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Paper 38
Entered November 23, 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 IPR2014-00875
Patent 7,559,388 B2

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

DESHPANDE, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. Background

Ford Motor Company ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1–4, 6, 12, and 19 of U.S. Patent No. 7,559,388 B2 (Ex. 1001; "the '388 patent"). Paper 2 ("Pet."). Paice LLC & The Abell Foundation, Inc. (collectively, "Patent Owner") filed a Preliminary Response. Paper 8 ("Prelim. Resp.").[1] Pursuant to 35 U.S.C. § 314, we instituted *inter partes* review of the '388 patent, on December 11, 2014, under 35 U.S.C. § 103(a), as to claims 1, 3, and 19 as obvious over Ehsani[2] and Vittone,[3] claim 2 as obvious over Ehsani, Vittone, and Caraceni,[4] claim 6 as obvious over Ehsani, Vittone, and Fjällström,[5] claim 12 as obvious over Ehsani, Vittone, and Yamaguchi,[6] and claims 1, 3, 4, and 19 as obvious over Kawakatsu[7] and Vittone. Paper 11 ("Dec.").

Patent Owner filed a Response (Paper 19, "PO Resp."), and Petitioner filed a Reply (Paper 22, "Pet. Reply"). Patent Owner filed a Motion to Seal

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[1] Patent Owner filed both redacted and unredacted versions of its Preliminary Response. Papers 7, 8. Our Decision cites to the redacted version, i.e., Paper 8, which is marked "Public."
[2] U.S. Patent No. 5,586,613, issued Dec. 24, 1996 (Ex. 1003) ("Ehsani").
[3] Oreste Vittone, *Fiat's Conceptual Approach to Hybrid Car Design*, 12TH INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM (1994) (Ex. 1005) ("Vittone").
[4] A. Caraceni et al., *Hybrid Power Unit Development for Fiat Multipla Vehicle*, SAE 981124 (1998) (Ex. 1006) ("Caraceni").
[5] U.S. Patent No. 5,120,282, issued June 9, 1992 (Ex. 1007) ("Fjällström").
[6] U.S. Patent No. 5,865,263, issued Feb. 2, 1999 (Ex. 1008) ("Yamaguchi").
[7] U.S. Patent No. 4,335,429, issued June 15, 1982 (Ex. 1004) ("Kawakatsu").

(Paper 9, "Mot."). Oral hearing was held on July 1, 2015, and the hearing transcript has been entered in the record. Paper 35 ("Tr.").

The Board has jurisdiction under 35 U.S.C. § 6(c). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons discussed below, we are persuaded that Petitioner has shown by a preponderance of the evidence that claims 1–4, 6, 12, and 19 of the '388 patent are unpatentable.

B. Related Proceedings

Petitioner indicates that the '388 patent is the subject of the proceedings in *Paice, LLC v. Ford Motor Co.*, No. 1:14-cv-00492 (D. Md.) and *Paice LLC v. Hyundai Motor America*, No. 1:2012-cv-00499 (D. Md.). Pet. 1–2.

Additionally, Petitioner indicates that this Petition is related to IPR2014-00568, IPR2014-00570, IPR2014-00571, IPR2014-00579, IPR2014-00852, IPR2014-00884, IPR2014-00904, IPR2014-01415, and IPR2014-01416. Pet. 2; Paper 10, 1.

C. The '388 Patent

The '388 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 torque transfer between the engine, the motors, and the drive wheels of the vehicle. Ex. 1001, 17:7–47, Fig. 4. The hybrid vehicle features a hybrid control strategy that runs the engine only under conditions of high efficiency, typically when the vehicle's instantaneous torque demand (i.e., the amount of torque required to propel the vehicle at a desired speed) is at least equal to 30% of the engine's maximum torque output ("MTO"). *Id*. at

20:28–35, 35:5–14; *see also id*. at 13:44–46 ("the engine is never operated at less than 30% of MTO, and is thus never operated inefficiently").

Running the engine only under efficient operating conditions leads to improved fuel economy and reduced emissions. *Id*. at 13:35–37. To achieve such efficiency, the hybrid vehicle includes different operating modes that depend on the vehicle's instantaneous torque demand, the battery's state of charge, and other operating parameters. *Id*. at 19:31–33. For example, the hybrid vehicle operates in: (1) an all-electric mode, where only the traction motor provides the torque to propel the vehicle, whenever 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, whenever the engine can run at an efficient level (i.e., highway cruising); (3) a hybrid mode, where the traction motor provides additional torque to propel the vehicle beyond that already provided by the engine, whenever the instantaneous torque demand 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 35:6–64.

D. Illustrative Claim

Petitioner challenges claims 1–4, 6, 12, and 19 of the '388 patent. Pet. 15–60. Claim 1 is illustrative of the claims at issue and is reproduced below:

> 1. A hybrid vehicle, comprising:
> at least two wheels, operable to receive power to propel said hybrid vehicle;
> a first alternating current (AC) electric motor, operable to provide power to said at least two wheels to propel said hybrid vehicle;
> a second AC electric motor;

> an engine coupled to said second electric motor, operable to provide power to said at least two wheels to propel the hybrid vehicle, and/or to said second electric motor to drive the second electric motor to generate electric power;
>
> a first alternating current-direct current (AC-DC) converter having an AC side coupled to said first electric motor, operable to accept AC or DC current and convert the current to DC or AC current respectively;
>
> a second AC-DC converter coupled to said second electric motor, at least operable to accept AC current and convert the current to DC;
>
> an electrical storage device operable to store energy converted to DC by said AC-DC converters and to provide energy to be converted to AC by at least said first AC-DC converter to power at least said first electric motor; and
>
> a controller;
>
> wherein a rate of change of torque output of said engine is limited to a threshold value, wherein when a rate of change of road load exceeds said threshold value of the rate of change of torque output of the engine, said controller is operable to operate said first motor and/or said second motor to supply additional power to at least said two wheels to supply remaining required torque.

