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DECLARATION OF DR. NIKOLAOS PAPANIKOLOPOULOS

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I. QUALIFICATIONS AND BACKGROUND

1. My name is Nikolaos Papanikolopoulos and I have been retained as an expert witness by Tesla in a petition for *inter partes review* challenging the claims of U.S. Patent No. 8,972,161. My qualifications for forming these conclusions are summarized below and additional details are provided in my CV.

2. I am the McKnight Presidential Endowed Professor and Distinguished McKnight University Professor in the Department of Computer Science and Engineering of the University of Minnesota in Minneapolis, Minnesota. I am also the Director for the Minnesota Robotics Institute.

3. I have been a professor at the University of Minnesota (originally as an assistant professor, and then as an associate professor) since the Fall of 1992. Between Fall 2001 and Spring 2004, and between Fall 2010 and Spring 2013, I was the Director of Undergraduate Studies of the College of Science and Engineering.

4. In 1992, I received my Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University. My thesis was entitled “Controlled Active Vision” and focused on using computer vision in a controlled fashion to detect, track, and manipulate objects in the environment. In 1988, I received my M.S. in Electri-

cal and Computer Engineering from Carnegie Mellon University. My B.S. in Electrical Engineering was received in 1987 from the National Technical University in Athens, Greece.

5. For over thirty years, my research and teaching work has focused on intelligent vehicles, computer vision, and robotics. This research has included detection and tracking of humans and objects such as vehicles using information from stationary or moving cameras. It has also included object detection and recognition including work with artificial intelligence and pattern recognition systems for surveillance applications. Finally, my research involved using the sensory information to control the motion of vehicles in real-time.

6. I currently teach three courses related to intelligent vehicles: (i) CSci 5551 Introduction to Intelligent Robotic Systems, (ii) CSci 5561 Computer Vision, and (iii) CSci 5511 Artificial Intelligence.

7. I am currently serving as a Senior Editor in the IEEE Transactions on Intelligent Transportation Systems with responsibility in assigning papers to Associate Editors based on their expertise. I was Associate Editor in the same journal for twelve years.

8. I have received research grants for various projects involving the transportation industry, including vehicle tracking, assessing truck parking, detection of pedestrians, and obstacle avoidance. My industry experience includes

founding a robotics company in 2005 named ReconRobotics Inc. that develops different robotic platforms. I have also been a consultant since 1997 for numerous companies and provided technical expertise in developing computer vision algorithms for vehicle tracking and traffic control, camera calibration, inspection, precision agriculture, human tracking, object recognition, and fingerprint recognition. In one of my consulting assignments, I had to develop computer vision algorithms for inspection of industrial parts by using different illumination sources (Banner Engineering). I have licensed my algorithms to several companies.

9. My research has produced more than 380 journal and conference publications. More than 90 publications are in refereed journals. Many of my publications and research grants relate to vehicle technologies. Some examples include:

Wang, Z., and Papanikolopoulos, N., “Estimating Pedestrian Crossing States Based on Single 2D Body Pose”, Proceedings of the 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS '20), pp 2205-2210, Las Vegas, NV, October 25-29, 2020.

Zermas, D., Izzat, I., and Papanikolopoulos, N., “Fast Segmentation of 3D Point Clouds: A Paradigm on LiDAR Data for Autonomous Vehicle Applications”, Proceedings of the 2017 IEEE Int. Conference on Robotics and Automation, pp 5067-5073, Singapore, May 29 – June 3, 2017.

Cook, D., Morris, T., Morellas, V., and Papanikolopoulos, N., “An Automated System for Persistent Real-Time Truck Parking Detection and Information Dissemination”, *Proceedings of the 2014 IEEE Int. Conference on Robotics and Automation*, Hong Kong, China, May 31 – June 7, 2014, PP. 3989-3994.

Atev, S., Miller, G., and Papanikolopoulos, N.P., "Clustering of Vehicle Trajectories", *IEEE Trans. on Intelligent Transportation Systems*, Volume 11, No. 3, September 2010, PP. 647-657.

Atev, S., Arumugam, H., Masoud, O., Janardan, R., and Papanikolopoulos, N.P., "A Vision-Based Approach to Collision Prediction at Traffic Intersections", *IEEE Trans. on Intelligent Transportation Systems*, Volume 6, No. 4, December 2005, PP. 416-423.

Masoud, O., and Papanikolopoulos, N.P., "A Novel Method for Tracking and Counting Pedestrians in Real-time Using a Single Camera", *IEEE Trans. on Vehicular Technology*, Volume 50, No. 5, September 2001, PP. 1267-1278.

Du, Y., and Papanikolopoulos, N.P., "Real-time Vehicle Following Through a Novel Symmetry-Based Approach", *Proceedings of the 1997 IEEE Int. Conf. on Robotics and Automation*, PP. 3160-3165, Albuquerque, NM, April 20-25, 1997.

10. My work in vehicle detection and tracking has focused on using image and video processing techniques, including object detection, tracking, and recognition, to accurately track vehicles in real-time. These algorithms have been applied to different scenarios, such as urban traffic monitoring and surveillance. Moreover, machine learning techniques have helped in the improvement of these methodologies.

11. My research also involved tracking autonomous vehicles. My interests include developing tracking algorithms and systems that can handle the complexities of autonomous vehicles, including predicting their future movements and understanding their intentions. The work has been extended to monitor the intentions of pedestrians.

12. These vehicle tracking systems enable continuous monitoring and tracking of vehicles, providing valuable information for traffic control and management, law enforcement, and security purposes.

13. My paper “Detection and Classification of Vehicles,” published in the IEEE Transactions on Intelligent Transportation Systems in March 2002, is one of the most cited papers in the history of this journal (more than a thousand citations). The paper, among other contributions, shows how to use detected headlights and taillights to extract vehicles from videos and images in low-light conditions. One should note that the majority of my papers in the broader area of intelligent vehicle systems dealt with the detection of vehicles, pedestrians, trucks, etc., by using a variety of techniques which were mainly based on computer vision. I also have nine patents in pertinent areas.

14. My research work has been funded by several government agencies. For example, I have received funding from the Department of Homeland Security to monitor threats at Mass Transit Sites, like the 30th Street Station in Philadelphia, PA, and the Light Rail Station in the Minneapolis-Saint Paul International Airport. Monitoring parked vehicles was an essential task for which we developed a variety of computer vision algorithms and tools.

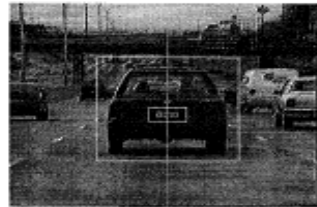
15. For more than a decade, I have been developing computer vision-based systems to assess truck parking availability at truck rest areas. The funding

came from Federal Highway Administration (FHWA), Minnesota Dept. of Transportation (MnDOT), Wisconsin Dept. of Transportation (WiscDOT), and Kansas Dept. of Transportation (KansasDOT). The approach uses multiple cameras to detect trucks and other vehicles and determine empty spaces. The system operates in all weather conditions around the clock.

16. I have received numerous honors and awards for my research and contributions. I have been a Distinguished McKnight University Professor at the University of Minnesota since 2007 and have been a McKnight Presidential Endowed Professor in Computer Science since 2016. Also in 2007, I was nominated and became an IEEE Fellow. In 2016, I received the IEEE RAS George Saridis Leadership Award in Robotics and Automation as well as the Center for Transportation Studies Research Partnership Award. I have also received the IEEE VTS 2001 Best Land Transportation Paper Award for the paper “A Novel Method for Tracking and Counting Pedestrians in Real-Time Using a Single Camera” (with Osama Masoud).

17. The figures below show the detection and tracking of a vehicle by a camera mounted in a car that follows a target vehicle. These figures are from a paper that I had published in 1997: Du, Y., and Papanikolopoulos, N.P., “Real-time Vehicle Following Through a Novel Symmetry-Based Approach,” *Proceedings of*

the 1997 IEEE Int. Conf. on Robotics and Automation, PP 3160-3165, Albuquerque, NM, April 20-25, 1997.



(a)



(b)



(c)



(d)

Fig. 2 A sequence of images processed by the symmetry-based scheme in real-time

18. I have also worked in the use of sensors to monitor driver fatigue. I developed a computer vision-based system that analyzes facial features and eye movements to detect signs of drowsiness and driver fatigue. By monitoring factors such as eye closure, head pose, and blink patterns, the system can alert drivers

when they show signs of fatigue and suggest appropriate actions (this research took place in the late 90s). The proposed algorithms and systems considered the continuously evolving light conditions that vehicular systems operate within.

19. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the relevant field(s); my experience in teaching subjects in these field(s); and my experience in working with others involved in those fields. In addition, I have analyzed the following publications and materials, in addition to other materials I cite in my Declaration:

- TESLA-1001 U.S. Patent No. 8,972,161 (“the ’161 Patent”) and its accompanying prosecution history (TESLA-1002)
- TESLA-1005 U.S. Pat. Pub. No. 2004/0068359 (“Neiss”)
- TESLA-1006 U.S. Patent No. 6,161,072 (“Clapper”)
- TESLA-1007 W. C. Morchin, “Energy management in hybrid electric vehicles,” 17th DASC. AIAA/IEEE/SAE. Digital Avionics Systems Conference. Proceedings, Bellevue, WA, USA, 1998, pp. I41/1-I41/6 vol.2 (“Morchin”)
- TESLA-1008 U.S. Patent No. 6,658,344 (“Hirasago”)
- TESLA-1009 U.S. Patent No. 6,005,494 (“Schramm”)
- TESLA-1011 U.S. Patent No. 6,836,719 (“Andersson”)

- TESLA-1012 U.S. Patent No. 5,584,208 (“Ha”)
- TESLA-1013 U.S. Patent No. 5,129,475 (“Kawano”)
- TESLA-1014 U.S. Patent No. 4,225,007 (“Voges”)
- TESLA-1015 Excerpt from Random House Webster’s Unabridged Dictionary, Second Edition (2001)
- TESLA-1016 Excerpt from Collins English Dictionary Complete and Unabridged, sixth edition (2003)
- TESLA-1017 Excerpt from The New Oxford American Dictionary (2001)
- TESLA-1018 U.S. Patent No. 8,271,166 (“Wolf”)
- TESLA-1019 Japanese Patent Pub. No. 11220807 (“Hosoda Original”)
- TESLA-1020 Certified Translation of Japanese Patent Pub. No. 11220807 (“Hosoda”) (all cites to Hosoda are to this certified translation)
- TESLA-1021 U.S. Patent No. 6,314,347 (“Kuroda”)
- TESLA-1022 U.S. Patent No. 7,013,205 (“Hafner”)

II. LEGAL PRINCIPLES

A. Anticipation

20. I have been informed that a patent claim is invalid as anticipated under 35 U.S.C. § 102 if each and every element of a claim, as properly construed, is found either explicitly or inherently in a single prior art reference. Under the principles of inherency, if the prior art necessarily functions in accordance with, or includes the claimed limitations, it anticipates.

21. I have been informed that a claim is invalid under 35 U.S.C. § 102(a) if the claimed invention was known or used by others in the U.S., or was patented or published anywhere, before the applicant's invention. I further have been informed that a claim is invalid under 35 U.S.C. § 102(b) if the invention was patented or published anywhere, or was in public use, on sale, or offered for sale in this country, more than one year prior to the filing date of the patent application (Critical Date). And a claim is invalid, as I have been informed, under 35 U.S.C. § 102(e), if an invention described by that claim was described in a U.S. patent granted on an application for a patent by another that was filed in the U.S. before the date of invention for such a claim.

B. Obviousness

22. I have been informed that a patent claim is invalid as "obvious" under 35 U.S.C. § 103 in light of one or more prior art references if it would have been

obvious to a POSITA, taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness, which include: (i) “long felt need” for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others. For purposes of my analysis above and because I know of no indication from the patent owner or others to the contrary, I have applied a date of November 17, 2005, as the date of invention in my obviousness analyses, although in many cases the same analysis would hold true even at an earlier time than November 17, 2005.

23. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason to modify the single prior art reference, or combine two or more references, in order to achieve the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference or references themselves, the knowledge or “common sense” of one skilled in the art, or from the nature of the problem to be solved, and may be explicit or implicit from the prior art as a whole. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more

than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

III. OVERVIEW OF CONCLUSIONS FORMED

24. This expert Declaration explains the conclusions that I have formed based on my analysis. To summary those conclusions:

- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1-3, 5-6, 8-15, and 17-18 are obvious over Neiss;
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claim 4 is obvious over Neiss and Hirasago; and
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1, 3, 6-10, 12-13, 15-18 are obvious over Schramm and Clapper.

IV. BACKGROUND KNOWLEDGE ONE OF SKILL IN THE ART WOULD HAVE HAD PRIOR TO THE PRIORITY DATE OF THE '161 PATENT

25. Based on the foregoing and upon my experience in this area, a person of ordinary skill in the art ("POSITA") relating to the subject matter of the '161

Patent as of November 17, 2005 (“Critical Date”) would have had a bachelor’s degree in electrical engineering, computer engineering, mechanical engineering (including automotive engineering), civil engineering (transportation systems), physics, or a related field, and at least four years of experience (or the academic equivalent) in the field of transportation systems. Additional graduate education could substitute for professional experience, and vice versa.

26. Based on my experiences, I have a good understanding of the capabilities of a POSITA as I possessed and exceeded qualifications of a POSITA at the time of the Critical Date. Moreover, I have taught, participated in organizations with, and worked closely with many such persons over the course of my career.

V. INTERPRETATIONS OF THE ’161 PATENT CLAIMS AT ISSUE

27. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent’s history of examination before the Patent Office. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill

at the time of the invention was made (not today). I have been informed by Counsel that I should use November 17, 2005 as the point in time for claim interpretation purposes.

VI. OVERVIEW OF THE '161 PATENT

28. The '161 Patent relates generally to “determin[ing] the optimal speeds to drive throughout” a route to a specified destination. TESLA-1001, 3:18-20. In more detail, the claims are directed to a method of managing a vehicle’s power consumption that involves calculating energy values consumed by a vehicle to travel a route based on a plurality of variations in a target speed of the vehicle between pairs of segment destinations. *Id.*, 26:20-23. The claimed method involves determining a plurality of efficient speeds that achieve a best summation of said energy values. *Id.*, 26:24-25. An operator of the vehicle is notified about these efficient speeds (claim 1), or power corresponding to the efficient speeds is applied to an engine of the vehicle (claim 10).

29. The '161 Patent is generally in the field of vehicle navigation, for instance, because it relates to determining vehicle speeds for navigation along a route, *e.g.*, to solve the problem of how to control of vehicle operation along a route. *See* TESLA-1001, 14:14-19 (“The power required by the vehicle to travel along a route, or a segment of the route, may be estimated or calculated, and this

calculation may be used to determine a calculated speed for the vehicle so that the power usage is optimized or minimized”), 14:25-28 (“the speed(s) that the vehicle travels the route (or a segment of the route) can be optimized”), 14:28-32 (“the simulation could determine the most energy efficient speed for the vehicle to travel over one or more segments by minimizing the power requirement for the vehicle while allowing the speed to vary within the range of acceptable speeds”). I note that the ’161 Patent was allowed with no prior art rejection.

VII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. [GROUND 1A] – Claims 1-3, 5-6, 8-15, and 17-18 are rendered obvious by Neiss

1. Overview of Neiss¹ (TESLA-1005)

30. Neiss describes a “predictive cruise control system [that] utilizes information about the current vehicle position, as well as upcoming terrain... to save fuel and increase driving comfort.” TESLA-1005, Abstract.

31. Generally, Neiss’s cruise control system uses “[f]orward-looking terrain information ... to determine, as a function of position, a desired speed inside [a] speed band ... to maximize fuel savings.” *Id.*, Abstract, ¶[0031]. For instance,

¹ All emphasis is added unless otherwise indicated.

with reference to Figure 2, shown below, a vehicle implementing Neiss's predictive cruise control may “slow[] down as it moves uphill until it reaches a minimum speed on top of the hill, and regains speed on the downhill part, thus completely converting the potential energy into kinetic energy.” *Id.*, ¶[0031].

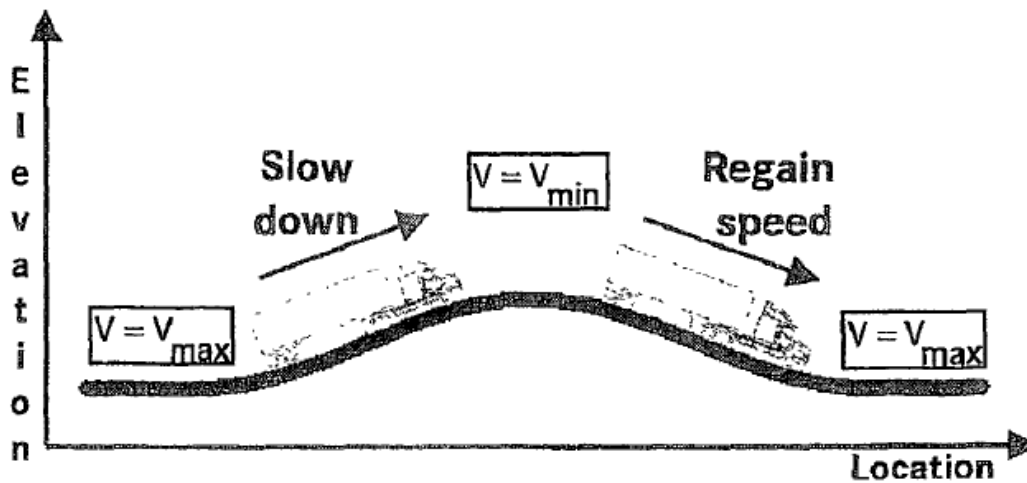


Fig. 2

TESLA-1005, FIG. 2

32. Neiss's cruise control unit aims to “minimize[] vehicle operating costs” by optimizing “a vehicle operating cost function” that is defined based on “environmental parameters, vehicle parameters, vehicle operating parameters[,], and route parameters.” *Id.*, ¶¶[0001], [0015]. “As the vehicle proceeds” along its route, “an onboard computer iteratively calculates and stores in a memory vehicle control parameters that optimize the vehicle operating cost function for a predeter-

mined distance ... along the route ahead of the vehicle.” *Id.*, ¶[0015]. “The vehicle is then controlled by reading the optimized vehicle control parameters from the memory, corresponding to the current position of the vehicle.” *Id.*

33. Neiss describes an optimization problem with a cost function (J) that depends on multiple subfunctions including fuel consumption (J_{fuel}). Before the Critical Date, a POSITA would have known that optimization involves computing values for these variables that minimize the overall cost function, and that this formulation can incorporate constraints regarding these variables (e.g., an upper limit” and “a lower limit” for the vehicle’s velocity) through the use of mathematical constructs, like Lagrange multipliers. *See also* TESLA-1005, ¶¶[0136]-[0160], [0088], [0092]-[0104], [0126], claims 8-9, 12.

34. A POSITA would have also recognized that Neiss discloses in the equation below factors that play a role in the computation of the total cost:

$$J = J_{\Phi} + J_{time} + J_{fuel} + J_{velocity} + J_{lateral \text{ ---} accel} + J_{penalty}$$

Id., ¶¶[0088], [0126]. For example, this formulation uses an overall “cost function” (represented as J) that is defined mathematically (as shown in the equation above) to reflect one or more objectives, including “consum[ing] less fuel” and “activat[ing] the brakes as little as possible” (represented as J_{fuel}), “maintain[ing] a specified velocity (Set Speed)” (represented as $J_{velocity}$), maintaining the “vehicle’s

velocity” between “an upper limit” and “a lower limit” (represented as $J_{penalty}$), minimizing “travel time” (represented as J_{time}), and/or reducing “lateral acceleration while driving in curves” so as not “to impair driving comfort and safety” (represented as $J_{lateral_accel}$). See TESLA-1005, ¶¶[0082]-[0126]. Combining all these individual costs to a total cost that depends on all these variables is an extensively researched process which has as an objective total cost that captures all the variables that may play a role for the underlying optimization task. J is a total cost which is expressed as a function of variables that the user can optimize through an optimization technique. See *id.*

35. A POSITA would have known how to select and apply a technique like gradient descent, linear programming, etc. to find the values of the variables that minimize the overall cost function while the constraints are satisfied. Furthermore, reducing one cost through changes in the value of the corresponding variable may impact another cost. Optimization is often described as a balancing act where different tradeoffs need to be considered. It should be noted that the optimization techniques often include iterative steps to continuously adjust the values of the variables so lower individual costs can be achieved. A POSITA would have known that neural networks, simulated annealing and other techniques could have been used to find the optimal values that minimize the aforementioned total cost.

36. Additionally, as mentioned above and in one example, Neiss describes this “vehicle operating cost function” (J) including an objective defined to minimize fuel consumption (represented as J_{fuel}), which Neiss mathematically expresses as follows:

$$J_{fuel} = \frac{1}{2} \cdot h \cdot \sum_{k=0}^{N-1} S \psi v_k t h_k^2, \quad (\text{Eq. 18})$$

Id., ¶¶[0081]-[0082], [0097]-[0098]. This equation represents “a function of [at least] vehicle speed, road gradient[,] and throttle position” at points along the route ahead of the vehicle. *Id.*, ¶¶[0097]-[0098], Claims 10-11; *see id.*, ¶[0162]. Neiss thus describes an optimization problem with a cost function that depends on multiple subfunctions including fuel consumption (J_{fuel}).

37. A POSITA would have known that neural networks, simulated annealing and other techniques could have been used to find the optimal values that minimize the aforementioned total cost.

38. The “Prediction Horizon” is “a predetermined distance ... along the route ahead of the vehicle.” *Id.*, ¶[0015]. As illustrated in Figure 10, shown below, the “Prediction Horizon” along the route ahead of the vehicle “is separated into Frames.” *Id.*, ¶[0170]. Each frame corresponds to “a specified distance” to be covered by the vehicle and is composed of a number of integration steps h . *Id.*,

¶¶[0169]-[0170] (“the Prediction Horizon must be a multiple of the Frame Length (also measured in number of integration steps h)”).

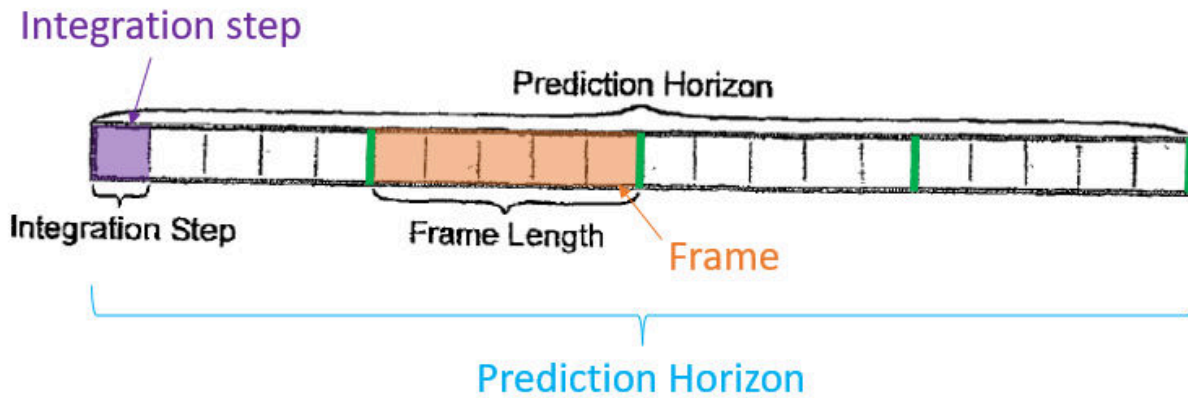


Fig. 10

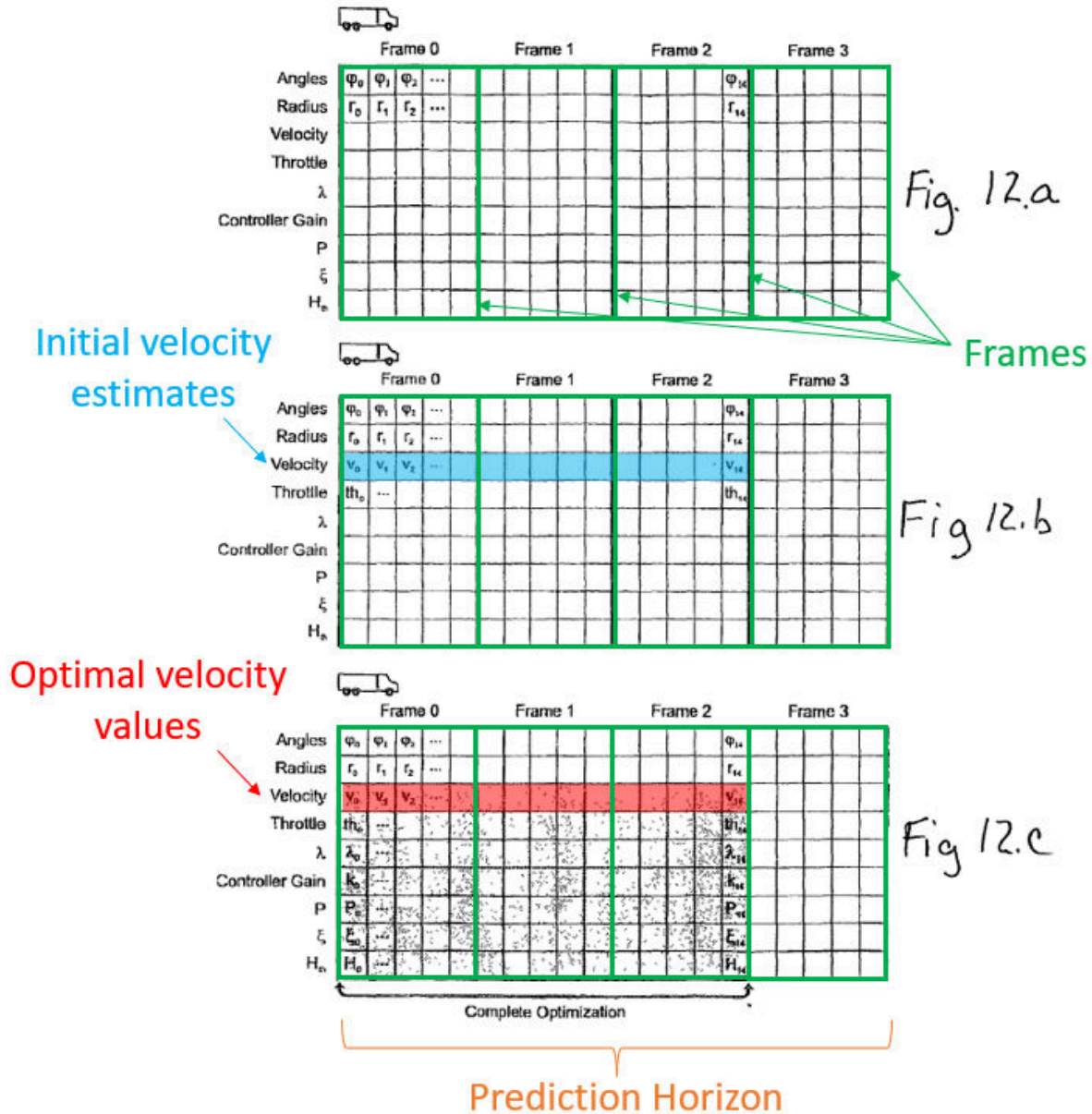
TESLA-1005, FIG. 10 (annotated)

39. To perform the minimization of the above-described “vehicle operating cost function,” an iterative optimization algorithm is executed to calculate vehicle control parameters including “optimal velocity, throttle pedal positions, and controller gain series” “[f]or an area around the current vehicle position[] (“Prediction Horizon”).” *Id.*, ¶¶[0015], [0162].

40. The optimization of the “vehicle operating cost function” along the Prediction Horizon is performed, with a lookup table being used to store the calculated “values for vehicle velocity, throttle position and controller gain” for each in-

tegration step of the Frames, as well as the values for “variables needed for the calculation of the optimization algorithm.” *Id.*, ¶[0171]; *see also id.*, ¶[0162] (“For an area around the current vehicle position[] (“Prediction Horizon”), the optimal velocity, throttle pedal positions, and controller gain series are stored in a look-up table”).

41. As part of the optimization, Neiss’s cruise control system uses an initial set of estimated vehicle control parameters to compute a first set of optimized vehicle control parameters, including vehicle speed, for frames along the prediction horizon. TESLA-1005, ¶¶[0171]-[0181], [0186], [0048], [0149]-[0160], FIGS. 12a-c. The initial estimates and the computed, optimized vehicle parameters are stored in a lookup table corresponding to the frames of the prediction horizon, as shown below:



TESLA-1005, FIGS. 12a-c (annotated)

42. These vehicle control parameters are “continuously updated and replaced by new data as the vehicle moves along, thereby adjusting [these parameters] to reflect actual vehicle historical operating experience during the journey.”

TESLA-1005, Abstract; *see id.*, ¶[0180] (explaining that the calculation is an iterative process that is carried out “until the algorithm has converged and thus the values are optimal”).

43. Specifically, in the initialization stage, “angle [road grade] and radius [radius of curvature of the road] values” are populated in the lookup table “from cell zero up to the last cell of the next to last frame,” that is, for each integration step (distance increment). *Id.*, ¶[0179]; *see id.*, FIG. 12a. Also, as part of the initialization stage, “starting values are estimated for the velocity trajectory, and the appropriate throttle pedal positions are computed” for each distance increment. *Id.*, *see id.*, FIG. 12b (velocity values highlighted in blue). Notably, in Figure 12b, “[t]he white background of the velocity memory cells ... indicates that these values are starting estimates ... and thus are not optimal.” TESLA-1005, ¶[0181].

44. In the second step of the initialization stage, before the “vehicle reaches the start point on the road where the predictive cruise control (PCC) system is triggered,” “several optimization iterations are applied on the memory range” (i.e., through the next to last frame of the Prediction Horizon) “until the algorithm has converged and thus the values are optimal.” TESLA-1005, ¶¶[0178], [0180]; *see id.*, FIG. 12c (optimal velocity values highlighted in red). In contrast to Figure 12b, Figure 12c’s velocity values and throttle pedal positions are high-

lighted with a “dark background,” which “indicates that the velocity values are optimal.” *Id.*, ¶[0181]. Each iteration of the optimization calculation involves the calculation of “velocity, throttle[,] and controller gain values.” *Id.*, ¶[0186]; *see also id.*, ¶¶[0048], [0149]-[0160].

45. After initialization, optimization of the cost function continues “while the vehicle is driving,” as illustrated in FIGS. 13a-d, below. TESLA-1005, ¶[0177]. Specifically, with reference to FIGS. 13a-d (reproduced below), Neiss explains that a “new calculation is triggered “[w]hen the vehicle reaches the end of the first frame.” *Id.*, ¶[0188]. The new calculation is initialized, assigning estimated “starting value[s]” of *v* and *th* for frame 3. *Id.*, ¶[0189]; *see* FIG. 13a (velocity values highlighted in blue). For this optimization iteration, “the current vehicle velocity is used as [the] start[ing] velocity in order to take the actual vehicle state into account. *Id.*, ¶[0190]. “The current vehicle velocity is used as start velocity” and “a whole optimization iteration is applied” to calculate the “more optimal” values for vehicle control parameters for frames 1, 2, and 3. *Id.* Later, “when the vehicle is driving in frame 2,” another “optimization iteration is applied on frames 2, 3, and 0,” yielding velocity values for frame 3 that “approach closer to the optimal values” (highlighted in red in FIG. 13d). *Id.*, ¶[0191].

