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Paper 45
Entered: September 28, 2015

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 IPR2014-00579
Patent 7,104,347 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

Ford Motor Company ("Ford") filed a Petition ("Pet.") for *inter partes* review of claims 1, 7, 8, 18, 21, 23, and 37 of U.S. Patent No. 7,104,347 B2 ("the '347 patent"), which is owned by Paice LLC & The Abell Foundation, Inc. (collectively, "Paice"). In a preliminary proceeding, we determined there is a reasonable likelihood that the challenged claims are unpatentable under 35 U.S.C. § 103, and instituted trial ("Dec. to Inst."). In support of patentability, Paice filed a Patent Owner Response ("PO Resp."), and Ford followed with a Reply ("Reply"). After hearing oral argument from both parties,[1] and pursuant to our jurisdiction under 35 U.S.C. § 6(c), we conclude Ford has proven, by a preponderance of the evidence, that all of the challenged claims are unpatentable.

II. BACKGROUND

A. *The '347 patent* [2]

The '347 patent describes a hybrid vehicle with an internal combustion engine, two electric motors (a starter motor and a traction motor), and a battery bank, all controlled by a microprocessor that directs the transfer of torque from the engine and traction motor to the drive wheels of the vehicle. Ex. 1101, 17:5–45, Fig. 4. The microprocessor features an engine control strategy that runs the engine only under conditions of high efficiency, typically when the vehicle's instantaneous torque requirements (i.e., the amount of torque required to propel the vehicle, or "road load") is

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[1] A transcript ("Tr.") has been entered into the record. Paper 44.

[2] The '347 patent is also the subject of several co-pending cases, including *Paice LLC v. Ford Motor Co.*, No. 1:14-cv-00492 (D. Md.), filed Feb. 19, 2014 (Pet. 1), and *Paice LLC v. Hyundai Motor Co.*, No. 1:12-cv-00499 (D. Md.), filed Feb. 16, 2012 (PO Resp. 6).

at least equal to 30% of the engine's maximum torque output ("MTO") capability. *Id*. at 20:52–60, 35:5–14; *see also id*. at 13:47–61 ("the engine is never operated at less than 30% of MTO, and is thus never operated inefficiently").

Running the engine only when it is efficient to do so leads to improved fuel economy and reduced emissions. *Id*. at 13:47–51. To achieve such efficiency, the hybrid vehicle includes various operating modes that depend on the vehicle's torque requirements, the battery's state of charge, and other operating parameters. *Id*. at 19:53–55. For example, the hybrid vehicle may operate in: (1) an all-electric mode, where only the traction motor provides the torque to propel the vehicle and operation of the engine would be inefficient (i.e., stop-and-go city driving); (2) an engine-only mode, where only the engine provides the torque to propel the vehicle and the engine would run at an efficient level (i.e., highway cruising); (3) a dual-operation mode, where the traction motor provides additional torque to propel the vehicle beyond that already provided by the engine and the torque required to propel the vehicle exceeds the maximum torque output of the engine (i.e., while accelerating, passing, and climbing hills); and (4) a battery recharge mode where the engine operates a generator to recharge the battery while the traction motor drives the vehicle. *Id*. at 35:66–36:58, 37:26–38:55.

B. The challenged claims

Ford challenges the patentability of claims 1, 7, 8, 18, 21, 23, and 37. Pet. 3. Of the challenged claims, claims 1 and 23 are independent. Claim 1 is directed to a "hybrid vehicle" (Ex. 1101, 58:13), while claim 23 is directed to a "method of control" of a hybrid vehicle (*id*. at 60:22). Each of the independent claims recites that the engine is employed when it can produce torque "efficiently," which claim 1 describes as when the torque required to propel the vehicle is "at least equal to a setpoint (SP) [but] substantially less than the maximum torque output (MTO)" of the engine (*id*. at 58:29–37), and claim 23 describes as when the torque required to propel the vehicle is "between a lower level SP and a maximum torque output MTO" (*id*. at 60:23–42).

Claim 1 is illustrative of the challenged claims:

> 1. A hybrid vehicle, comprising:
>
> an internal combustion engine controllably coupled to road wheels of said vehicle;
>
> a first electric motor connected to said engine [a]nd operable to start the engine responsive to a control signal;
>
> a second electric motor connected to road wheels of said vehicle, and operable as a motor, to apply torque to said wheels to propel said vehicle, and as a generator, for accepting torque from at least said wheels for generating current;
>
> a battery, for providing current to said motors and accepting charging current from at least said second motor; and
>
> a controller for controlling the flow of electrical and mechanical power between said engine, first and second motors, and wheels,
>
> *wherein said controller starts and operates said engine when torque require[d] to be produced by said engine to propel the vehicle* and/or to drive either one or both said electric motor(s) to charge said battery *is at least equal to a setpoint (SP) above which said engine torque is efficiently produced*, and wherein the torque produced by said engine when operated at said setpoint (SP) is substantially less than the maximum torque output (MTO) of said engine.

Ex. 1101, 58:13–37 (emphases added).

C. The instituted grounds of unpatentability

In a preliminary proceeding, we instituted trial because Ford made a threshold showing of a "reasonable likelihood" that the challenged claims were unpatentable as obvious over five publications that share a common author, Professor James R. Bumby, which are referred to individually as Bumby I,[3] Bumby II,[4] Bumby III,[5] Bumby IV,[6] and Bumby V,[7] and collectively as "the Bumby references" or "Bumby." Dec. to Inst. 13. We now decide whether Ford has proven the unpatentability of the challenged claims by a "preponderance of the evidence." 35 U.S.C. § 316(e).

