Mechanism design of MG series bulb automatic packing machine

Di Chen*, Yunxia Wang, and Ping Ni
School of Mechanical Engineering, Nanjing Institute of Technology, Nanjing, China

Corresponding author: 1416787145@qq.com

Abstract. Packing is the last process of product production, the speed of packing to a large extent affects the production efficiency of enterprises. In order to solve a series of problems caused by manual packing, this paper mainly studies the light bulb automatic packing machine, and designs an MG series light bulb automatic packing machine. The packing machine can be used in a variety of types of light bulbs, and compact structure, easy to operate, high degree of automation, can greatly improve the quality and speed of packing, thereby reducing production costs and increasing productivity.

1. Introduction
In recent years, China's production automation level has been increasing, the production and use of automatic packing machine is also increasing. According to this great trend of development, the prospect of automatic packing should be very good. But the opposite is true, and the profits of the automatic packing machine industry have not increased as rapidly as their own numbers. At present, there are not many automatic packing machines for light bulbs put into use on the market, and light bulb enterprises still use manual packing methods almost. In order to speed up the productivity of the product, it is necessary not only to improve the production and processing speed and quality of the product itself, but also to improve the speed and quality of product packaging. The appearance of automatic packing machine can solve the problem of production efficiency, more importantly, it can reduce the production cost in packaging, and can achieve higher quality requirements. There is still a big gap between domestic automatic packing machine and foreign advanced enterprises, which needs to be used for reference.

2. Mechanism design of MG series Bulb automatic packing machine

2.1 Artificial packing process for bulb packing
Light bulbs are fragile products, in the production, transport process cannot have bumps, inverted phenomenon occurred, otherwise the light bulb will be damaged will not be normal use [1]. So in the light bulb packing process, the workers need to pay extra attention. The packing process of the bulb was carried out by a group of four workers, and the work of three workers was: the first worker folded the carton, the second worker tucked into the corresponding number of light bulb boxes, the third worker tucked into the corresponding number of light bulbs, and the fourth worker sealed the cartons. The manual packing process diagram collected on site is shown in the Fig.1.
Fig.1. Manual packing process diagram

The main operation process of manual packing is: Folding carton, bottom with tape adhesion-carton horizontal, the light bulb box at one end of the paper cover, and then put into the box, so that the opening end and the paper cover above, the light bulb and instruction manual into the box, and the opening end of the paper cover, carton vertical, the opening end with tape adhesion.

2.2 Selection of working mode of light bulb automatic packing machine
Packing machine is used to complete the transport packaging, the packaging of the finished product in a certain arrangement and quantitative loading into the box, and the opening part of the box closed or sealed machinery [2]. Select a light bulb box with a single box size of 4cmx4cmx16cm, the corresponding outer box size of 22cmx22cmx18cm, a box can fill the number of single boxes is 25. Determine the packing method: pneumatic manipulator coordinate packing machine, this packing machine is mainly composed of manipulator, programmable controller, stepper motor and so on. The cylinder drive is used to drive the linear motion of two axes or three axes, so as to realize the linear motion on the multi-point coordinates, so as to achieve the packing purpose.

2.3 Workflow design of light bulb automatic packing machine
Each function module of the automatic packing machine is a separate mechanical equipment, The working flow chart of the light bulb automatic packing machine is shown in the Fig.2

3. Design of automatic lamp packing machine body
The main content of the body design scheme is to take two parallel tracks [3], the carton conveyor chain and the box conveyor chain are located in two tracks respectively. When the lamp box and cartons are to be boxed, the pneumatic manipulator moves to the box to be packed, drops to crawl, then rises, and finally transports the bulb box to the carton packing station, descending will crawl the box to send people to the packing station box. As shown in the Fig.3.
The material entry and exit direction of the light bulb automatic packing machine is left in right out which are shown in the Fig.4 and Fig.5.

3.1 Manipulator Design
Manipulators are generally made up of grippers and connecting drive parts. The most important of these is the structure of the gripper, the choice of gripper to conform to the shape of the object being caught. Because the surface of the light bulb outside the box cannot guarantee enough smoothness, and because of the paper material of the box, so that the surface of the box is uneven, so the bulb box crawl using a clamping gripper. The grip clamping area is the end of the box at both ends of the flip. And the clamping gripper has the category, according to the hand movement form, has the return transformation and the translation type. The main difference between the two is that the rotary structure is simple and easy to manufacture, and the translation structure is complex. Therefore, the grasp of this topic is designed to return to the transformation of the hand.

