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Paper 41
Date: March 6, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INDUCTEV INC.,[1]
Petitioner,

v.

WITRICITY CORPORATION,
Patent Owner.

IPR2021-01165
Patent 7,741,734 B2

Before JAMESON LEE, JO-ANNE M. KOKOSKI, and SCOTT E. RAEVSKY, *Administrative Patent Judges.*

LEE, *Administrative Patent Judge*.

JUDGMENT

Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

We instituted an *inter partes* review of claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–

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[1] Petitioner recently changed its name from Momentum Dynamics Corporation to InductEV Inc. Paper 34.

70 ("challenged claims") of U.S. Patent No. 7,741,734 B2 (Ex. 1001, "the '734 patent") owned by Witricity Corporation ("Patent Owner"). Paper 9 ("Decision to Institute" or "Inst. Dec.").

We have authority to conduct this *inter partes* review under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. We determine that InductEV Inc. ("Petitioner") has proved by a preponderance of the evidence that claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–70 of the '734 patent are unpatentable.

A. Background

Petitioner filed a Petition (Paper 2 ("Pet.")) requesting *inter partes* review of claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–70 of the '734 patent. Patent Owner filed a Preliminary Response. Paper 6. We initially denied institution. Paper 7. Petitioner filed a Request for Rehearing. Paper 8. We then granted Petitioner's Request for Rehearing and instituted review. Paper 9 ("Decision to Institute" or "Inst. Dec.").

Post institution of review, Patent Owner filed a Response. Paper 21 ("PO Response"). Petitioner filed a Reply. Paper 29 ("Reply"). Patent Owner filed a Sur-Reply. Paper 33 ("Sur-Reply"). Oral hearing was held on December 15, 2022. A copy of the hearing transcript has been entered into the record. Paper 40 ("Tr.").

B. Real Parties in Interest

Petitioner identifies itself as the real party in interest. Pet. 76. Patent Owner identifies Massachusetts Institute of Technology and WiTricity Corporation as real parties in interest. Paper 3, 1.

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C. Related Matters

Petitioner and Patent Owner identify the following litigation as one in which the '734 patent is asserted: *WiTricity Corp. v. Momentum Dynamics Corp.*, No. 1:20-CV-01671-MSG (D. Del.). Pet. 76; Paper 3, 1.

D. The '734 Patent (Ex. 1001)

The '734 patent relates to using oscillatory resonant electromagnetic modes for wireless non-radiative energy transfer. Ex. 1001, 1:19–22. A first resonator structure is provided having resonant frequency ω_1, and a second resonator structure is provided having resonant frequency ω_2, separated by a distance D. *Id.* at 2:11–21. The '734 patent contemplates transferring energy non-radiatively between the first and second resonator structures through coupling of the resonant-field evanescent tails of the resonator structures. *Id.* at 2:21–26. The '734 patent defines "non-radiative" as "D is smaller than each of the resonant wavelengths λ_1 and λ_2, where c is the propagation speed of radiation in the surrounding medium." *Id.* at 2:27–29.

The '734 patent explains that radiative modes of energy transfer do not work well because (1) use of omni-directional antennas leads to wasting a vast majority of the energy into free space, and (2) directed radiation modes using lasers or highly-directional antennas require the existence of an uninterruptible line-of-sight and a complicated tracking system in the case of mobile objects. *Id.* at 1:29–38.

Claims 1 and 6 are each independent and reproduced below, with bracketed headings for claim elements corresponding to those used by Petitioner in its Petition, to facilitate discussion and analysis:

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1. [Preamble] A method of transferring electromagnetic energy comprising:

[a] providing a first electromagnetic resonator structure

[i] receiving energy from an external power supply,

[ii] said first resonator structure having a first mode with a resonant frequency ω_1,

[iii] an intrinsic loss rate Γ_1,

[iv] and a first Q-factor $Q_1 = \omega_1 / (2\Gamma_1)$,

[b] providing a second electromagnetic resonator structure

[i] being positioned distal from said first resonator structure and not electrically wired to the first resonator structure,

[ii] said second resonator structure having a second mode with a resonant frequency ω_2,

[iii] an intrinsic loss rate Γ_2,

[iv] and a second Q-factor $Q_2 = \omega_2 / (2\Gamma_2)$,

[c] transferring electromagnetic energy from said first resonator structure to said second resonator structure over a distance D that is smaller than each of the resonant wavelengths λ_1 and λ_2 corresponding to the resonant frequencies ω_1 and ω_2, respectively,

[d] wherein the electromagnetic resonator structures are designed to have $Q_1 > 100$ and $Q_2 > 100$.

Ex. 1001, 11:39–58.

6. [Preamble] An electromagnetic energy transfer system comprising:

[a] a first electromagnetic resonator structure

[i] receiving energy from an external power supply,

[ii] said first resonator structure having a first mode with a resonant frequency ω_1,

[iii] an intrinsic loss rate Γ_1,

[iv] and a first Q-factor $Q_1 = \omega_1 / (2\Gamma_1)$, and

[b] a second electromagnetic resonator structure

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[i] being positioned distal from said first resonator structure and not electrically wired to the first resonator structure,

[ii] said second resonator structure having a second mode with a resonant frequency ω_2,

[iii] an intrinsic loss rate Γ_2,

[iv] and a second Q-factor $Q_2 = \omega_2 / (2\Gamma_2)$,

[c] wherein said first resonator transfers electromagnetic energy to said second resonator over a distance D that is smaller than each of the resonant wavelengths λ_1 and λ_2 corresponding to the resonant frequencies ω_1 and ω_2, respectively,

[d] wherein the electromagnetic resonator structures are designed to have $Q_1 > 100$ and $Q_2 > 100$.

Id. at 11:64–12:18.

E. References and Other Evidence[2]

The Petition relies on the following references:

References		Date	Exhibit
Stark	Joseph C. Stark, III, *Wireless Power Transmission Utilizing a Phased Array of Tesla Coils* (2004)	Published 2004	Ex. 1006
Mecke	R. Mecke & C. Rathge, *High Frequency Resonant Inverter for Contactless Energy Transmission over Large Air Gap,* 2004 IEEE 35th Annual Power Electronics Specialists Conference (June 20, 2004)	Published June 20, 2004	Ex. 1007

[2] The '734 patent issued from Application 11/481,077, filed July 5, 2006. Ex. 1001, codes (21), (22). The '734 patent also claims priority to Provisional Application 60/698,442, filed July 12, 2005. *Id.* at code (60).

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Petitioner also relies on the Declaration and Supplemental Declaration of Darrin J. Young, Ph.D. (Ex. 1003, Ex. 1032).[3] Patent Owner relies on the Declaration of Hamid A Toliyat, Ph.D. (Ex. 2003).[4]

F. Asserted Grounds of Unpatentability

Petitioner asserts the challenged claims are unpatentable as follows:

Claims Challenged	35 U.S.C. §[5]	Basis
1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–61, 64, 67–70	103	Stark

[3] Patent Owner suggests that because Dr. Young's supplemental declaration is more than three times the length of Petitioner's Reply that it supports, Petitioner has incorporated arguments into the Reply by reference, which is prohibited under 37 C.F.R. § 42.6(a)(3). Sur-Reply 25. On that basis, Patent Owner asks that we not consider arguments improperly included only in Dr. Young's Supplemental Declaration. *Id.* The request is dismissed because Patent Owner does not specifically identify arguments that have been improperly incorporated by reference.

[4] Petitioner asserts that Dr. Toliyat's declaration should be given no weight because it "merely repeats the attorney argument of Patent Owner's Response, word-for-word." Reply 2. We disagree. A declaration that repeats the assertions in a party's brief is not for that reason alone entitled to little or no weight. We must consider whether the testimony discloses the supporting evidence in the record. *See* 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 not specifically identified any testimony of Dr. Toliyat that does not cite to supporting evidence such as the disclosure of Stark.

[5] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112–29, 125 Stat. 284, 287–88 (2011), revised 35 U.S.C. §§ 102 and 103 effective March 16, 2013. Because the parties do not dispute that the effective filing date of the '734 patent is prior to March 16, 2013 (Ex. 1001, code (22)), we refer to the pre-AIA versions of §§ 102, 103.

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Claims Challenged	35 U.S.C. §[5]	Basis
61, 62, 64, 65	103	Stark
61, 62, 64, 65	103	Stark, Mecke

II. ANALYSIS

A. The Burden of Proof on Challenged Patent Claims

Petitioner must demonstrate by a preponderance of the evidence that the challenged claims are unpatentable. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d) (2020). That burden never shifts to the patentee. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

B. Level of Ordinary Skill in the Art

Petitioner asserts that one of ordinary skill in the art in July 2005 (1) "would have had at least a bachelor's degree in electrical engineering (or equivalent) and at least two to three years of industry or equivalent research experience in the field of wireless power transfer," and (2) "would have been familiar with the use of induction to provide power or data wirelessly." Pet. 4. Patent Owner has not made its own assertion of the level of ordinary skill. PO Resp. Nor has Patent Owner expressed disagreement with Petitioner's articulation. *Id.*

In the Decision to Institute, we adopted Petitioner's articulation of the level of ordinary skill, but deleted the qualifier "at least" for the level of education and for the amount of experience, to keep the level from being vague and overbroad and extending into the level of an expert. Inst. Dec. 2; Paper 7, 6–7. Post institution, neither party objected to our determination of the level of ordinary skill in the art.

We maintain our initial determination of the level of ordinary skill in the art. In summary, one with ordinary skill in the art at the pertinent time period would have had a bachelor's degree in electrical engineering (or equivalent) and two to three years of industry or equivalent research experience in the field of wireless power transfer, and would have been familiar with the use of induction to provide power or data wirelessly.

C. Claim Construction

We use the same claim construction standard that would be used to construe a claim in a civil action under 35 U.S.C. § 282(b), including construing the 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 this standard, claim terms are generally given their ordinary and customary meaning as would be understood by one with ordinary skill in the art in the context of the specification, the prosecution history, other claims, and extrinsic evidence including expert and inventor testimony, dictionaries and learned treatises, although extrinsic evidence is less significant than the intrinsic record. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc) Only those claim terms that are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011).

Petitioner states that "no claim terms require a specific construction." Pet. 6. Patent Owner does not address claim construction in its Response. We determine that no claim term requires an express claim construction to resolve the parties' dispute. *Nidec Motors*, 868 F.3d at 1017.

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D. Alleged Obviousness of Claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–61, 64, and 67–70 over Stark

1. Principles of Obviousness

A patent claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed invention and the prior art are such that the claimed invention, as a whole, would have been obvious to a person having ordinary skill in the art to which the claimed invention 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 ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). There must be reasoning with rational underpinning to support combining teachings from multiple references. *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006).

2. Objective Evidence of Nonobviousness

Patent Owner presents evidence of nonobviousness. PO Resp. 41–46. Such evidence is discussed below in Section II.F. Although the discussion of the evidence of nonobviousness appears after Section II.D, the conclusions of obviousness we make in Section II.D are made after full consideration of the evidence of nonobviousness and based on our weighing of all of the evidence before us, both for and against obviousness. In our view, the evidence of obviousness is particularly strong and the evidence of nonobviousness is weak. On balance, the evidence of obviousness outweighs the evidence of nonobviousness.

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3. Overview of Stark

Stark is a Masters Degree thesis discussing the theory and design of coupled resonant systems and how they can be linked in a phased array for the wireless transmission of electrical power. Ex. 1006, 3. Specifically, Stark makes use of multiple Tesla coils, arranged in an array and synchronized in frequency, to generate high voltage, high frequency electrical power, to be radiated to a receiver through an antenna array. *Id.* at 11. Stark states: "this project considers a new topology of multiple, separate Tesla coils operated in synchronization so as to create an array with directional attributes." *Id.* at 12. Stark further states:

> For some applications, a focused radiation pattern would be optimal, while for others, such as nanosensors spaced about a wide area, an omnidirectional radiation pattern would be appropriate. The receiver is itself a resonant system tuned to the high frequency of the radiated power for maximum power transfer, much as a radio receiver must be tuned to a given frequency for higher reception gain.

Id. at 11–12.

In Chapter 3, Stark explains the basic component of its method and system, the Tesla coil. *Id.* at 12. Stark states:

> The second [subsequent] chapter [Chapter 3] discusses how two second order systems can be coupled to yield a single fourth order circuit with a mutual inductance coupling [of] the inductors of the two circuits. These two second order circuits are known as the primary and secondary of the Tesla coil. As the traditional Tesla coil is comprised of two coupled second order systems sharing a resonant frequency, the Tesla coil is also referred to as a coupled resonant system throughout this thesis. The issues of matched resonant frequencies and the interaction of quality factors are presented.

Id.

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Stark further states: "The 'magic' behind Tesla coil operation is the use of resonant circuits coupled in such a way as to take energy stored in the primary side of the circuit and transfer it into the secondary coil in a modified state." *Id.* at 41. Figure 3-1 is an illustration of the basic topology of a fourth order Tesla coil circuit and is reproduced below:

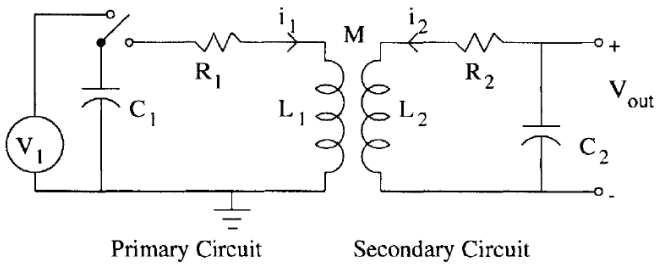

Figure 3-1: Two second order circuits with inductive coupling.

Figure 3-1 shows two second order circuits with inductive coupling, in a basic fourth order topology. *Id.* at 42.

Stark describes:

> When combining two second order circuits, each with its own resonant frequency and Q factor, the behavior of the total, fourth order system is not simply a sum, difference, or average of the two constituent circuits' parameters. Instead, different parts of the circuit resonate at different frequencies related to the original independent fundamental frequencies. As the system is driven by an external source, the energy it transfers to the circuit is moved between the energy storage elements of the circuit according to each devices' constitutive relations. The result is that the circuits will load one another and affect their natural resonance frequencies and individual Q factors.

Id. at 42.

Stark still further describes that *"[t]he coupling coefficient, k, is the single most important factor in determining the operation of the Tesla coil."* *Id.* at 93. Stark states that when the resonant frequencies of the primary and secondary circuits are matched, the behavior of the output voltage waveform depends largely on the value of coupling coefficient *k*. *Id.* at 46. Stark

explains that when the quality factors are roughly equal, $k = k_{crit}$ "is the coupling that yields a maximum gain when the system is driven at the frequency w_n." *Id.* at 80; *see also id.* at 46. Stark describes that when $k = k_{crit}$, the two circuits are impedance matched and a maximum amount of power can be transferred from source to load. *Id.* at 80–81. Additionally, Stark describes that k is bounded to between 0 and 1, that "[t]he greater the k, the more flux transferred between the two coupled inductors," and that "as k approaches unity, the system approaches that of an ideal transformer with complete energy transfer." *Id.* at 55, 99, 228. Stark gives the following formula for k_{crit}:

$$k_{crit} = \frac{1}{\sqrt{Q_1 Q_2}}$$

Id. at 47. Figure 3-3 of Stark is reproduced below:

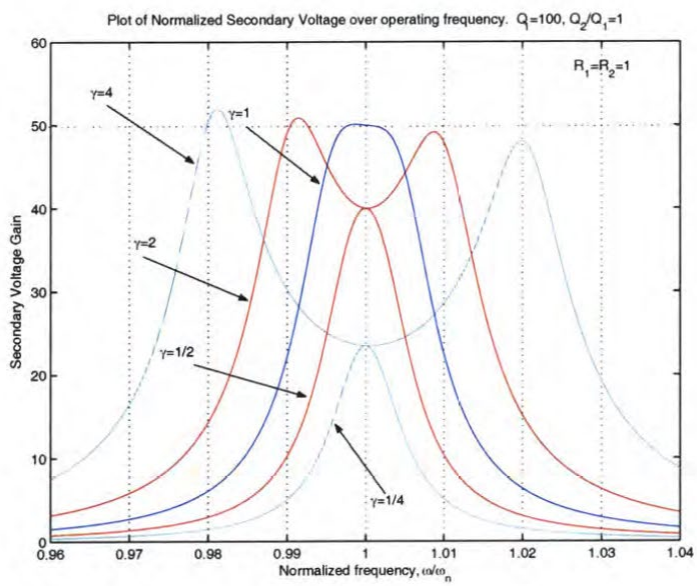

Figure 3-3: Plot of secondary voltage gain over normalized frequency, $Q_1 = Q_2 = 100$, $R_1 = R_2 = 1$. $\gamma = \frac{k}{k_{crit}}$

Figure 3-3 is a plot of normalized voltage gain over operating frequency, where $Q_1 = Q_2 = 100$, $R_1 = R_2$, and $\gamma = k / k_{crit}$. Ex. 1006, 48.

