Trade of Toolmaking

Module 2:	Turning
Unit 6:	Recessing and Radiusing
	Phase 2

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Document Release History

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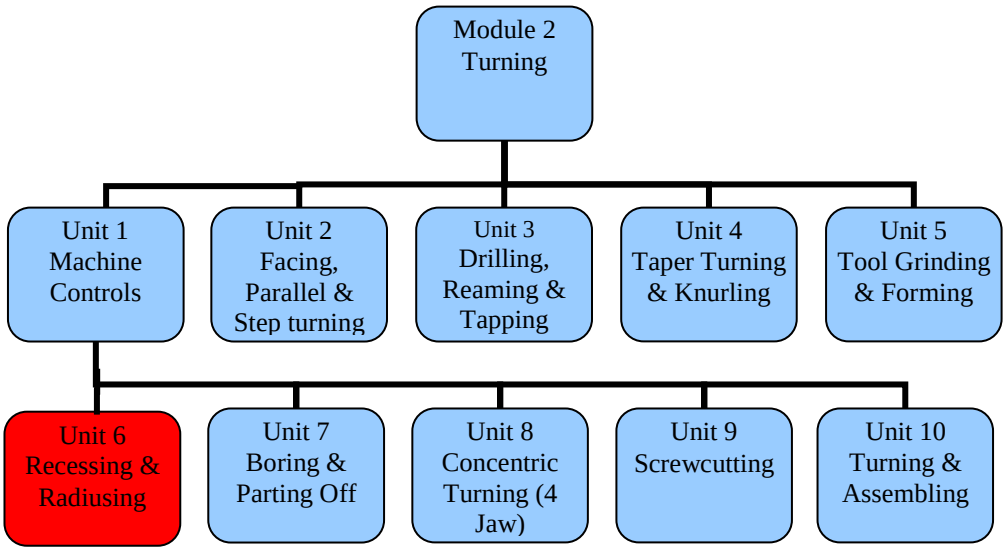
Unit Objective

On completion of this unit you will be able to set-up and perform step turning, recessing, radiusing and boring operations.

Introduction

Module two of this course covers turning. This is the sixth unit in module two and introduces the techniques associated with setting up and using recessing, radiusing tools and boring bars. These tools can be used to produce recesses and radii on a one-off part or on multiple parts. The boring bar is used to produce precise bores or stepped holes. The boring bar can also be used to create internal recesses, radii and for screw threading in drilled out or bored holes.

Vernier callipers and micrometers are used to measure features such as external turned diameters and recessed or stepped distances. Radius gauges are used to check the radius produced by the radius tool. The vernier callipers can be used to measure internal diameters, but for more precise measurements the internal micrometer or telescopic gauges are used.



By the end of this unit you will be able to:

- Correctly setup and use recessing and radiusing tools.
- Step turning, recessing and radiusing.
- Step boring to toleranced dimensions.

1.0 Setting Up And Using Recessing And Radiusing Tools

Key Learning Points

Tool set-up for recessing and radiusing tools. Boring bars, types and use off. Plan and sequence operations. Forces acting on cutting tools.

1.1 Tool Set-Up For Recessing And Radiusing Tools

Tools such as radius tools and recessing tools are normally used when the standard turning operations have already been completed. When setting up the tool it is important that the cutting edge is set to the correct height, which is on the central axis of the workpiece and that the side of the tool is parallel with the front face of the workpiece.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 151.

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1.2 Boring Bars, Types And Use Off

Boring bar is used when holes need to be machined to a precise dimension. The boring bars are available with HSS cutting tips and can be double ended, one end for a turning tool and the other can hold an undercut tool or a screw cutting tool. Boring bars are also available with tungsten carbide tips.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 153.

