Introduction to drilling machines and drilling

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Challenge the future

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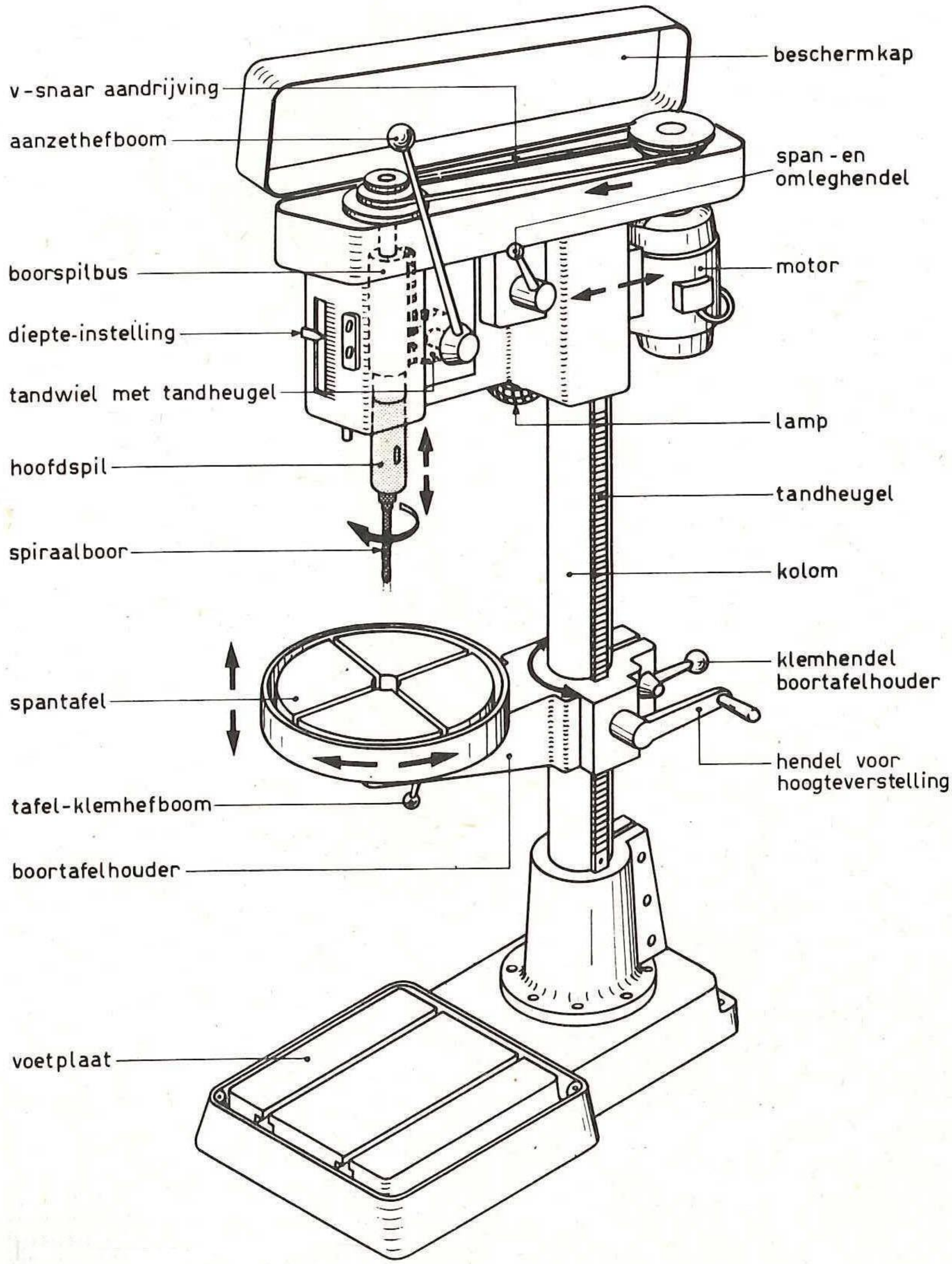
Parts glossary



Drill

To drill round holes in metal workpieces, we usually use a twist drill bit.
The drill bit is rotated using a drill. There are various types of drill. The drills most commonly used for metalworking are:

Pillar drill

A pillar drill consists of a base, a column, an adjustable table, and a head with the main spindle and a motor.

