(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 939 901 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.11.2015 Bulletin 2015/45

(21) Application number: **13867115.1**

(22) Date of filing: **09.09.2013**

(51) Int Cl.:
B61L 23/14 *(2006.01)* ***B61L 3/12*** *(2006.01)*

(86) International application number:
PCT/JP2013/005317

(87) International publication number:
WO 2014/103102 (03.07.2014 Gazette 2014/27)

(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
Designated Extension States:
BA ME

(30) Priority: **28.12.2012 JP 2012287515**

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(54) **TRAIN CONTROL SYSTEM AND TRAIN CONTROL METHOD**

(57) Even when a radio communication disabled section occurs so as to include a part or all of an interlocking control section, an operation such as overtaking and waiting is enabled in this section at low cost.

In a train control method which has a ground radio communication unit that communicates with an on-board communication unit provided in a train, and a ground coil that is installed at a predetermined stop position at which the train stops, and is communicable with the train, calculates a stop limit position to be given to the train, based on information through the ground radio communication unit, and performs operation control of the train in a predetermined section, when the radio communication between the on-board radio communication unit and the ground radio communication unit is disrupted, a calculated radio communication disruption section including a section in which the radio communication is disrupted is set, with respect to a train traveling through the calculated radio communication disruption section, an on-rail state of the train is estimated, based on a first stop limit position so that the train reaches up to a position of the ground coil, or a second stop limit position that is ahead of the calculated radio communication disruption section, and a lastly received train position, and operation control of the train is performed, based on the estimated on-rail state of the train.

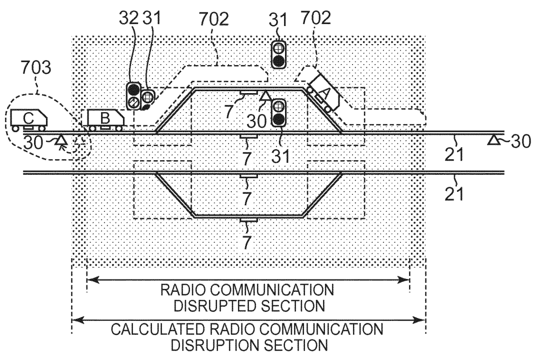

FIG. 7-2

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2012-268515, filed on December 28, 2012; the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present embodiment relates to a train control system and a train control method.

BACKGROUND ART

[0003] Recently, a train control system has been developed which notifies a train position detected by a train itself to a ground-side control device using wireless. In the system, it is possible to set a train stop limit position with a higher resolution than a security function using a track circuit of a current situation, and it is possible to reduce a train operation interval by the movement block. In addition, while the track circuit needs a lot of complicated interconnections, less ground facilities are required and reduction in facility costs is also expected.

[0004] However, in a case where a ground-side radio base station malfunctions, and a radio communication disabled section occurs, a position of a vehicle that resides in that section cannot be grasped at the ground side, and a stop limit position cannot be notified to the train. Hence, the operation of the train is interrupted on both sides of this section.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Patent Publication No. 4301888

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006] Generally, in a case where radio communication cannot be performed in a section including a branch part (hereinafter, described as an "interlocking control section"), a ground-side device cannot judge whether the train resides in front of a point, resides above the point, or has passed the point. Therefore, while the train resides in the radio communication disabled section, the point cannot be converted, and it is impossible to perform an operation such as overtaking by a high-class train. In addition, when a train that has stuck in the radio communication disrupted section is guided and evacuated to the outside of the section by a human system, since an interlocking control device (also called an interlocking device) cannot acquire information indicating that the train has sequentially moved on a track circuit, the interlocking control device judges this situation as an "improper dropping", and might make all signal information stop indication, and thus, the train operation might be stopped.

[0007] A problem to be solved by the present invention is to provide, in a train control system that notifies a train on-rail position from a train to a ground using wireless, a train control system and a train control method that enables the train to be operated, even when a radio communication disabled section occurs.

MEANS FOR SOLVING THE PROBLEM

[0008] A train control system of an embodiment is a train control system including ground radio communication means that transmits and receives information with on-board radio communication means of a train, ground communication means that is installed at a predetermined stop position at which the train stops, and transmits and receives information with the on-board communication means of the train, interlocking control means that performs a conversion of a point and a locking of a route, and ground control means that calculates a stop limit position to be given to each train, based on a train position and an opening state of a train route, and controls the interlocking control means so as to perform operation control of each train in a predetermined section, wherein the ground control means calculates a first stop limit position such that the train does not enter a calculated radio communication disruption section including all or part of a section in which the radio communication is disrupted between the ground radio communication means and the on-board radio communication means, calculates, with respect to a train that is made to travel through the calculated radio communication disruption section, a second stop limit position so that the train reaches up to a position of the ground communication means, or a third stop limit position that is ahead of the calculated radio communication disruption section, and in a state in which all or part of the train resides in the calculated radio communication disruption section, with respect to the train of which the radio communication is disrupted, estimates a current train position, based on an end position of the calculated radio communication disruption section in a train traveling direction, the second or third stop limit position, and a lastly received train position, and performs operation control of each train.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

[Fig. 1] Fig. 1 is a diagram illustrating an entire configuration (outline) of a train control system described as an embodiment.

[Fig. 2] Fig. 2 is a diagram describing a problem when radio communication is disrupted in a conventional train control system.

[Fig. 3-1] Fig. 3-1 is a diagram describing a specific example when radio communication is disrupted.

[Fig. 3-2] Fig. 3-2 is a diagram describing a specific example when the radio communication is disrupted.

[Fig. 4-1] Fig. 4-1 is a diagram describing a virtual traffic signal in the embodiment.

[Fig. 4-2] Fig. 4-2 is a diagram describing a virtual traffic signal in the embodiment.

[Fig. 4-3] Fig. 4-3 is a diagram describing a virtual traffic signal in the embodiment.

[Fig. 4-4] Fig. 4-4 is a diagram describing a virtual traffic signal in the embodiment.

[Fig. 5] Fig. 5 is a flow chart describing a basic operation of the train control system of the embodiment.

[Fig. 6] Fig. 6 is a diagram describing a radio propagation range and a calculated radio communication disruption section in the embodiment.

[Fig. 7-1] Fig. 7-1 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-2] Fig. 7-2 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-3] Fig. 7-3 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-4] Fig. 7-4 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-5] Fig. 7-5 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-6] Fig. 7-6 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-7] Fig. 7-7 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-8] Fig. 7-8 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-9] Fig. 7-9 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-10] Fig. 7-10 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-11] Fig. 7-11 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-12] Fig. 7-12 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-13] Fig. 7-13 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-14] Fig. 7-14 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 7-15] Fig. 7-15 is a diagram for describing a specific operation of the train control system of the embodiment.

[Fig. 8-1] Fig. 8-1 is a diagram describing an operation when defining a calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

[Fig. 8-2] Fig. 8-2 is a diagram describing an operation when defining the calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

[Fig. 8-3] Fig. 8-3 is a diagram describing an operation when defining the calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

[Fig. 8-4] Fig. 8-4 is a diagram describing an operation when defining the calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

[Fig. 8-5] Fig. 8-5 is a diagram describing an operation when defining the calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

[Fig. 8-6] Fig. 8-6 is a diagram describing an operation when defining the calculated radio communication disruption section in the middle of the route setting change in the train control system of the embodiment.

EMBODIMENT TO PRACTICE THE INVENTION

[0010] Fig. 1 is a diagram that illustrates an entire configuration (outline) of a train control system described as an embodiment.

[0011] In the same drawing, an operation management device 1, a system management device 2, a ground control device 3, an interlocking control device 4, a ground radio communication device 5 and an antenna 6 thereof, an ATO (automatic train control) ground coil 7, a position correction ground coil 8, an inter-base network 9, and a wayside network 10 are installed on a ground side.

[0012] The operation management device 1 performs a route setting request, or the like to the ground control device 3, based on a train operation diagram or an operation situation of a train 11.

[0013] The system management device 2 performs operation situation monitoring, setting change, or the like of the entire system.

[0014] The ground control device 3 receives train position information from each train 11 through the ground radio communication device 5 and the wayside network 10, grasps an on-rail situation of each train 11 from the received position information, transmits the information through the wayside network 10 to the operation management device 1 and the system management device 2, and further transmits the information to the interlocking control device 4.

[0015] The interlocking control device 4 outputs a necessary command to a point device (point) 20, based on the information of the train on-rail situation from the ground control device 3 and the route setting request from the operation management device 1, performs a conversion or a lock of the point device 20, and transmits signal information (progress indication/stop indication) to the ground control device 3, based on a route opening situation.

[0016] In the present embodiment, the ground control device 3 obtains an obstacle position (herein, an end position of the preceding train 11) as a leading end position of a progression-possible range of the (succeeding) train 11, from the signal information received from the interlocking control device 4 and the on-rail situation of the train 11, and sets a position upstream from that position by a security control margin distance, as a stop limit position, and transmits the information of the stop limit position to an on-board control device 12 through the ground radio communication device 5 and an on-board radio communication device 15. In addition, when the train 11 stops at a station, the information of the stop limit position like this is transmitted to the on-board control device 12 through an on-board coil 17 and the ATO ground coil 7.

[0017] The ATO ground coil 7 performs communication with an ATO device 13 for the purpose of home door control or the like, and is necessarily installed at a stop position of the station. Since the train 11 stops above the ATO ground coil 7 or stops in the vicinity thereof, in the present embodiment, the ATO ground coil 7 is also used for communication between the ground control device 3 and the train 11 side.

[0018] In addition, the position correction ground coil 8 is a ground coil that gives position information such that, using the given position information, a speed/position detection device 14 can correct the position information of its own train calculated by this device.

[0019] The inter-base network 9 is a communication path that is established over an entire line section to be controlled by the corresponding train control system, communicably connects the operation management device 1 and the system management device 2, and a plurality of ground control devices 3, and also communicably connects the plurality of ground control devices 3 to one another. On the other hand, the wayside network 10 is a communication path that is established over a control range of the ground control device 3, communicably connects the ground control device 3 and a plurality of ground radio communication devices 5, and also communicably connects the plurality of ground radio communication devices 5 within the control range of the ground control device 3, to one another.

[0020] Then, in Fig. 1, the on-board control device 12, the ATO device (automatic train operation device) 13, the speed/position detection device 14, the on-board radio communication device 15 and an antenna 16 thereof, and the on-board coil 17 are installed on the train 11.

[0021] The on-board control device 12 issues a brake command to a braking device (not illustrated) of the train 11, so that the train does not overrun the stop limit position received from the ground control device 3, and also the train speed does not exceed a speed limit.

[0022] The ATO device 13 performs control, such as power running/braking of the train 11, on the vehicle. The train 11 travels on a rail 21, while wheels 19 are driven/braked by a driving/braking device (not illustrated), based on a power running/brake command of the ATO device 13, and stops above the ATO ground coil 7 installed at a predetermined stop position of the station with a predetermined accuracy.

[0023] The speed/position detection device 14 counts the number of pulses of a TG (tachogenerator) 18, and detects a speed based on a wheel diameter and the number of teeth of the TG 18. In addition, the means that acquires the speed signal is not limited to the TG 18, and may use another means such as a pulse generator (PG). Furthermore, the speed/position detection device 14 calculates a moving distance by integrating the number of pulses of the TG 18 or the detected speed, and in addition, calculates the position of the own train, and further corrects the position information of the own train, based on the position information received from the position correction ground coil 8 through the on-board coil 17. The correction of the position information may be performed, such that the position information of the own train is corrected, based on ground coil installation position information read from a database (not illustrated), based on ground coil identification information received from the position correction ground coil 8 through the on-board coil 17. In addition, in a case where a GPS (Global Positioning System) device is mounted on the train 11, the position of the own train may be acquired using position information detected by the GPS device. Furthermore, the information acquired using the TG 18 or the GPS device may be mainly used as the position information of the own train, and the position information acquired from the other side may be used as auxiliary information for correction or the like.

[0024] The speed/position detection device 14 transmits the position information of the own train which has been detected as described above, to the ground control device 3 through the on-board radio communication device 15 and the ground radio communication device 5. In addition, when the train 11 stops at a station, the speed/position detection device 14 also transmits the position information of the own train to the ground control device 3 through the on-board coil 17 and the ATO ground coil 7.

[0025] The functions such as the information processing and the control in the operation management device 1, the system management device 2, the ground control device 3, the interlocking control device 4, and the on-board control device 12 can be realized using an information processing unit.

[0026] The train control system of the present embodiment configured as described above has, as one feature, a point that the train control system not only performs the same radio communication as a conventional train control system that uses the radio communication by the ground radio communication device 5 and the on-board radio communication device 15, but also when the train 11 stops at the station, the train control system performs the communication between the ground control device 3 and the on-board control device 12 also through the on-board coil 17 and the ATO ground coil 7, transmits the information of the stop limit position from the ground side to the on-board control device 12, and transmits the position information of the train 11 from the on-board side to the ground control device 3.

