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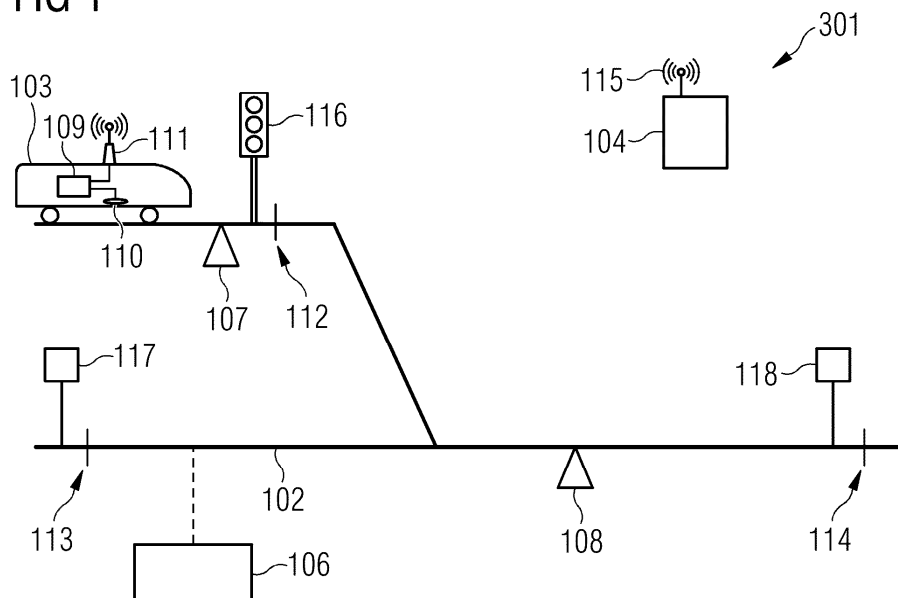
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(54) **RAILWAY CONTROL SYSTEMS**

(57) A method for operating a railway control system for controlling a train travelling along a railway track is disclosed. The method comprises receiving a radio frequency signal from the train describing an operating parameter of the train, for example a mode or level or operation, and a position of the train, determining the operating parameter of the train and the position of the train based on the radio frequency signal, determining whether the operating parameter of the train meets an

operating parameter criteria, determining whether the position of the train meets a position criteria, determining a further operating parameter, for example a permission to proceed or an order to stop, for the train based on the determination of whether the operating parameter of the train meets the operating parameter criteria and whether the position of the train meets the position criteria, and transmitting a radio frequency signal to the train describing the further operating parameter.

**FIG 1**



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## Description

### Field of the Disclosure

**[0001]** The present disclosure relates to railway control systems.

### Background of the Disclosure

**[0002]** Railway control systems are used to control the movement of trains along a railway track. An objective of such control systems is to optimise utilisation of the railway track by trains whilst ensuring the safety of the trains. An implementation of railway control systems is to supervise trains using automated train control systems distributed along the railway track that communicate with the trains to exchange control information as the train travels along a respective section of the track.

### Summary of the Disclosure

**[0003]** A first aspect of the present disclosure provides a method for operating a railway control system for controlling a train travelling along a railway track, the method comprising: receiving a radio frequency signal from the train describing an operating parameter of the train and a position of the train, determining the operating parameter of the train and the position of the train based on the radio frequency signal, determining whether the operating parameter of the train meets operating parameter criteria, determining whether the position of the train meets position criteria, determining a further operating parameter for the train based on the determination of whether the operating parameter of the train meets the operating parameter criteria and whether the position of the train meets the position criteria, and transmitting a radio frequency signal to the train describing the further operating parameter.

**[0004]** In implementations, the determining whether the position of the train meets the position criteria comprises determining whether the train is positioned along a portion of the railway track that is preconfigured in the railway control system.

**[0005]** In implementations, the determining whether the train is positioned along a predefined portion of the railway track comprises determining whether the train is positioned along a portion of the railway track that is preconfigured in the railway control system as permitting generation of an operating parameter, for example, an M\_level, in respect of a forward route.

**[0006]** In implementation, the determining whether the operating parameter of the train meets operating parameter criteria comprises determining whether the railway control system has previously provided that operating parameter to the train.

**[0007]** In implementations, the method is for controlling the train in accordance with the European Train Control System (ETCS), wherein the determining the operating

parameter of the train comprises determining an M\_level of the train. The 'M\_level' is also often referred to simply as the 'Level'.

**[0008]** In implementations, the determining whether the operating parameter of the train meets operating parameter criteria comprises determining whether the M\_level of the train is Level 2. A 'Level 2' level is also often referred to within the ETCS nomenclature by the designation 'M\_level=3'.

**[0009]** In implementations, the determining a further operating parameter for the train comprises determining the further operating parameter to require the train to stop in response to determining that the train does not meet the position criteria.

**[0010]** In implementations, the determining a further operating parameter for the train comprises determining the M\_level of the train to be Level 2 in response to determining that the train does not meet the position criteria.

**[0011]** A second aspect of the present disclosure provides a railway control system comprising: at least one processor, and at least one memory including machine-readable instructions, wherein the at least one memory and the machine-readable instructions are configured to, with the at least one processor, cause the railway control system to perform the method of the first aspect of the present disclosure.

**[0012]** In implementations, the railway control system comprises a radio block centre for location along a railway track, the radio block centre being configured to perform the method of the first aspect of the present disclosure.

**[0013]** A third aspect of the present disclosure provides a computer program comprising instructions, which, when executed by a train control system causes the railway control system to carry out the method of the first aspect of the present disclosure.

**[0014]** A fourth aspect of the present disclosure provides a computer-readable data carrier having the computer program of claim 10 stored thereon.

**[0015]** These and other aspects of the invention will be apparent from the embodiment(s) described below.

### Brief Description of the Drawings

**[0016]** In order that the present invention may be more readily understood, embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows schematically an example of a railway embodying the present disclosure, comprising a train control system for controlling trains travelling along the railway track;

Figure 2 shows schematically another view of the railway;

Figure 3 shows schematically another view of the

railway;

Figure 4 shows schematically another view of the railway;

Figure 5 shows schematically another view of the railway;

Figure 6 shows schematically components of the train control system;

Figure 7 shows schematically a method performed the train control system to control a train on the railway track, which includes a process of sending operating parameters to the train; and

Figure 8 shows processes involved in the process of sending operating parameters to the train.

