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(54) **SYSTEM AND METHOD FOR MANAGING TRAFFIC OF TRACK VEHICLES OVER A WORK ZONE**

(57) System and method for improving safety of a track worker on a worksite of a railway network, said method comprising launching (201) a process for protecting the worksite (11), said method comprising:
- determining (202) worksite location data by locating the worksite (11) on a representation of the railway network (1) displayed via a user interface (31) of a wearable device (3);
- automatically sending (203), via a communication module (34) of said wearable device (3), the worksite location data to a control system (2) of the railway network (1), wherein said worksite location data are configured for triggering the control system (2) to automatically block access to a track section comprising or crossing the worksite (11) for any approaching track vehicle that has to pass through the worksite (11);
- informing (204), via said user interface (31), that the worksite (11) is safe upon reception, by the wearable device (3), of a confirmation signal from the railway network control system (2) indicating that the track section has been successfully blocked.

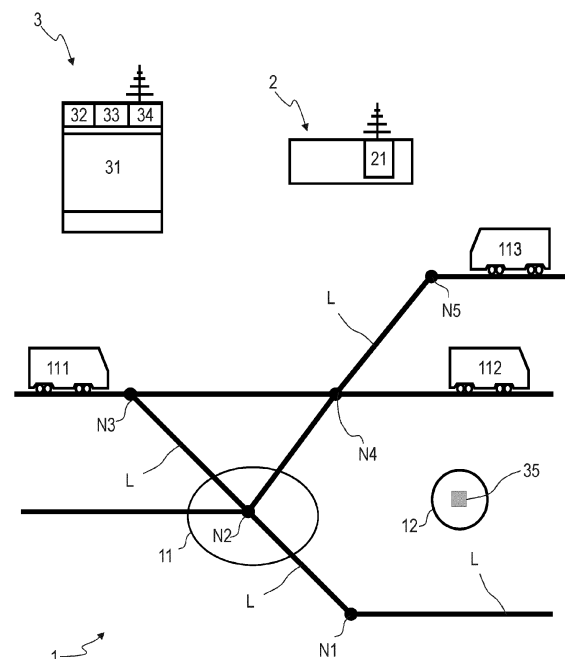


FIG 1

Description

[0001] The present invention concerns a system and a method for managing traffic of track vehicles over a work zone of a railway network in order to improve track worker safety on said work zone.

[0002] Indeed, the safety of people working on or near a railway network infrastructure is a very important topic for railway companies. The works performed for building, inspecting, maintaining the railway track or trackside infrastructure are considered as very hazardous. Danger comes in particular from track vehicles (e.g. train) moving within the working area, notably in case of maintenance or inspection carried out without interrupting the rail traffic. This requires indeed a constant vigilance of the track workers: they have to be aware of any approaching track vehicle. Incidents usually involve collisions of a track worker with an approaching vehicle, but also collisions between an approaching train and a track vehicle used for the maintenance/construction/inspection of the track.

[0003] To improve track worker safety, different solutions have been developed. They are notably based on track warning systems that are configured for automatically providing an early audio and/or visual warning. A first solution consists in an independent system comprising one or several devices that need to be installed at the track area wherein track works have to be carried out (i.e. on the worksite or work or working zone). The system is configured for independently detecting an approaching train and automatically sending said audio/visual warning to the track workers for each detected approaching train. The track workers have then to move to a safe place for letting the approaching train pass through the worksite. A disadvantage of this first solution is notably the need to install on the track area said one or several devices which might be particularly dangerous. Other solutions are based on an installation of a device within trains of the railway network. Said device is configured for launching an audio and/or visual warning within the train cabin in order to alert the train crew about approaching a work-site wherein track workers are present. The train operator has then to decrease the speed of the train and signal its presence in a visual and/or audible way. The above-mentioned solutions might also be combined. Other solutions involve the control of the railway signaling system by an operator so that traffic through the work zone be prevented. In this case, the track workers and said operator are in constant communication for enabling the management of the rail traffic through the work zone. Yet other solutions are based on an independent and additional layer of track safety usually requiring an installation of additional track safety devices on or near the track for warning the track workers and/or a train driver.

[0004] Despite the existing solutions, there are still too many incidents involving track workers, and therefore, safety still needs to be improved.

[0005] An objective of the present invention is to propose a method and device for improving track worker

safety, that may work free of any installation of a dedicated physical device on the worksite and/or within track vehicles of the railway network, and that enable an efficient and simple management of the rail traffic over the worksite while ensuring said safety of the track workers.

[0006] This objective is achieved by the measures taken in accordance with the independent claims. Further advantageous embodiments are proposed by the dependent claims.

