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TRAIN RUNNING CONTROL SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a train running control system for processing the information item about a suitable operation speed of the following train at the foreseeing time of delay occurrence of a preceding train and directing the following train to run in accordance with this processed operation speed information item to thus minimize the delay of the following train.

Description of the Related Art

Fig. 11 is a block diagram showing the configuration of a conventional train running control system disclosed, for example, in Japanese Patent Laid-Open No. 2-92776. As shown in Fig. 11, a conventional train running control system comprises a central control section 7 provided on the center side and station processing section 8 provided at individual stations. Each station processing section 8 controls the route of a train in accordance with the directive of the central control section 7.

The central control section 7 comprises a central computer system 1 for generating the running directive of each train in a preset sequence and conducting the pursuit, control and schedule maintenance of the train, a running display device 2 for displaying the position, number and suchlike of the train, a manual route setup device 3 for manually conducting the control of a route when the central computer system 1 fails, and

moreover a transmission device 4a for connecting the data input and output lines of the central computer system 1, the running display device 2, the manual route setup device 3 and the station processing sections 8 to conduct a mutual data transmission.

Each station processing section 8 comprises a transmission device 4b for conducting a transfer of running directive and such like with the transmission device 4a on the side of the central control section 7, a relay interlocking device 6 for detecting the position, outputting the route and checking the route conditions of a train and an input/output device (I/F device) 5 for connecting the transmission device 4b and the relay interlocking device 6 to conducting a data input/output between them.

Next, the operation of a conventional apparatus will be described.

Under normal circumstances, the central control section 7 provided on the center side issues a running directive according to a procedure previously established by the central computer system 1 and transmits this running directive to each relay interlocking device 6 via transmission devices 4a and 4b.

Alternatively, when the central computer system 1 fails, an operator directly manipulates the manual route setup device 3 while observing the running content or the like displayed on the running display section 2 and inputs the running directive to each relay interlocking device 6 via the transmission devices 4a and 4b to directly control the train running by the manual intervention.

Besides, under normal circumstances, each station processing section 8 conducts the route control of a train passing the relevant train in according with the running directive fed from the central control section 7. Alternatively, when the running directive from the central control section 7 becomes incapable of feed for some cause, an operator directly manipulates the control board of the relay interlocking device 6 to control the running of a train.

BRIEF SUMMARY OF THE INVENTION

Object of the Invention

Since a conventional train running control system is composed as mentioned above, for a definite station where passengers are excessively concentrated at morning rush hours and such like, the station halt time interval at the definite station is prolonged. However, since the following train starts at the preceding station in accordance with a predetermined schedule, there is a problem that the following train undergoes an inter-station halt in some cases and the delay time interval in the whole line increases to thus affect all train schedules in the worst case.

Furthermore, on a detailed examination of this problem by using Fig. 4, prolonged station halt time interval of the preceding train (Ctr) leads to a running of the preceding train (Ctr) according to the Ctr predicted schedule and a delay of pace-up of the ATC signal in the block boundaries d and c. Consequently, the following train (Dtr) advancing into the block boundaries d and c according to a predetermined schedule receives an ATC signal, is braked and stops between the block

boundaries d and c. Thereafter, the following train (Dtr) needs the time taken for the reacceleration to raise the operation speed to the predetermined one and accordingly is greatly delayed in entering the station B.

Made in order to solve these problems, the present invention has an object of obtaining a train running control system for computing and directing a suitable operating speed of the following train in consideration of the position and operating speed of the preceding train and the conditions of train waiting passengers at individual stations, thus minimizing the delay of the following train.

Summary of the Invention

A train running control system according to the present invention, comprising: counter means for counting the number of passengers provided at individual stations; central processing means for obtaining the counted results from said counter means and obtaining the speed information item and train position information item of each train in accordance with an output of the speedometer attached to each train; and train running guide unit for predicting the future speed and position of each train subsequent to the present time from the speed information item and train position information item of each train in said central processing means, calculating the suitable running speed of the following train succeeding a preceding train in accordance with the resultant running estimation of said preceding train from the counted results from said counter means, is so arranged as to calculate a suitable driving speed

of the following train subsequent to a preceding train at the predicting time of the delay occurrence in the preceding train.

Besides, with a train running control system according to the present invention, drive display means for displaying the notch switching point or brake point of the following train from a suitable running speed of the following train according to the train running guide unit are provided on individual trains.

Besides, with a train running control system according to the present invention, the notch information item obtained from the train control means is so arranged to be reflected on the prediction of the speed and position of the relevant train.

