

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

Petitioners,

v.

METROM RAIL, LLC
Patent Owner.

Case No. IPR2023-00470
Patent No. 8,812,227

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

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37 C.F.R. § 42.100(b)	8
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APPENDIX LISTING OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 8,812,227 (“’227 patent”)
1002	Prosecution File History of US Patent No. 8,812,227
1003	Declaration of Scott Andrews
1004	Curriculum Vitae of Scott Andrews
1005	European Patent Application No. EP 1 785 744 (“Suzuki”)
1006	U.S. Patent No. 6,759,948 (“Grisham”)
1007	Declaration of Sylvia Hall-Ellis, Ph.D.
1008	An Outdoor UWB Tracking System to Improve Safety of Semi-Autonomous Vehicle Operations (“Richardson”)
1009	[reserved]
1010	Copy of Complaint Metrom Rail, LLC v. Siemens Mobility, Inc., et al., No. 1:22-cv-00049-RGA (D. Del.), filed 01/13/2022
1011	U.S. Patent No. 8,874,359 (“Douglas”)
1012	U.S. Patent Publication No. 2009/0255329 (“Connell”)
1013	U.S. Patent No. 6,133,876 (“Richards”)
1014	U.S. Patent Publication No. 2010/0052945 (“Breed ’945”)
1015	U.S. Patent Publication No. 2007/0255498 (“McDaniel”)
1016	International Application No. WO 03/009254 (“Nixon”)
1017	[reserved]
1018	U.S. Patent Publication No. 2008/0150786 (“Breed ’786”)
1019	U.S. Patent 2,188,293 (“Williams”)
1020	U.S. Patent No. 3,898,652 (“Rashid”)
1021	“Driving Assistance Provided by Adaptive Cruise Control”
1022	SAE J2735/2009-11
1023	U.S. Patent No. 5,036,478 (“MacDougall”)

1024	“Operation of the Eaton VORAD Collision Warning System and Analysis of the Recorded Data”
1025	US Patent Publication 20070293153 (“Molisch”)
1026	IEEE Std 802.15.4™-2011, IEEE Standard for Local and Metropolitan Area Networks: Part 15.4: Low-Rate Wireless Personal Area Networks
1027	Time Domain’s Ultra Wideband (UWB) Definition and Advantages, Time Domain (March 2011)
1028	U.S. Patent Publication No. 2006/0009240
1029	U.S. Patent No. 7,725,252 (“Heddebaut”)
1030	U.S. Patent No. 2,216,575 (“Seinfeld”)
1031	“Transponder History - RADAR Identification of Aircraft”
1032	“Collision of Metrolink Train 111 With Union Pacific Train LOF65-12”
1033	“Collisions & Casualties by Year”
1034	“Fatal Crashes at Highway Rail Grade Crossings”
1035	“Highway-Rail Grade Crossings Overview”
1036	“Railroad Accident: Common Causes, Statistics and Prevention”
1037	U.S. Patent No. 6,631,322 (“Arthur”)
1038	Positive Train Control (May 2012)
1039	“CCS: A Railway Corridor Control System Utilizing UWB Radio Technology”
1040	Docket as of January 13, 2023 for Metrom Rail, LLC v. Siemens Mobility, Inc., et al., No. 1:22-cv-00049-RGA (D. Del.)

MANDATORY NOTICES

A. Real Party-In-Interest – § 42.8(b)(1)

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

B. Related Matters – § 42.8(b)(2)

1. United States Patent & Trademark Office

U.S. Patent No. 8,812,227 (“the ’227 patent”) claims the benefit of the filing date of provisional application Nos. 61/519,201; 61/627,697; and 61/598,750. U.S. Patent Application No. 14/252,987, filed April 15, 2014, now U.S. Patent No. 9,043,131, claims the benefit of the filing date of the ’227 patent. Petitioners are also filing an IPR with respect to the ’131 patent.

2. District Court Matters

The ’227 patent is at issue in the following pending case: *Metrom Rail, LLC v. Siemens Mobility, Inc., et al.*, No. 1:22-cv-00049-RGA (D. Del.).

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

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coordinate and act through the designated lead counsel. With the exception of Petitioner Siemens Mobility, Inc., each individual petitioner's designation of Mr. Galluzzo as lead counsel is not representation of an attorney-client relationship between Mr. Galluzzo (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 – § 42.103

The *inter partes* review fee 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 of claims 1-28 of the '227 patent.

I. INTRODUCTION

The '227 Patent describes a collision-avoidance system for monitoring the location, speed, and separation distance between rail-line vehicles. EX1001, Abstract, 1:57-60. Each rail-line vehicle in the system includes vehicle-mounted modules that include, a transponder sensor module, which uses an ultra-wide band (UWB) radio and “time-of-flight” ranging calculations to determine its distance to a transponder sensor module on another rail-line vehicle. *Id.*, 6:41-11:4; EX1003, ¶¶71-81.

Ground 1A demonstrates that Grisham (EX1006) discloses a collision-avoidance system comprising the same devices and components recited in the '227 patent claims, including rail-vehicle-mounted modules with UWB units and use of a “time of flight technique” to determine a separation distance between rail-line vehicles. Grisham alone renders obvious many of the challenged claims.

Ground 2A demonstrates that POSITAs would have had reason to combine Grisham with Nixon (EX1016) to achieve a collision-avoidance system that utilizes Nixon’s GPS unit in a complementary fashion with the components disclosed in Grisham. Grisham and Nixon render obvious many additional challenged claims directed toward the use of UWB and GPS in a collision-avoidance system.

Grounds 1B-1E and **Grounds 2B-2F** respectively demonstrate that the remaining challenged claims recite conventional features of communications electronics and/or well-known features of train-control and collision-avoidance systems that would have been obvious over Grisham (1B-1D) or Grisham and Nixon (2B-2D) in view of other prior art.

Ground 3A demonstrates that Suzuki (EX1005), which discloses a UWB-based collision-avoidance system for vehicles including cars, alone or in combination with Grisham renders obvious many of the challenged claims, including the independent claims. **Grounds 3B-3F** demonstrate that the remaining challenged claims recite conventional features of communications electronics and/or collision-avoidance systems that would also have been obvious over Suzuki in view of other prior art.

II. CERTIFICATION OF STANDING

The '227 patent is available for IPR, and Petitioners are not barred or estopped from requesting IPR.

III. UNPATENTABILITY GROUNDS

Petitioners request cancellation of claims 1-28 as follows:

Ground	Reference(s)	Claim(s)	Basis
1A	Grisham	1, 11, 14	103
1B	Grisham, Douglas	2-4	103

Ground	Reference(s)	Claim(s)	Basis
1C	Grisham, Richardson	5-6	103
1D	Grisham, Breed '945	12-13	103
1E	Grisham, Connell	15	103
2A	Grisham, Nixon	7-9, 17-19, 21, 24-26	103
2B	Grisham, Nixon, Richardson	20	103
2C	Grisham, Nixon, Douglas	22, 27-28	103
2D	Grisham, Nixon, McDaniel	10	103
2E	Grisham, Nixon, McDaniel, Connell	16	103
2F	Grisham, Nixon, McDaniel, Connell, Breed '945	23	103
3A	Suzuki Alternatively: Suzuki, Grisham	1, 7-8, 11-14, 17-19, 24-25	103
3B	Suzuki, Richardson Alternatively: Suzuki, Grisham, Richardson	2-6, 20, 22, 27-28	103
3C	Suzuki, Nixon Alternatively: Suzuki, Grisham, Nixon	9, 21, 26	103
3D	Suzuki, Connell Alternatively: Suzuki, Grisham, Connell	15	103

Ground	Reference(s)	Claim(s)	Basis
3E	Suzuki, Nixon, McDaniel Alternatively: Suzuki, Grisham, Nixon, McDaniel	10	103
3F	Suzuki, Nixon, McDaniel, Connell Alternatively: Suzuki, Grisham, Nixon, McDaniel, Connell	16, 23	103

Douglas is prior art (at least) under pre-AIA § 102(e) based on its PCT filing date (February 19, 2010). The other above-identified references are prior art (at least) under pre-AIA § 102(b) based on the following publication dates, each of which is more than one year prior to the '227 patent's earliest-alleged priority date (May 19, 2011):²

Reference	Publication
Grisham	2004-07-06
Richardson	2010-02-25
Breed '945	2010-03-04
Connell	2009-10-15
Nixon	2003-01-30

² Should Patent Owner allege that post-AIA provisions apply, the prior art cited here would remain prior art under either post-AIA §§ 102(a)(1) or (a)(2). All references are patent publications except Richardson, which is a printed publication that was publicly available more than one year prior to May 19, 2011. *See* EX1007, ¶¶42-51.

Reference	Publication
McDaniel	2007-11-01
Suzuki	2007-05-16

IV. THE '227 PATENT

The '227 patent describes a collision-avoidance system for monitoring the location, speed, and separation distance between rail-line vehicles. EX1001, Abstract, 1:57-60. The system includes various modules, *id.*, 4:7-6:6, which can be integrated into one unit or separated as a set of discrete units that can be used to construct a more complex structure, and where the individual units need not be included in a single housing. *Id.*, 6:6-12. The system uses sensors including, in some embodiments, Ultra Wideband (UWB) sensing technology and/or GPS. *Id.*, Abstract and 5:53-63. In some embodiments, UWB units transmit and receive pulses communicated between UWB units, and in other embodiments, the UWB units transmit and receive pulses that have been reflected off an object or surface. *Id.*, 13:32-38. The UWB units may be capable of communicating data and ranging between vehicles. *Id.*, 14:18-29.

Sensor information may be used to determine separation distance between vehicles. *Id.*, 1:17-23. If a separation criterion is violated, the system may generate a warning signal. *Id.*, Abstract. The separation distance may be measured by determining how long it takes a pulse to travel between two transceivers, which is referred to as "Time of Flight" (TOF). *Id.*, 13:40-46; EX1003, ¶¶71-81.

A. Challenged Claims

Challenged system claims 1-28 are reproduced in the Appendix of the Challenged Claims. The claims are directed to systems discussed in the specification:

- Independent claim 1 and dependent claims 2-6 and 9-16 recite a collision-avoidance system utilizing an “ultra wideband unit.”
- Dependent claims 7 and 8, independent claim 24, and its dependent claims 25-28 recite a similar system utilizing a GPS unit in addition to either an “ultra wideband unit” (claims 7, 8, 25) or, alternatively and more broadly, a “radio communication unit” (claims 24, 26-28).
- Independent claim 17 and its dependent claims 18-23 recite a “rail vehicle module mountable on a rail vehicle” with similar components to those recited in the other claims discussed above.

Each independent claim recites basic components of such a system or device including a “vehicle mounted module,” a “transponder” module, a “control electronics module,” and a “user interface” capable of interacting with a vehicle operator, and recites basic capabilities including the ability to communicate with

other rail vehicles or to apply a “time of flight technique” to determine “separation distance” from other rail vehicles.

The dependent claims add conventional features of communications electronics and well-known features of train-control and collision-avoidance systems, such as “a central tracking unit,” “a progressive warning signal,” and “an accelerometer or a gyroscope.” These and other conventional features added by other dependent claims were well known in the prior art, and POSITAs had reason to implement them in collision-avoidance systems at the time of the alleged invention. EX1003, ¶¶101-361.

B. Level of Ordinary Skill in the Art

POSITAs would have had a background in wireless electronics, including at least a bachelor’s degree in electrical engineering or a related field, and would have at least two years of experience with using such electronics for control systems applications such as collision-avoidance systems or positioning systems. EX1003, ¶¶23-28.

C. Prosecution History

The ’227 Patent issued from U.S. Patent Application No. 13/474,428 (“the ’428 Application”), which was filed on May 17, 2012. EX1001. It claims priority to Provisional Application No. 61/598,750, which was filed on Feb. 14, 2012;

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Provisional Application No. 61/627,697, which was filed on October 17, 2011; and Provisional Application No. 61/519,201, which was filed on May 19, 2011. *Id.*

Originally filed claims 1-24 of the '428 Application were rejected as being anticipated by U.S. Patent Publication No. 2008/0150786 ("Breed '786") or as obvious over Breed '786 in combination with other references. EX1002, pp.139-46. In response, Applicants canceled those claims and added new claims 25-52. *Id.*, pp.301-08. Applicants argued that Breed '786 (1) "does not relate to rail line vehicles," (2) does not teach "using time of flight techniques," and (3) teaches communicating with stationary transmitters at fixed locations rather than directly between vehicles. *Id.*, pp.309-12. The Examiner thereafter issued a Notice of Allowance. *Id.*, pp.324-31.

V. CLAIM INTERPRETATION

Claim limitations 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 claim limitations, no express constructions are necessary. *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, 11, and 14 Obvious over Grisham

1. Grisham (EX1006)

Grisham teaches a railroad collision-avoidance system and method for preventing train accidents that utilizes direct train-to-train communications using UWB technology (impulse radios) and “time of flight” techniques, published July 6, 2004, and was not cited during prosecution.³ Figures 21 and 22 below depict the impulse radio units on two rail line vehicles in communication with each other and the steps in such communication and alerting the vehicle operator about potentially dangerous situations, respectively.

³ A different Grisham reference was of record.

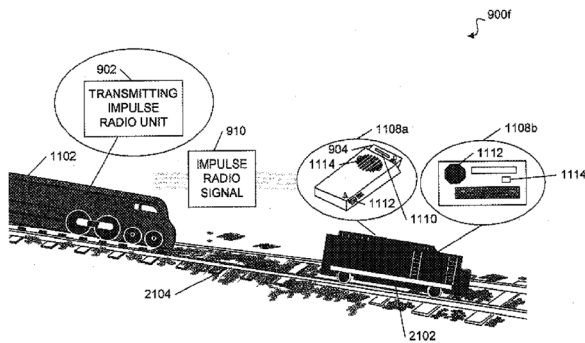


FIG. 21

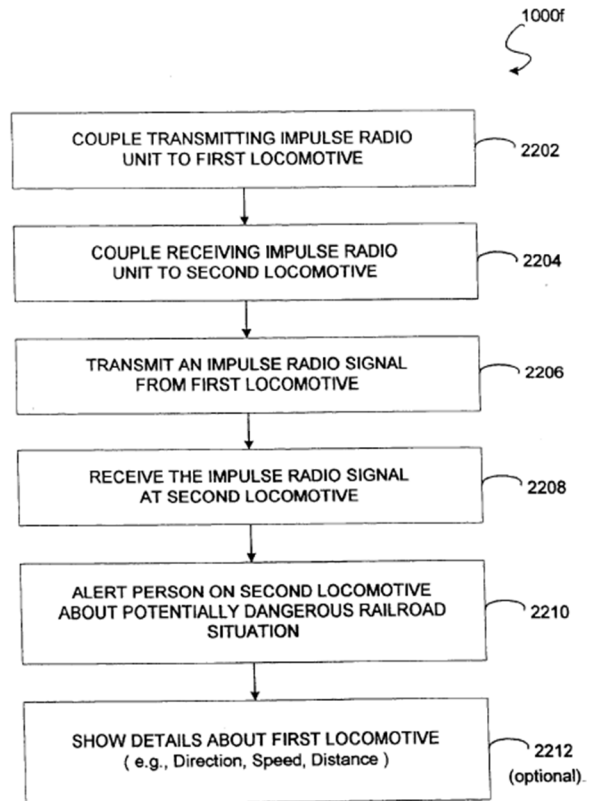


FIG. 22

EX1006, FIGS. 21-22; EX1003, ¶¶84-86.

2. Claim 1

[1-Pre]⁴ – A collision avoidance system comprising:

Whether or not the preamble is limiting, Grisham discloses “a railroad collision avoidance system” for preventing train accidents. EX1006, [title], 2:16-31, 24:46; EX1003, ¶¶103-05.

⁴ See Appendix of the Challenged Claims for full identification of the limitations referred to by shorthand herein.

[1A] – one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising:

Grisham discloses a set of interrelated units each mounted on a rail-vehicle. As shown in Figures 21 and 22 below, Grisham discloses a radio unit 902 that is coupled (*mounted*) at step 2202 to a first locomotive 1102 (*rail vehicle*). EX1006, 23:33-38, FIGS. 21-22. Similarly, Grisham discloses a second radio unit 904 coupled at step 2204 to a second locomotive. *Id.*, 23:39-40, FIGS. 21-22; EX1003, ¶¶106-07. These radio units 902 and 904 are part of the interrelated set of units that are mounted on a rail vehicle. Additional units within the set are discussed below regarding limitations [1B]-[1D]. Together, radio units 902, 904 and the additional units discussed in [1B]-[1D] below comprise a “*vehicle mounted module*,” as claimed. EX1003, ¶¶106-18.

