Pocket guide on drilling with hand-held machines

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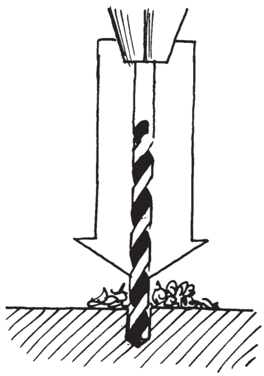
Drilling with hand-held machines

This pocket guide has been written in the first instance for you who use hand-held drills professionally. This may be a matter of industrial production drilling, where drilling with a hand-held drill complements permanent drilling stations or of assembly and repair work at different workplaces.

Although this pocket guide deals with pneumatic drilling machines you will nevertheless find everything related to drilling technique useful, regardless of whether you use an electric or a pneumatic hand-held drill.

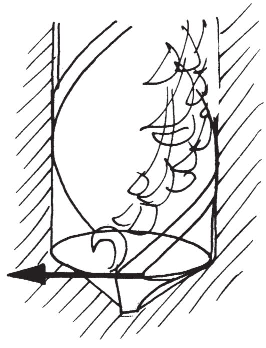
The decisive factors in all drilling operations are the feed force, the cutting speed (in metres per minute) and the type of bit.

Feed force



An ordinary human being is incapable of achieving the feed forces used, for example, in a column drilling machine, except when small bit sizes are used.
In hand drilling it is therefore necessary to reduce the feed force needed by selecting the correct bit and drilling technique.

Cutting speed



The speed at which the cutting edges penetrate through the material is called the cutting speed. It is zero in the centre of the hole and highest in the periphery, which is also where it is measured. It is specified in metres per minute (m/min). Different types of material require different cutting speeds.

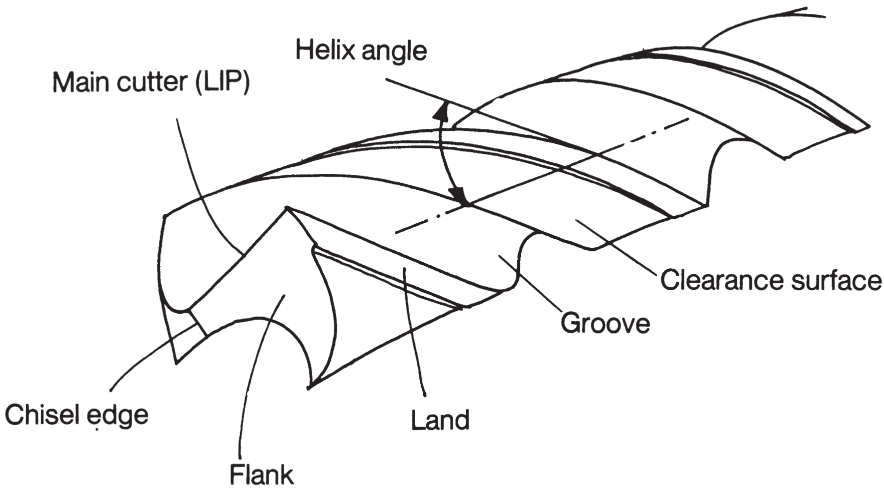
Speed

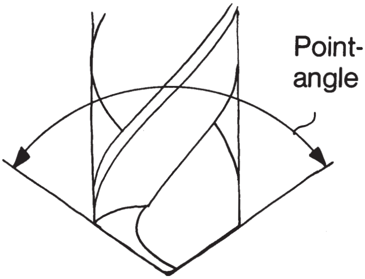
The free speed of a drilling machine is specified in number of revolutions per minute (rpm) and is stated on the rating plate of the tool. On the last two pages of this book you will find a selection guide showing the relationships between material/cutting speed, bit size and speed (rpm).

The drill bit

Drill bit terminology

The commonest type of bit is the twist drill. This can be given different properties, depending on the manner in which it is designed. In order to talk about bits and to find the correct kind of bit in catalogues it is necessary to know what the parts of the bit are called.





Point angle

The normal point angle is 118°. The point angle can vary between 118-135°, however, depending on the type of bit.

Drill bit material

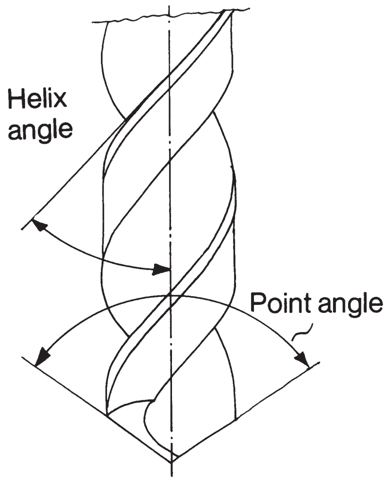
High-speed steel is by far the most common material used in the manufacture of bits and is usually also the best. Avoid using bits of carbon steel since these, although they are indeed cheaper, become blunted far more quickly. For highly abrasive materials such as composites with reinforcement of fibre-glass, carbon fibre or kevlar fibre, cemented-carbide bits are essential to ensure that they can be used for a reasonable length of time between resharpenings.

