

CONTROL SYSTEM FOR DISTRIBUTOR VALVE OF BATTERY ELECTRIC ENGINEERING LOCOMOTIVE BRAKE SYSTEM

Field of the Invention

- 5 The invention mainly relates to the field of control of brake systems in battery electric engineering locomotives, and in particular to a control system for a distributor valve of a battery electric engineering locomotive brake system.

Background of the Invention

- 10 With the development of modern railroad technology, higher requirements have been raised for the safety and control precision of a brake system of a battery electric engineering locomotive, and different distributor valve control modes influence the control precision of a brake cylinder, and thus influence the safety and reliability of the brake system of a battery electric engineering locomotive. Currently, braking and releasing instructions in the existing battery electric
15 engineering locomotive brake systems are open-loop controlled by air transmission, which results in slow response and low control precision of the brake systems; and all the brake systems adopt a single pure air distributor valve system without a backup system, and the system reliability is poor: in emergency braking, main air is directly filled into the brake cylinder or a precontrol volume, which tends to produce too large brake cylinder pressure and thus result in
20 wheel sliding. Therefore, the distributor valve needs to be controlled by a new method, so as to be able to adapt to the requirement for battery electric engineering locomotives by modern railways.

Summary of the Invention

- 25 In view of the disadvantage of low control precision of the existing distributor valve, the invention aims at providing a control system for a distributor valve of a battery electric engineering locomotive brake system, and through close-loop control of the locomotive brake cylinder by means of precontrol air cylinder pressure, the device can greatly improve the control precision of the brake cylinder pressure.

To achieve the above object, the invention adopts the following solution: the control system for the distributor valve of the battery electric engineering locomotive brake system is structurally characterized by comprising an electric distributor valve closed-loop control system enabled in normal conditions, a backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails, and an emergency braking rapid pressurizing control system enabled in emergency conditions;

The electric distributor valve closed-loop control system enabled in normal conditions comprises a pressure sensor connected to a distributor valve's balancing part; an air inlet branch formed by successively connecting in series a main air cock controlling main air intake and cut off, a main air pressure regulator regulating the main air pressure, an air inlet high-speed electric pneumatic valve, a precontrol air cylinder, a distributor valve and a pressure regulator; and an air outlet branch composed of an air outlet high-speed electric pneumatic valve, wherein signal input ends of the air inlet high-speed electric pneumatic valve and an air outlet high-speed electric pneumatic valve are respectively connected with a brake control unit BCU, within which a proportional controller is provided; a signal input end of the proportional controller is connected with an output end of the pressure sensor, and a signal output end of a driver controller is connected with the brake control unit BCU; and according to an instruction of the driver controller, comparison is made between the pressure sensor and the instruction to obtain a difference, to control the power up and power down of the air inlet high-speed electric pneumatic valve and the air outlet high-speed electric pneumatic valve.

The backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails is composed of a brake pipe, the distributor valve, the pressure regulator, a work air cylinder, a volume chamber supplement air cylinder, and a changeover electric pneumatic valve controlled by the brake control unit BCU. All these parts mentioned above are successively connected in series by pipes.

The emergency braking rapid pressurizing control system enabled in emergency condition is composed of the main air cock, the main air pressure regulator, a cock, a large drift diameter electric pneumatic valve, the precontrol air cylinder and the distributor valve's balancing part, wherein the large drift diameter electric pneumatic valve is connected to an emergency braking

loop, on which a driver controller-emergency position, an emergency braking button, an excessive low main air pressure protection, and the like are connected in series; and another signal output end of the emergency braking button is connected with the brake control unit BCU, so that when any link on the emergency braking loop is cut off, the large diameter electric pneumatic valve is powered down, and the emergency braking rapid pressurizing control system is started.

In the invention, through regulating a setting value of the pressure regulator or the main air pressure regulator, the pressure in the precontrol air cylinder is not higher than the setting value set for the main air pressure regulator when the electric distributor valve closed-loop control system enabled in normal conditions works. The pressure in the precontrol air cylinder is not higher than the setting value set for the pressure regulator when the backup air distributor valve control system enabled as electric distributor valve closed-loop control system fails works, so that the distributor valve defines the maximal value of the brake cylinder to be not higher than the setting value.

An air cylinder connected to the distributor valve's balancing part is provided with a pressure detection port, through which other standard pressure detecting instrument, such as a high-precision digital pressure gauge, is used to test whether the actually regulated pressure of the distributor valve's balancing part air cylinder is correct, and thus the correctness and practicality of the pressure control system can be further improved.

The proportional controller is a pulse width modulation (PWM) proportional controller.

The invention will be further described in conjunction with the drawings.

