

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AIR PRODUCTS AND CHEMICALS, INC.
Petitioner,

v.

EVONIK OPERATIONS GMBH and EVONIK CORPORATION
Patent Owner.

IPR2024-00611
Patent 10,471,380 B2

Before JEFFREY W. ABRAHAM, AVELYN M. ROSS, and
MICHAEL G. McMANUS, *Administrative Patent Judges*.

McMANUS, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background and Summary

Air Products and Chemicals Inc. (“Petitioner”) filed a petition for an *inter partes* review (Paper 6)¹ (“Pet.”) challenging claims 1–23 of U.S. Patent No. 10,471,380 B2 (Ex. 1001 (“the ’380 Patent”)). Evonik Operations GmbH and Evonik Corporation (collectively, “Patent Owner”) filed a Preliminary Response. Paper 11 (“Prelim. Resp.”).

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314 (2018); 37 C.F.R. § 42.4(a)(2024). An *inter partes* review may be instituted where “the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a). For the reasons set forth below, we determine the information presented in the Petition establishes a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. Accordingly, we institute an *inter partes* review.

B. Related Matters

The parties state that the ’380 patent is at issue in one district court litigation: *Evonik Operations GMBH v. Air Products and Chemicals, Inc.*, 1:22-cv-01543-MN (D. Del.). Pet. 62; Paper 5.

C. The ’380 Patent (Ex. 1001)

The ’380 patent, titled “Process for Separation of Gases with Reduced Maintenance Costs,” issued Nov. 12, 2019, and is directed to “a specific

¹ Petitioner filed its initial Petition for *Inter Partes* Review (Paper 2) on February 23, 2024 and a Corrected Petition for *Inter Partes* Review (Paper 6), by leave of the Board, on May 1, 2024.

process and apparatus for separation of gas mixtures with reduced maintenance costs.” Ex. 1001, codes (45), (54), (57). Figure 1 of the ’380 patent is reproduced below.

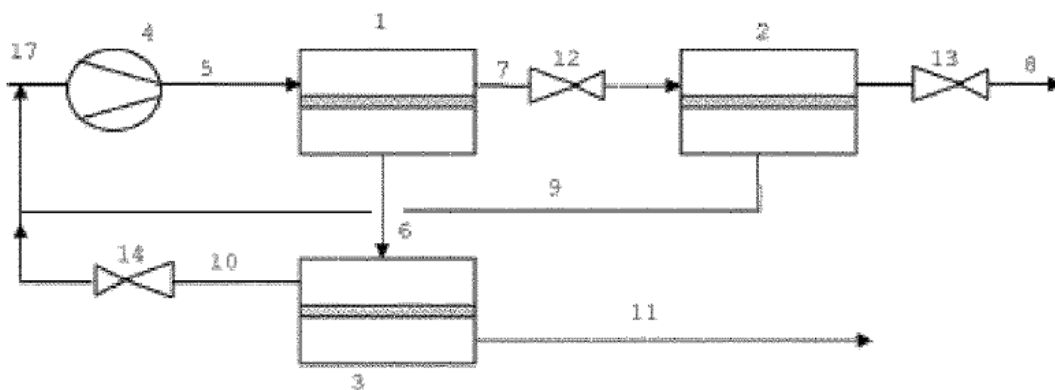


Figure 1 is described as an “[i]llustrative connection arrangement of several membrane modules according to [the] invention.” *Id.* at Fig. 1.

In the figure above, raw gas stream (17) is combined with recycled gas (streams 9 and 10) to form feed stream (5). *Id.* at 4:1–5. The feed stream passes through compressor (4) to feed stream separation stage (1). *Id.* at 4:54–60. This stage separates “the feed stream (5) into a first permeate stream (6) and a first retentate stream (7).”² *Id.* at 4:15–17. Retentate separation stage (2) separates first retentate stream (7) into second permeate stream (9) and second retentate stream (8). *Id.* at 4:18–22. Permeate separation stage (3) separates first permeate stream (6) into third permeate stream (11) and third retentate stream (10). *Id.* at 4:23–28. This general arrangement is conventional. *Id.* at 1:32–38.

The Specification of the ’380 Patent teaches that “[t]he process and the apparatus of the invention allow [one] to produce simultaneously

² The ’380 Patent uses the term “permeate” for gas that passes through a membrane and “retentate” for gas that does not pass through a membrane. Ex. 1001, 3:33–45.

retentate gas and . . . permeate gas streams, with high purity.” *Id.* at 5:61–63.

The Specification further teaches that “the process of the present invention allows [one] to reduce the membrane capacities, required in sum for all separation stages in the process. Thus, the investment costs and in particular the maintenance costs can be reduced significantly.” *Id.* at 5:64–6:3.

The ’380 Patent defines “membrane capacity” as “the product of the membrane surface and the permeance of the membrane.” *Id.* at 2:53–55. The ’380 Patent defines permeance as “material flow per time unit, area and differential pressure through a membrane.” *Id.* at 3:18–19. As a consequence, where two membranes’ “permeance is identical . . . the ratio of membrane capacities used in two separation stages correlates to the ratio of the membrane surfaces.” *Id.* at 3:3–5.

The ’380 Patent includes a discussion of the prior art. *Id.* at 1:7–44. The ’380 Patent teaches that it is conventionally known that gas mixtures can be separated by the use of membranes having different permeabilities for different gases. *Id.* at 1:7–9. The patent further teaches that the prior art includes “membrane separation processes with three membrane separation stages, wherein a retentate stream from stage 3 and a permeate stream from stage[] 2 are recycled to the crude gas stream.” *Id.* at 1:35–37. Such prior art processes are taught to be “optimized in view of product purity in combination with the lowest energy consumption” so that that they “provide two high pure product streams in an energy optimized way.” *Id.* at 1:41–44. The ’380 Patent makes reference to the Ungerank³ patent, relied on by Petitioner in support of Ground 1. The ’380 Patent states that “[t]he energy

³ U.S. Patent No. 8,999,038, published Jan. 5, 2012 (Ex. 1006).

optimized process of [Ungerank] requires higher selective membranes, which are more expensive.” *Id.* at 2:45–47.

