

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CONTINENTAL AG, CONTITECH AG,
CONTITECH NORTH AMERICA, INC., CONTITECH USA, INC., and
CONTITECH ANTRIEBSSYSTEME GMBH,
Petitioner,

v.

GATES CORPORATION,
Patent Owner.

IPR2021-00466
Patent 7,254,934 B2

Before SCOTT A. DANIELS, JAMES A. WORTH, and
SEAN P. O'HANLON, *Administrative Patent Judges*.

DANIELS, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background

Continental AG, ContiTech AG, ContiTech North America, Inc., ContiTech USA, Inc., and ContiTech Antriebssysteme GmbH (“Petitioner”) filed a Petition requesting *inter partes* review of claims 9–26 of U.S. Patent No. 7,254,934 B2 (Ex. 1001, “the ’934 patent”). Paper 1 (“Pet.”). Gates Corporation (“Patent Owner”) filed a Preliminary Response to the Petition. Paper 7. With our authorization, Petitioner filed a Reply (Paper 8) and Patent Owner filed a Sur-reply (Paper 9).

Following our Institution Decision (Paper 10, “Inst. Dec.”), Patent Owner filed a Response. Paper 14 (“PO Resp.”). Petitioner filed a Reply. Paper 21 (“Reply”). Patent Owner filed a Sur-Reply. Paper 22 (“PO Sur-Reply”). A hearing was held on May 5, 2022. A transcript of the hearing has been entered as Paper 26 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). For the reasons explained below, we determine that claims 9–26 are unpatentable.

B. Additional Proceedings

The parties indicate that the ’934 patent has been asserted against Petitioner in *Gates Corporation v. Continental AG et al.*, Case No. 1-19-cv-01346 in the United States District Court for the District of Delaware. Pet. 70; Paper 6, 2.

C. Real Parties in Interest

Petitioner identifies Continental AG, ContiTech AG, ContiTech North America, Inc., ContiTech USA, Inc., and ContiTech Antriebssysteme GmbH as real parties in interest. Pet. 70. Patent Owner identifies Gates Corporation as the Real Party in Interest. Paper 6, 2.

D. The '934 Patent (Ex. 1001)

The '934 patent relates “to endless belts” such as an automotive alternator belt “comprising a load carrier cord, and particularly to such belts wherein the cord comprises a plurality of plied yarns that are twisted together to form the cord in a direction opposite that of the first twist of the plied yarns.” Ex. 1001, 1:6–10, 30–32. The '934 patent more specifically describes

a load carrying cord for incorporation in a rubber composite article such as an endless belt, a flexible shaft coupling, an airspring or a tire, comprising a plied cord formed from a plurality of twisted yarns, wherein the twisted yarns possess a configuration corresponding to a first twist multiplier, and the plied cord possesses a configuration corresponding to a second twist multiplier, and characterized in that the second twist is in the opposite direction from the first twist, *and the ratio of the first twist multiplier to the second twist multiplier is at least 1.5.*

Id. at 1:53–63 (emphasis added).¹

Figure 1 of the '934 patent, reproduced below, provides a cross section perspective view of a belt embodiment. Ex. 1001, 2:23–25.

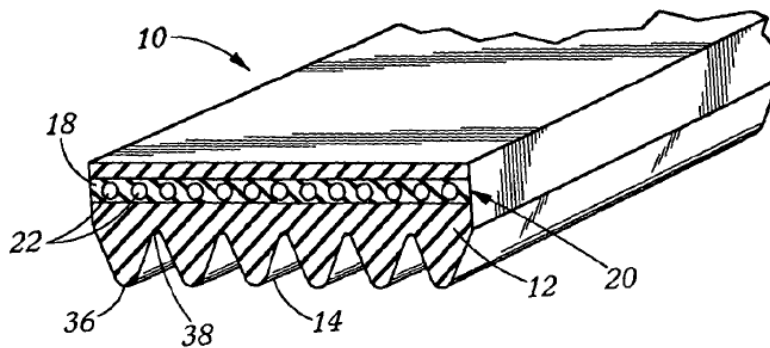


FIG. 1

¹ The '934 patent explains that the second twist is applied opposite the first twist in order “to achieve a balanced twist; i.e., that arrangement which will not cause the cord to twist on itself when held in an open loop.” Ex. 1001, 1:22–24.

Figure 1, above, depicts multi-v-ribbed belt 10 including elastomeric main belt body portion 12 and sheave contact portion 14. *Id.* at 2:67–3:3. Load-carrying cord section 20 is positioned above main belt body portion 12 for providing support and strength to belt 10. *Id.* at 3:19–21. Load-carrying cord section 20 includes at least one longitudinally-extending tensile cord 22 in contact with—or embedded in—adhesive rubber member 18. *Id.* at 3:21–27.

Tensile cord 22 is formed of one or more base yarns of polyethylene naphthalate (PEN), poly(p-phenylene-2,6-benzobisoxazole) (PBO), aramid, or liquid crystal polymer (LCP). *Id.* at 5:67–6:1. According to the '934 patent,

“Base Yarn” refers to a bundle of filaments or fibers in the form as received from a base-yarn manufacturer, which may include twisted yarn or yarn with no twist. “Strand” or “yarn” or “ply” refers to a base yarn or yarns that have been folded or twisted or plied or cabled as an intermediate step in forming a cord. “Cord” refers to one or more strands, plies, or yarns that have been twisted or plied or cabled together in a final step in forming the cord. The term “twist multiplier” or “TM” will be utilized to describe the twist feature as it applies to the practice of the present invention, and is defined as the ratio of the turns per inch (TPI) to the square root of the yarn count. Yarn count is defined as the ratio of 5315 to the end denier in grams per 9000 meters. Thus, the following equation defines the twist multiplier:

$$TM = \frac{TPI}{\sqrt{5315/\text{denier}}}.$$

Id. at 6:42–63.

The '934 patent explains that higher modulus cords formed of PEN, PBO, aramid, or LCP are known to exhibit high load carrying capability, but exhibit relatively poor flexural fatigue resistance. Ex. 1001, 1:35–40. The

'934 patent discloses that flexural fatigue resistance can be improved by constructing cords having an unbalanced-twist approach, in which the first TM—that is the yarns, is greater than the second TM of the strands. *Id.* at 7:17–18.

According to one embodiment, “the present invention identifies a ratio of first TM to second TM, and opposite twist directions for each twist stage,” where “the ratio of the first TM to the second TM is greater than about 1.5, or in the range of from about 1.5 to about 4, or of from about 2 to about 3. *Id.* at 7:18–20, 21–31. Figure 7 of the '934 patent, reproduced below, is a side elevation view of a portion of a load carrier tensile cord constructed according to one embodiment. Ex. 1001, 2:41–44.

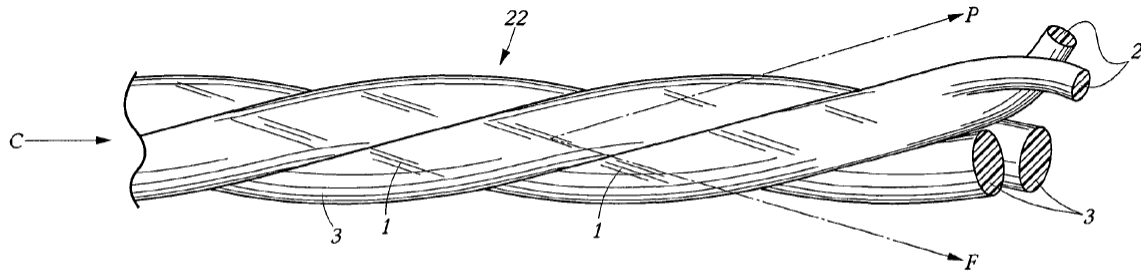


FIG. 7

Figure 7 depicts tensile cord 22 having three strands 3, each formed of two base yarns 2 comprising a plurality of filaments. *Id.* at 8:5–11. Base yarns 2 are twisted in a first direction having filament alignment direction F and form a strand 3. *Id.* To form the cord, three strands 3 are twisted together in a second direction that is opposite the first direction, which results in strand direction P relative to cord direction C. *Id.* at 8:12–14.

E. Illustrative Claim

Of the challenged claims, claims 9, 18, and 24 are independent. Each of dependent claims 10–17 depends ultimately from claim 9, claims 19–23

depend from claim 18, and claims 25 and 26 depend from independent method claim 24. Claim 9 illustrates the claimed subject matter and is reproduced below:²

9. [9.1] In an endless multi-v-ribbed belt comprising an elastomeric belt body and a load carrier cord embedded in said body;

[9.2] said cord comprising a plurality of yarns having a first twist corresponding to a first twist multiplier and a first twist direction, [9.3] and having a second twist corresponding to a second twist multiplier in a direction opposite said first twist direction;

[9.4] the improvement characterized in that the ratio of said first twist multiplier to said second twist multiplier is greater than about 1.5.

Ex. 1001, 12:15–23.

Similar to limitation [9.4], independent claim 18 recites “the ratio of said first twist multiplier to said second twist multiplier is in the range of from about 1.5:1 to about 4:1,” and independent claim 24, a method claim, recites the step of “selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier.” *Id.* at 12:21–23, 14:1–2.

F. Level of Ordinary Skill in the Art

Factors pertinent to a determination of the level of ordinary skill in the art include: (1) educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology, and (6) educational level of workers active in the field. *Env'tl. Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 696–697 (Fed. Cir. 1983) (citing *Orthopedic Equip. Co. v. All Orthopedic Appliances, Inc.*, 707 F.2d 1376, 1381–82

² We reference Petitioner’s labels and breaks in claim 9. *See* Pet. 10–12.

