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

(11) **EP 3 581 461 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.12.2019 Bulletin 2019/51

(51) Int Cl.:
B61L 27/00 *(2006.01)*

(21) Application number: **19175779.8**

(22) Date of filing: **21.05.2019**

(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
Designated Validation States:
KH MA MD TN

(30) Priority: **06.06.2018 JP 2018108756**

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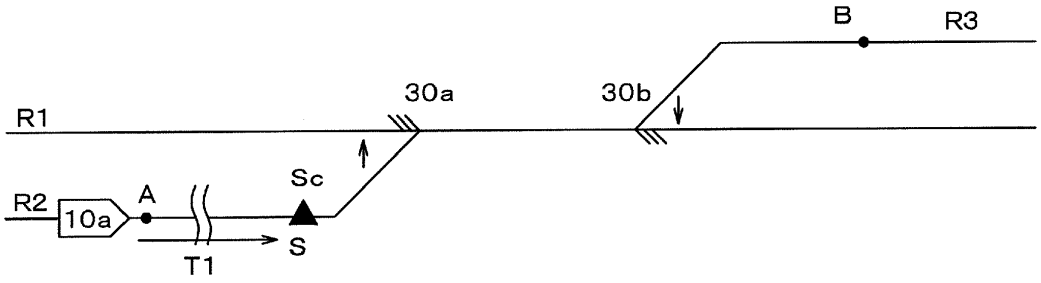
(54) **ON-VEHICLE APPARATUS**

(57) After setting a starting point A and an arrival point B, an operation management apparatus extracts a route traveling on the track R up to the arrival point B of the own train 10a. Subsequently, the own train 10a travels on the extracted route, trouble positions that hinder traveling are extracted, and among these trouble positions, a trouble position first existing is extracted as a trouble point S. Once only an occupied section T1 up to the trouble point S is locked in the route and the trouble point S is set, the own train 10a starts traveling in the occupied section T1. By repeating operation management control of route-locking only the occupied section T1 up to a trouble point S first existing on the route, and then traveling, unnecessary passage waiting is prevented based on the route-locking by another train 10.

FIG. 6



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Description

Technical Field

[0001] The present invention relates to an on-vehicle apparatus of a train of which the operation control is performed by a train operation management system.

Background Art

[0002] JP-2000-229574 discloses an operation management apparatus including an interlocking device state receiving unit that receives information from an interlocking device, a route control determining unit that determines route control based on the information of the interlocking device from the interlocking device state receiving unit, a facility state receiving unit that receives an existence of a train on a track circuit together with time information, and a route control command unit that issues a route control command. In order to allow the train to travel to a destination position, the operation management apparatus performs operation management to prevent another train from traveling in a route-locked section by setting the track circuit on a route in a locked state.

[0003] In the operation management apparatus of JP-2000-229574, in a case where a preceding train up to the destination position is locked in a route, once a position at which a route of a next train conflicts with the route of the preceding train exists, the next train needs to wait until the route-locking of the preceding train is released. Then, since the route-locking of the preceding train is released, and the route-locking of a route in which the next train travels is performed, the operation control is performed to allow the next train to enter the route.

[0004] However, in the operation management apparatus of JP-2000-229574, even though it is obvious that the next train is able to pass through a conflicting section in the route earlier than the preceding train, since a train that has secured the route earlier takes precedence, the next train needs to wait at a predetermined position until the train, which has secured the route, passes through the route-locked section.

[0005] Furthermore, in the operation management apparatus of JP-2000-229574, since a section for ensuring the route is a unit of the track circuit, there is also a problem that it is impossible to perform operation control of setting a route from a position of the own train on the track to an optional position in a locked state.

[0006] To solve the aforementioned problem, an object of the invention is to provide an on-vehicle apparatus of a train of which traveling management control is performed by a train operation management system that performs operation management control of locking an optional section on a track in a route and preferentially route-locking a train first attempting to pass through a passage section, to be allowed to pass therethrough.

Summary of the Invention

[0007] In order to achieve the object, there is provided an on-vehicle apparatus according to the invention which communicates with an operation management apparatus that performs operation control of extracting a route up to an arrival point in a case where the arrival point of an own train is set, extracting a first trouble position that hinders traveling on the route as a trouble point, and setting the trouble point by route-locking only a section up to the trouble point as an occupied section of the own train, such that it is possible to prevent another train from entering the occupied section; and is disposed on the own train traveling on a track, the on-vehicle apparatus performing traveling management control by setting the trouble point in a case where traveling information including the trouble point is received from the operation management apparatus.

[0008] According to the on-vehicle apparatus of the invention, by repeating the operation management control, by a train operation management system, such that each train locks only an occupied section up to a trouble point first existing on the route, in the route, sets a stop determination position, and travels in the occupied section, it is possible to prevent unnecessary passage waiting based on the route-locking by another train.

[0009] Also, by traveling management control of the on-vehicle apparatus, without the passage waiting, the own train is able to travel in a section which the own train is able to pass through until the other train arrives, and it is possible to safely move each train to the arrival point.

Brief Description of the Drawings

[0010]

Fig. 1 is a system configuration diagram of a train operation management system.

Fig. 2 is an explanatory diagram of a point machine disposed in a track.

Fig. 3 is a flowchart diagram of the operation control of an operation management apparatus.

Fig. 4 is a flowchart diagram of traveling management control of an on-vehicle apparatus.

Fig. 5 is a route map on which a starting point and an arrival point of the own train are set.

Fig. 6 is a route map when the first trouble point is extracted.

Fig. 7 is a route map when a trouble point occurring at a railroad crossing is interrupted on the route map of Fig. 6.

Fig. 8 is a route map in a state where an occupied section up to a next trouble point is locked at a stop determination position in the route.

Fig. 9 is a route map when an occupied section of another train exists and the own train arrives at the stop determination position.

Fig. 10 is a route map when the own train stops be-

fore a trouble point due to the occupied section by another train.

Fig. 11 is a route map in a state where an occupied section of another train exists and the own train locks the occupied section up to the trouble point in the route.

Fig. 12 is a route map in a state in which the own train locks the occupied section up to the trouble point that is another train, in the route.

Fig. 13 is a route map in a state where the occupied section up to the trouble point moved by the own train is locked in the route.

Fig. 14 is a route map when a trouble point occurring at a railroad crossing is interrupted on a route map in Fig. 6 as a modified example.

Mode for Carrying Out the Invention

[0011] The invention will be described in detail, by way of example, based on the embodiments illustrated in the drawings.

[0012] Fig. 1 is a configuration diagram of a train operation management system according to this embodiment. This train operation management system includes: a train 10 traveling on a track R; a central control unit 20 that performs communication control with a ground apparatus installed in the vicinity of each train 10 and the track R; a point machine 30 and a railroad crossing apparatus 40 that are ground apparatus and that are connected to the central control unit 20; and a radio communication unit 50 that is connected to the central control unit 20 and performs communication with each train 10 through a radio communication line.

[0013] The point machine 30 and the railroad crossing apparatus 40 and the central control unit 20 are connected by a first communication network L1, and the radio communication unit 50 and the central control unit 20 are connected by a second communication network L2.

[0014] Although the first communication network L1 and the second communication network L2 are illustrated as a wired network, they may be wireless networks, and the first communication network L1 and the second communication network L2 may be a single network.

[0015] A radio communication unit 50, which is a base station having a communication area in a predetermined range, is installed, for example, at certain distance intervals, and by partially overlapping communication areas, communication between the train 10 and the central control unit 20 is prevented from being interrupted. In the communication between the train 10 and the central control unit 20, it is possible to perform communication using a loop antenna and a leaking coaxial cable laid along the track R as the radio communication unit 50, in addition to performing communication through the radio communication line.

[0016] The train 10 is provided with an antenna unit 11 for transmitting and receiving various types of information to and from the radio communication unit 50, and an on-vehicle apparatus 12 connected to the antenna unit 11. The on-vehicle apparatus 12 incorporates an arithmetic processing unit and a storage unit (not illustrated), manages the speed control of the train 10, and displays traveling information such as information on the operation management received from the central control unit 20 and the current position of the train 10, on a route map or the like displayed on a monitor apparatus provided in an operator console of a driver's seat (not illustrated) or the like.

[0017] Furthermore, it is possible to perform various types of setting processing and the like by the driver through an input unit such as a keyboard (not illustrated). Also, on-vehicle information including a train ID, a traveling speed and a traveling position, and the like of the train 10, to be processed by the on-vehicle apparatus 12 is transmitted to the central control unit 20, through the antenna unit 11 and the radio communication unit 50 at any time, independently of transmission information based on a flowchart to be described later.

[0018] The traveling speed of on-vehicle information is calculated based on, for example, the number of revolutions detected by a tachometer attached to an axle. Also, the traveling position is calculated, for example, in kilometers. Alternatively, a GPS terminal may be mounted so that latitude and longitude information may be transmitted as the traveling position. Furthermore, the on-vehicle apparatus 12 performs speed control and the like of the train 10, according to command information such as speed control information transmitted from the central control unit 20.

