 10 times higher modulus compared to nylon filaments, but due to low elongation (about 3.0%), flat-spot phenomena can easily occur in tires. Therefore, considering both the cord's physical properties and cost, the mixing ratio of nylon filaments is preferably from 20% to 80%, with aramid filaments correspondingly 80% to 20%.

[0043]
If nylon filaments are excessively used, the modulus of the final hybrid fiber cord follows the nylon's lower modulus, resulting in increased flat-spot phenomena. Conversely, excessive use of aramid filaments increases modulus but decreases elongation, impairing the belt cord's capability to absorb movement effectively, thereby significantly raising manufacturing costs.

[0044]
Additionally, nylon and aramid yarns in the hybrid fiber cord have identical twist numbers. Generally, increased twist numbers decrease tensile strength but enhance fatigue properties. Conversely, lower twist numbers increase tensile strength but reduce fatigue performance.

[0045]
According to the invention, the two types of lower yarns (110, 120) have identical twist numbers and, as illustrated in Figure 2, the two yarns show similar strength and fatigue properties due to their identical twisted structure. The applied twist numbers for nylon yarn (110) and aramid yarn (120) are determined based on the nylon yarn.

[0046]
In the hybrid fiber cords of this invention, nylon yarn (110) and aramid yarn (120) preferably have twist numbers ranging from 300 to 500 TPM. For example, when the total denier of nylon filaments is 840 denier, a suitable twist number for nylon yarn (110) and aramid yarn (120) is about 470 TPM (Twists Per Meter), and when the total denier of nylon filaments is 1890 denier, a suitable twist number is about 300 TPM.

[0047]
The denier of aramid filaments is preferably similar or within a comparable range to the nylon filaments.

[0048]
Hereinafter, the manufacturing method of the hybrid fiber cord according to the present invention will be described in more detail.

[0049]
The hybrid fiber cord according to the invention is manufactured by simultaneously twisting nylon yarns (110) and aramid yarns (120) with identical twist numbers in each twisting step. Then, the twisted cord (100) formed through these upper and lower twisting processes is impregnated with an adhesive solution and dried.

[0050]
In the conventional twisting process, lower yarns are manufactured separately and then twisted together to produce a cabled yarn. In contrast, the twisting process of the present invention simultaneously applies identical twist numbers to yarns made from different materials. Thus, lower yarns are twisted at the same time using a Cable Corder, simplifying the manufacturing process. Also, unlike conventional methods where upper twisting is done separately after lower yarn manufacturing, the present invention performs upper twisting simultaneously with the previously twisted lower yarns (100), ensuring uniform twist distribution and reducing structural instability in the final hybrid fiber cord.

[0051]
Conventionally, hybrid fiber cords consist of nylon yarns (11) and aramid yarns (12) twisted separately, resulting in aramid yarns (12) often covering nylon yarns (11) due to their different twist numbers. Consequently, uneven elongation and internal friction occur, weakening the cord (10). In addition, when adhesive solution impregnation and drying occur, slippage between aramid yarns (12) and guiding devices results in uneven yarn distribution. This invention addresses these issues by ensuring nylon yarns (11) and aramid yarns (12) have identical twist numbers, thereby greatly enhancing uniformity and dimensional stability.

[0052]
In the present invention, nylon and aramid yarns are twisted simultaneously and uniformly. Therefore, unlike conventional cords, there is no occurrence of yarn covering, and the twisting force is evenly distributed. Thus, this invention fundamentally resolves irregular twisting and poor uniformity resulting from yarn slippage.

[0053]
As shown in Figure 2, nylon yarns (110) and aramid yarns (120) twisted together under identical twist conditions can form a stable structure despite their differences in modulus. By individually adjusting the tension applied during twisting, cords composed of filaments with substantially different moduli can be balanced.

[0054]
To enhance adhesion with rubber, the twisted cord (100) manufactured as described above is impregnated in an adhesive solution, passed through rollers, dried, and then heat-treated to form the final hybrid fiber cord.

[0055]
The adhesive solution used here is not specifically limited. A commonly used adhesive in tire manufacturing is a resorcinol-formaldehyde-latex (RFL) solution, which may be used in the present invention.

[0056]
The drying step for the impregnated cord varies according to the adhesive solution formulation. Typically, the cord is dried at temperatures ranging from 70 to 200°C for about 30 to 120 seconds.