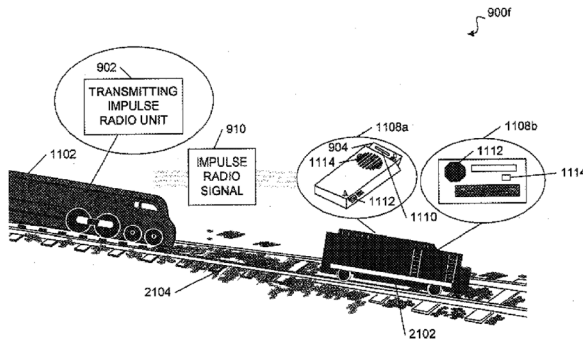


FIG. 21

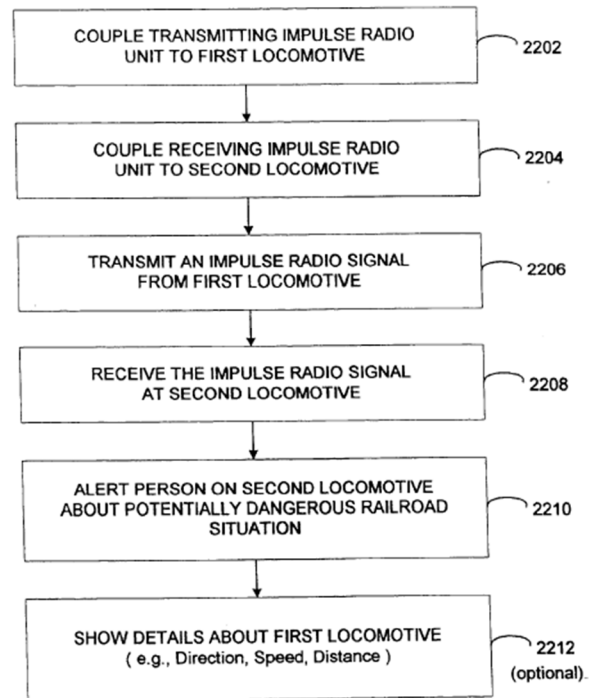


FIG. 22

[1B] – a transponder sensor module operable to send and receive data wirelessly, the transponder module comprising a first ultra wideband unit and a first antenna;

Grisham discloses a transmitting impulse radio unit 902 and a receiving impulse radio unit 904 that send and receive signals (*send and receive data wirelessly*). EX1006, 23:33-47; *id.*, 16:39-49, 16:59-60, Figs. 6-7. Grisham also describes that those transmitter/receiver radio units can be combined into a transceiver impulse radio unit (*transponder sensor module*) on a locomotive that sends and receives data wirelessly, thereby achieving “substantial economy” over separate transmit/receive impulse radios. *Id.*, 17:44-46.

Grisham also notes that its use of “impulse radio” is interchangeable with “ultra-wideband system.” *Id.*, 4:44-53. Indeed, Grisham notes its preference for its “emitted signal [to be] wide-band or ultrawide-band,” *id.*, 16:47-49, and describes using an “ultra-wideband” antenna. *Id.*, 6:12, 6:36-43, 16:39-49, 16:59-60, 17:44-46. Accordingly, POSITAs would understand Grisham’s impulse radio in the transceiver unit and its antenna (*transponder sensor module*) are “*a first ultra wideband unit*” and “*a first antenna*” as claimed. EX1003, ¶111; *id.*, ¶¶108-10.

[1C] – a control electronics module comprising a processor in communication with at least the transponder sensor module unit; and

Grisham describes a controller 1110 (*control electronics module*) “within the receiving impulse unit 904,” which is part of the transponder sensor module discussed in [1B] above. POSITAs would have understood that Grisham’s controller comprises a processor or would have been motivated to include one for processing the data it receives. EX1003, ¶115. The controller 1110 (and its processor) communicates with the transponder sensor module (the receiving impulse unit 904 within the transponder sensor module), e.g., to communicate with other radio units via “the impulse radio signal 910 transmitted between” them. EX1006, 23:64-24:24, FIG 22; EX1003, ¶¶112-14. *See* [1E] below.

[1D] – a user interface module including a user interface, the user interface being operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator; and

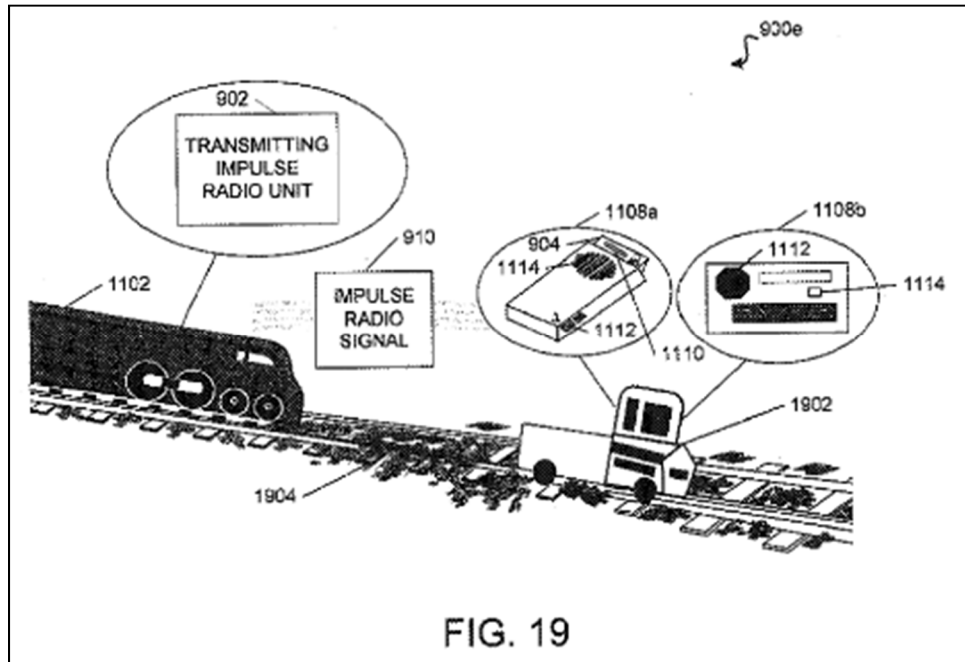
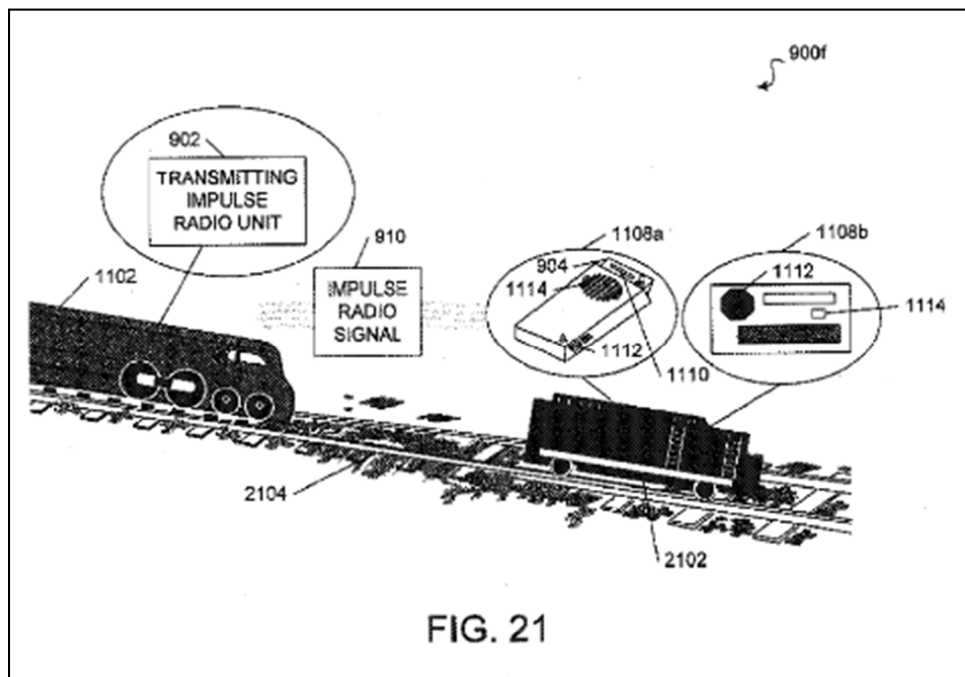
Grisham’s “receiving impulse unit 904 may be incorporated within or coupled to an after-market display 1108a” or an “in-dash-display.” EX1006, 23:52-56, FIG 21. Either type of display (*user interface module*) can display the direction, distance, and speed of an oncoming train (*rail vehicle information*) to a vehicle operator. *Id.*, 23:57-66. The display can also receive communications from the train operator (*input from the vehicle operator*) “to communicate with a person” (e.g., a train operator) on a second train. *Id.*, 23:60-62; EX1003, ¶¶116-17. POSITAs also would have understood that it was conventional for a displays, including “after-market” displays, to receive user input, such as adjustments to the display’s settings. EX1003, ¶118.

[1E] – wherein each vehicle mounted module is operable to communicate with at least one other vehicle mounted module mounted on at least one other rail vehicle, and

In addition to Grisham’s disclosures discussed in [1A] and [1B] above, Grisham’s transmitting impulse radio unit can “continually transmit (step 2206) an impulse radio [*i.e.*, a UWB] signal.” EX1006, 23:40-47. A receiving impulse radio unit 904 on a second train receives that signal. *Id.*, 23:48-49, 24:25-29.

For example, Figures 19 and 21 illustrate UWB communications between a transmitting impulse radio unit 902 coupled to a locomotive on the one hand, and a

receiving impulse radio unit 904 coupled to a rail work vehicle (in Fig. 19) or a second locomotive (in Fig. 21) on the other. EX1006, Figs. 19, 21, 22:45-49, 23:36-40; EX1003, ¶¶119-21.



[1F] – wherein each vehicle mounted module is operable to apply a time of flight technique to determine a separation distance between the rail vehicles.

Grisham’s radio-unit controller uses “time position measurement” to measure “propagation delay and determine the link distance between the receiving impulse radio unit 904 and the locomotive 1102.” EX1006, 24:18-24. Grisham further describes this application of time of flight (TOF) technique by reference to U.S. Patent No. 6,133,876 (“Richards,” EX1013), which Grisham incorporates by reference. *Id.*, 14:56-62. Richards explains TOF is calculated using two sequences of pulses between two transceivers. EX1013, 2:31-44. Richards explains “a time difference between the delayed first reference signal and the first reference signal is measured.” *Id.*, 2:38-42. The difference in the two times is the “total time of flight” of the sequences and the distance between the transceivers is determined from the time difference. *Id.*, 2:42-46; EX1003, ¶¶122-23. POSITAs would have read Grisham (including Richards) to disclose that TOF calculations are performed by the embodiment shown in Figures 21 and 22 of Grisham. EX1003, ¶124; EX1006, 24:18-24.

3. Claim 11 – Ground Speed Detection Module

As described in [1B] and [1C] in Ground 1A, Grisham discloses vehicle-mounted radio units that comprise controllers and ultra wideband units. As described in [1E] in Ground 1A, Grisham discloses that those radio units

communicate with each other. POSITAs would understand these radio units to be a type of *ground speed detection module* because the controller within the radio unit *determines the speed of the rail vehicle* based on the measurements by the ultrawide-band units, particularly when one of the radio units is on a control box or railroad pole (thus having zero velocity itself). EX1006, 18:60-19:4, 23:64-24:24; EX1003, ¶¶125. POSITAs would also understand that such ground speed detection modules communicate with the vehicle mounted modules of Grisham. EX1003, ¶¶125-27.

4. Claim 14 – Varying Center Frequencies

Grisham discloses its radio units use “a desired center frequency” such that “the waveform may be altered significantly in practice for a given application.” EX1006, 4:61-5:12. POSITAs would have understood this teaching of Grisham to mean its radio units were designed to transmit and receive ultrawide-band signals with *varying center frequencies*. EX1003, ¶¶128-31.

B. Ground 1B – Claims 2-4 Obvious over Grisham and Douglas

1. Douglas (EX1011)

Douglas is titled “Collision Avoidance Method, System and Apparatus,” published October 21, 2010, and was not cited during prosecution.

Douglas teaches “equipping a plurality of trains each with a transceiver and broadcasting a signal periodically from the transceiver of each train. The signal contains a unique identification of a respective train and a unique identification of a track the respective train is moving on.” EX1011, Abstract. Douglas also teaches

similarly equipping train stations with transceivers. *Id.*, 4:32-49, 7:10-12; EX1003, ¶¶97-98.

2. Claim 2 – Central Tracking Unit

Douglas teaches an “apparatus 32 located at the station 30,” which “receive[s] information transmitted by the trains” such as “the track the respective train is moving on” and similarly broadcasts the location of trains within a certain range (via a list of links to be traversed by and the direction of motion of each train). EX1011, 3:18-23, 3:31-47, 4:32-49, 7:10-12. These broadcasts go to “the transceiver 34 of the apparatus 20 of each of the trains.” *Id.*, 6:25-31. Because list of links to be traversed by and the direction of motion of each train disclose the path of trains, POSITAs would understand Douglas’s station-based apparatus *tracks the location* of the trains by repeatedly updating the trains’ paths. EX1003, ¶¶132-35.

Both Grisham and Douglas teach train collision-avoidance systems by communicating with trains. *Id.*, ¶136. Accordingly, POSITAs would be motivated to combine Grisham’s train-to-train-communication embodiment with Douglas’s apparatus (*central tracking unit*) at a station *in communication* with nearby trains to take advantage of preexisting railway and train-control infrastructure in a complementary way to Grisham’s train-to-train-communication embodiment. *Id.* Identifying conflicts between the paths of trains can identify potential collisions before the trains enter into the range where Grisham’s train-to-train-communication

is effective. *Id.* In the combination, Douglas's apparatus (*central tracking unit*) broadcasts to Grisham's vehicle mounted modules (*inter alia* radio units, controller). *Id.* POSITAs would also understand that this apparatus at a station is "*central*" at least as to the locomotives passing near its location. *Id.*

3. Claim 3 – Distributed Central Tracking Unit

As described in Claim 2, Douglas describes an embodiment that uses an apparatus at a station (*central tracking unit*) to communicate with transceivers on trains a list of links to be traversed by and the direction of motion of each train. Douglas further describes that, "[a]lternatively, the state table of links 23, 25, 27 each train 12, 14, 16, 18 may be generated at the apparatus 20 each train 12, 14, 16, 18 is equipped with." EX1011, 7:12-19. In this alternative, each train would have a central tracking unit (CTU) component included in a vehicle mounted module. EX1003, ¶¶137-39. CTU components on multiple trains would take advantage of the collision-avoidance electronics already installed on trains (as described in Grisham). *Id.* These components would also function in areas that may be far from preexisting railway and train-control infrastructure. *Id.*

4. Claim 4 – Central Tracking Unit Housing

Douglas discloses its apparatus at a station to be in a *discreet*⁵ housing, as shown in FIGS. 1 and 1b. EX1011, FIGS. 1, 1b, 3:1-30; EX1003, ¶¶140-41. Whether to house the apparatus 32 in a discreet housing is a matter of design choice. EX1003, ¶¶140-41. POSITAs would understand that an apparatus at a station like that in Douglas can be subject to the elements or within view of the passersby, and therefore it would be obvious to POSITAs to select or, at the very least to try, (of the only two possible options—discreet or not discreet) a discreet housing in which to protect the apparatus from the elements and from passersby who may attempt to vandalize the apparatus. *Id.*

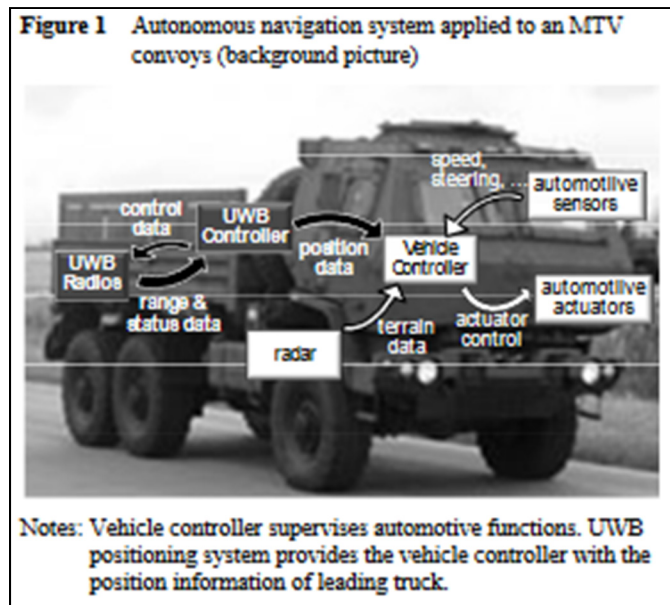
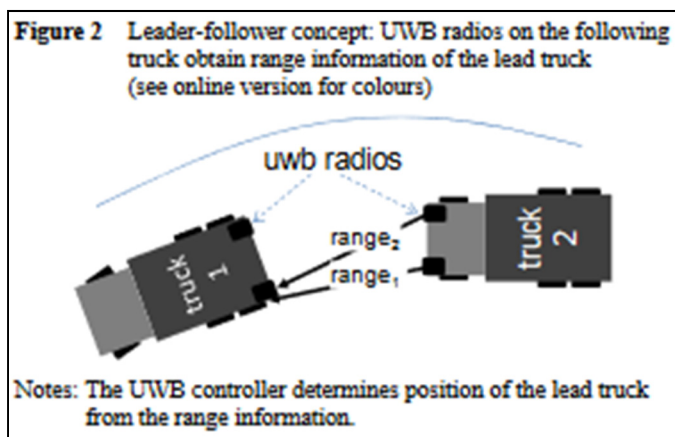
⁵ Even if Patent Owner argues that “discreet” is a typo of “discrete,” even without certificate of correction, this claim is still obvious. POSITAs would have understood that modules in a collision-avoidance system can be integrated into one unit or separated as a set of discrete units, and therefore it would be obvious to a POSITA to select or, at the very least to try, (of the only two possible options—discrete or not discrete) a discrete housing to keep the module in one unit that would be more easily replaced via repair or upgrade. EX1003, ¶141n.5.

