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Paper 28
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FORD MOTOR COMPANY,
Petitioner,

v.

PAICE LLC & THE ABELL FOUNDATION, INC.,
Patent Owner.

Case IPR2015-00758
Patent 7,237,634 B2

Before SALLY C. MEDLEY, KALYAN K. DESHPANDE, and CARL M. DEFRANCO, *Administrative Patent Judges.*

DEFRANCO, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

Paice LLC & The Abell Foundation, Inc. (collectively, "Paice") are the owners of U.S. Patent No. 7,237,634 B2 ("the '634 patent"). Ford Motor Company ("Ford") filed a Petition for *inter partes* review of the '634 patent, challenging the patentability of claims 80–90, 114–124, 161–171, 215–225, and 294 under 35 U.S.C. § 103. Paper 1 ("Pet."). In a preliminary proceeding, we instituted an *inter partes* review because Ford made a threshold showing of a "reasonable likelihood" that the challenged claims are unpatentable under 35 U.S.C. § 314. Paper 12 ("Dec.").

Subsequent to institution, Paice filed a Patent Owner Response (Paper 16, "PO Resp."), and Ford followed with a Reply (Paper 18, "Reply"). An oral hearing was held on June 28, 2016, and a transcript of the hearing is included in the record. Paper 27 ("Tr."). After reviewing the evidence and arguments of the parties, and pursuant to our jurisdiction under 35 U.S.C. § 6, we conclude, *first*, that Ford is estopped from maintaining its challenge in this proceeding against claims 80, 114, 161, and 215, and, *second*, that Ford has proven, by a preponderance of the evidence, that remaining claims 81–90, 115–124, 162–171, 216–225, and 294 are unpatentable.

II. BACKGROUND

A. Related Cases

The '634 patent, which includes over 300 claims, has previously been before us, having been the subject of multiple petitions filed by Ford for *inter partes* review ("IPR"). Aside from this case, the IPRs on which we have instituted trial include IPRs 2014-00904, 2014-1416, 2015-00606, 2015-00722, 2015-00784, 2015-00785, 2015-00787, 2015-00790, 2015-00791, 2015-00799, 2015-00800, and 2015-00801. And, with our decision today, we have rendered final decisions in all of these IPRs, many of which include some overlap in terms of claims challenged or prior art asserted or both. Indeed, four of the five independent claims challenged here—claims 80, 114, 161, and 215—were adjudicated previously in IPR2014-01416 (Paper 29) on grounds identical to those asserted here. *See Ford Motor Co. v. Paice LLC*, 2016 WL 932948 (PTAB Mar. 10, 2016).[1]

The ’634 patent is also the subject of co-pending district court actions, including *Paice, LLC v. Ford Motor Co.*, No. 1:14-cv-00492 (D. Md.), filed Feb. 19, 2014, and *Paice LLC v. Hyundai Motor Co.*, No. 1:12-cv-00499 (D. Md.), filed Feb. 16, 2012. Pet. 2.

B. The ’634 Patent

The ’634 patent describes a hybrid vehicle with an internal combustion engine, at least one electric motor, and a battery bank, all controlled by a microprocessor that directs the transfer of torque between the engine, the motor, and the drive wheels of the vehicle. Ex. 1201, 17:17–56, Fig. 4. The microprocessor determines whether to operate the engine, the motor, or both, in response to “road load,” that is, the instantaneous torque required to drive the vehicle. *Id*. at 12:42–46. The microprocessor “can effectively determine the road load by monitoring the response of the vehicle to the operator’s command for more power.”[2] *Id*. at 37:42–49. The operator commands include “the rate at which the operator depresses [accelerator and

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[1] The Final Decision in the -1416 IPR is currently on appeal at the U.S. Court of Appeals for the Federal Circuit.

[2] The ’634 patent contrasts the claimed invention to prior control strategies “based solely on speed,” which are “incapable of responding to the operator’s commands, and will ultimately be unsatisfactory.” Ex. 1201, 13:39–42.

brake] pedals 69 and 70 as well as the degree to which [they] are depressed." *Id*. at 27:26–38, Figs. 3, 4. The microprocessor uses information from the operator commands "as an indication that an amount of torque . . . will shortly be required." *Id*. at 27:41–57.

The microprocessor then compares the vehicle's torque requirements against a predefined "setpoint," or "SP," and uses the results of the comparison to determine the vehicle's mode of operation, e.g., straight-electric, engine-only, or hybrid. *Id*. at 40:16–49. The microprocessor utilizes a hybrid control strategy that operates the engine only in a range of high fuel efficiency, which occurs when the instantaneous torque required to drive the vehicle, or road load (RL), reaches a setpoint (SP) of approximately 30% of the engine's maximum torque output (MTO). *Id*. at 20:61–67; *see also id*. at 13:64–65 ("the engine is never operated at less than 30% of MTO, and is thus never operated inefficiently"). In other words, when the road load is above 30% of the engine's maximum torque output, the vehicle operates in an engine-alone mode. *Id*. at 37:42–44. When the road load is below 30% of the engine's maximum torque, the vehicle operates in a straight-electric mode. *Id*. at 37:24–28. Operating the engine in a range above the setpoint but below the engine's maximum torque output maximizes fuel efficiency and reduces pollutant emissions of the vehicle. *Id*. at 15:55–58.

C. The Challenged Claims

Of the challenged claims, five are independent—claims 80, 114, 161, 215, and 294. Common to the independent claims, except for claim 294, is a hybrid control strategy that compares "road load" of the vehicle to a "setpoint" in order to determine when to operate the engine and motor.[3] The challenged claims depending from these base claims combine that hybrid control strategy with additional limitations requiring that energy supplied from the battery to the motor be at a specific "maximum DC voltage" and a specific "maximum current." For instance, a first set of dependent claims relates to maximum voltage supplied from the battery: "the maximum DC voltage is at least approximately 500 volts" (the "maximum voltage" limitations). A second set of claims relates to maximum current, requiring that it be "less than approximately 150 amperes" (the "maximum current" limitations). And a third set of claims requires that "a ratio of maximum DC voltage to maximum current supplied is at least 2.5" (the "ratio" claims). Claim 294, the other independent claim under challenge, requires that the maximum current be "no more than about 75 amperes."

