

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DYNAENERGETICS US, INC. and
DYNAENERGETICS GMBH & CO. KG,
Petitioners,

v.

GEODYNAMICS, INC.,
Patent Owner.

Case IPR2016-01850
Patent 8,544,563 B2

Before HYUN J. JUNG, BEVERLY M. BUNTING, and
TIMOTHY J. GOODSON, *Administrative Patent Judges*.

GOODSON, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

Petitioners filed a Petition (Paper 2, “Pet.”) requesting *inter partes* review of claims 1–26 and 28–34 of U.S. Patent No. 8,544,563 B2 (Ex. 1001, “the ’563 patent”). Patent Owner filed a Preliminary Response. Paper 6. We instituted an *inter partes* review of claims 1–26 and 28–34 on the following grounds:

References	Basis	Claim(s)
Veehmayer ¹ and Bates ²	§ 103	1–26, 28, and 30–34
Bates and Reese ³	§ 103	1–18, 20–26, 28, and 31–34
Bates, Reese, and Delacour ⁴	§ 103	29
Bates and Bourne ⁵	§ 103	1–18, 20–26, 28, and 31–34

See Paper 7 (“Dec. on Inst.”).

After institution of trial, Patent Owner filed a Patent Owner Response. (Paper 9, “PO Resp.”), and Petitioners filed a Reply (Paper 16, “Reply”). An oral hearing was held, a transcript of which is included in the record. Paper 25 (“Tr.”). There are no pending motions.⁶

¹ German Patent App. Pub. No. DE 10 2005 059 934 A1, published Aug. 24, 2006, Ex. 1002. Patent Owner does not dispute that Veehmayer qualifies as prior art to the ’563 patent. See Dec. on Inst. 7 n.1; Tr. 29:10–30:5.

² Int’l Patent App. Pub. No. WO 2005/035939 A1, published Apr. 21, 2005, Ex. 1003.

³ U.S. Patent No. 5,567,906, issued Oct. 22, 1996, Ex. 1004.

⁴ U.S. Patent No. 3,235,005, issued Feb. 15, 1966, Ex. 1005.

⁵ Int’l Patent App. Pub. No. WO 03/042625 A1, published May 22, 2003, Ex. 1006.

⁶ Petitioners filed evidentiary objections to exhibits and papers filed in connection with the Patent Owner Response. See Paper 11. However, Petitioners did not file a motion to exclude, which is required to preserve any evidentiary objection. See 37 C.F.R. § 42.64(c).

We have jurisdiction under 35 U.S.C. § 6. Petitioners bear the burden of proving unpatentability of the challenged claims, and the burden of persuasion never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. See 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons that follow, we determine that Petitioners have shown by a preponderance of the evidence that claims 1–26 and 28–34 of the '563 patent are unpatentable. See 35 U.S.C. § 316(e).

A. Related Matters

Patent Owner is asserting the '563 patent in a civil action in the U.S. District Court for the Eastern District of Texas, *GeoDynamics, Inc. v. DynaEnergetics US, Inc.*, Civil Action No. 2:16-cv-00697. Pet. 2; Paper 18, 2; Paper 22, 2. The parties do not list any related proceedings before the Board.

B. The '563 Patent

The '563 patent relates to a reactive shaped charge liner for a perforator for use in oil and gas well completions. Ex. 1001, [57], 1:9–11. The patent explains that carrying out a well completion in a cased well involves providing a flow path between the production zone or formation and the well bore. *Id.* at 1:14–17. A perforator, typically in the form of a shaped charge, can be used to provide that flow path. *Id.* at 1:17–18, 28–29.

As described in the '563 patent,

A shaped charge is an energetic device made up of a housing within which is placed a typically metallic liner. The liner provides one internal surface of a void, the remaining surfaces

being provided by the housing. The void is filled with an explosive, which when detonated, causes the liner material to collapse and be ejected from the casing in the form of a high velocity jet of material. This jet impacts upon the well casing creating an aperture, the jet then continues to penetrate into the formation itself, until the kinetic energy of the jet is overcome by the material in the formation.

Id. at 1:32–41. Figure 1 of the '563 patent is reproduced below:

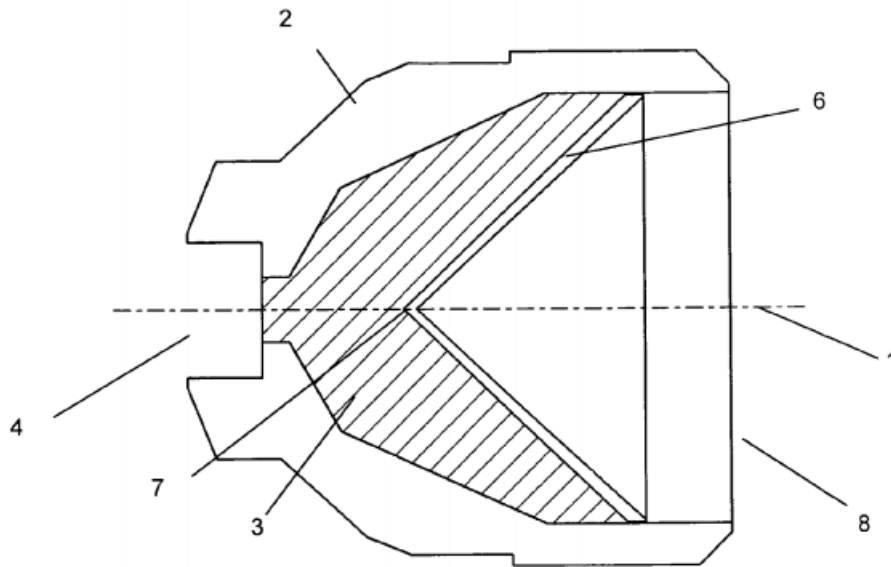


Figure 1 is a cross section view of a shaped charge “of generally conventional configuration” that includes housing 2, liner 6 in open end 8 of housing 2, and high explosive material 3 within the volume between housing 2 and liner 6. *Id.* at 10:23–34. A detonator in recess 4 initiates high explosive material 3 at the closed end of the device, proximate apex 7 of liner 6. *Id.* at 10:34–37.

The '563 patent explains that the materials “typically used in reactive liners may have significantly reduced penetrative depth due to their physical properties.” *Id.* at 2:43–45. The patent seeks to offer a shaped charge liner that produces a jet that provides additional heat energy after the initial detonation of the shaped charge device. *Id.* at 2:46–49. This heat energy is

imparted to the rock strata, increasing fracturing and leading to larger hole volumes and improved oil flow. *Id.* at 2:49–59. The '563 patent explains that “the inclusion of a further metal, preferably one which does not react with the reactive composition, particularly a high density metal, provides a fracture (tunnel) possessing unexpectedly large volume.” *Id.* at 3:1–5. According to the '563 patent, “[i]t has been unexpectedly found that only low percentage amounts of the reactive composition material are required in combination with the typical shaped charge liner material to afford very large increases in hole volume. . . .” *Id.* at 3:7–11.

The '563 patent describes that “[a] suitable starting material for the liner comprises a Ni-Al-W, composition, containing 69.43 wt % tungsten, 9.6265 wt % aluminum and 20.9435 wt % nickel. This produces a stoichiometric Ni-Al mix.” *Id.* at 10:38–41. The '563 patent further describes testing carried out in simulated down well conditions, in which a series of shaped charge liners were prepared with stoichiometric amounts of nickel and aluminum, with varying amounts of tungsten being added. *Id.* at 11:3–26. After the shots using the different liners were fired, the characteristics of the tunnel were measured. Table 1, reproduced below, shows the results:

TABLE 1

showing percentage inclusion of tungsten and tunnel profile.						
Powder Composition (weight)	Shot no.	% tungsten	Core Entrance hole diameter	CT Clear Tunnel	% CT	TCP Total Core Penetration
21% Ni, 9% Al	19, 20	70% W	1.01	12.50	98%	12.75
41% Ni, 19% Al	16, 17	40% W	1.20	9.21	96%	9.55
62% Ni, 28% Al	15	10% W	1.22	8.75	98%	8.90
68.5% Ni, 31.5% Al	13	0% W	1.27	5.35	100%	5.35
68.5% Ni, 31.5% Al	7, 8	0% W	1.82	6.91	92%	7.50
68.5% Ni, 31.5% Al	5, 6	0% W	1.30	7.89	100%	7.89
Cu, Pb, W Baseline	1, 2, 4	0% W	0.55	9.59	78%	12.38

The results indicate that the addition of tungsten served to increase depth.

