

Design of automatic assembly device of automobile power connector

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Abstract: *Automobile power connector is a very important workpiece in the automobile. Its quality determines the safety of the automobile. This paper makes a comprehensive analysis of the automobile power connector assembly and the detection equipment, so that the machine can be operated in accordance with the manufacturer's requirements, and to optimize each step so as to get the qualified products.*

Keywords: *automotive power connectors; automatic assembly device design; assembly; testing equipment*

1. Introduction

In view of the present situation that the automation degree is not high enough and the efficiency is low, carries on the automobile connector automatic assembly control system design, uses the PLC as control core, it uses solenoid valve to control cylinder to make each work station move, monitors the production condition through touch screen, adjusts the machine, and gives an alarm when the machine breaks down and displays the alarm information on the touch screen, facilitate the operator to carry out troubleshooting. Another important aspect, because the reliability and consistency of its operation can effectively improve product quality, enterprise theory and industry competitiveness has been greatly improved.

2. Necessity of automatic assembly device design of automobile power connector

Close collaboration often requires a wide variety of parts, in which car connectors play an important role. Whether it is the traditional cars or the new energy vehicles, the analysis of the traffic accidents has found that many traffic accidents are caused by the poor contact with the connector. Car power supply is a very important part of the car, the car needs it to start, the use of electronic equipment in the car needs it, and the car power connector is the bridge between the power supply and the car, in this case, the quality of the connector has become the focus of manufacturers.

Some modern enterprises still use manual workpiece assembly and manual plug gauge method for detection, this way is long and may be because of the fatigue of the human body detection results is not accurate, low production efficiency, product quality is not guaranteed, so according to the requirements of the enterprise to manufacture the corresponding automation equipment has become the trend of The Times. Automobile connector automatic assembly device belongs to a miniaturized device, different from the large production line, this miniaturized assembly equipment needs to consider many practical factors. For example, a professor at the University of Tokyo in Japan has developed an automated assembly technology for small parts, which combines many small parts together for ^[1] by using the "self-organization" of the parts. At present, the automatic assembly technology has developed rapidly in the field of large equipment assembly, but the assembly process and technology of small products and small equipment are very lacking. Therefore, we should accelerate the research and application of related technologies, and promote the common development of ^[2] of automatic assembly in multiple fields.

The design of the automotive power connector assembly automatic control system will be able to solve the characteristics of the low level of automation and the low efficiency of the troubleshooting mechanism existing in the current industry. Through intelligent control of control and monitoring system, labor can be liberated from heavy and repetitive manual labor. Using highly automated

assembly equipment can not only improve production efficiency, but also greatly improve product quality. On the one hand, the automatic assembly greatly improves the production efficiency. Another important aspect, because the reliability and consistency of its operation can effectively improve the product quality, the theory of enterprises and the industry competitiveness has been greatly improved.

3. Workpiece assembly and design

This part of the vibration plate for feeding, vibration plate is an automatic assembly or automatic processing machinery auxiliary feeding equipment. The vibration plate is controlled by the controller to vibrate at a certain frequency. Due to the action of the vibration and the rise of the vibration plate along the spiral rib support plate, the workpiece enters the next process [3] according to the specified requirements, as shown in FIG. 1. Later, the vibration of the flat vibration track is controlled by the controller to drive the workpiece forward, send the workpiece to the track where the claw is located, and drive the workpiece through the claw, as shown in Figure 2.



