

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

STIHL INCORPORATED and ANDREAS STIHL AG & CO. KG,
Petitioner,

v.

ELECTROJECT TECHNOLOGIES, INC.,
Patent Owner.

Case IPR2018-00018
Patent 6,955,081 B2

Before JOSEPH A. FISCHETTI, MEREDITH C. PETRAVICK, and
WILLIAM V. SAINDON, *Administrative Patent Judges*.

SAINDON, *Administrative Patent Judge*.

FINAL WRITTEN DECISION

Finding All Challenged Claims Unpatentable

35 U.S.C. § 318(a)

Denying Petitioner's Motion to Strike

37 C.F.R. §§ 42.23(b); 42.5(a)

I. INTRODUCTION

We have jurisdiction under 35 U.S.C. § 6. The evidentiary standard is a preponderance of the evidence. *See* 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). This Final Written Decision (hereinafter, “Decision”) is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

Stihl Incorporated and Andreas Stihl AG & Co. KG (“Petitioner”) filed a Petition requesting an *inter partes* review of claims 1–18 of U.S. Patent No. 6,955,081 B2 (Ex. 1001, “the ’081 patent”). Paper 1 (“Pet.”). We instituted an *inter partes* review on each challenged claim. Paper 13 (“Dec. on Inst.”).¹ Electrojet Technologies, Inc., (“Patent Owner”) filed a Response. Paper 23 (“PO Resp.”). Petitioner filed a Reply. Paper 25 (“Pet. Reply”). Patent Owner, with our authorization, filed a Sur-Reply. Paper 27 (“PO Sur-Reply”). We held an oral hearing on January 24, 2019, and the transcript was entered into the record. Paper 34 (“Tr.”).

This Decision also addresses Petitioner’s Motion to Strike portions of Patent Owner’s Sur-Reply. Paper 29 (“Pet. Mot. Strike”). Patent Owner filed an opposition. Paper 30 (“PO Opp. Mot. Strike”).

Upon consideration of the arguments and evidence before us, we determine that Petitioner has established by a preponderance of the evidence that claims 1–18 of the ’081 patent are unpatentable. We deny Petitioner’s Motion to Strike.

¹ We instituted on all claims but not initially on all grounds. We brought all grounds back into the proceeding after the SAS decision. *See* Paper 21 (discussing the effects on this proceeding of *SAS Inst., Inc. v. Iancu*, 138 S.Ct. 1348, 1355 (2018)).

A. Related Matters

The parties identify the following matters related to the '081 patent (Pet. 1; Paper 5, 1):

Electrojet Techs, Inc. v. Stihl Inc. and Andreas Stihl AG & CO. KG, Case No. 2:17-cv-00224-RAJ-DEM (D. Va).

In addition, in IPR2018-00022, Petitioner has filed a petition challenging Patent Owner's U.S. Patent No. 7,225,793, which Patent Owner characterizes as "related to" the '081 patent and Petitioner characterizes as "claim[ing] priority to the same original parent application . . . and shar[ing] much of the same disclosure." Paper 5, 1; Pet. 1–2. We denied institution in that proceeding.

B. The '081 Patent

The '081 patent describes the invention as "an intake air pressure sensor assembly for an internal combustion engine . . . for determining intake air mass and controlling the fuel injectors and ignition timing of said engine." Ex. 1001 1:21–25. It is known "that [air] intake pressures fluctuate with the opening and closing of the intake valves [of the cylinder] during the intake stroke [of the piston]." *Id.* at 2:18–20. The air intake pressures are "understood in the art . . . [to] be used for intake air mass calculations in fuel injection control." *Id.* at 2:33–35. As to ignition timing, the '081 patent states that crankshaft position measurements and camshaft position measurements were typically measured by sensors and used to determine the angular position of the engine. *Id.* at 2:55–3:37. The aim of the '081 patent is to utilize the intake air pressure sensor to perform the functions of these other sensors, to measure engine timing and intake air mass, for reducing the

total number of sensors required to run a fuel-injected engine. *Id.* at 3:65–4:19.

C. Challenged Claims

Petitioner challenges claims 1–18 of the '081 patent. Of the challenged claims, claims 1, 6, 11, and 15 are independent. Independent claim 1 is illustrative and reproduced below.

1. An engine control apparatus for determining engine position and intake air mass from a single sensory means, comprising:
 - (a) an engine having at least one cylinder, a piston in said cylinder, a crankshaft connected to said piston, said piston being adapted to reciprocate between top dead center position and bottom dead center position defining a combustion chamber, an intake valve controlling the induction of an air mass into said combustion chamber with predetermined timing related to said crankshaft's angular position, said engine air induction system having its chamber contiguous with said valve and said engine combustion chamber, a pressure sensing element in communication with said air induction chamber;
 - (b) a pressure sensor means for developing periodic sensor voltage timing pulses, the cycle time between timing pulses being an indication of engine crankshaft speed, and the pulse timing being an indication of a particular crankshaft degree of angular position;
 - (c) a pressure sensor means for measuring intake air mass for the determination intake air mass;
 - ([d]) a means for measuring in real-time, intake air pressure, cycle time, and crankshaft position.

D. Prior Art and Asserted Grounds

Petitioner asserts the following obviousness grounds:

References	Claims Challenged
Abe ² and Kupske ³	1–12, 14–16, and 18
Abe, Kupske, and knowledge of POSA ⁴	13 and 17
Ostdiek ⁵ and Vernier ⁶	1, 3, 5, 6, 8, 10–12, and 14
Ostdiek, Vernier, and knowledge of POSA ⁷	2, 4, 7, 9, 13, and 15–18

Pet. 4.

II. PATENTABILITY ANALYSIS

A. Claim Construction

Petitioner sets forth its claim constructions for several means-plus-function terms. Pet. 9–16. Patent Owner indicates that it “does not contest these constructions” because it “believes the Petition to be insufficient

² US 4,866,620, iss. Sept. 12, 1989 (Ex. 1004).

³ DE 101 16 485 A1, published Oct. 10, 2002 (Ex. 1006) (certified translation).

⁴ “Person of Ordinary Skill in the Art.” Petitioner states that the ’081 patent “expressly admits that [a crank trigger] was well known [to a POSA].” Pet. 42 (citing Ex. 1001, 3:13–15 (“[m]any small engines utilize a crankshaft trigger mechanism for indicating a predetermined crankshaft position for ignition purposes.”); Ex. 1010, 103–105).

⁵ US 5,092,301, iss. Mar. 3, 1992 (Ex. 1007).

⁶ US 5,261,369, iss. Nov. 16, 1993 (Ex. 1008).