Figure 3-9 of Stark is reproduced below:

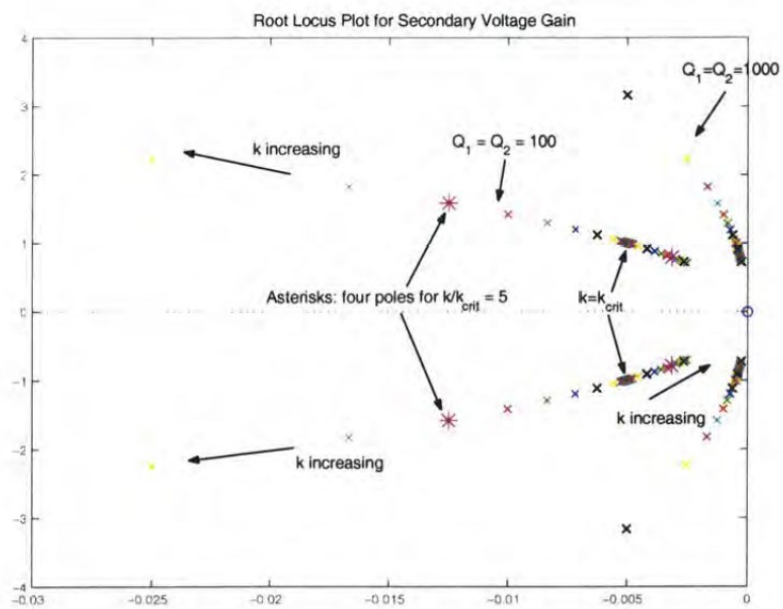

Figure 3-9 is a "Pole-Zero plot for the Secondary Voltage." *Id.* at 53.

Figure 3-31 of Stark is reproduced below:

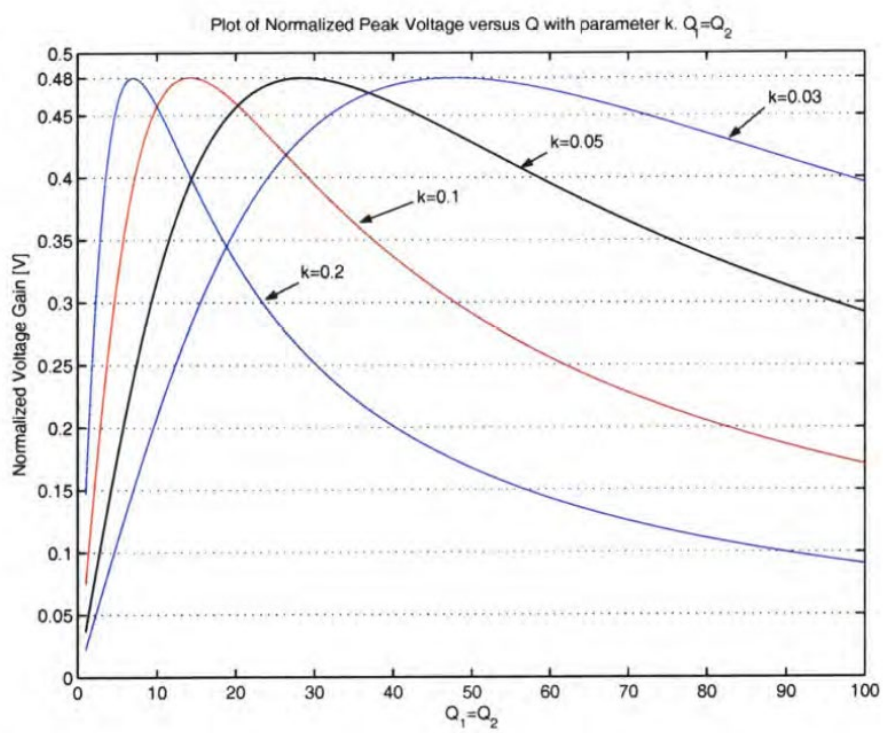

Figure 3-11 is a plot of normalized peak voltage versus *Q* with parameter *k*, with Q_1 set to equal Q_2 and R1 set to equal R2 = 1. Ex. 1006, 84.

Figure 4-3 of Stark is reproduced below:

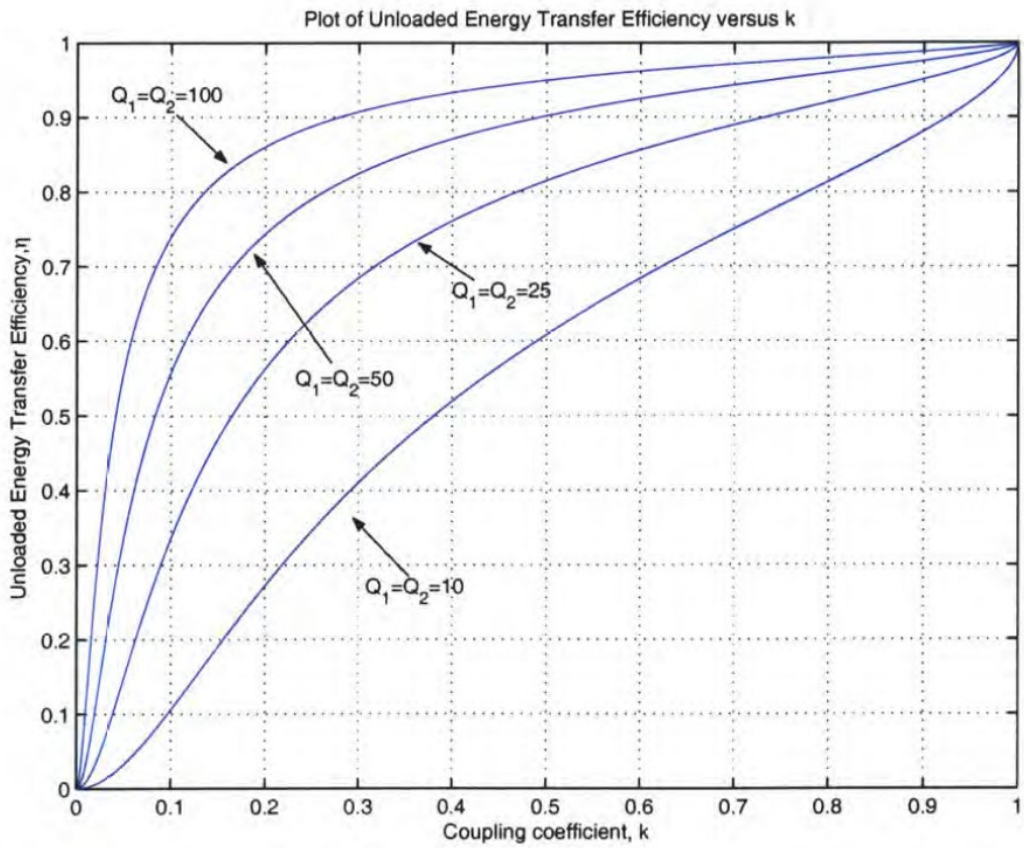

Figure 4-3 is a plot showing the tradeoff between coupling coefficient *k* and the transfer efficiency η with Q as a parameter. *Id.* at 101. It shows that at whatever value of coefficient *k*, the higher are Q_1 and Q_2, the higher is the energy transfer efficiency η. *Id.* Also, it shows that for the same Q values, the higher is the coupling coefficient *k*, the higher is the energy transfer efficiency η. *Id.* "There is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient." *Id.*

Stark describes that where *k* is close to k_{crit}, there would be very low efficiency. *Id.* Stark also explains that for the case $0 < k \leq k_{crit}$, holding

other network parameters constant, if the quality factors are increased, the initial peak output voltage will increase. *Id.* at 79.

Chapter 7 of Stark describes a working prototype of an array of resonant systems that was constructed according to Stark. Ex. 1006, 145.

Figure 7-40 is reproduced below:

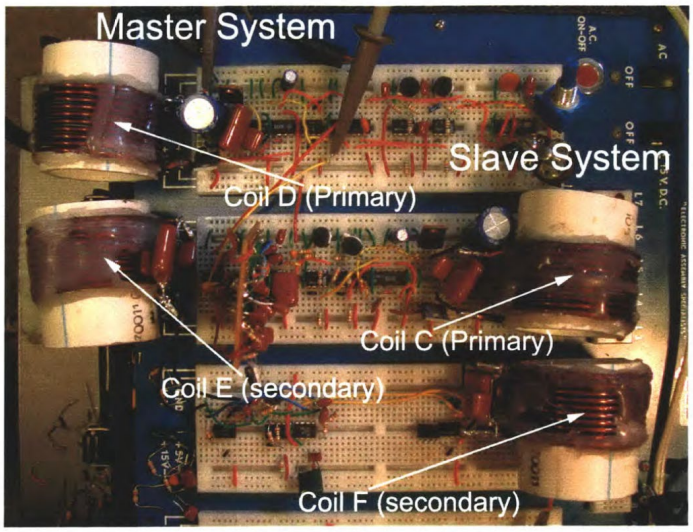

Figure 7-40 shows an array of two resonant systems, a master system and a slave system. *Id.* at 187.

Figure 7-41 is reproduced below:

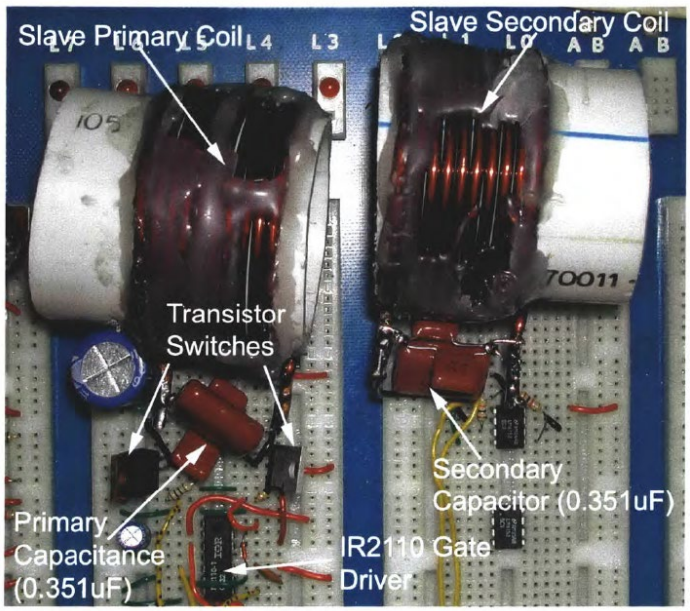

Figure 7-41 illustrates the slave resonant system having a primary coil and a secondary coil. *Id.* at 188.

Coils D and E are the primary and secondary coils in the master resonant system, and Coils C and F are the primary and secondary coils in the slave resonant system. *Id.* at 187.

Stark describes operating and adjusting the prototype and obtaining three sets of measured Qs for the two coils of the master resonant system and three sets of Qs for the two coils of the slave system: master resonant system coils D and E ($Q_1 = 70$, $Q_2 = 64$), ($Q_1 = 32$, $Q_2 = 34$), ($Q_1 = 29$, $Q_2 = 26$); slave resonant system coils C and F ($Q_1 = 65$, $Q_2 = 61$), ($Q_1 = 23$, $Q_2 = 22$), ($Q_1 = 20$, $Q_2 = 20$). *Id.* at 218. Table 8.2 is reproduced below:

Coil:	D	E	C	F
Previous Q	70	64	65	61
$N_{beats} = 3$	$Q_1 = 32$ $R_1 = .13\Omega$ $\delta_{upper} = 1.3e4$	$Q_2 = 34$ $R_2 = .12\Omega$ $\delta_{lower} = 1.0e4$	$Q_1 = 23$ $R_1 = .19\Omega$ $\delta_{upper} = 1.9e4$	$Q_2 = 22$ $R_2 = .19\Omega$ $\delta_{lower} = 1.5e4$
$N_{beats} = 2$	$Q_1 = 29$ $R_1 = .15\Omega$ $\delta_{upper} = 1.4e4$	$Q_2 = 26$ $R_2 = .16\Omega$ $\delta_{lower} = 1.3e4$	$Q_1 = 20$ $R_1 = .22\Omega$ $\delta_{upper} = 2.0e4$	$Q_2 = 20$ $R_2 = .21\Omega$ $\delta_{lower} = 1.8e4$

Table 8.2 shows the measured Q values of the various coils C, D, E, and F in Stark's working prototype. *Id.*

4. Independent Claim 1

Petitioner accounts for elements 1[Preamble], 1[a], 1[a][i], 1[a][ii], 1[a][iii], 1[a][iv], 1[b], 1[b][i], 1[b][ii], 1[b][iii], and 1[b][iv] on pages 11–33 of the Petition, where Petitioner asserts that Stark discloses each and every one of these elements. Pet. 11–33. Petitioner's assertions and arguments are

supported by the cited portions of Stark and the cited testimony of Dr. Young. *Id.* Patent Owner does not present contrary arguments for these elements. *See generally* PO Response. We are persuaded that Stark discloses elements 1[Preamble], 1[a], 1[a][i], 1[a][ii], 1[a][iii], 1[a][iv], 1[b], 1[b][i], 1[b][ii], 1[b][iii], and 1[b][iv].

a) claim element 1[c]

On pages 33–36 of the Petition, Petitioner accounts for how Stark discloses claim element 1[c]. Pet. 33–36. Claim element 1[c] reads as follows:

> transferring electromagnetic energy from said first resonator structure to said second resonator structure over a distance D that is smaller than each of the resonant wavelengths λ_1 and λ_2 corresponding to the resonant frequencies ω_1 and ω_2, respectively,

Ex. 1001, 11:52–56. We have reviewed Petitioner's accounting for this limitation on pages 33–36 of the Petition and we find that claim element [1c] is met by Stark.

Petitioner explains: "Energy is transferred by means of 'the primary coil, L_1, magnetically coupled to the secondary coil, L_2, induc[ing] a voltage that creates current through the secondary coil.' Stark 42; Young Decl. [Ex. 1003] ¶186." Pet. 33. Petitioner further explains that Stark discloses transferring energy from its primary circuit to its secondary circuit over a distance and that that distance is the distance between primary coil L_1 and secondary coil L_2. *Id.* at 34 (citing Ex. 1003 ¶ 187; Ex. 1006, 42). Petitioner asserts: "Stark discloses using its prototype to transfer energy from primary coil to secondary coil at distances of up to 10 inches, as measured between the closest surface of each coil." *Id.* at 36 (citing Ex.1003 ¶ 190; Ex. 1006, 179–184).

