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(71) Applicant: **Hitachi, Ltd.**
Chiyoda-ku
Tokyo (JP)

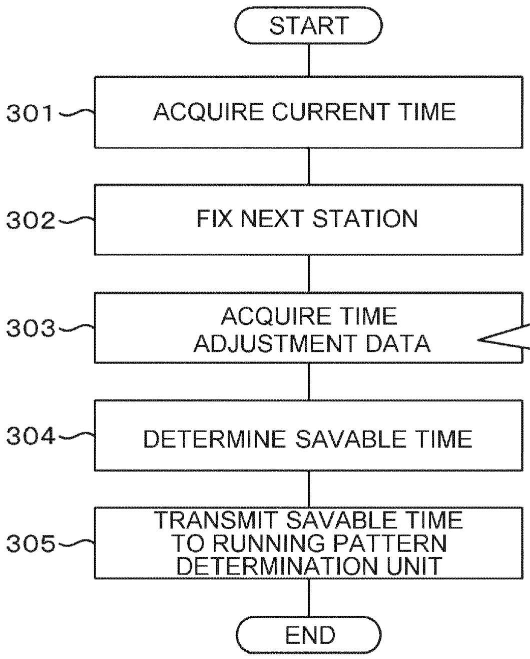
(72) Inventors:
- **Oda, Atsushi**
  Chiyoda-ku, Tokyo 100-8220 (JP)
- **Sato, Yutaka**
  Chiyoda-ku, Tokyo 100-8220 (JP)
- **Miyauchi, Tsutomu**
  Chiyoda-ku, Tokyo 100-8220 (JP)

(74) Representative: **Gill, Stephen Charles et al**
Mewburn Ellis LLP
33 Gutter Lane
London
EC2V 8AS (GB)

(54) **Vehicle system**

(57) A vehicle system includes a next station detecting unit configured to detect a station at which a train will stop next, and further includes, on the basis of number of passengers information of the station as the next stop, a running speed pattern determining unit configured to determine a running speed pattern between stations from a station that the train arrives and the station as the next stop, or a vehicle speed determining unit configured to determine the maximum speed of the train between the stations.

FIG. 2



NEXT STATION	TIME PERIOD	CATEGORY	SAVABLE TIME [SEC]
XX STATION	FROM 5:00 TO 6:00	OFF-HOUR	10
	FROM 6:00 TO 7:00	SEMI-RUSH HOUR	5
	FROM 7:00 TO 8:00	RUSH HOUR	0
	FROM 8:00 TO 9:00	SEMI-RUSH HOUR	5
	⋮		
⋮			

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a vehicle system.

Description of the Related Art

[0002] Recently, in view of conservation of the global environment, further energy saving has been required also for trains. It has been known that the energy consumption varies depending on running control of the train between stations.

[0003] As a technological field for realizing energy saving by power running control between stations when the train starts early, there is JP-A-5-124514 (Patent Document 1). The publication describes that "even when the vehicle 1 starts early, similarly, the power running time Tv can be obtained easily according to Figs. 3 and 4, and further, the power running time may be received at the vehicle side from the controller 5 and displayed in the display part at the vehicle side or the like, and the driver may perform power running operation according to the displayed power running time" (JP-A-5-124514, paragraph [0024]).

[0004] In the train, the running time between stations and the energy consumption have a relationship of an energy consumption curve 101 shown in Fig. 9. This is because, as the running time between stations increases, the maximum speed between stations becomes lower and the loss due to running resistance decreases. Further, for energy-saving operation by decreasing the loss due to running resistance, reduction of the maximum speed is effective, and, when the maximum speed is reduced, the running time between stations increases. That is, for decreasing the loss due to running resistance, the increase of the running time between stations or the reduction of the maximum speed is required. When the running time between stations is simply increased, the increase may cause influences such that the journey time increases and it becomes hard to take or necessary to adjust the time for connection to another line due to the increase of the journey time. Accordingly, it is desirable that the running time between stations is increased while the departure time is maintained.

[0005] However, in Patent Document 1, there have been problems in convenience that the energy saving may be realized only in the case of an early start such that the train starts ahead of time, and, when the early start is executed, the passenger who has come in time for the departure time misses the train.

SUMMARY OF THE INVENTION

[0006] Accordingly, an object of the invention is to provide a vehicle system that realizes energy saving while maintaining the departure time.

[0007] In order to address the problems, the invention includes a next station detecting unit configured to detect a station at which a train will stop next, and further includes, on the basis of number of passengers information of the station as the next stop, a running speed pattern determining unit configured to determine a running speed pattern between stations from a station that the train arrives and the station as the next stop, or a vehicle speed determining unit configured to determine the maximum speed of the train between the stations.

[0008] According to the invention, a vehicle system that reduces loss due to running resistance and realizes energy saving while maintaining the departure time may be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is an apparatus configuration diagram in Embodiment 1.
Fig. 2 is a flowchart showing a flow of processing within a savable time determination unit in Embodiment 1.
Fig. 3 shows a method 1 of creating time adjustment data.
Fig. 4 shows a method 2 of creating time adjustment data.
Fig. 5 shows a method 3 of creating time adjustment data.
Fig. 6 is a flowchart showing a flow of processing within a running pattern determination unit in Embodiment 1.
Fig. 7 shows display contents of a display device in Embodiment 1.
Fig. 8 is a system configuration diagram in Embodiment 2.
Fig. 9 is a schematic diagram showing a relationship between running time between stations and energy consumption.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0010] As below, embodiments of the invention will be explained using the drawings.

Embodiment 1

[0011] Fig. 1 is an apparatus configuration diagram of Embodiment 1, and an example of the configuration of the invention will be explained using Fig. 1.