#### Detailed Description of the Disclosure

**[0017]** Example embodiments are described below in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

**[0018]** Accordingly, while embodiments can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included. Elements of the example embodiments are consistently denoted by the same reference numerals throughout the drawings and detailed description where appropriate.

**[0019]** The terminology used herein to describe embodiments is not intended to limit the scope. The articles "a," "an," and "the" are singular in that they have a single referent, however the use of the singular form in the present document should not preclude the presence of more than one referent. In other words, elements referred to in the singular can number one or more, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including," when used herein, specify the presence of stated features, items, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, items, steps, operations, elements, components, and/or groups thereof.

**[0020]** An example of a railway 101 embodying the present disclosure is depicted schematically in Figures 1 to 5. An example method of operating the railway 101 embodying the present disclosure will be described here-

in.

**[0021]** The railway 101 comprises a railway track 102 and a train 103 running on the railway track 102. The railway 101 further comprises a railway control system, which comprises a plurality of train control systems 104 located trackside along the railway track 102, one or more track control systems 106 located trackside along the railway track 102, and plural trackside beacons 107, 108 also located along the railway track 102. The components of the railway 101 are not depicted to scale in the Figures. For the purposes of the example operation described herein, the train 103 is described as travelling from the left to the right of the Figure.

**[0022]** The train 103 comprises an onboard motion control system 109 operable to control the motion of the train, a radio transceiver 110 operable to receive radio signals from the trackside beacons 107, 108, and a radio transceiver 111 operable to receive and transmit radio signals to communicate with the train control systems 104. The radio transceiver 111 could, for example, comprise a Global System for Mobile communications protocol device (GSM). The onboard motion control system 109 may further comprise a speed sensor, for example, an axle sensor for sensing a speed of motion of the train.

**[0023]** The track control system 106 is provided for the purpose of configuring and monitoring the condition of the railway track 102, and monitoring the movement of trains along the railway track 102. The track control system 106 is responsible for the section of track between the track detection section joints 112, 113 and 114. The track control system 106 comprises sensors for monitoring various conditions of the track, for example, track characteristics such as the configuration of points on the track and the presence of trains on the section of track. The track control system 106 communicates with the train control system 104 via an ethernet network. A particular objective of the track control system 106 is to ensure the safety of trains travelling along the railway track 102, by ensuring that conflicting train movements, e.g., two trains travelling on a same section of track at a same time, is avoided, and ensuring that track points are correctly configured. The track control system 106 may thus define operational restrictions for trains running on the track, for example, positions to which a train may proceed. In the technical field, systems that are functionally equivalent to the track control system 106 are commonly referred to as an interlocking system, and for clarity this terminology will be used herein.

**[0024]** The train control system 104 are provided for the purpose of communicating control information with the train 103 as it travels along the track 102. Such control information may include the train reporting its current operating parameters, position and speed to the train control system 104, and the train control system 104 providing permissions to proceed and operating parameters to the train. The train control system 104 may also convey track condition data and other information from

the track control system 106 to trains running on the track. Each of the train control system 104 comprises onboard processing resource for processing data and a radio transceiver 115 for communicating with the train 103. The radio transceiver 115 could, for example, comprise a Global System for Mobile communications protocol device (GSM). In the technical field, systems that are functionally similar to the train control system 104 are commonly referred to as Radio Block Centres (RBC), and for clarity this terminology will be used herein.

**[0025]** The trackside beacons 107, 108 function as transponders, and are utilised by the train 103 as passive positioning devices. When the train 103 passes over a trackside beacon the antenna 110 of the train's onboard control unit 110 energises the beacon and reads the characteristic radio signal generated by the trackside beacon. From the received signal the train 103 may determine its position, for example, by reference to a pre-defined lookup table stored by the onboard control unit 109 associating positions with characteristics of the signals received from the beacons 107, 108. In combination with the speed sensors of the onboard motion control system 109, the onboard motion control unit 109 may thereby utilise the trackside beacons 107, 108 to determine a position of the train as it travels along the track. In the technical field, systems that are functionally similar to the trackside beacons 107, 108 are commonly referred to as a balise, and for clarity this terminology will be used herein.

**[0026]** Within the control method implemented by the railway control system, the railway track 102 is notionally sub-divided into a plurality of successive sections, such as the section of railway track depicted in Figures 1 to 5, and a second section of railway track located after the first section in the example direction of motion of the train 103. Within this scheme, each section of the track is assigned to a respective one of the radio block centres 104. Thus, Figures 1 to 5 depict a first section of track assigned to a first train control system 104, whereas earlier and later sections of track may be assigned to respective further like train control systems 104.

**[0027]** In this arrangement, as the train 103 travels along the track 102, it communicates with the radio block centre associated with the respective section of track, to thereby exchange control information with the radio block centre, and ultimately with any other control systems communicating with the radio block centre, e.g., the interlocking. When the train proceeds onto the next section of track, it ceases communication with the current radio block centre and establishes communication with the radio block centre associated with the new section of track.

**[0028]** The present disclosure is useful, for example, in the context of an Automatic Train Protection system (ATP) compliant with the European Train Control System (ETCS) standards. The ETCS is a train control standard based on in-cab equipment able to supervise train movements, including stopping the train, according to the

maximum permitted speed at each line section. Information on track description is received from the ETCS equipment installed beside the track, e.g., the balises 107, 108 and the RBC 104, and the information is used to calculate and supervise the train operation.

**[0029]** In particular, operating parameters provided to the train within the ETCS system may include an operating mode of the train, known in the technical field as an 'M\_Mode', or 'mode' and an operating level of the train, known in the technical field as 'M\_Level' or 'Level'.

**[0030]** The 'M\_level' effectively defines the manner in which the train will exchange control information with the supervising control system, and depends on the control equipment with which the track is equipped to collect information about the railway track and exchange control information with the train. Generally speaking, the higher the M\_level, the greater the degree to which the control of the train is automated and controlled by the ETCS system, with lesser requirement for driver control. Currently there are four ETCS levels in operation, Level 0 (L0), Level NTC (LNTC), Level 1 (L1) and Level 2 (L2). Note that within the ETCS nomenclature the 'M\_level' number designation differs from the 'Level' number designation, for example, 'M\_level=2' corresponds to 'Level 1', and 'M\_level=3' corresponds to 'Level 2'.

