Trade of Toolmaking

Module 2:	Turning
Unit 8:	Concentric Turning (4-jaw)
	Phase 2

Published by

SOLAS
An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Table of Contents

Document Release History

Date	Version	Comments
25/09.2014	2.0	SOLAS transfer

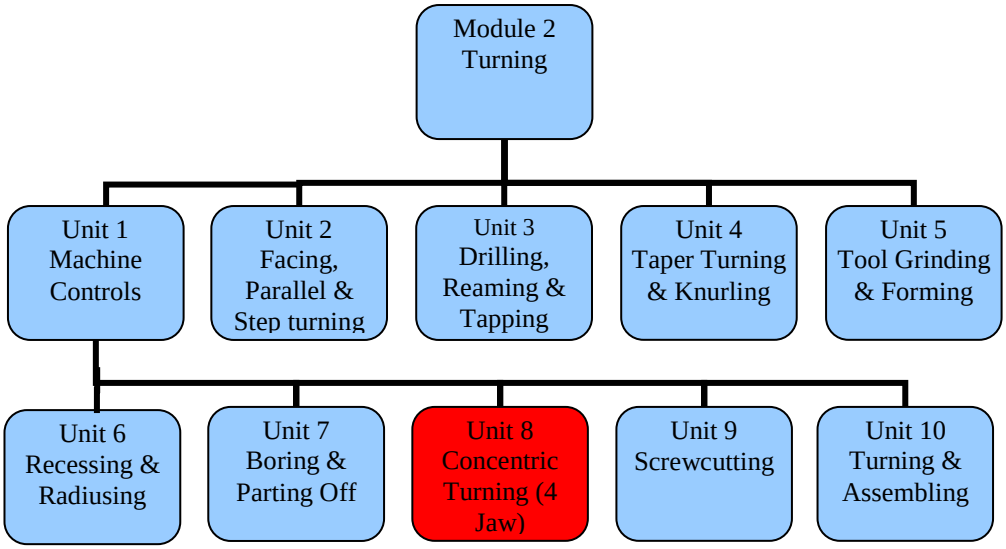
Unit Objective

On completion of this unit you will be able to safely mount a 4-jaw chuck, centre the workpiece and perform turning operations.

Introduction

Module two of this course covers turning. This is the eight unit in module two and introduces the techniques associated with operating a lathe. This unit explains how to safely remove and fit a lathe chuck and how to set up and centre a workpiece in a 4-jaw chuck. Speed, feeds and material removal rates are also explained.

The 4-jaw chuck is much more heavily constructed then the self centering 3-jaw chuck and has much greater holding power. Each jaw is moved independently and can also be reversed for holding larger workpieces. They can be used for holding irregularly shaped components and for machining eccentric work. They can be used to set up work concentrically and with greater accurately. The jaws can also be reversed for holding larger work and has superior holding power. When compared to the 3-jaw chuck, the set up of the 4-jaw chuck may seem laborious, but with practice, this should only take a few minutes.



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

- Mount safely the 4-jaw chuck.
- Centre workpiece from datum edge.
- Centre workpiece using plunger type dial test indicator and magnetic stand.
- Machine concentric diameters.

1.0 Mounting The 4-Jaw Chuck

Key Learning Points

Safe removal and fitting of chucks.

1.1 Safe Removal And Fitting Of Chucks

When removing or fitting a chuck, first place a board on the bed slide ways in order to protect them. A key is used to loosen the cam lock nuts, which are rotated until the indicator marks line up. The chuck should be held with the right hand, while a mallet tapped against the chuck to remove it from the taper. Both hands should be used to hold the chuck at the sides, not underneath. The chuck should be slowly lowered onto the board.

When lifting the chuck, it is important to keep your back straight and bend your knees when lifting or lowering the chuck. Ensure that the floor space around the lathe is free from debris, oil or coolant. These chucks are heavy, especially the 4-jaw chuck. If you have difficulty lifting or fitting these chucks, ask for help. Never leave the chuck key in the spindle or in the chuck.

When fitting the chuck, it should be carefully lifted onto the board, which should be placed on the bed slide ways. A clean cloth should be used to clean the back face, cam lock studs and taper. Also clean spindle face and taper. The chuck is fitted onto the spindle by locating the cam lock studs in their sockets. While holding the chuck with your right, hand tighten the cam lock nuts. When all nuts have been hand tightened, lock all nuts with the key using both hands.

2.0 Centre Workpiece From Datum Edge

Key Learning Points

Loading and unloading workpieces. Centring of workpiece.

2.1 Loading And Unloading Workpieces

The chuck key is used to open and close the chuck, when loading and unloading the workpiece. It is important that the chuck key is removed from the chuck immediately after use.