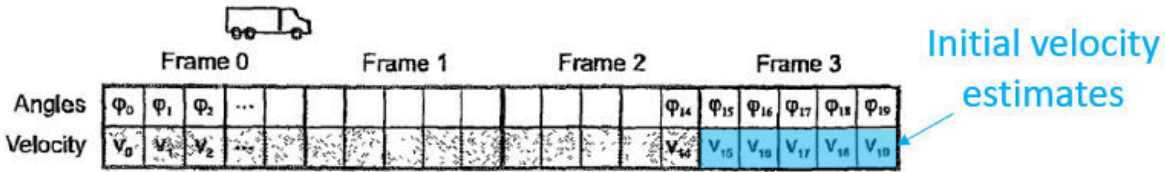


Fig. 13.a

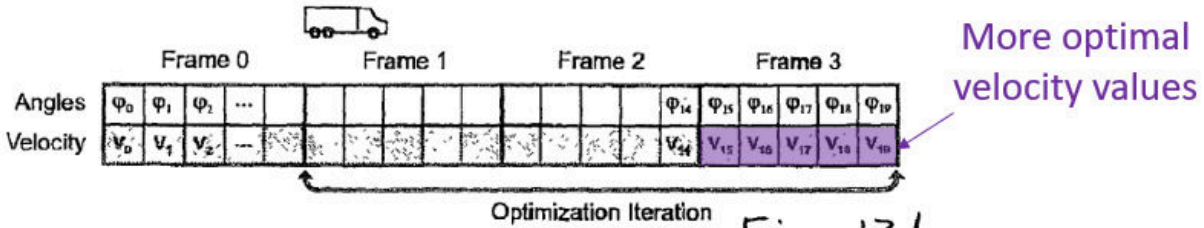


Fig. 13.b

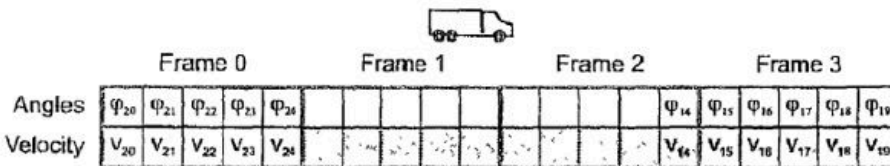
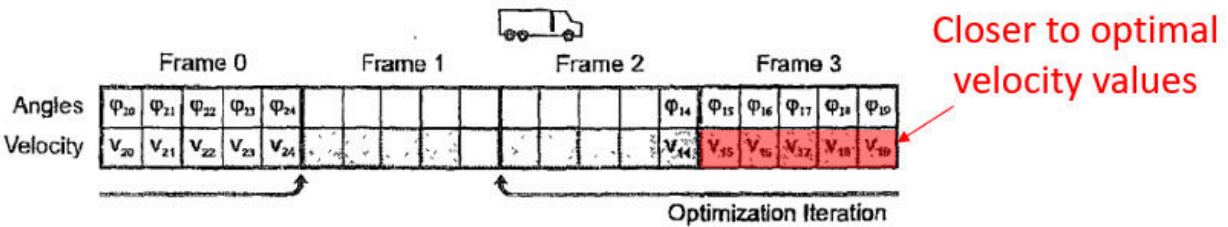


Fig. 13.c



TESLA-1005, FIGS. 13a-d (annotated)

46. Neiss further notes that when the “vehicle velocity drifts significantly from the velocity stored in the look-up table for the current position (as might be caused, for example, by a slower vehicle driving ahead), the velocity values for the

following positions in the look-up table then can no longer be considered to be optimal.” *Id.*, ¶[0167]. When this occurs, “an online version of the algorithm can adapt these values by taking the current velocity into account.” *Id.*

47. Notably, although FIGS. 12a-c and 13a-d show a Prediction Horizon spanning only four frames “to make the basic operation of the ring buffer clear,” Neiss explains that “[r]ealistic values for the Prediction Horizon would be 4000 assuming an Integration Step Size of 1 m, and 200 for the Number of Frames.” TESLA-1005, ¶[0192]. Thus, “nearly 200 optimization iteration steps are performed with regard to the values in one frame before they are actually read out.” *Id.*

48. When the calculated optimized parameters are read out of the lookup table (e.g., for the corresponding location where the vehicle is positioned/located), they are provided as inputs to a controller “which controls the vehicle to follow the calculated velocity trajectory.” *Id.*, ¶[0041]; *see id.*, ¶[0188]. Generally, “the desired vehicle speed” (i.e., the calculated optimized speed stored in the lookup table) is “converted to a desired engine speed, which is sent to the engine and the engine achieves it via its own controller or using a separate adaptive cruise controller.” *Id.*, ¶[0042]. For example, “the engine determines how much fuel to inject” or determines “a throttle angle.” *Id.*

49. Neiss is analogous art to the '161 Patent: it is from the same field of endeavor (*e.g.*, vehicle navigation) and is reasonably pertinent to the problem the '161 Patent was trying to solve (*e.g.*, how to control of vehicle operation along a route).

2. Analysis

(a) Claim 1

[1pre] A method of managing the power consumption of a vehicle, comprising:

50. If the preamble is determined to be limiting, Neiss renders it obvious.

51. As explained below, Neiss's teachings and algorithm for minimizing fuel consumption of a vehicle, in the context of the '161 Patent and the relevant technical field, would be understood by a POSITA to correspond to ***managing the power consumption of the vehicle***.² For example, the '161 Patent states that "optimizing the power supplied to the engine typically means minimizing the energy loss from the vehicle, thereby increasing fuel efficiency." TESLA-1001, 6:17-20. Thus, in the case of fuel-powered vehicles, ***managing the power consumption*** refers to minimizing fuel consumption at the vehicle. *See id.*, 6:25-33 (also noting that the claimed invention can apply to all appropriate vehicles, including fuel-powered vehicles, hybrid vehicles, and electric vehicles). In the relevant field, a

² Claim language is denoted in bold italics throughout this declaration.

POSITA would have recognized that fuel is a power source and managing power consumption in a vehicle would encompass managing the consumption of the power source(s) for the vehicle, such as fuel in the case of fuel-powered vehicles. This is further corroborated by, e.g., Hosoda (TESLA-1020, ¶¶[0015], [0025], FIG. 10 (explaining that hybrid vehicles are powered by both power supplied from a battery and the force of liquid fuel, such as gasoline, which collectively constitute a “power unit for generating driving force”; recognizing the need to monitor both via a “fuel and power storage remaining amount display 210”)).

52. In particular, Neiss describes a “predictive cruise control system [that] utilizes information about the current vehicle position, as well as upcoming terrain in order to save fuel and increase driving comfort.” TESLA-1005, Abstract. Specifically, Neiss’s predictive cruise control system minimizes a vehicle operating cost function, “based on an analysis of vehicle operating parameters and route information regarding a route section ahead of the vehicle.” TESLA-1005, ¶[0001], [0015], [0081]-[0082]. Indeed, Neiss explains that in optimal control theory, a cost function is used to define a desired operating behavior of the system and minimizing the cost function achieves the optimal or desired system operation. TESLA-1005, ¶[0081].

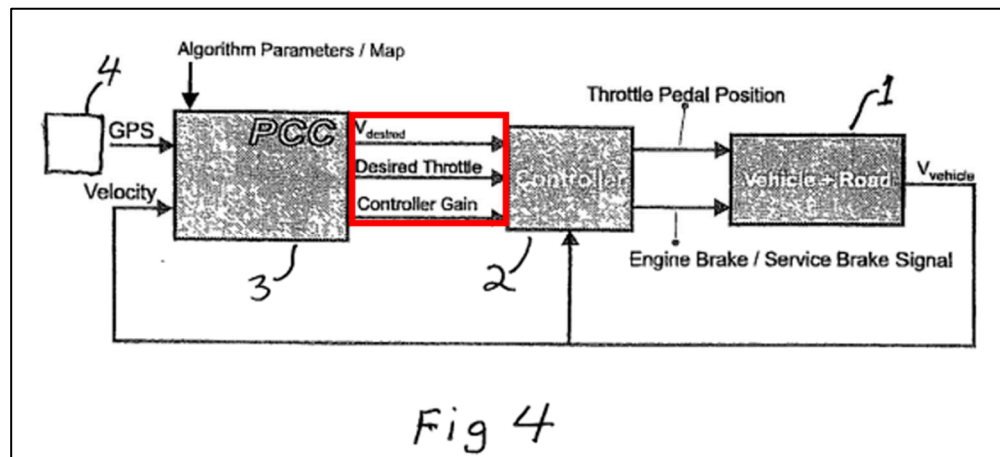
53. In one embodiment, Neiss’s predictive cruise control system identifies “vehicle control parameters,” such as speed and throttle position, that “minimize[]

vehicle operating costs,” *e.g.*, optimize vehicle operation, “based on an analysis of vehicle operating parameters and route information regarding a route section ahead of the vehicle.” TESLA-1005, ¶¶[0001], [0015]. For instance, one goal of Neiss’s optimization is to reduce fuel consumption. *See id.*, ¶¶[0081]-[0082] (“the following goals were established to define ‘optimal operation’: The vehicle should consume less fuel and should activate the brakes as little as possible”), Claims 1 and 10 (“iteratively calculating ... vehicle control parameters that minimize said vehicle operating cost function ... wherein said cost function includes vehicle fuel consumption as a function of vehicle speed, road gradient, and throttle position”), ¶¶[0014] (“the predictive cruise control system according to the invention ... utilizes information about the current vehicle position, as well as upcoming terrain in order to save fuel and increase driving comfort.”), [0004].

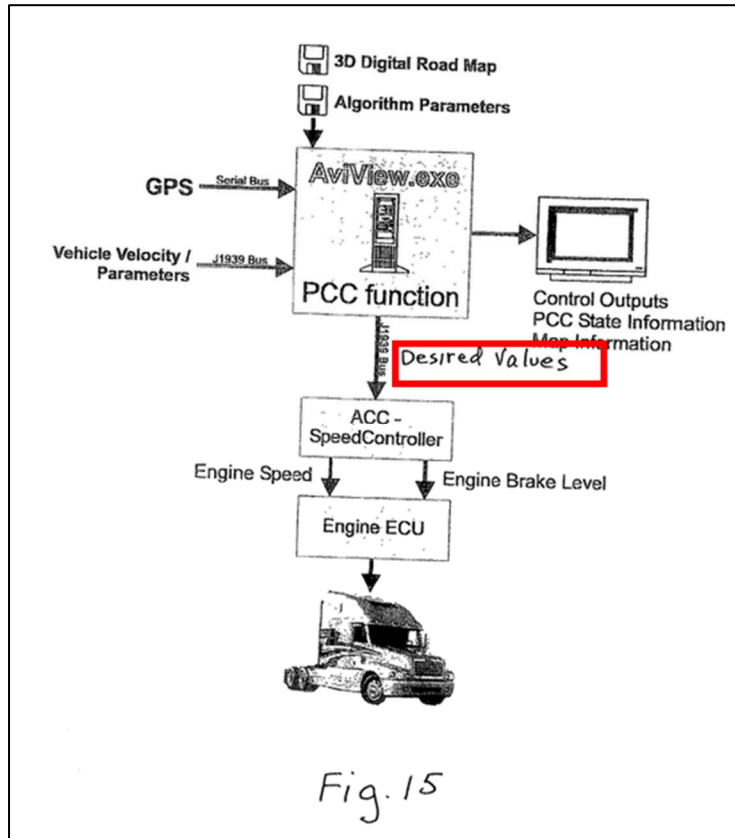
54. Moreover, Neiss describes controlling the vehicle according to the vehicle parameters determined by the optimization of the vehicle operating cost function. Specifically, the calculated optimized vehicle control parameters are stored in memory and subsequently used by a controller to control the vehicle in accordance with these vehicle control parameters. *See, e.g.*, TESLA-1005, ¶¶[0015] (“The vehicle is then controlled by reading the optimized vehicle control parameters from the memory, corresponding to the current position of the vehicle”), [0014] (“The

vehicle velocity is then controlled to follow an analytically computed optimal driving strategy”), Claim 1 (“controlling current vehicle operation based on said optimized vehicle control parameters”), ¶[0042].

55. Neiss achieves this control by “convert[ing]” “the desired vehicle speed” (as computed by its optimization algorithm) to “a desired engine speed, which is sent to the engine and the engine achieves it via its own controller or using a separate adaptive cruise controller,” *e.g.*, by injecting fuel or specifying a throttle angle. TESLA-1005, ¶[0042]. As shown in Figures 4 and 15 below, the “desired values” (i.e., the calculated optimized velocity, throttle, and controller gain values) are applied to a speed controller, which applies the corresponding “engine speed” and “engine brake level” to the engine ECU to cause the vehicle to implement the output of Neiss’s predictive cruise algorithm at the vehicle.



TESLA-1005, FIG. 4 (annotated)



TESLA-1005, FIG. 15 (annotated)

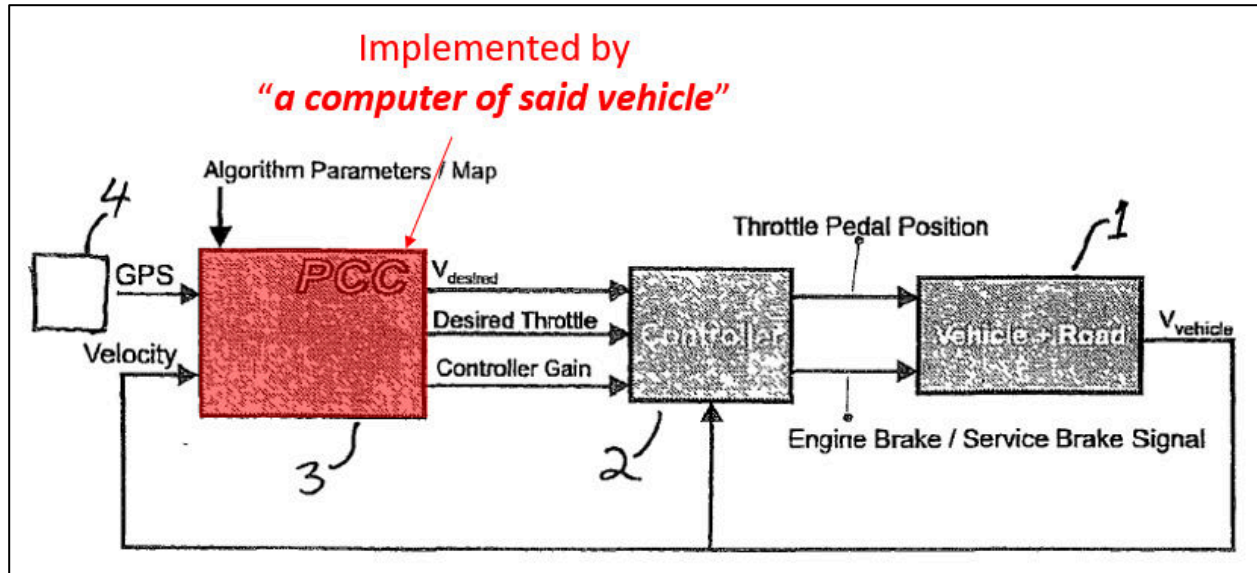
56. Thus, the computation of optimal vehicle control parameters (including vehicle velocity) that allow the vehicle to “consume less fuel,” and the subsequent control of the vehicle according to those parameters, corresponds to ***managing the power consumption of the vehicle***, e.g., in that control parameters identified to minimize fuel consumption are used to control the operation of the vehicle engine.

[1a] (a) receiving a route at a computer of said vehicle;

57. Neiss renders limitation [1a] obvious for the reasons described below.

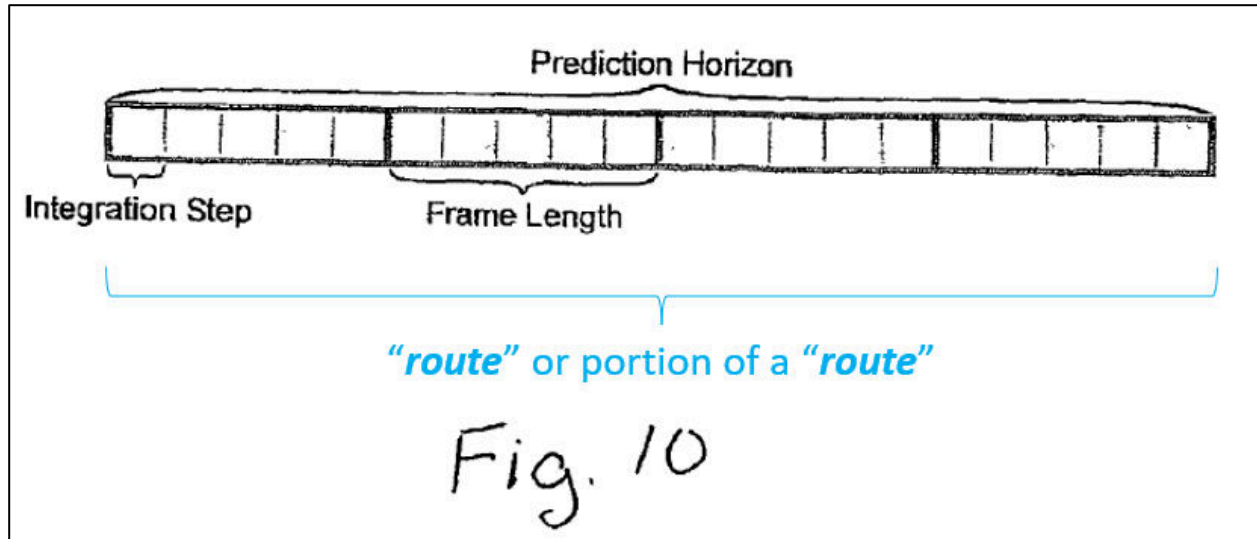
58. Neiss teaches a ***computer of said vehicle***. Specifically, Neiss discloses an onboard computer that includes memory and a data processor. *See, e.g.*, TESLA-1005, Abstract (“an onboard computer iteratively calculates and stores in a memory vehicle control parameters that optimize the vehicle operating cost function for a predetermined Prediction Horizon along the route ahead of the vehicle”), ¶¶[0015], [0034], [0037]-[0041], [0044] (describing the predictive cruise control (PCC) block as computing the optimal vehicle control parameters, such as desired speed, throttle, and controller gain), FIGS. 4, 15 (showing and describing PCC block implemented at the vehicle), Claim 15 (describing a data processor to calculate optimum vehicle control parameters and memory for storing road map and a lookup table including the calculated optimal vehicle control parameters).

59. Neiss’s PCC block executes the optimization algorithm, and, because Neiss’s onboard computer is also described as executing the optimization algorithm, the PCC block would be understood as being part of the onboard computer. Neiss’s “PCC vehicle control system,” as implemented by Neiss’s onboard computer, includes “a PCC block 3” that “generates as outputs” the optimized velocity, throttle, and controller gain values, and provides these values as “inputs for the controller 2 which controls the vehicle to follow the calculated velocity trajectory.” TESLA-1005, ¶¶[0034], [0037]-[0041]; *see* FIG. 4, below.



TESLA-1005, FIG. 4 (annotated)

60. Neiss's optimization algorithm "iteratively calculat[es] ... vehicle control parameters that optimize the vehicle operating cost function for a predetermined distance (referred to as a Prediction Horizon) along the route ahead of the vehicle." TESLA-1005, ¶[0015]; *see id.*, ¶[0001] ("a cruise control unit for a motor vehicle, which minimizes vehicle operating costs, based on an analysis of vehicle operating parameters and route information regarding a route section ahead of the vehicle"), [0049], Abstract, Claim 1 ("iteratively calculating and storing in a memory, vehicle control parameters that minimize said vehicle operating cost function for a predetermined distance along said route ahead of said vehicle").

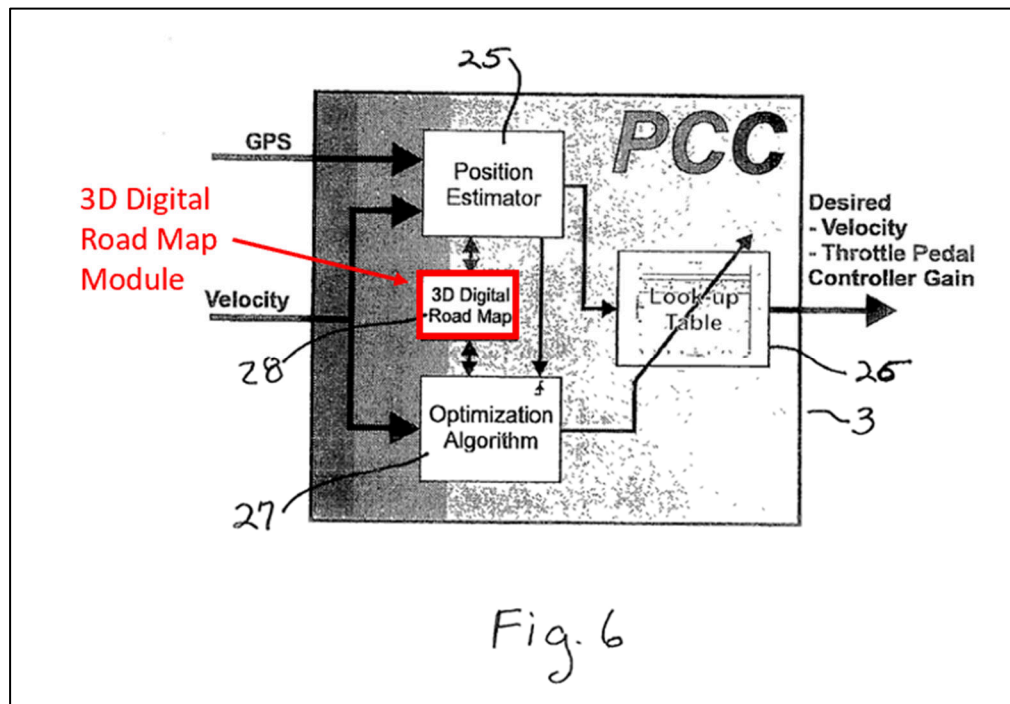


TESLA-1005, FIG. 10 (annotated)

61. The Prediction Horizon (shown above in blue; *see* FIG. 10, above) corresponds to *a route*, *e.g.*, because it constitutes a path being traveled by the vehicle. Additionally, or alternatively, Neiss discloses that the vehicle traverses an overall route (*e.g.*, one with a starting point and an ending point or final destination where the vehicle stops) and that its optimization operations are performed iteratively for portions of the overall route (which Neiss refers to as the Prediction Horizon) ahead of the vehicle as the vehicle continues to travel the route to its final destination. TESLA-1005, Abstract, ¶¶[0001], [0015]. As such, a POSITA would have understood that Neiss discloses a vehicle traversing an overall route, with optimizations performed on each iteratively updated Prediction Horizon (*i.e.*, predetermined distance) ahead of the vehicle as it travels this route. *See id.*

62. Moreover, and as explained below, Neiss teaches *receiving a route* (e.g., receiving either the immediate Prediction Horizon ahead of the vehicle or the route represented by a starting position and an ending position or final destination) *at a computer of said vehicle* (e.g., onboard computer in Neiss's vehicle).

63. In particular, Neiss's PCC block that is implemented on the onboard computer includes a "3D Digital Road Map." TESLA-1005, Abstract, ¶¶[0004]-[0005], [0014]-[0015], [0049], [0179], FIG. 6 (reproduced below).



TESLA-1005, FIG. 6

64. Neiss further discloses that, as the vehicle travels a "particular route," the PCC block accesses information about the route ahead of the vehicle using this 3D Digital Road Map. TESLA-1005, ¶¶[0049] ("3D Digital Road Map 28: The

Optimization Algorithm [of the PCC] ... uses information read from the digital map to determine the gradient angles and curve radii of the upcoming road”), [0004] (“the current vehicle position may be determined, for example, by means of a Global Positioning System (GPS), and information about the upcoming terrain can be taken from a three-dimensional digital road map for the purpose of controlling vehicle operation”), [0014]-[0015] (same), [0049], [0179], Claim 15 (“wherein said predictive cruise control module comprises: a first memory having stored therein a road map including route parameters that characterize routes within a vehicle operating area; [and] a data processor programmed to calculate said optimum vehicle control parameters, based on ... said route parameters”).

65. In particular, Neiss describes that the current position of the vehicle is used to query the 3D Digital Road Map to identify the area “along the route” ahead of the vehicle (which Neiss refers to as the Prediction Horizon) and access information about the identified Prediction Horizon (e.g., “gradient angles and curve radii for the upcoming road”) therefrom. *See id.* Neiss’s optimization algorithm thus uses this “[f]orward-looking terrain information” “for a predetermined distance (referred to as a Prediction Horizon) along the route ahead of the vehicle” to “determine, as a function of position, a desired speed,” e.g., the onboard computer uses information about upcoming terrain (of the Prediction Horizon) to calculate vehicle

control parameters. *Id.*, ¶¶[0031], [0015]; *see id.*, Claim 15 (“wherein said predictive cruise control module comprises ... a data processor programmed to calculate said optimum vehicle control parameters”), ¶[0162].

66. Further still, Neiss teaches that its optimization algorithm operates “iteratively” to identify subsequent Prediction Horizons ahead of the vehicle (as the vehicle continues driving) and accesses each such Prediction Horizon and associated road information from the 3D Digital Road Map, which are then used by the optimization algorithm to iteratively compute the optimal vehicle control parameters. TESLA-1005, ¶¶[0012], [0014], [0031], [0045]-[0049], [0163], [0167], [0181], [0186], [0190], FIGS. 12a-c, FIGS. 13a-d.

67. From these disclosures, a POSITA would have understood that the onboard computer (which implements Neiss’s PCC block) *receiv[es] a route* (e.g., receives a Prediction Horizon, or receives the set of Prediction Horizons that constitute a complete, origin-to-destination route) because Neiss’s optimization algorithm (1) uses the 3D Digital Road Map to identify (*receive*) each Prediction Horizon ahead of the vehicle (where the Prediction Horizon is itself a *route* or a portion of the *route* formed of successive Predictions Horizons, each of which is received until the vehicle reaches its final destination) and (2) performs optimization calculations using the information about this route (e.g., road curvature and gradient information) as received from the 3D Digital Road Map.

68. If it is determined that the present limitation requires receiving an *entire* route (i.e., an end-to-end route with a starting point to a final destination) *at once*, a POSITA would have found that to be obvious in view of Neiss. As described above, Neiss's onboard computer iteratively receives predetermined distances of the route ahead of the vehicle, as the vehicle drives from a starting point and until it reaches its final destination. A POSITA would have found it obvious to modify Neiss so that Neiss's onboard computer receives the entire end-to-end route all at once, instead of receiving it iteratively in the manner described by Neiss.

69. A POSITA would have been motivated to modify Neiss in this manner for at least the following reasons.

70. **First**, receiving the entire route at once would be computationally efficient because it would enable quicker computations on upcoming route segments/frames by avoiding or reducing use of network and computational resources that would otherwise be needed to obtain this information as the vehicle drives and thereafter perform the computations on such received information.

71. **Second**, a vehicle onboard computer receiving an entire end-to-end route (e.g., from external map applications) was well-known in the context of vehicle control systems and enabled receipt of accurate routes that, e.g., account for real-time events, such as road and/or traffic conditions. This is corroborated by,

e.g., Kuroda (TESLA-1021, 1:42-43) (teaching that a vehicle can include a “route retrieving unit [that] retriev[es] a route to a destination”). Thus, modifying Neiss’s onboard computer to receive the route would have been an application of known techniques (e.g., an onboard computer of a cruise control system receiving a route) to a known system (e.g., a vehicle onboard computer implementing a predictive cruise control system that processes information about the route) to yield predictable results (e.g., an onboard route computer for predictive cruise control that receives an entire route with respect to which optimizations and/or analytic operations can be performed).

72. A POSITA would have also had a reasonable expectation of success in configuring Neiss in this manner. That is because (1) it was well-known and conventional for vehicle onboard computer to receive routes, e.g., from map applications (e.g., using user input specifying a start position and a final destination, and a map application including routing logic that identifies and provides to an onboard vehicle computer the identified route (*see, e.g.,* Hafner (TESLA-1022, 7:52-54 (teaching that the driver “informs the system of her[] destination,” and the “system access all available prior information about this destination and various routes to the destination”))), (2) Neiss already includes a digital map that stores information about routes that the vehicle drives (e.g., TESLA-1005, ¶¶[0049], [0031], Abstract), and (3) Neiss’s optimization algorithm already obtains/receives information

about the route ahead of the vehicle for its optimization calculations (*see id.*).

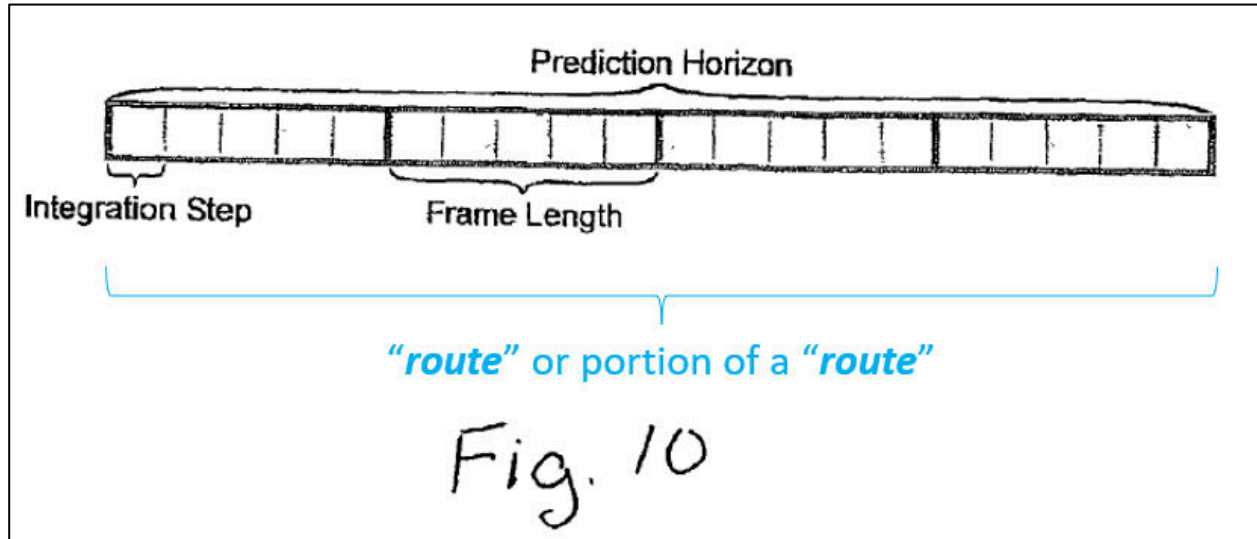
Thus, it would have been straightforward and well within a POSITA's skillset to configure Neiss's map application (e.g., the 3D Digital Road Map) with such conventional routing logic that enables identification of the entire route and enables Neiss's onboard computer (and its associated optimization algorithm) to receive the entire route from the map application (e.g., using the same mechanism by which the optimization algorithm already communicates with the 3D Digital Road Map).

[1b] (b) segmenting said route into a plurality of segment destinations;

73. Neiss renders limitation [1b] obvious for the reasons described below.

74. As an initial matter, the '161 Patent does not use the term "segment destination." *See generally* TESLA-1001. Moreover, while the specification describes segmenting a route, it describes segmenting the route into segments (and not segment destinations, as claimed). *See, e.g., id.*, 13:44-50 (a "route may be broken up into segments," where a "segment may comprise any distance to be traveled, including the entire route, or small portions of the route"). Thus, in the context of the '161 Patent's specification, a POSITA would have understood that the present limitation encompasses segmenting a route into a plurality of segments, where each segment has an end point/destination.

75. Similarly, Neiss discloses segmenting the route into segments, each segment having an endpoint or destination. In particular, and as explained below, Neiss discloses segmenting the route into frames, where each frame has an endpoint. See, e.g., TESLA-1005, ¶[0170], FIG. 10.

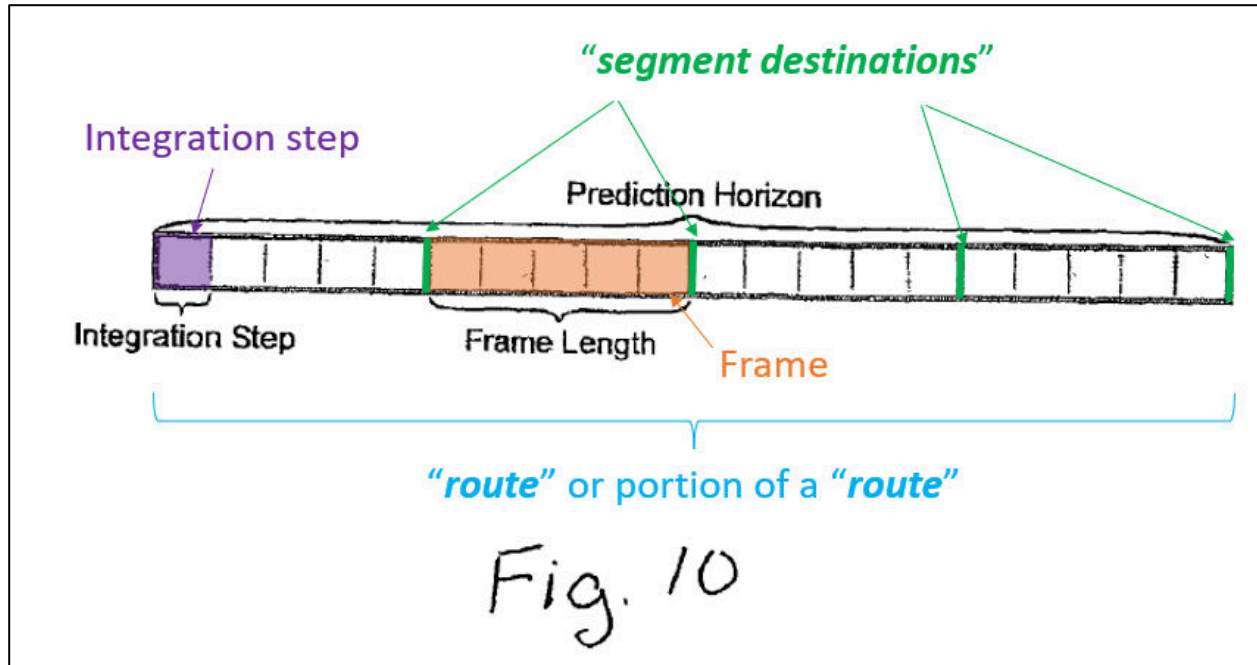


76. As described for limitation [1a], Neiss “iteratively calculates and stores in a memory vehicle control parameters that optimize the vehicle operating cost function” as the vehicle proceeds along a route. *Id.*, Abstract. Each optimization iteration is performed for a “predetermined distance ... along the route ahead of the vehicle,” which Neiss refers to as the “Prediction Horizon.” *Id.*, ¶[0015].

