

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. TBD

Patent No. 10,179,595

DECLARATION OF MICHAEL BRAASCH, PH.D.

Siemens Exhibit 1003 Siemens et al. v. Metrom Rail

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I, Michael Braasch, declare:

1. I have been retained by counsel for Petitioners to assess claims 1-30 (the “challenged claims”) of U.S. Patent No. 10,179,595 (“the ’595 patent”). I am being compensated for my time at my standard rate of \$500.00 per hour, plus actual expenses. My compensation is not dependent in any way upon the outcome of the *inter partes* review of the ’595 patent.

I. PERSONAL AND PROFESSIONAL BACKGROUND

2. My complete qualifications and professional experience are described in my curriculum vitae, a copy of which is provided as Exhibit 1004. The following is a brief summary of my relevant qualifications and professional experience.

3. I am currently a Professor with tenure in the School of Electrical Engineering and Computer Science at Ohio University. I received my Bachelor of Science and Master of Science degrees in Electrical Engineering from the Ohio University in 1988 and 1989 respectively. In 1992, I received a Ph.D. in Electrical Engineering also from Ohio University. During that time, my post-baccalaureate and doctoral work focused on navigation systems. My M.S. thesis involved the development of a computer simulation of an interrogation-reply ranging system known as the Distance Measuring Equipment (DME).

4. From 1989 to 1993, I was a research engineer in the Avionics Engineering Center at Ohio University. I became an assistant professor in the Department of Electrical and Computer Engineering at Ohio University in 1994 and have been on the faculty at Ohio University since that time. I have held the title of Professor in the School of Electrical Engineering and Computer Science since 2003 and was appointed as the Thomas Professor of Electrical Engineering in 2004. As a professor of Electrical Engineering, I have taught courses in navigation including ranging systems such as DME.

5. I am a Licensed Professional Engineer (P.E.) in the State of Ohio. In my professional career, I have specialized in the areas of electronic navigation receiver design, electronic navigation system engineering, satellite-based navigation systems, inertial navigation systems, and integrated navigation systems.

6. Since the mid-1980s, I have been involved with research related to navigation and transportation systems including navigation system computer modeling and validation; characterization of GPS error sources and development of mitigation strategies; design, development and testing of software-defined GPS receiver architectures; design, development and flight testing of advanced cockpit displays; and analysis of safety-certification issues in unmanned aerial vehicle operations. I have been the recipient of over 65 research grants and contracts, including awards from the U.S. Department of Transportation, Federal Aviation

Administration, Air Force Office of Scientific Research and NASA. In 1992, I received the RTCA (formerly known as the Radio Technical Commission for Aeronautics) William E. Jackson Award in recognition of an outstanding aviation electronics publication.

7. I have published over 80 journal articles, book chapters, conference papers, and workshop papers, most of which were related to navigation systems. I have authored or co-authored over 20 academic publications in the areas of graphical display systems, electronic navigation system engineering, satellite-based navigation systems with emphasis in GPS, and integrated navigation systems. These publications include book chapters in *Global Positioning System: Theory and Applications*, American Institute of Aeronautics and Astronautics, Washington, D.C. (1996). A complete list of my publications is included in my curriculum vitae (EX1004).

8. I have given numerous presentations at various conferences and universities worldwide on these topics. In particular, I have been invited to speak and publish in connection with conference proceedings on the navigation systems at venues around the world. Additional contributions of mine to the field are set forth in my current curriculum vitae (EX1004).

9. In addition to gaining expertise via my academic training, professional experiences, and research accomplishments described above, I have kept abreast of

various sub-disciplines within the field of navigation systems, such as locating technologies, by reading technical literature, attending and presenting at conferences, and attending and presenting at symposia. I have been invited to participate in the peer review process for various technical journals, and conferences, and have reviewed manuscripts submitted by other engineers relating to navigation system technology. Furthermore, I have collaborated with or have communicated with many of the engineers in the field of navigation systems.

II. MATERIALS REVIEWED AND CONSIDERED

10. My findings, as explained below, are based on my years of education, research, experience, and background in the field of positioning systems and techniques, as well as my investigation and study of relevant materials for this declaration. When developing the opinions set forth in this declaration, I assumed the perspective of a person having ordinary skill in the art, as set forth in Section IV below. In forming my opinions, I have studied and considered the materials identified in the list below.

Exhibit	Description
1001	U.S. Patent No. 10,179,595 (“’595 patent”)
1002	Prosecution History of U.S. Patent No. 10,179,595
1005	U.S. Provisional Application No. 62/177,683
1006	U.S. Patent Application Pub. No. 2012/0296562A1 (“Carlson”)
1007	WO International Publication No. 2013/056244 (“Cross”)
1008	U.S. Patent Application Pub. No. 2012/0326891A1

Exhibit	Description
1009	U.S. Patent Application Pub. No. 2007/0241888A1 (“Mantovani”)
1010	U.S. Patent Application Pub. No. 2008/0170533A1 (“Cyzs”)
1011	German Patent Application Pub. No. DE102008020700A1 (“Meyer-German”) (Attached as Exhibit A to EX1013)
1012	Certified English-Language Translation of German Patent Application Pub. No. DE102008020700A1 (“Meyer”) (Attached as Exhibit B to EX1013)
1013	Declaration of Harry Gigas
1014	U.S. Patent Application Pub. No. 2009/0243397A1 (“Cook”)
1015	U.S. Patent Application Pub. No. 2013/0256466A1
1016	U.S. Patent No. 5,907,294 (“Welte”)
1017	U.S. Patent Application Pub. No. 2013/0021215A1
1018	U.S. Patent Application Pub. No. 2013/0214990A1
1019	U.S. Patent Application Pub. No. 2004/0155822A1
1020	U.S. Patent Application Pub. No. 2007/0281745A1
1021	U.S. Patent Application Pub. No. 2013/0237273A1
1022	U.S. Patent Application Pub. No. 2010/0039978A1
1023	U.S. Patent Application Pub. No. 2010/0124898A1
1024	U.S. Patent No. 5,283,589
1025	U.S. Patent Application Pub. No. 2012/0182191A1
1026	U.S. Patent Application Pub. No. 2005/0143037A1
1027	U.S. Patent Application Pub. No. 2012/0077537A1
1028	U.S. Patent Application Pub. No. 2006/0199146A1
1029	U.S. Patent No. 7,075,427
1030	U.S. Patent No. 6,597,293

Exhibit	Description
1031	U.S. Patent Application Pub. No. 2011/0084854A1
1032	U.S. Patent No. 6,113,037
1033	U.S. Patent Application Pub. No. 2016/0176422A1
1036	“Broadcast,” The Free Dictionary, https://www.thefreedictionary.com/broadcast
1037	IEEE Std 802.15.4™-2011, IEEE Standard for Local and Metropolitan Area Networks: Part 15.4: Low-Rate Wireless Personal Area Networks
1038	Newton’s Telecom Dictionary (27th ed 2013)
1039	Dictionary of Computer Science, Engineering, and Technology (2001)
1040	Microsoft Computer Dictionary (5th Ed. 2002)
1041	U.S. Patent Application Pub. No. 2014/0173155A1

III. MY UNDERSTANDING OF PATENT LAW

11. In developing my opinions, I discussed various relevant legal principles with Petitioner’s attorneys. Though I do not purport to have prior knowledge of such principles, I understood them when they were explained to me and have relied upon such legal principles, as explained to me, in the course of forming the opinions set forth in this declaration. My understanding in this respect is as follows:

12. I understand that “*inter partes* review” (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent’s claims based on prior-art patents and printed publications.

13. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the '595 patent are unpatentable by a preponderance of the evidence. I understand that “preponderance of the evidence” means that a fact or conclusion is more likely true than not true.

14. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSA”) in the context of the entire patent and the prosecution history pertaining to the patent. If the specification provides a special definition for a claim term that differs from the meaning the term would otherwise possess, the specification’s special definition controls. If a claim element is expressed as a “means” for performing a specified function, I understand that it covers the corresponding structure described in the specification and equivalents of the described structure. I have applied these standards in preparing the opinions in this declaration.

15. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the effective filing date (also known as the priority date) to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in

sufficient detail to convey with reasonable clarity to the POSA that the inventor had possession of the claimed invention as of the earlier application's filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

16. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—*i.e.*, not anticipated) and not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

17. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior-art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSA would have understood the reference to disclose the limitation based on inferences that a POSA would reasonably be expected to draw from the explicit teachings in the reference when read in light of the POSA's knowledge and experience.

18. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the

reference, regardless of whether a person of ordinary skill recognized the presence of that limitation in the prior art.

B. Obviousness

19. I understand that a patent claim may be unpatentable if it would have been obvious in view of a single prior-art reference or a combination of prior-art references.

20. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the relevant field at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- if present, objective factors indicative of non-obviousness,

sometimes referred to as “secondary considerations.” To my knowledge, the Patent Owner has not asserted any such secondary considerations with respect to the ’595 patent.

21. I understand that in order for a claimed invention to be considered obvious, a POSA must have had a reason for combining teachings from multiple

prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

22. I further understand that in determining whether a prior-art reference would have been combined with other prior art or with other information within the knowledge of a POSA, the following are examples of approaches and rationales that may be considered:

- combining prior-art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” *i.e.*, choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;

- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion or motivation may come from a prior-art reference or from the knowledge or common sense of one of ordinary skill in the art.

23. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSA must have been able to arrive at the claimed invention by altering or combining the applied references.

IV. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

24. I have been informed and understand that for purposes of assessing whether prior-art references disclose every element of a patent claim (thus “anticipating” the claim) and/or would have rendered the claim obvious, the patent and the prior-art references must be assessed from the perspective of a person having ordinary skill in the art (“POSA”) to which the patent is related, based on the understanding of that person at the time of the patent claim’s priority date. I have been informed and understand that a POSA is presumed to be aware of all pertinent prior art and the conventional wisdom in the art, and is a person of ordinary creativity. I have applied this standard throughout my declaration.

25. The '595 patent involves technology in the field of positioning systems and techniques. I have been asked to provide my opinions as to the state of the art in this field by 2015. I use this timeframe because the face of the '595 patent indicates an earliest claimed priority date of the March 23, 2015 filing date of a provisional application. '595 patent (EX1001), (60). Whenever I offer an opinion in this declaration about the knowledge of a POSA, the manner in which a POSA would have understood the claims of the '595 patent or its description, the manner in which a POSA would have understood the prior art, or what a POSA would have been led to do based on the prior art, I am referencing the 2015 timeframe, even if I do not say so specifically in each case.

26. I understand that the Patent Owner may attempt to prove that the alleged invention recited in the challenged claims was conceived at some time prior to the earliest claimed priority date on the face of the patent. At the time of this declaration, I am unaware of the Patent Owner having alleged any earlier conception date or produced any evidence to establish any earlier conception date.

27. In my opinion, a POSA in 2015 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 had at least two years of experience with using such electronics for control systems applications such as collision avoidance systems or positioning systems. More education could substitute for experience,

and vice versa. This person would have been capable of understanding and applying the teachings of the '595 patent and the prior-art references discussed in this declaration.

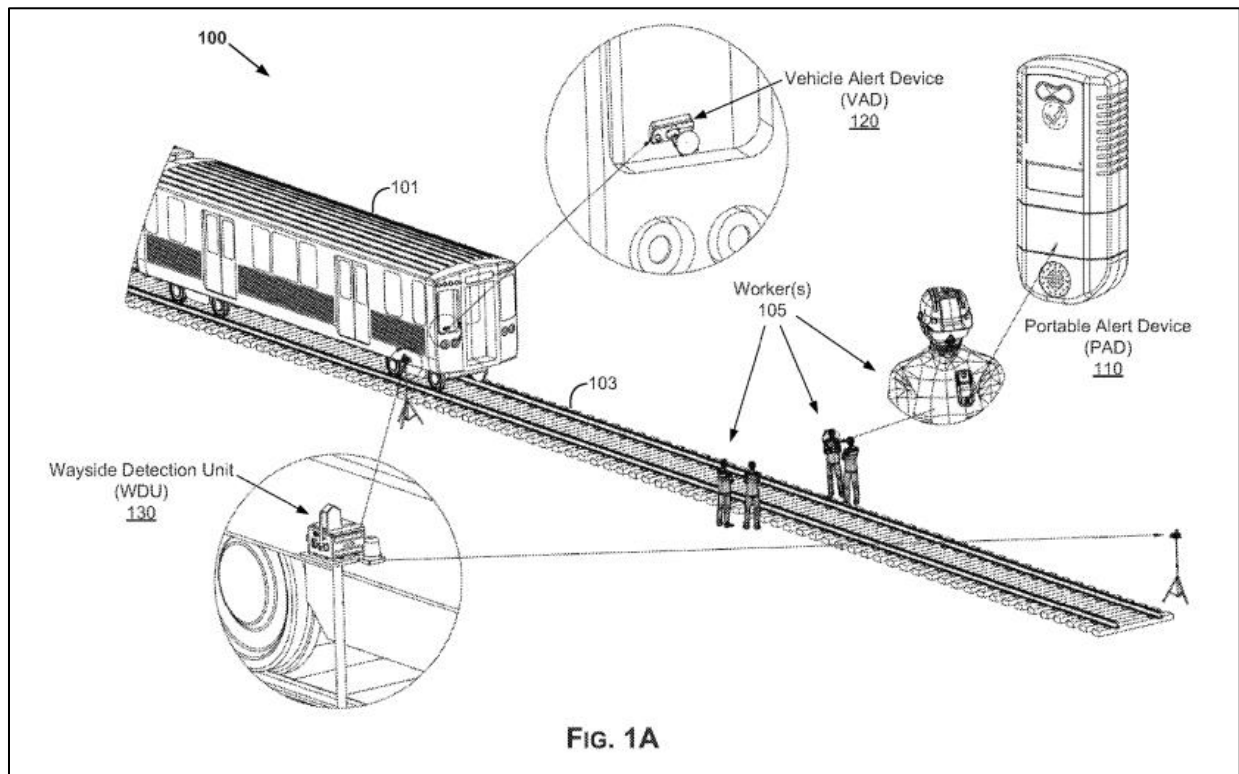
28. By 2015, I held a Ph.D. in Electrical Engineering, and I had 20+ years of experience with positioning systems and techniques. Therefore, I was a person of more than ordinary skill in the art during the relevant timeframe. However, I have taught and supervised many people who fit the characteristics of the POSA, and I am familiar with their level of skill. When developing the opinions set forth in this declaration, I assumed the perspective of a person having ordinary skill in the art, as set forth above.

V. THE '595 PATENT

29. The '595 patent concerns systems and devices for protecting workers (*e.g.*, railroad workers) from collisions with approaching trains. EX1001, Abstract. For example, the system “issue[s] alerts” to railroad workers, for example, “when a particular vehicle (*e.g.*, a train...) is approaching.” EX1001, 2:28-31. The patent criticizes prior art systems as being “costly, inefficient, and/or ineffective” (EX1001, 1:20-25), but the disclosed system nonetheless uses conventional electronics (*e.g.*, wireless communication circuits) and conventional techniques (*e.g.*, transmitting alert signals) for alerting workers to dangers. Specifically, the system utilizes three companion devices: (1) “vehicle alert devices (VADs)” that

are “mounted on vehicles (*e.g.*, the train)”;

(2) “portable alert device (PADs)” that are “worn by worker(s)” (*e.g.*, attached to “worker(s)” clothing); and (3) “wayside detection units (WDUs)” that are positioned “near [the vehicle path]” (*e.g.*, at the “work site”). EX1001, 2:36-64. The three devices are illustrated in Figure 1A, copied below:



As I discuss below (§ V.A.1), PADs, WDUs, and VADs exchange wireless signals (comprising alerts or alert-triggering signals) and include conventional “receivers” and “antennas” for existing “Global Navigation Satellite System (GNSS) technologies” (*e.g.*, GPS), to “enable obtaining location/positioning information”

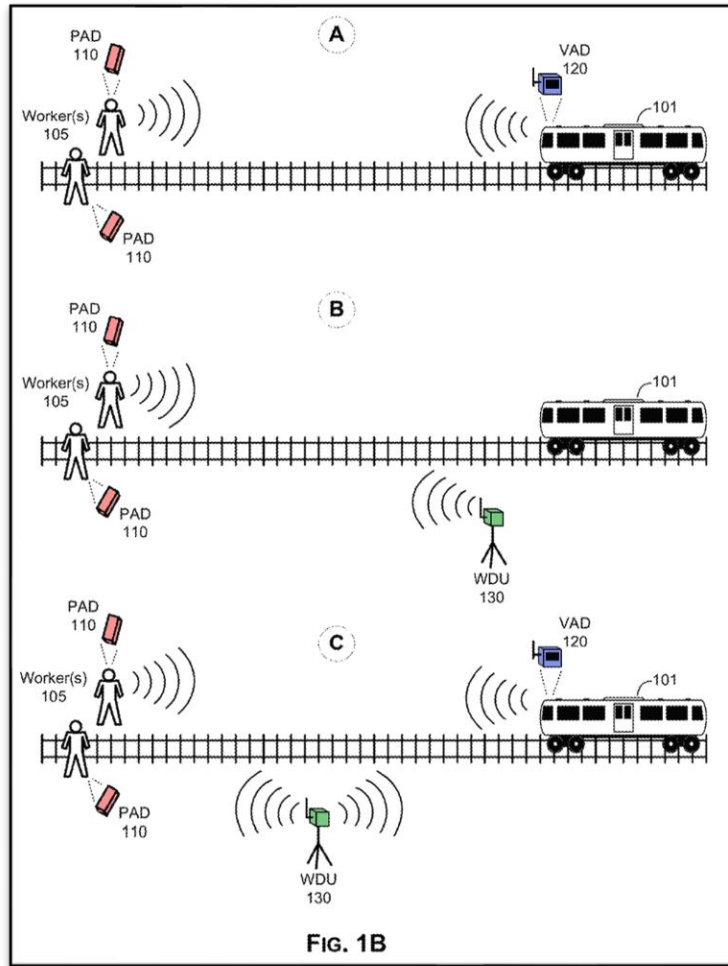
to determine when “the train/vehicle comes within a programmed distance” from the workers. EX1001, 4:29-56.

30. As I discuss in sections V.A.2-V.A.4 below, each of the PADs, WDUs, and VADs are disclosed as comprising conventional electronic components (*e.g.*, antennas, power supplies, processors, etc.) for transmitting, receiving, and processing wireless signals that were well-known in the prior art. *See, e.g.*, EX1001, 8:29-10:49, FIG. 2A (describing PAD’s components); 10:50-13:47, FIG. 3 (describing VAD’s components); 13:48-31, FIG. 4 (describing WDU’s components). As seen in Figures 2A, 3, and 4 below, each device is configured for its particular application. For example, the PAD can be a “small and light device” with a clip for attaching to a worker. EX1001, 2:65-3:2. The worker-worn PAD also has audio and visual indicators that are “configured to provide visual and/or audio indication in response to triggering of alerts” (EX1001, 9:15-26) as well as “an alert acknowledgement element, such as a confirmation button to silence alarms” (EX1001, 3:10-13). The vehicle-mounted VAD, in turn, includes an “operator unit” with a “user interface” (*e.g.*, display) that “provide[s] the vehicle operator” with “alert related data” (*e.g.*, “distance to the workers”). EX1001, 11:16-66. The wayside WDU includes sensors that “monitor, detect, and track [an] approach[ing] vehicle,” as well as “support structure” (*e.g.*, a tripod) that allows the WDU to be placed “near train tracks.” EX1001, 14:5-26.

A. Described Embodiments

1. Alert and Alert-triggering signals

31. As I discuss below, the VADs, PADs, and WDUs “interact” and wirelessly communicate alert and alert-triggering signals. EX1001, 7:15-20. In operation, the worker-worn PADs communicate via wireless signals with VADs mounted on trains and with the wayside WDUs that are positioned at a worksite with workers present. 2:36-51. Examples of the ’595 patent’s system are depicted in annotated Figure 1B, below, in which I have annotated the VADs in blue, the WDUs in green, and the PADs in red:



32. In operation of the (A) embodiment in FIG. 1B above, the train is “equipped with a VAD” and the VAD “broadcasts signals to interface with the PADs... to detect if the train... is in proximity.” EX1001, 7:21-30. When PADs “are detected by any train-based VAD,” the “PADs... issue an alert (*e.g.*, audible alarm).” EX1001, 7:24-30. “[W]hen the PADs... are detected,” the VAD “may further provide information to the operator” of the train. EX1001, 7:30-32. For example, the VAD may “receiv[e] signal indications triggering of alerts,” as well as “confirmation of such alerts by workers.” EX1001, 11:55-60. The VAD, after

triggering alerts, generates related data: data (i) to calculate “how many PADs... (and thus workers...) are present within the specified distance” (EX1001, 7:32-35); (ii) to determine “distance to workers” (EX1001, 2:54-59); (iii) to “indicate whether workers have confirmed the alarm” (EX1001, 2:54-59); (iv) and to determine the “calculated time till [the vehicle] reach[es] the workers” (EX1001, 11:41-46).

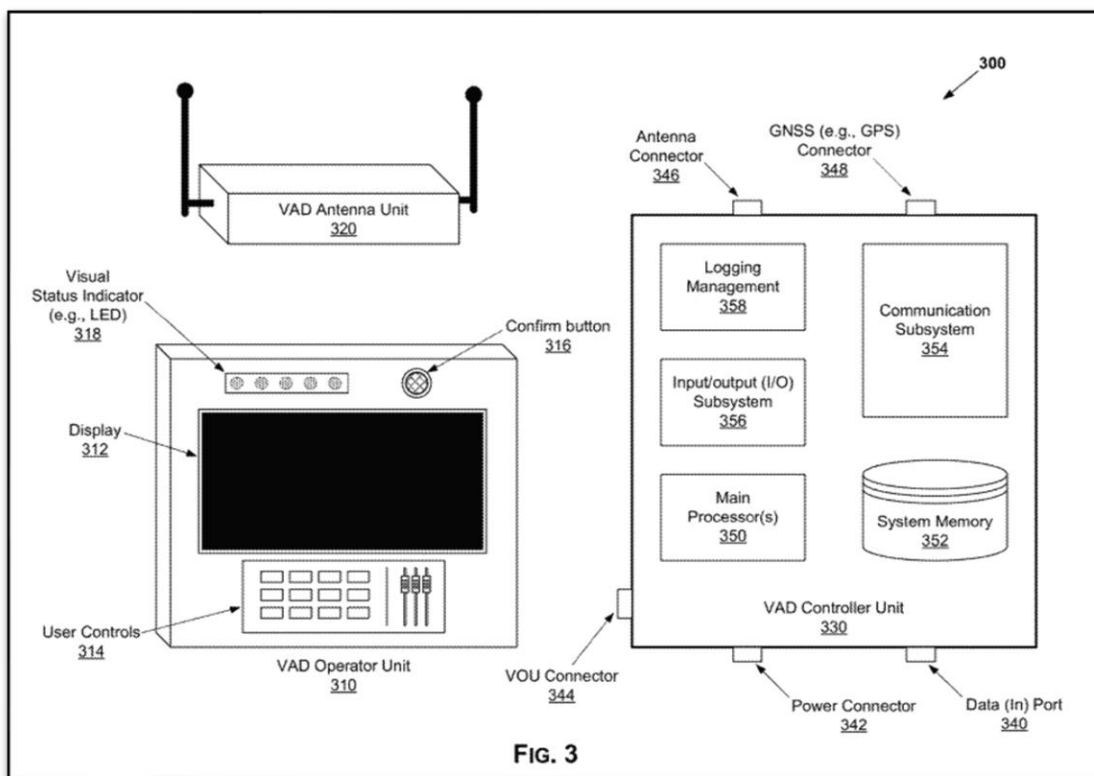
33. In operation of the (B) embodiment in FIG. 1B above, no VADs are employed, but “rather, the [PADs] are only in communication with the [WDUs].” EX1001, 7:40-43. The WDUs “monitor and detect approaching vehicles” like the “train,” “broadcast alarms (or signals [that] trigger[] alarms) when a vehicle is in proximity” such as when it is “at a particular distance from the wayside device and/or moving at a particular speed.” EX1001, 7:43-48. For instance, the WDU “detect[]s” the train when the train “passes” or when the train “moves within certain distance from” the WDU. EX1001, 7:48-52. The WDU then “sends a proximity warning to all local PADs.” EX1001, 7:48-52. “[I]n response to signals received from the companion alert device,” such as the WDU, the PAD “generate[s]... a safety alert.” EX1001, 16:28-30. Thus, WDUs “detect[] approaching vehicles, trigger[] alerts [by the PADs] (*e.g.*, by broadcasting signals configured for interfacing with the” PADs), which “trigger[s] critical alarms when a train enters a work area.” EX1001, 13:62-14:2.

34. In operation of the (C) embodiment in FIG. 1B above, the worker-worn PADs communicate via wireless signals with VADs on trains and with WDUs that are positioned at a worksite with workers present. EX1001, 2:36-51. The VADs and WDUs are configured to transmit either alerts to the worker-worn PADs or to transmit signals that cause the PADs themselves to trigger alerts. EX1001, 2:39-42. The VAD “may communicate directly with the WDU 120 as the train approaches it” or when the train is “a specified distance” from the WDU, which causes the WDU to “send proximity warnings (trigger alarms) to all local PADs.” EX1001, 7:64-8:1. Additionally, “the VAD 120 may communicate directly with the local PADs 110, to trigger alarm” (*e.g.*, when the VAD is “at a particular distance [from the PAD] and/or speed”). EX1001, 8:2-5. That is, the PADs may “be activated and/or triggered by vehicle-mounted devices for redundancy (thus enhanced protection).” EX1001, 7:60-63. For example, a VAD is configured to “trigger alerts under particular conditions—*e.g.*, when it detects it is approaching a crew equipped with” PADs. EX1001, 2:43-51. Likewise, a WDU is configured to trigger an alert when, for example, it detects a train approaching a worksite. EX1001, 2:59-64. When an alert is triggered, the PADs may “issue an indication (*e.g.*, audio, visual, tactile, etc.) to alert the worker wearing it of an approaching object (that pose[s] a safety concern).” EX1001, 3:3-9.

2. Vehicle Alert Devices (VADs)

35. The VAD comprises components that are temporarily or “permanently mounted” on vehicles. EX1001, 3:22-25. The VAD comprises “a first physical unit comprising the antennas (and related circuitry or other support components)” and “one or more physical units housing the remaining components of the VADs.” EX1001, 3:47-51. Alternatively, the VAD may be “within a single housing incorporating and/or attaching all components of the VAD.” EX1001, 11:4-5, 3:41-44 (disclosing that the VAD may also be a “singular physical component, incorporating all components (including antennas)”).

36. As FIG. 3 (below) illustrates, the VAD comprises a communication component that comprises an “antenna unit,” which comprises “one or more antennas... configured for use in transmitting and/or receiving signals.” EX1001, 11:12-15, 11:55-58. The “antenna unit may be... plac[ed]... on [the] roof of [the] front car [on the] train.” EX1001, 3:41-53.



37. The VAD also comprises “hardware (including circuitry and/or other hardware components), software, and combination[s] thereof” to support “the vehicle-mounted functionality.” EX1001, 10:50-55. For instance, the VAD comprises a “main processor,” which has “suitable circuitry operable to process data, and/or control and/or manage operations of the VAD... and/or tasks and/or applications performed” by the VAD. EX1001, 12:5-8. The main processor may be “a general purpose processor (*e.g.*, CPU)” or “a special purpose processor (*e.g.*, application-specific integrated circuit (ASIC).” EX1001, 12:11-14. As the ’595 patent explains, “the terms ‘circuits’ and ‘circuitry’ refer to physical electronic components (*e.g.*, hardware) and any software and/or firmware (‘code’) which may

configure the hardware, be executed by the hardware, and or otherwise be associated with the hardware.” EX1001, 1:63-67.

38. The VAD further comprises an “operator unit” (EX1001, 11:12-15), which includes “input/output (I/O) components” (EX1001, 11:16-23). The I/O components may include a “display” and “user controls.” EX1001, 11:16-23. The user controls may “be implemented in the form of a touch screen (*e.g.*, as part of the display...), or be implemented with an alpha-numeric display.” EX1001, 11:39-41. The user controls “comprise various types of user input elements” such as “buttons” or “dials” that “allow[the] vehicle operator(s)... to provide input” and/or “configure the VAD... and its operations.” EX1001, 11:34-39. The VAD’s operator unit may also “provid[e] indications relating to triggering of alerts and/or receiving feedback (*e.g.*, confirmation) relating to such indications.” EX1001, 11:22-27. For example, the VAD operator unit may include “a speaker... configured for providing audible indications of triggered alerts” and a configuration button... configured to receive indication of user acknowledgment... when alert indication(s) is/are outputted.” EX1001, 11:27-34; 3:34-37. The VAD’s I/O components may also “provide the vehicle operator” with “alert related data (*e.g.*, indicate the quantity of workers detected, and the approximate distance to the workers, calculated time tile reaching the workers, etc.).” EX1001, 11:41-66; *see also* 3:37-40. The VAD also “broadcast[s] signals that are specifically

configured to interface[] with the... PADs... and may also interface with the... WDU... to provide increased distance.” EX1001, 3:30-34.

3. Personal Alerts Devices (PADs)

39. The PAD is a “portable device[]” (EX1001, 8:19) that “may be designed and configured as [a] small and light device.” EX1001, 2:65-67. The PAD may have an “attachment structure” for “wearability” (EX1001, 8:39-58), like “a clip, arm band or belt clip” (EX1001, 3:1-2). For example, as shown in FIG. 2A, which I have annotated below, the PAD includes “a clip structure 260, so that the PAD 200 may be clipped onto the worker’s clothing [or] belt.” EX1001, 8:45-51.

