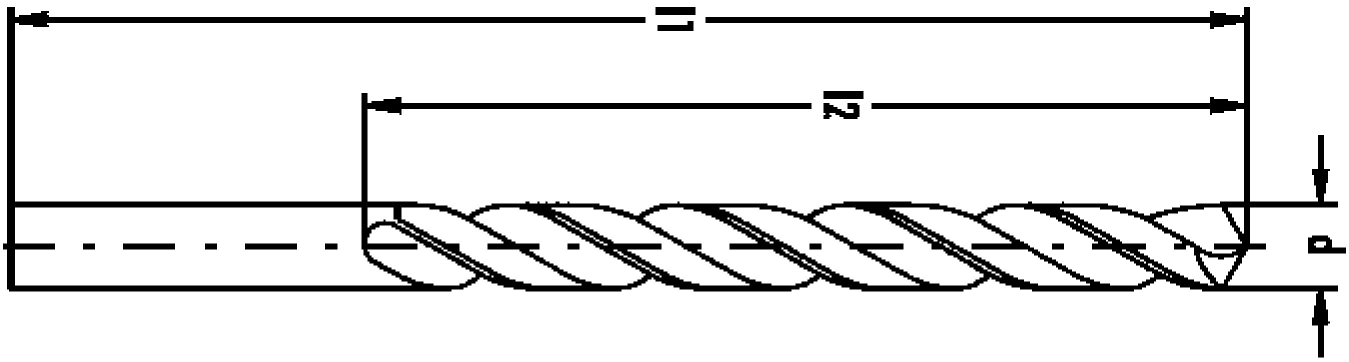
# PRESTO INTERNATIONAL UK LTD

# TRAINING MANUAL

## Part 2

# INTRODUCTION TO TWIST DRILLS




DEFINITION:-

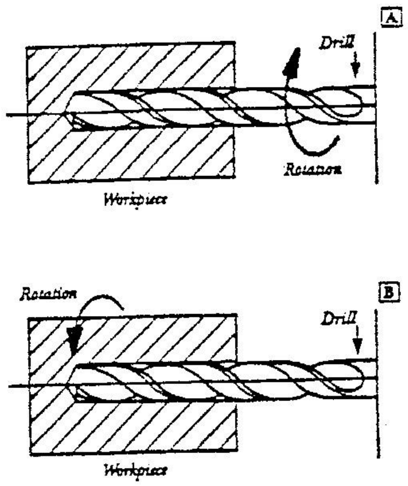
"A rotary end cutting tool having two or more cutting lips, and having two or more spiral (helical) or straight flutes for the passage of chips and the admission of cutting fluid"

A twist drill produces an accurate hole to a very close tolerance. The hole is larger in diameter than the diameter of the drill. In some cases a drill is used to enlarge an existing hole.  Specialise drills can produce two diameters or more at the same time.

Generally, drills are manufactured to BS 328 and DIN 338. These are manufacturing standards.

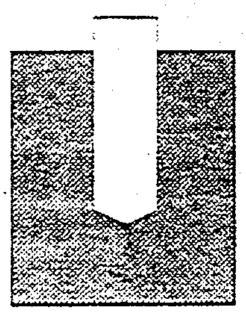
# How drills are used

When drilling, the work piece, the drill, or both, must rotate in order to create a hole.

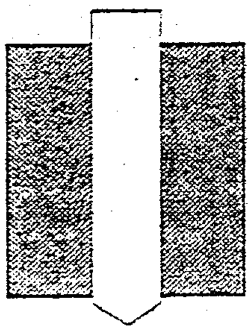



Example A shows the work piece stationary whilst the drill rotates in contrast to example B, where the work piece rotates and the drill is stationary. Normally used with Left hand Drills.

In situations where both the drill and the work piece are rotating, they rotate in opposite directions.