C. Ground 1C – Claims 5 and 6 Obvious over Grisham and Richardson

1. Richardson (EX1008)

Richardson, titled “An Outdoor UWB Tracking System to Improve Safety of Semi-Autonomous Vehicle Operations,” was publicly accessible to POSITAs exercising reasonable diligence on February 25, 2010, EX1007, ¶¶42-51, and was not cited during prosecution.

Richardson teaches a UWB positioning system integrated into the control system of semi-autonomous vehicles to improve navigation capability and safety by providing operators with positional information about nearby objects and vehicles. EX1008, Abstract and p.209-210. Figures 1 and 2 illustrate a “leader-follower” application, where multiple UWB units on each vehicle provide positioning information of a lead vehicle to a following vehicle based on multiple points on the lead vehicle:



EX1003, ¶¶87-88.

2. Claim 5

[5a] - Auxiliary Transponder Sensor Module

Richardson teaches each of its vehicles have four UWB transceivers, numbers 1 and 2 offset by a distance r_b , as shown in Figs. 6 and 7. EX1008, Figs. 6 and 7. POSITAs would have understood the benefits of Richardson's provision of *an auxiliary transponder sensor module with an offset* to the transponder sensor

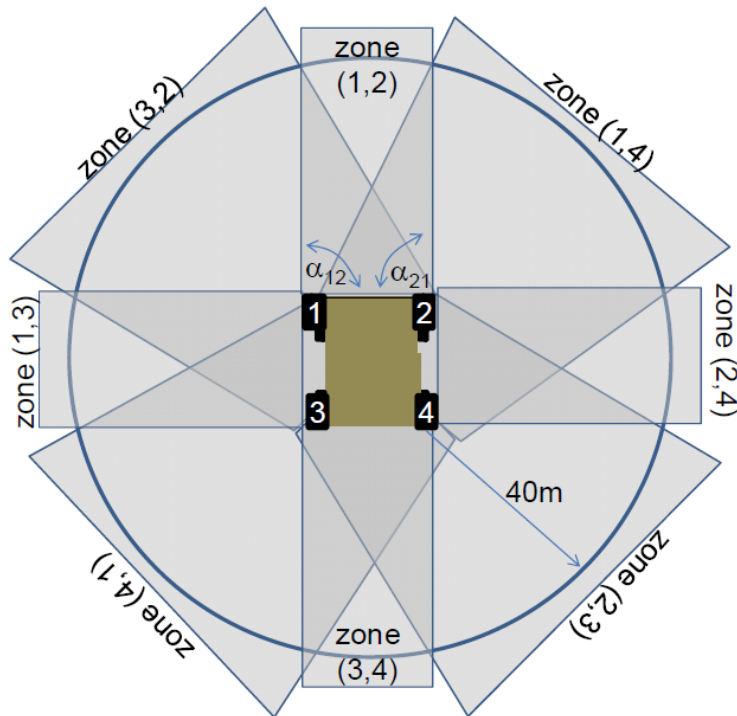
module, including better location measurements and improved collision avoidance due to more precise information relating to length of the vehicle and mounting location of each sensor as is described and depicted in Richardson. EX1003, ¶¶142-45.

While Grisham is capable of providing distance calculations at the location of the impulse radio modules, POSITAs would have understood that the trains contemplated by Grisham can be quite long (*e.g.*, over a mile) and thus that distance calculations at one point on the train would not adequately avoid collisions at other points on the train (such as the end of the train potentially over a mile away). *Id.*, ¶146. Because of this, POSITAs would have been motivated to supplement Grisham's single-UWB-transceiver-based system with other vehicle proximity detection systems, including Richardson's use of multiple UWB transceivers, that can account for the length of a train, particularly to prevent collisions at both the front and rear of the trains. *Id.* POSITAs also would have understood the benefits of providing Richardson's auxiliary transponder sensor module with an offset to impulse radio modules discussed above, including better location measurements and improved collision avoidance due to more precise information relating to length of the vehicle and mounting location of each sensor. *Id.*

[5b] – User Interface for Calibration

Richardson further teaches using the vehicle length (1 to 3 and 2 to 4 in Fig. 6 below) and the mounting location of the transceivers to define eight zones to calibrate ranging from vehicle to vehicle. *E.g.*, EX1008, Fig. 6; EX1003, ¶147.

Figure 6 Eight zone definitions defined by coordinate radio pairs
(see online version for colours)



Notes: Ambiguous positions resulting from bilateration
will never be in the same zone.

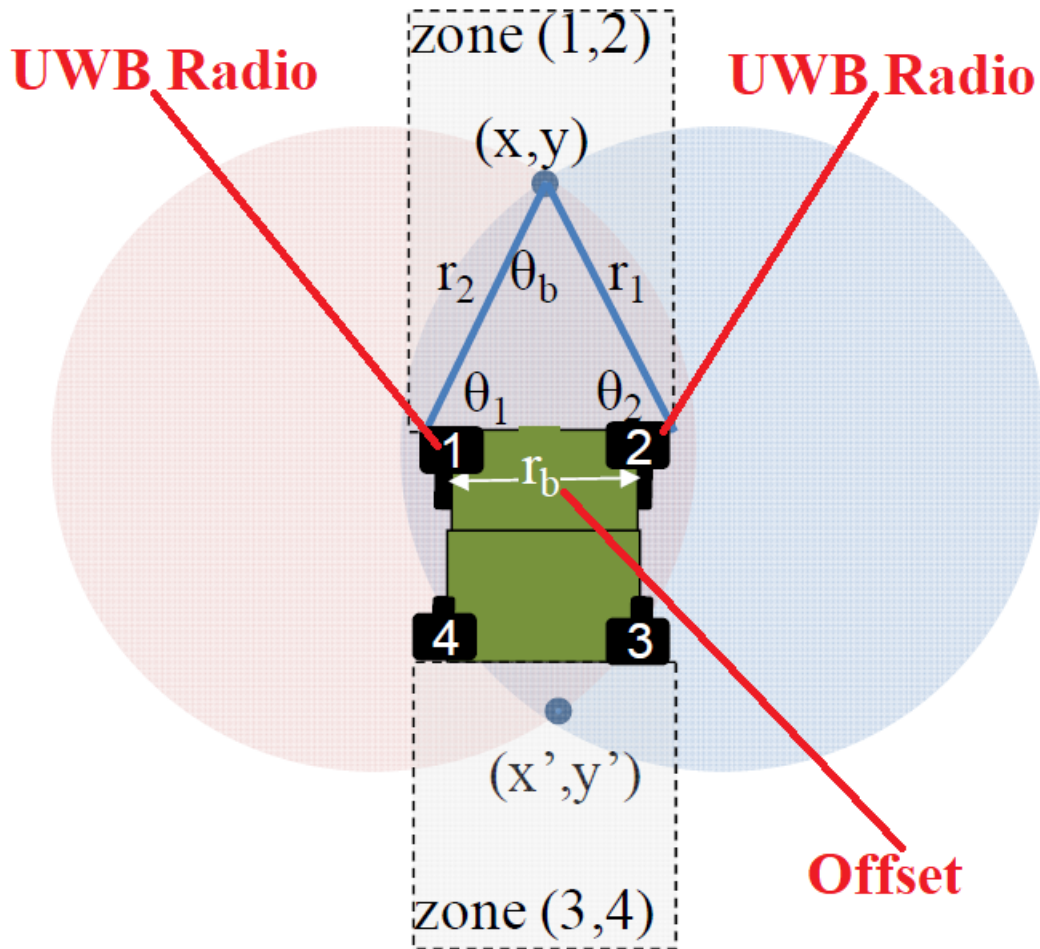
It would have been obvious to POSITAs to add this information to the user interface of Grisham (when combined with Richardson as discussed above), which already provides the vehicle operator with other information pertinent to collision avoidance, such as information about other trains in proximity. EX1003, ¶147. For example, a train operator would be able to verify the calibration information related

to the length of the train against the actual length, which may change as the train drops off cars at their destinations. *Id.* Also, POSITAs would have been motivated to combine the teachings of Grisham and Richardson for the reasons discussed in [5A] above. *Id.*

3. Claim 6 – Auxiliary Antenna

Claim 6 recites substantially the same limitations as Claim 5, which are satisfied by the combination of Grisham and Richardson for the same reasons provided for claim 5 in Ground 1C. Claim 6 further specifies that the auxiliary module includes an antenna that connects to a UWB unit.

Richardson teaches UWB radios with antennas connected to other UWB radios on the vehicle. EX1008, p.211, Section 2.1, p.214, Section 3 (“The height of the transmit antennae, *htx*, and receive antenna, *hrx*, were both set to 1 m. Truth points were established using a high precision laser”). Richardson also teaches mounting the auxiliary antenna at an offset (r_b) from the other unit, as illustrated in Figure 7. EX1008, Fig. 7, p.213 (annotated).



Notes: Ambiguous position at (x', y') is eliminated by assigning targets into zones based on last measurement.

POSITAs would have been motivated to combine Grisham with Richardson for the same reasons provided for claim 5 in Ground 1C. EX1003, ¶¶148-52.

D. Ground 1D – Claims 12 and 13 Obvious over Grisham and Breed '945

1. Breed '945 (EX1014)

Breed '945 is titled “Vehicular Communication Arrangement and Method,” published March 4, 2010, and was not cited during prosecution.⁶

Breed '945 is directed to a vehicle-to-vehicle communication system to avoid collisions, including among trains. EX1014, [0011], [0088], [0109]. Breed '945 teaches the use of an “[i]nertial measurement unit (IMU), inertial navigation system (INS) [or] inertial reference unit (IRU).” *Id.*, [0093], [0205]. The information collected from the IMU can be used to “substantially improve the crash sensing algorithms.” *Id.*, [0206]. Breed '945 explains the IMUs “contain 3 accelerometers and 3 gyroscopes.” *Id.*, [0093]; EX1003, ¶¶89-90.

2. Claim 12 – Inertial Measurement Unit

Breed '945 teaches the use of an inertial measurement unit containing accelerometers as part of a vehicle system. EX1014, [0093], [0205]. Breed '945 teaches that the accelerometers can measure “vehicle acceleration in the latitude, longitude and vertical directions.” *Id.*, [0567]. These changes in speed are sent to a processor. *Id.*, [0225]; EX1003, ¶¶153-56.

⁶ A different Breed reference (Breed '786) was of record. Breed '945 is from a different patent family than Breed '786.

POSITAs looking at Grisham would have been motivated to look at speed and acceleration detection systems, such as that of Breed '945, to supplement Grisham's UWB-based system to ensure position data and calculations regarding the potential for collision are as exact as possible. EX1003, ¶¶157-58. For example, POSITAs would have understood that tracking changes in speed or acceleration is important for knowing a train's location and avoiding collisions. *Id.* Also, Breed '945's acceleration data would "substantially improve the crash sensing algorithms" that Grisham uses to determine whether to trigger an alarm. *Id.*

POSITAs would have been motivated to modify Grisham in view of Breed '945 to couple Breed '945's inertial measurement unit, with its accelerometers and gyroscopes that provide accurate speed and acceleration data beyond the working range of UWB and to provide heading information useful to train-safety systems, to Grisham's locomotive 1102 to communicate speed changes of locomotive 1102 to the controller within its control electronics module. *Id.*, ¶159. The main purpose of Grisham is to prevent the collision of rail vehicles travelling at potentially high speeds. EX1006, [title], 2:16-31, 24:46. POSITAs would have known or understood that accelerometers and gyroscopes are accurate and readily available devices that can assist in this task. EX1003, ¶159. Breed '945 is additionally directed to a vehicle-to-vehicle communication system to avoid collisions. *Id.* Also, given the

catastrophic consequences of collisions between rail vehicles, POSITAs would have been motivated to include redundant systems to guard against system failures. *Id.*

3. Claim 13 – Accelerometer or Gyroscope

Breed '945 teaches inertial measurement units via a “device having a plurality of accelerometers and a plurality of gyroscopes generally within the same package.” EX1014, [0093]; EX1003, ¶¶160-61.

E. Ground 1E – Claim 15 Obvious over Grisham and Connell

1. Connell

Connell is titled “Method and System for Determining Brake Shoe Effectiveness,” published October 15, 2009, and was not cited during prosecution.

Connell teaches a control system that dynamically determines the effectiveness of a train’s brake shoes during travel based on braking data (braking arrangement, brake application level, etc.) and train data (train speed, track profile, etc.). EX1012, [0025]-[0026]. Connell also teaches, “[o]nce the selected or desired brake shoe effectiveness data 22 is determined, a variety of control and operational parameters of the train TR can be determined or set.” *Id.*, [0028]; EX1003, ¶¶95-96.

2. Claim 15 – Stopping Distance Calibration

Connell explains that “the distance required for the train TR to completely stop” is calibrated by dynamically determining brake shoe effectiveness as the train travels. EX1012, [0025]-[0026]. POSITAs would have understood this to mean the

distance between a first location when the brakes are engaged and a second location when the vehicle comes to a complete stop. EX1003, ¶¶162-65.

Grisham's systems are intended to avoid collisions of any rail vehicle, regardless of speed or track conditions. *Id.*, ¶¶166-68. POSITAs would have understood that a collision-avoidance system would need a way of alerting an operator only to potential collision situations, not merely situations where a train is nearby. *Id.* Situations where a collision may occur can vary, and the distance between trains may not, on its own, be the best indication of collision risk given the difference in stopping distances between braking in ideal conditions compared to braking in the rain or in other conditions that increase stopping distance or decrease stopping ability. *Id.* POSITAs thus would have been motivated to incorporate Connell's stopping distance calibration feature for vehicle collision avoidance into Grisham's collision-avoidance system in order to avoid collisions when rail vehicles are approaching at different speeds or braking conditions. *Id.* Because Grisham's *first vehicle mounted module* already detects potential collisions, improving Grisham's detection via calibration of stopping distance for a train would have been a routine design change by POSITAs. *Id.*

F. Ground 2A – Claims 7-9, 17-19, 21, and 24-26 Obvious over Grisham and Nixon

1. Nixon (EX1016)

Nixon is titled “Method and Apparatus for Avoiding Collisions,” published January 30, 2003, and was not cited or considered during prosecution.

Nixon teaches using GPS as a way of determining the absolute position of moving vehicles, such as trains. EX1016, 6-7. Nixon discloses mounting collision-avoidance equipment to a vehicle, such as a train. *Id.*, 6. Nixon also discloses an alarm system that produces an alert signal based on the proximity of the trains to each other. *Id.*, 5-6. For example, if the control processor “determines that the target is closer, beeping is faster.” *Id.*; EX1003, ¶¶93-94.

2. Claim 7 – GPS System

Nixon teaches using a GPS receiver as part of its collision avoidance equipment. *Id.*, 6. The GPS receiver “receives GPS signals” and determines the position of the receiver based on the signals. *Id.*, 6. GPS is based on signals received from one or more satellites. EX1003, ¶171. Nixon explains that once the GPS receiver has determined the location, it communicates the position to collision avoidance equipment. EX1016, 7. Nixon further teaches that the vehicle equipment, like trains, can be equipped with a GPS receiver to determine the absolute location of the vehicle. *Id.*, 6-7; EX1003, ¶¶169-72.

