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Paper 30
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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 IPR2014-01415
Patent 8,214,097 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. 8,214,097 B2 ("the '097 patent"). Ford Motor Company ("Ford") filed a Petition (Paper 3, "Pet.") for *inter partes* review of the '097 patent, challenging the patentability of claims 1–6, 8–16, 18–26, 28–30, and 34 under 35 U.S.C. § 103. In a preliminary proceeding, we instituted trial because Ford demonstrated a reasonable likelihood that it would prevail in proving unpatentability of the challenged claims. Once trial was instituted, Paice filed a Patent Owner Response (Paper 21, "PO Resp."), and Ford followed with a Reply (Paper 25, "Reply"). The parties waived oral argument here, choosing instead to rely on arguments presented during a prior, consolidated hearing conducted in several related proceedings, namely, IPR2014-00570, -571, -579, -875, -884, and -904.[1] Pursuant to our jurisdiction under 35 U.S.C. § 6(c), we conclude that Ford has proven, by a preponderance of the evidence, that the challenged claims are unpatentable.

II. BACKGROUND

A. Related Cases

The instant Petition challenges a claim of the '097 patent that was adjudicated previously in IPR2014-00570 ("the -570 proceeding"), only on different grounds. Specifically, that prior proceeding led to final written decision that claim 30 is unpatentable under 35 U.S.C. § 103, along with other claims of the '097 patent. 2015 WL 5782083 (PTAB Sept. 28, 2015). We granted institution of trial in the instant proceeding in March 2015, well before our final written decision in the -570 proceeding.

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[1] Transcripts have been entered into the record in those earlier proceedings.

The ’097 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. 1; PO Resp. 4 (referencing the district courts’ claim constructions).

B. The ’097 Patent

The ’097 patent describes a hybrid vehicle with an internal combustion engine, an electric motor, and a battery bank, all controlled by a microprocessor that controls the direction of torque transfer between the engine, the motor, and the drive wheels of the vehicle. Ex. 1101, 16:61–17:5, Fig. 4. The microprocessor monitors the vehicle’s instantaneous torque requirements, also known as “road load (RL),” to determine whether the engine, the electric motor, or both, will be used to propel the vehicle. *Id*. at 11:50–52. Aptly, the ’097 patent describes the vehicle’s various modes of operation in terms of an engine-only mode, an all-electric mode, or a hybrid mode. *Id*. at 35:14–36:4, 36:39–37:22.

As summarized in the ’097 patent, the microprocessor selects the appropriate mode of operation “in response to evaluation of the road load, that is, the vehicle’s instantaneous torque demands and input commands provided by the operator of the vehicle.”[2] *Id*. at 17:16–21. “[T]he microprocessor can effectively determine the road load by monitoring the response of the vehicle to the operator’s command for more power.” *Id*. at 36:57–64. “[T]he torque required to propel the vehicle [i.e., road load]

[2] The ’097 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. 1101, 13:24–28.

varies as indicated by the operator's commands." *Id*. at 37:23–25. For example, the microprocessor "monitors the rate at which the operator depresses pedals [for acceleration and braking] as well as the degree to which [the pedals] are depressed." *Id*. at 26:59–27:4. These operator input commands are provided to the microprocessor "as an indication that an amount of torque" from the engine "will shortly be required." *Id*. at 27:6–22.

The microprocessor then compares the vehicle's torque requirements against a predefined "setpoint (SP)" and uses the results of the comparison to determine the vehicle's mode of operation. *Id*. at 36:39–37:21, 39:27–59. The microprocessor utilizes a hybrid control strategy that runs the engine only in a range of high fuel efficiency, such as when the 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 20:37–45, 36:39–59; *see also id*. at 13:48–50 ("the engine is never operated at less than 30% of MTO, and is thus never operated inefficiently").

The microprocessor also limits the rate of increase of the engine's torque output so that combustion of fuel occurs at a substantially stoichiometric air-fuel ratio and utilizes the electric motor to meet any shortfall in torque required to operate the vehicle in response to the operator's command. *See, e.g., id*. at 27:31–35, 29:63–30:12, 37:2–6, 38:62–39:14. Other operating parameters may also play a role in the microprocessor's choice of the vehicle's mode of operation, such as the battery's state of charge and the operator's driving history over time. *Id*. at 19:40–47; *see also id*. at 36:34–38 ("according to one aspect of the invention, the microprocessor 48 controls the vehicle's mode of operation at any given time in dependence on 'recent history,' as well as on the instantaneous road load and battery charge state"). According to the '097 patent, this microprocessor control strategy maximizes fuel efficiency and reduces pollutant emissions of the hybrid vehicle. *Id*. at 15:38–41.

C. The Challenged Claims

Of the challenged claims, claims 1, 11, 21, and 30 are independent. Claim 1 is illustrative:

> 1. A method for controlling a hybrid vehicle, said vehicle comprising a battery, a controller, wheels, an internal combustion engine and at least one electric motor, wherein both the internal combustion engine and motor are capable of providing torque to the wheels of said vehicle, and wherein said engine has an inherent maximum rate of increase of output torque, said method comprising the steps of:
>
> operating the internal combustion engine of the hybrid vehicle to provide torque to operate the vehicle;
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> operating said at least one electric motor to provide additional torque when the amount of torque provided by said engine is less than the amount of torque required to operate the vehicle; and
>
> employing said controller to control the engine such that a rate of increase of output torque of the engine is limited to less than said inherent maximum rate of increase of output torque, and wherein said step of controlling the engine such that the rate of increase of output torque of the engine is limited is performed such that combustion of fuel within the engine occurs at a substantially stoichiometric ratio; and comprising the further steps of:
>
> operating said internal combustion engine to provide torque to the hybrid vehicle 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, and wherein SP is substantially less than MTO;

> operating both the at least one electric motor and the engine to provide torque to the hybrid vehicle when the torque required to operate the hybrid vehicle is more than MTO; and
>
> operating the at least one electric motor to provide torque to the hybrid vehicle when the torque required to operate the hybrid vehicle is less than SP.

Ex. 1101, 56:47–57:14.

D. The Instituted Grounds

In the preliminary proceeding, we instituted trial because Ford made a threshold showing of a "reasonable likelihood" that:

> (1) claims 1, 2, 5, 6, 8–12, 15, 16, 18–22, 25, 26, 28, and 29 were unpatentable as obvious over Severinsky[3] and Anderson[4];
>
> (2) claims 3, 13, and 23 were unpatentable as obvious over Severinsky, Anderson, and Yamaguchi[5];
>
> (3) claims 4, 14, and 24 were unpatentable as obvious over Severinsky, Anderson, Yamaguchi, and Takaoka[6]; and
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> (4) claims 30 and 34 were unpatentable as obvious over Severinsky and Takaoka.

