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(71) Applicant: **ALSTOM Holdings**
93400 Saint-Ouen-sur-Seine (FR)

(72) Inventors:
- **GINIS, Guillaume**
  6120 COUR-SUR-HEURE (BE)
- **DATH, Pierre-Alain**
  7033 CUESMES (BE)
- **DENAYER, Eric**
  7170 MANAGE (BE)

(74) Representative: **Lavoix**
2, place d'Estienne d'Orves
75441 Paris Cedex 09 (FR)

(54) METHOD FOR CONTROLLING A PLURALITY OF TRACK DEVICES AND RAILWAY CONTROL SYSTEM

(57) Method for controlling a plurality of track devices (14A, ... 14G) distributed along a railway track having a plurality of track sections, the method being implemented by a railway control system (4) comprising a plurality of local controllers (12A, ... 12G), each local controller (12A, ... 12G) controlling at least one of the track devices (14A, ... 14G), the railway control system (4) furthermore comprising a central data system (8) comprising a central database (16) memorizing, for each track section, a section state attribute (SEC) corresponding to a state of the track section, and subscription data (SUB) defining a specific subscription of each local controller (12A, ... 12G) for receiving a predetermined selection of the section state attribute(s) (SEC),
wherein the method comprises the steps of receiving at least one itinerary request for a railway vehicle intended to operate on the railway track, updating, transmitting, determining and modifying.

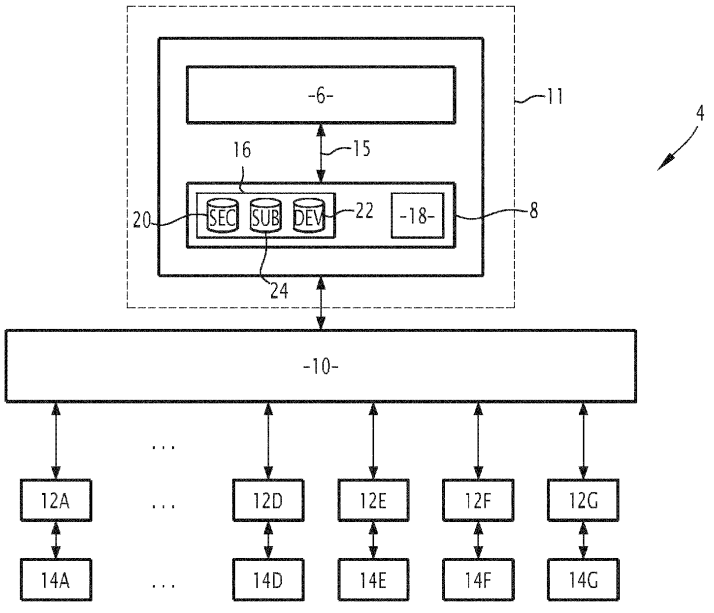

FIG.2

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Description

[0001] The present invention concerns a method for controlling a plurality of track devices distributed along a railway track.

[0002] The present invention furthermore concerns a railway control system.

[0003] Conventionally, railway control systems comprise a central interlocking system which is configured for processing requests received from a train control system (TCS) or train management system (TMS), and to transmit commands to trackside equipment which executes these commands upon reception. For example, if a light signal receives a command to switch to green, the signal turns green if it receives such command.

[0004] Such control systems rely on correct operation of the central interlocking system. In case of breakdown or failure of the central interlocking system, the trackside equipment passes for example in a safety mode, such as a red light for the case of a light signal form the equipment, not allowing any railway vehicle to pass.

[0005] Furthermore, in case of modification, such as adding or removal of trackside equipment, operation of the central interlocking system is interrupted in order to modify for example determination logics in the central interlocking system in view of the modified equipment. During the interruption, the railway control system is inoperative, so that no railway vehicles are authorized to circulate on railway track controlled by the system, or such railway vehicles use a secondary fall back control system.

[0006] These solutions are not entirely satisfactory. An aim of the present disclosure is thus to overcome, at least partially, the above-mentioned drawbacks.

[0007] In particular, an aim of the present disclosure is to obtain a method for controlling a plurality of track devices and a control system, which allow reducing data exchanges.

[0008] To that end, the present disclosure concerns a method for controlling a plurality of track devices distributed along a railway track having a plurality of track sections, the method being implemented by a railway control system comprising a plurality of local controllers, each local controller controlling at least one of the track devices, the railway control system furthermore comprising a central data system comprising a central database memorizing, for each track section, a section state attribute corresponding to a state of the track section, and subscription data defining a specific subscription of each local controller for receiving a predetermined selection of the section state attribute(s).

[0009] The method comprises the steps of:

- receiving, by the central data system, at least one itinerary request for a railway vehicle intended to operate on the railway track, the itinerary request comprising a start point and end point connected via at least one of the track sections,
- updating the central database by the central data system, comprising updating the at least one section state attribute of the at least one track section connecting the start point and the end point, so as to obtain at least one updated section state attribute,
- transmitting, by the central data system, the at least one updated section state attribute only to the local controller(s) among the plurality of local controllers which have subscribed to the updated section state attribute according to the subscription data,
- determining, by the local controller having subscribed to the updated section state attribute, a command for modifying a current state of the track device controlled by said local controller in function of the updated section state attribute, the command being determined by applying the updated section state attribute to a set of predetermined decision rules specific to the local controller,
- modifying the current state of said track device according to the determined command.

[0010] The method allows reducing data exchanges between the central data system and the local controllers thanks to transmission of the corresponding section state attributes only to the local controllers which have subscribed to these section state attributes.

[0011] Also, for example no commands are transmitted from the central data system to the local controllers, as such commands are determined locally by the local controllers by applying the updated section state attribute(s) to the set of predetermined decision rules specific to the local controller. In particular, instead of commands, according to the present disclosure, the updated section state attributes are transmitted, and a corresponding command is determined by each local controller itself. This also allows reducing the amount of data to be transmitted.

[0012] Further embodiments may relate to one or more of the following features, which may be combined in any technical feasible combination:

- the central database furthermore memorizes, for each track device, at least one device state attribute corresponding to the current state of the track device;
- the step of receiving furthermore comprises receiving, from one of the local controllers, at least one device state attribute modified by one of the local controllers, called modified device state attribute;
- the step of updating furthermore comprises updating the central database with the modified device state attribute;
- the subscription data furthermore defines a specific subscription of each local controller for receiving a predetermined selection of the device state attribute(s);
- the step of transmitting furthermore comprises transmitting the modified device state attribute only to the local controller(s) among the plurality of local con-

trollers which have subscribed to the modified device state attribute according to the subscription data;

