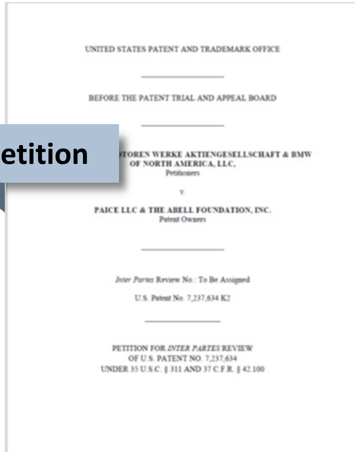
Petitioners' Oral Argument Demonstratives

Bayerische Motoren Werke Aktiengesellschaft &
BMW of North America, LLC,
Petitioners
v.
Paice LLC & The Abell Foundation, Inc.,
Patent Owners

IPR2020-01386
U.S. Patent No. 7,237,634 K2

Challenged Claims Mostly Consist of Limitations in 156 Claims Previously Found Unpatentable

Petition


UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

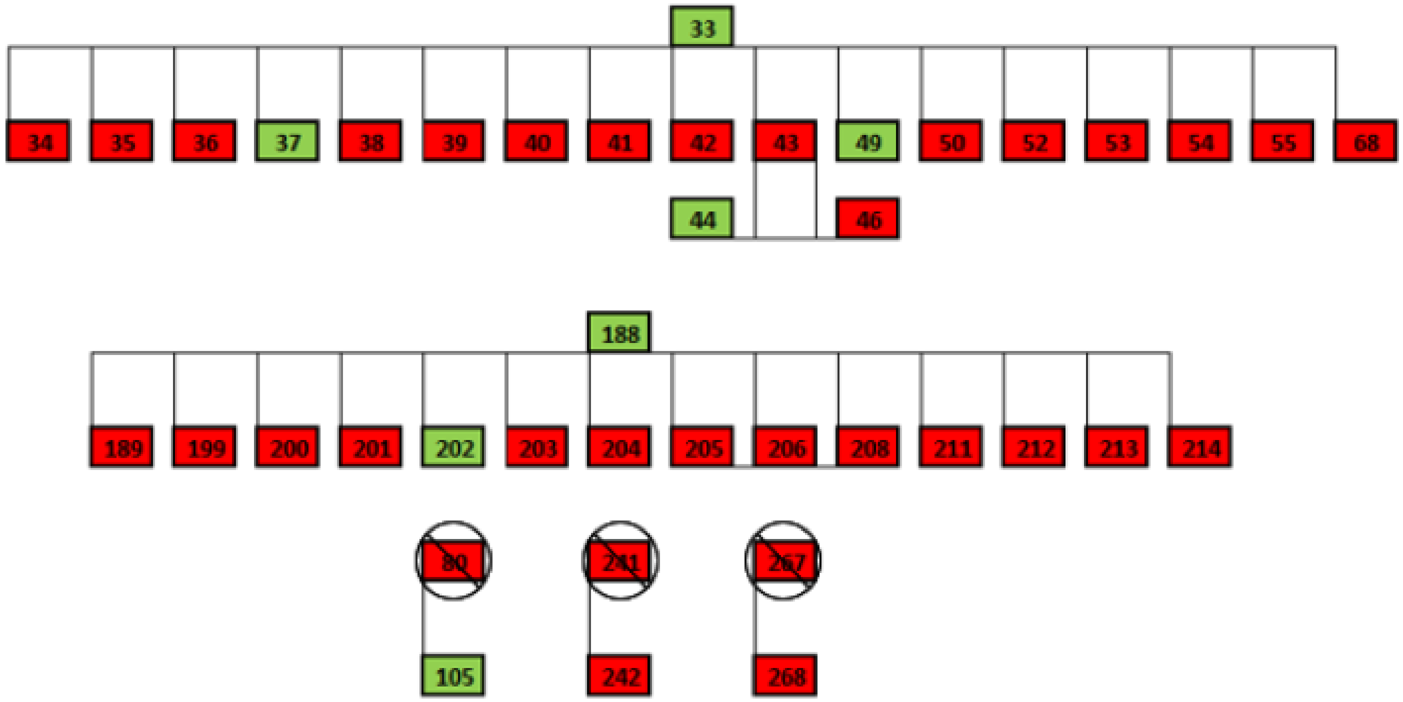
...TOREN WERKE AKTIENGESELLSCHAFT & BMW OF NORTH AMERICA, LLC,
Petitioners

v.

PAICE LLC & THE ABELL FOUNDATION, INC.
Patent Owners

Inter Partes Review No.: To Be Assigned
U.S. Patent No. 7,237,634 B2

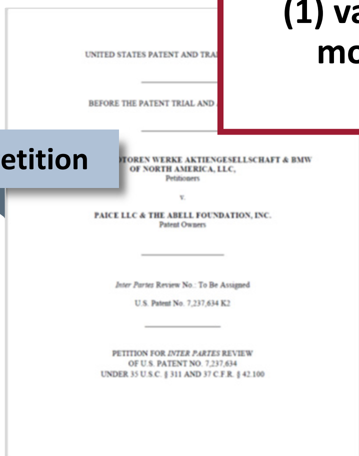
PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 7,237,634
UNDER 35 U.S.C. § 311 AND 37 C.F.R. § 42.100



Source: *E.g.*, Pet. at 1-16; Reply at 1-2.

Patent Owners Only Dispute Well-Known Nature of Two Hybrid Vehicle Features

Petition


PAICE LLC & THE ABELL FOUNDATION, INC.
Patent Owners

Inter Partes Review No.: To Be Assigned

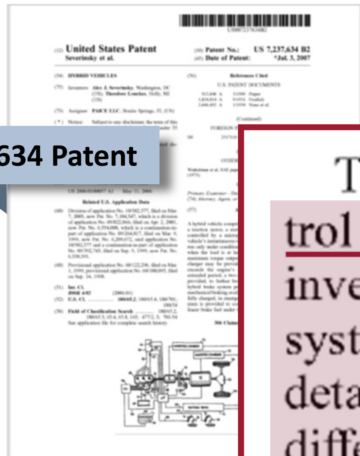
PETITION FOR *INTER PARTES* REVIEW

(1) varying the setpoint based on monitored patterns of driver operation over time

(2) turbocharging an engine in a hybrid vehicle to increase its MTO

Source: *E.g.*, Pet. at 1-7; Reply at 1-2.

Board Has Already Found '634 Patent's Supposedly Novel Control Strategies Unpatentable



'634 Patent

Turning now to detailed discussion of the inventive control strategy according to which the hybrid vehicles of the invention are operated: as in the case of the hybrid vehicle system shown in the '970 patent, and as discussed in further detail below, the vehicle of the invention is operated in different modes depending on the torque required, the state of charge of the batteries, and other variables Throughout, the object is to operate the internal combustion engine only under circumstances providing a significant load, thus ensuring efficient operation. In the following, the relationships

Source: *E.g.*, Pet. at 2; *e.g.*, BMW1001 at 35:3-9, 25:11-24.

Claim 33 Tacks On Same Well-Known "*Monitoring*" Functionality As in '347 Patent

'634 Patent

33. A method for controlling a hybrid vehicle, comprising:
determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);
operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO;
operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and
monitoring patterns of vehicle operation over time and varying the SP accordingly.

'347 Patent

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

2. The vehicle of claim **1**, wherein said controller monitors patterns of vehicle operation over time and varies said setpoint SP accordingly.

Source: *E.g.*, Pet. at 2-3, 9-11; BMW1001 at Claims 33, 188; U.S. Patent No. 7,104,347 at Claims 2, 24.

Claims 49, 105, and 188 Tack On Well-Known "*Turbocharger*" Functionality Even Broader Than in '347 Patent

'634 Patent

188. A method for controlling a hybrid vehicle, comprising:

determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;

operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);

operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO; and

operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and

operating a turbocharger controllably coupled to the engine to increase the MTO of the engine when desired.

'347 Patent

1. A hybrid vehicle, comprising:

7. The vehicle of claim **1**, wherein said vehicle is operated in a plurality of operating modes responsive to the value for the road load (RL) and said setpoint SP, both expressed as percentages of the maximum torque output of the engine when normally-aspirated (MTO), and said operating modes include:

a low-load mode I, wherein said vehicle is propelled by torque provided by said second electric motor in response to energy supplied from said battery, while RL<SP,

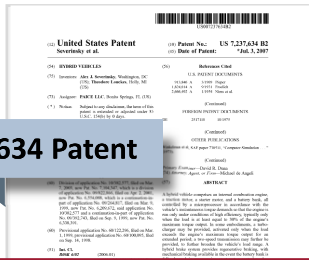
a highway cruising mode IV, wherein said vehicle is propelled by torque provided by said internal combustion engine, while SP<RL<MTO, and

an acceleration mode V, wherein said vehicle is propelled by torque provided by said internal combustion engine and by torque provided by either or both electric motor(s) in response to energy supplied from said battery, while RL>MTO.

11. The vehicle of claim **7**, further comprising a turbocharger operatively and controllably coupled to said internal combustion engine for being operated and thereby increasing the maximum torque output of said internal combustion engine to more than MTO when desired, and wherein said controller controls selection of the operational mode of said vehicle between a low-load mode I, a cruising mode IV, an acceleration mode V, and a sustained high-power turbocharged mode VI, in response to monitoring the instantaneous torque requirements (RL) of the vehicle over time.

Source: *E.g.*, Pet. at 2-3, 9-11; ID at 28-29; *e.g.*, BMW1001 at Claims 49, 105, 188; U.S. Patent No. 7,104,347 at Claims 11, 33.

Additional Evidence Confirms These Tacked On Limitations Were Well-Known



’634 Patent

By monitoring the road load over time, and comparing it to different setpoints accordingly, much of this undesirable repetitive sequence of engine starting and shut-off can be eliminated. It might be preferable to commence mode IV operation upon the occurrence of differing conditions; for example, mode IV might be entered from mode I only after the road load exceeded a first, lower setpoint SP for an extended period of time, so that the engine would be run for extended low-speed cruising, but to start the engine immediately if the road load exceeded a higher setpoint SP2, e.g. 50% of MTO, as during acceleration to highway speed. Similarly, the engine might preferably be shut down only if the road load was less than a minimum setpoint for mode IV operation for an extended period of time. Thus providing “hysteresis” in the mode-switching determination would limit repetitive engine starts in certain types of driving. These limits could be further adjusted as the driving pattern became clear, i.e., as discerned by the microprocessor.

Dr. Shahbakhti

Q. Okay. And so you would agree that
this paragraph starting at line 30 of column
41 and ending at line 47 is another example of
the patent providing for varying the setpoint,
correct?

* * *

A. This is an example of showing
claim 33 for monitoring and adjusting the
setpoints.

* * *

So a POSITA would look at it, when
reading that previous paragraph, as providing
the main example, and then here you are

Source: *E.g.*, Reply at 11-12; BMW1088 at ¶¶27-30; BMW1001 at 41:4-47; BMW1105 at 29:14-32:6.