ISBN-13: 9780750660730

1.3 Plan And Sequence Operations

Job planning is important prior to starting any task. The drawing should first be studied and understood. The drawing can initially be used to calculate the material requirement for the component to be manufactured. The workpiece needs to be cut from bar stock using the bandsaw. The sequence of operations should be planned so as to minimise the number of setups in the chuck.

1.4 Forces Acting On Cutting Tools

When machining on a lathe, three forces act on the tool, (i) the vertical or tangential force, (ii) the feed force and (iii) and radial force that tends to push the tool away from the workpiece. If the vertical and feed forces are known, they can be drawn to scale and lines drawn parallel to create a parallelogram. The diagonal line can be measured to determine the resultant or the radial force.

2.0 Step Turning, Recessing And Radiusing

Key Learning Points

Production of steps and radii on components. Use of radius and form gauges.

2.1 Production Of Steps And Radii On Components

The largest diameter should be turned to size along the full length of the part. The step can be marked off using a vernier callipers and a scriber. A stop can be set, which will automatically stop the carriage. The step is turned to this line using the automatic feed. When the workpiece diameter is that as specified on the drawing, the cross slide is used to machine the face.

When a radius tool or a recess tool is being used, the speed of the chuck should be half that for ordinary turning speed. When cutting the radius, position the radius tool close to the corner of the workpiece and then use the hand wheels on the top slide and the cross slide to feed the tool. Radius gauges can be used to check the machined feature.

For recessing, the tool is positioned as explained above. The tool is then fed in by hand using the cross slide, where the dial can be set to zero. This can be used as a guide to determine the depth. It is important to withdraw the tool if there is a build up of swarf and to check the diameter of the machined feature.

2.2 Use Of Radius And Form Gauges

Radius gauges are available in sets of incremental radii. They can be used to measure a radius when the workpiece has been machined with a radius tool. For a particular form a special gauge can be manufactured for measuring non-standard radii or forms.

3.0 Step Boring To Toleranced Dimensions

Key Learning Points

First and third angle projection and geometric symbols. Reading of tolerances on step bored component drawings. Surface finish symbols on drawings. Use of telescopic gauges, internal micrometers and depth micrometers. Internal boring techniques.

3.1 First And Third Angle Projection And Geometric Symbols

In technical drawing there are two systems of projection, (i) First Angle, each view shows what would be seen by looking on the far side of an adjacent view and (ii) Third Angle each view shows what would be seen by looking on the near side of an adjacent view.

Ref: Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology, chapter 4, *Principles of first and third angle orthographic projection*, p. 33.

ISBN-13: 9780750651202

3.2 Reading Of Tolerances On Step Bored Component Drawings

All dimensions on a drawing will have a tolerance. It is important to work within the tolerance band for each dimension being machined.

Ref: Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology, chapter 19, *Limits and fits*, p. 153.

ISBN-13: 9780750651202

3.3 Surface Finish Symbols On Drawings

The drawing may specify the surface finish requirements of the workpiece. The surface roughness is expressed as surface roughness average (Ra) and is measured in micrometers (0.001mm). Surface roughness comparator sets are available and can be used to compare the machined surface of the workpiece and determine an approximate Ra value.

Ref: Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology, chapter 14, *Dimensioning principles*, p. 109.

ISBN-13: 9780750651202

3.4 Use Of Telescopic Gauges, Internal Micrometers And Depth Micrometers

A vernier caliper should be used to measure the diameter and the depth. If a more accurate measurement is required, then a telescopic gauge or an internal micrometer can be used to measure the diameter and a depth micrometer can be used for the depth.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 6, *Measuring equipment*, p. 95.

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3.5 Internal Boring Techniques

The centre of the workpiece needs to be drilled out prior to using the boring bar. The boring bar cutting tip should be aligned with the central axis of the workpiece and the bar should be parallel with the axis. The automatic traverse of the saddle generates the internal bore. The

smallest bore should be bored out first. In order to ensure the correct depth for the step, the tool can be touched off the front face of the workpiece and the digital readout can used to measure the distance moved by the tool when boring.

