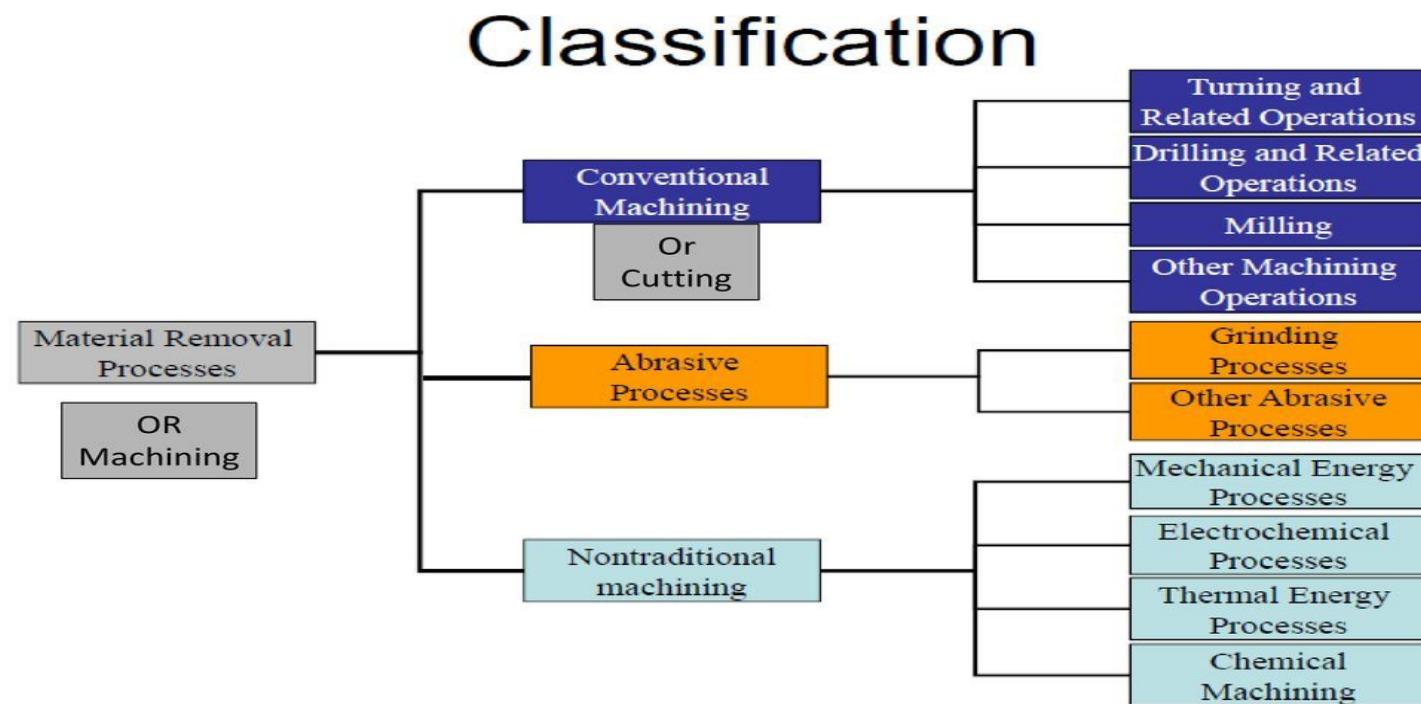


Automation application in Material Removal

L-7

Material Removal Processes

- (i) Conventional Machining Processes
- (ii) Unconventional Machining Processes



Conventional Machining Processes

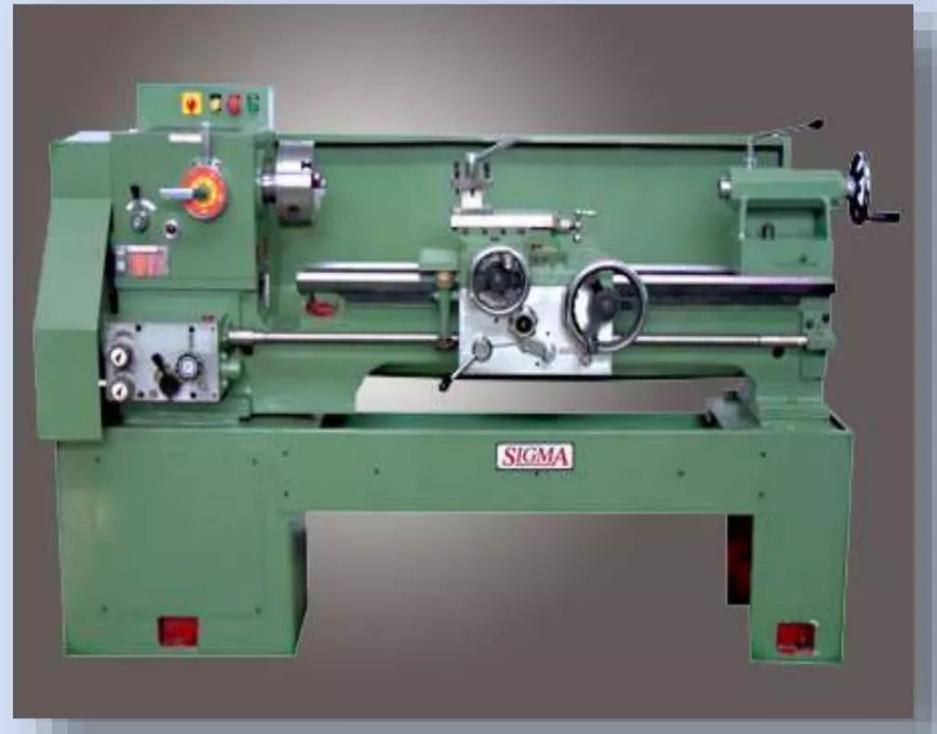
MACHINES USED FOR MACHINING

Lathe	Reducing Length/Diameter
Milling	Reducing Thickness/Slotting
Drilling	Making Hole
Shaper	Reducing Thickness/Slotting
Planner	Reducing Thickness/Slotting

LATHE

“The Mother of Machines”

It can make Cylindrical and Flat Surface



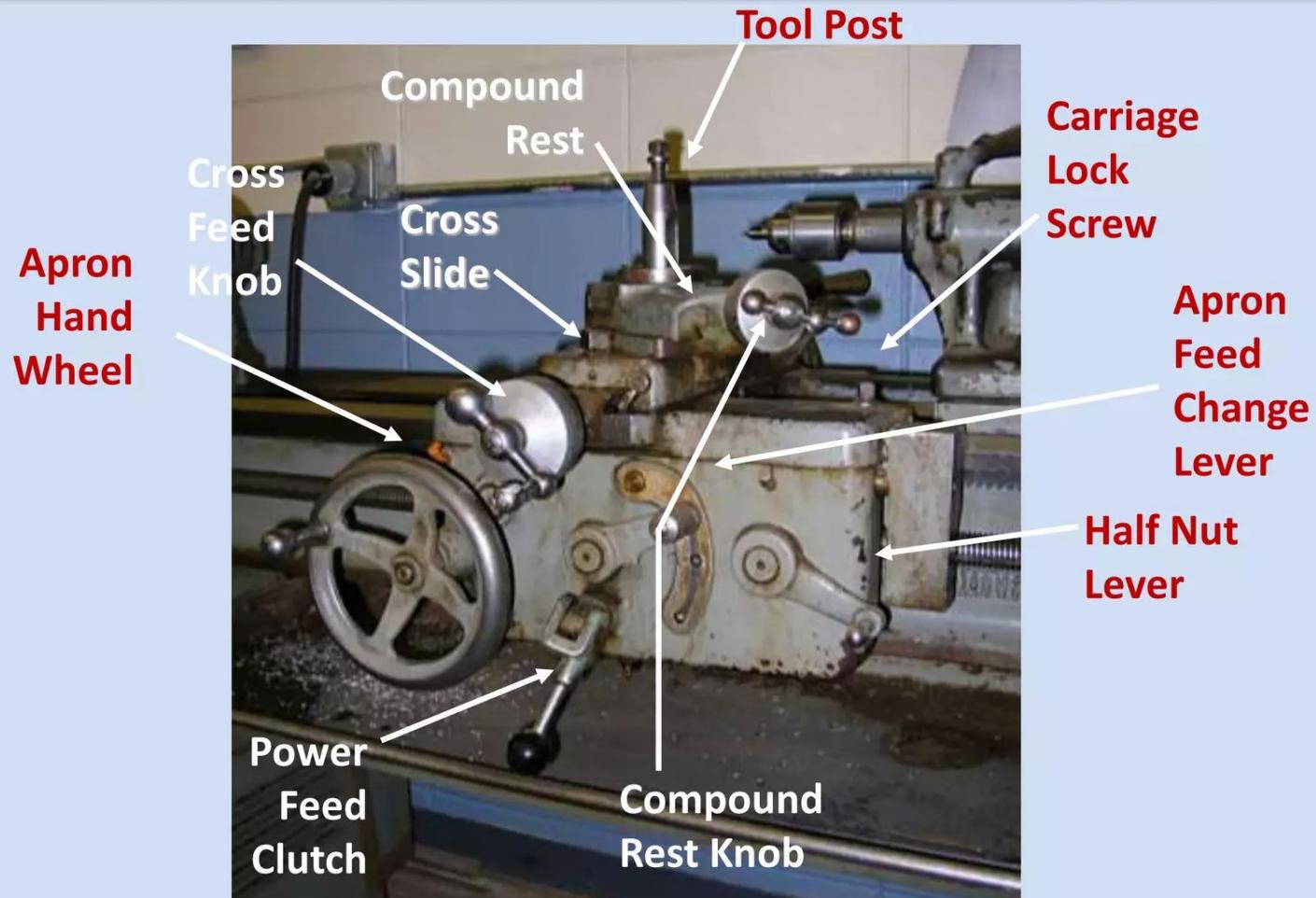
TYPES

- Engine Lathe
- Speed Lathe
- Bench Lathe
- Tool Room Lathe
- Special Purpose Lathe
- Gap Bed Lathe