Id. at 12:24–26. In addition,

unexpectedly and advantageously[,] the percentage of debris free volume available in the tunnel remained at a very high level. . . . It was very surprising to find that even at 70% inclusion of tungsten with Ni-Al only being present at 30% that nearly 100% of the tunnel created was usable.

Id. at 12:26–31.

C. Claims Challenged in Instituted Grounds

As noted above, we instituted trial as to claims 1–26 and 28–34. *See* Dec. on Inst. 25–26. Of these, only claims 1, 31, and 34 are independent claims. Claims 2–26 and 28–30 depend, directly or indirectly, from claim 1, and claims 32 and 33 depend from claim 31. Claim 1 is representative, and is reproduced below with additional indentations added for clarity:

1. A reactive oil and gas well shaped charge perforator liner comprising
a reactive composition comprising at least two metals that are
capable of an exothermic reaction,
wherein the liner further comprises at least one further metal,
which is not capable of an exothermic reaction with the at
least two metals and

said further metal is present in an amount greater than 40% w/w of the liner.

Ex. 1001, 13:40–46.

II. CLAIM CONSTRUCTION

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs. LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016) (upholding the use of the broadest reasonable interpretation standard). In our Institution Decision, we determined that resolution of the disputed issues at that stage of the proceeding did not require an express interpretation of any claim term. *See* Dec. on Inst. 6 (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). In its Patent Owner Response, Patent Owner argued that we should interpret the preamble of claim 1 to be limiting. *See* PO Resp. 5–9. At the hearing, Petitioners argued that it is unnecessary to determine whether the preamble is limiting or to construe any other claim term, and Patent Owner conceded that construction of the preamble is unnecessary. Tr. 7:3–26, 26:7–18. Based on our review of the complete record, we agree with the parties that no express construction is necessary to resolve the disputed issues in this proceeding.

III. OBVIOUSNESS ANALYSIS

A. Legal Standards

In *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966), the Supreme Court set out a framework for assessing obviousness under § 103 that requires consideration of four factors: (1) the “level of ordinary skill in the pertinent art,” (2) the “scope and content of the prior art,” (3) the “differences between the prior art and the claims at issue,” and

(4) “secondary considerations” of nonobviousness such as “commercial success, long felt but unsolved needs, failure of others, etc.” *Id.* at 17–18; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 407 (2007). We discuss each of these *Graham* factors below.

B. Level of Ordinary Skill in the Art

In determining the level of skill in the art, we consider the type of problems encountered in the art, the prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level of active workers in the field. *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986); *Orthopedic Equipment Co., Inc. v. U.S.*, 702 F.2d 1005, 1011 (Fed. Cir. 1983).

The record developed by the parties on the level of ordinary skill in the art is scant. Petitioners’ declarant, Dr. William P. Walters, testifies that

a person of ordinary skill in the art of designing and using shaped charges, including for use in oil and gas well perforation as of the filing date of the ’563 patent would typically hold an advanced degree in petroleum or mining engineering, mechanical engineering, or a comparable discipline, and at least three to five years of experience in shaped charge development, or an equivalent combination of education and experience.

Ex. 1008 ¶ 44.

When asked at the hearing whether it agrees with this definition, Patent Owner responded that it disagrees that an advanced degree is necessary and argued that additional experience after an undergraduate degree can be sufficient. Tr. 27:15–22. Patent Owner also referred to the testimony of its declarant, Mr. Philip D. Church, as defining the level of ordinary skill in the art. *Id.* at 40:22–24 (citing Ex. 2002, 17). However, the

cited testimony only opines on what would or would not have been obvious to or appreciated by a person of ordinary skill in the art; it does not set forth a definition of the level of ordinary skill in the art. Ex. 2002, 17.

We adopt the definition of the level of ordinary skill in the art as set forth by Dr. Walters, which is the most direct articulation of the level of ordinary skill in the art that we find in the record. Patent Owner's argument at the hearing that relevant work experience after an undergraduate degree can substitute for an advanced academic degree is reasonable, but Dr. Walter's proposal allows for such a substitution insofar as it expressly includes other "equivalent combination[s] of education and experience." Ex. 1008 ¶ 44. For the foregoing reasons, we find that a person of ordinary skill in the field of the '563 patent would have had an advanced degree in petroleum or mining engineering, mechanical engineering, or a comparable discipline, and at least three to five years of experience in shaped charge development, or an equivalent combination of education and experience.

C. Scope and Content of the Asserted Prior Art References

1. Summary of Bates

Bates relates to a reactive shaped charge liner for an oil well perforator. Ex. 1003, 1:6–7. In its Background section, Bates discloses the following:

The kinetic energy of the jet from a shaped charge is provided exclusively by the detonative pressure of the explosive which forces the collapse of the liner. This in turn leads to the liner material being ejected at a high velocity. Once the jet is in motion there is no further energy available from the system.

Ex. 1003, 3:20–24. Bates seeks to "produce a shaped charge liner whose jet can provide additional energy after the detonative event. . . ." *Id.* at 4:6–7.

To that end, Bates describes a reactive shaped charge liner that comprises “a composition capable of an exothermic reaction upon activation of the shaped charge liner.” *Id.* at 4:13–14. Bates discloses that the exothermic reaction “can be achieved by using a typically stoichiometric (molar) mixture of at least two metals which are capable upon activation of the shaped charge liner to produce an intermetallic product and heat.” *Id.* at 4:20–23. Bates describes numerous combinations that may be used, *id.* at 5:1–20, but states that “[t]he preferred metal-metal compositions are nickel and aluminum or palladium and aluminum, mixed in stoichiometric quantities.” *Id.* at 5:30–32.

Bates also describes an “alternative arrangement” in which the liner further comprises at least one further metal, where the at least one further metal does not participate in the exothermic reaction when the shaped charge is activated. . . . The purpose of adding a further metal is to provide additional mechanical strength to the liner and thus to increase the penetrative power of the jet. The properties of tungsten and copper as shaped charge liners are well known and they are typically used as liner materials due to their high density and ductility, which traditionally make them desirable materials for this purpose. Therefore, it may further be desirable to incorporate a portion of either copper or tungsten or an alloy thereof, into the reactive liner of the invention in order to provide a reactive liner of increased strength and hence a more powerful jet.

Id. at 9:9–21.

2. Summary of Reese

Reese is entitled “Tungsten Enhanced Liner for a Shaped Charge” and relates to shaped charges used for oil well perforating. Ex. 1004, 1:18–19. Reese describes that it was known to include as much as 35 percent by weight of tungsten in liner compositions, but that greater amounts of

tungsten were not used because it was believed that doing so would not improve performance. *Id.* at 2:27–39. Reese describes using a larger percentage of tungsten in the liner. Specifically, Reese discloses that “[t]he powdered metal of the liner 5 of the present invention can consist of approximately 80 percent by weight of tungsten and 20 percent by weight of a powdered metal binder.” *Id.* at 3:36–39. According to Reese, “the penetration depth of the shaped charge 10 is improved by using powdered tungsten in the liner 5 material, compared with the depth of penetration achieved by shaped charges having liners of compositions known in the art which primarily include powdered copper.” *Id.* at 3:45–50.

3. *Summary of Delacour*

Delacour describes “shaped explosive charge devices which are capable of producing in hard materials greatly improved cracking or breaking effects which in certain cases may occur after perforation has taken place.” Ex. 1005, 1:12–16. According to Delacour, known shaped charges were effective at penetrating the casing, but were only partially effective in cracking the cement surrounding the casing, and the fluid flow through the perforation was therefore impeded. *Id.* at 1:24–28; 2:16–22. One of Delacour’s objectives is to provide a shaped charge device for well casing perforating operations that “provide for the cleaning of the perforations which otherwise might be completely or partially plugged up with foreign matter of one kind or another.” *Id.* at 1:40–42. For that purpose, Delacour describes “providing between the actual explosive charge and the cavity which characterizes the shaped or hollow charge a substance or a mixture of substances which is adapted to produce a highly exothermic chemical reaction under the action of the explosion.” *Id.* at 1:43–48.