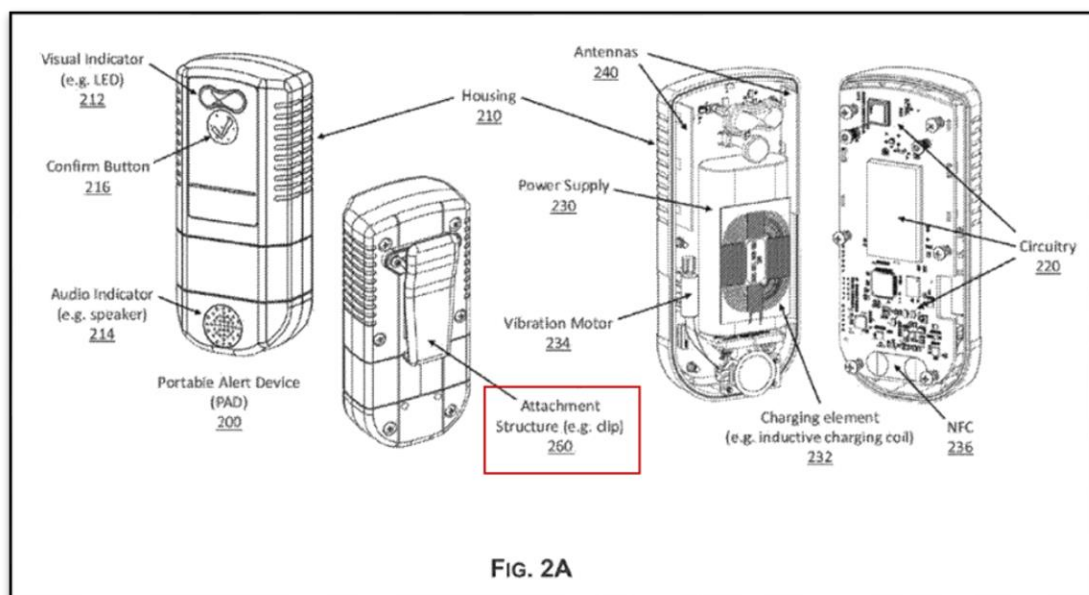
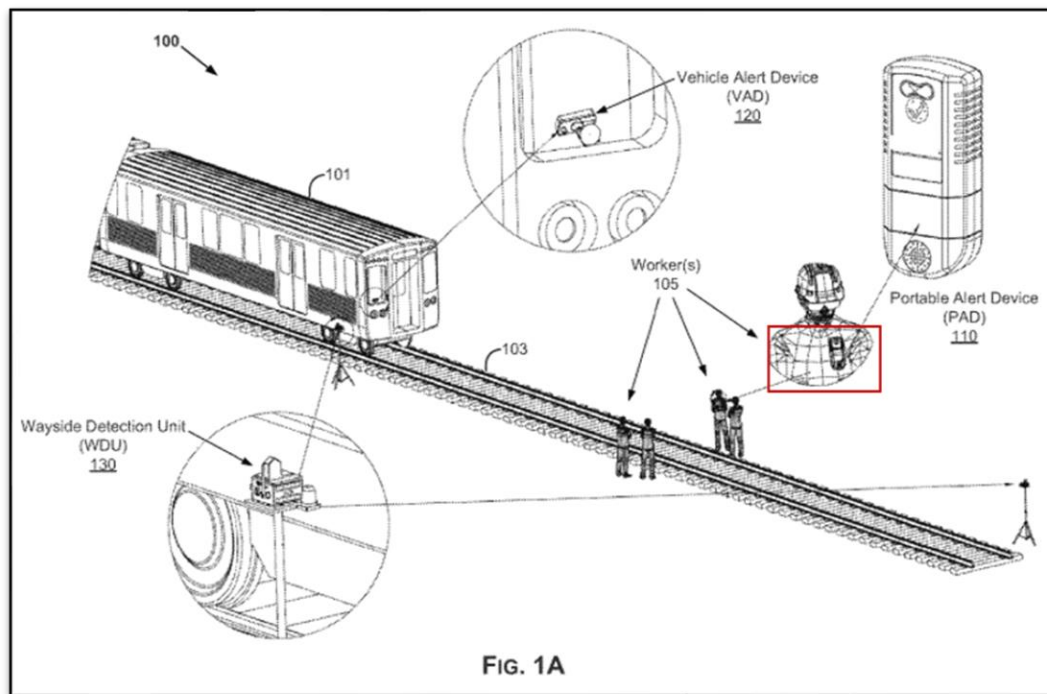


FIG. 1A, which I have annotated below, depicts the PAD attached to the worker:



40. The PAD comprises a “housing” for “enclosing various components of the PAD.” EX1001, 8:29-31. The PAD also contains “an integrated/internal power supply... for powering the various components of the PAD.” EX1001, 8:59-61. The ’595 patent explains that the “power supply” “may be rechargeable” (EX1001, 8:61-62), for example, rechargeable “batteries or similar power sources” (EX1001, 5:42-44). The PAD may also “support one or more power-saving modes” such as “transitioning to low functionality states, or completely shutting down.” EX1001, 5:54-60. For example, the PAD “may comprise a component (*e.g.*, accelerometer) for determining when the device is idle for an extended period of time.” EX1001, 5:65-6:1. The “accelerometer detects the lack of motion for a

period of time to enter the power-saving mode” and “return[s] to normal operating mode when movement is detected.” EX1001, 6:3-5.

41. The PAD comprises “one or more antennas” “configured for transmitting and/or receiving signals” such as “broadcast[ing] alert related signals” to vehicle VADs (discussed above, § V.A.2) and/or wayside WDUs (discussed below, § V.A.4). EX1001, 8:52-55. The PAD “may incorporate diversity antennas of identical or differing polarity, to improve signal reception reliability.” EX1001, 6:38-40.

42. The PAD includes “warning component[s],” such as an “audio warning component” like a “speaker,” a “visual warning component” like an “LED indicator,” and/or a “tactile indicator component” for “vibration.” EX1001, 3:5-10. The PADs “provide alerts regarding approaching vehicles that may pose safety threats to workers at particular locations.” EX1001, 8:17-21. For example, the PAD provides “one or more of visual, audio, and tactile indications” (EX1001, 9:22-24) when “issu[ing] an indication... to alert the worker... of an approaching object” (EX1001, 3:5-10). The alert indications “may continue until acknowledged by the workers.” EX1001, 7:52-55. For instance, the “audible alarms [will] continue until silenced” until the worker “hit[s] a ‘confirm’ button.” EX1001, 7:52-55. The PAD “may, in response to receiving user confirmations, generate and transmit acknowledg[ment] messages” to WDUs. EX1001, 9:31-35.

43. Further, the PAD “may be configurable to provide alerts adaptively based on a particular pre-set conditions—*e.g.*, to provide at least a 15 second warning in line of sight conditions, when a train is approaching at 60 mph.” EX1001, 3:17-21. “[M]ultiple threshold types may be used.” EX1001, 4:47-48. For instance, “at low speeds, below a configurable speed threshold, the workers will not get a TTA [*i.e.*, time-to-arrival] or DFT [*i.e.*, distance-from-train] alerts; rather, the alert triggering is held off until the train/vehicle comes within a programmed short distance.” EX1001, 4:53-56. Thus, alerts may be triggered “when a preset (programmed) alert trigger threshold is satisfied,” such as when a “vehicle’s speed exceed[s] [a] particular limit” or the “distance to workers fall[s] below [a] particular value.” EX1001, 4:44-47 .

44. In setting up “particular pre-set conditions” (EX1001, 3:17-21), “particular areas/locations” may be a factor for the “operator (*e.g.*, a transit agency)” to “modif[y] alerting rules.” (EX1001, 4:60-66). The PAD can be “reconfigured...by the use of (re-)customization stations at entry points to those areas/locations,” in which the “rules are... updated” after the PAD is “placed in proximity to the customization stations briefly.” EX1001, 4:66-5:7. The “PAD charging station” may “support and/or facilitate exchange of data with the PADS,” such as the “input of data into the PAD” like “(re)configuration data.” EX1001, 10:3-7.

45. The PAD comprises “circuitry... for performing various actions in support of its functions.” EX1001, 9:4-5. For example, circuitry is “operable to store data (including code); run and/or execute various applications and/or functions (alert related); handle transmitted and/or reception of signals (and processing transmitted and/or received signals); provide power management; manage logging operations in the PAD” and “handle input/output functions (*e.g.*, supporting different forms of alert indications, including visual, audio, and/or tactile, and handling user input, such as acknowledge[ment] of alerts.” EX1001, 9:6-14. The PAD may also “comprise circuitry for data recording and/or logging,” which may be used “for training, for location tracking, and/or even for even recreating (*e.g.*, during accident investigation).” EX1001, 6:9-13. The “log files” comprise” information about “alerts as well as related events and/or activities” like “users’ responses, such as alert silencing actions.” EX1001, 6:13-19.

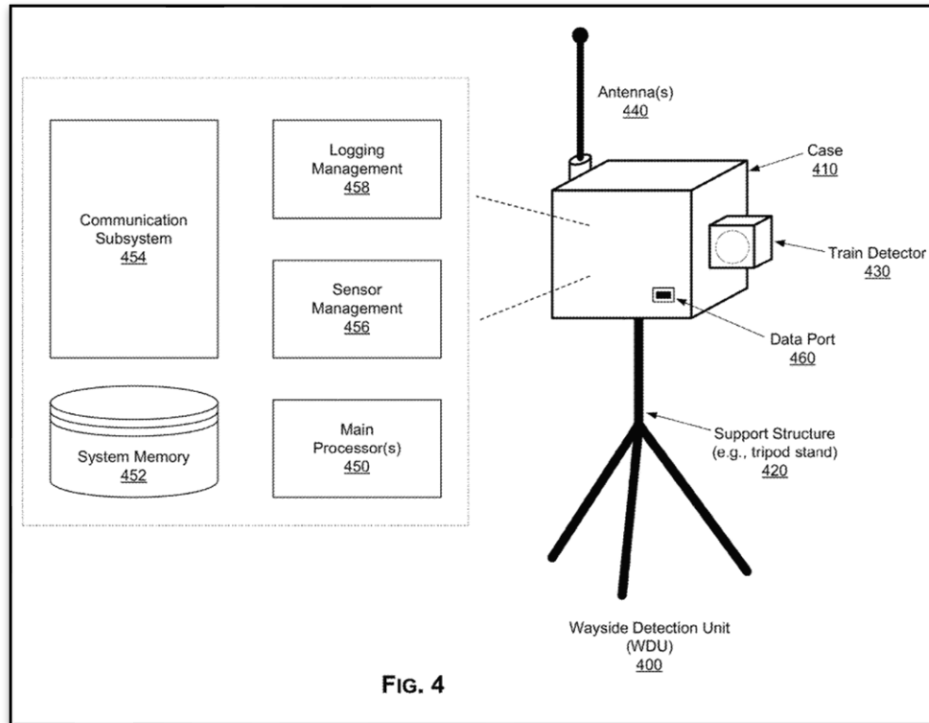
46. The PAD also has circuitry that “process[es]... received signals (9:8-9) transmitted by “the companion alert device” (EX1001, 16:32-37). Using this and transmitter circuitry, the PADs “communicate with one or more companion [alert] devices, which are configured to directly trigger (and transmit signals causing issuing of alerts by the PADs...) alerts, or transmit signals causing issuing of alerts by the PADs.” EX1001, 2:39-42. The PADs may also, “in response to receiving user confirmations, generate and transmit acknowledge[ment]

messages[] to other alert devices” such as WDUs, VADs, and/or other PADs.

EX1001, 9:27-35. The PADs may also “relay alerts (*e.g.*, of approaching trains) to other devices nearby... that may have not been able to receive the signals/alerts directly.” EX1001, 6:56-62.

4. Wayside Device Units (WDUs)

47. The WDUs (FIG. 4 below) are “devices that are placed in a ‘wayside’ manner,” such as “along or near path of the approaching... train” (*e.g.*, near “the worksite”). EX1001, 2:43-51. The WDU “provide redundant warning capabilities” for “additional range” (EX1001, 2:61-64) or for “increased distance” (EX1001, 3:30-34). WDUs “typically... comprise (or can be coupled to) a support structure... such as a rigid tripod... [for] placement of the WDU... near train tracks.” EX1001, 14:23-26. The WDUs “comprise a housing... for enclosing various components of the WDU... and/or allowing attachment to certain external elements or structures” (EX1001, 14:5-8) such as an antenna.



48. To “detect[] approaching vehicles” and “trigger[] alerts at [PADs]” (EX1001, 13:62-14:4), the WDU comprises “antenna(s)” which are “configured to support broadcast of alert related signals.” EX1001, 15:11-14. The antenna(s) “transmit[s] and/or receiv[es] signals (*e.g.*, broadcast[s] alert related signals).” EX1001, 14:15-17. The WDU may also “relay alerts... to other devices nearby, thus improving the field strength of warning signals, by increasing the probability that all nearby PADs... receive the alerts (even devices that may not have been able to receive the signals/alerts directly.” EX1001, 6:56-62.

49. The WDU also comprises a “power supply” (EX1001, 5:49-42) and “circuitry for performing various operations in support of its function[s]” (EX1001, 13:51-14:15). For instance, the “main processor” is “operable to process data,

and/or control and/or manage operations of the WDU... and/or tasks and/or applications performed in the WDU.” EX1001, 14:33-36. The main processor also “enable[s] running and/or execution of applications, programs, and/or code.” EX1001, 14:43-46. Further, the WDU comprises a “sensory management component” (EX1001, 15:15) which includes “suitable circuitry for managing sensors, such as a train detector” (EX1001, 15:15-17). The train detector may “monitor, detect, and track [an] approach[ing] vehicle, using one or more suitable technologies” such as “visual,” “infrared” or “laser ranging.” EX1001, 14:18-23. The sensor management component, in turn, may “process information obtained via the train detector... to generate corresponding data” such as the “distance to [the] approaching train” or “relative speed” of the train. EX1001, 15:17-23.

B. Prosecution History of the '595 Patent

50. The application that became the '595 patent was filed on March 23, 2016 though it purports to claim priority to a provisional application No. 62/177,683, filed on March 23, 2015. EX1001, 1:5-10. I have not been asked to determine whether the challenged claims of the '595 patent contain written description support in provisional application No. 62/177,683 and, instead, have been asked to assume for purposes of this declaration only, that the challenged claims are entitled to a priority date of March 23, 2015.

51. I have reviewed the prosecution history of the '595 patent (EX1002). The as-filed application included 30 claims. EX1002, 166-172. The Examiner initially rejected claims 1-20 over U.S. Patent Application 2011/0006912 ("Sheardown"). EX1002, 62-69. Specifically, the Examiner rejected claims 1, 7, 8, 12, 15, and 20 under 35 U.S.C. 102 as being anticipated by Sheardown. EX1002, 63-65. The Examiner also rejected claims 2-5, 6, 9, 10, 13, 14, 16, 17, and 19 under 35 U.S.C. 103 as being unpatentable over Sheardown in view of other prior art references. EX1002, 65-68.

- Claims 2-5 were rejected as obvious over Sheardown in view of U.S. Patent Application 2014/0045547. EX1002, 65-66;
- Claims 6, 13, and 14 were rejected as obvious over Sheardown in view of U.S. Patent Application 2011/015397. EX1002, 66-67;
- Claims 9, 10, 13, 16, 17, and 19 were rejected as obvious over Sheardown in view of U.S. Patent Application 2012/0296562 ("Carlson"). EX1002, 67-68.

52. For reasons unknown and unclear from the prosecution history, the Examiner appeared to believe only claims 1-20 were pending and thus failed to address independent claims 21 and 27 and their respective dependent claims 22-26, and 28-30, respectively, at all. EX1002, 62. Metrom, in its response to the office

action, noted that “[i]t is unclear if this [was] an oversight” by the Examiner.

EX1002, 31.

53. Following the rejection, Metrom amended claim 1 into its issued form by limiting the “personal alert device” of the first claimed system to one that received signals from a companion device, “wherein the companion alert device is deployed locally in proximity of the personal alert device and/or within vehicles operating in areas serviced by workers.” EX1002, 24. Metrom argued that this was not taught by Sheardown. EX1002, 32-33. Moreover, because the obviousness rejections relied on the teachings in Sheardown in combination with the disclosures in other prior art, the Applicant argued that claims rejected under 35 U.S.C. § 103 were patentable. EX1002, 35-36. The Examiner then allowed claims 1-30 without providing reasoning and without ever substantively examining claims 21-30. EX1002, 4.

C. The Challenged Claims

54. I have been asked to provide my opinions regarding claims 1-30 (the “challenged claims”). Section VII below includes a Claim Listing of claim 1-30 with annotations added to label claim limitations. The challenged system claims are directed to one of the three companion devices discussed in the specification. As I discuss below:

- Independent claim 1 and its dependent claims 2-19 recite a system that includes a “wearable personal alert device.”
- Independent claim 20 and its dependent claims 21-26 recite a system that includes a “vehicle-mounted alert device.”
- Independent claim 27 and its dependent claims 28-30 recite a system that includes a “wayside detection unit.”

55. Each independent claim recites basic components that its respective device includes (*e.g.*, “a housing,” “antennas,” “circuits”) and describes alert-related operations the device performs, *e.g.*, “generate, in response to signals received from the companion alert device, a safety alert” (claim 1), “broadcast alert triggering signals” (claim 21), or “broadcast, to one or more companion alert devices, alert related signals, relating to the approaching of [a] vehicle” (claim 27).

56. The dependent claims add conventional features of electronic devices, and well-known features of safety-alert systems. For example, the claims that depend from claim 1 (claims 2-20), are summarized as follows:

- claims 2-5 add conventional power-management techniques for battery-powered devices;
- claim 6 adds any well-known, prior art antenna-diversity technique;

- claims 7-8 add simple alert thresholds (*e.g.*, time-to-arrival of vehicles);
- claims 9-10 add conventional processing like forwarding and logging alert signals;
- claim 11 identifies the types of “companion alert device[s]” (*e.g.*, a vehicle-, wayside, or personal-alert device);
- claim 12 identifies conventional, generic “indicator components” (*e.g.*, “visual indicator”);
- claim 13-14 generically recite a “rechargeable power supply” (claim 13) that is “recharge[able] without direct connection” (claim 14);
- claims 16-17 recite an “acknowledge component” and communicating the acknowledgement, respectively;
- claim 18 generically recites a housing that “completely seals internal space enclosing components” and “charging the power supply” and/or “communication of data” “without direction connection”;
- claim 19 recites “configurable alarm management for allowing setting and/or adjusting of rules” for “triggering and/or handling of alerts”: and

- claim 20 recites prior art GNSS satellite signals (*e.g.*, GPS) for determining location information for use in “at least one of the operations of the personal alert device.”

These, and other conventional features added by other dependent claims, were well-known and POSAs had reason to implement them in devices operating in systems for worker protection, meeting the challenged claims, as I discuss in Sections VII.A-VII.G below.

VI. CLAIM INTERPRETATION

57. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the claim. I discuss in the sections below the interpretations I have applied to certain claim terms, in accordance with the standards set forth in Section III above. For the reasons I discuss in Sections VII.A-VII.G below, it is my opinion that the prior art I consider in those sections plainly disclose the claim limitations without having to determine the exact outer boundary of the claim terms’ scope and meaning.

VII. THE CHALLENGED CLAIMS ARE UNPATENTABLE IN LIGHT OF THE PRIOR ART IDENTIFIED IN THE PETITION

58. I have been asked to provide my opinion concerning whether claims 1-30 of the ’595 patent are anticipated by or would have been obvious to a POSA in light of the prior-art. For the reasons explained below, it is my opinion that each

of claims 1-30 is anticipated by and/or would have been obvious to a POSA over the prior art discussed below.

A. Ground 1A: Claims 1, 7-15, and 19-25 are Anticipated by and/or Would Have Been Obvious Over Cross

1. Overview of Ground 1A

59. For the reasons I discuss below in §§ VII.A.3-18, it is my opinion that claims 1, 7-15 and 19-25 are anticipated by and/or would have been obvious over Cross (EX1007) in view of the knowledge of a person of ordinary skill at the time of the alleged invention of the '595 patent.

2. Cross (EX1007): PCT Application Publication No. WO 2013/056244 A1

60. According to the face of the document, Cross is an international application published under the Patent Cooperation Treaty (PCT) that published on April 18, 2013 (EX1007, code (43)), titled “Mass Transit Safety Notification System and Device” (EX1007, code (54)). Because Cross was published in 2013, I understand that Cross qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* '595 patent, code (60)). I understand that Cross was not cited during prosecution of the '595 patent. *See* '595 patent, code (56) (references cited).

61. Like the '595 patent, Cross discloses “a safety notification system and device” for workers in a mass transit system. Cross, Abstract,[001]-Summary,

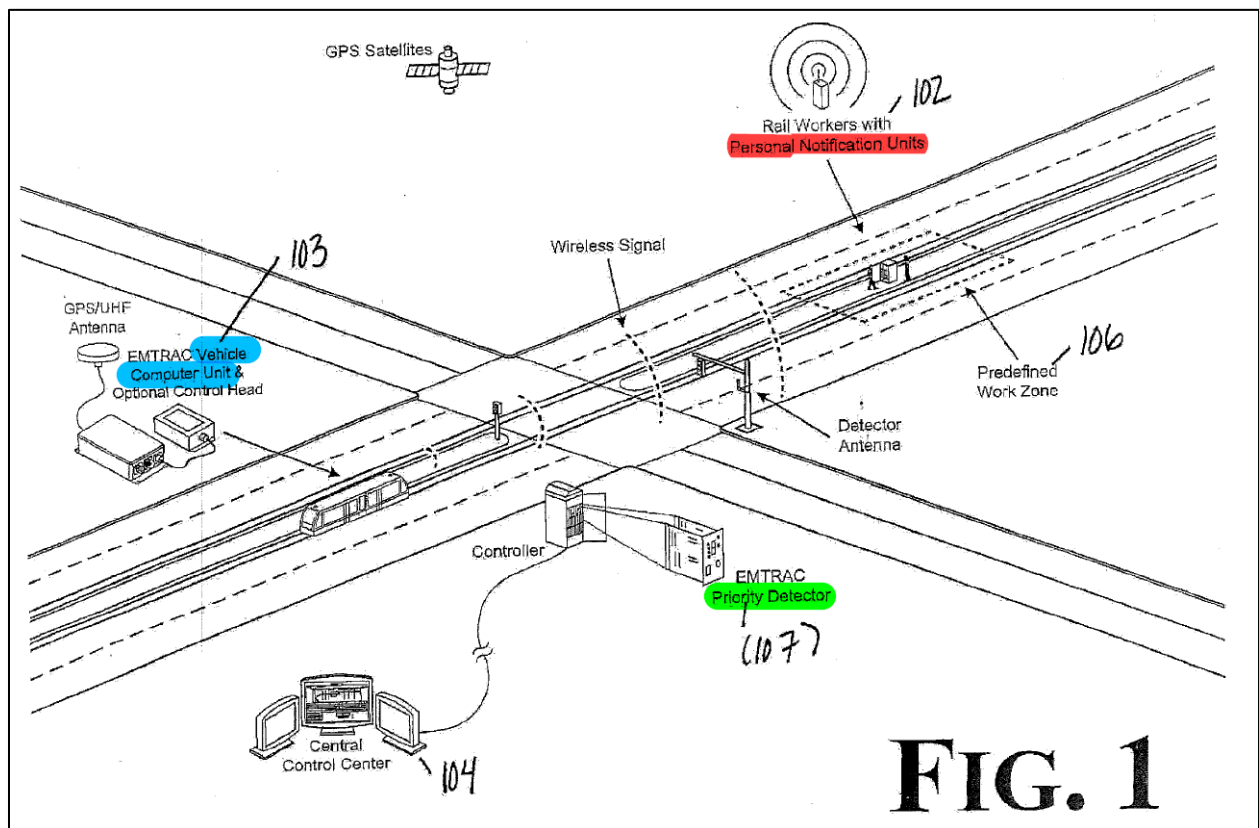
[026].¹ In Cross’s system, maintenance workers are warned of approaching trains and train-operators are warned of nearby workers. Cross’s “safety notification system and device (101)” can also be “integrated into existing systems known to those of ordinary skill in the art which monitor and control the operation of the mass transit system.” Cross, [026]. “[A]pplicable mass transit system include, but are not limited to, rapid transit... subway..., metropolitan railway, light rail,... dedicated bus and trains” (all referred to as “trains” in Cross for simplicity). Cross, [026]. The functionality of Cross’s safety system generally includes “1) alert[ing] mass transit, train, and road maintenance workers of an approaching mass transit vehicle; 2) alert[ing] train and mass transit vehicle operators when they are approaching an area where workers are located; and 3) inform[ing] administrators of the location of vehicles and workers within a traffic grid in real-time, among other safety functions for workers.” Cross, [001]-Summary.

62. Cross’s Figure 1 (below) illustrates “a perspective view of a diagram of the rail-maintenance safety notification system and device (101) in use with warning zones.” Cross, [021]. Like the system of the ’595 patent, Cross’s system

¹ I note that the paragraphs that are in the first two sections of Cross – Cross Reference to Related Application(s) and Background of the Invention – are numbered paragraphs [001] to [005] and then Cross’s Summary of the Invention Section restarts the paragraph numbering to [001]. That is, Cross’s “Background” (pp. 1-2) and “Summary of the Invention” (pp. 3-7) each include paragraphs [001]-[005]. To avoid confusion, I have included either “Background” or “Summary” to paragraph [001]-[005] citations, *e.g.*, [001]-Background or [001]-Summary.

relies on three companion devices: (1) “worker equipment unit, also known as the personal notification unit (PNU) (102)” (Cross, [029]); (2) “at least one mass transit equipment unit, also known as the vehicle computer unit (VCU) (103)” (Cross, [029]); and (3) “a plurality of priority detectors (107),” which “are wayside devices” (Cross, [049]).

63. Figure 1 (which I have annotated below) depicts an exemplary implementation of Cross’s system with all three companion devices—(1) a PNU; (2) a VCU; and (3) a wayside priority detector—in Cross’s system:



64. The PNUs and VCUs “are comprised of at least a receiver, a transmitter, a computer and a navigation system” (*e.g.*, GPS). Cross, [031]. In

operation, the PNUs and VCU are “consistently sending and receiving location-based packaged data over the network.” Cross, [030]; *see also* Cross, [029] (noting that the disclosed devices are “communicatively attached to each other over a network”). “Based upon this exchanged location-based data” and other information (*e.g.*, “route and bearing” of “vehicles in the grids” and/or the location of vehicles or PNU “relative to a designated warning area or route), an alert mode is triggered by the” PNU, the VCU, or the “central control server.” Cross, [030]. For example, when “an alert mode is triggered” by one or more devices, an “alert signal will be set off” to “notify a worker equipped with a PNU (102), a vehicle operator, or an administrator of a potentially dangerous interaction between an equipped worker and a vehicle.” Cross, [030].

65. The PNU is “a simple hardware device” that attaches to a worker using “a clip.” Cross, [045]. “The PNU (102) is generally a small, portable device capable of receiving GPS and transmitting its location data and storing detailed activity and alert logs, among other functions.” Cross, [041]. Cross’s Figure 2 (below) “provides a perspective view of an embodiment of a portable handheld PNU (102).” Cross, [022].



The PNU shown in Figure 2 is “a simple hardware device that can be carried by or attached to an individual rail-maintenance worker by a method known to” a POSA. Cross, [045]. The PNU can be “integrated into safety equipment worn by a rail maintenance worker including, but not limited to, helmets, belts and safety vests” or “in alternate embodiments, may simply be temporarily attached to the safety equipment by a pocket, clip or other applicable attachment modality known to” a POSA. Cross, [045].

66. The PNU “contains a power source,” which “include[s], but [is] not limited to” various known and rechargeable “batteries” and/or “self-contained power sources such as solar power, movement-based power generation, and energy harvesting,” which power the device and recharge the batteries without wires to an

external power source. Cross, [042]. The batteries can also be recharged at “PNU (102) charging stations.” Cross, [047].

67. The PNU also comprises a computer ([031]), which Cross describes broadly as “inclusive of all computational devices including, but not limited to, processing devices or processors, personal computers...portable computers, and hand held computers.” Cross, [032]. The PNU’s computer has “four main functions”:

- (1) “transmit[ing]... the location data of the worker equipped with the PNU (102) to the VCU (103), central control server (104), other PNUs (102), a plurality of signal controllers, a plurality of priority detectors (105), and/or other components of the network”;
- (2) “receiv[ing] communications and information” (*e.g.*, AVL packets, which I discuss below) from these other devices (*e.g.*, from VCUs, other PNUs and priority detectors);
- (3) “identify[ing] alert mode conditions” “based upon the location data received from the plurality of VCUs (103) in the system, the location of warning areas (106), the bearing of VCUs on pre-defined routes, and the location-data of the PNU (102), amongst other information transmitted over the system”; and

(4) “transmit[ing] audible, movement or visual warning to a worker when it determines an alert condition exists or when it receives an alert signal” from another device in the system. Example “audio, movement and visual alert signals include, but are not limited to, ultra bright LEDs, vibrations and high volume speakers,” whose “strength... can vary depending on the risk presented.”

Cross, [043]. For example, when the PNU “determines that an alert condition is present, the PNU (102) will go into alert mode,” wherein the PNU will “send[] out an alert signal” and “transmit a special high alert packet into the network and [to] each of the components of the network to notify them of the alert situation.”

Cross, [044].

68. As noted above, another component of Cross’s system is a vehicle-mounted VCU 103 (illustrated in FIG. 1 above as comprised of three separate components). Each VCU “is generally an onboard unit” that can be “integrated with a PTC [positive train control] system, that tracks real-time vehicle location, transmits approaching-vehicle alerts, receives signals from other components in the system (such as alert signals from PNUs), controls or has the ability to alter vehicle function, and stores activity logs.” Cross, [034]. The VCU’s are installed in vehicles “either permanent[ly], by direct integration into the mass transit vehicle—particularly into the PTC (102) of the particular mass transit unit and the overall

grid—or temporary], through a mobile receiver that can be taken into and removed from the vehicle.” Cross, [035]. The VCUs are “generally capable of sending communications to and receiving communications from” the other devices in the system (*e.g.*, PNUs (102), signal light controllers, and priority detectors (107)). Cross, [034]. For example, as I discuss below, the VCU (like the PNU) receives information (*e.g.*, alert signals) from other devices in the system (*e.g.*, PNUs), and also transmits its own “automatic vehicle location (AVL) packets” to those other devices. Cross, [036]-[038].

69. The VCUs also comprise a computer ([036]) that executes similar functionality as the PNUs. The VCU’s computer “functions to send safety signals to and receive safety signals from PNUs in the network, the vehicle operator, and operators at the central control server (106) monitoring the overall grid.” Cross, [036]. Based on “the inputs received” from other devices (*e.g.*, PNUs) and “knowledge of the route” and grid (*e.g.*, location of “warning areas (106)”), the VCU’s computer “functions to send safety signals to and receive safety signals from PNUs in the network, the vehicle operator, and operators at the central control server (106) monitoring the overall grid.” Cross, [036]. For example, “when... workers equipped with a PNU (102) are within a certain location, time, bearing, distance or velocity of a vehicle,” “an alert signal will be sent to an

approaching vehicle.” Cross, [036]. The VCU’s computer can then “instruct the train to gradually slow down.” Cross, [037].

70. Alerts may also be triggered when the VCU “send[s] automatic vehicle location (AVL) packets to the other components of the network, in particular to the plurality of PNUs (102).” Cross, [038]. The AVL “signal includes, but is not limited to, location-based information about the vehicle (*e.g.*, its velocity, acceleration, direction, route, bearing, etc.).” Cross, [038]. Information conveyed in AVL packets can be determined from “a GPS receiver (or other contemplated positioning system”). Cross, [035]. The AVL packets can be sent “automatically” or “in response to an event (such as the VCU receiving a signal from a PNU in the system)” and are “transmitted through the network to the plurality of PNUs (102).” Cross, [038]. The VCU’s computer also includes “monitor software which allows for the real-time monitoring and display of worker activity and locations on a user interface,” via an input/output (I/O) component that “can be located in the vehicle” or “via a mobile interface known to [POSAs], such as a tablet computer or smart phone.” Cross, [039]. The VCU’s computer also includes “the capability to create detailed logs and reports which show worker location and alert histories along the route.” Cross, [039]. The VCU’s computer can also function to provide “PNU warning,” whereby “a signal is sent to a given PNU (102), warning of an impending mass transit vehicle.” Cross, [040].

71. The priority detectors are “wayside devices capable of receiving radio frequency (RF) signals and forwarding the received data through the network to a plurality of signal controllers, a plurality of VCUs, a plurality of PNUs, the centralized control server and other known and contemplated components of the network.” Cross, [049]. The priority detectors are “located at various locations along particular vehicle’s route.” Cross, [049]. Cross discloses that “one common location for priority detectors (107) will be at or in close proximity to intersection” (Cross, [049]), though Cross does not limit the priority detectors to intersections. The priority detectors generally “function as intermediaries in the overall system (101)” by “receiving signals from” devices (*e.g.*, PNUs and VCUs) and “forwarding the real-time vehicle and worker activity and alert notifications received in these signals to” devices (*e.g.*, PNUs and VCUs). Cross, [049].