MONITORING PATTERNS

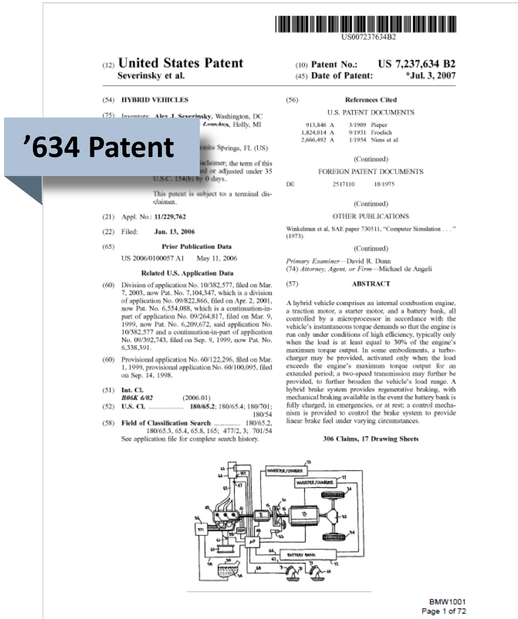
CLAIM 33 IS OBVIOUS OVER

SEVERINSKY + NII (GROUNDS 1, 4-9)

SEVERINSKY + QUIGLEY (GROUNDS 2, 4-9)

SEVERINSKY + GRAF (GROUNDS 3, 4-9)

Claim 33 Adds That the Known Setpoint-Based Control Strategy Can Be Modified Based on Monitored Patterns



33. A method for controlling a hybrid vehicle, comprising:
determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);
operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO;
operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and
monitoring patterns of vehicle operation over time and varying the SP accordingly.

Source: *E.g.*, Pet. at 1-7; BMW1001 at Claim 33.

"Pattern" and *"Monitoring Patterns"* Have Been Broadly Construed

IPR2015-00722 ID

Trials@uspto.gov
571-272-7822

Paper 13
Entered: October 26, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

PAICE LLC & THE ABELL FOUNDATION, INC.,
Patent Owner.

Case IPR2015-00722
Patent 7,237,634 B2

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

MEDLEY, *Administrative Patent Judge*.

DECISION
Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

Petitioner, Ford Motor Company, filed a Petition requesting an *inter partes* review of claims 33, 36, 42–44, 46, 50–52, 55, 78, 161, 173, 215, 228, 233, 235–237, 239, and 240 of U.S. Patent No. 7,237,634 B2 (Ex. 1260, "the '634 patent"). Paper 1 ("Pet."). Patent Owner, Paice LLC & The Abell Foundation, Inc., filed a Preliminary Response in both unredacted

BMW1060
Page 1 of 30

logical form, order, etc." Ex. 2253, 3. Thus, we agree with Patent Owner that a pattern is a regular and repeated course of conduct or behavior and that the phrase "monitoring patterns of vehicle operation over time" requires monitoring a driver's repeated driving operations over time.

The Word "Pattern" Must Have Meaning

PO's '761 Demonstratives (IPR2020-01299)

…lain meaning of … ope…

Dr. Mahdi Shahbakhti
Patent Owners' Expert

52. A person of ordinary skill in the art would understand a "patter… operation of said hybrid vehicle" to require an order or sequence of dri… operations. Ex. 2029 (defining "pattern" as a "regular or logical form, order, et… Ex. 2030, 3 (defining pattern as "[a]n established sequence of steps in a proce… Ex. 2031, 3 (defining pattern as "a regular or repetitive form, order… arrangement"). There is no order or sequence with respect to a single measure…

PAICE2016, ¶ 52

Sur-Reply, 8-9

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE 22

52. A person of ordinary skill in the art would understand a "pattern of operation of said hybrid vehicle" to require an order or sequence of driving operations. Ex. 2029 (defining "pattern" as a "regular or logical form, order, etc.");

Source: *E.g.*, Pet. at 8-11; BMW1060 at 8; ID at 14; IPR2020-01299, Exhibit 2036 at 22.

Nii Teaches "*Monitor[ing]*" Same "*Patterns of Vehicle Operation Over Time*" as '634 Patent

'634 Patent

It is also within the scope of the invention for the microprocessor to monitor the vehicle's operation over a period of days or weeks and reset this important setpoint in response to a repetitive driving pattern. For example, suppose the operator drives the same route from a congested suburban development to a workplace about the same time every morning; typically the road load might remain under 20% of MTO for the first few minutes of each day, then vary between 0 and 50% of MTO for another few minutes as the operator passes through a few traffic lights, and then suddenly increase to 150% of MTO as the operator accelerates onto a highway. It is within the skill of the art to program a microprocessor to record and analyze such daily patterns, and to adapt the control strategy accordingly. For example, in response to recognition of a regular pattern as above, the transition point might be adjusted to 60% of MTO; this would prevent repetitive engine starts as the road load exceeded 30% of MTO for a few hundred yards at a time, as might often occur in suburban traffic. Similarly, the engine starting routine might be initiated after the same total distance had been covered each day.

Nii

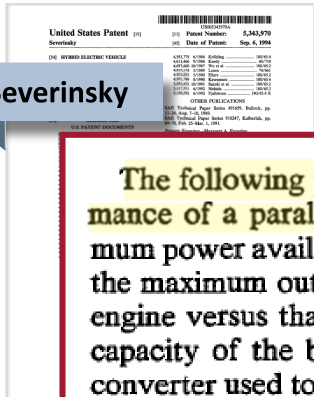
According to the present invention, the output of a generator is set to a generator output equal to the power consumption value corresponding to the travel pattern in the case of traveling according to a travel pattern. Therefore, it is possible to generate optimum electrical power at a constant value by a generator. Thus, it is possible to decrease harmful components in the exhaust gas of a generator and increase the power consumption of an engine for driving the generator. For example, for a regular travel pattern such as people commuting using a standard vehicle or taking people to and from their offices using a commercial vehicle, it is possible to minimize the power generation

"repetitive driving pattern" = "regular travel pattern" (*e.g.*, daily commute)

Source: *E.g.*, Pet. at 19-20; Reply at 3; BMW1001 at 40:50-41:3; BMW1022 at 2:21-24, 5:59-64; BMW1008 at ¶¶274-75; BMW1088 at ¶37.

Severinsky's *Setpoint*-Based Control Algorithm Could Be Improved Using Nii's *Pattern Monitoring* Functionality

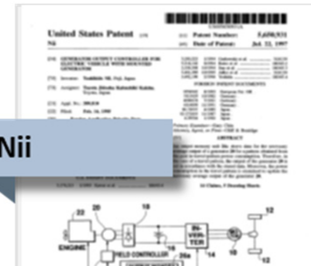
Severinsky



The following parameters are relevant to the performance of a parallel hybrid vehicle: 1) the total maximum power available to drive the vehicle; 2) the ratio of the maximum output power of the internal combustion engine versus that of the electric motor; 3) the energy capacity of the battery; 4) the function of the power converter used to convert mechanical energy to electrical energy for storage and vice versa; 5) the availability of power to recharge the battery at any time; 6) the optimization of the control algorithm; and 7) appropriate mechanical linkage between the engine, the motor, and the drive wheels. According to the invention, these parameters are optimized so as to ensure that the engine is operated at all times at its maximum point of efficiency, and such that the driver need not consider the power source being employed at any given time.

Thus, in accordance with the objects of the invention a hybrid electric vehicle is provided that is fully competitive with conventional internal combustion engine driven vehicles in terms of acceleration, cost, weight, and manufacturing and operational convenience, while obtaining very substantial improvements in fuel efficiency and even more substantial reduction in emission of pollutants.

Nii



According to the present invention, the output of a generator is set to a generator output equal to the power consumption value corresponding to the travel pattern in the case of traveling according to a travel pattern. Therefore, it is possible to generate optimum electrical power at a constant value by a generator. Thus, it is possible to decrease harmful components in the exhaust gas of a generator and increase the power consumption of an engine for driving the generator. For example, for a regular travel pattern such as people commuting using a standard vehicle or taking people to and from their offices using a commercial vehicle, it is possible to minimize the power generation

Source: *E.g.*, Pet. at 20-23; Reply at 3-5; BMW1008 at ¶¶276-84; BMW1088 at ¶¶34-36; BMW1013 at 5:24-37; 21:23-38; 21:48-55; BMW1022 at 2:13-24.

Increasing Hybrid Vehicle Efficiency Was One of Severinsky's Goals

Dr. Shahbakhti

Q. So would a person of skill in the art be motivated to improve the efficiency of a hybrid vehicle?

A. I believe the question you are asking is repeating to what you asked earlier. We discussed that efficiency is always one of the variables that is very important as part of design, but then others comes together. And then so we discussed already this efficiency is one of the important objective.

Q. So as a general matter, Severinsky '970 is concerned with enhancing the efficiency of a hybrid vehicle, right?

* * *

A. Efficiency should be one of the factors that is considered, because in the sentence I mention, fuel economy was mentioned.

Source: *E.g.*, Pet. at 20-23; Reply at 3-5; BMW1008 at ¶¶276-84; BMW1088 at ¶¶34-36; BMW1089 at 77:9-18, 130:11-131:21.

Using Actual Patterns of Operation To Adjust Severinsky's Factory-Defined Setpoint Would Increase Efficiency

36. A person of ordinary skill would have understood that these predefined parameters could be improved based on actual vehicle usage, such as by using the pattern information disclosed by Nii. (BMW1008 at ¶¶ 280-82.) Such an improvement would enhance the vehicle's efficiency both when employing hysteresis and more broadly since the pattern information would be reflective of actual vehicle usage, rather than of pre-set parameters. (BMW1008 at ¶¶ 280-82; Severinsky (BMW1013) at 8:30-33.) Knowing how a vehicle will actually be operated is the holy grail for fine-tuning hybrid vehicle efficiency. Thus, a person of skill in the art would have found the claimed limitations in the prior art and been motivated to combine them in the broad manner claimed.

Dr. Davis

Dr. Shahbakhti

Q. And is predictability an important
thing to have? Is it an important benefit to
hybrid electric control systems?
A. It depends on the accuracy of the --
those predictions. And then if I know a person
going from point A and B and everything is
predicted that what would be the -- the road
load conditions, everything is predicted, then
will become more like, let's say, autonomous
cars that everything's controlled there, then
depending on the strategy that the person will
design to utilize that predicted information,
that can provide useful information for, let's
say, improving the vehicle performance.

Source: *E.g.*, Pet. at 20-23; Reply at 3-5; BMW1008 at ¶¶276-84; BMW1088 at ¶¶34-36; BMW1089 at 80:3-81:16.