- the method comprises furthermore a step of reconfiguration of the central database, wherein in case of a removal or adding of one of the local controllers from the central data system, called modifying local controller, the central data system modifies, in the central database, only the subscription data related to the modifying local controller and/or the or each device state attribute of the track device controlled by said modifying local controller, the step of reconfiguration being implemented in particular during operation of the railway vehicle on one of the track sections other than the track section controlled by said modifying local controller;
- during the step of determining, the command is furthermore determined by applying, to the set of predetermined decision rules, the device state attribute(s) to which the local controller has subscribed to, according to the subscription data, in order to take into account said device state attribute(s);
- each device state attribute is an attribute chosen from: a light color of a signal, a position of a switch point, a number of counted axles, a position of a level crossing barrier, and an occupation state of a track circuit;
- the step of updating comprises transforming a plurality of itinerary requests into the updated section state attribute(s) to be memorized in the central database so as to allow operation of a plurality of railway vehicles on the railway track, preferably depending on a reception order of the itinerary requests;
- during the step of transmitting, at least the at least one updated section state attribute is transmitted by power-line communication via an electrical cable to the local controller(s), said electrical cable preferably providing electrical power to at least one of the track devices;
- the method comprises furthermore a step of transmitting, by each local controller, a keep alive signal to the central data system, indicating an operative connection of the local controller to the central data system;
- each track device is chosen from a switch point, a track circuit, an axle counter, a light signal, and a level crossing;
- each section state attribute is an attribute chosen from: section is occupied, section is clear of railway vehicles, section is reserved for itinerary, section out of service, construction work in section, and section is set corresponding to a track section being validated for operation of the railway vehicle on that section;
- the step of transmitting is implemented by a virtual private network between the central data system and the plurality of local controllers.

[0013] The present disclosure further relates to a railway control system for controlling a plurality of track devices distributed along a railway track having a plurality of track sections, the railway control system comprising:

- a plurality of local controllers, each local controller being configured for controlling at least one of the track devices,
- a central data system comprising a central database configured for memorizing, for each track section, a section state attribute corresponding to a state of the track section, and subscription data defining a specific subscription of each local controller for receiving a predetermined selection of the section state attribute(s).

[0014] The central data system is configured for:

- receiving at least one itinerary request for a railway vehicle intended to operate on the railway track, the itinerary request comprising a start point and end point connected via at least one of the track sections,
- updating the central database, wherein the updating comprises updating the at least one section state attribute of the at least one track section connecting the start point and the end point, so as to obtain at least one updated section state attribute,
- transmitting the at least one updated section state attribute only to the local controller(s) among the plurality of local controllers which have subscribed to the updated section state attribute according to the subscription data.

[0015] The local controller having subscribed to the updated section state attribute is configured for determining a command for modifying a current state of the track device controlled by said local controller in function of the updated section state attribute, the command being determined by applying the updated section state attribute to a set of predetermined decision rules specific to the local controller, so as to modify the current state of said track device according to the determined command.

[0016] These features and advantages of the present disclosure will be further explained in the following description, given only as a non-limiting example, and with reference to the attached drawings, wherein:

- figure 1 is a schematic view of an example of a portion of a railway infrastructure comprising a railway track and a railway control system according to the present disclosure;
- figure 2 is a schematic view showing details of the railway control system of figure 1;
- figure 3 is a schematic view of a local controller of the railway control system of figure 1;
- figure 4 is flowchart of an example of a method according to the present disclosure, implemented by the railway control system of figure 1.

[0017] With reference to figures 1 and 2, a railway in-

frastructure 1 comprises a railway track 2 and a railway control system 4.

[0018] The railway track 2 comprises a plurality of track sections T1, T2, T3, T4, T5, T6, T7, T8 each defining a part of the track to be controlled. This plurality of track sections is designated by T1 to T8 hereafter. For example, each track section T1 to T8 is defined such that at maximum one railway vehicle, not shown, is authorized to circulate in the corresponding track section T1 to T8.

[0019] The railway control system 4 is configured for controlling the safe operation of the railway vehicle(s) circulating on the railway track 2.

[0020] The railway control system 4 comprises for example a train management system 6, a central data system 8, a communication network 10, a plurality of local controllers 12A, 12B, 12C, 12D, 12E, 12F, 12G and a plurality of track devices 14A, 14B, 14C, 14D, 14E, 14F, 14G distributed along the railway track 2 so as to control the circulation of the railway vehicle along an itinerary according to an itinerary request.

[0021] The itinerary comprises a start point and an end point on the railway track 2, connected via at least one of the track sections T1 to T8. The itinerary request defines a reservation for the itinerary.

[0022] According to an example, the itinerary request comprises only the start point and the end point. In this case, the central data system 8 is configured for determining the track section(s) T1 to T8 connecting the start and end point, for example according to predetermined determination rules.

[0023] According to another example, the itinerary request comprises, in addition to the start point and the end point, the specific track section(s) T1 to T8 connecting the start and end point.

[0024] According to embodiments, the train management system 6 is configured for interfacing with the central data system 8.

[0025] For example, the train management system 6 is distant from the other elements of the railway control system 4.

[0026] According to another example, the train management system 6 and the central data system 8 are positioned together in a same building, such as a same control room 11.

[0027] The train management system 6 is also called train control system. The train management system 6 comprises for example at least one computer configured for executing logical operations.

[0028] The train management system 6 is configured for generating one or several itinerary requests and for transmitting the itinerary request(s) via a data connection 15 to the central data system 8.

[0029] The central data system 8 comprises a central database 16 and a database controller 18 configured for sending requests to the central database 16 in order to modify data in the central database 16.

[0030] The central data system 8 is configured for communicating, via the communication network 10, with each local controller 12A, ... 12G.

[0031] The communication network 10 comprises for example at least one electrical cable and associated communication equipment, not shown, configured for implementing power-line communication via the electrical cable between the central data system 8 and each local controller 12A, ... 12G. For example, the electrical cable is configured for providing electrical power to at least one of the track devices 14A, ... 14G.

[0032] The implementation of power-line communication allows using the same electrical cable for data communication and for providing electrical power. This allows in particular simplifying the railway control system 4.

[0033] In addition or according to an alternative, the communication network 10 comprises one or several data cable(s), such as a fiber optic cable and/or a copper cable.

[0034] In addition or according to an alternative, the communication network 10 comprises a wireless data connection.

[0035] According to an example, the communication network 10 forms a virtual private network (or VPN) for communication between the central data system 8 and the plurality of local controllers 12A, ... 12G.

[0036] The VPN allows improving data and communication safety. In particular, the VPN allows guaranteeing the integrity of transmitted data, so as to avoid modification of transmitted data by a third party, for example by an intervention along the railway track 2. In addition, the VPN allows guaranteeing data authenticity, for example by obtaining a certification indicating that a data packet is emitted from the central data system 8 or a specific local controller 12A, ... 12G.

[0037] Each local controller 12A, ... 12G is configured for controlling at least one of the track devices 14A, ... 14G. For example, each local controller 14A, ... 14G is configured for controlling only one track device 14A, ... 14G. According to another example at least one local controller 12A, ... 12G is configured for controlling a plurality of track devices 14A, ... 14G.

[0038] In the example of figure 1, the local controller 12A is configured for controlling the track device 14A, the local controller 12B is configured for controlling the track device 14B, and so on.

[0039] According to embodiments, each track device 14A, ... 14G is distant form the other elements of the railway control system 4. In particular, each track device 14A, ... 14G is configured for interfacing with the central data system 8 via the corresponding local controller 12A, ... 12G and the communication network 10.

