

Filed on behalf of: Kolon Industries, Inc.

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 IPR2025-00664
Patent 9,617,663

**DECLARATION OF DR. DAVID BROOKSTEIN
IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE**

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I. Introduction and Background

1. I have been retained as an expert witness by Kolon Industries, Inc. (“Kolon”) to provide my analysis and conclusions on certain technical aspects of this dispute. I understand Kolon is the Patent Owner and that HS Hyosung Advanced Materials Corp. (“Hyosung”) is the Petitioner in this case. I understand that Petitioner has challenged the patentability of claims 1-3 (the “Challenged Claims”) of U.S. Patent No. 9,617,663 (Ex.1001) (the “’663 patent”).

2. I am being compensated for my work at my standard consulting rate. My compensation does not depend on the outcome of this proceeding.

3. I have been asked to provide my opinions as to whether the Challenged Claims are patentable. My opinions are set forth in this Declaration.

II. Qualifications

4. I am both a mechanical engineer and a textile engineer with substantial experience in the field of textile and fibrous materials, including in the field of high strength yarns and cords. In forming the opinions expressed in this Declaration, I have considered and relied upon my education, background, and experience. My experience, qualifications, and education are detailed in my *curriculum vitae* (“CV”), a copy of which is attached as Exhibit 2018. My CV also lists my relevant textile patents and identifies parties on behalf of whom I have previously provided expert testimony.

5. I received a Bachelor of Textile Engineering from the Georgia Institute of Technology (“Georgia Tech”) in 1971, a Master of Science degree in Textile Technology from the Massachusetts Institute of Technology (“MIT”) in 1973, and a Doctor of Science degree in the field of Mechanical Engineering from MIT in 1976, with Minor Studies in Management from Sloan School of Management. My doctoral research involved yarn mechanics and manufacturing, which have direct relevance to the subject matter of the ’663 patent.

6. In 1975, I accepted a position as an Assistant Professor of Textile Engineering at Georgia Tech. I taught and conducted research in the fields of textile engineering and composites engineering. One of the textbooks I used in teaching was “Textile Yarns – Technology, Structure, and Applications,” the relevant chapters of which are attached in Exhibit 2020. I obtained substantial funding from the U.S. Department of Energy during my time at Georgia Tech.

7. In 1981, I accepted a part-time position as an Adjunct Professor in Mechanical Engineering at Northeastern University in Boston. I taught undergraduate courses in statics, dynamics, and mechanics of deformable bodies and material science. I was also an Adjunct Professor during my full-time employment at Albany International Research Co. (formerly Fabric Research Laboratories). *See ¶8.*

8. From 1980 to 1994, I was employed by Albany International Research Co. (formerly Fabric Research Laboratories). I started as a Senior Research Associate, was promoted to Assistant Director in 1983, and was again promoted to Associate Director in 1992. In these positions, I directed all activities of the professional engineering group responsible for contract research, development, and manufacture of advanced composite materials and technical polymeric materials of yarns and fabrics. My textile engineering innovations during this time led to 13 U.S. patents and many other unpatented trade secrets.

9. In 1994, I accepted a position with Philadelphia University (formerly Philadelphia College of Textiles and Sciences). From 1994 to 2010, I was the Dean and Professor of Mechanical Engineering at the School of Engineering and Textiles. From 2010 to 2012, I was the Executive Dean for University Research and Professor of Mechanical Engineering. During my time at Philadelphia University, I held many other positions, including Executive Director of the Institute for Textile and Apparel Product Safety, Executive Director of Pennsylvania Advanced Textile Research and Innovation Center including Biomedical Textile Structures Laboratory, and Executive Director of Research. I was also a Principal Investigator for 8 years on a Department of Defense funded project focused on working with the US Army to develop new garment-based soldier protection systems.

10. From 2002 to 2003, I was a Visiting Scholar at Harvard University Center for Textile and Apparel Research (Division of Engineering and Applied Sciences and Harvard Business School). During this time, I studied trends in patent applications involving textile structures.

11. From 2009 to 2012, I also worked as a part-time consultant at MAG Industrial Automation Systems, where I was an engineering consultant to a worldwide manufacturer of engineered automation systems for the aerospace industry.

12. In 2012, I accepted a position as Dean for Science, Technology, Engineering and Mathematics (STEM) at Montgomery County Community College. In this role, I was Chief Academic Officer for all programs in engineering, physical sciences, biological sciences and computer sciences.

13. In 2013, I accepted a role as Director of Market Development at ICF Mercantile. In this role, I was responsible for technical and market development of antimicrobial, antifungal, and flame-resistant textile fabrics.

14. In 2014, I accepted a role as Professor of Mechanical Engineering and Director of Undergraduate Affairs at the Temple University College of Engineering, and in 2017, I was promoted to Senior Associate Dean for Undergraduate Studies at the Temple College of Engineering. From 2014 to 2024, I was responsible for the senior design capstone courses for all engineering

students and was responsible for engineering program accreditation from the Accreditation Board for Engineering and Technology.

15. In 2024, I retired and became Professor Emeritus of Mechanical Engineering at Temple University College of Engineering, which is my current position.

16. From 2000 to today, I have also owned and operated Brookstein Consulting LLC. In this role, I provide engineering and litigation consulting services in the fields of textiles, mechanical assemblies made from textile materials, garment systems, fibers, yarns, fabrics, and composites.

17. In 1992, I was elected by my peers as a Fellow of The Textile Institute (United Kingdom). In 1993, I was awarded the Techtextil Innovation Prize (Germany). In 1995, I was elected by my peers as a Fellow of the American Society of Mechanical Engineers, which is an honorific awarded to only about 1% of its members. In 1998, I was awarded the ASTM Harold Dewitt Smith Award for textile fiber utilization.

18. I have also been a member of the American Society for Engineering Education, the Institute of Industrial and Systems Engineers, the American Conference of Academic Deans, the Fiber Society, and the Society for Advanced Materials and Processes.

19. I am the named inventor on 13 U.S. patents, all of which relate to structures made using the principles of textile engineering and science. I have also developed numerous trade secret inventions.

20. Based on my education and professional experience, I believe I am an expert in the relevant field of the '663 patent and have been an expert in this field since before the first application for the '663 patent was filed. I am familiar with how a person of ordinary skill in the art ("POSITA") would have understood and used the terminologies found in the '663 patent as of the date of the invention.

III. Summary of Analysis and Conclusions

21. In my opinion, Petitioner fails to show that **any** claim of the '663 patent is unpatentable. In particular, Petitioner fails to demonstrate claim 1 and all dependent claims are rendered obvious by Tamura and Fritsch, in view of Rowan and optionally Buchanan. In addition, Petitioner fails to demonstrate that claim 1, and all claims dependent on it, are rendered obvious by Fritsch alone. This Declaration focuses on the deficiencies in Petitioner's analysis for claim 1. I reserve my right to opine on other claims in this or other proceedings. I explain the bases for my opinion in detail in this Declaration.

IV. Summary Of Materials Reviewed And Considered

22. All of the opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. In forming

the opinions expressed in this Declaration, while drawing on my experience in the field of technical yarns and cords, I reviewed the following documents as well as the documents cited in this Declaration:

- Petition for *Inter Partes* Review of U.S. Patent No. 9,617,663, and the exhibits to the Petition;
- Ex.2019, Advances in Yarn Spinning Technology;
- Ex.2020, Textile Yarns – Technology, Structure, and Applications;
- Ex.2021, Kevlar Technical Guide;
- Ex.2022, Mechanical Behavior of PET and PEN;
- Ex.2023, Handbook of Yarn Production – Technology, Science and Economics;
- Ex.2024, Young's Modulus;
- Ex.2025, Kevlar[®] 49 Aramid Fibers for High Performance Composite;
- Ex.2026, IPR2025-00662 Petition;
- Ex.2027, IPR2025-00662 Ex.1003 Dr. Rust Declaration; and
- Ex.2034, The Pneumatic Tire.

23. My opinions are additionally guided by my appreciation of how a POSITA would have understood the claims of the '663 patent at the time of the alleged invention, which I have been asked to assume is June 29, 2015.

V. Legal Standards

24. I understand that a patent claim is invalid for obviousness if the differences between the claimed invention and the prior art would have been obvious to a POSITA before the filing date of the claimed invention.

25. I understand that determining whether a prior art renders a patent claim invalid as obvious is a two-step process. First, the claims must be properly construed. Second, the properly construed claim is compared against the prior art to determine whether a POSITA would have found the claimed invention obvious in light of the prior art. I understand that a determination of whether or not a claim would have been obvious requires determining the scope and content of the prior art, ascertaining differences between the prior art and the claims at issues, resolving the level of skill in the pertinent art, and assessing evidence of secondary considerations when such evidence is presented.

26. I understand that in determining the scope of the prior art, there is an analogous art requirement that applies to each reference. That is, a reference qualifies as prior art for an obviousness determination only when it is analogous to the claimed invention. I understand that prior art is analogous if (1) the art is from the same field of endeavor, regardless of the problem address, or (2) when the reference is not within the field of the inventor's endeavor, the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

27. I further understand that a claim involving multiple components is not proved obvious just by demonstrating that each element was independently known in the art. Even when all elements were independently known in the art at the time of invention, the obviousness inquiry must still determine whether one of ordinary skill in the art would have had a reason to combine the known elements as expressed in the claim and have had a reasonable expectation of success in doing so.

28. Although I understand that evidence of motivation to combine in the prior art is not required, I understand that it is still important to identify a reason that would have prompted a POSITA to combine the elements as the invention does.

29. I understand that a prior art reference teaches away from the claimed invention if one of ordinary skill in the art, upon reading the reference, would have been led in a different direction from the path taken by the invention. I further understand that each prior art reference may teach away to different degrees, and thus each reference must be examined for what it in fact teaches. I understand that if a POSITA would not have believed at the time of the invention that a particular combination of prior art references would have had a reasonable expectation of success, such a combination may not be obvious.

30. I understand that, because the obviousness determination is based on the knowledge of one of ordinary skill in the art at the time of the invention, it is impermissible to use the benefit of hindsight or to rely on the teachings of the claimed invention to determine whether a POSITA would have found the invention obvious.

VI. Brief Technical Background

31. Since the invention of automobiles, these vehicles have required reinforced rubber tires with specific physical properties to allow for operating the vehicle. Just as the automobile industry has advanced significantly since its inception, so too has the tire industry and the industry for reinforcements of rubber for tires.

32. One of the main components that provides the tire with the appropriate strength, stability, and durability is the tire cord. Tire cords make up the cap ply of the tire, which is a layer of rubberized cords that is wrapped circumferentially under the tread of the tire. The physical restriction of the cap ply causes the movement of the belt edge to be significantly reduced and has three very important and significant consequences. First, it reduces stresses and fatigue and loss of properties in the rubber surrounding the belt edges. Second, it reduces the growth of microscopic separations that can develop into larger separations. Third, it reduces tire temperatures—elevated temperatures weaken rubber through a

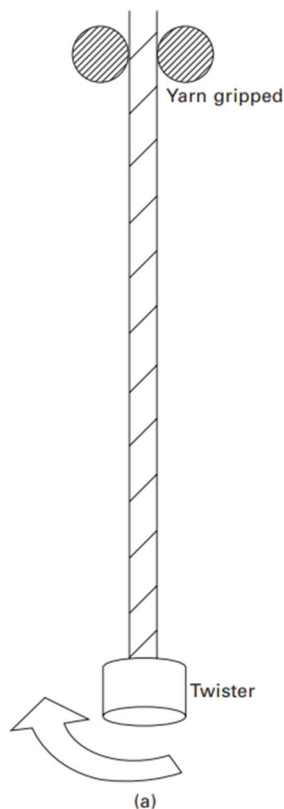
process known as ageing. As a result, tires with cap plies are more durable, less likely to fail from belt separations, and therefore safer and create a more comfortable driving experience than tires without cap plies.

33. Improved vehicle performance and road conditions have brought about gradually increasing vehicle driving speed. As a result, tires with cap plies before the invention of the '663 patent experienced problems, including, for example, with durability of the tires.

34. As the '663 patent explains, “[r]ecently, improved highway conditions have resulted in increased vehicle speeds, causing problems such as deformation of the belt of the tire and deterioration in drive comfort. For this reason, importance of a cap ply to prevent deformation of the belt is increasing.” Ex.1001, 1:32-37.

