UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

_____

SIEMENS MOBILITY, INC., GROUND TRANSPORTATION SYSTEMS USA, INC., and PIPER NETWORKS, INC.,

Petitioners,

v.

METROM RAIL, LLC,
Patent Owner.

_____

Case No. IPR2024-00947
Patent No. 9,731,738

_____

PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.1 *et seq.*

Table of Contents

I. INTRODUCTION 1

II. CERTIFICATION OF STANDING 2

III. UNPATENTABILITY GROUNDS 2

IV. THE '738 PATENT 3

A. Challenged Claims 4

B. Level of Ordinary Skill in the Art 5

C. Prosecution History 5

V. CLAIM INTERPRETATION 6

VI. GROUNDS OF UNPATENTABILITY 7

A. Ground 1A – Claims 1-2, 6-8, and 13-15 Are Obvious in View of Kane and Heddebaut 7

1. The Asserted References 7

1. Claim 1 12

2. Claim 2 – Color Status of Control Signal 27

3. Claim 6 29

4. Claim 7 – Threshold Distance Alert 33

5. Claim 8 – Threshold Distance Braking 34

6. Claim 13 35

7. Claim 14 41

8. Claim 15 43

B. Ground 1B – Claims 3-5 Are Obvious in View of Kane, Heddebaut, and Das 46

1. Das (EX1007) 46

2. Claim 3 – Stop-Time Duration 46

3. Claim 4 – Speed Limit 48

4. Claim 5 – Speed Limit After Stop-Time Duration 49

C. Ground 1C – Claims 9-11 and 16-17 Are Obvious in View of Kane, Heddebaut, and Ackerman 49

1. Ackerman (EX1008) 49

2. Claim 9 – RFID Subsystem 50

3. Claim 10 54

4. Claim 11 – Distance Based on RFID 56

5. Claim 16 56

6. Claim 17 – Distance Based on RFID and Speed 57

D. Ground 1D – Claims 12 and 18 Are Obvious in View of Kane, Heddebaut, and Hungate 57

1. Hungate (EX1009) 57

2. Claim 12 58

3. Claim 18 – External Access Point 62

E. Ground 1E – Claims 13-15 Are Obvious in View of Kane, Heddebaut, and Grisham 62

1. Grisham (EX1010) 62

2. Claim 13 64

3. Claim 14 67

4. Claim 15 68

F. Ground 1F – Claims 16-17 Are Obvious in View of Kane, Heddebaut, Grisham, and Ackerman 68

G. Ground 1G – Claim 18 Is Obvious in View of Kane, Heddebaut, Grisham, and Hungate 69

VII. No Basis for Discretionary Denial 69

A. Section 314(a) 69

1. Stay Potential 70

2. Trial Timing 70

3. Litigation Investment 70

4. Overlap of Issues 70

5. Litigation Defendants 71

6. Other Circumstances 71

B. Section 325(d) 71

1. Step 1: The Petition Advances Art and Arguments Not Previously Considered 72

2. Step 2: The Office Erred Materially 72

VIII. CONCLUSION 74

TABLE OF AUTHORITIES

Cases **Page(s)**

Adobe v. Rah Color,
IPR2019-00627, Paper 41, 20 (Sept. 10, 2019) 74

Advanced Bionics, LLC v. MED-EL Elektromedizinische Geraete GmbH,
IPR2019-01469, Paper 6 (Feb. 13, 2020) 71, 72, 73

Apple, Inc. v. Fintiv, Inc.,
IPR2020-00019 ..... 69, 71

Bowtech, Inc. v. MCP IP, LLC,
IPR2019-00382, Paper 12, 12 (Aug. 6, 2019) 72, 73

Markforged Inc. v. Continuous Composites,
IPR2022-00679, Paper 7, 32-33 (Oct. 25, 2022) 71

Sand Revolution II v. Cont'l Inter. Group-Trucking LLC,
IPR2019-01393, Paper 24, 12-13 (June 16, 2020) 71

SHDS v. Truinject,
IPR2020-00937, Paper 11, 8-12 (Nov. 17, 2020) 72

Snap Inc. v. SRK Tech. LLC,
IPR2020-00820, Paper 15, 9 (Oct. 21, 2020) 70

Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.,
200 F.3d 795 (Fed. Cir. 1999) 7

Other Authorities

37 C.F.R. § 42.100(b) 6

Appendix Listing of Exhibits

Exhibit	Description
1001	U.S. Patent No. 9,731,738 ("'738 Patent")
1002	Prosecution History of US Patent No. 9,731,738
1003	Declaration of Foster J. Peterson
1004	Curriculum Veritas of Foster J. Peterson
1005	U.S. Patent No. 6,957,131 ("Kane")
1006	U.S. Patent Publication No. 2006/0151672 ("Heddebaut")
1007	International Application No. WO 2011/125074 ("Das")
1008	U.S. Patent No. 5,803,411 ("Ackerman")
1009	U.S. Patent No. 5,950,966 ("Hungate")
1010	U.S. Patent No. 6,759,948 ("Grisham")
1011	U.S. Patent Publication No. 2007/0293153 ("Molisch")
1012	Time Domain's Ultra Wideband (UWB) Definition and Advantages, Time Domain (March 2011)
1013	Paul A. Flaherty, "CCS: A Railway Corridor Control System Utilizing UWB Radio Technology," Proceedings of the 2004 ASME/IEEE Joint Rail Conference (2004)
1014	IEEE Std 802.15.4™-2011, IEEE Standard for Local and Metropolitan Area Networks: Part 15.4: Low-Rate Wireless Personal Area Networks (Sept. 5, 2011)
1015	[reserved]
1016	U.S. Patent Publication No. 2008/0111688 ("Nikitin")
1017	U.S. Patent No. 6,133,876 ("Fullerton")
1018	Copy of Opinion and Order Granting Motion to Stay, *Metrom Rail, LLC v. Siemens Mobility, Inc., et al.*, No. 1:23-cv-03057-MKV (S.D.N.Y.), 01/29/2024 (ECF No. 90)

1019	Copy of Second Amended Complaint, *Metrom Rail, LLC v. Siemens Mobility, Inc., et al.*, No. 1:23-cv-03057-MKV (S.D.N.Y.), 05/26/2023 (ECF No. 69-1)
1020	U.S. Patent Publication No. 2006/0009240 ("Katz")
1021	European Patent Application No. EP 1 785 744 ("Suzuki")
1022	"United States Frequency Allocations: The Radio Spectrum," U.S. Dept. of Com.: Nat'l Telecomm. and Info. Admin. Office of Spectrum Mgmt. (Oct. 2003)
1023	U.S. Patent No. 6,631,322 ("Arthur")
1024	U.S. Patent No. 6,338,152 ("Fera")
1025	Automatic Train Control and Advanced Civil Speed Enforcement System; Northeast Corridor Railroads, 63 Fed. Reg. 39343 (July 22, 1998)
1026	49 C.F.R. § 236.0 (2010)
1027	George D. Bibel, *Train Wreck: The Forensics of Rail Disasters* 65-99 (The Johns Hopkins Univ. Press ed., 2012)
1028	*Report of the Railroad Safety Advisory Committee to the Federal Railroad Administrator: Implementation of Positive Train Control*, Railroad Safety Advisory Committee (Sept. 8, 1999)
1029	*RFID Working on the Railroad*, IEEE Potentials, September/October 2015
1030	*Standard for Automatic Equipment Identification: Standard S-918*, AAR Manual of Standard and Recommended Practice Railway Electronics (adopted 1991)
1031	Beth Bacheldor, *South African Railroad Switches to Passive RFID*, RFID Journal (Jan. 26, 2007)
1032	U.S. Patent No. 8,200,380 ("Ghaly")
1033	General Code of Operational Rules (GCOR) (6th ed. 2010)
1034	Northeastern Operating Rule Advisory Committee (NORAC) (10th ed. 2011)
1035	42 Fed. Reg. 5065 (Jan. 27, 1977) (to be codified at 49 C.F.R. § 218.35)

1036	Federal Railroad Administration, "Type Approval – Advanced Civil Speed Enforcement System (ACSES) II (May 27, 2010)

MANDATORY NOTICES

A. Real Party-In-Interest – 37 C.F.R. § 42.8(b)(1)

Petitioners Siemens Mobility, Inc., Ground Transportation Systems USA Inc., and Piper Networks, Inc. are real parties-in-interest. Humatics Corp. is also a real party-in-interest.

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

1. United States Patent and Trademark Office

U.S. Patent No. 9,731,738 ("the '738 Patent") claims the benefit of the filing date of Provisional Application No. 61/959,729, filed September 3, 2013, and U.S. Patent Application No. 14/476,338, filed September 3, 2014.

2. District Court Matters

The '738 Patent is at issue in the following pending case: *Metrom Rail, LLC v. Siemens Mobility, Inc., et al.*, No. 1:23-cv-03057-MKV (S.D.N.Y.). The '738 Patent is not yet at issue in the following pending case involving Ground Transportation Systems USA Inc. and Piper Networks, Inc.: *Metrom Rail, LLC v. Ground Transportation Sys. USA, Inc., et al.*, 23-cv-02920-DLC (S.D.N.Y.).

C. Counsel and Service Information – 37 C.F.R. § 42.8(b)(3) and (b)(4)

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[1] For purposes of this IPR, the individual petitioner parties have designated Mr. James of Crowell & Moring as lead counsel. Counsel for each petitioner will coordinate and act through the designated lead counsel. For the avoidance of doubt, with the exception of Petitioner Siemens Mobility, Inc., each individual petitioner's designation of Mr. James as lead counsel is not a representation of an attorney-client relationship between Mr. James (or Crowell & Moring) and the individual petitioners.

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Powers of attorney are submitted with this Petition. Counsel for Petitioners consent to service of all documents via electronic mail.

D. Payment of Fees – 37 C.F.R. § 42.103

The *inter partes* review fee required by 37 C.F.R. § 42.103 accompanies this Petition. Petitioners authorize the PTO to charge any additional fees to Deposit Acct. No. 05-1323 (Reference No. 117385.0000004).

Petitioners request *inter partes* review ("IPR") of claims 1-18 of the '738 Patent.

I. INTRODUCTION

The '738 Patent describes a train control system "for enforcing observance to rail signals, for enforcing rail speed limits, for controlling and enforcing rail vehicle separation on railroad lines, or for temporary speed restriction enforcement for railway workers or degraded rail conditions, for example, on light rail lines." EX1001, 6:53-58.

Ground 1A demonstrates that a person of ordinary skill in the art ("POSITA") would have had reason to combine Kane (EX1005) with Heddebaut (EX1006) to achieve a train control system that utilizes the ultra-wideband ("UWB") technology disclosed in Heddebaut's train control system in a complementary fashion with the train control system disclosed in Kane, which comprises the same devices and components recited in the '738 Patent claims, including a control signal interface subsystem and a vehicle-mounted subsystem that communicate with each other regarding a signal indication, determine a behavior rule for a train in response to the signal indication, and observe operation of the train to evaluate compliance with the behavior rule. Kane and Heddebaut also render obvious additional challenged claims directed toward conventional features of communications electronics and/or well-known features of train control systems.

Grounds 1B-1G demonstrate that the remaining challenged claims recite conventional features of communications electronics and/or well-known features of train control systems that would have been obvious in view of Kane and Heddebaut combined with other prior art.

II. CERTIFICATION OF STANDING

The '738 Patent is available for IPR, and Petitioners are not barred or estopped from requesting IPR.

III. UNPATENTABILITY GROUNDS

Petitioners request cancellation of claims 1-18 as follows:

Ground	Reference(s)	Claim(s)	Basis
1A	Kane, Heddebaut	1-2, 6-8, 13-15	35 U.S.C. § 103
1B	Kane, Heddebaut, Das	3-5	35 U.S.C. § 103
1C	Kane, Heddebaut, Ackerman	9-11, 16-17	35 U.S.C. § 103
1D	Kane, Heddebaut, Hungate	12, 18	35 U.S.C. § 103
1E	Kane, Heddebaut, Grisham	13-15	35 U.S.C. § 103
1F	Kane, Heddebaut, Grisham, Ackerman	16-17	35 U.S.C. § 103
1G	Kane, Heddebaut, Grisham, Hungate	18	35 U.S.C. § 103

The above-identified references are prior art (at least) under either post-AIA 35 U.S.C. § 102(a)(1) or (a)(2) based on the following publication dates, each of

which is prior to the '738 Patent's earliest-claimed priority date of September 3, 2013. All references are patent publications.

Reference	Publication Date
Kane	2005-10-18
Heddebaut	2006-07-13
Das	2011-10-13
Ackerman	1998-09-08
Hungate	1999-09-14
Grisham	2004-07-06

IV. THE '738 PATENT

The '738 Patent describes a train control system in which a vehicle-mounted subsystem (VMCS) communicates with a control signal interface subsystem (CSIS) regarding "the signal that the station is currently indicating." EX1001, 8:45-57. The VMCS then determines a behavior rule for the vehicle, such as stop time duration or speed, and observes the vehicle's operation to evaluate compliance with the rule. *Id.*, 30:39-57, 31:6-31. Both the VMCS and CSIS utilize UWB radio communications, including data comprising at least one of a unique ID associated with the VMCS, a signal indication, a track number, a track direction, speed, and direction of travel. *Id.*, 15:59-67, 27:28-42; EX1003, ¶¶55-66.

Additionally, the UWB communications of the VMCS and CSIS may be used to determine the separation distance between them, or between two VMCSs. EX1001, 26:60-27:27. Also, the train control system includes an RFID subsystem

that scans RFID tags outside the vehicle, to retrieve information that can be used to determine the distance between the VMCS and CSIS. *Id.*, 4:3-32, 28:4-21, 29:56-30:7. Lastly, the train control system includes an access point external to the vehicle where the VMCS can send stored data regarding prior behavior of the vehicle. *Id.*, 25:22-26, 31:32-46; EX1003, ¶¶67-72.

A. Challenged Claims

Challenged system claims 1-18 are reproduced in the Appendix of the Challenged Claims, below. The independent claim recites basic components of a train control system including a CSIS and a VMCS, and recites basic capabilities including the ability of the VMCS to communicate with the CSIS regarding the status of a control signal, determine a behavior rule for a vehicle in response to the signal status, and observe the vehicle's operation to evaluate compliance with the behavior rule.

The dependent claims add conventional features of communications electronics and well-known features of train control systems, such as "a braking system," "an alert," "at least one RFID tag," and "an access point." These and other conventional features added by other dependent claims were well-known in the prior art at the time of the alleged invention, and a POSITA would have been motivated to implement them in train control systems at the time of the alleged invention. EX1003, ¶¶89-281.

B. Level of Ordinary Skill in the Art

A POSITA would have had a background in rail operations, signaling, and train/rail vehicle control systems, including at least a bachelor's degree in mechanical or electrical engineering or a related field, and would have had at least two years of experience with rail operations, signaling, and train/rail vehicle control systems such as collision avoidance systems. EX1003, ¶¶23-28.

C. Prosecution History

The '738 Patent issued from U.S. Patent Application No. 14/809,950 ("the '950 Application"), which was filed on July 27, 2015. EX1001. The '950 Application claims priority to Provisional Application No. 61/959,729, which was filed on September 3, 2013. *Id.*

After responding to a Requirement for Restriction/Election, Applicants submitted claims 16-32 of the '950 Application for examination. EX1002, pp. 151-62. Claims 16-20 were rejected as being anticipated by U.S. Patent Publication No. 2010/0063656 ("Knott"), and claims 21-32 were rejected as obvious in view of Knott with other references. *Id.*, pp. 169-78.

Later during prosecution, Applicants amended claim 16 to require that the CSIS and VMCS comprise UWB components, and that the UWB communications include data comprising at least one of a unique ID associated with the VMCS, a signal indication, a track number, a track direction, speed, direction of travel, and

positioning related information. *Id.*, p. 224. Applicants also added dependent claim 33. *Id.*, p. 229. Subsequently, claims 16-21, 23, 26-27, 29, and 32 were rejected as obvious in view of Knott with U.S. Patent Publication No. 2013/0138276 ("Soderi"), and claims 22, 24-25, 28, 30-31, and 33 were rejected as obvious in view of Knott and Soderi with other references. *Id.*, pp. 245-54. In response, Applicants amended claim 16 "to omit the recitation of 'positioning related information' as one of the types of information for the data carried in the communicated signals." *Id.*, pp. 267-68. The Examiner thereafter issued a Notice of Allowance that stated:

> The Examiner agrees with the Applicant's arguments filed 1/31/2017, in that, Soderi et al. (US 2013/0138276) cannot be said to "communicate UWB signals carrying data pertinent to evaluating vehicle operation compliance, the data comprising at least one of: a unique ID associated with the vehicle mounted control system, a signal indication, a track number, a track direction, speed, and direction of travel," as recited in claim 16. Soderi's UWB signals are used to determine the vehicle position, but the signals do not carry one of the above listed data types.

