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(54) System and method for checking the integrity of a multi-unit vehicle

(57) The present invention concerns a system and a method for controlling completeness of a multi-unit vehicle (2) comprising N units U_i, with i= 1, ..., N, the system comprising:
- at least N-1 RFID readers R_k and N-1 RFID tags T_k, with k = 1,...,N-1, wherein the RFID reader R_k is configured for being installed on the vehicle unit $U_{i=k}$ and the RFID tag T_k is configured for being installed on the vehicle unit $U_{i=k+1}$ so that the RFID tag T_x and the RFID reader R_k are able to exchange at least one data D_k only if the vehicle units $U_{i=k}$ and $U_{i=k+l}$ are separated by a distance smaller than a predefined distance threshold d, each RFID reader R_k being configured for providing a message M_k comprising information related to the reception or non-reception of the data D_k;
- an integrity controller (11) configured for being installed on-board the multi-unit vehicle (2), wherein the integrity controller (11) is configured for communicating with at least one RFID reader R_k for receiving said message M_k, the integrity controller (11) being configured for controlling the completeness of the multi-unit vehicle (2) from the information comprised in each message M_k he receives.

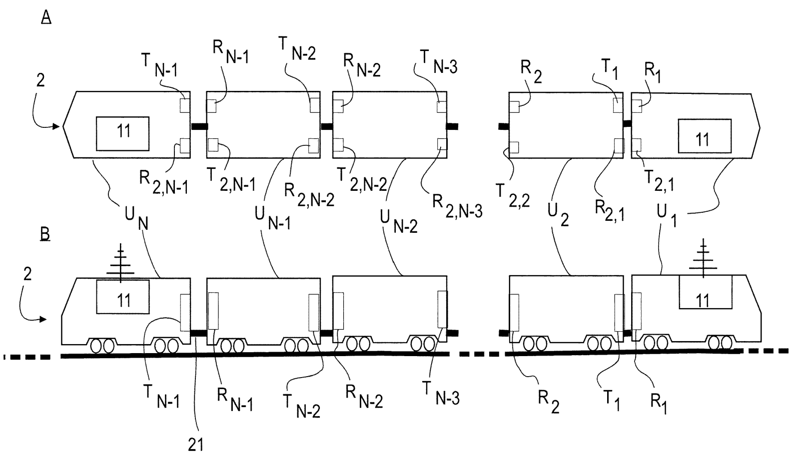

FIG 1

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Description

[0001] The present invention concerns a system and a method for checking the integrity or completeness of a multi-unit vehicle, said vehicle being preferentially a guided vehicle.

[0002] The present invention is related to vehicles comprising multiple units (or cars/coaches) and for which the integrity or completeness has to be ensured, notably for security reasons. From a general point of view the present invention concerns all kinds of vehicles comprising multiple units or cars, but is preferentially directed to multiple unit guided vehicles, wherein "guided vehicle" refers to public transport means such as buses, trolleybuses, streetcars, subways, trains or train subunits, etc., as well as load transporting means such as, for example, freight trains, for which safety is a very important factor and which are guided along a route or railway by at least one rail, in particular by two rails.

[0003] Multi-unit vehicle integrity, like train integrity, ensures that the multi-unit vehicle is complete at any time, i.e. that the back of the multi-unit vehicle (train) has not become separated from the front and that the multi-unit vehicle integrity is preserved.

[0004] Different solutions have been provided to check the integrity of a multi-unit vehicle. For example train integrity is ensured by wayside devices like track circuits, axle counter, or similar systems, and/or by onboard devices like double coupling which provides two couplings on every vehicle unit, or tail lamp with positioning capability which refers to a device installed at the rear of the train that communicates information (e.g. position of the rear of the train, its speed or its distance from the front of the train) related to train integrity to either the front of the train or the ground, e.g. a wayside device, or alarmed coupling wherein a physical link between two vehicle units provides an alarm if the link is broken, or train circuit wherein a wired link through all vehicles in the train for which any break in the link can be detected.

[0005] Nevertheless, the above-mentioned solutions are expensive and the future of railway traffic management requires, as in many other fields, cheaper solutions characterized also by lower maintenance costs. Moreover, for ETCS level 3, the train itself shall ensure that it is complete without resting on an integrity check provided by wayside devices. Therefore for modern train traffic management system, train completeness shall be ensured by trains instead of infrastructure like wayside devices. It becomes then challenging to provide train integrity for freight vehicles which have typically no power sources and for which the composition of a train can change frequently.