Ref: Black, Bruce J 2004, Workshop processes, practices and materials, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 140.

ISBN-13: 9780750660730

2.2 Centring Of Workpiece

One method of loading and setting up the workpiece on centre is to scribe the centre of the workpiece using the height gauge on the surface table. The workpiece should be positioned roughly in the centre of the chuck. On the face of the chuck, the concentric rings can be used as a guide to for preliminary setting of the work piece and the jaws. This will allow the workpiece to be set up within a millimetre of centre. With the workpiece held lightly by the four jaws, use the lines that have been scribed on the centre of the workpiece as a guide centring it to tailstock centre.

Ref: Black, Bruce J 2004, Workshop processes, practices and materials, 3rd edn, Elsevier Science & Technology, chapter 9, *Turning*, p. 146.

ISBN-13: 9780750660730

3.0 Centre Workpiece Using Dial Indicator

Key Learning Points

Use of dial test indicator. Avoidance of errors when using a dial test indicator.

3.1 Use of dial test indicator

A more accurate method of centring the workpiece is to use a dial indicator. A plunger type dial indicator should be setup on the far side of the workpiece. The chuck can then be rotated by hand and the jaws loosened or tightened until the workpiece is centred. With experience, this exercise will become easier and quicker.

Ref: Black, Bruce J 2004, Workshop processes, practices and materials, 3rd edn, Elsevier Science & Technology, chapter 6, *Measuring equipment Dial indicators*, p. 108.

ISBN-13: 9780750660730

3.2 Avoidance Of Errors When Using A Dial Test Indicator

Ensure that the plunger of the dial test indicator is aligned square to the surface of the workpiece, otherwise a false reading will occur. Also check that the magnetic stand is secure and that the joints in the extension arms are locked. Prior to using the dial indicator it is important to check that the plunger moves uniformly up and down and does not stick or jump.

4.0 Machining Concentric Diametres

Key Learning Points

Speeds and feeds and depth of cut. Volumes: metal removal rates, calculation of volumes of regular solids. Production of concentric diameters using the 4-jaw chuck. Job planning and sequencing. Housekeeping, tidy work area when transporting heavy chucks. Energy transfer from tool to coolant.

4.1 Speeds And Feeds And Depth Of Cut

When using boring bars to machine internal recesses or undercuts, the speed of the chuck should be half that for ordinary turning speed. It is important to use coolant for all boring operations. Cutting speed is expressed in meters per minute. This refers to the distance covered by the tool across the material when machining. A chart is available listing various materials and their corresponding cutting speeds. To find the correct RPM (revs per minute) setting of the spindle the following formula should be used;

$$\text{RPM} = \frac{\text{Cutting Speeds in metres per minute x 1000}}{\text{Circumference of cutter in millimeters}}$$

$$= \frac{S \times 1000}{\pi \times D}$$

Ref: Black, Bruce J 2004, Workshop processes, practices and materials, 3rd edn, Elsevier Science & Technology, chapter 7, p. 123.

ISBN-13: 9780750660730

Feed is the rate at which the cutting tool moves along or across the work. For each single revolution of the workpiece, the tool will move along the work a certain distance. This is referred as the feed per revolution. For example, if the rate is set at 0.25mm, the tool will move 0.25mm per revolution. Speed, feed and depth of cut determine the rate at which material is removed. Use coolant when using a High Speed Steel (HSS) cutting tool.

4.2 Volumes: Metal Removal Rates, Calculation Of Volumes Of Regular Solids

Speed, feed and depth of cut determine the rate at which material is removed. It is important to select the correct speed and feed because it not only affects the quality of the work but also the time taken to machine the workpiece. As a guide the feed rate for rough cutting using a high speed steel tool is between 0.125 and 0.250mm. The feed rate for a finishing cut is between 0.001 and 0.005mm.

The volume of material removed can be determined by subtracting the volume of the remaining cylinder from that of the original cylinder.

The volume of a cylinder $= \pi r^2 h$

Where r = radius of the cylinder

h = height of cylinder

Ref: Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology, chapter 24, p. 181.

ISBN-13: 9780750665759

4.3 Production Of Concentric Diameters Using The 4-Jaw Chuck

The workpiece to be machined needs to be setup concentrically in the 4-jaw chuck by using a dial indicator as explained above. 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 top slide is used to machine the face.

4.4 Job Planning And Sequencing

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 should 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.

4.5 Housekeeping, Tidy Work Area When Transporting Heavy Chucks

When lifting the chuck, you should ensure that the floor space around the lathe is free from debris, oil or coolant. These chucks are heavy, especially the 4-jaw chuck. If you have difficulty lifting or fitting these chucks, ask for help.