Besides, with a train running control system according to the present invention, the train running guide unit is so arranged as to predict the station stop time interval from the count results of count means provided at the platform, wicket or changing-car corner.

Besides, with a train running control system according to the present invention, at the timing when the front head of a train steps into a track circuit boundary, the central processing means are so arranged as to correct the train position information item of the relevant train in accordance with the kilometer distance of the stepping-in track circuit boundary.

Besides, with a train running control system according to the present invention, the speed information item acquired from the speedometer and the timing information item on the front head of a train stepping into a track circuit boundary are so arranged as to be transmitted to the central processing means

together with the acquisition time of individual information items.

Furthermore, with a train running control system according to the present invention, the on-the-ground conditions of a railroad track and the vehicle conditions retained as basic data and a signal actual-status indication pattern developed in accordance with the acquired signal actual-status indication information item are used to make up the operation curve of a train and predict a future speed and position of the train after the present time.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a train running control system according to one embodiment of the present invention;

Fig. 2 is a flowchart explaining the operation of a train running control system according to one embodiment of the present invention;

Fig. 3 is am illustration of train diagrams not subjected and subjected to a train speed control by a train running control system according to one embodiment of the present invention;

Fig. 4 is a driving pattern diagram explaining the method for evaluating Dtr patterns by a train running control system according to one embodiment of the present invention;

Fig. 5 is an illustration of a standard braking curve and a standard accelerating curve in the driving pattern diagram;

Fig. 6 is an illustration of a brake release point in the driving pattern diagram;

Fig. 7 is an illustration of a brake point in the driving pattern diagram;

Fig. 8 is an illustration of a notch switching point in the driving pattern diagram;

Fig. 9 is a diagram showing a driving pattern after the making-out;

Fig. 10 is a chart showing the calculation of the number of passengers waiting the ride according to one embodiment of the present invention; and

Fig. 11 is a block diagram of a conventional train running control system;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Embodiment 1:

Hereinafter, embodiments of the present invention will be described referring to the drawings. Fig. 1 is a block diagram of a train running control system according to the present invention. As shown in Fig. 1, the train running control system comprises a central control section 7A provided on the center side and station processing section 8A provided at individual stations. Each station processing section 8A controls the route of a train in accordance with the directive of the central control section 7A.

The central control section 7A comprises a central computer system 1 for generating the running directive of each train in a preset sequence and conducting the pursuit, control and schedule maintenance of the train, a running display device 2 for displaying the existing line position, train number and suchlike of the train, a manual route setup device 3 for manually

conducting the control of a route at the downtime of central computer system 1 and moreover a transmission device 4a for transmitting the control information of the central control section 7A to individual station processing section 8A and transmitting the existing line information item of individual station processing section 8A to the central computer system 1 and a train wireless central device 9 for distributing an information item from the central computer system 1 onto trains. Furthermore, the central computer system 1 includes a train running guide device 10 for calculating the most suitable train running speed for preventing an increase in the delay of the following train.

Each station processing section 8A comprises a transmission device 4b for conducting a sending/receiving of running directive and suchlike with the transmission device 4a on the side of the central control section 7A, a relay interlocking device 6 for outputting a control signal for points or signals, detecting the existing line position of a train and checking the conditions at the output time of a route signal, and an input/output device (I/F device) 5 for connecting the transmission device 4b and the relay interlocking device 6 to conducting a data input/output between them. Furthermore, each station processing section 8A also comprises a passenger number count device 15 serving as a count means for counting the number of passengers waiting the ride on the station, the number of passengers flowing from platform wickets and the number of passengers flowing from changing-car corners in the counter (1) 15a, counter (2) 15b and counter (3) 15c shown in Fig. 10 and

conveying the count information item to the central control section 7A via the transmission device 4b.

On the other hand, another transmission device 4b is connected to a subsidiary train wireless station 11 for transmitting an item of information in the train wireless central device 9 onto trains via a transmission path (leakage coaxial cable) 12 and transmitting an item of information on a train to the train wireless central device 9 via the transmission path 12. In a train, train wireless on-train devices 13a and 13b for sending/receiving an item of information with a ground office via the transmission path 12 and transmitting the running speed of the self-train to the train wireless central device 9 and on-train monitor devices 14a and 14b simultaneously serving as drive display means for displaying the train running speed calculated by the train running guide device 10 in the central control section 7A.