[0027] By the way, when the ground radio communication device 5 cannot perform communication due to malfunction or the like, a radio communication disrupted section occurs. In a state in which the radio communication is disrupted, the train position cannot be notified from the on-board side to the ground side, and the stop limit position cannot be notified from the ground side to the on-board side. Therefore, in order to ensure safety, it is determined that the train 11 of which the radio communication is disrupted emergently stops. In a conventional train control system, the train of which the radio communication is disrupted is evacuated by a manual visual operation, and then, a shuttle operation is performed on both sides of the radio communication disrupted section, until the malfunctioned ground radio communication device 5 is recovered, and the radio communication is enabled again, as illustrated in Fig. 2. Thus, the train operation is interrupted on the both sides of the same section. In addition, even in the case of passing the train 11 by treating the calculated radio communication disruption section as the fixed block, it is impossible to confirm whether the train 11 is not on rail in the branch part inside the section, while the train 11 resides in the calculated radio communication disruption section. Therefore, it is impossible to perform the conversion of the point device 20, and it is impossible to perform an operation such as overtaking or waiting by a subsequent train 11. Here, a specific example of a case where the radio communication is disrupted will be described with reference to Fig. 3-1, Fig. 3-2. Incidentally, here, the trains 11 will be described as a train A, a train B, ... , so as to distinguish the trains 11 from one another.

[0028] In 301 of Fig. 3-1, the train B resides on the branch part, and in 302 in the same drawing, the train A having left the station stops in front of the branch part. However, the ground control device 3 cannot judge whether the train B having arrived at the station, or the train A having left the station stops in front of the branch part, or stops on the branch part, or is passing through the branch part. Therefore, it is impossible to convert the point device 20, until the radio communication is recovered, and it is confirmed that the train A or the train B is not on rail in the branch part. In addition, when the train A is guided and evacuated by the human system as indicated by 303 in the same drawing, it is impossible to acquire the information indicating that the train A has sequentially progressed on the track circuit. Therefore, the interlocking control device 4 might detect "improper dropping", and the operation of each train 11 might be stopped.

[0029] In addition, the trains A, B which have stuck in the radio communication disrupted section are guided and evacuated by the human system, and then, as indicated by 304 of Fig. 3-2, when a train C is made to enter this section by a visual operation, the ground control device 3 cannot confirm that the train C is not on rail in the branch part, until the train C moves out of the section in which the radio communication is disrupted and the communication is recovered. Therefore, the point device 20 cannot be converted, and it is impossible to perform an operation to pass a train D through a main track, while the train C stops in a subsidiary main track. In addition, when the train C is guided and advanced by the human system as indicated by 305 of the same drawing, since the information indicating that the train C has sequentially progressed on the track circuit cannot be obtained, the interlocking control device 4 might detect "improper dropping", and the operation of each train 11 might be stopped.

[0030] When the radio communication is disrupted in the interlocking control section in this manner, a conventional control method cannot perform operations such as overtaking or waiting.

[0031] Here, "virtual traffic signals" indicated by a symbol of a traffic signal in Fig. 3-1 and Fig. 3-2 (the same as those illustrated in Fig. 7-1 to Fig. 7-15, and Fig. 8-1 to Fig. 8-6) will be described with reference to Fig. 4-1 to Fig. 4-4.

[0032] A plurality of routes are respectively defined in down and up directions in the interlocking control device 4. In examples of Fig. 4-1, Fig. 4-2 in which there is no shuttle operation, routes 0 to 3 are respectively defined for down and up directions. In examples of Fig. 4-3, Fig. 4-4 in which there is the shuttle operation, routes 0 to 5 are respectively defined for down and up directions.

[0033] As information indicating the permission or denial of entrance into each route defined as above, signal information of the virtual traffic signal is given from the interlocking control device 4 to the ground control device 3. For example, in Fig. 4-1, in a case where the down train 11 intends to stop at the station through the route 0, when any route is unlocked, any virtual traffic signal is made to show stop indication. When the operation management system requests setting of the route 0 to the interlocking control device 4, the interlocking control device 4, after confirming that the route 0 and the competing route 1 are unlocked and another train 11 is not present on the route 0, converts the point device 20 necessary for setting the route 0, sets the route 0, locks the route 0, and makes the virtual traffic signal of the entrance of the route 0 to show progress indication. The train 11 can enter the route 0 in which the progress indication is outputted. When the train 11 arrives at a home on the route 0, the interlocking control device 4 unlocks the route 0, because the train 11 has arrived at the last track circuit of the route. By this means, it becomes possible to set the route 1 for the next train 11. In addition, virtual traffic signals 33 illustrated in the drawing do not specifically exemplify the stop indication/progress indication, but are illustrated as symbols alone.

[0034] In addition, the cases of the other routes illustrated in Fig. 4-1 and the routes illustrated in Fig. 4-2 to Fig. 4-4 are the same as the case of setting the route 0 illustrated in Fig. 4-1 as described above. When the operation management system requests setting of any route (here, this route is described as a route X) to the interlocking control device 4, the interlocking control device 4, after confirming that the route X and the competing route are unlocked, and another train 11 is not present on the route X, converts the point device 20 necessary for setting the route X, sets the route X, locks the route X, and makes the virtual traffic signal of the entrance of the route X show progress indication. The train 11 can enters the route X in which the progress indication is output, and when the train 11 arrives at the last track circuit of the route X, the interlocking control device 4 unlocks the route X. By this means, it becomes possible to set the route X and the competing route for the next train 11.

[0035] Next, a specific train control operation of the train control system of the present embodiment will be described with reference to Fig. 5, Fig. 6, Fig. 7-1 to Fig. 7-15. Fig. 5 is a flow chart describing a basic processing of the train control system of the present embodiment, and Fig. 6 is a diagram describing a radio propagation range and a calculated radio communication disruption section in the present embodiment. In addition, Fig. 7-1 to Fig. 7-15 are diagrams describing specific operations of the train control system of the present embodiment. In addition, here, a situation is assumed that the train A having left the station from the subsidiary main track, the train B arriving at the station from the main track, and the train C subsequent to the train B are on rail. In addition, in each drawing, a stop limit position 30 immediately before each train 11 in the traveling direction indicates a stop limit position of each train 11. Furthermore, the virtual traffic signal 31 shows the stop indication and the virtual traffic signal 32 shows the progress indication.

[0036] The basic processing of the train control system of the present embodiment (including the operation by the human system, such as the evacuation of the train 11) is shown in the flow chart shown in Fig. 5. That is, to begin with, setting of the calculated radio communication disruption section is performed (A01), next, a processing of grasping whether the train 11 having stuck in the calculated radio communication disruption section is on the rail is performed (A02), next, evacuation of the train 11 having stuck in the calculated radio communication disruption section is performed (A03), and then, a train operation control is performed in the calculated radio communication disruption section (A04). In the following, details of the above processings will be described.

[1. Setting of Calculated Radio Communication Disruption Section]

[0037] To begin with, when a radio communication disrupted section occurs due to malfunction or the like of the ground radio communication device 5, the train A and the train B that are on rail in this section detect the radio communication disruption, and emergently stop (Fig. 7-1: 701). For example, the ground control device 3 sets the calculated radio communication disruption section, based on a radio propagation range (range in which a propagation strength above a certain level is ensured) of the ground radio communication device 5 from which abnormality has been detected, which is read from a database (not illustrated), based on identification information of the ground radio communication device 5 from which abnormality is detected.

[0038] In the present embodiment, the radio propagation range of each ground radio communication device 5, which is present in the database, is set as a minimum range of a changing radio propagation range that is covered by each ground radio communication device 5 (that is, a range in which a propagation strength above a certain level is ensured). Therefore, the calculated radio communication disruption section to be set in the above, is set wider than the range in which the radio communication has actually been disrupted, in consideration of uncertainty (Fig. 6: in the same drawing, the malfunction of the central ground radio communication device 5 is assumed). However, the calculated radio communication disruption section illustrated in Fig. 6 is an example, and can be set wider than the illustrated one. Also, the method of detecting the malfunction of the radio communication device can use a method disclosed in, for example, Japanese Patent Application Publication No. 2007-124148. In addition, for example, the database can be configured by storing the identification information of the ground radio communication device 5 and the radio propagation range thereof in association with each other.

[2. Grasping Whether Train Resides in Calculated Radio Communication Disruption Section]

[0039] Next, with respect to the trains A, B of which communication is disrupted in the calculated radio communication disruption section, the ground control device 3 regards a range from a lastly received train end position to a position of an upstream side (side into which the train 11 enters), out of the stop limit position of each of the trains A and B and the end position of the calculated radio communication disruption section (in the drawing, the right end position of the calculated radio communication disruption section), as an on-rail range of each of the trains A, B (Fig. 7-2: 702), and notifies the on-rail ranges to the interlocking control device 4. The ground control device 3 holds the lastly received train end positions, in order to determine the on-rail ranges of the trains A and B as described above.

[0040] On the other hand, a stop limit position is given to the train C of the upstream side of the calculated radio communication disruption section, such that the train C does not enter the calculated radio communication disruption section. At that time, it is likely that the stop limit position given to the train C will be retracted more in front (upstream side) than the stop limit position determined by the position of the preceding train 11 (Fig. 7-2: 703). In that case, the train C may not be able to stop before reaching a new stop limit position, depending on a distance to the start of the calculated radio communication disruption section (in the drawing, the left end of the calculated radio communication disruption section). In this way, although it is likely that the train C will overrun the new stop limit position, even when the stop limit position before retraction is more downstream than the branch part, and the train C overruns up to the branch part, for example, since the interlocking control device 4 locks the route up to the stop limit position before retraction, the safety is ensured.

[3. Evacuation of Train in Calculated Radio Communication Disruption Section]

[0041] Next, out of the trains A, B which have stuck in the calculated radio communication disruption section, the train A in which the route up to outside the calculated radio communication disruption section is ensured is advanced by visual operation guided by the human system (Fig. 7-3: 704). In the train A advanced from the calculated radio communication disruption section, the communication with the ground control device 3 is recovered, and since the train A reports the position of the own train, the ground control device 3 can update the train position information, and the train A can be returned to the normal operation (Fig. 7-4: 705).

[0042] After that, the interlocking control device 4 is notified from the ground control device 3 that the train A has arrived at the end of the route, and unlocks the locked departure route (Fig. 7-4: 706). Regarding the on-rail information notified from the ground control device 3, since the on-rail range of the train A does not transit by skipping the middle of the route, the operation cannot be stopped by detecting abnormality (improper dropping) in the interlocking control device 4.

[0043] Next, out of the trains A, B which have stuck in the calculated radio communication disruption section, the train B that is more upstream than the station stop position is guided by the human system and moved to the stop position by visual operation, because the route to the station stop position is taken (Fig. 7-5: 707). Since the train B stopped at a predetermined stop position reports the position of the own train to the ground control device 3 through the on-board coil 17 and the ATO ground coil 7, the ground control device 3 can update the train position information (Fig. 7-6: 708). After that, the interlocking control device 4 is notified from the ground control device 3 that the train B has arrived at the end of the route, and unlocks the locked route (Fig. 7-6: 709).

[0044] Since both of the trains A, B which have stuck in the section at the time of occurrence of the calculated radio communication disruption section as described above are in a state that the trains A, B have advanced outside the calculated radio communication disruption section, or are in a state that the positions thereof can be grasped through the ATO ground coil 7, the trains are in a state in which the on-rail situation in the calculated radio communication disruption section can be grasped.

[4. Train Operation Control in Calculated Radio Communication Disruption Section]

[0045] Next, regarding the train operation in the calculated radio communication disruption section, two cases will be described: a case where the train B is first departed, and a case where the train B and the train C perform waiting.

(4-1. Case where Train B is First Departed)

[0046] In this case, since it is confirmed that any train 11 is not on rail in the route departing from the station or the competing route, the interlocking control device 4 sets the route (Fig. 7-7: 710) for the train B to depart from the station, based on the route setting request from the operation management device 1, locks the route, and makes the route signal information progress indication (Fig. 7-7: 32) .

[0047] While the stop limit position of the train B calculated from the signal information from the interlocking control device 4 and the on-rail situation of each train 11 is more upstream than a position at which the end of the train can exit from the calculated radio communication disruption section, the ground control device 3 notifies the stop limit position in which a departure route entrance is made as an obstacle position, in place of the calculated stop limit position, to the on-board control device 12 of the train B, through the ATO ground coil 7 and the on-board coil 17. During this time, the train B remains stopped.

[0048] When the stop limit position of the train B calculated from the signal information from the interlocking control device 4 and the on-rail situation of each train 11 is more downstream than the position at which the end of the train can exit from the calculated radio communication disruption section, the ground control device 3 transmits the stop limit position, the end position of the calculated radio communication disruption section, and an instruction to shift to a mode in which emergency stop is not performed even when the radio communication is disrupted (emergency brake is not applied), to the on-board control device 12 of the train B, through the ATO ground coil 7 and the on-board coil 17 (Fig. 7-7: 711). After that, the train B departs by an automatic operation. Generally, in the section in which the radio communication is disrupted, the train 11 emergently stops by applying the emergency brake, but, in the present embodiment, when the operation mode is shifted to the "mode in which emergency stop is not performed even when the radio communication is disrupted", the automatic operation is possible because the train 11 continuously operates without stop even when the radio communication is disrupted.

