FACTFILE:

ENGINEERING & MANUFACTURING QUALITY CONTROL

UNIT 3.2.2 – USING MATERIALS, PARTS, COMPONENTS, TOOLS, EQUIPMENT AND PROCESSES

Rewarding Learning

Machine Tools

Introduction

Students should be able to:

identify, use and state the application of:

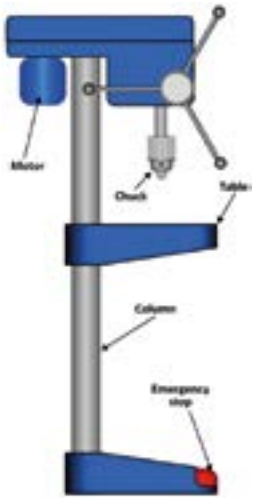
– drills and drill bits;

apply knowledge and understanding of and use the following machines:

– pillar drill;
– lathes (wood and metal);
– linisher; and
– mill; and

apply knowledge and understanding of the following machines:

– circular saw; and
– hand router.



Pillar drill

The pillar drill is used to cut circular holes in a range of materials. The pillar drill is set up so that holes will be square to the table and the depth of cut can be controlled using adjustable stops.

The force that drives the drill is supplied via a rack and pinion mechanism operated by rotating a set of lever handles. The Pillar drill is fitted with a 3 jaw chuck which will hold parallel shank drills up to 13mm diameter. The chuck can be removed from the machine spindle to accommodate larger diameter taper shank drills.

The drill is driven by a stepped cone vee belt drive which can deliver three or four drill speeds. Small diameter drills need to run at the highest speed and large diameter drills at slower speeds.

The speed a drill should be run at can be calculated from the diameter of the drill and the cutting speed of the material. For example steel has a cutting speed of 30 Meters per minute so a 10mm drill must rotate at 955rpm and a 25mm drill must rotate at 382rpm. The cutting speed is different for each material for example aluminium has a cutting speed of 200–300 meters per minute. Charts of drilling speeds can be found in workshop data books and charts and the closest speed on the machine is selected.

Example cutting speed calculation for a 10mm drill.

Firstly calculate the circumference of the drill - $c = \pi d$

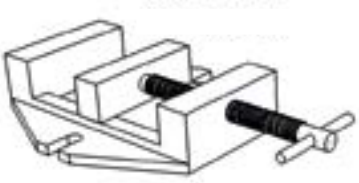
$= 3.142 \times 10$

$= 31.4mm$

In one rotation the cutting edge travels 31mm.
Given that the optimal speed for cutting steel is 30 meters per minute therefore the cutting speed in rpm is equal to -

$$\frac{\text{Cutting speed}}{\text{Tool circumference}} = \frac{30 \times 1000}{31.4} = 955 \text{ rpm}$$

When drilling, the work piece should be firmly held in a vice and a guard should be fitted to protect the user.



Machine Vice

The machine vice can be bolted to the drill table if required.

Hand Vice

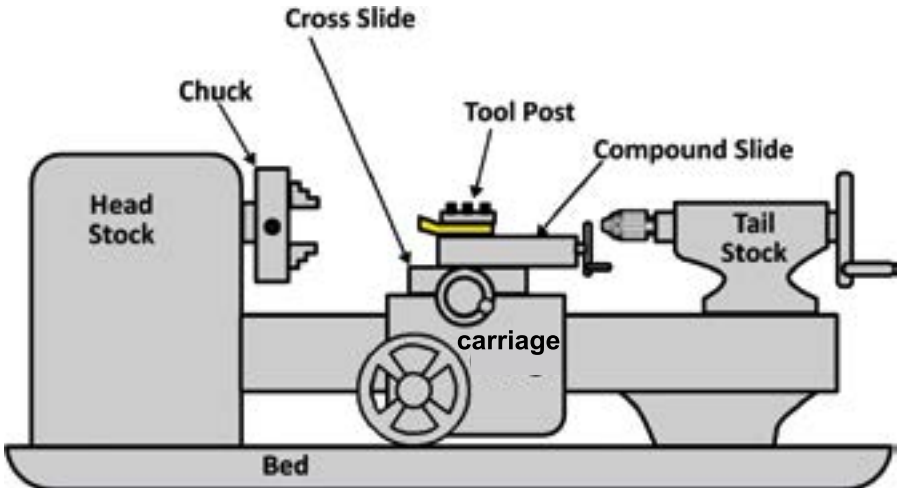
Thin material such as sheet metal can be held using a hand vice.