[0007] According to an aspect of the invention, a wearable device is proposed for managing traffic of track vehicles over a work zone or worksite of a railway network, said wearable device being preferentially configured for coordinating with a control system a management of said traffic over said work zone or worksite, or in other words for cooperating with said control system for managing track vehicle traffic over said work zone or worksite of a railway network in order to improve safety of track workers on said worksite. The wearable device comprises:

- a user interface;
- a memory comprising instructions;
- a processor for executing said instructions;
- a wireless communication module for communicating with said control system configured for managing traffic of track vehicles on the railway network;

wherein, when executed by the processor, said instructions cause the processor to perform acts comprising:

i. launching a process for protecting the worksite, said process comprising:

- determining worksite location data by locating the worksite on a representation of the railway network;
- automatically sending, via the wireless communication module, the worksite location data to said control system of the railway network, wherein said worksite location data are configured for triggering the control system to automatically block access to a track section comprising or crossing the worksite for any approaching track vehicle that has to pass through the worksite;
- informing, via said user interface, that the worksite is safe upon reception, by the wireless communication module, of a confirmation signal, from the railway network control system, indicating that the access to the track section has been successfully blocked;

ii. upon reception, by the wireless communication module, of a request for unblocking the access to the track section for a currently approaching track vehicle, launching a process for temporary authorizing a moving of said currently approaching track vehicle through the worksite, comprising:

- automatically generating, by the wearable device, a warning signal for warning the track worker about the currently approaching track vehicle and for prompting the track worker to move into a position of safety; 5
- verifying whether the track worker is located at said position of safety, and, only in the affirmative, automatically sending, via the wireless communication module and to the control system, a safe position acknowledgement notification configured for triggering the control system to automatically and temporary un-block the access to the track section for authorizing the currently approaching track vehicle to access said track section and pass through the worksite. 10 15

[0008] In particular, upon reception, by the wireless communication module, of a signal configured for informing the wearable device that the currently approaching track vehicle passed through the worksite and/or left said track section, then said instructions cause the processor to perform acts comprising automatically re-blocking the access to the worksite. Finally, said instructions might also be configured to cause the processor to perform acts comprising: 20 25

iii. launching a process for removing the protection of the worksite, said process comprising:

- receiving, via the user interface, a user input for removing the protection of the worksite; 30
- automatically sending, by the wireless communication module and to the control system, a signal configured to trigger the control system to automatically unblock the access to said track section comprising or crossing the worksite. 35

[0009] A track worker safety system (hereafter "TWSS") is also proposed, said TWSS comprising the previously described wearable device and the control system for managing traffic of a track vehicle on the railway network. 40

[0010] According to another aspect of the present invention, a method for managing traffic of track vehicles over a work zone of a railway network in order to improve track worker safety on said worksite is proposed. Said method comprises the following steps: 45

- i. launching, by means of a wearable device, a process for protecting the worksite, said process comprising: 50
- determining, by said wearable device, worksite location data by locating the worksite on a representation of the railway network;
 - automatically sending, via a wireless communication module of the wearable device, the worksite location data to a control system of the railway network, wherein said worksite location data 55

are configured for triggering the control system to automatically block access to a track section comprising or crossing the worksite for any approaching track vehicle that has to pass through the worksite;

- informing, via a user interface of the wearable device, that the worksite is safe upon reception, by the wireless communication module, of a confirmation signal, from the railway network control system, indicating that the track section access has been successfully blocked; and

ii. upon reception, by the wireless communication module, of a request for unblocking the access to the track section for a currently approaching track vehicle, the method comprises launching a process for temporary authorizing a moving of said currently approaching track vehicle through the worksite, said process comprising

- automatically generating, by the wearable device, a warning signal for warning the track worker about the currently approaching track vehicle and for prompting the track worker to move into a position of safety;
- verifying whether the track worker is located at said position of safety, and, only in the affirmative, automatically sending, via the wireless communication module and to the control system, a safe position acknowledgement notification configured for triggering the control system to automatically and temporary un-block the access to the track section for authorizing the currently approaching track vehicle to access said track section and pass through the worksite.

[0011] In particular, the method may further comprise automatically re-blocking the access to the worksite upon reception, by the wireless communication module, of a signal configured for informing the wearable device that the currently approaching track vehicle passed through the worksite. Finally, the method according to the invention might further comprise:

iii. launching a process, by the wearable device, for removing the protection of the worksite, said process comprising:

- receiving, via the user interface, a user input for removing the protection of the worksite;
- automatically sending, by the wireless communication module and to the control system, a signal configured to trigger the control system to automatically unblock the access to said track section comprising or crossing the worksite.

[0012] Further aspects of the present invention will be better understood through the following drawings, wherein like numbers designate like objects:

Figure 1 schematic illustration of a TWSS according to the invention;

Figure 2 flowchart of a preferred embodiment of a method according to the invention.

[0013] Figure 1 shows the general framework of the invention. In particular, a railway network 100 is schematically represented as an infrastructure comprising nodes N_i , $i=1, \dots, 5$, and links L , wherein each node N_i is connected to at least one another node. The links L typically represent tracks and the nodes N_i might represent junctions or crossing of said tracks. As known in the art, said infrastructure comprises also an interlocking, i.e. an arrangement of signal apparatus and appliances (e.g. points, switches, etc.) for preventing conflicting movements of track vehicles 111, 112, 113 through the railway network. The track vehicles 111, 112, 113, are for instance passenger trains or freight trains. For managing the rail traffic on said railway network, a control system 2 is configured for being connected, e.g. via communication means like the modem 21, on one hand with the track vehicles 111, 112, 113, and on the other hand with the interlocking for sending and/or getting appropriate signals and/or information enabling a proper management of said rail traffic. Such control systems 2 are well-known in the art and do not require a further description.