BASICS



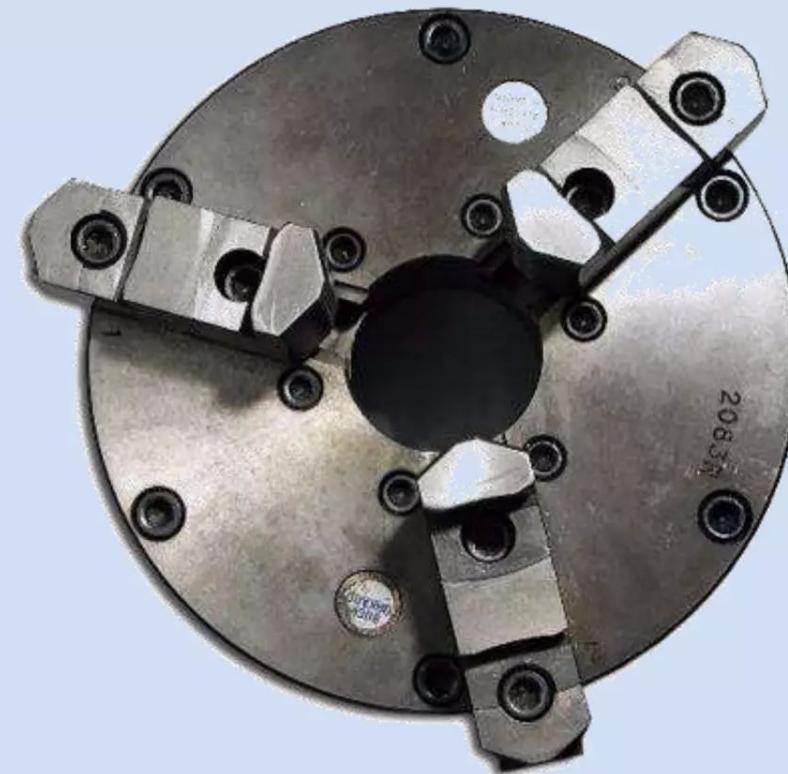
Lathe Carriage and Apron



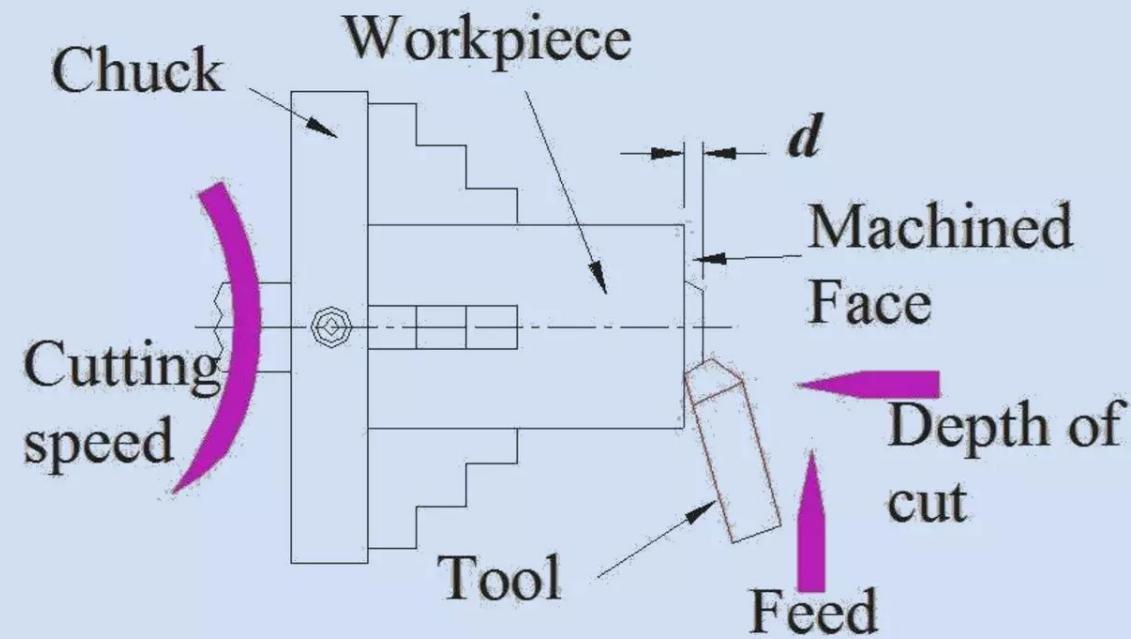
CHUCK

Three Jaw Chuck

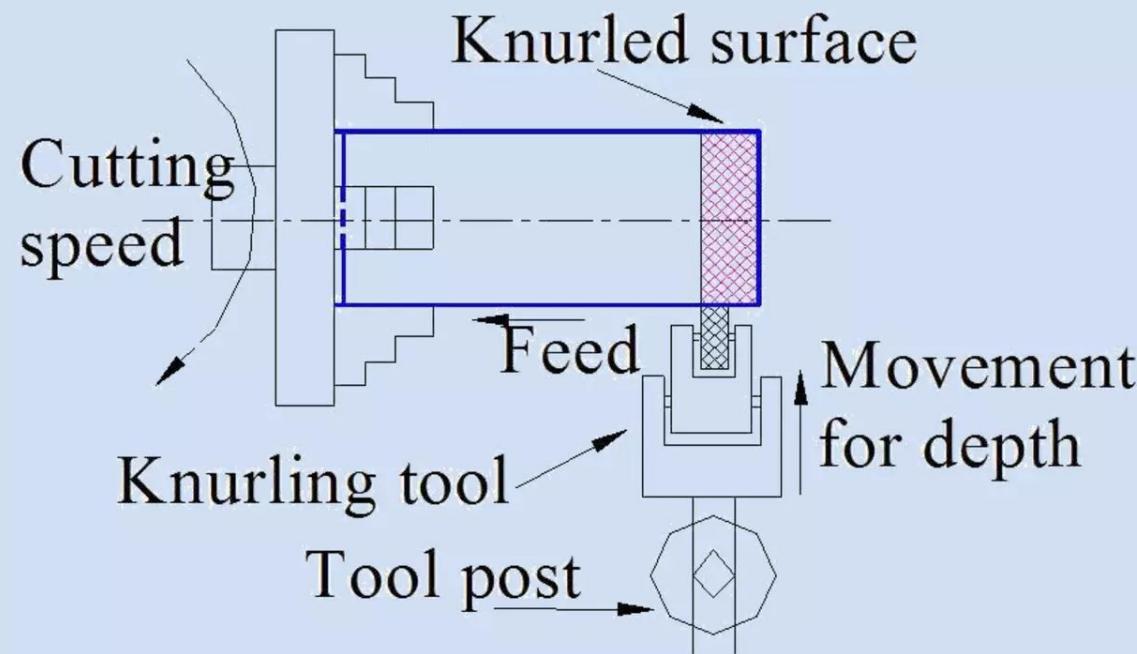
- For holding cylindrical stock centered.
- For facing/center drilling the end of your aluminum stock



FACING

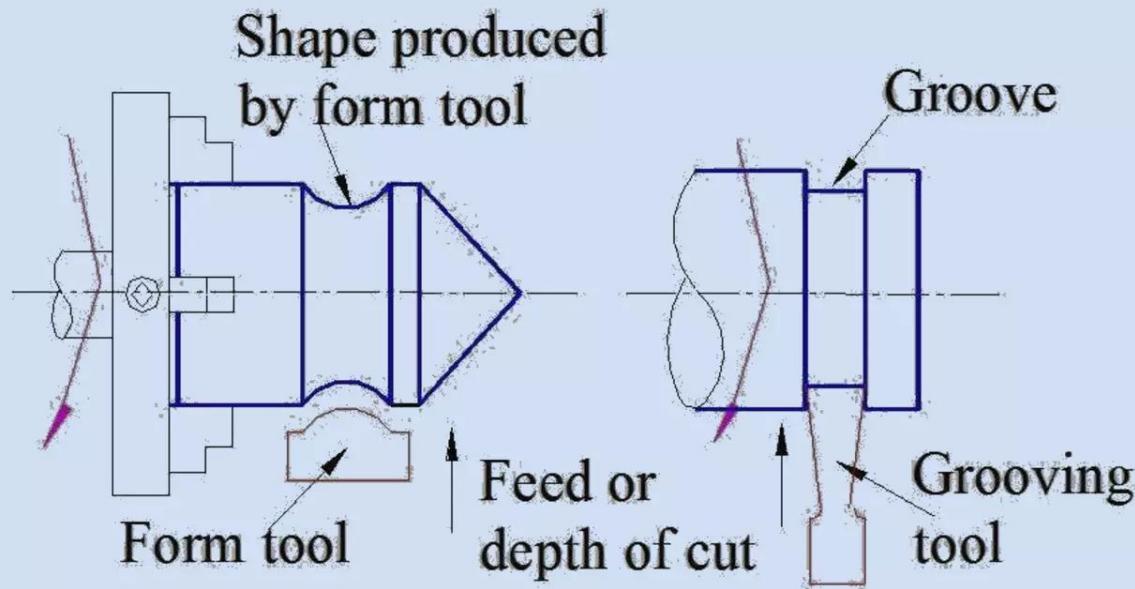


KNURLING



A *Forming* Process: Produce rough textured surface
For **Decorative** and/or **Functional** Purpose
Knurling Tool

GROOVING



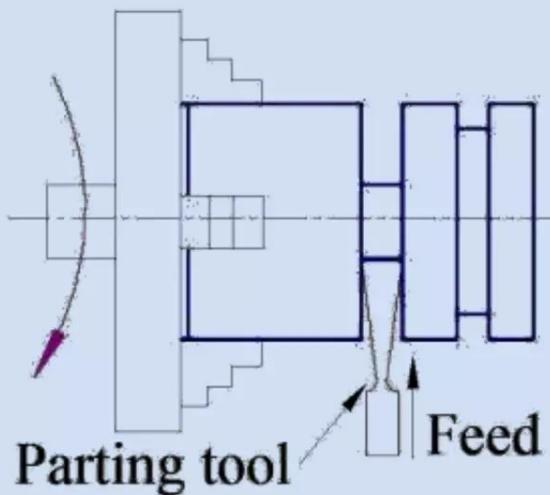
Produces a **Groove on workpiece**

Shape of tool \Rightarrow shape of groove

Carried out using Grooving Tool \Rightarrow A form tool

Also called Form Turning

PARTING OFF



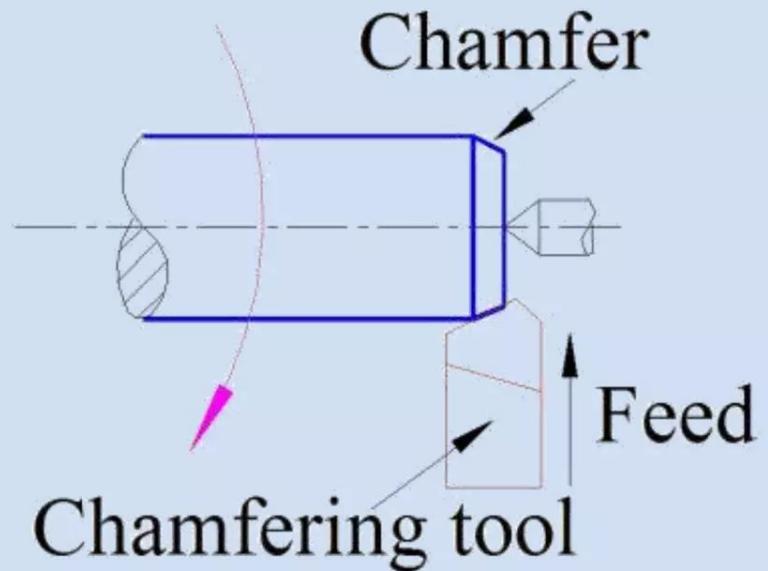
Cutting workpiece into **Two** Similar to grooving