[0049] When the train B starts moving, and the ATO ground coil 7 and the on-board coil 17 are disconnected, since the communication between the ground control device 3 and the on-board control device 12 is disrupted, the ground control device 3 regards a range from a lastly received train end position (end position when the train stops at the station) to a position of the upstream side, out of the stop limit position of the train B and the end position of the calculated radio communication disruption section, as the on-rail range of the train B (Fig. 7-8: 712). After that, in the train B which has advanced from the calculated radio communication disruption section, the communication with the ground control device 3 is recovered, and since the train B reports the position of the own train, the ground control device 3 can update the train position information, and the train B can release the mode in which emergency stop is not performed even when the radio communication is disrupted, and can return to the normal operation (Fig. 7-9: 713).

[0050] The interlocking control device 4 is notified from the ground control device 3 that the train B has arrived at the end of the route, and unlocks the locked departure route (Fig. 7-9: 714). Regarding the on-rail information notified from the ground control device 3, since the on-rail range of the train B does not transit by skipping the middle of the route, the operation cannot be stopped by detecting abnormality (improper dropping) in the interlocking control device 4.

(4-2. Case where Train B and Train C Perform Waiting)

[0051] In this case, since it is confirmed that the train 11 is not on rail in the route entering the station or the competing route, the interlocking control device 4 issues a conversion command of the point device 20, based on the route setting request from the operation management device 1, sets the route (Fig. 7-10: 715) for the train C to arrive at the station, locks the route, and makes the route signal information progress indication (Fig. 7-10: 32).

[0052] While the stop limit position of the train C calculated from the signal information from the interlocking control device 4 and the on-rail situation of the train B is more upstream than a position that can reach up to a predetermined station stop position (ATO ground coil 7), the ground control device 3 notifies the stop limit position in which the start of the calculated radio communication disruption section is made as an obstacle position, in place of the calculated stop limit position, to the train C by radio communication. By this means, the train C does not enter the calculated radio communication disruption section.

[0053] After that, (1) in a case where the stop limit position of the train C calculated from the signal information from the interlocking control device 4 and the on-rail situation of the train B becomes more downstream than a position that can reach up to a predetermined station stop position (ATO ground coil 7), and the stop limit position is more upstream than the position at which the train end of the train C can exit from the radio disrupted section, the ground control device 3 transmits the stop limit position that is the position at which the communication can be performed with the ground coil 7 when the train is stopped, the end position of the calculated radio communication disruption section, and an instruction to shift to the mode in which the emergency stop is not performed even when the radio communication is disrupted, to the train C by radio communication. In addition, (2) in a case where the stop limit position of the train C calculated from the signal information from the interlocking control device 4 and the on-rail situation of the train B becomes more downstream than the position that can reach up to the predetermined station stop position (ATO ground coil 7), and the stop limit position is the position at which the train end of the train C can exit from the radio disruption section, the ground control device 3 transmits the stop limit position, the end position of the calculated radio communication disruption section, and an instruction to shift to the mode in which the emergency stop is not performed even when the radio communication is disrupted, to the train C by radio communication (Fig. 7-10: 716). In response to this, the train C enters the calculated radio communication disruption section by automatic operation, and travels the set route (Fig. 7-10: 715).

[0054] When the train C enters the calculated radio communication disruption section, and the radio communication between the ground control device 3 and the on-board control device 12 is disrupted, the ground control device 3 regards a range from a lastly received train end position to the position of the more upstream side, out of the stop limit position of the train C and the end position of the calculated radio communication disruption section, as the on-rail range of the train C (Fig. 7-11: 717).

[0055] Since the train C having arrived at the station and stopped at a predetermined stop position reports the position of the own train through the on-board coil 17 and the ATO ground coil 7, the ground control device 3 can update the train position information (Fig. 7-12: 718). The interlocking control device 4 is notified from the ground control device 3 that the train C has arrived at the end of the route, and unlocks the locked route (Fig. 7-12: 719).

[0056] In this case, the procedure of causing the train C (or the train B) to depart from the station is the same as the case 4-1. where the train B is made to first depart, and the description thereof will be omitted here. The drawings corresponding to above-described Fig. 7-7 to Fig. 7-9 in this case are illustrated in Fig. 7-13 to Fig. 7-15. Portions of symbols 720 to 724 illustrated in these drawings respectively correspond to portions of symbols 710 to 714 of above-described Fig. 7-7 to Fig. 7-9.

[0057] In addition, instead of the operation in which the train B and the train C wait, an operation that enables the train C to overtake the train B can be performed, by setting and locking the route passing through the station, and by giving the stop limit position so that the train can advance the calculated radio communication disruption section in 716 of Fig. 7-10.

[0058] Next, as another embodiment, an operation of the case where a calculated radio communication disruption section occurs in the middle of the route setting change in the train control system of the present embodiment will be described with reference to Fig. 8-1 to Fig. 8-6. Fig. 8-1 to Fig. 8-6 are diagrams describing the operation of the case where the calculated radio communication disruption section occurs in the middle of the route setting change in the train control system of the embodiment. In addition, the manner of description in Fig. 8-1 to Fig. 8-6 conforms to that is Fig. 7-1 to Fig. 7-15 described above.

[0059] In a state in which the station arrival route to the main track and the departure route from the main track are locked for the train E illustrated in Fig. 8-1 (at this time, the virtual traffic signal on the main track route is a virtual traffic signal 32 showing progress indication: others are virtual traffic signals 31 showing stop indication), when the train D which stops on the subsidiary main track is made to first depart, because the arrival of the train E is delayed, the operation management device 1 requests the interlocking control device 4 to unlock the main track departure route, and to lock the subsidiary track departure route. The interlocking control device 4 makes the signal information with respect to the main track departure route stop indication (Fig. 8-2: 801), and based on this, the ground control device 3 calculates the stop limit position in which the main track departure route entrance is made the obstacle position. At this time, the stop limit position of the train E is retracted (Fig. 8-2: 802).

[0060] In this case, when there is no obstacle in the radio communication, the ground control device 3 notifies the calculated stop limit position to the on-board control device 12 of the train E.

[0061] Having received the notification, the on-board control device 12 of the train E responds to the ground control device 3 that the train E can stop before reaching the new stop limit position (Fig. 8-3: 803). And having received the response, the ground control device 3 notifies that the route of the stop indication can be unlocked, to the interlocking control device 4.

[0062] Having received the notification, the interlocking control device 4 waits for the time necessary for the train E to stop, unlocks the main track departure route (Fig. 8-3: 804), sets the subsidiary main track departure route (Fig. 8-3: 805) for the train D, and locks the route.

[0063] On the other hand, in a case where the radio communication disrupted section occurs before the on-board control device 12 of the train E receives the stop limit position (Fig. 8-4), the train E emergently stops due to the radio communication disruption (Fig. 8-4: 806). However, until then, since the train E travels with the recognition that the entry into the main track departure route is permitted, it is likely that the train E enters up to the inside of the main track departure route and then stops. When the ground control device 3 unlocks the main track departure route after the elapse of a predetermined time, after reporting that the retracted stop limit position has been transmitted to the train E to the interlocking control device 4, as in a conventional interlocking control, it is likely that the train E will enter the branch part in which the point device 20 is not fixed, and be derailed.

[0064] In the present embodiment, the on-board control device 12 always notifies the ground control device 3 of the notified stop limit position and whether the train E can stop before reaching the stop limit position. Since the radio communication is disrupted before the train E receives the retracted stop limit position, the information which the ground control device 3 has received lastly from the on-board control device 12 of the train E is information that the train E can stop before reaching the stop limit position before retraction (= stop limit position capable of passing through the station).

[0065] With respect to the signal information, the ground control device 3 notifies to the interlocking control device 4 such that: (1) "unlocking impossible" with respect to the route of the progress indication, (2) "unlocking possible" with respect to the route of the stop indication, in a case where the notification that the train can stop up to the route entrance is obtained from the on-board control device 12, and (3) "unlocking impossible" in the other cases. Having not obtained the information indicating "the train can stop up to the main track departure route entrance" from the on-board control device 12 of the train E, the ground control device 3 notifies the interlocking control device 4 of "unlocking impossible" with respect to the main track departure route (Fig. 8-5: 807). In addition, the ground control device 3 sets the calculated radio communication disruption section, as described above, and performs control while regarding the range illustrated in Fig. 8-5: 808, as the on-rail range of the train E.

[0066] The interlocking control device 4 can unlock the set route before the train enters the set route, only when the information of "unlocking possible" is obtained. Here, since the information of "unlocking impossible" is notified from the ground control device 3, since the main track departure route remains locked, the safety is ensured.

[0067] When the train E which has stuck in the calculated radio communication disruption section is guided and moved to the station stop position by the human system (Fig. 8-6: 809), the on-board control device 12 can receive a new stop limit position from the ground control device 3 through the ATO ground coil 7, and can return the information indicating that the train can stop before reaching the stop limit position", and thereby the ground control device 3 notifies "unlocking possible" to the interlocking control device 4. Having received this notification, the interlocking control device 4 can safely unlock the main track departure route (Fig. 8-6: 810).

[0068] As described above, it is possible to continue the operation of the train 11, even when the calculated radio communication disruption section occurs in the middle of the route setting change.

[0069] As described above, according to the train control system of the above-described embodiments, in the train control system which notifies the train on-rail position from the train to the ground side control device using wireless, even when the radio communication disabled section occurs in all or part of the interlocking control section, the operations such as overtaking and waiting in this section can be realized at low costs, while safety is ensured.

[0070] While certain embodiments and examples of the present invention have been described, these embodiments and examples have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments and examples described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments and examples described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

DESCRIPTION OF THE SYMBOLS

[0071]

1	operation management device
2	system management device
3	ground control device
4	interlocking control device
5	ground radio communication device
6, 16	antenna
7	ATO ground coil
8	position correction ground coil
9	inter-base network
10	wayside network
11	train
12	on-board control device
13	ATO device
14	speed/position detection device
15	on-board radio communication device
17	on-board coil
18	TG
19	wheel
20	point device
21	rail

Claims

1. A train control system comprising:

ground radio communication means that transmits and receives information with on-board radio communication means of a train;
ground communication means that is installed at a predetermined stop position at which the train stops, and transmits and receives information with the on-board communication means of the train;
interlocking control means that performs a conversion of a point and a locking of a route; and
ground control means that calculates a stop limit position to be given to each train, based on a train position and an opening state of a train route, and controls the interlocking control means so as to perform operation control of each train in a predetermined section;
wherein the ground control means:

calculates a first stop limit position such that the train does not enter a calculated radio communication disruption section including all or part of a section in which the radio communication is disrupted between the ground radio communication means and the on-board radio communication means;
calculates, with respect to a train that is made to travel through the calculated radio communication disruption section, a second stop limit position so that the train reaches up to a position of the ground communication means, or a third stop limit position that is ahead of the calculated radio communication disruption section; and
in a state in which all or part of the train resides in the calculated radio communication disruption section, with respect to the train of which the radio communication is disrupted, estimates a current train position, based on an end position of the calculated radio communication disruption section in a train traveling direction, the second or third stop limit position, and a lastly received train position, and performs operation control of each train.

2. The train control system according to Claim 1, wherein: while the train stops at the predetermined stop position, the ground communication means receives position information from the on-board communication means of the train, and transmits the third stop limit position to the on-board communication means of the train.

3. The train control system according to Claim 1, wherein, before the train enters the calculated radio communication disruption section or while the train stops at the predetermined stop position, in a case where the stop limit position of the train becomes the third stop limit position, the ground control means transmits information including the third stop limit position, and an instruction to shift to a mode in which the train does not emergently stop even when the radio communication is disrupted, to the on-board communication means of the train through the ground communication means.

4. The train control system according to Claim 3, wherein: before the train enters the calculated radio communication disruption section, in a case where the stop limit position of the train is ahead of a position where the train can reach up to the predetermined stop limit, and is within the calculated radio communication disruption section, the ground control means transmits information including the second stop limit position designating the predetermined stop position, and the instruction to shift to the mode in which the train does not emergently stop even when the radio communication is disrupted, to the on-board radio communication means of the train through the ground radio communication means.

5. The train control system according to Claim 1, wherein: the ground communication means is communication means provided for controlling a home door.

6. In a train control method which has a ground radio communication unit that communicates with an on-board communication unit provided in a train, and a ground coil that is installed at a predetermined stop position at which the train stops, and is communicable with the train, calculates a stop limit position to be given to the train, based on information through the ground radio communication unit, and performs operation control of the train in a predetermined section, the train control method comprising:

when the radio communication between the on-board radio communication unit and the ground radio communication unit is disrupted, setting a calculated radio communication disruption section including a section in which the radio communication is disrupted;
with respect to a train traveling through the calculated radio communication disruption section, estimating an on-rail state of the train, based on a first stop limit position so that the train reaches up to a position of the ground coil, or a second stop limit position that is ahead of the calculated radio communication disruption section, and a lastly received train position; and
performing operation control of the train, based on the estimated on-rail state of the train.

7. The train control method according to Claim 6, further comprising:

calculating a third stop limit position such that the train does not enter the calculated radio communication disruption section;
wherein operation control of the train is performed to a train that is located upstream of the calculated radio communication disruption section, based on the third stop limit position, such that the train does not enter the calculated radio communication disruption section.