Dec. to Inst. 11–12. We now decide whether Ford has proven the unpatentability of these same claims by a "preponderance of the evidence." 35 U.S.C. § 316(e).

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[3] U.S. Patent No. 5,343,970, iss. Sept. 6, 1994 (Ex. 1104, "Severinsky").
[4] C. Anderson & E. Pettit, *The Effects of APU Characteristics on the Design of Hybrid Control Strategies for Hybrid Electric Vehicles*, SAE TECHNICAL PAPER 950493 (1995) (Ex. 1105, "Anderson").
[5] U.S. Patent No. 5,865,263, iss. Feb. 2, 1999 (Ex. 1106, "Yamaguchi").
[6] T. Takaoka et al., *A High-Expansion Ratio Gasoline Engine for the Toyota Hybrid System*, TOYOTA TECHNICAL REVIEW, vol. 47, no. 2 (Apr. 1998) (Ex. 1107, "Takaoka").

III. ANALYSIS

A. 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). Ford proposes a construction for three claim terms, namely, "rate of change," "setpoint," and "road load." Pet. 13–19. Paice takes issue with Ford's proposed construction of "setpoint," and is silent on the other two terms. PO Resp. 3–7. We address all three terms, beginning with the parties' dispute over the meaning of "setpoint."

1. "Setpoint" or "SP"

The term "setpoint" or "SP" is found in independent claims 1, 11, and 21, as well as dependent claims 8, 18, and 34. Ford proposes that "setpoint" be construed, in the context of the claims, as a "predetermined torque value." Pet. 15, 17. In that regard, Ford correctly notes that the claims compare the setpoint against a *torque* value. *Id*. at 15–16. For example, claims 1 and 11 speak of "setpoint" or "SP" as being the lower limit 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."[7] Ex. 1101, 57:1–6, 58:11–16 (emphases added). Claim 21 similarly compares the setpoint "SP" against the torque required to propel the vehicle "RL." *Id*. at 59:7–11. These express recitations suggest that

[7] Paice's declarant, Mr. Neil Hannemann, similarly testified that under the "most straightforward" approach for the claimed "comparison," the "setpoint is a torque value." Ex. 1132, 79:16–80:25.

"setpoint" is not just any value, but a value that—per the surrounding claim language—equates to a measure of "torque." *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").

Paice, on the other hand, argues that "setpoint" is synonymous with a "transition" point, not a torque value. PO Resp. 4–7. Citing the specification, Paice urges that "setpoint" must be construed to indicate a point "at which a transition between operating modes may occur." *Id*. at 4, 7. Paice's argument is misplaced. Although Paice is correct that *sometimes* the specification describes the setpoint in terms of a "transition point" (*see id*. at 5), the claim language itself makes clear that setpoint relates simply to a torque value, without requiring that it be a transition point. Indeed, the specification acknowledges that the mode of operation does not always transition, or switch, at the 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. 1101, 19:45–51 (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.

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. 1101, 39:60–63. But, just because a setpoint may be reset under certain circumstances does not foreclose it from being "set," or "fixed," at some point in time.[8] A setpoint for however short a period of time is still a setpoint. Thus, we construe "setpoint" as a "predetermined torque value that may or may not be reset."

Finally, Paice argues that any construction limiting the meaning of setpoint to a "torque value" is inconsistent with the construction adopted by two district courts in related litigation.[9] PO Resp. 4. Although, generally, we construe claim terms under a different standard than a district court, and thus, are not bound by a district court's prior construction, Paice's emphasis on the district court's construction compels us to address it. *See Power Integrations, Inc. v. Lee*, 797 F.3d 1318, 1327 (Fed. Cir. 2015) ("Given that [patent owner's] principal argument to the board . . . was expressly tied to the district court's claim construction, we think that the board had an obligation, in these circumstances, to evaluate that construction").

In that regard, the district court held:

> there is nothing in the claims or specification that indicate a given setpoint value is actually represented in terms of torque.

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

[9] *Paice LLC v. Toyota Motor Corp.*, No. 2:07-cv-00180, 2008 WL 6822398 (E.D. Tex. Dec. 5, 2008); *Paice LLC v. Hyundai Motor Co.*, No. 1:12-cv-00499, 2014 WL 3725652 (D. Md. July 24, 2014).

> In fact, the specification clearly indicates that the state of charge of the battery bank, 'expressed as a percentage of its full charge' is compared against setpoints, the result of the comparison being used to control the mode of the vehicle.

Ex. 1120, 13 (discussing "setpoint" in the context of related U.S. Patent No. 7,104,347 B2). But, as discussed above, although claims are read in light of the specification, it is the use of the term "setpoint" within the context of the claims themselves that provides a firm basis for our construction. *See Phillips, supra*. Here, the claims instruct us that "setpoint," when read in the context of the surrounding language, is limited to a torque value. Thus, we construe "setpoint" as representing a torque-based value.

2. "Road load" or "RL"

The term "road load" or "RL" appears in independent claim 21, as well as dependent claims 8, 18, and 26. Both Ford and Paice appear to agree that "road load" means the instantaneous torque required to propel the vehicle. Pet. 18–19; PO Resp. 22, 29–30. That proposed construction comports with the specification, which 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." Ex. 1101, 12:28–32.

In further defining "road load," the specification notes that:

> the operator's depressing the accelerator pedal signifies an increase in desired speed, *i.e., an increase in road load*, while reducing the pressure on the accelerator or depressing the brake pedal signifies a desired reduction in vehicle speed, *indicating that the torque being supplied is to be reduced or should be negative*.

Id. at 12:35–41 (emphases added). As such, the specification states that road load "can be positive or negative." *Id*. at 12:41–47. Thus, consistent with the specification, we construe "road load" or "RL" as "the amount of instantaneous torque required to propel the vehicle, be it positive or negative."

3. "Rate of Change"

Finally, Ford asks that the term "rate of change," found in claims 21 and 30, be construed to mean "rate of increase" because that construction is consistent with an amendment that was requested during prosecution of the '097 patent, but "mistakenly failed" to get entered, even though the amendment was entered with respect to other occurrences of the "rate of change" term found elsewhere in the claims. Pet. 13–14 (citing Ex. 1103, 234). Without that construction, Ford argues, the term "rate of change" in claims 21 and 30 is left with "no antecedent basis." *Id*. at 14. Paice does not oppose Ford's proposed construction, and we see merit in reconciling the "rate of change" term with applicant's clear intention that it be "rate of increase," as evidenced by the prosecution history. Ex. 1103, 234. Thus, we conclude that the term "rate of change" is properly construed to mean "rate of increase."