Parting Tool

Hogging – tool rides over – at slow feed

Coolant use

CHAMFERING



Beveling sharp machined edges

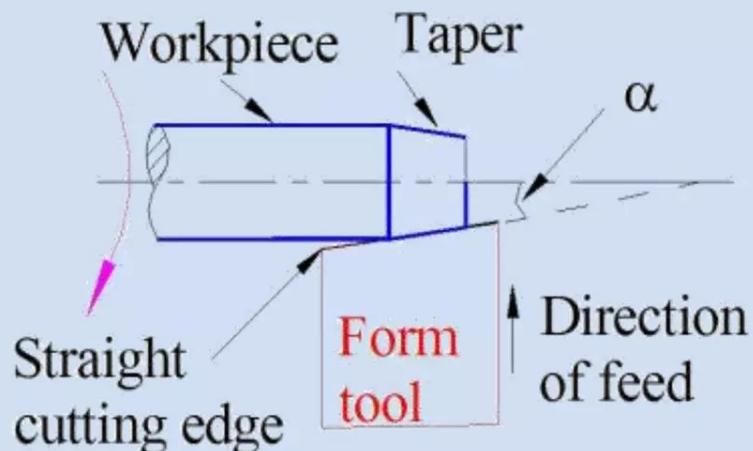
Similar to form turning

Chamfering tool – 45°

To

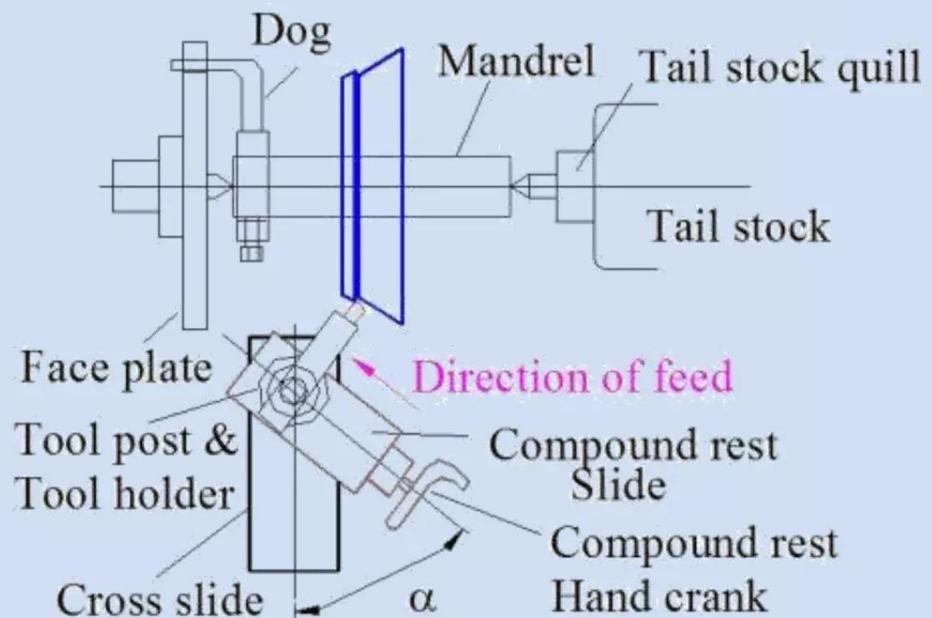
- Avoid Sharp Edges
- Make Assembly Easier
- Improve Aesthetics

TAPER TURNING

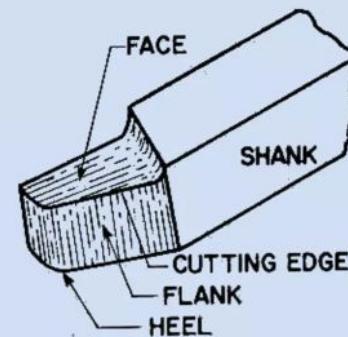
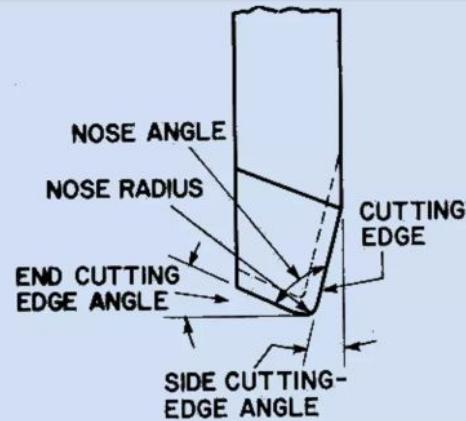


BY FORM TOOL

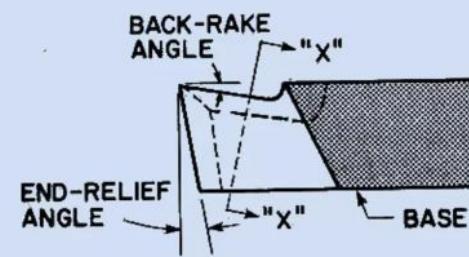
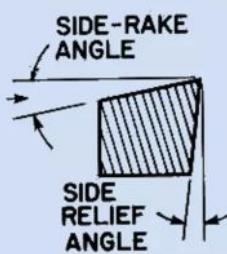
BY COMPOUND REST



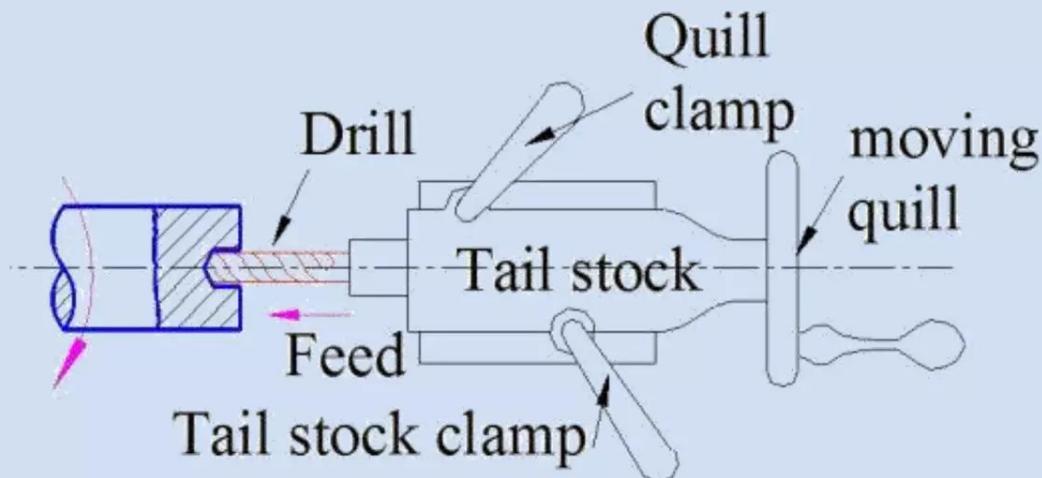
CUTTING TOOL



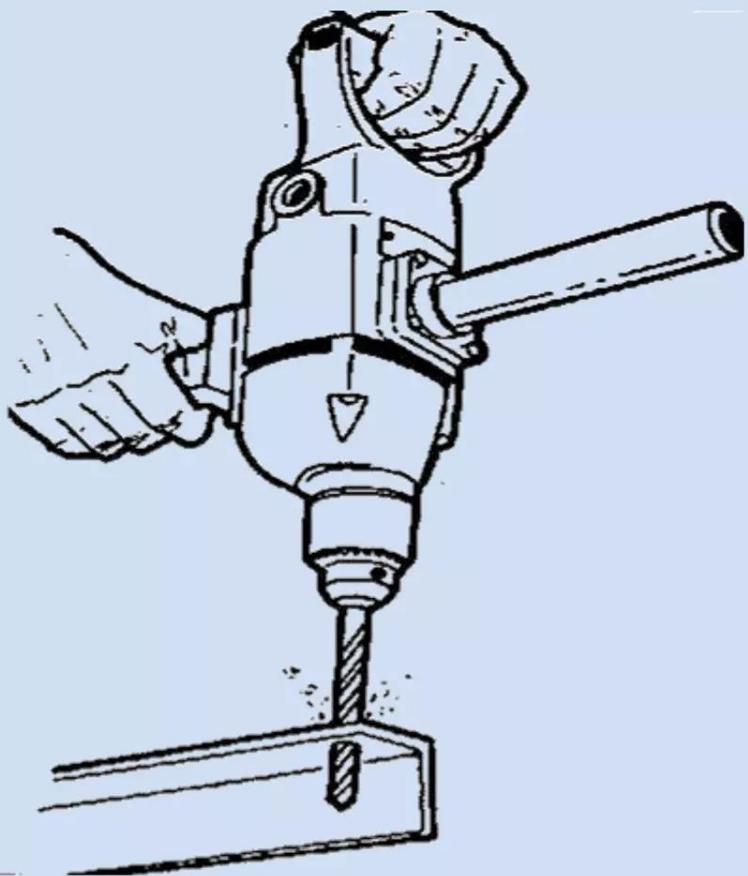
SECTION "X"- "X"



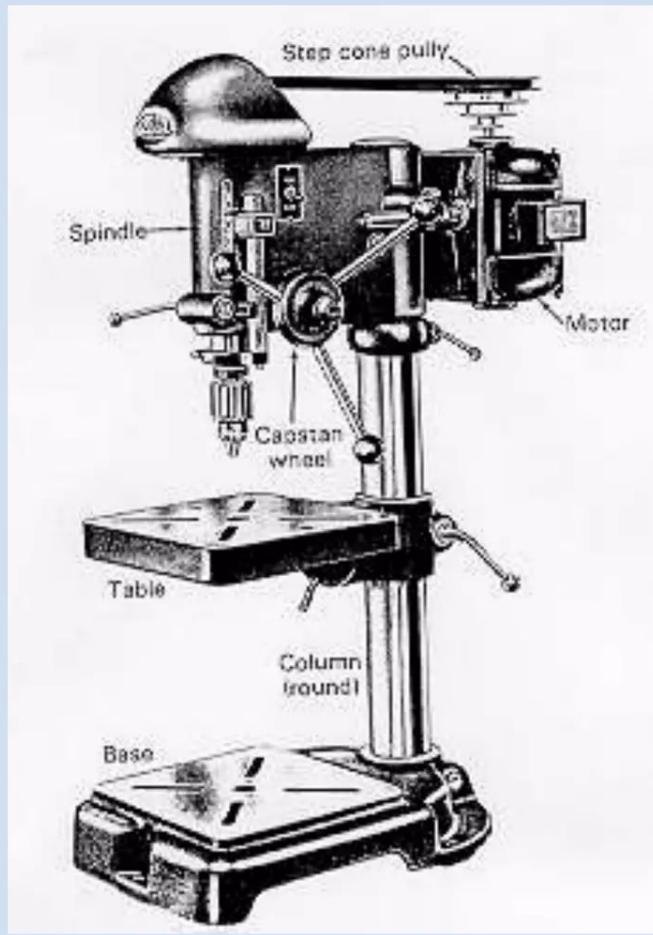
DRILLING/REAMING/BORING



PORTABLE DRILLING MACHINE



SENSITIVE DRILLING MACHINE



Sensitive

- Light weight-light duty
- Feed of the drill is “sensitive” to the touch of the operator
- Used primarily for low production