[0019] The central control unit 20 installed at a station or the like in the train operation management system includes an operation management apparatus 21 connected to the first communication network L1 and the second communication network L2; and an operation terminal 22 connected to the operation management apparatus 21 and operated by an operator.

[0020] The operation management apparatus 21 is a so-called server apparatus, incorporating an arithmetic processing unit and a storage unit (not illustrated). The operation management apparatus 21 receives various types of information from the train 10, the point machine 30 and the railroad crossing apparatus 40 at any time, stores the various types of information thereof in the storage unit, and transmits various types of command information to the train 10 and the point machine 30 at any time, through arithmetic processing of the operation management control by the arithmetic processing unit to be described later.

[0021] The operation terminal 22 is a so-called client apparatus connected to the operation management apparatus 21. By means of a route map or the like displayed on a monitor apparatus (not illustrated), the operation terminal 22 is able to monitor a position and an operation management state of each train based on the on-vehicle information from each train 10, and a state of the ground apparatus such as a locked state of the point machine

30, at any time. Furthermore, it is possible to perform various types of setting processing and the like by an operator through an input unit such as a keyboard and a mouse (not illustrated).

[0022] The point machine 30 includes a changeover unit 31 for moving a switch rail of a branch point of the track R, and a locking lock unit 32 for maintaining the locked state by issuing an operation command to the changeover unit 31.

[0023] The locking lock unit 32 is connected to the operation management apparatus 21 of the central control unit 20 through the first communication network L1. Then, the locking lock unit 32 performs a changeover operation on the changeover unit 31 based on the command information from the operation management apparatus 21, and transmits locking lock information indicating the locked state of a normal position or an opposite position to be described later, to the operation management apparatus 21 of the central control unit 20.

[0024] Fig. 2 is an explanatory diagram of point machinees 30a and 30b disposed at the branch point of the track R. The point machine 30a is disposed at a position where a main track R1 and a sub track R2 are joined, and the point machine 30b is disposed at a position where a sub track R3 branches from the main track R1.

[0025] The point machinees 30a and 30b are disposed such that the locked state is at a normal position relative to a central linear main track R1. The state of the normal position is a state in which the switch rail is changed such that the train 10 goes straight along the main track R1, and conversely, a state in which the switch rail is changed such that the train 10 proceeds to the sub tracks R2 and R3 on sides branching from the main track R1 is referred to as the locked state of the opposite position.

[0026] Also, the diagonal lines as illustrated at the installed positions of the point machinees 30a and 30b represent a normal position side, and the arrows indicate the locked state of the current normal position and opposite position. Therefore, Fig. 2 illustrates in the explanatory diagram that both of the point machinees 30a and 30b are locked in the state of the normal position.

[0027] Fig. 3 is a flowchart of the operation management control of the train 10 in the operation management apparatus 21 of the central control unit 20, and Fig. 4 is a flowchart diagram of traveling management control of a train 10, by the on-vehicle apparatus 12 of the train 10.

[0028] As illustrated in Fig. 5, for example, the operation management control for the own train 10a and the traveling management control on the own train 10a in a case where the own train 10a exists in the sub track R2 will be described based on the flowcharts illustrated in Figs. 3 and 4.

[0029] On-vehicle information transmitted from each train 10 including the own train 10a and locking lock information transmitted from the point machine 30 are stored in the storage unit of operation management apparatus 21 of the central control unit 20. Then, the arithmetic processing unit of the operation management apparatus 21 performs the operation management control to transmit the command information to each train 10 including the own train 10a on the track at any time, or to transmit command information for locking control, and changeover of the point machine 30 at any time, so that it is possible to safely operate the own train 10a up to the arrival point that is a set destination.

[0030] After the operation management apparatus 21 of the central control unit 20 starts an operation management control program which is the flowchart of the operation management control, in step ST1 of Fig. 3, first, a starting point A and an arrival point B in the traveling direction of the own train 10a are set and a route is extracted.

[0031] This setting may be input by operating a monitor screen using the operation terminal 22, or conditions may be input to the operation management apparatus 21 in advance. The starting point A may be a traveling position on the track where the own train 10a exists, and in this case, only the arrival point B is input.

[0032] Alternatively, by receiving the destination information of the current position which is the starting point A and the arrival point B set in the on-vehicle apparatus 12 of the own train 10a to be described later, the starting point A and the arrival point B may be set in operation management apparatus 21.

[0033] After setting the starting point A and the arrival point B in this manner, the arithmetic processing unit of the operation management apparatus 21 extracts a route traveling on the track R up to the arrival point B.

[0034] Subsequently, the processing proceeds to step ST2, in which the own train 10a travels on the extracted route, trouble positions that hinder traveling are extracted, and among these trouble positions, a trouble position first existing on the route, after departing from the starting point A that is the current position of the own train 10a, is extracted as a trouble point S.

[0035] It is possible to divide this trouble point S into a mobile trouble point Sa that moves on the track like another train 10 and a stationary trouble point Sb that stays stationary at a position on the track. Incidentally, in a case where there is not one of a mobile trouble point Sa and a stationary trouble point Sb up to the arrival point B, the arrival point B is extracted as a trouble point S.

[0036] On the track R where the own train 10a travels, the mobile trouble point Sa corresponds to another train 10b approaching or the other train 10c preceding the own train, so that the position of the trouble point moves on the track R over time. Also, in addition to processing of another train 10 itself as the mobile trouble point Sa, it is also possible to process an occupied section T occupied by the other train 10 as the mobile trouble point Sa.

[0037] On the other hand, the stationary trouble point Sb such as the point machine 30 stays stationary at a predetermined position on the track R. Furthermore, the stationary trouble point Sb is a trouble point Sc based on the point machine 30, a trouble point Sd occurring at a railroad crossing F where the railroad crossing apparatus

40 is installed, and a trouble point Se occurring at a position where crossing of the track R occurs in a cross shape, and so on. Also, the stationary trouble point Sb is not limited thereto, but may include any trouble point appropriately occurring that is detectable on the track R.

[0038] In the trouble point Sc based on the point machine 30, it is changed whether or not a certain point is extracted as the trouble point Sc according to the locked state of the normal position and the opposite position relative to the traveling direction. In a state where the traveling direction according to the locked state of the normal position and the opposite position of the point machine 30 does not coincide with the traveling direction of the train 10, that is, in a case where it is impossible to pass through the point machine 30 in the current locked state of the point machine 30, a certain point is extracted as the trouble point Sc, and the trouble point Sc occurs at a predetermined position on the track R provided on a train 10 side of the point machine 30.

[0039] Conversely, in a state where the traveling direction according to the locked state of the normal position and the opposite position of the point machine 30 coincides with the traveling direction of the train 10, that is, in a case where it is possible to pass through the point machine 30 in the current locked state, a certain point is not extracted as the trouble point Sc.

[0040] In this way, the own train 10a travels on the track R, and in a case where positions where crossing of the point machine 30, the railroad crossing F and the track R occurs in a cross shape are in a state of hindering traveling, these positions are extracted as trouble positions, and a trouble position first existing on the track R from the current position of the own train 10a is extracted as a trouble point S. Also, in a case of not hindering the own train 10a from traveling, the positions will not be extracted as a trouble position or a trouble point S.

[0041] Fig. 6 is a route map when the trouble point S is extracted as the trouble point Sc based on the route in step ST2 of Fig. 3 and the point machine 30. It is understood that the point machine 30a in front of the own train 10a is maintained in the state of the normal position from the direction of an arrow indicating the current locked state of the normal position and the opposite position.

[0042] Therefore, since the locked state of the point machine 30a is different from the locked state of the opposite position which corresponds to the traveling direction of the own train 10a, the point machine 30a is determined to be the trouble point Sc that is the first trouble position on the route of the own train 10a, and corresponds to a trouble point S. Once this trouble point S is set at a position before the point machine 30a, and is confirmed and set as the trouble point S to be described later, the trouble point is presented as a triangular mark for representing the trouble point S on the sub track R2.

[0043] Also, the trouble point Sd occurring at the aforementioned railroad crossing F is a trouble point occurring in response to an emergency signal being transmitted from the railroad crossing apparatus 40 to the central control unit 20, when an object is detected in the line by an object detector or the like, after an interrupter, which operates as the own train 10a approaches the railroad crossing F, completely shuts off the passage of vehicles or passersby.

[0044] Alternatively, by pressing an emergency button provided at the railroad crossing F, the emergency signal is transmitted from the railroad crossing apparatus 40 to the central control unit 20, and a trouble position occurs. In a case where this trouble position is determined as a trouble point S first existing on the route, the trouble point occurs at a predetermined position on the track R on the own train 10a side of the railroad crossing F, as the trouble point Sd. In a case where the trouble position is confirmed and set as a trouble point S that is the first trouble position, the trouble point is presented as a triangular mark on the track, similarly to the trouble point Sc.