B. Ground 1—Claims 1, 2, 5, 6, 8–12, 15, 16, 18–22, 25, 26, 28, and 29—Obviousness over Severinsky and Anderson

Ford relies on Severinsky and Anderson as together teaching the limitations of independent claims 1, 11, and 21, and dependent claims 2, 5, 6, and 8–10, 12, 15, 16, 18–20, 22, 25, 26, 28, and 29. Pet. 20–44. Ford also advances a reason why a skilled artisan would have combined their teachings to arrive at the claimed invention. *Id*. at 44–45. Specifically, like the claimed invention, Severinsky discloses the essential components of a hybrid electric vehicle, including an internal combustion engine, an electric motor, a battery, and a microprocessor for controlling operation of the engine and motor.[10] *Compare* Ex. 1104, Fig. 3 (Severinsky) *with* Ex. 1101, Fig. 4 (the '097 patent). Also, Severinsky teaches that "stoichiometric combustion" is important "[t]o lower the toxic hydrocarbon and carbon monoxide emissions" of the engine. Ex. 1104, 12:13–17.

Acknowledging that Severinsky does not disclose achieving stoichiometric combustion by limiting the "rate of increase," or "rate of change," of the engine's output torque, as required by independent claims 1, 11, and 21, Ford relies on Anderson as teaching this limitation. Pet. 22–23 (citing Ex. 1105, 7). Notably, Anderson discloses a hybrid control strategy that "maintains the stoichiometric air fuel ratio" of the engine by limiting "engine starts and transients," and more specifically, by performing "slow transients" so the "speed of the transient" is not "too fast."[11] Ex. 1105, 7. The benefit of this strategy, according to Anderson, is that "[hydrocarbon and carbon monoxide] emissions are minimized." *Id*. In combining Severinsky and Anderson, Ford submits that supplementing Severinsky's engine control strategy with Anderson's "slow transients" strategy would have been obvious to a skilled artisan because both references correlate "stoichiometric" combustion with minimizing carbon emissions. Pet. 44 (citing Ex. 1102 ¶¶ 546–550). We agree.

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[10] Ford's declarant, Dr. Jeffrey L. Stein, whose testimony we credit, confirms the teachings of Severinsky with respect to the basic elements and functions recited by claims 1, 11, and 21, i.e., the engine, motor, battery, and controller. Ex. 1102 ¶¶ 128–134, 266–272, 400–406.

[11] The term "transients" is used to describe relatively short-term events between steady-state conditions. The engine "transients" disclosed in Anderson refer to the relatively rapid changes in the output torque of the engine due to a change in the amount of torque requested. The speed of the transient refers to its rate of increase over time. Ex. 1102 ¶¶ 81–83, 152.

Paice, in turn, argues several points in response to Ford's reliance on the combination of Severinsky and Anderson: *first*, the references fail to teach or suggest the claimed "controller" and its associated functional limitations; and, *second*, the references cannot be combined because Severinsky's "parallel" hybrid control strategy "teaches away" from Anderson's "series" hybrid control strategy. PO Resp. 2, 12–32, 37–47. We are not persuaded by Paice's arguments.

1. The Claimed "Controller"

Paice starts out by arguing that Ford has failed to prove that the combination of Severinsky and Anderson discloses or suggests a controller "responsive to an operator command." PO Resp. 15, 17, 18. This argument fails for the simple reason that none of claims 1, 11, and 21 requires that the controller be responsive to an operator command; instead, this limitation is found in claim 30, which is part of a different ground.

In any event, Severinsky discloses a controller in much the same way as the challenged claims, stating that "microprocessor 48 controls the flow of torque between the motor 20, the engine 40, and the wheels 34 responsive to the mode of operation of the vehicle." Ex. 1104, 10:27–30. Likewise, Severinsky discloses that "microprocessor 48 is provided with all information relevant to the performance of the system, and appropriately controls torque transfer unit 28, internal combustion engine 40, switching unit 28, and electric motor 20 to ensure that appropriate torque is delivered to the wheels 34 of the vehicle." *Id*. at 12:64–13:2. And, although not required by claims 1, 11, and 21, Severinsky further discloses that "microprocessor 48 . . . responds to operator commands received over control line 68." *Id*. at 12:60–64; *see also id*., Fig. 3 (depicting input of

"Operator Commands" to "µP Controller 48"). Based on these explicit disclosures, we find that Severinsky teaches the "controller" limitation of the challenged claims. *See* Ex. 1102 ¶¶ 138–148.

2. Operating the Electric Motor "To Provide Additional Torque" When the Engine's Torque is Inefficient or Insufficient

Paice next argues that the combination of Severinsky and Anderson does not teach "a controller that supplements engine torque with motor torque." PO Resp. 15. According to Paice, "[t]here is no disclosure in Severinsky that *the electric motor is used to provide additional torque* to propel the vehicle when the rate of increase of engine output torque is limited or when the engine is operating below its capabilities." *Id*. at 17 (emphasis added). We disagree.

As required by claims 1, 11, and 21, the controller activates the electric motor "to provide additional torque" when the torque required to propel the vehicle exceeds the amount of torque provided by the engine. Put simply, the electric motor helps the engine drive the vehicle when the engine cannot do it alone. Severinsky teaches this limitation, expressly recognizing that the "[m]icroprocessor 48 monitors the operator's inputs and the vehicle's performance, *and activates electric motor 20 when torque in excess of the capabilities of engine 40 is required*." Ex. 1104, 14:15–18 (emphasis added). For example, "[t]he electric motor . . . is used *to supply additional power as needed* for acceleration and hill climbing, and is used to supply all power at low speeds, where the internal combustion engine is particularly inefficient, e.g., in traffic." *Id*. at 9:52–57 (emphasis added); *see also id*. at 10:36–38 ("[i]f the vehicle then starts to climb a hill, the motor 20 is used to supplement the output torque of engine 40"). Likewise, Severinsky specifies "a highspeed acceleration and/or hill climbing mode, wherein *both internal combustion engine 40 and electric motor 20 provide torque* to road wheels 34." *Id*. at 14:22–25 (emphasis added). Those express disclosures by Severinsky are no different than what the claims require—that the controller activate the motor "to provide additional torque" when the torque provided by the engine is insufficient to drive the vehicle. *See* Ex. 1102 ¶¶ 143–147, 424–430. We find that Severinsky's teaching of supplementing the torque of the engine with that of the motor meets squarely the functional limitation of the electric motor recited by challenged claims 1, 11, and 21.

