

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TOPSOE, INC.,
Petitioner

v.

CASALE,
Patent Owner

IPR2025-01454
U.S. Patent No. 11,286,168

**PETITIONER'S OPPOSITION TO PATENT OWNER'S CONTINGENT
MOTION TO AMEND UNDER 37 C.F.R. § 42.121**

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TABLE OF EXHIBITS SUBMITTED WITH PETITIONER’S OPPOSITION

Exhibit	Description
1063	Declaration of James A. Ritter, Ph.D. in Support of Petitioner’s Opposition to Patent Owner’s Contingent Motion to Amend, with Appendix A, dated July 28, 2026
1064	U.S. Patent No. 5,068,058 to Bushinsky et al. (“the ’058 Patent”)
1065	Aasberg-Petersen et al., “Synthesis Gas Production for FT Synthesis,” Chapter 4 of Fischer-Tropsch Technology, Studies in Surface Science and Catalysis Vol. 152 (2004) (“KAP 2004”)
1066	Deposition Transcript of Colin A. Wolden, Ph.D., July 23, 2026

I. Introduction

Patent Owner's contingent motion to amend should be denied because Proposed Substitute Claims 24, 25, 26, and alternative 27 are unpatentable. The amendment adds nothing to Claim 10; it subtracts. Claim 10 recited, in the disjunctive, the three conventional fired consumers of fuel gas in a syngas plant front end: a steam production and/or superheating furnace, a furnace pre-heating the autothermal reformer ("ATR") charge, and a furnace pre-heating the natural gas desulphurization charge. Each Substitute Claim isolates one member of that list—each a decades-old destination for recycled, decarbonized fuel gas long before the February 15, 2017 Critical Date.

The prior art made each destination conventional. In 1991, the '058 Patent showed an ammonia synthesis gas plant in which a single fired heater—fueled entirely by CO₂-depleted, H₂-rich offgas recycled from the syngas purification train—pre-heats both the natural gas charge ahead of the desulphurization bed and the ATR charge. EX1064 at Fig. 1; 5:1-21; 10:11-18; Table 1; EX1063 ¶24. KAP 2004 confirmed that configuration was "typical." EX1065 at 45, Fig. 50. 2007 IFA taught substituting a hydrogen fuel fraction, split from the CO₂-depleted syngas of an ATR-based ammonia plant, for a portion of the hydrocarbon fuel in the plant's fired equipment, including the fired steam boiler. EX1006 at 7-9. Terrien taught the same, directing a portion of the split hydrogen stream to "hydrogen fueling" of an

ATR-based unit. EX1007 ¶¶35, 46, 73, 94-95.

Splitting a disjunctive list of conventional alternatives into three claims does not make any alternative less conventional. Patent Owner’s expert agrees: pre-heating the charge upstream of the pre-reformer “is not new” and the Claim 1 flowsheet “was available prior to 2017.” EX1066, 124:12-126:6, 128:9-15, 285:17-22. What allegedly “makes [the ’168 Patent] an innovation” is “that they replace [the hydrocarbon fuel] with hydrogen”—the Claim 1 fuel substitution, not the furnace identity the amendment appends. *Id.* PO has not shown the “need” required to rebut the presumption that one substitute claim suffices per challenged claim; its own one-for-one alternative (Claim 27) concedes as much. All Substitute Claims are unpatentable over the prior art of record and newly presented prior art responsive to the amendment, and Claim 26 also lacks written description support. The motion should be denied.

II. Legal Standards

A motion to amend must satisfy 35 U.S.C. § 316(d) and 37 C.F.R. § 42.121. The substitute claims must respond to a ground of unpatentability, must not enlarge claim scope or introduce new matter, and must be supported by written description. *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 15, at 4-8 (PTAB Feb. 25, 2019) (precedential). Petitioner bears the burden of proving unpatentability by a preponderance of the evidence on the entire record. 37 C.F.R. § 42.121(d)(2);

Lectrosonics, Paper 15, at 4; *Nike, Inc. v. Adidas AG*, 955 F.3d 45, 51 (Fed. Cir. 2020).

Because proposed substitute claims are newly presented and unexamined, Petitioner is not limited to the grounds or prior art of the petition. It may raise new prior art, new theories, and new grounds, such as lack of written description under 35 U.S.C. § 112, so long as they respond to the amendment. *Am. Nat’l Mfg. Inc. v. Sleep Number Corp.*, 52 F.4th 1371, 1379-81 (Fed. Cir. 2022); *Nike*, 955 F.3d at 51-52. Everything below is responsive: PO’s amendment isolates the individual apparatus options of original Claim 10, and Petitioner’s evidence is directed to those limitations.

