Research on a Machining Mechanism of Rod External Round Forming

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Keywords: Processing of slender bar parts, New technology and equipment, Research and design

Abstract: For slender bar parts, the traditional turning and grinding process, due to clamping deformation, thermal deformation, as well as the elastic deformation and vibration caused by cutting force, will affect the machining accuracy and roughness of slender bar parts. In this paper, the principle of boring head and boring is used to carry out reverse transformation. A ring-shaped rolling mechanism of rod body is designed. This mechanism can better guarantee the high accuracy and low roughness of the slender rod parts.

1. Introduction

Many of China's current machinery will use slender rod parts, if such parts in the manufacturing process accuracy are not accurate or quality problems. Will directly affect the safety of the use of subsequent types of machinery and equipment, and then bring potential threats to user safety. This will not only increase the burden on users, but also affect the credibility of processing enterprises. Reducing the competitiveness of enterprises and affecting their production efficiency. Therefore, the processing of slender rod parts is very important for users and production enterprises [1]. Machining has always been known as “the lathe worker is afraid of the rod, the fitter is afraid of the eye”. In order to obtain high precision and low roughness in the processing of slender bar parts, based on the analysis of the problems existing in the traditional processing methods, this paper studies and designs a ring rolling mechanism of bar body by using the principle of boring head for reference and carrying out reverse transformation. The rolling mechanism can well overcome the influence of the elastic deformation and vibration caused by clamping deformation, thermal deformation, cutting force and other factors in the processing of slender bar parts.

2. Problems Existing in the Traditional Method of Machining the Cylindrical Surface of Slender Bar Parts

The rigidity and thermal deformation of long and thin bar parts are poor. If the traditional machining method of top clamping and grinding is adopted, the workpiece will be affected by radial cutting force and axial cutting force, which will directly bend the workpiece. Due to the poor rigidity and stability of the slender shaft, the slender shaft will also bend when the axial cutting force is too large [2]. Moreover, the top clamping method of clamping the workpiece itself will produce a pressing force on the processed workpiece, reduce the rigidity and stability of the processed workpiece, cause bending, and increase the amount of runout of the workpiece during processing.

In addition, whether it is turning or grinding, there will be problems of elastic bending and runout of the slender workpiece. During grinding, the grinding wheel has its own beating. When the workpiece rotates, it will also be shaken due to the deformation and circular beating of the workpiece. And the longer the slender rod workpiece is, the greater the vibration will be, which will cause the surface of the slender rod workpiece to produce patterns and residual knife patterns, as well as the rod body out of round and other problems, and will never get high-quality parts.

  DOI: 10.25236/iiicec.2019.053

3. Research on ring Rolling Mechanism of Bar

In order to solve the above problems, although some people have proposed to use one-time forming processing to replace grinding with rolling, this kind of program has the following advantages compared with the traditional grinding process: ① rolling processing efficiency and processing quality are higher than grinding. ② Cost reduction, convenient adjustment, and reduced auxiliary time. ③ The processed surface is strengthened after rolling, which can improve the service life and economic benefits. However, such schemes are complicated due to the integration of multiple processes. Compared with traditional turning and grinding machines, the volume is huge. How to reserve enough space for clamping, making knives and changing clothes has always puzzled designers. This article focuses on optimizing and improving the clamping, tooling, and changing equipment while optimizing the processing technology.

The ring rolling mechanism of the slender rod body forming process researched and designed in this paper is as follows:

Based on a 6140C lathe and appropriately modified. As shown in FIG. 1, the three-jaw chuck 34 is connected to the flange of the chuck base of the main shaft 35, and the positioning is correct. Turn the hand wheel 1 to drive the mandrel 8 to straighten the workpiece through the screw 2, use the four jaw chuck 13 to correct the workpiece, and then tighten the screw handle 7 to lock. (see Figure 1 and Figure 5)