Next, the operation of this embodiment will be described. Under normal circumstances, the central control section 7A provided on the center side issues a running directive according to a procedure previously established by the central computer system 1 and transmits this running directive to each relay interlocking device 6 via transmission devices 4a and 4b. Alternatively, at the downtime of this central computer system 1, an operator directly manipulates the manual route setup device 3 while observing the running content or the like displayed on the running display section 2 and inputs the running directive to each relay interlocking device 6 via the

transmission devices 4a and 4b to directly control the train running by the manual intervention.

Besides, under normal circumstances, each station processing section 8A conducts the route control of a train passing the relevant station in accordance with the running directive fed from the central control section 7A. Alternatively, when the running directive from the central control section 7 becomes incapable of feed for some cause, an operator directly manipulates the control board of the relay interlocking device 6 to control the running of a train.

Next, with the progress of the flowchart of Fig. 2, the operation of this embodiment will be described. This flowchart shows the processing flow for suppressing the arrival delay to the minimum when a delay occurs in the preceding train. An output from the not shown speedometer, e.g., speed dynamo, of each rain is converted into a speed information item by a on-train monitor device 14 and taken into the central computer system 1 via the train wireless on-train device 13, the leakage coaxial cable 12, the subsidiary train wireless site 11, the transmission devices 4b and 4a and the train wireless central device 9, and further the notch information item of each train is also taken into the central computer system 1 along a similar route as an item of information for predicting a change in speed (step S201).

Furthermore, in each train, the on-train monitor device 14 creates a train position information item from an output of the speed dynamo of the train and the inside measured time and outputs it along a similar route to the central computer system

1 (step S202). The actual-status indication information item of each signal is taken into the central computer system 1 via a relay interlocking device 6, I/F device 5 and transmission devices 4b and 4a (step S203).

Train positions in the unit of a track circuit are made into correspondence to train numbers by a continuous pursuit logic in the central computer system 1 in accordance with the track circuit falling information item taken into the central computer system 1 through a route similar to that for the actual-status indication information item of each signal to create an train position information item in the unit of a track circuit (step S204).

An information item about the number of passengers in each station is counted at a definite period by the passenger count device 15 and is taken into the central computer system 1 via the subsidiary train wireless site 11, the transmission devices 4b and 4a and the train wireless central device 9 (step S205).

In the calculating section 1a shown in Fig. 10, the central computer system 1 calculates, for example, the total number of ride-waiting passengers in the station B at the arrival time of the preceding train (Ctr).

When the central computer system 1 takes in an information item about the stepping timing of the head of each train into the track circuit boundary (track circuit falling information item) together with the information acquisition time via the relay interlocking device 6, the I/F device 5 and the transmission devices 4b and 4a, correction of the train position information item created in accordance with an output of the

speed dynamo is performed by using the kilometer distance in the corresponding track circuit boundary (step S206).

This means that if it is recognized from the track circuit falling information item that the train has stepped into the track circuit boundary, an accurate train position can be calculated by correcting the train position information item created in accordance with an output from the speed dynamo with reference to kilometer distance.

The train running guide device 10 takes in an item of information obtained at the steps S201 to S204 (the step S202 is corrected in the step S206) together with the information acquisition time, estimates the operating curve of each train as shown in Fig. 4 by using a signal actual-status display pattern developed in accordance with these items of information, on-the-ground conditions such as the gradient and radius of curvature in railroad, vehicle conditions such as tensile force and weight and a signal actual-status indication information acquired at the step S203, and predicts the future speed and existing line position of each train from the present time (step S207).

That is, because of the provision of means for making up the operating curve of each train and predicting the future speed of each train from the present time, the train running guide device 10 estimates the most suitable notch switching point or brake point as allows to reach the target position at the target speed and displays them on the on-train monitor device 14a and 14b. Thereafter, the running of the self-train is operated and controlled according to the operating curve from the notch switching point or brake point.

The halt time interval in a station is predicted in accordance with an item of information about the number of passengers in individual stations according to step S205 (step S208). Consideration of the type of a train and the congestion degree of a train enables the station halt time interval to be calculated at a higher accuracy. In accordance with these information items about the prediction of the number of passengers in individual stations, the train running guide device 10 calculates data such as time curve for leading the following train and the most suitable operating speed of the following train in order to minimize the effect received by the following train when the preceding train stops at a station for a long time from some cause (step S209).