**[0031]** The 'M\_Mode' effectively defines a level of supervision that the train driver is required to assume for operating the train. Where the radio block centre is able to determine with certainty, e.g., from information received by the radio block centre from the interlocking and/or from the train, that a section of track is clear from obstruction, the radio block centre may issue a 'Full-Supervision' (FS) permission to proceed to the train. In this instance, the radio block centre is effectively assuming full responsibility for the train, allowing the train to proceed at maximum speed with minimum responsibility on the driver to intervene. Alternatively, where the radio block centre is unable to determine whether a section of track is clear of obstructions, for example, due to a failure in communications between the radio block centre and the interlocking, the radio block centre may issue an 'On-Sight' (OS) permission to proceed to the train. In this instance, the train driver is required to assume responsibility for detecting track obstructions and braking the train. Thus, the maximum speed of the train, and so throughput of the line, may be disadvantageously reduced.

**[0032]** The railway depicted in Figures 1 to 5 is equipped to an ETCS Level 2 standard, whereby in normal operation all control information is exchanged with the train via the RBC, and most physical signs and signals along the railway track are not required. In this system, in normal operation, the train constantly communicates via radio with the RBC that is assigned to the relevant section of track, and as the train enters a new section of track, the preceding radio block centre supplies train control information to the succeeding radio block centre. Where the train and track are equipped to a

Level 2 standard, it is operationally advantageous for the train to make full use of the standard and proceed in a Level 2 operating level.

**[0033]** Typically, the M\_level and M\_mode is provided to the train by the RBC. In some situations however, a difficulty may arise where a train is entering onto the railway track without having prior communication with the relevant RBC. This situation could occur, for example, where the train is beginning a journey in a radio black-spot, such as when the train is leaving a depot, or a siding that is outside of radio coverage, as depicted in Figure 1.

**[0034]** Referring to Figures 1 and 2, conventionally in this scenario, within the ETCS system, the train would access the main track when given Proceed Authority (PA) by the signal 116 in a low ETCS level, for example, Level 0, whereby the driver is highly responsible for manually controlling the train. The train would then initiate a Conditional Level Transfer (CLT) process, by which process the train could transition to a higher M\_level, such as Level 2, in response to receiving a CLT order from the balise 107. Within the CLT framework, the train initiates a radio communication session with the relevant RBC, e.g., RBC 104 in the case of Figures 1 to 5, and then initiates a Prove Clear Ahead (PCA) procedure in conjunction with the RBC, whereby the train establishes that the railway track ahead of the train is free of other obstructions, for example, other trains. The RBC may then send the train the desired high level operating parameters in the form of a Level 2 Movement Authority (MA), and the train may then proceed onto and along the track under that Level 2 MA. The RBC will conventionally treat completion of the PCA procedure by the train as a precondition for providing a train with a Level 2 MA.

**[0035]** However, the process of establishing the radio communication session between the train and the RBC may be problematic, for example, the communication may fail, or may otherwise take a relatively time to establish, potentially in the order of minutes. In this scenario, without having established communication with the RBC, and so without having completed the PCA procedure, conventionally the RBC would refuse to accept a train reporting in Level 2 level (M\_level=3), and would send the train an Unconditional Emergency Stop (UES) order, requiring the train to stop immediately.

**[0036]** The present disclosure presents an alternative control method, whereby the RBC may safely accept a train in Level 2 level, even without the train having completed the PCA procedure.

**[0037]** Thus, referring to Figure 2, in the present method, the train 103 may enter the route in response to a PA from the signal 116, and may receive a CLT order from the balise 107 located at the depot/siding exit, and a session management packet prompting the train to contact the RBC 104 ready for the transition to Level 2. The train may then transition into a Level 1 mode (M\_level=2) with a Level 1 MA valid until the virtual marker board 118.

**[0038]** Referring next to Figures 3 between the first and second balises 107, 108, the train may establish a com-

munication session with the RBC 104, and once completed may send a message to the RBC confirming establishment of the session, and also a train position report (TPR) message reporting the current level and mode of operation and the train position.

**[0039]** Referring next to Figure 4, as the train traverses the switchable balise 108 on the main line, the train will receive a further CLT order containing a Level 2 and Level 0 message. This will result in the train transitioning to Level 2 (M\_level=3). Having transitioned to Level 2 the train will send a further TPR to the RBC 104 reporting the new level and mode of operation and the train position.

**[0040]** Referring next to Figure 5, once the RBC 104 has received the PA from the interlocking 106 for the forward route, the RBC will perform a check to determine whether the train may safely be accepted in the Level 2 mode, notwithstanding that the RBC did not itself supply the Level 2 MA to the train. If the RBC determines that the train may safely be accepted, the RBC will send the train a Level 2 'FS' MA valid from the balise 108 into the next route.

**[0041]** The determination method performed by the RBC in determining whether to accept the train involves determining whether the train that is reporting the Level 2 MA is positioned in a particular portion 117 of the railway track 102 preceding the track detection section joint 114. The determination method performed by the RBC will be described in further detail with reference to Figures 7 and 8.

**[0042]** Referring next to Figure 6, in examples, each of the radio block centres 104 comprises a processor 601, memory 602, radio transceiver 115, input/output device 603 and system bus 604. Each of the radio block centres 105, 106 is configured to run a computer program for controlling the operation of trains on the railway track 102.

**[0043]** Processor 601 is configured for execution of instructions of the computer program for controlling the operation of trains on the railway. Memory 602 is configured for non-volatile storage of the computer program, defining machine-readable instructions, for execution by the processor, and for serving as read/write memory for storage of operational data associated with computer programs executed by the processor 601. Radio transceiver 115 is configured for communicating by radio with trains running on the track 102, e.g., train 103, and with other of the radio block centres. Radio transceiver 115 may, for example, operate as a GSM protocol transceiver. Input/output interface 603 is configured for connection of the radio block centre 104 to other external systems, e.g., for connection to an ethernet protocol local area network to enable communication with the interlocking 106. The components of the radio block centre 104 are in communication via system bus 604.

**[0044]** Referring next to Figure 7, in examples the computer program for controlling trains on the railway track 102 implemented by each of the radio block centres 104 comprises three operations 701 to 703.