3. Limiting the "Rate of Increase" of the Engine's Output Torque To Achieve "Substantially Stoichiometric" Combustion

Ford relies on the combination of Severinsky and Anderson for teaching that the controller limits the "rate of increase" of the engine's output torque so that fuel combustion "occurs at a substantially stoichiometric ratio," as required by claims 1, 11, and 21. Pet. 22–24; *see also* Ex. 1102 ¶¶ 148–161. To begin, Severinsky teaches that the "microprocessor controller 48 controls the rate of supply of fuel to engine 40." Ex. 1104, 10:4–6. According to Ford's declarant, Dr. Stein, that teaching by Severinsky is "one way the microprocessor 48 limits the rate of increase of output torque of the engine 40." Ex. 1102 ¶¶ 149–150; Ex. 1129 ¶¶ 41–42.

With that foundation in mind, Ford proffers Anderson as teaching an additional hybrid control strategy—one that actively limits the rate of increase of the engine's output torque "by only allowing *slow engine transients*," with the objective of optimizing fuel economy and reducing harmful emissions. Pet. 23, 44–45 (emphasis added). Ford then surmises that supplementing Severinsky's microprocessor strategy, which already limits the rate of increase of the engine's output torque by controlling the rate of fuel supply to the engine, with Anderson's "slow transients" strategy, would have been obvious to a skilled artisan because both references are concerned with hybrid control strategies for improving fuel economy and reducing harmful emissions. *Id*. at 44–45 (citing Ex. 1102 ¶¶ 541–550). We find Ford's argument persuasive.

Anderson is clearly focused on a hybrid control strategy that slows engine transients in an effort to reduce the carbon emissions associated with engine combustion. For instance, in describing an optimum hybrid control strategy for the engine (or "APU"), Anderson explains that "slower transients are desirable for reducing emissions" because:

> [t]ransients present an emissions problem that is largely related to the speed of the transient. . . . If the transient is too fast, the engine may run rich, increasing CO and HC emissions, or lean, increasing NO_x emissions. Some of this effect can be reduced using *a hybrid strategy that only allows slow transients*, but this places greater strain on the LLD [battery].[12]

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[12] We do not find persuasive Paice's argument that Anderson's recognition of certain tradeoffs (such as strain on the battery) would have discouraged a skilled artisan from using her "slow transients" control strategy. *See* PO Resp. 19. Recognizing that her "slow transients" strategy comes with certain tradeoffs, Anderson emphasizes that "the design of an optimum control strategy for that [hybrid] system *should be concurrent to allow tradeoffs to be made while the designs are still fluid*. An efficient optimization process must involve all aspects of the system . . . from the beginning." Ex. 1105, 3. And, she later recognizes that "[t]he APU control strategy must be robust," despite "[t]radeoffs . . . made between engine complexity, cost, fuel efficiency, and battery lifetime." *Id*. at 7. Thus, while

Ex. 1105, 7 (emphasis added). That disclosure of slower engine transients suggests limiting the rate of increase of the engine's output torque. Ex. 1102 ¶ 153. Importantly, Ford's declarant, Dr. Stein, testifies that a skilled artisan "would know that slowing engine transients means slowing the rate of increase of engine output torque to something less than the [engine's] maximum rate of increase." Ex. 1102 ¶ 666; *see also id*. ¶ 154. Thus, we find that Anderson's "slow transients" strategy would have suggested to a skilled artisan a hybrid control strategy that limits the engine's output torque "to less than [its] inherent maximum rate of increase of output torque," as required by claims 1, 11, and 21. Ex. 1129 ¶¶ 32, 33, 43–45.

With respect to limiting the engine's output torque to achieve combustion at "a substantially stoichiometric ratio," Anderson explains that engine transients make it "difficult" to maintain a "stoichiometric air fuel ratio"—the ratio at which complete combustion occurs. Ex. 1105, 7. On that point, Anderson elaborates as follows:

> Frequently, one of the principle aims of a hybrid vehicle is to reduce vehicle emissions to ULEV (Ultra Low Emission Vehicle) levels. Consequently, APU [engine] emissions are very important for system success. In general, *emissions are minimized when a stoichiometric air to fuel ratio is maintained* by a closed loop feedback system (using an oxygen sensor for feedback). *In some operating regimes, such as engine starts and transients, the stoichiometric ratio is very difficult to maintain resulting in an increase in emissions*.

Id. (emphases added).

Anderson recognizes certain tradeoffs in the design process, nowhere does she discourage the use of "slow transients" in her hybrid control strategy.

As a result, to resolve this difficulty, Anderson's control strategy "maintains the stoichiometric air fuel ratio" by purposefully slowing "the speed of the transient" so it is not "too fast." *Id*. Ford's declarant, Dr. Stein, confirms as much, testifying that Anderson's disclosure of slower engine transients (i.e., limiting a rate of increase of the engine's output torque) "helps the vehicle's closed loop feedback system maintain operation near the stoichiometric air/fuel ratio, thereby reducing emissions." Ex. 1102 ¶ 161. Dr. Stein further testifies that "the slower engine transients provide more time for the closed loop feedback system to react to sensed oxygen levels and adjust the fuel rate so that stoichiometric combustion can occur." *Id.*

Paice responds that Anderson's disclosure of "slow transients" is linked to "engine speed, *not* engine torque." Ex. 2102 ¶ 129. But Paice fails to account for Anderson's description of the engine's "transient capabilities" in terms of "power output" and "combinations of speed *and torque*" for greater optimization of the hybrid control strategy. Ex. 1105, 7 (emphasis added); *see also* Ex. 1129 ¶¶ 34–37. When viewed properly in the context of the skilled artisan, Anderson teaches a hybrid strategy that limits the rate of increase of the engine by controlling engine transients and their effect on stoichiometric combustion. *See* Ex. 1129 ¶¶ 44–47, 50–53, 69–71. We are not persuaded by Paice's attempt to focus on isolated passages in Anderson, to the exclusion of its import as a whole.

Based on the express disclosures of Severinsky and Anderson, as well as the testimony of Ford's declarant, Dr. Stein, we are persuaded that the combined teachings of Severinsky and Anderson would have suggested to a skilled artisan a hybrid control strategy in which "the rate of increase of output torque of the engine is limited" so that fuel combustion occurs "at a substantially stoichiometric ratio," as required by claims 1, 11, and 21. This is nothing more than applying a known technique from the prior art (slowing the rate of increase of the engine's output torque) for the same purpose (maintaining stoichiometric combustion) to achieve the same benefit (improving fuel economy and reducing carbon emissions). *See* Ex. 1102 ¶ 543; Ex. 1129 ¶¶ 46–53, 69–71.