(Fed. Cir. 1983)). Not all such factors may be present in every case, and one or more of these or other factors may predominate in a particular case.

Id. Moreover, these factors are not exhaustive but are merely a guide to determining the level of ordinary skill in the art. *Daiichi Sankyo Co. Ltd, Inc. v. Apotex, Inc.*, 501 F.3d 1254, 1256 (Fed. Cir. 2007).

In determining a level of ordinary skill, we also may look to the prior art, which may reflect an appropriate skill level. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). Additionally, the Supreme Court informs us that “[a] person of ordinary skill is also a person of ordinary creativity, not an automaton.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007).

Petitioner asserts that a person of ordinary skill in the art at the time of the ’934 patent “would have had a Bachelor’s Degree in mechanical engineering, textile engineering, or a similar discipline, with one to two years of experience in this or a related field.” Pet. 5. Patent Owner does not dispute Petitioner’s asserted level of ordinary skill in the art. *See* PO Resp. 8 (stating that Patent Owner “generally agrees with Petitioner’s definition of a [person of ordinary skill in the art]”).

Petitioner’s proposed level of ordinary skill in the art is consistent with our review and understanding of the technology and descriptions in the ’934 patent and the asserted prior art references. We rely on Petitioner’s proposed level of ordinary skill in the art.

G. Claim Construction

We interpret claims in the same manner used in a civil action under 35 U.S.C. § 282(b) “including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” Only terms that are in controversy need to be construed, and then only to the

extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

1. twist multiplier

Petitioner asserts that “Patent Owner’s definition for the term ‘twist multiplier’ (or ‘TM’) is ‘the ratio of the turns per inch (TPI) to the square root of the yarn count. Yarn count is defined as the ratio of 5315 to the end denier in grams per 9000 meters.’” Pet. 6 (quoting Ex. 1001, 6:51–56). Patent Owner does not propose an alternative construction for the term “twist multiplier.” *See generally* PO Resp.

We find Petitioner’s assertion consistent with the meaning of “twist multiplier” as set forth in the ’934 patent and Patent Owner does not dispute this definition. *Id.* at 6–7 (citing Ex. 1001, 6:42–63).

2. having improved flex fatigue resistance (claim 24)

Independent claim 24 is a method claim reciting in part, “[a] method for making an endless power transmission belt *having improved flex fatigue resistance. . .*” Ex. 1001, 13:8–9 (emphasis added). Patent Owner argues that this phrase is a limitation, and not “an intended use or purpose or effect of the invention, but rather discloses a characteristic of the invention that helps define it.” PO Resp. 7. Petitioner does not propose an alternative construction for this phrase. *See generally* Reply.

Patent Owner argues that a person of ordinary skill in the art “would have construed the expression ‘improved flex fatigue resistance’ to mean an improved belt when compared to the known prior art belts, and in particular compared to belts using a balanced cord, and/or belts using a cord with a second twist multiplier greater than 4.0.” PO Resp. 8 (citing Ex. 2055 ¶ 155).

For several reasons we are skeptical that this phrase is truly a limitation of claim 24 as Patent Owner characterizes it. First, this phrase is in the preamble prior to the word “comprising,” and does not, in our opinion, provide antecedent basis for any subsequent limitations in the body of the claim. *See Eaton Corp. v. Rockwell Int’l Corp.*, 323 F.3d 1332, 1339 (Fed. Cir. 2003) (“[w]hen limitations in the body of the claim rely upon and derive antecedent basis from the preamble, then the preamble may act as a necessary component of the claimed invention.”).

Second, the phrase plainly reads as a desired result or effect of “selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier,” which is the last step recited in the body of claim 24. Ex. 1001, 14:1–2. *See Poly-Am., L.P. v. GSE Lining Tech., Inc.*, 383 F.3d 1303, 1310 (Fed. Cir. 2004) (The Federal Circuit explaining that “a preamble is not limiting where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention.”) (citations omitted). Notably, neither “flex fatigue” nor “improved flex fatigue” are mentioned in the specifically recited steps of the claimed method. Ex. 1001, 13:13–14:2.

Third, Patent Owner mainly asserts that this phrase “is a fundamental characteristic of the claim and consequently, is a limitation of claim 24.” PO Resp. 7–7. Such a desired result, improving flex fatigue, as it is recited in claim 24, in our view, does not explain satisfactorily why this phrase in “the preamble is necessary to give life, meaning, and vitality” to the claimed method. *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1306 (Fed. Cir. 1999). Accordingly, we are not persuaded that this phrase is a limitation.

For the sake of argument, we can as Patent Owner argues, treat the phrase “improved flex fatigue resistance” as a limitation by considering, initially, the claim language itself. *See Eastman Kodak Co. v. Goodyear Tire & Rubber Co.*, 114 F.3d 1547, 1552 (Fed. Cir. 1997) (“The claim language itself defines the scope of the claim.”). The meaning of “improved” is well understood. For example, and although we acknowledge that it is extrinsic evidence, the word “improved,” means to “make better.” MERRIAM-WEBSTER ONLINE DICTIONARY, <https://www.merriam-webster.com/dictionary/improved> (last visited July 23, 2022). The plain meaning of “improved,” however, does not provide much clarity. So, there must be something else, some other language of import in the method claim to help the reader understand the nature of the improvement. In other words, the phrase may be best construed by asking a very basic question—how is the flex fatigue resistance improved?

Considering the language in claim 24, as reproduced below, we can determine whether there are other recitations, explanations, or limitations in the claim that perhaps best describe the improvement. *See TQ Delta, LLC v. DISH Network LLC*, 929 F.3d 1350, 1357 (Fed. Cir. 2019) (“We begin our analysis with the claim language.”).

24. A method for making an endless power transmission belt *having improved flex fatigue resistance* and comprising a belt body portion and a load carrier cord comprising base yarns of high-modulus organic fibers, said cord embedded in said belt body, comprising the steps:

twisting one or more said base yarns together in a first twist direction with a first twist multiplier to form strands;

twisting one or more said strands together in a second twist direction opposite said first direction with a second twist multiplier to form said cord; and

selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier.

Ex. 1001, 13:8–14:2 (emphasis added). The claim initially describes several components of an endless transmission belt, e.g. a “belt body” and a “load carrier cord,” and “yarns of high-modulus organic fibers,” but considering the prior art, these appear to be well-known structures and components of a transmission belt. Ex. 1001, 1:35–40. Moreover, this is a method claim, so for proper context we look to the three claimed steps of the method recited in the body of the claim. The first two steps are helpful in understanding the improvement. These steps describe twisting the base yarns in one direction “with a first twist multiplier,” and then twisting the strands in another direction “with a second twist multiplier.” But, Patent Owner has not asserted that such first and second twist multipliers, alone, are novel. *See, e.g., id.* at 1:17–20 (“[I]t is known to twist the individual yarns in one direction in the first twist stage and to ply the twisted yarns in the opposite direction in the second twist stage.”). It is the last step of claim 24 where we can best understand *how* the flex fatigue resistance is improved. The last step explains that the improvement occurs by “selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier.” Ex. 1001, 14:1–2. On its face, a plain reading of the claim itself best provides the meaning of “improved flex fatigue resistance.”

Patent Owner’s proposed construction reads in limitations from the specification that are not in claim 24. For example, nowhere in claim 24 is there recited any specific step or comparison with “known prior art belts,” a “balanced cord,” or a “second twist multiplier greater than 4.0.” *See Hill-Rom Servs., Inc. v. Stryker Corp.*, 755 F.3d 1367, 1371 (Fed. Cir. 2014) (The Federal Circuit explaining that “[w]hile we read claims in view of the

specification, of which they are a part, we do not read limitations from the embodiments in the specification into the claims.”). Notably, independent claim 18 includes the limitation of a first and second twist multiplier ratio “from about 1.5:1 to 4:1, but does not include the “improved flex fatigue resistance” limitation. Ex. 1001 12:48–56. We appreciate that such cord characteristics may be described in the specification, and that the patentee’s desired outcome of performing the claimed steps is “an endless power transmission belt having improved flex fatigue resistance,” as claim 24 recites. Yet, based on a plain reading of the claim, we are not persuaded to read such limitations into the claim.

Thus, to understand the preamble phrase as a limitation, and we are not persuaded it is in fact a limitation, we need look no further than the claim language itself to determine that “improved flex fatigue resistance” is obtained by “selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier.” *Id.* at 13:8–14:2.

H. Instituted Grounds

We instituted trial based on all asserted claims and grounds of unpatentability as follows:³

³ Petitioner supports its challenge with a first Declaration of Dr. Sabit Adanur (Ex. 1003 or “Adanur I”), and a second Declaration by Dr. Adanur (Ex. 1012 or “Adanur II”). Patent Owner relies upon a first Declaration by Dr. David Brookstein (Ex. 2014 or “Brookstein I”) and a second Declaration by Dr. Brookstein (Ex. 2055 or “Brookstein II”). *See infra*. Patent Owner also relies upon a Declaration by Dr. Shawn Xiang Wu (Ex. 2029, or “Wu Declaration”).

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1	9–26	103(a) ⁴	Hasaka ⁵
2	9–26	103(a)	Kinoshita ⁶
3	9–26	103(a)	Hasaka, Carlson ⁷
4	9–26	103(a)	Kinoshita, Carlson

II. ANALYSIS

A. Legal Standards of Obviousness

Section 103(a) forbids issuance of a patent when “the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” *KSR*, 550 U.S. at 406.

