

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Mercedes-Benz USA, LLC

BMW of North America, LLC,

Petitioners,

v.

Michigan Motor Technologies, LLC

Patent Owner.

IPR2023-01224

PETITION FOR *INTER PARTES* REVIEW OF

U.S. PATENT NO. 6,557,540

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LIST OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 6,557,540 to Mianzo et al (“the ’540 patent”)
1002	Prosecution File History of U.S. Patent No. 6,557,540 (“’540 file history”)
1003	Expert Declaration of Gerald J. Micklow, Ph.D., PE
1004	Curriculum Vitae of Gerald J. Micklow, Ph.D., PE
1005	US Pat. Pub. 2002/0029757 to Ogawa et al. (“Ogawa”)
1006	U.S. Patent No. 5,713,317 to Yoshioka (“Yoshioka”)
1007	“Torque Management of Engines with Variable Cam Timing,” M. Jankovic, F. Frischmuth, A. Stefanopoulou, and J. A. Cook, IEEE Control Systems, October 1998 (“Jankovic”)
1008	Expert Declaration of Sylvia D. Hall-Ellis, Ph.D.
1009	Curriculum Vitae of Sylvia D. Hall-Ellis, Ph.D.
1010	Jankovic MARC Record from the Linda Hall Library of Science, Engineering & Technology
1011	Jankovic MARC Record from the OCLC Bibliographic Database

I. CLAIM LISTING

A. Claim 1

1[pre]	A method for calculating a valve timing command for an engine of a vehicle, comprising:
1[a]	obtaining an engine performance command;
1[b]	receiving an environmental conditions signal;
1[c]	determining a valve feedforward term based on the engine performance command and the environmental conditions signal;
1[d]	receiving an engine performance feedback;
1[e]	calculating a valve feedback term based on the engine performance command and the engine performance feedback; and
1[f]	calculating a valve timing command based on the valve feedforward term and the valve feedback term.

B. Claim 2

2	The method of claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.
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C. Claim 7

7	The method of claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data.
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D. Claim 10

10	The method of claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.
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E. Claim 11

11	The method of claim 1 further comprising receiving fuel conversion data.
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F. Claim 14

14	The method of claim 1 further comprising receiving engine emissions data.
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II. INTRODUCTION

Mercedes-Benz USA, LLC (“MBUSA”) and BMW of North America, LLC (“BMW”) (collectively, “Petitioners”) petition for *Inter Partes* Review of claims 1-2, 7, 10-11, and 14 of U.S. Patent No. 6,557,540 to Mianzo et al. (“the ’540 patent”), titled “Method of calculating a valve timing command for an engine.”

The ’540 patent claims nothing more than conventional methods for controlling engine valve timing. The ’540 patent relies on known measures of engine performance and operating conditions as inputs to its valve timing control, and does not purport to have invented a new method for gathering these inputs. Nor is the ’540 patent’s method for calculating its valve timing control new. The ’540 patent uses the well-known techniques of feedforward and feedback control to determine valve timing. Thus, the ’540 patent claims nothing more than measuring engine performance and operating condition and using feedforward and feedback control to adjust valve timing.

There is nothing inventive about this approach. The prior art includes a variety of references that calculate commands for controlling valve timing based on feedforward and feedback terms. For example, Ogawa, Yoshioka, and Jankovic all disclose calculating valve timing commands based on feedback and feedforward terms. Accordingly, Petitioner requests that the challenged claims be held unpatentable.

III. REQUIREMENTS UNDER 37 C.F.R. 42.104

A. Grounds for Standing

Petitioners respectfully requests *inter partes* review (“IPR”) of Claims 1-2, 7, 10-11, and 14 (“Challenged Claims”) of the ’540 patent (Ex. 1001), which is indicated as assigned to Michigan Motor Technologies LLC (“MMT”). Petitioners certify that the ’540 patent is available for *inter partes* review and Petitioners are not barred or estopped from requesting review of the Challenged Claims on the grounds identified in this Petition.

B. Precise Relief Requested

The relief requested is cancellation of the challenged claims, as follows:

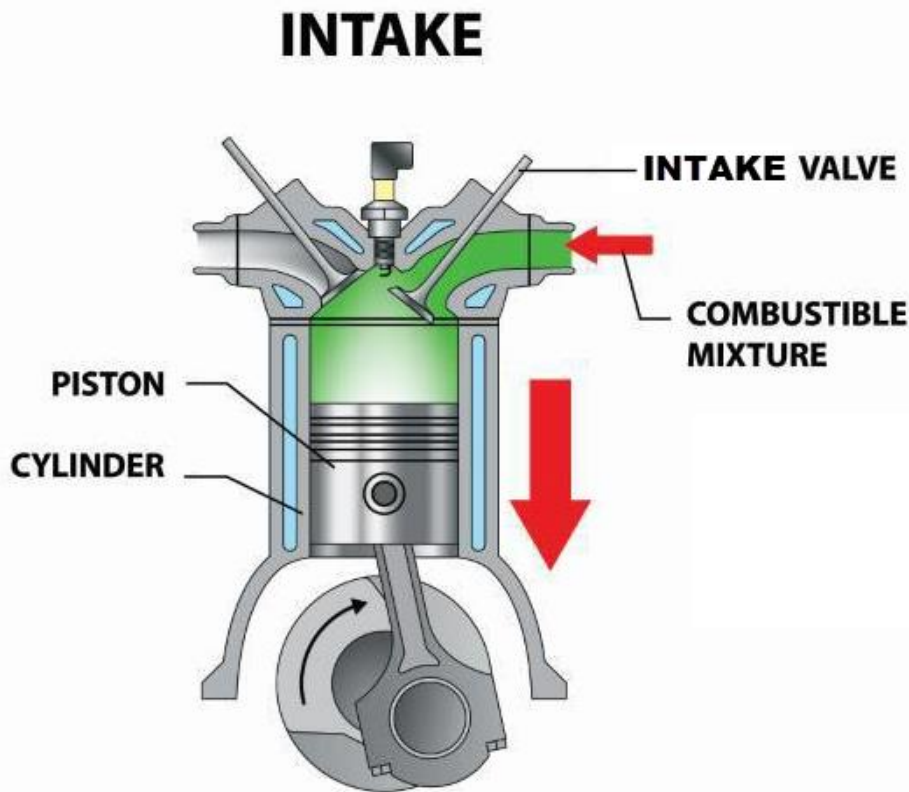
Ground	’540 Patent Claims	References	Basis
1	1-2, 7, 10-11, 14	Ogawa, Yoshioka	§103
2	1-2, 7, 10-11, 14	Yoshioka, Ogawa, Jankovic	§103

IV. OVERVIEW OF THE ’540 PATENT

The claims of the ’540 patent disclose methods for calculating commands to control the valve timing of the intake and exhaust valves of the combustion cylinders for internal combustion engines. Ex. 1001 at Abstract.

Four-stroke gasoline engines generate power through four strokes or stages. *Id.* at 1:13-14. In the first stroke, an intake valve opens, and a piston moves down in the cylinder drawing air and fuel through the intake port and the intake valve into

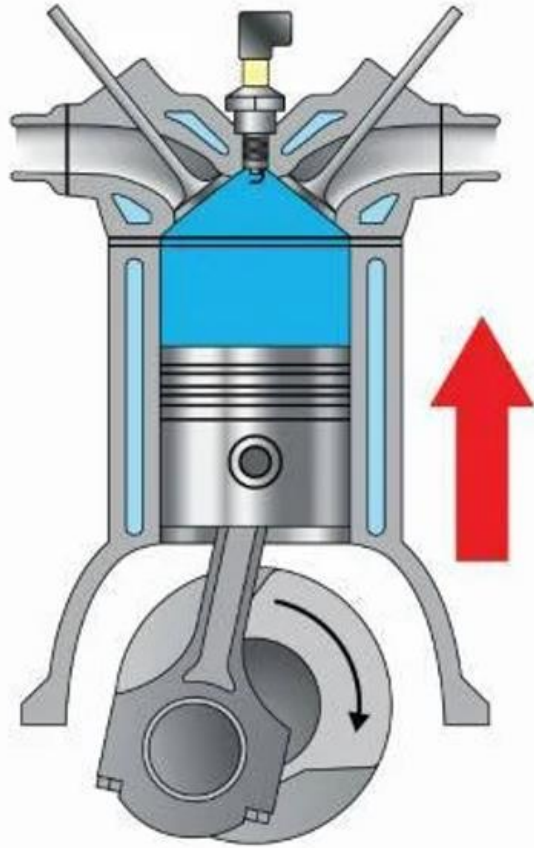
the cylinder. *Id.* at 1:14-16.



Pure Diesel Power, *The Four-Stroke Cycle of An Automotive Engine* (Sept. 23, 2023), <https://puredieselpower.com/blog/four-stroke-cycle-automotive-engine>.

In the second stroke, the intake valve closes and the piston reverses direction and moves up in the cylinder to compress the air/fuel mixture. Ex. 1001 at 1:16-18.

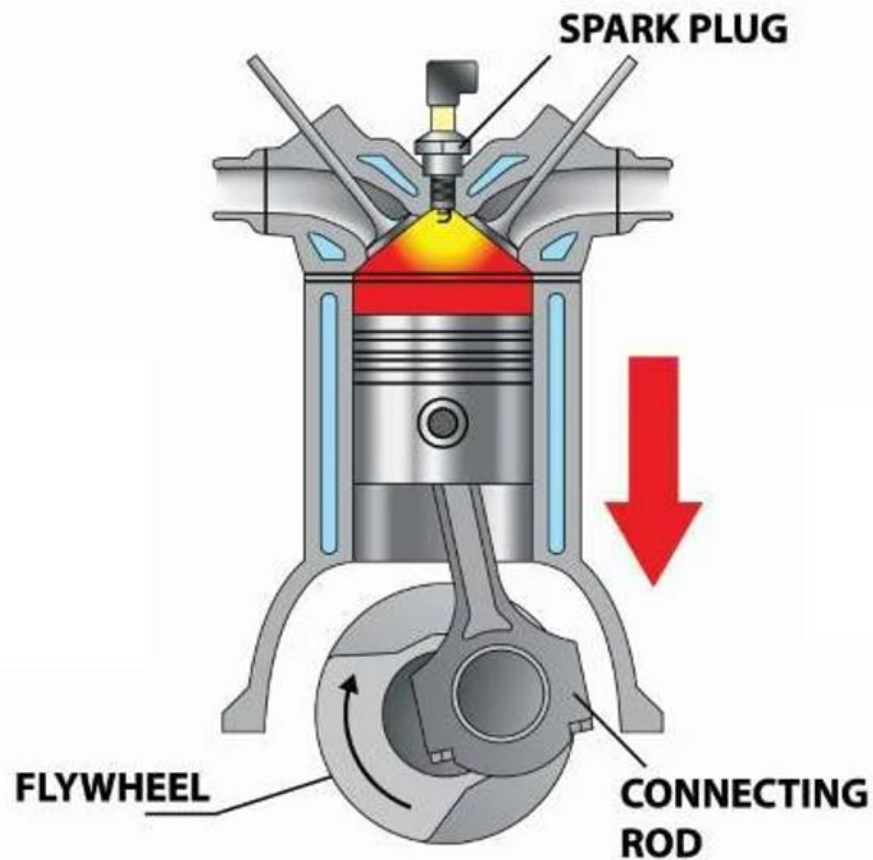
COMPRESSION



Pure Diesel Power, *The Four-Stroke Cycle of An Automotive Engine* (Sept. 23, 2023), <https://puredieselpower.com/blog/four-stroke-cycle-automotive-engine>.

In the third stroke, or power or working stroke, a spark combusts the mixture, which drives the piston down and powers the vehicle. Ex. 1001 at 1:18-20.

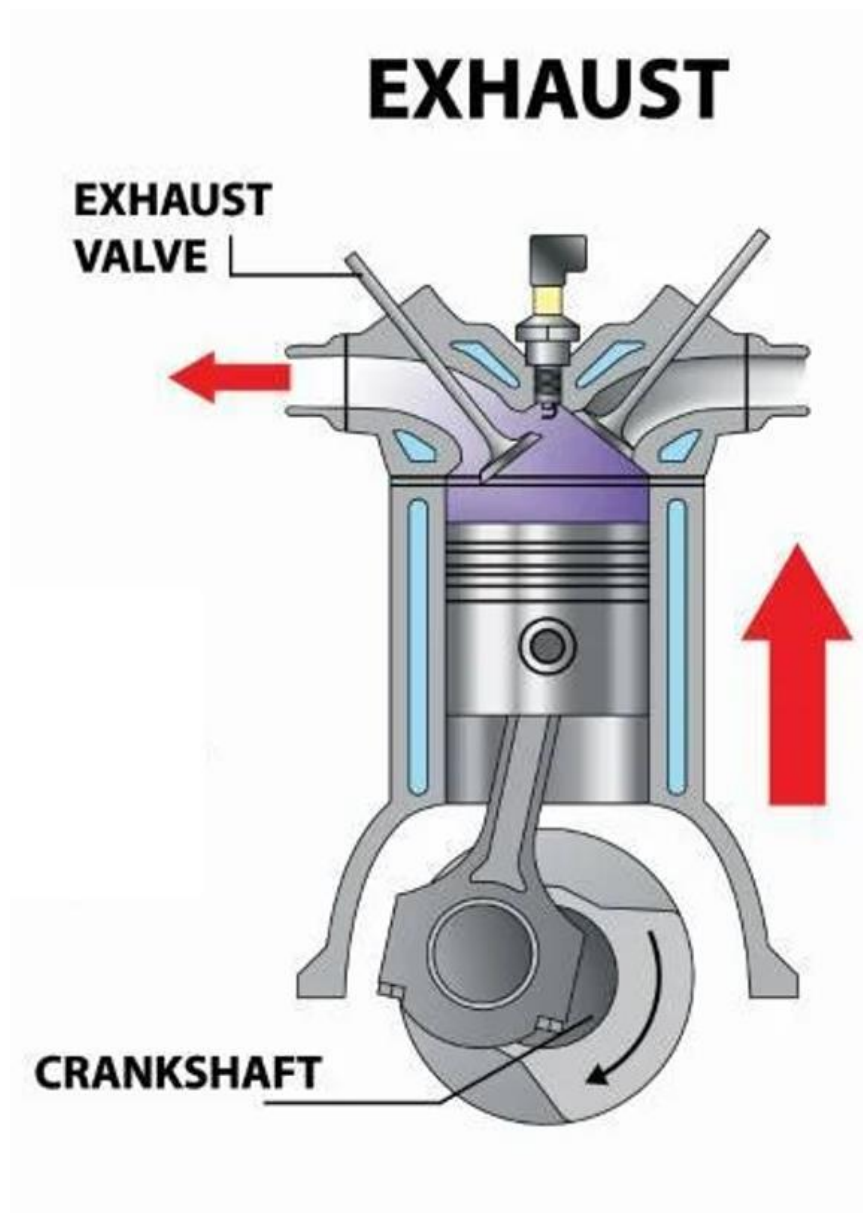
WORKING STROKE



Pure Diesel Power, *The Four-Stroke Cycle of An Automotive Engine* (Sept. 23, 2023), <https://puredieselpower.com/blog/four-stroke-cycle-automotive-engine>.

In the fourth stroke, an exhaust valve opens, and the piston reverses direction to push the combusted mixture through the exhaust valve and out of the cylinder.

Ex. 1001 at 1:20-23.



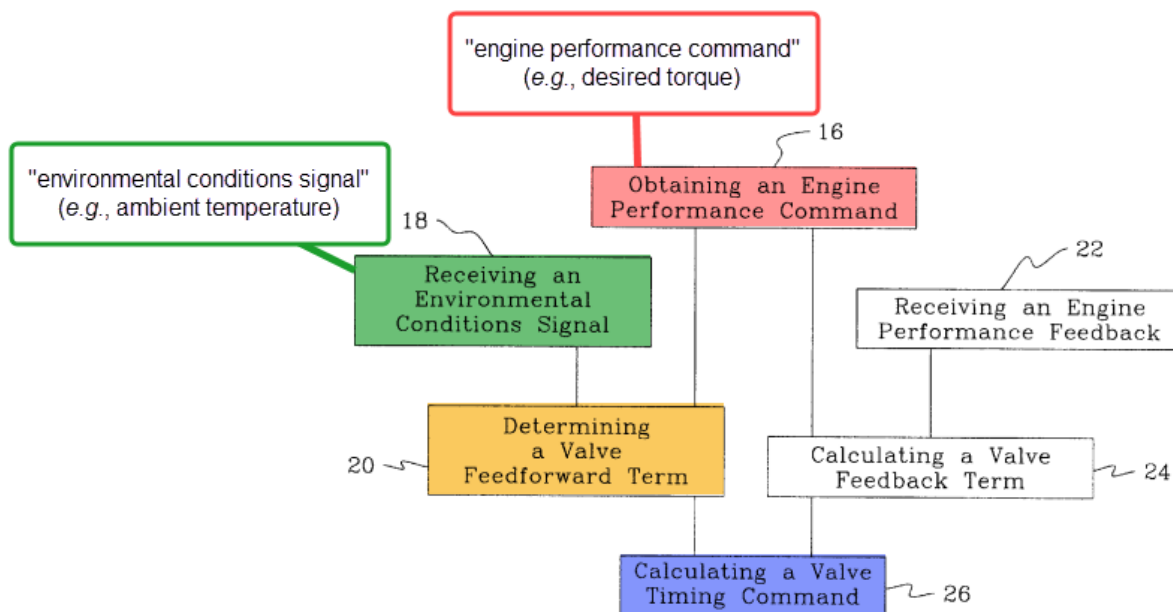
Pure Diesel Power, *The Four-Stroke Cycle of An Automotive Engine* (Sept. 23, 2023), <https://puredieselpower.com/blog/four-stroke-cycle-automotive-engine>.

Controlling the timing of the opening and closing of the intake and exhaust valves is significant because it can be used to optimize both the fuel efficiency and the power output of the engine. Ex. 1001 at 1:30-33.

The '540 patent claims nothing more than adjusting valve timing based on

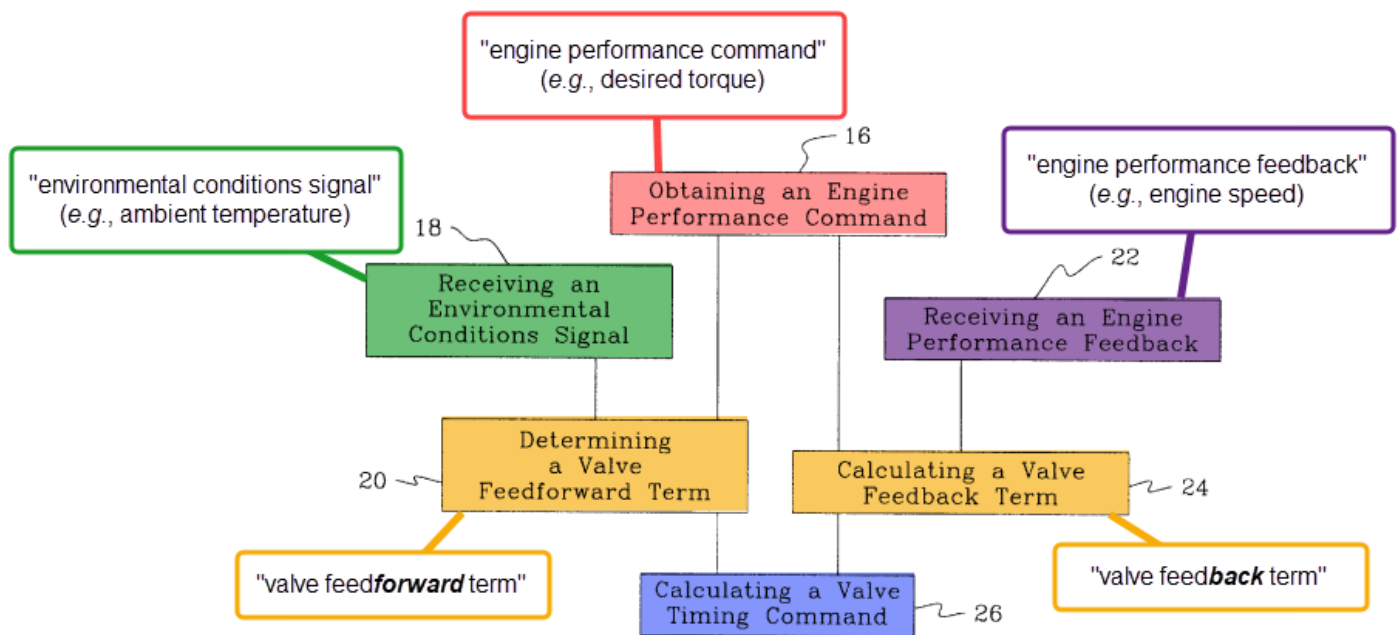
engine performance and operating conditions. In particular, the '540 patent claims obtaining an “engine performance command” indicating desired engine performance. The specification discloses that the claimed “engine performance command” may be, for example, desired engine torque. *Id.* at 2:16-19. The system also receives an “environmental conditions signal.” *Id.* at 2:23-26. The specification discloses that the “environmental conditions signal” may be, for example, ambient temperature. *Id.* at 2:23-33.

The “engine performance command” (*e.g.*, desired torque) and “environmental conditions signal” (*e.g.*, ambient temperature) are used to determine a “valve feedforward term.” The specification provides no limitation on the format of the “valve feedforward term,” and instead only discloses that the “valve feedforward term” is used in part to compute a “valve timing command”:



Id. at FIG. 2 (annotated).

As shown in the figure, the claimed system also calculates a “valve feed**back** term” using the “performance engine command” and an “engine performance feedback.” *Id.* at 2:66-3:7. The specification explains that the “engine performance feedback” may include data gathered by an engine sensor, such as engine speed. As shown in the figure below, the “valve feedback term” is used in conjunction with the “valve feedforward term” to calculate a “valve timing command”:



Ex. 1001 at FIG. 2 (annotated).

The patent does not place any restriction on how the “feedforward” and “feedback” terms may be used to compute a “valve timing command.”

The specification discloses that a variety of “valve timing commands” may be

computed, including, for example, a command to open the exhaust valve (“EVO”), a command to close the exhaust valve (“EVC”), a command to open the intake valve (“IVO”), or a command to close the intake valve (“IVC”).

V. PROSECUTION HISTORY

The ’540 patent issued May 6, 2003, from U.S. Application No. 10/014,286 (“the ’286 application”), which was filed on December 11, 2001. Ex. 1001. Thus, the ’540 patent’s earliest possible priority date is December 11, 2001.

The examiner allowed all claims of the ’286 application without any rejections. See Ex. 1002. Prior art references Ogawa, Yoshioka, and Jankovic were not before the examiner during prosecution. *Id.*

VI. THE HYUNDAI AND VOLKSWAGEN IPRS

Hyundai Motor Company (“Hyundai”) and Volkswagen Group of America, Inc. (“VW”) each previously filed a petition for *inter partes* review of the ’540 patent. See IPR Nos. IPR2018-01061 and IPR2020-00160. The petition in IPR2018-01061 challenged claims 1-2, 7, 10-11, and 14 based on Yoshioka and Jankovic. See IPR No. IPR2018-01061 at Paper 2 (Petition). These references are also relied upon by MBUSA in this Petition. The petition in IPR2020-00160 challenged claims 1-16 based on Yoshioka, U.S. Patent No. 4,995,351 and U.S. Patent No. 6,308,671. See IPR No. IPR2020-00160 at Paper 2 (Petition). Neither Hyundai nor VW’s petition relied on the Ogawa reference cited in this petition. See IPR No. IPR2018-01061 at Paper 2 (Petition); IPR No. IPR2020-00160 at Paper 2 (Petition).

In IPR2018-01061, Patent Owner settled its litigation with Hyundai and moved for termination of the IPR before the PTAB issued an institution decision. The PTAB granted the termination request.

The PTAB denied institution of the IPR2020-00160 petition on the grounds that the petition did not show that Yoshioka taught the “obtaining an engine performance command” limitation recited in the ’540 patent’s claim 1. IPR No. IPR2020-00160, Paper 8 at 20.

VII. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA at the time of the alleged invention would have had a B.S. degree in Electrical Engineering or Mechanical Engineering (or equivalent), as well as at least 1-2 years of academic or industry experience in the design and analysis of internal combustion engines or, alternatively, at least an M.S. degree in Electrical Engineering or Mechanical Engineering. Ex. 1003 at ¶ 47.

VIII. CLAIM CONSTRUCTION

The PTAB construes challenged claims in an IPR “using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). Claim terms must be given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention, in light of the specification and the prosecution history of the patent. *Id.*; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-1313 (Fed. Cir. 2005) (en banc); *see also* 83 Fed. Reg. 51,340 (Oct. 11, 2018).

Petitioners provide the following claim constructions. All claim terms not identified below should receive their plain and ordinary meaning, in the context of the '540 patent specification, under the *Phillips* standard. Petitioners take no position in this Petition as to whether the claims are indefinite, and no statements herein should be interpreted to mean that the terms are definite.

A. Claims 1, 2, 6, and 8: “engine performance command”

Claims 1, 2, 6, and 8 recite an “engine performance command.” The '540 patent teaches that an engine performance command “is preferably a desired engine torque” but that it “may alternatively be another suitable variable, such as a desired engine acceleration.” Ex. 1001 at 2:16-22.

