Introduction to Lathe and Workpiece

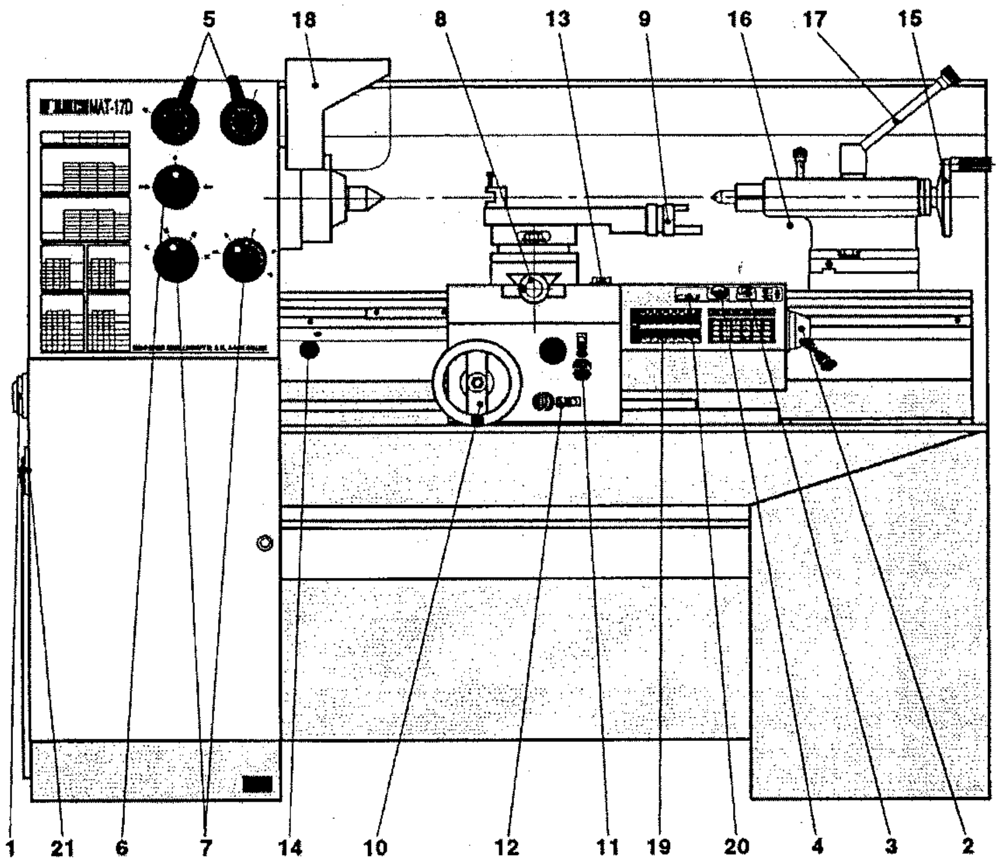
Introduction to Lathe and lathing exercise piece

Delft University of Technology

Challenge the future

Contents

Bedieningselementen



Bedieningselementen (EMCOMAT 17D).

1 hoofdschakelaar van de machine (vergrendelbaar)
2 schakelaar voor hoofdspindel (aan/uit, linksom/rechtsom)
3 NOODSTOP-knop
4 regelaar voor het toerental (EMCOMAT 17D/20D)
5 hendels voor het instellen van het mechanische toerental
6 draaiknop voor de voedingsrichting
7 draaiknoppen voor het instellen van voeding en draadspoed
8 handwiel voor de dwarsslede (X-as)
9 handwiel voor de bovenslede (Zo-as)
10 handwiel voor de langsslede (Z-as)
11 hendel voor langs- of dwarsvoeding
12 hendel voor de slotmoer
13 vastzetschroef voor de langsslede
14 draaiknop voor het aan- en ontkoppelen van de transporteur
15 handwiel voor de pinole van de losse kop
16 hendel voor het vastzetten van de pinole
17 hendel voor het vastzetten van de losse kop
18 klauwplaatafscherming met schakelaar
19 digitale positie-aanwijzing (bij EMCOMAT 17D/20D)
20 digitale toerental-aanwijzing (bij EMCOMAT 17D/20D)
21 schakelaar voor de koelmiddelpomp (accessoire)

Control elements of EMCOMAT 17D

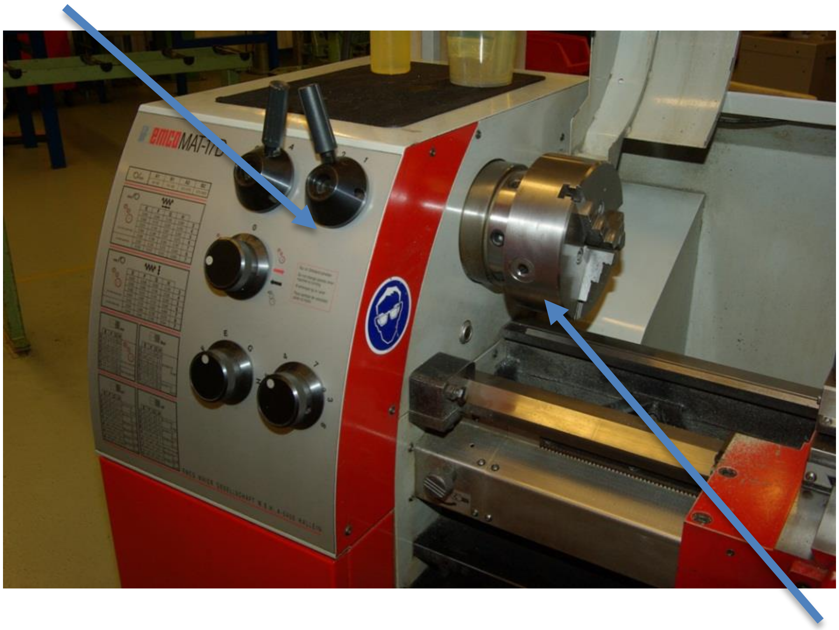
1. Main switch (lockable)
2. Main spindle switch (on/off, anticlockwise/clockwise)
3. EMERGENCY STOP button
4. Rotational speed control (EMCOMAT 17D/20D)
5. Mechanical speed adjustment levers
6. Rotary switch for feed direction
7. Rotary switches for adjusting feed and thread pitch
8. Cross-slide handwheel (X axis)
9. Top slide handwheel (Z0 axis)
10. Longitudinal slide handwheel (Z axis)
11. Longitudinal and transverse feed control

12. Lock nut lever
13. Longitudinal slide locking screw
14. Rotary switch for coupling and disconnecting conveyor
15. Tailstock sleeve handwheel
16. Tailstock sleeve locking lever
17. Tailstock clamping lever
18. Chuck guard with limit switch
19. Digital position display (for EMCOMAT 17D-20D)
20. Digital speed display (for EMCOMAT 17D-20D)
21. Switch for coolant pump (accessory)