[0006] There is thus a need for a cheap and flexible solution that provides multiple units vehicle integrity for all kind of multi-unit vehicles. An objective of the present invention is therefore to propose a system and a method for ensuring completeness of a multi-unit vehicle that is cheap, easy to implement/install/reconfigure on any multi-unit vehicles and that uses little or no power.

[0007] The present invention proposes to use Radio-Frequency Identification (RFID) techniques and system for checking that a multi-unit vehicle, i.e. a vehicle comprising multiple units, e.g. N units, is complete or not.

[0008] The invention provides notably a system for ensuring completeness of a multi-unit vehicle comprising N units U_i, with i= 1,..., N, the vehicle units being successively named $U_1,...,U_N$, wherein U_1 is the first vehicle unit (for example the head-end vehicle unit), directly adjacent to the second vehicle unit U_2, which is also directly adjacent to the third vehicle unit U_3, ... , the vehicle unit U_{N-1} being directly adjacent to the vehicle units U_{N-2} and U_N (U_N being for example the tail-end vehicle unit), each vehicle unit U_j being therefore adjacent to a vehicle unit U_{j-1} and U_{j+1} with j = 2,..., N-1, the system comprising:

- at least N-1 RFID readers R_k and N-1 RFID tags T_k, with k = 1,...,N-1, the RFID readers being successively named for convenience $R_1,...,R_{N-1}$, and the RFID tags being successively named $T_1,...,T_{N-1}$, wherein the RFID reader R_k is configured for being mounted/installed on the vehicle unit $U_{i=k}$ and the RFID tag T_k is configured for being installed/mounted on the vehicle unit $U_{i=k+1}$ so that for each k the RFID tag T_k is able to exchange at least one data D_k with the RFID reader R_k only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than a predefined distance threshold d, said data D_k being thus correlated to the presence or absence of the vehicle unit $U_{i=k+1}$ and providing thus an information regarding the integrity/completeness of the multi-unit vehicle since no data D_k will be exchanged if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance greater than d, each RFID reader R_k being configured for providing a message M_k comprising information related to the reception or non-reception of the data D_k, i.e. to the presence or absence of the vehicle unit $U_{i=k+1}$. The message M_k may also comprise a reference number indicating on which vehicle unit the RFID reader R_k is mounted;
- an integrity controller configured for being mounted/installed on-board the multi-unit vehicle, preferentially in a cab of the multi-unit vehicle, for instance in an active cab of the multi-unit vehicle, wherein the integrity controller is configured for communicating with at least one RFID reader R_k for receiving said message M_k (in particular, the integrity controller mounted on-board the vehicle unit U_i is always at least able to communicate with the RFID reader mounted on-board the same vehicle unit U_i), the integrity controller being configured for determining a completeness of the multi-unit vehicle from the information contained in each message M_k he receives. In particular, the integrity controller may receive said information directly from the RFID readers R_k which sent the message M_k directly to the integrity controller or may receive said information indirectly.

In the latter case, said information is sent by at least one of the RFID readers R_k by means of the message M_k, wherein the message M_k also comprises information related to the reception or non-reception of at least one data $D_{z\neq k}$. Indeed, preferentially, each RFID reader $R_{z\neq k}$ may send the message M_z to at least another RFID reader which is able to incorporate the information related to the reception or non-reception of the data D_z into its own message, and wherein the at least another RFID reader may send its own message either to a subsequent RFID reader $R_{w\neq k}$, or to the integrity controller, wherein the subsequent RFID reader may behave as said another RFID reader.

[0009] The present invention also concerns a method for ensuring completeness/integrity of the multi-unit vehicle previously described, said multi-unit vehicle comprises said N units U_i with i= 1,..., N. The method according to the invention comprises:

- for each vehicle unit $U_{i=k}$, wherein k=1, ..., N-1, using a RFID reader R_k installed/mounted on the unit $U_{i=k}$ for checking a presence or absence of the unit $U_{i=k+1}$ by checking if at least one data D_k might be exchanged with/received from a RFID Tag T_k installed/mounted on the vehicle unit $U_{i=k+1}$, wherein notably said data D_k might be exchanged with/received by the RFID Reader R_k only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than a predefined distance threshold d;
- providing a message M_k by means of each RFID reader R_k wherein said message M_k comprises information related to the reception or non-reception of the data D_k;
- determining a completeness of the multi-unit vehicle from the information comprised in the message M_k provided, e.g. directly or indirectly provided, by each RFID reader R_k, said determination being in particular performed on-board the multi-unit vehicle by means of an integrity controller.