PILLAR / UPRIGHT DRILL PRESS



Upright Drill Press

- Larger than the sensitive
- Can be equipped with a gearbox and variable speed head
- Hand and automatic feed mechanism
- Automatic coolant system
- Table can move on a rack and pinion system

RADIAL DRILL PRESS



GANG DRILLING MACHINE



MULTI SPINDLE DRILLING MACHINE



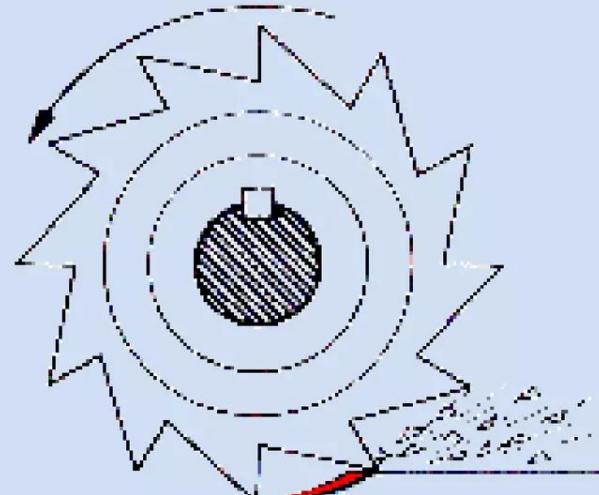
MILLING

Milling is one of the basic machining processes.

Milling is a very versatile process capable of producing simple two dimensional flat shapes to complex three dimensional interlaced surface configurations.

CONVENTIONAL UP/DOWN MILLING

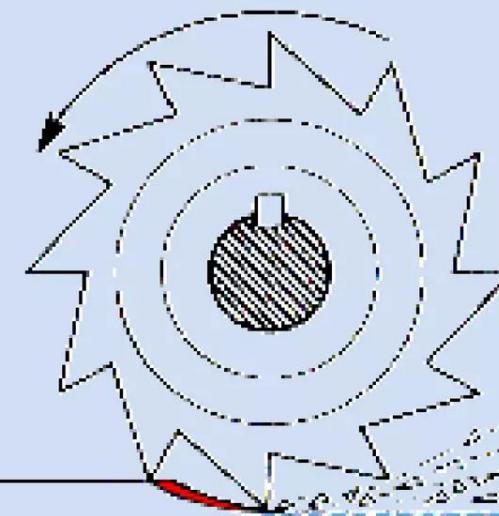
DIRECTION OF CUTTER ROTATION



← Feed

Conventional Up Milling

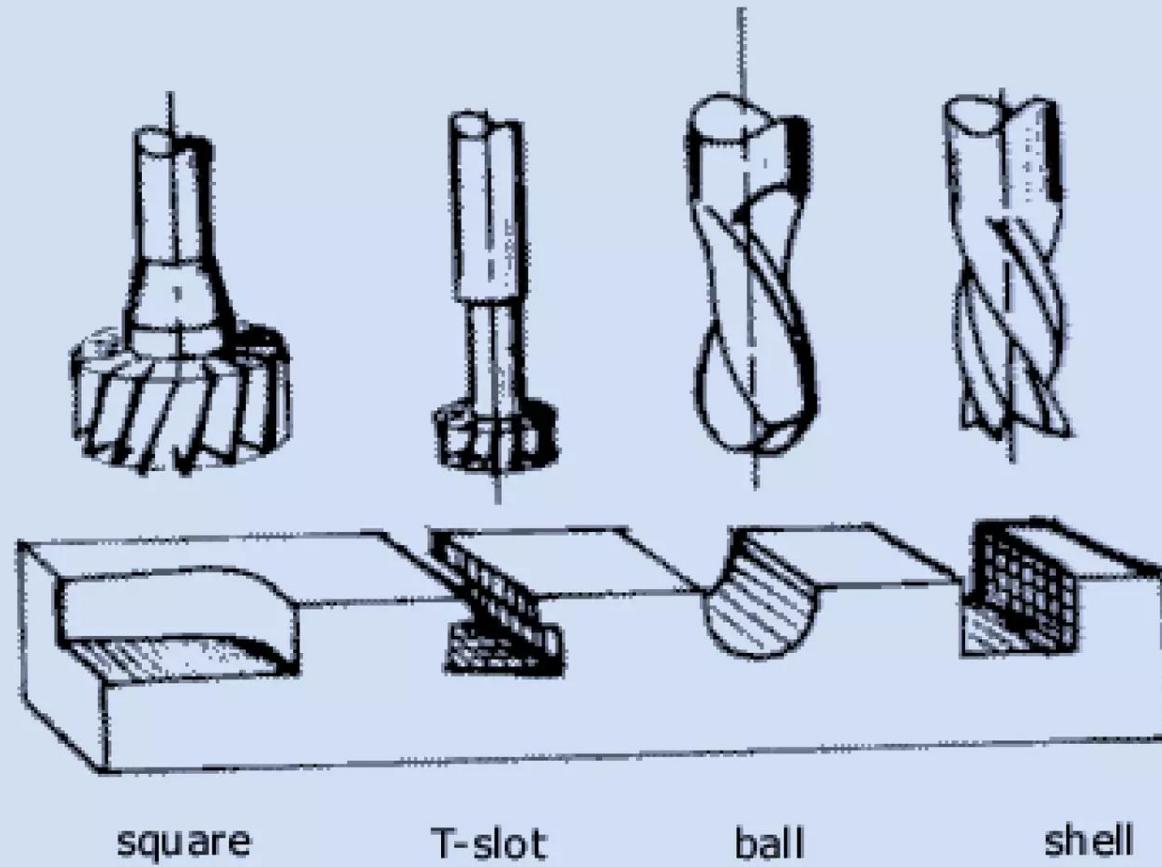
DIRECTION OF CUTTER ROTATION



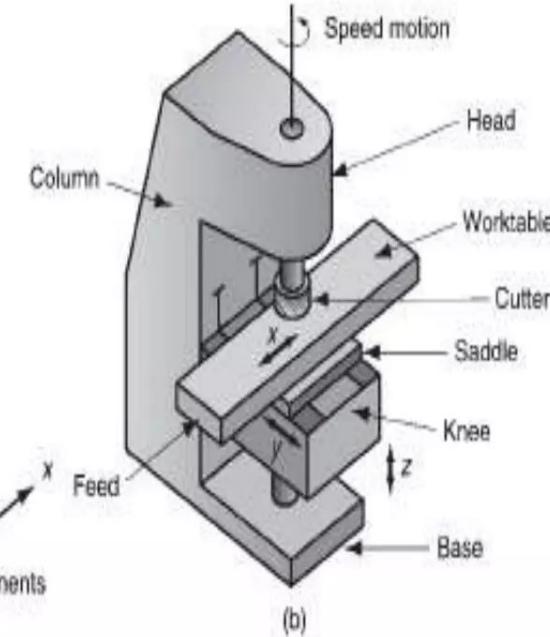
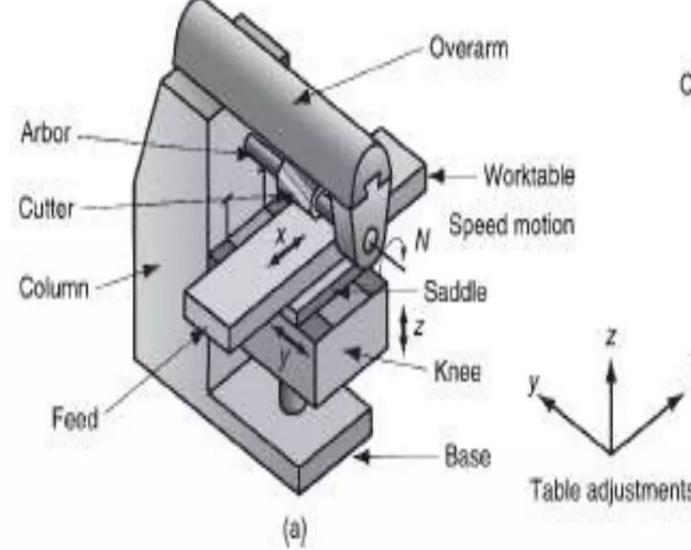
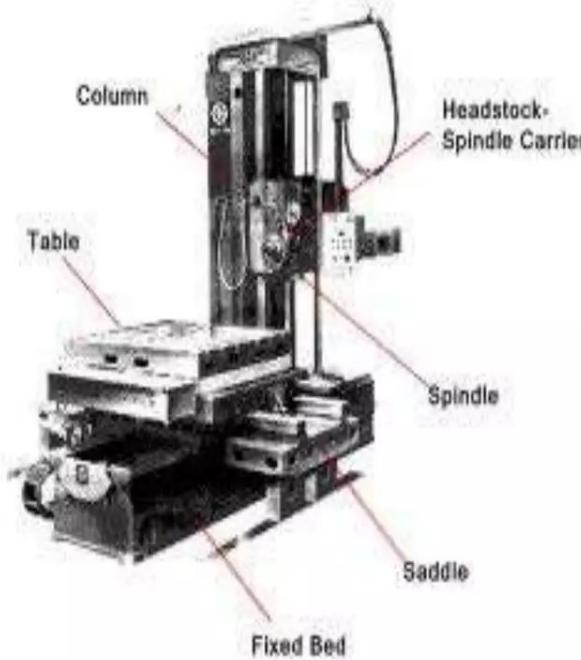
Feed →