Petitioner also explains that Stark discloses operating its primary and secondary circuits at exemplary frequencies $\omega_1 = \omega_2 = 100$ kHz, in which case the corresponding resonant wavelengths are approximately 19 kilometers:

$$\lambda_1 = \lambda_2 = \frac{2\pi * [3 * 10^8]}{100\ kHz} \approx 19\ km$$

Id. at 37. Petitioner notes that Stark also describes operating its prototype at 1 MHz frequency, in which case the corresponding wavelengths would be approximately 1.9 kilometers. *Id.* Petitioner's assertions about these wavelengths and the distance between Stark's primary and secondary coils are supported by the cited evidence, including the testimony of Dr. Young (Ex. 1003 ¶¶ 188–190), and are not disputed by Patent Owner.

Ten inches is plainly less than 1.9 or 19 kilometers. For limitation [1c], Patent Owner argues only that this limitation has to be met at the same time as limitation [1d] is met, which requires both $Q_1 > 100$ and $Q_2 > 100$. PO Resp. 2–5. We address below whether it would have been obvious to use or adjust Stark's prototype to have $Q_1 > 100$ and $Q_2 > 100$. There is no argument by Patent Owner that when the parameters of Stark's prototype are adjusted to have $Q_1 > 100$ and $Q_2 > 100$, the distance between L_1 and L_2 in the Tesla coils would have to be made greater than 1.9 kilometers or 19 kilometers in violation of claim element [1c], and we have no reason to find that it would. In that regard, Dr. Young testifies:

> Stark's coupled resonant system operates at distances significantly smaller than 19 kilometers, or even 1.9 kilometers, between the primary coil and the secondary coil. A POSA [person of ordinary skill in the art] would understand that Stark's coils could not successfully operate at distances on the order of kilometers apart, as the system is designed for near-field

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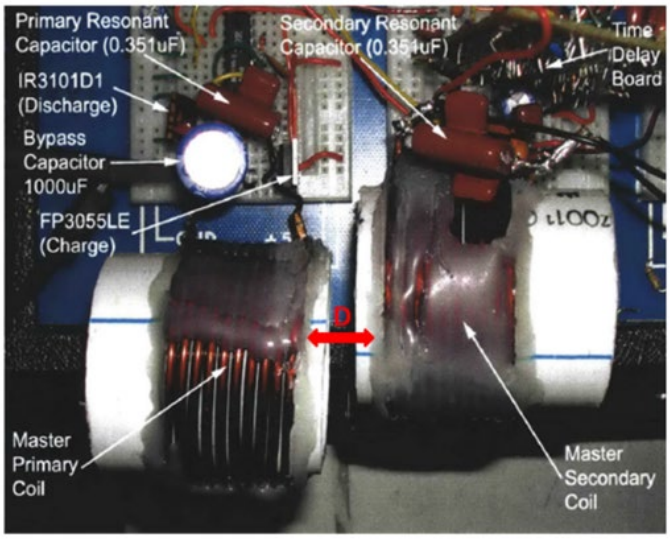
> transmission between the primary and secondary coils. This is confirmed by the specific distances disclosed in Stark. For example, Figure 7–24, below [annotated by Petitioner to show the distance D], shows that the distance between Stark's primary coil and its secondary coil is less than the diameter of standard schedule 40 PVC pipe, and therefore on the order of inches, not kilometers.



[Figure 7-24 of Stark shows primary and secondary coils as well as the gate controls and transistor switches of the master resonant system. Ex. 1006, 170]

Ex. 1003 ¶ 190. We credit this testimony of Dr. Young.

b) claim element 1[d]

What remains is limitation 1[d]: "wherein the electromagnetic resonator structures are designed to have Q_1 >100 and Q_2 >100." Ex. 1001, 11:57–58. Petitioner accounts for this limitation by relying on the declaration of Dr. Young and other evidence. Pet. 37–49.

Petitioner explains:

> Stark discloses "design[ing] a coupled resonant system tailored to a specific use by setting certain parameters and system specifications." Stark 109; Young Decl. ¶¶193–197. Those "parameters" include Q_1 and Q_2, which are set in accordance with the resistance, capacitance, inductance, and resonant frequency

> chosen for each circuit using the provided formulas [depicted below]. Stark 109–10; Young Decl. ¶¶195–98.
>
> *Quality factor of the primary circuit*
>
> $$Q_1 = \frac{1}{R_1}\sqrt{\frac{L_1}{C_1}} \quad (5.4)$$
>
> $$Q_1 = \frac{\omega_1 L_1}{R_1} \quad (5.5)$$
>
> *Quality factor of the secondary circuit*
>
> $$Q_2 = \frac{1}{R_2}\sqrt{\frac{L_2}{C_2}} \quad (5.6)$$
>
> $$Q_2 = \frac{\omega_2 L_2}{R_2} \quad (5.7)$$
>
> Stark 110–11.

Pet. 38. The above assertions are supported by the cited evidence and not disputed by Patent Owner. The above depicted formulas for quality factors Q_1 and Q_2 appear in Chapter 5 of Stark, titled "Tesla Coil Design Constraints and Tradeoffs." Ex. 1006, 109.

Petitioner notes further that, also in Chapter 5, "Stark teaches that these formulas [for Q_1 and Q_2] should be used to 'determine component values to match the ***intended operational specifications*** of the resonant system,' including by '[u]sing the results of the previous chapters.' Stark 109; Young Decl. ¶195." Pet. 38. That assertion is supported by the express language of Stark. In particular, Stark states that "[u]sing the results of previous chapters, it is now possible to design a coupled resonant system tailored to a specific use by setting certain parameters and system specifications. . . . the approach is to determine component values to match the intended operational specifications of the resonant system." Ex. 1006, 109.

Petitioner asserts that "results of the previous chapters" include the results of Chapter 3, and in particular the computer simulation results of Figure 3-9, which provide a range of Q values including both the case of $Q_1 = Q_2 = 100$ and $Q_1 = Q_2 = 1{,}000$. *Id.* A Petitioner annotated version of Stark's Figure 3-9 appears on page 39 of the Petition and is reproduced below:

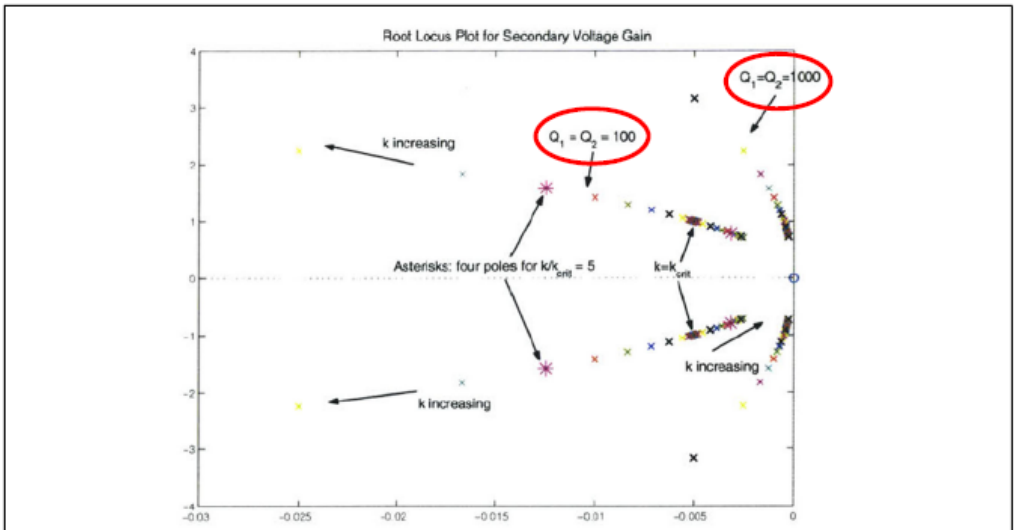


Figure 3-9: A Pole-Zero plot for the Secondary Voltage. Notice how range of Q affects the values of ζ and ω_{peaks}. As k approaches unity, poles go to negative infinity and $j\omega$ axis.

[Figure 3-9 is a Pole-Zero plot for the Secondary Voltage, and Petitioner's annotation identifies the data point illustrations where $Q_1 = Q_2 = 100$ and $Q_1 = Q_2 = 1{,}000$]

Thus, Petitioner asserts that "Stark discloses using its [quality factor] formulas to design its systems with 'intended operational specifications' such that the Q of the primary circuit and of the secondary circuit are each 1,000. Stark 52–53 (Fig. 3-9); Young Decl. ¶¶193–98." Pet. 39.

To further support its position that $Q_1 = Q_2 = 1{,}000$ in Figure 3-9 reflects intentional design, Petitioner identifies Stark's disclosure of increased energy transfer efficiency as an advantage for having high Qs.

Pet. 44. Specifically, Petitioner identifies Stark's statement "[t]here is no fundamental limit to the [increased] unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient." *Id.* (citing Ex. 1006, 101; *see also* Fig. 4-3 (Ex. 1006, 101)). Petitioner also identifies Stark's statement that "[h]olding other network parameters constant, if the quality factors are increased, the initial peak output voltage will increase." *Id.* (emphasis omitted) (citing Ex. 1006, 79).

We find support for Petitioner's position in Stark, in particular Figure 4-3 of Stark, reproduced below:

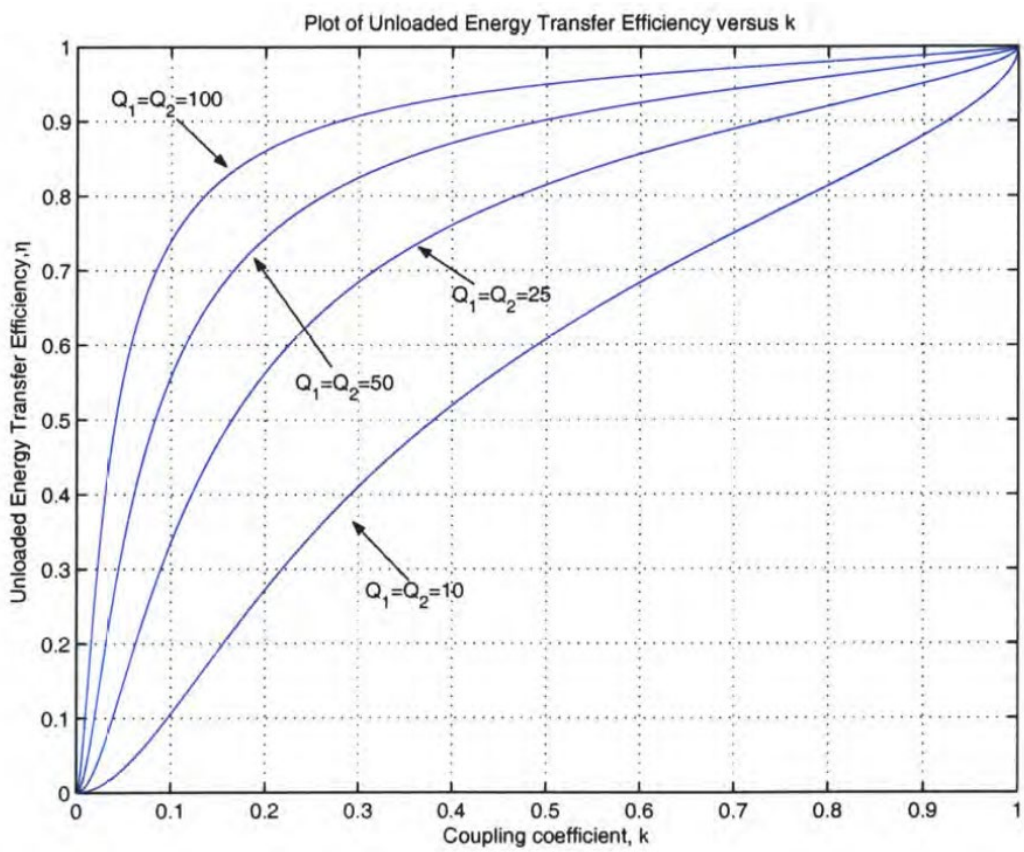


Figure 4-3 of Stark is a plot showing higher unloaded energy transfer efficiency for higher Qs for all values of coupling coefficient *k*, and that high energy transfer efficiency can be obtained at very small values of coupling coefficient k, e.g., < 0.1, by increasing the values of Q. Ex. 1006, 101. It

clearly shows increased unloaded energy transfer efficiency with higher Q values. The corresponding description quoted by Petitioner above, i.e., "[t]here is no fundamental limit to the [increased] unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient," *id.*, indicates there is no upper bound to this increased efficiency, but for how high one can increase the Q and how high one can increase the *k*.

Alternatively, Petitioner contends that even if Stark does not already describe having $Q_1 = Q_2 = 1{,}000$, it would have been obvious to one with ordinary skill in the art to have $Q_1 > 100$ and $Q_2 > 100$, and even higher Q values. Pet. 41–49. We do not reach that alternative argument, because it is unnecessary to do so.

Notwithstanding Patent Owner's contrary arguments, discussed below, we find that Stark discloses $Q_1 = Q_2 = 1000$ as one of the exemplary intended operational specification for its coils. We find also that Stark describes formulas for determining hardware component values and resonant frequency values that are needed to have the intended result of $Q_1 = Q_2 = 1{,}000$. Ex. 1006, 109–110; Ex. 1003 ¶¶ 195–198.

(1) Patent Owner Contentions

Patent Owner makes numerous arguments, which we address in turn. First, in summarizing its arguments, Patent Owner repeatedly refers to our statement in the initial decision not to institute review, prior to our granting of Petitioner's Request for Rehearing, that the Stark prototype described in Chapter 8 "was not designed or implemented with $Q_1 = Q_2 = 1{,}000$." PO Resp. 3–4 (citing Paper 7, 16). But that statement in the initial denial of instituting review was based on Patent Owner's representation in the Preliminary Response that Figure 3-9 of Stark illustrated situations in which

the resonant frequencies of the primary and secondary coils are not matched or are not the same, a circumstance Patent Owner characterized as "mistuned" (Prelim. Resp. 13). Paper 7, 16.

Petitioner, in its Request for Rehearing, persuaded us that it is not true that Figure 3-9 pertains to "mistuned" circuits with non-matching resonant frequencies for the primary and secondary coils, and that Figure 3-9 also depicts tuned circuits where the resonant frequencies ω_1 and ω_2 of the primary and secondary coils are the same. *See* Paper 8, 3–5. That was the determinative reason we granted Petitioner's Request for Rehearing and instituted review. Inst. Dec. 5. Post institution, Patent Owner expressly stated it was no longer arguing that Figure 3-9 pertains to situations involving mismatched frequencies or mistuned circuits. PO Resp. 3 ("In this response, we do not further debate that issue."). Thus, Patent Owner's reliance on our statement in the initial decision denying review, which has since been superseded by our Decision to Institute, is misplaced and unavailing.

Second, in summarizing its arguments, Patent Owner states that Petitioner's "sole justification" for implementing Stark's working prototype circuit with Q values in the hundreds or thousands is that one with ordinary skill in the art would have been motivated to "maximize Q." PO Resp. 4, 15. That is an inaccurate characterization of Petitioner's arguments.

As we noted above, Petitioner's primary position is that Stark (1) expressly describes the case of $Q_1 = Q_2 = 1{,}000$ (Figure 3-9); (2) illustrates that the higher are Q_1 and Q_2 the higher is the unloaded energy transfer efficiency (Figure 4-3); (3) states that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient," (Ex. 1006, 101); and (4) further

states in Chapter 5 that using the results of previous chapters makes it possible to design a coupled resonant system by setting certain parameters and system specifications by determining component values that match the intended operational specifications of the resonant system (Ex. 1006, 109). Pet. 38–39, 44. In other words, Stark already discloses the case of $Q_1 = Q_2 = 1{,}000$, useful for implementation, and that is Petitioner's purported reason why one with ordinary skill in the art would have used and adjusted Stark's disclosed working prototype to implement the case of $Q_1 = Q_2 = 1{,}000$. That it would have been obvious to maximize Q is only Petitioner's alternative contention, which as we explained above, we do not reach. Pet. 41–49.

