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DESCRIPTION

TECHNICAL FIELD

[0001] The present application relates to the field of rail transit, in particular to a brake control system of a rail train and a train.

BACKGROUND

[0002] At present, the traditional passenger train transmits a brake control signal through a pressure change of a train pipe, and the vehicles of the train can be flexibly marshaled by means of the train pipe running through the whole train. All of the high-speed trains are in form of fixed formation, namely 8-vehicle formation and 16-vehicle formation, and the vehicles of the train cannot be flexibly marshaled.

[0003] With the development of passenger transport diversification, the high-speed trains develop in the direction of flexible formation gradually, so as to adapt to the diversified passenger flows and maintenance trends. But the requirement for a brake control also comes along with the realization of flexible formation. For example, the existing fixed formation mode has determined the structure of a braking device and a control method of a braking force, and a control process of the braking force is also calculating and distributing the braking force according to the fixed train formation mode. After the number is changed, a system cannot operate normally, and then the flexible formation cannot be realized. Besides, the braking of the traditional passenger train is realized by means of the train pipe running through the whole train and a three-way valve; specifically, pressure reduction of the train pipe applies the braking, and pressure boost of the train pipe releases the braking. The traditional passenger train merely transfers an air braking instruction through the train pipe, and cannot perform more advanced control on the braking force.

[0004] WO2014190003A1 shows a thermally optimized train brake system.

[0005] WO2004054840A1 shows a braking system for implementation on a multi-axle vehicle.

[0006] CN105438222A shows a train formation control method.

[0007] EP3179674A1 shows a gateway apparatus and method for a brake control system.

[0008] EP1306283A2 shows a method for operating a communication system for trains.

[0009] CN102991536A shows a network control system for trains.

[0010] JP2005341784A shows a railway vehicle information control system.

[0011] EP2476573A2 shows a flexible energy management system.

SUMMARY

[0012] In view of this, embodiments of the present application are intended to provide a brake control system of a rail train.

[0013] To this end, a technical solution of the embodiments of the present application is implemented as follows. Any embodiment in the present disclosure that does not fall within the scope of protection of the present invention shall be regarded as an example for understanding the present invention but not belonging to the present invention.

[0014] A rail train includes multiple vehicles, and the multiple vehicles include a power vehicle and a non-power vehicle. The system includes: a vehicle brake control unit, a train brake control unit, a traction control unit, and a communication control unit. Each vehicle of a rail train is provided with the vehicle brake control unit. Each of the vehicles located at both ends of the rail train is provided with the train brake control unit and the communication control unit. Each of the power vehicles of the multiple vehicles is provided with the traction control unit. The vehicle brake control unit, the train brake control unit, the traction control unit and the communication control unit perform communication by means of gateways.

[0015] The train brake control unit is configured to calculate, according to braking information sent by the vehicle brake control unit and the traction control unit, data of air braking force and an electric braking force to be applied.

[0016] The vehicle brake control unit is configured to perform air braking on the train according to the data of the air braking force to be applied which is sent by the train brake control unit.

[0017] The traction control unit is configured to perform electric braking on the train according to the data of the electric braking force to be applied which is sent by the train brake control unit.

[0018] The communication control unit is configured to receive a braking instruction from a driver controller, and send the braking instruction to a system where the instruction is executed.

[0019] Each vehicle is provided with a multifunction vehicle bus. Each of the vehicle brake control unit, the train brake control unit, the traction control unit and the communication control unit is connected to the multifunction vehicle bus. The multifunction vehicle bus is connected to the gateway. The gateways between the multiple vehicles are connected to one another by means of a wired train bus.

[0020] The train brake control unit includes a primary unit and an auxiliary unit. The primary unit is the train brake control unit which is provided on the vehicle at one end of the rail train where the driver is located. The auxiliary unit is the train brake control unit which is provided on the vehicle at the other end of the train. The primary unit and the auxiliary unit are connected to one another by means of the gateway. When the primary unit malfunctions, the auxiliary unit is upgraded to service as the primary unit.

[0021] In some examples, the train brake control unit is further configured to:

receive the braking instruction from the communication control unit sent by the driver controller, wherein the braking instruction at least comprises a brake grade;

receive weight information of each vehicle sent by each vehicle brake control unit, calculate and latch the total weight of the train according to the weight information of each vehicle, and update the total weight of the train each time when the train starts;

receive and record speed information sent by each vehicle brake control unit, and send a record result to the communication control unit;

receive an actual speed of the train which is calculated by the communication control unit according to the record result;

acquire a current braking acceleration of the train according to the brake grade and the actual speed of the train, and acquire data of total braking force for the train according to the total weight of the train and the current braking acceleration of the train;

receive data of maximum available electric braking force for single vehicle sent by the vehicle brake control unit provided on each power vehicle, and calculate data of total maximum available electric braking force for the train according to the data of maximum available electric braking force for single vehicle;

calculate, according to the data of total braking force for the train and the data of total maximum available electric braking force for the train, data of electric braking force required by the traction control unit provided on each power vehicle, and send the data of electric braking force to the traction control unit through the vehicle brake control unit, at the same time, receive data of electric braking force actually applied by the traction control unit which is sent by the vehicle brake control unit;

receive data of maximum available air braking force for single vehicle sent by the each vehicle brake control unit, and calculate data of total maximum available air braking force for the train according to the data of maximum available air braking force for single vehicle; and

determine, according to the data of actually applied electric braking force which is sent by the traction control unit, whether a supplement of air braking force to the train is required, when the supplement of air braking force to the train is required, data of air braking force required by each vehicle brake control unit is calculated and is send to the corresponding vehicle brake

control unit.