As shown in Fig. 1, the control system for the distributor valve of the battery electric engineering locomotive brake system comprises an electric distributor valve closed-loop control system enabled in normal conditions, a backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails, and an emergency braking rapid pressurizing control system enabled in emergency conditions.

The electric distributor valve closed-loop control system enabled in normal conditions comprises a pressure sensor 7 connected to a balancing part of a distributor valve 15; an air inlet branch formed by successively connecting in series a main air cock 1 controlling main air intake and cut

off and connected with a main air output port, a main air pressure regulator 2 regulating the main air pressure, an air inlet high-speed electric pneumatic valve 3, a precontrol air cylinder 12, the distributor valve 15, and a pressure regulator 9; and an air outlet branch composed of an air outlet high-speed electric pneumatic valve 4, wherein signal input ends of the air inlet high-speed electric pneumatic valve 3 and an air outlet high-speed electric pneumatic valve 4 are respectively connected with a brake control unit BCU 17, and a PWM proportional controller 5 is arranged within the BCU 17; a signal input end of the proportional controller 5 is connected with an output end of the pressure sensor 7, and a signal output end of a driver controller 18 is connected with the brake control unit BCU 17; and according to an instruction of the driver controller 18, comparison is made between the pressure sensor 7 and the instruction to obtain a difference, to in turn control the power up and power down of the air inlet high-speed electric pneumatic valve 3 and the air outlet high-speed electric pneumatic valve 4.

The backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails is composed of a brake pipe, the distributor valve 15, the pressure regulator 9, a work air cylinder 14, a volume chamber supplement air cylinder 13, and a changeover electric pneumatic valve 6 which are successively connected in series by pipes; and the changeover electric pneumatic valve 6 is controlled by the brake control unit BCU 17.

The emergency braking rapid pressurizing control system enabled in emergency conditions is composed of the main air cock 1, the main air pressure regulator 2, a cock 10, a large drift diameter electric pneumatic valve 11, the precontrol air cylinder 12 and the distributor valve 15 which are successively connected in series by pipes. As shown in Fig. 3, the large drift diameter electric pneumatic valve 11 is connected to an emergency braking loop, on which the driver controller 18-emergency position, an emergency braking button 19, an excessive low main air pressure protection, and the like are connected in series; and another signal output end of the emergency braking button 19 is connected with the brake control unit BCU 17, so that when any link on the emergency braking loop is cut off, for example, when the driver controller 18 turns to the emergency position or presses the emergency braking button 19, the large diameter electric pneumatic valve 11 is powered down, and the emergency braking rapid pressurizing control system is started.

The control system for the distributor valve of the battery electric engineering locomotive brake system comprises three modes: the electric distributor valve closed-loop control system is adopted in normal conditions; the backup air distributor valve control system is automatically started if the electric distributor valve closed-loop control system fails; and an emergency
5 braking rapid pressurizing control system is started when emergency braking is conducted.

In normal conditions, the electric distributor valve closed-loop control system is adopted for the pressure of the brake cylinder precontrol air cylinder 12 of the balancing part of the distributor valve 15; the brake control unit BCU 17 sending a pulse width modulation (PWM) signal obtains a target value of the precontrol air cylinder pressure by calculating the brake pipe pressure,
10 compares the target value with a real time pressure value of the balancing part of the distributor valve 15 fed back by the pressure sensor 7; and the internal proportional controller 5 controls the air inlet high-speed electric pneumatic valve 3 and the air outlet high-speed electric pneumatic valve 4, to achieve the purpose of precisely controlling the pressure of the precontrol air cylinder 12, that is, the brake cylinder precontrol pressure of the balancing part of the distributor valve 15,
15 and thus precisely control the brake cylinder pressure.

As shown in Fig. 2, when the proportional controller 5 for the pulse width modulation (PWM) signal fails, or hardware failure occurs in the brake control unit BCU 17 and results in crash, the brake control unit BCU 17 controls all output to be zero through a diagnostic program thereof, that is, the changeover electric pneumatic valve 6 is powered down, and the electric distributor
20 valve closed-loop control system is automatically switched to the backup air distributor valve system ; and if failure occurs in a component constituting the electric distributor valve, such as the air inlet high-speed electric pneumatic valve 3, the air outlet high-speed electric pneumatic valve 4 or the pressure sensor 7, the output of the brake control unit BCU 17 needs to be manually cut off, so that the changeover electric pneumatic valve 6 is powered down to switch to
25 the backup air distributor valve control system. At that time, as the changeover electric pneumatic valve 6 is powered down, the precontrol air cylinder 12 and the volume chamber compensation air cylinder 13 are communicated, and the distributor valve 15 is controlled by the brake pipe pressure and the work air cylinder 14, and the pressure of the precontrol air cylinder

12 and the volume chamber compensation air cylinder 13 is amplified by the balancing part of the distributor valve 15 to control the brake cylinder pressure.