**[0045]** In Figure 7, the operations are presented in an

example order to be consistent with the scenario illustrated in Figure 1, in which the radio block centre 104 accepts responsibility for the train 103 entering the track from a radio blackspot, and then subsequently hands over responsibility for the train 103 to the next radio block centre along the track as the train enters the next section of track.

**[0046]** At operation 701, the computer program causes the processor 601 of the radio block centre 104 to establish radio communication with the train, as described previously with reference to Figure 3.

**[0047]** At operation 702, the computer program causes the processor 601 of the radio block centre 104 to send operating parameters to the train, as described previously with reference to Figure 5.

**[0048]** At operation 703, the computer program causes the processor 601 of the radio block centre 104 to continue to supervise the train, that is, to exchange control information with the train, whilst the train is travelling along the section of track assigned to that radio block centre.

**[0049]** Referring next to Figure 8, operation 702 performed by the radio block centre 104 for sending operating parameters for the train comprises six operations.

**[0050]** At operation 801, the computer program causes the processor 601 of radio block centre 104 to receive position and operating parameter data from the train 103, as previously described with reference to Figure 4.

**[0051]** At operation 802, the computer program causes the processor 601 of the radio block centre 104 to determine the position of the train 103 based on the position data received at operation 801. Operation 802 could, for example, involve the processor 201 processing aggregated data received at process 801 to extract the relevant position and operating parameter data, or performing some other processing operation. Thus, in the example of Figures 1 to 5 operation 802 could involve the RBC 104 determining that the train 103 is currently in Level 2 operating parameter mode and located at the position of the balise 108.

**[0052]** At operation 803, the computer program causes the processor 601 of the radio block centre 104 to determine whether the operating parameter of the train 103 determined at operation 802 meets operating parameter criteria. In the example of Figures 1 to 5, this could involve the RBC determining whether the train is reporting in an acceptable low mode or a potentially unacceptable high mode. Where at operation 803 it is determined for example that the train is only in a low mode, e.g., Level 1, the process may proceed to operation 805. Else, if the train is reporting in a high mode, e.g., in Level 2, the process may proceed to operation 804.

**[0053]** Additionally, operation 803 may involve the RBC determining whether the RBC has itself previously supplied an MA to the train for the reported operating parameter, e.g., for the Level 2 mode reported by the train. Again, if the RBC has already provided the relevant MA to the train, the process may proceed to operation

805. Else, if the RBC has not previously provided the MA to the train, indicating a potentially unacceptable train condition, the process may proceed to process 804.

**[0054]** At operation 804 the computer program causes the processor 601 of the radio block centre 104 to determine whether the position of the train 103 determined at process 802 meets particular position criteria. An object of operation 804 is to determine whether the train 103 is in the appropriate position with respect to the supervised track section, and specifically to determine whether the train is positioned in the portion of track 117. In essence, a purpose of the RBC detecting whether the train is positioned in the portion of track 117 is to determine whether the RBC can safely treat the train as an acceptable exception to the general rule that a train reporting a Level 2 MA should have received that MA from the RBC, which would ordinarily have required the train to have proved clear ahead, as discussed previously with reference to Figure 5. The portion of the track 117 is configured such that a MA for the forward route, that is to say the route ahead of the train, may be generated by the RBC.

**[0055]** Thus, operation 804 involves the RBC checking that the train reporting Level 2 is doing so within the predefined portion of track 117. The portion of the track 117 is configured such that a MA for the forward route, that is to say the route ahead of the train, may be generated by the RBC. The determination at operation 804 of whether or not the train is positioned in the portion of track 117 is then utilised by the RBC in determining the relevant operating parameter command to be sent to the train at operation 805.

**[0056]** At operation 805, the computer program causes the processor 601 of the radio block centre 104 to determine an operating parameter for the train, based on the determinations of whether the operating parameter met the operating parameter criteria, and on whether the position of the train met the position criteria. For example, as discussed previously with reference to Figure 5, where it is determined at operation 803 that the RBC has not previously provided the Level 2 MA to the train, and where the train is not positioned in the portion of track 117, the RBC may determine that the correct operating parameter is for the train to stop immediately. Whereas, where it is determined that the RBC did previously send the train the Level 2 MA, or as an exception, where notwithstanding that the RBC did not previously send the train the Level 2 MA the train is positioned in the portion of track 117, the RBC may determine that a correct operating parameter for the train for the next route is a Level 2 MA.

**[0057]** At operation 806, the computer program causes the processor 601 of the first radio block centre 105 to send the operating parameter data determined at operation 805 the train 103, such that the onboard motion control unit 109 of the train 103 may subsequently implement that operating parameter when it reaches the next route.

**[0058]** The system and apparatus described above may use dedicated processor systems, micro controllers, programmable logic devices, microprocessors, or any combination thereof, to perform some or all of the operations described herein. Some of the operations described above may be implemented in software and other operations may be implemented in hardware. Any of the operations, processes, and/or methods described herein may be performed by an apparatus, a device, and/or a system substantially similar to those as described herein and with reference to the illustrated figures.

**[0059]** The processor may execute instructions or "code" stored in memory. The memory may store data as well. The processing device may include, but may not be limited to, an analog processor, a digital processor, a microprocessor, a multi-core processor, a processor array, a network processor, or the like. The processing device may be part of an integrated control system or system manager, or may be provided as a portable electronic device configured to interface with a networked system either locally or remotely via wireless transmission.

**[0060]** The memory may be integrated together with the processing device, for example RAM or FLASH memory disposed within an integrated circuit microprocessor or the like. In other examples, the memory may comprise an independent device, such as an external disk drive, a storage array, a portable FLASH key fob, or the like. The memory and processing device may be operatively coupled together, or in communication with each other, for example by an I/O port, a network connection, or the like, and the processing device may read a file stored on the memory. Associated memory may be "read only" by design (ROM) by virtue of permission settings, or not. Other examples of memory may include, but may not be limited to, WORM, EPROM, EEPROM, FLASH, or the like, which may be implemented in solid state semiconductor devices. Other memories may comprise moving parts, such as a known rotating disk drive. All such memories may be "machine-readable" and may be readable by a processing device.