Independent claim 80 and dependent claims 81 through 83 are illustrative of the claims being challenged:

> 80. A method for controlling a hybrid vehicle, comprising:
>
> determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
>
> monitoring the RL over time;
>
> operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);
>
> operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce

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[3] Claim 294 does not recite a "setpoint," but does utilize a hybrid control strategy that is responsive to "road load" for determining when to operate the engine and motor.

> torque above the SP, and wherein the SP is substantially less than the MTO; and
>
> wherein said operating the internal combustion engine to propel the hybrid vehicle is performed when: the RL>the SP for at least a predetermined time; or the RL>a second setpoint (SP2), wherein the SP2 is a larger percentage of the MTO than the SP; and operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO.
>
> 81. The method of claim 80,
>
> wherein said operating the at least one electric motor comprises supplying power from a battery;
>
> wherein a ratio of maximum DC voltage to maximum current supplied is at least 2.5.
>
> 82. The method of claim 81, wherein the maximum DC voltage is at least approximately 500 volts.
>
> 83. The method of claim 81, wherein the maximum current is less than approximately 150 amperes.

Ex. 1201, 65:11–42.

D. The Instituted Grounds

In a preliminary proceeding, we instituted trial because Ford made a threshold showing of a "reasonable likelihood" under 35 U.S.C. § 314(a) that:

> claims 161–166 and 215–220 are unpatentable as obvious over Severinsky,[4]
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> claims 80–85 and 114–119 are unpatentable as obvious over Severinsky and Frank,[5] and

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[4] U.S. Patent No. 5,343,970, iss. Sept. 6, 1994 (Ex. 1203, "Severinsky '970").

[5] U.S. Patent No. 5,842,534, iss. Dec. 1, 1998 (Ex. 1204, "Frank").

> claims 86–90, 120–124, 167–171, 221–225, and 294 are unpatentable as obvious over Severinsky, Frank, Field,[6] and SAE 1996.[7]

Dec. 14–15. We now decide, first, whether Ford is estopped under 35 U.S.C. § 315(e)(1) from maintaining its challenge against independent claims 80, 114, 161, and 215 because they are the subject of a prior final written decision, and second, whether Ford has proven the unpatentability of any remaining claims by a "preponderance of the evidence" under 35 U.S.C. § 316(e).

III. ANALYSIS

A. Petitioner Estoppel

As discussed above, in IPR2014-01416, we issued a final decision finding claims 80, 114, 161, and 215 of the '634 patent unpatentable. *See Ford Motor Co. v. Paice LLC*, 2016 WL 932948 (PTAB Mar. 10, 2016). In view of that decision, Paice contends that Ford is now estopped under 35 U.S.C. § 315(e)(1) from maintaining its challenge in this IPR against these same claims. PO Resp. 17. Ford does not dispute that estoppel attaches to claims 80, 114, 161, and 215. Reply 5. Instead, Ford requests that we use our discretion to keep these independent claims in this IPR because they are incorporated as a matter of dependency within the body of other claims under challenge. *Id*. But the grounds asserted here against claims 80, 114, 161, and 215 are identical to the grounds asserted against these same claims in the -1416 IPR. And, because our final decision in the -1416 IPR

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[6] PCT Int'l Pub. WO 93/23263 A1, pub. Nov. 25, 1993 (Ex. 1242, "Field").
[7] Kozo Yamaguchi, *Development of a New Hybrid System—Dual System*, STRATEGIES IN ELECTRIC AND HYBRID VEHICLE DESIGN, SAE SPECIAL PUBLICATION SP-1156, No. 960231, 25–33, pub. Feb. 1996 (Ex. 1230, "SAE 1996").

addresses these claims and grounds, we see no benefit in revisiting our analysis from the -1416 proceeding. Thus, Ford is estopped under 35 U.S.C. § 315(e)(1) from maintaining its challenge against claims 80, 114, 161, and 215. As such, we dismiss the *inter partes* review with respect to these independent claims.[8]

B. Claim Construction

In an *inter partes* review, claim terms in an unexpired patent are given their broadest reasonable construction in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142–46 (2016). Ford proposes a construction for two claim terms[9] recited in the independent claims, "road load" and "setpoint." Pet. 13–16. We construed both terms in our Decision to Institute. Dec. 6–8. Ford does not challenge our original constructions. *See* Reply 2–3. Paice, however, requests that we "reconsider" our construction of the term "setpoint." PO Resp. 5–9. Paice also requests clarification of the term "maximum torque output" as used in the context of the claims. *Id*. at 9–14. We address both of these terms, as requested by Paice, but first we summarize our construction of "road load" from the institution decision.

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[8] Although we address the parties' contentions with respect to independent claims 80, 114, 161, and 215, because their respective limitations are necessarily included in the dependent claims under challenge, we do not otherwise provide a final written decision on their merits.

[9] Ford also proposes a construction for the terms "low-load mode I," "highway cruising mode IV," and "acceleration mode V," as recited in claim 161. Pet. 10. Paice does not dispute Ford's proposed construction. *See* PO Resp. 4–14. Because those terms are already expressly defined by claim 161 itself (Ex. 1201, 73:53–74:3), we determine that, for purposes of our review, no further construction is necessary.