4. *Summary of Bourne*

Bourne relates to compositions of liners for shaped charges. Ex. 1006, 1. Bourne describes that maximizing the depth of a jet's penetration is often desirable. *Id.* Bourne teaches that using a liner material with high density, such as tungsten, improves the penetration depth. *Id.* at 2. Prior art liners included "a composition of up to 90% tungsten," and "[s]uch liners [for shaped charges] show improved penetration depths over traditional liner compositions but have the drawback of being brittle." *Id.* Bourne seeks to provide a liner that provides increased penetration depth but mitigates the problems of known tungsten enhanced liners. *Id.* The liner Bourne teaches for that purpose has "a composition greater than 90% by weight of powdered tungsten and up to 10% by weight of a powdered binder, the composition being formed into a substantially conically shaped body and having a crystal structure of substantially equi-axed grains with a grain size of between 25[]nano-metres to 1 micron." *Id.*

5. *Summary of Veehmayer*

Veehmayer is directed to liners for shaped charges made of cold-pressed powder metal mixtures. Ex. 1002 ¶ 1. Veehmayer teaches that the powder metal mixtures "may vary widely. A mixture may contain, for example, 10 to 30% by weight a soft metal, which serves as a binding agent, while the remaining fraction may consist of harder metals." *Id.* ¶ 3. According to Veehmayer, lead is used as a binding agent in a majority of commercially available liners, but other metals, including nickel, are "[a]lso conceivable." *Id.* Because increasing the density of the liner material enhances penetration depth, mixing tungsten and lead was a known powder mixture. *Id.* ¶ 4. However, this mixture suffered some drawbacks, including

the formation of slugs that block the penetration channels after the blast and a low hole diameter for the charge opening holes. *Id.* ¶¶ 5–6.

Veehmayer seeks to provide liners for shaped charges that enable large hole diameter and high penetration depth. *Id.* ¶ 7. Veehmayer purports to have “discovered that the addition of light-metal powders, for example aluminum powder and/or titanium powder, to tungsten-lead mixtures or tungsten-copper/bronze-lead mixtures leads to a marked increase in the hole diameter without significant losses in terms of penetration depth.” *Id.* ¶ 8. Veehmayer describes as a preferred embodiment a powder metal mixture containing “14 to 30% by weight lead, 70 to 85% by weight tungsten and 1 to 16, preferably 3 to 11% by weight aluminum.” *Id.* ¶ 11.

6. Whether the Cited References Constitute Analogous Art

The parties dispute whether the references on which Petitioners’ challenges rely qualify as analogous art for purposes of assessing the obviousness of the claims of the ’563 patent. Specifically, Patent Owner concedes that Bates and Delacour are directed to reactive liners and are, therefore, analogous art, but Patent Owner contends that none of Reese, Bourne, and Veehmayer, is analogous because those references are all directed to non-reactive liners. *See* Tr. 23:13–26. Petitioners argue that each of the references should be considered analogous art because the relevant field of the ’563 patent is not limited to reactive liners, and because each of the references is pertinent to the problems that the ’563 patent seeks to address. *See* Reply 7; Tr. 11:4–13.

“A reference qualifies as prior art for an obviousness determination under § 103 only when it is analogous to the claimed invention.” *In re Klein*, 647 F.3d 1343, 1348 (Fed. Cir. 2011) (citation omitted). “Two

separate tests define the scope of analogous prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.” *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004) (citation omitted).

According to Petitioners, the field of endeavor of the '563 patent is “liners for shaped charges used in oil and gas extraction.” Reply 7. Patent Owner argues that the field of endeavor is reactive liners. Tr. 24:1–3. The Federal Circuit has explained that a patent's field of endeavor is determined “by reference to explanations of the invention's subject matter in the patent application, including the embodiments, function, and structure of the claimed invention.” *Bigio*, 381 F.3d at 1325. After considering the parties' arguments on this issue and the disclosure of the '563 patent, we find that Petitioners' identification of the field of endeavor is the correct one. The title of the '563 patent is “Oil Well Perforator,” its sole figure is “a cross section view of a shaped charge . . . of generally conventional configuration,” and the function of the shaped charge is to “perforat[e] and fractur[e] subterranean well completions.” See Ex. 1001, at (54), 10:23–25, 1:10–11. While the '563 patent describes and recites reactive liners in the written description and claims, “[t]he field of endeavor of a patent is not limited to the specific point of novelty, the narrowest possible conception of the field, or the particular focus within a given field.” *Unwired Planet, LLC v. Google Inc.*, 841 F.3d 995, 1001 (Fed. Cir. 2016). Because each of the cited references is within the field of liners for shaped charges used in oil

and gas extraction, we conclude that the cited references are analogous art under the field of endeavor test.

Even if Patent Owner is correct that the field of endeavor is limited to reactive liners, we also agree with Petitioners that Reese, Bourne, and Veehmayer are reasonably pertinent to the problem with which the inventors of the '563 patent were concerned. "A reference is reasonably pertinent if . . . it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem." *Scientific Plastic Prods., Inc. v. Biotage AB*, 766 F.3d 1355, 1359 (Fed. Cir. 2014) (quoting *Innovation Toys, LLC v. MGA Entm't, Inc.*, 637 F.3d 1314, 1321 (Fed. Cir. 2011)). "If a reference disclosure and the claimed invention have a same purpose, the reference relates to the same problem, which supports an obviousness rejection." *Unwired Planet*, 841 F.3d at 1001.

The '563 patent explains that "[g]enerally, the aim of the well completion engineer is to obtain an appropriate size of aperture in the casing together with the deepest and largest diameter hole possible in the surrounding formation." Ex. 1001, 1:57–60. The '563 patent further describes that liners that undergo secondary reactions can provide additional energy, but that use of reactive liners may result in reduced penetrative depth. *Id.* at 2:41–45. Thus, the general problem with which the '563 patent was concerned was to obtain a large hole in the formation so as to provide a large and clear flow path between the formation and the well bore. *See id.* at 1:14–21. The more specific problem with which the '563 patent was concerned was increasing the penetrative depth of a shaped charge with a reactive liner. *Id.* at 2:41–45.

Each of Veehmayer, Reese, and Bourne is pertinent to increasing penetrative depth of a shaped charge so that the flow rate from the formation to the well bore would be increased. Reese describes that “an object of [its] invention [is] to provide a liner material for a shaped charge which increases the penetration depth of the shaped charge.” Ex. 1004, 2:40–42. Bourne seeks to “provide a liner material for a shaped charge that gives increased penetration depth and which also mitigates some of the . . . problems with known tungsten enhanced liners.” Ex. 1006, 2. Veehmayer’s stated purpose is “to provide liners for shaped charges, by means of which a large hole diameter combined with a high penetration depth is achieved.” Ex. 1002 ¶ 7. Thus, each of these references shares a common purpose with the ’563 patent, relates to the same problem, and logically would have commended itself to the inventor’s attention in considering that problem.

Patent Owner’s argument that Reese, Bourne, and Veehmayer are directed to non-reactive liners does not demonstrate that the references are nonanalogous because, as the Federal Circuit recently noted in rejecting a nonanalogous art argument, “[a] reference must be considered for everything it teaches by way of technology and is not limited to the particular invention it is describing and attempting to protect.” *Bosch Automotive Service v. Matal*, 878 F.3d 1027, 1036 (Fed. Cir. 2017) (quoting *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 907 (Fed. Cir. 1985)).

Accordingly, we find that each of the cited references qualifies as analogous art to the ’563 patent.

D. Obviousness Challenge Based on Bates and Reese

Petitioners contend that claims 1–18, 20–26, 28, and 31–34 are unpatentable under 35 U.S.C. § 103(a) as obvious over Bates and Reese. Pet. 49–54.⁷

1. Analysis of Claim 1

a. Whether the Cited Combination Teaches Each Limitation

We are persuaded by Petitioners’ contentions, which Patent Owner does not dispute, that Bates and Reese together teach every limitation of claim 1.⁸ See Pet. 49–51; Tr. 28:15–22. To summarize how Petitioners relate the teachings of Bates and Reese to the limitations of claim 1, Petitioners contend that Bates teaches every limitation of claim 1 except for the presence of at least one further metal “in an amount greater than 40% w/w of the liner.” Pet. 49, 51. Patent Owner agrees. Tr. 28:19–21. The evidence supports Petitioners’ assertion that Bates teaches the claimed “reactive composition comprising at least two metals that are capable of an

⁷ As the discussion below makes clear, there is substantial overlap in the disputed issues for the various asserted grounds. See, e.g., PO Resp. 34–35 (providing a bulleted list of arguments against the Bates and Reese ground and simply referring back to the arguments against Veehmayer and Bates for a full explanation of those arguments). To facilitate review, we discuss the grounds in a different sequence than is presented in the Petition. Although none of the instituted grounds is difficult to understand, the challenge based on Bates and Reese is, in our view, the most straightforward.

