Design Research of the Electric Gun Mounting Bracket Used for Parking Pre-tightening Force Adjusting Nut

YAFEI WU

ABSTRACT

For the problem how to fix constant torque electric gun, in parking brake equipped with automatic adjustment system, we propose two solutions, and select a more suitable solution by theoretical analysis. Based on the structure of the handbrake and the electric gun, using 3D modeling software to design the selected solution. At same time, use the finite element analysis to analyze the stress and strain of the leaf spring status. Finally, the solution will be converted to real, and verified that liquid rubber can effectively reduce the spring leaf rivals on the handbrake spring leaf structure by test method, and ultimately proved the feasibility of the design.

INTRODUCTION

With the continuous development of the automotive industry, people have become increasingly demanding performance of the car, and the parking brake system is an important part of the car, and the parking brake pre-tight force has great influence on vehicle braking performance, current process is difficult to ensure consistency, so to design an automatic adjustment parking brake system is very necessary. Parking brake pre-tight force is ensured by constant torque electric gun matter adjusting nut, how to design the electric gun fixation bracket to make electric gun work more reliable is a very important issue.

PARKING BRAKE AUTOMATIC ADJUSTMENT SYSTEM

Many automobile manufacturers still use manual adjustment methods when adjust parking brake, but there are many problems with manual adjustment, such as large labor intensity, the poor consistency of brake cable pre-tight, etc. especially pre-tight force is too small issue. If the parking brake effect is not obvious, there may be security issues; if the pre-tight force is too large, it may cause the parking brake cannot be completely removed, there might be residual block force, thereby affecting the car's performance seriously, so the design of an automated adjustment system to ensure the consistency of the brake preload is necessary.
Parking brake automatic adjustment is made of hardware and software components. The hardware include scan code gun, drives, motors and gear motors, sensors, guns and other components. Software part mainly through programs written in LabVIEW. Verified the consistency of the automatic adjustment system is much higher than the manual adjustment methods by several experiment and thereby improve the braking performance of the car.

**PROBLEMS IN ELECTRIC GUN IMMOBILIZATION**

Automobile used handbrake line structure shown in Fig. 2-1. For the adjustment nut adjustment, the existing process is workers use constant torque electric gun to set adjustment nut. If automatic adjustment system, you need to mount the gun in the appropriate position before starting the device, thus need to design a certain structure which can ensure a connection between the electric gun and adjustment screw.

We can see from Fig.2-1 handbrake structure, with the reciprocating motion of the hand brake, the adjusting nut position does not remain stationary relative to the ground, but about the axis of rotation of the handbrake. Based on the movement of the adjusting nut, the immobilization of electric gun has two options, one is to ensure the electric gun to remain stationary relative to the ground; the second is make electric gun rotate with the axis of handbrake, that is remain relatively stationary compare to the adjusting nut.

![Fig.2-1. Handbrake chart.](image1)

![Figure 3-1. Stun gun mounting bracket.](image2)
THE IMMOBILIZATION PROPOSE OF ELECTRIC GUN

Requirements of electric gun immobilization structure

When design the electric gun immobilization bracket, it should meet the following requirements: (1) Solid structure, and ensure that electric gun will not broke away from adjustment nut; (2) Can be rotated about the handbrake axis, that is remain relatively stationary state compare to adjustment nut; (3) When handbrake works to maximum stroke, electric gun bracket cannot be detached from the handbrake structure; (4) Ensure that electric gun relatively static compare to mounting bracket; (5) Be convenience to install and remove; (6) Cannot tear the handbrake structure.

Electric gun immobilization bracket structure

For the first proposal, through a certain structure between electric guns and adjustment nut to ensure that both have been connected. Electric gun’s position is fixed, adjusting nut rotate around the axis, the distance between electric guns and the adjustment nut is constantly changing, and that is, the axial structure direction should be a certain amount of stretching. Scalable cross shaft universal joint can meet the above requirements, but only when the joint is in a state line, passing efficiency is rather high, therefore, in the moment of electric gun work shall be as far as possible to ensure universal joint for linear state. But in the process of electric gun installation, workers could not guarantee the initial position of universal joint is consistent, if workers deliberately to adjust its initial position, not only can increase the labor intensity of workers, more importantly will severely reduce the production efficiency of production line. So the electric gun relative to ground the stillness of the plan is not feasible.

For the second solution, through a certain structure to make the electric gun and adjusting nut remain relatively static. Electric gun and adjusting nut were connected directly by the sleeve, this can effectively guarantee the electric gun’s torque transmission efficiency. By contrast analysis, finally adopt the second solution.

As shown in fig.3-1 is the electric gun’s fixed final plan. What the design needs to consider is how to constraint electric gun. Put electric gun in the slot as in the picture above, groove’s width is same as the electric gun width, to limit the freedom of electric gun relative movement to bracket. Design as shown in fig.3-2 u-shaped slot, is installed in the tail end of the electric gun’s fixed bracket gaps, installation of M6 is a long bolt hole, with the method of interference fit to make the electric gun to be pressure within the bracket slot, thus preventing electric gun’s movement to bracket, but also to prevent the rotation and movement. Electric gun around itself around the axis.

