

MULTI-POWER SUPPLY MODE TRACTION SYSTEM FOR MULTIPLE-UNIT TRAIN

[0001] The present application claims the priorities to Chinese Patent Application
5 No.201811482748.4, titled "MULTI-POWER SUPPLY MODE TRACTION SYSTEM FOR
MULTIPLE-UNIT TRAIN", filed on December 5, 2018 with the Chinese Patent Office, and
Chinese Patent Application No.201822038028.0, titled "MULTI-POWER SUPPLY MODE
TRACTION SYSTEM FOR MULTIPLE-UNIT TRAIN", filed on December 5, 2018 with the
Chinese Patent Office, both of which are incorporated herein by reference in their entireties.

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FIELD

[0002] The present disclosure relates to the technical field of multiple-unit trains, and in
particular to a multi-power supply mode traction system for a multiple-unit train.

15 BACKGROUND

[0003] At present, the traction system for a multiple-unit train operates only in one power
supply mode. For example, a voltage of 25kV is supplied, a traction transformer on the
multiple-unit train perform voltage conversion on the voltage, then the converted voltage is
inputted to a traction converter for rectification and inversion, and the rectified and inverted
20 voltage is outputted to a traction motor, to supply power to the traction motor.

[0004] With a rapid development of the multiple-unit trains, the diversity of the
multiple-unit train is limited due to the single power supply mode. Therefore, a technical
problem urgently to be solved by those skilled in the art is how to provide a multi-power
supply mode traction system for a multiple-unit train, to improve the diversity of the
25 multiple-unit train.

SUMMARY

[0005] In view of the above, a multi-power supply mode traction system for a multiple-unit
train is provided according to the embodiments of the present disclosure to improve the

diversity of the multiple-unit train.

[0006] To achieve the above object, the following technical solutions are provided according to the embodiments of the present disclosure.

[0007] A multi-power supply mode traction system for a multiple-unit train includes: an
5 alternating-current pantograph, a direct-current pantograph, an isolation switch, an alternating-current high-voltage box, a direct-current high-voltage box, a traction transformer, a traction auxiliary converter, and a traction motor.

[0008] The alternating-current high-voltage box is connected to the alternating-current
10 pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph and a first current flowing through the alternating-current pantograph conform to alternating-current power supply parameters, and disconnect from the alternating-current pantograph if the first voltage and the first current do not conform to the alternating-current power supply parameters.

[0009] The isolation switch is connected to the direct-current pantograph, and is configured
15 to determine whether a voltage across the direct-current pantograph is a non-direct-current voltage, and disconnect from the direct-current pantograph if the voltage across the direct-current pantograph is a non-direct-current voltage.

[0010] The direct-current high-voltage box is connected to the isolation switch, and is
20 configured to detect whether a second voltage across the isolation switch and a second current flowing through the isolation switch conform to direct-current power supply parameters, and disconnect from the isolation switch if the second voltage and the second current do not conform to the direct-current power supply parameters.

[0011] The traction transformer is connected to the alternating-current high-voltage box and
25 the direct-current high-voltage box. A primary side of the traction transformer is connected to a grounding device, and each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer.

[0012] An input terminal of the traction auxiliary converter is connected to the traction
transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor.

30 **[0013]** Specifically, the isolation switch includes: an overcurrent detection device and an

overcurrent protection device.

[0014] The overcurrent detection device is connected to the direct-current pantograph, and is configured to detect whether a first current flowing through the direct-current pantograph is higher than a first current threshold, and send alarm information if the first current is higher than the first current threshold.

[0015] The overcurrent protection device is connected to the overcurrent detection device, and is configured to disconnect from the overcurrent detection device based on the alarm information.

[0016] Specifically, the system further includes an alarm device.

[0017] The alarm device is connected to the isolation switch, and is configured to issue an alarm based on the alarm information.

[0018] Specifically, the direct-current high-voltage box includes: a direct-current voltage sensor, a direct-current current sensor, and a direct-current breaker.

[0019] The direct-current voltage sensor is connected to the isolation switch, and is configured to detect whether the second voltage across the isolation switch meets a direct-current voltage requirement, and send a direct-current voltage pre-warning signal if the second voltage does not meet the direct-current voltage requirement.