4. The Claimed "Setpoint"

Also central to our analysis of claims 1, 11, and 21 are the limitations directed to the "setpoint," or "SP," at which the controller operates the engine to propel the vehicle. Specifically, claims 1 and 11 recite that the controller operates the engine "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." Ex. 1101, 57:1–7, 58:11–17. And, claim 21 adds that "when RL is between SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above SP." *Id*. at 59:7–12.

In determining whether to employ the engine or the motor or both, Severinsky teaches 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

[13] Paice's declarant, Mr. Hannemann, testified that a skilled artisan would have understood that "power is a product of *torque* and speed." Ex. 1132, 31:6–13 (emphasis added).

> vehicle forward and the internal combustion engine is used only to charge the batteries as needed.

Ex. 1104, 7:8–16 (emphasis added); *see also id*. at 9:40–52 ("the internal combustion engine operates only in its most efficient operating range"). Even more importantly, Severinsky teaches that the point at which the engine operates efficiently is based on a "torque" value, stating that the microprocessor runs 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 20:63–66 (emphasis added).

Paice does not dispute that Severinsky teaches operating the engine when it is efficient to do so. Rather, emblematic of its response, Paice argues that Severinsky fails to teach the claimed "setpoint" because Severinsky purportedly turns the engine on "based on the vehicle speed, and not the road load or any other torque demand or metric." PO Resp. 25; *see also id*. at 8, 21, 27–28, 58 (arguing same). In Paice's view, "Severinsky determines *when* to turn the engine on based on the speed of the vehicle in contrast to the '097 patent, which turns the engine on based on road load (claim 21) or the torque necessary to operate the vehicle (claims 1 and 11)." PO Resp. 25.

We are not persuaded by Paice's isolated reading of Severinsky, while downplaying its teaching as a whole. It is the totality of Severinsky that must be assessed, not its individual parts. Paice argues that "speed" is the *sole* factor used by Severinsky's microprocessor in determining when to employ the engine. That is not the case. Although Severinsky describes the use of "speed" as a factor considered by the microprocessor, Severinsky makes clear that the microprocessor also uses the vehicle's "torque" requirements in determining when to run the engine. Importantly, Severinsky discloses that

> *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. 1104, 17:11–15 (emphases added).

Although Severinsky does not use the term "road load" expressly, neither do claims 1 or 11. Instead, both Severinsky and the claims describe operation of the engine in terms similar to our construction of "road load." For example, just as claims 1 and 11 describe the controller as operating the engine in response to "the torque required to operate the hybrid vehicle," so too does Severinsky describe its microprocessor as operating the engine in response "to the load imposed by the vehicle's propulsion requirements." *Id*. The similarity of those descriptions provides ample support for finding that Severinsky teaches an engine control strategy that depends on the torque required to propel the vehicle, as called for by claims 1 and 11.[14]

Moreover, Severinsky teaches elsewhere that efficient operation of the engine is based on torque, not speed. In particular, Severinsky specifies that the microprocessor runs the engine "only in the near vicinity of its most

[14] We also are not persuaded by the testimony of Paice's declarant, Mr. Hannemann, who testifies that this passage in Severinsky relates to "providing torque *to the motor*" and "is not related to determining when to employ the engine." Ex. 2102 ¶ 176. Plainly, this passage in Severinsky relates to operation of *the engine*—for it states expressly that the microprocessor determines the load "to be provided *to the engine*" and responds to that load "so that *the engine 40 can be operated* in its most fuel efficient operating range." Ex. 1104, 17:7–15 (emphases added).

efficient operational point, that is, such that it produces 60–90% of its maximum torque whenever operated." *Id*. at 20:63–67 (emphasis added). Just as Severinsky's "efficient operational point" is expressed as a *percentage of maximum torque*, so too is the claimed "setpoint," which is described in the '097 patent as being "equal to 30% of MTO." Ex. 1101, 39:55; *see also id*. at 20:43–45 ("the engine is never run at less than 30% of maximum torque output ('MTO')"). That Severinsky describes the engine's "efficient operational point" in terms similar to, if not the same as, the "setpoint" in the '097 patent, i.e., *a percentage of maximum torque*, runs counter to Paice's argument that Severinsky employs the engine based on speed alone.

Paice cites a number of passages in Severinsky that purportedly evince a control strategy that is based on speed, as opposed to torque. PO Resp. 22, 25, 28. We do not find the cited passages supportive of Paice's argument. For example, Paice accuses Ford of ignoring Severinsky's disclosure that the engine is turned off during "low speed" or "traffic" situations, and turned on during "moderate speed" or "highway cruising" situations. *Id*. at 25, 28. Those disclosures, however, do not foreclose Severinsky from teaching that the engine's torque requirements are a determinative factor of when to employ the engine. In other words, torque and speed are not mutually exclusive concepts.[15] Indeed, the '097 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.

[15] *See supra* n.13.

1101, 17:24–25, 19:23–24, respectively (emphasis added). Thus, just as "speed" plays a role in the control strategy of the '097 patent, so too does it in Severinsky.

Paice also points to Severinsky's disclosure of "speed-responsive hysteresis" as purported evidence of a control strategy based on "a speed threshold and not based on a torque demand." PO Resp. 28. According to Paice, "[i]t simply makes no sense for Severinsky to use 'speed responsive-hysteresis' if Severinsky uses road load to control engine starts and stops." *Id*. But Severinsky only discusses the hysteresis feature as "speed-responsive" because it is used to avoid cycling the engine on and off in "low-speed" situations where engine speed may dip temporarily to "20-25 mph" while in a highway mode. Ex. 1104, 18:23–42. That discussion of low-speed hysteresis is essentially the same as the description of hysteresis in the '097 patent, which discloses that "excessive mode switching otherwise likely to be encountered in suburban traffic can be largely avoided [by] implementing this '*low-speed* hysteresis'." Ex. 1101, 42:65–44:1.

In any event, 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. We find persuasive the testimony of Ford's other declarant, Dr. Gregory Davis, who confirms that even if Severinsky is disclosing the use of speed in the context of hysteresis in mode switching, a skilled artisan would not "read the actual words in divorce from the rest of the [Severinsky] patent," which, in his opinion, discloses "in other areas that they're looking clearly at the torque" in determining when to switch between modes. Ex. 2108, 167:16–170:20.

Generally speaking, Paice is attempting to 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. 1104, 17:11–15. We reject Paice's arguments that criticize Severinsky's references to "speed," when the '097 patent itself recognizes that "speed" plays a role in a road load-responsive hybrid control strategy.