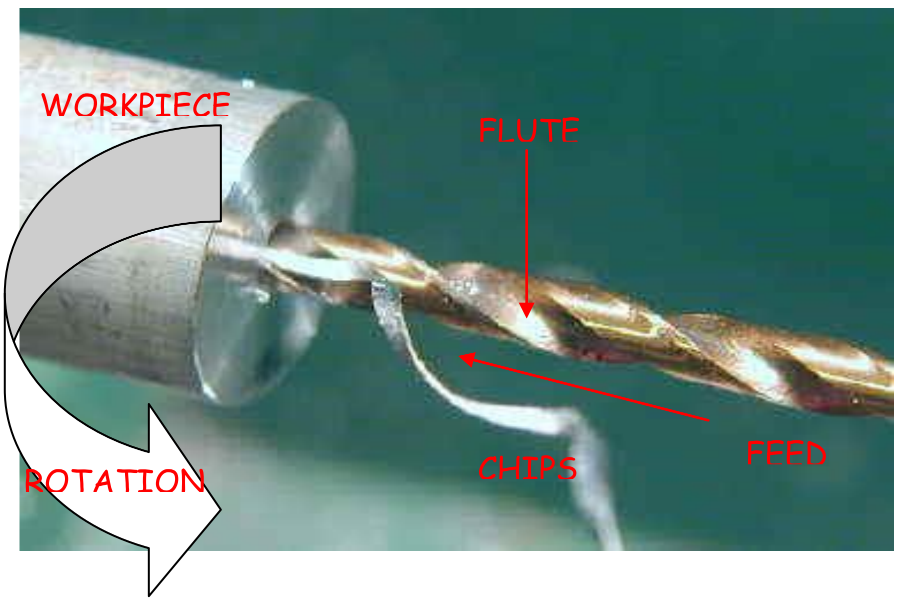


Blind Hole



Thru Hole

A drill can produce a through hole or a blind hole as seen opposite.




This image demonstrates how a drill cuts. The drill in question is non rotating: it is being fed in to a rotating work piece. The cutting edges at the front of the drill remove the material from the work piece.

# Equipment used when drilling

Pneumatic Air Gun

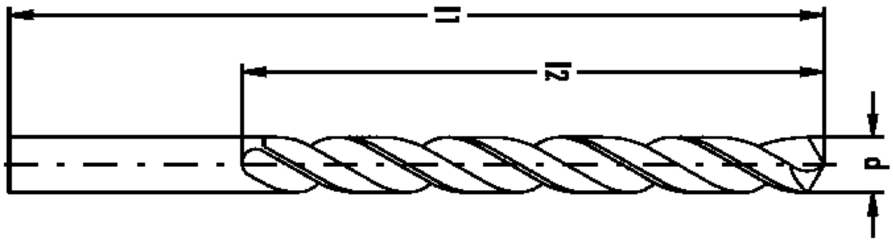
Hand Drill

Pedestal Drill

Lathe


CNC Lathe

# Parts of a drill




The image above shows a basic straight shank drill in profile. Drills are commonly known as drill bits or twist drills.

A drill consists of 3 main parts.

| | |
|---|---|
| The Shank | This is used to mount in a drilling machine. |
| The Body (l2) | This has flutes and cutting edges that help in the cutting and the removal of material. |
| The Point | This is made up of cutting edges and is he main working part of the drill. |

Drill Shank Elements

The shank is that part of the drill which fits in to a tool holder ( a chuck or a spindle or a collet)

There are 4 types of shank; straight, straight with tang, reduced and Morse Taper. All Morse Taper Shank drills have a tang.

Straight shanks are cylindrical and may have a slightly smaller shank diameter than the cutting diameter of the drill. The shanks are usually softer so that the drill chuck can firmly grip the drill.
Reduced shanks are produced so that larger Diameter drills can fit in to a portable drill or a holder that has a limited range. The two most common reduced shank diameters are ¼" and ½".

