Design and Development of Automatic Drilling Machine for Cable Reel

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Abstract: With the rapid development of science, technology and economy, companies have put forward higher requirements for the performance and quality of cable reels. A central hole must be opened in the middle of the wooden disk in the cable reel, and a plurality of small holes distributed in a circular array on the center line of the central hole must be opened on the wooden disk. The current drilling holes are manually rotated, and the processing is precise and difficult to control, and processing efficiency is low. This paper designs an automatic cable reel drilling machine. According to the object to be processed, the overall layout of the equipment is determined, and the feeding system, drilling system, rotating system and unloading system are designed in detail, and the three-dimensional modeling of the equipment is completed. . At the same time, a static analysis of the key parts of the machine was carried out using finite element software. The equipment can improve processing efficiency, improve the quality of processed products, reduce the labor intensity of enterprise workers, and has good social value and economic benefits.

1. Introduction

Cable reels are widely used in many fields such as electrical machinery plants, docks and coal plants. At present, most companies use manual methods to cut and assemble cable reels [1-2]. According to the actual needs of cable reel manufacturers, this paper uses timing belts, motors, cylinders and other components to form a cable reel automatic drilling machine to realize automatic feeding, automatic drilling and automatic cutting, and the elements of each part are measured by PLC. The control of devices and mechanisms simplifies the layout of production, reduces production costs, improves labor conditions, and improves production efficiency. It is conducive to promoting enterprises to realize modern production and has strong practical value.

2. The Overall Design of the Cable Reel Automatic Cutting Assembly Machine

The automatic drilling process of the cable reel includes loading, drilling and unloading. The part designed and developed in this design is a disc type wooden disc with a diameter of 200-500mm and a thickness of 10mm. A hole with a diameter of 40mm needs to be machined in the middle of the wooden disc, and a small hole with a diameter of 8mm is made with a diameter of 80mm centered on the hole. Then, the processed wooden discs are unloaded and sent to the subsequent work stations.

In order to achieve better operating results, the equipment must meet the following conditions [3]:

(1)The machine and main parts must have good static and dynamic performance, and have a certain degree of shock resistance.

(2)The machine requires convenient loading and unloading, and simple operation and maintenance.

(3)The designed mechanical structure must be safe and reliable.

(4)Use PLC for automatic control.

The automatic cable reel drilling machine is divided into a feeding system, a drilling system, a

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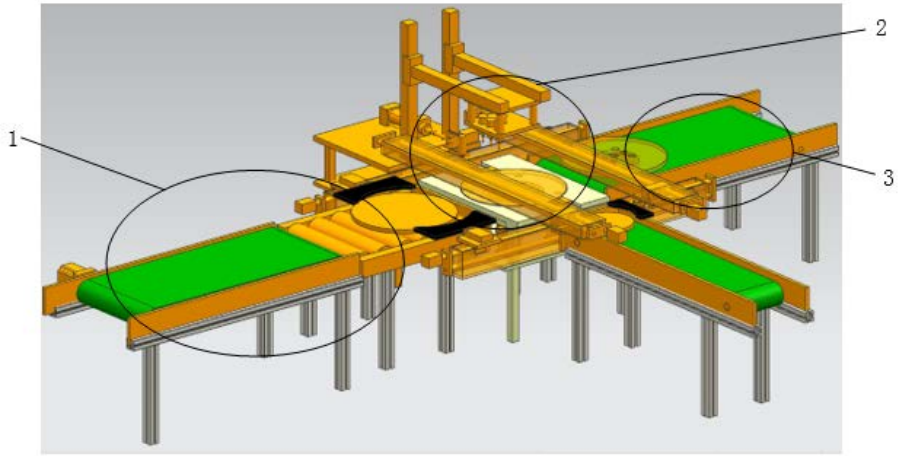
rotating system and a feeding system, as shown in Figure 1. A flat belt, a cylinder and a ball screw are used on the conveying device to realize the transmission of the wooden disc.

In the feeding system, the wooden disc is conveyed by the flat belt rotation, and then the wooden disc is moved to the processing area by the double-rod cylinder and the ball screw; in the drilling system, the drilling kit and the double-line rail slide are used. Cooperative processing of the table; in the rotating system, an electric rotating table is used, which is controlled by PLC[4-5]. In the unloading system, the unloading is carried out in the same way as the loading system.

