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Paper 11
Entered: March 8, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

GEODYNAMICS, INC.,
Patent Owner.

Case IPR2017-02008
Patent 8,220,394 B2

Before BEVERLY M. BUNTING, TIMOTHY J. GOODSON and ROBERT J. SILVERMAN, *Administrative Patent Judges.*

SILVERMAN, *Administrative Patent Judge.*

DECISION
Denying Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

Petitioner filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–6, 11–26, and 28 (the "challenged claims") of U.S. Patent No. 8,220,394 B2 (Ex. 1001, "the '394 patent"). Patent Owner filed a Preliminary Response to the Petition. Paper 8 ("Prelim. Resp.").

We have authority under 35 U.S.C. § 314, which provides that an *inter partes* review may not be instituted "unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." We decide whether to institute an *inter partes* review on behalf of the Director. Upon consideration of the Petition and Patent Owner's Preliminary Response, and for the reasons explained below, we determine that Petitioner has not demonstrated that there is a reasonable likelihood that the challenged claims are unpatentable. Accordingly, we do not institute an *inter partes* review of any of the challenged claims of the '394 patent.

A. Related Matters

The parties state that Patent Owner is asserting the '394 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. 2:17-cv-00371. Pet. 6; Paper 4, 2. The parties do not list any related proceedings before the Board.

B. The '394 Patent (Ex. 1001)

The '394 patent relates to a reactive shaped-charge liner for a perforator used in oil and gas well completions. Ex. 1001, Abstract, 1:5–7. The process of carrying out a completion involves providing a flow path between the well bore and the surrounding formation (also known as the production zone). *Id.* at 1:11–14. Typically, such a flow path is formed

with the use of a perforator that employs a shaped charge of energetic material in the process of perforation — i.e., creating an opening in the casing of the well bore that extends into the formation. *Id.* at 1:15–20. The '394 patent provides the following description of a shaped-charge perforator:

> 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. The liner may be hemispherical but in most perforators is generally conical. The liner and energetic material are usually encased in a metallic housing.

Id. at 1:29–41.

Figure 1 of the '394 patent is reproduced below:

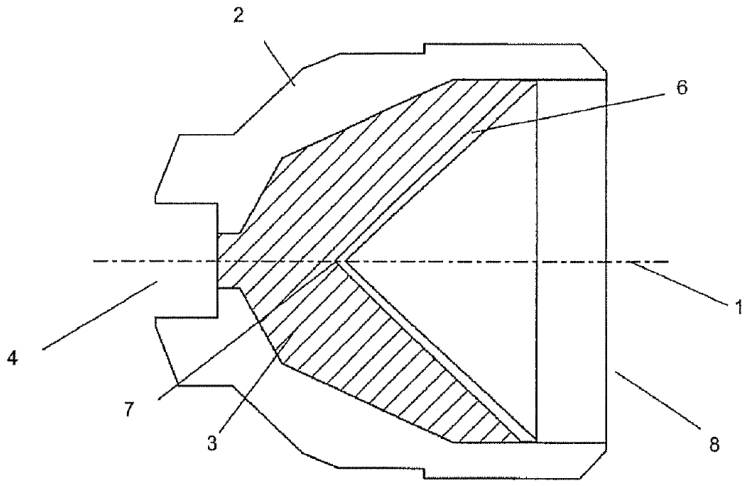

Figure 1 is a cross-sectional view of a shaped charge that includes a substantially cylindrical housing 2, a liner 6 that fits closely in the open end

8 of the cylindrical housing 2, and high explosive material 3 within the volume enclosed between the housing and the liner. *Id.* at 7:7–16. Typically, a detonator or detonator transfer cord is located in recess 4 and is used to initiate the high explosive material. *Id.* at 7:16–20.

The '394 patent states that one aspect of the invention is to provide a liner material that is capable of an exothermic reaction upon activation of the explosive material, which can provide thermal energy — in addition to the kinetic energy of the jet — that can be directed into the target substrate and may help to further distress and fracture the completion, so as to improve fluid outflow. *Id.* at 2:31–35, 50–60, 4:5–7, 6:6–8, 54–60. Another benefit of the reactive liner is that the liner material may be consumed, such that there is no slug of liner material left in the hole formed by the perforation. *Id.* at 8:8–11. Such an exothermic reaction of the liner can be achieved with a 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 2:61–3:3. The preferred metal-metal compositions identified in the '394 patent are the combinations of nickel with aluminum and palladium with aluminum. *Id.* at 3:45–48. Further, according to the '394 patent, the liners give particularly effective results when the two metals are provided in "proportions calculated to give an electron concentration of 1.5, that is a ratio of 3 valency electrons to 2 atoms such as in NiAl or PdAl." *Id.* at 3:52–56, 7:27–36. The '394 patent states that testing has shown NiAl to give particularly good results. *Id.* at 7:46–47.

Another aspect of the invention is the use of a further metal, in the liner, which is considered to be inert and does not participate in the exothermic reaction when the shaped charge is activated. *Id.* at 5:43–46.