[0040] According to an example, each track device 14A, ... 14G is part of the railway track 2 and in particular not part of the railway control system 4.

[0041] Each track device 14A, ... 14G comprises an actuator, a sensor and/or a signaling element configured for controlling safe operation of the railway vehicle on the railway track 2.

[0042] For example, each track device 14A, ... 14G is

chosen from a switch point, a track circuit, an axle counter, a light signal and a level crossing.

[0043] With reference to the example of figure 1, each of the track devices 14A, 14B, 14C and 14D is a light signal, and each of the track devices 14E, 14F and 14G is a switch point.

[0044] The central database 16 is described in the following in more detail.

[0045] The central database 16 comprises for example a first partition 20, a second partition 22 and a third partition 24.

[0046] The first partition 20 is configured for memorizing, for each track section T1 to T8, a section state attribute SEC corresponding to a state of the track section T1 to T8.

[0047] By "section state attribute", it is understood a state, such as a condition or status, of the track section T1 to T8 concerning the permission of a railway vehicle to circulate in this track section.

[0048] Each section state attribute SEC is for example an attribute chosen from: section is occupied, section is clear of railway vehicles, section is reserved for itinerary, section out of service, construction work in section, and section is set, which corresponds to a section being validated for operation of the railway vehicle on that section.

[0049] According to an example, each section state attribute SEC is an attribute received from the database controller 18 further to an itinerary request.

[0050] The second partition 22 is configured for memorizing, for each track device 14A, ... 14G, at least one device state attribute DEV corresponding to a current state of the track device 14A, ... 14G.

[0051] For example, the device state attribute DEV defines an entry condition into the track section T1 to T8 controlled by the track device 14A, ... 14G associated to this device state attribute DEV.

[0052] Each device state attribute DEV is for example an attribute chosen from: light color of a signal, position of a switch point, number of counted axles, position of a level crossing barrier, occupation state of a track circuit.

[0053] According to an example, each section state attribute SEC is an attribute being computed by a value of the device state attribute(s) DEV corresponding to the track device(s) 14A, ... 14G of the itinerary.

[0054] The third partition 24 is configured for memorizing subscription data SUB defining a specific subscription of each local controller 12A, ... 12G for receiving a predetermined selection of the section state attribute(s) SEC.

[0055] The subscription data SUB defines in particular a rule defining which section state attribute(s) is/are to be transferred to a given local controller 12A, ... 12G.

[0056] By "specific subscription of each local controller 12A, ... 12G", it is understood that the corresponding local controller 12A, ... 12G is configured for receiving, in case of a modification or update of a section state attribute SEC or a device state attribute DEV, this modified or updated attribute only if this local controller 12A, ... 12G has subscribed to this attribute.

[0057] For example, the subscription data SUB defines, for a given local controller 12A, ... 12G, a subscription to the section state attribute SEC of the track section T1 to T8 having the track device 14A, ... 14G controlled by the local controller 12A, ... 12G, and optionally to the section state attribute(s) of neighboring track sections T1 to T8.

[0058] With reference to figure 1, the subscription data SUB for local controller 12C comprises for example a subscription to the section state attributes SEC of track sections T7 and T8. The subscription data SUB for local controller 12E comprises for example a subscription to the section state attributes SEC of track sections T2, T4 and T6.

[0059] According to an example, the subscription data SUB furthermore defines a specific subscription of each local controller 12A, ... 12G for receiving a predetermined selection of the device state attribute(s) DEV.

[0060] For example, the subscription data SUB for a specific local controller 12A, ... 12G comprises a subscription to device state attributes DEV of neighboring track devices 14A, ... 14G, such as state devices 14A, ... 14G of the same track section T1 to T8 or an adjacent track section T1 to T8.

[0061] As an example, with reference to figure 1, the subscription data SUB for local controller 12D comprises a subscription to the device state attributes DEV of the track device 14A and of the track device 14F.

[0062] An example of the local controller 12A is described with reference to figure 3. According to an example, one or several of the other local controllers 12B, ... 12G are similar or identical to the local controller 12A.

[0063] The local controller 12A comprises an input communication module 26 configured to be connected to the central data system 8 via the communication network 10, a processing module 28 and at least one output communication module 30A, 30B, 30C, 30D, for example one output communication module. In the example of figure 3, the local controller 12A comprises four output communication modules 30A, 30B, 30C, 30D.

[0064] The input communication module 26 comprises for example an interface to connect to the electrical cable of the communication network 10 so as to implement power-line communication.

[0065] In addition or according to an alternative, the input communication module 26 comprises a Small Form-factor Pluggable module (or SFP module) so as to implement communication via a fiber optic cable.

[0066] In addition or according to another alternative, the input communication module 26 is configured for implementing communication according to the Ethernet protocol via communication network 10.

[0067] The processing module 28 comprises for example an electronic board configured to implement a set of predetermined decision rules specific to the local controller 12A.

[0068] For example, the processing module 28 com-

prises a memory configured for memorizing the predetermined decision rules and at least one processor configured for executing the decision rules.

[0069] According to another example, the processing module 28 is implemented at least partially as a Field Programmable Gate Array (or FPGA) or as an integrated circuit, such as an Application Specific Integrated Circuit or ASIC configured to execute the predetermined decision rules.

[0070] The predetermined decision rules comprise for example the same generic rules for each type of track device 14A, ... 14G, for example the same generic rules are implemented for each light signal.

[0071] The fact that the predetermined decision rules comprise the same generic rules for each type of track device 14A, ... 14G allows in particular integrating new track devices easily and fast.

[0072] Each predetermined decision rule comprises input variables, such as specific section state attribute(s) SEC and/or specific device state attribute(s) DEV and output variables which comprise at least one command for one of the track devices 14A, ... 14G, determined in function of the input variables.

[0073] The processing module 28 is for example configured for satisfying the Safety Integrity Level 4 (or SIL 4).

[0074] Each output communication module 30A, 30B, 30C, 30D is configured for being connected respectively to at least one track device 14A, ... 14G, in order to exchange data with the corresponding track device(s). For example, each output communication module 30A, 30B, 30C, 30D to emit the command to the corresponding track device 14A, ... 14G and to receive a state of the track device 14A, ... 14G via connections 31.

[0075] A method 100 for controlling the track devices 14A, ... 14G will now be described. The method 100 is implemented by the railway control system 4.

[0076] The method 100 comprises a generating step 110, a receiving step 112, an updating step 114, a transmitting step 116, a determining step 118, a modifying step 120, an emitting step 122 and a reconfiguration step 124.

[0077] Furthermore, the method 100 comprises for example an additional transmitting step 126 and an authorizing step 128.

[0078] At least one of the steps 110, 122, 124, 126 and 128 is an optional step.

[0079] During the generating step 110, the train management system 6 generates one or several itinerary requests and transmits the itinerary request(s) to the central data system 8 via the data connection 15.

[0080] During the receiving step 112, the central data system 8 receives the itinerary request(s).