POSITAs would have been motivated to supplement the range of Grisham's UWB-based collision-avoidance system including by looking to complementary technologies, such as the GPS units of Nixon. EX1003, ¶173-76. POSITAs would have known that UWB has outstanding accuracy but is relatively range-limited due to low transmission power. *Id.* POSITAs would have further understood that trains can be over a mile long and take over a mile of distance to come to a complete stop, meaning that positioning within the distance limitations of UWB lessens the usefulness of UWB in some potential collision situations necessitating stopping a train that is very long or going very fast. *Id.*

POSITAs also would have been motivated to supplement the data regarding relative distance between trains that Grisham's UWB-based system relays with additional data that UWB may not always be able to provide, such as heading, acceleration, or other important characteristics to know in a collision-avoidance system. *Id.* POSITAs would have further understood that details such as heading, speed, or acceleration are especially helpful in train-safety systems because a train that is at a heading different from the track on which it is running likely means that the train has derailed. *Id.*

One of the most common positioning systems by the earliest-alleged priority date was GPS, and POSITAs would have known that GPS systems pair well with UWB systems because of their complementary feature sets. *Id.* For example, GPS

can make up for the shortfalls of UWB discussed above by allowing positioning at larger distances between trains and by providing heading and other information useful to train-safety systems. *Id.* One such GPS system that is used for a railway collision-avoidance system is described in Nixon. EX1016, 6-7. Grisham describes a UWB system, which is effective for small distances, and Nixon describes a system that is effective at larger distances. EX1003, ¶¶173-76. Given the catastrophic consequences of collisions between rail vehicles, POSITAs would have been motivated to include redundant positioning systems to guard against system failures. *Id.*

Also, POSITAs would have also understood that trains often operate in rail yards, where the trains operate safely in close proximity to one another on different tracks. *Id.* Using only UWB radar to determine collision potential could result in false alerts. *Id.* POSITAs would have thus understood that using GPS location data to track the paths of the trains would assure a more robust and error free collision warning system. *Id.* Both UWB and GPS provide positioning data, so it would have been readily apparent to POSITAs how to implement GPS into the radio units from Grisham. *Id.* Accordingly, POSITAs would have been motivated to implement a GPS receiver (*GPS unit*) into Grisham's *first vehicle mounted module*. *Id.* POSITAs would have been motivated to communicate position data from a GPS receiver (*GPS unit*) to Grisham's controller within its *control electronics module*, so the collision-

avoidance system could account for the train's position, so that operators could see the train's position on the user interface, and so that the collision-avoidance system could communicate its train's position to other trains. *Id.*

3. Claim 8 – GPS + UWB and Warning Signal

Grisham teaches the use of an alarm to alert the operator. EX1006, 23:57-60, FIG. 21. Grisham's user-interface display can be 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" (vehicle separation criteria) according to UWB data received by the radio unit. *Id.*, 23:57-58; EX1003, ¶¶177-78.

Nixon also teaches an alarm system that produces an alert signal based on the proximity of the trains to each other based on GPS data received by the GPS receiver. EX1016, 5-6. Nixon describes an alert transceiver with a control processor that estimates range and speed of oncoming trains from signals received from alert transceivers of the oncoming trains. *Id.*, 5. The control processor then outputs alert signals and an alarm produces a sound or light based on the alert signals. *Id.*; EX1003, ¶179.

POSITAs would have been motivated to implement the combined UWB/GPS collision-avoidance system discussed in Claim 7 to include an alerting system based

on information from the UWB and GPS units that are passed to the vehicle-mounted module to determine whether vehicle separation criteria are violated. EX1003, ¶180.

4. Claim 9 – Progressive Warning Signal

Nixon discloses an alarm system that produces an alert signal whose sound or light is variable with range. EX1016, 5. Nixon teaches if the control processor “determines that the target is closer, beeping is faster.” *Id.* Nixon explains that approaching speed is “estimated by tracking the change in distance.” *Id.*, 5-6. Regardless of whether the distance monitor is turned on, “a rapidly approaching vehicle within a certain range will always cause a panic alarm.” *Id.*, 6; EX1003, ¶¶181-83.

POSITAs would have been motivated to make Grisham’s collision alarm systems more effective by distinguishing the alarm for collisions from other alarms, when the alarm is triggered, and what causes the alarm to change frequency, such as is taught by Nixon. EX1003, ¶184. POSITAs would have been motivated to modify Grisham to ensure a train operator can determine the proximity of an oncoming train and the urgency of when the operator needed to change the speed of the train, as specifically taught in Nixon. *Id.* Because Grisham already captures speed and distance information from other rail vehicles to trigger an alarm, a progressive alarm would simply and routinely be implemented into its system. *Id.*

5. Claim 17

The limitations of [17-Pre], [17A], and [17B] track to [1-Pre], [1A], [1B], and [1F], including because the recited “radio communication unit” in claim 17 includes the “ultra wideband unit” recited in claim 1, and are satisfied by Grisham for the same reasons provided for claim 1 in Ground 1A. EX1003, ¶¶185-88.

[17C] – a wireless communications antenna operable to send and receive data over the air; and

The radio units of Grisham continuously transmit and receive impulse radio signals wirelessly. EX1006, FIG. 22, 23:42-47. The signals provide data such as direction, speed, and distance of each rail vehicle (showing the separation distance between trains). *Id.*, FIG. 22. As shown in FIGS. 6 and 7, Grisham details each component of impulse radios, which includes a “transmit antenna 624” and a “receive antenna 704.” *Id.*, 16:39-41, 59-60. Likewise, in the transceiver embodiment discussed in relation to claim 1 which achieves “substantial economy” by combining the transmitter and receiver, a single antenna 704 is used to *send and receive data over the air*. *Id.*, 17:44-48; EX1003, ¶189.

[17D] – a global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail vehicle;

The limitations of [17D] track to Claim 7 and are satisfied by Grisham and Nixon for the same reasons provided for claim 7 in Ground 2A. EX1003, ¶¶190-91.

[17E] through [17G]

The limitations of [17E]-[17G] track to [1C]-[1F] and are satisfied by Grisham for the same reasons provided for [1C]-[1F] in Ground 1A. EX1003, ¶¶192-94.

6. Claim 18 – UWB

The limitations of Claim 18 track to [1B] and are satisfied by Grisham for the same reasons provided for [1B] in Ground 1A. EX1003, ¶195.

7. Claim 19 – Varying Center Frequencies

The limitations of Claim 19 track to Claim 14 and are satisfied by Grisham for the same reasons provided for claim 14 in Ground 1A. EX1003, ¶196.

8. Claim 21 – UWB + GPS and Progressive Warning Signal

The limitations of Claim 21 track to Claims 8-9 and are satisfied by Grisham and Nixon for the same reasons provided for claims 8-9 in Ground 2A. EX1003, ¶¶197-98.

9. Claim 24

The limitations of [24-Pre] through [24C] track to [1-Pre], [1A], [1B], and [1F], including because the recited “radio communication unit” in claim 24 includes the “ultra wideband unit” recited in claim 1, and are satisfied by Grisham for the same reasons provided for [1-Pre], [1A], [1B], and [1F] in Ground 1A. EX1003, ¶¶199-202.

[24D] – a global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail line vehicle;

The limitations of [24D] track to Claim 7 and are satisfied by Grisham and Nixon for the same reasons provided for claim 7 in Ground 2A. EX1003, ¶203.

[24E] through [24G]

The limitations of [24E]-[24G] track to [1C]-[1F] and are satisfied by Grisham for the same reasons provided for [1C]-[1F] in Ground 1A. EX1003, ¶¶204-06.

[24H] – wherein each rail vehicle module is operable to use information provided by the radio communication unit and the global positioning system unit to determine whether one or more vehicle separation criteria are violated, and to generate a warning signal if one or more vehicle separation criteria are violated.

The limitations of [24H] track to Claim 8 and are satisfied by Grisham and Nixon for the same reasons provided for claim 8 in Ground 2A. EX1003, ¶207.

10. Claim 25 – UWB

The limitations of Claim 25 track to [1B] and are satisfied by Grisham for the same reasons provided for [1B] in Ground 1A. EX1003, ¶208.

11. Claim 26 – Progressive Warning Signal

The limitations of Claim 26 track to Claim 9 and are satisfied by Grisham and Nixon for the same reasons provided for claim 9 in Ground 2A. EX1003, ¶209.

G. Ground 2B – Claim 20 Obvious over Grisham, Nixon, and Richardson⁷

Claim 20 contains limitations that track the limitations of claims 5 and 6, and its limitations are satisfied for the same reasons as explained above for claims 5-6 in Ground 1C.

As discussed in for claims 7 and 9 in Ground 2A above, POSITAs would have been motivated to supplement the distance-measurement range of Grisham’s UWB-based collision-avoidance system with features of collision-avoidance systems having longer ranges, such as Nixon’s GPS, and POSITAs would have been motivated to modify Grisham’s alarm to ensure a train operator can determine the proximity of an oncoming train and the urgency of when the operator needed to change the speed of the train, via Nixon’s progressive alarm.

Also, as discussed for claim 5 in Ground 1C above, POSITAs would have been motivated to supplement Grisham and Nixon with Richardson’s auxiliary transponder sensor module with an offset for better location measurements and improved collision avoidance due to more precise information relating to length of the vehicle and mounting location of each sensor. And POSITAs would understand

⁷ For purposes of this analysis, Petitioners treat the “first antenna” and “first wireless communications antenna” recited in claim 20 to be the same as the “wireless communications antenna” recited in claim 17.

that the antenna identified as the auxiliary antenna in claim 6 is the *second wireless communications antenna*. EX1003, ¶¶210-12.

H. Ground 2C – Claims 22, 27, and 28 Obvious over Grisham, Nixon, and Douglas

1. Claim 22 – Central Tracking Unit

The limitations of Claim 22 track to Claims 2 and 3 and are satisfied by Grisham and Douglas for the same reasons provided for claims 2-3 in Ground 1B. Additionally, as described in relation to claim 3, the trains communicate their position to each other through their CTU components. EX1011, 7:12-19. Moreover, POSITAs would have been motivated to have the plurality of CTU components on the trains of Douglas to communicate to each other in order to give critical up-to-date information to operators. EX1003, ¶¶213-15.

2. Claim 27 – Central Tracking Unit

The limitations of Claim 27 track to Claim 2 and are satisfied by Grisham and Douglas for the same reasons provided for claim 2 in Ground 1B. EX1003, ¶216.

3. Claim 28 – Distributed Central Tracking Unit

The limitations of Claim 28 track to Claim 3 and are satisfied by Grisham and Douglas for the same reasons provided for claim 3 in Ground 1B.

POSITAs would understand that the provision of CTU components distributed across trains would take advantage of the collision-avoidance electronics already installed on those trains (as described in Grisham). EX1003, ¶217. These

components would also function in areas that may be far from preexisting railway and train-control infrastructure, where, for example, the CTU is solely located at a station. *Id.*

I. Ground 2D – Claim 10 Obvious over Grisham, Nixon, and McDaniel

1. McDaniel (EX1015)

McDaniel is titled “Systems and Method for Determining Threshold Warning Distances for Collision Avoidance,” published November 1, 2007, and was not cited during prosecution.

McDaniel teaches an adaptive threshold warning distance, which is the “minimum distance that may be required by the host machine 110 to avoid a collision.” EX1015, [0039]; EX1003, ¶¶91-92.

2. Claim 10 – Adaptive Threshold Feature

McDaniel teaches a threshold warning distance feature (*adaptive threshold feature*). *Id.*, [0039]. The threshold distance is the “minimum distance that may be required by host machine 110 to avoid a collision.” *Id.* A controller determines (*adapts*) the threshold warning distance “based on the respective velocities of host machine 110 [the first train] and target object 130 [the second train].” *Id.*, [0038]-[0039]; EX1003, ¶¶218-19.

As discussed for claims 7 and 9 in Ground 2A above, POSITAs would have been motivated to supplement the range of Grisham’s UWB-based collision-

avoidance system with features of collision-avoidance systems with longer ranges, such as Nixon's GPS, and POSITAs would have been motivated to modify Grisham's alarm to ensure a train operator can determine the proximity of an oncoming train and the urgency of when the operator needed to change the speed of the train, via Nixon's progressive alarm.

Grisham's systems are intended to avoid collisions of any rail vehicle, regardless of speed. EX1003, ¶220. POSITAs would have understood that a collision-avoidance system would need a way of alerting an operator only to potential collision situations, not merely situations where a train is nearby, given the number of trains that can safely be positioned within feet of each other in, for example, a train yard. *Id.* POSITAs thus would have been motivated to incorporate McDaniel's adaptive threshold warning system for vehicle collision avoidance into the collision-avoidance system in order to accurately and effectively avoid collisions when rail vehicles are approaching at different speeds and to avoid nuisance alerts to the operator of the safe approach or close proximity of other trains. *Id.*

Because Grisham already collects speed and distance data, modifying Grisham to implement an adaptive threshold feature would have been a routine and simple change by POSITAs. *Id.* Accordingly, POSITAs would have been motivated to implement McDaniel's adaptive threshold feature into Grisham's *first vehicle mounted module*. *Id.*

J. Ground 2E – Claim 16 Obvious over Grisham, Nixon, McDaniel, and Connell

Claim 16 contains limitations that track the limitations of claims 9 and 10, and its limitations are satisfied for the same reasons as explained above for claim 9 in Ground 2A and claim 10 in Ground 2D.

Also, as discussed for claim 15 in Ground 1E and claim 10 in Ground 2D above, POSITAs would have been motivated to incorporate McDaniel's adaptive threshold warning system and Connell's stopping distance calibration feature for vehicle collision avoidance into Grisham and Nixon's collision-avoidance system in order to accurately and effectively avoid collisions when rail vehicles are approaching at different speeds or braking conditions and to avoid nuisance alerts to the operator of the safe approach or close proximity of other trains. EX1003, ¶¶221-22.

K. Ground 2F – Claim 23 Obvious over Grisham, Nixon, McDaniel, Connell, and Breed '945

The limitations of Claim 23 track to Claim 12 and are satisfied by Breed '945 for the same reasons provided for claim 12 in Ground 1D.

As discussed for claim 16 in Ground 2E above, POSITAs would have been motivated to combine Grisham, Nixon, McDaniel, and Connell. Also, as discussed for claim 12 in Ground 1D, POSITA would have been further motivated to incorporate Breed '945's inertial measurement units with accelerometers and

gyroscopes to provide accurate speed and acceleration data beyond the working range of UWB and to provide heading information useful to train-safety systems. EX1003, ¶¶223-24.

L. Ground 3A: Claims 1, 7-8, 11-14, 17-19, 24, and 25 Obvious over Suzuki Alone or in Combination with Grisham

1. Suzuki (EX1005)

Suzuki, titled “In-Vehicle Radar Device and Communication Device,” published May 16, 2007, and was not cited or considered during prosecution.

Suzuki describes a method for preventing collisions between vehicles that uses UWB devices having both communication and radar/ranging functions. EX1005, (57). The UWB-radar function is used to measure the distance between two vehicles. *Id.* Based on the result, a hazard warning may be issued to the vehicle driver or a pre-crash operation may be carried out. *Id.* Each vehicle also measures its own position using GPS and transmits such location information to the other vehicle; the separation distance between the vehicles may be measured based on this location information and a hazard warning issued or a pre-crash operation carried out. EX1005, [0057], [0013], Fig. 7. The operating frequency and transmission power of the radar are changed based on the vehicle’s own location information, thereby reducing interference from other wireless systems. EX1005, (57). Figures 1A and 1B of Suzuki illustrate an exemplary embodiment of the system and certain of its components:

FIG.1A

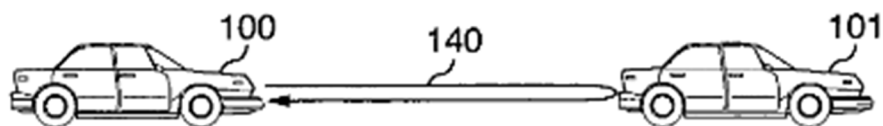
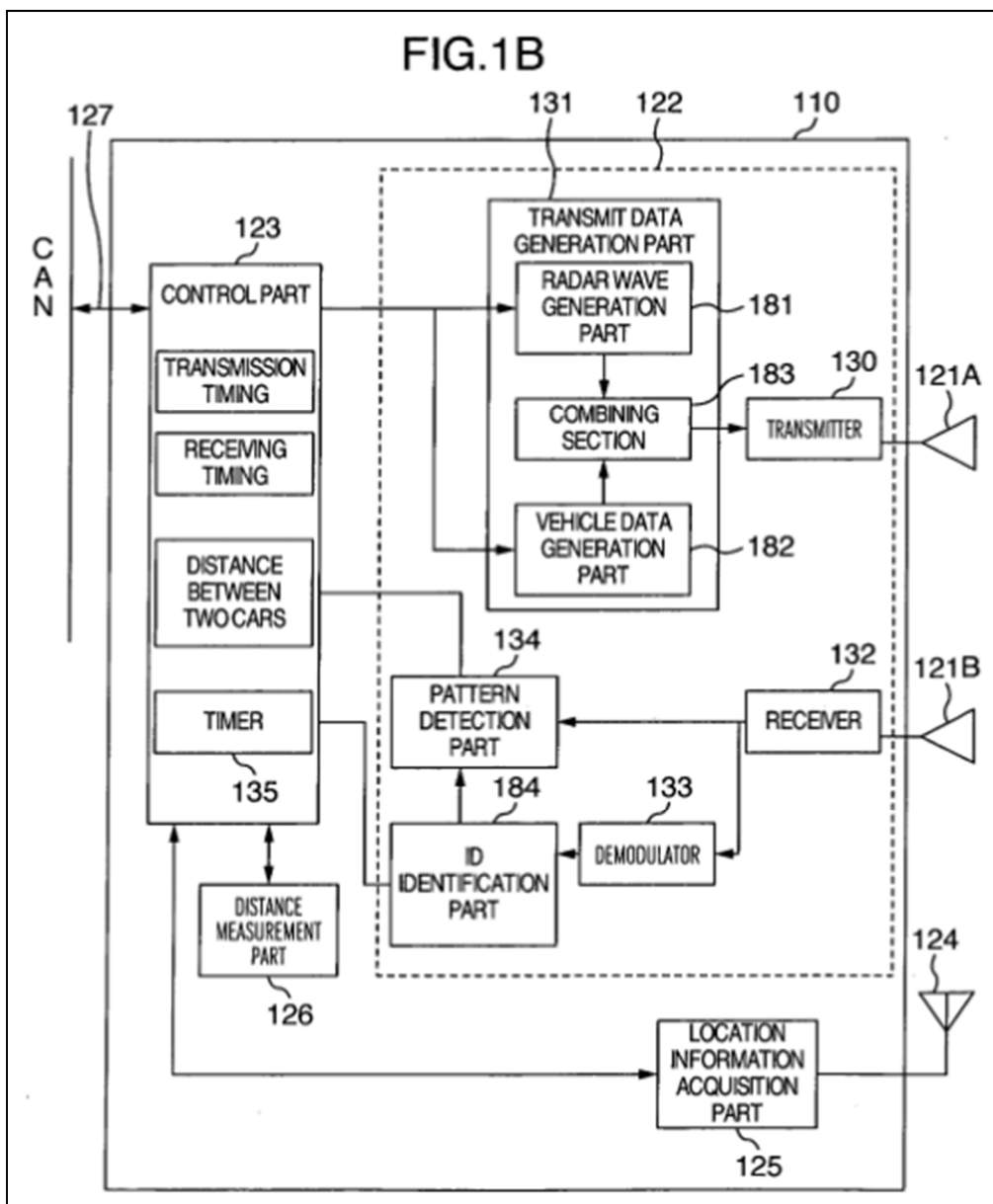


FIG.1B



EX1003, ¶¶82-83.

