

**PRESTO INTERNATIONAL UK LTD**

**TRAINING MANUAL**

**Part 5**

**MILLING CUTTERS**

# MILLING CUTTERS

## Definition:-

“A rotary tool having two or more cutting edges and having two or more helical flutes for the passage of chips and admission of cutting fluid. It has the capability of cutting on the end of the tool in addition to the diameter”

## Materials

<b>M2</b>	<b>High Speed Steel</b>
<b>M35</b>	<b>2.5% Cobalt</b>
<b>M42</b>	<b>8% Cobalt</b>
<b>Solid Carbide</b>	



# MILLING CUTTERS

## Styles of Milling Cutters

### Slot Drill



Slot Drills have two flutes and are always end cutting

### End Mill



End Mills have more than two flutes and may be end cutting. They are sometimes referred to as Finishing End Mills.

### Ripping Cutter or Roughing End Mill



# MILLING CUTTERS

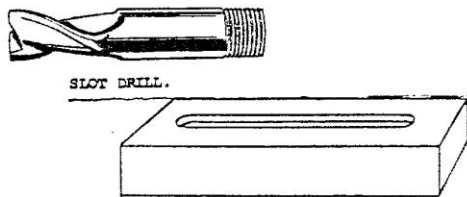
Ripping cutters are End Mills with a chipbreaker type profile ground in to the cutting edge for fast removal of material.

## Use of a Milling Cutter

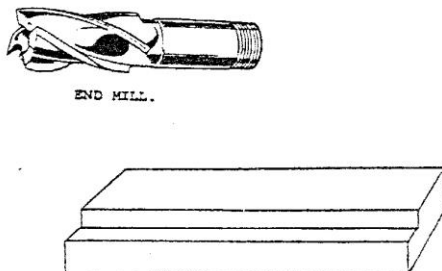
Milling cutters are very versatile tools, being able to cut on both the side and the end of the tool.

They can create shapes as simple as a slot in a piece of metal or a complicated profile as found in the mould making industry. (e.g. moulds for plastic toys)

Typical applications include slotting, milling, contour milling and occasionally drilling.



A slot drill (with only two teeth) can be fed INTO the work to produce a flat bottomed hole, also ALONG the work to produce a round ended slot.



An End Mill cannot be fed in vertically into a piece of work, only lengthways from OUTSIDE the edges of the work

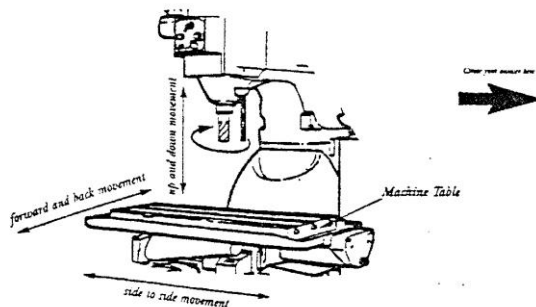
# MILLING CUTTERS

## How Milling Cutters are used

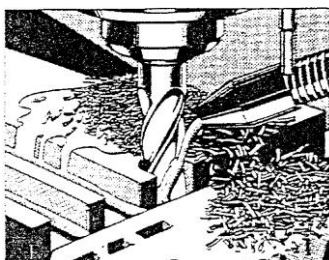
In most cases the workpiece is clamped to the machine table and moved in a predetermined direction whilst the milling cutter rotates.

However, the cutter or the workpiece can move in up to three directions:- up and down, side to side and forward and back.

For simple milling, such as creating a slot, only one movement at a time is necessary. For more complex or curved shapes, two and sometimes all three movements must occur at the same time.



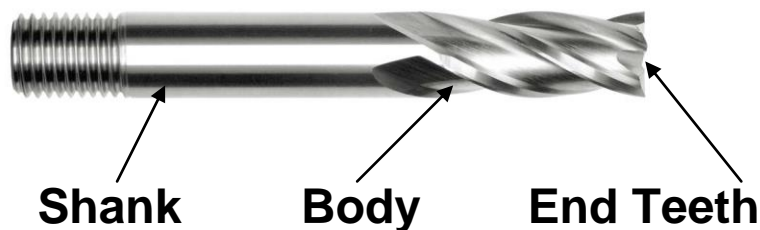
## How Milling Cutters cut



# MILLING CUTTERS

The previous picture shows a milling cutter performing a slotting operation. The workpiece is fed from side to side across the rotating milling cutter. Cutting edges on the side and end of the milling cutter remove material (chips) from the workpiece and these flow up the flutes, away from the cut.