[0012] When a train arrives at a station and the next stop is fixed, a savable time determination unit 201 determines a savable time 251 in the next station at the current time. Specifically, the time periods with larger numbers and smaller numbers of passengers are previously extracted from statistical data showing the relationship between the time and the number of passengers. The length of the time period to be extracted may be arbitrarily set. For example, resolution of only rush-hours and off-hours may be set, or the length may be set to one hour. The time that can be saved in the stoppage time is previously defined as the savable time 251 with respect to each time period. The savable time determination unit 201 transmits the savable time 251 to a running pattern determination unit 202. The running pattern determination unit 202 determines a running pattern with respect to each section between stations from the savable time 251 and the vehicle weight. The running pattern determination unit 202 transmits a determined running pattern 252 to a display device 203. The display device 203 informs the driver of the running pattern 252 by displaying it on the screen. Note that the informing method may not only by display on the screen but also by sound.

[0013] Fig. 2 shows a flow of processing within the savable time determination unit 201 in Fig. 1. The savable time is determined at steps 301 to 304 in Fig. 2.

Step 301:

[0014] The current time is acquired. The current time is acquired from a vehicle controller or the like. The process moves to step 302.

Step 302:

[0015] The next station is detected from the current location of the train itself and station location information. The current location is calculated by acquisition of the vehicle speed from a speed sensor and time integration of the vehicle speed. The current location is corrected at predetermined mileage of the stop at each time when the train stops at the station, and thereby, the current location may be accurately estimated. The current location may be corrected by communication using GPS or wireless communication. In the invention, any method may be used as long as the next station may be specified.

Step 303:

[0016] Time adjustment data is acquired. The time adjustment data is savable time by time period information in which the savable time is defined with respect to each time period. The data is held with respect to each section between stations, and the data is acquired using a communication unit (not shown). The process moves to step 304.

Step 304:

[0017] Which time period of the time adjustment data includes the current time is determined. The savable time corresponding to the time period is read out. The process moves to step 305.

Step 305:

[0018] The savable time is transmitted to the running pattern determination unit.

[0019] The time adjustment data at step 303 may be held with respect to each station, or a control office may be provided at outside of train and the control office may hold the data. In the case where the control office is provided, the data may be shared by communication between two of the train and the control office or among three of the train, the station, and the control office.

[0020] Next, a method of creating the time adjustment data in Fig. 2 will be explained by taking the case where the predetermined stoppage time is set to 30 seconds and the stoppage time is shortened to 20 seconds as an example. First, the number of passengers who can board and exit in the stoppage time of 20 seconds is calculated. The calculation method includes a method of calculating it from experimental data obtained in actual apparatus tests and a method of theoretically calculating it from the door area and the movement speed of people. In the invention, any method may be used as long as the relationship between the number of passengers and the time necessary for the number of passengers to board and exit may be grasped. The calculated number of passengers is used as a reference number of passengers. The changes 401 of the number of passengers per day obtained from the statistical data are as shown in Fig. 3. In Fig. 3, in the time periods 403, 405 in which the number of passengers is smaller than the reference number of passengers 402, boarding and exiting of passengers are completed in 20 seconds, and 10 seconds obtained by subtraction of 20 seconds in which boarding and exiting of passengers are completed from 30 seconds as the predetermined stoppage time is the savable time. Accordingly, the savable time in the time periods 403, 405 is defined to be 10 seconds in the time adjustment data. On the other hand, in the time periods 404, 406 in which the number of passengers is larger than the reference number of passengers 402, boarding and exiting of passengers are not completed in 20 seconds, and the savable time is defined to be zero seconds.

[0021] Next, when a plurality of the reference numbers of passengers are set, further energy saving may be realized. In the above described example, only one reference number of passengers is set, and the savable time is zero seconds for the stations requiring 20 seconds or more for boarding and exiting. Fig. 4 shows the case where a plurality of the reference numbers of passengers are set. For example, in addition to a first reference number of passengers 502 as the number of passengers who can board and exit in 20 seconds, the number of passengers who can board and exit in 25 seconds is defined as a second reference number of passengers 503. In this case, if changes 501 of the number of passengers are as shown in Fig. 4, time periods 505, 507, 509 in which the savable time is five seconds are newly generated and the time periods in which energy-saving operation can be performed increase. Note that, obviously, in the case where the number of passengers is even smaller, the stoppage time is further shortened, and the energy-saving effect may be greater.

[0022] Further, the savable time may be calculated from the number of passengers with respect to each time period. Fig. 5 shows the explanation of the method. From changes 601 of the number of passengers of the statistical data, a number of passengers 603 with respect to a time period 602 is calculated. The stoppage time necessary for the number of passengers to board and exit is calculated. The savable time is expressed by the following equation (1).

(savable time)= (predetermined stoppage time) - (necessary stoppage time) ... (1)

[0023] If the number of passengers in the statistical data varies depending on the weather and the presence or absence of events around the stations, the time adjustment data may be created with respect to each weather or event. Further, in the case of the station connecting to another line, the time adjustment data may be created inconsideration of the timetable of the other line. Furthermore, the statistical data that has once been created may be updated. By updating of the statistical data, the savable time further adapted to the new environment may be calculated. In this case, the new data may be added to the statistical data as it is, or the old data may be deleted when the new data is added.

[0024] Fig. 6 shows a flow of processing within the running pattern determination unit 202 in Fig. 1. The running pattern is determined at steps 701 to 705 in Fig. 6.

Step 701:

[0025] The next station is fixed from the current location of the train itself and the station location information. The process moves to step 702. Note that the next station information fixed at step 302 may be acquired from the savable time determination unit 201. In this case, at step 305, not only the savable time but also the next station information is transmitted.

Step 702:

[0026] The savable time is acquired from the savable time determination unit 201. The process moves to step 703.

Step 703:

[0027] The vehicle weight is calculated. The vehicle weight is calculated using a value of a weight sensor mounted on the vehicle, for example, a pressure sensor provided within an air spring. The process moves to step 704.