77. Also, as explained for limitation [1a], the “Prediction Horizon” immediately ahead of the vehicle corresponds to the claimed **route** or alternatively, the claimed **route** is made up of successive Prediction Horizons from the vehicle’s

start location to its final destination. As a vehicle travels along the route, the Prediction Horizon is iteratively updated to reflect a new pre-determined distance of the route ahead of the vehicle. TESLA-1005, ¶[0047] (clarifying that the “Prediction Horizon” is “an area ... around the current vehicle position,” which changes as the vehicle continues to traverse the route). In this manner, Neiss’s iterative algorithm would be understood as operating on portions of the route ahead of the vehicle until the vehicle’s final destination is reached.

78. Neiss further describes that each Prediction Horizon (i.e., the route or a subset of the route) “is separated into Frames.” TESLA-1005, ¶[0170]; *see id.*, ¶[0192], FIG. 10, below. As shown below, each frame (highlighting one frame in orange in FIG. 10) is “a specified distance,” i.e., a portion (segment) of the route. TESLA-1005, ¶[0169]. Each frame in turn is composed of multiple “integration steps” (one of which is highlighted in purple below), with each integration step corresponding to a “small distance[]” along its frame. *Id.*, ¶¶[0162], [0170]. The endpoint of each frame in the Prediction Horizon corresponds to a ***segment destination*** (noted in green) given that it is the end (destination) of a frame (segment) of the Prediction Horizon.

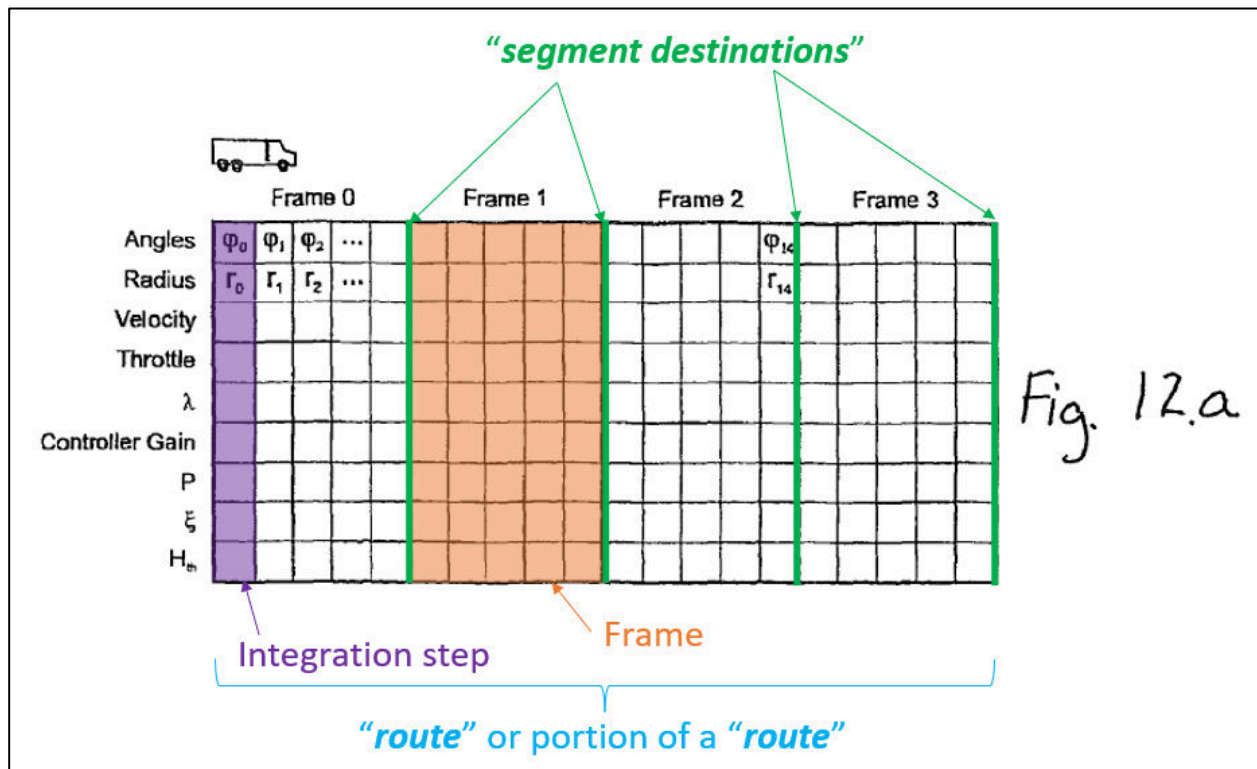


TESLA-1005, FIG. 10 (annotated)

79. Each Prediction Horizon ahead of the vehicle (*said route*) is thus *segment[ed] ... into segment destinations* at least because each Prediction Horizon is composed of a plurality of frames (*segment[s]*), each having a respective endpoint (*segment destinations*). In the above example of FIG. 10, "the Number of Frames is 4," but Neiss acknowledges that in real-world implementations, the number of frames in a Prediction Horizon can be substantially more, e.g., 4000). TESLA-1005, ¶¶[0169]-[0170], [0192].

80. In more detail, Neiss's optimization algorithm is implemented using a look-up table "that corresponds to the length (in frames and integration steps) of the Prediction Horizon." TESLA-1005, ¶[0171]; *see id.*, Claim 18 ("said ring

buffer memory is divided into a plurality of frames which collectively correspond to said prediction horizon, each frame including a predetermined number of cells corresponding to said integration interval”), FIGS. 12a(below)-c, FIGS. 13a-13d. The locations in the lookup table that correspond to the endpoints of the frames of the Prediction Horizon likewise correspond to the *segment destinations* of said route.



TESLA-1005, FIG. 12a (annotated)

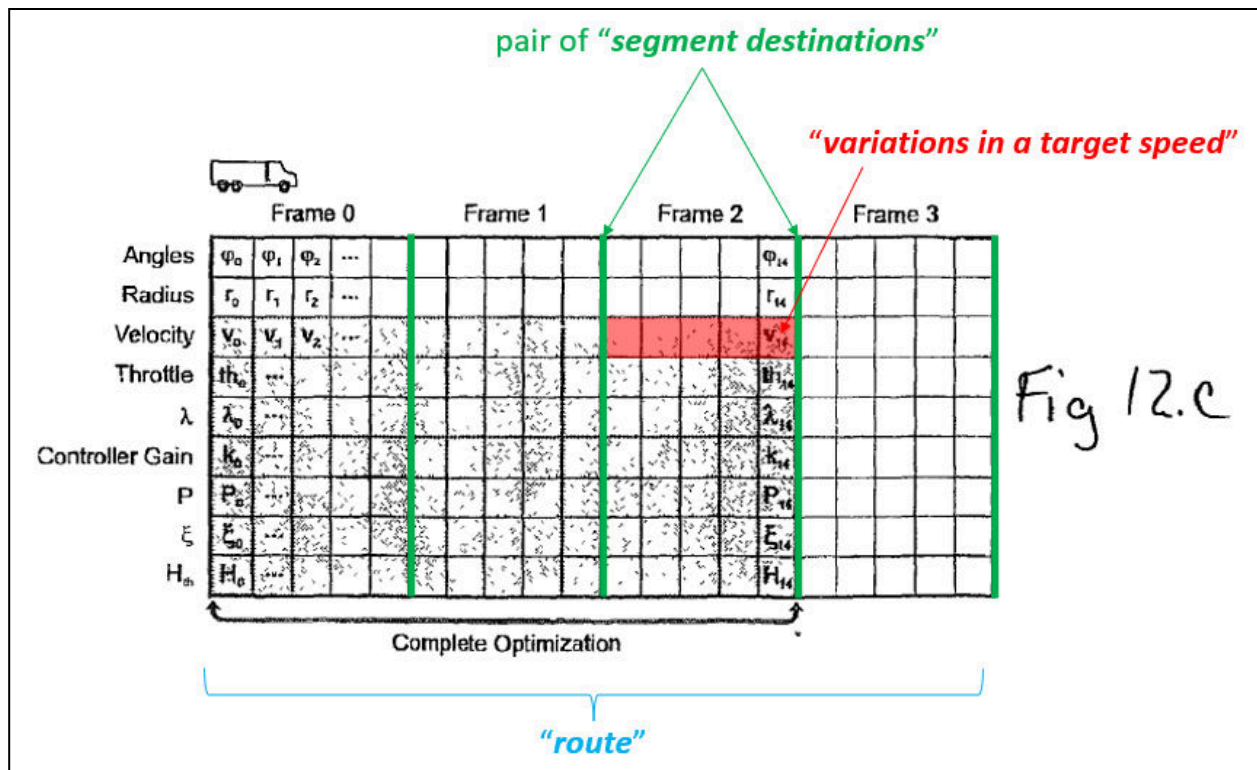
[1c] (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;

81. Neiss renders limitation [1c] obvious for the reasons described below.

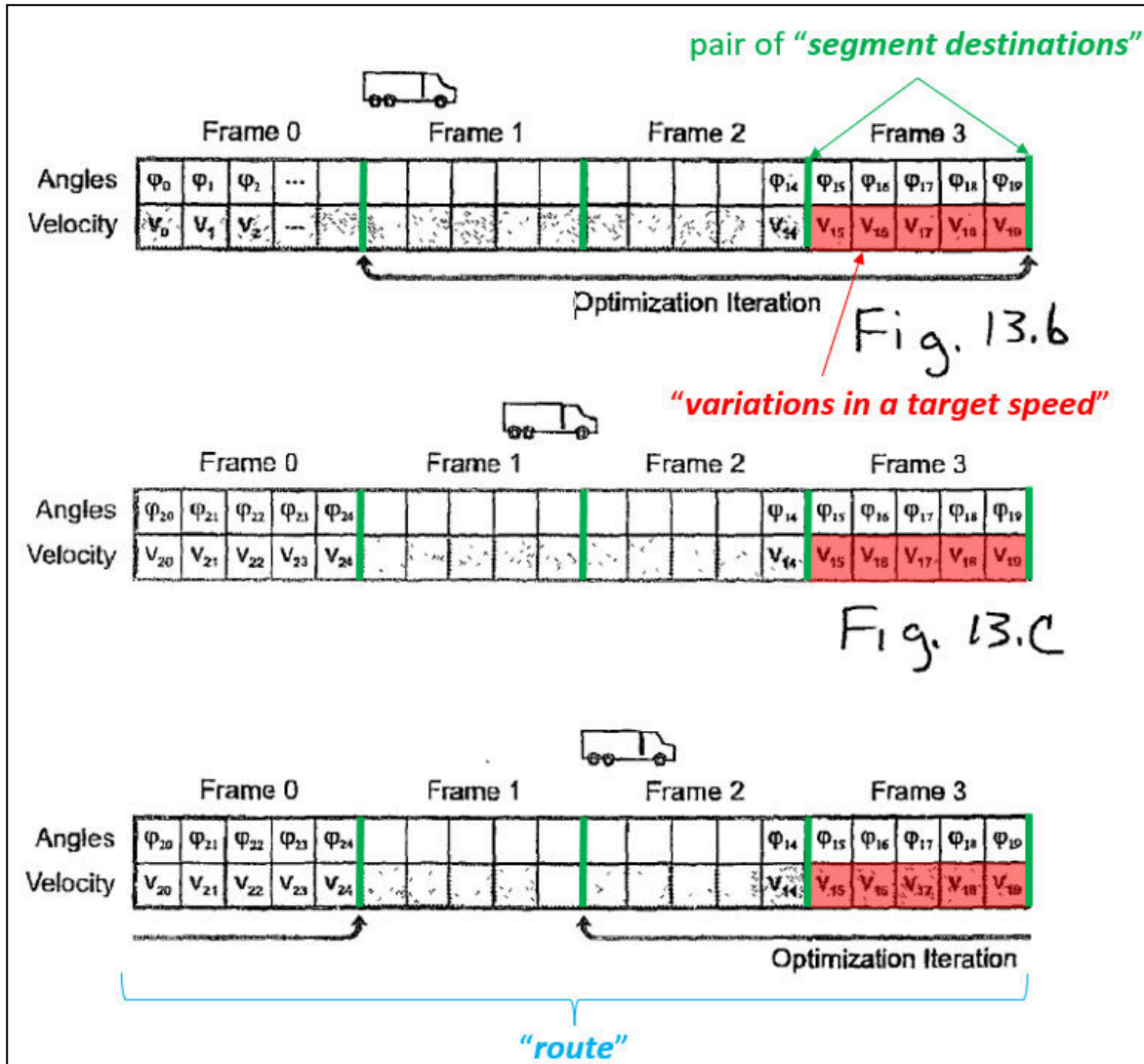
Neiss's determined speeds at locations within each frame of the Prediction Horizon correspond to variations in a target speed between pairs of segment destinations

82. Neiss describes that vehicle speeds along the Prediction Horizon that result in a minimized overall vehicle operating cost function, J , are determined by performing an iterative optimization on the overall cost function. See TESLA-1005, [0015] (“an onboard computer iteratively calculates ... vehicle control parameters that optimize the vehicle operating cost function”), claim 1 (“iteratively calculating ... vehicle control parameters that minimize said vehicle operating cost function”), claim 13 (“parameters which minimize said analytically calculated vehicle operating cost”). For each iteration, this optimization process yields a speed value for each of the N locations (which Neiss also refers to as integration steps) of the frames in the Prediction Horizon. See TESLA-1005, [0180] (“several optimization iterations are applied on the memory range described above until the algorithm has converged and thus the values are optimal”), [0190] (“a whole optimization algorithm iteration is applied on the specified range in the ring buffer,” resulting in “[speed] values [that] are ‘more optimal’ than the start estimations since one optimization iteration step is applied on them”), [0191] (“now two optimization iterations have been performed for this memory range, and so these values approach closer to the optimal values”), FIG. 12c (below), FIGS. 13b-d (below),

83. These per-location speed values determined in each iteration of the optimization algorithm, some of which are highlighted in red in FIGS. 12c and FIG. 13b-d, correspond to *variations in a target speed of the vehicle between pairs of segment destinations*, as discussed in the following paragraphs.



Excerpt from Neiss, FIG. 12c (annotated)



Excerpt from Neiss, FIGS. 13b-13d (annotated)

84. Neiss's overall vehicle operating cost function, J , incorporates the cost function, $J_{velocity}$, which targets the objective that "[t]he vehicle should attempt to maintain a specified velocity (Set Speed)." TESLA-1005, [0083]; *see* [0100] ("To reduce drifts from the desired Set Speed, $v_{desired}$, a[] term for the cost function is $J_{velocity}$ "), claim 3 ("said vehicle control parameters include at least a desired vehicle speed"), claim 12 (defining the cost function based on "a desired vehicle

speed”), [0126]. This “Set Speed” corresponds to *a target speed of the vehicle*, e.g., in that the Set Speed is the specified (target) speed for vehicle operation. The overall cost function, J , imposes a further constraint that the speed remains within a speed band—as specified by “an upper limit” and “a lower velocity limit”—via its inclusion of the cost function $J_{penalty}$. TESLA-1005, [0084]; see [0103] (“the objective is to keep the velocity within certain limits”), [0104] (“make the velocity remain between the lower velocity limit, v_{lower} , and the upper velocity limit V_{upper} ”), claim 8 (“wherein said cost function comprises a desired vehicle speed range and imposes a cost penalty based on an extent to which the vehicle speed exceeds an upper or lower limit of said speed range”), claim 12 (defining the cost function based on “an upper limit of a speed range” and “a lower limit of a speed range”).

85. Through these two individual cost functions, the determined per-location speed values along the Prediction Horizon that optimize the overall vehicle operating cost function, J , are constrained to be (1) close to the Set Speed (*target speed*) and (2) between the upper and lower limits. These determined speed values can vary by location (e.g., for each integration step along the Prediction Horizon) subject to these constraints, e.g., they correspond to *variations in the target speed of the vehicle*. See TESLA-1005, [0031] (“Forward-looking terrain information is used to determine, as a function of position, a desired speed inside the speed band ... in order to maximize fuel savings”), Eq. 30.

86. These determined speed values (*variations in target speed*) are *between pairs of segment destinations*. As discussed in [1b], above, adjacent pairs of segment destinations define a frame, with each frame composed of multiple integration steps. See TESLA-1005, [0162], [0169]-[0170], FIG. 10, FIGS. 12a-12c, FIGS. 13a-13d (above). Also, as shown above in the annotated FIGS. 12c and 13b-d, within each iteration of the optimization process, a speed value is determined for each location (e.g., each integration step), and thus multiple vehicle speeds (*a plurality of variations in target speed*) are determined for each frame, e.g., *between each pair of segment destinations*. See TESLA-1005, [0180] (“several optimization iterations are applied on the memory range described above until the algorithm has converged and thus the values are optimal”), [0185]-[0186] (“For a specified range in the ring buffer the series of v , P , Δ and H_{th} are calculated simultaneously ... and stored in the respective ring buffer cells”), [0190] (“a whole optimization iteration is applied on the specified range in the ring buffer ... the light gray background of the velocity memory cells of frame no. 3 indicate that these values are ‘more optimal’ than the start estimations since one optimization iteration step is applied on them”), [0191] (“an optimization iteration is applied on frames 2, 3, and 0 ... The background color of the velocity cells of frame 3 are now darker than in the previous step, denoting that now two optimization iterations have been performed for this memory range”), FIG. 12c, FIGS. 13b-d.

87. For instance, FIG. 13b, above, depicts the outcome of a first “optimization iteration” performed on the Prediction Horizon, from which five vehicle speed values v_{15} - v_{19} (red) are determined between the pair of segment destinations (green) defining Frame 3; other speed values (not explicitly illustrated) are determined between other pairs of segment destinations defining the other frames of the Prediction Horizon. TESLA-1005, [0190]. Speed values calculated during subsequent iterations are depicted in FIGS. 13c-d. *See* TESLA-1005, [0191]. Similarly, FIG. 12c, above, illustrates the outcome of “several optimization iterations,” from which vehicle speed values are determined for the integration steps of the multiple frames; the speed values for one such frame are highlighted in red. TESLA-1005, [0180]. Across the multiple frames of the Prediction Horizon, the vehicle speeds (*variations in target speed*) determined during a single optimization iteration thus correspond to *variations in target speed between pairs of segment destinations*, e.g., between the pairs of segment destinations defining each frame of the Prediction Horizon.

The values of Neiss’s cost functions collectively correspond to energy values consumed by the vehicle to travel the route

88. Neiss’s overall cost function, J , is expressed as the sum of multiple individual cost functions corresponding to various objectives. *See* TESLA-1005, [0080]-[0087],[0126]-[0130]. One such overall cost function is:

$$J = \Phi + J_{\text{time}} + J_{\text{fuel}} + J_{\text{velocity}} + J_{\text{lateral-accel}} + J_{\text{penalty}}$$

where the individual cost functions specify objectives including minimizing travel time (J_{time}), minimizing fuel consumption and braking (J_{fuel}), maintaining a specified velocity (J_{velocity}), reducing lateral acceleration ($J_{\text{lateral-accel}}$), and keeping the velocity between upper and lower limits (J_{penalty}). See TESLA-1005, [0082]-[0087], [0126].

89. The individual cost functions can be expressed collectively as the summation of the value of a function, L , for each of N locations (integration steps) along the Prediction Horizon:

$$J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min \quad (\text{Eq. 30})$$

90. The value of the function L at a given location k in the Prediction Horizon depends on the position of that location (s_k) and the vehicle speed ($v(s_k)$) and throttle pedal position ($th(s_k)$) at that location. The value of the overall cost

function, J , is thus the summation of the values of L at each location along the Prediction Horizon, plus a “final state ... cost function” Φ .³ TESLA-1005, [0123].

91. Notably, the function L incorporates the cost function J_{fuel} , which represents the “fuel consumption” of the vehicle as it travels along the Prediction Horizon, *e.g.*, energy consumed by the vehicle. TESLA-1005, [0093]; *see* [0082] (“the vehicle should consume less fuel”), [0128] (“for predictive cruise control focusing on fuel savings”), claim 10 (“wherein said cost function includes vehicle fuel consumption as a function of vehicle speed, road gradient and throttle position”), [0126]-[0130], Eq. 29; *see* TESLA-1001, 1:40-42. As indicated by Eq. 18, J_{fuel} is specified based on the velocity v_k and throttle position th_k for each of the N locations along the Prediction Horizon:

³ The inclusion of Φ in the overall vehicle cost function is optional. *See* TESLA-1005, [0122];

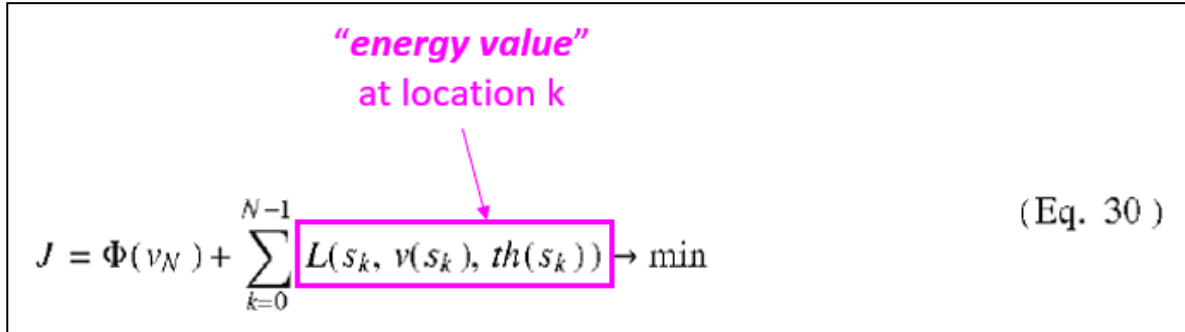
$$J_{fuel} = \frac{1}{2} \cdot h \cdot \sum_{k=0}^{N-1} S\psi v_k t h_k^2, \quad (\text{Eq. 18})$$

92. See TESLA-1005, [0093]-[0098]. The value of J_{fuel} at each location (outlined in pink above) corresponds to *an energy value consumed by the vehicle* at that location, at least in that it represents fuel (energy) consumption of the vehicle. The values of J_{fuel} for all of the N locations along the Prediction Horizon collectively correspond to *a plurality of energy values consumed by the vehicle to travel the route*, e.g., the energy values consumed by the vehicle in traversing the entirety of the Prediction Horizon. *Id.*.

93. I note that fuel (energy) consumption of the vehicle relates to power consumption of the vehicle (which I discussed above for element [1pre]). Power is, generally, the rate at which energy is transferred, e.g., the rate of fuel consumption. For instance, the '161 Patent recognizes this relationship, stating that “an operator controls the power applied to the vehicle ... by operating the ignition, break [sic] and gas pedals [sic].” TESLA-1001, 1:40-42.

94. As discussed above, the fuel consumption cost function J_{fuel} , together with cost functions representing other objectives, are added together to give the

overall vehicle operating cost function J , which is represented as the summation of a function L :



$$J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min \quad (\text{Eq. 30})$$

See TESLA-1005, [0126]-[0132]. The value of the function L at each location incorporates the J_{fuel} expression for fuel (energy) consumption at that location, and thus the value of the function L at a given location alternatively/additionally corresponds to ***an energy value consumed by the vehicle*** at that location, at least because L incorporates the value of J_{fuel} at that location. See Eq. 30, below. Still alternatively/additionally, the value of L at each location corresponds to ***an energy value*** because L , like J_{fuel} , is a function of velocity v_k and throttle position th_k at that location, both of which affect the vehicle's energy consumption. See Eq. 15 of Neiss, which expresses the "fuel consumption per second" in terms of $v(t)$ and $th(t)$. TESLA-1005, [0093]. The values of L for all of the N locations along the Prediction Horizon collectively correspond to ***a plurality of energy values consumed by the vehicle to travel the route***, e.g., the energy values consumed by the vehicle in traversing the entirety of the Prediction Horizon. *Id.*

Neiss's energy values are calculated based on variations in target speed

95. To optimize Neiss's overall vehicle operating cost function, "several optimization iterations are applied," where, in each iteration, "velocity, throttle and controller gain values" are calculated for each of the N points in the Prediction Horizon. TESLA-1005, [0180], [0185]-[0186]; *see* [0162]-[0163] ("For an area around the current vehicle position[] ('Prediction Horizon'), the optimal velocity, throttle pedal positions, and controller gain series are stored" in a look-up table ... The look-up table values are calculated online, in real time as the vehicle proceeds along the traveled route"), [0177] ("the whole Prediction Horizon (except for the last frame) is calculated"), [0190], claim 1 ("iteratively calculating .. vehicle control parameters"). As I indicated above, a POSITA would have been aware of a variety of specific ways to approach these optimizations described by Neiss.

96. The value of the function L at each location k (an *energy value*) is *calculated* based on these calculated parameters: "said operating cost function provides an analytic calculation of vehicle operating cost based on said parameters." TESLA-1005, claim 13. For instance, the value of the function L at a given location k (an *energy value*) is *calculated* in that it is specified mathematically based on the calculation of the values of velocity ($v(s_k)$) and throttle ($th(s_k)$) at that location, as expressed in Eq. 30:

The diagram shows Equation 30: $J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min$. A pink rectangular box is drawn around the term $L(s_k, v(s_k), th(s_k))$. A pink arrow points from the text "*energy value* at location k" to the pink box. The text "(Eq. 30)" is located to the right of the equation.

$$J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min \quad (\text{Eq. 30})$$

See TESLA-1005, [0171] (“the values for vehicle velocity, throttle position and controller gain calculated as described previously are entered into a ring buffer memory ... together with the following variables needed for the calculation of the optimization algorithm”); TESLA-1015, 2 (defining “calculate” as “to determine or ascertain by mathematical methods; compute”); TESLA-1016, 3 (defining “calculate” as “to solve (one or more problems) by a mathematical procedure; compute”); TESLA-1017, 3 (defining “calculate” as “determine (the amount or number of something) mathematically”).

97. For similar reasons, the value of the J_{fuel} at a given location k (alternatively/additionally an *energy value*) is *calculated* in that it is specified mathematically based on the calculation of the values of velocity ($v(s_k)$) and throttle ($th(s_k)$) at that location, as expressed in Eq. 18:

$$J_{fuel} = \frac{1}{2} \cdot h \cdot \sum_{k=0}^{N-1} S \psi v_k t h_k^2, \quad (\text{Eq. 18})$$

“energy value”
at location k

98. The values of L and J_{fuel} for the N locations along the Prediction Horizon (*a plurality of energy values consumed by the vehicle to travel the route*) are calculated *based on a plurality of variations in the target speed*, as demonstrated by Eqs. 18 and 30, below, and as discussed in the following paragraph.

$$J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min \quad (\text{Eq. 30})$$

“energy value”
at location k

“variations in a target speed”

$$J_{fuel} = \frac{1}{2} \cdot h \cdot \sum_{k=0}^{N-1} S \psi v_k t h_k^2, \quad (\text{Eq. 18})$$

“energy value”
at location k

“variations in a target speed”

99. Specifically, for each iteration of the optimization algorithm, multiple speed values (*a plurality of variations in the target speed*) are determined *between*

pairs of segment destinations, e.g., a speed value is calculated for each location k across the multiple frames of the Prediction Horizon, as discussed above. See TESLA-1005, [0162], [0169]-[0170], FIG. 10, FIGS. 12a-12c, FIGS. 13a-13d. The values of L and J_{fuel} for each location are determined mathematically (*calculating an energy value*) based on the corresponding speed value, as also discussed above.

100. Thus, determining the values of L and/or J_{fuel} for the multiple locations along the Prediction Horizon based on the calculated speed values corresponds to *calculating a plurality of energy values consumed by the vehicle to travel the route* (e.g., the values of L and/or J_{fuel} for the N locations along the Prediction Horizon) *based on a plurality of variations in a target speed of said vehicle between pairs of segment destinations* (e.g., based on the per-location calculated speeds along the Prediction Horizon).

[1d] (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and

101. Neiss renders limitation [1d] obvious for the reasons described below.

102. Neiss's overall vehicle operating cost function, J , is a summation, over the N locations along the prediction horizon, of the values of the function L (*energy values*; see [1c], above), e.g., the overall cost function J corresponds to a *summation of said energy values*:

$$J = \Phi(v_N) + \sum_{k=0}^{N-1} L(s_k, v(s_k), th(s_k)) \rightarrow \min \quad (\text{Eq. 30})$$

“energy value”
at location k

“summation of energy values”

TESLA-1005, [0132].

103. Neiss’s optimization process aims to “minimize vehicle operating ‘costs,’ *e.g.*, to minimize the overall vehicle operating cost function J (the *summation of said energy values*). TESLA-1005, [0132]; *see* [0127] (“the cost function J [] is used in the minimization analysis”), [0161] (“the Cost Minimization Algorithm”), [0001] (“a cruise control unit for a motor vehicle, which minimizes vehicle operating costs”), [0081] (“A system is later called optimal if the calculated control sequence minimizes the cost function”), claim 1 (“iteratively calculating ... vehicle control parameters that minimize said vehicle operating cost function”), claim 13 (“parameters which minimize said analytically calculated vehicle operating cost”), [0169], [0171], [0177]-[0187], [0189]-[0191]. Minimizing the cost function J (that is represented as a summation of energy values) corresponds to identifying the speed (v_k) and throttle (th_k) values for each location along the Pre-

diction Horizon that result in a minimum (*best*) value for the summation that defines the function J , e.g., that *achieve a best summation of said energy values*.

For instance, the minimum value for the summation corresponds to a *best summation*, e.g., in that a minimized operating cost function J reflects “minimize[d] vehicle operating ‘costs’” that achieve the objectives specified by the individual cost functions incorporated into the overall cost function J . TESLA-1005, [0132]; *see* [0126]. For instance, minimization of J (a *best summation of said energy values*) addresses the objective that “[t]he vehicle should consume less fuel.” TESLA-1005, [0082]; *see* [0031] (“determine ... a desired speed ... in order to maximize fuel savings”).

104. The minimization of J reflects the objective that “[t]he vehicle should consume less fuel,” e.g., as expressed by the cost function J_{fuel} . TESLA-1005, [0082]. Minimization of J thus corresponds to minimization of J_{fuel} (subject to constraints of other relevant cost functions). TESLA-1005, [0082]. The J_{fuel} cost function is a summation of the J_{fuel} value for each of the N locations of the Prediction Horizon (*energy values*; *see* [1c], above), e.g., the J_{fuel} cost function corresponds to *a summation of said energy values*:

$$J_{fuel} = \frac{1}{2} \cdot h \cdot \sum_{k=0}^{N-1} S \psi v_k th_k^2, \quad (\text{Eq. 18})$$

“**energy value**”
at location k

“**summation of energy values**”

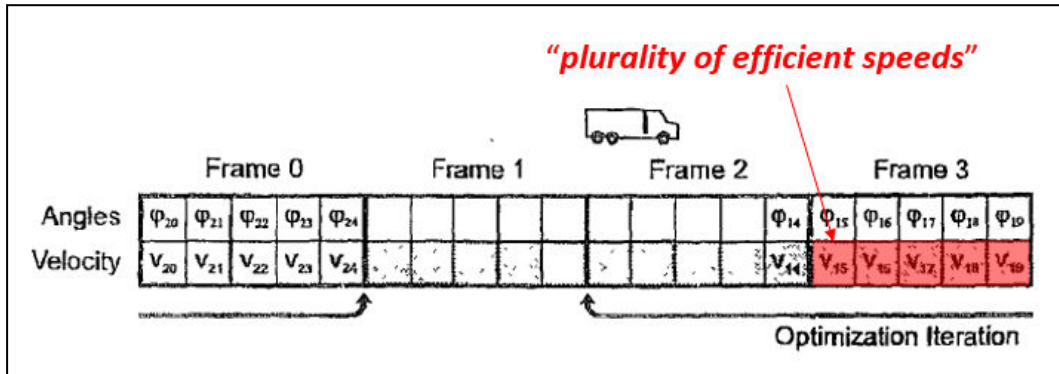
Thus, the minimization of J_{fuel} (achieved through identification of the speed (v_k) and throttle (th_k) values for each location along the Prediction Horizon that minimize the overall cost function J , as discussed above) corresponds to minimization of the summation that defines the function J_{fuel} , *e.g.*, **achieving a best summation of said energy value**. For instance, the minimum value for the summation corresponds to a **best summation**, *e.g.*, in that a minimized J_{fuel} cost function achieves the objective that “[t]he vehicle should consume less fuel.” TESLA-1005, [0082].

105. Neiss’s optimization process is implemented via an iterative optimization algorithm that calculates values for “optimal velocity, throttle pedal positions, and controller gain series” for each location along the Prediction Horizon. TESLA-1005, [0162]. After one or more iterations, the calculated values “approach closer to the optimal values,” *e.g.*, the values that minimize the overall operating cost function J . TESLA-1005, [0191]; *see* [0162]-[0163] (“the optimal ve-

locity, throttle pedal positions, and controller gain series are stored in a look-up table,” where “[t]he look-up table values are calculated online, in real time as the vehicle proceeds along the traveled route”), claim 1 (“as the vehicle travels said route, iteratively calculating ... vehicle control parameters that minimize said vehicle operating cost function”) [0171], [0185]-[0186], [0190].