Ex. 1001, 56:42–57:5.

E. Claim Construction

The Board interprets claims of an unexpired patent using the broadest reasonable interpretation in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b); *see also In re Cuozzo Speed Techs., LLC*, 793 F.3d 1268, 1278–80 (Fed. Cir. 2015) ("Congress implicitly approved the broadest reasonable interpretation standard in enacting the AIA," and "the standard was properly adopted by PTO regulation."). Under the broadest reasonable interpretation standard, claim terms are given their ordinary and customary meaning, as would be understood by one of ordinary

skill in the art in the context of the entire disclosure. *In re Translogic Tech. Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

1. "road load (RL)"

The term "road load" or "RL" is found in independent claims 1 and 19. The specification 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. 1001, 12:24–28 (emphasis added). Petitioner and Patent Owner agree that this definition of "road load" is consistent with its plain meaning and as it is commonly understood in the art. *See* PO Resp. 23–24; Pet. Reply 2. Patent Owner argues "road load" should additionally account for external forces acting on the vehicle. PO Resp. 26–28 (citing Ex. 2003 ¶¶ 76–78); *see* Ex. 2003 ¶¶ 71, 73. Although external 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." We see no reason to depart from the '388 patent specification's express definition of "road load" in terms of an amount of torque, such that "road load" is "the amount of instantaneous torque required to propel the vehicle." *See* Ex. 1001, 11:46–48, 12:24–28, 35:14–17, 12:57–13:3, 37:13–15, 37:45–47, 38:5–10.

II. ANALYSIS

A. Claims 1, 3, and 19 – Obvious over Ehsani and Vittone

1. Overview

Petitioner contends that claims 1, 3, and 19 of the '388 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani and Vittone. Pet. 15–36. Petitioner provides citations for where each claim limitation is disclosed by Ehsani and Vittone. *Id*. Petitioner also articulates reasoning

with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani and Vittone. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claims 1, 3, and 19 are obvious over Ehsani and Vittone. *See id*.

2. Ehsani (Ex. 1003)

Ehsani discloses an electrically peaking hybrid system and method of generating hybrid electric-combustion power. Ex. 1003, 1:14–17. The hybrid electric-combustion system includes an engine to generate mechanical energy, a battery to store and deliver electric energy, a drive mechanism coupled to the engine, and an electric machine coupled to the engine and battery. *Id.* at 2:45–56. The system has two modes of operation: in the first mode, the power requirements of the system exceed the power available from the engine and the electric motor draws energy from the battery to provide the engine with additional power; in the second mode, the power requirements are less than that being supplied by the engine and the electric motor acts as a generator to convert excess mechanical energy to electrical energy to be stored in the battery. *Id.* at 4:20–53.

3. Vittone (Ex. 1005)

Vittone discusses various motivations behind the development of hybrid cars, where parallel configuration of the propulsion system allows for short trips using only the electric motor driveline and long trips with performance close to that of conventional cars, but lower emissions. Ex. 1005,[8] 20. In hybrid mode, both the electric motor and the thermal

[8] Ex. 1005 includes page numbers indicated by the publication itself and different page numbers provided by Petitioner. Our references are to the

engine are active and the torque is split between the two drivelines to assure good drivability, to optimize the consumptions, and to reduce emissions. *Id.* at 26. The thermal engine is set to a maximum torque and the electric motor supplies additional torque to meet the total torque required. *Id.* at Fig. 8.

4. Analysis

Petitioner contends that claims 1, 3, and 19 of the '388 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani and Vittone. Pet. 15–36. Petitioner provides citations for where each claim limitation is disclosed by Ehsani and Vittone, contending that each of the claim limitations are disclosed by Ehsani, except for the "wherein" limitation. *Id*. Petitioner argues that Vittone discloses the "wherein" limitation. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani and Vittone. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claims 1, 3, and 19 are obvious over Ehsani and Vittone. *See id*.

