IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HS HYOSUNG ADVANCED MATERIALS CORP.,

Petitioner,

v.

KOLON INDUSTRIES, INC.,

Patent Owner.

Case No. IPR2025-00663

U.S. Patent No. 10,196,765

DECLARATION OF JON RUST, PH.D. IN SUPPORT OF PETITION FOR INTER PARTES REVIEW OF UNITED STATES PATENT NO. 10,196,765

Kolon Industries, Inc.
Exhibit 2029
HS Hyosung v. Kolon
IPR2025-00662

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I. INTRODUCTION

1. I have been retained by HS Hyosung Advanced Materials Corp. ("Petitioner") as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") against Kolon Industries, Inc. ("Patent Owner") regarding U.S. Patent No. 10,196,765 ("the '765 patent") (Ex. 1001).[1] I have been asked to submit this Declaration on behalf of Petitioner.

2. I have been asked to consider whether certain references disclose or render obvious the features recited in claims 1-3 (collectively, the "Challenged Claims") of the '765 patent. My opinions are set forth below. Based on my experience and expertise, it is my opinion that the prior art renders obvious all limitations of the Challenged Claims, as I discuss in detail below.

3. I am being compensated at a rate of $500 per hour for my work in this proceeding. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

4. All of my opinions stated in this Declaration are based on my own personal knowledge and professional judgment. I am over 18 years of age and, if I

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[1] Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the '765 patent.

am called upon to do so, I would be competent to testify as to the matters set forth in this Declaration.

II. BACKGROUND AND QUALIFICATIONS

5. Below I provide a summary of my educational background, career history, publications, and other relevant qualifications.

6. I am a Professor of Textile Engineering in the Textile Engineering, Chemistry and Science (TECS) Department in the Wilson College of Textiles at North Carolina State University.

7. I am a Professor Emeritus of Textile Engineering in the Textile Engineering, Chemistry and Science (TECS) Department in the Wilson College of Textiles at North Carolina State University.

8. I graduated from Clemson University with a B.S. in Mechanical Engineering in 1982 and an M.S. in Fiber Science in 1985. In 1990, I earned my Ph.D., with a focus on Fiber and Polymer Science, from North Carolina State University.

9. I have 37 years of experience in the field of textile engineering and development. Since 1985, I have held various positions with NC State University's Department of Textile Engineering, Chemistry and Science ("TECS"). Between 2008 and 2014, I was the Department Head. I have served as Associate Dean for Academics in the Wilson College of Textiles and Interim Associate Dean for

General Education Program Implementation for NC State University. Presently, I am Professor Emeritus of Textile Engineering in the TECS Department, a title I have held since 2020.

10. Separately, I was the Interim Director of Zeis Textiles Extension Education for Economic Development (“ZTE”) between 2014 and May of 2019. ZTE provides training and certification in textiles and Lean Six Sigma, and serves the textile industry’s prototyping and pilot production needs in its laboratories – spun yarn, knitting, extrusion, weaving, physical testing, and chemical processing including dyeing and finishing.

11. Throughout my career, I have designed, manufactured, tested and/or provided expert testimony concerning many types traditional textile products and nontraditional as well. These have included patented hernia meshes, artificial turf, nasal swabs, warp knitted bale covers, dog-bite protection devices, non-lubricated slides using low friction filament yarns, rock-climbing ropes and a test method for testing castability of various filament fishing lines.

12. I have taught various courses at the undergraduate and graduate levels relating to textile engineering including, most recently, TMS 211, Introduction to Fiber Science; TT 327, Yarn Production and Properties; TE 201, Textile Engineering Science; TE 301, Engineering Textile Structures I: Linear Assemblies; TE 401 and 402 and Textile Engineering Design I and II.

13. I have received over $3 million in grant funds to conduct textile engineering research, with relevant projects including fabric development related to moisture management for use in performance apparel, textile material sustainability, color control and uniformity and process improvement related to many different textile processes. Most of my funding was sponsored by industry and therefore proprietary and not published.

14. For 17 years, I led multidisciplinary teams of students from several universities working on process improvement projects in the textile industry, including in connection with Milliken and Company, Burlington Industries, UNIFI and others.

15. While at NC State University, I received recognition for my work in textile engineering, including through awards and honors such as the Gertrude Cox Award: for *Innovative Excellence in Teaching and Learning with Technology*; the Division of Undergraduate Academic Programs Award: for *Outstanding Contributions to Undergraduate Education*; the Chancellors Creating Community Award for Outstanding Faculty Committed to Diversity; the NC State Alumni Distinguished Undergraduate Professor; and Outstanding Teacher at NC State University.

16. Throughout my career, I have written or co-written 40 peer-reviewed journal articles, most of which focused on the subject of textile engineering. My

substantial work in textile engineering also led to the issuance of the following U.S. Patents, of which I am a listed co-inventor: # **12,018,414:** "Warp Knit Fabric for Textile and Medical Applications and Methods for Manufacturing the Same", (w/ H. Levinson, JB Davis & D Ward), June 25, 2024; # **11,001,948:** "Warp Knit Fabric for Textile and Medical Applications and Methods for Manufacturing the Same", (w/ H. Levinson, JB Davis & B Ward), May 11, 2021; # **10,602,791:** "Multi-layered Protective Covering and Uses Thereof", (w/ Jur, Gorga, et al), 2020; # **8,261,415** ("An Apparatus for Cotton Ginning, Processes and Methods Associated Therewith"); # **8,120,769** ("Method and System for Fiber Properties Measurement"); # **6,882,423** ("Apparatus and Method for Precision Testing of Fiber Length Using Electrostatic Collection and Control of Fibers"); # **5,774,942** ("Feedforward and Feedback Autoleveling System for Automated Textile Drafting System"); # **5,796,220** ("Synchronous drive system for automated textile drafting system"); # **5,774,943** ("Tongue and Groove Drafting Roller Autoleveling System for Automated Textile Drafting System"); # **5,761,772** ("Securing and Pressuring System for Drafting Rollers for Automated Textile Drafting System"); and # **5,774,940** ("Draftless Sliver Coiler Packaging System for Automated Textile Drafting System"). I am also listed as a co-inventor on Chinese Patent No. **ZL200680044482.4** ("An Apparatus for Cotton Ginning, Processes and Methods Associated Therewith").

17. Accordingly, I am an expert in the field of textile engineering, and I was an expert in this field prior to June 29, 2015. As a result of my experience and frequent interaction with skilled artisans, I am familiar with the knowledge and understanding of a person of ordinary skill. In formulating my opinions set forth herein, I have relied upon my training, knowledge, and experience in the relevant art.

18. A complete statement of my industrial and academic and employment records including a listing of the above publications and patents is included with my curriculum vitae in Exhibit 1004.

19. Based on my professional experience, I believe I am qualified to testify as an expert on matters related to the patent at issue.

III. LEGAL STANDARDS

20. Petitioner's attorneys have explained to me the legal standards that apply in this case. My understanding of those standards is described below. I am not an attorney, and I do not have formal training in the law regarding patents. I have used my understanding of the following legal principles set forth in this section in reaching my opinions.

21. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims are invalid by a preponderance of the evidence.

A. Obviousness

22. I have been informed that a claim is invalid as obvious under 35 U.S.C. § 103 (pre-AIA) if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time of the invention to a person of ordinary skill in the art. I have been informed that the following matters are relevant to determining whether the claimed invention would have been obvious: (1) the scope and content of the prior art, (2) the difference or differences between the patent claim and the prior art, (3) the level of ordinary skill in the art at the time the invention of the patent, and (4) any secondary considerations or objective indicia of non-obviousness.

23. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a claim simply arranges prior art elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, then such a combination is obvious. When a patent claims a structure already known in the prior art altered by the mere substitution of one element for another known in the field, the combination is likely to be obvious unless the combination yields an unpredictable result.

24. I have been informed that when a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it,

either in the same field or a different one. If a person of ordinary skill in the art can implement a predictable variation, such a variation is likely unpatentable. For the same reason, if a technique has been used to improve one device, and one of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill. One question to consider is whether the improvement is more than predictable using prior art elements according to their established functions.

25. I have been informed that it may often be necessary, in a validity analysis, to consider whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. This can be accomplished by looking to interrelated teachings of multiple patents or other publications or pieces of prior art; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by one of ordinary skill in the art.

26. I have been informed that a validity analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim; it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I have been informed that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton.

27. I have been informed that a claim composed of several elements is not proved obvious merely by demonstrating that each element was, independently, known in the prior art. I have been informed that it can be important to identify a reason that would have prompted a person of ordinary skill in the art in the relevant field to combine the elements in the way the claimed new invention does. I am told that one way that subject matter can be proved obvious is by noting there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I have been informed that any need or problem known in the field of endeavor at the time of the claimed invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

28. I have been informed that one should not assume that a person of ordinary skill in the art attempting to solve a problem will be led only to those elements of prior art designed to solve the same problem. Instead, I have been informed that since familiar items may have obvious uses beyond their primary purposes, in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like pieces of a puzzle.

29. I have been informed that, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, persons of ordinary skill in the art have good reason to pursue the known options within their technical grasp. If this leads to the anticipated success, the

product was likely not accomplished by innovation but by using ordinary skill and common sense. I have been informed that, in such an instance, the fact that the combination was obvious to try may show that the combination was obvious.

30. I have been informed that, when determining whether a claimed combination would have been obvious, the correct analysis is not whether a person of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I have been informed that the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

31. I have been informed that, when determining whether a claimed invention is obvious, any "secondary considerations" of non-obviousness identified by the patentee should also be considered. These secondary considerations can include:

- commercial success of the invention, causally related to the invention itself rather than to companion factors, such as advertising or attractive packaging;

- the invention taught away from the technical direction followed by those skilled in the art;

- a long-felt but unsatisfied need for the invention while the needed implementing arts and elements had long been available;
- the invention achieves results unexpected to those skilled in the art;
- copying of the invention by competitors as distinguished from their independent development
- unsuccessful attempts by those skilled in the art to make the invention;
- acquiescence by the industry to the patent's validity by honoring the patent through taking licenses or not infringing the patent, or both; and
- skepticism, disbelief in or incredulity by those skilled in the art that the patentee's approach worked.

32. I have been informed that, for the above information to impact the obviousness of a patent claim, there must be a nexus between the alleged secondary considerations and the claims. In addition, I have been informed that the burden of introducing evidence of secondary considerations generally is on the Patent Owner. If the Patent Owner or its expert should assert secondary considerations of non-

obviousness, I reserve the right to provide a Declaration addressing assertions of non-obviousness due to secondary considerations.

B. Claim Construction

33. I have been informed that claim terms are typically given their plain and ordinary meanings, as would have been understood by a person of ordinary skill in the art at the time of the earliest alleged priority date. I have further been informed that when considering the meaning of any terms in the Challenged Claims of the ’765 patent, I should apply the plain and ordinary meaning of those terms. I have further been informed that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record.

34. I have been informed that in general, a preamble limits the invention if it recites essential structure or steps, or if it is necessary to give life, meaning, and vitality to the claim. I have further been informed that a preamble is not limiting where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I have further been informed that dependence on a particular disputed preamble phrase for antecedent basis may limit claim scope because it indicates a reliance on both the preamble and claim body to define the claimed invention. I have further been informed that clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation

because such reliance indicates use of the preamble to define, in part, the claimed invention.

IV. PERSON OF ORDINARY SKILL IN THE ART AND THE TIME OF THE ALLEGED INVENTION

35. I have been asked to assume that the ’765 patent is entitled to its earliest alleged priority date of June 29, 2015. *See* Ex. 1001. Beyond this assumption, I have not undertaken an analysis to determine the earliest priority date to which the ’765 patent is entitled.

36. Based on the materials and information I have reviewed and based on my experience in the technical areas relevant to the ’765 patent, a person of ordinary skill in the art at the time of the alleged invention of the ’765 patent would have had at least a Bachelor of Science degree in materials science and engineering, textile engineering, chemistry, or an equivalent field, and at least two years of experience with tire reinforcement cord design and manufacture, and/or fiber or polymer science and processing. More education can supplement practical experience and vice versa. Based on my knowledge and experience, including as discussed above in Section II, I exceeded the level of skill of a person of ordinary skill in the art at the time of the alleged invention of the ’765 patent and can provide opinions regarding the knowledge of a person of ordinary skill in the art as of that time. My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill

in the art at that time. I myself had more than these capabilities at the time of the alleged invention of the ’765 patent.

V. THE ’765 PATENT

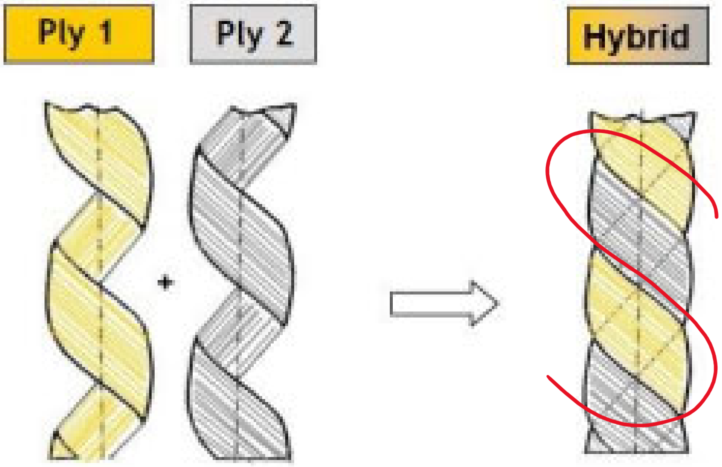
A. Background of the Technology

37. The ’765 patent is directed to manufacturing a hybrid tire cord by twisting together an aramid twisted yarn and a nylon twisted yarn. Below, I provide some background information helpful for understanding the role of tire cords within a tire.

38. One of the most important parts of a tire is its reinforcement. It provides strength and stability to the tire, like bones in a human body. Tire reinforcements can be made of various materials, including textiles. Originally, textile reinforcements were made of cotton, which was slowly replaced by rayon. And at the time of the ’765 patent, nylon and aramid tire reinforcement materials were prevalent—particularly for use in the tire’s cap ply. The “use of tire cords made from high tenacity organic fibers such as rayon, nylon, aramid, and polyester in a construction of moderate twist has remained the principal reinforcing method.” Rowan at ¶5.

39. One important way to improve tire performance is to improve the physical properties of the tire cord used as a reinforcing material. Ex. 1010 (Kwon), ¶2. Previously, reinforcement cords were entirely nylon or entirely aramid. Aramid

is a high-tenacity, high-modulus, low-elongation, and thermally-stable material. And nylon 6.6 is a high elongation, low-modulus, high-fatigue-resistant material. In the early 2000's, Michelin developed a new textile reinforcement which combined the beneficial aspects of nylon and aramid and significantly improved high-performance tires—i.e., the nylon-aramid hybrid reinforcement cord. Hybrid cords are a combination of two or more types of yarns plies twisted together (e.g., a nylon yarn and an aramid yarn).