Figure 1: Vibrating plate material supply

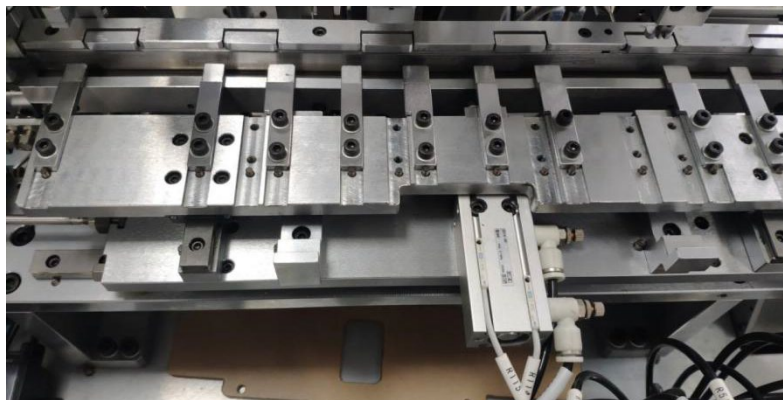


Figure 2: Claw dialing movement

The plastic body and the plug board continue along the flat vibration track to the designated position. The manipulator passes through and supports the center of the plug board, brings the plug board up, and the manipulator moves through the slide track and puts the insert board into the plastic shell. There are left and right limits on the track. In order to consider the safety, the action of the manipulator will generally not exceed the left and right limit. If the machine reaches the limit, it should be reset through the reset button to make it operate normally. The workpiece moves to the next step, the bottom of the machinery has the same size of the plastic shell as the metal plate as shown in Figure 3, the metal plate pressure, make the plastic body plug plate tight, complete the workpiece assembly, through the touch screen workpiece pressure adjustment, the upper sensor to protect, to prevent the

damage caused by excessive pressure into the workpiece.

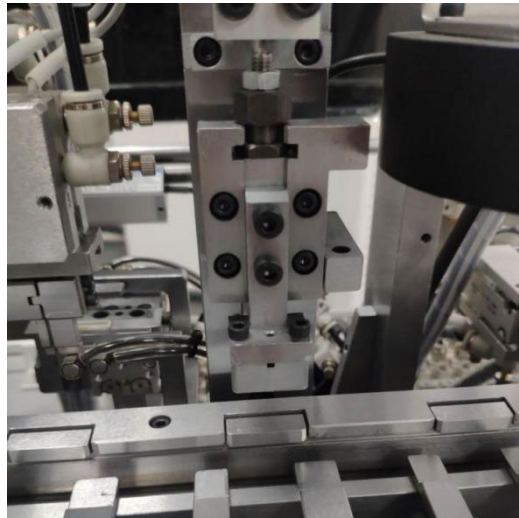


Figure 3: Workpiece pressure-in

The power source of the device is mainly selected in pneumatic transmission and hydraulic transmission, we use liquid as working medium to drive, called hydraulic transmission; gas as working medium to drive, called pneumatic transmission. And the hydraulic transmission is generally used in high-power occasions, for our equipment is a little overqualified, and the hydraulic price is expensive relative to the air pressure, the cost is higher, does not conform to the law of the industry for the cost. At the same time, the efficiency of the pneumatic transmission is higher than the hydraulic transmission to improve the equipment efficiency. In addition, the working medium of pneumatic transmission is air, inexhaustible. Gas is not easy to block the flow channel, after using it can be discharged into the atmosphere at any time, do not pollute the environment. The characteristics of the air are less affected by the temperature. It can work reliably at high temperature without combustion or explosion; and when the temperature changes, the viscosity of the air influence is minimal, so it will not affect the transmission performance. Compared with the hydraulic transmission, the pneumatic action is fast, fast reaction, generally only 0.02~0.3 seconds can reach the working pressure and speed. Pneumatic components have high reliability and long service life. Electrical components can run one million times, while pneumatic components can run 20 million to 40 million times. The pneumatic unit is simple in structure, low in cost and easy for maintenance for^[4].

4. Workpiece testing and design

After the assembly of the workpiece, the quality of the test product should be tested. Here, CCD is used to detect the workpiece for damage, and the high-precision digital sensor is used to press into the height of the test^[5]. The test part distinguishes the products into good products and bad products, namely OK products and NG products. If there is a problem with assembly, NG and counted in the touch screen.

Because the plastic body (HSG) is a hollow product, the workpiece may be squeezed during the feeding or compression process of the workpiece, so the plastic body needs to track through the CCD camera detection. If the workpiece is damaged, it will not be detected in all the testing steps. The CCD is the industry-standard appearance detection tool. We need to select the camera according to the detection content, the selection criteria are three points: (1) flaw detection: the tool can detect defects and stains compared with the surrounding concentration grade, but also only the size, concentration, shape, number of small foreign bodies in the inner side and bottom of the container, the foreign body in the previous binary treatment near the darker part of the container, so it cannot be detected. Defect detection mode can ignore the concentration and light difference, only stable detection of foreign bodies.(2) Trend edge defect detection: the best suitable for burr / defect detection; the tool can extract the contour from the edge of the workpiece and identify the contour as burr / defect^[6]; with the edge information of up to 5000 points, support not only circle or line detection, but also the detection of complex shape profile composed of ellipses or free curves.(3) Linear defect extraction: this treatment can exclude the interference information within the detection range, and only presents the linear information. The following figure shows the metal workpiece. In the condition of the rough and uneven state on the workpiece surface, the linear defects can be tested.