The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when available, objective evidence such as commercial success, long-felt but unsolved needs, and failure of others.⁸ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *see KSR*, 550 U.S. at 407 (“While the sequence of these questions might be

⁴ The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. § 103, effective March 16, 2013. Because the application from which the ’934 patent issued has an effective filing date prior to March 16, 2013, the pre-AIA version of § 103 applies. *See* Ex. 1001, code (22).

⁵ Ex. 1004, U.S. Patent No. 6,689,005 B2 (iss. Feb. 10, 2004).

⁶ Ex. 1005, a certified translation of Japanese Unexamined Patent Application Publication JP 2003–194152 (pub. July 9, 2003).

⁷ Ex. 1006, U.S. Patent No. 4,083,260 (iss. Apr. 11, 1978).

⁸ The parties have not directed us to any such objective evidence.

reordered in any particular case, the [*Graham*] factors continue to define the inquiry that controls.”). The Court in *Graham* explained that these factual inquiries promote “uniformity and definiteness,” for “[w]hat is obvious is not a question upon which there is likely to be uniformity of thought in every given factual context.” *Graham*, 383 U.S. at 18.

The Supreme Court made clear that we apply “an expansive and flexible approach” to the question of obviousness. *KSR*, 550 U.S. at 415. Whether a patent claiming the combination of prior art elements would have been obvious is determined by whether the improvement is more than the predictable use of prior art elements according to their established functions. *Id.* at 417. To reach this conclusion, however, it is not enough to show merely that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, obviousness additionally requires that a person of ordinary skill at the time of the invention “would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention.” *Id.*

A claimed invention may be obvious even when the prior art does not teach each claim limitation, so long as the record contains some reason why one of skill in the art would have modified the prior art to obtain the claimed invention. *See Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1307 (Fed. Cir. 2006). And, as a factfinder, we also must be aware “of the distortion caused by hindsight bias and must be cautious of arguments reliant upon *ex post* reasoning.” *KSR*, 550 U.S. at 421. This does not deny us, however, “recourse to common sense” or to that which the prior art teaches. *Id.*

B. Petitioner's Patentability Challenges

As summarized above, Petitioner asserts four grounds for unpatentability of the claims of the '934 patent—Grounds 1–4. *See supra* Section I.H. Because we are persuaded by Petitioner's arguments and evidence that the challenged claims are obvious under Ground 1 in view of Hasaka, we do not address Grounds 3–4.

We review Petitioner's challenges and Patent Owner's arguments, along with the parties' evidence, below.

C. Obviousness over Hasaka—Claims 9–26

Petitioner argues that claims 9–26 of the '934 patent would have been obvious over Hasaka. As discussed below, and having reviewed the full record now before us, including the relevant portions of the supporting testimony of Dr. Adanur, Dr. Brookstein, and Dr. Wu, we are persuaded that Petitioner has demonstrated by a preponderance of the evidence that the challenged claims would have been unpatentable over Hasaka.

1. Overview of Hasaka (Ex. 1004)

Hasaka “relates to power transmission belts and, more particularly, to a power transmission belt having a body with an inside and an outside and a fabric material applied to at least one of the inside and outside of the body.” Ex. 1004, 1:8–11. Hasaka discloses a power transmission belt having at least one embedded load carrying element, i.e. a cord, extending lengthwise relative to the length of the belt's body. *Id.* at 1:60–66.

Figure 1 of Hasaka, reproduced below, is a cross-sectional view of an embodiment of a power transmission belt.

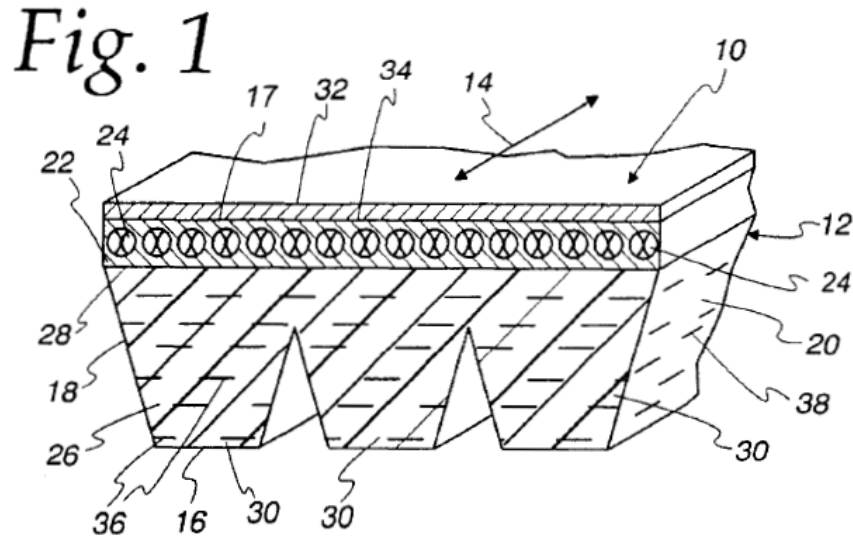


Figure 1 depicts power transmission belt 10 comprising body 12, inside surface 16, outside surface 17, and side surfaces 18, 20. Ex. 1004, 3:20–24. Body 12 has cushion rubber layer 22 with embedded load carrying cords 24, which are spirally wrapped and extend lengthwise relative to body 12. *Id.* at 3:25–28.

Load carrying cords 24 may be made of polyester fiber, aramid fiber, or glass fiber. Ex. 1004, 6:40–41. Preferably, load carrying cords 24 have a total denier of 4,000–8,000. *Id.* at 6:41–43. Hasaka discloses that

[t]he cords are formed by twisting a bundle of polyester fiber filaments. With this construction, the slip rate of the belt may be controlled and the belt may be made with a relatively long life. *The cords are twisted with a final twist of 10 to 23 per 10 cm, with a primary twist of 17 to 38 per 10 cm.*

Id. at 6:43–48 (emphasis added). In one embodiment, V-ribbed belts were manufactured with a TM ratio of 1.0 where “[a] load carrying cord was formed by twisting 1,000 denier of poly (ethyleneterephthalate) (PET) fiber with reverse primary and final twist directions. The primary and final twist

factors were 3.0 to make a 2x3 twist configuration with a total denier of 6,000.”⁹ *Id.* at 13:10–15.

2. Independent Claims 9 and 24

Considering the elements of claim 9, as reproduced above, and claim 24, we address below the respective arguments of both parties as to claims 9 as well as the “flex fatigue resistance” limitation of claim 24.¹⁰

a) Petitioner’s Arguments

(1) Preamble and Limitation [9.1]

Petitioner argues that Hasaka discloses an endless multi-v-ribbed belt 10 having an elastomeric belt body 12 incorporating a load carrier cord 24 embedded in the belt body. Pet. 10 (citing Ex. 1003 ¶ 60; Ex. 1004, Fig 1, 3:5–6, 3:18–21, 13:29–42). Figure 1 of Hasaka is reproduced below.

⁹ Dr. Wu acknowledges that “[a]lthough Hasaka et al. do not mention twist multiplier, or provide a formula, it appears that the ‘twist factor’ mentioned in [0086] is probably the same as the twist multiplier.” Wu declaration ¶ 30.

¹⁰ We analyze claim 24, in part, along with claim 9 because Patent Owner’s state of the art arguments address in particular the “flex fatigue resistance” limitation recited only in claim 24.

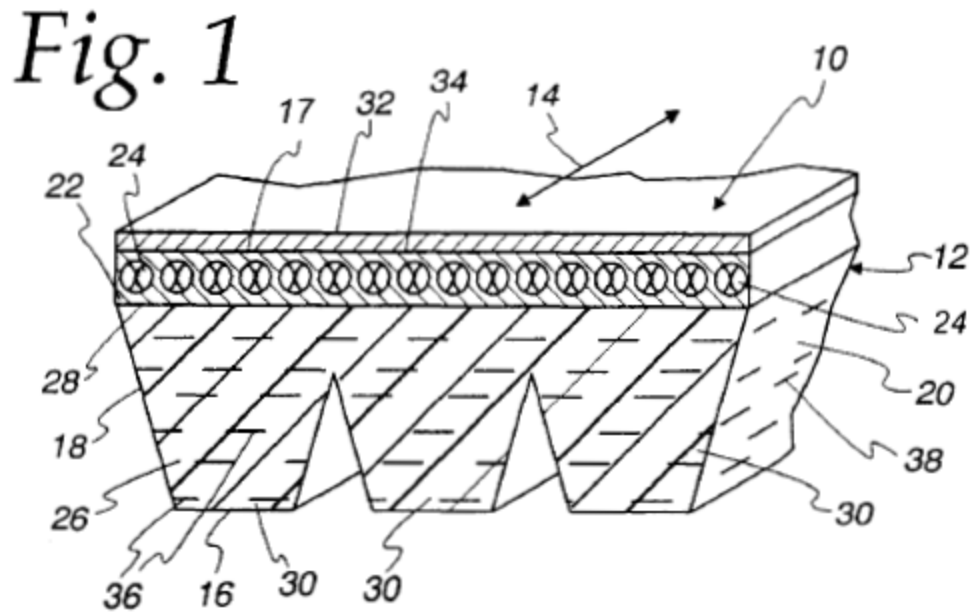


Figure 1, above, of Hasaka illustrates a cross section of a multi-v-ribbed belt 10. Hasaka's belt 10 includes body 12 having a cushion rubber layer 22 in which twisted load carrying cords 24 are embedded.

(2) Limitations [9.2]–[9.3]

Petitioner argues that in one embodiment Hasaka teaches a first twist, where yarns are twisted in one direction. Pet. 11 (citing Ex. 1004, 13:10–15). According to Petitioner, in this embodiment Hasaka teaches the yarns “twisted to achieve a TM of 3, which corresponds to a TPI of 4.89.” *Id.* (citing Ex. 1004, 13:10–15).

