Development of a workpiece transfer machine based on a gas-electric hybrid system

Qiang Gu1*, Wenxing Wang2, Yu Cao3  
1College of Mechanical and Power Engineering, China Three Gorges University, Yichang, 443002, China.  
2College of Materials and Chemical Engineering, China Three Gorges University, Yichang, 443002, China.  
3College of Science, China Three Gorges University, Yichang 443002, China.

ABSTRACT

To solve the problem of transferring the workpiece to the next process, design a gas-electric hybrid workpiece transfer machine. The mechanical structure of workpiece transfer in automatic production line is discussed. The transfer of workpiece can be realized by pulse motor, pneumatic system is used to clamp and lift the workpiece, and design this system, analyze the principle of pneumatic system and design the PLC circuit. The results show that the designed device has the characteristics of simple structure, operability and practicability.

Keywords: Gas-electric hybrid power system; PLC workpiece transfer device

*Correspondence to Author:  
Qiang Gu  
College of Mechanical and Power Engineering, China Three Gorges University, Yichang, 443002, China.

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1. Introduction
In industry, the workpieces transferred on the assembly line continuously enter the nodes, artifacts are processed at each node [1]. For example, assembly changes placement state setting parameters and so on. The change of the workpiece's spatial position or spatial state is usually accompanied by the movement of carrying, turning and vibration with a large workload. Moving from one process to the next on the assembly line, need man to complete it. This makes the labor intensity of workers high production, low efficiency and labor cost high. using of automation can make every link docking closely, Mechanical transfer, can reduce the labor intensity of workers to reduce labor costs to improve production efficiency, the assembly line environment and the quality of the workpiece. Workpiece transfer device plays an important role in the process of process transfer, its design directly affects the quality of the workpiece, so it is extremely important to set up the device reasonably [2].

2. Design purpose
Rotate the workpiece on the conveyor belt and transfer it to the next step. The order of work is as follows: Clamp down → Holding workpiece → Clamp rise → 90°rotary . 180°rotary Clamp → Clamp down→ Loose workpiece→ Clamp rise.

3. Mechanical structure design
3.1 General layout
As a result of the characteristics of the work, the overall mechanical device using column type, the overall results are shown in figure 1. The lifting cylinder lowers the clamp to the specified position, then clamped by pneumatic fixture, the lifting cylinder drives the fixture up to a certain height, then the pulsed motor drives the overall rotation 90 degrees, larger wheel turns the smaller wheel by 180 degrees. Finally, the fixture drops to the designated position and releases the workpiece, which completes the process of transferring the whole workpiece.


3.2 Mechanical features specifications, dimensions
Transfer degree: 90°
Rotation degree: 180°
Lifting cylinder stroke: 10mm
close stroke: one side 3mm
outline dimension: W136(before turn) x D403 x H398

3.3 The implementation of the transfer

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function
The workpiece transfer is realized by the rotation of the pulse motor, the large wheel drives the small wheel, the synchronous belt wheel ratio is 2:1, the large wheel rotates 90 and the small wheel rotates 180 to drive the fixture to rotate 90.
Inertia torque borne by the pulse motor is more important. The selection calculation of the motor is shown below.

Time to move at a 90-degree Angle t0: 0.5sec

Acceleration time t1: 0.1sec

Swing components moment of inertia : JL=4.16×10⁻² Kg·m²

Action angle: θ=90°, minimum step Angle of the pulse moto: θₙ=0.072°

Action pulse number: A=θ/ θₙ=1250

Running pulse speed: f₂=A/(t₀-t₁)=3125Hz

Running speed : NM= θₙ /360×f₂×60 = 37.5r/min

Inertia moment of the rotor of the selected motor: J₀ = 1.1×10⁻⁴

Gear ratio of motor: i = 1/10

Calculated acceleration torque: Ta = (J₀ × i² +JL)/9.55×NM/t₁ = 2.065N · m

Calculate the required torque: TM = Ta× safety factor = 4.13N · m (safety factor :2)

Select the motor according to the torque characteristics of the motor. Confirm the inertia ratio: JL / (J₀ × i² ) = 3.78 ≤ 10

Friction coefficient and workpiece weight should be considered when selecting clamping force of pneumatic fixture. Blessing force = 10 x mg (When the friction force is 0.2, the safety factor is set to 10, and m is the mass of the workpiece)

4. Working principle of aerodynamic system

When the workpiece on the assembly line is under the fixture, press the start button SB,YV1 get power, move the fixture down until the limit switch SQ1 is touched and YV3 get power, clamping workpiece, pressure relay SP action to power YV2, make the clamping device move up, touch SQ2, the pulse voltage makes the motor rotate while the synchronous belt wheel makes the workpiece rotate 180. When it touches SQ4, the power of YV1 causes the clamping device to move down while the pressure relay SP is reset. When SQ1 is touched again, YV4 releases the workpiece and continues along the pipeline to complete a cycle.

Fig. 2 The schematic diagram of pneumatic part control

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5. Control scheme design and circuit design

Table 1 input / output elements and control functions

<table>
<thead>
<tr>
<th>In put</th>
<th>PLC soft components</th>
<th>Component text symbol</th>
<th>Component name</th>
<th>control function</th>
</tr>
</thead>
<tbody>
<tr>
<td>X0</td>
<td>SB</td>
<td>Start button</td>
<td>control</td>
<td></td>
</tr>
<tr>
<td>X1</td>
<td>SQ1</td>
<td>Limit switch</td>
<td>Lower limit of lifting cylinder</td>
<td></td>
</tr>
<tr>
<td>X2</td>
<td>SQ2</td>
<td>Limit switch</td>
<td>Upper limit of lifting cylinder</td>
<td></td>
</tr>
<tr>
<td>X3</td>
<td>SQ3</td>
<td>Limit switch</td>
<td>Suitable limit</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td>SQ4</td>
<td>Limit switch</td>
<td>Inverse limit</td>
<td></td>
</tr>
<tr>
<td>X5</td>
<td>SP</td>
<td>Pressure relay</td>
<td>Work holding</td>
<td></td>
</tr>
<tr>
<td>Out put</td>
<td>Y1</td>
<td>YV1</td>
<td>Solenoid valve</td>
<td>Drop of lifting cylinder</td>
</tr>
<tr>
<td>Y2</td>
<td>YV2</td>
<td>Solenoid valve</td>
<td>Rise lifting cylinder</td>
<td></td>
</tr>
<tr>
<td>Y3</td>
<td>YV3</td>
<td>Solenoid valve</td>
<td>Clamping device clamping</td>
<td></td>
</tr>
<tr>
<td>Y4</td>
<td>YV4</td>
<td>Solenoid valve</td>
<td>Releasing device clamping</td>
<td></td>
</tr>
</tbody>
</table>

PLC wiring diagram of pneumatic power station is as shown in Fig. 4.

6. Conclusion

Gas-electric hybrid transfer device implements the artifact quickly moved to the next working procedure function, has many advantages: reducing the workers, save the labor cost, reduce the labor intensity, the reliability of a significant
boost can also according to the different choice of different pneumatic clamping workpiece, good commonality can reduce machining line length, reduce factory building covers, and so on.

References