Accordingly, a POSITA would understand “engine performance command” in view of the claims and the specification to mean a “command that defines a desired engine torque, or other desired measure of engine performance, such as engine speed or engine acceleration.”¹ Ex. 1003 at ¶¶ 62-63.

Notably, the Grounds in this petition do not turn on this construction. Indeed, the prior art expressly discloses an “engine performance command” in the form a

¹ The PTAB previously construed “engine performance command” as a “command that defines a desired engine torque or other measure of engine performance, such as engine speed or engine acceleration.” *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00160, Paper 9 at 12 (PTAB June 5, 2020).

desired engine torque, which the specification expressly states is one type of “engine performance command.”

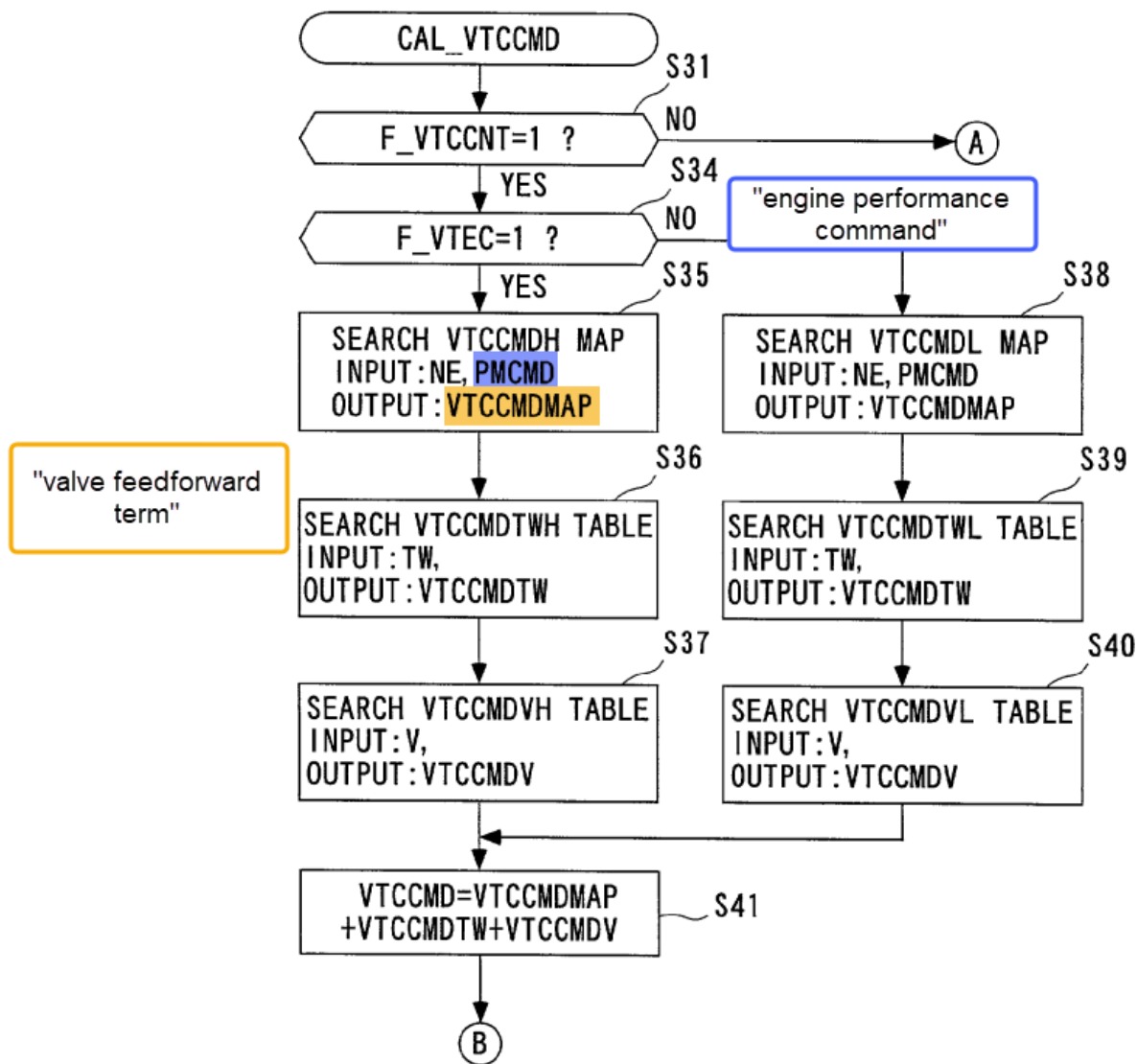
IX. SUMMARY OF PRIOR ART

A. Ogawa

U.S. Patent Application Publication 2002/0029757 by Ogawa et al., “Valve timing controller, valve timing control method and engine control unit for internal combustion engine” (Ex. 1005, “Ogawa”), was filed on September 14, 2001, before the ’540 patent’s earliest possible priority date. Therefore, Ogawa is prior art at least under 35 U.S.C. § 102(e) (pre-AIA).

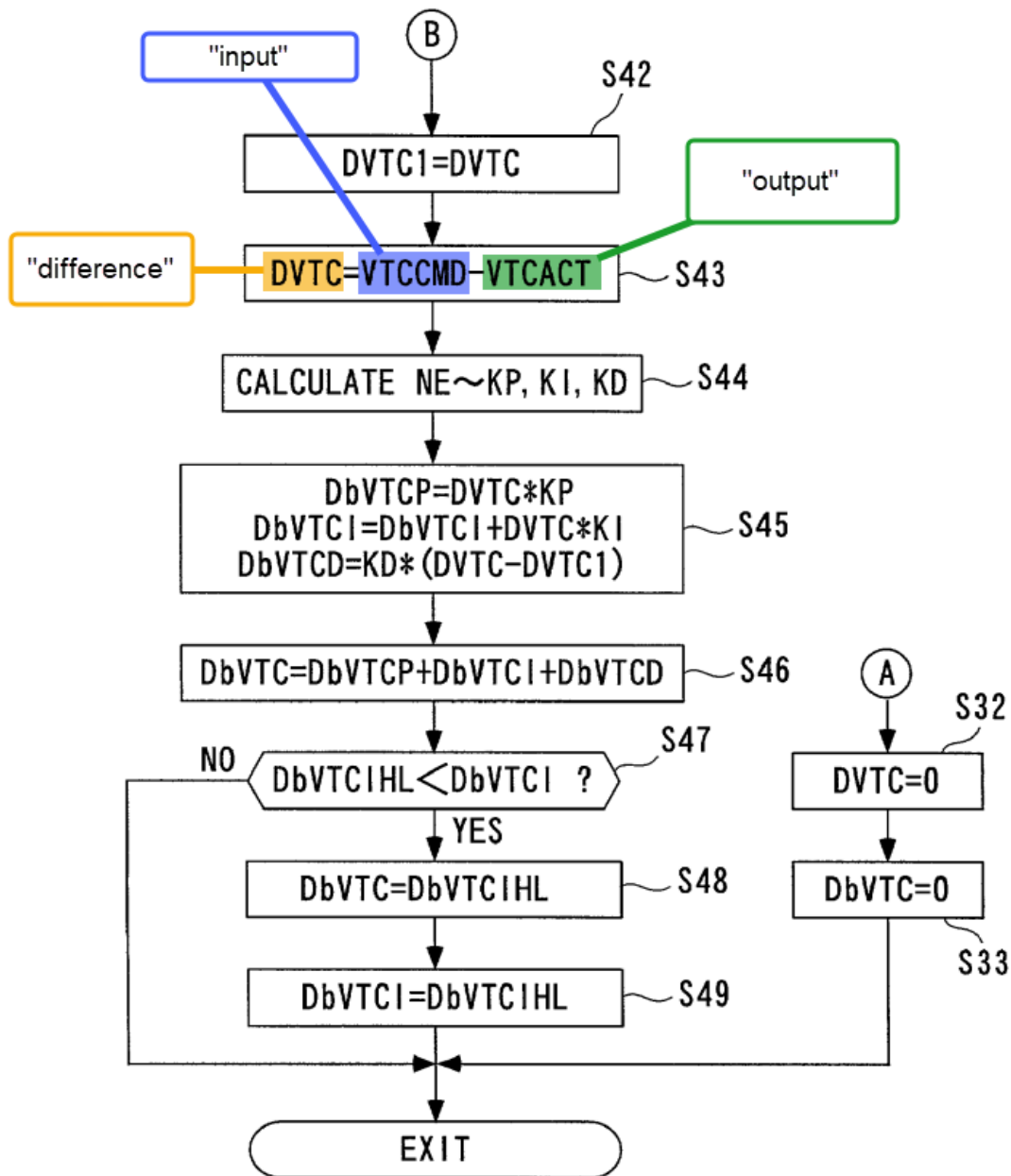
Like the ’540 patent, Ogawa discloses “a valve timing control method” that includes receiving data regarding a desired engine performance (required engine torque), the engine’s environmental operating conditions (atmospheric pressure), and engine performance (engine rotational speed). *Id.* at ¶¶ 0002, 0072, 0070, 0010.

Ogawa also teaches calculating both a valve feedforward and a valve feedback term. Ogawa teaches using its inputs to calculate the phase of a camshaft (“cam”) that controls the time at which either an intake or exhaust valve opens and closes. *Id.* at ¶ 0002. To control the cam phase, Ogawa teaches calculating a basic value target cam phase VTCCMDMAP, *i.e.*, a valve feedforward term, based on the desired engine torque PMCMD. *Id.* at ¶ 0084.



Id. at FIG. 3 (annotated).

Just like the '540 patent, Ogawa teaches calculating a valve feedback term by comparing an input to an output. Ogawa teaches comparing an adjusted target valve cam phase VTCCMD to an actual valve cam phase VTCACT to calculate a difference amount DVTC, *i.e.*, a valve feedback term. *Id.* at ¶ 0090.



Id. at FIG. 4.

Finally, Ogawa teaches calculating a valve timing command DbVTC based on its valve feedforward term VTCCMDMAP and valve feedback term DVTC. Ogawa teaches calculating DbVTC, which determine the duty ratio of the driving

signal that controls the valve cam shaft phase and, thus, the timing of the opening and closing of the valve. *Id.* at ¶¶ 0059, 0060, 0082. Like the '540 patent, Ogawa's valve timing command DbVTC is calculated based on its valve feedforward term VTCCMDMAP and valve feedback term DVTC. DVTC is calculated based on the valve feedforward term VTCCMDMAP, and DbVTC is calculated based on DVTC. *Id.* at (1), ¶ 0091, FIG. 4.

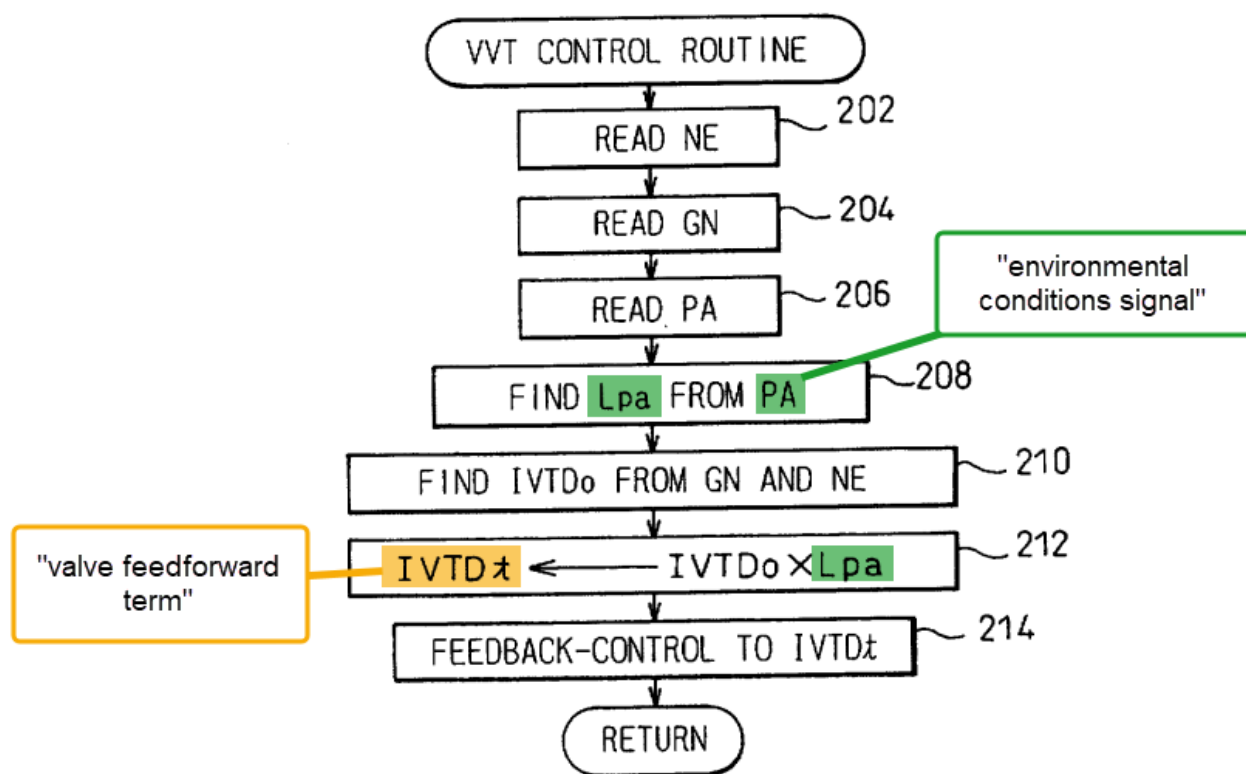
B. Yoshioka

U.S. Patent No. 5,713,317 to Yoshioka, "Method of and apparatus for continuously and variably controlling valve timing of internal combustion engine" (Ex. 1006, "Yoshioka"), issued on February 3, 1998, more than three years before the earliest effective priority date of the '540 patent. Therefore, Yoshioka is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

Like the '540 patent, Yoshioka teaches a method that "controls a continuously variable valve timing mechanisms of an internal combustion engine to continuously and variably control the timing of an intake valve." Ex. 1006 at Abstract. Also like the '540 patent, Yoshioka teaches receiving data regarding atmospheric pressure, *i.e.*, the environmental conditions the engine is operating in, and engine speed, *i.e.*, engine performance. *Id.* at Ex. 1006 at 4:42-5:46, 7:24-25 .

Yoshioka further teaches calculating both a valve feedforward and a valve feedback term, just like the '540 patent. Yoshioka teaches calculating a target timing displacement IVTDt, *i.e.*, a valve feedforward term, to control the valve

opening and closing based on atmospheric pressure PA, engine load GN, and engine revolution speed NE. Ex. 1006 at 7:57-67.



Id. at FIG. 9 (annotated).

Like the '540 patent, Yoshioka teaches calculating a valve feedback term by comparing an input to an output. Yoshioka teaches calculating a target displacement $IVTD_t$, and then using “feedback-control,” *i.e.*, calculating a valve feedback term, “[t]o bring the displacement of the intake valve 23 to the target displacement $IVTD_t$.”

Id. at 8:5-7.

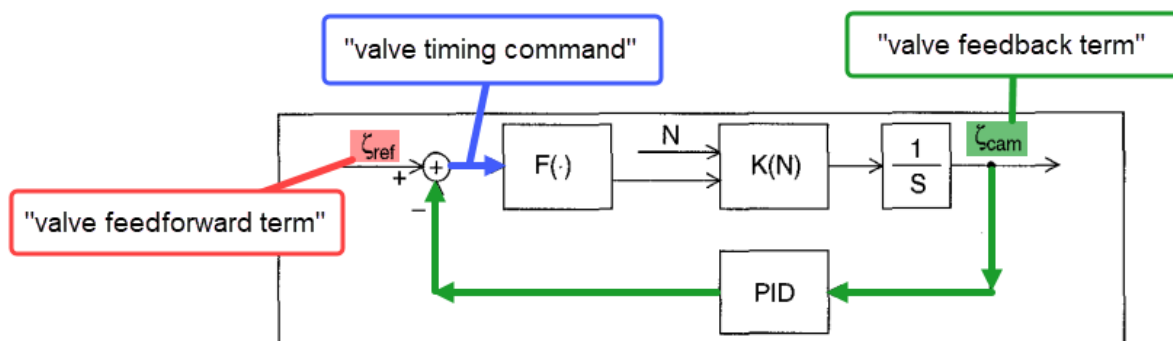
Finally, just like the '540 patent, Yoshioka teaches using its valve feedforward and feedback term to calculate a valve timing command. Yoshioka teaches using

its valve feedforward term IVTDt and feedback control, *i.e.*, a valve feedback term, to calculate control signals for a hydraulic control valve to bring the actual intake valve displacement to the target displacement. Ex. 1006 at 8:5-7.

C. Jankovic

“Torque Management of Engines with Variable Cam Timing,” M. Jankovic, F. Frischmuth, A. Stefanopoulou, and J. A. Cook, IEEE Control Systems, October 1998 (Ex. 1007, “Jankovic”), was published in October 19, 1998, more than one year before the earliest effective priority date of the ’540 patent. See Ex. 1008 at ¶¶ 37-42. Therefore, Jankovic is prior art under at least 35 U.S.C. § 102(b) (pre-AIA).

Just like the ’540 patent, Jankovic teaches using feedforward and feedback terms to calculate a valve timing command. Jankovic discusses a “variable cam timing (VCT) system” for controlling valve timing. Ex. 1007 at 34. Jankovic teaches calculating a cam phasing command that controls a valve cam shaft phase, *i.e.*, a valve timing command, in a “feedback loop” based on a valve feedback term cam position ζ_{cam} and a valve feedforward term, the previously calculated ζ_{ref} . Ex. 1007 at 36, 40, 41.



Id. at FIG. 8 (annotated).

X. DISCRETIONARY FACTORS

As discussed in detail below, the Board should not exercise its discretion to deny this IPR petition.

A. The Board Should Not Deny Institution Under Section 325(d)

The Board uses a two-part framework to analyze denial under § 325(d). *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 7 (PTAB Feb. 13, 2020) (precedential). For prong one, the Board considers whether the same or substantially the same prior art or arguments were presented during the prosecution of the patent or any post-issuance proceedings. *Id.* at 7-8. For prong two, the Board considers whether the office materially erred in determining patentability of the challenged claims. *Id.* at n. 9. If the first prong is not met, the Board does not need to address the second prong. *Godbersen-Smith Constr. Co. v. Guntert & Zimmerman Const. Div., Inc.*, IPR2021-00050, Paper 24 at 21 (PTAB May 7, 2021). Here, the *Advanced Bionics* analysis weighs in favor of institution.

An analysis of the '540 patent prosecution history and Hyundai and VW's prior IPR petitions favors institution. First, this Petition relies on art not considered during prosecution of the '540 patent—Ogawa, Yoshioka, and Jankovic were not cited by the examiner or the applicant. *See* Ex. 1002.

Second, this Petition relies on combinations of prior art not cited in any post-

issuance proceeding of the '540 patent. In particular, this petition relies on the Ogawa reference in combination with Yoshioka and Jankovic. Neither Hyundai nor VW relied on Ogawa in their petitions. See IPR No. IPR2018-01061 at Paper 2 (Petition); IPR No. IPR2020-00160 at Paper 2 (Petition). Accordingly, § 325(d) concerns are not implicated here because this Petition addresses new arguments based on prior art not addressed during prosecution or any post-issuance proceeding. *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, Paper 6 at 7 (PTAB Feb. 13, 2020) (considering whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office.); *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 28 (PTAB Dec. 15, 2017) (informative) (finding that a cited reference was cumulative when the same base reference was substantively evaluated during prosecution).

As such § 325(d) does not counsel in favor of a discretionary denial. Therefore, the Board does not have to address the second prong of the analysis.

B. The General Plastic Factors Weigh In Favor Of Institution

Factor 1: whether the same petitioner previously filed a petition directed to the same claims of the same patent. Neither VW nor Hyundai's prior IPR bear a "significant relationship" such that Factor 1 would favor discretionary denial. *Twitter v. Palo Alto Research Center Inc.*, IPR2021-01398, Paper 12 at 40-41 (PTAB Mar. 15, 2022). MBUSA and BMW were sued separately from Hyundai

and VW: MMT sued Hyundai in the Eastern District of Michigan in 2017; MMT sued VW in the Eastern District of Michigan two years later in 2019; and MMT sued MBUSA and BMW in the Northern District of Illinois three years later in 2022. See *Michigan Motor Technologies LLC v. Hyundai Motor Company*, No. 2:17-cv12901 (E.D. Mich.); *Michigan Motor Technologies LLC v. Volkswagen AG*, No. 2:19-cv10485 (E.D. Mich.); *Michigan Motor Technologies, LLC v. Mercedes-Benz USA, LLC*, Case 1:22-cv-03957 (N.D. Ill.); *Michigan Motor Technologies, LLC v. Bayerische Motoren Werke AG et al*, Case 1:22-cv-03804 (N.D. Ill.). Accordingly, there is no relationship between the IPRs, let alone a significant one.

Moreover, there is no overlap between MBUSA or BMW's accused products and the accused products that were at issue in the litigation with Hyundai or VW. MMT's complaint against MBUSA accuses three Mercedes-AMG engines and the Mercedes-Benz GLC 350e of infringement. *Michigan Motor Technologies, LLC v. Mercedes-Benz USA, LLC*, Case 1:22-cv-03957 (N.D. Ill.), Dkt. 1 at ¶¶ 13-17. MMT's complaint against Hyundai accused multiple Hyundai vehicles of infringement. *Michigan Motor Technologies LLC v. Hyundai Motor Company*, No. 2:17-cv12901 (E.D. Mich.), Dkt. 1 at ¶¶ 13, 181. MMT's complaint against BMW accuses two BMW engines and four series of BMW vehicles of infringement. *Michigan Motor Technologies, LLC v. Bayerische Motoren Werke AG et al*, Case 1:22-cv-03804 (N.D. Ill.), Dkt. 1 at ¶¶ 14-17. MMT's complaint against VW accused multiple VW and Audi engines and vehicles of infringement. *Michigan*

Motor Technologies LLC v. Volkswagen AG, No. 2:19-cv10485 (E.D. Mich.), Dkt. 1.

Furthermore, neither MBUSA or BMW coordinated with Hyundai or VW in the preparation of this Petition, Hyundai's petition in IPR2018-01061, or VW's petition in IPR2020-00160. In these circumstances, the Board has found Factor 1 weighs in favor of institution. IPR2021-01398, Paper 12 at 40-41.

Factor 2: whether at the time of filing of the first petition the petitioner knew of the prior art asserted in the second petition or should have known of it. This factor does not apply because neither MBUSA nor BMW previously filed a petition. Moreover, as explained with regard to Factor 1 above, neither MBUSA nor BMW had reason to know of the prior art asserted in this Petition at the time of Volkswagen's petition at least because MMT had not yet sued MBUSA or BMW. Likewise, there is no significant relationship between MBUSA or BMW and Hyundai or Volkswagen. Thus, Factor 2 weighs in favor of institution. IPR2021-01398, Paper 12 at 41-42.

Factor 3: whether at the time of filing of the second petition the petitioner already received the patent owner's preliminary response to the first petition or received the Board's decision on whether to institute review in the first petition. This factor does not apply because neither MBUSA nor BMW previously filed a petition. Likewise, there was no delay by Petitioners in filing its IPR petition after being sued by MMT. Accordingly, Factor 3 weighs in favor of institution.

Factor 4: the length of time that elapsed between the time the petitioner learned of the prior art asserted in the second petition and the filing of the second petition. This factor does not apply because neither MBUSA nor BMW previously filed a petition. Further, MBUSA and BMW did not learn of the prior art asserted in this Petition until after MBUSA and BMW received service of MMT’s complaints in the respective district court litigations. This IPR petition is timely filed before both MBUSA and BMW’s statutory bar date and, thus, there is also no delay. Accordingly, Factor 4 also weighs in favor of institution.

Factor 5: whether the petitioner provides adequate explanation for the time elapsed between the filings of multiple petitions directed to the same claims of the same patent. For the same reasons discussed with respect to Factor 4, Factor 5 is also irrelevant. Accordingly, Factor 5 weighs in favor of institution.

Factor 6: the finite resources of the Board. The petition is not a “follow-on” petition like those discussed in *General Plastic* or a “serial attack” on the ’540 patent by the same petitioner. Moreover, Petitioners are not attempting to “strategically stage their prior art and arguments in multiple petitions”—this Petition was filed as a direct response to MMT’s new complaints against Petitioners filed more than two years after VW’s petition of the ’540 patent and more than four years after Hyundai’s petition, both of which were filed in response to MMT’s complaints against Hyundai and VW, respectively. *Ameristar Perimeter Sec. Usa, Inc. v. Rsa Protective Techs., LLC*, No. IPR2020-01369, Paper 11 at 15 (PTAB Feb. 5, 2021)

(finding *General Plastics* factors weighed in favor of institution where petitioner was not involved in prior petitions, was not attempting to strategically stage prior art, and instead searched for prior art in response to the commencement of litigation); *Samsung Elecs. Co. v. Iron Oak Techs., LLC*, IPR2018-01554, Paper 9 at 31 (PTAB Feb. 13, 2019) (complaint about serial petitions unpersuasive where “the volume [of petitions] appears to be a direct result of [the patent owner’s] own litigation activity”).