"It Is Within the Skill of the Art" To Take Nii's Pattern Monitoring and "Adapt [Severinsky's] Control Strategy Accordingly"

'634 Patent

It is also within the scope of the invention for the microprocessor to monitor the vehicle's operation over a period of days or weeks and reset this important setpoint in response to a repetitive driving pattern. For example, suppose the operator drives the same route from a congested suburban development to a workplace about the same time every morning; typically the road load might remain under 20% of MTO for the first few minutes of each day, then vary between 0 and 50% of MTO for another few minutes as the operator passes through a few traffic lights, and then suddenly increase to 150% of MTO as the operator accelerates onto a highway. It is within the skill of the art to program a microprocessor to record and analyze such daily patterns, and to adapt the control strategy accordingly. For example, in response to recognition of a regular pattern as above, the transition point might be adjusted to 60% of MTO; this would prevent repetitive engine starts as the road load exceeded 30% of MTO for a few hundred yards at a time, as might often occur in suburban traffic. Similarly, the engine starting routine might be initiated after the same total distance had been covered each day.

Nii

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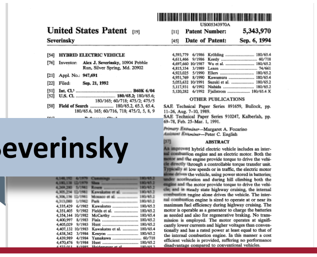
Source: *E.g.*, Pet. at 23; Reply at 4-5; BMW1001 at 40:50-41:3; BMW1022 at 2:14-24; BMW1008 at ¶¶278, 283; BMW1088 at ¶71.

Severinsky's Default Setpoint Is Arbitrary



Severinsky

75 and 150 horsepower. FIG. 1 thus indicates that the typical internal combustion engine operates with reasonable efficiency only when producing between about 50 and about 90% of its maximum output power. The typical automobile only requires such substantial power under conditions of extreme acceleration or hill climbing. Thus, only during relatively brief intervals is the engine operating efficiently. As can be seen, during

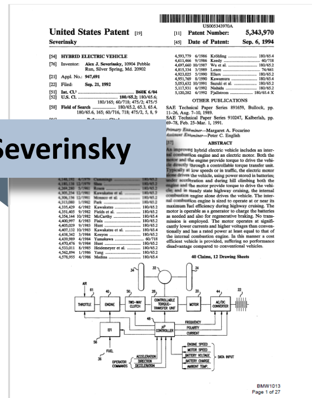
It will be appreciated that according to the invention the internal combustion engine is run only in the near vicinity of its most efficient operational point, that is, such that it produces 60–90% of its maximum torque whenever operated. This in itself will yield improvement in fuel economy on the order of 200–300%. More

Dr. Davis

35. Many of Severinsky's setpoints are preset and some are arbitrary. For example, Severinsky's hysteresis utilizes a preset torque value (and corresponding speed range) to lower the setpoint for running the engine outside of its most efficient operating range for an arbitrary period of time. Even Severinsky's default setpoint of 60% MTO provides room for improvement over its preset value, as Severinsky teaches that "the typical internal combustion engine operates with reasonable efficiency only when producing between about 50 and about 90% of its maximum power." (Severinsky (BMW1013) at 8:27-30.)

Source: *E.g.*, Pet. at 20-23; Reply at 3-4; BMW1008 at ¶¶276-84; BMW1088 at ¶¶34-36; BMW1013 at 8:27-35; 20:63-67; 18:23-42; ID at 34-35.

Severinsky Discloses "*Vary[ing] Said Setpoint*" During Hysteresis



Severinsky

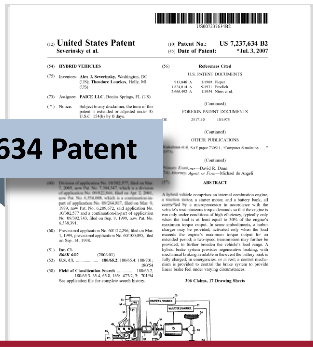
It is within the scope of the invention to operate the engine 40 outside its most fuel efficient operating range, on occasion. For example, if the torque transfer unit does not provide a limited-slip mode of operation the combined load of low-speed vehicle operation in traffic together with battery charging may be less then the minimum power produced by the engine in its most efficient operating range. In these circumstances, it is preferable to use the engine somewhat inefficiently rather than to discharge the batteries excessively, which would substantially reduce the battery lifetime.

At moderate speeds, as experienced in suburban driving, the speed of the vehicle on average is between 30–45 mph. The vehicle will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30–35 mph. The engine will continue to run unless the engine speed is reduced to 20–25 mph for a period of time, typically 2–3 minutes. This speed-responsive hysteresis in mode switching will eliminate nuisance engine starts.

Source: *E.g.*, Pet. at 20-23; Reply at 2-13; BMW1008 at ¶¶276-84; BMW1088 at ¶¶7-71; BMW1013 at 8:27-30; 20:63-67; 18:23-42; ID at 34-35.

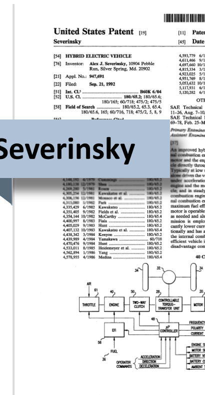
Severinsky and '634 Patent Confirm Severinsky's Speed Values Correspond to Torque Values and Vice Versa

'634 Patent



motors when appropriate. See FIGS. 3 and 4 hereof. As in the '970 patent, an internal combustion engine is provided, sized to provide sufficient torque to be adequate for the range of cruising speeds desired, and is used for battery charging as needed. The internal combustion engine is connected to the drive wheels by a clutch operated by the microprocessor responsive to its selection of the vehicle's mode of operation in response to evaluation of the road load, that is, the vehicle's instantaneous torque demands and input commands provided by the operator of the vehicle. A relatively high-powered "traction" motor is connected directly to the output shaft of the vehicle; the traction motor provides torque to propel the vehicle in low-speed situations, and provides additional torque when required, e.g., for acceleration, passing, or hill-climbing during high-speed driving.

Severinsky



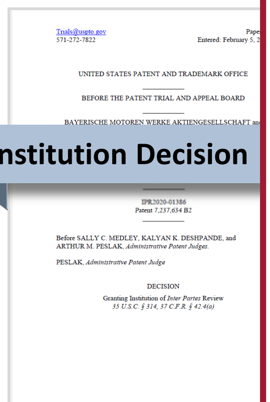
It will be appreciated that according to the invention the internal combustion engine is run only in the near vicinity of its most efficient operational point, that is, such that it produces 60–90% of its maximum torque whenever operated. This in itself will yield improve-

At moderate speeds, as experienced in suburban driving, the speed of the vehicle on average is between 30–45 mph. The vehicle will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30–35 mph. The engine will continue to run unless the engine speed is reduced to 20–25 mph for a period of time, typically 2–3 minutes. This speed-responsive hysteresis in mode switching will eliminate nuisance engine starts.

More particularly, according to the invention, the internal combustion engine is operated only under the most efficient conditions of output power and speed. When the engine can be used efficiently to drive the vehicle forward, e.g. in highway cruising, it is so employed. Under other circumstances, e.g. in traffic, the

Source: *E.g.*, Pet. at 48; Reply at 10-11; BMW1008 at ¶48; BMW1088 at ¶¶8-26; BMW1001 at 17:36-50; BMW1013 at 20:63-67; 18:23-42; 7:8-16.

Prior IPR Decisions and Dr. Davis Confirm Severinsky's Speed Values Correspond to Torque Values and Vice Versa



Trials@uspto.gov
571-272-7822

Pape
Entered: February 5, 2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT an

IPR2020-01386
Patent 7,237,634 B2

Before SALLY C. MEDLEY, KALYAN K. DESHPANDE, and ARTHUR M. PESLAK, *Administrative Patent Judges*.

PESLAK, *Administrative Patent Judge*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4(a)

Institution Decision

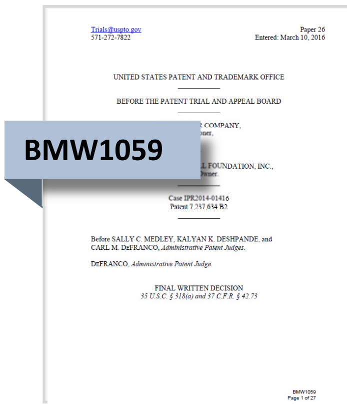
Severinsky specifically describes that the vehicle normally operates "in a highway mode with the engine running constantly after the vehicle reaches a speed of 30–35 mph." Ex. 1013, 18:36–38. This highway mode corresponds to the limitation in claim 33 of "operating … the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO." Ex. 1001, 61:4–6. In the speed-responsive hysteresis mode, Severinsky "will continue to run the engine unless the engine speed is reduced to 20–25 mph for a period of time, typically 2–3 minutes." Ex. 1013, 18:38–40. This speed range is outside the speed range of Severinsky's highway mode, and given the Board's prior finding that speed plays a role in the road load responsive control strategy of the '634 Patent, Petitioner has sufficiently established that Severinsky discloses varying the setpoint, at least for the time period when the vehicle operates in the hysteresis mode.

Dr. Davis

engine's MTO. (BMW1008 at ¶¶ 254-56.) In other words, the speed-based thresholds in Severinsky correlate to torque-based thresholds, and vice versa, which is also true in the '634 Patent, whose vehicle operation is disclosed to function "as in the [Severinsky] '970 patent." (*See* Severinsky (BMW1013) at 7:8-

Source: *E.g.*, Reply at 9-13; BMW1088 at ¶¶9-10; ID at 34-35; BMW1059 at 14-17.

Board Rejected Years Ago Paice's Argument That Severinsky's Control System Only Takes Speed Into Account



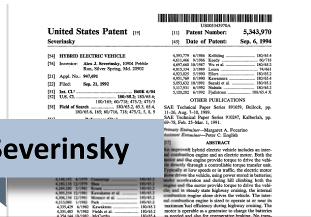
Paice would have us believe that "speed" is the *sole* factor used by Severinsky in determining when to employ the engine. That is not the case. Severinsky makes clear that the controller uses the "load" requirements of the vehicle in determining when to run the engine. Importantly, Severinsky discloses that

> *at all times* the microprocessor 48 may determine the load (if any) to be provided to the engine by the motor, *responsive to the load imposed by the vehicle's propulsion requirements*, so that the engine 40 can be operated in its most fuel efficient operating range.

Ex. 1103, 17:11–15 (emphases added). We are not persuaded by Paice's focus on Severinsky's disclosure of "speed," when Severinsky plainly teaches using "load" for determining the engine's "most fuel efficient operating range." It is the totality of Severinsky that must be assessed, not its individual parts.