Note in particular the following two statements in the Petition: (1) "In addition and in the alternative, this limitation [$Q_1 > 100$ and $Q_2 > 100$] would have been obvious in view of Stark's disclosure" (Pet. 41); and (2) "To the extent Patent Owner argues that Figure 3-9 does not expressly disclose [$Q_1 > 100$ and $Q_2 > 100$], it would have been obvious to modify Stark's primary and secondary circuits to each achieve Q values of at least 1,000 as described in Figure 3-9" (Pet. 43–44).

Third, Patent Owner asserts that "Stark includes no instructions on how to obtain a Q of 1000, such as how to construct and vary the 'resistance, inductance, capacitance, and resonant frequency' of the coils to obtain a Q of 1000." PO Resp. 14. Patent Owner states that the mere inclusion of a mathematical relationship does not provide such instruction. *Id.* Patent Owner asserts: "[N]either Petitioner nor its expert identify any explanation in Stark or any other reference of how to actually construct a coil with a Q of 1000 that would be suitable for use in Stark's prototype circuit, nor do they offer an explanation themselves." *Id.* The argument is unavailing. The

formulas appear facially sufficient, and neither Patent Owner nor Dr. Toliyat adequately explain (PO Resp. 14; Ex. 2003 ¶ 26) why Stark's formulas 5.4–5.7 (Ex. 1006, 110–111), reproduced below, are not sufficiently instructive:

Quality factor of the primary circuit

$$Q_1 = \frac{1}{R_1}\sqrt{\frac{L_1}{C_1}} \tag{5.4}$$

$$Q_1 = \frac{\omega_1 L_1}{R_1} \tag{5.5}$$

Quality factor of the secondary circuit

$$Q_2 = \frac{1}{R_2}\sqrt{\frac{L_2}{C_2}} \tag{5.6}$$

$$Q_2 = \frac{\omega_2 L_2}{R_2} \tag{5.7}$$

[Formula 5.4 expresses Q_1 in terms of R_1, L_1, and C_1. Formula 5.5 expresses Q_1 in terms of R_1, L_1 and ω_1. Formula 5.6 expresses Q_2 in terms of R_2, L_2, and C_2. Formula 5.7 expresses Q_2 in terms of R_2, L_2, and ω_2.]

Further, Dr. Toliyat does not assert that one with ordinary skill would not have known, given Stark's formulas 5.4–5.7, how to adjust Stark's prototype to operate with $Q_1 = Q_2 = 1{,}000$, or simply $Q_1 > 100$ and $Q_2 > 100$.

Fourth, Patent Owner argues that Stark discloses operating the prototype with six coils A, B, C, D, E, and F (Q values ranging from 57–70), and then operating the prototype with lower Q values for coils C, D, E, and F (Q values ranging from 26 to 32). PO Resp. 8. Patent Owner states that "not once did Stark suggest a Q value even close to 100." *Id.* at 7 (citing Ex. 1006, 175, 218). Patent Owner asserts it is clear "that Q values of circuits that are configured as disclosed in its prototype are limited to below values nearing or exceeding 100." *Id.* at 9.

These arguments are misplaced and unavailing. The Q values disclosed by Stark are not limited to what Stark actually implemented with its prototype. Stark includes chapters additional to Chapters 7 and 8 describing the prototype. Further, the alleged ground of unpatentability is based on obviousness, not anticipation. If Stark actually implemented in its prototype Q_1 and Q_2 values exceeding 100, it would anticipate claim 1.

As we noted above, Petitioner's position is: (1) "Stark teaches that these formulas [for Q_1 and Q_2] should be used to 'determine component values to match the ***intended operational specifications*** of the resonant system,' including by '[u]sing the results of the previous chapters.' Stark 109; Young Decl. ¶195" (Pet. 38); and (2) "results of the previous chapters" include the results of Chapter 3, and in particular the computer simulation results of Figure 3-9, which provide a range of Q values including both the case of $Q_1 = Q_2 = 100$ and $Q_1 = Q_2 = 1{,}000$ (*id.*). Thus, Stark already discloses the case of $Q_1 = Q_2 = 1{,}000$, useful for implementation. That Stark did not actually implement $Q_1 = Q_2 = 1{,}000$ in its prototype is inconsequential in Petitioner's assertion of obviousness.

Fifth, Patent Owner argues:

> Stark describes that its prototype circuit is designed to produce particular voltage waveforms including a number of beats. Stark, 207–208; *see also* 67. FIG. 8-2 from Stark shows one of these voltage waveforms [annotated by Patent Owner to identify the beats]:

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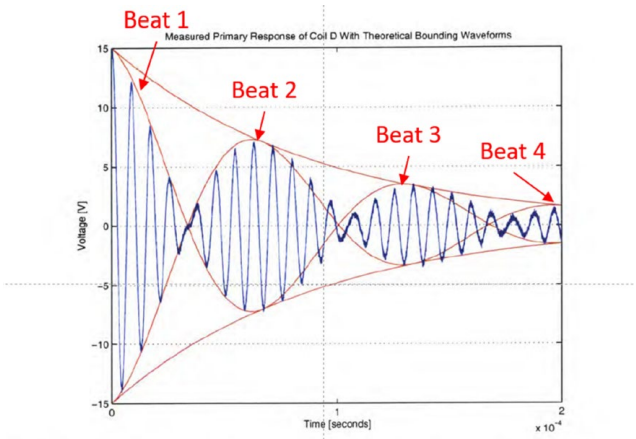

Figure 8-2: Plot of primary coil response with theoretical envelope waveforms. Parameters: $Q_1 = 32$, $Q_2 = 34$, and $k = \frac{1}{8}$.

Stark, FIG. 8-2 (annotated)

[Figure 8-2 shows primary coil response with theoretical envelope waveforms (Ex. 1006, 208]

> The number of beats in these waveforms contributes to the power transfer characteristics of the Tesla coil, and is determined based on the values of Q1, Q2, and k in the circuit. Stark, 207 ("There is a straightforward procedure for finding the parameters Q1, Q2, and k that best fit the system."); WT-2003, [18]. Stark teaches that "the number of beats in the waveform is known to be $N_{beats} = k/k_{crit}$ where $k_{crit} = 1/\text{sqrt}(Q1Q2)$." Stark, 207.
>
> Therefore, the Q values for the coils in Stark's prototype circuit affect the shape of the voltage waveform produced by the circuit. Specifically, based on the formula above, for a fixed value of k (determined from the distance between the coils), increasing Q1 and [Q2] will decrease the value of k_{crit}, thereby increasing k/k_{crit} and increasing the number of beats in the waveform. WT-2003, [20]; *see*, *e.g.*, Stark, 207. Thus, increasing Q values to, for example, 1000, as Petitioner proposes, would alter the voltage waveform of the prototype circuit by drastically increasing the number of beats in the waveform. WT-2003, [20]. *There is no teaching in Stark that it would be desirable to alter the waveform of the prototype circuit in this way. Id.*

PO Resp. 9–10 (emphasis added).

Patent Owner's argument is misplaced because altering the shape of the waveform to increase the number of beats in the output waveform is not

Petitioner's stated motivation for using and adjusting Stark's prototype to operate with $Q_1 = Q_2 = 1{,}000$. Rather, Petitioner's position is that Stark (1) expressly describes the case of $Q_1 = Q_2 = 1{,}000$ (Figure 3-9); (2) illustrates that the higher are Q_1 and Q_2, the higher is the unloaded energy transfer efficiency (Figure 4-3); (3) states that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient," (Ex. 1006, 101); and (4) further states in Chapter 5 that using the results of previous chapters, it is now possible to design a coupled resonant system by setting certain parameters and system specifications, and that the approach is to determine component values to match the intended operational specifications of the resonant system (Ex. 1006, 109). Pet. 38, 39, 44. Petitioner's reason for using and adjusting Stark's prototype to implement $Q_1 = Q_2 = 1{,}000$ is not to increase the number of beats in the output waveform.

Sixth, Patent Owner asserts that

> the plot in FIG. 3-9 is simply the output of a MATLAB simulation; it does not represent the operation of any constructed circuit. *See* Ex. 1003, [162]; Stark, 237–238; WT-2003, [23]. Further to this point, none of the Chapter 7 prototype circuits have Q values greater than 100, much less 1000. *See* Stark, 145-204; WT-2003, [23].

PO Resp. 12. On that basis, Patent Owner asserts:

> A POSITA would thus understand the MATLAB adduced Q of 1000 shown by FIG. 3-9 to be merely theoretical, or at best inapplicable to other relied-upon circuit disclosures within Stark, not an instruction to construct a circuit with such a value of Q, and certainly not an instruction to move away from distinct Q values attributed expressly by Stark to circuits that it elsewhere disclosed.

Id. at 13. The argument is unavailing.

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The illustrated Q parameters in Figure 3-9 of Stark are only theoretical in that a circuit with the shown Q values was not actually constructed by Stark, but was simulated by use of MATLAB software. The illustrated Qs are not theoretical in the sense of Stark characterizing them to be an ideal circumstance not achievable in non-simulated reality. Stark has made no such characterization. Stark also has not described simulated $Q_1 = Q_2 = 1{,}000$ and $Q_1 = Q_2 = 100$ scenarios as a failure or otherwise leading to unsuccessful results. On this record, that was a successful simulation. In that regard, Patent Owner's expert, Dr. Toliyat, when asked whether people of ordinary skill would use MATLAB to simulate what they would expect of a real world device, answered:

> As -- as a first step, I would say, as part of the -- sometimes people directly go to the lab and build something. But, in fact, I prefer first simulation and then -- and then fabricating and then commenting on seeing what the discrepancies are, what the differences are, improve on the model. I try -- ideally speaking, you want to model that as close as possible represent your actual system, but it's not easy. It's not easy per se or things can get very complicated with your model.

Ex. 1027, 122:10–23. Further, Figure 3-9 illustrates both the case of $Q_1 = Q_2 = 1{,}000$ and $Q_1 = Q_2 = 100$. Patent Owner points to nothing in Stark that distinguishes the case of $Q_1 = Q_2 = 100$ from the case of $Q_1 = Q_2 = 1{,}000$, on the basis of one being realistic and the other not. "[R]egardless of the forum, prior art patents and publications enjoy a presumption of enablement, and the patentee/applicant has the burden to prove nonenablement for such prior art," which Patent Owner has not done here. *Apple Inc. v. CorePhotonics, Ltd.*, 861 Fed. App'x 443, 450 (Fed. Cir. 2021) (nonprecedential) (further stating that "this presumption and burden apply during . . . AIA trial proceedings").

Additionally, as discussed above, Figure 4-3 of Stark shows that the higher are Q_1 and Q_2, the higher is the energy transfer efficiency η. Ex. 1006, 101. In corresponding description, Stark expressly states: "There is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient." *Id.* Stark nowhere described $Q_1 = Q_2 = 1{,}000$ or $Q_1 = Q_2 = 100$ as exceeding the practical or realistic constraints on Q. As noted above, Stark's Formulas 5.4–5.7 define the Q values as functions of resistance (R), capacitance (C), inductance (L), and resonant frequency (ω). Ex. 1006, 110-111. By varying the values of each of these variables, one can arrive at $Q_1=Q_2=1000$.

Dr. Toliyat does not assert that resistors, capacitors, and inductors with the necessary resistance, capacitance, and inductance, were unavailable at the time of invention of the '734 patent, or that a required level of frequency, ω_1 and ω_2, would have been too high to achieve. Neither has Dr. Toliyat testified that one with ordinary skill in the art would not have known how to use and adjust Stark's prototype to operate with $Q_1 = Q_2 = 100$, or $Q_1 = Q_2 = 1{,}000$. Patent Owner likens Stark's illustration of $Q_1 = Q_2 = 1{,}000$ to a plot of $Q = \infty$ (infinity) in the journal article *The Story of Q*.[6] PO Resp. 13. For all the reasons indicated above, we disagree.[7]

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[6] Estill I. Green, *The Story of Q*, 43 Am. Scientist 584 (October 1955). Ex. 1009.

[7] We note further that in an article published shortly after the filing of the '734 patent and authored by the inventors of the '734 patent, which Patent Owner asserts presents substantially the same description of the inventive technique as the '734 patent and additionally describes an experimental demonstration (PO Resp. 42), the designed Q value is approximately 2,500 and actually measured at 950 ± 50. Ex. 2011, 3.

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Patent Owner notes that the MATLAB simulation software assumes AC steady state voltage for the hypothetical circuits simulated in Figure 3-9, whereas Stark's actual prototype is constructed using a pulsed voltage source. PO Resp. 13. The significance of this difference is not adequately explained. Dr. Toliyat does not assert, much less explain, that the results shown in Figure 3-9 of Stark are unique to circuits using an AC power source and would be substantially different if a pulsed voltage source were used.

Patent Owner cites to page 129 of Stark which states: "The individual values of the quality factors are unimportant here so long as their product is constrained to $Q_1Q_2 = 1/k^2_{crit} = 400$ and they are within the same order of magnitude." *Id.* at 12–13, 24. Given Figures 3-9 and 4-3 of Stark, and Stark's description in Chapter 5 that using the results of previous chapters, it is possible to design a coupled resonant system by setting certain parameters and system specifications by determining component values to match the intended operational specifications of the resonant system (Ex. 1006, 109), we find the characterization of quality factors as unimportant and the $Q_1Q_2 = 400$ constraint not as something general or broadly applicable but, rather, pertaining only to the design example Stark discusses on pages 127–129.

The statement at issue appears on page 129 and includes the qualifier "here": "The individual values of the quality factors are unimportant *here* so long as their product is constrained to $Q_1Q_2 = [1/k^2_{crit}] = 400$ and they are within the same order of magnitude." Ex. 1006, 129 (emphasis added). On cross examination, Dr. Toliyat also indicates that this statement is about the quality factors for that particular example:

Q. But I -- and I guess my question is, this is talking about the quality factors for this design example; right?

A. That's correct.

Ex. 1027, 115:25–116:3.

Further, we note that only one of the numerous implementations Stark constructed through its prototype is within the $Q_1Q_2 = 400$ constraint, as shown in Stark's Table 8.2, reproduced below:

Coil:	D	E	C	F
Previous Q	70	64	65	61
$N_{beats} = 3$	$Q_1 = 32$ $R_1 = .13\Omega$ $\delta_{upper} = 1.3e4$	$Q_2 = 34$ $R_2 = .12\Omega$ $\delta_{lower} = 1.0e4$	$Q_1 = 23$ $R_1 = .19\Omega$ $\delta_{upper} = 1.9e4$	$Q_2 = 22$ $R_2 = .19\Omega$ $\delta_{lower} = 1.5e4$
$N_{beats} = 2$	$Q_1 = 29$ $R_1 = .15\Omega$ $\delta_{upper} = 1.4e4$	$Q_2 = 26$ $R_2 = .16\Omega$ $\delta_{lower} = 1.3e4$	$Q_1 = 20$ $R_1 = .22\Omega$ $\delta_{upper} = 2.0e4$	$Q_2 = 20$ $R_2 = .21\Omega$ $\delta_{lower} = 1.8e4$

Table 8.2 shows the measured Q values of the various coils C, D, E, and F in Stark's working prototype. Ex. 1006, 218. Of the reported combinations, only coils C and F, when $N_{beats} = 2$, meets the $Q_1Q_2 = 400$ constraint.