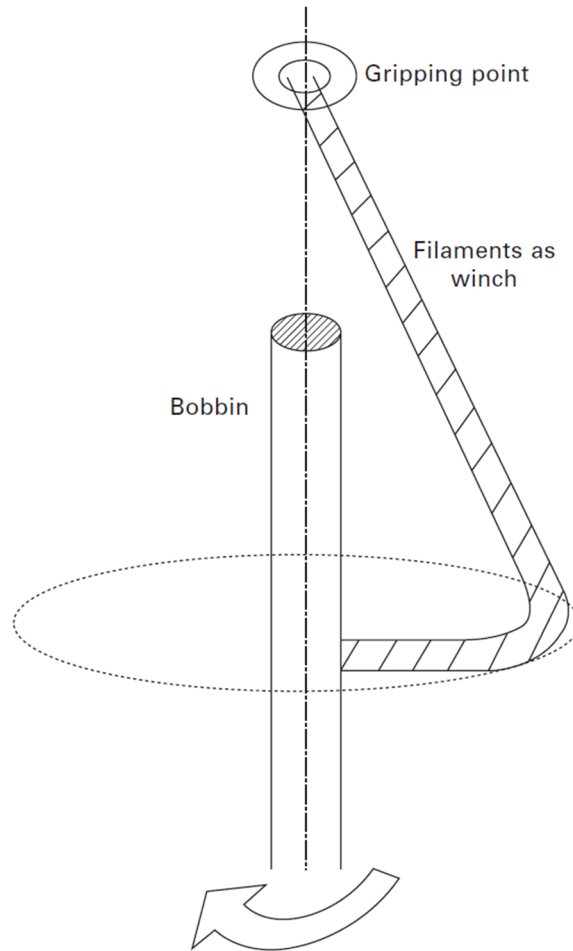
35. Conventional tire cords were originally made with a single yarn material, such as nylon or rayon. In an attempt to utilize beneficial properties of multiple materials, tire cord manufacturers attempted to combine single yarn materials together into hybrid tire cords. Hybrid cords consist of at least two different yarn types.

36. The principle of inserting twist into an assembly of fibers is illustrated in the figure below:



Ex.2019 (Advances in Yarn Spinning Technology), 12.

37. A POSITA would have known that a **ring twister (shown below)** inserts twist by having the assembly of fibers or filaments traverse through a guide, then looped around a traveler on a ring and then onto a rotating bobbin. Due to the friction between the traveler and the ring, the traveler revolves around the bobbin at a slower rotational speed than that of the bobbin. Hence, the twisted assembly of fibers or filaments are wound onto the bobbin.



Ex.2019 (Advances in Yarn Spinning Technology), 12.

38. When the rotating bobbin is going in the clockwise direction, the fibers or filaments are oriented in the “Z” direction. When the rotating bobbin is going in the counter-clockwise direction, the fibers or filaments are oriented in the “S” direction.

39. Figure 6.11 of “Textile Yarns – Technology, Structure, and Applications” (below) shows the expected behavior of yarns at different twist levels (designated by α , which is the helix angle). A POSITA would have known

that helix angle is the angle between the fibers and the longitudinal axis of the yarn or cord.

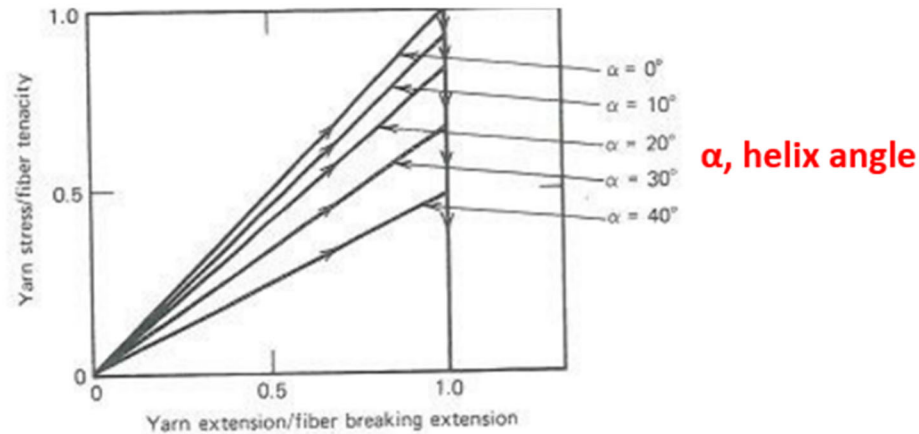
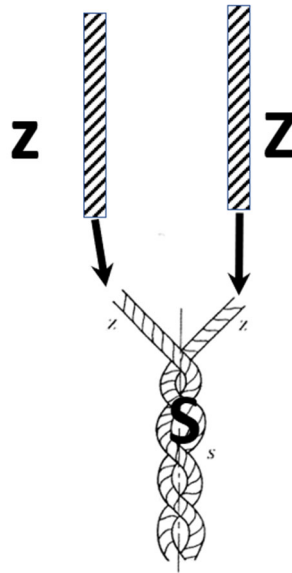


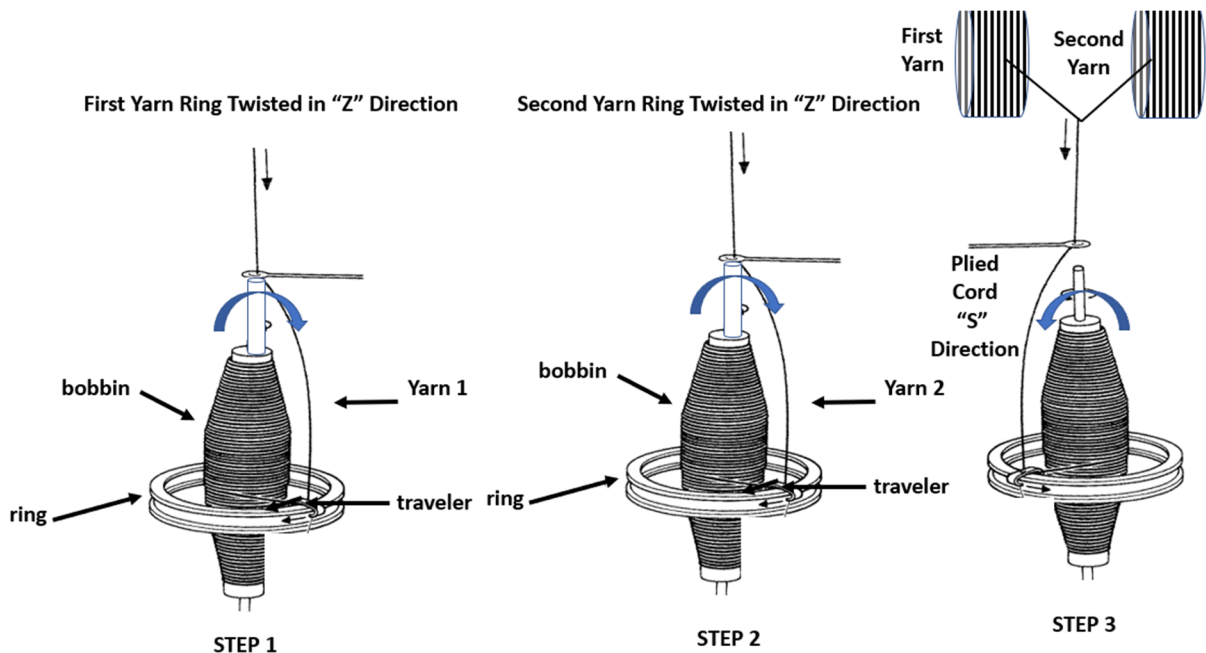
Figure 6.11. Expected behavior of yarns with catastrophic rupture.

Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 62 (annotated). Thus, the tensile strength of a twisted assembly decreases as the amount of twist is increased. Stated another way, the inherent tensile strength of the fibers is not fully realized for a twisted assembly when twist is added. Accordingly, to obtain the full strength of the fibers or filaments, it is common practice to ply two twisted assemblies, both twisted in one direction, in the opposite direction. After this, the “off-axis” individual filaments can be closely aligned along the longitudinal axis of the twisted structure, as shown below:



Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 8 (annotated).

40. The method described above is one way that plied tire cords have generally been produced. This production method requires 3 separate steps. For example: step 1) ring twist one yarn assembly in one direction, step 2) ring twist a second yarn assembly in the same direction as the first assembly, and step 3) ply the first and second assemblies in the opposite direction to produce a cord. The three steps are shown below:



Tire cords are generally produced from at least two plies of twisted assemblies that are twisted together in the manner illustrated above.

41. However, prior to the '663 invention, the structure of the 2-ply hybrid tire cord had many drawbacks. The '663 patent explains:

The 2-ply yarn having a covering structure . . . has drawbacks of low production efficiency and high manufacturing cost because it is produced by a three-step process using a ring twister (that is, a first step of primarily twisting an aramid filament yarn to form an aramid primarily twisted yarn, a second step of primarily twisting a nylon filament yarn to form a nylon primarily twisted yarn, and a third step of secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn).

In addition, there are problems of high deviation in physical properties and increased defect rate in the manufacture of the hybrid

cord, because the aramid primarily twisted yarn for covering the nylon primarily twisted yarn is pulled by friction with a guide or roller to form a roof, or the nylon primarily twisted yarn is compressed, thus causing shape non-uniformity, during drying and thermal treatment after dipping the 2-ply yarn having a covering structure in an adhesive agent solution.

Ex.1001, 2:14-40.

42. A merge or plied structure has been developed to solve the problems of the covering structure by creating cord where the nylon and aramid primarily twisted yarns have an identical structure. Ex.1001, 2:51-56. This merge structure still had drawbacks:

However, in the case of a hybrid cord having a merge structure, stress is intensely applied to the aramid primarily twisted yarn upon repeated tension and compression of tires, thus inevitably causing low fatigue resistance of tire cord and, disadvantageously, resulting in impossibility of securing safety of tires during long-term, high-speed driving.

Ex.1001, 2:51-56.

VII. The '663 Patent

A. Summary of the '663 Patent

43. The '663 patent, entitled "Hybrid Tire Cord and Method for Manufacturing the Same," relates to 2-ply aramid and nylon hybrid tire cord and methods for making it. Ex.1001, Title, Abstract. The '663 patent explains that

vehicle performance and road conditions have brought about increased driving speed, which led to a need for tire cords capable of maintaining stability and durability of tires for high-speed driving. Ex.1001, 1:29-37.

44. Tire cords treated with an adhesive agent, referred to as “dip cords,” are widely used as reinforcing materials of rubber products such as tires. One of the essential methods of improving performance of final rubber products is to improve physical properties of tire cords used as reinforcing materials. Ex.1001, 1:16-23.

45. “Major materials for currently used tire cords for cap ply are nylon and aramid.” Ex.1001, 1:38-39. “[N]ylon is applied to most tires due to low cost, superior adhesivity and superior fatigue resistance as compared to other materials,” and “nylon has a high compressive stress which is advantageous for preventing deformation of belts during high-speed driving.” Ex.1001, 1:39-43. “However, nylon has a problem of causing flat spots due to low modulus and great deformation with variation in temperature.” Ex.1001, 1:44-46.

46. Aramid, when “used as another material for the cap ply, in addition to the nylon, has almost no flat spot phenomenon in which a tire is deformed upon parking for a long time due to very high modulus and less change in modulus at room temperature and high temperature.” Ex.1001, 1:47-51. Aramid is “generally for high-quality tire.” Ex.1001, 1:51-52. “However, aramid is inapplicable to

general-purpose tires because it is very expensive.” Ex.1001, 1:52-54. “In addition, aramid has drawbacks of relative difficulty in tire molding due to high modulus, and low fatigue resistance and durability due to low breaking elongation.” Ex.1001, 1:54-57.

47. The inventions of the '663 patent include a method of manufacturing 2-ply aramid and nylon hybrid tire cord that can be more efficiently manufactured and is applicable to ultra-high performance tires due to high strength and fatigue resistance:

In accordance with an aspect of the present invention, the above and other objects can be accomplished by the provision of a hybrid tire cord including 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, and after untwisting (post-untwist) of the secondary twisting of the hybrid tire cord having a predetermined length, a length of the aramid primarily twisted yarn is 1.005 to 1.025 times a length of the nylon primarily twisted yarn.

Ex.1001, 2:66-3:2, 3:19-28. The '663 patent further discloses the following:

In another aspect of the present invention, provided is a method of manufacturing a hybrid tire cord including: a first step of primarily twisting an aramid filament yarn in a first direction to form an aramid primarily twisted yarn; a second step of primarily twisting a nylon filament yarn in a second direction to form a nylon primarily twisted

yarn, the second step and the first step being conducted **simultaneously**, and a third step of secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn in a third direction to form a plied yarn, the third step being conducted **continuously** with the first and second steps, wherein the first, second and third steps are conducted by one twister, the second direction is the same as the first direction, the third direction is opposite to the first direction, tension applied to the nylon filament yarn in the second step is higher than tension applied to the aramid filament yarn in the first step, and the tension applied to the nylon filament yarn in the second step is higher than the tension applied to the aramid filament yarn in the first step in Such an amount that the aramid primarily twisted yarn is 1.005 to 1.025 times longer than the nylon primarily twisted yarn after untwisting of the secondary twist of the hybrid tire cord with a predetermined length.