Id., p. 279.

V. CLAIM INTERPRETATION

Claims are construed according to their ordinary meaning in light of the specification and prosecution history. 37 C.F.R. § 42.100(b). Because the prior art plainly discloses the limitations of the challenged claims, Petitioners contend that

there are no claim terms that require construction. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

VI. GROUNDS OF UNPATENTABILITY

A. Ground 1A – Claims 1-2, 6-8, and 13-15 Are Obvious in View of Kane and Heddebaut

1. The Asserted References

a. Kane (EX1005)

Kane, titled "Positive Signal Comparator and Method," published October 18, 2005, and was not cited during prosecution of the '738 Patent. Kane teaches a train control system and method for preventing train accidents that comprises a wayside signaling device 190 (which includes a control signal interface subsystem) and a controller 110 that connects to several components of a train, such as engineer/trainman "pendants" 120/130 (which are essentially a man-machine interface controller on the train), a transceiver 140, a positioning system 150, a database 160, a tachometer 170, and a brake interface 180 (collectively, a vehicle-mounted subsystem) that communicate with each other regarding a signal indication, determine a behavior rule for a train (such as a target speed or train behavior associated with a "medium approach medium" signal indication), and observe operation of the train to evaluate compliance with the rule. EX1005, 3:23-7:51; EX1003, ¶¶73-74.

Figures 1 and 3 below depict a block diagram of the disclosed train control system and a flow chart illustrating operation of the system, respectively. In Figure 1, signal device 190 is located on the wayside (next to the tracks), while the remaining components are located on a train. EX1005, 3:23-5:24. In Figure 3, flowchart 300 illustrates operation of the system 100. *Id.*, 5:25-7:51.

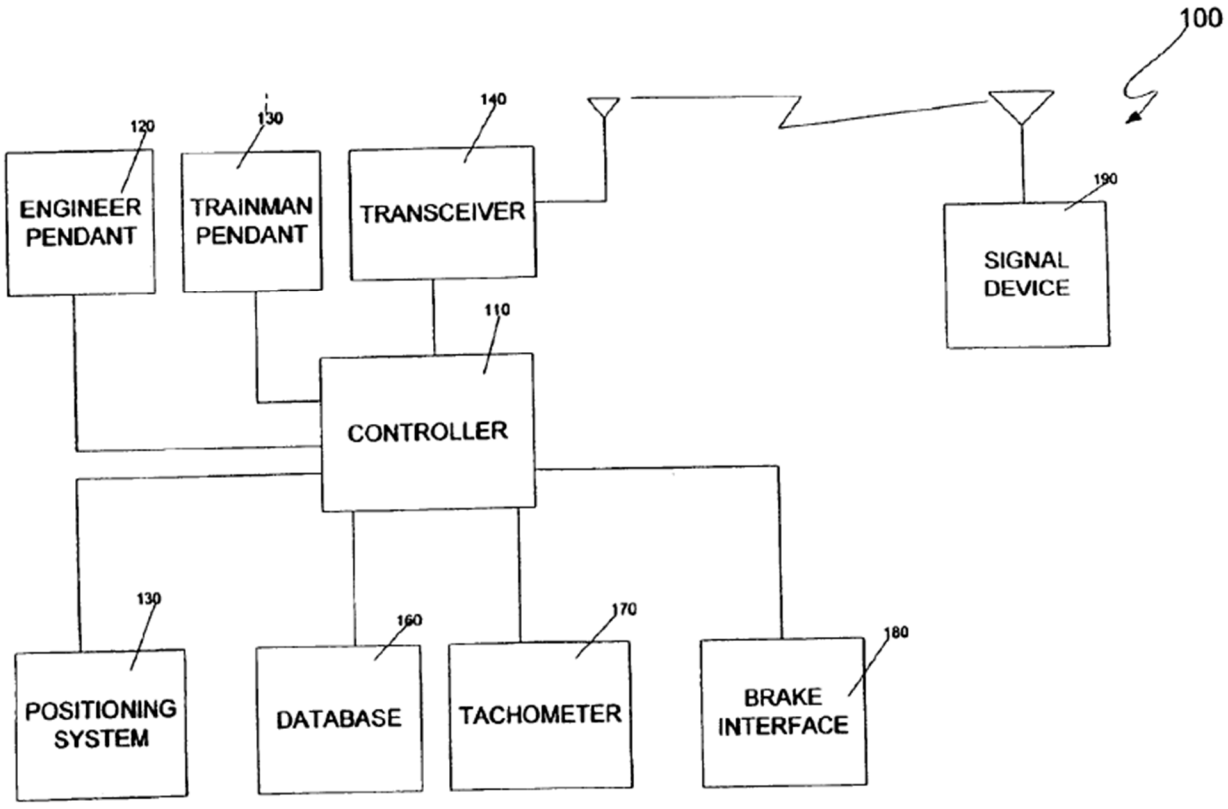


Figure 1

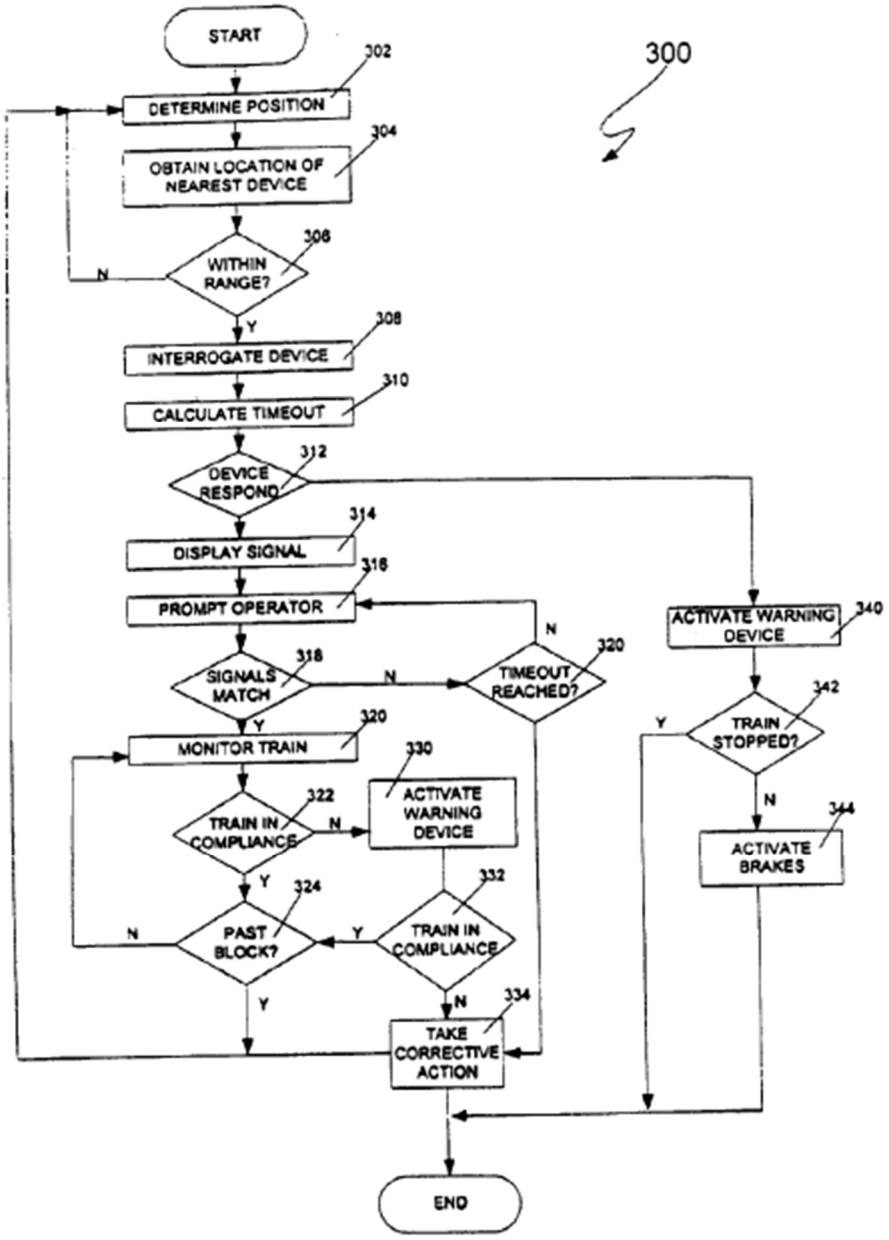
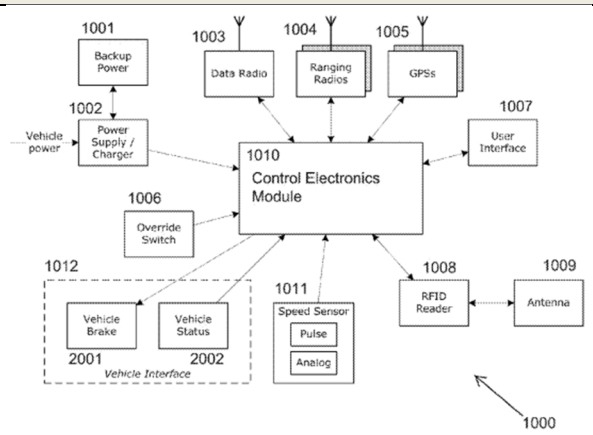
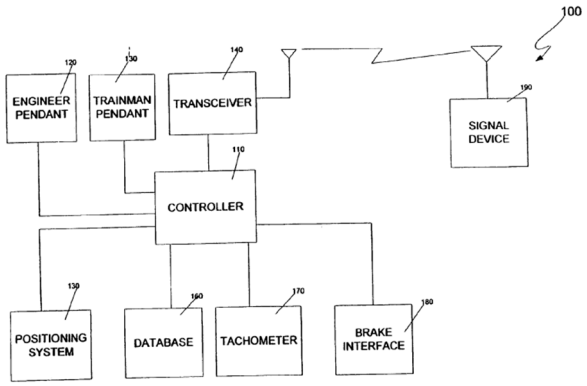
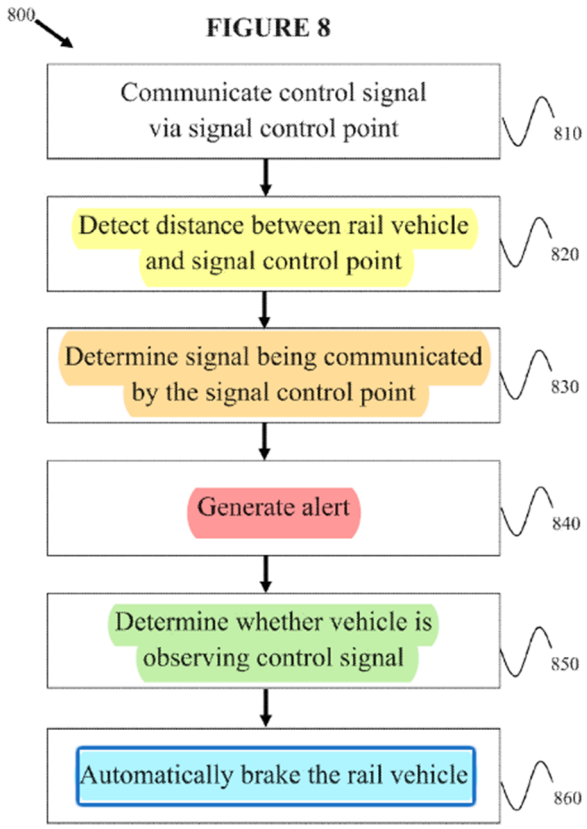
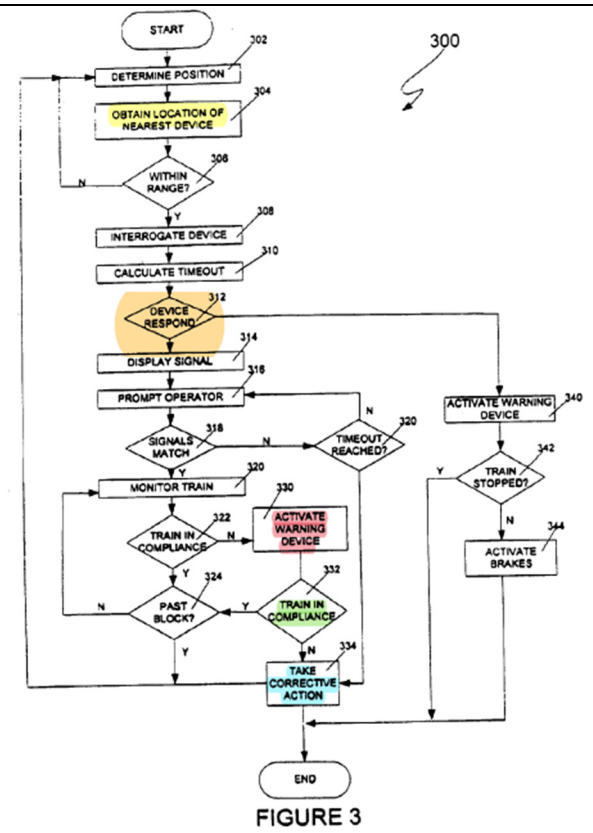


FIGURE 3

Id., Figs. 1, 3; EX1003, ¶74.

As is evident from comparing their respective figures (annotated below), Kane's system and the '738 Patent's system are structurally and operationally similar:

’738 Patent	Kane
 FIG. 9	 Figure 1
	 FIGURE 3

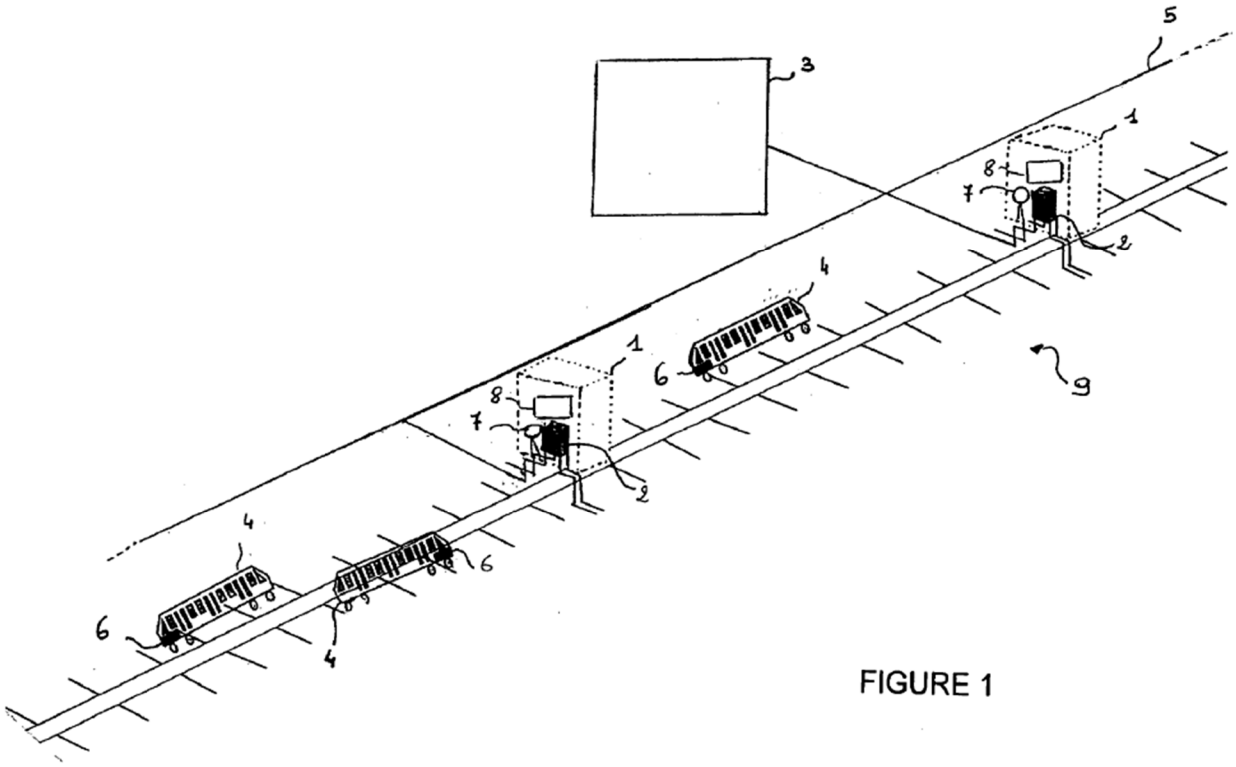
EX1003, ¶75. For instance, as shown in Figure 9 in the ’738 Patent and Figure 1 in Kane, both systems include a controller (or control electronics module) connected to several components of a train to create “a vehicle-mounted subsystem.” EX1003,

¶76. The vehicle-mounted subsystems in both systems receive information corresponding to the control signal status, determine a rule for vehicle behavior based on the control signal status, and observe the vehicle's compliance with that rule. *Id.* Additionally, as shown in Figure 8 in the '738 Patent and Figure 3 in Kane, both systems in operation include distance detection between a rail vehicle and a wayside device (yellow), signal determination (orange), alarm generation (red), observation of vehicle behavior (green), and corrective vehicle control (blue). *Id.*

b. Heddebaut (EX1006)

Heddebaut, titled "Device and Method for Positioning and Controlling Railway Vehicles with Ultra-Large Bandwidth," published July 13, 2006, and was cited in an IDS but not cited by the examiner during prosecution of the '738 Patent.