Patent Owner argues that (a) Vittone fails to disclose "road load," (b) Vittone fails to disclose limiting a rate of change of engine torque output to a threshold value, (c) Vittone fails to disclose operating the first and/or second AC motor to supply the remaining required torque when a rate of change of "road load" exceeds the threshold value, and (d) a person with ordinary skill in the art would not have combined Ehsani and Vittone in the manner

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page numbers provided by Petitioner and not the page numbers printed on the publication itself.

asserted by Petitioner. PO Resp. 20–38. Patent Owner presents these same arguments for claim 3. PO Resp. 37–38. For the foregoing reasons, we are not persuaded by Patent Owner's arguments that claims 1, 3, and 19 are patentable over Ehsani and Vittone.

a. "Road Load"

Patent Owner argues that Vittone fails to disclose "road load." *Id*. at 22–28. Patent Owner explains that Vittone discloses a "driveability torque requirement," and Petitioner argues that "driveability torque requirement" is equivalent to "road load." *Id*. at 22–23. Patent Owner further explains that Vittone discloses that "that the accelerator pedal position defines the requested torque to the drivetrain and that the driver, through the accelerator pedal position, sets the total traction torque, which is referred to as the driveability torque requirement." *Id*. at 24 (citing Ex. 2003 ¶¶ 68–69). Patent Owner argues the total traction torque or the driveability torque requirement represents the accelerator pedal position, but does not represent "road load." *Id*. (citing Ex. 2003 ¶¶ 68–69). Patent Owner argues that the accelerator pedal position controls the flow of fuel and air into the engine, which has "nothing to do with using 'road load' as part of a vehicle control strategy." *Id*. at 24–26 (citing Ex. 2003 ¶¶ 68–69). Patent Owner argues that accelerator pedal position represents the driver's request, not the instantaneous torque required to propel the vehicle. *Id*. at 27 (citing Ex. 2003 ¶ 74).

We are not persuaded by Patent Owner's arguments. As discussed above, we have interpreted "road load" to mean "the amount of instantaneous torque required to propel the vehicle." *See* Section I.E.1. Vittone discloses the "driveability torque requirement" and the "total

traction torque," and we agree with Petitioner that the plain meaning of "driveability torque requirement" and "total traction torque" is the torque required to propel the vehicle. Pet. Reply 2–3. Although Patent Owner argues that "driveability torque requirement" and "total traction torque" are represented by the accelerator pedal position (PO Resp. 24–26), Patent Owner and Patent Owner's declarant, Mr. Hannemann, fail to provide any persuasive argument or evidence that the "driveability torque requirement" and the "total traction torque" do not represent the torque required to propel the vehicle.

We further credit the testimony of Dr. Stein, who explains that a person with ordinary skill in the art would have understood that the "driveability torque requirement" and the "total traction torque" represent the instantaneous torque required to propel the vehicle. Pet. Reply 2–3 (citing Ex. 1002 ¶ 173); Pet. 22–24. Contrary to Patent Owner's argument, Dr. Stein explains that, although Vittone discloses the "driveability torque requirement" and the "total traction torque" are based on accelerator pedal position, "driveability torque requirement" and "total traction torque" are based also on other factors, including brake pedal position. Pet. Reply 3–4 (citing Ex. 1028 ¶¶ 20–30); Pet. 22–24. Therefore, the "driveability torque requirement" and the "total traction torque" do not only represent the accelerator position.

Patent Owner further argues that Vittone fails to disclose "road load" because Vittone's "driveability torque requirement" does not take into account external torque requirements, such as driving conditions and also does not take into account operating conditions. PO Resp. 27–28 (citing Ex. 2003 ¶¶ 72, 75). We are not persuaded by this argument because we

decline to import "external torque requirements" into our interpretation of "road load," as discussed above. *See* Section I.E.1.

Accordingly, we are persuaded by Petitioner that "driveability torque requirement" and "total traction torque" represent the instantaneous torque required to propel the vehicle and, therefore, Vittone discloses "road load."

b. "Rate of Change of Torque Output of Said Engine is Limited to a Threshold Value"

Patent Owner argues Vittone fails to disclose limiting a rate of change of engine torque to a threshold value. PO Resp. 28–31. Patent Owner specifically argues that Vittone discloses that the "the total traction torque is split between the engine and the electric motor and that the electric motor is used to assist the engine when the pedal position changes (*i.e.,* during acceleration) and when the pedal position indicates that the total traction torque is greater than the maximum engine torque," however, Vittone does not disclose that the slope of the engine torque output is limiting the rate of change of engine torque to a threshold value. *Id*. at 28–29 (citing Ex. 2003 ¶ 77). Patent Owner also argues that, although Vittone discloses "how the total traction torque is split between the engine and electric motor, it does not specify the management strategy of the IC engine," and Vittone does not disclose how "steady state" management of the thermal engine is accomplished. *Id*. at 30–31 (citing Ex. 2003 ¶ 79).

We are not persuaded by Patent Owner's arguments. Vittone discloses that the "driveability torque requirement" or the "total traction torque" (i.e., "road load") is split between the two drivelines, the thermal engine and the electric motor. *See* Pet. 24 (citing Ex. 1005, 26). Vittone further discloses that in order to reduce emissions, a "steady state"

management is used during transient phases, where the thermal engine is supported by the electric motor in order to meet the required torque. *See id.* at 23–26 (citing Ex. 1005, 26, 29, 30); Pet. Reply 7–10. We further credit the testimony of Dr. Stein, who explains that Vittone discloses that during transient phases, the "driveability torque requirements" or "road load" increases at a constant rate. Ex. 1002 ¶¶ 177–178, 181 (citing Ex. 1005, Fig. 8); Pet. Reply 7–10. Dr. Stein further explains that Vittone discloses that during two different transient phases, each transient phase representing a different rate of change of "road load," the rate of change of torque output of the engine is approximately the same value. *Id*. Dr. Stein explains that this common rate of change of torque output of the engine is due to the "steady state" management of the thermal engine that limits its rate of change of torque output and the common value is a threshold value. *Id*. Therefore, Dr. Stein concludes that Vittone discloses "rate of change of torque output of said engine is limited to a threshold value."

