

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ADVANCED ENERGY INDUSTRIES INC.,
Petitioner,
v.

RENO TECHNOLOGIES INC.,
Patent Owner.

IPR2021-01397
Patent 10,707,057 B2

Before JO-ANNE M. KOKOSKI, CHRISTOPHER M. KAISER, and
WESLEY B. DERRICK, *Administrative Patent Judges*.

DERRICK, *Administrative Patent Judge*.

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

I. INTRODUCTION

Advanced Energy Industries Inc. (“Petitioner”) filed a Petition (Paper 2, “Pet.”) requesting an *inter partes* review of claims 1–17 of U.S. Patent No. 10,707,057 B2 (Ex. 1001, “the ’057 patent”). Reno Technologies Inc. (“Patent Owner”) filed a Preliminary Response to the Petition (Paper 6, “Prelim. Resp.”).

Under 35 U.S.C. § 314(a), 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.”¹ Upon consideration of the arguments and evidence presented by Petitioner and Patent Owner, we are persuaded that Petitioner has demonstrated, under 35 U.S.C. § 314(a), a reasonable likelihood that it would prevail in showing the unpatentability of at least one of the challenged claims. Accordingly, we institute an *inter partes* review of the challenged claims.

A. *Related Proceedings*

The Parties do not identify any related matter involving the ’057 patent. Pet. 4; Paper 4, Section B. Petitioner identifies IPR2019-00248 that challenged “a parent to the ’057 Patent,” US Patent No. 9,496,122 B1. Pet. 4; Ex. 1015 (Decision Denying Institution).

B. *The ’057 Patent*

The ’057 patent, titled “RF Impedance Matching Circuit and Systems and Methods Incorporating Same,” is directed to a radio frequency (RF) impedance matching circuit configured to be coupled between an RF source and a plasma chamber. Ex. 1001, codes (54), (57). The impedance

¹ By regulation, the Director has delegated the decision whether to institute trial to the Board. 37 C.F.R. § 42.4(a).

matching circuit includes first and second electronically variable capacitors (EVCs) and a control circuit. *Id.* at code (57). A control circuit determines a first and second capacitance value for the first and second EVC, respectively, and generates a signal for the first and second EVCs “to alter the first variable capacitance accordingly, causing the RF power reflected back to the RF source to decrease while the frequency of the RF source is not altered.” *Id.*

C. Challenged Claims

Petitioner challenges claims 1–17 of the ’057 patent. Pet. 1. Claims 1, 4, 10, and 12 are independent claims. Claim 1 is illustrative of the subject matter at issue and is reproduced below:

1. A radio frequency (RF) impedance matching circuit comprising:
 - an RF input configured to operably couple to an RF source providing an RF signal having a frequency;
 - an RF output configured to operably couple to a plasma chamber;
 - a first electronically variable capacitor having a first variable capacitance;
 - a second electronically variable capacitor having a second variable capacitance; and
 - a control circuit operably coupled to the first and second electronically variable capacitors to control the first variable capacitance and the second variable capacitance, wherein the control circuit is configured to:
 - determine a first parameter related to the plasma chamber;
 - determine, based on the first parameter, a first capacitance value for the first electronically variable capacitor and a second capacitance value for the second electronically variable capacitor; and

generate a control signal to alter the first variable capacitance and the second variable capacitance to the first capacitance value and the second capacitance value, respectively;

wherein the alteration of the first variable capacitance and the second variable capacitance cause RF power reflected back to the RF source to decrease while the frequency of the RF source is not altered.

Ex. 1001, 52:33–60.

D. The Asserted Grounds of Unpatentability

Petitioner asserts that claims 1–17 would have been unpatentable on the following eight grounds:

References/Basis	35 U.S.C. §	Claim(s) Challenged
Mavretic, ² Mason ³	103	1, 2, 4, 5, 9–13, 16, 17
Mavretic, Mason, Navigator II ⁴	103	3, 6–8, 14, 15
Mavretic, Mason, Howald ⁵	103	3, 6, 8, 14

Petitioner relies on the Declaration of Steven H. Voldman, Ph.D. (Ex. 1002).

II. ANALYSIS

A. Discretion Under 35 U.S.C. § 325(d)

Patent Owner urges the Board to exercise its discretion under 35 U.S.C. § 325(d) to deny institution, arguing that the Petition presents the same or substantially the same art or arguments previously presented to the Office. Prelim. Resp. 34–41.

² U.S. Patent No. 5,654,679, issued Aug. 5, 1997 (Ex. 1004).

³ U.S. Patent No. 8,436,643 B2, issued May 7, 2013 (Ex. 1005).

⁴ *Navigator® II Matching Networks With a Solid-State Technology Option*, presented by Advanced Energy Industries, Inc. at SEMICON West 2012 (“Navigator II”) (Ex. 1006).

⁵ U.S. Patent No. 6,259,334 B1, issued July 10, 2001 (Ex. 1007).

We have discretion to deny review when “the same or substantially the same prior art or arguments previously were presented to the Office.” 35 U.S.C. § 325(d). In that respect, section 325(d) provides that the Director may elect not to institute a proceeding if the challenge to the patent is based on matters previously presented to the Office. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7 (PTAB Feb. 13, 2020) (precedential) (“*Advanced Bionics*”).

In evaluating the exercise of discretion to deny institution under § 325(d), the Board applies a two-part framework: (1) first, we determine whether the same or substantially the same art previously was presented to the Office, or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of the first part of the framework is satisfied, we examine whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims. *Id.* at 8.

In applying the two-part framework, we consider several non-exclusive factors (“the *Becton Dickinson* factors”), including:

- (a) the similarities and material differences between the asserted art and the prior art involved during examination;
- (b) the cumulative nature of the asserted art and the prior art evaluated during examination;
- (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection;
- (d) the extent of the overlap between the arguments made during examination and the manner in which petitioner relies on the prior art or patent owner distinguishes the prior art;

(e) whether petitioner has pointed out sufficiently how the examiner erred in its evaluation of the asserted prior art; and

(f) the extent to which additional evidence and facts presented in the petition warrant reconsideration of the prior art or arguments.

Becton, Dickinson & Co. v. B. Braun Melsungen AG, IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (precedential as to Section III.C.5, first paragraph) (“*Becton Dickinson*”).

Factors (a), (b), and (d) of the *Becton Dickinson* factors relate to whether the art or arguments presented in the petition are the same or substantially the same as those previously presented to the Office. *Advanced Bionics*, 10. Factors (c), (e), and (f) “relate to whether the petitioner has demonstrated a material error by the Office” in its prior consideration of that art or arguments. *Id.* Only if the same or substantially the same art or arguments were previously presented to the Office do we then consider whether petitioner has demonstrated a material error by the Office. *Id.* “At bottom, this framework reflects a commitment to defer to previous Office evaluations of the evidence of record unless material error is shown.” *Id.* at 9.

1. Same or Substantially the Same Art or Arguments

All asserted grounds rely on *Mavretic* and *Mason*. Patent Owner relies on “Patent Owner [having] cited both during prosecution” as “weigh[ing] heavily in the 325(d) analysis” in favor of denying institution. Prelim. Resp. 35. Patent Owner concedes that there was no rejection based on these references during prosecution of the ’057 patent. *Id.* at 36–37.

Petitioner contends that the citation of *Mavretic* and *Mason* as part of an Information Disclosure Statement (IDS) listing two hundred and eighty references does not suffice. Pet. 70–71; *see also* Ex. 1013, 3–13 (the listing

of references with Mavretic and Mason as entries 21 and 143, respectively). Petitioner further contends that neither Navigator II nor Howald were included in the IDS. Pet. 71.

“Previously presented art includes art made of record by the Examiner, and art provided to the Office by an applicant, such as on an Information Disclosure Statement (IDS).” *Advanced Bionics*, 7–8. Thus, citation of Mavretic and Mason on an IDS satisfies part one of the *Advanced Bionics* framework for at least the first ground.

2. *Whether the Office Erred in a Manner Material to the Patentability of Challenged Claims*

Next, we proceed to the second part of the framework set forth in *Advanced Bionics*. As discussed above, neither Mavretic nor Mason were applied in a rejection during prosecution of the '057 patent—the Examiner's consideration of both references appears limited to initialing an IDS. *See* Ex. 1013, 160, 164. Patent Owner also relies, however, on Mavretic having been used “as the primary reference in rejecting the ['057 patent's grandparent] application *twice* under section 103.” Prelim. Resp. 36; Ex. 1014, 445–455, 492–504. Regardless, there was no rejection grounded on Mavretic during prosecution of the '057 patent, and the claims in the '057 patent differ from those in the grandparent application. Thus, as to factor (c) of *Becton Dickinson*, “the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection,” the circumstances do not weigh heavily in favor of discretionary denial.