After the CCD camera detection is completed, the next step is advanced. High-precision contact digital sensor is used to detect whether the plug board insertion meets the requirements. The accuracy is 0.01mm, which can be accurately detected. Many typical contact sensing heads use pulse counting methods, and the target object may miss the data when moving at high speed. But KEYENCE uses a binary transformer to track the absolute position of the contact object, eliminating skipping (missing) data. All use Keens this high-precision contact digital sensor, the sensor head is fixed, to extend the spindle through the air pressure, when the spindle reaches the work piece to release the air pressure to make the spindle contraction, so as to get an accurate number, and compared with the given value, to measure whether the product meets the requirements. If it is not met, the subsequent steps will not detect it. The detection device is shown in Figure 4.

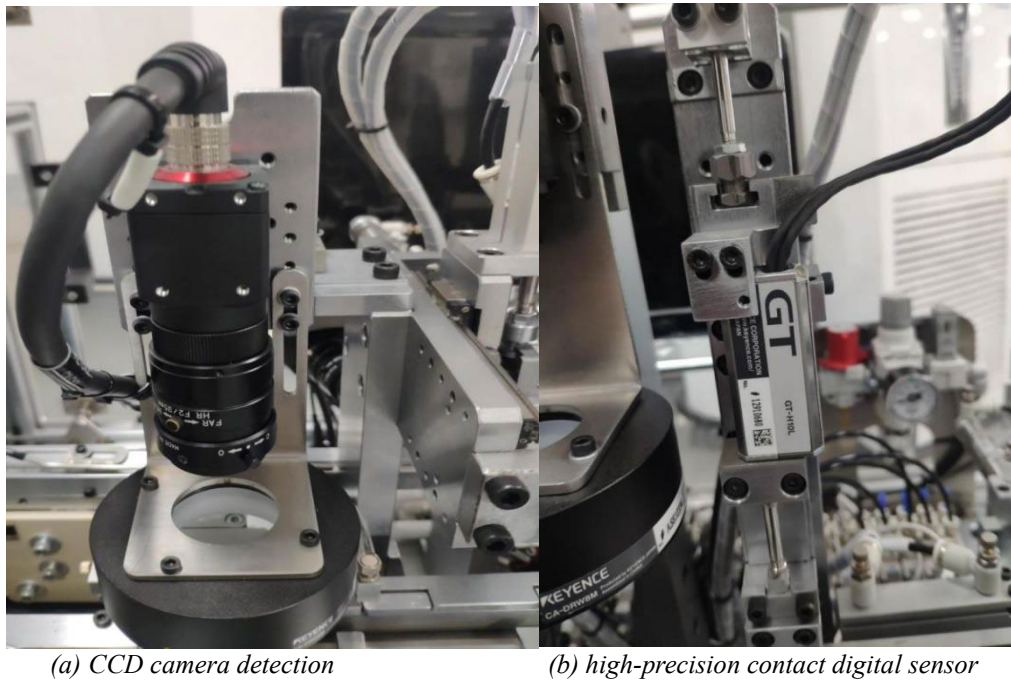


Figure 4: Detection device

5. Product collection device and public station status expression

After the test, distinguish the distinction between good and bad products, that is, OK products and NG products, NG products through the track and fall directly into the waste box, OK products are pushed into the slide. Enter the packing machine through the slide OK product, and set the photoelectric sensor in the slide to count. The packing machine uses a cylindrical bucket to collect, a total of six long buckets, the number in the bucket is set, when the specified number of products in a bucket, the bucket is switched. The button box of the packaging machine is set at the upper corner edge, and the button light (green light) will flash if there is a full memory in the # 2-6 barrels. After replacing the 2-6 lamp bag, press this switch, reset the charging memory of the 2-6 lamp (but limited to the lamp 1, not reset), the reset lamp out, for safety, do not turn when opening the door. After off, normally set to stop when the capacity reaches 600 (no need to reset the switch by the packing machine). If the safety door of the packaging machine is opened, the discharge blocking cylinder will block the subsequent feed, accumulate more than 5, and will automatically stop during the second to fourth cylinder filling period. The three-color lamp (yellow light) will always flash as the buffer time for the continuous replacement of the bag. The aggregator Packer is shown in Figure 5.