[0014] Within this framework, the present invention introduces a new wearable device 3 designed for ensuring the safety of track workers having to accomplish works, like maintenance or inspection works, on a worksite or work zone 11 of said railway network 1. In the example of Fig. 2, said work zone 11 surrounds the junction node N_2 . The wearable device 3 according to the invention is able to launch a process for preventing the track vehicles 113, 111 entering the work zone 11 during track works as long as track workers are present within said work zone 11. Indeed, according to the present invention, any approaching track vehicle 111, 113 will need an authorization for entering the work zone 11 as long as said track works are in progress, i.e. as long as a track worker (or more precisely, the wearable device of said track worker) is present on the work zone 11. Advantageously and preferentially, the wearable device 3 enables a direct cooperation or coordination with the control system 2 for managing the allocation of said authorization, so that the track worker be aware of any approaching track vehicle and can leave the work zone 11 at an appropriate time before an approaching track vehicle passes the work zone 11.

[0015] For this purpose, said wearable device 3 comprises a user interface 31, a memory 32, a processor 33, and a wireless communication module 34. Said wearable device 3 is for instance a smartphone or a tablet, or any other smart device enabling an interaction with a user, capable of processing some signal, and of communicating with another device using mobile communication. In particular, said user interface comprises a human-ma-

chine interface. The latter may comprise a physical input device (like a keyboard and/or a touchscreen and/or a microphone, etc.) and/or a physical output device (like a screen or touchscreen and/or a speaker and/or a vibration device, etc.). The user interface 31 enables an interaction between the track worker and the wearable device 3. In particular, the wearable device 3 according to the invention might automatically select a type of interaction with the track worker in function of a detected environment, as well as parameters controlling said type of interaction. For instance, the wearable device is able to detect a noisy environment through its microphone and to adapt a volume of its speaker in function of a noise volume of said environment or to automatically switch to, or to additionally start, a vibration mode for alerting the track worker. In addition, or alternatively, the wearable device preferentially displays any information and alarms via its user interface.

[0016] According to the present invention, the wireless communication module 34 is configured for mobile communication with the control system 2. It typically enables a mobile data connection between the wearable device 3 and the control system 2, and optionally between the wearable device 3 and at least one of the track vehicles 111, 112, 113. It comprises typically a wireless or cellular modem. In other words, it is configured for enabling sending mobile data to and/or receiving mobile data from said control system 2, and optionally to/from said at least one track vehicle for the purpose of managing traffic over the work zone 11.

[0017] The wearable device 3 together with the control system 2 form the so-called TWSS according to the invention. In particular, said TWSS comprises, or cooperates with, a secure mobile data communication network enabling secure wireless internet access for the wearable device 3 and the control system 2, as well for said at least one track vehicle. Through said secure mobile data communication network, the wearable device 3, the control system 2, and optionally said at least one track vehicle are able to send and/or receive mobile data from each other.

[0018] Contrary to other smart devices, the wearable device 3 according to the invention further comprises instructions, which, when executed by the processor 33, cause the latter to perform acts comprising (i) launching a process for protecting the worksite 11, (ii) launching a process for temporary authorizing a moving of a currently approaching track vehicle through the worksite 11, and preferentially, (iii) launching a process for removing the protection of the worksite. In other words, the wearable device 3 according to the invention is able to manage, together with the control system 2, the traffic of track vehicles over the work zone 11.

[0019] This cooperation in, or coordination of, the management of the traffic over the work zone 11 by the wearable device 3 according to the invention will be now explained in more details with respect to Figure 2.

[0020] At step 201, the wearable device 3 launches a

process for protecting the work zone 11. In particular, said process might be launched automatically by the wearable device 3 itself. For instance, the wearable device 3 might be configured for automatically determining its current GPS coordinates (i.e. its position within a map), and to further determine whether said GPS coordinates fall within a geographical area which has been memorized in its memory 32 as comprising a work zone. In the affirmative, the wearable device 3 automatically launches said process for protecting the work zone. In particular, as long as the track worker (i.e. the wearable device) is located within a geographical area comprising a work zone, but protection of said work zone has not yet been confirmed by the wearable device, the latter is configured for signal to the track worker said unprotection, e.g. by emitting a sound, and/or light, and/or vibration, and/or by displaying an alarm notification. Once the protection is confirmed, i.e. once the wearable device 3 received a signal from the control system 2 confirming the protection of the worksite, then said emission of the sound and/or light and/or said vibration and/or display of the alarm notification automatically stop(s). In particular, different sounds and/or lights and/or vibration might be used for encoding different safety issues, e.g. a first sound plus first vibration corresponding to an approaching train, and a second sound being used for notifying an entering of a geographical area comprising a work zone not yet protected.

[0021] According to the present invention, the memory is preferentially configured for storing different work zones within the railway network, for instance according to a planned schedule for performing maintenance or inspections of the railway network, and for each work zone, and preferentially, a geographical area. Preferentially, each stored work zone 11 is associated to location data (i.e. location data are defined for each work zone) enabling to locate said work zone 11 within a representation of the railway network, e.g. an interactive map of the railway network. Similarly, each geographical area is also associated to geographical location data comprising notably one or several geographical coordinates enabling its location within a geographical map typically comprising the railway network. For instance, said geographical location data may comprise geographic coordinate (latitude and longitude) of a central position of the geographical area, and a radius R enabling to define a circular zone around said central position, the area comprised within said circular zone being the so-called geographical area. Of course, the skilled person might implement other ways of defining a geographical area based on appropriate sets of geographical location data.