Table drill

This is essentially a scaled-down version of the pillar drill. It has fewer functions, and as the name suggests, it is usually fixed to a table or workbench.

Electric hand drill (mains or battery)

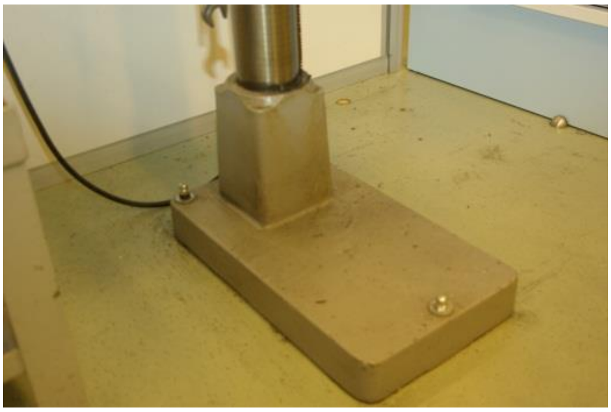
Used for light drilling work on workpieces that are difficult to clamp, or as a screwdriver during assembly work.
The drill chuck usually allows a maximum drill bit size of 13 mm.

Pneumatic hand drill

Drill with a compressed air motor instead of an electric motor, used for light drilling work for assembly purposes.
Again, the maximum drill bit size is usually 13 mm.

Pillar drill

The most commonly used drills for metalworking are the pillar drill and the table drill.
Both types of drill consist of the following parts:



The base

The drill stands on its base on the floor or on a table.

The column and the table

The column is mounted on the base, and the table can be adjusted vertically on the column, as well as rotated around the axis of the column.
The clamping tools and the workpiece can be attached to the table.

The head

The head contains the drive mechanism and the drill spindle.
Depending on the structure of the machine, the spindle speed can be controlled by repositioning the drive belt on the step pulleys, using adjustable driving discs or electronically.

Clamping the drill bit

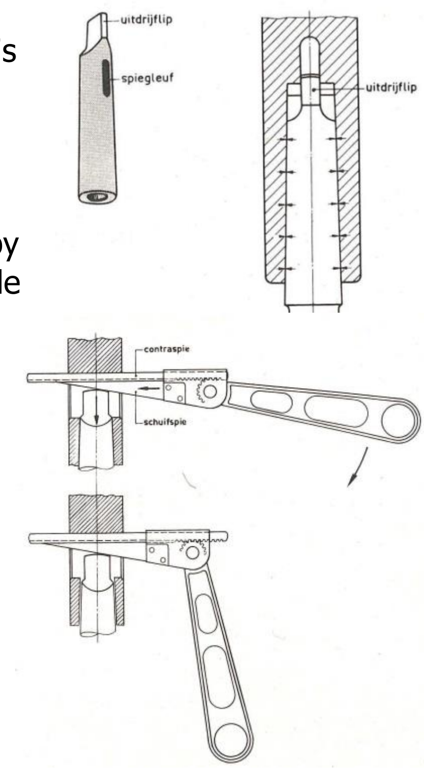
A drill bit can be clamped in a drill spindle in two ways:

- by inserting the Morse taper of the bit in the matching Morse taper of the spindle.
- by clamping a cylinder shank in a drill head.

The conical shank can only be placed in a counter-cone, and the cylinder shank only in a quick-acting drill head/drill chuck.

Morse Taper

The drill has a conical (Morse Taper) shank. The most commonly used Morse Tapers are the MK1, MK2 and MK3, each increasing in diameter.
Certain sizes of conical shank drills can be placed in the drill spindle directly.
If the drill shank is smaller than the conical hole in the drill spindle, the drill can be attached using a drill sleeve. The drill sleeve shows which Morse Taper is suitable.
Thanks to the shallow taper, the tapers are self-locking, and the drill will not fall out of the spindle.
For successful clamping and bit rotation, the Morse Taper needs to be extremely clean at the drill and drill spindle.
There must be sufficient friction between the drill shank and the conical hole in the drill spindle to prevent the bit from slipping. As this is not always the case, there is a lip at the top of the shank that falls into a slot in the shank and thus prevents slipping.