Accordingly, we are persuaded by Petitioner that a person with ordinary skill in the art would have understood that Vittone's "steady state management" of the thermal engine meets the limitation of the "rate of change of torque output of said engine is limited to a threshold value."

c. Operating the Motor to Supply Remaining Required Torque When a Rate of Change of Road Load Exceeds the Threshold Value

Patent Owner argues that Vittone fails to disclose "using the motor to supply remaining required torque when a rate of change of road load exceeds the threshold value." PO Resp. 31 (citing Ex. 2003 ¶ 81). Patent Owner specifically argues that a person with ordinary skill in the art would have understood that Vittone discloses "the electric motor is used to assist

the engine when there is a change in pedal position (*i.e.*, during acceleration) and when the pedal position indicates that the total traction torque is greater than the engine's maximum torque," but Vittone fails to disclose using the electric motor to supply the remaining required torque when a rate of change of road load exceeds the threshold value. *Id*. at 30–31 (citing Ex. 1005, 25–26).

We are not persuaded by Patent Owner's arguments. As discussed above, we are persuaded by Petitioner that Vittone discloses "road load" and the "rate of change of torque output of said engine is limited to a threshold value." *See* Sections II.A.4.a, II.A.4.b. Vittone further discloses that when the rate of change of "driveability torque requirements" or "road load" exceeds the threshold of the rate of change of the engine torque output, the electronic control unit operates the electric motor to supply the remaining required torque to meet the "driveability torque requirements" or "road load." *See* Pet. 26 (citing Ex. 1005, 26, 30; Ex. 1002 ¶¶ 182–188); Pet. Reply 10–11. Vittone discloses that this "steady state" management is done during transient phases in order to reduce emissions. Ex. 1005, 26, Fig. 8; *See* Pet. 26.

d. Combination of Ehsani and Vittone

Patent Owner argues that "it would not have been obvious to one of ordinary skill in the art to combine the control strategy of Ehsani with the control strategy of Vittone," because Ehsani and Vittone are directed to very different engine control strategies. PO Resp. 32–33 (citing Ex. 2003 ¶ 83). Patent Owner explains that Ehsani discloses an engine that operates at a constant power output and uses the electric motor to supplement the engine when needed, or uses excess engine power for storage in the battery,

whereas Vittone discloses a hybrid mode, where both the electric motor and the engine are used based on accelerator position, and absent hindsight, "[i]t is even difficult to imagine what that system would look like." *Id*. at 33–37 (citing Ex. 2003 ¶¶ 84–86). Patent Owner argues that a person with ordinary skill in the art would not have combined Ehsani and Vittone because "maintaining constant power would require changing torque to keep the power output constant." *Id*. at 35.

We disagree with Patent Owner. Both Ehsani and Vittone are directed towards hybrid vehicles. *See* Pet. Reply 11 (citing Ex. 1003, 7:25–30; Ex. 1005, 26). Ehsani and Vittone are directed also towards reducing emissions. *Id*. Ehsani discloses that a controller controls the engine with a predetermined trajectory of speed and power in order to improve efficiency and reduce emissions. Ex. 1003, 7:25–30. Vittone discloses expressly the "steady state" management of the thermal engine in order to reduce emissions. Ex. 1005, 26. We credit the testimony of Dr. Stein, who explains that "implementing a particular control strategy is a simple substitution of (or modification of) an existing control strategy that may not, and likely does not, even require changes to the underlying system architecture." Ex. 1002 ¶¶ 253–254; Ex. 1028 ¶ 51. A person with ordinary skill in the art would have combined the elements of Ehsani and Vittone, and, therefore, such a reconstruction is not based in hindsight. A person with ordinary skill in the art would have looked to even further reduce the emissions of the Ehsani hybrid vehicle by implementing Vittone's "steady state" management strategy. Accordingly, we agree with Petitioner that both Ehsani and Vittone are concerned with the same problem of reducing emissions in hybrid vehicles, and a person with ordinary skill in the art

would have been motivated to further reduce Ehsani's emissions by implementing Vittone's "steady state" management control strategy.

Patent Owner further argues that Ehsani eliminates the need for a transmission, and, therefore, teaches away from Vittone's use of a transmission. *Id*. (citing Ex. 1003, 2:59–63). Therefore, Patent Owner specifically argues that Ehsani is critical of a transmission and teaches away from Vittone. *Id*. We are not persuaded by this argument. First, Petitioner does not argue for modifying Ehsani's hybrid vehicle to include Vittone's transmission. *See* Pet. 35–36. Rather, Petitioner proposes the simple substitution or modification of Ehsani's control strategy with Vittone's control strategy. *Id*. Accordingly, whether Ehsani teaches away from the use of a transmission is not relevant.

Furthermore, "[a] reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *Ricoh Co., Ltd. v. Quanta Computer, Inc.,* 550 F.3d 1325, 1332 (Fed. Cir. 2008) (citations omitted). A reference does not teach away if it merely expresses a general preference for an alternative invention from amongst options available to the ordinarily skilled artisan, and the reference does not discredit or discourage investigation into the invention claimed. *In re Fulton,* 391 F.3d 1195, 1201 (Fed. Cir. 2004). Ehsani proposes an advantage that can be gained without the use of a transmission, but does not discredit or discourage the use of a transmission. In fact, Ehsani discloses an embodiment that uses a transmission. Pet. Reply 13–14 (citing Ex. 1003, 8:6–11).