Drill bit surface treatment

For the most part black, i.e. steam-tempered bits, are best. Their surface is smoother and consequently there will be less friction. The drilled material does not stick so easily. Steamtempering also protects against corrosion.

For special materials, bits with special surface treatment are available. Act on the advice given in the bit manufacturers' recommendations.

Drill bit type



Depending on the material you are intending to drill there are three main types of bit to choose from. These may also be ground in different ways.

The main rule is:

- Large helix angle for long-chipping material.
- Small helix angle for short-chipping material.

Jobber drill

The commonest type of bit has a helix angle of 28° and a point angle of 118°. It can be used to drill in most materials, but is best in steel, cast iron and similar materials.

Quick spiral drill

This has a helix angle of 40° and is used in long-chipping materials. A point angle of 118° is used in aluminium, aluminium alloys, copper and similar soft materials.

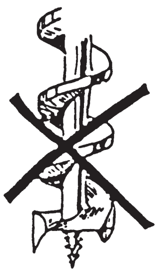
A point angle of 135° is used in stainless acid-resistant and heat-resistant steels.

Slow spiral drill

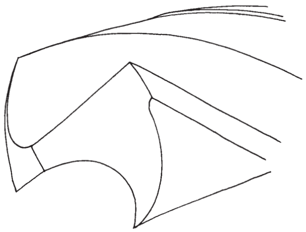
Helix angle 15°. Long twist bits are used in short-chipping materials such as brass, bronze, hard rubber and certain plastics.

Wood bits

Special types of bit are used to drill wood. Twist drills with a point are best up to about 12 mm whereas spade bits are used to drill larger holes.

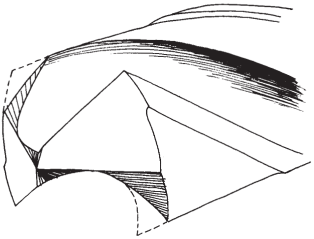


CAUTION!
Never use brace bits of the corkscrew type in a drilling machine.



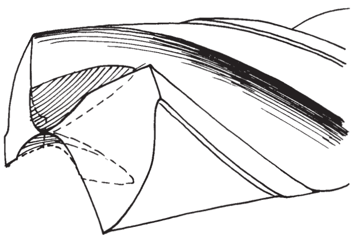
Chisel edge

This is the normal and most commonly used point. It requires a large feed force and is therefore less suitable for large hole diameters.



Split point

Needs appreciably lower feed force than the chisel edge and centres better when applying the bit to the workpiece. The cutters overlap at the point and therefore cut better in the centre of the hole.



Point with web thinning

In this case the chisel edge is made shorter to reduce the feed force. The hollowing is done when the bit is reground. Gives the bit almost the same performance as a cross-point bit.

Use short bits

Always use as short a bit as possible in a hand-held drill, especially if the bit diameter is less than 6 mm.

In this way, you will avoid vibrations and bit failure and the bits will retain their strength for longer. Most bit manufacturers have short bits in their range.

Grinding the bit

This is something that cannot be overemphasized. Sharp bits are absolutely essential when drilling by hand. Moreover, regrinding bits is a matter of good tool economy, especially if you are using quality bits which then amply justify their higher purchase price. A reground bit will be just as sharp as a new one.

Regrinding is best done in a bit grinder. An investment in a machine of this kind rapidly pays off.

Detailed instructions on regrinding of bits can be obtained from the manufacturers of bits and grinding machines.

The drilling machine

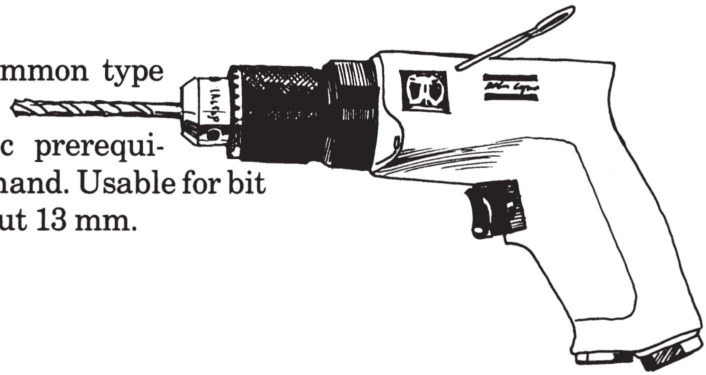
In all hand-held drilling operations requiring both speed and precision it is advantageous for the machines to be light and strong, and for them to be so designed that they do not cause operator fatigue.