III. Level of Ordinary Skill in the Art

Petitioner applies the level of ordinary skill set forth in the Petition: a POSA would have a graduate degree in chemical engineering or a related field, with several years of experience designing and operating synthesis gas production processes and systems, or equivalent education and experience. Pet. at 3; EX1005 ¶35; EX1063 ¶12. The analysis does not change under either party’s articulation. EX1063 ¶12; EX2007, ¶52; POR, 7.

IV. Claim Construction

A. “Furnace”

PO has insisted throughout that “furnace” in the ’168 Patent means “an

apparatus chosen from among: a steam reformer or a charge preheater or a steam generator or a steam superheater.” Paper 33 at 8; Paper 34 at 17, 20. Without conceding its “plain and ordinary meaning” arguments, Petitioner applies that construction here. Under it, a fired charge preheater (such as heater 210 of the ’058 Patent and the fired heater of KAP 2004’s typical ATR flowsheet) is a “furnace,” and a fired boiler that combusts fuel to raise steam (such as 2007 IFA’s auxiliary and package steam boilers and Rytter’s hydrogen station combusting hydrogen “to steam”) is a “steam generator” and thus also a “furnace.” EX1063, ¶17. PO’s own construction therefore supplies the apparatus identifications on which the grounds below rest.

B. “said at least one furnace” (Substitute Claims 25 and 26)

Substitute Claims 25 and 26 replace Claim 10’s “one or more furnaces” with “said at least one furnace,” which PO explains refers back to the “at least one furnace” of Claim 1 to which the fuel fraction is fed. Paper 34 at 3, 7. Petitioner applies that antecedent reading: in each ground below, the furnace that receives the fuel fraction under Claim 1 and the furnace that performs the recited pre-heating duty are the same apparatus. That is what the prior art discloses: the ’058 Patent’s heater 210 both burns the recycled fuel and performs both pre-heating duties, so PO’s amendment narrows the claims directly onto the prior-art configuration. *Infra* § VIII.

V. The Contingent Posture and the Structure of Petitioner’s Grounds

PO’s motion is contingent: the Substitute Claims are reached only if the Board finds Claims 1 and 10 unpatentable on an instituted ground—Ground 1 (2007 IFA), Ground 2 (Rytter), Ground 3 (Fjellhaug), or Ground 3B (Fjellhaug in view of Rytter). Petitioner therefore presents grounds keyed to each primary reference, plus an independent Terrien-based path. Whichever ground the Board adopts, a matching ground establishes the substitute claims’ unpatentability on the same Claim 1 foundation for the reasons in the Petition and trial record. Each Substitute Claim carries Claim 1 forward unchanged and adds only the identity of the furnace the fuel fraction feeds—conventional decades before the Critical Date. EX1063, App. A (claim charts).

One feature strengthens the Claim 25 and 26 combinations throughout. PO’s principal attack on Claim 1 is that each primary reference feeds fuel to a gas turbine rather than a “furnace.” Paper 33 at 9-11. But in the combinations below the apparatus receiving Claim 1[c]’s fuel fraction is the ’058 Patent’s and KAP 2004’s fired charge preheater, indisputably a “furnace” under PO’s own construction, so those combinations satisfy Claim 1[c] however the Board resolves that dispute. The same holds for Claim 24, whose steam production furnace is itself a “steam generator.” EX1063, ¶¶33, 44.

VI. The Motion Proposes an Unreasonable Number of Substitute Claims Without Demonstrating Need

The statute permits only “a reasonable number of substitute claims” “for each challenged claim.” 35 U.S.C. § 316(d)(1)(B). “The presumption is that only one substitute claim will be needed to replace each challenged claim,” rebuttable only “by a demonstration of need.” 37 C.F.R. § 42.121(a)(3); *Lectrosonics*, Paper 15, at 4-5. PO proposes three substitute claims (24, 25, and 26) for the single challenged Claim 10 and does not carry its burden.

PO’s justification is that Claim 10 recites Options A, B, and C in the alternative and that presenting them as three independent claims is “easier and clearer” while “the scope has not changed.” Paper 34 at 4-5. Even on its own terms, that at most describes the amendment; it does not demonstrate need. Nor is the premise correct: Claims 25 and 26 replace Claim 10’s “one or more furnaces” with “said at least one furnace,” a change of scope. *Supra* § IV.B. The Options were already separately assessable within Claim 10’s disjunctive list, and the POR argued each against each ground. Paper 33 at 31-32, 45, 51-56. If the three claims re-present exactly Claim 10’s alternatives, then by PO’s own account one claim suffices. The Motion identifies no ground- or feature-specific reason why a single substitute claim reciting the Option PO contends is patentable would not fully respond.