**[0061]** Operating instructions or commands may be implemented or embodied in tangible forms of stored computer software (also known as "computer program" or "code"). Programs, or code, may be stored in a digital memory and may be read by the processing device. "Computer-readable storage medium" (or alternatively, "machine-readable storage medium") may include all of the foregoing types of memory, as well as new technologies of the future, as long as the memory may be capable of storing digital information in the nature of a computer program or other data, at least temporarily, and as long as the stored information may be "read" by an appropriate processing device. The term "computer-readable" may not be limited to the historical usage of "computer" to imply a complete mainframe, mini-computer, desktop or even laptop computer. Rather, "computer-readable" may comprise storage medium that may be

readable by a processor, a processing device, or any computing system. Such media may be any available media that may be locally and/or remotely accessible by a computer or a processor, and may include volatile and non-volatile media, and removable and non-removable media, or any combination thereof.

**[0062]** A program stored in a computer-readable storage medium may comprise a computer program product. For example, a storage medium may be used as a convenient means to store or transport a computer program. For the sake of convenience, the operations may be described as various interconnected or coupled functional blocks or diagrams. However, there may be cases where these functional blocks or diagrams may be equivalently aggregated into a single logic device, program or operation with unclear boundaries.

**[0063]** While the application describes specific examples of carrying out embodiments of the invention, those skilled in the art will appreciate that there are numerous variations and permutations of the above described systems and techniques that fall within the spirit and scope of the invention as set forth in the appended claims. For example, while specific terminology has been employed above to refer to electronic design automation processes, it should be appreciated that various examples of the invention may be implemented using any desired combination of electronic design automation processes.

**[0064]** One of skill in the art will also recognize that the concepts taught herein can be tailored to a particular application in many other ways. In particular, those skilled in the art will recognize that the illustrated examples are but one of many alternative implementations that will become apparent upon reading this disclosure.

**[0065]** Although the specification may refer to "an", "one", "another", or "some" example(s) in several locations, this does not necessarily mean that each such reference is to the same example(s), or that the feature only applies to a single example.

## Claims

1. A method for operating a railway control system for controlling a train travelling along a railway track, the method comprising:

receiving a radio frequency signal from the train describing an operating parameter of the train and a position of the train,  
determining the operating parameter of the train and the position of the train based on the radio frequency signal,  
determining whether the operating parameter of the train meets operating parameter criteria,  
determining whether the position of the train meets position criteria,  
determining a further operating parameter for the train based on the determination of whether

- the operating parameter of the train meets the operating parameter criteria and whether the position of the train meets the position criteria, and transmitting a radio frequency signal to the train describing the further operating parameter. 5
2. The method of claim 1, wherein the determining whether the position of the train meets the position criteria comprises determining whether the train is positioned along a portion of the railway track that is preconfigured in the railway control system. 10
3. The method of claim 2, wherein the determining whether the train is positioned along a predefined portion of the railway track comprises determining whether the train is positioned along a portion of the railway track that is preconfigured in the railway control system as permitting generation of an operating parameter in respect of a forward route. 15 20
4. The method of claim 1, wherein the determining whether the operating parameter of the train meets operating parameter criteria comprises determining whether the railway control system has previously provided that operating parameter to the train. 25
5. The method of claim 1, for controlling the train in accordance with the European Train Control System (ETCS), wherein the determining the operating parameter of the train comprises determining the M\_level of the train. 30
6. The method of claim 5, wherein the determining whether the operating parameter of the train meets operating parameter criteria comprises determining whether the M\_level of the train is Level 2. 35
7. The method of claim 6, wherein the determining a further operating parameter for the train comprises determining the further operating parameter to require the train to stop in response to determining that the train does not meet the position criteria. 40
8. The method of claim 7, wherein the determining a further operating parameter for the train comprises determining the M\_level of the train to be Level 2 in response to determining that the train does meet the position criteria. 45 50
9. A railway control system comprising:
- at least one processor, and  
at least one memory including machine-readable instructions, 55  
wherein the at least one memory and the machine-readable instructions are configured to, with the at least one processor, cause the railway control system to perform the method of claim 1.
10. The railway control system of claim 9, comprising a radio block centre for location along a railway track, the radio block centre being configured to perform the method of claim 1.
11. A computer program comprising instructions, which, when executed by a train control system causes the railway control system to carry out the method of claim 1.
12. A computer-readable data carrier having the computer program of claim 11 stored thereon.