Lathe

A lathe is a piece of equipment that rotates a workpiece about an axis of rotation against a cutting tool (bit).
The cutting tool can move along the rotating workpiece over two axes, thus removing material from the workpiece.
A lathe consists of the following components:

The headstock

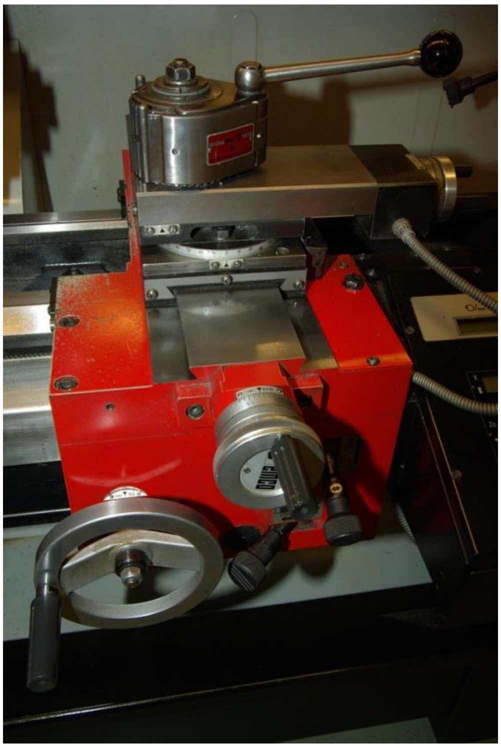


The workpiece is clamped on the headstock using a clamping device.
Various holding devices can be mounted on the headstock to clamp the workpiece, such as a three- or four-jaw chuck, clamping collets, carriers and clamping centres.

The ways

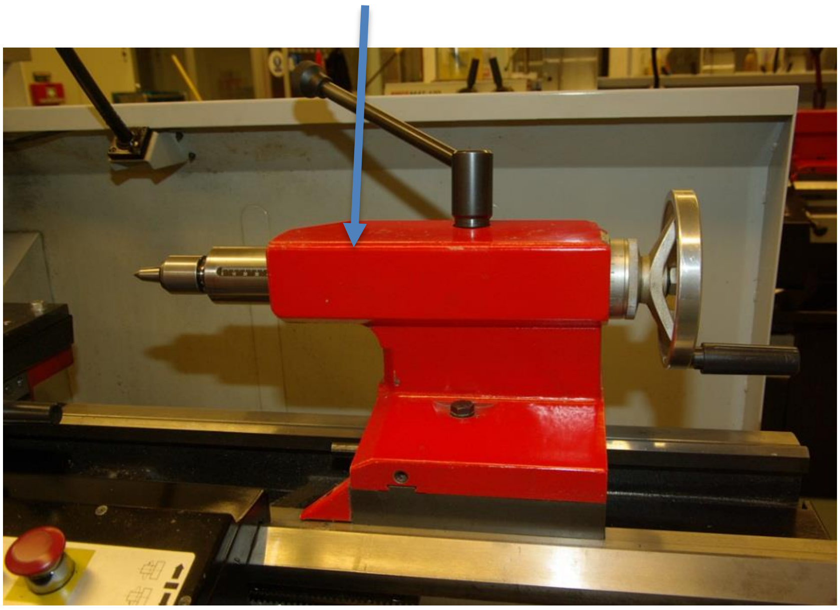
The ways is a ground casting with two guide prisms. The machine bed runs parallel to the centre line between the headstock and tailstock of the lathe with great precision. This applies both to height and transverse precision.

Slides



The (cutting) tool is attached to the slides in a tool holder.
The longitudinal slide moves along the bed in the longitudinal (Z) direction of the workpiece.
A cross slide is affixed to the longitudinal slide which moves along a cross bed (X direction), at right angles to the bed and workpiece.
On top of the cross slide there is a tool- or auxiliary slide which can be rotated 180° and in principle is set at 0°, i.e. longitudinally like the bed. (Z 0 direction).

Tailstock



Drills, centres and other auxiliary tools are mounted in the tailstock.

In addition to this are the feet on which the lathe stands.

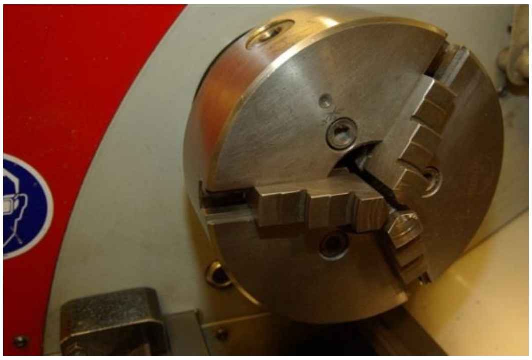
Lathe tools

From top to bottom and from left to right, we see:
- Square chuck key for adjusting the three- and four-jaw chuck.
- square box spanner for the various square bolts.
- Morse Taper adaptor sleeves.
- various tool holders.
- Morse Taper ejector wedge.
- open-end spanner.
- rotating centre.
- drill chuck.
- various cutting tools.
- centre drill.
- Between the bottom cutting tool holders, the reversible jaws for the three-jaw chuck.

Workpiece clamping tools

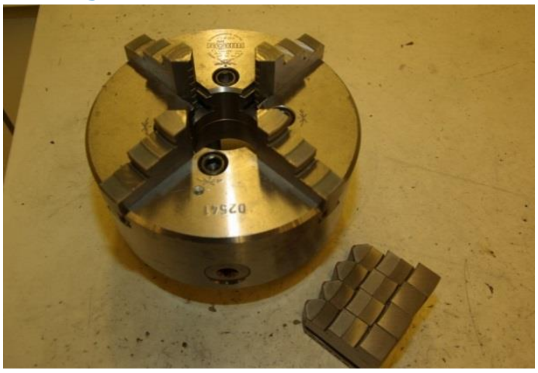
The workpiece is clamped to the headstock with the clamping tool. The clamping tool rotates around the centre line.
Commonly used clamping tools:

Three-jaw chuck



A self-centring three-jaw chuck has three jaws which open or close at the same time when the square hole is turned using the square lathe chuck key. The self-centring three-jaw chuck is usually used to clamp round materials, but equilateral hexagonal materials are also possible.

Four-jaw chuck



A self-centring four-jaw chuck has a similar construction and function to the three-jaw chuck, but has four jaws, in which round, equilateral quadrangular and octagonal materials can be clamped.
For non-equilateral quadrangular materials, an independent four-jaw chuck can be clamped.