The ’380 Patent teaches that recently a new problem has arisen that “some gas separation plants are operated at sites where energy is very cheap. At such locations the focus of operators of separation plants lies on investment and maintenance costs rather than on an energy saving.” *Id.* at 1:47–51. The ’380 Patent teaches that a “maintenance cost optimum” for three-stage membrane systems may be achieved by the following steps:

- increasing the total gas volume recycled in sum with the second permeate stream (9) and the third retentate stream (10), in combination with
- an increase of the total membrane capacity of the retentate separation stage (2) compared to the total membrane capacities of separation stage (1) and preferably also of stage (3), and
- a specific quotient of the pressure ratios of the permeate separation stage (3) over the feed stream separation stage (1).

Id. at 2:31–40 (numerals above refer to the sole figure of the ’380 Patent, reproduced above).

D. Illustrative Claim

Of the challenged claims, claim 1 is the sole independent claim. Claim 1 is illustrative and is reproduced below.

1. A method for separating gases from a crude gas stream comprising at least two components, wherein in an apparatus comprising a feed stream separation stage, a retentate separation stage and a permeate separation stage, each stage being a membrane separation stage with gas separation membranes,

- a) a feed stream is separated in the feed stream separation stage into a first permeate stream and a first retentate stream,
- b) the first retentate stream is separated in the retentate separation stage into a second permeate stream and a second retentate stream,

- c) the first permeate stream is separated in the permeate separation stage into a third retentate stream and a third permeate stream,
- d) the second retentate stream is removed as a first product,
- e) the third permeate stream is removed as a second product, and
- f) the second permeate stream and the third retentate stream are combined with the crude gas stream to give the feed stream, and wherein
- i) the combined gas volume of the second permeate stream and the third retentate stream is from 60 to 100% of the volume of the crude gas stream,
- ii) the total capacity of the gas separation membranes in the retentate separation stage is higher than the total capacity of the gas separation membranes in the feed stream separation stage, the total capacity being measured for nitrogen Grade 4.8 under standard conditions as defined in the description, and
- iii) the quotient of the pressure ratio over the permeate separation stage to the pressure ratio over the feed stream separation stage is in a range of from 0.5 to 8.

Ex. 1001, 29:61–30:55.

E. Asserted Unpatentability Challenges

Petitioner asserts that claims 1–23 are unpatentable based on the following challenges:

Claims Challenged	35 U.S.C. §	Reference(s)
1–5, 7, 9, 11–23	103	Ungerank, Scholz ⁴
1–13, 16, 17, 21, 23	103	Scholz

⁴ M. Scholz et al., *Structural optimization of membrane-based biogas upgrading processes*, Journal of Membrane Science 474, 1–10 (2015) (Ex. 1007).

Pet. 2. The Petition is supported by the declaration testimony of Dr. Richard W. Baker (Ex. 1003), Ms. June Munford (Ex. 1034), Mr. Nathaniel E. Frank-White (Ex. 1035), and Ms. Luaine Bandounas (Ex. 1036). Patent Owner's Preliminary Response is supported by the declaration testimony of Dr. Markus Ungerank (Ex. 2001).

II. ANALYSIS

A. Level of Ordinary Skill in the Art

Petitioner asserts that a person of ordinary skill in the art would have held a Master of Science degree in physical chemistry, chemistry, chemical engineering, or a related field, and had at least three years of work experience in membrane gas-separation systems, including but not limited to biogas membrane separations. Pet. 11. Patent Owner does not challenge Petitioner's proposed definition for present purposes. Prelim. Resp. 5.

For the purpose of deciding whether to institute review, we apply Petitioner's definition because, based on this preliminary record, it appears to be consistent with the disclosures of the asserted prior art references. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (providing that the prior art itself can reflect the appropriate level of ordinary skill in the art). Further, on this record, Petitioner's definition is supported by the declaration testimony of Dr. Baker, Ex. 1003 ¶¶ 57–59, and stands uncontested by Patent Owner.

B. Claim Construction

We construe the terms of a patent claim “in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). Under that standard, claim terms generally are given

their plain and ordinary meaning as would have been understood by the ordinarily skilled artisan at the time of the invention and within the context of the entire patent disclosure. *See Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc).

We expressly construe disputed claim terms as necessary to resolve the controversy. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Here, Petitioner states that no formal claim construction is necessary. Pet. 4. Patent Owner similarly states that no formal claim construction is needed. Prelim. Resp. 5.

In view of the foregoing, and upon review of the claims and the cited references, we determine that no claim construction is necessary.

C. The Patentability Challenges

1. Ground I: Obviousness of Claims 1–5, 7, 9, and 11–23 Over Ungerank in View of Scholz

Petitioner argues that claims 1–5, 7, 9, and 11–23 are unpatentable as obvious over Ungerank in view of Scholz. Pet. 18–43.

a. Ungerank

Ungerank is a U.S. patent titled “Process for Separation of Gas,” filed May 26, 2011, and issued April 7, 2015, to Evonik Fibres GmbH. Ex. 1006, codes (22), (45), (54), (73). The lead inventor is Markus Ungerank. *Id.*, code (75). Markus Priske, the sole inventor of the ’380 Patent, is also named as an inventor of Ungerank. *Id.*, code (75); Ex. 1001, code (72). Figure 11 of Ungerank is identical to Figure 1 of the ’380 Patent. *Compare* Ex. 1006, Fig. 11, *with* Ex. 1001, Fig. 1.

Ungerank addresses three stage gas separation systems with selective membranes. In this context, “selectivity” describes the degree to which a

membrane will preferentially allow one gas to permeate relative to another.⁵

Ungerank teaches that “[m]embranes of higher selectivity have the advantage that the separation becomes more effective and less permeate has to be recycled” thus “it is necessary to compress less gas twice, which entails economic advantages in the operation of the plant.” Ex. 1006, 9:14–20. Ungerank further teaches that “the inventive operation can be conducted in a much more economically viable manner with more selective membranes, and the necessary size of the compressor and the energy required can be reduced.” *Id.* at 9:31–34.