[0022] In some examples, the vehicle brake control unit is further configured to:

prestore vehicle information of the corresponding vehicle and send the information to the train brake control unit and the communication control unit, wherein the vehicle information at least comprises whether the vehicle corresponding to the vehicle brake control unit is the power vehicle;

make the vehicle brake control unit on the power vehicle receive the data of maximum available electric braking force for single vehicle and the actually applied electric braking force which are sent by the traction control unit provided on a same vehicle where the vehicle brake control is located, and receive the data of required electric braking force sent by the train brake control unit;

calculate the data of maximum available air braking force for single vehicle of each vehicle under current operating condition, and send it to the vehicle brake control unit;

receive and apply the data of required air braking force sent by the train brake control unit, and send data of the actually applied air braking force to the train brake control unit;

calculate and latch the weight information of each vehicle before the train starts, and send the weight information of each vehicle to the train brake control unit and the traction control unit;

detect the speed information of each vehicle, and send the speed information to the train brake control unit and the communication control unit.

[0023] In some examples, the vehicle brake control unit is further configured to detect a pressure of an air spring between the vehicle and a bogie, and convert the pressure to acquire the weight information of each vehicle.

[0024] In some examples, the vehicle brake control unit is further configured to:

receive the braking instruction from the communication control unit sent by the driver controller; the braking instruction at least comprises service braking and emergency braking;

when the braking instruction is the service braking, receive and apply the data of required air braking force sent by the train brake control unit, and send the data of actually applied air braking force to the train brake control unit; and

when the braking instruction is the emergency braking, apply the emergency braking through an emergency braking safety circuit of the train.

[0025] In some examples, the vehicle brake control unit is further configured to:
when the vehicle corresponding to the vehicle brake control unit is the power vehicle and the vehicle brake control unit receives a sliding braking instruction from the driver controller sent by the communication control unit, cut off the traction control unit provided on a same vehicle where the vehicle brake control unit is located.

[0026] In some examples, vehicle brake control unit is configured to: perform fault diagnosis to the corresponding vehicle.

[0027] In some examples, the traction control unit is further configured to:

receive and latch the weight information sent by the vehicle brake control unit on a same vehicle where the traction control unit is located, and update the weight information each time when the train starts;

calculate the data of maximum available electric braking force for single vehicle of each vehicle under current operating condition, and send it to the vehicle brake control unit;

receive the data of required electric braking force which is calculated by the train brake control unit and sent by the vehicle brake control unit on a same vehicle where the traction control unit is located, apply the electric braking force according to the data of required electric braking force, and send the data of actually applied electric braking force to the vehicle brake control unit; and

detect the speed information of each vehicle, and send the speed information to the vehicle brake control unit and the communication control unit.

[0028] In some examples, the traction control unit is further configured to:
receive the sliding braking instruction sent by the vehicle brake control unit provided on a same vehicle where the traction control unit is located, and perform an anti-skid protection operation after receiving the sliding braking instruction.

[0029] In some examples, the traction control unit is further configured to:
receive an electric braking force removing signal sent by the vehicle brake control unit provided on a same vehicle where the traction control unit is located, remove the electric braking force after receiving the electric braking force removing signal, and feed back a signal indicating the removal of the electric braking force to the vehicle brake control unit; at this point, the electric braking force applied by the traction control unit is zero.

[0030] In some examples, the communication control unit is further configured to:

monitor a handle state of the driver controller, and acquire a first braking instruction;

receive a second braking instruction sent by other brake systems except the driver controller in

the train;

select the braking instruction to be executed among the first braking instruction and the second braking instruction, and send the braking instruction to the corresponding device.

[0031] In some examples, the communication control unit is further configured to receive speed information sent by the train brake control unit, the vehicle brake control unit and the traction control unit, and calculate the current actual speed of the train according to the speed information.

[0032] The present application also provides a train, which is provided with the above brake control system of a rail train.

[0033] The present application has the following beneficial effects.

[0034] The control system in the present application acquires the braking force to be applied according to the weight information and speed of the train, and respectively controls the electric braking force and the air braking force to be applied; the VBCU is provided on each vehicle to apply the air braking force, the TCU is provided on each power vehicle to apply the electric braking force, and the TBCU performs centralized control and management to the VBCU and the TCU, thereby realizing the flexible train formation according to different passenger flows and maintenance ways.

BRIEF DESCRIPTION OF DRAWINGS

[0035]

FIG. 1 is a principle diagram of a brake control system of a rail train according to an embodiment.

FIG. 2 is a schematic diagram of installation position and network topology of the brake control system of a rail train according to an embodiment.

FIG. 3 is an information interaction diagram of the brake control system of a rail train according to an embodiment.

FIG. 4 is an information interaction diagram of the brake control system of a rail train when a train runs normally according to an embodiment.

FIG. 5 is an information interaction diagram of the brake control system of a rail train during service braking of a train according to an embodiment.

DETAILED DESCRIPTION

[0036] In order to make the technical solutions and advantages in embodiments of the present application clearer, the exemplary embodiments in the present application are further elaborated below in combination with the accompanying drawings. It is apparent that the described embodiments are only a part of the embodiments of the present application but not all. It is to be noted that the embodiments in the present application and the characteristics in the embodiments may be combined under the condition of no conflicts.

[0037] An embodiment provides a brake control system of a rail train, which is provided on a rail train. The rail train is in form of a regular train, including multiple vehicles. The vehicles include a power vehicle and a non-power vehicle.

[0038] As illustrated in FIG. 1, the system includes a vehicle brake control unit, a train brake control unit, a traction control unit, and a communication control unit. each vehicle of a rail train is provided with the vehicle brake control unit. Each of the vehicles located at both ends of the rail train is provided with the train brake control unit and the communication control unit. Each of the power vehicles of the multiple vehicles is provided with the traction control unit. The vehicle brake control unit, the train brake control unit, the traction control unit and the communication control unit perform communication by means of gateways 601.

