

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.

IPR2023-01032

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 6,581,565**

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LIST OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 6,581,565 (“565 patent”)
1002	Prosecution File History of U.S. Patent No. 6,581,565 (“565 File History”)
1003	Expert Declaration of C. Arthur MacCarley, Ph.D., P.E.
1004	Curriculum Vitae of C. Arthur MacCarley, Ph.D., P.E.
1005	U.S. Patent No. 6,006,717 A to Suzuki et al., titled “Direct Injection Spark-Ignition Type Engine Control Apparatus,” issued December 28, 1999 (“Suzuki”)
1006	U.S. Patent No. 5,241,855 A to Cullen et al., titled “Method and Apparatus for Inferring Engine Torque,” issued September 7, 1993 (“Cullen”)
1007	U.S. Patent No. 6,047,681 A to Scherer et al., titled “Process and Apparatus for Adjusting the Torque of an Internal-Combustion Engine,” issued April 11, 2000 (“Scherer”)
1008	U.S. Patent No. 5,282,449 A to Takahashi et al., titled “Method and System for Engine Control,” issued February 1, 1994 (“Takahashi”)
1009	Understanding Automotive Electronics, Fifth Edition (1998), William B. Ribbens, Ph.D. (“Ribbens”)

I. LIST OF CHALLENGED CLAIMS

A. Claim 1

1[pre]	A device for controlling a torque output of an engine, the device comprising:
1[a]	a torque demand controller for generating a torque demand signal; and
1[b]	a torque producer which receives the torque demand signal, the torque producer includes:
1[c]	an estimator which receives as inputs a current spark angle signal, a current air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal;
1[d]	a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal;
1[e]	a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent; and
1[f]	a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal and a spark adjustment signal.

B. Claim 2

2	The device in claim 1, wherein the estimated air charge signal is produced by an air charge controller which receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal and an air charge temperature signal
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C. Claim 3

3	The device in claim 2, wherein the air charge demand signal is produced by an air charge demand controller which receives as inputs the desired torque signal, a desired spark angle signal and a desired air/fuel.
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D. Claim 4

4[a]	The device of claim 1, in which the engine is a direct injection spark ignition engine, wherein the transient torque controller is arranged to receive a combustion mode signal indicating whether the engine is operating in a stratified mode or a homogeneous mode, and
4[b]	wherein the transient torque controller is arranged to control the fuel adjustment signal when the combustion mode signal indicates that the engine is operating in the stratified mode, and

4[c]	wherein the transient torque controller is arranged to control the spark adjustment signal when the combustion mode signal indicates that the engine is operating in the homogeneous mode.
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E. Claim 5

5	The device in claim 4, wherein the estimated air charge signal is produced by an air charge controller which receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal and an air charge temperature signal
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F. Claim 6

6	The device in claim 5, wherein the air charge demand signal is produced by an air charge demand controller which receives as inputs the desired torque signal, a desired spark angle signal and a desired air/fuel.
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G. Claim 7

7[pre]	A method for controlling a torque output of an engine, the method comprising:
7[a]	estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal;
7[b]	comparing the estimated current torque signal with a desired torque signal to output a difference signal;
7[c]	filtering out a plurality of low frequency components from the difference signal; and
7[d]	controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal.

II. INTRODUCTION

Mercedes-Benz USA, LLC (“MBUSA”) and BMW of North America, LLC (“BMW”) petition for *Inter Partes* Review of claims 1-7 of U.S. Patent No. 6,581,565 to Heslop et al. (“the ’565 patent”), titled “Engine Torque Controller.” The ’565 patent claims nothing more than a conventional engine torque controller for engines that use direct cylinder injection. The claims recite well-known components such as a controller for generating a demanded torque, an estimator for estimating current torque, a comparator for outputting the difference between demanded torque and estimated torque, a high pass filter, and a transient controller for outputting fuel and spark adjustment signals based on the filtered difference signal. As discussed below, engines with these components were well known in the prior art years before the ’565 patent’s priority date.

In fact, the PTAB has already held it was reasonably likely that the same prior art combinations cited in this Petition invalidate all claims of the ’565 patent.¹ While the PTAB did not render a Final Determination on these claims because Patent Owner settled its case before briefing was completed in those proceedings, the prior art discloses each and every limitation of the challenged claims. Accordingly,

¹ *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38, 46 (PTAB Aug. 5, 2020); *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00445, Paper 12 at 39, 47 (PTAB Aug. 5, 2020).

Petitioners respectfully requests the challenged claims of the '565 patent be ruled unpatentable now.

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

A. Grounds for Standing

Petitioners respectfully requests *inter partes* review (“IPR”) of Claims 1-7 (“Challenged Claims”) of the '565 patent (Ex. 1001), which is indicated as assigned to Michigan Motor Technologies LLC (“MMT”). Petitioners certify that the '565 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	'565 Patent Claims	References	Basis
1	1, 4, 7	Suzuki, Cullen, Scherer	§103
2	2, 3, 5, 6	Suzuki, Cullen, Scherer, Takahashi	§103

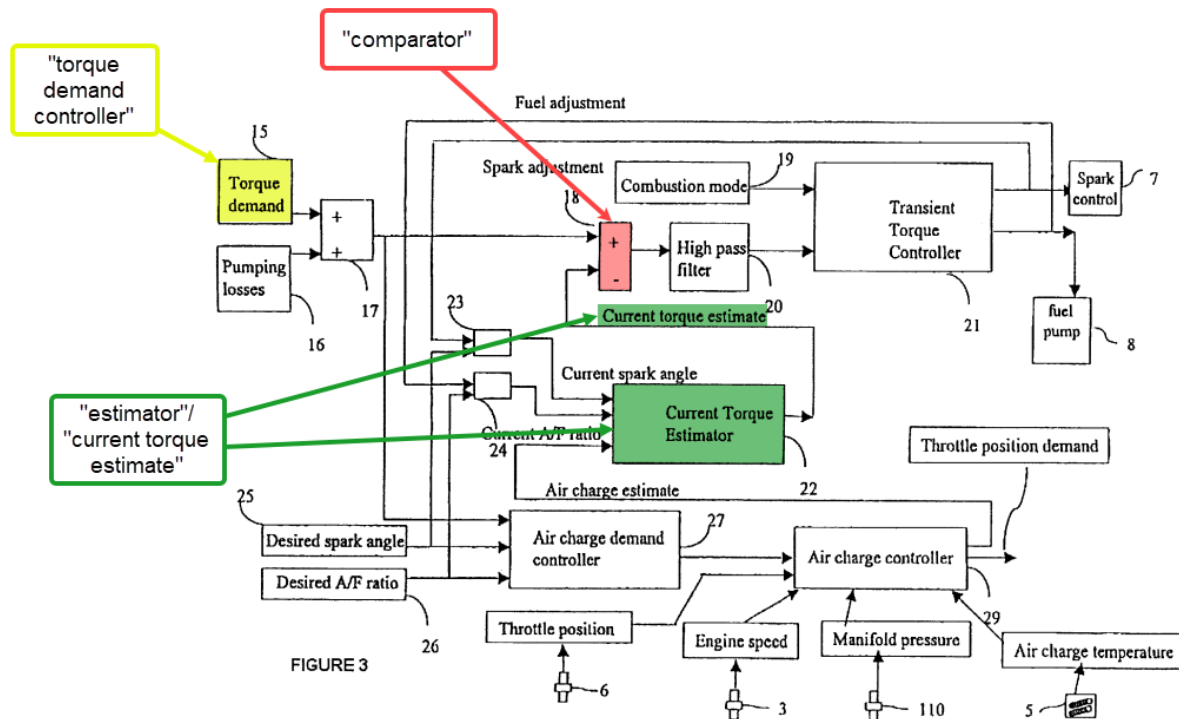
IV. BACKGROUND

A. Summary of the '565 Patent

The '565 patent issued June 24, 2003, from U.S. Application No. 10/191,641 (“the '641 application”), which was filed on July 9, 2002. Ex. 1001. The '565 patent claims priority to European Application No. 01306301, filed July 23, 2001. Thus, the '565 patent’s earliest possible priority date is July 23, 2001.

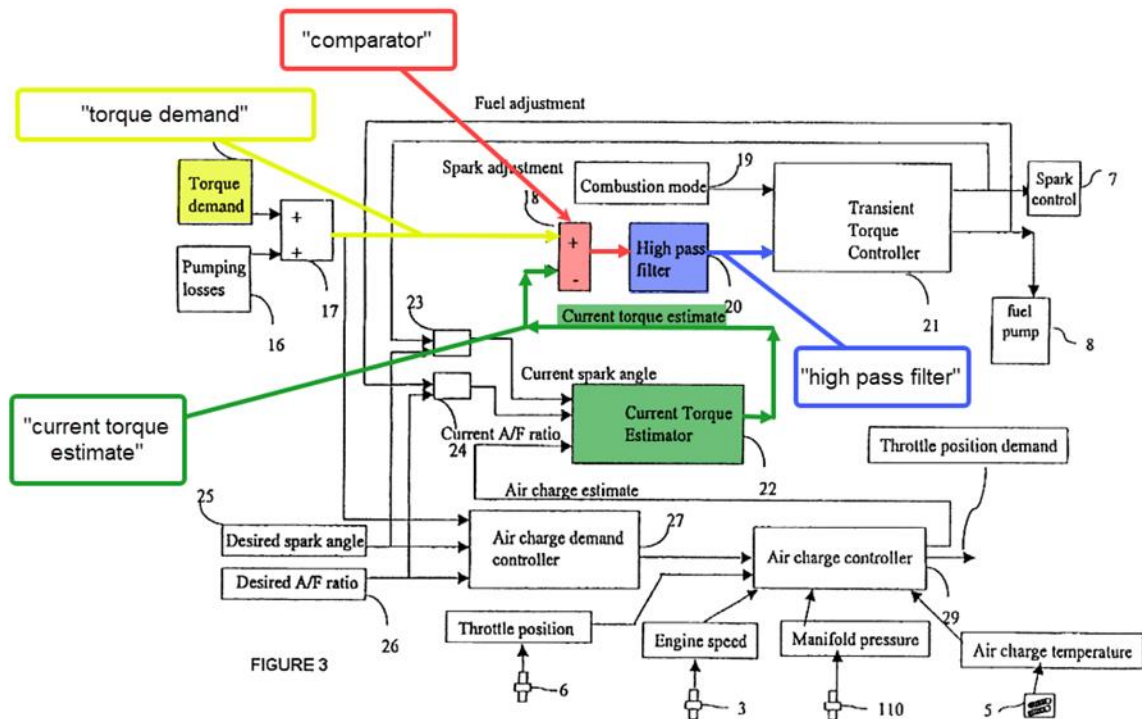
The '565 patent claims systems and methods for controlling torque in an engine (specifically, a spark ignition, direct injection internal combustion engine) based on the difference between a desired torque signal and an estimate of the current torque. See Ex. 1001 at Abstract. As illustrated below, what are recited in the challenged claims recite nothing more than an age-old feedback loop based on a comparison of a desired value with an actual value.

In particular, the '565 patent discloses a “torque demand controller 11 [that] calculates a required output torque signal”; and a “current torque estimator 22” that “generate[s] a signal representing an estimate of the current torque.” *Id.* at 3:1-33. This is shown, for example, in Figure 3 below:



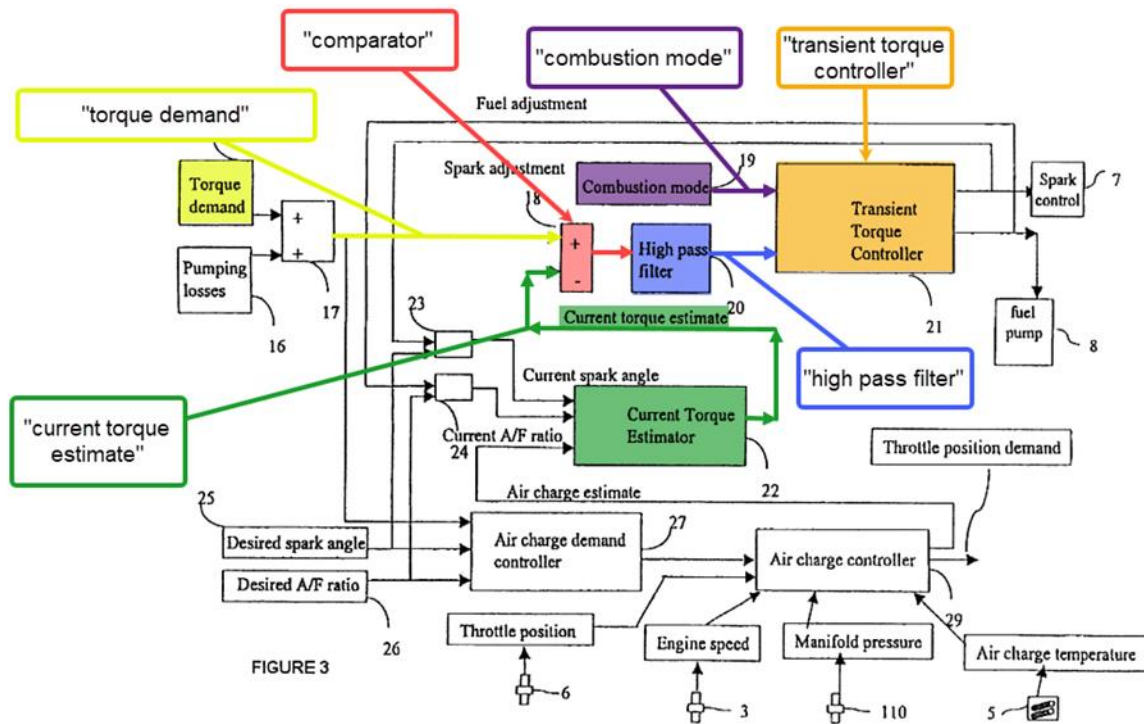
Id. at Fig. 3 (annotated). The claims recite that a “comparator” determines the difference between the estimated torque demand and estimated current torque, as shown in the same figure. *Id.* at 3:34-39.

This differential value is then filtered using a “high pass filter” to eliminate low frequency components of the signal and therefore isolate rapid changes in the signal, as shown in the additional annotations in Figure 3 below (*id.* at 3:34-39):



Id. at FIG. 3 (annotated).

After filtering out low frequency signals, the claimed system uses the torque differential value to adjust the engine operation in order to achieve the desired torque. In particular, the high-pass filtered torque differential signal is received by a “transient torque controller” that “generate[s] signals for temporarily adjusting the torque produced by the engine 100.” *Id.* at 2:57-59, 3:29-339. This transient torque controller is shown in the annotated figure below:

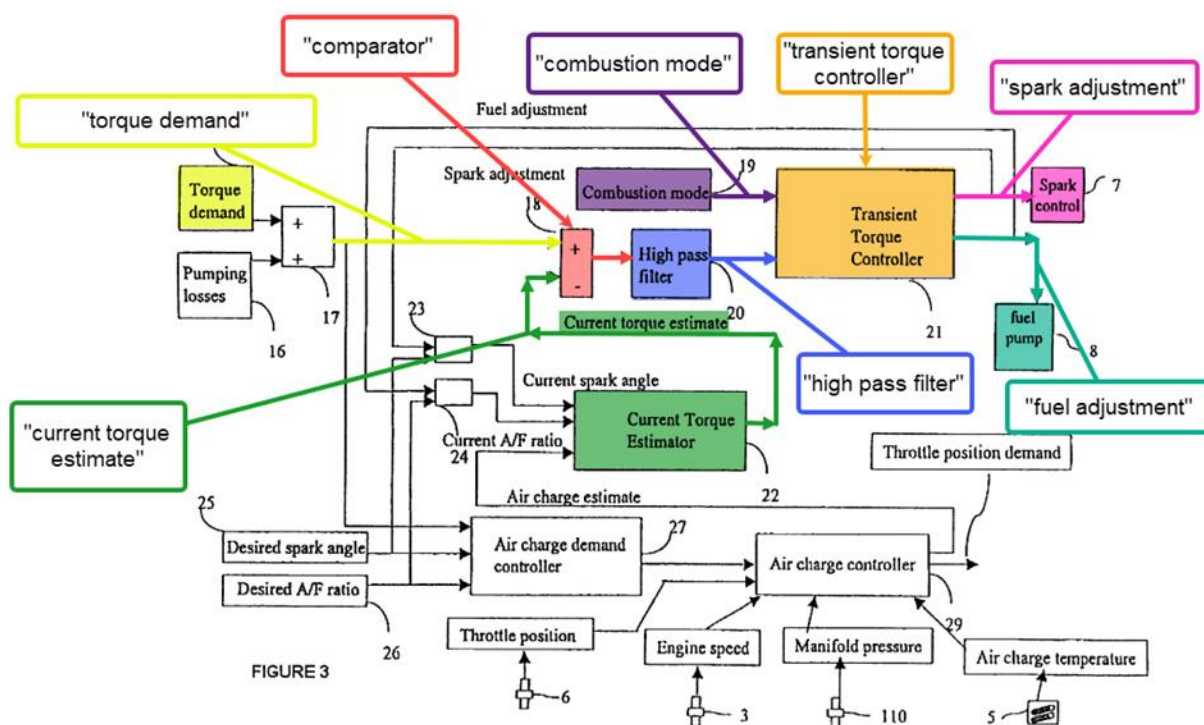


Id. at FIG. 3 (annotated).

The “transient torque controller” shown above receives a “combustion mode signal 19” that “indicates whether the engine 100 is operating in a *stratified mode* or in a *homogeneous mode*.” Id. at 3:40-43 (emphasis added). As the patent explains: “If the engine 100 is operating in the *stratified mode* then a *fuel adjustment* signal is generated and sent to the fuel pump 8 in order to adjust the amount of fuel which is injected into the combustion chamber 108 by the fuel injector 130” to adjust engine torque. Id. at 3:43-47 (emphasis added). Thus, the operative control mechanism in “stratified mode” is fuel quantity adjustment.

According to the specification, if “the engine 100 is operating in the *homogenous mode* then a *spark adjustment* signal is generated and sent to the spark

control unit 7 to adjust the timing of the ignition spark generated by the spark plug 106” to adjust engine torque. *Id.* at 3:47-50 (emphasis added). In other words, the operative control mechanism in homogenous mode is a spark adjustment.



B. Prosecution History

application”), filed July 9, 2002. *See* Ex. 1001, field (22). The ‘565 patent claims priority to European Patent Application EP01306301, filed July 23, 2001.²

The examiner allowed all claims of the ‘641 application without *any* rejections or Office Actions. *See* Ex. 1002. Prior art references Suzuki, Cullen, and Takahashi were **not** presented before the Examiner during prosecution. *Id.* While the Scherer reference was listed as prior art in the file history, it was never expressly considered or applied by the Examiner. *Id.*

V. 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, Mechanical Engineering, Automotive Engineering (or equivalent), as well as at least 2–4 years of industry or research experience in the relevant field of engine control systems or, alternatively, at least an M.S. degree in Electrical Engineering or Mechanical Engineering. Ex. 1003 at ¶¶ 36-37.

VI. CLAIM CONSTRUCTION

Petitioners submit that express interpretations of the Challenged Claims are not necessary. Ex. 1003 at ¶¶ 30-34. Petitioners takes 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.

² Thus, the earliest possible priority date is July 23, 2001. The references cited in this Petition all qualify as prior art if the ‘565 patent is given its July 23, 2001 priority date.