5. Conclusion

We have reviewed the Petition and supporting evidence, along with Patent Owner's arguments and evidence, and determine that Petitioner has shown by a preponderance of the evidence that claims 1, 3, and 19 are obvious over Ehsani and Vittone. *See* Pet. 15–38.

B. Obviousness of Claim 2 over Ehsani, Vittone, and Caraceni

1. Overview

Petitioner contends that claim 2 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Caraceni. Pet. 36–39. Petitioner provides citations for where each claim limitation is disclosed by Ehsani, Vittone, and Caraceni. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Caraceni. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 2 is obvious over Ehsani, Vittone, and Caraceni. *See id*.

2. Caraceni (Ex. 1006)

Caraceni discloses a hybrid vehicle that features a power train that integrates a thermal engine with an electric motor. Ex. 1006, 29.[9] Caraceni discloses a "Dual mode" configuration that includes the addition of an independent electric power train on the thermal vehicle, where the electric and thermal power trains operate in the alternative to meet the torque

[9] Ex. 1006 includes page numbers indicated by the publication itself and different page numbers provided by Petitioner. Our references are to the page numbers as they are printed on the publication itself and not the page numbers provided by Petitioner.

requirements. *Id.* at 30–31. The driver selects between four operating modes: hybrid mode, electric mode, economy mode, and recharge mode. *Id.* at 33–34. The driver, through the accelerator pedal position, sets the required traction torque. *Id.* at 34. In hybrid mode, the torque requirements are split between the engine and motor to optimize fuel economy, emission, and driveability. *Id.*

3. Analysis

Petitioner contends that claim 2 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Caraceni. Pet. 36–39. Claim 2 recites "said threshold value is no more than about 2% per revolution." Petitioner argues that Caraceni discloses this limitation. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Caraceni. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 2 is obvious over Ehsani, Vittone, and Caraceni. *See id*.

Patent Owner argues that Caraceni discloses an "absolute" rate of change, whereas claim 2 requires a "relative" change. PO Resp. 39–40. Patent Owner explains that Caraceni discloses "torque gradients," which are expressed as deca-Newton Meters per second. *Id*. Patent Owner argues that deca-Newton Meters per second are an absolute rate of change threshold, which is "fundamentally and mathematically different from the '2% per revolution' threshold of claim 2." *Id*. (citing Ex. 2003 ¶ 93).

We are not persuaded by Patent Owner's arguments. Claim 2 recites "said threshold value is no more than about 2% per revolution." Claim 1

defines the "threshold value" as "a rate of change of torque output of said engine." We agree with Petitioner that claim 2 does not require the rate of change to be expressed only as a "relative" change. *See* Pet. Reply 15. The "threshold value," as defined by claim 1, broadly requires a "rate of change" without specifying whether that rate of change is "absolute" or "relative." Patent Owner has not provided persuasive evidence that the scope of claim 2 is narrowed to require a "relative" change. Accordingly, we are not persuaded by Patent Owner's arguments that attempt to distinguish Caraceni from the claim 2 based on a "relative" rate of change of torque output from the engine.

Patent Owner further argues that Dr. Stein's calculations are flawed because Dr. Stein should not have used the maximum torque output ("MTO") of the engine in calculating a rate of change threshold. PO Resp. 41–42. Patent Owner specifically argues that a person with ordinary skill in the art would not have used MTO in calculating a rate of change of increase because the engine cannot increase its torque output at MTO. *Id*. (citing Ex. 2003 ¶ 96). Patent Owner further argues that limiting the rate of change of torque output of the engine at MTO would be unsafe. *Id*.

We are not persuaded by Patent Owner's arguments. As discussed above, claims 1 and 2 do not limit the scope of the "threshold value" such that it cannot be applied from the MTO. Although Patent Owner argues that limiting the rate of change of torque output of the engine at MTO is unsafe, the claims do not address the consideration of safety.

Petitioner contends that Caraceni discloses "torque gradient" values that can be converted to "% per revolution" values using engine speed and torque values, and "[f]orty of the forty-two torque gradient values disclosed

in Fig. 14 of Caraceni satisfy the 'no more than about 2% per revolution' limitation of claim 2." Pet. 37–38 (citing Ex. 1006, 4, Table 2; Ex. 1002 ¶¶ 255–273). We credit the testimony of Dr. Stein and are persuaded by Dr. Stein's calculations in determining that Caraceni discloses "said threshold value is not more than about 2% per revolution." *See* Ex. 1002 ¶¶ 255–273.

C. Obviousness of Claim 6 over Ehsani, Vittone, and Fjällström

1. Overview

Petitioner contends that claim 6 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Fjällström. Pet. 39–42. Petitioner provides citations for where each claim limitation is disclosed by Ehsani, Vittone, and Fjällström. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Fjällström. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 6 is obvious over Ehsani, Vittone, and Fjällström. *See id*.