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). This standard involves determining the ordinary and customary meaning of the claim terms as understood by one of ordinary skill in the art reading the patent's entire

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[3] J.R. Bumby, *Computer modelling of the automotive energy requirements for internal combustion engine and battery electric-powered vehicles*, IEE PROC., v. 132, pt. A, no. 5, 265–279 (Sep. 1985) (Ex. 1103).
[4] J.R. Bumby and I. Forster, *Optimisation and control of a hybrid electric car*, IEE PROC., v. 134, pt. D, no. 6, 373–387 Nov. 1987 (Ex. 1104).
[5] I. Forster and J.R. Bumby, *A hybrid internal combustion engine/battery electric passenger car for petroleum displacement*, PROC. INST. MECH. ENGRS., v. 202, no. D1, 51–64 Jan. 1988 (Ex. 1105).
[6] J.R. Bumby and P.W. Masding, *A Test-Bed Facility for Hybrid IC Engine-Battery Electric Road Vehicle Drive Trains*, TRANS. INST. MEAS. & CONT., v. 10, no. 2, 87–97 Apr. 1988 (Ex. 1106).
[7] P.W. Masding and J.R. Bumby, *Integrated microprocessor control of a hybrid i.c. engine/battery-electric automotive power train*, TRANS. INST. MEAS. & CONT., v. 12, no. 3, 128-146 Jan. 1990 (Ex. 1107).

written disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Here, our review centers on the construction of two claim terms—"road load (RL)" and "setpoint (SP)."[8]

1. "Road load" or "RL"

The terms "road load" and "RL" appear throughout the claims of the '347 patent. For example, claim 7, which depends from claim 1, recites that the operating modes are "responsive to the value for the road load (RL) and said setpoint (SP), both expressed as percentages of the maximum *torque* output of the engine," and claim 23 recites the step of "determining the instantaneous *torque* RL required to propel said vehicle responsive to an operator command."

The specification also describes "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, 12:40–57 (emphasis added). Elsewhere the specification similarly speaks of road load in terms of a "torque" requirement:

> The vehicle operating mode is determined by a microprocessor responsive to the *"road load," that is, the vehicle's instantaneous torque demands.*
>
> * * *
>
> While operating at low speeds, e.g., when *the vehicle's torque requirements ("road load," or "RL")* are less than

[8] Ford also contends that the terms "low-load mode I," "highway cruising mode IV," and "acceleration mode V" are in need of construction. Pet. 13–17. Those terms are expressly defined by claim 7 (Ex. 1101, 58:64–59:8), and, thus, no further construction is necessary.

> 30% of the engine's maximum torque output ("MTO"), engine 40 is run only as needed to charge battery bank 22.

Id. at 11:60–63, 36:8–11 (emphases added). Also, in distinguishing the claimed invention over the prior art, the specification explains that:

> Numerous prior art references . . . indicate the vehicle operating mode should be controlled in response to vehicle speed . . . [but none] recognizes that the desired vehicle operational mode should preferably be controlled *in response to the vehicle's actual torque requirements, i.e., the road load*. Doing so according to the invention provides superior performance, in terms of both vehicle response to operator commands and fuel efficiency. . . .

Id. at 13:1–15 (emphasis added).

These passages from the specification comport with a construction of "road load" that is limited to an instantaneous torque value, and, more specifically, a torque value which can be expressed in terms of *a percentage* of the engine's "maximum torque output" or "MTO." For instance, the specification states that:

> *road load* is shown . . . as varying from *0 at the origin to 200% of maximum torque output*.
>
> * * *
>
> During highway cruising . . . where the *road load* is between about *30% and 100% of the engine's maximum torque output*, the engine alone is used to propel the vehicle.
>
> * * *
>
> [W]hen the microprocessor detects that the *road load* exceeds *100% of the engine's maximum torque output*, it controls inverter/charger 27 so that energy flows from battery bank 22 to traction motor 25, providing torque propelling the vehicle in addition to that provided by engine 40.

Id. at 37:13–15, 37:45–47, 38:5–10 (emphases added).

We see no reason to depart from these express definitions of "road load" in terms of an amount of torque. Thus, consistent with the specification's many uses of the term, "road load" is properly construed to be "the amount of instantaneous torque required for propulsion of the vehicle."

Paice urges that our construction of "road load" should additionally account for external forces acting on the vehicle, such as "aerodynamic drag." PO Resp. 19–20 n.8. Although aerodynamic forces may play a role in the amount of torque required to propel the vehicle, we need not address them in order to construe the term "road load." That is because the claims and specification of the '347 patent consistently speak of "road load" in a more general sense. In fact, the specification mentions aerodynamic forces only in the context of a "heavy vehicle" having "high torque requirements" and "poor aerodynamic characteristics." Ex. 1101, 49:9–14. That singular example, however, is not enough for us to overlook the countless descriptions found elsewhere in the specification, where "road load" or "RL" is defined simply as "the amount of torque required to propel the vehicle," divorced from other potential forces acting on the vehicle.

2. "Setpoint" or "SP"

Each of independent claims 1 and 23 recites that the engine operates "efficiently" when the torque required to propel the vehicle is between a "setpoint (SP)" and a "maximum torque output (MTO)." Paice seeks to construe the term "setpoint" as "a definite, but potentially variable value at which a transition between operating modes may occur." PO Resp. 7. Ford, on the other hand, advocates that "setpoint" means a "predetermined torque value." Pet. 14. Paice protests any construction that limits the meaning of "setpoint" to a "torque value" (PO Resp. 11), arguing that the specification supports a broader definition that also could encompass a "state of charge of the battery" (Prelim. Resp. 13–16) or a "transition between operating modes" (PO Resp. 7–10).