Step 704:

[0028] The running pattern to the next station is acquired from the savable time and the vehicle weight. The process moves to step 705.

Step 705:

[0029] The running pattern is transmitted to the display device.
[0030] The running pattern is calculated in advance with respect to each vehicle weight and each savable time, and held in the running pattern determination unit as a table. In the running pattern, notches as notch information of levers of a master controller provided on the cab and speed ranges for handling the notches are described. Note that another method of describing the running patterns than the above method may be used, and the notches and the sections (locations) for handling the notches, torque or tractive force necessary for fulfillment of the running patterns, location-speed patterns, time-speed patterns, or threshold values of the maximum speed may be used. Further, another method of holding the running patterns than the method using the table may be used, and the running patterns may be determined in real time from an equation of motion. In the invention, any method of describing, any method of holding, and any location for holding the running patterns may be used as long as the running method to the next station may be grasped. Further, the classification by vehicle weight is not made, but the running patterns may be acquired according to the savable times. In this case, the device and computation for calculating the vehicle weight becomes unnecessary and the cost may be suppressed. In the example, the adjustment of the running pattern according to the savable time is important. Furthermore, the running speed pattern between stations may be generated from the savable time, or the maximum speed between stations may be set from the savable time. If it is possible to increase the running time between stations, the maximum speed may be reduced, and thus, the energy consumption may be reduced while the departure time is kept. Therefore, the running pattern determination unit 202 may be either a unit configured to determine the pattern of the running speed or a unit configured to determine the maximum speed between stations.
[0031] Fig. 7 shows an example of a display method in the display device 203. The display device 203 includes an area 801 for displaying the voltage of an electrical storage device as a power supply of the controller, an area 802 for displaying overhead wire voltages used as a power source of the vehicle, an area 803 for displaying operating conditions and failure conditions of various apparatuses mounted on the vehicle, an area 804 for displaying the vehicle speed, an area 805 for displaying brake notches as notch information of a brake lever of the main controller provided on the cab, an area 806 for displaying the operating condition of the air brake, an area 807 for displaying the running pattern, etc. The area 807 for displaying the running pattern may display the pattern of the running speed or the maximum speed.
[0032] Note that, other component elements of the display device 203 such as areas for displaying the operating condition of the door unit of the vehicle, the operating condition of the air-conditioner, and the running timetable may be set. That is, any configuration of the other display areas may be employed as long as the area for displaying the running pattern may be secured. Further, any numbers of the display devices 203 and the running pattern display areas 807 may be provided. Furthermore, the display of the running pattern may use another than the notches and the speed ranges for handling the notches, the notches and the sections (locations) for handling the notches, torque or tractive force necessary for fulfillment of the running patterns, location-speed patterns, or time-speed patterns may be used.
[0033] In Fig. 1, the savable time determination unit 201, the running pattern determination unit 202, and the display device 203 are mounted on the train, however, even when they are mounted on the station or the control office, the effects of the example may be achieved. In this case, the data communication unit may use wireless or wired communication.

Embodiment 2

[0034] In Embodiment 1, the number of passengers in the next station is predicted from the statistical data, and, in Embodiment 2, the number of passengers of the preceding train is used. Fig. 8 shows a system configuration of Embodiment 2. When the next station is fixed, a first train 901 makes inquiries to an information control device 902 about the number of passengers in the next station. The information control device 902 transmits 905 the number of passengers of a second train 903 as the latest train of the trains that have left the next station to the first train. When the train leaves the station, the information control device 902 receives 904 the number of passengers from the train. The train transmits the number of passengers to the information control device 902 when leaving the station. The second train 903 calculates the number of passengers from the value of the weight sensor mounted on the vehicle, for example, the pressure sensor provided within the air spring. Note that, in the invention, the conversion from the pressure sensor value into the number of passengers may be performed using any convertor of the second train 903, the first train 901, the information control device 902, or the like. Further, the information control device 902 may be installed in any location. The first train 901 calculates the necessary stoppage time from the number of passengers. Then, the savable time is calculated by the following equation (2).

$$\text{(savable time)} = \text{(predetermined stoppage time)} - \text{(necessary stoppage time)} \quad \ldots (2)$$

[0035] The subsequent control is the same as that of Embodiment 1.

[0036] Obviously, the effects of the embodiment may be achieved even when the train receiving the number of passengers is not the latest train. Further, the average value of the numbers of passengers of the trains that have left the next station may be used, or the number of passengers of the train in the same time period in another day may be used. In the case where other information than the information of the most recent train is used, the fluctuation range of the savable time becomes smaller and advantageous stability is obtained.

[0037] Further, information not only on the next station but also on the savable time in the station subsequent to the next station (for example, the station after the next) or the like may be used. Thereby, the savable time after the next station is available more earlier.

Embodiment 3

[0038] In Embodiment 1, the number of passengers in the next station is predicted from the statistical data, and, in Embodiment 3, door open time information of the preceding train is used. The system configuration may be realized by Fig. 8 like Embodiment 2. Further, the door open time is the length of time in which the passenger door of the train is open. The train as an object of energy-saving operation makes inquiries to the information control device about the door open time information in the next station when the next station is fixed. The information control device transmits the door open time information of the preceding train as the latest train of the trains that have left the next station to the train as the object. The train as the object of energy-saving operation calculates the savable time using the following equation (3).

$$\text{(savable time)} = \text{(predetermined stoppage time)} - \text{(door open time)} \quad \ldots (3)$$

[0039] The subsequent control is the same as that of Embodiment 1.

[0040] Further, as is the case of Embodiment 2, it is not necessary that the preceding train is the latest train that has left the next station. The average value of the numbers of passengers of the trains that have left the next station or the number of passengers of the train in the same time period in another day may be used. In the case where other information than the information of the most recent train is used, the fluctuation range of the savable time becomes smaller and advantageous stability is obtained.