PO’s own authority shows what the split accomplishes. A claim reciting

alternatives “is deemed anticipated if any of the structures or compositions within the scope of the claim is known in the prior art.” *Brown v. 3M*, 265 F.3d 1349, 1351 (Fed. Cir. 2001) (cited at Paper 34 at 4). Dividing Claim 10 into three claims converts one claim that falls if any Option is unpatentable into three that must each be separately defeated. The presumption does not license multiplying claims across pre-existing alternatives to enlarge the opponent’s burden.

PO’s own drafting history confirms this is strategy, not need: Claim 10’s disjunctive list is the product of PO’s prior narrowing amendment (in the reexamination ordered on its own supplemental examination request, PO deleted two of Claim 10’s five recited fuel destinations, leaving the three Options it now represents as Claims 24-26), and PO chose, then as at the outset, a single, disjunctive claim. EX1001, Reexam. Cert., cl. 10. Petitioner’s grounds challenge that same claim; nothing in them creates a need now for three.

PO’s alternative proposal concedes the point. “In the event that the Board finds that three new claims is an unreasonable number,” the Motion offers a single one-for-one substitute, Claim 27 reciting Option B, and acknowledges that it “satisfies the presumption.” Paper 34 at 5. A patentee that genuinely needed separate claims to Options A and C would not offer to abandon both. The Board should hold PO to the presumption, deny the Motion as to Claims 24-26 for failure to demonstrate need, and consider at most Claim 27—each unpatentable for the reasons

below.

VII. Substitute Claim 24 Is Unpatentable

A. Claim 24 is anticipated by 2007 IFA

2007 IFA discloses every limitation of Claim 1 for the reasons in the Petition and trial record. Pet. at 13-19; Paper 13 at 1-2; EX1005 ¶¶122-123, 131, 136-141, 153; EX1063 ¶¶32-33, App. A (Chart 2). 2007 IFA depicts a fired “Package HP Steam Boiler” and a fired “Auxiliary Boiler,” each receiving “Fuel,” EX1006 at 7-8, and its “Integrated reforming and power cycle” flowsheet discloses the claimed fuel fraction: an “H₂ Fuel” stream split from the CO₂-depleted synthesis gas and used, together with natural gas, as plant fuel. *Id.* at 9; EX1005 ¶¶51-57, 183-85, 205; EX1063 ¶32. PO’s expert agrees with the mapping’s essentials: page 9 shows “an ATR-based ammonia synthesis flow sheet” whose components “are the same” as the ’168 Patent’s Figure 1; its hydrogenator and sulphur absorber are “a typical desulfurization part of the process”; and, at “the split point,” the H₂ Fuel and the stream continuing to the methanator “would be the same” composition. EX1066, 250:15-252:15. 2007 IFA was a single, continuous talk by one author to one audience (EX1045 ¶¶13-15), and a POSA would read its slides together and in order. So read, 2007 IFA discloses feeding that fuel fraction to a fired boiler—a “steam generator” and thus the “at least one furnace” of Claim 1[c] under the ’168 Patent’s definition and PO’s own construction, independent of the gas-turbine dispute.

EX1001, 2:47-52; EX1063 ¶¶33-34. The page 8 slide confirms that reading. Its title—“integration of gas turbine driver in the ammonia process”—announces integration with the ammonia process, yet on PO’s expert’s account the depicted “Fuel” is exclusively natural gas. Asked where the integration then lies, the only candidate he could posit came from the preceding slide—“[t]here’s nothing else I could think of”—an answer that itself required reading the slides in sequence, “because they follow in chronological order”: the very cross-slide reading he refused to apply from page 9. EX1066, 279:8-282:9. Nor did he have any foundation for treating the deck as disconnected slides: he was not there and has no evidence they were not presented together. *Id.*, 247:19-248:20, 250:4-12. If the Board concludes the page 7-8 “Fuel” is not shown to include the same CO₂-depleted fraction identified on page 9, § VII.B independently establishes Claim 24 as obvious over 2007 IFA.

PO’s evidentiary objections to 2007 IFA are resolved by its author’s declaration authenticating EX1006 as the slides he presented at the open March 2007 IFA Technical Committee Meeting, without confidentiality restrictions, and later posted on the IFA’s public website. EX1045 ¶¶ 6-17.

B. Claim 24 is obvious over 2007 IFA in view of the knowledge of a POSA

Even if PO is right that the fuel streams on pages 7 and 8 of 2007 IFA are

natural gas rather than the H₂ fuel fraction (Paper 34 at 15-17), Claim 24 would still have been obvious over 2007 IFA itself. It rests on the same Claim 1 foundation as § VII.A and is properly presented against newly presented claims. *Sleep Number*, 52 F.4th at 1379-81.