We agree with Paice that the *specification* speaks of "setpoint" in terms of a "torque output," a "state of charge of the battery," or a "transition point." *See* Ex. 1101, 40:20–54. However, the *claim language* is not so broad. Although we recognize that the specification is an important tool in claim construction, it is the claim language—and the context in which the disputed term is used—that is of primary importance. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005) (en banc) ("the claims themselves provide substantial guidance as to the meaning of particular claim terms . . . the context in which a term is used in the asserted claim can be highly instructive") (citations omitted). Put another way, "the name of the game is the claim." *In re Hiniker Co.*, 150 F.3d 1362, 1369 (Fed. Cir. 1998) (quoting Giles Sutherland Rich, *Extent of Protection and Interpretation of Claims—American Perspectives*, 21 Int'l Rev. Indus. Prop. & Copyright L. 497, 499 (1990)).

Here, contrary to Paice's assertion, the claim language consistently refers to a "setpoint" in terms of a "torque" requirement. For instance, claim 1 recites that the controller starts and operates the engine

> when *torque require[d]* to be produced by said engine . . . *is at least equal to a setpoint (SP)* above which said engine torque is efficiently produced, and wherein the *torque produced* by said engine when operated *at said setpoint (SP)* is substantially less than the maximum torque output (MTO) of said engine.

Ex. 1101, 58:30–37 (emphases added). And, likewise, claim 23 speaks consistently of "setpoint" or "SP" as being the "lower level," or limit, at which the engine can efficiently produce torque, reciting that: the engine is capable of "efficiently producing *torque at loads between a lower level SP* and a maximum torque output"; the engine is employed to propel the vehicle "when the *torque RL required to do so is between said lower level SP* and MTO"; and "wherein the *torque produced* by said engine when operated *at said setpoint (SP)* is substantially less than the maximum torque output." *Id*. at 60:22–54 (emphases added). These express limitations suggest that "setpoint" is not just any value, but a value that—per the surrounding claim language—equates to the level of the engine's "torque."

Moreover, we note that claim 23 includes a limitation directed to "the state of charge of said battery," but it never correlates that limitation with a "setpoint" or "SP," even though those terms are used elsewhere throughout the claim. Nor does Paice point us to anywhere in the claims that describe the setpoint in the context of the battery's state of charge. Indeed, when speaking of "the state of charge of the battery," dependent claims 9 and 31 refer to it in terms of falling below "a predetermined level," not a "setpoint." Thus, given the claim language's unequivocal use of "setpoint" or "SP" in the context of a "torque" requirement, we construe the terms "setpoint" and "SP" to mean "a torque value." Our assessment does not end there, however.

The specification states that "the value of a setpoint (for example) may vary somewhat in response to recent [driving] history, or in response to monitored variables" or may be "reset . . . in response to a repetitive driving pattern." Ex. 1101, 40:37–59. But, just because a setpoint *may* vary under certain circumstances, that potential variation does not foreclose it from being "set," or "fixed," at some point in time.[9] A setpoint for however short a period of time still is a setpoint. Any other construction would defeat its purpose of being *set* for comparison against another value. For example, the specification states that "the microprocessor tests sensed and calculated values for system variables [such as road load (RL)] . . . *against setpoints, and uses the results of the comparisons* to control the mode of vehicle operation." Ex. 1101, 40:22–31 (emphasis added). That description makes clear that the comparative setpoint is a pre-defined value. Indeed, the specification refers to setpoint in terms of a "defined setpoint." *Id*. at 19:64. As such, we construe the term "setpoint" to mean at least "a predefined torque value that may or may not be reset."[10]

Finally, we cannot disregard Paice's argument that our construction is "directly at odds" with the construction adopted by two district courts in related actions.[11] PO Resp. 6. According to Paice, each of the district courts construed "setpoint," as used in the '347 patent, to mean "a definite, but potentially variable value at which a transition between operating modes may occur." *Id*. Although, generally, we construe claim terms under a different standard than that of a district court, and thus, are not bound by a district court's prior claim construction, we nonetheless feel compelled, by the circumstances of this case, to evaluate the district courts' construction in

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

[10] Even Paice's declarant agreed that, given the "comparison" being made in claims 1 and 23, the "most straightforward" construction is that "setpoint is a torque value." Ex. 1143, 79:1–80:25.

light of our construction. *See Power Integrations, Inc. v. Lee*, 2015 WL 4757642, at *6 (Fed. Cir. Aug. 12, 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").

Here, the first half of the district courts' construction—"a definite, but potentially variable value"—coincides squarely with our construction of "setpoint" as a "predefined" value "that may or may not be reset." The difference, however, lies in our construction of "setpoint" to be a "torque" value. On that point, 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. 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. 1115, 10 (citing the '347 patent, 40:28–31). 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*, 415 F.3d at 1314 ("the context in which a term is used in the asserted claim can be highly instructive"). Here, the claims instruct us that "setpoint," when read in the context of the surrounding language, is limited to a torque value. We decline to read the term as also encompassing a state of charge of the battery, as the district

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[11] *Paice LLC v. Toyota Motor Corp.*, No. 2:07-cv-00180, Dkt. 63 (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).

court did. Thus, we stand by our determination that claims 1 and 23 consistently refer to "setpoint" as a "torque" requirement.