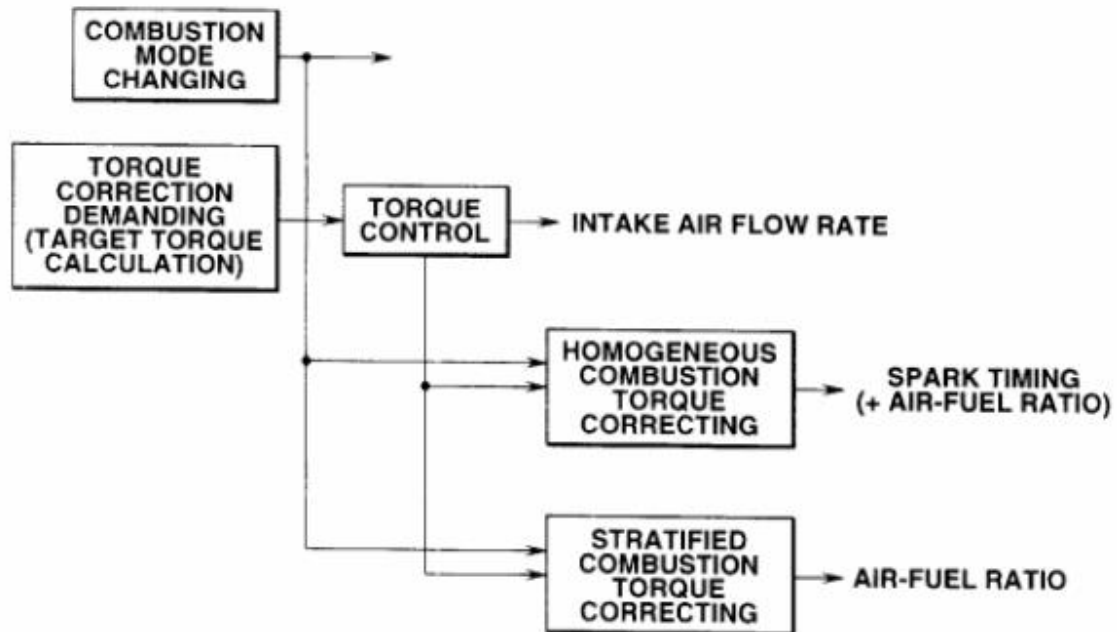
The PTAB previously found it was not necessary to expressly construe any claim language to determine the '565 claims' patentability. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 10-11 (PTAB Aug. 5, 2020).

VII. SUMMARY OF PRIOR ART

A. Suzuki

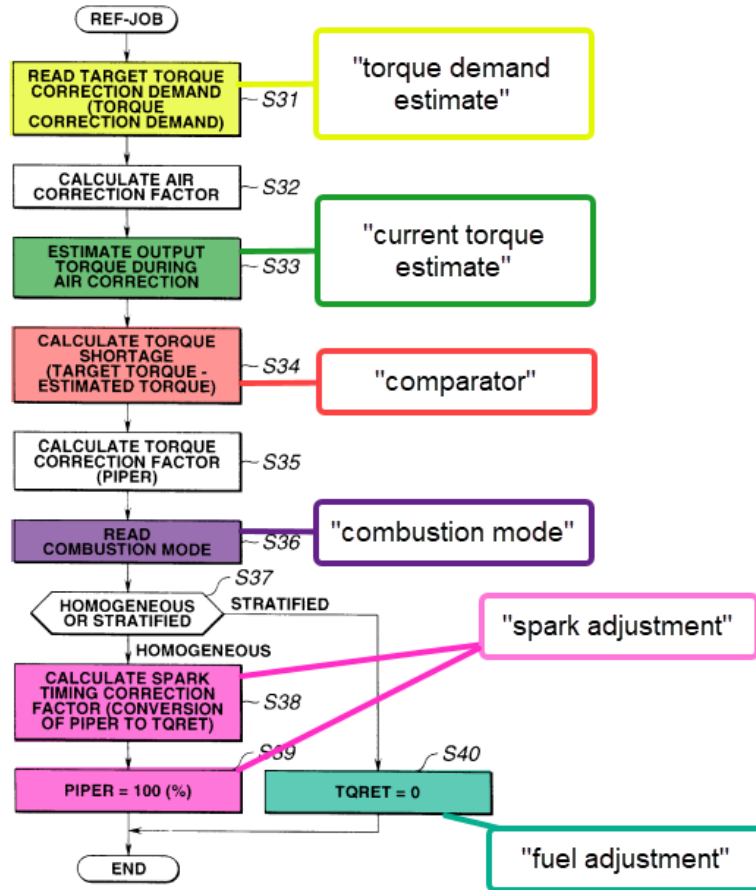
U.S. Patent No. 6,006,717 to Suzuki et al., “Direct-Injection Spark-Ignition Type Engine Control Apparatus” (Ex. 1005, “Suzuki”), issued December 28, 1999, more than one year before the '565 patent's earliest possible priority date. Suzuki predates the priority date for the '565 patent and is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

Like the '565 patent, Suzuki discloses controlling the torque output of a direct injection spark ignition (“DISI”) engine. Suzuki is directed to “torque correction during both homogeneous combustion and stratified combustion” where “[t]orque correction is made in response to a torque correction demand . . . by correcting the spark timing . . . during homogeneous combustion and by correcting the air-fuel ratio during stratified combustion.” Ex. 1005 at Abstract. Suzuki's feedback loop can be seen, for example, in Figure 1B:



Id. at FIG. 1B.

As shown in the annotated version of Suzuki's Figure 6 below, the particular operation of Suzuki's feedback loop matches the steps recited in the '565 patent's challenged claims:



Id. at FIG. 6 (annotations added).

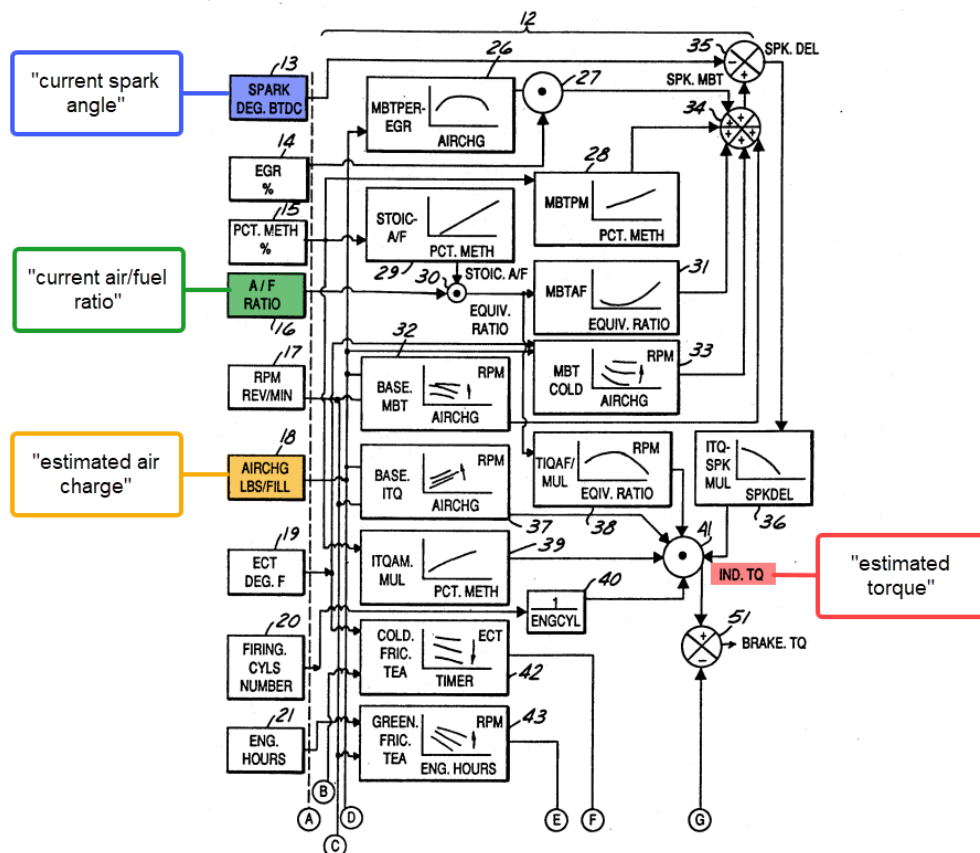
Like the '565 patent, Suzuki teaches a controller and method for adjusting torque by comparing a demanded torque to the engine's current torque and adjusting the engine's torque based on the difference. Suzuki discloses calculating a target torque based on a torque demand control. *Id.* at 7:14-16, FIG. 6 (S31). Suzuki teaches calculating the difference between the demanded and the engine's current estimated torque by subtracting the estimated torque from the demanded torque—just like the comparator in the '565 patent. *Id.* at 7:33-39, FIG. 6 (S33). Finally, Suzuki determines whether the engine is operating in homogenous or stratified mode (*id.* at FIG. 6 (S36)-(S37)) and, depending on the operation mode, adjusts either

spark timing (*id.* at FIG. 6 (S38)-(S39)) or air/fuel ratio to adjust the engine's torque output (*id.* at FIG. 6 (S34)), just like the '565 claims. *Id.* at 7:45-64.

B. Cullen

U.S. Patent No. 5,241,855 to Cullen et al., "Method and Apparatus for Inferring Engine Torque" (Ex. 1006, "Cullen"), issued September 7, 1993, more than **seven years** before the '565 patent's earliest possible priority date. Cullen pre-dates the priority date for the '565 patent and is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

Cullen, like Suzuki and the '565 patent, discloses an engine controller for "inferring and predicting engine torque [as] a function of . . . speed . . . air/fuel ratio and spark advance." Ex. 1006 at Abstract. Like the '565 patent, Cullen's engine controller estimates the current torque based on a current spark timing angle 13, a current air/fuel ratio 16, and an estimated air charge 18, among other engine parameters. *Id.* at 4:5-14, 5:35-50, 5:60-6:2. This is shown, for example, in the annotated version of Figure 3 of Cullen, below:



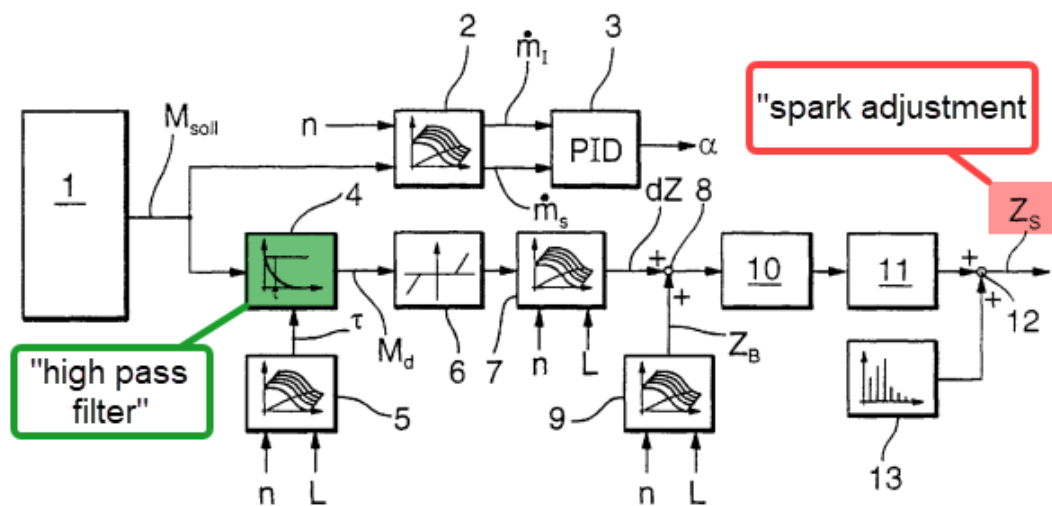
Ex. 1006 at FIG. 3 (annotations added).

C. Scherer

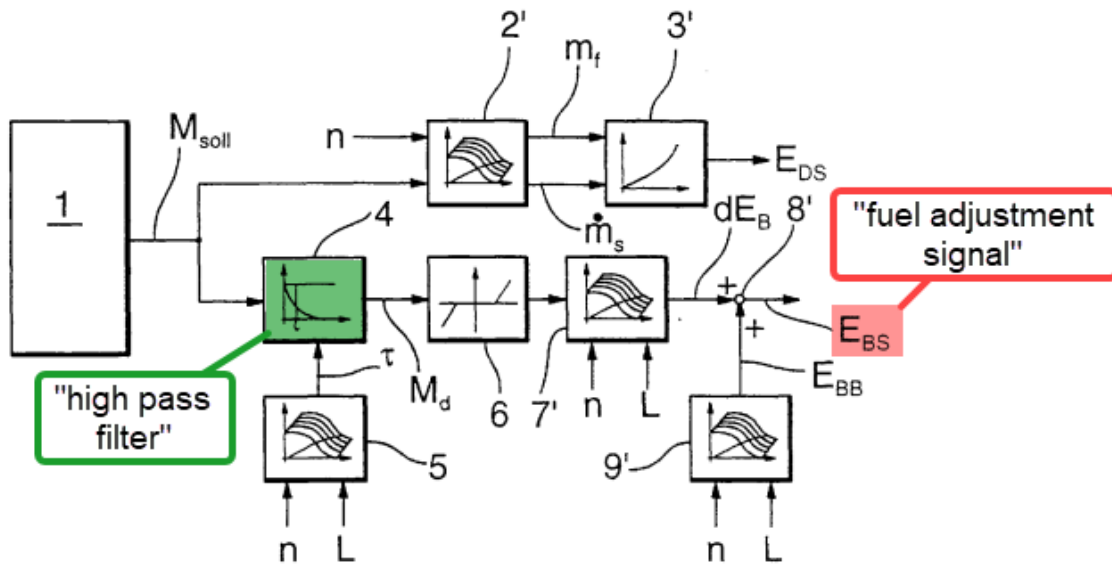
U.S. Patent No. 6,047,681 to Scherer et al., “Process and Apparatus for Adjusting the Torque of an Internal-Combustion Engine” (Ex. 1007, “Scherer”), issued April 11, 2000, more than one year before the ’565 patent’s earliest possible priority date. Therefore, Scherer is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

Like Suzuki, Cullen, and the ’565 patent, Scherer is also directed to “a process and an apparatus for controlling the engine torque of an internal-combustion engine.” Ex. 1007 at Abstract. Scherer’s controller adjusts torque output by making

adjustment of “the ignition point . . . of the injection start,” (*i.e.*, spark adjustments), “adjustment of the air flow rate,” or adjustment of “the fuel injection duration.” *Id.* Scherer further teaches using a high pass filter to filter a desired engine torque signal into a dynamic torque component, which is input to a torque controller that adjusts torque output through correcting spark timing for homogeneous engine operation or fuel delivery for heterogeneous (*i.e.*, stratified-charged) engine operation. *Id.* at 2:51-55, 3:49-67, 5:35-55. These features of Scherer are shown, for example, in annotated Figs. 1 and 2, below:



Id. at FIG. 1 (annotations added).



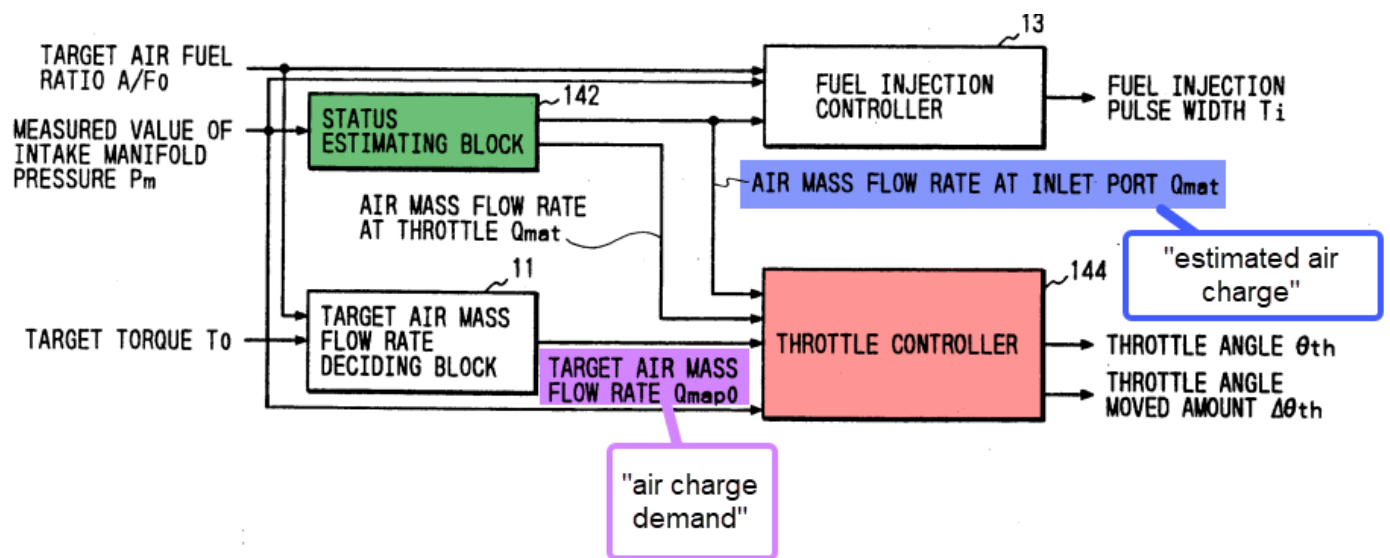
Id. at FIG. 2 (annotations added).

D. Takahashi

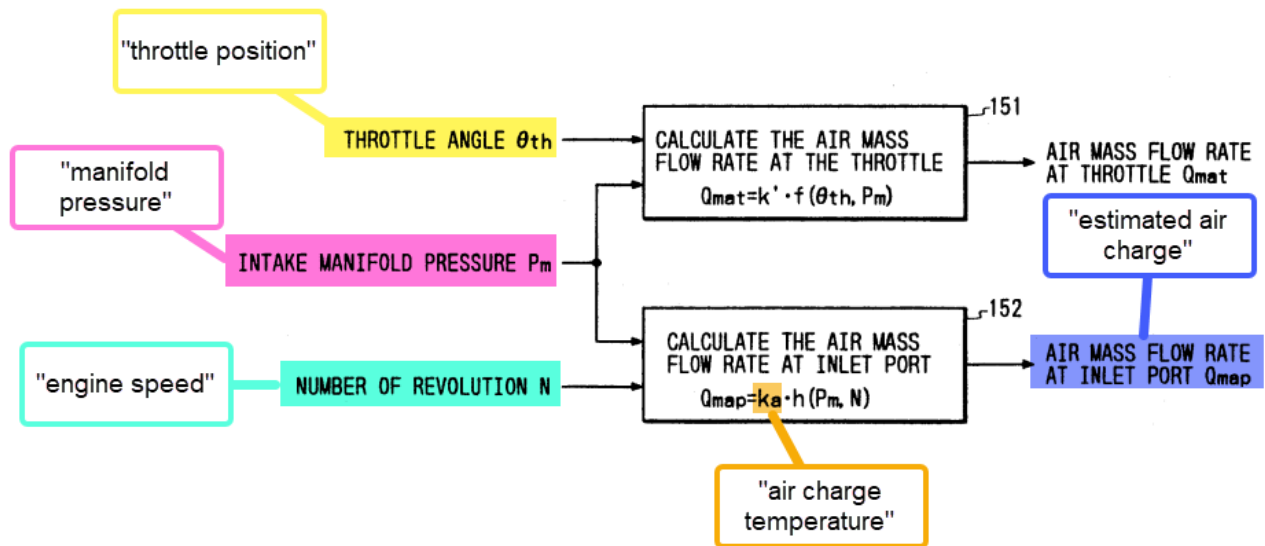
U.S. Patent No. 5,282,449 to Takahashi et al., “Method and System for Engine Control” (Ex. 1008, “Takahashi”), issued February 1, 1994, more than **seven years** before the ’565 patent’s earliest possible priority date. Therefore, Takahashi is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

Like Suzuki, Cullen, Scherer, and the ’565 patent, Takahashi is directed to a method and system for “control of the engine generated torque.” Ex. 1008 at Abstract. Takahashi’s controller “control[s] . . . the throttle valve and fuel injection to ensure that the torque and air fuel ratio of the . . . engine will reach target values.” *Id.* at 1:5-9. Takahashi’s controller “comprises [a] status estimating block [142], target air mass flow rate deciding block [11], fuel injection control block 13, and throttle control block [144].” *Id.* at 3:16-24. The throttle controller “determines

the throttle angle and the throttle angle moved amount, which achieve the target air mass flow rate.” *Id.* at 6:13-17. The throttle controller and status estimating block together operate as an air charge controller for “achiev[ing] the target air mass flow rate” (*i.e.*, air demand air charge) based on current air mass flow rate (*i.e.*, estimated air charge), intake manifold pressure, temperature, throttle angle, and number of engine revolutions (*i.e.*, engine speed). *Id.* at 6:13-17, 10:50-11:21.