## Elements of a milling cutter



**End Teeth** – are the cutting part of the milling cutter on the end

**Body** – is the circular part of the tool in which grooves or flutes are ground. The flutes carry the chips away and allow lubrication to be passed to the end teeth.

**Shank** – is the circular part of the tool behind the body. The shank is held in a chuck and can have different designs according to the design of the holder.

# MILLING CUTTERS

## Milling Cutter Elements – Shank

Shank Types



BS 122 Part 4  
Screwed Shank  
Suitable for use in  
chucks



ISO  
Plain Shank  
Suitable for use  
with collets

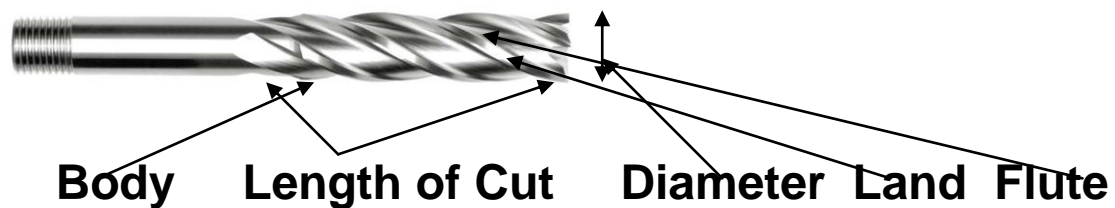
**Plain Shank – Held in a split collet type chuck**

**Flatted Shank – Held in a side lock holder chuck**

**Threaded Shank – Held in a screwed collet type  
chuck often referred to as a “ Clarkson type  
shank”**

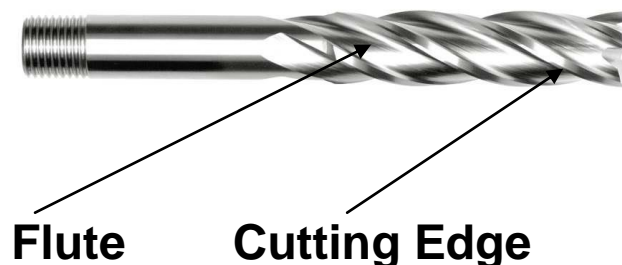
# MILLING CUTTERS

## Milling Cutter Elements – Body



The body is that part which falls in between the shank and the end teeth. The body is made up of the flute, length of cut, helix angle, land, core and diameter

## Milling Cutter Elements – Flute





# MILLING CUTTERS

The flutes are grooves that run along the body of a milling cutter. These are ground into the body to provide a path for the removal of chips and to carry cutting fluid to the cutting edge.

The edges of the flutes are sharpened to create a cutting edge. Increasing the number of flutes increases the strength of the cutter but reduces the space for chip flow. The reverse is also applicable.

## Milling Cutter Elements – Helix Angle



**Helix Angle**

The helix angle or spiral angle, is the angle formed by the axis or centre line of the cutter and the edge of the flute. The helix assists in chip removal. The standard helix for general milling is  $30^\circ$ . For softer material, the angle is increased and for harder material it is decreased.

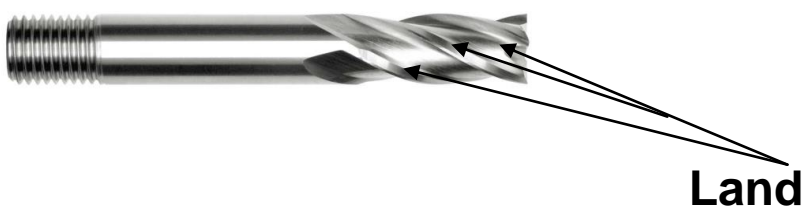
# MILLING CUTTERS

## End Mill Elements – Length of Cut



The length of cut is the sharpened portion of the flute length. It determines the length of cut that is possible by the milling cutter. The flutes will be longer than the length of cut to allow the entire cutting edge to be used. Various lengths of cut are available to suit different applications.