[0010] Finally, the present invention is also directed to a multi-unit vehicle as previously described and that comprises the system for ensuring completeness according to the invention, its units $U_{i=k}$ being equipped with the RFID reader R_k and its units $U_{i=k+1}$ being equipped with the RFID tag T_k, each pair of RFID reader R_k and RFID Tag T_k being installed/mounted on the respective vehicle units $U_{i=k}$ and $U_{i=k+1}$ so that they are able to exchange at least one data D_k only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than a predefined distance threshold d, the RFID reader R_k being configured for providing a message M_k to a integrity controller installed on-board the multi-unit vehicle which is itself configured for determining a completeness/integrity of the multi-unit vehicle from the message M_k that comprises information related to the reception or non-reception of the data D_k.

[0011] Preferentially, the integrity controller may control the integrity or completeness of the multi-unit vehicle by comparing the information related to the presence or absence of the vehicle units that he got through each message M_k he received with an initial information related to the initial configuration of the multi-unit vehicle. The initial information might be entered by an operator in a system of the multi-unit vehicle and stored in on-board storing means of the multi-unit vehicle and then read by the integrity controller connected to the multi-unit vehicle system, or might be stored by said operator directly in a memory of the integrity controller. Preferentially, the integrity controller is able to automatically determine the initial configuration of the multi-unit vehicle at a start of a mission by interacting with at least one RFID reader R_k in order to get said information comprised in each message M_k he receives and then to store in its memory said initial information related to the initial configuration of the multi-unit vehicle. Then, during the mission of the multi-unit vehicle, said integrity controller preferentially communicates with at least one of the RFID readers in order to receive said message M_k and controls if the information related to the presence or absence of a vehicle unit diverges from the initial information related to the initial configuration. In particular, in case of divergence, the multi-unit vehicle is able to send an alarm signal to the multi-unit vehicle system.

[0012] Optionally, at the start of a mission, each RFID reader stores in a memory, e.g. in own storing means, an information related to the absence or presence of at least one directly adjacent vehicle unit and then, during mission of the multi-unit vehicle, sends said message M_k to the integrity controller if and only if the RFID reader identifies a change in said information related to the absence or presence of at least one directly adjacent vehicle unit. In particular, in this case, the reception of the message M_k by the integrity controller may directly lead to a generation of an alarm signal by said integrity controller.

[0013] Further aspects of the present invention will be better understood through the following drawing, wherein like numerals are used for like and corresponding parts:

Figure 1 schematic representation of a top view (A) and a side view (B) of a preferred embodiment of a system according to the invention.

[0014] Figure 1 shows a preferred embodiment of a system according to the invention for ensuring completeness of a multi-unit vehicle 2 comprising N units U_i, with i= 1,..., N, the vehicle units being successively named U_1, ..., U_N, wherein U_1 is the first vehicle unit, for example the head-end vehicle unit, and U_N is the last vehicle unit, for example the tail-end vehicle unit. Each vehicle unit U_j being separated from an adjacent vehicle unit U_{j-1} and U_{j+1} with j = 2,..., N-1 by a distance d_{j-1} and respectively d_j, wherein the multi-unit vehicle is considered as complete if all the distances d_1, ..., d_{N-1} are smaller than a predefined threshold distance d, and the multi-unit vehicle is considered as being incomplete (for example because one of the unit couplings 21 broke) if at least one of said distances $d_1,...,d_{N-1}$ is greater than d.

[0015] For checking the integrity/completeness of the multi-unit vehicle 2, the present invention proposes to use a system comprising at least N-1 RFID Tags T_k and at least N-1 RFID readers R_k with k = 1,...,N-1, wherein each RFID tag T_k and RFID reader R_k are installed respectively on the unit $U_{i=k+1}$ and $U_{i=k}$ of the multi-unit vehicle 2 so as to be able to communicate with each other, notably for exchanging at least one data D_k. Preferentially, the RFID tags and readers are installed on part of vehicle units that faces parts of the other vehicles units. For example, the RFID tag T_k is installed on a part of the vehicle unit $U_{i=k+1}$ that faces a part on the vehicle unit $U_{i=k}$ where the RFID reader R_k is installed, so that they are able to communicate with each other as long as the distance d_k separating the vehicle unit $U_{i=k}$ from the vehicle unit $U_{i=k+1}$ is smaller or equal to d, said communication being broken or infeasible as soon as $d_k > d$.

