

(19)



(11)

EP 2 470 408 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
19.07.2017 Bulletin 2017/29

(51) Int Cl.:
B61L 1/14 ^(2006.01) **B61L 3/12** ^(2006.01)
B61L 27/00 ^(2006.01) **B61L 25/02** ^(2006.01)

(21) Application number: **11721085.6**

(86) International application number:
PCT/GB2011/050842

(22) Date of filing: **28.04.2011**

(87) International publication number:
WO 2011/135368 (03.11.2011 Gazette 2011/44)

(54) INITIALISATION OF A SIGNALLING SYSTEM

INITIALISIERUNG EINES SIGNALISIERUNGSSYSTEMS

INITIALISATION D'UN SYSTÈME DE SIGNALISATION

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **28.04.2010 GB 201007073**

(43) Date of publication of application:
04.07.2012 Bulletin 2012/27

(73) Proprietor: **Siemens Rail Automation Holdings
Limited
Frimley, Camberley GU16 8QD (GB)**

(72) Inventors:
• **CHADWICK, Simon**
Etchilhampton
Devizes
Wiltshire SN10 3JP (GB)
• **TURNER, Kevin**
Hilmarton
Calne
Wiltshire SN11 8SQ (GB)

(74) Representative: **Maier, Daniel Oliver et al**
Siemens AG
Postfach 22 16 34
80506 München (DE)

(56) References cited:
EP-A1- 0 836 978 EP-A2- 1 547 899

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 470 408 B1

Description

[0001] This invention relates to a method of initialising a rail signalling system for a rail network with a plurality of trains located therein and a rail signalling system for controlling the movement of one or more trains on a rail network.

[0002] Fig. 1 schematically shows a typical computer-based train control system, such as could be used, for example, with an unmanned metro or underground rail network. Two trains 1a, 1b are shown on a line 2. A platform 3 is shown near train 1a's location. The network is divided into signalling sections, shown by the dotted lines, with signalling equipment 4, in this case a signalling equipment hub, in each section. In this example, both trains 1a, 1b are within the same section. The trains are in bi-directional radio communication 5a, 5b with signalling equipment 4 within the section. Each signalling equipment 4 is connected to a central control system 6 allowing bi-directional communication therebetween.

[0003] When the system is fully operational, train location is detected on the train 1a, 1b, for example via absolute position references ("APR"s), for example where the train passes a unique identifiable marker (not shown in Fig. 1), or derived via odometry and / or via a tachometer. With these methods, the train location may only be determined if the train is moving. The trains report their location to the signalling equipment 4 by radio. The signalling equipment hub 4 uses the train location reports and requests from the control system 6 to compute the signalling data sent to trains 1a, 1b.

[0004] As other prior art may be mentioned US2005/0192720, US2005/0133673, US5950966, US2002/0062181, EP0638469, JP2004338520 and JP2002187552. Additionally, EP-A2-1547899 discloses a back-up safety system, while EP-A1-0836978 discloses a vehicle initialisation system reliant on train and trackside interaction.

[0005] There are systems where train location may be determined while stationary, for example by using GPS positioning techniques or by the use of track circuits. However, such techniques are not appropriate for all rail systems, for example metro or underground rail systems.

[0006] Such systems, while generally working well in normal use, may have problems associated with them, which are generally associated with one or more failures within the system. These include:

- Communications failures, such that the signalling system is not able to receive train locations;
- Failure of individual trains;
- Partial trackside signalling system failure; and
- Complete signalling system failure.

[0007] In the event of a partial or complete signalling system failure, for safety any trains located on the route in question are stopped. This may lead to problems following rectification of the signalling failure. In particular,

and as mentioned previously, train locations may generally only be determined if the trains are moving. Therefore there is a problem re-starting the system, as some or all of the train locations may not be known. In addition, certain trains may have been moved since the system failed, for example under manual supervision to allow egress of passengers.

[0008] The nature of the system demands that, as described above, trains need to move in order to determine their position. However, if the train positions are not all known, it is difficult to know which trains can move.

[0009] With a manned system, voice protocols can be used to report locations of "lost" trains, and verbal authorities can be given to move trains at slow speeds.

[0010] With an unmanned system however, this solution is not available.

[0011] It is an aim of the present invention to overcome these problems, such that the locations of trains can be determined sufficiently accurately to enable a timely return to operation following a system failure. The invention is considered to be particularly advantageous in relation to metro / underground rail systems and unmanned systems. In practice, unmanned systems are often also metro / underground systems.

[0012] This aim is achieved by providing a diverse, relatively coarse train detection system in a centralised, overseeing capacity, together with a train database, which monitors the locations of all trains within the railway (or area) under consideration.

[0013] Such a system provides for initialisation of a signalling system which does not have continuous trackside train detection, such as that provided by track circuits.

[0014] This enables re-starting of the railway in the following scenarios: after partial or complete failure of the signalling system, or after failure of an individual train.