⁸ We previously warned Patent Owner that “any arguments for patentability not raised in the [Patent Owner Response] will be deemed waived.” Paper 8, 3; see also 37 C.F.R. § 42.23(a) (“Any material fact not specifically denied may be considered admitted.”); *In re Nuvasive, Inc.*, 842 F.3d 1376, 1380–81 (Fed. Cir. 2016) (holding that a patentee waived an argument by presenting it only in the preliminary proceeding and not during the trial, despite the Board cautioning the patentee that arguments not briefed in the response would be deemed waived).

exothermic reaction” because it describes a “preferred metal-metal composition [of] nickel and aluminum” that produces an exothermic reaction upon activation. Pet. 31–32, 50 (citing Ex. 1003, 4:21–23, 5:30–32). We also agree with Petitioners that Bates teaches that the liner further includes “at least one further metal, which is not capable of an exothermic reaction with the at least two metals” as recited in claim 1 because Bates teaches the desirability of incorporating tungsten into the reactive liner as a further metal that does not participate in the exothermic reaction. *Id.* at 32–33, 50 (citing Ex. 1003, 9:9–21). Bates does not describe the amount of tungsten to incorporate into the liner, but as Petitioners correctly state, Reese describes liners that include approximately 80% by weight of tungsten, thereby teaching that the “further metal is present in an amount greater than 40% w/w of the liner,” as recited in claim 1. *Id.* at 49 (citing Ex. 1004, 2:46–52).

b. Reason to Combine and Reasonable Expectation of Success

When a combination of references together discloses all of the limitations in a claim, the Board “must determine whether there was an ‘apparent reason to combine the known elements in the fashion claimed by the patent at issue,’ and whether a person of skill in the art at the time of the invention would have had a ‘reasonable expectation of success’ in pursuing that combination.” *Los Angeles Biomedical Research Institute v. Eli Lilly & Co.*, 849 F.3d 1049, 1064 (Fed. Cir. 2017) (quoting *KSR*, 550 U.S. at 406; *Genzyme Therapeutic Prods. Ltd. v. Biomarin Pharm. Inc.*, 825 F.3d 1360, 1373 (Fed. Cir. 2016)). “Any motivation to combine references, whether articulated in the references themselves or supported by evidence of the knowledge of a skilled artisan, is sufficient to combine those references to

arrive at the claimed process.” *Outdry Techs. Corp. v. Geox S.p.A.*, 859 F.3d 1364, 1370–71 (Fed. Cir. 2017).

We find that Petitioners have presented a reason to combine Bates and Reese that is supported by rational underpinnings. Indeed, the teachings of the cited references themselves support the asserted motivation to combine. Specifically, we find persuasive Petitioners’ contention that it would have been obvious “to use the amount of tungsten disclosed by Reese with the reactive composition of Bates to provide ‘increased strength and hence a more powerful jet,’ as taught by Bates, and to provide increased depth of penetration, as disclosed by Reese.” Pet. 50 (citing Ex. 1003, 9:21; Ex. 1004, 3:45–50).

As Petitioners note (*see* Reply 9), Bates discloses the combination of nickel, aluminum, and tungsten and teaches that “the properties of tungsten . . . as shaped charge liners are well known.” Ex. 1003, 9:15–16. The purpose Bates teaches for including tungsten is “to provide additional mechanical strength and thus to increase the penetrative power of the jet.” *Id.* at 9:13–15. Bates describes penetration depth as “a critical factor in completion engineering” and teaches that “[g]enerally, the aim of the completion engineer is to obtain an appropriate size of aperture in the casing together with the deepest possible penetration into the surrounding formation.” *Id.* at 11:4–5, 2:14–16. These disclosures support Petitioners’ argument that a skilled artisan would have been motivated to optimize the known factors that affect penetration depth, including the amount of tungsten. *See* Reply 10. *See In re Ethicon, Inc.*, 844 F.3d 1344, 1351 (Fed. Cir. 2017) (“The normal desire of artisans to improve upon what is already generally known can provide the motivation to optimize variables such as

the percentage of a known polymer for use in a known device.”). Because Reese teaches the use of tungsten for the same purpose—to improve “the penetration depth of the shaped charge” (Ex. 1004, 3:45–50)—an ordinarily skilled artisan would have been motivated to incorporate Reese’s teachings regarding the amount of tungsten to include in the liner. *See KSR*, 550 U.S. at 416 (“[I]f a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.”).

We also find that an ordinarily skilled artisan would have had a reasonable expectation of success in pursuing the proposed combination of Bates and Reese. As noted above, Bates expressly teaches the use of tungsten in a reactive liner, but does not state what percentages of tungsten to include. Ex. 1003, 9:15–21; *see also* Ex. 1025, 82:25–83:8 (Patent Owner’s declarant, Mr. Church, agreeing that Bates discloses nickel and aluminum liners with tungsten, but Bates does not disclose how much tungsten). Bates’s disclosure that “the properties of tungsten . . . as shaped charge liners are well known” because they are “typically used as liner materials due to their high density and ductility” (Ex. 1003, 9:15–16) tends to indicate that Bates envisioned using tungsten in a similar manner as was known in other shaped charge liners.

Patent Owner does not direct us to any teaching or suggestion in Bates that in a reactive liner, only a small proportion of tungsten should be used. During the hearing, Patent Owner agreed that none of the prior art references of record concerning reactive liners advocate using a small amount of tungsten as opposed to a large amount of tungsten. *See* Tr. 39:5–8. We

credit the testimony of Dr. Walters that an ordinarily skilled artisan would have expected success in utilizing more than 40% w/w tungsten in the liner because “Reese overturned the preexisting belief that liners could not effectively have an excess of 35% w/w tungsten.” Ex. 1008 ¶ 108 (citing Ex. 1004, 2:30-37).

The similar purposes Bates and Reese teach for incorporating tungsten into the liner (*see* Ex. 1003, 9:13–15; Ex. 1004, 3:45–50), along with Bates’s suggestion to incorporate tungsten into the liner in the “well known” and “typical[]” manner (Ex. 1003, 9:15–21), provide a sound basis for belief that the amount of tungsten taught in Reese could be utilized in Bates’s liner. “In sum, there was little left to do but to confirm that the strategy suggested by the various prior art references would work.” *Genzyme*, 825 F.3d at 1373.

We have considered Patent Owner’s arguments concerning reasonable expectation of success, but we do not find those arguments persuasive. Patent Owner’s arguments generally focus on the “differences in the natures of the non-reactive liners and the reactive liners.” PO Resp. 34. In particular, Patent Owner argues that there are more variables to consider in designing a reactive liner than for a non-reactive liner, such that “metals cannot be added or substituted into reactive liners purely based on suggestions from prior art shaped charge liners that do not undergo exothermic intermetallic reaction.” *Id.* at 14–15 (citing Ex. 2009 ¶ 6; Ex. 2002, 9–15). According to Patent Owner, “the differences between the two types of liner technologies make it highly questionable that a person of ordinary skill in the art could substitute one metal for another, with ‘a reasonable expectation of success.’” *Id.* at 15–16. However, as Petitioners point out, the proposed combination of Bates and Reese does not require the

addition or substitution of metals from a non-reactive liner into a reactive liner because Bates itself teaches to use tungsten as a further metal that does not participate in the exothermic reaction. *See* Reply 11 (citing Ex. 1003, 9:10–18).

Relatedly, Patent Owner argues that the “empirical ‘trial and error’ nature” of reactive liner technology undermines a reasonable expectation of success in combining teachings from a non-reactive liner reference with Bates’s reactive liner. *See* PO Resp. 33–34 (citing Ex. 2002, 7–9, 19–21, App’x QQ4); *see also id.* at 23, 26, 30. In support of that argument, Patent Owner relies on the testimony of Mr. Church that experimental results indicate that the particular combination of “nickel/aluminum with tungsten powder . . . gave the desired effect” while other combinations of reactive materials did not, and the reasons why “were not clear.” *Id.* at 26 (citing Ex. 2002, 19–20). According to Patent Owner, Mr. Church’s testimony “establishes that the technology is empirical, subject to trial and error, and without clear guidance as to which combinations of reactive metals might react most favorably *in situ*,” which shows that an ordinarily skilled artisan would not have had a reasonable expectation of success in making the proposed combination. *Id.* at 29.