In order to make this clamping gripper suitable for a variety of light bulb packaging box, gripper finger set into a rectangle, and the inside of the finger with anti-skid measures [4], so that you can increase the grip between the gripper and the box between the friction, to prevent the box from falling off, resulting in damage to the light bulb. Manipulator size design as shown in the Fig.6.
According to the figure, the manipulator by 5 pairs of gripper, can realize the process of 5 boxes at a time. The manipulator as a whole is fixed on the lifting plate by the side plate on the left and right sides. The realization of manipulator grabbing box action is realized by cylinder drive. The light bulb automatic packing machine gripper is shown in Fig.7.

In order to ensure that the gripper work independently, the design gripper width of 2.2cm, the two ends of the gripper at work is equal to the two ends of the box. The thickness of the upper part of the gripper is designed to be 1cm, and the thickness of the lower part is designed to be 2.2cm. The main body of the manipulator is composed of vertical shaft 1, gripper connecting Plate 2 and 3, Gripper 4 and 5, connecting transverse axis 7 and vertical shaft tube 1. Vertical shaft 1 is the input of motion and power, that is, the original moving parts, components 2, 3, 4 and 5 are actuators. When the vertical shaft 1 moves up and down, the output member is driven to do planar motion. The degree of freedom of the institution f=3x3-2x4=1. As shown in the Fig.8.
3.2  **Linear reciprocating mechanism**

The requirement of light bulb automatic packing machine for horizontal linear reciprocating motion is fast moving speed and accurate positioning. Because the carton has a certain gap relative to the box, so the use of linear guide rail plus slider can be used, and for the manipulator up and down the straight line movement using chain drive, the driving mechanism using cylinder drive [5]. The components of the design horizontal linear reciprocating mechanism are cylinders, linear rails and sliders (connected to cylinders). The linear guide rail is fixed on the workbench, the slider is connected to the driving mechanism, that is, the cylinder, and there are two adding finite position bodies on the linear guide rail to limit the limit position of the slider movement. Pneumatic cylinder drive horizontal linear reciprocating mechanism as shown in Fig.9. The mechanism designed to drive the upper and lower straight line reciprocating motion is the rotating cylinder, and the main transmission member is the active shaft. The manipulator is fixed on the lifting plate as a whole, when the cylinder starts, the active shaft rotates, the active shaft drives the chain rotation on the active gear and gear, the chain is connected with the chain side plate, and the side plate and lifting plate are connected again. In this way, the upper and lower motion of the manipulator can be realized. Pneumatic cylinder drives up and down straight line reciprocating mechanism as shown in Fig.10.

3.3  **Pressure box Design**

The carton used for light bulb packing is corrugated box [6]. Corrugated box is made of corrugated cardboard rigid paper container, is one of the most widely used packaging products, dosage has been the first of a variety of packaging products, with a high strength. Cartons in the transport and packing process to show the carton cover, carton sealing plate upward state, and this in the packing will greatly affect the quality of the packing. When the light bulb is boxed, the carton's sealing plate will block the normal drop of the bulb box or affect the normal entry box of the bulb box. Therefore, considering the quality and efficiency of the packing, a pressure box device is designed to fold and fix the carton cover and sealing plate outward, to ensure the smooth completion of the packing process, and to improve the packing efficiency. Light bulb automatic packing machine pressure box device structure is: in the manipulator around the addition of paddle, when the manipulator drop will be the lamp box into the carton, the paddle with the manipulator down to rotate a certain angle, so that the box cover and sealing plate tilt outward, to ensure that the lamp box smoothly into the box. As is shown in the Fig.11.
4. Design of conveyor Chain

Calculation of life of deep groove ball bearings: (1) Because the main bear radial load, the selection of deep groove ball bearings. (2) Bearing model 6205, check the relevant statement: \( Cr =14000N, C_{0r} =7880N \). (3) Calculate equivalent dynamic load \( P \). The bearing is subjected to radial loads \( Fr=1800N \), axial loads \( Fa=100N \). Using interpolation method to find \( e=0.198 \). Check the relevant table to \( X=0.56, Y=2.22 \). Axial elastic retaining ring to be matched with the active shaft, and the diameter of the shaft \( d_0=25mm \), you can choose A-type shaft with elastic retaining ring, check the relevant table can get the basic size of the retaining ring for \( D=23.2mm, s=1.2mm, b\approx3.32mm \).

Ordinary V-belt is usually used as a transmission device with friction belt. Section size with top width \( b=13mm \), width \( b_p=11mm \), height \( h=8mm \), wedge Angle \( \phi =40^\circ \). The width of the band is equal to the length of the roller bus.

5. Conclusion

Design this MG series of light bulb automatic packing machine, the packing machine can be applied to a variety of types of light bulbs, and compact structure, easy to operate, high degree of automation, can improve the quality and speed of packing, reduce production costs and improve production efficiency. Because of my limited ability at present, it is not good for stress analysis, which is the place to be optimized later, but it's a good idea and will try to make it better.

6. References

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