[0015] In accordance with a first aspect of the present invention there is provided a method of initialising a rail signalling system for a rail network, as defined by claim 1. In accordance with a second aspect of the present invention there is provided a rail signalling system for controlling the movement of one or more trains on a rail network, the system having a signalling architecture comprising: signalling equipment, as defined by claim 7. The present invention is therefore capable of providing, inter alia, the following advantages:

- the restarting of a railway without continuous trackside train detection, following a partial or complete signalling system failure;
- the restarting of a railway without continuous trackside train detection, following failure of an individual train within the system;
- a means of providing "occupied areas" for individual trains which have failed, until those trains have been repaired or removed from the system, including over difficult border and transition areas;
- the ability to take into consideration any train moves which may have taken place under verbal controls,

- whilst the signalling system is failed;
- the ability to control trolleys and other track-mounted equipment during possessions for maintenance work.

[0016] The invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 schematically shows a typical computer-based train control ("CBTC") system; and

Fig. 2 schematically shows a computer-based train control system in accordance with the present invention.

[0017] An embodiment of the invention is schematically shown in Fig. 2. As far as possible, the numbering system used in Fig. 1 has been retained for like items.

[0018] As mentioned previously, the present invention can be directly applied to "closed" railway, with captive stock, such as a metro system or to an "open" railway, by transitioning trains into and out of the area. The embodiment shown and described with reference to Fig. 2 is for a typical computer-based train control ("CBTC") system, with no use of either track circuits or GPS.

[0019] As in Fig. 1, a portion of a rail network is shown having two trains, 1 a and 1b. Platforms are shown at 3, signalling equipment at 4 and a controller at 6. Bi-directional communications, for example bi-directional radio communications, between signalling equipment 4 and trains 1a and 1b are shown as 5a and 5b respectively. The combination of signalling equipment 4, controller 6 and train-carried signalling communication apparatus (not explicitly shown in Fig. 2) constitutes a signalling architecture.

[0020] In this embodiment, the network is divided into a plurality of relatively coarse train location blocks by trackside-located beacons 7. As shown, one beacon 7 is provided at each end of a platform 3. There need not be many of these beacons/sensors, as only coarse train detection is required. As will be described below, the provision of these beacons 7 enables each train 1 to be located within a block, each block being delimited by two beacons 7. The location definition provided is relatively coarse compared to that available through the signalling architecture in fault-free operation. Each block can contain more than one train.

[0021] Each beacon 7 has a unique identifier or ID, and furthermore is in communication with a train database 8, in this example via fixed lines which give optimum reliability, although wireless transmission, for example radio transmission, may alternatively be used. Train database 8 maintains a record of the location of each train on a block level. Train database 8 is communicatively connected to controller 6, for example by hard-wiring or wireless means, for communication therewith. In this embodiment, beacons 7 are capable of both wirelessly transmitting their unique identifiers to train-carried beacon detection means in the form of transceivers 9a, b when they

pass, and of receiving train identifiers (i.e. comprising the train-specific ID) from the transceivers 9a, b. Such wireless transmission may comprise radio frequency transmission, Bluetooth (RTM) or the like. In this embodiment, the transceivers 9a, b are also able to detect movement of the train using inertial navigation sensors. The transceivers 9a, b are fitted externally to the trains, and are battery-backed such that they contain their own power source. The beacons 7 are operable to send the received train identifiers from transceivers 9a, b, together with the beacons' own unique identifiers, to train database 8. In addition, transceivers 9a, b are operable to send their train identifiers together with the received beacon identifiers, to signalling equipment 4, via the train-carried signalling communication equipment using bi-directional communication 5. The beacon identifiers and train identifiers may then be forwarded to controller 6 and then on to train database 8. Therefore, whenever a train 1 passes a beacon 7, both the train identifier and beacon identifier are sent to the train database 8 so that the block location of the train 1 is recorded. Having this information sent by both the beacon 7 and train 1 provides the security of a back-up transmission path for redundancy.

[0022] Fig. 2 shows that each train 1 carries two transceivers 9, typically one (9a) proximate the front of the train, and one (9b) proximate the rear. Such an arrangement is useful to confirm that the entirety of the train has passed into one block, or conversely that the train straddles two adjacent blocks, with this confirmation being performed by the controller 6. Having two transceivers 9a, b also provides redundancy if one transceiver should fail.

[0023] The beacon to train database communications system is wholly diverse to the signalling architecture. Therefore, if one system should fail, the other will be unaffected.

[0024] The controller 6 has a processor which receives train reports from all valid sources as is known in the art, including from the train database 8. During failure conditions, it is possible that only this coarse train location may be received in certain areas.