Heddebaut teaches a train control system and method for preventing train accidents that utilizes UWB radio communications between a fixed station and a railway vehicle to enable distance measurement using "time of flight" techniques. EX1006, [0007]-[0014]; EX1003, ¶¶77-78. The train control system also "enables direct communication between vehicles." EX1006, [0007]. Figure 1 of Heddebaut, reproduced below, is a schematic representation of the fixed stations and railway vehicles.



EX1006, Fig. 1; EX1003, ¶78.

1. Claim 1

a. [1-Pre][2] – A system for evaluating vehicle operation compliance, wherein the system comprises:

Whether or not the preamble is limiting, Kane discloses a "positive signal comparator system" that monitors the train's compliance with a signal from a wayside signaling device 190, which is a system for evaluating vehicle operation compliance. EX1005, 5:59-6:25, 6:55-7:14, claims 1 and 31; EX1003, ¶¶92-95.

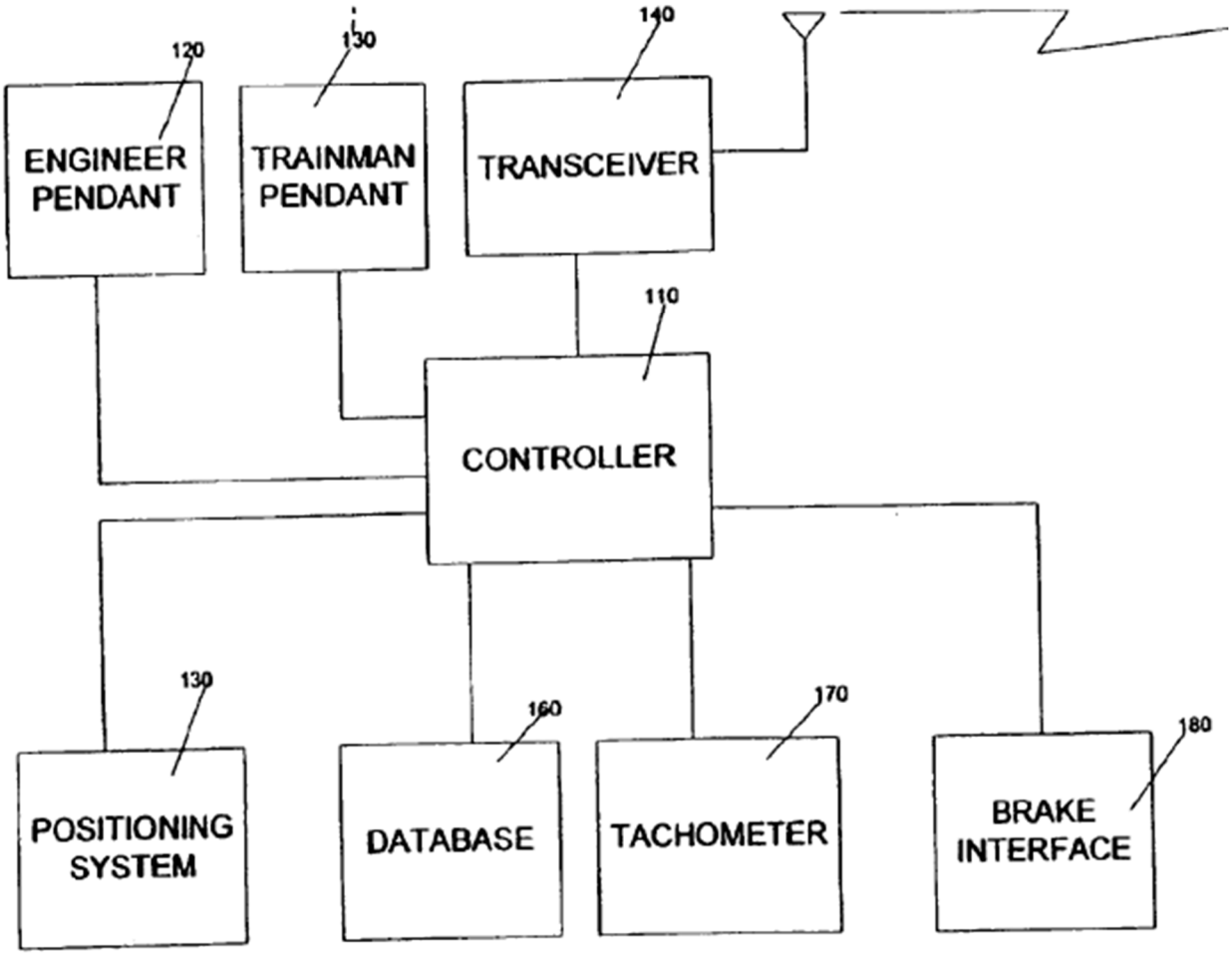
[2] *See* Appendix of the Challenged Claims for full identification of the limitations referred to by the shorthand notations used herein.

b. [1A] – a control signal interface subsystem; and

Kane discloses a wayside signaling device 190, which is a device that sits next to the tracks and communicates control signals to approaching railway vehicles wirelessly or visually via colored lights or more complex signals. *See* EX1005, 1:10-24, 4:15-31, 5:59-6:12, Figs. 1, 3, claims 1 and 31; EX1003, ¶¶96-98. Therefore, Kane discloses wayside signaling device 190 that includes a subsystem that interfaces with railway vehicles to transmit control signals to those vehicles ("a control signal interface subsystem" as claimed). EX1003, ¶¶96-99.

c. [1B] – a vehicle-mounted subsystem configured to:

Kane discloses a controller 110 that connects to several components of a train, such as engineer/trainman "pendants" 120/130 (which are essentially a man-machine interface controller on the train), a transceiver 140, a positioning system 150, a database 160, a tachometer 170, and a brake interface 180.



EX1005, Fig. 1; *see also id.*, 3:23-5:24, claims 1 and 31; EX1003, ¶¶100-02. Kane discloses that the transceiver is "located on a train." EX1005, Abstract, 1:66-2:12. Therefore, Kane discloses that all of these connected components (110, 120, 130, 140, 150, 160, 170, 180) together are "a vehicle-mounted subsystem" as claimed. EX1003, ¶¶100-04.

d. [1C] – communicate with the control signal interface subsystem to receive information corresponding to a status of a control signal;

Kane discloses that "the controller 110 causes the transceiver 140 to transmit an interrogation message" to a wayside signaling device 190, among other means for communicating between the transceiver 140 and the wayside signaling device 190. EX1005, 5:37-39, Fig. 3; *see also* 4:15-31, 5:59-6:4. Kane then discloses that its vehicle-mounted subsystem (including controller 110 and transceiver 140) wirelessly receives a response signal from the wayside signaling device 190. *Id.*, Abstract, 2:1-4, 5:59-62, Fig. 3. The response signal includes the status (or "signal indication") of the control signal, such as CLR (clear) or ADV (advance). *See id.*, 3:29-56, Fig. 2; *see also id.*, Abstract, 2:4-10, 2:44-63, 5:59-64, Fig. 3, claims 1 and 31.

Upon receiving the response signal, an engineer and/or trainman is prompted to match the signal via buttons 231-242 on engineer/trainman pendants 120/130 (Fig. 2, below).

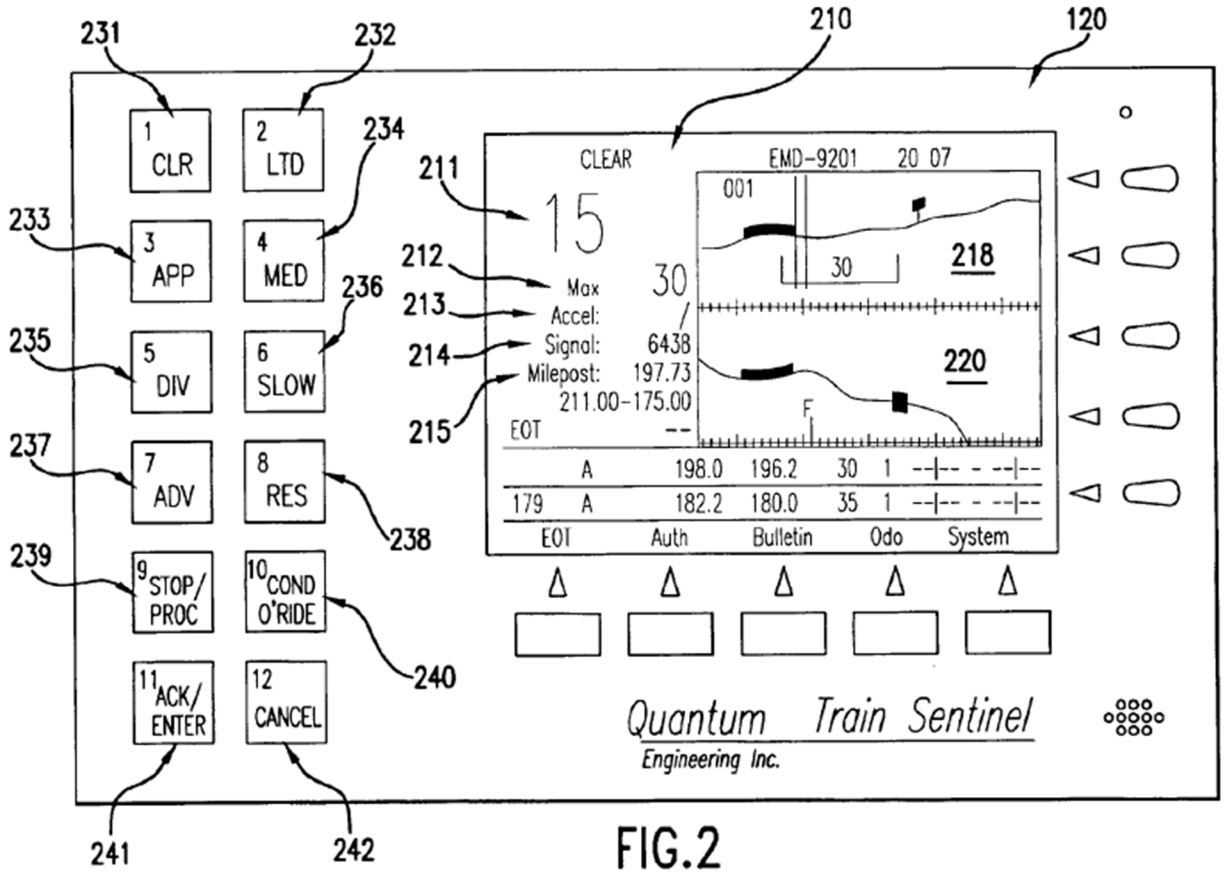


FIG.2

Id., Fig. 2. This means that both the buttons 231-240 and response signals from the wayside signaling device 190 correspond to "various signals defined in the GCOR (General Code of Operational Rules) and various other signaling systems used in the United States," such as "a 'medium approach medium' signal . . . (which means that the train is allowed to travel at medium speed through turnouts, crossovers sidings and over power operated switches, then proceed, approaching the next signal at a speed not exceeding the medium speed)." *Id.*, 3:29-56, Fig. 2; EX1003, ¶¶105-08. Therefore, Kane's vehicle-mounted subsystem (*inter alia* controller 110 and transceiver 140) communicates with the control signal interface subsystem (a

component of wayside signaling device 190) and receives a response signal from the wayside signaling device 190 conveying the status of the control signal (*e.g.*, speed, approach, slow). EX1003, ¶¶105-09.

e. [1D] – determine a rule for behavior of a vehicle according to the information corresponding to the status of the control signal; and

Kane discloses that controller 110 monitors the train's compliance with the status of the wayside signaling device 190, as reflected in the response signal received from that device: "If a correct matching signal is received from the engineer's pendant 120 (and, in some embodiments, the trainman's pendant 130) at step 318, *the controller then monitors the train's compliance with the signal at step 320*." EX1005, 6:4-25 (emphasis added); *see also id.*, Abstract, 2:6-12, 2:41-43, 6:55-67, 7:45-51, Fig. 3, claims 1-7, 9, 31, and 39-40. For example, the controller 110 is programmed so that when it receives the "medium approach medium" response signal, it automatically begins to monitor the train's operation to ensure compliance with the behavior rules for that signal ("travel at medium speed through turnouts, crossovers sidings and over power operated switches, then proceed, approaching the next signal at a speed not exceeding the medium speed"). EX1005, 3:29-56, 6:4-25, 6:55-60, Fig. 2; EX1003, ¶¶110-13.

The controller 110 is programmed so other response signals automatically trigger monitoring of other train behaviors associated with those signals. EX1003,

¶¶110-13. "An example of non-compliance is if the speed of the train exceeds the 'target' speed for a given signal by a prescribed speed over the target speed and the train is not decelerating, at a target deceleration amount (e.g., 1 mph/min)." EX1005, 6:56-60. In this example, the behavior rule is a speed limit for the train that is based on the "target" speed corresponding to the signal received from the wayside signaling device 190. EX1003, ¶112. Therefore, the controller 110 determines a behavior rule for the train according to the status of the wayside signaling device 190 (which comprises the control signal, as discussed for element [1C] above) via programming that links a behavior rule to each signal status. *Id.*, ¶¶110-13.

f. [1E] – observe operation of the vehicle to evaluate compliance with the rule; wherein:

As discussed above for element [1D], Kane discloses monitoring the train for compliance with the behavior rule. For example, "[i]f a correct matching signal is received from the engineer's pendant 120 (and, in some embodiments, the trainman's pendant 130) at step 318, the controller then monitors the train's compliance with the signal at step 320." EX1005, 6:4-8; *see also id.*, Abstract, 2:6-12, 2:41-43, 6:13-25, 6:55-67, 7:45-51, Fig. 3, claims 1-7, 9, 31, and 39-40. Monitoring the train for compliance with the signal received from the wayside signaling device 190 means that the controller 110 determined a behavior rule for the train based on the status of that signal (and then evaluated the train's behavior for compliance with that rule). EX1003, ¶¶114-17.

g. [1F] – the control signal interface subsystem comprises an ultra-wideband (UWB) communications component;

Kane discloses radio frequency components for wayside signaling device 190: "a plurality of wayside signal devices, each of the wayside signal devices including a radio frequency transceiver, each of the radio frequency transceivers being configured to transmit at a same frequency, each of the wayside signal devices being configured to transmit an identification number along with a wayside signal in response to an interrogation signal." EX1005, claim 34; *see also id.*, 7:25-30. As discussed with reference to element [1A] above, the wayside signaling device 190 includes "a control signal interface subsystem" as claimed. EX1003, ¶¶118-20. A POSITA would have understood that the radio frequency components were part of this subsystem. *Id.*, ¶120.

Kane's wayside signaling device 190 uses "radio frequency" communications, but Kane does not specify or otherwise limit which frequencies/modulation techniques are or could be used. EX1005, claim 34; EX1003, ¶120. A POSITA would have understood that Kane taught using any type of "radio frequency" communications components (transceivers) known in the art to be suitable for communication between a train and a wayside signaling device. EX1003, ¶¶121-22. By September 2013, it was well-known that UWB radio

transmissions were well-suited for communication between a wayside device and a railway vehicle in the manner claimed in the '738 Patent. *Id.*, ¶122.

Heddebaut discloses a first transmission-reception means 2 on a fixed station 1 that is located next to a railway.