Thus, this Petition does not waste the finite resources of the Board and this factor weighs in favor of institution.

Factor 7: the requirement that the Board issue a final determination within 1 year. The filing of this Petition will not adversely impact the PTAB’s one year deadline to issue a Final Written Decision. Accordingly, Factor 7 weighs in favor of institution.

For the foregoing reasons, the General Plastic factors weigh in favor of institution. Indeed, this is not the type of serial attack on a patent that the General Plastics factors are designed to prevent. *General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR No. IPR2016-01357 at 8-11 (Paper 19) (Precedential).

C. Institution Should Not Be Denied Under *Fintiv*

Discretionary denial under § 314 is analyzed under the *Fintiv* factors, and those factors weigh in favor of institution. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB Mar. 20, 2020) (precedential).

1. A Final Written Decision Will Issue Before Any Trial

A schedule has not yet been issued in the corresponding district court litigation. No trial date has been set. This petition is being filed on July 12, 2023. Thus, the approximate date of the PTAB hearing would be November 2024, whereas the trial date for the district court case (which has not been set) will likely not be until 2025. Accordingly, the PTAB trial will pre-date the district court trial, perhaps by many months.

Even if the trial occurs shortly before the PTAB hearing, the PTAB has held that such close proximity of a district court trial date weighs in favor of institution. *See, e.g., MediaTek Inc. et al. v. Nippon Telegraph and Telephone Corp.*, IPR2020-01607, Paper 12 at 14 (PTAB April 2, 2021).

2. The Merits of the Petition Support Institution

As discussed in more detail below, the prior art teaches every element of the challenged claims. Accordingly, the challenged claims should be held unpatentable. The merits of the petition weigh strongly in favor of institution. Likewise, as noted by the Director, “the PTAB will not rely on the *Fintiv* factors to discretionarily deny institution . . . where a petition presents compelling evidence of unpatentability.” USPTO Interim Procedure for Discretionary Denials, at 2.

3. Stipulation Not To Rely On The Petition’s Grounds In District Court

Petitioners stipulate that, if the Board institutes inter partes review, Petitioner will not seek resolution in the District Court of any ground of invalidity for the ’540

Patent that utilizes the same combination of prior art reference relied upon in the grounds of the instant petition. Petitioners' proposal addresses the concern of narrowing the issues, as this stipulation ensures there is no overlap between the '540 Patent invalidity theories before the Board and at issue in the District Court. Accordingly, this factor weighs in favor of institution.

XI. GROUND 1: THE COMBINATION OF OGAWA AND YOSHIOKA RENDERS OBVIOUS CLAIMS 1-2, 7, 10-11, AND 14.

A POSITA at the time of the alleged invention would have found claims 1-2, 7, 10-11, and 14 obvious over Ogawa in view of Yoshioka.

1. Motivation to Combine Ogawa with Yoshioka

A POSITA viewing Ogawa's methods for calculating valve timing commands would have been motivated to calculate a valve feedforward term based on an environmental conditions signal; receive fuel conversion and engine emissions data; and calculate EVO, EVC, IVO, and IVC commands, as taught by Yoshioka, for a variety of reasons.

First, a POSITA would have understood that modifying Ogawa's valve timing command calculation based on Yoshioka's teachings, including modifying the method to account for atmospheric pressure in calculating a feedforward term, would "improve the output of an engine at high altitude under high load." Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 74-81. In particular, Yoshioka discloses determining a valve feedforward term $IVTD_t$ by first calculating a correction coefficient L_{pa} based

on an atmospheric pressure signal PA, *i.e.*, an environmental conditions signal, and, based on IVTDt, calculating an EVO command, an EVC command, an IVO command, and an IVC command. Ex. 1006 at 6:16-36, 7:57-60.

Second, Yoshioka discloses that implementing its fuel conversion and engines emissions teachings “reduc[es] fuel consumption and improv[es] exhaust purifying performance at high altitudes under low/medium load.” Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 74-81. Yoshioka discloses “an air-fuel ratio feedback correction according to a signal from [an] O₂ sensor 45” that is located at the exhaust pipe and “detect[s] the concentration of the oxygen in the exhaust gas,” *i.e.*, fuel conversion and emissions data. Ex. 1006 at 4:48-52, 5:24-30.

Thus, a POSITA would have been motivated to modify Ogawa’s methods for calculating a valve timing command to calculate a valve feedforward term based on an environmental conditions signal; receive fuel conversion and engine emissions data; and calculate EVO, EVC, IVO, and IVC commands to (1) improve engine output at high altitude under high load, and (2) reduce fuel consumption and improve exhaust purifying at high altitudes under low/medium load. Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 74-81.

A POSITA would likewise be motivated to combine the teachings of Ogawa and Yoshioka because they are both in the *same field of endeavor* as the ’540 patent, controlling engine valve timing. Ex. 1001 at Abstract; Ex. 1005 at Abstract; Ex. 1006 at Abstract. As discussed below, both Ogawa and Yoshioka use *similar*

techniques to solve the same problem as the '540 patent—indeed, Ogawa discloses nearly all of the limitations of claims 1-2, 7, 10, 11, and 14, and Yoshioka discloses calculating a valve feedforward term based on an environmental conditions signal; receiving ambient temperature, fuel conversion, and engine emissions data; and calculating EVO, EVC, IVO, and IVC commands as claimed in claims 1, 3, 10, 11, and 14.

Moreover, a POSITA would have had a *reasonable expectation of success* of applying Yoshioka's teachings to Ogawa's valve timing control methods, including at least because Ogawa teaches that Ogawa's engine control unit ("ECU") already receives signals representing atmospheric pressure and engine speed, and that it sets its engine performance command PMCMD according to a particular engine load. A POSITA would easily be able to modify the code of Ogawa's ECU to implement the valve feedforward term calculation as taught by Yoshioka based on the atmospheric pressure, engine speed, and engine load data already utilized by Ogawa's ECU. Ex. 1006 at ¶¶ 0070, 0116; Ex. 1003 at ¶¶ 74-81.

Similarly, a POSITA would have understood that Ogawa's ECU already receives signals from a number of sensors and could be modified to receive a signal from an O₂ sensor placed in the system's exhaust pipe and an ambient temperature sensor, as taught by Yoshioka. Ex. 1003 at ¶¶ 74-81. Moreover, a POSITA could easily modify the code of Ogawa's ECU to read the fuel conversion and exhaust data from an O₂ sensor, and the temperature data from a temperature sensor. Ex. 1003

at ¶¶ 74-81.

Finally, A POSITA would have understood that Ogawa's ECU already calculates a target valve timing displacement VTCCMD and would easily be able to modify the code of Ogawa's ECU to implement the calculation to calculate an EVO, EVC, IVO, and IVC command based on the target displacement VTCCMD, as taught by Yoshioka. Ex. 1006 at ¶¶ 0070, 0116; Ex. 1003 at ¶¶ 74-81.

A POSITA would have therefore been motivated to modify Ogawa's methods for controlling engine valve timing to calculate a valve feedforward term based on an environmental conditions signal; receive ambient temperature, fuel conversion, and engine emissions data; and calculate EVO, EVC, IVO, and IVC commands because the modifications would improve engine output at high altitude under high load, and reduce fuel consumption and improve exhaust purifying at high altitudes under low/medium load. Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 74-81; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.").

2. Claim 1

- a. *1[pre]: "A method for calculating a valve timing command for an engine of a vehicle, comprising:"*

Ogawa discloses a method for calculating a valve timing command for an engine vehicle. Ex. 1003 at ¶¶ 82-83. Ogawa teaches "a valve timing control

method” for a vehicle’s “engine.” Ex. 1005 at ¶¶ 0002, 0037. Particularly, Ogawa teaches methods for “determining the valve timing” by “control[ing] the duty ratio DbVTC of a driving signal outputted to the VTC electronic magnetic control valve” that controls the valve cam shaft phase (*i.e.*, a valve timing command). *Id.* at ¶¶ 0017, 0060, 0082.

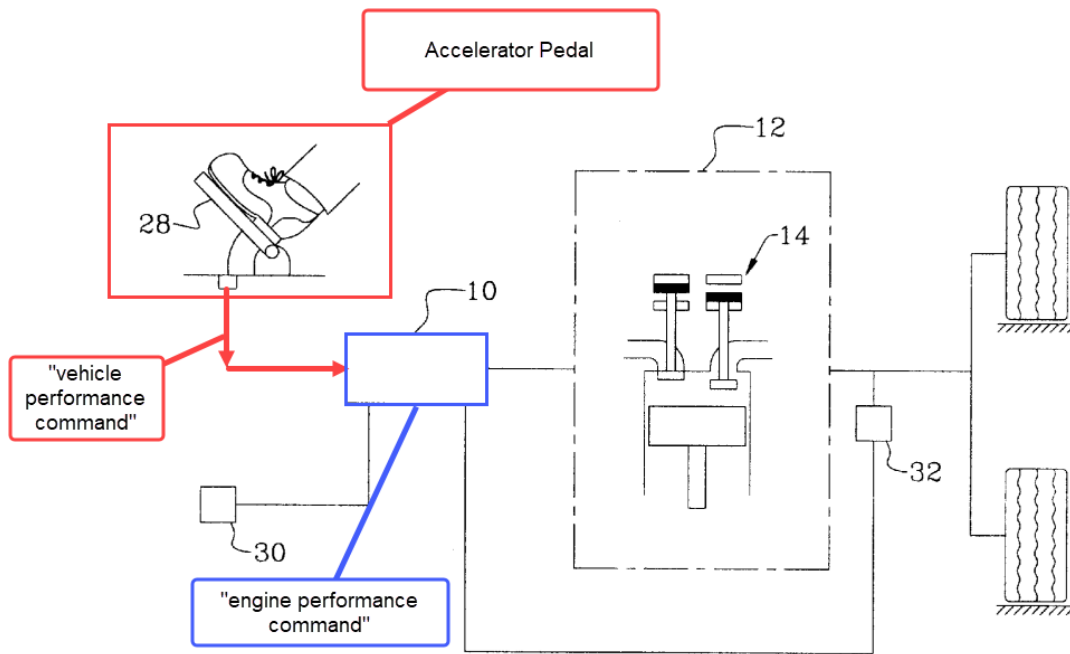
Thus, Ogawa discloses the preamble of claim 1. Ex. 1003 at ¶¶ 82-83

b. *1[a]: “obtaining an engine performance command;”*

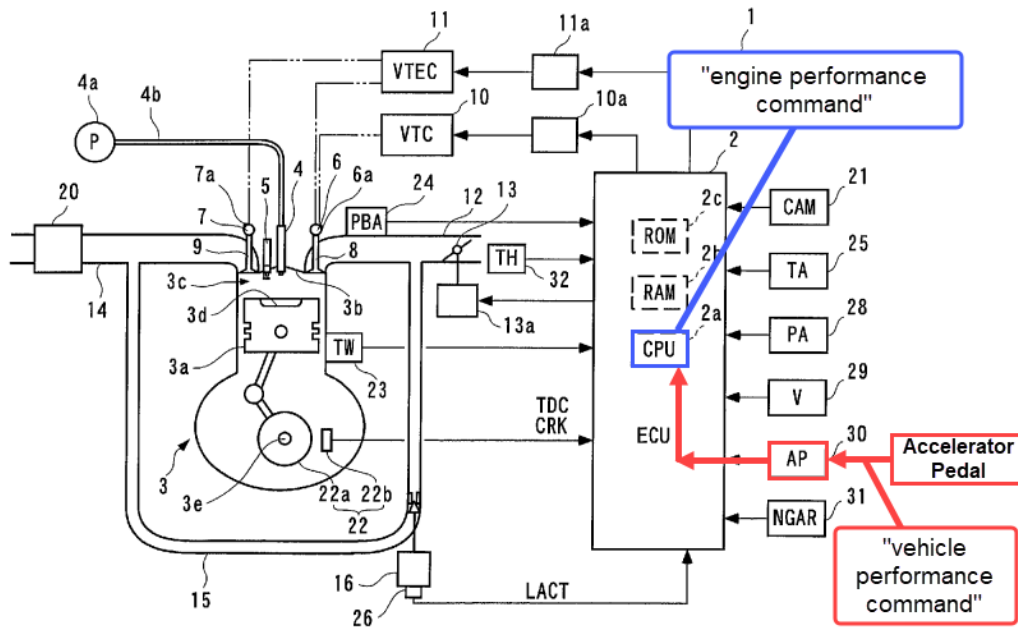
Ogawa discloses obtaining an engine performance command. Ex. 1003 at ¶¶ 84-86. Particularly, Ogawa teaches “the CPU 2a . . . determines a required torque PMCMD outputted by the engine 3,” *i.e.*, an engine performance command, based on “the accelerator pedal opening AP,” “which is an operation amount of an accelerator pedal.” Ex. 1005 at ¶¶ 0070, 0072. Thus, Ogawa discloses a “command,” PMCMD, “that defines a desired engine torque.” The ’540 specification expressly discloses that desired torque is one example of an “engine performance command.” Ex. 1001 at 2:17-18.

Indeed, Ogawa’s disclosure of deriving an engine performance command that is desired engine torque from a signal representing an accelerator pedal opening teaches the preferred embodiment of obtaining an engine performance command described by the ’540 patent. The ’540 patent describes “[t]he action of obtaining an engine performance command . . . preferably includes deriving the engine performance command from the vehicle performance command,” where “the vehicle

performance command is received from the foot of a driver with the use of a conventional pedal.” Ex. 1001 at 2:4-22. Likewise, Ogawa teaches receiving the “accelerator pedal opening AP” from an accelerator pedal operated by a driver, which is then used to “determine a required torque PMCMD,” *i.e.*, the engine performance command. Ex. 1005 at ¶¶ 0070, 0072.



Ex. 1001 at FIG. 1 (annotated).



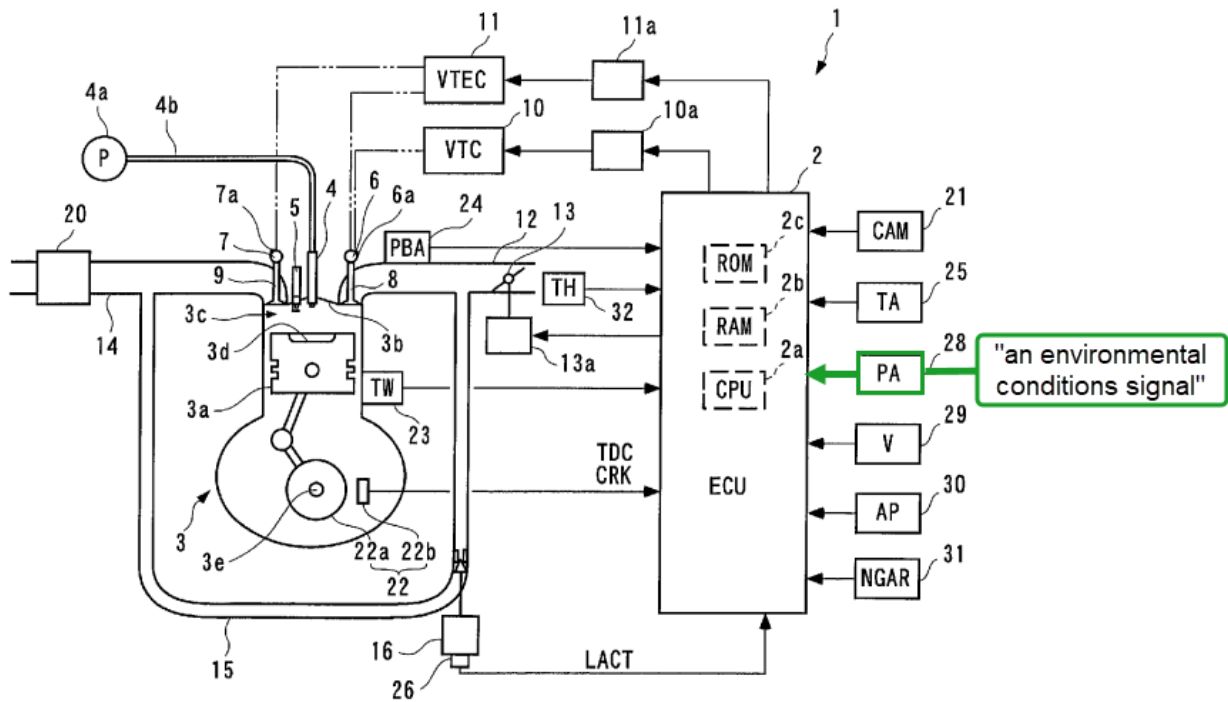
Ex. 1005 at FIG. 1 (annotated).

Thus, Ogawa discloses claim limitation 1[a]. Ex. 1003 at ¶¶ 84-86

c. 1[b]: “receiving an environmental conditions signal;”

Ogawa discloses receiving an environmental conditions signal. Ex. 1003 at ¶¶ 87-90.

Ogawa discloses that its ECU “is further supplied with a signal indicative of a detected atmospheric pressure PA from an atmospheric pressure sensor 28.” Ex. 1005 at ¶ 0070.



Id. at FIG. 1 (annotated).

Receiving an atmospheric or ambient pressure signal as taught by Ogawa is the type of environmental conditions signal the '540 patent describes receiving in its preferred embodiment. Ex. 1001 at 2:23-35.

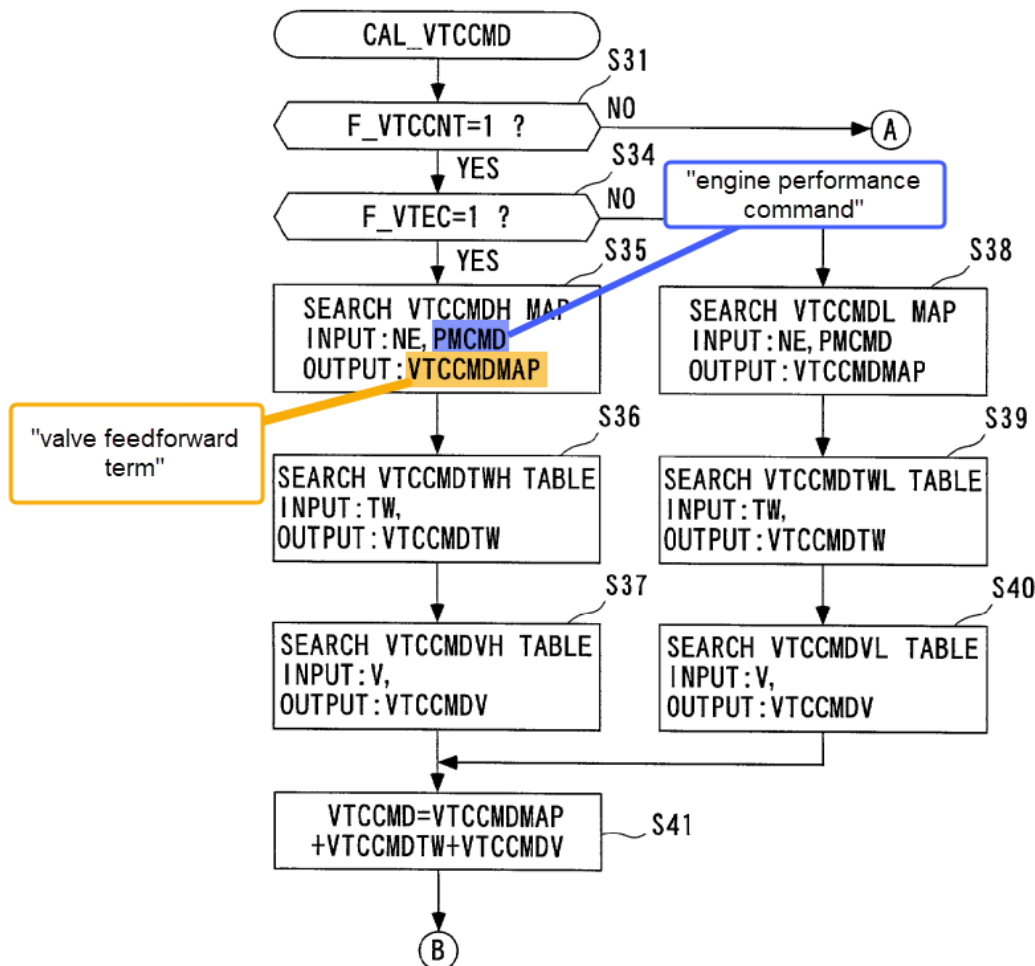
Thus, Ogawa discloses limitation 1[b]. Ex. 1003 at ¶¶ 87-90.

- d. 1[c]: “determining a valve feedforward term based on the engine performance command and the environmental conditions signal;”

Ogawa in view of Yoshioka discloses determining a valve feedforward term based on the engine performance command and the environmental conditions signal. Ex. 1003 at ¶¶ 91-96.

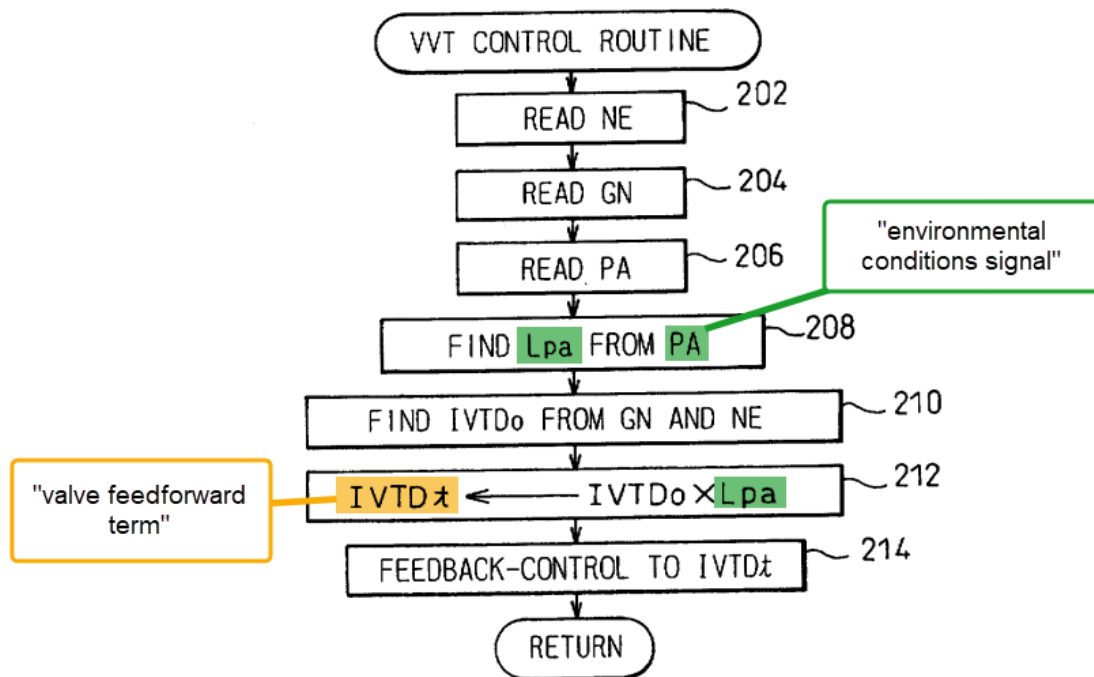
As explained in §§ XI.2.b and c, *supra*, Ogawa discloses obtaining an engine performance command—a desired engine torque PMCMD—and receiving an

environmental conditions signal—an atmospheric pressure signal. Ex. 1003 at ¶¶ 91-96. Ogawa further discloses determining a basic value target valve cam phase VTCCMDMAP, *i.e.*, a valve feedforward term. Ex. 1005 at ¶ 0082. Ogawa teaches that its basic value target valve cam phase is calculated based on “the required torque PMCMD,” *i.e.*, the engine performance command, and engine speed “so that the engine power can be appropriately set in accordance with a particular load.” *Id.* at ¶¶ 0082, 0084, 0116.



Id. at FIG. 3 (annotated).

Likewise, Yoshioka teaches calculating a target timing displacement $IVTD_t$, *i.e.*, a valve feedforward term. Ex. 1006 at 7:41-45. As shown below in Figure 9, Yoshioka determines its target timing displacement $IVTD_t$ by first calculating a correction coefficient L_{pa} based on an atmospheric pressure signal PA , *i.e.*, an environmental conditions signal. Ex. 1006 at 7:57-60. Yoshioka teaches then determining the initial valve displacement $IVTD_0$ based on engine load GN and engine speed NE . *Id.* at 7:63-67. Finally, Yoshioka's valve feedforward term $IVTD_t$ is calculated based on $IVTD_0$ and L_{pa} . *Id.* at 8:1-5.



Id. at FIG. 9 (annotated).

A POSITA would have understood that modifying Ogawa's valve

feedforward term to account for atmospheric pressure, as taught by Yoshioka, would “improve the output of an engine at high altitude under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load.” Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 91-96.

Moreover, a POSITA would have been able to easily modify Ogawa based on Yoshioka’s teachings. A POSITA would have understood that Ogawa’s ECU already receives signals representing atmospheric pressure and engine speed, and that it sets its engine performance command PMCMD according to a particular engine load. Ex. 1006 at ¶¶ 0070, 0116; Ex. 1003 at ¶¶ 91-96. Further, a POSITA would easily be able to modify the code of Ogawa’s ECU to implement the valve feedforward term calculation as taught by Yoshioka based on the atmospheric pressure, engine speed, and engine load data already utilized by Ogawa’s ECU. Ex. 1003 at ¶¶ 91-96.