The centre lathe

The centre lathe is used for producing parts that are round in shape. There is a wide variety of operations that can be performed on a lathe to produce complex parts either manually or using automated machines.

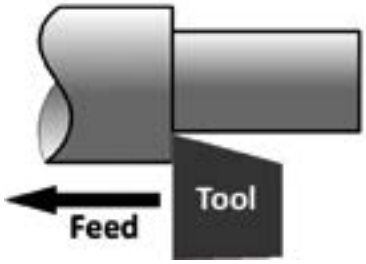
The centre lathe is a general purpose machine that is very versatile and is common throughout the engineering industry. The work is held in the chuck or between the chuck and the tailstock. The work is rotated towards the user. The cutting tool is held in the tool post. A range of tools can be used to perform basic lathe operations.

Shown below is the basic configuration of most modern manual Lathes.



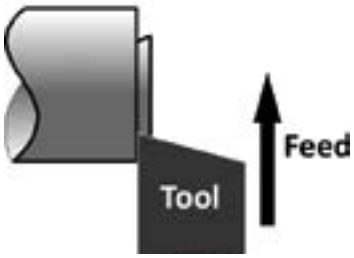
Lathe operations

Parallel Turning



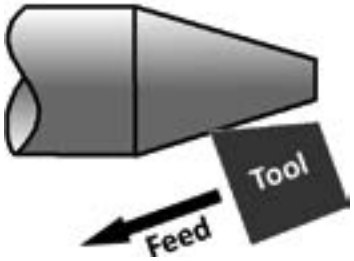
To produce parallel shafts and to reduce the diameter of the work piece.

Facing



Facing produces a flat face at the end of the part which is perpendicular to the axis of the machine.

Taper Turning

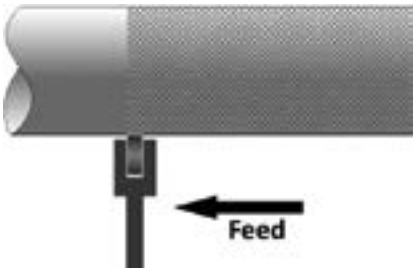


To cut a taper the compound slide must be set and locked in the required position. The compound slide hand wheel is used to move the tool and cut the taper.

Drilling

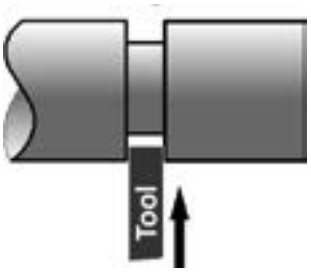
The work piece is rotated and the drill is held in the tail stock. Drilling on a lathe produces a hole in the centre of the work piece.

Knurling



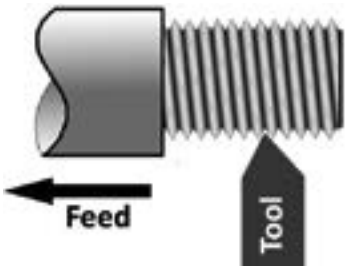
Knurling produces a regular roughened surface on cylindrical surfaces to provide grip on knobs and handles.

Parting off



Parting is a process which removes a piece of material from the end of a longer bar. The piece removed may be a completed part or a blank to be used in further processing.