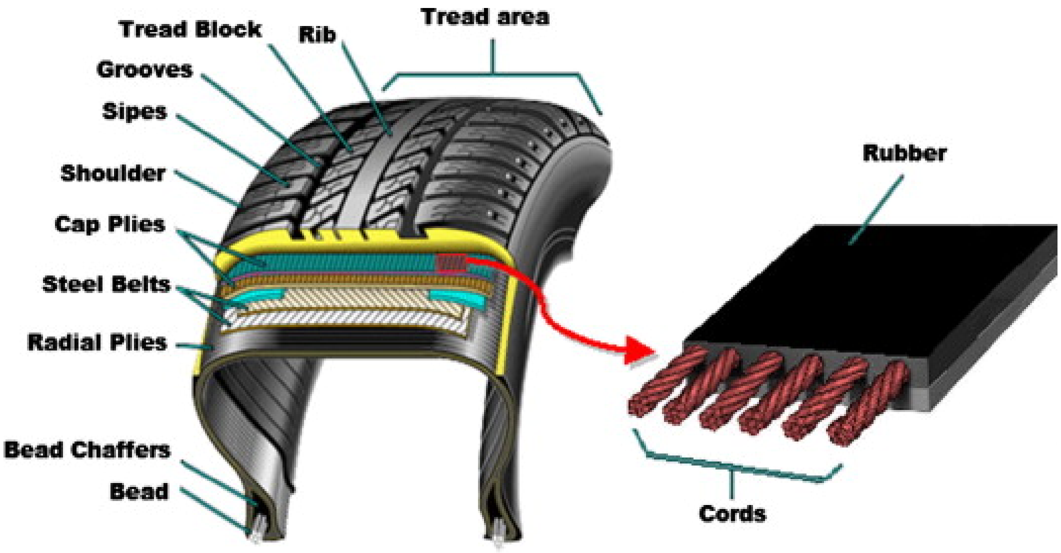


Wahl, G., Basics of Textile Reinforcement Materials for Tires (2006).

40. Each ply is twisted on its own axis and then with another ply before it is formed into a cord. The ply twisting directions are denoted by "z" and "s". If the direction of twist is from right to left, it is called "z" twist, and if the direction of twist is from left to right, it is called "s" twist. In some instances, each individual ply is twisted in the "z" direction and then the two individually-twisted plies are twisted together in "s" direction to form a cord. Twisting causes the cord to lose

tensile strength, but it simultaneously gains flex fatigue resistance. Hence the number of times a ply is twisted must strike a balance between tensile strength and flex fatigue resistance.

41. Further, because textile fabric adheres poorly to rubber, the textile reinforcements have long been treated with adhesive solutions, commonly Resourcinol-Formaldehyde-Latex or other epoxies, which acts as a bonding agent between the textile reinforcement cord and the rubber tire. The illustration below shows how reinforcement cords adhere to a rubber cap ply.



42. Drying and heat treating—i.e., stretching the textile cords at high temperatures—typically follows. This process reduces undesired thermal shrinkage.

43. On balance, aramid-nylon hybrid reinforcement cords were known to have better properties than the prior aramid-aramid and nylon-nylon cord constructions. For instance, when compared with aramid-aramid cords, the hybrid

cords have improved fatigue resistance, higher elongation, lower raw material cost, and controlled shrinkage. And when compared with nylon-nylon cords, the hybrid cord will have a lower shrinkage, improved handling and cornering stability, speed performance, and rolling resistance.

B. Description of the ’765 Patent’s Specification

44. The ’765 patent relates to “a hybrid tire cord including heterogeneous yarns having different physical properties,” and specifically that an aramid yarn is 1.005 to 1.025 times longer than the nylon yarn it is twisted with. Ex. 1001, 1:16-18; cl. 1.

45. The specification acknowledges that the typical materials for tire cords are nylon and aramid. *Id.*, 1:48-49. Nylon has “low cost, superior adhesivity and superior fatigue resistance,” but “has a problem of causing flat spots due to low modulus and great deformation with variation in temperature.” *Id.*, 1:49-56. Aramid, on the other hand, has “almost no flat spot phenomenon” due to “very high modulus,” but is “very expensive.” *Id.*, 1:57-64. Tire molding is also relatively more difficult due to the high modulus. *Id.*, 1:64-67.

46. The specification explains that it was known that such disadvantages with each material could be solved by a “hybrid cord to which both nylon and aramid are applied.” *Id.*, 1:1-3. The specification acknowledges that “[t]ypically,” the aramid yarn has a “greater twist number” compared to the nylon yarn, and the yarns

are twisted in opposite directions. *Id.*, 2:7-15. However, the specification alleges this method has "low production efficiency" because it requires a three-step process due to the yarns being twisted in opposite directions: (1) twisting the nylon yarn in one direction, (2) twisting the aramid yarn separately in the opposite direction, and (3) twisting the two yarns together. *Id.*, 2:25-33. Moreover, because the aramid yarn has a higher twist number, the strength of the aramid is "greatly deteriorated." *Id.*, 2:44-49.

47. Thus, the specification claims to invent a new method where the nylon and aramid yarn are twisted in the same direction, and thus "are conducted in one twister, thereby improving production efficiency," although this feature is not claimed. *Id.*, 3:33-38, 4:48-51. The alleged new method also uses less twists for the aramid yarn relative to the nylon yarn. *Id.*, 3:52-57. Finally, the aramid yarn is "1.005 to 1.025 times" the length of the nylon yard when the cord is untwisted. *Id.,* 3:33-42.

C. The '765 Patent's Prosecution History

48. I have reviewed the prosecution history of the '765 patent and summarize it below.

49. The application to the '765 patent was filed December 29, 2016 and claims priority to a June 29, 2015 Korean patent application.

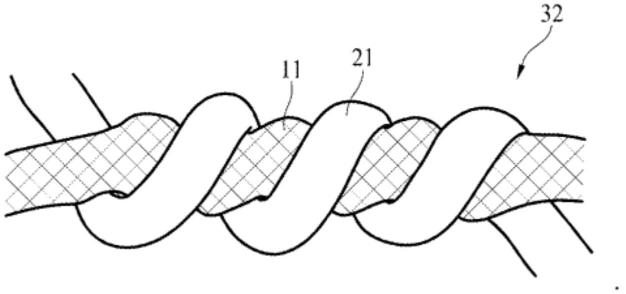
50. The primary difference between the original claims of the application and the allowed claims is that the original claims did not recite the limitation that the tire cord has a “merge structure having a partial covering structure.” The history for how that limitation was added is summarized below.

51. The examiner found that all of the original claims 1-6 were unpatentable over Love in view of Shepherd. Ex. 1002, 2-5. The examiner argued that while Love “fails to specifically teach” the specific claimed range of 0.1 to 5% lower twist number of the aramid yarn relative to the nylon yarn (Love instead teaches a larger range that includes part of the claimed range), it would have been obvious “to have utilized such a range, since it is understood that the degree of twist and longer length both contribute to the breaking strength of the material” and that a POSITA would have found the claimed range “through routine experimentation.” Ex. 1002, 82.

52. At first, the applicant did not respond by amending the claims. Instead, the applicant argued that the claimed tire cord “has a merge structure having a partial covering structure” (which was not yet recited in the claims), and that such a structure was not found in Love. Ex. 1002, 69. The applicant argued that “because the length of the aramid primarily twisted yarn is 1.005 to 1.025 times the length of the nylon primarily twisted yarn … after the secondary twist is untwisted, the hybrid tire cord can have a merge structure having a partial covering structure.” Ex. 1002,

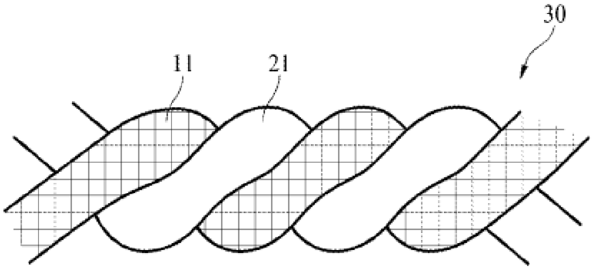
70. The applicant therefore indicated that the claimed difference in length of the yarns resulted in a "partial covering structure."

53. The applicant then went on to use figures from the application to distinguish the prior art tire cords. One such cord had what the applicant described as a "covering structure" with the aramid yarn 21 "covering" the nylon yarn 11, as shown in the below figure provided by the applicant. Ex. 1002, 71.



54. Although the applicant did not explain this, such a "covering structure" involves the aramid yarn having a noticeably longer length than the aramid yarn which it covers, which is why the aramid yarn appears to wrap around the nylon yarn.

55. The applicant also provided the below figure and described it as depicting a "merge structure," where the aramid yarn "has the identical structure" with the nylon yarn. Here, the aramid and nylon yarn are evenly wrapped around each other.



56. In this response, however, the applicant did not explain that this "merge structure" is ***not*** the claimed structure. That would not happen until later. For now, the applicant merely argued that "Love does not disclose the above features."

57. Following this response, the examiner issued a final rejection with the same wording as the first rejection. Ex. 1002, 61-62.

58. In response, the applicant amended claim 1 to include "the hybrid tire cord has a merge structure having a partial covering structure." The applicant then went on to make similar arguments as it did in its first response, though added additional details. First, the applicant argued that Love does not disclose the specific ranges for the differences in twist number ***and*** yarn length. Ex. 1002, 38.

59. The applicant then clarified that the first figure is a "conventional hybrid tire cord" where "the number of twist of the aramid primarily twisted yarn, the number of twist of the nylon primarily twisted yarn, and the number of twist of the secondarily twisted hybrid tire cord are different from each other." Ex. 1002, 39.

60. The applicant then went on to explain that the tire cord in the second figure has a "merge structure" produced "by secondarily twisting a nylon primarily twisted yarn and an aramid primarily twisted yarn, which have been primarily twisted in the same direction, in a direction opposite to the direction, wherein the secondary twisting is conducted such that the nylon and aramid primarily twisted yarns <u>have an identical structure</u>." Ex. 1002, 40. In other words, the specific twisting direction as claimed in claim 2 (where in the aramid and nylon yarns are twisted in the same direction, then twisted together in the opposite direction), and the yarns having an "identical structure," results in the merge structure of the second figure. However, the applicant clarified that the second figure embodiment "also has a drawback because the aramid primarily twisted yarn has a higher modulus than the nylon primarily twisted yarn and, thus, stress is intensely applied to the aramid primarily twisted yarn upon repeated tension and compression of tires, which inevitably causing a low fatigue resistance of the tire cord and resulting in a difficulty of securing safety of tires during long-term high-speed driving." Ex. 1002, 40.

61. Thus, the applicant argued that the claimed hybrid tire cord has a "merge structure having partial covering," which solves the problems of both figures. The applicant provided experimental data showing that "twist number of the aramid primarily twisted yarn is increased and the length of the aramid primarily twisted yarn is controlled to be longer than the nylon primarily twisted yarn,"

resulting in the claimed improved tire cord. Ex. 1002, 41-42. In other words, the applicant argued that the "merge structure having partial covering" is a result of the specific claimed differences in twist numbers and length of the yarns.

62. The applicant went on to provide additional experimental results from an experiment where applicant "attempted to produce a raw cord according to the process [and materials] described in Love" and tested their properties. Ex. 1002, 42-45. Notably, the applicant was able to produce raw cords that met the claimed differences in twist number and length. *Id.* The applicant then noted that the test data for these raw cords "clearly demonstrate ***that the claimed hybrid tire cords exhibit superior uniformity of physical properties, superior fatigue resistance***." Ex. 1002, 45. Applicant argued, however, that such superior results "only could be obtained thanks to the ***particular combination of the twist number and the different lengths of the aramid and nylon yarns*** contained in the dip cord, wherein the differences were finely controlled during the dip cord manufacturing process by way of heat treatment and tension applications; and such conditions and the superior results were not predicted or expected from the teaching of Love which is silent on these conditions." *Id.*, 45.

63. Following this response, the examiner allowed the claims, though did not provide any explanation. Ex. 1002, 22.

64. In my opinion, the prosecution history shows that the applicant was able to obtain the allowed claims by (1) amending the claims to add the limitation of the tire cord having a "merge structure having a partial covering structure," (2) arguing that such structure is a result of the specific claimed difference in twist number and yarn length, and (3) that this specific claimed different in twist number and yarn length resulted in improved physical properties that were unexpected and therefore would not have been obvious based on Love's teachings.

65. But as I explain below, these claimed differences in twist number and yarn length were well-known in the art, and in view of those teachings, it would have been obvious to incorporate them into an aramid-nylon hybrid cord.

D. Claim Construction

66. For the purposes of my analysis in this IPR proceeding, I understand that the words of a claim are given their plain meaning that those words would have had to a POSITA at the time of the alleged invention. I also understand that the structure of the claims, the specification, and the prosecution history may also be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a POSITA to a claim term at the time of filing. Furthermore, I understand that a Patent

Owner's own apparent interpretation of certain terms in related proceedings can be considered to determine the meaning of patent claims in an IPR proceeding.

67. I have followed this approach in my analysis, and, except as explicitly stated below, I have applied the plain and ordinary meaning of those terms as the would have been interpreted by a POSITA at the time the invention was made (not today). For purposes of my analysis here, I have used June 29, 2015 as the date of the invention.

68. I first note that the '765 patent's specification provides descriptions for certain terms found in the claims. In my opinion, these descriptions are consistent with the terms' plain meaning. However, while I do not provide any opinion as to whether the patentee acted as their own lexicographer, I apply these descriptions as definitions for their respective term.

1. "primarily twisted yarn"

69. The specification of the '765 patent states that the term "primarily twisted yarn" "refers to a single yarn made by twisting one filament yarn in one direction." Ex. 1001, 5:29-31. I apply this description in my analysis below.

2. "plied yarn"

70. The specification states that this term "refers to a yarn made by twisting two or more primarily twisted yarns together in one direction." *Id.*, 5:32-34. The

specification notes that this term is "also called a 'raw cord.'" *Id.* I apply this description in my analysis below.

3. "tire cord"

71. The specification states that the term "tire cord" "includes the 'raw cord' as well as 'dip cord' which means a plied yarn containing an adhesive agent so that it can be directly applied to rubber products." *Id.*, 5:35-38. In other words, a tire cord can mean either an untreated raw cord, or a dip cord that is the result of dipping a tire cord into an adhesive agent solution to apply it to a rubber product. I apply this description in my analysis below.

4. "twist number"

72. The specification states that the term "twist number" "means the number of twists per one meter and its unit is TPM (twist per meter)." *Id.*, 5:42-43. I apply this description in my analysis below.

5. "merge structure having a partial structure"

73. I understand that in the parallel litigation, Petitioner has asserted this term is indefinite because the term "partial" lacks definite boundaries. On the other hand, Patent Owner proposes a construction of "a structure where both the nylon and aramid yarns have been twisted together where each yarn partially covers the other." Ex. 1040, 19-22.

74. For the purposes of this proceeding only, Petitioner analyzes this limitation using Patent Owner's proposed construction and in view of Patent Owner's infringement contentions.