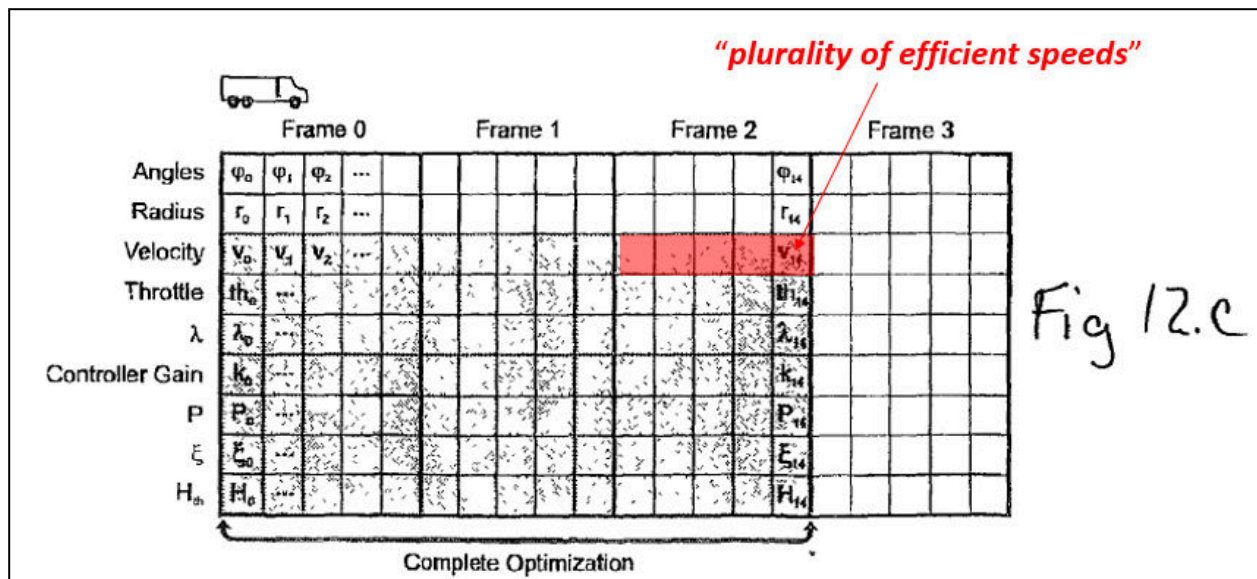
106. These “closer to [] optimal” speed values correspond to ***a plurality of efficient speeds*** (e.g., the optimized speed for each location along the Prediction Horizon) ***that achieve a best summation of said energy values*** (e.g., that minimize the overall vehicle operating cost function, J and the individual cost function J_{fuel}). TESLA-1005, [0191]. For instance, these identified speeds correspond to ***efficient speeds*** because they are speeds that achieve the objective that “[t]he vehicle should consume less fuel.” TESLA-1005, [0082]; *see* [0031] (“determine ... a desired speed ... in order to maximize fuel savings”). These ***efficient speeds*** are ***determined*** via the iterative execution of Neiss’s optimization algorithm. *See* TESLA-1005, [0178]-[0191].

107. For instance, the per-location speed values highlighted in red in FIG. 13d, below, correspond to some of these ***plurality of efficient speeds***, e.g., in that they are “closer to the optimal” speed values calculated (***determined***) via “two optimization iterations.” TESLA-1005, [0191].



Excerpt from Neiss, FIG. 13d (annotated)

108. Similarly, the per-location speed values highlighted in red in FIG. 12c, also below, likewise correspond to some of these *plurality of efficient speeds*, e.g., in that they are “optimal” speed values calculated (*determined*) via “several optimization iterations.” TESLA-1005, [0180]; see [0185]-[0186].



Excerpt from Neiss, FIG. 12c (annotated)

[1e] (e) notifying an operator of said vehicle about said efficient speeds to travel between each of said segment destinations.

109. Neiss renders limitation [1e] obvious for the reasons described below.

110. In Neiss’s “predictive cruise control system,” “[t]he vehicle is [] controlled by reading the optimized vehicle control parameters from the memory, corresponding to the current position of the vehicle.” TESLA-1005, [0015]; *see* [0014] (“The vehicle velocity is then controlled to follow an analytically computed optimal driving strategy”), claim 1 (“controlling current vehicle operation based on said optimized vehicle control parameters”), [0042]. That is, as the vehicle drives along the Prediction Horizon, the identified optimized speed (*efficient speed*) and throttle position for each current location of the vehicle is retrieved, and the vehicle is controlled to drive at that speed. *See* TESLA-1005, [0015], FIG. 4, FIG. 15. Over the entirety of the route, the vehicle is thus controlled to travel at the efficient speeds at the locations along the route that correspond to the locations within each frame (*said efficient speeds to travel between each of said segment destinations*). That is, Neiss’s predictive cruise control system controls the vehicle to travel at the optimized speed corresponding to the vehicle’s current position (*efficient speeds*) as the vehicle travels along the Prediction Horizon.

111. A POSITA would have found it obvious to *notify an operator of the vehicle* about the current speed of the vehicle as the vehicle travels along its route, as discussed in the following paragraphs. Because the current speed of the vehicle

is controlled to be the optimized speed corresponding to the vehicle's current position (*efficient speeds*), this notification thus corresponds to ***notifying an operator about said efficient speeds***. For instance, a POSITA would have found it obvious that, as the vehicle moves from one location to the next along the Prediction Horizon, the efficient speed, e.g., the current speed (which corresponds to the optimized speed for that location) is displayed on a dashboard (e.g., speedometer) display of the vehicle.

112. A POSITA would have found it obvious to display current vehicle speed to travel (*efficient speed*) at each location of a frame (between segment destinations) for at least the following reasons.

113. The first reason why a POSITA would have been motivated to display current speeds on a speedometer is because this was conventional: vehicles conventionally have a dashboard display (including a speedometer) that displays the current speed of the vehicle. *See* TESLA-1008, FIG. 3C (illustrating a speedometer); TESLA-1012, 2:44-45 (describing a dashboard speedometer); TESLA-1006, FIG. 4 (illustrating a dashboard display of the vehicle's current speed). Thus, a POSITA would have been motivated to display the current vehicle speed, as controlled by Neiss's predictive cruise control system, within an in-vehicle display, and such a configuration is just the application of known techniques (e.g., displaying current speed of a vehicle on a dashboard/speedometer display) to a known

system (*e.g.*, a vehicle implementing predictive cruise control). Moreover, the results of this implementation—a vehicle in which calculated current speeds are displayed—is predictable.

114. The second reason why a POSITA would have been motivated to display the current vehicle speed is because doing so provides the vehicle's operator with valuable information about the vehicle operation. For instance, knowing the vehicle's current actual speed can allow the driver to override the cruise control system for safety reasons, such as if the driver feels the vehicle is moving too quickly for current conditions (*e.g.*, rain/snow/fog/etc.); or for legal reasons, such as if there is a work zone with a lower speed limit that is not known to the cruise control system.

115. The third reason why a POSITA would have been motivated to display the current vehicle speed is because the POSITA can use this information for comfort or efficiency reasons. For instance, if a driver prefers to travel at a speed slightly below the speed limit because of his/her own comfort level with the road (*e.g.*, wanting to avoid a feeling of lateral acceleration due to curves in the road), the driver can monitor the vehicle's actual speed and override the cruise control if desired. In a similar vein, the driver can override the vehicle's actual speed for efficiency reasons, such as if the driver wants to accelerate in anticipation of overtaking a leading vehicle in a passing zone.

116. The fourth reason a POSITA would have been motivated to pursue this implementation is because display of current vehicle speed was a known technique applied to a known device (a vehicle implementing Neiss's predictive cruise control) ready for improvement. For instance, Neiss does not explicitly state that the current vehicle speeds are displayed, and a POSITA would have recognized the advantages of implementing current display in Neiss's vehicle, *e.g.*, for the reasons I discussed above.

117. A POSITA would have expected success in pursuing this implementation because it involves common techniques and devices, *e.g.*, dashboard display of current vehicle speeds at locations of a frame (between a pair of segment destinations). As I discussed above, dashboard speed displays are conventional, predictable technologies, and displaying vehicle current speed on a dashboard speedometer is common and presents no unexpected results.

118. I also note that a POSITA would have been motivated to display the determined efficient speed for an upcoming location as the vehicle travels along the Prediction Horizon (***notify an operator about said efficient speeds***). For instance, while the vehicle is traversing the location corresponding to a given integration step in the frame, a dashboard speed display would display the calculated speed for the next integration step. This would alert the driver to upcoming

changes in speed, *e.g.*, allowing the driver to override the system (*e.g.*, to accelerate or brake) if the driver feels that this calculated speed is undesirable. This implementation makes use of available data (calculated speeds for upcoming sections of a route, which is data that is already available in Neiss) in a straightforward way (simply displaying this already-calculated data). Moreover, I note that display of recommended speeds for upcoming route sections was well-known. *See, e.g.*, TESLA-1011 (Andersson), 2:35-39 (“the method may comprise the step of feeding said outputted speed plan to a driver display unit, for at least one of displaying the speed plan for the driver, and informing the driver of suitable speed adaptations based on the speed plan”), 4:2-5 (“It is also possible to combine the two modes, *e.g.* using autonomous control mode, and displaying speed changes on the display unit 6, in order to inform the driver of up-coming speed changes”).

(b) Claim 2

[2] The method of claim 1, further comprising the step of: continuously calculating said efficient speeds until a final destination is reached.

119. Neiss renders claim 2 obvious for the reasons described below.

120. Neiss describes that its process of calculating parameters to optimize the overall vehicle operating cost (*calculating said efficient speeds*; *see* [1d]) occurs “continuously ... as the vehicle (and hence the Prediction Horizon) moves along,” *e.g.*, *continuously calculating said efficient speeds*. TESLA-1005, [0015];

see [0012] (“a vehicle control system in which optimal vehicle control values are continuously calculated online during operation of the vehicle, taking into account the current vehicle velocity as it transits a particular route”), [0163] (“The look-up table values are calculated online, in real time as the vehicle proceeds along the traveled route”), [0009] (“one purpose of the present invention is to provide a vehicle control system which continually adjusts vehicle control parameters to optimum values based on current vehicle operating conditions as well as stored route information”), [0010] (“Another object of the invention is to provide a vehicle control system which exhibits a high degree of flexibility, and is able to adapt the velocity control to changing driving situations which result from the intervention of external constraints on driving behavior as the vehicle transits a particular route”), [0165]-[0167] (describing that real-time calculation “gives the opportunity to change the route while driving” and allows for “taking the current velocity into account”), [0169] (“a new optimization calculation only occurs once the vehicle has covered a specified distance ... or when the set speed is changed”), [0190] (“All these calculations are done while the vehicle is driving in the first frame”), [0191] (“when the vehicle is driving in frame 2 ... an optimization iteration is applied on frames 2, 3, and 0”). Given these disclosures, a POSITA would have understood Neiss’s calculation of efficient speeds to continue *until a final destination is reached*.

121. A POSITA would have found it obvious for the calculation to continue *until a final destination is reached*, for at least the following reasons.

122. The first reason why a POSITA would have found this to be obvious is because the calculation of vehicle control parameters has advantages. Specifically, calculating the vehicle control parameters allows for calculation of “optimal vehicle control values” to meet target objectives, such as minimization of fuel consumption. TESLA-1005, [0012]. A POSITA would have been motivated to continue this calculation throughout the vehicle’s entire trip (*e.g., until a final destination is reached*) to obtain these benefits for as much of the trip as possible. Otherwise, if calculation were to stop before the vehicle reaches the end of its trip, vehicle control parameters for later portions of the trip may not be optimal, for instance, if conditions change (*e.g., due to traffic, weather, etc.*) after the last calculation was completed.

123. The second reason why a POSITA would have been motivated to carry out these calculations until the end of the trip is because ongoing calculation of parameters allows for recalculation to address changes in conditions. For instance, recalculation may be warranted if there is “a slower vehicle driving ahead” or if the driver wishes to “change the route while driving.” TESLA-1005, [0165], [0167]. A POSITA would have recognized that continuing the calculation *until a final destination is reached* extends this flexibility throughout the vehicle’s entire

trip, and would have been motivated to pursue this implementation to obtain this flexibility, which would then help to ensure that optimized parameters for the current situation can be (re)calculated at any suitable point during the trip.

124. The third reason why a POSITA would have been motivated to pursue this implementation is because it is just the application of known techniques (*e.g.*, ongoing calculating of vehicle operating parameters until a final destination is reached) to a known system (*e.g.*, Neiss's system for ongoing calculation of such parameters). And the results of this implementation are predictable: a system for ongoing calculation of vehicle operating parameters until a final destination is reached.

125. The fourth reason why a POSITA would have found this implementation to be obvious because it is one of only a small number of conventional implementations for the calculation of the vehicle operating parameters. For instance, in a system implementing an algorithm such as Neiss's for ongoing, real time optimization of vehicle operating parameters, the optimization calculation can either be performed until a final destination is reached, or can end before the destination is reached. Either one of these implementations involves essentially the same process: real-time optimization of vehicle control parameters during travel, and given the advantages of performing the optimization until the final destination is reached a POSITA would have found it obvious to choose that specific implementation.

126. A POSITA would have expected success in pursuing this implementation because it involves common techniques and devices—specifically, merely extending the functionality described by Neiss (which already describes optimizations being performed iteratively for road sections ahead of the vehicle as its being driven) through the entirety of the trip. This implementation is conventional and predictable, and presents no unexpected results, because it is consistent with what is already taught by Neiss.

(c) Claim 3

[3] The method of claim 1, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.

127. Neiss renders claim 3 obvious for the reasons described below.

128. Neiss’s overall vehicle operating cost function “is based on a mathematical model of vehicle dynamics for a vehicle travelling on a road,” where the mathematical relationship includes the factor F_i , which are “longitudinal forces affecting vehicle operation.” TESLA-1005, claims 5-6; *see* [0050] (“In order to optimize operation of the vehicle in an adaptable analytical manner based on actual current vehicle operation as the journey progresses, a mathematical model of a vehicle driving on the road is needed,” which model depends on “the external and internal forces affecting the vehicle”).

129. The *determining of said efficient speeds* is based on the overall vehicle operating cost function, and thus is also based on this mathematical relationship. See [1d], above.

130. Neiss further explains that “ F_i comprises at least forces exerted by the vehicle engine, vehicle brakes, and drag, and forces exerted by road gradient and friction,” and therefore this mathematical relationship (and thus the *determining of said efficient speeds*) is based on drag (*based on (i) an aerodynamic drag of said vehicle*), forces exerted by road gradient (*(iii) a change in potential energy of said vehicle due* (among other things) *to a road gradient*), and friction (*(ii) a rolling resistance of said vehicle*). TESLA-1005, claim 7. See also TESLA-1005, [0054]-[0058] (listing “the forces that act on” a vehicle). One of these forces is F_{roll} , which is based on the “friction coefficient of the street ... [and] the grade of the street” (e.g., corresponding to *(ii) a rolling resistance* and *(iii) a change in potential energy due to a road gradient*). *Id.*, [0054]. Another force is F_{grade} , which is “[t]he force caused by the gravity” (e.g., corresponding to *(iii) a change in potential energy due to a road gradient*). *Id.*, [0055]. Yet another force is “[t]he turbulent friction,” which is based on “the density of the air, ... the surface area of the vehicle ... [and] velocity” (e.g., corresponding to *(i) an aerodynamic drag*)). Spe-

cifically, a POSITA would have understood that these forces relate to energy transfer at least because forces that move an object produce work, and work is associated with energy transferred.

131. Alternatively/additionally, Neiss also describes that the “cost function includes vehicle fuel consumption as a function of vehicle speed, road gradient, and throttle position,” *e.g.*, the cost function (and thus the *determining of said efficient speeds* using this function) is based on road gradient (*(iii) a change in potential energy of said vehicle due to a road gradient*). TESLA-1005, claim 10.

132. That the amount of energy (fuel) consumed by the vehicle is affected by vehicle characteristics such as the aerodynamic drag and the rolling resistance of the vehicle is corroborated by Morchin, which explains that “[t]he four components of energy use are acceleration, friction, air drag, and hill climbing,” and providing “equations of the energy used for propelling a ground vehicle,” including an equation for air drag that includes a “coefficient of aerodynamic drag,” and an equation for friction that includes a “coefficient of rolling resistance.” TESLA-1007, 2. Morchin also corroborates that vehicle energy consumption is affected by the road gradient. Morchin provides an equation for hills that include “road surface grade” factor as one of the “equations of the energy used for propelling a ground vehicle.” TESLA-1007, 2. As another example, Neiss describing that the “equation of motion” of a vehicle is based on “the grade of the street.” TESLA-

1005, [0053]-[0059]. More generally, a POSITA would have understood that a vehicle transiting a road gradient experiences a change in potential energy; for instance, a vehicle climbing an incline gains potential energy as it ascends.

(d) Claim 5

[5] The method of claim 1, wherein said determining of said efficient speeds is based on at least one of (i) an acceleration of said vehicle to one or more of said efficient speeds and (ii) a deceleration of said vehicle to one or more of said efficient speeds.

133. Neiss renders claim 5 obvious for the reasons described below.

134. Neiss's optimization process (and thus the *determining of said efficient speeds*; see [1d], above) accounts for acceleration/deceleration of the vehicle. Specifically, Neiss describes that "[t]he accelerating or decelerating force caused by the motor is calculated ... from the engine torque." TESLA-1005, [0061]. This force is incorporated into "the equation of motion" for the vehicle, which expresses "a mathematical model of a vehicle driving on the road." TESLA-1005, [0051], [0059]. The equation of motion is used as a constraint in the optimization process: "to minimize vehicle operating 'costs' (as defined), it is necessary to calculate a sequence of control values ... so that the cost function" is minimized "while keeping the equality constraints," which are specified by the vehicle's equation of motion. TESLA-1005, [0059], [0131]-[0133]; see [0051].

135. A POSITA would have understood that when the optimized speeds (*said efficient speeds*; *see* [1d], above) for two adjacent locations along the Prediction Horizon differ, the vehicle would be controlled to accelerate or decelerate to comply with this difference when moving from one location to the next (*e.g.*, to *accelerate to the efficient speed* of a next location when that speed is faster than that of a current location, or to *decelerate to the efficient speed* of the next location when it is slower than that of a current location). This acceleration/deceleration is accounted for in Neiss's optimization process through its reliance on the vehicle's equation of motion, which is based on "[t]he accelerating or decelerating force caused by the motor," *e.g.*, the optimization process (and thus the *determining of said efficient speeds*; *see* [1d], above) is *based on an acceleration of the vehicle to an efficient speed and/or a deceleration of the vehicle to an efficient speed*.

TESLA-1005, [0061].

(e) Claim 6

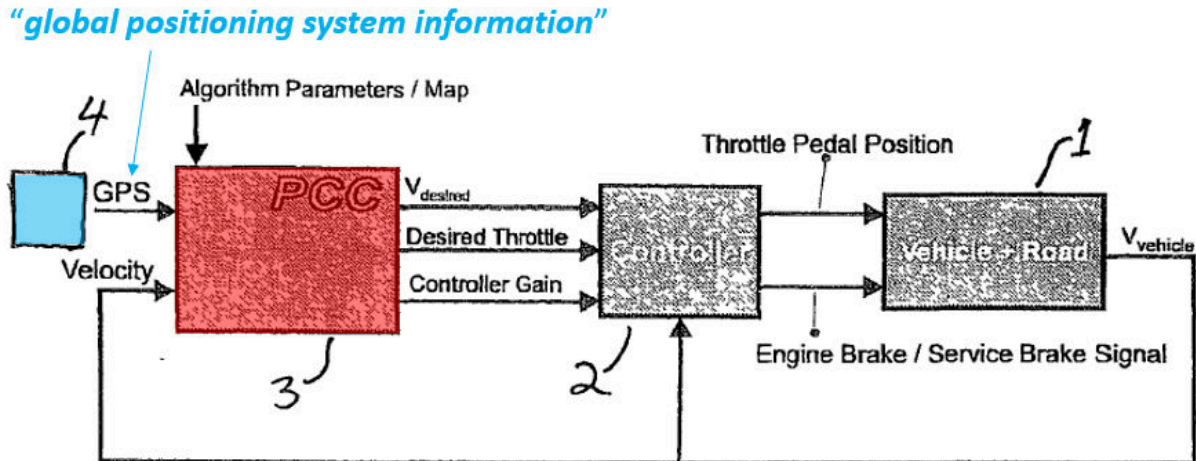
[6] The method of claim 1, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.

136. Neiss renders claim 6 obvious for the reasons described below.

137. As discussed above in [1d], determining the values of L for the multiple locations along the Prediction Horizon based on the calculated speed values corresponds to calculating said energy values. The Prediction Horizon is "the

route ahead of the vehicle,” e.g., the route ahead of a current location of said vehicle. TESLA-1005, [0015]; see [0047] (“desired velocity, throttle pedal, and controller gain values are stored for an area (the Prediction Horizon) around the current vehicle position”), [0162] (“an area around the current vehicle position[] (“Prediction Horizon”), claim 1 (“iteratively calculating ... vehicle control parameters ... for a predetermined distance along said route ahead of said vehicle”), Abstract. That is, determining the values of L (calculating said energy values) is based on speed values along the Prediction Horizon, which in turn is based on the current location of said vehicle, e.g., calculating said energy values is based on a current location of said vehicle.

138. Moreover, Neiss describes that the current location of said vehicle is determined by global positioning system information. Specifically, Neiss’s predictive cruise control system receives “information about the current position of the vehicle” from a “Global Positioning System 4,” blue in FIG. 4, below. TESLA-1005, [0034]-[0035]; see [0014] (“the current position is determined by means of a signal received from a Global Positioning System (GPS)”), [0046] (a “Position Estimator ... determines the current position of the vehicle on the road by integrating the vehicle velocity and taking into account the incoming GPS messages”), claim 4 (“wherein said vehicle position is determined based on input signals from a GPS system”), [0004], FIG. 6, FIG. 15.



Excerpt from Neiss, FIG. 4 (annotated)

(f) Claim 8

[8] The method of claim 1, further comprising the step of: calculating said target speed in response to a position of a gas pedal of said vehicle.

139. Neiss renders claim 8 obvious for the reasons described below.

140. Neiss describes that “[w]hen vehicle velocity drifts significantly from the velocity stored in the look-up table for the current position (as might be caused ... by a slower vehicle driving ahead,” the “velocity values for the following positions in the look-up table then can no longer be considered to be optimal,” and the optimization algorithm is re-executed “taking the current velocity into account.” TESLA-1005, [0167]. For instance, a POSITA would have recognized that this re-optimization may be triggered when the current speed drifts outside of the speed band, such that the vehicle is no longer operating in its optimal range. Furthermore, a POSITA would have found it obvious (as discussed below) that when this

new optimization is performed, the “Set Speed” (*target speed*; see [1c], above) for the optimization is determined based on the vehicle’s current speed. TESLA-1005, [0083].

141. Moreover, a POSITA would have understood that the vehicle’s current speed—which informs the setting of the target speed—is achieved by the driver’s interaction with the gas pedal, *e.g.*, pressing the gas pedal to accelerate or easing pressure on the gas pedal to decelerate. Indeed, this is the conventional function of the gas pedal of a vehicle. Thus, the *target speed* is set in response to driver interaction with the gas pedal in controlling the vehicle’s current speed, *e.g.*, *in response to a position of the gas pedal*. Furthermore, a POSITA would have understood that the target speed is *calculated* in response to the position of the gas pedal, *e.g.*, in that based on a new desired speed as specified in response to the driver’s interaction with the gas pedal, a new numerical value for the actual speed (and thus a new *target speed*) of the vehicle would be computed.

142. A POSITA would have been motivated to set the *target speed* based on the vehicle’s current speed (and thus *in response to a position of the gas pedal*) when a re-optimization process is performed for at least the following reasons.

143. The first reason for this is that a POSITA would have recognized that when the current velocity “drifts significantly from the velocity stored in the look-up table for the current position,” the current velocity may no longer be an optimal

velocity that satisfies the objectives specified by the vehicle cost function—particularly if the current speed is no longer within the prescribed speed band. TESLA-1005, [0167]. For instance, both the overall cost function J and the cost function J_{fuel} are dependent on vehicle speed. *See id.*, [0097], [0132]. Deviation from the per-location speed identified by optimizing these functions means that the vehicle is no longer operating under optimal conditions. When such a deviation occurs, a POSITA would have been motivated to re-optimize the vehicle operating parameters using the actual vehicle speed as the Set Speed (*e.g.*, to set the target speed based on current velocity) to restore optimal operation given actual current conditions.

144. The second reason why a POSITA would have been motivated to set the target speed based on current velocity is because doing so is just the application of known techniques (*e.g.*, setting the target speed of a cruise control system based on current vehicle speed) to a known system (*e.g.*, Neiss’s predictive cruise control system). Moreover, this implementation produces predictable results: a predictive cruise control system in which the current speed is used as the target speed.

145. The third reason why a POSITA would have been motivated to set the target speed based on current velocity is because this is an example of applying a known technique (again, setting the target speed of a cruise control system based

on current vehicle speed) to a known device (a vehicle implementing Neiss's predictive cruise control) ready for improvement. Specifically, Neiss's system is ready for improvement in that while Neiss indicates that a re-optimization may occur responsive to a deviation from the optimized speed, it does not explicitly describe how such a re-optimization would be implemented or how the deviation from the optimization speed is used in the recalculation of the vehicle operating parameters.

146. A POSITA would have expected success in pursuing this implementation because doing so makes use of known data (namely, the vehicle's current speed, and mathematical expressions defining cost functions for vehicle operation) in a predictable way (*e.g.*, according to Neiss's optimization algorithms). Moreover, a POSITA would have expected success because this approach is consistent with Neiss's teachings that re-optimization can be performed when actual speed deviates from the optimized speed at a given location. *See* TESLA-1005, [0167].

(g) Claim 9

[9] The method of claim 1, further comprising the step of: shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

147. Neiss renders claim 9 obvious for the reasons described below.

148. Neiss's predictive cruise control system controls the vehicle to travel at the optimized speed corresponding to the vehicle's current position (*efficient*

speeds) as the vehicle travels along the Prediction Horizon. *See* [1e], above; TESLA-1005, [0014]-[0015], [0042]. As discussed in the following paragraphs, a POSITA would have understood this control to include *shifting gears of an automatic transmission in said vehicle based on said efficient speeds*, *e.g.*, in order to achieve the efficient speed corresponding to each current vehicle position.

149. Neiss describes a vehicle that is powered by “fuel injection to the motor,” *e.g.*, a vehicle powered by internal combustion. TESLA-1005, [0039]. A POSITA would have understood such vehicle to have *a transmission*, which was and is a standard feature of fuel-powered vehicles that have internal combustion engines. For instance, this is explained by Ha, which describes “an automatic transmission for a vehicle.” TESLA-1012, 1:6-7. Wolf also corroborates this, stating that an “automatic transmission” was “known.” TESLA-1018, [0003]. Moreover, a POSITA would have found it obvious for the transmission of Neiss’s vehicle to be an *automatic transmission*, *e.g.*, because of the widespread adoption and advantages of automatic transmissions. For instance, Wolf describes that automatic transmissions are advantageous in terms of “fuel consumption.” TESLA-1018, [0004]. Moreover, automatic transmissions are simply easier for the driver to operate than manual transmissions, *e.g.*, because the driver does not need to attend to changing gears and the associated complexities, *e.g.*, with timing of clutch operation. *See also* Ha, describing a specific example of an automatic transmission

that “provides for a simplified system having improved fuel economy.” TESLA-1012, 6:27-35. Still alternatively or additionally, a POSITA would have found the implementation of an *automatic transmission* to be obvious because it is one of few conventional implementations for vehicle transmissions: including manual and automatic. *See* TESLA-1018, [0003] (“It is known that automatic transmissions in motor vehicles can be controlled to either fully automatically or manually change their reduction ratio.”)

150. It was conventional for a cruise control system to shift gears of an automatic transmission to achieve a desired travel speed. *See* TESLA-1013, 2:35-45 (“the cruise control device outputs a shift command signal to the automatic transmission to shift down the transmission ... [or] a shift command signal to shift up the automatic transmission, to thereby quickly increase the vehicle speed V toward the target speed V_O ”). Moreover, a cruise control system that shifts gears of a transmission is advantageous in that it enables efficient operation of the engine to maintain a desired speed consistent with environmental conditions. In an example, to maintain the vehicle’s speed as it travels up a hill, the cruise control may down-shift such that the engine can provide more power; when the vehicle reaches a relatively flat road, the cruise control may shift to a higher gear for more fuel-efficient engine operation. These examples are described by Neiss (TESLA-1005), *e.g.*, at [0031].

151. In light of the conventional nature of cruise control systems that shift gears of automatic transmissions, and given the advantages of such systems, a POSITA would have understood or found obvious that Neiss's predictive cruise control system would *shift gears of the automatic transmission* to control the vehicle to travel at the efficient speed for each current location of its travel along the Prediction Horizon, e.g., shifts gears *based on the efficient speeds*.

(h) Claim 10

[10pre] A method of managing a power consumption of a vehicle, comprising the steps of:

[10a] (a) receiving a route at a computer of said vehicle;

[10b] (b) segmenting said route into a plurality of segment destinations;

[10c] (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;

[10d] (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and

152. See [1pre]-[1d].

[10e] (e) applying power corresponding to said efficient speeds to an engine of said vehicle to travel between each of said segment destinations.

153. Neiss renders limitation [10e] obvious for the reasons described below.

154. In Neiss’s “predictive cruise control system,” “[t]he vehicle is [] controlled by reading the optimized vehicle control parameters from the memory, corresponding to the current position of the vehicle.” TESLA-1005, [0015]; *see* [0014] (“The vehicle velocity is then controlled to follow an analytically computed optimal driving strategy”), claim 1 (“controlling current vehicle operation based on said optimized vehicle control parameters”), [0042]. These “vehicle control parameters” include the optimized speed for each location along the Prediction Horizon (*said efficient speeds to travel between each of said segment destinations*). TESLA-1005, [0015]. That is, Neiss’s predictive cruise control system controls the vehicle to travel at the optimized speed corresponding to the vehicle’s current position (*efficient speeds*) as the vehicle travels along the Prediction Horizon.

155. Specifically, the vehicle control is implemented by providing “a command signal ... to the engine so that it attempts to achieve the desired speed.” TESLA-1005, [0042]; *see* [0041] (“All these output signals are inputs for the controller 2 which controls the vehicle to follow the calculated velocity trajectory”). Generally, Neiss describes that “the desired vehicle speed is converted to a desired engine speed, which is sent to the engine and the engine achieves it via its own controller or using a separate adaptive cruise controller.” *Id.*, [0042]. For instance, “[i]n the case of a diesel engine, the engine determines how much fuel to inject” to

achieve a target speed (*e.g.*, the ***efficient speed*** for each current position as the vehicle travels along the Prediction Horizon), *e.g.*, ***power is applied corresponding to said efficient speeds***. TESLA-1005, [0042]. Alternatively, “if the system is implemented with a gasoline engine, the command could actually be a throttle angle,” which controls applied power to achieve a target speed (*e.g.*, the ***efficient speed*** for each current position as the vehicle travels along the Prediction Horizon), *e.g.*, ***power is applied corresponding to said efficient speeds***. TESLA-1005, [0042]; *see* [0034] (“a closed loop cruise control system in which the throttle of the vehicle 1 is controlled based on an error signal between actual and desired vehicle speed.”).

(i) Claim 11

[11] The method of claim 10, further comprising the step of: continuously calculating said efficient speeds until a final destination is reached.

156. *See* [2].

(j) Claim 12

[12] The method of claim 10, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.

157. *See* [3].

(k) Claim 13

[13] The method of claim 10, further comprising the step of: notifying an operator of the vehicle about said efficient speeds to travel between each of said segment destinations.

158. See [1e].

(l) Claim 14

[14] The method of claim 10, wherein said determining of said efficient speeds is based on at least one of (i) an acceleration of said vehicle to one or more of said efficient speeds and (ii) a deceleration of said vehicle to one or more of said efficient speeds.

159. See [5].

(m) Claim 15

[15] The method of claim 10, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.

160. See [6].

(n) Claim 17

[17] The method of claim 10, further comprising the step of: calculating said target speed in response to a position of a gas pedal of said vehicle.