[0020] The direct-current current sensor is connected to the isolation switch and the direct-current voltage sensor, and is configured to detect whether the second current flowing through the isolation switch meets a direct-current current requirement, and send a direct-current current pre-warning signal if the second current does not meet the direct-current current requirement.

[0021] The direct-current breaker is connected to the direct-current current sensor, and is configured to disconnect the direct-current high-voltage box from the isolation switch based on the direct-current voltage pre-warning signal and/or the direct-current current pre-warning signal.

[0022] Specifically, the alternating-current high-voltage box includes: an alternating-current voltage transformer, an alternating-current current transformer, and an alternating-current breaker.

[0023] The alternating-current voltage transformer is connected to the alternating-current pantograph, and is configured to detect whether the first voltage across the alternating-current pantograph meets an alternating-current voltage requirement, and send an alternating-current voltage pre-warning signal if the first voltage does not meet the alternating-current voltage requirement.

[0024] The alternating-current current transformer is connected to the alternating-current pantograph and the alternating-current voltage transformer, and is configured to detect whether the first current flowing through the alternating-current pantograph meets an alternating-current current requirement, and send an alternating-current current pre-warning signal if the first current does not meet the alternating-current current requirement.

[0025] The alternating-current breaker is connected to the alternating-current current transformer, and is configured to disconnect the alternating-current high-voltage box from the alternating-current pantograph based on the alternating-current voltage pre-warning signal and/or the alternating-current current pre-warning signal.

[0026] Specifically, the overcurrent protection device includes a direct-current lightning arrester.

[0027] Specifically, the system further includes a prompting device.

[0028] The prompting device is connected to the isolation switch, and is configured to send a prompt signal based on a type of the alarm information.

[0029] Specifically, the alternating-current pantograph is a 25KV alternating-current pantograph. The direct-current pantograph is a 750V direct-current pantograph, a 1.5KV direct-current pantograph, or a 3KV direct-current pantograph.

[0030] Based on the foregoing technical solutions, a multi-power supply mode traction system for a multiple-unit train is provided according to the embodiments of the present disclosure. The system includes an alternating-current pantograph, a direct-current pantograph, an isolation switch, an alternating-current high-voltage box, a direct-current high-voltage box, a traction transformer, a traction auxiliary converter, and a traction motor. The alternating-current high-voltage box is connected to the alternating-current pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph and a first current flowing through the alternating-current pantograph conform to alternating-current

power supply parameters, and disconnect from the alternating-current pantograph if the first voltage and the first current do not conform to the alternating-current power supply parameters. The isolation switch is connected to the direct-current pantograph, and is configured to determine whether a voltage across the direct-current pantograph is a non-direct-current voltage, and disconnect from the direct-current pantograph if the voltage across the direct-current pantograph is a non-direct-current voltage. The direct-current high-voltage box is connected to the isolation switch, and is configured to detect whether a second voltage across the isolation switch and a second current flowing through the isolation switch conform to direct-current power supply parameters, and disconnect from the isolation switch if the second voltage and the second current do not conform to the direct-current power supply parameters. The traction transformer is connected to the alternating-current high-voltage box and the direct-current high-voltage box, a primary side of the traction transformer is connected to a grounding device, and each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer. An input terminal of the traction auxiliary converter is connected to the traction transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor. Therefore, a multi-power supply mode traction system for a multiple-unit train is provided according to the present disclosure to improve the diversity of the multiple-unit train. In addition, a secondary-side winding of the traction transformer is used as a smoothing reactor, saving an occupancy space of a circuit and improving economic performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The drawings to be used in the description of the embodiments or the conventional technology will be described briefly as follows, so that the technical solutions according to the embodiments of the present disclosure or according to the conventional technology will become clearer. It is apparent that the drawings in the following description only illustrate some embodiments of the present disclosure. For those skilled in the art, other drawings may be obtained according to these drawings without any creative work.