Id. at FIG. 14 (annotations added).



Id. at FIG. 16 (annotations added).

VIII. THE VOLKSWAGEN IPRS

Volkswagen Group of America, Inc. (“VW”) previously filed two petitions for *inter partes* review, both challenging claims 1-7 of the ’565 patent, on January 31, 2020. See IPR Nos. IPR2020-00444 (“’444 IPR”) and IPR2020-00445 (“’445 IPR”). The ’444 IPR petition relied on combinations of Suzuki, Cullen, Scherer and Takahashi—the same references are relied upon by MBUSA in this Petition. See ’444 IPR at Paper 2 (Petition). The ’445 petition relied on combinations of Robichaux (not relied upon by MBUSA in this Petition) as well as Scherer, Suzuki and Takahashi. See ’445 IPR at Paper 3 (Petition).

The PTAB instituted both petitions, finding a reasonable likelihood of success that the prior art—including Suzuki, Cullen, Scherer and Takahashi—invalidated the challenged claims. ’444 IPR at Paper 12; ’445 IPR at Paper 12. However, Patent Owner settled its litigation with VW, and moved for termination of both IPRs

before the post-institution briefing completed. The PTAB granted both termination requests. Accordingly, the PTAB did not have an opportunity to render a patentability determination regarding claims 1-7 of the '565 patent.

IX. 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 the first prong, the Board considers whether the same or substantially the same prior art or arguments were presented during the prosecution of the patent, and any post-issuance proceedings. *Id.* at 7-8. As to the second prong, the Board considers whether the office materially erred in determining patentability of the challenged claims, including by overlooking a specific teaching of the relevant prior art or an error of law, such as misconstruing a claim term. *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). The *Advanced Bionics* analysis weighs in favor of institution here.

The prosecution history weighs in favor of institution. The only prior art

cited in this Petition that is referenced in the prosecution history of the '565 patent is Scherer. Suzuki, Cullen and Takahashi were **not** presented during the prosecution of the '565 patent. Accordingly, Section 325(d) concerns are not implicated here because this Petition addresses new arguments based on prior art not addressed during prosecution. *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).

Likewise, Scherer is cited on the face of the '565 patent but was not used as the basis for any prior-art rejections and the Examiner provided no substantive analysis of Scherer. The Board has routinely held that denial is not warranted based on the mere citation of a reference without any substantive analysis. See, e.g., *Digital Check Corp. d/b/a ST Imaging v. E-Imagedata Corp.*, IPR2017-00178, Paper 6 at 12-13 (PTAB April 25, 2017) (instituting where: “The evidence supports Patent Owner’s assertion that [the prior art references] were cited in an IDS and the Examiner considered both references. But there is no indication in the record that the Examiner rejected any claims based on either reference or that the Examiner or

applicant substantively discussed either reference during prosecution[.]”). Accordingly, the prosecution history weighs in favor of institution under the *Advanced Bionics* framework.

An analysis of VW’s prior IPR petitions also favors institution. In those proceedings the PTAB only issued an institution decision—it did **not** issue a Final Written Decision on the merits and thus never decided whether any of the prior art references invalidated any claims of the ’565 patent. The Volkswagen IPRs were terminated before the briefing was completed. Because a final decision was never issued for the ’565 patent, 325(d) does not apply.

Indeed, as held in *Advanced Bionics*, “[a]t bottom,” the two-part framework utilized for 35 U.S.C. § 325(d) “reflects a commitment to defer to previous Office evaluations of the evidence of record unless material error is shown.” *Advanced Bionics* at 9. Here there was no previous “evaluation” because the case settled before the record was completed. The PTAB did not have full briefing of the issues or oral argument, and it issued no final decision. The PTAB’s institution decisions alone are also “not a sufficient demonstration that the [prior art] was previously considered” under prong 1 of *Advanced Bionics*. *Google LLC v. Uniloc 2017 LLC*, IPR2019-01584 (PTAB Mar. 24, 2020) paper 7 at 11-12 (“it is unwarranted to apply our discretion under 35 U.S.C. § 325(d) to deny the instant Petition simply because it relies on the same or similar references that we considered in an institution decision in a prior petition”). Accordingly, institution is warranted here because

the first prong of *Advanced Bionics* is not met by the prior VW IPRs.

While the second prong of *Advanced Bionics* need not be addressed in view of the first prong, it is also not met here. In particular, there can be no analysis regarding whether the Office “erred” under prong 2 of *Advanced Bionics*, because the Office never issued a final decision in the VW IPRs. Thus, 325(d) is not applicable here because there is no decision to review for errors. *See, e.g., Samsung Electronics Co., Ltd. V. Lynk Labs, Inc.*, IPR2021-01575, Paper 20 at 7-8 (May 20, 2022) (“There has been no final determination in [the IPR proceeding challenging the same patent]...As such, there is no reference points to determine whether the Office erred; there has simply been no final determination to analyze or reconsider. Accordingly, the framework described in *Advanced Bionics* is not yet applicable and does not support discretionary denial.”).

The PTAB’s precedent of instituting IPRs where unrelated parties filed earlier petitions that were never finally decided is grounded in sound policy. Indeed, the function of the PTAB to review the validity of issued patents would not be served by permitting patent owners to avoid invalidating prior art due to strategic settlement. If that were the case, then patent owners could simply settle with parties raising a genuine patentability challenges knowing that the PTAB would effectively be estopped from considering the invalidating prior art in any later challenge. While the PTAB should not have to entertain repeated arguments that it already finally decided, the PTAB should not be barred from considering prior art merely because

patent owner settled before an unpatentability determination was issued.

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.* This is the first post-grant proceeding brought against the '565 patent by either MBUSA or BMW. VW's prior IPRs do not 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 both sued separately from Volkswagen: MMT sued Volkswagen in the Eastern District of Michigan in 2019; MMT sued MBUSA and BMW in the Northern District of Illinois three years later in 2022. See *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 VW. MMT's complaint against MBUSA accuses three Mercedes-AMG engine types 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 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-cv-10485 (E.D. Mich.), Dkt. 1 at ¶¶ 11, 17, 23, 29, 35, 43, 49, 55, 62, 68, 76, 88, 96, 102, 110, 116, 122, 128, 134, 146.

In addition, neither MBUSA nor BMW coordinated with VW in the preparation of this Petition or VW's petitions. 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 any reason to know of the prior art asserted in this Petition at the time of VW's petitions at least because MMT had not yet sued MBUSA or BMW. Likewise, there is no significant relationship between MBUSA or BMW and 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 MBUSA and BMW in filing this 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, neither MBUSA nor BMW learned 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 either MBUSA or 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 ’565

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 MBUSA and BMW filed more than two years after the prior petitions of the ’565 patent that were filed in response to MMT’s complaint against VW. *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) (board will “decline to wield [the patent owner’s] own litigation activities as a shield in [an] inter partes review” and 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, accordingly, 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 in no way adversely impact the PTAB’s 1 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*, Case IPR2016-01357 at 8-11 (Paper 19) (Precedential) (setting forth seven factors directed towards “follow-on” petitions).

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 June 6, 2023. Thus, the approximate date of the PTAB hearing would be October 2024, whereas the trial dates for the district court cases (which have not been set) will likely not be until 2025. Accordingly, the PTAB trial will pre-date the district court trials, perhaps by many months.

Even if the trials occur 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 stipulates that, if the Board institutes *inter partes* review, Petitioners will not seek resolution in the District Court of any ground of invalidity for the ’565 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 ’565 Patent invalidity theories before the Board and at issue in the District Court. Accordingly, this factor weighs in favor of institution.

X. GROUND 1: SUZUKI, CULLEN, AND SCHERER RENDER OBVIOUS CLAIMS 1, 4, AND 7.

A POSITA at the time of the alleged invention would have found claims 1, 4, and 7 obvious over Suzuki in view of Cullen and Scherer.³ Suzuki discloses the majority of the limitations of claims 1, 4, and 7, including: a “torque demand

³ The PTAB previously found it was reasonably likely that the combination of Suzuki, Cullen, and Scherer invalidates claims 1, 4, and 7. ’444 IPR, Paper 12 at 38.

controller,” “a torque producer,” an “estimator,” a “comparator,” and a “transient torque controller” that outputs a “fuel adjustment signal” or a “spark adjustment signal” depending on whether the engine is operating in stratified or homogeneous combustion mode. *See, e.g.*, Ex. 1005 at Abstract, 1:5-7, 1:44-64, 3:6-12; 3:23-24, 4:6-38, 5:41-43, 5:59-64, 6:10-57, 7:11-19, 7:33-39, 7:44-8:4, 8:7-11, FIGS. 1B, 3-6.

Cullen discloses “an ***estimator*** which receives as inputs a current spark angle signal, a current air/fuel ratio signal, and an estimated air charge signal.” *See, e.g.*, Ex. 1006 at 4:5-15; 5:33-6:2, 6:67-7:2, FIG. 3.

Scherer discloses “a ***high pass filter*** which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent.” *See, e.g.*, Ex. 1007 at 3:59-63; 4:31-38, FIGS. 1-2.

A POSITA would have been motivated to include an estimator and a high pass filtering in Suzuki’s system based on the teachings of Cullen and Scherer for a variety of reasons.

1. Motivation to Combine Suzuki with Cullen and Scherer

A POSITA viewing Suzuki's torque control system would have been motivated to include an estimator as described in claim 1 of the '565 patent and high pass filtering based on the teachings of Cullen and Scherer, respectively.⁴

a. Combining Suzuki and Cullen

Suzuki already discloses using a torque estimator, which the '565 patent also refers to as a "torque producer." See claim 1[c], *infra*. Cullen also discloses a torque estimator, and provides additional explanation that its estimator receives as inputs a current spark angle signal, a current air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal. A POSITA would have been motivated to use an estimator with Cullen's spark and fuel inputs in Suzuki because Suzuki expressly teaches adjusting either spark timing (Ex. 1005 at FIG. 6 (S38)-(S39)) or air/fuel ratio (*id.* at FIG. 6 (S34)) to adjust the engine's torque output. Ex. 1003 at ¶¶ 61-64. A POSITA would understand that including spark and fuel inputs like those taught by Cullen would assist in Suzuki's process of spark and fuel adjustment. *Id.*

⁴ The PTAB previously found it was reasonably likely that a POSITA would be motivated to combine the teachings of Suzuki, Cullen, and Scherer. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 35-36, n. 7 (PTAB Aug. 5, 2020).

In addition, a POSITA would have been motivated to use an estimator in Suzuki that takes the same types of inputs as those described by Cullen because, as Cullen explains, doing so improves the accuracy of torque estimation. Indeed, Cullen explicitly teaches that its torque estimation makes “predicted torque calculation . . . more accurate.” Ex. 1006 at 2:32-40. Thus, a POSITA would seek to take advantage of Cullen’s improved accuracy by including such an estimator in Suzuki.

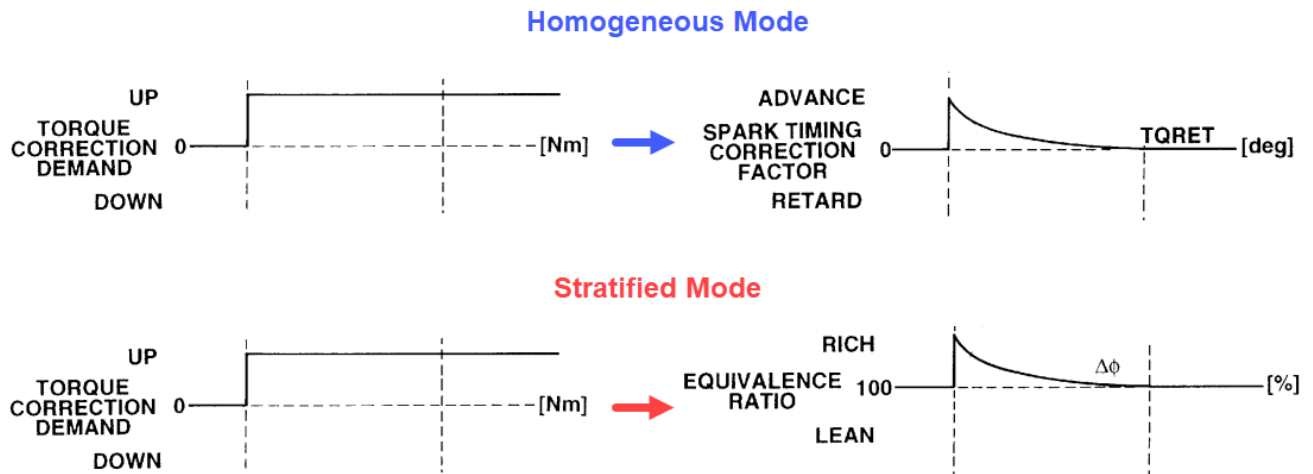
A POSITA would likewise be motivated to combine the teachings of Suzuki and Cullen for several additional reasons. First, they are both in the *same field of endeavor* as the ’565 patent, predicting and controlling engine torque. Ex. 1001 at Abstract; Ex. 1005 at Abstract; Ex. 1006 at Abstract. Second, as discussed below, both Suzuki and Cullen use *similar techniques to solve the same problem* as the ’565 patent—indeed, Suzuki discloses nearly all of the limitations of claims 1, 4, and 7 of the ’565 patent, and Cullen discloses the estimator that takes the spark and fuel inputs recited in claim 1. Third, a POSITA would have had a *reasonable expectation of success* of applying Cullen’s implementation of a torque estimator into Suzuki’s torque control system at least because Suzuki already teaches using the microcomputer in its control unit 20 to estimate current torque, and because Cullen already uses these inputs in a similar engine. Ex. 1003 at ¶¶ 61-64. A POSITA would understand that the code in Suzuki’s microcomputer implementing

the torque estimation could be easily modified to implement Cullen's method of torque estimation to improve accuracy. *Id.*

Thus, there is a motivation POSITA to combine the known elements of Cullen's torque estimating routine with Suzuki's control unit 20 using known methods because the modification would improve the accuracy of the system's torque estimation. Ex. 1003 at ¶¶ 61-64; *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.").

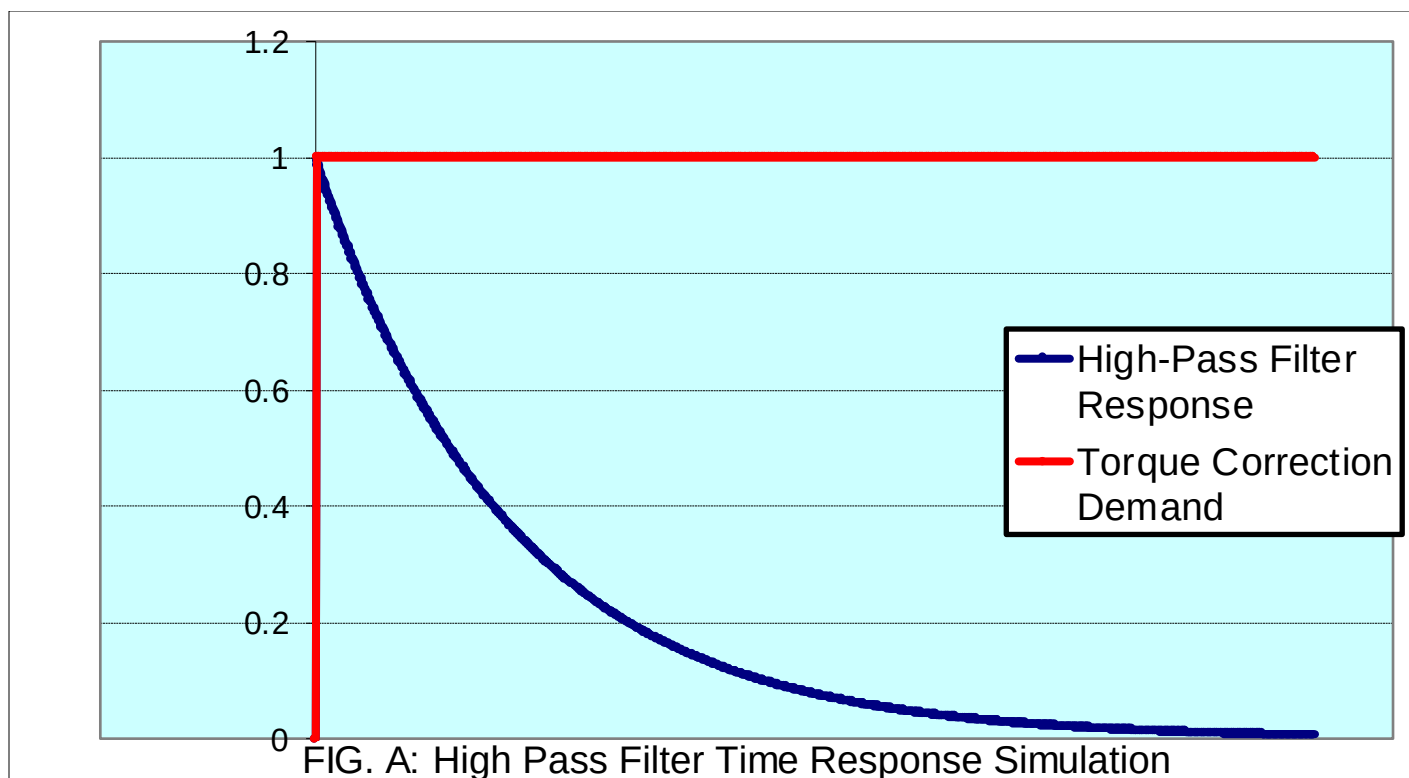
b. Combining Scherer with Suzuki and Cullen

A POSITA would have been motivated to modify Suzuki's torque controller to include a high pass filter like that taught by Scherer. In fact, a POSITA would understand that Suzuki's system already implicitly recites using such a high pass filter. In particular, as shown in the below excerpts from Figure 13, Suzuki's processing of the torque correction demand signal into either a spark timing correction signal or an air/fuel ratio adjustment signal generates an exponential decay curve. Ex. 1003 at ¶ 65.



Ex. 1005 at FIG. 13 (annotations added).

As demonstrated by Figure A of the expert declaration of Arthur MacCarley, the exponential decay curves in Suzuki's Figure 13 match the response a high pass filter would have to an abrupt change in the torque correction demand signal. Ex. 1003 at ¶¶ 66-67. Figure A shows two signals: the torque correction demand signal from Suzuki's Figure 13, and the output of a simulated high pass filtering of the torque correction demand signal. *Id.* As demonstrated by the high pass filter simulation in Figure A, the exponential decay curves in Figure 13 match the response a high pass filter would have to Suzuki's torque correction demand signal. *Id.*



Ex. 1003 at FIG. A.