Ex.1001, 3:62-4:18 (emphases added). As the '663 patent recites, the nylon filament yarns and the aramid filament yarns are twisted into their primary twist simultaneously in one twister (e.g., a cable cord twister), thereby forming the nylon primarily twisted yarn and the aramid primarily twisted yarn. Ex.1001, 3:62-4:18. For this reason, the first twist direction of the nylon primarily twisted yarn is the same as the second twist direction of the aramid primarily twisted yarn, and the third twist direction (i.e., secondary twisting direction) is the opposite to the first and second twist directions. Ex.1001, 5:36-44.

48. As such, the invention reduces the number of steps to produce the hybrid tire cord **AND** produces a hybrid tire cord wherein, if the secondary twist is untwisted, the length of the aramid primarily twisted yarn is 1.005 to 1.025 times longer than the nylon primarily twisted yarn.

49. By manufacturing the 2-ply aramid and nylon hybrid tire cord according to the claimed method with the specific length difference range, the '663 patent allows the hybrid tire cord to be manufactured with excellent stability and durability due to its physical properties, while at the same time being easy to manufacture with low defect rates, solving the problems of the prior art.

B. Prosecution History

50. I note that the examiner found three original claims of the application leading to the '663 patent recited patentable subject matter, subject to a required clarification related to the untwisting step in the manufacturing method. Ex.1002, 96-97, 99. I note that after applicant made these changes and canceled other pending claims, the examiner allowed the three claims of the '663 patent. Ex.1002, 11-13, 68.

C. Person of Ordinary Skill in the Art

51. Petitioner proposes the following description of a POSA:

A person of ordinary skill in the art ("POSITA") at the time of the '663 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.

Pet. 8 (citations omitted). For purposes of this Declaration, I have applied Petitioner's definition of a POSITA, but I reserve my right to provide an alternate definition in this or other proceedings. In addition, I note that, while I exceed this level of skill, I am familiar with the qualifications and capabilities of others in the relevant art with this level of skill and am able to provide testimony from the perspective of a POSITA with this level of skill.

D. Claim Construction

52. It is my opinion that Petitioner fails to show the prior art references render the subject matter of the Challenged Claims unpatentable under any reasonable construction, including their plain and ordinary meaning.

VIII. Summary of Prior Art References

A. Tamura (Ex.1006)

53. Tamura is a published Japanese patent application titled "Large Diameter Rubber Hose." Ex.1006, Title, [0009]-[0010]. Tamura discloses a relatively long fabric reinforced rubber hose for transporting oil from tankers to port. Ex.1006, Abstract, [0002]. A POSITA would have understood Tamura to be in a completely different field than the invention in the '663 patent—Tamura is for

use in an essentially statically loaded reinforced rubber hose, whereas the '663 patent tire cord is for use in a dynamically loaded tire.

54. Tamura relates to reinforcement fabric for large-diameter rubber hose and focuses on physical properties relevant for this type of reinforcement fabric. Ex.1006, Abstract, [0009]-[0010]. In one embodiment of Tamura, for example:

[T]he present invention provides a large-diameter rubber hose formed using vulcanized rubber reinforced by compounding fiber fabric and/or fiber cord, characterized in that the fiber fabric and/or fiber cord is composed of a composite fiber of aramid fiber and nylon fiber. ...

The large-diameter rubber hose of the present invention maintains sufficient adhesive strength between the rubber layer and the reinforcing material layer even after a long period of vulcanization and hardening, effectively preventing the rubber layer and the reinforcing material layer from peeling off during use, and furthermore, when a fluid is passed through the hose, the change in the hose diameter due to the pressure of the fluid is small In addition, since the composite fiber used in the present invention has high heat resistance, it is possible to shorten the vulcanization time by setting the vulcanization temperature high, thereby improving production efficiency.

Ex.1006, [0011]-[0012].

55. Tamura does not contain any disclosure of suggestion of “tire” or “tire cords.” *See generally* Ex.1006. Yet, Dr. Rust incorrectly asserts throughout his

Declaration that Tamura relates to hybrid tire cord. *See, e.g.*, Ex.1003, ¶¶71, 74-75, 95, 98.

B. Fritsch (Ex.1011)

56. Fritsch is a published U.S. patent application titled “Hybrid Cabled Cord and a Method to Make It.” Ex.1011, Title. A POSITA would have understood that Fritsch relates to polyethylene naphthalate (“PEN”) and polyethylene terephthalate (“PET”) hybrid cords. Ex.1011, [0009]. A POSITA would have known that PEN and PET are both made from polyester-type polymers. Ex.1011, [0004].

57. Fritsch discloses a specific type of length difference in the components of the hybrid cabled cord, which Fritsch calls the “Coring level,” and discloses non-zero Coring levels of -25% to +25%. Ex.1011, [0029]. Fritsch defines the Coring level as the following:

The phrase “unbalanced configuration” as used herein means that the at least two yarns have different lengths and therefore have a coring level which is not equal to zero[.] The phrase “balanced configuration” as used herein refers to a yarn having a coring level equal to zero. The difference in lengths is quantitated by determining the coring level. The coring level is measured by taking a sample of one meter of cabled cord and untwisting the cable in order to separate the two yarns which compose it. The so-separated 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. The length of each constituent yarn is then measured on the yarn in its as-fed state, and the coring level calculated using the following equation:

$$\text{Coring} = (A - B)/(B) \quad (1)$$

wherein A is the length of the yarn having the higher modulus and B is the length of the yarn having the lower modulus.

Ex.1011, [0019]-[0020]. Fritsch notes that in one preferred embodiment, the Coring level for a PEN/PET hybrid tire cord is between about 3% to about 15%.

Ex.1011, [0009].

58. Fritsch discloses examples and physical properties **only** for PEN/PET hybrid tire cords. Ex.1011, [0039]-[0042], Table 1, Fig. 2. While Fritsch contemplates aramid and nylon as alternative materials, it does not disclose any examples of physical properties of aramid and nylon hybrid cord at any Coring level, and Dr. Rust does not assert otherwise. *See generally* Ex.1011; Ex.1003, ¶¶68-70.

C. Rowan (Ex.2016)¹

59. Rowan is a U.S. patent issued January 9, 2007, titled “Process and System for Producing Tire Cords.” Ex.2016, Title. Rowan relates to a process and

¹ I note that Petitioner and Dr. Rust refer to “U.S. Pat. No. 6,886,320” as “Rowan” and attach Exhibit 1007 (Pet. v; Ex.1003, ¶61), but Exhibit 1007 is U.S. Patent No.

system for producing tire cords that combine twisting the cabled cord with treating the cord “without intermediate take-up.” Ex.2016, 2:38-53, 7:22-26. A POSITA would have understood that the process and system disclosed in Rowan differs from the method claimed in the '663 patent.

60. Rowan discloses an apparatus specific to its disclosed method as shown below:

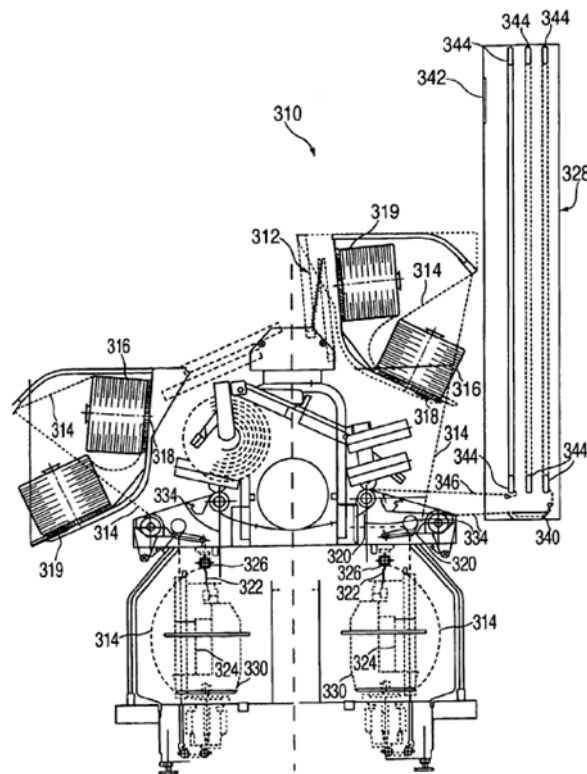


FIG. 4

7,159,381, a separate Rowan by the same inventor. The correct Rowan is attached as Exhibit 2016. The two Rowans are substantially the same, with the main difference being the column/line numbering.

Ex.2016, Fig. 4. Rowan explains in detail how this specific apparatus works, including disclosing separate individual twisting steps and specific means for applying a brake:

Yarns for producing a cable first may be processed through the DCU [“Direct [C]able Unit” (Ex.2016, 5:53)] 312. In so doing, an outer yarn 314 is pulled from the supply package 316 located in the bobbin creel 318 or reserve bobbin creel 319. The outer yarn 314 is pretensed by a tensioning device, such as brake 320. It will be appreciated that other tensioning devices ... may be substituted for or used in conjunction with the brake 320.

With continuing reference to FIGS. 4 and 5, the inner yarn 322 is drawn and unwinds from the inner supply package 324 which is held in stationary spindle container 330. The tension in the inner yarn 322 is controlled again by a tensioning device, such as a brake 326. The tension in the inner yarn 322 may be correlated with the tension in the outer yarn 314 set by brakes 320 and 326. Tension is measured and maintained via tension measuring devices known in the art It again will be appreciated that other tensioning devices ... may be adapted to, substituted for or used in conjunction with the brake 326.

The outer yarn 314 and the inner yarn 322 are twisted into a cord 334 as the yarns 314 and 322 pass through spinning discs 336, **which act to even any remaining differences in lengths between the yarns prior to twisting.**

Ex.2016, 7:34-64 (emphasis added). As shown in Rowan’s disclosure, a POSITA would have understood Rowan’s invention cannot produce a hybrid cord wherein

the length of the aramid primarily twisted yarn is 1.005 to 1.025 times longer than the nylon primarily twisted yarn, at least because Rowan explicitly teaches to “even any remaining differences in lengths between the yarns prior to twisting.” Ex.2016, 7:35-64.

61. Rowan discloses its inventive aspect as combining the treating sub-unit directly with the cabling unit such that cabling and treating can be done in one step:

With continuing reference to FIG. 4, the treating subunit 328 of the OCT 310 eliminates the hand[l]ing and transport operations 32, 36, 38 and 40 of process 10 in FIG. 1 and handling and transport operations 132, 136, 138, 140 and 172 of process 112 shown in FIG. 2. Individual feed yarns 314 and 322 are cabled in the DCU 312 but the raw cabled cord 334 so made is fed forward directly to a treating sub-unit 328 without any prior package take up. This is accomplished by connecting the treating subunit directly with the DCU 312 and controlling the tension on the cord as it proceeds from the DCU to the treating sub-unit 328.

Ex.2016, 7:65-8:8; *see also* Ex.2016, cls. 1, 2.