As to factors (e) and (f), “whether petitioner has pointed out sufficiently how the examiner erred in its evaluation of the asserted prior art” and “the extent to which additional evidence and facts presented in the

petition warrant reconsideration of the prior art or arguments,” respectively, the circumstances weigh against the discretionary denial of institution. As discussed below, Petitioner’s challenges show sufficiently how Mavretic discloses an impedance matching network to be placed between the RF generator and the plasma chamber, how Mason discloses using electronically variable capacitors with improved performance for use in an impedance matching network, and why one of ordinary skill in the art at the time of the invention would have modified impedance matching networks disclosed in Mavretic to include first and second electronically variable capacitors for their benefits of faster switching speed and lower cost. Pet. 25–47. Petitioner relies on the Dr. Voldman’s testimony as providing additional evidence. *Id.* at 73.

Patent Owner contends that Petitioner’s argument that the Examiner erred is limited to the purported strength of Petitioner’s grounds. Prelim. Resp. 37. Patent Owner further contends that the grounds are weak because they rely on “Petitioner’s misinterpretation of a portion of a Mason sentence that reads, ‘***The match 104 can include two or more variable capacitance elements . . .***.’” *Id.* at 38–39 (citing *id.* at 23–27). Patent Owner highlights that the complete sentence reads, “The match 104 can include two or more variable elements coupled in parallel,” omitting of “coupled in parallel.” *Id.*; Ex. 1004, 3:21–22. Patent Owner contends that this is fatal to Petitioner’s challenge. Prelim. Resp. 23–27, 37–39. Likewise, Patent Owner contends that the Petition and Dr. Voldman’s testimony does not raise additional evidence, but “mischaracterizes already-considered evidence.” *Id.* at 39–41.

As noted above, and discussed below, Petitioner’s grounds are not limited to reliance on the contended mischaracterization of Mason as disclosing two or more variable capacitors, but include reliance on its

teaching, more generally, of using electronically variable capacitors for their benefits of faster switching speed and lower costs. Similarly, Dr. Voldman's testimony is also not so limited that it has no evidentiary value, even if we were to find that Mason does not disclose an impedance matching network that includes two or more variable capacitance elements.

It is also apparent that the Examiner's reliance on Mavretic during examination of the grandparent application did not extend to the prior art impedance matching network depicted in Mavretic's Figure 1. The examiner of the grandparent application routinely refers to "RF power generator 210"—a variable frequency RF source—in Mavretic's impedance matching network. Ex. 1014, 445–55, 492–504. The prior art impedance matching network 100 depicted in Figure 1—with RF input 120—operates at a fixed frequency. Ex. 1004, 2:6–8, 2:35–37. The prior art impedance matching network 100 also uses two variable capacitors 102, 106. *Id.* at 2:6–25, Fig. 1. Mavretic's disclosure of an impedance matching network using a fixed frequency RF source and two variable capacitors 102, 106 reasonably appears to have been highly relevant, and overlooking it to be material error. *See Advanced Bionics*, 8–9 n.9 ("overlooking specific teachings of the relevant prior art" is an example of material error).

Accordingly, we decline to exercise our discretion to deny institution under § 325(d).

B. Legal Standard for Obviousness

A patent claim is unpatentable for obviousness 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) if in evidence, objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966); *see also KSR*, 550 U.S. at 407.

C. Level of Ordinary Skill in the Art

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

Petitioner contends that a person of ordinary skill in the art “was typically a person with a graduate degree in electrical engineering with knowledge of RF matching networks and plasma chamber processes,” or, alternatively, that they “could have sufficient work experience in these fields to have gained an understanding of the subject matter claimed.” Pet. 24 (citing Ex. 1002 ¶ 24).

Patent Owner does not contest Petitioner’s asserted level of ordinary skill in the art in its Preliminary Response. *See generally* Prelim. Resp.

On this record, we find Petitioner’s definition of the level of ordinary skill reasonable as to including “a person with a graduate degree in electrical engineering with knowledge of RF matching networks and plasma chamber processes.” We also recognize that work experience with RF matching networks and plasma chamber processes can likely substitute to an extent for

education, but it is unclear what levels of education and relevant work experience Petitioner contends are sufficient. However, given that the relevant testimony at this stage of the proceeding is from Dr. Voldman, who “has a Ph.D. in electrical engineering and extensive knowledge of both matching networks and plasma systems” (Pet. 24–25 (citing Ex. 1002 ¶¶ 8–17)), we need not address how work experience can substitute for education for this Decision, and so determine that the level of ordinary skill as including “a person with a graduate degree in electrical engineering with knowledge of RF matching networks and plasma chamber processes” (*id.* at 24).

D. Claim Construction

We apply the claim construction standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). *See* 37 C.F.R. § 42.100(b) (2020). Under *Phillips*, claim terms are afforded “their ordinary and customary meaning.” *Phillips*, 415 F.3d at 1312. “[T]he ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Id.* at 1313. Only terms that are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Neither party proposes an explicit construction for any claim term. Pet. 6–7; Prelim. Resp. 23.

On this record, we decline to construe any claim terms beyond the limited extent we do so below in our analysis, because it is not necessary to do so in reaching our decision on institution.

E. Asserted Obviousness over Mavretic and Mason

Petitioner challenges claims 1, 2, 4, 5, 9–13, 16, and 17 as unpatentable for obviousness over Mavretic in view of Mason. Pet. 25–61.

1. Overview of Mavretic (Ex. 1004)

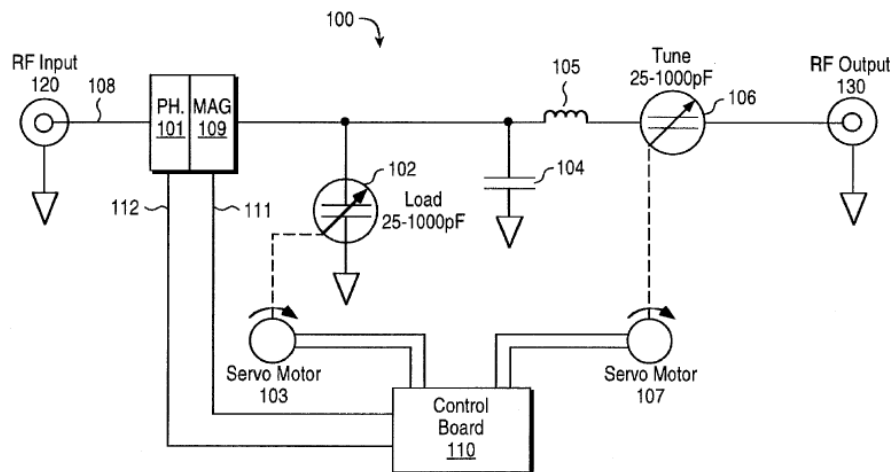
Mavretic is titled “Apparatus for Matching a Variable Load Impedance with an RF Power Generator Impedance” and is directed to “[a]n apparatus for matching the variable impedance of a load with the fixed impedance of a radio frequency (RF) power generator to provide maximum power transfer.” Ex. 1004, codes (54), (57). Mavretic issued on August 5, 1997. *Id.* at code (45). Mavretic explains that “[m]aximum power transfer bet,ween [sic, between] a generator and an attached load is achieved when the resistance of the load is equal to the internal resistance of the generator and the net reactance between the load and generator is zero.” *Id.* at 1:53–57. Mavretic further explains that “[a] net reactance of zero between the generator and the load occurs when the impedance of the load is the conjugate of the internal impedance of the generator,” and that an impedance matching network can be used to maintain a zero net reactance “as the frequency of the voltage applied by the generator to the load varies, and/or as the impedance of the load varies, so that maximum power transfer occurs between the generator and the load.” *Id.* at 1:59–2:5. Mavretic also discloses that its improved “impedance matching network . . . allows an RF power generator to vary the frequency of the voltage applied to a load, e.g., a plasma chamber as may be utilized in semiconductor or flat panel display manufacturing processes.” *Id.* at code (57).

Mavretic discloses an improved impedance matching network, which “eliminat[es] mechanical moving parts such as variable, vacuum type capacitors and servo motors in favor of an electronically controlled

impedance matching network having solid state components,” as well as a prior art impedance matching network. *Id.* at 2:6–37, 2:66–3:6, 3:13–20, 3:27–30, Fig. 1 (labeled as “prior art”).

Mavretic’s Figure 1, reproduced below, illustrates “a prior art impedance matching network [100] . . . [used] to match the impedance of the [RF power] generator and an attached load.” *Id.* at 3:27–30.