Because Suzuki's spark timing and air/fuel ratio signals match the response of a high pass filter to Suzuki's torque correction demand signal, a POSITA would recognize that Suzuki's system includes a high pass filter used to generate its spark timing and air/fuel ratio adjustment signals from Suzuki's torque correction demand signal. Ex. 1003 at ¶ 67.

Moreover, a POSITA would have been motivated to use a high pass filter in Suzuki because doing so would allow it to more accurately adjust for dynamically changing torque values. Ex. 1003 at ¶¶ 68-69. Scherer teaches that its high pass filtering method would enable Suzuki's torque controller to "react very rapidly to sudden changes of the engine torque" arising during transient engine operations.

Ex. 1007 at 4:20-25, 4:40-45, 5:10-15; Ex. 1003 at ¶¶ 68-69. Thus, a POSITA would have been motivated to include a high pass filter in Suzuki based on the teachings of Scherer to allow Suzuki to accurately react to rapid changes in torque.

A POSITA would likewise be motivated to combine the teachings of Suzuki, Cullen, and Scherer because they are all in the *same field of endeavor* as the '565 patent, predicting and controlling engine torque. Ex. 1001 at Abstract; Ex. 1005 at Abstract; Ex. 1006 at Abstract; Ex. 1008 at Abstract. As discussed below, Suzuki, Cullen, and Scherer all use *similar techniques to solve the same problem* as the '565 patent: Suzuki discloses nearly all of the limitations of claims 1, 4, and 7, Cullen discloses the estimator described in claim 1, and Scherer discloses the high pass filter disclosed in claim 1. Additionally, a POSITA would have had a *reasonable expectation of success* of applying Scherer's high pass filtering to Suzuki's torque control system at least because Suzuki already teaches using high pass filtering as described above, and because a POSITA would have recognized that the software instructions stored in Suzuki's control unit 20 could be modified to input Suzuki's torque difference signal into a high pass filter before outputting the difference signal to the rest of Suzuki's system. Ex. 1003 at ¶¶ 68-69.

A POSITA would have therefore been motivated to combine the known elements of Scherer's high pass filtering with Suzuki's control unit 20 using known methods because the modification would improve the response of the system to dynamic changes in torque demand. Ex. 1003 at ¶¶ 65-69; *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.”).

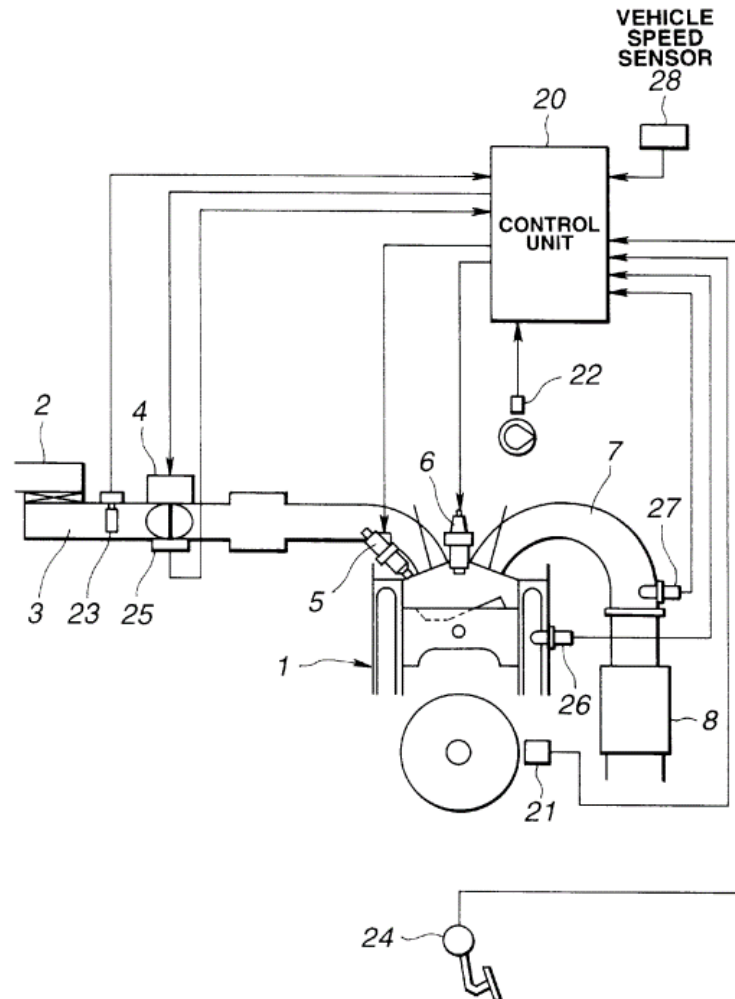
2. Claim 1:

- a. 1[pre] “A device for controlling a torque output of an engine, the device comprising”

Suzuki discloses a device for controlling an engine’s torque output. Ex. 1003 at ¶¶ 70-71.⁵ As discussed in more detail with respect to claim limitations 1[a]-[f], Suzuki teaches that its system is used “for correcting engine torque,” *i.e.*, controlling a torque output of an engine. *Id.* at 1:5-7. For example, Suzuki discloses “torque correction during both homogeneous combustion and stratified combustion” where “[t]orque correction is made in response to a torque correction demand . . . by correcting the spark timing . . . during homogeneous combustion and by correcting the air-fuel ratio during stratified combustion.” Ex. 1005 at Abstract. As shown below in Figure 2, Suzuki discloses a “direct-injection spark-ignition engine” 1 with a “control unit 20 that receives . . . signals from . . . various sensors,” including crank “angle sensors 21 and 22,” “an airflow meter 23,” “an accelerator sensor 24,” “a throttle valve sensor 25,” and “an O₂ sensor 27.” Ex. 1005 at 3:23-

⁵ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

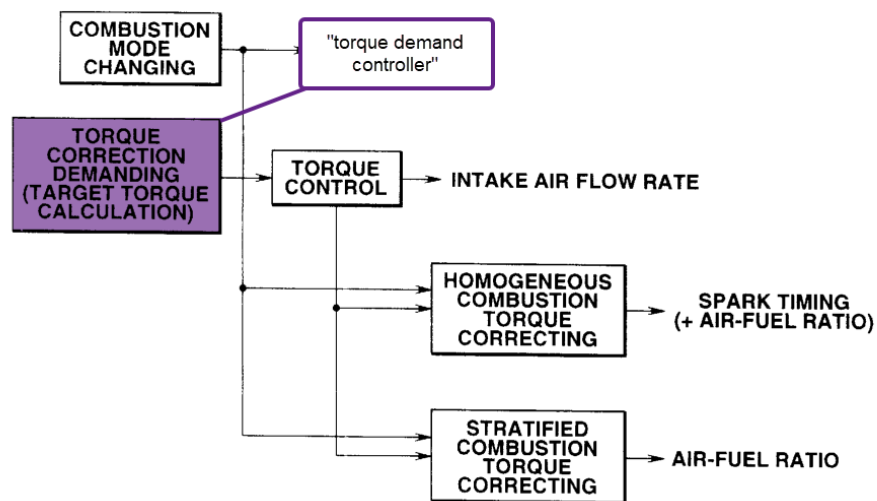
24, 4:6-32. Suzuki's control unit 20 includes a microcomputer that makes calculations based on the sensor input "to control the degree of opening of the electronic controlled throttle valve 4, the amount of fuel injected to the engine by the fuel injector 5, and the spark timing of the spark plug 6." *Id.* at 4:33-38.



Thus, Suzuki discloses the preamble of claim 1. Ex. 1003 at ¶¶ 70-71.

b. 1[a] “a torque demand controller for generating a torque demand signal”

Suzuki discloses a torque demand controller for generating a torque demand signal. Ex. 1003 at ¶¶ 72-74.⁶ Suzuki discloses a “torque correction demanding section” (i.e., the claimed “torque demand controller”) of control unit 20 “[that] **produces a torque correction demand** based on engine operating conditions.” Ex. 1005 at 3:10-12 (emphasis added). For example, Suzuki’s “torque demand control” includes “[a] torque calculation section” that “outputs a driver demand torque,” i.e., generates a torque demand signal. *Id.* at 8:7-11.



Id. at FIG. 1B (annotations added).

Suzuki’s torque correction demanding section discloses the claimed “torque demand controller” because the torque correction demanding section “produces a

⁶ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

torque correction demand” indicating a “a demand for increasing or decreasing the torque” and “a target torque,” which is used to control torque output. *Id.* at 3:10-12; 7:11-19; Ex. 1003 at ¶¶ 72-74.

Indeed, Suzuki’s torque correction demanding section operates in the same manner as the torque demand controller disclosed by the ’565 patent. Ex. 1003 at ¶¶ 72-74. The ’565 patent’s “torque demand controller 11 calculates a required output torque signal” based on engine operating conditions and throttle position. Ex. 1001 at 2:57-67. Similarly, Suzuki discloses a “torque demand control” that calculates “a target torque,” *i.e.*, a required output torque signal, for controlling torque output based on a change in engine operation. Ex. 1005 at 7:11-17. Accordingly, Suzuki expressly discloses this limitation.

Thus, Suzuki discloses claim limitation 1[a]. Ex. 1003 at ¶¶ 72-74.

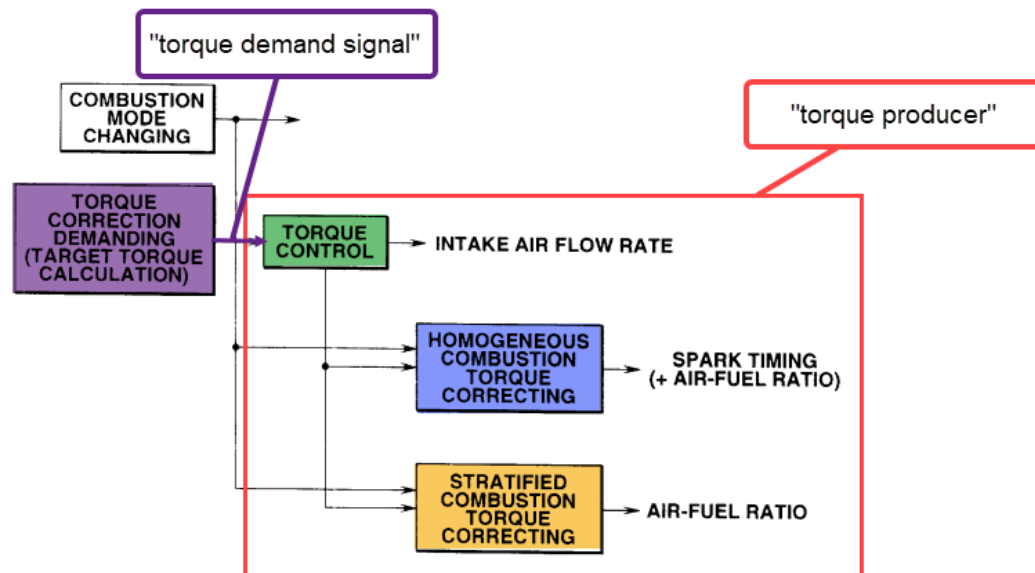
c. 1[b]: “a torque producer which receives the torque demand signal, the torque producer includes:”

Suzuki discloses a torque producer which receives the torque demand signal. Ex. 1003 at ¶¶ 76-79.⁷ Suzuki discloses that the control unit 20 includes “a torque correction section . . . which receives a torque correction demand and produces a

⁷ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

torque correction output in response to the torque correction demand.” Ex. 1005 at claim 1.

As shown below in Figure 1B, Suzuki’s “torque control section is responsive to the torque correction demand” and includes “a homogeneous combustion torque correcting section [that] corrects at least the spark timing” and “[a] stratified combustion torque correcting section [that] corrects at least the air-fuel ratio.” *Id.* at 3:10-22.



Id. at FIG. 1B (annotations added).

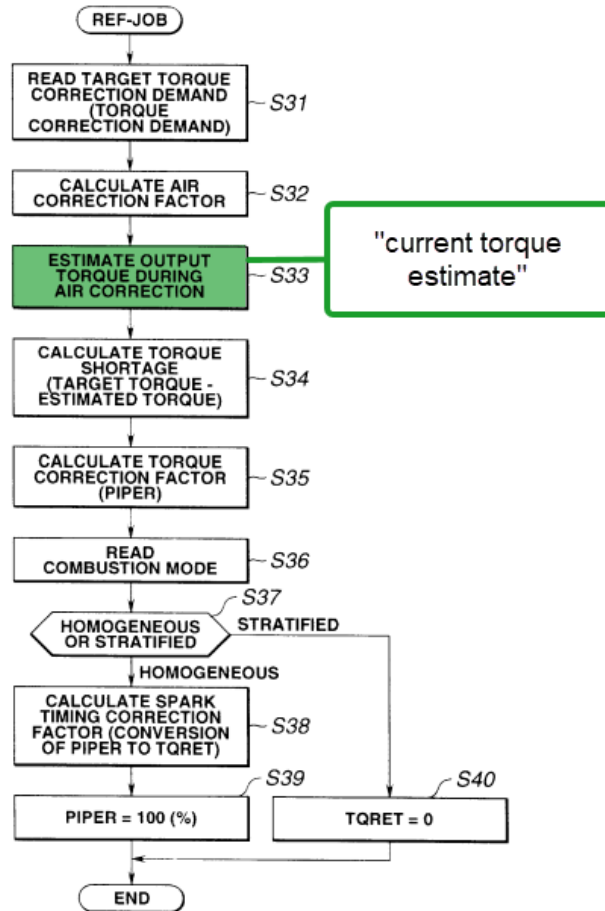
Suzuki’s torque control section, homogeneous combustion torque correction section, and stratified combustion torque correction section collectively disclose the torque producer recited in claim 1. Ex. 1003 at ¶¶ 76-79.

Thus, Suzuki discloses claim limitation 1[b]. *Id.*

- d. 1[c]: “an estimator which receives as inputs a current spark angle signal, a current air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal;”

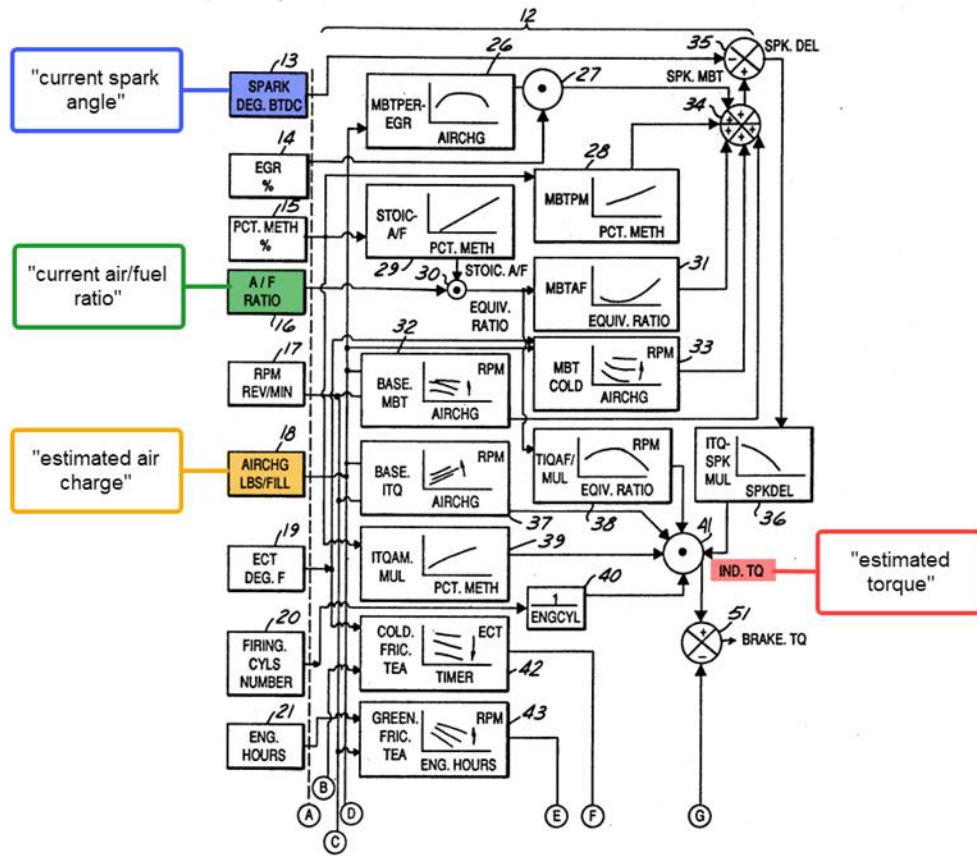
Suzuki in view of Cullen renders obvious a torque estimator which receives as inputs a current spark angle signal, a current air/fuel ratio signal, and an estimated air charge signal and outputs an estimated torque signal. Ex. 1003 at ¶¶ 80-87.⁸ Suzuki discloses a DISI engine controller for adjusting torque based on engine operating conditions by controlling the spark timing and the air-fuel ratio. Ex. 1005 at 1:4-7, 1:44-48. Suzuki’s control unit 20 functions as an estimator that estimates and outputs the estimated output torque, as shown below in Figure 6. *Id.* at 7:33-34, FIGS. 4-6; Ex. 1003 at ¶¶ 80-87.

⁸ The PTAB previously found it was reasonably likely that Suzuki in view of Cullen renders this claim limitation obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).



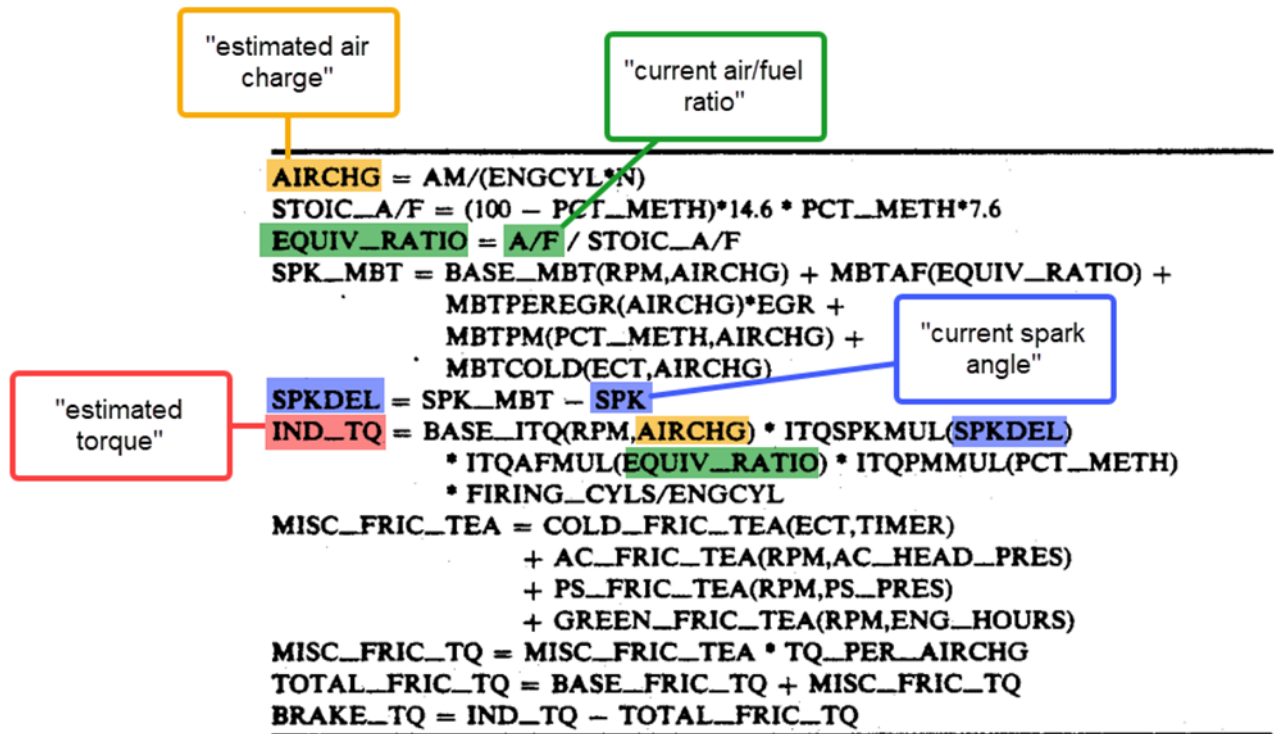
Ex. 1005 at FIG. 6 (annotations added).