[0032] Figure 1 is a schematic structural diagram of a multi-power supply mode traction system for a multiple-unit train according to an embodiment of the present disclosure;

[0033] Figure 2 is a schematic structural diagram of an isolation switch according to an

embodiment;

[0034] Figure 3 is a schematic structural diagram of a direct-current high-voltage box according to an embodiment;

[0035] Figure 4 is a schematic structural diagram of an alternating-current high-voltage box according to an embodiment;

[0036] Figure 5 is a schematic structural diagram of a multi-power supply mode traction system for a multiple-unit train according to an embodiment;

[0037] Figure 6 is a schematic structural diagram of a multi-power supply mode traction system for a multiple-unit train according to another embodiment; and

[0038] Figure 7 is a circuit diagram of a multi-power supply mode traction system for a multiple-unit train according to an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0039] At present, the traction system for a multiple-unit train operates only in one power supply mode. For example, a voltage of 25kV is supplied, a traction transformer on the multiple-unit train perform voltage conversion on the voltage, then the converted voltage is inputted to a traction converter for rectification and inversion, and the rectified and inverted voltage is outputted to a traction motor, to supply power to the traction motor.

[0040] However, with the rapid development of the multiple-unit trains, the diversity of multiple-unit trains is limited due to the single power supply mode. In a power grid with multiple power supply modes, it is impossible for the multiple-unit train to operate across multiple power supply modes during transportation.

[0041] Therefore, a multi-power supply mode traction system for a multiple-unit train is provided according to an embodiment. Reference is made to Figure 1, which is a schematic structural diagram of a multi-power supply mode traction system for a multiple-unit train according to an embodiment of the present disclosure. The multi-power supply mode traction system for a multiple-unit train includes: an alternating-current pantograph 11, a direct-current pantograph 12, an isolation switch 13, an alternating-current high-voltage box 14, a direct-current high-voltage box 15, a traction transformer 16, a traction auxiliary converter 17, and a traction motor 18.

[0042] The alternating-current high-voltage box is connected to the alternating-current pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph and a first current flowing through the alternating-current pantograph conform to alternating-current power supply parameters, and disconnect from the alternating-current

5 pantograph if the first voltage and the first current do not conform to the alternating-current power supply parameters.

[0043] The isolation switch is connected to the direct-current pantograph, and is configured to determine whether a voltage across the direct-current pantograph is a non-direct-current voltage, and disconnect from the direct-current pantograph if the voltage across the

10 direct-current pantograph is a non-direct-current voltage.

[0044] The direct-current high-voltage box is connected to the isolation switch, and is configured to detect whether a second voltage across the isolation switch and a second current flowing through the isolation switch conform to direct-current power supply parameters, and disconnect from the isolation switch if the second voltage and the second current do not

15 conform to the direct-current power supply parameters.

[0045] The traction transformer is connected to the alternating-current high-voltage box and the direct-current high-voltage box, a primary side of the traction transformer is connected to a grounding device, and each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer.

[0046] An input terminal of the traction auxiliary converter is connected to the traction transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor.

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[0047] Specifically, the pantograph is an electrical device used by an electric traction locomotive such as a high-speed train or a multiple-unit train to obtain power from a power supply catenary, and is generally installed on the roof of the locomotive or the multiple-unit train. The pantograph may be categorized into two types: a single-arm pantograph and a double-arm pantograph, each of which includes a slide plate, an upper frame, a lower arm (a lower frame in the double-arm pantograph), a base frame, a pantograph raising spring, a transmission cylinder and a support insulator and the like.

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[0048] The direct-current pantograph is used to obtain direct current power from the power

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supply catenary. The alternating-current pantograph is used to obtain alternating-current power from the power supply catenary. In the embodiment, the alternating-current pantograph and the direct-current pantograph are both arranged, such that the traction system for a multiple-unit train can operate in multiple power supply modes.

5 **[0049]** It is to be noted that, in the embodiment, the alternating-current pantograph and the direct-current pantograph may be arranged one behind the other, or may be arranged at the same horizontal level, which is not limited in the present disclosure, and may be arranged according to the actual conditions.