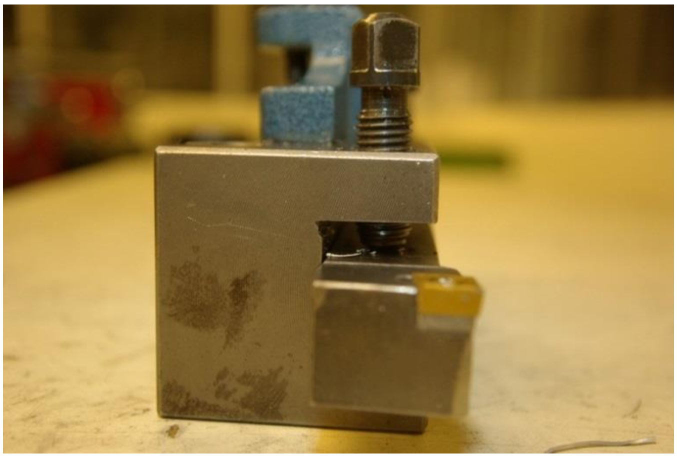
Clamping collets

Clamping collets are cut-to-size vice-grip jaws for round materials that are placed in a special clamping collet holder and may only be used for the material diameter indicated on the clamping collet. Clamping collets are cut in such a way that materials are clamped along the entire length of the collet, ensuring rotational accuracy.

Fixing the cutting tool

The cutting tool is fixed in the cutting tool holder.

The cutting tool head should protrude as little as possible from the cutting tool holder. The cutting tool is fixed in the cutting tool holder using the square-head bolts

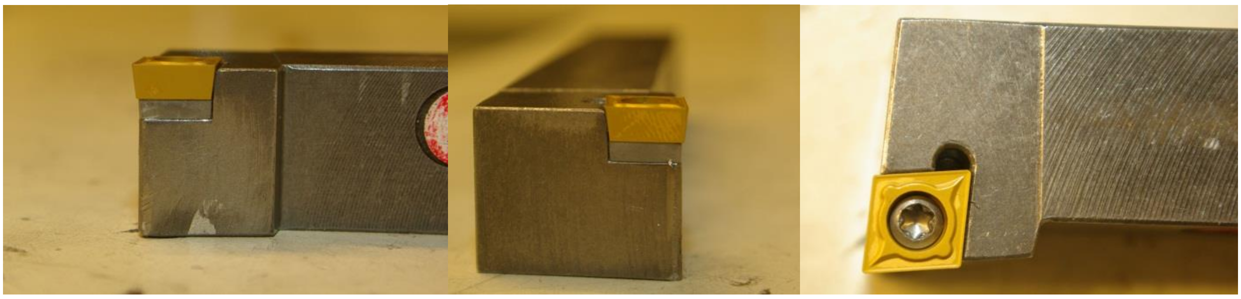


so that the centre of the cutting tool is positioned directly beneath the square-head screws.

The centre line

Between the centre of the headstock (e.g. if the jaws of the chuck have been fully tightened) and the centre of the tailstock (e.g. the point of the rotating centre) there is an imaginary line, the centre line.
This centre line runs parallel to the lathe ways, both in height and depth. The bed is ground in such a way that wherever the tailstock is positioned on the bed, it will always accurately follow the centre line.
Because the support can also move over the bed, it also follows the centre line regarding height and depth.
When the cutting tool point is aligned with the centre of the tailstock, the cutting tool point will therefore also follow the centre line when the support moves. This is necessary for the precision of the workpiece but is also important for the height of the cutting tool.

Cutting Tool Tip

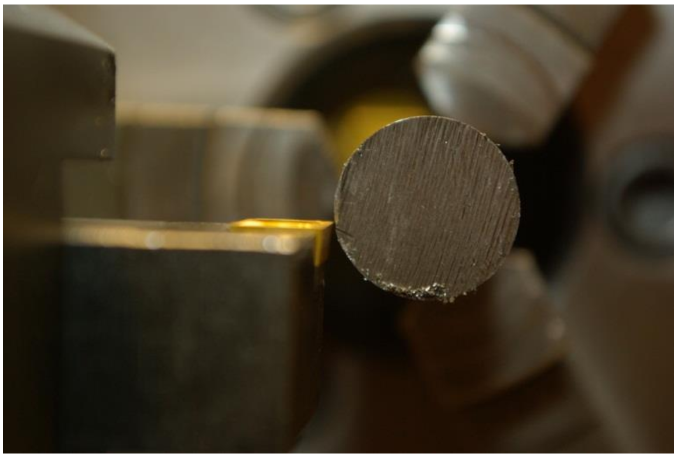


On all sides, the cutting tool has bevels at a certain angle. These so-called clearance angles depend on the type of cutting tool and the type of material to be machined.
The clearance angles ensure that, with the correct adjustment, only the tip of the cutting tool touches the material to be machined.

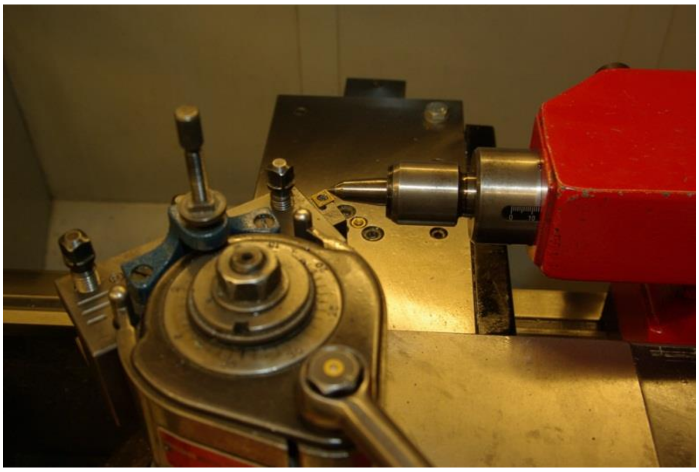
Adjusting the cutting tool

To be able to touch the material with the tip of the cutting tool, the tip of the cutting tool must be precisely at the centre line height, where the clamped material is widest.

If the tip of the cutting tool is too high above the centre line, it will not touch the material due to the clearance.



If the cutting tool is positioned too low, the material will tend to ‘creep onto’ the cutting tool or the cutting tool will end up under the material, causing the workpiece to deform or in the worst case, the cutting tool to break.

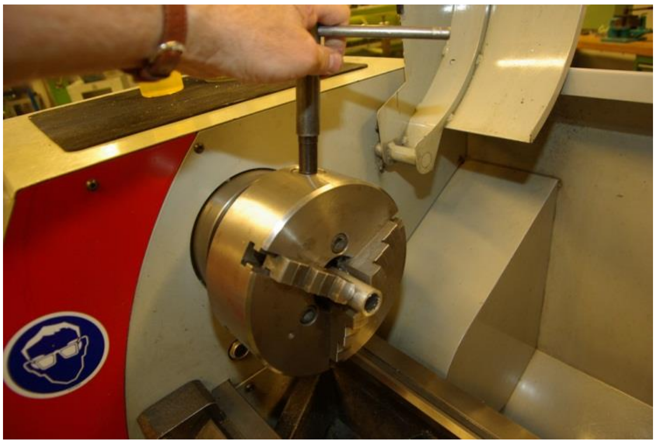


The cutting tool holder with the cutting tool is placed in the cutting tool holder clamp so that the point of the cutting tool can touch the point of the rotating centre in the tailstock.

