The Centre Lathe

Although the lathe is basically a machine for generating cylindrical forms, it is in fact much more than this, being a readily adaptable piece of mechanism which can be used to perform numerous other machining operations in addition to its basic functions.

The work, normally rotating towards the operator, can be set up between two centres which engage in countersunk holes at either end, or it can be gripped in a chuck or bolted to a face-plate. The cutting tool, mounted on top of the carriage, can be moved along the machine or square across it and these two motions perform the basic functions in the generation of a true cylinder. The lengthwise traverse of the tool is commonly referred to as 'sliding' which produces a round face and the cross-traverse as 'surfacing' (or 'facing') which produces a flat surface.

In addition to sliding and surfacing, the lathe can be used to produce tapered work, to cut screw threads, for boring and recessing, for profiling (shaping to contours), whilst the chucks and face-plates can be used in machining a variety of flat, cylindrical or irregular forms. A further range of operations can be undertaken by reversing the locations of tool and work, the tool rotating whilst the work is held on the carriage and brought up to the tool.

The main parts of the centre lathe are seen in the diagram.

The Bed

This is the foundation of the lathe, and made in cast iron, it is usually of a very robust box-like form, ribbed on the inside and ported so that coolant and swarf can pass through easily. The top surfaces of the bed, known as the 'ways' are accurately machined and often hardened, the satisfactory working of the lathe being very largely dependent on the alignment of these surfaces which are usually finished by precision grinding.

Headstock

At the left, and in the form of a stout box-casting, the headstock is precisely located and bolted to the bed. It is occasionally cast in one piece with the lathe bed. The headstock carries the spindle in precision bearings which must take both radial and end loads. They are usually of the tapered-roller type and on assembly, are pre-loaded to eliminate end-float and side-play in the spindle.

The spindle is hollow, to accommodate long bars in the chuck and the inner end of the bore is machined to a standard taper to receive the live centre or other accessories as required. The Morse standard taper is used on English lathes. The 'live' centre is so called because it is the one which always rotates with the work and is associated with the driving. The hollow spindle facilitates the ejection of the live centre with a length of rod passed through the bore.
Tailstock

The tailstock supports the free end of the work and is used also in the drilling and reaming of work held in chuck or on face-plate. It slides on and is guided by the bed-ways and in most lathes is made in two parts which permit of a lateral adjustment. This is used in off-centre taper-turning. The casting is bored to receive the barrel (or sleeve) whose axis is precisely in line with that of the spindle. The inner end of the barrel is machined to receive the tapered centre which can be of the stationary or rotating kind. The taper-socket in the barrel is used for holding taper-shank drills, reamers or other accessories. At the outer end, the barrel is threaded to take the adjusting screw which is operated by a hand-wheel.

Carriage or saddle

This forms the base of the unit which supports the cutting tool and it can be traversed along the whole length of the bed by hand control or by power feed. It can be clamped at any point along the bed. A cross slide is provided for cross traversing or 'surfacing' and on this slide is mounted the compound slide (top slide) which can be pivoted and locked at any angle for use in, turning short tapers. To the front of the carriage is fixed the apron which extends well down over the front of the bed and here are found the controls for hand or power feeding when surfacing or sliding.

Chucks

Every lathe should be equipped with two chucks, one a self-centring (SC) 3-jaw chuck and the other a 4-jaw independent chuck, both of the size recommended by the lathe manufacturer.

Self-centring chucks

The 3-jaw SC chuck will automatically centre rounds or hexagons, all jaws opening or closing together as the scroll is turned with the key. The jaws are matched to the scroll during manufacture and each is numbered so that it can be returned to its correct slot after removal.

Independent jaw chucks

Whilst the 4-jaw independent chuck is indispensable for holding work of irregular shape and for off-centre turning, it can also be used for holding squares or rounds. Centring takes a little longer but it can be done very accurately using each individual jaw adjustment. Independent jaw chucks are supplied with only one set of jaws since these are reversible.

The face-plate.

