Research and Design of an Automatic Press-Fitting Device for Engine Cylinder Head Valve Guides

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Abstract: Engine duct pressing is a common process that ensures a tight fit between the duct and cylinder head through pressure control. Aiming at the problems of low efficiency, low accuracy, and high environmental requirements in the current pipeline pressing method, a research and design of an automatic pressing device suitable for engine cylinder head pipelines has been carried out. The device consists of a feeding device system, a positioning fuel injection system, and a pipe pressing system, which realizes the entire process of pipe feeding, cylinder head cleaning, positioning, and pressing. It has high flexibility and scalability, reducing the impact of human factors on the production process to a certain extent, and achieving the goal of improving production efficiency and product quality.

Keywords: Cylinder Head; Catheter; Automatic Press Fit; Device Design

1. Introduction

In the engine assembly process, the pressing operation of the cylinder head guide pipe is a common and critical industrial process, and its core lies in achieving tight and reliable assembly between the guide pipe and the cylinder head through precise pressure regulation. This process plays a crucial and irreplaceable role in ensuring the stability of key connection parts of the engine, maintaining the sealing performance of the engine, and extending the overall service life of the engine[1-2]. However, the widely used catheter pressing technology still faces many challenges, including but not limited to low operational efficiency, insufficient assembly accuracy, and strict requirements for operating environmental conditions, which to some extent restrict the further improvement of engine production efficiency.

In view of this, this study focuses on the optimization and innovation of pipe pressing technology, aiming to solve the bottleneck problem in existing technology by developing an automatic pressing device designed for engine cylinder head pipes. The automatic pressing device integrates a series of functions such as automatic feeding of pipes, surface cleaning of cylinder heads, precise positioning, and efficient pressing, significantly improving production efficiency and product quality stability, and effectively reducing human interference in the production process[3-5]. In addition, the device exhibits a high degree of flexibility and scalability, which can adapt to the production needs of various types of engine bodies, providing strong support for the intelligent and efficient development of the engine manufacturing industry[6-8].

2. Design of Automatic Cylinder Head Pipe Compression Device

2.1 Design Purpose

In order to overcome the limitations of existing pipe pressing technology, improve the efficiency and accuracy of pipe pressing, and promote the development of engine production towards automation and intelligence, the new device integrates advanced mechanical design, sensor technology, and automation control concepts to achieve integrated automatic pressing of cylinder head pipes, thereby promoting the overall technological level of the engine industry.

2.2 Design Content

The fineness and progressiveness of the press fitting process of the engine cylinder head guide pipe are crucial to the engine operation. The components of the new automatic press fitting device for the engine cylinder head guide pipe are shown in Figure 1, which are respectively the feeding device system, the positioning fuel injection system and the guide pipe press fitting system. The working principle of the device is as follows: the conduit is placed in a cylindrical

annular material channel in a certain direction, and the sensor receives the induction and controls the conduit to enter the curved material transport pipe for press fitting. The cylinder head is transported by the roller conveyor to the positioning and oil spraying system for positioning processing and oil spraying lubrication, and then transported to the interior of the conduit press fitting system by the roller conveyor. After positioning by the positioning pin, the sensor receives the cylinder head signal, takes pictures of the cylinder head information, uploads it to the database, and transmits the signal to the curved material transport pipe. The conduit is released into the press fitting system to complete the final press fitting. After the press fitting is completed, it is transported by the roller conveyor. The efficiency of the pressing device is significantly improved compared to manual pressing, and the pressing accuracy is higher.

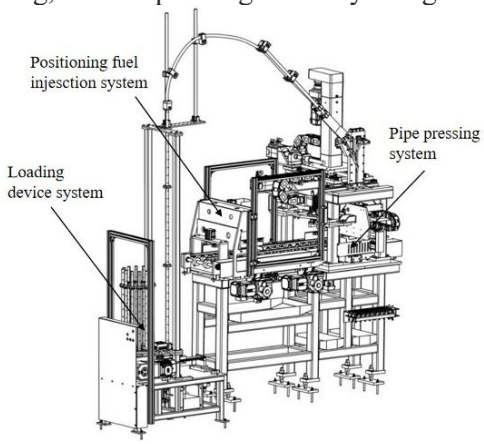

Figure 1. Schematic Diagram of the Automatic Press-Fitting Device for Engine Cylinder Head Valve Guides

3. Design of the Feeding System

The feeding device system mainly includes: cylindrical annular material channel, servo motor, material transfer detection sensor, air valve, cylinder, sliding device, top rod, storage pipe, material resistance sensor, material resistance baffle, conveying clamp, feeding system return pipe, feeding system return box, and curved feeding pipe, as shown in Figure 2.