75. However, as I noted above in my summary of the prosecution history, this term was at issue during prosecution. As I explained above, the applicant argued during prosecution that this limitation is distinguishable from a "covering structure" where only one yarn covers the other yarn ***and*** a depiction of a "merge structure" where the yarns have "identical structure." Ex. 1002, 40-42. The applicant contended that both structures exhibited problems. The applicant argued that a "merge structure having a partial covering structure … solves [these] problems" because of the claimed differences in yarn length and twist number. Ex. 1002, 40-45, 45 ("[S]uch superior results only could be obtained thanks to the ***particular combination of the twist number and the different lengths*** of the aramid and nylon yarns contained in the dip cord").

76. In addition, the specification notes that in the claimed embodiment, "the length of the aramid primarily twisted yarn is 1.005 to 1.025 times the length of the nylon primarily twisted yarn"—"***[t]hat is***, the hybrid tire cord of the present invention has a ***merge structure having a partial covering structure***." Ex. 1001, 5:67-6:4. In other words, the specification supports the notion that a "merge structure having a partial covering structure" is a result of the claimed difference in

yarn length and twist number. I analyze this limitation using both Patent Owner's construction and the understanding that this structure results from a tire cord with the claimed differences.

VI. OVERVIEW OF THE PRIOR ART

A. Nakayasu (Ex. 1007)

77. U.S. Pat. No. 5,558,144 ("Nakayasu") was issued September 24, 1996.

78. Nakayasu discloses a tire cord made from twisting two primarily twisted yarns of different materials: nylon and aramid. Nakayasu at 2:44-2:67 ("[A] pneumatic radial tire comprises … ***the hybrid cord*** comprising a low elastic modulus thread and a high elastic modulus thread"); 3:16 ("[T]he low elastic modulus fiber, ***nylon fibre***"), 5:23-24 ("To form a high elastic modulus thread 21, one or more ***aramid fibers*** are first-twisted together in a certain direction."). Nakayasu discloses that the nylon fiber and the aramid fiber are twisted in the same direction to form their respective threads, and then the two threads are "finally-twisted together … to form a hybrid cord 23." *Id.*, 5:23-28. The threads are twisted "in the reverse direction to the first-twist." *Id.*

B. Fritsch (Ex. 1023)

79. U.S. Pat. App. Pub. No. 2003/0159768 ("Fritsch") was published August 28, 2003.

80. Fritsch teaches a method for creating a cord with an "unbalanced configuration" which "means that at least two yarns [of the cord] have different

lengths." Fritsch at ¶19. Fritsch notes that its method results in a "hybrid cabled cord of polymeric materials having excellent properties at a reduced capital cost and is useful as a tire cord." *Id.*, ¶2. As Fritsch explains it, with conventional twisting machines, their design "is intended to achieve a balanced tension control in the cabled cord produced which effectively means that the two yarns are pulled off with the same rate and thus equal lengths are incorporated into the cabled cord." *Id.*, ¶24. But Fritsch's inventors discovered that "modulat[ing] the tension on the individual plies" can result in an "unbalanced configuration" where one yarn is longer than the other when untwisted. *Id.*, ¶25. This results in a cord with "greater tensile strength retention." *Id.*, ¶27.

81. In order to quantify the difference in length of the yarns, Fritsch describes a measurement called a Coring level, which is the percentage difference in length of the higher modulus yarn relative to the lower modulus yarn. *Id.*, ¶¶19-20. For example a Coring level of 5% means the higher modulus yarn is 5% longer than the lower modulus yarn. *Id.*

82. Fritsch provided experimental results that showed an improvement with unbalanced configurations, *i.e.* a non-zero Coring level. Specifically, Fritsch tested 10 "inventive examples" using PEN (polyethylene napthalate) and PET (polyethylene terephthalate) materials, with Coring level ranges from -15% to 15%, and compared their physical properties to three cords with 0% Coring level. These

results are shown in Table 1, reproduced below. *Id.*, ¶40. The table shows that having a positive Coring level results in "a combination of a high breaking strength and a high elongation at break." *Id.*, ¶41. Fritsch notes that the desired combination of "physical properties (breaking strength, elongation at break, energy to break and modulus) can be optimized by an appropriate coring level." *Id.*

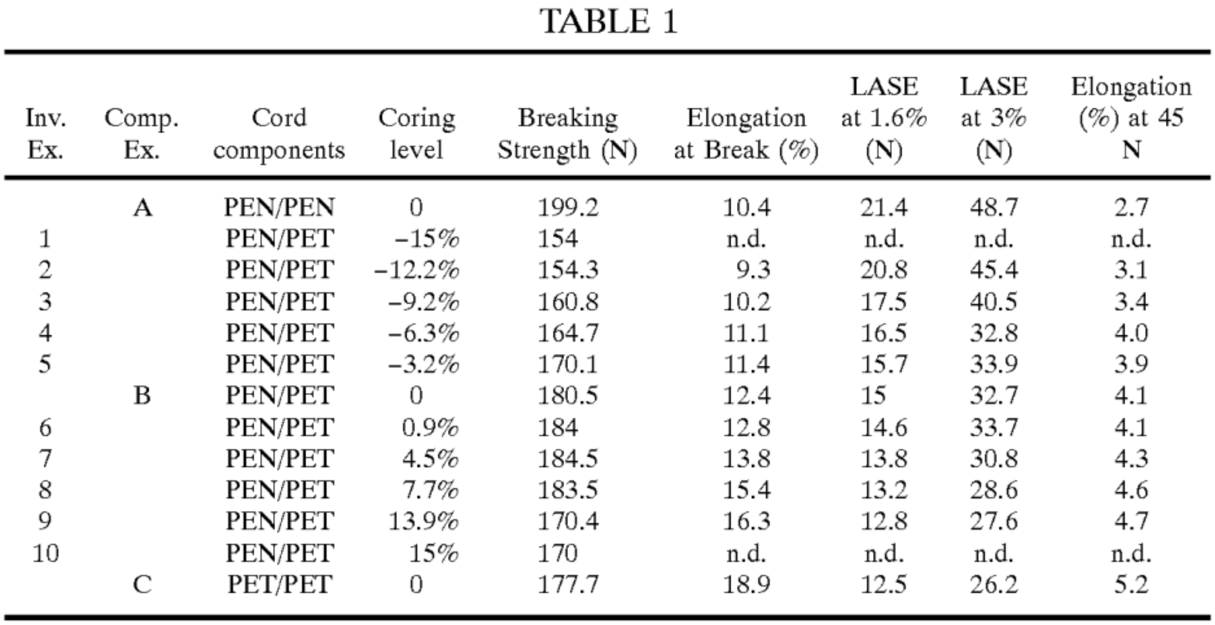


TABLE 1

Inv. Ex.	Comp. Ex.	Cord components	Coring level	Breaking Strength (N)	Elongation at Break (%)	LASE at 1.6% (N)	LASE at 3% (N)	Elongation (%) at 45 N
	A	PEN/PEN	0	199.2	10.4	21.4	48.7	2.7
1		PEN/PET	−15%	154	n.d.	n.d.	n.d.	n.d.
2		PEN/PET	−12.2%	154.3	9.3	20.8	45.4	3.1
3		PEN/PET	−9.2%	160.8	10.2	17.5	40.5	3.4
4		PEN/PET	−6.3%	164.7	11.1	16.5	32.8	4.0
5		PEN/PET	−3.2%	170.1	11.4	15.7	33.9	3.9
	B	PEN/PET	0	180.5	12.4	15	32.7	4.1
6		PEN/PET	0.9%	184	12.8	14.6	33.7	4.1
7		PEN/PET	4.5%	184.5	13.8	13.8	30.8	4.3
8		PEN/PET	7.7%	183.5	15.4	13.2	28.6	4.6
9		PEN/PET	13.9%	170.4	16.3	12.8	27.6	4.7
10		PEN/PET	15%	170	n.d.	n.d.	n.d.	n.d.
	C	PET/PET	0	177.7	18.9	12.5	26.2	5.2

VII. GROUNDS OF REJECTION

A. __Ground 1__: Nakayasu in View of Fritsch Renders Obvious Claims 1-6

83. A summary of this ground is as follows. Nakayasu is directed to what was well-known at the time of the ’765 patent: a hybrid tire cord comprising an aramid yarn and a nylon yarn, where the aramid and nylon yarns are individually twisted in the same direction, and then are together twisted in the opposite direction. Nakayasu also describes several embodiments where the aramid and nylon yarns are

individually twisted with different twist numbers. In one of these embodiments, the aramid yarn has a slightly lower twist number than the nylon yarn. Finally, Fritsch describes having a high modulus yarn have a slightly longer length (0.9%) than a low modulus yarn, which can be achieved by applying less tension to the higher modulus yarn.

84. Together, these references render obvious each and every limitation of claims 1-6, and as I explain below, a POSITA would have been motivated to combine these references.

1. Motivation to Combine

85. In my opinion, a POSITA would have found it obvious and been motivated to combine Nakayasu's hybrid tire cord with Fritsch's teachings of a hybrid cord where a high modulus yarn is 0.9% longer than a low modulus yarn. The combination would therefore result in Nakayasu's hybrid tire cord where the aramid yarn is 0.9% longer than the nylon yarn. Fritsch teaches that this difference in length provides beneficial improvements to the physical properties of the tire cord.

86. Specifically, Fritsch teaches a method for creating a cord with an "unbalanced configuration" which "means that at least two yarns [of the cord] have different lengths." *Id.*, ¶19. Fritsch further teaches that an unbalanced configuration can be achieved by changing the tension applied to each yarn during twisting.

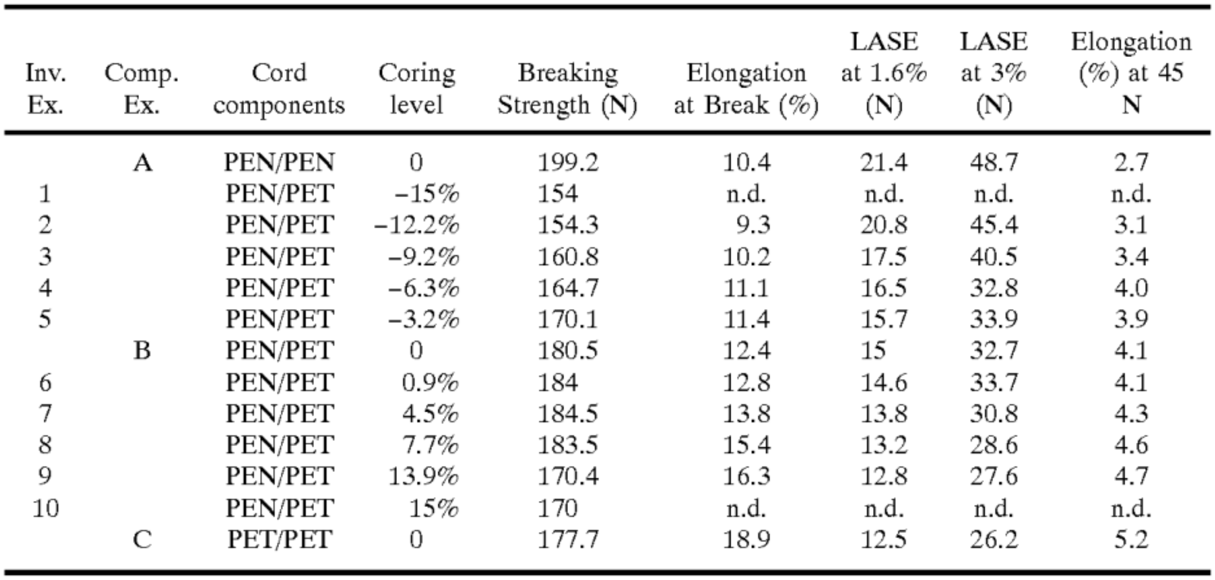
87. A POSITA would be motivated to combine such teachings because of the benefits described within Fritsch. Fritsch discovered that by having different yarn lengths, this results in a "hybrid cabled cord of polymeric materials having excellent properties at a reduced capital cost and is useful as a tire cord." Fritsch at ¶2. As Fritsch explains it, with conventional twisting machines, their design "is intended to achieve a balanced tension control in the cabled cord produced which effectively means that the two yarns are pulled off with the same rate and thus equal lengths are incorporated into the cabled cord." *Id.*, ¶24. But Fritsch's inventors discovered that "modulat[ing] the tension on the individual plies" can result in an "unbalanced configuration" where one yarn is longer than the other when untwisted. *Id.*, ¶25. This results in a cord with "greater tensile strength retention." *Id.*, ¶27.

88. In order to quantify the difference in length of the yarns, Fritsch describes a measurement called a Coring level, which is the percentage difference in length of the higher modulus yarn relative to the lower modulus yarn. *Id.*, ¶¶19-20. For example a Coring level of 5% means the higher modulus yarn is 5% longer than the lower modulus yarn. *Id.*

89. Fritsch provided experimental results that showed an improvement with unbalanced configurations, *i.e.* a non-zero Coring level. Specifically, Fritsch tested 10 "inventive examples" using PEN (polyethylene napthalate) and PET (polyethylene terephthalate) materials, with Coring level ranges from -15% to 15%,

and compared their physical properties to three cords with 0% Coring level. These results are shown in Table 1, reproduced below. *Id.*, ¶40. The table shows that having a positive Coring level results in "a combination of a high breaking strength and a high elongation at break." *Id.*, ¶41. Fritsch notes that the desired combination of "physical properties (breaking strength, elongation at break, energy to break and modulus) can be optimized by an appropriate coring level." *Id.*

TABLE 1



Inv. Ex.	Comp. Ex.	Cord components	Coring level	Breaking Strength (N)	Elongation at Break (%)	LASE at 1.6% (N)	LASE at 3% (N)	Elongation (%) at 45 N
	A	PEN/PEN	0	199.2	10.4	21.4	48.7	2.7
1		PEN/PET	−15%	154	n.d.	n.d.	n.d.	n.d.
2		PEN/PET	−12.2%	154.3	9.3	20.8	45.4	3.1
3		PEN/PET	−9.2%	160.8	10.2	17.5	40.5	3.4
4		PEN/PET	−6.3%	164.7	11.1	16.5	32.8	4.0
5		PEN/PET	−3.2%	170.1	11.4	15.7	33.9	3.9
	B	PEN/PET	0	180.5	12.4	15	32.7	4.1
6		PEN/PET	0.9%	184	12.8	14.6	33.7	4.1
7		PEN/PET	4.5%	184.5	13.8	13.8	30.8	4.3
8		PEN/PET	7.7%	183.5	15.4	13.2	28.6	4.6
9		PEN/PET	13.9%	170.4	16.3	12.8	27.6	4.7
10		PEN/PET	15%	170	n.d.	n.d.	n.d.	n.d.
	C	PET/PET	0	177.7	18.9	12.5	26.2	5.2

90. Based on these improved results, in my opinion, a POSITA would have been motivated use one or more of these Coring levels with the hybrid cord of Nakyasu in order to achieve the improved physical properties found in Fritsch. One such Coring level is 0.9%, used by "Inv. Ex. 6." In my opinion, a POSITA would be particularly motivated to use this Coring level because it provides a good combination of high values for Breaking Strength, Elongation at Break, LASE at

1.6% and LASE at 3%. *Id.*, ¶40. As I discuss in fuller detail below, "LASE" stands for "load at specified elongation," and is the amount of load needed to elongate the tire cord at the specified amount. For example, the 0.9% Coring level embodiment in Fritsch required 14.6 Newtons of force to elongate by 1.6%

91. I do note that Fritsch states that it is directed to a cord with Coring level between 3% to 15%. Fritsch at ¶9. However, a POSITA would understand that the 0.9% Coring level provides excellent results, and thus a POSITA would still be motivated to use a Coring level of 0.9%. I understand that obviousness does not require using the most optimal result provided in the prior art.