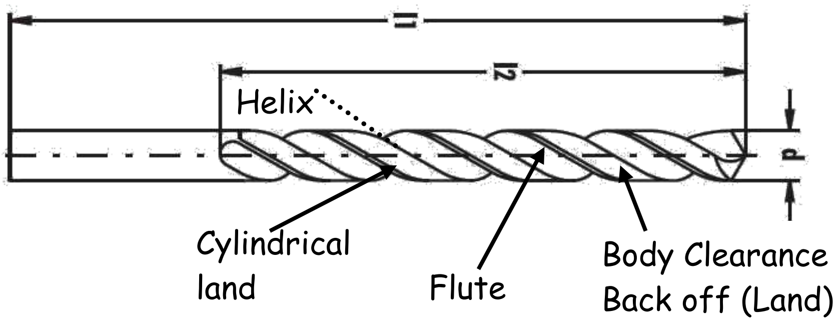
Parallel Shank Drill

Taper Shank Drill

Par Shank Drill

Drill Elements – The Body (l2)

The body of the drill is between the point and the shank. The body is made up of flutes, the land, Cylindrical Land, and the back off.
Any measurements taken for the flute length, helix angle, and diameter are taken within the body.




**Drill Elements – The Flute (l2)**

The flutes run along the body of the drill. The flutes can be either milled with a milling cutter or ground with a grinding wheel.
The purpose of the flute is to carry the cutting fluid to the tip, and to provide a path for the removal of chips, and to make a cutting edge or lip.
The flute length is measured from the point of the drill to the end of the flute. The length, size and depth of a flute determine how deep a hole can be drilled.

## Drill Elements – The Helix Angle

The helix angle, sometimes known as the spiral angle, is the angle formed by the axis of the drill and the edge of the flute. The helix angle of the drill helps to lift the chips out of the hole. Angles range from 20 to 40 degrees depending on the material to be drilled.

## Drill Elements – The Land

The land is the part of the body between the flutes. This provides the strength to the drill.
Widening the land for additional strength reduces space in the flute for chips. Land widths are designed to be a balance between strength and adequate chip space.

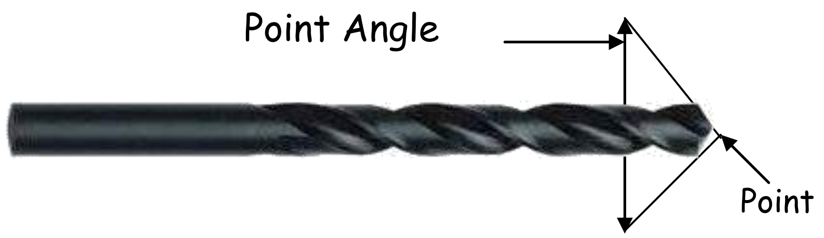

## Drill Elements – The Cylindrical Land

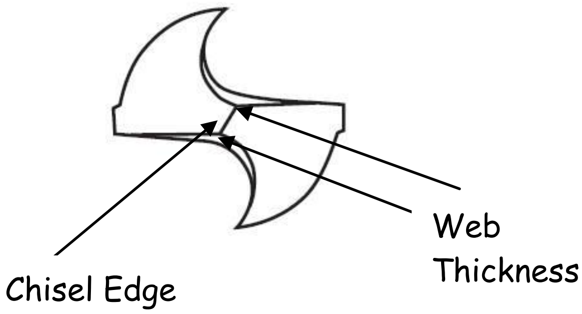
The cylindrical land is the narrow raised section of the land. It provides support and guidance for the drill in to the hole. The reminder of the land is reduced in diameter and this is known as the cleared diameter or body clearance. The body clearance reduces the width of the land to prevent rubbing and friction in the work piece.

## Drill Elements – The Diameter (d) & Body Back Taper

The diameter of the drill is measured behind the point of the drill, across the top of the lands. The size of the hole produced is slightly larger than the diameter of the drill.
Back taper on a drill is the slight decrease in the diameter of the drill body from front to back. This back taper creates clearance between the work piece and that drill so that the back of the drill will not rub and create friction or heat that could dull the drill.