The working principle of the whole scheme: First, the feeding system rotates flat belt. When the wooden disc is transferred to the specified position, the double-rod cylinder clamps the wooden disc, and the ball screw rotates to move the wooden disc. After reaching the processing area, the double-rod cylinder When loosened, the wooden plate falls to the drilling processing area. Then, the cylinders on both sides of the wooden disc are clamped, and the drill bit goes down to drill. After drilling a hole, start the rotating platform of the rotating system, and repeat the drilling action three times. Finally, after the processing is completed, the wooden disc is supported by the four cylinders below, and then clamped by the double-rod cylinder, and conveyed to the feeding system. In the unloading area, the wooden tray is transported out through the flat belt to complete the unloading action. The above actions can be controlled by Mitsubishi PLC to realize automatic operation [6].



3. Feeding System 2. Drilling System 3. Unloading System

Fig.1 Three-Dimensional Diagram of Equipment

4. Structural Design of the Feeding System

The feeding system is composed of a stepping motor, a ball screw, a double rod cylinder, and a frame. The ball screw is driven by the stepping motor, the wooden disc is transported to the limit slot of the processing table by the feeding device, and the wooden disc is fixed by the clamping device to prepare for the next step of drilling. The positioning device is mainly used to transfer the wooden disc to the middle of the platform. The platform is made of wood, and a circle is milled in the middle with a diameter of 330mm, which is slightly larger than the processed wooden disc and a depth of 15mm.

5. Design of Drilling System

Drilling is an important part of the automatic cutting of cable reels and wooden discs. In this process, the stability and reliability are high. It is necessary to deal with the positioning problem of the wooden plate to prevent the wooden plate from shaking during the processing and affecting the processing quality. Therefore, the wooden disc needs to be fixed during the drilling process, and the equipment is clamped by a pair of double-rod and double-axis cylinders. The drilling system consists of a drilling device, a processing platform, a rotating table and other components.

5.1 Design of Drilling Device

The automatic processing machine for cable reels and wooden reels needs to process a hole with a diameter of 8mm and a depth of 15mm. The double-track sliding table is used to realize the up and down movement of the entire drilling component. The sliding table stroke is 450mm, and two 30*30*400mm aluminum profiles are installed on its platform. A small electric drill is selected on the drilling device. The structure is small and exquisite, suitable for installation in occasions where there is not much space to meet the requirements of the machine. The main shaft of the drilling machine is powered by a DC motor; the working principle of the drilling device is: the movement form of moving up and down through the double-track slide table, and the high-speed rotation of the drill bit is used to realize the function of drilling the cable reel wooden disc.

5.2 Design of Clamping Mechanism

In the process of drilling, the drill bit rotates rapidly and exerts a large force on the wooden disc, which makes the wooden disc unable to maintain the principle position. Therefore, when the wooden disc is punched, the wooden disc needs to be fixed to prevent dangerous accidents and other damages. element. For this reason, two grooves are opened on the processing platform, the width of the groove is 210mm, and a pair of double-rod cylinders are installed in the middle of the groove to make a pair of wooden disc fixtures. The clamping surface of the fixture is arc-shaped and the arc radius is Determined according to the diameter of the processed wooden disc. If the diameter of the wooden board processed by the equipment is 300mm, the radius of the clamping surface of the fixture can be set to 150mm. After completion, it is matched with the cylinder to form a clamping jaw, and the wooden disc is clamped and fastened by the expansion of the cylinder.

5.3 Design of the Rotating System

Since the drilling of the wooden disc needs to be processed on the circumference with the center of the wooden board as the center, the rotation of the wooden board should be realized during the processing. Therefore, a second layer of space is built under the processing platform, a rotating mechanism is placed under the wooden plate, and a small electric rotating platform is installed to support the processing parts and realize the rotation of the wooden plate. The rotating platform is made of wear-resistant materials and has undergone precision processing. It has strong wear resistance, high rotation accuracy, and large load-bearing, and stable movement. It is automatically controlled by a PLC control panel.

6. Structural Design of the Blanking System

The blanking system transfers the wooden trays to the subsequent processing procedures. In the process of unloading, it is consistent with the feeding method. The wooden disc is clamped by an air cylinder and moved to the rear flat belt through the rotation of the screw rod. The only difference is that the wooden disc during processing is fixed in the processing platform by the limit device. To clamp the wooden disc, the wooden disc must first be propped up, so four fixed cylinder accessories are designed. The four opening slots of the fixed cylinder fittings facilitate the access of the cylinder interface from any direction. Put four SC-type cylinders into the fixing parts and fix them on the bottom plate, which can be extended by controlling the cylinders to lift up the wooden discs in the processing area.