Thus, Ogawa in view of Yoshioka renders obvious claim limitation 1[c]. *Id.*

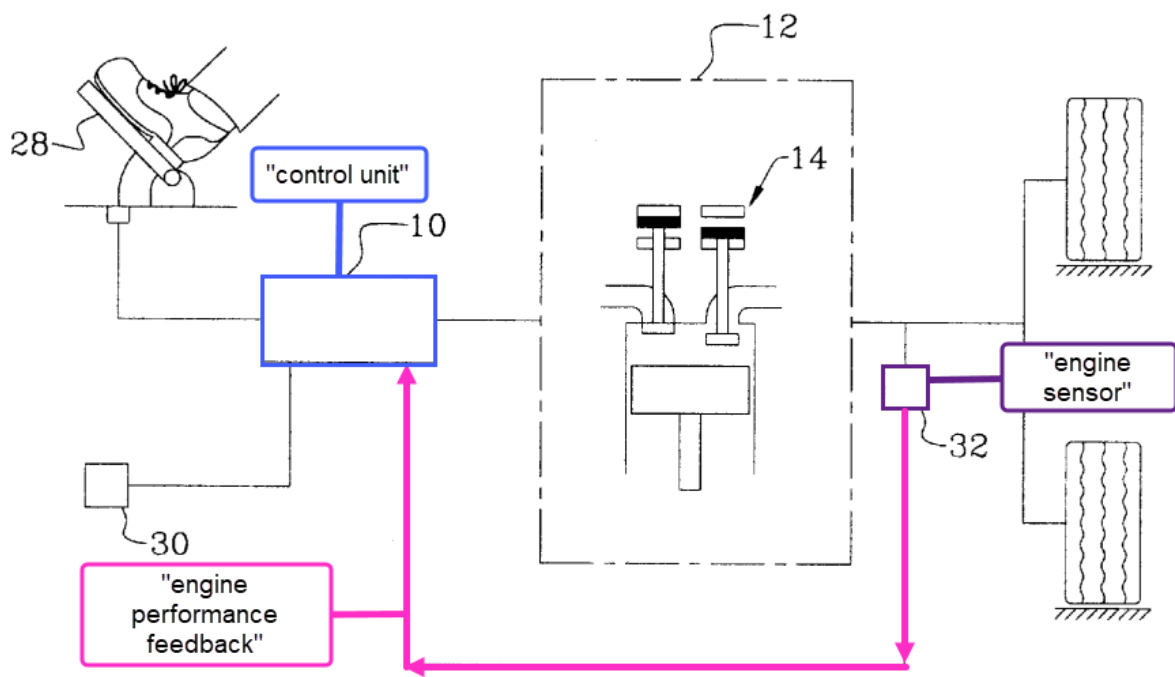
e. *1[d]: “receiving an engine performance feedback;”*

Ogawa discloses receiving an engine performance feedback. Ex. 1003 at ¶¶ 97-100.

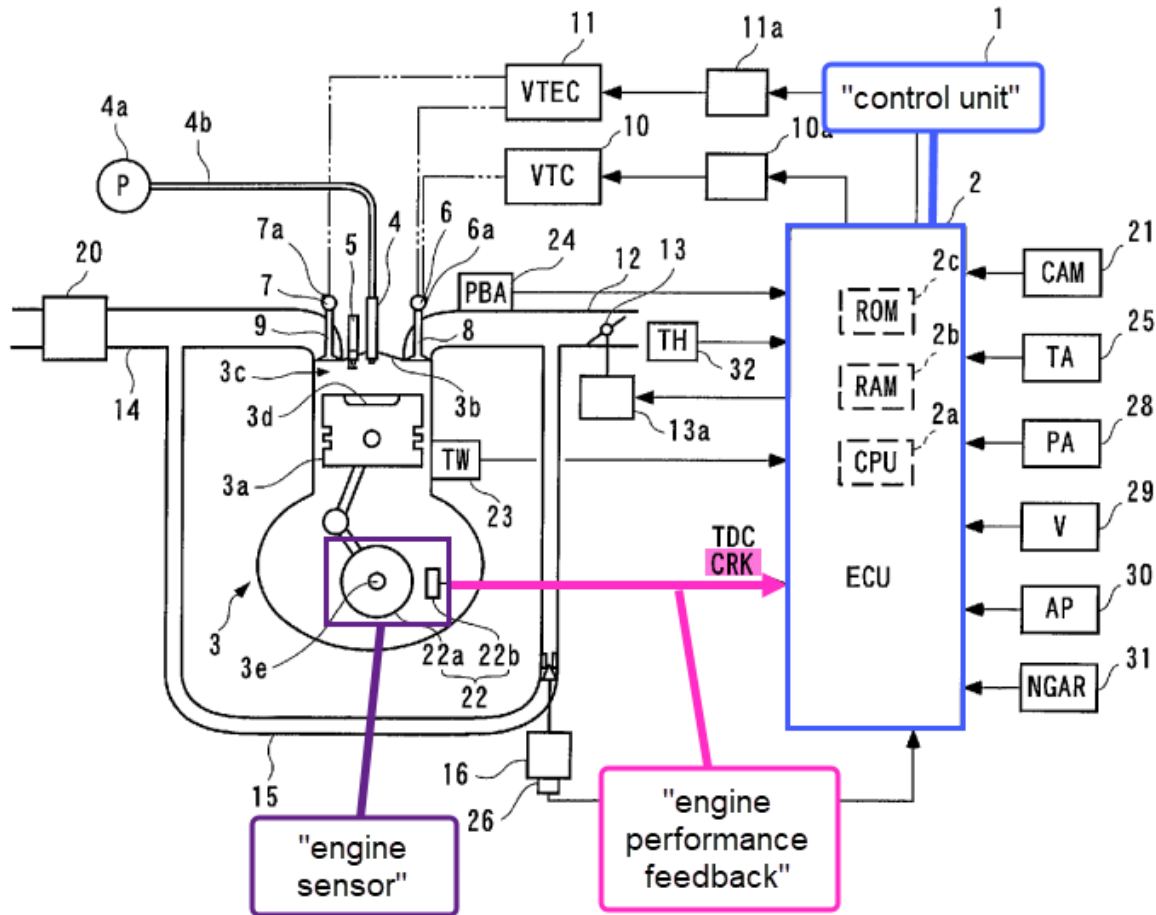
Ogawa discloses “a crank angle sensor 22” that operates as an “engine rotational *speed* detecting means” and “outputs a CRK signal,” *i.e.*, an engine performance feedback, from which “ECU 2 calculates the engine rotational *speed*.” Ex. 1005 at ¶¶ 0064, 0065. Ogawa teaches that the signal CRK is a “pulse signal”

and “[o]ne pulse of the CRK signal is outputted every predetermined crank angle (for example, every 30°).” *Id.* at ¶ 0065. “The ECU 2 calculates the engine rotational speed NE . . . based on the CRK signal.” *Id.*

Indeed, Ogawa’s disclosure of calculating engine speed through its crank angle sensor and subsequent output signal, CRK, teaches the ’540 patent’s preferred embodiment of an engine performance feedback. The ’540 patent describes “receiving an engine performance feedback 22 preferably includes receiving the engine performance feedback from an engine sensor 32 in the vehicle” and that sensor “preferably senses the engine *speed* . . . and communicates this data to the control unit 10.” Ex. 1001 at 2:36-42 (emphasis added). Likewise, Ogawa teaches that its ECU receives the CRK signal, *i.e.*, the engine performance feedback, from a crank angle sensor in the vehicle, *i.e.*, an engine sensor, which is then used to calculate engine rotational speed. Ex. 1005 at ¶¶ 0064, 0065.



Ex. 1001 at FIG. 1 (annotated).



Ex. 1005 at FIG. 1 (annotated).

Thus, Ogawa discloses limitation 1[d]. Ex. 1003 at ¶¶ 97-100.

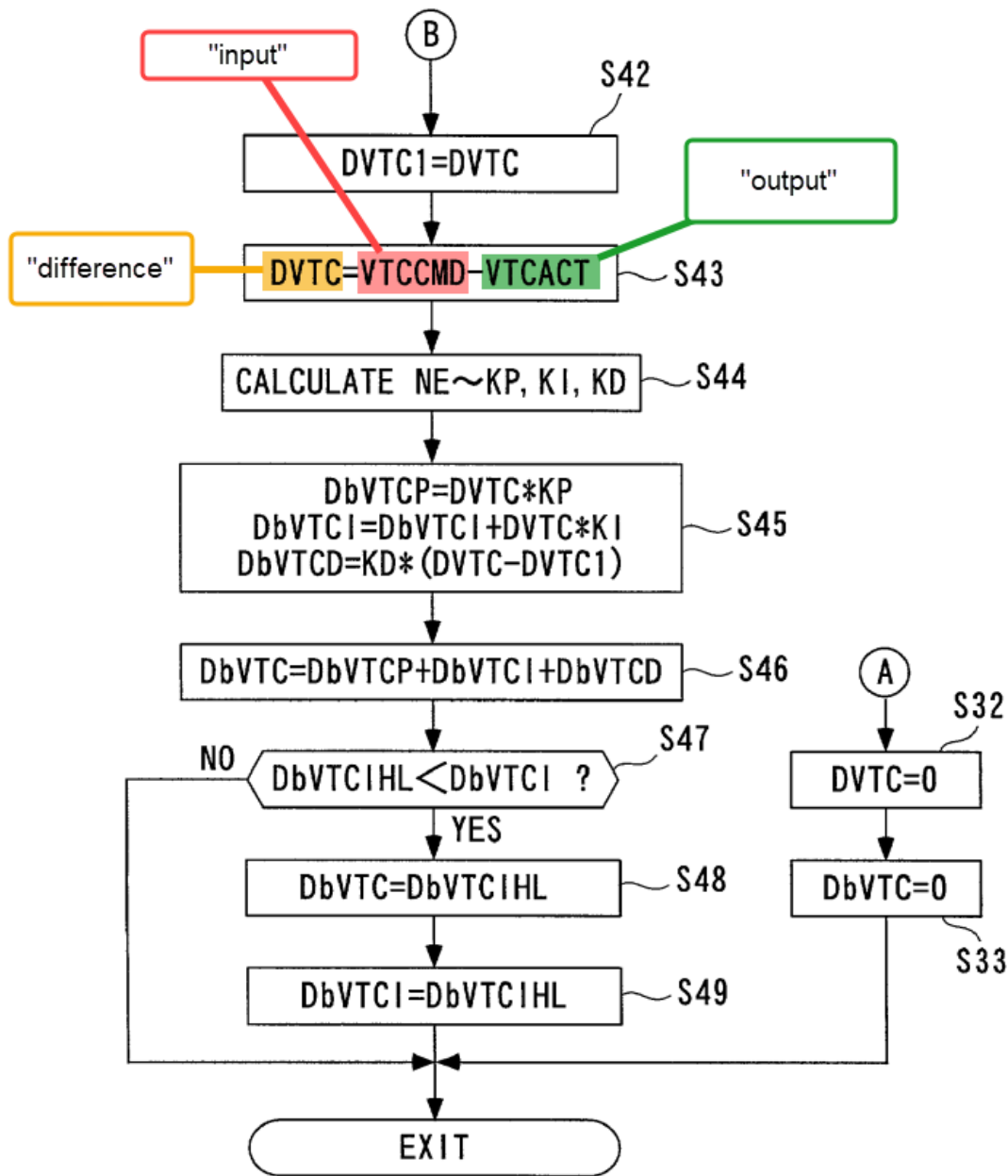
- f. 1[e]: “calculating a valve feedback term based on the engine performance command and the engine performance feedback; and”

Ogawa discloses calculating a valve feedback term based on the engine performance command and the engine performance feedback. Ex. 1003 at ¶¶ 101-107.

The claims place no restriction on how the “valve feedback term” is calculated. The ’540 patent gives one embodiment of the calculation can be done by “compar[ing] [an] input with [an] output and [] calculat[ing] a correction term based

on the difference.” Ex. 1001 at 2:66-3:4.

Ogawa teaches this very method for computing a “valve feedback term.” Ogawa discloses that its ECU “calculates a deviation between the target cam phase VTCCMD,” *i.e.*, an input, “and a detected actual cam phase . . . VTCACT,” *i.e.*, an output, “as a current cam phase deviation DVTC,” *i.e.*, a difference. Thus, Ogawa discloses calculating a valve feedback term DVTC. Ex. 1003 at ¶¶ 101-107.

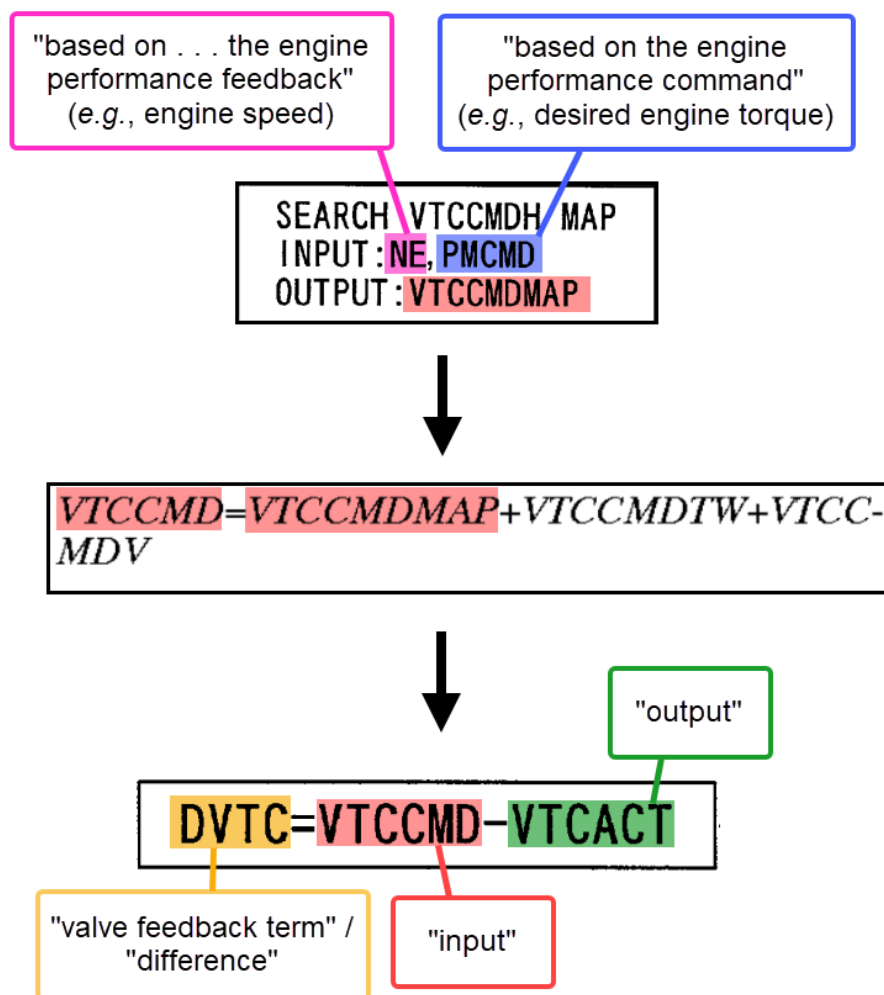


Ex. 1005 at FIG. 4 (annotated.)

Moreover, Ogawa teaches that calculating DVTC is based on an engine performance command and engine performance feedback. Ex. 1003 at ¶¶ 101-107.

As explained in §§ XI.2.b and d, *supra*, respectively, Ogawa's ECU obtains desired

engine torque PMCMD, which is an engine performance command, and signal CRK, which is an engine performance feedback and is used to determine engine rotational speed NE. Ex. 1005 at ¶¶ 0064, 0065, 0070, 0072. As shown in the figure below, Ogawa's valve feedback term DVTC is calculated based on the engine performance command PMCMD and the engine performance feedback CRK. Ex. 1003 at ¶¶ 101-107.



Id. at FIG. 3, (1) (annotated).

Ogawa teaches that “engine rotational speed NE” is calculated based on the

engine performance command CRK. Ex. 1005 at ¶ 0065. Further, engine rotational speed NE and Ogawa’s engine performance command PMCMD are inputs used to calculate basic value target cam phase VTCCMDMAP. *Id.* at ¶ 0084. VTCCMDMAP is further used to calculate adjusted target cam phase VTCCMD. *Id.* at (1). Finally, VTCCMD is the input used to calculate valve feedback term DVTC.

Thus, Ogawa discloses calculating valve feedback term DVTC based on engine performance command PMCMD (required engine torque) and engine performance feedback CRK (engine speed). Ex. 1003 at ¶¶ 101-107.

Thus, Ogawa discloses limitation 1[e]. *Id.*

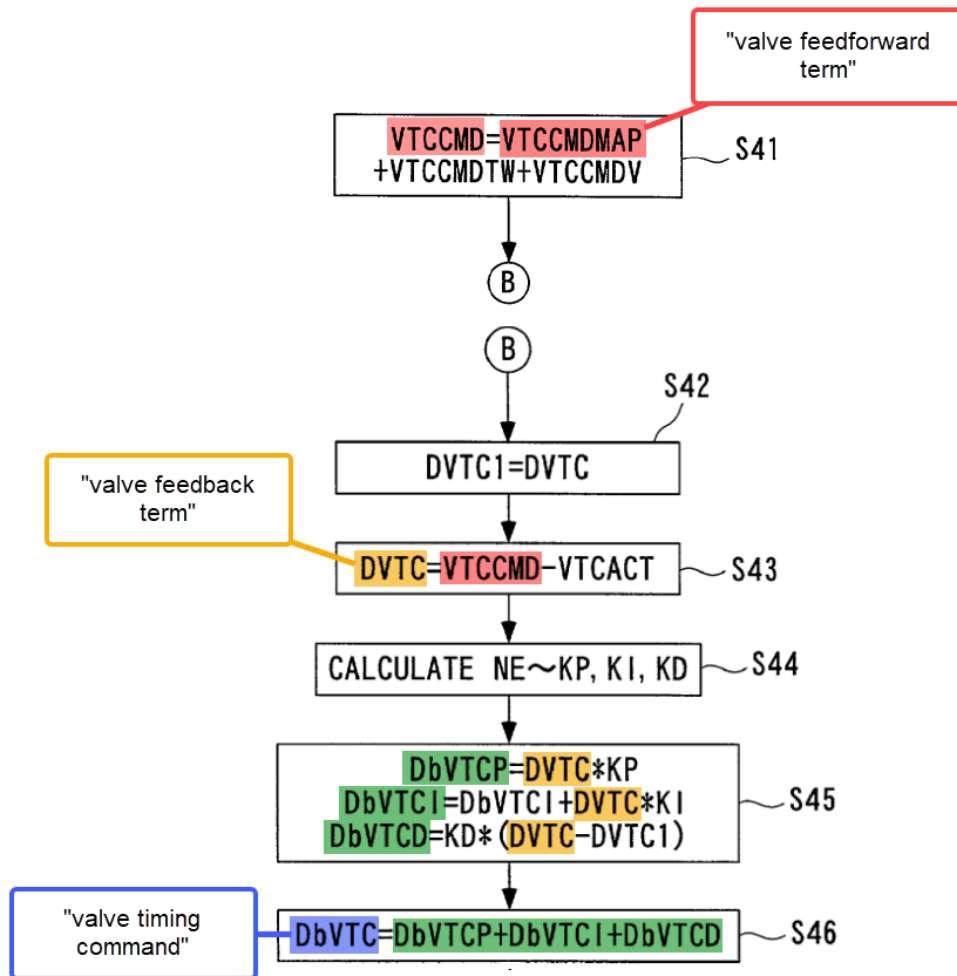
- g. *1[f]: “calculating a valve timing command based on the valve feedforward term and the valve feedback term”*

Ogawa discloses calculating a valve timing command based on the valve feedforward term and the valve feedback term. Ex. 1003 at ¶¶ 108-112.

The claims place no restrictions on how the “valve timing command” is calculated—they merely require that the “valve timing command” be based on the “valve feedforward term” and “valve feedback term.” Ogawa teaches calculating a “valve timing command” based on its “valve feedforward term” and “valve feedback term.”

Particularly, Ogawa teaches calculating a “valve feedforward term,” namely, VTCCMDMAP. Ogawa uses the “valve feedforward term” to calculate a “valve

feedback term,” i.e., Ogawa’s DVTC. In turn, Ogawa’s “valve feedback term” is used to calculate a “valve timing command,” Ogawa’s “DbVTC.” This process flow is depicted across Figures 3 and 4. The annotated figure, below, excerpts these particular steps within the overall system flow:



Id. at FIGS. 3-4 (annotated).

As shown in the figure, Ogawa uses its VTCCMDMAP value (“feedforward term”) to compute the “target cam phase VTCCMD” at step 41. Subsequently, the “target cam phase VTCCMD” (derived from the “feedforward term”) is used to computer Ogawa’s DVTC (“feedback term”) at step 43. In step 45, Ogawa’s

“feedback term” DVTC (derived from its “feedforward term” VTCCMDMAP) is used to generate three values: a P-term (DbVTCP), an I-term (DbVTCI), and a D-term (DbVTCD). These P/I/D-terms—which were derived based on Ogawa’s “feedforward” and “feedback” terms—are then added to generate Ogawa’s “valve timing command” (DbVTC) at step 46. Thus, Ogawa teaches calculating a “valve timing command” (DbVTC) based on “feedforward” (VTCCMDMAP) and “feedback” (DVTC) terms.

Therefore, Ogawa discloses calculating a valve timing command DbVTC based on the valve feedback term DVTC and the valve feedforward term VTCCMDMAP. Ex. 1003 at ¶¶ 108-112.

Thus, Ogawa discloses limitation 1[f]. *Id.*

3. Claim 2:

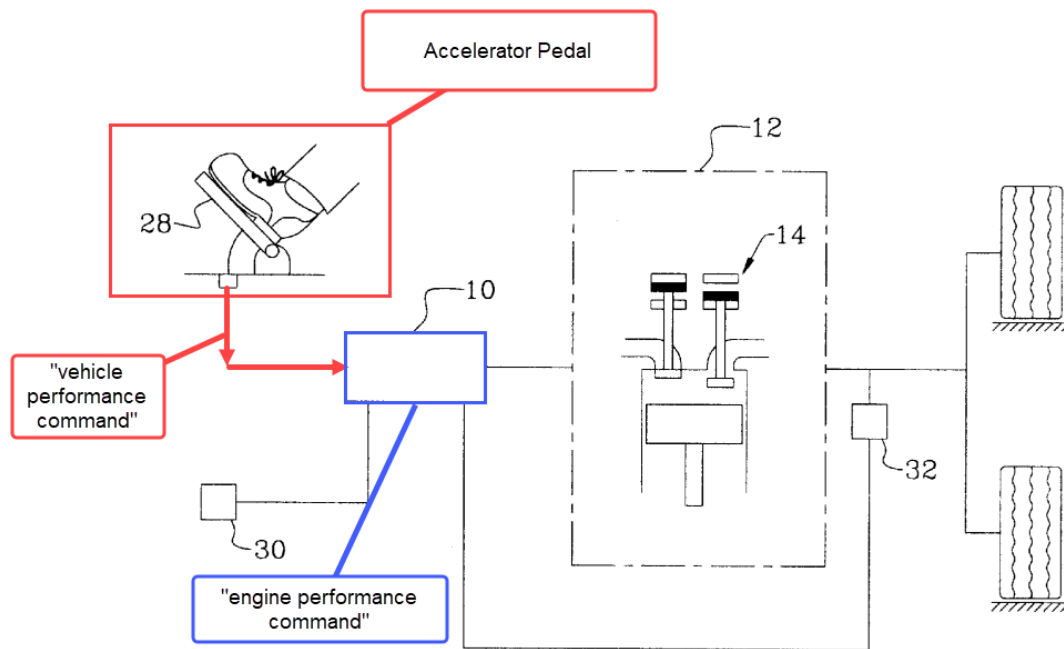
- a. *“The method of claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.”*

Ogawa in view of Yoshioka discloses the method of claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command. Ex. 1003 at ¶¶ 113-116.