10 **[0050]** The alternating-current pantograph may be a 25KV alternating-current pantograph. The direct-current pantograph may be a 750V direct-current pantograph, a 1.5KV direct-current pantograph, or a 3KV direct-current pantograph. Specifically, an alternating-current power of 25KV is usually supplied in an alternating-current power supply mode, and a 750V direct-current pantograph, a 1.5KV direct-current pantograph, a 3KV direct-current pantograph, and a 25KV alternating-current pantograph are usually adopted in a
15 direct-current power supply mode, where the voltage value represents a power supply voltage that can be withstood by the pantograph for a long period of time.

[0051] The isolation switch is connected to the direct current pantograph, and is configured to determine whether non-direct current power is supplied, and disconnect from the direct current pantograph in a case that non-direct current power is supplied.

20 **[0052]** As shown in Figure 2, a structure of the isolation switch is provided according to the embodiment. The isolation switch includes: an overcurrent detection device 21 and an overcurrent protection device 22.

[0053] The overcurrent detection device is connected to the direct-current pantograph, and is configured to detect whether a first current flowing through the direct-current pantograph is
25 higher than a first current threshold, and send alarm information if the first current is higher than the first current threshold.

[0054] The overcurrent protection device is connected to the overcurrent detection device, and is configured to disconnect from the overcurrent detection device based on the alarm information.

30 **[0055]** Specifically, the overcurrent detection device is connected to the direct-current

pantograph, and is configured to detect whether a current flowing through the direct-current pantograph exceeds a predetermined range, and send an overcurrent alarm signal if the current flowing through the direct-current pantograph exceeds the predetermined range. The overcurrent protection device is connected to the overcurrent detection device, and is
5 configured to disconnect from the overcurrent detection device on the reception of the overcurrent alarm signal.

[0056] The isolation switch including the overcurrent detection device and the overcurrent protection device is connected to the direct-current pantograph. The isolation switch determines, with the overcurrent detection device, whether the current flowing from the
10 direct-current pantograph exceeds a predetermined current range for a direct-current power supply mode and send an overcurrent alarm signal in a case that the current flowing from the direct-current pantograph exceeds the predetermined current range, such that the isolation switch automatically disconnect, with the overcurrent protection device, from the overcurrent detection device on the reception of the overcurrent alarm signal.

[0057] In a case that a direct-current pantograph is supplied with an alternating-current power, since a current supplied in an alternating-current power supply mode is far greater than a current supplied in a direct-current power supply mode, it may be determined whether an alternating-current power is wrongly supplied by performing overcurrent detection. Specifically, various components can be used for performing overcurrent detection, and the
20 most suitable component can be selected flexibly. The overcurrent protection device may be a direct-current arrester or the like.

[0058] The direct-current high-voltage box is connected to the isolation switch, and is configured to detect whether a voltage across the isolation switch and a current flowing through the isolation switch meet a direct-current power supply requirement, and disconnect
25 from the isolation switch if the voltage and current do not meet the direct-current power supply requirement.

[0059] The alternating-current high-voltage box is connected to the alternating-current pantograph, and is configured to detect whether a voltage across the alternating-current pantograph and a current flowing through the alternating-current pantograph meet an
30 alternating-current power supply requirement, and disconnect from the alternating-current pantograph if the voltage and current do not meet the alternating-current power supply

requirement.

[0060] Each of the direct-current high-voltage box and the alternating-current high-voltage box functions to detect whether a voltage and a current inputted into the direct current high-voltage box or the alternating current high-voltage box meet the power supply requirement for a corresponding power supply mode, and disconnect from an upper layer device if the voltage or the current inputted into the direct current high-voltage box or the alternating current high-voltage box does not meet the power supply requirement for the corresponding power supply mode. The voltage or the current failing to meet the power supply requirement for the corresponding power supply mode indicates that power is wrongly transmitted, for which there are various reasons, such as a fault of an intermediate component, abnormal power supply from an upper level component, and undesirable power cannot be further processed normally and eventually converted to the traction force for driving the train to travel.

[0061] As shown in Figure 3, a structure of a direct-current high-voltage box is provided according to an embodiment. The direct-current high-voltage box includes: a direct-current voltage sensor 31, a direct-current current sensor 32, and a direct-current breaker 33.