Patent Owner’s argument regarding the lack of clarity surrounding why nickel and aluminum worked while other reactive combinations did not misses the mark because Bates discloses nickel and aluminum as reactive metals with tungsten as a nonreactive further metal. Ex. 1003, 5:30–31 (“The preferred metal-metal compositions are nickel and aluminum or palladium and aluminum, mixed in stoichiometric quantities.”); *id.* at 9:18–21 (“[I]t may further be desirable to incorporate a portion of either copper or

tungsten or an alloy thereof, into the reactive liner of the invention in order to provide a reactive liner of increased strength and hence a more powerful jet.”). A skilled artisan starting from Bates’s disclosure would not have needed to undertake the alleged trial and error to identify nickel and aluminum as the preferred reactive metals.

Further, to the extent that Patent Owner is correct that the technology of reactive liners is “empirical,” that state of the art would suggest that a skilled artisan would not predict with confidence what amount of tungsten to include in Bates’s liner and would, therefore, seek to test a wide range. *See* Reply 12 n.8. A skilled artisan beginning with Bates’s teachings of nickel and aluminum in stoichiometric quantities as a preferred metal-metal composition and further including tungsten in an unspecified amount would naturally want to include in that testing an amount of tungsten that Reese taught provided satisfactory depth of penetration, since that is the same purpose tungsten serves in Bates’s disclosure. *See* Ex. 1003, 5:30–32, 9:13–21; Ex. 1004, 3:45–47.

In further arguing against a reasonable expectation of success, Patent Owner analogizes the reactive metals in the liner to gunpowder in a cartridge and the tungsten to a bullet. PO Resp. 22–23. With citation to Mr. Church’s testimony, Patent Owner argues that an ordinarily skilled artisan would have expected that a large bullet (i.e., more tungsten) and a small cartridge with less gunpowder (i.e., less aluminum and nickel) would provide less penetration than a large cartridge with a small bullet. *Id.* at 22–23 (citing Ex. 2002, 15–17). On this point, Petitioners reply that Mr. Church acknowledged during his deposition that the bullet analogy does not sensibly describe either Bates’s reactive liners that do not include a further inert

metal (which would be akin to blanks) or high-tungsten non-reactive liners (which would be all bullet and no gunpowder). Reply 17 (citing Ex. 1025, 79:1–12, 81:9–24; Ex. 1003, 4–8).

We agree with Petitioners that the bullet analogy is overly simplistic and unreliable as a model characterizing or predicting the operability of shaped charge liners. Under the bullet analogy, Bates’s embodiment without a further non-reactive metal and the prior art non-reactive liners with large portions of tungsten, such as Reese, would be inoperable. As Petitioners also point out, the purpose of the reactive composition in Bates’s reactive liner is to produce heat, not propulsion. *See* Ex. 1003, 4:13–23; Reply 17 (citing Ex. 2002, 14:13–15). Accordingly, we are not persuaded that the bullet analogy reflects that a skilled artisan would have expected low success in using a large portion of tungsten in a reactive liner.

Patent Owner also argues that the lack of a reasonable expectation of success is demonstrated by “the teaching away of the Schlumberger and Halliburton papers.” PO Resp. 34 (citing Ex. 2009 ¶¶ 8–13). In particular, Patent Owner asserts that publications by engineers at Schlumberger and Halliburton, two industry leaders, discouraged the use of reactive liners in shaped charges. *Id.* at 18–22 (citing Ex. 2006; Ex. 2007 Ex. 2009 ¶¶ 8–12). According to Patent Owner, the Halliburton paper concluded “that reactive metals were deleterious to penetration, and should not be added to a conventional liner.” *Id.* at 18 (citing Ex. 2006). Patent Owner asserts that “Schlumberger concluded that the reactive charges reduced production by from 29 to 66%[, which represents] a strong teaching away from using reactive liners from a credible industry source.” *Id.* at 20.

Although Patent Owner refers to these aspects of the Schlumberger and Halliburton papers as teachings away, none of Petitioners' obviousness challenges relies on either of those papers. Patent Owner does not cite any authority to support that disclosure in a publication that is not among the cited references on which an obviousness challenge is predicated can teach away from a proposed obviousness combination. To the extent the Schlumberger and Halliburton papers discourage the proposed combination, such discouragement would seem to fit more naturally into the secondary considerations analysis as potential evidence of industry skepticism.

In any event, Patent Owner's arguments that the Schlumberger and Halliburton papers discourage using reactive metals in liners do not undermine Petitioners' obviousness arguments based on Bates and Reese. Petitioners' proposed combination begins with Bates, which teaches a reactive liner, as Patent Owner agrees. *See* Ex. 1003, 4:21–23; Tr. 23:15–17. Petitioners' proposed combination only modifies Bates by incorporating the amount of tungsten described in Reese. *See* Pet. 49–50. That certain publications may have cast doubt on the efficacy of reactive liners altogether does not tend to undercut Petitioners' argument that a skilled artisan beginning with Bates's reactive liner would have had a reasonable expectation of success in incorporating the amount of tungsten described in Reese.

For the foregoing reasons, we find that an ordinarily skilled artisan would have been motivated to combine Bates and Reese in the manner recited in claim 1 and would have had a reasonable expectation of success in doing so.

c. Secondary Considerations

Patent Owner argues that secondary considerations of nonobvious, in the form of long felt need, industry skepticism, the failure of others, and commercial success, weigh in favor of patentability. *See* PO Resp. 53–62.

For its evidence of long felt need, industry skepticism, and failure of others, Patent Owner relies on the Schlumberger and Halliburton papers discussed in Section III.D.1.b. above, as explicated by Mr. John Hardesty. PO Resp. 54–59 (citing Ex. 2009 ¶¶ 8–12). Mr. Hardesty has been an employee of Patent Owner since 2005, and his current title is Vice President of Engineering and Product Development. Ex. 2009 ¶¶ 1–2. Mr. Hardesty testifies that the Schlumberger paper shows that there was a long felt but unsatisfied need in the marketplace for shaped charges that create perforation tunnels without a crushed zone of reduced permeability. PO Resp. 54; Ex. 2009 ¶¶ 8–9; Ex. 2007. According to Patent Owner and Mr. Hardesty, the Schlumberger paper also shows that the industry was skeptical that reactive liners would meet that need because Schlumberger’s testing showed reduced productivity for reactive liners compared to conventional charges, and because the Schlumberger paper was critical of Delacour, which discloses a reactive liner. PO Resp. 54–56; Ex. 2009 ¶¶ 10–11; Ex. 2007. As to the Halliburton paper, Mr. Hardesty testifies that it “does not assert worse performance from reactive liner shaped charges, but concludes that there was no statistically measurable advantage in using reactive liner shaped charges; that penetration depth was reduced, and that production (flow performance) ratio was better with conventional charges.” Ex. 2009 ¶ 12 (citing Ex. 2006); *see also* PO Resp. 56–57. Thus, according to Mr. Hardesty, the Halliburton paper buttresses the Schlumberger paper in

that “both discourage the use of reactive liner shaped charges.” Ex. 2009 ¶ 12.

To the extent Patent Owner is correct that the Schlumberger and Halliburton papers represent skepticism of reactive liners generally, that skepticism does not support the nonobviousness of claim 1 over Bates and Reese. See Reply 23 (arguing that “any skepticism expressed in [the Schlumberger and Halliburton papers] is directed to reactive liners in general, rather than the specific features of the ’563 patent”). The difference between claim 1 and Bates is not the use of a reactive liner, because it is undisputed that Bates teaches a reactive liner. See Ex. 1003, 4:21–23; Tr. 23:15–17. As discussed in Section III.D.1.a., the only limitation in claim 1 not taught in Bates is the presence of tungsten “in an amount greater than 40% w/w of the liner.” Patent Owner has not presented persuasive evidence of skepticism, in the Schlumberger and Halliburton papers or elsewhere, as to the efficacy of using tungsten in a reactive liner in an amount within the claimed range. See *In re Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011) (“Where the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention.”).