[0081] According to an example, during the receiving step 112, the central data system 8 receives furthermore, from one of the local controllers 12A, ... 12G, at least one device state attribute DEV modified by one of the local controllers 12A, ... 12G, called modified device state attribute DEV. In particular, the central data system 8 receives the modified device state attribute DEV further to the emitting step 122 or the reconfiguration step 124. The transmission of the modified device state attribute DEV further to step 122 or 124 is for example illustrated in figure 4 by a loop L.

[0082] During the updating step 114, the central data system 8 updates the central database 16. The central data system 8, and in particular the database controller 18, updates at least one of the section state attributes SEC, so as to obtain at least one updated section state attribute SEC.

[0083] In particular, the database controller 18 updates all the section state attributes SEC of the track sections T1 to T8 which are comprised in the itinerary request, for example by modifying each of these section state attributes SEC into "section is reserved for itinerary".

[0084] If one of the track sections T1 to T8 to be reserved comprises the attribute SEC "construction work in section", "section out of service" or "section is occupied", the database controller 18 updates for example the attribute SEC of an alternative track section T1 to T8 for obtaining the requested itinerary if such alternative track section T1 to T8 exists.

[0085] According to an example, the database controller 18 updates the first partition 20 so as to generate a waiting list comprising update items for the respective track section T1 to T8. Each update item corresponds to an input used for determination of the attribute SEC in function of the itinerary request. For example, one update item for an itinerary request number 801 comprises the information according to which the section is to be reserved for itinerary 801.

[0086] If the central data system 8 receives, during the receiving step 112, at least one modified device state attribute DEV, the updating step 114 furthermore comprises updating the central database 16 with the modified device state attribute DEV. In particular, the database controller 18 replaces the corresponding device state attribute DEV in the central database 16 with the modified device state attribute DEV.

[0087] If the central data system 8 receives, during the receiving step 112, a plurality of itinerary requests, the updating step 114 furthermore comprises transforming the plurality of itinerary requests into the updated section state attribute(s) SEC to be memorized in the central database 16 so as to allow operation of a plurality of railway vehicles on the railway track 2. For example, the database controller 18 updates the section state attribute(s) SEC depending on a reception order of the itinerary requests.

[0088] During the transmitting step 116, the central data system 8 transmits the updated section state attribute(s) SEC only to the local controller(s) 12A, ... 12G among the plurality of local controllers which have subscribed to the updated section state attribute SEC according to the subscription data SUB.

[0089] In particular, the central data system 8 does not transmit the updated section state attribute(s) SEC to the

local controller(s) 12A, ... 12G which have not subscribed to this attribute SEC.

[0090] If the updating step 114 comprises updating the central database 16 with the modified device state attribute DEV, the transmitting step 116 furthermore comprises transmitting the modified device state attribute DEV only to the local controller(s) 12A, ... 12G among the plurality of local controllers 12A, ... 12G which have subscribed to the modified device state attribute DEV according to the subscription data SUB.

[0091] The transmitting step 116 is for example implemented by transmission via the electrical cable by power-line communication between the central data system 8 and the local controller(s) 12A, ... 12G. For example, the updated section state attribute(s) SEC and/or the modified device state attribute(s) DEV is/are transmitted by power-line communication.

[0092] According to an example, the transmitting step 116 is implemented by the virtual private network between the central data system 8 and the plurality of local controllers 12A, ... 12G.

[0093] During the determining step 118, the or each local controller 12A, ... 12G having subscribed to the updated section state attribute SEC, determines a command for modifying the current state of the track device(s) 14A, ... 14G controlled by this local controller 12A, ... 12G in function of the updated section state attribute SEC. The local controller 12A, ... 12G applies the updated section state attribute SEC to the set of predetermined decision rules specific to the local controller 12A, ... 12G so as to obtain the command.

[0094] According to an example, the local controller 12A, ... 12G determines the command furthermore by applying, to the set of predetermined decision rules, the device state attribute(s) DEV to which the local controller 12A, ... 12G has subscribed to, according to the subscription data SUB in order to take into account this or these device state attribute(s) DEV. In particular, the local controller 12A, ... 12G determines the command by applying the modified device state attribute(s) to which it has subscribed to.

[0095] For example, the local controller 12A, ... 12G determines the command by applying both the updated section state attribute(s) SEC and the modified device state attribute(s) to which it has subscribed to, to the set of predetermined decision rules.

[0096] During the modifying step 120, the or each track device 14A, ... 14G modifies its state according to the determined command received from the local controller 12A, ... 12G.

[0097] During the emitting step 122, the or each track device 14A, ... 14G emits its modified state to the local controller 12A, ... 12G which transforms the modified device state attribute DEV corresponding to the modified state of the local controller 12A, ... 12G to the central data system 8. Preferably, in this case, the central data system 8 implements the receiving step 112, and the updating step 114 so as to update the central database 16 with the modified device state attribute DEV.

[0098] The reconfiguration step 124 is preferably implemented in case of a removal or an adding of one of the local controllers 12A, ... 12G from the central data system 8. This local controller 12A, ... 12G is called modifying local controller.

[0099] By "removal", it is understood that the corresponding local controller 12A, ... 12G is operationally separated from the railway control system 4, for example by an operator, further to a reconfiguration of the railway infrastructure 1.

[0100] In particular, the expression "removal" is different from an unintended disconnection for example in the case of a loss of communication between the local controller 12A, ... 12G and the communication network 10.

[0101] By "adding", it is understood that the corresponding local controller 12A, ... 12G is added to the railway control system 4, for example by an operator, further to a reconfiguration of the railway infrastructure 1. During the reconfiguration step 124, the central data system 8 modifies, in the central database 16, only the subscription data SUB related to the modifying local controller 12A, ... 12G and/or the or each device state attribute DEV of the track device 14A, ... 14G controlled by the modifying local controller 12A, ... 12G.

[0102] Preferably, the step of reconfiguration 124 is implemented during operation of a railway vehicle on one of the track sections T1 to T8 other than the track section controlled by the modifying local controller 12A, ... 12G.

[0103] For example, the step of reconfiguration 124 is implemented without any modification of the subscription data SUB related to the local controllers 12A, ... 12G other than the modifying local controller 12A, ... 12G.

[0104] The reconfiguration step 124 allows to easily add new track devices 14A, ... 14G or to easily remove track devices 14A, ... 14G, as preferable the other railway sections T1 to T8 continue to be controlled by the respective local controllers 12A, ... 12G during the reconfiguration step 124.

[0105] The additional transmitting step 126 and the authorizing step 128 are preferably implemented subsequently to the updating step 114. For example, after at least one sequence of subsequent implementation of the steps 110 to 122, the steps 112 and 114 are implemented, so as to update the central database 16 and subsequently the additional transmitting step 126 and the authorizing step 128 are implemented.