The addition of inert metal provides additional mechanical strength to the liner and increases the penetrative power of the jet. *Id.* at 5:49–51, 55–59. Tungsten and copper have high density and ductility, which makes them desirable materials for this purpose. *Id.* at 5:51–55.

C. Illustrative Claim

Of the challenged claims, claims 1 and 28 are independent. Claims 2–6 and 11–26 depend, directly or indirectly, from claim 1. Claim 1 is representative of the challenged claims, and is reproduced below (with line breaks and indentations added):

> 1. A reactive, oil and gas well shaped charge perforator comprising
>
> a liner and an associated shaped charge,
>
> whereby the liner is a green compacted particulate composition formed from a powder mixture comprising at least two metal elements, and
>
> whereby the liner is reactive such that the at least two metal elements will undergo an intermetallic alloying reaction to give an exothermic reaction upon activation of the associated shaped charge, and
>
> in which the at least two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5, and
>
> wherein the composition further comprises at least one further inert metal,
>
> wherein the at least one further inert metal is not capable of an exothermic reaction with the at least two metal elements upon activation of the shaped charge liner.

Ex. 1001, 7:64–8:10.

D. Grounds Asserted

Petitioner asserts the following grounds of unpatentability:

References	Basis	Claims Challenged
Liu[1] and Fischer[2]	§ 103	1–3, 17–26, and 28
Liu and Theis[3]	§ 103	1–3, 17–26, and 28
Liu and Becker[4]	§ 103	1–4, 6, 12, 17–26, and 28
Liu, Fischer, and Reese[5]	§ 103	4, 5, and 11
Liu, Fischer, and Bourne[6]	§ 103	12, 13, and 14
Liu, Fischer, and Lussier[7]	§ 103	15 and 16

In addition to the references listed above, Petitioner relies on the declaration of Dr. William Place Walters (Ex. 1013).

II. ANALYSIS

A petition must show how the construed claims are unpatentable under the statutory ground it identifies. 37 C.F.R. § 42.104(b)(4). Petitioner bears the burden of demonstrating a reasonable likelihood that Petitioner

[1] U.S. Patent No. 7,393,423 B2, issued July 1, 2008, Ex. 1004.
[2] S.H. Fischer and M.C. Grubelick, *A Survey of Combustible Metals, Thermites, and Intermetallics for Pyrotechnic Applications*, Paper No. SAND95-2448C (July 1996), Ex. 1005.
[3] FR2749382 A1, published December 5, 1997, Ex. 1006 (includes certified English translation). Citations to Theis, herein, refer to the English translation.
[4] WO 01/77607 A1, published October 18, 2001, Ex. 1007.
[5] U.S. Patent No. 7,011,027 B2, issued March 14, 2006, Ex. 1008.
[6] WO 03/042625 A1, published May 22, 2003, Ex. 1009.
[7] U.S. Patent No. 6,668,726 B2, issued December 30, 2003, Ex. 1010.

would prevail with respect to at least one challenged claim for a petition to be granted. 35 U.S.C. § 314(a).

A. Claim Construction

We interpret the claims of an unexpired patent using the broadest reasonable interpretation in light of the specification of the patent. 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). Under this standard, a claim term generally is given its ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definitions for claim terms or phrases must be set forth with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). In the absence of such a definition, limitations are not to be read from the specification into the claims. *See In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993).

Petitioner (*see* Pet. 14–16) and Patent Owner (*see* Prelim. Resp. 52–55) advance different constructions of the claim term "two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5," which appears in each of the independent claims 1 and 28. Petitioner contends that this claim language is unclear, but is nevertheless capable of being construed, to the extent that the limitation is, at least, satisfied by stoichiometric combinations of aluminum/nickel and aluminum/palladium. Pet. 15–16. For the purpose of evaluating the Petition, Patent Owner does not dispute the use of this construction. Petitioner's position appears to be consistent with the '394 patent's

Specification, Patent Owner's statements during prosecution of the '394 patent, and Patent Owner's infringement contentions in district court litigation involving the '394 patent. *See id.* at 14–16. Accordingly, we adopt Petitioner's proposed construction of this claim term. Specifically, we adopt Petitioner's position that the claim term — i.e., "two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5" — is satisfied by stoichiometric combinations of aluminum/nickel and aluminum/palladium. *See* Pet. 15–16.

Additionally, Petitioner contends that the following language of independent claims 1 and 28 is unclear: "at least one further inert metal, wherein the at least one further inert metal is not capable of an exothermic reaction with the two metal elements." *Id.* at 16. Nevertheless, Petitioner contends that this claim language is capable of being construed, to the extent that the limitation is, at least, satisfied by the '394 patent's exemplary "inert" metals of tungsten and copper. *Id.* For the purpose of evaluating the Petition, Patent Owner does not dispute the use of this construction. In the absence of a dispute, we adopt Petitioner's proposed construction of this claim term. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.") Specifically, we adopt Petitioner's position that the claim term — i.e., "at least one further inert metal, wherein the at least one further inert metal is not capable of an exothermic reaction with the two metal elements" — is satisfied by copper and tungsten. *Id.* at 16.