FIG. 1 (Prior Art)

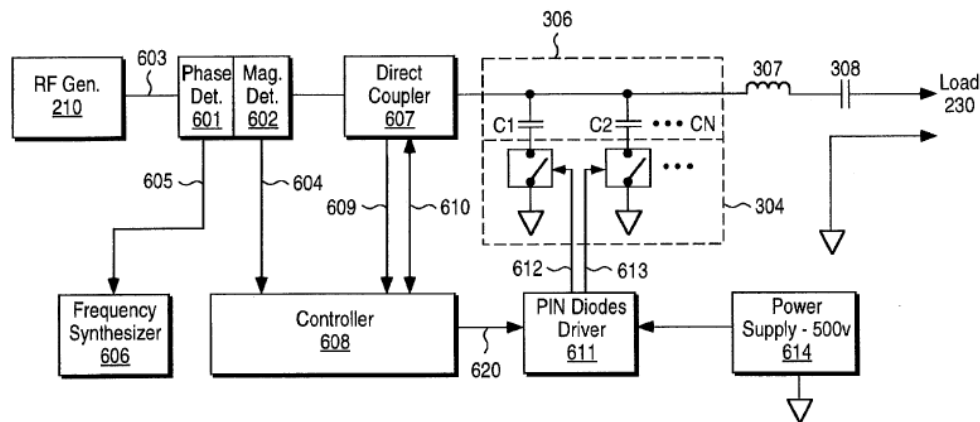


Ex. 1004, Fig. 1 (depicting an impedance matching network). Prior art impedance matching network 100 includes phase detector 101, which generates a signal over line 112, and magnitude detector 109, which generates a signal over line 111. *Id.* at 2:10–12, 2:18–20. Control board 110 receives these signals and causes servo motor 103 and servo motor 107 to turn variable capacitor 102 and variable capacitor 106, respectively, to match the impedance of the generator with the impedance of the load. *Id.* at 2:12–34. Mavretic discloses that “the prior art impedance matching network 100 is relatively slow” in matching the impedance of the generator with the impedance of the load “because of the time needed for servo motors 103 and 107 to turn capacitors 102 and 106, respectively.” *Id.* at 2:30–34. Mavretic also discloses that prior art impedance matching network 100 “does not

allow the generator to change the frequency of the applied voltage.” *Id.* at 2:35–36.

Mavretic’s Figure 6, reproduced below, illustrates “a preferred embodiment” of its improved impedance matching network. *Id.* at 3:41–42.

FIG. 6



Ex. 1004, Fig. 6 (depicting an impedance matching network connected between RF generator 210 and load 230). Mavretic’s L-type impedance matching network includes shunt capacitance 306 (also referred to as load capacitance), series inductance 307, and capacitance 308. *Id.* at 5:12–16, 6:23–34. In this depicted embodiment, “capacitance 306 . . . is electronically variable by way of PIN diode-controlled switch circuit 304.” *Id.* at 6:30–32; *see also id.* at Fig. 3 (including label for element 304).

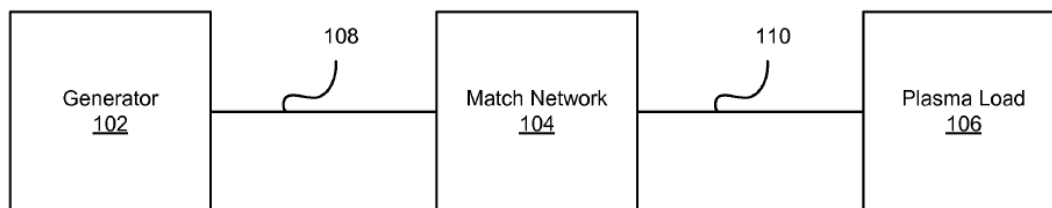
“[P]hase detector 601 samples the impedance on the transmission line 603 . . . and generates a signal 605 that controls a frequency synthesizer circuit 606,” which “adjusts, via line 630, the frequency of the applied voltage provided by the RF generator 210.” *Id.* at 7:33–39. “[M]agnitude detector 602 samples impedance on the transmission line 603 . . . and generates a signal 604 that switches on [via controller 608, control line 620, and PIN diode driver circuit 611] a bank of one or more . . . capacitors

comprising capacitance 306 via their respective PIN diodes, depending on the magnitude of the input impedance which varies according to the load.” *Id.* at 6:37–42, 6:66–7:2, 7:13–14. Directional coupler 607 is coupled to phase detector 601 and magnitude detector 602 and outputs signals 609 and 610 to controller 608, which uses these signals in “generat[ing] control voltages to drive [the] PIN diode driver circuit 611.” *Id.* at 6:60–7:2.

2. Overview of Mason (*Ex. 1005*)

Mason is titled “High Frequency Solid State Switching for Impedance Matching” and is directed to “a switching apparatus and method that uses a switching circuit having a pair of solid-state diodes . . . to switch a capacitor in or out of a variable capacitance element of an impedance matching network” with “[m]ultiple such switching circuits and capacitors . . . connected in parallel to provide variable impedance for the purpose of impedance matching.” *Ex. 1005*, codes (54), (57). Mason issued May 7, 2013. *Id.* at code (45).

Mason’s Figure 1, reproduced below, illustrates “a circuit diagram of a plasma processing system.” *Id.* at 2:53–54.



Ex. 1005, Fig. 1 (depicting a block diagram of a plasma processing system including “generator 102 [that] transmits RF power to [an impedance matching network] 104 via a transmission line 108 . . . and then onto [sic, on to] a plasma load 106 via an electrical connection 110”), 3:13–17, 1:19–20.

Mason discloses that its impedance matching network 104 “can include two or more variable capacitance elements coupled in parallel.” *Id.* at 3:21–22.

Mason acknowledges that variable capacitance elements are known, noting that, “such variable capacitance elements can be mechanically-varied capacitors” or “made from banks of parallel electronically switched capacitors” using “PIN diodes to switch capacitors in and out of the variable capacitance element.” *Id.* at 3:22–30. Mason explains that the “mechanically-varied capacitors . . . are bulky, slow, and expensive” compared to those made using “electronically switched capacitors, which are smaller, faster, and cheaper.” *Id.* at 3:24–29. Mason also explains that “PIN diodes can be too slow for RF power applications, or can require excessive power to accomplish the switching at acceptable speeds” and “PIN diodes are also expensive and only produced by a handful of manufacturers.” *Id.* at 1:49–54. Mason discloses an improvement in that “common and inexpensive transistors can be used to switch diodes . . . and thus switch the capacitors in and out of the variable capacitance element.” *Id.* at 3:31–34.

Mason’s Figure 2, reproduced below, “illustrates a variable capacitance element” according to its invention. *Id.* at 2:55–56.

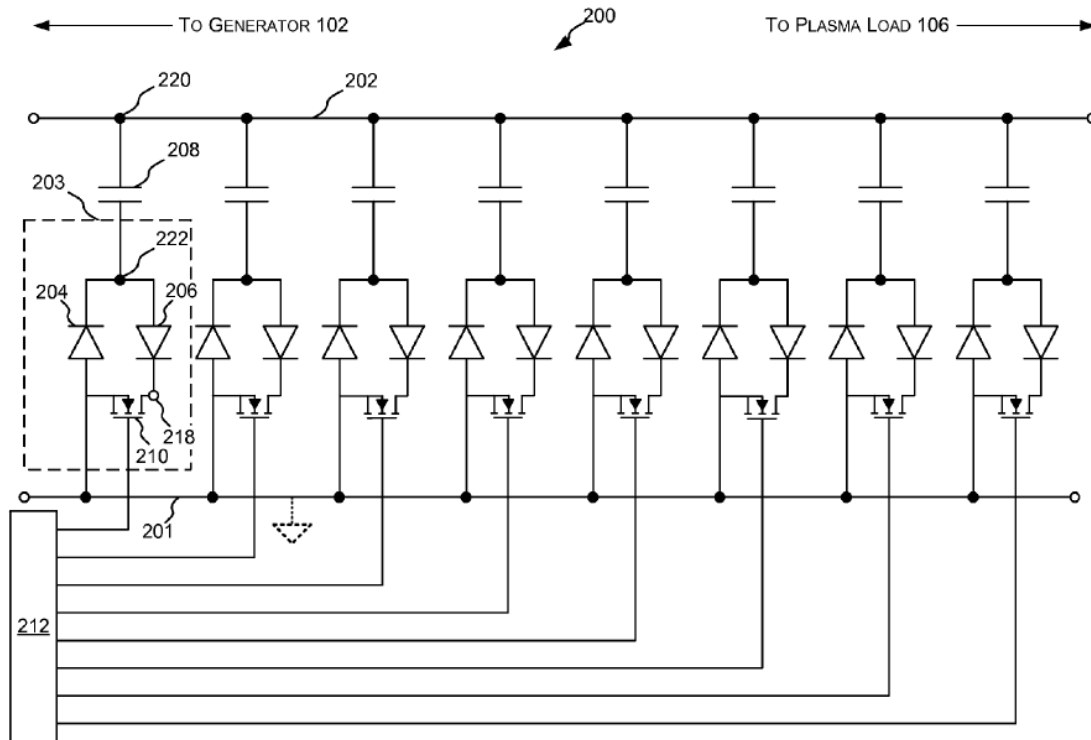


FIGURE 2

Ex. 1005, Fig. 2 (depicting a variable capacitance element for use in an impedance matching network), 1:17–21, 2:55–56. Mason’s variable capacitance element 200 comprises various switched capacitors 208 coupled in parallel with each switched capacitor 208 having a switching circuit 203 that is controlled by controller 212. *Id.* at 3:35–41, 6:31–34. Mason further discloses that “the switching in and out of each of the various switched capacitors 208 alters the impedance of the variable capacitor element 200.” *Id.* at 3:36–39.