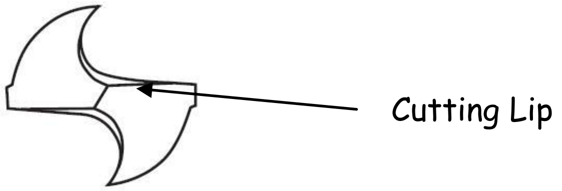
## **Drill Elements – The Point**

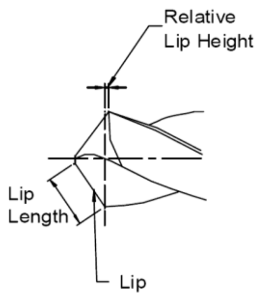



The point is that part of a drill which performs the cutting action. It is the end, cone shaped tip, made up of the cutting lip, web and chisel edge. The point angle is determined by measuring the angle made by the cutting lips against the axis or centre line.

## **Drill Elements – Web Thickness**

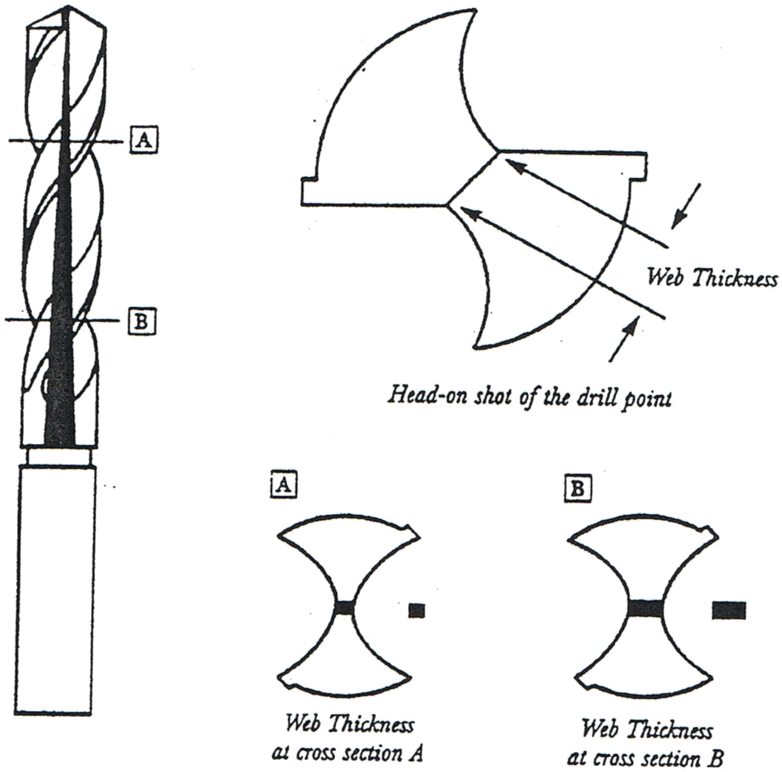



The cutting edges of a drill at the point are known as the cutting lips. The cutting lips extend from the centre of the drill to the outer diameter, and when properly designed, should form a straight line, or edge. The cutting edge along the cutting lip removes material from the part, so creating chips.

## Drill Elements – Web Thickness

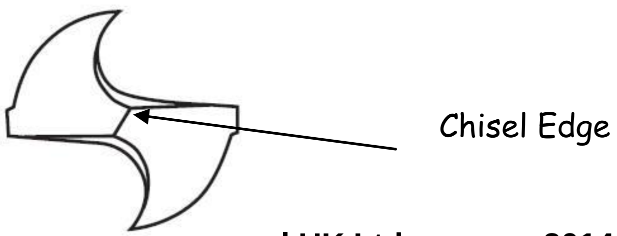
The web thickness of a drill will normally increase towards the shank, so increasing its strength. Drills manufactured for deep hole drilling generally have no increase in web thickness. This allows chips to flow up and out of the flutes with minimum resistance. Heavy duty drills are manufactured with a thicker web than normal to give them increased strength.




These cross cut sections of the body of a drill show how the web thickness increases towards the shank of a drill

## Drill Elements – Point Angle


The angle of the point is determined by the properties of the material to be drilled, and the nature of the application. The point angle is measured, as indicated above. The most common point angle is 118°



The chisel edge is located at the centre of the drill point and creates a straight line joining the cutting lips. Generally, the length of the chisel edge and the thickness of the web at the point are the same.