With regard to the second half of the district courts' construction of "setpoint" as "a transition between operating modes," we believe it imports an extraneous limitation into the meaning of "setpoint" that is neither supported by the claim language nor the specification. In particular, claims 1 and 23 expressly describe "setpoint (SP)" as being the lower limit at which the engine can "efficiently" produce torque. Those claims make no mention of this lower limit as being a "transition" point for the "operating modes," although it potentially may be. 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 operating parameters:

> 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, 19:53–64 (emphasis added).

Moreover, that a "setpoint" is not a *per se* transition between operating modes is reinforced by the fact that only the dependent claims, for example claims 7 and 28, mention "setpoint" in terms of "operating modes." *See id*. at 58:58–60, 61:11–13. Where the meaning of a claim term is clear from the context of its use in an independent claim, we will not further limit the meaning of the term by its use in a dependent claim, absent justification for doing so. *See Phillips*, 415 F.3d at 1315 ("the presence of a dependent claim that adds a particular limitation gives rise to a presumption that the limitation in question is not present in the independent claim"). Thus, although the district courts may have had justification for a narrower construction of "setpoint," we believe it is necessary here and may lead to confusion given our standard of applying the "broadest reasonable construction" to the terms of a claim. *See* 37 C.F.R. § 42.100(b). As such, we maintain our construction of "setpoint," as discussed above, which arguably may differ from the construction arrived at in the related district court actions.

B. The sole asserted ground—obviousness over the Bumby references

Ford relies on the five Bumby references as teaching, collectively, the limitations of the contested claims, and a reason why a skilled artisan would have been combined them to arrive at the claimed invention. Pet. 28–59. Specifically, like the contested claims, the Bumby references disclose the essential components of a hybrid electric vehicle, including an internal combustion engine, an electric motor, a battery, and a controller for controlling the vehicle's different modes of operation. *Compare* Ex. 1104, Fig. 2 (Bumby II) *with* Ex. 1101, Fig. 4 (the '347 patent). The "different operating modes," according to Bumby III, include an electric mode, a hybrid mode, an engine mode, and a battery charge mode. Ex. 1105, 4–5 (Table 2), 11–12 (Fig. 15).

In turn, Bumby IV teaches that the "microprocessor" controller is "the heart of the drive-train control system" and "implement[s] the hybrid-vehicle control strategy . . . *in the most efficient way to meet driver demand*." Ex. 1106, 4 (emphasis added). Efficiency is achieved, Bumby IV explains, by operating the engine only "when load demand is high," rather than at "low speed, low load situations [where] the ic engine is inefficient compared with the electric traction system." Ex. 1106 at 3–4; Ex. 1108 ¶¶ 254–255, 258.

And, notably, Bumby II and III define "maximum engine efficiency" in terms of a "lower torque bound" and an "upper torque bound." Ex. 1104 at 10–11 (Fig. 16); Ex. 1105 at 7–8 (Fig. 8). "Above the upper torque bound," according to Bumby II, "true hybrid operation is used with the electric motor supplying the excess torque above the maximum available from the engine." Ex. 1104, 11. "Below the lower torque bound and the lower speed bound, all-electric operation is favoured [which] eliminates inefficient use of the engine." *Id*. Thus, taken together, the five Bumby references teach a hybrid vehicle in which the internal combustion engine and the electric motor are capable of driving the road wheels, with the mix of power between the engine and motor being controlled by a microprocessor to provide maximum engine efficiency.[12]

Paice, in turn, argues essentially five points in rebuttal of Ford's reliance on the Bumby references: *first*, a skilled artisan would not have combined the Bumby references because they "teach away" from one another; *second*, the Bumby references do not disclose or suggest the use of "setpoints (SP)," as required by claims 1, 7, and 23; *third*, the Bumby references do not disclose or suggest the use of "road load (RL)," as required by claims 7 and 23; *fourth*, the Bumby references do not disclose or suggest the "first electric motor" of claims 1 and 8; and *fifth*, the Bumby references do not disclose or suggest the "battery charging" mode of claims 1 and 23. PO Resp. 15, 21, 34, 37, 43, respectively. We are not persuaded by any of Paice's arguments.

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[12] Ford's declarant, Dr. Davis, whose testimony we find persuasive, confirms the teachings of each of the Bumby references. Ex. 1108 ¶¶ 238–244, 251–255, 259–272.

1. The reason to combine the Bumby references

Despite the overlapping teachings of the Bumby references, Paice argues that Ford's "only reasons" for combining the Bumby references are that they "share a common author and cite to each other." PO Resp. 15. We disagree. Aside from their citation to one another, the Bumby references document, chronologically, the evolution of a hybrid vehicle project undertaken by Professor James Bumby and his team at the University of Durham in the 1980s. *See* Pet. 18–28; *see also* Ex. 1106, 2 and Ex. 1107, 2–3 (referencing earlier Bumby references). Indeed, common to the five Bumby references is the stated objective of the project—to develop an optimal control strategy for maximizing efficient operation of a hybrid vehicle. *See, e.g.*, Ex. 1104, 6, Ex. 1105, 6, 15, Ex. 1106, 2; *see also* Ex. 1108 ¶¶ 206, 208, 220, 230.

Also, evidence proffered by Paice itself, a doctorate thesis by Philip Masding in 1988 (Ex. 2104, "the Masding Thesis"), further supports the rationale to combine.[13] The Masding Thesis brings together the five Bumby references in a single compilation and summarizes the efforts undertaken by Professor Bumby and his team. Ex. 1140 ¶¶ 5–16, 21–22 (citing Ex. 2104, 35–49). Even Paice's own declarant, Mr. Hannemann, testified that the "thesis written by Masding . . . encompasses a lot of the elements of all of the other five [Bumby] papers." Ex. 1141, 17:1–9.