Train Database

[0025] The following summarises the functions in the train database 8:

1. Maintain the location of all trains in the system against the railway layout, using all train location data available. Where possible maintain a fine level of train location, but a coarse level must always be maintained. Algorithms using time-dependent "train-growing" variables may need to be used. Note that there may be more than one train per section. The time of entry of a train into a section should also be recorded.
2. Continually process train location reports from trackside beacons and train-carried sensors. There

is redundant information in this, which needs to be resolved to both fine level and simple coarse block level occupancy.

3. Process addition / removal of trains to / from the network, such that the trains are added to or removed from the database following their entry or exiting the network. In a "closed" railway, this should not happen very often. Joining and splitting of trains will also need to be catered for.
4. Publish the coarse train locations to the signalling system. Also indicate whether there are any "lost" trains in the system.

System operation under initialisation conditions

[0026]

A) The following summarises the required restarting operation of the signalling system, when recovering from a partial or complete signalling system failure:

1. Check if all trains are accounted for, by using the data published by the train database. If there are trains for which the location is not known, then manual intervention will be required.
2. Treat any coarse train location blocks containing one or more trains as occupied in the signalling system.
3. Start trains moving one by one, dependent on the order of entry into the block if the block ahead of that train in the direction of travel is not occupied. The trains may be restarted in the order in which they entered the block, or alternatively in the reverse order if they need to change direction, for example if for operational reasons (such as the line being blocked), it is necessary to reverse and detain passengers at the nearest station in rear. This may be via an automated algorithm, or via the intervention of a single central controller.
4. As each train moves, it will report location again. This information can be correlated with the train database information, until such time as the coarse train location blocks can be regarded as "clear".

B) The following non-claimed summary describes the required restarting operation of the signalling system, when recovering from the failure of an individual train:

1. Check if all trains are accounted for, by using the data published by the train database. If there

are trains for which the location is not known, then manual intervention will be required.

2. Treat any coarse train location blocks containing one or more trains as occupied in the signalling system.

3. Check using the train locations stored in the database 8 which trains are in the same coarse section as the failed train, and permit those in front of the failed or "lost" train to proceed if the coarse block ahead of that train in the direction of travel is not occupied, whilst sending stop messages to those behind the failed or "lost" train.

4. After the failed or "lost" train has been removed via manual procedures, permit those which were behind the failed or "lost" train to proceed in dependence on their order of entry into the block. If it is required to reverse the trains behind the failed or "lost" train, in order to permit egress of passengers at a station, the trains can be given permission to move in the reverse order to that which they entered the coarse section.

5. Once all trains have been removed from the coarse section, including the failed or "lost" train, normal operation can be resumed.

[0027] The above-described embodiments are exemplary only, and other possibilities and alternatives within the scope of the invention will be apparent to those skilled in the art. For example, while the embodiment shown in Fig. 2 enables the train and beacon identifiers to be transmitted to the train database via two diverse communications routes, for simplicity only one such route could be used. In this case, it is preferable to rely upon the beacon - train database route so that this communication will not be affected by failure of the signalling architecture.

[0028] In addition, other modifications / alternative arrangements are possible within the scope of the invention, for example:

- Train locations may be passed from the signalling system to the train database, in order to enable clearing of the "coarse blocks".
- The communications system could be "mesh" based, with limited use of fixed communications.
- In a system with visibility to the skies, i.e. not entirely within tunnels, the train location in these areas could be determined via GPS, rather than via trackside beacons.
- The system could be extended to include other equipment, for example trolleys and other track-

mounted equipment etc. used during possessions. This would require different types of trains in the train database, and then an output from the train database to indicate whether or not such items were still on the railway.

Claims

1. A method of initialising a rail signalling system for a rail network with a plurality of trains (1a, 1b) located therein, the signalling system having a signalling architecture comprising signalling equipment (4), signalling communication equipment located on each train for enabling train location information (5a, 5b) to be sent from the train to the signalling equipment (4); and a controller (6), in communication with the signalling equipment (4), for controlling the signalling equipment;
the method comprising the steps of:

- a) dividing the network into a plurality of blocks;
- b) providing a train location detection system, diverse to the signalling architecture, comprising a train database (8) for storing the location of each train (1a, 1b) within the network at a block level, the train database (8) being in communication with the controller (6) for sending train location information thereto; and

for restarting the signalling system following a partial or complete failure of the signalling system causing the trains to stop the steps of:

- c) setting the controller (6) to treat any blocks with at least one train located therein as occupied;
- d) causing one train to move if the block ahead of that train in the direction of travel is not occupied; and
- e) repeating the previous step for each of the plurality of trains in the order in which they entered the block or in the reverse order.

2. A method according to 1, wherein the train database (8) additionally stores the location of trolleys or other track-mounted equipment within the network.

3. A method according to any preceding claim, further comprising the step of:

- f) determining the location of each train at a higher resolution than at the block level once the train is moving, using the signalling architecture.

4. A method according to any preceding claim, wherein step c) includes the initial step of consultation of the location information stored by the train database (8)

to check that the location of all trains on the network is known at the block level.