## Drilling Practice

The flute form, web thickness and helix angle of standard drills are suitable for most materials producing semi-continuous chips.

Drilling sizes below ½" (12.5mm) diameter in soft materials which produce continuous chips, eg copper, a bright quick helix drill may be required to remove the chips more efficiently, especially in fast machining.
Conversely, on materials producing short chips e.g. brass and some plastics, a slow helix drill is preferable.

For effective drilling, the rigidity of the drill and work piece are the most important factors. The shorter the flute, the stronger the drill. Long drills must be adequately bushed or supported to reduce vibrations which adversely affect drill life.

Heavy duty, thick web, drills may be necessary on more difficult materials. Or where the set up lacks rigidity. These drills must be point thinned or have a split point.

## Cutting Diameter Tolerances of Twist Drills BS338

| Diameter | | Tolerance | |
|---|---|---|---|
| Mm | | mm | |
| Over | Up to | High + | Low - |
| | 3 | 0 | 0.014 |
| 3 | 6 | 0 | 0.018 |
| 6 | 10 | 0 | 0.022 |
| 10 | 18 | 0 | 0.027 |
| 18 | 30 | 0 | 0.033 |
| 30 | 50 | 0 | 0.039 |
| 50 | 80 | 0 | 0.046 |
| 80 | 100 | 0 | 0.054 |

# DRILL CUTTING SPEEDS

| MATERIAL | Hard's | SPEEDS & (feeds) | | |
|---|---|---|---|---|
| **Steel** | | Stub | Jobber | Long S |
| leaded free cutting | 120Hb | 36 (5) | 33 (4) | 22 (3) |
| low carbon | 150Hb | 32 (5) | 27 (4) | 20 (3) |
| medium carbon | 250Hb | 27 (4) | 22 (3) | 17 (3) |
| Alloy Steel | 250Hb | 21 (4) | 18 (3) | 16 (2) |
| Alloy steal treated | 300Hb | 14 (3) | 11 (2) | 9 (2) |
| Alloy steel treaded | 350Hb | 9 (2) | 7 (2) | 6 (2) |
| **Stainless steel** | | | | |
| Free cutting | 250Hb | 16 (4) | 14 (2) | 12 (2) |
| Austenitic Non-Mag | 250Hb | 9 (4) | 7 (4) | 6 (3) |
| Duplex alloys | 300Hb | 12 (3) | 9 (3) | 7 (2) |
| **Cast Irons** | | | | |
| Plain Grey Cast | 150Hb | 35 (4) | 33 (4) | 25 (3) |
| SG & Malleable | 250Hb | 30 (4) | 22 (4) | 20 (3) |
| Alloy cast | 300Hb | 19 (4) | 17 (3) | 15 (3) |
| **Aluminium** | | | | |
| Soft & Extruded | 100Hb | 55 (7) | 50 (6) | 40(5) |
| Wrought & Treated | 150Hb | 45 (5) | 40 (5) | 30 (3) |
| Cast 5% Si | 120Hb | 40 (5) | 35 (4) | 30 (3) |
| Cast 10% Si | 150Hb | 33 (4) | 30 (4) | 27 (3) |
| **Copper alloys** | | | | |
| Pure Copper | 100Hb | 42 (5) | 40 (4) | 30 (3) |
| Brass Soft Yellow | 150Hb | 40 (5) | 40 (5) | |
| Brass Tough Red | 200Hb | 37 (5) | 37 (5) | |
| Hi-tensile Bronze | 250Hb | 28 (4) | 25 (4) | 23 (3) |
| **Titanium** | | | | |
| Pure Titanium | 200Hb | 28 (4) | 18 (4) | 15 (3) |
| Titanium Alloys | 300Hb | 9 (2) | 7 (2) | 6 (2) |
| **Nickel** | | | | |
| Pure Nickel | 200Hb | 12 (4) | 14 (4) | 10 (3) |
| Nimonics 75, Hasteloy | 300Hb | 10 (4) | 9 (4) | 7 (3) |
| Inconel 718 | 300Hb | 7 (3) | 5 (3) | 3 (2) |