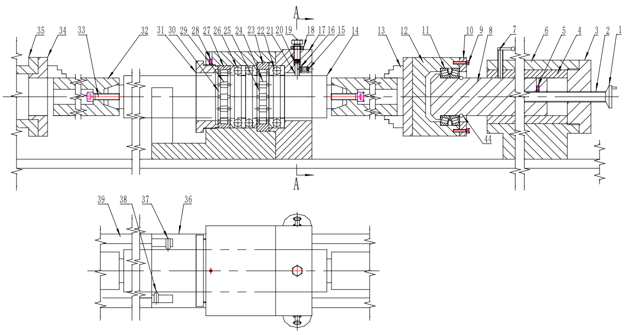

Fig.1 Workpiece clamping diagram

In Fig.1, 1. Handwheel; 2. Screw; 3. Screw Sleeve; 4. Tailstock Liner; 5. Taper End Set Screw; 6. Tailstock; 7. Screw Handle; 8. Core Shaft; 9. Socket Head Cap Screw; 10. Baffle; 11. Tapered Roller Bearing; 12. Coupling Sets; 13. Four Jaw Chuck; 14. Processing Workpiece; 15. Hexagon Socket Set Screw; 16. Steel Ball; 17. Main Body of Center Frame; 18. Lock Nut; 19. Upper Bolt; 20. Pressure Spring; 21. Pressure Bar; 22. Thrust Ball Bearing I; 23. Cylindrical Roller Bushing; 24. Cylindrical Roller; 25. Cylindrical Roller Holder; 26. Thrust Ball Bearing Ii; 27. Tapered Roller Bush; 28. Taper End Set Screw; 29. Tapered Roller; 30. Tapered Roller Cage; 31. Threaded Sleeve; 32. Extension Bush; 33. Socket Head Cap Screw; 34. Three Jaw Chuck; 35. Spindle; 36. Mechanism Matrix; 37. Finishing Turning Tool; 38. rough Turning Tool; 39. Lathe Guide; 44. Steel Wire Retaining ring.

As shown in Fig. 5, connect the four jaw chuck 13 with the coupling sleeve 12. First, install two pieces of tapered roller bearing 11 symmetrically on the left and right into the mandrel 8, and limit the inner ring of the bearing with the steel wire retaining ring 44 and the shaft shoulder to prevent its axial movement. Then install the coupling sleeve 12, and use the hexagon socket screw 9 to connect the baffle plate 10 to limit the outer ring of the bearing to eliminate the axial movement.

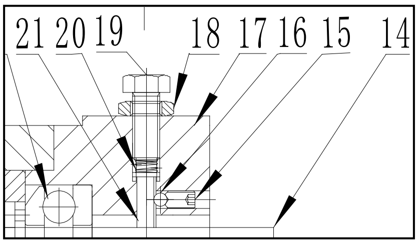

Fig.2 Schematic diagram of floating center frame to eliminate clearance and shock absorption

In Fig.2, 14. Processing Workpiece; 15. Hexagon Socket Set Screw; 16. Steel Ball; 17. Main Body of Center Frame; 18. Lock Nut; 19. Upper Bolt; 20. Pressure Spring; 21. Pressure Bar.