3. Analysis

Petitioner contends that “Mavretic and Mason are analogous references with both teaching RF impedance match networks having electronically variable capacitors for plasma processing.” Pet. 25 (citing Ex. 1002 ¶ 60). Petitioner relies on Mavretic disclosing “an RF generator coupled to a plasma chamber via match networking, electronically variable

capacitor, sensors to determine network parameters, control circuit to alter the variable capacitors based on the network parameters, and processing substrates in a plasma chamber.” *Id.* (citing Ex. 1002 ¶ 60).

Petitioner relies on Mason as disclosing “an RF match network with a fixed frequency and more than one EVC” and “improved electronically variable capacitors [that] decrease the tuning time from milliseconds to microseconds,” providing “a speed improvement over RF match networks that use PIN diodes, like those used in Mavretic.” *Id.* at 26 (citing Ex. 1002 ¶ 62; Ex. 1004, 2:66–3:2, 6:31–36; Ex. 1005, 1:49–54, 3:21–34, 6:35–40, 7:46–8:32, Figs. 3, 8–11).

Petitioner highlights that Mavretic’s embodiment “us[ing] a single EVC along with a variable frequency to tune the circuit” has “an advantage in tuning speed” over the prior art impedance matching network using a fixed frequency that has two mechanically variable capacitors driven by servos. *Id.* (citing Ex. 1004, 3:48–53; Ex. 1002 ¶ 61); Ex. 1004, 2:6–50 (discussing the prior art impedance matching network and the need for an impedance matching network using fixed solid state components to rapidly adjust the input impedance of the attached load), 2:66–3:2 (disclosing the speed advantage as allowing the input impedance of the attached load to be matched very quickly, within milliseconds)).

Petitioner also highlights that despite the advantage of Mavretic’s preferred embodiment as to the tuning speed provided relative to when using mechanically variable capacitors, as illustrated in Mavretic’s Figure 1, the use of a variable frequency source has “disadvantages compared to only using variable capacitors,” namely, “a more limited impedance match range and causing interference with the operation of other equipment in the plasma processing system.” Pet. 26 (citing Ex. 1002 ¶ 61; Ex. 1012, 2:20–40).

Petitioner relies on “Mason’s improved electronically variable capacitors . . . negat[ing] the speed advantage provided by variable frequency sources,” allowing “an RF match network with a fixed frequency” that is faster than “RF match networks that use PIN diodes, like those used in Mavretic,” while avoiding “the disadvantages of using a variable frequency.” *Id.* (citing Ex. 1002 ¶ 62; Ex. 1004, 2:66–3:2; Ex. 1005, 3:21–34, 6:35–40, 7:46–8:32 and Fig. 3, 8–11); *see also* Ex. 1005, 1:49–50 (stating “such PIN diodes can be too slow for RF power applications”).

Petitioner contends that a person of ordinary skill in the art “would have reason to use two EVCs and a fixed source frequency as taught by Mason to implement a match network capable of tuning even quicker than Mavretic’s variable source frequency system while providing a broader range of impedance matching without interfering with other plasma processing equipment.” Pet. 27 (citing Ex. 1002 at ¶63); *see also id.* at 26 (discussing disadvantages of using a variable source frequency).

a) Independent claim 1

(1) A radio frequency (RF) impedance . . .

Petitioner relies on Mavretic as disclosing “[a] radio frequency (RF) impedance matching circuit.” Pet. 27–29 (citing Ex. 1004, 2:9–22, 4:10–19, 5:60–67, 6:23–34, 6:47–7:9, Figs. 2, 6; Ex. 1002 ¶¶ 68–69). Petitioner notes that “Mason is analogous art” and that it is “directed to ‘[impedance matching circuits] of a power supply for generating and sustaining a plasma in, or provided to, a plasma processing chamber.’” *Id.* at 27 (citing Ex. 1005, 3:8–12).

Patent Owner argues that “Mason is not directed to a matching network . . . [but] instead describ[es] and claim[s] a supposedly-inventive switching circuit for an electronically-variable capacitor that may be used in

a matching network.” Prelim. Resp. 2; *see also id.* at 15 (citing Ex. 1005, 2:1–29, and stating “Mason is directed to a switching circuit . . . that may form part of a matching network.”). Patent Owner argues that, while Mason’s Figure 1 illustrates an impedance matching network as “generic block 104,” it “never provides a schematic of a matching network.” *Id.* at 15.

On this record, we are persuaded that Petitioner sufficiently establishes that Mavretic discloses a radio frequency matching circuit as Mavretic is directed to “[a]n apparatus for matching the variable impedance of a load with the fixed impedance of a radio frequency (RF) power generator to provide maximum power transfer.” Ex. 1004, code (57). Petitioner also reasonably establishes, at the very least, that Mason is directed to switching circuits for use in impedance matching networks, even if it does not describe the networks in detail.

(2) *an RF input configured to . . .*

Petitioner relies on Mavretic as disclosing “an RF input configured to operably couple to an RF source providing an RF signal having a frequency; an RF output configured to operably couple to a plasma chamber.” Pet. 29–30 (citing Ex. 1004, 4:20–33, 5:60–63, Figs. 2, 3, 6; Ex. 1002 ¶ 70) (highlighting the disclosure by reference to Figures 2 and 6); *see also id.* at 35 (discussing a prior art matching network depicted in Mavretic’s Figure 1 with “RF Input 120” and “RF Output 130”).

On this record, Petitioner sufficiently establishes that Mavretic discloses these limitations as to the RF input and RF output.

(3) *a first electronically variable . . .*

Petitioner relies on both Mavretic and Mason as disclosing “a first electronically variable capacitor having a first variable capacitance,” but

more particularly on it having been obvious to one of ordinary skill in the art to use “Mason’s improved EVC” “in place of Mavretic’s slower and more expensive PIN diode based EVC.” Pet. 30–34. Petitioner contends that both “Mavretic and Mason disclosed the use and benefits of EVCs over mechanical vacuum variable capacitors.” *Id.* at 30 (citing Ex. 1002 ¶ 71; Ex. 1004, 3:13–20, 4:8–10; Ex. 1005, 3:23–29). Petitioner then contends Mason teaches a faster and cheaper EVC than “Mavretic’s slower and more expensive PIN diode based EVC” and that a person of ordinary skill in the art “would apply Mason’s . . . faster, cheaper EVC . . . in place of Mavretic’s . . . EVC.” *Id.* at 31–32 (citing Ex. 1002 ¶ 73; Ex. 1004, 4:48–51; Ex. 1005, 1:43–54, 3:29–34).

Petitioner relies on Mason’s Figure 2, reproduced below, as disclosing an improved EVC. *Id.* at 32.