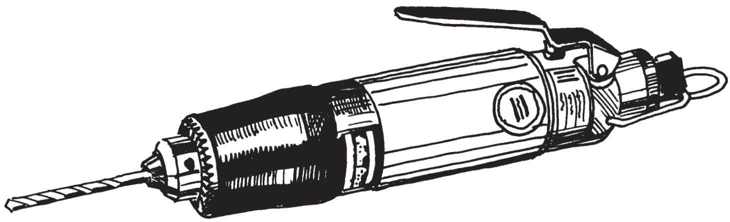
Pneumatic drills are compact and are also distinguished by their low weight in relation to their motor outputs. Consequently, they can be designed so that they are easy to hold, with hand grips adapted to the anatomy of the arm and hand.

Drill types

Pistol-grip drills

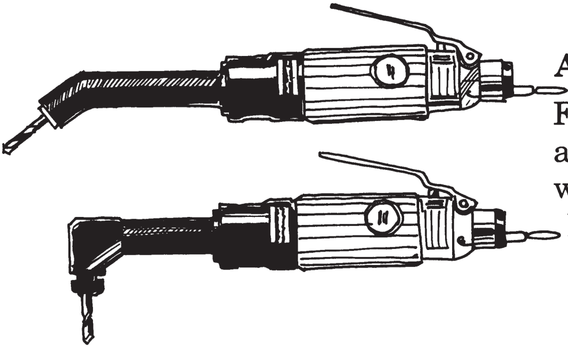
By far the most common type and the one giving the best ergonomic prerequisites for drilling by hand. Usable for bit diameters up to about 13 mm.





Straight drills

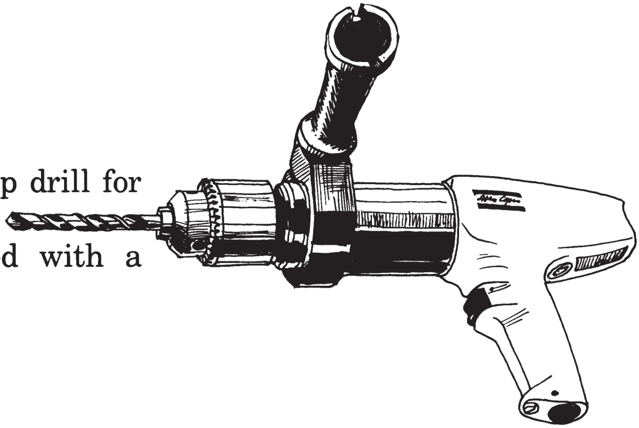
For drilling vertical holes and drilling in cramped and awkward spaces.



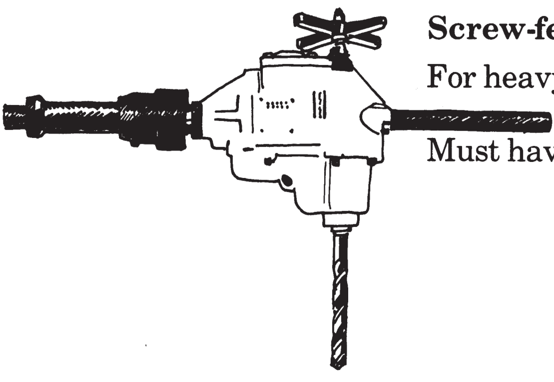
Angle drills

For drilling in cramped and awkward spaces. Obtainable with both 30° and 90° angle heads.

Two-handed drills



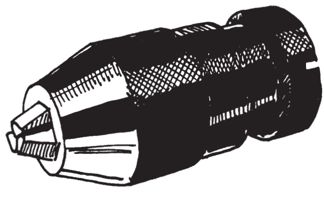
A powerful pistol-grip drill for larger bit diameters. Always used with a two-handed grip.



Screw-feed drills

For heavy-duty drilling with 10-50 mm bits. Must have a fixed reaction bar.

Accessories that make the work easier

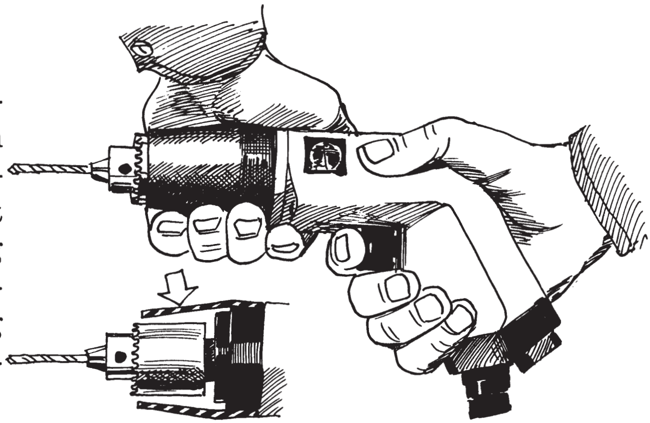


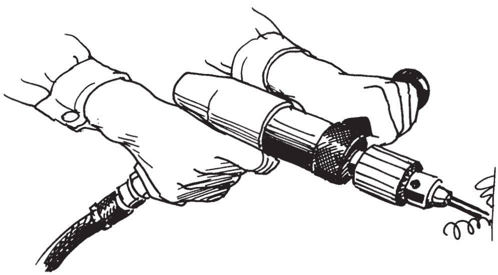
Quick chuck

Saves a lot of time and trouble when several holes of different diameters are to be drilled consecutively. The bit is secured and released by turning the knurled sleeve on the chuck. No chuck key is needed.