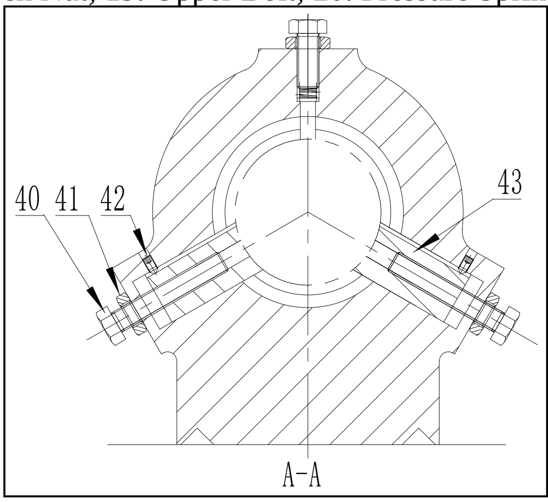

Fig.3 Floating center frame structure diagram

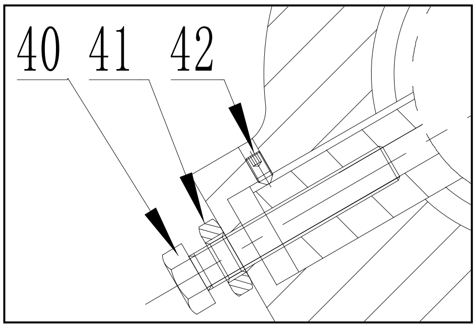

Fig.4 Center frame support sleeve positioning and fixing diagram

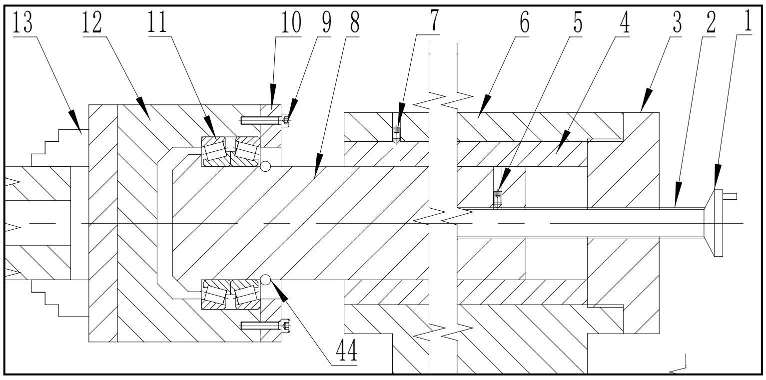

Fig.5 Tailstock component structure diagram

In Fig.5, 1. Handwheel; 2. Screw; 3. Screw Sleeve; 4. Tailstock Liner; 5. Taper End Set Screw; 6. Tailstock; 7. Screw Handle; 8. Core Shaft; 9. Socket Head Cap Screw; 10. Baffle; 11. Tapered

Roller Bearing; 12. Coupling Sets; 13. Four Jaw Chuck; 14. Processing Workpiece; 15. Hexagon Socket Set Screw; 16. Steel Ball; 17. Main Body of Center Frame; 18. Lock Nut; 19. Upper Bolt; 40. Lower Bolts; 41. Lower Lock Nut; 42. Taper End Set Screw; 43. Support Sleeve; 44. Steel Wire Retaining ring.

Before machining, the standard sample shall be installed from the main shaft hole, three jaw chuck shall be used for positioning, and four jaw chuck shall be adjusted and corrected. The diameter of the middle section of the standard sample shall be slightly smaller than that of the processed workpiece, and the feeler gauge shall be used to adjust the rolling mechanism and the center frame to ensure the concentricity with the three jaw chuck and the four jaw chuck. Although the end runout of the two ends of the chuck clamp is slightly larger than the top clamp, the axial pulling clamp method can be used to straighten the workpiece from both ends, so as to avoid bending deformation caused by the top clamp and the workpiece self weight. And it can improve the workpiece's resistance to deformation caused by radial cutting force and axial cutting force during turning and deformation due to heat. Furthermore, the overall runout of the workpiece is reduced, and the ring-shaped rolling mechanism and the center frame also have a straightening effect. Figure 1 shows the processing of a slender rod. This structure is suitable for cold-rolled sections or hot-rolled sections after rough processing.

4. Processing Process Introduction

As shown in Figure 1, during machining, the tool is fed from right to left, and the rough turning tool 38 and the fine turning tool 37 are turned at the same time. The ring-shaped rolling mechanism is uniformly stressed on the circumference when rolling, which avoids the unilateral grinding and the uneven force on the single-sided rolling in the traditional processing method. In the traditional processing method, the tool holder is often used. Although the tool holder has the middle supporting function, it can realize the supporting function of “three points and one line”, but in order to avoid card issuing, it is necessary to reserve the yield clearance and poor stability. The grinding wheel itself vibrates during the grinding process, which will inevitably lead to the reduction of the machining accuracy and surface quality of the grinding slender bar due to the vibration. While the ring rolling mechanism has eliminated the yield clearance and has good stability, which can effectively control the roundness, straightness and roughness of the workpiece.