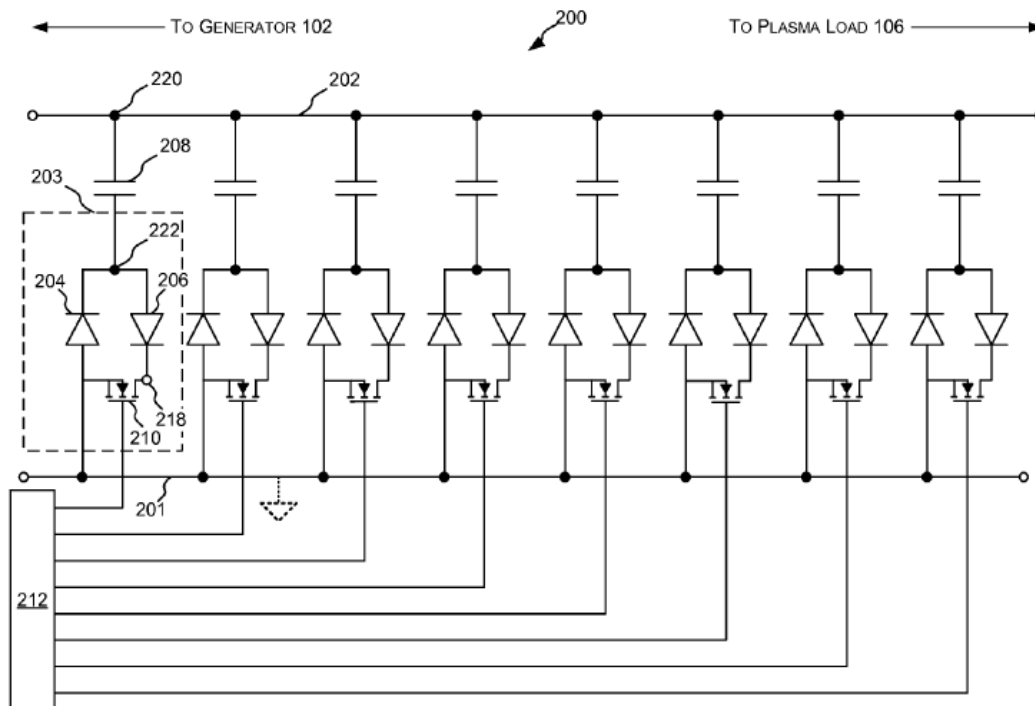
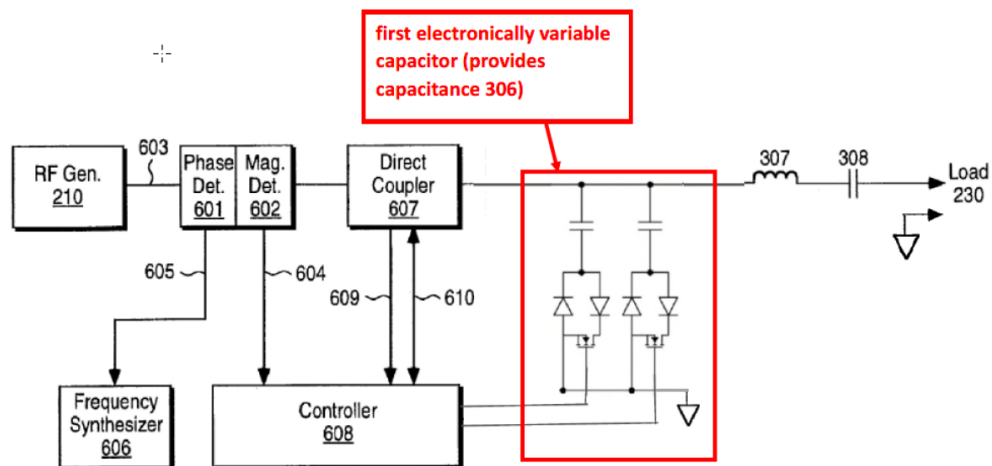


FIGURE 2

Mason’s Figure 2 depicts variable capacitance element 200. Ex. 1004, 2:55–56, Fig. 2. Petitioner relies on its disclosure of “discrete capacitors 208

having corresponding electronic switches 203 which are individually switched on or off by a signal from controller 212,” where electronic switches 203 “are solid-state components including a transistor 210 . . . and two diodes 204 and 206.” Pet. 32 (citing Ex. 1005, 3:35–51, 5:12–24, 5:37–51; Ex. 1002 ¶ 74).

Petitioner provides a figure, reproduced below, that “illustrates *one way* a [person of ordinary skill in the art] would view the replacement of Mavretic’s EVC, including the associated PIN driver and power supply circuitry, with Mason’s improved EVC having autobiased diodes.” *Id.* at 33 (citing Ex. 1002 ¶ 75) (emphasis added).



**Illustration of Mavretic’s RF matching network
incorporating Mason’s electronically variable capacitor**

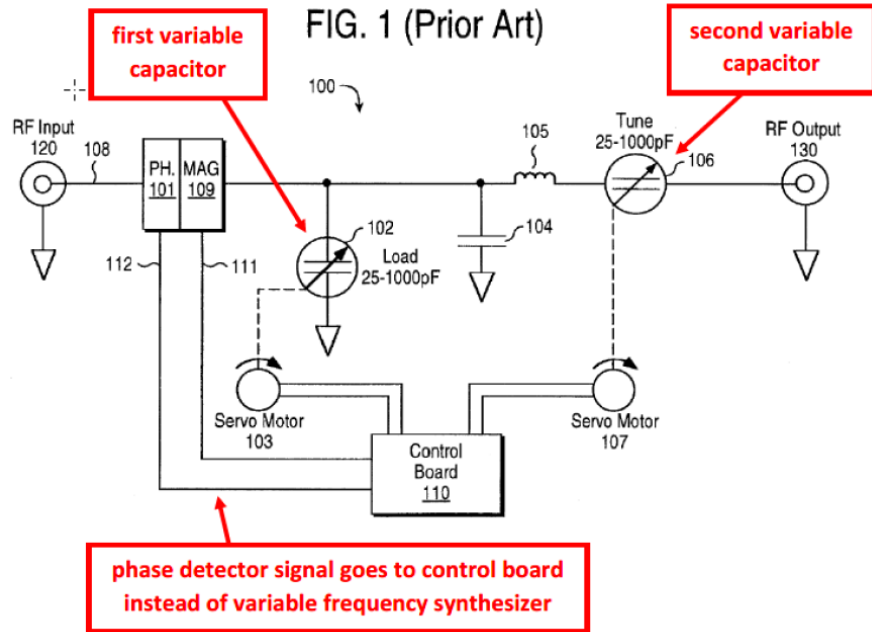
Pet. 33 (reproducing “Illustration of Mavretic’s RF matching network incorporating Mason’s electronically variable capacitor”). Petitioner contends that a person of ordinary skill in the art “would replace Mavretic’s EVC with Mason’s EVC to increase tuning speed, reduce power usage, and reduce costs,” that there is a “reasonable expectation of success” because it “is a simple and predictable modification,” and that this “combination

teaches a first electronically variable capacitor . . . having a first variable capacitance.” *Id.* at 34 (citing Ex. 1002 ¶¶ 76–77).

At this stage of the proceeding, Patent Owner does not address Petitioner’s proposed substitution of Mavretic’s EVC with Mason’s EVC. *See* Prelim. Resp.

(4) *a second electronically variable . . .*

As to “a second electronically variable capacitor having a second variable capacitance,” Petitioner relies on Mason teaching “using ‘two or more variable capacitance elements’ where each of the ‘variable capacitance elements can be made from banks of parallel electronically switched capacitors” and Mavretic acknowledging that “a matching network with two vacuum variable capacitors and fixed frequency source . . . was known prior art.” Pet. 34–35 (citing Ex. 1004, 2:6–35, Fig. 1; Ex. 1005, 3:21–29, 3:35–51, 6:35–40, 7:46–8:32, Figs. 3, 8–11; Ex. 1002 ¶¶ 78–79). Petitioner further notes that the prior art impedance matching network, depicted in Petitioner’s annotated version of Mavretic’s Figure 1, reproduced below, differs from Mavretic’s variable frequency embodiment in that “the phase detector signal goes directly to the controller to determine what capacitance values to alter the variable capacitors to.” *Id.* at 35 (citing Ex. 1002 ¶ 79).



Ex. 1004 at Figure 1 (annotated)

Pet. 35 (reproducing Mavretic's Figure 1 of fixed frequency impedance matching network with two variable capacitors annotated with arrows identifying the first variable capacitor, the second variable capacitor, and the location where the phase detector signal goes to the control board instead of the variable frequency synthesizer).

Petitioner contends that, “[t]o obtain a substantial match for both the real and imaginary values of impedance, a second degree of tuning freedom is generally required and may be provided by a second variable capacitor or a variable source frequency.” Pet. 36 (citing Ex. 1002 ¶ 80; Ex. 1008, 17–20). Petitioner contends that a person of ordinary skill in the art “would have implemented Mason’s teaching of a second EVC with a fixed source frequency to increase the matching range while eliminating the potential interference with other equipment or circuits.” *Id.* (citing Ex. 1002 ¶ 81); *see also id.* at 26 (discussing benefits of using variable capacitors over a

variable source frequency and how Mason's improved EVCs negate the speed advantage provided by variable source frequency sources).

Petitioner also relies on Mason's EVCs allowing their capacitance values to be altered so fast (within microseconds) as compared to Mavretic's EVCs to support its contention that a person of ordinary skill in the art "would understand that implementing Mason's EVCs in Mavretic would substantially increase the tuning speed, compensating for any tuning speed lost by switching from a variable frequency to a fixed frequency" and that using Mason's two EVCs with a fixed frequency would also "reduc[e] interference with other electronic circuits." *Id.* at 36–37 (citing Ex. 1002 ¶ 82; Ex. 1004, 2:66–3:2, 6:31–36; Ex. 1005, 1:49–54, 6:35–40, 7:46–8:32, Figs. 8–11).

Petitioner contends that a person of ordinary skill in the art "would immediately discern at least two alternative implementations based on well-known matching network topologies for L-type and Pi-type matching networks," each adding a second variable capacitor and removing the frequency synthesizer in Mavretic's preferred embodiment. Pet. 37 (citing Ex. 1002 ¶ 83; Ex. 1004, 2:9–16, Fig. 1; Ex. 1008, 12; Ex. 1010; Ex. 1011). Petitioner provides a diagram, reproduced below, to illustrate the L-type matching network, reproduced below.