Embodiment 4

[0041] In Embodiment 1, the number of passengers in the next station is predicted from the statistical data, and, in Embodiment 4, camera information of the next station is used. Images of the locations near the passenger doors are taken by cameras provided on the platform of the station or the train. From the camera information, the time from start to finish of boarding and exiting may be calculated, or the number of passengers may be calculated by image analysis. The subsequent control is the same as that of Embodiment 1.

[0042] In Embodiments 1 to 4, when the number of passengers in the next station is smaller, the running time between stations is adjusted to be longer for energy saving, and obviously, in the invention, when the number of passengers in the next station is larger and the savable time is negative, the method of adjusting the running time between stations to be shorter for control the accurate departure time may be used. In this application, some of the number of passengers information in the next station, the number of passengers information of the preceding train, the door open time information of the preceding train, the camera information of the next station as the information used in Embodiments 1 to 4 may be combined for use. Some pieces of the information are used, and thereby, more reliable information may be obtained, and the reliability of the control may be improved.

[0043] Further, Embodiments 1 to 4 have been explained on the assumption that the driver performs operation of the train, however, in the case where a device for automatically driving the train such as an automatic train operation is mounted, the same effects may be obtained if the running pattern is transmitted to the automatic train operation.

Claims

1. A vehicle system comprising a next station detecting unit configured to detect a station at which a train will stop next, and
further comprising, on the basis of number of passengers information of the station as the next stop,
a running speed pattern determining unit configured to determine a running speed pattern between stations from a station that the train arrives and the station as the next stop, or
a vehicle speed determining unit configured to determine the maximum speed of the train between the stations.

2. The vehicle system according to claim 1, further comprising a savable time generating unit configured to generate a savable time of a stoppage time in the station as the next stop,
wherein the running speed pattern determining unit determines the running speed pattern based on the generated savable time, or the vehicle speed determining unit determines the maximum speed of the train based on the generated savable time.

3. The vehicle system according to claim 1 or 2, wherein the number of passengers information of the station as the next stop has a predetermined time period and savable time by time period of the stoppage time in the predetermined time period, and
the savable time by time period is set based on statistical data.

4. The vehicle system according to claim 3, wherein the statistical data can be updated.

5. The vehicle system according to claim 2, or according to claim 3 or 4 as dependent on claim 2, further comprising an information control unit configured to perform communication between the train and a train that has left the station as the next stop,
wherein the savable time generating unit generates the savable time based on the information from the train that has left the station as the next stop.

6. The vehicle system according to claim 5, wherein the information control unit transmits, from the train that has left the station as the next stop to the train, either one or both of
number of passengers information in the station as the next stop of the train that has left the station as the next stop, or
passenger door open time information in the station as the next stop of the train that has left the station as the next stop.

7. The vehicle system according to any one of claims 1 to 6, wherein the train includes a weight sensor that can measure a vehicle weight, and
the running speed pattern is determined based on the vehicle weight of the train.

8. The vehicle system according to claim 2, or according to any one of claims 3 to 7 as dependent on claim 2, wherein the savable time generating unit generates the savable time based on a predetermined stoppage time in the station as the next stop and necessary stoppage time calculated from the number of passengers of the station as the next stop.

9. The vehicle system according to any one of claims 1 to 8, wherein the next station detecting unit detects the station at which the train will stop next based on the current time and station location information as information of locations of the respective stations.

10. The vehicle system according to any one of claims 1 to 9, further comprising an informing unit configured to inform the running speed pattern or the maximum speed.