During drilling, the conical shank is clamped so tightly in the conical drill spindle that the bit can no longer be removed from the spindle by hand. So you need to use an ejector pin, which is inserted in the hole at the top of the drill spindle. The lip at the top of the drill can be seen through the hole. Hit the ejector pin against the lip to release the clamp between the drill taper and tapered hole and remove the drill bit. A hinged ejector pin that makes it easier to remove the bit is increasingly being used.

Keyless chuck

Bits with a cylindrical shank are clamped in a keyless holder. The large sleeve and the top ring are turned in opposite directions so that the jaws at the bottom of the keyless holder move outwards and clamp the drill. The keyless holder is in turn fixed in the drill spindle of the drill with a Morse Taper.
There are keyless chucks for drills of 1-10 mm and from 1-13 mm.

Clamping the workpiece

The workpiece must always be clamped in a tool and never be held in the hand during drilling. Otherwise, if the drill should 'grab', serious injuries could result. There are various tools for clamping workpieces.

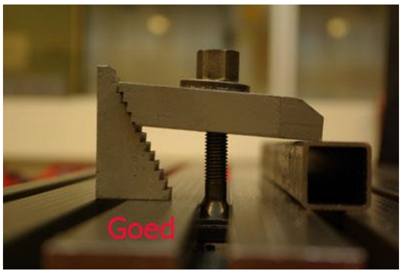
Machine vice

In many cases, a machine vice is used to clamp the workpiece. This works in much the same way as a bench vice.
The machine vice is fixed to the drill table using T-bolts and nuts, and only needs to be detached in special circumstances.
Smaller machine vices are slid onto a guide rail so that the drill can easily be positioned above the marked point. The guide rail prevents the machine vice from rotating as well if the drill starts grabbing.

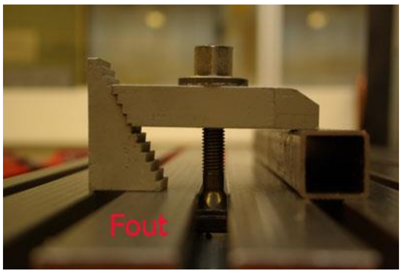
Usually, there are two prisms ground at right angles to each other in one of the jaws of the machine vice so that round materials can easily be clamped parallel or at right-angles to the drill table.
The top of the jaws is often tapered to enable thin materials to be easily clamped parallel (flat) to the drill table.
Material to be machined should be clamped in such a way that the machine vice cannot be damaged by the drill bits. Make sure that the underside of the material is free of the machine vice so that the bit does not damage the machine vice guides when it emerges from the workpiece.

Beam clips

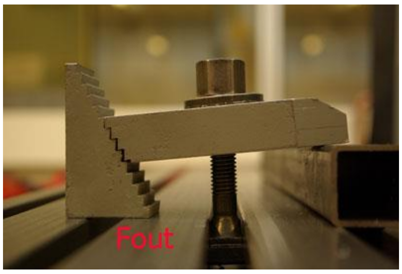
Beam clips can be used to clamp long or irregular workpieces directly to the drill table. It is essential to use several clips for each workpiece and to clamp the workpiece to resist the direction of rotation of the drill. A clip consists of a clamp, a support, and a T-bolt with a nut and ring. For secure clamping, the end of the beam must touch the material at a slight angle. This can be adjusted by setting the stepped support on the beam and the support at the correct position for the height of the workpiece.



The



nut



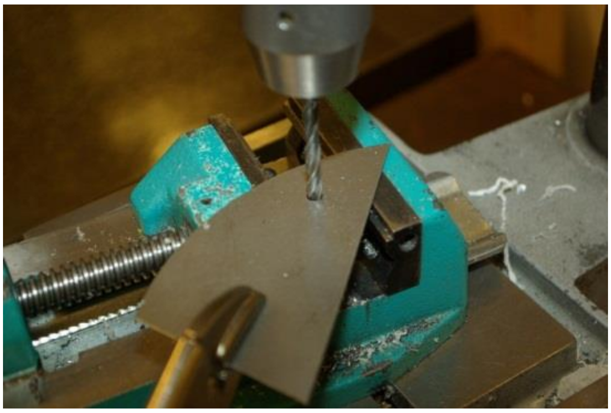
has a convex side which must fall into the concave side of the washer so that the washer can follow the clip if it slants.
If the workpiece has to be drilled all the way through, bearing plates must be used so that the underside of the workpiece is free of the drilling table and it is impossible to drill into the drilling table.
The way the workpiece shown on the photo has been clamped, it is only possible to drill into the upper wall of the tube.
It is not acceptable under any circumstance for the bit to touch or drill into the machine vice or table, so be sure to prevent this!!