[0016] In particular, according to the present invention, each vehicle unit between the first and the last vehicle unit is equipped with at least one RFID reader, preferentially two, and at least one RFID tag, preferentially two, while the first and the last vehicle units are either equipped with a RFID tag or with a RFID reader. Preferentially, the first and the last vehicle units might also be equipped with one RFID reader and one RFID tag in order to be able to communicate with a vehicle unit of another multi-unit vehicle equipped with RFID tag and/or RFID reader according to the invention and that might be coupled to the first or the last vehicle unit of the multi-unit vehicle according to the invention. In this case, a RFID tag or a RFID reader might be installed on/close to the front of the first vehicle unit and respectively on/close to the rear part of the last vehicle unit in order to be able to communicate with a RFID reader or tag of a vehicle unit of another multi-unit vehicle that might be coupled to the first or last vehicle unit.

[0017] Preferentially, the present invention also comprises equipping the vehicle unit $U_{i=k}$ with a RFID tag $T_{2,k}$ and the vehicle unit $U_{i=k+1}$ with a RFID reader $R_{2,k}$ wherein k = 1,...,N-1, the RFID readers being successively named for convenience $R_{2,1},..., R_{2,N-1}$, and the RFID tags being successively named $T_{2,1}, ...,T_{2,N-1}$, wherein the RFID reader $R_{2,k}$ is configured for being mounted/installed on the vehicle unit $U_{i=k+1}$ so as to be able to exchange at least one data $D_{2,k}$ with the RFID tag $T_{2,k}$ that is configured for being installed/mounted on the vehicle unit $U_{i=k}$ if and only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than the predefined distance threshold d, said data $D_{2,k}$ being, as D_k, correlated to the presence or absence of the vehicle unit $U_{i=k}$ and providing thus an information regarding the integrity/completeness of the multi-unit vehicle since no data $D_{2,k}$ will be exchanged if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance greater than d, each RFID reader R_k being configured for providing a message $M_{2,k}$ comprising information related to the reception or non-reception of the data $D_{2,k}$, i.e. information related to the presence or absence of the vehicle unit $U_{i=k}$. According to this preferred embodiment, each vehicle unit between the first and the last vehicle units is equipped with at least two RFID readers and at least two RFID tags, each RFID reader, respectively RFID tag, of a same vehicle unit being configured and installed for communicating with a RFID tag, respectively RFID reader, of a different vehicle unit. According to this preferred embodiment, the first and the last vehicle units are both equipped with one RFID tag and one RFID reader for communicating with the RFID tag/reader of the second vehicle unit and respectively of the penultimate vehicle unit. Of course, the first and the last vehicle units might also be equipped with an additional pair comprising one RFID tag and one RFID reader for checking the coupling of the first/last vehicle unit with a vehicle unit of another multi-unit vehicle. Advantageously, equipping a vehicle unit U_i with

- at least one RFID reader and at least one RFID tag configured for communicating respectively with a RFID tag and a RFID reader of an adjacent vehicle unit U_{i-1},
- at least one RFID reader and at least one RFID tag configured for communicating with respectively a RFID tag

and a RFID reader of another adjacent vehicle unit U_{i+1}, allows a determination/detection of the presence or absence of both vehicle units, i.e. said adjacent vehicle unit U_{i-1} and said other adjacent vehicle unit U_{i+1}, directly surrounding the vehicle unit. In particular, the RFID reader R_{k+1} and the RFID reader $R_{2,k}$ equipping a same vehicle unit U_{k+1} may communicate with each other for exchanging information regarding the presence or absence of the surrounding vehicle units U_k and U_{k+2}. According to the present invention, the cooperation and working of the RFID reader R_k, RFID tag T_k and integrity controller 11 apply mutatis mutandis to the RFID reader $R_{2,k}$ and RFID tag $T_{2,k}$ and the exchange of the message $M_{2,k}$ and the data $D_{2,k}$.