The working process of the feeding device system is as follows: manual feeding of the guide tube is completed on the cylindrical ring material channel. The material blocking sensor receives the material signal and drives the blocking baffle to block the guide tube in the material tube. Compressed air is transmitted to the cylinder through the air valve, and the cylinder drives the sliding device to move back and forth. When the blocking baffle releases the conduit, the conduit falls onto the conveying clamp, and the sliding device drives the conveying clamp to move above the top rod. The cylinder drives the top rod to press the conduit into the storage pipe, and after passing through the storage pipe, it reaches the curved conveying pipe. After the use of the conduit in a single material tube of the cylindrical annular material channel, the two opposite installed material transfer detection sensors receive signals from each other. At this time, the servo motor drives the cylindrical annular material channel to rotate counterclockwise, so that the other material tube is in the feeding state. After a machine model completes the installation of the conduit, the sliding device slides left and right to drive the conveying clamp, and the excess materials in the cylindrical annular material channel and storage pipe are returned to the upper material system return box through the feeding system return pipe.

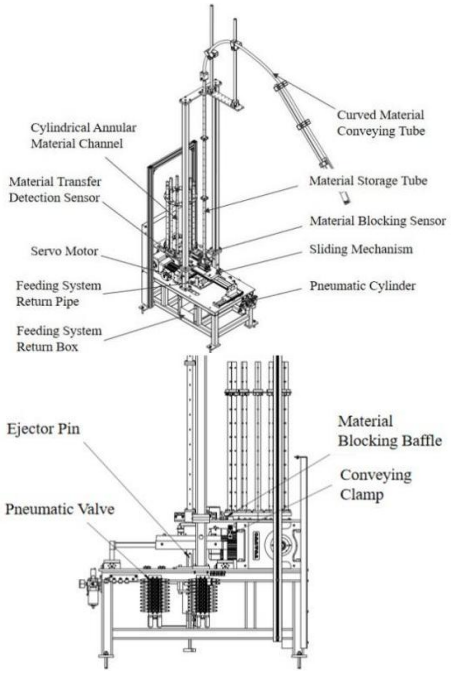

Figure 2. Schematic Diagram of the Feeding System

4. Design of the Positioning and Oil Spray System

The main components of the positioning fuel injection system include: roller conveyor, baffle plate, control motor, cylinder block, lifting device, positioning pin, fuel injector, and position detection sensor. The components of the fuel injection system are located as shown in

Figure 3. In the positioning fuel injection system, the control motor controls the start and stop of the roller conveyor. When the cylinder head moves from the roller conveyor to the stopper plate, the position detection sensor detects the cylinder head and transmits a signal to the stopper plate. The cylinder head is blocked by the stopper plate, and the roller conveyor stops rotating. The positioning pin is connected to the lifting device, and the cylinder block drives the lifting device to lift upwards. The positioning pin is aligned with the cylinder head pin hole to achieve precise positioning of the cylinder head position and accurate fuel injection. After the positioning is completed, the fuel injector performs fuel injection treatment on the cylinder head.

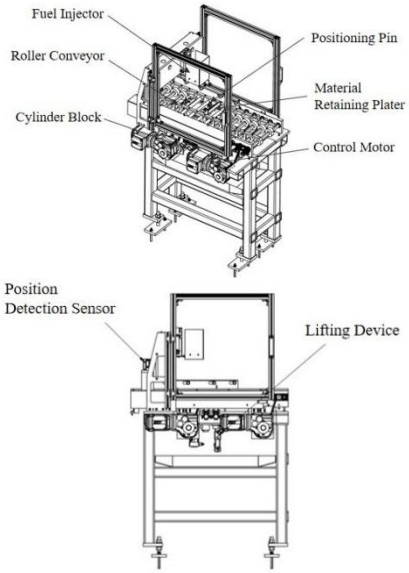

Figure 3. Schematic Diagram of the Positioning and Oil Spray System

This positioning device can ensure that the guide pipe is accurately installed at the preset position of the cylinder head, ensuring the accuracy of the fit between the cylinder head and the guide pipe, and reducing problems such as engine performance degradation caused by installation deviations. The fuel injection process plays a role in lubrication and cleaning, helping the guide pipe to enter the installation position more smoothly, further improving the accuracy of positioning. At the same time, the lubricating oil film can reduce the frictional resistance between the guide pipe and the cylinder head, avoiding the guide pipe from being offset or damaged due to excessive friction during the press fit process.