[0039] Specifically,

the train brake control units (TBCU, Train Brake Control Unit) 100 are provided on a head vehicle 501 and a tail vehicle 502, take charge of controlling management of braking forces of the whole train, and are configured to calculate, according to braking information sent by the vehicle brake control unit and the traction control unit, data of air braking force and an electric braking force to be applied;

the vehicle brake control units (VBCU, Vehicle Brake Control Unit) 200 are provided on each vehicle, take charge of controlling calculation of data of the braking force for the vehicle, and performing air braking on the train according to the data of the air braking force to be applied, which is sent by the TBCU 100;

the traction control units (TCU, Traction Control Unit) 300 are provided on the power vehicles, take charge of controlling traction, and performing electric braking on the train according to the data of the electric braking force to be applied, which is sent by the TBCU 100;

the central control units (CCU, Central Control Unit) 400 are provided on the head vehicle 501 and the tail vehicle 502, and are connected to a driver controller 603, and are configured to receive a braking instruction sent from a driver controller 603, and send the braking instruction to a system where the instruction is executed.

[0040] As illustrated in FIG. 2, the network of the rail train in the embodiment uses a structure of Train Communication Network (TCN, Train Communication Network); the network in each vehicle is a Multifunction Vehicle Bus (MVB) network 607; network devices in all of the vehicles transmit control information through an MVB protocol. The network between the vehicles is a Wired Train Bus (WTB, Wired Train Bus) network 602. WTB data and MVB data are forwarded through the gateway 601 provided in the vehicle. The braking instruction from the driver controller 603 is sent to the gateway 601 through the CCU 400.

[0041] The brake control system in the embodiment uses a two-stage control structure. The TBCU 100 and the VBCU 200 form a master Brake Control Unit 606 (BCU, Brake Control Unit). The TBCU 100 takes charge of brake management of the whole train, and the VBCU 200 takes charge of applying the braking of the respective vehicle. The head and tail vehicles 501, 502 are in a two-layer structure including the TBCU 100 and the VBCU 200, performing the management of the braking force of the whole train and the brake control of the head and tail vehicles. The other vehicles only have the VBCU 200 in charge of the brake control of themselves. As illustrated in FIG. 3, two TBCUs 100 in head and tail vehicles 501, 502 are redundant and standby for each other. After the train is powered on, the TBCU 100 in the vehicle where the driver is located is a primary TBCU 100, and the TBCU 100 at the other side is an auxiliary TBCU 100. The two TBCUs 100 performs communication of life signals with each other, and after the primary TBCU 100 malfunctions, the auxiliary TBCU 100 automatically becomes the primary TBCU 100 to perform the brake control of the whole train.

[0042] The above is a network communication mode of the system described in the embodiment. These units described in the embodiment are elaborated below.

[0043] The train brake control unit (TBCU, Train Brake Control Unit) 100 is configured to:

receive the braking instruction from the communication control unit sent by the driver controller 603, in which the braking instruction at least includes a brake grade;

receive weight information M1 of each vehicle sent by each vehicle brake control unit, calculate and latch the total weight of the train according to the weight information of each vehicle, and update the total weight M2 of the train each time when the train starts;

receive and record speed information sent by each vehicle brake control unit, and send a record result to the communication control unit;

receive an actual speed of the train which is calculated by the communication control unit according to the record result;

acquire a current braking acceleration a of the train according to the brake grade and the actual speed of the train, and acquire the data of total braking force $F=M2*a$ for the train according to the total weight M2 of the train and the current braking acceleration of the train;

receive data of maximum available electric braking force for single vehicle sent by the vehicle

brake control unit provided on each power vehicle, and calculate data of total maximum available electric braking force F_{EDMAX} for the train according to the data of maximum available electric braking force for single vehicle;

calculate, according to the data of total braking force F for the train and the data of total maximum available electric braking force F_{EDMAX} for the train, data of electric braking force required by the traction control unit provided on each power vehicle, and send the data of electric braking force to the traction control unit through the vehicle brake control unit, at the same time, receive data of electric braking force actually applied by the traction control unit which is sent by the vehicle brake control unit;

receive data of maximum available air braking force for single vehicle sent by the each vehicle brake control unit, and calculate data of total maximum available air braking force F_{EPMAX} for the train according to the data of maximum available air braking force for single vehicle; and

determine, according to the data of actually applied electric braking force which is sent by the traction control unit, whether a supplement of air braking force to the train is required, when the supplement of air braking force to the train is required, data of air braking force required by each vehicle brake control unit is calculated and is send to the corresponding vehicle brake control unit.

[0044] The vehicle brake control unit (VBCU, Vehicle Brake Control Unit) 200 is configured to:

prestore vehicle information of the corresponding vehicle and send the information to the train brake control unit and the communication control unit, wherein the vehicle information at least comprises whether the vehicle corresponding to the vehicle brake control unit is the power vehicle;

make the vehicle brake control unit on the power vehicle receive the data of maximum available electric braking force for single vehicle and the actually applied electric braking force which are sent by the traction control unit provided on a same vehicle where the vehicle brake control is located, and receive the data of required electric braking force sent by the train brake control unit;

calculate the data of maximum available air braking force for single vehicle of each vehicle under current operating condition, and send it to the vehicle brake control unit;

receive and apply the data of required air braking force sent by the train brake control unit, and send data of the actually applied air braking force to the train brake control unit;

detect a pressure of an air spring between the vehicle and a bogie before the train starts, convert the pressure to acquire the weight information M1 of each vehicle, and send the weight information M1 of each vehicle to the train brake control unit and the traction control unit;

detect the speed information of each vehicle, and send the speed information to the train brake

control unit and the communication control unit;

receive the braking instruction from the communication control unit sent by the driver controller 603; the braking instruction at least comprises service braking and emergency braking; when the braking instruction is the service braking, receive and apply the data of required air braking force sent by the train brake control unit, and send the data of actually applied air braking force to the train brake control unit; and

when the braking instruction is the emergency braking, apply the emergency braking through an emergency braking safety circuit of the train; and

performing fault diagnosis on the corresponding vehicle.