[13] Mr. Masding was part of Professor Bumby's team at the University of Durham and a listed author on some of the Bumby references. *See* Exs. 1106, 1107. Although the Masding Thesis is not a basis for the instituted ground, it is offered as relevant evidence to corroborate certain testimony of the declarants and to indicate the level of skill in the art.

Nonetheless, Paice contests that a skilled artisan would have combined the Bumby references, arguing that Bumby IV and V "teach away" from Bumby II and III. PO Resp. 15–21. According to Paice, Bumby IV and V teach an "arbitrary *speed-based* mode controller" that would be incompatible, or "impractical," for use with the "sub-optimal control strategy" taught by Bumby II and III. PO Resp 16–18. But the mere disclosure of more than one design in a prior art reference does not constitute a teaching away if "such disclosure does not criticize, discredit, or otherwise discourage" one design over the other. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004).

Here, although Bumby V describes the use of two control strategies, it explains clearly that one is for purposes of initial testing while the other is for actual use in the hybrid vehicle. More specifically, the "arbitrary [speed-based] strategy," Bumby V acknowledges, "is intended *purely to demonstrate*" that the "more sophisticated [control] strategy" of Bumby II and III is capable of being implemented on a hybrid vehicle. Ex. 1107, 19 (emphasis added). In other words, Bumby V is simply teaching how to test, and prove, the feasibility of the sub-optimal control strategy taught earlier by Bumby II and III, rather than criticizing or disparaging it. And, contrary to Paice's protest, we credit the testimony of Ford's declarant, Dr. Davis, that nowhere does Bumby V characterize the sub-optimal control algorithm as inadequate or inoperable. Ex. 1140 ¶¶ 23–32.

Paice continues to protest the combination, proffering the testimony of its declarant, Mr. Hannemann, that "it was not technically feasible to implement" the sub-optimal control strategy of the Bumby references due to potential problems with "gear shifting." PO Resp. 18–19 (citing Ex. 2102

¶¶ 66–68). But, upon further questioning, Mr. Hannemann clarified that the "gear shifting" problem was merely "a challenge" that Professor Bumby and his team were "trying to tackle." Ex. 1141, 56:14–17. Simply because a prior art reference recognizes a problem, and discusses the work to solve it, does not necessarily teach away from what the reference otherwise discloses, for it is still "prior art for all that it teaches." *Beckman Instruments v. LKB Produkter AB*, 892 F.2d 1547, 1551 (Fed. Cir. 1989).

Moreover, rather than criticizing the sub-optimal control strategy taught by the Bumby references, the Masding Thesis (proffered by Paice) provides encouragement that corrections to the implementation software will alleviate the gear-shifting problem:

> Once correct action of the component controllers and associated sequencing logic had been demonstrated with the speed based mode strategy, *the logical extension is to introduce a mode control strategy aimed at maximizing vehicle efficiency. To do this the sub-optimal controller, devised in previous work at Durham, is most appropriate. At this point however the necessary software to implement such control has not been perfected*, specifically problems have arisen in avoiding excessive numbers of gear shifts.

Ex. 2104, 240 (emphasis added). That passage suggests that, while not yet "perfected," the sub-optimal control strategy discussed in Bumby II and III is still the "most appropriate" and "logical" choice. Ford's declarant, Dr. Davis, confirms as much, testifying that "reading the entire paragraph in context," a skilled artisan would have recognized that the sub-optimal control strategy is operable and "would be implemented" into a hybrid vehicle. Ex. 1140 ¶¶ 20–25.

Still, Paice argues that the Bumby references would have led a skilled artisan "to avoid hybrid technology altogether" because their sub-optimal control strategy "actually results in a hybrid car with *worse* fuel consumption than a conventional non-hybrid car." PO Resp. 19–20 (citing Ex. 2102 ¶¶ 69–75). According to Paice, test data from the Bumby references show that a conventional vehicle with a "3-cylinder engine" outperformed a hybrid vehicle with the same "3-cylinder engine." *Id*. Although that may be true, the Bumby references nonetheless describe *another configuration* that showed just the opposite. In that regard, we find more credible the testimony of Ford's declarant, Dr. Davis, who testifies that Paice's declarant, Mr. Hannemann, ignores additional data results showing that the sub-optimal control algorithm provided "*better fuel economy*" over the conventional vehicle when the "base configuration" of the two vehicles was evaluated. Ex. 1140 ¶¶ 27–29 (emphasis added). At a minimum, this would indicate to a skilled artisan that, in certain configurations, hybrid vehicles outperform conventional vehicles, which hardly amounts to a teaching away. *Id*. ¶¶ 30, 32.

After considering the evidence and arguments presented, we find that Bumby IV and V do not teach away from using the sub-optimal control strategy taught by Bumby II and III. To the contrary, we find that a skilled artisan would have viewed the five Bumby references as describing various phases of the same development effort for implementing an operable control strategy for a hybrid vehicle, and, thus, would have been led to combine their respective teachings.

2. The "setpoint" limitation of claims 1, 7, and 23

Paice argues that the Bumby references do not teach or suggest the use of a "setpoint (SP)," as required by claims 1, 7, and 23. PO Resp. 21–34. According to Paice, the sub-optimal control strategy taught by the

Bumby references is not based on a "predetermined torque value," per our construction of "setpoint," but rather on "demand power." *Id*. at 21–22 (citing Ex. 1105, 7). We disagree.