We also find unpersuasive Patent Owner’s argument that the Schlumberger and Halliburton papers show that at the time of the invention of the ’563 patent, there was a long felt need for, and the failure of others to provide, a shaped charge that creates perforation tunnels without a crushed zone of reduced permeability. The Schlumberger and Halliburton papers both indicate a publication date in 2009. See Ex. 2006, 1, Ex. 2007, 1. The ’563 patent claims priority to a filing date of February 20, 2007. Ex. 1001,

at (30). Patent Owner acknowledges that the Schlumberger and Halliburton papers post-date the claimed invention date of the '563 patent. *See* Tr. 42:5–7. Publications from years after the date of the invention are not probative that at the time of the invention, there was a recognized long felt need in the industry. *See Procter & Gamble Co. v. Teva Pharms. USA, Inc.*, 566 F.3d 989, 998 (Fed. Cir. 2009) (“[W]e look to the filing date of the challenged invention to assess the presence of a long-felt and unmet need.”). Because “[l]ong felt need is analyzed as of the date of an articulated identified problem and evidence of efforts to solve that problem,” the Federal Circuit has discounted arguments of long-felt need when the patentee “provided no evidence to explain how long [the alleged] need was felt, or when the problem first arose.” *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1332–33 (Fed. Cir. 2009) (quoting *Texas Instruments v. U.S. Int’l Trade Comm’n*, 988 F.2d 1165, 1178 (Fed. Cir. 1993)). Those evidentiary shortcomings are also present in Patent Owner’s long felt need argument here.

Moreover, Patent Owner does not present evidence or argument as to why a liner as described in Bates—i.e., a reactive liner formed of nickel and aluminum mixed in stoichiometric quantities, and optionally including tungsten in an unspecified amount (Ex. 1003, 5:30–32, 9:9–21)—would not have fulfilled the alleged need for a cleaner tunnel. Indeed, the evidence of record tends to indicate that it would provide that benefit. Bates teaches that the reactive liner “may help to further distress and fracture the completion. A yet further benefit is that the material of the reactive liner may be consumed such that there is no slug of liner material left in the hole that has just been formed. . . .” Ex. 1003, 10:4–7. As Petitioners point out, the

testing results reported in the '563 patent support that the Bates reactive liner without any tungsten would have provided a tunnel free of debris. *See* Reply 21. Specifically, the '563 patent describes testing of several “reactive liners using only Ni-Al in stoichiometric amounts,” with no tungsten included. Ex. 1001, 12:10–12, Table 1. The '563 patent states that the test results for those samples “show a clear and marked improvement in the percentage of the tunnel which is essentially free from debris, in the range of 92-100%.” *Id.* at 12:15–17.

Turning to commercial success, Patent Owner argues that its “reactive liner shaped charges made and marketed under the '563 patent as ConneX were highly commercially successful,” as shown by a bar graph reflecting sales growth from 2008 to 2017. PO Resp. 59–60 (citing Ex. 2009 ¶ 18). Patent Owner further cites the testimony of its CEO, David Wesson, and Mr. Hardesty. *Id.* at 60–61 (citing Ex. 2004; Ex. 2009). The cited testimony from Mr. Wesson is from the trial in a district court case concerning U.S. Patent No. 9,080,431 B2 (“the '431 patent,” Ex. 1011). Mr. Wesson testified that the sales of ConneX for use in the method of the '431 patent have been commercially successful. Ex. 2004, 64:17–19. Regarding the reasons for that success, Mr. Wesson testified as follows:

Q. Now, is the success of the CONNEX charge just related to the charge itself, or is it mainly related to the method of the '431 patent?

A. I'd say it's related to both.

Q. Which one's more important?

A. It -- it depends on the situation and the well conditions. Some places, they still shoot CONNEX balanced or underbalanced, and some places they shoot CONNEX, like the '431, in a overbalanced without changing pressure condition situation so it depends.

...

Q. And what about marketing, is the success of the '431 patent due to just really good marketing by GEODynamics?

A. You know, I think we have, you know, some marketing, but we're engineers. . . . I don't consider myself a great marketer. I consider myself a great engineer. And the company is a great engineering company so it sells because it's a great product, not because we're great marketers.

Id. at 66:2–25.

Mr. Hardesty “endorse[s] and agree[s] with the testimony provided by Mr. Wesson.” Ex. 2009 ¶ 19. Specifically, Mr. Hardesty agrees that sales are not due to marketing efforts: “In my experience at GEODynamics, we are an engineer-driven company and our sales are driven by technology, not by clever marketing, as in some consumer goods.” *Id.* Mr. Hardesty further testifies that

sales success was due to a combination of features of the reactive liner technology. There is a substantial nexus between these features and invention, as claimed in the '563 patent, including the effects of the exothermic reaction of the two metals combined with the additional inert metal creating clean tunnels and tip fractures.

Id. ¶ 19. According to Mr. Hardesty, “[i]t is my opinion that one of the key features of the reactive liner shaped charges, that has led to commercial success of embodiments of the '563 patent was the addition of a further metal that is non-reactive during perforation operations.” *Id.* ¶ 21.

Patent Owner's commercial success argument is diminished somewhat by the absence of any market share data by which to evaluate its sales figures for ConneX. *In re Applied Materials, Inc.*, 692 F.3d 1289, 1300 (Fed. Cir. 2012) (“[T]he more probative evidence of commercial

success relates to whether the sales represent ‘a substantial quantity in th[e] market.’” (citation omitted)).

More significantly, Patent Owner has not presented sufficient evidence tying success of ConneX to the merits of the invention claimed in the ’563 patent. See Reply 18–19. “Evidence of commercial success is only relevant to the obviousness inquiry ‘if there is a nexus between the claimed invention and the commercial success.’” *In re Affinity Labs of Tex., LLC*, 856 F.3d 883, 901 (Fed. Cir. 2017) (quoting *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1312 (Fed. Cir. 2006)). Determining whether a nexus exists “require[s] consideration of whether ‘the marketed product embodies the claimed features.’” *ClassCo, Inc. v. Apple, Inc.*, 838 F.3d 1214, 1222 (Fed. Cir. 2016) (quoting *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1130 (Fed. Cir. 2000)).

Patent Owner has not presented sufficient evidence that the ConneX product embodies any claim of the ’563 patent. We note Mr. Hardesty’s testimony that the ConneX product was “made and marketed under the ’563 patent” and that the sales success of ConneX “was due to a combination of features of the reactive liner technology. There is a substantial nexus between these features and invention, as claimed in the ’563 patent. . . .” Ex. 2009 ¶¶ 18, 19. However, neither Mr. Hardesty nor any of Patent Owner’s other declarants present explanation or evidence establishing that ConneX includes each limitation of any claim of the ’563 patent. At the hearing, Patent Owner referred to paragraphs 4 and 5 of Mr. Hardesty’s declaration as its evidence that ConneX embodies the claimed invention. Tr. 39:9–40:19, 45:12–14. Yet the cited paragraphs only summarize the disclosure of the ’563 patent; there is no discussion of ConneX. Ex. 2009 ¶¶ 4–5. The

conclusory statements in Mr. Hardesty's declarations do not show that ConneX embodies the '563 patent, and therefore fail to establish a nexus. *See Bosch*, 878 F.3d at 1037 (upholding Board's determination that a declarant's testimony that allegedly commercially successful products embodied the challenged patent was conclusory and lacked foundation); *In re Cree, Inc.*, 818 F.3d 694, 703–04 (Fed. Cir. 2016) (agreeing with the Board that an expert declaration that merely repeats, in conclusory fashion, that the success of the product is due to the claimed invention is insufficient to establish a nexus).⁹

Moreover, Mr. Hardesty's testimony tends to undercut Patent Owner's argument that commercial success was due to the merits of the invention

⁹ We note that the Federal Circuit has recently clarified that neither a limitation-by-limitation analysis nor documentary evidence is required for a Patent Owner to establish that the presumption of a nexus applies. *See Polaris Indus., Inc. v. Artic Cat, Inc.*, __ F.3d __, 2018 WL 797462, at *13 n.7 (Fed. Cir. 2018). In *Polaris*, the court held that the Board erred in failing to find that the products at issue embodied the inventions claimed in the challenged patents because the patentee provided an expert declaration testifying that he had reviewed the patent and the literature associated with the products at issue, compared the products to the claims, and determined based on his "analysis, inspection, and study" that the products embodied each element recited in the challenged claims. *Id.* at *13. The Federal Circuit explained that "[o]ur case law does not require a patentee and its expert to go further than *Polaris* did here . . . to demonstrate that its commercial products are the inventions disclosed in the challenged claims, where the proffered evidence is not rebutted and the technology is relatively simple." *Id.* Here, Mr. Hardesty's declaration does not indicate that he studied the ConneX products and compared them to each element of any claim in the '563 patent. *See* Ex. 2009. Further, Patent Owner's evidence and argument that ConneX embodies the '563 patent is not unrebutted because Petitioners challenged the sufficiency of Patent Owner's showing on this point. *See* Reply 18–19.

claimed in the '563 patent, as opposed to features known in the prior art. Specifically, Mr. Hardesty expresses his opinion that “one of the key features of the reactive liner shaped charges, that has led to commercial success . . . was the addition of a further metal that is non-reactive during perforation operations.” Ex. 2009 ¶ 21. That feature is taught in Bates. See Ex. 1003, 9:9–21.

d. Conclusion Regarding Claim 1

We have weighed Patent Owner’s objective evidence of nonobviousness in the form of long felt need, industry skepticism, the failure of others, and commercial success along with the evidence of obviousness. Based on the evidence in this record, we conclude that there is strong evidence of obviousness and that the weak evidence of nonobviousness does not tip the scale in favor of patentability. Accordingly, we determine that Petitioners have shown by a preponderance of the evidence that claim 1 would have been obvious to a person of ordinary skill in the art based on the combination of Bates and Reese.