3. Claim 1

a. [1PRE] 1. A system for worker protection, the system comprises:

72. If the preamble of claim 1 is a limitation of the claim, Cross discloses it. Cross discloses “a safety notification system” for protecting “maintenance workers” and workers on trains from being injured from collisions. Cross, [001]-Summary. As I discuss further below (§ VII.A.3.g), worker protection occurs by, for example, “notify[ing] roadway maintenance workers of an approaching mass transit vehicle and, conversely, [] notify[ing] the operators ... of mass transit

vehicles of roadway maintenance workers within the vicinity of an approaching section of track.” Cross, [002]-Background (Background of the Invention). *See also* Cross, [046] (disclosing that PNU works with other devices “to identify potentially unsafe conditions and also alert maintenance, construction, and first-response personnel when potentially unsafe conditions exist”), [050] (disclosing that wayside priority detectors forward “real-time vehicle and worker activity and alert notifications”).

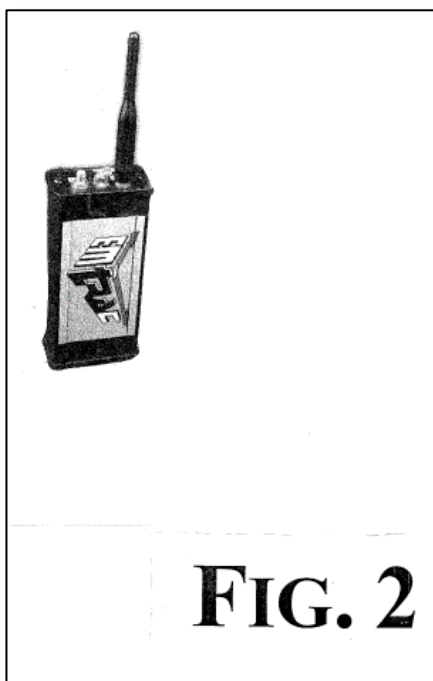
73. Thus, Cross discloses a system for worker protection, as claimed.

**b. [1A] a compact wearable personal alert device,
configured for use by a worker,**

74. As discussed above (§ VII.A.2), Cross’s system comprises Cross’s “personal notification unit (PNU).” Cross, [029]. Each PNU is a “small, portable device” ([041]) that is “integrated into safety equipment worn by a rail maintenance worker” (*e.g.*, “helmets, belts and safety vests”) by “attach[ing] to the piece of safety equipment” (Cross, [045]); *see also* Cross, [002]-Summary (disclosing that individuals are “equipped with the personal notification units”), [022] (disclosing that FIG. 2 “provides a perspective view of” a PNU), [061] (disclosing various alert notifications to workers when in an alert mode), FIG. 2. The PNU is thus a compact wearable personal alert device that is configured for use by a worker, as claimed.

c. [1B] the personal alert device comprising: a housing for enclosing components of the personal alert device;

75. Cross's PNU is a "hardware device," and as such comprises a housing that encloses the device's components, like its transmitter/receiver that I discuss in § VII.A.3.f below. Cross, [045]. Cross's Figure 2 (copied below) illustrates the hardware housing enclosing the components of the PNU, as claimed:



d. [1C] an attachment structure for attaching the personal alert device to the worker or an item used by the worker;

76. Cross discloses that the PNU "may be temporarily attached to the [worker] safety equipment" using a "clip or other applicable attachment modality." Cross, [045]. The "clip or other applicable attachment modality" is an attachment structure, as claimed. For example, the '595 patent's claim 15, which depends

from claim 1, recites that the “attachment structure comprises **a clip** structure.”

Alternatively, Cross discloses that exemplary “safety equipment” to which the PNU is attached are items worn and used by the worker, like “helmets, belts and safety vests.” Cross, [045]. A POSA would understand that a clip on the housing in Cross’s FIG. 2 would conventionally either slide over a pocket or clip around a belt ring on the worker’s belt, as was conventional for portable electronic devices like the one illustrated in Figure 2. Thus, the attachment structure (*e.g.*, clip) is for attaching the PNU to the worker or an item used by the worker, as claimed.

e. [1D] a power supply for powering components of the personal alert device;

77. Cross discloses that the PNU “contains a power source” for power components of the PNU device. Cross, [042]. Exemplary power sources include various batteries (*e.g.*, “lithium ion batteries”) and “self-contained power sources such as solar power.” Cross, [042], [063] (disclosing that the PNU “will require only occasional battery recharging”). Thus, the PNU comprises a power supply (*e.g.*, batteries and/or solar power source) for powering components of the PNU alert device, as claimed.

f. [1E] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;

78. As discussed above (§ VII.A.2), the PNU includes a transmitter and a receiver. Cross, [031]. The transmitter is “an electronics device which produces

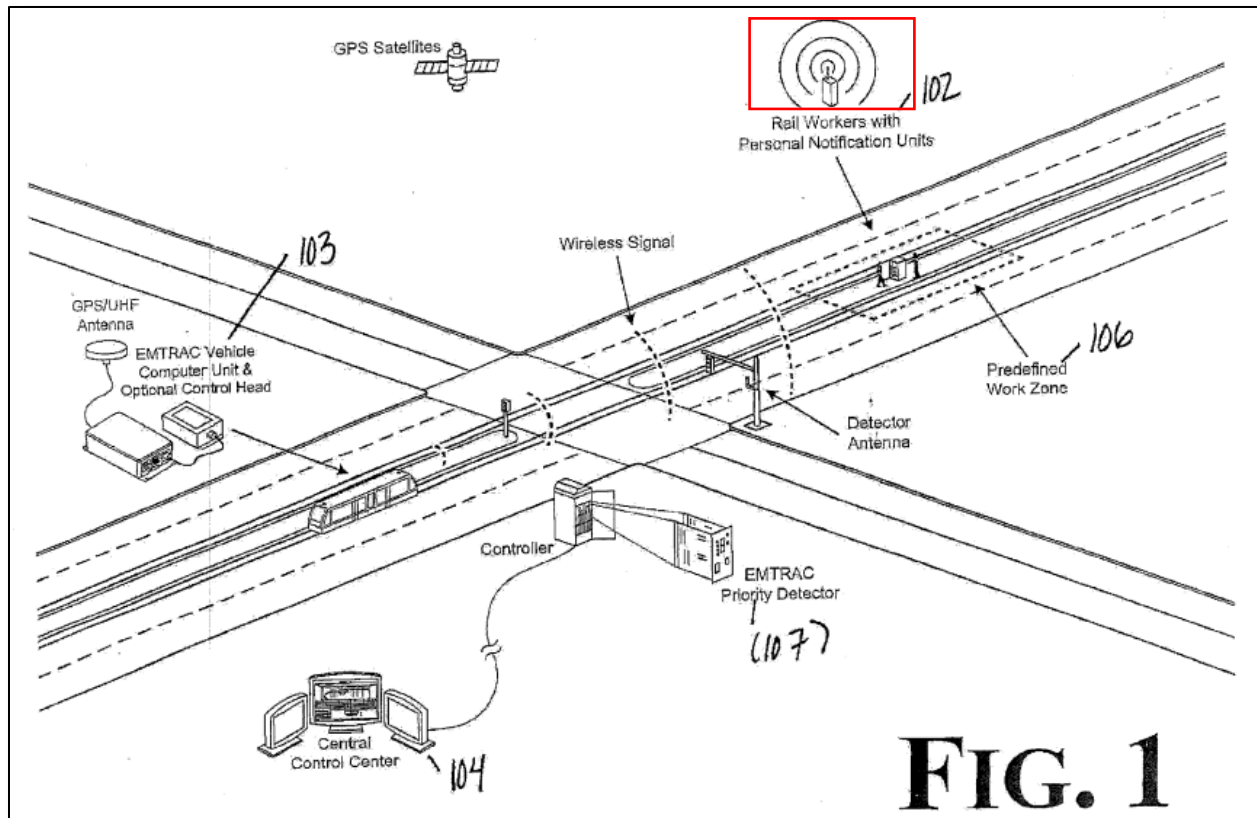
radio waves” as “known to those skilled in the art” and the receiver is “electronic circuit known to those of skill in the art that is capable of receiving radio signal inputs.” Cross, [031]. The transmitting and receiving functionality can also be implemented in a transceiver that both sends and receives wireless communications to other devices (*e.g.*, VCUs). Cross, [041]. A POSA understood that the radio waves that the PNU transmits and receives are wireless signals. For example, Cross at [048] discloses that the devices are linked by a “wireless network” and Cross’s Figure 1 illustrates a “wireless signal” emanating from the vehicle’s VCU and a POSA would understand that the dashed circles surrounding the PNU in Figure 1 are wireless signals.

79. A POSA would have understood that transmitting and receiving wireless signals in wireless communication devices—like the PNU—conventionally requires antennas to transmit and receive wireless signals. My opinion is corroborated, for example, by EX1017 at [0002], which teaches that “an antenna **is needed** to give a wireless communication function to a small mobile device.” (Emphasis added). Similarly, EX1018 at [0005] teaches that “[i]n a wireless transmission system, an antenna **is needed** for transmitting and receiving electromagnetic waves.” (Emphasis added). Likewise, EX1019 at [0004] teaches that in a wireless communication device “an antenna is **a necessary unit.**” (Emphasis added).

80. A POSA would have understood that the antenna in Cross's PNU is depicted in Figure 2, which I have annotated below to show the antenna element extending from the PNU:



81. Cross's Figure 1 (which I have annotated below), likewise illustrates wireless signals centered around and radiating from the PNU's vertical component, which reinforces to a POSA that the vertical component is the PNU's antenna.



I note that the '595 patent's FIG. 1B illustrates wireless signals emanating from antennas (*e.g.*, WDU antennas) in similar ways to Cross's FIG. 1.

82. Thus, for the reasons above, Cross's PNU (the personal alert device) comprises a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals, as claimed.

g. [1F] one or more indicator components, for outputting alert indications; and

83. Cross discloses that "when an alert mode is activated in the system certain alert signals will be set of" to "notify a worker equipped with a PNU." Cross, [030]. Cross discloses that the PNU "can transmit audible, movement or

visual warning when it determines an alert mode exists or when it receives an alert signal” from another device in the system (*e.g.*, VCUs or wayside priority detectors). Cross, [043]. These “alert signals” (*i.e.*, alert indications) are output by corresponding indicator components, like “ultra bright LEDs, vibrations and high volume speakers.” Cross, [043]; *see also* Cross, [044] (teaching that when a PNU “determines that an alert condition is present” the PNU will “send[] out an alert signal”), [057] (“alert mode”), [059] (discloses that the PNU’s “alerts signal” can include “a low beep” when operating in “fail safe alert mode”). Thus, Cross’s PNU (the personal alert device) comprises one or more indicator components (*e.g.*, “LEDs” and “speakers”), for outputting alert indications (*e.g.*, “audio...visual alert signals”), as claimed.

h. [1G] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the personal alert device;

84. The ’595 patent broadly defines a “circuit” as “physical electronic components,” *e.g.*, a “processor and memory,” and “software” associated with, executed by, or which configures the components. EX1001, 1:63-2:4.

85. Cross’s PNU includes a “computer” (Cross, [031]), which Cross broadly describes as a device that is “inclusive of all computational devices,” including “processing devices or processors” (Cross, [032]). Thus, Cross’s “processor” (and the software it executes) is a physical electronic component, that

is a “circuit” under the broad use of “circuit” in the ’595 patent. A POSA would have also understood that computational devices like Cross’s processing devices or processors conventionally comprised numerous circuits operable to process signals and data, as claimed.

86. The PNU’s computer “serves four main functions.” Cross, [043]. These functions relate to operations of the PNU device like “transmit[ting]...location data of the worker,” “identify[ing] alert mode conditions,” and “transmit[ting] audible, movement or visual warnings to a worker when it determines an alert condition exists.” Cross, [043]. Each of these functions relating to operations of the PNU is performed by the PNU’s computer processing signals and data, as claimed (*e.g.*, processing alert signals and alert-triggering signals received from VCUs, which I discuss further below in section § VII.A.3.i).

87. Thus, Cross’s PNU (comprises one or more circuits operable to process signals and data (*e.g.*, a computer and associated processor), and to perform one or more applications or functions relating to operations of the personal alert device (*e.g.*, like determining whether to enter an alert mode and produce corresponding alert signals), as claimed.

- i. **[1H1] wherein the personal alert device is operable to: process signals received from a companion alert device, wherein the companion alert device is deployed locally in proximity of the personal alert device and/or within vehicles operating in areas service by workers;**

88. As discussed above (§ VII.A.3.f), the PNU includes a receiver or transceiver that “receiv[es] communications,” *i.e.*, wireless signals, from companion alert devices like VCUs and wayside priority detectors. Cross, [041], [043] (explaining that PNUs receive “communications and information” from VCUs). As I discussed above (§ VII.A.2E), Cross’s FIG. 1 illustrates the VCUs are devices within vehicles operating in areas serviced by workers (as claimed) and the wayside priority detectors are devices deployed locally in proximity of the PNU (as claimed). Cross, [029]-[030]. *See also* Cross, [034] (disclosing that the VCU sends communications to and receives communications from PNUs).

89. Among the communications the PNU receives from VCUs are “automatic vehicle location (AVL) packets.” Cross, [038]; *see also* Cross, [040] (disclosing that VCUs send PNUs signals that “warn[] of an impending mass transmit vehicle”). The PNU also receives signals from wayside priority detectors/units, for example, the wayside devices “forward[] the real-time vehicle ... and alert notifications in the[] signals” the priority detector receives from other devices (*e.g.*, VCUs). Cross, [049]. As I discuss below in §§ VII.A.3.j – VII.A.3.k ([1H2-1H3]), the PNU processes the signals it receives from these companion

devices to “determine[] whether to enter an alert mode.” Cross, [056] (disclosing that a PNU determines whether to enter an alert mode in a warning area based on processing an “(AVL) from an approaching vehicle”); *see also* Cross, [061] (PNU “determined whether or not an alert mode needs to be triggered” based “[u]pon the exchange of” information received in wireless signals from other devices).

90. Thus, Cross’s PNU is operable to process signals received from a companion alert device (*e.g.*, a VCU or priority detector), wherein the companion alert device is deployed locally in proximity of the personal alert device (*e.g.*, priority detector(s)) and/or within vehicles operating in areas service by workers (*e.g.*, VCUs), as claimed.

j. [1H2] generate, in response to signals received from the companion alert device, a safety alert; and

91. Cross discloses that that the PNU takes certain actions in response to “receiv[ing] communications and information” from companion alert devices, like VCUs or wayside detectors. Cross, [043]; *see also* Cross, [049] (disclosing that wayside priority detectors forward “real-time vehicle and worker activity and alert notifications received in these signals” to PNUs). The communications and signals received from companion alert devices include AVL packets comprising information about (*e.g.*, location of) approaching vehicles. *See* Cross, [043]-[044], [050]. *See also* § VII.A.4 below. Based on the AVL packets received from VCUs and/or priority detectors, the PNU’s computer “can identify alert mode conditions”

(Cross, [043]) and if such a condition exists, the PNU “will go into alert mode” (Cross, [0044]). *See also* Cross, [056] (disclosing that the PNU processes received AVL packets to “determine[] whether to enter an alert mode”).

92. The determination that an “alert mode” exists is a “safety alert” that the PNU’s computer generates in response to received signals from the VCUs and/or wayside detectors (*e.g.*, AVL packets received from these devices). Thus, Cross’s PNU is operable to generate, in response to signals received (*e.g.*, AVL packets) from the companion alert device (*e.g.*, the VCU and/or wayside priority detector), a safety alert (*e.g.*, an alert mode condition and the data and signals associated therewith), as claimed.

k. [1H3] output, via the one or more indicator components, one or more alert indications to the worker based on the safety alert.

93. Once the PNU “determines an alert condition exists” and has entered alert mode, the PNU’s computer outputs “audio, movement and visual alert signals” via its indicator components that I discussed above in § VII.A.3.g, the PNU’s “LEDs, vibration[al components] and...speakers.” Cross, [043]. As discussed above (§ VII.A.3.j), determining whether an alert mode condition is based on the safety alert generated by the PNU. *See* Cross, [056] (PNU “will trigger a warning call, as discussed previously, to notify the equipped worker of the high risk event”), [061] (“**Upon activation of the alert mode, the PNU (102) will**

trigger an alert signal and notify the worker, via audio, movement, visual or other signals” (emphasis added)). Thus, the physical alert indications output by the indicator components are based on the existence of an “alert mode” (*i.e.*, based on the safety alert). Accordingly, Cross’s PNU is operable to output, via the one or more indicator components (*e.g.*, LEDs and speakers), one or more alert indications to the worker (*e.g.*, lights and sounds) based on the safety alert generated by the PNU, as claimed.

* * *

94. Accordingly, for the reasons discussed above in §§ VII.A.3.a-VII.A.3.k, in my opinion Cross meets every limitation of claim 1.

4. Claim 7: The system of claim 1, wherein triggering of alerts and/or broadcast of signals triggering of the alerts is based on one or more types of alert thresholds.

95. Cross discloses that the PNU identifies whether an “alert mode condition” exists based on information the PNU receives, such as an AVL packet that identifies the location of a train equipped with a VCU. Cross, [043]-[044], [050]. As discussed above in § VII.A.3.k, an alert mode condition triggers the PNU to generate alert signals. Cross, [043]-[044], [050]. For example, “an alert mode is triggered by the PNU [] when, based on the AVL packet received by the approaching vehicle, it is determined that the PNU [] is within a....***defined***

estimated time of arrival of the approaching vehicle.” Cross, [057]² (emphasis added). The “defined estimated time of arrival,” which “can be modified and changed at the level of the PNU” ([057]), is an alert threshold, as claimed, because if the ETA is greater than the defined ETA alert mode is not triggered. In addition to ETA, another type of alert threshold used to determine whether to trigger alerts is “a given distance away” from the PNU. Cross, [061]. The selected (*i.e.*, “given”) distance away is the alert threshold. Cross at claim 19 similarly discloses an “alert mode” that is triggered based on a “certain defined variable” (*i.e.*, threshold).

96. Thus, Cross’s system meets triggering of alerts that is based on one or more types of alert thresholds, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 7.

² I note that Cross at [057] refers to “the AVL packet received **by** the approaching vehicle.” However, a POSA would understand that this is a clear-typographical error that a POSA would mentally substitute to say “**from** the approaching vehicle” because Cross is clear that AVL packets – automatic **vehicle** location packets – are generated by the VCU in vehicles, not in PNUs (which receive AVL packets). See, *e.g.*, Cross, [038] (“the **VCU (103)** will also **send** automatic vehicle location (AVL) packets **to** the other components, in particular **to** the plurality of PNUs (102)”), [043] (“the computer of **the PNU (102)** **receives** communications and information **from the VCU** ... [s]uch information includes, but is not limited to, the AVL of vehicles in the grid”); [056] (“Upon **receiving** an automatic vehicle location packet (AVL) **from an approaching vehicle**, the PNU”); [059] (“If a **PNU receives** a AVL packet **from a VCU**....”).

5. **Claim 8: The system of claim 7, where the one or more types of alert thresholds comprise time-to-arrival (TTA), distance-from-train (DFT), and low-speed close proximity distance alert (CPD).**

97. As I discussed above for claim 7 (§ VII.A.4), one exemplary alert threshold the PNU utilizes is estimated time of arrival of the vehicle to a worker location (Cross, [057]), which is time-to-arrival, as claimed. *See also* Cross, [055] (noting that PNUs “can be set up and adjusted to alert at a certain ETA (*e.g.*, **20 seconds prior to arrival**),” *i.e.*, a 20-second time-to-arrive (TTA) (emphasis added)). Another threshold that I discussed above is the vehicle’s “distance away” from the PNU (Cross, [055]), which is distance-from-train (DFT), as claimed. Because the plain language of claim 8 is satisfied based on just “one” type of alert threshold, either of the types of alert thresholds discussed above (time of arrival and distance away) meet claim 8. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 8.

6. **Claim 9: The system of claim 1, wherein the personal alert device is operable to communicate with one or more nearby alert devices, to forward received signals and/or alerts generated in response to the received signals among the personal alert device and the one or more nearby alert devices.**

98. Claim 9 recites, in part, that the PNU is operable “to forward received signals and/or [forward] alerts generated in response to the received signals.” A POSA would understand that “alerts generated in response to *the* received signals”

refers to the safety alert generated in limitation [1H2] above. Because that safety alert is generated by the personal alert device, which claim 9 says can forward the alert to other devices, POSAs would understand that in context of claim 9 “forward” includes transmitting signals generated by the personal alert device itself.

99. As I discussed above in §§ VII.A.4-VII.A.5 with respect to claims 7-8, a PNU will trigger an “alert mode” based on the location of an approaching vehicle (*e.g.*, time of arrival to and/or distance away from the PNU). Cross, [057], [055]. As I discussed above in § VII.A.3.j ([1H2]), when the PNU enters an “alert mode,” the PNU will “transmit a special high alert packet into the network and [to] each of the components of the network.” Cross, [044]. Thus, the PNU is operable to forward alerts (high alert packets) generated in response to the received signals (generated in response to AVL packets, *see* § VII.A.3.j above), among the personal alert devices and nearby alert devices (*e.g.*, other PNUs, VCUs, and wayside priority detectors), as claimed.

100. Alternatively, Cross teaches devices in the system forward signals received from other devices. Specifically, Cross describes using wayside priority detectors in certain locations in the system to forward “the real-time vehicle and worker activity and alert notifications received in these signals to” VCUs and PNUs. Cross, [049]. In view of Cross’s teaching, POSAs would have had reason

to provide each component in Cross's system—including PNUs—with the same ability to forward received signals—*e.g.*, AVL packets from VCU—to nearby companion devices, like nearby PNUs and VCUs. Given noises and interferences typically present with wireless communication, a POSA would have understood that one PNU would have sometimes received an AVL packet from an approaching vehicle but the same AVL packet might not have been received by another nearby PNU that was equally at risk of collision with the vehicle. Thus, a POSA would have understood that having additional devices in the system (like PNUs) forwarding alert-triggering signals improves worker safety by better ensuring that all at-risk workers received timely alert-triggering signals at their PNUs.

101. POSAs also had reason to forward alert triggering signals (*e.g.*, AVL packets) received by PNUs to other PNUs and other nearby alert devices, because it would have been using a known technique (forwarding received signals) to improve similar devices (portable safety devices) in a predictable way (by increasing the likelihood that all safety devices received alert-triggering signals). For documentary evidence corroborating my testimony regarding a POSA's background knowledge in the art, I note that EX1020 at [0070] taught having a personal digital assistance (PDA) device—which is a small portable electronic device—“operate as a repeater unit for relaying data [*i.e.*, forwarding data] from

other PDA devices 10 located in relatively close proximity.” EX1020 notes that doing this allows the network to “achieve greater transmission distance.” EX1020, [0070]. EX1020 further notes that this is useful in situations where a “firefighter may be in an area of a building from which direct communication with his wireless LAN 70 is impossible or unreliable” but each PDA is still able to communicate and thus relay important data. As I discussed above, a POSA would have understood that a similar situation could occur in Cross’s system: a PNU is not receiving alerts or alert triggering signals but is in wireless communication range of another PNU that is. Similarly, EX1021 at [0114] discloses “improving safety conditions in hazardous environments” is achieved by using peer-to-peer communication for “relaying of public safety information.” Thus, EX1020 and EX1021 corroborate my testimony that forwarding data among portable electronic devices was a known and useful technique for improving safety systems based on wireless communication, like Cross’s.

102. POSAs would have reasonably expected success in using their ordinary skill to have Cross’s PNUs forward AVL packets to other devices because the PNUs were already capable of transmitting and receiving wireless signals (*see* § VII.A.3.f above) and Cross already discloses forwarding signals using wayside priority detectors (Cross, [049]). Forwarding alert-triggering signals like AVL

packets would thus not have required any additional components in the PNU devices.

103. Thus, for the above reasons, it would have also been obvious to a POSA to have Cross's PNU be operable to communicate with one or more nearby alert devices, to forward received signals and/or alerts generated in response to the received signals among the personal alert device and the one or more nearby alert devices, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 9.

7. Claim 10: The system of claim 1, wherein the personal alert device is operable to log data relating to alerts triggered and/or handled by the personal alert device.

104. Cross discloses that the PNU is operable to log data relating to at least the alerts triggered by the PNU. For example, Cross at [013] notes that the PNUs "store information on personal notification unit activity and alert logs." Cross at [041] similarly discloses that the PNU "stor[es] detailed activity and alert logs." And Cross at [047] refers to a PNU Interrogator that downloads "the activity, alert logs, and other data stored in each individual PNU." *See also* Cross, claim 14 ("the personal notification units store information on personal notification unit activity and alert logs"). The alert logs stored in the PNUs relate to the alerts triggered by the device that I discussed above in § VII.A.3.j.

105. Thus, Cross's PNU (the personal alert device) is operable to log data relating to alerts triggered and/or handled by the personal alert device, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 10.

8. Claim 11: The system of claim 1, wherein the companion alert device comprises a vehicle-mounted alert device, a wayside detection unit, or another personal alert device.

106. As I discussed above (§§ VII.A.3.i-VII.A.3.j ([1H1]-[1H2])), Cross's PNU receives signals from companion alert devices and generates a safety alert in response to those received signals. As I also discussed above (§§ VII.A.3.i-VII.A.3.j), the companion alert devices comprise (i) vehicle-mounted devices, *i.e.*, VCUs and (ii) wayside detection units, *i.e.*, wayside priority detectors. *See* Cross, [029]-[030], [041], [049], FIG. 1 (elements 102, 103, 107).

107. Thus, in Cross's system, the companion alert device comprises a vehicle-mounted alert device (VCUs) and a wayside detection unit (priority detectors), as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 11.

9. Claim 12: The system of claim 1, wherein the one or more indicator components comprise at least one of visual indicator, audio indicator, and a tactile indicator.

108. As I discussed above (§ VII.A.3.g ([1F])), the PNUs in Cross's system include several indicator components, such as "LEDs, vibrations and

high[-]volume speakers,” which produce visual (“visual alert signals), tactile (“movement...alert signals”), and audio (“audio...alert signals”) indications, respectively. Cross, [043]; *see also* Cross, [061] (PNU “will trigger an alert signal and notify the worker, via audio, movement, visual or other signals”). Thus, the one or more indicator components in Cross’s PNU comprise at least one of visual indicator, audio indicator, and a tactile indicator, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 12.

10. Claim 13: The system of claim 1, wherein the power supply comprises a rechargeable power supply.

109. As I discussed above (§VII.A.3.e ([1D])), the PNUs in Cross’s system comprise various power supplies, including known rechargeable battery types like lithium-ion batteries. Cross, [042]-[043]. Cross at [063] discloses that PNUs sometime require “battery **recharging**.” (Emphasis added). Thus, the power supply in Cross’s PNU comprises a rechargeable power supply, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 13.

11. Claim 15: The system of claim 1, wherein the attachment structure comprises a clip structure or a strap structure.

110. As I discussed above (§ VII.A.3.d ([1C])), the PNU in Cross’s system includes an attachment structure that comprises a “clip” (Cross, [045]), as claimed.

Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 15.

12. Claim 19: The system of claim 1, wherein the personal alert device is operable to implement configurable alarm management for allowing setting and/or adjusting of rules controlling triggering and/or handling of alerts.

111. As I discussed above with respect to claims 7-8 (§§ VII.A.4-VII.A.5), PNUs will enter an alert mode based on a “defined” ETA (Cross, [057]) of an approaching vehicle (*e.g.*, “20 seconds prior to arrival”) (Cross, [055]). Cross teaches the “defined” ETA that triggers an alert “can be modified or changed.” Cross, [057]. For example, Cross discloses that PNUs “can be set up and adjusted to alert at a certain ETA”: a specific example would be changing the ETA trigger from “20 seconds prior to arrival” to 10 second prior to arrival. The ETA threshold is used in the rules controlling the triggering of alerts. Cross, [055] (teaching that these changes can be made “either by group or on an individual basis”). The PNU is, therefore, operable to set/adjust rules controlling the triggering of alerts (*e.g.*, setting/adjusting the ETA).

112. Thus, the PNU (personal alert device) in Cross’s system is operable to implement configurable alarm management for allowing setting and/or adjusting of rules controlling triggering and/or handling of alerts, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 19.

13. Claim 20

- a. **[20A]: 20. The system of claim 1, wherein the personal alert device is operable to: receive Global Navigation Satellite System (GNSS) signals;**

113. In Cross' system, the PNU (personal alert device) is "capable of receiving GPS." Cross, [041]. As Cross confirms at [034], GPS is a "satellite positioning system known to one of ordinary skill." A POSA understood, and the '595 patent (at 4:31-37) confirms, the signals received from GPS satellites are GNSS signals, as claimed. See '595 patent, 4:31-37 (explaining that GNSS "technologies" include "GPS").

- b. **[20B] determine location information based on the received GNSS signals; and**

114. Cross discloses that the PNU uses "a satellite positioning system": like GPS as a "positioning system" to "determine[e] the worker's position." Cross, [041]. As Cross teaches, and POSAs would have known, a satellite-based positioning receiver "calculate[s] its position by precisely timing the [GNSS] signals sent by satellites." Cross, [034]. Cross (at [059]) reinforces that the PNU determines its position from global positioning (GNSS) signals because Cross discloses that when the PNU enters a tunnel the PNU may "los[e] its ability to determine location" because "global positioning ... satellite signal is lost." The PNU loses its ability to determine location when GPS signals cannot be received.

Thus, the PNU determines (calculates) its location information (its position) based on the received GPS (GNSS) signals, as claimed.

c. [20C] utilize the location information in conjunction with at least one of the operations of the personal alert device.

115. As discussed above (§ VII.A.3.h), one operation of Cross's PNU is "transmit[ing]...location data of the worker." Cross, [041]. The PNU uses its "satellite positioning system," *i.e.*, GPS, to "determin[e] the worker's position [*i.e.*, location] ... in real time." Cross, [041]. Thus, Cross's PNU utilizes the location information obtained from GPS in conjunction with at least one of the operations of the PNU (*e.g.*, transmitting the worker's location to other devices in the system), as claimed.

* * *

116. Accordingly, for the reasons discussed above in §§ VII.A.13.a-VII.A.13.c, in my opinion Cross meets every limitation of claim 20.

