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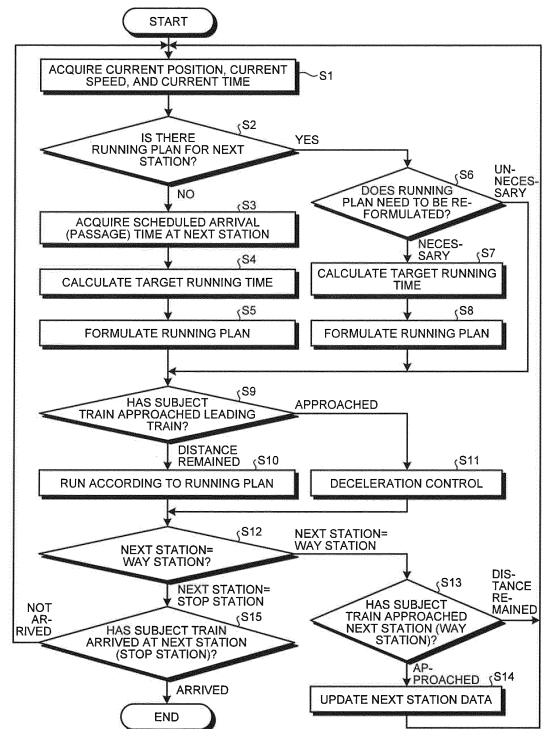
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(54) **TRAIN CONTROL DEVICE**

(57) A train control device in an embodiment of the present invention is provided with the following: a detection unit for detecting the current position and speed of a train provided with the device; a timing unit for tracking the current time; a schedule input unit for inputting schedule data comprising an expected arrival time of the train at each station on a route; and a calculation unit for calculating a travel plan to the next station on the basis of a target travel time found by subtracting the tracked current time from the expected arrival time for the next station, which is included in the inputted schedule data, as well as on the basis of the detected current position, the detected speed, and the operating properties of the train and the route conditions.

FIG.2



Description**BRIEF DESCRIPTION OF DRAWINGS****FIELD****[0006]**

[0001] Embodiments of the present invention relate to a train control device.

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FIG. 1 is a block diagram illustrating a configuration of a train control device according to a first embodiment.

BACKGROUND

FIG. 2 is a flowchart illustrating one example of operations of the train control device according to the first embodiment.

[0002] Conventionally, vehicles such as trains comprise an automatic train operation (ATO) to maintain stable operation and reduce possibility of delays. The ATO generates, in advance, a running plan for a section from one station to the next stop station, and perform various kinds of controls such as speed control and brake control in accordance with the running plan.

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FIG. 3 is a conceptual diagram exemplifying a running plan.

FIG. 4 is a conceptual diagram exemplifying a running plan in which way stations are present.

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FIG. 5 is a conceptual diagram exemplifying a running plan in which way stations are present.

FIG. 6 is a conceptual diagram exemplifying a running plan in which way stations are present.

FIG. 7 is a block diagram illustrating a configuration of a train control device according to a second embodiment.

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FIG. 8 is a conceptual diagram exemplifying a relationship between a brake pattern estimated from a speed limit and a running plan.

CITATION LIST**Patent Literature**

[0003] Patent Literature 1: Japanese Patent Application Laid-open No. 2003-235116

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FIG. 9 is a conceptual diagram exemplifying recalculation of a running plan for a case when a distance from a leading train is increased.

SUMMARY**Problem to be Solved by the Invention**

[0004] The running plan in the ATO is calculated according to railroad data or vehicle model data so that a running time of the running plan becomes close to a predetermined running time determined for each distance between stations. However, the running plan is not created by taking into account an arrival time at the next station. Therefore, according to the above-mentioned conventional technique, when a train leaves a station with a delay behind a train operation diagram, the train may arrive at the next station with a delay behind the train operation diagram.

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DETAILED DESCRIPTION

[0007] In the following, embodiments of a train control device are described in detail with reference to the attached drawings.

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First Embodiment

[0008] FIG. 1 is a block diagram illustrating an configuration of a train control device 1 according to a first embodiment. As illustrated in FIG. 1, a train T is provided with the train control device 1 and a drive and brake control device 3 that drives and brakes the train T according to a drive instruction or a brake instruction from the train control device 1. The train T runs on a rail R as the drive and brake control device 3 drives and brakes wheels 2. The drive and brake control device 3 includes an inverter for controlling a motor and a brake control device for performing cooperative control of air braking by the brake device and electric braking by the motor.

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[0009] The train control device 1 includes a speed and position detection unit 10, an automatic train control (ATC) on-vehicle device 20, an ATO device 30, a diagram input unit 31, a database 32, a clock unit 33, and a display device 60. The speed and position detection unit 10 detects the speed of the train T running on the rail R and position of the train T on the route. Specifically, the speed and position detection unit 10 detects the speed of the train T based on an output value from a tachogenerator (TG) 12 linked with rotation of the wheels 2. A pulse gen-

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Means for Solving Problem

[0005] A train control device of an embodiment comprises a detection unit, a clock unit, a diagram input unit, and a calculating unit. The detection unit detects a current position and a speed of a train. The clock unit keeps a current time. The diagram input unit inputs diagram data including a scheduled arrival time of the train at each of stations on a route. The calculating unit calculates a running plan to a next station based on a target running time obtained by subtracting the current time from a scheduled arrival time at the next station included in the input diagram data, the detected current position, the detected speed, operational characteristics of the train, and a route condition.

erator (PG), linked with rotation of the wheels 2, can be used in place of the TG 12. The speed and position detection unit 10 also detects the current position of the train T on the route, based on a running distance obtained by integrating the speed of the train T and a signal from a ground coil 13 received by a pickup coil 11. The speed and current position of the train T detected by the speed and position detection unit 10 are output as speed and position information to the ATC on-vehicle device 20 and the ATO device 30.

[0010] The ATC on-vehicle device 20 receives, via a power receiver 21, information provided by an ATC ground device 22 as an analog signal via a track circuit 23 formed by using the rail R. The ATC on-vehicle device 20 outputs a brake instruction to the drive and brake control device 3 based on the information output from the ATC ground device 22 and the speed of the train T. The information from the ATC ground device 22 includes a signal aspect indicating a speed limit (hereinafter referred to as "aspect speed limit") for a blocked section where the train T resides. The ATC on-vehicle device 20 compares the aspect speed limit output from the ATC ground device 22 with the speed of the train T. If the speed of the train T exceeds the aspect speed limit, the ATC on-vehicle device 20 outputs a brake instruction to the drive and brake control device 3. The ATC on-vehicle device 20 also outputs the aspect speed limit received via the power receiver 21 to the ATO device 30.