Down Milling

BASIC MILLING OPERATIONS



Milling Machines



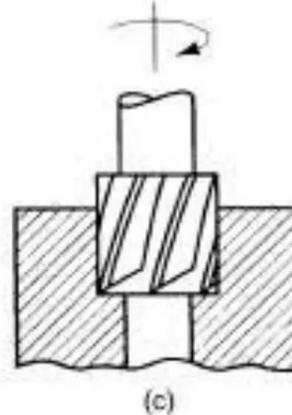
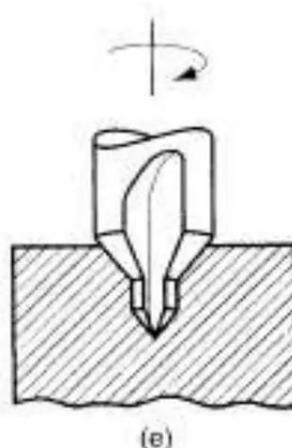
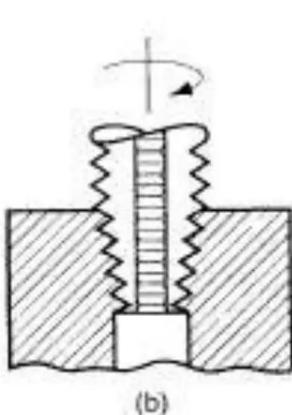
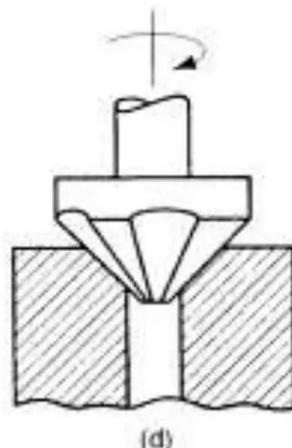
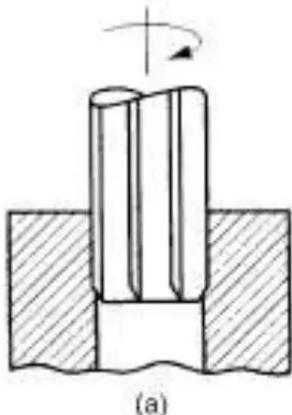
Bed Type

Knee-Type (Horizontal and Vertical)

Drilling Related Operations



The figure below illustrates the various operations related to drilling.



- (a) Reaming
- (b) Tapping
- (c) Counterboring
- (d) Countersinking
- (e) Center drilling
- (f) Spot facing

Boring

The boring operation is used to enlarge a pre-drilled hole. The enlargement is done with a single-point cutting tool. Initially, a small hole is drilled with the help of a drill press or any other alternative. Boring tools can be mounted on lathes, milling machines, and drill presses. Applications of boring are:

Engine shafts

Gun cylinders

Turbine cylinders

Grinding

GRINDING MACHINES

Conventional grinding machines can be broadly classified as:

- (a) Surface grinding machine
- (b) Cylindrical grinding machine
- (c) Internal grinding machine
- (d) Tool and cutter grinding machine



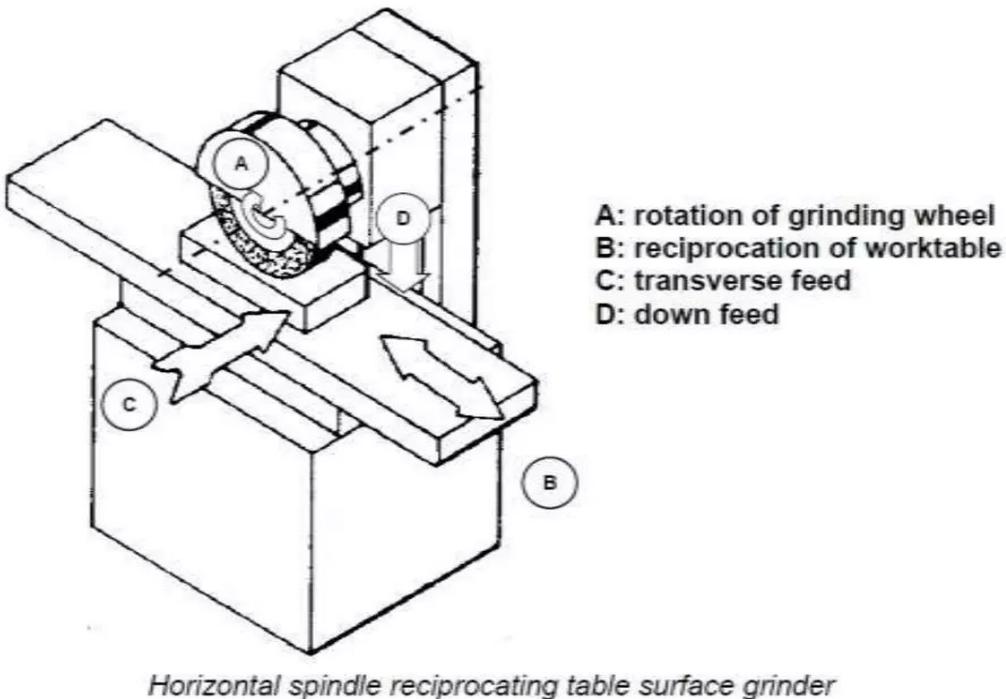
SURFACE GRINDING MACHINE

- Horizontal spindle and reciprocating table
- Vertical spindle and reciprocating table
- Horizontal spindle and rotary table
- Vertical spindle and rotary table



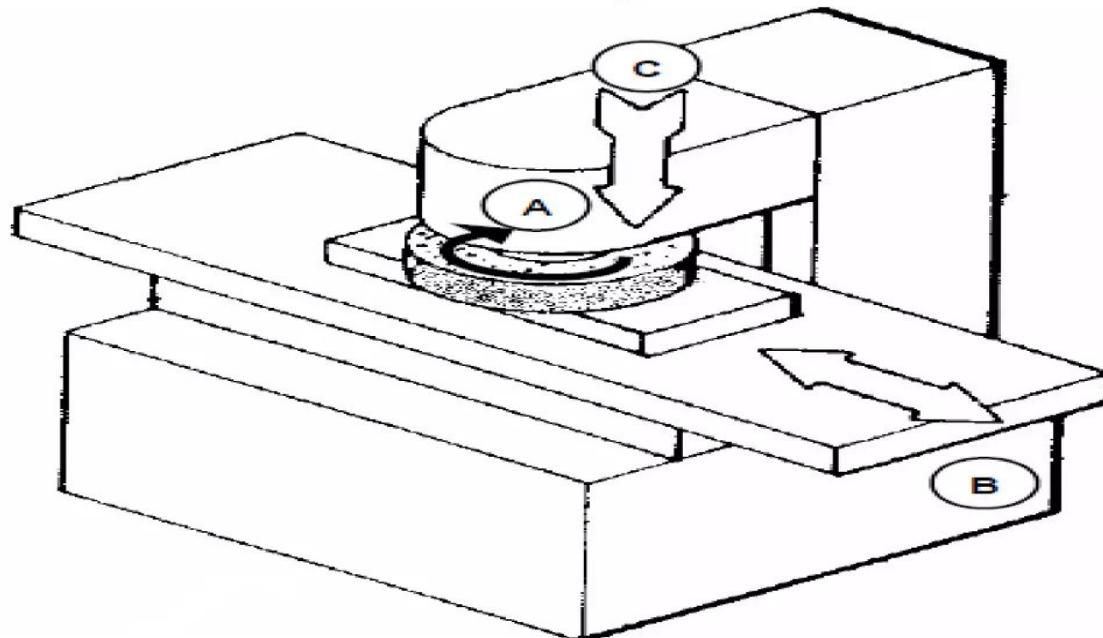
HORIZONTAL SPINDLE RECIPROCATING TABLE GRINDER

- A disc type grinding wheel performs the grinding action with its peripheral surface. Both traverse and plunge grinding can be carried out in this machine



VERTICAL SPINDLE RECIPROCATING TABLE GRINDER

- The grinding operation is similar to that of face milling on a vertical milling machine
- In this machine a cup shaped wheel grinds the workpiece over its full width using end face of the wheel

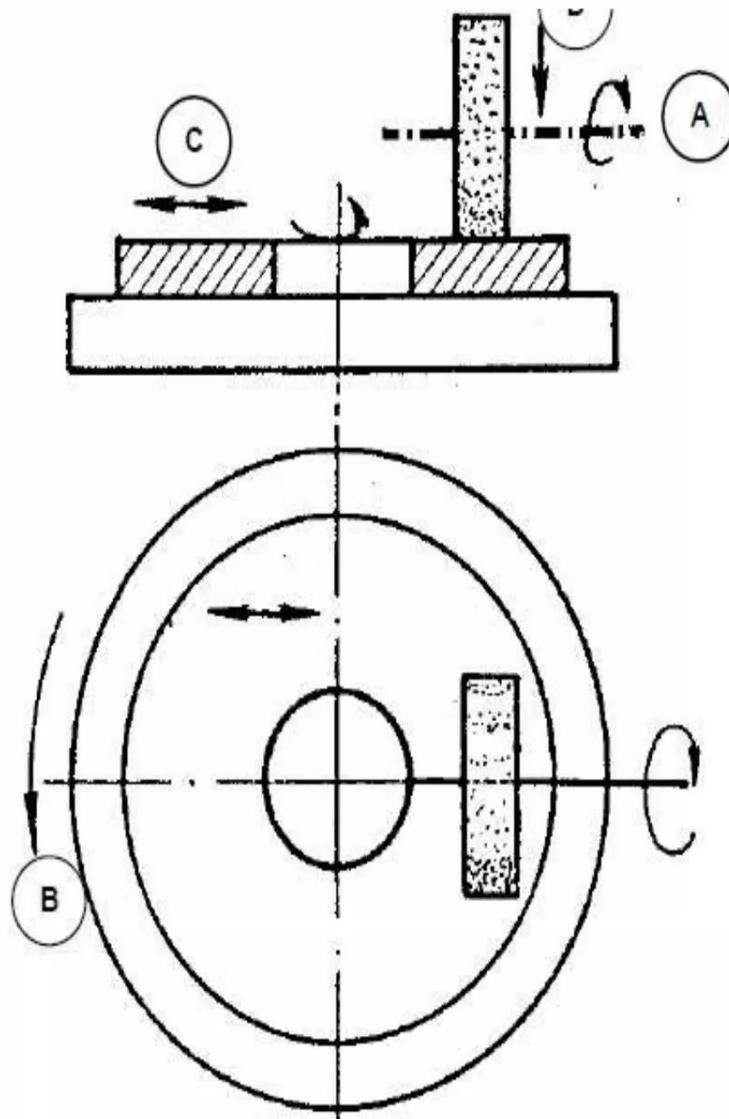


Vertical spindle reciprocating table surface grinder

HORIZONTAL SPINDLE ROTARY TABLE GRINDER

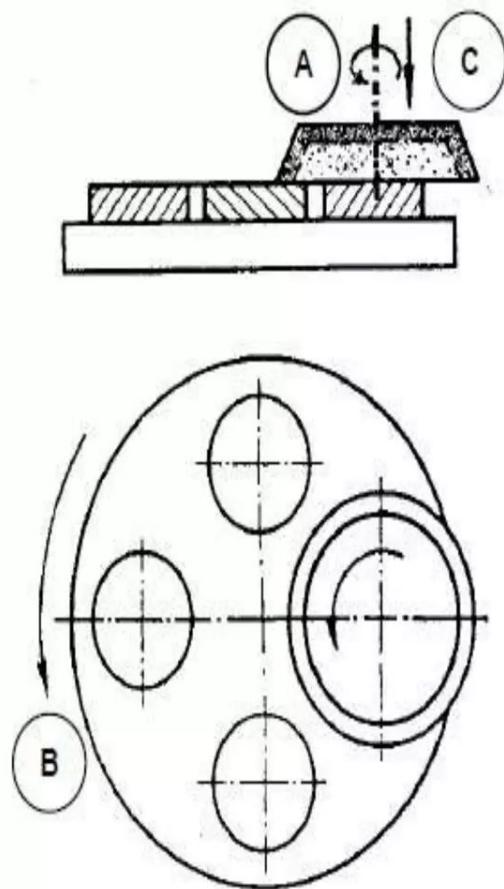
- In principle the operation is same as that for facing on the lathe.
- This machine has a limitation in accommodation of workpiece and therefore does not have wide spread use.
- However, by swivelling the worktable, concave or convex or tapered surface can be produced on individual part