[0106] During the additional transmitting step 126, the central data system 8 transmits a signal to the train management system 6 indicating that, according to the device state attribute(s) DEV in the central database 16, the itinerary request(s) generated previously by train management system 6 is ready to be traveled by the railway vehicle. This is for example the case if all device state attribute(s) DEV in track sections T1 to T8 of the itinerary corresponding to the itinerary request are such that the itinerary can be implemented, such as the light(s) of light signals is/are in a predetermined color allowing the im-

plementation of the itinerary, such as green or orange, the switch point(s) is/are in the corresponding position, etc.

[0107] During the authorizing step 128, the train management system 6 transmits to the railway vehicle a signal authorizing the vehicle to run along the requested itinerary, for example if each track section state attribute SEC of the track section T1 to T8 implementing the requested itinerary are in the state "section is set".

[0108] According to an example, the method 100 furthermore comprises a step of transmitting, by each local controller 12A, ... 12G, a keep alive signal to the central data system 8. Each keep alive signal indicates in particular the operative connection of the corresponding local controller 12A, ... 12G to the central data system 8. This step is not shown in the flowchart of figure 4. In particular, each local controller 12A, ... 12G transmits a specific keep alive signal in a predetermined time interval, in particular independently from the execution of the other steps of the method 100.

[0109] According to an example, the method 100 is implemented in an event-based manner. For example, each step 110 to 128 is implemented as a consequence of the previous step, in particular in the order 110-112-114-116-118-120-122(-124)-
112-114-126-128, wherein step 124 is in particular optional.

[0110] An illustrating example of the method 100 is now described with reference to figures 1 and 4.

[0111] During the determining step 110, the train management system 6 generates the itinerary request from light signal 14A to light signal 14C via track sections T1, T3, T5 and T7.

[0112] During the receiving step 112, the central data system 8 receives this itinerary request.

[0113] During the updating step 114, the central data system 8 updates the section state attributes SEC of track sections T1, T3, T5 and T7 to "section is reserved for itinerary".

[0114] During the transmitting step 116, the central data system 8 transmits the updated section state attribute(s) SEC of track sections T1, T3, T5 and T7 to the local controllers 12A, 12D, 12F, 12G and 12C only, because these local controllers have subscribed to the attributes SEC of track sections T1, T3, T5 and T7 for example.

[0115] During the determining step 118, the local controller 12A determines the command modifying the current state of the light signal 14A to a predetermined color indicating the itinerary is to be implemented, such as orange, the local controller 12D determines the command to modify the current state of the light signal 14D to orange, the local controller 12F determines the command to modify the current state of the switch point 14F so as to connect sections T3 and T5, the local controller 12G determines the command to modify the current state of the switch point 14G so as to connect sections T5 and T7 and the local controller 12C so that the light signal 14C stays for example red so as to mark the end of the itinerary.

[0116] During the modifying step 120, the track devices 14A, 14D, 14F and 14G modify their current state according to the command, e.g. the light signal 14A turns to orange.

[0117] During the emitting step 122, the track devices 14A, 14D, 14F and 14G emit their modified state to the corresponding local controller 12A, 12D, 12F, 12G, e.g. the light signal 14A transmits the state "orange" to the local controller 12A.

[0118] During the receiving step 112, subsequently implemented according to the present example, the central data system 8 receives the modified device state attribute DEV of local controllers 12A, 12D, 12F and 12G corresponding to the state attributes of the track devices 14A, 14D, 14F and 14G and updates the central database during the subsequent updating step 114 in particular with the modified device state attribute DEV. For example, during the subsequent implementation of the updating step 114, the central data system 8 updates the section state attributes SEC of track sections T1, T3, T5 and T7 to "section is set", in particular if the modified device state attribute(s) DEV are in a state allowing the implementation of the requested itinerary, such as the switch points are in the corresponding position.

[0119] The state "section is set" indicates in particular that the sections T1, T3, T5 and T7 are validated for operation of the railway vehicle on these sections.

[0120] During the additional transmitting step 126, the central data system 8 transmits the signal to the train management system 6 indicating that the itinerary from track device 14A to track device 14C is ready to be implemented.

[0121] During the authorizing step 128, the train management system 6 transmits to the railway vehicle the signal authorizing the vehicle to run the itinerary from track device 14A to 14C.

[0122] The method for controlling 100 and the railway control system 4 present many advantages.

[0123] In particular, the method for controlling 100 and the control system 4 allow reducing data exchanges, because the attributes SEC, DEV are only transmitted to some of the local controllers 12A, ... 12G, according to the subscription data SUB.

[0124] Also, thanks to the event-based communication of the method 100, i.e. a transmission only in case of updated attributes SEC, DEV, the amount of data to be transmitted is further reduced and/or simplified. The event-based communication is in particular advantageous compared to a method in which data concerning track sections is transmitted in a cyclical way, i.e. in predetermined time steps, because for example the number of messages is reduced according to the method 100.

[0125] Also, the method and system according to the present disclosure allow obtaining a high availability time of the control of the railway track 2. For example, in case of modification of one or more local controllers 12A, ...

12G, called modifying local controller(s), the track sections T1 to T8 controlled by local controllers 12A, ... 12G other than the modifying controller(s) remain operational, as the central data system 8 is not interrupted during modification of the local controller(s) 12A, ... 12G.

Claims

1. Method (100) for controlling a plurality of track devices (14A, ... 14G) distributed along a railway track (2) having a plurality of track sections (T1 to T8), the method (100) being implemented by a railway control system (4) comprising a plurality of local controllers (12A, ... 12G), each local controller (12A, ... 12G) controlling at least one of the track devices (14A, ... 14G), the railway control system (4) furthermore comprising a central data system (8) comprising a central database (16) memorizing, for each track section (T1 to T8), a section state attribute (SEC) corresponding to a state of the track section (T1 to T8), and subscription data (SUB) defining a specific subscription of each local controller (12A, ... 12G) for receiving a predetermined selection of the section state attribute(s) (SEC), wherein the method (100) comprises the steps of:

   - receiving (112), by the central data system (8), at least one itinerary request for a railway vehicle intended to operate on the railway track (2), the itinerary request comprising a start point and end point connected via at least one of the track sections (T1 to T8),
   - updating (114) the central database (16) by the central data system (8), comprising updating the at least one section state attribute (SEC) of the at least one track section (T1 to T8) connecting the start point and the end point, so as to obtain at least one updated section state attribute (SEC),
   - transmitting (116), by the central data system (8), the at least one updated section state attribute (SEC) only to the local controller(s) (12A, ... 12G) among the plurality of local controllers (12A, ... 12G) which have subscribed to the updated section state attribute (SEC) according to the subscription data (SUB),
   - determining (118), by the local controller (12A, ... 12G) having subscribed to the updated section state attribute (SEC), a command for modifying a current state of the track device (14A, ... 14G) controlled by said local controller (12A, ... 12G) in function of the updated section state attribute (SEC), the command being determined by applying the updated section state attribute (SEC) to a set of predetermined decision rules specific to the local controller (12A, ... 12G),
   - modifying (120) the current state of said track device (14A, ... 14G) according to the determined command.