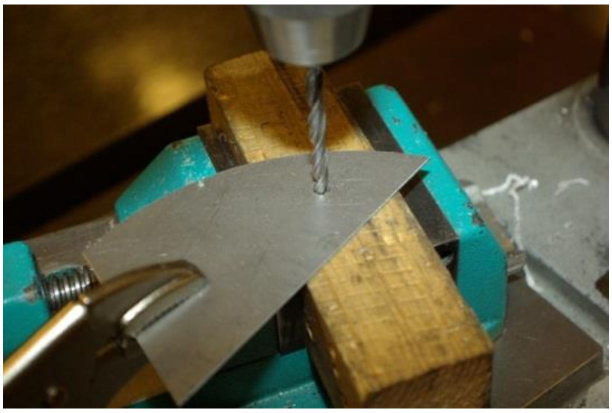
Vice-grip locking pliers

If it is not possible to clamp the workpiece with the vice, for example, in the case of large sheet material that does not fit between the jaws of the vice, vice-grip locking pliers can be used. Use enough force to make sure that the pliers clamp the workpiece very securely. This can be adjusted using the screw at the end of the pliers.

If the workpiece is not clamped in firmly, it is essential to make sure that the drill is always free of the support when the bit emerges from the workpiece so that there is no risk of drilling into the drilling table or machine vice. For example, by drilling between the jaws of the opened machine vice or by supporting the workpiece with a piece of wood.

NEVER hold a workpiece and certainly not sheet material using only your hands.
If the workpiece is grabbed and spun round by the drill it will be pulled through your hands, with painful – and bloody – consequences!





Types of drills

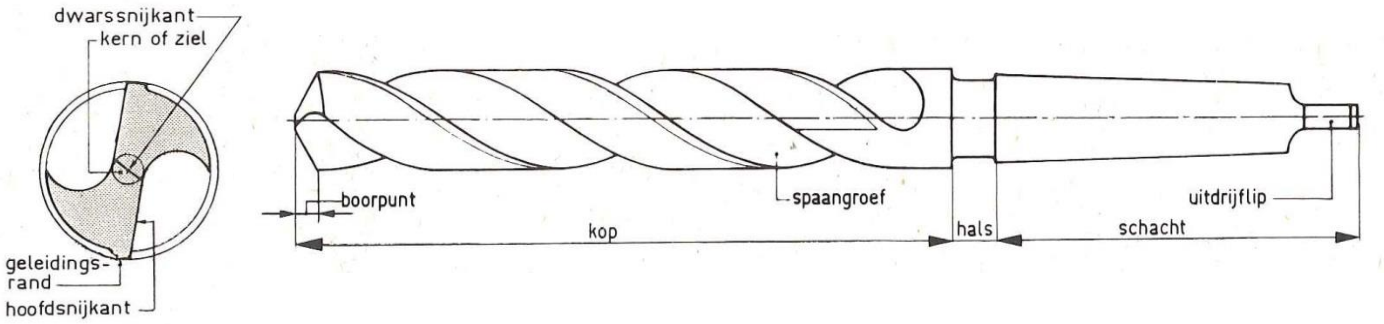
Twist drill

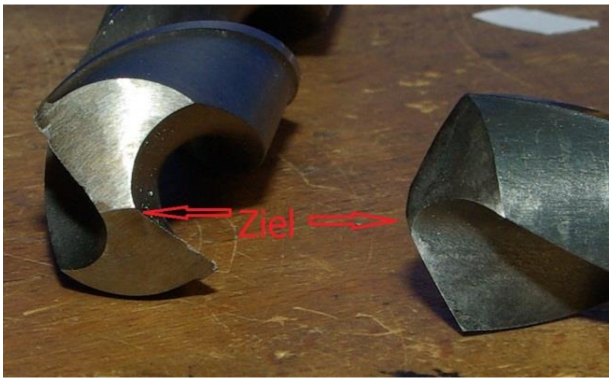
To drill round holes in workpieces, we often use a twist drill.
It is called a twist drill because of the helical grooves at the head of the drill.
The purpose of these grooves is:

- To create cutting lips at the head of the drill.
- To remove chips.
- To supply cooling fluid.