Paice also faults Severinsky for disclosing that "the microprocessor receives inputs from the driver." PO Resp. 29. But, once again, Paice fails to recognize that, first, the '097 patent says the same thing, and second, the claims do not preclude the controller from receiving inputs from the driver as part of the engine control strategy. Specifically, the '097 patent describes the controller as receiving operator input commands, stating that the microprocessor is "responsive to . . . evaluation of the road load, that is, the vehicle's instantaneous torque demands *and input commands provided by the operator of the vehicle*." *Id*. at 17:40–44. The '097 patent further explains that the "operator input commands" monitored by the microprocessor include the position of the accelerator and brake pedals. *Id*. at 27:26–38. Given that the '097 patent itself calls for the microprocessor to be responsive not only to the vehicle's torque demands but also to the operator's input commands (such as pedal position), we are not persuaded by Paice's attack on Severinsky for teaching a microprocessor control strategy that relies on these same factors.

As another purported difference, Paice argues that Severinsky's disclosure of "potential *output* torques of the engine" is "unrelated to the input torque demand control strategy taught by the '097 patent, for example, using the instantaneous torque required to propel the vehicle (i.e., road load)." PO Resp. 22. In other words, Paice takes issue with Severinsky's expression of road load in terms of a torque output. This argument fails for the simple reason that, like Severinsky, the '097 patent itself expresses "road load" as a torque *output*, not an input. Notably, according to the '097 patent, "[t]he road load is expressed as a function of the engine's maximum torque *output*." Ex. 1101, 37:57–58 (emphasis added); *see also id*. at 36:25–27 ("[t]he road load is shown . . . as varying from 0 at the origin to 200% of the engine's maximum torque output"). Thus, we disagree with Paice's attempt to characterize the claimed "road load" as a torque "input" when the '097 patent itself expressly states otherwise.

In the end, we are not persuaded by Paice's argument that Severinsky does not teach the "setpoint" required by the claims. *See* PO Resp. 21–27, 37–38. Rather, we credit the testimony of Ford's declarant, Dr. Stein, that a skilled artisan would have understood the lower limit of Severinsky's range—60% of MTO—to be a predetermined setpoint that is based on torque. *See* Ex. 1102 ¶¶ 167–172, 177–184, 187–189; *see also* Pet. 24–25, 35–36. Indeed, Paice admits that Severinsky's "60% of MTO is a torque value," but argues it is not a setpoint because there is no evidence "that a 'transition between operating modes may occur' at this [torque] value." PO Resp. 38. That argument, however, is premised on an improper construction of setpoint, a construction that we hold does not require a transition between operating modes. *See* Section III.A.1 above. Thus, we find that Severinsky fulfills the claim requirement of operating the engine when the torque required to propel the vehicle is equal to a setpoint (SP) that is substantially lower than the engine's maximum torque output (MTO).

5. The Reason to Combine

As discussed above, we are persuaded that a skilled artisan would have been led to combine the basic hybrid control strategy of Severinsky with the known technique of slowing the engine transient, as taught by Anderson, because both references share the same fundamental goals of reducing carbon emissions by maintaining a stoichiometric air-to-fuel ratio. *See* Ex. 1102 ¶¶ 541–550; Ex. 1129 ¶¶ 38–49. Paice argues, however, that Severinsky and Anderson cannot be combined because they "are directed to very different hybrid architectures and control strategies." PO Resp. 38–39. At the heart of Paice's argument is that "the *serie*s hybrid engine control strategies of Anderson would not work with the *parallel* hybrid architecture and control strategies of Severinsky." *Id*. at 39 (emphases added); *see also id*. at 35, 42 (same).

In making this distinction, Paice contends that Anderson's control strategy of using "slow transients" is limited to a series hybrid system, whereas Severinsky's control strategy requires "fast transients" because it is a parallel system. PO Resp. 39–42. As support, Paice points to a single reference in Anderson to "fast transients," and argues that Anderson itself proves that "the engine in a parallel hybrid system *must perform fast transients*." *Id*. at 39 (citing Ex. 1105, 5); *see also id*. at 42 (same). And, according to Paice, "[n]owhere does Anderson suggest that the [slow transients] hybrid control strategies articulated for a series hybrid can be applied to a parallel hybrid." *Id*. at 9.

A close review of Anderson, however, does not support Paice's position. Specifically, Anderson speaks of "fast power transients" only when discussing "two distinct extremes," not the optimum strategy for a hybrid vehicle. Ex. 1105, 5. Indeed, later in the same passage, Anderson points out that "neither of these [extreme] strategies would be the optimum strategy" for the hybrid vehicles "under consideration." *Id*. And, when speaking of the "optimum" strategy being considered (later described to be "slow transients"), Anderson makes clear that it applies equally to both series-type and parallel-type hybrid vehicles.

More specifically, in beginning her discussion of "the design of an optimum control strategy," Anderson describes both types of hybrid vehicles—"Series System" and "Parallel System." Ex. 1105, 3–5. Immediately following that description of series-type and parallel-type vehicles, Anderson makes the following important observation: "[t]he thought processes presented in this paper are sufficiently general that *they can be applied to any type of vehicle*." *Id*. at 4. Paice's argument to the contrary would require us to ignore Anderson's clear indication to the reader that her ensuing discussion of the optimum control strategy applies equally to both parallel and series-type vehicles.

Although Anderson describes her strategy of "slow transients" in terms of a series-type vehicle, she does so because it permits versatility in the design process, explaining that: "[t]o fully explore the flexibility allowed by the hybrid system, we focus on the design of a strategy for the most versatile layout: the power assist [series-type] hybrid." *Id*. at 4–5. As for what a skilled artisan would understand from Anderson's utilization of a series-type vehicle over a parallel-type vehicle in describing her control strategy, Ford's declarant, Dr. Stein, testifies:

> [In] thinking about optimizing the design of the vehicle, hybrid electric vehicle, it's important to understand the tradeoffs between the different components. *And she [Anderson] feels that she can illustrate this trade-off by—perhaps more dramatically, in the short amount of space she has here—by focusing on the series system. But she makes it clear that looking at these trade-offs are the same things you do in both the series and parallel configurations*.
>
> * * *
>
> [B]y virtue of what the statement says and my own technical expertise that she's providing a design methodology that she [Anderson] primarily illustrates on a series system, *but is quite clear in showing that it is applicable to a parallel system, as well*.

Ex. 2106, 180:13–182:2.

Based on Dr. Stein's testimony of how a skilled artisan would have understood Anderson's disclosure as a whole, including Anderson's recognition of applying her control strategy equally to series-type and parallel-type hybrid vehicles, we are persuaded a skilled artisan would have understood Anderson as teaching that "slow engine transients" are the optimum strategy for both series-type and parallel-type hybrid vehicles. *See* Ex. 1129 ¶¶ 38–53, 69–71. As such, we conclude that a skilled artisan would have been led to combine Anderson's known strategy of slowing engine transients with Severinsky's base, parallel-type control system in order to better maintain stoichiometric combustion and, thereby, reduce carbon emissions. *See* Ex. 1102 ¶¶ 541–550; Ex. 1129 ¶¶ 38–49. We have considered Paice's evidence and arguments to the contrary, but we find more persuasive Ford's rationale for combining Severinsky and Anderson.