1. “Road load (RL)”

The term “road load” or “RL” appears in each of the challenged independent claims. Neither Ford nor Paice challenges our construction of “road load” from the Decision to Institute. As noted therein, the specification of the ’634 patent expressly defines “road load” as “the vehicle’s instantaneous torque demands, i.e., that amount of torque required to propel the vehicle at a desired speed,” and further notes that it “can be positive or negative, i.e., when decelerating or descending a hill, in which case the negative road load . . . is usually employed to charge the battery bank.” Dec. 6 (citing Ex. 1201, 12:42–61). Thus, consistent with the specification, we construed the term “road load,” or “RL,” to mean “the amount of instantaneous torque required to propel the vehicle, be it positive or negative.” We do not perceive any reason or evidence that might compel us to alter our original analysis.

2. “Setpoint (SP)”

The term “setpoint” or “SP” is found in four of the five challenged independent claims, namely, claims 80, 114, 161, and 215. In our Decision to Institute, after taking into consideration the parties’ arguments and supporting evidence, we construed “setpoint” or “SP” to mean “a predetermined torque value that may or may not be reset.” Dec. 6–8. Ford agrees with that construction, but Paice does not. Reply 3; PO Resp. 5–9. Paice maintains, as it did in the preliminary proceeding, that “setpoint” or “SP” should “not be limited to a torque value” but rather should be construed as “a definite, but potentially variable value *at which a transition between operating modes may occur*.” PO Resp. 5 (emphasis added).

As discussed in our Decision to Institute, we looked first to the context in which the term "setpoint" appears in the claims. *See Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005) (en banc) ("[T]he claims themselves provide substantial guidance as to the meaning of particular claim terms. . . . [T]he context in which a term is used in the asserted claim can be highly instructive"). In that regard, we determined that the claims compare the setpoint against a *torque* value. *Id*. For example, each of claims 80, 114, 161, and 215 speaks of "setpoint" or "SP" as being the lower limit of a range at which the engine can produce torque efficiently, i.e., "*when the torque required* to operate the hybrid vehicle is between a setpoint (SP) and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above SP." *See, e.g.*, Ex. 1201, 65:19–24 (emphasis added). This express language suggests that "setpoint" is not just any value, but a value that—per the surrounding claim language—equates to a measure of "torque."[10]

Paice, on the other hand, urges that "setpoint" is synonymous with a "transition" point, not a torque value. PO Resp. 6–8. Paice points to a passage from the specification, exclusive of the claims, as supporting a construction of "setpoint" that "marks a point at which the vehicle may transition between two modes," such as from the motor propelling the vehicle to a mode in which the engine is also used to propel the vehicle. *Id*. at 6–7 (citing Ex. 1201, 40:41–49). Paice's argument is misplaced. Although the passage of the specification on which Paice relies says that

[10] Paice's technical expert, Mr. Neil Hannemann, similarly agreed that the comparison made in the claims is "most straightforward" if the "setpoint is a torque value." Ex. 1257, 79:16–80:25.

"sometimes" the setpoint may serve as a "transition point" (*see id*.), the claim language itself makes clear that setpoint relates simply to a torque value, without requiring that it be a transition point. In other words, a transition between modes is neither an intrinsic property nor a necessary and required condition of the setpoint as claimed. Indeed, the specification acknowledges that the mode of operation does not always transition, or switch, at a setpoint, but instead depends on a number of parameters. For instance,

> the values of the sensed parameters in response to which the operating mode is selected may vary . . . , so that the operating mode is *not repetitively switched simply because one of the sensed parameters fluctuates around a defined setpoint*.

Ex. 1201, 19:67–20:6 (emphasis added). That disclosure suggests that a transition does not spring simply from the recitation of "setpoint." Thus, we will not import into the meaning of "setpoint" an extraneous limitation that is supported by neither the claim language nor the specification. As such, we reject Paice's attempt to further limit the meaning of setpoint to a transition between operating modes.

Paice additionally argues that "setpoint" should not be limited to a torque value because the specification describes that the system variable, "the state of charge of the battery BSC," may be compared against a setpoint. PO. Resp. 8–9 (citing Ex. 1201, 40:16–26). This argument also is misplaced. As discussed above, each of claims 80, 114, 161, 215 requires a comparison of the setpoint to a variable expressed as a torque value, not a variable expressed as a state of electrical charge. Thus, in the context of these claims, and those depending therefrom, a setpoint must be a torque value, and not some state of charge of a battery.

We also regard as meaningful that nothing in the specification precludes a setpoint from being reset, after it has been set. The specification states that the value of a setpoint may be "reset . . . in response to a repetitive driving pattern." Ex. 1201, 40:50–53. That a setpoint may be reset under certain circumstances, however, does not foreclose it from being "set," or "fixed," at some point in time.[11] A setpoint for however short a period of time still is a setpoint. Thus, for the foregoing reasons, we construe "setpoint" and "SP" as a "predetermined torque value that may or may not be reset."

3. "Maximum Torque Output (MTO)"

Paice requests that we make clear that each of the challenged claims requires a comparison of road load (RL) not only to the setpoint (SP) but also to the *maximum torque output (MTO)* of the engine. PO Resp. 9–14. As an example, Paice points to limitations from claim 80 calling for such a comparison: "operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, . . . operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO." *Id*. at 9. According to Paice, this limitation calls expressly for a comparison with MTO. *Id*. at 9–10. We agree that each of claims 80, 114, 161, and 215 has limitations directed to a comparison with a setpoint (SP) and a maximum torque output

[11] The definition of "set" is "determined . . . premeditated . . . fixed . . . prescribed, specified . . . built-in . . . settled." *Merriam-Webster's Collegiate Dictionary* (10^{th} ed. 2000). Ex. 3001.

(MTO). But, in our view, that comparison is clear from the claim language itself, and, thus, no further construction is necessary.

Nor does Ford dispute that such a comparison takes place. Instead, Ford disputes Paice's attempt to read an additional limitation into the claims, i.e., that "a comparison of the RL to a setpoint (SP) results in a determination." Reply 4. To the extent that Paice requests that we add such a requirement (*see* PO Resp. 10–14), we decline to do so, as it is unclear what is meant by "determination" when only a comparison is required. And, just to be clear, although claims 80, 114, 161, and 215 may require a comparison at some juncture with maximum torque output (MTO), that does not mean the claims exclude a comparison with other parameters.