⁷ As explained in our discussion below, we need not reach the merits of Petitioner’s assertions regarding the scope of the knowledge of a person of ordinary skill in the art. Thus, we do not list here the specific knowledge relied upon by Petitioner.

regardless.” PO Resp. 9. In our Decision to Institute, we adopted Petitioner’s proposed constructions. Dec. on Inst. 5–6. Claim interpretation has not been an issue in the trial portion of the proceeding. We again adopt Petitioner’s proposed constructions for this Decision, but we decline to expressly construe any terms in this Decision. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (only those 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) (applying *Vivid Techs.* in the context of an *inter partes* review).

B. Level of Ordinary Skill in the Art

There is no dispute as to the level of ordinary skill in the art in this proceeding, nor does any issue turn on a precise definition of such a person’s level of skill. Nevertheless, we note the following definitions provided by the parties’ experts.

Petitioner’s expert, Mr. C. Art MacCarley, states that a person of ordinary skill “would have had at least a Bachelor of Science in Mechanical Engineering, Electrical Engineering, Automotive Engineering, or an equivalent field as well as at least three years of industry, academic, or other work experience in the design and operation of fuel-injected internal combustion engines.” Ex. 1003 ¶ 18. Patent Owner’s expert, Dr. Gregory Davis, provides the exact same definition. Ex. 2001 ¶ 36. Accordingly, we find that a person of ordinary skill in the art would be very familiar with how to design the various engines and engine control systems we discuss in our analysis of Petitioner’s grounds, as well as how they operate.

*C. Obviousness Over Abe (Ex. 1004) and Kupske (Ex. 1006)
(Claims 1–12, 14–16, and 18)*

In general, claim 1 is directed to an engine control for determining engine position and intake air mass from a single sensory means, specifically a pressure sensor means. Petitioner explains where Abe and/or Kupske describes each limitation of claim 1. Pet. 27–33. Petitioner’s ground begins with assertions that Abe describes the limitations directed to an engine (*id.* at 27–29), the pressure sensor means with respect to measuring intake air mass (*id.* at 32), and a means for measuring that intake air mass (*id.* at 32–33). Petitioner then asserts that Kupske discloses the limitation directed to a pressure sensor developing timing pulses indicating engine crankshaft speed (cycle time) and position. *Id.* at 29–32. Patent Owner does not dispute Petitioner’s arguments and evidence cited for each limitation of claim 1; the focus of the trial portion of this proceeding has been on the rationale for combination. Therefore, we will only briefly address each limitation of claim 1; we adopt Petitioner’s citations as to where Abe and Kupske teach each limitation of claim 1 as our own findings. See Pet. 27–33.

1. Claim 1, Element-by-Element

Claim 1 first requires an engine having various common components such as a cylinder, piston, crankshaft, intake valve, and a pressure sensor. Abe discloses engine 1 having a cylinder with piston 11, crankshaft, intake valve 8, and pressure sensor 14. Ex. 1004, Fig. 2, 3:60–61, 3:66–67, 4:23–27.

Claim 1 next requires a pressure sensor means for developing timing pulses, with the timing pulses indicating crankshaft speed and degree of rotation. Abe discloses pressure sensor 14. Ex. 1004, 3:66–68. Kupske

discloses using a pressure sensor to emulate (reproduce) crankshaft sensor signals (which is what indicates crankshaft/engine speed and degree of rotation). Ex. 1006 ¶¶ 19–21; *see also id.* ¶ 19 (stating that the emulated crankshaft sensor signal indicates engine speed as well as time intervals); Ex. 1004, 4:23–27 (describing a crankshaft sensor signal as producing pulses at predetermined intervals).

Claim 1 also requires a pressure sensor means for measuring intake air mass. Abe discloses pressure sensor 14 used to measure intake air mass (Q). Ex. 1004, 5:50–53, 7:31–37; *see also* Ex. 1001, 2:33–35 (admitting that it is well understood in the art that air pressure can be used for calculating intake air mass).

Claim 1 lastly requires a means for measuring, in real time, intake air pressure, cycle time, and crankshaft position. Abe measures these three things in real time to control engine timing. *See generally* Ex. 1004, Figs. 4A, 4B (describing how to set ignition timing as the engine runs). Specifically, Abe measures intake air pressure in step 110 at a certain point in the engine cycle. Ex. 1004, 5:50–6:3 (stating that Q is determined by measuring intake air pressure P_m when the piston is at the bottom of the cylinder). Abe discloses that the engine knows the piston is at the bottom of the cylinder by using information gleaned from at least one of the crankshaft position sensor (crank angle sensor) or an air flow sensor. *Id.* at 2:14–32. Abe also discloses measuring cycle time (engine speed). *Id.* at Fig. 4B, item 210.

Kupske also discloses a means for measuring. In addition to the traditional mode of gathering these measurements (*see* Ex. 1006, Fig. 4), in the event the crankshaft sensor fails, Kupske teaches a method of using the

intake air pressure to emulate the crankshaft sensor signal to allow continued engine operation. Ex. 1006 ¶¶ 16, 17. Specifically, the crankshaft sensor signal is emulated on the basis of the intake pressure, to allow continued engine operation. *Id.* ¶¶ 19–21. Because the crankshaft signal provides cycle time and crankshaft position and because the signal itself is emulated, Kupske discloses the limitation.

Accordingly, Abe and Kupske disclose each limitation of claim 1. We now turn to the disputed portion of the ground, the rationale for combination.

2. Petitioner’s Rationale for Combination

With respect to the combination of Abe and Kupske, Petitioner asserts that it would have been obvious to “incorporate Kupske’s engine controller (which uses the signals from an intake pressure sensor to determine engine position and engine cycle time) into the ECU disclosed in Abe.” Pet. 25. Specifically, Petitioner states that a person of ordinary skill in the art would have been motivated to use Kupske’s teachings “to calculate engine position as an emergency backup when the crankshaft sensor (12) fails.” *Id.* at 25–26. Petitioner asserts that such a combination would have been “nothing more than the use of known techniques to improve similar methods in the same way[,] or the combination of prior art elements according to known methods to yield predictable results.” *Id.* at 26.⁸

⁸ Petitioner also arguably raises a separate “obvious to try” rationale. Pet. 26–27; *see also* PO Resp. 26–30 and Pet. Reply 14–15 (both arguing whether the arguments satisfy a stand-alone “obvious to try”-type rationale). We do not treat this as a separate, standalone rationale here but rather just consider the statements on pages 25–27 as a whole as a part of Petitioner’s articulated rationale. Even if it would fail as a stand-alone “obvious to try”

Patent Owner argues that there are two flaws with Petitioner's rationale stated above. First, Patent Owner alleges that the combination does not address how Abe's engine would know when to detect air pressure if its crank angle sensor were to fail as proposed by Petitioner. PO Resp. 15–22. Second, Patent Owner alleges that Abe's ignition timing correction routine would be disrupted by incorporation of Kupske's failover mechanism. *Id.* at 22–26. We address these in turn.