5. Design of the Conduit Press-Fit System

The pipe pressing system can achieve precise adjustment of pressure and displacement, with higher control accuracy, and can better meet the high-precision requirements of pipe pressing. The servo system has a fast response speed and can adapt to the tight production cycle of the engine, improving overall production efficiency. Equipped with online data recording function, it can achieve data management throughout the entire pressing process, ensuring product quality consistency and stability.

The main components of the pipe pressing system include: pressing control motor, screw, large tank chain, feeding groove, blocking cylinder, circular feeding sensor, feeding control motor, small tank chain, camera device, pipe storage box, pipe receiving fixture, pipe placement column, pressing head, depth stop block, depth stop block sensor, stop block, lifting sensor, lifting positioning device, cylinder head scanning sensor, roller conveyor, return pipe, and return box, as shown in Figure 4.

The working principle of the catheter press fitting system is as follows: two press fitting control motors respectively control the screw movement in the front back and left and right directions. The screw drives the large tank chain to move forward back and left and right, thereby driving the press fitting head to move forward back and left and right. After the cylinder head is positioned by the positioning fuel injection system, it moves along the roller conveyor to the stop block and is blocked. The lifting sensor receives the signal and transmits it to the lifting positioning device. The cylinder head is lifted to a fixed position, and the positioning pin is inserted into the cylinder head pin hole for positioning. The cylinder head scanning sensor scans the cylinder head part number and uploads it to the storage system. The cylinder head scanning sensor transmits the signal to the press fit head and the depth stop block. At this time, the depth stop block is driven to be placed on the four pin holes of the cylinder head. The material blocking cylinder is located on the feeding groove, blocking the conduit stored in the curved tube. When it receives the signal from the circular feeding sensor, it discharges the material and releases a conduit to the circular feeding sensor. The camera device takes pictures of the pipes located in the pipe storage box to determine their orientation. If the pipes are in reverse, the device will report an error. After the photo is taken, the pipes will fall down onto the pipe receiving fixture. The feeding control motor

drives the small tank chain to transport the pipe receiving fixture to the pipe placement column, and the pipe receiving fixture will retreat back to its original position. There are two rubber rings slightly larger than the inner diameter of the pipes on the press fitting head. The press fitting head uses the rubber rings to vertically remove the pipes and move them above the depth stopper to press them into the cylinder cover pin hole. The depth block sensor is used to store depth blocks and press fit heads. When different depth blocks and press fit heads are used, if they are different from the system setting model, the depth block sensor will transmit a signal to the system, and the system will display a fault prompt. When replacing with another type of conduit, execute the system return procedure. The conduit receiving fixture receives the conduit and transfers it to the return pipe. After releasing the fixture, the conduit passes through the return pipe and falls into the return box.

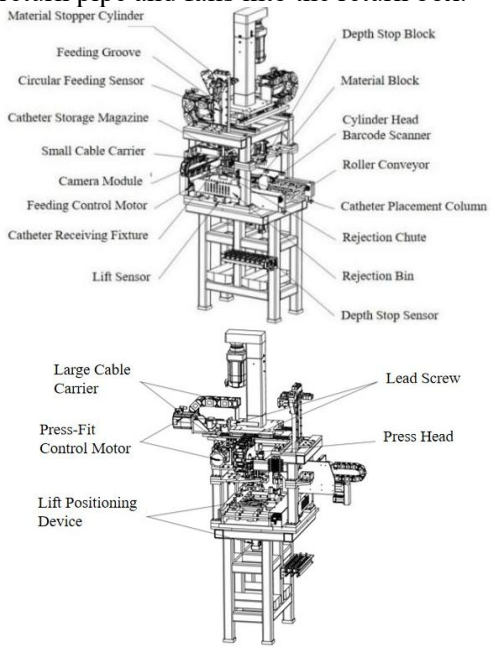

Figure 4. Schematic Diagram of the Conduit Press-Fit System

6. Conclusion

(1) Aiming at the problems of cumbersome operation, manual participation and monitoring in each link of the existing pipeline pressing method, which leads to long pressing cycle and low accuracy, a device suitable for automatic pressing of engine cylinder head pipelines is designed. Through the collaborative work of the feeding device system, positioning fuel injection system, and pipeline pressing system, precise pressing of pipelines is completed, reducing manual intervention, improving production efficiency, and using the same model of pipeline pressing. (2) Configure high-precision force and displacement sensors to monitor real-time changes in force and displacement during the pressing process, ensuring a pressing accuracy of ± 0.01 mm and ± 0.5% FS, with high precision and stability. (3) It can record and analyze cylinder head information, making it easy to trace information; Equipped with real-time monitoring devices, it can monitor abnormal situations during the pressing process, such as incorrect direction of the catheter.

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