



Research Article

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The optimal design of processing system of cold extrusion for the big diameter internal thread of high strength steel

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ABSTRACT

In this paper, the system uses cold extrusion to process the big diameter internal thread of high strength steel on the basis of the fundamental of metal plastic forming. The workpiece's organization structure is improved because of plastic formation of organizational structure. Favorable surface integrity of workpiece is obtained, and mechanical properties are improved. This paper aims at higher extrusion torsion, low thread accuracy, rejecting rate high, vibration tapping is adopted to obtain high quality in the processing interior thread with big diameter.

Key words: The Internal Thread of High Strength Steel; Cold Extrusion; Vibration Processing;

INTRODUCTION

With the rapid development of modern industry, more and more instruments and parts with large load, high speed and dynamic load appear in some industries, such as aviation and space industry, transport industry and petroleum exploitation industry. Higher performance of the fasteners and anti-fatigue manufacturing technology are required. Not only high accuracy and hardness, low surface but also high surface finish is required for thread. It is well known that modern machining technology is moving in the direction of less cutting and no cutting[1]. The interior thread is coldly extruded through principles of metal plastic forming. Because of plastic deformation of organizational structure, this technology can improve the workpiece's organization structure, obtain good surface integrity and improve mechanic performances[2, 3].

The big diameter internal thread is generally machining in the lathe. The workpiece is clamped into the machine chuck, the screw tap is installed into the lathe slide or the lathe tailstock by the special fixture. The workpiece is moved in a circular motion by the machine chuck, and the cold extrusion processing of interior thread is achieved by the movement of screw tap in a linear motion. For the machining of the big diameter internal thread, there exist some defects such as high extrusion torsion, extrusion temperature and difficulty of coolant entrance in the extrusion area. The screw is easy to be broken off by these defects. The surface quality of thread is dissatisfactory. But now, the cold extrusion of interior thread is mainly used to the machining of the small thread.

In order to overcome these above problems, this paper designs a processing system of cold extrusion for the big diameter internal thread of high strength steel. The processing system can meet the modern industry's requirements of anti-fatigue performance on the basis of some factors, such as high large load, high speed and dynamic load. The system can fully reduce torque, lower the working temperature in the extrusion area, prolong the service life of extrusion taps[4-6].

DESIGN OF OVERALL PLAN

The structure of the cold extrusion processing system is shown in figure.1, including: lathe, screw tap, tapping clamp, auxiliary processing plant. And the auxiliary processing plant includes torsional vibration pole, torsional

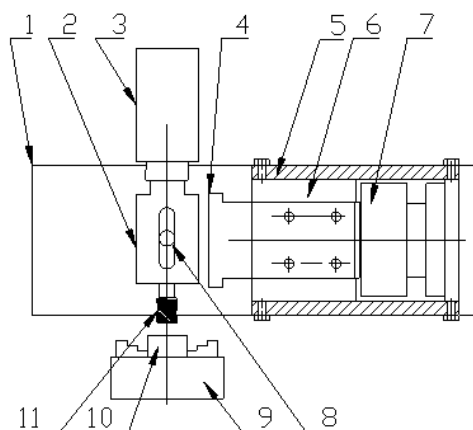
vibration plate, fixed plate, bed.

Firstly, the workpiece with prefabricated underport is installed into machine chuck, then the spindle speed is adjusted; secondly, the screw tap is moved to the appropriate position through adjusting lathe tailstock, the lathe slide is moved in order to balance torsional vibration plate installed on the auxiliary processing plant with torsional vibration pole installed into the tapping clamp.

Compared to processing methods, this processing method add vibratory tapping, vibration tapping is adopted, vibrating displacements on the fixed plate are produced through electromagnetic vibration exciter driving torsional vibration plate, the torsional vibration pole installed on the extrusion tapping clamp is shocked to obtain vibrating procedures of cold extrusion of interior thread.

DESIGN OF ASSIST PROCESSING DEVICE

The auxiliary processing device is based on magnetic vibration exciter. This auxiliary device includes fixed plate, base, torsional vibration plate and magnetic vibration exciter. In processing, the fixed plate is attached on the base; the torsional vibration plate is installed on the fixed plate by a slide connection; the magnetic exciter is fixed on the fixed plate; one end of the torsional vibration plate is touched with the torsional vibration pole installed into the tapping clamp. In the cold extrusion process, use magnetic exciter as vibration source, the torsional vibration plate is vibrated, through guide groove in the fixed plate, the torsional vibration plate impacts the torsional vibration pole in a specific direction. The torsional vibration pole drives extrusion tapping clamp to be vibrated.