2. Claim 1

Suzuki alone or (alternatively) in combination with Grisham renders obvious Claim 1. EX1003, ¶¶225-26. As discussed below, Suzuki alone teaches or suggests all the limitations of the claims under this ground, with the possible argument that Suzuki's preferred embodiment uses motor vehicles ("cars") rather than rail-line vehicles. Yet POSITAs would have understood Suzuki's teachings to be applicable more broadly to all ground vehicles, including rail-line vehicles, because Suzuki generally refers to "vehicles" throughout its disclosure, only sometimes further specifying that those vehicles are "cars." *Id.*, ¶¶233-35. Indeed, POSITAs would understand that some rail vehicles, like dual-mode work vehicles (also known as DMVs, road-rail vehicles, or hi-rail trucks) like railroad work vehicles, are essentially motor vehicles or cars with the ability to operate on tracks and road. *Id.* Nevertheless, should the Board find that Suzuki's teachings are not broad enough, on their own, to teach POSITAs to use its collision-avoidance systems on rail vehicles, then using Suzuki's collision-avoidance system on rail vehicles would have been obvious to POSITAs in view of Grisham, as discussed herein. *Id.*, ¶¶236-42.

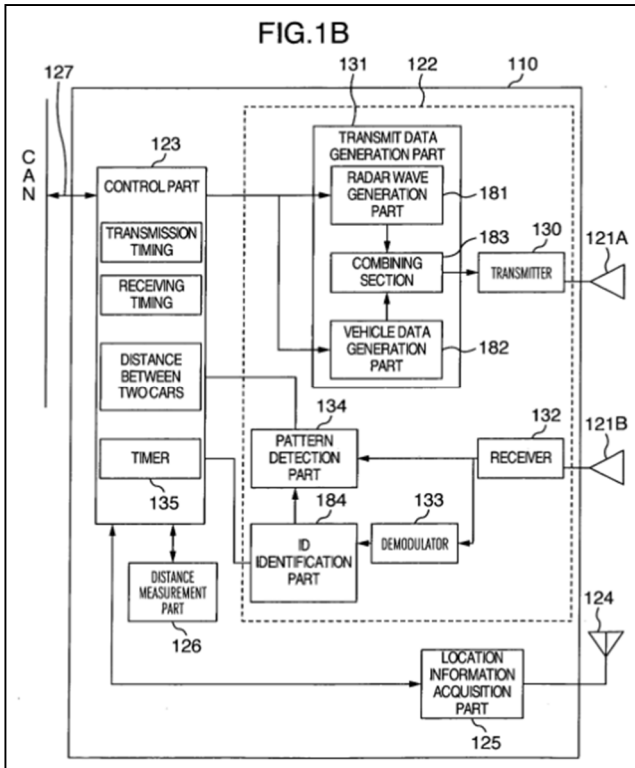
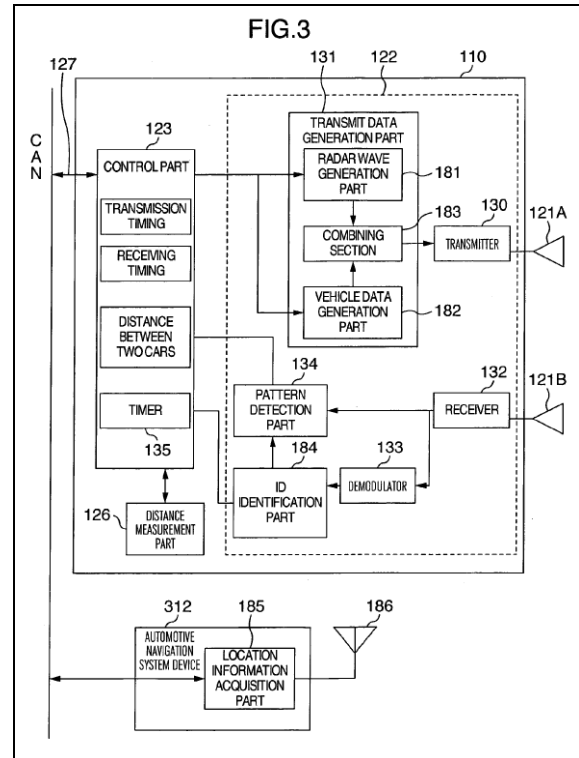
[1-Pre]⁸ – A collision avoidance system comprising:

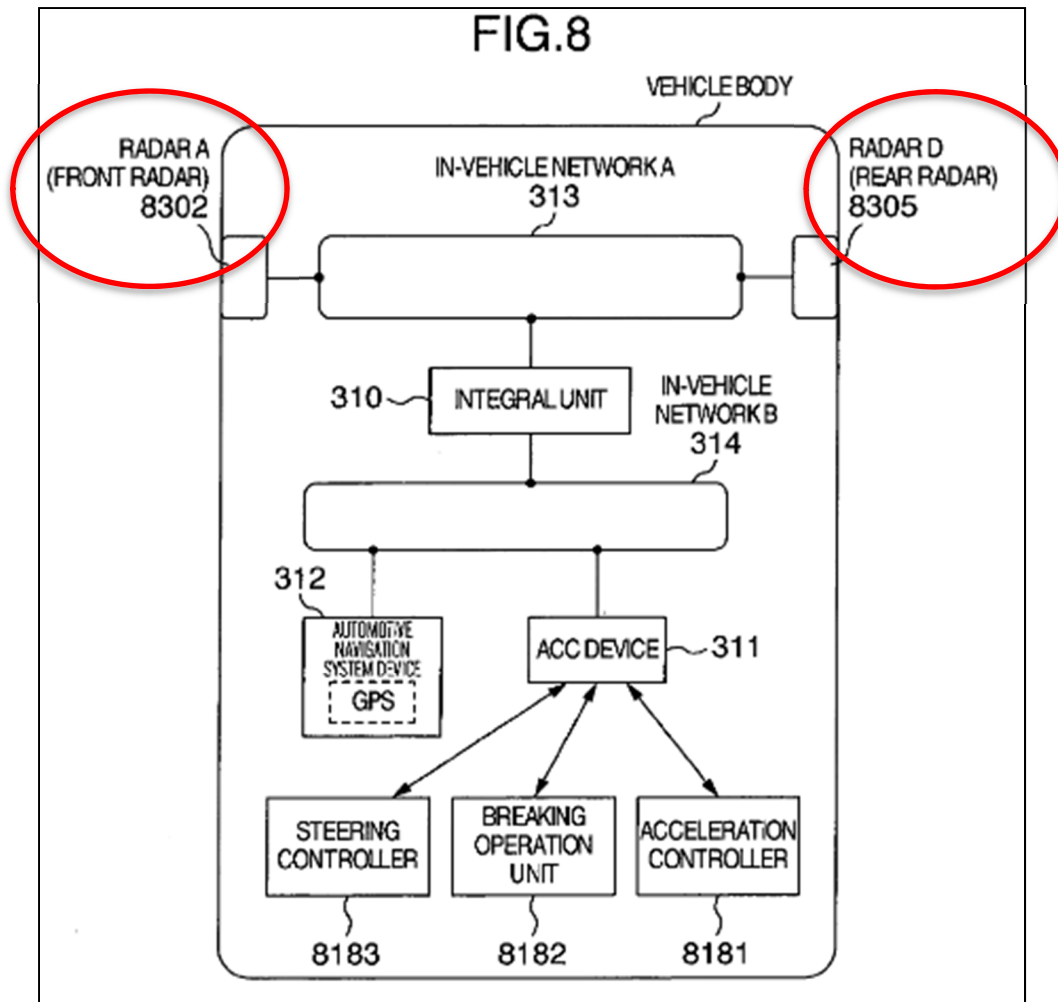
Whether or not the preamble is limiting, Suzuki teaches a collision-avoidance system. EX1005, (57) and [0008]. EX1003, ¶¶227-29.

[1A] – one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising:

Suzuki discloses in-vehicle radar devices 110 in various configurations containing a number of interrelated components (*e.g.*, EX1005, Figs. 1B, 3) that may operate in conjunction with a user interface that issues warnings to drivers (as shown in Fig. 8). EX1005, [0035], Figs. 1B, 3, 8; EX1003, ¶¶230-31; EX1005, [0035]-[0036] (explaining the embodiments of Figs. 1B and 3 are incorporated into the dual-radar embodiment of Fig. 8).

⁸ See Appendix of the Challenged Claims for full identification of the limitations referred to by shorthand herein.





These radar devices and associated user interface are part of the interrelated set of units that are mounted on a vehicle. Additional units within the set are discussed below regarding limitations [1B]-[1D]. Together, in-vehicle radar devices 110 and the additional units discussed in [1B]-[1D] below comprise a “vehicle-mounted module,” as claimed. EX1003, ¶232. And, as discussed above, POSITAs would have understood Suzuki’s teachings to be applicable to rail vehicles. *Id.*, ¶¶233-35.

While Suzuki alone teaches or suggests [1A], as discussed above, in the alternative, Suzuki in view of Grisham also does so. EX1003, ¶236. As discussed

in [1A]-[1D] in Ground 1A above, Grisham teaches that collision-avoidance systems using UWB communications and displays for user alerts and inputs can be utilized for rail vehicles, such as railroad work vehicles (which travel on the tracks) or trains themselves. *E.g.*, EX1006, 22:42-23:32, Fig. 19 (depicting “work vehicle 1902” having a collision-avoidance system). Grisham also teaches that its collision-avoidance systems can be similarly used in conventional cars. *E.g.*, *id.*, 19:20-20:14, Fig. 11 (depicting “vehicle 1104” having a collision-avoidance system); EX1003, ¶¶237-38.

Accordingly, if the Board does not find that Suzuki alone teaches or suggests vehicle-mounted modules mounted on rail vehicles, POSITAs would have been motivated to apply Suzuki’s collision-avoidance system to rail vehicles and mount Suzuki’s vehicle-mounted modules and other components on rail vehicles, in view of Grisham, and would have a reasonable expectation of success. *Id.*, ¶¶239-40. Both references relate to the use of UWB-sensor and communications systems in the operation of vehicles to avoid collisions, and thus POSITAs would look to combine their teachings. *Id.* In fact, Grisham and Suzuki address the same problem—vehicular collision avoidance—in substantially the same way, one in vehicles (such as cars) and the other in cars, work vehicles, and trains. *Id.* Grisham explicitly discloses an embodiment with a mounted UWB unit in a car communicating with a mounted UWB unit in a rail vehicle; thus, POSITAs would naturally look to other

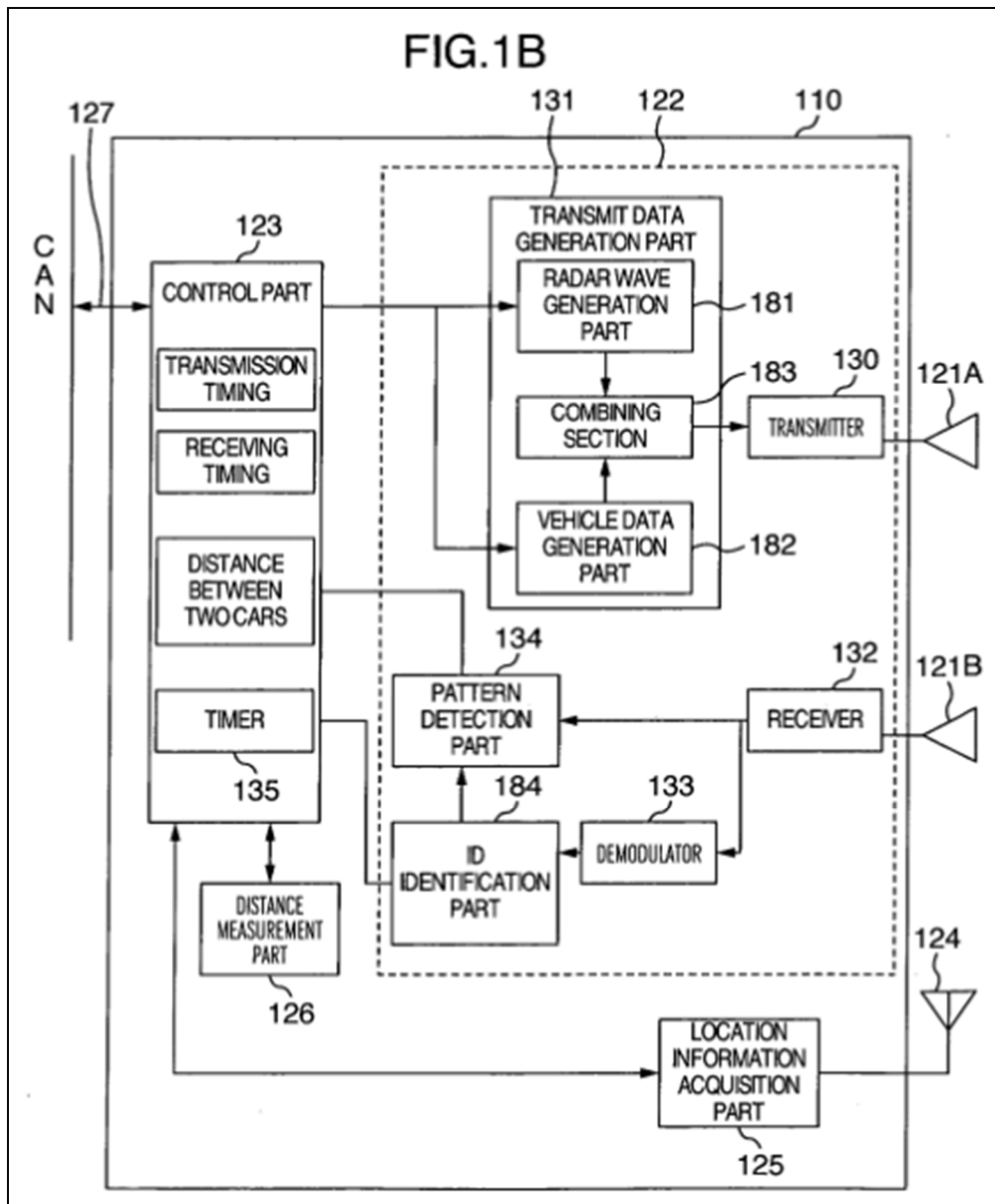
systems involving collision avoidance in cars such as in Suzuki. *E.g.*, EX1006, 19:20-20:14, Figs. 11-12; EX1003, ¶¶239-40. Indeed, Grisham expressly teaches how to use its rail system in a car. EX1006, 22:28-30. Grisham teaches why collision avoidance systems using UWB sensors would be beneficial in rail vehicles, and it would be a trivial modification for POSITAs to apply the vehicle mounted modules of Suzuki to rail vehicles as in the collision avoidance system taught by Grisham. EX1003, ¶¶239-40.