62. A POSITA would have found that Petitioner and Dr. Rust have not shown that Rowan discloses simultaneously twisting the individual yarns in a first and second step, nor continuously twisting the hybrid cord together after the individual twisting steps. *See* Pet. 18-21, 32-36, 39-40; Ex.1003, ¶¶74-81, 107-

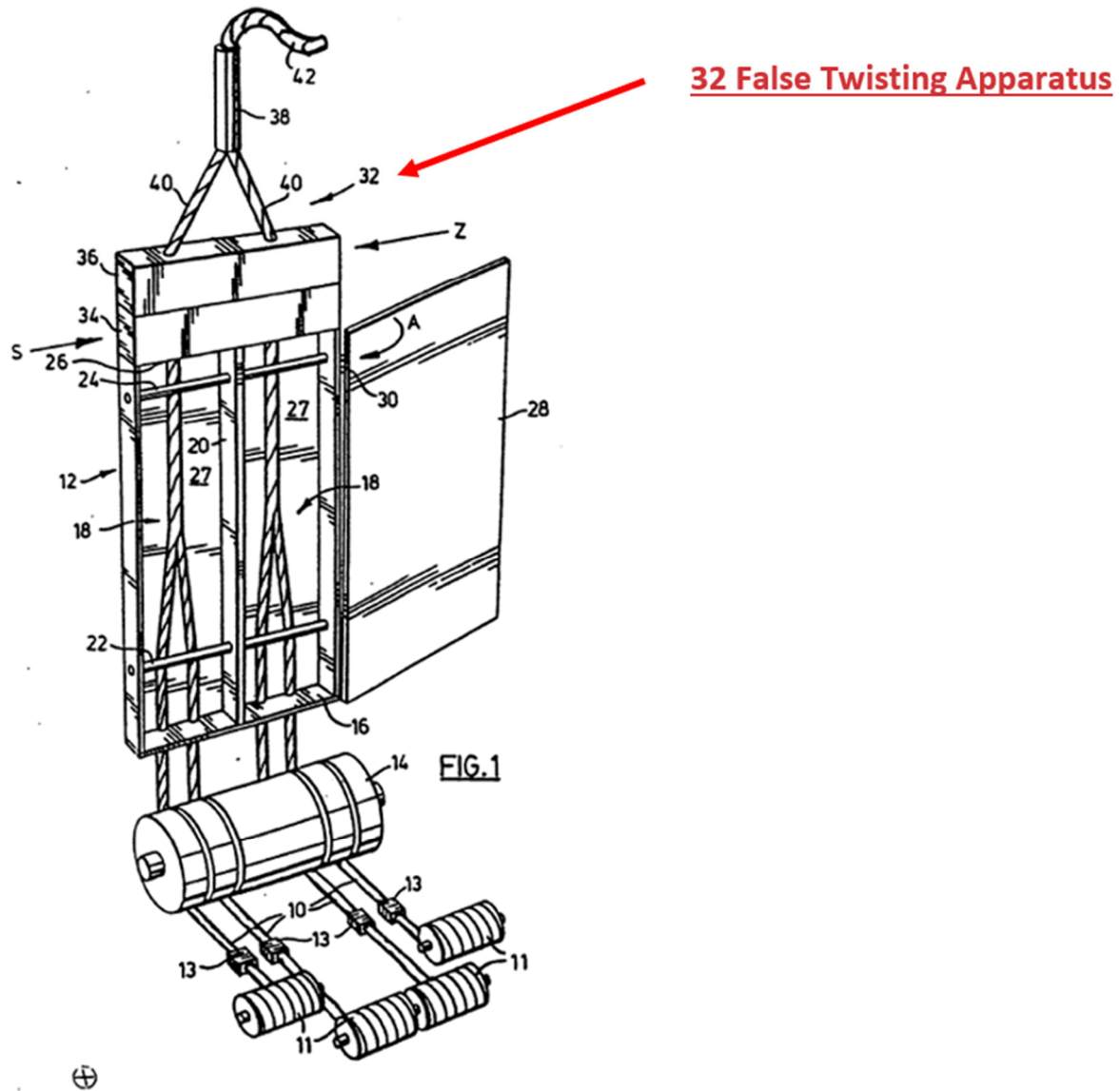
111, 118. A POSITA would have also found that Petitioner and Dr. Rust have not pointed to any disclosure in Rowan of whether the individual yarns are twisted at all but only addresses twisting yarns together into cabled cord. *See* Pet. 18-21, 32-36, 39-40; Ex.1003, ¶¶74-81, 107-111, 118.

D. Buchanan (Ex.1010)²

63. Buchanan is a published European patent application published January 2, 1991, titled “Composite Yarn and Method and Apparatus for Making Composite Yarn.” Ex.1010, Title. A POSITA would have understood the method and apparatus disclosed in Buchanan differs from the method claimed in the ’663 patent.

64. Buchanan relates to air jet false twisting composite yarns for sewing, weaving, and carpet applications. Ex.1010, 2:15-26. Buchanan discloses a specific “false twisting apparatus 32” shown below:

² I note that Petitioner and Dr. Rust cite alternately to column/line numbers and paragraph numbers of Buchanan throughout the Petition and Dr. Rust’s declaration. *See, e.g.*, Pet. 13 (citing Ex.1010, ¶9), 14 (citing “Ex.1010, ¶11” and “*Id.*, 3:50-4:5” within same paragraph), 36-37; Ex.1003, ¶¶67, 112-113. However, Buchanan (Ex.1010) does not include paragraph numbers.



Ex.1010, Fig. 1 (annotated), 3:36-39.

65. Buchanan discloses that this method makes:

[C]omposite yarn [that] is therefore generally stronger than the individual yarns used to make it and so is ideal for use as sewing thread or weaving yarn in high strength applications. This yarn may also be used to make carpet which is more resilient than and has a

different appearance than conventional carpet made from the same type of fibre.

Ex.1010, 2:14-26. A POSITA would have understood that Buchanan's method makes yarns intended for "sewing thread" or for "carpet[s]." Ex.1010, 2:14-26.

66. Buchanan further discloses that its apparatus is used for air jet false twisting:

The twisting apparatus 32 is located above the second retaining pin 24. This apparatus 32 comprises a lower air jet 34 for applying twist to the yarn in the S direction and the upper air jet 36 for applying twist to the yarn in the Z direction. These jets 34, 36 are alternately actuated for equal periods of time. A compression tube 38 is located above the twisting apparatus 32.

Ex.1010, 3:15-22.

67. Buchanan does not relate to twisting yarns for hybrid tire cords, nor does it disclose twisting yarns in accordance with the method claimed in the '663 patent. Buchanan also does not contemplate using aramid as a feed yarn.

IX. Ground 1: In my opinion, Petitioner and Dr. Rust do not show that Tamura in view of Fritsch, Rowan, and optionally Buchanan render obvious claims 1-3

68. Petitioner and Dr. Rust contend that claims 1-3 of the '663 patent are rendered obvious by Tamura in view of Fritsch, Rowan, and optionally Buchanan. Pet. 29-51; Ex.1003, ¶¶97-152. But a POSITA would have found that Petitioner and Dr. Rust have not established a reasonable basis to conclude that any claim of

the '663 patent would have been obvious based on Tamura in view of Fritsch, Rowan, and optionally Buchanan.

69. In my opinion, Petitioner's and Dr. Rust's contentions fail for four reasons. First, Petitioner and Dr. Rust have not shown that Tamura is analogous art. Second, Petitioner and Dr. Rust have not established a motivation to combine the references or that a POSITA would have arrived at a method achieving the claimed range of length difference. Third, Petitioner and Dr. Rust have not shown a reasonable expectation of success in combining parts of the prior art references to arrive at the limitations of the claimed invention. Lastly, Petitioner and Dr. Rust have not shown that multiple limitations of claim 1 of the '663 patent are met by the prior art references.

A. Petitioner and Dr. Rust have not shown that a POSITA would have combined Tamura with Fritsch, Rowan, and optionally Buchanan

1. Tamura is not analogous art

70. Petitioner and Dr. Rust have not established why a POSITA would have considered Tamura when analyzing the '663 patent, because a POSITA would not have considered Tamura to be analogous prior art.

71. Tamura is not analogous prior art because it is (1) not in the same field of endeavor as the '663 patent nor (2) reasonably pertinent to the particular problem with which the inventors of the '663 patent were solving.

72. Petitioner and Dr. Rust contend that Tamura and the '663 patent are analogous, “because they” (i.e., Tamura, Fritsch, Rowan, Buchanan, and the '663 patent) “are all directed to the same field of endeavor, specifically, the manufacture of cords from twisting yarn.” Pet. 21-22; Ex.1003, ¶82 (similar). But a POSITA would have found Petitioner’s and Dr. Rust’s alleged field of endeavor to be unreasonably broad, because it would capture methods of manufacturing of *any* cord for *any* kind of technical application. Considering the appropriate field of endeavor for the '663 patent, a POSITA would have found that Tamura is not analogous art.

73. A POSITA would have understood that the appropriate field of endeavor for the '663 patent is methods for manufacturing hybrid tire cords. Ex.1001, 1:6-12. The '663 patent explains the technical field as excerpted below:

The present invention relates to a hybrid tire cord including heterogeneous yarns having different physical properties and a method for manufacturing the same. More specifically, the present invention relates to **a hybrid tire cord** which can be easily manufactured and has more uniform physical properties, and improved strength and fatigue resistance and **a method for manufacturing the same.**

Ex.1001, 1:6-12 (emphases added). Thus, a POSITA would have understood that the appropriate field relates to “method for manufacturing” these “hybrid tire cords.” Ex.1001, 1:6-12. Further, claim 1 of the '663 patent is directed to “[a]

method of manufacturing a hybrid tire cord.” Ex.1001, Abstract. Indeed, all embodiments in the '663 patent relate to processes for manufacturing hybrid tire cords. Ex.1001, 8:54-10:67. Based on these disclosures in the '663 patent, a POSITA would have understood that the relevant field of endeavor is methods for manufacturing hybrid tire cord.

74. Even Petitioner's expert, Dr. Rust, states that “[t]he '663 patent is directed to manufacturing a hybrid tire cord.” Ex.1003, ¶36. In discussing the background of the relevant technology, both Petitioner and Dr. Rust focus on tire cord. Pet. 3-6; Ex.1003, ¶¶36-42. For example, Petitioner and Dr. Rust state that “[o]ne important way to enhance tire performance is to improve the physical properties of the tire cord used as a reinforcing material.”. Pet. 3; Ex.1003, ¶38.

75. Petitioner's and Dr. Rust's “motivation to combine” argument is based on the incorrect premise that Tamura relates to a method for manufacturing hybrid tire cord. Petitioner states throughout the Petition, and Dr. Rust largely repeats through the supporting declaration, that Tamura's teaching relates to tire cord, but that is plainly incorrect. I list some examples below, with emphases added, where Petitioner and Dr. Rust erroneously assert that Tamura teaches hybrid tire cord:

- “Tamura, which was filed by Bridgestone Corporation and published in 2009, describes the benefits of a nylon-aramid hybrid *tire cord*.

Tamura explains that given the different physical properties of the two materials, it is beneficial to create a *tire cord* where the nylon and aramid threads are twisted in one direction to form nylon and aramid yarns, and then the yarns are twisted in the opposite direction to form the *tire cord*. This results in a *tire cord* with low stress.” Pet. 2.

- “Tamura describes a nylon yarn and an aramid yarn twisted in one direction, which are then twisted in an opposite direction to form a hybrid *tire cord*.” Pet. 17; Ex.1003, ¶71 (verbatim).
- “A POSITA would have been motivated to combine Tamura’s teachings of a hybrid *tire cord* with Rowan’s single twister apparatus.” Pet. 18; Ex.1003, ¶74 (verbatim).
- “As I discussed below, Tamura describes a method for manufacturing a *tire cord* using a well-known two-step process: first, twisting two different single threads of yarn into a respective twisted yarn (or a “ply”), and then twisting two plies into a cord.” Ex.1003, ¶75.
- “Thus, a POSITA would have expected the combination to yield the predictable result of improving the physical properties of Tamura’s *tire cord*.” Pet. 29; Ex.1003, ¶95 (verbatim).

- “Tamura discloses a tire cord made from twisting two primarily twisted yarns of different materials: nylon and aramid, *i.e. a hybrid tire cord.*” Pet. 29 (emphasis in original); Ex.1003, ¶98 (verbatim).
- “Tamura describes several embodiments of hybrid *tire cords* with a linear density of 3,070 dt (*i.e.* decitex, grams per 10,000 meters [of the cord]).” Pet. 50; Ex.1003, ¶150 (verbatim).
- “A POSITA would have found it obvious to apply Rowan’s teachings of 4 Newtons of force as a desirable amount of tension to apply to a dip cord during the treatment process, including Tamura’s *tire cord.*” Pet. 50; Ex.1003, ¶152 (similar).
- “As explained in the above Motivation to Combine section, a POSITA would have found it desirable to apply the same treatment process described in Rowan to the *tire cord* disclosed by Tamura, and thus there would be a motivation to combine and a reasonable expectation of success.” Pet. 50-51; Ex.1003, ¶152 (similar).

76. Despite Petitioner’s and Dr. Rust’s repeated assertions, in reality, Tamura does not mention “tires” or “tire cords” at all—not even once. *See generally* Ex.1006. Instead, a POSITA would have understood that Tamura discloses a “large-diameter rubber hose” for “transporting a large amount of liquid,” such as transporting oil from tankers to port. Ex.1006, Abstract (“The

present invention provides a large-diameter rubber hose”), [0002] (“transporting a large amount of liquid using a hose”), [0009]. Thus, in my opinion, Tamura is not within the appropriate field of endeavor—methods for manufacturing hybrid tire cord.

77. A POSITA would have understood that Tamura is also not reasonably pertinent to the particular problem with which the '663 patent inventors were involved. As Tamura's disclosures make clear, a POSITA developing reinforcement fabric for hoses for transporting oil would have focused on addressing problems specific to hoses, which would be different than the configurations and physical properties that a POSITA would have focused on in developing methods for manufacturing hybrid tire cord for use in tires. As Tamura explains, it focuses on solving problems of “large-diameter rubber hose” relating to “durability,” “dimensional stability,” and to make sure that “the rubber layer and the reinforcing layer do not peel off during use.” Ex.1006, Abstract, [0006]-[0007].