8. The train control method according to Claim 6, wherein:

when the train resides in the calculated radio communication disruption section, and the second stop limit position is set to the train, operation control of the train is performed such that the train in which a route is ensured is evacuated up to the outside of the calculated radio communication disruption section.

9. The train control method according to Claim 6, wherein:

when the train that is within the calculated radio communication disruption section, and is located more upstream than a position of the ground coil has moved to the position of the ground coil, the ground coil communicates with the train, to grasp the position of the train, and operation control is performed based on the position.

10. The train control method according to Claim 9, wherein:

when the train stops at the position of the ground coil, and the second stop limit position is set to the train, information including the second stop limit position and an instruction to shift to a mode in which the train does not emergently stop even when the radio communication is disrupted is transmitted to the on-board communication means of the train through the ground coil.

11. The train control method according to Claim 6, wherein:

the operation control of the train performs interlocking control between an upstream-side point to branch a route of the train into a first route and a second route, and a downstream-side point to make the first route and the second route join the route.

12. The train control method according to Claim 11, wherein:

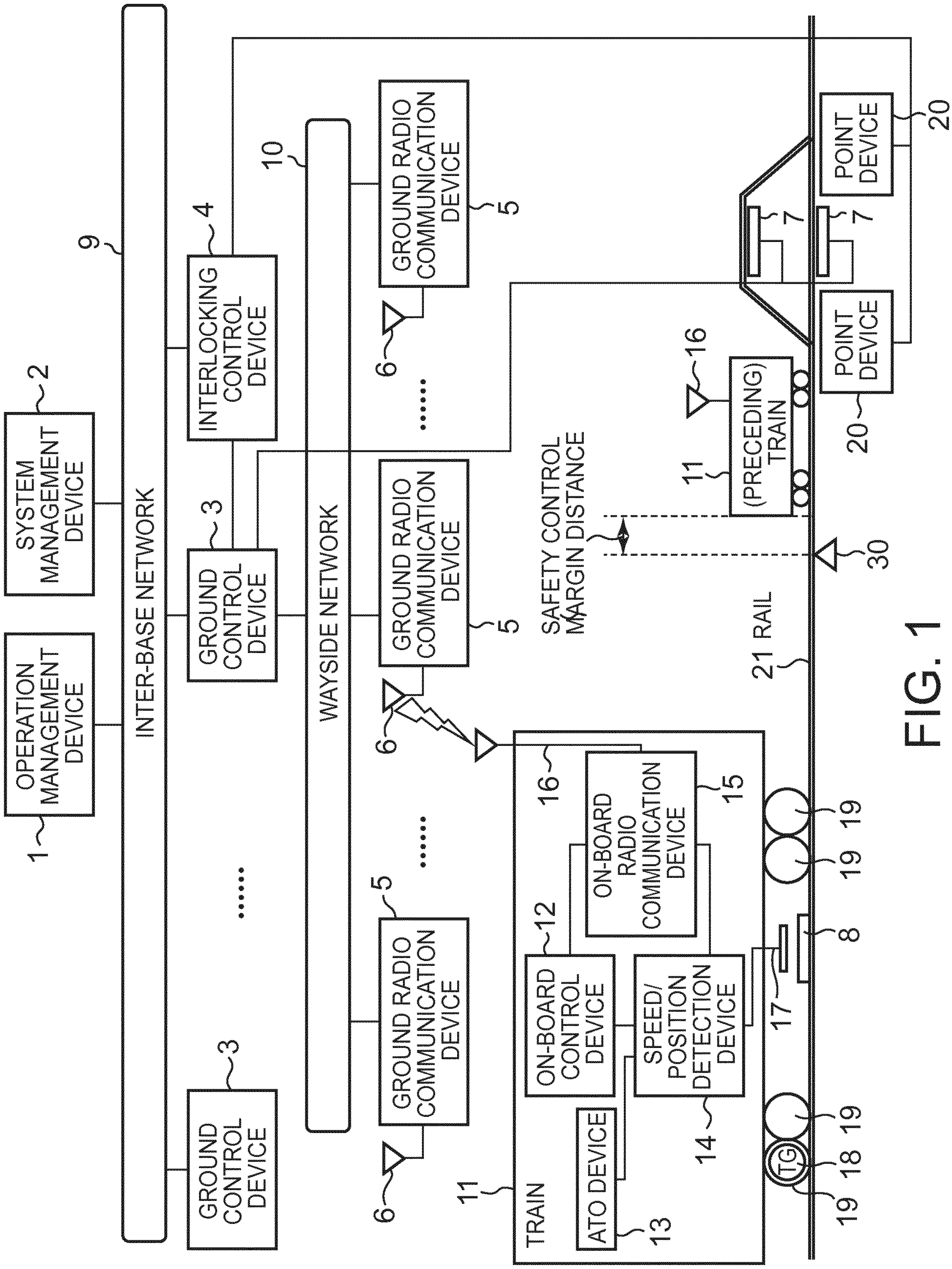
when the train traveling through the calculated radio communication disruption section stops at a position of a first ground coil on the first route, the route is converted to the second route by the upstream-side point device; and
with respect to a subsequent train traveling through the calculated radio communication disruption section, an on-rail state of the subsequent train is estimated, based on a fourth stop limit position so as to make the train reach up to a position of a second ground coil on the second route, and a lastly received train position.

13. The train control method according to Claim 12, wherein:

when the subsequent train becomes on rail within the calculated radio communication disruption section, and on the downstream side of the ground coil;
an on-rail state of the subsequent train is estimated, based on the stop limit position, an end position of the calculated radio communication disruption section in a traveling direction, and a lastly received position of the subsequent train; and
conversion control is performed to the route, by operating the downstream-side point, such that the train can advance from the second route.

14. The train control method according to Claim 6, wherein:

before the train enters the calculated radio communication disruption section, and in a case where the stop limit position of the train is ahead of the position of the ground coil and is within the calculated radio communication disruption section, information including the second stop limit position designating the ground coil, and an instruction to shift to a mode in which the train does not emergently stop even when the radio communication is disrupted is transmitted to the on-board radio communication means of the subsequent train through the ground radio communication means.


OPERATION MANAGEMENT DEVICE
SYSTEM MANAGEMENT DEVICE
INTER-BASE NETWORK
GROUND CONTROL DEVICE
INTERLOCKING CONTROL DEVICE
WAYSIDE NETWORK
GROUND RADIO COMMUNICATION DEVICE
SAFETY CONTROL MARGIN DISTANCE
(PRECEDING) TRAIN
POINT DEVICE
21 RAIL
TRAIN
ATO DEVICE
ON-BOARD CONTROL DEVICE
SPEED/ POSITION DETECTION DEVICE
ON-BOARD RADIO COMMUNICATION DEVICE
TG
1
2
3
4
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6
7
8
9
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20
30

FIG. 1

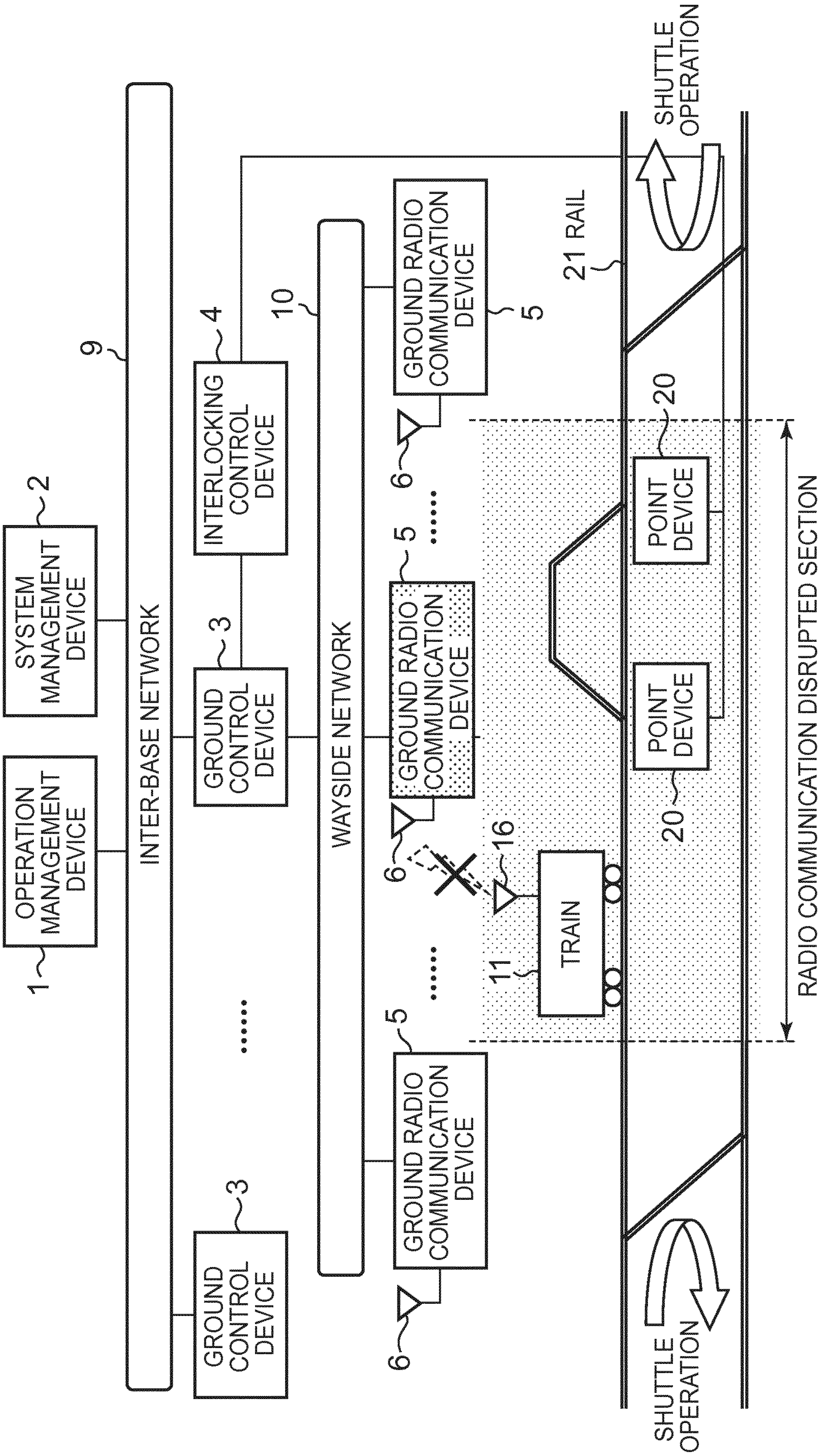

1
OPERATION MANAGEMENT DEVICE
2
SYSTEM MANAGEMENT DEVICE
9
INTER-BASE NETWORK
3
GROUND CONTROL DEVICE
4
INTERLOCKING CONTROL DEVICE
3
GROUND CONTROL DEVICE
10
WAYSIDE NETWORK
5
GROUND RADIO COMMUNICATION DEVICE
5
GROUND RADIO COMMUNICATION DEVICE
5
GROUND RADIO COMMUNICATION DEVICE
6
6
6
16
11
TRAIN
20
POINT DEVICE
20
POINT DEVICE
21 RAIL
SHUTTLE OPERATION
SHUTTLE OPERATION
RADIO COMMUNICATION DISRUPTED SECTION