2. Fjällström (Ex. 1007)

Fjällström discloses a vehicle transmission system that includes the combination of at least one electric motor generator and planetary or epicyclic gear means, comprising an outer ring, planet gears, and a sun gear. Ex. 1007, 1:8–11. The outer ring transmits torque to the planetary gears and sun gear, which are rotatably journaled on a shaft that drives the wheels. *Id.* at 2:43–47. The relative speed between the outer ring and shaft is controlled by the motor generator. *Id.* at 2:47–51. The system also includes a further motor generator coupled to a second pair of wheels. *Id.* at 2:51–55.

3. Analysis

Petitioner contends that claim 6 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Fjällström. Pet. 39–42. Petitioner argues that Ehsani and Vittone disclose every limitation of claim 6, except for the limitation "said third AC electric motor is coupled to a second pair of wheels to provide power to said second pair of wheels to propel said hybrid vehicle." *Id*. Petitioner argues that Fjällström discloses this limitation. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Fjällström. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 6 is obvious over Ehsani, Vittone, and Fjällström. *See id*.

Patent Owner argues claim 6 depends from claim 1, and is not obvious for the reasons asserted for claim 1. PO Resp. 42. However, we are not persuaded by Patent Owner's arguments for claim 1, and, accordingly, are not persuaded by those arguments for claim 6 for the same reasons discussed above. *See* Section II.A.4.

Patent Owner further argues that Ehsani discloses an alternative embodiment of an all-wheel drive ("AWD") hybrid vehicle with two electric motors providing power to two pairs of wheels, and, therefore, a person with ordinary skill in the art would not have combined Ehsani and Fjällström in order to provide an AWD hybrid vehicle, as argued by Petitioner. PO Resp. 43. We disagree with Patent Owner. As argued by Petitioner, Ehsani discloses several configurations and further explains that substitutions and alterations can be made. Pet. Reply 18 (citing Ex. 1003,

9:8–12). Accordingly, we agree with Petitioner that a person with ordinary skill in the art would have looked to the configuration provided by Fjällström when considering modifications to the Ehsani vehicle. *Id*.

Patent Owner further argues that Fjällström discloses DC electric motors, whereas Ehsani discloses AC electric motors, and, therefore, a person with ordinary skill in the art would not have combined Fjällström's DC electric motor with Ehsani's AC electric motors. PO Resp. 42–44. Patent Owner specifically argues that AC electric motors work differently than DC electric motors and require additional components and changes to the battery and wiring. *Id*. Patent Owner argues that Dr. Stein, Petitioner's declarant, testified that the torque speed and characteristics of AC motors and DC motors depend on the type of AC and DC motor, and, therefore, switching between AC motors and DC motors is not a simple design choice. *Id*.

We are not persuaded by Patent Owner. We credit the testimony of Dr. Stein, who explains that a person with ordinary skill in the art knew how to implement both AC motors and DC motors and "such systems were common place." Pet. Reply 19 (citing Ex. 1002 ¶¶ 84–86; Ex. 2007, 29:9–30:4). We further agree with Petitioner that a person with ordinary skill in the art would have not have been deterred from looking to Fjällström's configuration of a third electric motor coupled to the second pair of wheels in making modifications to the Ehsani system because of the type of motor being implemented. Rather, a person with ordinary skill in the art would have been motivated to combine these features from Fjällström to Ehsani's vehicle in order to provide an all-wheel drive hybrid electric vehicle. Pet. 41–42; Ex. 1002 ¶¶ 282–284. Thus, although AC motors and DC

motors have different characteristics, we are not persuaded by Patent Owner that a person with ordinary skill in the art would have not modified Ehsani's vehicle with Fjällström's configuration because Ehsani and Fjällström disclose the use of different types of motors.

Patent Owner also argues that a person with ordinary skill in the art would not have combined Ehsani and Fjällström because they are directed to different hybrid vehicle architectures. PO Resp. 45–46. Patent Owner specifically argues that Fjällström is concerned with a hybrid vehicle transmission with a planetary gear system, whereas Ehsani discloses that it is advantageous to eliminate the transmission. *Id*. Thus, Patent Owner argues that Ehsani teaches away from the use of a transmission system. *Id*. We are not persuaded by Patent Owner that Ehsani teaches away from the use of a transmission. As discussed above, Petitioner does not argue for modifying Ehsani's hybrid vehicle to include Fjällström's transmission. *See* Pet. 39–42; Pet. Reply 19–20; *see* Section II.A.4.d. Rather, Petitioner proposes the modification of Ehsani's structure to include Fjällström's third motor that is coupled to the second pair of wheels. *Id*. Accordingly, whether Ehsani teaches away from a transmission is not relevant.

Furthermore, "[a] reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant.' *Ricoh Co., Ltd. v. Quanta Computer, Inc.,* 550 F.3d 1325, 1332 (Fed. Cir. 2008) (citations omitted). A reference does not teach away if it merely expresses a general preference for an alternative invention from amongst options available to the ordinarily skilled artisan, and the reference does not discredit or discourage

investigation into the invention claimed. *In re Fulton,* 391 F.3d 1195, 1201 (Fed. Cir. 2004). Ehsani proposes an advantage can be gained without the use of a transmission, but does not discredit or discourage the use of a transmission. In fact, Ehsani discloses an embodiment that uses a transmission. Pet. Reply 19–20 (citing Ex. 1003, 8:6–11).