161. See [8].

(o) Claim 18

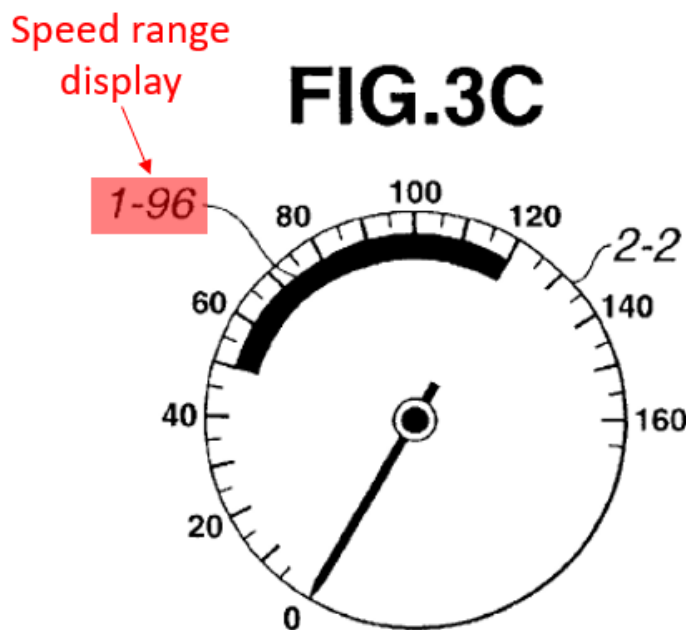
[18] The method of claim 10, further comprising the step of: shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

162. See [9].

B. [GROUND 1B] – Claim 4 is rendered obvious by Neiss-Hirasago

1. Overview of Hirasago (TESLA-1008)

163. Hirasago describes “a constant-speed cruise control for keeping a vehicle speed at a set speed.” TESLA-1008, 1:6-9. One aspect of Hirasago’s system is “a speed range display disposed along a scale of a speedometer,” *e.g.*, “speed range display section 1-96 which is disposed along a speed scale of analog-type speedometer 2—2 in a belt shape.” *Id.*, 1:37-38, 6:31-33, FIG. 3C (below).



Except from Hirasago, FIG. 3C (annotated)

164. The display of the speed range “enables a driver to easily compare a present vehicle speed with a set-condition speed range.” *Id.*, 1:30-34. Hirasago explains that “[t]he set-condition speed range represents a speed range within which it is possible to execute a setting operation of the traveling control.” *Id.*,

12:3-5. With display of this speed range, “[w]hen the driver intends to execute the traveling control ... the driver first looks at speedometer 2—2 to recognize that the present vehicle speed ... is within the set-condition speed range,” and if so, sets the vehicle’s cruise control. *Id.*, 12:32-40.

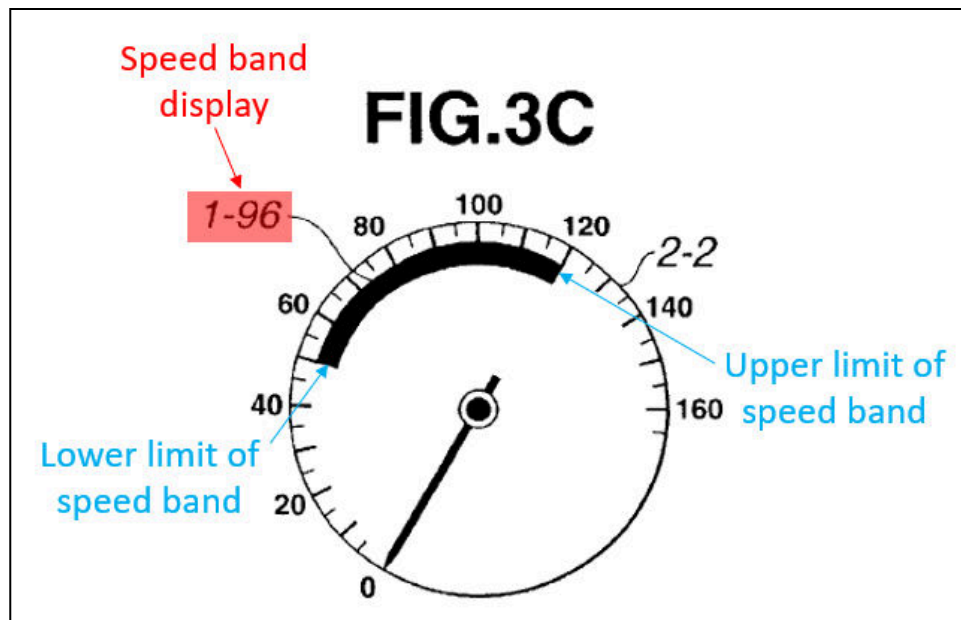
165. Hirasago is analogous art to the ’161 Patent: it is from the same field of endeavor (*e.g.*, vehicle navigation) and is reasonably pertinent to the problem the ’161 Patent was trying to solve (*e.g.*, how to control of vehicle operation along a route).

2. Combination of Neiss and Hirasago

166. Neiss, in combination with Hirasago, renders obvious notifying a vehicle operator (*e.g.*, via display on a vehicle speedometer, which was a conventional component of driver-operated vehicles), information about the speed band, *e.g.*, the range of per-location speed values determined during the optimization of the overall vehicle cost function, as discussed in more detail below.

167. Neiss’s optimization process takes into account a constraint that “[t]he vehicle’s velocity should neither exceed an upper limit nor understood a lower velocity limit,” *e.g.*, that the vehicle speed should remain within a “speed band.” TESLA-1005, [0031], [0084]. In the Neiss-Hirasago combination, this speed band is displayed based on Hirasago’s teachings of displaying speed ranges in the context of vehicle cruise control systems. *See* TESLA-1008, 1:37-38, 6:31-33, FIG.

3C. For instance, the speed band is displayed on the speedometer of the combination vehicle as a “belt shape,” with the lower end of the belt corresponding to the “lower velocity limit” of the speed band and the higher end corresponding to the “upper limit,” as illustrated below. TESLA-1008, 6:31-33.



Neiss-Hirasago composite figure based on Hirasago, FIG. 3C

168. A POSITA would have been motivated to display the speed band in the combination vehicle for at least the following reasons.

169. The first reason why a POSITA would have been motivated to pursue this implementation is to provide the driver with information about vehicle operation, *e.g.*, so the driver understands the speed band within which the predictive cruise control system will operate. Such information can be useful, for instance, to

enable the driver to decide whether to temporarily override the cruise control system, *e.g.*, when passing a slower vehicle or to comply with posted speed limits for a particular road section.

170. The second reason why a POSITA would have been motivated to pursue this implementation because it is just the application of known techniques (*e.g.*, display of a speed band in the context of a cruise control system) to a known system (*e.g.*, a vehicle implementing Neiss's predictive cruise control). And this combination produces predictable results: a vehicle in which a speed band is displayed in the context of a predictive cruise control system.

171. The third reason why a POSITA would have been motivated to pursue this implementation because it is the application of a known technique (*e.g.*, display of a speed band in the context of a cruise control system) to a known device ready for improvement (*e.g.*, a vehicle implementing Neiss's predictive cruise control). Specifically, Neiss describes that its vehicle makes use of a speed band in its cruise control, but does not mention whether the driver is informed of the speed band. A POSITA would have recognized the benefits of improving Neiss's vehicle to display this speed band information, *e.g.*, as I discussed above, to result in a vehicle in which a speed band is displayed in the context of a predictive cruise control system.

172. A POSITA would have had a reasonable expectation of success in pursuing this combination because Hirasago already demonstrates that displaying a speed band in the context of a cruise control system is a viable implementation. *See* TESLA-1008, 1:37-38, 6:31-33, FIG. 3C. Moreover, a POSITA would have expected success because implementation of the combination involves common techniques and devices—display of speed band information (information which is already present in Neiss’s system)—implemented in a conventional way (displayed on a speedometer, as taught by Hirasago, and which is a conventional device commonly present in vehicles). Finally, a POSITA would have expected success because displaying speed information was conventional and predictable, and presents no unexpected results. TESLA-1008, FIG. 3C; TESLA-1012, 2:44-45, FIG. 1; TESLA-1006, FIG. 4.

3. Analysis

(a) Claim 4

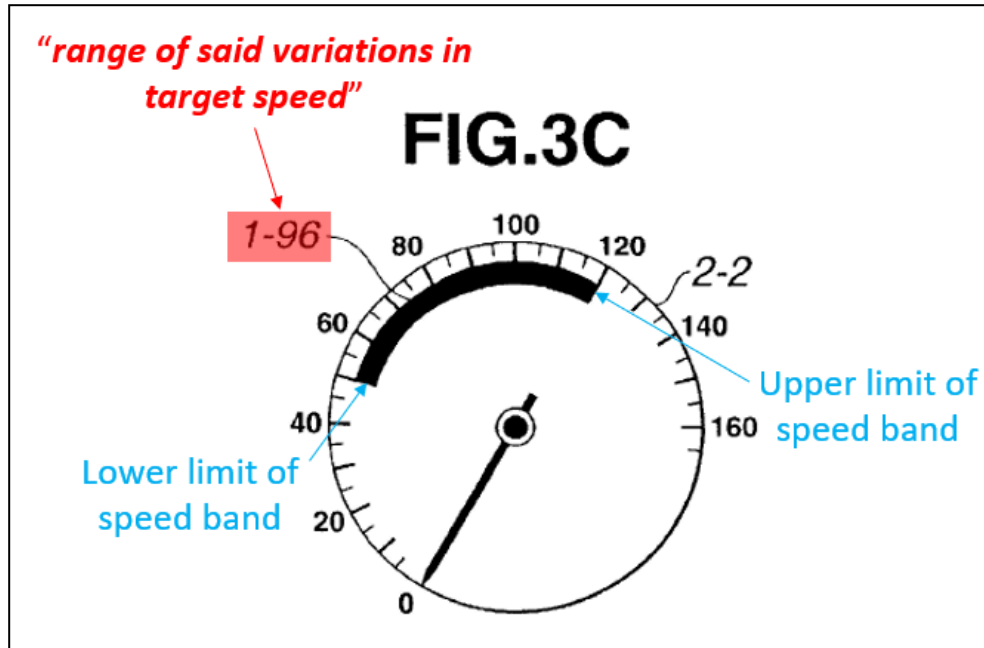
[4] The method of claim 1, further comprising the step of: notifying said operator of a range of said variations in said target speed.

173. Neiss-Hirasago renders claim 4 obvious for the reasons described below.

174. In the Neiss-Hirasago combination, the per-location speed values determined for each iteration of the optimization algorithm correspond to ***variations***

in said target speed, as discussed above for [1c]. The optimization process operates subject to a constraint that these determined speed values “should neither exceed an upper limit nor understood a lower velocity limit,” *e.g.*, that the determined speeds fall within a “speed band.” TESLA-1005, [0031], [0084]; *see* [0103] (“the objective is to keep the velocity within certain limits”), [0104] (“the velocity [should] remain between the lower velocity limit, v_{lower} , and the upper velocity limit V_{upper} ”), claim 8 (“wherein said cost function comprises a desired vehicle speed range and imposes a cost penalty based on an extent to which the vehicle speed exceeds an upper or lower limit of said speed range”), claim 12 (defining the cost function in terms of “an upper limit of a speed range” and “a lower limit of a speed range”). This speed band defines the range of values for the per-location speed values, *e.g.*, ***a range of said variations in said target speed***.

175. In the Neiss-Hirasago combination, illustrated below, the speed band (the ***range of said variations in target speed***) is displayed on a speedometer of the vehicle, based on Hirasago’s teachings of displaying speed bands in the context of cruise control systems. *See* TESLA-1008, 1:37-38, 6:31-33, FIG. 3C. This display informs the vehicle operator of the speed band, *e.g.*, ***notifies said operator of a range of said variations in said target speed***.



Neiss-Hirasago

C. [GROUND 2] – Claims 1, 3, 6-10, 12-13, 15-18 are rendered obvious by Schramm-Clapper

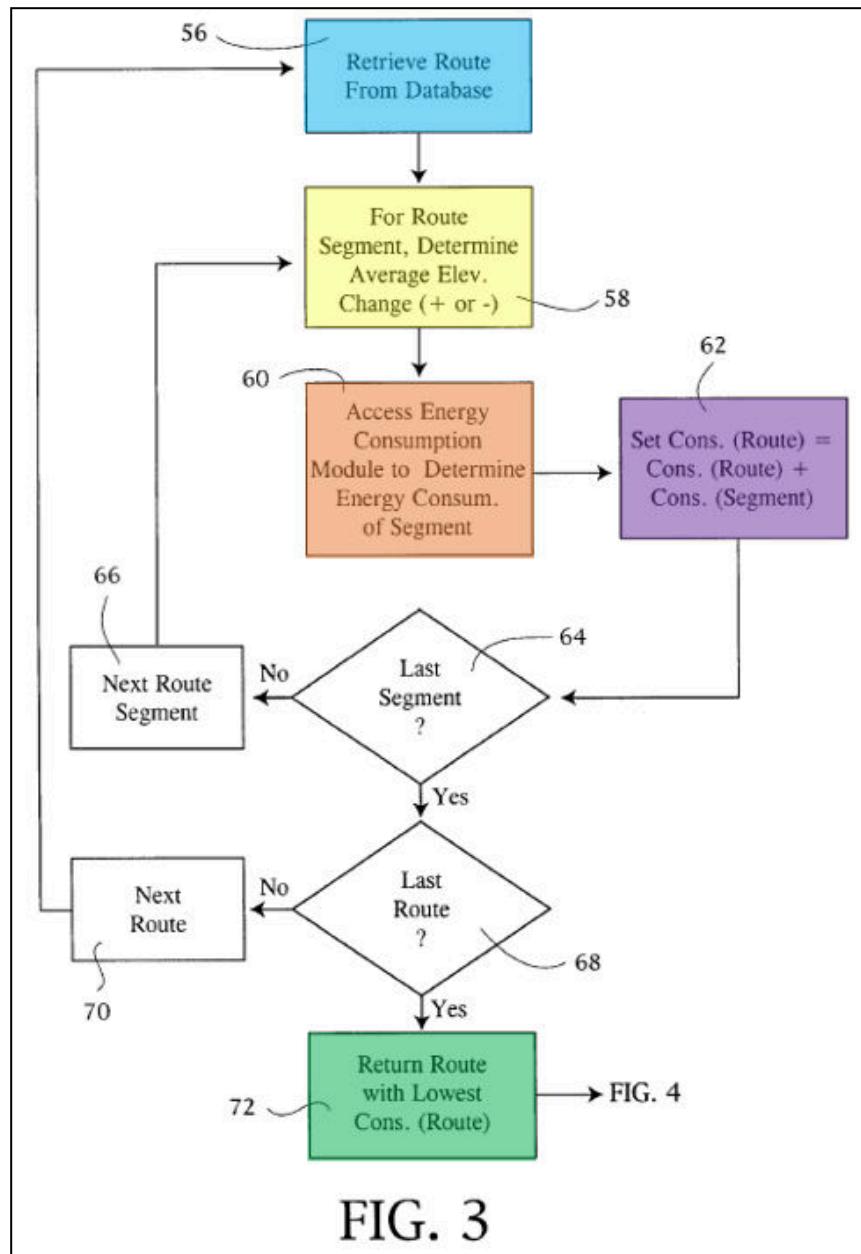
1. Overview of Schramm

176. Schramm describes an approach “for determining an energy-optimum route for a vehicle to take between an origin and a destination.” TESLA-1009, Abstract. Generally, multiple routes are available between an origin and a destination, where “[e]ach route is characterized by an energy consumption.” *Id.*, 2:15-18. A vehicle on-board computer “determines a select route having a minimum energy consumption among the possible routes.” *Id.*, 2:19-21.

Identification of an energy-optimum route

177. In Schramm’s route optimization process, an operator initially specifies an origin and a destination. *See* TESLA-1009, 5:1-13. Additionally, a desired

speed is determined, *e.g.*, by an operator specifying a “desired average speed at which the operator intends to drive [the] vehicle to the destination point” or by determining “the current speed of the vehicle.” TESLA-1009, 5:14-20. Based on the origin, destination, and desired speed, a minimum-energy route is determined by following the process illustrated in Schramm’s FIG. 3, which I have reproduced and annotated below.



Excerpt from Schramm, FIG. 3 (annotated)

178. Specifically, in this process, the vehicle computer accesses a database to retrieve a route between a specified origin and a specified destination (block 56 of FIG. 3, highlighted in blue). *See* TESLA-1009, 5:21-24. The retrieved route is composed of “a series of contiguous route segments,” such as segments that are

each “one mile in length.” *Id.*, 5:32-35. For each segment, the computer determines “the average elevation change” for the segment (block 58, yellow) and then “accesses [an] energy consumption module ... to determine the energy consumption that would be required for the vehicle 12 to traverse the route segment under test at the speed that was input” by the operator (block 60, orange). *Id.*, 5:41-48. I discuss this block 60 process in more detail below.

179. The energy consumption value for each segment of the route is summed with energy consumption values for previously analyzed segments of the route to determine a total energy consumption for the route through the current segment (block 62, purple), as follows: “the logic of the routing module 42 sets a variable ‘consumption_{route}’ (initialized at zero) to be equal to ‘consumption_{route}’ plus the energy consumption (consumption_{segment}) determined at block 60.”

TESLA-1009, 6:11-16. The variable consumption_{route} is the sum of all the energy consumption values of the route up until the current segment. This analysis and summation process is performed iteratively until the energy consumption values for all segments of the route that have been determined and added together. The resulting sum of all of the energy consumption values represents the total energy consumption for the route (*e.g.*, the variable consumption_{route}, when consumption_{segment} values for all route segments have been added together), as shown in blocks 64 and 66 of FIG. 3. *Id.*, 6:16-22.

180. This process of determining the total energy consumption for a route is repeated (blocks 68 and 70 of FIG. 3) for each of multiple possible routes between the origin and the destination. *See* TESLA-1009, 6:22-28. Once the energy consumption values for all routes have been evaluated, “the logic returns the route with the lowest overall energy consumption” (block 72, green). *Id.*, 6:30-31. That is, the value of the variable $\text{consumption}_{\text{route}}$ is evaluated for each of the possible routes by adding together the energy consumption values $\text{consumption}_{\text{segment}}$ for the segments of each route. The values of $\text{consumption}_{\text{route}}$ are compared for all of the evaluated routes, and “the route with the lowest overall energy consumption” is the route that has the lowest value of $\text{consumption}_{\text{route}}$. *Id.*, 6:30-31.

181. Returning to the question of identifying energy consumption values for this route optimization process, the energy consumption values for each of the evaluated route segments are determined (block 60 of FIG. 3, orange) using “an energy consumption table,” shown in FIG. 6, which I have reproduced and annotated below. TESLA-1009, 5:45-53. The energy consumption table includes energy consumption values that correspond to various combinations of elevation change and speed, as I discuss in the next few paragraphs.

		Δ Elev. Factors, For ~~Speech~~ = ("speed")		
Segment Δ Elev. (Aug.)		Speed values		
		1	2	3
Elevation values (base energy consumption)	-x	.8	.8	1 . . .
	.	.	.	.
	.	.	.	.
	.	.	.	.
	0	1	1.01	.
	1	1.01	1.02	.
	2	1.02	1.03	.
	.	.	.	.
	.	.	.	.
	.	.	.	.
	+ x	n	m	k . . .

Excerpt from Schramm, FIG. 6 (annotated)⁴

182. The entries in the first column of this energy consumption table “represent average elevational changes” for a segment, ranging “from a high negative value denoted -X, through zero, to a high positive value denoted +X.” *Id.*, 5:53-59.

⁴ Based on the context of Schramm and its description of the FIG. 6 energy consumption table, I understand the phrase “For Speech” in this table to be a typographical error that should have read “For Speed.” See TESLA-1009, 5:61-63 (describing each column as a “speed column[.]”).

The columns are “speed columns ... with the headings representing the desired speed of the vehicle 12 along the route segment.” *Id.*, 5:61-63. “[T]he numerals under the speed column headings represent energy consumption units” for the respective combinations of elevational change (rows) and speed value (columns). *Id.*, 6:3-5. That is, Schramm’s FIG. 6 table stores data quantifying a vehicle’s energy consumption for multiple combinations of elevation change and speed.

183. For instance, for a segment with an elevation change value of 2 (vertical axis), and for a speed corresponding to a speed value of 1 (horizontal axis), the energy consumption value (highlighted in red in FIG. 6 above) to traverse the segment is 1.02. A segment with the same elevation change value but for a speed value of 2 has an energy consumption value (highlighted in green above) of 1.03.

184. Practically speaking, a POSITA would have understood that the average elevation change and speed values indexing Schramm’s FIG. 6 table correspond to ranges of elevation change and speed. That is, the numbers in the column headings correspond to respective speed ranges, and the numbers in the row headings correspond to respective elevation change ranges. For instance, the values in the column for the speed value of 1 encompass the energy consumption values for various elevation change ranges within a range of vehicle speeds corresponding to the speed value 1, while the values in the column for the speed value of 2 encom-

pass the energy consumption values for various elevation change ranges within another range of higher vehicle speeds corresponding to the speed value 2. Similarly, the values in the row for the elevation change value of 2 encompass the energy consumption values for various speed ranges within a range of average elevation changes corresponding to the elevation change value of 2, while the values in the column for the elevation change value of 1 encompass the energy consumption values for various speed ranges within another range of smaller elevation changes corresponding to the elevation change value of 1.

185. The energy consumption values in the table are representative of the energy consumption of the vehicle for the respective combination of elevation change and speed, and can be actual energy consumption values or normalized values. *See* TESLA-1009, 7:16-22 (“the logic loads default energy consumption unit values into energy consumption table shown in FIG. 6. Alternatively, the energy consumption units can be factors which, when multiplied by an empirically-determined base energy consumption value, produce an energy consumption unit value for the particular elevational change and speed represented by the factor”).

186. With reference to the energy consumption table of FIG. 6, the determination of the energy consumption value for each route segment (block 60 (orange) of FIG. 3) “is undertaken ... by selecting, from the table shown in FIG. 6, the energy consumption value in the row corresponding to the average elevation

change [for the segment] ... and the column corresponding to the speed that was input” by the operator. TESLA-1009, 5:64-6:2. The energy consumption values for all of the segments of a given route are added together to determine the total energy consumption for the route. *See id.*, 6:11-16.

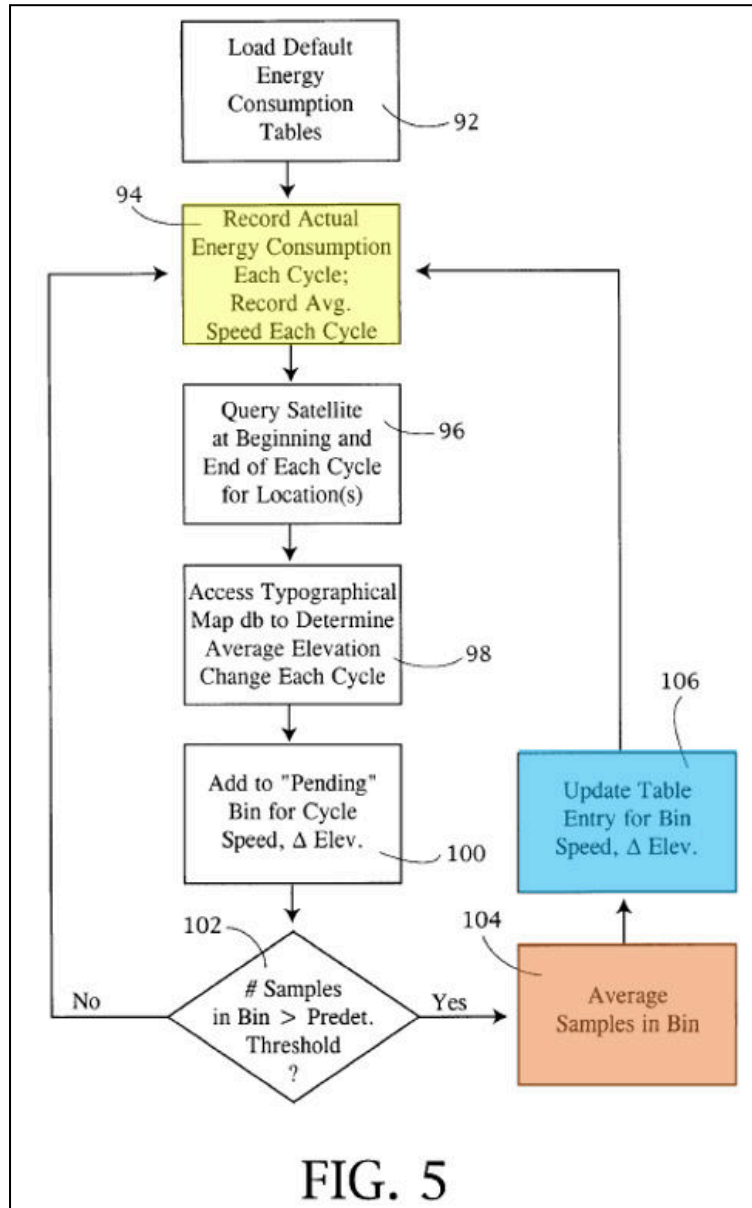
187. The “energy-optimum route” identified by this iterative process is displayed to the driver, *e.g.*, along with “information regarding nearby refueling stations.” *See* TESLA-1009, Abstract. Optionally, the vehicle computer further can “determine whether the energy consumption ($\text{consumption}_{\text{route}}$) of the route ... is less than or equal to the relevant onboard energy reserve of the vehicle,” and can indicate to the driver whether the vehicle “has sufficient energy to travel from the original point ‘A’ to the destination point ‘B’ at the desired speed.” *Id.*, 6:44-58.

188. I note that Schramm describes a one-dimensional implementation of a multidimensional optimization problem. That is, while Schramm recognizes that both elevation change and speed affect energy consumption (as indicated by Schramm’s FIG. 6), Schramm allows only elevation change to vary along a route, imposing an artificial constraint of a fixed speed for the segments of a route. Given Schramm’s teachings that speed also affects energy consumption, it would have been well within the bounds of a POSITA’s knowledge to implement a multi-dimensional optimization analysis consistent with Schramm’s teachings, to deter-

mine an energy-optimum route that reflects both speed and elevation change variations. One way to do this is explained with reference to Clapper, as I discuss in the following section. A POSITA would have also had access to other implementations, such as approaches in which a route is treated as multiple sub-routes, each of which has a corresponding speed, but which together constitute a complete route in which speed varies.

Calculation of the values in Schramm's energy consumption table

189. The values in Schramm's energy consumption table are "empirically determined, preferably on a vehicle model-by-model basis." TESLA-1009, 6:5-7. This process is illustrated in Schramm's FIG. 5, which I have reproduced and annotated below. The table is developed starting from "default energy consumption unit values" (block 92). *Id.*, 7:17-18. Then, "the actual energy consumption of the vehicle 12, along with the average speed of the vehicle 12, is recorded each cycle, e.g., every minute" (block 94, yellow). *Id.*, 7:23-32. The vehicle's position is determined "at the beginning and end of the cycle to obtain the start point and end point of the segment," which is used to identify the segment traversed by the vehicle and, in turn, "the elevation characteristics of the segment" (blocks 96-98). *Id.*, 7:30-39.



Excerpt from Schramm, FIG. 5 (annotated)

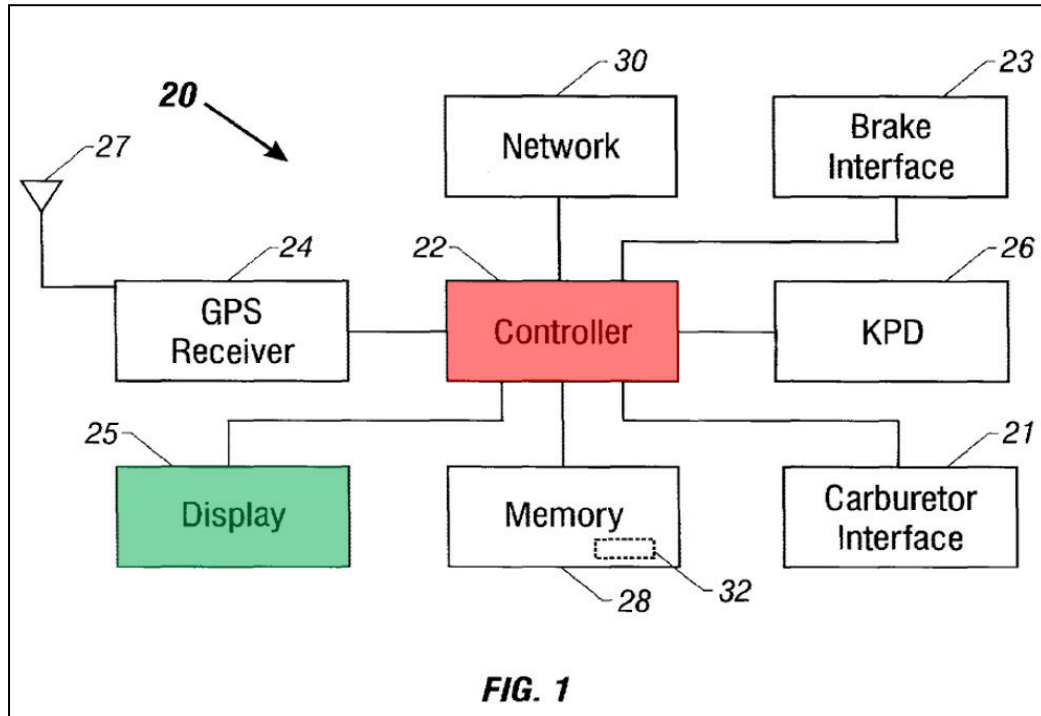
190. The data for each cycle are “added to a pending bin that represents actual energy consumption for the particular speed and elevational change under test” (block 100). TESLA-1009, 7:40-43. When the number of data samples for a given speed-elevation change combination “exceeds a predetermined threshold” (block

102), “the actual energy consumption values for the samples ... are averaged” (block 104, orange) and “the energy consumption table shown in FIG. 6 is updated ... by replacing the energy consumption value for the test speed and elevation change” with the newly determined average value (block 106, blue). *Id.*, 7:43-50.

191. Schramm is analogous art to the '161 Patent: it is from the same field of endeavor (*e.g.*, vehicle navigation) and is reasonably pertinent to the problem the '161 Patent was trying to solve (*e.g.*, how to control of vehicle operation along a route).

2. Overview of Clapper

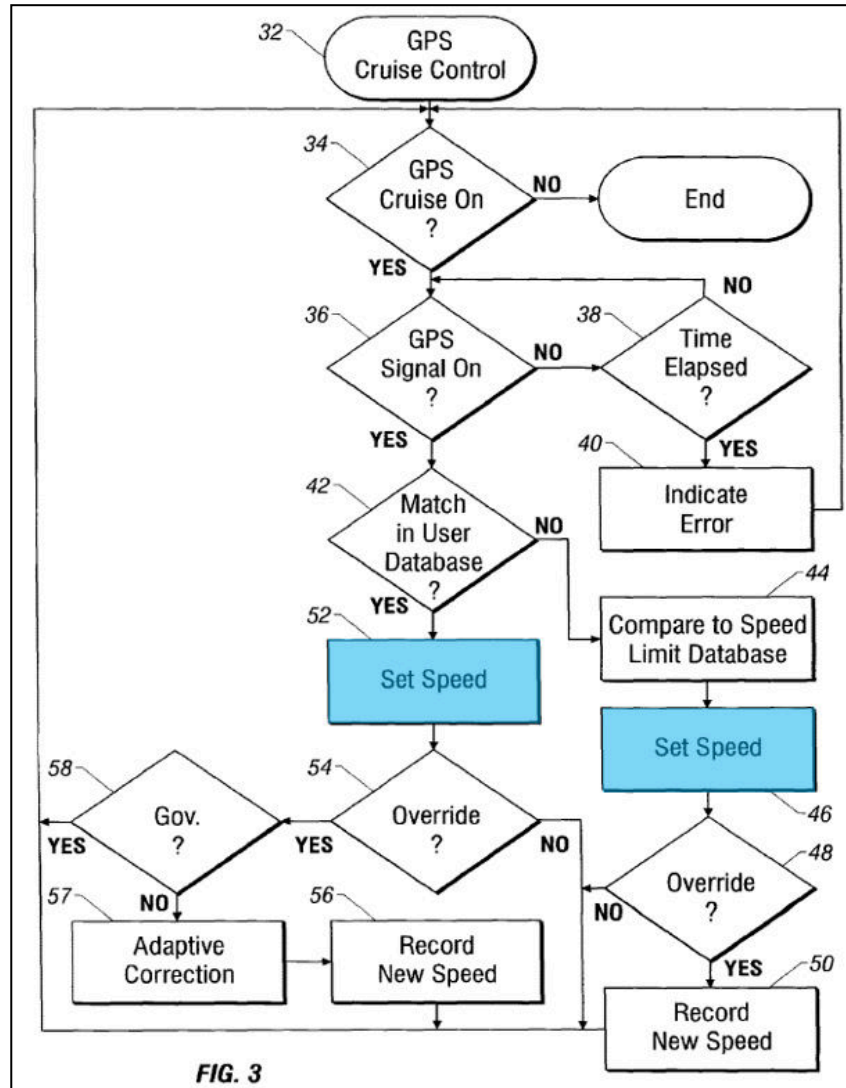
192. Clapper describes an “automatic cruise control 20,” shown in FIG. 1, reproduced below, that “automatically control[s] the speed of a vehicle based on the vehicle’s current position.” TESLA-1006, 1:43-44. For instance, “the automatic cruise control 20 may set the vehicle’s speed based on the speed that the driver used previously at the same location,” *e.g.*, “at the same or more similar times previously recorded.” *Id.*, 1:54-64. This approach advantageously “may reduce the amount of effort that the driver must invest in continually changing speed or resetting the cruise control.” *Id.*, 1:55-57. The cruise control has a controller 22, red, that “control[s] vehicle speed” via “[a] brake interface 23 and a carburetor interface 21.” *Id.*, 2:15-16.