- A: rotation of grinding wheel
- B: table rotation
- C: table reciprocation
- D: down feed of grinding wheel

Surface grinding in Horizontal spindle rotary table surface grinder

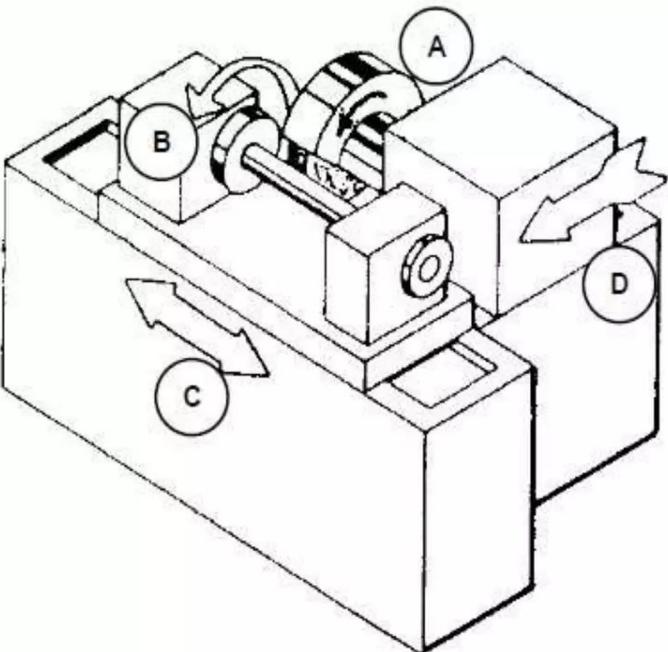


- A: rotation of grinding wheel
- B: work table rotation
- C: down feed of grinding wheel

Surface grinding in vertical spindle rotary table surface grinder



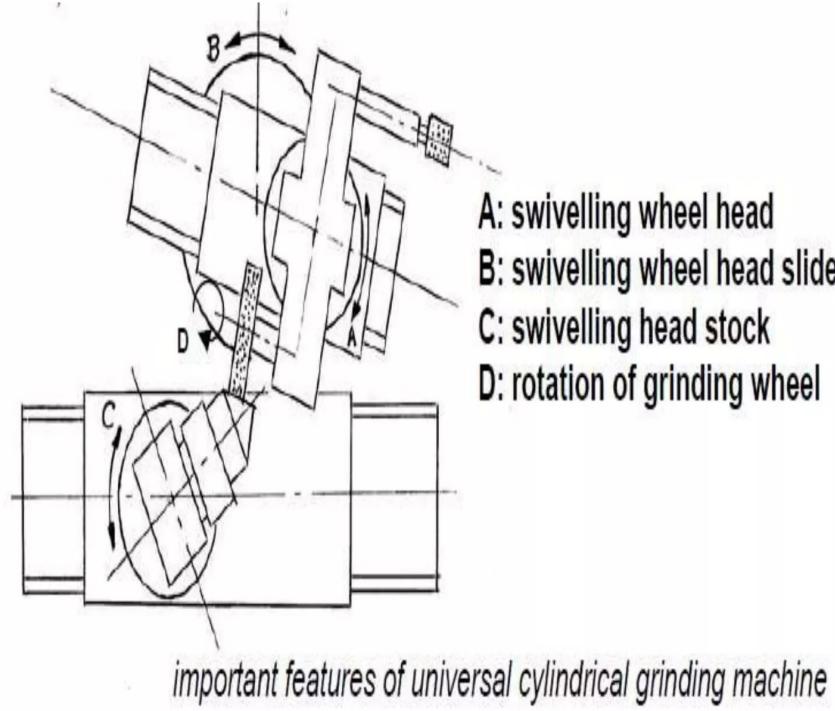
Cylindrical Grinding Machine



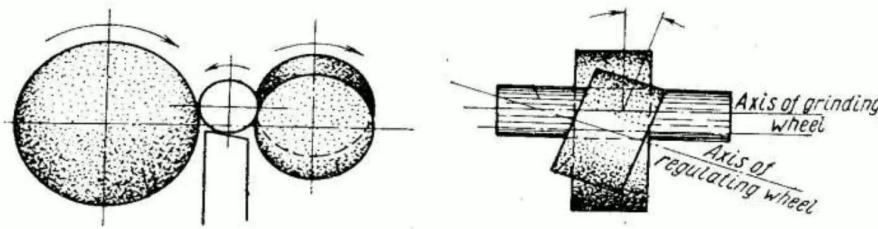
- A: rotation of grinding wheel
- B: work table rotation
- C: reciprocation of worktable
- D: infeed

Plain centre type cylindrical grinder

Universal Grinding Machine



External centreless Grinder



A: rotation of grinding wheel

B: workpiece rotation

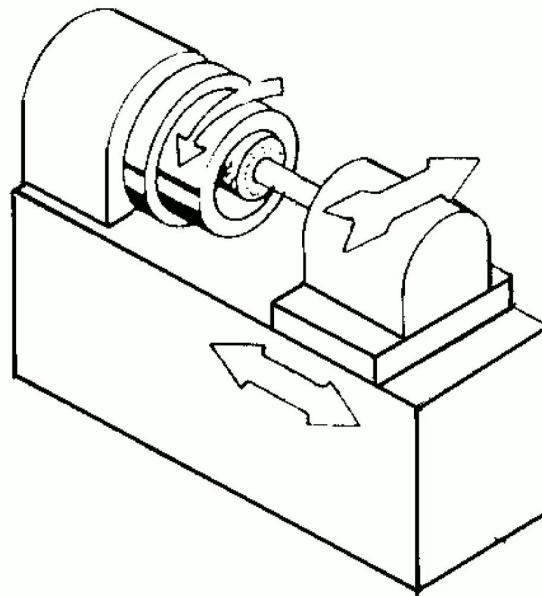
C: reciprocation of worktable

Internal Grinding Machine

1. Chucking type internal grinder
2. Planetary internal grinder
3. Centreless internal grinder



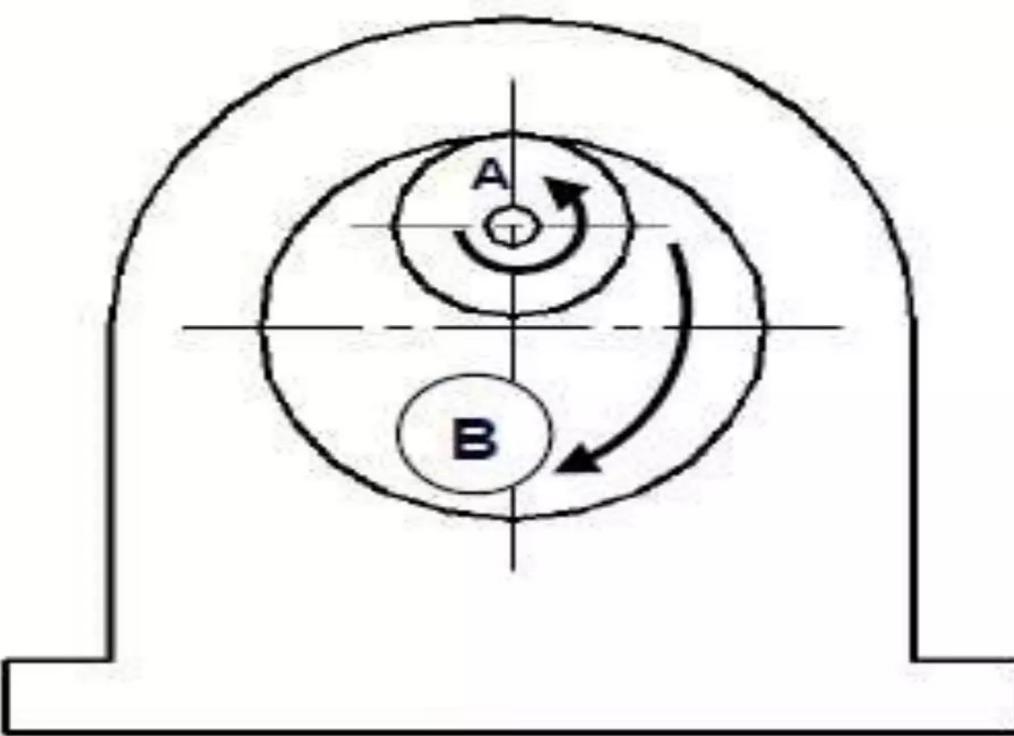
Chuck Type



PLANETARY INTERNAL GRINDER

- Planetary internal grinder is used where the workpiece is of irregular shape and can not be rotated conveniently
- In this machine the workpiece does not rotate. Instead, the grinding wheel orbits the axis of the hole in the workpiece.





