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Design of Positioning System for Glass Plate Printer

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Abstract. Glass plate printing has been widely used in production and life. However, for fragile glass plate, high precision positioning system is the key in the printing process. In this paper, a motor driving and positioning system consisting of operating mechanism, positioning mechanism and lifting mechanism is proposed. The structure and design scheme of each mechanism are given. Finally, the finite element analysis and stress checking of key parts are carried out. The results provide a new idea for the design of similar systems and have a good reference value

1. Introduction

Printing press is a machine for printing words and images. China was the first country to invent printing press. The invention and development of printing press play an important role in the spread of civilization and human culture. For glass plate printing machine, before glass plate printing, it is necessary to carry out the process of feeding, positioning and dust removal. Because the glass plate is light and fragile, the traditional mechanical positioning clamping device cannot meet the requirements. Therefore, this paper proposes a positioning system for glass plate printing press, which makes the positioning process more convenient, fast and efficient.

2. Scheme Design

For any workpiece, whether in the formulation of its processing technology or in the design of its fixture, the positioning problem is very important. It involves what positioning elements should be used for positioning, and how to analyze and calculate positioning errors, so as to take measures to control the magnitude of the control errors and meet the requirements of workpiece processing technology. In the design process of glass plate printing press, the planning of positioning scheme is an important link. The quality of product processing and the success or failure of fixture design are directly affected by positioning scheme planning.

According to the requirement, the glass plate with large area and thin thickness should be positioned in the design. The requirements for positioning system are:

(1) Sufficient accuracy.
(2) Good wear resistance.
(3) Adequate strength and stiffness.
(4) Good Technology.

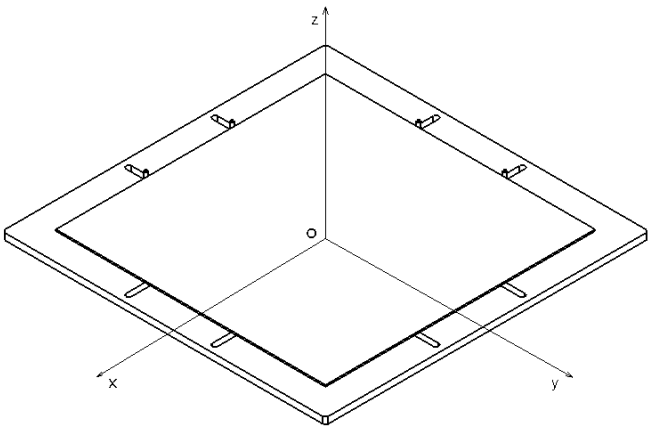

Figure 1. Position platform

Any workpiece in space position is uncertain. If there is no restriction on it, it can move in any direction or rotate along any axis. The possibility of motion of this kind of workpiece is called the degree of freedom of the workpiece. Placing the workpiece in the space rectangular coordinate system, the workpiece has six degrees of freedom, namely, the degree of freedom of movement along three coordinate axes (x axis, y axis, Z axis) and the degree of freedom of rotation around three coordinate axes. Taking the centre of the position platform as the origin, the space rectangular coordinate system shown in Fig. 1 is established. The positioning process of glass plate should limit all six degrees of freedom of glass plate. Among them, the initial positioning bottom plate as a plane can hinder the glass plate moving along Z axis and rotating around X axis and Y axis, limiting three degrees of freedom. The rest of the degrees of freedom can be accomplished in combination with the initial positioning of the bottom plate, the column, the bottom plate and other components.

