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# Application of the Beam Unloading Clamping Device in Gantry Machine Tool

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## Abstract

In order to solve the problems of large deformation of beam and column and low accuracy maintenance performance caused by traditional clamping method in heavy gantry machine tool, a new unloading clamping method is designed based on the analysis of the existing domestic and foreign traditional gantry machine tool beam clamping method, the guide rail and clamping rail are arranged separately, so as to achieve the purpose of high guide precision of guide rail and small clamping deformation of clamping rail, and the structure can be widely used in heavy gantry machine tool.

## Keywords

Heavy gantry machine tool; the beam clamping; unloading.

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## 1. Introduction

Heavy Gantry machine tool is widely used in machining, high degree of automation, and is a necessary equipment for modern large and heavy parts processing. To meet the demand of heavy parts processing, heavy-duty gantry machine tool has a large size and weight, especially on the heavy beam gantry machine tool, the length of the machine tool bar and affiliated parts can reach 10 meters, up to 50 tons in weight. In the machine tool work, the beam must be positioned and clamped so that the tool can be machined as required. But in the vertical direction fixed heavy beams will be too tight because of the clamping force, resulting in too large deformation of the beams and columns, which will seriously affect the precision of repeated positioning of the machine tool. Therefore, it is very important to study the clamping method and device which can make the beam and column clamping.

## 2. Traditional Beam Clamping Device

The structure of the beam clamping device currently has: mechanical lever, cylinder piston straight wedge type [2]. In several ways, the clamping of the beam is achieved by eliminating the gap between the crosshead and the column sliding guideway. Therefore, the conventional structure directly applies the clamping force to the sliding rail of the beam and the column. Although the traditional clamping method has the advantages of simple structure and convenient installation and adjustment, the common disadvantage of such clamping methods is that the clamping force is too large to cause large deformation to the machine beam and the column. Assuming that the weight of the heavy-duty crossbeam and its attachment is 10t, the friction coefficient between the crossbeam and the column guide surface is 0.02 [1], the clamping method is symmetrical clamping at the left and right ends, and irrespective of other factors, The required clamping force of the end is at least 2450KN, so the huge clamping force will deform the beam and the column guide rail, which will seriously affect the repetitive positioning accuracy of the machine tool.

The new unloading clamping method proposed in this paper can be used to clamp the beams of the heavy duty gantry crane by adding a clamping guide rail to the column of the machine tool to make up for the shortcoming of the traditional beam clamping method and eliminate the problem caused by clamping Beam deformation.

### 3. Principle of Unloading Beam Clamping Device

Unloading beam clamping device working principle diagram as shown in FIG.1, the clamping device includes the clamping system and testing system, the clamping system by beams and columns, the clamping mechanism, clamping guide rail; The detection system consists of sensor, switch and switch bracket. The purpose of the clamping force unloading is to separate the guide sliding guide and the clamping guide. Its working principle is: the hydraulic piston front-end connecting wedge block, along the hydraulic cylinder thrust through wedge institutions into perpendicular to the clamping guide the clamping force, realize the machine tool bar clamping, and clamping force will have clamping deformation of beam and column. Equipped with intelligent detection device on the clamping device, the working status of the clamping mechanism can be detected by the combination of sensor chip and proximity switch to ensure personal safety.

Clamping force is the principle of unloading, increase on machine tool column is dedicated to the clamping of the guide rail, slide the traditional separation and clamping of guide rail, the traditional direct clamping of slide guide is adjusted for only for clamping rail clamping, achieve the purpose of the machine tool bar clamping force unloading, reduce the wear and machine tool slide guide beam deformation.