4.6 Energy Transfer From Tool To Coolant

The movement of the tool over the workpiece generates heat due to friction. If coolant is not used when turning, then the heat will eventually cause the tool to break down. The use of coolant will result in the heat transferring from the tool into the coolant, which will prolong the life of the tool. Coolant will also produce a better surface finish and helps to remove swarf.

Summary

Mounting the 4-jaw chuck: When removing or fitting a chuck, first place a board on the bed slide ways in order to protect them. A key is used to loosen the cam lock nuts, which are rotated until the indicator marks line up. The chuck should be held with the right hand, while a mallet tapped against the chuck to remove it from the taper. Both hands should be used to hold the chuck at the sides, not underneath. The chuck should be slowly lowered onto the board.

When lifting the chuck, it is important to keep your back straight and bend your knees when lifting or lowering the chuck. Ensure that the floor space around the lathe is free from debris, oil or coolant. These chucks are heavy, especially the 4-jaw chuck. If you have difficulty lifting or fitting these chucks, ask for help. Never leave the chuck key in the spindle or in the chuck.

When fitting the chuck, it should be carefully lifted onto the board, which should be placed on the bed slide ways. A clean cloth should be used to clean the back face, cam lock studs and taper. Also clean spindle face and taper. The chuck is fitted onto the spindle by locating the cam lock studs in their sockets. While holding the chuck with your right, hand tighten the cam lock nuts. When all nuts have been hand tightened, lock all nuts with the key using both hands.

Centre workpiece from datum edge: One method of loading and setting up the workpiece on centre is to scribe the centre of the workpiece using the height gauge on the surface table. The workpiece should be positioned roughly in the centre of the chuck. On the face of the chuck, concentric rings can be used as a guide to for preliminary setting of the work piece and the jaws. This will allow the workpiece to be set up within a millimetre of centre. With the workpiece held lightly by the four jaws, use the lines that have been scribed on the centre of the workpiece as a guide centring it to tailstock centre.

Centre workpiece using dial indicator: A more accurate method of centring the workpiece is to use a dial indicator. A plunger type dial indicator should be setup on the far side of the workpiece. The chuck can then be rotated by hand and the jaws loosened and tightened until the workpiece is centred. With experience, this exercise will become easier and quicker.

Machining concentric diameters: Cutting speed is expressed in feet per minute or meters per minute. This refers to the distance covered by the tool across the material when machining. A chart is available listing various materials and their corresponding cutting speeds. The revolutions per minute (RPM) is calculated by entering the cutting speed and the diameter of the material into the RPM formula.

Suggested Exercises

1. What the procedure for removing a 3-jaw chuck and fitting a 4-jaw chuck.
2. Remove a 3-jaw chuck and fit a 4-jaw chuck using the correct procedure.
3. Explain how to load and centre a workpiece in a 4-jaw chuck.
4. Load and centre a workpiece on a 4-jaw chuck.
5. Calculate the volume of a cylinder that has a diameter of 30mm and is 40mm long.

Questions

1. Explain how a chuck is safely removed from the spindle of a lathe.
2. Explain how to safely lift and store the chuck when it has been removed from the spindle of the lathe.
3. Explain how to centre a workpiece in a 4-jaw chuck using a dial indicator.
4. What are the advantages of a 4-jaw chuck?
5. What are the disadvantages of a 4-jaw chuck?

Answers

1. When removing or fitting a chuck, first place a board on the bed slide ways in order to protect them. A key is used to loosen the cam lock nuts, which are rotated until the indicator marks line up. The chuck should be held with the right hand, while a mallet tapped against the chuck to remove it from the taper. Both hands should be used to hold the chuck at the sides, not underneath. The chuck should be slowly lowered onto the board.
2. When lifting the chuck, it is important to keep your back straight and bend your knees when lifting or lowering the chuck. Ensure that the floor space around the lathe is free from debris, oil or coolant. These chucks are heavy, especially the 4-jaw chuck. If you have difficulty lifting or fitting these chucks, ask for help.
3. A plunger type dial indicator should be setup on the far side of the workpiece. The chuck can then be rotated by hand and the jaws loosened or tightened until the workpiece is centred.
4. The 4-jaw chuck can be used to hold (i) regular or irregularly shaped work, (ii) work can be set to run concentrically or eccentrically, (iii) it has considerable gripping power, (iv) Jaws are reversible and (iiv) there is no loss of accuracy as the chuck becomes worn.
5. (i) the chuck is heavy and difficult to setup in the spindle of the lathe, (ii) a dial indicator is needed to align the workpiece, which can take time, (iii) the gripping power is so great that fine work can be damaged.

Recommended Additional Resources

Reference Books

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

ISBN-13: 9780750660730

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