2. Method according to claim 1, wherein the central database (16) furthermore memorizes, for each track device (14A, ... 14G), at least one device state attribute (DEV) corresponding to the current state of the track device (14A, ... 14G),

   wherein the step of receiving (112) furthermore comprises receiving, from one of the local controllers (12A, ... 12G), at least one device state attribute (DEV) modified by one of the local controllers (12A, ... 12G), called modified device state attribute (DEV), and
   wherein the step of updating (114) furthermore comprises updating the central database (16) with the modified device state attribute (DEV).

3. Method according to claim 2, wherein the subscription data (SUB) furthermore defines a specific subscription of each local controller (12A, ... 12G) for receiving a predetermined selection of the device state attribute(s) (DEV), and
   wherein the step of transmitting (116) furthermore comprises transmitting the modified device state attribute (DEV) only to the local controller(s) (12A, ... 12G) among the plurality of local controllers (12A, ... 12G) which have subscribed to the modified device state attribute (DEV) according to the subscription data (SUB).

4. Method according to claim 2 or 3, comprising furthermore a step of reconfiguration (124) of the central database (16), wherein in case of a removal or adding of one of the local controllers (12A, ... 12G) from the central data system (8), called modifying local controller (12A, ... 12G), the central data system (8) modifies, in the central database (16), only the subscription data (SUB) related to the modifying local controller (12A, ... 12G) and/or the or each device state attribute (DEV) of the track device (14A, ... 14G) controlled by said modifying local controller (12A, ... 12G), the step of reconfiguration (124) being implemented in particular during operation of the railway vehicle on one of the track sections (T1 to T8) other than the track section (T1 to T8) controlled by said modifying local controller (12A, ... 12G).

5. Method according any one of claims 2 to 4, wherein, during the step of determining (118), the command is furthermore determined by applying, to the set of predetermined decision rules, the device state attribute(s) (DEV) to which the local controller (12A, ... 12G) has subscribed to, according to the subscription data (SUB), in order to take into account said device state attribute(s) (DEV).

6. Method according to any one of claims 2 to 5, wherein each device state attribute (DEV) is an attribute chosen from: a light color of a signal, a position of a switch point, a number of counted axles, a position of a level crossing barrier, and an occupation state of a track circuit.

7. Method according to any one of the preceding claims, wherein the step of updating (114) comprises transforming a plurality of itinerary requests into the updated section state attribute(s) (SEC) to be memorized in the central database (16) so as to allow operation of a plurality of railway vehicles on the railway track (2), preferably depending on a reception order of the itinerary requests.

8. Method according to any one of the preceding claims, wherein, during the step of transmitting (116), at least the at least one updated section state attribute (SEC) is transmitted by power-line communication via an electrical cable to the local controller(s) (12A, ... 12G), said electrical cable preferably providing electrical power to at least one of the track devices (14A, ... 14G).

9. Method according to any one of the preceding claims, comprising furthermore a step of transmitting (116), by each local controller (12A, ... 12G), a keep alive signal to the central data system (8), indicating an operative connection of the local controller (12A, ... 12G) to the central data system (8).

10. Method according to any one of the preceding claims, wherein each track device (14A, ... 14G) is chosen from a switch point, a track circuit, an axle counter, a light signal, and a level crossing.

11. Method according to any one of the preceding claims, wherein each section state attribute (SEC) is an attribute chosen from: section is occupied, section is clear of railway vehicles, section is reserved for itinerary, section out of service, construction work in section, and section is set corresponding to a track section (T1 to T8) being validated for operation of the railway vehicle on that section.

12. Method according to any one of the preceding claims, wherein the step of transmitting (116) is implemented by a virtual private network between the central data system (8) and the plurality of local controllers (12A, ... 12G).

13. Railway control system (4) for controlling a plurality of track devices (14A, ... 14G) distributed along a railway track (2) having a plurality of track sections (T1 to T8), the railway control system (4) comprising:

- a plurality of local controllers (12A, ... 12G), each local controller (12A, ... 12G) being configured for controlling at least one of the track devices (14A, ... 14G),
- a central data system (8) comprising a central database (16) configured for memorizing, for each track section (T1 to T8), a section state attribute (SEC) corresponding to a state of the track section (T1 to T8), and subscription data (SUB) defining a specific subscription of each local controller (12A, ... 12G) for receiving a predetermined selection of the section state attribute(s) (SEC),

wherein the central data system (8) is configured for:

- receiving at least one itinerary request for a railway vehicle intended to operate on the railway track (2), the itinerary request comprising a start point and end point connected via at least one of the track sections (T1 to T8),
- updating the central database (16), wherein the updating comprises updating the at least one section state attribute (SEC) of the at least one track section (T1 to T8) connecting the start point and the end point, so as to obtain at least one updated section state attribute (SEC),
- transmitting the at least one updated section state attribute (SEC) only to the local controller(s) (12A, ... 12G) among the plurality of local controllers (12A, ... 12G) which have subscribed to the updated section state attribute (SEC) according to the subscription data (SUB),

wherein the local controller (12A, ... 12G) having subscribed to the updated section state attribute (SEC) is configured for determining a command for modifying a current state of the track device (14A, ... 14G) controlled by said local controller (12A, ... 12G) in function of the updated section state attribute (SEC), the command being determined by applying the updated section state attribute (SEC) to a set of predetermined decision rules specific to the local controller (12A, ... 12G), so as to modify the current state of said track device (14A, ... 14G) according to the determined command.