The calculated data is transmitted to the on-train monitor devices 14a and 14b via the central computer system 1, the train wireless central device 9, the transmission devices 4a and 4b, the subsidiary train wireless site 11, the leakage coaxial cable 12 and the train wireless on-train devices 13a and 13b.

The on-train monitor devices 14a and 14b calculates the most suitable self-train operating curve for the self-train from the transmitted data (step S210) and the most suitable operating curve is displayed from the calculated self-train operating curve and offered to a driver. By conducting a running of the train according to the operating speed following the operating curve, the driver can reach the destination (station B) with the delay of the self-train minimized. Incidentally, it can be so arranged also that the self-train is automatically driven according to the data such as the most suitable operating speed

of the following train calculated by the train running guide device 10 and reaches the destination (station B) with the delay of the self-train minimized.

Fig. 3 is an illustration indicating the difference in the delay status of a train between a case where the control of a drive speed is not executed and a case where the control of a drive speed is executed. As shown in (a) of Fig. 3, the scheduled diagram of the Ctr before entering the station B is the line 301, but the actual diagram is assumed to change into the Ctr forecast diagram 302 because an excessive concentration of passengers at the station B results in an increase in the station halt time interval of the Ctr.

At that time, if performing a train running according to the initial scheduled diagram without running speed control, the following train Dtr (scheduled diagram: 303) ends in inter-station stop by the brake directive due to the actual-status display up delay occurring under influence of the Ctr forecast diagram 302 and performs a running according to the forecast diagram 304, changed on account of the need for time in re-acceleration, to reach the station B, so that the arrival time interval are greatly delayed.

Thus, with this embodiment, drive speed control of the following train is carried out according to the Ctr forecast diagram 302 ((a) of Fig. 3) subsequent to the present time estimated in consideration of the existing line position and driving speed of the preceding train and the station halt time interval with an item of information about the number of passengers included.

Such a driving pattern guidance can be displayed to a driver by means of the rain running guide device 10 that the train runs in the state of the forecast diagram 306 at a decreased speed according to this Ctr forecast diagram 302, is accelerated at the moment of passing the blockage boundary d310 and enters the station B as shown in Fig. 3 (b).

In a detailed description of the Dtr forecast diagram 306 of Fig. 3 (b), if the Ctr forecast diagram is predicted as shown in Fig. 4, the arrival delay to the station B is minimized by driving the following train (Dtr) according to the Dtr forecast diagram.

That is, as shown in Fig. 4, such a control as to minimize the delay of the Dtr is accomplished by foreseeing the time of the ATC signal to pace up at a predetermined blockage boundary, instructing the brake start point with the aide of the driving curve to decrease the speed so that the train passes the blockage boundary after the pacing up of the ATC signal and instructing the notch switching point at the moment of going out of the blockage boundary d310 to increase the speed. As a result, the Dtr can shorten the delay time intervals in arrival at the station B as compared with the driving according to the scheduled diagram 304 in a case where no driving speed control is made.

Next, a method for making out a driving curve of the Dtr capable of reaching the destination (station B) to reduce the delay of the Dtr to the minimum will be described between the blockage boundaries b and c by referring to Figs. 5 to 9. First, as shown in Fig. 5, from the present speed and position

(A), a deceleration pattern is calculated in accordance with the deceleration performance of the Dtr to draw a standard braking curve (broken line) for the speed at the point A equal to 30km.

Then, in accordance with the acceleration performance of the Dtr in a case of passing the point B at a speed of 30km, an accelerating pattern is calculated to draw a standard braking curve (one-point chain line) for the speed at the point B equal to 30km. Furthermore, a uniform speed pattern connecting the decelerating pattern and accelerating pattern is calculated.

In drawing a uniform curve according to the calculated uniform speed pattern, since the standard braking curve and the standard accelerating curve do not cross each other, a uniform running curve (solid straight line) is inserted between both curves as shown in Fig. 6. The starting point of this uniform running curve becomes a brake release point (R).

In Fig. 6, the standard accelerating curve and the uniform speed curve are connected with each other, but a change in speed is discontinuous in this condition and accordingly a braking curve is inserted between the middle section of the uniform running curve and the standard curve as shown in Fig. 7. The crossing point of the uniform running curve and the braking curve and that of the braking curve and the standard curve are made a brake point (BP2) and a notch switching point (AP1), respectively (Fig. 8). If individual points are calculated as described above, these points are connected to form a driving curve comprising the decelerating pattern, uniform speed pattern and accelerating pattern between the blockage boundaries b and c (Fig. 9) as indicated by the two-point chain line of Fig. 4.