Internal recesses are machined with specially ground recessing tool, which is held in a boring bar.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 153.

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Summary

Setting up and using recessing and radiusing tools: Tools such as radius tool and recessing tools are normally used when the standard turning operations have already been completed. When setting up the tool it is important that the cutting edge is set to the central axis of the workpiece and the side of the tool is parallel with the front face of the workpiece.

When using the recess tool or a parting-off tool, set-up the tool as explained above.

Boring bar is used when holes need to be machined to a precise dimension. The boring bars are available with HSS cutting tips and can be double ended, one end for a turning tool and the other can hold an undercut tool or a screw cutting tool. Boring bars are also available with tungsten carbide tips.

Step turning, recessing and radiusing: The largest diameter should be turned to size along the full length of the part. The step can be marked off using a vernier calliper and a scriber. A stop can be set, which will automatically stop the carriage. The step is turned to this line using the automatic feed. When the workpiece diameter is that as specified on the drawing, the cross slide is used to machine the face.

When a radius tool or a recess tool is being used, the speed of the chuck should be half that for ordinary turning speed. When cutting the radius, position the radius tool close to the corner of the workpiece and then use the hand wheels on the top slide and the cross slide to feed the tool. Radius gauges can be used to check the machined feature.

For recessing, the tool is positioned as explained above. The tool is then fed in by hand using the cross slide, where the dial can be set to zero. This can be used as a guide to determine the depth. It is important to withdraw the tool if there is a build up of swarf and to check the diameter of the machined feature.

Step boring to toleranced dimensions: The centre of the workpiece needs to be drilled out prior to using the boring bar. The boring bar cutting tip should be aligned with the central axis of the workpiece and the bar should be parallel with the axis. The automatic traverse of the saddle generates the internal bore. The smallest bore should be bored out first. In order to ensure the correct depth for the step, the tool can be touched off the front face of the workpiece and the dial in the carriage used to measure the distance moved by the tool when boring. A vernier caliper should be used to measure the diameter and the depth. If a more accurate measurement is required, then a telescopic gauge can be used to measure the diameter and a depth micrometer can be used for the depth.

Technical Drawing: In technical drawing there are two systems of projection, (i) First Angle, each view shows what would be seen by looking on the far side of an adjacent view and (ii) Third Angle each view shows what would be seen by looking on the near side of an adjacent view.

Suggested Exercises

1. State is the main advantage of using a boring bar instead of a drill or reamer?
2. List the three forces acting on a tool when turning?
3. Explain the difference between first and third angle projection in technical drawing?
4. List the steps taken to bore out a workpiece to a Ø30mm?
5. Bore a workpiece to a diameter of 30mm and use a telescopic gauge to measure the bore diameter.

Questions

1. How is a radius tool setup prior forming the workpiece.
2. What types of boring bars are available?
3. How is a radius checked on a workpiece after its being machined?
4. What is an Ra value?
5. What instruments are used to measure an internal bore.

Answers

1. When setting up the tool it is important that the cutting edge is set to the correct height, which is on the central axis of the workpiece and that the side of the tool is parallel with the front face of the workpiece
2. The boring bars are available with HSS cutting tips and can be double ended, one end for a turning tool and the other can hold an undercut tool or a screw cutting tool. Boring bars are also available with tungsten carbide tips.
3. A radius gauge is used to measure a radius when the workpiece has been machined with a radius tool. Radius gauges are available in sets of incremental radii.
4. The surface roughness is expressed as surface roughness average (Ra) and is measured in micrometers (0.001mm).
5. A vernier caliper can be used to measure the diameter and the depth. If a more accurate measurement is required, then a telescopic gauge or an internal micrometer can be used to measure the diameter.

Recommended Additional Resources

Reference Books

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

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Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology.

ISBN-13: 9780750651202

Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology.

ISBN-13: 9780750665759