Furthermore, Petitioner neither stated nor suggested, as Patent Owner implies (PO Resp. 13), that Figure 3-9 of Stark is an instruction to construct a circuit with a Q value of 1,000, and an instruction to move away from distinct Q values elsewhere disclosed in Stark. Rather, Petitioner's primary position is that Stark (1) expressly describes the case of $Q_1 = Q_2 = 1{,}000$ (Figure 3-9); (2) illustrates that the higher are Q_1 and Q_2, the higher is the unloaded energy transfer efficiency (Figure 4-3); (3) states that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for

constraints on the quality factors and the coupling coefficient," (Ex. 1006, 101); and (4) further states in Chapter 5 that using the results of previous chapters, it is possible to design a coupled resonant system by setting certain parameters and system specifications, by determining component values to match the intended operational specifications of the resonant system (Ex. 1006, 109). Pet. 38–39, 44. Patent Owner mischaracterizes Petitioner's assertions.

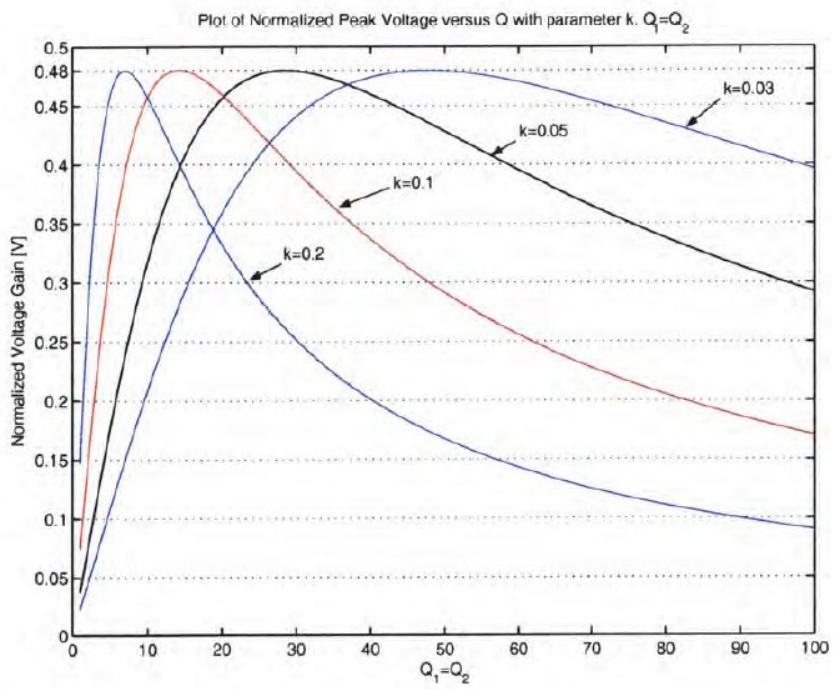
For all of the foregoing reasons, Patent Owner's assertion that one with ordinary skill in the art would have found Stark's disclosure of $Q_1 = Q_2 = 1{,}000$ to be inapplicable to other relied-upon circuit disclosures within Stark is not supported by sufficient facts and reasoning.

Seventh, Patent Owner contends that Stark "teaches away" from $Q_1 = Q_2 = 1{,}000$ or maximizing Q. PO Resp. 15–18. We disagree. A reference teaches away from a claimed invention if it "criticize[s], discredit[s], or otherwise discourage[s]" modifying the reference to arrive at the claimed invention. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). We do not, however, "read into a reference a teaching away from a process where no such language exists." *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1364 (Fed. Cir. 2006).

The disclosure of Stark does not "teach away" from $Q_1 = Q_2 = 1{,}000$ or from maximizing Q. In Figure 3-9, Stark specifically discloses the case of $Q_1 = Q_2 = 1{,}000$, simulated by MATLAB software, and in Figure 4-3, Stark shows that at any coupling coefficient k, the higher are Q_1 and Q_2, the higher is the unloaded energy transfer efficiency. Ex. 1006, 53, 101. Stark also states that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient." *Id.* at 101. These disclosures express an affinity for

high Q values, so long as they can be achieved or attained. Stark also nowhere describes the case of $Q_1 = Q_2 = 1{,}000$ as a failure, something to be avoided, or as otherwise undesirable.

Patent Owner refers to Figure 3-31 of Stark, reproduced below:



[Figure 3-31 is a plot of normalized peak voltage versus Q with parameter k (Ex. 1006, 84)]

PO Resp. 16. Patent Owner explains:

> As Dr. Young admitted during his deposition, for each value of k, there is an optimal Q value that maximizes voltage gain. Young Transcript [Ex. 2002], 30:9-32:19. And if Q is increased beyond this optimal value for a particular k, the voltage gain in fact decreases. *See id.*; Stark, FIG. 3-9; WT-2003. [28].
>
> This is borne out in FIG. 3-31. For example, for k=0.2, FIG. 3-31 shows the optimal Q value to be less than 20, where a maximum voltage gain of 0.48 is obtained. Young Transcript [Ex. 2003], 31:19-20 ("for k equal to .1, the Q is less 20"). But FIG. 3-31 also shows that, as Q is increased beyond this optimal value for k=0.2, the voltage gain ***decreases*** below its maximum level, with a Q of 100 yielding a much lower voltage gain of

> around 0.17. *See* Stark, FIG. 3-31; WT-2003, [29]. This holds true for each value of k shown in the figure. *See id.*

Id. at 16–17.

Figure 3-31 of Stark does show what Patent Owner asserts it shows, and Dr. Young does not dispute Patent Owner's assertion. But the stated showing of Figure 3-31 is less than complete, in the context of Patent Owner's "teaching away" argument. Claim 1 includes no constraint on the coupling coefficient k. If reduced voltage gain resulting from higher Q values is a problem, Figure 3-31 also shows that a lower coupling coefficient k can compensate by increasing the voltage gain. Thus, Stark's Figures 3-31 and 4-3 do not necessarily urge toward different directions for Q values, when adjusting coupling coefficient k is taken into account. For instance, Figure 3-31 shows that as Q values go from the low 20's to the mid-90's, and coupling coefficient k is changed from 0.2 to 0.05, the voltage gain remains about the same. At best, Patent Owner has shown that the benefit of Petitioner's proposed use and adjustment of Stark's prototype to have $Q_1 = Q_2 = 1{,}000$, i.e., increased energy transfer efficiency, comes at the cost of lower voltage gain, ***if*** the coupling coefficient is unchanged.

Further, Figure 3-31 also shows that higher Q value would be needed to achieve peak voltage gain, as coupling coefficient k gets smaller. Patent Owner's expert, Dr. Toliyat, agrees with that reading of Figure 3-31. Ex. 1027, 106:17–22. Dr. Toliyat explains "Yeah. If you go from .2 to .03 [coupling coefficient k], roughly speaking, you're going from a Q of 10 to a Q of 50, let's say." *Id.* at 106:20–22.

Even assuming that raising Q values beyond a certain level always lowers the voltage gain, Stark does not "teach away" from having $Q_1 = Q_2 = 1{,}000$, or high Q values generally. That is because Stark gives a

beneficial reason for making Q values high, i.e., increased energy transfer efficiency as shown in Figure 4-3, and expressly describes the case of $Q_1 = Q_2 = 1{,}000$ without criticism, discouragement, or disparagement.

A person of ordinary skill in the art can be motivated to make modifications, which in this case is to use and adjust Stark's disclosed prototype to implement $Q_1 = Q_2 = 1{,}000$, to obtain desirable properties, even at the expense of foregoing certain other benefit taught by Stark. *See In re Urbanski*, 809 F.3d 1237, 1243–44 (Fed. Cir. 2016); *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) ("a given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine."). Patent Owner's "teaching away" argument is based on its mistaken view that a reference teaches away from a feature so long as it associates any disadvantage with that feature, even if it also describes advantages of having the feature without any statement of criticism, discouragement, or disparagement.

"A reference may be said to teach away when a person of ordinary skill in the art, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994). Given Stark's Figures 3-9 which shows simulation of the case $Q_1 = Q_2 = 1{,}000$, Stark's Figure 4-3 which shows the higher the Q the higher is the energy transfer efficiency, and Stark's statement that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient," (Ex. 1006, 101), one with ordinary skill would not be discouraged or led divergent from raising Q values to any level that can be achieved, including 1,000. As noted above, Patent Owner does not contend

that a Q value of 1,000 is not realistically attainable or that one with ordinary skill in the art would not have known how to raise the Q values to 1,000. For ease of reference, we reproduce Stark's Figure 4-3 below:

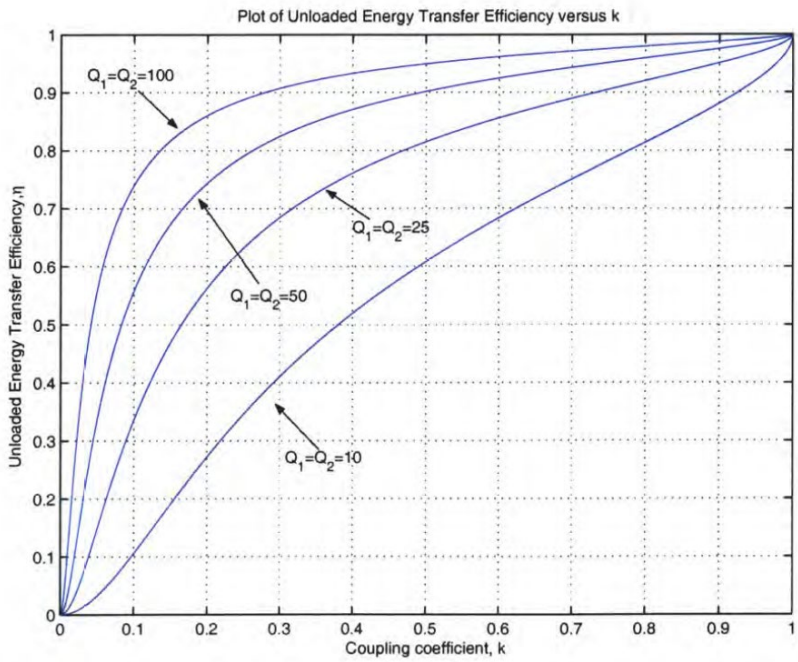


Figure 4-3 of Stark is a plot showing higher unloaded energy transfer efficiency for higher Q values at any coupling coefficient k, and that high energy transfer efficiency can be obtained even at very small values of coupling coefficient k, e.g., < 0.1, by increasing the values of Q. Ex. 1006, 101.

Eighth, Patent Owner argues that Petitioner does not account for Stark's teachings of a relationship between k, k_{crit}, and Q. PO Resp. 18–19. Patent Owner explains:

> Stark repeatedly discloses that the maximum voltage gain in its circuit "occurs when the coupling coefficient is equated to $k = k_{crit} = [1 / \text{sqrt}(Q1*Q2)]$" Stark, 122; *see also id.*, 47, 80, 89, 129, FIG. 3-2. Based on this equation, as Q_1 and Q_2 increase, k_{crit} and k decrease. *See id.*; WT-2003, [33]. Thus, increasing the Q values has the effect of decreasing k, which is counter to Stark's teachings regarding the importance of high k to the operation of

> its Tesla coils. *See, e.g.*, Stark, 89 ("for this value of critical coupling, $k = k_{crit}$, the maximum possible amount of energy capable of being transferred was transferred to the secondary") (emphasis in original), 93 ("The coupling coefficient, k, is the single most important factor in determining the operation of the Tesla coil."), 93 (relatively high k values, close to unity, i.e., 1, are preferable); WT-2003, [33].

PO. Resp. 18.

The argument is misplaced and unavailing. Patent Owner assumes that one would always set k to equal k_{crit} and that having the maximum voltage gain or the maximum possible amount of energy transferred is the only thing that matters, to the exclusion of everything else, including energy transfer efficiency. That clearly is not the case in the context of Stark, which also shows Figure 4-3 regarding energy transfer efficiency of the coils. Patent Owner's single minded focus on what is needed to maximize the voltage gain or the amount of energy transferred reflects an overly restrictive reading of Stark.

Stark includes no statement that it wants k to be as near unity as possible, at all times and for all circumstances. To the contrary, Stark's Figure 4-3 shows that high energy transfer efficiency can be obtained at very small values of coupling coefficient k, e.g., < 0.1, by increasing the values of Q. Ex. 1006, 101. Also, Stark's statement that *"[t]he coupling coefficient, k, is the single most important factor in determining the operation of the Tesla coil*" is neutral between selecting for higher voltage gain and selecting for higher energy transfer efficiency. *Id.* at 93. Patent Owner reads too much into the statement that "*[t]he coupling coefficient, k, is the single most important factor in determining the operation of the Tesla coil*." *Id.* It does not mean k always has to be set high and it does not mean k always has to be set to equal k_{crit}.

Patent Owner asserts that increasing Q at the expense of k is contrary to the teaching of Stark. PO. Resp. 19 (citing Ex. 1006, 89, 93, Ex. 2003 ¶ 34). We disagree. Patent Owner directs us to pages 89 and 93 of Stark, but neither includes anything indicating that nothing should ever be done if it lowers k. Dr. Toliyat makes the same assertion and also cites to the same pages. Ex. 2003 ¶ 34. We do not credit that testimony, because Dr. Toliyat does not provide an explanation why that is so, and because the assertion is contrary to the evidence. For instance, Stark's Figure 4-3 shows that high energy transfer efficiency can be obtained at very small values of coupling coefficient k, e.g., < 0.1, by increasing the values of Q. Ex. 1006, 101. Stark shows that high Q values can compensate for a low coupling coefficient, at least insofar as energy transfer efficiency is concerned.

In any event, it is not necessary for Petitioner to account for Stark's disclosure that raising Q_1 and Q_2 would lower k_{crit}, the coupling coefficient at which the maximum voltage gain occurs, because (1) the case of $Q_1 = Q_2 = 1{,}000$ is expressly disclosed by Stark, (2) claim 1 has no constraint on either the coupling coefficient k or the amount of voltage gain, (3) Stark's statement that "*[t]he coupling coefficient, k, is the single most important factor in determining the operation of the Tesla coil*" has not been shown by Patent Owner to select for higher voltage gain over energy transfer efficiency, and (4) Stark does not say that it wants the coupling coefficient k to be as high as possible, or near unity, at all times. *Id.* at 93. The express disclosure of $Q_1 = Q_2 = 1{,}000$, without any criticism, disparagement, and discouragement, and without characterization as a failure or something to avoid, means all properties associated with it, even if not optimal, are either accepted or acceptable as a tradeoff.

Stark discloses that there are numerous parameters which may be selected to be optimized. Ex. 1006, 122 ("Most resonant system designs aim to optimize only one or two parameters and allow the others to be set by engineering tradeoffs."). The AC steady state voltage gain is just a commonly maximized parameter. *Id.* Dr. Toliyat agrees that Stark describes optimizing for a parameter that is different from the AC steady state voltage, such as set frequency and input impedance. Ex. 1027, 119:20–120:7. With respect to Figure 4-3, Stark expressly refers to "a tradeoff." Ex. 1006, 101. It is evident that a high Q with a low k, or a low Q with a high k, can achieve the same energy transfer efficiency. This further supports Petitioner's position that the simulated case of $Q_1 = Q_2 = 1{,}000$ as shown in Figure 3-9 is presented as something contemplated for actual implementation, and not as in theory only or as a case of failure.

Ninth, Patent Owner argues that the various publications relied on by Petitioner, unnamed in the asserted grounds of unpatentability, to support Petitioner's argument that one with ordinary skill in the art would have known to maximize Q values in Stark's circuit actually do not support maximizing Q values. PO Resp. 19–22. We need not address this Patent Owner argument about Petitioner's corroborating evidence for maximizing Q values because, as noted above, we do not reach Petitioner's alternative argument that it would have been obvious to one with ordinary skill in the art to maximize Q values. Our decision is based on Petitioner's primary argument that Stark expressly discloses the case of having $Q_1 = Q_2 = 1{,}000$ in its resonant system.