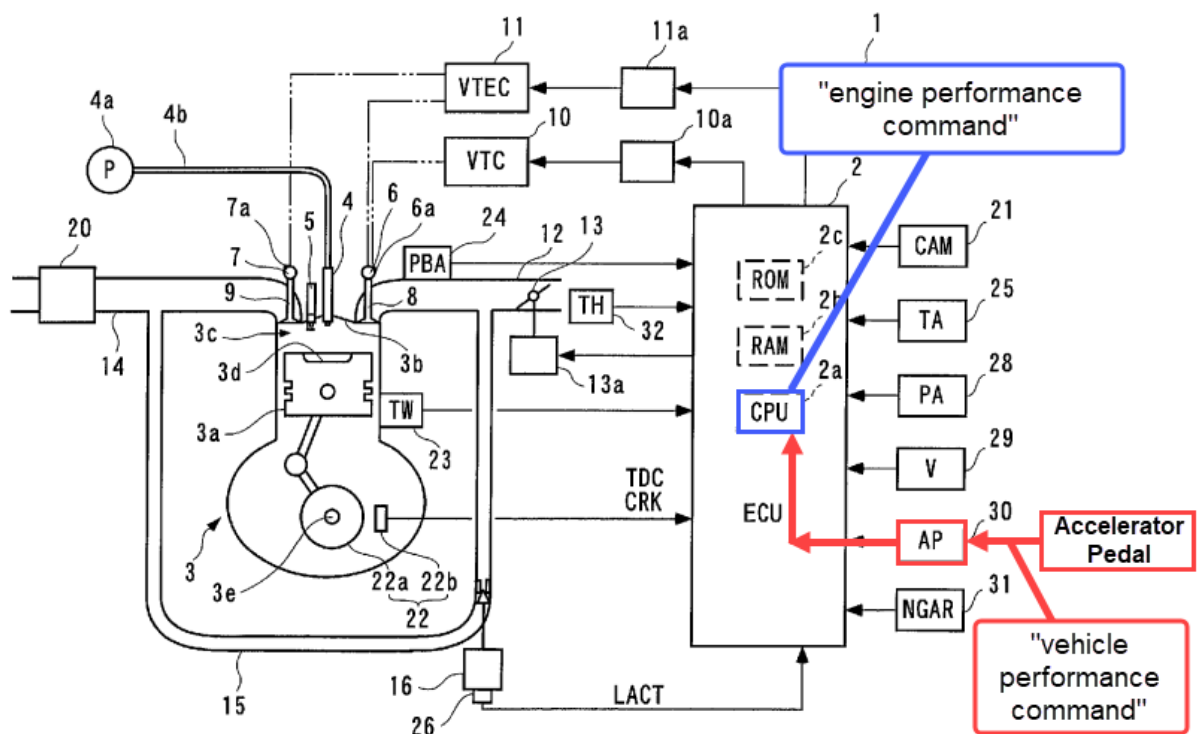
As explained in § XI.2, *supra*, Ogawa in view of Yoshioka discloses the

method of claim 1. Moreover, Ogawa teaches “the CPU 2a . . . determines a required torque PMCMD outputted by the engine 3,” *i.e.*, an engine performance command, based on “the accelerator pedal opening AP,” “which is an operation amount of an accelerator pedal,” *i.e.*, a vehicle performance command. Ex. 1005 at ¶¶ 0070, 0072. The ’540 specification expressly discloses that desired torque is one example of an “engine performance command,” and that a signal “received from the foot of a driver with the use of a conventional pedal” is one example of a “vehicle performance command.” Ex. 1001 at 2:4-18.

Indeed, Ogawa’s disclosure of deriving an engine performance command that is desired engine torque from a signal representing accelerator pedal opening teaches the ’540 patent’s preferred embodiment of the limitation. The ’540 patent describes “[t]he action of obtaining an engine performance command . . . preferably includes deriving the engine performance command from the vehicle performance command,” where “the vehicle performance command is received from the foot of a driver with the use of a conventional pedal.” Ex. 1001 at 2:4-22. Likewise, Ogawa teaches receiving the “accelerator pedal opening AP” from an accelerator pedal operated by a driver, which is then used to “determine a required torque PMCMD,” *i.e.*, the engine performance command. Ex. 1005 at ¶¶ 0070, 0072.



Ex. 1001 at FIG. 1 (annotated).



Ex. 1005 at FIG. 1 (annotated).

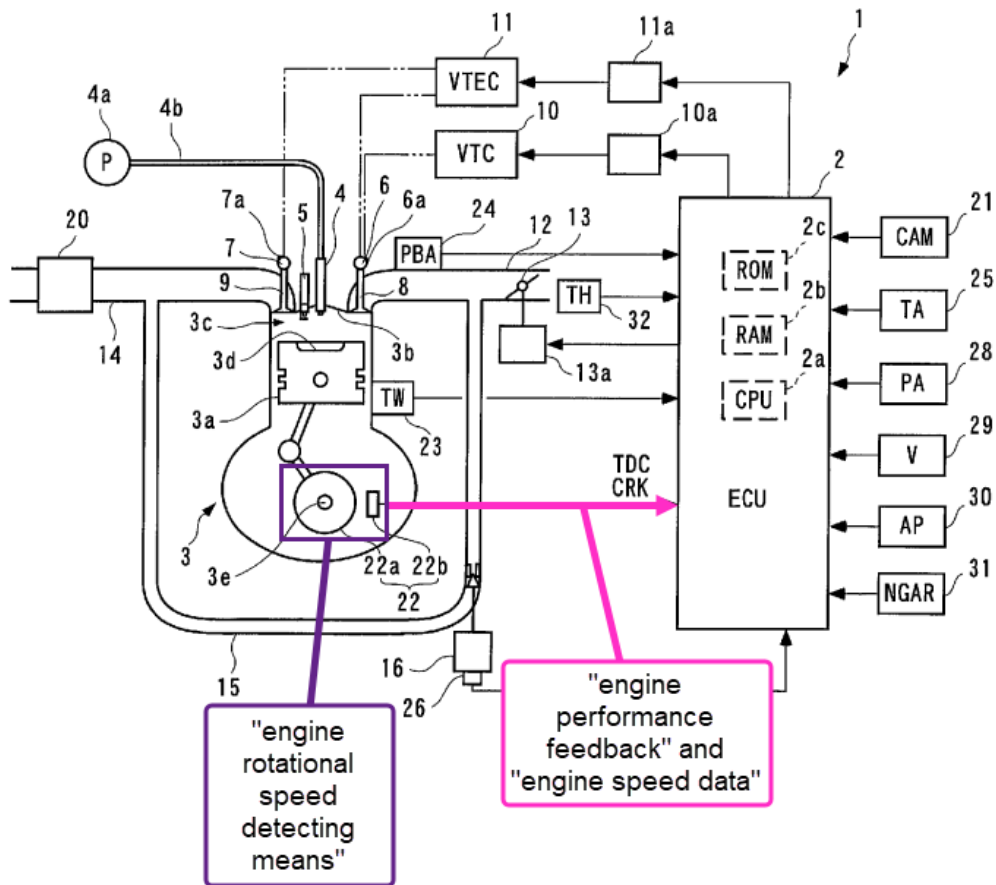
Thus, Ogawa in view of Yoshioka renders obvious claim 2. Ex. 1003 at ¶¶ 113-116.

4. Claim 7:

- a. *“The method of claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data.”*

Ogawa in view of Yoshioka discloses the method of claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data. Ex. 1003 at ¶¶ 117-119.

As explained in § XI.2, *supra*, Ogawa in view of Yoshioka discloses the method of claim 1. Moreover, Ogawa discloses “a crank angle sensor 22” that operates as an “engine rotational speed detecting means” and “outputs a CRK signal,” *i.e.*, an engine performance feedback, from which “ECU 2 calculates the engine rotational speed,” *i.e.*, the received CRK signal is engine speed data. Ex. 1005 at ¶¶ 0064, 0065. Particularly, Ogawa teaches that the signal CRK is a “pulse signal” and “[o]ne pulse of the CRK signal is outputted every predetermined crank angle (for example, every 30°),” *i.e.*, engine speed data. *Id.* at ¶ 0065. “The ECU 2 calculates the engine rotational speed NE . . . based on the CRK signal.” *Id.*



Id. at FIG. 1 (annotated).

Thus, Ogawa in view of Yoshioka discloses claim 7. Ex. 1003 at ¶¶ 117-119.

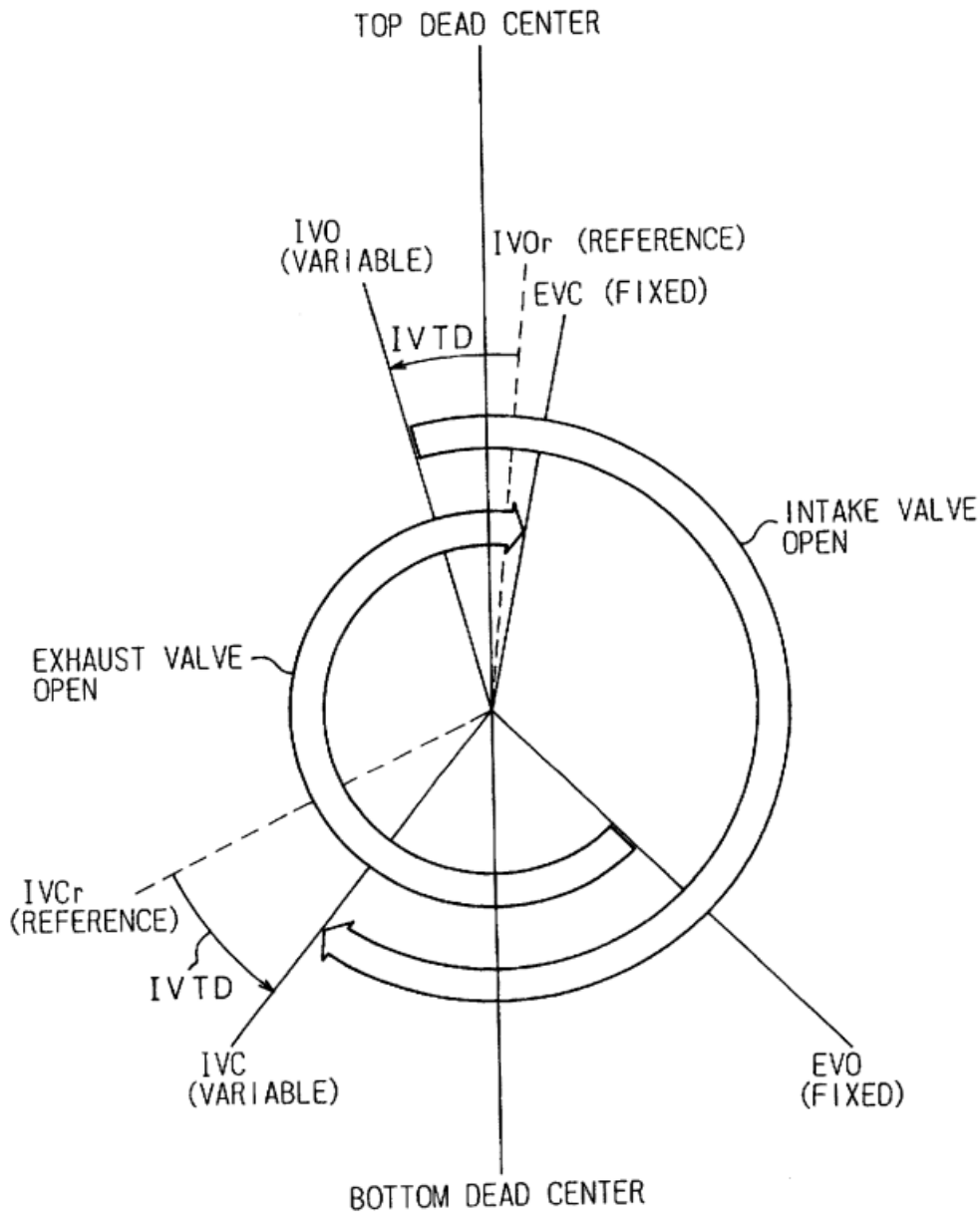
5. Claim 10:

- a. *“The method of claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.”*

Ogawa in view of Yoshioka renders obvious the method of claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command. Ex. 1003 at ¶¶ 120-125.

As explained in § XI.2, *supra*, Ogawa in view of Yoshioka discloses the

method of claim 1. Moreover, Yoshioka discloses calculating an EVO command, an EVC command, an IVO command, and an IVC command. Yoshioka discloses that its method includes calculating “crank angles corresponding to the open/close timing of the intake and exhaust valves.” Ex. 1006 at 6:16-18. Yoshioka teaches calculating “a fixed value open timing EVO” at which “[t]he exhaust valve 26 is opened,” *i.e.*, an EVO command. *Id.* at 6:18-19. Yoshioka further discloses the exhaust valve “is closed at fixed valve close timing EVC,” *i.e.*, an EVC command. *Id.* at 6:18-22. With respect to its intake valve, Yoshioka discloses calculating a “variable valve opening timing IVO and close timing IVC,” *i.e.*, IVO and IVC commands. *Id.* at 6:22-24. Moreover, Yoshioka discloses that calculating its valve timing displacement IVTD, *i.e.*, a valve timing command, includes calculating the valve opening and closing timings because such open and closing times are dependent on valve timing displacement IVTD. *Id.* at 6:25-36. Thus, Yoshioka discloses calculating a valve timing command, IVTD, which includes calculating an EVO command, an EVC command, an IVO command, and an IVC command. Ex. 1003 at ¶¶ 120-125. The valve displacement defined by each of these commands are shown below in Yoshioka’s Figure 3.



Id. at FIG. 3.

A POSITA would have understood that modifying Ogawa’s valve timing command calculation method to calculate EVO, EVC, IVO, and IVC commands, as taught by Yoshioka, would “improve the output of an engine at high altitude under

high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load.” Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 120-125.

Moreover, a POSITA would have been able to easily modify Ogawa based on Yoshioka’s teachings. A POSITA would have understood that Ogawa’s ECU already calculates a target valve timing displacement VTCCMD. Ex. 1006 at ¶¶ 0070, 0116; Ex. 1003 at ¶¶ 120-125. Further, a POSITA would easily be able to modify the code of Ogawa’s ECU to implement the calculation as taught by Yoshioka to calculate an EVO, EVC, IVO, and IVC command based on the target displacement VTCCMD Ogawa already calculates. Ex. 1003 at ¶¶ 120-125.

Thus, Ogawa in view of Yoshioka discloses claim 10. Ex. 1003 at ¶¶ 120-125.

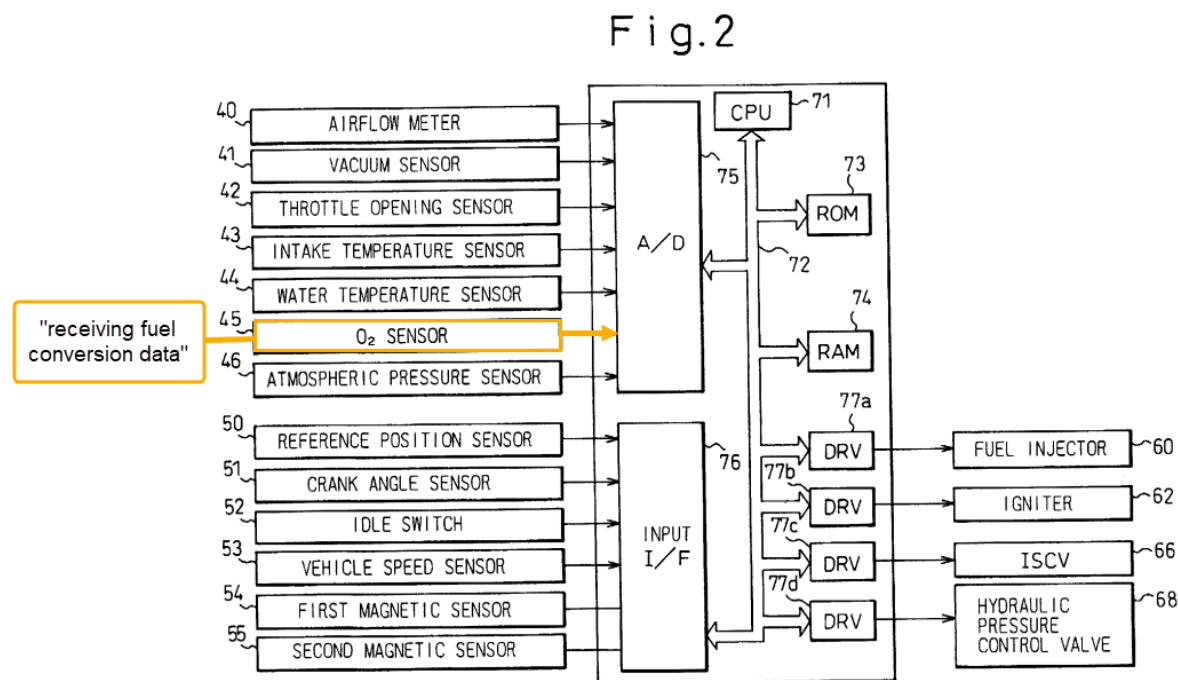
6. Claim 11:

- a. *“The method of claim 1 further comprising receiving fuel conversion data.”*

Ogawa in view of Yoshioka discloses the method of claim 1 further comprising receiving fuel conversion data. Ex. 1003 at ¶¶ 126-131.

As explained in § XI.2, *supra*, Ogawa in view of Yoshioka discloses the method of claim 1. Moreover, Yoshioka discloses “an air-fuel ratio feedback correction according to a signal from [an] O₂ sensor 45” that is located at the exhaust pipe and “detect[s] the concentration of the oxygen in the exhaust gas,” *i.e.*, fuel

conversion data. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54. Yoshioka further teaches that the fuel conversion data from its O₂ sensor is received by Yoshioka's ECU:



Id. at FIG. 2 (annotated).

Yoshioka's disclosure of receiving fuel conversion data from its O₂ sensor teaches the preferred embodiment of receiving fuel conversion data as described by the '540 patent. The '540 patent describes the "action of receiving fuel conversion data . . . preferably include[s] receiving the fuel conversion data . . . from suitable emission sensors . . . in the . . . exhaust port of the engine." Ex. 1001 at 3:27-34. Likewise, Yoshioka teaches receiving concentration of oxygen in Yoshioka's exhaust gas via an O₂ sensor located in the system's exhaust pipe. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54.

Moreover, a POSITA would have understood that modifying Ogawa's ECU to receive fuel conversion data from an O₂ sensor, as taught by Yoshioka, would "improve the output of an engine at high altitude under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load." Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 126-131.

A POSITA would have been able to easily modify Ogawa based on Yoshioka's teachings. A POSITA would have understood that Ogawa's ECU already receives signals from a number of sensors and could be modified to receive a signal from an O₂ sensor placed in the system's exhaust pipe. Ex. 1003 at ¶¶ 126-131. Further, a POSITA would easily be able to modify the code of Ogawa's ECU to read the data from the O₂ sensor. Ex. 1003 at ¶¶ 126-131.

Thus, Ogawa in view of Yoshioka renders obvious claim 11. *Id.*

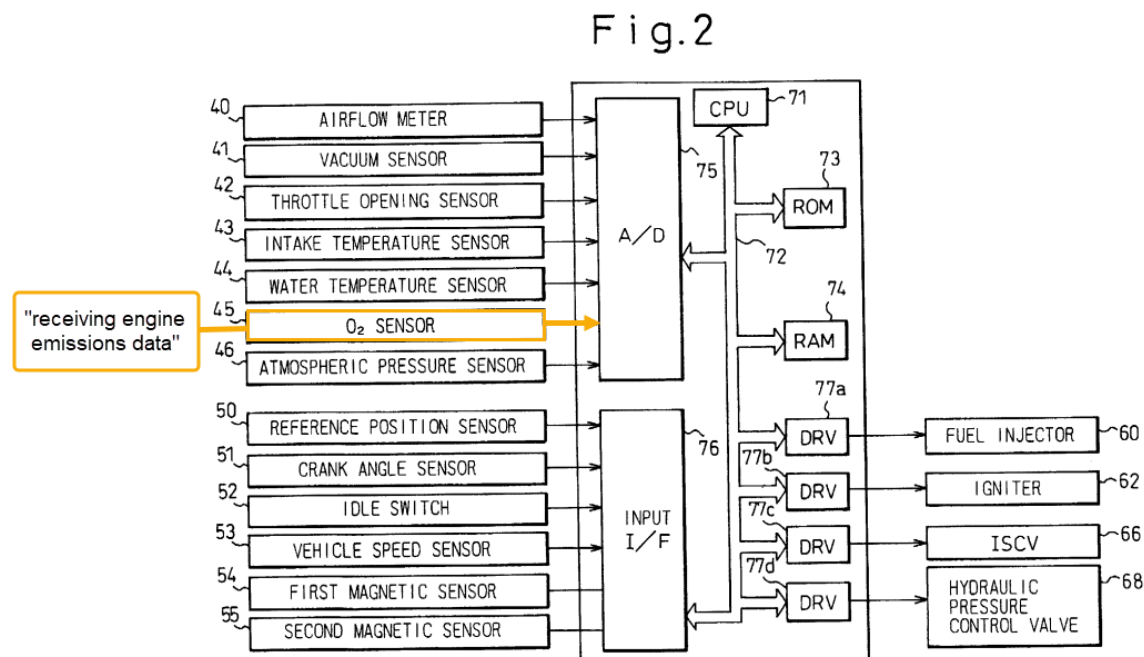
7. Claim 14:

- a. *"The method of claim 1 further comprising receiving engine emissions data."*

Ogawa in view of Yoshioka discloses the method of claim 1 further comprising receiving engine emissions data. Ex. 1003 at ¶¶ 132-137.

As explained in § XI.2, *supra*, Ogawa in view of Yoshioka discloses the method of claim 1. Moreover, Yoshioka discloses an "O₂ sensor 45" that is located at the exhaust pipe and "detect[s] the concentration of the oxygen in the exhaust gas," *i.e.*, engine emissions data. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54.

Yoshioka further teaches that engine emissions data from its O₂ sensor is received by Yoshioka's ECU:



Id. at FIG. 2 (annotated).

Yoshioka's disclosure of receiving engine emissions data teaches the step of receiving engine emissions data as described by the '540 patent's preferred embodiment. The '540 patent describes the "action of receiving . . . engine emissions data . . . preferably include[s] receiving the . . . engine emissions data from suitable emissions sensors . . . in the . . . exhaust port of the engine." Ex. 1001 at 3:27-34. Likewise, Yoshioka teaches receiving data regarding the concentration of oxygen in Yoshioka's exhaust gas via an O₂ sensor located in the systems exhaust pipe. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54.

A POSITA would have understood that modifying Ogawa's ECU to receive

engine emissions data from an O₂ sensor, as taught by Yoshioka, would “improve the output of an engine at high altitude under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load.” Ex. 1006 at 1:44-49; Ex. 1003 at ¶¶ 132-137.

Moreover, a POSITA would have been able to easily modify Ogawa based on Yoshioka’s teachings. A POSITA would have understood that Ogawa’s ECU already receives signals from a number of sensors and could be modified to receive a signal from an O₂ sensor placed in the system’s exhaust pipe. Ex. 1003 at ¶¶ 132-137. Further, a POSITA would easily be able to modify the code of Ogawa’s ECU to read the engine emissions data from the O₂ sensor. Ex. 1003 at ¶¶ 132-137.

Thus, Ogawa in view of Yoshioka renders obvious claim 14. *Id.*

XII. GROUND 2: THE COMBINATION OF YOSHIOKA, OGAWA, AND JANKOVIC RENDERS OBVIOUS CLAIMS 1-2, 7, 10-11, AND 14.

A POSITA at the time of the alleged invention would have found claims 1-2, 7, 10-11, and 14 obvious over Yoshioka in view of Ogawa and Jankovic.

1. Motivation to Combine Yoshioka with Ogawa

A POSITA viewing Yoshioka’s methods for calculating valve timing commands would have been motivated to obtain an engine performance command, determine a valve feedforward and valve feedback term based on that command, and receive a vehicle performance command as taught by Ogawa for a variety of reasons.

First, a POSITA would have understood that modifying Yoshioka’s valve

timing command calculation based on Ogawa's teachings, including modifying the method to calculate valve feedback and feedforward terms based on an engine performance command, would enable Yoshioka's method to "set[] a valve timing in accordance with an engine load even in the stratified combustion mode," which would enable Yoshioka's method to maintain fuel efficiency while "ensuring required engine power." Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 138-142.

Second, Ogawa discloses that implementing its teachings regarding an engine performance command and calculating valve feedforward and feedback terms enables the method to ensure required engine power even when there are changes in throttle valve opening, intake pipe inner pressure, the amount of intake air, or other engine operation variables. Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 138-142. Particularly, Ogawa discloses that its "CPU 2a . . . determines a required torque PMCMD outputted by the engine 3," *i.e.*, an engine performance command, based on "the accelerator pedal opening AP," "which is an operation amount of an accelerator pedal," *i.e.*, a vehicle performance command. Ex. 1005 at ¶¶ 0070, 0072. Ogawa further discloses calculating a valve feedforward term VTCCMDMAP and a valve feedback term DVTC based on the engine performance command PMCMD. Ex. 1005 at ¶¶ 0082, 0084, 0116.

Thus, a POSITA would have been motivated to modify Yoshioka's methods for calculating a valve timing command to calculate a valve feedforward and feedback term based on an engine performance command derived from a vehicle

performance command, as taught by Ogawa, to set valve timing in accordance with engine load while maintaining fuel efficiency, and ensure required engine power even when there is variability in engine operation, such as varying intake pressure or amount of intake air. Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 138-142.

A POSITA would likewise be motivated to combine the teachings of Yoshioka and Ogawa because they are both in the ***same field of endeavor*** as the '540 patent, controlling engine valve timing. Ex. 1001 at Abstract; Ex. 1005 at Abstract; Ex. 1006 at Abstract. As discussed below, both Yoshioka and Ogawa use ***similar techniques to solve the same problem*** as the '540 patent—indeed, Yoshioka discloses nearly all of the limitations of claims 1-2, 7, 10, 11, and 14, and Ogawa discloses obtaining an engine performance command, determining a valve feedforward term based on the engine performance command, calculating a valve feedback term based on the engine performance command, and receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command as claimed in claims 1 and 2.