As Bumby III clearly illustrates, the sub-optimal control strategy evaluates "*torque* and speed values" relative to an optimum region for operating the engine in determining the mode of operation. Ex. 1105, 7–8 (Fig. 8) (emphasis added). Bumby II further explains that the sub-optimal control strategy is based on a "box region . . . defined by an upper and lower *torque* bound and an upper and lower speed bound." Ex. 1104, 10–11, Fig. 16 (emphasis added). "Within this box," Bumby II states, "engine-only operation is favoured while, when the operating point is outside this box, the selected mode of operation depends on the actual torque and speed values." *Id*. at 10–11. Bumby II further provides that, when the actual torque requirement is "[b]elow the lower torque bound, an all-electric operation is favoured," and when the torque requirement is "[a]bove the upper torque bound, true hybrid operation is used." *Id*. at 11; *see also* Ex. 1105 (Bumby III), 7 ("By defining an operating region or 'box' around the i.c. engine maximum efficiency region as shown in Fig. 8 then a region of acceptable engine performance is defined. The control algorithm always seeks to place the i.c. engine operating point within the 'box'").

That the Bumby references, in particular Bumby II and III, define the operating box, or region, in terms of *torque* boundaries would have suggested to a skilled artisan a setpoint that utilizes torque as a factor in determining the operational mode—an all-electric mode when the torque requirement is below the lower boundary, an engine-only mode when the torque requirement is within the boundaries, and a hybrid mode when the torque requirement is above the boundary. Ex. 1108 ¶¶ 277–280 (confirming that the "lower torque bound" in Bumby III is "one setpoint" for ensuring that the engine only operates when it can do so "efficiently"). Based on the Bumby references' clear teaching of determining the mode of operation based on torque and speed values, we are not persuaded by Paice's contention that it is based solely on "power demand."

Nonetheless, Paice maintains that the mode decisions in Bumby are made based on the "position" of the accelerator pedal, which is indicative of "demand power." PO Resp. 32–34. Although pedal position (i.e., "demand power") may be an input, Bumby II makes clear that "the suboptimal control algorithm *converts the instantaneous power* and speed requirement *into a torque* and speed demand." Ex. 1104, 11 (emphases added). And, Bumby III further explains that the sub-optimal control algorithm "accepts demand power as its control variable and, by sensing road speed, *transforms this power to a torque* at the output of the transmission." Ex. 1105, 7 (emphasis added). With that conversion, according to Bumby III, a "set of torque and speed values" can be calculated that relate to "discrete gear ratio[s]" for the transmission, i.e., the mode of operation. *Id*. A skilled artisan would have understood these disclosures as teaching that "demand power" is converted to a *torque* value for deciding the mode of operation. Ex. 1140 ¶¶ 37–39. Thus, we are not persuaded by Paice's assertion that the Bumby references only determine the mode of operation based on power, not torque.

In sum, the Bumby references compare calculated torque values against the "lower torque bound" to determine whether the engine and/or electric motor should be used for propelling the vehicle. Ex. 1104, 10–11 (Fig. 16), Ex. 1105, 7–8 (Fig. 8). When the torque value is above the lower torque bound, the engine is used to propel the vehicle. *Id.* When the torque value is below the lower torque bound, the electric motor is used to propel the vehicle. *Id.* As such, the Bumby references teach a control strategy that uses a boundary, or setpoint, for determining the operating mode of the engine and motor, as required by claims 1, 7 and 23. The control strategy of the challenged claims requires nothing more.

Finally, we have considered Paice's argument that Bumby's control strategy "is at its core a transmission control system," and, thus, "a fundamentally different method of controlling a hybrid vehicle than the '347 patent's use of 'road load' and 'setpoints'." PO Resp. 31. We do not find this argument persuasive for the simple reason that Paice's position is wholly unmoored from the specification and claims of the '347 patent. Specifically, the '347 patent recognizes, expressly, the desirability of a transmission as part of the claimed invention:

> it now appears that in some circumstances *a two-speed transmission may be desired in some cases* to broaden the range of utility of the vehicles of the invention (principally to extend their load carrying capabilities) while still providing highly efficient operation, and to include such *a two-speed transmission is accordingly part of the invention* of the present continuation-in-part application.

Ex. 1101, 20:5–12 (emphases added).

And, consistent with the specification, challenged claim 18 of the '347 patent covers the specific use of a "variable-ratio transmission" with the claimed control strategy. *Id.* at 60:1–3. Thus, rather than being "fundamentally different," as Paice urges, the Bumby references' use of a transmission with its sub-optimal control strategy is very much akin to the claimed invention's inclusion of a transmission, as called for by claim 18.

And, we credit the testimony of Ford's declarant, Dr. Davis, that the Bumby references teach the compatibility of a transmission with a hybrid control strategy, just as the claimed invention does. Ex. 1108 ¶¶ 354–359; *see also* Ex. 1106, 4 ("The M68000 microprocessor system is the heart of the drivetrain control system . . . it must implement the hybrid-vehicle control strategy which means *controlling the electric traction system, ic engine and transmission in the most efficient way* to meet driver demand"). Thus, we are not persuaded by Paice's attempt to distinguish the Bumby references from the claimed invention based on a feature that the claimed invention itself includes.

3. The "road load" limitation of claims 7 and 23

Claims 7 and 23 use the term "road load," which we construed to mean the "the amount of instantaneous torque required for propulsion of the vehicle." Paice contends that the Bumby references "do not calculate and compare 'the instantaneous torque required for propulsion of the vehicle'" to a setpoint. PO Resp. 34. We disagree with this contention.