Screw Cutting



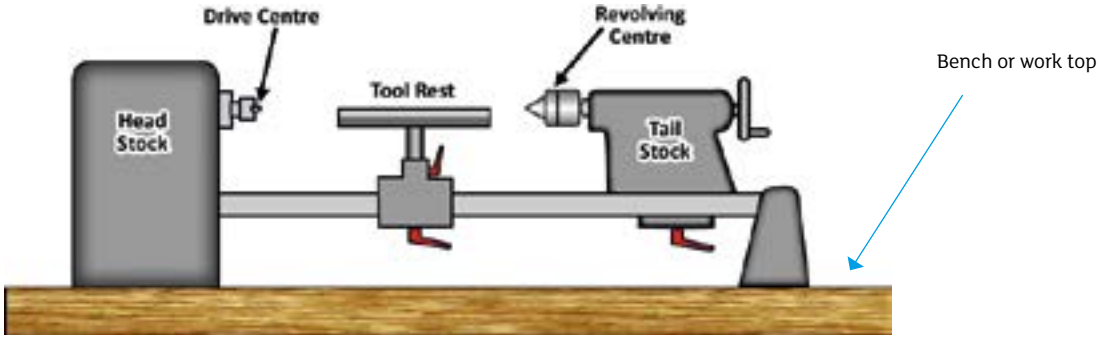
Screw cutting uses the feed mechanism to cut a specific pitch of thread with a precise tool ground to the correct angle. Internal and external threads Can be cut on a lathe.

Wood Lathe

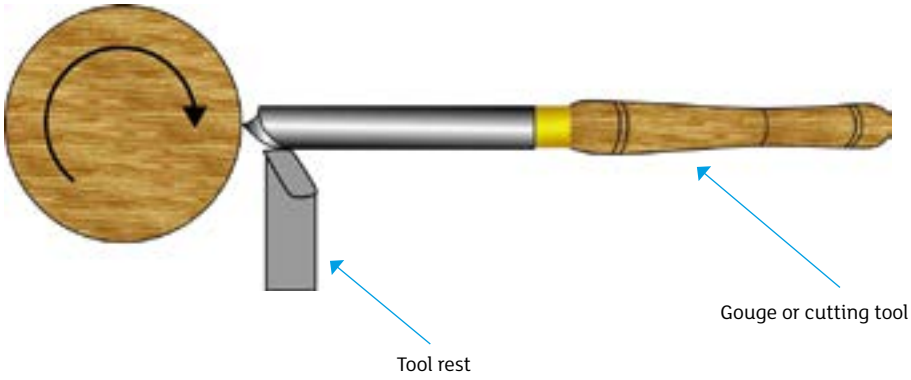
The wood turning lathe is used to produce parts or products that are round in shape, such as a wood spindle or bowl. The work is held between the head stock and the tail stock and rotates at high speed while cutting tools, including a variety of chisels and gouges, gradually cut and shape it.

The wood lathe uses a range of chisels and gouges to cut the spinning wood into complex profiles.

Basic diagram of woodturning lathe



The work rotates towards the user. The tool rest is set close to the work piece and the chisel is held firmly up to the work.