D. Obviousness of Claim 12 over Ehsani, Vittone, and Yamaguchi

1. Overview

Petitioner contends that claim 12 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Yamaguchi. Pet. 42–43. Petitioner provides citations for where each claim limitation is disclosed by Ehsani, Vittone, and Yamaguchi. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Yamaguchi. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 12 is obvious over Ehsani, Vittone, and Yamaguchi. *See id*.

2. Yamaguchi (Ex. 1008)

Yamaguchi discloses a hybrid vehicle driven by a motor and an internal combustion engine. Ex. 1008, 1:6–8. The vehicle includes a control unit for controlling the engine, generator/motor, and driving motor. *Id.* at 4:66–5:2. The vehicle control unit supplies the engine control system with ON/OFF signals in response to various detected conditions. *Id.* at 5:9–14. The vehicle control unit further supplies the generator/motor control unit with a target rotation speed based on the accelerator pedal sensor and

supplies the driving motor control unit with a torque signal based on the accelerator pedal sensor. *Id.* at 5:15–29.

3. Analysis

Petitioner contends that claim 12 of the '388 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Ehsani, Vittone, and Yamaguchi. Pet. 42–43. Claim 12 recites "said engine is preheated prior to starting." Petitioner argues that Yamaguchi discloses this limitation. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Ehsani, Vittone, and Yamaguchi. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claim 12 is obvious over Ehsani, Vittone, and Yamaguchi. *See id*.

Patent Owner argues claim 12 depends from claim 1, and is not obvious for the reasons asserted for claim 1. PO Resp. 46. However, we are not persuaded by Patent Owner's arguments for claim 1, and, accordingly, are not persuaded by those arguments for claim 12 for the same reasons discussed above. *See* Section II.A.4.

Patent Owner also argues that Yamaguchi fails to disclose "said engine is preheated prior to starting." PO Resp. 46. Patent Owner contends that Yamaguchi discloses that the engine is started when the engine temperature has reached a predetermined value, but fails to disclose that the "engine is preheated or that the engine temperature or predetermined value is sufficient to preheat the engine." *Id*. (citing Ex. 1008, 11:26–33; Ex. 2003 ¶ 104). We are not persuaded by Patent Owner. Yamaguchi discloses that the engine is started responsive to the detection of the temperature of the

engine. Pet. 42–43 (citing Ex. 1008, 11:26–33; Ex. 1002 ¶¶ 285–288); Pet. Reply 20–22 (citing Ex. 1008, 8:62–67). Yamaguchi further discloses that the engine may be rotated at a relatively high speed prior to starting. Pet. Reply 20–22 (citing Ex. 1008, 8:62–67). We credit the testimony of Dr. Stein, who explains that rotating the engine at high speeds heats the engine, and in combination with the disclosure that the engine is started once the temperature has reached a predetermined value, Yamaguchi discloses "said engine is preheated prior to starting." Pet. Reply 21–22 (citing Ex. 2007, 164:13–165:14).

Patent Owner further argues that a person with ordinary skill in the art would not have been motivated to combine Ehsani, Vittone, and Yamaguchi because Vittone teaches away from "said engine is preheated prior to starting." PO Resp. 46–47. Patent Owner specifically argues that Vittone discloses that the warm-up of the main catalyst is performed "while the engine works at a minimum rpm," and, therefore, Vittone teaches away from "preheating the engine by rotating the engine at a higher speed, as taught in Yamaguchi." *Id*. (citing Ex. 1005, 26; Ex. 2003 ¶107)(emphasis omitted).

We are not persuaded by Patent Owner. Vittone merely refers to a heated catalyst for performing the warm-up of the main catalyst, while the thermal engine works at a minimum rpm. Pet. Reply 21 (citing Ex. 1028 ¶¶ 103–106). As such, we agree with Petitioner that this disclosure refers to a mode after the engine has already started. *Id*. Furthermore, although Vittone discloses a preference for a heated catalyst used to warm-up the main catalyst while the thermal engine works at a minimum RPM, Vittone does not discredit or discourage preheating an engine by rotating the engine at high RPMs. Patent Owner has not directed us to evidence that Vittone

discredits or discourages the manner in which Yamaguchi discloses "said engine is preheated prior to starting," and, therefore, Patent Owner's argument that Vittone teaches away from Yamaguchi is not persuasive.

E. Obviousness of Claims 1, 3, 4, and 19 over Kawakatsu and Vittone

1. Overview

Petitioner contends that claims 1, 3, 4, and 19 of the '388 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Kawakatsu and Vittone. Pet. 43–58. Petitioner provides citations for where each claim limitation is disclosed by Kawakatsu and Vittone. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Kawakatsu and Vittone. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claims 1, 3, 4, and 19 are obvious over Kawakatsu and Vittone. *See id*.

2. Kawakatsu (Ex. 1004)

Kawakatsu discloses an apparatus for controlling a hybrid vehicle to reduce its fuel consumption. Ex. 1004, 1:8–11. The apparatus employs an internal combustion engine and two electric motors. *Id.* at 2:12–14. If the output shaft speed is within an optimum speed range of the internal combustion engine, any additional torque required will be supplied by one motor while the engine operates at its maximum torque rating. *Id.* If the output shaft speed is outside of this optimum speed range, additional torque is supplied by one or both of the electric motors. *Id.* at 2:16–24.