5. A method according to any preceding claim, wherein the train location detection system further comprises a plurality of beacons (7), defining the blocks, located at spaced locations within the network, and communications means for enabling information confirming that a train has passed a beacon to be sent to the train database (8).

6. A method according to any preceding claim, comprising the step of updating the train database (8) with train location information from the signalling architecture.

7. A rail signalling system for controlling the movement of one or more trains (1a, 1b) on a rail network, the system having a signalling architecture comprising:

signalling equipment (4), signalling communication equipment located on each train (1a, 1b) for enabling train location information to be sent from the train to the signalling equipment (4); and a controller (6) in communication with the signalling equipment (4), for controlling the signalling equipment (4);

wherein the rail signalling system further comprises:

a train location detection system comprising:

a train database (8) for storing the location of each train (1a, 1b) at a block level within the network, the train database (8) being in communication with the controller (6) for sending train location information thereto; a plurality of beacons (7), defining the blocks, located at spaced locations within the network; means for detecting that a train (1a, 1b) passes a beacon (7); and communications means for enabling information confirming that a train has passed a beacon to be sent

to the train database (8);

the signalling architecture and train location detection system being diverse, wherein following a partial or complete failure of the signalling architecture causing the trains to stop, the signalling system is restarted by a) setting the controller (6) to treat any blocks with at least one train located therein as occupied; b) causing one train to move if the block ahead of that train in the direction of travel is not occupied; and

- c) repeating the previous step for each of the plurality of trains in the order in which they entered the block or in the reverse order.
8. A system according to claim 7, wherein each beacon (7) has a unique identifier. 5
9. A system according to claim 8, wherein the detecting means comprises beacon detection means (9a, 9b) located on each train, and means for receiving the identifier from that beacon. 10
10. A system according to claim 9, wherein the communications means comprises communication equipment located on each train for sending the received identifier information to the train database (8) via the signalling equipment (4). 15
11. A system according to either of claims 9 and 10, comprising a first beacon detection means (9a) located substantially at the front of each train and a second beacon detection means (9b) located substantially at the rear of each train. 20
12. A system according to any of claims 7 to 11, wherein the detecting means comprises train detection means located at each beacon. 25
13. A system according to claim 12, wherein the communications means comprises beacon communication equipment for enabling communication between each beacon and the train database. 30
14. A system according to any of claims 7 to 13, wherein the controller (6) is adapted to send train location information to the train database (8). 35
15. A system according to any of claims 7 to 14, wherein the train database (8) is adapted for storing the location of trolleys or other track-mounted equipment within the network. 40

Patentansprüche

1. Verfahren zur Initialisierung eines Bahnsignalisierungssystems für ein Schienennetz mit mehreren darin befindlichen Zügen (1a, 1b), wobei das Signalisierungssystem eine Signalisierungsarchitektur aufweist, welche Signalisierungsausrüstung (4), Signalübertragungseinrichtungen, die an jedem Zug angeordnet sind, um zu ermöglichen, dass Zugpositionsinformationen (5a, 5b) vom Zug zu der Signalisierungsausrüstung (4) gesendet werden, und eine Steuereinheit (6), die mit der Signalisierungsausrüstung (4) in Kommunikation steht, zum Steuern der Signalisierungsausrüstung umfasst; wobei das Verfahren die folgenden Schritte umfasst: 50

- a) Aufteilen des Netzes in mehrere Blöcke;
b) Bereitstellen eines von der Signalisierungsarchitektur verschiedenen Zugortungssystems, das eine Zugdatenbank (8) zum Speichern der Position jedes Zuges (1a, 1b) innerhalb des Netzes auf einer Blockebene umfasst, wobei die Zugdatenbank (8) in Kommunikation mit der Steuereinheit (6) steht, um Zugpositionsinformationen an sie zu senden; und

zum Neustarten des Signalisierungssystems nach einem teilweisen oder vollständigen Ausfall des Signalisierungssystems, der ein Anhalten der Züge bewirkt, die folgenden Schritte:

- c) Einstellen der Steuereinheit (6) dafür, alle Blöcke, in denen sich wenigstens ein Zug befindet, als belegt zu behandeln;
d) Bewirken, dass sich ein Zug bewegt, falls der in der Fahrtrichtung vor diesem Zug befindliche Block nicht belegt ist; und
e) Wiederholen des vorhergehenden Schrittes für jeden der mehreren Züge in der Reihenfolge, in der sie in den Block eingefahren sind, oder in der umgekehrten Reihenfolge. 25

2. Verfahren nach Anspruch 1, wobei die Zugdatenbank (8) zusätzlich die Position von Rollböcken oder anderen auf den Gleisen angebrachten Einrichtungen innerhalb des Netzes speichert.
3. Verfahren nach einem der vorhergehenden Ansprüche, welches ferner den folgenden Schritt umfasst:

- f) Bestimmen der Position jedes Zuges mit einer höheren Auflösung als auf der Blockebene, sobald sich der Zug bewegt, unter Verwendung der Signalisierungsarchitektur.