POSITAs would further have been motivated to combine Suzuki and Grisham because the pertinent prior art includes both cars and rail vehicles and because solutions to their common problem of collision avoidance would benefit from interoperability or compatibility between cars and rail vehicles, as taught explicitly by Grisham's car-train embodiment. *Id.*, ¶241. POSITAs would have understood that systems for use in cars and rail vehicles would need to and in fact do work well together, particularly given the embodiment disclosed in Grisham in which cars and rail vehicles are used in the same system. *Id.*, ¶242. Since rail vehicles have fewer degrees of freedom of movement than cars, POSITAs would have understood that a system for collision avoidance for cars would readily be applied to a system for collision avoidance for rail vehicles, as it would simply be applying a more robust technology to a simpler technical problem (at least from a freedom-of-movement perspective, given that rail vehicles are constrained to travel on defined railways

whereas cars are not). *Id.* For example, POSITAs reading Grisham would have understood that rail systems and car systems must coexist and be compatible with each other, and further that there are many more cars, at least in the United States, than rail vehicles. *Id.* Thus, POSITAs would naturally look to collision-avoidance systems for cars, such as in Suzuki, in creating or improving such a system for rail vehicles and cars as disclosed in Grisham, including providing compatibility with car systems. *Id.*

[1B] – a transponder sensor module operable to send and receive data wirelessly, the transponder module comprising a first ultra wideband unit and a first antenna;

Suzuki teaches the use of an in-vehicle radar device 110 that sends, via an antenna 121A, both radar waves and data including location information for the vehicle and a vehicle ID. EX1005, [0014], Figs. 1B, 3, 8. Suzuki further teaches that the in-vehicle radar device receives radar waves and data including vehicle ID information via an antenna 121B. EX1005, [0015], [0027], Figs. 1B, 3.



Suzuki also discloses that the antenna for sending and receiving radar and communication data can be shared (antenna 121C). EX1005, [0020], Fig. 2. The in-vehicle radar device disclosed in Suzuki is a UWB module: “a Ultra Wide Band (UWB) device having a communication function and a radar function are used.” EX1005, (57) and [0008]; EX1003, ¶¶243-46.

[1C] – a control electronics module comprising a processor in communication with at least the transponder sensor module unit; and

Suzuki discloses control part 123, which is part of radar device 110, and which sends commands to transceivers and “collects and processes the information” from the respective front- and rear-mounted radar devices. EX1005, [0014], [0035]-[0036], Figs. 1B, 3, 8. Suzuki further discloses that integral unit 310 includes control part 123. *Id.* While Suzuki does not expressly state it uses a processor, it does describe processing of information, which POSITAs would understand is done by a processor or at least would have been preferably done by a processor. EX1003, ¶¶247.

[1D] – a user interface module including a user interface, the user interface being operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator; and

Suzuki teaches a “display” operable to provide vehicle information to the vehicle operator, including by transmitting a warning to the driver when the distance between two vehicles is less than a predetermined value. EX1003, ¶¶248-50; EX1005, [0008] (“a hazard warning is issued to the driver”), [0018], [0028] (discussing calculation of vehicle-to-vehicle distance and activating warning function based on distance). An “alarm display or alarm tone generation is transmitted to the automotive navigation system 312” when a short time to crash is calculated. EX1005, [0037]. While Suzuki does not explicitly state an ability to

receive input from the vehicle operator, it would be obvious that the warning and alarm displays and the automotive navigation system disclosed in Suzuki (which POSITAs would have understood conventionally appear on a vehicle display) would preferably receive input from a driver, such as muting the alarm or adjusting the volume. EX1003, ¶251. For example, it would be obvious to POSITAs that in any sort of display that has sound, a user needs to be able to mute or adjust volume. *Id.*; EX1001, 18:14-16 (“Examples of other input switches are buttons that acknowledge (temporary mute) a buzzer, alarm or a horn.”).)

It would also be obvious to POSITAs that the warning and alarm displays in Suzuki would provide rail-vehicle information just as readily as they can provide other vehicle information. EX1003, ¶252. In fact, POSITAs would have understood that both cars and rail vehicles face the problem of avoiding collisions, and that applying a warning/alarm for cars to rail vehicles would not require any substantial technical modification, and in fact is actually less complex (at least from a freedom-of-movement perspective). *See* [1A], Ground 3A; EX1003, ¶252.

While Suzuki alone renders this element obvious, in the alternative, Suzuki in view of Grisham also does so. EX1003, ¶¶253-54. As discussed in [1D] in Ground 1A above, Grisham teaches a user interface module including a display that provides information to and can receive input from the vehicle operator, such as by allowing the vehicle operator to communicate with other vehicle operators through Grisham’s

display. Accordingly, if the Board were to find that Suzuki does not teach or suggest this limitation, POSITAs would have been motivated to combine Suzuki's collision avoidance system including warning and alarms with Grisham's display providing rail vehicle information and receiving operator input for the reasons described above and have a reasonable expectation of success. *See* [1A], Ground 3A; EX1003, ¶¶253-54.

[1E] – wherein each vehicle mounted module is operable to communicate with at least one other vehicle mounted module mounted on at least one other rail vehicle, and

Suzuki teaches vehicles communicating their positions to each other via UWB. EX1005, [0008]. Suzuki's vehicle mounted module (including UWB device) may send a signal with its own location information or vehicle ID to another vehicle having a vehicle mounted module and receive such signals from other vehicles. EX1005, [0015], [0016]. Suzuki teaches "a plurality of vehicles equipped with the above-describe in-vehicle radar device." EX1005, [0055]; Fig. 17. For the reasons described in [1A] in Ground 3A above, it would be obvious to POSITAs that Suzuki's vehicle-mounted modules would be mounted on rail vehicles. EX1003, ¶¶255-60.

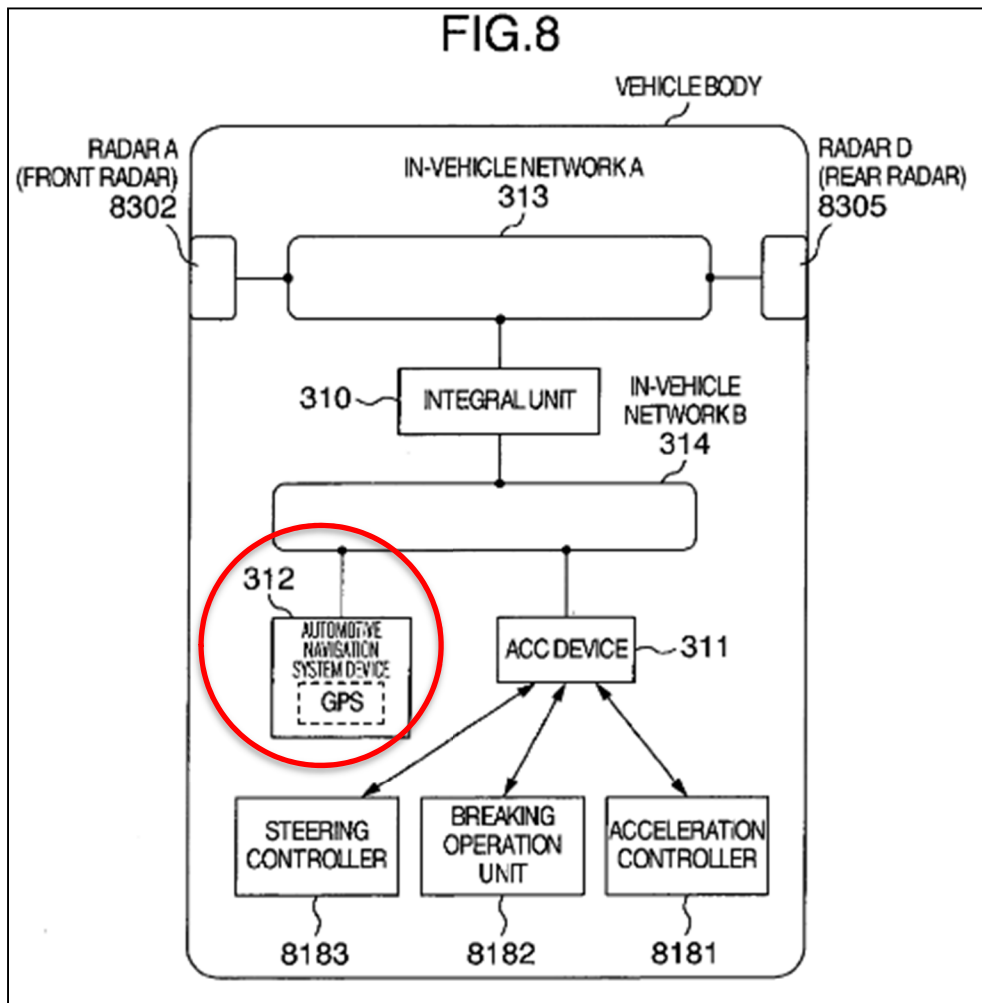
[1F] – wherein each vehicle mounted module is operable to apply a time of flight technique to determine a separation distance between the rail vehicles.

Suzuki teaches that if it detects its own vehicle ID in a received radar transmission, “the transmission timing and the reception timing obtained from the pattern detection part 134 are sent to the vehicle-to-vehicle distance measurement part 126, and then in the vehicle-to-vehicle distance measurement part 126 the value of a distance obtained *by multiplying the time difference between these transmission timing and reception timing by the speed of light is divided by two to thereby calculated the distance to a vehicle which reflected the radar wave . . .*” EX1005, [0032] (emphasis added); *id.*, [0004]. This discloses using TOF (time of flight) to calculate a separation distance between the vehicles. EX1003, ¶¶261-62.

For the reasons described above, it would be obvious to POSITAs that the TOF determination of separation distance between vehicles in Suzuki would just as readily be used to determine separation distance between rail vehicles. *Id.*, ¶¶263-64. In fact, POSITAs would have understood that both cars and rail vehicles face the problem of avoiding collisions, and that applying a TOF determination of separation distance between cars to rail vehicles is actually less complex because rail vehicles have fewer degrees of freedom. *Id.* POSITAs would have understood that the same TOF calculations in Suzuki would be applied to rail vehicles without any material technical modification. *Id.*

3. Claim 7 – GPS System

Suzuki teaches the use of a GPS unit where “the in-vehicle radar device 110 receives signal from a GPS satellite via an antenna 124, and measures its own position to transmit this to a vehicle-to-vehicle distance measurement part 126.” EX1005, [0013]; Figs. 1B, 3, 8 (element 312), [0021], [0045]; EX1003, ¶¶265-67.



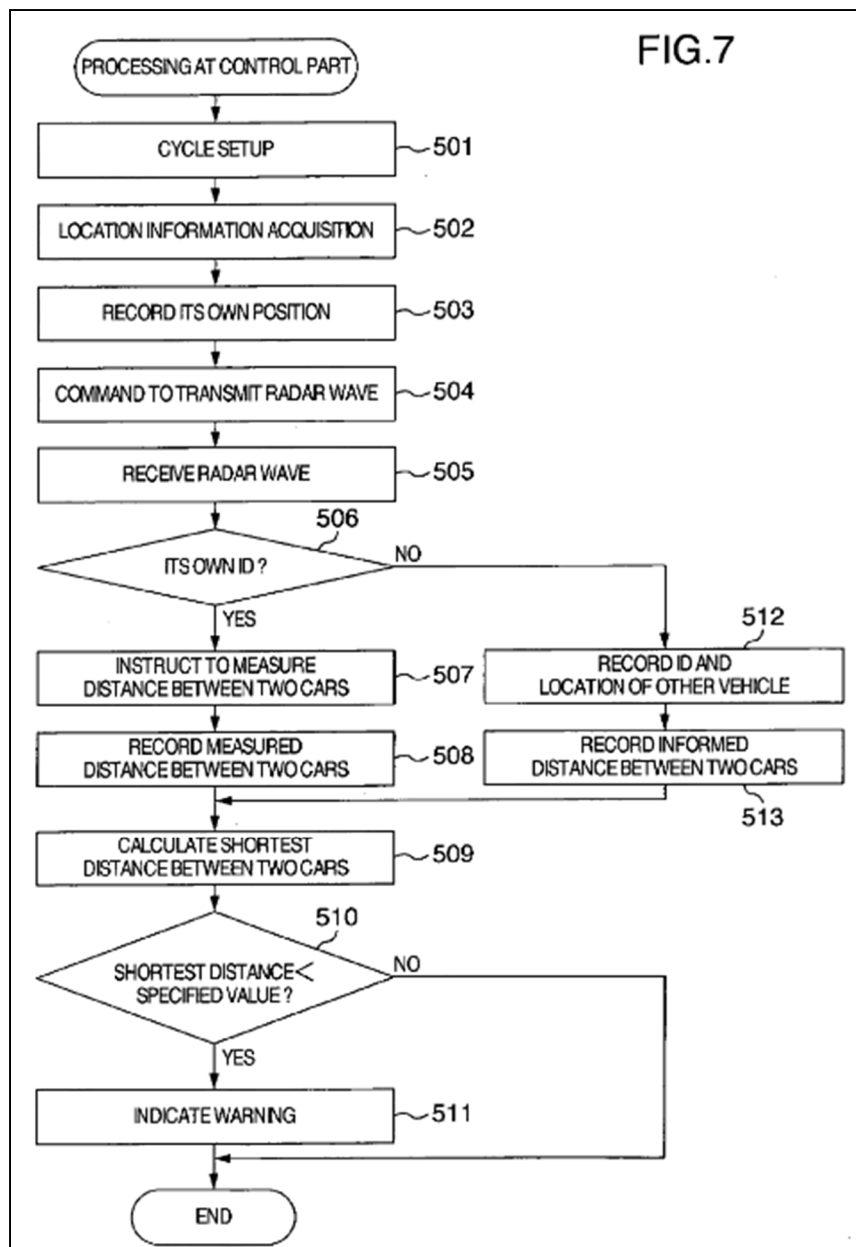
As discussed in [1A] in Ground 3A above, it would be obvious to POSITAs in view of Suzuki alone (or alternatively in view of Grisham) that Suzuki’s vehicle

mounted modules would be mounted on rail vehicles and thus Suzuki's GPS would determine the position of the rail vehicle. *Id.*, ¶269.

Further, Suzuki's GPS unit is in communication with the control electronics module. *Id.*, ¶268. For example, Suzuki's Figure 3 shows an automotive navigation system device 312 including location information acquisition part 185 that is in communication with control part 123. EX1005, [0021], Fig. 3. Similarly, Figure 8 shows the automotive navigation system device 312, including GPS, in communication with the control electronics module (integral unit 310) via an in-vehicle network. EX1005, Figs. 3 and 8.

4. Claim 8 – GPS + UWB and Warning Signal

Suzuki teaches receiving information from UWB radios and GPS to determine whether vehicle separation criteria are violated. For example, Figure 7 illustrates measuring the distance between two vehicles using information provided by UWB (*e.g.*, steps 504-505) and GPS (*e.g.*, step 502) to determine if the shortest distance is less than a specified value (step 510). EX1005, Fig. 7, [0029], [0030]-[0034] (further describing the steps illustrated in Fig. 7), [0045].



More specifically, control part 123 reads location information from the GPS unit (location information acquisition part 125) and then measures the distance to a front vehicle via UWB radar, demonstrating Suzuki uses both GPS and UWB in conjunction. *Id.*, [0030].

Suzuki further teaches generating a warning signal if vehicle separation criteria are violated. *Id.*, [0018]; [0034]. As discussed in [1A] in Ground 3A above, it would have been obvious to POSITAs that such an arrangement in Suzuki would just as readily be used for rail vehicles as in non-rail vehicles. EX1003, ¶¶270-73.

5. Claim 11 – Ground Speed Detection Module

Suzuki teaches a ground-speed-detection module that can determine the speed of the vehicle and communicate with the vehicle mounted module. EX1005, [0023], [0029]. It would have been obvious to POSITAs that Suzuki's speed detection would just as readily be used to determine speed of a rail vehicle. EX1003, ¶¶274-76. POSITAs would have understood the same speed determination in Suzuki would be applied to rail vehicles without any significant technical modification. *Id.* For example, the same off-the-shelf components for determining vehicle speed in cars would be used in rail vehicles and vice versa. *See* [1A], Ground 3A; EX1003, ¶¶274-76.

While Suzuki alone teaches or suggests this element, in the alternative, Suzuki in view of Grisham also does so. EX1006, 23:64-24:24. POSITAs would have been motivated to combine Suzuki's collision avoidance system including speed detection to determine vehicle speed with Grisham's use of speed detection to determine rail-vehicle speed. EX1003, ¶¶277-78. In fact, POSITAs would have understood that Suzuki's speed detection in vehicles would just as readily be applied to rail vehicles

because this would entail applying Suzuki's robust technology to a simpler technical problem (at least from a freedom-of-movement perspective). *Id.* Grisham expressly teaches vehicle-mounted radio units that comprise controllers and ultra wideband units (see [1B] and [1C] in Ground 1A), and POSITAs would understand these radio units to be a type of ground speed detection module because the controller within the radio unit determines the speed of the train based on the measurements by the ultrawide-band units, particularly when one of the radio units is on a control box or railroad pole. EX1003, ¶¶277-78. Therefore, POSITAs would have understood that speed detection in car systems is applicable to rail vehicles and vice versa. *See* [1A], Ground 3A; EX1003, ¶¶277-78.