[0018] The present invention proposes to use known RFID techniques and devices for carrying out the system and method according to the invention. According to RFID techniques, a radio-frequency electromagnetic field is used by the RFID tag and the RFID reader to transfer data, in the particular case of the present invention, for transferring at least said data D_k, in order to automatically identify and/or track a RFID tag, e.g. T_k or respectively $T_{2,k}$, attached to an object, presently the vehicle unit $U_{i=k+1}$ or respectively $U_{i=k}$. In particular, depending on the power of the electromagnetic field, the distance at which the RFID reader is still able to identify a RFID tag might be tuned. It is thus possible to define for each RFID reader/tag said threshold distance d over which they will not be anymore capable of communicating with one another. Radio-frequency identification/tracking is done wirelessly and free of any contact between the RFID tag and the RFID reader. In particular, each RFID tag according to the invention comprises electronically stored information related to the vehicle unit on which it is or it has to be installed. According to the present invention, some or all RFID tags might be powered by and read at short ranges (a few meters) via a magnetic field (electromagnetic induction) generated by the RFID reader, and then act as a passive transponder to emit in return microwaves or UHF radio waves. Preferentially, some other or all RFID tags use a local power source such as a battery for generating the magnetic field and may operate at hundreds of meters.

[0019] Each RFID Tag according to the invention might be passive, active, or battery-assisted passive. They comprise in particular a circuit connected to an antenna configured for sending a signal to and receiving a signal from the RFID reader with which it cooperates. The signal sent by the RFID tag T_k to the RFID reader R_k might comprise in particular the data D_k and other relevant data related to the vehicle unit on which it is installed, and the signal sent by the RFID reader R_k to the RFID tag T_k might comprise data related to the vehicle unit on which the RFID reader is mounted. The circuit is at least able to store and process information/data transmitted by the RFID reader or that have to be transmitted to the RFID reader with which it cooperates, like the data D_k. Said circuit might be able to modulate and/or demodulate a radio-frequency signal sent to/by the RFID reader and/or to collect DC power from the electromagnetic field generated by the RFID reader.

[0020] Passive RFID tags according to the invention are free of any battery power supply. Their advantages are to be cheap and easy to be installed/ mounted on any vehicle unit due to their small size. Active RFID tags according to the invention have their own power supply used to supply energy to the circuit and to send periodically information to the RFID reader, notably said data D_k. Battery-assisted passive RFID tags according to the invention comprises a battery, but only send information to the RFID reader, e.g. the data D_k when they are activated by said RFID reader. Message send to reader is power by the reader antenna energy. The RFID tags according to the invention might be read-only tags, might have a factory-assigned serial number, or might be read/write tags where vehicle unit-specific data are stored in storing means of the circuit of the RFID tag.

[0021] Each RFID reader R_k according to the invention is able to read information stored in the storing means of the RFID tag T_k and/or to store information in the storing means of the RFID tag T_k. In particular, the RFID reader R_k according to the invention has Wireless Local Area Network (WLAN) capabilities and is therefore able to wirelessly communicate with another RFID reader of the system according to the invention, or with the integrity controller 11 which comprises in particular means for wirelessly communicating with at least one of the RFID reader R_k, R_{2k}.

[0022] Preferentially, each RFID reader R_k is capable to generate periodically or continuously a magnetic field for powering the RFID tag T_k. In response to said powering, the RFID tag T_k provides the RFID reader R_k with the data D_k that comprises for example an identification number of the vehicle unit $U_{i=k+1}$, and/or a timestamp. The RFID reader R_k is in particular able to generate a message M_k comprising either an information related to the reception of the data D_k, e.g. the identification number, or information related to a non-reception of the data D_k. According to a preferred embodiment, each message RFID reader directly send said message M_k to the integrity controller 11, for example by means of wireless communication like Wifi. According to another preferred embodiment, each RFID reader R_k may provide another RFID reader $R_{z\neq k}$ with the message M_k. Preferentially, each RFID reader $R_{z\neq k}$ receiving a message M_k from a RFID reader R_k is configured for reading said message M_k and incorporating to the message M_z in addition to the information related to the presence or absence of the vehicle unit $U_{i=z+1}$ any information related to the presence or absence of any vehicle unit $U_{i\neq z+1}$ that was comprised in the message M_k. In particular, any RFID reader R_p with j=2,...,N-2 may provide the next and/or previous RFID reader, i.e. R_{p+1} and/or R_{p-1}, with the message M_p. Preferentially, the RFID readers R_1 and R_{N-1} send their respective messages M_1 and M_{N-1} directly to the integrity controller 11 and/or only to the RFID readers M_2 and M_{N-2} respectively.