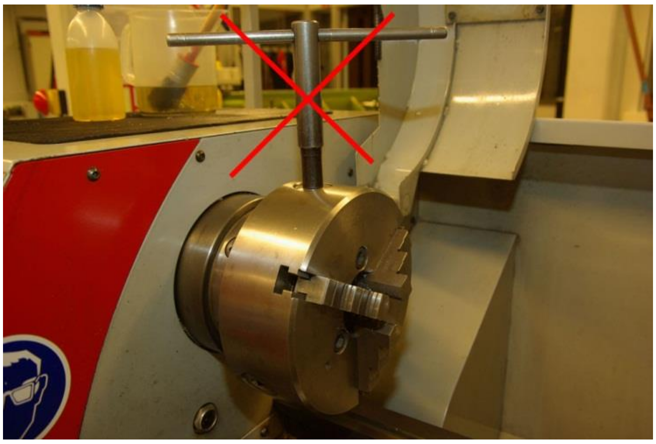
Using the height adjustment screw of the cutting tool holder, the cutting tool point is brought to the same height as the point of the rotating centre in the tailstock.
The lock nut on the height adjustment screw is tightened to prevent undesired movement of the height adjustment screw.

The cutting tool holder is then fixed so that the cutting tool is at right angles to the centre line.

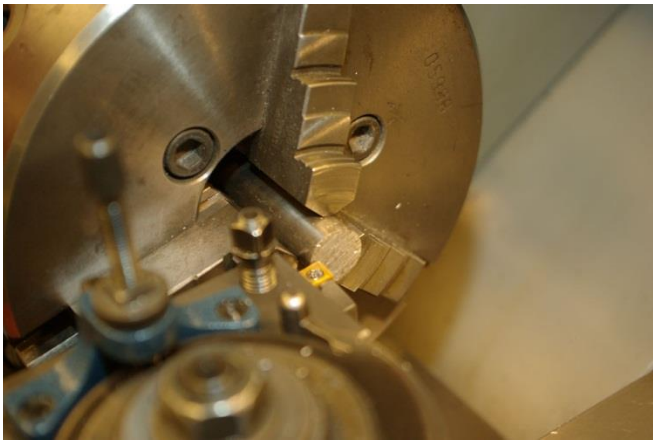
Clamping the workpiece



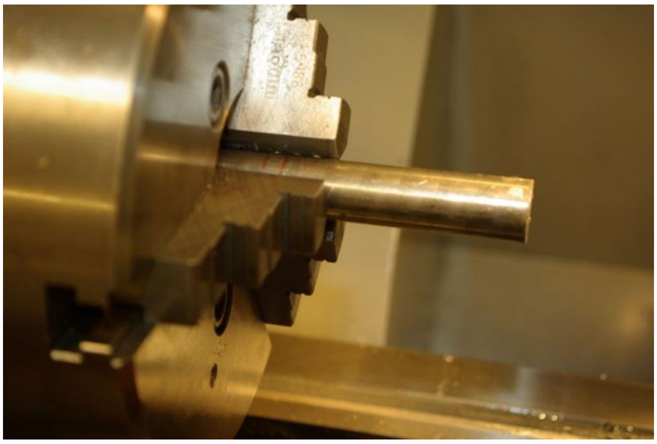
The workpiece is clamped in the three- or four-jaw chuck using a square lathe chuck key.



NB Never leave square lathe chuck keys unattended in the chuck!



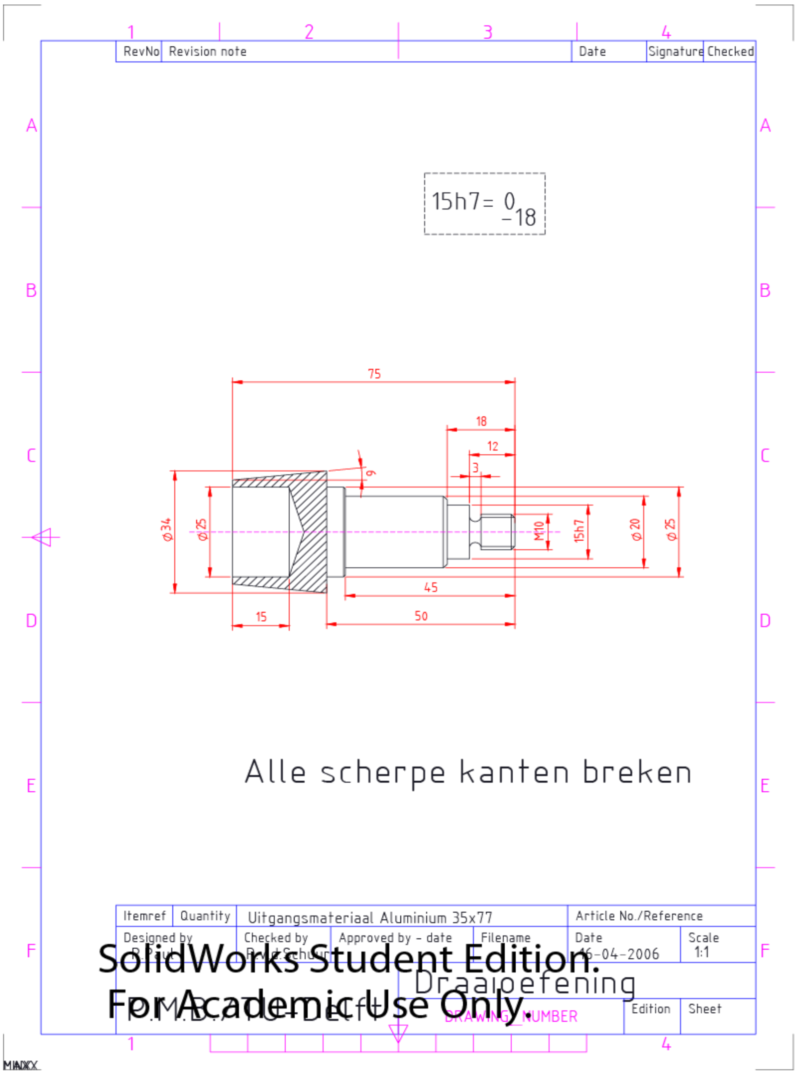
A self-centring three-jaw chuck is most commonly used for simple workpieces.
The workpiece is usually a sawn-off piece of rod of a certain diameter. For the sawn-off side of the workpiece to be at a good right angle to the diameter, the sawn-off side must be faced. For this, the workpiece is placed in the three-jaw chuck protruding by about 10 mm. The sawn side can then be faced.