2. Analysis of Claims 2–18, 20–26, 28, and 31–34

Petitioners explain how the limitations of claims 2–18, 20–26, 28, and 31–34 are taught by Bates and Reese. See Pet. 51–54, 36–48. Patent Owner does not present any argument to these claims separate from the arguments discussed above regarding claim 1. See Tr. 28:23–29:9.

We are persuaded by Petitioners’ contentions. In particular, we find that Bates teaches the subject matter of claim 2 because it discloses tungsten as the further metal to be included in the liner. See Pet. 36; Ex. 1003, 9:18–21. We find that Bates teaches the subject matter of claims 3–8 because it discloses nickel and aluminum, mixed in stoichiometric quantities, as a

preferred metal-metal composition. *See* Pet. 36–37; Ex. 1003, 5:30–32. We find that Bates teaches the subject matter of claim 9 because it describes that the inert metal can be “mixed and uniformly dispersed within the reactive composition.” Ex. 1003, 9:21–25; Pet. 37–38. We find that Bates teaches the subject matter of claims 10 and 11 because it discloses that “[t]he liner composition may preferably be a pressed particulate composition. . . . To aid consolidation a binder may also be added.” Ex. 1003, at (57); *see also* Pet. 38. We find that Bates teaches the subject matter relating to binders recited in claims 12–16. *See* Pet. 38–39; Ex. 1003, 7:19–28. We find that Bates teaches particulate sizes within the ranges recited in claims 17 and 18. *See* Pet. 39–40; Ex. 1003, 8:2–4. We find that Bates also teaches the limitations recited in claims 20–26 and 28. *See* Pet. 40–43; Ex. 1003, at (57), 10:4–5, 11:11–15, 16:16–24.

We find that Bates teaches each of the limitations of claim 31 except for the “wherein” clause reciting that “the at least one further metal is present in an amount greater than 40% w/w of the liner.” *See* Pet. 43–45; Ex. 1003, 4:20–23, 9:9–25, 10:4–5, 11:17–20. We find that Reese teaches the subject matter of the wherein clause that is not disclosed in Bates. *See* Pet. 52; Ex. 1004, 3:35–38. For the reasons discussed in Section III.D.1., we find that an ordinarily skilled artisan would have been motivated to combine Bates and Reese in the proposed manner and would have had a reasonable expectation of success in doing so. We also find that Bates teaches to a person of ordinary skill in the art the subject matter of claims 32 and 33, which depend from claim 31. *See* Pet. 45–47; Ex. 1003, 4:16–20, 6:24–30; Ex. 1008 ¶ 100.

We find that Bates teaches each of the limitations of claim 34 except for the limitation that the at least one further metal “is present in an amount greater than 40% w/w of the liner.” *See* Pet. 47–48; Ex. 1003, 5:30–32, 9:9–21, 11:17–20. We find that Reese teaches the limitation that is absent from Bates. *See* Pet. 53–54; Ex. 1004, 3:35–38. We find that an ordinarily skilled artisan would have been motivated to combine Bates and Reese in the proposed manner and would have had a reasonable expectation of success in doing so. *See supra* § III.D.1.

Accordingly, we determine that Petitioners have shown by a preponderance of the evidence that claims 2–18, 20–26, 28, and 31–34 would have been obvious to a person of ordinary skill in the art based on the combination of Bates and Reese.

E. Obviousness Challenge Based on Bates, Reese, and Delacour

Petitioners contend that claim 29 is unpatentable under 35 U.S.C. § 103(a) as obvious over Bates, Reese, and Delacour. Pet. 54–55.

Claim 29 recites “[a] method of improv[ing] the clean up of the perforation tunnel, comprising the step of using one or more reactive liners according to claim 1.” Ex. 1001, 14:43–45. Petitioners argue that to the extent Bates and Reese do not explicitly describe cleaning up a perforation tunnel using a reactive liner, it would have been obvious to do so in light of Delacour “since both Bates and Delacour teach reactive liner compositions, and it would be desirable to remove debris formed as a result of the perforating explosion to improve flow from the perforations, as described by Delacour.” Pet. 54–55.

We are persuaded by Petitioners’ contentions. We note that claim 29 is quite broad, in that it simply requires using one or more reactive liners

according to claim 1 in a method of improving perforation tunnel clean up. Neither party proposes a construction for what improving the clean up means, or what the improvement is relative to. Delacour's teachings that an additional exothermic reaction separate from the explosion of the charge can provide a cleaner tunnel echoes similar teachings in Bates. *See* Ex. 1005, 1:40–48; Ex. 1003, 10:4–8. Petitioners' stated reason for combining Delacour with Bates and Reese—to improve flow from the perforations by removing debris from the explosion (Pet. 54)—is based on rational underpinnings.

We have considered Patent Owner's rebuttal arguments, but we do not find them persuasive. *See* PO Resp. 35–41. To the extent Patent Owner's rebuttal relies on the same arguments discussed above in Section III.D.1., those arguments are unpersuasive for the reasons already discussed. *See id.* at 40–41 (presenting bulleted list and referring back to earlier portions of brief). Aside from those arguments, Patent Owner also argues that “[t]here is simply no similarity” between Delacour and the '563 patent because “Delacour's teachings differ significantly from that of the '563 patent.” *See* PO Resp. 38–39. Specifically, “the ‘mixtures’ suggested in Delacour are different from the listings of metals in the '563 patent.” *Id.* at 39. This argument does not identify any limitation in claim 29 that is absent from the proposed combination.¹⁰ Arguments regarding differences in the teachings of the '563 patent and Delacour do not address the challenge Petitioners have presented.

¹⁰ Indeed, Patent Owner does not appear to recognize that claim 29 is the sole claim challenged in this ground. The heading for this section of the Patent Owner Response mistakenly lists claims 1–18, 20–26, 28, and 30–34, and claim 29 is never referred to in this section. *See* PO Resp. 35–41.

Patent Owner further argues that Delacour is an example of a failed attempt to satisfy the long felt need for a perforation tunnel free of the crushed zone. *Id.* at 36–38. In this regard, Patent Owner points to Mr. Hardesty’s testimony concerning the Schlumberger paper, in which he states that the Schlumberger paper found that reactive liners reduced productivity compared to conventional charges. *Id.* at 37 (citing Ex. 2009 ¶¶ 8–10). Mr. Hardesty further testifies that the Schlumberger paper discussed Delacour and “characterized the Delacour charges as reactive shaped charges that ‘significantly pressurize the surrounding materials,’ but [the Schlumberger paper went] on to point out, at page 2, that while increased pressure is considered ‘desirable,’ it is important to know when and where the reaction occurs.” Ex. 2009 (citing Ex. 2007, 1–2). We agree with Petitioners that, because the Schlumberger paper was published years after the filing date claimed by the ’563 patent, the Schlumberger paper sheds little light on “a POSA’s thinking at the time of invention, or a POSA’s willingness to combine articles of prior art.” Reply 15. Moreover, the discussion of Delacour in the Schlumberger paper simply reflects, as Mr. Hardesty notes, “some recognition that not all reactive liner shaped charges are the same: the charge must appropriately provide the increased pressure at the right time and place.” Ex. 2009 ¶ 10; *see also* Ex. 2007, 1–2. This discussion does not support Patent Owner’s argument that the Schlumberger paper considered Delacour a failure. The role of Delacour in Petitioners’ proposed combination is to teach that reactive liners can provide a cleaner tunnel. Neither Patent Owner nor Mr. Hardesty explain why the Schlumberger paper’s discussion of Delacour rebuts Petitioners’ use of Delacour in the proposed combination.

F. Obviousness Challenge Based on Bates and Bourne

Petitioners contend that claims 1–18, 20–26, 28, and 31–34 are unpatentable under 35 U.S.C. § 103(a) as obvious over Bates and Bourne. Pet. 55–64.