[0023] Preferentially, each RFID reader R_m with $m\neq 1$ and $m\neq N-1$ receiving a message $M_{z\neq m}$, wherein the message $M_{z\neq m}$ is in particular sent by a neighboring RFID reader, is configured for reading said message M_z and:

- optionally, directly forwarding said message M_z to the integrity controller 11 if the message M_z already comprises information about the presence or absence of the vehicle unit $U_{i=k+1}$; otherwise
- incorporating to the message M_k any information related to the presence or absence of any vehicle unit $U_{i\neq k+1}$ that was comprised in the message M_z in addition to the information related to the presence or absence of the vehicle unit $U_{i=k+1}$, and send the message M_k to the next/previous RFID reader;

  and

  the RFID readers R_1 and R_{N-1} being configured

  - for sending their respective messages M_1 and M_{N-1} directly to the integrity controller 11 if they respectively received a message M_2 and a message M_{N-2}, wherein the message M_1, respectively M_{N-1}, comprises any information related to the presence or absence of any vehicle unit $U_{i\neq 2}$, respectively $U_{i\neq N}$, that was comprised in the message M_2, respectively M_{N-2}, in addition to the information related to the presence or absence of the vehicle unit U_2, respectively U_N;

otherwise

- for sending their respective message M_1 and M_{N-1} to the RFID readers M_2 and M_{N-2} respectively.

[0024] Preferentially, the integrity controller 11 is configured for selecting among the RFID readers R_k a single RFID reader will first generate a message. Preferentially, the integrity controller orders the RFID reader R_1 or the RFID reader R_{N-1} to first generate a message M_1 or M_{N-1}. Preferentially, each RFID reader R_k generate a message M_k only if it has been selecting by the integrity controller 11 for being the first RFID reader to generate a message M_k or if it has received a message M_z from another RFID reader, in particular from a directly neighboring RFID reader.

[0025] According to the present invention, the integrity controller 11 may receive any message M_k directly from any RFID reader R_k, wherein preferentially each RFID reader R_k directly sends the message M_k to the integrity controller 11 by means of wireless communication. According to a preferred embodiment, the integrity controller 11 receives only messages comprising information related to the presence or absence of all vehicle units. Preferentially, it receives only the messages M_1 or M_{N-1}, wherein each of said messages M_1 or M_{N-1} comprises additional information related to the absence or presence of the vehicle unit $U_{i\neq 2}$ or $U_{i\neq N}$ by subsequent incorporation of information related to the presence or absence of a vehicle unit by each RFID reader R_k with $k\neq 1$ and $k\neq N-1$.

[0026] Preferentially, the integrity controller 11 is configured for automatically determining the configuration of the multi-unit vehicle 2 at a start of a mission by collecting the message M_k. Preferentially, the integrity controller 11 is able to store said configuration. In particular, the integrity controller 11 is able to determine said configuration, and notably the order of the vehicle units, from each reference number and each identification number received through each message M_k. Preferentially, during the whole mission of the multi-unit vehicle, the integrity controller receives each message Mk and update the multi-unit vehicle configuration. In particular, the integrity controller 11 is configured for checking any change of the configuration of the multi-unit vehicle 2 during the mission, notably by determining if at least one information related to an absence of a vehicle unit is comprised in a message M_k send by a RFID reader R_k. Preferentially, if at least one message M_k received by the integrity controller 11 comprises an information related to an absence of a vehicle unit, then the integrity controller 11 is configured for forwarding said information to an onboard equipment, notably in order to generate an alert.

[0027] According to another embodiment, the configuration determined by the integrity controller 11 might be validated or amended by an operator, or compared to a predefined configuration stored in a memory of the integrity controller or in on-board storing means of the multi-unit vehicle. Preferentially, only the configuration validated or amended by the operator is stored by the integrity controller 11 in its memory on in the on-board storing means, and used later for controlling if a change in the configuration happens or not. Preferentially, if the integrity controller 11 determined a configuration different from the predefined configuration, an alarm is generated by the integrity controller. In particular, the integrity controller 11 may trigger an alarm in the case of an absence of a reception of a message M_k from a RFID reader R_k when each RFID reader directly provides its message M_k to the integrity controller.