The drawing is used to determine along what length the workpiece should be machined, and the workpiece is clamped in the three-jaw chuck for this length + 5 mm for clearance and safety.
The material is now ready for machining.

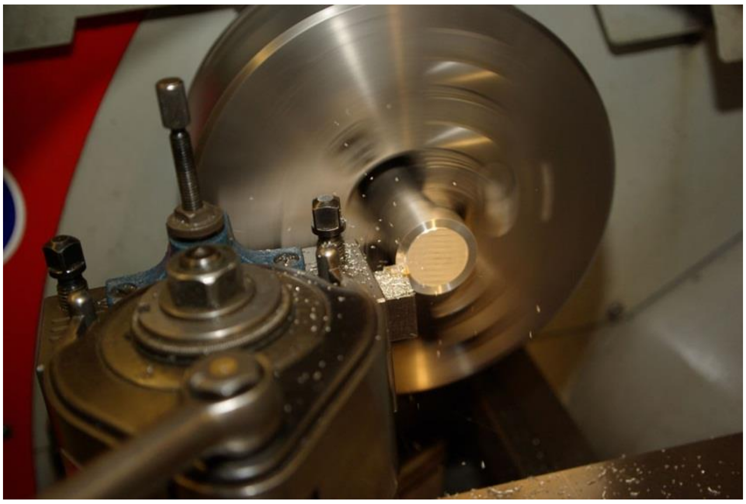
The cutting tool and workpiece are clamped and work can start.

Machining sequence

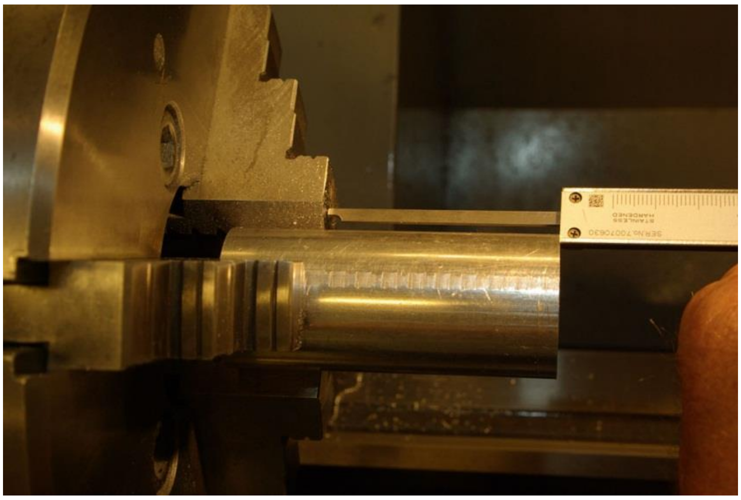


Before starting on a workpiece, you need a drawing. The drawing shows the machining sequence to be followed.
For turning, this is;
- Front face
- Inside
- Outside

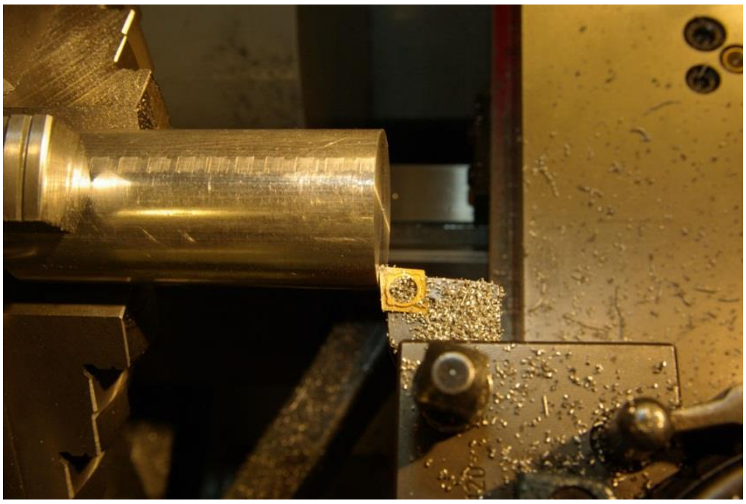
In this case, this is slightly different because you need to start on the side where the outside will not be tapered, as you cannot clamp the tapered side.
In the case of this drawing, the sequence is therefore:
- smooth the front face
- first make the side with the taps and screw thread
- turn the workpiece round
- drill and turn out the hole
- make the tapered side.



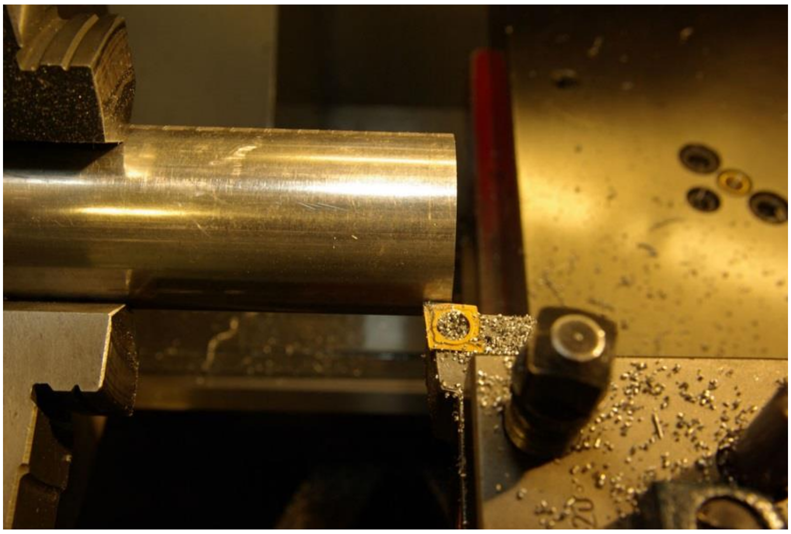
We start by clamping the workpiece so that we can smooth the cut front face. At this point, the workpiece should not protrude too far from the three-jaw chuck (10 mm is sufficient). This is particularly important when working with materials with a small diameter. The front side is smoothed.