[0011] The ATO device 30 outputs a drive instruction or a brake instruction to the drive and brake control device 3 under the ATC on-vehicle device 20. Specifically, the ATO device 30 outputs to the drive and brake control device 3 a control instruction (notch instruction) such as a drive instruction or a brake instruction based on the speed and current position of the train T detected by the speed and position detection unit 10. Accordingly, the train T runs at a speed within a range at which the speed does not exceed the signal-indicative speed output from the ATC on-vehicle device 20, and stop the train T at a predetermined position in a station.

[0012] The ATO device 30 also calculates a running plan for the train T at the current position and the speed detected by the speed and position detection unit 10 to arrive at the next station according to operation characteristics of the train T and route conditions (detailed descriptions will be provided later). The running plan includes data defining sections to which driving operation, coasting operation, and braking operation are assigned, and further includes running curves, in order to run and stop the train T at a target position in the next station on a predetermined running time. The ATO device 30 operates the train T according to the calculated running plan.

[0013] When performing automatic operation, the ATO device 30 outputs a drive instruction or a brake instruction to the drive and brake control device 3 based on the running plan. The train control device 1 then automatically operates the train T according to the running plan. When performing manual operation, the ATO device 30 causes

the display device 60 installed in the driver's platform to display a target speed based on the running plan. The driver manipulates a master controller (not illustrated) to follow the target speed displayed on the display device 60. Thus, the train T can manually be operated according to the running plan.

[0014] The diagram input unit 31 receives diagram data including scheduled arrival (passage) times of the train T at individual stations on the route. For example, the diagram input unit 31 obtains the diagram data through wireless communication via a communication device 40 or obtains the diagram data from a memory unit 52, such as an IC card, of a duty card 51 connected to an I/F device 50, or the like. The diagram data input from the diagram input unit 31 is recorded as operational conditions in the database 32.

[0015] In this example, the diagram data for each of trains running on the route is managed in management center 41. The diagram data is sent, via a telecommunication line to a station management device 42 on the route of the train T. The station management device 42 provides the train T with the diagram data for the train T obtained from the operation management center 41 by performing wireless-communications with the communication device 40 installed in the train T or by writing to the memory unit 52 of the duty card 51 inserted by the driver into the I/F device 50 at the start of operation.

[0016] The communication device 40 is a device for performing wireless-communications with the station management device 42, receive GPS signals, and the like. The communication device 40 receives, via wireless, the diagram data output from the station management device 42 and forwards the diagram data to the diagram input unit 31. The I/F device 50 is a card reader or the like to read the diagram data from the memory unit 52 of the duty card 51 and output the diagram data to the diagram input unit 31.

[0017] The database 32 stores data necessary for operation of the train T such as route conditions (gradients, curvatures, speed limits, and/or the like), operational conditions (target stop positions at individual stations, diagram data including scheduled passage or arrival times at individual stations, and/or the like), and vehicle characteristics (vehicle weight, train operation characteristics such as acceleration/deceleration performance, and/or the like). Specifically, the database 32 may be a hard disc installed in the train T or an IC card carried by the driver or the like. In the case of an IC card, the driver can use the database 32 by inserting the IC card into the I/F device 50 when initiating operation.

[0018] The clock unit 33 has real time clock (RTC) function to keep the current time. The current time kept by the clock unit 33 is output to the ATO device 30. It is assumed that the current time kept by the clock unit 33 is synchronized with the current time referenced by the operation management center 41 when generating the diagram data. Specifically, the current time is to be synchronized with GPS time included in the GPS signal at

the operation management center 41 and the train T. Also, the synchronization of the current time of the clock unit 33 with the current time used by the operation management center 41 may be performed by wireless-communications during stopping at stations.

[0019] Next, detailed descriptions will be given as to calculation of the running plan by the ATO device 30 and running of the train T according to the calculated running plan. FIG. 2 is a flowchart illustrating one example of operations performed by the train control device 1 according to the first embodiment.

[0020] As illustrated in FIG. 2, the ATO device 30 obtains the current position and current speed of the train T from the speed and position detection unit 10 and further obtains the current time from the clock unit 33 (S1). Then, the ATO device 30 determines whether a running plan for getting to the next station has been prepared (S2). Here, the ATO device 30 determines that no running plan to the next station has been prepared when the train T is standing by for leaving or the next station data has been updated at S14, because such a running plan is yet to be calculated. Otherwise, the ATO device 30 determines that a running plan to the next station has been prepared when the train T is running according to the calculated running plan.

[0021] When it is determined at S2 that no running plan has been prepared, the ATO device 30 refers to the diagram data included in the operational conditions input by the diagram input unit 31 and recorded in the database 32 to obtain the scheduled arrival (passage) time at the next station (S3). Next, the ATO device 30 calculates the target running time by subtracting the current time from the scheduled arrival (passage) time at the next station (S4), and calculates a running plan in which the running time becomes close to the target running time based on the route conditions and vehicle characteristics recorded in the database 32 (S5). Accordingly, the ATO device 30 performs automatic operation or manual operation according to the calculated running plan.

[0022] FIG. 3 is a conceptual diagram for exemplifying a running plan P. As illustrated in FIG. 3, the train T is stopping at a station ST1 and has a scheduled arrival time at 12:02:30 at a next station ST2. When the train T leaves the station ST1 at 12:00:18, the target running time between the stations ST1 and ST2 becomes 0:02:12. The ATO device 30 calculates the running plan P to define sections and running curves for driving operation, coasting operation, and braking operation so that the running time based on the running plan becomes close to the target running time between the stations ST1 and ST2 and follows the speed limit in the route conditions recorded in the database 32. Here, the running plan P is calculated by using a publicly-known method for predicting the running behavior of the train T with the use of a mechanical train model based on vehicle characteristics, such as a method described in Japanese Patent Application Laid-open No. H4-284684, for example.

[0023] The running time in the running plan P calculated

as described above may deviate from the target running time. Specifically, despite an attempt to make the running time of the calculated running plan P close to the target running time, the attempt may fail due to delay in leaving a station, a running speed lower than that in the running plan resulting from the driver's operation between the stations, and/or the like. Therefore, in such a case, the ATO device 30 causes the display device 60 to display a warning screen to notify the driver of a possibility that the train T may not arrive at the next station on time according to the train operation diagram. Specifically, the ATO device 30 displays, on the display device 60, a delay time behind the train operation diagram based on the running time in the running plan P and the scheduled arrival time. This notification may be provided by a warning sound from a speaker or the like, or may be provided to the station management device 42 and the operation management center 41 via the communication device 40 so that an operator other than the driver is notified.