11. A train having the vehicle system of any one of the previous claims.

FIG. 1

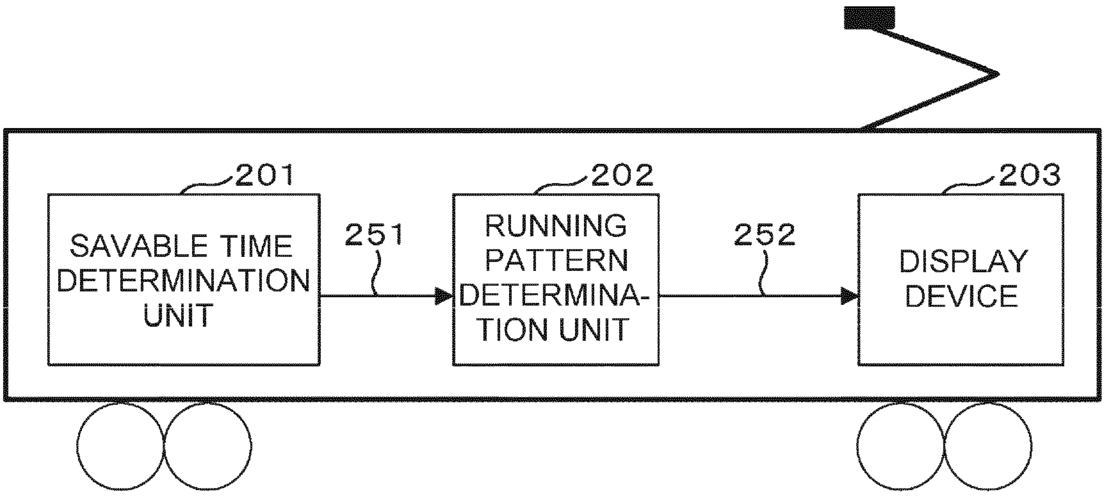

201
SAVABLE TIME DETERMINATION UNIT
251
202
RUNNING PATTERN DETERMINATION UNIT
252
203
DISPLAY DEVICE

FIG. 2

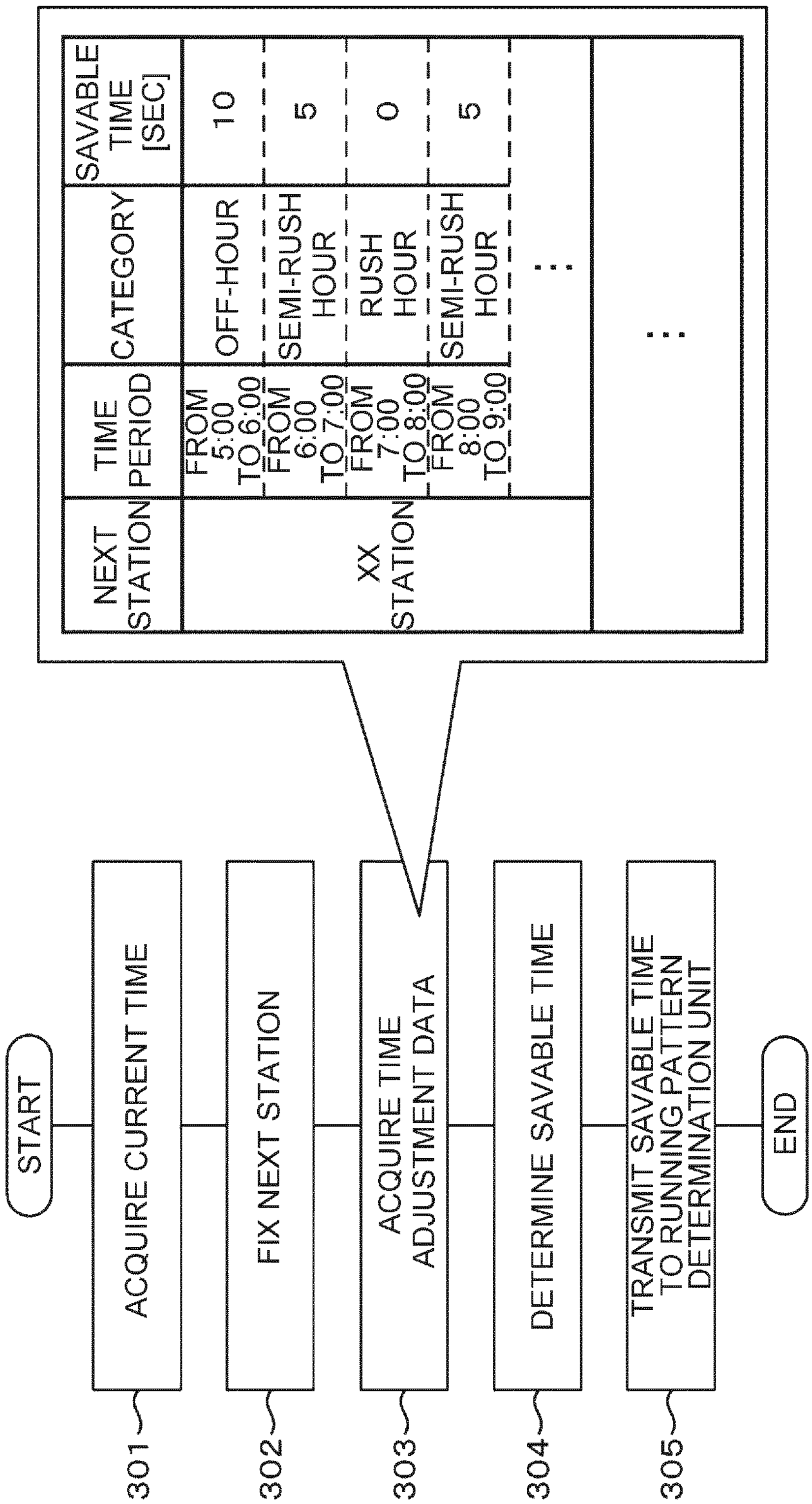

START
301
ACQUIRE CURRENT TIME
302
FIX NEXT STATION
303
ACQUIRE TIME ADJUSTMENT DATA
304
DETERMINE SAVABLE TIME
305
TRANSMIT SAVABLE TIME TO RUNNING PATTERN DETERMINATION UNIT
END
NEXT STATION
TIME PERIOD
CATEGORY
SAVABLE TIME [SEC]
XX STATION
FROM 5:00 TO 6:00
OFF-HOUR
10
FROM 6:00 TO 7:00
SEMI-RUSH HOUR
5
FROM 7:00 TO 8:00
RUSH HOUR
0
FROM 8:00 TO 9:00
SEMI-RUSH HOUR
5
...
...