Finally, Patent Owner provides a construction of the term "green compacted particulate composition," which appears in independent claims 1

and 28. Prelim. Resp. 51–52. However, Patent Owner does not dispute that the Liu reference, which Petitioner relies upon for teaching the limitation (*see, e.g.*, Pet. 17, 29), satisfies the "green compacted" limitation. Accordingly, an express construction of this claim term is not "necessary to resolve the controversy." *Vivid Techs.*, 200 F.3d at 803.

B. Legal Standard for Obviousness

A claim is unpatentable under § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc*., 550 U.S. 398, 406 (2007). 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 skill in the art; and (4) when in evidence, objective indicia of non-obviousness (i.e., secondary considerations). *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). "To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

An obviousness analysis that involves a combination of references must be supported by a reason, based upon rational underpinnings, why a person of ordinary skill would have been motivated to combine the prior art to achieve the claimed invention. *In re Nuvasive, Inc.*, 842 F.3d 1376, 1381–82 (Fed. Cir. 2016); *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)

(cited with approval in *KSR*, 550 U.S. at 418). The requirement of a reason to combine is a safeguard against hindsight bias, which is characterized by the "temptation to read into the prior art the teachings of the invention in issue." *KSR*, 550 U.S. at 421 (quoting *Graham*, 383 U.S. at 36).

C. Asserted Obviousness over Liu and Fischer

Petitioner challenges the patentability of claims 1–3, 17–26, and 28 under 35 U.S.C. § 103(a) as obvious over Liu and Fischer. Pet. 16–41. Relying on the testimony of Dr. Walters, Petitioner alleges that the combined references teach or suggest all the limitations of these challenged claims and that a person of ordinary skill in the art would have combined the references, so as to achieve the claimed subject matter. *Id*. Patent Owner disputes that the cited references teach or suggest all of the limitations of the challenged claims and that a person of ordinary skill in the art would have combined the references in the manner Petitioner alleges. Prelim. Resp. 2–3, 6–8, 10–17, 22–28, 33–37, 43–47, 55–56. We begin our analysis with a brief summary of these references, and then address the parties' contentions in turn.

1. Summary of Liu

Liu discloses the use of perforators that may be used in the oil and gas industry, typically having a machined steel case, a liner, and an explosive contained between the case and the liner. Ex. 1004, 2:35–41. When used inside an oil well, upon the detonation of the explosive, such liners become a high-velocity jet that penetrates into a hydrocarbon formation, thereby creating a perforation surrounded by a hardened, "crushed zone" (being less permeable than the formation itself) that hinders the flow of hydrocarbons into the oil well. *Id.* at 2:41–48. Liu addresses this problem, through its

disclosure of liners made of energetic material. *Id.* at 6:16–21. Liu discloses that the energetic material (such as aluminum) may be driven (in a molten state) into the perforation, by the action of the explosive, such that the energetic liner material undergoes an oxidation reaction with water, where it creates a second explosion within the perforation that releases a large amount of heat, pressure, and hydrogen gas, which make multiple fractures in the formation. *Id.* at 5:46–6:47; 19:35–37; 20:4–9, 29–63; 25:27–26:8. Liu also discloses liners that include inert metals, such as tungsten, iron, tin, copper, and lead that increase the density of the jet exiting the perforator case, so as to increase the depth of the jet's penetration depth into the formation. *Id.* 24:42–49; 26:15–56.

2. Summary of Fischer

Fischer discloses a listing of reactions involving metals — specifically metal combustion (metal oxidation reactions), thermites (reactions between metals and metal oxides), and intermetallics (reactions between two metals), including the state of reaction products and the amount of heat produced. Ex. 1005, 1, 5–23. Among the intermetallic reactions, included in Fischer's Table 2, are reactions between: aluminum and lithium, aluminum and nickel, and aluminum and palladium. *Id.* at 9. Fischer states that applications for intermetallic materials is their use in "shaped-charge liners." *Id.* at 1.

3. Discussion

Petitioner contends that Liu teaches all of the limitations of independent claims 1 and 28 (*see id.* at 16–18), except that "Liu does not expressly describe 'at least two metal elements . . . provided in respective proportions calculated to give an electron concentration of 1.5'" (*id.* at 19).

Petitioner turns to Fischer for this claim element, specifically the teachings in Fischer regarding the use in shaped liners of "intermetallic reactants including stoichiometric quantities of aluminum and nickel (Al + Ni) and aluminum and palladium (Al + Pd)." *Id.* (citing Ex. 1005, 1, 9; Ex. 1013 ¶¶ 54–56). As discussed above (Section II.A), this claim limitation is construed herein, such that it is satisfied by stoichiometric combinations of aluminum/nickel and aluminum/palladium.

Petitioner advances three arguments for why a person of ordinary skill in the art would have combined Liu and Fischer.

First, Petitioner contends that a person of ordinary skill would have employed Fischer's teaching of an intermetallic reaction between nickel and aluminum, as one of the "predictable alternatives to lithium in exothermic reactions with aluminum." Pet. 20–21.