Moreover, a POSITA would have had a ***reasonable expectation of success*** of applying Ogawa's teachings to Yoshioka's valve timing control methods, including at least because Yoshioka's ECU already receives information from a "throttle sensor 42" that "detects the opening of the throttle valve 5." Ex. 1006 at 4:20-21. A POSITA would understand that in a vehicle where acceleration is controlled via

an accelerator pedal, data from a throttle sensor like Yoshioka's is indicative of how far the accelerator pedal has been pushed down from which, as taught by Ogawa, a desired engine torque engine performance command may be derived. Ex. 1003 at ¶¶ 138-142. A POSITA would easily be able to modify the code of Yoshioka's ECU to determine the desired engine torque engine performance command from the throttle opening data, which is indicative of accelerator position, and calculate a valve feedforward and valve feedback term based on that engine performance command as taught by Ogawa. Ex. 1003 at ¶¶ 138-142.

A POSITA would have therefore been motivated to modify Yoshioka's methods for controlling engine valve timing to obtain an engine performance command and calculate a valve feedback and valve feedforward term based on that command because it would enable Yoshioka's method to (1) set valve timing in accordance with engine load while maintaining fuel efficiency, and (2) to ensure required engine power even when there is variability in engine operation, such as varying intake pipe pressure or amount of intake air. Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 138-142; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) ("The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.").

2. Motivation to Combine Yoshioka and Ogawa with Jankovic

A POSITA viewing Yoshioka's methods for calculating valve timing commands, modified based on the teachings of Ogawa, would have been motivated

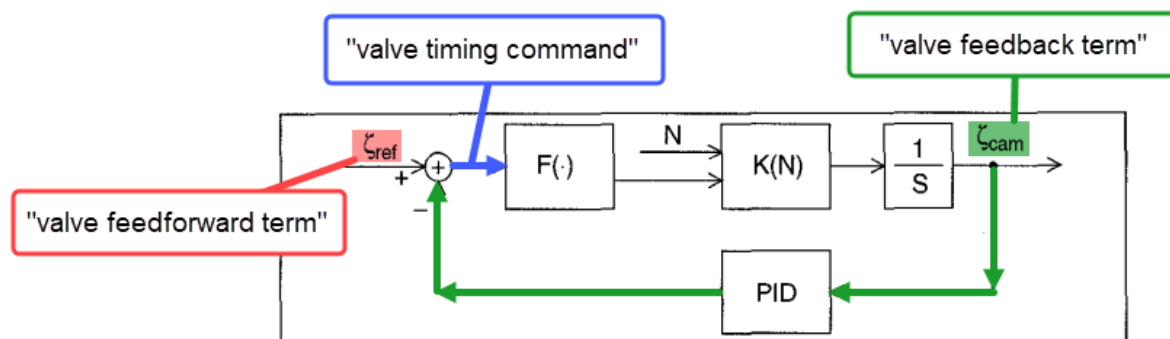
to modify the Yoshioka-Ogawa combination to calculate a valve timing command based on a valve feedforward term and a valve feedback term as taught by Jankovic because it would enable Yoshioka's method to reduce engine emissions and optimize valve timing during a wide range of engine operating conditions.

First, a POSITA would understand that Yoshioka already discloses calculating a valve timing command from a valve feedback and valve feedforward term. As explained in §§ XI.2.d and f, *infra*, Yoshioka discloses calculating a valve feedforward term IVTDt and a valve feedback term to use feedback control to bring the displacement of the intake valve to the target displacement. Yoshioka further discloses using IVTDt, *i.e.*, the valve feedforward term, and the feedback control, *i.e.*, the valve feedback term, to calculate control signals for the hydraulic control valve 68, *i.e.*, a valve timing command, to bring the actual displacement of the intake valve to the target displacement. Ex. 1006 at 8:5-7. Because Yoshioka teaches calculating a feedforward term, using feedback control based on that feedforward term, and controlling valve displacement based on the feedforward term and feedback control, a POSITA would recognize that Yoshioka's method calculates a valve timing command based on a valve feedforward and valve feedback term. Ex. 1003 at ¶¶ 143-148.

Moreover, even if Yoshioka did not disclose calculating a valve timing command, a POSITA would have been motivated to calculate a valve timing command based on a valve feedforward term and a valve feedback term because, as

taught by Jankovic, doing so would enable Yoshioka's method to reduce engine emissions and optimize valve timing during a wide range of engine operating conditions.

A POSITA would have understood that modifying Yoshioka's valve timing control method to use a feedback loop that calculates a valve timing command based on a feedforward and feedback term, as taught by Jankovic, would reduce engine emissions and optimize valve timing during a wide range of engine operating conditions. Ex. 1007 at 34; Ex. 1003 at ¶¶ 143-148. In particular, Jankovic teaches calculating a cam phasing command that controls a valve cam shaft phase, *i.e.*, a valve timing command, in a "feedback loop" based on a valve feedback term cam position ζ_{cam} and a valve feedforward term ζ_{ref} . Ex. 1007 at 36, 40, 41.



Id. at FIG. 8 (annotated).

Thus, a POSITA would have been motivated to modify Yoshioka's method to calculate a valve timing command based on valve feedforward and valve feedback terms to reduce engine emissions and optimize valve timing during a wide range of engine operating conditions. Ex. 1007 at 34; Ex. 1003 at ¶¶ 143-148.

A POSITA would likewise be motivated to modify Yoshioka based on the teachings of Jankovic because they are both in the ***same field of endeavor*** as the '540 patent, controlling engine valve timing. Ex. 1001 at Abstract; Ex. 1006 at Abstract; Ex. 1007 at 34-45. As discussed below, both Yoshioka and Jankovic use ***similar techniques to solve the same problem*** as the '540 patent—indeed, Yoshioka discloses nearly all of the limitations of claims 1-2, 7, 10, 11, and 14, and Jankovic discloses calculating a valve timing command based on a valve feedforward and valve feedback term as claimed in claim 1.

Moreover, a POSITA would have had a ***reasonable expectation of success*** of applying Jankovic's teachings to Yoshioka's valve timing control methods, including at least because Yoshioka already discusses calculating a valve timing command based on a valve feedforward and feedback term. Ex. 1006 at 8:5-7; Ex. 1003 at ¶¶ 143-148. Moreover, even if Yoshioka did not disclose calculating a valve timing command, a POSITA would have easily been able to modify the code of Yoshioka's ECU based on Jankovic's teachings to calculate a valve timing command based on the valve feedforward term and valve feedback term. Ex. 1003 at ¶¶ 143-148.

A POSITA would therefore have been motivated to modify Yoshioka's methods to calculate a valve timing command based on the valve feedforward and feedback term as taught by Jankovic because it would enable Yoshioka's method to reduce engine emissions and optimize valve timing during a wide range of engine

operating conditions. Ex. 1007 at 34; Ex. 1003 at ¶¶ 143-148; *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) (“The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.”).

3. Claim 1

- a. *1[pre]: “A method for calculating a valve timing command for an engine of a vehicle, comprising:”*

Yoshioka discloses a method for calculating a valve timing command for an engine vehicle. Ex. 1003 at ¶¶ 149-150. Yoshioka teaches a method that “controls a continuously variable valve timing mechanisms of [a vehicle’s] internal combustion engine to continuously and variably control the timing of an intake valve.” Ex. 1006 at Abstract, 4:38-47. Particularly, Yoshioka teaches methods for calculating a target valve displacement IVTDt and controls to Yoshioka’s hydraulic valve control, *i.e.*, a valve timing command, that brings the displacement of the engine’s intake valve to the target displacement. *Id.* at 8:5-7.

Thus, Yoshioka discloses the preamble of claim 1. Ex. 1003 at ¶¶ 149-150.

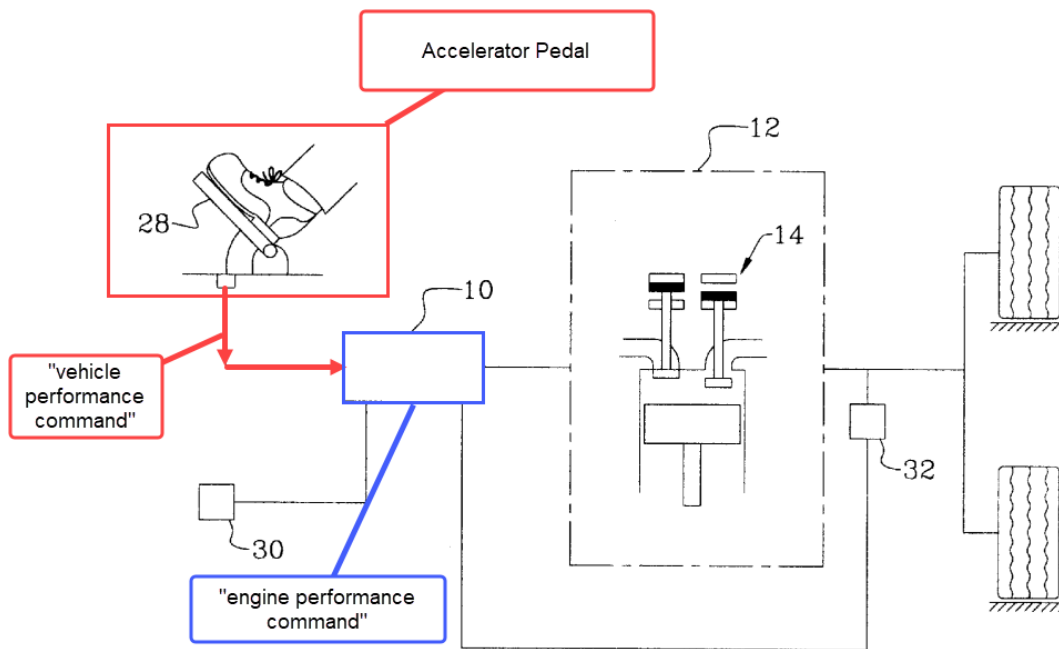
- b. *1[a]: “obtaining an engine performance command;”*

Yoshioka in view of Ogawa discloses obtaining an engine performance command. Ex. 1003 at ¶¶ 151-156.

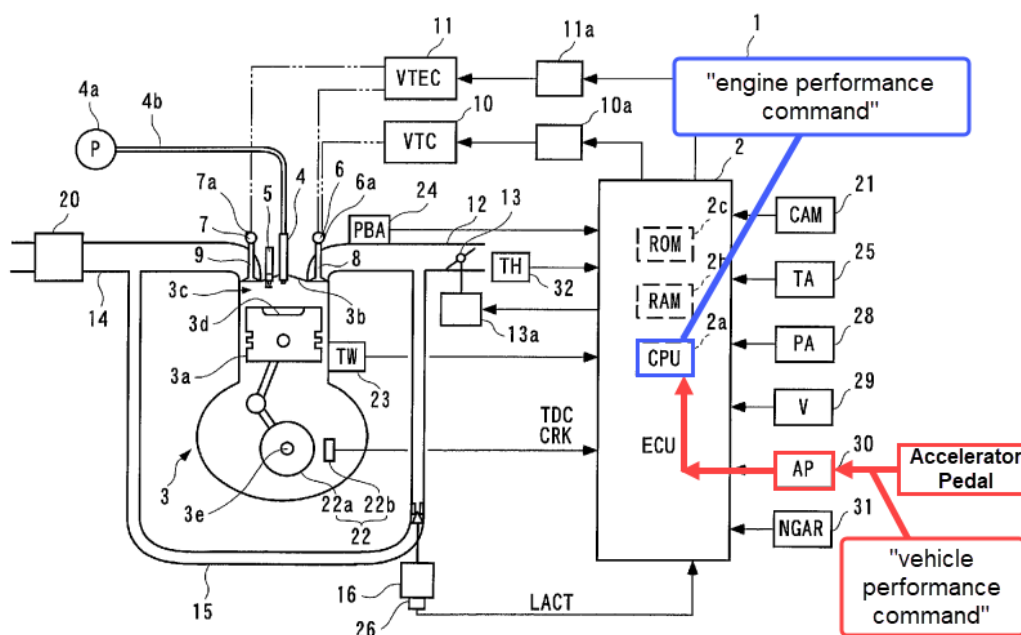
Particularly, Ogawa teaches “the CPU 2a . . . determines a required torque PMCMD outputted by the engine 3,” *i.e.*, an engine performance command based on “the accelerator pedal opening AP,” “which is an operation amount of an

accelerator pedal.” Ex. 1005 at ¶¶ 0070, 0072. Thus, Ogawa discloses a “command,” *i.e.*, PMCMD, “that defines a desired engine torque.” The ’540 specification expressly discloses that desired torque is one example of an “engine performance command.” Ex. 1001 at 2:17-18.

Indeed, Ogawa’s disclosure of deriving an engine performance command that is desired engine torque from a signal representing accelerator pedal opening teaches the ’540 patent’s preferred embodiment of obtaining an engine performance command. The ’540 patent describes “[t]he action of obtaining an engine performance command . . . preferably includes deriving the engine performance command from the vehicle performance command,” where “the vehicle performance command is received from the foot of a driver with the use of a conventional pedal.” Ex. 1001 at 2:4-22. Likewise, Ogawa teaches receiving the “accelerator pedal opening AP” from an accelerator pedal operated by a driver, which is then used in conjunction with the “detected engine rotational speed” to “determine a required [engine] torque PMCMD,” *i.e.*, the engine performance command. Ex. 1005 at ¶¶ 0011, 0070, 0072.



Ex. 1001 at FIG. 1 (annotated).



Ex. 1005 at FIG. 1 (annotated).

A POSITA would have understood that modifying Yoshioka's method to obtain an engine performance command, as taught by Ogawa, would enable

Yoshioka's method to "set[] a valve timing in accordance with the required torque, i.e., the load," and thus the valve timing would not be "intake pipe inner pressure, amount of intake air, and so on." Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 151-156. Using this method, as taught by Ogawa, "the filling efficiency can be appropriately controlled to ensure required engine power." Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 151-156.

Moreover, a POSITA would have been able to easily modify Yoshioka based on Ogawa's teachings. Yoshioka's ECU already receives information from a "throttle sensor 42" that "detects the opening of the throttle valve 5." Ex. 1006 at 4:20-21. A POSITA would understand that in a vehicle where acceleration is controlled via an accelerator pedal, data from a throttle sensor like Yoshioka's is indicative of how far the accelerator pedal has been pushed down from which, as taught by Ogawa, a desired engine torque engine performance command may be derived. Ex. 1003 at ¶¶ 151-156. Further, a POSITA would easily be able to modify the code of Yoshioka's ECU to determine the desired engine torque engine performance command based on throttle opening data, which is indicative of accelerator position, and engine rotational speed as taught by Ogawa. Ex. 1003 at ¶¶ 151-156.

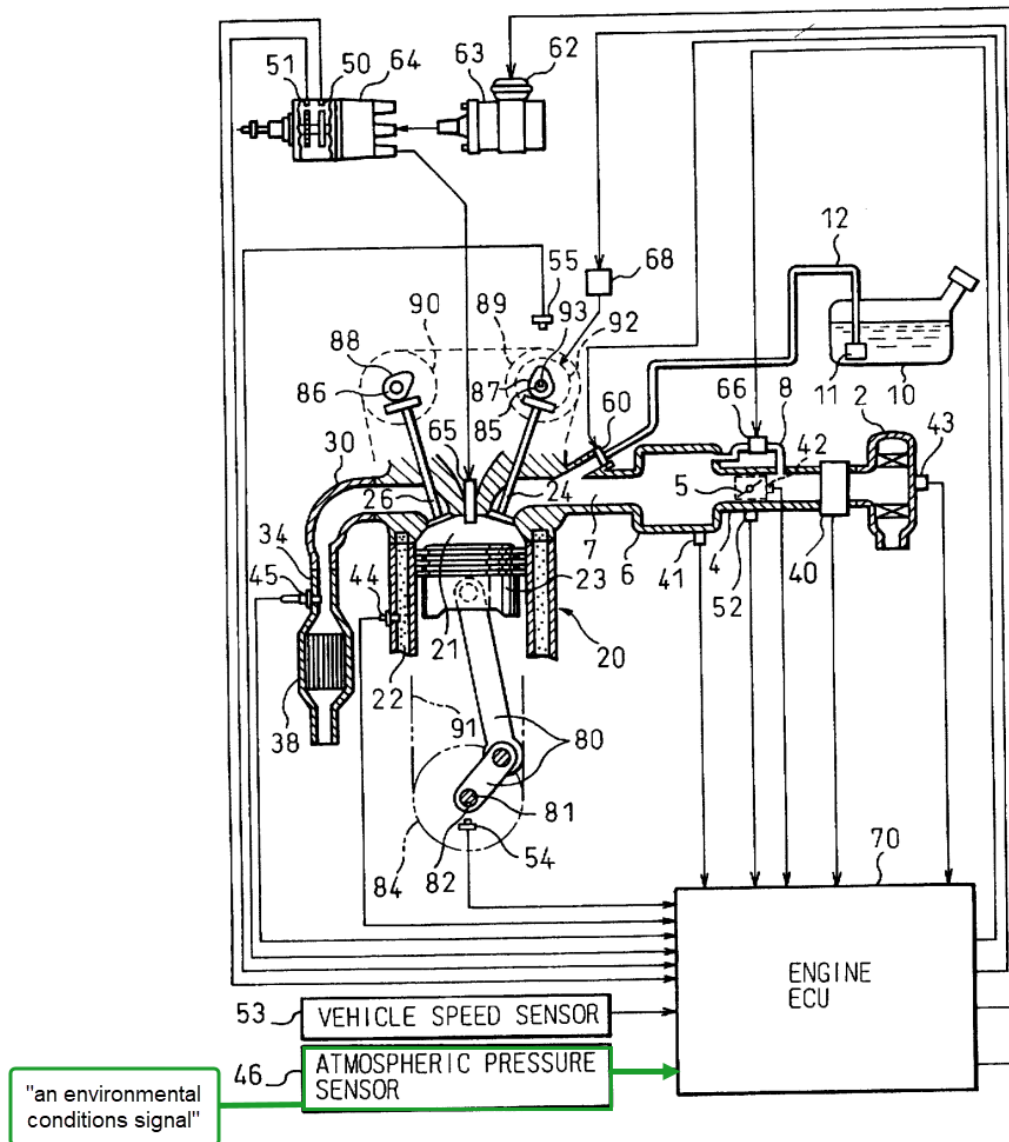
Thus, Yoshioka in view of Ogawa renders obvious claim limitation 1[c]. *Id.*

c. *1[b]: "receiving an environmental conditions signal;"*

Yoshioka discloses receiving an environmental conditions signal. Ex. 1003

at ¶¶ 157-160.

Yoshioka discloses that its ECU receives “an atmospheric pressure PA detected by [an] atmospheric pressure sensor 46.” Ex. 1006 at 7:24-25.



Id. at FIG. 1 (annotated).

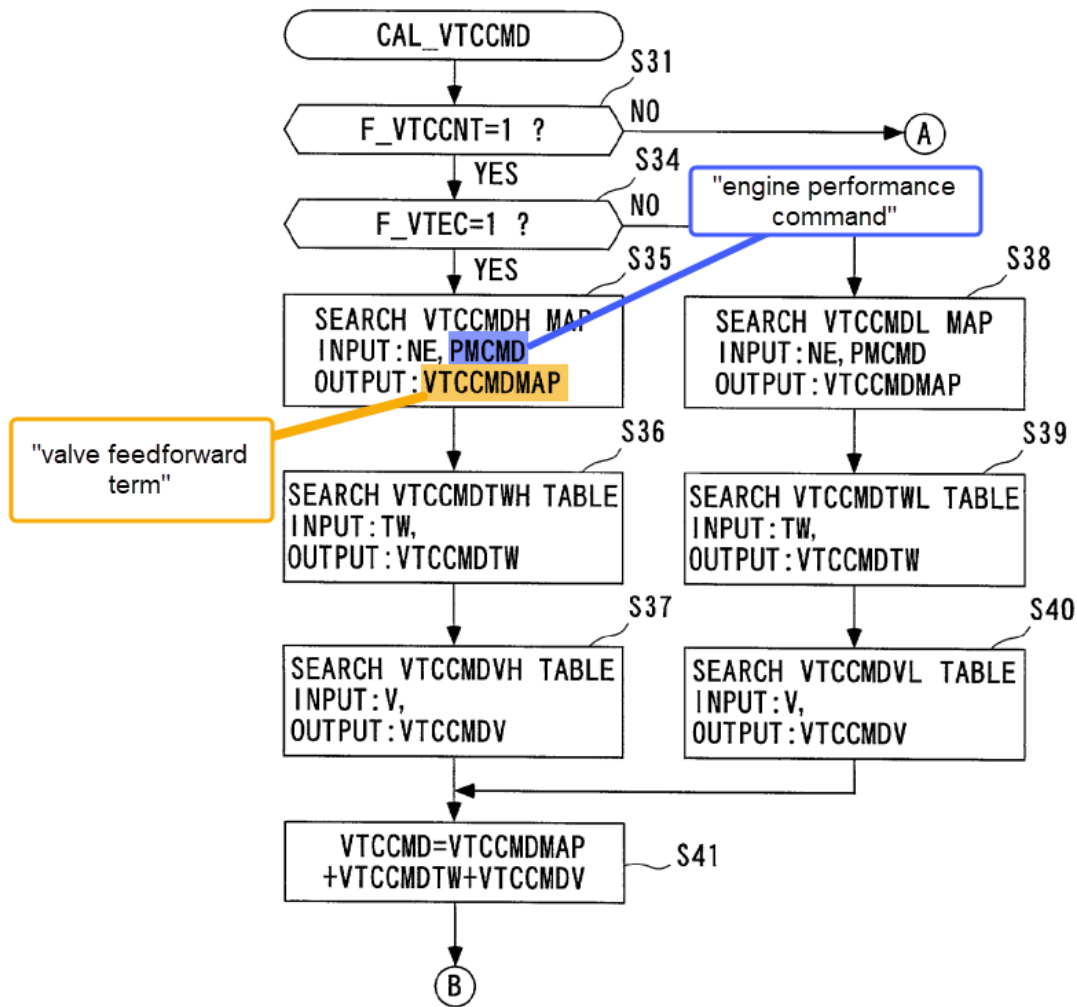
Receiving an atmospheric pressure signal as taught by Yoshioka is the type of environmental conditions signal the '540 patent describes receiving in its preferred embodiment. Ex. 1001 at 2:23-35.

Thus, Yoshioka discloses limitation 1[b]. Ex. 1003 at ¶¶ 157-160.

- d. *1[c]: “determining a valve feedforward term based on the engine performance command and the environmental conditions signal;”*

Yoshioka in view of Ogawa discloses determining a valve feedforward term based on the engine performance command and the environmental conditions signal. Ex. 1003 at ¶¶ 161-166.

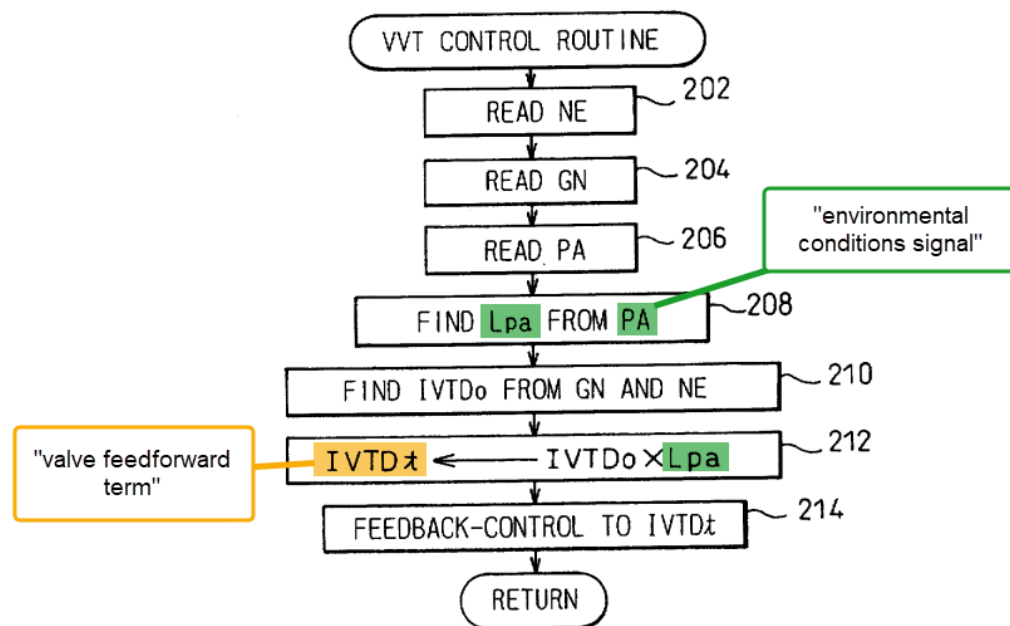
As explained in §§ XII.b and c, *supra*, Ogawa discloses an engine performance command—a desired engine torque PMCMD determined from a driver input—and Yoshioka discloses an environmental conditions signal—an atmospheric pressure signal. Ex. 1003 at ¶¶ 161-166. Ogawa further discloses determining a basic value target valve cam phase VTCCMDMAP, *i.e.*, a valve feedforward term. Ex. 1005 at ¶ 0082. Ogawa teaches that its target valve cam phase is calculated based on “the required torque PMCMD,” *i.e.*, the engine performance command, and engine speed “so that the engine power can be appropriately set in accordance with a particular load.” *Id.* at ¶¶ 0082, 0084, 0116.



