

Design of Spindle Box for CNC Gantry Milling Machine

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Abstract: With the advance of industrialization process, numerical control technology will inevitably become an important part of the development of all industries in China. The CNC gantry milling machine mainly consists of a spindle box, feed servo system, machine bed, etc. The article describes the design method of spindle in a CNC gantry milling machine system in detail.

Keywords: CNC Technology; Gantry Milling; Headstock

1. INTRODUCTION

1.1 Overview of CNC Technology Development

CNC technology has also played an increasingly important role in the development of some important fields related to the industry and the lives of people, and the numerical control system equipped by these industries has become an important trend in the development of modern industry. Most of the numerical control systems used in China are traditional enclosed structure, which can no longer to adapt the development trend of the manufacturing industry [1]. Therefore, the reform of CNC technology has become particularly important. In terms of market requirements, it is necessary to focus on solving the problems of the reliability and production scale of the CNC system and other related components, so as to make the production scalable and industrialization.

1.2 The working principle and composition of CNC machine tools

The so-called numerical control machine tool is a tool that uses a digital control system to control a machine tool [2]. In the process of machining the workpiece with CNC machine tools, first of all, the size and technical requirements for the dimensions required on the parts drawing should be converted into numerical control programs, that is, that is to write the processing program with the prescribed code and format, and storing it in the machine tool system; Secondly, using the related machine input system to input the programmed instructions into the machine system, that is, the CNC unit. The CNC unit sends out processing instructions to the various systems of the machine tool after the program is translated and driven. The machine parts are machined to finally process the qualified parts we need.

1.3 Mechanical structure of CNC machine tools

The mechanical structure of CNC machine tools generally consists of the following components: ①The main drive system includes the power transmission device and the main movement execution device (such as the spindle, etc.) Its main function is to make the CNC machine realize the main movement. ②The feed transmission system includes Power plant , a clamping transmission device and main movement execution equipment (such as workbench tool holder, etc.) Its main function is to enable the CNC machine tools to achieve feed movement. ③Basic support part. The main function of the basic support is to support the parts and components of the machine tool body, and to make these parts and the position of the component during the processing is accurate. ④The auxiliary system. This system mainly includes the cooling system, lubrication system and the drainage system, etc. Its main function is to assist in the completion of the production and processing process, so that the production process is more efficient and safer. In addition, according to CNC machine tools processing functions and processing needs, some CNC machine tools are also equipped with rotary table automatic tool changer accuracy detection device and monitoring device.

2. DESIGN OF SPINDLE BOX

2.1 Determine the type of motor

The stepless speed regulation devices commonly used on numerical control machine tools are DC or AC speed control motor. The power of DC motor is usually kept constant. It changes the current in the magnetic field by rasing the speed from the rated value to the maximum value to achieve the purpose of changing the speed. AC speed regulating motor is based on the method of adjusting the frequency of power supply. Therefore, in the case of no need of large power, AC motor is usually used. In this paper, suppose that the maximum value of design spindle speed of the machine tool is 4500 r/min, and the maximum value of the cutting power is 5.5kW, so choose the BWSK-8 type AC spindle motor from Jiangsu Baofei Motor Manufactory, the highest speed is 4500r/min [3].

2.2 Determine the structural dimensions of the drive shaft

In the process of determining the structure dimension of the transmission shaft, the carrying capacity required during the production of the product must be achieved, includes the strength and stiffness performance requirements. The strength requirements can ensure that the drive shaft have a high precision in the case of a number of external loads, and a certain stiffness requirement can be made to make a transmission under the action of external force, the shape of the shaft will not change greatly. If the drive shaft can not reach the stiffness required for processing, then in the working process of the CNC machine tool, the parts of the transmission shaft will be greatly changed by the shape of the transmission shaft, resulting in the vibration and noise production, and even the parts produce a large amount of heat, the coefficient of friction increases and reduces the service life of the parts, until the parts are permanently damaged. In the process of determining the structural dimensions of the drive shaft, the

following steps should be taken: ①The minimum value of the diameter of the drive shaft should be determined according to the condition of the shaft subjected to the twisting load. ② Drawing the force and torque diagram of the drive shaft. ③Determine the other geometric parameters of the drive by combining the fit between the various components and their force conditions. ④Check the rigidity of the transmission shaft.

2.3 Estimation of gear modulus

For the estimation of the gear module, tooth number of all gears must be determined in order to avoid undercutting when processing gears. Therefore, the number of gear teeth calculated must be more than 17 [4]. According to the design requirements, the minimum number of teeth in all gears must be z_3' , while z_3 and z_3' are the biggest gear ratios. So take $Z_3 = 20$, $S = 114$, then there is $Z_3 = 94$, the calculation speed of Z_3 is 750r/min.

According to the formula of gear bending fatigue estimation

$$m_w \geq 32_3 \sqrt{\frac{N}{z * nj}} = 2.4$$

Calculated according to the contact fatigue strength estimation formula for gears: $m = 2.84$

Because the diameter of the transmission shaft will affect the operation of the whole equipment, the modulus of all the gears is $m = 3$, so the gear should not only meet the requirement of the gear contact fatigue, but also meet the tooth root bending fatigue strength requirements for the gap between the two-transmission shaft. The number of all gears in a gearshift group is equal, that is, $m = 3$.

3. CONCLUSION

CNC Gantry Milling Machine is a relatively common production equipment in our life. It is of great importance for the production of industrial production efficiency and production automation. The article mainly designed the headstock of CNC Gantry Milling Machine. From the final design results, the designed CNC milling machine basically meets the design requirements of a reasonable and economical structure with high precision.

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