[0045] The traction control unit (TCU, Traction Control Unit) 300 is configured to:

receive and latch the weight information sent by the vehicle brake control unit on a same vehicle where the traction control unit is located, and update the weight information each time when the train starts;

calculate the data of maximum available electric braking force for single vehicle of each vehicle under current operating condition, and send it to the vehicle brake control unit;

receive the data of required electric braking force which is calculated by the train brake control unit and sent by the vehicle brake control unit on a same vehicle where the traction control unit is located, apply the electric braking force according to the data of required electric braking force, and send the data of actually applied electric braking force to the vehicle brake control unit;

detect the speed information of each vehicle, and send the speed information to the vehicle brake control unit and the communication control unit;

receive a sliding braking instruction sent by the vehicle brake control unit provided on a same vehicle where the traction control unit is located, and perform an anti-skid protection operation after receiving the sliding braking instruction;

receive an electric braking force removing signal sent by the vehicle brake control unit provided on a same vehicle where the traction control unit is located, remove the electric braking force after receiving the electric braking force removing signal, and feed back a signal indicating the removal of the electric braking force to the vehicle brake control unit; at this point, the electric braking force applied by the traction control unit is zero.

[0046] The central control unit (CCU, Central Control Unit) 400 is configured to:

monitor a handle state of the driver controller 603, and acquire a first braking instruction;

receive a second braking instruction sent by other brake systems (namely the systems able to send the braking instruction, for example, an ATP system) except the driver controller 603 in the train;

select, according to a preset rule, the braking instruction to be executed among the first braking instruction and the second braking instruction, and send the braking instruction to the corresponding device; for example, select the braking instruction with the maximum execution braking force or apply the braking according to a specific braking instruction source order; when both the driver controller 603 and the ATP system have the braking instruction, apply preferentially the braking instruction of the ATP;

receive speed information sent by the train brake control unit, the vehicle brake control unit and the traction control unit, and calculate the current actual speed of the train according to the speed information.

[0047] Specifically, for the train with flexible formation, the brake system needs to acquire the following train parameters in the process of controlling the braking force:

1. 1. the total number of vehicles in the formation of the train;
2. 2. the position of each vehicle in the formation, which is used for differentiating it from other vehicles;
3. 3. whether each vehicle is the power vehicle; and
4. 4. the weight of the vehicle in consideration of a moment of inertia.

[0048] The gateway 601 of each vehicle records the number of train and the number of vehicle through software. Take a four-digit code 0408 as an example, the first two digits represent the identification number of train, and the last two digits represent the identification number of vehicle. After the flexible marshaling of the train, information is sent through the gateway 601, and formation information of the train can be checked on a Human Machine Interface (HMI) 604 in the vehicle of cab. At the same time, the CCU 400 acquires the formation information of the train.

[0049] The TBCU 100 acquires the formation information of the train, and checks the number of information of the VBCU 200. In case of inconsistency is detected, the TBCU 100 makes fault alert; in case of consistency, the TBCU 100 performs the brake control based on the number.

[0050] The train information corresponding to all identification numbers of the VBCU 200 is collected in software of the VBCU 200. The train information comprises the characteristic of the air spring and the weight of the vehicle, and whether the vehicle is the power vehicle. Four BCU_Ident signals are input through an input board of the VBCU 200. The BCU 606 detects

the 0/1 state of the four signals to determine the identification number of the BCU, for example, 0001 represents the BCU No. 1, and 1011 represents the BCU No. 11. The BCU confirms the characteristic of the air spring and the weight of the vehicle, and whether the vehicle is the power vehicle, by confirming its own identification number and by the information of the BCUs 606 collected in advance in the software of the BCU 606.

[0051] When the train is powered on to operate each time, the TBCU 100 checks the formation information of the train. When finding that the formation information is wrong or inconsistent, the TBCU 100 reports fault information.

[0052] FIG. 4 is an information interaction diagram of these units in the system of the embodiment when the train runs normally. The VBCU 200 determines the weight of the corresponding vehicle according to the pressure 701 of the air spring, and the sends the weight 704 of the vehicle to the TBCU 100 and the TCU 300. The TBCU 100 calculates the total weight 707 of the train. The VBCU 200 sends wheel speed information 702 to the TBCU 100. The TCU 300 sends a speed 709 of a motor to the CCU 400. The CCU 400 determines the speed 706 of the train according to a comprehensive judgment, and sends the speed 706 of the train to the TBCU 100 and the TCU 300. The VBCU 200 determines the maximum available air braking force 710 according to the speed and the weight of the train. The TCU 300 determines the maximum available electric braking force 711 according to the speed and the weight of the train.

[0053] FIG. 5 is an information interaction diagram of these units in the system of the embodiment when the train is in service braking. First, the CCU 400 receives the braking instruction 800 of performing the service braking sent by the driver controller 603, and the sends the braking instruction 800 of performing the service braking to the TBCU 100; the TCU 300 sends data of maximum available electric braking force to the TBCU 100 through the VBCU 200; the VBCU 200 sends data of maximum available air braking force 710 to the TBCU 100; the TBCU 100 determines a braking acceleration through the braking instruction 800 and the speed of the train, determines data of total braking force according to the total weight of the train, and calculates the braking forces, including the air braking force 803 and electric braking force 804 to be applied, required by each VBCU 200 and the corresponding TCU 300 according to a preset braking force distribution policy. If the current vehicle is the power vehicle, the TBCU 100 requires 801 the VBCU 200 for applying the electric braking force, and the VBCU 200 forwards the data of electric braking force to be applied to the TCU 300 of the vehicle; at the same time, the TBCU 100 requires 802 the VBCU 200 for the air braking force. The TCU 300 provided on the power vehicle receives the data of electric braking force to be applied, outputs the electric braking force through a traction motor 805, and feeds back data of actually applied electric braking force to the TBCU 100 through the VBCU 200 provided on a same vehicle where the TCU 300 is located. The VBCU 200 receives the data of air braking force to be applied, applies the air braking force through a foundation brake device 806, and sends data of applied air braking force to the TBCU 100.