When the solenoid valve is energized and the gas enters the cylinder through the trachea, the four cylinders start to operate, propping up the wooden disc, higher than the processing platform, and then clamped by the upper double rod and double shaft cylinder. Therefore, the blanking system uses air cylinders, flat belts, dual-rod dual-axis air cylinders, and ball screws to realize the blanking action. These devices are simple in structure and convenient in maintenance and repair, which can not only meet the needs of use, but also have low manufacturing costs.

7. Static Analysis of Important Parts

Static analysis refers to the analysis of the response of a fixed load to the structure, but this situation does not exist in actual engineering, but the load and response change very slowly with time. The basic steps of static analysis include: model establishment, network division, definition of analysis types, application of loads and boundary conditions, final solution and post-processing.

The most important part of the equipment is the Z-axis screw component, because the weight of the Z-axis screw component is far greater than the X-axis screw component, and the Z-axis screw component is responsible for driving the drilling component up and down to complete the wooden disk drilling. During the drilling process, the Z-axis screw components bear greater cutting force, and at the same time, a higher safety factor must be ensured. The profile supported below the Z-axis screw component is subjected to a relatively large load, and this part of the support profile is taken as the analysis object.

The first is the selection of materials: the analysis part is a profile, and the material of the profile is aluminum alloy. In the finite element software, the material is selected as aluminum alloy, and other parameters are selected as default parameters; after the material is selected, use the ANSYS meshing tool to mesh Divide, use hexahedral meshing, and keep other parameters as default options; the third step is to apply loads and constraints. According to the equipment working conditions, fix the linear module on the applied constraints, and then use 25kg as the load-bearing weight analysis and add them separately Constraints and loads, solution results.

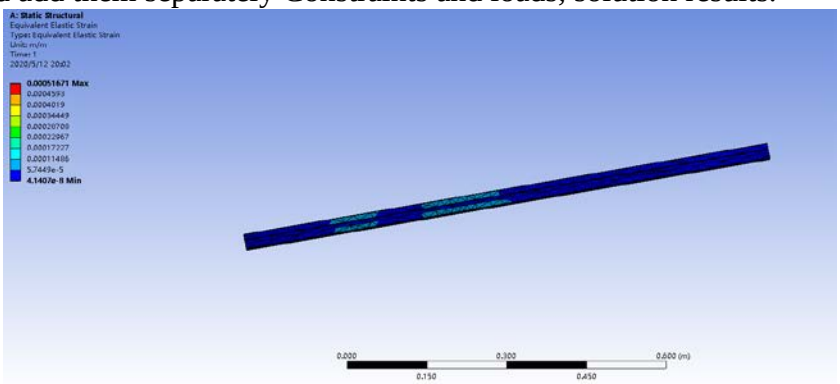


Fig.2 Strain Cloud Diagram of Finite Element Analysis

As can be seen from Figure 2 above, the maximum stress on the profile frame is 2.146×〖10〗^7pa, the maximum displacement is 0.11502mm, and the maximum strain is 5.167×〖10〗^(-4). The selected 6061 aluminum alloy has a yield strength of 55.2Mpa, the maximum stress is far less than the yield limit of the selected material, and the amount of deformation is also less than the allowable value of the material, which will not affect the use. Through the static stress analysis of ANSYS software, the part meets the requirements of all actual work operations, and has a large safety margin, which can ensure the normal operation of the equipment.

8. Plc Control System Design

The equipment control system mainly uses PLC control panel, travel switch, air cylinder and solenoid valve for control. The production line of automated processing is mainly composed of a transfer unit and a drilling unit. The PLC control circuit is mainly the distribution of I/O ports. The input port transmits the operation status and work instructions of the equipment to the PLC system through the input unit. The PLC system passes the control instructions through the output unit after program calculation, work judgment, and signal processing. It is transmitted to each actuator to realize the control operation of the equipment to achieve the desired result.

9. Conclusion

In view of the current poor processing quality of cable reels and low production efficiency, this paper determines the structure and function of the cable reel automatic drilling machine according to the actual needs of cable reel manufacturers, and completes the overall design of the equipment.

It mainly includes the design and three-dimensional modeling of the loading system, drilling system, rotation system and unloading system. The PLC is used to coordinate the operation of the four systems to realize the automatic processing of cable wooden discs. And use ANSYS software to analyze the important parts, verify the stiffness and strength of the parts, analyze the stress of the structure, and get the stress, strain, and total deformation cloud diagram, which ensures the reliability of the equipment.

The cable reel automatic drilling machine is a relatively advanced production equipment in the woodworking machinery industry. It can effectively improve the processing methods of small cable wood processing companies, and convert manual processing to automated processing, which can greatly improve the company's Production efficiency, product quality and reduction of production costs have broad prospects for development in the field of wood disk processing.

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