Tenth, Patent Owner asserts that Petitioner's obviousness analysis failed to consider the entire disclosure of Stark. PO Resp. 22–26. These arguments essentially are, in substance, the same as those discussed above as

Patent Owner's seventh and eighth argument, i.e., that Stark "teaches away" from $Q_1 = Q_2 = 1{,}000$ or maximizing Q, and that Petitioner does not account for Stark's teachings of a relationship between k, k_{crit}, and Q. For substantially the same reasons discussed above in the context of Patent Owner's seventh and eighth argument, this tenth argument is also unavailing.

In summary, we determine that Petitioner reasonably explains that Stark expressly discloses the case of $Q_1 = Q_2 = 1{,}000$ (Figure 3-9) as well as the benefits of having high Q values (Figure 4-3), and states that "[t]here is no fundamental limit to the unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient," (Ex. 1006, 101). We also determine that Petitioner accurately notes that Stark states in Chapter 5 that using the results of previous chapters, it is now possible to design a coupled resonant system by setting certain parameters and system specifications, and that the approach is to determine component values to match the intended operational specifications of the resonant system (Ex. 1006, 109). For these reasons, one with ordinary skill in the art would have been motivated to use and adjust Stark's prototype, described in Chapters 7 and 8, to implement the described and simulated case of $Q_1 = Q_2 = 1{,}000$. We need not and do not reach Petitioner's alternative argument that it would have been obvious to one with ordinary skill in the art to maximize Q or to have $Q_1 = Q_2 = 1{,}000$.

Eleventh, Patent Owner argues that we should accord the testimony of Petitioner's expert, Dr. Young, little or no weight, because (1) Dr. Young ignored, overlooked, or failed to consider Stark's use and description of Tesla coils (PO Resp. 27–30), (2) Dr. Young ignored, overlooked, or failed to consider Stark's use and description of k_{crit} (PO Resp. 30–34), and

(3) Dr. Young ignored, overlooked, or failed to consider Stark's lengthy description of the various energy transfer waveforms obtained with different values of the coupling coefficient k (PO Resp. 34–37). Patent Owner contends that Dr. Young failed to consider Stark in its entirety. PO Resp. 26.

Those contentions of Patent Owner have little application to Petitioner's primary argument based essentially entirely on the express teachings of Stark. That it would have been obvious to maximize Q is only Petitioner's alternative contention. Pet. 41–49. As noted above, we do not reach Petitioner's alternative argument.

Additionally, Patent Owner does not point to any specific testimony of Dr. Young, in the context of Petitioner's primary argument, that it urges we should accord little or no weight. Further, our discussion of Patent Owner's seventh and eighth argument above, i.e, that Stark teaches away from having high Q values and that Petitioner failed to account for the relationship between k, k_{crit}, and Q, similarly applies.

In any event, we are not persuaded that Dr. Young failed to consider Stark in its entirety. Patent Owner makes inaccurate characterizations. For instance, Patent Owner asserts that Dr. Young concludes that having only one beat corresponding to the energy transfer between the coils is a negative aspect of the circuit's performance when $k=k_{crit}$. PO Resp. 35 (citing Ex. 2002, 34:8–36:12). We find no such indication or conclusion by Dr. Young at the cited portion of the transcript of Dr. Young's cross-examination. Patent Owner also asserts that Dr. Young testified that he is not aware of any discussion of the one beat waveform in Stark. *Id.* (citing Ex. 2002, 36:11–12). We find no such testimony at the cited portion of the transcript. Patent Owner asserts that Dr. Young testified that he was not

aware of any description in Stark of the energy transfer waveforms. *Id.* at 36 (citing Ex. 2002, 36:11–12). We find no such testimony at the cited portion of the transcript.

We also are unpersuaded that Dr. Young failed to consider Stark's use and description of Tesla coils, because Stark largely is about use of Tesla coils in resonant systems, and Dr. Young testified that "Stark['s] system use[s] two coils that are magnetically coupled to each other that transfer energy from one coil to the other coil through the near field coupling." Ex. 2002, 33:9–12. Patent Owner does not dispute that what Dr. Young described in that testimony is a Tesla coil. Stark itself states: "[T]he term Tesla coil was used interchangeably with coupled resonant system." Ex.1006, 225.

Twelfth, Patent Owner in its Sur-Reply addresses Petitioner's statement that "the performance of Stark's breadboard prototype 'closely resemble[s] the theoretical models derived in previous chapters,' including Chapter 3, demonstrating that Stark's theory works in practice." Sur-Reply 19 (citing Reply 4 (citing Ex. 1006, 205)). Patent Owner asserts:

> But the full quote from Stark states that the "*waveforms* shown in" Chapter 7 for the prototype circuit "closely resemble the theoretical models derived in previous chapters." Stark, 205. This statement says nothing about operating the prototype circuit using the higher Q values found in the theoretical discussions in Chapters 3 and 4—it only compares the voltage waveforms produced by the prototype circuit to those described in the prior chapters. *See id.*

Sur-Reply 19. Patent Owner misses the point made by Petitioner.

Whether the statement is as phrased by Petitioner or as quoted by Patent Owner, Petitioner does not assert that it conveys one should use and adjust the prototype to implement all previously mentioned Q values.

Rather, Petitioner's point is that because the measurements from the prototype are consistent with the theoretical models presented in previous chapters, the previously mentioned Q values are meaningful and not something to be avoided or understood as failures. Reply 4 ("Therefore, a POSA would have understood that Figure 3-9's disclosure of Q=1,000 (and Q=100) were meaningful values to be used when designing a real system."). We agree with Petitioner that the statement does add to Petitioner's position that the large Q values in Figure 3-9 are not disclosed as something that is unachievable, a failure, or unsuccessful, and therefore should be avoided. In any event, we are persuaded by Petitioner that the Q values in Figure 3-9 are real and meaningful, even without reliance on the statement at issue here, for reasons already discussed above.

In its Sur-Reply, Patent Owner raises three arguments which, if raised at all, should have been raised in the Patent Owner Response and not for the first time in Patent Owner's Sur-Reply. Just like a reply is not a place for Petitioner to start a new accusation against the challenged claims, a sur-reply is not a place for Patent Owner to start its opposition to Petitioner's accusations anew. *See* 37 C.F.R. § 42.23(b).

The Consolidated Trial Practice Guide (November 2019 ("CTPG"))[8] provides: "Sur-replies should only respond to arguments made in the reply briefs, comment on reply declaration testimony, or point to cross-examination testimony." CTPG 73–74. The word "respond" here "does not mean proceed in a new direction with a new approach as compared to the positions taken in a prior filing." *Id.* at 74. That would be unfair to

[8] *Available at* https://www.uspto.gov/TrialPracticeGuideConsolidated.

Petitioner who has no opportunity to respond. It also would undermine the integrity of the adjudicative process of *inter partes* review.

Patent Owner asserts for the first time in the Sur-Reply that, according to Stark, having Q values of 1,000 would increase the number of "beats" in the output waveform so high that Stark's system would be rendered useless. Sur-Reply 8. No such argument was made in the Patent Owner Response, which merely asserts that having just one beat in the output waveform is optimum for voltage gain. We decline to consider this new argument improperly raised in the Sur-Reply.

Even if we were to consider the new argument, it is unavailing. We find no indication by Stark, at the portions cited by Patent Owner (Ex. 1006, 30–3, 89–90), that having Q values of 1,000 would increase the number of "beats" in the output waveform so high that Stark's system would be rendered useless. Patent Owner also has not determined how many beats would correspond to Q values of 1,000, and why that number of beats would render Stark's system "useless." As we explained above, record evidence shows that whatever the disadvantage is associated with Q values of 1,000 is still deemed accepted or acceptable as a tradeoff for the associated advantages.

Patent Owner also asserts in the Sur-Reply that if one implemented Q values of 1,000, and also reduced k to equal a changed and smaller k_{crit}, the distance between the primary and secondary coils would exceed the 0 to 10 inch range provided for by Stark's prototype. Sur-Reply 16. No such argument was made in the Patent Owner Response. We decline to consider this new argument improperly raised in the Sur-Reply.

Even if we were to consider the new argument, it is unavailing. Patent Owner does not indicate how much longer than 10 inches the required

distance would be or why one with ordinary skill in the art would not have known to lengthen the separation to longer than 10 inches if that is necessary. We see no reason why one with ordinary skill in the art, when implementing higher Q values, would be bound to the 0 to 10 inches range for the separation and not capable of effecting a bigger separation if that is necessary for the higher Q values. Just as one with ordinary skill in the art would have known to adjust other parameters in the prototype, e.g., resistance values R_1 and R_2, capacitance values C_1 and C_2, and inductance values L_1 and L_2, one of ordinary skill would not have been limited to the 0 to 10 inches range of separation.

Finally, Patent Owner responds to Petitioner's statement that Stark in Chapter 5 encourages using the results of the previous chapters to determine component values when designing a system. Sur-Reply 20–21. Petitioner's statement is a pillar of Petitioner's primary obviousness argument made in the Petition. Pet. 38. In its Reply, Petitioner was reiterating the position it took in the Petition. Patent Owner may not wait until its Sur-Reply to respond, for the first time, to that argument.

Even if we were to consider this new argument, it is unavailing. Patent Owner asserts:

> [A]ssuming that Stark practices what he preaches, the circuit values listed in Chapter 7's description of the prototype circuit represent values actually chosen for the circuit from the theoretical survey described in the earlier chapters that are appropriate for the "particular application" of Stark's prototype circuit (*i.e.*, "generat[ing] high voltage, high frequency electrical power" to be "radiated to a receiver through an antenna array."). *See* Stark, 11, 109.

Sur-Reply 20–21. We disagree with Patent Owner's assumption that whatever is not actually implemented by the prototype was deliberately

eliminated by Stark as inappropriate or unsuccessful. As we described above, Stark never described simulated Q values of 1,000 as a failure or unsuccessful. Also, Stark's Figure 4-3 expressly discloses increased energy transfer efficiency resulting from higher Qs, and Stark's corresponding description to Figure 4-3 is that "[t]here is no fundamental limit to the [increased] unloaded energy transfer efficiency save for constraints on the quality factors and the coupling coefficient." Ex. 1006, 101.

(2) Conclusion for Claim 1

We have considered Patent Owner's evidence of nonobviousness, discussed below in Section II.F, and weighed all of the evidence before us, both for and against obviousness. The evidence of obviousness is strong and the evidence of nonobviousness is weak. On balance, the evidence of obviousness outweighs the evidence of nonobviousness.

Accordingly, we find that Petitioner proves, by a preponderance of the evidence, that claim 1 would have been obvious over Stark.

5. Independent Claim 6

Claim 6 is an apparatus claim substantively essentially corresponding to and having similar scope as method of claim 1. For example, whereas claim 1 recites "providing a first magnetic resonator structure," claim 6 directly recites "a first electromagnetic resonator structure." Ex. 1001, 11:41, 11:65–12:1. Also, whereas claim 1 recites "providing a second electromagnetic resonator structure," claim 6 directly recites "a second electromagnetic resonator structure." *Id.* at 11:46, 12:4.

Both Petitioner and Patent Owner commonly addressed claims 1 and 6, with no separate arguments for either claim. Our discussion above, for claim 1, equally applies to independent claim 6. Accordingly, we determine

that Petitioner proves, by a preponderance of the evidence, that claim 6 would have been obvious over Stark.

6. Claims 2, 5, 13, 19–22, 25, 26, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 60, 61, 64, and 67–70 as Obvious over Stark

Claims 2, 4, 5, 13, 19–22, 25, 26, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57, 60, 61, 64, and 67–70 each depend, directly or indirectly, from claim 1 or claim 6, and incorporate all the limitations of the independent claim from which it depends. On pages 50–70 of the Petition, Petitioner presents arguments and evidence accounting for the added limitations of each dependent claim. Petitioner's assertions are supported by the cited evidence. Patent Owner does not present contrary arguments with respect to any of these dependent claims, other than those it has asserted for independent claims 1 and 6. *See generally* PO Resp. We are persuaded by Petitioner's arguments pertaining to these dependent claims.

We specifically address claim 5. Claim 5 depends from claim 1, and additionally recites: "wherein $Q_1 > 1000$, and $Q_2 > 1000$." Ex. 1001, 11:64. Petitioner explains:

> With respect to Q > 1,000, Stark teaches that "keeping the Q of the system *exactly* at" a given value "is difficult." Stark 30 (emphasis original). Accounting for this difficulty, a POSA would view Stark's disclosure of Q = 1,000 as also disclosing Q values slightly above and slightly below those benchmarks, including Q > 1,000. Young Decl. ¶234. In addition, a POSA would have understood that there is no meaningful difference between resonators with Q of 1,000 (as disclosed) and Q marginally greater than 1,000 (as claimed). *See* Element 1/6[d]; *Titanium Metals*, 778 F.2d at 783; *In re Brandt*, 886 F.3d at 1177.
>
> In addition and in the alternative, a POSA would have considered it obvious, in view of Stark and their background knowledge, to design Stark's primary circuit and secondary circuit such that Q_1 and Q_2 are both greater (if only slightly) than

> the claimed ranges of 200, 500, or 1,000. Young Decl. ¶¶203–05, 235. As described with respect to element 1/6[d], both Stark and decades of background art taught the feasibility and desirability of maximizing Q. A POSA would know how to maximize Q, such as by using different wire and selecting an optimum resonant frequency, or by changing the RLC characteristics of the resonant circuit, and would have been motivated to do so because it would improve the efficiency and further optimize the power transmission from Stark's primary to secondary circuits. Young Decl. ¶¶206–21, 235; *see* element 1/6[d].

Pet. 52–53. On this record, Petitioner's reasoning for extending Q from 1,000, which is disclosed by Stark, to just slightly above 1,000 has a rational underpinning and is supported by the cited testimony of Dr. Young. Patent Owner has not presented contrary arguments additional to those we discussed above for claims 1 and 6.

After giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness, we determine that Petitioner proves, by a preponderance of the evidence, that each of claims 2, 4, 5, 13, 19–22, 25, 26, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57, 60, 61, 64, and 67–70 would have been obvious over Stark.

7. Claims 3, 4, 7, and 57 as Obvious over Stark

Claim 3 depends from claim 1 and further recites "wherein Q_1>200, and Q_2>200." Ex. 1001, 11:62. Claim 7 depends from claim 6 and further recites "wherein Q_1>200, and Q_2>200." *Id.* at 12:19–20. Patent Owner asserts that "Stark fails to render claims 3 and 7 obvious for at least the same reasons explained above with respect to claim 1." PO Resp. 37. Patent Owner also asserts that should Stark be found to render obvious Q values

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greater than 100, then Stark fails to render obvious Q values greater than 200 as recited in claims 3 and 7. *Id.* at 38.

Claim 4 depends from claim 1 and further recites "wherein Q_1>500, and Q_2>500." Ex. 1001, 11:63. Claim 57 depends from claim 6 and further recites "wherein Q_1>500, and Q_2>500." *Id.* at 14:23. Patent Owner does not specifically address claims 4 and 57 in the Patent Owner Response.

Petitioner's argument that Stark expressly discloses Q1 = Q2 = 1,000 fully accounts for the subject matter of claims 3, 4, 7, and 57. Patent Owner does not present any substantive argument in addition to those presented for independent claims 1 and 6. Accordingly, for the same reasons set forth above that Petitioner shows, by a preponderance of the evidence, that claims 1 and 6 would have been obvious over Stark, we determine that Petitioner proves, by a preponderance of the evidence, that each of claims 3, 4, 7, and 57 would have been obvious over Stark. This determination is made after giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness.