Likewise, Cullen discloses particular implementation details for estimating torque, including an estimator which receives as inputs a current spark angle signal, a current air/fuel ratio signal, and an estimated air charge signal, that would have been readily applicable to Suzuki's torque controller. Ex. 1003 at ¶¶ 80-87. Cullen discloses "an electronic engine control module 12 which includes various algorithms for processing a spark timing input 13 . . . an air/fuel ratio input 16 . . . [and] an engine air charge input 18" "to provide indicated torque," *i.e.*, estimated torque. Ex. 1006 at 5:59-6:2, 6:67-7:2.



Id. at FIG. 3 (annotations added).

Cullen further discloses particular functions that use estimated air charge (“AIRCHG”), current air/fuel ratio (“A/F”), and current spark angle (“SPKDEL”/“SPK”), among others, as inputs to calculate estimated torque (“IND_TQ”). *Id.* at 4:5-15; 5:33-6:2, 6:67-7:2.



Id. at 5:33-53 (annotations added).

A POSITA would have understood that combining Cullen's torque estimating methods and functions with Suzuki's torque controller would have more accurately estimated the engine torque, allowing Suzuki's control unit 20 to calculate a more accurate difference between demanded torque and estimated torque. Ex. 1003 at ¶¶ 80-87; Ex. 1006 at 2:32-42 ("This invention recognizes that a predicted torque calculation can be made more accurate by" using the invention's systems and methods).

Moreover, a POSITA would have been able to easily implement Cullen's teachings simply by modifying the application instructions stored in the microcomputer of Suzuki's control unit 20 such that the estimator section receives a

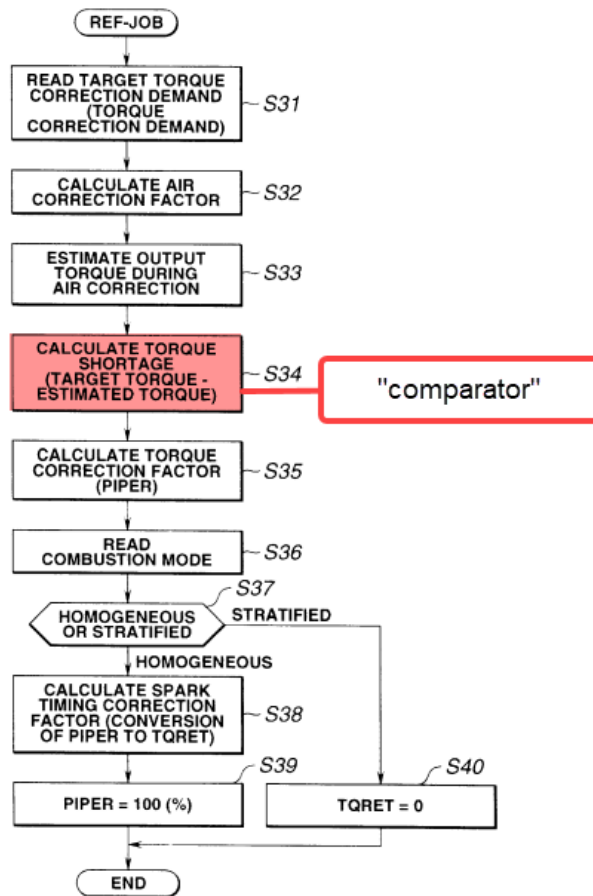
current spark angle signal, a current air/fuel ratio signal, and an estimated air charge signal as inputs for generating a torque estimate. Ex. 1003 at ¶¶ 80-87.

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

- e. 1[d]: “a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal;”

Suzuki discloses a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal. Ex. 1003 at ¶¶ 88-92.⁹ As shown below in FIG. 6, Suzuki discloses a torque correction section that subtracts estimated torque from target torque to output a torque shortage signal (S34). Ex. 1005 at 7:35-39 (“In step S34, the estimated torque is subtracted from the target torque...to calculate the torque shortage”).

⁹ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).



Id. at FIG. 6 (annotations added).

Thus, Suzuki's torque correction section includes a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal. Ex. 1003 at ¶¶ 88-92.

Further, Suzuki's torque correction section at S34 operates in the same manner as the '565 patent's comparator. Ex. 1003 at ¶¶ 88-92. The '565 patent's comparator subtracts the current torque estimate from the demanded torque to calculate a torque error signal. Ex. 1001 at 3:34-39, FIG. 3. Similarly, Suzuki

discloses a portion of its torque correction section that subtracts estimated torque from target torque to calculate a torque shortage. Ex. 1005 at 7:35-39, FIG. 6.

Moreover, Suzuki's calculated torque shortage is a difference signal. Ex. 1003 at ¶¶ 88-92. Suzuki teaches that "the estimated torque is subtracted from the target torque . . . to calculate the torque shortage," *i.e.*, the difference between estimated and target torque. *Id.* at 7:35-39.

As shown above, Suzuki discloses claim limitation 1[d]. Ex. 1003 at ¶¶ 88-92.

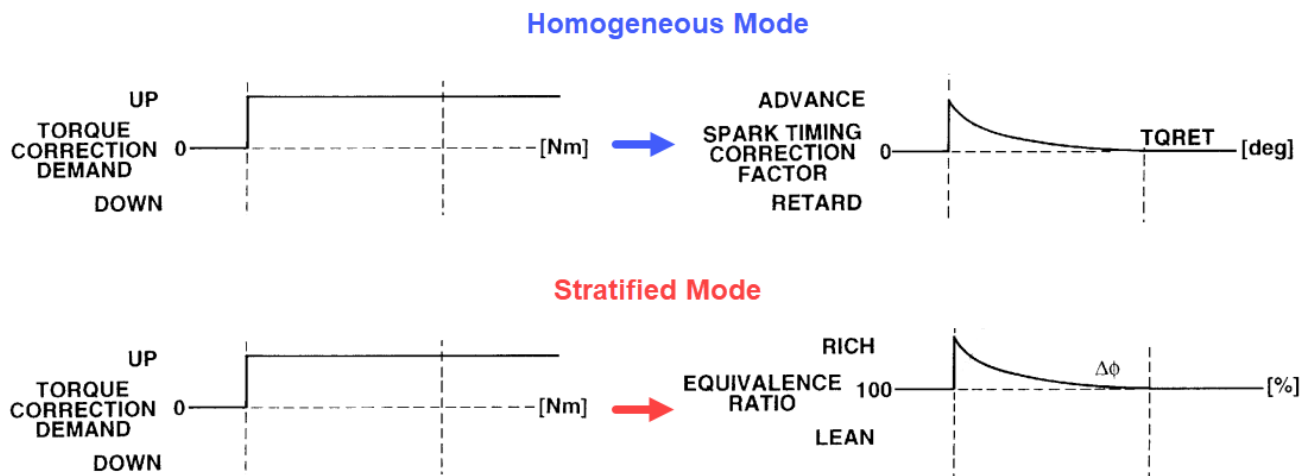
- f. 1[e]: "a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent; and"

Suzuki in view of Scherer renders obvious a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent. Ex. 1003 at ¶¶ 93-102.¹⁰

Suzuki discloses a DISI engine controller for adjusting torque based on engine operating conditions by controlling the spark timing and the air-fuel ratio. Ex. 1005 at 1:4-7, 1:44-48. As explained in § IX.2.e, *supra*, Suzuki's system calculates a difference signal, which Suzuki refers to as torque shortage. Ex. 1003 at ¶¶ 93-102.

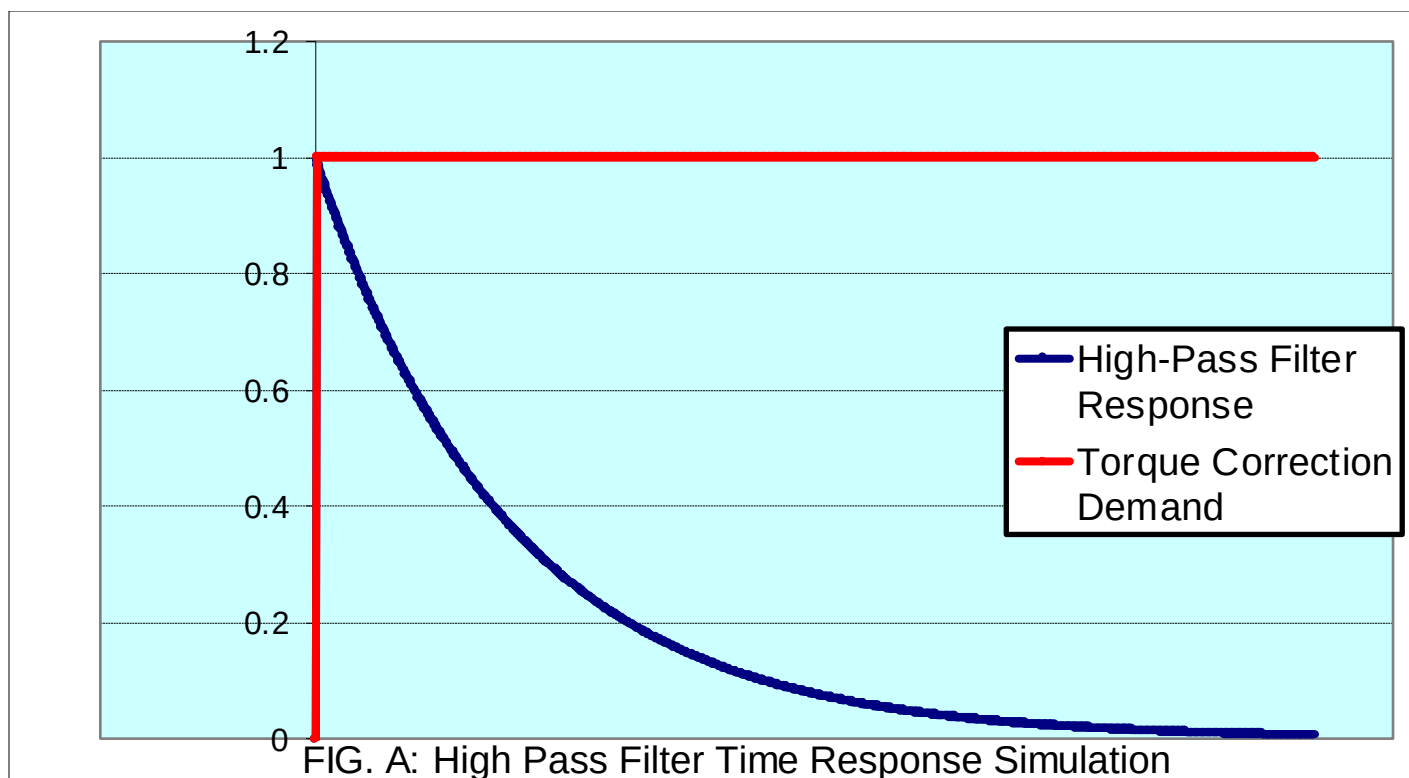
¹⁰ The PTAB previously found it was reasonably likely that Suzuki in view of Cullen and Scherer renders this claim limitation obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

A POSITA would have understood that the correction factor response curves disclosed in Suzuki's Figures 12-15 suggest using a high pass filter. Ex. 1003 at ¶¶ 93-102. For example, as shown below in FIG. 13, Suzuki discloses a torque correction demand signal wave that steps from zero up to some positive value. Ex. 1005 at FIG. 13; Ex. 1003 at ¶¶ 93-102. When the engine is operating in homogeneous mode, Suzuki teaches generating a spark timing correction factor signal from processing the torque correction demand signal through the torque correction routine shown in FIGS. 4 and 6. Ex. 1005 at 7:51-58, 8:1-2. When the engine is operating in stratified mode, Suzuki teaches generating a signal representing an air/fuel ratio adjustment signal from processing the torque correction demand signal through the torque correction routine shown in Figures 5 and 6. *Id.* at 7:60-64, 8:2-4. As shown in the below excerpts from Figure 13, Suzuki's processing of the torque correction demand signal into either a spark timing correction signal or an air/fuel ratio adjustment signal generates an exponential decay curve. Ex. 1003 at ¶¶ 93-102.



Ex. 1005 at FIG. 13 (annotations added).

As demonstrated by Figure A of the expert declaration of Arthur MacCarley, the exponential decay curves in Suzuki's Figure 13 match the response a high pass filter would have to the torque correction demand signal. Ex. 1003 at ¶¶ 93-102. Figure A shows two signals: the torque correction demand signal from Suzuki's Figure 13, and the output of a simulated high pass filtering of the torque correction demand signal. Ex. 1003 at ¶¶ 93-102. As demonstrated by the high pass filter simulation in Figure A, the exponential decay curves in Figure 13 match the response a high pass filter would have to Suzuki's torque correction demand signal. Ex. 1003 at ¶¶ 93-102.

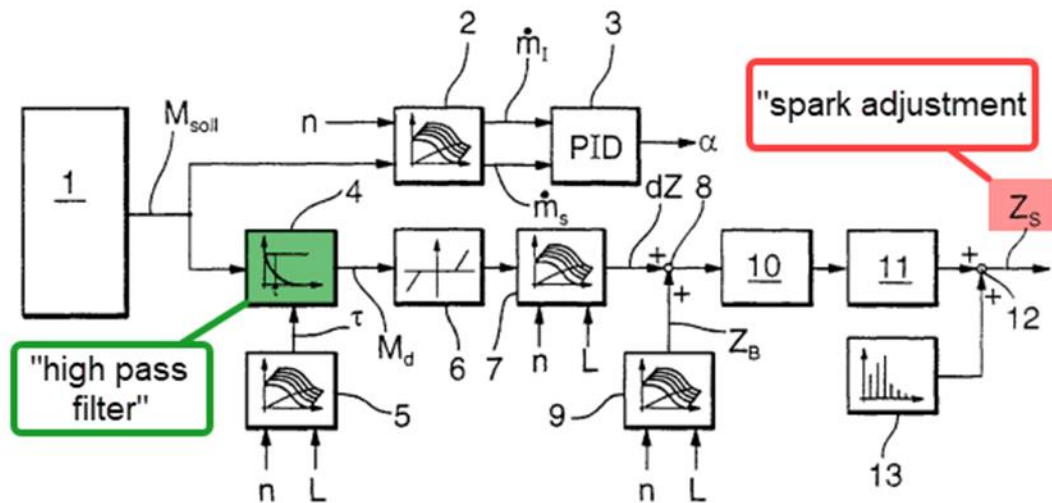


Ex. 1003 at FIG. A.

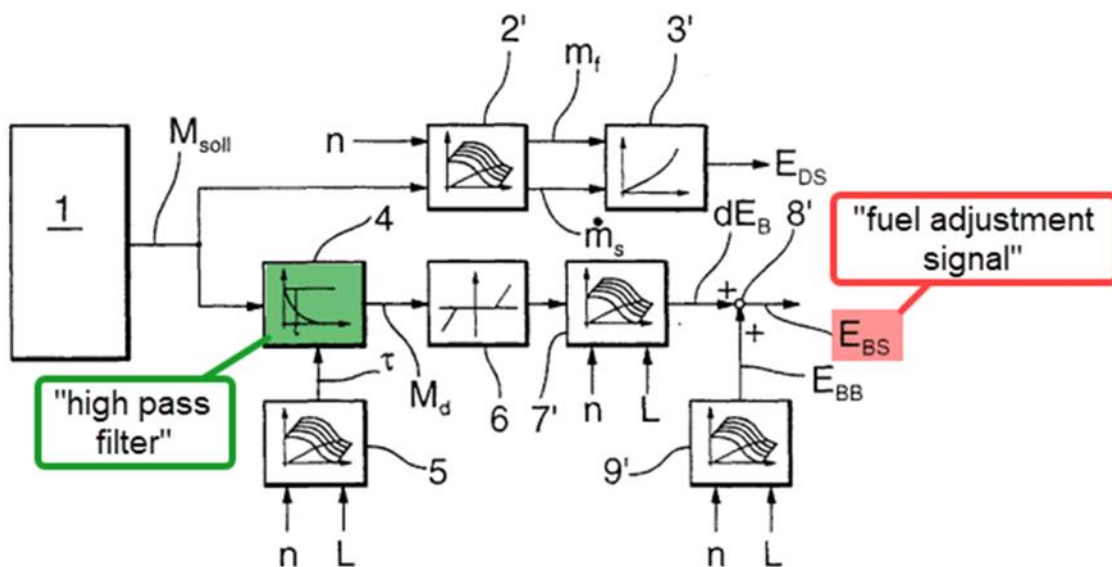
Because Suzuki's spark timing and air/fuel ratio signals match the response a high pass filter would have to Suzuki's torque correction demand signal, a POSITA would recognize that Suzuki's system includes a high pass filter used to generate its spark timing and air/fuel ratio adjustment signals from Suzuki's torque correction demand signal. Ex. 1003 at ¶¶ 93-102.

Further, Scherer explicitly discloses particular implementation details for controlling engine torque, including using a high pass filter to filter a signal related to torque demand. *Id.* Scherer discloses a "high pass filter stage, which precisely determines [a] dynamic desired torque component" from "a signal indicative . . . of the desired engine torque." Ex. 1007 at 3:59-63; 4:31-38. As shown below in FIG.

1 and 2, the filtered torque demand signal is used to generate spark timing or fuel injection timing signals, depending on the operation state of the engine, to adjust engine torque.



Id. at FIG. 1 (annotations added); Ex. 1003 at ¶¶ 93-102.



Id. at FIG. 2 (annotations added); Ex. 1003 at ¶¶ 93-102.

A POSITA would have understood that Scherer's adjustment of ignition timing or fuel injection based on engine operating conditions corresponds to Suzuki's homogeneous and stratified torque adjustment methods. Ex. 1003 at ¶¶ 93-102. As Scherer teaches, a POSITA would have recognized that using Scherer's high pass filtering would enable Suzuki's torque controller to "react very rapidly to sudden changes of the engine torque," arising during transient engine operations. Ex. 1007 at 4:20-25, 4:40-45, 5:10-15; Ex. 1003 at ¶¶ 93-102.