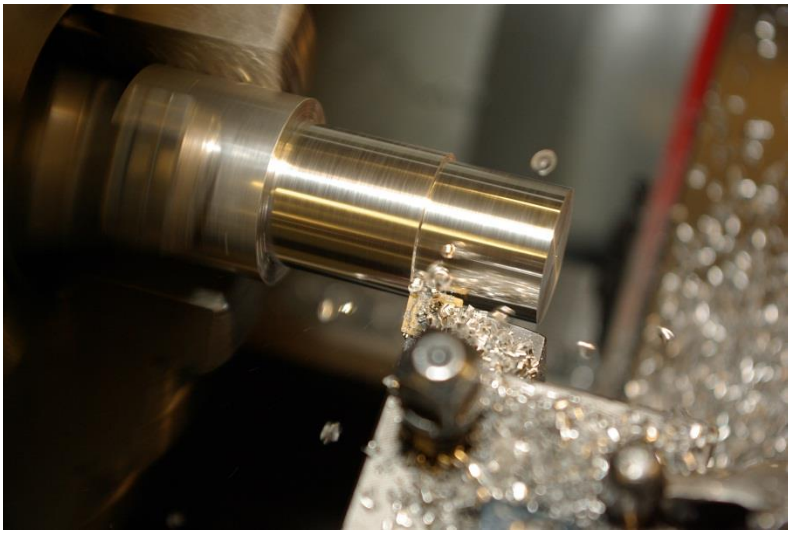
The workpiece is then clamped in the three-law chuck so that it protrudes further. The length depends on the longest taper that needs to be turned. Add 5 mm to this length for cutting tool clearance in relation to the chucks.



The cutting tool is positioned against the end of the turning workpiece so that it only just engages with the workpiece. Then, the end of the workpiece is again turned clean with a very small movement, which is the calibration zero point for the Z direction. The Z is set to zero on the keyboard.

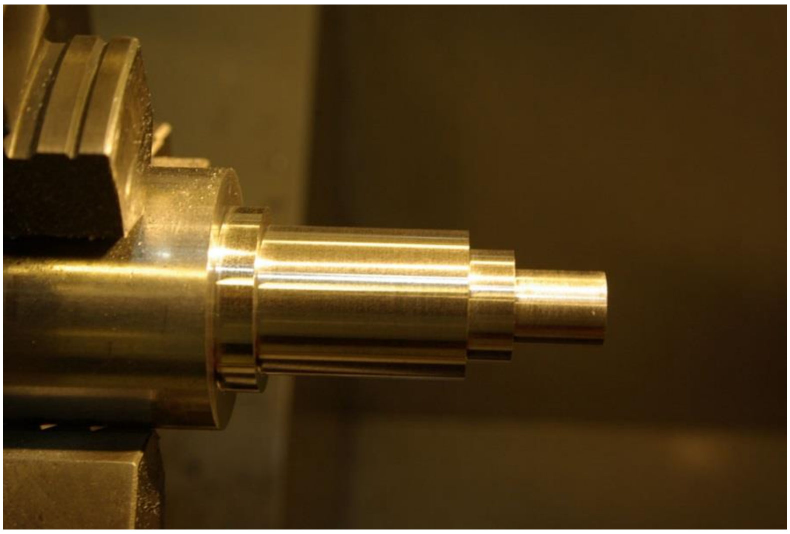


We then do the same with the X axis on the longitudinal side of the material. Skim the rotating material until the cutting tool just leaves a mark. This will then be the X0. The X is entered on the keyboard.

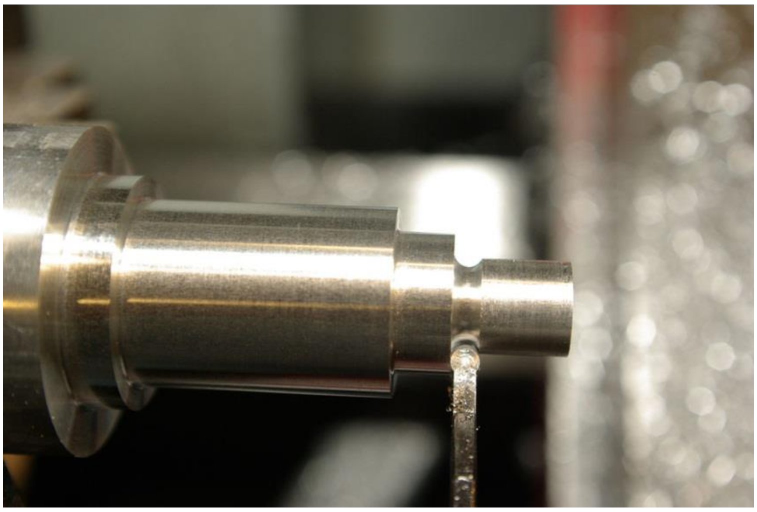


If the diameter allows, the material is now turned clean by e.g. advancing by 0.2 mm and turning lengthwise. When this happens, the cutting tool is not moved in the X direction. The precise diameter is measured and entered using the keyboard. Then, the longitudinal taps are turned to the required length and diameter.

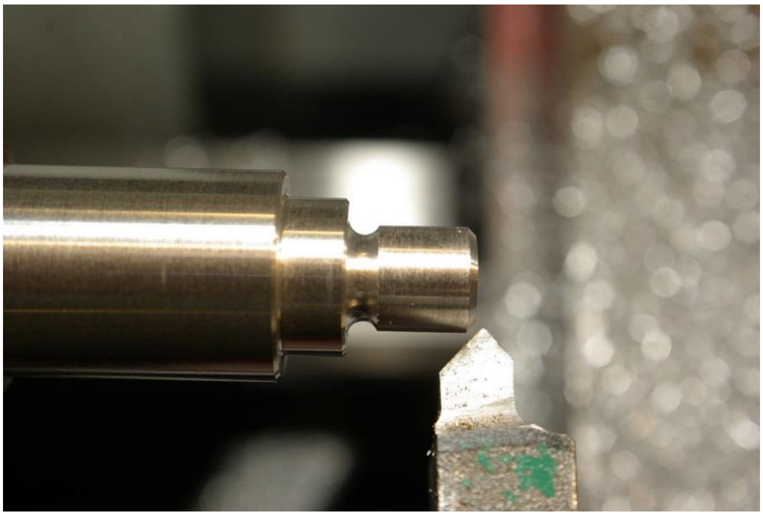
Longitudinally (Z), the length is turned in accordance with the drawing until reaching 0.2mm under size. Continue to do this until achieving the specified diameter, and then, at the last longitudinal section, continue until the correct longitudinal distance (Z) is reached. Next, turn the X all the way back and past the initial diameter along the tapered head of the workpiece so that it becomes entirely smooth.



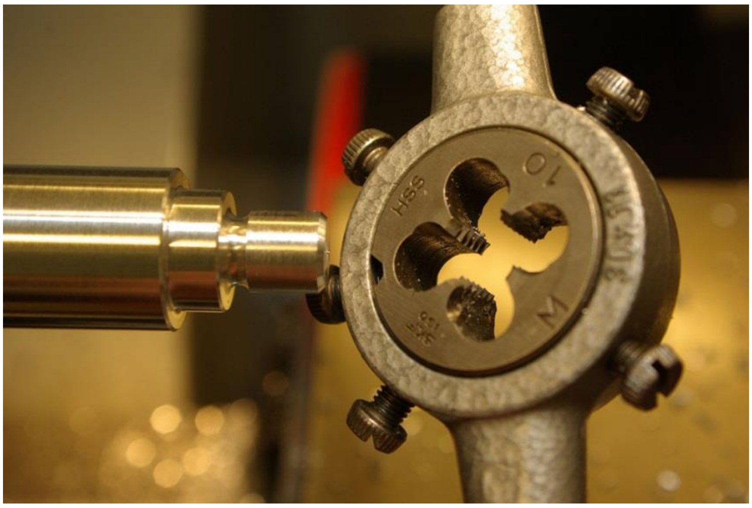
This is repeated until all the longitudinal taps have the correct diameter.
The tap on which the screw thread is to be cut is made to the diameter of the thread, and if necessary, kept 0.1mm smaller to make it easier to cut the thread. In this case, M10 thread is turned around 10mm and kept 0.1mm smaller, makes 9.9 mm.