Petitioner contends that, in the same embodiment, Hasaka discloses the strands are twisted in a second twist *opposite* to the first twist direction of the yarns. *Id.* (citing Ex. 1004, 13:10–15). In the embodiment, similar to the yarns, Hasaka teaches that the cord’s “three strands are twisted to achieve a TM of 3, which corresponds to a TPI of 2.82.” *Id.* at 11–12.

(3) *Limitation [9.4]*

Petitioner argues that, in addition to the embodiment discussed above, Hasaka discloses a range of first and second TPIs, and hence a range of first and second TMs that “result in a strand-to-cord TM ratio of 1.97, which is greater than 1.5.” Pet. 12. Petitioner argues specifically that Hasaka discloses a range of twist rate for the first twist “between ‘17 to 38 per 10 cm’ which corresponds to 4.32 to 9.65 TPI.” *Id.* at 13. According to Petitioner’s declarant, Dr. Adanur, a person of ordinary skill in the art “would have found it obvious to produce the strands using 9.65 TPI for a first TM of 5.92 while maintaining the cord’s second twist TPI and TM values [2.82 and 3] for several reasons.” Adanur I ¶ 65. In other words, instead of a balanced twist-multiplier ratio of $(TM_1)^3 / (TM_2)^3 = 1$, as in Hasaka’s specific embodiment, Dr. Adanur testifies that given the first and second ranges of TPIs in Hasaka, a person of ordinary skill in the art would have known to increase the first twist to 9.65 TPI, within Hasaka’s disclosed range, to obtain a TM_1 of 5.92, and maintain the second TM at 3, as it is also within Hasaka’s disclosed range, to obtain a twist-multiplier ratio of $(TM_1)^3 / (TM_2)^3$, which equals 1.97. *Id.* ¶¶ 64–68.

Dr. Adanur testifies that given the specific ranges of first and second TPI values in Hasaka, a person of ordinary skill in the art “would have been motivated to find the optimal TPI values for the first and second twists that, when combined, produce[] the optimal cord.” *Id.* ¶ 66 (citing Ex. 1004, 6:40–54, 13:10–15). Dr. Adanur testifies that it was well known in the art that “increasing the twist rate of yarn was known to improve the flexural fatigue at the cost of tensile strength.” *Id.* (citing Ex. 1007, 4:15–34). Dr. Adanur also testifies that selecting the value of 9.65 TPI to obtain a TM of 5.92 for the first twist range disclosed in Hasaka was simply a predictable

solution “easily achieved using standard equipment and materials at the time” by one of ordinary skill in the art. *Id.* ¶ 67. According to Dr. Adanur, a resulting first to second TM ratio “of 1.97 would also be an expected result because it is a simple calculation based on the known cord configuration, material, and twist rates of the yarns and strands.” *Id.* ¶ 68.

b) Patent Owner’s State of the Art Arguments

Initially, Patent Owner addresses the state of the art, arguing that Petitioner has provided no persuasive evidence, including U.S. Patent No. 3,233,648 to Kovac, to support Dr. Adanur’s testimony that increasing the twist rate of yarns, i.e. the primary or first twist rate, improves flexural fatigue of a cord. *See* PO Resp. 8 (Patent Owner arguing that Kovac does not “disclose improving any property by modifying the twist *rates* of a *cord*.”). Specifically, Patent Owner argues that Kovac does not disclose that increasing the yarn twist rate increases *flexural fatigue* resistance. *Id.* at 9.

Relying on its declarant, Dr. Brookstein, Patent Owner contends that Kemmnitz, a paper in the Journal of Applied Polymer Science, by Gunter Kemmnitz titled, “A Study of the Compression Fatigue and the Damping Phenomena of Tire Cord,” discloses that increasing twist rate, specifically increasing the second TM twist rate, as opposed to the first TM, i.e., yarn twist rate, is known to increase flexural fatigue resistance of a cord. *Id.* at 19–20 (Patent Owner arguing that “Kemmnitz makes it clear that that ‘*the cord performance is more affected by the cord twist than by the ply twist*.’”). In addition, Patent Owner argues that other prior art references, *inter alia*, Japanese Examined Patent Application No. S63-193080 to Nakanishi (Ex. 2001), U.S. Patent No. Kurokawa (Ex. 2020), and U.S. Patent No. 4,083,260 to Carlson (Ex. 1006), support its position “that flex fatigue resistance is affected by the second twist factor, [and] increases with

increasing second TM.” *Id.* at 19 (citing Ex. 2001, 2–3). For example, pointing to Kurokawa’s data showing that increasing the second twist multiplier increases fatigue resistance, Dr. Brookstein testifies that a person of ordinary skill in the art “would more likely increase the second twist rather than the first twist if looking to improve flexural fatigue resistance.” Ex. 2055 ¶ 89 (citing Ex. 2020, Abstract, 2:67–3:2; 4:11–14; Table 1).

Patent Owner also argues that a person of skill in the art would have been more likely to make and use a balanced cord, i.e., with a primary to secondary twist ratio of 1, rather than an unbalanced cord. PO Resp. 26 (citing Ex. 2055 ¶ 101). Dr. Brookstein testifies that “[a]t the time of the ‘934 patent filing date, the state of the art clearly preferred a balanced cord for use in a power transmission belt.” Ex. 2055 ¶ 101. In summary, Patent Owner argues that Petitioner’s arguments and evidence go against the state of the art cord design by

- (1) providing an unbalanced cord; (2) focusing solely on the first twist by dramatically increasing it to the highest disclosed first twist rate, while slightly decreasing or maintaining the second twist; and (3) providing a second TM of 3 or less than 3.

PO Resp. 27. We address initially, below, the parties’ arguments and evidence as to each of these issues as they pertain to the state of the art.

c) Whether Kovac’s “Fatigue Resistance” Covers Flexural Fatigue Resistance

In particular as it relates to independent claim 24, and “improved flex fatigue resistance,” Kovac is relied upon by Petitioner as background information and knowledge to show that it was well known to those of ordinary skill in the art that “increasing the twist rate of yarn was known to improve the flexural fatigue at the cost of tensile strength.” Pet. 14 (citing Ex. 1007, 4:15–34). Patent Owner first argues that Kovacs does not

“disclose improving any property by modifying the twist *rates* of a *cord*.” PO Resp. 8 (citing Brookstein II ¶ 51). Patent Owner argues specifically that Kovac teaches the replacement of a cord by use of a single yarn, and thus does not adequately support Petitioner’s position that increasing the twist rate of yarn was known to improve the flexural fatigue of a cord at the cost of tensile strength. *Id.* (citing Adanur I ¶ 66).

We disagree with Patent Owner’s argument on this point, at least because Petitioner is not directly relying on Kovac for increasing any property of a complete cord, but rather, for teaching the increasing flexural fatigue properties of yarn. It is well settled that “[t]he use of patents as references is not limited to what the patentees describe as their own inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain.” *In re Lemelson*, 397 F.2d 1006, 1009 (CCPA 1968). Moreover, Dr. Adanur testifies that “a person of ordinary skill in the art would have understood that a cord constructed of yarns that each have improved flexural fatigue resistance would likewise produce a cord with improved flexural fatigue resistance.” Adanur II ¶ 11. And, although Patent Owner asserts that the absence of a cord and a second twist are detrimental to Petitioner’s reliance on Kovac, Dr. Adanur’s testimony on this point is essentially un rebutted. *See, e.g.*, PO Sur Reply 23 (Patent Owner arguing “[t]hat Kovac would modify his first twist is rather unremarkable because Kovac only has one twist to work with, given that his invention is focused on eliminating the reverse/second twist.”).

In addition, Patent Owner argues that Kovac generically refers to “fatigue resistance” and not “flex fatigue resistance” as recited in independent claim 24. PO Resp. 9 (citing Brookstein II ¶ 55). Dr.

Brookstein testifies that “there is not enough information provided by Kovac to know what type or types of fatigue are discussed.” Brookstein II ¶ 58.

We disagree. Kovac states for example that “[t]wist does become desirable however, in introducing other yarn characteristics such as the ability to absorb compression forces and withstand fatigue.” Ex. 1007, 2:57–60.

Petitioner’s declarant, Dr. Adanur, testifies that “a person of ordinary skill in the art would have known that compression forces and compression fatigue are tested using flexural fatigue testing, which uses alternating cycles of bending (which induces both compressive and tensile forces) and relaxation.” Adanur II ¶ 12. Kovac also describes the forces on the yarn in use, in terms of flexure and compression where

[a]s the tire *is flexed* during use the yarns are also required to withstand *compressive* forces. The yarn must move with the surrounding rubber without suffering permanent damage, as often occurs when a conventional reinforcement cord is subjected *to compression*. In the high twist cord of the present invention, contraction can occur along the entire yarn length, whereas an ordinary twisted cord will have a tendency to buckle at one location, thus permanently fixing that spot as *the point of flexure* for future stress reversals.

Ex. 1007, 4:35–46 (emphases added). In addition, Dr. Adanur testifies that F.J. Kovac’s textbook titled, TIRE REINFORCING SYSTEMS, (Ex. 1015)

“defines ‘Fatigue’ as flexural fatigue — “The resistance of a tire to weakening or failure as a result of alternate tension-compression cycles.”