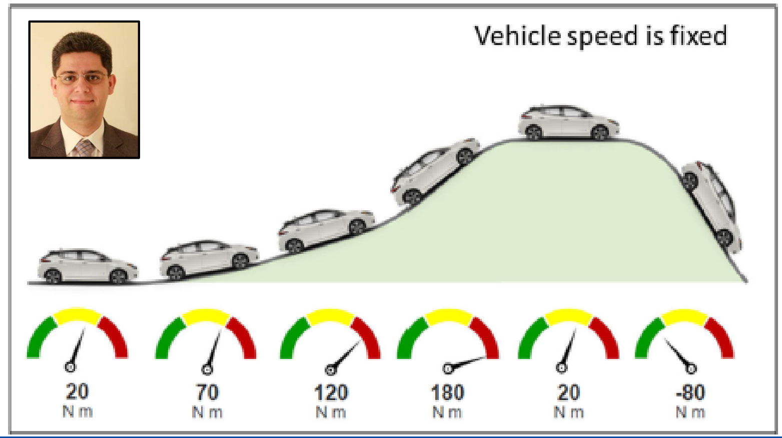
Source: *E.g.*, Reply at 13; ID at 30, 34-35; BMW1059 at 14-17; BMW1013 at 18:23-42, 20:63-67.

Severinsky Takes Instantaneous Torque Into Account "at all times"


United States Patent [19]
Severinsky
[11] Patent Number: 5,343,970
[45] Date of Patent: Sep. 6, 1994
[54] HYBRID ELECTRIC VEHICLE

Severinsky

Thus, at all times the microprocessor 48 may determine the load (if any) to be provided to the engine by the motor, responsive to the load imposed by the vehicle's propulsion requirements, so that the engine 40 can be operated in its most fuel efficient operating range.



Dr. Davis

12. Indeed, Severinsky's so-called "speed-based hysteresis" *must* take torque into account. As I have explained, during hysteresis Severinsky's controller lowers the engine setpoint to allow the engine to stay on at lower speed conditions than the minimum 30-35 mph (and correlated 60% MTO) required in "highway mode." (BMW1008 at ¶ 461.) However, the control system must still take into account higher requested road load demand such as is encountered during Dr. Shahbakhti's example of a vehicle climbing a hill (*see* Shahbakhti Decl. at ¶ 70), or in other instances, while still minimizing nuisance engine starts. Otherwise, the controller would not properly respond to the instantaneous road load requirements of the vehicle. A skilled artisan would have understood that the vehicle control must always respond to the operator commands, and that the road load request of the operator and the speed are primary inputs required by a control system such as Severinsky's. (*See, e.g.*, Severinsky (BMW1013) at 6:19-48, 17:11-15 ("the load imposed by the vehicle's propulsion requirements" is monitored "at all times").)

Source: *E.g.*, Reply at 10-11; BMW1088 at ¶¶8-26; BMW1013 at 17:11-15; Exhibit 2016 at ¶70.

Severinsky *Varies Setpoint* from 30-35 mph During Normal Operation to 20-25 mph During Hysteresis

'634 Patent

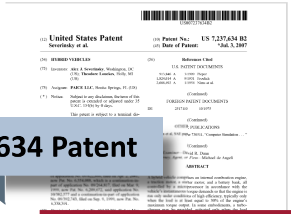
33. A method for controlling a hybrid vehicle, comprising:
determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);
operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO;
operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and
monitoring patterns of vehicle operation over time and varying the SP accordingly.

Severinsky

At moderate speeds, as experienced in suburban driving, the speed of the vehicle on average is between 30–45 mph. The vehicle will operate in a highway mode with the engine running constantly after the vehicle reaches a speed of 30–35 mph. The engine will continue to run unless the engine speed is reduced to 20–25 mph for a period of time, typically 2–3 minutes. This speed-responsive hysteresis in mode switching will eliminate nuisance engine starts.

Source: *E.g.*, Pet. at 21-22; Reply at 9-13; BMW1001 at Claim 33; BMW1013 at 18:34-42; BMW1008 at ¶¶274-84; BMW1088 at ¶¶7-71.

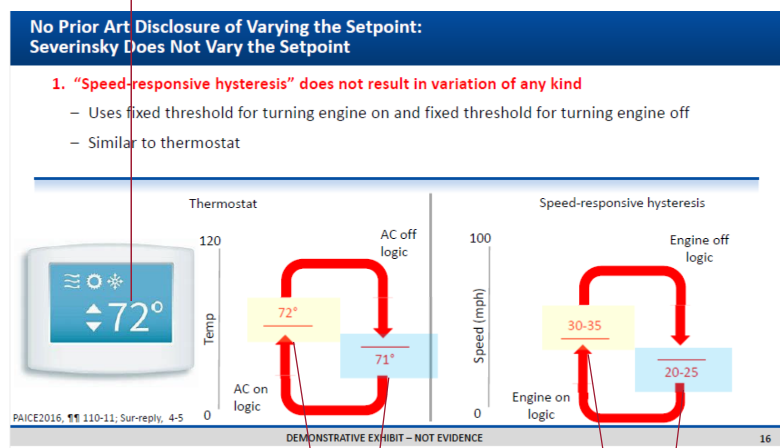
PO's Thermostat Example Is Misplaced



'634 Patent

33. A method for controlling a hybrid vehicle, comprising:
determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;
operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);
operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO;
operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and
monitoring patterns of vehicle operation over time and varying the SP accordingly.

user desired temperature

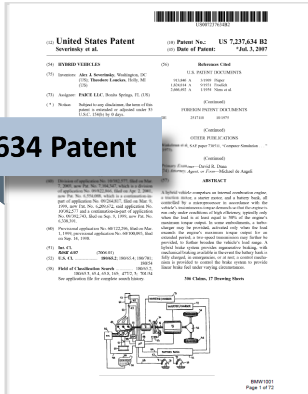


setpoint being varied

setpoint being varied

Source: *E.g.*, Pet. at 21-22; Reply at 9-13; BMW1001 at Claim 33; BMW1008 at ¶¶274-84; BMW1088 at ¶¶7-71; POSR at 5; IPR2020-00994, Exhibit 2030 at 16.

’634 Patent Includes Using Two Different Setpoints as Example of “Varying”



’634 Patent

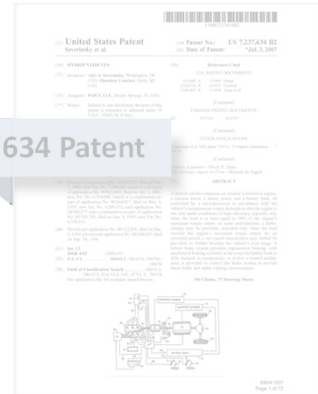
It is also within the scope of the invention to make the setpoint SP to which the road load is compared to control the transition from mode I to mode IV somewhat t“fuzzy”, so that SP may vary from one comparison of road load to MTO to the next depending on other variables. For example, as discussed above, if during low-speed operation the operator depresses the accelerator pedal rapidly, this can be treated as an indication that full power will shortly be required, and the engine-starting operation begun before the road load reaches any particular setpoint SP.

The value of the transition point may also vary in dependence on the mode of operation in effect when the road load equals a given setpoint SP. For example, suppose the setpoint at which the mode of operation is controlled to change from the low-speed mode to the highway cruising mode is normally set to 30% of MTO, as in the examples discussed above. If traffic conditions were such that the road load fluctuated around this value, and engine operation were controlled solely in response to road load, the engine would be repeatedly started and shut off as the road load exceeded 30% of MTO for a few hundred yards at a time, and then fell back below 30% of MTO, as might often occur in suburban traffic. Repeated restarts might also occur if the road load averaged over 30% of MTO but occasionally dropped below this value, as might occur in moderate-speed, flat-road cruising.

By monitoring the road load over time, and comparing it to different setpoints accordingly, much of this undesirable repetitive sequence of engine starting and shut-off can be eliminated. It might be preferable to commence mode IV operation upon the occurrence of differing conditions; for example, mode IV might be entered from mode I only after the road load exceeded a first, lower setpoint SP for an extended period of time, so that the engine would be run for extended low-speed cruising, but to start the engine immediately if the road load exceeded a higher setpoint SP**2**, e.g. 50% of MTO, as during acceleration to highway speed., Similarly, the engine might preferably be shut down only if the road load was less than a minimum setpoint for mode IV operation for an extended period of time. Thus providing “hysteresis” in the mode-switching determination would limit repetitive engine starts in certain types of driving. These limits could be further adjusted as the driving pattern became clear, i.e., as discerned by the microprocessor.

Source: *E.g.*, Reply at 11-12; BMW1088 at ¶¶27-30; BMW1001 at 41:4-47.

Dr. Shahbakhti Admits Using Two Different Setpoint Values Is “Main Example” of “*Varying the Setpoint*” in ’634 Patent



’634 Patent

It is also within the scope of the invention to make the setpoint ... transition ... that SP n ... to the n ... discussed ... depresse ... an indica ... engine-st ... any parti ...

The va ... dence on ... equals a ... point at ... from the ... normally ... above. I ... fluctuate ... controlle ... be repeat ... 30% of M ... back bel ... traffic. R ... averaged ... this valu ... cruising.

By monitoring the road load over time, and comparing it

Dr. Shahbakhti

Q. Okay. And so you would agree that this paragraph starting at line 30 of column 41 and ending at line 47 is another example of the patent providing for varying the setpoint, correct?

* * *

A. This is an example of showing claim 33 for monitoring and adjusting the setpoints.

* * *

So a POSITA would look at it, when reading that previous paragraph, as providing the main example, and then here you are talking about smaller refinements that you will consider another factor in addition. But the main example is presented in the previous paragraph.

Source: *E.g.*, Reply at 11-12; BMW1088 at ¶¶27-30; BMW1001 at 41:4-47; BMW1105 at 29:14-32:6.

BMW's Arguments Are Consistent with Its Adopted Arguments from Prior IPRs, Which the Board Previously Credited

Petition

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

PAICE LLC & THE ABELL FOUNDATION, INC.
Patent Owners

Inter Partes Review No.: To Be Assigned

Though Severinsky's discussion of "hysteresis" references speed, Severinsky's vehicle nevertheless "operate[s] in different modes depending on the *torque* required." *See* BMW1001, 35:3-17. The discussion of speed merely comports with Severinsky's description of low-load "moderate"/"suburban" driving situations in which less torque is required. BMW1013, 18:38-42; 5:46-52; BMW1008, ¶¶462-464.

Severinsky discloses a "hysteresis" mode in which the engine will continue to operate (and the electric motor will remain off) "unless the engine speed is reduced to 20-25 mph for a period of time, typically 2-3 minutes." BMW1013, 18:23-42. A POSA would have understood that reducing the engine speed would have a corresponding reduction in *road load* and that operating the vehicle at 20-25 mph would result in the engine operating "outside its most fuel efficient operating range" (i.e., below the 60% of MTO *setpoint*). BMW1008, ¶¶478-481.