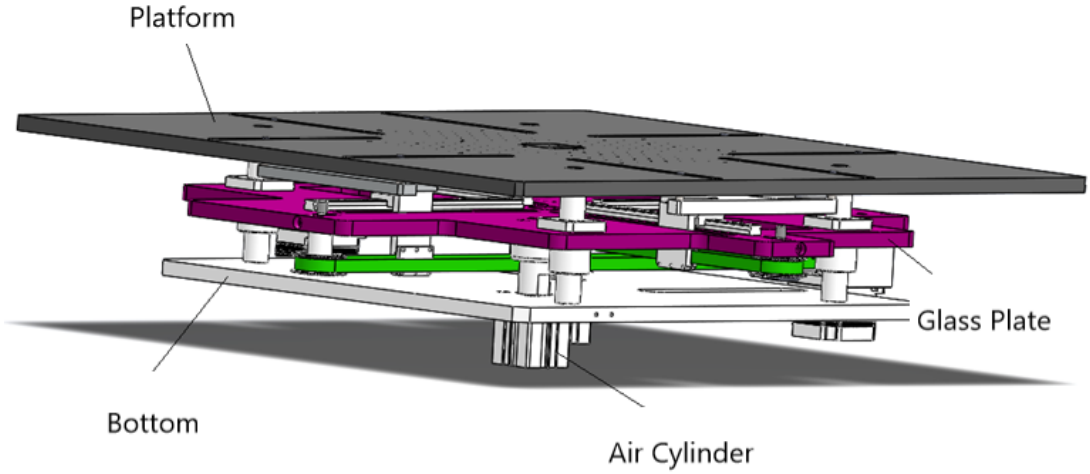

Figure 2. Position System

In the printing process, the feeder places the glass plate on the position platform, the glass plate triggers the photoelectric switch in the platform centre, the PLC commands the motor driver to make the motor move, and the positioning column in two directions (X direction and Y direction) moves toward the glass plate through the synchronous toothed belt in the motion mechanism, so that the glass plate is located in the platform centre location. Subsequently, the vacuum generator acts by adsorbing the glass plate on the platform through the air holes on the platform to complete the initial positioning function; at the same time, the cylinder fixed on the bottom plate acts, and the piston rod connecting the initial positioning bottom plate drops, so that the positioning rod falls below the platform, and the positioning column returns to its original position under the action of synchronous belt. The glass plate

is in the process of dust removal. After dust removal, the manipulator takes the glass plate off and puts it on the printing platform, and the positioning device returns to its original position, waiting for the next positioning work. As shown in Figure 2.

The function of vertical lifting mechanism is lifting tray. After the manipulator grabs the workpiece on the flat belt conveyor, the feature points of the workpiece are identified by the camera, and then the workpiece is put into the pallet. For each workpiece, the motor drives the ball screw to drop one unit vertically, waiting for another workpiece until the tray is full. The tray with full workpiece is sent out by the transverse discharging mechanism. The linear module of ball screw is driven by stepping motor, which can achieve better servo control. Because of the need to achieve multi-point residence and infinite speed regulation, the ball screw nut actuator driven by stepping motor is selected.

3. Mechanism Composition

The positioning system is mainly composed of operating mechanism, positioning mechanism and lifting mechanism. The function of the operating mechanism is to complete the opposite movement of the positioning column in the X direction and the Y direction. The operation mechanism is mainly composed of synchronous toothed belt and two positioning columns. The synchronous belt and the guide rail are mounted on the initial positioning base plate, and the two positioning columns are mounted on both sides of the belt and are located in the centrosymmetrical position. When the motor rotates, the synchronous drive drives the positioning column to move in opposite direction on the guide rail. There are three photoelectric sensors installed on the initial positioning base plate, two of which play a limiting role and one is used as the origin of calculation. The induction plate is mounted on one side of the positioning column, as shown in Figure 3.