The face of the plate has a series of holes and radial slots so that irregular shaped work, such as castings, can be bolted onto it.
Centres.
Lathe centres can be put into the headstock spindle or tailstock barrel.

The headstock centre turns with the work and is not subject to friction. It can therefore be left soft, and is known as the live or soft centre.

The tailstock centre remains stationary while the work rotates. This causes friction, and so the centre must be hardened and grease must be used to lubricate it. It is known as the dead or hard centre. On a revolving centre, the centre is mounted in a bearing which allows it to rotate with the work to prevent friction.

On a half centre part of the centre point has been ground away so that the tool can cut up to the centre hole of the work while it is being supported by the tailstock.

Lathe work processes

Surfacing or facing off.
When the tool moves across the end of the work, at right angles to the axis of rotation of the work, a flat surface is produced on the end.

Sliding or parallel turning.
When the tool moves sideways, parallel to the axis of rotation of the work, a cylindrical shape is produced.

Taper turning.
When the tool moves along the work, at an angle to the axis of rotation, a conical shape is produced.
- To turn a very short chamfer use a form tool.
- To turn a short taper rotate the compound slide to the required angle, tighten the clamping screws, and move the tool with the compound slide handle. The maximum length of taper which can be turned is limited to the length of feed on the slide.
- To turn a long gradual taper offset the tailstock or use a taper turning attachment. The work must be mounted between centres for this.
Drilling in the lathe.
This is more accurate than drilling on a drilling machine. Because it is not possible to centre punch work held in the lathe before drilling, we use a centre drill instead.

Knurling

Knurling tools are used to press (not cut) a diamond or straight pattern of lines into metal, usually to provide a grip. Two very hard steel wheels mounted in a swivelling head are needed to make a diamond knurl, but only a single wheel for straight knurling. Fine, medium, and coarse knurling tools are available. Oil should be used to lubricate the wheels when knurling steel.

Feed the tool into the work and adjust it until the impression made by the wheels is equal and even from left to right. Then increase the pressure until a full knurled print is being made on the metal, and slowly move the tool along the work.

Lathe tool shapes

Round nosed tools give a smoother finish than pointed tools, but larger cuts can be taken with a pointed tool. A knife tool is necessary to turn to a sharp shoulder, and can be used to take roughing cuts. It must have a slight radius at its tip, produced by using a slip stone, to prevent the extreme tip from burning or breaking off and to improve finish.

When roughing with a knife tool set it to give the correct approach angle as shown, with the tool angle trailing, so that swarf is directed away from the work, and so that it will swing safely out of the way without digging into the material if the tool comes loose.
Right-hand knife tools can be used to face off the right-hand end of a bar, to cut to a right-handed shoulder, or to cut along the work from right to left.

Left-hand knife tools can be used to cut to a left-handed shoulder or cut along the work from left to right.

Round nosed tools can be used to cut in either direction and to cut to left- or right-handed shoulders where a radiused corner is wanted.

Parting tool. See parting off.

Form tools can be specially ground to produce any required shape, such as the curved top of a turned screwdriver handle.

Parting-off

A narrow tool is fed into the work, exactly square to the axis, to cut it to the correct length and face it off at the same time.

The tool is offset to the left so that you can part off as close to the chuck as possible. The sides of the tool taper 1° or 2° from the cutting edge to the back to prevent the tool jamming in the groove. The sides also taper 2° from top to bottom and the tool has a front clearance of about 5°.

The top rake is 5° for steel and aluminium, flat for cast iron and 2° negative for brass. The cutting edge slopes so that the workpiece is cut off cleanly, and the pip remains on the spare material where it is faced off.

Setting up lathe tools

The correct height for general purposes is to set the tool at centre height as shown.

Always support the tool in the toolpost, as near to the cutting edge as possible. A large overhang increases the risk of vibration or chatter, causing poor finish, inaccurate work and the risk of tool breakage. A tool which is set too high will simply rub against the work without cutting. A tool which is set too low will dig into the work and try to go underneath it. This may bend the work or break the tool.