2007 IFA frames its problem in terms of the plant's fired fuel consumers: roughly 25% of the plant's hydrocarbon is burned as fuel, and it identifies two fired, CO₂-emitting consumers, the reformer and the auxiliary boiler. The solution: "[r]emove CO₂ from flue gases (reformer and auxiliary boiler)." EX1006 at 7-8. The central teaching, culminating in the page 9 flowsheet, is to substitute a decarbonized hydrogen fuel fraction split from the CO₂-depleted syngas for a portion of the hydrocarbon fuel. *Id.* at 8-9. Applying that substitution to the auxiliary or package steam boiler uses a known technique on a known device for its intended purpose, with predictable results: eliminating the CO₂ in the boiler's flue gas. *KSR Int'l Co v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). Because the page 9 ATR-based flowsheet has no primary reformer, the steam system is the principal remaining fired consumer; a POSA would route the H₂ fuel there as a matter of course. EX1063 ¶35. It was also the predictable destination: PO's expert testified that pre-2017 gas turbines accepted "at best" roughly 10% H₂, while diffusion burners "could burn hydrogen before 2017." EX1066, 118:14-119:5, 224:1-14. PO's observation that the page 7 boiler's flue gas contains CO₂ (Paper 34 at 16) only confirms the motivation: eliminating

that CO₂ by burning hydrogen is the presentation's point.

C. Claim 24 is anticipated by, or obvious over, Rytter

Rytter's disclosure of the Claim 1 limitations is in the Petition and trial record. Pet. at 39-45; Paper 13 at 2; EX1005 ¶¶ 122, 124, 142-143, 154; EX1063 ¶36. Rytter resolves Claim 24 as it did Claim 10's first option: it discloses a hydrogen-fired steam generator.

Rytter discloses that the separated surplus hydrogen "may be passed to a hydrogen power station 7, which is also supplied with air for the combustion of the hydrogen gas to steam producing electrical power." EX1008, 6:8-13. Rytter elsewhere calls such equipment a "heat generating station," *id.* at 1:33-36; cl. 8, but the operative description of station 7's function controls its identity under the '168 Patent's structural definition. Station 7 is an air-supplied unit combusting hydrogen "to steam." That makes it a hydrogen-fired steam generator, and thus both a "furnace" and a steam production furnace under PO's own construction. EX1001, 2:47-52; EX1063 ¶36. Because Rytter's fuel fraction feeds that steam generator, Claim 24 is anticipated by, or at least obvious over, Rytter.

PO characterizes station 7 as a gas turbine (Paper 34 at 19-21), but its only support, EX1008, 1:33-36, is background on prior-art uses of hydrogen. Station 7 combusts hydrogen with supplied air "to steam," and the steam produces power—boiler duty in a steam cycle, not a gas turbine. Gas turbines produce power by

expanding hot combustion gases rather than combusting fuel “to steam.” EX1063 ¶37. PO’s expert confirmed that the gas-turbine reading is inference, not disclosure. Asked where Rytter places a gas turbine in station 7, he pointed only to that background passage and Rytter’s general gas-turbine discussion—neither describing station 7—and acknowledged that “[a]ll [the patent] really shows is that hydrogen go into the – into 7 and that steam and electricity come out.” EX1066, 311:3-312:4, 316:19-317:9, 318:14-319:13. Asked whether station 7 could instead be a steam-generating furnace supplying a steam turbine: “I don’t know.” *Id.*, 323:3-12; *see also id.*, 320:9-15 (“steam could be produced in a steam generating furnace”). The one alternative he offered fails on the face of the sentence: pressed to reconcile Rytter’s language, he recast the “steam” as byproduct water vapor in a hydrogen-fired turbine’s exhaust. *Id.*, 318:1-12. That inverts Rytter—the steam produces the power, whereas turbine exhaust produces none. Rytter’s focus on methanol does not change this: it is analogous art addressing the same CO₂-reduction problem and expressly contemplates that hydrogen not consumed in methanol synthesis may be “fed to ammonia synthesis.” EX1008, 3:10-16, 4:41-50, 6:8-13; EX1063 ¶37.

D. Claim 24 is obvious over Fjellhaug in view of Rytter

Fjellhaug in view of Rytter discloses or renders obvious every limitation of Claim 1 for the reasons in the Petition and trial record. Pet. at 47-64; Paper 13 at 3; EX1005 ¶¶ 122, 124, 142-143, 149-150, 156; EX1063 ¶38. Rytter supplies the Claim

24 furnace—the hydrogen-fired steam generator of station 7—for the reasons in § VII.C. EX1008, 6:8-13; EX1001, 2:47-52; EX1063 ¶¶36, 38.