14. Claim 21

a. [21PRE] A system for worker protection comprises:

117. Cross discloses a system for worker protection, as I discussed above for limitation [1PRE] (§ VII.A.3.a). *See* Cross, [001]-[002], [046], [050].

b. [21A] a vehicle-mounted alert device, configured for use on a vehicle

118. Cross's system includes a "vehicle computer unit (VCU)" (Cross, [029]) that is an "onboard unit" (Cross, [034]). As I discuss below (§ VII.A.14.e),

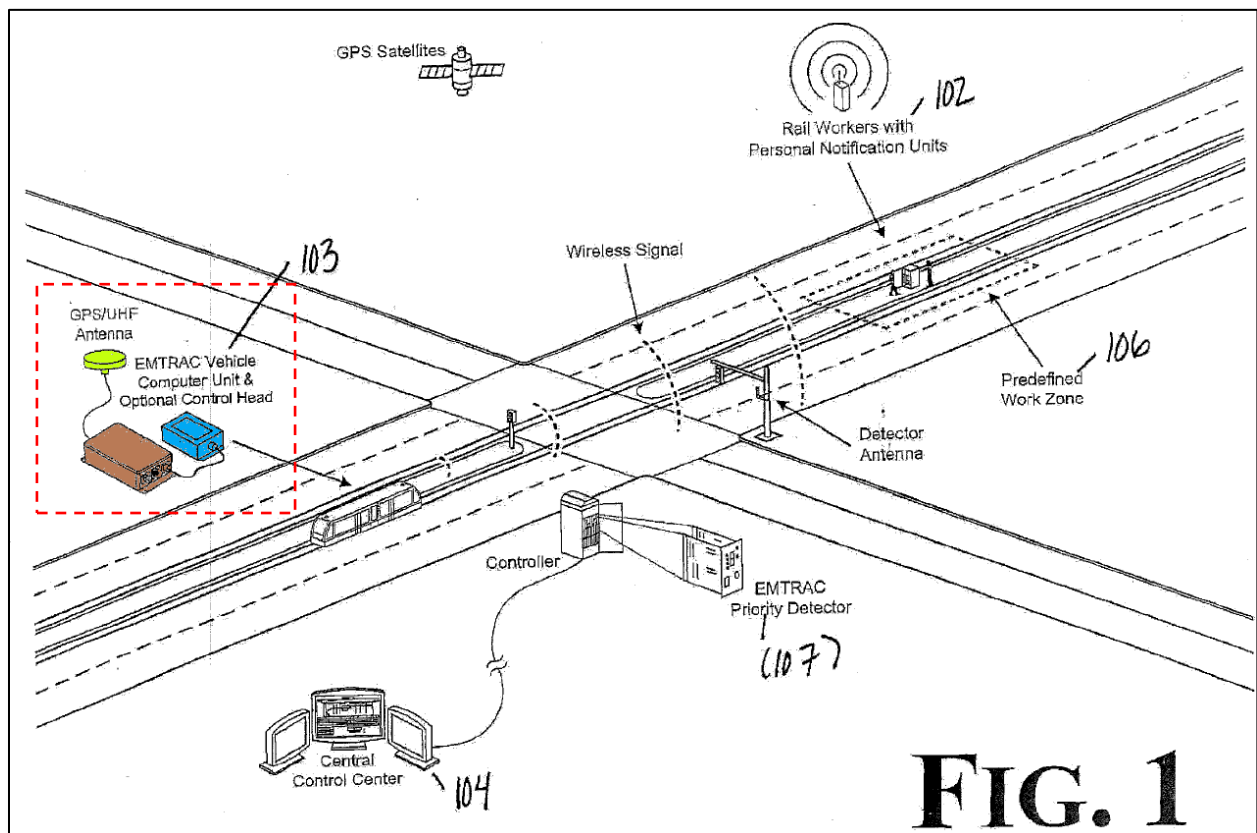
the VCU is an alert device that transmits alerts, alert-triggering signals, and generates alerts for workers operating the vehicle. Cross discloses that the VCU is installed “into [a] mass transit vehicle,” where the installation can be “either permanent—by direct integration into the [] vehicle”—“or temporary, through a mobile receiver that can be taken into and removed from the vehicle.” Cross, [029], [034]-[035]. In either implementation, Cross’s VCU is a vehicle-mounted alert device, configured for use on a vehicle, as claimed. *See also* § VII.A.15 (claim 22 below) (explaining how at least part of the VCU is configured to be portable, detachable and movable from the vehicle).

a. [21B] the vehicle-mounted alert device comprising: a housing for enclosing components of the vehicle-mounted alert device;

119. The VCU includes several components like “a receiver, a transmitter, a computer and a navigation system.” Cross, [031]-[032]. As illustrated in FIG. 1, VCU components are enclosed in several housings, which I have annotated below. The VCU’s includes a housing for a “mobile receiver that can be taken into and removed from the vehicle.” Cross, [035]. The ability to take the receiver into and the vehicle and remove it from the vehicle reinforces that there is a housing enclosing the components of the receiver to allow it to be carried into and removed from the vehicle.

120. As I discussed above (§ VII.A.14.b ([21A])), rather than be a mobile unit, Cross discloses that the VCU can also be “permanent[ly]” installed in a vehicle. Cross, [035]. It would have been conventional for a permanently installed computing system, like the VCU, to include a housing for its electronic components (whether using housings the ones shown in FIG. 1 or using another conventional housing).

121. Thus, Cross’s vehicle-mounted VCU comprises a housing for enclosing components of the device, as claimed.



b. [21C] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;

122. As Cross's Figure 1 (annotated above) illustrates, Cross's VCU has a "GPS/UHF Antenna" (which I annotated in green above), which is configured to transmit and receive UHF wireless signals (and receive GPS signals). The VCU also has a transmitter and receiver (or transceiver). Cross, [037]. A POSA would understand the transmitter and receiver (or transceiver) use the UHF antenna to "produce" (*i.e.*, transmit) and "receiv[e]" UHF (ultra-high frequency) radio signals.

123. A POSA understood that radio signals are wireless signals. Cross, [031], [033] ("receivers and transmitters" support "ultra-high frequency (UHF)" wireless signals). For example, Figure 1 above illustrates several "Wireless Signal[s]" emanating from the vehicle. Thus, at least the VCU's antenna is a communication component configured for transmitting and/or receiving wireless signals, as claimed.

124. Cross also discloses that the VCU's receiver is an "electronic circuit," which performs "processing and converting [of] the [received] signal...into usable form" ([031]) for use in VCU functions like "track[ing] real-time vehicle location, transmit[ing] approaching vehicle-alerts, ...alter[ing] vehicle function, and stor[ing] activity logs" ([034]). Thus, the VCU's receiver (and transmitter or

transceiver) is another communication component configured for transmitting and/or receiving wireless signals, as claimed.

- c. **[21D] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the vehicle-mounted alert device; and**

125. The VCU includes a “computer” (Cross, [031]), which Cross broadly defines as a device that is “inclusive of all computational devices,” including “processing devices or processors” (Cross, [032]). As I explained above (§ VII.A.3.h ([1G])), Cross’s “computer,” (which has a “processor”) is a circuit as defined by the ’595 patent (EX1001, 1:63-2:4). A POSA also understood that computational devices like processing devices or processors comprise many circuits operable to process signals and data, as claimed.

126. The VCU’s computer “serves four main functions.” Cross, [043]. The VCU’s computer performs these functions by processing various signals and data. For example, the VCU’s computer processes “inputs received” from PNUs, which are signals conveying data from the PNU to VCU, and other data regarding the vehicle (*e.g.*, the “current velocity of the vehicle”). Cross. [036]. As I discuss further below (§ VII.A.14.f), the inputs received from the PNUs and various other data are processed by the VCU’s processor to performs various functions relating to the VCU’s operation including (i) “send[ing] safety signals to and receiv[ing] safety signals from PNUs” and (ii) “instruct[ing] the train to gradually slow down.”

Cross, [036]-[037]. Thus, the VCU's computer are circuits operable to process signals and data, and to perform functions relating to operations of the vehicle-mounted VCU, as claimed.

127. The VCU's receiver is explicitly described in Cross as an "electronic circuit" that performs "processing and converting [of] the [received] signal...into usable form" (Cross, [031]), *e.g.*, demodulating received wireless signals to facilitate conversion to digital data. The radio signals processed into usable form by the receiver are used to perform functions of the VCU, like "track[ing] real-time vehicle location, transmit[ting] approaching vehicle-alerts, ...alter[ing] vehicle function, and stor[ing] activity logs." Cross, [034].

128. Thus, Cross's VCU comprises one or more circuits operable to process signals and data (*e.g.*, a computer and associated processor and a receiver), and to perform one or more applications or functions relating to operations of the personal alert device (*e.g.*, like transmitting and reacting to alert signals), as claimed.

d. [21E] one or more input/output (I/O) components, for receiving input from an operator of the vehicle and/or for providing output to the operator of the vehicle;

129. The VCU includes several input/output components. For example, the VCU includes "monitor software" that "allows for the real-time monitoring and display of worker activity and locations on a *user interface*." Cross, [039]

(emphasis added). This vehicle “user interface” can take the form of a “tablet computer.” Cross, [039]. When the user interface is implemented as a tablet computer, the tablet is a user interface that comprises input/output (I/O) components. The ’595 patent at 11:16-46 itself discloses that exemplary I/O components include a “display” with a “touch screen,” which would have conventionally been part of a tablet computer.

130. Through its user interface (*e.g.*, tablet), the VCU produces outputs to the operator of the vehicle. For example, the VCU’s user interface “displays the location” of VCUs and PNUs in the system “in real time.” Cross, [012]. Likewise, the VCU’s “interface will display worker locations on or near the rail line or route on geographics maps.” Cross, [039].

131. Through its user interface (*e.g.*, tablet), the VCU also receives inputs from the operator of the vehicle and/or it would have been obvious to implement the VCU such that it received input via its user interface. For example, Cross discloses that a train operator can “manually” instruct the VCU to issue an AVL packet into the network. Cross, [038]. It would have also been obvious to configure the VCU so that the operator could issue this instruction through the VCU’s user interface (*e.g.*, by touching a physical or “soft button” on the tablet). Similarly, Cross discloses that the VCU can “set up and adjust” how PNUs respond to alert signals. Cross, [055]. The VCU can also be used to “create[],

modif[y], delete[] or otherwise control[]” warning areas. Cross, [055]. POSAs would have understood that the operator caused the VCU to perform these system adjustments via inputs to a user interface

132. If Cross is found not to disclose that operators input instructions or other commands to the VCU via its user interface (*e.g.*, the tablet), then POSAs would have had reason to implement Cross such that its user interface, *e.g.*, tablet, received the operator’s inputs because electronic devices—like the VCU—conventionally received inputs from their I/O component, like the tablet that could be used as the VCU’s interface.

133. Thus, Cross’s VCU comprises input/output (I/O) components for receiving input from an operator of the vehicle and for providing output to the operator of the vehicle, as claimed.

e. [21F1] wherein the vehicle-mounted alert device is operable to: broadcast alert triggering signals; and

134. The ’595 patent does not provide a special definition of broadcast. In the ordinary sense the patent uses the term, a POSA would understand “broadcast” to be the transmission of a signal to multiple devices simultaneously using a one-to-many model of transmission, rather than a one-to-one or targeted model of transmission. For example, the website www.freedictionary.com defines “broadcast” as “[t]**o communicate or transmit** (a signal, a message, or content, such as audio or video programming) **to numerous recipients simultaneously** over

a communication network,” which in my opinion is consistent with the plain meaning of “broadcast” in the ’595 patent at the time of the alleged invention. (Emphasis added). Similarly, Newton's Telecom Dictionary (2013) defines broadcast as “[t]o send information to two or more received devices simultaneously....” EX1038, 227; *see also* EX1039, 54 (“to send a message to all recipients”); EX1040, 73 (“Sent to more than one recipient.”).

135. As discussed above (§ VII.A.14.b), the VCU’s transmitter transmits signals using an ultra-high frequency (UHF) transmission spectrum. Cross, [033]. For example, the VCU’s transmitter “send[s] automatic vehicle location (AVL) packets to the other components of the networks, in particular to the plurality of PNUs (102) in the network.” Cross, [038]. Cross repeatedly discloses that VCUs transmit signals to a “plurality of PNUs.” *See* Cross, [034] (explaining VCU sends communications to “a plurality of PNUs”), [035] (VCU’s “transmitter functions to transmit information and radio signals to a plurality of PNUs”), [043]-[044]. The conventional technique for a single transmitting device (like the VCU) to send wireless data packets simultaneously to a “plurality” of receiving devices (like PNUs), including when using a UHF-based wireless communication network, was to “broadcast” the data packet, *i.e.*, transmit the data packet to a plurality of devices in the network simultaneously.

136. Moreover, even if Cross is not considered to disclose that its VCU “broadcasts” AVL packets, POSAs would have also recognized the benefit of implementing the VCU such that it did broadcast its AVL packets to all companion devices in wireless communication range (*e.g.*, all nearby PNUs). POSAs would have recognized the benefit of broadcasting, rather than narrow casting, because doing so would ensure that all companion devices within wireless communication range of the VCU’s transmitter—both known and **unknown** to the VCU—received the AVL packets. A VCU may not be aware of all PNUs within communication range and a POSA would have recognized safety to workers would be increased by having PNUs receive AVL packets from the VCU without having to wait for the VCU to first identify the PNU. Corroborating my opinion that broadcasting was a well-known way to communicate with multiple devices at a time, Meyer teaches transmitting alerts from a vehicle “using the broadcast method such that it can be received in a certain radius by the corresponding receiving units.” Meyer, [0017], [0036]. Similarly, EX1022 at [0003]-[0004] teaches as background information that “[b]roadcasting allows stations to transmit information to a large number of end devices efficiently” so that “all people within a broadcast area receive the broadcast signals.” As further corroboration of my opinion that a POSA had reason to broadcast Cross’s AVL packets, EX1023 at [0005] taught as background

information that “[i]t may be desirable to efficiently send and receive broadcast alert messages” rather than “unicast messages sent to individual users.”

137. In Cross’s system, the AVL packets broadcast by the VCU are alert-triggering signals. Cross discloses that “an alert mode is triggered by” PNUs based on receiving AVL packets, which are processed by the PNU’s computer to determine a vehicle’s “route and bearing” and/or “location.” Cross, [030]. Cross at [043] similarly explains that PNUs “can identify alert mode conditions” based in part on “location data received from the plurality of VCUs” (*i.e.*, the AVL packets broadcast by VCUs). Cross at [056]-[057] similarly discloses that “alert mode is triggered by the PNU...based on the AVL packet received by [sic: from] the approaching vehicle.”³ Thus, AVL packets broadcast by VCUs are alert triggering signals, as claimed.

f. [21F2] generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle; and

138. When a PNU identifies an alert mode condition exists based on the AVL packet received from an approaching vehicle, the PNU “transmits a special high alert packet into the network and [to] each of the components of the network to notify them of the alert situation.” Cross, [044]. Cross explains that “[t]his

³ I explained in Footnote 2 above why a POSA would understand there to be a typo in [057] because the VCUs (or priority detectors as intermediaries), not PNUs, transmit AVL packets.

special alert mode packet notifies the other components of the system [] of the high risk event.” Cross, [055]. By receiving the alert mode packet from the PNU, the VCU is thus notified of the alert that its AVL packet triggered in the PNU.

139. Cross further discloses that, after triggering a PNU to issue an alert, the VCU’s computer generates data relating to the alert and/or other companion devices in the path of the vehicle. For example, the VCU computer “create[s] detailed logs and reports which **show worker location** and **alert histories** along the route.” Cross, [039] (emphasis added). Additionally, when an alert mode is activated in the system, the VCU generates data that is used to initiate the “alert signals” that are produced by the VCU’s output components to “notify...a vehicle operator...of a potentially dangerous interaction between an equipped worker and a vehicle within the grid.” Cross, [030], [052]. As another example of data generated by the VCU in response to triggering of alerts that relates to the alerts and devices in the path of the vehicle (*e.g.*, PNUs), the VCU “upon receiving the alert mode, will slow down [the vehicle] to a speed that will allow it to stop, if needed, before encountering the PNU-equipped worker.” Cross, [062]; *see also* Cross, [037] (VCU’s computer “through the PTC” (positive train control) “will instruct the train to gradually slow down”).

140. Thus, Cross's VCU is configured in the several ways discussed above to generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle, as claimed.

g. [21F3] output based on the data, via the one or more I/O components, feedback information to the operator.

141. Based on the data generated by the VCU that I discussed for limitation [21F2] (§ VII.A.14.f), the VCU outputs various feedback information to the operator via the VCU's I/O components (§ VII.A.14.d above), like the VCU's display, speakers and/or LED lights. For example, the VCU outputs "detailed logs and reports which **show** worker location and alert histories along the route." Cross, [039] (emphasis added). These logs and reports show (*i.e.*, display) the worker location and alert histories to network "administrators or other interested individuals," *e.g.*, the vehicle operator, who uses knowledge of worker location to make decisions about how to operate the vehicle. Cross, [039]. Similarly, the VCU outputs "alert signals" that "notify" the vehicle operator of an impending dangerous situation (*e.g.*, sounds or displayed text to warn of a potential collision). Cross, [030], [052]. These alerts are also a form of "feedback" to the operator that is generated via the VCU's I/O components (*e.g.*, speakers and display). As another example, when the VCU causes the vehicle to slow down, the VCU's display of the vehicle's speed will reflect the changing vehicle speed. The slowing

down of the vehicle and the reduced speed that would show on the display of speed are also feedback information to the operator, telling the operator that the VCU determined a collision is possible.

142. Thus, Cross's VCU is configured in several ways to output based on the data that meets [21F2], via the one or more I/O components, feedback information to the operator, as claimed. Accordingly, for the reasons discussed above in §§ VII.A.14.a-VII.A.14.g, in my opinion Cross meets every limitation of claim 21.

15. Claim 22: The system of claim 21, wherein the vehicle-mounted alert device is configured, at least in part, as portable, detachable and movable from the vehicle.

143. Cross teaches that the VCU (vehicle-mounted alert device) is configurable as a “temporar[ily]” installed “mobile receiver that can be taken into and removed from the vehicle,” and thus the VCU device is portable, detachable and movable from the vehicle, as claimed. Cross, [035], FIG. 1. Cross also discloses that the VCU's user interface can be implemented as a tablet (§ VII.A.14.d above; Cross, [039]). A tablet implementation of the VCU's user interface also meets claim 22 because a POSA would understand that a conventional tablet is a device that is portable, detachable, and movable. For example, it would have been conventional by the mid-2010s to have a docking station for attaching an electronic device like a tablet to a vehicle and for providing

an interface between the tablet and the vehicle's internal systems. As corroboration of my opinion, EX1041 discloses “ a mobile device dock configured to couple a mobile device [*e.g.*, ‘a tablet computer’] to a passenger vehicle to form a transportation system.” EX1041, Abstract. EX1041's docking station, for example, (1) allows inputs to the mobile device to be sent to and control the vehicle's internal system and (2) powers device's batteries. EX1041, [0035]-[0038]. Though EX1041 is the context of a passenger vehicle, POSAs would have understood that it would have been a matter of design choice to adapt a docking station for use in other vehicles, like trains. Thus, Cross's VCU is a device that is configured, at least in part, as portable, detachable and movable from the vehicle, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 22.

16. Claim 23: “The system of claim 21, wherein the vehicle-mounted alert device is operable to log data relating to alerts triggered in response to movement of the vehicle.”

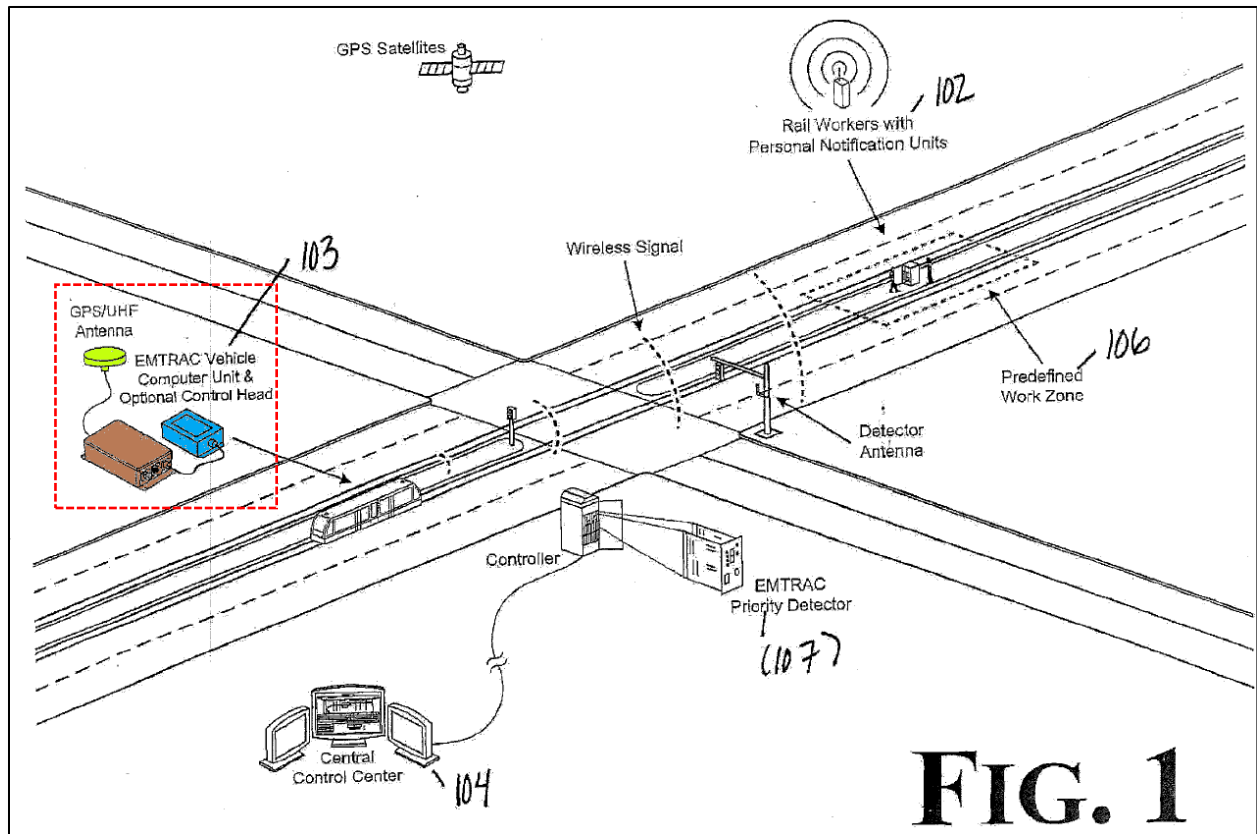
144. Cross discloses that the VCU's computer (§ VII.A.14.c above) is operable “to create detailed logs and reports which show...alert histories along the route.” Cross, [039], [034]. The alert histories are the alerts that I discussed above (§ VII.A.4 (Claim 7)), which are triggered in response to movement of the vehicle. For example, alerts that are logged that are based on vehicle-movement information conveyed in AVL packets (*e.g.* the vehicle's AVL packet indicates to

the PNU that has moved closer to a PNU device) and/or when the vehicle approaches PNUs or enters a “warning zone.” Cross, [027], [034]-[036], [038], [051], [061], FIGS. 3-4.

145. Thus, Cross’s VCU is operable to log data relating to alerts triggered in response to movement of the vehicle, as claimed. Accordingly, for the reasons discussed above, in my opinion Cross meets every limitation of claim 23.

17. Claim 24: The system of claim 21, wherein the vehicle-mounted alert device is arranged into a plurality of separate physical units that comprises at least a broadcast unit comprising at least the communication component, the broadcast unit is configured to attachment external to the vehicle.

146. Cross’s Figure 1 (which I annotated below) illustrates that the VCU 103 comprises three separate physical units: (1) “onboard vehicle computer unit”; (2) GPS/UHF antenna; and (3) “optional control head.” The physical separation of the VCU’s computer from its antenna (and optional control head) is consistent with the ’595 patent’s description of a vehicle alert device. EX1001, 3:41-57.



147. The GPS/UHF antenna (which I have annotated green above) is a broadcast unit that includes the VCU's communication component—*i.e.*, the antenna itself, which is a communication component as I discussed above in § VII.A.14.b. Though Cross's text does not explicitly state where each VCU's antenna is mounted on the vehicle, a POSA would have had reason to configure the VCU's antenna for attachment external to the vehicle, as claimed. In general, there would have been only two locations to mount the antenna: inside or outside the vehicle. By 2015, it would have been conventional to a POSA to locate a GPS/UHF antenna(s) on top of a vehicle because mounting antennas externally

would have improved line-of-sight thereby reducing interference for wireless communications to and from the antenna. My opinion that it would have been conventional (and beneficial) to mount the UHF antenna on top of the vehicle is corroborated by EX1024: EX1024 (at 1:30-42) discloses as background information that it is preferable to mount UHF antennas on vehicles “higher” on the vehicle to improve the “communications range” and that “**the most desirable location for an antenna on a vehicle would be the rooftop** or mounting as close to the roof ... as possible.” (Emphasis added). My opinion is also corroborated by EX1025, which discloses (at [0006]) that “[m]ounting an antenna **outside of the vehicle lessens interference** and a roof-mounted outdoor antenna is less likely to receive reflected ghost signals” and “increases the amount of direct signal it [the antenna] can receive from a transmitter.” (Emphasis added). As another example, Carlson (at [0056]) discloses installing various communication components of a vehicle-mounted unit “on the upper extremity of a vehicle.”

148. As further evidence of the obviousness of mounting Cross’s antenna external to the vehicle, another prior art patent application filed by Cross’s first-named inventor discloses mounting an identical combination GPS/UHF antenna for a similar VCU “**on top of the LRV vehicle.**” EX1033, [0039] (“Generally, the combo antenna or separate antennas **will be mounted on the top of the LRV** [Light Rail Vehicle]...”) (emphasis added), FIGS. 1-2.

149. Accordingly, based on a POS's general knowledge of conventional antenna placement and disclosures by the Cross-inventor, POSAs had reason to implement Cross such that its GPS/UHF antenna(s) are configured for attachment external to the VCU, as claimed. Accordingly, for the reasons discussed above in, in my opinion Cross meets every limitation of claim 24.

18. Claim 25: The system of claim 24, wherein the plurality of separate physical units comprises an operator unit comprising at least the one or more I/O components, the operator unit is configured for use by the operator.

150. As I discussed above (§ VII.A.14.d ([21E])), each VCU includes a “user interface” (an operator unit, as claimed) that comprises I/O components. The I/O components are separate physical units—like a “tablet” and/or a separate “display” device (Cross, [039])—as claimed.

151. These user interfaces are configured for use by the operator to receive inputs and/or provide outputs, as I discussed above (§§ VII.A.14.d, VII.A.14.g). Cross, [039]. Accordingly, for the reasons discussed, in my opinion Cross meets every limitation of claim 25.

B. Ground 1B: Claims 2-5: Obvious Over Cross and Mantovani

1. Overview of Ground 1B

152. As I discuss below, Claims 2-5 generally limit the personal alert device of claim 1 to one that includes conventional power-savings techniques. For

the reasons I discuss below in §§ VII.B.4-VII.B.7, claims 2-5 would have been obvious to a POSA over Cross in view of Mantovani (EX1009).

2. Mantovani (EX1009): U.S. Patent Application Pub. No. 2007/0241888A1

153. According to the face of the document, Mantovani is a publication of a U.S. patent that published on October 18, 2007 (code (43)), titled “Location enabled device with power saving control and method thereof.” Because Mantovani was published in 2007, I understand that Mantovani qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* ’595 patent, code (60)). I understand that Mantovani was not cited during prosecution of the ’595 patent. *See* ’595 patent, code (56) (references cited).

154. Mantovani “relates generally to mobile electronic devices that include device position determinators [*e.g.*, GPS units],” in particular those that are “energy constrained” (*i.e.*, devices where conserving battery power is important, which is a general concern for portable electronic devices). Mantovani, [0001]. Mantovani discloses a method that “saves power in a location enabled, energy constrained device by...eliminating unneeded position information updates.” Mantovani, [0012]. As Mantovani explains, “battery operated” mobile electronic devices generally “need to be power efficient,” but they are also conventionally “equipped with device position determinators, such as [GPS] measurement

circuitry” that continually draw power. Mantovani, [0002], [0004]. For example, Mantovani notes that “[p]eriodic position information determination may represent a significant power drain for a mobile device battery due to excessive current drain.” Mantovani, [0004]. Mantovani discloses methods for reducing the amount of power that position determinators, like GPS circuits, draw from the device’s battery based on the device’s movement. Mantovani, [0012].

155. In an embodiment, when an electronic device receives a request for its position, a determination is made whether the device has moved since the last time its position was requested. Mantovani, [0026], FIG. 5 (step 320), claims 1-2. If the device has moved (and thus the prior position determination may no longer be valid), then its current position is requested from its “position determinator,” and the device reports that position to the application requesting it. Mantovani, [0026], FIG. 5 (steps 330, 340), claims 1-2. However, if the device has not moved since a previous location determination, then its previously reported position is reported to the application. Mantovani, [0026]. Because the device’s position can be reported without needing the “position determination” to calculate the device’s current position, the “position determinator” is allowed to remain in a “low power consumption mode.” Mantovani, [0026], FIG. 5 (step 350), claims 1-2.

156. By not requesting position information from the position determinator when the device is determined to be stationary, “[u]nnecessary power consumed

during the position information update is thereby eliminated.” Mantovani, [0012]. As Mantovani explains, the “low power consumption mode” “reduce[s] power consumption” in the device and is triggered when the device “does not request position information over a request time period.” Mantovani, [0022] To determine whether the electronic device has moved, Mantovani uses a conventional “motion sensor,” *e.g.*, an “accelerometer.” Mantovani, [0024].

3. The Cross-Mantovani Combination

157. In my opinion, POSAs would have had reasons to use Mantovani’s movement-based power-savings method in Cross’s PNU.

158. **First**, Mantovani teaches that “[p]remature interruption of service due to complete battery discharge is a serious issue if the mobile device is used for security or safety purposes.” Mantovani, [0004]. Cross’s battery-operated PNU is a device used for safety purposes, as I discussed above (§ VII.A.3). Mantovani, likewise, teaches that “[r]educing power consumption in location enabled battery power devices is useful for improving product usefulness.” Mantovani, [0004]. Cross’s PNU is a location enabled battery power device, as I discussed above (§§ VII.A.3.e, VII.A.13). As Mantovani explains (and as would have been known to a POSA), avoiding “unnecessary battery consumption” will “extend device operation between battery charges, extend battery life, improve device usefulness, and enhance consumer satisfaction.” Mantovani, [0013]. Mantovani, thus, would

have explicitly motivated POSAs to use its power-savings technique in Cross's PNU, to prevent "premature interruption of service" and "improv[e] product usefulness."

159. **Second**, a POSA had reason to combine Mantovani's power-saving technique with Cross's PNU because it would have been using a known technique (Mantovani's power-savings technique) to improve similar devices (location-enabled battery-powered mobile devices) in the same way (by optimizing power consumption based on movement).

160. In view of Mantovani's teachings, a POSA would have implemented Cross's PNU with a conventional "motion sensor" like an "accelerometer."

Mantovani, [0024]. Using the accelerometer, the PNU's computer would have detected whether the PNU was moving and would have requested position information from the PNU's GPS circuitry when the computer detected that the PNU had moved (and a previously determined position had been obtained).

Mantovani, [0026], FIG. 5. When the PNU's computer detected that the PNU had not moved, then the PNU's GPS circuitry would have entered a "low power consumption mode" (as Mantovani taught) and the PNU would have transmitted its last calculated GPS coordinates until the PNU detects that the device has moved.

Mantovani, [0012], [0022], [0026], FIG. 5. Once movement was substantially detected by the motion sensor, the PNU's computer would have requested updated

GPS coordinates from the GPS circuitry (as Mantovani taught), causing the circuitry to exit the low power consumption mode. Mantovani, [0012], [0022], [0026], FIG. 5.

161. POSAs would have had a reasonable expectation of success in the above-described Cross-Mantovani combination because Mantovani's power-management technique applies to "any suitable mobile communication device including, but not limited to, a global positioning device,...a radio communication device, [or] a tracking device" (Mantovani, [0014]). Each of these performs functions similar to Cross's PNU, which includes a GPS and radio communication devices (*e.g.*, transmitter/receiver), as I discussed above (§§ VII.A.3.f, VII.A.13). It would have required only ordinary skill for POSAs to add to Cross's PNU (1) a conventional motion detector/sensor (*e.g.*, Mantovani's accelerometer) to (2) implement Mantovani's power-management technique (*e.g.*, which Mantovani teaches can be implemented as a software algorithm, Mantovani, [0015]). This is because by the mid-2010s, motion detectors like accelerometers were small and required low-power to operate and Cross's PNU already included GPS and a "computer" for executing device-functionality (*see* §§ VII.A.3.h, VII.A.13 above), and thus could run a software-based algorithm like Mantovani's power-management method. Cross, [032]; Mantovani, [0015]-[0016].