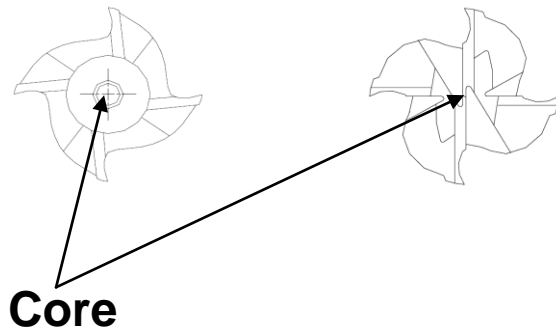
## End Mill Elements – Land



The land is situated between the flutes. The width of the land provides strength to the cutting edge. Like the flutes, the top of the land is sharpened to form a cutting edge.

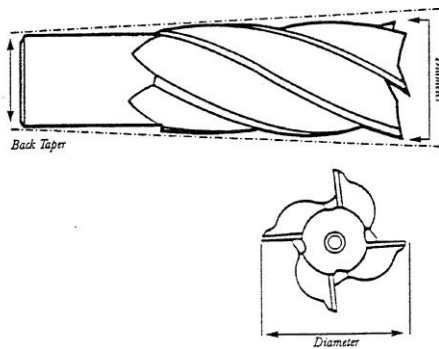
# MILLING CUTTERS

## Milling Cutter Elements – Core



The core is the centre portion of the cutter that separates the flutes. The core provides strength to the tool. As the number of flutes increase the core becomes larger, increasing the strength of the cutter.

## Milling Cutter Elements – Diameter



The diameter of the milling cutter is measured at the front of the cutter across the top of the lands at the cutting edge. Behind the front of the cutter, the diameter increases very slightly towards the shank. This is known as back taper.

# MILLING CUTTERS

Back taper creates clearance between the workpiece and the milling cutter.

## Milling Cutter Elements – End Teeth



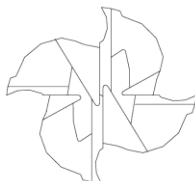
End Teeth

The cutting edges at the front of the milling cutter are known as end teeth. These are created when the flute is extended around the front end of the cutter and then sharpened to create cutting edges. Not all milling cutters have end teeth – some do not. End teeth allow the milling cutter to cut on both the outside diameter and the end in the same milling operation.

## Centre cutting and non-centre cutting



Non Centre  
Cutting



Centre Cutting

# **MILLING CUTTERS**

**Some milling cutters can be fed in to the workpiece to create or drill a hole like a drill. This is known as plunge cutting and is usually undertaken by a slot drill, which always have end teeth. Only end mills which have teeth extending to the centre of the end can plunge cut. These milling cutters are often referred to as centre cutting end mills. End mills that have a hole in the end centre cannot plunge cut but can be used for milling and profiling.**

## **Other styles of End Mills**

### **Ripping Cutters**



**Ripping cutters are multi flute cutters with the addition of chip-breaker grooves ground in to the cutting edges. These grooves break up the chips and facilitate easy removal. Ripping cutters can be centre or non-centre cutting. They are manufactured to give a coarse or a fine cut and are used to remove more material in a given time than a conventional milling cutter.**

# MILLING CUTTERS

However the finish of the cut is not as good and that is why a conventional end mills are often referred to as “finishing end mills” and ripping cutters as “roughing end mills”.

## Three Flute Cutters – Tri Cutters



A tri-cutter is designed to offer all the advantages of a slot drill and an end mill in one tool. It can perform profiling and end cutting operations at the same time

## Ball Nose Slot Drill



A ball nose slot drill is a 2 flute slot drill with a radius ground in to the end teeth. This allows milling of radiused slots in keyways

# MILLING CUTTERS

## Throwaway Cutters



**As their name implies these cutters are designed to be discarded after the cutting edge has become dull, and not to be re-ground.**

**Usually supplied on a 6mm shank they are available in small diameters from 1mm to 8mm With threaded or plain shanks.**