4. Verfahren nach einem der vorhergehenden Ansprüche, wobei Schritt c) den Anfangsschritt der Durchsicht der von der Zugdatenbank (8) gespeicherten Positionsinformationen beinhaltet, um zu prüfen, ob die Position aller Züge auf dem Netz auf der Blockebene bekannt ist. 45

5. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Zugortungssystem ferner mehrere die Blöcke definierende Baken (7), die an voneinander beabstandeten Orten innerhalb des Netzes angeordnet sind, und Kommunikationsmittel zum Ermöglichen, dass Informationen, welche bestätigen, dass ein Zug eine Bake passiert hat, an die Zugdatenbank (8) gesendet werden, umfasst. 50

6. Verfahren nach einem der vorhergehenden Ansprüche, welches den Schritt des Aktualisierens der Zugdatenbank (8) mit Zugpositionsinformationen von 55

der Signalisierungsarchitektur umfasst.

7. Bahnsignalisierungssystem zum Steuern der Bewegung eines oder mehrerer Züge (1a, 1b) auf einem Schienennetz, wobei das System eine Signalisierungsarchitektur aufweist, welche umfasst:

Signalisierungsausrüstung (4),
Signalübertragungseinrichtungen, die an jedem Zug (1a, 1b) angeordnet sind, um zu ermöglichen, dass Zugpositionsinformationen vom Zug zu der Signalisierungsausrüstung (4) gesendet werden, und eine Steuereinheit (6), die mit der Signalisierungsausrüstung (4) in Kommunikation steht, zum Steuern der Signalisierungsausrüstung (4);

wobei das Bahnsignalisierungssystem ferner umfasst:

ein Zugortungssystem, welches umfasst:

eine Zugdatenbank (8) zum Speichern der Position jedes Zuges (1a, 1b) auf einer Blockebene innerhalb des Netzes, wobei die Zugdatenbank (8) in Kommunikation mit der Steuereinheit (6) steht, um Zugpositionsinformationen an sie zu senden;
mehrere die Blöcke definierende Baken (7), die an voneinander beabstandeten Orten innerhalb des Netzes angeordnet sind;
Mittel zum Erkennen, dass ein Zug (1a, 1b) eine Bake (7) passiert; und
Kommunikationsmittel zum Ermöglichen, dass Informationen, welche bestätigen, dass ein Zug eine Bake

passiert hat, an die Zugdatenbank (8) gesendet werden;

wobei die Signalisierungsarchitektur und das Zugortungssystem voneinander verschieden sind, wobei nach einem teilweisen oder vollständigen Ausfall der Signalisierungsarchitektur, der ein Anhalten der Züge bewirkt, das Signalisierungssystem neu gestartet wird durch a) Einstellen der Steuereinheit (6) dafür, alle Blöcke, in denen sich wenigstens ein Zug befindet, als belegt zu behandeln; b) Bewirken, dass sich ein Zug bewegt, falls der in der Fahrtrichtung vor diesem Zug befindliche Block nicht belegt ist; und

c) Wiederholen des vorhergehenden Schrittes für jeden der mehreren Züge in der Reihenfolge, in der sie in den Block eingefahren sind, oder in der umgekehrten Reihenfolge.

8. System nach Anspruch 7, wobei jede Bake (7) eine

eindeutige Kennung aufweist.

9. System nach Anspruch 8, wobei die Erkennungsmittel an jedem Zug angeordnete Bakenerkennungsmittel (9a, 9b) und Mittel zum Empfangen der Kennung von der betreffenden Bake umfassen.

10. System nach Anspruch 9, wobei die Kommunikationsmittel an jedem Zug angeordnete Kommunikationseinrichtungen zum Senden der empfangenen Kennungsinformationen über die Signalisierungsausrüstung (4) an die Zugdatenbank (8) umfassen.

11. System nach einem der Ansprüche 9 und 10, welches ein erstes Bakenerkennungsmittel (9a), das im Wesentlichen an der Vorderseite jedes Zuges angeordnet ist, und ein zweites Bakenerkennungsmittel (9b), das im Wesentlichen an der Rückseite jedes Zuges angeordnet ist, umfasst.

12. System nach einem der Ansprüche 7 bis 11, wobei die Erkennungsmittel Zugerkenennungsmittel umfassen, die an jeder Bake angeordnet sind.

13. System nach Anspruch 12, wobei die Kommunikationsmittel Baken-Kommunikationseinrichtungen zum Ermöglichen einer Kommunikation zwischen jeder Bake und der Zugdatenbank umfassen.

14. System nach einem der Ansprüche 7 bis 13, wobei die Steuereinheit (6) dafür ausgelegt ist, Zugpositionsinformationen an die Zugdatenbank (8) zu senden.