Ungerank teaches that the amount of recycled gas should be less than 60 percent by volume of the crude gas stream. Specifically, Ungerank states:

The process according to the invention or the inventive apparatus is notable particularly in that it is configured such that the gas volume recycled in the second permeate stream (9) and in the third retentate stream (10) totals less than 60% by volume, preferably to 50% by volume, most preferably 20 to 40% by volume, of the volume of the crude gas stream (17).

Id. at 7:19–24.

Ungerank includes one comparative example (“Comparative Example 1”) as well as four inventive examples. *Id.* at 10:17–14:43. Comparative Example 1 describes a system having the connection arrangement of Ungerank’s Figure 11, where “[t]he sum of recycled gas streams (9) and (10) is . . . 86.7%.” *Id.* at 10:62–63.

Comparative Example 1 further describes certain pressure values at various points in the system. *Id.* at 10:36–39, 53–56.

⁵ Ungerank states that “[t]he quotient of the permeances of the individual gases gives the selectivity of the membrane for separation with regard to the two gases.” Ex. 1006, 3:47–49.

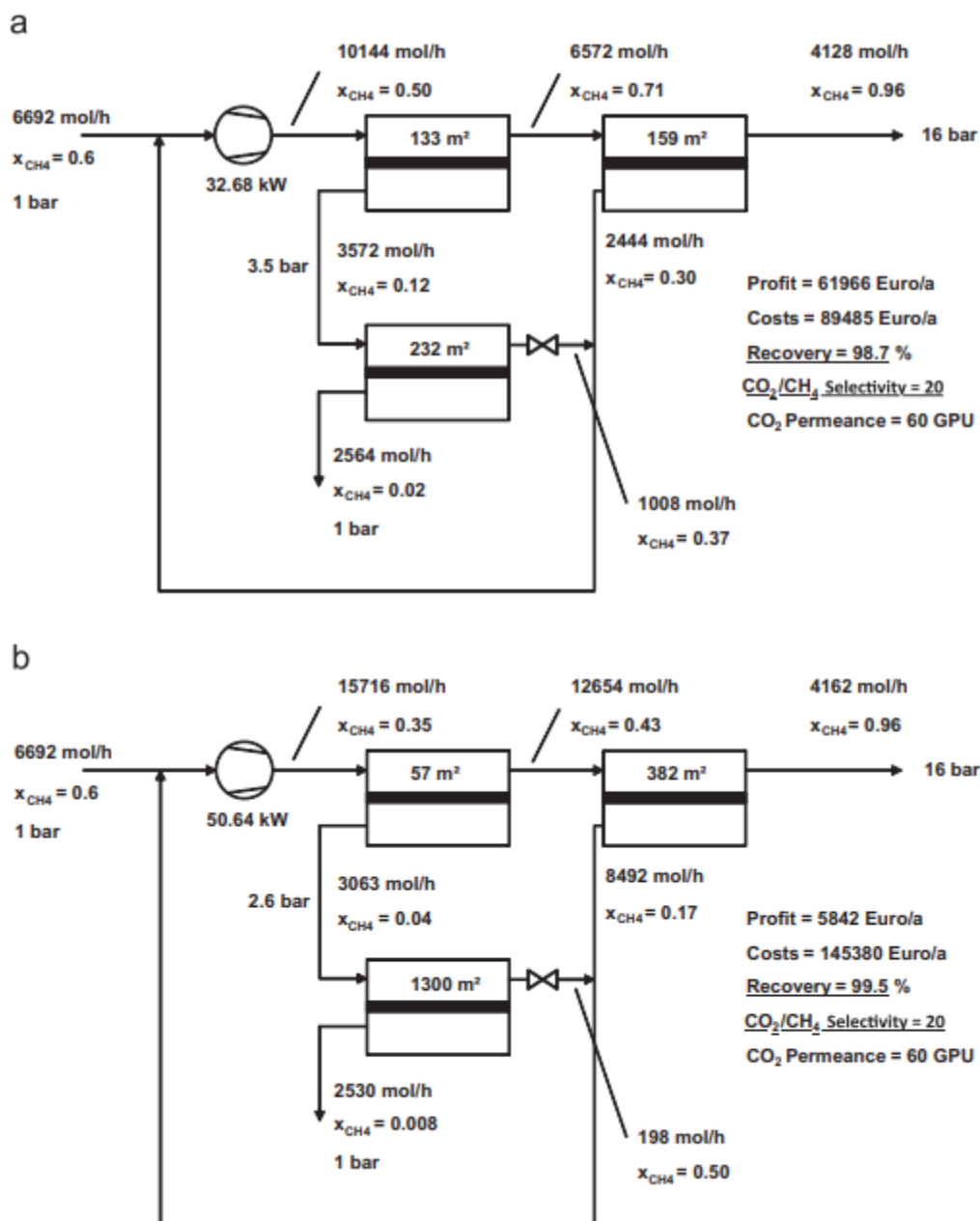
b. Scholz

Scholz is a journal article titled *Structural optimization of membrane-based biogas upgrading processes*. Ex. 1007, 1. Scholz was published in the Journal of Membrane Science in 2015. *Id.* at 1. Petitioner asserts that “Scholz was available by at least October 2014 on the www.sciencedirect.com website.” Pet. 3.

Scholz states that “[c]ommonly, the design of multistage gas permeation processes relies on heuristics and experience, so that often sub-optimal separation processes are designed. We apply a structural optimization approach to biogas upgrading processes.” Ex. 1007, 1 (Abstract). Scholz further states that “[h]ere, (i) the optimal process configuration, (ii) the required membrane areas in the various stages and (iii) the pressure to drive the gas permeation process for a commercial membrane material are determined simultaneously.” *Id.* at 1. Scholz teaches that “[i]n general, feed gas conditions, product gas requirements and economic parameters such [as] product gas pressure and energy costs considerably determine the optimal process configuration.” *Id.* at 2.

While Scholz states that its process model can be adapted to various gas separation problems (e.g., separation of helium from natural gas), its simulations each concern the separation of carbon dioxide (CO₂) and methane (CH₄). *Id.* The Scholz membranes preferentially allow the permeation of carbon dioxide such that “CO₂ will permeate faster through the membrane so that the permeate is enriched in CO₂. Thus, CH₄ is enriched on the retentate side of the membrane.” *Id.*

Figures 7(a) and (b) of Scholz are reproduced below.