C. Ground 1—Claims 162–166 and 216–220 As Obvious Over Severinsky

Ford challenges claims 161–166 and 215–220 on the ground that the claimed invention would have been obvious over Severinsky.[12] Pet. 10. As discussed above, we dismiss the challenge against independent claims 161 and 215. *See* Section III.A. Thus, with respect to this ground, only claims 162–166 and 216–220, which depend from claims 161 and 215, remain before us. Nonetheless, these dependent claims necessarily include the limitations of their respective base claim. Accordingly, we address first the limitations incorporated from the base claims into the dependent claims still at issue. Notably, Paice's response to Ford's challenge centers mainly on the hybrid control strategy recited in these base claims. *See* PO Resp. 17–41.

[12] Paice does not dispute that Severinsky is prior art to the '634 patent.

1. Base Claims 161 and 215

Claims 161 and 215 are directed to a hybrid control strategy that compares "road load" to a "setpoint" for determining the "operating" modes of a hybrid vehicle, i.e., whether to operate the engine, the motor, or "both" to propel the vehicle. Ex. 1201, 73:41–74:6, 79:10–31. Ford provides a detailed analysis of how Severinsky teaches all of the limitations of these base claims. Pet. 10–29; Reply 6–9. In doing so, Ford proffers the testimony of Dr. Gregory W. Davis, an expert witness retained by Ford, who explains Severinsky's teachings and maps them to their relevant claim limitations. Ex. 1207 ¶¶ 173–314. We are persuaded by Ford's showing, which we adopt as our own, that Severinsky teaches the limitations of base claims 161 and 215.

At the outset, we find that, like claims 161 and 215, Severinsky describes the basic components of a hybrid vehicle, including an internal combustion engine, at least one electric motor, a battery, and a controller. *Compare* Ex. 1203, Fig. 3 (Severinsky) *with* Ex. 1201, Fig. 4 (the '634 patent); *see also* Ex. 1207 ¶¶ 181, 203, 226. More significantly, Severinsky teaches the various modes of "operating" the vehicle as recited in claims 161 and 215, including an engine-only mode, a motor-only mode, or a "both" mode. For instance, Severinsky discloses "controlling the relative contributions of the internal combustion engine and electric motor" so that the hybrid vehicle "may be operated in a *variety of operating modes selected dependent on desired vehicle performance*." Ex. 1203, 22:19–39 (emphasis added). These modes, according to Severinsky, include:

> "a low speed/reversing mode, wherein all energy is supplied by said battery and all torque by said electric motor";

> "a high speed/cruising mode, wherein all energy is supplied by combustible fuel and all torque by said engine"; and
>
> "an acceleration/hill climbing mode, wherein energy is supplied by both combustible fuel and said battery, and torque by both said engine and said motor."

Ex. 1203, 22:39–50; *see also id*. at 10:24–11:6 (describing each mode in greater detail). We find that those disclosures in Severinsky meet the general configuration of the "operating" modes recited by claims 161 and 215.

Claims 161 and 215 additionally require that the engine be operated when the "road load (RL)," which we have construed as torque required to propel the vehicle, reaches a "setpoint (SP)" so that the engine produces torque "efficiently." Ex. 1201, 73:55–60 (claim 161), 79:18–24 (claim 215). We are persuaded, notwithstanding the arguments of Paice (which we address below), that Severinsky teaches a comparison of road load to a setpoint for determining when to operate the engine, even though Severinsky may not employ the exact same language as the claims.

In particular, Severinsky explains that a microprocessor "monitors the performance of the electric motor and the internal combustion engine, the state of charge of the battery, and other significant variables [and] . . . *determines whether the internal combustion engine or the electric motor or both should provide torque to the wheels under various monitored operating conditions*." Ex. 1203, 6:19–23 (emphasis added). In determining whether to employ the engine, Severinsky further elaborates that the microprocessor operates the engine only when it is "efficient" to do so, and if not, the motor is used:

> *the internal combustion engine is operated only under the most efficient conditions of output power[[13]] and speed*. When the engine *can be used efficiently* to drive the vehicle forward, e.g. in highway cruising, it is so employed. Under other circumstances, e.g. in traffic, the electric motor alone drives the vehicle forward and the internal combustion engine is used only to charge the batteries as needed.

Id. at 7:8–16 (emphasis added); *see also id*. at 9:40–52 ("the internal combustion engine operates only in its most efficient operating range").

These disclosures indicate that Severinsky's microprocessor monitors the performance of the vehicle to ensure the engine operates within a certain range of efficiency. Even more specifically, Severinsky discloses that to maximize efficiency, the microprocessor operates the engine "only in the near vicinity of *its most efficient operational point*, that is, such that it produces *60–90% of its maximum torque* whenever operated." *Id*. at 20:63–67 (emphasis added). That alone, Severinsky says, will yield improvement in fuel economy on the order of 200–300%. *Id*. at 20:67–68.

Ford's expert, Dr. Davis, explains that because the engine in Severinsky is not operated below 60% of MTO (maximum torque output of the engine), 60% MTO is a "setpoint" at or above which the engine is operated to propel the vehicle, and that when road load is between this setpoint and MTO, the engine alone produces the required torque. Ex. 1207 ¶¶ 204–208, 227–228. Dr. Davis further explains that the 60% of MTO in

[13] Paice's technical expert, Mr. Neil Hannemann, testified that a skilled artisan would have understood that "power is a product of *torque* and speed." Ex. 1257, 31:6–13 (emphasis added); *see also* Ex. 2208 ¶ 37 ("For every engine speed, *there is an associated torque value*. Another way of defining an engine's operating range would be by its output power, which is the engine's speed multiplied by the output *torque*") (emphases added).