[0022] Said work zone location data and/or geographical location data might be stored in the memory of the wearable device. According to the present invention, the geographical area is configured for typically surrounding the work zone, i.e. the work zone is included within the geographical area, the latter covering a surface strictly greater than the surface of the work zone, and is further

configured for enabling a triggering of an automatic launching of said process for protecting the work zone by comparing said current GPS coordinates with the coordinates of the geographical area typically stored in the memory. Of course, in such a case, the wearable device 3 would also comprise a GPS system for determining its current position. Advantageously, the automatic launching of the protection of the work zone 11 enables the track worker to keep hands free for other tasks when moving towards a work zone.

[0023] According to a preferred additional or alternative embodiment, the track worker may launch said process for protecting the work zone 11 via the user interface, e.g. by requesting, via said user interface, a protection for a given work zone. In particular, the wearable device may comprise a web browser or an application enabling the track worker to file, via said user interface, a request for protection of the work zone 11, for instance on a website of the control system, or via said application. Said web browser or application is thus notably configured for connecting to said website of the control system 2. For instance, the track worker may simply click on an icon of said website or application displayed via said user interface. According to the present invention, the wearable device 3 is thus able to connect to a server of the control system 2 for sending and receiving information, via mobile data, for managing the traffic of track vehicles over the work site 11, and preferentially for blocking access to the work site 11 to approaching track vehicles.

[0024] At step 202, the wearable device 3 is configured for determining location data of the worksite 11 on a representation of the railway network. According to the present invention, locating the worksite on said representation of the railway network might be automatically performed by the wearable device from GPS data of a GPS system of the wearable device or from an input manually entered via said user interface by the trackworker. In particular, said representation of the railway network, typically displayed on a display of the wearable device, might be a map, preferentially a schematic and/or interactive map of the railway network, or a geographical map of the railway network, or any other representation enabling a location of a worksite on a railway network. The wearable device 3 is notably configured for displaying said representation of the railway network via the user interface, e.g. on a screen of the wearable device. In particular, the track worker may directly locate said worksite on said representation of the railway network that is displayed on the screen of the wearable device. In such a case, the wearable device is configured for automatically displaying said railway network representation to the track worker via the user interface once the process for protecting a work zone has been launched. Optionally, the representation of the railway network may comprise one or several predefined and planned worksites configured for being selectable by the track worker. Typically the track worker can then locate the worksite on the railway network representation or select a predefined and

planned worksite, for instance by directly interacting with said representation displayed on a touchscreen of the wearable device. The track worker can for instance directly indicate, using a simple or multi-touch gestures with one or more fingers, where, within said representation displayed on the touchscreen, the worksite is located. In particular, the work zone can be directly defined by the track worker on the railway network representation displayed by the user interface of the wearable device. According to the present invention, the wearable device is configured for automatically determining location data corresponding to the work zone defined or selected or located via the user interface by the track worker.

[0025] The wearable device 3 might also be configured for using said current GPS coordinates (which have been used for automatically launching the process for protecting the work zone 11 (cf. step 201)) for automatically determining said location data of the worksite 11. In such a case, the current GPS coordinates of the wearable device 3 are thus used first, for triggering said launching of the process for protecting the work zone 11 by determining whether said coordinates fall within a memorized geographical area, and second, for determining or acquiring from the data stored in its memory, the location data of the work zone 11 for which said geographical area has been defined.

[0026] The wearable device might be further configured for automatically acquiring GPS coordinates of the wearable device after a launching, by the track worker, of said process for protecting the work zone 11, and for automatically providing to said track worker a location of the work zone on said railway network representation, wherein the provided location is the location of the work zone for which a geographical area is characterized by coordinates matching said automatically acquired GPS coordinates (i.e., the wearable device 3 is configured for determining whether the automatically acquired GPS coordinates which indicate the current position of the wearable device fall within said geographical area given its coordinates stored in the memory).

[0027] At step 203, the wearable device 3 is configured for automatically sending said work zone location data to the control system 2. For this purpose, it uses its wireless communication module 34, sending mobile data comprising the work zone location data. The work zone location data are data configured for enabling a location of the work zone on a representation of the railway network. For instance, if a track worker selects a planned and predefined work zone 11 on said representation of the railway network, then said location data can corresponds to an identification data of the selected planned and predefined work zone 11, wherein said identification data enables the control system 2 to locate the selected planned and predefined work zone on the representation of the railway network. According to other preferred embodiment, said location data can comprise geographical coordinates, or any other data enabling to directly or indirectly locate the work zone on said railway network rep-

resentation. According to the present invention, said sending of the location data is configured for triggering the control system 2 to automatically block access to a track section comprising or crossing the work zone 11 for any approaching track vehicle that has to pass through the work zone 11 if the wearable device, and thus the track worker, is located at said worksite 11. The track section(s) that have to be blocked are automatically determined by the control system 2 from the received location data. Said track section might be a physical (e.g. delimited by signaling apparatus) or virtual track section within the railway network 1. In particular, the control system 2 is configured for automatically determining one or several track sections to be blocked (i.e. whose access has to be blocked) in function of the received location data and planned itinerary for track vehicles 111, 112, 113 in order to prevent any approaching track vehicle to access said work zone 11 as long as a track worker is present on said work zone 11. In particular, the blocking of the access to the track section(s) by the control system 2 might be configured for implementing a track vehicle braking process that is automatically launched if a track vehicle enters said track section without authorization. Once the access to said track section(s) is blocked, then the control system 2 is configured for automatically sending back to the wearable device 3 a confirmation signal configured for informing the wearable device 3 about a successful blocking of the access to said track section(s).