FIG. 2

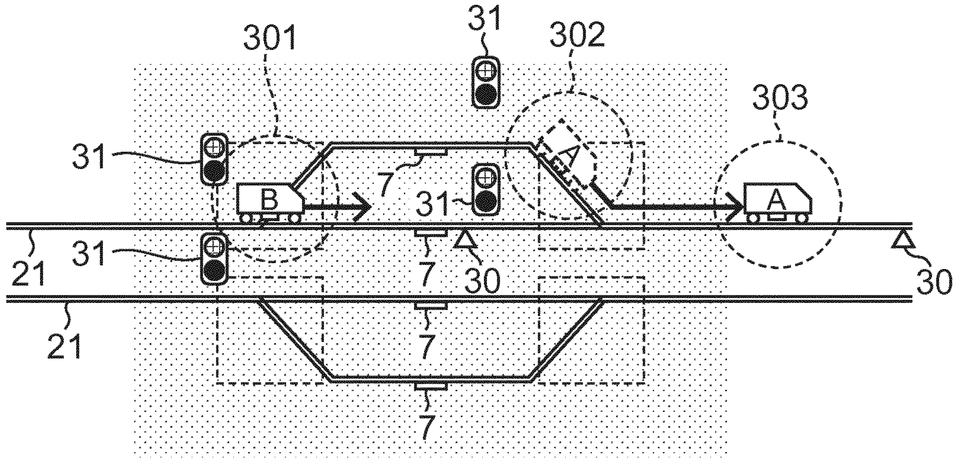


FIG. 3-1

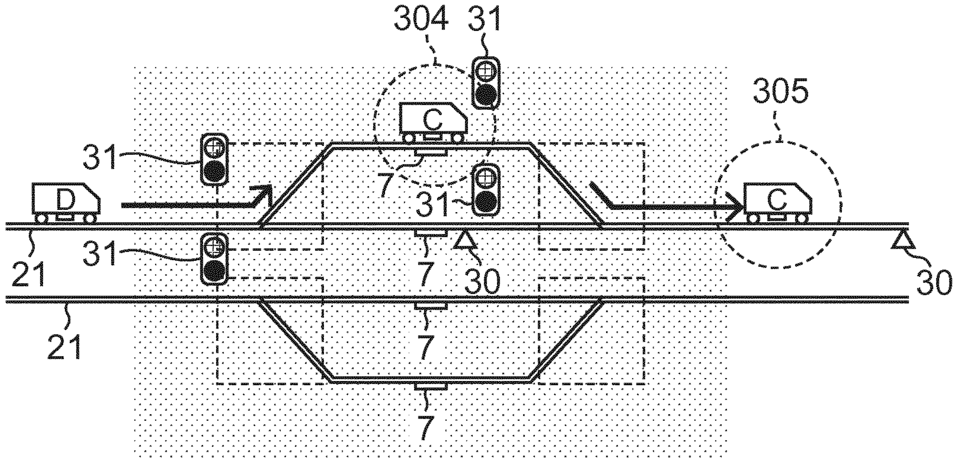


FIG. 3-2

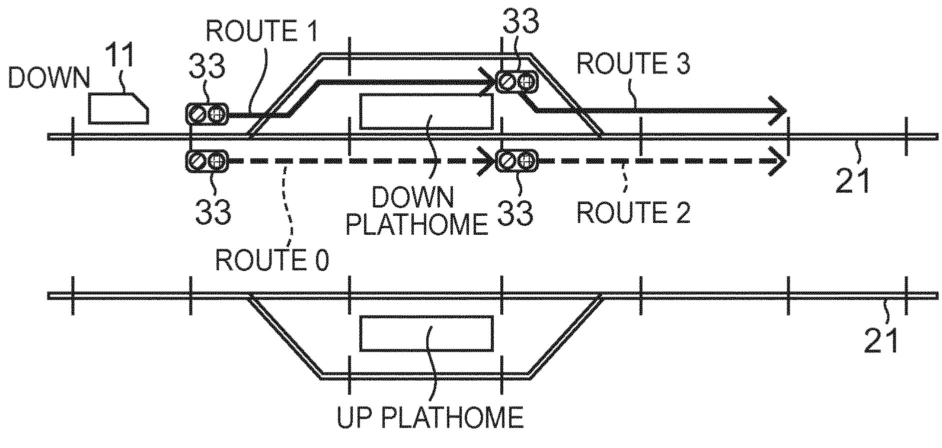


FIG. 4-1

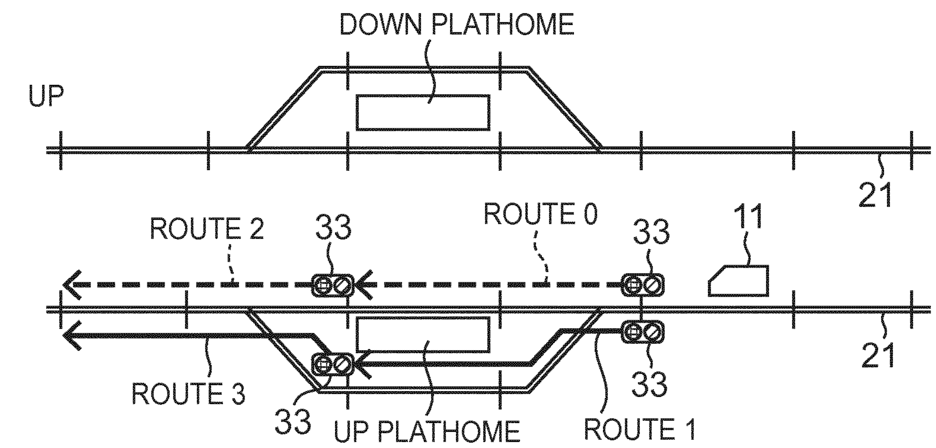


FIG. 4-2

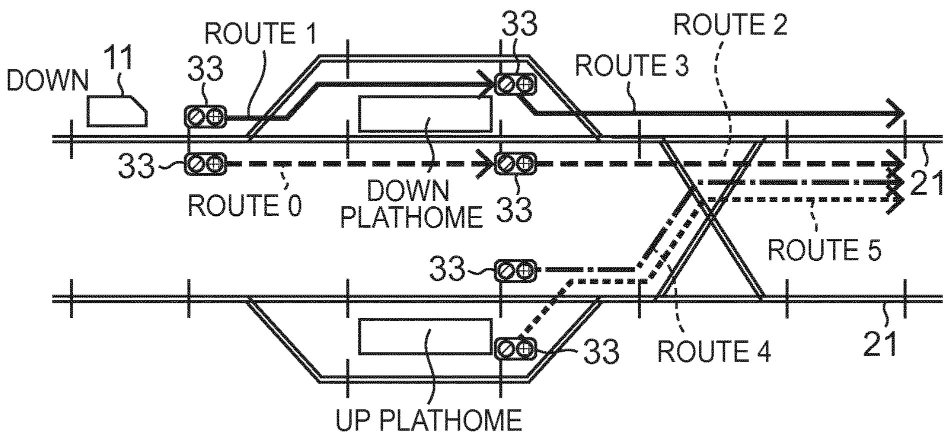


FIG. 4-3

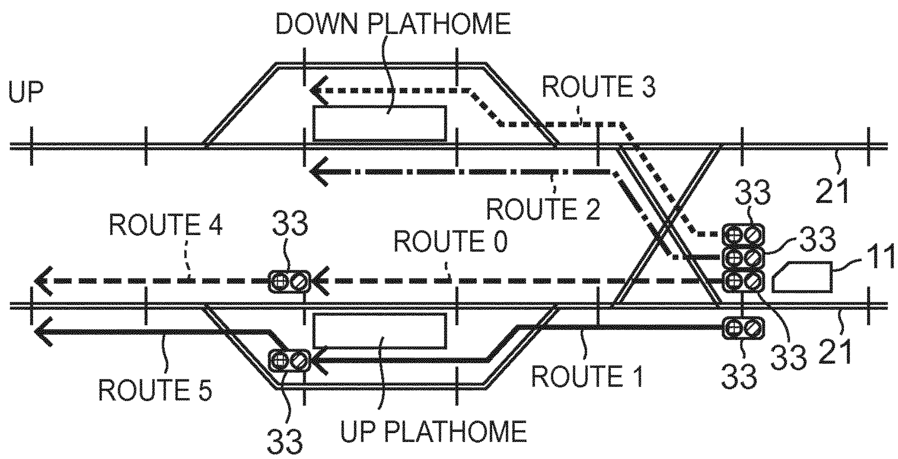


FIG. 4-4

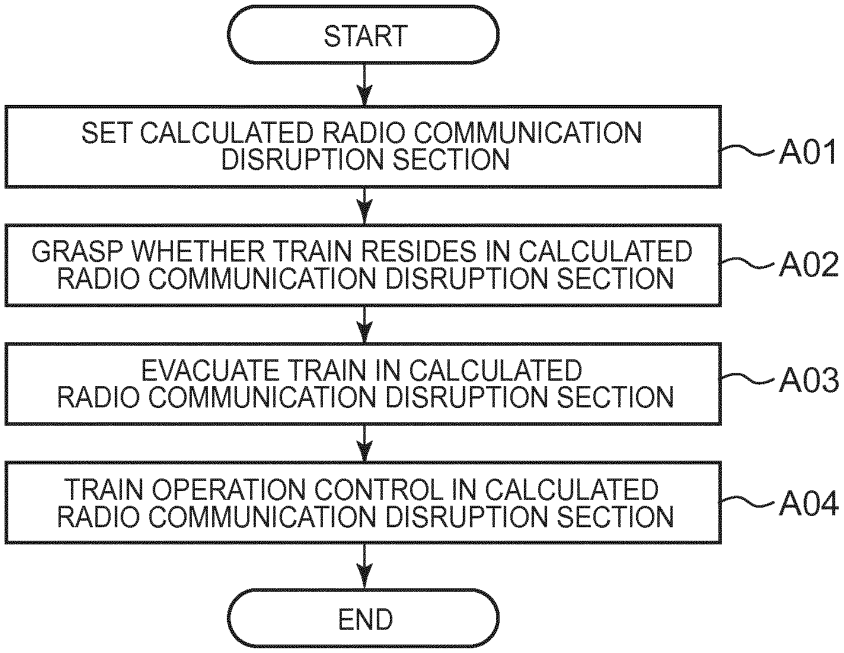

START
SET CALCULATED RADIO COMMUNICATION DISRUPTION SECTION
A01
GRASP WHETHER TRAIN RESIDES IN CALCULATED RADIO COMMUNICATION DISRUPTION SECTION
A02
EVACUATE TRAIN IN CALCULATED RADIO COMMUNICATION DISRUPTION SECTION
A03
TRAIN OPERATION CONTROL IN CALCULATED RADIO COMMUNICATION DISRUPTION SECTION
A04
END

FIG. 5

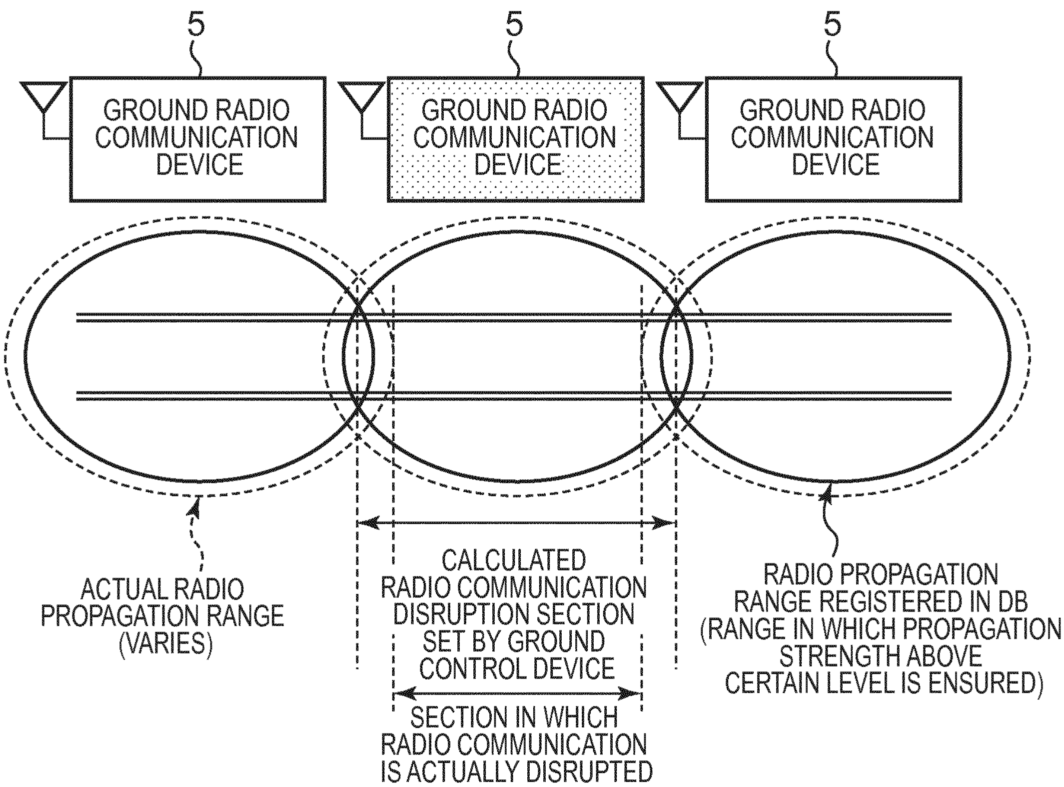

5
GROUND RADIO COMMUNICATION DEVICE
5
GROUND RADIO COMMUNICATION DEVICE
5
GROUND RADIO COMMUNICATION DEVICE
ACTUAL RADIO PROPAGATION RANGE (VARIES)
CALCULATED RADIO COMMUNICATION DISRUPTION SECTION SET BY GROUND CONTROL DEVICE
SECTION IN WHICH RADIO COMMUNICATION IS ACTUALLY DISRUPTED
RADIO PROPAGATION RANGE REGISTERED IN DB (RANGE IN WHICH PROPAGATION STRENGTH ABOVE CERTAIN LEVEL IS ENSURED)