78. As an example, Tamura explains that one problem it addresses is that when the rubber hose is being produced, “heat vulcanization is carried out for a long period of time, such as 500 to 1000 minutes, in order to completely vulcanize and harden the hose to the inside.” Ex.1006, [0003]. A POSITA would have understood that the claimed methods for manufacturing hybrid tire cord in the '663

patent do not involve a similar issue, and the claims in the '663 patent do not require vulcanization. *See generally* Ex.1001. Even when vulcanization is mentioned in the specification of the '663 patent, as an example, the '663 patent only states “vulcanized at 160°C for 20 minutes,” which is drastically different from vulcanization in Tamura. Ex.1001, 11:30-35.

79. As another example, Tamura focuses on development of reinforcement fabric that can withstand the internal pressure from the flow of material through the hose by providing excellent durability and dimensional stability and avoiding peeling of the reinforcing layer from the rubber layer. *See* Ex.1006, Abstract, [0006]-[0007], [0009] (“The present invention has been made in consideration of the above circumstances, and aims to provide a large-diameter rubber hose that maintains the adhesive strength between the rubber layer and the reinforcing material layer even after long-term vulcanization, does not peel off from the rubber layer during use, and exhibits little change in hose diameter due to fluid pressure even when transporting fluid, and has excellent durability and dimensional stability.”). Tamura also involves the problem of creating fabric reinforcement that can withstand elevated temperatures, which may occur as fluid flows through the hose. Ex.1006, [0004] (“However, this PET fiber does not necessarily have sufficient heat resistance, and when used in the large-diameter hose, thermal degradation occurs during the long period of time of 500 to 1000

minutes during which the rubber is vulcanized and hardened, resulting in a significant decrease in adhesion between the rubber layer and the reinforcing material layer.”). A POSITA would not find Tamura’s problems applicable to tires or the development of methods for manufacturing hybrid tire cord for tires, because tires and tire cords do not involve large amounts of liquid flowing within the tire, or any temperature of such liquid.

80. The ’663 patent is therefore directed to an entirely different field of endeavor than Tamura and is aimed at solving entirely different problems. The ’663 patent focuses on methods for manufacturing hybrid tire cord for use in tires and designs hybrid tire cord to address issues that arise from use of tires over time. Tamura, on the other hand, focuses on fabric reinforcement for relatively long hoses and designs this fabric to solve problems in the use of the hoses over a long period of time to transport fluids long distances. As an example of the stark difference, the ’663 patent identifies that one problem the invention addresses is flat spots that develop in tires due to when the tire on a car sits in place for an extended period of time, because “nylon has a problem of causing flat spots due to low modulus and great deformation with variation in temperature.” Ex.1001, 1:44-46. The ’663 patent further explains that “[w]hen the weight of nylon primarily twisted yarns exceeds 4 times the weight of aramid primarily twisted yarns,

physical properties of finally obtained hybrid tire cords become similar to those of nylon and flat spots thus occur.” Ex.1001, 7:8-11.

81. Tamura would not have considered flat spots as a problem, because the large-diameter rubber hoses in Tamura do not develop flat spots as may hybrid tire cords that bear the weight of a parked vehicle over a prolonged period of time, and even if the large-diameter rubber hose in Tamura develop any flat spots, fluid such as oil can still flow through the hose despite the flat spots.

82. Thus, because Tamura does not address problems related to tires and tire cords, such as flat spotting, a POSITA aiming to improve methods of manufacturing hybrid tire cord would not have been motivated to consider Tamura or to pursue teachings in Tamura.

83. Therefore, because the '663 patent is directed to a different field of endeavor and different problems in its application than Tamura, Tamura is not analogous prior art.

2. A POSITA would not have combined Tamura with Rowan

84. Petitioner and Dr. Rust also have not shown that a POSITA would have combined Tamura with Rowan.

85. Petitioner and Dr. Rust argue that Rowan teaches combining a two-step process for producing raw hybrid cord into a single machine, and “Tamura also teaches the same two-step process for producing raw cord, and a POSITA

would have been motivated to combine Tamura's two-step process with Rowan's teachings of a single apparatus for performing the same steps simultaneously and continuously." Pet. 18; *see also* Ex.1003, ¶75. Petitioner and Dr. Rust contend that POSITAs would have been motivated to use Rowan's apparatus to perform Tamura's two-step process because of the advantages of the one-step process. A POSITA would have found that Petitioner and Dr. Rust have not shown support for their assertions.

86. First, Petitioner and Dr. Rust incorrectly assume that "Tamura's two-step process for producing a raw cord" is a ring twisting process that requires "separate and independently operated machines," and incorrectly state that Rowan's one-machine technique improves on Tamura's process. *See, e.g.*, Pet. 18-19; Ex.1003, ¶¶74-77. A POSITA would have found that Tamura does not disclose a particular machine for the manufacturing of its cord. Tamura only states the following:

The above-mentioned composite fiber cord is obtained by **lower twisting** a predetermined number of aramid fibers and nylon fibers, each of which is individually twisted, and then **upper twisting** the resulting fibers together. The above-mentioned composite fiber woven fabric is obtained by weaving the above-mentioned composite fiber cord in a conventional manner.

Ex.1006, [0018] (emphases added).

87. Beyond Tamura's minimal discussion of its method of manufacturing its "large-diameter rubber hose," Tamura does not provide other details of its manufacturing method. *See generally* Ex.1006. Further, although Petitioner and Dr. Rust claim that Tamura experiences challenges in its fiber twisting process, Tamura does not discuss or indicate any such challenges. *See generally* Ex.1006.

88. Further, to the extent Tamura does disclose a multi-step twisting process, a POSITA would have understood that ring twisters operate completely differently from the one-step apparatuses of Rowan. I explained above in ¶¶37, 40 the process of ring twisters, where the method requires a multi-step process of ring twisting a first yarn, ring twisting a second yarn, and then plying the first and second yarns together. On the other hand, a one-step process for producing a hybrid tire cord is a two-for-one process when two yarn chasses (bobbins) are twisted at the same time. Ex.2023 (Handbook of Yarn Production – Technology, Science and Economics), 15-16.

89. Petitioner and Dr. Rust have not shown that it would have been obvious to a POSITA how modifying the two-step process into a one-step process would be accomplished, and Petitioner and Dr. Rust fail to explain how a POSITA could have done this.

90. Second, the reasoning behind Petitioner's and Dr. Rust's motivation to combine is unclear. A POSITA would have understood that there are three

twisting steps in the '663 patent: “a first step of primarily twisting an aramid filament yarn in a first direction to form an aramid primarily twisted yarn; a second step of primarily twisting a nylon filament yarn in a second direction to form a nylon primarily twisted yarn, ... and a third step of secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn in a third direction to form a plied yarn,” where “the second step and the first step [are] conducted simultaneously,” and “the third step [is] conducted continuously with the first and second steps.” Ex.1001, cl. 1. Petitioner and Dr. Rust claim that “a POSITA would have been motivated to combine Tamura’s two-step process with Rowan’s teachings of a single apparatus for performing the same steps simultaneously and continuously.” Pet. 18; *see also* Ex.1003, ¶75. It appears that Petitioner’s and Dr. Rust’s “two-step process” includes a first step of “twisting two different single threads of yarn into a respective twisted yarn (or a ‘ply’)” and a second step of “twisting two plies into a cord.” Ex.1003, ¶75; *see also* Pet. 18. However, it is unclear which steps in the proposed combination are performed simultaneously and which are performed continuously, because Petitioner’s and Dr. Rust’s characterizations of the steps conflate the claim language.

91. Thus, POSITAs would not have known from Petitioner’s and Dr. Rust’s analysis how to modify Tamura’s two-step process into a one-step process as disclosed in Rowan to arrive at the claimed invention. Petitioner and Dr. Rust

do not explain *how* a POSITA would modify Tamura based on disclosures in Rowan to achieve the claimed invention. *See* Pet. 18-22; Ex.1003, ¶¶74-82.³

92. Thus, in my opinion, a POSITA would not have combined Tamura with Rowan.

3. Petitioner and Dr. Rust do not show that a POSITA would have combined Tamura and Rowan with Fritsch

93. Petitioner and Dr. Rust propose to combine Fritsch's teachings of "applying different tension to yarns twisted to form a cord with one yarn being longer than the other" with Tamura and Rowan. Pet. 25; Ex.1003, ¶89 (verbatim). However, a POSITA would have understood that Tamura does not disclose the tension applied to yarns during manufacture. *See generally* Ex.1006. Rowan discloses the use of a "tensioning device" (Ex.2016, 7:34-60), but Petitioner and Dr. Rust do not provide any reason why a POSITA would have modified Rowan's "tensioning device" to apply the differing tension amounts that Fritsch discloses. *See* Pet. 25-29; Ex.1003, ¶¶89-96. In fact, Petitioner and Dr. Rust do not appear to address Rowan at all, but only state that "a POSITA would have been motivated

³ I note that Petitioner and Dr. Rust cite to paragraphs in Rowan (*See, e.g.*, Pet. 19; Ex.1003, ¶77 (both citing to "Ex.1007, ¶39")), but Exhibit 1007 does not contain any paragraph numbers. Neither does Exhibit 2016 contain any paragraph numbers.

to use one or more of [Fritsch's] Coring levels with Tamura to achieve improved physical properties.” Pet. 27; Ex.1003, ¶93 (verbatim). But their assertion is directly contrary to their assertion that an unbalanced tire cord (i.e., having a length difference between the yarns) compromises tire performance in another IPR, challenging another patent owned by Patent Owner, where they argue: “non-uniform (or unbalanced) cord construction” (i.e., cord construction following Fritsch's teachings) “often lead to uneven stress distribution within the tire and composite tire performance ... As a result [of the unbalanced cords construction,] ... the tire performance would be less stable.” Ex.2026 (IPR2025-00662, Petition), 24 (citations omitted); Ex.2027 (IPR2025-00662, Ex.1003 (Rust Declaration)), ¶77. This is precisely the opposite of what Petitioner and Dr. Rust argue in this IPR. Thus, Petitioner and Dr. Rust have not provided any reason to combine Fritsch with Tamura and Rowan in the first place.

94. Petitioner and Dr. Rust then contend that based on Fritsch's teaching, “a POSITA would have been motivated to alter the tension so that the aramid yarn is 0.9% longer than the nylon yarn, since Fritsch teaches that such a difference provides beneficial improvements to the physical properties of the tire cord.” Pet. 25; Ex.1003, ¶89. Petitioner and Dr. Rust further assert the following:

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. 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. Third, Fritsch expressly teaches that cords using aramid and nylon are “[p]olymeric yarns useful in the inventive method and product” and expressly teaches such *[sic]* cords preferably have a coring level between -25% and 25%.

Ex.1003, ¶94 (citations omitted); Pet. 27-28 (citations omitted). However, in my opinion, a POSITA would not have been motivated to combine Fritsch’s disclosure because Petitioner and Dr. Rust are relying on erroneous assumptions.

95. A POSITA would not have been motivated to apply a length difference for a PEN/PET hybrid cord, as disclosed in Fritsch, to make an aramid/nylon hybrid tire cord with a similar length difference, because aramid and nylon have substantially different chemical and physical properties from PEN and PET. A POSITA would have understood that Fritsch discloses PEN/PET hybrid cord and its properties, not methods of manufacturing aramid and nylon hybrid cord pursuant to the claims of the ’663 patent. In fact, Fritsch discloses the drawbacks of using aramid and nylon in the following passage:

Polyester tire cord has become increasingly common in recent years. *Polyester, specifically, polyethylene terephthalate (PET), has many advantages over cords made of rayon or polyamide [e.g., nylon and*

aramid]. Rayon has good dimensional stability but has low strength, poor durability and is hygroscopic. *Polyamide [e.g., nylon and aramid] has higher strength and durability compared to rayon but has poor dimensional stability.* PET tire cord possesses high strength, good durability, better modulus and low creep. Another polyester, polyethylene naphthalate (PEN), provides even better mechanical properties, including modulus, breaking strength and elongation, for use in tires than PET.

Ex.1011, [0004] (emphases added). A POSITA would have understood that instead of disclosing a method for manufacturing aramid and nylon hybrid cord, Fritsch discourages the use of polyamides such as aramid and nylon. Ex.1011, [0004]. A POSITA would have understood that Tamura, on the other hand, discourages using PET fiber for its “large-diameter rubber hose,” because “PET fiber does not necessarily have sufficient heat resistance, and when used in the large-diameter hose, thermal degradation occurs during the long period of time of 500 to 1000 minutes during which the rubber is vulcanized and hardened, resulting in a significant decrease in adhesion between the rubber layer and the reinforcing material layer.” Ex.1006, [0004].