A POSA would have been motivated to combine Fjellhaug and Rytter with a reasonable expectation of success. Both address the identical problem in the same field: disposing of a decarbonized, hydrogen-rich fuel fraction from a natural gas-based syngas process while minimizing CO₂ emissions. EX1010, 3:14-15, 4:34-50; EX1008, 3:10-16, 6:8-13. Fjellhaug already burns the fuel fraction to raise steam, using gas-turbine exhaust heat in a steam generator 27 and superheater 30. EX1010, 4:38-50. Adding Rytter’s directly fired hydrogen steam generator is a simple substitution of one known steam-raising means for another, using conventional boiler hardware, with predictable results: fuel gas in, steam and power out, and no flue-gas CO₂. *KSR*, 550 U.S. at 416-17; EX1063 ¶38. PO’s expert agrees the two routes are known alternatives: “generally you can produce electricity through gas turbines or through steam turbines,” or “both” in combined cycle. EX1066, 333:13-334:19. That how-and-why analysis answers PO’s objection under *Metalcraft of Mayville, Inc. v. Toro Co.*, 848 F.3d 1358, 1366-67 (Fed. Cir. 2017) and *In re Stepan Co.*, 868 F.3d 1342, 1345-47 (Fed. Cir. 2017): those cases condemn conclusory assertions, not combinations resting on a shared problem and conventional equipment. Paper 34 at 22-24; EX1063 ¶38.

E. Claim 24 is obvious over Terrien in view of Rytter

Claim 24 is also obvious over Terrien in view of Rytter, independent of the instituted grounds. Terrien discloses every limitation of Claim 1 (§ X), including the same-composition split of the PSA hydrogen product stream with a portion recycled as plant fuel. EX1007 ¶¶35, 46, 73, 78, 95; EX1063 ¶¶39, 51. Rytter supplies the steam production furnace, EX1008, 6:8-13, for the reasons in § II.C. Both teach recycling the decarbonized hydrogen stream of a natural-gas-based, CO₂-capturing syngas plant as fuel; directing it to one of the plant's few fired consumers is a design choice among a finite set of predictable options, with a reasonable expectation of success. EX1007 ¶3; EX1008, 3:10-16; EX1005 ¶¶ 206, 316-19; *KSR*, 550 U.S. at 421; EX1063 ¶39.

VIII. Substitute Claim 25 Is Unpatentable

The '058 Patent and KAP 2004 supply a core factual predicate for both Claims 25 and 26: a single, integrated fired heater—not separate devices—was the industry-standard destination for recycled fuel gas in an ATR-based front end decades before the Critical Date. One apparatus therefore satisfies Claim 1[c]'s “at least one furnace,” Claim 25's ATR-charge duty, and Claim 26's desulphurization-charge duty simultaneously, and KAP 2004 confirms that design was the industry's “typical” one by 2004. EX1065 at 45, Fig. 50; EX1063 ¶¶20, 23-24, 26, App A (Charts 3-4).

A. Claim 25 is obvious over 2007 IFA in view of the '058 Patent, further in view of KAP 2004

2007 IFA supplies the Claim 1 limitations for the reasons summarized in § VII.A-B. In the combination, the “at least one furnace” receiving Claim 1[c]’s fuel fraction is the fired charge preheater supplied by the '058 Patent and KAP 2004—a “furnace” under PO’s own construction, EX1001, 2:47-52—so the combination satisfies Claim 1[c] regardless of the gas-turbine dispute. Claim 25’s added limitation is established below.

1. The '058 Patent discloses the claimed furnace and the claimed fuel routing

The '058 Patent discloses an ammonia synthesis gas process squarely within the '168 Patent’s field—natural gas converted in an autothermal reformer fed oxygen-enriched air, shift conversion, and CO₂ removal by pressure swing adsorption—and its Figure 1 embodiment discloses exactly the apparatus Claim 25 recites, performing the recited duty with the recited class of fuel. EX1064, Abstract, 3:45-4:10; EX1063 ¶22.

First, heater 210 pre-heats the ATR charge: the major portion of the hydrocarbon-and-steam feed (line 215) “is further heated to a temperature in the range of 900° to 1000° F. . . . in the radiant section of heater 210 and is introduced by line 218 into the inlet of an autothermal reactor 220.” EX1064, 5:16-27. Heater 210 is a fired charge preheater, and thus a “furnace” pre-heating the ATR charge

under PO's own construction. EX1063 ¶23.

Second, that same heater is fired with hydrogen-containing offgas recycled from the syngas purification train: the PSA offgas streams “may be mixed . . . and the mixture employed as fuel in the gas heater 210 (as indicated by line 254 of FIG. 1).” EX1064, 10:11-18; Fig. 1 (“FUEL FROM PSA” to heater 210) (The “254” is an apparent typographical error for line 251, the “PURGE TO FUEL” stream of Fig. 1 and Table 1. EX1063, ¶25 & n.1.) More than a quarter century before the Critical Date, the '058 Patent thus disclosed an ATR-based ammonia syngas plant in which a H₂-rich, CO₂-depleted stream fuels the very heater that pre-heats the ATR charge—the one-apparatus arrangement Claim 25's “said at least one furnace” requires. EX1063 ¶24.