[0028] At step 204, the wearable device 3 is configured for automatically informing, via said user interface 31, that the worksite 11 is safe (i.e. protected), upon reception, by the wireless communication module 34, of said confirmation signal indicating that the access to the track section has been successfully blocked by the control system 2. The information about the successful blocking of the access to the track section comprising or crossing the work zone 11 might be outputted by the wearable device 3 visually and/or audibly and/or via vibrations.

[0029] In case of an approaching track vehicle needing to pass through the work zone 11 while the latter is currently protected, i.e. while access to the latter is blocked, the control system 2, or said approaching track vehicle, is configured for automatically sending a signal (i.e. mobile data) configured for requesting the wearable device 3 to unblock the access to the work zone, and thus the access to the track section for said approaching track vehicle. At step 205, upon reception of said signal, the wearable device 3 is configured for automatically launching a process for temporary authorizing a moving of said approaching track vehicle through the work zone 11. For this purpose, the wearable device 3 is configured for automatically generating, at step 206, a warning signal and/or notification for warning the track worker about the currently approaching track vehicle. Said warning signal and/or notification might take place in an audible and/or visual and/or vibrational form. Said warning signal and/or notification aims to prompt the track worker to move into a position of safety, also called hereafter safe or safety

position 12, before arrival of the approaching track vehicle, so that the latter does not need to stop and any delay be avoided. Preferentially, for each work zone 11 stored in the memory, an associated safe position 12, and corresponding safe position location data (e.g. a set of geographical coordinates enabling to define a safe position and/or a safe area for the track workers, wherein, if a safe area is defined, then any position within said safe area is a safe position) of said safe position 12 are stored in the memory. In the following, unless otherwise specified, a safe position 12 may represent a single position (e.g. a single geographical coordinate) or any position within a safe area.

[0030] At step 207, the wearable device 3 is configured for verifying whether the track worker is located at said safe position 12. Said verification might take place according to different ways, which can be combined with each other, for instance as a redundant verification. For instance, the wearable device 3 might be configured for applying at least two different ways or techniques for verifying whether the track worker is at said safe position, wherein the wearable device is configured for sending of a temporary moving authorization to an approaching track vehicle only if the two different ways/techniques provide the same result that the track worker is located at said safe location. Of course, each of said ways/techniques might be applied separately and independently.

[0031] According to a first implementation, the track worker might be automatically requested, via the user interface, to confirm that he moved to said safe position 12. The acknowledgement by the track worker that he is currently located at said safe position (e.g. at any position within the safe area) is then configured for automatically triggering a sending of said safe position acknowledgement notification. In this case, the verification that the track worker is located at said safe position 12 takes place "manually", upon reception of a user input confirming a location at a safe position.

[0032] According to a second implementation, GPS coordinates of the wearable device are used for automatically determining whether the wearable device 3 is currently located at said safe position (e.g. at any position within said safe area) by comparing said GPS coordinates to the memorized safe position location data. In the affirmative, then the wearable device automatically sends said safe position acknowledgement notification.

[0033] According to a third implementation, the present invention comprises additionally a mobile trackside device 35, that is a portable device physically independent from the wearable device 3, and that is capable of cooperating with the wearable device 3 for automatically verifying, or for enabling the wearable device 3 to automatically verify, whether a current position of the wearable device 3 is a safe position, i.e. is a position within said safe area that is considered as safe for the track worker and within which the track worker shall be present when a track vehicle is crossing the work zone. Said mobile trackside device 35 is notably designed for being in-

stalled, notably temporary, during the time a track worker is present on said worksite, at the center of said safe area in order to verify or enable the verification that the track worker is at a safe position (e.g. within said safe area which is configured for surrounding the mobile trackside device 35) when an approaching track vehicle needs to pass the worksite. For this purpose, the mobile trackside device 35 may use any known in the art techniques capable of detecting a presence of the wearable device 3 within a predefined distance from the mobile trackside device 35, like RFID techniques. For instance, the mobile trackside device 35 might comprise a RFID tag that is readable by the wearable device 3 only when the track worker (i.e. the wearable device) is within said predefined distance from the mobile trackside device 35. The reading of the RFID tag by the wearable device 3 takes place automatically and is configured for triggering the sending of said safe position acknowledgement notification configured for acknowledging that the track worker is located at said safe position. According to other embodiments, the mobile trackside device 35 might determine whether the wearable device 3 is within said predefined distance, using for instance a camera system or by processing a signal sent by the wearable device, etc. In other words, the mobile trackside device 35 and the wearable device 3 are configured for cooperating with each other in order to determine whether a distance separating the wearable device 3 from the mobile trackside device 35 is less or equal to said predefined distance, in which case, the wearable device 3 is then configured for automatically sending said safe position acknowledgement notification to the control system 2. Said mobile trackside device 35 is thus preferentially a portable device, typically configured for being installed on the ground, for instance placed by a track worker at a safe position, in order to define a safe area where the track worker has to move in case of an approaching track vehicle. At said safe area, the cooperation between the mobile trackside device 35 and the wearable device 3 enables an automatic detection of the track worker once said track worker is at said predefined distance from the mobile trackside device 35, which is preferentially used for triggering the automatic sending of said safe position acknowledgement notification. Advantageously, the track worker has his hands free during the whole process of granting access to the track section for an approaching track vehicle. Advantageously, a single mobile trackside device 35 is needed per group of track workers having to work on a same worksite.