92. It is also my opinion that a POSITA would have considered it obvious to try the 0.9% Coring level with Nakayasu's tire cord. Fritsch only provides a finite set of Coring levels, and in particular, the positive Coring level cords show good physical properties. Thus, a POSITA would have found it obvious to try them.

93. It is also my opinion that, even though Fritsch describes a Coring level of 0.9% for a PEN/PET hybrid cord, a POSITA would have understood that the disclosed benefits would also apply to an aramid/nylon hybrid cord. First, Fritsch itself contemplates an aramid/nylon hybrid cord as one of its inventive cords. Fritsch at cls. 8-9. Second, an aramid/nylon hybrid cord uses material with a higher modulus (aramid) and material with a lower modulus (nylon), which is similar to a PEN/PET hybrid cord, as Fritsch describes PEN as having a higher modulus and PET having

a lower modulus. Fritsch at ¶¶20-21. Third, Fritsch expressly teaches that cords using aramid and nylon are "[p]olymeric yarns useful in the inventive method and product" and expressly teachessuch cords preferably have a coring level between -25% and 25%. *Id.*, ¶29.

94. Furthermore, it is also my opinion that although Fritsch is directed to altering the tension of an apparatus called a direct cabler, a POSITA would have nevertheless found it obvious to apply Fritsch's teachings to any apparatus for twisting yarn, including ring twisters, as a POSITA would be motivated by the benefits of an "unbalanced configuration" as described in Fritsch regardless of the type of twister used for manufacturing the tire cord.

95. In my opinion, a POSITA would have had a reasonable expectation of success in combining the references. A POSITA would have understood that Fritsch's method of modulating the tensions would have been well-within the skill of an ordinary artisan to implement in the manufacture of tire cords. Fritsch also explains that its method is useful for all sorts of yarn materials, including "aramid, nylon-6, nylon-6,6 and nylon-4,6," the same materials disclosed by Nakayasu. Fritsch at ¶29. In addition, Fritsch specifically teaches applying an unbalanced configuration of hybrid cord using nylon-6 yarn and aramid yarn or using nylon-6,6 yarn and aramid yarn. Fritsch at cls. 8-9. Thus, a POSITA would have expected the

combination to yield the predictable result of improving the physical properties of Nakayasu's tire cord.

96. In my opinion, Fritsch, Nakayasu, and the '765 patent are all directed to the same field of endeavor of manufacturing cords from twisting strands of yarn. Nakayasu at Abstract ("The hybrid cord includes a low elastic modulus thread and a high elastic modulus thread which are finally-twisted together"); Fritsch at Abstract ("The present invention is directed to a hybrid cabled cord comprising: at least two yarns having different properties and an unbalanced configuration wherein the hybrid cabled cord has improved tensile strength retention."); Ex. 1001 at Abstract ("The hybrid tire cord includes a nylon primarily twisted yarn and an aramid primarily twisted yarn, wherein the nylon primarily twisted yarn and the aramid primarily twisted yarn are secondarily twisted together").

2. Claim 1

(i) 1[pre]: A method of manufacturing a hybrid tire cord comprising:

97. In my opinion, Nakayasu discloses this limitation, to the extent the preamble is limiting.

98. Nakayasu discloses a tire cord made from twisting two primarily twisted yarns of different materials: nylon and aramid, *i.e.* ***a hybrid tire cord***. Nakayasu at 2:44-2:67 ("[A] pneumatic radial tire comprises … ***the hybrid cord*** comprising a low elastic modulus thread and a high elastic modulus thread"); 3:16

("[T]he low elastic modulus fiber, ***nylon fibre***"), 5:23-24 ("To form a high elastic modulus thread 21, one or more ***aramid fibers*** are first-twisted together in a certain direction."). As discussed below in limitations 1[a], 1[b], and 1[c], Nakayasu discloses a hybrid tire cord made by twisting together an aramid primarily twisted yarn and a nylon primarily twisted yarn.

99. As I discussed above, the '765 patent specification describes a "tire cord" as including either a raw cord or a dip cord. Ex. 1001, 5:35-38. In my opinion, Nakayasu's hybrid cord is a ***raw cord*** because it is formed by twisting two threads and is therefore untreated at the time it is formed. Nakayasu at 5:26:28.

(ii) 1[a]: a nylon primarily twisted yarn; and

100. In my opinion, Nakayasu discloses this limitation.

101. Nakayasu discloses that "to form a low elastic modulus thread 22 [*i.e.* ***nylon primarily twisted yarn***], one or more nylon fibers are first-twisted together." Nakayasu at 5:24-26. The "low elastic modulus thread" is a "primarily twisted yarn" as described in the specification because it is a nylon filament yarn twisted in one direction.

(iii) 1[b]: an aramid primarily twisted yarn,

102. In my opinion, Nakayasu discloses this limitation.

103. Nakayasu discloses that the "one or more aramid fibers are first-twisted together in a certain direction" in order "[t]o form a high elastic modulus thread 21,"

i.e. ***aramid primarily twisted yarn***. Nakayasu at 5:23-24. The "high elastic modulus thread" is a "primarily twisted yarn" as described in the specification because it is an aramid filament yarn twisted in one direction.

> *(iv) 1[c]: wherein the nylon primarily twisted yarn and the aramid primarily twisted yarn are secondarily twisted together,*

104. In my opinion, Nakayasu discloses this limitation.

105. Nakayasu teaches a step where high elastic modulus thread 21 (*i.e.* ***aramid primarily twisted yarn***) and the low elastic modulus thread 22 (*i.e.* ***nylon primarily twisted yarn***) are "finally-twisted together … to form a hybrid cord 23," *i.e.* ***secondarily twisted together***. Nakayasu at 5:23-28.

> *(v) 1[d]: if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, a length of the aramid primarily twisted yarn would be 1.005 to 1.025 times a length of the nylon primarily twisted yarn,*

106. In my opinion, Nakayasu in view of Fritsch renders obvious this limitation.

107. Fritsch discloses a cord with an "unbalanced configuration" where one of the cord's yarns has a Coring level of 0.9%, that is, the higher modulus yarn is 0.9% longer than the cord's lower modulus yarn, *i.e.* ***1.005 to 1.025 times the length***. As I discussed above, a POSITA would have been motivated to combine Fritsch's teachings with Nakayasu.

108. Fritsch teaches that the ratio of the lengths of the yarns is measured using a value called "coring level," which Fritsch discloses can be ***1.005 to 1.025 times longer***. Fritsch at ¶19. The "coring level" is measured by "taking a sample of one meter of cabled cord [*i.e.* ***hybrid tire core with a predetermined length***] and ***untwisting*** the cable in order to separate the two yarns which compose it," following which the two yarns "are then ***untwisted*** by the same number of turns as it took to separate the cable, and in the opposite direction, to yield the two yarns in their as-fed state," *i.e.* ***the hybrid tire cord is untwisted***. Fritsch at ¶19. The "coring level" is calculated as $Coring = (A - B)/B$ "wherein A is the length of the yarn having the higher modulus," *i.e.* ***the aramid primarily twisted yarn***, and "B is the length of the yarn having the lower modulus," *i.e.* ***the nylon primarily twisted yarn***. *Id.*

109. A Coring level of 0.005 to 0.025, or ***0.5% to 2.5%***, corresponds with the higher modulus yarn being ***1.005 to 1.025 times longer*** than the lower modulus yarn.

110. Fritsch teaches Coring levels of 0.5% to 2.5%. Fritsch mentions that a "[p]referred" Coring level is a "non-zero" value "no greater than about 25% and no less than about -25%," which includes the claimed range. Fritsch at ¶29.

111. For example, in Table 1, one of the "inventive cords" that was tested had a Coring level of 0.9%. Fritsch at ¶40. Notably, this cord had a relatively high Breaking Strength of 184 (second highest among the tested cords) and a relatively

high Elongation at Break percentage of 12.8%. *Id.* Fritsch notes that it is desirable to balance the two values. *Id.*, ¶41. The desirable breaking strength of this inventive cord is depicted in the below annotated Figure 2, which is a graph of the Coring level of the tested inventive cords against their Breaking Strength.

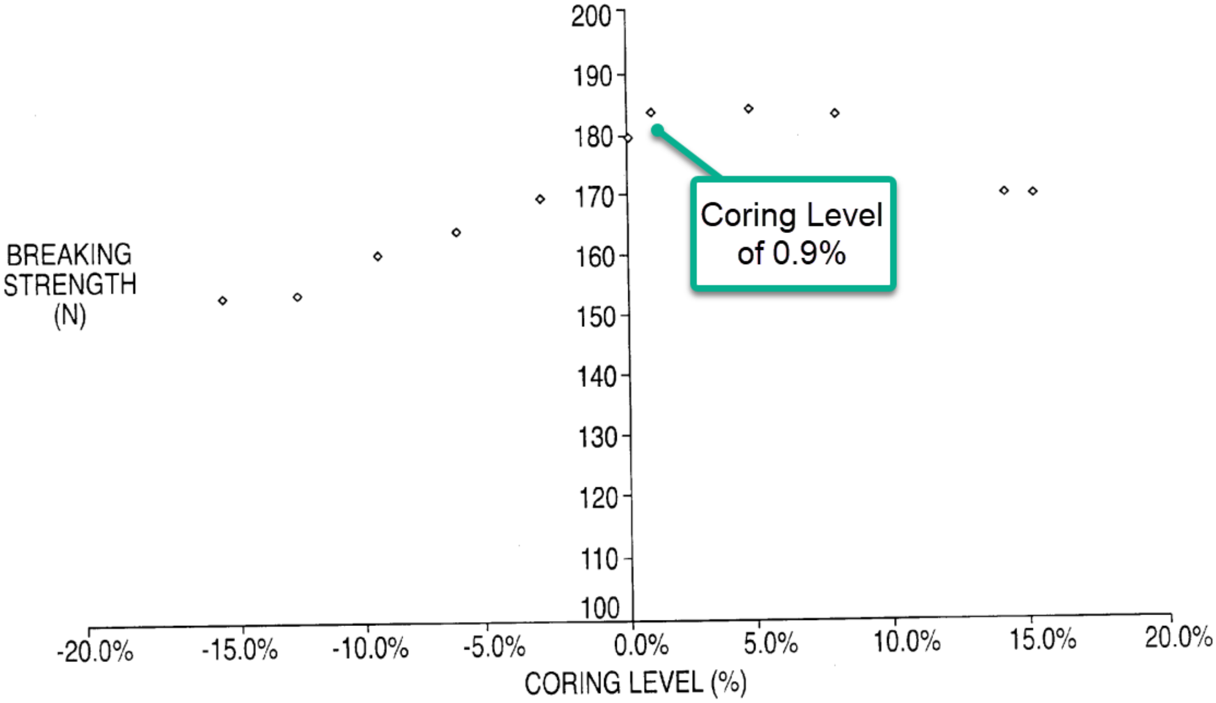


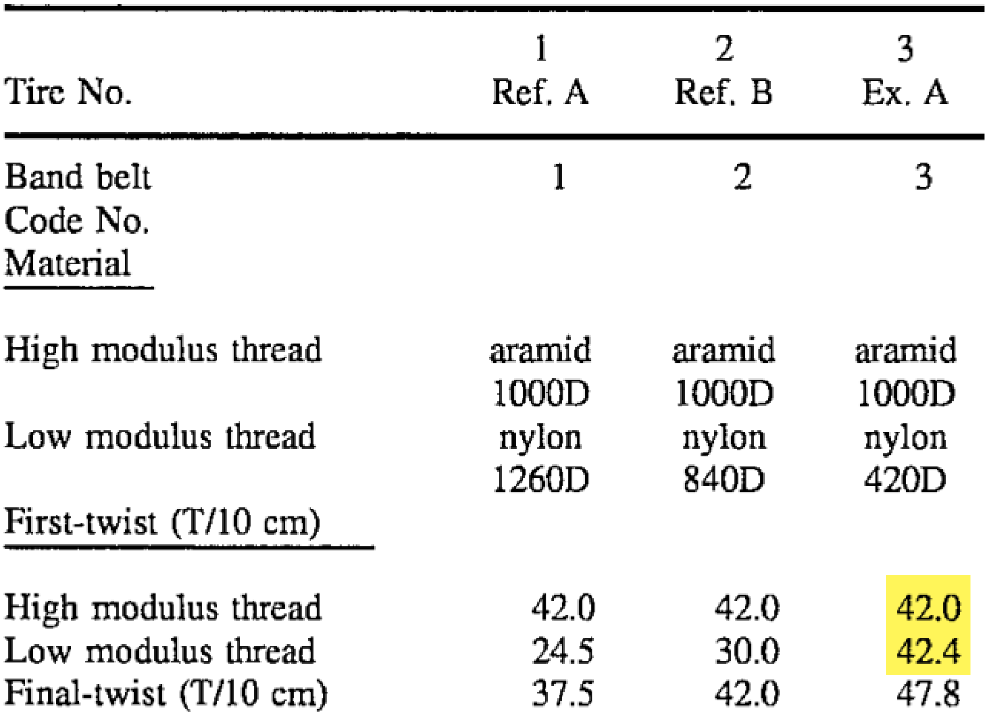
FIG. 2

> *(vi) 1[e]: the aramid primarily twisted yarn has a 0.1 to 5% lower twist number than a twist number of the nylon primarily twisted yarn, and*

112. In my opinion, Nakayasu discloses this limitation.

113. Nakayasu discloses a tire cord embodiment where its ***aramid primarily twisted yarn*** has a ***0.9% lower twist number*** than that of its ***nylon primarily twisted yarn***. Nakayasu teaches as a general matter that "rigidity [of the tire cord] can be increased by … decreasing the first-twist of the high elastic modulus thread," *i.e.* ***the***

aramid primarily twisted yarn. Nakayasu at 3:43-47. Consistent with this teaching, Table 1 of Nakayasu, which “shows the specifications of [nine] test tires,” shows that the third tire cord “Ex. A” had an aramid “[h]igh modulus thread” with “42.0” twists per 10 cm (or 420 twists per meter (TPM)) and a nylon “[l]ow modulus thread” with “42.4” twists per 10 cm (or 424 TPM). Nakayasu at 5:38, 6:21-22, Table 1. 420 TPM is 0.9% lower than 424 TPM, which falls within the claimed range.