Scholz describes Figures 7(a) and (b) as “[o]ptimal process design and process conditions for gas permeation membranes with a CO_2/CH_4 selectivity of 20 and a CO_2 permeance of 60 GPU. (a) The required CH_4 recovery is higher than 95%. (b) The required CH_4 recovery is higher than 99.5%.” Ex. 1007, 7.

In both Figure 7(a) and 7(b) the membrane surface area and, thus, the membrane capacity (given that the membranes have the same permeance) of the retentate stage membranes (159 m² in Figure 7(a) and 382 m² in Figure 7(b)) is greater than that of the feed stage membranes (133 m² in Figure 7(a) and 57 m² in Figure 7(b)).

c. Analysis

i. Claim 1

Petitioner argues that claim 1 would have been obvious over Ungerank in view of Scholz. Pet. 18–32. Petitioner generally asserts that all limitations of claim 1 are taught by Ungerank other than limitation 1 f.ii which concerns the ratio of the capacity of the gas separation membranes in the retentate separation stage to the capacity of the gas separation membranes of the feed stream separation stage. *Id.* at 25–29. Petitioner relies on Scholz as teaching limitation 1 f.ii. *Id.* at 29. Petitioner further argues that one of skill in the art would have had reason to combine the teachings of Ungerank’s Comparative Example 1 and Scholz’s Figure 7 (*id.* at 19–24), and a reasonable expectation of success in doing so (*id.* at 24–25).

Patent Owner does not meaningfully address Petitioner’s reliance on Ungerank Comparative Example 1 as teaching claim elements 1[a] through 1[f]. Nor does Patent Owner directly dispute that Ungerank’s Comparative Example 1 teaches limitations 1 f.i (recycle volume) and 1 f.iii (pressure ratio quotient). *See, e.g.*, Prelim. Resp. at 21, 26. Neither does Patent Owner meaningfully dispute Scholz’s disclosure in Figure 7 of a retentate stage having greater surface area and, thus, greater capacity at constant permeance than that of the feed stream separation stage. *See, e.g., id.* at 19–20; *but see id.* at 35 (including a general statement that Scholz does not teach any of

claim elements 1f.i, 1f.ii, or 1f.iii). Accordingly, Patent Owner relies on its arguments relating to reason to combine and reasonable expectation of success.

1. Petitioner's Contentions

With respect to reason to combine, Petitioner asserts that three-stage membrane separation systems were well known prior to the critical date. Pet. 5; Ex. 1003 ¶ 67. Petitioner further asserts that the use of lower selectivity membranes in such systems was known to be generally less expensive than higher selectivity gas separation membranes. *Id.* at 7. Petitioner cites Scholz for the proposition that “[f]or high selectivity [membranes], permeance drops which increases the required membrane area remarkably,” resulting in “higher investment costs and membrane replacement costs [that] reduce the profitability[.]” *Id.* at 20 (quoting Ex. 1007, 4).

Petitioner indicates that the use of lower-selectivity membranes typically required that a greater amount of gas was compressed and, as a consequence, more energy was expended. *Id.* at 7–8. Petitioner cites Ungerank for the proposition that “[m]embranes of higher selectivity have the advantage that the separation becomes more effective and less” gas “has to be recycled” making it “necessary to compress less gas twice, which entails economic advantages in the operation of the plant” and that “with more selective membranes...the necessary...energy required can be reduced.” *Id.* at 19 (quoting Ex. 1006, 9:14–20, 9:31–34). Thus, Petitioner argues, there was a known tradeoff between the expense of higher selectivity membranes and the increased compression and energy costs associated with lower selectivity membranes. *Id.* at 20, 22.

Petitioner argues that there was also a known need for systems employing lower selectivity, lower cost membranes prior to the critical date. *Id.* at 20. Petitioner asserts that one exemplary environment where lower-selectivity separation membranes were used is offshore platforms where smaller membranes were used due to weight concerns and low-cost energy was readily available. *Id.*; Ex. 1003 ¶ 125.

Petitioner argues that a person of ordinary skill in the art who sought to make a system with lower-cost, lower-selectivity membranes would have initially looked to the teachings of Ungerank's Comparative Example 1 because it describes a three-stage single compressor system which Scholz describes as profitable. Pet. 22. Petitioner further argues that, because Ungerank's Comparative Example 1 is silent as to membrane surface area, one would look to Scholz for guidance as to membrane size and size ratios. *Id.* at 19, 23; Ex. 1003 ¶¶ 134–136. Petitioner asserts that one would have looked to Scholz, in part, because Scholz sought to optimize its processes “**including membrane areas.**” Pet. 23–24 (quoting Ex. 1007, Abstract) (emphasis in Petition). Similarly, Petitioner directs us to Scholz's teaching that its Figure 7 indicates “[o]ptimal process design and process conditions for gas permeation membranes with a CO₂/CH₄ selectivity of 20 and a CO₂ permeance of 60 GPU.” *Id.* at 29–30 (quoting Ex. 1007, 7 (Figure 7 caption)).

Petitioner additionally argues that a person of ordinary skill in the art would have had a reasonable expectation of success in combining the teachings of Ungerank and Scholz. Pet. 24–25. Petitioner asserts that the references' detailed information as well as their similarities in gases separated and selectivity of membranes would have made success in combining their teachings likely. *Id.* at 24–25. Petitioner further directs us to

Scholz's teaching that its "process model can easily be adapted to other gas separation problems . . . to determine the most profitable process configurations." *Id.* at 25 (quoting Ex. 1007, 2).

Petitioner relies on Scholz's Figure 7 as teaching limitation 1f.ii, which requires that "the total capacity of the gas separation membranes in the retentate separation stage is higher than the total capacity of the gas separation membranes in the feed stream separation stage." *Id.* at 29–31; Ex. 1001, 30:47–50 (claim 1). The '380 Patent defines membrane capacity as "the product of the membrane surface and the permeance of the membrane" at standard conditions. Ex. 1001, 2:53–57. Thus, according to the '380 Patent, for membranes of the same permeance, "the ratio of membrane capacities used in two separation stages correlates to the ratio of the membrane surfaces." *Id.* at 3:3–5. Scholz describes the membranes of Figure 7 as having "a CO₂ permeance of 60 GPU." Ex. 1007, 7 (Figure 7 caption). Thus, Petitioner asserts, they are of equal permeance. Pet. 29.