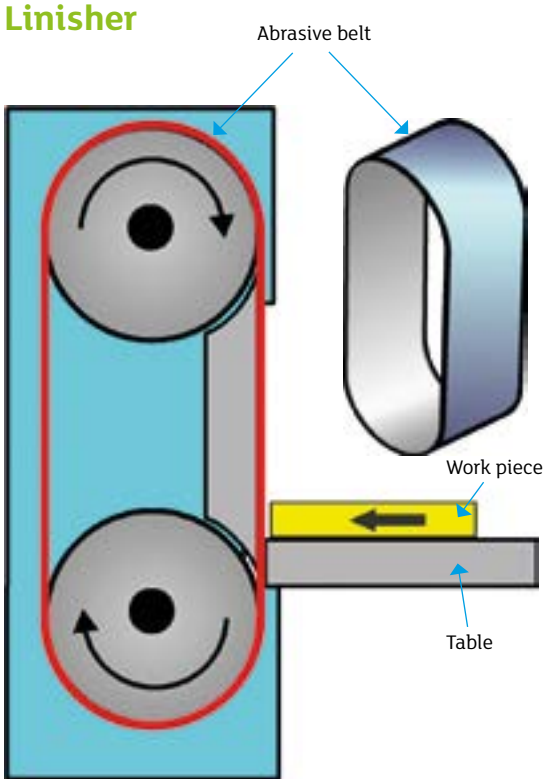


Wood turning lathes in use

© starman963/iStockphoto/thinkstockphotos

© PlazacCameraman /iStockphoto/Thinkstockphotos

Linisher



A linisher turns a belt of abrasive material which is used to smooth a workpiece, creating a level, even surface. Materials that can be used on a linisher are usually wood or metal.

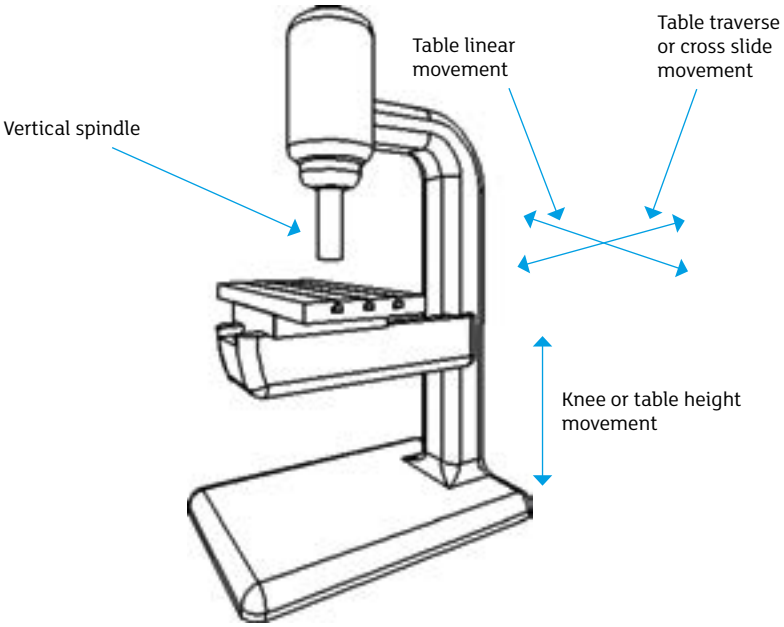
The belts used on a linisher are continuous and run over rollers. One of the rollers is driven by an electric motor.

The abrasive belts are available from 40 grit to 400 grit to suit the material removal rate or the finish required.

The work piece must be held flat on the table and fingers and hands must be kept away from the belt. There are many configurations of linisher including belted and disc sanders.

Milling Machine

The basic features of a milling machine are shown in the diagram below.



Milling is a machining operation that uses a rotating cutter to remove material from the work piece. There are two main groups of milling machine, those with a vertical spindle and those with a horizontal spindle. A vertical milling machine is shown. The cutter rotates in a fixed position and the work piece is bolted to the machine table or held in a sturdy machine vice.

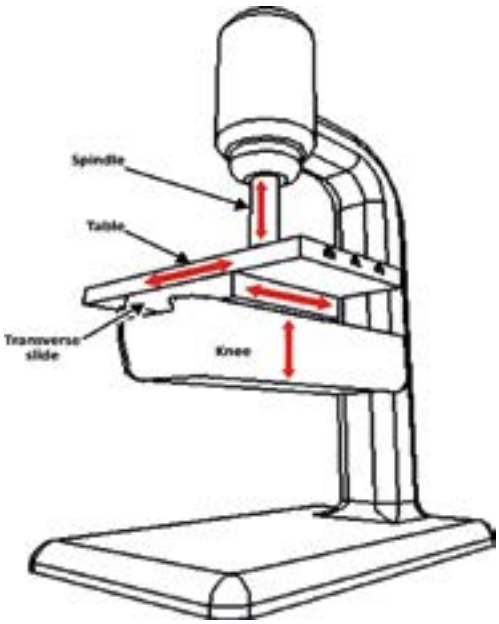
The machine table can be moved in three axes to move the work piece in relation to the cutter. The axes of the machine are moved by turning a series of hand wheels that have graduated scales to indicate the linear distance moved by each axis.

