IOP Conference Series: Materials Science and Engineering

Computer Design of Overload Protection Device of Adsorption Automatic Locking Screw Machine

To cite this article: Xiaoyan Zhu and Ziqiang Fang 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **562** 012164

IOP Conf. Series: Materials Science and Engineering **562** (2019) 012164 doi:10.1088/1757-899X/562/1/012164

Computer Design of Overload Protection Device of Adsorption Automatic Locking Screw Machine

Xiaoyan Zhu[1,*] and Ziqiang Fang[2]

[1] School of Mathematics and Computer Science, Jianghan University, Wuhan 430056, China
[2] School of Electromechanical and Architectural Engineering, Jianghan University, Wuhan 430056, China
453527677@qq.com

Abstract. This paper studies the overload protection structure of the single-axis adsorption automatic locking screw machine commonly used in industrial production, focusing on the simulation analysis of the overload protection coupling and the buffer shaft. The computer design requirements and functions of these two structures in the process of product design are discussed.

1. Introduction

Under the impetus of scientific and technological progress, the industrial production level has also made great progress. The industrial production line is constantly developing towards automation and intelligence. In the context of continuous updating of production methods, the factory must carry out reforms and the replacement of products must be sufficient. Profits are the basis, and today's market competition is so fierce. The cost of the products should be reduced as much as possible. The way to reduce costs is mainly for the labor costs that can be mastered within the factory. Equipment cost and management cost are optimized. In some uncomplicated processes, machine equipment is used instead of labor. Although the equipment cost is increased in a short time, in the long run, the machine can work efficiently for a long time and reduce the artificial The loss caused by the error factor reduces the number of workers, which naturally reduces the labor cost, and correspondingly reduces the management cost. The equipment cost can quickly make up for the early equipment cost due to the long-term high efficiency of the machine.

The Auto-Screw driving Machine [1] is such a low-cost, high-efficiency automation device that is suitable for replacing labor. Nowadays, almost all products that require rigid fastening connections on the market use screws [2]. Since the screw installation of many products is irregular in space distribution, the locking action is not simple, because ordinary machines cannot be automated in traditional production lines. Under the demand of production efficiency, the automatic locking screw machine gradually stepped onto the stage.

The current automatic locking screw machine is upgraded with the production mode, and it is becoming more and more intelligent. Now there are robot-related products. At present, the existing screw machine can reach the level of independent operation even if it is unmanned. However, there are still many deficiencies in the front, such as the loss of the bit head due to improper torque when the screw is locked, and the screw sliding [3].

IOP Conf. Series: Materials Science and Engineering **562** (2019) 012164 doi:10.1088/1757-899X/562/1/012164

2. Computer Design of Overload Protection Coupling

Due to the different types of locks, the torque required by the screws under different conditions is different. The difference in output torque can be adjusted by adjusting the voltage of the motor. It can also be changed by adjusting the maximum torque that the overload protection coupling can carry. It can prevent the situation such as slipping caused by excessive torque. Although many overload protection couplings on the market can adjust the limit torque, most types of couplings rotate with the shaft due to the overload protection structure [4]. It is not convenient to adjust the torque. Therefore, the friction plate type overload protection coupling is used. The variable pressure type friction overload protection coupling is designed to change the maximum static friction between the two friction discs by changing the pressure applied to the friction disc, thereby changing the ultimate torque of the coupling. When the screw has been locked, if the motor has not stopped rotating, the two friction surfaces will slip, preventing excessive torque and causing the wire to slip. The main structure of the coupling is shown as Figure 1:

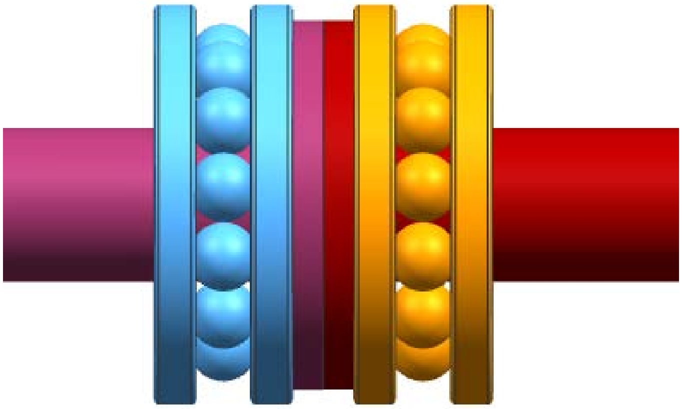

Figure 1. Overload protection coupling

To ensuring the coaxiality of the two thrust bearings and the perpendicularity of the axis and the friction surface, the two shafts should be as concentric as possible in order to make the output shaft jump smaller, so the inner and outer tapered surfaces are designed to cooperate with each other at the center of the friction disc. The design of the two shafts is as following:

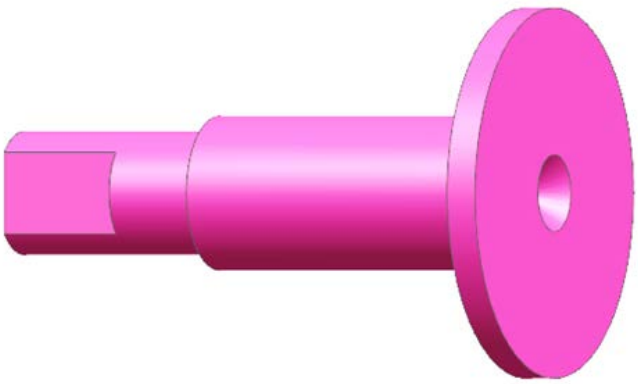

Figure 2. Coupling 1

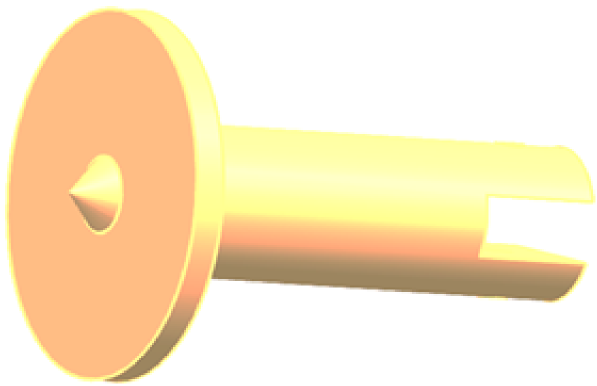

Figure 3. Coupling 2

From Figure 2 and Figure 3, since the electric batch is impacted during the downward locking of the screw, it may cause damage to the thread or affect the equipment. Therefore, the buffer part is designed on the output shaft, and the electric batch part is positioned downward to contact the surface of the equipment. There is an axial movement, as shown in Figure 4:

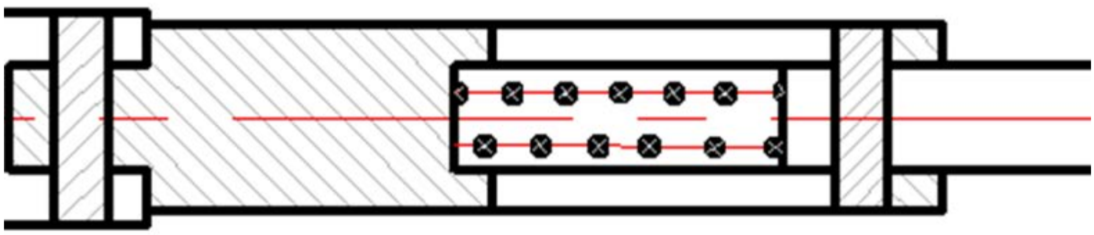

Figure 4. Buffer shaft structure

The buffer part mainly has a buffer sleeve and a buffer shaft. The buffer shaft is fixed in the buffer sleeve by a pin, but can slide along the guide groove, and a spring is placed in the sleeve as an energy storage part, which can weaken the impact and is a buffer part. The key parts and buffer bushings are as Figure 5:

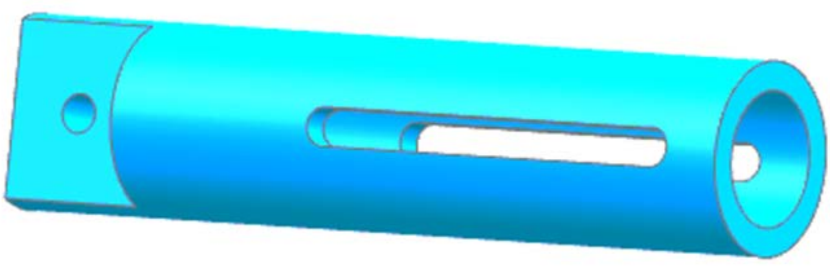

Figure 5. Buffer bushing

3. Buffer Shaft Design

The torsion strength condition of the shaft is:

IOP Conf. Series: Materials Science and Engineering **562** (2019) 012164 doi:10.1088/1757-899X/562/1/012164

$$\tau_T = \frac{T}{W_T} \approx \frac{9550000\frac{P}{n}}{0.2d^2} \leq [\tau_T] \quad (1)$$

The diameter relationship of the common axis is:

$$\mathrm{d} \geq \sqrt[3]{\frac{9550000P}{0.2[\tau_T]n}} = \sqrt[3]{\frac{9550000}{0.2[\tau_T]}}\sqrt[3]{\frac{p}{n}} = A_0\sqrt[3]{\frac{p}{n}} \quad (2)$$

For hollow shafts:

$$\mathrm{d} \geq A_0\sqrt[3]{\frac{p}{n(1-\beta^4)}} \quad (3)$$

The material of the shaft is 40Cr, then:$A_0 = 112 \sim 97$.
For ordinary axes, according to Equation 2:

$$\mathrm{d} \geq 8.34 \sim 6.55 \quad (4)$$

For hollow shafts:$\beta = \frac{d_1}{d} = 0.6$, according to Equation 3:

$$\mathrm{d} \geq 8.88 \sim 7.03 \quad (5)$$

Therefore, the hollow shaft diameter is greater than 8.88mm to meet the requirements.

4. Conclusion

This paper discusses a single-axis adsorption type automatic locking screw machine overload protection device, which is applied in industrial robots. The research result can effectively prevent the automatic locking screw machine from being overloaded, which causes equipment failure.

5. References

[1] An H X, Hong Y, Chao G. Development of Double-Position and Handheld Auto-screw Driving Machine[M]// Advances in Electrical Engineering and Electrical Machines. 2011.
[2] Dieter V, Roland I. Changeover bit for extended life, varied formations and steady wear:, US4690228[P]. 1987.
[3] Gotz B. Mechanical overload protection device for machines, particularly jaw crushers[J]. 1994.
[4] Toyoda M, Sakagami K, Okano M, et al. Improved sound absorption performance of three-dimensional MPP space sound absorbers by filling with porous materials[J]. Applied Acoustics, 2017, 116:311-316.