[0054] The braking force distribution policies preset in the TBCU 100 include an electric

braking force preferential distribution mode, an equal distribution mode, and a snow removal mode

[0055] The electric braking force preferential distribution mode is that the electric braking force is preferentially distributed, the insufficient part of the electric braking force is complemented by the air braking force, and the air braking of the trailer vehicle is preferentially complemented.

[0056] The equal distribution mode is that: the total braking force is equally distributed to all the vehicles; for the braking force to be applied to the power vehicle, the electric braking force on the power vehicle is preferentially used.

[0057] The snow removal mode is that: a small pressure value of a brake cylinder, for example, 50kPa, is applied to the air braking, so that the foundation brake device generates a slight braking force, and generates heat to remove snow. In case of a high speed (above 100km/h), a snow removal brake is applied intermittently and circularly, for example, a cycle period is applying the brake for 30s after releasing the brake for 30s. In case of a low speed (below 100km/h), the snow removal brake is applied all the time.

[0058] In this process, a calculation process of the maximum available air braking force of the power vehicle is as follows:

the VBCU 200 determines the maximum available total braking force ftmax of the power vehicle according to the speed and the weight of the vehicle;

the TCU 300 sends the maximum available electric braking force f_{edmax} and the applied electric braking force f_{ed} to the VBCU 200;

when the maximum available electric braking force f_{edmax} is valid, but the applied electric braking force f_{ed} is invalid, the maximum available electric braking force f_{epmax}=the maximum available total braking force f_{tmax}-the maximum available electric braking force f_{edmax};

when the maximum available electric braking force f_{edmax} is valid, and the applied electric braking force f_{ed} is valid, the maximum available electric braking force f_{epmax}=the maximum available total braking force f_{tmax}-the applied electric braking force f_{ed}.

[0059] Being valid means there are values sent, and the valid digit of data is 1; being invalid means there is no value sent, and the valid digit of data is 0.

[0060] Correspondingly, an embodiment also provides a train including the brake control system of a rail train. The VBCU 200 is provided in each vehicle of a train, the TBCU 100 is provided in the compartment of the power vehicle, and the TBCU 100 and the CCU 400 are provided in the head and tail vehicles 501, 502 of the train. The system acquires the braking force to be applied according to the weight information and the speed information of the train,

and respectively controls the electric braking force and the air braking force to be applied. The VBCU 200 is provided on each vehicle to apply the air braking force, the TCU 300 is provided on each power vehicle to apply the electric braking force, and the TBCU 100 performs centralized control and management to the VBCU 200 and the TCU 300, thereby realizing the flexible train marshalling according to different passenger flows and maintenance ways.

List of reference symbols

[0061] 100-TBCU; 200-VBCU; 300-TCU; 400-CCU; 501-Head vehicle; 502-Tail vehicle; 601-gateway; 602-Wired Train Bus network; 603-Driver controller; 604-Human Machine Interface; 606-BCU; 607-Multifunction Vehicle Bus network; 101-Primary TBCU; 102-Auxiliary TBCU; 701- Pressure of air spring; 702-Speed of wheel; 703-VBCU speed; 704- Weight of the single vehicle; 705- TBCU speed; 706-Speed of train; 707-Total weight of train; 708- TCU speed; 709- Motor speed; 710-Maximum available air braking force; 711- Maximum available electric braking force; 800-Braking instruction; 801-Request for an electric braking force; 802-Request for an air braking force; 803-Applied air braking force; 804-Applied electric braking force; 805-Traction motor; 806- Foundation brake device

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

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- WO2004054840A1 **[0005]**
- CN105438222A **[0006]**
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Patentkrav

1. Bremsestyresystem af et skinnetog omfattende flere køretøjer, hvor de flere køretøjer omfatter drivkøretøjer og ikke-drivkøretøjer, hvor systemet omfatter en køretøjsbremsestyreenhed (200), en togbremsestyreenhed (100), en traktionsstyreenhed (300) og en kommunikationsstyreenhed (400); hvor hvert køretøj af et skinnetog er forsynet med køretøjsbremsestyreenheden (200); hvor hvert af køretøjerne, som er anbragt ved begge ender af skinnekøretøjet, er forsynet med togbremsestyreenheden (100) og kommunikationsstyreenheden (400); hvor hvert af drivkøretøjerne af de flere køretøjer er forsynet med traktionsstyreenheden (300); hvor køretøjsbremsestyreenheden (200), togbremsestyreenheden (100), traktionsstyreenheden (300) og kommunikationsstyreenheden (400) foretager kommunikation ved hjælp af gateways (602);
hvor togbremsestyreenheden (100) er indrettet til at beregne, i overensstemmelse med bremseinformationer, sendt af køretøjsbremsestyreenheden (200) og traktionsstyreenheden (300), data for luftbremsekraft og en elektrisk bremsekraft, der skal påføres;
hvor køretøjsbremsestyreenheden (200) er indrettet til at udføre luftbremsning på toget i overensstemmelse med dataene for luftbremsekraften, der skal påføres, som er sendt af togbremsestyreenheden (100);
hvor traktionsstyreenheden er indrettet til at udføre elektrisk bremsning på toget i overensstemmelse med dataene for den elektriske bremsekraft, der skal påføres, som er sendt af togbremsestyreenheden (100); og
hvor kommunikationsstyreenheden (400) er indrettet til at modtage en bremseinstruktion fra en førercontroller (603) og sende bremseinstruktionen til et system, hvor instruktionen eksekveres,
hvor hvert køretøj er forsynet med en multifunktionskøretøjsbus; hvor hver af køretøjsbremsestyreenheden (200), togbremsestyreenheden (100), traktionsstyreenheden og kommunikationsstyreenheden (400) er forbundet med multifunktionskøretøjsbussen; hvor multifunktionskøretøjsbussen er forbundet med gatewayen (602); hvilke gateways (602) mellem de flere køretøjer er forbundet med hinanden ved hjælp af en fortrådet togbus,
kendetegnet ved, at togbremsestyreenheden (100) omfatter en primær enhed (101) og en hjælpeenhed (102); hvor den primære enhed (101) er togbremsestyreenheden (100), som er tilvejebragt på køretøjet ved den ene ende