6. Claim 12 – Inertial Measurement Unit

Suzuki illustrates a speed detection module that can determine the speed of the vehicle. EX1005, [0023]. Suzuki further teaches that the control part 123 receives the vehicle speed information from the control device of the vehicle via the internal controller area network ("CAN"); thus Suzuki discloses this unit is in communication with at least the control electronics module. *Id.* Suzuki further teaches that the vehicle driving control information includes "its own speed (wheel speed)" and "acceleration/deceleration in traveling direction (acceleration sensor information)." EX1005, Fig. 16.

FIG.16

DATA TYPE	PRIORITY	NUMBER OF OCCUPIED CHANNELS
<ul style="list-style-type: none"> • VEHICLE DRIVING CONTROL INFORMATION <ul style="list-style-type: none"> • INDIVIDUAL VEHICLE ID (IDENTIFICATION DATA) • ITS OWN SPEED (WHEEL SPEED) • BRAKE ON/OFF • BRAKE PRESSURE INFORMATION • ACCELERATOR OPEN RATIO INFORMATION • STEER ANGLE INFORMATION (STEERING WHEEL SENSOR INFORMATION) • ACCELERATION / DECELERATION IN TRAVELING DIRECTION (ACCELERATION SENSOR INFORMATION) • ENGINE ROTATIONAL SPEED • GEAR INFORMATION 	1	TRANSMIT 1 CHANNEL RECEIVE 1 CHANNEL
<ul style="list-style-type: none"> • VOICE COMMUNICATION 	2	TRANSMIT 1 CHANNEL RECEIVE 1 CHANNEL
<ul style="list-style-type: none"> • IN-VEHICLE VIDEO COMMUNICATION (VIDEO TELEPHONE) 	3	TRANSMIT 1 CHANNEL RECEIVE 1 CHANNEL
<ul style="list-style-type: none"> • INTERNET COMMUNICATION USING CAR-TO-CAR COMMUNICATION AND ROAD-TO-CAR COMMUNICATION 	4	TRANSMIT 1 CHANNEL RECEIVE 1 CHANNEL

Thus, Suzuki teaches an inertial measurement unit (an acceleration sensor) in communication with at least a control electronics module, the inertial measurement unit being operable to detect changes in a speed of the rail vehicle. EX1003, ¶¶279-83.

For the reasons described in [1A] in Ground 3A above, it would have been obvious to POSITAs that speed detection taught in Suzuki would just as readily be applied to rail vehicles. *Id.*, ¶284. An inertial measurement unit operable to detect changes in vehicle speed would have been obvious to POSITAs given the acceleration sensor information taught in Suzuki. *Id.* POSITAs would have understood that Suzuki implies the presence of an inertial measurement unit because it included acceleration sensor information in Fig. 16. *Id.* In fact, common, off-the-shelf acceleration sensors were readily available and would be used in both cars and rail vehicles. *Id.*

While Suzuki alone teaches and/or suggests this element, in the alternative, Suzuki in view of Grisham also does so, as POSITA would have been motivated to combine the detection of changes in speed of vehicles taught by Suzuki with Grisham's collision avoidance system in rail vehicles to detect changes in rail vehicle speed. *See* [1A] and claim 11, Ground 3A; EX1003, ¶284.

7. Claim 13 – Accelerometer or Gyroscope

As described for claim 12 in Ground 3A above, Suzuki teaches an acceleration sensor. POSITAs would have understood that the acceleration sensor disclosed in Suzuki would include accelerometers or gyroscopes, which were commonly known devices for detecting changes in vehicle speed. *See* claim 12, Ground 3A; EX1003, ¶¶285-86.

8. Claim 14 – Varying Center Frequencies

Suzuki teaches a UWB unit that can vary the center frequencies used based on location, where different frequency bands are assigned to different map areas and the automotive navigation system 312 can read and transmit the varied frequency bands depending on the area of the determined current location. EX1005, [0042]; EX1003, ¶¶287-90; EX1005, [0050].

9. Claim 17

The limitations of [17-Pre], [17A], and [17B] track to [1-Pre], [1A], [1B], and [1F], including because the recited “radio communication unit” in claim 17 includes the “ultra wideband unit” recited in claim 1, and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham for the same reasons provided in Ground 3A. EX1003, ¶¶291-94.

[17C] – Wireless Communications Antenna

Suzuki teaches the use of a wireless communications antenna to send and receive data over the air. *See* [1B], Ground 3A; EX1003, ¶295. POSITAs would be motivated to use the single-antenna embodiment of Figure 2 in the in-vehicle radar device 110 because it would reduce the cost of antennas and save space inside of the vehicle mounted module. EX1003, ¶295.

[17D] – GPS Unit

The limitations of [17D] track to Claim 7 and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided for claim 7 in Ground 3A. EX1003, ¶296.

[17E] through [17G]

The limitations of [17E]-[17G] track to [1C]-[1F] and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided in Ground 3A. EX1003, ¶¶297-99.

10. Claim 18 - UWB

The limitations of Claim 18 track to [1B] and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided in Ground 3A. EX1003, ¶300.

11. Claim 19 – Varying Center Frequencies

The limitations of Claim 19 track to Claim 14 and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided for claim 14 in Ground 3A. EX1003, ¶301.

12. Claim 24

The limitations of [24-Pre] through [24C] track to [1-Pre], [1A], [1B], and [1F], including because the recited “radio communication unit” in claim 24 includes the “ultra wideband unit” recited in claim 1, and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided in Ground 3A. EX1003, ¶¶302-06.

[24D] – GPS Unit

The limitations of [24D] track to Claim 7 and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided for claim 7 in Ground 3A. EX1003, ¶307.

[24E] through [24G]

The limitations of [24E]-[24G] track to [1C]-[1F] and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided in Ground 3A. EX1003, ¶¶308-10.

[24H] – GPS + Radio and Warning Signal

The limitations of [24H] track to Claim 8 and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham, for the same reasons provided for claim 8 in Ground 3A. EX1003, ¶¶311.

13. Claim 25 - UWB

The limitations of Claim 25 track to [1B] and are satisfied by Suzuki alone or, alternatively, Suzuki in view of Grisham for the same reasons provided for [1B] in Ground 3A. EX1003, ¶312.

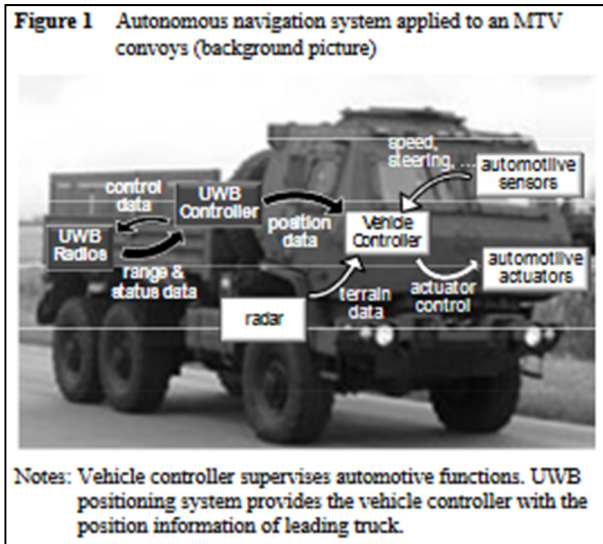
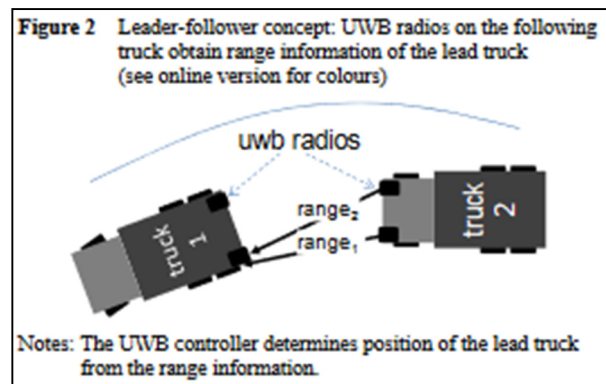
M. Ground 3B: Claims 2-6, 20, 22, and 27-28 Obvious over Suzuki and Richardson or Suzuki, Grisham, and Richardson

1. Claims 2 and 3 – Central Tracking Unit and Distributed Central Tracking Unit

Suzuki describes a “platoon” functionality by a plurality of vehicles each having its in-vehicle radar devices 110 (including the multiple radars of Fig. 8) in

which the vehicles measure distance from each other in order to follow each other's' driving patterns. *E.g., id.*, [0055]-[0056], Fig. 17 (depicting 3 or 4 vehicles in the platoon).

As discussed in Ground 1C, Richardson teaches a convoy of semi-autonomous vehicles in a “leader-follower” application each having multiple UWB units that provide positioning information of a lead vehicle to a second vehicle to follow the lead vehicle's driving patterns. EX1008, Abstract, p.209-210, Figs. 1, 2.



As shown in Figure 1 and described in Figure 2 above, each vehicle contains a “UWB controller” that “determines position of the lead truck from the range information” from the UWB radios. *Id.*; EX1003, ¶¶313-16. In other words, each vehicle's UWB controller is in communication with its four mounted UWB radios, as well as the mounted UWB radios on adjacent vehicles, and can receive position information from the vehicle mounted modules of other vehicles, including leading

and following vehicles. EX1008, p. 210, Figure 1, p.212, Section 2.3; EX1003, ¶¶316-18. This distribution allows each vehicle to be able to track the vehicle in front of it and the vehicle behind it. EX1003, ¶¶316-18.

POSITAs would understand, relevant to claim 2, that the UWB controller in a vehicle in Richardson's convoy that is central to other vehicles constitutes a "*central tracking unit*" as claimed at least because it is in communication with and tracking the location of the UWB radios on its vehicle, is in communication with and tracking the location of the UWB radios on adjacent vehicles, and is central to those other vehicles. EX1003, ¶319. Moreover, Because Richardson discloses the distributed CTU of claim 3 (as discussed below), and because claim 3 depends from claim 2, Richardson necessarily discloses the "central tracking unit" of claim 2 because a dependent claim falls within the scope of its parent claim. *AK Steel Corp. v. Sollac & Ugine*, 344 F.3d 1234, 1242 (Fed. Cir. 2003) (holding that parent claims "must be at least as broad as the claims that depend from them").

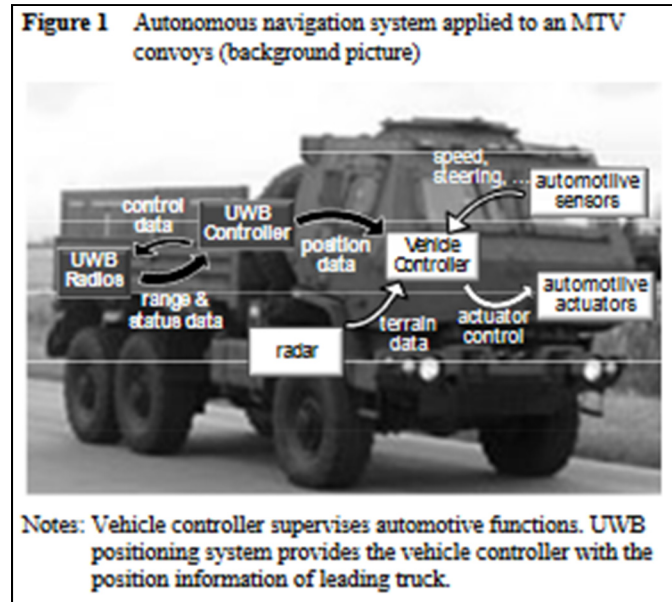
POSITAs would further understand, relevant to claim 3, that a convoy could include many vehicles that could be considered central to other vehicles, and thus that many vehicles distributed in the convoy have UWB controllers that constitute a "*central tracking unit distributed among a plurality*" of vehicles. EX1003, ¶320.

POSITAs would have been motivated to combine the teachings of Suzuki and Richardson, or, in the alternative, Suzuki, Richardson and Grisham, because they are

all directed to systems using vehicle-proximity detection to improve safety and prevent vehicle collisions and because Suzuki's disclosure of UWB communication and control over a "platoon" of vehicles is analogous to Richardson's disclosure of UWB communication and control over a "convoy" of vehicles. EX1003, ¶321. POSITAs would have looked to known technologies, such as Richardson's use of UWB controllers acting as (distributed) CTUs, to improve the collision avoidance systems of Suzuki and Grisham, which would yield a reasonable expectation of success. *Id.* POSITAs also would have understood that users of Suzuki's or Grisham's collision avoidance system would benefit from using (distributed) CTUs as taught by Richardson, including reducing potential collisions by monitoring in a unified manner the locations of and distances between multiple vehicles. *Id.*

2. Claim 4 – Central Tracking Unit Housing

Richardson teaches a UWB controller (*central tracking unit*) as shown in Fig 1:



Whether to house the UWB controller in a *discreet*⁹ housing is a matter of design choice. EX1003, ¶¶322-23. POSITAs would understand that UWB controllers like that in Richardson can be subject to the elements or within view of the user, and therefore it would be obvious to POSITAs to select or, at the very least to try, (of the only two possible options—discreet or not discreet) a discreet housing in which to protect the UWB controller from the elements and from causing a user distraction while driving. *Id.*

3. Claim 5 – Auxiliary Transponder Sensor Module

As discussed in Claim 5 in Ground 1B above, Richardson teaches the limitations of this claim.

⁹ See footnote 5. EX1003, ¶323.

POSITAs would have been motivated to combine Suzuki and Richardson for the same reasons discussed above in Ground 3B. EX1003, ¶¶324-26. Additionally, POSITAs would have understood the benefits of providing *an auxiliary transponder sensor module with an offset to the transponder sensor module*, including better location measurements and improved collision avoidance due to more precise information relating to length of the vehicle and mounting location of each sensor. *Id.* Suzuki expressly teaches use of multiple sensors on a vehicle in offset locations (for example, front and rear of the vehicle), thus POSITAs would naturally look to references such as Richardson with multiple sensors per vehicle and their use of offsets between the multiple sensors. *See* claims 2-3, Ground 3B; EX1003, ¶¶324-26. Moreover, it would have been obvious to POSITAs to add Richardson's vehicle-length information to the user interface of Suzuki and/or, in the alternative, Suzuki and Grisham. EX1003, ¶¶327-28. For example, a train operator can verify the calibration information related to the length of the train against the actual length, which may change as the train drops off cars at their destinations. *Id.*

4. Claim 6 – Auxiliary Antenna

As discussed in Claim 6 in Ground 1B above, Richardson teaches that the auxiliary module includes an antenna that connects to a UWB unit and that the auxiliary antenna is mounted at an offset from the other unit (and its antenna).

POSITAs would have been motivated to combine Suzuki with Richardson, and in the alternative, Suzuki, Richardson and Grisham for the same reasons provided for claims 2-3 and 5 in Ground 3B. EX1003, ¶¶329-32.

5. Claim 20 – Offset Antenna

Claim 20 contains limitations that track the limitations of claims 5 and 6, and its limitations are satisfied by Suzuki in view of Richardson or, alternatively Suzuki in view of Grisham and Richardson for the same reasons provided for claims 5-6 in Ground 3B. *See* Claim 20, Ground 2B; EX1003, ¶¶333-36.

6. Claim 22 – Central Tracking Unit

The limitations of Claim 22 track to Claims 2 and 3 and are satisfied by Suzuki in view of Richardson or, alternatively, Suzuki in view of Grisham and Richardson for the same reasons provided for claims 2-3 in Ground 3B. EX1003, ¶¶337-39.

7. Claim 27 – Central Tracking Unit

The limitations of Claim 27 track to Claim 2 and are satisfied by Suzuki in view of Richardson or, alternatively, Suzuki in view of Grisham and Richardson for the same reasons provided for claims 2-3 in Ground 3B. EX1003, ¶¶340-42.

8. Claim 28 – Distributed Central Tracking Unit

The limitations of Claim 28 track to Claim 3 and are satisfied by Suzuki in view of Richardson or, alternatively, Suzuki in view of Grisham and Richardson for the same reasons provided for claims 2-3 in Ground 3B.

Additionally, POSITAs would have understood that this combination teaches that each of the one or more rail vehicle modules includes a CTU component, each CTU component being in communication with the control electronics module of the rail vehicle module. EX1003, ¶¶343-47.

N. Ground 3C: Claims 9, 21, and 26 Obvious over Suzuki and Nixon or Suzuki, Grisham and Nixon

1. Claim 9 – Progressive Warning Signal

Suzuki alone or, alternatively, Suzuki in view of Grisham, teaches or suggests alerts based on separation distance between vehicles. *See* [1D], [24F], [24G], Ground 3A. While neither expressly discloses progressive warnings, Nixon teaches such subject matter. *See* claim 9, Ground 2A; EX1003, ¶¶348-51.