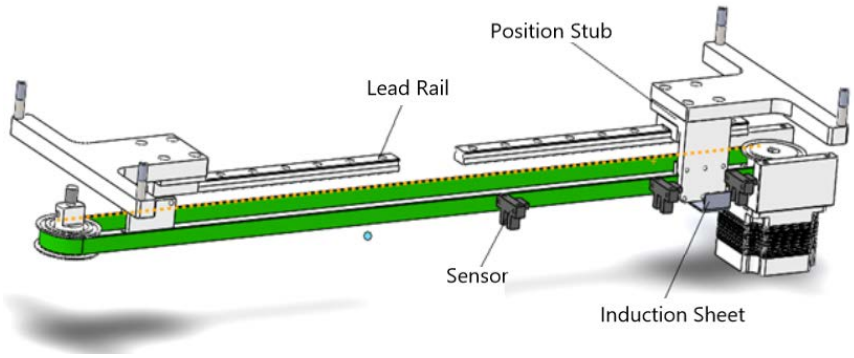

Figure 3. Operating Mechanism

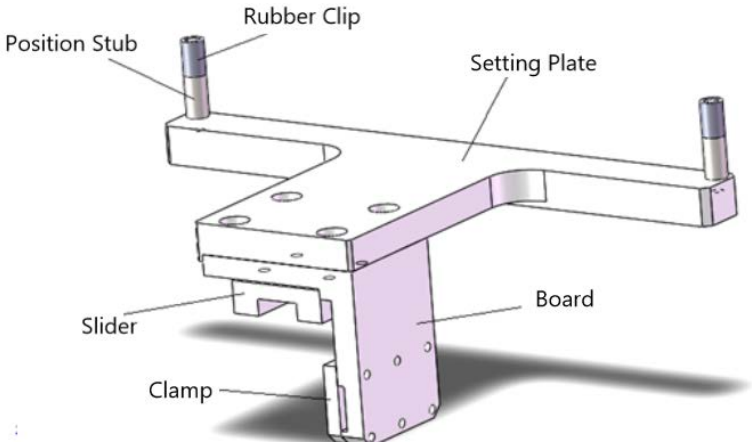

Figure 4. Location mechanism

The positioning mechanism consists of a splint, a press plate, a slider, a fixing plate of a positioning rod and two positioning rods. Each part is connected by a screw. According to the minimum specification of glass plate, the distance between two positioning rods can be determined. In

order to protect the glass plate from collision, the positioning rod is equipped with rubber chucks. The positioning column is fixed on the synchronous belt by splint and pressure plate. The positioning column slides on the guide rail under the synchronous drive to complete the positioning process, as shown in Figure 4.

The function of the lifting mechanism is to complete the lifting and lifting of the operating mechanism so as to ensure that the positioning process does not interfere with other processes. Before discharging, the lifting mechanism is in the lifting state, and the positioning rod exposes the positioning platform to prevent the glass plate from being outside the positioning range of the positioning rod. After the positioning is completed, the cylinder action reduces the operating mechanism to prevent interference with the following dust removal process. After the dust removal is completed, the operating mechanism is lifted up to prepare for the next positioning. The lifting mechanism consists of bottom plate, initial positioning bottom plate, two cylinders and equal height supporting flange, four columns and connecting flange. Among them, the cylinder is installed on the bottom plate, and the flange of equal height support is fixed on the initial positioning bottom plate. It cooperates with the piston rod of the cylinder to support the initial positioning bottom plate and rectify the operation mechanism. Connecting flanges are installed on the initial positioning base plate to enable it to slide on the column installed on the base plate, so as to achieve a smooth lifting motion, as shown in Figure 5.