Second, Petitioner argues that each of Liu and Fischer teaches, suggests, or motivates the combination. Pet. 22–23. Specifically, "Liu teaches that part of aluminum powder in a liner composition can be replaced with 'other materials that can be generally classified as 'fuel', such as magnesium, lithium, zirconium, silicon, boron, etc.'" Pet. 22 (citing Ex. 1004, 20:47–49). Fischer, Petitioner argues, "serves as a reference catalogue that provides those other options for intermetallic 'fuels' that react in the presence of aluminum." Pet. 22 (citing Ex. 1005, 2, 9). "Thus," according to Petitioner, "one of ordinary skill in the art following the instruction in Liu to use additional metals in combination with aluminum would have consulted Fischer to select additional reactants for the aluminum-based, intermetallic, reactive shaped charge liners of Liu." Pet. 22. Conversely, Petitioner argues that Fischer "encourages the use of the exothermic

reactions in the oil and gas industry," because Fischer states that "[a]pplications for intermetallic reactions include . . . shaped-charge liners." Pet. 22–23 (quoting Ex. 1005, 1).

Third, Petitioner argues that the proposed combination of Liu and Fischer would have been "obvious to try," based upon Liu's identification of a need for perforators having shaped-charge liners that could provide additional thermal energy, from a reaction involving liner material — a need that Petitioner states was "confirmed by" the challenged '394 patent. Pet. 23 (citing Ex. 1004, 6:16–21; Ex. 1001, 2:50–53). In support, Petitioner asserts that "Liu teaches the use of aluminum and other metal elements like lithium to create a shaped charge liner that will react exothermically upon detonation of the associated charge." Pet. 24. Petitioner further states that "Liu teaches an intermetallic reaction between aluminum and a metal fuel" (*id.* at 25 (citing Ex. 1004,[8] 6:16–21; Ex. 1013 ¶ 82)) and "Liu teaches the use of an exothermic, intermetallic reaction" (*id.* (citing Ex. 1013 ¶ 83)). "Thus," Petitioner concludes, "starting with Liu's reactive liner employing aluminum and an additional 'fuel,' it would have been obvious to try additional well-known and predictable reactive combinations with aluminum, such as the aluminum/nickel metal fuel combination disclosed in Fischer." Pet. 25.

In response, Patent Owner, relying upon the testimony of its expert, Lawrence Behrmann (Ex. 2023), contends that the references do not teach or suggest certain limitations and that a person of ordinary skill in the art would not have combined the references in the manner asserted by Petitioner. *See* Prelim. Resp. 2–3, 6–8, 10–17, 22–28, 33–37, 43–47, 55–56. In particular,

[8] We understand Petitioner's "*id.*" citation (Pet. 25), which accompanies the passage of the Petition quoted here, to refer to Liu.

Patent Owner contends that Liu fails to teach the "liner" recited in claim 1, in which "the at least two metal elements will undergo an intermetallic alloying reaction to give an exothermic reaction." *See id.* at 2–3, 6–8, 10–12, 16, 26, 33–43, 55–56, Ex. 2023 ¶¶ 45, 50, 57, 59. Yet, Petitioner also relies upon Fischer for this claim element (*see* Pet. 30, 39) and Patent Owner does not dispute that Fischer teaches exothermic intermetallic reactions (*see* Prelim. Resp. 3–4, 21, 27, 34, 37).

Additionally, Patent Owner contends that Petitioner's reasons for combining the references rely on improper hindsight, and that combining Liu with Fischer, in the manner asserted by Petitioner, fails to show a predictable result with a reasonable chance of success. Prelim. Resp. 22–28. Patent Owner contends that unexpected results achieved by the subject matter of claim 1 support nonobviousness. *Id*. at 22–24. Patent Owner supports this position with a declaration submitted during prosecution of the '394 patent. *Id.* at 23 (citing Ex. 2002, 98–99; Ex. 2006). In addition, relying on the testimony of Mr. Behrmann, Patent Owner explains that "[t]he experimental results showed advantages in both a substantial increase in 'entry hole size' and 'tunnel volume' and '100% tunnel cleanup' nowhere predicted in any prior art reference in Grounds 1–6, alone or in combination, as well as with respect to the 'unexpected' results of an 'expanded tip' to the perforation tunnel which enhances fluid flow." *Id*. at 24 (citing Ex. 2023 ¶ 37).

We agree with Patent Owner that Petitioner has not shown a sufficient reason with rational underpinnings explaining why a person of ordinary skill in the art would have combined the teachings of Liu and Fischer in the manner recited in independent claims 1 and 28 of the '394 patent.

Each of the three reasons presented, for combining Liu with Fischer, relies upon Petitioner's assertion that Liu teaches an intermetallic alloying reaction between aluminum and lithium. *See* Pet. 20–22, 24–25; *see also id.* at 42, 53 (referring to the reasons for combining Liu and Fischer and the reaction of "aluminum/lithium as disclosed in Liu" and stating that "Liu instructs that aluminum can be combined with 'fuel.'") Indeed, Petitioner does not provide any alternative explanation with technical reasoning as to how the reaction of materials in Liu's liner might be combined with the intermetallic reaction of Fischer, in order to achieve the claimed subject matter.