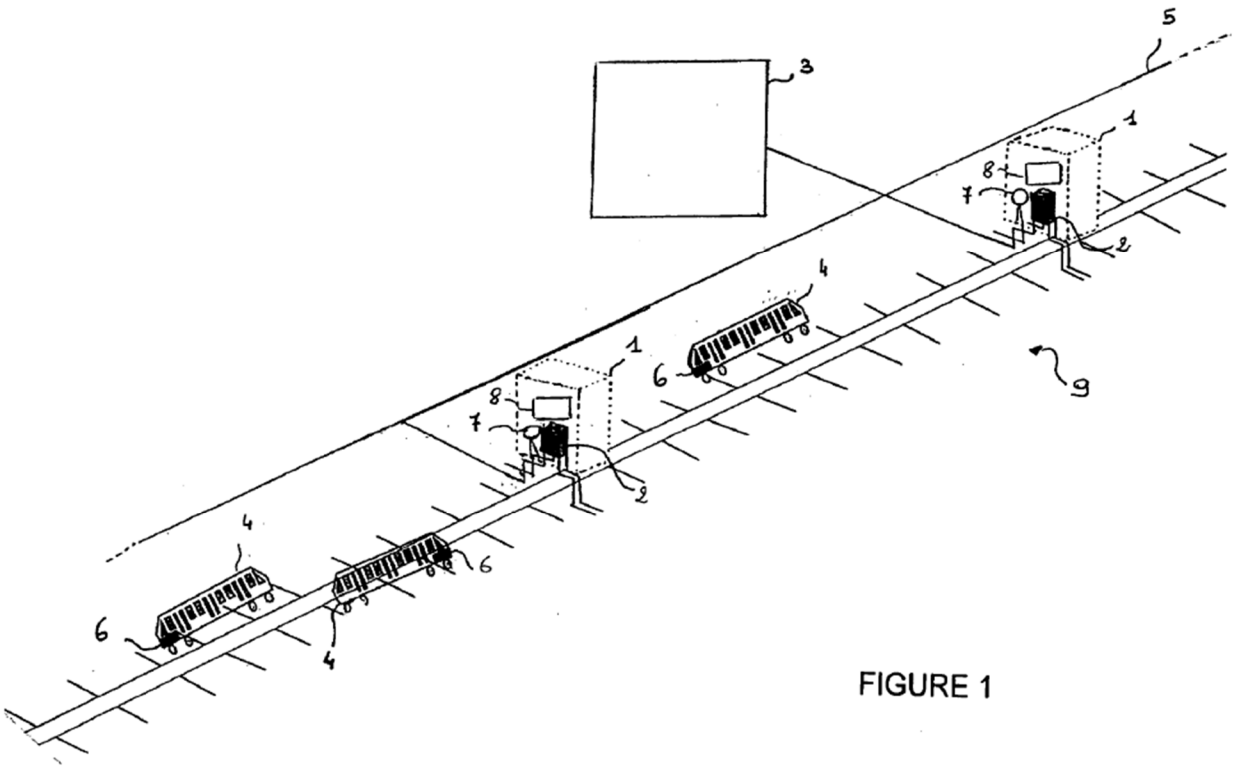


FIGURE 1

EX1006, [0041], Fig. 1; *see also id.*, Abstract, [0008], [0024], claim 1; EX1003, ¶123. Thus, like Kane, Heddebaut discloses that a wayside device includes "a control signal interface subsystem" as claimed, on its fixed station 1. EX1003, ¶123. In Heddebaut, both "rail vehicle 4 and fixed station 1 modulate a pulse string according to an ultra wide band technique." EX1006, [0045]. Therefore, Heddebaut discloses that a control signal interface subsystem on fixed station 1 (the first

transmission-reception means 2) includes a UWB communications component EX1003, ¶124. Thus, Heddebaut demonstrates that UWB was a known communications technology well-suited to be used for Kane's "radio frequency" communication between a train and a wayside device. *Id.*, ¶¶118-24. A POSITA would have been motivated to implement communications at UWB frequencies, as taught by Heddebaut, into the radio system disclosed by Kane for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶137-44.

h. [1G] – the vehicle-mounted subsystem comprises an ultra-wideband (UWB) communications component; and

For the same reasons discussed above with reference to element [1B], Kane discloses that the controller, receiver, and transmitter are a part of "a vehicle-mounted subsystem" as claimed. *Id.*, ¶¶125-27. Also, as explained for element [1F], Kane discloses using RF infrastructure for automatic updates, EX1005, 7:25-30, and a POSITA would have understood that Kane was disclosing use of any type of "radio frequency" communications components (the transmitter and receiver) known in the art for communication between a vehicle-mounted subsystem and a wayside signaling device, and that one type of "radio frequency" communications that was well-known and well-suited as of September 3, 2013, was UWB. EX1003, ¶¶126-29.

Heddebaut also discloses a second transmission-reception means 6, as there is one such means on each of the multiple rail vehicles 4.

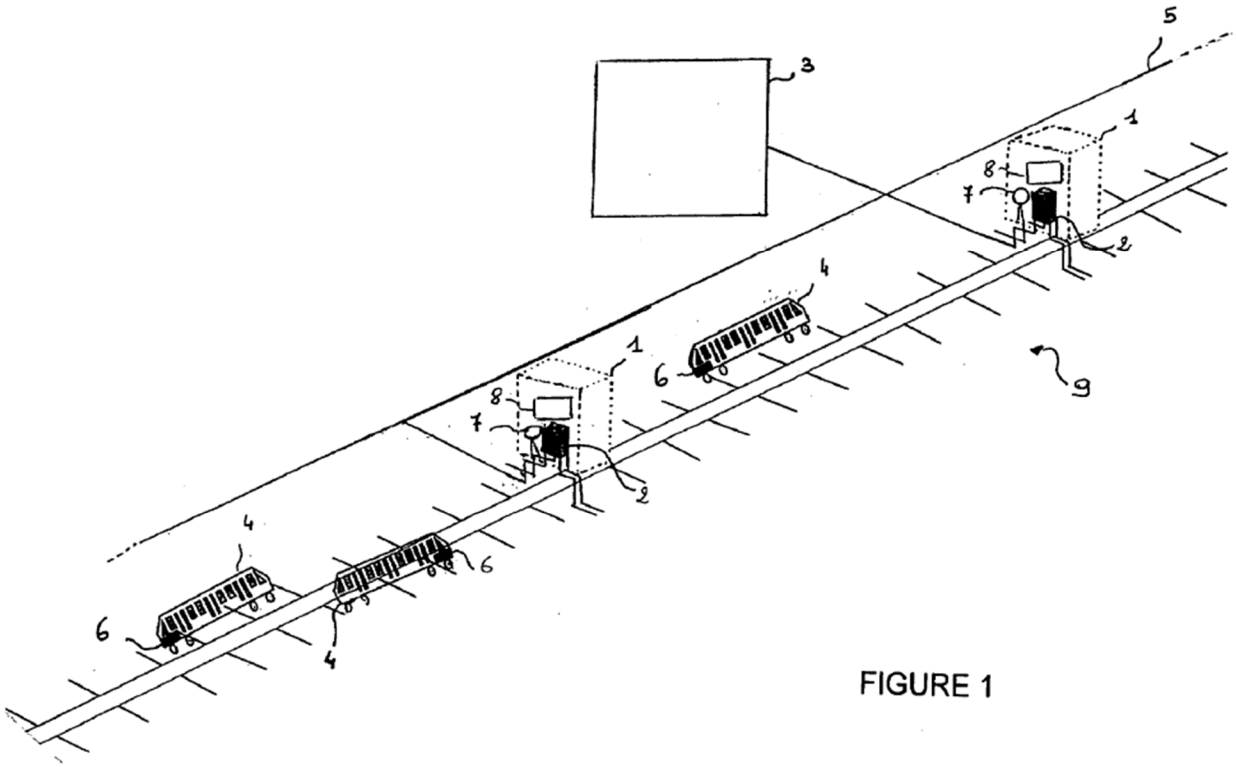


FIGURE 1

EX1006, [0044], Fig. 1; *see also id.*, Abstract, [0010], [0026], [0057], claim 1; EX1003, ¶130. Thus, Heddebaut discloses that each rail vehicle 4 includes "a vehicle-mounted subsystem" as claimed. EX1003, ¶130. Both "rail vehicle 4 and fixed station 1 modulate a pulse string according to an ultra wide band technique." EX1006, [0045]. Therefore, Heddebaut discloses that a vehicle-mounted subsystem on rail vehicle 4 (the second transmission-reception means 6) includes a UWB communications component. EX1003, ¶131. Thus, as discussed above for element [1F], Heddebaut demonstrates that UWB was a known communications technology

well-suited for use as Kane's "radio frequency" communication between a train and wayside device. *Id.*, ¶¶125-31. A POSITA would have been motivated to combine Kane and Heddebaut for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶137-44.

i. [1H] – the vehicle-mounted subsystem and the control signal interface subsystem are further configured to communicate UWB signals carrying data pertinent to evaluating vehicle operation compliance, the data comprising at least one of: a unique ID associated with the vehicle-mounted subsystem, a signal indication, a track number, a track direction, speed, and direction of travel.

As discussed with reference to elements [1F] and [1G], Kane and Heddebaut disclose UWB signals communicated by "the vehicle-mounted subsystem" and "the control signal interface subsystem." With respect to the content of those UWB signals, Kane discloses a response signal that includes at least a signal indication (e.g., "medium approach medium") and a target speed (e.g., medium speed), as discussed with reference to elements [1C] and [1D]. EX1003, ¶¶132-33. Therefore, Kane discloses radio-frequency signals carrying data pertinent to evaluating vehicle operation compliance, including at least two of the particular types of content specified in the claim (i.e., a signal indication and a track speed). *Id.*, ¶133.

Additionally, Heddebaut's UWB signals "contain a specific identifier of the transmitter and at least one message," the identifier being "a specific code and a specific identity which are ascribed to a transmitter." EX1006, [0044]-[0045].

Heddebaut further discloses that the first and second transmission-reception means 2 and 6 "collect the operating data transmitted (identity, speeds, positions, state of the trains and stations . . .)." *Id.*, [0048]-[0049]. Therefore, Heddebaut discloses that the subsystems (first and second transmission-reception means 2 and 6) communicate UWB signals that include data pertinent to evaluating vehicle operation compliance including at least an identifier and a message regarding the identity, speeds, positions, state of the trains and stations. EX1003, ¶¶134-36. As discussed above for element [1F], Heddebaut demonstrates that UWB was a known communications technology well-suited for Kane's "radio frequency" communication between a train and wayside device. *Id.* A POSITA would have been motivated to combine Kane and Heddebaut for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶137-44.

j. Motivation to Combine Kane and Heddebaut to Use UWB for Communication Between Trains and Wayside Devices

Both Kane and Heddebaut teach train control systems that rely, at least in part, on communication between trains and wayside devices. *Id.*, ¶137. Also, both Kane and Heddebaut disclose communicating radio signals between "a control signal interface subsystem" and "a vehicle-mounted subsystem" that include data comprising at least one of: a unique ID associated with the vehicle-mounted subsystem (Heddebaut's identifier), a signal indication (the information included in

Kane's response signal (*e.g.*, "medium approach medium") and Heddebaut's state of station), and speed (Kane and Heddebaut's speed). *Id.* The difference between Kane and Heddebaut is that Kane broadly discloses that the signals are "radio frequency" signals, without limiting them to any particular frequency or frequency band, while Heddebaut specifically discloses using UWB radio signals. *Id.*

Such UWB radio signals were well-known at the time of the '738 Patent, and Heddebaut itself explains why a POSITA implementing Kane's train control system would have been motivated to use UWB for communication between the trains and wayside devices. *Id.*, ¶¶42-50, 138. Heddebaut discloses (and a POSITA would have known) that traditional wireless communications are not ideal for underground transportation, particularly tunnels, and that UWB not only performs better, but is simple in design and operating mode and limits the risk of interference with other wireless communications. EX1006, [0005]-[0007]; EX1003, ¶138. Kane and Heddebaut both disclose train control systems that would be expected to operate in various environments (including tunnels), and Heddebaut demonstrates that UWB was a known communication technology well-suited for Kane's "radio frequency" communication between a train and a wayside device. EX1003, ¶139. Also, it would have been obvious for a POSITA to try UWB as the specific radio frequency for the same reasons. *Id.*

UWB technology "is a wireless technology for transmitting large amounts of data over a wide spectrum of frequency bands with very low power and for a short distance." EX1011, [0003]. UWB signals also "have the ability to carry signals through doors and other obstacles that tend to reflect signals having more limited bandwidths and a higher power." *Id.* "UWB communication has three main types of application:" "radar applications," "data transmission applications," and "location awareness applications" (i.e., ranging). *Id.*, [0005]. One way UWB systems achieve high-bandwidth is by transmitting impulse-like waveforms, which have a short time profile and wide frequency profile, unlike traditional RF modulated sine waves that have a long time profile and narrow frequency profile. EX1012, 3. These benefits of UWB would have motivated a POSITA to implement Heddebaut's UWB communications in Kane's train control system at the time of the purported invention of the '738 Patent. EX1003, ¶¶140-41.

UWB-based technology also has several benefits over other common wireless technologies. First, because of the wide-bandwidth / short-pulse duration of UWB signals, they are naturally resistant to multipath effects, improving operation in cluttered or non-line-of-sight (NLOS) environments without the need for additional techniques to overcome multipath effects. *See, e.g.*, *id.*, ¶142. As another advantage, UWB-based ranging provides high resolution for precise distance measurements. *Id.* As still another advantage, UWB-based ranging can be combined with UWB-

based data communication functionality to use the same UWB signals for both ranging and (non-ranging) data communication. *Id.* Yet another benefit of UWB technology is that it requires low operating power, making UWB efficient and unlikely to interfere with coexisting RF systems. *Id.* These additional benefits of UWB would have motivated a POSITA to implement Heddebaut's UWB communications in Kane's train control system at the time of the purported invention of the '738 Patent. *Id.*

Moreover, a POSITA reasonably would have expected to succeed using UWB with train control and collision-avoidance systems like the one disclosed in Kane because such systems were already known in the art, including U.S. Patent No. 6,759,948 ("Grisham"). EX1010, 11:33-37; EX1006, [0045]; EX1013, 1-4; EX1003, ¶143. Moreover, a POSITA would have had a reasonable expectation of success for this combination because both Kane and Heddebaut teach train control systems by communicating between trains and wayside devices via radio signals between "a control signal interface subsystem" and "a vehicle-mounted subsystem" that include data comprising at least one of a signal indication and speed. EX1003, ¶¶143-44.

2. Claim 2 – Color Status of Control Signal

As discussed above with reference to elements [1A] and [1C], Kane discloses a wayside signaling device 190 that generates signals with a visual indication, such

as colored lights, and that the visual indications are "defined in the GCOR (General Code of Operational Rules) and various other signaling systems used in the United States." *See* EX1005, 3:29-56, 4:15-24, 5:59-6:12, Figs. 1-3, claims 1 and 31. A POSITA would have understood that the colored light visual indications would be red, yellow, or any other color; particularly red or yellow because they are signals defined in the GCOR and the Northeastern Operating Rule Advisory Committee (NORAC) rules. EX1033, 5-3 to 5-7; EX1034, 76-91 (e.g., approach slow = double yellow, approach = yellow); EX1003, ¶¶145-47. As discussed with reference to element [1D], Kane discloses determining a behavior rule for the train based on the signal indication received from the wayside signal device. EX1005, 6:55-67; *see also id.*, Abstract, 2:6-12, 2:41-43, 6:4-25, 7:45-51, Fig. 3, claims 1-7, 9, 31, and 39-40; EX1003, ¶148. Therefore, Kane discloses a train's behavior rule that corresponds to a red, double red, yellow, or double yellow visual indication. EX1003, ¶¶145-48. A POSITA would have been motivated to combine Kane and Heddebaut for the same reasons discussed above with reference to claim 1. *Id.*, ¶¶137-44.

3. Claim 6

a. [6A] – The system of claim 1, wherein the vehicle-mounted subsystem is configured to: interface with a braking system of the vehicle;

As discussed above with reference to element [1B], Kane discloses "a vehicle-mounted subsystem," including controller 110, that interfaces with the train's braking system through brake interface 180: "a brake interface 180 connected to the controller 110 allows the controller 110 to activate and control the train brakes when necessary to slow and/or stop the train." EX1005, 5:20-22; *see also id.*, Abstract, 1:66-2:12, 6:18-25, 6:30-32, 6:55-67, claims 2, 39-40. Indeed, Kane discloses that such "[b]rake interfaces are well known in the art." *Id.*, 5:22-24. Therefore, Kane discloses a vehicle-mounted subsystem configured to interface with a train's braking system. EX1003, ¶¶149-50.

b. [6B] – communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the vehicle-mounted subsystem; and

As discussed with reference to elements [1F] and [1G] above, Kane discloses that the UWB communications components of "the vehicle-mounted subsystem" and "the control signal interface subsystem" communicate via "radio frequency" signals, and a POSITA would have understood that UWB was particularly well-suited for the system described in Kane. Additionally, as discussed in the context of elements [1F] and [1G] above, Heddebaut discloses that the UWB communications

components of "the control signal interface subsystem" (the first transmission-reception means 2) and "the vehicle-mounted subsystem" (the second transmission-reception means 6) communicate via UWB signals. *Id.*, ¶151.

c. [6C] – determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem.