The drawing shows the following components of the twist drill:

- The head, with the cutting point.
- The shank, which is the part that is clamped in the machine.
- The neck. In larger drills, this is the part between the head and the shank, on which the drill diameter is indicated.
- The flutes which allow the chips to escape from the drill hole.
- The margin (see bottom view) that keeps the drill body free of the drilled hole and leads the coolant to the cutting point.



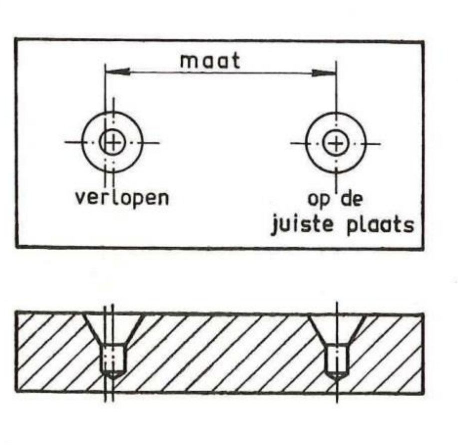


When using a twist drill to drill holes larger than ± 12 mm, it is customary to first
drill a smaller hole. This can be explained as follows:
When the diameter of a drill increases, so will the web.
As a result, the cross-cutting edge on the web will also increase in length. This cross-cutting edge makes it difficult to machine the material and causes a lot of friction. If we now drill a hole approximately the same size as the web, drilling pressure will be reduced considerably.
A common mistake is to perform this pre-drilling in steps with a drill that is only a couple of millimetres larger, until we reach the right size. It is better not to do this because a drill that is only a couple of millimetres larger will tend to grab in the hole that was previously drilled.

For large scale production, special drills are used. Drills are available with various spiral and cutting point angles for different kinds of materials.
There are also drills with channels in the spirals that allow coolant to directly reach the cutting edges.
Step drills are twist drills with two diameters, allowing both the hole for the bolt and that for the bolt head to drilled in a single drilling movement.

Centre drill

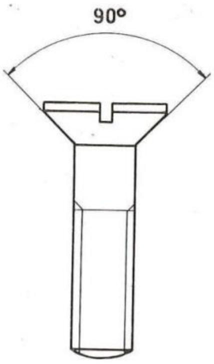
To accurately centre workpieces, we can use a centre drill.
Using a centre punch, we lightly hammer a small centre point at the intersection of the marked off measuring lines.
On the drilling machine, with a centre drill in the drill head, we drill at this centre point with the first bit. Two centric circles have now been created, with the narrow drilling section and the bevel of the sloped section. A centre drill is always used to drill until approximately halfway down the bevel.
We can now see immediately whether the two centric circles are correctly positioned in relation to the marked off lines.

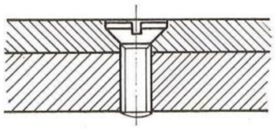


Centre drills depend on the size of the final hole to be drilled. The dimensions of the thin drill section and the shank dimensions are indicated on the centre drills.

Countersink

We use a countersink bore for countersinking holes and deburring drilled holes.
The head of a countersink bore has the same angle as the heads of countersunk screws or bolts. Countersink bores come in various shapes, with the one shown being the most common. The diameter of the taper may differ depending on the size of the hole to be deburred or countersunk.





To countersink holes for screws with a cylindrical head, we use
a flat-head countersink drill with fixed pin.
The pin must fit snugly into the hole to be countersunk. In other words, you need to use the correct size when pre-drilling. This is why the dimensions of the pin and countersink are shown on the drill bit. In flat-head countersink drills, the dimensions of the pin and drill correspond to the head and shank dimensions of the various screws.

A flat-head countersink drill can therefore also be used to countersink holes for countersunk head screws. In that case, the cutting part is ground at an angle of 45°.

Sheet drill

When drilling into a thin sheet with a twist drill, the angled cutting point always cuts through the sheet in the middle while the outsides have not yet begun cutting at the top of the sheet, and because the spirals are always at 180° in relation to each other, there is a considerable chance that a double-spiral twist drill will 'grab' in the hole being drilled.