[0045] Also, the trouble point Se occurring at a position where crossing of the track R occurs in a cross shape, is a trouble point occurring in a case where a crossing track crossing the track R, on which the own train 10a travels, exists and this crossing track is locked by another train 10 in the occupied section T on the route. This trouble point Se occurs at a predetermined position on the track R provided on the own train 10a side of the crossing position, and once the trouble point is confirmed and set as a trouble point S, the trouble point is presented as a triangular mark on the track, similarly to the trouble point Sc.

[0046] These stationary trouble points Sb, of which occurring positions stay stationary in advance, are managed by the operation management apparatus 21, so as to be located at a predetermined distance, for example, 30 meters before positions where crossing of installed positions of the point machinees 30a and 30b, the installed position of the railroad crossing F, and the track R occurs in a cross shape.

[0047] Similarly, the operation management apparatus 21 will manage the mobile trouble point Sa to be located at, for example, 30 meters before the leading end of another train 10b in the case of the approaching, and to be located at, for example, 30 meters behind the rear end of still another train 10c in the case of the preceding vehicle.

[0048] In this way, after extracting the trouble point S that is the first trouble position, the processing proceeds to step ST3 in Fig. 3. Then, it is determined in step ST3 whether or not a route up to the trouble point S is occupiable. Incidentally, the occupancy of the route does not mean a locked state based on a track circuit using the track R in the related art, but may mean locking a route on software.

[0049] Then, in a case where the route up to the trouble point S is occupiable, the processing proceeds to step ST4 in Fig. 3, where the route from the starting point A to the trouble point S is occupied, and only the occupied section T is locked in the route.

[0050] Conversely, for some reasons, in a case where the route up to the trouble point S is not occupiable, for example, in a case where a distance to the trouble point S is very short, and the like, it is not possible to proceed to step ST4 in Fig. 3, and by performing repetition from the extraction processing of the trouble point S in step ST2 to the occupancy determination processing in step ST3, the own train 10a waits until the route up to the trouble point is occupiable.

[0051] Since the own train 10a locks a section from the starting point A to the trouble point S in the route as the occupied section T1 illustrated in Fig. 6, the own train 10a is able to enter the occupied section T1.

[0052] Then, for the occupied section T1 locked by the own train 10a in the route, in order to prevent another train 10 from entering the occupied section T1, the operation control is performed not to permit the other train 10 to set and lock an occupied section T including part or all of the occupied section T1.

[0053] Therefore, the other train 10 is not able to set a route including part or all of the occupied section T1 as the occupied section T, until the own train 10a passes through the occupied section T1 and the occupied section T1 is released.

[0054] Once a section up to the trouble point S is locked in the route as the occupied section T1, the trouble point is presented as a triangular mark representing a trouble point S on the sub track R2, and the trouble point S is set.

[0055] Next, the processing proceeds to step ST5 in Fig. 3, and the traveling information of the starting point A, the arrival point B, the route and the trouble point S for permitting the own train 10a to enter the occupied section T1 is transmitted from the operation management apparatus 21 to the own train 10a, through the radio communication unit 50 and the antenna unit 11. In the processing of transmitting the traveling information from the operation management apparatus 21, the traveling information may be transmitted, after a request signal for requesting the traveling information is received from the on-vehicle apparatus 12 of the own train 10a.

[0056] Subsequently, a flowchart of the on-vehicle apparatus 12 of the own train 10a in Fig. 4 including the processing of the traveling information received by the own train 10a will be described. First, in a case where a program is started on the on-vehicle apparatus 12, in step TST1, using the monitor apparatus in the operator console of the train 10a or the like, it is determined, by the driver, whether or not the starting point A and the arrival point B have been set.

[0057] In this determination processing, the on-vehicle apparatus 12 may wait for a predetermined period of time until the starting point A and the arrival point B are set, or without setting the starting point A and the arrival point B, that is, by providing a setting unit such as a point machine for requesting traveling information to the operation management apparatus 21 of the central control unit 20, the determination may be performed by setting of the setting unit.

[0058] In a case where setting of the starting point A and the arrival point B is performed by the on-vehicle apparatus 12, the processing proceeds to step TST2, and the destination information of the starting point A and the arrival point B is transmitted to the operation management apparatus 21 of the central control unit 20. The operation management apparatus 21 performs the processing of step ST1 in Fig. 3, based on the received destination information.

[0059] In a case where the starting point A and the arrival point B have not been set in the on-vehicle apparatus 12 of step TST1 in Fig. 4, the processing proceeds to step TST3 and waits for the reception of the traveling information from the operation management apparatus 21 of the central control unit 20. Also, a request signal for requesting traveling information may be transmitted to the operation management apparatus 21 until traveling information is received.

[0060] Then, in step TST3, once the on-vehicle apparatus 12 receives the traveling information of the starting point A, the arrival point B, the route and the trouble point S obtained in step ST5 of Fig. 3, from the operation management apparatus 21 of the central control unit 20, the traveling information is stored in the storage unit of the on-vehicle apparatus 12. According to the information of these trouble points S, the traveling management control is performed by the own train 10a, and traveling to the arrival point B that is the destination is possible.

[0061] In a case where the traveling information is received from the central control unit 20 in step TST3 of Fig. 4, the starting point A, the arrival point B, the route and the trouble point S of the traveling information are displayed on the monitor apparatus provided in the operator console or the like.

[0062] Subsequently, the processing proceeds to step TST4, and once the on-vehicle apparatus 12 sets a trouble point S and a stop determination position P based on the trouble point S, and permits traveling of the own train 10a, the own train 10a starts traveling.

[0063] The stop determination position P is a position located at a stop distance d before the trouble point S. The stop distance d may be a fixed distance or the stop distance d may be appropriately varied according to a traveling speed and the like. This stop distance d is a distance that does not exceed the trouble point S when stopping is executed according to a normal deceleration pattern from the stop determination position P, and is set with some margin in distance. Then, the stop determination position P is displayed on the monitor apparatus provided in the operator console or the like.

[0064] Next, in step TST5 of Fig. 4, confirmation of the traveling information from the operation management apparatus 21 of the central control unit 20, that is, confirmation of whether or not a new trouble point S has been received, is performed. In step TST5, upon receiving the new trouble point S, the on-vehicle apparatus 12 proceeds to step TST6.

[0065] In step TST6, the setting of the latest trouble

point S is released, and a new trouble point S which is a trouble position different from the latest trouble point S is set. Then, the setting of the latest stop determination position P is released, a new stop determination position P is set based on the new trouble point S, and the processing proceeds to step TST7.

[0066] In this way, whenever the on-vehicle apparatus 12 receives traveling information including the trouble point S, including the loop processing of returning to the step TST5 to be described later, the setting of this trouble point S and the stop determination position P based on this trouble point S is performed.

[0067] In step TST5 of Fig. 4, the traveling information from the operation management apparatus 21 of the central control unit 20 is confirmed, and in a case where a new trouble point S has not been received, the processing proceeds to step TST7, in which the on-vehicle apparatus 12 monitors whether or not the own train 10a has passed through the stop determination position P located at a predetermined distance before the trouble point S, based on the traveling position.

[0068] In a case where the own train 10a arrives at the stop determination position P and has passed through the stop determination position P, the processing proceeds to step TST8 in Fig. 4. In step TST8, stop control is performed by decelerating the own train 10a according to the deceleration pattern or the like stored in the on-vehicle apparatus 12. In other words, the deceleration stop processing, in which deceleration is started and stopped before the trouble point S of the point machine 30a, is performed.

[0069] Alternatively, the deceleration stop command information transmitted from operation management apparatus 21 of the central control unit 20 includes the deceleration pattern calculated from the speed, position, and the like of the own train 10a, and the own train 10a may perform deceleration stop processing of stopping before the trouble point S, according to the deceleration pattern of the received deceleration stop command information.

[0070] Next, the processing proceeds to step TST9 in Fig. 4, and it is determined whether or not the own train 10a has arrived at the arrival point B. Once the own train 10a arrives at the arrival point B and stops, the processing proceeds to step TST10, in which the arrival information arriving at the arrival point B is transmitted to the central control unit 20, and the on-vehicle apparatus 12 ends the traveling management control program.

[0071] In step TST9 of Fig. 4, in a case where the own train 10a has not arrived at arrival point B, the processing proceeds to step TST5 in Fig. 4. In a case where the trouble point S is not released and the new trouble point S is not received in the step TST5, the loop processing of the steps TST5, and steps TST7 to TST9 is repeatedly performed. The own train 10a continues deceleration stop processing of stopping before the point machine 30a that is the trouble point S, so that the own train 10a is unable to pass through the point machine 30a.