3. Analysis

Petitioner contends that claims 1, 3, 4, and 19 of the '388 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Kawakatsu and Vittone. Pet. 43–58. Petitioner provides citations for where each claim limitation is disclosed by Kawakatsu and Vittone, contending that each of the claim limitations are disclosed by Kawakatsu, except for the "wherein" limitation. *Id*. Petitioner argues that Vittone discloses the "wherein" limitation. *Id*. Petitioner also articulates reasoning with rational underpinnings on why a person of ordinary skill in the art at the time of the invention would have combined Kawakatsu and Vittone. *Id*. We have reviewed the Petition and supporting evidence and find that Petitioner has shown by a preponderance of the evidence that claims 1, 3, 4, and 19 are obvious over Kawakatsu and Vittone. *See id*.

Patent Owner argues Vittone fails to disclose the "wherein" limitation for the same reasons discussed above. PO Resp. 47–48. However, we are not persuaded by Patent Owner's argument that Vittone fails to disclose the "wherein" limitation, as discussed above, and, accordingly, are not persuaded by this same argument here for the same reasons. *See* Section II.A.4.

Patent Owner further argues that a person with ordinary skill in the art would not have combined the engine control strategy of Vittone with the engine control strategy of Kawakatsu. PO Resp. 48–51 (citing Ex. 2003 ¶ 114). Patent Owner specifically argues that Kawakatsu and Vittone disclose different control strategies, where Kawakatsu only uses the electric motor to provide additional torque when the engine is at its maximum capability. *Id*. at 48–50.

We are not persuaded by Patent Owner's arguments. Similar to the combination of Ehsani and Vittone discussed above, both Kawakatsu and Vittone are directed towards hybrid vehicles. *See* Pet. Reply 22–23 (citing Ex. 1004, 1:25–30; Ex. 1005, 26). Kawakatsu and Vittone also are concerned with reducing emissions. *Id*. Kawakatsu explains that it is desired to have engine exhaust that is more pure in order to reduce air pollution, and the exhaust gas from an efficient engine is more pure. Ex. 1004, 1:25–30. Kawakatsu solves this problem by providing a control apparatus for a hybrid vehicle that operates an internal combustion engine only in its region of minimum fuel consumption in order to improve efficiency. *Id*. at 2:25–30. Vittone expressly discloses the "steady state" management of the thermal engine in order to reduce emissions. Ex. 1005, 26. We credit the testimony of Dr. Stein, who explains that "implementing a particular control strategy is a simple substitution (or modification of) an existing control strategy that may not, and likely does not, even require changes to the underlying system architecture." Ex. 1002 ¶¶ 434–435; Ex. 1028 ¶¶ 115–116. Therefore, a person with ordinary skill in the art would have combined the elements of Kawakatsu and Vittone. A person with ordinary skill in the art would have looked to even further reduce the emissions of the Kawakatsu hybrid vehicle by implementing Vittone's "steady state" management strategy. Accordingly, we agree with Petitioner that both Kawakatsu and Vittone are concerned with the same problem of reducing emissions in hybrid vehicles and a person with ordinary skill in the art would have been motivated to further reduce Kawakatsu's emissions by implementing Vittone's "steady state" management control strategy.

Patent Owner further argues Kawakatsu discloses DC electric motors, whereas Vittone discloses AC electric motors, and "it would not have been a simple change to switch the DC electric motors to AC electric motors and add an AC-DC converter between the AC electric motor and the DC battery." PO Resp. 50–51 (Ex. 2003 ¶ 115). Patent Owner specifically argues that AC electric motors work differently than DC electric motors and require additional components and changes to the battery and wiring. *Id*. Patent Owner argues that Dr. Stein testified that the torque speed and characteristics of AC motors and DC motors depend on the type of AC and DC motor, and, therefore, switching between AC motors and DC motors is not a simple design choice. *Id*.

We are not persuaded by these arguments. As discussed above, we credit the testimony of Dr. Stein, who explains that a person with ordinary skill in the art knew how to implement both AC motors and DC motors and "such systems were common place." Pet. Reply 19 (citing Ex. 1002 ¶¶ 84–86; Ex. 2007, 29:9–30:4); *see* Section II.C.3. We further agree with Petitioner that a person with ordinary skill in the art would have not been deterred from looking to Vittone's control strategy in making modifications to the Kawakatsu vehicle because of the type of motor being implemented. Rather, a person with ordinary skill in the art would have been motivated to implement Vittone's "steady state" management control strategy in Kawakatsu's vehicle in order to reduce emission and increase efficiency. Pet. 57–58; Ex. 1002 ¶¶ 434–435. Thus, although AC motors and DC motors have different characteristics, we are not persuaded by Patent Owner that a person with ordinary skill in the art would have not modified

Kawakatsu's vehicle with Vittone's control strategy because Kawakatsu and Vittone disclose the use of different motor types.

III. CONCLUSION

We are persuaded that Petitioner has demonstrated by a preponderance of the evidence that claims 1–4, 6, 12, and 19 of the '388 patent are unpatentable.

IV. ORDER

Accordingly, it is hereby:

ORDERED that, based on the grounds under review, claims 1–4, 6, 12, and 19 of U.S. Patent No. 7,559,388 B2 have been shown by a preponderance of the evidence to be unpatentable; and

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

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