af skinnetoget, hvor føreren er anbragt, og hjælpeenheden (102) er togbremsestyreenheden (100), som er tilvejebragt på køretøjet ved den anden ende af toget; hvor den primære enhed (101) og hjælpeenheden (102) er forbundet med hinanden ved hjælp af gatewayen (602); hvor, når den primære enhed (101) har en fejlfunktion, hjælpeenheden (102) opgraderes til at tjene som den primære enhed (101).

2. System ifølge krav 1, hvor togbremsestyreenheden (100) endvidere er indrettet til at:

modtage bremseinstruktionen fra kommunikationsstyreenheden (400) sendt af førercontrolleren (603), hvor bremseinstruktionen i det mindst omfatter en bremsegrad;

modtage vægtinformationer for hvert køretøj sendt af hver køretøjsbremsestyreenhed (200), beregne og fastlåse den samlede vægt af toget i overensstemmelse med vægtinformationerne for hvert køretøj og opdatere den samlede vægt af toget hver gang, når toget starter;

modtage og registrere hastighedsinformationer sendt af hver køretøjsbremsestyreenhed (200) og sende et registreringsresultat til kommunikationsstyreenheden (400);

modtage en faktisk hastighed af toget, som er beregnet af kommunikationsstyreenheden (400) i overensstemmelse med registreringsresultatet;

indhente en aktuel bremseacceleration af toget i overensstemmelse med bremsegraden og den faktiske hastighed af toget og indhente data for en samlet bremsekraft for toget i overensstemmelse med den samlede vægt af toget og den aktuelle bremseacceleration af toget;

modtage data for maksimalt disponibel elektrisk bremsekraft for et enkelt køretøj sendt af køretøjsbremsestyreenheden (200), som er tilvejebragt på hvert drivkøretøj, og beregne data for en samlet maksimalt disponibel elektrisk bremsekraft for toget i overensstemmelse med dataene for den maksimalt disponible elektriske bremsekraft for et enkelt køretøj;

beregne, i overensstemmelse med dataene for den samlede bremsekraft for toget og dataene for den samlede maksimalt disponible elektriske bremsekraft for toget, data for elektrisk bremsekraft, der er påkrævet af traktionsstyreenheden, som er tilvejebragt på hvert drivkøretøj, og sende dataene for elektrisk

bremsekraft til traktionsstyreenheden (300) gennem køretøjsbremsestyreenheden (200), samtidigt modtage data for elektrisk bremsekraft, som faktisk er påført af traktionsstyreenheden (300), der er sendt af køretøjsbremsestyreenheden (200);

modtage data for maksimalt disponibel luftbremsekraft for et enkelt køretøj sendt af hver køretøjsbremsestyreenhed (200) og beregne data for en samlet maksimalt disponibel luftbremsekraft for toget i overensstemmelse med dataene for den maksimalt disponible luftbremsekraft for et enkelt køretøj; og

bestemme, i overensstemmelse med dataene for faktisk påført elektrisk bremsekraft, der er sendt af traktionsstyreenheden (300), om et supplement af luftbremsekraft til toget er påkrævet, når supplementet af luftbremsekraft til toget er påkrævet, beregnes data for luftbremsekraft, som er påkrævet af hver køretøjsbremsestyreenhed (200), og sendes til den tilsvarende køretøjsbremsestyreenhed (200).

3. System ifølge krav 2, hvor køretøjsbremsestyreenheden (200) endvidere er indrettet til at:

forhåndslagre køretøjsinformationer for det tilsvarende køretøj og sende informationerne til togbremsestyreenheden (100) og kommunikationsstyreenheden (400), hvor køretøjsinformationerne i det mindste omfatter, om køretøjet svarende til køretøjsbremsestyreenheden (200) er drivkøretøjet;

foranledige, at køretøjsbremsestyreenheden (200) på drivkøretøjet modtager dataene for maksimalt disponibel elektrisk bremsekraft for et enkelt køretøj og den faktisk påførte elektriske bremsekraft, som er sendt af traktionsstyreenheden (300), der er tilvejebragt på et samme køretøj, hvor køretøjsbremsestyringen er anbragt, og modtage dataene for påkrævet elektrisk bremsekraft sendt af togbremsestyreenheden (100);

beregne dataene for maksimalt disponibel luftbremsekraft for et enkelt køretøj af hvert køretøj under aktuel driftsbetingelse og sende dem til køretøjsbremsestyreenheden (200);

modtage og anvende dataene for påkrævet luftbremsekraft sendt af togbremsestyreenheden (100) og sende data for den faktisk påførte luftbremsekraft til togbremsestyreenheden (100);

beregne og fastlåse vægtinformationerne for hvert køretøj, før toget starter, og sende vægtinformationerne for hvert køretøj til togbremsestyreenheden (100) og traktionsstyreenheden (300);
detektere hastighedsinformationerne for hvert køretøj og sende hastighedsinformationerne til togbremsestyreenheden (100) og kommunikationsstyreenheden (400).

4. System ifølge krav 3, hvor køretøjsbremsestyreenheden (200) endvidere er indrettet til at detektere et tryk af en luftfjeder mellem køretøjet og en bogie og omdanne trykket for at indhente vægtinformationerne for hvert køretøj.