96. In my opinion, a POSITA would have further not found the proposed combination obvious because their teachings conflict with each other. For example, Petitioner and Dr. Rust contend that a POSITA would have applied the disclosure in Fritsch of adjusting tensions to Tamura, but a POSITA would not

have found Rowan to disclose using tensioning to adjust individual yarn lengths in manufacturing hybrid tire cord, not to mention using unbalanced tensions. *See* Ex.2016, 7:34-60. Instead, Rowan teaches the following:

The outer yarn 314 and the inner yarn 322 are twisted into a cord 334 as the yarns 314 and 322 pass through spinning discs 336, which act to **even any remaining differences in lengths** between the yarns prior to twisting.

Ex.2016, 7:61-64 (emphasis added). In other words, Rowan discloses utilizing “spinning discs” to make sure that there are no remaining length differences between the yarn. Ex.2016, 7:61-64. Thus, a POSITA would not have been motivated to apply the disclosure of adjusting tension for PEN/PET hybrid cords in Fritsch to arrive at different yarn lengths in Rowan’s approach of manufacturing hybrid tire cord.

97. Further, Petitioner and Dr. Rust point to the discussion of a “butterfly pulley” in Fritsch and argue this discloses how to adjust individual tension and therefore the lengths of yarns in hybrid tire cord. Pet. 56-57; Ex.1003, ¶126. Petitioner and Dr. Rust assert that Fritsch teaches the tension on the yarn can be unbalanced by wrapping the two yarns around the butterfly pulley an unequal number of times. Pet. 56-57; Ex.1003, ¶126. Petitioner and Dr. Rust, however, do not explain how this teaching would apply to Rowan. Rowan does not disclose any pulleys, let alone “butterfly pulleys.” *See generally* Ex.2016. There is also no

discussion of wrapping the yarn around the tensioning device, such as a brake, in Rowan. *See* Ex.2016, 7:34-45. Rowan also contains no discussion of adjusting individual yarn tension and instead, Rowan discloses using the same tension to achieve the same yarn length. Ex.2016, 7:35-46.

98. Accordingly, Petitioner and Dr. Rust have not explained how a POSITA would have been able to combine the teachings in Fritsch with the apparatus and method in Rowan needed to modify Tamura to achieve any kind of unbalanced hybrid tire cord, let alone why a POSITA would have been motivated to do so to achieve the claimed invention.

4. A POSITA would not have had a motivation to combine Tamura, Fritsch, and Rowan with Buchanan

99. Petitioner and Dr. Rust argue that Buchanan could be “optionally” combined with Tamura, Rowan, and Fritsch. Pet. 22-24; Ex.1003, ¶¶83-87. Petitioner and Dr. Rust contend that Buchanan is in the same field of endeavor as the '663 patent because both relate to “manufacturing cords from twisting strands of yarn.” Pet. 24; Ex.1003, ¶88. However, as I explained previously, the field of endeavor that Petitioner and Dr. Rust assert, “manufacturing cords from twisting strands of yarn,” is overly broad, and a POSITA would have understood the appropriate field of endeavor for the '663 patent as methods for manufacturing hybrid tire cord. Buchanan discloses that its relevant field for using its yarns is “sewing thread or weaving yarn in high strength applications,” or “to make carpet.”

Ex.1010, 2:19-26. A POSITA would have understood that Buchanan is not within the same field of endeavor as the '663 patent and also not reasonably pertinent to the particular problem that the inventors of the '663 patent were involved. Thus, a POSITA would not have found Buchanan to be analogous art.

100. Further, Petitioner and Dr. Rust do not show why a POSITA would have modified Rowan in view of Buchanan to achieve simultaneous twisting. Petitioner and Dr. Rust contend the following:

Thus, a POSITA would have been motivated to look to Buchanan in order to give effect to Rowan's teachings, specifically an apparatus that twists a thread into a yarn, and does so *simultaneously* in order that the yarns can be twisted into a cord *continuously* as taught by Rowan. A POSITA would understand that simultaneity in the twisting of the yarns is needed in order that they are ready to be twisted to form a cord in Rowan's continuous process that lacks "intermediate take-up." If the yarns are not twisted at the same time, then the apparatus could not "treat[] the cord in a continuous process without intermediate take-up" as required by Rowan.

Pet. 23-24 (emphases in original; citations omitted); Ex.1003, ¶85 (verbatim). However, Petitioner and Dr. Rust fail to show that a POSITA would find Rowan or Buchanan to require or teach that the individual plies be twisted simultaneously. *See generally* Ex.2016; Ex.1010. Further, a POSITA would understand that a process can be continuous, without any intermediate take-up, where the yarns

move within one machine from individual twisting, twisting together, and dipping in adhesive, even where the two individual yarns are not twisted simultaneously. Thus, Petitioner's and Dr. Rust's argument is unsupported.

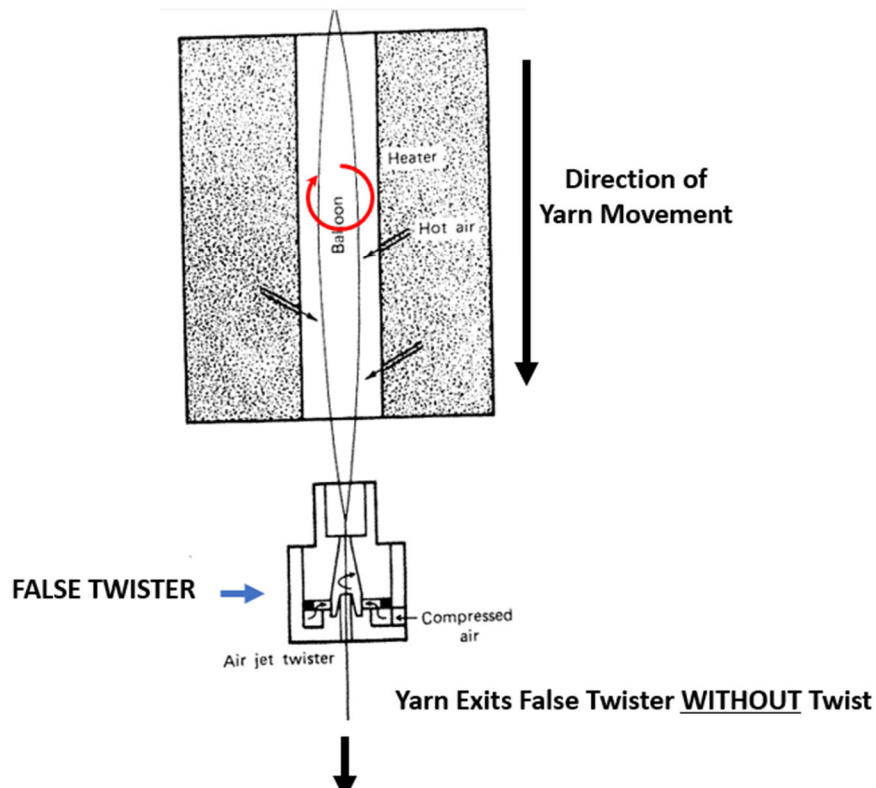
101. In addition, Petitioner and Dr. Rust do not show *how* a POSITA would have applied the teachings in Buchanan to modify Rowan in order to twist individual plies simultaneously. A POSITA would not have known how to apply any teaching in Buchanan to Rowan because they disclose different twisting apparatuses for different cord applications. One example is that Rowan, to the extent it discloses twisting a yarn, discloses using spinning discs, while Buchanan discloses twisting using a “lower air jet.” *Compare* Ex.2016, 7:61-64 (“The outer yarn 314 and the inner yarn 322 are twisted into a cord 334 as the yarns 314 and 322 pass through spinning discs 336, which act to even any remaining differences in lengths between the yarns prior to twisting.”), *with* Ex.1010, 3:16-19 (“This apparatus 32 comprises a lower air jet 34 for applying twist to the yarn in the S direction and an upper air jet 36 for applying twist to the yarn in the Z direction.”).

102. Buchanan further explains that “the strands are twisted and plied together by the false twisting apparatus 32 in alternating S and Z bundle directions of twist, with equally spaced nodes of zero twist in between.” Ex.1010, 3:36-39. Air jet false twisting, sometimes referred to as fluid twisting system, as disclosed in Buchanan, is a process where yarns are twisted and then untwisted, such that

bulk is imparted to the yarn but **the fibers are not ultimately twisted together when they exit the process** disclosed in Buchanan. Ex.1010, 3:36-39; Ex.2019 (Advances in Yarn Spinning Technology), 11; Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 184. As the textbook “Advances in Yarn Spinning Technology” discloses:

If a fibre strand that is kept stationary by gripping it at both ends is twisted at some point in between, the strand length on each side of the twist insertion point, i.e. the twisting element, will obtain the same number of turns of twist, but with opposite directions (Fig. 2.2(a)). On moving the fibre strand through the point of twist insertion, the torque present in the upstream length will be cancelled as it passes the twisting element by the opposite torque present in the downstream length of the fibre strand. Thus, on passing the twisting element, the fibre strand would be twistless ...”

Ex.2019 (Advances in Yarn Spinning Technology), 11. The textbook “Textile Yarns – Technology, Structure, and Applications” also shows air jet or fluid false twisting in the annotated diagram below:



Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 184 (annotated). A POSITA would have recognized that Petitioner and Dr. Rust have not shown how to modify Rowan to implement Buchanan’s teachings.

103. Thus, a POSITA would not have had a motivation to combine Tamura, Fritsch, and Rowan with Buchanan.

B. Petitioner and Dr. Rust have not shown obviousness of multiple claim limitations

104. Even assuming, counterfactually, that Tamura, Rowan, Fritsch, and optionally Buchanan could be combined, the proposed combination still would not meet multiple limitations of independent claim 1.

105. Independent claim 1 recites the following:

1. A method of **manufacturing a hybrid tire cord comprising:**
a first step of primarily twisting an aramid filament yarn in a first direction to form an aramid primarily twisted yarn;
a second step of primarily twisting a nylon filament yarn in a second direction to form a nylon primarily twisted yarn, **the second step and the first step being conducted simultaneously;** and
a third step of secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn in a third direction to form a plied yarn, **the third step being conducted continuously with the first and second steps,**
wherein the first, second and third steps are conducted by one twister, the second direction is the same as the first direction, the third direction is opposite to the first direction, and tension applied to the nylon filament yarn in the second step is higher than tension applied to the aramid filament yarn in the first step in such an amount that, **if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn.**

Ex.1001, cl. 1 (emphases added).

1. **Petitioner and Dr. Rust have not established a reasonable likelihood of showing that the claimed “manufacturing a hybrid tire cord comprising” would have been obvious**

106. Petitioner and Dr. Rust argue that Tamura alone meets the claim element “[a] method of manufacturing a hybrid tire cord comprising.” Pet. 29-30;

¶¶97-99. As I explained above, Petitioner's and Dr. Rust's arguments are incorrect at least because Tamura is not analogous art to the '663 patent. Tamura does not disclose or mention any "tire," "tire cord," or any method of manufacturing it. *See generally* Ex.1006. Thus, Tamura also cannot disclose a method of manufacturing a hybrid tire cord as recited in claim 1.

107. Petitioner and Dr. Rust do not offer any support or reasoning to close the gap between Tamura's hose reinforcement fabric and the claimed method of manufacturing hybrid tire cord in the '663 patent, and therefore, in my opinion, Petitioner and Dr. Rust fail to identify any prior art meeting this claim limitation.

2. Petitioner and Dr. Rust have not shown that the proposed combination renders obvious the claim limitation "the second step and the first step being conducted simultaneously"

108. Claim 1 recites "a first step of primarily twisting an aramid filament yarn in a first direction to form an aramid primarily twisted yarn; a second step of primarily twisting a nylon filament yarn in a second direction to form a nylon primarily twisted yarn, and the second step and the first step being conducted simultaneously." Ex.1001, cl. 1. Based on the disclosure in Tamura, Petitioner and Dr. Rust contend that "[a] POSITA would understand that both threads being 'lower twist[ed]' means both threads are twisted simultaneously." Pet. 32 (emphasis omitted); Ex.1003, ¶106 (verbatim). But a POSITA would have understood that Petitioner's and Dr. Rust's arguments are unsupported.

109. Petitioner and Dr. Rust describe Tamura as teaching a “two-step process,” where each yarn is individually twisted and then the yarns are separately twisted together, performed in discrete steps. Pet. 18; Ex.1003, ¶75. As I have detailed above, Tamura does not provide further specificity on its twisting process, and this interpretation of Tamura is not based on any evidence that Petitioner or Dr. Rust cite to or rely on. In any event, Petitioner and Dr. Rust claim that this process relates to a two-step ring-twisting method that was “widely-known” in the industry. Ex.1003, ¶¶76-78; Pet. 18-19. However, Fritsch describes the ring twister process as following:

The ring-twister machine is disadvantageous as it requires multiple steps to yield the final product; the constituent yarns must first be twisted *separately* and then combined in another step to be twisted into the cabled cord. Therefore manufacture cost of such hybrid cabled cords using a ring twister is high.