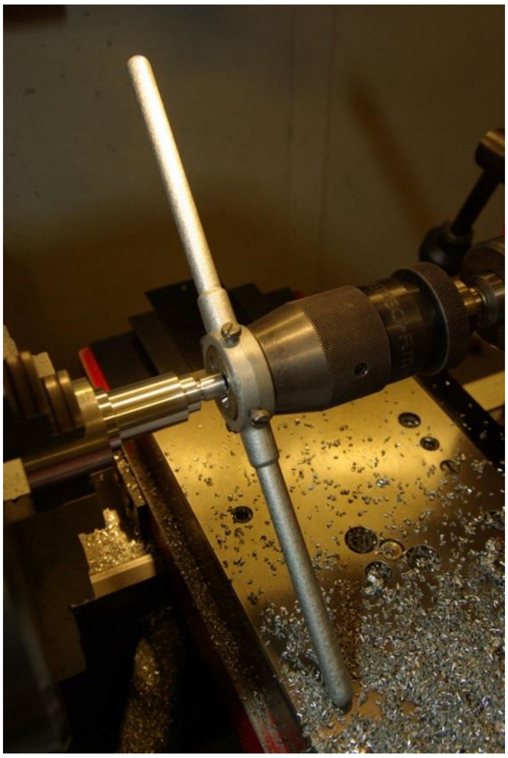
Next, a radius bit is used to mortise the run-out of the screw thread to be made. The bitl is clamped in a cutting tool holder and positioned at centre height, and then clamped at right angles to the centre line.
Because the bit grooves the full width of the material, the turning speed is lowered and the bit applied slowly to the material.



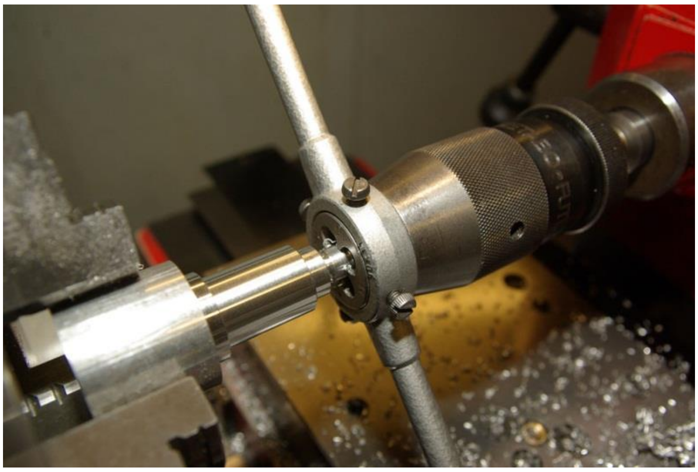
Finally, the straight edges are broken using a 45 bit and chamfered where necessary.
The diameter where screw thread is to be made is chamfered further to make it easier to cut the thread



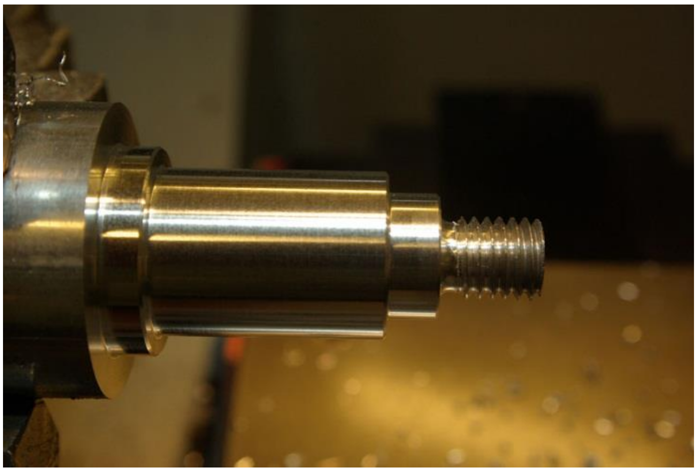
In this case, the screw thread is cut using a die in a die stock. On the front of the threading die, the details are shown of the thread to be cut and the material from which the die is made; in this case, we have an HSS die for standard M10 thread.
The side with the details is the feed side of the die and is held against the material to be cut. By applying pressure and turning the die, the screw thread is cut into the material.



To get the screw thread at right angles and straight on the material, we place the die in the die stock between the drill chuck and the material. For this, the drill chuck is placed in the tailstock. The front of the drill chuck is flat and positioned at right angles to the centre line. The die is clamped between the drill chuck and the workpiece by fixing the tailstock and rotating the drill chuck via de tailstock sleeve.

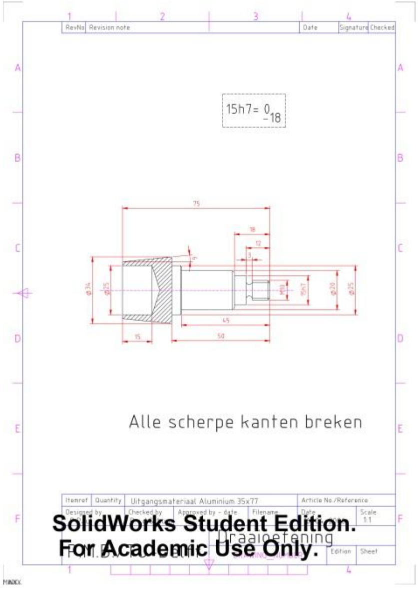


Applying light pressure to the drill chuck by tightening the tailstock sleeve while turning the three-jaw chuck containing the workpiece by **<u>hand</u>** pulls the die onto the workpiece so the thread cutting can start.
If you don't have enough strength to turn the three-jaw chuck by hand, you may use the square lathe chuck key.