[0072] Also, in the operation management apparatus 21 of the central control unit 20, according to the flowchart of the operation management control in Fig. 3, the processing from steps ST6 to ST8, or the processing from step ST6 to ST9 is repeatedly performed.

[0073] In a case where arrival information arriving at the arrival point B is not received from the own train 10a in step ST6 in Fig. 3, the trouble position from the current position to the arrival point B, and the trouble points S are extracted in step ST7, similarly to step ST2.

[0074] In a case where, even though the trouble point S is extracted, the trouble point is not different from the latest trouble point S, it is determined in step ST8 that there is no change in the trouble point S, and the processing proceeds to step ST6. Also, in a case where the arrival information arriving at the arrival point B is received from the own train 10a in step ST6, the operation management apparatus 21 ends the operation management control program.

[0075] In step ST7 of Fig. 3, the trouble point S is extracted. Once it is determined in step ST8 that this trouble point S has been changed to a new trouble point S, the processing proceeds to step ST9, in which it is determined whether or not a route up to the new trouble point S is occupiable.

[0076] In a case where it is impossible to occupy the route up to the new trouble point S in step ST9, the processing returns to step ST6, and the processing of extracting the trouble point S in step ST7, and the processing of determining in step ST8 whether or not the trouble point S is changed to the new trouble point S, and the occupancy determination processing in step ST9 are repeated.

[0077] In a case where it is possible to occupy the route up to the new trouble point S in step ST9, the processing proceeds to step ST10, and the setting of the latest trouble point S is released. Then, a new occupied section T1 from the current vehicle position to a new trouble point S is locked in the route and a new trouble point S is set.

[0078] Next, the processing proceeds to step ST11 in Fig. 3, and the traveling information including a new trouble point S, for permitting the traveling of the own train 10a to the new occupied section T1, is transmitted from the operation management apparatus 21 to the own train 10a, through the radio communication unit 50 and the antenna unit 11.

[0079] According to the flowchart of the traveling management control in Fig. 4, once the on-vehicle apparatus 12 of the own train 10a receives traveling information including a new trouble point S from the operation management apparatus 21 of the central control unit 20 in step TST5 of Fig. 4, the traveling information is stored in the storage unit of the on-vehicle apparatus 12.

[0080] Upon receiving the traveling information including the new trouble point S, the on-vehicle apparatus 12 of the own train 10a sets a new trouble point S and a new stop determination position P based on this new trouble point S in step TST6 of Fig. 4.

[0081] In step TST7, in a case where the own train 10a has not passed the stop determination position P, the processing proceeds to step TST11, in which it is determined whether or not the deceleration stop processing is being executed.

[0082] The step TST11 of Fig. 4 is a step in which, when a new trouble point S and a new stop determination position P are set after the deceleration stop processing is started in the step TST8, the deceleration stop processing is released for the own train 10a that has not passed the new stop determination position P.

[0083] In a case where it is determined in step TST11 in Fig. 4 that the deceleration stop processing is being executed, the processing proceeds to step TST12. Once the deceleration stop processing is released in step TST12, the own train 10a stops deceleration and returns to a normal traveling. Thereafter, the processing returns to step TST5.

[0084] Also, in a case where it is also determined in step TST11 in Fig. 4 that the deceleration stop processing is not being executed, the processing returns to step TST5, and the loop processing of these steps are also repeatedly performed.

[0085] In a case where the own train 10a has not passed the stop determination position P of the trouble point S, that is, in a case where the own train 10a is traveling toward the stop determination position P, the processing of steps TST5 to TST7, and TST11 in Fig. 4, and the processing of returning to step TST5 are repeatedly performed, and in this loop processing, as illustrated in Fig. 7, there is a case where a trouble point Sd occurring at the railroad crossing F occurs by interruption before the trouble point Sc in Fig. 6.

[0086] In such a case, in the operation management apparatus 21 of the central control unit 20, the trouble point Sd, which has occurred by interruption, is extracted as a new trouble point S in step ST7 of Fig. 3, and in a step ST9, in the case where a route up to a new trouble point S is occupiable, the occupied section T1 is also changed to the occupied section T up to the trouble point Sd.

[0087] Then, the processing proceeds to ST10, in which the setting of the trouble point S by interruption is released, the new occupied section T1 is locked in the route, and a new trouble point S is set, and then in a step ST11, traveling information including a new trouble point S is transmitted.

[0088] Next, once the on-vehicle apparatus 12 of the own train 10a receives the traveling information including the new trouble point S in step TST5 of Fig. 4, in the step TST6, the setting of the trouble point S before interruption is released and a new trouble point S is set. Then, the setting of the stop determination position P before interruption is released, a new stop determination position P based on the new trouble point S is set, and the own train 10a travels in the occupied section T1.

[0089] In a case where the trouble point Sd occurring at the railroad crossing F, that is, the trouble point S is not released, the loop processing of step TST5, and steps TST7 to step TST9 in Fig. 4 is repeatedly performed, and finally, the own train 10a will stop before the railroad crossing F that is the trouble point S.

[0090] Fig. 8 is a route map when the own train 10a in Fig. 6 travels in the occupied section T1 and arrives at the stop determination position P. The figure indicates a state in which, according to the approach of the own train 10a to the point machine 30a, the point machine 30a is changed from the locked state of the normal position to the locked state of the opposite position, in response to an instruction from the operation management apparatus 21.

[0091] In a case where the own train 10a approaches the point machine 30a on a condition that the point machine 30a does not maintain the locked state of the normal position by the route-locking of the other train 10, in order for the own train 10a to pass, the operation management apparatus 21 of the central control unit 20 transmits, to the point machine 30a, command information for moving the switch rail of the changeover unit 31, thereby changing the point machine 30a from the locked state of the normal position to the locked state of the opposite position.

[0092] Under the control in this way, the trouble point S of the point machine 30a is released, and according to the repetition from step ST6 to step ST10 in Fig. 3, the trouble point Sc of the point machine 30b will be newly extracted as the next trouble point S.

[0093] A new trouble point S is set by releasing the setting of the trouble point S of point machine 30a and locking the occupied section T1 up to the new trouble point S in the route. Then, in step ST11, the traveling information including the new trouble point S is transmitted to the own train 10a.

[0094] Next, upon receiving traveling information including a new trouble point S in step TST5 of Fig. 4, the on-vehicle apparatus 12 of the own train 10a releases the setting of the latest trouble point S in step TST6, and sets the new trouble point S. Then, after releasing the setting of the latest stop determination position P, a new stop determination position P based on the new trouble point S is set, and the own train 10a starts traveling in the occupied section T1.

[0095] Figs. 9 and 10 are route maps in a state where, at the time when the own train 10a arrives at the stop determination position P, for example, another train 10b traveling from a sub track R3 direction toward a sub track R2 direction has already locked an occupied section T2 that is an occupied section T, in the route, to travel on the main track R1.

[0096] In a case where the other train 10b has already locked the occupied section T2 of the other train 10b in the route, the own train 10a starts deceleration stop processing after passing through the stop determination position P. Then, as long as the trouble point S of point machine 30a is not released, the own train 10a performs deceleration stop control of stopping before the trouble

point S.

[0097] Since the occupied section T2 of the other train 10b is open at any time for allowing the other train 10b to pass therethrough, and the other train 10b passes through the point machine 30a, it is possible to change the point machine 30a from the locked state of the normal position to the locked state of the opposite position.

[0098] According to an instruction from the operation management apparatus 21 of the central control unit 20, the point machine 30a is changed from the locked state of the normal position to the locked state of the opposite position, thereby releasing the trouble point S of the point machine 30a. Then, the operation management apparatus 21 extracts the trouble point Sc of the point machine 30b as a new trouble point S, similarly to the route map in Fig. 8.

[0099] The operation management apparatus 21 of the central control unit 20 releases the setting of the trouble point S of the point machine 30a, locks only an occupied section T1 up to a new trouble point S in the route, and sets the new trouble point S, and then transmits traveling information including the new trouble point S to the own train 10a.

[0100] Once the on-vehicle apparatus 12 of the own train 10a receives traveling information including a new trouble point S and sets a new trouble point S, a new stop determination position P based on the new trouble point S is set, so that traveling in the occupied section T1 is started.

[0101] Figs. 11 to 13 are route maps in a state where, for example, a starting point A of the own train 10a and an arrival point B on the main track R1 are set, and another train 10c traveling from the sub track R2 direction toward the sub track R3 direction has already occupied an occupied section T3 that is an occupied section T of the other train 10c traveling on the main track R1.

[0102] The operation management apparatus 21 of the central control unit 20 extracts a trouble point S that is a first trouble position on the route of the own train 10a, locks an occupied section T1 up to the trouble point S in the route, and sets the trouble point S, and then transmits traveling information including the trouble point S from the operation management apparatus 21 to the own train 10a. Once the on-vehicle apparatus 12 of the own train 10a receives traveling information and sets a trouble point S, a stop determination position P based on this trouble point S is set, and the own train 10a starts traveling.