15. System nach einem der Ansprüche 7 bis 14, wobei die Zugdatenbank (8) dafür ausgelegt ist, die Position von Rollböcken oder anderen auf den Gleisen angebrachten Einrichtungen innerhalb des Netzes zu speichern.

Revendications

1. Procédé d'initialisation d'un système de signalisation ferroviaire destiné à un réseau ferroviaire dans lequel une pluralité de trains (1a, 1b) sont situés, le système de signalisation ayant une architecture de signalisation comprenant un équipement de signalisation (4), un équipement de communication de signalisation situé sur chaque train en vue de permettre que des informations (5a, 5b) sur la position des trains soient envoyées du train à l'équipement de signalisation (4), et un dispositif de commande (6), communiquant avec l'équipement de signalisation (4), en vue de commander l'équipement de signalisation, le procédé comprenant les étapes consistant :

- a) à diviser le réseau en une pluralité de cantonnements ;
- b) à réaliser un système de détection de la position des trains, distinct de l'architecture de signalisation, comprenant une base de données (8) sur les trains en vue de stocker la position de chaque train (1a, 1b) dans le réseau à l'échelon d'un cantonnement, la base de données (8) sur les trains communiquant avec le dispositif de commande (6) pour lui envoyer des informations sur la position des trains, et

en vue de relancer le système de signalisation après une défaillance partielle ou totale du système de signalisation amenant les trains à s'arrêter, les étapes consistant :

- c) à régler le dispositif de commande (6) pour qu'il traite comme étant occupé tout cantonnement dans lequel au moins un train est situé ;
 - d) à amener un train à se déplacer si le cantonnement en aval de ce train dans le sens de marche n'est pas occupé, et
 - e) à répéter l'étape précédente pour chaque train de la pluralité de trains dans l'ordre dans lequel ils sont entrés dans le cantonnement, ou dans l'ordre inverse.
2. Procédé selon la revendication 1, dans lequel la base de données (8) sur les trains stocke en plus la position de draisines ou d'autres équipements montés sur les voies à l'intérieur du réseau.
 3. Procédé selon l'une quelconque des revendications précédentes, comprenant par ailleurs l'étape consistant :
 - f) à déterminer, en utilisant l'architecture de signalisation, la position de chaque train suivant une résolution plus élevée que l'échelon du cantonnement une fois que le train se déplace.
 4. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'étape c) comprend l'étape initiale de consultation des informations sur la position stockées par la base de données (8) sur les trains afin de vérifier que la position de tous les trains sur le réseau est connue à l'échelon du cantonnement
 5. Procédé selon l'une quelconque des revendications précédentes, dans lequel le système de détection de la position des trains comprend par ailleurs une pluralité de balises (7), définissant les cantonnements, situées en des endroits espacés à l'intérieur du réseau, et des moyens de communication en vue de permettre que les informations confirmant qu'un train a dépassé une balise, soient envoyées à la base

de données (8) sur les trains.

6. Procédé selon l'une quelconque des revendications précédentes, comprenant l'étape consistant à mettre à jour la base de données (8) sur les trains au moyen d'informations sur la position des trains provenant de l'architecture de signalisation.
7. Système de signalisation ferroviaire permettant de réguler le mouvement d'un ou de plusieurs trains (1a, 1b) sur un réseau ferroviaire, le système ayant une architecture de signalisation comprenant :

un équipement de signalisation (4), un équipement de communication de signalisation situé sur chaque train (1a, 1b) en vue de permettre que les informations sur la position d'un train soient envoyées du train à l'équipement de signalisation (4), et un dispositif de commande (6) communiquant avec l'équipement de signalisation (4) en vue de commander l'équipement de signalisation (4),
étant entendu que le système de signalisation ferroviaire comprend par ailleurs :

un système de détection de la position des trains comprenant :