"Road load" is clearly a determinative factor in the sub-optimal control strategy taught by the Bumby references. For instance, in describing the control strategy for the hybrid vehicle, Bumby III teaches certain interim calculations in which "*the torque required at the road wheels* to overcome both vehicle drag and rolling resistance . . . is determined at discrete (typically one second) intervals." Ex. 1105, 5. That reference to "the torque required at the road wheels" equates to our construction of the term, "road load." Indeed, later in this same passage, Bumby III refers to "road load" expressly in discussing these interim calculations—"full account is taken of efficiency, . . . so that the calculated energy consumed accounts for both the *road load requirement* and the system losses." *Id*. (emphasis added). Ford's declarant, Dr. Davis, confirms that a skilled artisan would have understood these references as speaking to the road load required to propel the vehicle. Ex. 1108 ¶¶ 312–317.[14] We find that testimony persuasive.

Paice argues this disclosure does not pertain to road load because the torque value is calculated in "one second" intervals, which it asserts is "far too long to be practical in an actual vehicle." PO Resp. 35. But none of the challenged claims address *how* road load is calculated. Indeed, Paice's own declarant, Mr. Hannemann, acknowledged that the '347 patent does not teach a skilled artisan how to calculate, measure, or determine road load because "that's something that wasn't a part of the patent." Ex. 1143, 60:15–62:5. Because Paice's argument extends beyond the scope of the claims, we are not persuaded that *how* the Bumby references calculate road load distinguishes over the claimed invention. Rather, we find that the Bumby references' comparison of torque values to the "lower torque bound," as depicted in Fig. 16 of Bumby II and Fig. 8 of Bumby III, as well as its description of a control strategy that "accounts for both *the road load requirement* and the system losses," satisfy the claimed "road load" and "setpoint" comparisons required by claims 7 and 23. *See* Ex. 1108 ¶¶ 312–317.

As it did with "setpoint," Paice also argues that the Bumby references determination of road load is based on "pedal position." PO Resp. 34, 36. We addressed this argument previously (*supra* at 20–21) and for those reasons, we do not find it persuasive.

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[14] Bumby III also refers to "road load requirement" in illustrating the "torque capability of the drive system." Ex. 1105, 3–4 (Fig. 2).

4. The "first electric motor" limitation of claims 1 and 8

Claims 1 and 8 speak to a "first electric motor . . . to start the engine responsive to a control signal." At the outset, we note that Bumby IV and V teach a "conventional starter motor" that is activated by "a microprocessor-controlled starting system." Ex. 1106, 7; Ex. 1107, 6, 19; *see also* Ex. 1108 ¶¶ 245–250. Acknowledging that the Bumby references' starter motor amounts to a "first electric motor," Paice nonetheless argues that it is not capable of accepting current from the battery, as also required by claim 1. PO Resp 37–38. We find this argument untenable.

In describing its engine starting system, Bumby V expressly states that, during a failed engine start sequence, the "starter motor is disengaged, *to allow battery recovery*." Ex. 1107, 6 (emphasis added). That the battery needs to recover in the event of a failed engine start clearly suggests that Bumby's starter motor (i.e., "first electric motor") is typically connected to the battery in order to start the engine. Ex. 1108 ¶ 264. Indeed, Ford's declarant, Dr. Davis, confirms as much, testifying that "[i]t was well known in the art that the battery *must be* connected to power the starter motor when engine starting is required." *Id*. at ¶ 263 (emphasis added) (citing Ex. 1134, 23).

Despite Bumby's express suggestion that the starter motor receives current from the battery, which is all the claims require, Paice maintains that Bumby's "216 V battery cannot be used to provide current to a 'conventional starter motor' . . . that would typically accept no more than 12 to 24 V." PO Resp. 39. We disagree. Instead, we credit the testimony of Ford's declarant, Dr. Davis, that it was basic knowledge to "knock the voltage down" of a high voltage battery so as to accommodate a lower voltage starter motor in a hybrid vehicle. Ex. 1140 ¶¶ 63–65; Ex. 2106, 262:20–264:1. That testimony persuades us that a skilled artisan would have understood the Bumby references to teach a starter motor that receives current from the battery, as required by claim 1.

We also have considered Paice's arguments with respect to claim 8 but do not find them persuasive. Po Resp. 42–43. Again, we are more persuaded by the testimony of Ford's declarant, Dr. Davis, that Bumby's starter motor disengages in times of low engine efficiency and engages in times of high engine efficiency, as required by claim 8. *See* Ex. 1108 ¶¶ 350–353.

5. The "battery charge" mode of claims 1 and 23

Claims 1 and 23 recite a battery charging mode in which the engine produces torque to charge the battery.[15] At the outset, we note that Bumby III discloses a "[b]attery charge mode," in which "[t]he engine provides both the propulsion power and power to charge the batteries." Ex. 1105, 5. It further states that, "on long journeys, should the state of charge of the battery become unacceptably low, then battery charging from the i.c. engine would be adopted." *Id*. at 7.

Paice argues that, while the Bumby references may teach a battery charging mode, they do not teach or suggest charging the battery based on a "setpoint" for efficient operation of the engine, as required by claims 1 and 23. PO Resp. 44–45. According to Paice, "the Bumby references merely disclose operating the engine whenever the state of charge of the battery

[15] We recognize that independent claim 1 recites this limitation in the disjunctive, but independent claim 23 does not.

indicates the need to do so, regardless of the efficiency of the engine." *Id*. at 45. We do not find this argument persuasive.