Chuck guard

Protects against unintentional contact with the rotating chuck. Allows the operator's left hand to hold the drilling machine at a point closer to the drill bit, giving a steady grip for bit positioning.





Support handle

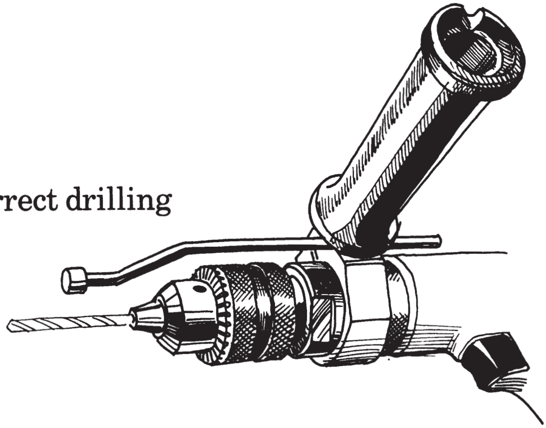
Available for both pistol-grip and straight tools. Enables you to increase the feed force and resist the reaction torque on bit penetration and when drilling large-diameter holes.

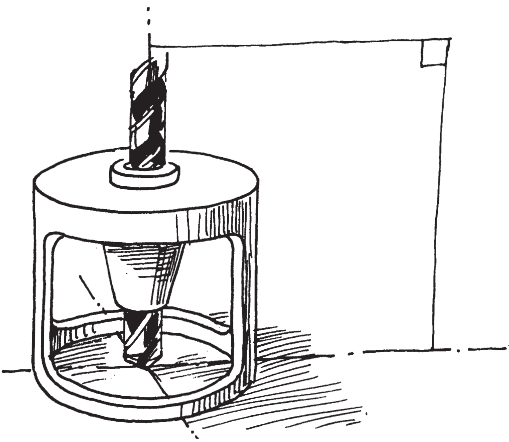
Morse taper socket

An alternative to a chuck in two-handed drills. Standard in screw-feed drills, giving absolutely "slipless" attachment of bits with taper shank. Used for bit diameters of 10 mm and upwards.

Depth stop

To ensure the correct drilling depth or prevent penetration.





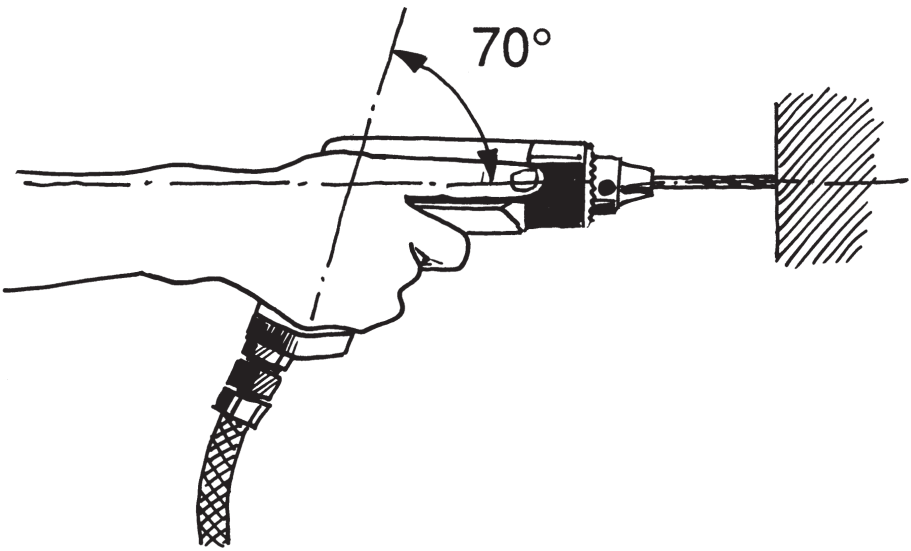
Right-angle guide

For use when perfectly right-angled holes are essential. Available in several versions from different manufacturers of accessories.