[0103] Then, in a case where, when the own train 10a travels and passes through the stop determination position P, the other train 10c is not passing through the point machine 30a, the locked state of the point machine 30a is not changed from the state of the normal position, and the trouble point S is not released. Therefore, the own train 10a will stop before the trouble point S.

[0104] As illustrated in Fig. 12, since the other train 10c passes through the point machine 30a, it is possible to change the point machine 30a from the locked state of the normal position to the locked state of the opposite position. Since, according to the instruction from the operation management apparatus 21, the point machine 30a is changed from the locked state of the normal position to the locked state of the opposite position, the trouble point S of the point machine 30a is released.

[0105] Then, the operation management apparatus 21 extracts a mobile trouble point Sa of the other train 10c as a new trouble point S, and releases the setting of the trouble point S of the point machine 30a. The operation management apparatus 21 locks an occupied section T1 up to the new trouble point S that is the mobile trouble point Sa, and then transmits the traveling information including the new trouble point S to the own train 10a.

[0106] Once the on-vehicle apparatus 12 of the own train 10a receives traveling information including a new trouble point S and sets the new trouble point S, a new stop determination position P based on the new trouble point S is set, and the own train 10a starts traveling in the occupied section T1. Since this mobile trouble point Sa is moving, the stop determination position P also moves according to the movement of the other train 10c.

[0107] Therefore, in a case where the mobile trouble point Sa is set as a trouble point S, and in a case where the other train 10c that is the mobile trouble point Sa continues to stop, once the own train 10a passes the stop determination position P, the processing proceeds to the step TST8 in Fig. 4, in which the on-vehicle apparatus 12 of the own train 10a starts deceleration stop processing, and the own train 10a also stops before the other train 10c.

[0108] Also, in a case where another stationary trouble point Sb has occurred by interruption while the own train 10a follows the other train 10c, the stationary trouble point Sb is extracted as a new trouble point S.

[0109] On the route map of Fig. 13, once the other train 10c travels as it is, it is expected that the arrival point B, which is the last trouble position, occurs by interruption as a trouble point S, and the operation management apparatus 21 of the central control unit 20 locks the occupied section T1 up to the arrival point B in the route, sets the arrival point B as the trouble point S, and then transmits the traveling information including the trouble point S to the own train 10a.

[0110] Upon receiving the traveling information including the trouble point S, the on-vehicle apparatus 12 of the own train 10a sets the received trouble point S and sets the stop determination position P based on the set trouble point S, so that the own train 10a is able to arrive at the arrival point B.

Modified Example

[0111] A modified example of the train operation management system will be described by exemplifying a case where a trouble point Sd occurring at the railroad crossing F has occurred by interruption before the trouble point Sc in Fig. 6, for example, as illustrated in Fig. 14. As

illustrated in the figure, while the trouble point S, the occupied section T1, and the stop determination position P of the point machine 30a, that have been already set, are maintained as they are, it is considered for the trouble point Sd occurring at the railroad crossing F to perform interruption processing.

[0112] In such a case, the trouble point S of the point machine 30a illustrated in Fig. 14 is not released, and the trouble point Sd, which has occurred by interruption, is set as a trouble point S'. Since the occupied section T1 from the own train 10a to the trouble point S including the trouble point S' is locked in the route, it is not necessary to perform route-locking for the trouble point S', again.

[0113] The operation management apparatus 21 of the central control unit 20 transmits traveling information for setting the trouble point S' as a new trouble point S to the own train 10a. The own train 10a receives traveling information including a new trouble point S (trouble point S') as usual, sets a new stop determination position P based on the new trouble point S, and performs control of starting deceleration stop processing or releasing deceleration stop processing.

[0114] In a case where the trouble point S' is released, the operation management apparatus 21 needs not to newly extract a trouble point S of the point machine 30a, needs not to lock the occupied section T1 in the route, and needs not to set the trouble point S, and it is possible to transmit traveling information including the maintained trouble point S to the own train 10a.

[0115] In this way, according to the train operation management system, by repeating the operation management control such that each train 10 locks only an occupied section T1 up to the trouble point S first existing on a route, in the route, sets a stop determination position P, and travels in the occupied section T1, it is possible to prevent unnecessary passage waiting based on the route-locking by another train 10. Then, without the passage waiting, the own train 10a is able to travel in a section which the own train is able to pass through until another train 10 arrives.

[0116] The operation management control is performed such that the route is preferentially locked for the train 10 first arriving at a passage section to pass through the passage section, and each train 10 is able to safely move to the arrival point B.

[0117] Also, since the operation management control of each train 10 is performed on the software of the operation management apparatus 21 without using the track circuit, it is possible to set optional positions as the starting point A and the arrival point B. Reference Signs List

10	Train
10a	Own train
10b, 10c	Another train
12	On-vehicle apparatus
20	Central control unit
21	Operation management apparatus
22	Operation terminal
30, 30a, 30b	Point machine
50	Radio communication unit

Claims

1. An on-vehicle apparatus which communicates with an operation management apparatus that performs operation control of extracting a route up to an arrival point in a case where the arrival point of an own train is set, extracting a first trouble position that hinders traveling on the route as a trouble point, and setting the trouble point by route-locking only a section up to the trouble point as an occupied section of the own train, such that it is possible to prevent another train from entering the occupied section; and is disposed on the own train traveling on a track,
the on-vehicle apparatus performing traveling management control by setting the trouble point in a case where traveling information including the trouble point is received from the operation management apparatus.

2. The on-vehicle apparatus according to claim 1,
wherein the traveling management control is performed to prevent the own train from passing through the trouble point.

3. The on-vehicle apparatus according to claims 1 or 2,
wherein the arrival point set by the own train is transmitted to the operation management apparatus.

4. The on-vehicle apparatus according to any one of claims 1 to 3,
wherein a stop determination position is set at a predetermined distance before the trouble point, and the own train starts deceleration stop control, in a case where the own train travels in the occupied section and has passed through the stop determination position.

5. The on-vehicle apparatus according to claim 4,
wherein, after passing through the stop determination position, in a case where a new trouble point is newly set as the trouble point, the deceleration stop control of the own train is released.

6. The on-vehicle apparatus according to any one of claims 1 to 5,
wherein, whenever traveling information including the trouble point is received, a stop determination position is set at a predetermined distance before the received trouble point.