Excerpt from Clapper, FIG. 1 (annotated)

193. As illustrated in FIG. 3, also reproduced below, Clapper's automatic cruise control detects the current position of the vehicle, *e.g.*, using GPS, and compares "the current position ... to entries in a user database" that specify "speeds used at given locations in the past." *Id.*, 1:50-51, 2:52-56; *see* block 42. If the current position matches an entry in the database, the cruise control sets the vehicle's speed "in accordance with the existing speed from prior trips" (block 52, highlighted in blue). *Id.*, 2:55-56. Optionally, "[t]hat speed may also be adjusted based on the actual time of day information," *e.g.*, to reflect historical vehicle operation "at one speed at one time and a different speed at a different time (at the same location) when driving conditions, including traffic conditions, may be different." *Id.*,

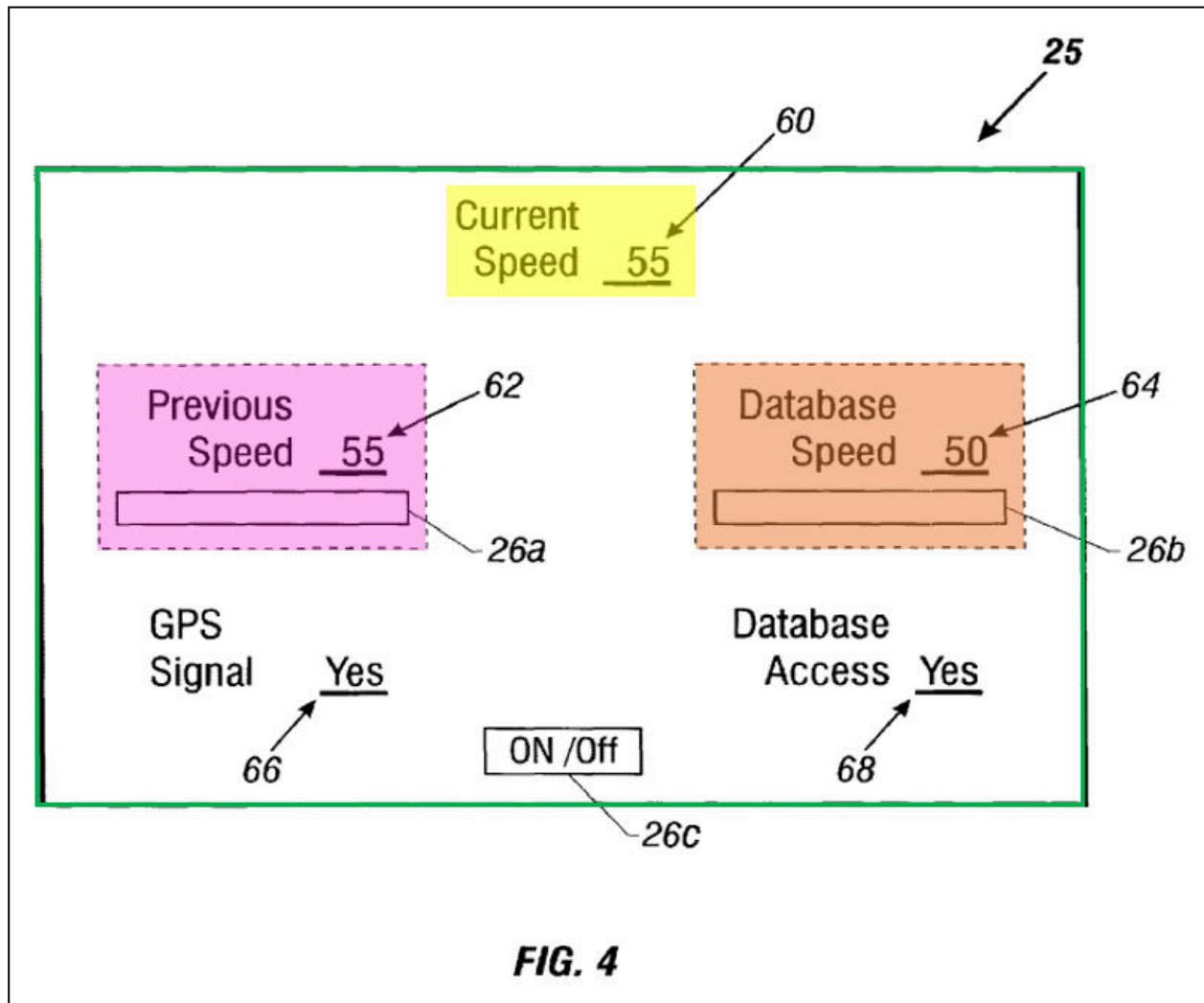
1:64-67, 2:57-60. “If no match [for the vehicle’s location] is found in the user’s own database of prior speeds, the current location may be compared to a speed limit database” that “provide[s] information about speed limits on existing roads and highways correlated to their GPS coordinates” (block 44) and the speed for the vehicle’s current location is set to the stored speed limit value (block 46, also highlighted in blue). *Id.*, 3:13-20.



Excerpt from Clapper, FIG. 3 (annotated)

194. Clapper’s system also provides functionality for adjusting the speed based on environmental conditions. *See* TESLA-1006, 2:8-11. For instance, a website hosting the database mapping speeds to locations “may provide information about current driving conditions which may be used to moderate the user’s previous history.” *Id.*, 2:8-10. As an example, “if it is snowing the stored speeds may be reduced.” *Id.*, 2:10-11.

195. Clapper's automatic cruise control includes a display 25 (green in FIG. 4, which I have reproduced and annotated below) that "provide[s] speed information" and a key pad 26 that "enables the user to input information for the controller." TESLA-1006, 2:17-18. This display and keypad is implemented as "a graphical user interface with integrated key pad functions." *Id.*, 3:28-30. The display may be located "in the speedometer region of the dashboard, elsewhere on the dashboard, above the dashboard, on the steering column, or other convenient locations." *Id.*, 3:30-34.



Excerpt from Clapper, FIG. 4 (annotated)

196. As shown above, the display displays “the current actual speed as indicated at 60,” highlighted in yellow. *Id.*, 3:38-39. The display also shows “[t]he speed from the memory 28,” *e.g.*, the driver’s “speed from prior trips,” “displayed as the previous speed as indicated at 62,” pink. *Id.*, 2:53-56, 3:39-40. Additionally, the database shows a “speed suggested from a database over the network con-

nection” at 64, orange. *Id.*, 3:40-42. For instance, a speed suggested from a database can be a speed suggested based on “current driving conditions,” a proposed speed for “locations which the user has never before traveled,” or a “speed limit.” *Id.*, 2:8-14, 2:37-38.

197. Clapper is analogous art to the ’161 Patent: it is from the same field of endeavor (*e.g.*, vehicle navigation) and is reasonably pertinent to the problem the ’161 Patent was trying to solve (*e.g.*, how to control of vehicle operation along a route).

3. Combination of Schramm and Clapper

198. Schramm generally describes an approach to identifying an optimized route that has the best summation of energy values for a vehicle to traverse segments of the route at a single, specified speed, while Clapper articulates that vehicle speed may vary along a route. Combining these teachings as a whole, it is my opinion that a POSITA would have arrived at a route optimization process that accounts for different per-segment energy values based on variations in segment speed when identifying the optimized route that has a best summation of energy values. I discuss this combination, as well as the reasons that would have motivated a POSITA to make this combination, in more detail below.

In the Schramm-Clapper combination, route optimization takes into account different speeds for the segments of the route

199. As I discussed above in my overview of Schramm, Schramm's energy optimized route identification process applies a single speed (*e.g.*, a user-specified "desired average speed" or the current speed at a particular moment in time) to all segments of the possible routes under evaluation. TESLA-1009, 5:1-16; *see* 5:41-48. A POSITA implementing a route optimization process, though, would have recognized that a vehicle traveling along a route would not necessarily travel all segments at the same speed. For instance, a vehicle traveling along a route that includes segments along both residential streets and highways would travel the different types of segments at different speeds: a slower speed on the residential streets and another, faster speed on the highways.

200. These speed variations along the vehicle's route impact the energy consumption of the vehicle as it travels along the route. In fact, the impact of speed on energy consumption is shown in the table of Schramm's FIG. 6. It is my opinion that given the recognition that speed can vary along a route, and that speed variations impact vehicle energy consumption, a POSITA would have found it obvious to make an adjustment to Schramm's route optimization process to account for these variations. *See* TESLA-1009, 5:45-50, 5:65-6:7. The specific nature of the adjustment is based on Clapper, as I discuss below. Although there are many

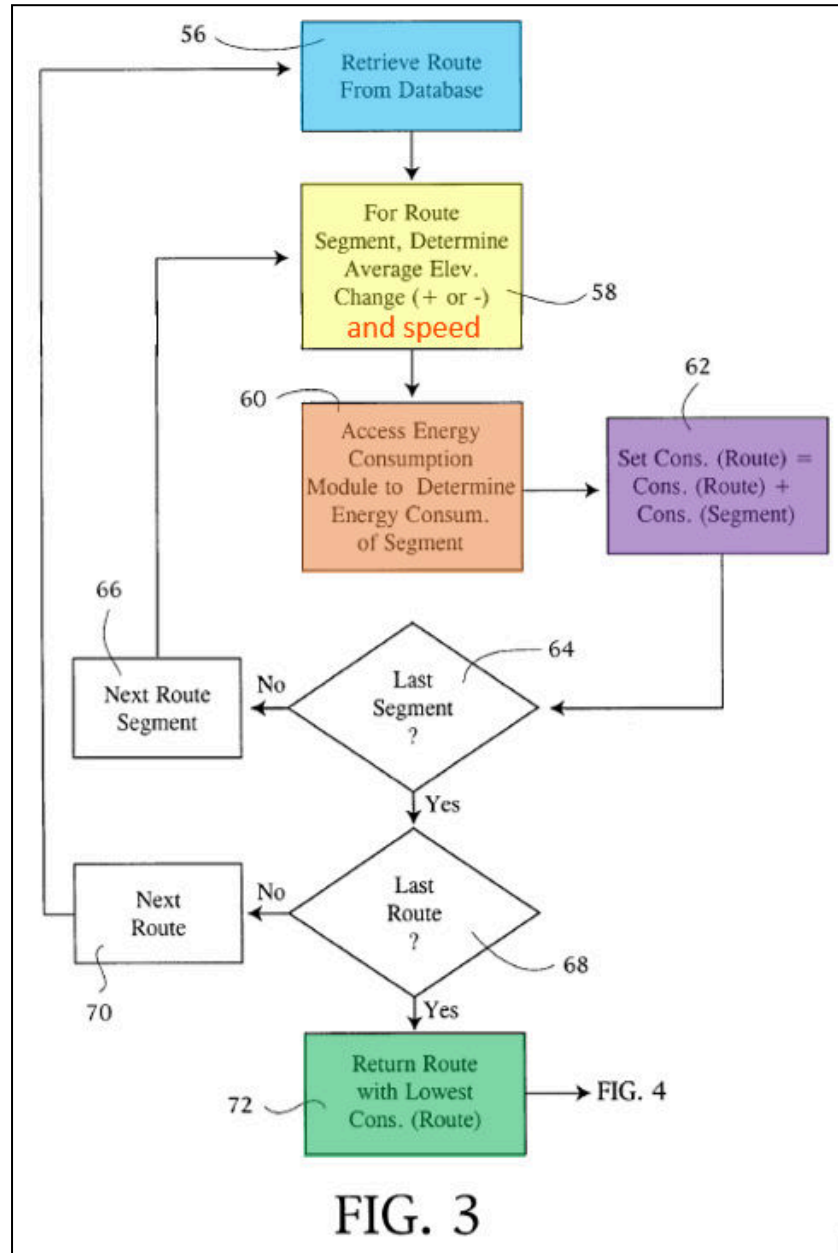
benefits to this adjustment, as I also discuss below, generally, a POSITA would have recognized that this modified route optimization process would have improved accuracy as compared to Schramm's route optimization process, which does not specifically discuss allowing for speed variations along the route.

201. In more detail, the reality that vehicle speed may vary along a route is recognized by both Schramm and Clapper. *See* TESLA-1009, 57:23-25; TESLA-1006, 1:50-67, 3:13-27. Prompted by this reality, a POSITA would have modified Schramm's route optimization process to allow for different speeds at different segments of a route, removing Schramm's constraint that the speed of each segment remain the same for the entire route when evaluating energy consumption of the possible routes. This modification is based on Clapper: a POSITA would have incorporated variations in speed by segment (which is described by Clapper) into a route optimization process based on Schramm to obtain a more realistic, and thus more accurate, energy computation, and to thus enable a more accurate determination of the "energy-optimum route." TESLA-1009, Abstract.

202. Specifically, in the Schramm-Clapper combination, speed values for various locations are stored in a database, as taught by Clapper. *See* TESLA-1006, 1:50-67, 2:37-44, 2:52-57, 3:13-23. For instance, as Clapper teaches, the database in the combination can store "[t]he driver's previous speed[s]" "at given loca-

tions,” and optionally “at given times” of day. TESLA-1006, 1:59-64. Alternatively or additionally, the database can store “information about speed limits on existing roads and highways.” *Id.*, 3:15-17. During the combination route optimization process, the stored speed data for each segment under evaluation are accessed from the database and used along with the elevation change for that segment to identify the appropriate energy value from the table. That is, the energy consumption value corresponding to the particular combination of the retrieved speed and the elevation change for the particular segment is used in the route optimization process.

203. I illustrate an example process flow for route optimization in the Schramm-Clapper combination in the following composite figure, followed by explanation in the next paragraphs.



Schramm-Clapper composite figure based on Schramm, FIG. 3

204. In this combination process, a “route between the origination point ‘A’ and the destination point ‘B’ is retrieved” (block 56, highlighted in blue) for evaluation of its overall energy consumption, as taught by Schramm. TESLA-

1009, 5:23-24. For each segment of this route, two pieces of information are retrieved (modified block 58, yellow): “the average elevation change” of the segment, as taught by Schramm, and a speed for the segment, based on Clapper.

TESLA-1009, 5:41-45; *see* TESLA-1006, 1:50-67, 2:37-44, 2:52-57, 3:13-23. The speed for the segment can be “the speed that the driver used previously” on the same segment or a “speed limit” for that segment. TESLA-1006, 1:55-56, 3:14-15. For instance, these speed data can be stored in a database in association with location information, as taught by Clapper, and retrieved for each segment based on a location of the segment, such as by comparing “the current position ... to entries in a user database” that specify “speeds used at given locations in the past” or “speed limits on existing roads and highways correlated to their GPS coordinates.” *See* TESLA-1006, 1:50-67, 2:37-44, 2:52-57, 3:13-23; TESLA-1009, 1:50-67, 2:37-44, 2:52-57, 3:13-23.

205. For each segment of the route under test, the two retrieved values—elevation change and speed—are used to determine the “energy consumption that would be required for the vehicle 12 to traverse the route segment” (block 60, highlighted in orange) consistent with the functioning of Schramm’s, *e.g.*, by accessing an energy consumption table such as that of Schramm’s FIG. 6, which I have reproduced again below. TESLA-1009, 5:46-5. Specifically, consistent with Schramm’s usage of the energy consumption table, “the energy consumption value

in the row corresponding to the average elevation change” and in “the column corresponding to the speed” for each segment of a possible route under evaluation is retrieved. TESLA-1009, 5:66-6-2. The energy values for all of the segments of the route are similarly retrieved based on the average elevation change and the speed for those segments. In this way, the route optimization process accounts for different per-segment speeds (*e.g.*, different historical speeds driven by the driver and/or different speed limits) in calculating the energy consumption for a given route.

		Δ Elev. Factors, For ~~Speed~~ = (“speed”)						
		Speed values						
		1	2	3				
Elevation values (base energy consumption)	-x	.8	.8	l	.	.	.	.
	.	.	.	.	.	.	.	.
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	0	1	1.01	.	.	.	.	.
	1	1.01	1.02	.	.	.	.	.
	2	1.02	1.03	.	.	.	.	.
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	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
	+ x	n	m	k	.	.	.	.

Excerpt from Schramm, FIG. 6 (annotated)

206. This is illustrated using the following example of a route including two segments. The first segment of this hypothetical route has zero average elevation change and a speed value (as retrieved from a database based on the teachings of Clapper) corresponding to a speed value of 2, which together correspond to an energy value of 1.01 (highlighted in green in the FIG. 6 table above) to be retrieved for this segment. The second segment of this hypothetical route has an elevation change corresponding to an elevation change value of +2 and a slower speed limit corresponding to a speed value of 1, which together correspond to an energy value of 1.02 (highlighted in red) to be retrieved for this segment.

207. Consistent with Schramm's route optimization process, in the Schramm-Clapper combination process, the energy consumption values that are retrieved for each segment of a given route under evaluation are summed to determine the total energy consumption for the route (block 62, purple in the composite flow chart above). *See* TESLA-1009, 6:12-23. This process of retrieving and summing per-segment energy values to determine the total energy consumption is determined for all retrieved routes between the origin and the destination, taking into account both average elevation change and speed for the segments of each route as I discussed above. As an output of the process, "the route with the lowest overall energy consumption" is returned (block 72, green). TESLA-1009, 6:23-31.

208. A POSITA would have been motivated to account for different speeds for the segments of a route when identifying an energy-optimal route for at least the following reasons.

209. The first reason why a POSITA would have been motivated to modify the route optimization process to account for different per-segment speeds is that the POSITA would have recognized that Schramm's route optimization process imposes an artificial constraint of a fixed average speed along an entire route. The POSITA would have been motivated to pursue the Schramm-Clapper implementation I discussed above to allow for the real-world likelihood that segments of a route are not necessarily travelled all at a uniform speed, for instance, depending on the type of road (*e.g.*, residential, state highway, interstate, etc.) and/or the driver's driving habits (*e.g.*, the driver may typically drive slower than the posted speed limit on a congested portion of a road).

210. The second reason why a POSITA would have been motivated to modify the route optimization process to account for different per-segment speeds is that the POSITA would have recognized that removing Schramm's fixed average speed requirement and instead incorporating, into the route optimization process, the ability to account for the realistic possibility that segments may have different speeds would enhance the accuracy of the process. Energy consumption can vary with speed. *See* TESLA-1009, FIG. 6. Thus, the energy-optimum route when

the per-segment speed is allowed to vary to reflect that actual speeds for the segments of the route may be different from the route that would have been identified as the energy-optimum route in a process that artificially holds speed to be constant. Moreover, a POSITA would have recognized the benefits with respect to achieving energy efficient vehicle operation that would be afforded by improving the accuracy of route optimization. Namely, in this more accurate process, the driver would be provided with an optimized route that was determined by taking into account realistic information.

211. Third, as a follow-on to this, the POSITA also would have recognized that the more realistic and accurate energy optimum route identified via the Schramm-Clapper route optimization process would provide more reliable, and thus useful, information to the driver. Schramm describes that based on the identified optimized route, the system determines whether the vehicle “has sufficient energy to travel” from the origin to the destination, and if it does not, the system identifies “all CEPFs [commercial energy purchasing facilities] within the range of the vehicle 12 along the route.” TESLA-1009, 5:44-67. For instance, this allows the driver to make decisions about refueling along the route. A POSITA would have recognized the importance of accurately determining whether the vehicle has sufficient energy to reach its destination, which is predicated on an accurate energy

consumption calculation for the route. And similarly, a POSITA would have recognized the critical importance of accurate identification of CEPFs that are within range of the vehicle, if it cannot reach its destination, which again necessitates an accurate energy consumption calculation.

212. The fourth reason a POSITA would have been motivated to pursue this implementation is because it is just the application of known techniques (maintaining data correlating speeds to segments of road, as taught by Clapper) to a known system (Schramm's route optimization process). Moreover, the results of this combination—route optimization that accounts for varying speed along segments of the route—is predictable.

213. The fifth reason a POSITA would have been motivated to pursue this implementation because doing so is the application of a known technique (maintaining data correlating speeds to segments of road, as taught by Clapper) to a known device that has room for improvement (Schramm's route optimization process, the accuracy and relevance of which can be improved by accounting for speed variations along a route, as I discussed above). And again, the results of this combination—route optimization that accounts for varying speed along segments of the route—is predictable.

214. A POSITA would have had a reasonable expectation of success in pursuing this combination because Schramm already appreciates that speed impacts energy consumption, as shown by the dependence of energy values on speed in the table of Schramm's FIG. 6. *See* TESLA-1009, 5:59-6:6. The modification of Schramm's algorithm based on Clapper to account for different per-segment speeds thus makes use of existing data (specifically, energy values for various segment speeds, which is already stored in Schramm's FIG. 6 table) in a manner that is consistent with the general outlines of Schramm's original route optimization process. *See* TESLA-1009, 5:21-6:32, FIG. 3. Indeed, the combination route optimization process involves only a straightforward and predictable modification of Schramm's route optimization process: speed values for segments—which is readily available information based on Clapper—are used together with elevation change data to retrieve the energy consumption data that are already present in Schramm's energy consumption table. *See* TESLA-1009, 5:41-48; TESLA-1006, 1:50-51, 2:52-60, 3:13-20. Moreover, a POSITA would have expected success because implementation of the Schramm-Clapper combination involves common techniques and devices, *e.g.*, databases storing per-segment speed values (based on Clapper) and energy values for various segment speeds (already present in Schramm's unmodified process). And this construct—such as a database storing

per-segment speed values—would have required minimal additional resources beyond the framework already involved in implementing Schramm’s unmodified process, and the integration of these additional resources would have been well within the hardware capabilities at the time.

In the Schramm-Clapper combination, the vehicle is controlled by an automatic cruise control system

215. Optionally, in the Schramm-Clapper combination, a display in the vehicle “present[s] information representative of the select route,” *e.g.*, “routing directions” for the identified route with the lowest overall energy consumption, consistent with the operation of Schramm’s system. TESLA-1009, 3:2-14, 3:64-66. As the driver operates the vehicle along this route, an “automatic cruise control,” based on the teachings of Clapper, is used “to automatically control the speed of [the] vehicle based on the vehicle’s current position,” *e.g.*, as determined by GPS. TESLA-1006, 1:42-44.

216. As Clapper teaches, in the combination, the automatic cruise control is implemented by a controller that “control[s] vehicle speed” using “[a] brake interface 23 and a carburetor interface 21” of the vehicle. TESLA-1006, 2:15-16. As taught by Clapper, the controller controls vehicle speed “based on the speed that the driver used previously at the same location,” *e.g.*, on the segment where the vehicle is currently located. TESLA-1006, 1:53-56. Alternatively, or additionally,

the controller controls the vehicle speed based on “the speed for a given location found in the speed limit database,” *e.g.*, the speed limit for the segment where the vehicle is current located. TESLA-1006, 3:17-19.

217. A POSITA would have been motivated to control the vehicle of the Schramm-Clapper combination using an automatic cruise control system for at least the following reasons.

218. The first reason why a POSITA would have been motivated to implement automatic cruise control is because the POSITA would have recognized that implementation of automatic cruise control improves driver experience and comfort. For instance, cruise control removes the need for the driver to focus on the speed of the vehicle and to adjust the vehicle speed, *e.g.*, in response to changing speed limits along the route, easing the burden on the driver. *See* TESLA-1006, 1:14-17 (“Existing cruise control systems remove some of the tedium involved in driving. However the user must still adjust and readjust the speed as appropriate under different speed limits and different driving conditions”).

219. The second reason why a POSITA would have been motivated to implement automatic cruise control is to facilitate optimized fuel consumption, which is enabled by the use of cruise control. Optimization of fuel consumption is consistent with Schramm’s objective of “minimizing the energy consumption of vehicles.” TESLA-1009, 1:10-11. And the role of cruise control in improving fuel

consumption was well-known. *See* TESLA-1018, [0004]; TESLA-1012, 6:27-35; TESLA-1005, [0031]; *see also* my discussion of the fuel consumption advantages of cruise control in claim 9 of Ground 1A, above.

220. The third reason why a POSITA would have been motivated to implement automatic cruise control specifically in the context of the Schramm-Clapper energy optimized route is because of the efficiencies that can be achieved by controlling the vehicle to follow the per-segment speeds for that energy optimum route. Specifically, the Schramm-Clapper process identifies the most energy efficient route, assuming the vehicle travels each segment of the route at a particular specified speed for that segment, *e.g.*, based on the segment's speed limit or on the driver's driving history along that segment. *See* TESLA-1009, 5:41-6:31; TESLA-1006, 1:50-51, 2:52-60, 3:13-20. A POSITA would have recognized that controlling the vehicle to drive at these specified speeds along this energy optimum route allows the fuel efficiencies that were associated with the selection of this route to be achieved, for instance, because the vehicle is controlled to drive at the specific speeds that were used for identifying that route. Moreover, implementation of automatic cruise control—which in itself promotes fuel efficiency, as I discussed in the preceding paragraph—in concert with the Schramm-Clapper optimum route identification process allows for the fuel efficiencies indicated by identifying the optimum route to be realized with minimum burden to the driver.

221. The fourth reason why a POSITA would have been motivated to implement automatic cruise control is because this implementation would improve safety by allowing the cruise control system to adjust speed automatically to reflect road/environmental conditions. *See* TESLA-1006, 2:8-11 (“The website may provide information about current driving conditions which may be used to moderate the user’s previous history. For example, if it is snowing the stored speeds may be reduced.”).

222. The fifth reason why a POSITA would have been motivated to pursue this implementation is because it is just the application of known techniques (automatic cruise control) to a known system (a vehicle implementing Schramm’s route optimization approach), and it produces predictable results (specifically, a vehicle that is controlled by automatic cruise control while operated by a driver along an already identified, energy-optimized route).

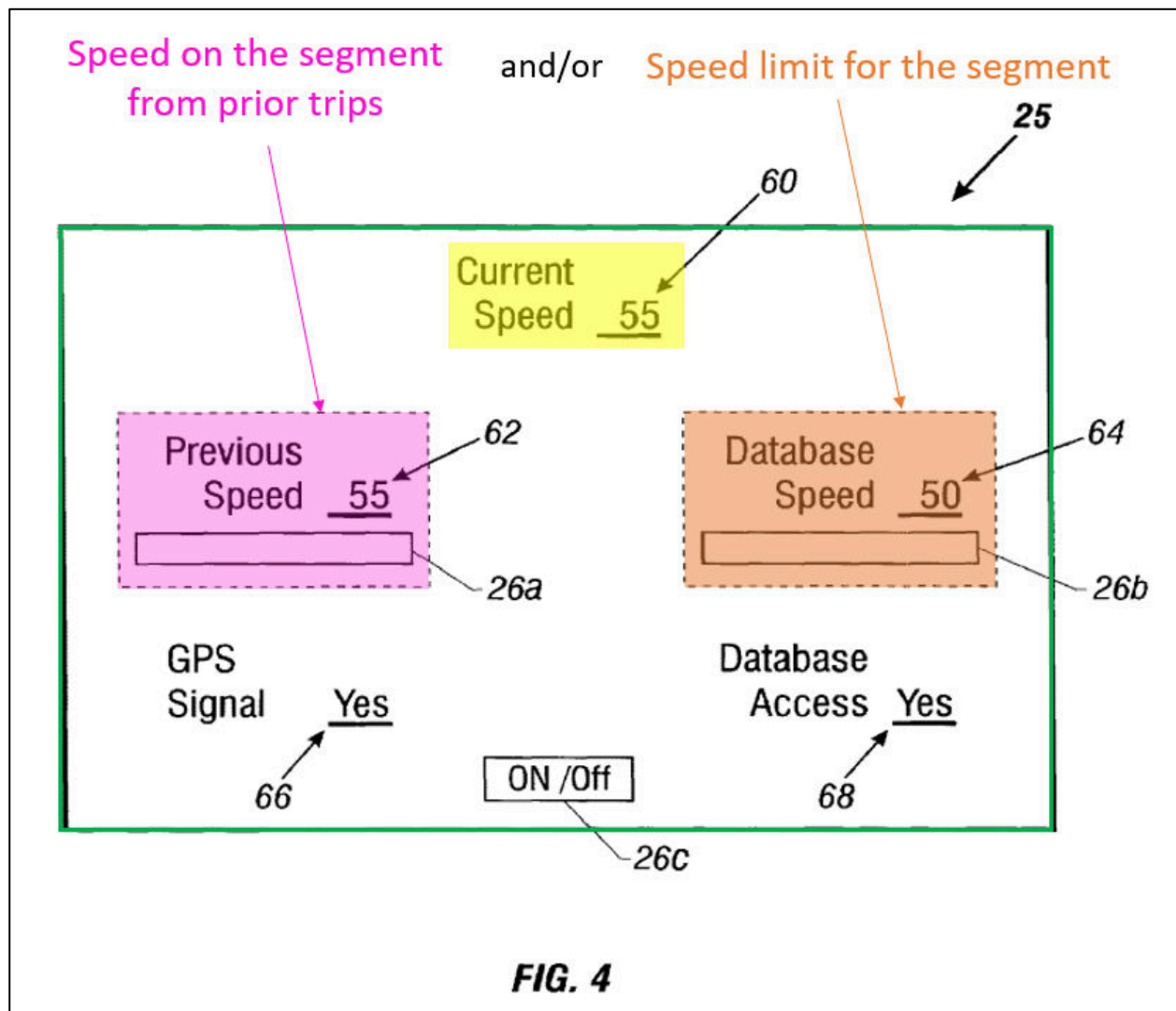
223. The sixth reason why a POSITA would have been motivated to pursue this implementation is because it is the just use of a known technique (cruise control along a specified route) to improve a similar device (a vehicle based on Schramm, that determines a specified route) in the same way (*e.g.*, improvement of driver experience by allowing the driver the freedom to not focus on controlling the vehicle to precise specified speeds; *see* TESLA-1006, 1:14-17, noting that

“[e]xisting cruise control systems remove some of the tedium involved in driving”).

224. A POSITA would have expected success in pursuing this implementation because automatic cruise controls were conventional and predictable systems as of the Critical Date. *See* TESLA-1013, 1:9-11 (“The present invention relates to a cruise control device capable of automatically changing the speed of a motor vehicle and maintaining it at a desired speed”); TESLA-1011, 1:16-22 (“Within the vehicle industry, many systems are currently being developed for assisting a driver to keep an appropriate vehicle speed. The most straightforward systems are the cruise control systems, keeping a vehicle at a pre-set speed, unless the driver overrides the system by, for example, engaging the brake”) . No aspect of Schramm would change the operation of this conventional cruise control system, nor would implementation of automatic cruise control change the execution of the combination route optimization process. Moreover, a POSITA would have expected success because implementation of the Schramm-Clapper combination involves common techniques and devices, *e.g.*, conventional hardware and software components of a cruise control system, which would have been well within the skill of a POSITA to implement.

In the Schramm-Clapper combination, the set speed for the segments of the route are displayed

225. Optionally, in the Schramm-Clapper combination, the vehicle implements a display based on the teachings of Clapper, *e.g.*, as illustrated in Clapper's FIG. 4, which I have reproduced and annotated below. *See* TESLA-1006, 3:28-45.



Schramm-Clapper composite figure based on Clapper, FIG. 4

226. The combination display “display[s] the current actual speed as indicated at 60,” highlighted in yellow—that is, the speed the vehicle is actually traveling at. TESLA-1006, 3:37-38. The combination display also displays “[t]he speed from the memory 28” at 62, pink, which, as described by Clapper, is the driver’s “speed from prior trips” at the current location of the vehicle. *Id.*, 2:53-56, 3:39-40. In the combination, this displayed “speed from the memory” may vary as the vehicle travels from segment to segment. For instance, the displayed “speed from the memory” when the vehicle is located at a given segment corresponds to “the speed that the driver used previously” on that segment, and as the vehicle travels along the route from segment to segment, that “speed that the driver used previously” may change, thus causing the displayed speed at 62 (pink) to change as well. TESLA-1006, 3:39-40, 1:55-56.

227. Alternatively, or additionally, the combination display displays “a speed suggested from a database” at 64, orange, which, as described by Clapper, is, for instance, a “speed limit.” TESLA-1006, 3:40-42. In the combination, this displayed suggested speed (*e.g.*, a speed limit) may vary as the vehicle travels from segment to segment, for instance, to reflect changing speed limits along the route. *See* TESLA-1006, 2:37-38, 3:13-23.

228. A POSITA would have been motivated to display stored speeds for current segments as a vehicle travels along a route for at least the following reasons.

229. The first reason why a POSITA would have been motivated to display stored speeds to the driver is to provide the user with information that would allow the user to control a vehicle that otherwise would be operated by automatic cruise control, *e.g.*, to override the speed that has been selected by the cruise control system. For instance, display of stored historical speeds and speed limits for current segments would allow the user to “select either the previous speed 62 or the database speed 64,” *e.g.*, so that the automatic cruise control will operate the vehicle at the user’s selected speed. TESLA-1006, 3:42-45. A POSITA would have recognized the advantages of providing the user with such a control mechanism, *e.g.*, enhancing safety by allowing the user to require the cruise control to obey a speed limit or enabling flexibility by allowing the user to specify operation at an historically used speed.