6. Conclusion

We conclude that Ford has demonstrated, by a preponderance of the evidence, that independent claims 1, 11, and 21 would have been obvious over the combined teachings of Severinsky and Anderson.

Paice does not argue dependent claims 2, 5, 6, and 8–10, 12, 15, 16, 18–20, 22, 25, 26, 28, and 29 separately, but instead relies on the same arguments it made for claims 1, 11, and 21. Nonetheless, we are persuaded by Ford's evidence and analysis with respect to these dependent claims, and, accordingly adopt Ford's analysis as our own. *See* Pet. 37–44. For example, with respect to claim 2, Anderson expressly teaches that "O_2 levels can be sensed" in the exhaust stream to maintain the stoichiometric ratio. Ex. 1105 at 7. With respect to claims 8, 16, 18, and 26, Severinsky discloses that either the engine or the motor can be operated in a "battery charge mode . . . responsive to monitoring the state of charge of battery." Ex. 1104, 15:1–10, 16:67–17:15. Finally, as to claims 9, 10, 19, 20, 28, and 29, Severinsky discloses that the battery supplies energy to the motor at voltages "between 500 and 1500 volts" and "less than 75 amperes." *Id*. at 19:39–49. Thus, based on our review of the arguments and evidence presented, we determine that Ford also has demonstrated, by a preponderance of the evidence, that dependent claims 2, 5, 6, and 8–10, 12, 15, 16, 18–20, 22, 25, 26, 28, and 29 would have been obvious over Severinsky and Anderson.

C. Ground 2—Claims 3, 13, and 23—Obviousness over Severinsky, Anderson, and Yamaguchi

Dependent claims 3, 13, and 23 recite that the "engine is rotated at at least 300 rpm" so that "the engine is heated, prior to supply of fuel for starting the engine." Ford relies on Yamaguchi, in combination with Severinsky and Anderson, as teaching this limitation. Pet. 45–48 (citing Ex. 1102 ¶¶ 551–560). Yamaguchi discloses rotating an engine to 600 rpm before starting it, and then starting the engine once it reaches a predetermined temperature. Ex. 1106, 8:62–9:5, 11:27–33, Figs. 3, 8, 11. Ford's declarant, Dr. Stein, testifies that this process amounts to heating the engine before igniting it. Ex. 1102 ¶¶ 553–558.

Paice responds that, because Severinsky teaches "operating the engine at a lower temperature," it "teaches away from heating the engine," as taught by Yamaguchi. PO Resp. 50–51. We are not persuaded for two reasons. First, Severinsky refers to a "lower temperature" in terms of *operating the engine*, not "starting the engine," as claims 3, 13, and 23 require. Ex. 1104, 12:13–21 ("the engine 40 will be operated in lean burn mode . . . at a lower temperature . . . than is a conventional engine"). Ford's declarant, Dr. Stein, confirms as much, explaining that Severinsky's "lower temperature" relates to "engine coolant temperature is typically around 200 degrees F *during steady operating conditions*," and not "the temperature of a cold engine" in need of heating. Ex. 1129 ¶ 82 (emphasis added).

Second, Ford's challenge of claims 3, 13, and 23 is predicated on Severinsky, *as modified by Anderson's stoichiometric control strategy*. As Paice's declarant, Mr. Hannemann, confirms, "if you employ a stoichiometric strategy, then you don't really need to worry about a lower temperature." Ex. 1131, 68:8–23. Because the combination of Severinsky and Anderson incorporates Anderson's control strategy (of operating the engine at a stoichiometric air-fuel ratio) into Severinsky's control strategy, Ford's declarant, Dr. Stein, testifies that a skilled artisan would have understood Severinsky's modified control strategy does not apply to low temperature engine starts, and thus, would not teach away from claims 3, 13, and 23. Ex. 1129 ¶ 81.

Based on the testimony of both parties' declarants, we are persuaded that Severinsky's modified control strategy would not have been viewed by a skilled artisan as "teaching away" from being combined with Yamaguchi's teaching of heating the engine prior to starting it. Rather, we find Ford's evidence and arguments of a rationale to combine the teachings of Yamaguchi with Severinsky and Anderson to be more persuasive than Paice's evidence and arguments to the contrary. *See* Ex. 1102 ¶¶ 587–595. Accordingly, we adopt Ford's analysis as our own. Thus, we conclude that Ford has demonstrated, by a preponderance of the evidence, that dependent claims 3, 13, and 23 are unpatentable as obvious over the combined teachings of Severinsky, Anderson, and Yamaguchi.

D. Ground 3—Claims 4, 14, and 24—Obviousness over Severinsky, Anderson, Yamaguchi, and Takaoka

Claims 4, 14, and 24 depend, respectively, from claims 3, 13, and 23, and add the step of supplying fuel and air to the engine "at a fuel:air ratio of no more than 1.2 of the stoichiometric ratio for starting the engine." Ford relies primarily on Takaoka[16] for teaching this limitation, in combination

[16] Ford establishes, and Paice does not dispute, that Takaoka is a printed publication disseminated before September 1998. Ex. 1127.

with Severinsky, Anderson, and Yamaguchi. Pet. 48–50; *see also* Ex. 1102 ¶¶ 596–606.

Takaoka teaches that, in order for a hybrid system to lower emission levels and optimize fuel consumption, the engine should "operate with $\lambda = 1$ over its entire range." Ex. 1107, 2. Ford's declarant, Dr. Stein, testifies a skilled artisan would have understood that "a λ value of 1 ($\lambda = 1$) corresponds [to] a air-fuel ratio of 1.0 of the stoichiometric ratio" and that operating the engine at this ratio "over its entire range" necessarily includes engine starts. Ex. 1102 ¶¶ 601–606. We credit Dr. Stein's testimony, which is corroborated by the '097 patent's disclosure of "lambda" as indicative of stoichiometric ratio. *See* Ex. 1101, 39:10–12. Thus, we find that Takaoka's disclosure of achieving an air-fuel ratio of 1.0 of the stoichiometric ratio over its entire range falls within the claimed range of "no more than 1.2 of the stoichiometric ratio for starting the engine."