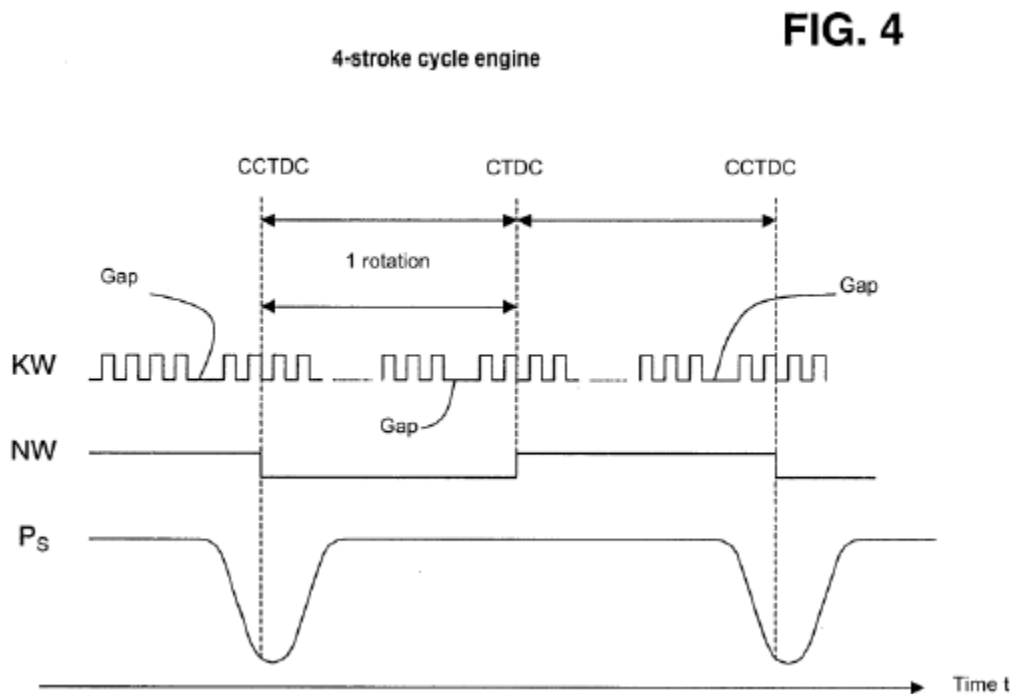
3. *Issue: Air Pressure Detection Timing*

We find that Abe's engine in Petitioner's proposed combination would be able to properly detect air pressure. Abe uses the engine crank angle sensor to determine when the cylinder is at the end of its intake stroke; according to Abe, this point in time marks the best time to measure the amount of air the cylinder took in during the intake stroke. Ex. 1004, 5:50–6:6. Patent Owner's argument is that the proposed combination presumes that the engine crank angle sensor will fail, but if that happens, then the engine will no longer know when to measure intake air quantity. See PO Resp. 15–20; *id.* at 15 (“Abe teaches sampling the air pressure at moments that are directly tied to the detected crank angle . . . , while Kupske's system works when the crank angle . . . sensor fails”). However, the premise of Petitioner's combination is that Kupske's teachings provide for the replacement of the functionality of the engine crank angle sensor, i.e., Kupske's teachings provide an equivalent signal if the crank angle sensor

rationale, the statements made therein are otherwise indistinguishable from a more usual “reason to combine” analysis, and we see no reason to ignore the evidence and arguments raised here solely based on their label.

fails. *See, e.g.*, Pet. 32–33 (“Kupske discloses that the ECU can use the signals from the same intake pressure sensor to measure engine cycle time and crankshaft position”); Ex. 1006 ¶ 19.⁹

Specifically, Kupske discloses a way to keep an engine running if the engine crank angle sensor breaks. Ex. 1006 ¶ 19. The engine crank angle sensor signal (KW) normally looks like a square wave, as shown in Figure 4 of Kupske, reproduced below:



⁹ Petitioner also points out that Abe teaches the intake measurement could be based off of an air flow sensor reading instead of the crank angle reading. *See, e.g.*, Pet. Reply 4–10. We need not address this alternative factual basis because we agree with Petitioner’s position that Kupske discloses how to keep using a crank angle sensor signal when that sensor fails. *See, e.g.*, Pet. 32–33 (discussing “arithmetically determin[ing] current engine timing” by using Kupske’s teachings).

Figure 4 of Kupske illustrates the relationship between the crankshaft signal KW (also known as the crank angle sensor signal), the camshaft signal NW, and the inlet manifold pressure signal Ps. *Id.* ¶ 21.

Kupske teaches that, in the event the crank and/or cam signals fail, they can be imitated by creating those signals from the manifold pressure signal. *Id.* ¶ 21 (“it is possible to arithmetically emulate . . . a crankshaft signal KW on the basis of the inlet manifold pressure signal Ps . . . in the event of a failure”). Accordingly, in the proposed combination, when the crank angle sensor breaks, Kupske’s technique is applied such that the crank angle sensor *signal* continues, now being arithmetically emulated using the pressure signal. As such, the engine would not lose the ability to use the crank angle sensor *signal* to trigger when to measure the intake air. Indeed, we find that it would be getting the same signal (albeit an arithmetically derived version). In conclusion, we find that the Petitioner’s proposed combination would be able to properly detect engine pressure at the appropriate time.

As to Patent Owner’s argument that using “Kupske’s backup system would frustrate the intended purpose of Abe,” PO Resp. 18–20, we find such an argument unpersuasive and unsupported by the evidence of record. Patent Owner points out how Abe is concerned with obtaining the air pressure measurement after bottom dead center of the stroke. *Id.* (citing, e.g., Abe’s title). Patent Owner asserts that “Abe’s only disclosed method of utilizing intake air pressure sensor (14) is to do so based on signals from the crank angle sensor.” *Id.* at 20. But Abe teaches (at least) two different ways to determine when to measure the air pressure—by using information derived from the crank angle sensor *or* using an air flow sensor. Ex. 1004,

2:21–38 (listing the timing as determined by “an operation parameter,” “an output of a flow rate sensor,” or “a predetermined crank angle”). As we found above, Kupske provides an emulated crank angle sensor signal when the actual crank angle sensor breaks. Thus, in the proposed combination, even if the only way Abe determined when to measure air pressure near bottom dead center was in conjunction with a signal from the crank angle sensor, the proposed combination satisfies that requirement by providing the same signal, just from a different source. Further, given that Abe expressly states that other sensors can be used to determine that timing of bottom dead center, we find that even if Kupske’s emulated crank angle signal were not used, the flow rate sensor is also usable for this purpose.

We also point out that this case differs substantially from another case where we did not institute on an Abe-Kupske ground. Patent Owner points out our Decision Denying Institution in IPR2018-00022 as purportedly supporting its position here. *See, e.g.*, PO Resp. 18, 20. But the outcome in that proceeding does not bear on this one because of critical claim scope distinctions. We construed the claim in that proceeding to at least prohibit a throttle valve position sensor (which is not prohibited in the claims of the ’081 patent). Abe relied on a throttle valve position sensor to operate, yet the petition in that case did not address how Abe would operate if it no longer had a throttle valve position sensor. Accordingly, statements we made in that proceeding are based on particular facts and circumstances, and do not bear on this proceeding.

