Design and Implementation of Automatic Assembly Mechanism for Bushing and Pin of Shifter DQ GEN 2

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Abstract. By analyzing the assembly process of the bushing and pin, an automatic assembly mechanism for bushing and pin of Shifter DQ GEN 2 is presented with assembly mechanism for bushing, grease smearing machine (grease smearing machine for bushing, grease smearing machine for shift lever cage, grease smearing machine for the hole), assembly mechanism for pin as main parts. This machine uses PLC and touch screen as control core, which has achieved the assembly automation on assembly process of bushing and pin in shifter unit, improved automation level and production efficiency, reduced rejection rate.

1. Preface
Automobile gear shifter is an important part of automobile control system. The comfort and reliability of the operation is very important. People's requirements on the quality of the shifter are also increasing year by year. Therefore, more and more attention has been paid to the manufacture of shifters.

Figure 1. Shifter semi-finished product schematic
Figure 2. Finished product

The shifter is mainly composed of outer shell, inner shell, base, pull rod, shift lever cage, bushing. The shifter is shown in Figure 1. The shift rod is fitted with a plastic cylindrical pin. The pin has a spring at the bottom. This method ensures that there is elastic contact between the pin and the guide groove. Guide groove and pin cooperate to realize the function of car shifting. Guide groove’s working area has a plurality of grooves in its surface area. And there is a one-to-one correspondence between grooves and gears. When the driver performs the shift operation, the head of the pin slides...
along the working area on the surface of the guide slider and enters a certain groove so that the car enters the corresponding gear position.

For the assembly process, the factory still employs manual press-fitting methods. This leads to uneven quality of the product. Therefore, it is very important to develop an automatic production equipment and improve the current manufacturing process.

2. Design of automatic assembly mechanism for bushing and pin of Shifter DQ GEN 2

The overall layout of the station is shown in Figure 3. The station consists of four parts: shelf, implementing mechanism, bin and electric control box. Implementing mechanism is divided into three parts: grease smearing machine, assembly mechanism for bushing and assembly mechanism for pin. The device can achieve the positioning, greasing and assembly. The electrical components are centrally installed in the electric control box. It completes all control functions of the station. The station is equipped with parts bin. It has a material missing reminder function to ensure that the product is accurate and reliable.

![Figure 3. Station diagram](image)

In the assembly process of bushing of shifter, the operator needs to apply a large axial force to both sides of the sleeve at the same time. It is more difficult to rely on workers to complete it manually. In the grease process, in order to make the grease evenly applied in the correct position, the workers needs to be kept attentively at all times. The effect of smearing grease is affected by the operator's proficiency. During the installation process, assembly is more difficult due to the small size of the pin. In order to achieve automated assembly, we designed multiple devices that are relatively independent. The process is shown in Figure 5.

![Figure 5. Process flow diagram](image)

Assembly process is described below. First put the bushing and shift lever cage into the grease smearing machine. After the sensor detects the parts, the program starts the grease valve to complete greasing of the bushing and shift lever cage. The shift lever cage and electromagnet and the pull rod are installed by the workers manually. After the parts are installed, place them in the device. Then put the bushing into the positioning hole. After the sensor detects the part, the worker presses the two-hand switch to achieve the bushing press-fit function. Then put the installed parts in the assembly
mechanism for pin. Put the pin in the mechanism and press the button to complete the pin assembly operation.

2.1 Design of grease smearing machine

The grease used by the car shifter is a kind of special grease which belongs to the category of dry oil and has little fluidity in the natural state. Therefore, it is necessary to design corresponding mechanism to exert the necessary flow power. In order to realize the quantitative oil injection, the lubricating grease measurement function was added in the system for reference in the literature [1].

The lubricating grease conveying and the quantitative mechanism are mainly composed of electric lubricating pump, overflow valve, filter, pressure regulating valve, quantitative valve, and corresponding pipe fittings, etc. Figure 6 shows the schematic diagram of its structure.