A number of different types of cutter can be fitted to the spindle. A number of specialist methods can be used to hold the work. Two basic methods are:

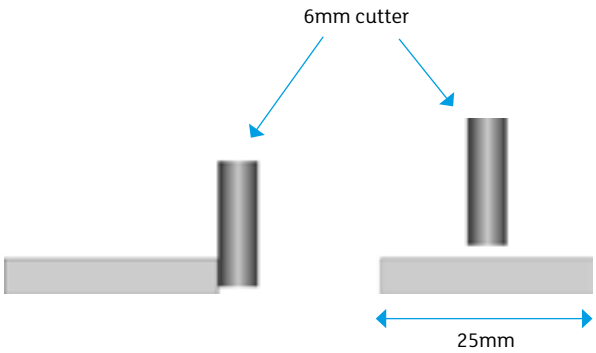
- use the T-slots on the table to directly clamp the work
- use a machine vice with a swivel base.

Once the work piece is clamped in position the tool must be touched on to the face of the work piece and the axis read out set to zero.

When indexing the tool into position to make a cut it is important to allow for the tool diameter.



To cut a slot in the centre of a 25mm wide steel strip with a 6mm cutter, first touch on to the edge of the strip and set the read out to zero. Raise the cutter and move it a distance equal to half the diameter of the cutter plus half the width of the steel strip which in this example equals 12.5 +3 (15.5mm).



Circular saws

Circular saws are so called due to the shape of the blade. Circular saws can be hand held, table mounted or floor mounted and are used mainly to cut wood. Handheld circular saws are portable and can be used where an electrical power source is available for example on a building site.

Typical circular saw blade

Circular saws are among the most dangerous tools and must be used with strict observance of Health and safety.

Floor mounted circular saws can be found in specialist timber merchants and are used to cut and prepare timber and manufactured board to specific lengths and widths. The blade of the saw can be set to an angle to produce a tapered edge. A dust extraction system must be used when operating the saw. The blade of the saw must always have a safety cover fitted and a push stick must always be used when cutting with this circular saw.

Hand Router

A router can be one of the most useful woodworking tools. A router holds a cutter in a collet chuck and spins up to 3000rpm. The router has a base plate mounted at 90 degrees to the cutter and is faced with low friction material to allow the router to be moved freely over the material surface.

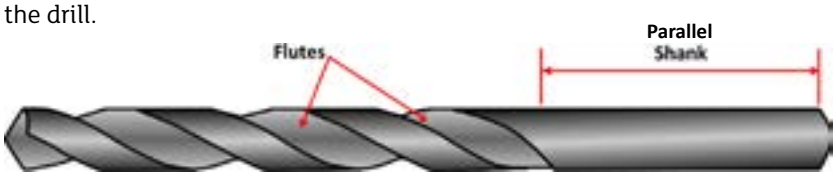
Cutters are available in a range of standard diameters (6mm, 10mm and 12mm) and can be parallel cutters or cut complex curves and profiles onto the wood edge.