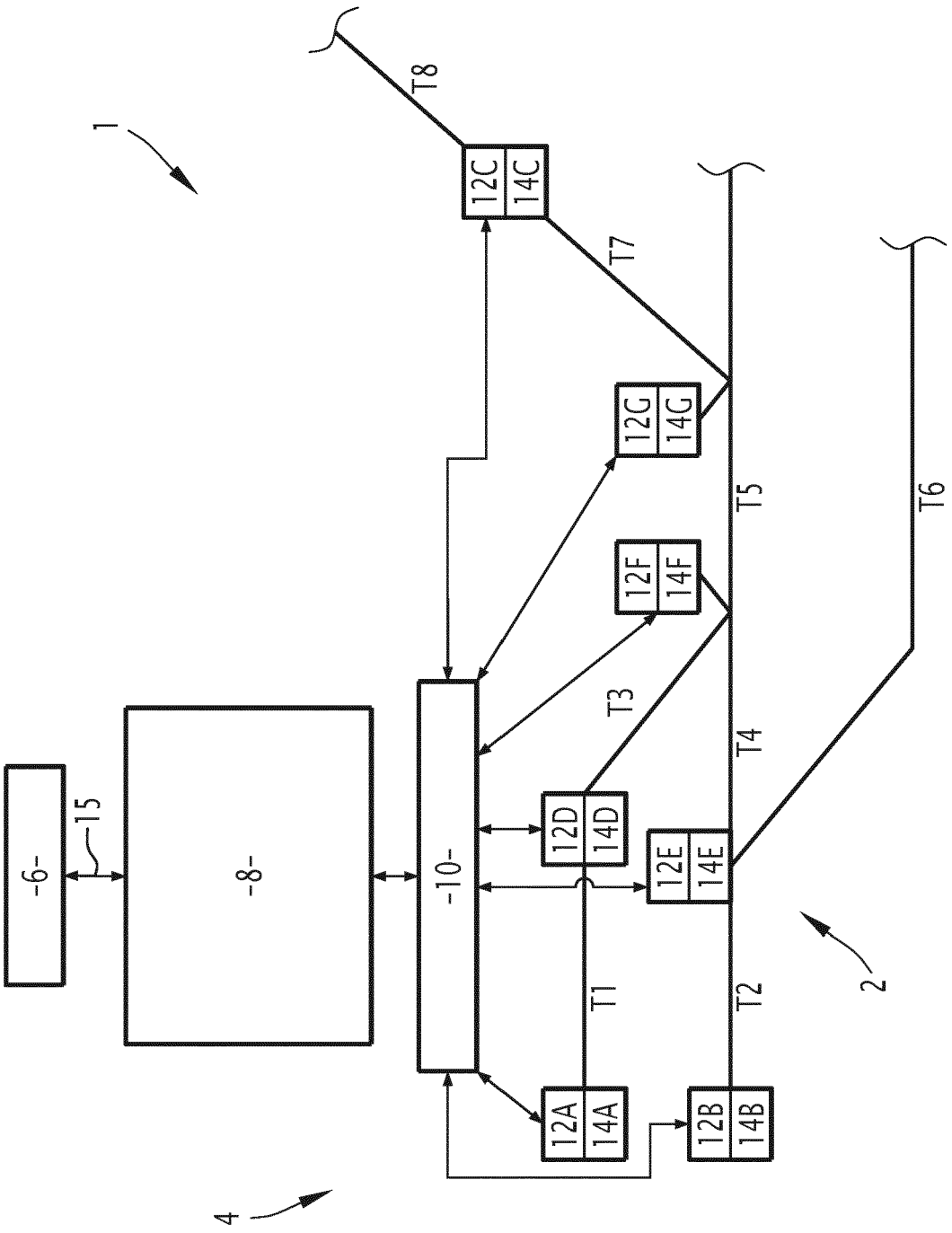
1
T8
12C
14C
T7
12G
14G
T5
T6
12F
14F
T3
T4
-6-
15
-8-
-10-
12D
14D
12E
14E
T1
T2
2
12A
14A
12B
14B
4

FIG.1

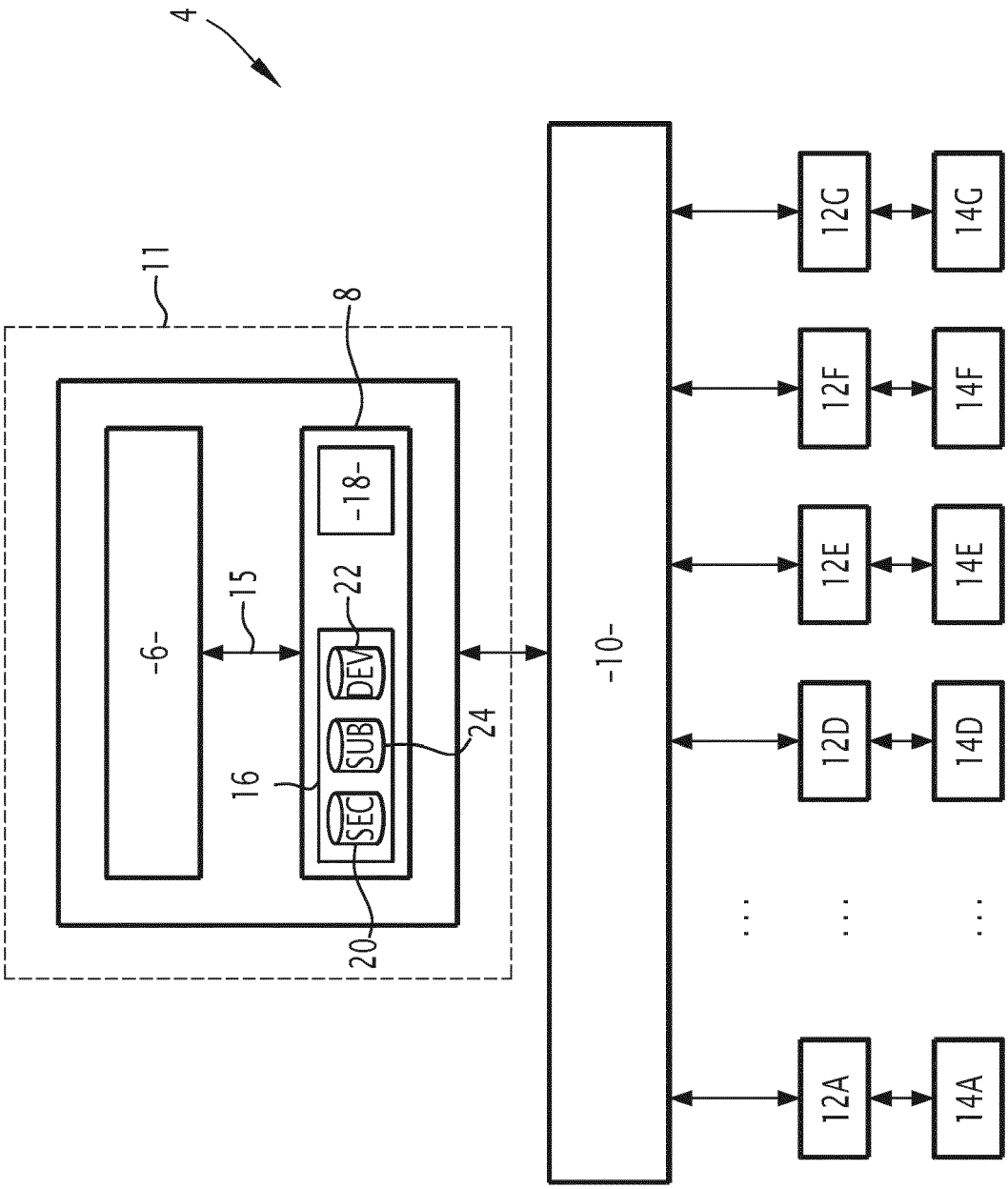
4
11
8
-6-
15
-18-
22
DEV
SUB
SEC
16
24
20
-10-
12G
14G
12F
14F
12E
14E
12D
14D
12A
14A

