# Research on dedicated rail power supply system for electric cars

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**Abstract:** in order to improve the endurance capacity and driving safety of electric vehicles, a special track power supply system for electric cars on expressways is studied. The working principle of the main components of the system, such as sliding contact charging track and mechanical charging arm, is simulated and analyzed by using SolidWorks software. The results show that the charging function of the contact track can provide unlimited endurance for electric vehicles, and the guidance function of the track can also ensure the safety of high-speed driving.

**Key words:** electric vehicle; Charging track; Manipulator structure; Working principle;

Introduction: the “carbon peak” and “carbon neutral” initiatives not only resonate globally, but also promote the rapid development of charging highways. At present, many countries in Europe and the United States have carried out the research on wireless induction charging system and achieved experimental success, but it has not been widely promoted due to the low efficiency and slow speed of wireless charging.

The paper uses contact rail power supply, which can not only improve the charging efficiency, but also improve the vehicle driving safety. The car roof height is low, and the height of different models varies greatly, so it is not suitable to adopt roof power supply mode similar to electrified railway. On the contrary, the chassis height of the car has little difference, and the distance from the ground is small, so using the ground track power supply has congenital advantages. The track power supply system is mainly composed of a double pole manipulator and a power supply track. The double pole manipulator is the bridge and link between vehicles and roads, and it is also the technical key of the whole system.

## 1 Research Overview

1.1 research background

Although electric cars have many advantages such as green environmental protection, they also have many disadvantages, such as less charging piles, slow charging, short mileage, short battery life, few professional technicians to repair electric cars, immature technology, etc. At the same time, the safety of high-speed driving is also one of the problems to be solved. Therefore, the rail power supply system, which can not only improve the endurance capacity of electric vehicles, but also improve the driving safety of vehicles, came into being.

1.2 domestic research status

The traditional domestic tram or trolley bus installs the collector pole above the car body, which has two disadvantages: first, the lifting of the collector pole depends on the spring tension, which usually requires the installation of a complex spring mechanical system on the roof, and because the collector pole is hard, straight and non retractable, the metal collector pole will fall off due to external force, This will lead to the danger of electrifying the car body, so the installation and maintenance costs are high and lack of safety; Second, both the tram system and the trolley bus system need to lay a large number of poles and cables, which greatly increases the construction and maintenance costs.

1.3 foreign research status

Both developed and developing countries have experienced industrialization and the rapid growth of car ownership, and the attendant environmental problems have gradually attracted the attention of all countries. Vehicle electrification is widely regarded as the ultimate goal to solve the pollution of vehicle tail. As early as 2018, Sweden carried out the world’s first charging road experiment that can power electric cars, as shown in Figure 1.

**Fig. 1 charging road test site in Sweden**

On the charging Road, a mobile mechanical arm is installed at the bottom of the electric car or electric truck, and the power of the charging track is input into the electric vehicle through the mechanical arm. Once the electric vehicle deviates from the track, the mechanical arm will automatically disconnect. The charging highway is composed of several sections of 50 meters, each of which is used to supply power for electric vehicles separately.

## 2 system composition

2.1 overall system structure

The rail power supply system is composed of a sliding contact charging rail and a mechanical charging arm. The overall structure of the system is shown in Figure 2.

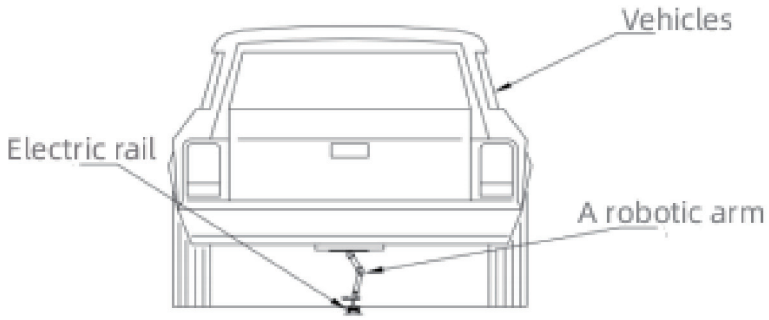


**Figure 2 overall system structure**

The charging track of the system is connected to the grid and laid in sections. After the charging track is energized, the current flows through the mechanical charging arm and enters the battery pack through the power management system for charging.

2.2 charging track structure

The overall shape of the charging track adopts I-shaped structure. The whole structure is divided into two layers, the upper layer is the transmission layer, and the lower layer is the waterproof layer. The charging track adopts 48V DC power supply, and the positive and negative contacts are located on the base of the left and right insulating layers respectively. The lower surface of the contact and the surface of the guide rail are protected by the insulating layer to avoid electric shock and short circuit accidents caused by direct or indirect contact of the positive and negative contacts. See Figure 3 for the specific structural cross section of the charging track.

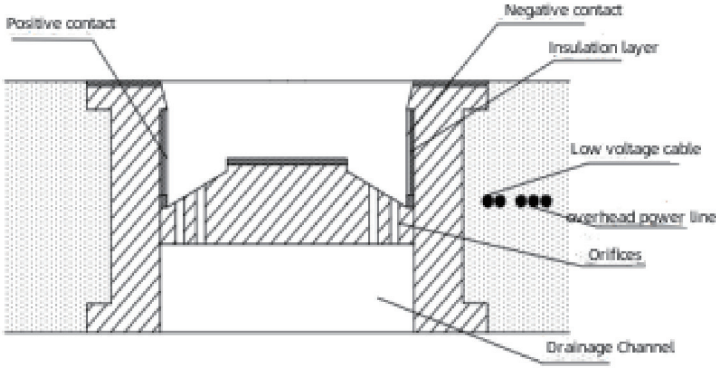


**Figure 3 Schematic diagram of specific structure cross section of charging track**

When the vehicle passes, the conductive brush connects the positive contact and the negative contact, and the charging track starts to run. The middle part of the charging track is slightly concave relative to the charging tracks on both sides, which is convenient for the reasonable placement of the double rod manipulator and the good connection between the conductive brush and the positive and negative contacts.