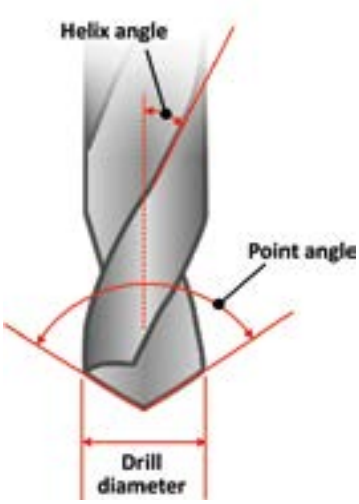
The depth of cut is adjustable and can be set by means of a depth stop. When setting a depth, it is always worth checking it by routing into a piece of scrap before working on the actual workpiece. Some manufacturers offer routing tables to suit their routers. In such cases the router is normally fitted upside-down with the cutter projecting above the table surface so that the workpiece can be laid on top and, normally, run against a fence across the cutter.

Drill Bits

The parallel shank twist drill is the most common drill and fits directly into a chuck. The standard point angle is 118 degrees but this can vary depending on the metal it is used on e.g. 130 degrees is recommended for drilling brass. Two spiral grooves called flutes run along the length of the drill and serve to guide the swarf produced upward and out of the hole. The flutes also provide a means for cutting fluid to reach the cutting edges.

The geometry of the twist drill has been developed over many years to produce accurate holes, minimise cutting forces and maximise the life of the drill.





Large diameter drills generally above 13 mm have a taper shank to ensure correct alignment of the drill. The tapered section fits into the spindle of the drilling machine or tail stock of a lathe and locks in position. The taper used is called a morse taper and is self-locking in that it will grip and hold in position and must be removed from the spindle by using a wedge called a drift to release the taper.

Taper Shank

The taper shank drill has a tang on the end of the taper to ensure a positive drive from the spindle of the drilling machine.

There are a number of specialist woodworking drill bits e.g. the forstner, countersunk and flat bit. The flat bit is shown and described below.

Flat Bits

These wood boring bits have a point located in the centre, which is flanked by flat steel on either side. Flat wood boring drill bits can cut fairly large flat-bottomed holes with a central point.

Flat wood boring bits produce a lot of splintering when they break out the back of the board, but this can be reduced by using a backing board to support the back face of the material. Flat wood drill bits are not suitable for enlarging existing holes.

Revision Questions

1. Explain how the drill speed may be changed on a pillar drill.

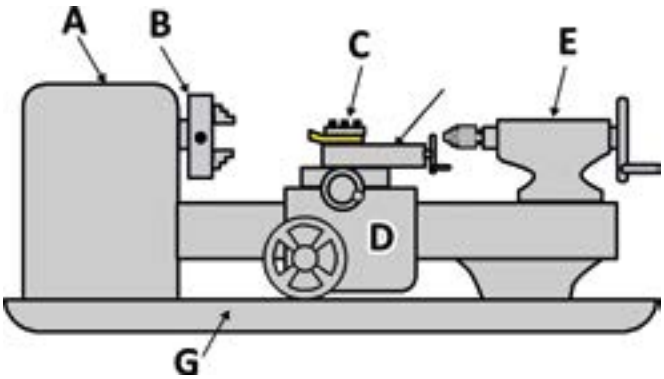
2. How might one ascertain the correct drill speed for a given drill diameter?

3. What safety precautions should be taken when using a pillar drill?

4. Explain why a component may have a knurl applied to it.

5. Name the parts of the centre lathe labelled in the diagram below.

A _____
B _____
C _____
D _____
E _____
F _____
G _____



6. Explain the purpose of the flutes in a twist drill.

7. What is the purpose of the tang on a taper shank drill?

8. Explain why a backing board would be required when using a flat wood boring bit.

Additional Resources

Removing a taper shank

https://www.youtube.com/watch?v=KbI_7IHAsyw

How to Change the Speed of your Drill Press

https://www.youtube.com/watch?v=YzNWuumF-L8

Lathe Workshop for Beginners Part 1, Turning

https://www.youtube.com/watch?v=fDSLWYHuj4g

Wood turning a Basic Bowl Part I

https://www.youtube.com/watch?v=TIvROyV2n6w

Crash Course in Milling

https://www.youtube.com/watch?v=U99asuDT97I&list=PLfmaggeseM2901aQchjJutwqbgM3bVNkO