[0062] The direct-current voltage sensor is connected to the isolation switch, and is configured to detect whether the second voltage across the isolation switch meets a direct-current voltage requirement, and send a direct-current voltage pre-warning signal if the second voltage does not meet the direct-current voltage requirement.

[0063] The direct-current current sensor is connected to the isolation switch and the direct-current voltage sensor, and is configured to detect whether the second current flowing through the isolation switch meets a direct-current current requirement, and send a direct-current current pre-warning signal if the second current does not meet the direct-current current requirement.

[0064] The direct-current breaker is connected to the direct-current current sensor, and is configured to disconnect the direct-current high-voltage box from the isolation switch based on the direct-current voltage pre-warning signal and/or the direct-current current pre-warning signal.

[0065] The components in the alternating current high-voltage box for the alternating

current power supply mode are similar to corresponding components in the direct current high-voltage box, as long as the corresponding components are replaced by alternative current components. As shown in Figure 4, the alternating-current high-voltage box includes: an alternating-current voltage transformer 41, an alternating-current current transformer 42, and an alternating-current breaker 43.

[0066] The alternating-current voltage transformer is connected to the alternating-current pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph meets an alternating-current voltage requirement, and send an alternating-current voltage pre-warning signal if the first voltage does not meet the alternating-current voltage requirement.

[0067] The alternating-current current transformer is connected to the alternating-current pantograph and the alternating-current voltage transformer, and is configured to detect whether a first current flowing through the alternating-current pantograph meets an alternating-current current requirement, and send an alternating-current current pre-warning signal if the first current does not meet the alternating-current current requirement.

[0068] The alternating-current breaker is connected to the alternating-current current transformer, and is configured to disconnect the alternating-current high-voltage box from the alternating-current pantograph based on the alternating-current voltage pre-warning signal and/or the alternating-current current pre-warning signal.

[0069] The traction transformer is connected to the alternating-current high-voltage box. The current flows from a primary side of the traction converter to a grounding device, then is returned to a transformer substation along a rail, to reduce the transmitted alternating-current voltage. Each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer, to perform differential protection for the traction transformer.

[0070] In the direct-current power supply mode, a traction winding of the traction transformer is used as a smoothing reactor, to effectively reduce the weight of the locomotive and save the occupancy space of the device, which can be realized by a multi-stage conversion switch in the traction converter.

[0071] An input terminal of the traction auxiliary converter is connected to the traction

transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor, and the traction auxiliary converter is configured to perform auxiliary conversion processing on the power transmitted from the traction transformer to obtain a traction voltage for the traction motor.

5 **[0072]** The traction motor is configured to convert the traction voltage to a traction force.

[0073] Therefore, a multi-power supply mode traction system for a multiple-unit train is provided according to the present disclosure to improve the diversity of the multiple-unit train. In addition, a secondary-side winding of the traction transformer may be used as a smoothing reactor, to save the occupancy space of a circuit and improve economic performance.

10 **[0074]** Based on the above embodiments, as shown Figure 5, a multi-power supply mode traction system for a multiple-unit train is provided according to an embodiment. The system further includes an alarm device 51.

[0075] The alarm device is connected to the isolation switch, and is configured to issue an alarm based on the alarm information.

15 **[0076]** That is, the overcurrent alarm signal may be transmitted to a driver's cab of the train, such that the driver of the train can switch the power supply mode in time on the reception of the overcurrent alarm signal, thereby exiting a wrong power supply mode in time essentially. In this way, it is unnecessary for the direct-current pantograph to withstand a high-voltage alternating-current power for a long period of time, thus improving the service life of the
20 components.

[0077] Based on the above embodiments, as shown Figure 6, a multi-power supply mode traction system for a multiple-unit train is provided according to an embodiment. The system further includes a prompting device 61.

[0078] The prompting device is connected to the isolation switch, and is configured to send
25 a prompt signal based on a type of the alarm information.

[0079] That is, the prompting device issues different prompt signals according to the type of the received alarm information, thereby facilitating determination of the driver, thus avoiding errors during driving caused by distraction.

