The structure and control method on the electromagnetic brake system with electromagnetic clutch function

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Abstract. Electromagnetic brake system with electromagnetic clutch includes frictional function and electromagnetic brake device brake, friction brakes and electromagnetic brake are mounted coaxially on the rear axle, and the friction brake disc friction braking and electromagnetic brake device are provided with matching chuck and electromagnetic clutch disc clutch engagement. When the car brakes, the controller will control the output current to the electromagnetic clutch sucker, sucker electromagnetic clutch after clutch engagement will energize the disc against the spring force of pulling, the rolling bearing moves toward the direction of the electromagnetic clutch sucker and eventually pull together. After calculating the torque of the electromagnetic brake system with electromagnetic clutch function, the simulation and experiment are carried out. As the result shows that the electromagnetic brake system can recover the energy of the car during the brake process, and let the car brake effectively.

Introduction

In the vehicle braking energy efficiency, the traditional mechanical friction brake rely on frequent or prolonged mechanical friction to brake and friction braking process not only produce large amounts of toxic dust, but can also cause the brake drum (disc) and friction plate (brake linings) overheat, resulting in braking performance decline even brake failure. It has been reported by an electromagnetic brake as auxiliary brake system of the vehicle, however, since the structure is complex and bulky, not in the narrow space around the hub installation. In order to solve the technical problem, consider an electromagnetic clutch having an electromagnetic brake system functions, including electromagnetic brakes and friction brakes, friction brakes and electromagnetic brake means mounted coaxially on the rear axle, electromagnetic brake disc friction brake disc friction brakes and electromagnetic brakes are provided with matching chuck and electromagnetic clutch disc clutch engagement^[1-9].

Structure of electromagnetic brake system components

The present invention has an electromagnetic brake electromagnetic clutch system functions, including friction brakes and electromagnetic brakes, friction brakes and an electromagnetic brake device coaxially mounted on the rear axle housing, electromagnetic brake disc friction brake disc friction brakes and electromagnetic brakes are provided with matching chuck and electromagnetic clutch disc clutch engagement.

Electromagnetic brake device mainly by the electromagnetic disc brake, the electromagnetic brake coil 10, the electromagnetic brake bracket 9 that the electromagnetic brake bracket and fastening rear axle housing; electromagnetic brake electromagnetic brake coil is wound on the core 11, the electromagnetic brake core a correct electromagnetic brake, electromagnetic brake core and the other end is connected with the electromagnetic brake fastening bolt 12 connected to the electromagnetic brake bracket; there are four groups electromagnetic brake coil, between each by three wires are connected in series and finally the controller 8 connection, electromagnetic brake coil is controlled by the electric current controller; electromagnetic brake disc and the rolling bearing 17

fastening, bearing 15 is tightly pressed against the spring embedded into the rear axle housing of the bearing retainer 16, and the spring side connect the other side of the rolling bearing and embedded into the rear axle housing of the spring retainer 14 is connected.

Side friction brake disk 4 is connected with the wheel bolt 1 and 2 by the brake disc hub flange 3 are connected, hub flange via a bearing supported on the rear axle, rear axle remains stationary relative to the body, with the hub flange the rotation of the wheels rotate and thus drive the rotation of the brake disc. Sucker electromagnetic clutch 5 is connected via a clutch 6 bolt connected to the other side of the friction brake disc brake disc clutch engagement disk 7 by a hinge plate 19 is connected with the electromagnetic brake disc 18.



Fig. 1 the structure of the electromagnetic brake system with electromagnetic clutch function

1.brake disc bolts; 2.wheel;3. wheel flange;4friction brake disc; 5.sucker electromagnetic clutch; 6.clutch connecting bolts;7 .disc clutch is engaged; 8.the controller; 9.the electromagnetic brake bracket;10.electromagnetic brake coil;11.electromagnetic brake core; 12.electromagnetic brake connecting bolt;13.rear axle; 14.spring retainer; 15.spring, 16.bearing retainer; 17.bearings; 18.electromagnetic brake disc;19 .the hinge plates.

The working principle of electromagnetic brake system

When the car after braking, the brake controller 8 receives a signal, the controller will control the output current to the electromagnetic clutch sucker, sucker electromagnetic clutch will pull energized electromagnetic suction disc clutch engagement, the clutch engagement disk electromagnetic suction to overcome the force of the spring under the effect of pulling the rolling bearing move toward the direction of the electromagnetic clutch sucker and eventually pull together; this time, the controller controls four groups electromagnetic brake coil is energized, the electromagnetic brake coil is energized after the eddy current generated in the clutch engagement plate , engages the clutch plate

retarder, thereby connecting bolts \rightarrow friction brake disc through the electromagnetic clutch sucker \rightarrow

clutch, brake the vehicle to achieve. The controller controls the wheel slip ratio of the electric current electromagnetic brake coil and thereby control the output of the braking torque, and finally to the wheels when braking slip ratio between 0.15-0.25.

When using an electromagnetic brake system of the present invention, the controller collecting wheel speed sensor signal, and the current wheel slip ratio obtained by calculation, the main role of the controller output current is adjusted by controlling the braking effect, thereby controlling the wheel slip ratio between 0.15-0.25. When the controller is calculated current slip ratio is less than 0.15, then increase the output current to the coil on the strength of the electromagnetic brake, braking effect enhanced; if the calculated current slip ratio is greater than 0.25, the car has a trend of locking, the

controller will reduce the output to the electromagnetic brake coil current intensity, in order to avoid wheel locking. When the brake signal disappears, the controller will cut off the electromagnetic brake current to the electromagnetic force disappears, the electromagnetic clutch sucker electromagnetic clutch engagement plate separation. Rolling bearing retainer is moved and pressed in the direction of the bearing retainer towards the elastic force of the spring.

Electromagnetic braking system braking torque

The braking torque of the electromagnetic brake disc can be calculated as following^[10]: $T_t = s R^2 S dB^2 w$

(1)

In formula: *s*—Conductivity brake of disc, Ω^{-1} ; *R*—Brake disc from the center to the pole in the center of the projection on the disc, m; *S*—Electromagnetic brake pole area, m²; *d*—Brake disc thickness, m; *B*—magnetic induction through the brake disc, *T*; *w*—Brake disc rotation angular velocity, *rad/s* \circ

$$B = \frac{8prm_0 NI}{16prl_g + \sqrt{2}S\Delta_h m_0 k_e w},$$

$$I_e = \frac{1}{\sqrt{2}}i_e = \frac{\sqrt{2}S\Delta_h Bw}{8pr},$$

$$S = ab$$
(3)

(4)

(2)

In formula: a —the width of the pole section, m; b—The length of the pole faces, m;

r —Brake disc resistivity, $\Omega \cdot m$; Δ_h —Eddy on the brake disc skin depth; $\Delta_h = \sqrt{\frac{2r}{wm_0m_r}}$ m_r —Relative permeability, relative permeability of air is generally 1; ; m_0 —Permeability of vacuum, $m_0 = 4p \times 10^{-7} H/m$; N: the turns of the coil around the core; I—the eddy current of the magnetic brake, A; l_g —gas distance, m; k_e —Conversion coefficient, $k_e = 1.5$ °

Conclusions

After calculating the torque of the electromagnetic brake system with electromagnetic clutch function, the simulation and experiment are carried out. As the result shows that the electromagnetic brake system can recover the energy of the car during the brake process, and let the car brake effectively.

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