FIG. 1

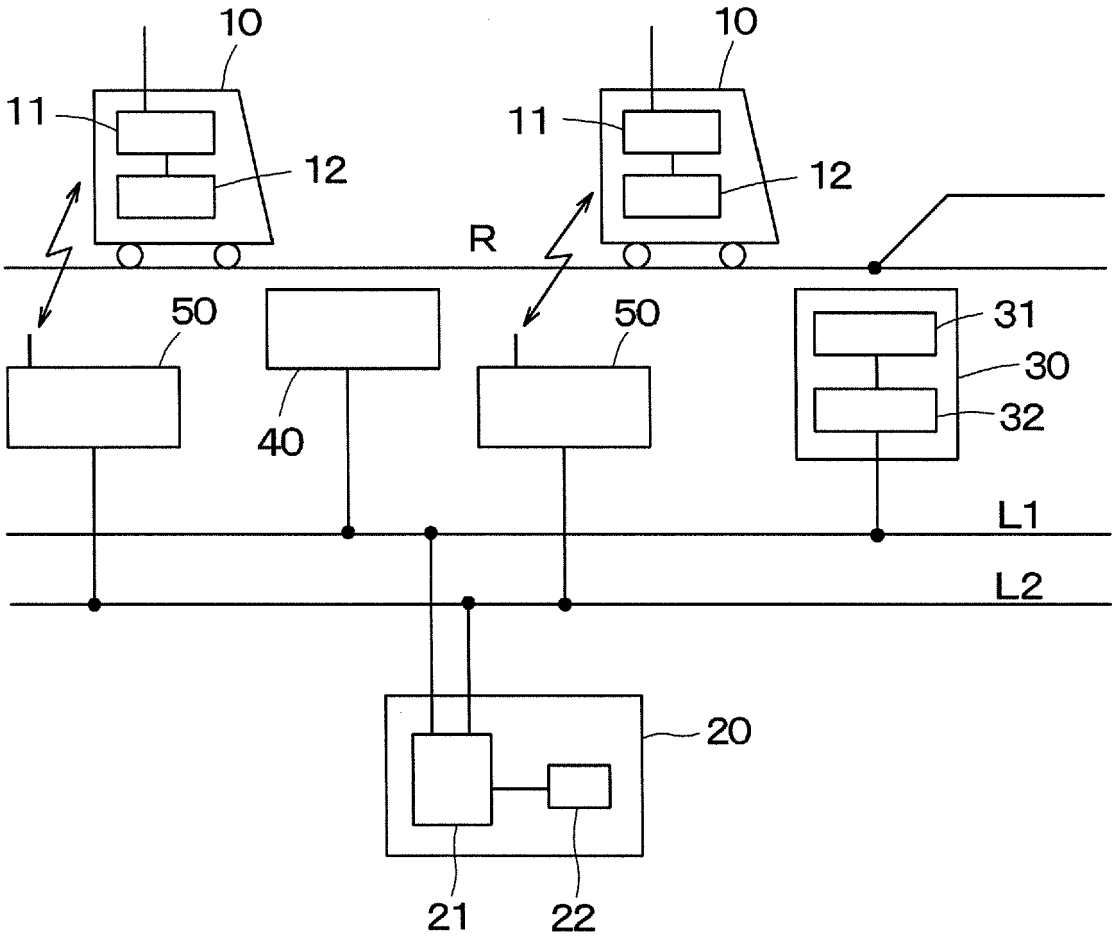


FIG. 2

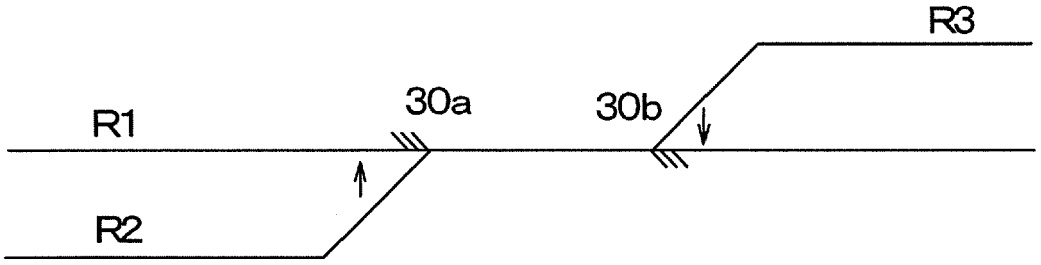


FIG. 3

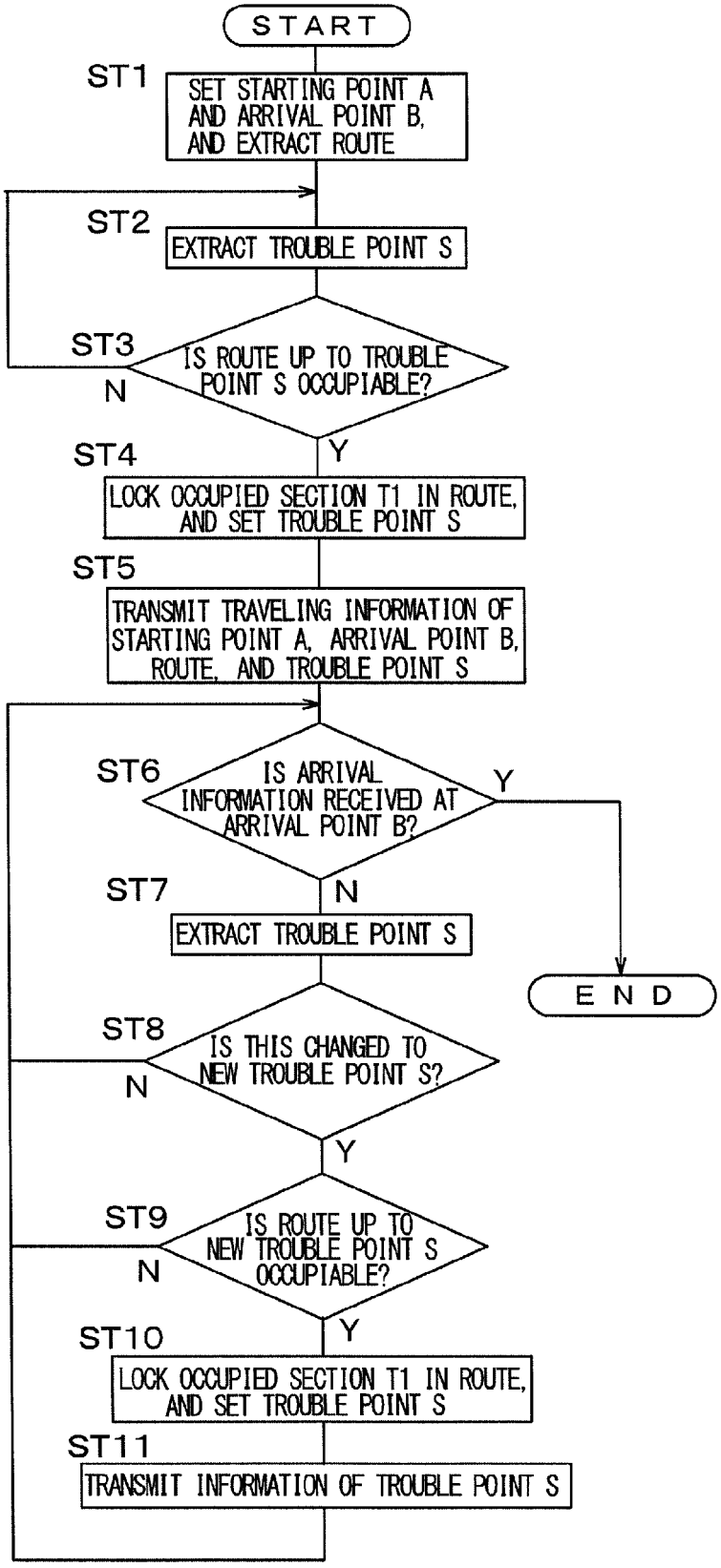
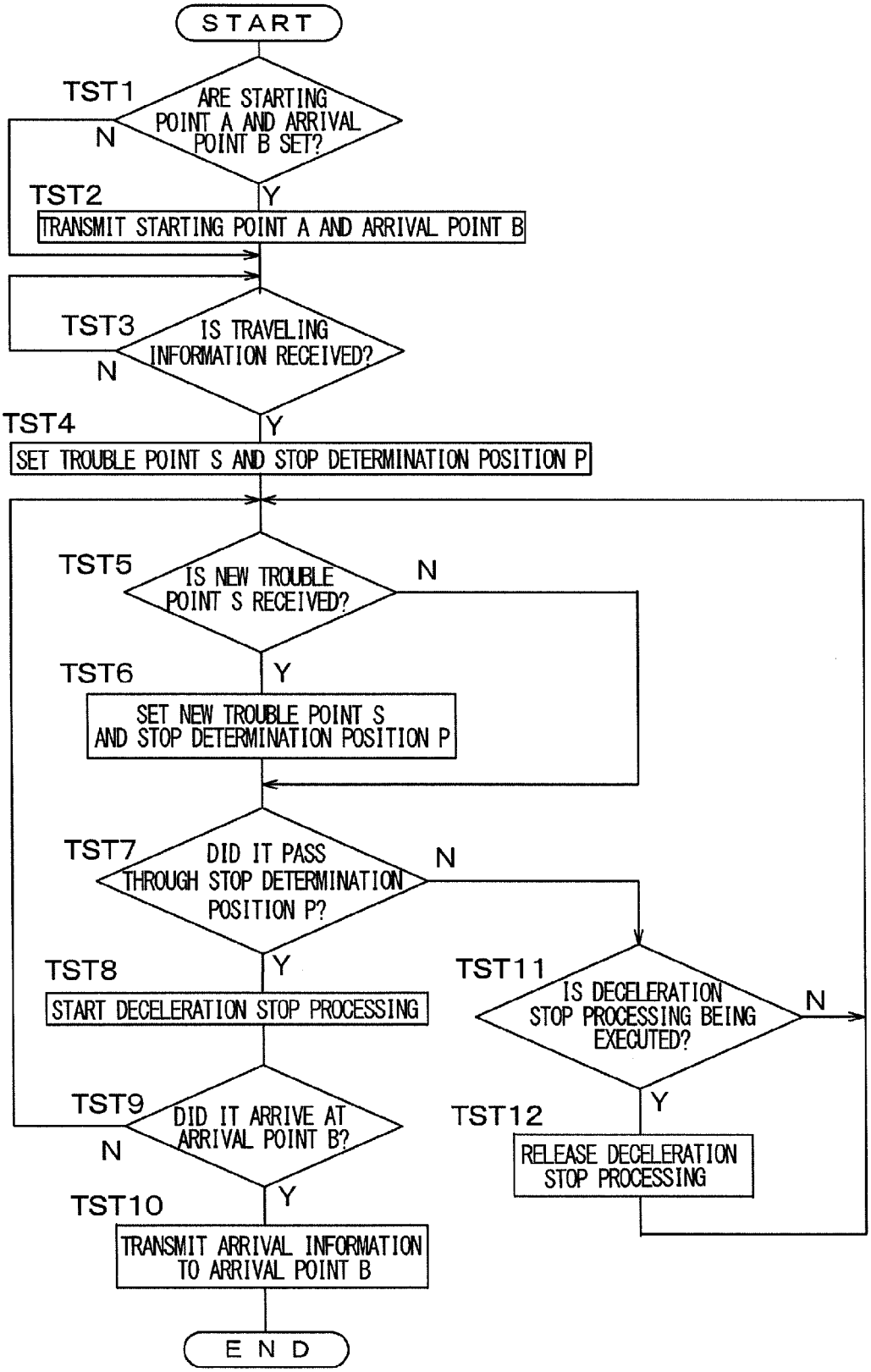