Tire No.	1 Ref. A	2 Ref. B	3 Ex. A
Band belt Code No.	1	2	3
Material			
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D
First-twist (T/10 cm)			
High modulus thread	42.0	42.0	42.0
Low modulus thread	24.5	30.0	42.4
Final-twist (T/10 cm)	37.5	42.0	47.8

(vii) 1[f]: the hybrid tire cord has a merge structure having a partial covering structure.

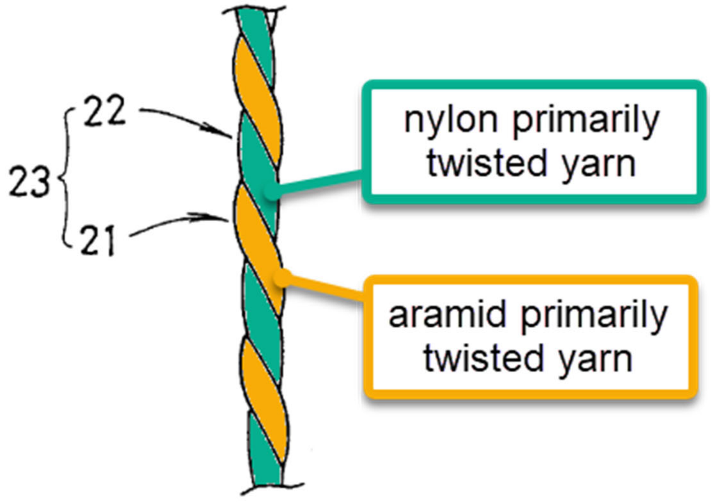
114. In my opinion, Nakayasu discloses this limitation.

115. As I mentioned above, I understand that Patent Owner has proposed that the term “merge structure having a partial covering structure” be construed as “a structure where both the nylon and aramid yarns have been twisted together where

each yarn partially covers the other." Ex. 1040, 19. In my opinion, under this construction, Nakayasu discloses this limitation.

116. As I discussed above in limitation 1[c], Nakayasu discloses that the nylon and aramid yarns are "finally-***twisted together*** … to form a hybrid cord." Nakayasu at 5:23-28. As depicted in Figure 4 of Nakayasu, the yarns are twisted together such that ***each yarn partially covers the other***.

Fig. 4



117. Nakayasu states that Figure 4 is "an exterior view of hybrid cord No. 2." Nakayasu at 4:29. However, I rely on Nakayasu's "Ex. A" embodiment, which is a hybrid tire cord with yarns with the claimed difference in twist numbers. However, in my opinion, a POSITA would understand that Nakayasu's "Ex. A" hybrid cord would have a similar merge structure as shown in Figure 4. A POSITA would understand that the difference twist numbers of the yarns in "Ex. A" is

relatively close (420 TPM and 424 TPM), at least moreso than the difference for "hybrid cord No. 2" (420 TPM and 300 TPM). As I discussed above, applicant had argued that the "merge structure" of Figure 2 provided by applicant is a result of the two yarns having an "identical structure," whereas the "covering structure" of the Figure 1 provided by applicant is a result of the two yarns having relatively high different lengths and twist numbers. Ex. 1002, 61-62, 38-40.

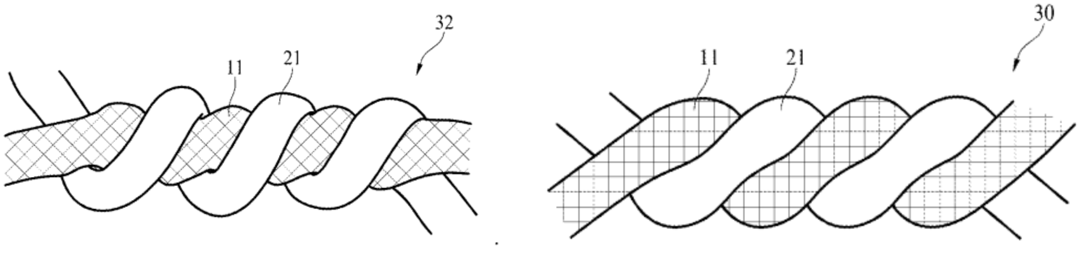
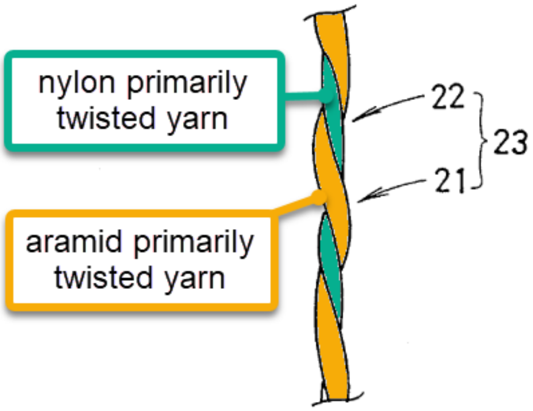


Fig. 1 ("covering structure") (left), Fig. 2 ("merge structure") (right)

118. Because Nakayasu's "Ex. A" embodiment has yarns that are closer to an identical structure (*i.e.* less difference in TPM) than the "hybrid cord No.2" embodiment, a POSITA would understand that the "Ex. A" embodiment would have a structure that more closely resembles the "merge structure" of Figure 2 that applicant introduced. This can be seen in Figure 5 of Nakayasu, which depicts "hybrid cord No. 6." This figure depicts a hybrid tire cord that has less of "merge structure" and more of a "covering structure" compared to Figure 4's "hybrid cord No. 2." Ex. 1001, 4:30. Consistent with that depiction, the difference in twists between the aramid and nylon yarns of "hybrid cord No. 6" (420 TPM vs. 100 TPM)

is significantly larger than both “hybrid Cord No. 2” (420 TPM vs. 300 TPM) and “Ex. A” (420 TPM vs. 424 TPM). Ex. 1001, Table 1.

Fig.5



119. In addition, Fritsch also discloses that its tire cord with yarns of uneven length has a ***merge structure having a partial covering structure***. For example, Figure 1 is an illustration of its “inventive hybrid cabled card illustrating a coring level not equal to zero,” which depicts a cord having a merge structure with a partial covering structure. In this figure, yarn 10 “has the higher modulus” (*e.g.* aramid) and thus has a “greater length … than yarn 12,” resulting in a positive Coring level. Fritsch at ¶21. Consistent with the above, yarn 10 partially covers yarn 12 while the cord still exhibits a merge structure.

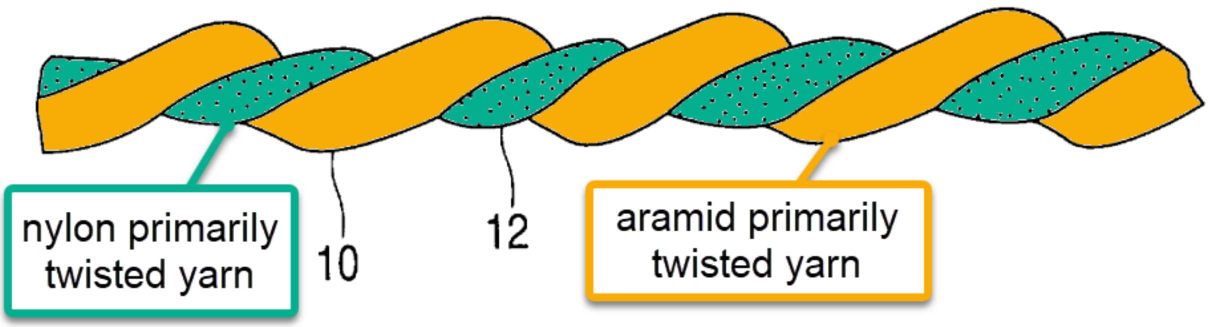


FIG. 1

120. Regardless, a POSITA would understand that Nakayasu's "Ex. A" embodiment in view of Fritsch has a "merge structure having a partial covering structure" because, as applicant argued during prosecution, such a structure is a result of having the claimed difference in yarn length and twist number. As discussed above, Nakayasu's "Ex. A" embodiment in view of Fritsch meets the claimed difference.

3. Claim 2

(i) 2[pre]: The hybrid tire cord according to claim 1, wherein the nylon primarily twisted yarn has a first twist direction,

121. In my opinion, Nakayasu discloses this limitation.

122. Nakayasu discloses that "to form a low elastic modulus thread 22 [*i.e.* ***nylon primarily twisted yarn***], one or more nylon fibers are ***first-twisted together***." Nakayasu at 5:24-26. The direction of the twist is a ***first twist direction***.

(ii) 2[a]: the aramid primarily twisted yarn has a second twist direction,

123. In my opinion, Nakayasu discloses this limitation.

124. Nakayasu discloses that the "one or more aramid fibers are first-twisted together in a certain direction" in order "[t]o form a high elastic modulus thread 21," *i.e.* ***aramid primarily twisted yarn***. Nakayasu at 5:23-24. The direction of the twist is a ***second twist direction***.

> *(iii) 2[b]: the nylon primarily twisted yarn and the aramid primarily twisted yarn are secondarily twisted together in a third twist direction,*

125. In my opinion, Nakayasu discloses this limitation.

126. Nakayasu teaches a step where high elastic modulus thread 21 (*i.e.* ***aramid primarily twisted yarn***) and the low elastic modulus thread 22 (*i.e.* ***nylon primarily twisted yarn***) are "finally-twisted together … to form a hybrid cord 23," *i.e.* ***secondarily twisted together***. Nakayasu at 5:23-28. The direction of the twist is a ***third twist direction***.

> *(iv) 2[c]: the second twist direction is the same as the first twist direction, and*

127. In my opinion, Nakayasu discloses this limitation.

128. Nakayasu discloses that the "nylon fibers are first-twisted together ***in the same direction*** as the aramid fibers." Nakayasu at 5:23-24.

> *(v) 2[d]: the third twist direction is opposite to the first twist direction.*

129. In my opinion, Nakayasu discloses this limitation.

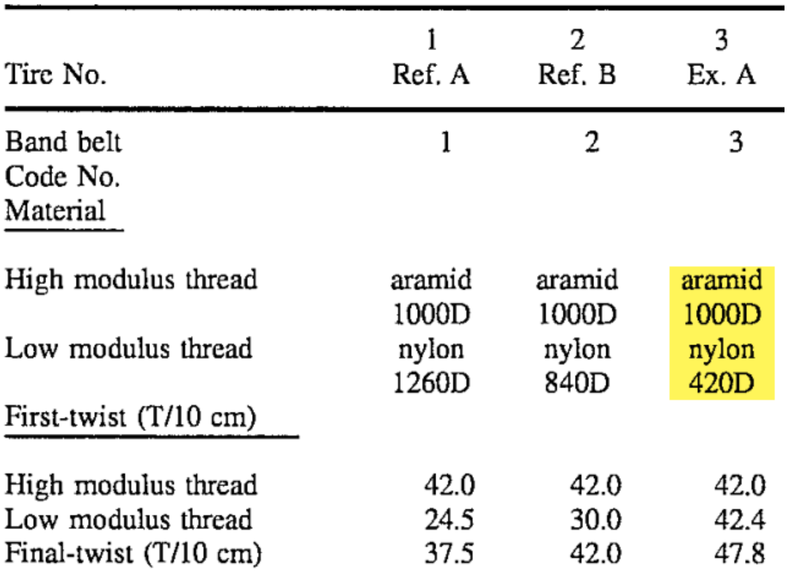
130. Nakayasu teaches that the high elastic modulus thread 21 (*i.e.* ***aramid primarily twisted yarn***) and the low elastic modulus thread 22 (*i.e.* ***nylon primarily***

twisted yarn) are "finally-twisted together in the reverse direction to the first-twist," *i.e.* ***a third twist direction opposite to the first twist direction***. Nakayasu at 5:23-28.

4. Claim 3: The hybrid tire cord according to claim 1, wherein a weight ratio of the nylon primarily twisted yarn to the aramid primarily twisted yarn is 20:80 to 80:20.

131. In my opinion, Nakayasu discloses this limitation.

132. Nakayasu discloses several embodiments that have the claimed weight ratio, including the "Ex. A" embodiment. In the "Ex. A" embodiment, the ***aramid primarily twisted yarn*** is ***1000 denier***, a denier being a unit of measurement for linear density, specifically grams per 9,000 meters of yarn. Nakayasu at Table 1, 5:67 ("high elastic modulus thread of ***1000 denier*** aramid fibers"). And in that same embodiment, the ***nylon primarily twisted yarn*** is ***420 denier***. Nakayasu at Table 1, 6:20-22 ("[T]he thickness of the low elastic modulus thread was ***420 denier***").



Tire No.	1 Ref. A	2 Ref. B	3 Ex. A
Band belt Code No.	1	2	3
Material			
High modulus thread	aramid 1000D	aramid 1000D	aramid 1000D
Low modulus thread	nylon 1260D	nylon 840D	nylon 420D
First-twist (T/10 cm)			
High modulus thread	42.0	42.0	42.0
Low modulus thread	24.5	30.0	42.4
Final-twist (T/10 cm)	37.5	42.0	47.8

133. A POSITA would understand that the denier of a tire cord using two threads would be the sum of the denier of each thread. For example, in the Tamura reference, a tire cord made with an aramid fiber with linear density of 1400 dt (decitex, which is grams per 10,000 meters) and a nylon (N66) fiber of 1670 dt had a total linear density of 3070 dt. Tamura at ¶36, Table 1.

134. For a cord wherein the nylon and aramid yarn are the same length, this results in a nylon to aramid weight ratio of 29.6 to 70.4, which is within the claimed range of ***20:80 to 80:20***.

$$\%\, weight\ per\ 9{,}000m\ (aramid) = \frac{linear\ density\ denier\ (aramid)}{linear\ density\ denier\ (total\ cord)}\ x\ 100$$

$$\frac{1000\ denier}{1000\ denier + 420\ denier}\ x\ 100 = 70.4\%$$

$$\%\, weight\ per\ 9{,}000m\ (nylon) = \frac{linear\ density\ denier\ (nylon)}{linear\ density\ denier\ (total\ cord)}\ x\ 100$$

$$\frac{420\ denier}{1000\ denier + 420\ denier}\ x\ 100 = 29.6\%$$

135. However, as discussed in limitation 1[d], it would have been obvious to combine Nakayasu and Fritsch such that the aramid yarn's length is 0.9% longer than the nylon yarn's length when untwisted. The weight of aramid yarn would therefore be 1.009 times more than the aramid yarn in an embodiment where the yarn lengths are the same. For example, for every 9,000 meter of nylon yarn, the tire cord would have 9,081 meters of aramid yarn. Based on the linear density used

in "Ex. A," this results in 420 grams of nylon yarn and 1,009 grams of aramid yarn, a weight ratio of 29.4 to 70.6, which is still within the claimed weight-ratio range.

136. Indeed, for the linear densities of "Ex. A," an aramid yarn that is 1.005 to 1.025 times the length of the nylon yarn will always be within the claimed weight-ratio range. A 1000 denier aramid yarn that is 1.005 times the length of a 420 denier nylon yarn has a weight-ratio of 29.5 to 70.5, and a 1000 denier aramid yarn that is 1.025 times the length of a 420 denier nylon yarn has a weight-ratio of 29.1 to 70.9.