4. Claim 2: The system of claim 1, wherein the personal alert device is operable to implement a power management scheme for optimizing power consumption in the personal alert device.

162. Similar to Mantovani, the '595 patent explains that optimizing “power consumption” of a personal alert device can be achieved by using power-savings modes wherein certain components within a device enter a low-function state or are turned off. EX1001, 5:53-6:5.

163. In the Cross-Mantovani combination that I described above (§ VII.B.3), Cross’s PNU (personal alert device) would have implemented Mantovani’s power-management technique (*i.e.*, scheme) that I discussed above (§ VII.B.2) to optimize the PNU’s power consumption. For example, in Cross-Mantovani, the PNU’s GPS circuit (Cross, [041]) would have (based on Mantovani’s teachings) entered a “low power consumption mode” when the PNU’s computer does not request position information from the GPS circuit for a particular period of time. Mantovani, [0022]). For example, the PNU’s computer would not request position information (or updated position information) from the GPS when the PNU is determined to not be moving and so the previous position information would still be valid. Mantovani, [0022]. This “low power consumption mode” would have optimized the PNU’s power consumption by “eliminating unnecessary position information requests,” as Mantovani taught at [0013].

164. Thus, the Cross-Mantovani PNU (the personal alert device) is operable to implement a power management scheme for optimizing power consumption in the device, as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Mantovani combination meets every limitation of claim 2.

5. **Claim 3: The system of claim 2, wherein the power management scheme comprises transitioning the personal alert device from a full operation mode to a power-saving mode, the power-saving mode comprising at least one of shut-down mode and low-function mode.**

165. In the Cross-Mantovani combination that I described above (§ VII.B.3), based on Mantovani's teachings discussed above (§ VII.B.2), the PNU operates in normal, *i.e.*, full, operation mode when the PNU is moving but then transitions to a power-saving low-function mode when the PNU detects that it is not moving. Specifically, when implemented to perform Mantovani's power-management technique, the Cross-Mantovani PNU's GPS circuit (Cross, [041]) will function in its normal operating mode when the PNU's computer (based on data provided by an accelerometer (a motion sensor)) determines that the PNU is moving. Mantovani, [0024], [0026], FIG. 5 (steps 330, 340). And when the PNU's computer determines that the PNU has stopped moving, the PNU's computer will cease requesting new position information from the GPS circuit, which will cause the circuit to enter a "low power consumption mode," as

Mantovani taught. Mantovani, [0022], [0024], [0026], FIG. 5 (step 350). As Mantovani teaches, when the motion sensor determines that the device “has not moved over a period of time,” the device will “stop issuing position information requests [] to the device position determinator,” which causes the determinator (*e.g.*, GPS) to “automatically enter a low power consumption mode.” Mantovani, [0024]. This will save power in the device because, as Mantovani teaches, the motion sensor can be “configured to exhibit very low current drain such that continuous operation of the motion sensor [] does not cause significant battery drain” (Mantovani, [0024]), compared to the battery drain of obtaining GPS-based position information. *See also* Mantovani, [0026] (teaching that providing “previous position information” when the device has not moved allows the “device position determinator 130 [to remain] in low power consumption mode”).

166. Thus, the Cross-Mantovani PNU (the personal alert device) is operable to implement a power management scheme that comprises transitioning the personal alert device from a full operation mode to a power-saving mode (Mantovani’s “lower power consumption mode”), where the power-saving mode comprises at least one of shut-down mode and low-function mode (*e.g.*, shutting down processing used to obtain GPS signals and calculate position from those signals), as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Mantovani combination meets every limitation of claim 3.

6. Claim 4: The system of claim 2, wherein the personal alert device comprises at least one control component for generating control data applicable to the power management scheme.

167. In the Cross-Mantovani combination that I described above (§ VII.B.3), the PNU (a personal alert devices) includes a conventional motion sensor circuit, *e.g.*, an accelerometer and conventional associated circuitry for processing accelerometer data, which is “a control component,” as claimed. The motion sensor (accelerometer and associated circuitry) is a control component that generates control data that “set[s] or clear[s]” a “motion detection flag” that Cross-Mantovani PNU’s computer uses “to determine whether to request device position from” the PNU’s GPS circuitry. Mantovani, [0024]. The data generated by the accelerometer and associated circuitry that is used to set/clear the “motion detection flag” is applicable to Mantovani’s power-management scheme because the flag would have been used to determine whether the Cross-Mantovani PNU’s computer should have requested position information from the GPS circuitry (because motion has been detected) or leave the circuitry in a low-power mode (because no motion has been detected). Further corroborating my opinion that Mantovani’s motion sensor circuitry meets claim 4’s “control component,” claim 5 (which I address in § VII.B.7 below) recites that “the at least one control component *comprises a movement sensor.*”

168. Thus, the Cross-Mantovani PNU (the personal alert device) comprises at least one control component (*e.g.*, an accelerometer and associated circuitry) for generating control data applicable to the power management scheme (*e.g.*, providing data sets or clears a flag indicating the device has moved), as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Mantovani combination meets every limitation of claim 4.

7. Claim 5: The system of claim 4, wherein the at least one control component comprises a movement sensor for sensing movement of the worker, configured to generate indications when the personal alert device is moving or not.

169. In the Cross-Mantovani combination that I described above (§ VII.B.3), the PNU's control component includes a movement sensor (*e.g.*, an accelerometer and associated circuitry), which detects whether the PNU (and thus the worker wearing it) is moving and "set[s]" or "clear[s]" a "motion detection flag" that indicates to the PNU's computers whether the worker-worn PNU is moving or not. Mantovani, [0024].

170. Thus, the Cross-Mantovani PNU (the personal alert device) comprises a control component that comprises a movement sensor (*e.g.*, accelerometer and associated circuitry) for sensing movement of the worker, and the movement sensor is configured to generate indications (that is used to set or clear a motion detection flag) when the personal alert device is moving or not, as claimed.

Accordingly, for the reasons discussed above, in my opinion the Cross-Mantovani combination meets every limitation of claim 5.

C. Ground 1C: Claims 6: Obvious Over Cross and Cyzs

1. Overview of Ground 1C

171. As I discuss below, Claim 6 requires the personal alert device of claim 1 to comprise diversity antennas and support diversity during transmitting and/or receiving wireless signals. For the reasons I discuss below in § VII.C.4, claim 6 would have been obvious to a POSA over Cross in view of Cyzs.

2. Cyzs (EX1010): U.S. Patent Application Publication No. 2008/0170533A1 A1

172. According to the face of the document, Cyzs is a U.S. published patent application that published on July 17, 2008 (code (43)), titled “Near-Field Spatial Multiplexing” (code (54)). Because Cyzs published in 2008, I understand that Cyzs qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* ’595 patent, code (60)). I understand that Cyzs was not cited during prosecution of the ’595 patent. *See* ’595 patent, code (56) (references cited).

173. Cyzs discloses that as of its early-2000s filing date it was a POSA’s background knowledge that “[s]patial diversity is a well-known method for increasing the capacity and reliability of wireless links.” Cyzs, [0003]. As Cyzs explains, when using receiver diversity, “a wireless receiver is equipped with

multiple antennas, which are spaced a certain distance apart” (Cyzs, [0003]), which is typically at least one-half wavelength apart for the frequency at-issue (*e.g.*, ~ 6-12 cm for the 2.4 / 5 GHz ISM bands used by many conventional wireless protocols). Because the multiple receive antennas are spaced apart, “signals received by the different antennas vary due to environmental conditions, such as fading and multi-path effects.” Cyzs, [0003]. The antennas are often identical (*e.g.*, same length and polarization), but they can also (or alternatively) be polarized along different orientations (*e.g.*, orthogonal polarizations), which provides a similar diversity effect as achieved by using two separated identical antennas.

174. Cyzs discloses that in conventional receive diversity, “[t]he receiver takes advantages of these differences to compensate for degradation that may occur as the signals travel from the transmitter to the receiver, thereby increasing the effective rate at which the receiver is able to receive data.” Cyzs, [0003]. Cyzs discloses that transmit spatial diversity was also known, wherein the “[t]ransmitter may be equipped with redundant antennas for the same reasons”—*e.g.*, by transmitting the same signal from identical antennas spaced a sufficient distance apart, there is a greater likelihood that at least one of the transmissions will be received of sufficient quality. Cyzs, [0003], [0004]-[0006] (describing prior art diversity techniques).

175. Using receive and transmit diversity in the same system was conventional by the early 2000s. For example, Cyzs (at [0004]) incorporates by reference U.S. Patent No. 6,058,105 which, according to Cyzs, disclose using “multiple transmit and/or receive antennas” to “increase[] the capacity of the actual communication channel,” which was a well-known advantage of many conventional diversity techniques. Cyzs (at [0005]) incorporates by reference U.S. Patent No. 5,691,727, which, according to Cyzs, discloses a “[p]olarization diversity,” where the “receiver includes two antennas, one for each of two possible orthogonal polarizations, and combines the polarized signals that it receives according to weighting factors.” (Combining the signals received at the receive antennas or selecting the strongest signal were, and still are, common techniques for implementing receive diversity. *See, e.g.*, U.S. Patent Publication No. 2005/0143037A1, [0001]); *see also* Cyzs, [0006] (incorporating by reference U.S. Patent No. 6,144,711, which “describes a space-time processing system” to “gain a multiplicative increase in capacity”).

3. The Cross-Cyzs Combination

176. In my opinions, POSAs would have had reasons to implement in Cross’s PNU diversity antennas (*e.g.*, identical antennas or antennas having orthogonal polarization) to perform a conventional transmit and receive diversity technique, which Cyzs teaches was well-known in the art.

177. **First**, POSAs would have been motivated by Cyzs’s teaching that antenna-diversity techniques (*e.g.*, spatial diversity techniques) were “well-known” to those in the art as a way to “compensate for degradation” in wireless communication caused by “fading and multi-path effects” due to environmental conditions. Cyzs, [0003]. Detrimental effects like fading and multipath were a well-known fact of wireless communication in most operating environments. Reducing wireless signal degradation in Cross would have improved its safety system by “increasing the effective rate at which” the PNU can receive and transmit data. Cyzs, [0003]. This is because transmitted and/or received signals would have been less likely received with low SNR or lost.

178. **Second**, as I discussed above (§ VII.C.2), Cyzs corroborates that diversity antennas and techniques were well-known in the prior art. Thus, the combination of Cross and Cyzs would have used known antenna-diversity techniques (*e.g.*, like conventional transmit and receive spatial diversity known in the art) to improve similar devices (wireless-communication devices) in the same way (using conventional diversity antennas and processing to overcome fading and multipath and other detrimental effects in wireless communications).

179. In the Cross-Cyzs combination, Cross’s PNU would have included multiple antennas to implement conventional receive- and transmit-diversity techniques referenced in Cyzs. In my opinion, POSAs would have reasonably

expected success in using ordinary skill to use multiple antennas in PNUs because by the early-2010s it was conventional to include in wireless, portable devices like PNUs: (1) multiple antennas having either identical or different polarizations, and (2) conventional diversity algorithms (code/software instructions) to process wireless signals to/from multiple antennas. For example, EX1026 at [0001] corroborates my opinion that it was “[c]onventional” for wireless receivers to “employ antenna diversity to improve the received signal quality” by “employing two antennas having different polarizations or two antennas separated, for example, by a wavelength of the carrier frequency” (which is a very small distance). A conventional way to use two antennas for antennas diversity would have been to use two identical antennas (*e.g.*, because it would have simplified the design, modeling of the design, and procurement of components). EX1026 at [0001] also notes that even a “low cost method of switching between” the signals received by the antennas (*e.g.*, selecting the one received with the best SNR) “can provide substantial improvement in some situations.” Thus, EX1026 further corroborates my opinion that diversity techniques were conventional and a known way to improve wireless communication quality.

4. **Claim 6: The system of claim 1, wherein the one or more antennas comprise diversity antennas of identical or differing polarity, and the personal alert device is operable to support use of diversity during the transmitting and/or receiving of wireless signals.**

180. The '595 patent describes “diversity antennas” as antennas that use diversity “optimization techniques,” *i.e.*, spatial-diversity techniques. EX1001, 8:55-58. In the Cross-Cyzs combination that I described above (§ VII.C.3), the Cross-Cyz PNU comprises multiple diversity antennas (having either identical or differing polarity) to support using “spatial diversity” for wireless “signals received” and wireless signals transmitted by the device, consistent with Cyzs’s teaching that such techniques were conventional by the late-2000s. Cyzs, [0003]-[0005]; *see also* EX1026, [0001] (further corroborating my opinion that diversity techniques were conventional). A POSA understood that spatial diversity would have required antenna separation equal to approximately half the wavelength of the wireless signals being used. For the UHF frequency band (300 MHz to 3 GHz), for example, the half-wavelength distance ranges from about 2 inches to 1.5 feet. To the extent the PNU device’s housing needed to be enlarged to allow for sufficient antennas separation, it would have required ordinary skill to modify the device’s housing and arrange the spatial diversity antennas sufficiently apart from each other. And as the selected frequency of operation increases, the separation

required for spatial diversity decreases (*e.g.*, the ISM radio band, used for, for example, IEEE Wi-Fi communications, as discussed in paragraph 173 above).

181. Thus, the antennas in the Cross-Cyzs PNU (the personal alert device) are diversity antennas having identical or differing polarity because those were the two conventional options for diversity antennas to implement spatial-diversity techniques, as I discussed above (§ VII.C.3). Cyzs, [0003]-[0005]. As discussed above (§ VII.C.3), the Cross-Cyzs PNU personal alert device would have been operable to use its diversity antennas to support use of diversity during the transmitting and receiving of wireless signals, as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Cyzs combination meets every limitation of claim 6.

D. Ground 1D: Claims 16-17, 26: Obvious Over Cross and Meyer

1. Overview of Ground 1D

182. Claims 16 and 17 depend on claim 1 and are about the personal alert device of claim 1. Claims 16 and 17 are generally directed to adding an acknowledgement component to the personal alert device, which workers use to acknowledge receipt of a safety alert and which is communicated to a companion alert device (*e.g.*, a vehicle mounted or wayside unit). As I discuss below in § VII.D.2, acknowledgement buttons and signals for worker personnel safety devices was taught by Meyer. For the reasons I discuss below in §§ VII.D.4-

VII.D.5, claims 16-17 would have been obvious to a POSA over Cross in view of Meyer.

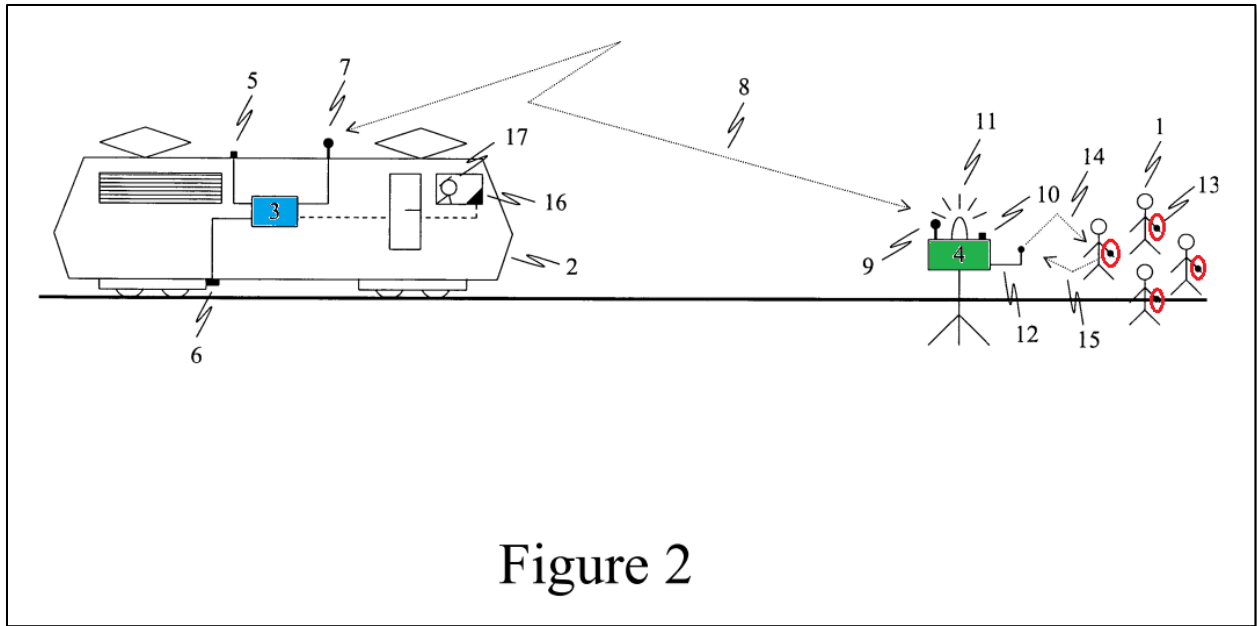
183. Claim 26 depends on claim 21 and is about the vehicle mounted alert device of claim 21. Like claims 16 and 17, claim 26 generally recites receiving acknowledgement signals from worker personal units and indicating acknowledgements to the operator of the vehicle via the vehicle-mounted alert device's I/O components. As I discuss below in § VII.D.6, receiving acknowledgement signals at vehicle-mounted safety devices and indicating acknowledgements to the vehicle operator via I/O components were techniques known in the art. For the reasons I discuss below in § VII.D.6, claim 26 would have also been obvious to a POSA over Cross in view of Meyer.

2. Meyer (EX1012): German Published Patent Application No. DE 10 2008/020700 A1

184. I understand EX1012 to be “a true and accurate copy of an English translation of DE102008020700A1”. See EX1013, ¶¶1-6 (declaration of Harry Gigas, a translator at TransPerfect, Inc.). According to the face of the (translated) document, Meyer is a German published patent application that published on May 11, 2009 (code (43)), titled “Railway Collision Warning Device” (code (54)). Because Meyer published in 2009, I understand that Meyer qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (see '595 patent, code (60)). I understand

that Meyer was not cited during prosecution of the '595 patent. *See* '595 patent, code (56) (references cited).

185. Meyer “relates to a railway collision warning system to warn of a collision risk between a rail-bound vehicle and at least one person.” Meyer, [0001]. Similar to Cross (and the '595 patent), Meyer’s system relies on three companion devices: (1) a “stationary unit” that is installed on a train, (2) a wayside “mobile or portable unit” that is placed along the train track near a “construction site” where workers are present, and (3) “mobile or portable transponders” that can be “arranged on or attached to the personnel to be warned.” Meyer, [0017]-[0023]. Meyer’s Figure 2 (which I have annotated below) “shows the basic structure of a train collision warning device with a mobile unit, as described in Fig. 1.” Meyer, [0040]; *see also* FIG. 1. In the annotated version of Figure 2 below, I have annotated the vehicle-mounted stationary unit in blue, annotated the wayside-located “mobile unit” in green, and annotated the various workers wearing “portable transponders” in red:



186. Meyer discloses a mobile unit that can be located at various locations where workers are working and which communicates with companion devices on workers and approach trains. For example, the “mobile or portable transponders [] can be arranged on or attached to the personnel to be warned.” Meyer, [0023], [0037]. There is also “a mobile unit with a receiving unit designed to be arranged in the proximity of at least one person.” Meyer, [0016]. Thus, as illustrated in Figure 2 (annotated above), “mobile unit 4” is a wayside device.

187. The wayside-located mobile units detect the presence of an approaching train, via a wireless communication link with the train, and wirelessly transmit a “near-range warning signal” to the worker-worn transponders that then generate audio, physical, or visual alerts to the workers. Meyer, [0023]. For example, “when the mobile [wayside] unit detects a collision risk with an

approaching rail-bound train, the mobile unit issues a near-range warning signal that can be received by the [worker-associated] transponders.” Meyer, [0023].

When the transponders attached to workers receive “a near-range warning signal” from the wayside “mobile unit[s that] detect[] a collision risk with an approaching rail-bound train,” the workers’ transponders generate alerts (*e.g.*, “acoustic, optical, and/or haptic signal[s]”) (*i.e.*, audio, visual, and/or physical alerts, respectively) to the worker personnel. Meyer, [0023]; *see also* Meyer, [0038] (*e.g.*, a “light signal” is “emitted by the mobile unit”), [0040] (“personnel 1 to be warned are equipped with a mobile transponder 13 that can, for example, be worn on the wrist in the form of a wristwatch,” which can “warn the personnel 1 by acoustic, optical, or haptic means, that is to say, by emitting a corresponding warning signal”).

188. Meyer also teaches that it is “exceedingly advantageous” that the worker-worn “portable transponder has an actuation element, such as a pushbutton, in order to receive an acknowledgement from the personal to be warned about the issued warning.” Meyer, [0024], [0042]. “The personnel to be warned must for this purpose actuate the actuating element after the transponder issued a warning about an approaching train,” which causes the transponder to “transmit[] a near range acknowledgement signal that can be received by the mobile [wayside] unit.” Meyer, [0024]; *see also* Claim 9. “After this actuation button [i]s pressed by the personnel 1 to be warned ..., a corresponding near-range acknowledgment signal

15 is sent to the mobile unit 4 that can be received by the near-range transmission and receiving unit 12.” Meyer, [0042]. The mobile unit(s) that receive the acknowledgement signal can then “determine the number of transponders having received the near-range warning signal” and “compare the number of transponders that have acknowledged the collision warning with a predetermined number of personnel exposed to a collision risk.” Meyer, [0025]-[0026]; *see also* Meyer, [0043] (“[T]he mobile unit 4 can now determine the number of acknowledgments 15 to infer the number of personnel who have reacted to the warning signal 14” and “compare the number of personnel who reacted to the acknowledgment signal 15 to a predetermined number of personnel expected to be present in the hazard zone.”).

189. Based on the comparison, the mobile unit can determine if any personnel expected to acknowledge the warning have not done so and, if so, “the mobile unit has a transmitter unit that can transmit the collision status signal to the rail-bound vehicle with which a collision risk is imminent.” Meyer, [0027], [0044] (“[T]he mobile unit 4 in turn relies on a corresponding transmission unit to transmit a radio signal to the rail-bound vehicle 2 to notify the latter that the hazard zone is not yet clear of personnel 1.”). The “rail-bound vehicle has a corresponding receiving unit... in order to receive such a collision status signal,” which can be used to “determine a potential collision risk with the construction

crew” (Meyer, [0027]) and then the train may be “automatically slowed down to avoid a collision.” Meyer, [0027]-[0028]. As Meyer explains, the “vehicle operator 17 can then initiate appropriate measures” and/or the train’s control system (*e.g.*, PTC system) can “automatically slow down the rail-based vehicle” (Meyer, [0044]-[0045]). *See also* Meyer, [0038]-[0046], *e.g.*[0044] (“The stationary unit 3 on the rail-bound vehicle 2 can then for example be connected to a display unit 16 in the operator cab of the vehicle operator 17 to display to the latter that there is an imminent collision risk with personnel.”), [0046] (disclosing “tables...highlight[ing] the sequence of events”), claims 10-14.

3. The Cross-Meyer Combination

190. In my opinion, POSAs would have had reason to (1) include in Cross’s system Meyer’s teaching to have workers acknowledge warnings of potential collisions, (2) have such acknowledgments sent to an approaching train and indicated to the operator of the train, and (3) have the train perform Meyer’s teaching of comparing the number of acknowledgements it receives to the predetermined number of workers exposed to a collision risk.

191. **First**, Meyer expressly motivates the combination by teaching that it is “exceedingly **advantageous**” for worker personnel of transit system to acknowledge safety warnings and transmit acknowledgements to other devices in the safety system. Meyer, [0024], [0027]-[0028] (emphasis added). As I discussed

above in § VII.D.2, Meyer discloses that the benefits of these acknowledgement signals include confirming that worker personnel have received a warning and “can clear the hazard zone” (and thereby reduce and hopefully eliminate the risk of collision). Meyer, [0025]-[0026], [0038]-[0039]. In addition, by having the rail-bound vehicles receive the acknowledgements, the rail-bound vehicles can themselves determine the risk of collision and “initiate appropriate measures” (*e.g.*, indicate to the operator that preventative action needs to be taken and, if not taken, “automatically slow down” the vehicle). Meyer, [0043]-[0045].

192. **Second**, this combination of Cross and Meyer would have been using a known technique (Meyer’s acknowledgements from worker devices) to improve similar devices (Cross’s and Meyer’s similar worker-safety systems for transit system) in the same way (to increase safety by using workers’ acknowledgments of warnings to confirm and/or make safety decisions in vehicles).

193. In the Cross-Meyer combination, Cross’s PNU would have included an actuator “pushbutton” (see Meyer, [0024], [0042]), which the workers would have used to transmit acknowledgement signals to Cross’s wayside priority detectors in response to receiving alert-triggering signals (see § VII.A.3.j above), just like Meyer’s personal transponders transmits acknowledgments to wayside mobile units (Meyer, [0024], [0042]). As I discussed above (§ VII.A.3.i), Cross’s PNUs can communicate directly with the VCUs on approaching vehicles. See,

e.g., Cross, [034], [041], [046], [049], [056]). POSAs also had reason to take advantage of the communication between PNUs and VCUs to have the PNUs also transmit acknowledgments directly to VCUs, rather than just to wayside units. This would have been advantageous because it would have allowed the acknowledgements to be received by the VCUs that were within communication range of the PNUs, without having to wait for the wayside unit(s) to forward the acknowledgement(s). This would have also been advantageous as additional redundancy in the system (*e.g.*, an alternative path for acknowledgements to reach the vehicles in case a wayside priority detector was inoperable). POSAs would have understood that redundancy is particularly advantageous in a worker-safety system.

194. In this combination, the VCUs receiving acknowledgements (either directly from PNUs or indirectly from a priority detector) would then execute Meyer's technique to (1) determine whether all personnel had acknowledged warning signals and (2) take "appropriate measures" (*e.g.*, display acknowledgements and warnings on vehicles and/or automatically adjust vehicle speed), as Meyer taught. Meyer, [0043]-[0045].

195. In my opinion, POSAs would have reasonably expected success in the combination because Cross and Meyer disclose similar safety systems (*see* § VII.D.2 above), and Cross's alert devices (VCUs, PNUs, and priority detectors)

were already communicating wirelessly, as I discussed above in §§ VII.A.3.i, VII.A.14.b-VII.A.14.c. It would have required only ordinary skill for a POSA to add or adapt existing button(s) on Cross's PNU to function as an acknowledgement button (like Meyer's "actuation button") and have it cause the PNU devices to transmit acknowledgement signals to wayside priority detectors and VCUs. It would have also required only ordinary skill to program the VCU's computer/processor to determine, based on the received acknowledgements, whether all expected personnel had acknowledged the safety signals and display those acknowledgements to vehicle operators using VCU I/O components (see § VII.A.14.d above). *See also* Meyer, [0042]-[0044]. In addition to displaying acknowledgements, it would have required only ordinary skill to program the VCU to warn of potential collisions based on the received acknowledgements, as Meyer taught. *E.g.* Meyer, [0027]-[0028].

4. Claim 16: The system of claim 1, wherein the personal alert device comprises one or more acknowledgment components, configured for receiving input from the worker, to indicate acknowledgment of the safety alert.

196. In the Cross-Meyer combination that I discussed above (§ VII.D.3), the Cross-Meyer PNU would have included an acknowledgement component (*e.g.*, Meyer's "pushbutton") which would have been configured "to receive a confirmation [*i.e.*, an acknowledgement] from the person to be warned" (*i.e.*, the worker with the PNU, § VII.A.3.d above ([1C])), as Meyer taught. Meyer, [0024]-

[0025], [0042]-[0043]. Pushing the actuating button (and the corresponding signal it causes to be generated) indicates acknowledgement of the safety alert, as claimed.

197. Thus, the personal alert PNU device in the Cross-Meyer combination would have comprised an acknowledgement component that would have been configured for receiving input from the worker (*e.g.*, pushing a button), which indicates acknowledgement of the safety alert at the PNU, as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer combination meets every limitation of claim 16.

5. Claim 17: The system of claim 16, wherein the personal alert device is operable to communicate a signal to the companion alert device to indicate the acknowledgment of the safety alert by the worker.

198. In the Cross-Meyer combination that I discussed above (§ VII.D.3), after the worker “has confirmed the warning signal,” the PNU “emits a short-range confirmation signal that can be received by” companion alert devices, as I discussed in § VII.A.3.i ([1H1]) above). Meyer, [0024]. As Meyer taught, the devices receiving the confirmation signals include a “mobile unit” (Meyer, [0024]), which is Cross’s priority detector in the Cross-Meyer combination. As I also explained above (§ VII.D.3), POSAs also had reason to have the confirmation signal be received by Cross’s VCU.

199. Thus, the Cross-Meyer personal alert PNU device would have been operable to communicate a signal (Meyer’s “confirmation signal”) to the companion alert device (Cross’s priority detector and VCUs) to indicate the acknowledgment of the safety alert by the worker, as claimed. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer combination meets every limitation of claim 17.

6. Claim 26

- a. [26A]: The system of claim 21, wherein the vehicle-mounted alert device is operable to: receive a signal indicating an acknowledgment of a safety alert by a worker in response to the broadcasted alert triggering signals**

200. In the Cross-Meyer combination that I discussed above (§ VII.D.3), the vehicle’s VCU is operable to receive acknowledgement signals from worker PNUs (directly from the PNUs and/or after being forwarded from priority detectors). Once received, the VCU would use the acknowledgements to determine whether all expected workers had acknowledged receiving the alert-triggering signals broadcast by the VCU (*e.g.*, AVL packets), as Meyer taught, as I discussed above (§ VII.D.2). Thus, worker acknowledgements would have been received by the VCU in response to the broadcasted alert triggering signals, as claimed.

b. [26B]: and provide, via the one or more I/O components, an indication of the acknowledgement to the operator of the vehicle.

201. In Meyer’s system, “the vehicle operator can be warned about a collision with the construction crew...when the collision status signal indicates that not all personnel have acknowledged the collision warning.” Meyer, [0028]. When a POSA applied this teaching to the Cross-Meyer combination (§ VII.D.3), the collision “warn[ing]” would have been communicated to the operator via the VCU’s I/O component, which is the VCU’s tablet computer, as I discussed above (§ VII.A.14.d). The warning would have been communicated via VCU’s tablet computer because that is the component in the Cross-Meyer combination’s VCU that provides outputs (audio, visual signals) to the operator and it is the component that permits the operator to provide inputs to the system so the operator can take “appropriate measures,” as Meyer (at [0044]) taught.

* * *

202. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer combination meets every limitation of claim 26.

E. Ground 1E: Claims 14 and 18: Obvious Over Cross and Cook

1. Overview of Ground 1E

203. As I discuss below, claim 14 recites a conventional rechargeable battery supply for the worker-worn device that is rechargeable without direct

connection and claim 18 has a similar battery limitation and a limitation for completely sealing the internal space enclosing components of the worker-worn device. For the reasons I discuss below in §§ VII.E.4-VII.E.5, claims 14 and 18 would have been obvious to a POSA over Cross in view of Cook (EX1014).