5. System ifølge krav 4, hvor køretøjsbremsestyreenheden (200) endvidere er indrettet til at:
modtage bremseinstruktionen fra kommunikationsstyreenheden (400) sendt af førercontrolleren (603); hvor bremseinstruktionen i det mindste omfatter driftsbremsning og nødbremsning;
når bremseinstruktionen er driftsbremsningen, modtage og anvende dataene for påkrævet luftbremsekraft sendt af togbremsestyreenheden (100) og sende dataene for faktisk påført luftbremsekraft til togbremsestyreenheden (100); og
når bremseinstruktionen er nødbremsningen, påføre nødbremsningen gennem et nødbremsesikkerhedskredsløb af toget.

6. System ifølge krav 5, hvor køretøjsbremsestyreenheden (200) endvidere er indrettet til at:
når køretøjet svarende til køretøjsbremsestyreenheden (200) er drivkøretøjet, og køretøjsbremsestyreenheden (200) modtager en glidebremseinstruktion fra førercontrolleren (603), der er sendt af kommunikationsstyreenheden (400), afbryde traktionsstyreenheden (300), der er tilvejebragt på et samme køretøj, hvor køretøjsbremsestyreenheden (200) er anbragt.

7. System ifølge krav 6, hvor køretøjsbremsestyreenheden (200) er indrettet til at: udføre en fejldiagnose ved det tilsvarende køretøj.

8. System ifølge krav 3 eller 7, hvor traktionsstyreenheden (300) endvidere er indrettet til at:

modtage og fastlåse vægtinformationerne, der er sendt af køretøjsbremsestyreenheden (200) på et samme køretøj, hvor traktionsstyreenheden (300) er anbragt, og opdatere vægtinformationerne hver gang, når toget starter;
beregne dataene for maksimalt disponibel elektrisk bremsekraft for et enkelt køretøj af hvert køretøj under aktuel driftsbetingelse og sende dem til køretøjsbremsestyreenheden (200);
modtage dataene for påkrævet elektrisk bremsekraft, der er beregnet af togbremsestyreenheden (100) og sendt af køretøjsbremsestyreenheden (200) på et samme køretøj, hvor traktionsstyreenheden (300) er anbragt, påføre den elektriske bremsekraft i overensstemmelse med dataene for påkrævet elektrisk bremsekraft og sende dataene for faktisk påført elektrisk bremsekraft til køretøjsbremsestyreenheden (200); og
detektere hastighedsinformationerne for hvert køretøj og sende hastighedsinformationerne til køretøjsbremsestyreenheden (200) og kommunikationsstyreenheden (400).

9. System ifølge krav 8, hvor traktionsstyreenheden (300) endvidere er indrettet til at modtage en glidebremseinstruktion, der er sendt af køretøjsbremsestyreenheden (200), som er tilvejebragt på et samme køretøj, hvor traktionsstyreenheden (300) er anbragt, og udføre en antiglidningsbeskyttelsesoperation efter modtagelse af glidebremseinstruktionen.

10. System ifølge krav 9, hvor traktionsstyreenheden (300) endvidere er indrettet til at:
modtage et signal om fjernelse af en elektrisk bremsekraft sendt af køretøjsbremsestyreenheden (200), som er tilvejebragt på et samme køretøj, hvor traktionsstyreenheden (300) er anbragt, fjerne den elektriske bremsekraft efter modtagelse af signalet om fjernelse af en elektrisk bremsekraft og tilbageføre et signal, der indikerer fjernelsen af den elektriske bremsekraft, til køretøjsbremsestyreenheden (200); hvor den elektriske bremsekraft, der er påført af traktionsstyreenheden (300), på dette tidspunkt er nul.

11. System ifølge krav 10, hvor kommunikationsstyreenheden (400) endvidere er indrettet til at:

overvåge en håndteringstilstand af førercontrolleren (603) og indhente en første bremseinstruktion;
modtage en anden bremseinstruktion sendt af andre bremsesystemer bortset fra førercontrolleren (603) i toget;
vælge bremseinstruktionen, der skal eksekveres blandt den første bremseinstruktion og den anden bremseinstruktion, og sende bremseinstruktionen til den tilsvarende indretning.

12. System ifølge krav 11, hvor kommunikationsstyreenheden (400) endvidere er indrettet til at modtage hastighedsinformationer sendt af togbremsestyreenheden (100), køretøjsbremsestyreenheden (200) og traktionsstyreenheden (300) og beregne den aktuelle faktiske hastighed af toget i overensstemmelse med hastighedsinformationerne.