Found in the real vehicle test experiment, after constant torque electric tightened adjusting nut to a certain position, with the handbrake reciprocating rotation, this can drive sleeve nut to reverse a certain angle, and this will have impact on the parking brake’s pre-tightening force. To avoid the adjusting nut inversion issue, use one-way clutch structure and range of the sleeve to prevent the reversal of the adjusting nut. The sleeve and electric gun is clearance fit, in order to prevent the departure between the structure, the design as shown in fig.3-3, one-way clutch slot in the corresponding position, by limiting the one-way clutch back and forth motion, to ensure the
connection between sleeve and electric gun the connection, this adopts the screw connection between the structure and electric gun rack. Under the joint action of structure and support the tail in the u-shaped slot structure, the electric gun back and forth motion was limited.

As shown in figure 3-4 for the fixed bracket and the structure of the hand brake assembly drawing, according to installation location in the fixed bracket in the figure, when a handbrake reciprocating rotation, fixed bracket will be along with the rotation axis of rotation. To avoid fixed bracket in the process of turning away from the axis of rotation, in the contact place between electric gun fixed brackets with the hand brake axis’s four fixed respectively as shown in figure 3 to 5 leaf spring, accomplished by deformation of leaf spring clamp. Spring leaf thickness is 0.4 mm, and protrusion height is 5 mm.

Figure 3-2. U-groove configuration diagram.

Figure 3-3. Clutch single mounting groove.

Figure 3-4. Overall structure of Fig.
Spring piece Simulation

Finite element analysis was carried out on the spring piece, mainly observe the spring piece of stress and strain. Constraint spring piece on left six degrees of freedom, and only allow the spring to the right lateral movement, and the longitudinal ridges. Through calculation of the size of parts structure, to squeeze the spring leaf swelled parts more than 1 mm, to install the electric gun fixed bracket to corresponding position. So in finite element analysis, set the spring compression of protuberant part for 1 mm, as shown in figure 3-6, spring leaf protuberant peak position for maximum longitudinal displacement.

When spring leaf protuberant location is compressed, the lateral deformation of leaf spring will occur, and its length will increase, so the electric gun fixed bracket and the right end of spring leaf should be leaved some space. The spring piece’s length is 50mm, electric gun fixed stent installing plane part of the spring piece length is 55 mm, so there are 5 mm between the distance. Fig.3.7 is the lateral deformation of leaf spring. The maximum lateral deformation is 0.9 mm, electric gun fixed bracket and spring piece to the right distance can allow the transverse elongation of leaf spring. There is no structure interference problem.
Fig. 3-8 for leaf spring deformation stress nephogram. Spring leaf protuberant peak and right end swelled with the plane of the stress of the transition of the biggest, this is because the leaf spring compression force is applied directly on the ridges, deformation at that point, the largest and swelled with plane stress is big because the department structure mutations in transition, so they have a certain amount of stress concentration.

In the figure the biggest stress of the leaf spring is 1108 MPa. Spring leaf material adopt 60 Si2MnA spring steel, and spring steel use material after normal heat treatment (quenching + tempering) yield strength 1345 MPa. The leaf spring can meet the requirements, but must carry on the corresponding heat treatment.

**Stun gun fixation physical testing**

Install the electric gun in the corresponding position of the mast, and repeated the experiment, the stent observe whether the structure is reliable, there is a need to improve, further improve the electric gun fixed bracket.

Trial didn't found the phenomenon that fixed bracket departure from of electric gun, but after many experiments, found some wear and tear happened on the place spring leaf to its contact with the hand brake structure, and parking brake equipped with automatic adjustment system is used for mass production line, line of cars are not allowed to exist wear, so you should consider how to avoid the wear to a car. The causes of the wear is the spring of hardness is too high, but if you lower the hardness of spring leaf may cause electric gun and manual rotation axis out. Only by avoiding direct contact between the spring leaf and the handbrake structure to solve the problem of wear and tear, so chose to a certain thickness of liquid rubber on the face of spring leaf in. Liquid rubber adhesion, can firmly bonding in spring leaf surface, and liquid rubber with good abrasion resistance, can avoid the structure of the brake wear better.

**SUMMARY**

(1) The parking brake equipped with automatic adjustment system can improve the consistency of brake pre-tightening force, at the same time can largely reduce the labor intensity of workers.

(2) As the handbrake movement, electric gun fixed bracket need rotate with axis rotation, which guarantee the torch around the axis of rotation.

(3) Spring leaf can effectively prevent because of gravity and hand brake structure from electric gun, on a spring leaf surface, apply a layer of liquid rubber can avoid spring leaf rival brake wear.

**REFERENCES**

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