4. Issue: Ignition Timing

We are also not persuaded that Petitioner’s proposed combination would be precluded due to an ignition timing issue. Abe describes an

ignition timing routine wherein a well-known base ignition timing θ_{base} is modified after taking into account several other engine operating parameters. Ex. 1004, 5:40–49. Figure 4A of Abe, a modified¹⁰ version of which is reproduced below, illustrates the ignition timing correction routine:

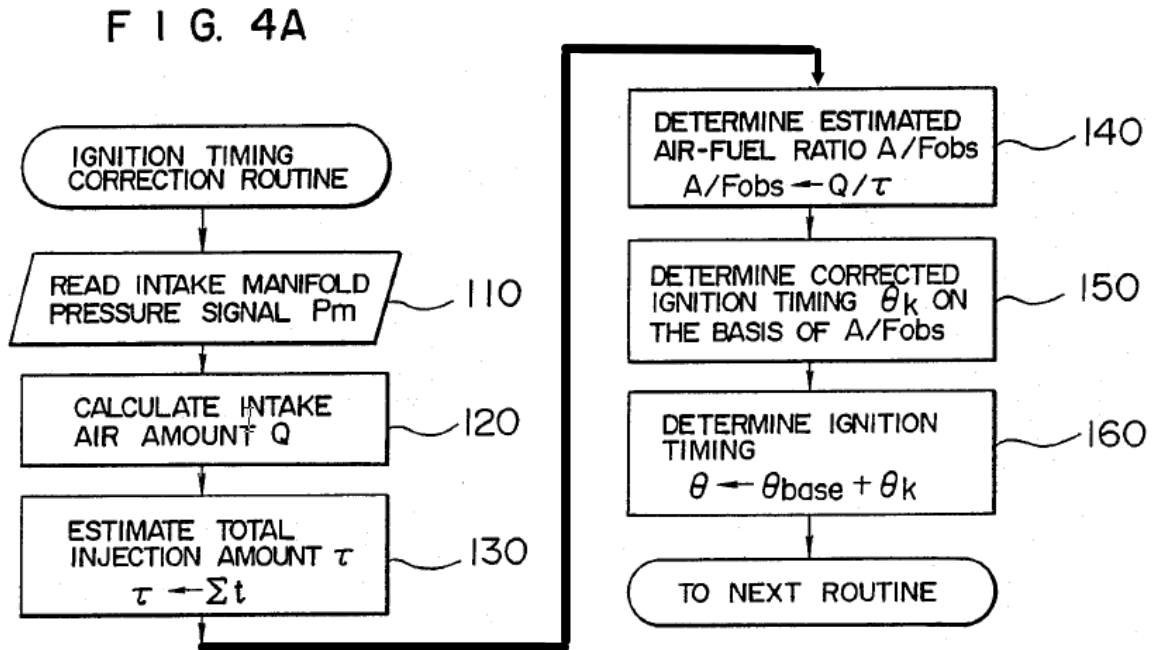


Figure 4A of Abe depicts an ignition timing correction routine. The purpose is to modify the ignition timing (firing of the spark plug) to optimize it based on the actual air-fuel ratio in the cylinder.¹¹ In order to modify the timing based on the air-fuel ratio, the air-fuel ratio must be determined. This is done by first calculating the amount of air (Q) drawn in by the cylinder

¹⁰ Figure 4A of Abe has been split in two to fit within a smaller vertical space, with an arrow added to join the now-separated portions of the flowchart.

¹¹ Timing is important because (1) it takes time for a given quantity of fuel to burn in a given quantity of air and (2) for a given engine speed, the cylinder only has so much time in its power stroke (where it is being pushed down by expanding combustion) before it begins reciprocating back up (and any further combustion would be fighting that return).

during the intake stroke. Ex. 1004, Fig. 4A, step 120. This is done by considering known relationships between air quantity and air pressure, especially when the cylinder is drawn all the way down, such that no more air is sucked into the cylinder. *Id.* at 5:50–6:6, Fig. 5.¹² After determining air quantity Q , the routine estimates the amount of fuel τ injected into the cylinder, effectively by measuring how long the injector was open. *Id.* at 6:7–20, Fig. 4A, step 130. At step 140, air quantity and fuel quantity are divided to calculate the estimated air/fuel ratio in the cylinder, after which, at step 150, a correction factor θ_k is determined. *Id.* at 6:21–36. The base ignition timing θ_{base} is determined using a “well-known ignition timing calculation routine” using engine load (Q/N), engine speed (N), and air/fuel ratio (A/F) from air-fuel ratio sensor 17 on the exhaust manifold. *Id.* at 5:34–49 (calculating base ignition timing); 4:16–19 (describing air-fuel ratio sensor 17). At step 160, ignition timing is determined using the above values. *Id.* at 6:29–36.

When we consider the proposed modification in view of this timing routine, we do not find that using Kupske’s arithmetically emulated crankshaft angle sensor signal renders the proposed combination non-obvious or without a reasonable expectation of success. Much as we explained in the prior section, the purpose of Kupske is to *emulate* the crank angle sensor signal if the sensor fails. *See, e.g.*, Ex. 1006 ¶¶ 19 (explaining that the emulated signals are “provided to the engine controller 2 in the same

¹² According to Abe, the amount of intake air (Q) can be most accurately measured when the cylinder is at or near bottom dead center. Ex. 1004, 5:59–6:3. How to determine when the cylinder is at this point is the subject of the prior section.

way as the [original crankshaft sensor signals,” based on using the number of teeth on the crankshaft wheel, which results in the engine controller being “provided with substantially the same input variables” (emphasis omitted)), 21 (describing that it will “arithmetically emulate . . . a crankshaft signal” if it fails). This means that the emulated signal would sufficiently imitate the output of the crank angle sensor 19 to at least keep the engine in Abe running in an emergency as proposed by Kupske. Accordingly, in the ignition timing correction routine of Abe, we find that each of the inputs relying on the crank angle sensor signal (e.g., timing on step 110, engine speed N) could continue, using Kupske’s emulated signal.

Patent Owner argues that using an emulated crank angle signal based on a pressure signal (as taught in Kupske) would result in “[u]sing the output from one sensor as both a base and a correction to the base is nonsensical, and would yield a redundant, inaccurate correction routine.” PO Resp. 24–25 (citing Ex. 2001 ¶ 59). But what Patent Owner and its expert are arguing here misses the fact that Abe already uses “one sensor” (the crank angle sensor) to determine base and corrected ignition timing, because Abe uses the crank angle sensor to determine when to measure pressure (step 110) as well as to calculate engine speed, which is used to calculate base timing (step 160). Ex. 1004, Fig. 4A. Thus, using the same sensor as inputs for both the base and corrected timings is not an issue per se. Further, Kupske’s teaching is to reproduce the signal, meaning the proposed modification to Abe does not affect it in terms of which inputs are available to the engine controller in Abe.