Yet, as Patent Owner points out, Petitioner's evidence does not support the assertion that Liu involves an intermetallic alloying reaction. *See* Prelim. Resp. 2–3, 6–8, 10–12, 16, 26, 33–43, 55–56. The portion of Liu that Petitioner relies upon for such teaching (*see* Pet. 17, 20, 22 (citing Ex. 1004, 20:47–49)) instead discloses the reaction of aluminum and other materials with water — not the reaction of such materials with each other, as Petitioner contends. The identified portion of Liu concerns some "variations" to the preferred embodiments, wherein "a part of aluminum is replaced by other materials that can be generally classified as 'fuel', such as magnesium, lithium, zirconium, silicon, boron, etc." Ex. 1004, 20:29, 47–49. Indeed, Liu goes on to explain:

> So far in the specification of this invention, the use of aluminum is preferred as a fuel in the aluminum-water reaction. However, other light metals can also be used in place of aluminum without departure from the spirit of the present invention. Such substitutes include but are not limited to: aluminum in its alloy form with other metals, such as aluminum alloyed with magnesium, aluminum-lithium alloy, magnesium and its alloys, etc. The said substitutes can also be used in a

> surplus amount in stoichiometry to mix with high explosives or oxidizers in the purpose to produce molten metal and to react with water. Similarly, water solution of oxidizers can also be used in place of plain water so that its reactivity with the said substitute molten metal can be increased, as will be described in the present invention.

Ex. 1004, 20:50–63. *See* Prelim. Resp. 10–12, 33–37. Liu's "fuel" — aluminum (or the various "substitutes" that "replace[ ]" aluminum) — following the detonation of an explosive, becomes "molten metal . . . to react with water." Ex. 1004, 20:47–60. *See* Prelim. Resp. 10–12, 33–37. Other portions of Liu reinforce the determination that the disclosed liner materials are the "fuel[s]" that react with ambient water, as opposed to the liner materials themselves undergoing an intermetallic alloying reaction with each other. *See* Ex. 1004, Abstract ("A chemical reaction between molten aluminum and an oxygen carrier such as water to do useful work is disclosed"), 1:8–11 ("The present invention relates to the use of aluminum in general, and in particular to the chemical reaction between molten aluminum and an oxygen carrier such as water to do useful work in engineering"); 1:37–42 ("The present invention uses aluminum's reactivity in its molten form with some commonly seen oxygen-carrying chemicals like water or metal oxides. When Al is heated to above its melting point (660° C.), it reacts with water and gives off a large amount of energy. In such a reaction molten aluminum is fuel, and water functions as an oxidizer."); 11:3–6 ("[T]he use of the present invention creates a 'dual-explosion'. The first explosion is from the reaction of the explosive device, and the second being the Al-H_2O reaction."); 22:10–12 ("Once molten aluminum is produced by an explosive device in the presence of water, an Al-H_2O reaction will immediately follow the actuation of the said explosive

device."); 32:38–40 ("Here in the reaction both the fuel (Al in molten state) and the oxidizer (water) are in liquid form."); 39:29–31 ("The presence of water in the drillhole is a prerequisite to use the Al-H_2O reaction and to create the secondary explosive event.")

As Patent Owner explains (*see* Prelim. Resp. 6–8), beyond these differences between the chemical reactions involved in Liu and those in Petitioner's proposed combination with Fischer (so as to achieve the subject matter of independent claims 1 and 28 of the '394 patent), there are also differences in their physical operations. Each of claims 1 and 28 of the '394 patent recites a reaction of two metals in the liner: "the liner is reactive such that the at least two metal elements will undergo an intermetallic alloying reaction." Ex. 1001, 8:1–3, 9:12–10:2. By contrast, Liu's disclosed use of its embodiments, for oil/gas exploration, involve a jet of molten liner material propelled into a perforation created in the hydrocarbon-bearing formation, such that "a layer of molten aluminum 100 [is] applied right on top of the crushed zone" within the perforation. Ex. 1004, 25:39–40, Fig. 9. "Immediately after perforating," Liu continues,

> there is a pressure increase in the well due to the release of a substantial amount of detonation products from the charges. Consequently, water 110 in the well is forced to enter the perforation 80, reacting explosively with the molten aluminum 100 there.

Ex. 1004, 25:40–45, Fig. 9. Liu states that "[t]he energetic Al-H_2O reaction in the small perforation releases a large amount of heat and hydrogen gas, and generate a pressure pulse," such that "[a]fter the explosion, the layer of molten aluminum in the perforation is consumed, the crushed zone 90 is pulverized and multiple fractures 120 are created in the formation." *Id.* at 26:3–8, Fig. 10; *see also id.* at 5:46–6:47. Thus, as Patent Owner explains

(Prelim. Resp. 6–8), unlike claim 1 of the '394 patent (where the liner itself includes two reactants that undergo an alloying reaction), the embodiments of Liu that Petitioner relies upon involve one reactant in the liner and another reactant in the ambient environment, wherein the pressure caused by the detonation brings the two reactants together in a perforation that undergo an oxidation reaction that releases hydrogen gas.