START
ST1
SET STARTING POINT A AND ARRIVAL POINT B, AND EXTRACT ROUTE
ST2
EXTRACT TROUBLE POINT S
ST3
IS ROUTE UP TO TROUBLE POINT S OCCUPIABLE?
N
Y
ST4
LOCK OCCUPIED SECTION T1 IN ROUTE, AND SET TROUBLE POINT S
ST5
TRANSMIT TRAVELING INFORMATION OF STARTING POINT A, ARRIVAL POINT B, ROUTE, AND TROUBLE POINT S
ST6
IS ARRIVAL INFORMATION RECEIVED AT ARRIVAL POINT B?
Y
N
ST7
EXTRACT TROUBLE POINT S
END
ST8
IS THIS CHANGED TO NEW TROUBLE POINT S?
N
Y
ST9
IS ROUTE UP TO NEW TROUBLE POINT S OCCUPIABLE?
N
Y
ST10
LOCK OCCUPIED SECTION T1 IN ROUTE, AND SET TROUBLE POINT S
ST11
TRANSMIT INFORMATION OF TROUBLE POINT S

FIG. 4


START
TST1
ARE STARTING POINT A AND ARRIVAL POINT B SET?
N
Y
TST2
TRANSMIT STARTING POINT A AND ARRIVAL POINT B
TST3
IS TRAVELING INFORMATION RECEIVED?
N
Y
TST4
SET TROUBLE POINT S AND STOP DETERMINATION POSITION P
TST5
IS NEW TROUBLE POINT S RECEIVED?
N
Y
TST6
SET NEW TROUBLE POINT S AND STOP DETERMINATION POSITION P
TST7
DID IT PASS THROUGH STOP DETERMINATION POSITION P?
N
Y
TST8
START DECELERATION STOP PROCESSING
TST9
DID IT ARRIVE AT ARRIVAL POINT B?
N
Y
TST10
TRANSMIT ARRIVAL INFORMATION TO ARRIVAL POINT B
END
TST11
IS DECELERATION STOP PROCESSING BEING EXECUTED?
N
Y
TST12
RELEASE DECELERATION STOP PROCESSING