Ergonomics = best hand grip and working posture

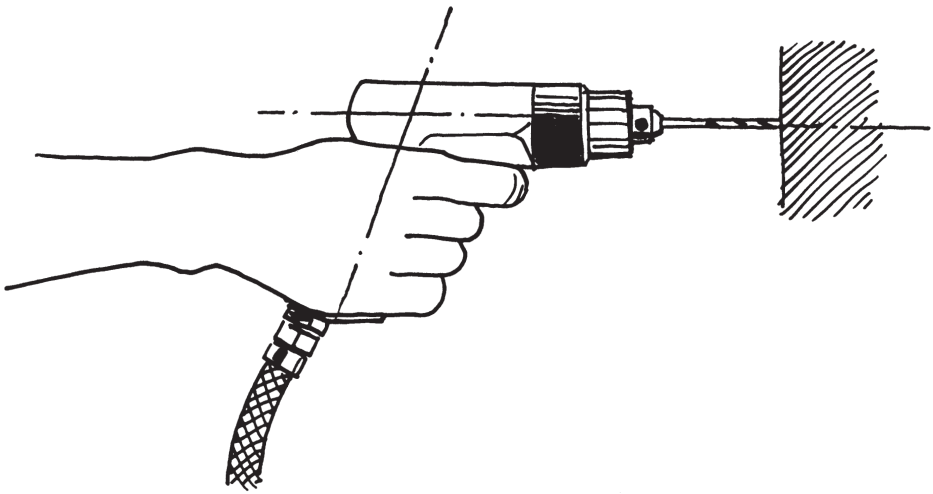
Hand grip

If you hold your hand straight in relation to your forearm and take hold of a baton, for instance, then the angle between the baton and the forearm will be approx. 70°. This is the natural grip angle. Consequently, a pistol-grip drill that is properly ergonomically designed must have the handle at an angle of 70° to the axis of the bit. When you hold a drill like this with your wrist straight the bit will point in the same direction as your forearm.



If you are also able to hold the drill with a high grip, in other words with your thumb and index finger along the motor casing, then the bit and your index finger will point in the same direction. It will then be easy to "feel" exactly where the bit is. With this grip you can also apply a lot of pressure without over-exerting the muscles of your forearm. You will also easily find a good supporting grip for your other hand.

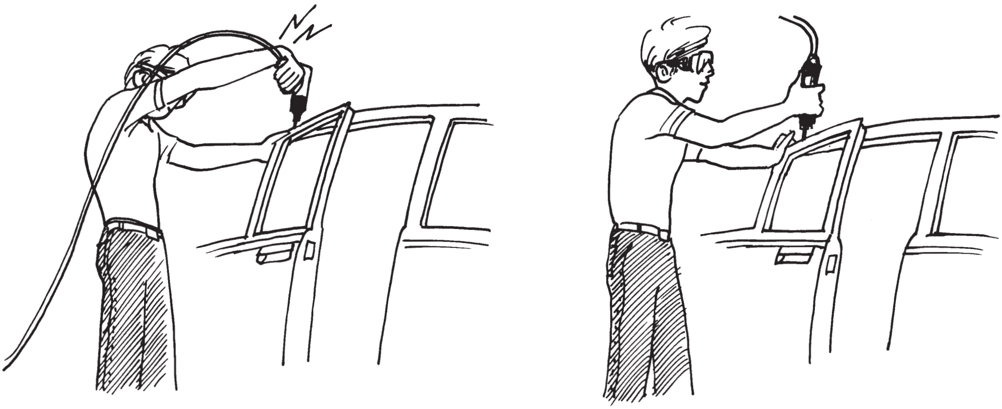
With a low grip, i.e. the ordinary pistol grip, it is easier to resist turning forces.



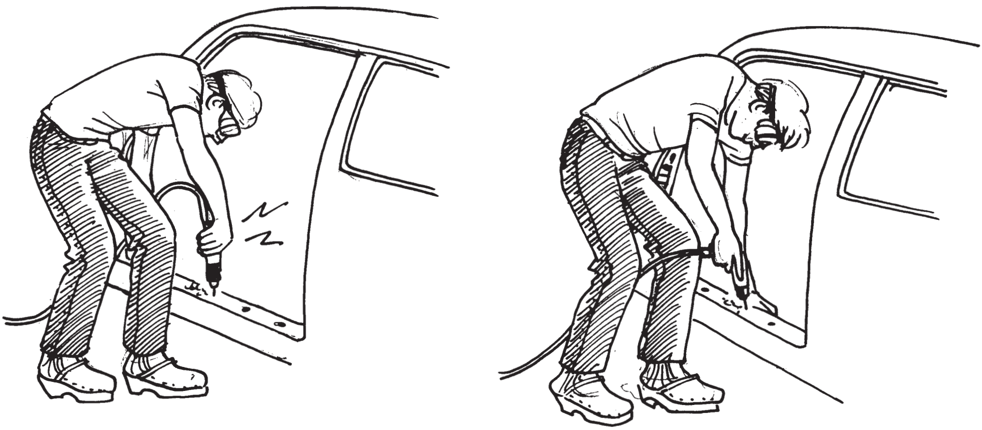
The drilling result is also influenced by the design of the trigger. A good trigger should make it easy to start the tool "gently". It should be used as a one-finger throttle which is pressed in by the middle joint of the index finger or middle finger.