In view of the different respective chemical reactions involved in Liu and Fischer, we are persuaded by Patent Owner's arguments (*see* Prelim. Resp. 6–8, 10–12, 33–37) that combining these references does not entail the more straightforward matter of replacing one intermetallic alloying reaction (i.e., an aluminum-lithium reaction allegedly taught in Liu) with another intermetallic alloying reaction (i.e., the aluminum-nickel reaction disclosed in Fischer) that Petitioner characterize as "a particularly predictable variation of the aluminum/lithium combination in Liu" (Pet. 20–21). Accordingly, Petitioner does not provide adequate technical reasoning to explain why a person of ordinary skill in the art would have employed an intermetallic alloying reaction (taught in Fischer) in place of Liu's disclosed reaction between aluminum — or such other materials that Liu identifies as "fuel" (Ex. 1004, 20:47–63) — and water. Nor does Petitioner adequately explain why a person of ordinary skill would have combined Liu with Fischer, such that the resulting combination employed the distinctly different physical operation involved in claim 1 of the '394 patent — wherein the liner includes both reactants — as opposed to the identified embodiments of Liu, in which the liner material is brought together with an external, ambient reactant (i.e., water), as a consequence of the detonation. In addition, whereas Liu discusses the significance of the reaction of liner material with

water that produces hydrogen gas (*see* Ex. 1004, 26:3–5), Fischer shows that the intermetallic reactions that Petitioner discusses (*see* Pet. 19–21 (aluminum/lithium, aluminum/nickel, and aluminum/palladium)) produce no hydrogen and no gaseous products at all (*see* Ex. 1005, 9). Accordingly, in a situation such as the present one, "[w]ithout any explanation as to how or why the references would be combined to arrive at the claimed invention, we are left with only hindsight bias that *KSR* warns against." *Metalcraft of Mayville, Inc. v. The Toro Co.*, 848 F.3d 1358, 1367 (Fed. Cir. 2017) (citing *KSR*, 550 U.S. at 421). Petitioner's third proposed reason for combining Liu with Fischer — i.e., that there was a need for perforators having shaped-charge liners that could provide additional thermal energy, from a reaction involving liner material — reflects such reliance on hindsight, because Petitioner contends that the development of the challenged '394 patent "confirmed" the existence of such a need. Pet. 23. "The inventor's own path itself never leads to a conclusion of obviousness; that is hindsight." *Otsuka Pharm. Co. v. Sandoz, Inc.*, 678 F.3d 1280, 1296 (Fed. Cir. 2012). For the foregoing reasons, Petitioner has not shown a reasonable likelihood of prevailing in establishing that independent claims 1 and 28 would have been obvious based on the combination of Liu and Fischer. Accordingly, for the same reasons, we are not persuaded that Petitioner has established a reasonable likelihood that they would prevail in their challenge to claims 2, 3 and 17–26 (which depend from claim 1) and for which Petitioner relies upon the same arguments discussed above. *See* Pet. 16–27. *See also In re Fritch*, 972 F.2d 1260, 1266 (Fed. Cir. 1992) ("[D]ependent claims are nonobvious if the independent claims from which they depend are nonobvious.")

D. Obviousness Based on Liu and Theis

Petitioner contends that claims 1–3, 17–26, and 28 are unpatentable under 35 U.S.C. § 103(a) as obvious over Liu and Theis. Pet. 41–51. Relying again on the testimony of Dr. Walters, Petitioner alleges that the combined references teach or suggest all the limitations of these challenged claims and that a person of ordinary skill in the art would have combined the references, so as to achieve the claimed subject matter. *Id.*

1. Summary of Theis

Theis discloses a projectile or warhead employing "a composite material comprising two metal components that can be made to undergo a highly exothermic reaction induced by a shock wave." Ex. 1006, 1:1–4. Theis refers to composite material "in the form of an insert or liner" that "can exert an incendiary effect" on the target. *Id.* at 1:11–13. Theis states that metal components that undergo such "highly exothermic reaction[s] with each other include to form an inter-metal bond" include reactions between palladium and aluminum, between nickel and aluminum, and between platinum and aluminum. *Id.* at 3:14–17.

2. Analysis

This ground is similar to Petitioner's first ground (based upon Liu and Fischer, discussed above), except that here Petitioner relies upon Theis — instead of Fischer — for the limitations that Liu is not alleged to teach. *Id.* at 41–42, 45–51. Specifically, Petitioner argues that Theis' disclosure of intermetallic exothermic reactions to form "Ni-Al and Pd-Al compounds satisfy the limitation [of independent claims 1 and 28] for 'two metal elements . . . provided in respective proportions calculated to give an electron concentration of 1.5." *Id.* at 41–42. Further, just as in the Liu-

Fischer combination, Petitioner's claim chart suggests that the secondary reference (Theis, here) might also teach the claimed "two metal elements will undergo an intermetallic alloying reaction" of independent claims 1 and 28. *Id.* at 46, 50.