8. Claims 29, 58, and 59 as Obvious over Stark

a) Claim 29

Claim 29 depends from claim 20, which depends from claim 1. Ex. 1001, 13:3–7, 13:18. Claim 29 further recites "wherein $\kappa/\mathrm{sqrt}(\Gamma_{1*}\Gamma_{2)}>5$." *Id.* at 18. The parties agree that this limitation means $k/k_{crit} > 5$. Tr. 73:18–74:22. Petitioner asserts: "Stark expressly teaches designing its coupled resonant system to achieve values of that expression [k/k_{crit}] between 1.2 and 1.55 (Stark 84), as high as 2 or 5, (Stark 86–87), or even exceeding 10 or 40 (Stark 54). Accordingly, Stark discloses values for the claimed expression that exceed the claimed values." Pet. 60–61.

Alternatively, Petitioner asserts that it would have been obvious to one with ordinary skill the art to implement $k/k_{crit} > 5$ in its resonant circuit. *Id.* at 61–62. We do not reach Petitioner's alternative argument, because we are persuaded, notwithstanding Patent Owner's contrary argument discussed below, that Stark discloses implementing the case of $k/k_{crit} > 5$.

Patent Owner argues that "Stark is emphatic that k must equal k_{crit} to ensure maximum gain." PO Resp. 38. According to Patent Owner, the other examples of k merely "are comparing the behavior of Stark's system with a suboptimal k value to its behavior of the system when $k=k_{crit}$." *Id.* In essence, Patent Owner asserts that those instances of k exceeding k_{crit} are examples of what not to have, and that Stark teaches away from such large values of k. We disagree.

Stark does not convey that k should not or cannot be set to anything except k_{crit}. Stark does not refer to the examples where k exceeds k_{crit}, as examples of what not to have in any circumstance for any reason. Stark also does not state that maximum gain must be obtained at all costs. In contrast, Stark shows advantages for having high "k"s. Figure 4-3 of Stark is reproduced below:

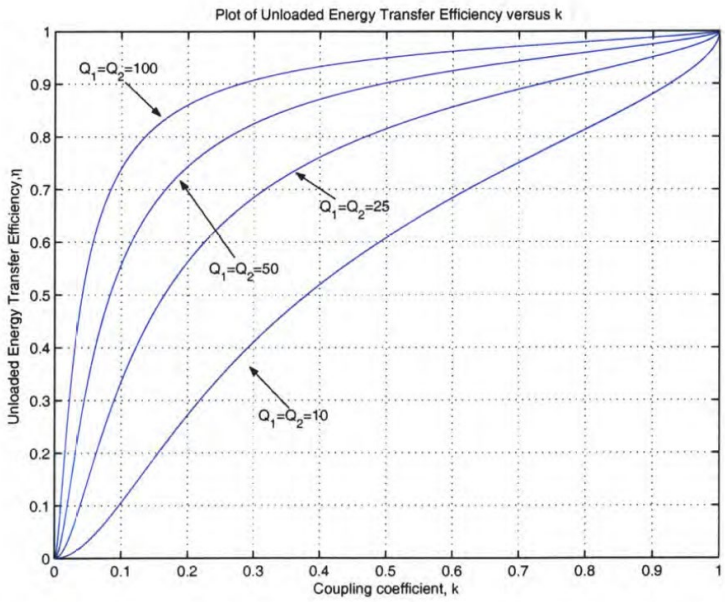

Figure 4-3 is a plot showing the relationship between coupling coefficient k and the energy transfer efficiency with Q as a parameter. Ex. 1006, 101. Stark states that "[t]here is no fundamental limit to the unloaded transfer efficiency save for constraints on the quality factors and the coupling coefficient." *Id.* Additionally, Stark describes that, as k approaches unity, the system behavior is "consistent with the operational dynamics of an ideal transformer." *Id.* at 93. Given such disclosures in Stark, we find that the exemplary values of k satisfying $k/k_{crit} > 5$ are not examples of what not to have and that Stark does not teach away from $k/k_{crit} > 5$.

After giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness, we determine that Petitioner has proved by a preponderance of the evidence that claim 29 would have been obvious over Stark.

b) Claims 58 and 59

Claim 58 depends from claim 1 and further recites: "wherein the first and second resonator structures are movable relative to one another."

Ex. 1001, 14:25–26. Claim 59 depends from claim 6 and further recites: "wherein the first and second resonator structures are movable relative to one another." *Id.* at 14:27–28.

Petitioner explains:

> Stark discloses that its primary and secondary circuits are movable relative to one another. Young Decl. ¶¶261–67. Stark describes building an exemplary prototype primary and secondary coil, based on the circuit designs disclosed in Figures 3–1 and 4–1. *Id.* ¶¶123–30, 265–66; *see* element 1/6[c]. Stark discloses operating this prototype by placing the primary and secondary coils "along a wooden track with a ruler attached to its surface," and then "moving the . . . coils, with their associated capacitors, apart by a specified amount and recording the secondary's output waveform." Stark 179; Young Decl. ¶¶265-66. In doing so, Stark discloses that the coils are movable from distances as little as "[z]ero separation" to as much as "10 inch separation between coils." Stark 180-83. Young Decl. ¶266.

Pet. 63. Petitioner's assertion is supported by the cited disclosure of Stark, Notwithstanding the contrary argument of Patent Owner below, we are persuaded that in Stark's disclosed prototype, the primary and secondary coils are movable relative to each other.

Patent Owner argues to the contrary:

> In Stark, the two resonators forming each Tesla coils are not designed to move relative to one another. To the contrary, there are repeated teachings in Stark to fix the separation between the primary coil and secondary coil in the Tesla coil because this will set the coupling coefficient k between the coils. WT-2003, [70]; *see, e.g.*, Stark, 89, 93.
>
> For example, as discussed above, Stark emphasizes at the conclusion of Chapter 3 that the "***coupling coefficient, k, is the single most important factor*** in determining the operation of the Tesla coil." Stark, 93; WT-2003, [71].
>
> Similarly, in section 5.4.1 titled "Constructing a coil with a specific k," Stark states that the "goal of this section is [to]

> give procedures for getting k close to a desired value, specifically k_{crit}." Stark, 127; WT-2003, [72].

PO Resp. 39. Patent Owner also argues that Figure 7-40 shows the primary coils are fixed in position relative to the secondary coils. *Id.* at 39–40. Figure 7-40 is reproduced below:

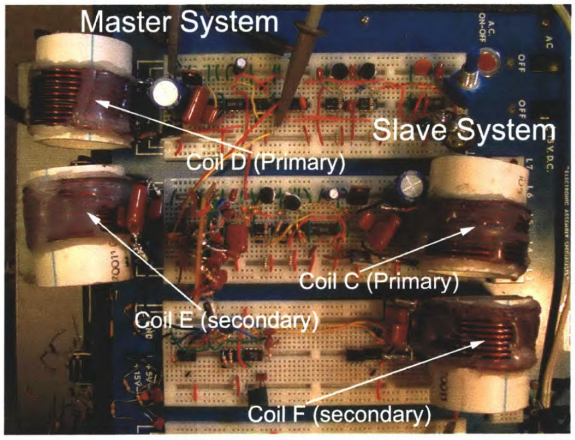

Figure 7-40 of Stark shows an array of two resonant systems, a master system and a slave system, each having a primary coil and a secondary coil. Ex. 1006, 187.

Patent Owner's argument is misplaced and unavailing. The claims require the primary and secondary coils to be movable relative to each other, not the primary and secondary coils to be moving relative to each other while in operation. The fixed position referred to by Patent Owner is only at a moment in time and is not inconsistent with the coils being "movable" relative to each other. Patent Owner points to nothing in Stark that indicates that the coils should be made non-movable relative to each other to preclude adjustments that are necessary to match the coupling coefficient to a different k_{crit} in case the parameters of the circuit, such as Q_1, Q2, or the resonant frequency, change. Indeed, with respect to its prototype, Stark changed the Q values numerous times. *See* Ex. 1006, 218 (Table 8.2).

Patent Owner further argues:

> While Chapter 7 of Stark does describe performing measurements for different separations between the primary and secondary coils circuits in each Tesla coil, this was only for the purpose of experimentally measuring the coupling coefficient, not for any final implementation of the phase array of Tesla coils. WT-2003, [73]; *see, e.g.*, Stark 145-205. Thus, the clear requirement in Stark is to set and fix a value for k to achieve the desired properties of the output waveform for the Tesla coil. *See id.* Stark therefore fails to teach or suggest that "the first and second resonator structures are movable relative to one another" as recited in claims 58 and 59.

PO Resp. 40–41.

This argument is also misplaced and unavailing. Petitioner's position is based on Stark's description of its prototype, which meets the added limitation of claims 58 and 59, not on what one may speculate about the structure of a future product, if any, that was then non-existent. The prototype description is a valid disclosure of Stark for Petitioner to rely on, regardless of speculation about future products or disclosures.

After giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness, we determine that Petitioner proves by a preponderance of the evidence that claims 58 and 59 would have been obvious over Stark.

9. Conclusion

After giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness, we determine that Petitioner proves by a preponderance of the evidence that claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42,

45, 46, 49, 50, 53, 54, 57–61, 64, and 67–70 of the '734 patent would have been obvious over Stark.

E. Alleged Obviousness of Claims 61, 62, 64, and 65 Over Stark alone or over Stark and Mecke

Claim 61 depends from claim 1 and claim 64 depends from claim 6, and each additionally recites: "wherein D > 1 cm." Ex. 1001, 14:32, 14:35. As set forth above, we already determined that Petitioner establishes, by a preponderance of the evidence, that claims 61 and 64 would have been obvious over Stark. *See* Section II.D.

Petitioner alternatively additionally also relies on the combination of Stark and Mecke as applied to claims 62 and 65 for claims 61 and 64. Pet. 70. Claim 62 depends from claim 1 and claim 65 depends from claim 6, and claims 62 and 65 each additionally recites: "wherein D > 30 cm." Ex. 1001, 14:33, 14:36. We understand Petitioner's rationale to be that when D > 30 cm, it is also true that D > 1 cm, and thus if the combination of Stark and Mecke would have rendered obvious claims 62 and 65, the combination also would have rendered obvious claims 61 and 64. We do not disagree.

With respect to claims 62 and 65, Petitioner asserts that Mecke discloses an inductive power transmission system including a primary coil that wirelessly transfers energy to a secondary pickup coil. Pet. 71 (citing Ex. 1007, 1737). Petitioner asserts: "A POSA would understand that Stark and Mecke rely on the same method of operation and could be built with the same circuitry." *Id.* (citing Ex. 1003 ¶¶ 298, 301).

Petitioner explains:

> Mecke further states that its system operates through an "air gap of several hundred millimeters[s]" between the primary and secondary coils. Mecke Abstract, 1737, Figs. 1–2; Young

> Decl. ¶¶298–99. Mecke's system is disclosed to operate, in particular, at distances including "300 mm," "400 mm" and "800 mm." Mecke 1737–38; Young Decl. ¶¶117, 299–304.
>
> A POSA implementing Stark's system would have been motivated to include an air gap of more than 300 mm (30 cm), as also described in Mecke, in order to transmit power over larger distances and better suit a wider range of wireless charging applications. Young Decl. ¶¶297–301. As Mecke describes, wireless power is useful because it avoids cables (which can trail or break), avoids wear and tear on electrical contacts, and minimizes potential sparking. Mecke 1737; Young Decl. ¶299. As a result, wireless charging is particularly useful for powering "robots" or "electric vehicles." Mecke 1737; Young Decl. ¶¶298–99. In such cases, as a POSA would understand, larger air gaps are desirable not only because they allow devices to be powered from further away, but because they avoid practical concerns, such as vehicles with a small air gap scraping against uneven asphalt. Mecke 1737; Young Decl. ¶¶298–303.
>
> It would have been with[in] a POSA's knowledge to modify Stark's system to include an air gap > 30 cm. As described above, Stark's system and Mecke's system operate similarly. While Mecke uses larger coils than those used in Stark's prototype, a POSA reading Stark have reason to, and have a reasonable expectation of success in, substituting larger coils into Stark's system, and operating the system at larger distances. Young Decl. ¶¶298–303.

Id. at 72–73. The above reasoning is supported by the cited disclosures of Stark and Mecke. But it is persuasive only with respect to the proposed combination of Stark and Mecke, not with respect to Stark alone, because Petitioner relies heavily on the specific disclosures of Mecke. Petitioner has not made clear what one with ordinary skill in the art would have known or desired to do based on Stark's disclosures in the absence of the disclosures of Mecke.

However, as explained elsewhere by Petitioner, Stark already discloses that its primary and secondary coils can be separated by a distance

of up to 11.9 inches (30.226 cm), if the separation is measured from the center of each coil. Pet. 64 (citing Ex. 1003 ¶¶ 273–74, 280–83). The distance of 30.226 cm already is greater than 30 cm. For that reason, the requirement of D > 30 cm would have been obvious over Stark alone as well.

Patent Owner does not present arguments with respect to claims 61, 62, 64, and 65, and with respect to Petitioner's reasons for combining the teachings of Stark and Mecke, other than what Patent Owner argues for independent claims 1 and 6, which we already addressed above.

After giving full consideration to the objective evidence of obviousness presented by Patent Owner and discussed below in Section II.F, and after weighing the totality of the evidence before us both for and against obviousness,[9] we determine that Petitioner proves by a preponderance of the evidence that claims 61, 62, 64, and 65 of the '734 patent would have been obvious over Stark alone or over the combined teachings of Stark and Mecke.

F. Objective Evidence of Nonobviousness

1. Overview

Patent Owner asserts that its claimed invention received industry praise and made significant impact in research and development. PO Resp. 41–46. For reasons discussed below, the evidence submitted by Patent Owner in that regard is weak. First, it is unclear that what Patent Owner refers to as industry praise even qualifies as a substantive "praise" for an

[9] The evidence of obviousness is particularly strong and the evidence of nonobviousness is weak. On balance, the evidence of obviousness outweighs the evidence of nonobviousness.

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advancement in technology. Second, it is unclear whether that alleged significant impact in research has anything to do with technical advancement. Third, there is no presumption of nexus in the absence of any product and Patent Owner has not shown a nexus between the claimed invention and the alleged industry praise and peer recognition.

All of Patent Owner's objective evidence of nonobviousness stems from an article allegedly written by the inventors of the '734 patent and published shortly after filing the application that issued as the '734 patent.[10] PO Resp. 42–46 (referring to Exhibit 2011 (hereinafter "Science article")). According to Patent Owner, the Science article "presents substantially the same description of the inventive technique as that set forth in the ['734 patent's] application, including the insight that the quality factors Q for the resonators need to be high, and conversely the intrinsic loss rates Γ for the resonators need to be low." *Id.* at 42 (citing Ex. 2011, 83, Ex. 1001, 5:2–10). We see nothing on the cited page of the Science article, however, which describes that Q needs to be high and Γ needs to be low, or how high such high should be and how low such low should be. Ex. 2011, 84.

Also, the Science article contains a description of an experimental demonstration which is not contained in the disclosure of the '734 patent. Petitioner identifies numerous differences between the parameters of the experimental demonstration and the embodiment of the '734 patent cited by Patent Owner as similar. Reply 23 (citing Ex. 1032 ¶¶ 117–120). Whether the Science article and the disclosure of the '734 patent are substantially the same in all respects is inconsequential. What is relevant is that the Science

[10] Kurs et al., *Wireless Power Transfer via Strongly Coupled Magnetic Resonance*, Science, Vol. 317 pp. 83–86 (July 6, 2007). Ex. 2011.

article describes an experimental demonstration of a resonant system with a first and second coil, where the Q values are designed to be approximately 2,500 and actually measured to be 950 ± 50, with a resonant frequency of 9.9 MHz, which transfers power wirelessly to a 60-Watt light bulb across a 2 meter gap. *Id.* at 83–84.