230. The second reason why a POSITA would have been motivated to display stored speeds is to notify the driver of suggested driving conditions, *e.g.*, to keep the user informed about his or her typical operation of the vehicle in a given area and/or about speed limits in the area. For instance, if a particular section of

road is typically congested, the stored historical speed for the segments in that section may be lower than the speed limit, and seeing these two values displayed on the dashboard can be valuable to the user, *e.g.*, in understanding whether current traffic conditions are typical. Having this information can be useful, for instance, because if current traffic conditions are abnormal (as would be indicated, for instance, if the historical speed values are higher than the actual speed that the vehicle is currently traveling), the driver may decide to recalculate the route, to make a rest stop, or to otherwise change plans.

231. The third reason why a POSITA would have been motivated to pursue this implementation is because it is just the application of known techniques (displaying speeds to a driver, as taught by Clapper) to a known system (a vehicle implementing Schramm's route optimization approach), and it produces predictable results (specifically, a vehicle in which set speeds for segments of a route are displayed during transit along that route).

232. The fourth reason why a POSITA would have been motivated to pursue this implementation is because it reflects the use of a known technique (display of per-segment speeds, as taught by Clapper) to improve a similar device (a vehicle based on Schramm, that determines a route having varying per-segment speeds) in the same way (specifically, providing the driver with information about the vehicle operation).

233. A POSITA would have expected success in pursuing this implementation because display technology, *e.g.*, display of speeds in a vehicle, was conventional and predictable. *See* TESLA-1008, FIG. 3C; TESLA-1012, 2:44-45, FIG. 1. Furthermore, no aspect of Schramm would change the operation of this conventional approach to speed display. Moreover, a POSITA would have expected success because implementation of the Schramm-Clapper combination involves common techniques and devices, *e.g.*, a display device in a vehicle, which are conventionally present in vehicles and would have been well within the skill of a POSITA to implement.

4. Analysis

(a) Claim 1

[1pre] A method of managing a power consumption of a vehicle, comprising the steps of:

234. If the preamble is deemed to be limiting, the Schramm-Clapper combination renders it obvious.

235. For instance, the Schramm-Clapper combination implements a route optimization algorithm that has the objective of “minimizing the energy consumption of vehicles, and more particularly ... determining energy-optimizing routing of vehicles.” TESLA-1009, 1:9-12; *see* 1:32-49 (“the present invention recognizes that it is usually the case that more than one route exists between a vehicle origin

and a desired destination, and that energy conservation can be enhanced by selecting the most energy efficient route”), 1:50-61 (“the present invention further recognizes that modern computers ... can be used to select and present energy-efficient routes between operator selected origins and destinations”), 1:62-65 (“it is an object of the present invention to provide a system for determining an optimum route between an origin and a destination”), 2:19-21 (“the computer ... determines a select route having a minimum energy consumption among the possible routes”).

The identification of “an energy-optimum route for a vehicle to take” corresponds to *managing a power consumption of a vehicle* at least because the vehicle’s energy expenditure relates to the vehicle’s power consumption, and identification of a route to minimize energy expenditure is a way to manage that power consumption. TESLA-1009, Abstract.

236. Moreover, in the combination, the set speeds for the segments of the identified energy optimum route (*e.g.*, the driver’s speed from prior trips and/or the speed limit for each segment; *see* my discussion below for element [1d]) are displayed based on the teachings of Clapper. *See* TESLA-1006, 3:28-45, FIG. 4; *see also* my discussion below for element [1e]. Displaying these speeds alternatively or additionally corresponds to *managing a power consumption of the vehicle* because the display provides the driver with information enabling him to operate the

vehicle at the appropriate per-segment speeds along the identified route, which facilitates achieving the energy efficiencies that are indicated by identification of that optimum route with its specific per-segment speeds.

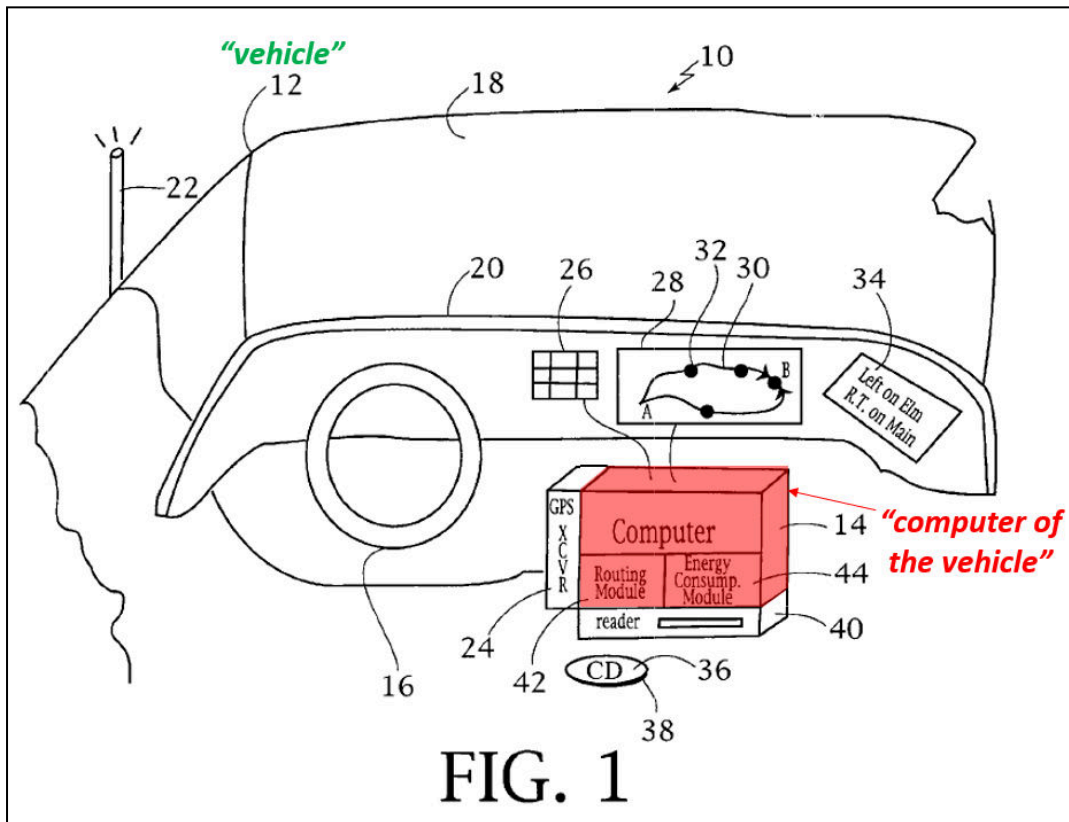
237. Optionally, also based on Clapper, the vehicle is controlled by an automatic cruise control system to travel at the set speeds for the segments of the identified energy optimum route (*e.g.*, the driver's speed from prior trips and/or the speed limit for each segment; *see* my discussion below for element [1d]). Controlling the vehicle to operate at these set speeds along the identified energy-optimum route alternatively or additionally corresponds to ***managing a power consumption of the vehicle*** at least because operating the vehicle at the appropriate per-segment speeds along the identified energy-optimum route facilitates achieving the energy efficiencies that are indicated by the identification of that optimum route with its specific per-segment speeds.

238. Notably, the Schramm-Clapper combination system is applicable to ***managing a power consumption*** of various types of vehicles, including “gasoline” powered vehicles as well as “vehicles that are battery powered or are powered by a hybrid form of battery-internal combustion.” TESLA-1009, 3:60-62.

[1a] (a) receiving a route at a computer of said vehicle;

239. Schramm-Clapper renders limitation [1a] obvious for the reasons described below.

240. In the Schramm-Clapper combination, Schramm describes “a computer 14 that is onboard the vehicle 12.” TESLA-1009, 3:42-43; *see* Abstract (“A system for determining an energy-optimum route for a vehicle ... includes a computer onboard the vehicle”), claim 9 (“A computer program device medium residing in a motor vehicle”), claim 17 (“A vehicle, comprising ... a computer”), claim 1. This computer is highlighted in red in Schramm’s FIG. 1, reproduced below. In the combination, Schramm’s computer (*e.g.*, computer 14) onboard a vehicle (*e.g.*, vehicle 12) corresponds to *a computer of the vehicle*.

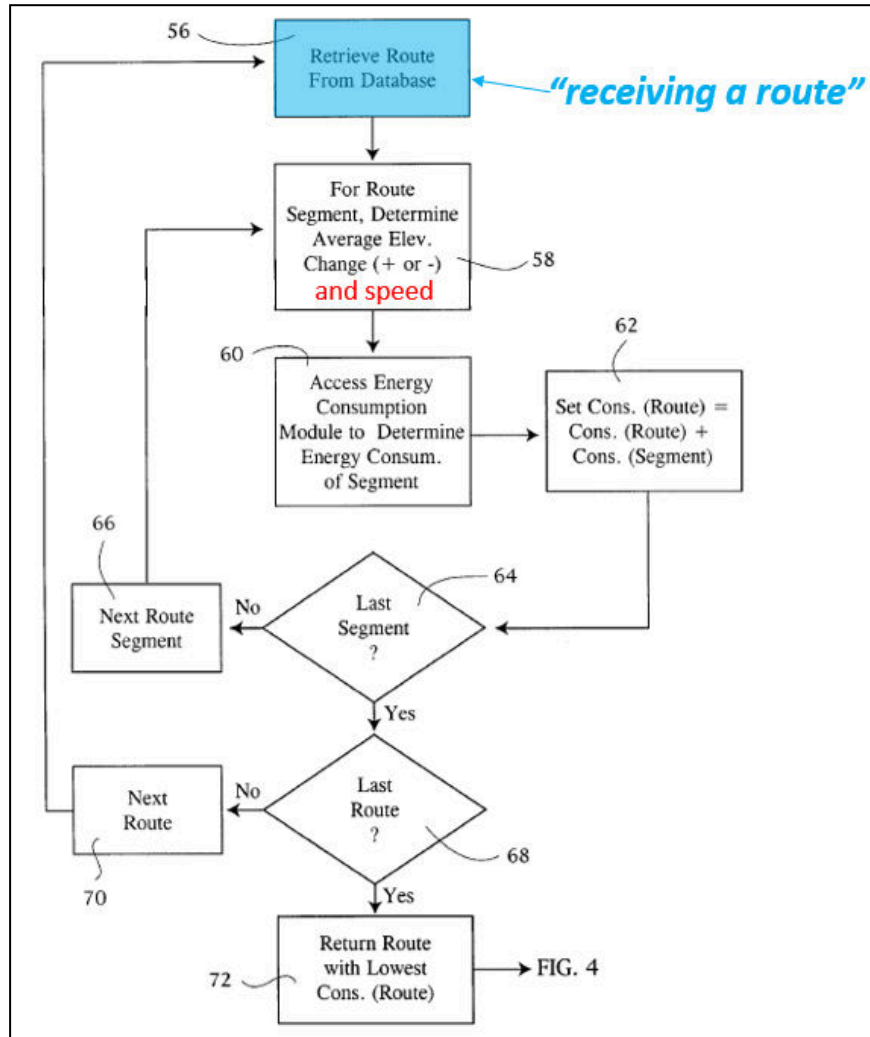


Excerpt from Schramm, FIG. 1 (annotated)

241. The Schramm-Clapper combination also renders obvious ***receiving a route at a computer of the vehicle***. In the Schramm-Clapper combination, “an energy-optimum route” is identified by the onboard computer based on the Schramm-Clapper combination iterative calculation process, as I discussed above in my overview of the Schramm-Clapper combination. TESLA-1009, Abstract; *see* 5:1-6:32, FIG. 3. Schramm describes that this iterative process is implemented by “a routing module 42 and an energy consumption module 44” of the onboard computer, *i.e.*, that the iterative route identification process is implemented by the computer of the vehicle. TESLA-1009, 4:22-25.

242. As part of this route identification process, the routing module (which is an element of the onboard computer of the vehicle) “retrieves from the database ... a route between the origination point ‘A’ and the destination point ‘B.’”

TESLA-1009, 5:21-24. This corresponds to the routing module (*e.g.*, ***the computer of the vehicle***) ***receiving a route***. This action is illustrated in block 56 (highlighted in blue) of the composite flow chart figure below.



Schramm-Clapper composite figure based on Schramm, FIG. 3

243. Further description in Schramm confirming that the onboard computer of the vehicle receives a route can be found at least as follows: 2:14-17 ("a computer in communication with the database ... the computer receives the origin and destination and accesses the database to determine possible routes existing between the origin and the destination"), 2:55-59 ("These logic means include logic means for receiving the origin and destination, and logic means for accessing a database

containing topographic information of a plurality of possible routes from the origin to the destination, with each possible route being characterized by an energy consumption”), 3:5-7 (“the computer receives an origin and a destination and accesses the database to determine possible routes existing between the origin and the destination”), 4:22-27 (“the computer 14 includes a routing module 42 and an energy consumption module 44. ... the modules 42, 44 cooperate to determine an energy efficient route between the origin ‘A’ and destination ‘B’ of possible routes that exist in the topographical map database 36”), claim 1 (“a database containing route information ... and a computer in communication with the database, the computer receiving the origin and destination, and accessing the database to determine possible routes existing between the origin and the destination”), claim 17 (“A vehicle, comprising ... a computer ... accessing the database to determine possible routes existing between the origin and the destination”), claim 9, 5:24-32.

[1b] (b) segmenting said route into a plurality of segment destinations;

244. Schramm-Clapper renders limitation [1b] obvious for the reasons described below.

245. As I discussed above for Ground 1A, the ’161 Patent’s specification does not use the term “segment destination.” *See generally* TESLA-1001. Given the context of the ’161 Patent, as I detailed above, a POSITA would have under-

stood that limitation [1b] encompasses segmenting a route into a plurality of segments, where each segment has an end point/destination, *e.g.*, a ***segment destination***.

246. Similar to the situation in the '161 Patent, in the Schramm-Clapper combination, Schramm renders obvious ***segmenting said route into a plurality of segment destinations***. For instance, Schramm describes that “each route includes one or more segments, and the computer determines an energy consumption for each segment.” TESLA-1009, 2:33-35; *see* 5:32-33 (“each route retrieved is regarded by the logic below as a series of contiguous route segments”), claim 1 (“each possible route comprises one or more segments”), claim 9, claim 17, FIG. 3. The “end point” of a given segment of the route corresponds to a ***segment destination***, at least because it is the end point (*e.g.*, ***destination***) of that segment.

TESLA-1009, 7:33. Each segment is defined by a pair of adjacent segment destinations, *e.g.*, the starting point of a given segment is defined by the segment destination of the immediately prior segment, and the endpoint of the segment is defined by the segment destination of that segment.

247. The combination optimization process logic regards “each route ... as a series of contiguous segments.” TESLA-1009, 5:32-33. This corresponds to ***segmenting the route into a plurality of segment destinations*** at least because the optimization process logic divides the route into segments, each of which ends at a

corresponding segment destination. Moreover, because the route optimization process is carried out by the onboard computer of the vehicle, as I discussed above for element [1a], the onboard computer carries out this segmenting of the route.

248. In a specific example, Schramm describes a “route between points ‘A’ and ‘B’ that is one hundred miles in length” and “composed of 100 route segments.” *Id.*, 5:32-39. This route is *segmented* into 100 segments, each one mile in length, and thus is segmented into 100 *segment destinations*, one at the end of each mile along the route.

[1c] (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;

249. Schramm-Clapper renders limitation [1c] obvious for the reasons described below.

Entries in Schramm’s energy consumption table correspond to energy values in the Schramm-Clapper combination

250. In the Schramm-Clapper combination, entries in an energy consumption table such as that of Schramm’s FIG. 6, which I have reproduced and annotated below, correspond to *energy values consumed by said vehicle to travel said route*. For instance, in the Schramm-Clapper combination, Schramm’s FIG. 6 table includes “energy consumption value[s]” for vehicle travel along segments having various average elevation changes and at various speeds. TESLA-1009, 5:66-

6:2. Specifically, the headings of the rows of this table correspond to respective “average elevational changes along segments, from a high negative value denoted -X, through zero, to a high positive value denoted +x.” *Id.*, 5:56-59. Each column heading corresponds a value representing a different vehicle speed or range of speeds, “with the headings [of the columns] representing the desired speed of the vehicle 12 along the route segment.” *Id.*, 5:61-64; *see* 6:3-6 (“the numerals under the speed column headings represent energy consumption units, the default values of which are empirically determined”), claim 7 (“a vehicle energy consumption information source containing energy consumption information relative to the vehicle”).

		Δ Elev. Factors, For Speed = ("speed")			
Segment Δ Elev. (Aug.)		<i>"plurality of variations in a target speed"</i>			
		1	2	3	
-x		.8	.8	1	.
.		.	.	.	.
.		.	.	.	.
.		.	.	.	.
(base energy	0	1	1.01	.	.
consumption)	1	1.01	1.02	.	.
	2	1.02	1.03	.	.
.		.	.	.	.
.		.	.	.	.
.		.	.	.	.
+x		n	m	k	.

"energy values"

Excerpt from Schramm, FIG. 6 (annotated)

251. Each entry in the table represents the energy consumption value for the vehicle to travel along a segment with a given average elevation change at a given speed, and thus the set of energy consumption values in this table collectively correspond to *a plurality of energy values consumed by the vehicle*. I have highlighted three examples of *energy values* in FIG. 6 above.

252. Specifically, each energy consumption value corresponds to an *energy value consumed by the vehicle to travel* between a pair of segment destinations.

As I explained above for element [1b], a pair of segment destinations defines a segment: a segment extends between the two segment destinations that define it (*e.g.*, between the endpoint of the immediately previous segment and the endpoint of the segment itself). *See* TESLA-1009, 2:33-35, 5:32-33, claim 1. Each segment has a corresponding “average elevation change.” TESLA-1009, 5:56-59. When the vehicle travels along a segment having a given average elevational change (*e.g.*, *travels between a pair of segment destinations*) at a given speed, the energy consumption value for that combination of average elevational change and speed corresponds to *an energy value consumed by the vehicle to travel* along that segment, and thus to travel between the pair of segment destinations defining that segment. As an example, when the vehicle travels along a segment having an average elevation change corresponding to the “2” row in the table above, at a speed corresponding to the “2” speed, the *energy value* consumed by the vehicle to travel that segment (to travel between the pair of segment destinations defining that segment) is 1.03. By extension, the multiple values in the FIG. 6 table thus correspond to *a plurality of such energy values*.

253. In the Schramm-Clapper combination, the set speed for a given segment, *e.g.*, as specified based on the teachings of Clapper, corresponds to *a target speed* for that segment, and thus a *target speed* between the *pair of segment destinations* defining that segment. As I discussed previously, the set speed (*target*

speed) for a given segment can be specified (*e.g.*, in a database) “in accordance with the existing speed for prior trips” on that segment or by “a speed limit[]” for the segment, as taught by Clapper. TESLA-1006, 2:52-57, 3:13-23; *see* 1:50-67, 2:37-44. The stored speed value for a given segment—*e.g.*, the historical speed along that segment for past trips or the speed limit for that segment—is used as the set speed when performing route optimization, and this stored speed value corresponds to the *target speed* for the segment.

254. This set speed (target speed) may vary by segment along a route, *e.g.*, prompted by different speed limits or past user speeds for the segments of the route. This variation in segment speed for different segments along a route corresponds to *variations in the target speed*.

255. The energy values in Schramm’s FIG. 6 are *based on a plurality of variations in a target speed*, *e.g.*, in that they are energy values for travel along segments at various set speeds (*variations in a target speed*). *See* TESLA-1009, 5:62-64 (“the headings [of the table] representing the desired speed of the vehicle 12 along the route segment”), 5:47-49 (“the energy consumption that would be required for the vehicle 12 to traverse the route segment under test at the speed that was input”), 5:65-6:2 (“selecting ... the energy consumption value in ... the column corresponding to the speed that was input”) 6:3-6 (“the numerals under the

speed column headings represent energy consumption units, the default values of which are empirically determined”).

256. The energy values in the energy consumption table thus correspond to *energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations* at least because the energy values in the table are applicable to travel along the segments of the route (*between pairs of segment destinations* defining the segments of the route; *see* my discussion for element [1b]) with different set speeds (*variations in a target speed*), *e.g.*, as specified (based on Clapper) by different past driving patterns or speed limits on the various segments of the route.

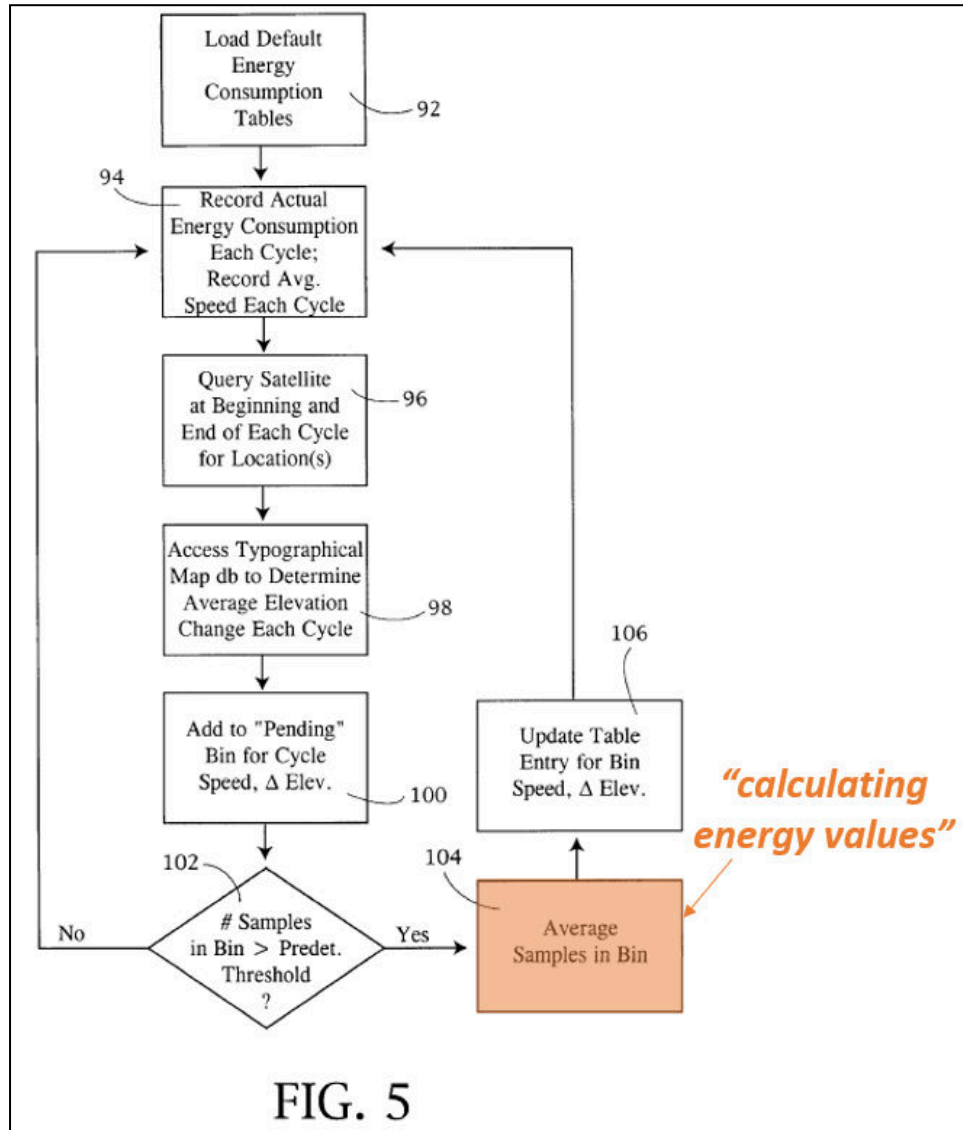
257. I give a specific example to illustrate this mapping. A hypothetical three-segment route has a first segment with an average elevation change corresponding to the “2” row and a speed limit that corresponds to the “2” speed, a second segment with an average elevation change corresponding to the “0” row and a speed limit that corresponds to the “1” speed, and a third segment with an average elevation change corresponding to the “+x” row and a speed limit that corresponds to the “3” speed. The *energy values consumed by the vehicle to travel this route* are 1.03, 1, and k, respectively, highlighted in FIG. 6 above. These energy values are *based on a plurality of variations in a target speed, e.g.*, the different set

speeds (2, 1, and 3, respectively) for the different segments of the route. Moreover, these energy values are for travel *between pairs of segment destinations*, e.g., between the pairs of segment destinations that define each of the three segments of the route.

Calculating energy values in the Schramm-Clapper combination

258. Also in the Schramm-Clapper combination, Schramm describes that “the entries of the table shown in FIG. 6” (the *energy values*) are “updated as the energy consumption module 44 ‘learns’ about the actual energy consumption of the particular vehicle.” TESLA-1009, 6:8-10. This corresponds to *calculating the energy values*. See also TESLA-1009, 2:38-41 (“The energy consumption for each segment is preferably provided by an energy consumption source such as a table, and the source can be updated based on the operation of the vehicle”), Abstract (“the vehicle energy consumption data can be modified as appropriate based on the operation of the vehicle, to account for the particular vehicle’s actual fuel consumption characteristics”), claims 7-8 (“a vehicle energy consumption information source containing energy consumption information relative to the vehicle,” “wherein the source is modified based upon operation of the vehicle”), 7:13-38, FIG. 5. Moreover, because the route optimization process is carried out by the onboard computer of the vehicle, as I discussed above for element [1a], the onboard computer carries out this calculation of the energy values.

259. Schramm's energy value calculation process is depicted in FIG. 5, which I have reproduced and annotated below. Specifically, Schramm describes that the energy consumption table is initially populated with "default energy consumption unit values." TESLA-1009, 7:17-19; *see* block 92 of FIG. 5. During operation of the vehicle, "the actual energy consumption of the vehicle 12, along with the average speed of the vehicle 12, is recorded each cycle, e.g., every minute." *Id.*, 7:23-28; *see* block 94 of FIG. 5. Additionally, "the elevation characteristics of the segment traversed during the cycle" are determined. *Id.*, 7:33-39; *see* blocks 96-98. These recorded energy consumption data are "added to a pending bin that represents actual energy consumption for the particular speed and elevational change." *Id.*, 7:40-43; *see* block 100.



Excerpt from Schramm, FIG. 6 (annotated)

260. When “the number of samples in the bin” for a particular speed-elevation combination “exceeds a predetermined threshold,” “the actual energy consumption values for the sample in the bin are averaged” (block 104 of FIG. 5) and the energy consumption table “is updated ... by replacing the [existing] energy

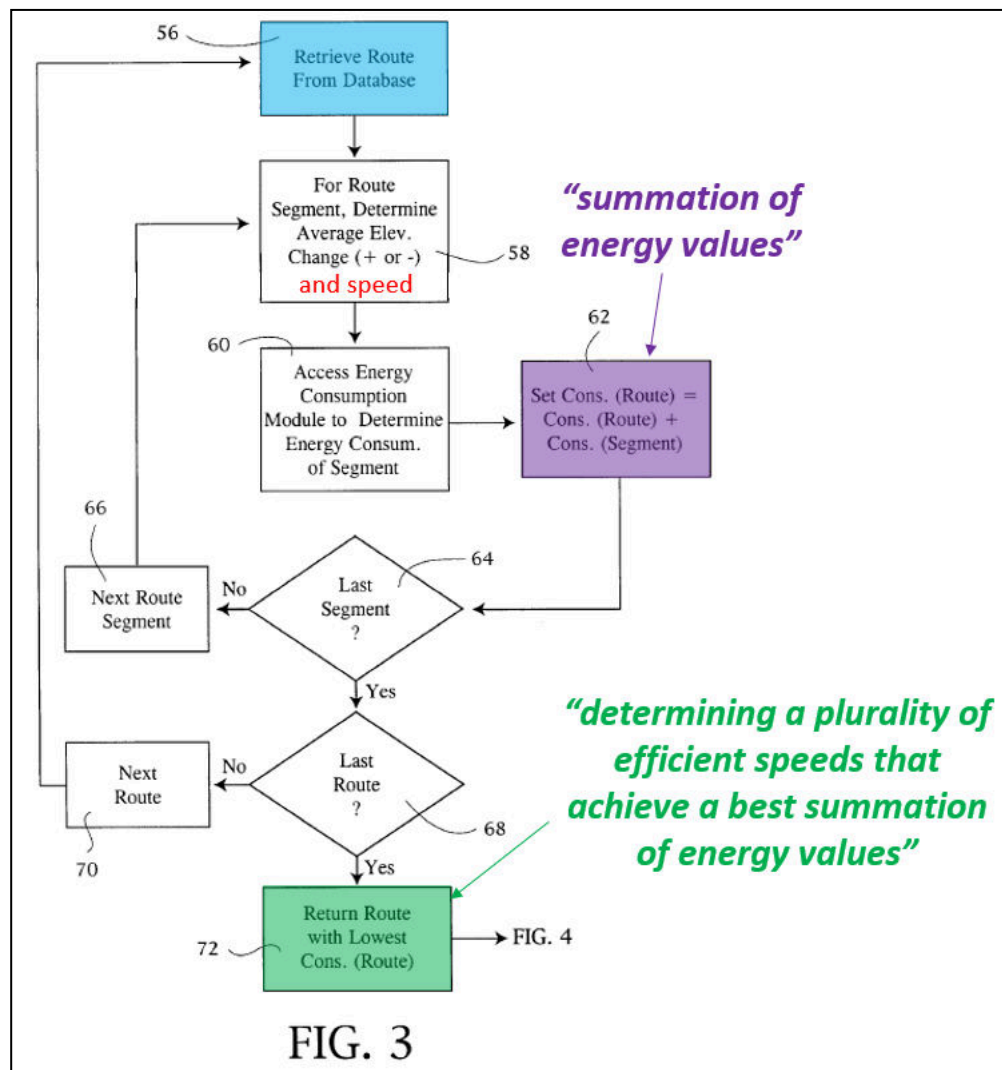
consumption value for the test speed and elevational change” with the newly determined average value (block 106). TESLA-1009, 7:44-50. The averaging of the energy consumption value samples in the pending bins for various speed-elevation combinations (block 104, orange) corresponds to ***calculating*** (e.g., mathematically determining) ***the energy values***, at least because this averaging process involves calculating (using an averaging calculation) energy consumption values that are used to populate the energy consumption table for the various speed-elevation combinations.

[1d] (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and

261. Schramm-Clapper renders limitation [1d] obvious for the reasons described below.

262. In the Schramm-Clapper combination, an iterative addition process is carried out to identify the route that has “the lowest overall energy consumption,” e.g., the lowest sum of the per-segment energy consumption values. TESLA-1009, Abstract, 6:30-31. This process for determining an energy-optimum route, illustrated in the composite figure below, corresponds to ***determining a plurality of efficient speeds that achieve a best summation of said energy values***, as I discuss in

the following paragraphs. Moreover, because the route optimization process is carried out by the onboard computer of the vehicle, as I discussed above for element [1a], the onboard computer carries out this determination of the efficient speeds.



Schramm-Clapper composite figure based on Schramm, FIG. 3

Efficient speeds that achieve a best summation of energy values in the Schramm-Clapper combination

263. In the Schramm-Clapper combination, the set speeds for the segments of the energy-optimum route identified via an optimization process based on that described by Schramm correspond to *a plurality of efficient speeds*, as discussed in this section.

264. In the Schramm-Clapper combination process depicted in the composite flow chart above, for each segment of a possible route between an origin and a destination, “the average elevation change” for the segment is retrieved, as taught by Schramm. TESLA-1009, 5:41-45; *see* block 58 of the composite flow chart, 5:41-44 (“the logic determines, starting with the first route segment of a first route, the average elevation change ... as indicated by the topographic map contained in the database”), claim 1 (“a database containing route information, where each possible route comprises one or more segments, and ground elevation information, where each segment of each possible route is characterized by an average elevational change value ... the computer further accessing the elevation information).

265. Additionally, a speed value for each segment of the possible route is retrieved. The speed limit for a segment can be “the speed that the driver used previously” on that segment or the “speed limit” of that segment, as taught by Clapper, and can be retrieved, *e.g.*, from a database or other repository of location-

based speed information. TESLA-1006, 1:53-55, 3:18-20; *see* 2:12-14 (“the web-site may provide speed limit information which may be used to propose a speed to the operator when traveling in locations which the user has never before traveled”), 2:37-38 (“a database with actual speed limit data may be provided”), 3:13-20 (“If no match is found in the user’s own database of prior speeds, the current location may be compared to a speed limit database ... The database may provide information about speed limits on existing roads and highways correlated to their GPS coordinates.”), 1:61-64 (“The system may store speeds that were used at given times and automatically apply those speeds at given locations at the same or most similar times previously recorded”); block 58 of the composite flow chart figure above; *see* TESLA-1009, 5:14-20.

266. Using these two values (elevation and speed) for each segment of the possible route, “the logic accesses the energy consumption module ... to determine the energy consumption value that would be required for the vehicle 12 to traverse the route segment under test at the speed” for that segment. TESLA-1009, 5:45-49. For instance, for each segment of the route under evaluation, a table such as that of Schramm’s FIG. 6 is accessed to retrieve “the energy consumption value in the row corresponding to the average elevation change” for the given segment and “the column corresponding to the speed” retrieved for that segment. TESLA-1009, 5:66-6:2; *see* block 60 of the composite flow chart figure above, 2:33-35 (“each

route includes one or more segments, and the computer determines an energy consumption for each segment”), claim 1 (“determining an energy consumption for each segment based at least in part on the average elevational change value for the segment”), 5:53-6:2.