[0057]
The heat-treatment step is carried out at temperatures of approximately 200 to 250°C for about 60 to 120 seconds.

[0058]
Through the adhesive impregnation, drying, and heat-treatment steps, adhesion and fatigue resistance between hybrid cords (100) and rubber are significantly improved, thereby greatly enhancing their performance as reinforcing materials.

[0059]
On the other hand, the hybrid fiber cords of this invention maintain identical twist numbers for lower yarns in the twisting step. However, during adhesive impregnation and drying, the differences in filament modulus may cause slight slippage between yarns, resulting in a twist difference of less than 15% between upper and lower yarns.

[0060]
Hybrid fiber cords manufactured by this method have a tensile strength ranging from 8.0 to 15.0 g/d, a modulus at 7% elongation of 7% to 15% measured according to ASTM D885, and a dry heat shrinkage of 1.5% to 2.5% measured at 180°C for 2 minutes under 0.01 g/d load.

[0061]
Furthermore, hybrid fiber cords of the invention exhibit an elongation uniformity within ±3%, calculated by comparing maximum and minimum elongation values measured under identical conditions.

[0062]
Moreover, the hybrid fiber cord according to this invention exhibits strength retention of at least **80%** in disk fatigue tests performed according to the Japanese Standard Association (JSA) standard **JIS-L 1017**.

[0063]
When applied to a tire's cap-ply, the hybrid fiber cord of the invention significantly reduces flat-spot phenomena caused by vehicle parking, and substantially improves performance in high-speed driving conditions.

[0064]
Furthermore, by blending relatively inexpensive nylon filaments with expensive aramid filaments having superior properties, the hybrid fiber cords of this invention can be produced more economically compared to cords made entirely from expensive aramid filaments. As a result, the cords become more competitive in the market due to improved productivity and reduced flat-spot generation.

[0065]
Hereinafter, the invention will be explained further through examples. However, the following examples are illustrative only and do not limit the scope of the invention.

[0066] Example 1

[0067]
Using a Cable Corder twister, nylon filaments (1260 denier) and aramid filaments (1500 denier) were simultaneously twisted with identical lower twists in the S-direction and subsequently upper-twisted in the Z-direction, producing a hybrid cord. Twist number was set at 300 TPM.

[0068]
The resulting hybrid cords were dipped in an adhesive solution containing 2.0% epoxy resin, 3.2% blocked isocyanate (37%), 1.1% sodium hydroxide, 13.6% resorcinol formaldehyde latex (RFL) (solid content: 15/70/15), and 80.1% water to achieve a pickup rate of 0.5 kg/cord, then passed through a roller.

[0069]
Subsequently, the dipped cord underwent drying at 150°C for 100 seconds and heat-treatment at 240°C for 100 seconds to complete the hybrid fiber cord.

[0070] Example 2

[0071]
Hybrid fiber cords were manufactured by the same method as in Example 1, except nylon filaments (840 denier) and aramid filaments (1000 denier) were used, and twist numbers were increased to 350 TPM to compensate for relatively lower filament strength.

[0072] Example 3

[0073]
Hybrid fiber cords were manufactured by the same method as in Example 1, except that twist numbers were set to 350 TPM.

[0074] Comparative Example

[0075]
Nylon filaments and aramid filaments were separately twisted at 300 TPM and 400 TPM, respectively. Using a Ring Twister, upper twisting was then performed, resulting in cords where aramid yarns predominantly covered nylon yarns. Except for these differences, hybrid fiber cords were manufactured under identical conditions to Example 1.

[0076]
Tensile strength, elongation uniformity, elongation at break, dry heat shrinkage, and disk fatigue strength of the hybrid fiber cords from the above examples and comparative examples were measured according to the following test methods, and the results are shown in Table 1.

[0077] Tensile Strength, Non-Uniformity, Elongation at Break, and Non-Uniformity

[0078]
According to the ASTM D-885 testing method, tensile strength was measured by applying a 250 mm gauge length and elongation speed of 300 mm/min using an Instron tester (Instron Engineering Corp., Canton, USA). Tensile strength was calculated by averaging ten hybrid fiber cords tested. Results were expressed in grams per denier (g/d). Additionally, elongation at break (%) was calculated by averaging values from ten measurements, and elongation uniformity was assessed by obtaining the difference between the maximum and minimum elongation (%) among the ten specimens.