Adanur II ¶ 12 (citing Ex. 1015, 40). Along with Dr. Adanur’s testimony and reading Kovac’s disclosure in context as to compressive and flex forces acting on the yarn filaments, we determine that Kovac describes yarn filaments having “the required tensile properties coupled with excellent fatigue properties” where the fatigue properties would have been reasonably

understood by those of ordinary skill in the art to be inclusive of compressive and flexural forces. Ex. 1007, 4:16–17.

d) Whether a Balanced Cord was the State of the Art

As we previously explained *supra* at footnote 1, the '934 patent describes “[c]onventionally . . . it has been found desirable to perform the twisting and plying operations to achieve a balanced twist; i.e., that arrangement which will not cause the cord to twist on itself when held in an open loop.” Ex. 1001, 1:22–24. There is no disagreement as to what a balanced cord is or that it was known in the art. The disagreement, as Patent Owner frames it, is whether it was known by those of ordinary skill in the art to use or produce an unbalanced cord.

Petitioner frames the issue as whether the prior art teaches away from making using an unbalanced cord, and asserting that not the prior art, not even Dr. Adanur’s own textbook, teach away from using unbalanced cord. Reply. 11. Petitioner argues that even if balanced cords were preferred or standard, it was well known to those of ordinary skill in the art to consider and use unbalanced cords. *Id.* at 12 (citing Ex. 1012 ¶ 25; Ex. 2001, 1).

We find Petitioner’s arguments and Dr. Adanur’s testimony and evidence the most persuasive on this issue. First, as Petitioner points out, one of the references that Patent Owner relies on for the state of the art, Nakanishi, (Ex. 2001), discloses a range of TM ratios between 0.83 and 1.43, i.e., the inverse of the stated twist factor ratio range $0.7 \leq K \leq 1.2$. Reply 12 (citing Adanur II ¶ 25). Thus, even if a TM ratio of 1 were preferred for a balanced twist, we are persuaded by Dr. Adanur’s testimony that a person of ordinary skill in the art would also consider a cord that was unbalanced. *See* Adanur II ¶ 25 (Dr. Adanur testifying that “[b]ased on my experience in this field and the prior art references cited by Patent Owner,

the use of balanced cords was only a general preference to those of ordinary skill in the art.”). Patent Owner’s declarant, Dr. Wu, to an extent, concurs, stating that “the conventional cord used in multi-v-ribbed belts had mostly a balanced twist.” Wu ¶ 5. Dr. Wu does not, however, dispute that unbalanced cords were known in the art. *See id.* ¶ 13 (Dr. Wu testifying that unbalanced cords “are relative rare in the art.”).

Patent Owner also argues that Dr. Adanur’s own textbook shows a preference for balanced cords. PO Resp. 26 (citing Ex. 1008, 93–94). Figure 18.5 from Dr. Adanur’s textbook is reproduced below.

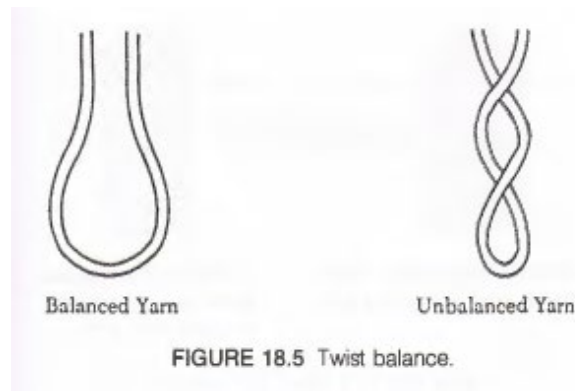


Figure 18.5 from Dr. Adanur’s textbook titled “Wellington Sears Handbook of Industrial Textiles” illustrates a balanced yarn on the left and an unbalanced yarn on the right. Ex. 1008, 94. The Handbook explains as follows:

In manufacturing plied yarns or cords, the attainment of yarn balance may be desirable in order to obtain stability in the resulting fabric. If twist balance is not obtained, the yarn will be wild and difficult to manage, and the resulting fabric may pucker, curl or otherwise distort. Of course, it will be apparent that for some purposes unbalanced or wild yarns are desired—for example in the manufacture of “twist” broadloom carpets or seersucker fabrics. Presumably for most industrial uses, however, balanced yarns and cords are an advantage.

Id. Dr. Adanur's textbook confirms that while balanced yarns and cords may be preferred, it does not rule out the use of unbalanced yarns and cords, whether for fabric or industrial use. Overall, the experts and prior art are generally consistent in that while balanced cords are preferred, unbalanced cords were also known to those of ordinary skill in the art. We are persuaded that the state of the art which a person of ordinary skill in the art would have considered included the manufacture and use of both balanced and unbalanced yarns and cords, although there was a preference for balanced cords in both fabric and industrial use.

e) Whether only Adjusting the Second TM was the State of the Art

There are various references which Patent Owner relies on to show that a person of ordinary skill in the art would have changed the second twist rate, not the first twist as in Petitioner's modification of Hasaka, in order to improve flexural fatigue resistance. PO Resp. 19. For example, in addition to Kemnitz and Kurokawa discussed above, Patent Owner points to U.S. Patent No 6,851,463 to Socci, and U.S. Patent No. 4,787,200 to Inada as similarly teaching to adjust the second twist rate. Socci describes

[a] balanced twist, that is, where the ply (yarn) twist is essentially equal to the cable (cord) twist, has been used for the invention examples, but an unbalanced cord twist can be used as the physical properties and fatigue life are dominated by the cable twist, not the yarn ply twist.

Ex. 2031, 7:5–11. And, Inada explains

that compression fatigue resistance has almost no relation to the number of the primary twists, N, and is mainly determined by the number of ply twists, M, and the compression fatigue resistance increases with increase in the number of ply twists, M.

Ex. 2030 3:39–43. We agree with Patent Owner that there is evidence in the prior art that a person of ordinary skill in the art would have considered changing the second TM to increase flex fatigue resistance.

Additionally, we determine that there is persuasive evidence presented by the parties that a person of ordinary skill in the art would have understood that changing the first twist rate also effects the flexural fatigue resistance of a cord. *See, e.g.*, Ex. 2031, 7:9–11 (Socci describing “an unbalanced cord twist can be used as the physical properties and fatigue life are dominated by the cable twist, not the yarn ply twist.”). Dr. Adanur has been consistent in his testimony, and it is unrebutted “as was well known in the art, [that] increasing the twist rate of yarn was known to improve the flexural fatigue at the cost of tensile strength.” Ex. 1003 ¶ 66. Patent Owner’s declarants have provided testimony generally consistent with Dr. Adanur. Dr. Brookstein testifies that it was known to those of ordinary skill in the art that “[t]here are far more relevant disclosures in the art dating back at least to the early 1960’s that disclose the impact twist rates (both first and second, not just a single twist as in Kovac) have on the cord’s performance properties.” Brookstein II ¶ 59. Dr. Brookstein testifies further that “I do agree with Dr. Adanur’s general statement that it was known in the art that increasing twist increases flexural fatigue resistance.” *Id.* Patent Owner’s evidence, despite showing that a higher second twist rate can increase flexural fatigue resistance, does not show that a person of ordinary skill in the art would have disregarded increasing the primary, or first twist, for the yarn. Overall, we agree with Petitioner that the evidence as a whole shows that a person of ordinary skill in the art would have understood that increasing either or both the first or second twist rates would raise the overall flexural fatigue resistance of a cord.

f) Whether the State of the Art Includes a Second Twist Factor of 3 or Less than 3.

Patent Owner argues that Petitioner's selection of a second TM of 3 or less goes against the state of the art where Kurokawa discloses a range for the second TM between 4 and 7, Nakanishi discloses a second TM above 3.5, and Carlson disclose a second TM range of 4–8. PO Resp. 56 (citing Ex. 2018, Abstract; 2:67–3:2; 4:11–14, Table 1; Brookstein II ¶ 94). Patent Owner argues that “every proposed Ground of Unpatentability requires a modification of Hasaka and Kinoshita to have a second twist multiplier far below Kurokawa's, Nakanishi's, and Carlson's lowest value.” *Id.*

Patent Owner's position mischaracterizes Petitioner's argument. Petitioner does not in fact modify Hasaka to have a lower second TM. Hasaka discloses a specific example with a first twist rate of 4.89 TPI and a second twist rate of 2.82 TPI, which is a second TM of 3.0. Ex. 1004, 6:40–54; Adanur I ¶ 63. Petitioner's assertion of obviousness specifically maintains Hasaka's second twist rate, e.g. cord twist rate, of 2.82 TPI and TM of 3, while increasing the first twist rate. *See* Pet. 12 (Petitioner arguing that a person of ordinary skill in the art “would have found it obvious to produce the strands using 9.65 TPI for a first TM of 5.92, while maintaining the cord twist rate of 2.82 TPI and second TM of 3.”) (citing Adanur I ¶¶ 63–68). Similarly, Dr. Adanur testifies that

[a] POSITA reading [Hasaka's] two disclosures related to the load carrying cord's configuration would have found it obvious to create the strands using 9.65 TPI for a first TM of 5.92 *while maintaining the cord's TPI and TM values for several reasons.*

Adanur I ¶ 65 (emphasis added).

We find Petitioner's evidence and Dr. Adanur's testimony persuasive that a person of ordinary skill in the art would have understood from reading

Hasaka that a second TM of 3.0 was known, along with the higher ranges and example of cord TMs disclosed by Kurokawa, Nakanishi, and Carlson.

g) Summary of the State of the Art

We appreciate Patent Owner's position that there is evidence indicating that there are ranges of second TMs disclosed in the prior art that are different from those in Hasaka, and as relied upon in Petitioner's arguments. *See, .eg.,* Ex. 2018 Abstract, 2:67–3:2; 4:11–14, Table 1. We also acknowledge, as do all the declarants in this proceeding, that balanced cords may have been preferred, but that unbalanced cords were not outside the purview of, and consideration by, a person of ordinary skill in the art. Ex. 1008, 94. Also, there is evidence that it was known to increase the second TM in order obtain an increased flex fatigue resistance. Brookstein II ¶ 59. But the state of the art does not negate, or teach away from, the clear evidence of the second TM of 3 taught by Hasaka, as it is relied upon by Petitioner and Dr. Adanur in the modification of the first TM within the provided ranges in Hasaka. We are also persuaded that one of ordinary skill in the art would have understood increasing the twist rate of a yarn would, to a point, increase the flex resistance of the yarn and ultimately to a cord in which the yarn was incorporated. Adanur I ¶ 66 (citing Ex. 1007, 4:15–34).