BMW1059

Trials@uspto.gov
571-272-7822

Paper 26
Entered: March 10, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Case IPR2014-01416
Patent 7,237,634 B2

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

With that background in mind, we credit the testimony of Dr. Davis that a skilled artisan would have been led to incorporate Frank's time-delay feature with Severinsky's engine control strategy because both hybrid strategies utilize a threshold, or "setpoint," for switching the engine on and off. Ex. 1107 ¶¶ 373–377. Also, we are not persuaded by Paice's contention that the proposed combination would result in a "speed-responsive hysteresis." PO Resp. 7, 18, 22, 24. As discussed above, Severinsky's setpoint already accounts for a torque value and is already available for use with a time-delay feature, such as that taught by Frank. Ex. 1107 ¶¶ 366–370. Thus, we find that Severinsky's disclosure of a *torque*-based setpoint for starting and stopping the engine, when combined with Frank's teaching of a time-delay with an on-off threshold for an engine, would have suggested to a skilled artisan the features of claims 80 and 114. *See* Pet. 39–42, 45–47.

Source: *E.g.*, Sur-Reply at 9, n.5; Pet. at 48, 50; BMW1059 (IPR2014-01416 FWD) at 21-22.

MONITORING PATTERNS

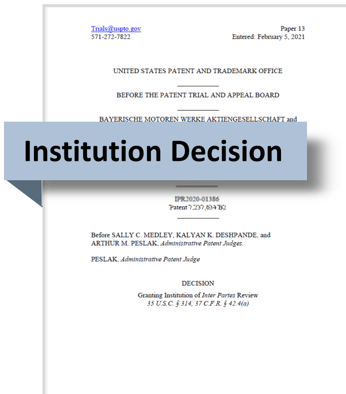
CLAIM 33 IS OBVIOUS OVER

SEVERINSKY + NII (GROUNDS 1, 4-9)

SEVERINSKY + QUIGLEY (GROUNDS 2, 4-9)

SEVERINSKY + GRAF (GROUNDS 3, 4-9)

Institution Decision On Quigley-Based Grounds Was Based On Two Misconceptions With Petition


Trials@uspto.gov Paper 13
571-272-7822 Entered: February 5, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT and

IPR2020-01386
Patent 7,237,634 B2

Before SALLY C. MEDLEY, KALYAN K. DESHPANDE, and ARTHUR M. PESLAK, *Administrative Patent Judges.*

PESLAK, *Administrative Patent Judge*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4(a)

Institution Decision

Pet. 8. Our review of Quigley and Dr. Davis's testimony does not reveal evidentiary support for Petitioner's contention that Quigley varies a setpoint that constitutes a "torque" value. *See* Pet. 26; Ex. 1008 ¶ 292.

rational underpinning. We note that unlike the combination of Severinsky and Nii discussed above in section II.D.3, the Petition does not propose modifying Severinsky's hysteresis mode with Quigley's monitoring information. For this ground, the Petition only mentions Severinsky's

Source: *E.g.*, ID at 40-41.

Petitioners Have Consistently Proposed Adjusting ***Severinsky's*** Torque-Based "*Setpoint*"

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Petition

...AKTIENGESELLSCHAFT & BMW ...ERICA, LLC,

PAICE LLC & THE ABELL FOUNDATION, INC.
Patent Owners

Inter Partes Review No.: To Be Assigned
U.S. Patent No. 7,237,634 K2

BMW1054, 130. A POSA would have likewise been motivated to modify Severinsky's control scheme to incorporate such control based on actual pattern of operation information to achieve the "optimal operation" of emissions and fuel consumption disclosed in Quigley. BMW1008, ¶¶294-295.

Since Severinsky's control scheme relies on setpoints to determine the mode of operation, a POSA viewing Quigley's teachings concerning the adjustment of the engine's operating values would similarly alter the setpoints used by the controller in Severinsky based on such monitored information. *See* BMW1008,

A POSA also would have understood how to implement Quigley's pattern-determining and utilization functionality into Severinsky's controller to alter the vehicle's setpoint. *Id.* Quigley explains that its controller "allow[s] journey parameters to be reliably estimated upon journey departure" by processing information from "signals derived from technology already present in modern day vehicles (e.g. electronic tachometer, engine management system)." BMW1054, 130. A POSA would only need to modify Severinsky's controller logic to use the information reflecting the monitored journey parameters as taught by Quigley, rather than simply using generic parameters independent of actual usage.

Source: *E.g.*, Pet. at 27-29.

Petitioners Have Consistently Proposed Modifying Severinsky's Setpoints in Normal Operation and During Hysteresis

Petition

130. A POSA would only need to modify Severinsky's controller logic to use the information reflecting the monitored journey parameters as taught by Quigley, rather than simply using generic parameters independent of actual usage. BMW1008, ¶297; *see also* BMW1001, 40:61-63. Notably, Severinsky's control scheme already temporarily changes the setpoints to vary engine operation in response to certain vehicle operating conditions (e.g., when using a hysteresis), further showing that this suggested modification would not require a significant alteration to Severinsky's controller. BMW1008, ¶¶297-98.

POR

Finally, as with Ground 1, BMW improperly focuses on modifying Severinsky's ***speed-based*** "hysteresis" functionality, not the ***torque-based*** 60% value on which BMW relies as its "setpoint." While the Petition refers to

Source: *E.g.*, Pet. at 26-29; Reply at 13-22; POR at 44-45, 49; BMW1008 at ¶¶294-98; BMW1088 at ¶¶72-98.

Quigley Teaches "*Monitoring Patterns of Vehicle Operation Over Time*" and Optimizing Hybrid Vehicle Control Accordingly

Quigley

PREDICTING THE USE OF A HYBRID ELECTRIC VEHICLE

C P Quigley, R J Ball, A M Vinsome. Dr. R P Jones.

Abstract: This paper outlines the initial stages of a project to analyze the requirements and then design an intelligent controller for hybrid electric vehicles. Such a controller would be required to manage energy flow through the hybrid drive train and for optimum control would require a number of parameters normally available only upon journey completion. This paper presents work to attempt to predict these parameters at the start of the journey using intelligent classification techniques and a knowledge base of previous journey histories.

A programme still very much in its infancy is the design of an intelligent controller. The proposed controller will allow journey parameters to be reliably estimated upon journey departure, and therefore allow for optimal operation with respect to exhaust emissions and fuel consumption.

The successful implementation of such a controller relies on the idea that many cars will have habitual usage characteristics for a high percentage of their journeys, and hence the ability to predict the occurrence of a journey and its associated characteristics will be quite high. A commuter journey is a particularly good example of a journey that exhibits habitual characteristics, and in the UK accounts for around 20% of all journeys taken by car (National Travel Survey, 1993). Other journey types

Source: *E.g.*, Pet. at 23-26; Reply at 14-15; BMW1008 at ¶¶286-93; BMW1088 at ¶¶72-98; BMW1054 at 129-30.

Severinsky's Setpoint-Based Control Algorithm Could Be Improved Using Quigley's *Pattern Monitoring* Functionality

Severinsky

The following parameters are relevant to the performance of a parallel hybrid vehicle: 1) the total maximum power available to drive the vehicle; 2) the ratio of the maximum output power of the internal combustion engine versus that of the electric motor; 3) the energy capacity of the battery; 4) the function of the power converter used to convert mechanical energy to electrical energy for storage and vice versa; 5) the availability of power to recharge the battery at any time; 6) the optimization of the control algorithm; and 7) appropriate mechanical linkage between the engine, the motor, and the drive wheels. According to the invention, these parameters are optimized so as to ensure that the engine is operated at all times at its maximum point of efficiency, and such that the driver need not consider the power source being employed at any given time.

Thus, in accordance with the objects of the invention a hybrid electric vehicle is provided that is fully competitive with conventional internal combustion engine driven vehicles in terms of acceleration, cost, weight, and manufacturing and operational convenience, while obtaining very substantial improvements in fuel efficiency and even more substantial reduction in emission of pollutants.

Quigley

Abstract: This paper outlines the initial stages of a project to analyze the requirements and then design an intelligent controller for hybrid electric vehicles. Such a controller would be required to manage energy flow through the hybrid drive train and for optimum control would require a number of parameters normally available only upon journey completion. This paper presents work to attempt to predict these parameters at the start of the journey using intelligent classification techniques and a knowledge base of previous journey histories.

A programme still very much in its infancy is the design of an intelligent controller. The proposed controller will allow journey parameters to be reliably estimated upon journey departure, and therefore allow for optimal operation with respect to exhaust emissions and fuel consumption.

Source: *E.g.*, Pet. at 26-29; Reply at 13-22; BMW1008 at ¶¶294-98; BMW1088 at ¶¶72-98; BMW1013 at 5:31-37; 21:23-38; 21:48-55; BMW1054 at 129-30.

A POSA Would "*Vary*" Severinsky's "*Setpoint*" Based on Actual Operation To Improve Efficiency

77. Because Severinsky's control strategy is *setpoint-based* and relies on a preset setpoint value, a person of ordinary skill would have recognized that this strategy could be optimized to increase the vehicle's efficiency by varying the setpoint to better account for and reflect actual operating conditions, as taught in Quigley. Rather than using a preset setpoint value, varying the setpoint would better adapt *Severinsky's controller* for a wider variety of vehicle operations. (BMW1008 at ¶¶ 294-97.) That would have been the most logical way to modify a control scheme that relies on setpoints to achieve improved efficiency (and there

80. Thus, as I previously explained in my First Declaration, a person of ordinary skill in the art would have been motivated to incorporate Quigley's use of monitored travel patterns into Severinsky's control scheme to further optimize Severinsky's operation "based on how the vehicle *is actually being used* to increase engine efficiency and reduce emissions," rather than by relying on "general purpose control parameter values." (BMW1008 at ¶¶ 294-98 (emphasis

Dr. Davis

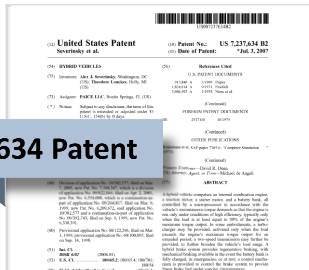
emissions and fuel economy improvements. Notably, Severinsky '970's control scheme already temporarily changes the setpoints to vary engine operation in response to certain vehicle operating conditions (e.g., during hysteresis), which shows that this suggested modification would not require a significant alteration to Severinsky '970's controller. A skilled artisan would have understood how to

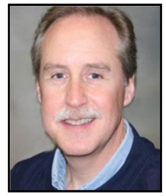
'970's controller." (BMW1008 at ¶ 297.) A skilled artisan would have recognized that if Severinsky's controller can vary the setpoint during hysteresis (i.e., within a single journey) based on a monitored pattern of operation, it would also be capable of varying the setpoint based on such a pattern at the start of a subsequent journey.

Source: *E.g.*, Pet. at 26-29; Reply at 13-22; BMW1008 at ¶¶294-98; BMW1088 at ¶¶72-98.