2. Cook (EX1014): U.S. Published Patent Application No. 2009/0243397 A1

204. According to the face of the document, Cook is a U.S. published patent application that published on October 1, 2009 (code (43)), titled “Packaging and Details of a Wireless Power Device” (code (54)). Because Cook published in 2009, I understand that Cook qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* ’595 patent, code (60)). I understand that Cook was not cited during prosecution of the ’595 patent. *See* ’595 patent, code (56) (references cited).

205. Cook discloses “[a] wireless power system” (Abstract) for “battery powered electronic devices.” Cook, [0002]. Cook discloses as background information that wireless communication devices often “require[d] wires” to recharge batteries. Cook, [0012]. Cook discloses that “charging and replacing batteries have become another chore,” requires “remember[ing] to change batteries and also to have the right charger at hand.” Cook, [0038]-[0039]. To “avoid[] wires, connectors or contacts between the powering station and the device,” Cook

discloses a system that uses “inductive coupling” (Cook, [0042]), which was a well-known technique for wirelessly recharging the batteries in an electronic device. *See, e.g.*, EX1027, [0007]-[0008] (“Common uses of resonance-enhanced electrodynamic induction are charging the batteries of portable devices.... It has been adopted as part of the Qi wireless charging standard.”). Cook further discloses that another advantage of wireless charging techniques, like inductive coupling, is that it facilitates manufacturing “hermetically sealed (waterproof) electronic devices.” Cook, [0042].

3. The Cross-Cook Combination

206. In my opinion, POSAs would have had reasons to include in Cross’s PNU’s the conventional wireless charging and hermetically sealing the housing, as discussed in Cook.

207. **First**, POSAs would have been motivated by Cook’s teaching that wireless charging “avoid[ed] wires, connectors or contacts between the powering station and the device” and facilitated “hermetically seal[ing]” the device to make it “waterproof.” Cook, [0002]. POSAs would have recognized the benefit to Cross’s system in avoiding the burden of carrying and the cost (in terms of money but also time and inconvenience) of charging via wires/cables. Cook, [0039]. POSAs would have also recognized the benefit to hermetically sealing a safety device, like Cross’s PNU, to make it more robust in wet and/or dirty environments

(*e.g.*, roadside or in damp, underground tunnels) that such devices would have been expected to be exposed to. Cook, [0042].

208. **Second**, each would have been using known techniques (inductive charging and hermetically sealing electronic-device housings) to improve similar devices (wireless electronic devices) in the same way (by removing the need for wires and protecting electronics from water and dust).

209. In the Cross-Cook combination, the PNU (1) would have included conventional inductive-charging components (*e.g.*, like a matching circuit and resonant antenna, as Cook taught at [0044], [0059]-[0060]) and (2) would have been hermetically sealed to completely seal its internal components (as Cook taught at [0042]). As Cross ([0053]) disclosed, the “PNU charging station[s]” are where “individual PNUs (102) are recharged” and, thus, in the Cross-Cook combination they would have been equipped with corresponding inductive-charging components (*e.g.*, corresponding inductive elements for transferring energy to the PNU’s batteries).

210. In my opinion, POSAs would have had a reasonable expectation of success because inductive charging and hermetically sealing were taught by Cook and were conventional for electronic devices by the early-2010s. My opinion that inductive charging and sealed housings were conventional by the early-2010s is corroborated by EX1028, which teaches as background information that using

“inductive coupling (link) technology to transfer energy” was “**well known**” and allowed for devices to “be **completely sealed**” without “exposed electrical contacts” because inductive charging eliminates the need for “actual physical contact” between the energy source and device to be charged. EX1028, [0005] (emphasis added).

4. **Claim 14: The system of claim 13, wherein the rechargeable power supply is operable to recharge without direct connection.**

211. In the Cross-Cook combination that I described above (§ VII.E.3), the PNU’s rechargeable power supply (*e.g.*, rechargeable batteries) that I discussed above in § VII.A.10 is recharged without direct connection, as claimed, via conventional “inductive coupling,” as Cook disclosed at [0042]. Accordingly, for the reasons discussed above, in my opinion the Cross-Cook combination meets every limitation of claim 14.

5. **Claim 18**

a. **[18A] The system of claim 1, wherein the housing completely seals internal space enclosing components of the personal alert device, and**

212. In the Cross-Cook combination that I described above (§ VII.E.3), the PNU’s housing is “hermetically sealed (waterproof)” as Cook at [0042] disclosed, thereby completely sealing the internal space enclosing PNU components (*e.g.*, its processor, transmitter, etc.). *See also* Cross, FIG. 2 (illustrating an example PNU device and housing).

b. [18B] wherein charging the power supply and/or communication of data to and/or from the portable alert device is done without direct connection.

213. As I discussed above for claim 14 (§ VII.E.4), in the Cross-Cook combination the PNU's power supply is charged without direct connection, *i.e.*, via inductive charging, as Cook disclosed (at [0042]). In the Cross-Cook combination, data is also communicated wirelessly from the PNU device, as I discussed above in § VII.A.3.f ([1E]). Wireless communication of data is without direct connection, as claimed, as thus also meets limitation [18B].

* * *

214. Accordingly, for the reasons discussed above, in my opinion the Cross-Cook combination meets every limitation of claim 18.

F. Ground 1F: Claims 27-30 Obvious Over Cross, Meyer and Welte

1. Overview of Ground 1F

215. Claims 27-30 are generally directed to the components and functionality of a wayside device in a safety system. For the reasons I discuss below in §§ VII.F.6-VII.F.9, claims 27-30 would have been obvious to a POSA over Cross, Meyer and Welte.

2. Cross (EX1007)

216. I discussed Cross above in Section § VII.A.2 and the various devices in its system, including a worker-worn PNU, a train-mounted VCU, and wayside priority detectors. Cross, [021]-[022], [026]-[047], [059].

3. Meyer (EX1012)

217. I discussed Meyer above in Section § VII.F.3. As most relevant to Ground 1F, I reiterate that Meyer discloses a mobile unit 4 (which I have annotated in Meyer's FIG. 2 below), that can be located at various locations where workers are working and which communicates with companion devices on workers and approach trains. Meyer, [0001], [0016]-[0028], [0037]-[0046]. The mobile unit includes an autonomous power source (Meyer, [0018]), and, as seen in Figure 2 (below), a tripod support structure:

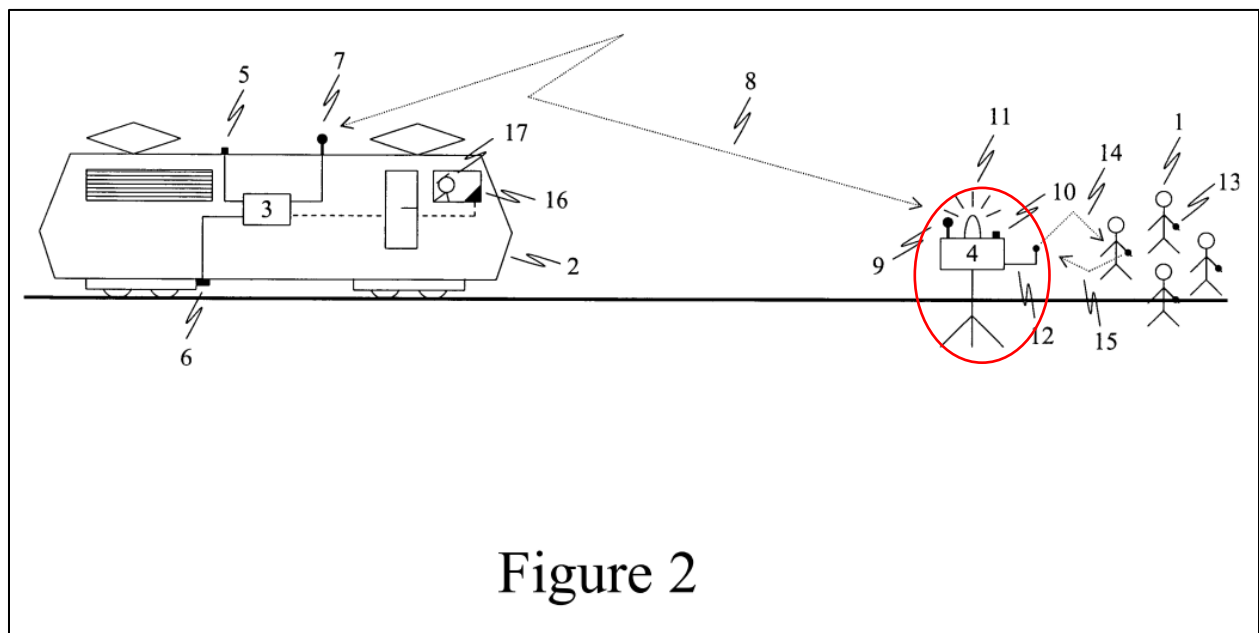


Figure 2

4. Welte (EX1016): U.S. Patent No. 5,907,294

218. According to the face of the document, Welte is an issued U.S. Patent that issued on May 25, 1999 (code (45)), titled “Process for Detecting Sources of Danger” (code (54)). Because Welte issued in 1999, I understand that Welte

qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* '595 patent, code (60)). I understand that Welte was not cited during prosecution of the '595 patent. *See* '595 patent, code (56) (references cited).

219. Welte discloses a “warning system for warning persons in a track building site of approaching trains.” Welte, Abstract. The warning system includes a “mobile” unit that includes a “sensor” that detects approaching vehicles. Welte, 4:14-16, 4:38-42. Welte’s vehicle-detecting sensor can be “an infrared or laser signal,” which were conventional sensor technologies then and through the mid-2010s. Welte, 4:54-55; *see also* 3:22-32 (discussing optical sensors like “infrared sensors, or other electronic sensors”), claim 6 (claiming an optical sensor that “utilize[s] an infrared sensor or a laser beam sensor” that “detects an object passing the rail”). When Welte’s mobile unit’s sensor detects an approaching train, the unit transmits wirelessly a “warning signal” to various “different receiving units,” one of which is a worker-worn unit that vibrates, flashes light, or generates an acoustic signal to indicate the warning to the worker. Welte, 1:14-37, 7:7-10, 7:27-40.

5. The Cross-Meyer-Welte Combination

220. As I discussed in Section VII.A.2 above, Cross’s worker-protection system includes “priority detectors” that are “generally located along a particular

vehicle's route," *e.g.* along a train's track. Cross, [049]. Cross explains that "one common location for priority detectors [] will be at or in close proximity to intersections" (*id.*), and it depicts priority detectors located at an intersection in Figure 1. As Cross's Figure 1 illustrates, when priority detectors are located at an intersection, they utilize existing structures—*e.g.*, a signal pole and signal controller cabinet—to house the priority detector's components (*e.g.*, transmitters/receivers).

221. Cross, however, does not explain how priority detectors are designed to operate in locations other than at an intersection, *e.g.*, at a worksite, despite Cross teaching that such detectors can be located "at various locations along a particular's vehicles route" and listing an intersection as merely an exemplary location. Cross, [049]. POSAs would have had reason to look to other prior art disclosing wayside devices to determine how to implement Cross's priority detectors when used at locations other than an intersection like a worksite.

222. Meyer teaches such an implementation. Specifically, Meyer teaches the use of a mobile unit that is located along areas of a track where work is being performed. Meyer, FIGS. 1-2, [0012], [0019], [0035], [0039]. As Meyer explains, construction and maintenance work are routinely performed on and around tracks, and there is a need to ensure worker safety at different worksites along the track. Meyer, [0012]. This common-sense recognition—*i.e.*, that workers will be present

at locations along a track other than an intersection—was well-known by 2015. For example, EX1029 taught that “railroad crews working or in the vicinity of active railroad tracks are susceptible to accidents as a result of not being sufficiently warned of an oncoming train” and that rail workers “are “typically in isolated regions away from crossing areas” (*i.e.*, away from intersections) and “therefore the work crews do not have the benefit of standard crossing signals to warn them of approaching trains.” EX1029, 3:12-18. Thus, EX1029 taught and corroborated that there was a “need for a reliable warning system” that was “portable and easily setup by the crew in a relatively short period of time.” EX1029, 3:18-30.

223. In view of Meyer’s teaching (and the common-sense recognition) that workers should be protected when working at track locations other than intersections, POSAs would have had reason to implement Cross’s priority detectors using the mobile-wayside unit design that Meyer describes and depicts. Beyond Meyer’s explicit motivation, the combination also would have been the routine (and obvious) use of one known technique (portable, wayside safety equipment) to improve similar devices (wayside devices operating in a railway system) in the same way (by making the device portable so that it could be placed wherever best suited to worker safety).

224. Moreover, in view of Welte, POSAs would have had reason to augment Cross's priority detector so that it included a laser or infrared sensor that could detect an approaching train and broadcast an alert signal when a train was detected as approaching the detector. Welte, 3:22-32, 4:14-55. Using sensors to detect an approaching vehicle would have added redundancy (and thus safety) to Cross's system. This is because in addition to receiving AVL packets broadcast by Cross's VCU (§ VII.A.2), Welte's teachings would have allowed wayside units to independently detect an approaching vehicle using their sensors, even if an AVL packet was not transmitted or was transmitted but not received or received in a corrupted format that made the information unusable.

225. In the Cross-Meyer-Welte combination, Cross's priority detector would have had the mobile design that Meyer depicts (*e.g.*, Meyer, Figures 1-2), and would have included an "autonomous power supply" (Meyer, [0018]), *e.g.*, batteries, to power its components when placed in locations without convenient access to the electric grid or signaling equipment at intersection. This portable priority detector would have also included Meyer's tripod legs to support the detector's housing, so that the detector could be moved to different locations along a track wherever workers were present, including locations without structures to attach the portable detector. Welte at 6:36-67 similarly discloses having batteries in its sensor unit and evaluating unit. The portable priority detector in the

Cross-Meyer-Welte combination would have otherwise maintained the same functionality (and corresponding hardware/software components) the priority detectors had in Cross's system but would have been augmented to include a laser/infrared sensor, as Welte taught (*e.g.*, 4:54-55). (That is, the Cross-Meyer-Welte portable priority detector would include a conventional laser (optical) sensor disclosed in Welte, which a POSA would have understood to be a conventional alternative to a vibrational sensor attached to the rails. Welte, 4:38-58) In the Cross-Meyer-Welte portable priority detectors, if the laser/infrared sensor detects an approaching train, the priority detector would broadcast an alert signal to companion devices in the system, *e.g.*, Cross's VCU's and PNU's, consistent with the teachings of both Welte and Meyer. *See, e.g.*, Welte, 7:7-10; Meyer, [0036] (describing "broadcast method" of signal transmission).

226. POSAs would have reasonably expected success in the Cross-Meyer-Welte combination discussed above because it would have required only ordinary skill to place Cross's detector components (*e.g.*, processor, transceiver, and antenna) in Meyer's portable housing (*i.e.*, a housing with an autonomous power supply – *e.g.*, batteries – that uses a tripod to support the housing) and Welte's conventional sensory components for detecting the presence of approaching vehicles.

6. Claim 27

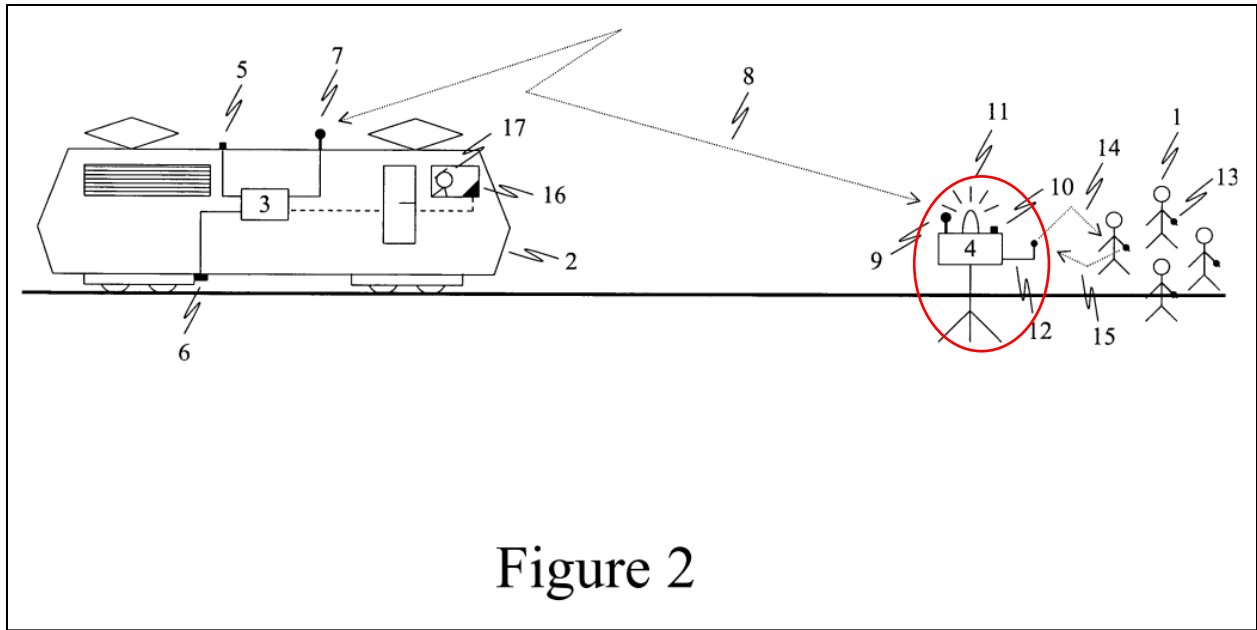
a. [27PRE] 27. A system for worker protection, the system comprises:

227. If the preamble of claim 27 is a limitation of the claim, the Cross-Meyer-Welte combination meets it because, consistent with Cross’ teachings, Cross-Meyer-Welte is a “safety notification system” for protecting “maintenance workers.” Cross, [001]-Summary; *see also* Cross, [002]-Background, [046], [050].

b. [27A] a wayside detection unit, configured for placement on or near path of a vehicle, the wayside detection unit comprising:

228. The Cross-Meyer-Welte combination that I described above (§ VII.F.5) includes Cross’s “priority detectors,” which “are wayside devices” “located at various locations along a particular vehicle’s route.” Cross, [049], FIG. 1.

229. As I discussed above in § VII.F.5, POSAs also had reason to design Cross’s priority detectors to use the portable housing Meyer describes and depicts in its figures, like Figure 2, which I have annotated below to identify the portable detector housing with a tripod support structure. *See* Meyer, FIG. 2 (annotated below), [0035], [0040].

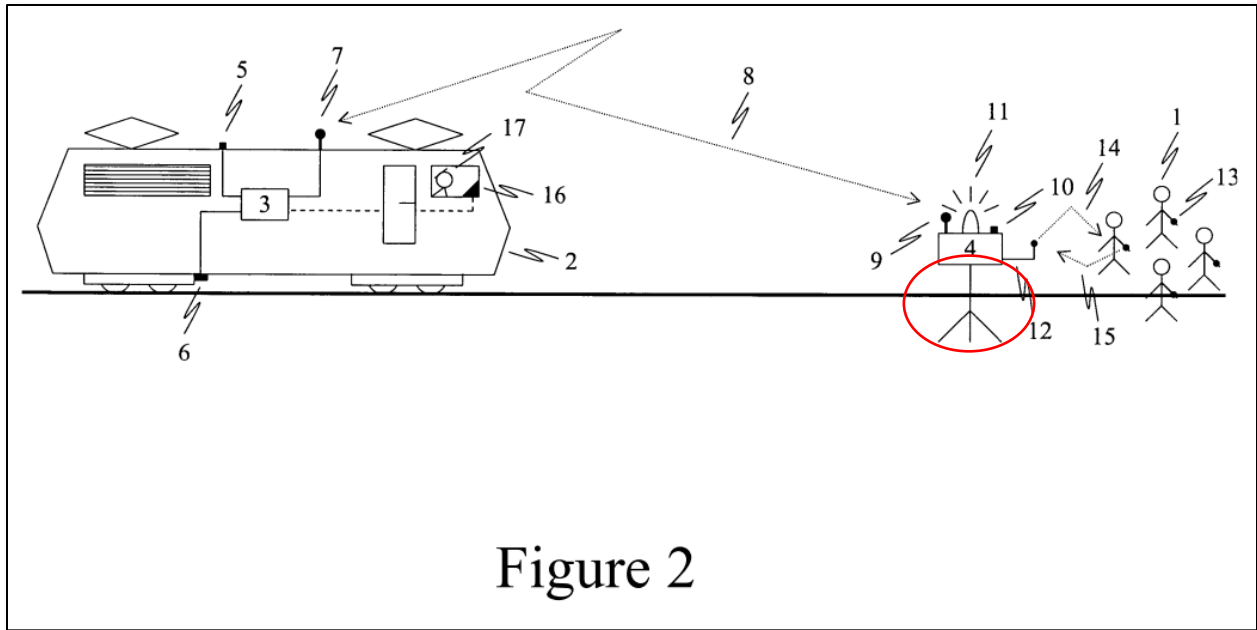


c. [27B] a housing for enclosing components of the wayside detection unit;

230. As I described above (§ VII.F.5), the components of the Cross-Meyer-Welte's wayside priority detectors are housed in Meyer's housing, illustrated in Meyer's Figure 2 (annotated above). *See also* Meyer, [0018], [0040]; FIGS. 1-2.

d. [27C] a support structure for holding and supporting the wayside detection unit when placed on or near the path;

231. In the Cross-Meyer-Welte combination, the wayside priority detectors, which are implemented using Meyer's design, would have included Meyer's tripod support structure for holding and supporting the unit when placed on or near the path, as claimed. Meyer, FIGS. 1-2, [0035]-[0037], [0040]. That support structure is illustrated in Meyer's Figure 2, which I have annotated below.



e. [27D] a power supply for powering components of the wayside detection unit;

232. In the Cross-Meyer-Welte combination, the wayside priority detectors include Meyer's "autonomous power supply" to power components in the units. Meyer, [0018]. A POSA would have understood that a battery would have been an example of a conventional autonomous power supply by the mid-2010s. Welte, for example, teaches a sensor unit with "an energy supply in the form of batteries." See Welte, 6:36-67, FIG. 1 (batteries). Cross at [063] discloses that PNU's, which are portable devices, have batteries that sometime require "battery **recharging**." A POSA would have understood that similar, conventional batteries, appropriately sized to the wayside priority detectors, could be used in the Cross-Meyer-Welte wayside priority detectors.

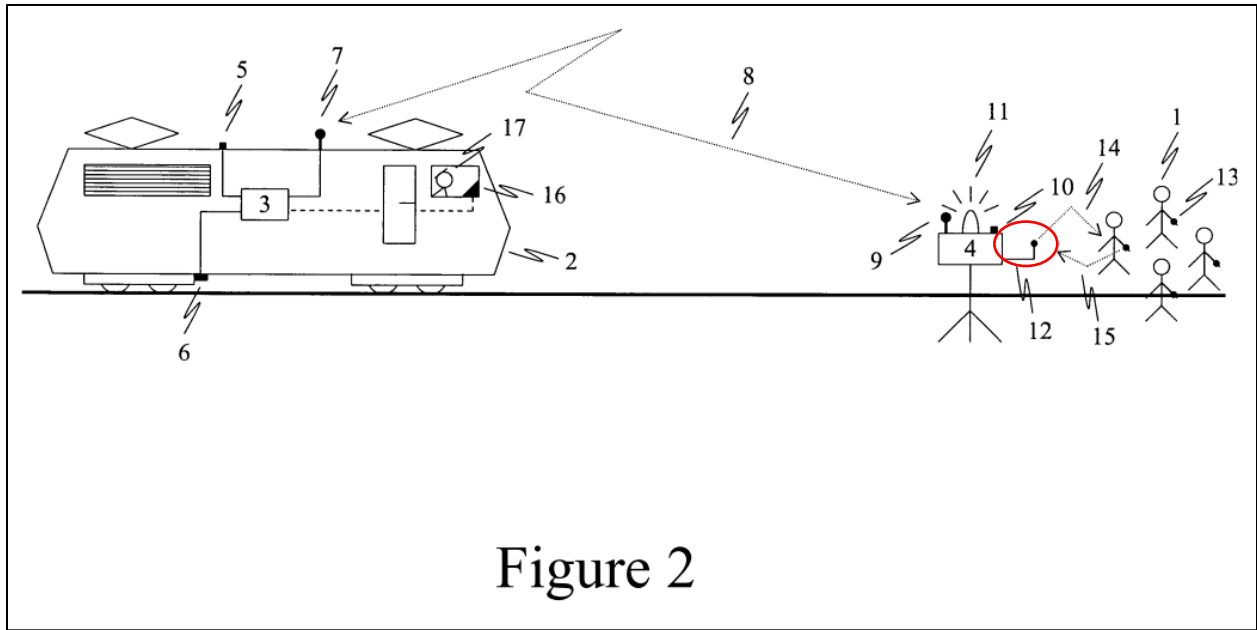
f. [27E] one or more sensory components, for detecting, monitoring, and/or tracking vehicles;

233. As I discussed above in § VII.F.5, Cross-Meyer-Welte's portable priority detectors use conventional sensory components such as a laser or infrared sensor, as taught by Welte (4:54-55) to detect and/or monitor vehicles that approach the detector units.

g. [27F] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;

234. The Cross-Meyer-Welte's wayside priority detectors would have included a "communication component" having an antenna for transmitting/receiving wireless signals. As Cross explains, its priority detectors are "capable of receiving radio (RF) signals and forwarding the received data through the network" to companion devices like Cross's PNUs or VCUs. Cross, [049].

235. When Cross's priority detector is implemented using Meyer's portable design in the Cross-Meyer-Welte combination, the priority detector would have maintained the ability to receive/transmit wireless RF signals and uses an antenna. Meyer's Figure 2, which I have annotated below, depicts such an antenna(s) on the exterior of its wayside unit, with various wireless signals (*e.g.*, signals 8-12, 14-15) being received or transmitted by the wayside detector:



236. In the Cross-Meyer-Welte combination that I described above in § VII.F.5, the wayside priority detector would have included a communication component comprising an antenna (like the one Meyer depicts) along with related circuitry for processing wireless RF signals—which together are a “communication component,” as claimed. Per Cross’s teachings, the Cross-Meyer-Welte detector would (1) “receiv[e]” wireless signals from components in the system such as a Cross’s VCUs, PNUs and other detectors (*see* § VII.F.2 above), and (2) “forward[],” *i.e.*, transmit, wireless alert notification signals to those same components, in order to increase the safety and reliability of the system. Cross, [049]. Additionally, per Welte’s teachings, the Cross-Meyer-Welte priority detector would also transmit a wireless signal to nearby alert devices, like those worn by workers, when its laser/infrared sensor detects a train approaching the

detector. Welte, 4:14-23, 7:28-39. The Cross-Meyer-Welte combination, therefore, meets limitation [27F].

h. [27G] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the wayside detection unit;

237. In the Cross-Meyer-Welte combination, the portable priority detectors would have included electronic circuits operable to process received wireless signals (and the data contained in those signals), like “real-time vehicle and worker activity and alert notifications,” and to transmit the signals (and associated data) to other components in the system, consistent with Cross’s teachings. Cross, [049]. As Cross at [031] teaches, “receivers...encompass an electronic circuit” and a POSA would understand that transmitters and/or transceivers do as well. These receiving and transmitting functions by the priority detector are operations of the wayside priority detectors and relate to operations of the wayside priority detectors (*e.g.*, they relate to the detectors’ relaying of data functionality).

238. Moreover, as I also discussed above in § VII.F.5, the Cross-Meyer-Welte priority detectors also include Welte’s conventional sensors for detecting the presence of approaching vehicles. Welte, 4:14-23, 7:28-39. In Welte, the sensor unit includes an “evaluating unit” that processes sensor signals to determine whether a train is approaching. Welte, 4:11-23, 6:49-7:20, FIG. 1. In the Cross-Meyer-Welte combination, the portable priority detectors would have included one

or more electronic circuits to execute the functionality performed by Welte's "evaluating unit." Thus, the Cross-Meyer-Welte detectors would have processed signals and data provided by the device's laser/infrared sensor to determine whether a vehicle is approaching and, if so, generate an alert for transmission to companion alert devices, like the system's VCUs and PNUs. A POSA would have understood that conventional sensors, like a laser or infrared sensor, would have included circuitry (*e.g.*, processors, memory, circuit boards, etc.) that are operable to process signals and data generated by the sensor when detecting vehicles and/or people approaching the sensor.

239. This additional sensor-related functionality in the Cross-Meyer-Welte priority detector also relates to operations of the wayside priority detectors, and thus is another reason the combination meets limitation [27G].

- i. **[27H1] wherein the wayside detection unit is operable to: determine, based on sensory data obtained from the one or more sensors, when the vehicle is approaching the wayside detection unit; and**

240. As I discussed above in §§ VII.F.5 and VII.F.6.f, the Cross-Meyer-Welte wayside priority detectors are operable to use Welte's conventional sensor components and sensory data they generate to detect when a vehicle is approaching the detector unit. Welte, 4:38-55; Meyer, [0023].

j. [27H2] broadcast, to one or more companion alert devices, alert related signals, relating to the approaching of the vehicle.

241. In the Cross-Meyer-Welte combination (§ VII.F.5), the wayside priority detectors broadcast to PNU's, VCU's, and other wayside units—which are all companion alert devices—alert related signals relating to the approaching of the vehicle, as claimed. The alert related signals that are broadcast by the wayside priority detector are signals to alert these other devices that the wayside priority detector had determined—using the detector's laser/infrared sensor—that a vehicle was approaching the detector. As Meyer explains (and was commonly understood at the time), broadcasting a signal to all nearby devices would have ensured that all devices capable of receiving the alert-related signal that were within a “certain radius” of the detector would receive the signal. Meyer, [0036]. POSAs thus would have designed the Cross-Meyer-Welte wayside priority detector to broadcast its approaching-vehicle alert signal to all companion devices (*i.e.*, VCU's, PNU's, and other priority detectors) within its vicinity, to ensure that any nearby workers and vehicles knew of the approaching vehicle, thereby beneficially increasing the safety and redundancy in the system.

* * *

242. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer-Welte combination meets every limitation of claim 27.

7. **Claim 28: The system of claim 27, wherein the wayside detection unit is operable to forward alerts and/or alert related signals communicated by one or more nearby alert devices, the one or more nearby alert devices comprises vehicle alert devices, personal alert devices and/or other wayside detection units.**

243. In the Cross-Meyer-Welte combination that I discussed above (§ VII.F.5), Cross-Meyer-Welte's priority detectors apply Cross's teaching to "function as intermediaries..., receiving signals [communicated] from VCUs (103) and PNUs (102) and **forwarding** the real-time vehicle and worker activity and alert notifications[and ETA information (*i.e.*, the alerts and alert-related signals discussed above § VII.F.6.j ([27H2]))]...to...VCUs (103), or PNUs (102)." The PNUs and VCUs receiving the forwarded signals are nearby vehicle and personal alert devices, respectively, as claimed. Cross, [049]; § VII.G.3 above (where I discuss Cross's VCUs), § VII.A.3 above (where I discuss Cross's PNUs).

244. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer-Welte combination meets every limitation of claim 28.

8. **Claim 29: The system of claim 27, wherein the wayside detection unit is operable to log data relating to alerts triggered in response to the broadcasted alert related signals.**

245. As I discussed above in §§ VII.A.7 and VII.A.16, Cross teaches "stor[ing] detailed activity and alert logs" in its PNU ([041]) and in its VCUs ([034]). As I also discussed above (§ VII.F.6.j ([27H2])), Cross-Meyer-Welte's

wayside priority detectors broadcast alerts to nearby companion devices (*e.g.*, PNUs and VCUs) when its sensor components detect an approaching train. POSA would have had reason to include in the Cross-Meyer-Welte's wayside priority detectors logging functionality like that found in Cross's PNUs and VCUs so that the priority detector could also log data regarding the alerts the priority detector broadcasts once its laser/infrared sensor determines a vehicle is approaching.