Patent Owner and its expert also appear to argue that Kupske’s emulated signal would create some sort of timing problem. See PO Resp. 25

(arguing “the determination of the air-fuel mixture for the current cycle would happen too late” (citing Ex. 2001 ¶ 59)). But this position is not supported by sufficient credible evidence. Both Patent Owner and its expert are correct to the extent that the air-fuel ratio in the base ignition timing is derived (at least in part) from what happened in the prior cycle. Specifically, air-fuel ratio sensor 17 measures the amount of oxygen in the *exhaust* manifold—after the air-fuel mixture has been burned and expelled from the cylinder. Ex. 1004, 4:16–19. But neither Patent Owner nor its expert articulates (nor do we see) how this fact is relevant to the outcome of this case. Again, the proposed modification is to allow the crank angle signal to be emulated when the crank angle sensor breaks, which is what Kupske provides.

Patent Owner and its expert next assert that the air-fuel ratio calculation for the current cycle is based on air pressure measured near bottom dead center (i.e., at a certain time). PO Resp. 25; Ex. 2001 ¶ 59. According to Patent Owner’s expert, “the location near bottom dead center would not be known until after the engine speed is determined by analyzing the intake air pressure waveform over the entire cycle.” Ex. 2001 ¶ 59. But Patent Owner’s expert provides no evidence in support of this bald assertion, nor does he provide any other technical explanation as to why this may be true. *Cf.* 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”). Indeed, the evidence we have before us on this topic—Kupske—states that the crank angle signal is arithmetically emulated, i.e., the same signal is reproduced so that the engine can continue running using “substantially the same input variables.” Ex. 1006 ¶ 19. Thus, Kupske is

not merely making a signal when the cylinder hits bottom dead center (e.g., something akin to Ps in Abe's Figure 4). Instead, Kupske is continuously producing the square-wave-like signals in order to *emulate* the crank angle signal. *Id.* ¶¶ 19, 21; *see also id.* at claim 11 (explaining how the pressure signal is used, in combination with the number of teeth on the crankshaft wheel, to provide the time intervals to the engine), Fig. 4 (depicting what the time intervals in a crankshaft angle signal (KW) look like). The crank angle signal is one way Abe uses to determine when to measure air pressure; thus, with Kupske's method providing that signal by way of emulation, no modification to that aspect of the timing routine is required.¹³ We do not find sufficient credible evidence that Kupske does not, in fact, emulate a crank angle sensor signal. As such, we do not find sufficient credible evidence to determine that Kupske's emulated signal would not work in the proposed combination.¹⁴ Instead, for the reasons expressed above in this paragraph, we find that Kupske's emulated signal would provide effectively the same signal the crank angle sensor would have provided, such that the proposed combination would have predictably operated. Ex. 1006 ¶ 19

¹³ As we found above, Abe actually teaches more than one way to determine when to measure air pressure. *See* Ex. 1004, 2:21–39; *cf.* PO Sur-Reply 4–5 (arguing about other ways of measuring air pressure). We focus on the crank angle sensor here because that is where the parties' arguments are most developed, and it is dispositive.

¹⁴ Patent Owner, in its Sur-Reply, asserts that "Abe is **not operable** if the crank angle sensor were to fail." PO Sur-Reply 3–4; *see also id.* at 6–9. This is irrelevant because the ground before us is not anticipation. As we have explained above, the proposed modification is to use Kupske's method of emulating the crank angle sensor signal when the crank angle sensor fails by using an air pressure signal.

(stating that the emulated signal means the engine “is provided with substantially the same input variables” regardless if the crank angle sensor fails).

5. Conclusion Regarding Claim 1

We found that Petitioner has shown where each element can be found in the prior art and that there is a reason to combine the teachings of the prior art in a manner that leads to the claimed invention. We found that such a combination would have been predictable and operable. Accordingly, we determine that Petitioner has shown, by a preponderance of the evidence, that the subject matter of claim 1 would have been obvious in view of the teachings of Abe and Kupske.

6. Claims 2–12, 14–16, and 18

Petitioner sets forth its assertions regarding how Abe and Kupske disclose each limitation of these claims. Pet. 33–42. No separate discussion as to whether these prior art references render obvious the claimed subject matter has been brought before us; all arguments that could touch these claims have already been addressed in our analysis of claim 1. *See also* Pet. Reply 20–22 (observing that Patent Owner makes no separate arguments with respect to these claims). Notwithstanding, we briefly address these remaining claims. We adopt Petitioner’s citations to Abe and Kupske addressing the limitations of these claims as our own findings. *See* Pet. 33–42.

Claim 2 depends from claim 1 and states that the engine control apparatus is in combination with a pressure sensor means to detect engine load. Petitioner asserts that Abe describes how a pressure sensor can be

used to detect engine load. Pet. 33 (citing Ex. 1004, 7:39–50). Specifically, we find that Abe states that the engine is “controlled on the basis of parameters including the load (Q/N) of the . . . engine obtained from . . . the intake manifold pressure Pm.” Ex. 1004, 7:42–51.

Claim 3 depends from claim 1 and states that the engine control apparatus is in combination with an additional sensory means to detect crankshaft position. Petitioner asserts that the crank angle sensor in Abe detects crankshaft position. Pet. 34 (citing Ex. 1004, 4:23–27). As we discussed with respect to claim 1, a pressure sensor (as taught in Kupske) may also be used to detect crankshaft position. Thus, in the proposed combination, the two sensory means to detect crankshaft position are the crank angle sensor and the pressure sensor.

Claim 4 depends from claim 3 and states that the engine control apparatus is in combination with a pressure sensor means to detect engine load. Petitioner again points to Abe’s disclosure of calculating engine load based on air pressure. Pet. 34 (citing Ex. 1004, 7:45–49).

Claim 5 also depends from claim 3 and states that in the event of a sensory component failure, the engine remains capable of determining crankshaft position. Petitioner directs our attention to the fact that this is the exact same premise as Kupske, which serves as the basis for Petitioner’s rationale of claim 1. Pet. 35; *see also, e.g.*, Ex. 1006 ¶ 21 (suggesting to emulate the crankshaft sensor signal using a pressure signal in the event the crankshaft sensor signal fails).

Claim 6 is independent and largely mirrors claim 1. Petitioner relies on the same showing as claim 1, addressing the slightly different claim language regarding detecting pressure fluctuations. Pet. 35–37. But there is

no argument before us that the slightly different language would lead us to a different conclusion, nor do we see one. Indeed, both Abe and Kupske disclose detecting pressure fluctuations in the intake chamber during the intake stroke. *See, e.g.*, Ex. 1006 ¶ 15 (describing Figure 3 as showing how the pressure curve indicates timing); Ex. 1004, 5:50–6:6. Further to this, our analysis with respect to claim 1 explains why this proposed combination is persuasive of obviousness.