"It Is Within the Skill of the Art" To Take Quigley's Pattern Monitoring and "Adapt [Severinsky's] Control Strategy Accordingly"

'634 Patent



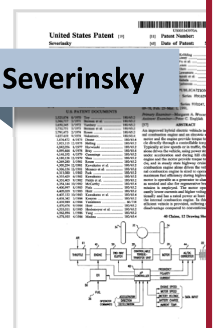


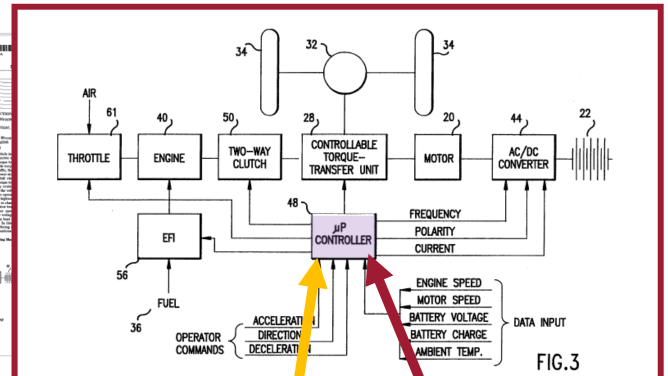
Dr. Davis

to adapt the control strategy accordingly." A skilled artisan would only need to modify Severinsky '970's logic to use the information reflecting the monitored journey parameters as taught by Quigley, rather than simply using general purpose parameters which are set independent of predicted usage.

It is also within the scope of the invention for the microprocessor to monitor the vehicle's operation over a period of days or weeks and reset this important setpoint in response to a repetitive driving pattern. For example, suppose the operator drives the same route from a congested suburban development to a workplace about the same time every morning; typically the road load might remain under 20% of MTO for the first few minutes of each day, then vary between 0 and 50% of MTO for another few minutes as the operator passes through a few traffic lights, and then suddenly increase to 150% of MTO as the operator accelerates onto a highway. It is within the skill of the art to program a microprocessor to record and analyze such daily patterns, and to adapt the control strategy accordingly. For example, in response to recognition of a regular pattern as above, the transition point might be adjusted to 60% of MTO; this would prevent repetitive engine starts as the road load exceeded 30% of MTO for a few hundred yards at a time, as might often occur in suburban traffic. Similarly, the engine starting routine might be initiated after the same total distance had been covered each day.

Severinsky





Quigley

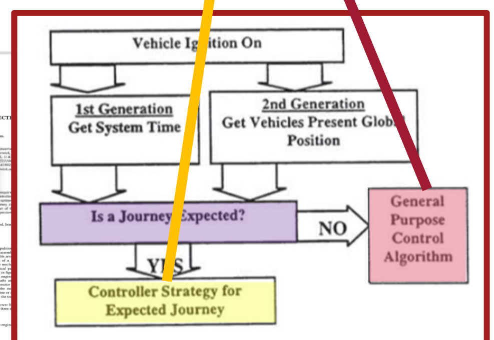
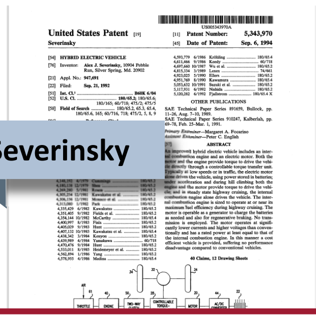


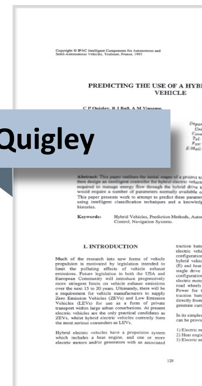
Figure 2. Decision Process of Where Am I Going?

Source: *E.g.*, Pet. at 29; Reply at 17; BMW1001 at 40:50-41:3; BMW1013 at Fig. 3; BMW1054 at Fig. 2; BMW1008 at ¶297; BMW1088 at ¶¶78-80.

Quigley Teaches Monitoring Signals Already Available in Hybrid Vehicles for Patterns To Optimize Control



Thus, at all times the microprocessor 48 may determine the load (if any) to be provided to the engine by the motor, responsive to the load imposed by the vehicle's propulsion requirements, so that the engine 40 can be operated in its most fuel efficient operating range.



As previously stated, the proposed controller will allow journey parameters to be reliably estimated upon journey departure. In order to do this the information available to the controller could take one of two forms:-

1st Generation Control

The essence of this type of control is that all information would only be available internally to the vehicle, from transducers belonging to the vehicle. A controller of this type, if implemented, would use signals derived from technology already present in modern day vehicles (e.g. electronic tachometer, engine management system).

Such information would include:-

a) Drivers Operational Inputs:- Throttle
Brake etc.
b) Time of day/year.
c) Engine Management Data:- Engine speed etc.
d) Road speed.

Abstract: This paper outlines the initial stages of a project to analyze the requirements and then design an intelligent controller for hybrid electric vehicles. Such a controller would be required to manage energy flow through the hybrid drive train and for optimum control would require a number of parameters normally available only upon journey completion. This paper presents work to attempt to predict these parameters at the start of the journey using intelligent classification techniques and a knowledge base of previous journey histories.

Source: *E.g.*, Pet. at 26-29; Reply at 13-22; BMW1008 at ¶¶294-98; BMW1088 at ¶¶72-98; BMW1013 at 17:11-15; BMW1054 at 129-30.

MONITORING PATTERNS

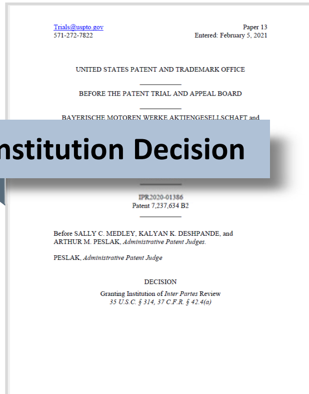
CLAIM 33 IS OBVIOUS OVER

SEVERINSKY + NII (GROUNDS 1, 4-9)

SEVERINSKY + QUIGLEY (GROUNDS 2, 4-9)

SEVERINSKY + GRAF (GROUNDS 3, 4-9)

Graf's Block 2 Teaches
"Monitor[ing] Patterns of Vehicle Operation Over Time"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Paper 13
Entered: February 5, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT and

IPR2020-01386
Patent 7,237,634 B2

Before SALLY C. MEDLEY, KALYAN K. DESHPANDE, and ARTHUR M. PESLAK, *Administrative Patent Judges.*

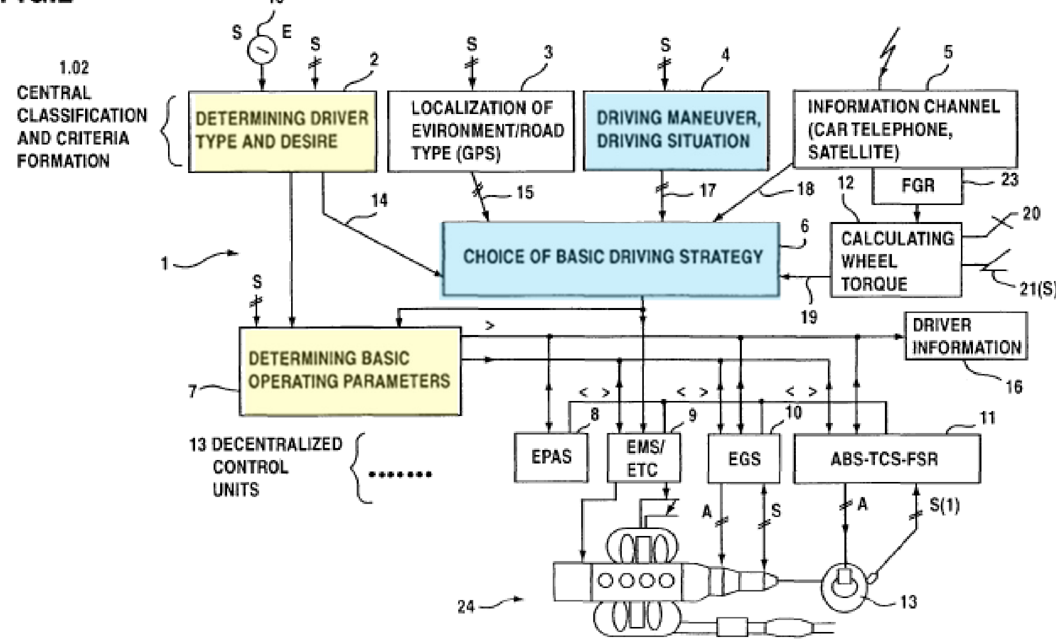
PESLAK, *Administrative Patent Judge*

DECISION
Granting Institution of *Inter Partes Review*
35 U.S.C. § 314; 37 C.F.R. § 42.4(a)

Institution Decision

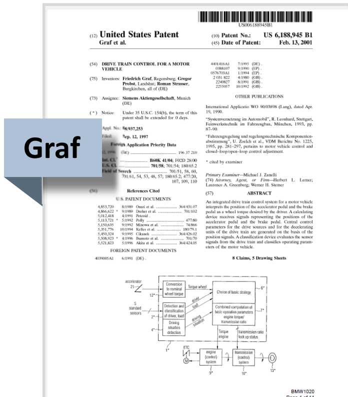
determined. Graf thus does not provide any explicit disclosure as to how the driving style of performance or economy modes is determined in Figure 2. Given that the signals from block 4 are sent to block 6, not block 2, it appears, based on the current record, that any monitoring of a driver's operation does not result in an input to block 2 where the determination of the driving style is made or that Graf monitors patterns of vehicle operation.

FIG.2



Source: *E.g.*, Pet. at 30-32; Reply at 22; ID at 45-46; BMW1020 at Fig. 2; BMW1008 at ¶¶300-06.

Graf's Block 2 Teaches *"Monitor[ing] Patterns of Vehicle Operation Over Time"*



Dr. Davis

The block (or circuit) 2 serves to determine the driver type, that is, to make a classification expressing a distinction between performance-oriented and economy modes. One example of such a function is described in European Patent Disclosure EP 0 576 703 A1. A signal characterizing the driving style of the driver is delivered to a basic driving strategy selector 6 via a line 14.

its operating parameters. (BMW1044 at 6:61-7:3). Farrall also discloses that it was known to implement "fuzzy rules" in a powertrain controller for a hybrid vehicle. (BMW1044 at 2:60-3:17). Those "fuzzy rules" can be "repeatedly modified" based on monitoring vehicle operation such as the "pedal movement value" and "engine speed" across a given interval. (BMW1044 at 4:58-5:31).

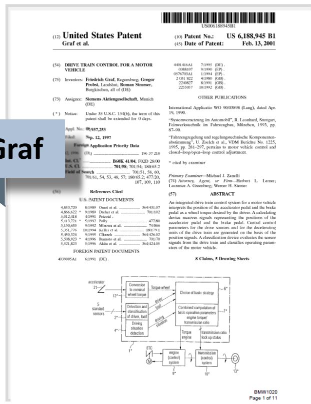
* * *

303. It is therefore my opinion that Graf discloses that it "*monitors a driver's repeated driving operations over time*" in order to "characteri[ze] the driving style of the driver." A skilled artisan would understand that this determination of driver "type" or driving "style" of Graf would be based on the monitoring of repetitive driver operation. That is the logical conclusion because, without monitoring or detecting a repeated driving operation by the driver over time, it would not have been possible to determine a driving *style*. For instance, if a brief instance of high lateral acceleration is detected, there would not be sufficient data to conclude that the driver has an aggressive or sporty style, as that brief acceleration may have been a short-term aberration due to road conditions.