[0024] Returning to FIG. 2, when it is determined at S2 that a running plan is prepared, that is, the train T is running according to the calculated running plan, the ATO device 30 determines whether the running plan needs to be recalculated (S6). Specifically, the ATO device 30 determines that the running plan needs to be recalculated if the speed of the train T detected by the speed and position detection unit 10 or the time indicated by the clock unit 33 has deviated from the running plan by a threshold value or more, if the signal-indicating speed (speed limit) has been changed by the analog ATC, or if a sufficient distance from a leading train is secured after slowing down due to extremely close proximity to the leading train. On the other hand, the ATO device 30 determines that the running plan does not need to be recalculated when no sufficient distance from the leading train has been yet maintained after slowing down due to extremely close proximity to the leading train because the ATO device 30 performs deceleration control (S10) not according to the running plan in the meantime. Specifically, when a predetermined period of time has elapsed after a sufficient distance from the leading train is secured and an increased aspect speed limit is notified via the ATC on-vehicle device 20 so as to agree to the speed limit in the route conditions at the current position of the running train T, the ATO device 30 determines that the distance from the leading train has become sufficient and thus the running plan needs to be recalculated.

[0025] When it is determined, at S6, that the running plan needs to be recalculated, the ATO device 30 calculates the target running time by subtracting the current time at which the running plan is recalculated from the scheduled arrival (passage) time at the next station (S7) as at S4 and S5. Then, the ATO device 30 calculates a running plan such that the running time becomes close to the target running time based on the route conditions and vehicle characteristics recorded in the database 32 (S8). Accordingly, the ATO device 30 performs automatic

operation or manual operation according to the newly calculated running plan. Therefore, for example, even when the train T has excessively approached the leading train between stations, a new running plan is calculated after a sufficient distance from the leading train has been maintained again. This makes it possible to continue an operation without deviating from the train operation diagram.

[0026] Then, during running according to the running plan, the ATO device 30 determines whether there is a leading train the train T is approaching (S9). Specifically, the ATO device 30 compares the speed limit in the route conditions at the current position of the running train T with the aspect speed limit notified via the ATC on-vehicle device 20. Then, the ATO device 30 determines that there is a leading train the train T is approaching if the aspect speed limit lowers due to the approach to the leading train. When a predetermined period of time has elapsed after the aspect speed limit increases and agrees to the speed limit in the route conditions, the ATO device 30 determines that a sufficient distance is maintained from the leading train.

[0027] When it is determined that there is a sufficient distance maintained from the leading train or there is no leading train the train T is approaching, at S9, the ATO device 30 continues the running of the train T according to the running plan (S10). On the other hand, when it is determined, at S9, that the train T has approached the leading train, the ATO device 30 performs deceleration control under which the train T is decelerated as compared to the running plan so as to satisfy a sufficient distance from the leading train (S11).

[0028] Subsequent to S10 and S11, the ATO device 30 determines whether the next station is a way station (next station = way station?) (S12). When it is determined, at S12, that the next station is a way station (next station = way station), the ATO device 30 then determines whether the train T has sufficiently approached the next station way station) based on speed and position information from the speed and position detection unit 10 (S13). The approach to the next station (way station) is determined depending on whether the train T has been within a predetermined distance from the next station (way station). More specifically, the ATO device 30 determines that the train T has sufficiently approached the next station when the first car of the train T has reached a predetermined entrance position of the station. When it is determined that the train T has not yet sufficiently approached the next station with a distance remained, the ATO device 30 returns the process to S1. When it is determined that the train T has sufficiently approached the next station, the ATO device 30 changes the station after next to the next station (S14).

[0029] Meanwhile, when it is determined at S12 that the next station is not a way station but a stop station (next station = stop station), the ATO device 30 determines whether the train T has arrived at the next station (stop station) based on speed and position information

from the speed and position detection unit 10 (S15). Specifically, when the train T has arrived at the target stop position in the stop station, the ATO device 30 determines that the train T has arrived at the stop station. When it is determined at S15 that the train T has arrived at the next station (stop station), the ATO device 30 terminates the process for running from the starting station to the stop station. When it is determined that the train T has not yet arrived at the next station, the ATO device 30 returns to S1 to continue the process for running from the starting station to the stop station.

[0030] FIGS. 4 to 6 are conceptual diagrams for exemplifying running plans P1 to P5 with way stations STa to STd. As illustrated in FIG. 4, with the way stations STa to STd between the stations ST1 and ST2, the running plans P1 to P5 are calculated for the individual way stations according to the flowchart described above, and the train T runs according to the running plans P1 to P5. Target stop position M1 refers to the position of the first car of the train T stopped at each of the stations, relative to which the scheduled arrival (passage) time of the train T at each of the stations is set. Entry start position M2 refers to the position at which the train T starts to enter each of the stations.

[0031] Specifically, when the train T leaves the station ST1 at 12:00:12 and the scheduled time of passage through the way station STa recorded in the database 32 is 12:02:15, the running plan P1 is calculated such that the train T runs in the target running time 0:02:03 and passes through the way station STa within a predetermined speed limit. Thus, as illustrated in FIG. 5, the train T runs according to the running plan P1 within the range from the target stop position M1 in the station ST1 to the target stop position M1 in the way station STa. Then, the running plan P2 is calculated with the target running time based on the time at which the train T has sufficiently approached the way station STa (the train T has arrived at the entrance position M2) and the scheduled time 12:04:45 of passage through the way station STb. Thus, as illustrated in FIG. 6, the train T runs according to the running plan P2 within the range from the entrance position M2 in the way station STa to the target stop position M1 in the way station STb. In the overlapping area between the running plan P1 and the running plan P2, to keep the continuity of the running plans, the train T runs according to the running plan P1 until the calculation of the running plan P2 is completed. Thereafter, when the running plan P2 is prepared, the train T runs according to the running plan P2. Then, in the same manner as described above, the running plans P3 to P5 are calculated with the running times based on the arrival times at the way stations STb to STd and the scheduled passage (arrival) times at the next stations, and the train T runs according to the running plans P3 to P5.

[0032] As described above, when the way stations STa to STd exist between the stations ST1 and ST2, the running plans can be finely calculated for the individual stations to reduce hardware resources necessary for calcu-

lation of the running plans and load thereon. In addition, when the train T runs according to the running plans calculated for the individual way stations, even if a delay or the like occurs at a way station in the course of running, it is possible to eliminate the delay at another way station and thus enhance punctuality of the train T relative to the scheduled times of passage through the individual way stations.

Second Embodiment

[0033] Although the analog ATC is used in the first embodiment, a digital ATC is used instead in a second embodiment.

[0034] FIG. 7 is a block diagram of an exemplary configuration of a train control device 1a according to a second embodiment. As illustrated in FIG. 7, an ATC on-vehicle device 20a receives, via a power receiver 21a, information provided by an ATC ground device 22a as a digital signal via the track circuit 23 formed by using the rail R. The ATC on-vehicle device 20a outputs a brake instruction to the drive and brake control device 3 based on the information provided by the ATC ground device 22a and the speed of the train T. The digital ATC system allows the ATC ground device 22a to provide a larger amount of information as compared to the analog ATC. The information provided by the ATC ground device 22a includes the number of open sections as well as an aspect speed limit in a closed section where the train T resides. The number of open sections indicates the number of closed section between the closed section in which the leading train is running and the closed section in which the train T is running. The ATC on-vehicle device 20 outputs to the ATO device 30 the aspect speed limit and the number of open sections received by the power receiver 21a.