[0028] To summarize, the present invention proposes a simple system and method for ensuring the completeness/integrity of a vehicle comprising multiple/several units. Said system and method uses the RFID technology for determining a presence or absence of neighboring units in the multi-unit vehicle.

Claims

1. System for controlling completeness of a multi-unit vehicle (2) comprising N units U_i, with i= 1, ..., N, the system comprising:

- at least N-1 RFID readers R_k and N-1 RFID tags T_k, with k = 1,...,N-1, wherein the RFID reader R_k is configured for being installed on the vehicle unit $U_{i=k}$ and the RFID tag T_k is configured for being installed on the vehicle unit $U_{i=k+1}$ so that the RFID tag T_k and the RFID reader R_k are able to exchange at least one data D_k only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than a predefined distance threshold d, each RFID reader R_k being configured for providing a message M_k comprising information related to the reception or non-reception of the data D_k;
- an integrity controller (11) configured for being installed on-board the multi-unit vehicle (2), wherein the integrity controller (11) is configured for communicating with at least one RFID reader R_k for receiving said message M_k, the integrity controller (11) being configured for controlling the completeness of the multi-unit vehicle (2) from the information comprised in each message M_k he receives.

2. System according to claim 1, wherein the integrity controller (11) comprises a memory for storing an initial information related to an initial configuration of the multi-unit vehicle (2).

3. System according to claim 2, wherein the integrity controller (11) is configured for comparing the information comprised in the message M_k to the initial information for deducting a change of the multi-unit vehicle configuration.

4. System according to one of the claims 1-3, wherein at least one RFID reader R_k is.configured for providing its message M_k to another RFID reader.

5. System according to one of the claims 2-4, wherein the integrity controller (11) is configured for automatically determining the initial configuration of the multi-unit vehicle (2) from the information comprised in each message M_k.

6. System according to one of the claims 1-5 further comprising N-1 RFID readers $R_{2,k}$ and N-1 RFID tags $T_{2,k}$, wherein the RFID tag $T_{2,k}$ are configured for being installed on the vehicle unit $U_{i=k}$ and the RFID readers $R_{2,k}$ are configured for being installed on the vehicle unit $U_{i=k+}1$ so as to be able to exchange at least one data $D_{2,k}$ with each other if and only if the vehicle units $U_{i=k}$ and $U_{i=k+1}$ are separated by a distance smaller than the predefined distance threshold d.

7. System according to one of the claims 1 to 6, wherein each RFID reader R_k is configured for directly sending the message M_k to the integrity controller (11).

8. System according to one of the claims 1 to 7, wherein a least one RFID reader R_k is configured for incorporating to its message M_k information that was comprised in another message $M_{z \neq k}$ that he received.

9. Multi-unit vehicle (2) comprising the system for controlling its completeness according to one of the claims.

10. Multi-unit vehicle (2) according to claim 9, wherein the integrity controller (11) is configured for cooperating with a system of the multi-unit vehicle (2).

11. Method for controlling the completeness of a multi-unit vehicle (2) comprising N units U_i, with i= 1,...,N, the method comprising:

