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Two Kinds of Lathe Improvement Techniques Based on ANSYS Simulation Analysis

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Abstract. Lathe is a kind of machine tool that use lathe tool to cut and profile spinning pieces, and is the most widely used lathe in mechanical manufacturing and assembling factories. So it is called the "Mother " lathe. Because of phenomena like being misused in the process of operation, conventional lathe cannot be normally operated, which has dramatically impacted the efficiency and the pace of working. In order to improve the reliability of our lathe, we come up with two technological methods——one is to improve the lathe tailstock "T" type three nuts to lengthen its life-span, the other is to make improvements to square turret lathe set screws to guarantee its better flexibility. The first section in your paper

1. Introduction

Lathe is a kind of machine tool that use lathe tool to cut and profile spinning pieces, and is the most widely used lathe in mechanical manufacturing and assembling factories. In the process of practical production, the failure of the lathe can make an inevitable impact to the rhythm of production in a negative way, that is, even some minor problems can cause reckoned effect to manufacturing. To achieve the goal of being cost-effective and convenient, and to solve the problems in practice, this article targets at the issues on the knife shelf cutter and the tailstock, which solves the problem that the "T" type three eye nut on the knife shelf cutter and the set screws on the tailstock are both so easy to break.

2. The analysis and improvement of tailstock "T" type three eye nut

When manufacturing parts like axis, core clammers are usually used to prop workpieces to ensure the stability of the machining. The movements of the tailstock of the lathe include both the movements of the body of the tailstock and the movements of the tailstock's sleeve. The movements of the body of the tailstock have two functions: first, they can adjust the tailstock to the required operating site during the process of manufacturing pieces classified to axis category; second, they function to adjust to the tailstock to a place with no interference when producing minor axis or plates. And the movements of the tailstock’s sleeve can help core clamper to loose or fasten the pieces, which are usually controled by hydraulic cylinders.
2.1 *In the process of its being actually used*

The main purpose lathe tailstock as follows\(^1\):

- When you're processing a long lathe parts, centre is install on its sleeve to provide a support for the long axis, when working.
- installed on the drill or reamer for drilling or reaming;
- fitted with taps or sets of wire tapping or threading device.
- To prevent the lathe from processing parts, the parts fall off due to the lateral force of the lathe tool.

The tailstock of the lathe is generally applied for:

- when installing, it can help with the accuracy of the lathe.
- it can drill holes, drill centre bores, and lengthen the long axis to combine the other end.
- it can do the eccentric shaft producing.

2.2. "T" type three eye nut

"T" type three eye nut locate in the tailstock, and cooperate with the axis. It can function to protect the screw of the lathe tailstock. Its location and structure are shown in Figure 1. During its being actually used, "T" type three eye is often damaged, the reason of which is the workers often increase the torque of the tailstock's handwheel too much, leading the "T" type three eye undergo excessive load. The most easy-damaged part is the spiral burr, as Figure 2 shows. This failure will not only make the lathe unable to sustain operation, but make the screw hole hard to repair because the screw's residual part may remain in the hole. Sometimes the damaged "T" type three eye nut may be locked with the screw, at this time the only way is to destroy the "T" type three eye nut by force. But this method can spoil the structure of the screw and cause extreme damage to the screw hole.

2.3. *The analysis of the operation environment of the "T" type three eye nut*

The material for the "T" type three eye nut is cast iron\(^2\), cooperating with the threaded steel during work. When the worker tightens the handwheel of tailstock, the "T" type three eye nut will be loaded with a torque. We use ANSYS to simulate real case scenario to conduct specific analysis and test. First, we established the model of the "T" type three eye nut in the lathe's tail block, as shown in Figure 3, and then we conducted the above three real case scenario, that is when the situation happens, the screw hole will get a bigger torque value, and that functions as the precondition of the real case scenario. Seen from the results of the analysis, it can be found that the shearing stress of the screw hole was so concentrated that the "T" type three eye nut got damaged because of bearing too much shearing stress and screw bearing too much pressure.

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Figure 1. lathe tailstock
Figure 2. a tailstock broken "T" Type three nuts

Figure 3. “T" type three eyes nuts model

Figure 4. ANSYS -simulation analysis cloud

Three concrete modes that lead to the above damage are as follows:

• too much drill power of the handwheel.
• when unloading the tools such as the top part or the drilling bit and the sleeve been put back to its final position, the handwheel may still be spun in an anticlockwise direction.
• when the handwheel’s sleeve is pushed to the most front site, the handwheel may still be spun in a clockwise direction.