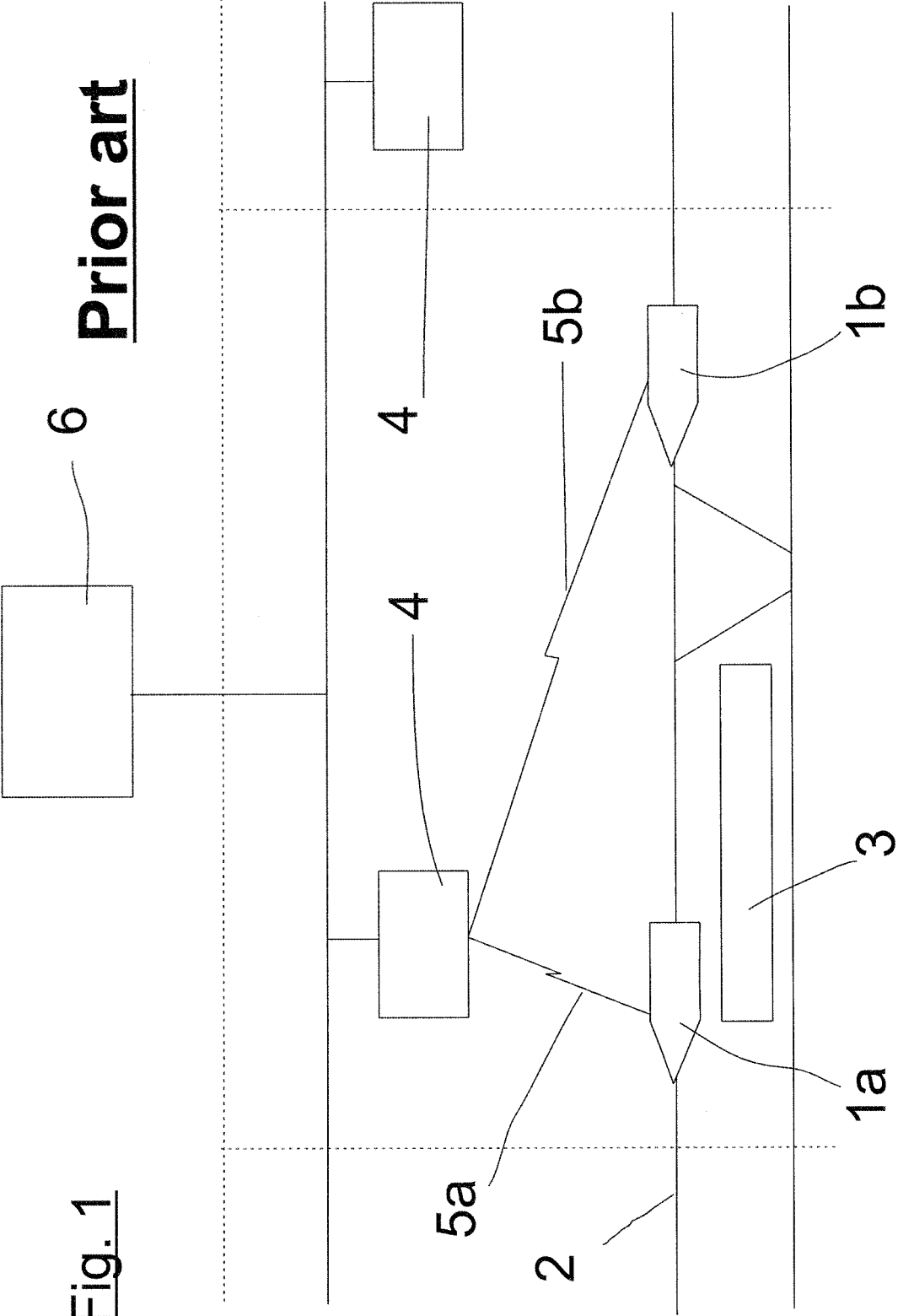
une base de données (8) sur les trains en vue de stocker la position de chaque train (1a, 1b) à l'échelon d'un cantonnement à l'intérieur du réseau, la base de données (8) sur les trains communiquant avec le dispositif de commande (6) en vue de lui envoyer des informations sur la position des trains ;
une pluralité de balises (7), définissant les cantonnements, situées à des endroits espacés à l'intérieur du réseau ;
des moyens permettant de détecter qu'un train (1a, 1b) dépasse une balise (7), et
des moyens de communication en vue de permettre que des informations confirmant qu'un train a dépassé une balise,

soient envoyées à la base de données (8) sur les trains, l'architecture de signalisation et le système de détection de la position des trains étant distincts, étant entendu que, après une défaillance partielle ou totale de l'architecture de signalisation amenant les trains à s'arrêter, on relance le système de signalisation a) en réglant le dispositif de commande (6) de façon qu'il traite comme étant occupé tout cantonnement dans lequel au moins un train est situé ; b) en ame-