Ex.1011, [0005] (emphasis added). A POSITA would have understood that twisting each of the individual yarns separately means does not require that the twists be conducted “simultaneously,” as the claim requires. Thus, Tamura does not disclose or render obvious simultaneous operation because Petitioner and Dr. Rust claim that it uses a two-step ring-twisting process. Pet. 18-19; Ex.1003, ¶¶75-78. Further, Tamura’s disclosure of “lower twist[ed]” does not relate to the yarns being twisted simultaneously. Tamura’s paragraph [0018] states, in relevant part:

The above-mentioned composite fiber cord is obtained by lower twisting a predetermined number of aramid fibers and nylon fibers, each of which is individually twisted, and then upper twisting the resulting fibers together. The above-mentioned composite fiber woven fabric is obtained by weaving the above-mentioned composite fiber cord in a conventional manner.

Ex.1006, [0018]. A POSITA would have understood that this passage merely refers to the individual twists in both yarns but does not disclose whether the yarns are twisted simultaneously. Ex.1006, [0018]. Thus, Petitioner and Dr. Rust have not shown that Tamura discloses conducting the first and second steps simultaneously.

110. Petitioner and Dr. Rust also rely on Rowan as disclosing the claimed simultaneous twisting. Pet. 32-36; Ex.1003, ¶¶107-111. Specifically, Petitioner and Dr. Rust rely on Rowan's statement that "[t]he OCT [i.e., one-machine cabled and treated cord unit] 310 cables and treats the cord in a continuous process without intermediate take-up in a manner yet to be described." Ex.2016, 7:22-24. It is true that Rowan discloses combining the ring twisting method into a single machine. Ex.2016, 7:27-64. But Petitioner and Dr. Rust have not shown that Rowan discloses the first and second steps of primarily twisting the aramid filament yarn and primarily twisting the nylon filament yarn to be conducted simultaneously. Still, Petitioner and Dr. Rust contend that "a POSITA would understand that the

twisting, *i.e. first and second step*, must occur simultaneously since each yarn is removed from the spool, tensioned, twisted into a cord, and treated in one ‘continuous process without intermediate take-up.’” Pet. 35-36 (citing Ex.2016, 7:22-24); Ex.1003, ¶111 (verbatim). But a POSITA would have understood Rowan’s disclosure that Petitioner and Dr. Rust rely on to describe a continuous process of twisting the plies together and then treating the plies, not that the individual plies are simultaneously twisted.

111. Petitioner and Dr. Rust also attempt to address this lack of disclosure in Tamura and Rowan by pointing to Buchanan. Pet. 36-38; Ex.1003, ¶¶112-113. But as I explained above, Buchanan is directed to a method of air jet false twisting yarns, where the yarns are twisted and then untwisted so that bulk is imparted to the yarn, but the fibers are not ultimately twisted together when they exit the process. Ex.1010, 3:36-39; Ex.2019 (Advances in Yarn Spinning Technology), 11; Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 184. A POSITA would have understood that in Buchanan, both air jets 34 and 36 must operate. Ex.1010, 1:36-42 (“Alternating twisting means are simultaneously applied to twist the strands of the bundles and ply the strands of each multi-strand bundle together in alternating S and Z bundle directions of twist separated by nodes, so that the bundles all have substantially the same twist pattern.”). A POSITA would have understood that the output of Buchanan’s process would not

meet the claimed limitations of “secondarily twisting the aramid primarily twisted yarn and the nylon primarily twisted yarn.” Ex.1001, cl. 1.

112. Further, a POSITA would not find that Buchanan’s yarns being twisted by the same apparatus to mean simultaneous operation. A single apparatus such as Buchanan’s false twister may process two yarns in serial operation to impart the same twist pattern, but a POSITA would not have understood that process to be the claimed simultaneous operation. Thus, a POSITA would not have found Buchanan to suggest simultaneous operation.

3. Petitioner and Dr. Rust have not shown that the proposed combination renders obvious the claim limitation “the third step being conducted continuously with the first and second steps”

113. Petitioner and Dr. Rust contend that Tamura discloses conducting the third step continuously with the first and second steps because it discloses “upper twisting” of the two yarns. Pet. 39; Ex.1003, ¶117. But a POSITA would have understood that the disclosure of “upper twisting” in Tamura is unrelated to conducting the third step continuously. As I explained above, Petitioner and Dr. Rust claim that Tamura uses a two-step ring-twisting process. Pet. 18-19; Ex.1003, ¶¶75-78. Under Petitioner’s and Dr. Rust’s view, the steps of individually twisting the yarns and twisting the yarns together are distinct steps that are completed by different twisters. Pet. 18; Ex.1003, ¶75. Thus, a POSITA would have found that Tamura’s distinct processes using different twisters are not a continuous process.

114. Further, the “upper twisting” disclosed in Tamura denotes the twisting of the yarns together and has no bearing on whether the yarns are twisted continuously, i.e., that there is a continuous feed of the primarily twisted yarn into the secondary twisting step. Ex.1006, [0018]. A POSITA would not find that Tamura discloses the timing of when that upper twisting occurs. Therefore, Petitioner and Dr. Rust have not shown that Tamura discloses “the third step being conducted continuously with the first and second steps.”

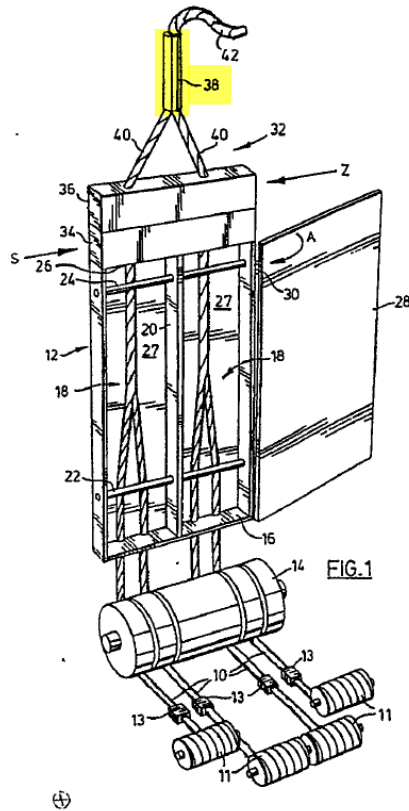
115. Petitioner and Dr. Rust also rely on Rowan, but Petitioner and Dr. Rust have not even shown that Rowan discloses the first and second steps, nor that it discloses or suggests that the third step is conducted continuously with the first and second steps. Pet. 35; Ex.1003, ¶118. Petitioner and Dr. Rust cite to Rowan’s disclosures as support, that “[t]he outer yarn 314 and the inner yarn 322 are twisted into a cord 334 as the yarns 314 and 322 pass through spinning discs 336, which act to even any remaining differences in lengths between the yarns prior to twisting,” and “[t]he OCT [i.e., one-machine cabled and treated cord unit] 310 cables and treats the cord in a continuous process without intermediate take-up in a manner yet to be described.” Pet. 39 (quoting Ex.2016, 7:61-64, 7:22-24); Ex.1003, ¶118 (verbatim). But the Rowan disclosures that Petitioner and Dr. Rust rely on do not include individually twisting the plies and then twisting the plies together. Instead, the disclosures that Petitioner and Dr. Rust cite relate to a

continuous process of twisting the plies together and then treating the plies. Thus, Petitioner and Dr. Rust have not shown that the claimed limitation is disclosed or rendered obvious by Rowan.

116. Petitioner and Dr. Rust further rely on Buchanan and contend that Buchanan “teaches that the two yarns are then converged in compression tube 38 and ‘pl[ied] together in a direction of twist ... which is opposite to the bundle direction of twist’ to form composite yarn 42.” Pet. 40; Ex.1003, ¶119 (verbatim). However, a POSITA would have understood that “compression tube 38” does not perform twisting at all. Buchanan explains the following:

The bundles relax and tend to unravel in the [compression] tube 38, but are constrained from completely unravelling by the walls of the tube 38. Instead the bundles 40 only *partially untwist* and since they are in close proximity to one another, ply together in a direction of twist hereinafter called the composite direction of twist, which is opposite to the bundle direction of twist.

Ex.1010, 3:53-4:1 (emphasis added). The “compression tube 38” is highlighted in Buchanan’s Figure 1 below:



Ex.1010, Fig. 1 (highlighted). Thus, Buchanan does not disclose any twisting process in the compression tube. A POSITA would have understood that Buchanan does not teach the claim limitation.

117. Thus, in my opinion, Petitioner and Dr. Rust have not shown that the continuous process required by claim 1 is disclosed or rendered obvious.

X. Grounds 1 and 2: Fritsch does not render obvious a method of making hybrid tire cord where, “if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn”

118. In both Grounds 1 and 2, Petitioner and Dr. Rust contend that Fritsch discloses or renders obvious a method of manufacturing aramid and nylon hybrid

tire cord where “if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn.” Ex.1001, cl. 1; Pet. 44-46, 58-60; Ex.1003, ¶¶129-133, 178-183. Fritsch does not disclose this limitation, and Petitioner and Dr. Rust have not shown that Fritsch, alone or in combination with Tamura, would have rendered this limitation obvious.

119. Petitioner and Dr. Rust contend that the claimed length difference corresponds to a “Coring level” of 0.5% to 2.5% in Fritsch, and that Fritsch discloses or renders obvious aramid and nylon hybrid tire cord with “a Coring level of 0.9%.” Pet. 46 (“a POSITA would have been motivated to combine Fritsch’s teachings with Tamura, including the application of a Coring level of 0.9% to Tamura’s aramid-nylon hybrid cord”); *see also* Ex.1003, ¶133; Pet. 59-60 (“To the extent Patent Owner argues that Fritsch does not expressly disclose an aramid-nylon tire cord with a Coring level of 0.9%, a POSITA would have considered it obvious to apply Fritsch’s teaching of a 0.9% Coring level to the nylon-aramid hybrid cord taught by Fritsch.”); *see also* Ex.1003, ¶182.

120. A POSITA would have understood that Fritsch does not disclose a 0.9% Coring level for a hybrid cord consisting of aramid and nylon. In fact, none of the examples listed in Fritsch describe the properties of an aramid/nylon hybrid tire cord. Instead, Fritsch only provides properties for a hybrid tire cord of entirely

different materials, PEN and PET. Ex.1001, Table 1 (Example 6). Petitioner and Dr. Rust rely on Fritsch's Table 1, Figure 2, and paragraphs [0041]-[0042] for disclosure of a 0.9% Coring level, but each disclosure is on PEN/PET hybrid cord, not aramid and nylon hybrid cord. Pet. 45-46, 59-60; Ex.1003, ¶¶132-133, 181-183. Fritsch's paragraph [0041] discloses that "physical properties (breaking strength, elongation at break, energy to break and modulus) can be optimized by *an appropriate coring level of PEN with PET.*" Ex.1011, [0041] (emphasis added).

Fritsch's Table 1 is shown below:

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
1	A	PEN/PEN	0	199.2	10.4	21.4	48.7	2.7
		PEN/PET	-15%	154	n.d.	n.d.	n.d.	n.d.
		PEN/PET	-12.2%	154.3	9.3	20.8	45.4	3.1
		PEN/PET	-9.2%	160.8	10.2	17.5	40.5	3.4
		PEN/PET	-6.3%	164.7	11.1	16.5	32.8	4.0
5	B	PEN/PET	-3.2%	170.1	11.4	15.7	33.9	3.9
		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	C	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.
		PET/PET	0	177.7	18.9	12.5	26.2	5.2

Ex.1011, Table 1 (annotated). As shown in Fritsch's Table 1, the 0.9% Coring level is associated with "PEN/PET" in "Inv. Ex. 6." Ex.1011, Table 1. Indeed, all examples have cord components of "PEN/PET." Ex.1011, Table 1.

121. Petitioner and Dr. Rust only acknowledge that the cord with 0.9% Coring level is made of PEN/PET in the alleged motivation to combine Fritsch with Tamura. Pet. 27; Ex.1003, ¶¶93-94. And even there, they only contend that “a POSITA would have been motivated to use the Coring level of 0.9%, because it provides a good combination of high Breaking Strength, Elongation at Break, LASE at 1.6% and LASE at 3%,” without explaining why a POSITA would have apply this Coring level for PEN/PET cord for cords made of the completely different materials of aramid and nylon. Pet. 27; Ex.1003, ¶93 (verbatim). The paragraph in Fritsch that Petitioner and Dr. Rust appear to cite for their contentions, Fritsch paragraph [0040], does not state that Inv. Ex. 6 with the 0.9% Coring level has “good properties.” Pet. 27; Ex.1003, ¶93. To the contrary, Fritsch’s paragraph [0041] discussing the results in Table 1 only discusses “good” properties for Inv. Exs. 2-5 and 7-8:

Notably the balanced configuration of the PET/PEN hybrid (Comp. Ex. B) had a breaking strength and LASE at 1.6% closer to that of the all-PET balanced configuration (Comp. Ex. C), and had elongation at break value closer to that of the all-PEN configuration (Comp. Ex. A). The inventive hybrid cords, having unbalanced configuration, depending on the degree and sign of the coring, possessed different properties. *Higher modulus hybrid cabled cord can be achieved by the use of negative coring (Inv. Exs. 2-5). For a combination of a high breaking strength and a high elongation at*

break, a positive coring value is satisfactory (Inv. Exs. 7 and 8).