Heddebaut discloses that "[a]ll the rail vehicles 4 may calculate their distances to the downstream and upstream fixed stations where they are situated locally." EX1006, [0054]. Heddebaut also expressly discloses that calculating the distance relative to a fixed reference upstream and/or downstream is based on the time-of-flight for UWB communications between the rail vehicles and the fixed stations: "Measuring the distance relative to a fixed reference upstream and/or downstream as based on the flight time of signals derived from pieces of geolocalised equipment and situated in upstream/downstream stations determines, with high degree of certainty and accuracy, the absolute position of the guided mobile." *Id.*, [0055]. Therefore, Heddebaut discloses that the UWB communications components of "the control signal interface subsystem" (the first transmission-reception means 2) and "the vehicle-mounted subsystem" (the second transmission-reception means 6) use

the time-of-flight of UWB signals to determine the distance between the subsystems. EX1003, ¶152.

d. Motivation to Combine Kane and Heddebaut to Implement UWB Ranging

A POSITA would have been motivated to use the known technique of UWB ranging disclosed in Heddebaut to augment the "positioning system 150" for the train control system disclosed in Kane. *Id.*, ¶¶42-50, 153. Kane and Heddebaut both disclose train control systems, and a POSITA would have understood that UWB ranging would improve Kane in the same way that it improves Heddebaut, such as by providing more accurate positioning information in environments where the GPS positioning disclosed in Kane may not work, such as in a tunnel. *Id.*

By 2007, six years before the earliest claimed priority date of the '738 Patent, the IEEE had established a UWB standard 802.15.4*a* which includes use of UWB in precision-ranging applications. EX1011, [0009] (noting as background information that the "IEEE 802.15.4*a* Task Group (TG) has been established to develop a UWB-based physical (PHY) layer standard with a precision ranging capability."); EX1003, ¶153; *see generally* EX1014. As discussed *supra* § VI.A.2.j, UWB-based technology has several benefits over other common wireless technology, including resistance to multipath effects, high resolution for precise distance measurements, combined ranging and communication functionalities, and low operating power. EX1003, ¶153.

Kane also discloses that tachometer 170 serves as a redundant positioning system if system 150 becomes unavailable. EX1005, 5:6-12. However, Kane discloses several problems with using tachometer 170 this way, such as wheel slippage and changes in wheel size. *Id.*, 5:12-14. Therefore, even if Kane uses a GPS positioning system, a POSITA would have been motivated to supplement the accuracy of the GPS system with complementary technologies, such as the UWB ranging of Heddebaut. EX1003, ¶154.

One of the most common positioning systems by the earliest-alleged priority date for the '738 Patent was GPS, and a POSITA would have known that GPS systems pair well with UWB systems because of their complementary feature sets. *Id.*, ¶155. For example, GPS allows positioning at larger distances between trains and provides heading and other information useful to train-safety systems, and UWB allows positioning to occur in locations where GPS signals may not reach a train, such as a tunnel. *Id.* One UWB ranging system that is used for a train control system is described in Heddebaut. *Id.* Kane describes a system that is effective at larger distances, and Heddebaut describes a UWB system which is effective at small distances and in tunnels. *Id.* Given the catastrophic consequences of collisions between rail vehicles, a POSITA would have been motivated to include redundant positioning systems to guard against system failures. *See, e.g.*, EX1005, 5:6-14; EX1021, [0007]-[0009], [0013]; EX1023, 4:66-5:5; EX1003, ¶155. Both UWB and

GPS provide positioning data, so it would have been readily apparent to a POSITA how to implement UWB into "the vehicle-mounted subsystem" and "the control signal interface subsystem" of Kane. EX1003, ¶156. UWB ranging is based on relative positioning, while GPS is based on absolute positioning, and a POSITA would have understood how to program the subsystem to interpret both absolute and relative positioning data. *Id.*

4. Claim 7 – Threshold Distance Alert

The system described in Kane is configured to generate an alert if, for example, a signal indication from an upcoming wayside signal device is not received, or an operator does not appropriately acknowledge a received signal indication, before a timeout expires. EX1005, 5:40-6:28. The timeout is measured from the time the controller 110 causes an interrogation message to be sent to the upcoming wayside signal device: "The timeout is chosen such that, at the expiration of the timeout, there will be sufficient distance and time in which to stop the train in the event of a problem (e.g., the device does not respond or the signal entered by engineer and/or trainman does not match the signal received from the device)." *Id.*, 5:45-50. The timeout is based on, among other things, "the distance between the train and the upcoming signaling device 190," so a POSITA would have understood that when the timeout expires, the train would be a certain distance from the wayside signaling device 190 based on "equations which are well known in the art." *See id.*,

5:50-56. Therefore, a POSITA would have known that the timeout corresponds to a distance threshold.

Kane further discloses that if the timeout period expires, "the controller activates a warning device at step 340." *Id.*, 6:26-28; *see also id.*, Abstract, 1:66-2:12, 2:33-43, 5:40-57, 6:13-25, claims 6-7, 37-38. The warning device "may be a horn, whistle, or other device." *Id.*, 6:14-18. Therefore, Kane discloses controller 110 generating an alert (*e.g.*, horn, whistle, etc.) if the distance between "the vehicle-mounted subsystem" and "the control signal interface subsystem" is less than a threshold distance required to stop the train before it passes the signal (*e.g.*, in case the signal indicates "stop"). EX1003, ¶¶157-60. A POSITA would have been motivated to combine Kane and Heddebaut for the same reasons discussed above with reference to claim 1. *Id.*, ¶¶137-44.

5. Claim 8 – Threshold Distance Braking

As discussed for claim 7 above, Kane discloses controller 110 generating an alert if, for example, a response has not been received from the wayside signal device or the operator has not correctly acknowledged the signal before a timeout expires, which corresponds to a distance threshold. EX1005, 5:40-6:28. Alternatively, Kane discloses controller 110 triggering the braking system if a timeout expires, which corresponds to the distance between "the vehicle-mounted subsystem" and "the control signal interface subsystem" being less than that threshold distance (*see supra*

§ VI.A.4). EX1003, ¶¶161-63. For example, Kane discloses that if the timeout period expires, corrective actions are taken, such as "the brakes are activated at step 344." EX1005, 6:26-32; *see also id.*, Abstract, 1:66-2:12, 2:33-43, 6:13-25, claims 2, 39-40. Therefore, Kane discloses causing controller 110 to activate the braking system if the distance between "the vehicle-mounted subsystem" and "the control signal interface subsystem" is less than a threshold distance required to stop the train before it passes the signal. EX1003, ¶¶161-63. A POSITA would have been motivated to combine Kane and Heddebaut for the same reasons discussed above with reference to claim 1. *Id.*, ¶¶137-44.

6. Claim 13

a. [13A] – The system of claim 1, further comprising: a second vehicle-mounted subsystem including a UWB communications component, wherein the second vehicle-mounted subsystem is configured to be mounted on another vehicle; and

As discussed in the context of elements [1F] and [1G] above, Kane and Heddebaut render obvious using the UWB communications component of "the vehicle-mounted subsystem" to communicate via UWB signals. Although Kane discloses a vehicle-mounted subsystem for a single, exemplary train, a POSITA would have understood Kane as disclosing a system that would be implemented on multiple trains within a railway system. EX1003, ¶¶164-65. Additionally, Heddebaut expressly describes a second vehicle-mounted subsystem mounted on a

second rail vehicle. *Id.*, ¶¶166-67. Specifically, Heddebaut emphasizes that a UWB communications component (included in "a second transmission-reception means 6") should be provided for "***each*** rail vehicle" in the train control environment, clearly indicating the presence of multiple vehicle-mounted subsystems. *See, e.g.*, EX1006, [0010], [0017], [0026], [0044], [0048], [0057] (emphasis added); EX1003, ¶¶166-67. Thus, Heddebaut discloses a second vehicle-mounted subsystem including a UWB communications component, wherein the second vehicle-mounted subsystem is configured to be mounted on another vehicle, as claimed. EX1003, ¶¶166-67. A POSITA would have been motivated to combine Kane and Heddebaut for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶179-87.

b. [13B] – wherein the vehicle-mounted subsystem is configured to: communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the vehicle-mounted subsystem;

The limitations of element [13B] track those of element [6B], and they are obvious in view of Kane and Heddebaut for the same reasons discussed above with reference to element [6B]. *Id.*, ¶168.

c. [13C] – communicate with the UWB communications component of the second vehicle-mounted subsystem

via the UWB communications component of the vehicle-mounted subsystem;

Heddebaut teaches that the inclusion of a UWB communications component in "a second transmission-reception means 6" on "each" vehicle "enables direct communication between vehicles[.]" EX1006, [0007], [0057], [0062]. Indeed, Heddebaut teaches that such direct communication is "necessary in certain operating modes." *Id.*, [0007]. Using direct vehicle-to-vehicle communications, "[t]he vehicles 4 may also acquire pieces of information regarding the identity, the speed and the position relative to other vehicles in the vicinity." *Id.*, [0054]. Thus, Heddebaut discloses UWB communications components communicating with each other on first and second vehicle-mounted subsystems, as claimed. EX1003, ¶¶169-71. A POSITA would have been motivated to combine Kane and Heddebaut for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶179-87.

d. [13D] – determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem; and

The limitations of element [13D] track those of element [6C], and they are obvious in view of Kane and Heddebaut for the same reasons discussed above with reference to element [6C]. *Id.*, ¶172.

e. [13E] – determine a distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem based on a time-of-flight of at least one communication between the UWB communications component of the second vehicle-mounted subsystem and the UWB communications component of the vehicle-mounted subsystem.

Heddebaut discloses using the train-to-train UWB communications to determine a distance between trains. *Id.*, ¶173. In particular, Heddebaut discloses that each vehicle-mounted subsystem is configured to "calculate [its] speeds relative to the fixed stations 1 or rail vehicles 4 with which the ultra wide band communication is established." EX1006, [0050]; *see also* [0054] ("The vehicles 4 may also acquire pieces of information regarding the identity, the speed and the position relative to the other vehicles 4 in the vicinity."). A POSITA would have understood that one way for a vehicle-mounted subsystem to calculate its speed relative to other rail vehicles would be to calculate its distance to those other vehicles and measure the change in distance over time. EX1003, ¶174. A POSITA would have further understood that such a distance calculation would be "based on the flight time of signals," the same ranging technique Heddebaut discloses for determining the distance between the rail vehicles and the fixed stations (see element [6C]) and the only ranging technique that Heddebaut discloses. EX1006, [0050], [0055]; EX1003, ¶174.

Heddebaut's disclosure of train-to-train distance determinations is further supported by Heddebaut's discussion of an "automatic driving system" for "keeping [a] distance D between each vehicle." EX1006, [0060]-[0061]. Heddebaut discloses that a "central control station" tracks and maintains these distances between vehicles but also states that "[t]hanks to the direct communication between vehicles, such calculation may also take place on-board trains without resorting to fixed technical means, on the ground." *Id.*, [0057]-[0062]. A POSITA would have understood that the obvious way for a vehicle-mounted subsystem to maintain a separation distance between vehicles would be to determine the distance between vehicles and take actions needed to maintain a proper separation distance. EX1003, ¶¶175-76. A POSITA would have further understood that if this is to be done "without resorting to fixed technical means, on the ground," such distance determinations would be based on time of flight calculations for UWB communications, as that is the ranging technique that Heddebaut expressly discloses. EX1006, [0055], [0062]; EX1003, ¶177.

Thus, Heddebaut demonstrates a vehicle-mounted subsystem with a UWB communications component configured to communicate with the UWB communications component of the second vehicle-mounted subsystem via UWB communications and configured to determine a distance between the subsystems based on a time-of-flight of the UWB communications, as claimed. EX1003, ¶¶173-

78. A POSITA would have been motivated to combine Kane and Heddebaut for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶179-87.

f. Motivation to Combine Kane and Heddebaut to Determine Separation Distance Between Trains

It would have been obvious to install Kane's vehicle-mounted subsystem in each rail vehicle as taught in Heddebaut. EX1003, ¶¶179-81. Indeed, it would have been counterintuitive to install a train control system on only a single train, without adding the same equipment to all (or, at the very least, a substantial number) of the trains. *Id.*

Moreover, it would have been obvious to use these multiple vehicle-mounted subsystems to perform vehicle-to-vehicle communication. *Id.*, ¶¶182-84. A POSITA would have recognized that this type of direct train-to-train communication offers advantages, including direct communication being faster than communicating via an intermediate wayside device or central office, having fewer points of potential failure for the communication, and providing communication and safety redundancy in the event of wayside-equipment failure. *Id.*

Beyond providing for train-to-train communication, it would have also been obvious to use these multiple vehicle-mounted subsystems to determine a distance between vehicles to augment Kane's "positioning system 150." *Id.*, ¶185. As already discussed in connection with Claim 6, a POSITA would have used Heddebaut's train-to-wayside ranging to supplement the positioning systems

contemplated by Kane (*e.g.*, GPS), which have limitations relative to UWB ranging. *Id.* Additionally, a POSITA would have recognized that utilizing Heddebaut's UWB ranging for not only train-to-wayside ranging but also train-to-train ranging would have offered the additional benefit of providing each train's position relative to other trains in the system. *Id.*, ¶186. Indeed, Heddebaut specifically teaches that its system is used to determine—and maintain—a "safety distance" between vehicles and that "such calculation may [] take place on-board trains without resorting to fixed technical means, on the ground." EX1006, [0057]-[0062]; EX1003, ¶187. Thus, by performing train-to-train distance determinations onboard each train, the system provides an additional layer of collision avoidance, including in the event that communication with the control signal interface is disrupted. EX1003, ¶¶185-87.

7. Claim 14

a. [14A] – The system of claim 13, wherein the vehicle-mounted subsystem is further configured to: generate an alert if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold; and

The limitations of element [14A] track those of claim 7, and they are obvious in view of Kane and Heddebaut for the same reasons discussed above with reference to claim 7. *Id.*, ¶¶188-89.

b. [14B] – generate an alert if the distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold.

Kane discloses generating an alert if, for example, a signal indication from an upcoming wayside signal device is not received, or an operator does not appropriately acknowledge a received signal indication, before a timeout expires, which corresponds to a distance threshold between the vehicle and the wayside device. EX1005, 5:40-6:28. Although Kane does not expressly disclose that its signal compliance functionality includes enforcing separation distances between trains, Heddebaut discloses using its train control system to calculate "safety distance" between vehicles and to "keep[] said distance D between each vehicle." EX1006, [0061]; EX1003, ¶¶190-91. The "safety distance" between vehicles is the second threshold, different from the first threshold, which is the distance between a vehicle and a wayside device. Heddebaut further discloses that using "direct communication between vehicles" enables this "calculation" to "take place on-board trains." EX1006, [0062]; EX1003, ¶192.

c. Motivation to Combine Kane and Heddebaut to Generate Alerts After Violation of a Required Separation Distance Between Trains

In view of these teachings, it would have been obvious to a POSITA to expand Kane's "warning device" to not only generate alerts before the train reaches a first threshold distance from the wayside signal device but also to generate similar alerts

if the train is not in compliance with a required separation distance (i.e., "safety distance") between trains as taught by Heddebaut. EX1003, ¶193. A POSITA would have understood that trains must be "prepared to stop within one-half the range of vision . . . unless the main track is known to be clear." EX1035, 5065; EX1003, ¶193. A POSITA also would have understood that the "safety distance" measurement would provide a more robust collision avoidance capability. EX1003, ¶194. The first threshold would prevent trains from missing signals from wayside devices or from entering segments of track that the train should not yet enter. *Id.* The second threshold would prevent trains from colliding, independent of any signals from wayside devices. *Id.* The first and second threshold are each addressing different aspects of the collision avoidance problem, and it would have been beneficial for a POSITA to combine the two from Kane and Heddebaut. *Id.*

8. Claim 15

a. [15A] – The system of claim 13, wherein the vehicle-mounted subsystem is further configured to: cause a braking system of the vehicle to activate if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold; and

The limitations of claim 15 track those of claim 8, and they are obvious in view of Kane and Heddebaut for the same reasons discussed above with reference to claim 8. *Id.*, ¶¶195-96.

b. [15B] – cause the braking system of the vehicle to activate if the distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold.