Centreless internal grinder

TOOL AND CUTTER GRINDER MACHINE

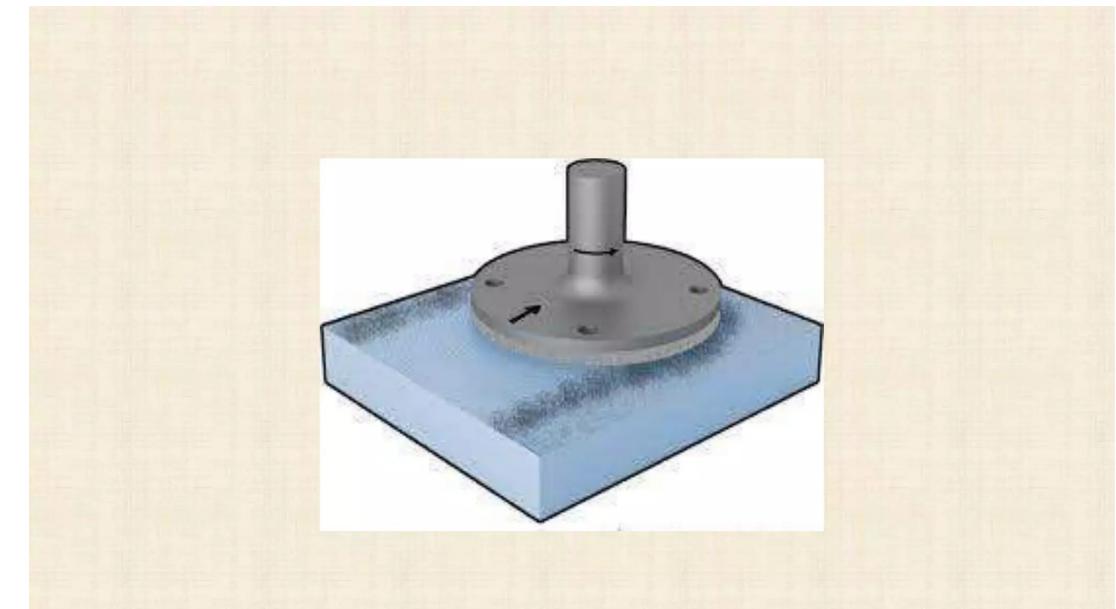
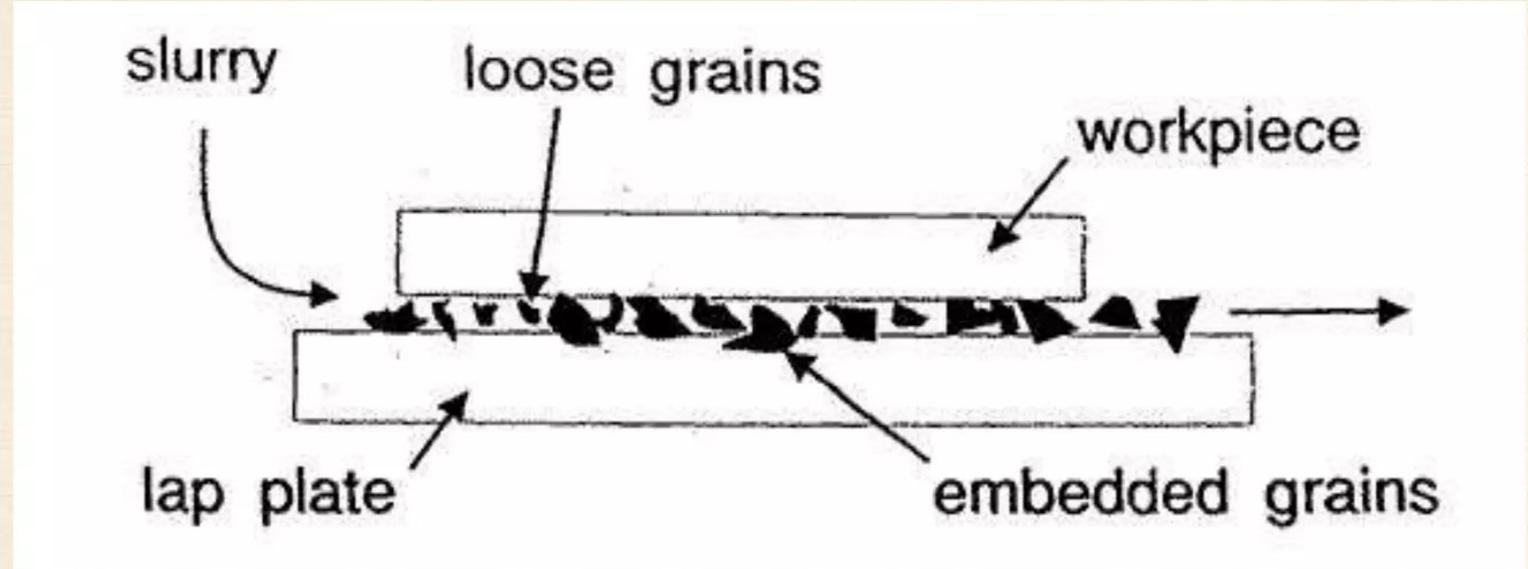
- Tool grinding may be divided into two subgroups: tool manufacturing and tool resharpening.
- There are many types of tool and cutter grinding machine to meet these requirements.
- Simple single point tools are occasionally sharpened by hand on bench or pedestal grinder.
- However, tools and cutters with complex geometry like milling cutter, drills, reamers and hobs require sophisticated grinding machine commonly known as universal tool and cutter grinder.



Lapping

Lapping Process

- The term "[lapping](#)" is used to describe a number of various surface finishing operations where loose abrasive powders are used as the grinding agent at normally low speeds. It is a process reserved for products that demand very tight tolerances of flatness, parallelism, thickness or finish



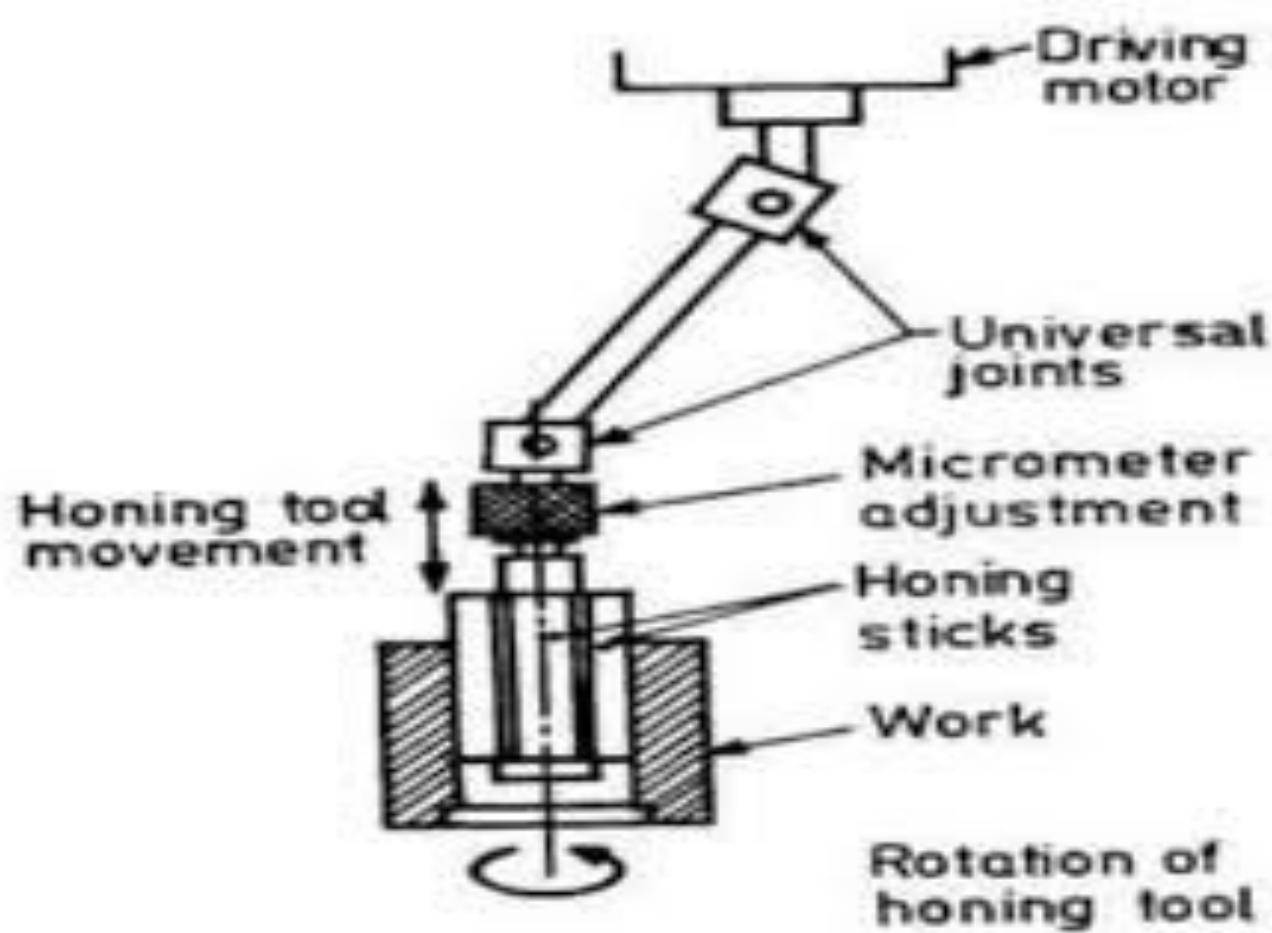
Honing

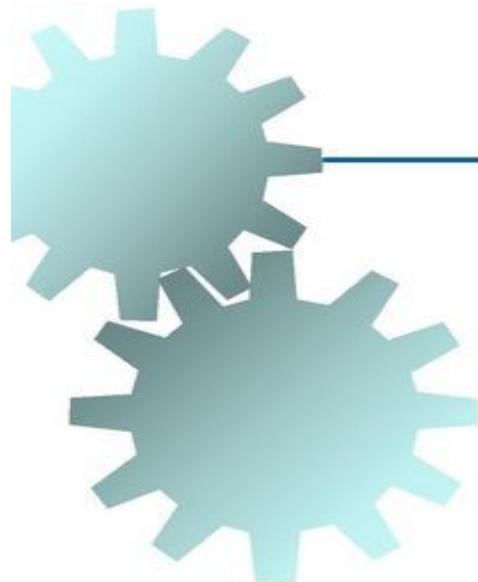
- **Honing** is an abrasive machining process that produces a precision surface on a metal work piece by scrubbing an abrasive stone against it along a controlled path.
- Honing is primarily used to improve the geometric form of a surface, but may also improve the surface texture.