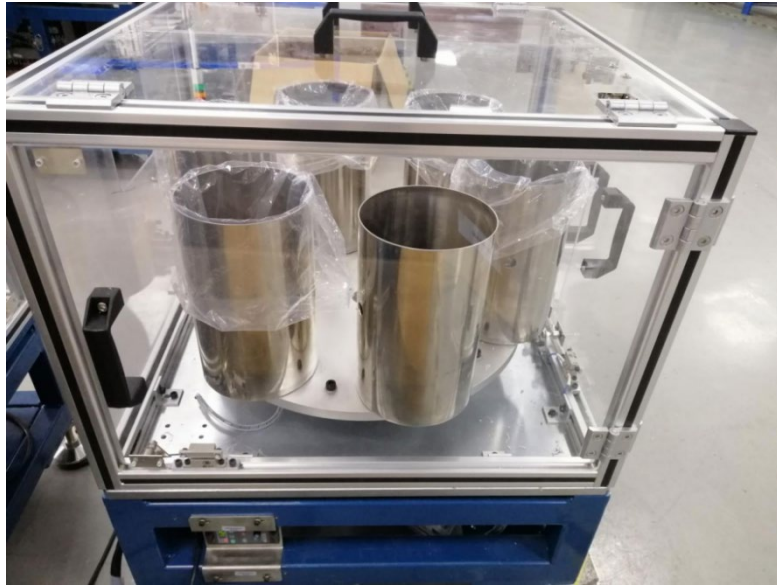


Figure 5: Gathering Device packing machine

Generally speaking, the first station of an automaton has only three states: not working, after processing, NG products, the intermediate station should have four working states: not working, before processing, after processing, NG products, the last station should only have three working states: not working, before processing, NG products. Encoding principle, as shown in Table 1, is the working state memory storage representation of the 8-station disk group installation. The advantage of this representation is that according to the state memory memory of each station, it can accurately determine which process of the product is caused by NG, which is very conducive to the tracking and accurate count of bad products.

Table 1: Engineering Station Status Expression and Transfer

workstation	storage area	No products	Before processing	After processing	Process NG	blowdown NG
ST1	D401	0		1	100	99
ST2	D402	0	1	2	101	99
ST3	D403	0	2	3	102	99
ST4	D404	0	3	4	103	99
ST5	D405	0	4	5	104	99
ST6	D406	0	5	6	105	99
ST7	D407	0	6	7	106	99
ST8	D408	0	7		107	99

6. Product hardware design

In the hardware design, the KV-N60AT model PLC is adopted, and according to the design requirements, the expansion input unit KV-N16EX is also used, and the output expansion module KV-N16ET is used. Compared with other PLC, the advantages of Keens are as follows: equipped with large capacity high speed RAM and FPU (floating decimal point type real number operation unit), the LD instruction through the 32 bit main CPU, realizes the processing time of 50 ns. Full fully in devices requiring high speed processing, perform 3k steps for 0.3 ms. The scan time bias was successfully suppressed by adjusting the processing while monitoring the scan. When running with a fixed scan time, the deviation can be suppressed below 10 μ s to reach the level of large PLC. And Kez is very good in visual detection, with the components needed for our equipment.

The device uses the PLC element output by the transistor. The transistor is an electronic element, which controls the conduction of the collector and the emitter through the base electrode current, which is a contact-less element. Compared with the relay output mode, their response time is relatively slow (about 10ms-20ms), the transistor response time is faster (about 0.2ms-0.5ms); the service life is also different, because the relay is the mechanical element is limited by the number of actions, and related to the load capacity, with the increase of load capacity, the contact life is almost reduced by series,

while the transistor is the electronic original, only aging, no service life limit. The transistor output drive current is small, high frequency and long life, which is suitable for controlling servo controller, solid state relay and other applications with high frequency and long life. For the continuous operation of the equipment, the PLC [7] output from the transistor shall be considered from all aspects. In addition, the main hardware used are solenoid valve, touch screen, CCD camera, high-precision digital sensor, sensor, speed governor, intermediate relay, switch power supply, circuit breaker and so on.