Working posture

Uncomfortable working postures are by no means unusual in handheld drilling operations, but this problem can often be remedied by using the right type of tool.



When drilling in a high position — use a straight drill.



When drilling in a low position — use a pistol-grip tool.

Practical drilling technique

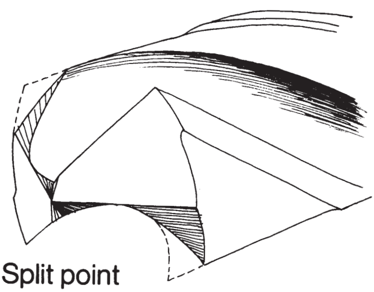
Handling a drill is by no means as difficult as it may seem. But in common for all tools the right knowledge makes the whole task much easier. The most useful hints are presented in this chapter, which ends with a guide enabling you to select the right tool when drilling in different materials and when drilling holes of different diameters.

Always drill with sharp bits!

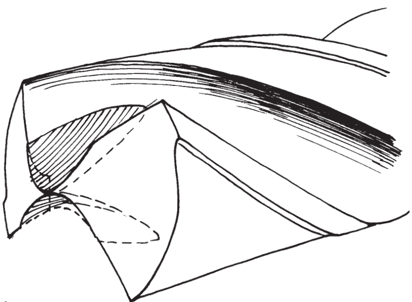
This cannot be overemphasized. Far too much energy and time is wasted with blunt bits. It always pays to use high-quality bits and good bit grinding equipment.

The right point can reduce the feed force by 30 per cent

The less force you have to use to press the bit against the workpiece, the easier it is to steer the drill so that the hole is straight and round. Bearing this in mind, always use splitpoint bits or thinned web bits.



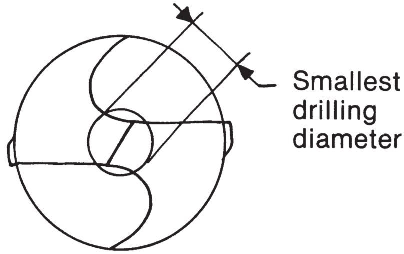
Split point



Web thinning

Predrill large holes

When the hole diameter is higher than 5-6 mm in steel the feed force necessary starts to exceed that which can be obtained with hand-held drilling. More than 70 per cent of the feed force is consumed at the chisel edge.



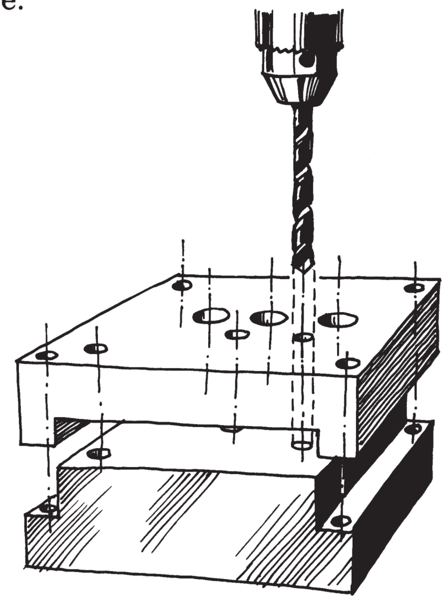
If you predrill the hole with a smaller bit diameter than the final one you can reduce the feed force just as much. Very large holes can be predrilled in several stages.

The art of locating the hole in exactly the right place

When starting up, the bit easily slips out of position, especially if you are using bits with a chisel edge.

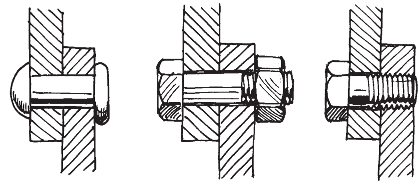
You can avoid this by:

- Using split-point or web thinning bits.
- Marking the centre with a centre-punch.
- Using a drill that can be creep-started.

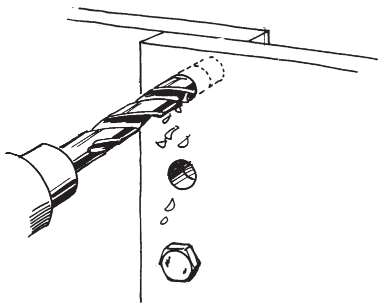


When drilling several equally spaced holes, simple drilling templates can make the task easier. In the same way, drilling templates are helpful when several holes are to be positioned in specific places in relation to one another.