Acknowledging the evidence provided by Patent Owner as to the state of the art, we must also keep in mind that teaching away requires a reference to actually criticize, discredit, or otherwise discourage investigation into the claimed solution. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004) (prior art does not teach away from claimed subject matter merely by disclosing a different solution to a similar problem unless the prior art also criticizes, discredits, or otherwise discourages the solution claimed). In this proceeding, although there are differing ranges and solutions provided in the

prior to increasing the flexural fatigue resistance of a cord, we are not apprised of anywhere in the prior art that expressly discourages the modifications to Hasaka of adjusting the first TM as proposed by Petitioner.

h) Patent Owner's Arguments Against Modifying Hasaka

Patent Owner makes four main arguments following its discussion of the state of the art. First, that it would not have been obvious to optimize the twist multiplier of Hasaka. PO Resp. 44. Second, Patent Owner argues that the prior art teaches away from Petitioner's proposed modification of Hasaka. *Id.* at 55. Third, Patent Owner argues that Hasaka was cited during prosecution against the claims in U.S. Patent No. 8,057,334, (related to the '934 patent as a continuation-in-part), which were found to be allowable. *Id.* at 58. Fourth, Patent Owner argues that Hasaka fails to disclose that the modified cords have "improved flex fatigue resistance" as recited in independent claim 24. We address these arguments in turn below.

i) Whether it Would Have Been Obvious to Optimize Hasaka's Twist Multiplier

Patent Owner argues that Petitioner's evidence and arguments focus on the increase of the twist rate, i.e., turns-per-inch, TPI, as opposed to the twist multiplier, TM. PO Resp. 46. Patent Owner argues that "Petitioner and Dr. Adanur repeatedly conflate twist rate (TPI) with twist multiplier (TM)" and that "simply referring to a high first twist and low second twist is irrelevant to the present claims, which require a first twist **multiplier** at least 1.5 times higher than the second twist **multiplier**." *Id.* at 46–47. Relying on its declarant, Dr. Brookstein, Patent Owner explains that "it is impossible to produce a balanced cord from the same yarn material without a higher first twist and a lower second twist." *Id.* at 46 (citing Ex. 2029 ¶ 8).

The problem with Patent Owner’s argument is two-fold—first Petitioner’s obviousness analysis does not presume all cords must be balanced. As discussed above, although it may be preferred in some manufacturing processes to use or make a balanced cord, it is not a necessity, and indeed we are persuaded that a person of ordinary skill in the art would have known that cords were known to be manufactured in an unbalanced state. *See* Ex. 2032, 3.

Second the Petition, and similarly the ’934 patent, are clear as to the correspondence between TPI and TM, where:

$$TM = \frac{TPI}{\sqrt{5315/\text{denier}}}.$$

Pet. 6; Ex. 1001, 6:60. Petitioner for example, explained that from Hasaka’s disclosed range for the first twist of 4.32–9.65 TPI, the value of 9.65 provides a TM of 5.92, and for the second twist maintaining a cord twist rate of 2.82 TPI, (from the disclosed range of 2.54 to 5.84 TPI) which provides a TM of 3, the ratio of 5.92/3=1.97, which, as Petitioner points out, is greater than 1.5 as recited in claim 9.

Hasaka discloses that “[t]he cords are twisted with a final twist of 10 to 23 per 10 cm, with a primary twist of 17 to 38 per 10 cm.” Ex. 1004, 6:47–48. Dr. Adanur’s un rebutted testimony is that 17 to 38 per 10 cm, “corresponds to 4.32 to 9.65 TPI,” and that 10 to 23 per 10 cm, “corresponds to 2.54 to 5.84 TPI.” Adanur I ¶¶ 45, 46. Petitioner and its declarant, Dr. Adanur, provided respective TMs corresponding to the disclosed TPI ranges in Hasaka and Patent Owner has not shown that the TMs calculated from Hasaka’s disclosed twist rate and TPI values are incorrect.

There is quite clearly disclosed in Hasaka a range of the first twist rate for the yarn from of 17 to 38 per 10 cm, and range of the second twist rate (in the opposite direction) for the cord that is 10 to 23 per 10 cm. Ex. 1004, 6:47–48. Dr. Adanur has testified that Hasaka’s disclosed cord twist rates result ultimately in a specific range of TPIs, and hence TMs, given that the denier is constant across both the first and second TM’s, and that a person of ordinary skill in the art “would have been motivated to find the optimal TPI values for the first and second twists that, when combined, produces the optimal cord.” Adanur I ¶ 66. Given the finite ranges disclosed by Hasaka, Dr. Adanur testifies that a person of ordinary skill in the art “would have tried the various first twist TPI values on the disclosed two-1,000 denier strand with a reasonable expectation of success because the materials, configuration of yarn, and the twist rate, would all be easily achieved using standard equipment and materials at the time.” *Id.* ¶ 67.

Dr. Adanur testifies that given Kovac’s disclosure relating to the level of knowledge and skill in the art, i.e., that increasing the twist rate of yarn, i.e. the first twist rate, results in increasing fatigue resistance, up to a point, a person of ordinary skill in the art “would have considered it obvious to try the finite number of disclosed first twist rate TPI values, including the disclosed 9.65 TPI value, to obtain a cord with a first-to-second TM ratio of 1.97.” *Id.* Pointing to the Background section of the ’934 Dr. Adanur testifies that “there was a market pressure and design need for designing belts and load carrying cords with improved flexural fatigue.” *See id.* (citing Ex. 1001, 1:46–49 (“The need remains for a high modulus load carrying cord, including for incorporation in an endless belt or similar rubber composite article, which exhibits a good balance of load carrying capability and flexural fatigue resistance.”))).

Dr. Adanur testifies further that a person of ordinary skill in the art “would have been motivated to use the disclosed 9.65 TPI first twist rate with the specific example’s 2.82 TPI second twist rate because using the 9.65 first twist rate would be a simple substitution of the specific example’s first twist rate with another first twist rate that was also disclosed in the same patent.” *Id.* ¶ 68. We are persuaded by Dr. Adanur’s testimony in this case. The motivation to interpolate values in disclosed ranges, such as those in Hasaka, is well-settled in our case law. *See In re Malagari*, 499 F.2d 1297, 1303, 182 USPQ 549, 553 (CCPA 1974) (claimed invention is rendered prima facie obvious by the teachings of a prior art reference that discloses a range that touches the range recited in the claim). Using the values provided by Dr. Adanur which are taken directly from Hasaka’s disclosure, a TM ratio of 1.97 is obtained which falls directly within the range recited in claim 9. Where a claimed range falls within a range disclosed in the prior art, a presumption of obviousness applies. *See Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1322 (Fed Cir. 2004) (rehearing denied).

To the extent Patent Owner argues that the first twist multiplier is not a result-effective variable, we disagree. PO Resp. 4. It is reasonably clear from Kovac that a person of ordinary skill in the art would have understood that increasing the twist rate of the yarn results in an increase in flex fatigue resistance while decreasing tensile strength of the yarn. Ex. 1007, 4:15–46. Kovac’s disclosure, and Dr. Adanur’s reliance on it to support his testimony as to the knowledge of a person of ordinary skill in the art, is confirmed by Patent Owner’s declarant, Dr. Wu, who testified that “[i]t also was my understanding at the time that the prior art disclosed that both an increase in either the first or second twist resulted in a higher flexural fatigue resistance.” Wu declaration ¶ 7; *see also In re Applied Materials, Inc.*, 692

F.3d 1289, 1297 (Fed. Cir. 2012) (“A recognition in the prior art that a property is affected by the variable is sufficient to find the variable result-effective.”). We find the evidence and testimony of the declarants for both parties persuasive that a person of ordinary skill in the art understood that increasing the first or second twist rate resulted in a corresponding increase in the respective first and second TMs and a higher flex fatigue resistance which are therefore result-effective variables. Overall, we are persuaded by Petitioner’s optimization argument, because the discovery of an optimum value of a result effective variable is ordinarily within the skill of the art, and thus usually obvious. *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1368 (Fed. Cir. 2007) (citing *In re Boesch*, 617 F.2d 272, 276 (CCPA 1980); *Aller*, 220 F.2d at 456).

Additionally, Dr. Wu confirmed that he was not the first person to test a power transmission belt with a cord having a twist multiplier ratio higher than 1.5. During his deposition, Dr. Wu was provided with a prior art reference relied upon by Patent Owner, Japanese Examined Patent Application Publication H5-83776, to Nakanishi, (Ex. 2001) and asked the following:

Q: And Nakanishi was testing belts with twisted cords; correct?

A: Yes.

Q: Okay. If you look at the first test, it’s the number 1 there, the first twist factor or twist multiplier was set to 4.2; correct?

A: Yes.

...

Q: Okay. We see one of the cords that Nakanishi tested has a twist multiplier -- a second twist multiplier of 1.8; correct? Do you see that in the bottom left corner?

A: Yes.

Q: So if the cord had a first twist multiplier of 4.2, a second twist multiplier of 1.8, that means the cord had a first to second twist multiplier ratio of 2.33; correct?

A: Yes.