When a driver finds an emergency situation needing emergency braking, and as he operates the emergency braking button 19 in a driver room or turning the handle of the driver controller 18 to the emergency position, the emergency braking loop is damaged, the large drift diameter electric pneumatic valve 11 is powered down, and an emergency braking device starts the emergency braking rapid pressurizing control system, and at that time main air is rapidly filled into the precontrol air cylinder 12 through the main air pressure regulator 2 and the large drift diameter electric pneumatic valve 11, so that the brake cylinder pressure quickly reaches the maximal value, and the locomotive brake cylinder produces emergency braking action.

The pressure in the precontrol air cylinder 12 is not higher than the setting value set for the main air pressure regulator 2 when the electric distributor valve closed-loop control system enabled in normal conditions works. The pressure in the precontrol air cylinder 12 is not higher than the setting value set for the pressure regulator 9 when the backup air distributor valve control system enabled as electric distributor valve closed-loop control system fails works.

Compared with the prior art, the invention has the beneficial effect that according to the invention, the control precision of the brake cylinder pressure is improved; the reliability of the brake system is increased; the response time of emergency braking is reduced; and the safety of the battery electric engineering locomotive is enhanced. In normal conditions, the pressure in the precontrol air cylinder is subject to closed-loop control, and is amplified by the balancing part of the distributor valve to obtain and the pressure of the locomotive brake cylinder, which can greatly improve the control precision of the brake cylinder pressure by the distributor valve; and the backup air distributor valve, serving as a backup, greatly improves the reliability of the brake system. When emergency braking is conducted, hare wire control is adopted for all, and the pressure of the precontrol air cylinder is connected in parallel with a main air path with a large drift diameter, thus effectively reducing the response time of emergency braking, and improving the reliability and safety of the battery electric engineering locomotive. In addition, the maximal pressure of the brake cylinder of the battery electric engineering locomotive is realized by the setting value of the regulators, which can improve the control precision of the pressure.

Brief Description of the Drawings

Fig. 1 is an air path schematic diagram of an embodiment of the invention;

Fig. 2 is a circuit control schematic diagram of an embodiment of the invention; and

Fig. 3 is a control schematic diagram of an emergency braking loop of the invention.

5 In the drawings:

1. main air cock;

2. main air pressure regulator;

3. a inlet high-speed electric pneumatic valve;

4. a outlet high-speed electric pneumatic valve;

10 5. proportional controller;

6. changeover electric pneumatic valve;

7. pressure sensor;

8. pressure detection port;

9. pressure regulator;

15 10. cock;

11. large drift diameter electric pneumatic valve;

12. precontrol air cylinder;

13. volume chamber compensation air cylinder;

14. work air cylinder;

20 15. distributor valve;

16. cock;

17. brake control unit BCU;

18. driver controller;

19. emergency braking button.

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Detailed Description of the Embodiments

As shown in Fig. 1, a control system for a distributor valve of a battery electric engineering locomotive brake system comprises an electric distributor valve closed-loop control system, a

backup air distributor valve control system, and an emergency braking rapid pressurizing control system.

The electric distributor valve closed-loop control system enabled in normal conditions comprises a pressure sensor 7 connected to a balancing part of a distributor valve 15; an air inlet branch
5 formed by successively connecting in series a main air cock 1 controlling main air intake and cut off and connected with a main air output port, a main air pressure regulator 2 regulating the main air pressure, an air inlet high-speed electric pneumatic valve 3, a precontrol air cylinder 12, the distributor valve 15, and a pressure regulator 9; and an air outlet branch composed of an air outlet high-speed electric pneumatic valve 4, wherein as shown in Fig. 2, signal input ends of the
10 air inlet high-speed electric pneumatic valve 3 and an air outlet high-speed electric pneumatic valve 4 are respectively connected with a brake control unit BCU 17, and a PWM proportional controller 5 is arranged within the BCU 17; a signal input end of the proportional controller 5 is connected with an output end of the pressure sensor 7, and a signal output end of a driver controller 18 is connected with the brake control unit BCU 17; and according to an instruction of
15 the driver controller 18, comparison is made between the pressure sensor 7 and the instruction to obtain a difference, to further control the power up and power down of the air inlet high-speed electric pneumatic valve 3 and the air outlet high-speed electric pneumatic valve 4.

The backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails is composed of a brake pipe, the distributor valve 15, the
20 pressure regulator 9, a work air cylinder 14, a volume chamber supplement air cylinder 13, and a changeover electric pneumatic valve 6 which are successively connected in series by pipes; and the changeover electric pneumatic valve 6 is controlled by the brake control unit BCU 17.