Kane discloses taking corrective actions such as activating the brakes if, for example, a signal indication from an upcoming wayside signal device is not received, or an operator does not appropriately acknowledge a received signal indication, before a timeout expires, which corresponds to a distance threshold between a vehicle and a wayside device. EX1005, 5:40-6:37; *see also id.*, Abstract, 1:66-2:12, 2:33-43, 5:40-57, claims 2, 39-40; EX1003, ¶197. Although Kane does not expressly disclose that its signal compliance functionality includes enforcing separation distances between trains, that is a common purpose for the signals presented by wayside signaling devices. EX1003, ¶198. In addition, Heddebaut discloses using its train control system to calculate "safety distance" between vehicles and to "keep[] said distance D between each vehicle." EX1006, [0061]; EX1003, ¶198. The "safety distance" between vehicles is the second threshold, different from the first threshold (the distance between a vehicle and a wayside device). Heddebaut further discloses that using "direct communication between vehicles" enables this "calculation" to "take place on-board trains." EX1006, [0062].

c. Motivation to Combine Kane and Heddebaut to Automatically Brake After Violation of a Required Separation Distance Between Trains

In view of these teachings, it would have been obvious to a POSITA to expand Kane's automatic braking to not only stop the train before it reaches a first threshold distance from the wayside signal device, but also to similarly stop the train before it reaches a second threshold distance from another train as taught by Heddebaut. EX1003, ¶199. A POSITA would have understood that trains must be "prepared to stop within one-half the range of vision . . . unless the main track is known to be clear." EX1035, 5065; EX1003, ¶199. A POSITA would have understood that the "safety distance" measurement would provide a more robust collision avoidance capability. EX1003, ¶200. The first threshold would reduce the risk of a train traveling through a signal without complying with the signal indication (e.g., entering a segment of track despite a "STOP" signal). *Id.* The second threshold would prevent trains from colliding, independent of any signals from wayside devices. *Id.* The first and second threshold are each addressing different aspects of the collision avoidance problem, and thus a POSITA would have been motivated to combine Kane and Heddebaut to get the benefits of both. *Id.*

B. Ground 1B – Claims 3-5 Are Obvious in View of Kane, Heddebaut, and Das

1. Das (EX1007)

Das, titled "Obstruction Independent Persistent Signalling System," published October 13, 2011, and was not cited during prosecution of the '738 Patent.

Das teaches "a railway signalling system used to control and manage the railway traffic." EX1007, Abstract. Das also describes radio frequency transponders installed on trains, fixed "station transponders" installed on tracks, and "signal towers" located at a station. *Id.*, 7:6-10, 7:22-25, 8:14-24. Das further explains that these transponders broadcast data including "recommended speed for the train moving past the station [and] stop durations if any." *Id.*, 8:14-24; EX1003, ¶¶79-80.

2. Claim 3 – Stop-Time Duration

a. Prior Art Disclosures

As discussed above with respect to claim 1 in Ground 1A, Kane discloses establishing and enforcing behavior rules based on the signal indication (status) of the wayside signal device. One such signal indication is "STOP." EX1005, Fig. 2, 3:29-56; EX1003, ¶¶202-03. Das similarly discloses rules for behavior of a vehicle in a train control system based on a control signal, including "recommended speed for the train moving past the station [and] stop durations if any." EX1007, 7:6-10, 7:22-25, 8:14-24; EX1003, ¶¶204-05.

b. Motivation to Combine Kane, Heddebaut, and Das to Add Handling of Stop Duration Signals

Kane, Heddebaut, and Das all teach train control systems that rely on communications between trains and wayside devices. EX1003, ¶206. Also, Kane and Das disclose establishing and enforcing behavior rules for a train in response to signal indications conveyed by a wayside device to a train. *Id.* For example, Kane discloses a "STOP" signal indication and a corresponding behavior rule for the train to stop and stay until it receives authorization to move, while Das discloses a stop duration (i.e., stopping for a predetermined period of time) as a signal indication that prompts a behavior rule. *Id.* These were two common signal types at the time of the purported invention, and thus a POSITA would have been motivated to add the handling of stop duration signals as disclosed in Das to the handling of other types of signals as disclosed in Kane and Heddebaut to promote enhanced safety and improved efficiency for railroad operations. EX1032, 5:47-6:9 (describing "stop" and "stop and proceed" signals); EX1034, 90-91 (same); EX1003, ¶206. A POSITA would have understood that a behavior rule of stop durations would improve Kane and Heddebaut in the same way that it improves Das (*e.g.*, "to completely overcome the situation of delay arrival or departure of trains during the fog, smog or haze"). EX1007, 4:3-4; EX1003, ¶206. If a train control system only tells a train to stop, then it will remain stopped until it receives an instruction to proceed. EX1003, ¶206.

A stop duration, however, tells the train to stop and when to proceed again through a single instruction. *Id.*

A POSITA would have been motivated to add accommodation for stop duration signals in a train control system combining the features of Kane and Heddebaut as discussed above, because stop duration rules were known in the art and not substantially different than handling a STOP signal in Kane. EX1003, ¶207. Moreover, a POSITA would have had a reasonable expectation of success for this combination because Kane, Heddebaut, and Das teach train control systems that rely on communicating between trains and wayside devices. EX1005, 5:37-39, 4:15-31, 5:59-6:4, Fig. 3; EX1006, [0041], [0044]-[0045], [0048]-[0049]; EX1007, 7:6-10, 8:14-24; EX1003, ¶207. All of these systems teach rules for stopping a train. EX1005, 6:26-32; EX1006, [0060]-[0061]; EX1007, 8:14-24; EX1003, ¶207. Das simply adds a stop duration as another well-known signal indication that is enforced. EX1007, 8:14-24; EX1003, ¶207.

3. Claim 4 – Speed Limit

As discussed above with reference to element [1D] in Ground 1A, Kane discloses determining a target speed behavior rule for the train corresponding to a signal received from the wayside signaling device 190. EX1003, ¶¶208-09. A POSITA would have been motivated to combine Kane, Heddebaut, and Das for the same reasons discussed above with reference to claim 3. *Id.*, ¶¶206-07.

4. Claim 5 – Speed Limit After Stop-Time Duration

As discussed above with reference to element [1D] in Ground 1A, Kane discloses determining a target speed behavior rule for a train corresponding to a signal received from a wayside signaling device 190. As discussed above for claim 3, Das discloses a stop duration as a signal indication that prompts a behavior rule for a train. Kane discloses specifying a maximum speed of 15 mph after a stop signal, so a POSITA would have understood that the same would apply for a stop duration signal. EX1005, 6:50-54; EX1003, ¶¶210-12. Therefore, Kane, Heddebaut, and Das disclose a behavior rule for the train that specifies the speed limit for the train after expiration of a stop duration. EX1003, ¶¶210-12. A POSITA would have been motivated to combine Kane, Heddebaut, and Das for the same reasons discussed above with reference to claim 3. *Id.*, ¶¶206-07.

C. Ground 1C – Claims 9-11 and 16-17 Are Obvious in View of Kane, Heddebaut, and Ackerman

1. Ackerman (EX1008)

Ackerman, titled "Method and Apparatus for Initializing an Automated Train Control System," published September 8, 1998, and was not cited during prosecution of the '738 Patent. Ackerman discloses "a control system that includes a vehicle, such as a train" and "a vehicle track, a first reader, an onboard computer and a tachometer." EX1008, Abstract, 4:14-22; EX1003, ¶¶81-82. Ackerman's onboard computer 24 "automatically tracks the train location" and "provide[s] train

protection and/or train speed control." EX1008, 4:14-22. Ackerman's system uses a "train reader" to "read or receive signals" from track-based "tags," which provide the train with their "exact location" and, in turn, allow for "the train's location [to] be pinpointed by the onboard computer." *Id.*, 4:62-5:22.

2. Claim 9 – RFID Subsystem

a. Prior Art Disclosures

Ackerman discloses a then well-known technique for using track-based RFID tags to determine train location. EX1003, ¶¶214-15. More specifically, Ackerman teaches that its train control system includes "a train reader, receiver, or interrogator 28" that "is secured to a vehicle 12 and is adapted to read or receive signals emitted from tags 'T' that represent identifying an exact location of the tag 'T' positioned along the main portion 22 of the track 18." EX1008, 4:65-5:2. The annotated Figures from Ackerman below depict the train reader (red) and external, track-based tags (blue):

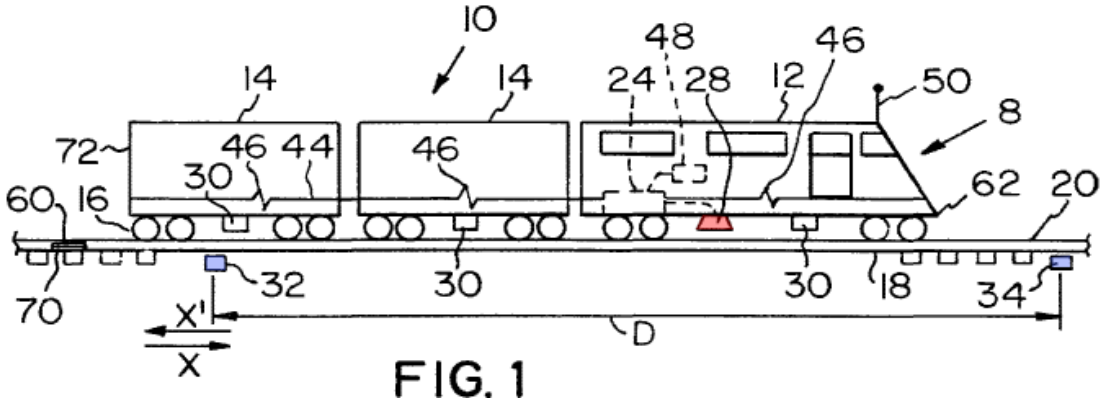


FIG. 1

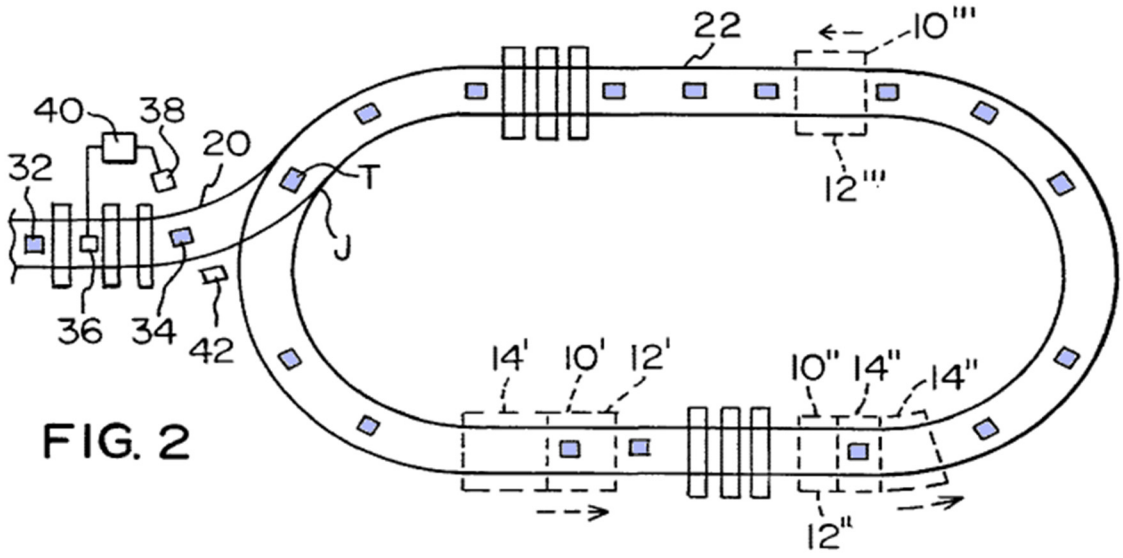


FIG. 2

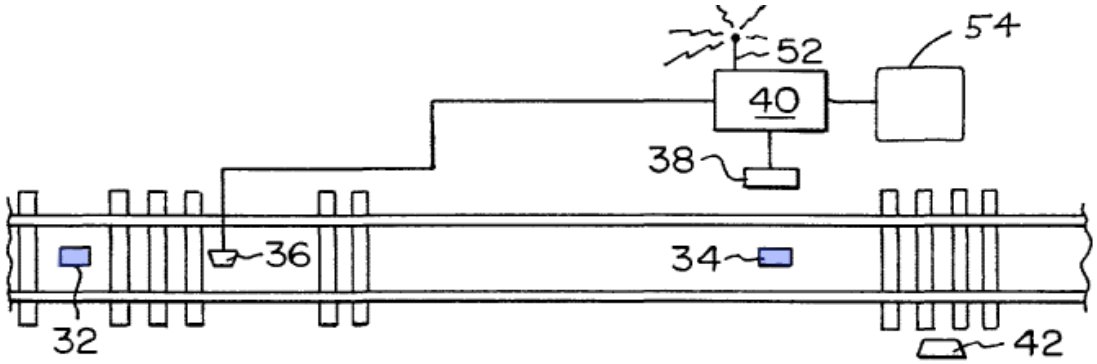


FIG. 3

This "tag/reader system is a radio-based communication system, which uses radio frequency (RF) communication between the vehicle reader 28 and tags 'T' 32 and 34." *Id.*, 5:10-13. Specifically, "[e]ach tag 'T,' 32 and 34 is a passive transponder, encoded with a unique identification, which is excited by RF energy from vehicle-based reader 28." *Id.*, 5:14-16. In response, "location information," is "received by the reader and is then sent to the onboard computer 24 so that the train's location can be pinpointed by the onboard computer map." *Id.*, 5:17-19. Therefore,

Ackerman discloses a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the RFID tag(s), as claimed. EX1003, ¶¶216-18.

b. Motivation to Combine Kane, Heddebaut, and Ackerman to Implement RFID Positioning

A POSITA implementing Kane's train control system would have been motivated to use positioning technology known in the prior art to complement Kane's GPS system and Heddebaut's time-of-flight ranging system (if used along with its UWB communication system). EX1003, ¶¶219-25. Specifically, a POSITA would have been motivated to use well-known techniques using RFID tags to determine a train's position within a rail system, as taught in Ackerman, as that approach can provide a very precise location of the train when it is traversing tracks fitted with RFID tags. *Id.*, ¶¶51-54, 219-25.

Although Kane and Heddebaut disclose techniques for determining a train's absolute position (*e.g.*, Kane's GPS) and the train's position relative to other objects in the system (*e.g.*, Heddebaut's time-of-flight ranging), a POSITA would have recognized Ackerman's train-positioning techniques to be a desirable complement for these positioning systems. *Id.*, ¶¶219-20. Indeed, Kane specifies that its positioning system is "preferably sufficiently accurate to unambiguously determine which of two adjacent tracks a train is on." EX1005, 4:52-54. However, a GPS signal can be blocked when a train is in a tunnel and may lack sufficiently accurate

position capabilities to distinguish between two adjacent tracks. EX1003, ¶¶220-21. A POSITA would have recognized Ackerman's positioning system to be an ideal solution for this situation because the track-based RFID tags would provide sufficiently specific identifying information for the controller to identify the track on which the train is traveling, even when located in a tunnel or when GPS is insufficiently accurate. *Id.* Moreover, a POSITA combining Ackerman, Kane, and Heddebaut would have recognized that the location information from Ackerman's RFID readers would provide a useful, additional datapoint in determining the train's position. This additional datapoint may be particularly useful in situations where the other location data is less reliable, such as where GPS signals are blocked (*e.g.*, a tunnel) or where UWB signals are weak (*e.g.*, due to long distance between transceivers). EX1016, [0003]; EX1003, ¶221.

Furthermore, Ackerman teaches that its track-based RFID tags provide further advantages in addition to providing pinpoint train location. EX1003, ¶¶222-25. For example, they are used to "determin[e]…the train direction, the train orientation and calibrat[e] the train's distance measuring device(s)." EX1008, 4:45-49; *see also* 1:64-67, 2:2-7, 5:63-6:5 (teaching tachometer calibration), 6:6-20 (teaching travel-direction determination), 8:27-40. Because Kane's GPS system and Heddebaut's UWB ranging do not provide train orientation or continuously calibrate the train's distance measuring devices, a POSITA would have had additional reason to add

Ackerman's RFID positioning system to supplement train control system capabilities. EX1003, ¶¶222-25.

3. Claim 10

a. [10A] – The system of claim 9, wherein: the vehicle-mounted subsystem is further configured to substantially continuously receive information relating to speed of the vehicle; and

Kane discloses that its controller continuously receives information relating to the speed of the vehicle. *Id.*, ¶¶226-27. Specifically, "[i]n addition to the positioning system 150, a tachometer 170 is also connected to the controller 110. The tachometer 170 measures the axle rotation, from which the speed of the train can be derived… ." EX1005, 5:6-9. Thus, Kane discloses a tachometer configured to determine information relating to the speed of the vehicle and to continuously provide this information to its vehicle-mounted subsystem. EX1003, ¶¶226-27.

b. [10B] – the vehicle-mounted subsystem determines a changing distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag and the information relating to speed of the vehicle.

Ackerman teaches that its train control system uses the "unique identification" received from the track-based RFID tags as "location information" that provides the train's "pinpoint[]" location when the train passes the tag. EX1008, 5:14-19.

Additionally, Ackerman teaches using a "tachometer" (like Kane's) to determine the train's position "when the train 10 travels between the tags." EX1008,

5:20-22. Thus, Ackerman discloses using both information stored on RFID tags (e.g., when it passes over an RFID tag) and information relating to the speed of the vehicle (e.g., when traveling between RFID tags) to determine the train's position. EX1003, ¶¶228-33.