[0035] In the same manner as described above referring to FIG. 2 in relation to the first embodiment, the running plan P is calculated by the ATO device 30 in the second embodiment. If the running time in the calculated running plan P is longer than the target running time (e.g., in a case where the train T is to be delayed behind the target running time even though the train T runs according to the fastest running plan), the ATO device 30 adjusts the running plan P so that the running speed of the train T becomes close to a brake pattern in the ATC on-vehicle device 20a estimated based on the speed limit in the route conditions until the running speed of the train T agrees to the brake pattern (so as to increase the degree of deceleration at the time of deceleration). In the course of running, when a wiring voltage is relatively high and an acceleration higher than initially envisioned in the running plan P is acquired so that the train T is to get an early arrival on the running according to the running plan P, the ATO device 30 adjusts the running plan P to decelerate the train T at a more anterior position (lower the degree of deceleration (return to the original level) at the time of deceleration).

[0036] FIG. 8 is a conceptual diagram for exemplifying a relationship between a brake pattern BP estimated from a speed limit and the running plan P. As illustrated in FIG. 8, the running plan P can be calculated as running plan Pb to shorten the running time within the range of the brake pattern BP estimated based on the speed limit in the ATC on-vehicle device 20a. Here, the running plan P is calculated as the running plan Pb by making the deceleration start position close to the brake pattern BP to make the running speed of the train T close to the brake pattern BP. In addition, the running plan P can also be calculated as running plan Pa to lengthen the running time by setting the deceleration start position to be anterior to that in the brake pattern BP. In the running plan Pa, ride quality can be improved by lessening of rapid deceleration as compared to the running plan Pb.

[0037] In case when there is a leading train the train T is approaching, the ATO device 30 determines whether the distance from the leading train is equal to or more than a predetermined distance (refer to FIG. 2, S9) depending on whether the number of open sections has become equal to or more than a predetermined value. This allows running in accordance with the distance from the leading train.

[0038] FIG. 9 is a conceptual diagram for exemplifying recalculation of a running plan for the case when a distance from a leading train T1 is increased. As illustrated in FIG. 9, when the train T is running from the station ST1 to the station ST2 according to a running plan P10 and is approaching the leading train T1, the train T is decelerated because the leading train T1 is made in contact with a brake pattern BP1. This deceleration increases the number of open sections between the train T and the leading train T1 and the brake pattern BP1 proceeds with running of the leading train T1, thereby to create a distance to a degree that no contact occurs with the brake pattern BP1. Therefore, when the number of open sections has reached the value with which no deceleration occurs according to the brake pattern BP, the ATO device 30 calculates a new running plan P20 for running the train T to the station ST2. Accordingly, it is possible to continue operation with less deviation from the train operation diagram while maintaining the distance from the leading train T1.

[0039] The present invention is not limited to the foregoing embodiments but can be embodied in a practical phase with modification of constitutional elements without deviating from the gist of the present invention. In addition, various inventions can be implemented by appropriate combinations of a plurality of constitutional elements disclosed relative to the foregoing embodiments. For example, some of the constitutional elements in the embodiments may be removed. Further, constitutional elements in different embodiments can be combined as appropriate.

[0040] As in the foregoing, some embodiments of the present invention are described. However, these embodiments are merely provided as examples and are not in-

tended to limit the scope of the present invention. These novel embodiments can be implemented in various other modes, and various omissions, replacements, and modifications can be made relative to the embodiments without deviating from the gist of the present invention. These embodiments and modifications thereof are included in the scope and gist of the present invention, and in the scope of the inventions described in the patent claims and equivalents thereof.

Claims

1. A train control device comprising:

a detection unit that detects a current position and a speed of a train;
 a clock unit that keeps a current time;
 a diagram input unit that inputs diagram data including a scheduled arrival time of the train at each of stations on a route; and
 a calculating unit that calculates a running plan to a next station based on a target running time obtained by subtracting the current time from a scheduled arrival time at the next station included in the input diagram data, the detected current position, the detected speed, operational characteristics of the train, and a route condition.

2. The train control device according to Claim 1, wherein the calculating unit calculates a running plan in which the running time is made close to the target running time by shortening the running time, the running time being shortened by making the running speed of the train close to a brake pattern within a range in which the running speed is made not in contact with a brake pattern of an automatic train control (ATC) based on the route condition.

3. The train control device according to Claim 1, wherein the calculating unit calculates a running plan in which the running time is made close to the target running time by elongating the running time, the running time being elongated by decelerating the train at a more anterior position within a range in which the running speed is made not in contact with a brake pattern of the ATC system based on the route condition.

4. The train control device according to Claim 1, wherein the diagram data includes scheduled passage times of the train at way stations on the route, and the calculating unit calculates, for each of the way stations, a running plan in which the running time is made close to the target running time that is obtained by subtracting the current time from the scheduled arrival or passage time at a next station included in

the input diagram data.

5. The train control device according to Claim 1, further comprising a notification unit that notifies of a warning if a running plan in which a running time deviates from the target running time is calculated.

6. The train control device according to Claim 1, wherein, when the train is decelerated due to approach of a leading train while the train is running in accordance with the running plan, the calculating unit recalculates the running plan when a distance between the leading train and the train has become a predetermined distance or more.

7. The train control device according to Claim 6, further comprising a reception unit that receives a number of open sections indicating a number of closed sections between the leading train and the train, wherein the calculating unit recalculates the running plan when the number of open sections has become a predetermined value or more.