Claims 7–10 depend from claim 6 and largely mirror dependent claims 2–5. Petitioner relies on the same persuasive showings. *See* Pet. 37–38.

Claim 11 is independent and largely mirrors claim 1. Petitioner relies on the same showing as claims 1 and 6, addressing the slightly different claim language regarding specifically determining engine timing and air intake mass. Pet. 38–40. As with claim 6, there is no argument before us that the slightly different language would lead us to a different conclusion, nor do we see one. Indeed, as we found above, Kupske’s emulated signals provide a replacement for the crankshaft sensor signal, which means they are provided in real time. *See, e.g.*, Ex. 1006 ¶ 21. In Abe, air intake mass Q is based on the intake manifold pressure signal. Ex. 1004, 5:50–65. In the proposed combination, in the event that the crank sensor fails, then engine timing is instead calculated on the basis of the intake air pressure as envisioned by Kupske. Ex. 1006 ¶¶ 17–21; Pet. 25–26 (reasoning that the proposed combination is obvious “as an emergency backup when the crankshaft sensor (12) fails”). Further to this, our analysis with respect to claim 1 explains why this proposed combination is persuasive of obviousness.

Claims 12 and 14 depend from claim 11 and largely mirror dependent claim 3. Petitioner relies on the same showings, with the addition, for claim 14, that Abe also includes an intake air temperature sensor and a throttle position sensor. Pet. 40 (citing Ex. 1004, 3:68–4:3, Fig. 2).

Claim 15 is independent and largely mirrors claim 11, and claims 16 and 18 depend therefrom and mirror claims 12 and 14, which in turn mirror claim 3. Pet. 40–42.

Reviewing Petitioner’s positions for claims 2–12, 14–16, and 18, we determine that each is unpatentable by a preponderance of the evidence for the reasons expressed therein and further articulated above.

*D. Obviousness Over Abe, Kupske, and Knowledge of a Person of Ordinary Skill in the Art
(Claims 13 and 17)*

Dependent claims 13 and 17 require that the crankshaft position sensor comprises a crank trigger. Petitioner asserts that the ’081 patent admits that this is well known at the time of the invention, and that it would accordingly have been obvious substitution to include this known feature. Pet. 42–43 (citing Ex. 1001, 3:13–25; Ex. 1003 ¶¶ 154–155; Ex. 1010, 103–105). Patent Owner directs our attention to its prior arguments with respect to the combination of Abe and Kupske. PO Resp. 31. Given that the limitation is an admittedly known alternative sensor type, and that we have already determined that claims 11 and 15, from which these claims depend, would have been obvious, we determine that Petitioner has shown by a preponderance of the evidence that claims 13 and 17 are not patentable.

*E. Obviousness Over Ostdiek and Vernier
(Claims 1, 3, 5, 6, 8, 10–12, and 14)
and
Ostdiek, Vernier, and Knowledge of a Person of Ordinary Skill in the Art
(Claims 2, 4, 7, 9, 13, and 15–18)*

We initially denied institution as to this ground (Dec. on Inst. 11–12), but later brought it back into the proceeding in light of our SAS guidance requiring us to institute on all claims and grounds (Paper 21). In our Decision on Institution, we stated:

Reviewing Petitioner’s ground, we determine that Petitioner has not articulated sufficiently a reason explaining why the claimed subject matter would have been obvious over these references. In the Abe-Kupske ground, Petitioner gave a specific reason for the combination: Kupske teaches using pressure sensors as a backup in case the crankschaft sensor failed. In contrast here, Petitioner merely states that the reason to combine is to obtain the result of the combination. . . . Pet. 48 (“obvious . . . to incorporate . . . to determine the engine’s position”). A reason for combination explains not the result of the combination, but why such a combination would have been obvious. Unlike Kupske, which gives a reason to measure the time between pressure peaks (as a backup), Vernier merely states that such a calculation is possible. Ex. 1008, 3:1:5. . . . Petitioner provides no sufficient reason to modify Ostdiek’s system in some manner with the teachings of Vernier. Accordingly, we determine that Petitioner has not established a reasonable likelihood of success with the Ostdiek-Vernier grounds.

Dec. on Inst. 12.

Reviewing the arguments and evidence before us (Pet. 43–68; PO Resp. 31–48; Pet. Reply 15–20; PO Sur-Reply 9–18), we determine that Petitioner has not shown, by a preponderance of the evidence, that the subject matter of any of claims 1–18 would have been obvious in view of Ostdiek and Vernier.

Ostdiek is directed to an engine control scheme that uses a single sensor to measure the quantity of air inhaled by the engine and the speed of the engine. Ex. 1007, 1:41–44. In particular, “the time required for a single cylinder engine to execute a complete operational cycle . . . may readily be measured from a wave form [of pressure fluctuations].” *Id.* at 3:34–38. In Ostdiek, measurement is performed by comparing when the air pressure in the intake manifold decreases below an average or medial value, such as shown in Figure 2, reproduced below:

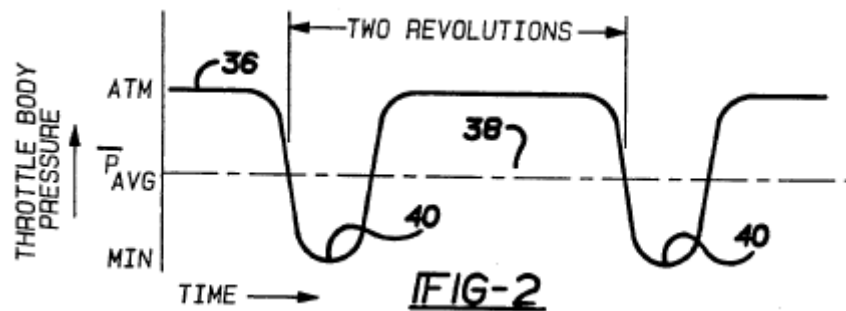


Figure 2 of Ostdiek depicts a pressure curve measured by a pressure sensor at the intake manifold of a single cylinder engine. *Id.* at 2:32–34. Figure 2 depicts the pressure varying above and below an average value, the pressure drops indicating a cylinder revolution.

Vernier likewise teaches that it was known to measure engine speed by detecting variations in a pressure waveform. Ex. 1008, 3:1–11, 6:28–38, 6:60–68, 7:33–39. Specifically, Vernier teaches that inflection points in the waveform “allow[] the positioning of the characteristic points of the power cycle.” *Id.* at 7:33–39.

Petitioner asserts that:

It would have been obvious to a POSITA to incorporate Vernier’s description of the use of signals from an intake pressure sensor to determine the engine’s position into the system disclosed in Ostdiek, as this would have amounted to

nothing more than the use of known techniques to improve similar methods in the same way or the combination of prior art elements according to known methods to yield predictable results.