7. Circuit design of the products

The product introduces 220V voltage as the main circuit voltage, with leakage protector, fuse, small circuit breaker protection, when the current in the circuit exceeds the circuit breaker rated current automatically jump off the circuit protection, QF2, QF3 for vibration plate protection, QF4 to protect the collection device packaging machine. A filter is connected to the circuit to effectively filter a specific frequency point or a frequency other than that frequency point in the power cord to obtain a power supply signal of a specific frequency. Use the intermediate relay to control the opening and breaking of the vibration plate to protect the PLC output port and prevent the damage to the PLC output terminal due to the long-term large number of opening and closing. Main Circuit 1 is shown in Figure 6.

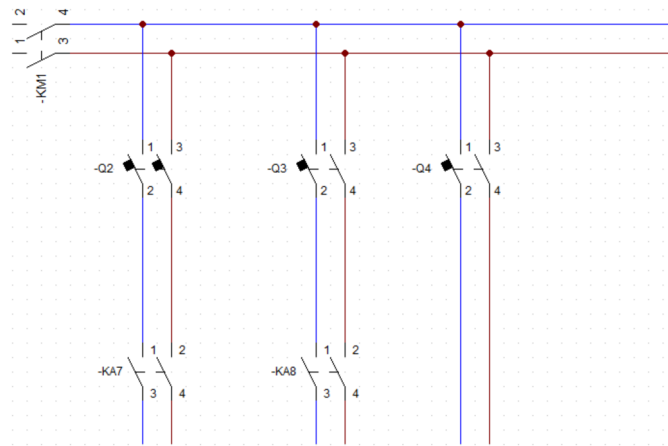


Figure 6: Main circuit 1

From the main circuit two access switch power, QF5, QF6 to the switch power protection, when the circuit in the fuse in the fuse in the circuit disconnected circuit to protect the circuit, the switch power will 220V ac power into 24V DC power, provide power for control circuit, and access small circuit breaker and fuse to protect the line, to achieve the purpose of safe production. Main Circuit 2 is shown in Figure 7.

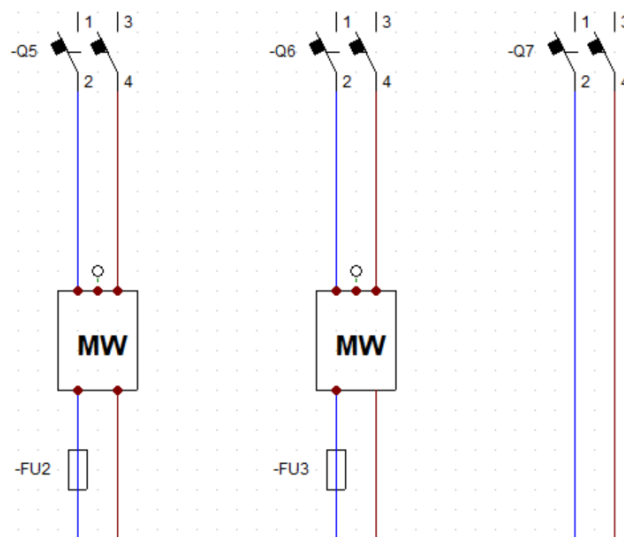


Figure 7: Main Circuit 2

The design of the control circuit is as follows: the 24V DC power supply converted by the switching and switching power supply energizes the touch screen, uses the touch screen to adjust the equipment parameters, and count the number of products, etc. Install the emergency stop button to stop the machine to protect workers. The 24VDC supplies the three-color lights and a buzzer. The three-color lamp includes three colors of red, red, yellow and blue. When the light flashes as red, it indicates that the equipment is abnormal and alarms through the buzzer. The abnormal situation is divided into emergency stop is pressed, the safety door is opened, the air source is low, the cylinder motion monitoring timeout and the equipment is not ready. When the light flashes yellow, the device is normal and in a waiting production state. The device is in production when the light flashes green.