FIG. 6

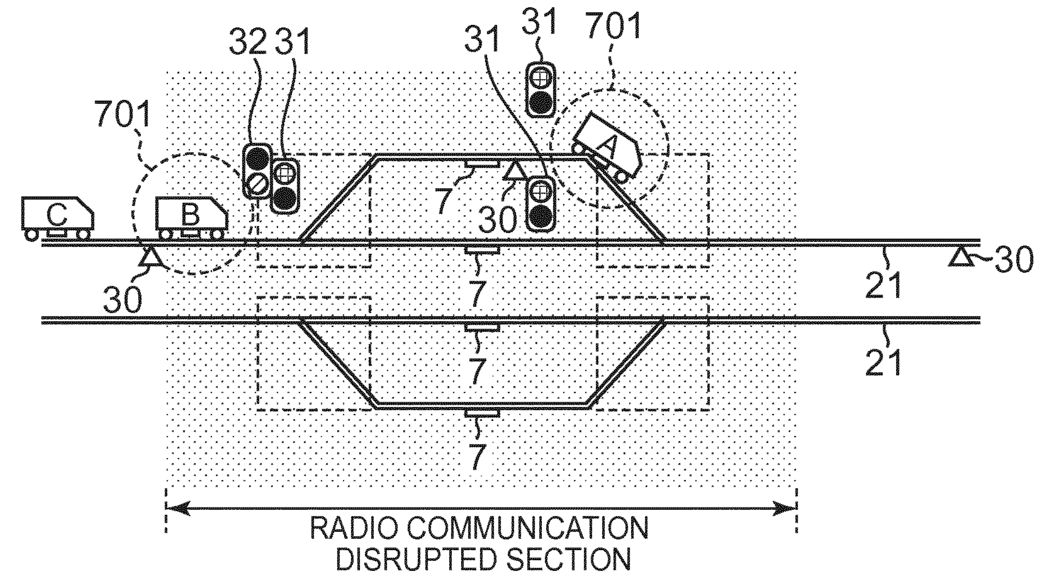

32
31
31
31
701
701
A
C
B
7
30
30
7
21
30
7
21
7
RADIO COMMUNICATION
DISRUPTED SECTION

FIG. 7-1

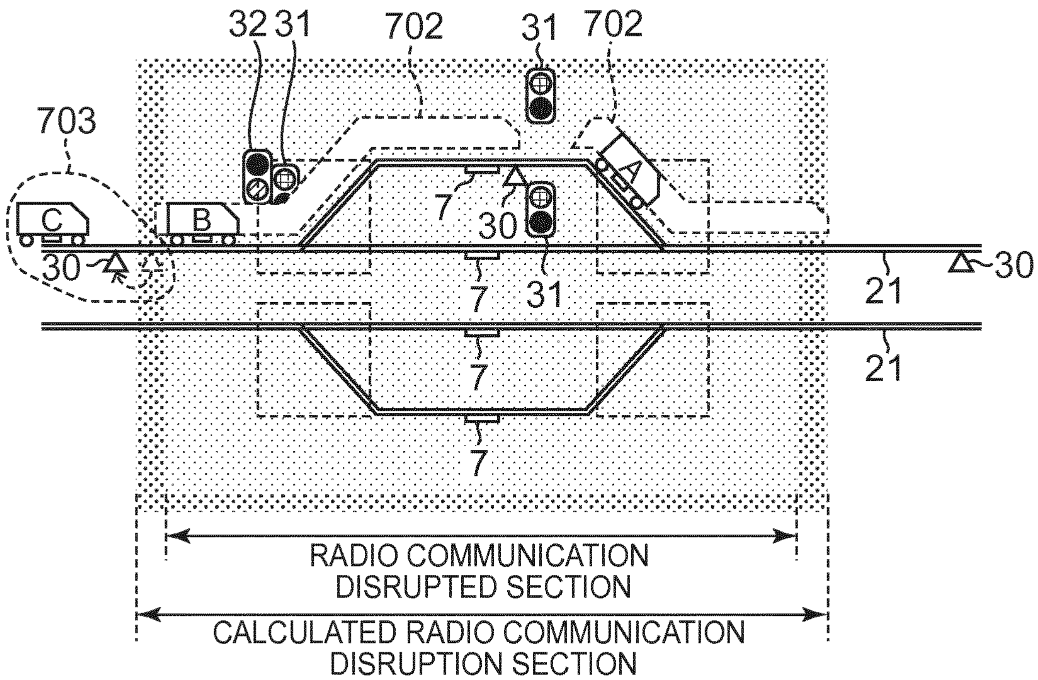

32
31
702
31
702
703
A
C
B
7
30
30
31
7
21
30
7
21
7
RADIO COMMUNICATION
DISRUPTED SECTION
CALCULATED RADIO COMMUNICATION
DISRUPTION SECTION