Q: So Nakanishi expressly teaches a cord with a first to second twist multiplier ratio greater than 1.5; correct?

A: Yes, he had that variable.

...

Q: So you weren't the first person to test a power transmission belt with a cord having a twist multiplier ratio greater than 1.5. Nakanishi did it first; right?

A Yes --

Ex. 1014, 45:13–47:8. Coincident with this admission, Dr. Wu asserted that he was the first person to “show good results at that ratio – better results at that ratio.” *Id.* at 47:11–12. Further, Dr. Brookstein, Patent Owner's other declarant, testified that a person of ordinary skill in the art would have known from Nakanishi to “vary[] the twist multiplier ratio of toothed belt reinforcement cords' first and second twists to ‘optimize’ flexural fatigue resistance, catenary, and strength of the resulting cord. Brookstein I ¶ 76. As discussed above, the first and second twist multiplier variables are result-effective variables and therefore we see no reason why Dr. Wu's assertion of “better results,” in light of Dr. Brookstein's testimony, is anything more than simply the exercise of ordinary skill in the art.

Patent Owner argues that the '934 patent produces an unexpected result where, prior to the '934 patent, it was generally understood in the field that increasing the second twist rate increased the flexural fatigue resistance. According to Patent Owner, Dr. Wu “discovered that increasing the second twist rate (and hence TM2) actually did the opposite, i.e., it decreased

flexural fatigue resistance, not increased it.” PO Resp. 5 (citing Ex. 2029 ¶¶ 13–20; Ex. 2055 ¶¶ 150–52.) Patent Owner argues that the invention did the unexpected and increased flexural fatigue resistance by using a lower second twist rate and TM2 thereby *increasing* the claimed TM ratio.” *Id.*

Dr. Wu, however, agreed during his deposition that the testing disclosed in the ’934 patent does not establish a relationship between the second TM and the flexural fatigue resistance.

Q: . . . And you would agree by looking at Table 1, it shows that it’s a combination of increasing the first twist while also decreasing the second twist that produces the increase in flexural fatigue resistance; correct?

A: From this table, yes.

Q: So you wouldn’t be able to conclude by looking at Table 1 that increasing the first twist results in improved flexural fatigue resistance; correct?

A: Well, in the claim we have ratios.

Q: Listen to my question. Sorry. So you wouldn’t be able to conclude by looking at Table 1 that increasing the first twist results in improved flexural fatigue resistance; correct?

A: Not in this case.

Q: In this case being Table 1; correct?

A: Increase for the first twist alone.

Q Based on Table 1; correct?

A: Yes. It’s the interaction.

Q: And similarly, you wouldn’t be able to conclude by looking at Table 1 alone that decreasing the second twist results in improved flexural fatigue resistance; correct?

A: Yes.

Ex. 1014, 35:8–36:7. In other words, Dr. Wu confirms that the critical result disclosed in the ’934 patent is not necessarily the increase or decrease of

either TM variable alone, but the ratio of the first twist and TM1 with the second twist and TM2. This testimony is consistent with the independent claims in the '934 patent and the recitations of a first TM to second TM ratio about or above 1.5. Ex. 1001, 12:23. Additionally, for the comparative examples A and B provided in Table 1 which maintain the first TM constant at 2 while lowering the second TM from 6 to 5, to obtain a flexural fatigue resistance increase of 1%, when asked about this data in Table 1 in his deposition, Dr. Wu admitted that “[s]mall differences may not be statistically meaningful.” Ex. 1014, 18:7–8.

The '934 patent discloses four comparative examples of certain ratios of first TM to second TM in Table 1, reproduced below.

TABLE 1

Example	Cord Material	Twist Multiplier Relationship	Tensile Strength (lbf)	Flexural Fatigue Resistance (%)	Durability (hrs.)
Comparative A	K-119	2 × 6	2804	79	170
Comparative B	K-119	2 × 5	3260	80	295
Comparative C	K-119	4 × 4	3123	83	157
Example 1	K-119	5 × 2	2775	91	282

Id. at 10:42–53. Table 1 includes a single example, Example 1, of a TM relationship above 1.5, i.e., ratio, of 2.5. One data point does not necessarily establish that there are unexpected results commensurate in scope with the claimed range. This is particularly true with respect to the recited range for claim 9 that “is greater than about 1.5,” which is practically a boundless range. *Id.* at 12:23. We are not persuaded, on the basis of one data point, that all other ratios above 1.5 would necessarily provide a commensurate increase in flexural fatigue resistance. *See In re Peterson*, 315 F.3d 1325, 1331 (Fed. Cir. 2003) (The Court affirming the Board of Patent Appeals and Interferences decision that no unexpected results are shown where “there are

no data to show that the addition of rhenium in the uppermost portion of the claimed range (*i.e.*, 3% rhenium) would lead to unexpected results.”), *see also In re Patel*, 566 F. App’x 1005, 1011 (Fed. Cir. 2014) (“Even if the single point of 0.915 g/cm³ exhibited unexpected results, Appellants did not disclose sufficient evidence of unexpected results over the *entire* claimed range.”). Considering Patent Owner’s arguments and evidence as to unexpected results as a whole, the record shows that a person of ordinary skill in the art would have understood that either the first or second TM values of a cord could be adjusted to test for and determine a ratio with improved flexural fatigue resistance. And, in light of the known prior art in the field, in particular Nakanishi which also discloses a ration above 1.5, we are not persuaded that the disclosure of one data point within the vast range recited in claim 9 proves unexpected results for the entire range.

j) Whether the Prior Art Teaches Away from Petitioner’s Modification of Hasaka

Teaching away requires a reference to criticize, discredit, or otherwise discourage investigation into the claimed solution. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004) (explaining that prior art does not teach away from claimed subject matter merely by disclosing a different solution to a similar problem unless the prior art also criticizes, discredits, or otherwise discourages the solution claimed). As described in Section II.C.(3)(b)–(g), we acknowledge that the prior art, and the state of the art, provides various disclosures and solutions different from those described and claimed in the ’934 patent. For example, the experts for both parties, consistent with the prior art, describe that balanced cords are often preferred for manufacturing methods and processes. *See, e.g.*, Ex. 2032, 3. It is also, however, undisputed that unbalanced cords were also known to those of

ordinary skill in the art. *Id.* Although Hasaka discloses in its primary example, a TM ratio of 1, nothing in Hasaka may be said to expressly discourage a person of ordinary skill from using values in the disclosed twist rate ranges that would incur an unbalanced cord. Patent Owner has not pointed to any persuasive disclosure in any reference that in fact overtly criticizes the use of unbalanced cords. It is true that Dr. Adanur's textbook explains the benefits of twist balance, and that "balanced yarns and cords are an advantage," but also acknowledges that "for some purposes unbalanced or wild yarns are desired." *Id.* And, as Dr. Wu acknowledged in his deposition, the record includes prior art disclosing testing of unbalanced cords, such as in Nakanishi, that are within the claimed range. Ex. 1014, 45:13–47:8 (Dr. Wu agreeing that Nakanishi describes a first and second TM ratio of 2.33, that is greater than 1.5).

k) U.S. Patent No. 8,057,334 B2

U.S. Patent No 8,057,334 B2 (the "'334 patent"), states that it "is a continuation in part of US. Patent application Ser. No. 11/088,602 filed Mar. 24, 2005 now U.S. Pat. No. 7,254,934." Ex. 2021, 1:4–6. Patent Owner argues that during the prosecution of U.S. patent application No. 11/825,010 (The "'010 application") that became the '334 patent, the Examiner rejected the claims as obvious over Hasaka for essentially the same reason as Petitioner provides in this proceeding. PO Resp. 58. Patent Owner explains that Hasaka was relied upon by the Examiner as disclosing a range of first and second TM values that, when the opposite extremes of the ranges were considered, resulted in a ratio greater than 1.5 as recited in the pending claims of the '010 application. *Id.* at 59 (citing Ex. 2055 ¶¶ 170, 171). Patent Owner argues that "in rejecting the pending claims the patent

examiner modified Hasaka's disclosure in the same manner Petitioner has proposed modifying Hasaka." *Id.*

In response to the Examiner's rejection, Patent Owner explains that a declaration was submitted to the Examiner by Dr. Wu stating that a person of ordinary skill in the art would have understood "Hasaka to have taught selecting twist rates to achieve a balanced cord having first and second TMs of 3, and a TM ratio of 1.0." *Id.* at 61 (citing Ex. 2029 ¶ 31). According to Patent Owner, "Dr. Wu testified that an explicit suggestion would be needed to lead a POSITA to try these extremes because balanced cords are recommended in the art." *Id.* (citing Ex. 2029 ¶ 33). Dr. Wu further explained in his declaration that

simultaneous application of the opposite extremes of the ranges of twist suggested by [Hasaka] would definitely lead to unbalance in a typical belt cord, one of ordinary skill in the art at the time would not have tried them and would have been careful to avoid such extremes.

Ex. 2029 ¶ 33. Patent Owner explains that based on Dr. Wu's testimony the Examiner withdrew the rejection, and stated that "***Applicant's arguments... have been fully considered and are persuasive.*** The rejection ... using Hasaka as a primary reference have been withdrawn." PO Resp.61 (quoting Ex. 2016, 87 (alterations in original)). Patent Owner argues that the office has, therefore, already considered Hasaka "and found claims reciting a twist multiplier ratio greater than 1.5 to be patentable." *Id.* at 62 (citing Ex. 2055 ¶ 174).

We do not find Patent Owner's argument persuasive because the record before us includes the testimony of 3 declarants, i.e., for Petitioner, Dr. Adanur, and for Patent Owner, Dr. Wu and Dr. Brookstein. In the '334

patent prosecution, Dr. Wu's declaration was before the examiner without any opposing facts or opinion provided by any third party.