2. *KAP 2004 confirms the fired charge preheater was the industry-standard configuration*

KAP 2004, a chapter of a standard synthesis gas reference text, depicts the “[t]ypical process flow diagram” for ATR-based synthesis gas production, in which a “fired heater” pre-heats the feed streams, including the natural gas feed ahead of desulphurization and the pre-reformed feed en route to the ATR. EX1065 at 45, Fig. 50. In the ATR-based front end Claim 1 requires by excluding a primary reformer, that fired heater is the principal, and often the only, fuel-consuming furnace in the plant. EX1063 ¶¶20, 26.

3. *A POSA would have combined the references with a reasonable expectation of success*

2007 IFA instructs the POSA to split a hydrogen fuel fraction from the CO₂-depleted synthesis gas of an ATR-based ammonia plant and burn it as plant fuel to reduce CO₂ emissions, leaving one design question: which fired equipment receives the fuel. EX1006 at 7-9. The '058 Patent and KAP 2004 supply the conventional answer: the front-end fired charge preheater, which the '058 Patent shows fired with a CO₂-depleted purification offgas the very arrangement claimed. EX1064, 10:11-18, Fig. 1; EX1065 at 45.

Routing 2007 IFA's H₂ fuel to that heater is obvious on at least three *KSR* rationales. First, it applies a known technique (fueling the front-end fired heater with H₂-rich, CO₂-depleted gas) to a known device (2007 IFA's ATR-based ammonia synthesis plant) for the same result. Second, it selects from a finite set of predictable destinations, the very three Claim 10 lists in the disjunctive, which the '168 Patent concedes were the recognized options. Third, it serves 2007 IFA's stated purpose: eliminating flue-gas CO₂ from the largest remaining emission point absent a primary reformer. *Cf.* EX1007 ¶94. *KSR*, 550 U.S. at 416-21; EX1063 ¶¶41-42, App. A (Chart 3).

The POSA would also have had a reasonable expectation of success: the modification uses a standard fired heater performing its ordinary duty, and firing it

with hydrogen-rich fuel required only routine burner selection, as the '058 Patent's hydrogen-containing PSA offgas firing confirms. EX1064, 10:11-18; EX1063 ¶43; EX1066, 223:6-224:14 (a furnace burning hydrogen-rich fuel "is still a furnace," and diffusion burners "could burn hydrogen before 2017").

4. *Patent Owner's anticipated response lacks merit*

First, PO may invoke Dr. Ritter's deposition testimony that 2007 IFA does not show fuel pre-heating an ATR charge. EX2008, 116:18-20; Paper 34 at 18. That testimony addressed what 2007 IFA shows standing alone; this ground does not rely on 2007 IFA for the furnace limitation—the '058 Patent and KAP 2004 supply that. Nonobviousness cannot be shown by attacking references individually where the ground rests on a combination. *In re Keller*, 642 F.2d 413, 426 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986).

Second, PO may argue KAP 2004 is directed to gas-to-liquid ("GTL") synthesis rather than ammonia. But KAP 2004 is analogous art twice over: it is in the same field of endeavor—synthesis gas production by autothermal reforming, which both parties' POSA definitions recite, and for which KAP 2004 provides ATR process schemes for methanol, ammonia, and GTL on consecutive pages, EX1065 at 44-45; 47—and it is reasonably pertinent to the inventor's problem of configuring and fueling an ATR-based front end. EX1063 ¶27. In any event, the '058 Patent is itself an ammonia synthesis gas reference, so the combination stands alone.

Third, PO may note that the '058 Patent's heater fuel is a H₂-rich, CO₂-depleted PSA offgas (84.5% H₂ among its combustible components, EX1064, Table 1; EX1063 ¶24) rather than the claimed H₂-rich, CO₂-depleted syngas fraction. Petitioner does not rely on the '058 Patent for the Claim 1[c] fuel-fraction limitations. The primary reference supplies those, and in the contingent posture, the Board has already found them. The '058 Patent is relied upon for the identity and duty of the furnace, the sole limitation the amendment adds. EX1063 ¶45.

B. Claim 25 is obvious over Terrien in view of the knowledge of a POSA, the '058 Patent, and KAP 2004

Claim 25 is independently obvious over Terrien combined with the ordinary knowledge documented by the '058 Patent and KAP 2004. Terrien discloses the Claim 1 limitations as set forth in § X. As to the added limitation, Terrien expressly directs the hydrogen fuel fraction to the ATR-based front end: “a portion of th[e] [hydrogen product] stream (27) can be used for hydrogen fueling of the feed gas producing unit (34),” EX1007 ¶¶35, 46, and defines “feed gas producing unit” to include “an ATR unit,” *id.* ¶73; *see also* ¶95. Terrien states the reason: carbon capture “approaching or achieving 100% capture, when hydrogen fueling is utilized.” *Id.* ¶94.