FIG 1

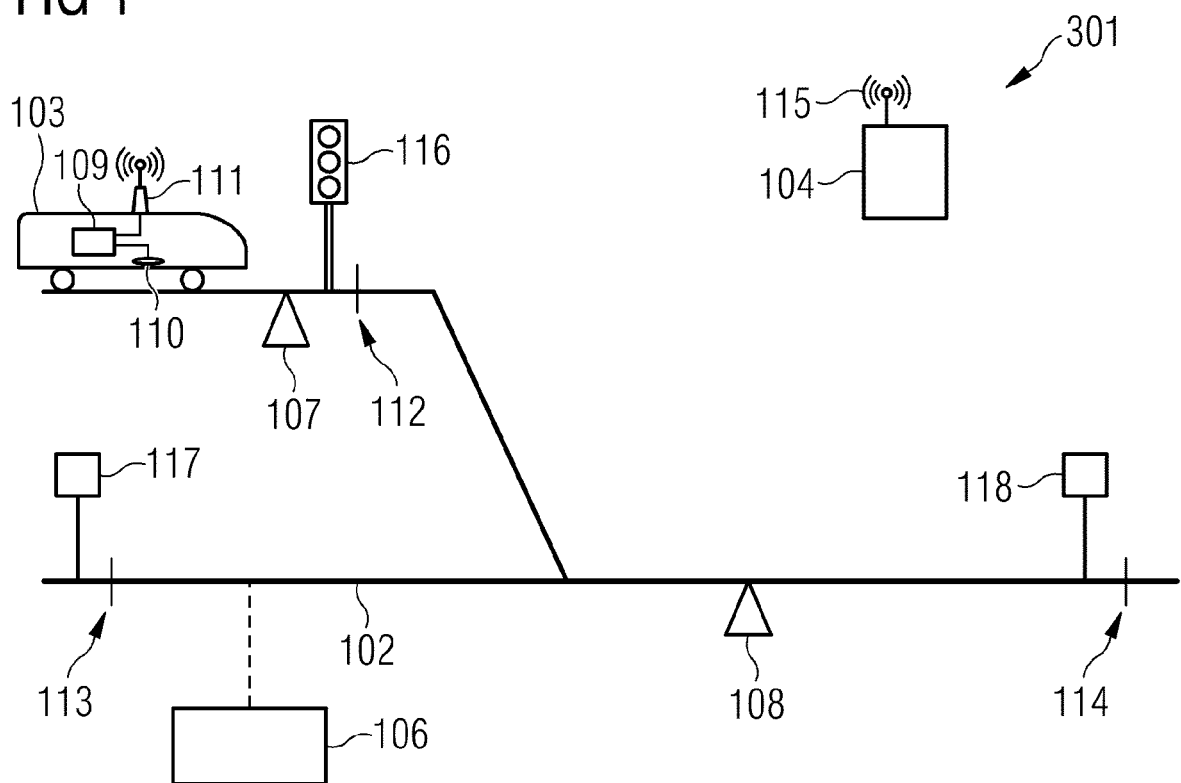


FIG 2

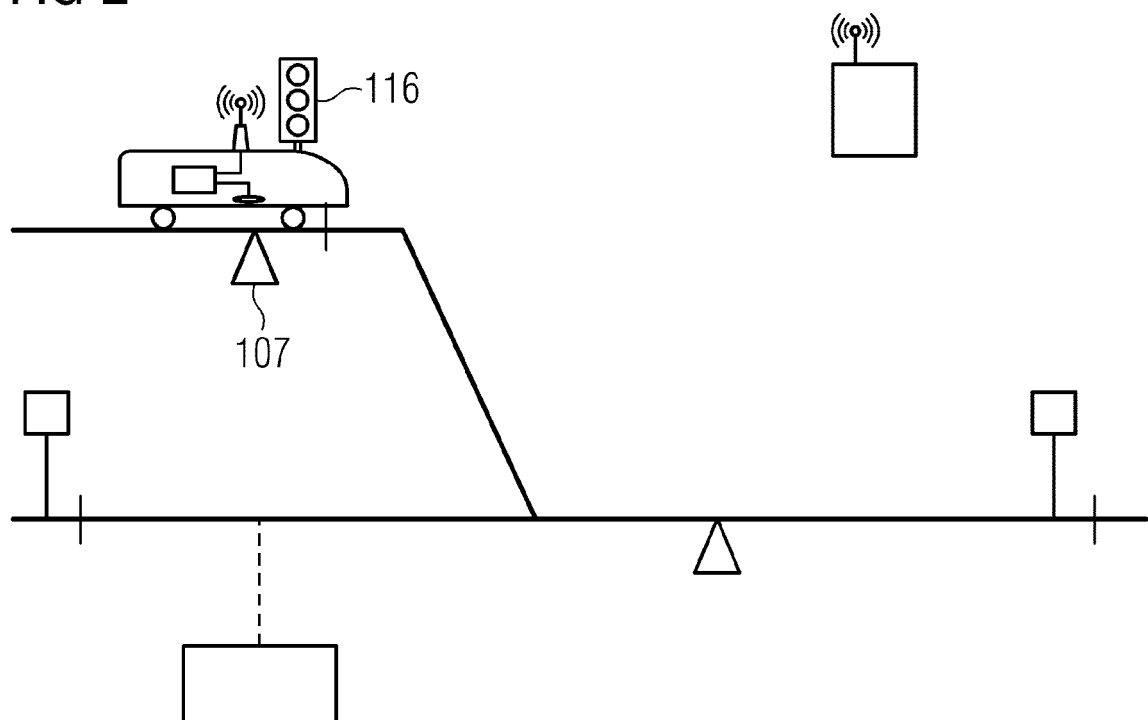


FIG 3

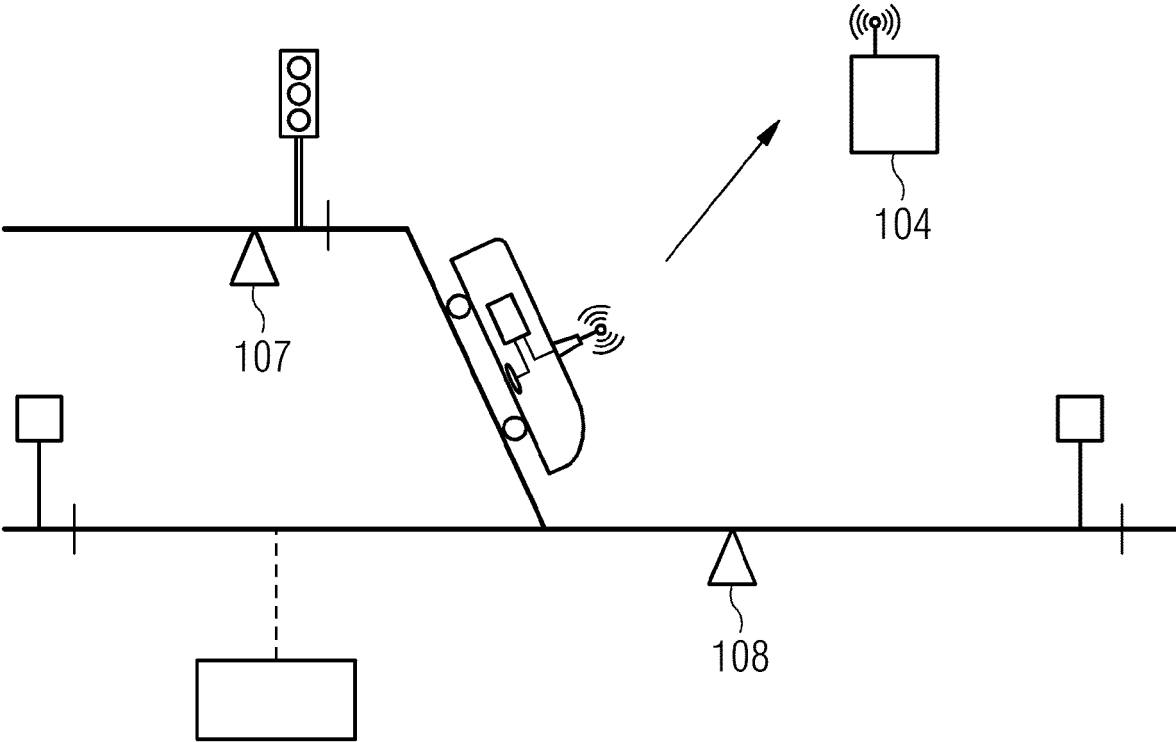


FIG 4

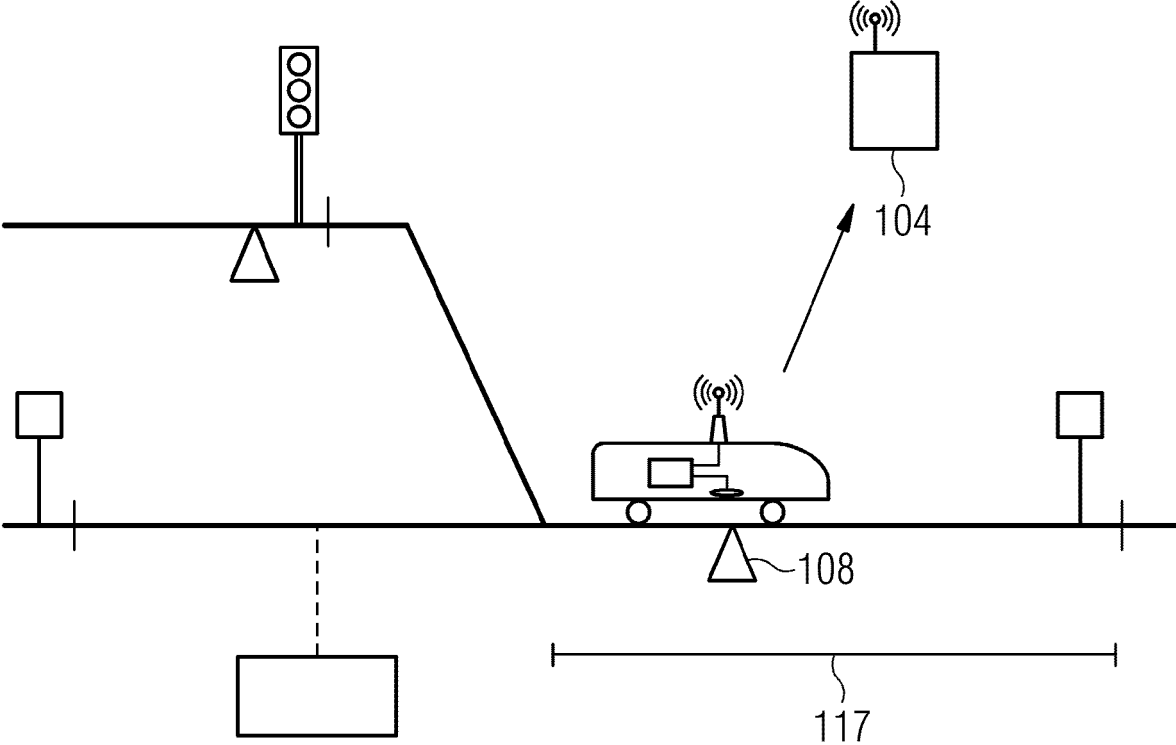


FIG 5

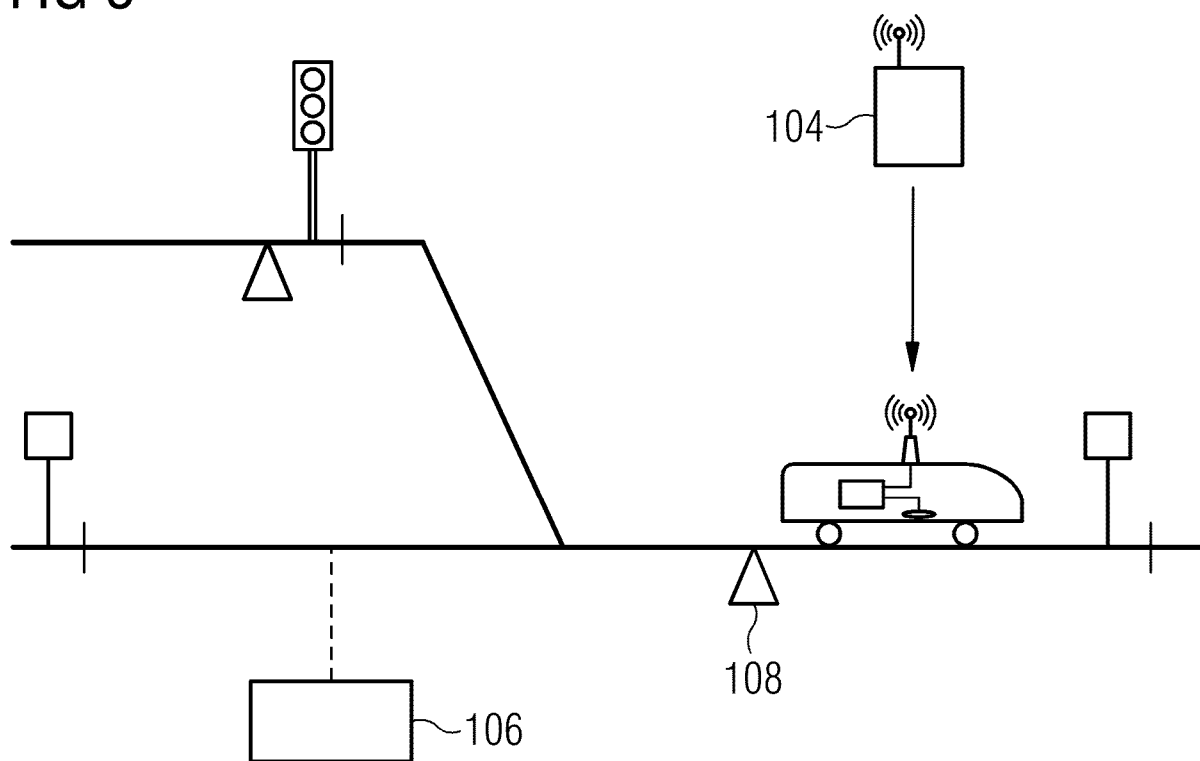


FIG 6

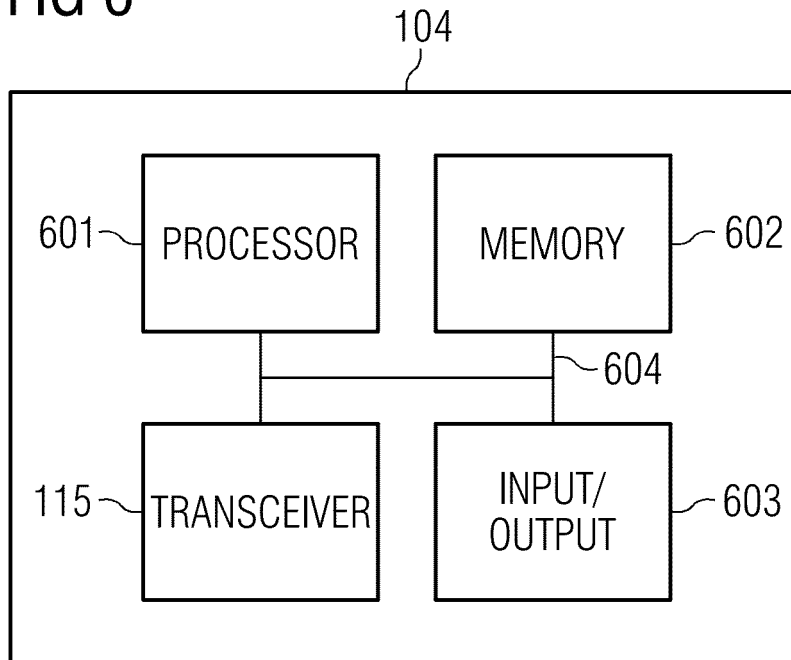


FIG 7

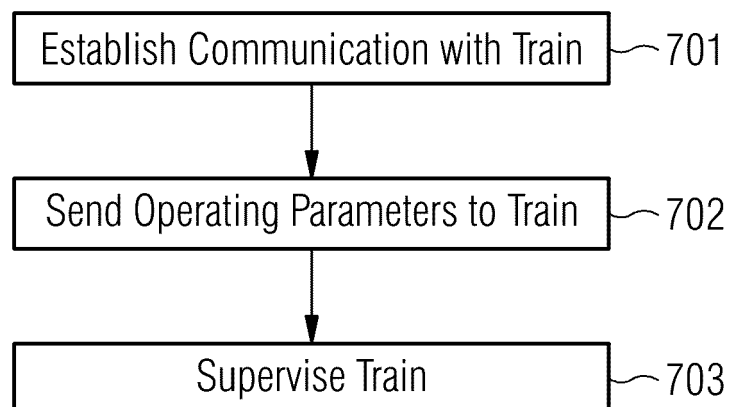
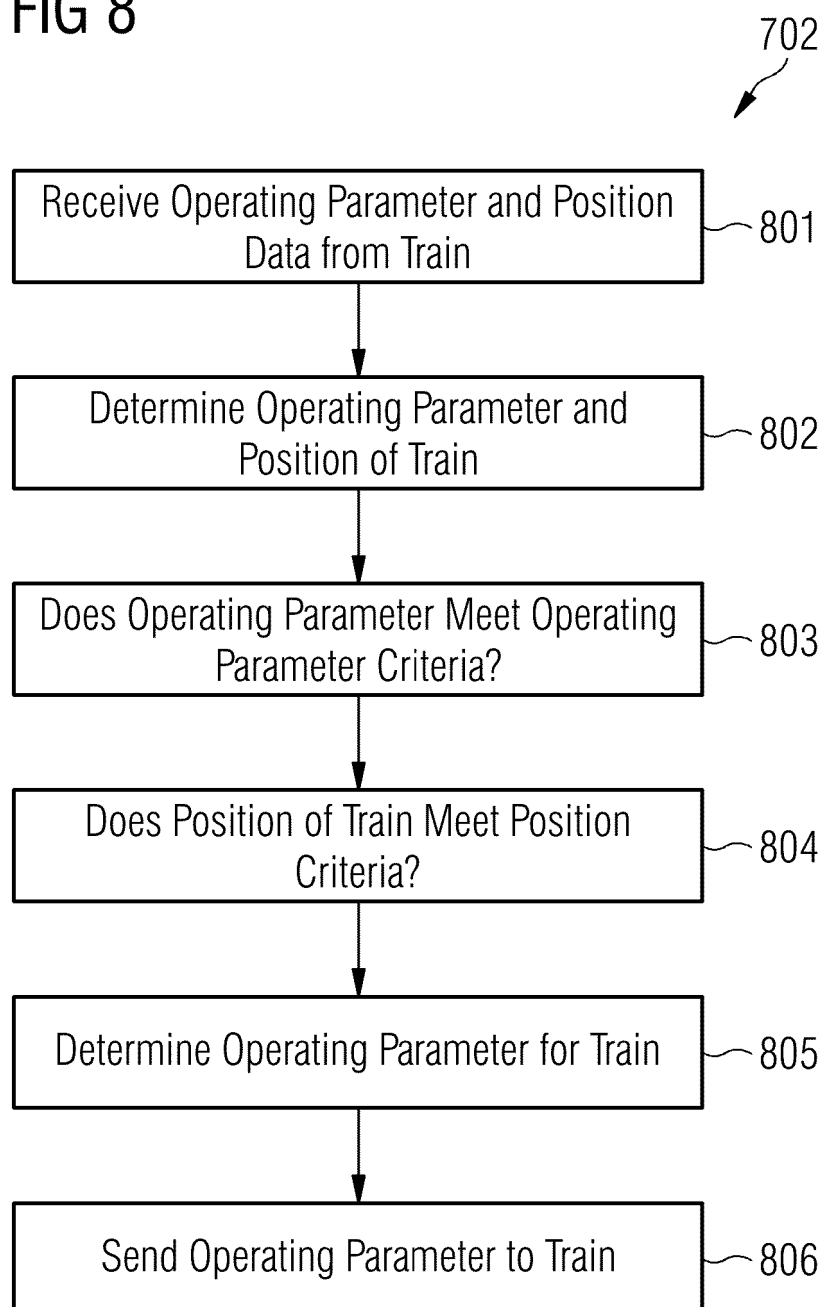


FIG 8





## EUROPEAN SEARCH REPORT

Application Number

EP 25 21 2447

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| Category                                                                                                                                                                                                                                                                              | Citation of document with indication, where appropriate, of relevant passages                                                                                                                                                                                                                                                           | Relevant to claim                                       | CLASSIFICATION OF THE APPLICATION (IPC)     |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                         |                                                         |                                             |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                         | Date of completion of the search<br><b>6 March 2026</b> | Examiner<br><b>Robinson, Victoria</b>       |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                         |                                                         |                                             |
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06-03-2026

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