246. This is because in the Cross-Meyer-Welte combination Cross's priority detectors were modified based on Meyer and Welte to include the ability to generate their own alert signals—*i.e.*, in response to detecting a vehicle approaching (§ VII.F.5 above). Thus, POSAs would have recognized the benefits to giving the priority detectors the same ability to store logs that the PNUs and VCUs already had in Cross's system because, in the Cross-Meyer-Welte combination, all of these devices would have generated alerts that a system operator would have wanted to log and keep track of. For example, as Cross teaches and was known in the art, such logs beneficially “allow[] for administrators to evaluate trends and identify reoccurring safety issues and locations in the mass transit system as a whole.” Cross, [063]. My opinion that logging data was conventional and beneficial is corroborated by EX1030, which teaches (at 5:19-25) that logs are “useful in cases where liability is an issue” and so the timing of alerts and/or operations of devices generating alerts in the system was important to

maintain in logs. Similarly, EX1031 (at [0039]) teaches that logs permit administrators to “easily analyze and verify operation of the system.” For the same reasons, an administrator of the Cross-Meyer-Welte combination would have wanted to analyze and verify operation of the devices in the system, including the portable priority detectors.

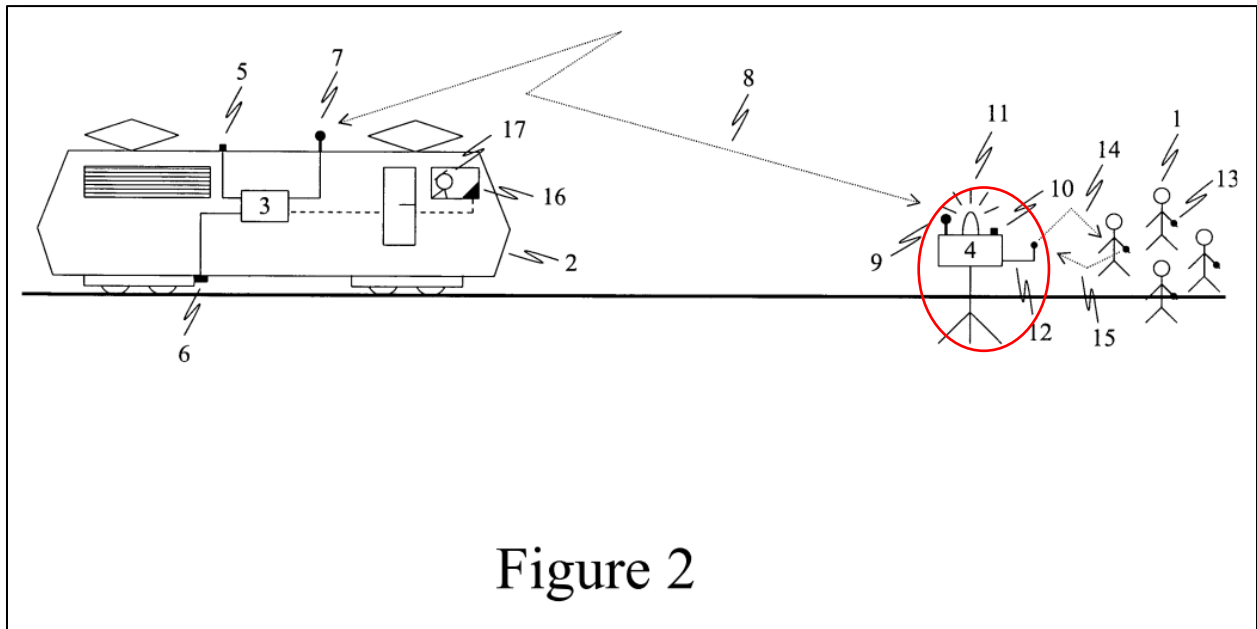
247. Consistent with the teachings in Cross, EX1030, and EX1031 that I discussed above, a POSA would have understood that logging data relating to the operations of the wayside device would have also been using a known technique (logging operations of wayside devices in a traffic system) to improve similar devices (wayside devices in the system) in the same way (by keeping records of operations and alerts for diagnostic and tracking purposes).

248. In my opinion, POSAs would have reasonably expected success in logging data relating to alerts in the Cross-Meyer-Welte priority detectors because Cross already teaches logging data in portable PNU devices and so it would have required only ordinary skill to include in priority detectors (1) similar instructions and/or software or firmware code to record alerts in a data log in the priority detectors and (2) conventional memory in the device to maintain the log data.

249. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer-Welte combination meets every limitation of claim 29.

9. Claim 30: The system of claim 27, wherein the support structure comprises a tripod or a connection element for permanent connection to wayside equipment.

250. As I discussed above in §§ VII.F.6.d-VII.F.6.e ([27C]-[27D]) Cross-Meyer-Welte's priority detector uses Meyer's portable housing, which comprises a tripod support structure on the wayside equipment, as claimed. The tripod support structure is shown, for example, in Meyer's Figure 2, which I have annotated below to identify the tripod structure. *See also* Meyer, FIG. 1.



251. Accordingly, for the reasons discussed above, in my opinion the Cross-Meyer-Welte combination meets every limitation of claim 30.

G. Ground 2: Claims 21-25: Anticipated by Carlson

1. Overview of Ground 2

252. For the reasons I discuss below in §§ VII.G.3-VII.G.7, it is my opinion that claims 21-25 are anticipated by Carlson in view of the knowledge of a person of ordinary skill at the time of the alleged invention of the '595 patent.

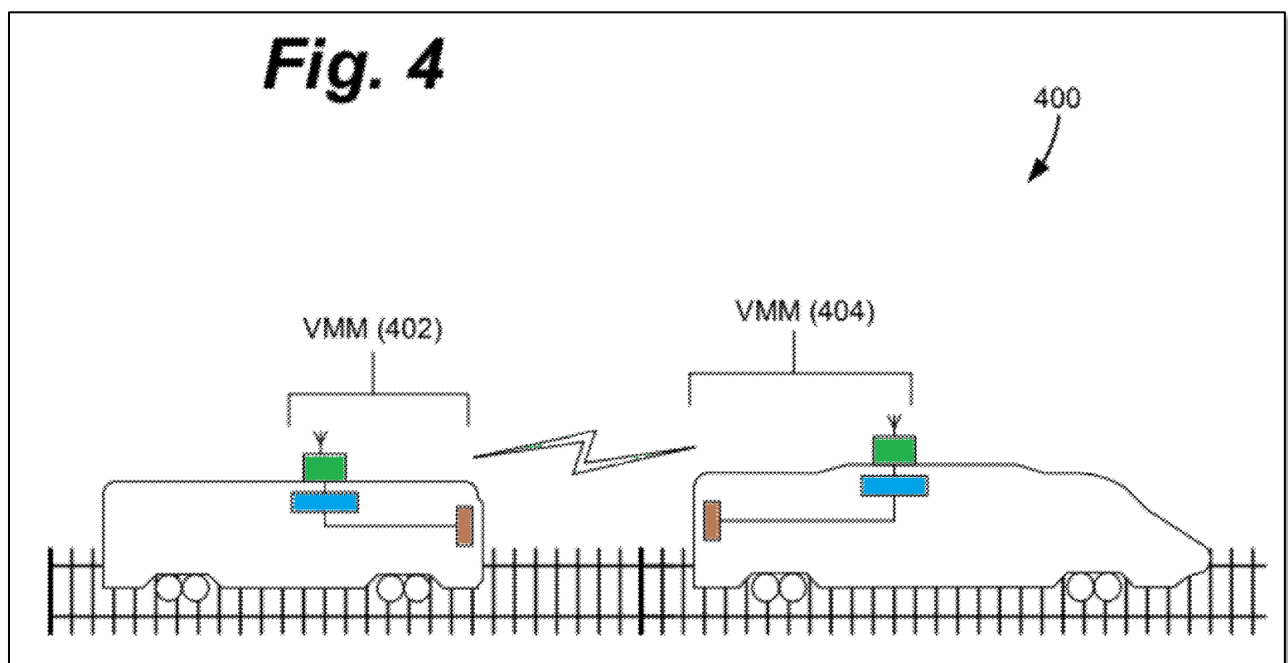
2. Carlson (EX1006): U.S. Patent Application Publication No. 2012/0296562 A1

253. According to the face of the document, Carlson is a U.S. published patent application published on November 22, 2012 (code (45)), titled “Collision Avoidance System for Rail Line Vehicles” (code (54)). Because Carlson published in 2012, I understand that Carlson qualifies as prior art even if the challenged claims were entitled to the March 23, 2015 filing date of Provisional Application No. 62/177,683 (*see* '595 patent, code (60)). As I discussed above in Section V.B, I understand that Carlson was cited during prosecution of the '595 patent, but only as to dependent Claims 9, 10, 13, 16, 17, and 19 as a secondary reference in an obviousness rejection with Sheardown. As I discuss in more detail below, in my opinion Carlson anticipates claims 21-26, which the Examiner failed to appreciate during prosecution of the '595 patent. According to the face of the document, the three named inventors of Carlson – Richard Carlson, Kurt Gunter, and Marc Cygnus – are also named inventors on the face of the '595 patent, and I understand that Carlson is also assigned to Patent Owner Metrom. *See* Carlson,

code (76); see

<https://patentcenter.uspto.gov/applications/13474428/assignments/abstract>.

254. Carlson discloses “systems, methods, techniques and/or solutions ... for a collision avoidance system ... that may monitor the location of and separation distance(s) between rail line vehicles, for example railroad maintenance vehicles.” Carlson, [0006]. Carlson’s “collision avoidance system may include the ability to monitor worker presence around machines so that a worker or foreman may be alerted if a worker is standing in an unsafe location.” Carlson, [0121]. FIG. 4, which I have annotated below, “depicts an illustration of an example collision avoidance system (CAS) 400,” in particular vehicle mounted modules (VMMs) 402 and 404. Carlson, [0037], [0041]. VMMs are “located in or on the vehicle,” as illustrated below. Carlson, [0037].



255. As illustrated in FIG. 6, which I have annotated below, each VMM comprises three main modules: (1) “control electronics modules (CEM) [602, annotated blue]..., [(2)] transponder sensor modules (TSM) 604 [annotated brown], and... [(3)] user interface modules (UIM) 606 [annotated green].” Carlson, [0043]. Within the CEM, “each VMM [also] includes its own CTU [central tracking unit] mobile/component [631] that tracks the location of other vehicles.” Carlson, [0041]; *see also* Carlson, [0040] (“the CTU ... may be distributed amongst the vehicles in the work gang, for example with a CTU module/component in each VMM”).

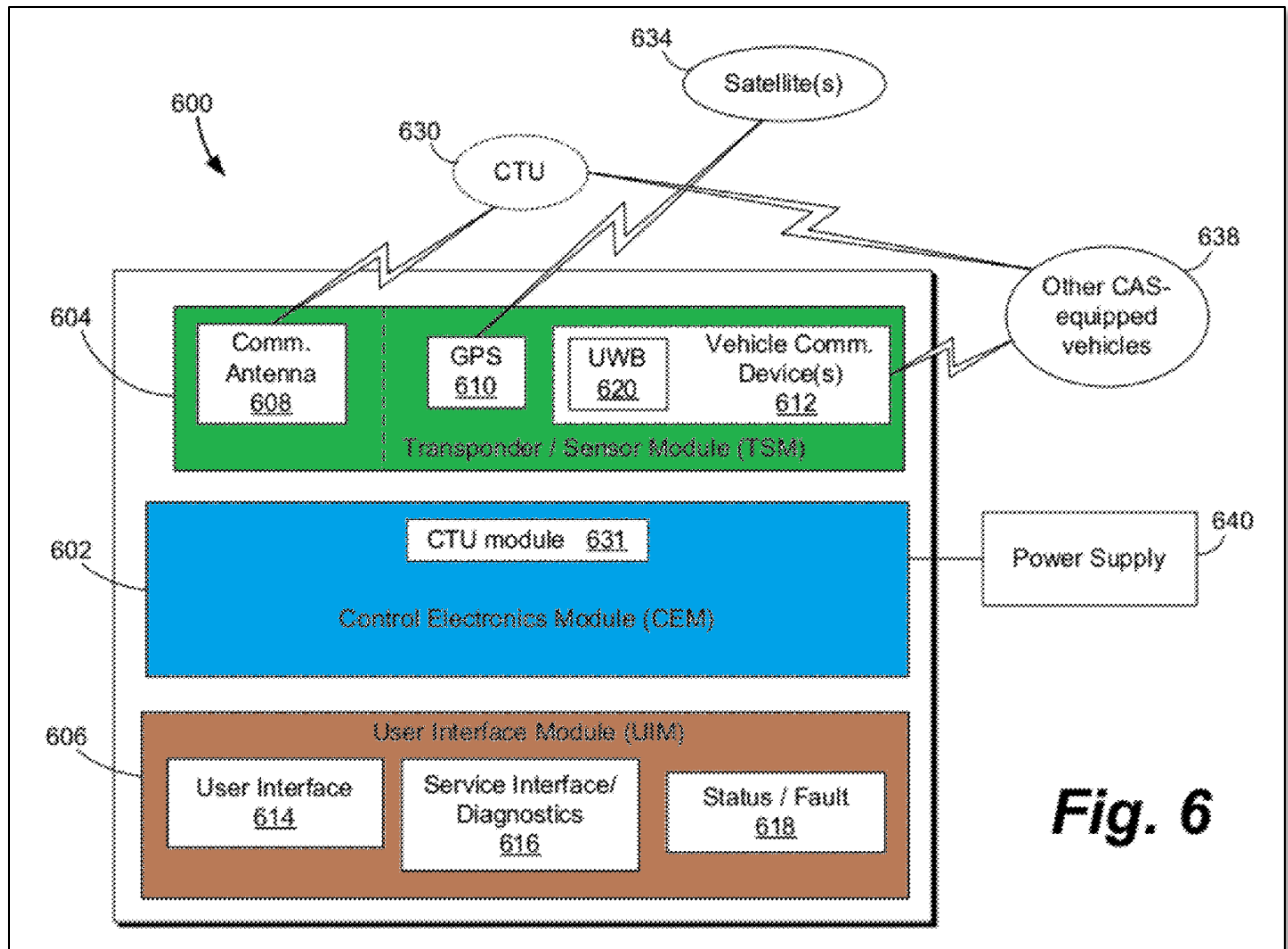
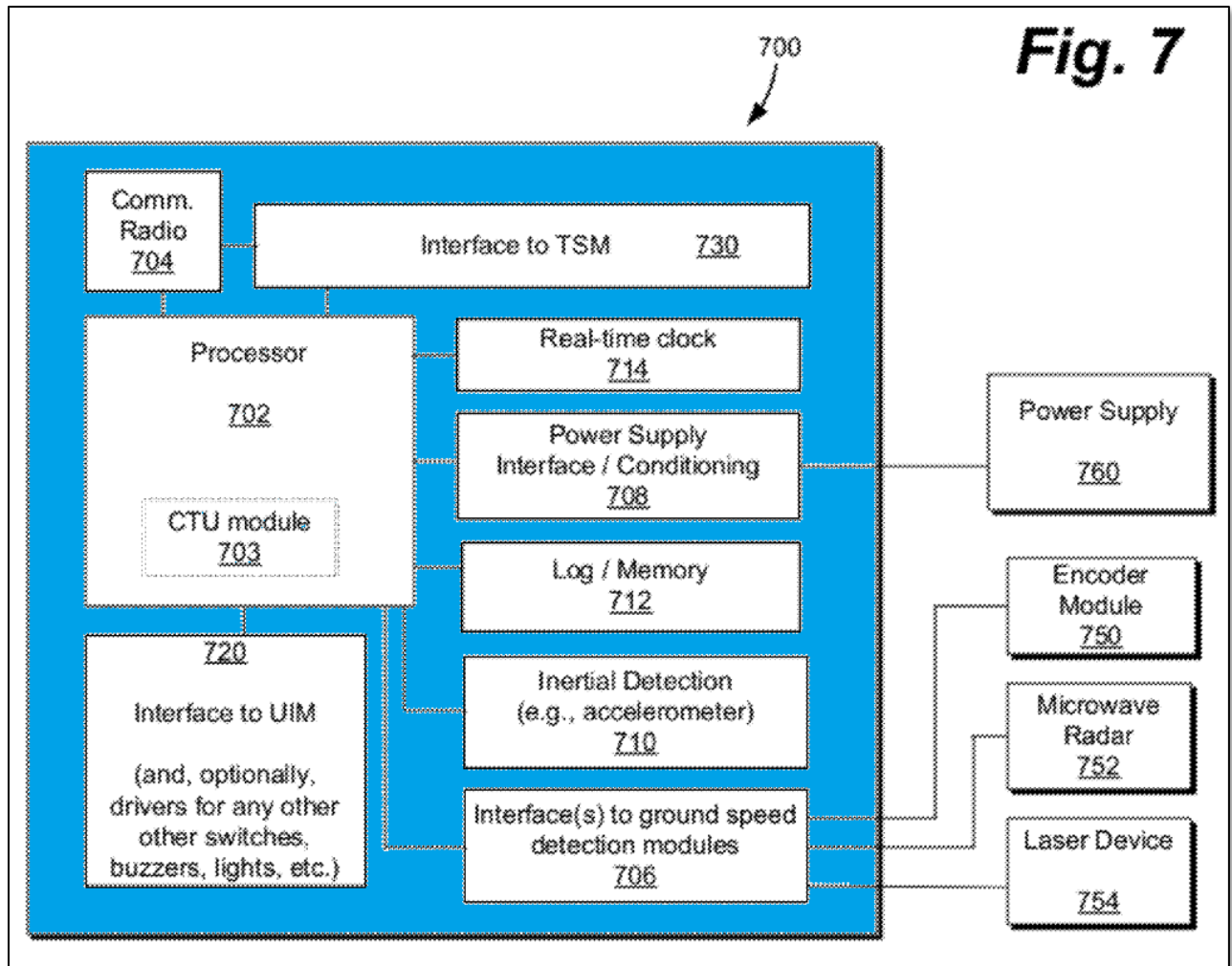


Fig. 6

256. As shown in Figure 6 above, the TSM (green) “includes a wireless communications antenna 608 (for example an RF antenna...),” “a GPS unit 610 [and] one or more vehicle communication devices 612” comprising, for example, a “UWB unit 620, and/or other sensors.” Carlson, [0043]-[0044]. The TSM (controlled by the CEM that I discussed below) “transmit[s] a variety of information to the CTU 630” or to the in-vehicle CTU 631. Carlson, [0044]-[0045]. This information includes “absolute position data, relative position data and speed data,” which are data “obtained by the VMM utilizing various

components and/or sensor, for example, the GPS unit 610, the UWB unit 620, and/or other sensors.” Carlson, [0044].

257. FIG. 7, which I have annotated below, is “a block diagram of an example control electronics module (CEM).” Carlson, [0047]. The CEM includes, *inter alia*, “a processor 702, a wireless communications radio 704 (such as an RF radio), an interface to a TSM 730, an interface to a UIM 720” and “a power supply interface/power conditioning system 708.” Carlson, [0047]. The “interface to the UIM 720 may further include one or more drivers to power visual and/or audio indicators” using the I/O components I discuss below. Carlson, [0047]. The CEM also includes “an inertial measurement unit 710” (*e.g.*, “accelerometers”) and “a log/memory 712.” Carlson, [0047].

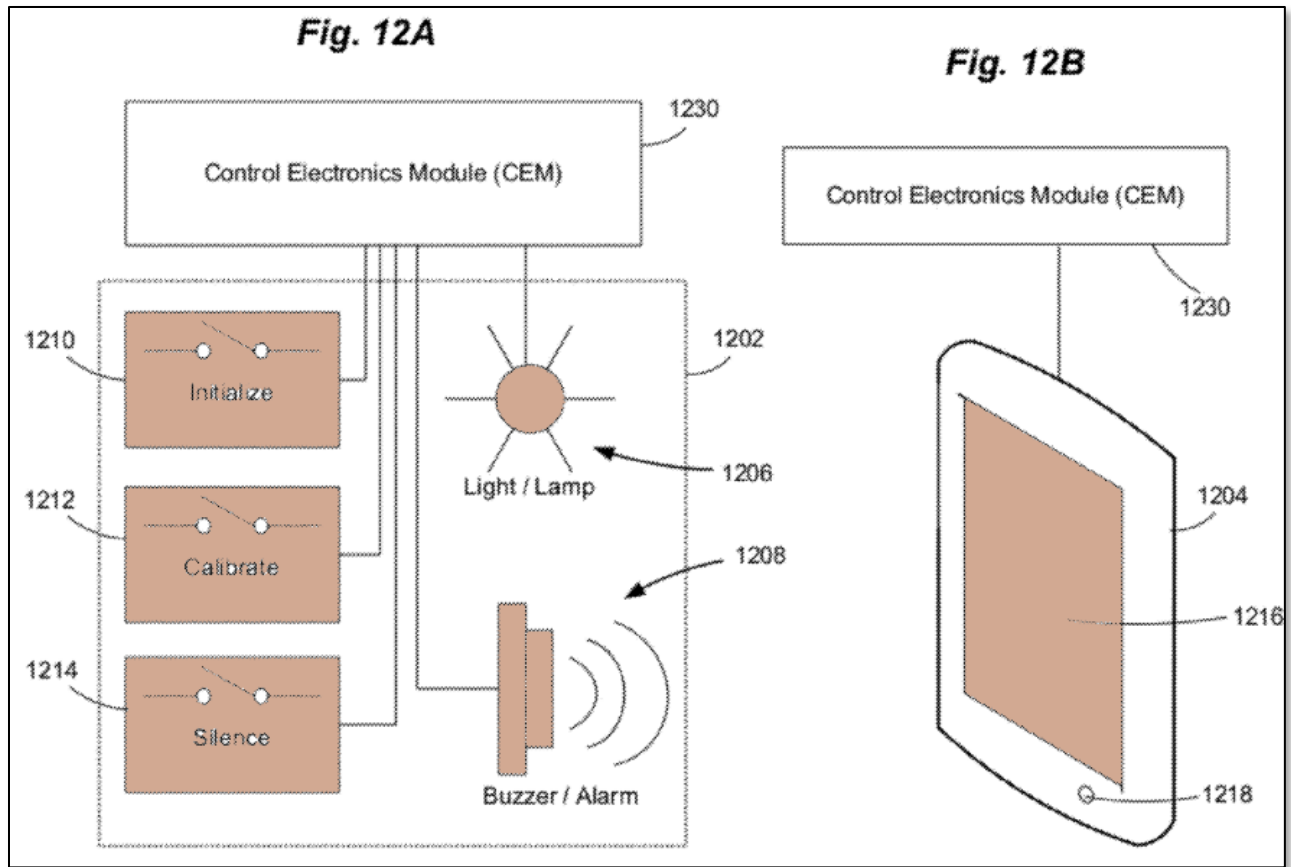


258. As illustrated in Figure 6 (annotated above), “CEM 700 may include a processor 702,” which “among other operations, process information received from the vehicle communication devices, for example via the interface to the TSM 730.” Carlson, [0049]. “The processor 702 may also process information received from other modules, components and/or subcomponents of the VMM.” Carlson, [0049]. For example, the processor 702 “handle[s] information and/or perform[s] computations to, among other things, track other vehicles in a work gang and

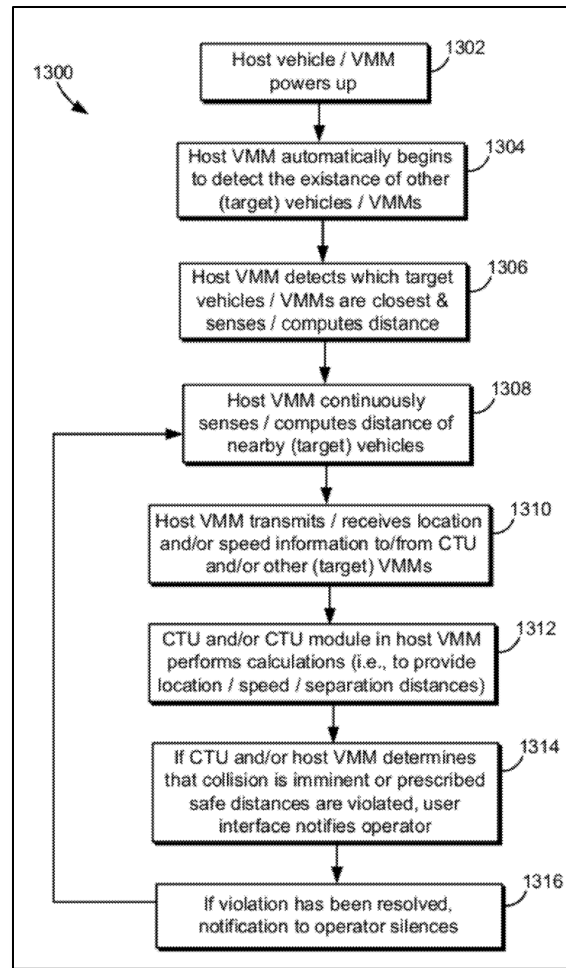
determine which vehicles present a potential hazard,” and to “process location and speed information from vehicles in a work gang and may also track vehicles in a work gang to determine when collisions may be imminent.” Carlson, [0049].

Thus, “some or all of the tracking and processing components of the CAS may be located within the VMMs (for example, within a CTU module [(703)]),” which “may be a software feature that is executed by the CEM processor 702.” Carlson, [0049].

259. Figures 12A-12B, which I have annotated below, illustrate “example user interfaces” for the UIM modules in VMMs. Carlson, [0080]. Using the user interfaces, the UIM includes “means of alerting an operator of events, for example if vehicle separation criteria are violated.” Carlson, [0080]. Figure 12B’s interface, for example, comprises “a touchscreen, tablet, [or] PDA” with “physical buttons” or configurable ““soft’/temporary buttons on the screen” and “one or more speakers and/or audio drivers” to “alert an operator to an event.” Carlson, [0081]-[0082]. “The screen 1216 of the touchscreen 1204 may also alert an operator to an event, offering similar functionally to hard lights, lamps and the like.” Carlson, [0082].



260. Figure 13 (below) illustrates “a flow diagram 1300 that shows exemplary steps in the operation of a CAS” to avoid collisions between vehicles and/or between a vehicle and worker.



The host VMM “detect[s] the existence of other vehicles/VMMs in the vicinity.”

Carlson, [0099]. For example, in steps 1304-1408, the VMM “search[es] for/link[s] with other vehicles both in front of the host vehicle and/or behind the host vehicle” and “determine[s] if there is any other VMM-type equipment nearby” and “calculates distances between the host vehicle and the target vehicles.”

Carlson, [0099]. As step 1310, the VMM “transmit[s] location and speed information to the CTU” or “to target vehicles/VMMs.” Carlson, [0100]. At step 1312, the “CTU module inside the host VMM may calculate information, for

example absolute and relative location of the vehicles in the work gang, speed and direction of vehicles, separation distances and/or safe distance violations.”

Carlson, [0100]; *see also* Carlson, [0039] (disclosing that CTUs can “determine if a separation distance between two vehicles has been violated, indicating that an accident may be likely”). At step 1314, if the “VMM determines that collision is imminent or prescribed safe distance are violated,” the VMM’s “user interface” will “notify the operator,” for example, by activating “warning indicators and/or audible buzzers, alarms and the like.” Carlson, [0100].

261. Carlson’s “collision avoidance system may include the ability to monitor worker presence around machines so that a worker or foreman may be alerted if a worker is standing in an unsafe location.” Carlson, [0121]. “For example, if a worker is standing on the tracks near a vehicle as another vehicle approaches and violates a predetermined separation criteria, the worker and the foreman may be alerted, and perhaps emergency brakes may be activated.” Carlson, [0121]. Worker locations are monitored “by communicating with a communication device that is located on the worker,” such as “a UWB device” that is “a subset of a UWB ranging system that includes components, some that are located on vehicles and some components that are located on workers.” Carlson, [0121].

3. Claim 21

262. As I discussed above (§ VII.G.2), Carlson has two principal embodiments for its system: one embodiment has a discrete CTU (central tracking unit) and one in which the CTU's functionality is (1) integrated into a module in the VMM's CEM (control electronics module) and (2) executed by the CEM's processor. My opinions relating to Ground 2 rely on the latter embodiment, in which the CEM's processor performs the CTU's functionality. As I discuss in more detail below, this embodiment of Carlson anticipates claims 21-25.

a. [21PRE] A system for worker protection comprises:

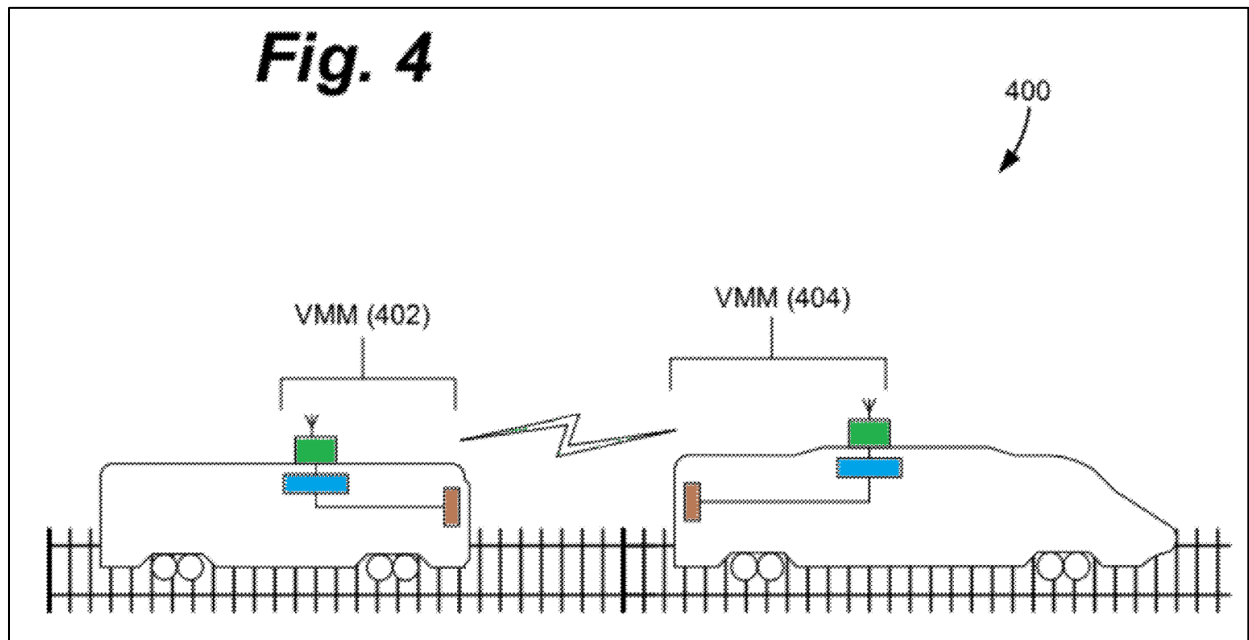
263. Carlson discloses “a collision avoidance system” that, among other functionality, has “the ability to monitor worker presence around machines so that a worker or foreman may be alerted if a worker is standing in an unsafe location. [0121]. Carlson at [0122]-[0124] summarizes aspects of the system. Carlson at [0122] notes that the system includes a communication device “located on a worker,” which “may communicate with one or more components located” in vehicle mounted units. Carlson at [0123] notes that the system utilizes “UWB technology and other close proximity sensing technologies” “to monitor distance between train cars” to calculate potential collisions. And Carlson at [0124] notes that the collision avoidance system monitors “speeds of vehicles, equipment and/or workers equipped with collision avoidance system technology.” *See also* Carlson,

[0003]-[0005] (explaining background information about safety concerns that are present when railroad workers perform maintenance on tracks).

b. [21A] a vehicle-mounted alert device, configured for use on a vehicle

264. Carlson's system includes a vehicle mounted module (VMM) comprised of various "modules that are located in or on the vehicle (for example, TSM 306, CEM 310 and UIM 314)." Carlson, [0003]; *see also* [0042]; FIGS. 3-4.