The technical meaning of “fueling” an ATR-based unit is not genuinely disputed. An ATR has no externally fired burners; its heat comes from partial

oxidation of the feed with oxygen inside the reactor. EX1063 ¶¶19, 46; EX1066, 120:7-121:21 (PO's expert: the '168 Patent's own "AUX" furnace is a charge preheater, and the ATR is not directly fired). A POSA reading Terrien's instruction to hydrogen-fuel an ATR-based unit would understand the fuel directed to the unit's fired equipment: the fired charge preheater the '058 Patent discloses and KAP 2004 depicts as typical. EX1064, 5:16-21, 9:63-10:3; EX1065 at 45; EX1063 ¶¶46-47. Terrien's reference to "desulfurized natural gas preheated to around 600° C" entering the pre-reformer confirms its front end includes that conventional fired preheat duty. EX1007 ¶74. Supplying that furnace identity from the '058 Patent and KAP 2004 is a paradigm obvious combination: same field, same CO₂-reduction purpose, a finite set of fired destinations, predictable results. *KSR*, 550 U.S. at 416-21; EX1063 ¶¶46-47, App. A (Charts 1, 3).

C. The same combination applies with Rytter, or with Fjellhaug in view of Rytter, as the primary reference(s)

Petitioner presents parallel combinations for Grounds 2 and 3/3B, each resting on the '058 Patent/KAP 2004 analysis and motivation of § VIII.A.

Rytter in view of the '058 Patent further in view of KAP 2004. Rytter supplies the Claim 1 limitations as incorporated in § VII.C and teaches separating surplus hydrogen from the CO₂-removed stream and recycling it as fuel to reduce CO₂ emissions. EX1008, 3:10-16, 6:8-13. The '058 Patent and KAP 2004 supply the

conventional fired consumer of that fuel in the required ATR-based front end (the fired charge preheater), and the § VIII.A.1-3 analyses apply. Because that charge preheater satisfies Claim 1[c]’s “furnace” under PO’s construction, PO’s gas-turbine attack on Rytter (Paper 33 at 10; Paper 34 at 19-21) is moot here. EX1063 ¶¶40-44.

Fjellhaug (alone or in view of Rytter) in view of the ’058 Patent further in view of KAP 2004. Fjellhaug, alone or with Rytter, supplies the Claim 1 limitations incorporated in § VII.D, and the ’058 Patent and KAP 2004 supply the furnace limitation under the § VIII.A.1-3 analyses: Fjellhaug teaches recycling the decarbonized fuel fraction as plant fuel to reduce CO₂ (EX1010, 3:14-15, 4:34-50), and the ’058 Patent and KAP 2004 identify the conventional fired destination in the required ATR-based front end. Dr. Ritter’s testimony that Fjellhaug’s only furnace is in its combined-cycle unit (EX2008, 157:9-19) addresses Fjellhaug alone and is consistent with this combination. *In re Keller*, 642 F.2d at 426; § VIII.A.4; EX1063 ¶¶40-44.

IX. Substitute Claim 26 Is Unpatentable

A. Claim 26 is obvious over the same combinations

Claim 26 differs from Claim 25 only in the furnace’s duty: pre-heating the charge of a natural gas desulphurization section rather than the ATR. The ’058 Patent discloses this furnace in the same embodiment—indeed, the same apparatus. The natural gas feed (line 204) “is passed through the flue gas stack of a small fuel-fired

heater 210 wherein it is preheated to a temperature of about 750° F. . . . and then desulfurized by being passed through a zinc oxide bed 211.” EX1064, 5:1-5; *see also* 13:22-26. Heater 210—the same fired heater that pre-heats the ATR charge and burns recycled purification offgas—is thus also the furnace pre-heating the desulphurization charge. *Id.*, 5:1-21; 10:11-18; Fig. 1; *supra* §§ VIII.A.1-2. That integrated dual-duty configuration was standard design, not invention: KAP 2004’s “typical” flowsheet likewise pre-heats the natural gas feed in the fired heater before desulphurization. EX1065 at 45, Fig. 50; EX1063 ¶48.

Claim 26 is accordingly obvious over each combination presented for Claim 25 (§§ VIII.A-C), with the ’058 Patent and KAP 2004 supplying the desulphurization-charge duty shown above, and the § VIII.A.3 motivation applies: directing the fuel fraction to the conventional front-end furnace is a choice among the finite, predictable destinations Claim 10 itself enumerates. EX1005 ¶¶316-19; *KSR*, 550 U.S. at 416-21; EX1063 ¶49, App. A (Chart 4). PO’s anticipated responses fail for the reasons in § VIII.A.4.