5. Claims 4-6

137. Claims 4-6 require that the tire cord of claim 1 exhibit certain test results within claimed ranges. But the preamble of claim 4 first requires that the tire cord have applied an adhesive agent. In my opinion, Nakayasu discloses this limitation.

138. Nakayasu teaches that "rigidity can be increased … by providing an extensibility for the hybrid cord through an ***adhesion process and heating process therefore***." Nakayasu at 3:43-47. A POSITA would understand that an adhesion and heating process involves coating both the aramid and nylon yarns of the raw tire cord by dipping the cord into an adhesive agent solution, and then curing it through heat. For example, Fritsch itself teaches a "dip/dry/stretch/dip/relax process" where the second dip uses "Resorcinol Formaldehyde Latex," a known ***adhesive agent solution*** as the '765 patent admits. Fritsch at ¶45-49; Ex. 1001, 8:50-52 ("A

resorcinol formaldehyde Latex (RFL) solution … can be used as the adhesive agent solution.”).

139. As for the claimed ranges of testing results recited in claims 4-6, these would have been obvious to achieve for the combined Nakayasu-Fritsch tire cord. A POSITA would understand that the specified test results (several of which are performed using well-known standards) would be dependent on the structure, materials, and coating of the tire cord. Because the Nakayasu-Fritsch tire cord has the claimed difference in yarn length and twist number, a POSITA would understand that such a tire cord would exhibit the same test results described in the specification for similar values, such as the ’765 patent’s Example 6, which has an aramid yarn 1.01 times longer than nylon yarn. Ex. 1001, col. 11-12, Table 2. The test results of such a cord meets claims 4-6. *Id.* (strength at break of 13.5, elongation at break of 11.3, shrinkage of 2.1%, disk fatigue of 96%).

140. This is consistent with the test results provided by applicant during prosecution. I note that the examiner himself explained that “[w]ith the same structure, same materials, and same coating, the hybrid cord of the combination would obvious[ly] produce the same test results, no matter the test involved.” Ex. 1002, 63. I further note that applicant did not dispute this particular statement. And the test results that applicant provided fully support the examiner’s statement. The applicant-provided test results showed that producing a tire cord embodied by the

claims ***even using the "procedure and condition described" in the prior art*** had test results that met claims 4-6. Ex. 1002, 44-45 (showing test results that had strength at break between 8 to 15 g/d, elongation at break between 7 to 15%, disk fatigue greater than 90%, and shrinkage between 1.5 to 2.5%). This indicates that by meeting the claimed tire cord from claim 1, the claimed test results from claims 4-6 will obviously and naturally be achieved.

141. Thus, a POSITA would consider claims 4-6 as obvious properties resulting from a tire cord meeting the claimed limitations of claim 1 and the preamble of claim 4.

B. Ground 2: Nakayasu and Fritsch in Further View of Tamura, Chung, Yokokura, Shepherd, and Rowan Renders Obvious Claims 4-6

142. Tamura (Ex. 1006), Chung (Ex. 1012), Yokokura (Ex. 1013), Shepherd (Ex. 1008), and Rowan (Ex. 1015) disclose the particular test results that are recited in claims 4-6, and each of these references explain such test results were achieved by a hybrid tire cord. Thus, this prior art demonstrates that the claimed test results were already known to be desirable physical properties and achievable through routine experimentation and optimization. As discussed herein, a POSITA would have been motivated to achieve such test results in view of those references.

143. I explain why a POSITA would be motivated for each limitation.

1. Claim 4

(i) 4[pre]: The hybrid tire cord according to claim 1, further comprising an adhesive agent coated on the nylon primarily twisted yarn and the aramid primarily twisted yarn,

144. As I discussed above for limitation 1, Nakayasu alone and in view of Fritsch discloses dipping the raw tire cord into an adhesive agent solution, specifically RFL.

(ii) 4[a]: wherein strength at break and elongation at break measured by ASTM D885 (2004) are 8.0 to 15.0 g/d and 7 to 15%, respectively, and

145. Strength at break refers to amount of force needed to break the tire cord, and elongation at break refers to how long the tire cord was elongated (percentage-wise) before it break. In my opinion, this limitation is rendered obvious by the prior art.

146. I first begin with a discussion of the unit measure "g/d," which refers to "grams-force per denier." As I mentioned above, a "denier" is a measurement for linear density of textile fibers. It is measured in mass in grams of a fiber that is 9,000 meters long.

147. Most of the prior art measures strength at break and elongation at break using different units of measurement than "g/d." For example, some references use Newtons, with one Newton being the amount of force on an object with a mass of one kilogram at Earth's gravity. In other words, a 9.81 Newton is one kilograms-

force. This results in a Newton being about 101.97 grams-force. Once a measurement in Newtons is converted to grams-force, "g/d" can be calculated by dividing that force by the linear density of the cord measured in denier.

148. I further note that sometimes a prior art reference only provides the linear density of the individual yarns of the tire cord. A POSITA would understand that the linear density of the tire cords is the sum of the density of each individual yarn, since they are twisted together to form a cord. For example, a tire cord with a 1000 denier first yarn (*i.e.* 1000 grams per 9,000 meters of yarn) and a 1300 denier second yarn (1300 grams per 9,000 meters of yarn) would have a mass of 2300 grams per 9,000 meters of yarn when twisted together. Tamura, for example, confirms this understanding, as it lists the "[t]otal fineness," *i.e.* the linear density, of its hybrid tire cords as a sum of each individual yarn's density. Tamura at ¶36, Table 1.

149. Now, I turn to the prior art disclosures. Tamura describes a "composite fiber cord" comprising aramid and nylon yarns, where the elongation at break was 10.5% and the breaking strength was 325 Newtons of force. Tamura at ¶39, Table 3. Tamura discloses that this cord had a "[t]otal fineness" (*i.e.* linear density) of 3070 dt, where "dt" refers to "decitex," and 1 decitex equals 0.9 denier. Tamura at ¶¶34, 36, Table 1. This is because a decitex is a gram per 10,000 meters of yarn. This results in 3070 decitext being 2,763 denier. As I discussed above, Newtons can be converted to the claimed "g/d" (*i.e.* grams-force per denier) by converting

Newtons into grams-force (1 Newton is 101.97 grams-force) and dividing by the denier of the cord. This converts to a breaking strength of 12 g/d, which corresponds to the "Strength" of the cord listed in Tamura's Table 2, and is within the claimed range.

150. Chung also describes the claimed breaking strength and elongation at break. Chung describes a "hybrid tire cord" comprising the twisting of a nylon filament and an aramid filament, with a breaking strength of "8.0 to 15.0 g/d" and "[e]longation at break of 10 to 20%," both of which are as "measured by ASTM D885." Chung at 5, cl. 6. Thus, Chung generally discloses the claimed ranges. But besides that general statement, Chung also discloses specific embodiments of tire cords that fall within the claimed ranges, specifically embodiment 1 (breaking strength of 12.2 g/d and elongation at break of 12.4%) and embodiment 2 (11.5 g/d and 13.4%). Chung at 8, Table 3.

151. Although Chung does not specifically disclose that the 2004 version of the ASTM[2] D885 was used, a POSITA would have understood Chung's disclosure of the ASTM D885 standard to refer to the then-recent editions of it—for example, the September 2001, April 2002, November 2002, February 2003, ***October 2004***. This is because a POSITA would generally find it desirable to use the latest standard

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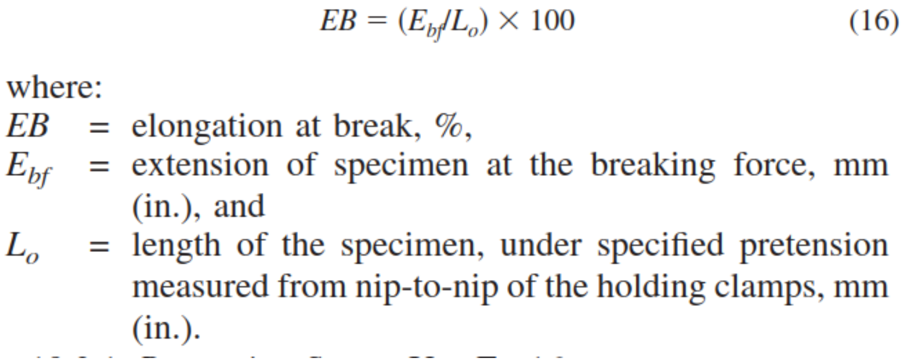
[2] A POSITA would have known that the American Society for Testing and Material (ASTM) develops international consensus standards, including model standard test methods for tire cords.

for testing. And I note that when Chung was first filed with the Korean Patent Office on June 3, 2005, the 2004 edition of the ASTM D885 was the most recent version. Thus, a POSITA would have understood Chung to disclose ***the 2004 edition***, as claimed. Moreover, as I explain below, the 2001-2004 editions of the ASTM D885 standard are substantially the same with respect to the breaking strength and elongation at break test methods. Exhibits 1027 through 1030 are true and correct copies of the ASTM D885 standards as published from 2001 to 2004.

152. Section 16 of each published standard provides the test for "Breaking Strength (Force) of Conditioned Yarns and Cords." Exs. 1027-30 at Section 16. Each published standard provides identical parameters and substantially the same description for the test. *Id.* The instructions state to test "ten specimens." *Id.* The "distance between the clamps on the testing machine" is "250 +/- 1 mm." *Id.* For the "Pretension-Start Procedure," the pretension is "20 +- 1 mN/tex … for aramid fibers" and "5 +- 1 mN/text … for all other fibers." *Id.* The testing machine is operated at "a rate specified in 15.1," which is identical for each of the published standards. *Id.* at Section 15.1. For example, for a "CRE-Type Tensile Testing Machine[]," the "crosshead travel rate" is ("120% … of the nominal gage length in millimetres … of the speciment" for "all fiber types, except aramid fibers" and 50% for aramid fibers. *Id.* at Section 15.1.1. The standards also instruct the tester to "[d]iscard speciments that break in the jaws or within 10 mm … of the nip of the

jaws." *Id.* at Section 16.3.1. The calculation is the "average breaking force" of the ten specimens "to the nearest 0.5 N." *Id.* at Section 16.4.

153. Similarly, the standards provide the same instructions for measuring "Elongation at Break of Conditioned Yarns and Cords," specified in Section 19. Exs. 1027-1030 at Section 19. The instructions state to conduct the test described above in Section 16 and to "Read the extension at the breaking force from the autographic recorder or by electronic means," providing the following equation for calculating elongation at break (if using pretension-start procedure). *Id.* at Section 19.2.



$$EB = (E_{bf}/L_o) \times 100 \qquad (16)$$

where:
EB = elongation at break, %,
E_{bf} = extension of specimen at the breaking force, mm (in.), and
L_o = length of the specimen, under specified pretension measured from nip-to-nip of the holding clamps, mm (in.).

154. In my opinion, these results confirm that the claimed breaking strength and elongation at break were achievable via routine optimization and experimentation. The prior art references show that by manufacturing tire cords, they will often achieve the claimed properties.

155. In my opinion, a POSITA would have understood that these prior art results were desirable and thus a POSITA would be motivated to manufacture a tire

cord that achieved such results, which would only require routine experimentation and optimization. Fritsch provides motivation, as it teaches that a "combination of a high breaking strength and a high elongation at break" is desirable, and so is "maximiz[ing]" the breaking strength. Fritsch at ¶¶41-42. In addition, a POSITA would have found it obvious to try manufacturing tire cords with such desirable test results. The above test results are a finite set of identified and predictable results achievable through routine experimentation and optimization.

156. In my opinion, a POSITA would have had a reasonable expectation of success that such test results would be achievable by the Nakayasu-Fritsch combination tire cord. As shown in the above references, achieving the disclosed breaking strength and elongation at break was a matter of routine experimentation and optimization. And this is entirely consistent with the applicant's test results that they presented during prosecution, which demonstrated the ability to achieve the claimed test results through routine experimentation and optimization. During prosecution, applicant presented test results for aramid-nylon hybrid tire cords with the claimed differences in yarn length and twist numbers which exhibited the claimed breaking strength and elongation at break. Ex. 1002, 41-45. The applicant admitted such tire cords were manufactured using prior art methods, and thus prior to the '765 patent, such claimed test results were straightforward to achieve. *Id.* Thus, the applicant proved that as long as the tire cords used the claimed materials,

were within the claimed differences in yarn length and twist numbers, and were dipped in an adhesive agent solution (all of which as demonstrated above were disclosed or rendered obvious by Nakayasu-Fritsch), achieving the claimed test results was merely a matter of routine experimentation and optimization, if not an inherent property of a tire cord with the claimed properties. This is especially true when a POSITA would have looked to Fritsch, Tamura, and Chung and have been motivated to achieve the test results disclosed in those references.

(iii) 4[b]: a strength maintenance percentage after disk fatigue test conducted by JIS-L 1017 (2008) of Japanese Standard Association (JSA) is 90% or higher.

157. In my opinion, this limitation is rendered obvious by the prior art.

158. I begin by noting that I am unaware of any 2008 version of JIS-L 1017. I believe the latest version of JIS-L 1017 at the time of the '765 patent was the version published in 2002. Ex. 1037. The version before that was published in 1995. Ex. 1036. This is consistent with Patent Owner's construction of "disk fatigue test conducted by JIS-L1017 (2008)" as "disc fatigue test conducted by JIS-L 1017 standard as of the priority date" from the parallel litigation. Ex. 1040, 26. In other words, Patent Owner has construed the term to exclude the "2008" requirement, which I think was motivated by the fact that the 2008 version does not exist. Regardless, I interpret this limitation to require use of JIS-L 1017 as published in 2002. I further note that both the 1996 and 2002 versions, which were the available

versions at the time Yokokura was published, provide the same "disk fatigue test." Ex. 1036 at 28-29; Ex. 1037 at 28-29.

159. Yokokura discloses the desirability of achieving a ***strength maintenance percentage of at least 90%*** following the disk fatigue test conducted in accordance with JIS-L 1017, and a POSITA would have been motivated to manufacture tire cords to achieve such test results.

160. Yokokura teaches a "tire having a reduced weight and improved durability" and "reinforcement cords being para-aramid cords." Yokokura at Abstract. According to Yokokura, "[a]fter [a] driving test [on a drum]" *i.e.* ***a disk fatigue test*** "each cord was removed from the corresponding tire and then evaluated for strength in accordance with JIS L 1017," and "[t]he measurement strength was converted into the retention ratio in %." *Id.*, ¶82. One of the embodiments in Yokokura exhibited a "strength retention ratio," *i.e.* ***strength maintenance percentage***, of at least 90%, specifically "Example 3-3" which had a strength maintenance percentage of 98%.