The emergency braking rapid pressurizing control system enabled when in emergency conditions is composed of the main air cock 1, the main air pressure regulator 2, a cock 10, a large drift
25 diameter electric pneumatic valve 11, the precontrol air cylinder 12 and the distributor valve 15 which are successively connected in series by pipes. the large drift diameter electric pneumatic valve 11 is connected to an emergency braking loop, as shown in Fig. 3, and the driver controller 18-an emergency position, an emergency braking button 19, an excessive low main air pressure protection, and the like are connected in series on the emergency braking loop; and another

signal output end of the emergency braking button 19 is connected with the brake control unit BCU 17, so that when any link on the emergency braking loop is cut off, for example, when the driver controller 18 turns to the emergency position or presses the emergency braking button 19, the large diameter electric pneumatic valve 11 is powered down, and the emergency braking rapid pressurizing control system is started.

Through regulating the setting value of the pressure regulator 9 or the main air pressure regulator 2, the pressure in the precontrol air cylinder 12 is not higher than the setting value set for the main air pressure regulator 2 when the electric distributor valve closed-loop control system enabled in normal conditions works. The pressure in the precontrol air cylinder 12 is not higher than the setting value set for the pressure regulator 9 when the backup air distributor valve control system enabled as electric distributor valve closed-loop control system fails works, so that the distributor valve defines the maximal value of the brake cylinder to be not higher than the setting value.

CLAIMS

1. A control system for a distributor valve of a battery electric engineering locomotive brake system, comprising an electric distributor valve closed-loop control system
5 enabled in normal conditions, a backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails, and an emergency braking rapid pressurizing control system enabled in emergency conditions, wherein the electric distributor valve closed-loop control system enabled in normal conditions comprises a pressure sensor (7) connected to a balancing part of a distributor valve
10 (15); an air inlet branch formed by successively connecting in series a main air cock (1) controlling main air intake and cut off and connected with a main air output port, a main air pressure regulator (2) regulating the main air pressure, an air inlet high-speed electric pneumatic valve (3), a precontrol air cylinder (12), the distributor valve (15), and a pressure regulator (9); and an air outlet branch composed of an air outlet
15 high-speed electric pneumatic valve (4), wherein signal input ends of the air inlet high-speed electric pneumatic valve (3) and an air outlet high-speed electric pneumatic valve (4) are respectively connected with a brake control unit BCU (17), and a proportional controller (5) is arranged within the brake control unit BCU (17); a signal input end of the proportional controller (5) is connected with an output end of
20 the pressure sensor (7), and a signal output end of a driver controller (18) is connected with the brake control unit BCU (17); and according to an instruction of the driver controller (18), comparison is made between the pressure sensor (7) and the instruction of the driver controller (18) to obtain a difference by the brake control unit BCU (17), and the brake control unit BCU (17) control the power up and power down
25 of the air inlet high-speed electric pneumatic valve (3) and the air outlet high-speed electric pneumatic valve (4);
the backup air distributor valve control system enabled when the electric distributor valve closed-loop control system fails is composed of a brake pipe, the distributor valve (15), the pressure regulator (9), a work air cylinder (14), a volume chamber

supplement air cylinder (13), and a changeover electric pneumatic valve (6) controlled by the brake control unit BCU (17), which are successively connected in series by pipes; and

the emergency braking rapid pressurizing control system enabled when in emergency condition is composed of the main air cock (1), the main air pressure regulator (2), a cock (10), a large drift diameter electric pneumatic valve (11), the precontrol air cylinder (12) and the balancing part of the distributor valve (15), wherein the large drift diameter electric pneumatic valve (11) is connected to an emergency braking loop, on which a driver controller (18)-an emergency position, an emergency braking button (19), an excessive low main air pressure protection are connected in series; and another signal output end of the emergency braking button (19) is connected with the brake control unit BCU (17), so that when any link on the emergency braking loop is cut off, the large diameter electric pneumatic valve (11) is powered down, and the emergency braking rapid pressurizing control system is started.

2. The control system for the distributor valve of the battery electric engineering locomotive brake system according to claim 1, characterized in that the pressure in the precontrol air cylinder (12) is not higher than the setting value set for the main air pressure regulator (2) when the electric distributor valve closed-loop control system enabled in normal conditions works

3. The control system for the distributor valve of the battery electric engineering locomotive brake system according to claim 1, characterized in that the pressure in the precontrol air cylinder (12) is not higher than the setting value set for the pressure regulator (9) when the backup air distributor valve control system enabled when electric distributor valve closed-loop control system fails works.

4. The control system for the distributor valve of the battery electric engineering locomotive brake system according to claim 1, 2 or 3, characterized in that the air cylinder of the balancing part of the distributor valve (15) is provided with a pressure detection port (8).

5. The control system for the distributor valve of the battery electric engineering locomotive brake system according to claim 1, 2 or 3, characterized in that the proportional controller (5) is a pulse width modulation proportional controller.