In Scholz's Figure 7(a), the surface areas of the retentate and feed stages are 159 m² and 133 m², respectively. Ex. 1007, 7. In Scholz's Figure 7(b), the surface areas of the retentate and feed stages are 382 m² and 57 m², respectively. *Id.* Petitioner argues that "[b]ecause the surface areas of the retentate stages are greater than the surface areas of the feed stages, and because for these systems, surface area is proportional to capacity, both systems meet" limitation 1f.ii. Pet. 30. Petitioner concludes that, for at least the foregoing reasons, "the Ungerank-Scholz combination teaches and/or suggests this limitation and would have rendered it obvious to a [person of ordinary skill in the art]." *Id.* at 31.

2. Patent Owner's Contentions

Patent Owner takes issue with the Petition on a number of bases.

Patent Owner asserts that “nowhere is it stated in the ’380 Patent disclosure that: (1) lower selective, lower cost membranes should be used to minimize investment and maintenance costs (Petition at 1), or that: (2) using lower selectivity membranes leads to lower costs.” Prelim. Resp. 9. Patent Owner further asserts that “[n]o portion of the ’380 Patent mentions anything about low-cost, lower selectivity membranes.” *Id.* at 10. Thus, Patent Owner argues, “when Petitioner alleges that Evonik was focused on cheaper and lower selectivity membranes . . . this constitutes an error as to the motivations of the Patent Owner and to those of one skilled in the art.” *Id.* Patent Owner indicates that it would be more accurate to state that “costs for membranes can be reduced by using a lower number of modules, *i.e.*, by reducing the required membrane capacity.” *Id.* at 11.

Patent Owner argues that Petitioner overgeneralizes where it states that the use of lower-selectivity membranes usually results in the need to compress more gas. *Id.* at 13 (citing Pet. 7). In support, Patent Owner directs us to several examples in the ’380 Patent where membranes with a selectivity of 20 were used. *Id.* at 14 (citing Ex. 1001, Examples 1.1, 1.2, Comparative Example, and Reference Example 1). Patent Owner asserts that, in the cited examples, the recycling rate varies between 49% and 98%, and thus, it is apparent that factors other than membrane selectivity may affect the quantity of gas recycled. *Id.* Patent Owner further asserts that Ungerank and Scholz both show various examples where identical membranes result in differing recycling rates depending upon other factors. *Id.*

Patent Owner further argues that Petitioner inappropriately uses membrane area as a proxy for capacity. *Id.* at 16. Patent Owner argues that Petitioner mischaracterizes Scholz based on such inappropriate use of membrane area. *Id.* at 17. Additionally, Patent Owner contends that the optimization taught by Scholz should not be viewed as teaching the membrane capacity limitation. *Id.*

Patent Owner argues that both Ungerank and Scholz teach away from the disclosures relied upon by Petitioner. *Id.* at 19–21. According to Patent Owner, Ungerank teaches one to use higher selectivity membranes in order to reduce recycle volumes. *Id.* at 19. Patent Owner thus argues that one of ordinary skill in the art would not have looked to Ungerank’s Comparative Example (using low selectivity membranes) as it is contrary to the main teachings of Ungerank. *Id.* at 19–20. Similarly, Patent Owner argues that one of ordinary skill in the art would not have looked to Scholz’s Figure 7 because Scholz identifies the process of Figure 5 as the most profitable. *Id.* at 20.

Patent Owner further argues that one of ordinary skill in the art would not have been motivated to combine Ungerank with Scholz. *Id.* at 21–27. Patent Owner reiterates its view that Ungerank and Scholz teach to use higher-selectivity membranes. *Id.* at 23. Accordingly, Patent Owner reasons, one of ordinary skill would not have looked to Ungerank’s Comparative Example or Scholz’s Figure 7 which each employ lower-selectivity membranes. *Id.* at 22–23. Patent Owner also reiterates its view that both Ungerank and Scholz teach away from the use of lower-selectivity membranes. *Id.* at 24. Patent Owner again disputes Petitioner’s “erroneous assumption that lower selectivity membranes are cheaper.” *Id.* at 25.

Patent Owner further asserts that any combination of Ungerank and Scholz's Figure 7(a) would result in "a process with a recycling rate of only 51%," (Scholz's Figure 7(a) has a recycle rate of 51%) which is below the range of claim 1. *Id.* at 26. Patent Owner states that it is "technically wrong to allege, as Petitioner does, that all parameters of Ungerank's Comparative Example 1, including the recycling ratio and pressure-ratio quotient therein, could be kept constant if simultaneously the membrane areas are chosen as in Scholz's Figure 7(a)." *Id.* at 26. Patent Owner further states that "Scholz's Figure 7(a) shows that if the membrane areas are not identical in all stages, the result is a recycling ratio and pressure-ratio quotient **different** from that of Ungerank's Comparative Example 1." *Id.* Accordingly, Patent Owner argues, the method of claim 1 is more than a "predictable technical solution." *Id.* at 27.

Patent Owner additionally argues that one of ordinary skill in the art would not have had a reasonable expectation of success in combining the teachings of Ungerank and Scholz. *Id.* at 27–33. Patent Owner argues that the "optimization" taught by Scholz is not the optimization of the recycle volume, membrane capacity, and pressure-ratio quotient required by claim 1. Thus, there is not a reasonable expectation that one would achieve the requirements of the claim. *Id.* at 29.

Although not relied upon by Petitioner in support of Ground I, Patent Owner nonetheless discusses Petitioner's arguments regarding Scholz's disclosure of the recycling rate limitation. *Id.* at 29–31. Patent Owner states that the system shown in Figure 7(a) of Scholz results in a recycling rate of 51%, while the system of Figure 7(b) results in a recycling rate of 135%, which each fall outside the claimed range of 60–100%. *Id.* at 29. Patent Owner further states that the quotient of the pressure ratio over the permeate

separation stage to that of the feed stream stage of Figure 7(b) is 0.42, outside of the scope of claim 1 (limitation 1 f.iii). *Id.*

Patent Owner additionally argues that “Scholz put his own ideas into the known process described by Ungerank’s Comparative Example 1” and that the resulting method is reflected by Figures 7(a) and 7(b) which do not meet all limitations of claim 1. *Id.* at 33.