Id. at FIG. 3 (annotated).

Likewise, Yoshioka teaches calculating a target valve timing displacement IVTD_t, *i.e.*, a valve feedforward term. Ex. 1006 at 7:41-45. As shown below in Figure 9, Yoshioka determines its target timing displacement IVTD_t by first calculating a correction coefficient L_{pa} based on an atmospheric pressure signal P_A, *i.e.*, an environmental conditions signal. Ex. 1006 at 7:57-60. Yoshioka teaches then determining the initial valve displacement IVTD₀ based on engine load G_N and

engine speed NE. *Id.* at 7:63-67. Finally, Yoshioka's valve feedforward term IVTD_t is calculated based on IVTD₀ and L_{pa}. *Id.* at 8:1-5.



Id. at FIG. 9 (annotated).

A POSITA would have understood that modifying Yoshioka's method to obtain an engine performance command and calculate Yoshioka's valve feedforward term based on that command, as taught by Ogawa, would enable Yoshioka's method to "set[] a valve timing in accordance with the required torque, i.e., the load," and thus the valve timing would not be affected by "intake pipe inner pressure, amount of intake air, and so on." Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 161-166. Using this method, as taught by Ogawa, "the filling efficiency can be appropriately controlled to ensure required engine power." Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 161-166.

Moreover, a POSITA would have been able to easily modify Yoshioka based on Ogawa's teachings. Yoshioka's ECU already receives information from a "throttle sensor 42" that "detects the opening of the throttle valve 5." Ex. 1006 at 4:20-21. A POSITA would understand that in a vehicle where acceleration is controlled via an accelerator pedal, data from a throttle sensor like Yoshioka's is indicative of how far the accelerator pedal has been pushed down from which, as taught by Ogawa, a desired engine torque engine performance command may be derived. Ex. 1003 at ¶¶ 161-166. Further, a POSITA would easily be able to modify the code of Yoshioka's ECU to determine the desired engine torque engine performance command from the throttle opening, which is indicative of accelerator position, and to implement the valve feedforward term calculation based on desired engine torque as taught by Ogawa. Ex. 1003 at ¶¶ 161-166.

Thus, Yoshioka in view of Ogawa renders obvious claim limitation 1[c]. *Id.*

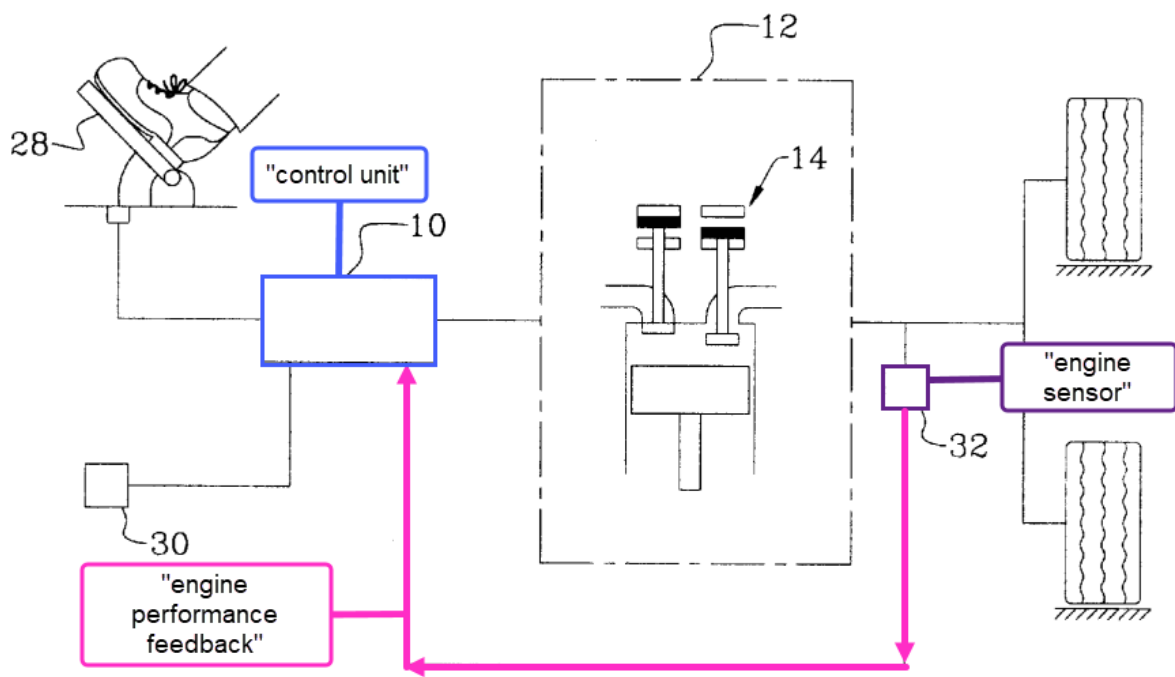
e. *1[d]: "receiving an engine performance feedback;"*

Yoshioka discloses receiving an engine performance feedback. Ex. 1003 at ¶¶ 167-170.

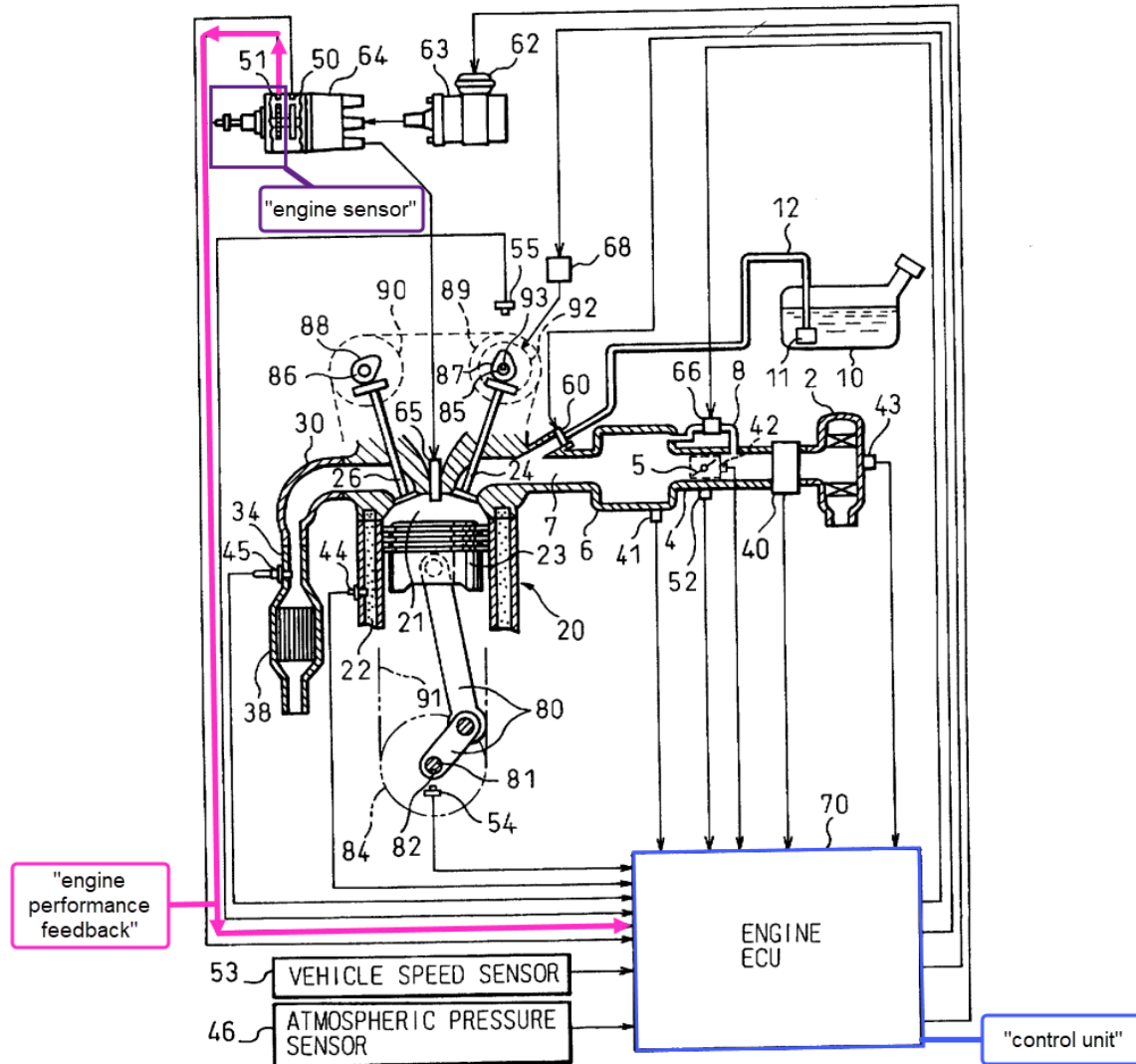
Yoshioka discloses a "crank angle sensor 51 [that] generates a position pulse," i.e., an engine performance feedback, from which "engine revolution speed is detected." Ex. 1006 at 4:42-43, 5:43-46. Particularly, Yoshioka teaches that the crank angle sensor "generates a position pulse for every 30 degrees of crank angle" rotation. *Id.* at 4:42-43. Yoshioka's ECU calculates engine revolution speed

based on the crank angle sensor's position pulse *Id.* at 5:43-46.

Indeed, Yoshioka's disclosure of calculating engine speed through its crank angle sensor and subsequent output signal teaches the '540 patent's preferred embodiment of an engine performance feedback. The '540 patent describes "receiving an engine performance feedback 22 preferably includes receiving the engine performance feedback from an engine sensor 32 in the vehicle" and that sensor "preferably senses the engine *speed*," for example, the speed at which the engine crank shaft is rotating, "and communicates this data to the control unit 10." Ex. 1001 at 2:36-42. Likewise, Yoshioka teaches that its ECU receives a position pulse signal for every 30 degree change in the crank angle, *i.e.*, the engine performance feedback, from a crank angle sensor in the vehicle, *i.e.*, an engine sensor, which is then used to calculate engine rotational speed. Ex. 1006 at 4:42-43, 5:43-46.



Ex. 1001 at FIG. 1 (annotated).



Ex. 1006 at FIG. 1 (annotated).

Thus, Yoshioka discloses limitation 1[d]. Ex. 1003 at ¶¶ 167-170.

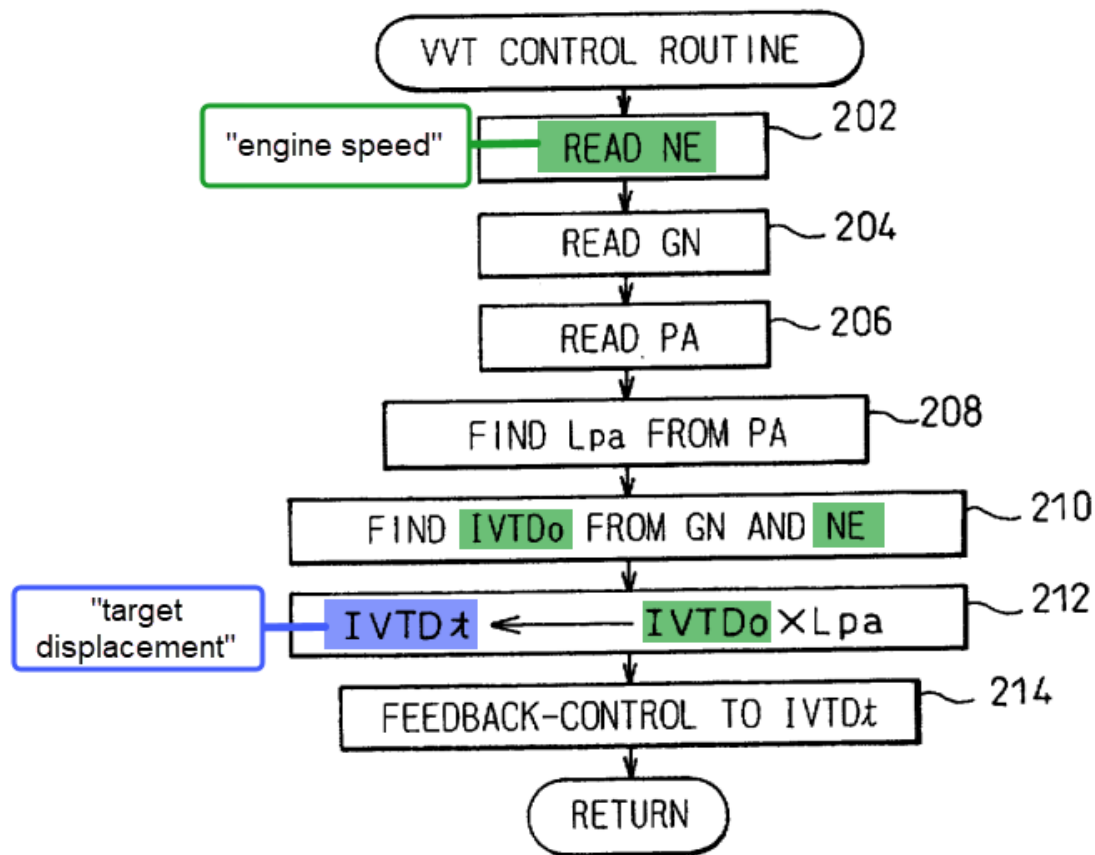
- f. 1[e]: “calculating a valve feedback term based on the engine performance command and the engine performance feedback; and”

Yoshioka in view of Ogawa discloses calculating a valve feedback term based on the engine performance command and the engine performance feedback. Ex. 1003 at ¶¶ 171-179.

The claims place no restriction on how the “valve feedback term” is calculated. The ’540 patent gives one example of calculating the valve feedback term by “compar[ing] [an] input with [an] output and [] calculat[ing] a correction term based on the difference.” Ex. 1001 at 2:66-3:4.

Yoshioka teaches this very method for computing a “valve feedback term.” Yoshioka discloses that its method performs “feedback-control [of] the hydraulic pressure control valve 68” to perform valve timing control. Ex. 1006 at 6:6-15; 7:41-45. Particularly, Yoshioka teaches calculating a target displacement IVTDt, and then using “feedback-control,” *i.e.*, calculating a valve feedback term, “[t]o bring the displacement of the intake valve 23 to the target displacement IVTDt.” *Id.* at 8:5-7.

Moreover, Yoshioka teaches that calculating its valve feedback term is based on engine performance feedback. Yoshioka’s valve feedback term is calculated based on the target displacement IVTDt. *Id.* at 8:5-7. Target valve displacement IVTDt is calculated based on engine speed NE, *i.e.*, “engine performance feedback,” as shown below in Figure 9.

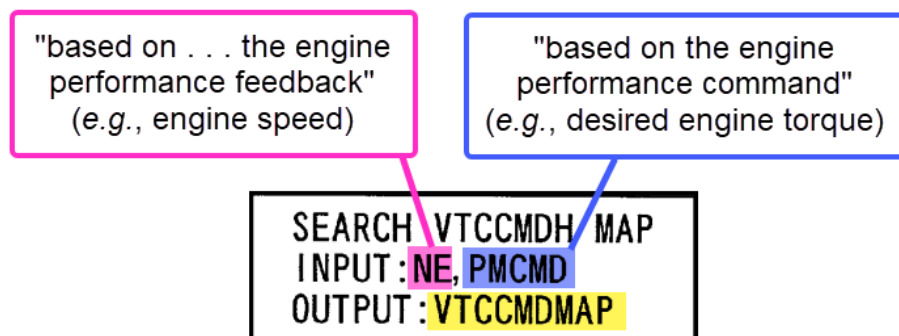


Id. at FIG. 9 (annotated).

Finally, as explained in § XII.3.e, *supra*, engine speed NE is calculated from the signal generated by Yoshioka's crank angle sensor, *i.e.*, the engine performance feedback. *Id.* at FIG. 9, 4:42-43, 5:43-46. Thus, Yoshioka discloses calculating a valve feedback term based on engine performance feedback. Ex. 1003 at ¶¶ 171-179.

Likewise, Ogawa discloses calculating a target valve displacement based on the engine performance command PMCMD. As explained in § XII.2.b, *supra*, Ogawa discloses receiving the engine performance command PMCMD. Ogawa further discloses calculating a basic value target cam phase VTCCMDMAP based

on its engine performance command PMCMD. *Id.* at ¶ 0084.



Id. at FIG. 3 (annotated).

A POSITA would have understood that modifying Yoshioka’s method to calculate its target valve displacement based on an engine performance command, as taught by Ogawa, would enable Yoshioka’s method to “set[] a valve timing in accordance with the required torque, i.e., the load,” and thus the valve timing would not be affected by “intake pipe inner pressure, amount of intake air, and so on.” Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 171-179. Using this method, as taught by Ogawa, “the filling efficiency can be appropriately controlled to ensure required engine power.” Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 171-179.

Moreover, a POSITA would have been able to easily modify Yoshioka based on Ogawa’s teachings. A POSITA would have understood that Yoshioka already calculates a target displacement which, as taught by Ogawa, could be calculated based on an engine performance command and engine rotational speed. Ex. 1005 at ¶ 0084; Ex. 1006 at FIG. 9, 4:42-43, 5:43-46; Ex. 1003 at ¶¶ 171-179. Further,

a POSITA would easily be able to modify the code of Yoshioka's ECU to implement target valve displacement calculation based on the engine performance command as taught by Ogawa. Ex. 1003 at ¶¶ 171-179.

Therefore, a POSITA would have been able to modify Yoshioka's method based on Ogawa's teachings to calculate a target displacement IVTDt based on the engine performance command PMCMD and the crank angle signal engine performance feedback. As taught by Yoshioka, that target displacement IVTDt is used to feedback control the valve displacement, *i.e.*, calculate a valve feedback term. *Id.* at 8:5-7.

Thus, Yoshioka in view of Ogawa renders obvious limitation 1[e]. Ex. 1003 at ¶¶ 171-179.

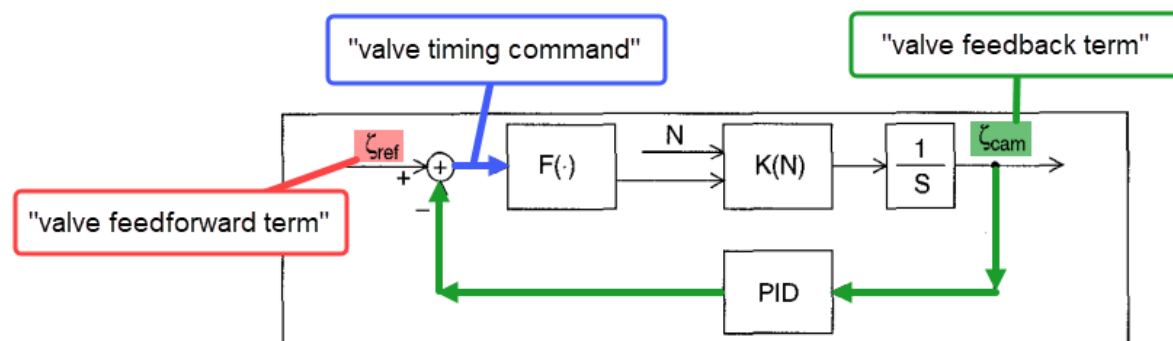
- g. *1[f]: "calculating a valve timing command based on the valve feedforward term and the valve feedback term"*

Yoshioka discloses calculating a valve timing command based on the valve feedforward term and the valve feedback term. Ex. 1003 at ¶¶ 180-185.

As explained in §§ XI.2.d and f, *supra*, Yoshioka discloses calculating a valve feedforward term IVTDt and a valve feedback term to use feedback control to bring the displacement of the intake valve to the target displacement. Yoshioka further teaches using IVTDt, *i.e.*, the valve feedforward term, and the feedback control, *i.e.*, the valve feedback term, to calculate control signals for the hydraulic control valve 68, *i.e.*, a valve timing command, to bring the actual displacement of the intake valve

to the target displacement. Ex. 1006 at 8:5-7.

Likewise, Jankovic teaches calculating a cam phasing command that controls a valve cam shaft phase, *i.e.*, a valve timing command, in a “feedback loop” based on a valve feedback term cam position ζ_{cam} and a valve feedforward term ζ_{ref} . Ex. 1007 at 36, 40, 41.



Id. at FIG. 8 (annotated).

A POSITA would have understood that, even if Yoshioka did not disclose calculating a valve timing command, modifying Yoshioka’s valve timing control method to use a feedback loop, as taught by Jankovic, would enable Yoshioka’s method to reduce engine emissions and optimize valve timing during a wide range of engine operating conditions. Ex. 1007 at 34; Ex. 1003 at ¶¶ 180-185.

Moreover, a POSITA would have been able to easily modify the combination of Yoshioka based on Jankovic’s teachings. A POSITA would have understood that, as explained in §§ XII.2.c, e, and g, *supra*, Yoshioka discloses calculating a valve feedforward term, a valve feedback term, and a valve timing command based on the valve feedforward and feedback terms. Ex. 1003 at ¶¶ 180-185. Even if

Yoshioka did not disclose calculating a valve timing command based on the feedforward and feedback term, a POSITA would have been able to modify the code of Yoshioka's ECU to use a feedback loop to calculate a valve timing command based on the valve feedforward term and valve feedback term, as taught by Jankovic. Ex. 1003 at ¶¶ 180-185.

Thus, Yoshioka in view of Jankovic renders obvious limitation 1[f]. *Id.*

4. Claim 2:

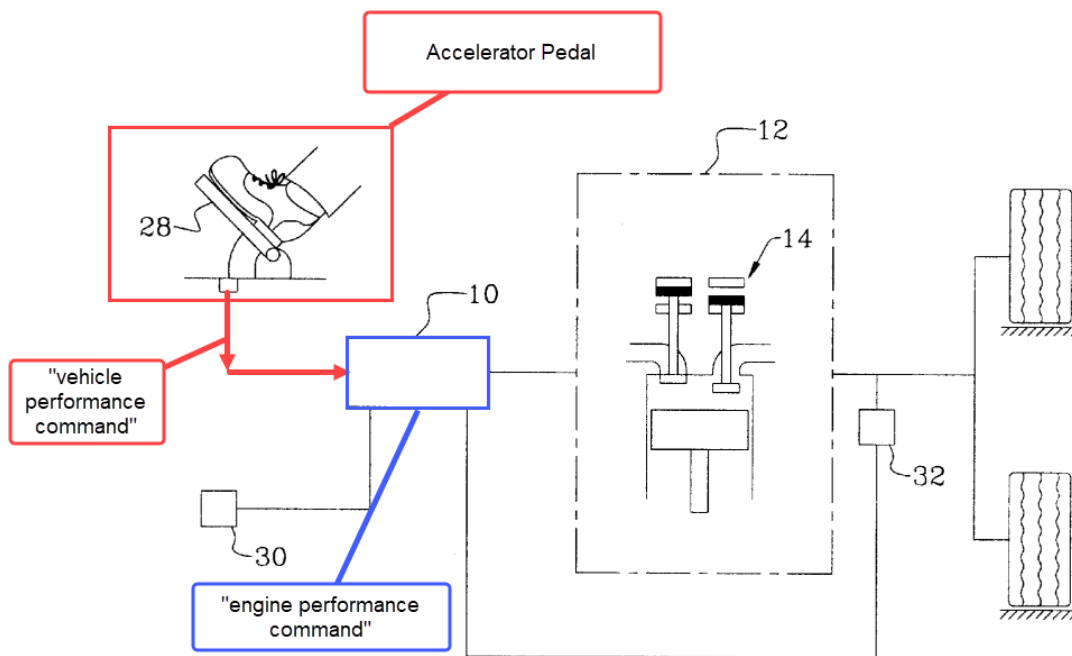
- a. *“The method of claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.”*

Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command. Ex. 1003 at ¶¶ 186-191.

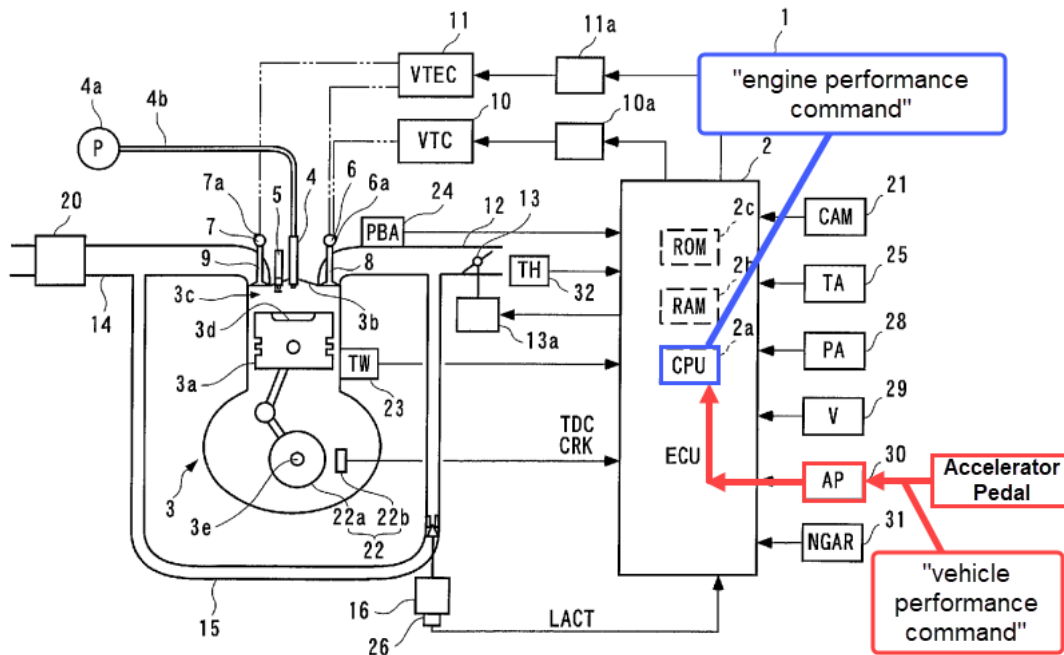
As explained in § XII.3, *supra*, Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1. Moreover, Ogawa teaches “the CPU 2a . . . determines a required torque PMCMD outputted by the engine 3,” *i.e.*, an engine performance command based on “the accelerator pedal opening AP,” “which is an operation amount of an accelerator pedal,” *i.e.*, a vehicle performance command. Ex. 1005 at ¶¶ 0070, 0072. The '540 specification expressly discloses that desired

torque is one example of an “engine performance command,” and that a signal “received from the foot of a driver with the use of a conventional pedal” is one example of a “vehicle performance command.” Ex. 1001 at 2:4-18.