FIG. 7-2

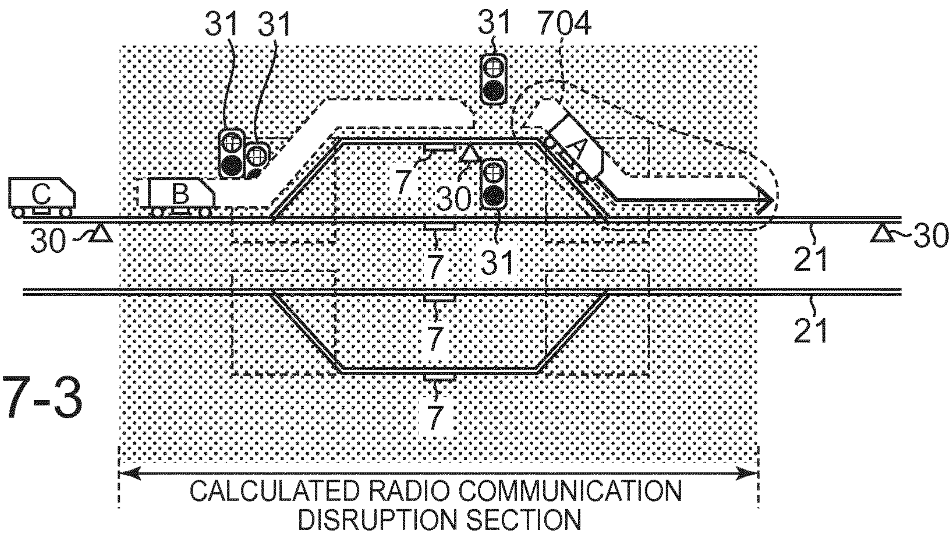


FIG. 7-3

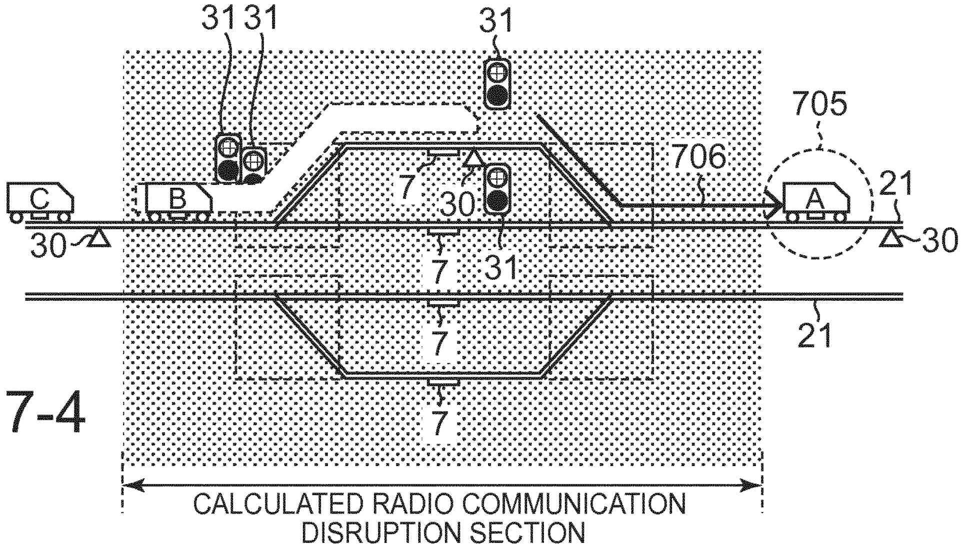


FIG. 7-4

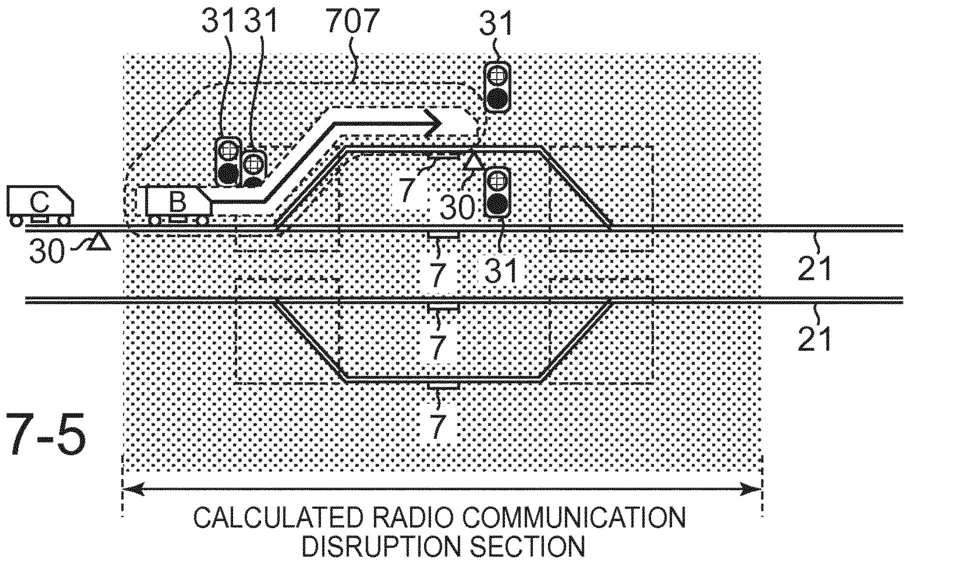


FIG. 7-5

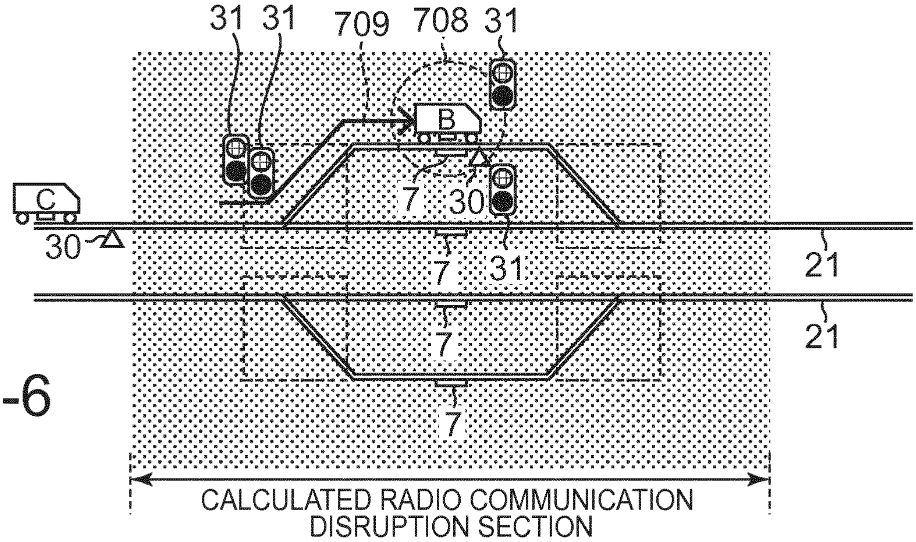


FIG. 7-6

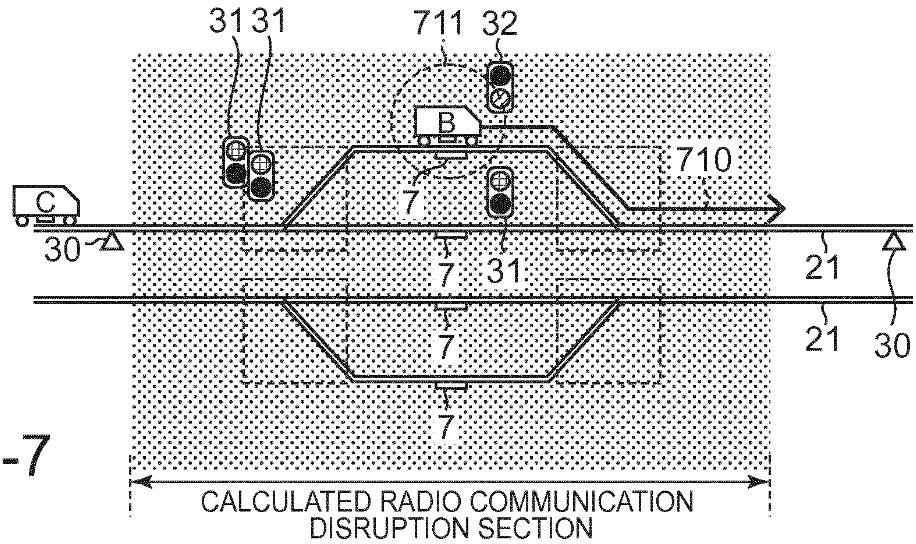


FIG. 7-7

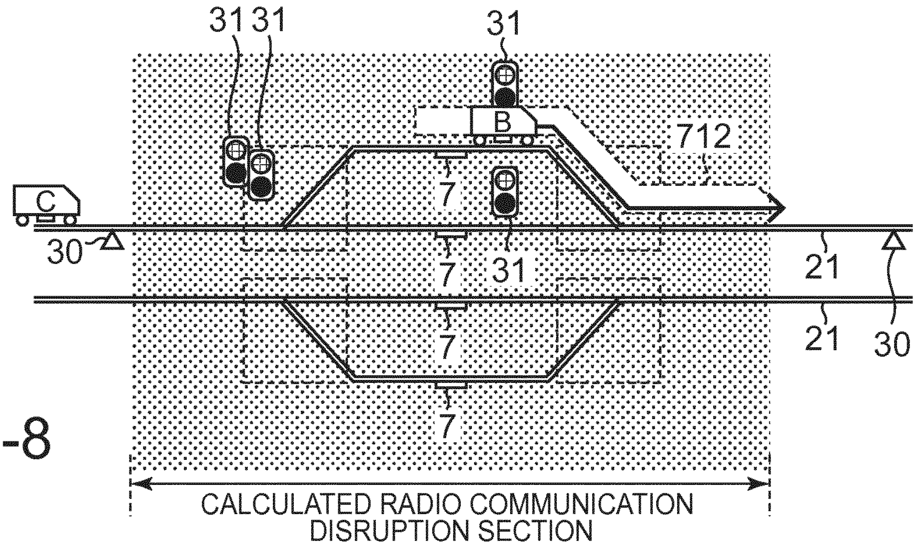


FIG. 7-8

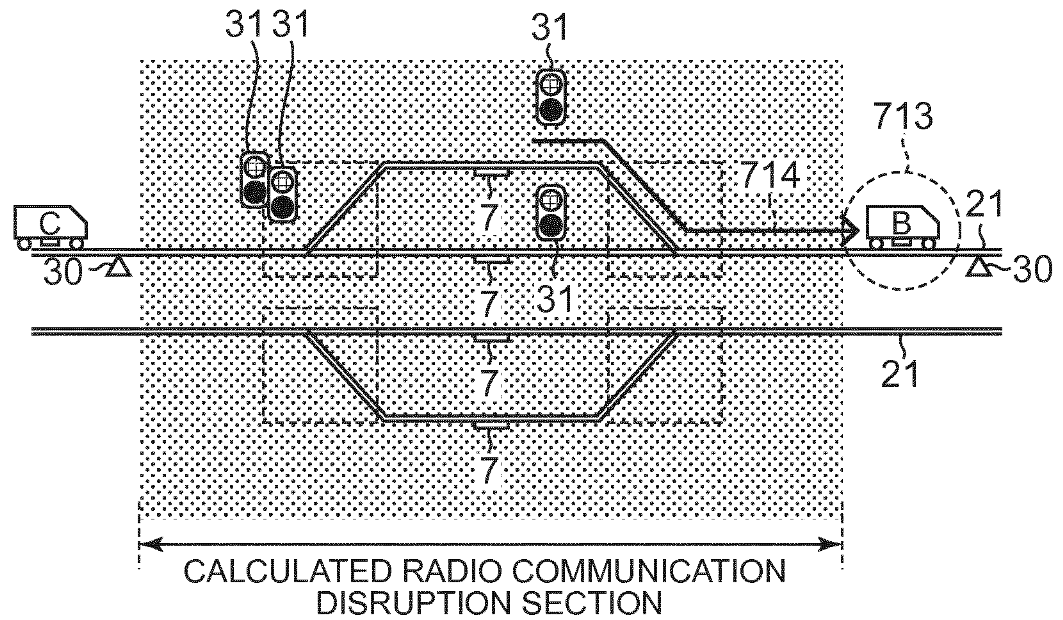


FIG. 7-9

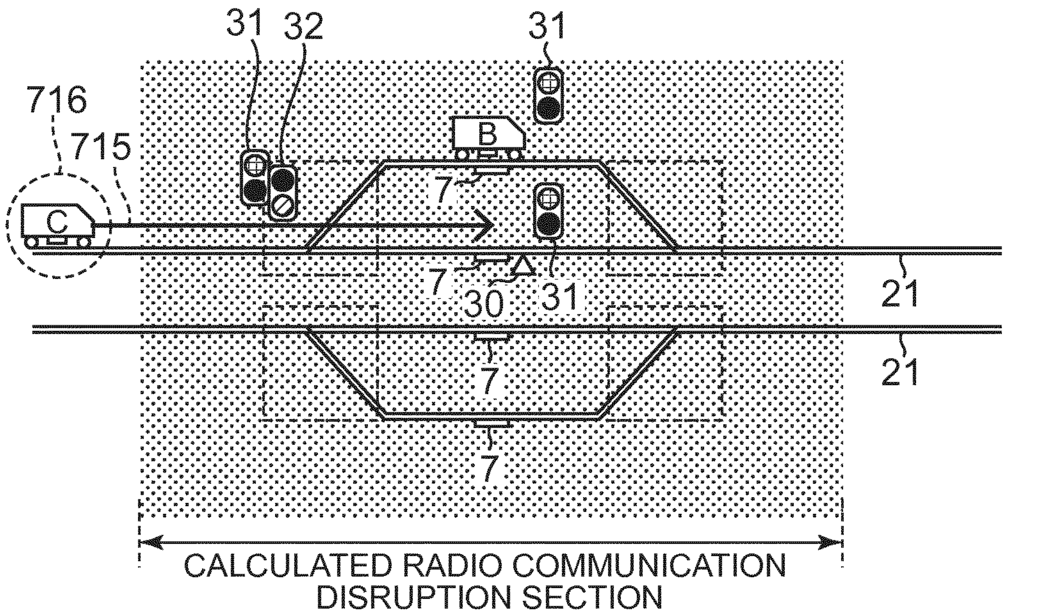


FIG. 7-10

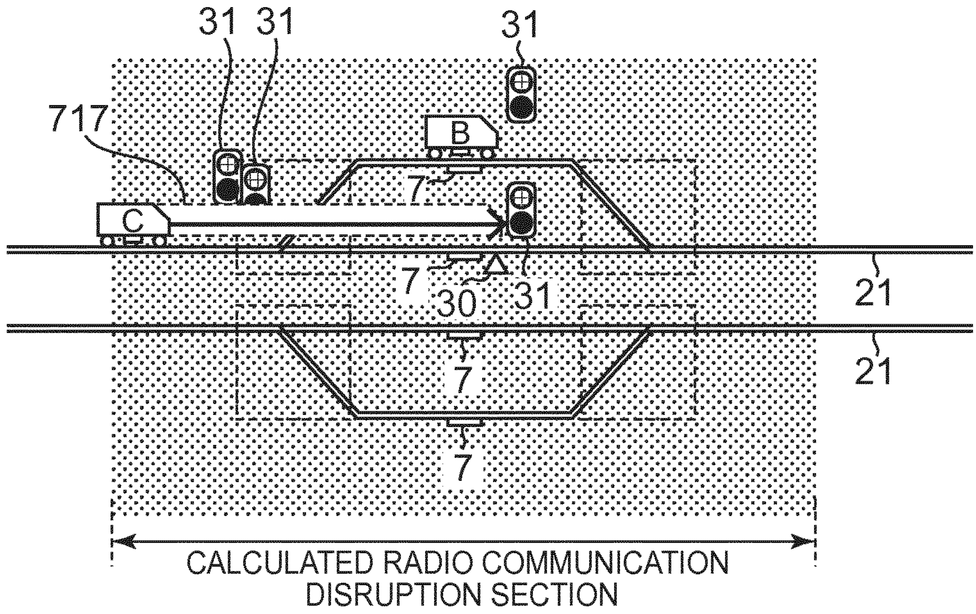


FIG. 7-11

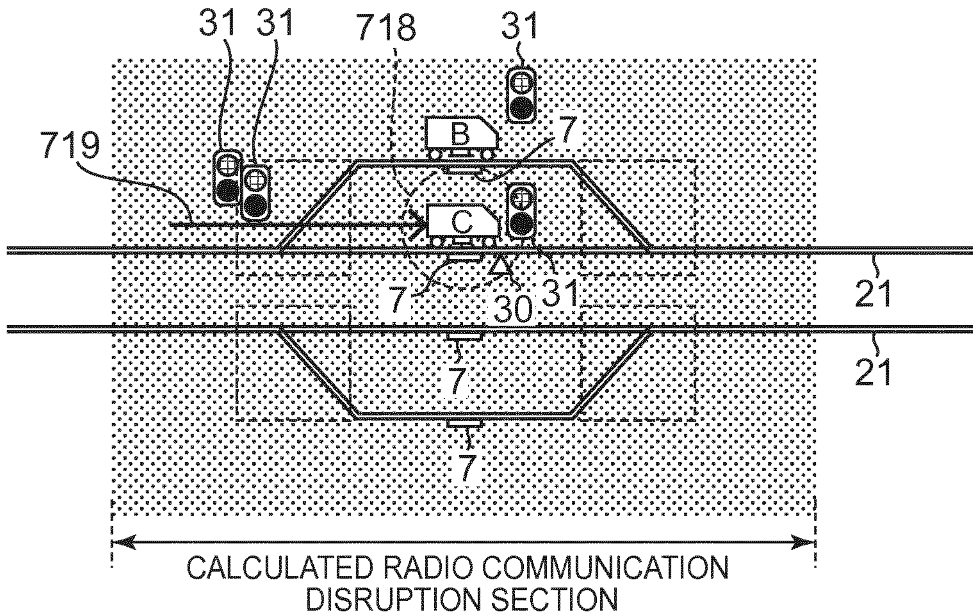


FIG. 7-12

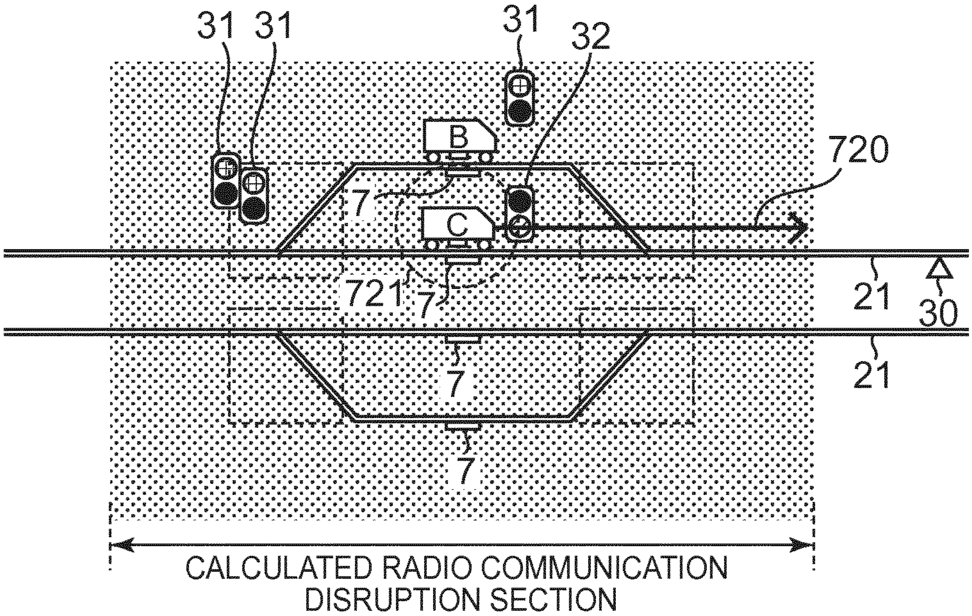


FIG. 7-13

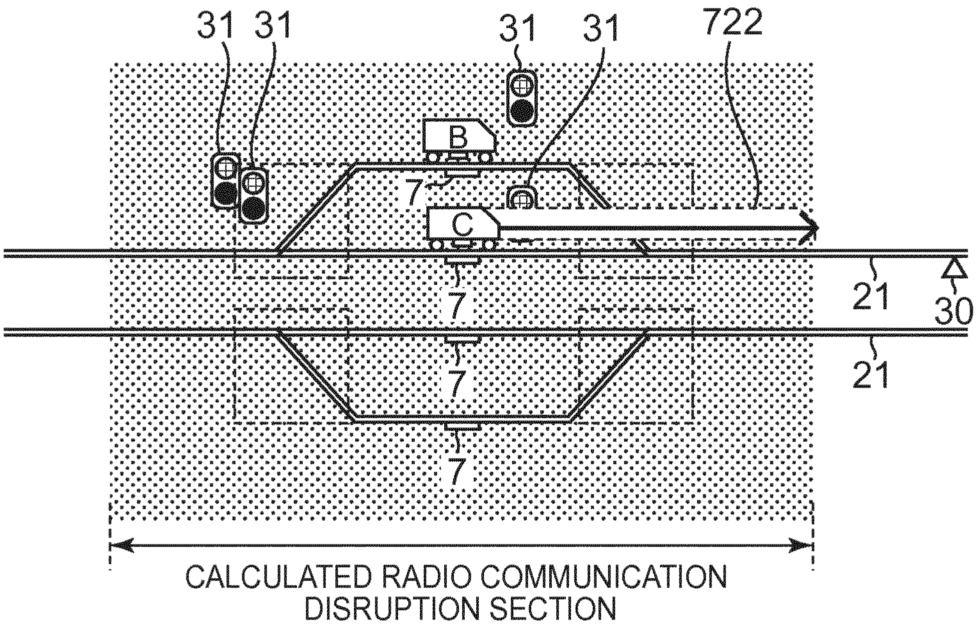


FIG. 7-14

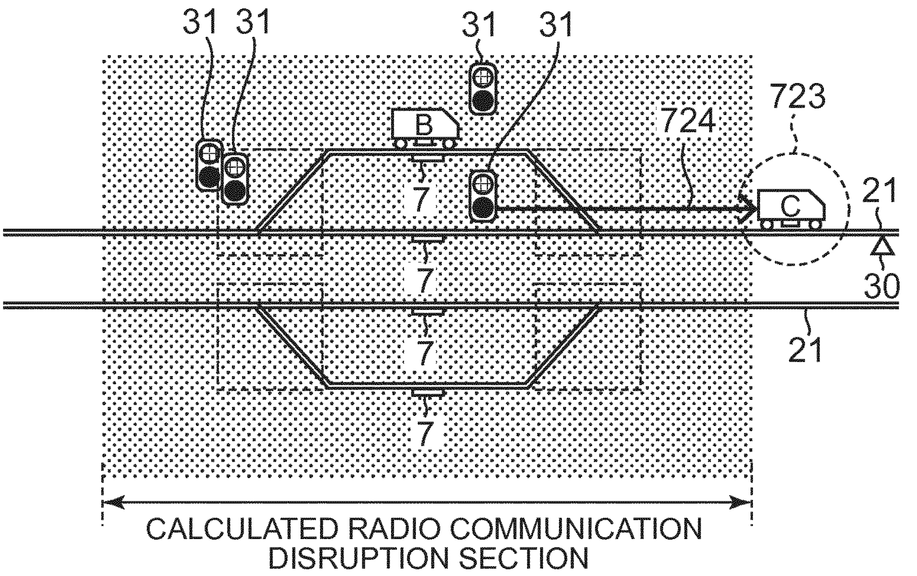


FIG. 7-15

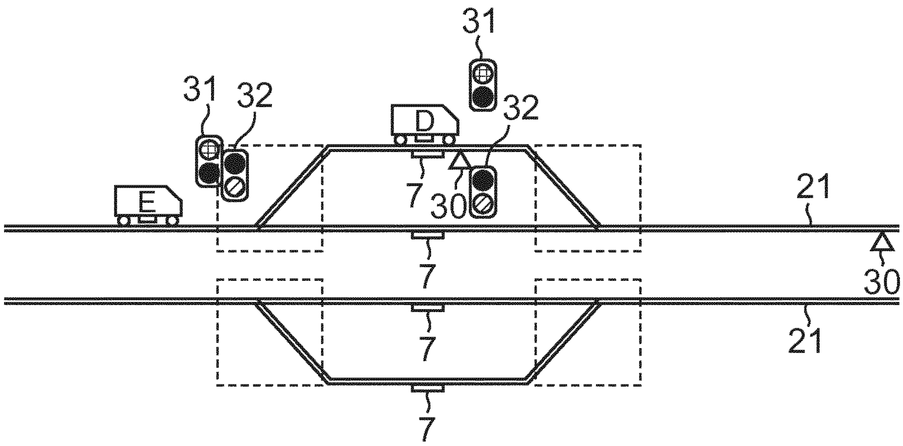


FIG. 8-1

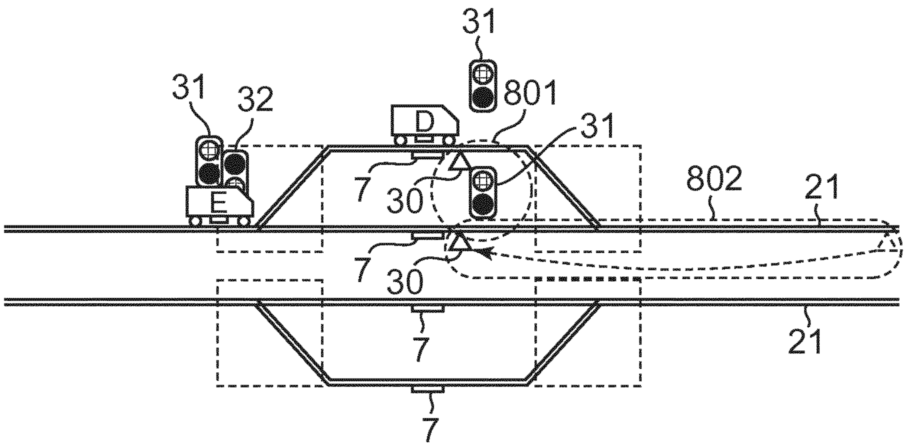
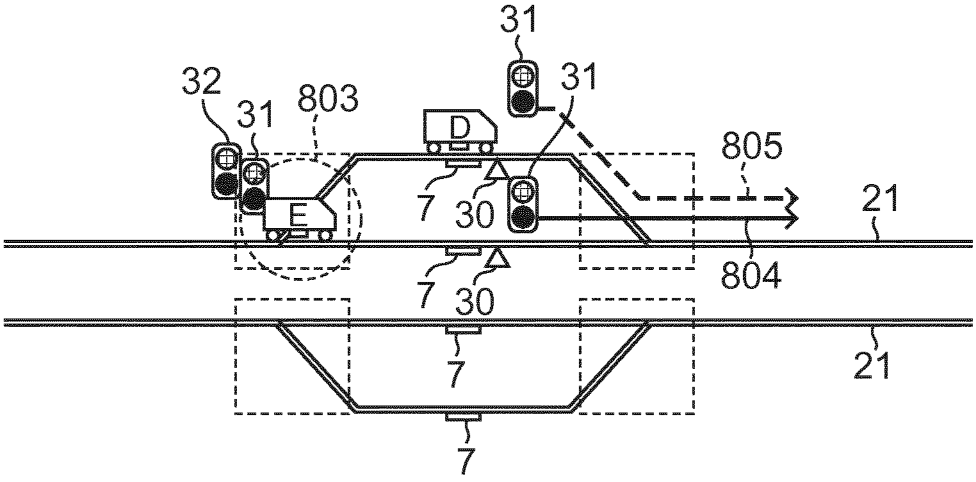


FIG. 8-2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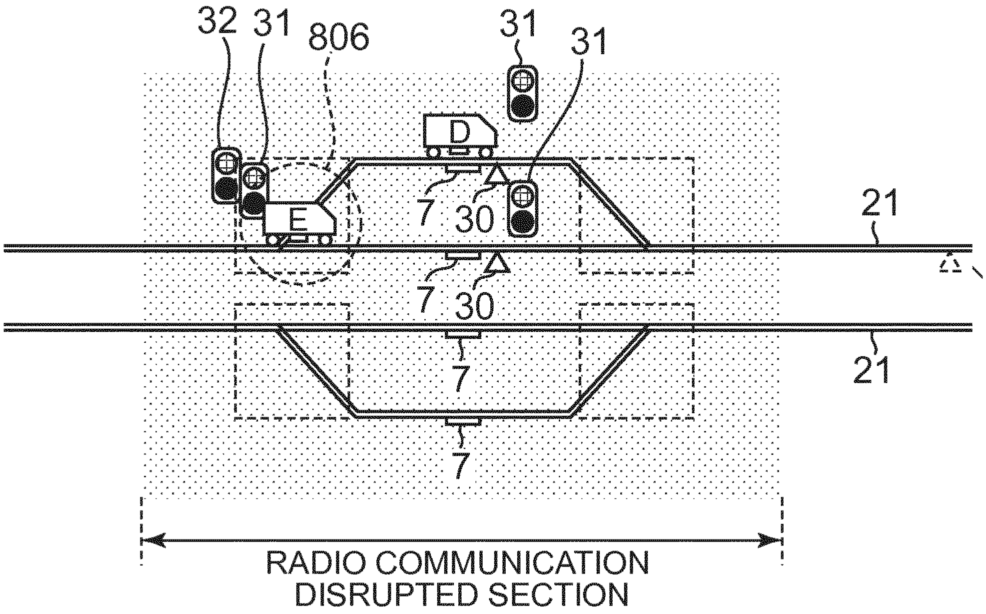
7

FIG. 8-3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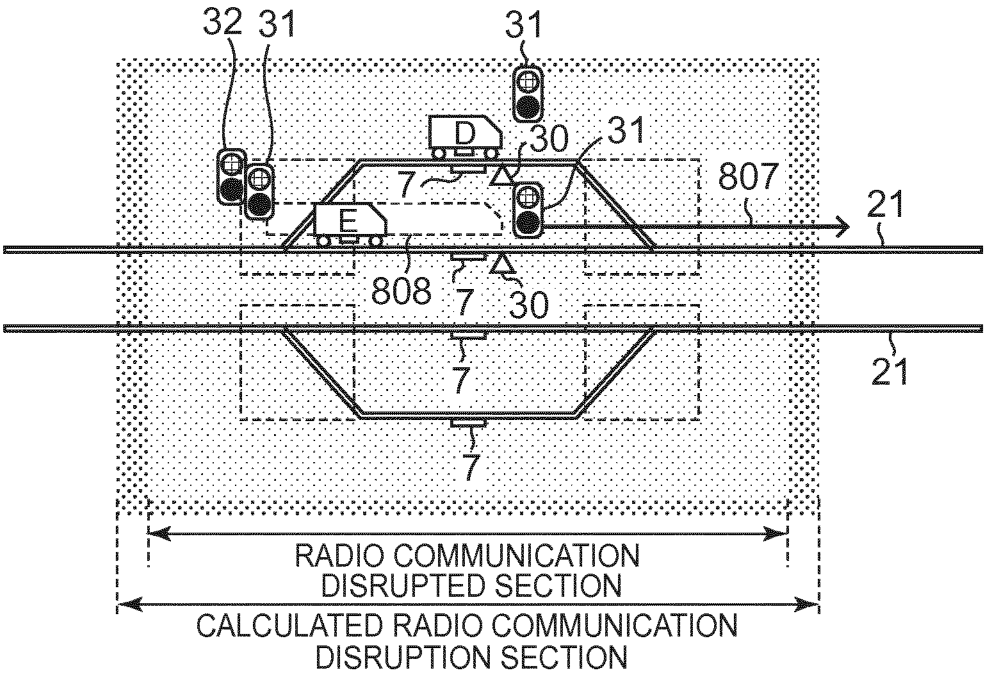
7
RADIO COMMUNICATION
DISRUPTED SECTION

FIG. 8-4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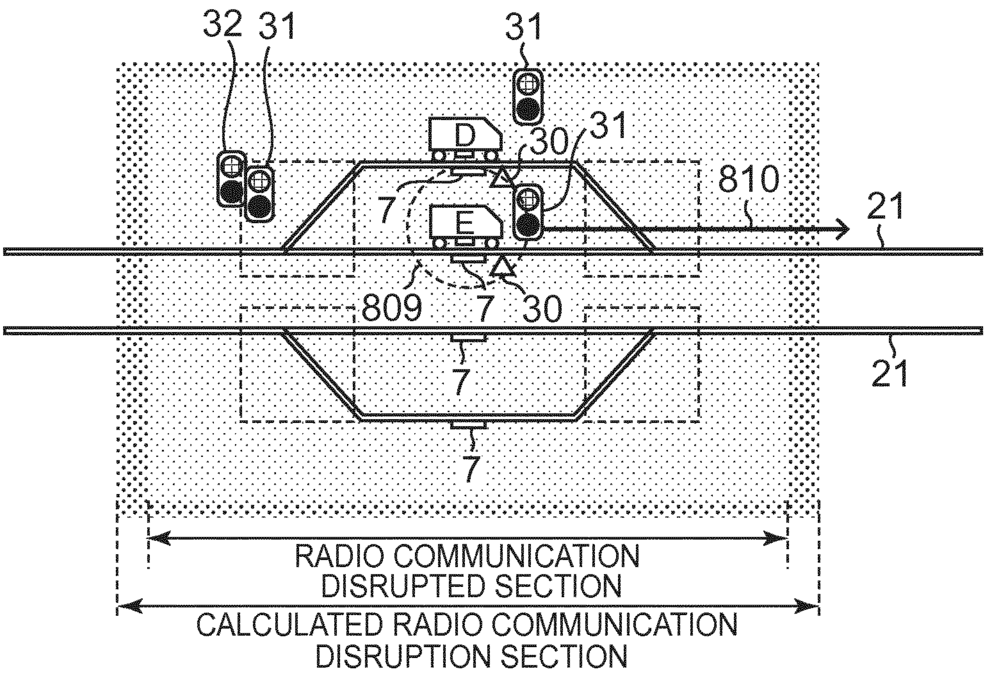
RADIO COMMUNICATION
DISRUPTED SECTION
CALCULATED RADIO COMMUNICATION
DISRUPTION SECTION

FIG. 8-5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RADIO COMMUNICATION
DISRUPTED SECTION
CALCULATED RADIO COMMUNICATION
DISRUPTION SECTION

FIG. 8-6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/005317

A. CLASSIFICATION OF SUBJECT MATTER
B61L23/14(2006.01)i, *B61L3/12*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61L23/14, B61L3/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-245818 A (Toshiba Corp.), 14 September 1999 (14.09.1999), entire text (Family: none)	1-14
A	JP 2003-276606 A (Kyosan Electric Mfg. Co., Ltd.), 02 October 2003 (02.10.2003), entire text (Family: none)	1-14
A	JP 2006-298069 A (Toshiba Corp.), 02 November 2006 (02.11.2006), entire text (Family: none)	1-14

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 October, 2013 (02.10.13)	15 October, 2013 (15.10.13)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/005317

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-256545 A (Hokkaido Railway Co.), 28 September 2006 (28.09.2006), entire text (Family: none)	1-14

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- JP 2012268515 A **[0001]**
- JP 4301888 B **[0005]**
- JP 2007124148 A **[0038]**