13. Tog, som er forsynet med et bremsestyresystem af et skinnetog ifølge krav 1 til 12.

DRAWINGS

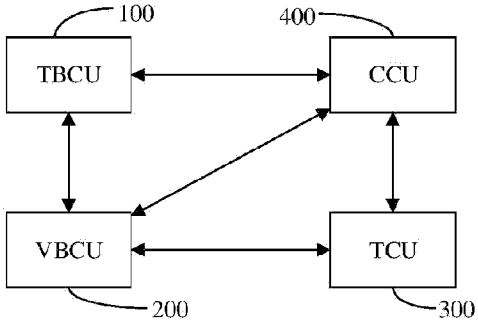


FIG. 1

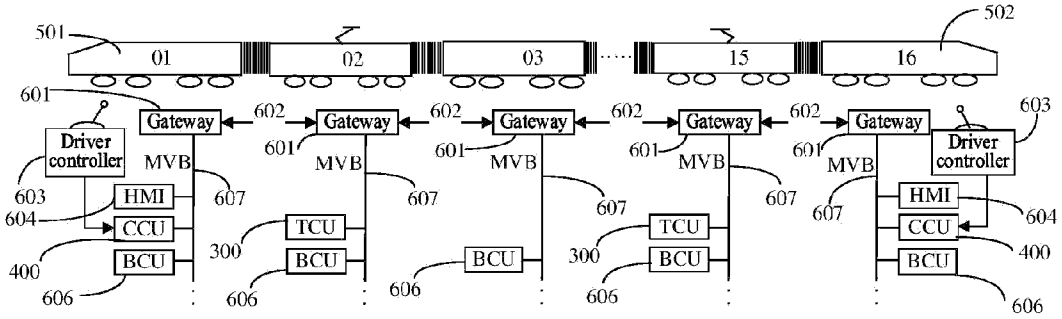


FIG. 2

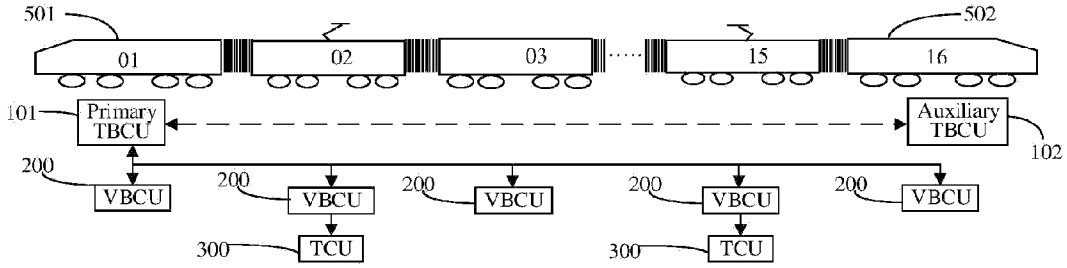


FIG. 3

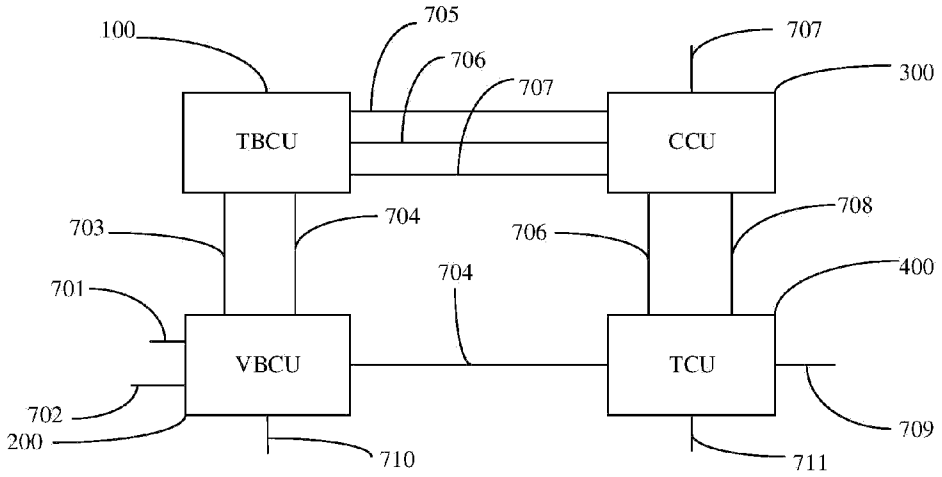
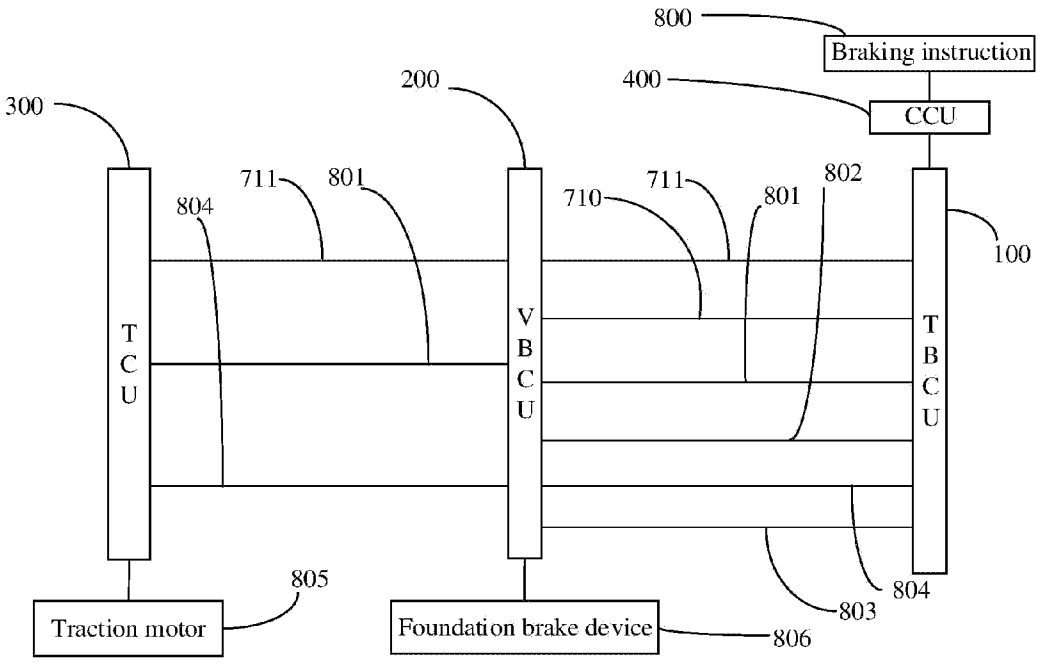

100
705
706
707
707
300
TBCU
CCU
703
704
706
708
704
400
701
VBCU
TCU
702
200
710
709
711

FIG. 4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Braking instruction
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400
CCU
300
711
801
804
710
711
801
802
100
T
C
U
V
B
C
U
T
B
C
U
805
804
803
Traction motor
Foundation brake device
806

FIG. 5