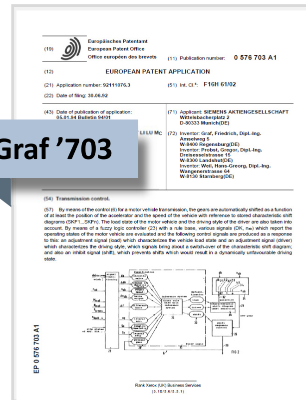
Source: *E.g.*, Pet. at 30-32; Reply at 22-24; BMW1020 at 5:36-42; BMW1008 at ¶¶117-22, 300-06; BMW1088 at ¶¶99-103.

Dr. Davis's Opinion Is Confirmed by European Graf Reference (Graf '703) Cited in Graf

Graf

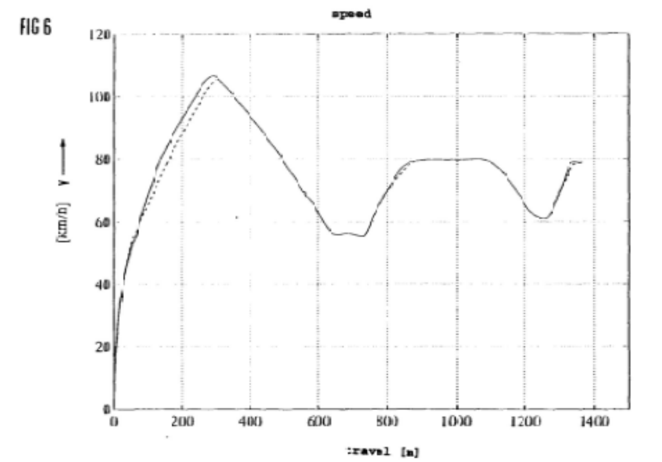


Graf '703



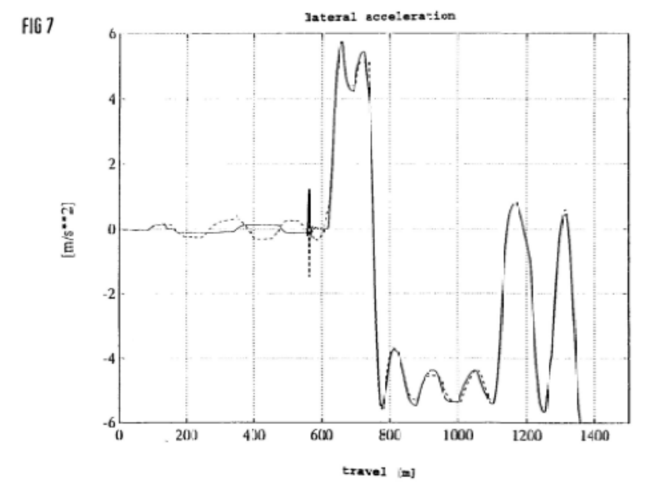
The block (or circuit) 2 serves to determine the driver type, that is, to make a classification expressing a distinction between performance-oriented and economy modes. One example of such a function is described in European Patent Disclosure EP 0 576 703 A1. A signal characterizing the driving style of the driver is delivered to a basic driving strategy selector 6 via a line 14.

FIG 6



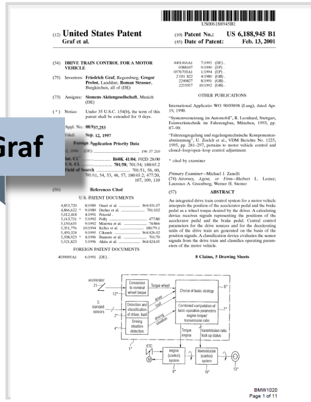
A sporty driver is detected in the case of high accelerator speed and high longitudinal acceleration.

FIG 7



Source: *E.g.*, Pet. at 30-32; Reply at 22-24; BMW1020 at 5:36-42; BMW1008 at ¶¶117-22, 300-06; BMW1088 at ¶¶99-103; BMW1090 at 6:13-26, 8:32-9:10, 10:3-9, 13:14-15, Figs. 6, 7.

Graf Adjusts "Individual Operating Points" at Which Engine and/or Motor Will Be Operated in Hybrid Vehicle Based on Driver Type



Graf

In accordance with another feature of the invention, the calculating device defines a type of drive source of the motor vehicle. Where the engine is a hybrid drive, the calculating device defines and adjusts individual operating points of the hybrid drive.

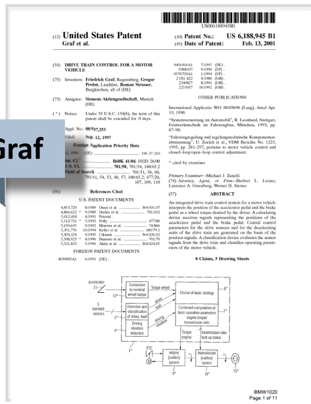
5. The drive train control system according to claim **1**, wherein the engine is a hybrid drive, and said calculating device is programmed to define and adjust individual operating points of the hybrid drive.

Dr. Davis

306. A skilled artisan would have understood that Graf's "drive type and in the case of a hybrid drive its individual operating points" refer to the points at which the engine or the motor (or both) are operated, and are expressed in terms of the "torque required to propel the vehicle." It is therefore my opinion that Graf discloses using a controller to "*monitor a driver's driving operations over time and varying the SP accordingly*" (i.e., to vary the engine's operating point based on the evaluated driver type characterization).

Source: *E.g.*, Pet. at 34; Reply at 22-24; BMW1020 at 2:20-24, Claim 5; BMW1008 at ¶¶300-06.

Graf Explicitly Describes a Hybrid Vehicle, Contradicting PO's Arguments Against Combining Graf's Teachings With Severinsky



> In accordance with another feature of the invention, the calculating device defines a type of drive source of the motor vehicle. Where the engine is a hybrid drive, the calculating device defines and adjusts individual operating points of the hybrid drive.

> The individual components of the drive train itself are shown toward the bottom of FIG. **2** and will not be explained further here because they are well known. In the case of a hybrid drive—that is, an internal combustion engine combined with an electric motor—the former is coupled to an electric motor and a generator G. One such hybrid drive is known, for instance, from VDI-Bericht [VDI Report; VDI= Association of German Engineers] No. 1225, 1995, pp. 281, 297.

> **5**. The drive train control system according to claim **1**, wherein the engine is a hybrid drive, and said calculating device is programmed to define and adjust individual operating points of the hybrid drive.

Source: *E.g.*, Pet. at 30-35; Reply at 24; BMW1020 at 2:20-24, 4:41-49, Claim 5; BMW1008 at ¶¶300-14.

TURBOCHARGER

CLAIM 49 IS OBVIOUS OVER
SEVERINSKY + (NII, QUIGLEY, OR GRAF) + MA (GROUND 7)

CLAIM 105 IS OBVIOUS OVER
SEVERINSKY + FRANK + MA (GROUND 10)

CLAIM 188 IS OBVIOUS OVER
SEVERINSKY + MA (GROUNDS 11-14)

Claims 49, 105, and 188 Tack On Well-Known "*Turbocharger*" Functionality Even Broader Than in '347 Patent

'634 Patent

188. A method for controlling a hybrid vehicle, comprising:

determining instantaneous road load (RL) required to propel the hybrid vehicle responsive to an operator command;

operating at least one electric motor to propel the hybrid vehicle when the RL required to do so is less than a setpoint (SP);

operating an internal combustion engine of the hybrid vehicle to propel the hybrid vehicle when the RL required to do so is between the SP and a maximum torque output (MTO) of the engine, wherein the engine is operable to efficiently produce torque above the SP, and wherein the SP is substantially less than the MTO; and

operating both the at least one electric motor and the engine to propel the hybrid vehicle when the torque RL required to do so is more than the MTO; and

operating a turbocharger controllably coupled to the engine to increase the MTO of the engine when desired.

'347 Patent

1. A hybrid vehicle, comprising:

7. The vehicle of claim **1**, wherein said vehicle is operated in a plurality of operating modes responsive to the value for the road load (RL) and said setpoint SP, both expressed as percentages of the maximum torque output of the engine when normally-aspirated (MTO), and said operating modes include:

a low-load mode I, wherein said vehicle is propelled by torque provided by said second electric motor in response to energy supplied from said battery, while RL<SP,

a highway cruising mode IV, wherein said vehicle is propelled by torque provided by said internal combustion engine, while SP<RL<MTO, and

an acceleration mode V, wherein said vehicle is propelled by torque provided by said internal combustion engine and by torque provided by either or both electric motor(s) in response to energy supplied from said battery, while RL>MTO.

11. The vehicle of claim **7**, further comprising a turbocharger operatively and controllably coupled to said internal combustion engine for being operated and thereby increasing the maximum torque output of said internal combustion engine to more than MTO when desired, and wherein said controller controls selection of the operational mode of said vehicle between a low-load mode I, a cruising mode IV, an acceleration mode V, and a sustained high-power turbocharged mode VI, in response to monitoring the instantaneous torque requirements (RL) of the vehicle over time.

Source: *E.g.*, Pet. at 2-3, 9-11; ID at 28-29; *e.g.*, BMW1001 at Claims 49, 105, 188; U.S. Patent No. 7,104,347 at Claims 11, 33.

Patent Owners No Longer Dispute That Supposedly Novel Portion of Claimed "Turbocharger" Limitations Was Well-Known

'634 Patent

49. The method of claim **33**, wherein the hybrid vehicle further comprises a turbocharger controllably coupled to the engine, wherein the method further comprises:
operating the turbocharger to increase the MTO of the engine when desired.

Institution Decision

Patent Owner's second contention is that Severinsky and Ma do not teach or suggest the limitation of claim 49 the "turbocharger controllably coupled to the engine." *Id.* at 59. Patent Owner contends that the Petition

* * *

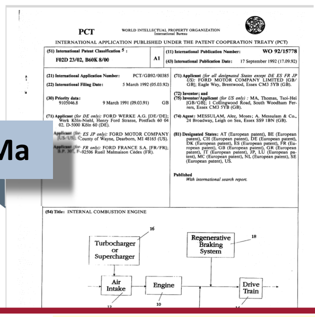
electric motor 20 is brought into operation." Ex. 1021, 7:27–30. Based on the present record, we discern no material difference between the disclosure of Ma and the '634 Patent relating to the question of whether the turbocharger is controllably coupled to the engine.