Petitioner contends that the three reasons for combining Liu and Fischer (discussed above) also apply to the combination of Liu and Theis. *Id.* at 42–43.

In addition, Petitioner presents a fourth reason to combine the references: "[T]he problem allegedly addressed by the '394 patent would have motivated a person of ordinary skill to combine" Liu and Theis. *Id.* at 43. According to Petitioner, the '394 patent (Ex. 1001, 2:36–53) reflects the need in the oil and gas industry for shaped-charge liners that could impart both penetrative and incendiary power — features that available in radioactive liner materials, which the '394 patent states "would not be considered appropriate" in oil and gas perforation — and that military technologies (such as Theis) could have provided a source for such teachings. Pet. 43–45. Further, Petitioner contends that Liu and Theis address "closely related problems," related to improving the penetrative force and incendiary energy that materials and projectiles deliver to a target. *Id.* at 44. "Thus," Petitioner argues, "one of ordinary skill in the art would have consulted Theis' teachings of pyrophoric charges for military applications and examples of composite, intermetallic projectile liner materials capable of reacting exothermically to provide both perforating and incendiary effects, for use with the shaped charge liners of Liu." *Id.* at 45.

In response, Patent Owner contends, again relying on Mr. Behrmann's testimony, that Theis does not teach or suggest that the intermetallic reaction

of nickel and aluminum could be substituted for Liu's aluminum-water reaction, that there is no adequate reason to combine the references, that any such combination was not predictable and would not have had a reasonable expectation of success, and that the purported similarity of the problems addressed in Liu and Theis does not suggest the transfer of military projectile technology to the oilfield context. Prelim. Resp. 28–29, 37–39.

We agree with Patent Owner that Petitioner has not shown a sufficient reason why a person of ordinary skill in the art would have combined the teachings of Liu and Fischer in the manner recited in claim 1 of the '394 patent. As discussed above, none of Petitioner's three reasons to combine Liu and Fischer, which Petitioner again relies upon, provides adequate technical reasoning, with rational underpinning, for combining the Liu's oil well perforation technology with a liner containing two elements that undergo an intermetallic alloying reaction, per claims 1 and 28 of the '394 patent. Nor does Petitioner's fourth reason, for combining Liu with the intermetallic-reaction technology of Theis, overcome the defects identified above — all of which apply equally to the Liu-Theis combination. Moreover, in view of its explicit reliance on the teachings of the challenged '394 patent, Petitioner's fourth reason even more clearly suffers from hindsight reasoning, as such use of a challenged patent is a token of hindsight. *See W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553 (Fed. Cir. 1983) ("To imbue one of ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.") For the foregoing reasons, Petitioner has not

shown a reasonable likelihood of prevailing in establishing that independent claims 1 and 28 would have been obvious based on the combination of Liu and Theis. Accordingly, we are not persuaded that Petitioner has established a reasonable likelihood that they would prevail in their challenge to claims 2–3 and 17–26 (which depend from claim 1). *See Fritch*, 972 F.2d at 1266.

E. Obviousness Based on Liu and Becker

Petitioner contends that claims 1–4, 6, 12, 17–26, and 28 are unpatentable under 35 U.S.C. § 103(a) as obvious over Liu and Becker. Pet. 52–62. Relying again on the testimony of Dr. Walters, Petitioner alleges that the combined references teach or suggest all the limitations of these challenged claims and that a person of ordinary skill in the art would have combined the references, so as to achieve the claimed subject matter. *Id.*

1. Summary of Becker

Becker discloses "a projectile for the destruction of large explosive targets which utilizes a pyrogenically activated intermetallic payload." Ex. 1007, 2:32–33. The intermetallic reactive payload may be "ignited post launch by an amount of tracer material in the projectile." *Id.* at 2:37–3:5. "[T]he preferred material for the intermetallic reactive payload may be any of several bi-metallic reactive combinations including combinations of titanium and boron which produce titanium boride (TiB) and nickel aluminum which react to produce nickel aluminide (NiAl)," although other similar combinations might be used. *Id.* at 6:30–35. The bi-metallic reactive payload is "preferably in finely divided particulate form, the particles having an average size of approximately 10 microns," mixed in stoichiometric proportions, and may also include "[b]inders such as

polytetrafluoroethylene or other inert materials" to "modulate the reaction rate or amount and type of gas vented during the reaction of the bi-metallic material." *Id.* at 7:7–12.

2. Analysis

This ground is similar to Petitioner's previous two grounds (based upon combinations of Liu/Fischer and Liu/Theis, respectively) discussed above, except that here Petitioner relies upon Becker — instead of Fischer or Theis — for the limitations of the challenged claims that are not allegedly met by Liu. *Id.* at 41–42, 45–51. Specifically, with regard to independent claims 1 and 28 of the '394 patent, Petitioner argues that Becker's disclosure of a bi-metallic reactive projectile payload of nickel and aluminum in a stoichiometric quantity that reacts to produce nickel aluminide (NiAl) satisfies the recitation of "two metal elements . . . provided in respective proportions calculated to give an electron concentration of 1.5." *Id.* at 52 (citing Ex. 1007, 3:7–9, 4:9–11, 6:30–33, 7:7–10).