1. G. E.

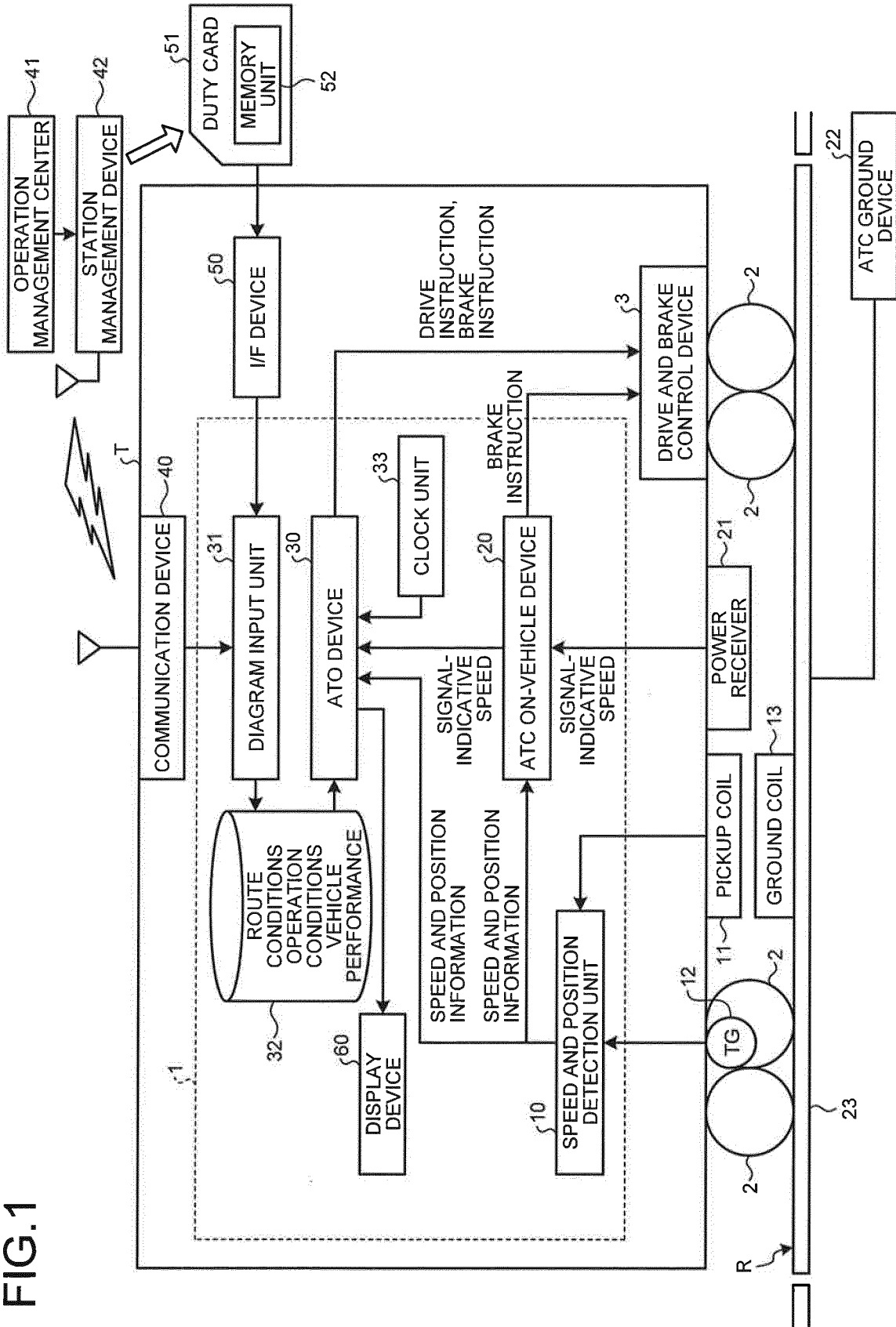


FIG.2

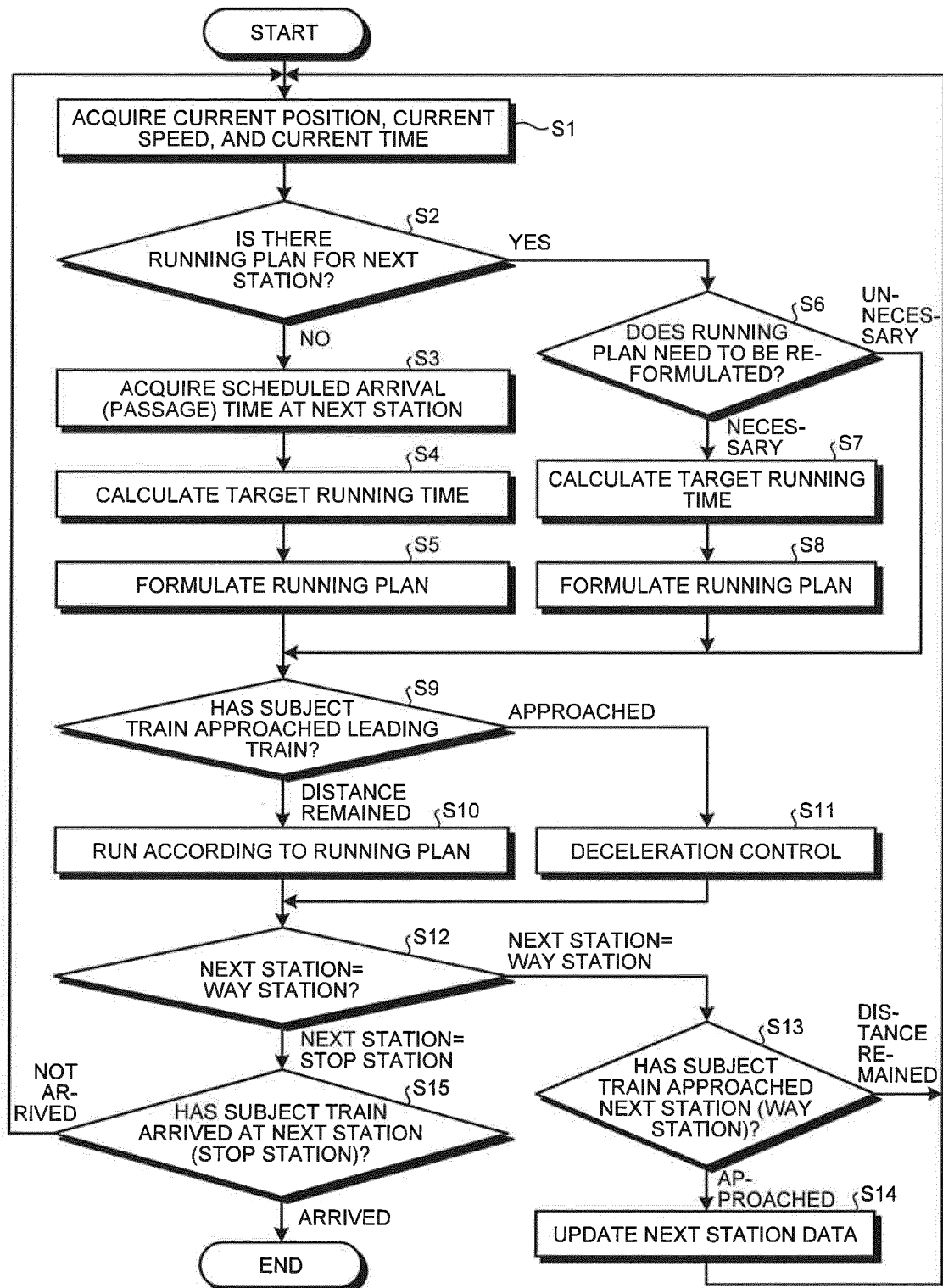


FIG.3

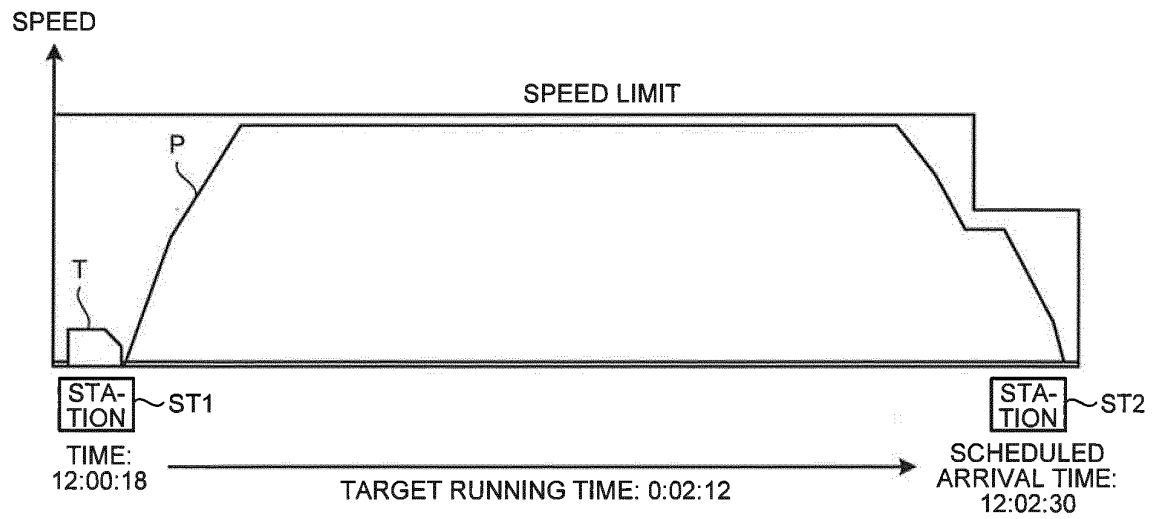


FIG.4

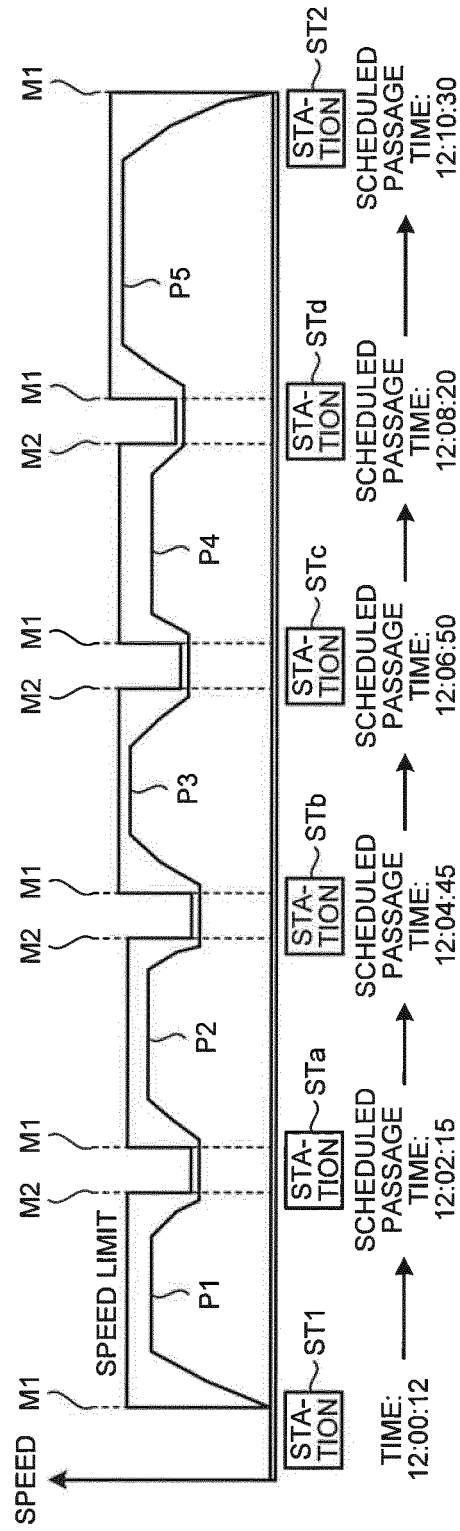


FIG.5

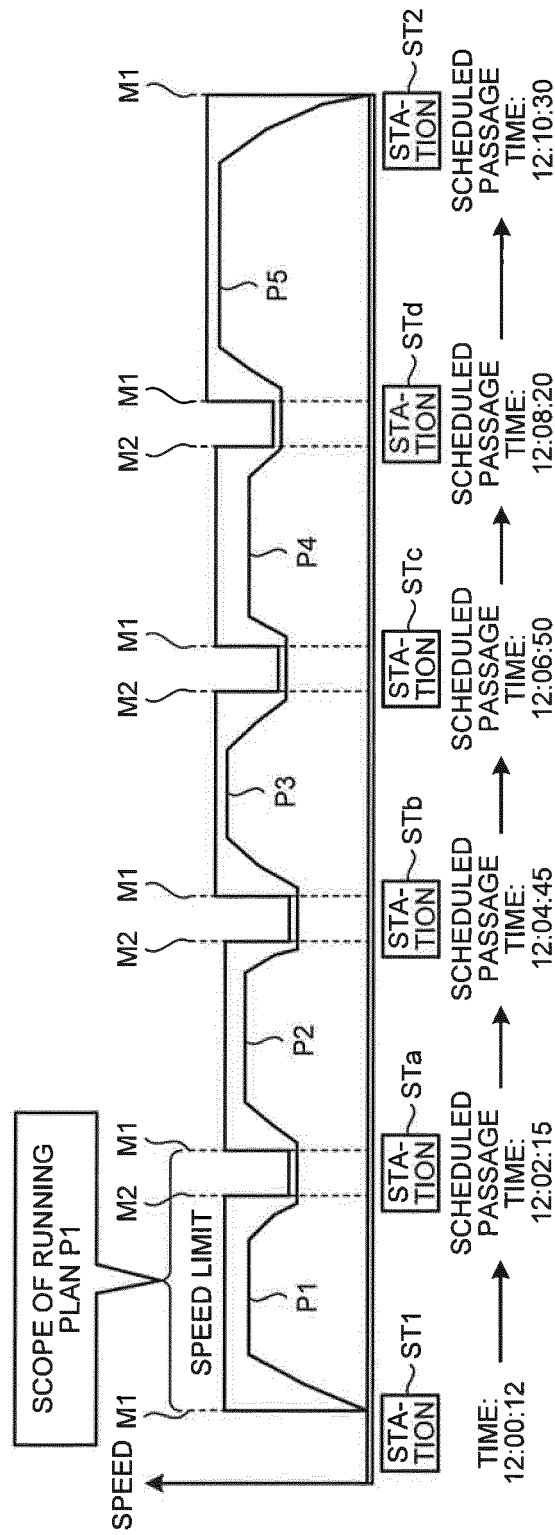


FIG.6

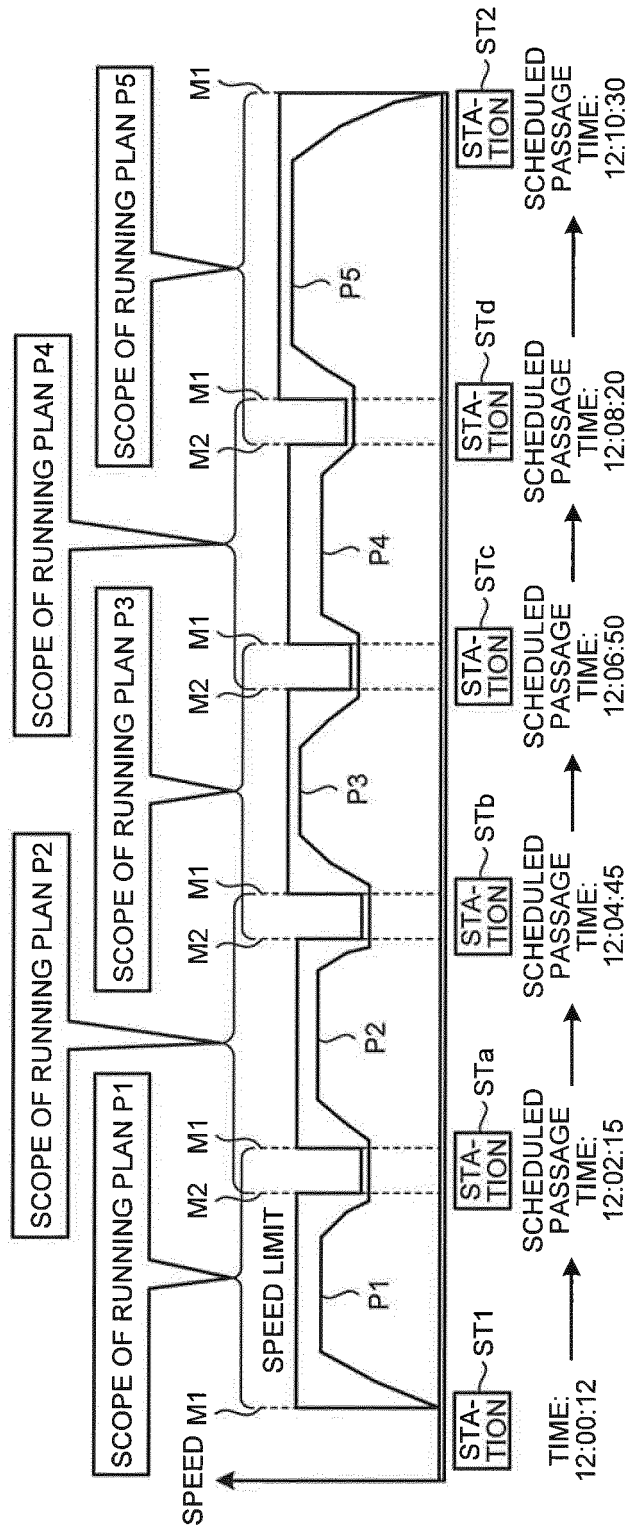


FIG. 7

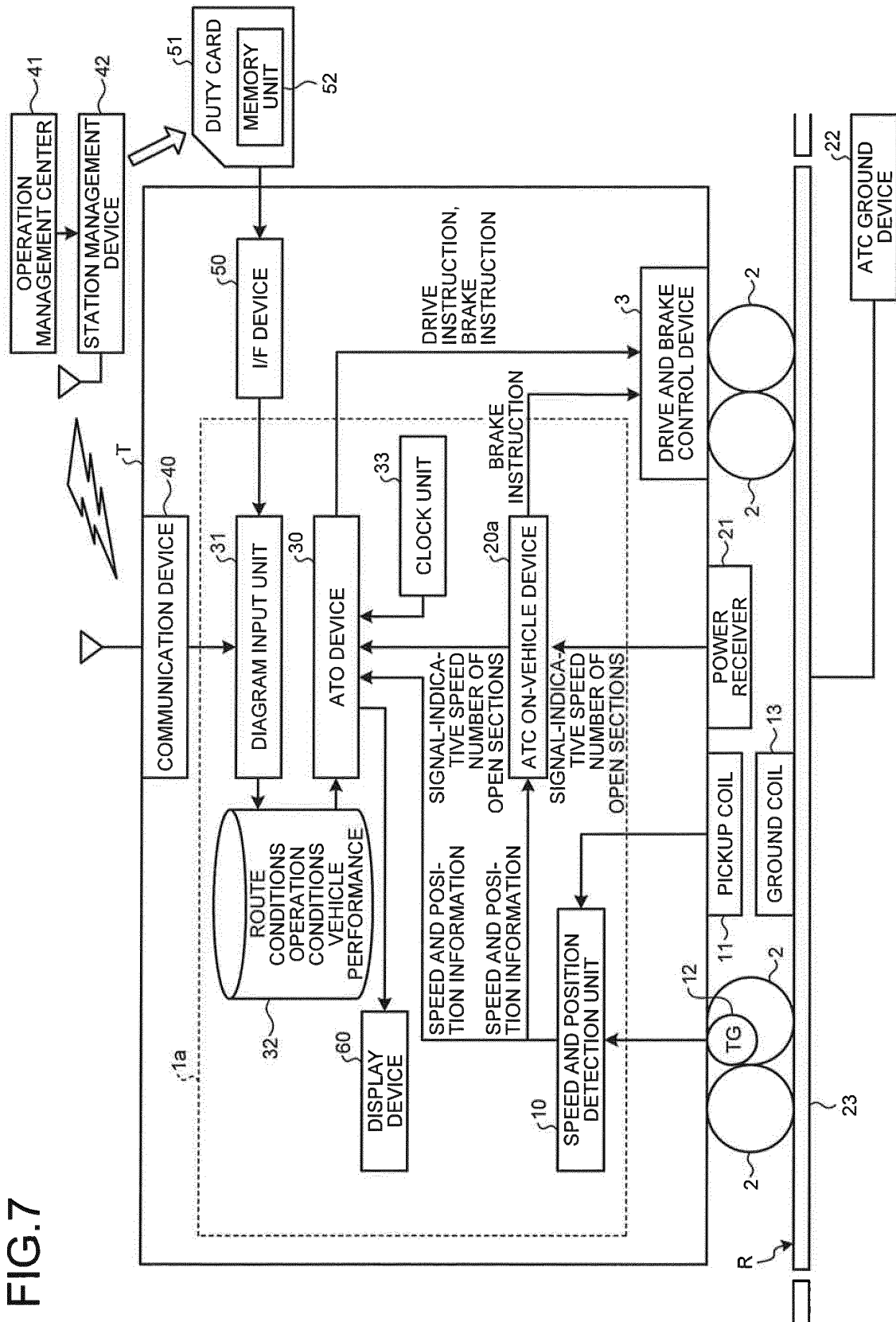


FIG.8

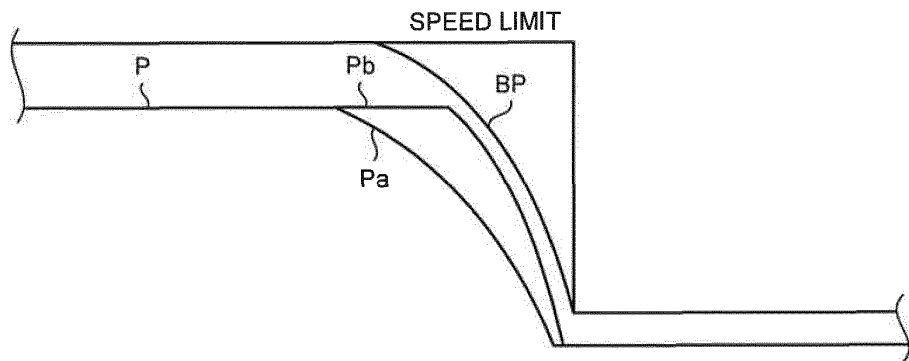
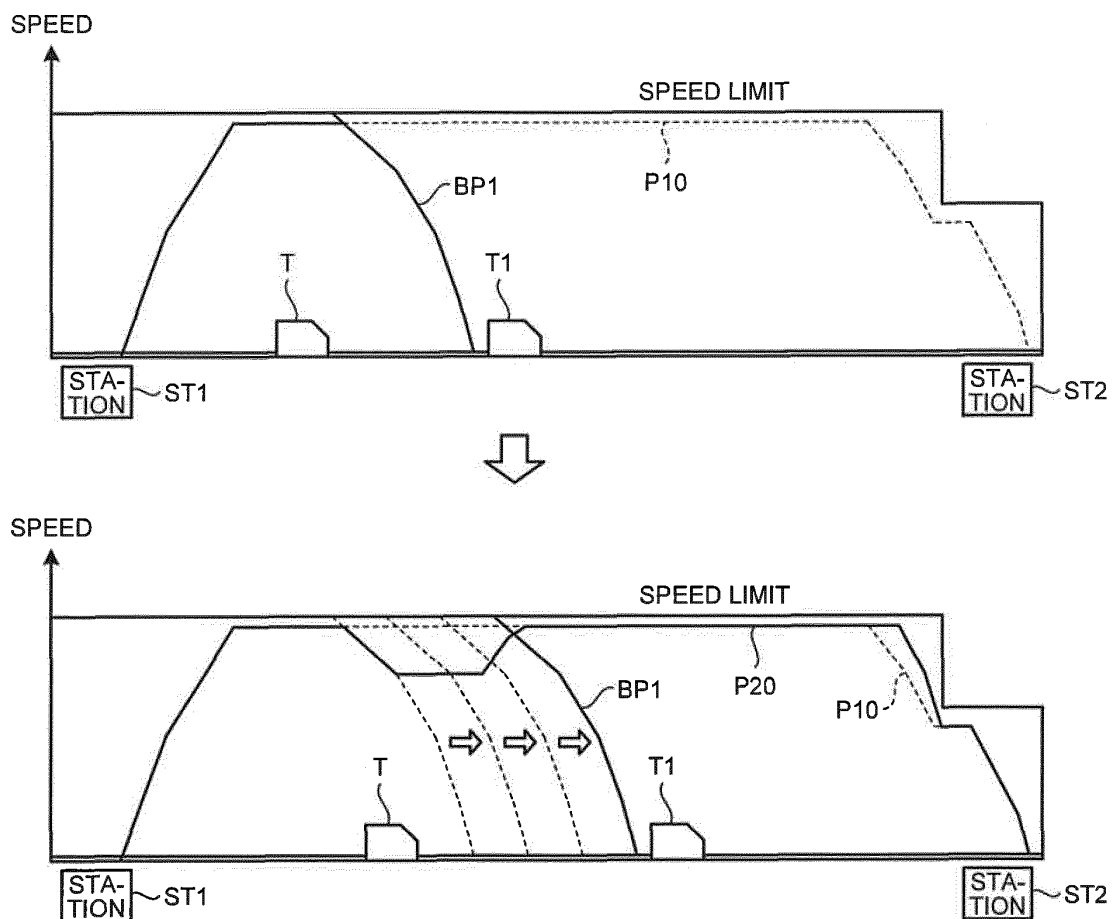


FIG.9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/061229

A. CLASSIFICATION OF SUBJECT MATTER