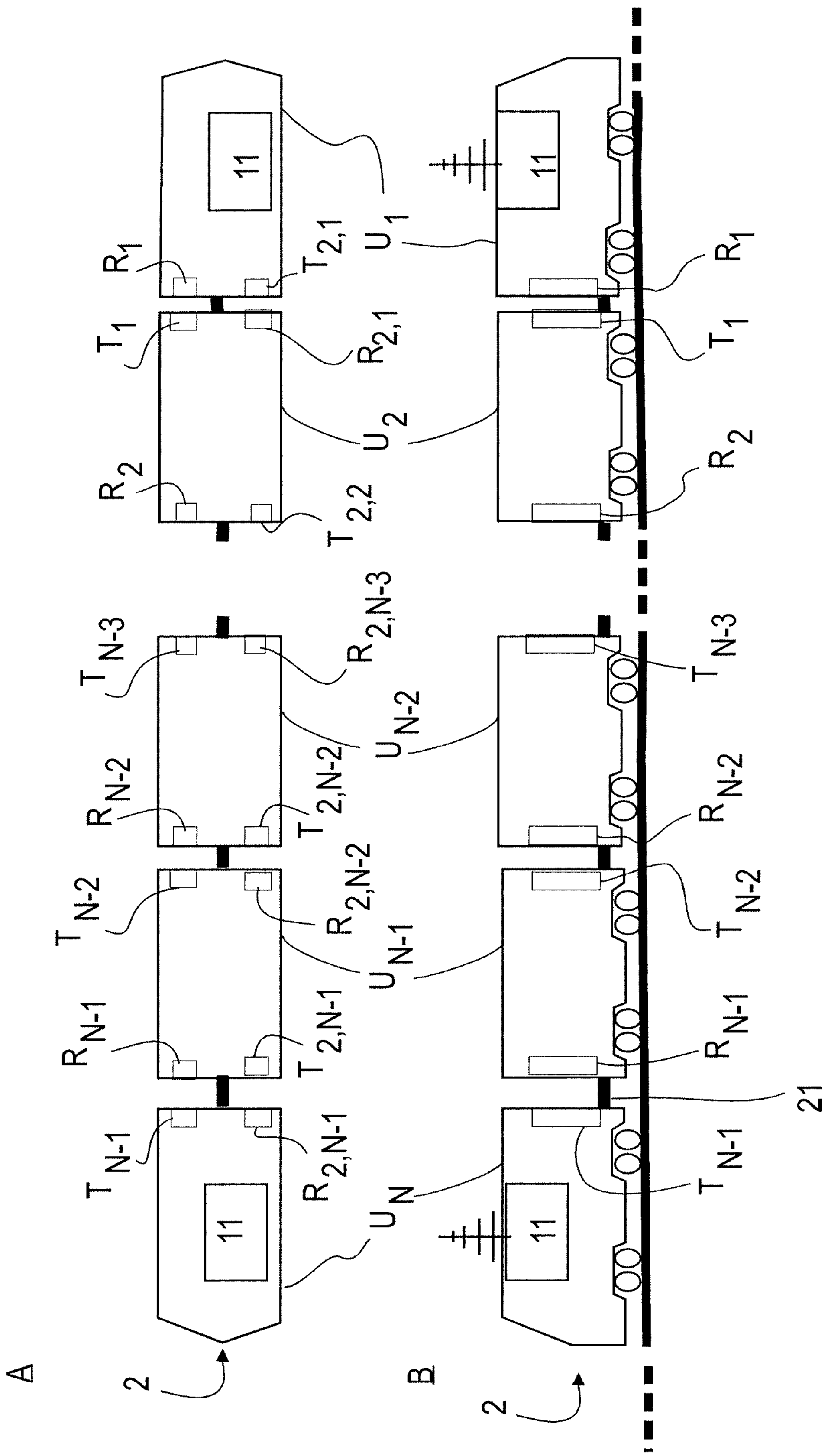
- for each vehicle unit $U_{i=k}$, wherein k=1, ..., N-1, using a RFID reader R_k installed on the unit $U_{i=k}$ for checking a presence or absence of the unit $U_{i=k+1}$ by checking if at least one data D_k might be exchanged with a RFID Tag T_k installed on the vehicle unit $U_{i=k+1}$;
- providing a message M_k by means of each RFID reader R_k wherein said message M_k comprises information related the presence or absence of the unit $U_{i=k+1}$;
- determining a completeness of the multi-unit vehicle (2) from the information comprised in the message M_k by means of an integrity controller (11).

12. Method according to claim 11, comprising automatically determining the initial configuration of the multi-unit vehicle (2) from the information comprised in each message M_k.

13. Method according to claim 12, comprising storing an initial information related to the initial configuration of the multi-unit vehicle (2).

14. Method according to one of the claims 11-13, comprising equipping the vehicle unit $U_{i=k}$ with a RFID tag $T_{2,k}$ and the vehicle unit $U_{i=k+1}$ with a RFID reader $R_{2,k}$ wherein k = 1, ..., N-1.

15. Method according to one of the claims 11-14, comprising providing the message M_k to another RFID reader.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U1
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T1
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TN-3
R2,N-3
RN-2
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R2,N-2
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T2,N-1
TN-1
R2,N-1
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FIG 1

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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
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