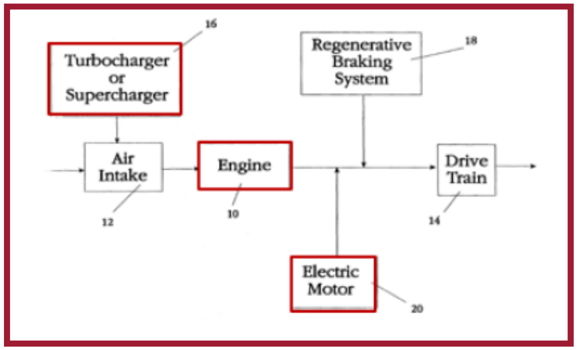
POR

Source: *E.g.*, BMW1001 at Claims 49, 105, 188; Pet. at 55-57; BMW1008 at ¶¶517-23; ID at 50-52; POPR at 4, 53-63; POR at 56-71.

Ma Expressly Contradicts POs' Argument That POSA Would Not Use Turbocharger with Electric Motor To Supplement Engine MTO

Ma





In one embodiment of the invention, the means for supplementing the total output torque include means for increasing the air mass trapped in the cylinders as compared with the mass of air trapped in a naturally aspirated engine. A turbocharger or supercharger may be used for this purpose.

In a second embodiment of the invention, the means for supplementing the total output torque include an electric motor driven by a battery which is charged by the engine during idling and cruising conditions.

In a further embodiment, the means for supplementing the total output torque include an inertial flywheel which is accelerated by the vehicle drive train during braking of the vehicle and/or by its own electric motor.

Of course, more than one source of supplementary torque may be used, for example regenerative braking may be used in conjunction with a supercharger.

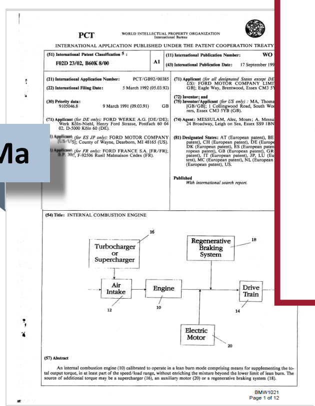
"torque is augmented by bringing any one or more of the supplementary sources … into operation"

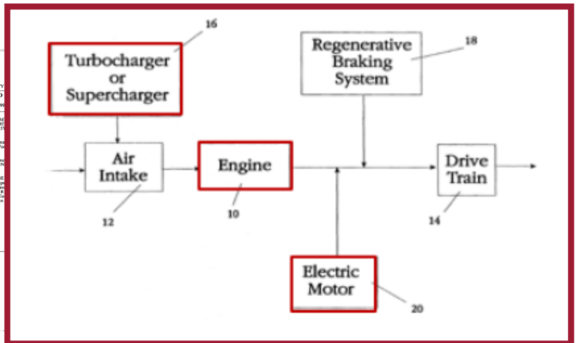
A control system within the engine 10 determines the fuel to air ratio at all times and which, if any of the turbocharger 16, the regenerative braking system 18 and the electric motor 20 is brought into operation. Under normal driving condition in idle and part load operation, the engine is set for lean burn operation. During the higher load regions of the statutory drive cycle, lean burn is maintained and torque is augmented by bringing any one or more of the supplementary sources of torque 16, 18 and 20 into operation. In this way, NO_x emissions remain low yet vehicle drivability and output torque remain acceptable.

Source: *E.g.*, BMW1021 at Fig. 1, 5:10-29, 7:11-37; Pet. at 55-58; Reply at 25-26; ID at 50; BMW1008 at ¶520; BMW1088 at ¶104.

Dr. Shahbakhti Conceded as Much, Despite Having Trouble Understanding Ma

Ma





Dr. Shahbakhti

Q. And that figure shows an architecture, including a turbocharger, an engine, an electric motor, and a regenerative braking system, all on the drivetrain. Is that right?

A. Yeah, it shows the engine, turbocharger, originally with the braking system and electric motor. And then it shows that they are linked by arrow to the drivetrain.

* * *

Q. Ma discloses that the electric motor operates in parallel with the turbocharged engine and the regenerative braking system. Is that right?

* * *

A. There are parts that -- in Ma that it's hard to understand and does not make sense. For example, on page 5 of PDF, on line

Source: *E.g.*, BMW1021 at Fig. 1; Pet. at 55-58; Reply at 26; BMW1089 at 148:23-149:24.

Severinsky and Ma Interrelatedly Concern Hybrid Vehicle Control To Maximize Engine Efficiency Through Supplemental Torque Sources, Providing a Motivation To Combine

Dr. Davis

519. Ma teaches that its invention is desirable "from the point of view of reducing fuel consumption." (BMW1021 at 1:30–34). Recognizing, however, that the problem with efficient engine operation is that "the engine lacks power," Ma describes an engine "in which performance and drivability are not seriously impaired." (BMW1021 at 2:1–2, 2:34–37). Like in Severinsky '970, Ma teaches that the total output torque can be supplemented with "an electric motor driven by a battery which is charged by the engine during idling and cruising conditions." (BMW1021 at 3:16–20).

Source: *E.g.*, Pet. at 57-58; Reply at 25; BMW1008 at ¶¶516-28; BMW1088 at ¶123.

A POSA Would Have Been Motivated to Add a Turbocharger To Improve Engine's Efficiency

Dr. Davis

108. Furthermore, there is no uncertainty as to my opinion that adding a turbocharger to Severinsky's hybrid vehicle would result in such efficiencies, despite Dr. Shahbakhti's suggestion to the contrary. (Shahbakhti Decl. at ¶ 133.) In fact, it was widely understood that the use of a turbocharger would improve engine fuel efficiency, in both diesel and spark-ignited (gasoline) engines, as I discussed in my First Declaration. (BMW1008 at ¶¶ 126-28.) For example, the Bosch reference I had previously cited expressly identifies increased fuel efficiency as one of the benefits of turbocharging in automotive engines:

> **Advantages of exhaust-gas turbocharging:**
>
> Considerable increase in specific output from a given configuration; enhanced torque within the effective engine-speed range; **significant improvement in fuel consumption relative to engines of equal output with atmospheric induction**; improvement in exhaust gas emissions.

(Bosch (BMW1093) at 381 (emphasis added).)

109. A person of ordinary skill would have understood that this improvement in fuel consumption for a vehicle would be due not only to the increase in peak engine fuel efficiency that can occur when using a turbocharger, but also due to the engine's resulting larger operating range at improved efficiency.

Source: *E.g.*, Pet. at 57-58; Reply at 25-30; BMW1008 at ¶¶524-28; BMW1088 at ¶¶105-28.

Benefits of Adding Turbocharger Would Not Have Been Redundant of Severinsky's Electric Motor

Institution Decision

Patent Owner's first contention is that Petitioner's proposed combination of Severinsky and Ma lacks an articulated reasoning with a rational underpinning because, according to Patent Owner, "Severinsky already discloses a solution for supplementing a small engine with additional torque from an external source when the demanded torque is greater than MTO." Prelim. Resp. 53–55. Patent Owner contends that the electric motor in Severinsky's parallel hybrid architecture provides the same alleged benefit as Ma's turbocharger and "the Petition is silent as to why a POSA would be motivated to include both a turbocharger and an electric motor to perform the same task." *Id.* at 54–56 (citing Ex. 1013, 8:52–9:55; Ex. 1021,

* * *

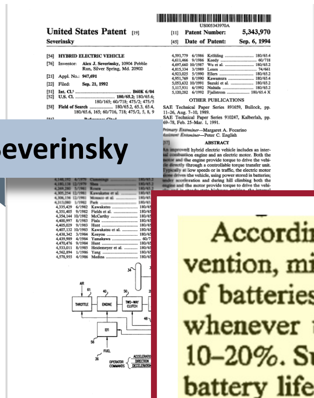
Consequently, based on the evidence and arguments presented in the Petition and after consideration of Patent Owner's contentions, we determine that Petitioner has sufficiently established a reasonable likelihood that claim 49 is unpatentable over Severinsky, Nii, and Ma. As to the combination of

Reply

PO also disputes that a POSA would have combined Ma's turbocharger by repeating its failed argument that "the alleged benefits are redundant." (POR, 57-60; ID, 49-50.) Not so. A POSA would have recognized that a turbocharger would "provide better engine efficiency" (and "improved fuel economy"), "allow[] a smaller engine to be used," and "help preserve battery charge." (Pet., 58; BMW1008, ¶¶525-26.) Each of these considerations would have provided additional motivation to combine the references as claimed. *See ZUP*, 896 F.3d at 1371 (identifying explicit and implicit bases for a motivation to combine).

Source: *E.g.*, ID at 49-52; Pet. at 57-58; Reply at 26-30; BMW1008 at ¶¶524-28; BMW1088 at ¶¶105-25.

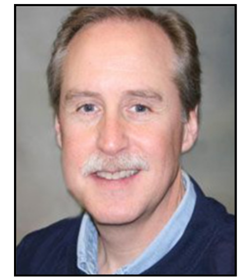
POSA Would Have Been Motivated To Add Turbocharger and Use It in Sustained Periods of High-Power Use To Preserve Battery Charge



Severinsky

According to a preferred implementation of the invention, microprocessor **48** monitors the state of charge of batteries **22** via line **66** and recharges the batteries whenever the charge is depleted by more than about 10–20%. Such frequent light charges result in improved battery life as compared to regularly allowing the batteries to be nearly fully discharged, followed by a lengthy recharge period, as is necessary in operation of entirely electric vehicles. Under conditions of maximum battery usage, e.g., in heavy traffic, the duty cycle of the internal combustion engine for battery charging is 10–20%; that is, in traffic, internal combustion engine **40** charges the battery perhaps once per hour for a period of approximately twelve minutes.

It is within the scope of the invention to operate the engine **40** outside its most fuel efficient operating range, on occasion. For example, if the torque transfer unit does not provide a limited-slip mode of operation the combined load of low-speed vehicle operation in traffic together with battery charging may be less then the minimum power produced by the engine in its most efficient operating range. In these circumstances, it is preferable to use the engine somewhat inefficiently rather than to discharge the batteries excessively, which would substantially reduce the battery lifetime.



Dr. Davis

526. As I explained above, the use of the turbocharger can provide higher engine efficiency while providing torque in excess of the engine's MTO, resulting in better fuel economy during this engine operating condition. (*See supra*, §§ IV.E.). A skilled artisan would have been particularly motivated to achieve these efficiency benefits during extended periods of driving under circumstances when the amount of instantaneous torque required to propel the vehicle exceeds the engine's MTO. Using a turbocharger to provide additional torque during such extended periods of high power usage would also help preserve battery charge, by taking some of the torque generation burden away from the motor as well.

Source: *E.g.*, BMW1013 at 6:19-26, 11:27-34, 18:9-33; Pet. at 57-58; Reply at 28-29; BMW1008 at ¶¶524-28; BMW1088 at ¶¶121-28.

Petitioners’
Oral Argument Demonstratives

Bayerische Motoren Werke Aktiengesellschaft &
BMW of North America, LLC,
Petitioners
v.
Paice LLC & The Abell Foundation, Inc.,
Patent Owners

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