3. *Whether Petitioner has Demonstrated a Reasonable Likelihood of Prevailing*

“In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring inter partes review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). Further, Petitioner bears the “burden to demonstrate both that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention[s], and that the skilled artisan would have had a reasonable expectation of success in doing so.” *In re Magnum Oil Tools, Int’l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Cir. 2016) (citation and internal quotation omitted). Having reviewed the parties’ arguments and evidence of record, we are persuaded that Petitioner demonstrates sufficiently that Ungerank and Scholz teach or suggest each limitation in claim 1. Petitioner also sets forth sufficient reasoning with a rational underpinning as to why one of ordinary skill in the art would have combined the teachings of Ungerank and Scholz in the manner recited in claim 1, with a reasonable expectation of success, so as to show a reasonable likelihood of prevailing.

Petitioner directs us to the portions of Ungerank and Scholz that correspond to the limitations recited in claim 1, as well as testimony from its declarant supporting its contention that the references disclose the limitations in claim 1. Pet. 25–32 (citing Ex. 1003 ¶¶ 143–166). We are also persuaded, at least for present purposes, by Petitioner’s contention, and supporting evidence, that a person of ordinary skill in the art would have looked to Scholz’s Figure 7 to supply information regarding the appropriate membrane capacity/surface area to implement the teachings of Ungerank’s Comparative Example 1. Pet. 29; Ex. 1003 ¶¶ 156–157.

Petitioner makes a sufficient showing that one of skill in the art would have understood that the use of higher-selectivity membranes results in the advantage of a reduced need to recycle gas through the system and, thus, reduced energy expense. Pet. 19. Similarly, Petitioner argues persuasively that one of skill in the art would have understood that higher-selectivity membranes require more membrane area and, thus, result in disadvantageous greater initial investment and ongoing maintenance costs. *Id.* at 20. Where one seeks to reduce initial costs, the use of lower-cost, lower-selectivity membranes appears reasonable. *Id.* at 21.

Based on the present record, we agree with Petitioner’s contention that one seeking to design a system employing lower-cost, lower-selectivity membranes would have looked to Comparative Example 1 of Ungerank which employs relatively lower-selectivity membranes (selectivity of 20) and achieves “[p]ure product streams . . . with a relatively high double compression rate.” Ex. 1006, 10:64–66; Pet. 22. As Ungerank’s Comparative Example 1 is silent regarding membrane surface area, a designer of a system employing lower-cost, lower-selectivity membranes would have reason to look to Scholz for guidance regarding membrane area.

Pet. 23; Ex. 1003 ¶ 134. Scholz's Figure 7 states that the figure illustrates "[o]ptimal process design and process conditions for gas permeation membranes with a CO₂/CH₄ selectivity of 20 and a CO₂ permeance of 60 GPU." Ex. 1007, 7 (Figure 7 caption).

On the present record, we find Patent Owner's arguments that both Ungerank and Scholz teach away from the use of low selectivity membranes or would have led one of ordinary skill in the art away from the method of claim 1 to be unavailing. Prelim. Resp. 19–27. Patent Owner asserts that Ungerank teaches to use membranes having a high selectivity rather than a lower selectivity. *Id.* at 19–20. Patent Owner further asserts that Scholz teaches that a system employing high selectivity membranes (as shown in Scholz's Fig. 5) is more profitable than the system using lower selectivity membranes shown in Figure 7. *Id.* at 20.

It is true that both Ungerank and Scholz include teachings indicating the benefits of higher-selectivity membranes. Such teachings, however, have not been shown to "teach away" from the relied upon teachings.

A reference does not teach away if it "does not criticize, discredit, or otherwise discourage investigation into the invention claimed." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1327 (Fed. Cir. 2009) (cleaned up). The Federal Circuit has explained that "a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine." *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). "The fact that the motivating benefit comes at the expense of another benefit ... should not nullify its use as a basis to modify the disclosure of one reference with the teachings of another. Instead, the benefits, both lost and gained, should be

weighed against one another.” *Winner Int’l Royalty Corp. v. Wang*, 202 F.3d 1340, 1349 n.8 (Fed. Cir. 2000).

Here, Ungerank teaches that, employing the method of the Comparative Example, “[p]ure product streams are obtained with a relatively high double compression rate.” Ex. 1006, 10:64–66. Further, Scholz teaches that the systems of Figure 7 represent “[o]ptimal process design and process conditions” for given methane recovery rates. Ex. 1007, 7 (Fig. 7 caption). While both references indicate the benefits of higher selectivity membranes, the teachings cited by Patent Owner do not rise to the level of discouragement necessary to support a finding of teaching away. Rather, one of skill in the art would weigh the costs and benefits of lower-selectivity and higher-selectivity membranes in a given context.

Moreover, the prior art teachings regarding the utility of higher-selectivity membranes do not negate prior art teachings regarding lower-selectivity membranes. Obviousness “does not require that the motivation be the best option, only that it be a suitable option from which the prior art did not teach away.” *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1197–98 (Fed. Cir. 2014); *see also In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (“[O]ur case law does not require that a particular combination must be the preferred, or the most desirable, combination described in the prior art in order to provide motivation for the current invention.”). Thus, absent a teaching away, Ungerank’s and Scholz’s disclosures regarding high selectivity membranes do not obviate their remaining teachings.

Further, Patent Owner’s contentions regarding the lack of any teaching in the ’380 Patent regarding low-cost, low-selectivity membranes, (Prelim. Resp. 9) appear to be in tension with the Specification (Ex. 1001, 2:45–47 (“The energy-optimized process of WO 2012/00727 requires higher

selective membranes, which are more expensive”). Nor does Patent Owner persuasively rebut Petitioner’s assertion that, in three-stage systems, lower-selectivity membranes usually require the compression of more gas. Prelim. Resp. 13–14; *cf.* Ex. 2001 ¶¶ 37, 43. Nor does Patent Owner show any specific error arising from Petitioner’s use of the terms “capacity” and “surface area.” Prelim. Resp. 16–17.