The sheet or cone drill was developed to prevent this ‘grabbing’.
The cutting point of the drill makes the initial hole and the cone then takes over drilling to the required diameter. One cutting lip is ground into the cone, while the rest of the cone guides the drill into the hole, reducing the tendency to ‘grab’. The cone is drilled into the hole to the desired diameter. Of course, this causes more friction, so it is always necessary to use drilling oil as a coolant when drilling sheet material.
Step drill bits are also available. Each step shows the diameter size, making it easy to drill the required size.

Tips for successful drilling

You can tell whether a drill has been ground properly by the chips it produces. A properly ground twist drill will simultaneously cut two identical chips. In addition, you can check whether the cutting lips of the drill are sharp and free of damage.

If you have to exert too much pressure on the drill while drilling, this will usually mean that the drill is either blunt or unsuitable for the material you are drilling in. There is then a good chance that the drill will break. An additional – and considerable – risk is that the drill will wander.
Replace the blunt drill or have it sharpened.

When drilling holes in steel, always use a coolant (drilling oil). Dry drilling is possible with cast iron, bronze and brass. When drilling in aluminium, use a very lean drilling oil. Both types of drilling oil are available in the IWS.

When drilling large holes, there is a considerable risk of wandering. You should therefore first pre-drill using a drill with a slightly larger diameter than the web of the drill you will be using for the final drilling. The first hole thus serves as a guide.

If you want to drill a very deep hole, you will keep having to withdraw the drill from the hole to remove the chips.
Always withdraw the drill regularly from holes that are deeper than four times the drill diameter.

If you need to drill holes to a certain depth that are not intended to penetrate right through the workpiece, e.g. blind holes, use the depth setting, which you will find on just about every drilling machine.
You can use this to determine the depth of the hole; a stop will prevent you from drilling too deep. This is particularly useful if you have to drill a lot of equal holes.

Safety

- Fix each workpiece to be drilled securely in an appropriate clamping device such as a machine vice, or use beam clips. Workpieces that are not properly clamped may come loose and cause considerable injury or damage.

- Keep long hair or loose clothing well away from any rotating spindle or drill parts. 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.

- When machining, always wear suitable protective clothing that is designed to tear.

- Always wear safety goggles when machining.

- Safety shoes are obligatory in the workshop.

- Never take hold of a rotating drill.

- Never remove chips from a rotating drill – they are razor sharp.




How to drill

To drill a hole in the material as shown in the drawing, proceed as follows:

- Mark the position of the hole by scribing two lines, as shown on the drawing. You can do this using a set square, a ruler and a scriber, or with a marking gauge. Where the centrelines cross, use a centre punch and a steel hammer to carefully tap shallow indents.
- Ensure the material is clamped and aligned underneath the drill head.
- If using a jig boring machine or a milling machine, the first two steps will not be necessary, because the workpiece is placed directly at the correct coordinates and you can immediately start drilling with the centre drill.
- The correct drilling speed can be selected depending on drill diameter and material. (See the simplified drill table).
- Using the centre drill, the crossing lines are drilled with the first bit.
- The hole is drilled to the correct depth using the appropriate drill. Pre-drill if necessary.

Use the appropriate drilling oil for the material while drilling. Do not exert too much pressure on the cutting point when drilling, as this will not speed up the process, and the risk of overheating and breaking of the drill will be greater.
When a drilling depth has been reached of approximately four times the drill diameter (about 1 turn of the drill spindle) the bit should be regularly withdrawn from the hole. Withdraw the drill entirely while it is still rotating so that it removes the chips from the hole. This is particularly important for softer materials such as aluminium, as is cooling with drilling oil, because the heat produced during drilling causes the material to toughen, and it may stick to the drill, producing even more heat and so much friction that the drill bit may break inside the hole. It is almost impossible to remove a broken drill from a workpiece without causing damage, so you will often have to start again.

Boorsnelheid in omw/min

Boordiameter in m.m	Staal	Gietijzer	Alum./messing	RVS
3	1580	2580	2580	700
4	1100	2180	2180	600
5	900	1580	1580	400
6	700	1350	1400	400
7	700	1250	1400	400
8	700	1250	1400	400
9	600	830	1200	350
10	550	830	1100	325
11	500	830	1000	300
12	450	830	950	300
15	400	500	800	275
20	300	350	500	200
25	250	300	400	180
30	180	250	250	120