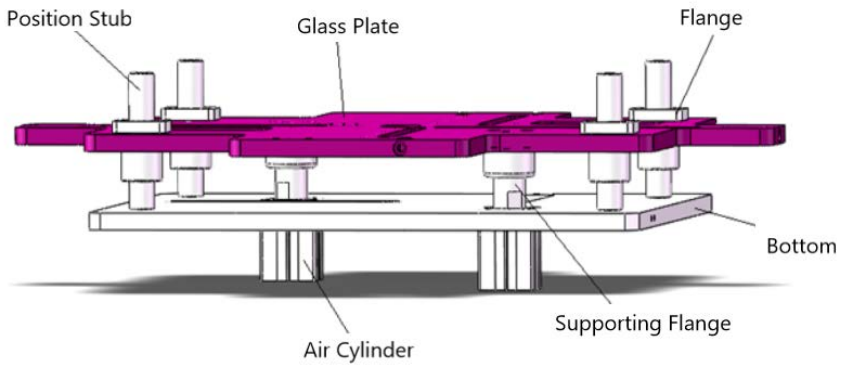

Figure 5. Lifting Mechanism

4. Stress Analysis

During the operation of positioning system of glass plate printing press, two flanges of equal height support the whole operating mechanism to move frequently, so it is necessary to calculate and analyze the strength of supporting flange. Finite element analysis is an important tool in mechanical design. The basic idea is to divide the continuous physical model into a finite number of elements. Then the physical quantities of each element are simulated to approximate the physical quantities of the whole body. Finite element method (FEM) not only has the advantages of high accuracy, but also can be applied to all kinds of complex shapes, so it has become one of the commonly used engineering analysis methods. As shown in Fig. 6, the finite element method is used to establish the model of supporting flange and mesh it.

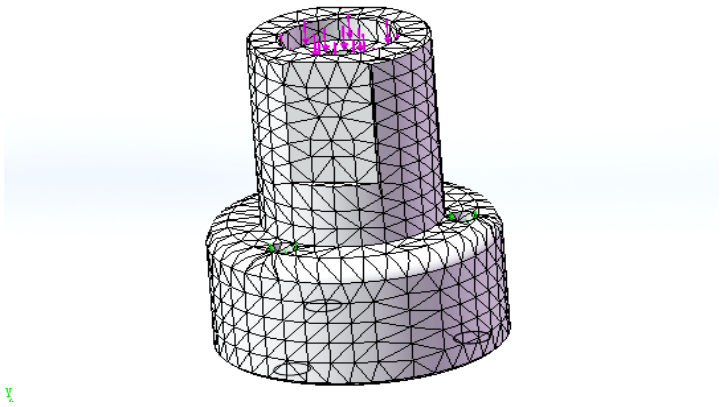

Figure 6. Finite Element Model of Supporting Flange

According to the designed parameters, the stress distribution of parts can be simulated by software program calculation, as shown in Figure 7. From Figure 7, it can be found that the position where the maximum stress occurs on the flange is at the junction of the flange with the cylinder. Referring to the material parameters, the value is less than the allowable stress value, so the strength meets the requirements.

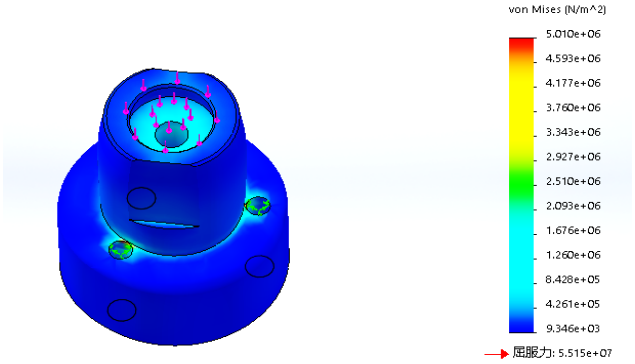

Figure 7. Finite Element Model of Supporting Flange

5. Conclusions

In this paper, a more efficient and automatic positioning system for glass printing press is designed, which includes operating mechanism, positioning mechanism and lifting mechanism. Synchronized belt drive is used in the operation mechanism to ensure the accuracy and efficiency of positioning. The pneumatic transmission is used in the lifting mechanism, which makes the platform have better bearing capacity and quick response. The travel control method is used in the positioning mechanism to ensure that the positioning elements do not interfere. Finally, finite element modelling and analysis of flanges are carried out to ensure that their strength meets the requirements.

6. References

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