When adding Ackerman's positioning to Kane's train control system, Ackerman's RFID-and-tachometer-derived location information would be used by Kane's "positioning system 150" to, *inter alia*, "continuously suppl[y] the controller 110 with position information," which the controller 110 can then use to "determine the train's position relative to wayside signal devices 190 in the system." EX1005, 4:48-58; *see also* 5:25-39 ("querying the positioning system 150 … to determine the position of the train," then "determin[ing] the nearest signaling device 190 based on the train's position" and "determin[ing] whether the signaling device 190 is within [] range"). Thus, in the combined system of Kane, Heddebaut, and Ackerman, the vehicle-mounted subsystem would determine the train's location—and, in turn, the distance to control signal interface subsystems—based on information stored in RFID tags and information relating to the speed of the vehicle, as claimed. EX1003, ¶¶234-36.

c. Motivation to Combine Kane, Heddebaut, and Ackerman to Use RFID Positioning to Determine Distance to Control Signal Interface Subsystems

As discussed for claim 9, a POSITA would have been motivated to add Ackerman's RFID-based positioning technology to the train positioning techniques of Kane (GPS and tachometer) and Heddebaut (time-of-flight UWB ranging). *Id.*, ¶¶219-225, 234-37.

4. Claim 11 – Distance Based on RFID

The limitations of claim 11 track those of element [10B], and they are obvious in view of Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to element [10B]. *Id.*, ¶¶238-39. A POSITA would have been motivated to combine Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to claim 10. *Id.*, ¶¶219-225, 234-37.

5. Claim 16

[16A] – The system of claim 13, wherein the vehicle-mounted subsystem further comprises: a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the at least one RFID tag; and

[16B] – wherein the vehicle-mounted subsystem is further configured to determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag.

The limitations of element [16A] track those of claim 9, and they are obvious in view of Kane, Heddebaut, and Ackerman for the same reasons discussed above with

reference to claim 9. *Id.*, ¶241. The limitations of element [16B] track those of element [10B], and they are obvious in view of Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to element [10B]. *Id.*, ¶¶242-43. A POSITA would have been motivated to combine Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to claims 9-10. *Id.*, ¶¶219-25, 234-37.

6. Claim 17 – Distance Based on RFID and Speed

The limitations of claim 17 track those of claim 10, and they are obvious in view of Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to claim 10. *Id.*, ¶244. A POSITA would have been motivated to combine Kane, Heddebaut, and Ackerman for the same reasons discussed above with reference to claim 10. *Id.*, ¶¶219-225, 234-37.

D. Ground 1D – Claims 12 and 18 Are Obvious in View of Kane, Heddebaut, and Hungate

1. Hungate (EX1009)

Hungate, titled "Distributed Positive Train Control System," published September 14, 1999, and was not cited during prosecution of the '738 Patent.

Hungate generally discloses "a distributed system and method for controlling train movement in a track network." EX1009, 1:5-6; EX1003, ¶¶83-84. More specifically, Hungate discloses "wayside controllers receive signals from individual trains, including position information which can be derived from a navigation

system. The wayside controllers interface with a central train control network and coordinate local train movement." EX1009, 1:62-66. Hungate discloses that block release reports and train position reports, which include the track portions a train has completed, its prior positions and speed, and the distance it has travelled are transmitted from a train to wayside controllers. *Id.*, 4:55-5:6; *see also id.* 3:10-19.

2. Claim 12

a. [12A] – The system of claim 1, further comprising: an access point external to the vehicle; and

Hungate discloses "a plurality of wayside controllers 20" (access points) that are located away from trains (and their "onboard systems 30") and are connected to "a central train control network 10," as is depicted in Hungate's Figure 1:

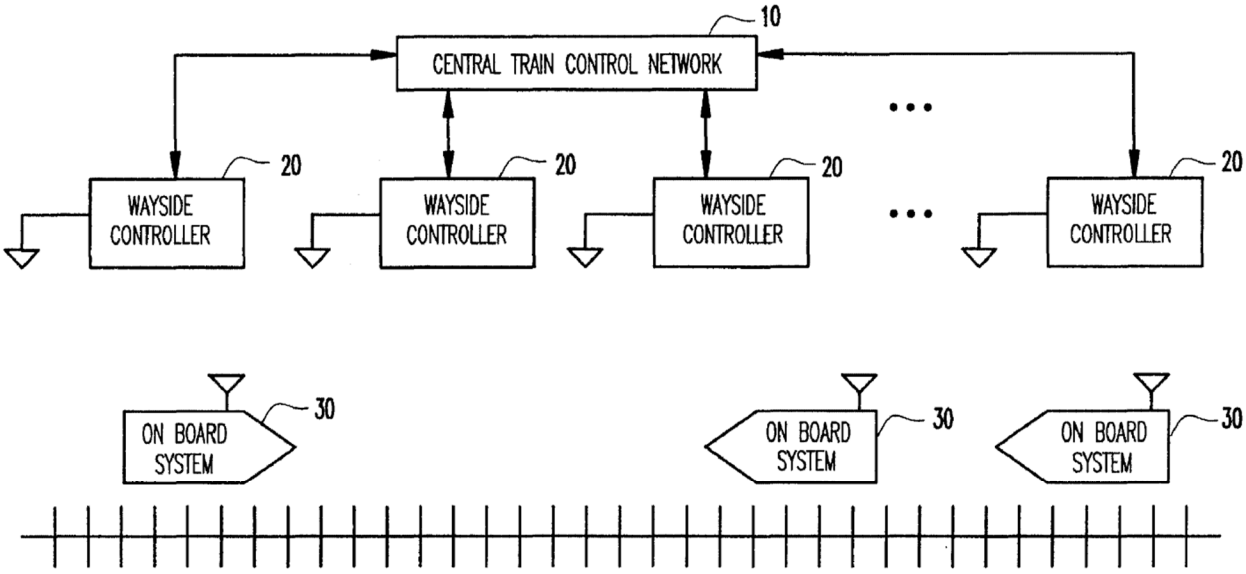


FIG.1

Id., 2:57-60, Fig. 3; EX1003, ¶247. A POSITA would have been motivated to combine Kane, Heddebaut, and Hungate for the reasons discussed in the Motivation to Combine Section below. EX1003, ¶¶252-56.

b. [12B] – wherein the vehicle-mounted subsystem is further configured to: store data relating to prior behavior of the vehicle; and

As discussed with reference to element [12A] above, Hungate discloses "onboard systems 30," which are mounted to trains. Hungate discloses that onboard system 30 includes "an onboard computer (OBC) 31." EX1009, 4:40-42. Hungate further discloses that OBC 31 generates block release reports and train position reports. *Id.*, 4:60-5:6. "A block release report refers to an indication that a train has completed its transit of a portion of track," and the train position report includes train position, speed, and distance travelled data. *Id.*, 3:10-11, 4:51-5:6. This data relates to prior behavior of the train: the track portions it has completed, its prior positions and speed, and the distance it has travelled. EX1003, ¶248. Hungate does not explicitly describe storing this data, but a POSITA would have expected a train's computer, such as OBC 31, to include memory where the data would be stored before transmission. *Id.*, ¶249. For example, both Kane and Heddebaut describe storage memory included in their vehicle-mounted subsystems. EX1005, 4:62-67; EX1006, [0048]. A POSITA would have understood that storing the data relating to prior behavior of the train would allow the vehicle-mounted subsystem to gather

and keep the data at least until successful transmission to the central station occurred. EX1003, ¶249. A POSITA would have been motivated to combine Kane, Heddebaut, and Hungate for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶252-56.

c. [12C] – communicate the data relating to prior behavior of the vehicle with the access point.

Hungate discloses that onboard system 30 also includes "a train data radio 33." EX1009, 4:40-43. Hungate discloses that block release reports and train position reports are "transmitted by the train data radio 33 to the wayside controllers 20." *Id.*, 4:55-5:6. Thus, Hungate communicates the data relating to prior behavior of the vehicle with an access point, as claimed. EX1003, ¶¶250-51. A POSITA would have been motivated to combine Kane, Heddebaut, and Hungate for the reasons discussed in the Motivation to Combine Section below. *Id.*, ¶¶252-56.

d. Motivation to Combine Kane, Heddebaut, and Hungate to Add Distributed Architecture for Monitoring Train Behaviors

It would have been obvious to a POSITA to add Hungate's distributed architecture for monitoring train behaviors to the combination of Kane and Heddebaut discussed above with respect to, for example, claim 1 in Ground 1A. *Id.*, ¶252. Kane enforces behavior rules in its train control system, and Hungate teaches techniques to improve the safety and efficiency of train operation in such a system, such as storing prior behavior of the trains and communicating it to a central control

entity via a wayside controller. *Id.*; EX1005, 3:10-19 (block release reports and train position reports enable "dynamic railroad traffic planning"); 3:55-4:5 (position reports enable functions that "enhance[] the vitality of the overall train control system"); 4:40-5:6. This allows a central control entity to monitor the behavior and position of multiple trains in a network and transmit revised control signals based on that information. EX1003, ¶¶252. It also allows a central control entity to determine if the train engineer requires additional training or if the train needs maintenance. *Id.*, ¶¶252-54.

Kane and Heddebaut both describe transmitting position and speed information to a central control entity. EX1005, 7:62-66; EX1006, [0061]. Hungate details how to implement this functionality by sending block release reports and train position reports to wayside controllers. EX1009, 4:40-5:6; *see also id.* 3:10-19. Although these reports could be transmitted directly from the train to a central control entity, a POSITA would have understood that trains sometimes travel far away from a central control entity or travel to locations that make transmission to a central control entity difficult (e.g., tunnels). *See* EX1006, [0003], [0005]-[0006]; EX1003, ¶255. Hungate provides these reports even when the train is not constantly in communication range of the central control entity because it discloses techniques for storing the behavior data on the train until it is possible to share the stored behavior data with a wayside controller in communication with the central control

entity. EX1009, 4:40-5:6; EX1003, ¶255. Thus, a POSITA would have been motivated to implement Hungate's teaching of sending block release/train position reports to wayside controllers in Kane and Heddebaut's train control system. EX1003, ¶255. Moreover, a POSITA would have had a reasonable expectation of success for this combination because Kane, Heddebaut, and Hungate teach train control systems that rely on communicating between trains and wayside devices. EX1005, 5:37-39, 4:15-31, 5:59-6:4, Fig. 3; EX1006, [0041], [0044]-[0045], [0048]-[0049]; EX1009, 3:10-19, 4:40-5:6; EX1003, ¶256.

3. Claim 18 – External Access Point

The limitations of claim 18 track those of claim 12, and they are obvious in view of Kane, Heddebaut, and Hungate for the same reasons discussed above with reference to claim 12. EX1003, ¶257. A POSITA would have been motivated to combine Kane, Heddebaut, and Hungate for the same reasons discussed above with reference to claim 12 in Ground 1D. *Id.*, ¶¶252-56.

E. Ground 1E – Claims 13-15 Are Obvious in View of Kane, Heddebaut, and Grisham

1. Grisham (EX1010)

Grisham, titled "Railroad Collision Avoidance System and Method for Preventing Train Accidents," published July 6, 2004, and is an ancestor of a continuation application that was listed in an IDS but not cited by the examiner during prosecution of the '738 Patent. Grisham teaches a railroad collision

avoidance system and method that includes direct train-to-train communications using UWB technology (impulse radios), to determine the distance between trains using "time of flight" techniques. EX1010, 23:33-24:29, Figs. 21-22; EX1003, ¶¶85-86. Figures 21 and 22 of Grisham, reproduced below, respectively depict the impulse radio units on two rail line vehicles in communication with one another, and the steps involved in such communication for alerting the vehicle operator about potentially dangerous situations.

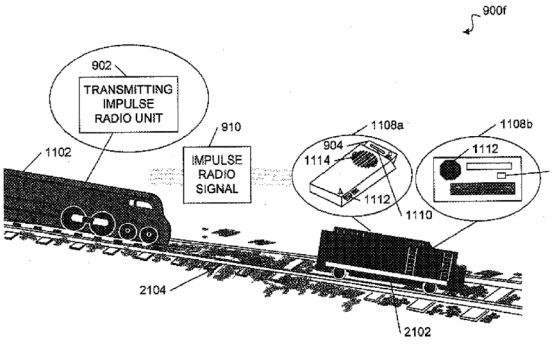


FIG. 21

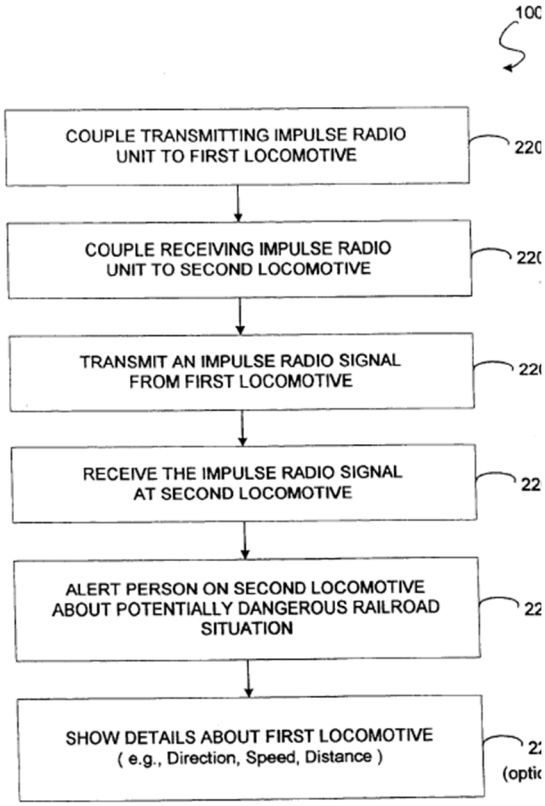


FIG. 22

EX1010, Figs. 21-22; EX1003, ¶86.

2. Claim 13

a. Prior Art Disclosures

As discussed *supra* § VI.A.6, all of the elements of claim 13 are disclosed by the Kane-Heddebaut combination, and a POSITA would have been motivated to combine the teachings of those references. EX1003, ¶¶164-87. However, to the extent Heddebaut is found not to disclose train-to-train UWB time-of-flight ranging (see element [13E]), these aspects of claim 13 are disclosed by Grisham. *Id.*, ¶¶259-63.

Specifically, as shown in Figures 21 and 22 below, Grisham discloses a radio unit 902 that is coupled at step 2202 to a locomotive 1102. EX1010, Figs. 21-22. Grisham discloses a radio unit 904 that is coupled at step 2204 to a second locomotive 2102. *Id.*, 23:33-40, Figs. 21-22.

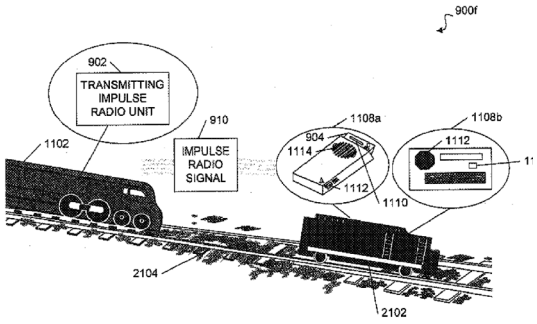


FIG. 21

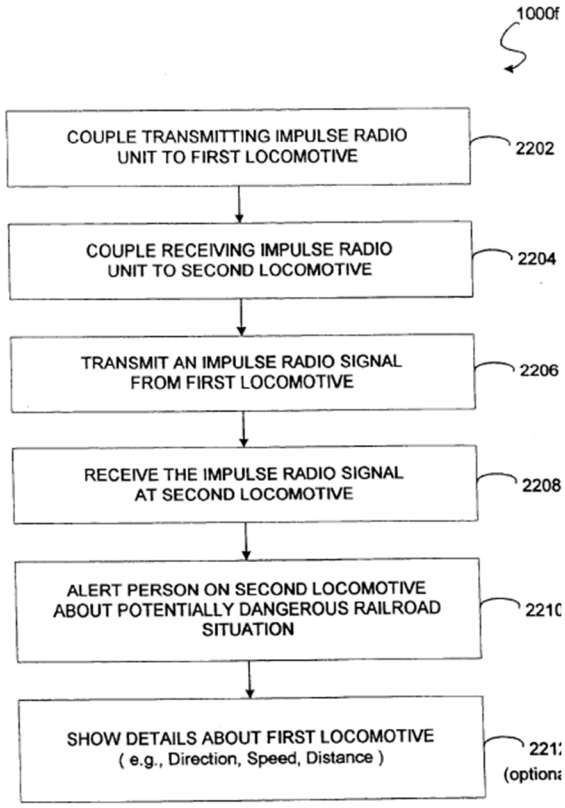


FIG. 22

EX1010, Figs. 21-22; EX1003, ¶264. Grisham discloses that radio units 902 and 904 send and receive UWB signals (send and receive data wirelessly). EX1010, 23:33-49; *see also id.*, 16:39-49, 16:59-60, 24:25-29, Figs. 6-7. Therefore, Grisham discloses a vehicle-mounted subsystem with UWB communications component (transmitting impulse radio unit 902) communicating with a second vehicle-mounted subsystem with UWB communications component (receiving impulse radio unit 904). EX1003, ¶265.