1) Electric lubrication pumps use the principle of a plunger pump. The pressure required for the flow of grease is generated by components such as motors and fuel tanks.

2) The overflow valve is used to set the maximum pressure of grease conveying and quantitative mechanism.

3) The filter is used to filter the impurities in the grease to prevent the pipe from clogging.

4) The pressure regulating valve is used to set the working pressure of the valve.

![Figure 6. Grease smearing system](image)

(a) Grease smearing machine for shift lever cage  
(b) Grease smearing machine for the hole  
(c) Grease smearing machine for bushing

Figure 7. Grease smearing machine

The grease smearing machine is shown in Figure 7. The main bracket oil injection mechanism consists of a main bracket oil injection positioning fixture, an in-position sensor, and a dosing valve. The operator put the shift lever cage into the grease smearing machine. The sensor detects the parts in place and then the quantitative valve is started. Automatically grease at specific locations; The grease smearing machine of bullet hole is composed of grease device, guide cylinder and quantitative valve. The position sensor detects that the workpiece is in place and the guide cylinder drives the grease
injection tooling into the bullet hole. Then the quantitative valve is activated to realize automatic grease function. The grease smearing machine for shift lever cage is made up of the oil filling position, the sensor and the quantitative valve. The worker put the bushing into the grease smearing machine for bushing. After the sensor detects the parts, the quantitative valve is started to realize accurate three-point grease. In order to ensure the accurate and reliable grease position, the grease device and positioning device are designed into one body. The accuracy and consistency of the grease position are ensured.

2.2 Assembly mechanism for bushing

The assembly mechanism for bushing is composed of two pressure mounting devices and positioning tooling. First, the operator puts the finishing piece of the last station into the assembly mechanism for bushing. The sensor detects the work piece in place and completes the RFID reading function. Next, the operator put the bushing into the positioning hole of the assembly mechanism. The assembly function is realized by the cylinder and the negative pressure generator. In order to keep the bushing from falling, negative pressure can be generated in the hole where the bushing is placed. In this way, the bushing is firmly attached to the hole. The operation worker presses the switch with both hands, the cylinder starts to complete the pressing operation, and the bullet hole is injected with grease. This kind of assembly mechanism with vacuum generator can effectively solve the problem of bushing shedding and positioning. The assembly mechanism can be used to install both sides of the axle sleeve, reduce the operation steps and improve the production efficiency. The assembly action can only be activated when negative pressure is detected on both sides of the negative pressure sensor. This design ensures the operator's safety and reduces the probability of misoperation. The assembly process of the station is controlled by PLC and touch screen.
2.3 Assembly mechanism for pin

The assembly mechanism for pin consists of the guide rod cylinder press device, the flexible positioning equipment and the o-ring detection device. The operator puts the parts into the flexible positioning tooling. The sensor detects that the workpiece is in place. O ring detection device to detect whether the o-ring is installed in place. There will be alarm if not installed. The pin is put into the assembly mechanism by the operator. The screw in the device will jam and locate the pin. The operator pushes the switch, pressing the handle to realize the assembly of the pin. Only after the switch is pressed in this design, the guide bar cylinder can be manually pressed. The cylinder does not automatically descend, the cylinder does not have downward force. In this way, it can ensure the safety of the operator. The assembly mechanism has high reliability and low cost.
3. Conclusion
The general scheme of automatic assembly mechanism for bushing and pin of Shifter DQ GEN 2 was determined by analyzing the demand for automation upgrade. A new kind of assembly mechanism for bushing, grease smearing machine and assembly mechanism for pin was designed. The whole assembly process is controlled by PLC and touch screen. The development of assembly mechanism for bushing and pin of Shifter DQ GEN 2 is completed. The assembly mechanism is in good condition during commissioning and meets the design requirements. After enterprises use equipment, they reflect that the equipment is stable and reliable. The function of assembly and grease was realized. The quality of the shifter has been improved, and the automation level and production efficiency of the factory have been improved.

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