Speeds given in Metres / min Feeds In brackets(4)

Use Cobalt Drills, or HSS at reduced speed of 66%

Specialist drills are available for most material or difficult applications please consult catalogue for application orientated drills

Use Quick Spiral Bright Finish on Aluminium, copper,
Use Slow Spiral Bright Finish on Brasses

If quick or slow spiral not available, bright finish is a good alternative for non ferrous materials

# DRILL SPEED CHART

| Diameter | 1/8" | 3/16" | 1/4" | 5/16" | 3/8" | 1/2" | 5/8" | 3/4" |
|---|---|---|---|---|---|---|---|---|
| *Meters/min* | **3** | **5** | **6** | **8** | **10** | **12** | **16** | **19** |
| | | | | | | | | |
| *5* | 530 | 318 | 265 | 199 | 159 | 133 | 99 | 84 |
| *7* | 743 | 446 | 371 | 279 | 223 | 186 | 139 | 117 |
| *9* | 955 | 573 | 477 | 358 | 286 | 239 | 179 | 151 |
| *12* | 1273 | 764 | 637 | 477 | 382 | 318 | 239 | 201 |
| *15* | 1591 | 955 | 796 | 597 | 477 | 398 | 298 | 251 |
| *20* | 2122 | 1273 | 1061 | 796 | 637 | 530 | 398 | 335 |
| *22* | 2334 | 1401 | 1167 | 875 | 700 | 584 | 438 | 369 |
| *25* | 2652 | 1591 | 1326 | 995 | 796 | 663 | 497 | 419 |
| ***27*** | **2865** | **1719** | **1432** | **1074** | **859** | **716** | **537** | **452** |
| *30* | 3183 | 1910 | 1591 | 1194 | 955 | 796 | 597 | 503 |
| *35* | 3713 | 2228 | 1857 | 1393 | 1114 | 928 | 696 | 586 |
| *40* | 4244 | 2546 | 2122 | 1591 | 1273 | 1061 | 796 | 670 |
| *45* | 4774 | 2865 | 2387 | 1790 | 1432 | 1194 | 895 | 754 |
| *50* | 5305 | 3183 | 2652 | 1989 | 1591 | 1326 | 995 | 838 |

**FEED CHART**

| Diameter | 3 | 5 | 6 | 8 | 10 | 12 | 16 | 19 |
|---|---|---|---|---|---|---|---|---|
| *Feed Code* | Feed per revolution in mm's | | | | | | | |
| *(1)* | 0.030 | 0.035 | 0.045 | 0.055 | 0.062 | 0.070 | 0.085 | 0.110 |
| *(2)* | 0.045 | 0.060 | 0.065 | 0.070 | 0.100 | 0.110 | 0.130 | 0.160 |
| ***(3)*** | **0.062** | **0.080** | **0.095** | **0.120** | **0.140** | **0.150** | **0.160** | **0.210** |
| *(4)* | 0.085 | 0.110 | 0.120 | 0.160 | 0.190 | 0.200 | 0.240 | 0.280 |
| *(5)* | 0.120 | 0.150 | 0.170 | 0.220 | 0.260 | 0.280 | 0.320 | 0.360 |
| *(6)* | 0.150 | 0.190 | 0.210 | 0.280 | 0.330 | 0.350 | 0.400 | 0.450 |
| *(7)* | 0.180 | 0.230 | 0.250 | 0.330 | 0.390 | 0.420 | 0.460 | 0.520 |

Feeds in Brackets (4) from speed chart above
Figure in **bold** are the best general purpose speed and feed for use on steel as a good starting point
To convert Metres/Minute peripheral speed to RPM use formula:-

$$\text{RPM} = \frac{\text{Metres per minute} \times 1000}{3.1416\ (\pi) \times \text{Diameter in MM's}}$$

Penetration rate = RPM x Feed per revolution

Speeds and Feeds are given as starting points, the design of the drill can effect the performance and life