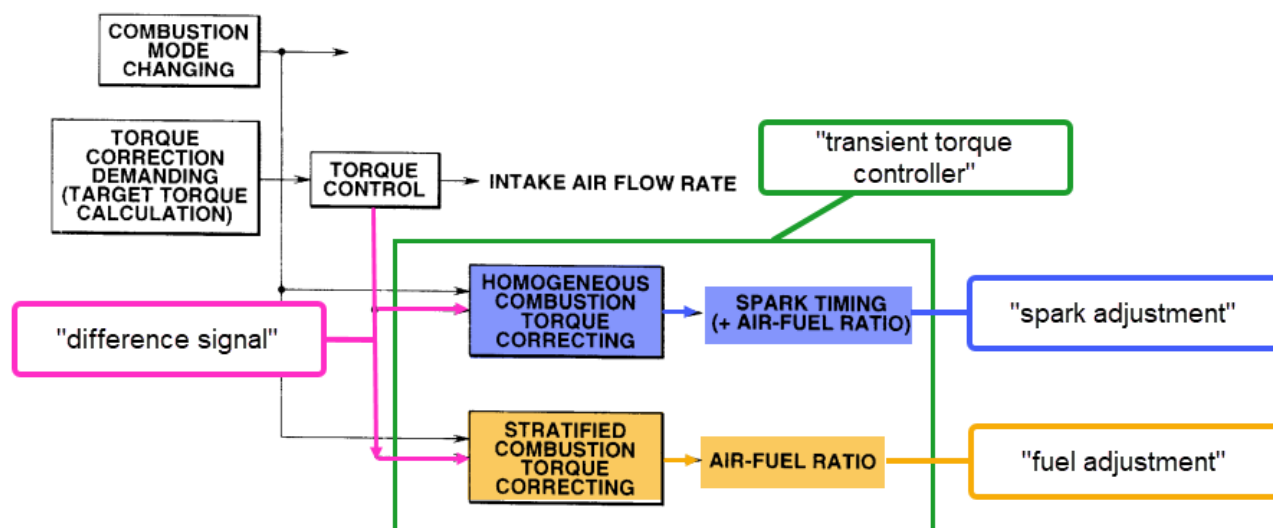
Moreover, methods for modifying Suzuki's torque controller to use Scherer's high pass filtering would have been known to a POSITA. A POSITA would have recognized that the software instructions stored in Suzuki's control unit 20 could be modified to input Suzuki's torque difference signal into a high pass filter before outputting the difference signal to the rest of Suzuki's system. Ex. 1003 at ¶¶ 93-102. A POSITA would have therefore been motivated to combine the known elements of Scherer's high pass filtering with the torque difference signal generated by Suzuki's control unit 20 to yield the predictable result of improving the response of the system to dynamic changes in torque demand. Ex. 1003 at ¶¶ 93-102.

Thus, Suzuki in view of Scherer renders obvious claim limitation 1[e]. *Id.*

- g. 1[f]: "a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal and a spark adjustment signal."

Suzuki in view of Scherer renders obvious a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal

and a spark adjustment signal. Ex. 1003 at ¶¶ 103-109.¹¹ As shown below in Figure 1B, Suzuki's "torque control section is responsive to the torque correction demand" and includes "a homogeneous combustion torque correcting section [that] corrects at least the spark timing" and "[a] stratified combustion torque correcting section [that] corrects at least the air-fuel ratio." Ex. 1005 at 3:10-22. Moreover, Suzuki's homogeneous and stratified torque correction sections are configured to adjust torque output "regardless of combustion mode . . . with a fast response to a torque correction demand . . . over the entire range of engine speed," i.e. during transient as well as steady state engine operation *Id.* at 1:44-64; Ex. 1003 at ¶¶ 103-109.

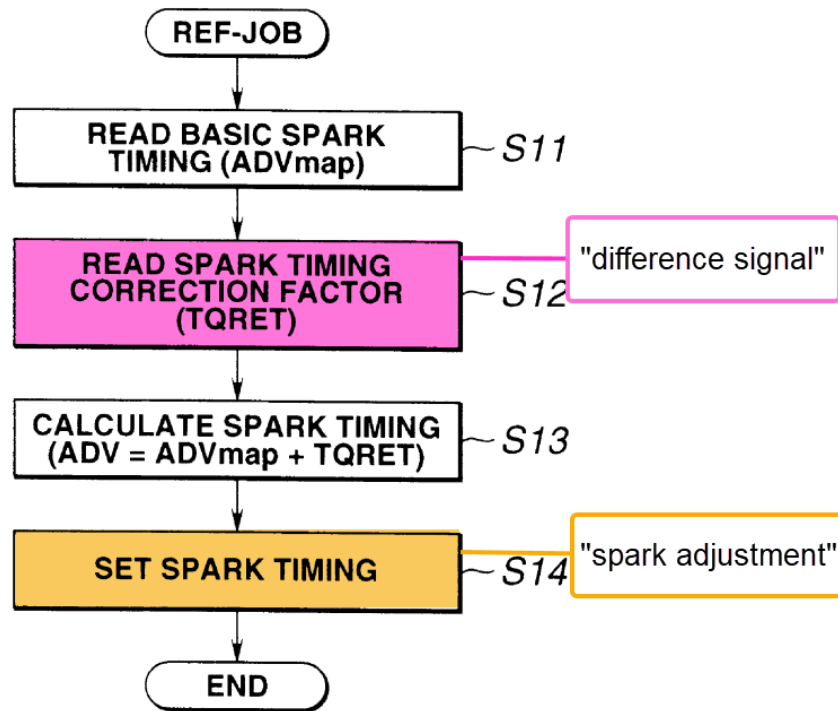


¹¹ The PTAB previously found it was reasonably likely that Suzuki in view of Scherer renders this claim limitation obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

Ex. 1005 at FIG. 1B (annotations added).

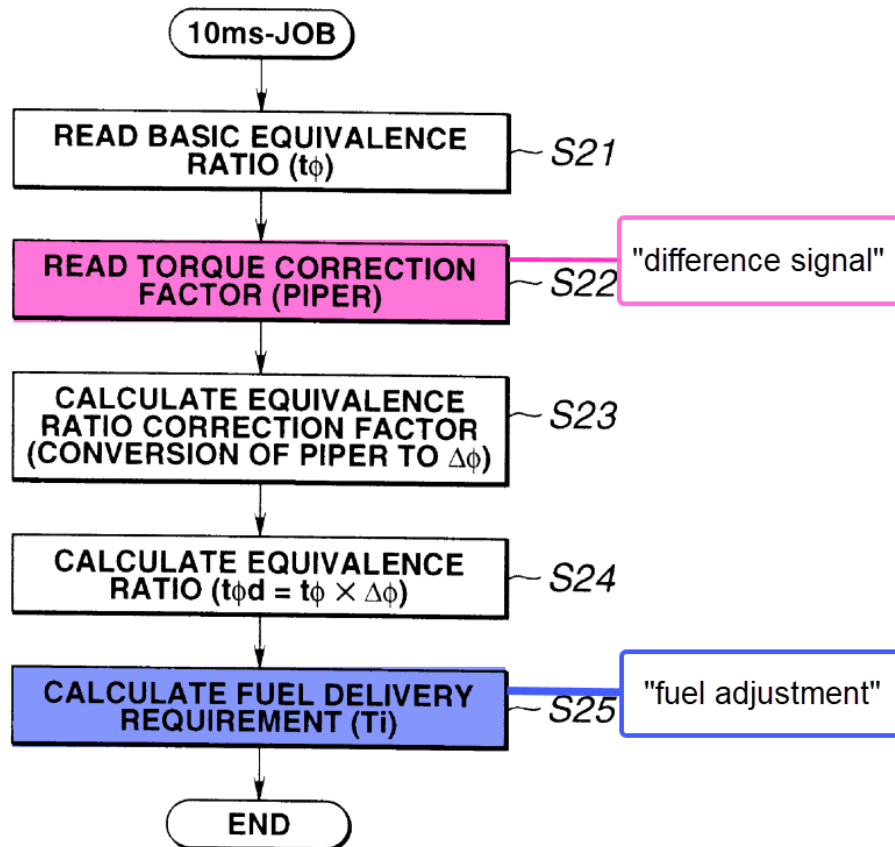
Suzuki teaches that the homogenous combustion torque correcting section converts the torque correction factor processed from the torque shortage signal (*i.e.*, the “torque difference signal”) “to a spark timing correction factor.” *Id.* at 7:51-59; Ex. 1003 at ¶¶ 103-109. Further, Suzuki’s stratified combustion torque correcting section converts the torque correction factor processed from the torque shortage signal (*i.e.*, the “torque difference signal”) into a “fuel delivery requirement” used to determine a fuel “injection pulse signal.” Ex. 1005 at 6:50-57.

As shown below in FIG. 4, Suzuki’s homogenous combustion torque correcting section discloses a “spark timing calculating routine.” Ex. 1005 at 5:41-43. “In step S12” Suzuki discloses reading “the spark timing correction factor TQRET,” which is calculated from a “torque correction factor PIPER,” that is itself based on an input torque shortage, *i.e.*, a difference signal. *Id.* at 5:21-26, 5:41-43, 7:40-44 (“a torque correction factor PIPER . . . is calculated in accordance with the torque shortage”); Ex. 1003 at ¶¶ 103-109. Suzuki teaches processing TQRET to calculate an output spark timing, *i.e.*, a “spark adjustment signal.” Ex. 1005 at 5:59-64.



Id. at FIG. 4 (annotations added).

As shown in FIG. 5 below, Suzuki’s stratified combustion torque correcting section discloses a “fuel delivery requirement calculating routine.” Ex. 1005 at 6:10-12. “In step S22” Suzuki discloses reading “the torque correction factor PIPER,” which is calculated from an input torque shortage *i.e.*, a difference signal. *Id.* at 6:20, 5:41-43, 7:40-44 (“a torque correction factor PIPER . . . is calculated in accordance with the torque shortage”); Ex. 1003 at ¶¶ 103-109. Suzuki teaches processing the torque correction factor to calculate fuel deliver requirement T_i , which determines the fuel injector’s injection pulse, *i.e.*, a “fuel adjustment signal.” Ex. 1005 at 6:10-57.



Id. at FIG. 5 (annotations added).

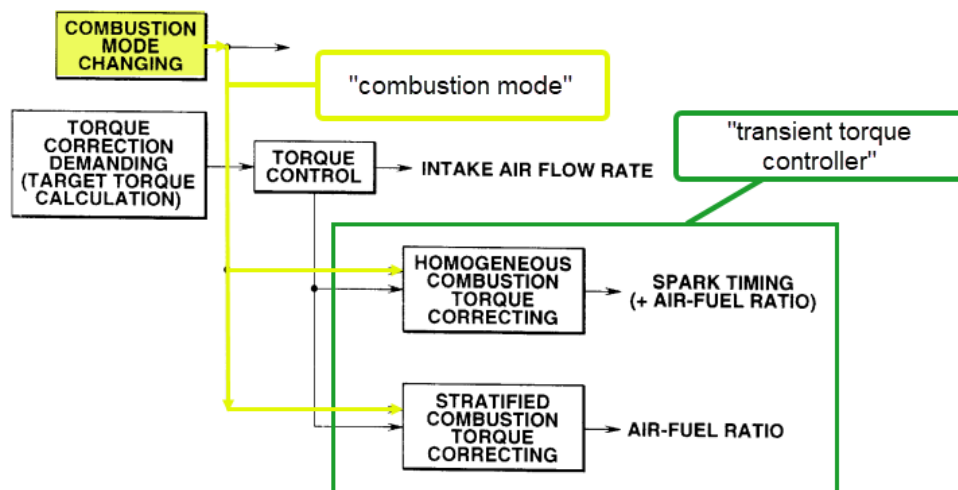
Thus, Suzuki discloses a transient torque controller which receives as an input a torque difference signal and outputs a fuel adjustment signal and a spark adjustment signal. As described in § IX.2.f, *supra*, Suzuki in view of Scherer renders obvious filtering the torque difference signal using a high pass filter. Thus, Suzuki in view of Scherer renders obvious claim limitation 1[f]. Ex. 1003 at ¶¶ 103-109.

3. Claim 4:

- a. 4[a]: “The device of claim 1, in which the engine is a direct injection spark ignition engine, wherein the transient torque controller is arranged to receive a combustion mode signal indicating whether the engine is operating in a stratified mode or a homogeneous mode, and”

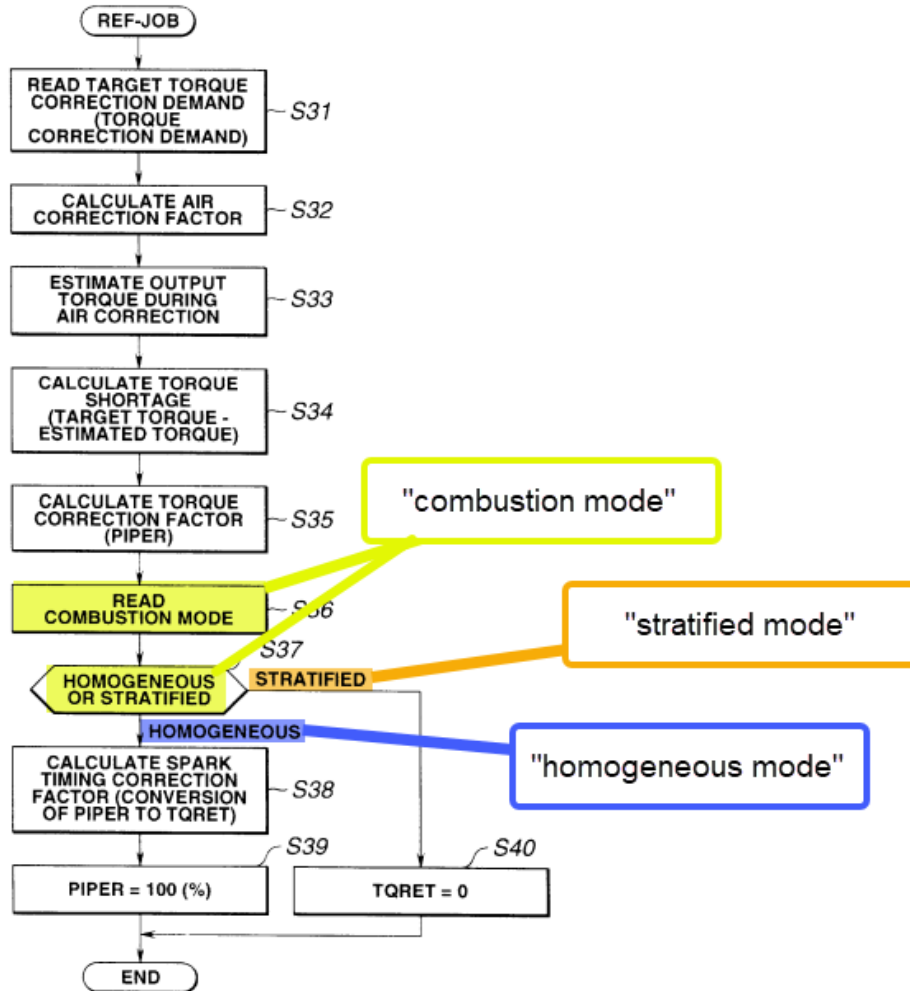
Suzuki discloses a DISI engine and a transient torque controller wherein the transient torque controller is arranged to receive a combustion mode signal indicating whether the engine is operating in a stratified mode or a homogeneous mode. Ex. 1003 at ¶¶ 110-12.¹² Suzuki discloses a “controller for a direct-injection spark-ignition type engine.” Ex. 1005 at 3:6-7. Suzuki’s controller includes “a combustion mode changing section for making a combustion mode change between homogenous combustion and stratified combustion.” *Id.* at 3:7-10. As shown below in Figure 1B, Suzuki’s homogeneous and stratified torque correction sections (collectively, a “transient torque controller,” *see* § IX.2.g, *surpa*) receive a signal from Suzuki’s combustion mode changing section. Ex. 1005 at 7:45-8:4.

¹² The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).



Id. at FIG. 1B (annotations added).

As shown below in FIG. 6, the signal received by Suzuki's transient torque controller from Suzuki's combustion mode changing section indicates to the transient torque controller whether the engine is operating in stratified mode or homogeneous mode. *Id.* at 7:45-50 ("In step S36, the combustion mode is read. In step S37, a determination is made as to whether the combustion mode is homogeneous . . . or stratified.")



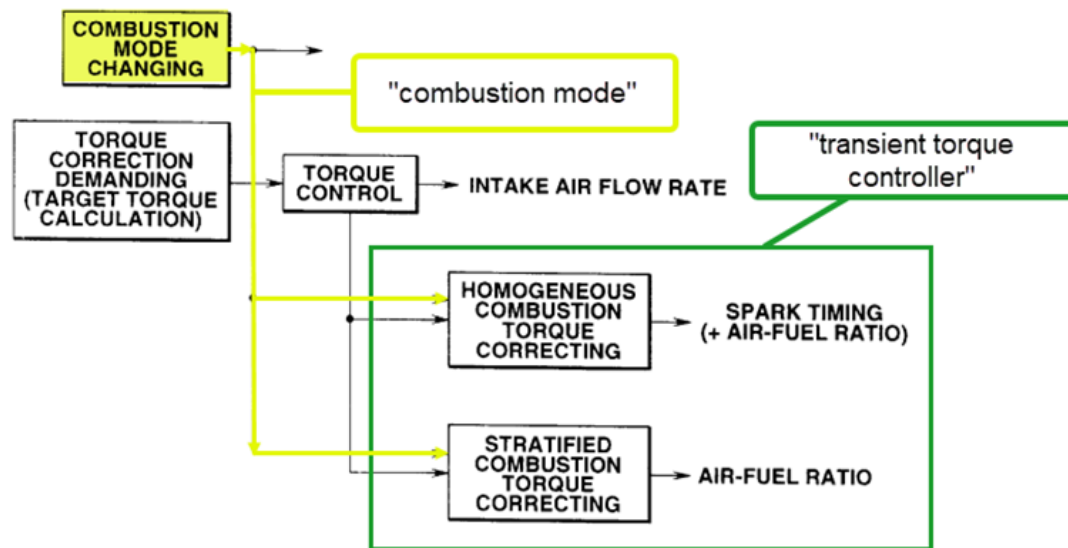
Id. at FIG. 6 (annotations added).

Thus, Suzuki discloses claim limitation 4[a]. Ex. 1003 at ¶¶ 110-12.

- b. 4[b]: “wherein the transient torque controller is arranged to control the fuel adjustment signal when the combustion mode signal indicates that the engine is operating in the stratified mode, and”

Suzuki discloses a transient torque controller arranged to control the fuel adjustment signal when the combustion mode signal indicates the engine is operating

in the stratified mode. Ex. 1003 at ¶¶ 113-15.¹³ Suzuki’s homogeneous and stratified torque correction sections collectively disclose a “transient torque controller.” See § IX.2.g, *surpa*; Ex. 1003 at ¶¶ 113-15.



Ex. 1005 at FIG. 1B (annotations added).