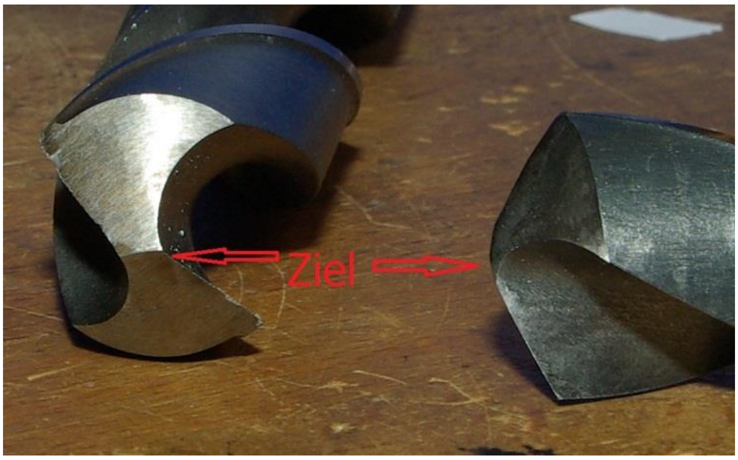


The workpiece is now ready on the tap side and can be turned in the three-jaw chuck.

On the other side too, a start is made turning the end of the workpiece. Next, the workpiece is turned longitudinally by repeatedly turning a maximum of 0.5 mm from the end in the X direction.

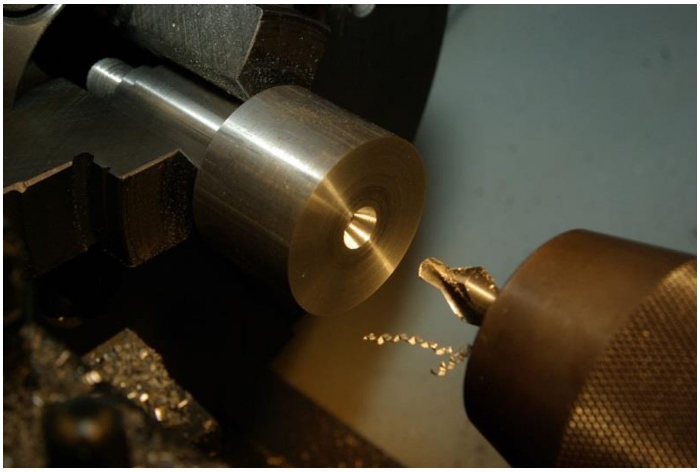


The drawing shows that an internal operation is needed on this side. If we follow the machining sequence of turning the grinding face, then the inside and outside, the hole must be machined first. As it is not possible to drill a hole in one go, the hole must first be pre-drilled.
To drill at the correct position in the centre, a centre drill is used. All these intermediate steps are necessary because a drill is ground according to a certain principle, creating a flat chiselled edge at the centre of the drill.
When the drill rotates, this flat edge tends to 'run ahead' over the material.



To avoid drilling with a large diameter and a large core area, a smaller drill (0.8x center of the next drill) is used which drills away the entire core of the hole to be drilled with the large drill.
This smaller drill in turn also has a core which may run ahead over the material. To prevent this running ahead, when working on sheet material, a centre hole is made into which the core of the drill can fall so that it cannot run ahead during turning.

When turning, the hole needs to be exactly at the centre of the workpiece, and centring by hand is not an option because this always takes place away from the middle of the workpiece. So to ensure that drilling always takes place at the centre of the workpiece, a centre drill is used.
A centre drill is a very short drill with an extremely thick shaft clamped shortly so that there is virtually no deviation from the centre.



The centre drill is drilled into the material until half of the bevelled side is in the material.

At the tailstock, there are two ways to determine the depth of the drill.
On the left-hand side of the tailstock sleeve, there is a millimetre graduation which roughly indicates the depth of the drilling.
On the right-hand side, behind the hand wheel, there is a vernier graduation allowing you to see the depth of drilling to an accuracy of up to 0.1mm. With this tailstock, 1 revolution is 3 mm movement of the tailstock sleeve.

Blind drilling

The hole needs to be around 25 mm. We start by drilling a hole that is a few mm smaller than the final hole. The hole is then turned to the desired size using an inside chasing tool.


We first pre-drill a hole using a drill that is slightly larger than the core of the final drill. Pre-drilling and final drilling are both done to almost the required depth.
Each drill requires its own speed of rotation depending on diameter and material.


The inside can now be hollowed out by turning. For this, an inside chasing tool is used. This tool is also placed at centre height, and the cutting tool set to zero in the X and Z directions.
The hole is turned to the required size.

Conical turning

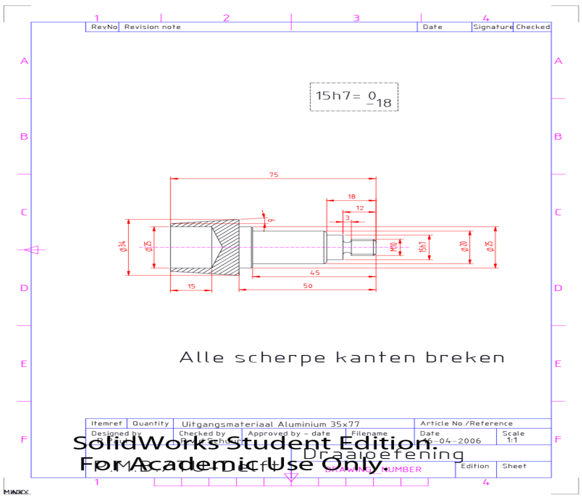
For conical longitudinal turning, the auxiliary longitudinal support is used (Z0).
This auxiliary or cutting tool carriage is positioned at the desired angle by slackening two nuts and turning the auxiliary longitudinal support, and then tightening the nuts again.

The cutting tool is then positioned so that it is again at right angles to the centre line.

By moving the auxiliary support, the cutting tool moves at an angle along the material to be machined, creating a conical part on the workpiece.

When the cone has been turned, the auxiliary support can be returned to the 0 position.
According to the drawing, the workpiece is now ready, and only needs to be finished by breaking the sharp edges using a 45° cutting tool on all the corners.

The sharp edge of the hole also needs to be broken. This is done using the inside chasing tool, which is placed at an angle against the **rear** side of the workpiece hole, that is, on the other side of the centre line where the cutting tool is normally placed. The direction of rotation must be reversed so that the material can still be lowered onto the sharp edge of the cutting tool.



Safety

- Always make sure that workpieces are securely clamped in appropriate clamping devices. Workpieces that are not properly clamped may come loose and cause considerable injury or damage.
- Before turning on the machine, always check manually that the workpiece rotates freely.
- Never get to close to a rotating part of the lathe with your hair or loose items of clothing.
- If you have long hair, tie it back or wear a hairnet. If your hair or a part of your clothing gets caught in the machine, you could sustain very severe injuries.
- Always wear industrial clothing with tear lines when machining.
- Always wear safety goggles when performing machining operations.
- Safety shoes are obligatory in the workshop.
- Never take hold of a rotating workpiece or try to slow it down with your hands.
- Never remove shavings from a rotating workpiece – they are razor sharp.
- Shavings should only be removed using a chip hook while the machine is stationary.