FIG. 3

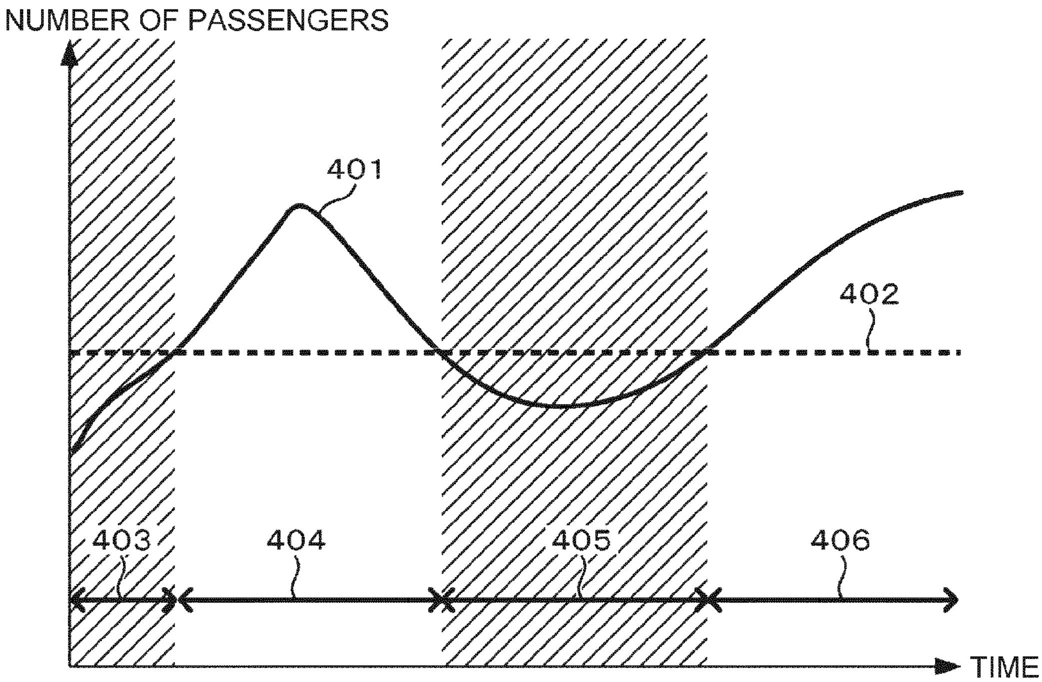

NUMBER OF PASSENGERS
401
402
403
404
405
406
TIME

FIG. 4

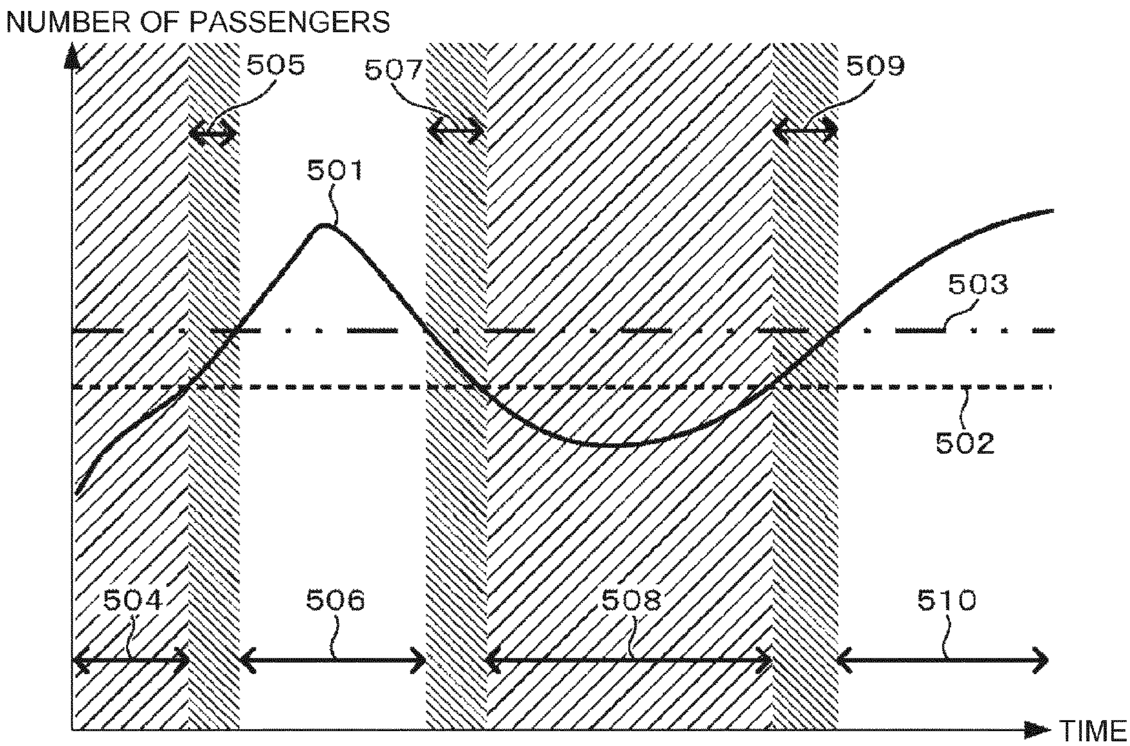

NUMBER OF PASSENGERS
505
507
509
501
503
502
504
506
508
510
TIME

FIG. 5

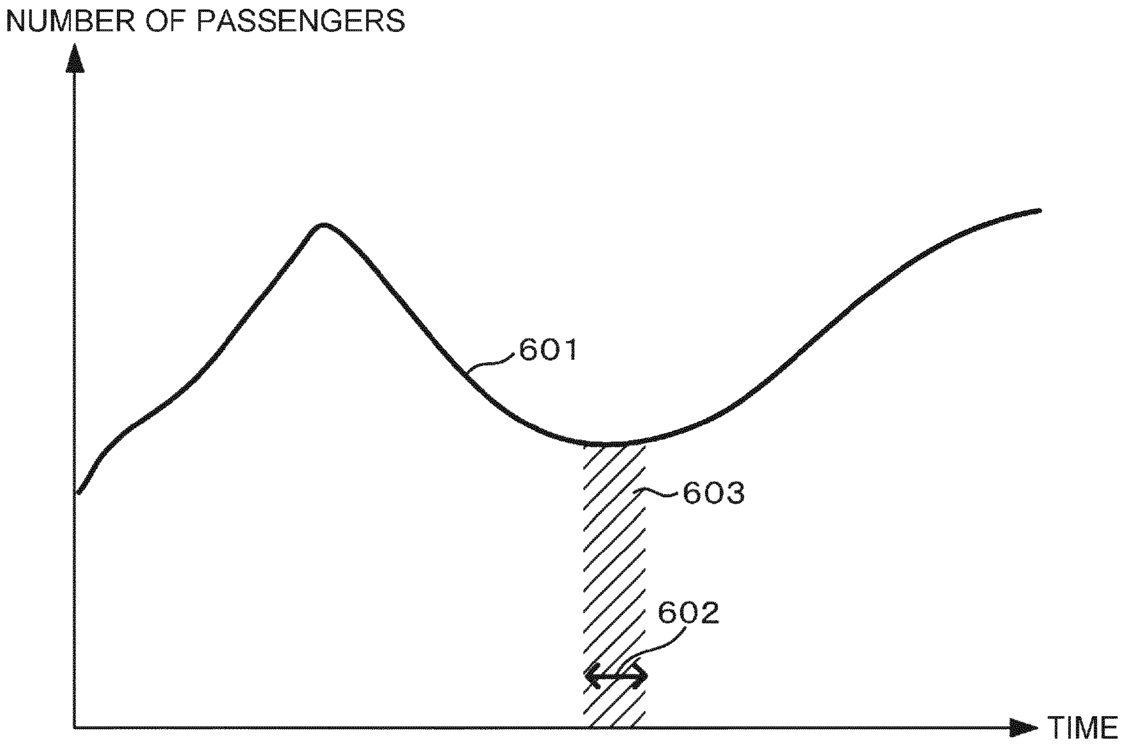
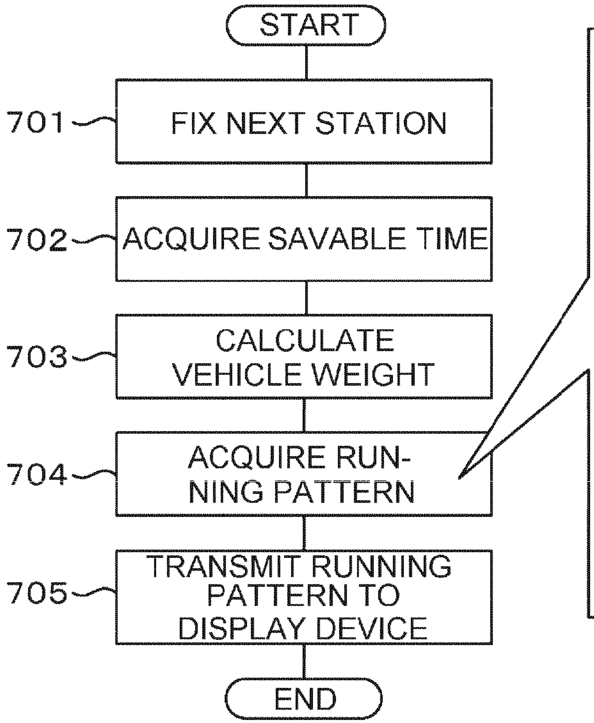


FIG. 6



NEXT STA-TION	VEHI-CLE WEIGHT [t]	SAVA-BLE TIME [SEC]	RUNNING PATTERN						
			COMMAND 1		COMMAND 2		...	FINAL COMMAND	
			NOTCH	SPEED RANGE	NOTCH	SPEED RANGE		NOTCH	SPEED RANGE
XX STA-RION	xx~yy	0	POWER RUNNING 5 NOTCHES	0→80	COASTING	80→50		BRAKE 4 NOTCHES	60→0
		5	POWER RUNNING 5 NOTCHES	0→75	COASTING	75→50	...	BRAKE 4 NOTCHES	60→0
		10	POWER RUNNING 5 NOTCHES	0→60	COASTING	60→50		BRAKE 4 NOTCHES	60→0
		⋮							
	yy~zz						...		
⋮									