Rolling mechanism is usually divided into tapered roller rolling or cylindrical roller rolling. Tapered roller rolling can adjust the amount of compression and compensate the gap after wear. However, the cylindricity and surface roughness of the workpiece rolled by conical surface are not as good as that by cylindrical roller. The rolling of cylindrical roller can not adjust the compression and compensate the gap after wear. In this paper, a thick ring rolling mechanism consisting of a tapered roller Bush 27, a taper end set screw 28, a tapered roller 29 and a tapered roller cage 30 is used. The outer surface of the workpiece 14 is subjected to rough rolling processing, and the adjusting screw sleeve 31 can adjust the rolling amount and compensate for the wear caused by the tapered rollers in the rough annular rolling mechanism. A precision ring-shaped rolling mechanism composed of a cylindrical roller bushing 23, a cylindrical roller 24, and a cylindrical roller holder 25 performs precise rolling of the outer surface of the workpiece 14. Therefore, the elastic rebound generated by the surface material of the workpiece in the rough rolling process is eliminated. The cylindrical roller 24 has the function of a sharpening blade similar to a fine turning tool, which can effectively improve the cylindricity and reduce the surface roughness. Although the cylindrical roller 24 cannot compensate the gap after wear, it is used for fine rolling after rough rolling. The wear of the cylindrical roller has been greatly reduced, which can effectively improve its service life.

After roughing and finishing rolling twice, the roundness and surface roughness of the workpiece can reach the precision grinding processing accuracy. When using the center frame, the clearance between the tools can be ignored. As shown in FIG. 2 and FIG. 3, after the positioning of the processed workpiece 14 is adjusted by adjusting the lower bolt 40, the lower bolt 40 is used for fastening. The adjusting upper bolt 19 pushes the compression spring 20 to provide a pre-tensioning force to the compression rod 21 to eliminate the gap, while leaving a margin to allow, so as to eliminate the influence of the precision of the workpiece caused by the ovality. The support sleeve 43 and the pressure bar 21 are made of ht350 material. During the initial processing, the groove should be made according to the processing workpiece 14 to increase the fit, improve the support performance and grinding effect. After many times of processing, the support sleeve 43, the pressure bar 21 and the processed workpiece 14 have been grinded and shaped, and the fit and support performance can be guaranteed. Compared with belt wheel and belt polishing, the grinding effect eliminates the surface defects caused by falling sand, which can not only reduce the cylindricity of the workpiece, but also improve the cylindricity of the workpiece.

As shown in Fig. 2, mill out the r-section groove on the cylindrical surface of the pressure bar 21, and press the ball 16 into the r-section groove with the set screw 15 at the concave end of the inner hexagon, which not only has the ball effect but also can avoid the impact of the rotation of the pressure bar 21 on the adhesion. As shown in Figures 3 and 4, the cylindrical surface of the center frame support sleeve 43 is milled into a V-shaped groove, and the hexagon socket taper set screw 42 is pressed into the V-shaped groove to prevent the support sleeve 43 from rotating when the lower bolt 40 is adjusted. Tighten it in place to ensure support and fit.

In addition, when processing the slender rod, the annular rolling mechanism needs to reserve process ends at both ends and is equipped with a central screw hole. As shown in Figure 1, the hexagon socket screw 33 is connected to the tapered end of the extension bushing 32, and the clamping end is lengthened to ensure the allowance of the knife. First, install the workpiece from the spindle hole for clamping, straightening and correction, and then screw the threaded handle 7 for fastening before processing. After forming, hang the workpiece with the hanging mechanism, loosen the threaded handle 7 and loosen the four claw chuck 13, turn the hand wheel 1 to withdraw the four claw chuck 13, take out the processed workpiece and cut off the process ends at both ends.

5. Conclusion

In this paper, the new processing method and ring rolling mechanism of slender bar parts are studied and designed. By using the axial pulling clamp method to straighten the workpiece from both ends, the straightness and deformation resistance of the workpiece are improved. The three jaw chuck of the main shaft is used for positioning and the four jaw chuck at the right end is used for correction, which reduces the overall runout of the workpiece during processing. At the same time, the rolling is designed to be rough rolling and fine rolling twice, which can effectively improve the dimensional accuracy, shape and position tolerance of the processed slender bar and effectively reduce its roughness and. After rolling, the floating center frame is used for correction, which can eliminate the gap and dampen the compression spring 20 at the lower end of the pressure rod 21. At the same time, the HT350 material selected for the support sleeve 43 and the pressing rod 21 and the rod body can be ground to avoid defects such as falling sand, which has a lower roughness than the abrasive cloth wheel and belt, which can replace polishing.

After processing by this kind of ring rolling method, the slender member also has the advantages of smoothing and strengthening the processed surface, enhancing the surface abrasion resistance, improving the surface corrosion resistance, and delaying the generation of fatigue cracks [3].

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