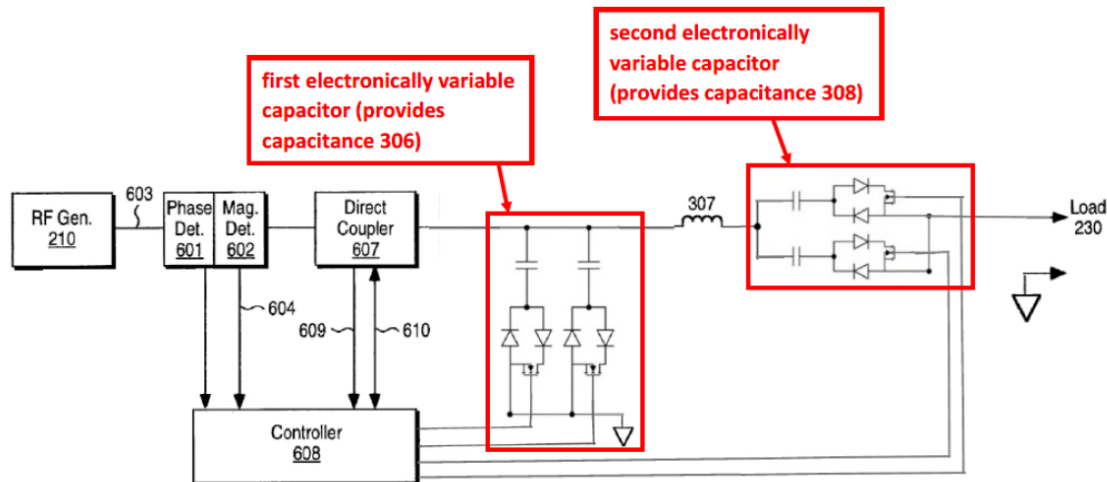


Illustration of combined matching network in L-type topology

Pet. 38 (depicting a combined matching network in L-type topology, annotated with Petitioner’s identification of the first and second electronically variable capacitors). Petitioner also contends that “[t]he L-type topology is nearly identical to the topology shown in the ‘prior art’ example of Mavretic, except that two of Mason’s EVCs are used instead of the two vacuum variable capacitors shown in Mavretic Figure 1.” *Id.* (citing Ex. 1002 ¶ 84; Ex. 1004, 2:6–37, Fig. 1). Petitioner also contends that implementing an “L-type . . . RF matching network as illustrated above is a routine and predictable implementation to a [person of ordinary skill in the art] and very likely to succeed given the well-known nature of these two matching network topologies.” *Id.* at 38–39 (citing Ex. 1002 ¶ 84; Ex. 1008, 12; Ex. 1010, Ex. 1011).

Patent Owner contends that Petitioner relies on “Mason teach[ing] a fixed frequency matching circuit that uses more than one faster switching electronically variable capacitor,” but that “Mason does not teach this.” Prelim. Resp. 1 (quoting Pet. 2–3). Patent Owner highlights that Petitioner relies on Mason stating that an impedance matching network “can include

two or more variable capacitance elements,” and that this “omits the rest of the sentence [in Mason] that states, ‘coupled in parallel.’” *Id.* (citing Ex. 1005, 3:22–23). In full, the sentence reads, “The match 104 can include two or more capacitive elements coupled in parallel.” Ex. 1005, 3:22–23. In this sentence, “match 104” is an impedance matching network. *Id.* at 1:19–21 (“an impedance-matching network (‘match’) is often used to match the load impedance to a desired input impedance”). Patent Owner argues that Mason’s disclosure of “capacitance elements . . . coupled in parallel” does not teach or suggest two electronically variable capacitors in an impedance matching network. Prelim. Resp. 1–2, 23–25, 25–27, 43–47, 53–56. Patent Owner thus contends that there is no teaching or suggestion in the combination of Mavretic and Mason to use two EVCs in an impedance-matching network. *Id.* at 41–56.

Patent Owner sets forth two sets of arguments. The first does not explicitly contest that Mason at least nominally discloses two EVCs.⁶ The second does.

Patent Owner contends that Petitioner’s substitution of both the EVC and fixed second capacitor in Mavretic’s Figure 6 with Mason’s EVCs is a “sleight of hand” that the Board should reject. *Id.* at 41–53. Patent Owner argues that Mason fails to suggest using two EVCs in any matching network

⁶ Although not squarely raised in the body of the argument for denying institution on the merits, Patent Owner raises elsewhere that two electronically variable capacitors coupled in parallel are the functional equivalent of a single electronically variable capacitor. Prelim. Resp. 2 (“coupling two electronically variable capacitors in parallel . . . would be the functional equivalent of a single electronically variable capacitor.”)), 40 (“Coupling two EVCs in parallel would simply be the functional equivalent of making a larger single EVC since EVCs are made-up of parallel fixed capacitors.”).

because it is “directed to a supposedly-inventive switching circuit for an EVC for use in an impedance matching network” and only “describes a generic matching network with respect to its figure 1”—a block diagram including “Match Network 104”—“in the context of explaining why use of the disclosed switching circuit supposedly is an improvement,” where the focus throughout Mason is on the switching circuit. *Id.* at 42–43 (citing *id.* at 13–16 (Section III.D.); Ex. 1005, codes (54) (Title), (57) (Abstract), 2:1–3, 2:15–17, 2:30–32, 3:22–23, 3:41–54, Figs. 1–2, 4, 5–6). Patent Owner argues that Mason does not suggest “using an EVC in place of Mavretic’s fixed capacitor 308 because fixed capacitor 308 is not . . . ‘coupled in parallel’ with Mavretic’s EVC 306.” Prelim. Resp. 44–45.

Patent Owner’s argument is, in effect, that the two EVCs according to Mason must be arranged in the same manner when combined with Mavretic as they are in Mason, i.e., in parallel. Prelim. Resp. 44–45. On this record, Patent Owner does not adequately explain why a person of ordinary skill in the art would understand EVCs taken from Mason for use in another impedance matching network would necessarily be arranged in parallel, or how this otherwise undercuts Petitioner’s challenge. Petitioner’s proposed combination of Mavretic and Mason largely relies on Mavretic as disclosing the topology of the combined matching network, on Mason for its disclosure of improved EVCs, and on it being known in the art to use a fixed frequency with two variable capacitors. Pet. 30–39. “The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference Rather, the test is what the combined teachings of those references would have suggested to those of ordinary skill in the art.” *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)

(citations omitted). On this record, we disagree that Mason’s disclosure is limited to teaching the improved EVCs coupled in parallel.

Patent Owner also argues that “the Petition actually proves that it was not obvious to use an EVC in place of fixed second capacitor 308 because, if it was obvious, a skilled artisan would have done so to avoid using a variable-frequency RF source.” Prelim. Resp. 45–47 (citing *id.* at 4–7 (Section III.A.); *see also id.* at 12–13 (discussing Mavretic’s failure to use two adjustable EVCs despite the disadvantages of variable-frequency RF sources). In support of this contention, Patent Owner argues that Mavretic uses only one variable EVC and a variable frequency RF source in the improved impedance matching network depicted in Figure 6, rather than simply replacing the two mechanically variable capacitors in the prior art fixed frequency impedance matching network depicted in Figure 1, despite the inherent advantages of a fixed frequency source. *Id.* at 46–47.

On this record, we are persuaded that Petitioner sufficiently establishes that using Mason’s faster EVCs with microsecond switching speeds increases the switching speed such that a variable RF source is not required. *See* Pet. 26, 31–32, 36–37. Although Patent Owner contests other aspects of Mason’s disclosure, it does not substantively contest that the switching speed is not fast enough. *See* Prelim. Resp. We see no apparent inconsistency in the requirement for a variable frequency RF source with slower-switching PIN diode-based EVCs used in Mavretic.

Patent Owner also argues that if Mason actually disclosed “using two EVCs as the first and second capacitors in a matching network, obviating any need for a variable-frequency RF source, then . . . Mason would have touted this great benefit,” but “Mason is silent.” Prelim. Resp. 47. Patent Owner also argues that Petitioner and Dr. Voldman are “flat wrong” that

“Mason ‘teaches an RF match network with a fixed frequency . . .’” *Id.* at 48–53. Patent Owner also addresses Petitioner’s contentions as to Mason’s disclosure of operation at a fixed frequency (Pet. 46), as reflecting an RF match network with at least two EVCs. In particular, Petitioner argues:

Mason teaches using a “simple sinusoidal RF signal as provided by a generator” shown graphically (Fig. 3) and on an oscilloscope (Fig. 8) with a constant frequency. Ex. 1005 at 6:35–46, 7:46–50 and Fig. 3 and 8; Ex. 1002 at ¶ 98. For example, the RF source frequency on node 220 is provided to each discrete capacitor and shown in Figure 8 as having a period of one cycle every microsecond which is a 1 MHz frequency. Ex. 1005 at 7:46–50 and Figs. 2 and 8; Ex. 1002 at ¶ 98. This 1 MHz RF source frequency shown in Figure 8 is not altered while the discrete capacitors are switched on and off as shown in Figures 9–11. Ex. 1005 at 7:51–8:32 and Figs. 9–11; Ex. 1002 at ¶ 98. As discussed above, turning on or off the switches associated with the discrete capacitors is what alters the first and second variable capacitance. Ex. 1005 at 3:35–50 and 6:31–34; Ex. 1002 at ¶ 98. Thus, a [person of ordinary skill in the art] understands that Mason teaches to not alter the frequency while altering the capacitance of the EVCs. Ex. 1002 at ¶ 98.