Reading the Bumby references as a whole, a skilled artisan would have understood them to teach operating the engine to charge the battery on the basis of a predetermined setpoint. For instance, Bumby II states that "the IC engine could supply torque *in excess of the value demanded at the road wheels*, such that the excess energy is used to charge the traction batteries." Ex. 1104, 3 (emphasis added). And, a few sentences later, Bumby II explains that, "*[a]t torque split values in excess of one*, the IC engine supplies the full torque demand, and *additional energy is used to charge the traction batteries*." *Id*. (emphasis added). Also, Bumby V teaches that "a *negative torque may be scheduled* from the motor so that the engine both drives the wheels and *charges the traction batteries*. Ex. 1107, 4 (emphasis added).

Those disclosures suggest that, when the torque required to propel the vehicle is less than a certain value, or setpoint, the excess torque output of the engine is used to charge the battery. Ex. 1108 ¶¶ 284–286, 438–449. Ford's declarant, Dr. Davis, confirms as much, testifying that:

> throughout the [Bumby] reference[s], they indicate that they're going to limit the operation of the engine to that most efficient operating region, and they talk about ways in which they would do that, and so one reading the totality of this when they read that section [in Bumby II] would fully understand that you would be operating the engine inside the box [shown in Bumby II, Fig. 16] and *using the excess torque that you have beyond what the instantaneous torque requirements of the vehicle in order to charge the batteries*.

Ex. 2106, 282:2–283:24 (emphasis added). Based on that testimony, as well as the disclosures of the Bumby references, we find a skilled artisan would have understood the Bumby references as teaching the efficient use of excess torque from the engine to charge the battery based on a "setpoint," as required by claims 1 and 23. *See* Ex. 1140 ¶¶ 71–77.

Also, we are not persuaded by Paice's repeated assertions that the Bumby references "teach away" from a battery charging mode. *See* PO Resp. 48–49, 51, 57. Although Bumby may teach that battery charging should be avoided in times of "low overall conversion efficiency," that aversion in particular situations does not discourage the use of a battery charging mode entirely. To the contrary, as discussed above, the Bumby references exalt the need for a battery charging mode "should the state of charge of the battery become unacceptably low." Ex. 1105, 7; *see also* Ex. 1104, 13 ("the control must be able to automatically change modes when the battery state of charge is low"); Ex. 1106, 3 (same); Ex. 1107, 7 (same). Thus, we conclude that the Bumby references do not "teach away" from a battery charging mode, as Paice alleges.

6. Conclusion

In sum, we conclude that claims 1, 7, 8, and 23 would have been obvious over the collective teachings of the Bumby references by a preponderance of the evidence. Also, we have considered Ford's challenge of dependent claims 18 and 21 (Pet. 49) and claim 37 (*id*. at 59), which Paice does not argue separately from independent claims 1 and 23. Based on our review of the arguments and evidence presented, we determine that Ford has demonstrated, by preponderant evidence, that claims 18, 21, and 37 also would have been obvious over the Bumby references.

C. Motion to Exclude

Paice seeks to exclude from evidence certain testimony by Ford's declarant, Dr. Davis (Ex. 1140 ¶¶ 63–65), as well as a prior art patent he mentioned (Ex. 1144), which Ford relied upon in its Reply to Paice's Response. PO Mot. 1. Paice argues essentially that the challenged testimony and exhibit are untimely and outside the scope of a proper reply. *Id*. at 1–2.

The mere fact that a petitioner submits rebuttal testimony that relies on new evidence not previously identified in the petition does not suffice to establish its impropriety. The very nature of a reply is to rebut the patent owner's response. 37 C.F.R. § 42.23(b). The need to rely on new evidence may not arise until a particular point has been raised in the patent owner response. Much depends on the specific arguments made in the patent owner response. For instance, where the patent owner response raises an argument that reasonably could not have been anticipated by the petitioner, the petitioner properly may, as a part of its reply, rely on new evidence or different aspects of previously submitted evidence.

Here, Ford's reliance on the challenged exhibits was a fair and appropriate rebuttal to evidence and arguments presented by Paice. Specifically, in its Response, Paice questioned the feasibility of the starter motor/battery connection taught by the Bumby references that Ford relied upon in its Petition. *See* PO Resp. 38–39. Paice claimed that a conventional starter motor "cannot be used" and "is not possible" with Bumby's hybrid battery (PO Resp. 39) and submitted the testimony of its own declarant that "cost and technical complexity" would not have precluded Bumby's configuration (Ex. 2102 ¶ 84). Ford, in turn, submitted the challenged testimony and exhibit in rebuttal to show that Bumby's starter motor/battery connection would have been feasible, and in fact, was well-known and obvious to skilled artisans in the relevant time frame. Reply 14–17 (citing Ex. 1140 ¶¶ 63–65, and Ex. 1144).

This is a classic case of shifting burdens of production and the appropriate use of rebuttal evidence to satisfy the parties' respective burdens. We do not discern anything inappropriate about Ford's submission of the challenged testimony and exhibit. In its reply, Ford merely elaborated on an initial position raised in its Petition and presented evidence in direct rebuttal to Paice's Response. Thus, we conclude that Exhibit 1140 (including ¶¶ 63–65) and Exhibit 1144 were properly introduced into evidence. Paice's motion to exclude is *denied*.

IV. CONCLUSION

Ford has demonstrated, by a preponderance of the evidence, that claims 1, 7, 8, 18, 21, 23, and 37 of the '347 patent would have been obvious over the collective teachings of the five Bumby references.

V. ORDER

Accordingly, it is hereby:

ORDERED that claims 1, 7, 8, 18, 21, 23, and 37 of the '347 patent are held unpatentable;

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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