When we weigh the testimony of the declarants, we have found the testimony and supporting evidentiary underpinnings provided by Dr. Adanur the most persuasive. For instance, although acknowledging that balanced twist rates may be desirable, Dr. Adanur and other evidence indicates that a person of ordinary skill in the would have known to consider unbalanced cord configurations. Dr. Adanur was consistent during his deposition explaining that in addition to Hasaka providing an example with a TM ratio of 1, Hasaka's ranges of first and second twist factors reveal TM ratio's apart from 1.

Q. And the prior art that we've talked about, Hasaka and Kinoshita, their examples both disclose a balanced cord, correct, a TM ratio of about 1?

A. Well, yeah, the example that they give, yes, includes 1 and others too within the range that they give.

Q. But they don't disclose an example of a cord that's unbalanced, do they?

A. Well, but they give the ranges so, I mean, it is as good as giving an example.

Q. Okay. Your 1995 book says that if you increase twist, you increase unbalance and that unbalance makes the yarn wild, right?

A. Yes. Well, it depends, you know, if -- also there is more explanation to that on page 620, it shows a balanced structure and an unbalanced structure so the fibers can be -- the cord or the plied yarn can be balanced or unbalanced. That is possible.

Ex. 2023, 181:22–182:18. As discussed above, we credit Dr. Adanur's testimony and the evidence before us in this proceeding is that, given the state of the art and the persuasive testimony and evidence that a person of

ordinary skill in the art would have understood that yarn and cord can be balanced or unbalanced. And, in the *ex parte* patent prosecution of the '334 patent, in which only Dr. Wu's testimony was presented, the Examiner did not have the benefit of the testimony of Dr. Adanur, who testifies persuasively in this proceeding that a person of ordinary skill in the art would consider not only the example in Hasaka, that is a balanced TM ratio of 1, but "would have been motivated to construct a cord using the disclosed cord configuration and the range of twist rates to determine the optimal twist rates for the primary and secondary twists to achieve the optimal cord."

Adanur I ¶ 66. Contrary to Dr. Wu's testimony before the Examiner, in this proceeding Dr. Adanur testifies for example that a person of ordinary skill in the art would have considered using the various values in Hasaka's disclosed ranges to optimize cord flex fatigue resistance, by

using the 9.65 first twist rate results in a first-to-second TM ratio of 1.97. A POSITA would have considered the substitution of the general description's 9.65 TPI first twist rate for the first twist rate used in the specific example to be a simple substitution because it would have been easily accomplished using standard equipment.

Id. ¶ 68. In this case we have found Dr. Adanur's testimony persuasive as it is supported by compelling evidentiary underpinnings that a person of ordinary skill in the art attempting to optimize the flexural fatigue resistance of a cord would have considered various ranges of twist rates taught by Hasaka, for example using 9.65 TPI first twist rate and 2.82 TPI second twist rate to achieve a cord having a TM ratio of 1.97 that was unbalanced.

l) Whether Hasaka Discloses "Improved Flex Fatigue Resistance" as Recited in Independent Claim 24

As discussed in our claim construction section, above, "improved flex fatigue resistance" is obtained by "selecting said first twist multiplier to be at

least about 1.5 times said second twist multiplier.” Section I.G.2. We have also determined, as previously discussed, that the first and second TM values derived from the respective first and second twist rates, are both result-effective variables. We are not persuaded by Patent Owner’s evidence that the ’934 patent and its claims embody any unexpected results for the reasons set for the above. On this record, we are persuaded that a person of ordinary skill in the considering Hasaka’s disclosure of first and second twist rate ranges, and understanding in general that increasing the twist rate of yarn provides an increase, to a point, in flexural fatigue resistance, would have been motivated to apply the values in these ranges to optimize the flexural fatigue resistance by an unbalanced cord where the first and second TM ratio is greater than 1.5.

3. Dependent Claims 10–17

Petitioner argues that claim 10–17, which all depend ultimately from independent claim 9, are also rendered obvious by Hasaka. Pet. 17–25. Patent Owner provides arguments directed only to dependent claim 13–16, which we discuss below. For claims 10–12 and 17 we have considered Petitioner’s arguments and evidence and adopt them as our own.

Dependent claim 13 requires a first TM between 2 and 9, and claim 14 narrows this range requiring a first TM between 4 and 6. Ex. 1001, 12:38–41. Petitioner argues that Hasaka discloses a first TM of 5.92, which is encompassed by both claimed ranges. Pet. 23.

Dependent claim 15 requires a second TM between .05 and 6, and claim 16 narrows this range requiring a second TM between 1.8 and 3.5. Ex. 1001, 12:42–45. Petitioner argues that Hasaka discloses a second TM of 3, which is encompassed by both claimed ranges. *Id.* at 23–24.

Patent Owner argues that “claims 13–16 of the ’934 patent recite ranges for first and second twist multipliers, none of which is disclosed by . . . Hasaka.” PO Resp. 63. We disagree. It is well settled that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456 (CCPA 1955). The values which Petitioner used from Hasaka’s disclosure, that is, a first TM of 5.92, and a second TM of 3, resulting in a TM ratio of 1.97 satisfy all the requirements of claims 9 and 13–16. We have considered Petitioner’s arguments and evidence as to claims 13–16 in light of Patent Owner’s arguments, and adopt Petitioner’s arguments and evidence as our own.

4. *Claims 18–23*

Independent claim 18 is somewhat differently worded from independent claim 9, particularly in that claim 18 puts an upper limit on the claimed TM ratio range. Claim 18 recites “that the ratio of said first twist multiplier to said second twist multiplier is in the range of from about 1.5:1 to about 4:1.” Ex. 1001, 12:54–56.

Petitioner argues that the scope of the claim limitations in claim 18 are essentially the same as in claim 9 and that a person of ordinary skill in the art “would consider it obvious to construct a load carrying cord with a first TM to second TM ratio of 1.97, which is between 1.5 and 4.” Pet. 27. Patent Owner does not specifically address claims 18–23. *See generally* PO Resp.

Having considered the entire record now before us, including the arguments and evidence presented by both parties, we adopt and incorporate Petitioner’s showing as to claims 18–23, as set forth in the Petition and summarized above, as our own. *See* Pet. 25–30. Accordingly, we are

persuaded by Petitioner's arguments and evidence that claims 18–23 would have been obvious over Hasaka.

5. *Claims 24–26*

As discussed previously in our claim construction for the phrase “having improved flex fatigue resistance,” recited in independent claim 24, and without ultimately deciding whether it is not a limitation, we construe the phrase “having improved flex fatigue resistance” to mean “selecting said first twist multiplier to be at least about 1.5 times said second twist multiplier,” as recited in claim 24. *See* Ex. 1001, 14:1–2, *see also* Section I.G.2.

Petitioner argues that the scope of the method claim limitations in claim 24 are essentially the same as in claim 9 and that a person of ordinary skill in the art “would consider it obvious to construct a load carrying cord with a first TM to second TM ratio of 1.97, which is between 1.5 and 4.” Pet. 31–32. Patent Owner does not specifically address independent claim 24 apart from claim construction. *See generally* PO Resp.

Based on its proposed, but ultimately incorrect, claim construction for “having improved flex fatigue resistance,” Patent Owner argues that “Petitioner has failed to present any evidence that the proposed modifications it has made to Hasaka and Kinoshita would produce a belt having improved flex fatigue resistance.” PO Resp. 64. Patent Owner argues specifically that the modifications to Hasaka's disclosure asserted by Petitioner “would have been expected to produce a belt having inferior flexural fatigue resistance.” *Id.* at 65. However, whether or not a belt is inferior or superior is not a limitation of claim 24. Based on the proper construction, the question is whether Hasaka as modified, discloses “selecting said first twist multiplier to be at least about 1.5 times said second

twist multiplier.” As discussed above with respect to claim 9, we determine that it does. Section II.C.2.h.–m.

Having considered the entire record now before us, including the arguments and evidence presented by both parties, we adopt and incorporate Petitioner’s showing as to claims 24–26, as set forth in the Petition and summarized above, as our own. *See* Pet. 31–33. Accordingly, we are persuaded by Petitioner’s arguments and evidence that claims 24–26 would have been obvious over Hasaka.

6. *Conclusion as to Obviousness Based on Hasaka*

Based on the complete trial record in the proceeding, for the reasons above we are persuaded that claims 9–26 would have been obvious in view of Hasaka. Because we determine that all the challenged claims of the ’934 patent are unpatentable over Hasaka, we do not reach Petitioner’s challenges asserting that claims 9–26 would have been obvious based on Kinoshita, Hasaka and Carlson, or Kinoshita and Carlson.

III. CONCLUSION

As summarized in the table below, the Petition and supporting evidence has shown by a preponderance of the evidence that claims 9–26 of the ’934 patent would have been obvious.¹¹

¹¹ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

Claims	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
9–26	103	Hasaka	9–26	
9–26	103	Hasaka and Carlson		
9–26	103	Kinoshita		
9–26	103 ¹²	Kinoshita and Carlson		
Overall Outcome			9–26	

IV. ORDER

For the reasons given, it is

ORDERED that, based on a preponderance of the evidence claims 9–26 of the '934 patent have been shown to be unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, any party to the proceeding seeking judicial review of this Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

¹² As explained above, because we determined that all the challenged claims of the '934 patent are unpatentable based on the ground of obviousness over Hasaka, we do not reach Petitioner's challenge asserting that claims 9–26 would have been obvious based on the remaining grounds. *Boston Sci. Scimed v. Cook Grp. Inc.*, 809 F. App'x 984, 990 (Fed. Cir. 2020).

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