Pet. 46; Prelim. Resp. 48–53 (addressing Petitioner’s argument).

Patent Owner contends that Mason’s Figure 3 fails to show a fixed frequency. Prelim. Resp. 49–50 (citing Ex. 1005, 7:32–38, Fig. 3). Patent Owner also argues that the Board should reject Petitioner’s contentions regarding Figures 8–11 as to the frequency remaining fixed because Mason states that the “plots . . . do not perfectly represent actual current and voltage waveforms” and there is no explanation “how it would even be possible to look at waveform plots such as those show in figures 8–11 and determine whether the frequency of the waveforms are fixed or variable.” *Id.* at 50.

Patent Owner also highlights that column 7, lines 46 to 50, of Mason fails to mention frequency. Prelim. Resp. 52–53.

On this record, we are not persuaded that Petitioner adequately establishes that Mason discloses an impedance matching circuit operating at a constant frequency. As highlighted by Patent Owner, Dr. Voldman does not sufficiently explain how he reached the conclusion that Mason’s apparatus operates at a constant frequency based on Mason’s disclosures. *See* Ex. 1002 ¶ 98. Accordingly, we give little weight to his testimony in this regard. *Velandier v. Garner*, 348 F.3d 1359, 1371 (Fed. Cir. 2003) (“It is within the discretion of the trier of fact to give each item of evidence such weight as it feels appropriate.”); *cf. Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 294 (Fed. Cir. 1985) (“Lack of factual support for expert opinion going to factual determinations, however, may render the testimony of little probative value in a validity determination.”); 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”).

Petitioner has, nonetheless, sufficiently established that it would have been obvious to use a second EVC in an impedance matching network operating at a fixed RF frequency. Pet. 34–39. Petitioner does not rely wholly on Mason for establishing the obviousness of using two EVCs. *Id.* As set forth above, Petitioner contends, in regard to an illustrated impedance matching network with two EVCs without a variable frequency RF source, that “[t]he L-type topology is nearly identical to the topology shown in the ‘prior art’ example of Mavretic, except that two of Mason’s EVCs are used instead of the two vacuum variable capacitors shown in Mavretic Figure 1.” Pet. 38 (citing Ex. 1002 ¶ 84; Ex. 1004, 2:6–37, Fig. 1). Petitioner also

contends that implementing an “L-type . . . RF matching network as illustrated . . . is a routine and predictable implementation to a [person of ordinary skill in the art] and very likely to succeed given the well-known nature of these two matching network topologies.” *Id.* at 38–39 (citing Ex. 1002 ¶ 84; Ex. 1008, 12; Ex. 1010, Ex. 1011). Petitioner also sets forth, accordingly, that it would have been obvious to one of ordinary skill in the art to substitute an EVC and fixed capacitor in Mavretic’s Figure 6 with two of Mason’s improved EVCs, allowing use of a fixed RF frequency, but also that it would have been obvious to substitute the two variable capacitors in Mavretic’s Figure 1. *Id.* at 38–39. In either case, Petitioner relies on Mason’s disclosure of improved EVCs that can be used in impedance matching circuits because the benefits of using two sufficiently fast EVCs at a fixed RF frequency instead of a single EVC and a variable frequency RF source were known to those of ordinary skill in the art, and there is un rebutted evidence that Mason’s improved EVCs with microsecond switching speeds are sufficiently fast.

Turning to Patent Owner’s second set of arguments, Patent Owner contends that Petitioner “is wrong in construing the sentence [containing the phrase “two or more variable capacitance elements”] as suggesting use of two EVCs” because “[w]hen read in the proper context, the phrase ‘two or more variable capacitance elements’ simply refers to two or more discrete capacitors of a single EVC.” Prelim. Resp. 53. Patent Owner reproduces the paragraph from Mason in which the phrase occurs, with added emphasis.

The match 104 can include two or more variable capacitance elements coupled in parallel. Often such variable capacitance elements can be mechanically-varied capacitors, which, as described above, are bulky, slow, and expensive. In the alternative, variable capacitive elements can be made from

banks of parallel electronically switched capacitors, which are smaller, faster, and cheaper than their mechanical counterparts. *Id.* (quoting Ex. 1005, 3:21–29). Patent Owner’s first argument is that the phrase “is referring to using two or more fixed (discrete) capacitors in a variable capacitor such as an EVC” because “EVCs are not coupled in parallel in a matching network . . . [as] parallel EVCs provide the same tuning degree” and “[c]oupling discrete capacitors in parallel is what enables an EVC to vary its capacitance.” *Id.* at 53–55 (citing Ex. 1004, 4:42–45; Ex. 1005, 3:25–27, Fig. 2).

Patent Owner’s second argument is that Mason “is not suggesting multiple EVCs in parallel” because what follows “two or more variable capacitance elements in parallel” is a sentence stating that “such variable capacitance elements can be mechanically-varied capacitors, which . . . are bulky, slow, and expensive,” and while mechanically-varied capacitors “are sometimes coupled in parallel to form a larger variable capacitor,” “EVCs can simply use higher-capacitance discrete capacitors to achieve a greater capacitance range.” *Id.* at 55 (citing Ex. 1005, 3:23–25; Ex. 2009, 5).

Patent Owner then appears to argue, based on the sentence of Mason that reads, ‘*In the alternative*, variable capacitance elements can be made from banks of parallel electronically switched capacitors, which are smaller, faster, and cheaper than their mechanical counterparts,’ both: that (1) “‘variable capacitive element’ always means ‘EVC’”; and (2) “‘EVC’ is not meant to be the exclusive meaning of the term ‘variable capacitance element, but an ‘alternative’ meaning from those previously discussed.” *Id.* at 55–56 (quoting Ex. 1005, 3:25–29).

On this record, we are persuaded that Mason does teach or suggest two or more EVCs in an impedance matching network. The plain language

of the contested paragraph sets forth that “[t]he [impedance matching network] 104 can include two or more *variable capacitance elements*” and that the “*variable capacitance elements* can be mechanically-varied capacitors” or, in the alternative, the “*variable capacitive elements* can be made from banks of parallel electronically switched capacitors.” Ex. 1005, 3:22–27. The fact that an EVC is comprised of parallel discrete capacitors is not contrary to the use of discrete EVCs also arranged in parallel. As to Patent Owner’s argument that EVCs are not coupled in parallel, there is no evidence of any meaning contrary to the plain language of Mason. Similarly, while it may be that mechanically-varied capacitors are more commonly arranged in parallel, Patent Owner directs us to no evidence indicating that discrete EVCs cannot also be arranged in parallel, or that there is no benefit from arranging them in parallel. Finally, as to the sentence in Mason that begins, “In the alternative,” we discern no basis in this record that it means anything more than that “variable capacitance elements can be made from banks of parallel electronically switched capacitors,” that is, as an alternative to the mechanically-varied capacitors.

Further, as set forth above, Petitioner’s challenge is sufficiently founded on the obviousness of using Mason’s faster EVCs in an impedance matching network, substituting for slower variable capacitors, including PIN diode EVCs and mechanically variable capacitors, as depicted in Mavretic’s Figure 6 and 1, respectively.

In sum, Petitioner sufficiently establishes the obviousness of using two of Mason’s EVCs in an impedance matching network for operation at a fixed frequency.

(5) *a control circuit operably . . .*

Petitioner relies on Mavretic disclosing “a control circuit operably coupled to the first and second electronically variable capacitors to control the first variable capacitance and the second variable capacitance, wherein the control circuit is configured to,” in its controller 608 in Figure 6 (or control board 110 in Figure 1) and sensors measuring characteristics on which the decision to alter capacitance values is based. Pet. 40–41 (citing Ex. 1004, 2:9–37, 6:37–42, 6:60–7:9, Figs. 1, 6; Ex. 1002 ¶¶ 86–88). Petitioner lists impedance, phase, and reflected power as particular characteristics measured by the sensors. *Id.* at 40. In association with its Figure 1, Mavretic discloses a phase detector 101 and a magnitude detector 109. Ex. 1004, 2:10–11, 2:18–19, Fig. 1.

On this record, Petitioner reasonably establishes that Mavretic teaches or suggests the recited control circuit.