[0034] Advantageously, in case of a group of track workers working on said worksite, then said sending of the safe position acknowledgement notification might only be released upon verification, by the wearable device 3 or by the mobile trackside device 35, that all track workers are at a safe position, e.g. within said safe area. For instance, each track worker of a group of several track workers might wear a wearable device according to the invention, creating therefore a group of wearable devices, and the latter are configured for communicating with

each other so that each wearable device is able to determine an identity of each other wearable devices worn by the track workers of said group, and for each identity a protection binary status, which is either "at a safe position" or "not at a safe position", is automatically determined using the previously described techniques (more precisely, the "not at a safe position" corresponds to a nominal (or by default) status, which can only be changed/turned into a "at a safe position" status if it is determined, according to the previously described different ways or techniques for verifying whether the track worker is at said safe position, that the wearable device is at said safe position), wherein said binary status is distributed, e.g. using a push functionality, within the group of wearable devices, so that each wearable device of the group is aware of the status of each other wearable device. Preferentially, then at least one of the wearable devices, e.g. a wearable device chosen as master, is configured for sending said safe position acknowledgement notification only if the status of all wearable devices of the group is "at a safe position", which means that all wearable devices, and thus track workers, are at a safe position, for instance within said predefined distance from the mobile trackside device 35.

[0035] The safe position acknowledgement notification according to the invention is sent by the wearable device 3 to the control system 2 and is configured for triggering the control system 2 to automatically and temporary un-block the access to the track section for authorizing the currently approaching track vehicle to access said track section and pass through the worksite. In other words, the safe position acknowledgement notification is configured for triggering the control system to send a temporary moving authorization to the approaching track vehicle so that the latter can pass the worksite. Preferentially, the wearable device 3 is configured for warning the track worker upon each approaching track vehicle for which access to the work zone has been granted, said warning taking place continuously until the approaching track vehicle for which access to the work zone has been granted passed the work zone and/or left the track section comprising or crossing said work zone. Said warning may take place visually and/or audibly and/or via vibrations. In particular, upon reception of a signal configured for informing the wearable device that the currently approaching track vehicle passed through the worksite and/or left the track section, then said wearable device or the control system is configured for automatically re-blocking the access to the track section. Preferentially, said signal, configured for informing the wearable device that the currently approaching track vehicle passed through the worksite and/or left the track section, is sent by said currently approaching track vehicle or by the control system 2. Preferentially, the leaving of said safe position 12 by the wearable device might automatically trigger a sending to the control system 2 of a request for re-blocking said track section, wherein said "track section re-blocking" request is configured for triggering the

control system to automatically block again the access to said track section. In addition or as alternative, the wearable device 3 might be configured for receiving a user input triggering the sending of said track section re-blocking request.

[0036] Once the works at said work zone 11 are completed, then the wearable device 3 is able to launch, at step 208, a process for removing the protection of the worksite. Preferentially, said process starts with the reception, via the user interface of the wearable device 3, of a user input requesting the removal of the protection of the worksite. Said reception of the user input by the wearable device is configured for triggering an automatic sending, to the control system 2, of a signal configured to trigger the control system 2 to automatically unblock (called hereafter "definitive unblock") the access to the track section comprising or crossing the worksite. Contrary to the temporary unblocking of the track section which enables only the approaching track vehicle having requested said unblocking to pass through the work zone, the definitive unblock make it possible for any approaching track vehicle to cross the work zone.

[0037] To conclude, the present invention proposes a new way to manage traffic over a work zone, wherein a wearable device 3 is able to send via mobile communication requests for blocking, temporary blocking or unblocking an access to a track section wherein said work zone is located, said requests being configured for triggering automatic blocking, temporary blocking, unblocking of the access to the work zone by a control system 2 in charge of management of the traffic of track vehicles over a railway network 1.

Claims

1. Wearable device (3) for managing traffic of track vehicles (111, 112, 113) on a worksite (11) of a railway network (1), said wearable device (3) comprising:

- a user interface (31);
- a memory (32) comprising instructions;
- a processor (33) for executing said instructions;
- a wireless communication module (34) for communicating with a control system (2) configured for managing traffic of track vehicles (111, 112, 113) on the railway network (1);

wherein, when executed by the processor (33), said instructions cause the processor (33) to perform acts comprising:

(i) launching (201) a process for protecting the worksite (11), said process comprising:

- determining (202) worksite location data by locating the worksite (11) on a representation of the railway network (1);