As in Petitioner's combination of Liu with Theis, Petitioner contends that the three proposed reasons for combining Liu and Fischer also apply to the combination of Liu and Becker. *Id.* at 53. Further, Petitioner contends that the additional (fourth) reason for combining Liu with Theis also applies to the combination of Liu with Becker, "particularly in light of the history of technological cross over from the military to the oil and gas industry." *Id.* at 53–54.

In response, Patent Owner contends, again relying on Mr. Behrmann's testimony, that Becker does not teach or suggest that the intermetallic reaction of nickel and aluminum could be substituted for Liu's aluminum-water reaction, that there is no adequate reason to combine the references,

that any such combination was not predictable and would not have had a reasonable expectation of success, and that the purported similarity of the problems addressed in Liu and Becker does not suggest the transfer of military projectile technology to the oilfield context. Prelim. Resp. 29–30, 39–41.

We agree with Patent Owner that Petitioner has not shown a sufficient reason why a person of ordinary skill in the art would have combined the teachings of Liu and Becker in the manner recited in independent claims 1 and 28 of the '394 patent. As discussed above, none of Petitioner's reasons to combine Liu with Fischer, or Liu with Theis — reasons that Petitioner again relies upon — provides adequate technical reasoning, with rational underpinning, for combining the Liu's oil well perforation technology with the intermetallic alloying reaction of nickel and aluminum, per claims 1 and 28 of the '394 patent.

Furthermore, unlike the Liu-Fischer and Liu-Theis combinations, Petitioner does not indicate that the secondary reference (Becker, here) might also teach the claimed "two metal elements will undergo an intermetallic alloying reaction" of independent claims 1 and 28. *Id.* at 55, 60. Because, as explained above (Section II.C.3), Liu does not teach this feature, the absence of this limitation presents an alternative reason why Petitioner does not establish that the Liu/Becker combination creates a reasonable likelihood that they would prevail in their challenge to claims 1 and 28.

For the foregoing reasons, Petitioner has not shown a reasonable likelihood of prevailing in establishing that claims 1 and 28 would have been obvious, based on the combination of Liu and Becker. Accordingly, we are

not persuaded that Petitioner has established a reasonable likelihood that they would prevail in their challenge to claims 2–4, 6, 12, and 17–26 (*see id.* at 26–27), which depend from claim 1. *See Fritch*, 972 F.2d at 1266.

F. Obviousness Based on Liu/Fischer with one of Reese, Bourne, and Lussier

Petitioner relies upon the Liu/Fischer combination, together with a third reference (i.e., one of Reese, Bourne, and Lussier) to support challenges to certain claims of the '394 patent that depend (whether directly or indirectly) from independent claim 1. *See* Pet. 62–68. Specifically Petitioner contends that following claims are unpatentable under 35 U.S.C. § 103(a), based upon the respective combinations of references (along with the testimony of Dr. Walters): claims 4, 5, and 11 (Liu, Fischer, and Reese); claims 12, 13, and 14 (Liu, Fischer, and Bourne); and claims 15 and 16 (Liu, Fischer, and Lussier). *Id.*

1. Summary of Reese

Reese relates to a shaped-charge liner that includes powdered metals, including a metal that acts a binder or matrix, such as in the form of a coating, to bind the higher density metal. Ex. 1008, 3:16–23, 5:48–52. Reese's disclosures include liners with "a range of from 40 percent by weight to 3 percent by weight of a metal binder coating." *Id*. at 6:18–20.

2. Summary of Bourne

Bourne relates to a shaped-charge liner having a composition that includes a powdered binder, in which the composition has grains with a grain size between 25 nanometers and 1 micron. Ex. 1009, 2.

3. Summary of Lussier

Lussier relates to a shaped-charge liner having a substantially uniform thickness of about 0.064 inches, having the form of a truncated cone, in

which the conical angle is about 26° and the truncated cone has a large end brim of about 1.8 inches in diameter and a height of about 0.5 inches. Ex. 1010, 8:29–34.

4. Analysis

Petitioner does not rely upon any of Reese, Bourne, and Lussier to teach any limitation of independent claims 1 and 28, or to advance a reason for combining Liu with Fischer. *See* Pet. 62–68. Therefore, Petitioner's use of Reese, Bourne, and Fischer does not remedy the deficiencies of Petitioner's obviousness case against independent claims 1 and 28, based upon the combination of Liu and Fischer. Accordingly, based upon the analysis presented above (regarding Petitioner's first obviousness ground involving the combination of Liu and Fischer), Petitioner has not demonstrated a reasonable likelihood of prevailing in any of their arguments that the subject matter of claims 4, 5, and 11–16 would have been obvious for any of the asserted grounds involving Liu and Fischer.

III. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that the Petition is denied as to all challenged claims of the '394 patent.

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