Severinsky is a setpoint below which only the electric motor is operated to propel the vehicle. *Id.* ¶¶ 210–211. As such, Dr. Davis concludes that a skilled artisan would have understood that Severinsky's lower limit of 60% of MTO is a "setpoint," thereby satisfying the claims. *Id.* ¶¶ 209, 229. Dr. Davis further concludes that the setpoint of 60% of MTO, disclosed by Severinsky, is "substantially less than MTO" of the engine, as also required by the claims. *Id*. ¶¶ 232–233.

Paice responds that Severinsky fails to disclose "using road load and setpoint to make mode selection decisions, let alone comparing road load to a setpoint." PO Resp. 17–18. According to Paice, "Severinsky determines when to use the internal combustion engine *based on the speed of the vehicle and not road load*." *Id*. at 18 (emphasis added). Paice repeats this argument throughout its response (*see id*. at 21, 24, 27, 32, 37, 41, 43–44), and likewise, argues that Severinsky uses speed in determining when to operate the motor as well (*id*. at 20).

Although we agree with Paice that the claims require a comparison of road load (i.e., the torque required to propel the vehicle) to a setpoint, we are unpersuaded that Severinsky does not make this comparison in determining when to operate the engine and motor. As discussed above, Ford and its declarant, Dr. Davis, whose testimony we find persuasive, make a specific accounting of how Severinsky teaches a comparison of the vehicle's torque requirements (road load) to a setpoint in the range of 60–90% of MTO.

And, to the extent that Paice points to passages in Severinsky that discuss "speed" as a factor in selecting the operating mode of the engine and/or motor (*see* PO Resp. 19–20), we decline to read those passages in isolation, as Paice does, without crediting Severinsky's disclosure as a whole. For instance, Paice argues that such passages indicate that "Severinsky only considers speed" as a factor in determining when to operate the engine. PO Resp. 20. That is, quite simply, not the case. Although it is true that certain passages in Severinsky describe the operating modes in terms of speed, other passages in Severinsky express a framework that clearly extends beyond considerations of speed: "More particularly, according to the invention, the internal combustion engine is operated only under *the most efficient conditions of output power and speed*." Ex. 1203, 7:8–10 (emphasis added). Paice's own expert, Mr. Hannemann, testified that "power is a product of *torque* and speed" and a skilled artisan would have understood as much. Ex. 1257, 31:6–13 (emphasis added). Thus, at the very least, Severinsky contemplates the use of both torque and speed in determining when the engine can be operated efficiently.

Moreover, in another passage, Severinsky makes clear that the microprocessor responds to "load" requirements of the vehicle in determining when the engine can be operated efficiently:

> Thus, at all times the microprocessor 48 may determine the load (if any) to be provided to the engine by the motor, *responsive to the load imposed by the vehicle's propulsion requirements, so that the engine 40 can be operated in its most fuel efficient operating range*.

Ex. 1203, 17:11–15 (emphases added). That Severinsky may reflect on speed in determining when to operate the engine does not nullify or undermine these otherwise express disclosures by Severinsky of employing the engine based on the "torque" or "load" requirements of the vehicle. With that in mind, we reject Paice's incorrect assertions that Severinsky considers "only" speed to determine when to operate the engine. *See* PO Resp. 20–21.

Paice also points to Severinsky's disclosure of "speed-responsive hysteresis" as purported evidence of "a speed-based control strategy to turn the engine on and off." PO Resp. 19–20. According to Paice, "[i]t makes no sense for Severinsky to use 'speed responsive-hysteresis' if it uses road load to control engine starts and stops." *Id*. at 20. But Severinsky discusses "speed-responsive" hysteresis only in the context of preventing the engine from cycling on and off in "low-speed" situations where engine speed may dip temporarily to "20-25 mph" while in a highway-cruising mode. Ex. 1203, 18:23–42. That Severinsky may teach an additional hysteresis feature as a way of controlling unintended engine starts during temporary dips in speed does not preclude Severinsky from also teaching the use of a torque value, or road load, as a way to determine when to employ the engine in the first instance. Indeed, like Severinsky, the '634 patent at issue here describes a speed-responsive hysteresis feature in the context of a torque-responsive control system for determining when to operate the engine. More specifically, similar to Severinsky, the '634 patent discloses that "excessive mode switching otherwise likely to be encountered in suburban traffic can be largely avoided [by] . . . implementing this '*low-speed* hysteresis'." Ex. 1201, 43:59–62 (emphasis added).

Paice also argues that Severinsky's use of the modifier "high-speed" and "low-speed" in describing some of the operating modes further infers that Severinsky considers speed in deciding when to use the engine versus the motor. PO Resp. 24. Those disclosures, however, do not foreclose Severinsky from teaching that the engine's torque requirements are also a determinant in employing the engine and/or motor. In other words, torque and speed are not mutually exclusive concepts. Thus, regardless of whether the modifier “high-speed” or “low speed” is used, Severinsky expressly describes the consideration of “torque” or “load” for triggering the mode, as discussed above. Indeed, the ’634 patent itself speaks of “speed” when describing the vehicle’s various operating modes, stating that “the traction motor provides torque to propel the vehicle in *low-speed situations*” and “[d]uring substantially steady-state operation, e.g., during *highway cruising*, the control system operates the engine.” Ex. 1201, 17:46–47, 19:45–46, respectively (emphasis added). Just as “speed” is a factor in the control strategy of the ’634 patent, so too is it in Severinsky.

In sum, Paice cannot hold Severinsky to a different standard than it holds the claimed invention. That Severinsky may discuss “speed” as one of the parameters used by the microprocessor does not negate its overall, and express, teaching of employing the engine “responsive to the load imposed by the vehicle’s propulsion requirements,” or road load, “so that the engine . . . can be operated in its most fuel efficient operating range.” Ex. 1203, 17:11–15. We reject Paice’s arguments that criticize Severinsky’s references to “speed,” when the ’634 patent itself recognizes that “speed” plays a role in a road load-responsive hybrid control strategy.