- automatically sending (203), via the wireless communication module (34), the worksite location data to said control system (2) of the railway network (1), wherein said worksite location data are configured for triggering the control system (2) to automatically block access to a track section comprising or crossing the worksite (11) for any approaching track vehicle that has to pass through the worksite;
 - informing (204), via said user interface (31), that the worksite (11) is safe upon reception, by the wireless communication module (34), of a confirmation signal, from the railway network control system (2), indicating that the access to the track section has been successfully blocked.
2. Wearable device (3) according to claim 1, wherein (ii) upon reception, by the wireless communication module (34), of a request for unblocking the access to the track section for a currently approaching track vehicle, launching (205) a process for temporary authorizing a moving of said currently approaching track vehicle through the worksite, comprising:
- automatically generating (206) a warning signal for warning the track worker about the currently approaching track vehicle and for prompting the track worker to move into a position of safety;
 - verifying (207) whether the track worker is located at said position of safety, and, only in the affirmative, automatically sending, via the wireless communication module (34) and to the control system (2), a safe position acknowledgement notification configured for triggering the control system (2) to automatically and temporarily unblock the access to the track section for authorizing the currently approaching track vehicle to access said track section and pass through the worksite (11).
3. Wearable device (3) according to claim 2, wherein said request is sent by the control system (2) or by said currently approaching track vehicle itself.
4. Wearable device (3) according to one of the claims 1 to 3, wherein locating the worksite (11) on said representation of the railway network (1) is automatically performed by the wearable device (2) from GPS data of a GPS system of the wearable device (2) or from an input manually entered via said user interface (31).
5. Wearable device (3) according to one of the claims 1-4, wherein, upon reception of a signal configured for informing the wearable device (2) that the currently approaching track vehicle passed through the worksite (11) and/or left the track section, then said instructions cause the processor (33) to perform acts comprising automatically re-blocking the access to the track section.
6. Wearable device (3) according to claim 5, wherein said signal, configured for informing the wearable device (3) that the currently approaching track vehicle passed through the worksite (11) and/or left the track section, is sent by said approaching vehicle or by the control system (2).
7. Wearable device (3) according to one of the claims 1 to 6, wherein said instructions cause the processor (33) to perform acts comprising: (iii) launching (208) a process for removing the protection of the worksite (11) comprising:
- receiving a user input for removing the protection of the worksite (11);
 - automatically sending to the control system (2) a signal configured to trigger the control system (2) to automatically unblock the access to said track section comprising or crossing the worksite (11).
8. Track worker safety System (hereafter "TWSS") for managing traffic of track vehicles (111, 112, 113) over a worksite (11) of a railway network (1) in order to improve safety of a track worker on said worksite (11), said TWSS comprising:
- the wearable device (3) according to one of the claims 1 to 7;
 - said control system (2) configured for managing traffic of a track vehicle (111, 112, 113) on the railway network (1).
9. TWSS according to claim 8, comprising a mobile trackside device (35) designed for being installed at said safety position (12) and configured for enabling a verification, by the wearable device (3), that a current position of the wearable device (3) is said safety position (12), in which case, the wearable device (3) is configured for automatically sending said safe position acknowledgement notification.
10. TWSS according to claim 9, wherein the cooperation between the wearable device (3) and the mobile trackside device (35) are configured for triggering the sending of the safe position acknowledgement notification only if a distance separating the mobile trackside device (35) and the wearable device (3) is less than or equal to a predefined distance.
11. Method for managing traffic of track vehicles (111, 112, 113) over a worksite (11) of a railway network

(1) for improving safety of a track worker on said worksite (11), the method comprising:

(i) launching (201) a process for protecting the worksite (11), said process comprising:

- determining (202) worksite location data by locating the worksite (11) on a representation of the railway network (1) displayed via a user interface (31) of a wearable device (3);
- automatically sending (203), via a communication module (34) of said wearable device (3), the worksite location data to a control system (2) of the railway network (1), wherein said worksite location data are configured for triggering the control system (2) to automatically block access to a track section comprising or crossing the worksite (11) for any approaching track vehicle that has to pass through the worksite (11);
- informing (204), via said user interface (31), that the worksite (11) is safe upon reception, by the wearable device (3), of a confirmation signal from the railway network control system (2) indicating that the track section has been successfully blocked.

12. Method according to claim 11, comprising

(ii) upon reception, by the wireless communication module (34), of a request for unblocking said track section for a currently approaching track vehicle, the method comprises launching (205) a process for temporary authorizing a moving of said currently approaching track vehicle through the worksite (11), said process comprising:

- automatically generating (206) a warning signal for warning the track worker about the currently approaching track vehicle and for prompting the track worker to move into a safety position (12);
- verifying (207) whether the track worker is located at said safety position (12), and, only in the affirmative, automatically sending, via the wireless communication module (34) and to the control system (2), a safe position acknowledgement notification configured for triggering the control system (2) to automatically and temporarily un-block the access to the track section for authorizing the currently approaching track vehicle to access said track section and pass through the worksite (11).

13. Method according to claim 11 or 12, further comprising:

(iii) launching (208) a process for removing the protection of the worksite (11), said process comprising:

- Receiving, via said user interface (31), a user input for removing the protection of the worksite (11);
- automatically sending to the control system (2) a signal configured to trigger the control system (2) to automatically unblock the access to said track section comprising or crossing the worksite (1).

14. Method according to one of the claims 11 to 13, comprising automatically re-blocking the access to the worksite (11) upon reception of a signal configured for informing the wearable device (2) that the currently approaching track vehicle passed through the worksite.

15. Method according to one of the claims 11 to 14, comprising automatically verifying, from a cooperation between the wearable device (2) and a mobile track-side device (35), that a current position of the wearable device (2) is said safety position (12), in which case, the wearable device (2) is configured for automatically sending said safe position acknowledgement notification.