B. Claim 26 lacks written description support

Independent of the prior art, Claim 26 fails the written description requirement, which applies to proposed substitute claims. 37 C.F.R. § 42.121(b)(1); *Sleep Number*, 52 F.4th at 1379-81. Claim 26 requires that the fuel fraction feed “said at least one furnace for pre-heating the charge of a natural gas desulphurization

section.” The Motion identifies no disclosure of that configuration. It cites EP ’305’s (EX2012) description of fuel feeding a front-end charge heater and passages describing revamp of an existing desulphurization section, then reasons that the front end “may include” the desulphurization section. Paper 34 at 12-13 (citing EX2012 ¶¶[0113], [0129]-[0130]). That possibility does not describe a furnace, fired by the fuel fraction, pre-heating the desulphurization charge; it shows at most that the configuration is not excluded, not possession. EX1063 ¶50. When the applicant wished to describe fuel-fraction destinations, it did so expressly (steam generators, steam superheaters, charge preheaters, EX2012 ¶¶[0014], [0065]), but never the desulphurization-charge preheat duty now claimed, as PO’s own expert admitted of the ’168 Patent’s specification: it “does not discuss the desulfurization process in any extent.” EX1066, 122:16-124:10.

X. The Terrien-Based Grounds Independently Establish the Claim 1 Limitations

For each ground relying on Terrien as the primary reference, Terrien discloses or renders obvious every limitation of Claim 1, as set forth in the accompanying declaration (EX1063 ¶51). Terrien discloses producing hydrogen from a hydrocarbon feed, preferably natural gas, capturing at least 80% and up to about 100% of a feed gas producing unit’s CO₂ emissions. EX1007 ¶73. That unit is defined to include “an ATR unit,” among four alternatives. *Id.*; *see also* ¶95.

Terrien's worked embodiment uses an SMR with water-gas shift, *id.* ¶¶74-78, but applying its hydrogen-fueling teaching to an ATR unit it expressly identifies is a selection among a finite set of predictable alternatives. EX1007 ¶73; *KSR*, 550 U.S. at 421; EX1005 ¶¶144-148; EX1063 ¶¶47, 51. Terrien satisfies the Claim 1 limitations: a pre-reformer receiving "desulfurized natural gas preheated to around 600° C." upstream of the ATR without a primary reformer therebetween (1[a]), *id.* ¶74; water gas shift conversion and CO₂ separation yielding CO₂-rich and CO₂-depleted streams (1[b]), *id.* ¶¶36, 72, 78, 93; and a split of hydrogen product stream 27, a portion recovered as product and "a portion . . . used for hydrogen fueling of the feed gas producing unit (34)," a single-stream split necessarily yielding first and second streams of the same composition (1[c]), *id.* ¶¶35, 46, 78; EX1005 ¶¶ 144-148; EX1063 ¶51. To the extent the preamble and Claim 1[d]'s ammonia limitations are deemed limiting and not disclosed, applying Terrien's scheme to ammonia synthesis would have been obvious: ammonia synthesis is a canonical downstream use of Terrien's hydrogen, nitrogen is available from the air supplied to the same front end, and a POSA needed only apply the decades-old ATR-to-ammonia route the '058 Patent and KAP 2004 confirm was standard. EX1064; EX1065 at 45-46; EX1063 ¶51, App. A (Chart 1); EX1005 ¶¶155, 291-93.

XI. Substitute Claim 27 Is Unpatentable

PO acknowledges that alternative Claim 27 is substantially identical to Claim

25. Paper 34 at 3, 13. Claim 27 is therefore unpatentable for the reasons in § VIII. EX1063 ¶52, App. A (Chart 3).

XII. No Objective Indicia Support Patentability

PO's Motion identifies no objective indicia of nonobviousness attributable to the added limitations, and its expert confirmed he offers no opinion or evidence of commercial success, licensing, industry praise, copying, or long-felt need. EX1066, 69:11-70:16. The claimed furnace selections were conventional practice, disclosed in the '058 Patent in 1991 and described as "typical" by 2004; no nexus ties any purported indicia to the apparatus options the amendment adds. EX1064; EX1065 at 45; EX1063 ¶54.

XIII. Conclusion

Each Substitute Claim adds to Claim 1 only a fuel destination that was conventional in ATR-based plants decades before the Critical Date, and Petitioner's grounds match every path by which the Board may find Claims 1 and 10 unpatentable. Claim 26 additionally lacks written description support, and the Motion independently fails for proposing three substitute claims without demonstrating need—as PO's own one-for-one alternative concedes. The contingent Motion to Amend should be denied.

Respectfully submitted,

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6(e), I certify that on July 28, 2026, a true and correct copy of the foregoing Petitioner's Opposition to Patent Owner's Contingent Motion to Amend Under 37 C.F.R. § 42.121 was served by electronic mail on Patent Owner's lead and backup counsel at the following email addresses:

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