265. As seen in Figure 4, which I have annotated below, the VMMs 402 and 404 (green) are "mounted on each vehicle." Carlson, [0042]:



Carlson at [0046] also teaches that the TSM's (transponder sensor module) "vehicle communication devices" are mounted on the "upper extremity of the vehicles," reinforcing the VMM is a vehicle-mounted device. *See also* Carlson,

[0056] (“TSM components (and/or other VMM components) may be installed on the upper extremity of a vehicle....”); claim 20 (“one or more vehicle mounted modules, each mounted on a vehicle”).

c. [21B] the vehicle-mounted alert device comprising: a housing for enclosing components of the vehicle-mounted alert device;

266. Carlson’s VMM’s components may “be housed within a unitary package/enclosure.” Carlson, [0037]. Carlson at [0046] similarly teaches “benefit[s] of a single package” because “it simplifies the installation process.” Alternatively, Carlson teaches that components may be housed “within separate enclosures” with each component connected to a “main VMM enclosure.” Carlson, [0046]. Carlson at [0084] similarly teaches that the components of vehicle units can be “implemented in one or more physical housings and/or devices” and that there is a “flexible mounting arrangement” that “may help to accommodate a wide range of equipment/vehicles.” *See also* Carlson, FIGS. 3-4. Either housing embodiment taught by Carlson—*i.e.*, single enclosure for all components or multiple separate enclosures for each component—results in a VMM with a housing for enclosing components of the vehicle-mounted alert device, as claimed.

- d. [21C] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;

267. Carlson's VMM (vehicle mounted module) includes a TSM (transponder sensor module), which includes "vehicle communication devices" that "communicate wirelessly" with other VMMs (*e.g.*, VMMs on other trains). Carlson, [0062]. One such communication device in the TSM is UWB unit 620 that "include[s] a control board, a data interface and/or a UWB **antenna**." Carlson, [0063] (emphasis added). Using its antenna, the UWB unit transmits and receives ultra-wideband wireless signals. For example, Carlson at [0062] teaches that the ("vehicle communication devices... include one or more **integrated antennas** for sending and receiving signals to and from other vehicles." Carlson at [0064]-[0067] comparing UWB to "other **wireless** technologies," reinforcing that UWB is a wireless communication technology. (Emphasis added.) Carlson's FIGS. 3-4 & 10 each illustrates wireless communications between VMM devices via an antenna. *See also* claims 1, 20. The vehicle-mounted unit's (VMM's) TSM is thus a "communication component" with an antenna (UWB unit 620's antenna) for transmitting/receiving wireless signals, as claimed.

- e. **[21D] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the vehicle-mounted alert device; and**

268. As I discuss below, the VMM includes circuits that process signals, process data, and perform one or more applications/functions relating to the VMM, as claimed.

269. As discussed in Section VII.G.3.d above ([21C]), the VMM includes a UWB unit that (1) processes UWB signals (and the data encoded in the UWB signals) to calculate the distance between itself and other UWB units and (2) transmits UWB signals (and data encoded in those signals) between itself and those units. See Carlson, [0063] (teaching that the UWB unit “communicate[s] with other VMMs” using circuits in “a control board, a data interface and/or a UWB antennas”), [0066] (teaching that the UWB unit transmits signals and can “enocod[e]...information” to “transmit data to other UWB units in addition to detecting the distance to other UWB units”). POSAs would understand that the UWB unit is a hardware component, and thus is a “circuit,” as broadly defined by the ’595 patent. See EX1001, 1:63-2:4. Thus, the UWB unit, *i.e.*, circuit, processes signals and data, *i.e.*, UWB signals (and the data transmitted in those signals), and performs a function of the VMM, *i.e.*, distance calculation, based on those signals/data, and thus meets limitation [21D].

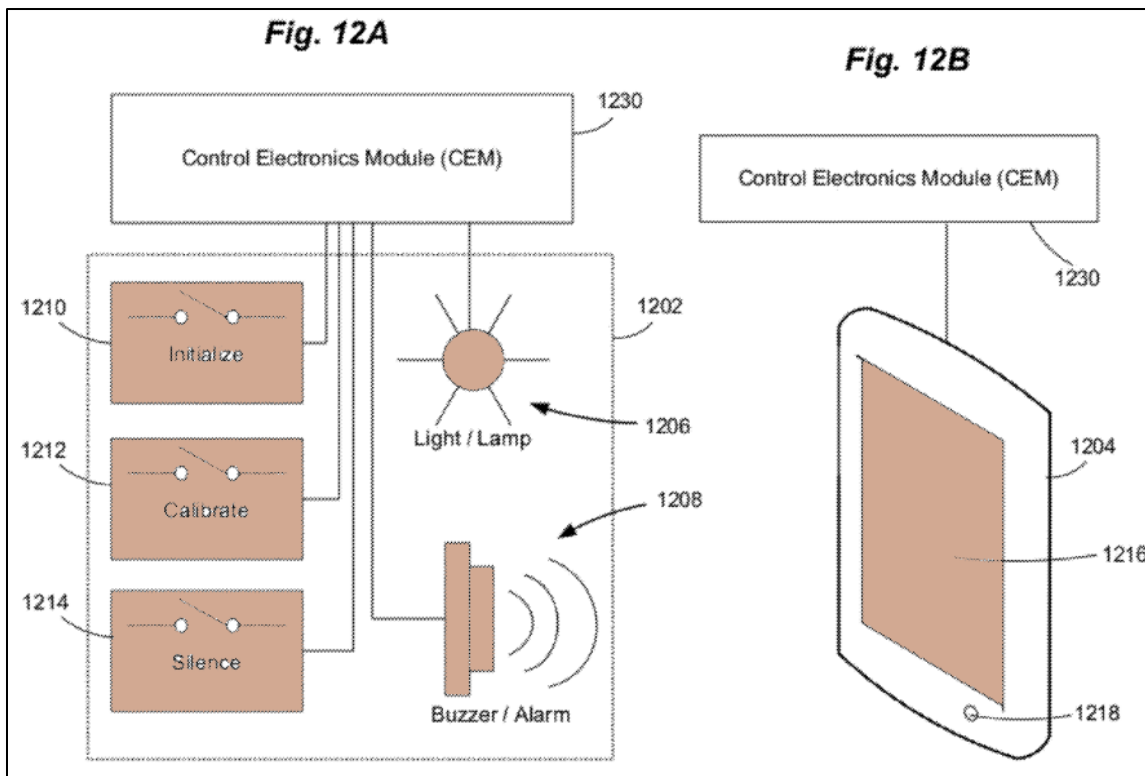
270. Carlson also teaches that the VMM has a CEM (control electronics module), which includes a “processor 702” that, “among other operations, process[es] information,” *i.e.*, signals and data, “received from the vehicle communication devices,” such as UWB unit 620. Carlson, [0049]. The CEM’s “processor” is thus another circuit(s) in the vehicle’s mounted unit operable to process signals and data, as claimed. The CEM’s “processor” “handle[s] information and/or perform[s] computations to, among other things, track other vehicles in a work gang and determine which vehicles present a potential hazard.” Carlson, [0049]; *see also* Carlson, [0050]-[0051] (teaching that the CEM includes circuitry for “an inertial measurement unit” and “real-time clock” for various location-related functionality of the device), [0060] (teaching that the CEM is “circuitry within the VMM” that “automatically compensate[s] (calibrate[s]) for the length of the vehicle and mounting location” to adjust location and distance computations), [0086] (teaching that the CMM may include “a service interface” which an operator can use “to input initialization information into the setup program”), [0103] (describing additional applications/functions of the VMM). The processor in the VMM thus performs one or more applications/functions relating to operations of the VMM, as claimed.

- f. **[21E] one or more input/output (I/O) components, for receiving input from an operator of the vehicle and/or for providing output to the operator of the vehicle;**

271. The VMM includes a UIM (user interface module) with a “user interface” that “provide[s] an operator with an interface by which the operator can engage with the technologies that are part of the VMM, and by which the operator may be alerted of events, for example if vehicle separation criteria are violated.” Carlson, [0043]. The user interface “provide[s] a vehicle operator with information,” *i.e.*, provides output to the operator, as claimed, “and may be operable to accept input from the vehicle operator,” *i.e.*, receives input from the operator, as claimed. Carlson, [0034]. *See also* Carlson, [0078] (noting the USM “provide[s] an operator with an interface by which the operator can engage with the technologies that are part of the VMM, and by which the operator may be alerted of evidence,” via “see[n] and hear[d] warning and alarm indications”), [0080] (noting that Figures 12A and 12B “depict illustrations of example user interfaces” that include various “indicators” and “switches/buttons” that “allow an operator to configure and/or interact with components of the VMM”).

272. The user interface receives input from the operator and provides outputs to the operator using input/output (I/O) components. For example, Figure 12B (which I have annotated below) depicts “a touchscreen” that “include[s] one or more physical buttons” and “allow[s] the operator to engage ‘soft’/temporary

buttons on the screen.” Carlson, [0081]-[0082]. The touchscreen and/or its buttons are for receiving input from an operator of the vehicle, as claimed. The touchscreen’s display and its “one or more speakers” ([0082]), which are for providing output to the operator of the vehicle, as claimed. *See also* Carlson, [0031], [0078]-[0080], [0083]-[0084], [0111], [0116], claim 20 (“user interface is operable to provide a vehicle operator with information and is operable to accept input from the vehicle operator”).



g. [21F1] wherein the vehicle-mounted alert device is operable to: broadcast alert triggering signals; and

273. The UWB unit within the VMM “periodically transmit[s] short duration pulses,” *i.e.*, signals, to perform a distance measurement by measuring how long it takes a particular pulse to travel from the UWB unit to UWB units on different vehicles and/or workers. See Carlson, [0064]-[0065] (describing how a UWB unit can detect distance by bouncing signals off objects or “[b]y measuring how long it takes a wave/pulse to travel...between transceivers”), [0069]-[0074] (describing UWB broadcast by VMM to “measure[...]vehicle separation”), [0099]-[0100] (describing signals broadcast by VMM to “calculate...safe distance violations” and to discover “targets”), FIGS. 10-11, 15. In addition to distance separation determinations, the UWB signals are also broadcast to measure the “relative speed” of the vehicle to which the UWB unit is attached. See Carlson, [0065]-[0066], [0069], [0074]. Because the UWB pulses are transmitted “in many directions” and sent to “UWB units” (*i.e.*, plural units), POSAs would have understood that the UWB unit “broadcasts” its signals for reception by multiple devices. See § VII.G.3.g; Carlson, [0063]-[0065], [0099] (describing transmissions used to “search” for multiple “hosts”). Carlson’s Figure 5 also shows multiple VMMs communicating with multiple other VMMs, which would have further informed a POSA that VMM signals are broadcast to multiple other VMM units at one time. See also Carlson, [0042] (“each VMM communicates with **nearby**

VMMs (in nearby vehicles)” (emphasis added)). Similarly, as shown in Figure 13, the VMMs detect multiple “target **vehicles**” (1306), “computes distance of nearby (target) **vehicles**” (1308), and “transmits / receivers” data with “other (target) **VMMs**” (1310), which further reinforces that VMMs broadcast their signals to communicate with multiple, other vehicles/VMMs at the same time. *See also* Carlson, [0098]-[0100].

274. Alternatively, were Carlson found not to disclose “broadcast[ing]” of UWB signals, POSAs had reason to implement Carlson such that the VMM broadcast UWB signals for the same reasons I discussed above in Section §VII.A.14.e. Moreover, “broadcasting” UWB-signals to perform distance ranging was also conventional by 2015 and codified as part of an IEEE standard at least by 2011. *See* EX1037, iv (“Precision ranging for ultra-wide band (UWB) PHYs”), 146 (“The PHY is responsible for the following tasks: ... Precision ranging for ultra-wide band (UWB) PHYs”).

275. The UWB-generated distance and relative speed data are processed to trigger alerts, as I explain below in connection with limitations [21F2] and [21F3] (§§ VII.G.3.h-VII.G.3.i =). Thus, the above-described broadcasted UWB signals are “alert triggering signals,” as claimed.

276. Additionally, the UWB unit’s broadcasted signals directly trigger alerts on nearby workers who are equipped with a UWB device. For example,

Carlson at [0121] teaches that a “worker and the foreman may be alerted” when a “vehicle approaches and violates a predetermined separation criteria.” A “communication device that is located on the worker, for example attached to the worker” may “be a UWB device” with “components that are located on workers” (Carlson, [0121]. The “communication device” on a worker “communicates with a vehicle mounted module” to determine “the orientation and distance of the worker in relation to the vehicle” (Cross, [0122]), and thus determine whether an alert should be triggered. Thus, the broadcasted UWB signals that I discussed above in this section are “alert triggering signals,” as claimed, for this additional reason that they can trigger alarms in the communication device located on the worker.

h. [21F2] generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle; and

277. Based on the distance and speed information that the UWB unit generated, the VMM “calculate[s],” among other things, the “absolute and relative location of the vehicles...separation distances and/or safe distance violations” to “determine [whether] collision is imminent or prescribed safe distances are violated.” Carlson, [0100]. *See also* Carlson, [0039], [0041], [0045], FIG. 13 (step 1312: “VMM performs calculations (*i.e.*, to provide location / speed / separation distances”). If collision is imminent or a safe distance is violated, then “one or more warning indicators and/or audible buzzers, alarms...will activate.”

Carlson, [0100], [0105], FIG. 13 (“If CTU and/or host VMM determines that collision is imminent or prescribed safe distance are violated, user interface notifies operator”).

278. In response to activating (*i.e.*, triggering) these alerts, the VMM generates data related to the alerts and/or to devices or objects in the path of vehicle, as claimed. For example, the VMM generates data to trigger the VMM’s “warning indicators and/or audible buzzers.” Carlson, [0105]-[0107], [0111]-[0113], [0116]-[0118]; claim 24. The VMM also generates data to create and store in a log of “[a]ll warning and alarms.” Carlson, [0120]. And when the VMM determines a worker is “standing on the tracks near a vehicle,” the VMM generates data used to activate the vehicle’s “emergency brake.” Carlson, [0122]. Thus, Carlson generates, in response to triggering of alerts, several data relating to alerts and/or to other devices or objects in path of the vehicle, as claimed.

i. [21F3] output based on the data, via the one or more I/O components, feedback information to the operator.

279. Based on the above-generated data that I discussed for limitation [21F2] (§ VII.G.3.h), the VMM outputs via its user interface’s I/O components (§ VII.G.3.f above ([21E])) feedback information to the operator, as claimed. Feedback information includes audio/visual alarms (*e.g.*, “notifications”: sounds and/or caution texts), event-log information, and/or adjustments to the vehicle’s

speed on the display (*e.g.*, when braking the vehicle). Carlson, [0104]-[0108], [0111]-[0114], [0120]-[0121].

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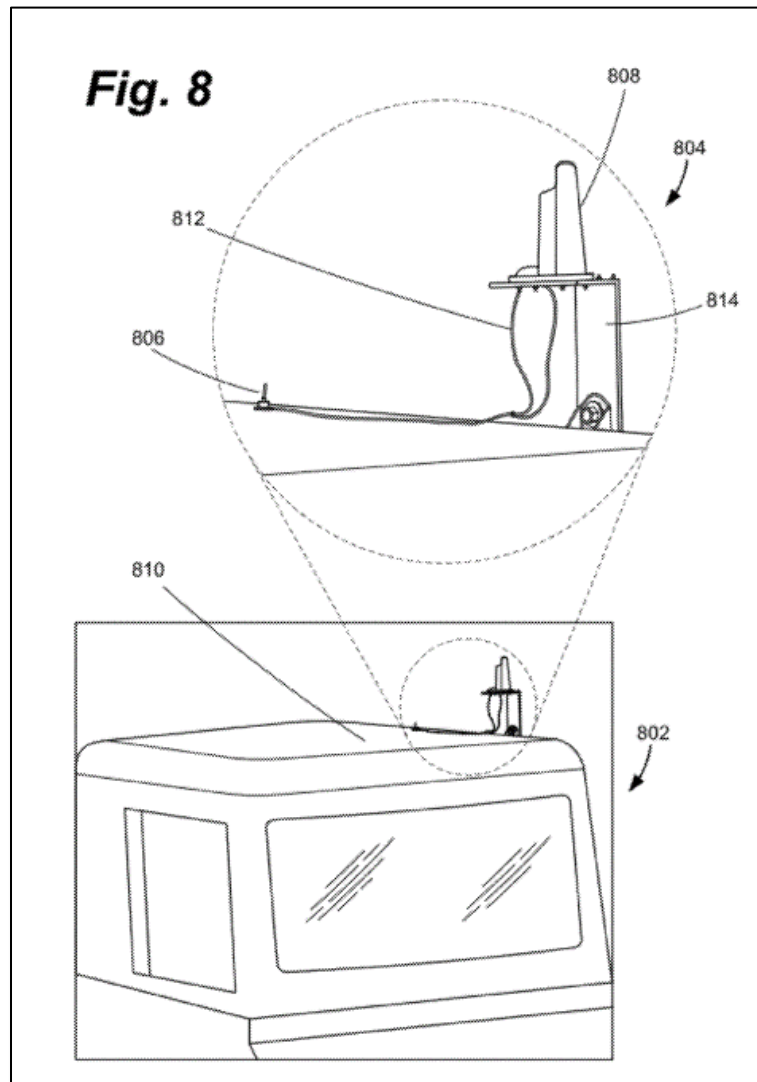
280. Accordingly, for the reasons discussed above in §§ VII.G.3.a-VII.G.3.i, in my opinion Carlson meets every limitation of claim 21.

4. Claim 22: The system of claim 21, wherein the vehicle-mounted alert device is configured, at least in part, as portable, detachable and movable from the vehicle.

281. As I discuss below, Carlson teaches the VMM, at least in part, may be portable, detachable, and moveable from the vehicle. For example, Carlson teaches that the VMM’s user interface can be a “tablet” or “PDA” ([0081]), each of which POSAs would have understood to be a device that is portable, detachable, and moveable from the vehicle, as claimed. Reinforcing a POSA’s understanding that the user interface component of the VMM is portable, detachable, and movable, Carlson teaches that the user interface can have a “wireless connection” with the CEM. Carlson, [0085].

282. Additionally, Carlson teaches that the VMM’s various TSM components, including its UWB unit, “may be installed on the upper extremity of a vehicle.” Carlson, [0056]; *see also* [0046] (explaining “vehicle communication devices 612,” *i.e.*, UWB unit 620, “may be **mounted separately** (optionally, in one or more enclosures) on the upper extremity of the vehicle” (emphasis added)). As shown in Carlson’s Figure 8 (below), the UWB unit (element 808) is portable,

detachable, and movable from the vehicle, *e.g.*, by unscrewing it from bracket 814. Carlson, [0055]-[0056]. This is another example of a component of the VMM that is portable, detachable, and movable, as claimed.



5. **Claim 23: “The system of claim 21, wherein the vehicle-mounted alert device is operable to log data relating to alerts triggered in response to movement of the vehicle.”**

283. The VMM (vehicle-mounted alert device) is operable to generate “logs of events that occur during the operation of the collision avoidance system,”

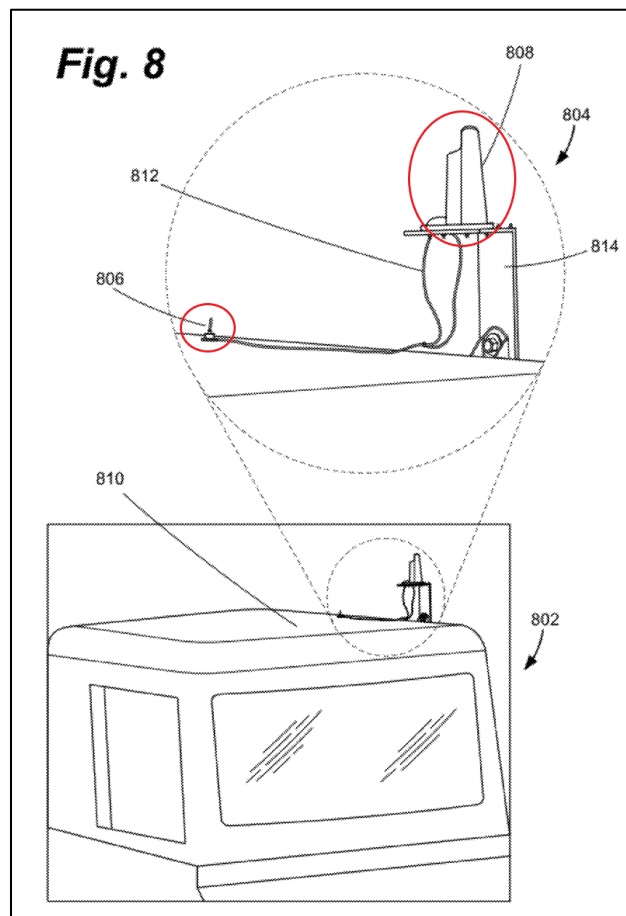
like “warnings and alerts.” Carlson, [0120], [0128]. The warnings and alerts are triggered in response to movement of the vehicle (*e.g.*, when it moves to a location where a potential collision becomes imminent), as I explained above in Sections VII.G.3.e ([21D]), VII.G.3.g-VII.G.3.i ([21F1-21F3])). *See also* Carlson, [0049], [0100], [0106]-[0108]. Accordingly, for the reasons discussed above, in my opinion Carlson meets every limitation of claim 23.

6. Claim 24: The system of claim 21, wherein the vehicle-mounted alert device is arranged into a plurality of separate physical units that comprises at least a broadcast unit comprising at least the communication component, the broadcast unit is configured to attachment external to the vehicle.

284. As I explained above in Section VII.G.3.c ([21B]), the VMM’s components may be housed “within separate enclosures.” Carlson, [0046]; *see also* Carlson, [0084]; FIGS. 3-4. Carlson teaches there are “benefits” to “packag[ing] one or more TSM components separately from other VMM components, for example on an upper extremity of a vehicle” and depicts such an implementation in Figure 8. Carlson, [0054]-[0055]; *see also* [0037] (noting that FIG. 3 “depicts an illustration of an example collision avoidance system” having “four main types of components” that “may or may not be housed within a unitary package/enclosure”); Fig. 3 (depicting TSM 306 on top of train); [0046] (explaining “wireless communication devices,” *i.e.*, UWB unit, “may be mounted separately (optionally, in one or more enclosures) on the upper extremity of the

vehicle”). In Carlson’s implementation shown in Figure 8, the TSM is disposed “on the roof of the vehicle,” separate from the CEM which is “disposed below the roof of the vehicle,” and the TSM’s UWB unit is mounted to a bracket on the vehicle’s roof to provide the unit with “a clear line of sight.” Carlson, [0052]-[0054].

285. As shown in Figure 8’s implementation (which I have annotated below), the TSM (*i.e.*, the physically separate broadcast unit, as claimed), includes a UWB unit (the communication component, as claimed) and the TSM is configured to attachment external to vehicle, as claimed.



Accordingly, for the reasons discussed above, in my opinion Carlson meets every limitation of claim 24.

7. **Claim 25: The system of claim 24, wherein the plurality of separate physical units comprises an operator unit comprising at least the one or more I/O components, the operator unit is configured for use by the operator.**

286. The VMM's UIM (user interface module) "may be packaged separately" in its own physical unit (*e.g.*, a touchscreen or tablet). Carlson, [0046], [0081]. As I discussed above in § VII.G.3.f ([21E]), the UIM is an operator unit that comprises I/O components (*e.g.*, touchscreen and buttons) that are configured for use by the operator, as claimed: for example, the UIM is used to "provide an operator with an interface by which the operator can engage with...the UIM" (*e.g.*, view displayed warnings, "activate and deactivate component interface," "send messages"). Carlson, [0079]-[0083]; *see also id.*, [0108]-[0113]. Accordingly, for the reasons discussed above, in my opinion Carlson meets every limitation of claim 25.

287. I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

288. I declare under penalty of perjury that the foregoing is true and correct.

Dated: January 3, 2023

A handwritten signature in black ink, reading "Michael S. Braasch". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

Michael S. Braasch, Ph.D., P.E.

VIII. CLAIM LISTING

Claim 1
[1PRE] 1. A system for worker protection, the system comprises:
[1A] a compact wearable personal alert device, configured for use by a worker,
[1B] the personal alert device comprising: a housing for enclosing components of the personal alert device;
[1C] an attachment structure for attaching the personal alert device to the worker or an item used by the worker;
[1D] a power supply for powering components of the personal alert device;
[1E] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;
[1F] one or more indicator components, for outputting alert indications; and
[1G] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the personal alert device;
[1H1] wherein the personal alert device is operable to: process signals received from a companion alert device, wherein the companion alert device is deployed locally in proximity of the personal alert device and/or within vehicles operating in areas service by workers;
[1H2] generate, in response to signals received from the companion alert device, a safety alert; and
[1H3] output, via the one or more indicator components, one or more alert indications to the worker based on the safety alert.
Claim 2
2. The system of claim 1, wherein the personal alert device is operable to implement a power management scheme for optimizing power consumption in the personal alert device.
Claim 3
3. The system of claim 2, wherein the power management scheme comprises transitioning the personal alert device from a full operation mode to a power-saving mode, the power-saving mode comprising at least one of shut-down mode and low-function mode.

Claim 4
4. The system of claim 2, wherein the personal alert device comprises at least one control component for generating control data applicable to the power management scheme.
Claim 5
5. The system of claim 4, wherein the at least one control component comprises a movement sensor for sensing movement of the worker, configured to generate indications when the personal alert device is moving or not.
Claim 6
6. The system of claim 1, wherein the one or more antennas comprise diversity antennas of identical or differing polarity, and the personal alert device is operable to support use of diversity during the transmitting and/or receiving of wireless signals.
Claim 7
7. The system of claim 1, wherein triggering of alerts and/or broadcast of signals triggering of the alerts is based on one or more types of alert thresholds.
Claim 8
8. The system of claim 7, where the one or more types of alert thresholds comprise time-to-arrival (TTA), distance-from-train (DFT), and low-speed close proximity distance alert (CPD).
Claim 9
9. The system of claim 1, wherein the personal alert device is operable to communicate with one or more nearby alert devices, to forward received signals and/or alerts generated in response to the received signals among the personal alert device and the one or more nearby alert devices.
Claim 10
10. The system of claim 1, wherein the personal alert device is operable to log data relating to alerts triggered and/or handled by the personal alert device.
Claim 11
11. The system of claim 1, wherein the companion alert device comprises a vehicle-mounted alert device, a wayside detection unit, or another personal alert device.

Claim 12
12. The system of claim 1, wherein the one or more indicator components comprise at least one of visual indicator, audio indicator, and a tactile indicator.
Claim 13
13. The system of claim 1, wherein the power supply comprises a rechargeable power supply.
Claim 14
14. The system of claim 13, wherein the rechargeable power supply is operable to recharge without direct connection.
Claim 15
15. The system of claim 1, wherein the attachment structure comprises a clip structure or a strap structure.
Claim 16
16. The system of claim 1, wherein the personal alert device comprises one or more acknowledgment components, configured for receiving input from the worker, to indicate acknowledgment of the safety alert.
Claim 17
17. The system of claim 16, wherein the personal alert device is operable to communicate a signal to the companion alert device to indicate the acknowledgment of the safety alert by the worker.
Claim 18
[18A] 18. The system of claim 1, wherein the housing completely seals internal space enclosing components of the personal alert device, and
[18B] wherein charging the power supply and/or communication of data to and/or from the portable alert device is done without direct connection.
Claim 19
19. The system of claim 1, wherein the personal alert device is operable to implement configurable alarm management for allowing setting and/or adjusting of rules controlling triggering and/or handling of alerts.
Claim 20
[20A] 20. The system of claim 1, wherein the personal alert device is operable to: receive Global Navigation Satellite System (GNSS) signals;
[20B] determine location information based on the received GNSS signals; and

[20C] utilize the location information in conjunction with at least one of the operations of the personal alert device.
Claim 21
[21PRE] A system for worker protection comprises:
[21A] a vehicle-mounted alert device, configured for use on a vehicle,
[21B] the vehicle-mounted alert device comprising: a housing for enclosing components of the vehicle-mounted alert device;
[21C] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;
[21D] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the vehicle-mounted alert device; and
[21E] one or more input/output (I/O) components, for receiving input from an operator of the vehicle and/or for providing output to the operator of the vehicle;
[21F1] wherein the vehicle-mounted alert device is operable to: broadcast alert triggering signals; and
[21F2] generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle ; and
[21F3] output based on the data, via the one or more I/O components, feedback information to the operator.
Claim 22
22. The system of claim 21, wherein the vehicle-mounted alert device is configured, at least in part, as portable, detachable and movable from the vehicle.
Claim 23
23. The system of claim 21, wherein the vehicle-mounted alert device is operable to log data relating to alerts triggered in response to movement of the vehicle.
Claim 24
24. The system of claim 21, wherein the vehicle-mounted alert device is arranged into a plurality of separate physical units that comprises at least a broadcast unit comprising at least the communication component, the broadcast unit is configured to attachment external to the vehicle.
Claim 25

25. The system of claim 24, wherein the plurality of separate physical units comprises an operator unit comprising at least the one or more I/O components, the operator unit is configured for use by the operator.
Claim 26
[26A] 26. The system of claim 21, wherein the vehicle-mounted alert device is operable to: receive a signal indicating an acknowledgment of a safety alert by a worker in response to the broadcasted alert triggering signals; and
[26B] provide, via the one or more I/O components, an indication of the acknowledgement to the operator of the vehicle.
Claim 27
[27PRE] 27. A system for worker protection, the system comprises:
[27A] a wayside detection unit, configured for placement on or near path of a vehicle, the wayside detection unit comprising:
[27B] a housing for enclosing components of the wayside detection unit;
[27C] a support structure for holding and supporting the wayside detection unit when placed on or near the path;
[27D] a power supply for powering components of the wayside detection unit;
[27E] one or more sensory components, for detecting, monitoring, and/or tracking vehicles;
[27F] a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals;
[27G] one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the wayside detection unit;
[27H1] wherein the wayside detection unit is operable to: determine, based on sensory data obtained from the one or more sensors, when the vehicle is approaching the wayside detection unit; and
[27H2] broadcast, to one or more companion alert devices, alert related signals, relating to the approaching of the vehicle.
Claim 28
28. The system of claim 27, wherein the wayside detection unit is operable to forward alerts and/or alert related signals communicated by one or more nearby alert devices, the one or more nearby alert devices comprises vehicle alert devices, personal alert devices and/or other wayside detection units.

Claim 29

29. The system of claim 27, wherein the wayside detection unit is operable to log data relating to alerts triggered in response to the broadcasted alert related signals.

Claim 30

30. The system of claim 27, wherein the support structure comprises a tripod or a connection element for permanent connection to wayside equipment.