Suzuki teaches that the “stratified combustion torque correcting section corrects at least the air-fuel ratio to make torque correction during stratified combustion.” *Id.* at 3:10-22. Suzuki’s stratified combustion torque correction section executes a fuel delivery requirement calculating routine that calculates a fuel deliver requirement T_i that is used to adjust the injection pulse signal (*i.e.*, a fuel adjustment signal) that is output to each fuel injector of the DISI engine. *Id.* at 6:10-

¹³ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

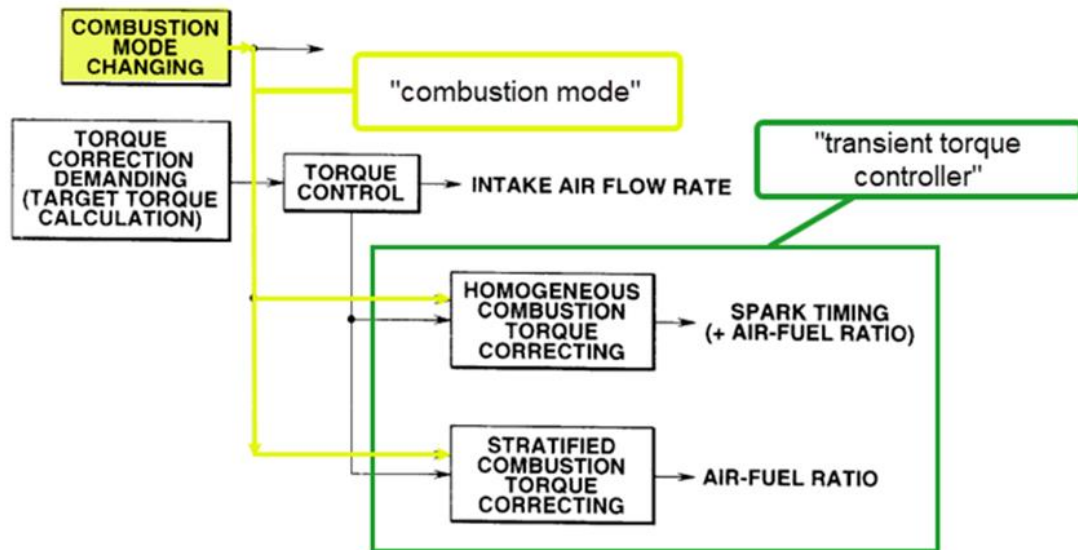
12; 6:50-57. Suzuki teaches that based on the combustion mode signal “a determination is made as to whether the combustion mode is . . . stratified,” and when the combustion mode is stratified “control is made according to . . . the fuel delivery requirement calculation routine.” *Id.* at 7:44-50, 7:65-67.

Thus, Suzuki discloses claim limitation 4[b]. Ex. 1003 at ¶¶ 113-15.

- c. 4[c]: “wherein the transient torque controller is arranged to control the spark adjustment signal when the combustion mode signal indicates that the engine is operating in the homogeneous mode.”

Suzuki discloses a transient torque controller arranged to control the spark adjustment signal when the combustion mode signal indicates the engine is operating in the homogeneous mode. Ex. 1003 at ¶¶ 116-18.¹⁴ Suzuki’s homogeneous and stratified torque correction sections collectively disclose a “transient torque controller.” *See* § IX.2.g, *surpa*; Ex. 1003 at ¶¶ 116-18.

¹⁴ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).



Ex. 1005 at FIG. 1B (annotations added).

Suzuki teaches that “a homogenous combustion torque correcting section corrects at least the spark timing in order to make a torque correction with a fast response . . . during homogeneous combustion.” *Id.* at 3:10-22. Suzuki’s homogeneous combustion torque correction section executes a spark timing calculating routine that calculates a spark timing (*i.e.*, a spark adjustment signal). *Id.* at 5:41-6:6. Suzuki teaches that based on the combustion mode a signal “a determination is made as to whether the combustion mode is homogeneous,” and when the combustion mode is homogeneous “control is made according to the spark timing calculation routine.” *Id.* at 7:44-50, 7:65-67.

Thus, Suzuki discloses claim limitation 4[c]. Ex. 1003 at ¶¶ 116-18

4. Claim 7:

- a. 7[pre]: A method for controlling a torque output of an engine, the method comprising:

As shown in the chart below, claim 7 recites a method virtually the same as the apparatus of claim 1:

Claim 7	Claim 1
7[pre]: A method for controlling a torque output of an engine, the method comprising:	1[pre]: A device for controlling a torque output of an engine, the device comprising:
7[a]: estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal;	1[c]: an estimator which receives as inputs a current spark angle signal, a current air/fuel ratio signal and an estimated air charge signal and outputs an estimated torque signal;
7[b]: comparing the estimated current torque signal with a desired torque signal to output a difference signal;	1[d]: a comparator which receives as inputs the estimated torque signal and a desired torque signal and outputs a difference signal;
7[c]: filtering out a plurality of low frequency components from the difference signal; and	1[e]: a high pass filter which receives as an input the difference signal and outputs a filtered difference signal in which low frequency components are absent; and
7[d]: controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal.	1[f]: a transient torque controller which receives as an input the filtered difference signal and outputs a fuel adjustment signal and a spark adjustment signal.

Suzuki discloses a method for controlling a torque output of an engine. 7[pre] is a method claim preamble analogous to the device claim preamble 1[pre], which is

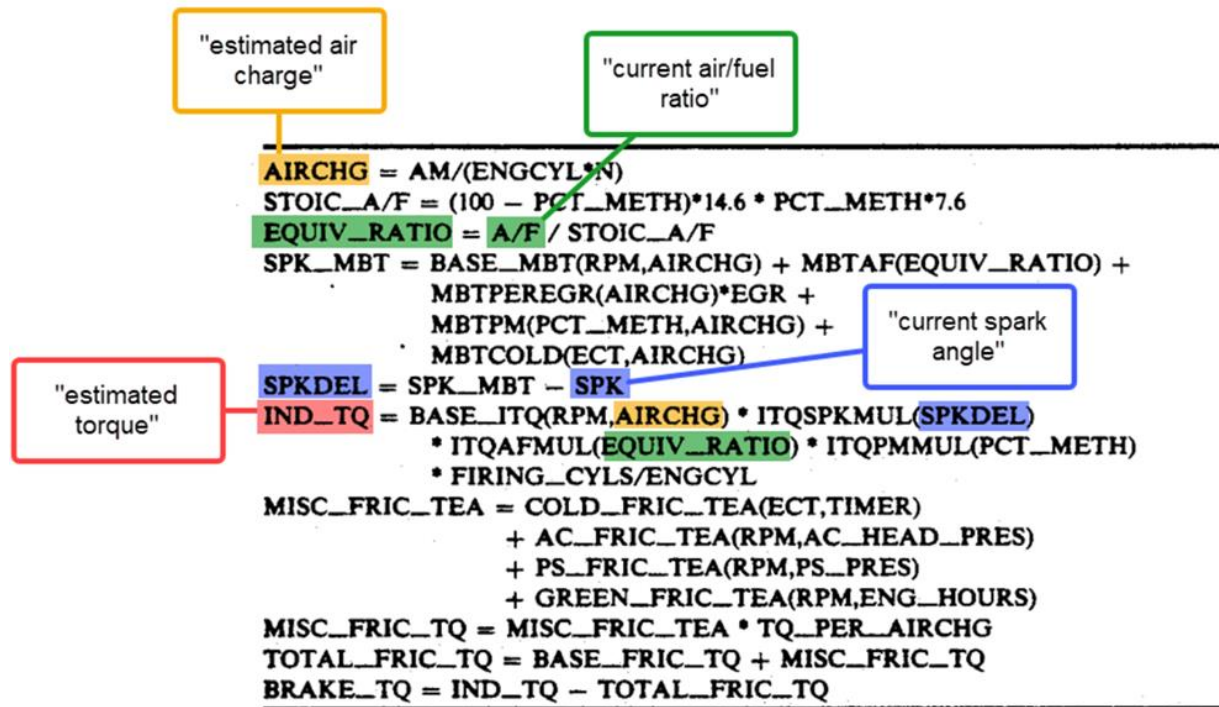
disclosed by Suzuki. See § IX.2.a, *supra*; Ex. 1003 at ¶¶ 119-21.¹⁵ Suzuki's Figure 6 teaches "a torque correcting routine" in which torque is adjusted based on "a torque increase demand" or "torque decrease demand," *i.e.*, a method for controlling a torque output of an engine. Suzuki, 7:10-44. Thus, Suzuki discloses claim limitation 7[pre], including for at least the same reasons as 1[pre]. Ex. 1003 at ¶¶ 119-21.

- b. 7[a]: estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal;

Suzuki in view of Cullen renders obvious estimating a current torque signal from a received current spark angle signal, a received current air/fuel ratio signal and a received estimated air charge signal. 7[a] is a method claim limitation analogous to the device claim limitation 1[c], which is rendered obvious by Suzuki in view of Cullen. See, § IX.2.d, *supra*; Ex. 1003 at ¶¶ 122-25. Suzuki teaches "the output torque during intake air correction is estimated." Ex. 1005 at 7:33-34. Cullen discloses particular implementation details for estimating torque, including estimating torque based on a current spark angle signal, a current air/fuel ratio signal, and an estimated air charge signal. Cullen discloses particular functions that use estimated air charge ("AIRCHG"), current air/fuel ratio ("A/F"), and current spark

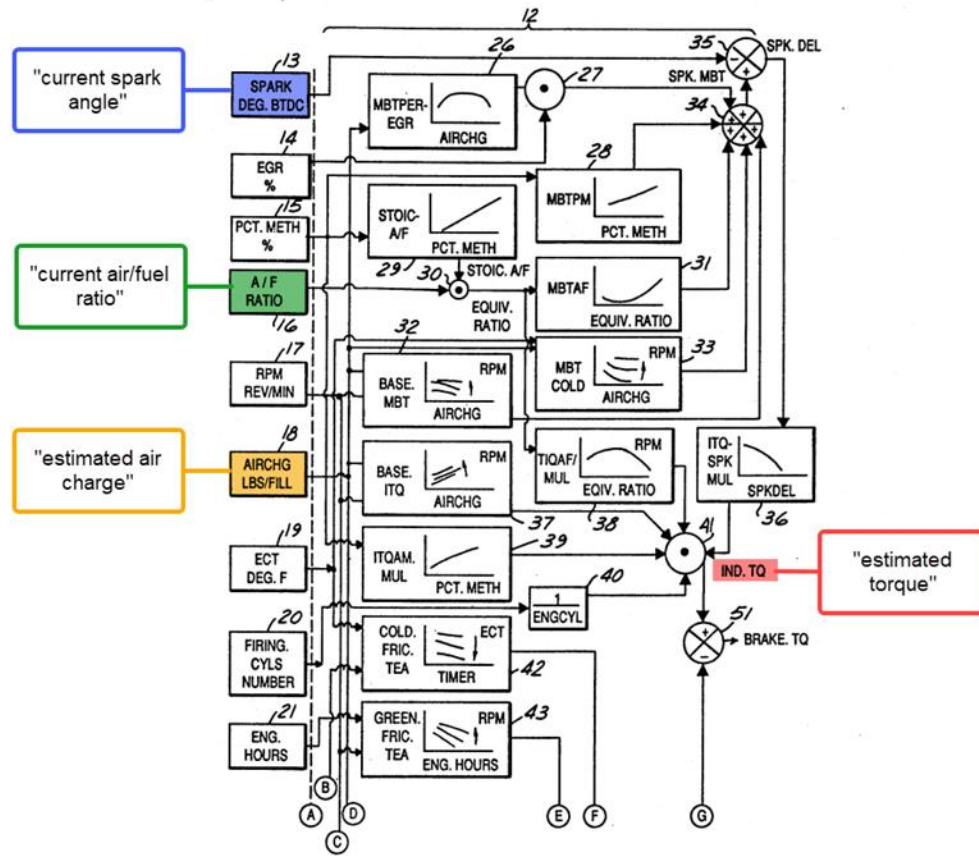
¹⁵ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

angle (“SPKDEL”/“SPK”), among others, as inputs to calculate estimated torque (“IND_TQ”). Ex. 1006 at 4:5-15; 5:33-6:2, 6:67-7:2.



Id. at 5:33-53 (annotations added).

Moreover, as shown below in Figure 3 Cullen teaches that the estimated air charge, current air/fuel ratio, and current spark angle are all signals received by a portion of a system that estimates torque.



Id. at FIG. 3 (annotations added).

Suzuki and Cullen render obvious claim limitation 7[a], including for at least the same reasons as claim limitation 1[c]. Ex. 1003 at ¶¶ 122-25.

- c. 7[b]: comparing the estimated current torque signal with a desired torque signal to output a difference signal;

Suzuki discloses comparing the estimated current torque signal with a desired torque signal to output a difference signal.¹⁶ 7[b] is a method claim limitation analogous to the device limitation 1[d], which is disclosed by Suzuki. See § IX.2.e,

¹⁶ The PTAB previously found it was reasonably likely that Suzuki discloses this claim limitation. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

supra; Ex. 1003 at ¶¶ 126-27. Suzuki discloses that “[i]n step S34, the estimated torque,” *i.e.*, an estimated current torque signal, “is subtracted from the target torque,” *i.e.*, a desired torque signal, “to calculate the torque shortage,” *i.e.* a difference signal Suzuki, 7:35-39; Ex. 1003 at ¶¶ 126-27.

Thus, Suzuki discloses claim limitation 7[b], including for at least the same reasons as claim limitation 1[d]. *Id.*

d. 7[c]: filtering out a plurality of low frequency components from the difference signal; and

Suzuki and Cullen in view of Scherer disclose filtering out a plurality of low frequency components from the difference signal.¹⁷ 7[c] is a method claim limitation analogous to the device limitation 1[e], which is rendered obvious by Suzuki (and Cullen) in view of Scherer. *See*, § IX.2.f, *supra*; Ex. 1003 at ¶¶ 128-32.

A POSITA would have understood that the correction factor response curves disclosed in Suzuki’s Figures 12-15 suggest using a high pass filter. Ex. 1003 at ¶¶ 128-32. Moreover, Scherer discloses a “high pass filter stage, which precisely determines [a] dynamic desired torque component” from “a signal indicative . . . of

¹⁷ The PTAB previously found it was reasonably likely that Suzuki in view of Scherer renders this claim limitation obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

the desired engine torque.” Ex. 1007 at 3:59-63; 4:31-38. Scherer’s high pass filter teaches filtering low frequency components from a signal related to torque demand. Ex. 1003 at ¶¶ 128-32. As explained in § IX.2.f, *supra*, with regard to limitation 1[e], it would have been obvious to a POSITA to use Scherer’s high pass filtering of Suzuki’s torque shortage, (*i.e.*, “the difference signal”), to enable Suzuki’s torque controller to “react very rapidly to sudden changes of the engine torque,” arising during transient engine operations. Ex. 1007 at 4:20-25, 4:40-45, 5:10-15; Ex. 1003 at ¶¶ 128-32.

Thus, Suzuki and Cullen in view of Scherer render claim limitation 7[c] obvious, including for at least the same reasons as limitation 1[e]. *Id.*

- e. 7[d]: controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal.

Suzuki and Cullen in view of Scherer render obvious controlling a fuel adjustment signal and a spark adjustment signal in dependence upon a filtered difference signal. Ex. 1003 at ¶¶ 132-136.¹⁸ 7[d] is a method claim limitation analogous to the device limitation 1[f], which is rendered obvious by Suzuki (and Cullen) in view of Scherer. *See* § IX.2.g, *supra*; Ex. 1003 at ¶¶ 132-136. Suzuki

¹⁸ The PTAB previously found it was reasonably likely that Suzuki in view of Cullen and Scherer renders this claim limitation obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 38 (PTAB Aug. 5, 2020).

discloses “a homogenous combustion torque correcting section [that] corrects at least the spark timing . . . during homogenous combustion” and a “stratified combustion torque correcting section [that] corrects at least the air-fuel ratio . . . during stratified combustion.” Ex. 1005 at 3:10-22. Suzuki’s spark timing adjustments during the homogenous combustion mode and fuel quantity adjustments during stratified mode constitutes the “controlling” recited in claim 7. Ex. 1003 at ¶¶ 132-136.

Moreover, Suzuki teaches that its spark timing adjustments and air-fuel ratio adjustments are made based on processing of a torque shortage signal (*i.e.*, the “torque difference signal”). Suzuki, 6:50-57, 7:51-59; Ex. 1003 at ¶¶ 132-136. As described in § IX.2.g, *supra*, Suzuki in view of Scherer renders obvious filtering the low frequency components of the torque difference signal.

Thus, Suzuki and Cullen in view of Scherer discloses claim limitation 7[d], including for at least the same reasons as limitation 1[f]. Ex. 1003 at ¶¶ 132-136.

XI. GROUND 2: THE COMBINATION OF SUZUKI, CULLEN, SCHERER, AND TAKAHASHI RENDERS OBVIOUS CLAIMS 2, 3, 5, AND 6.

1. Motivation to Combine Suzuki, Cullen, Scherer, and Takahashi

A POSITA would have been motivated to modify the system combining Suzuki, Cullen, and Scherer as described in § IX.1, *supra*, to include an air charge controller and air charge demand controller based on the teachings of Takahashi for

a variety of reasons.¹⁹

A POSITA would have been motivated to modify Suzuki’s torque controller to use air charge estimate and air charge demand calculation methods and functions like those taught in Takahashi because such methods and functions “ensure a high precision control of the torque to reach a target value.” Ex. 1008 at 1:43-48; Ex. 1003 at ¶¶ 138-42. Suzuki already discloses using an air charge controller and an air charge demand controller See claims 2, 3, 5, 6, *infra*. Likewise, Takahashi discloses an air charge controller that receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal, and an air charge temperature signal and outputs an estimated air charge signal. *Id.* Takahashi also discloses an air charge demand controller that receives as inputs a desired torque signal, a desired air/fuel ratio signal, and a desired spark angle signal and outputs an air charge demand signal. *Id.*

Takahashi expressly teaches that use of its air charge estimating and air charge demand generating methods and functions “ensure[s] a high precision control of the torque to reach a target value.” Ex. 1008 at 1:43-48; Ex. 1003 at ¶¶ 138-42. Thus, a POSITA would have been motivated to use an air charge controller and air charge

¹⁹ The PTAB previously found it was reasonably likely that a POSITA would be motivated to combine the teachings of Suzuki, Cullen, Scherer, and Takahashi. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 45-46 (PTAB Aug. 5, 2020).

demand controller that takes the same types of inputs as those described by Takahashi because, as Takahashi explains, doing so would “ensure a high precision control of the torque to reach a target value,” (Ex. 1008 at 1:43-48), furthering Suzuki’s stated goal of “ensur[ing] optimum torque correction.” Ex. 1005 at 139-43; Ex. 1003 at ¶¶ 138-42.

Moreover, it would have been trivial for a POSITA to modify Suzuki’s control unit 20 based on the teachings of Takahashi’s more accurate air charge estimating methods would have been known to a POSITA. Ex. 1003 at ¶¶ 138-42. A POSITA would have recognized that Suzuki’s control unit 20 could be modified to receive the input signals described in Takahashi, including *Qmap0 (i.e., air charge demand signal)* current throttle angle signal *θth (i.e., throttle position signal)*, an intake manifold pressure signal *Pm (i.e., manifold pressure signal)*, an engine speed signal *N (i.e., engine speed signal)*, and an intake air temperature signal from the intake air temperature sensor (*i.e., air charge temperature signal*), and the software instructions stored in Suzuki’s control unit 20 could be modified to implement the air charge estimation functions taught by Takahashi. Ex. 1003 at ¶¶ 138-42.