[0080] Specifically, as shown in Figure 7, a circuit diagram of a multi-power supply mode
30 traction system for a multiple-unit train is provided according to the embodiment.

[0081] In summary, a multi-power supply mode traction system for a multiple-unit train is provided according to the embodiments of the present disclosure. The system includes an alternating-current pantograph, a direct-current pantograph, an isolation switch, an alternating-current high-voltage box, a direct-current high-voltage box, a traction transformer, a traction auxiliary converter, and a traction motor. The alternating-current high-voltage box is connected to the alternating-current pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph and a first current flowing through the alternating-current pantograph conform to alternating-current power supply parameters, and disconnect from the alternating-current pantograph if the first voltage and the first current do not conform to the alternating-current power supply parameters. The isolation switch is connected to the direct-current pantograph, and is configured to determine whether a voltage across the direct-current pantograph is a non-direct-current voltage, and disconnect from the direct-current pantograph if the voltage across the direct-current pantograph is a non-direct-current voltage. The direct-current high-voltage box is connected to the isolation switch, and is configured to detect whether a second voltage across the isolation switch and a second current flowing through the isolation switch conform to direct-current power supply parameters, and disconnect from the isolation switch if the second voltage and the second current do not conform to the direct-current power supply parameters. The traction transformer is connected to the alternating-current high-voltage box and the direct-current high-voltage box, a primary side of the traction transformer is connected to a grounding device, and each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer. An input terminal of the traction auxiliary converter is connected to the traction transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor. Therefore, a multi-power supply mode traction system for a multiple-unit train is provided according to the present disclosure to improve the diversity of the multiple-unit train. In addition, a secondary-side winding of the traction transformer is used as a smoothing reactor, saving an occupancy space of a circuit and improving economic performance.

[0082] The embodiments in this specification are described in a progressive way, each of which emphasizes the differences from others, and the same or similar parts among the embodiments can be referred to each other. Since the device disclosed in the embodiments corresponds to the method therein, the description thereof is relatively simple, and for

relevant matters references may be made to the description of the method.

[0083] It may be known by those skilled in the art that, units and steps in each example described in conjunction with the embodiments disclosed herein can be realized by electronic hardware, computer software or a combination thereof. In order to clearly illustrate
5 interchangeability of the hardware and the software, steps and composition of each embodiment have been described generally in view of functions in the above specification. Whether the function is executed in a hardware way or in a software way depends on application of the technical solution and design constraint condition. Those skilled in the art can use different method for each application to realize the described function, and this is not
10 considered to be beyond the scope of the application.

[0084] The steps of the methods or algorithms described in conjunction with the embodiments of the present disclosure can be implemented with hardware, software modules executed by a processor, or a combination thereof. The software modules may reside in a Random Access Memory (RAM), an internal memory, a Read Only Memory (ROM), an
15 Electrically Programmable ROM, an Electrically-Erasable Programmable ROM, a register, a hard disk, a removable disk drive, CD-ROM, or other types of storage media well known in the technical field.

[0085] With the above descriptions of the disclosed embodiments, the skilled in the art may practice or use the present disclosure. Various modifications to the embodiments are apparent
20 for the skilled in the art. The general principle suggested herein can be implemented in other embodiments without departing from the spirit or scope of the disclosure. Therefore, the present disclosure should not be limited to the embodiments disclosed herein, but has the widest scope that is conformity with the principle and the novel features disclosed herein.

CLAIMS

1. A multi-power supply mode traction system for a multiple-unit train, comprising an alternating-current pantograph, a direct-current pantograph, an isolation switch, an alternating-current high-voltage box, a direct-current high-voltage box, a traction transformer, a traction auxiliary converter, and a traction motor, wherein

the alternating-current high-voltage box is connected to the alternating-current pantograph, and is configured to detect whether a first voltage across the alternating-current pantograph and a first current flowing through the alternating-current pantograph conform to alternating-current power supply parameters and disconnect from the alternating-current pantograph if the first voltage and the first current do not conform to the alternating-current power supply parameters;