Patent Owner’s argument that the recycle volume or pressure quotient ratio taught by Ungerank’s Comparative Example would be impacted by the hypothetical combination with the membrane properties of Scholz may have some merit. *See* Prelim. Resp. at 26 (“It is also technically wrong to allege . . . that all parameters of Ungerank’s Comparative Example 1 . . . could be kept constant if simultaneously the membrane areas are chosen as in Scholz’s Figure 7(a).”). On the present record, however, such contention is insufficiently supported to negate Petitioner’s showing.

Patent Owner additionally argues that one of ordinary skill in the art would not have had a reasonable expectation of success in achieving the method of the claim. Prelim. Resp. 27–33. In support of its contention, Patent Owner argues that Scholz’s disclosure regarding recycling rates and pressure ratios teach a method falling outside the scope of claim 1. *Id.* at 29–30. This part of Scholz’s disclosure, however, does not form part of Petitioner’s argument articulated in Ground I. *See* Pet. 28. Patent Owner further discusses *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775 (Fed. Cir. 1985). Prelim. Resp. 30. Such discussion, however, appears to be directed to a portion of that decision concerning anticipation rather than

obviousness.⁶ Accordingly, Patent Owner’s arguments regarding reasonable expectation of success are unavailing.

For all of the foregoing reasons, upon review of Petitioner’s and Patent Owner’s arguments and supporting evidence, we determine that Petitioner has shown that there is a reasonable likelihood it would prevail in demonstrating that claim 1 would have been obvious over the teachings of Ungerank and Scholz.

ii. Claims 2–5, 7, 9, and 11–23

Claims 2–5, 7, 9, and 11–23 depend directly or indirectly from claim 1. Petitioner directs us to portions of Ungerank and Scholz that disclose or suggest the limitations in these claims. Pet. 32–43. At this stage of the proceeding, Patent Owner does not meaningfully dispute whether the references disclose or suggest the additional limitations of the dependent claims. *See* Prelim. Resp. 18 (simply listing additional limitations of certain dependent claims.). In view of the absence of substantive contentions from Patent Owner, we leave for trial the issue of whether Petitioner establishes a reasonable likelihood that claims 2–5, 7, 9, and 11–23 would have been obvious over Ungerank in view of Scholz.

⁶ Patent Owner asserts that the relevant claims at issue in *Titanium Metals* “recited 0.2–0.4% molybdenum and 0.6–0.9% nickel.” Prelim. Resp. 30. Claim 1 of the *Titanium Metals* patent includes such recitation. Claim 1, however, was rejected as anticipated rather than as obvious. *See Titanium Metals Corp. of Am. v. Banner*, 778 F.2d 775, 780 (Fed. Cir. 1985) (stating that “we are left with the propriety of the rejection of claims 1 and 2 under § 102 and the rejection of claim 3 under § 103); *see also In re Patel*, 566 F. App’x 1005, 1009–10 (Fed. Cir. 2014) (discussing *Titanium Metals*).

2. *Ground II: Obviousness of Claims 1–13, 16, 17, 21, and 23 Over Scholz*

Petitioner additionally argues that claims 1–13, 16, 17, 21, and 23 are unpatentable as obvious over Scholz. Pet. 43–61.

a. *Claim 1*

Petitioner argues that claim 1 would have been obvious over Scholz. Pet. 43–52. Petitioner argues that Scholz discloses the preamble (to the extent it is limiting) and claim limitations 1a through 1f. *Id.* at 42–47. Patent Owner does not contest Scholz’s disclosure of these claim elements at this stage of the proceeding. Prelim. Resp. 35.

Petitioner argues that limitation 1f.i (requiring that the volume of recycled gas be 60–100% of the volume of the crude gas stream) is taught by the disclosure of Scholz’s Figures 7(a) and 7(b). Pet. 47–50. The recycle volume of Scholz’s Figure 7(a) is 51% while that of Figure 7(b) is 135%. *Id.* at 48 (citing Ex. 1003 ¶ 205). Petitioner argues that, because the claimed range falls between these two values, it would have been *prima facie* obvious. *Id.* (citing *Titanium Metals*, 778 F.2d at 781–83). Petitioner further argues that one of ordinary skill would have understood that “varying the recycle percentage within and around the range between the Figure 7 systems (a) and (b) would have a predictable effect on product recovery and operating costs.” *Id.* at 48. Petitioner additionally contends that the high purity permeate stream of Scholz’s Figure 7(b) (0.008 retentate) would be unnecessary in most applications and, thus, a person of ordinary skill would have had reason to modify the system to achieve a lesser purity and thereby reduce the volume of gas recycled. *Id.* at 49–50.

Petitioner relies on the reasoning it presents in connection with Ground I with respect to claim element 1f.ii. *Id.* at 51.

Petitioner argues that limitation 1 f.iii (requiring that the quotient of the pressure ratio of Stage 3 over that of Stage 1 falls within a range from 0.5 to 8) is disclosed by Scholz's Figure 7(a) which teaches a quotient of 0.77. *Id.* at 51. Petitioner additionally asserts that Figure 7(b) discloses a quotient of 0.42, and thus, under *Titanium Metals*, the claimed range overlaps the prior art range and is presumptively obvious. *Id.* Petitioner further argues that one of ordinary skill in the art would have understood that "varying pressure ratios (and thus 3/1 pressure ratio quotients) affects cost in predictable ways" and that "because of the 3/1 pressure ratio quotients' impact on membrane costs, a POSITA would have been motivated to avoid extreme 3/1 pressure ratio quotients." *Id.* (citing Ex. 1003 ¶¶ 214, 215).

Patent Owner argues that claim 1 would not have been obvious over Scholz for several reasons. Prelim. Resp. 33–45. First, Patent Owner asserts that Scholz does not teach or suggest the key features of claim 1: recycle volume; membrane capacity; and pressure-ratio quotient. *Id.* at 35.