B60L15/40 (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)

B60L15/40

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.
X	JP 2004-229359 A (Mitsubishi Electric Corp.),	1-4
Y	12 August 2004 (12.08.2004), paragraphs [0008] to [0021]; fig. 1 to 4 (Family: none)	5-7
Y	JP 4-252769 A (Toshiba Corp.), 08 September 1992 (08.09.1992), paragraph [0038] (Family: none)	5
Y	JP 6-284519 A (Toshiba Corp.), 07 October 1994 (07.10.1994), paragraph [0046]; fig. 10 (Family: none)	6, 7

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

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"&" document member of the same patent family

Date of the actual completion of the international search

08 July, 2013 (08.07.13)

Date of mailing of the international search report

16 July, 2013 (16.07.13)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/061229

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 2008-5585 A (Hitachi, Ltd.), 10 January 2008 (10.01.2008), paragraphs [0013] to [0022] (Family: none)	1-4
A	JP 2005-231447 A (Hitachi, Ltd.), 02 September 2005 (02.09.2005), paragraphs [0018] to [0024]; fig. 3 to 6 (Family: none)	1-4
A	JP 2004-266986 A (Mitsubishi Electric Corp.), 24 September 2004 (24.09.2004), entire text (Family: none)	1-7
A	JP 8-156794 A (Hitachi, Ltd.), 18 June 1996 (18.06.1996), column 9, line 28 to column 10, line 42; fig. 20 to 23 (Family: none)	6, 7
A	JP 5-193502 A (Toshiba Corp.), 03 August 1993 (03.08.1993), paragraphs [0084] to [0086] & EP 539885 A2 & DE 69219272 T	6, 7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003235116 A [0003]
- JP H4284684 B [0022]