Paice also faults Severinsky’s microprocessor for “monitoring the accelerator pedal position” and using that information as an input for determining whether to employ the engine and/or motor. PO Resp. 25 (citing Ex. 1203, 13:16–19). According to Paice, “the accelerator position alone is not determinative of road load.” *Id*. at 25–26. But, once again, Paice fails to recognize that, first, the controller in the ’634 patent at issue utilizes the same input, and, second, the claims do not preclude the controller from receiving such inputs as part of the control strategy.

A simple comparison of Severinsky to the ’634 patent bears out that both utilize accelerator pedal position as an input and that such an input would have been understood to be an indicator of the torque required to propel the vehicle, i.e., road load. For instance, Severinsky explains:

> A microprocessor *receives control inputs from the driver* of the vehicle and monitors the performance of the electric motor and the internal combustion engine, the state of charge of the battery, and other significant variables. The microprocessor *determines whether the internal combustion engine or the electric motor or both should provide torque to the wheels* under various monitored operating conditions.

Ex. 1203, 6:19–26 (emphasis added). The “control inputs from the driver,” according to Severinsky, include “acceleration, reverse, and deceleration or braking commands.” *Id*. at 10:14–16. And, like Severinsky, the ’634 patent recognizes that “[t]he microprocessor monitors the rate at which the operator depresses [accelerator and brake] pedals 69 and 70 as well as the degree to which pedals 69 and 70 are depressed [and] uses this information, and other signals provided . . . to properly control operation of the vehicle.” Ex. 1201, 27:36–44.

Moreover, the ’634 patent itself acknowledges that “the operator’s depressing the accelerator pedal signifies an increase in desired speed, i.e., an increase in *road load*” (*id*. at 12:50–52 (emphasis added)), and, for that reason, claims 161 and 215 expressly describe the determination of road load as being “responsive to an operator command” (*see, e.g., id.* at 65:12–14). Given that the ’634 patent itself utilizes input from the operator’s pedal position, and, indeed, equates that input with “road load,” we are not persuaded by Paice's attack on Severinsky's microprocessor for likewise utilizing accelerator pedal position as an input. If anything, Severinsky's discussion of pedal position, which the '634 patent admits is indicative of road load, lends further support to our finding that Severinsky uses road load in determining when to employ the engine.

Similarly, Paice argues that Severinsky's use of "potential output torques of the engine" as a control metric is "*unrelated* to input torque demands taught by the '634 patent, for example, the instantaneous torque required to propel the vehicle (i.e., road load)." PO Resp. 38 (emphasis added). Although not entirely clear, Paice appears to take issue with Severinsky's discussion of the engine's operating point as a percentage of "its maximum torque." *Id*. This argument fails for the simple reason that Severinsky expresses the engine's operating range in terms no different than the '634 patent. Notably, the '634 patent explains that "road load is expressed as a function of the engine's maximum torque *output*," which, in turn, is compared to a setpoint that is likewise expressed in terms of maximum torque output: "[t]he engine's output torque is constrained to the range of efficient operation . . . , this range is controlled to be between 30% and 100% of the engine's maximum torque *output* ("MTO")." Ex. 1201, 38:54–58 (emphases added); *see also id*. at 39:24–25 ("the engine's efficient operating range, e.g., 30% MTO>RL>100% of MTO."). Thus, Paice's attempt to fault Severinsky for expressing its setpoint as a percentage of torque output (i.e., "60–90% of its maximum torque"), when the '634 patent itself does the same, is without merit.

Paice repeatedly characterizes Severinsky's operating range of 60% to 90% of maximum torque output for the engine as "aspirational." PO Resp.

30–37. According to Paice, Severinsky's operating range is aspirational in the sense that it is a "goal" to be reached, rather than an actual teaching about a torque-based control strategy. *Id*. at 35, 37. This argument is unpersuasive for the simple reason that Paice does not point to any language in Severinsky that conveys uncertainty, or expresses a lack of expectation of success, with respect to its operational ranges being based on a torque value, i.e., road load. Nor does Paice allege that a skilled artisan would not have known how to implement the operational range of torque values expressed in Severinsky. We see no reason to discount or ignore the teachings in Severinsky of determining the engine's operational range on the basis of the torque required to propel the vehicle. Simply put, a prior art reference must be considered for all it teaches. In the absence of an enablement issue with Severinsky's teachings, we will not disregard those teachings simply because they utilize different words than the claimed invention.

In the end, we are not persuaded by Paice's argument that Severinsky does not teach the "setpoint" required by the claims. Rather, we give substantial weight to the testimony of Ford's expert, Dr. Davis, that a skilled artisan would have understood the lower limit of Severinsky's range—60% of the engine's maximum torque output—to be a predetermined torque value that functions as a setpoint for operation of the engine. *See, e.g.*, Ex. 1207 ¶¶ 200–213, 219–233; *see also* Pet. 10–27. And, while Paice argues that Severinsky's "60% of MTO" cannot be a setpoint because there is no evidence "that a 'transition between operating modes may occur' at this value" (PO Resp. 31), that argument is premised on a construction of setpoint that we have already rejected. *See* Section III.B.2 above.

We have considered Paice's other arguments but do not find them persuasive. In the end, we find that Severinsky discloses a hybrid control strategy that operates the engine and motor based on a comparison of road load to a setpoint, as called for by base claims 161 and 215.