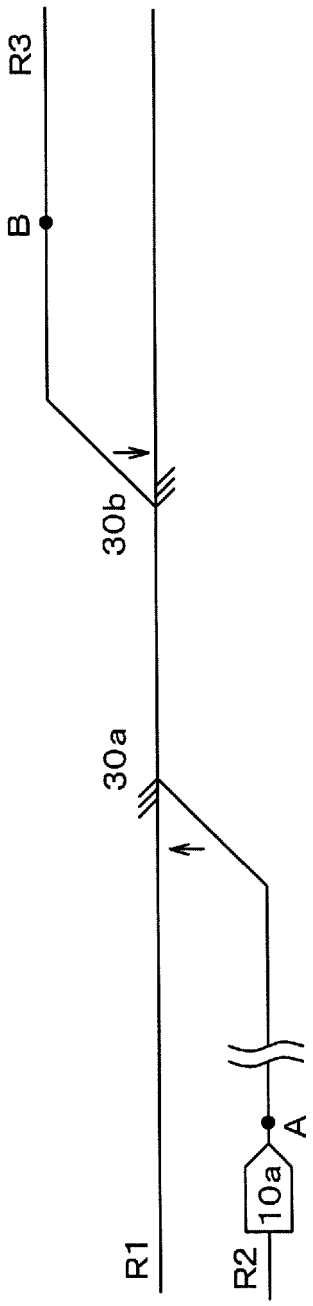


FIG. 5

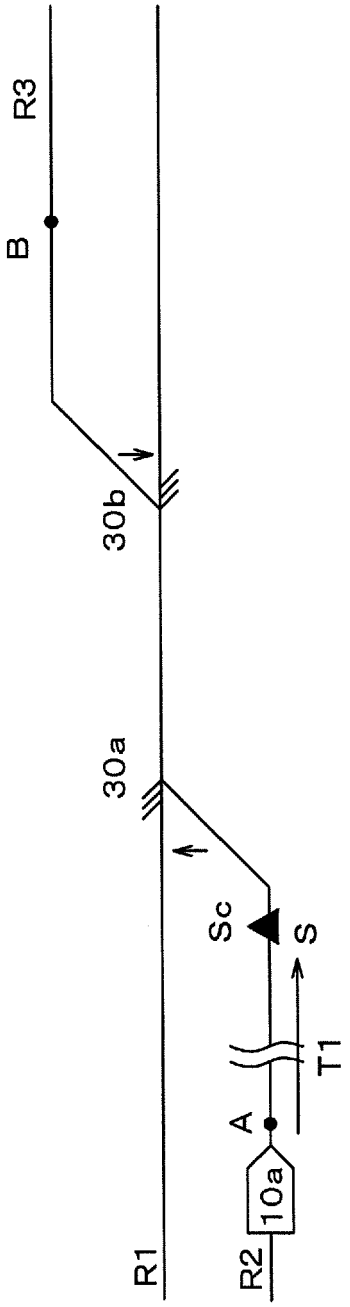


FIG. 6

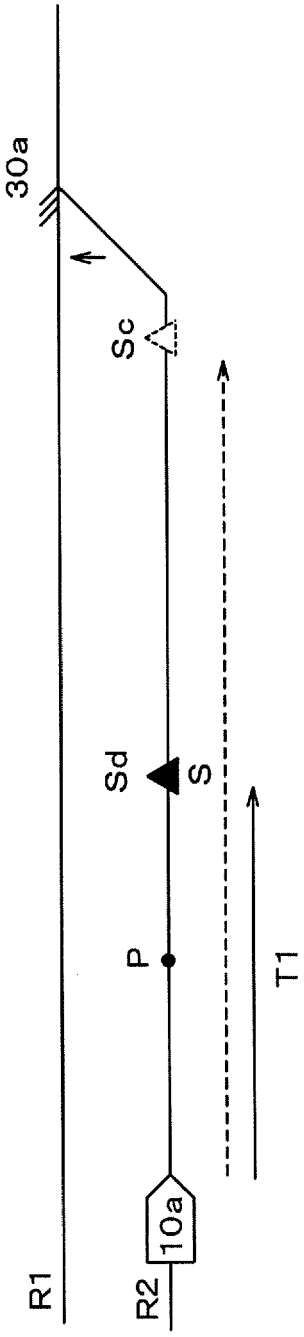


FIG. 7

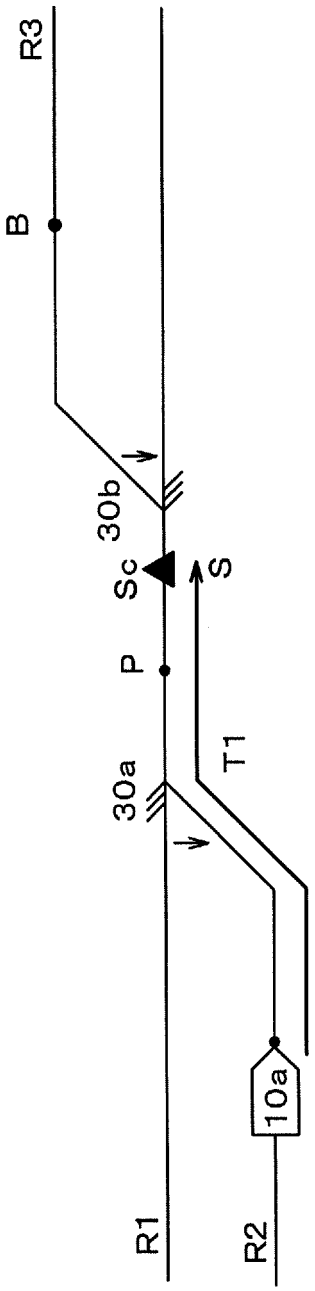


FIG. 8

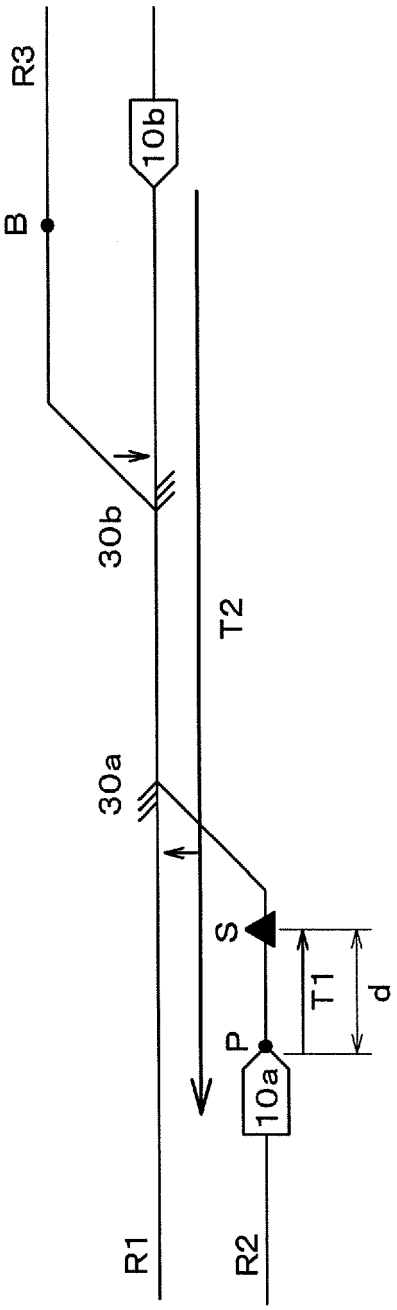


FIG. 9

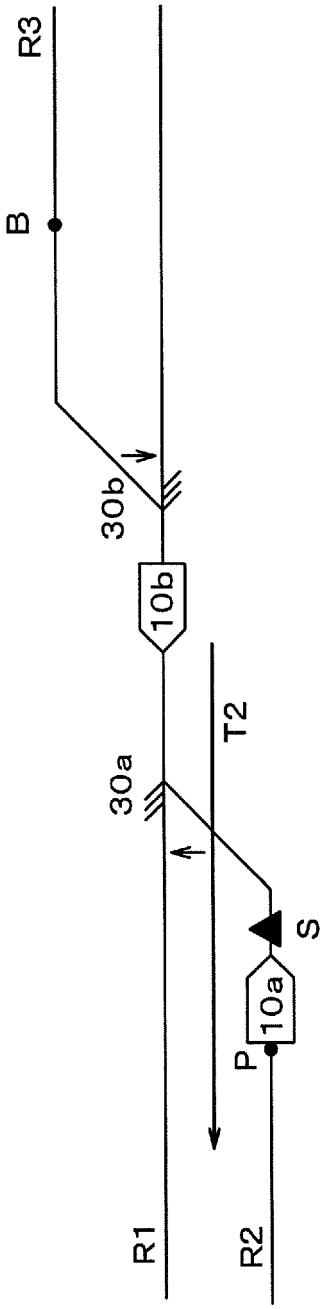


FIG. 10

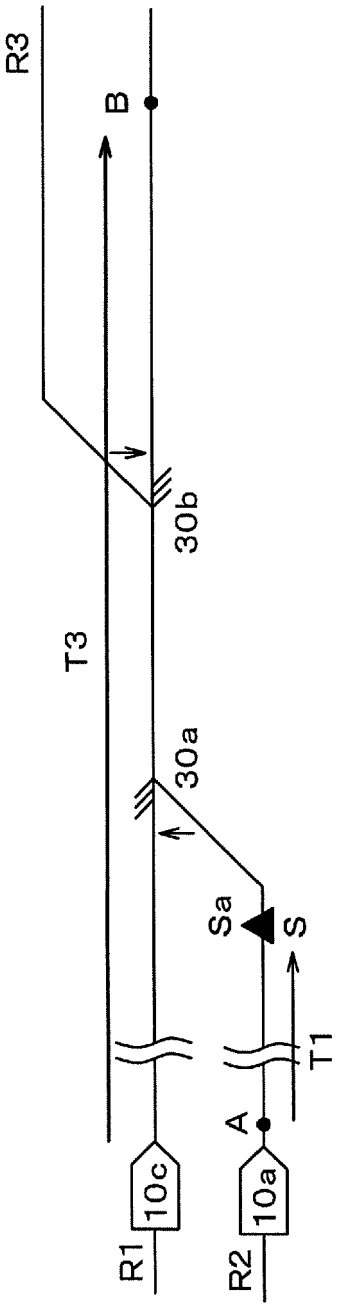


FIG. 11

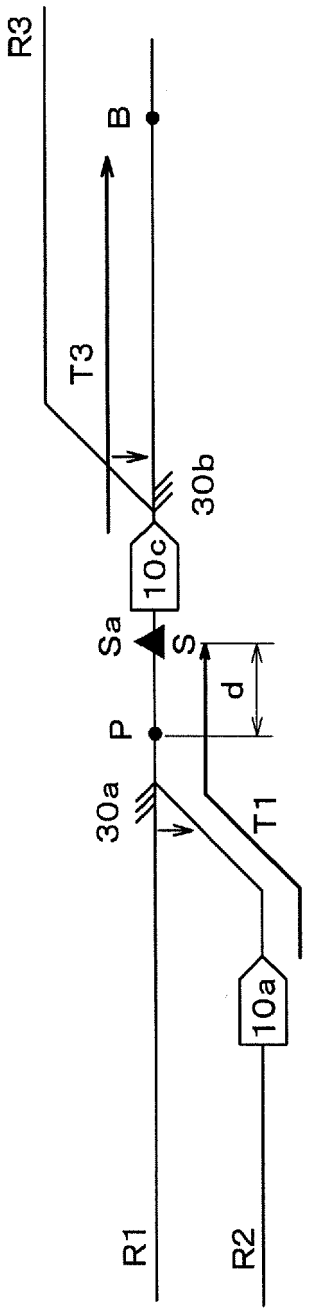


FIG. 12

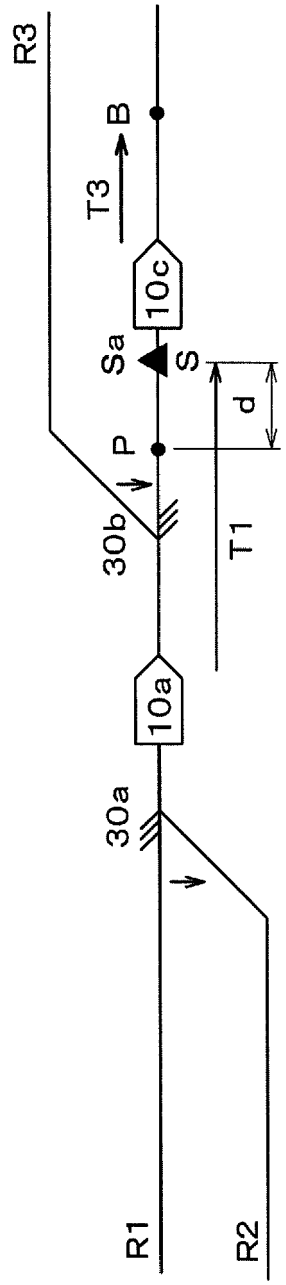


FIG. 13

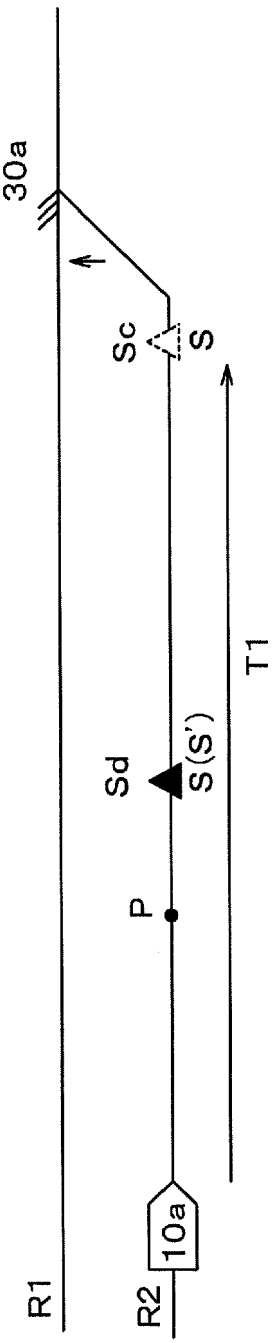


FIG. 14

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 5779

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2018/001674 A1 (SIEMENS AG [DE]) 4 January 2018 (2018-01-04) * figure 1; page 13, lines 20 - 29; page 14, lines 1 - 5; and page 17, lines 18 -26 *	1-6	INV. B61L27/00
A	EP 3 235 706 A1 (ALSTOM TRANSP TECH [FR]) 25 October 2017 (2017-10-25) * figures 1 and 2; paragraphs [0025] - [0045] *	1-6	
A	US 6 246 956 B1 (MIYOSHI MIYAKO [JP] ET AL) 12 June 2001 (2001-06-12) * figures 1 and 2; column 7, line 34 - column 10, line 2; figure 1 *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

B61L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 November 2019	Plützer, Stefan

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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07-11-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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