267. The computer “adds the energy consumption values” (*energy values*; *see my discussion of element [1c]*) “of the segments of [the] route to determine the energy consumption of the route.” TESLA-1009, 2:35-37. Specifically, for each segment of the route, “the logic of the routing module 42 sets a variable ‘consumption_{route}’ (initialized at zero) to be equal to ‘consumption_{route}’ plus the energy consumption (‘consumption_{segment}’) determined at block 60.” TESLA-1009, 6:11-15; *see block 62* (purple in the composite flow chart figure above), claim 1 (“adding the energy consumptions of the segments of the route to determine the energy consumption for the route”), claim 9, claim 17. The retrieval and summation of energy consumption values is repeated until all segments of the possible route have been accounted for. *See id.*, 6:17-23, blocks 64-66. The resulting “energy consumption of the route,” *e.g.*, the value of “consumption_{route},” as calculated by summing the energy consumption values (*energy values*) for all segments of a given route, corresponds to *a summation of the energy values* for the segments of that route. TESLA-1009, 2:35-37, 6:11-15.

268. This process of determining energy consumption for a possible route is repeated “for each route” under consideration between the origin and the destination. TESLA-1009, 6:18-19; *see* 6:23-29, blocks 68-70. Once the total energy consumption (*summation of the energy values*) has been calculated for each route, “the logic returns the route with the lowest overall energy consumption.” TESLA-1009, 6:29-30; *see* block 72 (green in the composite flow chart figure above). That is, the total energy consumption values for the routes under evaluation are compared, and the route with the lowest total energy consumption value is identified as the energy-optimum route.

269. The identification of “the route with the lowest overall energy consumption” corresponds to *determining* a route *that achieves a best summation of the energy values*, *e.g.*, a route that has the lowest value of the “consumption_{route}” summation, indicating that it is the “energy-optimum route” from among the evaluated routes. TESLA-1009, Abstract, 6:29-31; *see* 2:19-21 (“the computer ... determines a select route having a minimum energy consumption among the possible routes”), 4:25-28 (“the modules 42, 44 cooperate to determine an energy efficient route between the origin ‘A’ and destination ‘B’ of possible routes that exist in the topographical map database”), Abstract (“the computer determines ... an energy-optimum route”), 2:60-63, 3:10-12, claim 1, claim 9, claim 17. For instance, the lowest value of the consumption_{route} summation corresponds to a *best summation*

because it reflects the lowest energy consumption, in alignment with the goals of Schramm's route optimization process.

270. The identified energy-optimum route is composed of “a series of contiguous route segments.” TESLA-1009, 5:33-35; *see* my discussion of element [1b]. Based on Clapper, each route segment has a corresponding speed, *e.g.*, “the speed that the driver used previously” on that segment or the “speed limit” of that segment, as taught by Clapper. TESLA-1006, 1:53-55, 3:13-23; *see* 1:50-67, 2:37-44, 2:52-57. Indeed, these are the speeds that were used to retrieve the energy values for the segments of the route, as I discussed above. The speeds for the segments of the identified energy-optimum route correspond to ***a plurality of efficient speeds*** at least because they are a plurality of speeds for the plurality of segments of the identified energy-optimum (*e.g.*, efficient) route. These speeds can be considered ***efficient speeds*** because they correspond to energy values that, when summed, produce the “lowest overall energy consumption” (*e.g.*, ***best summation*** of energy values) for a route between origin and destination, as I discussed above. TESLA-1009, 6:29-31.

Determining the energy optimum route in the Schramm-Clapper combination corresponds to determining a plurality of efficient speeds

271. In the Schramm-Clapper combination, the efficient speeds (*e.g.*, the speeds for the segments of the energy-optimum route) are ***determined*** as part of the

energy optimum route identification process. Specifically, as I discussed in the preceding section, determining the route that achieves the best summation of energy values involves determining which “series of contiguous route segments” make up that energy-efficient route. TESLA-1009, 5:33-35. Each segment has a corresponding speed, which can be, for instance, “the speed that the driver used previously” on that segment or the “speed limit” of that segment, based on the teachings of Clapper. TESLA-1006, 1:50-67, 3:13-23; *see* 2:37-44, 2:52-57. Thus, when a possible route (and hence the segments of the route) is retrieved for evaluation, the stored speeds for the segments of the route are also retrieved. The segment speeds are used by the optimization process to look up the appropriate energy values for the segments (*e.g.*, via a table such as that of Schramm’s FIG. 6) based on both segment speed and segment elevation change. *See* TESLA-1009, 5:41-48. And determining the energy optimum route that has the best summation of energy values (*e.g.*, the energy values in a table such as that of Schramm’s FIG. 6, as discussed in the preceding section) corresponds to determining the speeds for the segments of that route (***determining a plurality of efficient speeds***) in that the identification of the energy optimum route determines (*e.g.*, specifies) the segments of the identified route, and thus determines (*e.g.*, specifies) the speeds of the

segments of that energy optimized route (e.g., “the speed that the driver used previously” on each segment or the “speed limit” of each segment). TESLA-1006, 1:50-67, 3:13-23; *see* 2:37-44, 2:52-57.

Controlling vehicle speed using automatic cruise control corresponds to determining the efficient speeds

272. Alternatively, or additionally, the efficient speeds (e.g., the speeds for the segments of the energy-optimum route) are ***determined*** as the vehicle drives along the segments of the identified energy-optimum route, e.g., through use of an “automatic cruise control” to control vehicle speed, as taught by Clapper. TESLA-1006, 1:54-64. Based on Clapper, as the vehicle travels along the segments of the identified energy-optimum route, “[t]he vehicle’s current position [is] determined,” and “the automatic cruise control [] set[s] the vehicle’s speed” to the set speed for the current segment, e.g., which can be a speed that is “based on the speed that the driver used previously at the same location,” or based on “the speed for [the] given location found in the speed limit database.” TESLA-1006, 1:43-56, 3:18-20. In the combination, the set speeds for the segments of the route correspond to the speeds for the segments of the identified energy-optimum route, e.g., the ***plurality of efficient speeds***. That is, in the combination, the automatic cruise control controls the operation of the vehicle such that it travels along segments of the energy-optimum route at the set speeds for the segments of the energy optimum route (***the***

efficient speeds). A POSITA would have understood the automatic cruise control to **determine** the efficient speeds for the segments of the identified route so that it is able to control the vehicle to travel at those efficient speeds. For instance, the automatic cruise control can **determine** the efficient speeds by accessing “entries in a user database” that specify “the existing speed from prior trips” or “the speed ... found in the speed limit database” for the segments of the identified route.

TESLA-1006, 2:52-55, 3:18-20.

Displaying speeds as the vehicle travels along the energy optimum route corresponds to determining the efficient speeds

273. Still alternatively or additionally, the efficient speeds (*e.g.*, the speeds for the segments of the energy-optimum route) are **determined** as the vehicle drives along the segments of the identified energy-optimum route such that these speeds can be displayed to the driver. *See* TESLA-1006, 3:37-45; FIG. 4, below. As discussed further in [1e], below, as the vehicle travels the identified energy-optimum route, a display displays “information about speeds used at given locations in the past” and/or a “speed limit” that corresponds to each current segment along which the vehicle is travelling. TESLA-1006, 1:50-55, 3:14-19; *see* 3:38-41. These speeds, for the segments of the energy-optimum route, correspond to the **plurality of efficient speeds**, as I discussed above, *e.g.*, the efficient speed for each segment of the route is displayed as the vehicle travels along that segment.

274. A POSITA would have understood these efficient speeds to be **determined** so that they are able to be displayed. For instance, as the vehicle travels along a segment of the route, the efficient speed for that segment is retrieved, *e.g.*, by obtaining “[t]he speed from memory” or the “speed suggested from a database” for that segment (*e.g.*, for the vehicle’s current location, and the retrieved speed is displayed to the driver. TESLA-1006, 3:38-40. Retrieving a speed from the database corresponds to **determining** that speed. As the vehicle drives along the entire route, then, the speeds for all of the segments of the routes are ultimately retrieved, *e.g.*, the efficient speeds are **determined**.

[1e] (e) notifying an operator of said vehicle about said efficient speeds to travel between each of said segment destinations.

275. Schramm-Clapper renders limitation [1e] obvious for the reasons described below.

276. The **efficient speeds**, *e.g.*, the speeds for the segments of the identified energy-optimum route (*see* my discussion of element [1d] above), correspond to **efficient speeds to travel between each of said segment destinations**, *e.g.*, because the efficient speed for a given segment corresponds to the speed to travel between the two segment destinations defining that segment. As I also discussed above, the **efficient speeds** correspond to the set speeds for the segments of the identified energy-optimum route, *e.g.*, specified based on “the existing speed for prior trips” on

those segments or by the “speed limits” for those segments, based on Clapper. *See* Clapper, 2:52-57, 3:13-23; *see* my discussion of element [1c] above.

277. In the combination, based on Clapper, a display displays speed information as the vehicle travels along the segments identified energy-optimum route, which corresponds to *notifying an operator of said vehicle about said efficient speeds to travel between each of said segment destinations*, *e.g.*, between the pairs of segment destinations defining each segment of the energy-optimum route. *See* my above discussion of element [1c]; TESLA-1009, 2:33-35, 5:32-33, claim 1; TESLA-1006, 3:37-45. An example of such a display is illustrated in the figure below, based on Clapper’s FIG. 4.

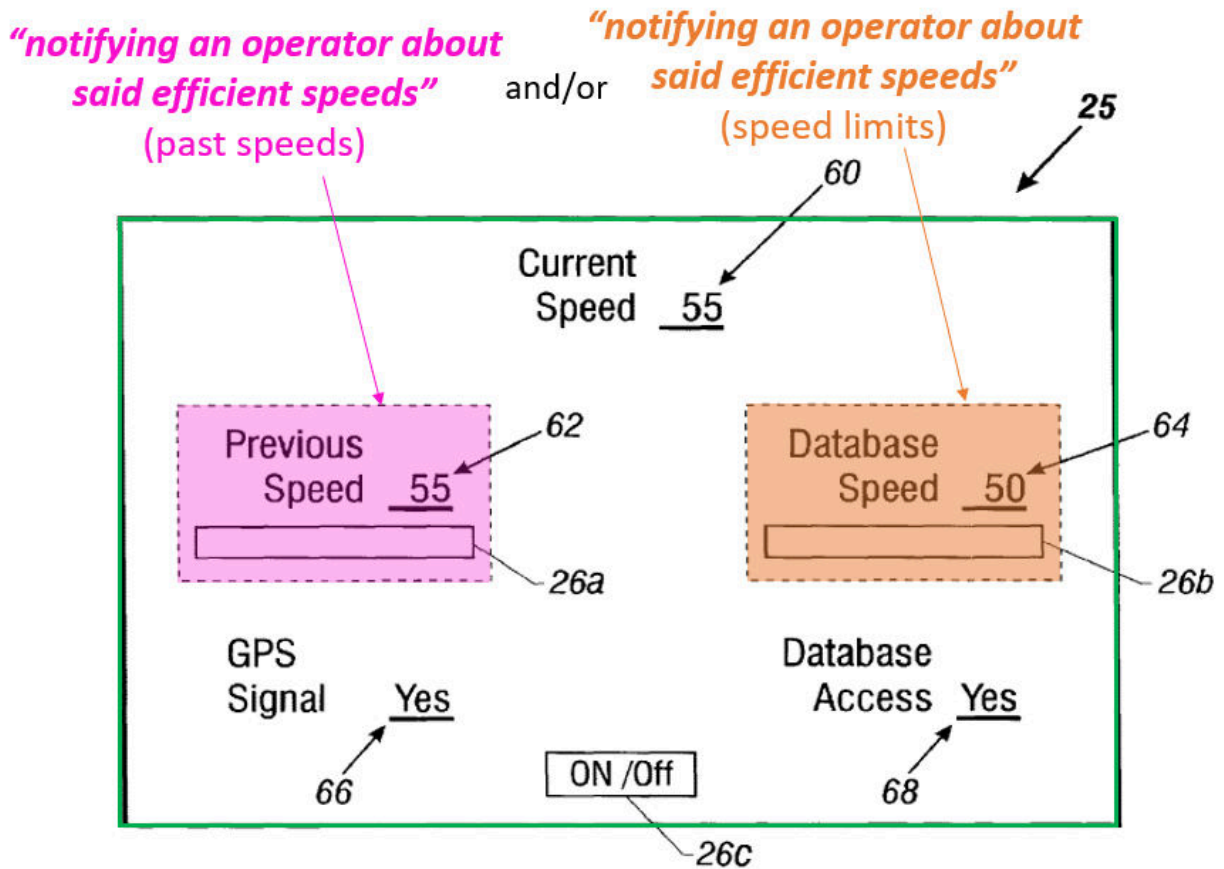


FIG. 4

Excerpt from Clapper, FIG. 4

278. Specifically, as the vehicle travels the identified energy-optimum route, the display displays “[t]he speed from memory,” pink, that corresponds to each current segment along which the vehicle is travelling. TESLA-1006, 3:38-39. The speeds from memory are “information about speeds used at given locations in the past,” which, as I discussed above for [1d], correspond to *the efficient speeds* for the segments of the identified energy-optimum route. TESLA-1006, 1:50-55.

Thus, as the vehicle drives along the segments of the identified energy-optimum route, “the speeds that the driver used previously” on those segments, *e.g.*, ***the efficient speeds*** for the segments of the energy-optimum route, are displayed.

TESLA-1006, 3:38-39.

279. Alternatively, or additionally, as the vehicle travels the energy-optimum route, the display displays “[a] speed suggested from a database,” such as a speed limit “found in the speed limit database” for each current segment. TESLA-1006, 3:14-19, 3:39-41. As also discussed above, the speed limits for the segments of the identified energy-optimum route correspond to ***the efficient speeds***. Thus, as the vehicle drives along the segments of the identified energy-optimum route, the stored speed limits for those segments, *e.g.*, ***the efficient speeds*** for the segments of the energy-optimum route, are displayed. *See* TESLA-1006, 3:14-19, 3:39-41; *see* [1d].

280. As the vehicle transits along the energy-optimum from one segment having one stored speed (*e.g.*, speed that the driver used previously, or the speed limit) to another segment having a different stored speed, the displayed speed changes to reflect the stored speed (***efficient speed***) for the new current segment. TESLA-1006, 3:38-39. Thus, once the vehicle has transited the entire energy-optimum route, the stored speed (*e.g.*, the speed that the driver used previously, or the

speed limit) for each of the segments of the energy-optimum route has been displayed, *e.g.*, the *efficient speeds* for all segments of the energy-optimum route are displayed.

281. The display of these efficient speeds corresponds to *notifying the operator of the vehicle about the efficient speeds*, at least in that the display of the speed information (*e.g.*, on the vehicle dashboard) provides information to (*notifies*) the vehicle operator about these speeds. *See* TESLA-1006, 3:30-34.

(b) Claim 3

[3] The method of claim 1, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.

282. Schramm-Clapper renders claim 3 obvious for the reasons described below.

283. In the Schramm-Clapper combination, determining the energy-optimum route, and hence the speeds for the segments of that route, corresponds to determining the efficient speeds, as discussed in [1d], above. The process of determining the energy-optimum route is based on the energy consumption values in a table such as that of Schramm's FIG. 6. *See* TESLA-1009, 5:41-6:31. These values—and thus the process of determining the efficient speeds—are based on (i) an aerodynamic drag of the vehicle, (ii) a rolling resistance of the vehicle and (iii) a

change in potential energy of the vehicle due to a road gradient, as discussed in the following paragraphs.

284. As discussed in [1c], above, the energy consumption values in the energy consumption table are calculated by averaging measured “actual energy consumption of the vehicle.” TESLA-1009, 7:23-25. The actual energy consumption is determined by “access[ing] the fuel gauge, battery discharge meter, or other fuel consumption instrument of the vehicle.” *Id.*, 7:25-28. In this context, a POSITA would have understood that the “actual energy consumption” of the vehicle, as measured by, e.g., a fuel gauge or battery discharge meter, indicates the amount of energy (e.g., fuel) consumed by the vehicle. *Id.*, 7:23-28.

285. Furthermore, a POSITA would have understood that the amount of energy (fuel) consumed by the vehicle is affected by vehicle characteristics such as the aerodynamic drag and the rolling resistance of the vehicle. This is demonstrated by Morchin, which explains that “[t]he four components of energy use are acceleration, friction, air drag, and hill climbing,” and providing “equations of the energy used for propelling a ground vehicle,” including an equation for air drag that includes a “coefficient of aerodynamic drag,” and an equation for friction that includes a “coefficient of rolling resistance.” TESLA-1007, 2. Neiss also provides corroboration, describing that the “equation of motion” of a vehicle is based on,

among other factors, a “friction coefficient of the street” and a “turbulent friction”). That is, the energy consumption values in the energy consumption table are determined based on actual energy consumption of the vehicle, which in turn is based on *(i) aerodynamic drag and (ii) rolling resistance of the vehicle*. TESLA-1005, [0053]-[0059]. *See also* TESLA-1009, 7:17-50, FIG. 5.

286. Additionally, the vehicle’s energy consumption is affected by the road gradient. Indeed, Schramm’s categorization of energy consumption values based on road gradient reflects that road gradient impacts energy consumption. *See* TESLA-1009, 5:41-51, 5:64-6:2, FIG. 6. More generally, a POSITA would have understood this to be the case. For instance, Morchin provides an equation for hills that include “road surface grade” factor as one of the “equations of the energy used for propelling a ground vehicle.” TESLA-1007, 2. As another example, Neiss describing that the “equation of motion” of a vehicle is based on “the grade of the street.” TESLA-1005, [0053]-[0059]. Furthermore, a POSITA would have understood that a vehicle transiting a road gradient experiences a change in potential energy; for instance, a vehicle climbing an incline gains potential energy as it ascends. Thus, the energy consumption values in the energy consumption table are determined based on actual energy consumption of the vehicle, which in turn is based on *(iii) change in potential energy of the vehicle due to a road gradient*. *See* TESLA-1009, 7:17-50, FIG. 5.

287. Because the process of determining the energy-optimum route (*determining the efficient speeds*) is based on the energy consumption values, which, as discussed in the previous paragraphs, are based on aerodynamic drag, rolling resistance, and change in potential energy of the vehicle, *e.g.*, *determining the efficient speeds is based on (i) aerodynamic drag, (ii) rolling resistance, and (iii) change in potential energy of the vehicle due to a road gradient.*

(c) Claim 6

[6] The method of claim 1, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.

288. Schramm-Clapper renders claim 6 obvious for the reasons described below.

289. In the Schramm-Clapper combination, averaging of energy consumption value samples in pending bins corresponds to *calculating the energy values*, as discussed in [1c], above. *See* TESLA-1009, 7:44-50, FIG. 5. The energy consumption value samples used in the averaging are assigned to their respective pending bins *based on a current location of the vehicle*, as discussed in the following paragraphs. *See* TESLA-1009, 7:23-39.

290. In the combination, Schramm describes that “the actual energy consumption of the vehicle” and “the average speed of the vehicle” are “recorded each cycle, *e.g.*, every minute.” *Id.*, 7:23-25; *see* block 94 of FIG. 5. Additionally, “the

elevational change of the segment traversed during the cycle is recorded.” *Id.*, 7:29-30. This is achieved by determining “the start point and end point of the segment” using a “GPS transceiver,” *e.g.*, determining ***a current location of the vehicle***. *Id.*, 7:30-33; *see* block 96 of FIG. 5.

291. This current location information is used “to correlate the segment” (*e.g.*, the current location) “with the appropriate segment stored in the database ... to thereby determine the elevation characteristics of the segment traversed during the cycle.” *Id.*, 7:34-39; *see* block 98 of FIG. 5. Based on the elevation characteristics (which in turn are determined based on the ***current location of the vehicle***) and the speed, the recorded vehicle energy consumption sample “is added to a pending bin” for that elevation-speed combination, and ultimately averaged with other samples in the bin to determine an “energy consumption value” to populate the table of Schramm’s FIG. 6. *Id.*, 7:40-50; *see* blocks 100-106 of FIG. 5. That is, averaging the energy consumption value samples (***calculating the energy values***; *see* [1c]) is based on the assignment of energy consumption value samples to pending bins, which in turn is based on current location of the vehicle, *e.g.*, ***calculating of the energy values is based on a current location of said vehicle***.

292. Moreover, in the combination, Schramm describes that ***the current location of the vehicle is determined by GPS information***: “the computer 14 causes the GPS transceiver 24 (FIG. 1) to query the satellite ... to obtain the start point

and end point of the segment.” TESLA-1009, 7:30-33; *see* Abstract (“A global positioning system (GPS) transceiver is also onboard the vehicle for receiving vehicle position data from the satellite”), 3:47-48 (“a satellite-implemented global positioning system (GPS) transceiver 24”).

(d) Claim 7

[7] The method of claim 1, wherein said calculating of said energy values is based on a plurality of speed limits between said segment destinations.

293. Schramm-Clapper renders claim 7 obvious for the reasons described below.

294. In the Schramm-Clapper combination, averaging of energy consumption value samples in pending bins corresponds to ***calculating the energy values***, as discussed in [1c], above. *See* TESLA-1009, 7:44-50, FIG. 5. The energy consumption value samples used in the averaging are assigned to their respective pending bins based on “the average speed of the vehicle” when each sample was recorded, *e.g.*, calculating the energy values is based on vehicle speed. TESLA-1009, 7:23-25; *see* 7:40-43 (“the data obtained at blocks 94 and 98 is added to a pending bin that represents actual energy consumption for the particular speed and elevational change under test”); *see* [6].

295. A POSITA would have understood that the “average speed of a vehicle” as it transits a segment is, at least in some cases, based on traffic laws applicable to that segment. For instance, the average speed to transit a segment is *based on a speed limit* of that segment, and indeed, is often below the assigned speed limit for the segment due to traffic conditions along that segment. TESLA-1009, 7:23-25. For instance, when the vehicle speed is controlled by an automatic cruise control based on Clapper, the automatic cruise control, in one example, sets “the speed for a given location found in the speed limit database” that specifies “speed limits on existing roads and highways,” *e.g.*, sets the speed of the vehicle to match the speed limit for the segment on which the vehicle is traveling. TESLA-1006, 3:15-19. Alternatively, or additionally, if the driver is controlling the speed of the vehicle, a POSITA would have found it reasonable for the driver to select a speed that is based on the speed limit, *e.g.*, a speed that is within a range of the speed limit that the driver deems acceptable or a speed that is based on, but lower than, the speed limit due to traffic considerations.

296. As discussed in [1c], above, a pair of segment destinations defines a segment. *See* TESLA-1009, 2:33-35, 5:32-33, claim 1. Thus, speed limit of a segment corresponds to a speed limit between a pair of segment destinations.

297. Averaging the energy consumption value samples (*calculating the energy values*; see [1c]) is based on assignment of energy consumption value samples to pending bins, as discussed in [6], above. See TESLA-1009, 7:40-42, FIG. 5. Assignment of energy consumption value samples to pending bins is based on vehicle speed when each sample was collected (see TESLA-1009, 7:23-30), which in turn is based on speed limit of the segment where the vehicle was located when that sample was collected (e.g., speed limit between a pair of segment destinations), as discussed in the previous paragraphs. Thus, averaging the energy consumption value samples (*calculating of the energy values*) is based on speed limits between pairs of segment destinations.

(e) Claim 8

[8] The method of claim 1, further comprising the step of: calculating said target speed in response to a position of a gas pedal of said vehicle.

298. Schramm-Clapper renders claim 8 obvious for the reasons described below.

299. As discussed in [1c], above, in the combination, the set speed for a segment, e.g., a speed set “based on the speed that the driver used previously” on that segment, corresponds to *a target speed*. TESLA-1006, 1:53-56; see 2:52-57 (“the database speed may be set in accordance with the existing speed from prior trips”). Notably, Clapper also describes that a user may “override[]” the set speed

“by accelerating beyond the proposed speed or by decelerating below it,” and this new, override speed is recorded to “thereafter be used as the speed for a given location at a given time,” *e.g.*, the **target speed** is set based on the driver accelerating/decelerating relative to the proposed speed. TESLA-1006, 2:61-66; *see* 3:19-22 (“this [set] speed may be overridden ... and in such case, a new actual speed may be recorded and stored in the user database of actual previous speed history”), 2:38-41. A POSITA would have understood that the driver accelerating/decelerating relative to the proposed speed—which informs the setting of the target speed—is achieved by the driver’s interaction with the gas pedal, *e.g.*, pressing the gas pedal to accelerate or easing pressure on the gas pedal to decelerate. Indeed, this is the conventional function of the gas pedal of a vehicle. Thus, based on Clapper, the target speed is set in response to driver interaction with the gas pedal, *e.g.*, ***in response to a position of the gas pedal***. Moreover, a POSITA would have understood that the target speed is ***calculated*** in response to a position of the gas pedal, *e.g.*, in that based on the driver’s acceleration/deceleration relative to the proposed speed, a new numerical value for the actual speed of the vehicle is determined. *See* TESLA-1015, 3; TESLA-1016, 3; TESLA-1017, 3.

(f) **Claim 9**

[9] The method of claim 1, further comprising the step of: shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

300. Schramm-Clapper renders claim 9 obvious for the reasons described below.

301. In the combination, based on Clapper, an “automatic cruise control,” is used “to automatically control the speed of [the] vehicle based on the vehicle’s current position” along the energy-optimum route determined by the Schramm-Clapper combination process. TESLA-1006, 1:42-44. Specifically, as the vehicle travels along the segments of the identified energy-optimum route, “[t]he vehicle’s current position [is] determined,” *e.g.*, by GPS, and “the automatic cruise control [] set[s] the vehicle’s speed based on the speed that the driver used previously at the same location,” or based on “the speed for [the] given location found in the speed limit database.” TESLA-1006, 1:43-55, 3:17-19. That is, in the combination, the automatic cruise control controls the operation of the vehicle such that it travels along segments of the energy-optimum route at the previously-used speeds or speed limits for the segments of the route (*the efficient speeds*; *see* [1d]). TESLA-1006, 1:50-51, 2:52-60, 3:13-20; *see* [1d].

302. A POSITA would have understood the vehicle of the Schramm-Clapper combination to have *a transmission*; indeed, this is a standard feature of vehicles such as the internal combustion, hybrid, or electric vehicles of the combination. *See* TESLA-1009, 3:57-63; TESLA-1012, 1:6-7; TESLA-1018, [0003]; *see also* my discussion of claim 9 for Ground 1A. Moreover, a POSITA would have

found it obvious for the transmission of the combination vehicle to be an ***auto-matic transmission***, *e.g.*, because of the widespread adoption and advantages of automatic transmissions. *See* TESLA-1018, [0004]; TESLA-1012, 6:27-35; *see also* my discussion of claim 9 for Ground 1A. Still alternatively or additionally, a POSITA would have found the implementation of an ***automatic transmission*** to be obvious because it is one of the few conventional implementations for vehicle transmissions (the main ones being manual or automatic). *See* TESLA-1018, [0003]; *see also* my discussion of claim 9 for Ground 1A.

303. It was conventional for a cruise control system to shift gears of an automatic transmission to achieve a desired travel speed. *See* TESLA-1013, 2:35-45. Moreover, a cruise control system that shifts gears of a transmission is advantageous in that it enables efficient operation of the engine to maintain a desired speed consistent with environmental conditions, as I discussed above for claim 9 of Ground 1A.

304. In light of the conventional nature of cruise control systems that shift gears of automatic transmissions, and given the advantages of such systems, a POSITA would have understood that the automatic cruise control of the Schramm-Clapper vehicle ***shifts gears of the automatic transmission*** to control the vehicle to travel at the efficient speed for each current segment of its travel along the identified energy-optimum route, *e.g.*, shifts gears ***based on the efficient speeds***.

(g) Claim 10

[10pre] A method of managing a power consumption of a vehicle, comprising the steps of:

[10a] (a) receiving a route at a computer of said vehicle;

[10b] (b) segmenting said route into a plurality of segment destinations;

[10c] (c) calculating a plurality of energy values consumed by said vehicle to travel said route based on a plurality of variations in a target speed of said vehicle between pairs of said segment destinations;

[10d] (d) determining a plurality of efficient speeds that achieve a best summation of said energy values; and

305. See [1pre]-[1d].

[10e] (e) applying power corresponding to said efficient speeds to an engine of said vehicle to travel between each of said segment destinations.

306. Schramm-Clapper renders limitation [10e] obvious for the reasons described below.

307. A POSITA would have understood the Schramm-Clapper vehicle to have ***an engine***, based on Schramm's disclosure that the vehicle is fueled at least in part by gasoline. See TESLA-1009, 1:57-63.

308. In the combination, based on Clapper, an "automatic cruise control," is used "to automatically control the speed of [the] vehicle based on the vehicle's current position" along the energy-optimum route determined by the Schramm-Clapper combination process. TESLA-1006, 1:42-53; see 2:52-60, 3:13-20. Spe-

cifically, as the vehicle travels along the segments of the identified energy-optimum route (*e.g.*, as the vehicle *travels between each of said segment destinations*), “[t]he vehicle’s current position [is] determined,” *e.g.*, by GPS, and “the automatic cruise control [] set[s] the vehicle’s speed based on the speed that the driver used previously at the same location,” or based on “the speed for [the] given location found in the speed limit database.” TESLA-1006, 1:43-51, 2:52-60, 3:13-20. That is, in the combination, the automatic cruise control controls the operation of the vehicle such that it travels along segments of the energy-optimum route (*travel between each of said segment destinations*; *see* [1c]; TESLA-1009, 2:33-35, 5:32-33, claim 1) at the previously-used speeds or speed limits for the segments of the route (*the efficient speeds*; *see* [1d]). TESLA-1006, 1:50-51, 2:52-60, 3:13-20; *see* [1d].

309. As taught by Clapper, the automatic cruise control of the combination controls vehicle speed via control of “[a] brake interface 23 and a carburetor interface 21.” TESLA-1006, 2:15-16. A carburetor controls the mixture of air and fuel entering an engine. This is explained, for instance, by Voges, which describes “a carburetor equipped with the usual throttle valve means controlling the flow of air-fuel flow to the intake manifold.” TESLA-1014, Abstract. Given this conventional functionality of a carburetor, a POSITA would have understood that by controlling a carburetor interface with the objective of controlling vehicle speed, as

taught by Clapper, the mixture of air and fuel supplied to the engine is controlled such that the vehicle travels at the desired speed, *e.g.*, at ***the efficient speed*** for each current segment of the route. Indeed, this is the conventional way that cruise control systems operate, for instance, as is also described by Voges: “A speed responsive device 17” which may be “the usual cruise control governor means found on many vehicles.” TESLA-1014, 2:39-50. More generally, while Clapper describes vehicle control by way of a carburetor interface, a POSITA, at the time of the Critical Date, would have recognized that there are many ways to implement vehicle control (*e.g.*, cruise control), with Clapper’s carburetor-based control as merely one example of several available implementations.

310. Moreover, a POSITA would have understood that controlling the carburetor interface (thereby controlling the air/fuel mixture supplied to the engine) to achieve travel at the efficient speeds corresponds to ***applying power to the engine corresponding to the efficient speeds***. Power is an amount of energy per unit time. Controlling the air/fuel mixture flowing into the engine corresponds to ***applying power to the engine*** at least because the flow of fuel into the engine is application, to the engine, of an amount of energy (*e.g.*, chemical energy of the fuel) over time. For instance, the power applied to the engine through the flow of air/fuel mixture into the engine is based on the flow rate of the fuel and the air/fuel ratio. Moreover, the applied power (*e.g.*, flow of air/fuel mixture) ***corresponds to the efficient***

speeds at least because the flow is controlled to achieve the efficient speed corresponding to each current segment of travel.

(h) Claim 12

[12] The method of claim 10, wherein said determining of said efficient speeds is based on (i) an aerodynamic drag of said vehicle, (ii) a rolling resistance of said vehicle and (iii) a change in potential energy of said vehicle due to a road gradient.

311. See [3].

(i) Claim 13

[13] The method of claim 10, further comprising the step of: notifying an operator of the vehicle about said efficient speeds to travel between each of said segment destinations.

312. See [1e].

(j) Claim 15

[15] The method of claim 10, wherein said calculating of said energy values is based on a current location of said vehicle as determined by global positioning system information.

313. See [6].

(k) Claim 16

[16] The method of claim 10, wherein said calculating of said energy values is based on a plurality of speed limits between said segment destinations.

314. See [7].

(l) Claim 17

[17] The method of claim 10, further comprising the step of: calculating said target speed in response to a position of a gas pedal of said vehicle.

315. See [8].

(m) Claim 18

[18] The method of claim 10, further comprising the step of: shifting gears of an automatic transmission in said vehicle based on said efficient speeds.

316. See [9].

VIII. ADDITIONAL REMARKS

317. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

318. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Dated: February 6, 2024

By:  _____