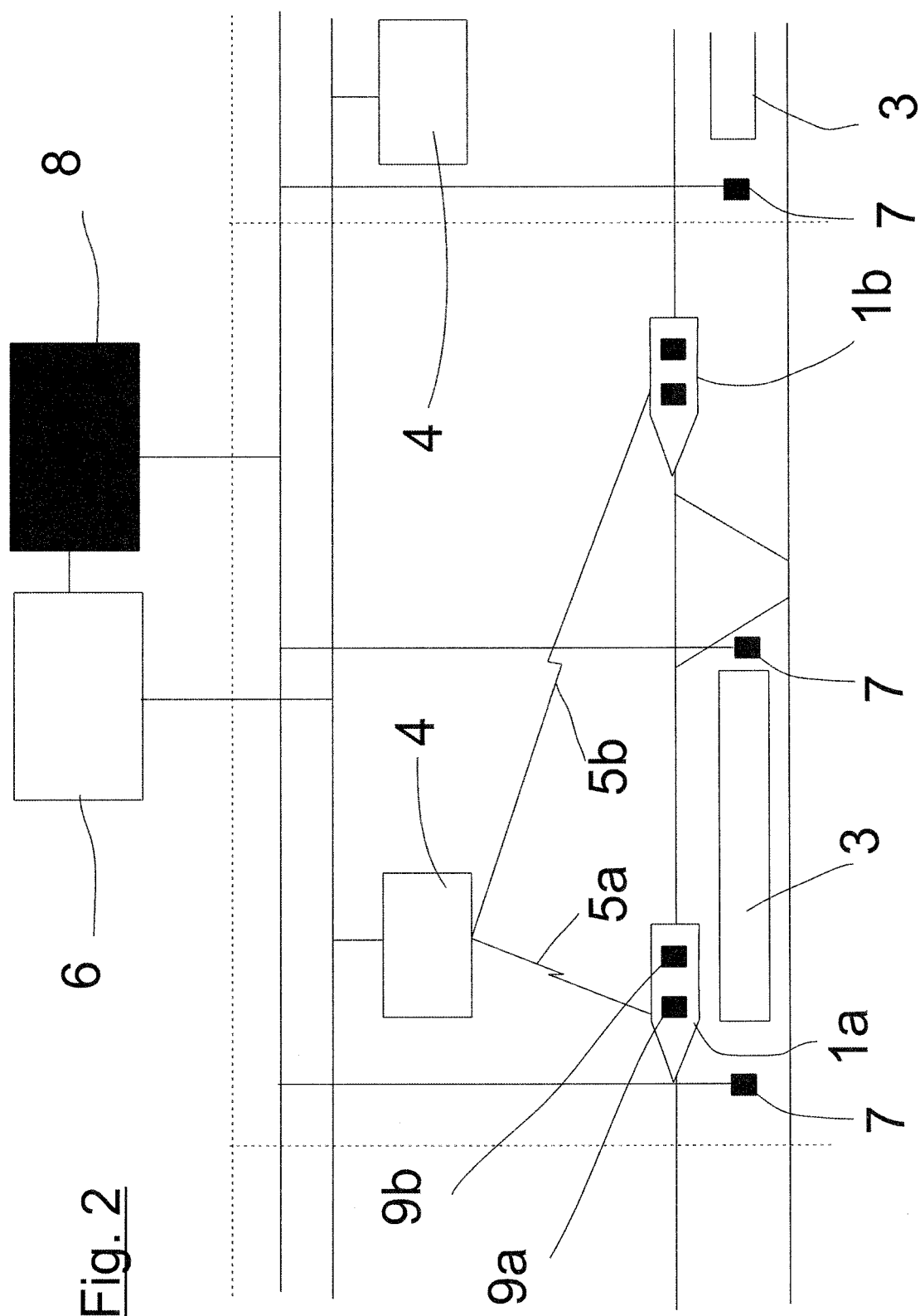
- nant un train à se déplacer si le cantonnement en aval de ce train dans le sens de marche n'est pas occupé, et c) à répéter l'étape précédente pour chaque train de la pluralité de trains dans l'ordre dans lequel ils sont entrés dans le cantonnement, ou dans l'ordre inverse. 5
8. Système selon la revendication 7, dans lequel chaque balise (7) a un identifiant unique. 10
9. Système selon la revendication 8, dans lequel les moyens de détection comprennent des moyens de détection (9a, 9b) de balises situés sur chaque train et des moyens permettant de recevoir l'identifiant de cette balise. 15
10. Système selon la revendication 9, dans lequel les moyens de communication comprennent un équipement de communication situé sur chaque train en vue d'envoyer les informations reçues sur l'identifiant à la base de données (8) sur les trains par le biais de l'équipement de signalisation (4). 20
11. Système selon l'une ou l'autre des revendications 9 et 10, comprenant un premier moyen de détection (9a) de balises situé sensiblement au niveau de la tête de chaque train et un second moyen de détection (9b) de balises situé sensiblement au niveau de la queue de chaque train. 25
30
12. Système selon l'une quelconque des revendications 7 à 11, dans lequel les moyens de détection comprennent un moyen de détection de trains situé sur chaque balise. 35
13. Système selon la revendication 12, dans lequel les moyens de communication comprennent un équipement de communication pour balise en vue de permettre la communication entre chaque balise et la base de données sur les trains. 40
14. Système selon l'une quelconque des revendications 7 à 13, dans lequel le dispositif de commande (6) est adapté en vue d'envoyer des informations sur la position des trains à la base de données (8) sur les trains. 45
15. Système selon l'une quelconque des revendications 7 à 14, dans lequel la base de données (8) sur les trains est adaptée en vue de stocker la position de draisines ou d'autres équipements montés sur les voies à l'intérieur du réseau. 50

55

Fig. 1



Prior art



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20050192720 A [0004]
- US 20050133673 A [0004]
- US 5950966 A [0004]
- US 20020062181 A [0004]
- EP 0638469 A [0004]
- JP 2004338520 B [0004]
- JP 2002187552 B [0004]
- EP 1547899 A2 [0004]
- EP 0836978 A1 [0004]