161. Tamura similarly discloses several embodiments with a "[s]trength retention rate" of at least 90%. Tamura, Table 2 (showing embodiments 1 and 3-6 having 90% or 91% strength retention rate). Tamura discloses that such values were calculated "[i]n accordance with JIS L 1017," and then used to measure "force" and the converted to a "strength (g/d)." Tamura at ¶34. The cord was then vulcanized

and then "subjected to a bending test," which a POSITA would understand to be ***a disk fatigue test***. *Id.*, ¶35. The "strength retention rate" was then calculated by dividing the strength after bending by the strength before bending, multiplied by 100. *Id.*

$$\boldsymbol{Strength\ Retention\ Rate} = \frac{Strength\ after\ bending}{Strength\ before\ bending}\ x\ 100$$

162. In my opinion, these results confirm that the claimed strength maintenance percentage was achievable via routine optimization and experimentation. The prior art references show that by manufacturing tire cords, they will often achieve the claimed properties.

163. In my opinion, a POSITA would have understood that these prior art results were desirable and thus a POSITA would be motivated to manufacture a tire cord that achieved such results, which would only require routine experimentation and optimization. As Yokokura explains, "[t]he higher the retention ratio is[,] the better the test result is." Yokokura at ¶82. Moreover, Kwon explains that if the strength retention rate of a tire cord does not exceed 90%, "the ability to support the tire is reduced due to deterioration of physical properties during driving, resulting in deterioration of driving performance and, in severe cases, tire rupture." Kwon (Ex. 1021) at ¶139.

164. In addition, a POSITA would have found it obvious to try manufacturing tire cords with such desirable test results. The above test results are a finite set of identified and predictable results achievable through routine experimentation and optimization.

165. In my opinion, a POSITA would have had a reasonable expectation of success that such test results would be achievable by the Nakayasu-Fritsch combination tire cord. As shown in the above references, achieving the disclosed strength maintenance percentage was a matter of routine experimentation and optimization. And this is entirely consistent with the applicant's test results that they presented during prosecution, which demonstrated the ability to achieve the claimed test results through routine experimentation and optimization. During prosecution, applicant presented test results for aramid-nylon hybrid tire cords with the claimed differences in yarn length and twist numbers which exhibited the claimed breaking strength and elongation at break. Ex. 1002, 41-45. The applicant admitted such tire cords were manufactured using prior art methods, and thus prior to the '765 patent, such claimed test results were straightforward to achieve. *Id.* Thus, the applicant proved that as long as the tire cords used the claimed materials, were within the claimed differences in yarn length and twist numbers, and were dipped in an adhesive agent solution (all of which as demonstrated above were disclosed or rendered obvious by Nakayasu-Fritsch), achieving the claimed test results was

merely a matter of routine experimentation and optimization, if not an inherent property of a tire cord with the claimed properties. This is especially true when a POSITA would have looked to Yokokura and Tamura and have been motivated to achieve the test results disclosed in those references.

2. Claim 5: The hybrid tire cord according to claim 4, wherein the hybrid tire cord has 3% LASE, 5% LASE, and 7% LASE measured by ASTM D885 (2004), of 0.8 to 2.0 g/d, 1.5 to 4.0 g/d, and 3.0 to 6.0 g/d, respectively.

166. In my opinion, this limitation is rendered obvious by the prior art.

167. LASE is an abbreviation for the measurement "load at specified elongation." This measurement refers to how much load (*i.e.* force or tension) is needed to elongate the tire cord to a certain percentage. Thus, 3% LASE is the amount of load needed to elongate the tire cord by 3%. This claim requires that the hybrid cord have the property of being elongated by 3% when applying 0.8 to 2.0 g/d of tension, 5% when applying 1.5 to 4.0 g/d, and 7% when applying 3.0 to 6.0 g/d.

168. I discuss several references below which disclose the 3%, 5%, and/or 7% LASE values within the claimed range.

169. For example, Shepherd discloses the claimed 3%, 5%, and 7% LASE. Figure 2 of Shepherd charts "load (stress) grams/denier" against "% elongation (strain)" for various tire cords, including an aramid/nylon tire cord. Shepherd, Fig. 2. Below, I have annotated Figure 2 to indicate what the approximate LASE value

is at 3%, 5%, and 7%. For 3%, the approximate load is 1.2 g/d, for 5% it is slightly more than 2 g/d, and for 7%, it is slightly more than 3 g/d. All of these values fall within the claimed range.

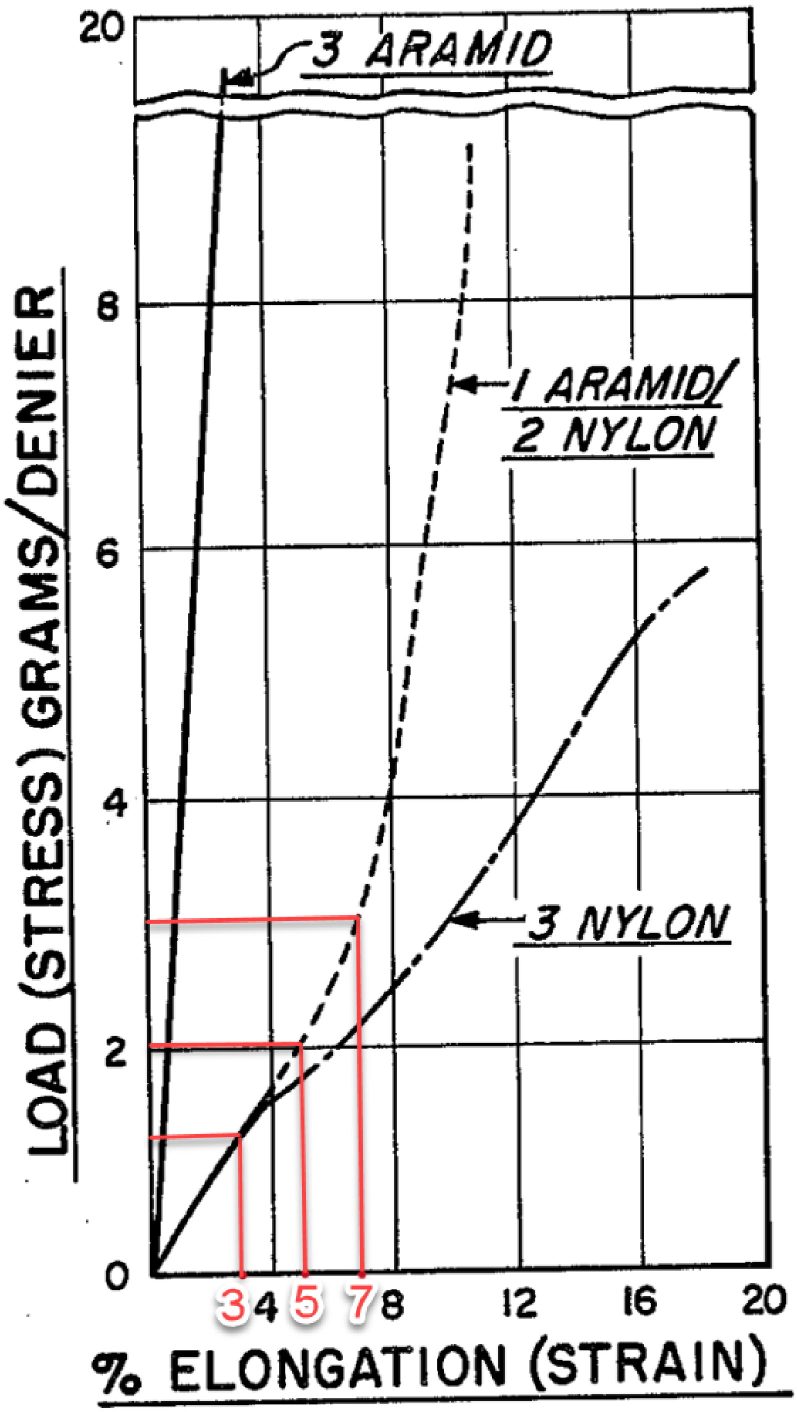


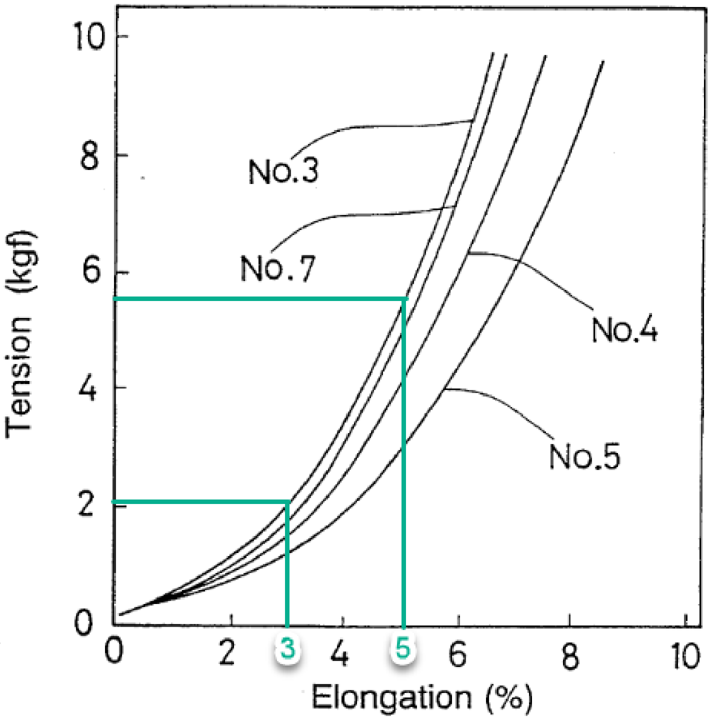
FIG. 2

170. Besides the above graph, Shepherd also measure 7% LASE for various embodiments of its aramid-nylon hybrid tire cords. Shepherd at col. 7-8, Table 3.

These cords used 1260 denier nylon and 1500 denier aramid, for a total of 2760 denier. *Id.*, 6:4-6. Shepherd recorded its loads using "lbs," *i.e.* pounds, and one pound equals 453.6 grams-force. Shepherd found 7% LASE values of 25.2 lbs (which is 4.1 g/d when converting 25.2 pounds to grams-force and dividing by 2760 denier), 21.2 lbs (3.5 g/d), 22.9 lbs (3.8 g/d), 17.8 lbs (2.9 g/d) and 28.1 lbs (4.6 g/d). Shepherd at col. 7-8, Table 3. Four of the five values are within the claimed range for 7% LASE.

171. Nakayasu also discloses 3% and 5% LASE within the claimed range for its "Ex. A" embodiment. Nakayasu's "Ex. A" embodiment uses an aramid yarn of 1000 denier and a nylon yarn of 420 denier, for a total density of 1420 denier. Nakayasu describes that a total load of 1.1 kgf (kilograms-force, which is 1,000 grams-force) results in 2% elongation, for a 2% LASE of 0.77g/d. Nakayasu also describes 6% elongation with a load of 8.0 kgf (5.6 g/d). Nakayasu at col. 7-8, Table 1. Figure 2 has a chart comparing kgf against elongation percentage, and it reflects these two values as well. I have annotated Figure 2 to indicate what the approximate LASE value is at 3% and 5%. The approximate value for 3% LASE is 2kgf (1.4 g/d) and for 5% LASE is 5.5 kgf (3.9 g/d). All of these fall within the claimed ranges.

Fig. 2



172. Tamura provides the load values for 3%, 4% and 4.5% elongation, which are consistent with the claimed ranges. Specifically, Tamura's Embodiment 1, which has a total density of 3070 dt (*i.e.* 2,763 denier) (*see* Tamura at Table 1, column "Total fineness (dt)"), had a load of 44 Newtons (1.6 g/d) at 3% elongation, 55 Newtons (2.0 g/d) at 4% elongation, and 66 Newtons (2.4 g/d) at 4.5% elongation. Given the progression of these values, a POSITA would understand that 5% elongation would be more than 2.4 g/d and less than 4.0 g/d.

173. Fritsch provides loads at 1.6%, 3% and 4.1% elongation for its tire cord embodiment that had a Coring level of 0.9%. Fritsch at ¶40, Table 1. The yarns of that tire cord each had a density of 1300 denier, for a total of 2600 denier. *Id.*, ¶39. Fritsch discloses a load of 14.6 Newtons (0.57 g/d) at 1.6% elongation, 33.7 Newtons

(1.3 g/d) at 3% elongation, and 45 Newtons (1.8 g/d) at 4.1% elongation. *Id.*, ¶40, Table 1. These values fall within and are consistent with the claimed ranges for 3% LASE and 5% LASE.

174. Below I provide a summary of these references and the LASE values they disclose. Each of these fall within the claimed range of 3% LASE of 0.8 to 2.0 g/d, 5% LASE of 1.5 to 4.0 g/d, and 7% LASE of 3.0 to 6.0 g/d.

Shepherd	3% LASE: 1.2 g/d
	5% LASE: 2 g/d
	7% LASE: 3 g/d, 4.1 g/d, 3.5 g/d, 3.8 g/d, 4.6 g/d
Nakayasu	2% LASE: 0.77 g/d
	3% LASE: 1.4 g/d
	5% LASE: 3.9 g/d
	6% LASE: 5.6 g/d
Tamura	3% LASE: 1.6 g/d
	4% LASE: 2 g/d
	4.5% LASE: 2.4 g/d
Fritsch	1.6% LASE: 0.57 g/d
	3% LASE: 1.3 g/d
	4.1% LASE: 1.8 g/d

175. It is my opinion that a POSITA would have found it obvious to use ASTM D885 (2004) ("D885-04") to measure LASE. A POSITA would have understood that ASTM D885 (2004) is a conventional industry standard for

measuring load. Indeed, Fritsch teaches that its LASE values were "determined according to ASTM D885M-94: Standard Test Methods for Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made From Manufactured Organic-Base Fibers." Fritsch at ¶35. Similarly, Chung teaches that "[t]ensile strength," *i.e.* ***load***, and "[e]longation at break" *i.e.* ***load***, are measured by ASTM D885, and therefore a POSITA would have understood to use ASTM D885 to likewise determine LASE given that, as I explain below, ASTM D885 measures LASE by measuring load during the breaking strength test. A POSITA would therefore have found it obvious and be motivated to use ASTM D885 (2004) to measure LASE, as that would provide industry standard measurements for comparing the physical characteristics of tire cords with other tire cords. And while Fritsch discloses using D885M-94, there is no material difference between that and D885-04.

176. D885M is identical to D885 except that the former used SI units while the latter (until 1998) used Imperial units. Ex. 1033 at 5 ("Methods D 885M is an SI companion to Methods D 885 using SI units only; therefore SI equivalents for metric and nonmetric units are not included in Methods D 885"). After 1998, D885M was withdrawn and D885 included both types of units.

177. In my opinion, ASTM D885M-94's LASE test is the same as the LASE test from D885-04. Exhibit 1033 are excerpts from a true and correct copy of ASTM's 1997 Annual Book of ASTM Standards, Section 7, Volume 7.01 ("1997

ASTM Annual”), which included the most recent D885 (and D885M) testing standards at the time, which was D885-94 (approved December 15, 1994 and published July 1995) and D885M-95 (which was approved August 15, 1995 and published February 1996). Ex. 1033 at 5, 18. D885-94 and D885M-95 each provide a test for “Load at Specified Elongation (LASE) of Conditioned Yarns and Cords.” Ex. 1033, 8, 23. Similarly, D885-04 provides a similar test for “Force at Specified Elongation (FASE) of Conditioned Yarns and Cords.” Ex. 1030, 10. All three tests instruct the tester to read the force/load “at the specified value of elongation for the fiber types listed” in accordance with the below table. Ex. 1033, 8, 23; Ex. 1030, 10-11.