...

... A POSITA would have been motivated to incorporate the continuous pressure monitoring capabilities of Vernier in order to detect pressure inflection points, and use this to determine engine position to enhance the operation of the fuel injection system in Ostdiek.

Pet. 48–49.

The first sentence quoted above asserts that the proposed combination would “improve” Ostdiek. The second sentence asserts that a person of ordinary skill would have been motivated to include some teaching from Vernier to detect inflection points to determine engine position.

1. *First Sentence – Improve Similar Methods*

The problem with the first sentence (and Petitioner’s analysis that follows) is that it is not clear to us how the proposed combination improves anything. As we found above, Ostdiek determines engine speed based on air pressure fluctuations. So does Vernier. Thus, it is not clear what specifically Vernier adds or how this improves Ostdiek.

Petitioner argues that Vernier would teach how to “determine engine position” using a “continuous pressure monitoring” capability of Vernier. Pet. Reply 16–17. But it is not clear to us that Vernier teaches determining engine position, or that continuous pressure monitoring of Vernier is any different from what occurs in Ostdiek. As to engine position, Petitioner bases that finding on the fact that Vernier says the inflection points “allow[] the positioning of the characteristic points of the power cycle.” Pet. 47–48

(emphasis omitted) (citing Ex. 1008, 7:33–39). But our reading of that portion of Vernier is that the inflection point itself is the characteristic point of the power cycle, and finding the inflection point finds only *that point* of the cycle. Other than perhaps bottom and top dead centers, it is not clear to us that Vernier actually reports engine position (akin to a crank angle sensor signal) in this passage. *Cf.* Ex. 1006 ¶ 19 (providing engine position by way of emulating the time intervals provided by the crank angle sensor), Fig. 4 (providing a depiction of a crankshaft angle sensor signal, which provides a more granular approximation of engine position).¹⁵ Vernier does not appear to provide any more information than Ostdiek in terms of engine position.

As to “continuous pressure monitoring,” again it is not clear how this is any different from what Ostdiek teaches. Ostdiek’s system also monitors a pressure wave to determine when the wave dips below a threshold value. Ex. 1007, 3:34–55. Thus, the Ostdiek system too must continuously monitor pressure in order to know when the instantaneous pressure value hits the threshold pressure value.

Petitioner then argues that Ostdiek’s system is more limited because it is based on comparing pressure to an average pressure. But Ostdiek also contemplates measuring at other pressures, such as “a minimum pressure value.” *Id.* at 3:44–46.

¹⁵ To the extent Petitioner wishes to construe “engine position” to encompass just one or two points of the engine cycle, rather than a more granular indication of engine position, no such claim construction or explicit argument based on such a construction was offered. *Cf.* Ex. 1001, 2:55–3:1 (explaining that it is common for engine position to be measured using a gear with 36 teeth); Ex. 1006, Fig. 4 (depicting a square wave KW of the signal generated using a toothed gear).

In sum, this portion of Petitioner's ground fails because it is predicated on an improvement that we do not find.

2. Second Sentence – Motivated to Detect Inflection Points

Petitioner's second sentence asserts that a person of ordinary skill in the art would have been "motivated to incorporate the continuous pressure monitoring capabilities of Vernier in order to detect pressure inflection points, and use this to determine engine position to enhance the operation of the fuel injection system in Ostdiek." Pet. 48–49. As we already discussed, however, Ostdiek contemplates measuring at inflection points, either by comparing to an average pressure threshold or a minimum pressure. Ex. 1007, 3:38–47. Thus, the problem with the rationale remains that it is not clear what teachings are being combined and why.

Petitioner argues that there is a problem with Ostdiek measuring an average pressure (Pet. Reply 16–17), but this appears to confuse Ostdiek's average pressure with a different measurement having the same name in Vernier. Vernier states that it is not possible to measure the engine speed ("tachometric recording") using an average value of air pressure. Ex. 1008, 1:39–44. This is true because measuring engine speed using air pressure requires two numbers (in order to compare an instantaneous and a threshold value), and simply taking the average of a series of values results in a single number. Ostdiek does not use the average pressure value alone to determine engine speed, but rather compares two values: the instantaneous air pressure and a threshold value (e.g., average pressure) to find the fluctuations that indicate a certain state of the engine. Ex. 1007, 3:18–55 (describing how to measure engine speed from air pressure), 3:65–68 (demonstrating that instantaneous measurements of air pressure are taken). That threshold value

can be an average, median, or minimum. *Id.* at 3:18–55. Accordingly, Vernier’s statement regarding average air pressure is not germane to Ostdiek’s statement regarding average air pressure. In sum, this portion of Petitioner’s ground fails because we do not find that a person of ordinary skill in the art would have been motivated to include continuous air pressure to detect inflection points, because Ostdiek already does so and Petitioner does not persuasively argue that Vernier suggests an alternative or better way to do so.

3. *Obvious to Try*

Lastly, we address Petitioner’s “obvious to try” rationale. Pet. 49. Here, Petitioner states that “Ostdiek’s teachings were consistent with Vernier’s” and notes several other similarities between the references. *Id.* As we noted in the prior two sections, Ostdiek and Vernier indeed include some similar teachings, e.g., measuring engine speed using air pressure. This rationale fails to explain, however, what from Vernier is being incorporated into Ostdiek—in other words, it fails to articulate what, specifically, would have been obvious to try. *See also* PO Resp. 45 (“Petitioner does not explain which, if any, physical components of Vernier’s measurement device 20 would be incorporated into Ostdiek”). Accordingly, we find that this rationale is insufficient to support an obviousness determination.

4. *Conclusion Regarding the Ostdiek-Vernier Combination*

Reading Petitioner’s ground as a whole, we find that it does not articulate a persuasive reason for the combination. This largely stems from the fact that it is not clear to us what specific combination is being offered.

The various cited portions of Vernier appear to describe what is already disclosed in Ostdiek. Yet the proposed combination clearly relies on both. Pet. 4, 43 (listing Ostdiek in view of Vernier, and never Ostdiek alone). Petitioner includes some language that “to the extent the PTAB determines that Ostdiek fails to teach or suggest [crankshaft position], Vernier discloses this feature.” *Id.* at 54. We reject any such statement as implying a one-reference obviousness ground based on Ostdiek, because it is Petitioner that is required to clearly set forth its grounds, and having grounds “buried” within other grounds (e.g., not otherwise called out but stating, “to the extent the PTAB determines” or perhaps, ~to the extent the patent owner argues~) does not satisfy 37 C.F.R. § 42.104(b)(2), which requires *Petitioner itself* in its Petition to specifically identify the appropriate statutory basis and prior art (i.e., the specific ground alleging unpatentability).