[0079]
Meanwhile, the difference between the maximum and minimum values of the shear strength among the 10 samples was calculated, and the difference between the maximum and minimum values of the fracture strain among the upper samples was also derived. Through this, the non-uniformity of the shear strength and fracture strain of the hybrid fiber cord was determined.

[0080] Dry Heat Shrinkage

[0081]
After being conditioned for more than 24 hours in an atmosphere of 25°C temperature and 65% relative humidity, the measurement was conducted using a Testrite device at 180°C for 2 minutes under a preload of 0.01g/De.

[0082] Disk Fatigue Test

[0083] The disk fatigue test was performed using a Disk Fatigue Tester according to the JSA (Japanese Standard Association) JIS-L 1017 method. Hybrid cords were vulcanized into rubber sheets to prepare test specimens. Specimens were subjected to repeated fatigue cycles at 80°C, 250 rpm, and a load of approximately 50 kgf, and fatigue strength was measured after 24 hours. Strength retention (%) was calculated based on tensile strength before and after testing.

[0084] <Calculation Formula 1>

[0085]
Strength Retention (%) = (Strength after fatigue test (kgf) / Strength before fatigue test (kgf)) × 100

[0086]
Tensile strength (before and after fatigue) was measured according to ASTM D-885, using an Instron tester (Instron Engineering Corp., Canton, Mass.) with a specimen length of 250 mm, applying an elongation rate of 300 mm/min.

[0087]

Table 1

	Example 1	Example 2	Example 3	Comparative Example
	Nylon 1260 De Aramid 1500 De	Nylon 840 Aramid 1000De	Nylon 1260 De Aramid1500 De	Nylon 1260 De Aramid 1500 De
Twist number (TPM)	300	350	350	300/400
Tensile strength (g/d)	13.4	13.2	11.7	8.7
Tensile strength uniformity (g/d)	0.3	0.2	0.2	3.1
Elongation at break (%)	11.5	11	13.3	12.1
Elongation uniformity (%)	1.6	1.2	1.8	5.1
Dry heat shrinkage (%)	2.1	1.9	2.2	2.1
Strength retention (%)	93.2	94.3	91.7	72.4

In the comparative example, the hybrid fiber cords exhibited unevenness in adhesion and twist, and overall uniformity was poorer compared to the practical examples. It can be inferred that significant differences in strength occurred due to damage and irregularities in the aramid filaments, which primarily contribute to cord strength. Additionally, since nylon is covered unevenly around the aramid filaments, this irregular formation causes greater differences in filament length, contributing further to irregularities. Due to these non-uniform properties, each cord also exhibited poorer strength retention than the practical examples when subjected to fatigue testing within different rubber compositions.

Explanation of Reference Numbers

[0089]
10, 100: Hybrid cord 11, 110: Nylon filament
12, 120: Aramid filament

Diagram

Diagram 1

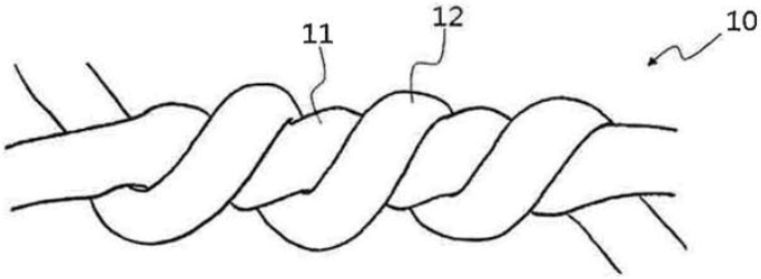
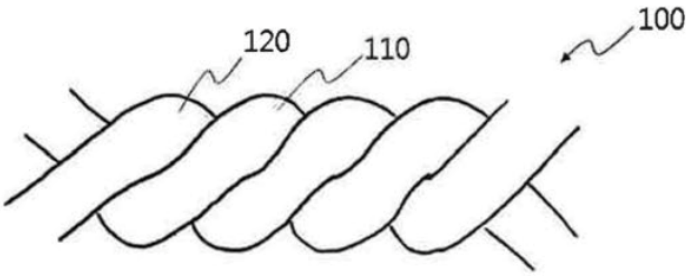



Diagram 2