Petitioner argues that the "approximately 2500" Q value in the Science article is only theoretical. Reply 24 (citing Ex. 2011, [84], Ex. 1032 ¶ 120). This argument is inconsequential. The Science article describes, for its experimentally demonstrated system, as follows: "The theoretical *Q* for the loops is estimated to be ~2500 (assuming $\sigma = 5.9 \times 10^7$ m/ohm), but the measured value is $Q = 950 \pm 50$." Ex. 2011, 84. That means the Q values were, by design, meant to be approximately 2,500, but actually measured, after construction of system components, at only 950 ± 50. The result of our analysis, assuming the Q values to be 1,000, rather than 2,500, is the same. Petitioner argued persuasively, in the context of claim 5 which requires Q_1 and Q_2 to be greater than 1,000, that there is no meaningful difference between resonators with Q of 1,000 and Q marginally greater than 1,000. Pet. 52.

Patent Owner's objective evidence comes in two categories. The first is Exhibits 2012–2022, which, according to Patent Owner, represent industry praise from "media and academia." PO Resp. 43.[11] The second is Exhibits 2023–2025, which, according to Patent Owner, show "impact of the invention." *Id.* at 44. Patent Owner states this impact of the invention "relates directly to the technical insight of the invention and attests to the

[11] Patent Owner did not submit an exhibit numbered as Exhibit 2014. PO Resp. iv (noting that the exhibit number 2014 is reserved).

admiration of highly renowned professors for the significance of the contribution by the present invention to science by opening a new field of research." *Id.* at 45–46. We address the two categories in turn.

2. Industry Praise (Exhibits 2012–2022)

Of these eleven exhibits, Patent Owner in the Patent Owner Response specifically discusses only four, i.e., Exhibits 2015, 2016, 2017, and 2018. PO Resp. 43–45. Patent Owner does not explain how the other exhibits in this group constitute praise for the claimed invention, and thus is not persuasive in that regard. Like Patent Owner, we focus on Exhibits 2015–2018.

Exhibit 2015 is a news article from the Wall Street Journal (hereinafter "WSJ news"). With regard to WSJ news, Patent Owner states nothing beyond "the wireless powering of the 60-Watt light bulb across 2 meters described in Science was picked-up by the Wall Street Journal." *Id.* at 43. WSJ news was reporting on the Science article authored by the named inventors of the '734 patent:

> A 60-watt light bulb that glows even though it isn't wired to a power source could pave the way for wireless recharging of cell phone and laptop batteries and the operation of mobile robots without batteries, *scientists reported*.
>
> *A team of researchers at Massachusetts Institute of Technology reported in the online publication of the journal Science*, that they had demonstrated wireless transmission of electric power by magnetically coupled resonators. They dubbed their technology "WiTricity" for wireless electricity.

Ex. 2015, 1 (emphases added). WSJ news also includes an interview with Marin Soljacic, a co-inventor of the '734 patent:

> Prof. Soljacic said that over short distances, wireless transmission appears to be about 80% as efficient as wired transmission. The resonant devices interact with each other

> without interfering with either biological processes or other electrical devices. Prof. Soljacic also noted that electricity pioneer Nicola Tesla worked on similar methods for wireless transmission in the early 20th century, but dropped the idea because it didn't work over long distances.

Id.

News reporting on favorable characteristics an inventor describes about his own invention does not constitute meaningful industry praise. It merely indicates that what the inventor said about his invention may be news worthy, which is not the same as industry praise by those who understand the technology for the technical merit of the invention, given the state of the art. For the foregoing reasons, WSJ news is not evidence of meaningful or substantial industry praise.

Exhibit 2016 is a news article from BBC News (hereinafter "BBC news"). It also reports on the experimental demonstration described in the science article: "US researchers have successfully tested an experimental system to deliver power to devices without the need for wires. The setup, reported in the journal Science, made a 60W light bulb glow from a distance of 2m (7ft)." Ex. 2016, 1. Like WSJ news, BBC news also interviewed Dr. Soljacic (*id.* at 2–3), but as we noted above, an inventor's own favorable description of his own invention does not constitute meaningful industry praise.

BBC news includes interviews of other people. *Id.* at 1. Patent Owner states:

> Commentators interviewed by BBC News touted the relevance of the inventors' work, despite its apparent simplicity in hindsight:
>
> > WiTricity, as it is called, exploits simple physics and could be adapted to charge other devices such as laptops.

> "There is nothing in this that would have prevented them inventing this 10 or even 20 years ago," commented Professor Sir John Pendry of Imperial College London who has seen the experiments.
>
> "But I think there is an issue of time. In the last few years we have seen an exponential growth of mobile devices that need power. The power cable is the last wire to be cut in a wireless connection."
>
> Professor Moti Segev of the Israel Institute of Technology described the work as "truly pioneering."

WT-2016, 1.

PO Resp. 43–44.

The reported comment from Prof. Pendry, who witnessed the experiment, is not at all laudatory or flattering. It expresses that from a technological perspective, the wireless charging of a 60 Watt light bulb from 2 meters away is not impressive, and could have been accomplished 10 or 20 years ago with pre-existing technology. Ex. 2016, 1. His comments explain that that accomplishment is now newsworthy because "[i]n the last few years we have seen an exponential growth of mobile devices that need power." *Id.*

Prof. Segev does describe the work as "truly pioneering," but provides no explanation. *Id.* The work may be pioneering simply for dusting off old technology to apply it to mobile devices that have become ubiquitous. We credit Prof. Pendry more than we do Prof. Segev, because Prof. Pendry's comment is well explained and Prof. Segev's comment is not explained, and because Prof. Pendry's comment even renders Prof. Segev's comment consistent with Prof. Pendry's comment.

For the foregoing reasons, BBC news is not evidence of meaningful or substantial industry praise.

With regard to Exhibits 2017 and 2018, Patent Owner in its Response merely states:

> Thereafter, in 2008, the New York Times reported how Intel was working on similar technology to "demonstrate the use of a magnetic field to broadcast up to 60 watts of power two to three feet," and how the Intel research project "builds on the work of the Massachusetts Institute of Technology physicists Marin Soljacic, who pioneered the idea of wirelessly transmitting power using resonant magnetic fields." *See* WT-2017, 1. An Intel press release from 2008 similarly attributes such research as being "[b]ased on principles proposed by MIT physicists." *See* WT-2018, 1.

PO Resp. 44. As in the case of Prof. Segev's comment in BBC news, the language "pioneered the idea of wirelessly transmitting power using resonant magnetic fields" in Exhibit 2017 is unexplained. Ex. 2017, 1. That is especially troublesome in light of the fact that Patent Owner does not dispute, in the context of Stark's disclosure, that a Tesla coil, already known in the art, transfers power from a primary coil to a secondary coil using resonant magnetic fields. Patent Owner does not allege that the inventors of the '734 patent invented the Tesla coil. Rather, Prof. Pendry's comment in BBC news appears to provide satisfactory explanation, i.e., the inventors of the '734 patent applied old technology, not much used for lack of commercial application, to a new and pressing need for such technology stemming from recent exponential growth of mobile devices which need to be charged. *See* Ex. 2016, 1.

As for the comments that new research builds on the work of Prof. Soljacic, or new research is proceeding based on the principles proposed by Prof. Soljacic and his team, in the absence of a reasonable explanation, that less reflects technical praise and marvel than affirms the

thought that Dr. Soljacic's work refocused the field on technology that was previously available from which new research can proceed..

Even assuming that Exhibits 2012 through 2022 represent industry praise, Patent Owner has not shown "nexus" between that praise and the claimed invention. "[T]o be accorded substantial weight in the obviousness analysis, the evidence of secondary considerations must have a 'nexus' to the claims, *i.e.*, there must be 'a legally and factually sufficient connection' between the evidence and the patented invention." *Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019); *see also Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1539 (Fed. Cir. 1983). Objective evidence of nonobviousness must be commensurate in scope with the claims. *In re Kulling*, 897 F.2d 1147, 1149 (Fed. Cir. 1990).

There are two ways in which a patent owner may show the required nexus. The first is by way of a presumption of nexus, if there is a specific "product" and if the patent owner shows that the asserted evidence is tied to that specific product and is the invention disclosed and claimed. *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019). In this case, Patent Owner points only to an experimental demonstration that it performed, and does not identify any specific "product" which has been sold or otherwise distributed. The experimental device was not in the possession of anyone but the inventors themselves, and no one can independently verify the components and operation of the device. We find that the experimental device is not a product, is not an equivalent to a "product," and is fundamentally different in kind to a "product." Further, Patent Owner made no showing that the experimental device satisfies all limitations of any claim. Accordingly, Patent Owner is not entitled to a presumption of "nexus" and cannot rely on a presumption.

Without a presumption based on a "product" having all features of the claimed invention, Patent Owner still may show the required "nexus" by showing that the evidence of secondary considerations is the "direct result of the unique characteristics of the claimed invention." *Fox Factory*, 944 F.3d at 1374. Patent Owner made no such showing for Exhibits 2012 through 2022. The comments seem directed to the result of wirelessly powering a 60-Watt light bulb from 2 meters away. That is not a feature of any claim. Patent Owner also has not shown that a feature recited in any claim, e.g., $Q_1>100$ and $Q_2>100$ (claims 1 and 6), $Q_1>200$ and $Q_2>200$ (claims 3 and 7), or $Q_1>500$ and $Q_2>500$ (claims 4 and 57), is what made possible wirelessly powering a 60-Watt light bulb from 2 meters away. None of Exhibits 2015, 2016, 2017, and 2018 makes any mention of the quality factor Q, and Patent Owner does not contend that a 60-Watt light bulb cannot be wirelessly powered from 2 meters away if the Q values are below 100.

3. Impact of the Invention (Exhibits 2023–2025)

Patent Owner states this alleged impact of the invention "relates directly to the technical insight of the invention and attests to the admiration of highly renowned professors for the significance of the contribution by the present invention to science by opening a new field of research." PO Resp. 45–46. Patent Owner asserts:

> Exhibits WT-2023 to WT-2025 show the impact of the invention. For example, Exhibit WT-2024 confirms how the inventors' work reinvigorated work in the field of wireless power transfer ("WPT"):
>
> > Since WPT was firstly proposed by Nikola Tesla in 1914[4], much efforts have been devoted to this field. But these efforts did not get much breakthrough for several decades. Until 2006, when a MIT research team achieved higher transfer

> efficiency and longer transfer distance by employing strongly coupled magnetic resonance method to WPT[3], [5], interests in WPT were restored and WPT became a research focus again.

WT-2024, 1.

This is also confirmed by the literature survey in Exhibit WT-2025, which shows the inventors' 2007 Science paper is by far the most cited paper in the field of WPT and how eight of the next nine most cited papers all followed the 2007 Science paper. *See* WT-2025, Table II.

Finally, the breakthrough of the inventors' work, juxtaposed with the prior bias in the art, is clearly summarized in the following excerpt from the Exhibit WT-2023, which is a review article from 2016:

> Engineers in the 20th century believed that wireless power transfer is due to the coupling coefficient k, indicating the percentage that is shared between two coils out [of] the total magnetic flux. This common sense interpretation was drastically altered by Kurs et al. In 2007 [22]. They demonstrated strong power transfer in spite of low k, i.e., at a long distance. The key index to success in their experiment was not k alone, but k x Q.

WT-[2023], 47.

Id. at 44–45.

The problem with Patent Owner's contention, however, is that Joseph C. Stark, author of the prior art reference Stark (Ex. 1006, published 2004), did not think in the same way as the characterized "20th century" engineer. Figure 4-3 in Stark already clearly illustrates that higher power transfer efficiency can be obtained at whatever coupling coefficient k (representing separation between coils) by increasing the quality factor Q, and Stark clearly states that "[t]here is no fundamental limit to the unloaded

transfer efficiency save for constraints on the quality factors and the coupling coefficient." Ex. 1006, 101.

Regarding the product k x Q, Figure 4-3 of Stark shows the negative effects in energy transfer efficiency due to a lower coupling coefficient (larger distance) can be completely overcome and even turned into an increase in energy transfer efficiency by a big enough increase in Q. Similarly, Figure 3-31 of Stark shows that the negative effects in voltage gain by increasing Q can be completely overcome and even turned into an increase in voltage gain by a big enough decrease in k. Thus, in 2004 Stark disclosed that the key lies in the product k and Q, not in just k or just Q. That is consistent with the reported comment of Prof. Pendry that "[t]here is nothing in this that would have prevented them inventing this 10 or even 20 years ago." Ex. 2016, 1.

The alleged recognition for technical advancement cannot be based on something already disclosed by Stark. *Cf. Tokai Corp. v. Easton Enters., Inc.*, 632 F.3d 1358, 1369 (Fed. Cir. 2011) ("If commercial success is due to an element in the prior art, no nexus exists."); *Ormco Corp. v. AlignTechnology, Inc.*, 463 F.3d 1299, 1312−1313 (Fed. Cir. 2006) ("[I]f the feature that creates the commercial success was known in the prior art, the success is not pertinent."); *J.T. Easton & Co., Inc. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997) ("[T]he asserted commercial success of the product must be due to the merits of the claimed invention beyond what was readily available in the prior art.").

Further, Patent Owner does not point out the k x Q product associated with the inventors' experimental demonstration, or why that product value satisfies any k x Q product requirement of any challenged claim. It also is

not apparent to us that the Science article indicates that the key to designing systems for wireless power transfer is the k x Q product.

For the foregoing reasons, Patent Owner has not shown that the evidence of secondary considerations in Exhibits 2023 and 2024 is the "direct result of the unique characteristics of the claimed invention." *Fox Factory*, 944 F.3d at 1374. The required "nexus" has not been shown.

With regard to Exhibit 2025 which is a survey of literature on the subject of "Wireless Power Transfer,"[12] Patent Owner's contention is overly general and not meaningful. That the Science article was the most cited paper on the subject of wireless power transfer (Ex. 2025, Table II) does not convey anything about what it was cited for, whether something in it was widely recognized as a significant technological advancement over the state of the art, and if so, what that was. The same is true with the fact that eight out of the nine next most cited papers on the subject of wireless power transfer were published subsequent to the Science article. Ex. 2025, Table II. Patent Owner assumes too much. We decline to do so. The situation may be that suggested by the reported comment of Prof. Pendry (Ex. 2016, 1), discussed above, that what the Science article was describing was essentially pre-existing technology which, by happenstance, became interesting because of recent exponential growth of mobile devices that need charging.

Patent Owner has not shown that the evidence of secondary considerations in Exhibit 2025 recognizes anything in the Science article as a significant advancement over the state of the art, and if so, that it was the

[12] Olivares-Galvan et al., *Wireless Power Transfer: Literature Survey*, 2013 IEEE International Autumn Meeting on Power Electronics and Computing (ROPEC) (November 15, 2013). Ex. 2025.

"direct result of the unique characteristics of the claimed invention." With respect to Exhibit 2025, Patent Owner has shown no recognition of substantive merit and also no nexus with the claimed invention.

4. Conclusion

Patent Owner's objective evidence is, for reasons discussed above, weak. In reaching our conclusion of obviousness of the challenged claims, summarized below in Section III, we have considered the entirety of the evidence, both for and against obviousness, and weighed them against each other.

III. CONCLUSION

The outcome for challenged claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–70 of the '734 patent is set forth in the Table below:[13]

[13] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

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Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatent-able	Claims Not shown Unpatent-able
1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–61, 64, 67–70	103	Stark	1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–61, 64, 67–70	
61, 62, 64, 65	103	Stark	61, 62, 64, 65	
61, 62, 64, 65	103	Stark, Mecke	61, 62, 64, 65	
Overall Outcome			1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–70	

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has proved by a preponderance of the evidence that claims 1–7, 13, 19–22, 25, 26, 29, 30, 33, 34, 37, 38, 41, 42, 45, 46, 49, 50, 53, 54, 57–62, 64, 65, and 67–70 of the '734 patent are unpatentable; and

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

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