1. Lathe slide 2. Taps fixture 3. Lathe tailstock 4. Torsional vibration plate 5. The base 6. The fixed plate 7. Exciter 8. Torsional vibration pole 9. Lathe chuck 10. the workpiece 11. Screw tap

Figure 1: The overall structure

As the magnetic exciter during machining, the magnetic exciter is fixed on the fixed plate. According to cold extruding torsion M[7], the appropriate is selected, its adjusting range of exciting force is from F_1 to F_2 (i.e. 500-1000kgf).

The torsional vibration pole is installed on the extrusion tapping clamp, and it is used to drive screw tap to obtain vibrating pulse procedures of cold extrusion. The length calculation is followed as

$$L = L_1 + L_2 = L_1 + M / F_1$$

Where, L_1 represents the threads length, L_2 represents the external length of the torsional vibration pole.

The structure of the torsional vibration pole is shown in Figure 2.

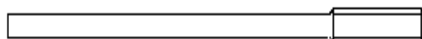


Figure 2: The structure of the torsional vibration pole

The torsional vibration plate is used to impact the torsional vibration pole under exciting force of the electromagnetic exciter, and the screw tap is driven to obtain the pulse vibration process. The screw tap is installed into the lathe tailstock, the torsional vibration pole will move in a straight path during processing. In order to solve steady vibration processing, the torsional vibration device is designed to be platelike. This structure can meet the

requirement of contact between the torsional vibration pole and the torsional vibration plate during machining process. As the same time, to achieve the exciting effect on the torsional vibration pole from the torsional vibration plate, there is a designed convex edge on the trail end of the torsional vibration plate, and the torsional vibration plate is match with the armature of the vibration exciter. There are four designed holes on the torsional vibration plate for installing the guide bolt. The guide bolt will be matched with the guide slot on the fixed plate of the vibration exciter to guide the vibration of the torsional vibration plate. The structure of the torsional vibration plate is shown in Figure 3.

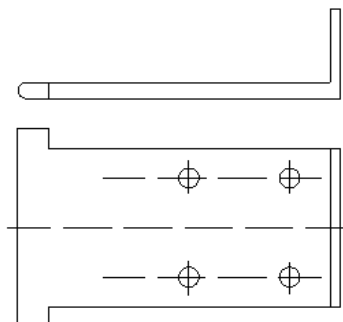


Figure 3: The structure of the torsional vibration plate

The fixed plate is used to adjust the height of the torsional vibration plate and place the vibration exciter. The vibration is installed in the slot of the fixed plate, and it is tighten on the convex edge through the bolts. There are two parallel guide slots on the fixed plate. The fixed plate is contacted with the torsional vibration plate by through the guide bolts, the two guide slots are used to guide the torsional vibration plate. On both sides of the fixed plate, there are the designed screw holes which are cooperate with the parallel slots in the base to adjust the height of the fixed plate.

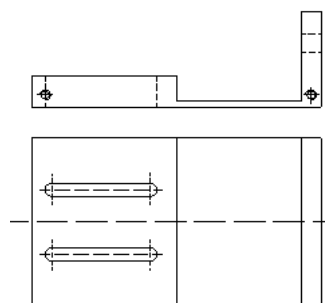


Figure 4: The structure of the torsional fixed plate

The base is fixed on the lathe slide, and it is used to support the entire assist device plate. On both sides of the base, there are two parallel strip-type slots which are used to adjust the height of the fixed plate.

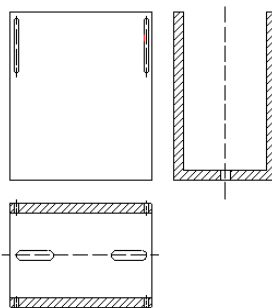


Figure 5: The structure of the base

CONCLUSION

Research result shows the processing quality is obviously improved by the cold extrusion system processing the big diameter internal thread of high strength steel.

Vibration tapping of the big diameter internal thread is achieved by the assist device in the processing system. The device can restrain the surface spring back and improve the surface finish obviously. The improved surface quality can further lower extrusion torque and prolong the service life of extrusion taps.

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