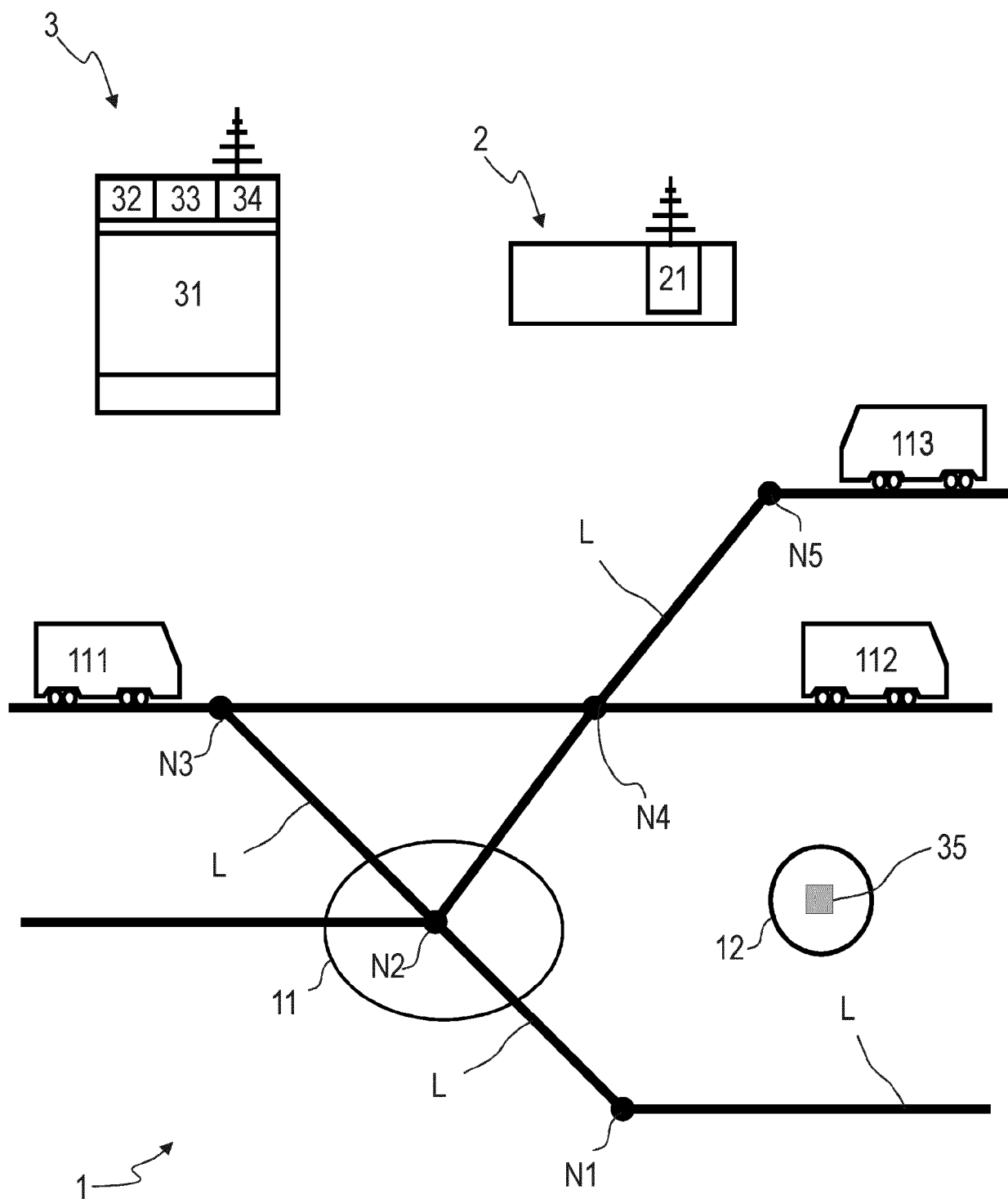


FIG 1

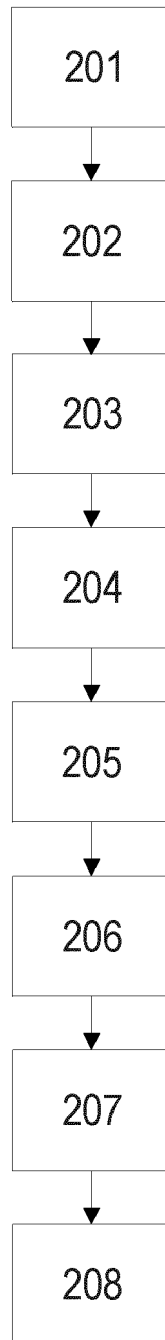


FIG 2



EUROPEAN SEARCH REPORT

Application Number

EP 23 16 3523

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 006 302 A1 (THALES DEUTSCHLAND GMBH [DE]) 13 April 2016 (2016-04-13)	1, 4-8, 11, 13, 14	INV. B61L23/06
Y	* paragraphs [0010] - [0019], [0029] - [0046] *	2, 3, 9, 10, 12, 15	
Y	IT 2020 0002 7074 A1 (SI CONSULTING S R L [IT]) 12 May 2022 (2022-05-12) * page 17 - page 18 *	2, 3, 9, 10, 12, 15	

TECHNICAL FIELDS SEARCHED (IPC)

B61L

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	19 October 2023	Amidjee, Samir
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document		

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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19-10-2023

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