Concluded from the accumulated statistic data of the machinery engineering training in a long run, the participants lack of experience often involve themselves with too much strength that cause damage to the "T" type three eye nut.
2.4. Improved "T" type three eye nut material characteristics

Traditional "T" type three eye nut is made up by cast iron, which can be very crispy, tough and short of flexibility. So when the "T" type three type eye nut got damaged, the screw got damaged too, and the repair and the replacement could be a waste of time and money[3].

If the material can be substituted by brass, which can be more soft, cheaper and more flexible than steel, so the "T" type three eye nut made by brass can be more sustainable.

3. Improvement of the tool slide tight set screw

Lathe is a kind of machine tool that use lathe tool to cut and profile spinning pieces. The lathe tool need to be tightened on the tool holder set . As the lathe in the long-term use, the need for frequent practice of knives and tool change, the square set screws with long dog point is broken, and the long-term repair makes screw hole deformation damage with the methods that use a larger screw tap to re-tapping to meet connectivity requirements. After several repair, the tool slide was scrapped. So, proposing a heat treatment method to improve the set screw on the material, thereby extending its life.

![Figure 5. Square set screws with long dog point](image)

3.1. Square set screws with long dog point is broken for the following reasons (the figure 5 for the screw broken arrows point):

- Tighten the cylinder head set screws without working alternately ;
- Tighten the square end with a cylindrical turret square head set screw rod afterburner;
- Square set screws with long dog point in a square tool post have a wrong design and improper heat treatment method.

The first two reasons are two wrong methods of operation and installation in the turning process and we can overcome it. The square set screws with long dog point that we bought actually design itself improper and have a improper heat treatment methods. If to be improved, greatly extend the life of square set screws with long dog point.

3.2. The improvement of square set screws with long dog point

- The improvement of design

As for square set screws with long dog point in a common lathe square tool post [4], it should be M12 screw with the length of 40–45mm. Threaded 20mm will be used in square tool post by a symmetrical distribution. And thread is around the screw. This design is unreasonable, after a long-term use, tip
diameter greater than 12mm, and when the screw is broken, you can not quit it, and this screw produced in a non-GB standard. If diameter of the screw is 9mm in the front 7mm and screw is not around thread in a diameter less than 12mm, we can easily remove the broken bolt and it produce according to GB.

- **The improvement of material characteristics**

  Square set screws with long dog point are hardened with a whole screw quenching in oil\(^5\). The hardness of screw thread is better, but the overall fatigue strength has declined, such as toughness decreased and torsion strength weakened. Thread length used in screws only around 20mm, around the front end 10mm and rear 10 ~ 15mm are not used. Square tool post threaded is cast iron, and the screws thread is steel. When used together, cast iron threaded more damage. So we only quench useful 20mm threaded, and front and rear ends without quenching. In particular, the front can not be quenched, the front end have the toughness to generate preload.

- **Specific measures are as follows:**

  If you buy a set screw that thread is around the screw, we should reduce its diameter to 10 mm in the front end 5mm to remove easily after a good screw is broken. Then screw is heated with acetylene at 10 ~ 30mm, be careful not to have clear boundaries, and then use the blacksmith pliers to grip the screw at the front end 10mm into the heated oil, especially 10mm do not put oil in the front. Then cool in air. If so, Set screws is front the most soft, the back-end take second place, the most hard in the middle.

  As the batch processing, Drill 4 mm hole in the front end, a set of set screw quench with a iron wire at the same time\(^6\). The holes can also facilitate set screw taking out later. Of course, you can also heat the front end 10mm with acetylene, then cooled in air. This treatment method is simple, but the result is not good as the former effect.

  Since square set screws with long dog point have M10, M12, M16, as for other specifications M16, if bought the screws is cylindrical end with whole tooth during the maintenance (GB cylindrical end: Long 8mm, diameter 12mm). At this time, due to the larger diameter screw is 16mm, we can change the screws 5mm front to a square with a milling machine, after easy maintenance. Then heat-treated according to the method described above can be.

4. **Conclusion**

The "T" type three eye nut made by brass instead of cast steel can run with more flexibility, wearability, and anti-blastwave. In a long period, using brass can lower the cost of repairing, and avoid unnecessary replacement.

After the improvement of design and material characteristics in the square set screws with long dog point, it could have better flexibility, better resistance to wear and difficult to break.

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