The issues and arguments in this ground are very similar to those discussed in Section III.D. regarding the challenge based on Bates and Reese. As in the Bates and Reese combination, Petitioners rely on Bates to teach all the elements of claim 1 except for the amount of the “further metal” exceeding 40% by weight. *See id.* at 57–59. In this ground, Petitioners rely on Bourne for that limitation. *Id.* at 58–59 (citing Ex. 1006, 2:15–16). Petitioners argue that a skilled artisan would have looked to Bourne for an understanding of how much non-reactive material to combine with Bates’ reactive metals, given Bates’ teaching to include non-reactive metal in an unspecified amount. *Id.* at 57. Petitioners point out that Bates and Bourne share a common inventor. Pet. 56. Petitioners’ declarant, Dr. Walters, testifies that because Bates does not specify the amount of tungsten to be used, a skilled artisan would have been motivated to consult other references for the amount, and another publication by one of Bates’ inventors would be a natural source to consult. Ex. 1008 ¶¶ 118–119. Dr. Walters further testifies that it would have been obvious to use the amount of tungsten disclosed in Bourne with the reactive composition taught in Bates “to provide ‘increased strength and hence a more powerful jet,’ as taught by Bates (Ex. 1003, 9:18–21), and to provide increased depth of penetration, as provided by Bourne I (Ex. 1006, at 2).” *Id.* ¶ 120.

We find Petitioners’ contentions persuasive. As discussed in Section III.D.1.a., Petitioners have shown that Bates teaches each limitation of claim

1 except for the presence of the further metal “in an amount greater than 40% w/w of the liner.” We find that Bourne teaches that missing limitation. *See* Pet. 58–59; Ex. 1006, 2 (disclosing “a liner for a shaped charge having a composition comprising greater than 90% by weight of powdered tungsten”). Bourne also teaches that “[t]ungsten has a high density and so by using a liner that comprises greater than 90% by weight tungsten the penetration depth is improved. . . .” Ex. 1006, 2. This teaching supports Petitioner’s asserted motivation for the combination. *See* Pet. 57; Ex. 1008 ¶ 120. We find that Petitioners have presented a reason to combine that is supported by rational underpinnings—namely, that a skilled artisan would have been motivated to include the amount of tungsten Bourne teaches in the Bates liner to provide a more powerful jet and to increase depth of penetration. Ex. 1008 ¶ 120; Ex. 1003, 9:18–21; Ex. 1006, 2. We also find that an ordinarily skilled artisan would have had a reasonable expectation of success in making the proposed combination, for largely the same reasons discussed above in Section III.D.1.b.

Patent Owner’s rebuttal arguments on this ground are the same as its arguments against the Bates and Reese ground, and those arguments are unpersuasive for the same reasons discussed in Section III.D.1. *See* PO Resp. 41–53. Apart from its repeated arguments, Patent Owner also argues that the absence of disclosure in Bates regarding the amount of tungsten shows that “Bates did not realize the import of a non-reactive metal added to a reactive metal liner at an amount in excess of 40 wt. %.” *Id.* at 43; *see also id.* (“[I]t would have been very easy at the time of preparing the Bates application to add the requirement of ‘greater than 40 % of the non-reactive metal’ liner component.”). We are not persuaded that Bates’s nondisclosure

of the amount of tungsten demonstrates the nonobviousness of the claimed range over Bates and Bourne. Indeed, Patent Owner's argument only shows why Bates is offered as part of an obviousness combination rather than as an anticipatory reference. *See CRFD Research, Inc. v. Matal*, 876 F.3d 1330, 1345 (Fed. Cir. 2017) (holding that a finding that a reference does not anticipate a claim is insufficient as a matter of law to decide that the claim is nonobvious over that reference).

Petitioners have also shown how Bates and Bourne teach the limitations of claims 2–18, 20–26, 28, and 31–34. *See* Pet. 59–64. Specifically, as discussed in Section III.D.2., we find that Bates teaches the subject matter of claims 2–18, 20–26, 28, 32, and 33, and each limitation of claims 31 and 34 except for the presence of at least one further metal “in an amount greater than 40% w/w of the liner.” We further find that Bourne teaches the limitations in claims 31 and 34 that are absent from Bates. *See* Pet. 62, 64; Ex. 1006, 2.

Accordingly, we determine that Petitioners have shown by a preponderance of the evidence that claims 1–18, 20–26, 28, and 31–34 would have been obvious to a person of ordinary skill in the art based on the combination of Bates and Bourne.

G. Obviousness Challenge Based on Veehmayer and Bates

Petitioners contend that claims 1–26, 28, and 30–34 are unpatentable under 35 U.S.C. § 103(a) as obvious over Veehmayer and Bates. Pet. 31–48.

We are persuaded by Petitioners' contentions, which Patent Owner does not dispute, that Bates and Veehmayer together teach every limitation of claim 1. *See* Pet. 17–18, 21, 31–35; Tr. 28:15–22. As discussed above in

Section III.D.1.a., Petitioners have shown, and Patent Owner agrees, that Bates teaches every limitation of claim 1 except for the presence of at least one further metal “in an amount greater than 40% w/w of the liner.” *See* Pet. 31–34; Tr. 28:19–21. As to the limitation of claim 1 that is absent in Bates, we agree with Petitioners that Veehmayer discloses a shaped charge liner including 70 to 85% by weight tungsten, thereby teaching that the “further metal is present in an amount greater than 40% w/w of the liner,” as recited in claim 1. *Id.* at 17–18, 21, 34 (citing Ex. 1002 ¶ 11).

We are also persuaded by Petitioners’ contentions that Bates and Veehmayer together teach every limitation of claims 2–26, 28, and 30–34. *See* Pet. 21–31, 36–48. Patent Owner does not present any argument to these claims separate from its arguments for claim 1. *See* Tr. 28:23–29:9. As discussed in Section III.D.2., we find that Bates teaches the subject matter of claims 2–18, 20–26, 28, 32, and 33, and each limitation of claims 31 and 34 except for the presence of at least one further metal “in an amount greater than 40% w/w of the liner.” We further find that Veehmayer teaches the limitations in claims 31 and 34 that are absent from Bates. *See* Pet. 28, 30–31; Ex. 1002 ¶ 11. Veehmayer also teaches the subject matter of claims 19 and 30. *See* Pet. 25, 26; Ex. 1002 ¶¶ 3, 11.

We further find that Petitioners have presented a reason to combine that is supported by rational underpinnings. As Petitioners point out, both Veehmayer and Bates “seek to achieve similar results of providing improved perforating of wells.” Pet. 34 (citing Ex. 1008 ¶¶ 102–104); Ex. 1002 ¶ 7; Ex. 1003, 11:17–21. The record supports Petitioners’ argument that Bates teaches that penetration depth is “a critical factor in completion engineering” and that the purpose of adding a further, non-reactive metal such as tungsten

in a reactive liner is to increase the penetrative power of the jet. Reply 9 (citing Ex. 1003, 11:4–5, 9:13–15). The evidence also supports Petitioners’ argument that Veehmayer “recognize[s] the enhanced tunnel perforation depth offered by higher amounts of tungsten, a high-density material.” *Id.*; *see also* Ex. 1002 ¶ 4 (“In order to achieve greater penetration depths, it is proposed in the relevant literature to select as high a density as possible for the liner material. From an economic standpoint, therefore, tungsten in particular lends itself as a material for powder-metal shaped charge liners. . . .”). Considering that both references have the same goal of maximizing flow by providing a large diameter hole with deep penetration (Ex. 1002 ¶ 7; Ex. 1003, 2:14–16, 10:4–8, 11:17–21), and considering further that both references teach the use of tungsten to enhance penetration depth (Ex. 1002 ¶ 4; Ex. 1003, 9:13–21), we find persuasive Petitioners’ argument that an ordinarily skilled artisan would have been motivated to employ the amount of tungsten taught in Veehmayer in Bates’s liner and would have had a reasonable expectation of success in doing so. *See* Reply 9.

We have considered Patent Owner’s rebuttal arguments (*see* PO Resp. 13–32), but those arguments are the same as discussed above in connection with the ground based on Bates and Reese and are unpersuasive here for the same reasons. *See supra* § III.D.1.b.

Accordingly, we determine that Petitioners have shown by a preponderance of the evidence that claims 1–26, 28, and 30–34 would have been obvious to a person of ordinary skill in the art based on the combination of Veehmayer and Bates.

III. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–26 and 28–34 have been shown to be unpatentable; and

FURTHER ORDERED that parties to the proceeding seeking judicial review of this Final Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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