Drilling through two parts simultaneously



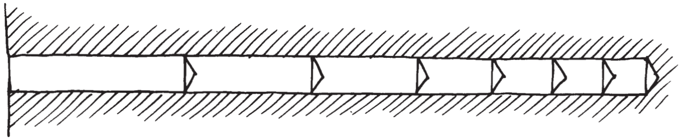
Drilling through two parts simultaneously for bolted or riveted joints is very commonly done with hand-held drills.



It is important that the parts are fixed together for as long as drilling proceeds. In the case of large and heavy structures it may therefore be a good idea to secure the parts together with a bolt or screw in the first hole before the other holes are drilled.

Penetration

This is the most difficult part of the job. As already mentioned, about 70 per cent of the feed force is consumed in getting the chisel edge to work its way through the material. Upon penetration, the chisel edge is the first part of the bit to pierce. That's why it is suddenly much easier as soon as the point has made its way through. If you don't have time to lighten the feed, the bit passes through so quickly that it doesn't have time to cut the hole cleanly. The bit jams. This is a problem that you can avoid almost completely by predrilling.

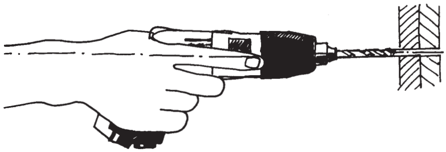


Drilling deep holes

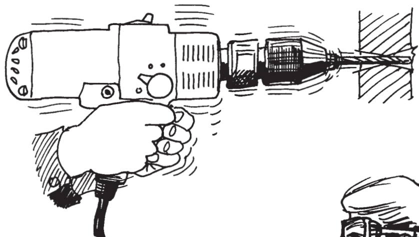
When drilling holes deeper than five times the bit diameter the cuttings will pile up inside the hole unless the bit is withdrawn at regular intervals for chip removal.

Repeat this more frequently as the hole gets deeper. Dip the bit in oil or water to cool it.

Hole quality



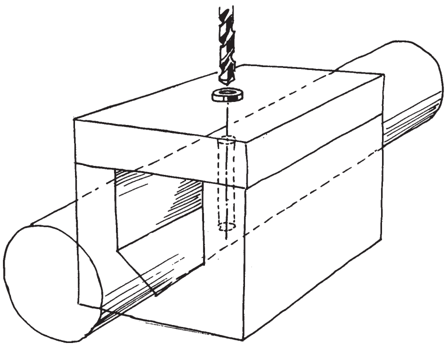
The quality of the hole is judged on its roundness/straightness, angular trueness and burrs on the back of the hole.



If the drilling machine is not held firmly, for instance on penetration, the hole will be both out of true and oval — this effect is worsened with soft material. There will be less risk of this happening if you have the right grip — a high grip — and work with an ergonomically designed tool that is easier to steer.

Drilling right-angled holes by hand with a pistol-grip tool is easiest if the workpiece is secured and the holes drilled at chest height. If you want to be absolutely certain that the hole is exactly perpendicular to the work surface, use a right-angle guide.

You can avoid burrs on the back of the hole by making sure that the bit is sharp and drilling if possible against an underlay. When drilling in composites, an underlay is nearly always necessary to ensure a clean hole exit.

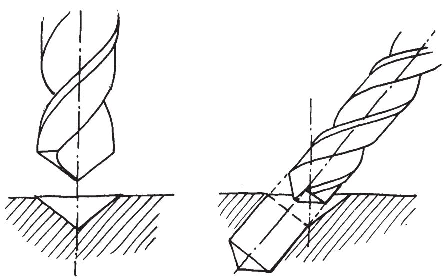


Crosswise holes in shafts and pipes

This can be quite a tricky task, especially if the diameter of the workpiece is small. Mark up the hole with a centre punch. Secure the workpiece firmly in a position giving a good working posture so that it is easier to align the bit. It is best to use a fixture which steers the bit straight through the diameter of the cylinder.

Sloping holes

Start off by drilling a recess, using a bit with twice as large a diameter as the diameter of the sloping hole. This provides you with a good starting point from which to drill the sloping hole.