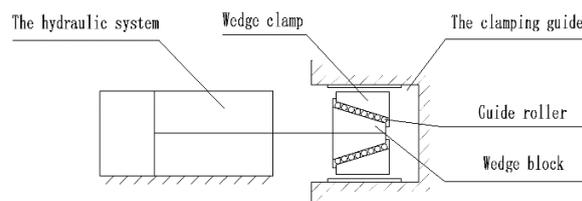


FIG.1 working principle diagram of unloading clamping device

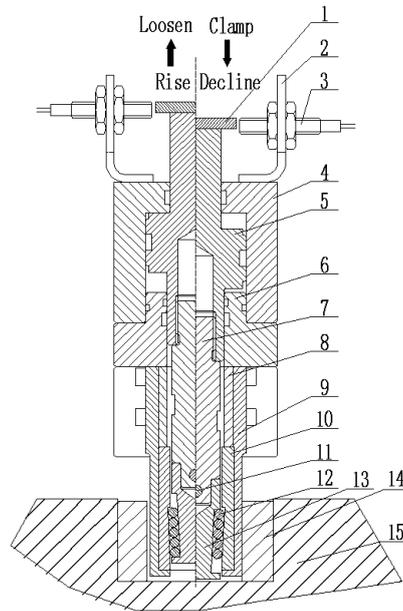
### 4. Structural Design of Unloading Clamping Device

The assembly drawing of unloading clamping device is shown in FIG. 2. It consists of hydraulic system, transmission element and clamping device. The unloading clamping device mainly includes clamping mechanism and clamping guide. The clamping mechanism is installed on the machine tool beam, as the output mechanism of clamping force, and the clamping and relaxing actions are carried out. Clamp the guide rail as the pressure element vertical to the machine or installed on the machine tool column. The elastic clamping plate is inserted into the clamping guide rail, and the clamping plate and the guide rail are provided with the proper clearance between the two sides, so that the movement is flexible, and the clamping time is small when clamping.

When beam moved to the specified location need clamp, hydraulic system to import clamping mechanism on hydraulic cylinder cavity pressure oil push the piston to move forward, the piston push the wedge block movement in both sides, the clamping plate in elastic deformation under the impetus of the wedge pressure piece of open, clamping force and effect on the clamping guide, will beam clamped on the column, the induction flat with the piston moving to the next check point, the position of the proximity switch signal is detected, the system can confirm the fastening device has been completed the clamping action.

When beam need to move, the hydraulic system to the clamping mechanism of hydraulic cylinder inferior vena import oil pressure, oil pressure to push the piston movement backward, the wedge pressure within the piston driven to withdraw, clamping plate under the action of its elastic reset, fastening device and clamping to restore the original space between the guide rail, the sensors with

the piston to move to top dead center, the location of the proximity switch signal is detected, the system can confirm clamping mechanism have completed relaxation action, ready for beam lifting.



1-Sensor chip; 2- switch bracket; 3- proximity switch; 4- hydraulic cylinder body; 5 - the piston; 6- hydraulic cylinder end plate; 7- connecting rod; 8 - bearing; 9- clamping plate; 10- wedge clamp; 11- connection pin; 12- guide roller; 13- wedge block; 14- guide film; 15 – pillar

FIG. 2 assembly drawing of unloading beam clamping device.

## 5. Design of Important Parts

### 5.1 Wedge - Oriented Structure

The wedge clamp and wedge are the guide parts of the device. The wedges are anchored by the cylinder pin, which is parallel to the wedges on either side of the wedge, and the two wedges of the wedge are parallel to the two wedges of the wedge, which is a guide groove between the wedges and the two wedges, and the steering grooves to the grooves of the grooves and the wedges of the steering grooves, so the wedges are not only to have the shape of the traditional mechanism, but the friction of the wedges is made by sliding friction into a rolling friction, reducing the fraying of the wedges, and increasing the life of the clamping device.

### 5.2 Elastic Clamping Plate

The outside of the two wedges has a clamp on the outside of the pressure plate, which is attached to the pedestal, and the elastic pressure is on the guide rail after the wedges are applied. To set up a limit plate between the two clamps, to limit the upper and lower positions of the wedge and guide roller. Design elastic clamping plate can make the clamping mechanism in motion, and there is proper clearance between clamping guide rail, can avoid clamping rail linking piece in sport contact and wear and tear, thus ensuring efficient clamp and lifting.

## 6. Conclusion

When the clamps are loaded, the beams don't create an asymmetrical deformation because the clamps are fixed, and the clamps of the beams are shifting toward zero. In terms of repair and maintenance, the maintenance time and repair costs are reduced due to the clamping plates and clamping plates of the clamping mechanism being removable separately. The clamping mechanism can also be used in parallel to realize the reinforcing effect in a machine tool requiring a large clamping force. With the

combination of clamping and relaxation of intelligent detection device, the intelligent clamping and relaxation of the beam can be realized, which can effectively improve the machining automation degree of the machine tool, which has certain promotion.

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