A POSITA would likewise be motivated to combine the teachings of Suzuki, Cullen, Scherer, and Takahashi because they are all in the ***same field of endeavor*** as the ’565 patent, predicting and controlling engine torque. Ex. 1001 at Abstract; Ex. 1005 at Abstract; Ex. 1006 at Abstract; Ex. 1007 at Abstract; Ex. 1008 at Abstract. As discussed throughout this Petition, Suzuki, Cullen, Scherer, and Takahashi all

use *similar techniques to solve the same problem* as the '565 patent—Suzuki discloses nearly all of the limitations of claims 1, 4, and 7 of the '565 patent; Cullen discloses the estimator described in claim 1; Scherer discloses the high pass filter disclosed in claim 1; and Takahashi discloses the air charge controller and air charge demand controller disclosed in claims 2, 3, 5, and 6. Moreover, a POSITA would have had a *reasonable expectation of success* of applying Takahashi's air charge controller and air charge demand controller to Suzuki's torque control system at least because Suzuki already teaches using the microcomputer in its control unit 20 to calculate an air correction factor, which would include calculating an estimated air charge and an air charge demand. Ex. 1003 at ¶¶ 138-42. A POSITA would understand that the code in Suzuki's microcomputer implementing the torque estimation could be modified to implement Takahashi's method of calculating an estimated air charge and a demanded air charge to improve accuracy. *Id.*

A POSITA would have therefore been motivated to combine the known elements of Takahashi's air-charge estimating techniques with Suzuki's control unit 20 using known methods to yield the predictable result of improving the accuracy of the system's air charge estimation. Ex. 1003 at ¶¶ 138-42; *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. Claims 2 and 5:

- a. 2/5: “The device in claim 1/4, wherein the estimated air charge signal is produced by an air charge controller which receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal, and an air charge temperature signal”

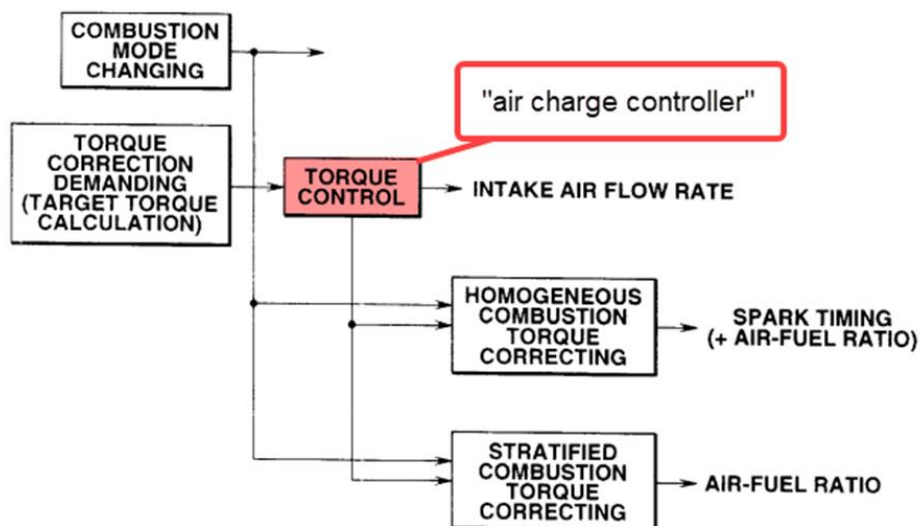
Suzuki in view of Cullen, Scherer, and Takahashi renders obvious claims 2 and 5. Ex. 1003 at ¶¶ 143-53.²⁰ Claims 2 and 5 depend from claims 1 and 4, respectively, and recite “wherein the estimated air charge signal is produced by an air charge controller which receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal and an air charge temperature signal.” Ex. 1001 at claim 2, claim 5. As explained in § IX.2 and 3, *supra*, Suzuki in view of Cullen and Scherer render claims 1 and 4 obvious.

A POSITA would understand the plain and ordinary meaning of the term “air charge” is the quantity of air mass that is drawn into the engine cylinder. Ex. 1009 at 176; Ex. 1003 at ¶¶ 143-53. A POSITA would further understand that, because air charge cannot be measured directly, it is estimated from air mass flow rate at the engine intake. Ex. 1003 at ¶¶ 143-53; Ex. 1009 at 176 (defining “air charge” as “the mass of air that is drawn into the cylinder” and explaining “[t]here is no

²⁰ The PTAB previously found it was reasonably likely that Suzuki in view of Cullen, Scherer, and Takahashi renders claims 2 and 5 obvious. *Volkswagen Group of America, Inc. v. Michigan Motor Technologies LLC*, IPR2020-00444, Paper 12 at 46 (PTAB Aug. 5, 2020).

practically feasible way of measuring [air charge] directly” but “the air charge can be determined from the mass flow rate of air into the engine intake”).

Suzuki discloses an air charge controller as claimed in claims 2 and 5. Ex. 1003 at ¶¶ 143-53. As shown below in Figure 1B and explained in § IX.2 and 3, *supra*, Suzuki discloses a torque control section that “controls the amount of air permitted to enter the engine” by “control[ing] the degree of opening of the electronic controlled throttle valve.” Ex. 1005 at 3:12-15, 4:33-38; Ex. 1003 at ¶¶ 143-53.

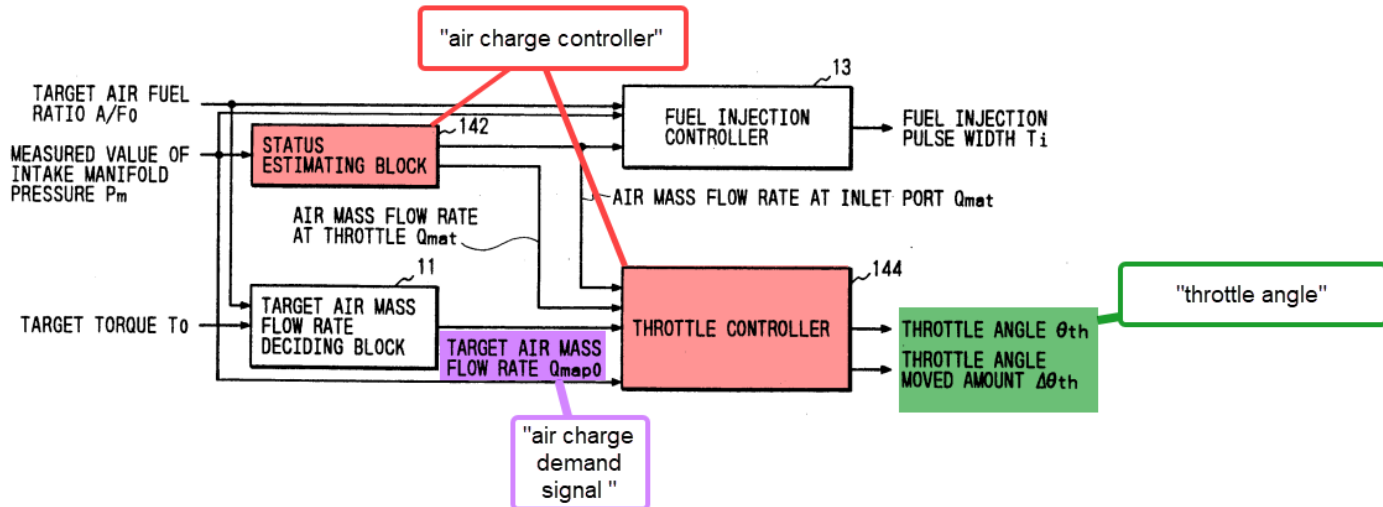


Ex. 1005 at FIG. 1B (annotations added).

A POSITA would understand that Suzuki’s torque control section operates as an air charge controller as claimed in claims 2 and 5 of the ’565 patent because Suzuki’s torque control section controls the amount of air that enters the engine cylinder by actuating the throttle valve. Ex. 1003 at ¶¶ 143-53.

Moreover, like the air charge controller taught in the '565 patent, Suzuki's torque control section generates a signal indicating the desired throttle position to generate the demanded air charge. Ex. 1001 at 3:19-22 ("The air charge controller 29 generates a signal indicating desired throttle position"); Ex. 1005 at 3:27-31 ("Air intake is controlled by an electronic controlled throttle valve . . . in response to a signal from control unit 20."). Thus, Suzuki discloses an air charge controller. Ex. 1003 at ¶¶ 143-53.

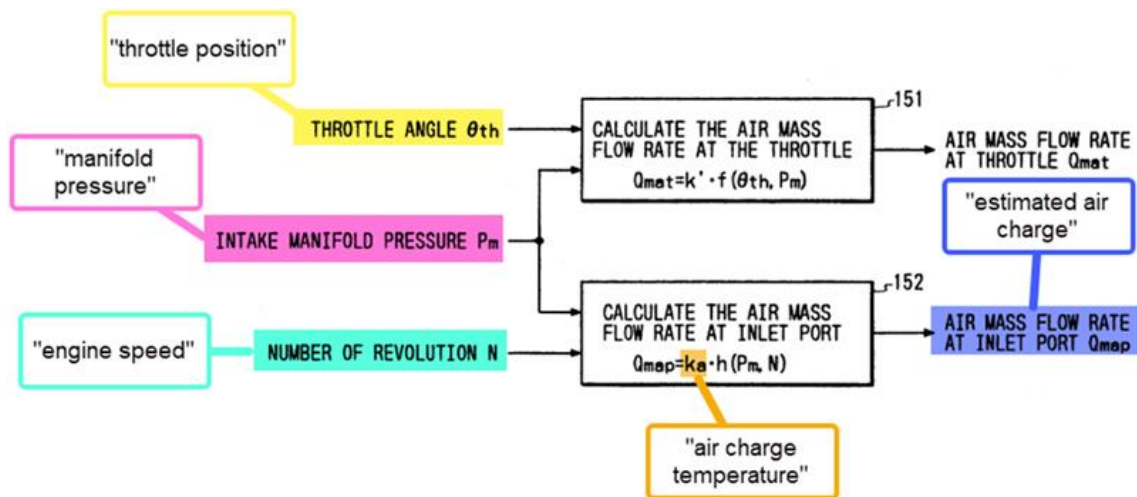
Likewise, Takahashi discloses an air charge controller with the claimed inputs, including an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal, and an air charge temperature signal. Ex. 1003 at ¶¶ 143-53. In particular, Takahashi's "status estimating block 142" and "throttle controller 114" together determine the throttle angle required to achieve the desired quantity of air mass entering the engine cylinder—*i.e.*, desired air charge—and thus collectively operate as an air charge controller. Ex. 1008 at 6:13-17; Ex. 1003 at ¶¶ 143-53. This is shown in annotated Figure 14 below:



Ex. 1008 at FIG. 14 (annotations added).

Takahashi's throttle controller 144 receives as an input target air mass flow rate Q_{map0} (*i.e., air charge demand signal*). *Id.* at 3:28-30, FIG. 14; Ex. 1003 at ¶¶ 143-53. Moreover, as shown below in Figure 15, the status-estimating block 142 receives the following as inputs:

- A current throttle angle signal θ_{th} , *i.e., a throttle position signal* (Ex. 1008 at 3:36-37; Ex. 1003 at ¶¶ 143-53);
- An intake manifold pressure signal P_m , *i.e., a manifold pressure signal* (Ex. 1008 at 3:36-37; Ex. 1003 at ¶¶ 143-53);
- A number of revolutions or engine speed signal N , *i.e., an engine speed signal* (Ex. 1008 at 3:36-37; Ex. 1003 at ¶¶ 143-53); and
- A correction coefficient ka that is “calculated according to the output of the intake air temperature sensor,” *i.e., an air charge temperature signal*. Ex. 1008 at 10:54-66; Ex. 1003 at ¶¶ 143-53.



Ex. 1008 at FIG. 15 (annotations added) (block diagram demonstrating the function Takahashi's status estimating block 142). Further, as shown above in blue, Takahashi's status estimating block produces a signal that estimates air mass flow rate at the inlet port, *i.e., an estimated air charge*. Ex. 1008 at 10:54-66; Ex. 1003 at ¶¶ 143-53. Thus, Takahashi's throttle controller and status estimating block collectively disclose an air charge controller that receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal, and an air charge temperature signal and produces an estimated air charge signal. *Id.* at 3:36-37, 6:13-17, 10:54-66; Ex. 1003 at ¶¶ 143-53.

Moreover, it would have been obvious for a POSITA to modify Suzuki's torque control section to use an air charge controller with the inputs and outputs taught by Takahashi. Ex. 1003 at ¶¶ 143-53. Takahashi discloses that its system, including its air-charge controller "provides a high precision control of the air mass flow rate at the inlet port and ensures a high precision maintenance of the engine-

generated torque at the target value.” Ex. 1008 at 2:18-24. Accordingly, a POSITA would have been motivated to combine the teachings of Takahashi with Suzuki (and Cullen and Scherer) to more precisely estimate air charge and ultimately more precisely control engine torque. Ex. 1008 at 2:18-24; Ex. 1003 at ¶¶ 143-53.

Moreover, a POSITA would have been able to easily implement Takahashi’s teachings simply by modifying the application instructions stored in the microcomputer of Suzuki’s control unit 20 such that its control unit estimator section receives as inputs an air charge demand signal, a throttle position signal, an engine speed signal, a manifold pressure signal and an air charge temperature signal and produces an estimated air charge signal as taught by Takahashi. Ex. 1003 at ¶¶ 143-53.

Thus, Suzuki, in combination with Cullen, Scherer, and Takahashi, renders obvious claims 2 and 5. *Id.*

3. Claim 3 and 6:

- a. 3/6: “The device in claim 2/5, wherein the air charge demand signal is produced by an air charge demand controller which receives as inputs the desired torque signal, a desired spark angle signal and a desired air/fuel.”

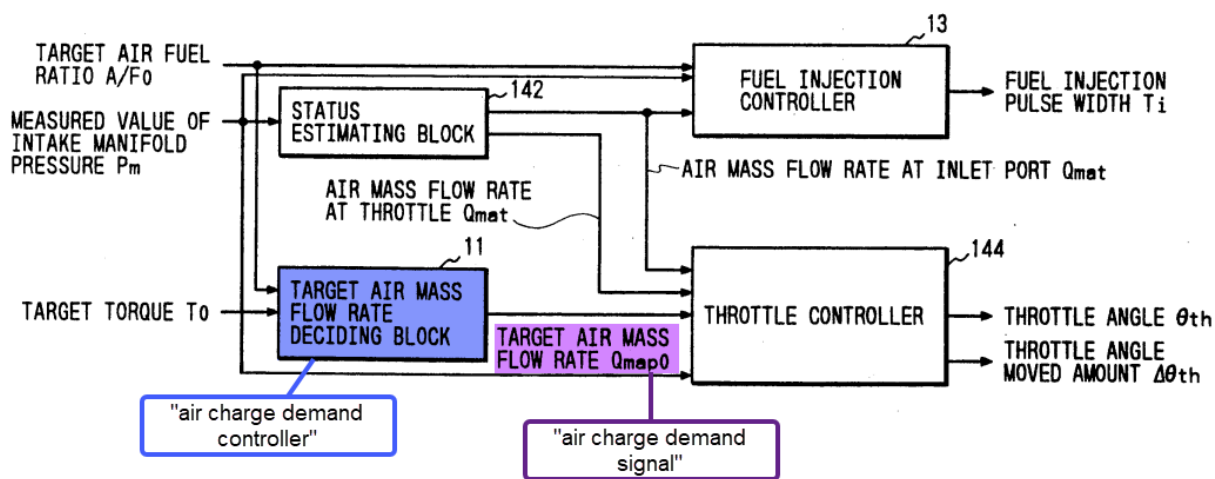
Suzuki in view of Cullen, Scherer, and Takahashi renders obvious claims 3 and 6. Ex. 1003 at ¶¶ 154-61.²¹ Claims 3 and 6 depend from claims 2 and 5,

²¹ The PTAB previously found it was reasonably likely that Suzuki in view of Cullen, Scherer, and Takahashi renders claims 3 and 6 obvious. *Volkswagen Group*

respectively, and recite “wherein the air charge demand signal is produced by an air charge demand controller which receives as inputs the desired torque signal, a desired spark angle signal and a desired air/fuel.” Ex. 1001 at claim 3, claim 6.

As explained in § X.2.a, *supra*, Suzuki in view of Cullen, Scherer, and Takahashi render claims 2 and 5 obvious. Ex. 1008 at 3:28-29, 10:42-50, FIG. 14; Ex. 1003 at ¶¶ 154-61.

Moreover, as shown below in Figure 15, Takahashi discloses a target air mass flow rate deciding block (*i.e., an air charge demand controller*) that produces a target air mass flow rate signal Q_{map0} (*i.e., an air charge demand signal*). Ex. 1003 at ¶¶ 154-61.



Id. at FIG. 15 (annotations added).

As shown below in Expression 1 recited in column 3 of Takahashi’s

of America, Inc. v. Michigan Motor Technologies LLC, IPR2020-00444, Paper 12 at 46 (PTAB Aug. 5, 2020).

specification, Takahashi further teaches that the target air mass flow rate deciding block 11 receives a target torque signal T_0 (*i.e., a desired torque signal*), a target air/fuel ratio signal A/F_0 (*i.e., a desired air/fuel*), and a spark advance signal θ_{adv} (*i.e., a desired spark angle signal*) to calculate the target mass flow rate Q_{map0} (*i.e., an air charge demand signal*). Ex. 1008 at 3:28-51; Ex. 1003 at ¶¶ 154-61.

"air charge demand signal"

$$Q_{map0} = \frac{N \cdot T_0}{K \cdot F_1(A/F_0) \cdot F_2(N) \cdot F_3(\theta_{adv})} \quad (\text{Expression 1})$$

where,

- "desired torque signal" T_0 : Target torque
- "desired air/fuel" A/F_0 : Target air fuel ratio
- "desired spark angle signal" θ_{adv} : Spark advance
- K : Constant
- F_1, F_2, F_3 : Specified function

Ex. 1008 at Expression 1 (annotations added).

Indeed, Takahashi's target air mass flow rate deciding block 11 functions in the same way as the air charge demand controller 27 disclosed by the '565 patent, which "receives as inputs the desired torque signal, a desired spark angle signal 25 and a desired air fuel ratio signal 26" and "generates an air charge demand signal." Ex. 1003 at ¶¶ 154-61; Ex. 1001 at 3:6-12.

Moreover, it would have been obvious for a POSITA to modify Suzuki's torque control section to use an air charge demand controller with the inputs and outputs taught by Takahashi. Ex. 1003 at ¶¶ 154-61. Takahashi teaches that

determining the target air mass flow rate based on the target torque, target air/fuel ratio, and spark advance “ensures a high precision estimation of the air flow status,” “high-precision control of the air mass flow rate at the inlet port,” and “a high-precision maintenance of the engine-generated torque.” Ex. 1008 at 1:49-57, 2:17-23, 3:24-51. Accordingly, a POSITA would have been motivated to modify Suzuki (and Cullen and Scherer) based on the teachings of Takahashi to more precisely estimate the target air flow and ultimately more precisely control engine torque. *Id.*; Ex. 1003 at ¶¶ 154-61.

Moreover, a POSITA would have been able to easily implement Takahashi’s teachings simply by modifying the application instructions stored in the microcomputer of Suzuki’s control unit 20 such that its control unit estimator section receives inputs the desired torque signal, a desired spark angle signal and a desired air/fuel and produces an air charge demand signal according to the function taught by Expression 1 disclosed in Takahashi. Ex. 1003 at ¶¶ 154-61.

Thus, Suzuki, Cullen, Scherer, and Takahashi render obvious claims 3 and 6. *Id.*

XII. 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.

XIII. 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 6,581,565 (the “565 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)

Petitioner provides the following counsel and service information. Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition. Petitioner agrees 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.

XIV. CONCLUSION

Petitioners respectfully request that *inter partes* review of the '565 patent be instituted and that the challenged claims be cancelled as unpatentable pursuant to 35 U.S.C. §318(b).

Respectfully Submitted,

June 6, 2023

/s/ Jim Glass

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CERTIFICATE OF SERVICE

In accordance with 37 C.F.R. §§42.6(e) and 42.105, the undersigned certifies that on June 6, 2023, a complete and entire copy of the **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,581,565 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:

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Date: June 6, 2023

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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 totals 13,835 words, within the 14,000 word limit allowed under § 42.24(a)(1)(i).

Date: June 6, 2023

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