Paice disputes Ford's application of Takaoka. The sum of Paice's argument is that Dr. Stein's analysis is conclusory because he purportedly admitted that he did not know if it was possible for Takaoka to achieve a stoichiometric air-fuel ratio "during cold starts." PO Resp. 51–52 (citing Ex. 2103, 92:4–25). But claims 4, 14, and 24 do not speak of "cold starts." Rather, by way of intervening claims 3, 13, and 23, claims 4, 14, and 24 require that "the engine is *heated* prior to supply of fuel for starting the engine." Ex. 1101 57:19–26 (emphasis added). Thus, claims 4, 14, and 24 are directed to starting an engine after it has been heated, *i.e.*, a hot start. *See* Ex. 1129 ¶¶ 92–95. Thus, we find inapposite Paice's elicitation from Dr. Stein on a point that is irrelevant to what the claims actually recite.

Also, we have considered but are not persuaded by Paice's argument that Takaoka cannot be combined with the hybrid systems of Severinsky, Anderson, and Yamaguchi. *See* PO Resp. 52. Instead, we find persuasive the rationale for the combination as explained by Ford's declarant, Dr. Stein. *See* Ex. 1102 ¶¶ 630–633. The modification of Severinsky's control algorithms to include Takaoka's stoichiometric operating scheme would have been obvious and well within the capability of a skilled artisan. *See id*. Accordingly, we adopt Ford's analysis as our own. Thus, after considering the evidence and arguments, we conclude that Ford has demonstrated, by a preponderance of the evidence, that dependent claims 4, 14, and 24 are unpatentable as obvious over the teachings of Severinsky, Anderson, and Yamaguchi when combined with Takaoka.

E. Ground 4—Claims 30 and 34—Obviousness Over Severinsky and Takaoka

Ford challenges independent claim 30 and dependent claim 34 on the ground that they would have been unpatentable as obvious over Severinsky and Takaoka.[17] Pet. 50–59; Ex. 1102 ¶¶ 634–695. Acknowledging that Severinsky may not disclose "limit[ing] the rate of change of torque

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[17] As discussed in Section II.A. above, claim 30 was the subject of the -570 proceeding that resulted in a final written decision of unpatentability for claim 30. Ground 4, however, is the first instance in which Ford challenges dependent claim 34. And, although claim 30 has been determined to be unpatentable, we exercise our discretion to maintain the instant proceeding against claim 30 because it is incorporated within the body of claim 34 as a matter of dependency. *See* 35 U.S.C. § 315(e)(1) (neither the plain terms of this provision, nor chapter 31 more generally, prohibits the Board from entering final decisions where it sees fit); *see also* 35 U.S.C. § 325(d) (conferring authority on the Board to decide how to deal with multiple proceedings). In any event, whatever renders obvious a dependent claim necessarily renders obvious the claim from which it depends.

produced by the engine" so that fuel combustion "occurs at a substantially stoichiometric ratio," as required by claim 30, Ford points to Takaoka's teaching of a hybrid control strategy that "reduce[s] quick transients in engine load so that the air-fuel ratio can be stabilized easily." Pet. 53 (citing Ex. 1107, 5–6). And, as Ford's declarant, Dr. Stein, explains, the slowing down of transients in engine load is simply another way of saying that the rate of change of engine torque is controlled to maintain combustion at a stoichiometric ratio. Ex. 1102 ¶¶ 666, 669–674.

Paice, in turn, argues that Takaoka is directed to "an underpowered engine to limit engine output, *not a control strategy*." PO Resp. 53 (emphasis added). According to Paice, Takaoka "tells a POSITA nothing about a control system for the [hybrid] vehicle." *Id*. at 54. We disagree. Takaoka discloses expressly a control scheme for lowering the emission levels of the engine: "Emissions levels much lower than the current standard values were attained by *optimum control of the motor and engine*." Ex. 1107, 8 (emphasis added). Takaoka further explains that "[b]y allocating a portion of the load to the electric motor, the system is able to reduce engine load fluctuation under conditions such as rapid acceleration" and "[t]his makes it possible to reduce quick transients in engine load so that the air-fuel ratio can be stabilized easily." *Id*. at 6. We credit the testimony of Ford's declarant, Dr. Stein, that a skilled artisan would have understood Takaoka's disclosure of an "optimal control" to "reduce engine load fluctuation" and "allocate a portion of the load to the electric motor" as referring to a control strategy for limiting engine torque, not as directed to the mechanical design of the engine. Ex. 1129 ¶¶ 98, 99. As Dr. Stein observed, "a mechanical component alone (e.g., an engine) is not capable of such control." *Id*. ¶ 101.

Paice also argues that "to [the] extent Takaoka discloses limiting any characteristic of the engine, it's the engine's *power*, not torque." PO Resp. 56. But Takaoka discloses expressly "reduc[ing] quick transients in engine load." Ex. 1107, 6. We find persuasive the testimony of Ford's declarant, Dr. Stein, that the terms "transients" and "engine load" in this context mean "torque." Ex. 1102 ¶¶ 658–661. As such, we find that the combination of Severinsky and Takaoka teaches "limit[ing] the rate of change of torque produced by the engine" so that fuel combustion "occurs at a substantially stoichiometric ratio," as required by claim 30,

After considering the evidence and arguments of both parties, we conclude that modifying the hybrid control strategy of Severinsky to incorporate the additional strategy of reducing quick transients in engine load, as taught by Takaoka, would have been obvious to a skilled artisan because both Severinsky and Takaoka are concerned with improving fuel economy and reducing emissions in hybrid vehicles, as argued by Ford. *See* Pet. 57–59 (citing Ex. 1102 ¶¶ 699–706). Accordingly, we adopt Ford's analysis as our own, and determine that Ford has demonstrated by preponderant evidence that claim 30 would have been unpatentable as obvious over Severinsky and Takaoka.

We are also persuaded by Ford's evidence and analysis with respect to claim 34, which depends from claim 30. *See* Pet. 56–59; Ex. 1102 ¶¶ 679–694. Here, Paice resurrects the same argument with respect to Severinsky as it made for claims 1, 11, and 21, i.e., that Severinsky determines when to switches modes "based on vehicle speed, not torque." PO Resp. 58. We reject Paice's argument for the same reasons as discussed above. *See* Section III.B.4. Thus, we conclude that Ford has demonstrated by preponderant evidence that claim 34 would have been unpatentable as obvious over Severinsky and Takaoka.

IV. CONCLUSION

Ford has demonstrated, by a preponderance of the evidence, that claims 1–6, 8–16, 18–26, 28–30, and 34 of the '097 patent are unpatentable for obviousness under 35 U.S.C. § 103.

V. ORDER

Accordingly, it is hereby:

ORDERED that claims 1–6, 8–16, 18–26, 28–30, and 34 of the '097 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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