The I / O allocation of PLC is as follows: a line is divided from the main circuit to power the PLC, 24VDC supplies power to the input point, the input point R000-R011 is connected to: the emergency stop signal, the equipment provides power by air pressure transmission, and the pressure switch is connected to detect the air pressure. Two alternate selectors are used for hand / automatic switching. Access the PBL4 automatic button and run the machine automatically when the debugging is completed. Other access to stop button, reset button and material cleaning button respectively.

HSG and S / R are two different workpieces, HSG is a black plastic body, while S / R is a white plug board. Input point R012-R111: HSG incoming sensing signal, S / R incoming sensing signal, HSG flat vibration filling signal outgoing detection signal, S / R flat vibration filling signal, flat vibration mixture detection signal and HSG dislocation origin and moving point. The most important thing is the amplifier unit, which is used in combination with a high-precision digital sensor to access the S / R height detection signal for subsequent height detection. These input points are connected to the sensor, the sensor signals the PLC, and the PLC moves the cylinder by controlling the on-off of the solenoid valve. When the material is full, the flat track is full of material, and the signal is transmitted to the PLC. The PLC sends the signal to the controller to reduce the vibration frequency, and reduce the workpiece drive on the flat track. The dislocation origin and the moving point control whether the machinery is moving, the position of the origin is the position when the cylinder is not moving, and the moving point signal is our working position, the origin and the moving point are adjusted and then the limit position is placed. The origin and moving point should be used in the program to control the solenoid valve and the cylinder driving mechanism.

Input point R112-R203: paw point and origin signal, paw point and origin signal, channel sensor signal, S / R dislocation origin and moving point signal, access sensor to control the on and break of the solenoid valve cylinder action. These sensors are used with solenoid valves and cylinders for touch screen adjustment of the machine. When taking the workpiece is made, the origin and the moving point position should be fixed through the touch screen, and the clip action is made when the moving point position is reached.

Input point is not enough to increase the expansion module PLC2 unit, input point R1000-R1015 connection: S / R claw moving point and origin signal, S / R lifting origin and moving point signal, S / R horizontal moving point and origin signal, HSG positioning origin and moving point signal, S / R pressure moving point and origin signal, height detection moving point and origin signal, dot moving point and origin signal. Access the sensor to control the opening of the solenoid valve to move the cylinder. These sensors are used with solenoid valves and cylinders for touch screen adjustment of the machine.

24VDC supplies power to the output point, output point R500-R511 connection: origin reset signal, automatic button signal, stop signal, reset button signal, clear button signal, safety door signal, abnormal signal, three-color lamp and buzzer signals, using different color with light button connected easy to distinguish. When the machine is wrong, adjust it quickly and put it back into production.

Output point is not enough to increase the expansion module PLC5 unit, output point R5000-R5015 is connected to: HSG dislocation signal, claw signal, claw signal, S / R dislocation signal, S / R claw clip signal, S / R lifting signal, S / R transverse shift signal. These signals are connected to the solenoid valve, respectively. The SV (cylinder) and the solenoid valve are connected through the trachea to power the entire system. The corresponding mechanism moving point origin signal from the PLC to the solenoid valve and control cylinder action.

The output point is not enough to increase the expansion module PLC6 unit, the output point R5100-R5115 connects: S / R pressure in signal, height detection signal, hitting signal, output dislocation signal, discharge signal, discharge signal, HSG positioning signal, feed blocking signal, HSG flat blowing signal, HSG circular blowing signal, S / R flat blowing signal, S / R circular blowing

signal. These signals are connected to the solenoid valve, which controls the cylinder through the trachea, and which acts when the solenoid receives the corresponding signal action.

8. Conclusion

Cars are mainly composed of different parts, and the assembly of auto parts has become very important. Many manufacturers still use manual assembly, which will undoubtedly greatly increase the production costs, and the limitation of human energy may lead to reduced production efficiency, and the quality of the assembly products will also be discounted. On the other hand, due to the impact of the epidemic, factories are places where people gather, which can easily cause large-scale diseases. Automatic assembly solves a lot of problems, the production efficiency will not be reduced, and each automation equipment will not require many personnel, will not produce aggregation phenomenon.

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