Thus, physical properties (breaking strength, elongation at break, energy to break and modulus) can be optimized by an appropriate coring level of PEN with PET.

Ex.1011, [0041] (emphases added). Thus, a POSITA would not have had reasons to apply Fritsch's Inv. Ex. 6 made of PEN/PET to completely different materials, aramid and nylon.

122. Petitioner and Dr. Rust assert that "Fritsch itself contemplates an aramid/nylon hybrid cord as one of its inventive cords." Pet. 27 (citing Ex.1011, cls. 8-9); Ex.1003, ¶94 (same). However, Fritsch's claims 8 and 9 are dependent on Fritsch's claim 1, and only states that the unbalanced configuration can include nylon and aramid yarns. Ex.1011, cls. 8-9. A POSITA would not find Fritsch mentions or suggests that the 0.9% Coring level applied to PEN/PET cords should be applied to aramid/nylon cords. For example, Fritsch's paragraph [0041] only focuses on "*an appropriate coring level of PEN with PET*" (Ex.1011, [0041] (emphasis added)) and Fritsch is silent as to any appropriate Coring level of aramid with nylon. Indeed, as I explain below, a POSITA would have understood that because aramid/nylon hybrid cords would be made with substantially different materials than PEN/PET hybrid cords (with substantially different elastic moduli ratios), a POSITA would not have used the Coring level for one set of cords for

another, nor would they expect applying a certain Coring level across hybrid cords made of different materials would lead to beneficial results.

123. Dr. Rust does not provide any additional support or evidence of why the Coring level of a PEN/PET hybrid cord would be transferrable to the different constituents of an aramid/nylon hybrid cord. Ex.1003, ¶94. Instead, Dr. Rust appears to simply repeat the assertions in the Petition. But contrary to Petitioner and Dr. Rust's contentions, as I explain further below, the difference in elastic moduli ratio between aramid and nylon compared to that between PEN and PET is substantial, such that a POSITA would not have understood the properties of a hybrid tire cord with a particular Coring level applied in making PEN/PET hybrid cord to be predictive or render obvious properties of aramid/nylon hybrid cord using that same Coring level. Thus, a POSITA would not have had any reasonable expectation of success in manufacturing aramid/nylon hybrid cord with the Coring level of PEN/PET hybrid cord to achieve good properties.

124. Petitioner and Dr. Rust further assert that "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." Pet. 27-28; Ex.1003, ¶94. I agree that both PEN/PET hybrid cord and aramid/nylon hybrid cord have materials (yarns) with higher and lower modulus. However, the same is

true for virtually *any* hybrid cord made of different materials, because the two materials will not necessarily have the same modulus. In other words, Petitioner and Dr. Rust are contending that because Fritsch teaches a 0.9% Coring level for *PEN/PET* cord, then that Coring level would be obvious for *any* hybrid cord, regardless of the material that the cord is composed of. Neither Petitioner nor Dr. Rust offer any support for such a broad claim. In reality, because the moduli ratio for PEN/PET cord is different from that for aramid/nylon cord, a POSITA would not have had any reason to use the Coring level from the PEN/PET cord for the aramid/nylon cord.

125. Modulus (sometimes referred to as Young's Modulus) of a yarn is the slope of a tensile stress-strain curve at the origin. It is "[t]he property describing a material's resistance to extension." Ex.2021 (Kevlar Technical Guide), 22. "In other words, it is how easily [the material or yarn] is bended or stretched." Ex.2024 (Young's Modulus), 1. Figure 6.2 of "Textile Yarns – Technology, Structure, and Applications" shows a typical stress-strain curve with the slope annotated:

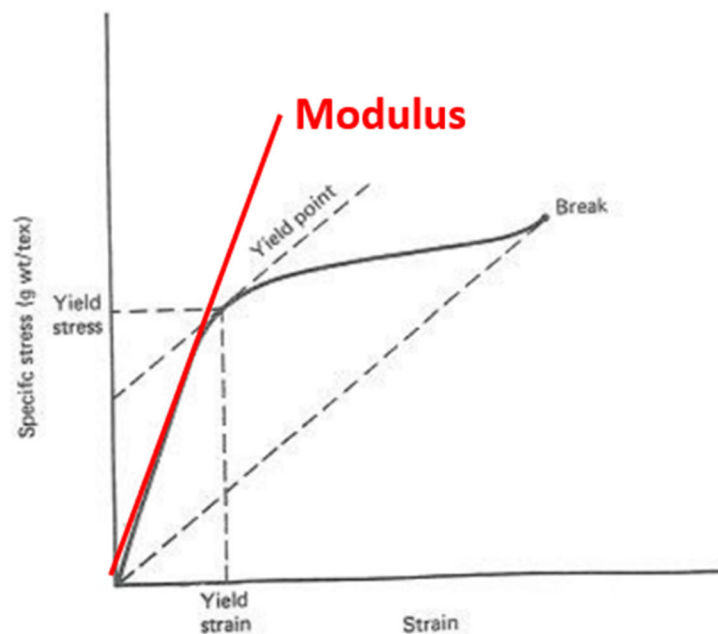


Figure 6.2. Yield point—Meredith's construction.

Ex.2020 (Textile Yarns – Technology, Structure, and Applications), 49 (annotated). The initial part of the stress-strain curve is relatively straight, and its slope (ratio of stress to strain) usually remains constant. Modulus provides a measure of the force required to produce a small extension. A highly inextensible yarn will have a high modulus, and an easily extensible yarn will have a low modulus. Modulus also sheds light on how a cord will perform as a reinforcement material. Moduli ratio, or the ratio of moduli, as the name suggests, is the ratio of the moduli of two different yarn materials. The moduli ratio reveals how one yarn material will interact with another, and when they are combined into a hybrid cord, the resulting physical properties of the hybrid cord. The most common units for

modulus are centinewton per decitex⁴ (cN/dtex), pounds per square inch (psi), and Pascals (Pa). Ex.2034 (The Pneumatic Tire), 16 (Table 3.10); Ex.2021 (Kevlar Technical Guide), 22.

126. The moduli of PEN and PET are 130 cN/dtex and 60 cN/dtex, respectively. Ex.2034 (The Pneumatic Tire), 16 (Table 3.10). The moduli ratio of PEN/PET would be 130:60, or around 2:1. In other words, the modulus of PEN is more than twice the modulus of PET. The moduli of aramid and nylon are 300 cN/dtex and 25 cN/dtex, respectively. Ex.2034, 16 (Table 3.10). The moduli ratio for aramid and nylon is 300:25, or 12:1. In other words, the modulus of aramid is twelve times the modulus of nylon. The moduli and moduli ratios are listed in the table below:

	Modulus (cN/dtex)	Moduli Ratio
PEN	130	2:1
PET	60	
Aramid	300	12:1
Nylon	25	

127. Comparing the 2:1 moduli ratio of PEN/PET with the 12:1 moduli ratio of aramid/nylon, the moduli ratio of aramid/nylon is six times higher than that

⁴ Grams per 10,000 meters of the yarn.

of PEN/PET cord.⁵ A POSITA would have been familiar with the difference in moduli ratio between these materials and would have understood that the six times difference is a significant difference. Because of this significant difference, a POSITA would have only been motivated to apply a Coring level with a larger difference in length for aramid/nylon cord as compared to the difference in length for PEN/PET cord. And also because of the significant different in moduli ratio, a POSITA would not have found the properties of the PEN/PET hybrid tire cord to be predictive or suggest properties of aramid/nylon hybrid tire cord, because a POSITA would have understood that aramid compared to nylon has much greater

⁵ Different references report different moduli of the yarns. One set of references report that the moduli ratio of an aramid/nylon cord is an order of magnitude higher than the moduli ratio of PEN/PET cord, where the moduli of aramid and nylon are 16.3×10^6 psi and 0.8×10^6 psi, respectively (moduli ratio of 20:1), and the moduli of PEN and PET are 26 ± 1 GPa (3.8×10^6 psi) and 13 ± 2 GPa (1.9×10^6 psi), respectively (moduli ratio of 2:1). Ex.2021, 7; Ex.2022 (Mechanical Behavior of PET and PEN), 4. I note that Kevlar 49 is the relevant aramid for hybrid tire cord. Kevlar 49 has a higher modulus and is commonly used in hybrid tire cord for high-performance tires. Ex.2025 (Kevlar[®] 49 Aramid Fibers for High Performance Composites), 3.

resistance to bending and stretching than the resistance of PEN compared to PET. Thus, a POSITA would have understood that these hybrid materials with substantially different moduli ratio will have resultant strength and elongation properties that are also substantially and unpredictably different. In my opinion, a POSITA would not have applied a 0.9% Coring level for PEN/PET hybrid cord to aramid/nylon cord, and also would not have a reasonable expectation of success in arriving at beneficial properties when applying a 0.9% Coring level to aramid/nylon cord.

128. Petitioner and Dr. Rust also contend that “Fritsch expressly teaches that cords using aramid and nylon are ‘[p]olymeric yarns useful in the inventive method and product,’ and expressly states such cords preferably have a Coring level between -25% and 25%.” Pet. 28 (quoting Ex.1011, [0029]); Ex.1003, ¶94 (verbatim). Fritsch continues to list over twenty “[n]on-limiting examples” and states that “[p]referred combinations are two yarns having different moduli with a non-zero coring level no greater than about 25% and no less than about -25%.” Ex.1011, [0029]. The claimed range in the ’663 patent, however, is that the aramid yarn is 0.5% to 2.5% longer than the nylon yarn. Ex.1001, cl. 1. In other words, the claimed range is only about 4% of the broad range in Fritsch. The ’663 patent explains the benefits of hybrid cords with length difference within the claimed range as the following:

[They] ... exhibit superior uniformity of physical properties, exhibit superior fatigue resistance because stress applied to the hybrid tire cord during repetition of tension/compression of the tire can be dispersed to not only the aramid primarily twisted yarn but also the nylon primarily twisted yarn, in particular, exhibit superior fatigue resistance when tension/compression deformation is serious, and maintain superior fatigue resistance when tension/compression/shearing is repeatedly applied upon actual tire driving.

Ex.1001, 12:1-10. In comparison, the '663 patent explains that cords with length difference outside of the claimed range result in the aramid yarn being too long compared to the nylon cord, thus leading to “stress [being] intensely applied to the aramid primarily twisted yarn upon repeated tension and compression of the tire.”

Ex.1001, 12:11-26. However, even the examples in the '663 patent with length difference outside of the claimed range are between 0% and 3%, which are well within the broad range that Fritsch discloses for its variety of yarns. Ex.1001, 12:11-26.

129. Fritsch, in fact, teaches that a POSITA should proceed in a different direction than the claimed invention. Fritsch discloses that the “preferred” Coring level for PEN/PET is “about 3% to about 15%.” Ex.1011, Abstract (“In a preferred embodiment one of the two yarns comprises polyethylene terephthalate [i.e., PET] and the second of at least two yarns comprises polyethylene naphthalate [i.e., PEN]

and the coring level is between about 3% to about 15%.”); [0009]. Similarly, Fritsch also discloses Coring levels from 3% to 15% and from -15% to -3%. Ex.1011, cls. 6-7, 26-27. These length difference ranges that Fritsch discloses fall outside of the claimed range. Petitioner and Dr. Rust also do not explain how a POSITA would have adjusted Fritsch’s ranges for the claimed range of aramid/nylon hybrid cord in view of the moduli ratio of aramid/nylon being six times higher than PEN/PET.

130. Thus, Petitioner and Dr. Rust have not shown a reasonable likelihood in their Grounds 1 and 2 that Fritsch alone, or in combination with Tamura, render obvious a method of manufacturing hybrid tire cord where, “if the secondary twist of the hybrid tire cord with a predetermined length were untwisted, the aramid primarily twisted yarn would be 1.005 to 1.025 times longer than the nylon primarily twisted yarn.”

131. In sum, Petitioner and Dr. Rust have not shown that independent claim 1 of the '663 patent, and all claims dependent on it, are rendered obvious. In my opinion, the Challenged Claims are patentable.

XI. CONCLUSION

All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

Executed on July 14, 2025 in Fort Washington, Pennsylvania.



David Brookstein