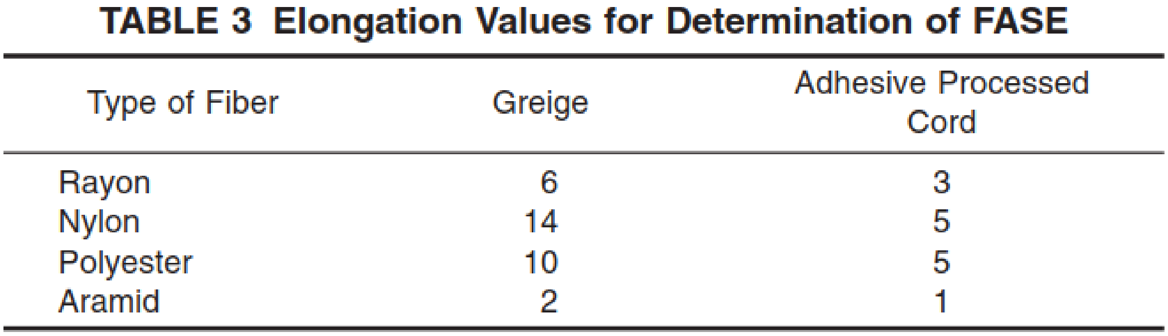


TABLE 3 Elongation Values for Determination of FASE

Type of Fiber	Greige	Adhesive Processed Cord
Rayon	6	3
Nylon	14	5
Polyester	10	5
Aramid	2	1

178. Note that all three tests instruct the user to make these readings with respect to the breaking strength, which I described above. D885M-95 has the same breaking strength test as D885-04, including the application of a higher pretension for aramid fibers (20 +/- 1 nM/tex) compared to testing non-aramid fibers (5 +/- 1 nM/tex). *Compare* Ex. 1033 at 21-22 (Section 15) *with* Ex. 1030 at 7-9 (Section

16). D885-94's Breaking Strength test is nearly the same, except that it only provides a pretension of 0.05 +/- 0.01 gf/den (which is equivalent to 5 +/- 1 nM/tex). Ex. 1033 at 8 (Section 15.2). However, a POSITA would have understood that when testing an aramid-nylon hybrid cord, the lower pretension would be applied, *i.e.* a pretension of 5 +/- 1 nM/tex (0.05 +/- 0.01 gf/den) that is disclosed in D885-94, D885M-95, and D885-04. The higher pretension provided in the later versions of D885 for aramid fibers was to account for the higher modulus of aramid fibers. However, since the hybrid cord has nylon fibers, which have a lower modulus, a higher pretension may negatively affect the breaking strength of the hybrid cord. I further note that this higher pretension for aramid fibers was removed by 2006. *See* Ex. 1031 at 7; Ex. 1032 at 7.

179. For aramid cords, both tests also instruct the tester to read the load from the load-elongation curve. *Id.* Note that D885M-95 and D885-04 are worded in nearly identical manner, whereas D885-94 is organized somewhat differently (*e.g.*, it has a separate section for "High-modulus Aramid Yarns and Cords") but the instructions are otherwise providing the same test, where the load/force is read off of the results from performing the strength at break test. *Id.*

180. While the 1997 ASTM Annual includes D885M-95 instead of D885M-94, it is my opinion that the LASE tests in D885M-95 are the same as the LASE tests in D885M-94. I base my conclusion on the fact that D885-94 was approved on

December 15, 1994, the same day that D885M-94 was approved. *See* Ex. 1038, 1039. Moreover, 1997 ASTM Annual states that the previous version of D885-94 was D885-85 published in 1992. Ex. 1033, 5. Thus, a POSITA would have known that D885M-94 would have been the SI version of D885-94. And since D885-94 and D885M-95 provide the same test for LASE, I conclude that D885M-94 also provides the same test for LASE. I further note that D885-94 and D885M-95 were both published in the 1997 ASTM Annual, several years after their respective approval and publications, and therefore a POSITA would understand that the tests were intended to have the same results.

181. In my opinion, the above results confirm that the claimed LASE values were achievable via routine optimization and experimentation. The prior art references show that by manufacturing tire cords, they will often achieve the claimed properties.

182. In my opinion, a POSITA would have understood that these prior art results were desirable and thus a POSITA would be motivated to manufacture a tire cord that achieved such results, which would only require routine experimentation and optimization. Fritsch explains that it is desirable to have "a combination of a high breaking strength and a high elongation at break," which a POSITA would understand to correspond with the relatively high LASE values disclosed in the above references. Fritsch at ¶41. Similarly, Nakayasu describes that its LASE

values provide a "suitabl[e] … balance." Nakayasu at 3:21-22. Shepherd describes that its LASE values for its aramid-nylon hybrid tire cord provides desirable "intermediary elongation." Shepherd at 4:63-5:4. Thus, these teachings provided a POSITA with the motivation to target the LASE values disclosed in the prior art references.

183. In addition, a POSITA would have found it obvious to try manufacturing tire cords with such desirable test results. The above test results are a finite set of identified and predictable results achievable through routine experimentation and optimization.

184. In my opinion, a POSITA would have had a reasonable expectation of success that such test results would be achievable by the Nakayasu-Fritsch combination tire cord. As shown in the above references, achieving the disclosed strength maintenance percentage was a matter of routine experimentation and optimization. Consistent with the test results provided by the applicant during prosecution, a POSITA would understand that as long as a tire cord used the claimed materials, were within the claimed differences in yarn length and twist numbers, and were dipped in an adhesive agent solution (all of which as demonstrated above were disclosed or rendered obvious by Nakayasu-Fritsch), achieving the claimed test results was merely a matter of routine experimentation and optimization, if not an inherent property of a tire cord with the claimed properties. Since a POSITA would

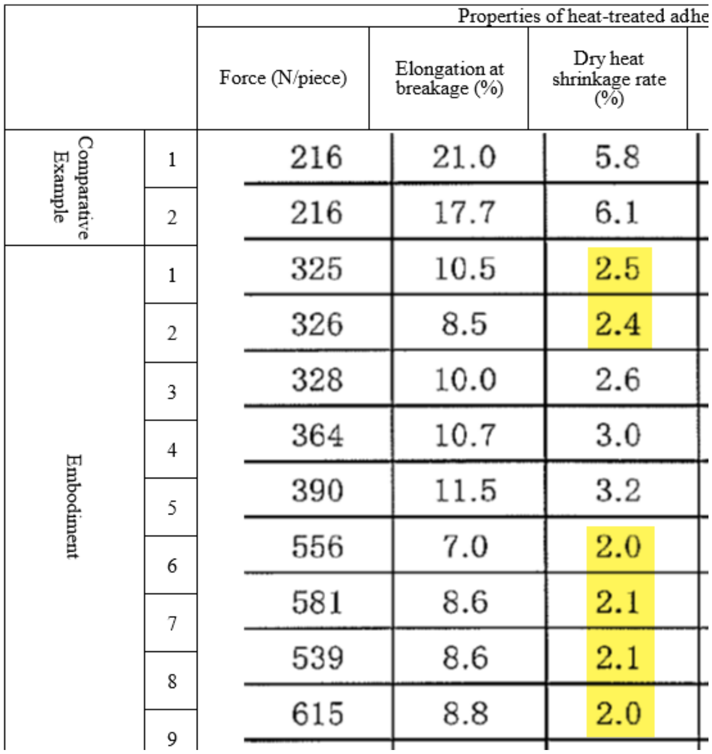
have looked to Shepherd, Nakayasu, Tamura, and Fritsch, said ordinary artisan have been motivated to achieve the test results disclosed in those references.

3. Claim 6

(i) 6[pre]: The hybrid tire cord according to claim 5, wherein the hybrid tire cord has a shrinkage of 1.5 to 2.5%,

185. In my opinion, this limitation is rendered obvious by the prior art.

186. A shrinkage of 1.5 to 2.5% was known to be a desirable property of tire cords, as shown by several references that I discuss below. For example, Tamura describes several aramid-nylon tire cord embodiments that had a shrinkage between 2.0 to 2.5%. Tamura at ¶37, Table 2.



		Properties of heat-treated adhe		
		Force (N/piece)	Elongation at breakage (%)	Dry heat shrinkage rate (%)
Comparative Example	1	216	21.0	5.8
	2	216	17.7	6.1
Embodiment	1	325	10.5	2.5
	2	326	8.5	2.4
	3	328	10.0	2.6
	4	364	10.7	3.0
	5	390	11.5	3.2
	6	556	7.0	2.0
	7	581	8.6	2.1
	8	539	8.6	2.1
	9	615	8.8	2.0

187. Similarly, Chung generally discloses hybrid tire cords with "a dry heat shrinkage of 2.0 to 5.0%," which falls within the claimed range. Chung at 5. Beyond

this general teaching, Chung discloses a tire cord embodiment that had a dry heat shrinkage of 2.6%. *Id.*, 9. In my opinion, this value is close enough to the claimed 2.5% shrinkage that because of obvious minor variances in test results, a POSITA would have expected a similar cord to exhibit 2.5% shrinkage.

188. Rowan also discloses treated hybrid tire cords with dry heat shrinkage between 1.5% and 2.5%, as shown in the below table. Rowan at col. 11, Table II.

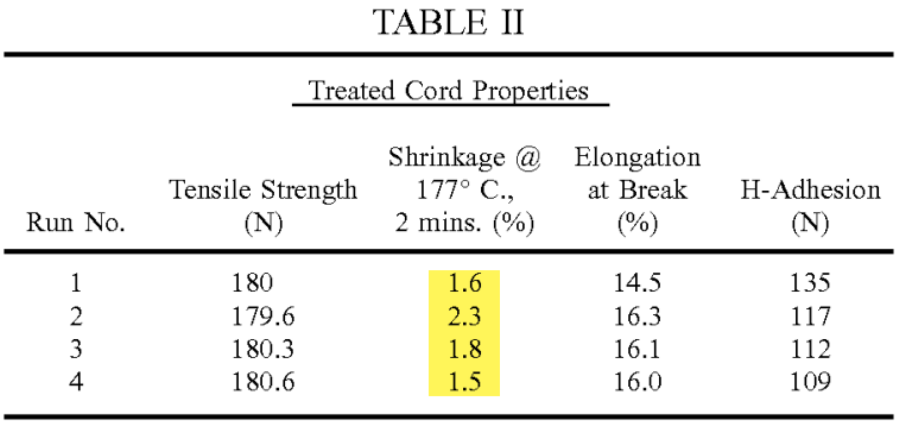


TABLE II

Treated Cord Properties

Run No.	Tensile Strength (N)	Shrinkage @ 177° C., 2 mins. (%)	Elongation at Break (%)	H-Adhesion (N)
1	180	1.6	14.5	135
2	179.6	2.3	16.3	117
3	180.3	1.8	16.1	112
4	180.6	1.5	16.0	109

189. In my opinion, these results confirm that the claimed strength maintenance percentage was achievable via routine optimization and experimentation. The prior art references show that by manufacturing tire cords, they will often achieve the claimed properties.

190. In my opinion, a POSITA would have understood that these prior art results were desirable and thus a POSITA would be motivated to manufacture a tire cord that achieved such results, which would only require routine experimentation and optimization. In fact, Shepherd describes that “low total shrinkage factor” is

"highly beneficial." Shepherd at 1:47-53. Rowan further explains that "dimensional stability means the ability of a textile material to resist shrinkage during heating," which a POSITA would understand indicates the desirability of a low shrinkage value. Rowan at ¶34. These were teachings that a POSITA would have known and thus be motivated to target the specific results found in the above references.

191. In addition, a POSITA would have found it obvious to try manufacturing tire cords with such desirable test results. The above test results are a finite set of identified and predictable results achievable through routine experimentation and optimization.

192. In my opinion, a POSITA would have had a reasonable expectation of success that such test results would be achievable by the Nakayasu-Fritsch combination tire cord. As shown in the above references, achieving the disclosed shrinkage rate was a matter of routine experimentation and optimization. And this is entirely consistent with the applicant's test results that they presented during prosecution, which demonstrated the ability to achieve the claimed test results through routine experimentation and optimization. During prosecution, applicant presented test results for aramid-nylon hybrid tire cords with the claimed differences in yarn length and twist numbers which exhibited the claimed shrinkage rate. Ex. 1002, 41-45. The applicant admitted such tire cords were manufactured using prior art methods, and thus prior to the '765 patent, such claimed test results were

straightforward to achieve. *Id.* Thus, the applicant proved that as long as the tire cords used the claimed materials, were within the claimed differences in yarn length and twist numbers, and were dipped in an adhesive agent solution (all of which as demonstrated above were disclosed or rendered obvious by Nakayasu-Fritsch), achieving the claimed test results was merely a matter of routine experimentation and optimization, if not an inherent property of a tire cord with the claimed properties. This is especially true when a POSITA would have looked to Tamura, Chung, and Rowan and have been motivated to achieve the test results disclosed in those references.

(ii) 6[a]: wherein the shrinkage is measured under a primary load of 0.01 g/denier at 180 ° C. for 2 minutes.

193. In my opinion, the prior art renders this limitation obvious.

194. Chung discloses that its hybrid tire cord has "physical properties" of "a dry heat shrinkage of 2.0 to 5.0% as measured at an initial load of 0.01 g/De' for 2 minutes at 180°C," which discloses the exact same parameters as this limitation. Chung at 6.

195. Rowan discloses that its shrinkage was "determined under a tension of 0.05 grams per decitex (g/dtex) or 2 minutes at 177° C. in a closed Testrite oven in accordance with the ASTM method." Rowan at ¶34. 0.05 g/dtex is 0.045 g/d. Fritsch used similar conditions of "177° C. for 2 mins," though applied "0.5 gms/dtex pretension." Fritsch at 10:61-63. These parameters are close enough to

the claimed parameters that one skilled in the art would have expected the cord to have dry heat shrinkages similarly falling within the 1.5-2.5% range when using the claimed parameters.

196. In addition, a POSITA would have found it obvious to use Chung's dry heat shrinkage testing parameters to achieve the desired shrinkage rates disclosed in the prior art. A POSITA would understand that Chung's testing parameters is standard parameters for testing shrinkage, and would further understand that the disclose shrinkage rates in the prior art were suitably low values that would be desirable to achieve using Chung's testing parameters. Moreover, Chung's testing parameters is a discrete and identified, predictable solution, with a reasonable expectation of success, as Chung explicitly describes that using its testing parameters on aramid-nylon hybrid tire cords should achieve a 2.0-5.0% shrinkage rate, which includes part of the claimed range. Thus, a POSITA would have looked to Chung's testing parameters to determine whether Nakayasu-Fritsch tire cord would achieve the relatively low shrinkage rate described by Chung.

VIII. CONCLUSION

197. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both,

under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this proceeding.

Executed on this February 27, 2025 by:

Jon Rust, Ph.D.