Second, Patent Owner argues that a person of ordinary skill in the art would not have had reason to modify Scholz as proposed by Petitioner. *Id.* at 35–41. Patent Owner argues that Petitioner's proposed basis for combination relies upon the "mistaken assumption that one of ordinary skill in the art would believe that lower selectivity membranes are necessarily cheaper than higher selectivity membranes; as well as an erroneous interpretation of the meaning of the term 'membrane capacity.'" *Id.* at 35–36.

Patent Owner asserts that Scholz lacks any teaching regarding reduction of costs or space requirements arising from reducing the number of membrane modules or reduced membrane capacity. *Id.* at 36–37. Patent Owner further asserts that there is no teaching in Scholz to optimize the

recycle volume, membrane capacity, or pressure-ratio quotient so as to achieve the claimed values. *Id.* at 37.

Patent Owner further directs us to Scholz's teaching that "the optimal process configuration presented here, is identified by applying the boundary conditions set here [and] . . . is most likely not optimal ***for the entire range of parameters.***" *Id.* at 38 (emphasis in Prelim. Resp.). Accordingly, Patent Owner argues, Scholz provides no guidance as to what different boundary conditions should be varied to optimize such process configurations." *Id.*

Patent Owner cites to the following portion of Scholz:

The energetic optimum can be fairly different from the economic optimum. In this study we determined the most profitable process configuration taking both, the operational costs, mainly caused by electrical energy consumption, and investment costs for the compression equipment and the membrane modules into account.

Prelim. Resp. 39 (quoting Ex. 1007, 3–4). Patent Owner argues that this passage teaches away from the selection of the particular boundary conditions recited in the claims of the '380 Patent. *Id.* at 39. Patent Owner further directs us to Scholz's teaching that "the process equipped with membrane materials with CO₂/CH₄ selectivity of 60 has higher profit and lower cost than the process with low selective membranes." *Id.* at 40 (citing Ex. 1007, 9). Patent Owner argues that such teaching would have led one of skill in the art to optimize the methods of Scholz using higher selectivity membranes. *Id.* Petitioner further argues that one of skill in the art would have had reason to follow the teachings of Scholz's Figure 5 due to its low investment costs and high profit relative to Figures 7(a) and (b). *Id.* at 40–41.

Patent Owner additionally argues that one of ordinary skill in the art would not have had a reasonable expectation of success in modifying Scholz so as to achieve the claimed process. *Id.* at 41–45. Patent Owner argues that Petitioner errs in its reliance on *Titanium Metals* to achieve the recycling volume and pressure-ratio quotient limitations. *Id.* at 42–43. Patent Owner asserts that Scholz, taken as a whole, would have led a person of ordinary skill in the art toward a system more like that of Scholz’s Figure 5 due to its profitability. *Id.* at 43. Figure 5 of Scholz teaches a system having a low recycling volume. *Id.* Thus, Patent Owner argues, one would not have achieved the method of the claims. *Id.*

The Panel has some concerns with Petitioner’s analysis regarding the recycling limitation and the pressure ratio limitation. Petitioner, relying on *Titanium Metals*, argues that the “range” of recycling values, Pet. 48, and quotients of the pressure ratios, *id.* at 51–52, taught by Scholz’s Figures 7(a) and (b) are sufficient to support a prima facie case of obviousness.

In *Titanium Metals*, the Patent Office rejected a claim as obvious. *Titanium*, 778 F.2d at 776. On review, the Federal Circuit found that the prior art “discloses two alloys having compositions very close to that of claim 3, which is 0.3% Mo and 0.8% Ni, balance titanium. The two alloys in the prior art have 0.25% Mo—0.75% Ni and 0.31% Mo—0.94% Ni, respectively.” *Id.* at 783. There, the Federal Circuit stated that “[t]he proportions are so close that prima facie one skilled in the art would have expected them to have the same properties.” *Id.* In the present matter, there is some ambiguity as to whether Petitioner has shown that one skilled in the art would have expected the systems of Figures 7(a) and 7(b) to have the same properties as the claimed system.

Because Petitioner meets the threshold for institution by demonstrating a reasonable likelihood that at least claim 1 is unpatentable as obvious on the basis set forth in Ground I, we need not decide whether Petitioner's second ground demonstrates the same with respect to claim 1. That determination, in our view, is best left for trial upon a fully developed record.

b. Claims 2–13, 16, 17, 21, and 23

Claims 2–13, 16, 17, 21, and 23 depend directly or indirectly from claim 1. Petitioner directs us to portions of Scholz that disclose or suggest the limitations in these claims. Pet. 52–61. At this stage of the proceeding, Patent Owner does not meaningfully dispute that Scholz discloses or suggests the additional limitations in claims 2–13, 16, 17, 21, and 23. We leave for trial the issue of whether Petitioner establishes that claims 2–13, 16, 17, 21, and 23 would have been obvious over Scholz.

D. Discretion Whether to Institute

Petitioner argues that the Board should not exercise its discretion to deny institution under 35 U.S.C §§ 314(a) or 325(d). Pet. 62–69. Patent Owner does not address discretionary denial. In view of the absence of argument from Patent Owner and minimal evidence bearing upon discretionary denial, we determine that there is no basis for discretionary denial.

III. CONCLUSION

Based on the arguments and evidence presented by the parties, we determine that there is a reasonable likelihood Petitioner would prevail with respect to at least one claim challenged in the Petition. Hence, we institute

an *inter partes* review of all challenged claims on all challenges included in the Petition. *See* 37 C.F.R. § 42.108(a) (“When instituting *inter partes* review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim.”); *see also SAS Inst. Inc. v. Iancu*, 138 S. Ct. 1348, 1355 (2018) (noting that the language of 35 U.S.C. § 314(b) “indicates a binary choice—either institute review or don’t”).

At this preliminary stage, we have not made a final determination about the patentability of any challenged claim, the construction of any claim term, phrase, or limitation, or any other legal or factual issue.

IV. ORDER

Accordingly, it is ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–23 of the ’380 Patent is instituted on all challenges included in the Petition; and

FURTHER ORDERED that, according to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial that commences on the entry date of this decision.

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Patent 10,471,380 B2
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