2. Claims 162–166 and 216–220

Dependent claims 162–166 and 216–220 combine the hybrid control strategy of base claims 161 and 215 with additional limitations requiring that the "maximum DC voltage" and "maximum current" supplied from the battery to the motor be within specific ranges. For example, some of the dependent claims require that "the maximum DC voltage [be] at least approximately 500 volts" (the "maximum voltage" limitation), others require that "the maximum current [be] less than approximately 150 amperes" (the "maximum current" limitation), and still others require that "a ratio of maximum DC voltage to maximum current supplied [be] at least 2.5" (the "ratio" limitation).[14]

Paice does not argue dependent claims 162–166 and 216–220 separately from their respective base claims. After considering Ford's analysis, which we adopt as our own, we are persuaded that Severinsky discloses, or at the very least suggests, each of the limitations of these dependent claims. *See* Pet. 30–33. Accordingly, we conclude that Ford has demonstrated, by a preponderance of the evidence, that claims 162–166 and 216–220 would have been unpatentable for obviousness over Severinsky.

[14] We refer to these maximum voltage and maximum current limitations, collectively, as the "electrical limitations."

D. Ground 2—Claims 81–85 and 115–119 As Obvious Over Severinsky and Frank

Ford challenges claims 81–85 and 115–119, as well as base claims 80 and 114 from which they depend, on the ground that the claimed invention would have been obvious over Severinsky and Frank. Pet. 33. Like the other base claims, the challenge against claims 80 and 114 is dismissed. *See* Section III.A. Thus, for this second ground, only dependent claims 81–85 and 116–119 remain before us. Nonetheless, these claims depend from claims 80 and 114, and, thus, include their limitations, so we address them first.

1. Base Claims 80 and 114

Because the limitations of claims 80 and 114 overlap substantially with the limitations of claims 161 and 215 in terms of the recited hybrid control strategy, many if not all of our findings with respect to claims 161 and 215 apply equally to claims 80 and 114. *See* Section III.C.1. In particular, each of these base claims requires a hybrid control strategy that compares road load to a setpoint for determining the operating modes of the engine and motor. We have already determined that Severinsky teaches these limitations.

Claim 80 further refines this control strategy by adding the limitation that the road load be above the setpoint "for at least a predetermined time" before operating the engine. Ex. 1201, 65:26–28. And claim 114 adds the limitation that the road load be below the setpoint "for at least a predetermined amount of time" before operating the motor. *Id*. at 68:43–45. The '634 patent describes this time-delay as "'hysteresis' in the mode-switching determination" for preventing undesirable and repetitive engine starts in certain types of driving. *Id*. at 41:30–47. Ford's expert, Dr. Davis, likewise confirms that this time-delay relates to the well-known concept of hysteresis in mode-switching. Ex. 1207 ¶¶ 346–348, 364–365.

For these time-delay limitations, Ford relies on the combined teachings of Severinsky and Frank. Pet. 35–39; Reply 9–12. To begin, Ford points out that Severinsky expressly contemplates "hysteresis" in mode switching:

> The vehicle will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30–35 mph. The engine will continue to run *unless the engine speed is reduced to 20–25 mph for a period of time, typically 2–3 minutes.* This speed responsive hysteresis in mode switching will eliminate nuisance engine starts.

Ex. 1203, 18:34–42 (emphasis added). Hysteresis, in that context, evidently means that the engine must run at a steady state for a period of time before switching the motor on and the engine off. Ex. 1207 ¶ 367.

In addition, Ford relies on Frank as teaching the well-known concept of utilizing a "time delay" with an on-off "threshold" to reduce excessive cycling of the engine, i.e., turning the engine on and off repetitively. Pet. 35–36 (citing Ex. 1204, 7:66–8:11). Ford's expert, Dr. Davis, explains that a skilled artisan would have understood Frank's "threshold" to be a setpoint for switching between operating modes. Ex. 1207 ¶¶ 345–347, 374. As such, Dr. Davis opines that a skilled artisan would have been led to implement Frank's time-delay feature with Severinsky's torque-based setpoint because both are concerned with a threshold, or setpoint, for preventing unwanted on-and-off cycling of the engine when switching between modes. *Id*. ¶¶ 344–349, 373–376, 412–416. We find Dr. Davis's rationale persuasive.

Paice responds that neither Severinsky nor Frank discloses "road-load-based hysteresis, as required by claims 80 and 114." PO Resp. 47. But it is clear from Paice's response that Paice attacks each reference separately without considering the combination as a whole. *See id.* at 47–51 (discussing Severinsky in one section titled "Severinsky's Hysteresis is Speed-Responsive" and Frank in another section titled "Frank's Hysteresis is Also Speed-Responsive"). Thus, Paice's argument is misplaced because Ford relies on the *combination* of Severinsky and Frank as teaching road-load based hysteresis, not any reference individually. *See* Pet. 38.

Also, according to Paice, Ford "offers no explanation as to how combining two speed-based hysteresis references would result in a road load-based hysteresis teaching." PO Resp. 52. We disagree. Ford's expert, Dr. Davis, explains in persuasive detail that, although Severinsky '970 discloses a torque-based setpoint, a skilled artisan would have had reason to apply Frank's speed-based hysteresis strategy to Severinsky because the whole reason behind the concept of hysteresis is to avoid excessive cycling in the vicinity of the threshold, or setpoint, at which the engine turns on and off. Ex. 1207 ¶¶ 414–415. That strategy remains true no matter how the setpoint is determined, be it speed-based or torque-based. For instance, Dr. Davis explains:

> it would be obvious considering that Severinsky '970 discloses a threshold which takes into account speed *and* torque operator commands for mode switching, that it would be beneficial to include a time-delay in order to prevent unwanted engine cycling. Frank confirms that a time-delay was known in the art to prevent frequent excessive cycling of the engine between modes in a hybrid vehicle. Such excessive start/stop cycles were known to contribute to undesirable engine wear and noise.

Ex. 1207 ¶ 375 (emphasis in original).

In sum, that Frank may disclose the hysteresis time-delay as "speed-responsive" does not negate or detract from its overall teaching of applying a time delay to an on-off setpoint to prevent frequent cycling between the engine and motor. Ex. 1207 ¶ 372. Ford's expert, Dr. Davis, explains that "[h]ysteresis mechanisms were frequently employed in traditional automatic transmissions . . . in order to prevent excessive shifting between gears." Ex. 1207 ¶ 346. And Dr. Davis confirms that "[a] person of ordinary skill in the art would have been familiar with these techniques to prevent adverse effects from rapid switching when the vehicle operation hovers around a particular *setpoint*." *Id*. Thus, we are not persuaded by Paice's argument that Ford fails to provide a reason to combine Severinsky and Frank.