Even if we did have a one-reference obviousness ground based on Ostdiek, that reference does not describe a determination of crankshaft position using a pressure sensor. Ostdiek only knows a certain position (e.g., bottom dead center) based on analysis of the air pressure waveform. *See* Ex. 1007, 3:18–55. This does not satisfy the requirement of claim 1 to use pulse timing to indicate crankshaft degree of angular position, it merely identifies one location of the crankshaft.¹⁶

¹⁶ Petitioner relies on the same type of reasoning when arguing that Vernier describes crankshaft position. Pet. 54 (arguing that Vernier “detects pressure inflection points that correspond to a known engine position when the intake valve begins to open”). Thus, even if we did find a rationale for combination, it is not clear that the combined references teach each limitation.

In sum, we do not find a rationale with articulated reasoning in support of Petitioner's proposed combination of Ostdiek's and Vernier's teachings. Accordingly, we determine that Petitioner has not shown, by a preponderance of the evidence, that claim 1 is unpatentable on this ground. By extension, this reasoning applies for claims 3, 5, 6, 8, 10–12, and 14, proposed to be unpatentable in view of Ostdiek and Vernier as well as for claims 2, 4, 7, 9, 13, and 15–18, proposed to be unpatentable in view of Ostdiek, Vernier, and the knowledge of a person of ordinary skill in the art.

III. OTHER MATTERS

A. Patent Owner's Argument that the MacCarley Declaration Should be Given No Weight

Patent Owner argues that the declaration of Petitioner's expert, Mr. MacCarley, "is almost entirely a copy of the Petition" and should "be given no weight." PO Resp. 48–51. We acknowledge Patent Owner's argument. We rely on Mr. MacCarley's testimony as to the level of ordinary skill, and give that weight because: his testimony is generally consistent with the level of skill implied when reading the prior art and the '081 patent; his testimony matches that of Patent Owner's expert; and his testimony is not merely something repeated in the Petition. As to our analysis of Petitioner's grounds, our findings and discussion of the parties' arguments are based on the prior art references and we find no need to specifically rely on Mr. MacCarley's testimony. In other words, in the context of Petitioner's grounds, we see no need to discount his testimony, to the extent it is merely providing the same discussion as Petitioner in its Petition, but we also see no need to give it any additional weight or persuasive value beyond the persuasive value of the Petition itself and the direct prior art evidence cited

therein.

B. Petitioner's Argument Regarding Dr. Davis

Petitioner argues that Patent Owner's expert, Dr. Davis, and the Inventor of the '081 patent, Mr. Schwulst, had an "extensive personal history" that "undermines his credibility." Pet. Reply 22–24. We do not find that any issue would be decided differently in this case, even if we agreed with Petitioner (which we do not).

The integrity of declaration testimony in these proceedings are assured, at least in part, by the fact that experts are required to provide supporting facts or data for their opinions. See 37 C.F.R. § 42.65(a). These are generally in the form of citations to exhibits, combined with articulated reasoning explaining how the facts support the opinion. Thus, in a "battle of the experts," the persuasive side is generally the one that has the most cogent articulation of why the evidence (for and against) favors his or her opinion—against this backdrop, there is little room for bias to play a decisive role. In this case, we do not find any issue turning on such a battle. Thus, even if Petitioner were correct (for the sake of argument) that the personal history in this case may affect Patent Owner's expert's testimony in some way, it would not affect the outcome of this case.

We have read through Petitioner's (Pet. Reply 22–24) and Patent Owner's (PO Sur-Reply 18–22) arguments on this topic, and the evidence cited therein. We do not find that any aspect of our Decision would change based on our review of the connections between Dr. Davis and the inventor of the '081 patent. Dr. Davis's connections to the inventor largely stem from (1) the fact that, approximately 12 years ago, the inventor rented a lab that is run by Dr. Davis and (2) the fact that, prior to renting the lab, the

inventor was a student at the university at which Dr. Davis teaches, and the inventor knew and interacted with Dr. Davis at that time. These are fairly conventional, non-personal relationships in context; something that would be expected of many professors. The connections between the two appear to be no more than conventional and do not appear to be ongoing or personal. There is no allegation that Dr. Davis would receive any pecuniary or prestige benefit regarding the outcome of this case.

We do not discount the testimony of Dr. Davis cited above on the basis of the alleged relationship to the inventor of the '081 patent.

C. Petitioner's Motion to Strike

Petitioner moves to strike a portion of Patent Owner's Sur-Reply for including "new arguments exceeding the proper scope [of reply]." Paper 29, 1. Petitioner argues that Patent Owner argued in its Response that Kupske's teachings would disrupt Abe's ignition timing correction routines, but argued in its Sur-Reply how the interrupt signal itself is generated. *Id.* at 2. In essence, Petitioner argues that Patent Owner argued in its Response that the fault in the prior art combination was disruption of the timing correction, whereas in the Sur-Reply, Patent Owner argues a different fault in the combination. Patent Owner argues, and we agree, that this is a proper use of a Sur-Reply. *See* Paper 30, 1 (arguing that "a sur-reply does not limit a [party] to only arguments that were brought in prior response briefing"). A Sur-Reply, like a Reply, is used to respond to arguments made in the immediately prior brief filed by the opposing party.¹⁷ *See* 37 C.F.R.

¹⁷ A limited exception is that petitioner replies may also respond directly to a decision on institution (e.g., where a patent owner does not set forth further arguments on grounds the Board indicated had no reasonable likelihood of

§ 42.23(b) (“A reply may only respond to arguments raised in the corresponding opposition, patent owner preliminary response, or patent owner response”). Patent Owner’s Sur-Reply is allowed to address arguments raised by Petitioner in Petitioner’s Reply. Accordingly, we will consider the arguments raised in Patent Owner’s Sur-Reply and we deny Petitioner’s Motion to Strike.

IV. ORDER

In view of the foregoing, it is hereby:

ORDERED that claims 1–18 of the ’081 patent are *unpatentable*:

Petitioner has shown that claims 1–12, 14–16, and 18 would have been obvious over Abe and Kupske;

Petitioner has shown that claims 13 and 17 would have been obvious over Abe, Kupske, and the knowledge of a person of ordinary skill in the art;

Petitioner has *not* shown that claims 1, 3, 5, 6, 8, 10–12, and 14 would have been obvious over Ostdiek and Vernier; and

Petitioner has *not* shown that claims 2, 4, 7, 9, 13, and 15–18 would have been obvious over Ostdiek, Vernier, and the knowledge of a person of ordinary skill in the art;

FURTHER ORDERED that Petitioner’s Motion to Strike is *denied*; and

success). As stated in our Revised Trial Practice Guide, this is due to the changes in procedure in light of SAS. Trial Practice Guide Update, page 14, Office Patent Trial Practice Guide, August 2018 Update, 83 Fed. Reg. 39989 (Aug. 13, 2018) (available at: <https://go.usa.gov/xU7GP>).

FURTHER ORDERED that this is a Final Written Decision under 35 U.S.C. § 318(a), and that parties to the proceeding seeking judicial review of the decision under 35 U.S.C. § 319 must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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