EFFECT OF THE INVENTION

As described above, with a train running control system according to the present invention, the provision of: counter means for counting the number of passengers provided at individual stations; central processing means for obtaining the counted results from said counter means and obtaining the speed information item and train position information item of each train in accordance with an output of the speedometer attached to each train; and train running guide unit for predicting the future speed and position of each train subsequent to the present time from the speed information item and train position information item of each train in said central processing means, estimating the respective station stop time interval of each train at individual stations from the counted results in said central processing means and calculating the suitable running speed of the following train succeeding a preceding train in accordance with the resultant running estimation of said preceding train enables a suitable driving speed of the following train subsequent to a preceding train to be calculated at the predicting time of the delay occurrence in the preceding train, so that measures can be taken to minimize the delay of the following train.

Besides, with a train running control system according to the present invention, since drive display means for displaying the notch switching point or brake point of the following train from a suitable running speed of the following train according to the train running guide unit are provided on individual trains, the display of the notch switching point or brake point

of the following train can be accomplished to minimize the delay of the following train.

Besides, with a train running control system according to the present invention, since the notch information item obtained from the train control means is so arranged to be reflected on the prediction of the speed and position of the relevant train, the speed and position of each train can be foreseen earlier and with higher accuracy.

Besides, with a train running control system according to the present invention, since the train running guide unit is so arranged as to predict the station stop time interval from the count results of count means provided at the platform, wicket or changing-car corner, a more detailed station halt time interval information item of the preceding train can be obtained.

Besides, with a train running control system according to the present invention, since at the timing when the front head of a train steps into a track circuit boundary, the central processing means are so arranged as to correct the train position information item of the relevant train in accordance with the kilometer distance of the stepping-in track circuit boundary, a more accurate position information item of each train can be obtained.

Besides, with a train running control system according to the present invention, since the speed information item acquired from the speedometer and the timing information item on the head of a train stepping into a track circuit boundary are so arranged as to be transmitted to the central processing means

together with the acquisition time of the information items, the reliability of the acquired information items can be promoted.

Furthermore, with a train running control system according to the present invention, since the on-the-ground conditions of a railroad track and the vehicle conditions retained as basic data and a signal actual-status indicating pattern developed in accordance with the acquired signal actual-status indication information item are used to make up the operation curve of a train and predict a future speed and position of the train after the present time, the speed and position of each train can be foreseen with higher accuracy.

What is claimed is:

1. A train running control system comprising:

counter means for counting the number of passengers provided at individual stations;

central processing means for obtaining the counted results from said counter means and obtaining the speed information item and train position information item of each train in accordance with an output of the speedometer attached to each train; and

train running guide unit for predicting the future speed and position of each train subsequent to the present time from the speed information item and train position information item of each train in said central processing means, calculating the suitable running speed of the following train in accordance with the resultant running estimation of the preceding train obtained by estimating the station stop respective time interval of each train at individual stations from the counted results in said counter means and calculating the suitable running speed of the following train succeeding a preceding train at the delay occurrence prediction of said preceding train.

2. A train running control system as set forth in Claim 1, wherein

drive display means for displaying the notch switching point or brake point of the following train from a suitable running speed of the following train according to the train running guide unit are provided on individual trains.

3. A train running control system as set forth in Claim 1 or Claim 2, wherein

the notch information item obtained from the train control means is so arranged to be reflected on the prediction of the speed and position of the relevant train.

4. A train running control system as set forth in any one of Claim 1 to Claim 3, wherein

said train running guide unit is so arranged as to predict the station stop time interval from the count results of count means provided at the platform, wicket or changing-car corner.

5. A train running control system as set forth in any one of Claim 1 to Claim 4, wherein

at the timing where the front head of a train steps into a track circuit boundary, said central processing means are so arranged as to correct the train position information item of the relevant train in accordance with the kilometer distance of said stepping-in track circuit boundary.

6. A train running control system as set forth in any one of Claim 1 to Claim 5, wherein

the speed information item acquired from the speedometer and the timing information item on the head of a train stepping into a track circuit boundary are so arranged as to be transmitted to said central processing means under acquisition time of information.

7. A train running control system as set forth in any one of Claim 1 to Claim 6, wherein

the on-the-ground conditions of a railroad track and the vehicle conditions retained as basic data and a signal actual-status indicating pattern developed in accordance with the acquired signal actual-status indication information item are

used to make up the operation curve of a train and predict a future speed and position of said train after the present time.