The lower layer of the charging rail is a drainage layer, and the diversion holes are evenly distributed at the bottom of the charging rail, which is conducive to the rapid discharge of water to the drainage pipe at the lower side. The drainage pipe is connected with the road drainage system, which can discharge the accumulated water in time. Even in rainy and snowy weather, there will be no danger of immersion and leakage when the precipitation is large, and the charging track system can still operate safely. The power supply cable is laid along the charging rail, and the positive contact and negative contact are connected with the main body of the charging rail with bolts.

2.3 double link manipulator structure

The double rod mechanical arm is mainly composed of top plate, upper bearing, upper arm, stepper motor, lower arm, lower bearing, guide rail and conductive brush. The top plate is connected to the bottom of the vehicle and is used to fix the double rod manipulator device. The upper arm is fixed in the top plate through the upper bearing and connected with the lower arm through the stepper motor. The upper

arm and the lower arm form two force rods through the middle rotating pair, and the lower arm is controlled by a stepping motor to realize lowering and recycling. The lower arm is connected to the guide rail and conductive brush through the lower bearing. See Fig. 4 for the structure of double link manipulator.

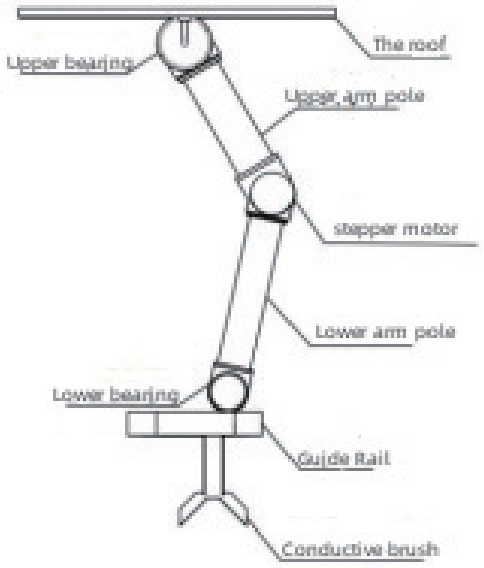


**Fig. 4 structure diagram of double link manipulator**

The double bar manipulator is composed of an approximate two bar structure, which is divided into a fixed roof structure at the top, a torsion two bar structure at the middle, and a movable guide rail structure at the bottom. The top of the double link manipulator is a flat roof with small screw holes for fixing it under the vehicle chassis and moving with the vehicle. The two force bar structure is divided into an upper arm and a lower arm. The top plate, the guide rail and the conductive brush are connected through the upper bearing and the lower bearing respectively. The two arms are connected by hinges. A stepping motor controlled by a single chip microcomputer is installed at the joints inside the bar, which drives the two arms to rotate relatively by sensing the motion state of the vehicle, so as to control the power supply between the conductive brush and the charging track. A straight edge oval guide rail is set at the bottom of the lower arm of the double link manipulator, and the groove space of the guide rail combines the lower bearing with the conductive brush through the pulley.

## 3 system working principle

3.1 charging principle

During the lowering process of the double link manipulator, the upper link, the lower link and the rotating pair between them control the manipulator up and down to actively adapt to the working conditions. The sensor installed on the “Y” shaped conductive brush and the sensor on the charging track can sense the specific position and angle of the conductive brush relative to the charging track. By adjusting the relative position of the guide rail and the conductive brush, the axis of the conductive brush coincides with the axis of the charging rail. After aligning the conductive brush, lower the double rod mechanical arm. When the conductive brush is lowered to a place 10 cm above the ground to stop, the stepper motor starts to drive quickly, so that the conductive brush is inserted into the charging track and connected with the positive and negative contact points to complete the lowering process of the double rod manipulator, so as to realize the contact charging in the movement.

3.2 working principle of end charging

After the charging is completed, the double lever mechanical arm retracts, drives the stepper motor to move rapidly, and lifts the double lever mechanical arm away from the charging track. The driving stepping motor slowly drives the lower arm to lift the base frame, the motor drives the rotary shaft actuator, and the conductive brush returns to the position where it coincides with the vehicle axis, completing the recovery of the double arm manipulator and ending the charging process.

3.3 learning function of the system

In the process of lowering and recovering the double link manipulator, in the case of up and down vibration and left and right offset, with the help of the deep learning function of the machine, adjust the guide rail to make the double link manipulator fine tune locally, so that the transmission system and the moving vehicle can cooperate with each other and move together to better complete the operation of the double link manipulator.

## 4 Conclusion

This paper studies a special rail power supply system for electric vehicles that can not only improve the driving safety of the vehicle, but also enable the vehicle to charge while driving. The system can not only solve the problem of insufficient mileage of electric vehicles,

but also greatly improve the driving safety of vehicles. The system puts forward new ideas for the development of electric vehicles, and can effectively promote China to achieve the strategic goal of "carbon peaking and carbon neutralization" as soon as possible.

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