Grisham's radio-unit controllers in the first and second radio units (the first and second vehicle mounted modules) use "time position measurement" to "measure

the propagation delay and determine the link distance between the receiving impulse radio unit 904 and the locomotive 1102." EX1010, 24:18-24. Grisham further describes this application of time-of-flight technique by reference to U.S. Patent No. 6,133,876 ("Fullerton," EX1017), which Grisham incorporates by reference. EX1010, 14:56-62; EX1003, ¶¶266-68.

b. Motivation to Combine Kane, Heddebaut, and Grisham to Determine Separation Distance Between Trains

It would have been obvious to use Grisham's train-to-train UWB time-of-flight ranging to augment the combination of Kane and Heddebaut. EX1003, ¶269. Indeed, Heddebaut already discloses that its UWB ranging system is used to determine—and maintain—a "safety distance" between vehicles and that "such calculation may [] take place on-board trains without resorting to fixed technical means, on the ground." EX1006, [0057]-[0062]; EX1003, ¶269. To the extent not already disclosed by Heddebaut, a POSITA would have looked to Grisham for its disclosures of how to perform this train-to-train ranging using UWB impulse radios. EX1003, ¶269. Also, a POSITA would have recognized that the positioning systems contemplated by Kane (e.g., GPS) have limitations and that there would have been several advantages to utilizing Grisham's train-to-train UWB time-of-flight ranging to complement Kane and Heddebaut for all of the reasons discussed *supra* § VI.A.3.d in connection with Claim 6. EX1003, ¶270. Utilizing UWB ranging for not only

train-to-wayside ranging but also train-to-train ranging would have offered the additional benefit of providing each train's position relative to other trains in the system. *Id.* Thus, performing train-to-train distance determinations onboard each train provides an additional layer of collision avoidance in the event that communication with the control signal interface is disrupted. *Id.*

3. Claim 14

a. Prior Art Disclosure

As discussed *supra* § VI.A.7, all of the elements of claim 14 are disclosed by the Kane-Heddebaut combination, and a POSITA would have been motivated to make the combination. *Id.*, ¶¶188-94. However, to the extent Kane and Heddebaut do not disclose generating alerts based on the distance to a second vehicle, this aspect of claim 14 is disclosed by Grisham. *Id.*, ¶¶271-73. Specifically, Grisham teaches the use of an alarm to alert the operator. EX1010, 23:57-60, Fig. 21. Grisham's user-interface display is configured to alert a train operator by "generating an alarm (see light 1112) or voice message (see Speaker 1114)." *Id.* Grisham teaches that the alarms activate when an oncoming train is "in their vicinity" (separation distance less than a second threshold). *Id.*, 23:57-58; EX1003, ¶273.

b. Additional Motivation to Combine Kane, Heddebaut, and Grisham to Generate Alerts After Violation of a Required Separation Distance Between Trains

In view of these teachings, it would have been obvious to a POSITA to implement Grisham's alarm to generate alerts if the train is in the vicinity of another

train. EX1003, ¶274. A POSITA would have understood that a responsive action should be taken when the distance between two trains becomes unsafe (i.e., below a "safety distance" disclosed in Heddebaut). *Id.* While automatic responsive actions may be available, a POSITA would have recognized that the simplest way to remedy the safety violation would often be to alert the operator so that he or she would be able to slow the train and avoid collision. *Id.*

4. Claim 15

The limitations of claim 15 are discussed above in connection with Ground 1A and are further rendered obvious in view of a combination that includes, in addition to the references discussed in Ground 1A, Grisham's train-to-train UWB time-of-flight ranging. *Id.*, ¶275. A POSITA would have also been motivated to combine Kane, Heddebaut, and Grisham for the same reasons discussed above with reference to claim 13. *Id.*, ¶¶269-70.

F. Ground 1F – Claims 16-17 Are Obvious in View of Kane, Heddebaut, Grisham, and Ackerman

The limitations of claims 16-17 are discussed above in connection with Ground 1C and are further rendered obvious in view of a combination that includes, in addition to the references discussed in Ground 1C, Grisham's train-to-train UWB time-of-flight ranging. *Id.*, ¶¶276-79. A POSITA would have also been motivated to combine Kane, Heddebaut, Grisham, and Ackerman for the same reasons discussed above with reference to claim 13 in Ground 1E. *Id.*, ¶¶269-70.

G. Ground 1G – Claim 18 Is Obvious in View of Kane, Heddebaut, Grisham, and Hungate

The limitations of claim 18 are discussed above in connection with Ground 1D and are further rendered obvious in view of a combination that includes, in addition to the references discussed in Ground 1D, Grisham's train-to-train UWB time-of-flight ranging. *Id.*, ¶¶280-81. A POSITA would have also been motivated to combine Kane, Heddebaut, Grisham, and Hungate for the same reasons discussed above with reference to claim 13 in Ground 1E. *Id.*, ¶¶269-70.

VII. NO BASIS FOR DISCRETIONARY DENIAL

A. Section 314(a)

The record does not support discretionary denial of institution pursuant to 35 U.S.C. § 314(a). To start, neither Ground Transportation Systems nor Piper have been served with a complaint alleging infringement of the '738 patent. There is thus no parallel district court proceeding involving the '738 patent for at least those two petitioners, making the typical *Fintiv* (*Apple, Inc. v. Fintiv, Inc.*, IPR2020-00019) analysis less relevant here.

Regardless, "the PTAB will not deny institution based on *Fintiv* if there is compelling evidence of unpatentability," which this Petition provides. Director's Interim Procedure for Discretionary Denials (June 21, 2022) ("Interim Procedure"). That should conclude the *Fintiv* analysis, but the *Fintiv* factors weigh against discretionary denial in any event.

1. Stay Potential

The district court has stayed Patent Owner's litigation against Siemens pending resolution of all IPR proceedings between the parties, including this proceeding. *See* EX1018, 9. Thus, barring further action by the court, there is no concern that the district court action will proceed in parallel with a trial before the Board. This factor thus weighs heavily against discretionary denial. *See Snap Inc. v. SRK Tech. LLC*, IPR2020-00820, Paper 15, 9 (Oct. 21, 2020) (precedential) (pending stay of litigation "weigh[s] strongly against exercising discretion to deny institution").

2. Trial Timing

There is no trial scheduled in the pending district court case. And with the case stayed, no trial is likely to be ***scheduled*** until after a final written decision issues. *Snap*, IPR2020-00820, Paper 15, 9. This factor thus also weighs against discretionary denial.

3. Litigation Investment

Little has occurred in the district court litigation other than initial pleading practice, and no further investment will occur while the case remains stayed. *See* EX1018, 9. This factor thus also weighs against discretionary denial.

4. Overlap of Issues

Patent Owner has not asserted challenged claims 3-5 in the pending litigation. EX1019, 23. That a trial here will address claims the district court will not address

weighs further against discretionary denial. *Markforged Inc. v. Continuous Composites*, IPR2022-00679, Paper 7, 32-33 (Oct. 25, 2022).

5. Litigation Defendants

Two of the four Petitioners (Ground Transportation Systems and Piper) are not litigation defendants and are unrelated to the other Petitioners, which also weighs against discretionary denial. *Fintiv*, Paper 11, 13-14 ("If a petitioner is unrelated to a defendant in an earlier court proceeding, the Board has weighed this fact against exercising discretion to deny institution ...."). As to Siemens, it "is far from an unusual circumstance" for IPR petitioners to be litigation defendants. *Sand Revolution II v. Cont'l Inter. Group-Trucking LLC,* IPR2019-01393, Paper 24, 12-13 (June 16, 2020). This factor also weighs against discretionary denial.

6. Other Circumstances

The Petition's "strong showing on the merits" weighs against discretionary denial as well. Interim Procedure, 3-5.

Thus, on balance, the *Fintiv* factors weigh heavily a discretionary denial of institution.

B. Section 325(d)

Under the rationale of *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geraete GmbH*, IPR2019-01469, Paper 6 (Feb. 13, 2020) (precedential), there is no basis for discretionry denial pursuant to 35 U.S.C. § 325(d).

1. Step 1: The Petition Advances Art and Arguments Not Previously Considered

Though Heddebaut and a continuation application of Grisham were cited in an IDS filed by Patent Owner during prosecution, neither was applied as a reference against any of the claims or otherwise discussed by the examiner during prosecution of the '738 Patent. The Board has "consistently held that a reference that 'was neither applied against the claims nor discussed by the Examiner' does not weigh in favor of exercising discretionary denial under § 325(d)." *Bowtech, Inc. v. MCP IP, LLC*, IPR2019-00382, Paper 12, 12 (Aug. 6, 2019).

Moreover, even if Grisham and/or Heddebaut *had* been relied upon by the examiner to reject any of the challenged claims, the Petition relies on Grisham and Heddebaut only in combination with other references that were neither disclosed nor relied upon during prosecution. Accordingly, step 1 of the *Advanced Bionics* test is not satisfied. *SHDS v. Truinject*, IPR2020-00937, Paper 11, 8-12 (Nov. 17, 2020) (step 1 not satisfied even though petition relied on art applied during prosecution because petition combined it with new art).

2. Step 2: The Office Erred Materially

If the Board finds step 1 satisfied merely because Grisham and Heddebaut were cited in an IDS during prosecution, discretionary denial is still unwarranted because the Office erred materially in its prior "evaluation" of that prior art. Step 2

focuses on *Becton, Dickinson* factors (c), (e), and (f) (*Advanced Bionics*, Paper 6 at 10), which all weigh against denial.

a. Factor (c): Grisham and Heddebaut Were Not Evaluated

Although Grisham and Heddebaut were cited in an IDS during prosecution, they were not used by the examiner as the basis for any rejection. As noted above, mere citation in an IDS "does not weigh in favor of exercising [] discretion under § 325(d)." *Bowtech*, Paper 12, 12. Petitioners are not asking the Office to reconsider any arguments regarding Grisham or Heddebaut made during prosecution of the '738 Patent; rather, they are asking the Office to consider for the first time whether Grisham and Heddebaut in combination with other new references renders the challenged claims obvious.

b. Factors (e)-(f): The Office Erred

Where "the Office's previous consideration of the art is not well developed or silent, then a petitioner may show the Office erred by overlooking something persuasive under factors (e) and (f)." *Advanced Bionics*, Paper 6 at 10. Here, the Petition details how Grisham and Heddebaut combine with other, new references to render the challenged claims obvious. This is "something persuasive" that the Office necessarily overlooked when it allowed the claims despite Grisham and Heddebaut being listed in an IDS. In addition, the Office also lacked the benefit of expert testimony regarding the prior art on which the Petition relies. Such new evidence

weighs heavily against denying institution. *Adobe v. Rah Color*, IPR2019-00627, Paper 41, 20 (Sept. 10, 2019).

VIII. CONCLUSION

For the reasons set forth above, there is a reasonable likelihood that Petitioners will prevail in demonstrating that claims 1-18 of the '738 Patent are unpatentable, and thus the Board should institute *inter partes* review.

Respectfully submitted,

Dated: May 22, 2024

By: /s/ *Joshua H. James*

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CERTIFICATE OF WORD COUNT

The undersigned hereby certifies that the foregoing Petition complies with the requirements of 37 C.F.R. § 42.24 and contains 13,922 words, excluding those contained in the following: Table of Contents, Table of Authorities, List of Exhibits, Mandatory Notices, Certificate of Word Count, and Certificate of Service.

Respectfully submitted,

Dated: May 22, 2024

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CERTIFICATE OF SERVICE

I, hereby certify that a true copy of the Petition for Inter Partes Review of U.S. Patent No. 9,731,738 and supporting materials (Exhibits 1001-1036 and Powers of Attorney) have been served in its entirety by e-mail and FTP this 22nd day of May, 2024, and by FedEx on the 23rd day of May, 2024, on the patent owner at the correspondence address of record for the subject patent, as indicated below:

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Chicago, IL 60661

Respectfully submitted,

Dated: May 22, 2024

By: */s/ Joshua H. James*

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APPENDIX OF THE CHALLENGED CLAIMS

The following claim listing assigns element labels (e.g., [1A], [1B], etc.) to certain claims for clarity.

Claim 1
[1-Pre] 1. A system for evaluating vehicle operation compliance, wherein the system comprises:
[1A] a control signal interface subsystem; and
[1B] a vehicle-mounted subsystem configured to:
[1C] communicate with the control signal interface subsystem to receive information corresponding to a status of a control signal;
[1D] determine a rule for behavior of a vehicle according to the information corresponding to the status of the control signal; and
[1E] observe operation of the vehicle to evaluate compliance with the rule; wherein:
[1F] the control signal interface subsystem comprises an ultra-wideband (UWB) communications component;
[1G] the vehicle-mounted subsystem comprises an ultra-wideband (UWB) communications component; and
[1H] the vehicle-mounted subsystem and the control signal interface subsystem are further configured to communicate UWB signals carrying data pertinent to evaluating vehicle operation compliance, the data comprising at least one of: a unique ID associated with the vehicle-mounted subsystem, a signal indication, a track number, a track direction, speed, and direction of travel.
Claim 2
2. The system of claim 1, wherein the rule corresponds to the status of the control signal being at least one of red, double red, yellow, or double yellow.
Claim 3
3. The system of claim 1, wherein the rule specifies a stop-time duration for the vehicle.
Claim 4
4. The system of claim 3, wherein the rule specifies a speed for the vehicle.
Claim 5
5. The system of claim 4, wherein the rule specifies a maximum speed for the vehicle after an expiration of the stop-time.
Claim 6

[6A] 6. The system of claim 1, wherein the vehicle-mounted subsystem is configured to: interface with a braking system of the vehicle;
[6B] communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the vehicle-mounted subsystem; and
[6C] determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem.
Claim 7
7. The system of claim 1, wherein the vehicle-mounted subsystem is further configured to generate an alert if a distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a threshold.
Claim 8
8. The system of claim 1, wherein the vehicle-mounted subsystem is further configured to cause a braking system of the vehicle to activate if a distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a threshold.
Claim 9
9. The system of claim 1, wherein the vehicle-mounted subsystem further comprises a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the at least one RFID tag.
Claim 10
[10A] 10. The system of claim 9, wherein: the vehicle-mounted subsystem is further configured to substantially continuously receive information relating to speed of the vehicle; and
[10B] the vehicle-mounted subsystem determines a changing distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag and the information relating to speed of the vehicle.
Claim 11
11. The system of claim 9, wherein the vehicle-mounted subsystem is further configured to determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag.
Claim 12

[12A] 12. The system of claim 1, further comprising: an access point external to the vehicle; and
[12B] wherein the vehicle-mounted subsystem is further configured to: store data relating to prior behavior of the vehicle; and
[12C] communicate the data relating to prior behavior of the vehicle with the access point.
Claim 13
[13A] 13. The system of claim 1, further comprising: a second vehicle-mounted subsystem including a UWB communications component, wherein the second vehicle-mounted subsystem is configured to be mounted on another vehicle; and
[13B] wherein the vehicle-mounted subsystem is configured to: communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the vehicle-mounted subsystem;
[13C] communicate with the UWB communications component of the second vehicle-mounted subsystem via the UWB communications component of the vehicle-mounted subsystem;
[13D] determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem; and
[13E] determine a distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem based on a time-of-flight of at least one communication between the UWB communications component of the second vehicle-mounted subsystem and the UWB communications component of the vehicle-mounted subsystem.
Claim 14
[14A] 14. The system of claim 13, wherein the vehicle-mounted subsystem is further configured to: generate an alert if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold; and
[14B] generate an alert if the distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold.
Claim 15
[15A] 15. The system of claim 13, wherein the vehicle-mounted subsystem is further configured to: cause a braking system of the vehicle to activate if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold; and

[15B] cause the braking system of the vehicle to activate if the distance between the vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold.
Claim 16
[16A] 16. The system of claim 13, wherein the vehicle-mounted subsystem further comprises: a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the at least one RFID tag; and
[16B] wherein the vehicle-mounted subsystem is further configured to determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag.
Claim 17
[17A] The system of claim 16, wherein: the vehicle-mounted subsystem is further configured to substantially continuously receive information relating to speed of the vehicle; and
[17B] the vehicle-mounted subsystem determines a changing distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag and the information relating to speed of the vehicle.
Claim 18
[18A] 18. The system of claim 13, further comprising: an access point external to the vehicle; and
[18B] wherein the vehicle-mounted subsystem is further configured to: store data relating to prior behavior of the vehicle; and
[18C] communicate the data relating to prior behavior of the vehicle with the access point.