FIG. 7

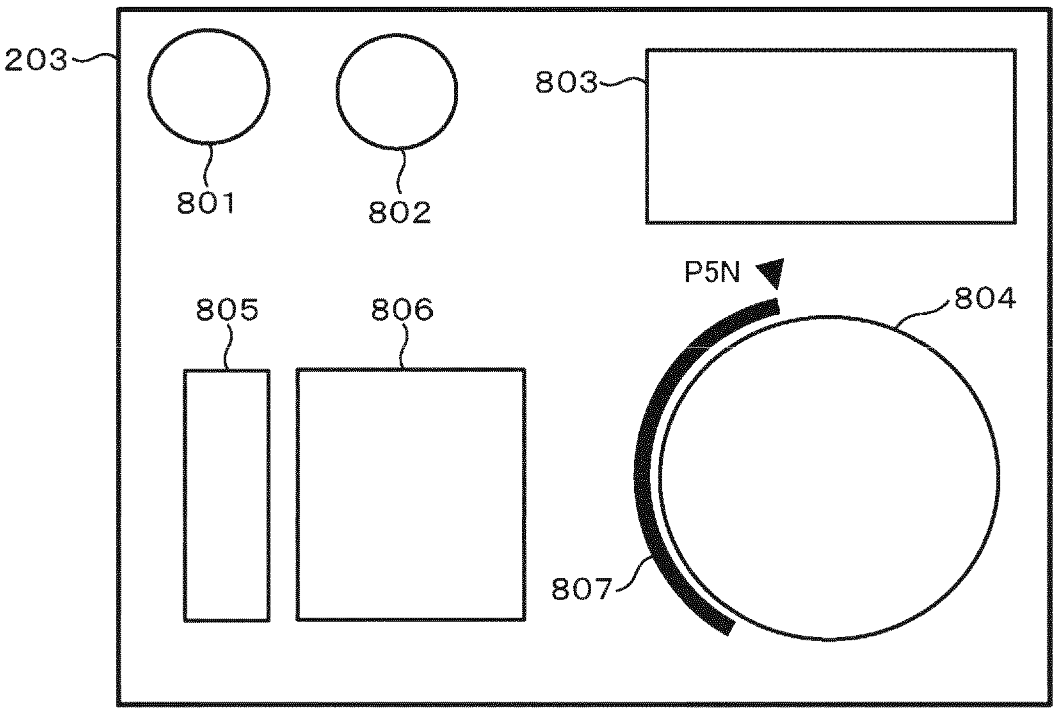


FIG. 8

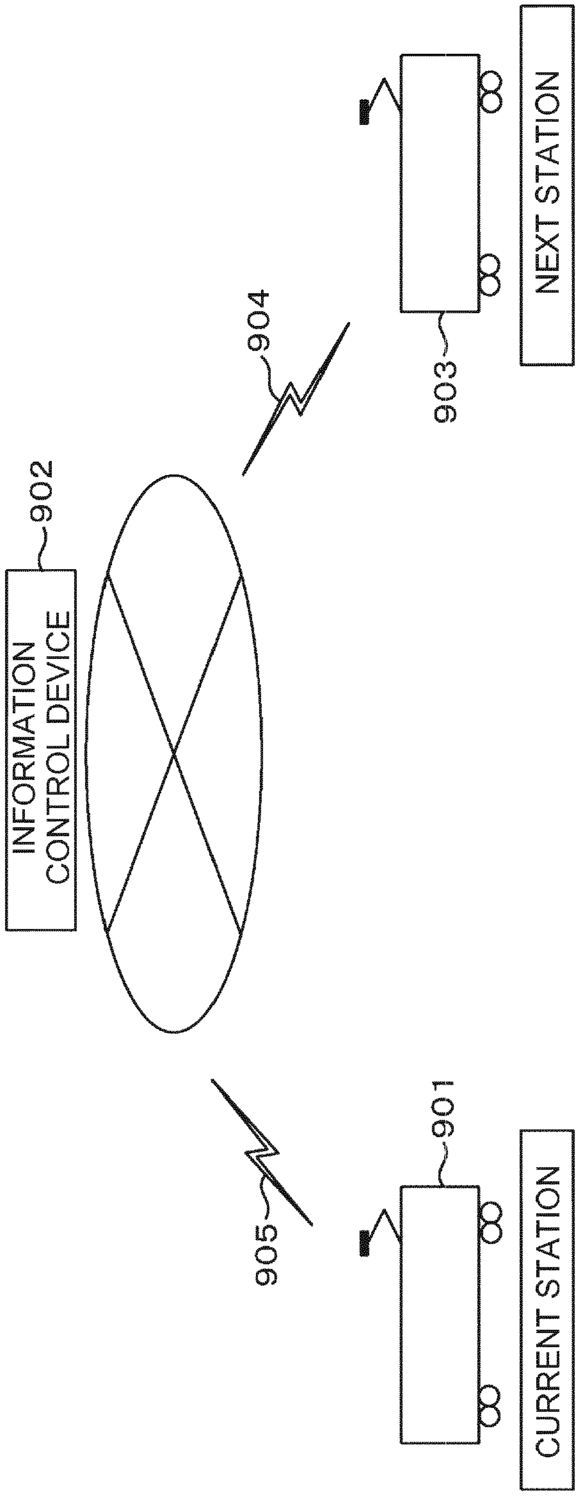
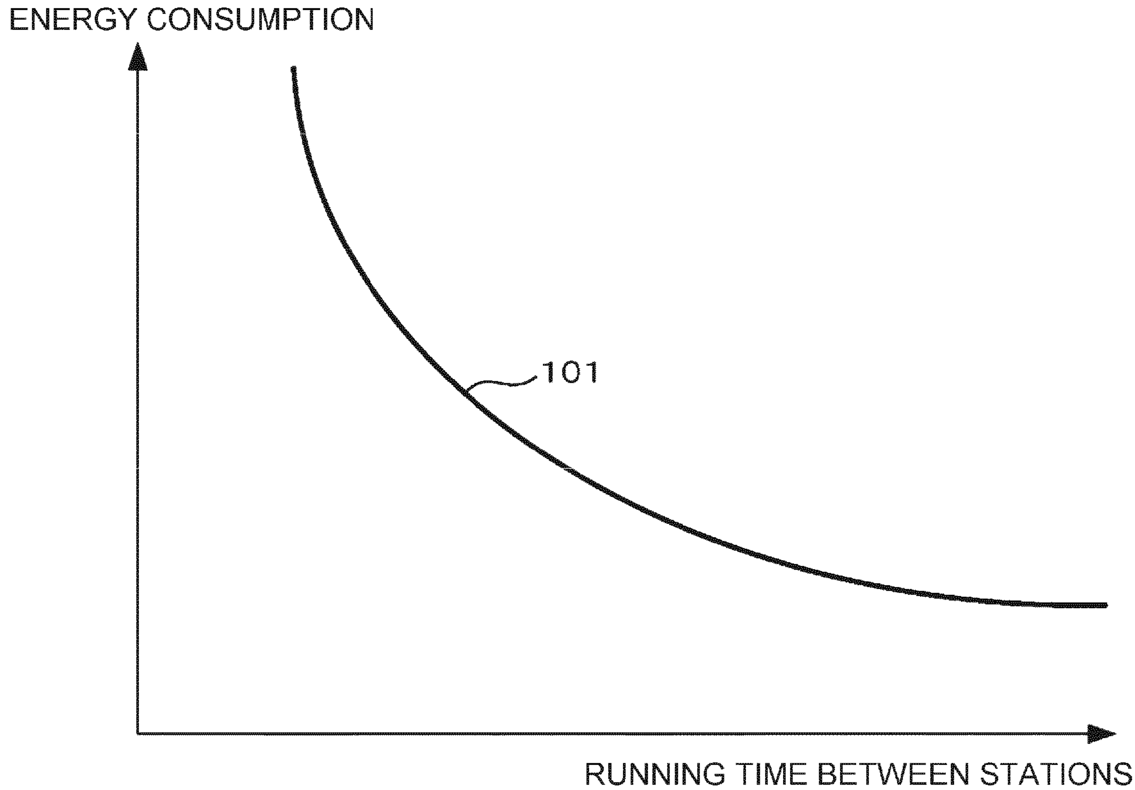

INFORMATION CONTROL DEVICE
902
904
903
NEXT STATION
905
901
CURRENT STATION

FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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