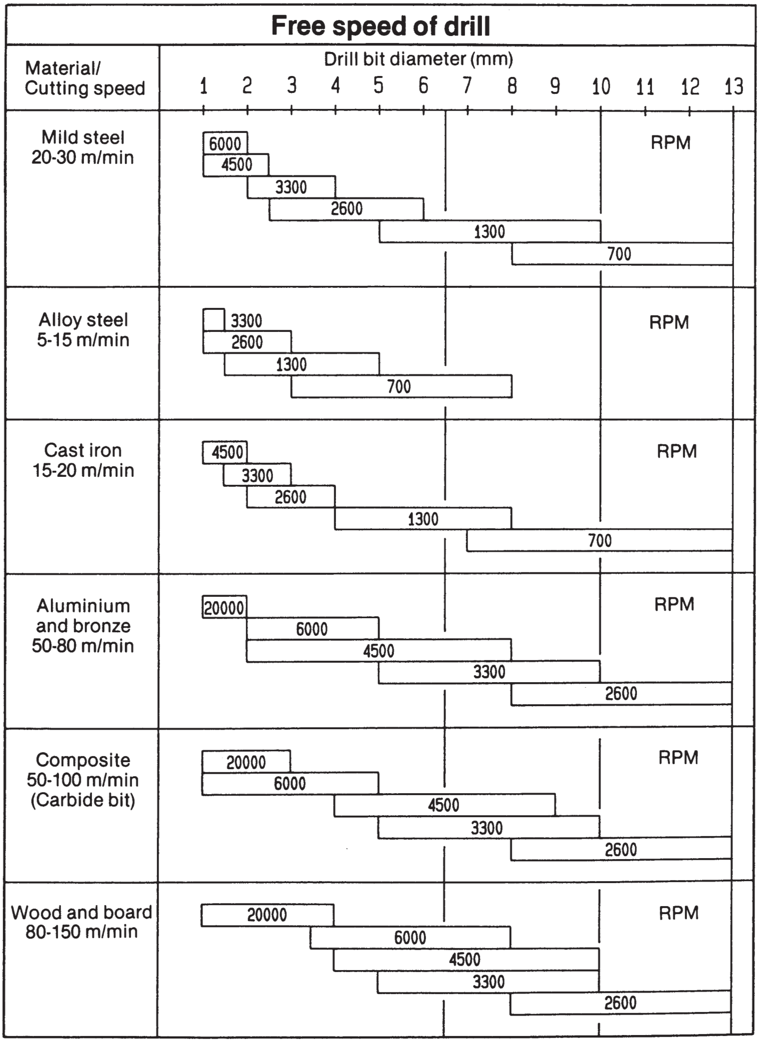


Drill selection guide

The speed for a specific drilling operation should be chosen on the basis of the material in the workpiece and the diameter of the hole.

In the selection guide, you will find proposals for suitable free speeds for selection of the correct tool.

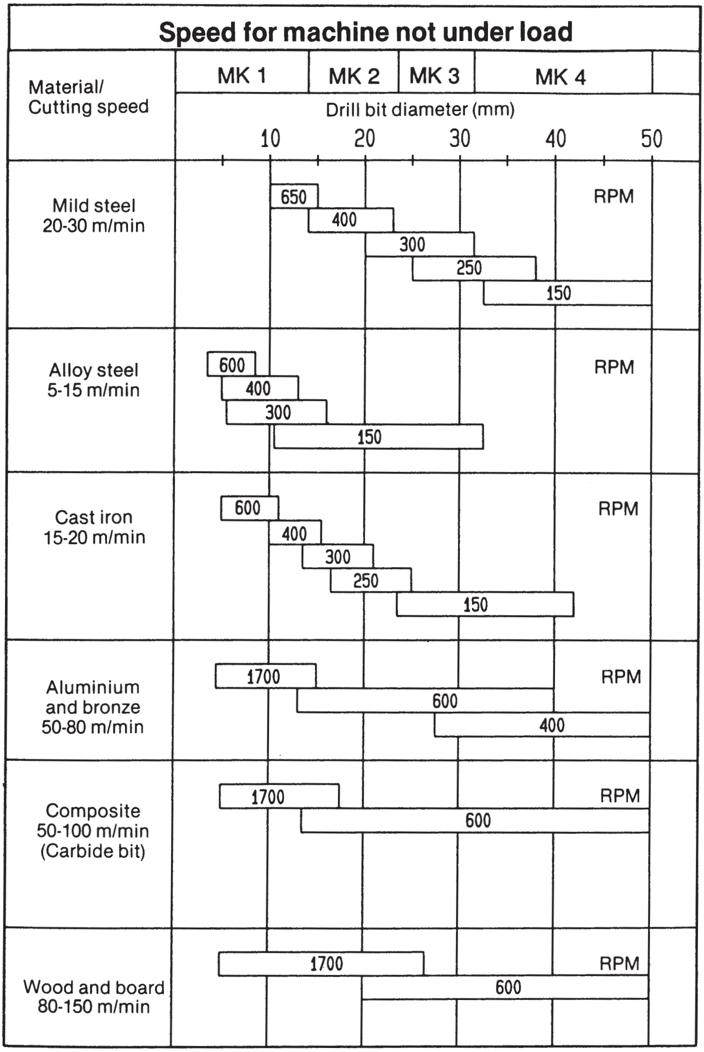
Small hand-held drills with high-speed-steel bits. Max. chuck capacity: 6,5, 10 and 13 mm.



Remember that:

1) The tool speed decreases under load.
2) If the speed is too high the bit quickly gets blunt.
3) If the speed is too low the cycle time increases.
4) Common chuck capacities are 6,5, 10 and 13 mm

Large hand-held drills with high-speed-steel bits. Max. chuck capacity 16 mm or for the bit with Morse taper 1, 2, 3 and 4.



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