FIG.2

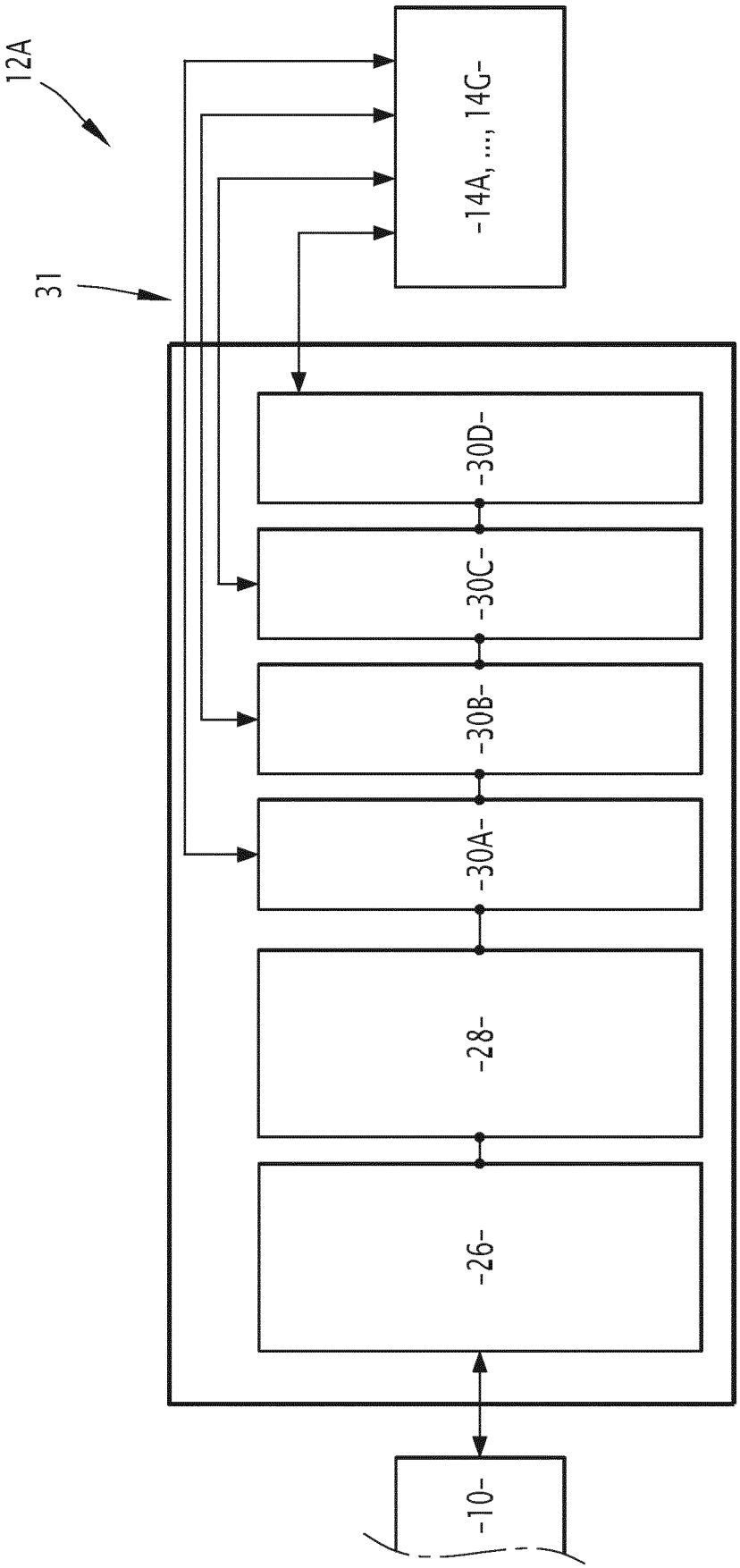

FIG.3

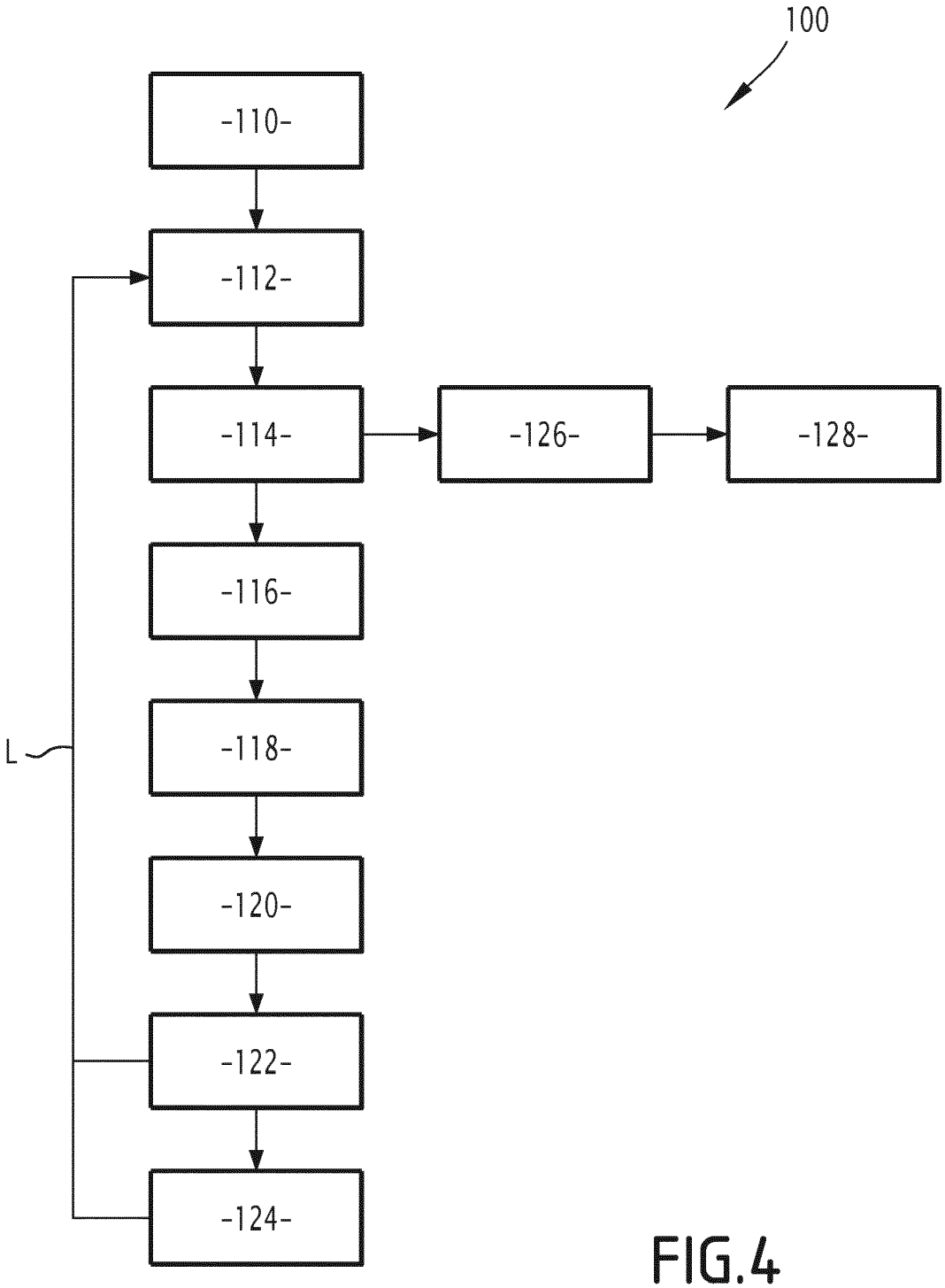

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 30 5217

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B61L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 August 2022	Martínez Martínez, J

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