We have considered Paice's other arguments, but do not find them sufficiently persuasive to rebut Ford's rationale for combining Severinsky and Frank. Accordingly, we determine that the limitations of base claims 80 and 114 are taught by the combination of Severinsky and Frank.

2. Dependent claims 81–85 and 115–119

Like the other dependent claims discussed above, claims 81–85 and 115–119 recite a specific range or ratio for the "maximum DC voltage" and "maximum current" supplied from the battery to the motor. Paice does not argue these dependent limitations separately from their respective base claims 80 and 114. After considering Ford's analysis, which we adopt as our own, we are persuaded that Severinsky discloses, or at the very least suggests, the voltage, current and ratio values of these dependent limitations. *See* Pet. 43–48. As such, we conclude that Ford has demonstrated, by a preponderance of the evidence, that claims 81–85 and 115–119 would have been unpatentable for obviousness over Severinsky and Frank.

E. Ground 3—Claims 86–90, 120–124, 167–171, and 221–225 As Obvious Over Severinsky, Frank, Field, and SAE 1996

Ford challenges claims 86–90, 120–124, 167–171, and 221–225 on the ground that the claimed invention would have been obvious over the combined teachings of Severinsky, Frank, Field, and SAE 1996. Pet. 40–55. All of these claims depend respectively from base claims 80, 114, 161, and 215, and, thus, include the hybrid control strategy as discussed above. The difference is that these claims add a two-motor configuration to the hybrid vehicle, while also including the maximum voltage/current/ratio limitations discussed above. Accordingly, many if not all of our earlier findings with respect to the hybrid control strategy and voltage/current/ratio limitations apply equally to this set of dependent claims.

Noting that Severinsky discloses only a *single* electric motor that acts as both a generator and a traction motor, Ford relies on SAE 1996 and Field as exemplifying the use of dual electric motors in a hybrid vehicle for purposes of simultaneously providing charging current to the battery and propulsion torque to the vehicle. *See* Pet. 42–47 (discussing Exs. 1230, 1242). We give substantial weight to the testimony of Ford's expert, Dr. Davis, that a skilled artisan would have known (and been able) to modify the "one motor" hybrid configuration of Severinsky to add a separate generator motor, as taught by SAE 1996 and Field, so as to gain the known advantage of increased efficiency and range that two-motor hybrid designs provide in urban city driving. Ex. 1207 ¶¶ 426–458, 464–466.

In the face of the combined teachings of Severinsky, Frank, SAE 1996, and Field, Paice does not argue claims 86–90, 120–124, 167–171, and 221–225 separately from their respective base claims. After considering Ford's analysis, which we adopt as our own, we are persuaded that the combination of Severinsky, Frank, SAE 1996, and Field teaches the hybrid control strategy, two-motor configuration, and voltage/current/ratio limitations of these dependent claims. *See* Pet. 40–55; *see also* Ex. 1207 ¶¶ 424–487. As such, we conclude that Ford has demonstrated, by a preponderance of the evidence, that claims 86–90, 120–124, 167–171, and 221–225 would have been unpatentable for obviousness over Severinsky, Frank, SAE 1996, and Field.

F. Ground 3—Claim 294

Claim 294 is the only independent claim remaining before us, as the others are dismissed for reasons of estoppel. Although claim 294 includes a hybrid control strategy that is responsive to "road load," it does not recite the additional requirement of the "setpoint" found in the base claims discussed above, i.e., claims 80, 114, 161, and 215. Indeed, Paice acknowledges that claim 294 does not involve a setpoint. PO Resp. 30, 41. As such, all of the arguments in Paice's response in that regard are inapplicable to claim 294.

Ford argues that the combination of Severinsky, Field, and SAE 1996 satisfies the limitations of claim 294, and proffers the testimony of Dr. Davis in support. Pet. 55–60 (citing Ex. 1207 ¶¶ 489–513). Paice, however, offers absolutely no response to Ford's analysis of claim 294. Perfunctory or undeveloped arguments are waived.[15] Thus, after reviewing Ford's analysis,

[15] The Board's Scheduling Order put Paice on notice that, as the patent owner, it must come forward with arguments for patentability, lest they be

we determine that the preponderance of the evidence weighs acutely in Ford's favor and demonstrates that claim 294 would have been obvious over Severinsky, Field, and SAE 1996.

IV. CONCLUSION

Ford has demonstrated, by a preponderance of the evidence, that (1) claims 162–166 and 216–220 would have been unpatentable for obviousness over Severinsky, (2) claims 81–85 and 115–119 would have been unpatentable for obviousness over Severinsky and Frank, (3) claims 86–90, 120–124, 167–171, and 221–225 would have been unpatentable for obviousness over Severinsky, Frank, SAE 1996, and Field, and (4) claim 294 would have been obvious over Severinsky, Field, and SAE 1996.

V. ORDER

Accordingly, it is hereby:

ORDERED that *inter partes* review of claims 80, 114, 161, and 215 is *dismissed*;

ORDERED that 81–90, 115–124, 162–171, 216–225, and 294 of the '634 patent are held *unpatentable*; and

FURTHER ORDERED that any party seeking judicial review of this Final Written Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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waived. Paper 13 at 3 ("[t]he patent owner is cautioned that any arguments for patentability not raised in the response will be deemed waived"). And our trial practice guide expressly states that "[t]he response should *identify all the involved claims that are believed to be patentable* and state the basis for that belief." *Office Patent Trial Practice Guide*, 77 Fed. Reg. 48756, 48766 (Aug. 14, 2012) (emphasis added).

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