POSITAs would have been motivated to combine Suzuki and Nixon, and in the alternative, Suzuki, Grisham, and Nixon, because they are directed to the same problem of preventing collisions between vehicles. EX1003, ¶¶348-51. POSITAs would have looked to Nixon's progressive warning feature to improve the alarms of Suzuki, or in the alternative Suzuki and Grisham, which would yield a reasonable expectation of success. *Id.* POSITAs also would have understood that users of Suzuki's and Grisham's collision-avoidance systems would benefit from using progressive warnings as taught by Nixon, which would further improve safety by progressively alerting a vehicle operator as collision risks increased. *Id.*

The combination of Suzuki and Nixon (and Suzuki, Nixon, and Grisham) teaches the progressive warning signal increases in at least one of signal rate, signal frequency, signal prominence, signal volume, or signal severity as the violation of the vehicle separation criteria approaches or extends beyond a vehicle separation threshold. *Id.*

2. Claim 21 – UWB + GPS and Progressive Warning Signal

Suzuki teaches the use of UWB radios and GPS to determine whether vehicle separation criteria are violated and, thus, whether indication of a warning is warranted. *See* claim 8, Ground 3A.

Claim 21 is rendered obvious by Suzuki, Grisham, and Nixon for the same reasons as discussed above with respect to claim 9. *See* claim 9, Ground 3C; EX1003, ¶¶352-53.

3. Claim 26 – Progressive Warning Signal

Claim 26 is rendered obvious by Suzuki, Grisham, and Nixon for the same reasons as discussed above with respect to claim 9. *See* claim 9, Ground 3C. EX1003, ¶354.

O. Ground 3D: Claim 15 Obvious over Suzuki and Connell or Suzuki, Grisham, and Connell

Connell teaches the claimed stopping-distance calibration feature. *See* claim 15, Ground 1E.

POSITAs would have been motivated to incorporate Connell's stopping-distance calibration feature for vehicle-collision avoidance into a collision-avoidance system for at least the reasons discussed for claim 15 in Ground 1E. POSITAs would have known that a collision-avoidance system should avoid collisions between vehicles at varying conditions. EX1003, ¶¶355-56.

P. Ground 3E: Claim 10 Obvious over Suzuki, Nixon, and McDaniel or Suzuki, Nixon, McDaniel, and Grisham

Suzuki in view of Nixon or, alternatively, Suzuki in view of Nixon and Grisham, renders claim 9 obvious. *See* claim 9, Ground 3C. While that combination does not teach the claimed adaptive threshold feature, McDaniel does. *See* claim 10, Ground 2D.

POSITAs would have been motivated to modify the alarm thresholds of a collision-avoidance system for at least the reasons discussed for claim 10 in Ground 2D. POSITAs would have known that a collision avoidance system should avoid collisions between vehicles at varying speeds and conditions. EX1003, ¶¶357-58.

Q. Ground 3F: Claims 16 and 23 Obvious over Suzuki, Nixon, McDaniel, and Connell or Suzuki, Nixon, McDaniel, Connell, and Grisham

1. Claim 16

Claim 16 adds the progressive warning signal of claim 9 which as previously discussed is taught by Nixon. *See* claim 9, Grounds 2A, 3C. Claim 16 also adds the adaptive threshold feature of claim 10 which as previously discussed is taught by

McDaniel. *See* claim 10, Grounds 2D, 3E. POSITAs would have been motivated to combine these references for at least the reasons discussed in those sections. EX1003, ¶¶359-60.

2. Claim 23

Claim 23 adds the inertial measurement unit of claim 12 which as discussed above is taught by Suzuki. *See* claim 12, Ground 3A; EX1003, ¶¶361-62.

VII. NO BASIS FOR DISCRETIONARY DENIAL

B. Section 314(a)

“[T]he 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 here. Regardless, the *Fintiv* factors also weigh against discretionary denial.

1. Potential for Stay

This factor is neutral because no stay has been requested. *Apple, Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 15 at 12 (PTAB May 13, 2020) (informative).

2. Timing of Trial

Petitioners filed this Petition before the district court has ruled on Petitioners’ motions to dismiss and before any procedural schedule has been set. EX1040. This factor thus weighs against discretionary denial. *Samsung Elecs. v. Netlist, Inc.*, IPR2022-00063, Paper 13 at 8 (PTAB May 5, 2022).

3. Litigation Investment

Other than initial motion practice, the parties have invested little in the district court litigation. This factor thus also weighs against discretionary denial. *Id.*

4. Overlap of Issues

Given its early stage, the validity issues in the litigation are unknown. However, Petitioners challenge all 28 claims, whereas patent owner has asserted only 17 in the litigation. EX1010, ¶¶36-53. The Board will thus address 11 claims that the district court will not address, weighing against discretionary denial. *Markforged Inc. v. Continuous Composites, Inc.*, IPR2022-00679, Paper 7 at 32-33 (PTAB Oct. 25, 2022).

5. Litigation Defendants

Although Petitioners are litigation defendants, the fact that no trial has been set means this factor weighs against discretionary denial. *Samsung Elecs.*, IPR2022-00063, Paper 13, 8.

6. Other Circumstances

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

C. Section 325(d)

Under *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geraete GmbH*, IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (precedential), the Board considers whether the Petition presents the same/substantially the same art/argument

previously presented and, if so, whether it shows that the Office materially erred in its prior evaluation.

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

The Grisham-based and Suzuki-based grounds demonstrate the unpatentability of every claim based on art and arguments never presented to the Office. This is reason alone to find that Step 1 is not satisfied. *Allgenesis Biotherapeutics Inc. v. Cloudbreak Therapeutics, LLC*, IPR2020-01438, Paper 7 at 11-12 (PTAB Feb. 18, 2021) (Step 1 not satisfied where petition included ground(s) challenging all claims using previously-unconsidered prior art).

Two patents in the same family as Grisham were listed by Patent Owner in an IDS among other references, but neither reference was cited by the Examiner or used to reject any claims during prosecution of the '227 patent. The Board has declined to exercise its discretion under § 325(d) based solely on a reference being cited in an IDS, as is the case here. *PEAG LLC d/b/a JLab Audio v. VARTA Microbattery GmbH*, IPR2020-01213, Paper 9 at 7-11 (PTAB Jan. 6, 2021). And none of Suzuki, Richardson, Breed '945, McDaniel, Connell, Douglas, and Nixon were cited by Patent Owner or the Office during prosecution. *Id.*, 9-10.

2. Step 2: The Office Erred Materially

If the Board finds Step 1 satisfied because Grisham was cited during prosecution, discretionary denial is still unwarranted because the Office erred

materially in its prior “evaluation.” Step 2 focuses on *Becton, Dickinson* factors (c), (e), and (f) (*Advanced Bionics*, IPR2019-01469, Paper 6 at 10), which all weigh against denial.

Under factor (c), the office erred because neither Grisham nor any patent related to Grisham was used, alone or in combination with another reference, as a basis for any rejection during prosecution. References related to Grisham were merely submitted as part of an IDS that included other references.

Under factors (e) and (f), 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.” *Id.*

The Petition details how Grisham renders obvious the challenged claims. This is “something persuasive” that the Office overlooked. *PEAG*, IPR2020-01213, Paper 9 at 11. Additionally, the Office overlooked the teachings of Breed ’945 because, while the Examiner cited a related reference, Breed ’786, Patent Owner overcame Breed ’786 by arguing that it “does not relate to rail line vehicles, an element recited in all of the currently pending claims.” EX1002, p.309. This is not correct; Breed ’786 discloses that its system can “apply for all vehicles including trucks [and] trains.” EX1018, [0194]. Regardless, Breed ’945 contains additional disclosure that defines its “vehicle” to include “railroad cars.” EX1014, [0088]. The Office thus overlooked “specific teachings in [Grisham (and Breed ’945)] such that

the error by the Office was material to the patentability of the challenged claims.”

Advanced Bionics, IPR2019-01469, Paper 6 at 8, 21.

VIII. CONCLUSION

Claims 1-28 of the '227 patent are unpatentable for the reasons set forth above.

Respectfully submitted,

Dated: January 13, 2023

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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 13,991 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: January 13, 2023

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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. 8,812,227 and supporting materials (Exhibits 1001-1040 and Powers of Attorney) have been served in its entirety by e-mail and FTP this 13th day of January, 2023, and by FedEx on the 14th day of January, 2023, on the patent owner at the correspondence address of record for the subject patent, as indicated below:

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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 collision avoidance system comprising:
[1A] one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising:
[1B] a transponder sensor module operable to send and receive data wirelessly, the transponder module comprising a first ultra wideband unit and a first antenna;
[1C] a control electronics module comprising a processor in communication with at least the transponder sensor module unit; and
[1D] a user interface module including a user interface, the user interface being operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator; and
[1E] wherein each vehicle mounted module is operable to communicate with at least one other vehicle mounted module mounted on at least one other rail vehicle, and
[1F] wherein each vehicle mounted module is operable to apply a time of flight technique to determine a separation distance between the rail vehicles.
Claim 2
[2A] 2. The collision avoidance system of claim 1, further comprising a central tracking unit in communication with the first vehicle mounted module and the second vehicle mounted module,
[2B] wherein the central tracking unit is operable to track the location of at least the first vehicle mounted module and the second vehicle mounted module.
Claim 3
[3A] 3. The collision avoidance system of claim 2, wherein the central tracking unit is distributed among a plurality of rail vehicles, including at least the first and second rail vehicles,
[3B] wherein the first vehicle mounted module comprises a first central tracking unit component.
Claim 4
4. The collision avoidance system of claim 2, wherein the central tracking unit is located in a discreet housing.

Claim 5
[5A] 5. The collision avoidance system of claim 1, wherein the first vehicle mounted module further comprises an auxiliary transponder sensor module, the auxiliary transponder sensor module mounted on the first rail vehicle with an offset with respect to the transponder sensor module, and
[5B] wherein the user interface is operable to provide calibration information related to the length of the first rail vehicle, the mounting location of the first transponder sensor module, and the mounting location of the auxiliary transponder sensor module.
Claim 6
[6A] 6. The collision avoidance system of claim 5, wherein the auxiliary transponder sensor module comprises an auxiliary antenna, the auxiliary antenna being connected to at least one of the first ultra wideband unit or an auxiliary ultra wideband unit, and
[6B] wherein the auxiliary antenna is mounted on the first rail vehicle with an offset with respect to the first antenna.
Claim 7
[7A] 7. The collision avoidance system of claim 1, wherein the first vehicle mounted module further comprises a global positioning system unit, the global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail vehicle,
[7B] wherein the global positioning system unit is in communication with the control electronics module.
Claim 8
8. The collision avoidance system of claim 7, wherein the first vehicle mounted module receives information generated by the global positioning system unit and the first ultra wideband unit to determine whether one or more vehicle separation criteria are violated, and generates a warning signal when one or more vehicle separation criteria are violated.
Claim 9
[9A] 9. The collision avoidance system of claim 1, wherein the first vehicle mounted module is operable to execute a progressive warning signal if one or more vehicle separation criteria are violated, and
[9B] wherein the progressive warning signal increases in at least one of signal rate, signal frequency, signal prominence, signal volume, or signal severity as the violation of the vehicle separation criteria approaches or extends beyond a vehicle separation threshold.
Claim 10

10. The collision avoidance system of claim 9, wherein the first vehicle mounted module executes an adaptive threshold feature that modifies one or more vehicle separation thresholds based on the speed of the first rail vehicle and the speed of the second rail vehicle.
Claim 11
11. The collision avoidance system of claim 1, further comprising at least one ground speed detection module operable to determine the speed of the rail vehicle, wherein the first vehicle mounted module communicates with the at least one ground speed detection module.
Claim 12
12. The collision avoidance system of claim 1, further comprising an inertial measurement unit in communication with at least the control electronics module, the inertial measurement unit being operable to detect changes in the speed of the first rail vehicle.
Claim 13
13. The collision avoidance system of claim 12, wherein the inertial measurement unit comprises at least one of an accelerometer or a gyroscope.
Claim 14
14. The collision avoidance system of claim 1 wherein the ultra wideband unit is adapted to transmit and receive signals with varying center frequencies.
Claim 15
[15A] 15. The collision avoidance system of claim 1, wherein the first vehicle mounted module is operable to execute a stopping distance calibration feature that measures a stopping distance under existing conditions,
[15B] wherein the stopping distance measures the distance between the point where the brakes are engaged to the point where the vehicle comes to a stop under the existing conditions.
Claim 16
[16A] 16. The collision avoidance system of claim 15, wherein the first vehicle mounted module executes a progressive warning signal if one or more vehicle separation criteria are violated,
[16B] wherein the progressive warning signal increases in at least one of signal rate, signal frequency, signal prominence, signal volume, or signal severity as the violation of the vehicle separation criteria approaches or extends beyond a vehicle separation threshold, and
[16C] wherein the first vehicle mounted module executes an adaptive threshold feature that modifies one or more vehicle separation thresholds based on the measured stopping distance.
Claim 17

[17-Pre] 17. A rail vehicle module mountable on a rail vehicle, the module comprising:
[17A] a transponder sensor module comprising:
[17B] a radio communication unit operable to employ time of flight techniques to detect a distance between the rail vehicle and at least one other vehicle;
[17C] a wireless communications antenna operable to send and receive data over the air; and
[17D] a global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail vehicle;
[17E] a control electronics module comprising a processor in communication with at least the first transponder sensor module; and
[17F] a user interface module including a user interface operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator;
[17G] wherein the rail vehicle module communicates with at least one other module mounted on at least one other vehicle to detect a separation distance between the rail vehicle and the at least one other vehicle.
Claim 18
18. The rail vehicle module of claim 17, wherein the radio communication unit comprises an ultra wideband unit configured to send and receive ultra wideband signals.
Claim 19
19. The rail vehicle module of claim 18, wherein the ultra wideband unit is adapted to transmit and receive signals with varying center frequencies.
Claim 20
[20A] 20. The rail vehicle module of claim 17, further comprising a second wireless communications antenna mounted on the rail vehicle with an offset with respect to the first antenna,
[20B] wherein the rail vehicle module is operable to receive calibration information related to the length of the rail vehicle, the mounting location of the first wireless communications antenna and the mounting location of the second wireless communications antenna.
Claim 21
[21A] 21. The rail vehicle module of claim 17, wherein the rail vehicle module is operable to utilize information generated by the radio communication unit and the global positioning system unit to determine whether one or more vehicle separation criteria are violated, and
[21B] generate a progressive warning signal if one or more vehicle separation criteria are violated, wherein the progressive warning signal increases in at least

one of signal rate, signal frequency, signal prominence, signal volume, or signal severity as the violation of the vehicle separation criteria approaches or extends beyond a vehicle separation threshold.
Claim 22
[22A] 22. The rail vehicle module of claim 17, further comprising a central tracking unit component,
[22B] wherein the central tracking unit component is in communication with a central tracking unit component mounted on the at least one other vehicle.
Claim 23
23. The collision avoidance system of claim 16, further comprising an inertial measurement unit in communication with at least the control electronics module, the inertial measurement unit being operable to detect changes in the speed of the first rail vehicle.
Claim 24
[24-Pre] 24. A collision avoidance system comprising
[24A] one or more vehicle mounted modules, each vehicle mounted module mountable on a rail vehicle, each vehicle mounted module comprising:
[24B] a transponder sensor module comprising:
[24C] a radio communication unit operable to employ time of flight techniques to detect a distance between rail vehicles; and
[24D] a global positioning system unit operable to receive information from one or more satellites to determine an absolute position of the rail line vehicle;
[24E] a control electronics module comprising a processor, the control electronics module being in communication with at least the transponder sensor module; and
[24F] a user interface operable to provide rail vehicle information to a vehicle operator and to receive input from the vehicle operator;
[24G] wherein each of the two or more rail vehicle modules communicate to determine a separation distance between each rail vehicle, and
[24H] wherein each rail vehicle module is operable to use information provided by the radio communication unit and the global positioning system unit to determine whether one or more vehicle separation criteria are violated, and to generate a warning signal if one or more vehicle separation criteria are violated.
Claim 25
25. The collision avoidance system of claim 24, wherein each radio communication unit comprises an ultra wideband unit.
Claim 26

26. The collision avoidance system of claim 24, wherein the progressive warning signal increases in at least one of signal rate, signal frequency, signal prominence, signal volume, or signal severity as the violation of the vehicle separation criteria approaches or extends beyond a vehicle separation threshold.

Claim 27

27. The collision avoidance system of claim 24, further comprising a central tracking unit in communication with each rail vehicle module, the central tracking unit operable to track the location of each rail vehicle module.

Claim 28

[28A] 28. The collision avoidance system of claim 27, wherein the central tracking unit is distributed among the rail vehicle modules,

[28B] wherein each of the one or more rail vehicle modules includes a central tracking unit component, each central tracking unit component being in communication with the control electronics module of the rail vehicle module.