the isolation switch is connected to the direct-current pantograph, and is configured to determine whether a voltage across the direct-current pantograph is a non-direct-current voltage, and disconnect from the direct-current pantograph if the voltage across the direct-current pantograph is a non-direct-current voltage;

the direct-current high-voltage box is connected to the isolation switch, and is configured to detect whether a second voltage across the isolation switch and a second current flowing through the isolation switch conform to direct-current power supply parameters and disconnect from the isolation switch if the second voltage and the second current do not conform to the direct-current power supply parameters;

the traction transformer is connected to the alternating-current high-voltage box and the direct-current high-voltage box, a primary side of the traction transformer is connected to a grounding device, and each of the primary side of the traction transformer and a grounding terminal is arranged with a current transformer; and

an input terminal of the traction auxiliary converter is connected to the traction transformer, and an output terminal of the traction auxiliary converter is connected to the traction motor.

2. The multi-power supply mode traction system for a multiple-unit train according to claim 1, wherein the isolation switch comprises: an overcurrent detection device and an

overcurrent protection device,

the overcurrent detection device is connected to the direct-current pantograph, and is configured to detect whether a first current flowing through the direct-current pantograph is higher than a first current threshold and send alarm information if the first current is higher than the first current threshold, and

the overcurrent protection device is connected to the overcurrent detection device, and is configured to disconnect from the overcurrent detection device based on the alarm information.

3. The multi-power supply mode traction system for a multiple-unit train according to claim 2, further comprising an alarm device, wherein

the alarm device is connected to the isolation switch, and is configured to issue an alarm based on the alarm information.

4. The multi-power supply mode traction system for a multiple-unit train according to claim 1, wherein the direct-current high-voltage box comprises: a direct-current voltage sensor, a direct-current current sensor, and a direct-current breaker, wherein

the direct-current voltage sensor is connected to the isolation switch, and is configured to detect whether the second voltage across the isolation switch meets a direct-current voltage requirement, and send a direct-current voltage pre-warning signal if the second voltage does not meet the direct-current voltage requirement;

the direct-current current sensor is connected to the isolation switch and the direct-current voltage sensor, and is configured to detect whether the second current flowing through the isolation switch meets a direct-current current requirement, and send a direct-current current pre-warning signal if the second current does not meet the direct-current current requirement; and

the direct-current breaker is connected to the direct-current current sensor, and is configured to disconnect the direct-current high-voltage box from the isolation switch based on the direct-current voltage pre-warning signal and/or the direct-current current pre-warning signal.

5. The multi-power supply mode traction system for a multiple-unit train according to claim 1, wherein the alternating-current high-voltage box comprises: an alternating-current

voltage transformer, an alternating-current current transformer, and an alternating-current breaker, wherein

the alternating-current voltage transformer is connected to the alternating-current pantograph, and is configured to detect whether the first voltage across the alternating-current
5 pantograph meets an alternating-current voltage requirement, and send an alternating-current voltage pre-warning signal if the first voltage does not meet the alternating-current voltage requirement;

the alternating-current current transformer is connected to the alternating-current pantograph and the alternating-current voltage transformer, and is configured to detect
10 whether the first current flowing through the alternating-current pantograph meets an alternating-current current requirement, and send an alternating-current current pre-warning signal if the first current does not meet the alternating-current current requirement; and

the alternating-current breaker is connected to the alternating-current current transformer, and is configured to disconnect the alternating-current high-voltage box from the
15 alternating-current pantograph based on the alternating-current voltage pre-warning signal and/or the alternating-current current pre-warning signal.

6. The multi-power supply mode traction system for a multiple-unit train according to claim 2, wherein the overcurrent protection device comprises a direct-current lightning arrester.

20 7. The multi-power supply mode traction system for a multiple-unit train according to claim 2, further comprising: a prompting device, wherein

the prompting device is connected to the isolation switch, and is configured to send a prompt signal based on a type of the alarm information.

8. The multi-power supply mode traction system for a multiple-unit train according to
25 claim 1, wherein

the alternating-current pantograph is a 25KV alternating-current pantograph, and

the direct-current pantograph is a 750V direct-current pantograph, a 1.5KV direct-current pantograph, or a 3KV direct-current pantograph.