Indeed, as explained in § XI.3.a, *supra*, and shown in the figures below, Ogawa’s disclosure of deriving an engine performance command that is desired engine torque from a signal representing accelerator pedal opening teaches the step of obtaining an engine performance command based on receiving a vehicle performance command described by the ’540 patent’s preferred embodiment.



Ex. 1001 at FIG. 1 (annotated).



Ex. 1005 at FIG. 1 (annotated).

A POSITA would have understood that modifying Yoshioka’s method to obtain an engine performance command based on receiving a vehicle performance command from a driver of the vehicle, as taught by Ogawa, would enable Yoshioka’s method to “set[] a valve timing in accordance with an engine load even in the stratified combustion mode,” and thus “the filling efficiency can be appropriately controlled to ensure required engine power” without being affected by “intake pipe inner pressure, amount of intake air, and so on.” Ex. 1005 at ¶¶ 0008, 0011; Ex. 1003 at ¶¶ 186-191.

Moreover, a POSITA would have been able to easily modify Yoshioka based on Ogawa’s teachings. Yoshioka’s ECU already receives information from a “throttle sensor 42” that “detects the opening of the throttle valve 5.” Ex. 1006 at

4:20-21. A POSITA would understand that in a vehicle where acceleration is controlled via an accelerator pedal, data from a throttle sensor like Yoshioka's is indicative of how far the accelerator pedal has been pushed down from which, as taught by Ogawa, a desired engine torque engine performance command may be derived. Ex. 1003 at ¶¶ 186-191. Further, a POSITA would easily be able to modify the code of Yoshioka's ECU to determine the desired engine torque engine performance command from the throttle opening data, which is indicative of accelerator position, as taught by Ogawa. *Id.*

Thus, Yoshioka in view of Ogawa and Jankovic renders obvious claim 2. *Id.*

5. Claim 7:

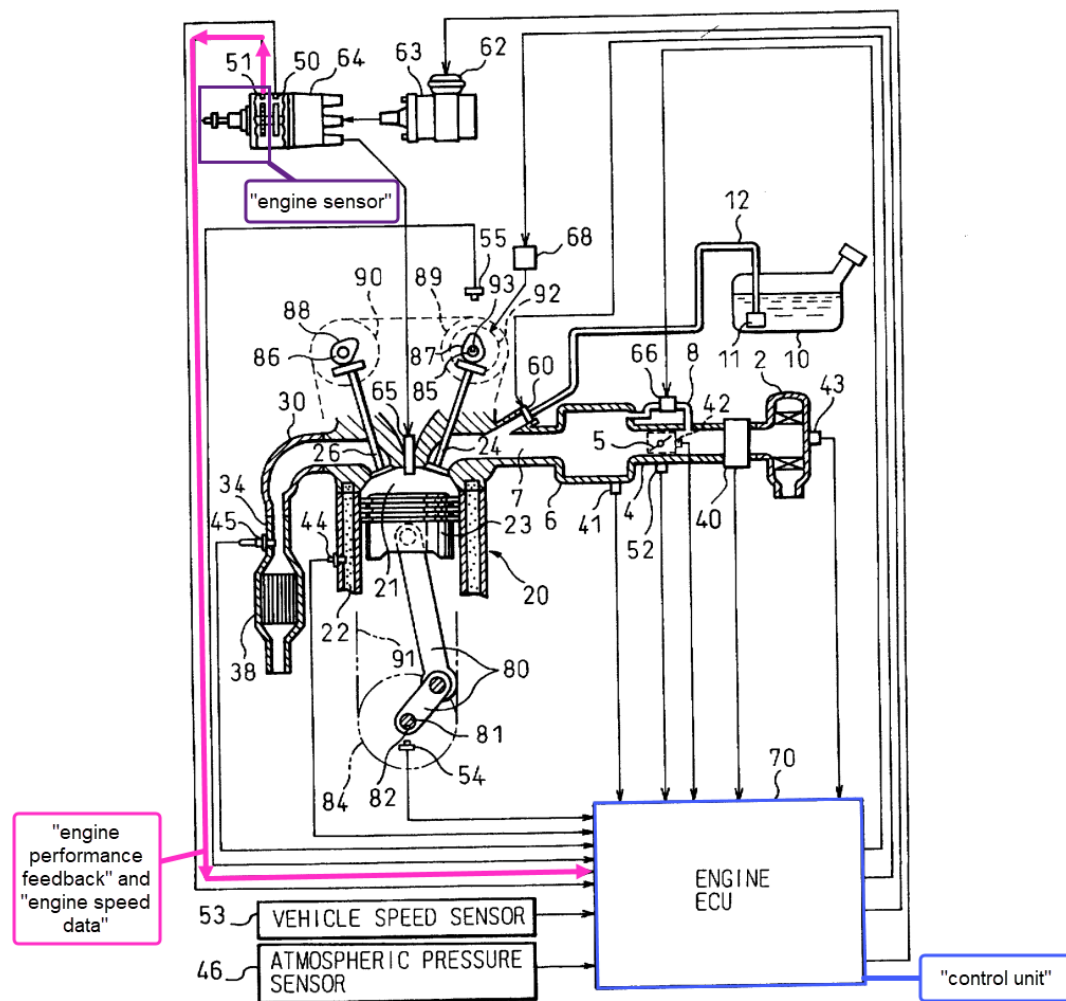
- a. *"The method of claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data."*

Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data. Ex. 1003 at ¶¶ 192-195.

As explained in § XII.3, *supra*, Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1. Moreover, Yoshioka discloses a "crank angle sensor 51 [that] generates a position pulse," *i.e.*, an engine performance feedback, from which "an engine revolution speed is detected." Ex. 1006 at 4:42-43, 5:43-46. Particularly, Yoshioka teaches that the crank angle sensor "generates a position pulse for every 30 degrees of crank angle." *Id.* at 4:42-43. Yoshioka's ECU

calculates engine revolution speed based on the crank angle sensor's position pulse

Id. at 5:43-46.



Id. at FIG. 1 (annotated).

Indeed, Yoshioka's disclosure of calculating engine speed through its crank angle sensor and subsequent output signal teaches the '540 patent's preferred embodiment of an engine performance feedback. The '540 patent describes "an engine performance feedback 22 preferably includes receiving the engine performance feedback from an engine sensor 32 in the vehicle" and that sensor

“preferably senses the engine *speed*,” for example, the speed at which the engine crank shaft is rotating, “and communicates this data to the control unit 10.” Ex. 1001 at 2:36-42. Likewise, Yoshioka teaches that its ECU receives a position pulse signal for every 30 degree change in the crank angle, *i.e.*, the engine performance feedback, from a crank angle sensor in the vehicle, *i.e.*, an engine sensor, which is then used to calculate engine rotational speed. Ex. 1006 at 4:42-43, 5:43-46.

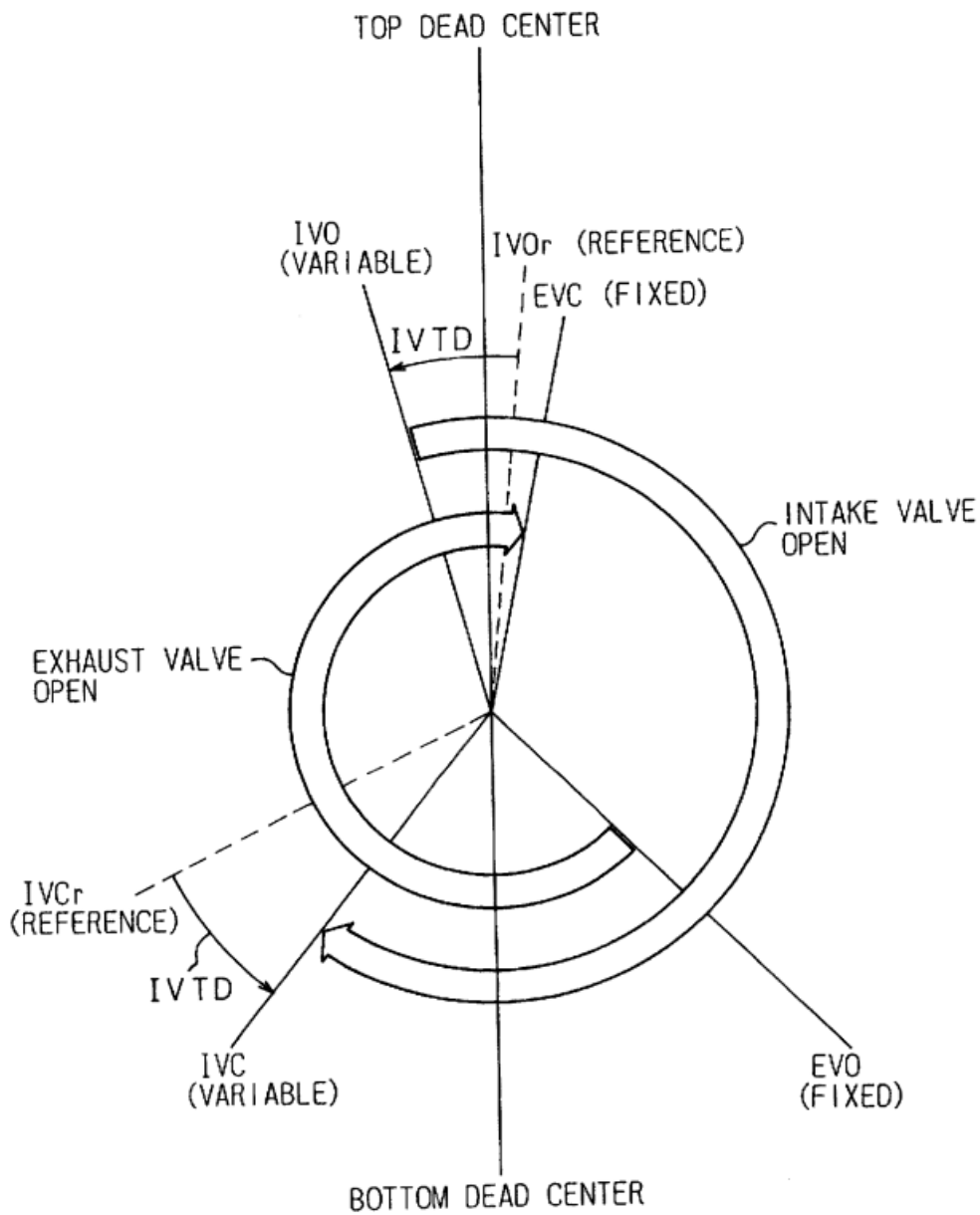
Thus, Yoshioka in view of Ogawa and Jankovic discloses claim 7. Ex. 1003 at ¶¶ 192-195.

6. Claim 10:

- a. *“The method of claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.”*

Yoshioka in view of Ogawa and Jankovic renders obvious the method of claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command. Ex. 1003 at ¶¶ 196-199.

As explained in § XII.3, *supra*, Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1. Moreover, as explained in § XI.5, *supra*, Yoshioka discloses calculating an EVO command, an EVC command, and IVO command, and an IVC command. Ex. 1006 at 6:16-36; 4:42-5:46. The valve displacement defined by each of these commands are shown below in Yoshioka’s Figure 3.



Id. at FIG. 3.

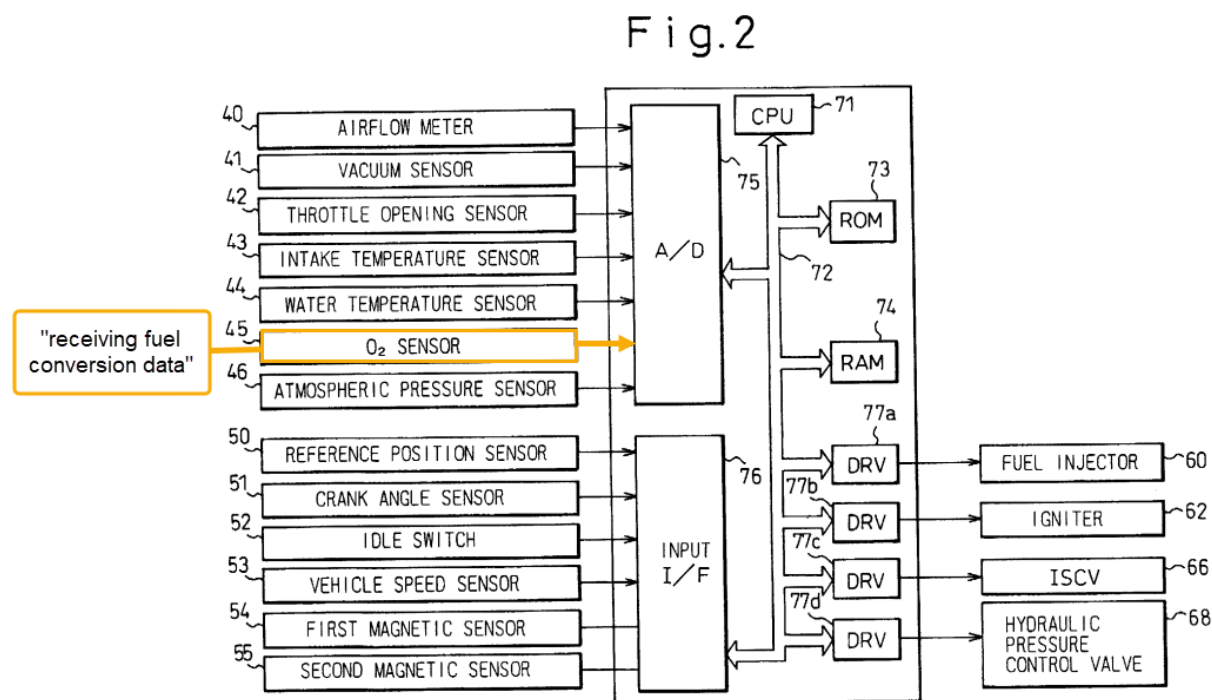
Thus, Yoshioka in view of Ogawa and Jankovic discloses claim 10. Ex. 1003 at ¶¶ 196-199.

7. Claim 11:

- a. *“The method of claim 1 further comprising receiving fuel conversion data.”*

Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1 further comprising receiving fuel conversion data. Ex. 1003 at ¶¶ 200-203.

As explained in § XII.3, *supra*, Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1. Moreover, as explained in § XI.6, *supra*, Yoshioka discloses “an air-fuel ratio feedback correction according to a signal from [an] O₂ sensor 45” that “detect[s] the concentration of the oxygen in the exhaust gas,” *i.e.*, fuel conversion data, that is received by Yoshioka’s ECU. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54.



Id. at FIG. 2 (annotated).

Thus, Yoshioka in view of Ogawa and Jankovic renders obvious claim 11.

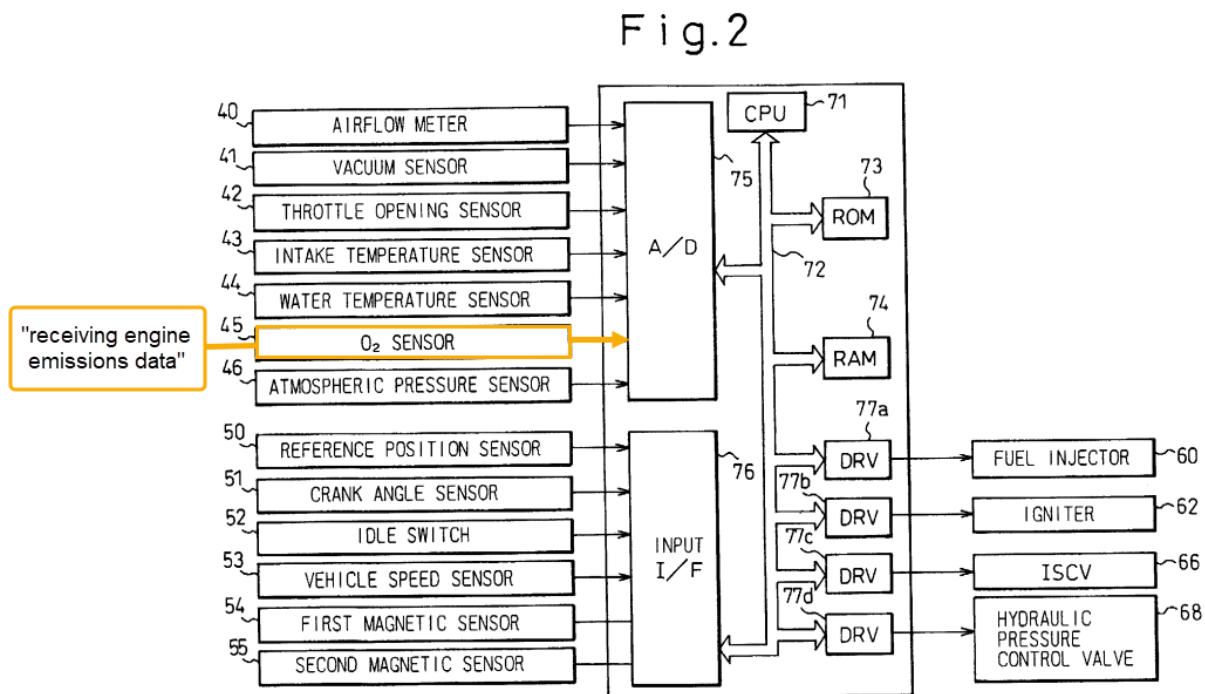
Ex. 1003 at ¶¶ 200-203.

8. Claim 14:

- a. *“The method of claim 1 further comprising receiving engine emissions data.”*

Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1 further comprising receiving engine emissions data. Ex. 1003 at ¶¶ 204-207.

As explained in § XII.3, *supra*, Yoshioka in view of Ogawa and Jankovic discloses the method of claim 1. Moreover, as explained in § XI.7, *supra*, Yoshioka discloses an “O₂ sensor 45” that is located at the exhaust pipe and “detect[s] the concentration of the oxygen in the exhaust gas,” i.e., engine emissions data, that is received by Yoshioka’s ECU. Ex. 1006 at 4:48-52, 5:24-30, 5:48-54.



Id. at FIG. 2 (annotated).

Thus, Yoshioka in view of Ogawa and Jankovic renders obvious claim 14. Ex. 1003 at ¶¶ 204-207.

XIII. SECONDARY CONSIDERATIONS DO NOT SUPPORT A FINDING OF NON-OBVIOUSNESS

At this stage of these proceedings, Petitioners have no burden to identify and rebut secondary considerations. Rather, Patent Owner must first present a *prima facie* case for such consideration, which Petitioners should then have the chance to rebut. *Sega of Am., Inc. v. Uniloc USA, Inc.*, IPR2015-01453, at *10 (Mar. 10, 2015). For that reason, the Board typically rejects arguments against institution based on objective indicia, so that the Petitioners can have a fair opportunity to address any secondary indicia evidence on reply. *Petroleum Geo-Services Inc. v. WesternGeco LLC*, IPR2015-01478, at *22 (Mar. 17, 2015); Ex. 1003, ¶ 119.

XIV. MANDATORY DISCLOSURES

A. Real Parties-in-Interest under 37 C.F.R. 42.8(b)(1)

The only real parties-in-interest are Petitioners Mercedes-Benz USA, LLC and BMW of North America LLC; Mercedes-Benz Intellectual Property GmbH & Co. KG; Mercedes-Benz AG and Mercedes-Benz Group AG; and Bayerische Motoren Werke AG.

B. Related Matters under 37 C.F.R. 42.8(b)(2)

U.S. Patent 6,557,540 (the “’540 patent,” Ex. 1001) is the subject of 2 pending

district court cases. These cases are listed below:

- *Michigan Motor Technologies, LLC v. Mercedes-Benz USA, LLC*, Case 1:22-cv-03957 (N.D. Ill.)
- *Michigan Motor Technologies, LLC v. Bayerische Motoren Werke AG et al*, Case 1:22-cv-03804 (N.D. Ill.)

C. Lead and Back-Up Counsel under 37 C.F.R. 42.8(b)(3)

Petitioners provide the following counsel and service information. Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition. Petitioners agree to accept electronic service at the email addresses below.

LEAD COUNSEL	BACK-UP COUNSEL
James M. Glass (Reg. No. 46729) jimglass@quinnemanuel.com <u>Postal and Hand Delivery Address:</u> QUINN EMANUEL URQUHART & SULLIVAN, LLP 51 Madison Ave, 22nd Floor New York, New York 10010 Tel: (212) 849-7000 Fax: (212) 849-7100	Brian Biggs (<i>pro hac vice</i> application forthcoming) Brian.biggs@us.dlapiper.com <u>Postal and Hand Delivery Address:</u> DLA Piper LLP (US) 1201 North Market Street Suite 2100 Wilmington, DE 19801 Tel: (302) 468-5700 Fax: (302) 394-2341

D. Service Information under 37 C.F.R. 42.8(b)(4)

A copy of this entire Petition, including all Exhibits and a power of attorney, is being served by FEDERAL EXPRESS, costs prepaid, to the address of the attorney or agent of record for Michigan Motor Technologies, LLC (“MMT” or “Patent Owner”) at the USPTO:

Timothy Devlin (Registration No. 41,706)
1526 Gilpin Ave.
Wilmington, DE 19806

Petitioners consent to service by electronic mail at: qe-mmt-mbusa@quinnemanuel.com. A Power of Attorney is filed concurrently herewith under 37 C.F.R. 42.10(b).

A. Payment of Fees under 37 C.F.R. § 42.15(a)

The undersigned authorizes the Office to charge the fee required for this Petition for Inter Partes Review to Deposit Account No. 50-5708. Any additional fees that might be due are also authorized.

XV. CONCLUSION

Petitioners respectfully request that *inter partes* review of the '540 patent be instituted and that the challenged claims be cancelled as unpatentable pursuant to 35 U.S.C. §318(b).

Respectfully Submitted,

July 18, 2023

/s/ Jim Glass
James M. Glass (Reg. No. 46729)
jimglass@quinnemanuel.com
QUINN EMANUEL URQUHART &
SULLIVAN, LLP
51 Madison Ave, 22nd Floor
New York, New York 10010
Tel: (212) 849-7000
Fax: (212) 849-7100

Brian Biggs (*pro hac vice* application
forthcoming)
Brian.biggs@us.dlapiper.com

DLA Piper LLP (US)
1201 North Market Street
Suite 2100
Wilmington, DE 19801
Tel: (302) 468-5700
Fax: (302) 394-2341

CERTIFICATE OF SERVICE

In accordance with 37 C.F.R. §§42.6(e) and 42.105, the undersigned certifies that on July 18, 2023, a complete and entire copy of the **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,557,540 UNDER 35 U.S.C. §§311-319 AND 37 C.F.R. §§42.100 *ET SEQ.*** (“Petition”) including exhibits and testimony relied upon were served on the Patent Owner at the correspondence address of record for the subject patent and counsel for Patent Owner in the District Court Litigation, as included below:

Timothy Devlin (Registration No. 41,706)
1526 Gilpin Ave.
Wilmington, DE 19806

Neil Benchell
DEVLIN LAW FIRM LLC
1526 Gilpin Avenue
Wilmington, DE 19806
Telephone: (302) 449-9010
nbenchell@devlinlawfirm.com

via FedEx overnight

Date: July 18, 2023

/s/ Jim Glass
James M. Glass (Reg. No. 46729)
jimglass@quinnemanuel.com
QUINN EMANUEL URQUHART &
SULLIVAN, LLP
51 Madison Ave, 22nd Floor
New York, New York 10010
Tel: (212) 849-7000
Fax: (212) 849-7100

CERTIFICATION UNDER 37 C.F.R. §42.24(d)

Pursuant to 37 C.F.R. §42.24(d), the undersigned hereby certifies that the word count under §42.24(a)(1) for the foregoing Petition for *Inter Partes* Review 13,900 words, within the 14,000 word limit allowed under §42.24(a)(1)(i).

Date: July 18, 2023

/s/ Jim Glass

James M. Glass (Reg. No. 46729)

jimglass@quinnemanuel.com

QUINN EMANUEL URQUHART &
SULLIVAN, LLP

51 Madison Ave, 22nd Floor

New York, New York 10010

Tel: (212) 849-7000

Fax: (212) 849-7100