(6) *determine a first parameter . . .*

Petitioner relies on Mavretic as disclosing that the “control circuit” “determine[s] a first parameter related to the plasma chamber.” Pet. 41–42. Petitioner sets forth Mavretic’s disclosure of measuring parameters and how each relates to the plasma chamber: (1) impedance (*id.* at 41 (citing Ex. 1004, 2:1–8, 6:37–45, Figs. 1, 6; Ex. 1002 ¶ 89)); (2) phase (*id.* at 42 (citing Ex. 1004, 2:9–17; Ex. 1002 ¶ 90)); (3) incident and reflected power (*id.* (citing Ex. 1004, 6:60–7:9, Ex. 1002 ¶ 91; Ex. 1010, 5–6)). Petitioner contends that it would have been obvious to implement a control circuit that determines a parameter related to the plasma chamber to improve the impedance match. *Id.* (citing Ex. 1002 ¶ 92).

On this record, Petitioner reasonably establishes that it would have been obvious to implement a control circuit that determines a parameter related to the plasma chamber.

(7) *determine, based on the first . . .*

Petitioner relies on Mavretic suggesting “determin[ing], based on the first parameter, a first capacitance value for the first electronically variable capacitor and a second capacitance value for the second electronically variable capacitor,” in that “[t]he controller’s selection of which discrete capacitors to activate is based on the parameters related to the plasma chamber as discussed previously (impedance, phase, and reflected power) in order to improve the match.” Pet. 44 (citing Ex. 1004, 2:9–30, 6:37–45, 6:60–7:9, Figs. 1, 6; Ex. 1002 ¶ 95).

On this record, Petitioner sufficiently establishes determining first and second capacitance values based on a first parameter as set forth above.

(8) *generate a control signal . . .*

Petitioner relies on Mason as disclosing “generat[ing] a control signal to alter the first variable capacitance and the second variable capacitance to the first capacitance value and the second capacitance value, respectively.” Pet. 44–45. Petitioner reasonably relies on Mason’s disclosed control signals as the combination includes two of Mason’s EVCs; contending that “the controller provides the control signal (e.g., gate signal in a FET or base signal in a BJT or IGBT) to a control terminal of the transistor to control the on off state of the transistor” (*id.* at 44 (quoting Ex. 1005, 6:31–34); citing Ex. 1002 ¶ 96)) and that “[t]urning on or off a transistor controls if the corresponding discrete capacitor is switched in or out, thereby altering the capacitance value of an EVC” (*id.* at 44–45 (citing Ex. 1005, 3:35–50; Ex. 1002 ¶ 96)).

On this record, Petitioner sufficiently establishes that the control circuit generates the control signals for altering the capacitances as required.

(9) *wherein the alteration of the first . . .*

Petitioner relies on both Mavretic and Mason as disclosing that “the alteration of the first variable capacitance and the second variable capacitance causes RF power reflected back to the RF source to decrease while the frequency of the RF source is not altered.” Pet. 45–47. Although, as discussed above, Petitioner does not sufficiently show that Mason operates at a fixed frequency, Petitioner sufficiently establishes this element. Petitioner relies on Mavretic as disclosing that a “RF matching network ‘provides maximum power transfer between an RF power generator and a load’” (*id.* at 45 (quoting Ex. 1004, 5:60–67), and that a person of ordinary skill in the art would have understood “that the purpose of an RF match network is to reduce power reflected back to the source and . . . [that it] will do so when altering the first and second variable capacitors to improve the impedance match between the RF source and the load” (*id.* at 45–46 (citing Ex. 1002 ¶ 97; Ex. 1008, 4; Ex. 1009, 5–6)). Petitioner further relies on it being obvious to one of ordinary skill in the art to use a fixed frequency when improving the impedance match because it would reduce interference with other electronic circuits. *Id.* at 47 (citing Ex. 1002 ¶ 100).

Although Patent Owner contests that Mason discloses an impedance matching network that operates at a fixed frequency, at this stage of the proceeding it does not contest that it was known to use fixed frequencies to reduce interference with other electronic circuits. *See, e.g.*, Prelim. Resp. 38 (stating “there is inherent benefit in using two variable capacitors in a matching network because such use avoids the limitations and interference

problems of variable-frequency voltage sources”) (citing *id.* 23–27 (Section V.C.)).

On this record, Petitioner reasonably establishes what is required by this phrase that states, essentially, the desired end of a radio frequency impedance matching circuit operating at a fixed frequency of decreasing the RF power reflected back to the RF source.

In sum, for the reasons discussed above, Petitioner establishes a reasonable likelihood of prevailing on this challenge with respect to claim 1.

Having determined that Petitioner demonstrates a reasonable likelihood of success in proving that at least one claim of the ’057 patent is unpatentable, the statutory threshold for instituting trial as to all challenged claims on all grounds has been met. *See SAS Inst.*, 138 S. Ct. at 1359–60; USPTO, Guidance on the Impact of *SAS* on AIA Trial Proceedings (April 26, 2018; 37 C.F.R. § 42.108(a)).

We offer the following views on other claims subject to this ground and on the remaining grounds for the parties’ consideration.

b) Other independent claims

Independent claim 4 is directed to a method of matching impedance and is essentially analogous to independent claim 1 directed to a circuit for matching impedance. *Compare* Ex. 1001, 53:1–29 (claim 4), *with id.* at 52:33–60 (claim 1). Relying on Dr. Voldman’s testimony, Petitioner argues that a person of ordinary skill in the art “would find claim 4 obvious for the same reasons as claim 1.” Pet. 51–53 (citing Ex. 1002 ¶¶ 109–110).

We note some discrepancy between the labeling for corresponding sections in claim 1 set forth in the Petition and in Dr. Voldman’s testimony. *Compare id.* at 52–53, *with* Ex. 1002 ¶ 110.

Independent claim 10 is directed to a method of manufacturing a semiconductor, and recites additional limitations related to the plasma chamber, in addition to limitations essentially analogous to corresponding sections in independent claim 1. *Compare* Ex. 1001, 53:63–54:32 (claim 10), *with id.* at 52:33–60 (claim 1). Independent claim 12 is directed to an apparatus, and is essentially analogous to claim 1 but for additional limitations corresponding to the additional limitations of claim 10. *Compare id.* at 54:39–55:3, *with id.* at 52:33–60 (claim 1), 53:63–54:4 (portion of claim 10 with “additional limitations”).

Petitioner relies on Mavretic meeting the “additional limitations” in its teachings that “the RF matching network is coupled to a plasma chamber that contains a mixture of gases that ‘may be used for etching, deposition, or cleaning target material in the plasma chamber’” (*id.* at 54–55 (citing Ex. 1004, 6:11–13, 1:13–30, 2:62–65, Fig. 2; Ex. 1002 ¶¶ 116–117)) and that “the RF power provided by the RF generator ignites the gases in the plasma chamber turning the gas into plasma” (*id.* at 55 (citing Ex. 1004, 1:41–49, 6:1–16; Ex. 1002 ¶ 118)).

On this record, Petitioner’s reliance on Mavretic for these limitations appears reasonable.

F. Asserted Obviousness over Mavretic, Mason, and Navigator II

Petitioner challenges claims 3, 6–8, 14, and 15 as unpatentable for obviousness over Mavretic in view of Mason and Navigator II. Pet. 61–67.

Patent Owner does not separately argue this ground. Prelim. Resp. 22 (“Because the combination of Mavretic with Mason underpins each ground in the Petition, this response addresses only those references.”).

We offer no comment on this ground.

G. Asserted Obviousness over Mavretic, Mason, and Howald

Petitioner challenges claims 3, 6, 8, and 14 as unpatentable for obviousness over Mavretic in view of Mason and Howald. Pet. 67–69.

Patent Owner does not separately argue this ground. Prelim. Resp. 22.

We offer no comment on this ground.

III. CONCLUSION

Based on the evidence before us, we determine Petitioner demonstrates a reasonable likelihood of prevailing in showing that at least one claim of the '057 patent is unpatentable. Accordingly, we institute an *inter partes* review on all the challenged claims and all of the grounds presented in the Petition. *See* 37 C.F.R. § 42.108(a). At this stage of the proceeding, we have not made a final determination as to the patentability of the challenged claims. Our final decision will be based on the record as fully developed during trial.

IV. ORDER

Accordingly, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review is hereby instituted as to claims 1–17 of the '057 patent with respect to all grounds set forth in the Petition; and

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

IPR2021-01397
Patent 10,707,057 B2

FOR PETITIONER:

James Murphy
Gregory Durbin
POLSINELLI PC
jpmurphy@polsinelli.com
gdurbin@polsinelli.com

FOR PATENT OWNER:

Daniel Goettle
BAKER & HOSTETLER LLP
dgoettle@bakerlaw.com

Joseph Miller
THE BELLES GROUP PC
joseph.miller@thebellesgroup.com