The surface of a honed workpiece



Honing Process





Broaching

- Moves a multiple tooth cutting tool linearly relative to work in direction of tool axis

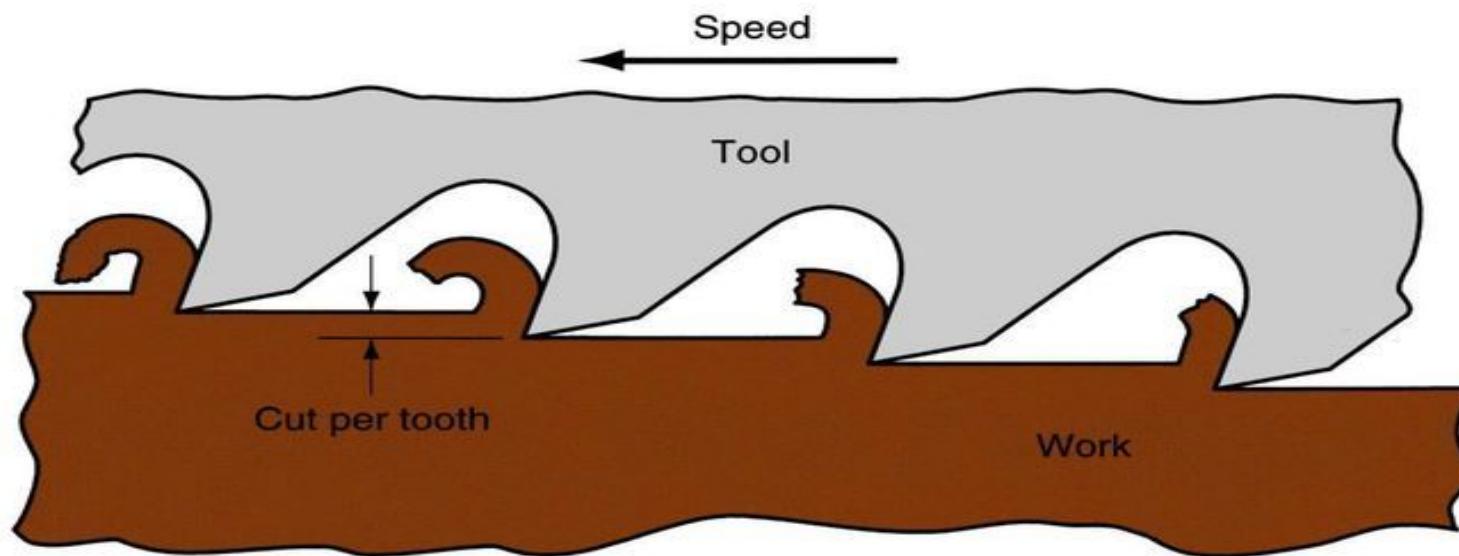


Figure 22.33 Broaching operation.

Broaching

Advantages:

- Good surface finish
- Close tolerances
- Variety of work shapes possible

Cutting tool called a *broach*

- Owing to complicated and often custom-shaped geometry, tooling is expensive

Internal Broaching

- Performed on internal surface of a hole
- A starting hole must be present in the part to insert broach at beginning of stroke

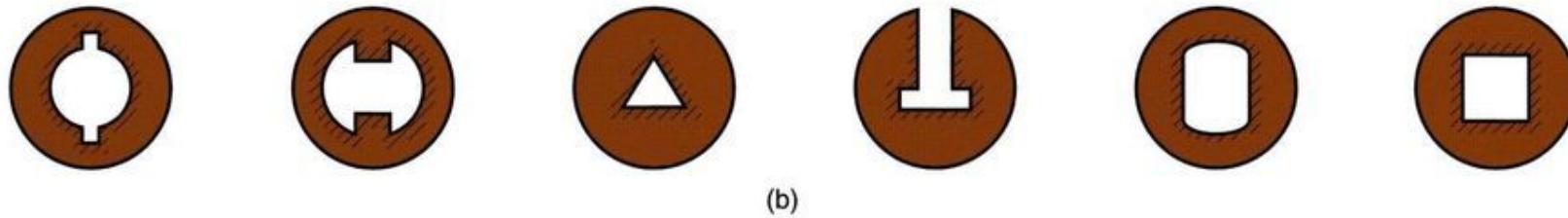


Figure 22.34 Work shapes that can be cut by internal broaching; cross-hatching indicates the surfaces broached.

Sawing

- Cuts narrow slit in work by a tool consisting of a series of narrowly spaced teeth
- Tool called a *saw blade*
- Typical functions:
 - Separate a workpart into two pieces
 - Cut off unwanted portions of part

Power Hacksaw

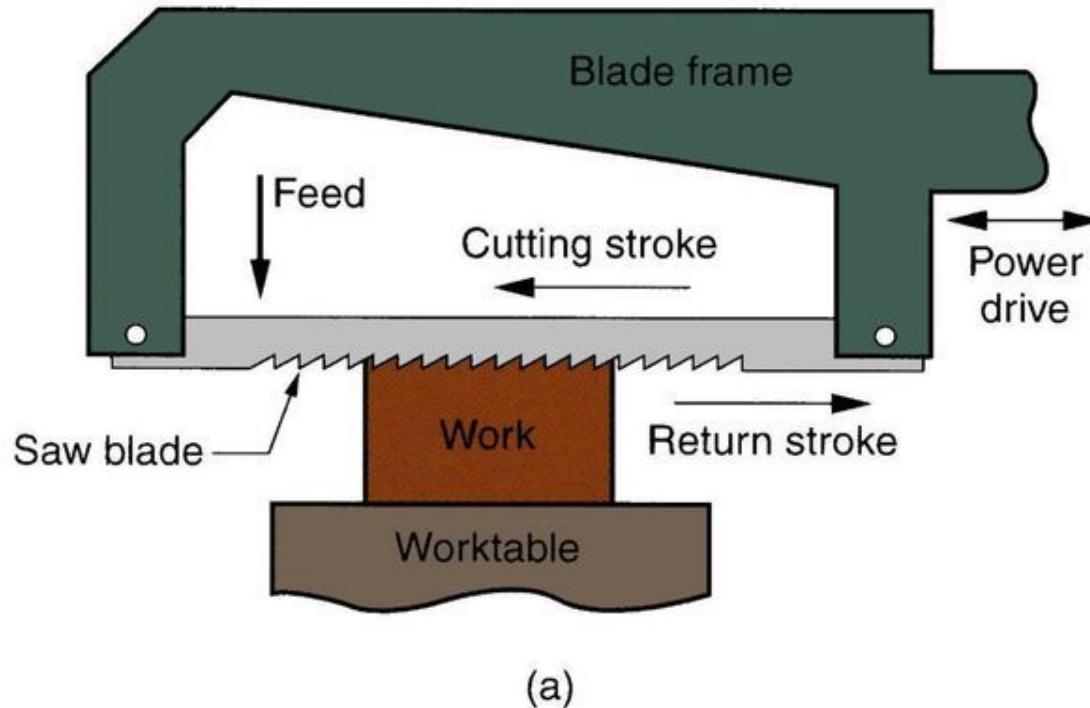
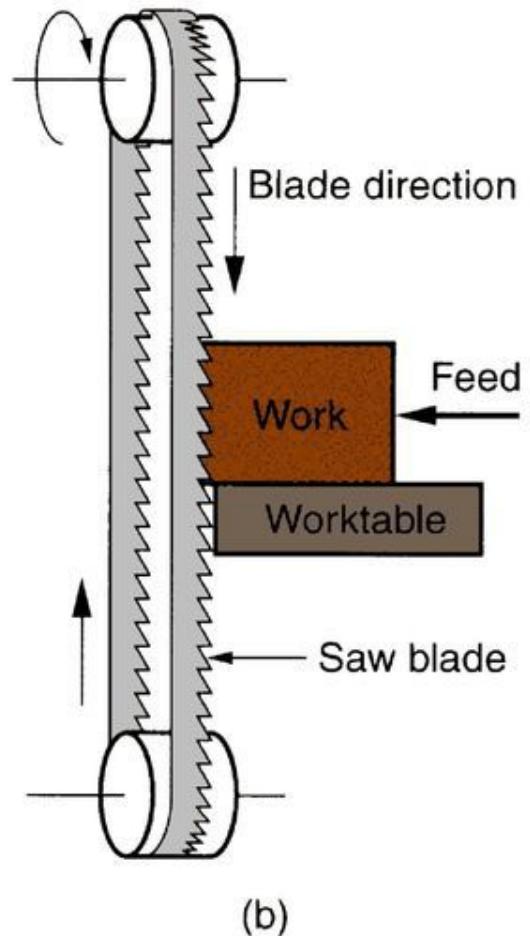


Figure 22.35 (a) power hacksaw –linear reciprocating motion of hacksaw blade against work.

Band Saw

Figure 22.35 (b) bandsaw (vertical) – linear continuous motion of bandsaw blade, which is in the form of an endless flexible loop with teeth on one edge.



Circular Saw

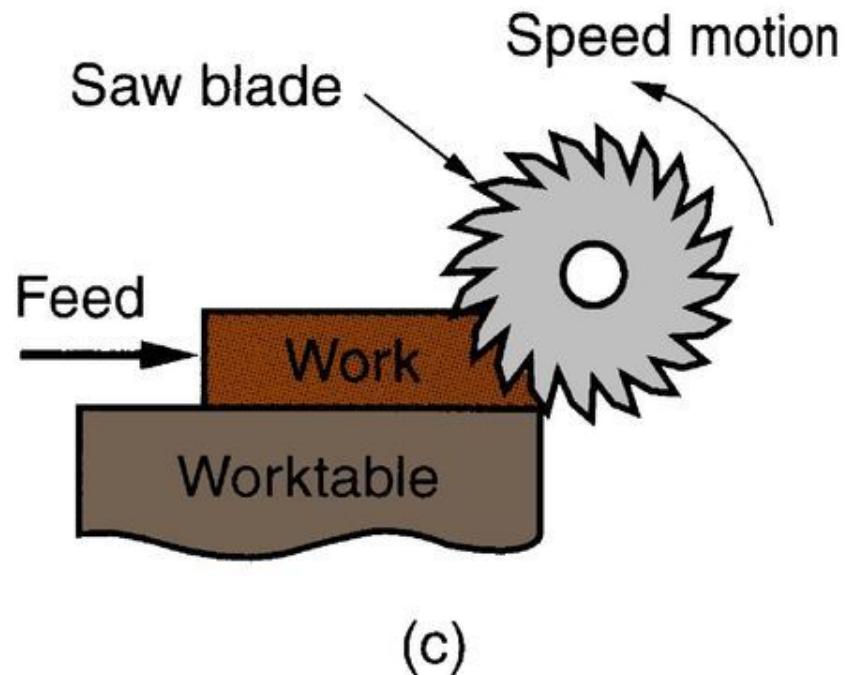


Figure 22.35 (c) circular saw – rotating saw blade provides continuous motion of tool past workpart.

Shaper Machine

INTRODUCTION

- The shaper is reciprocating type of machine tool primarily to produce flat surfaces. These surfaces may be horizontal, vertical or inclined.
- It can produce any surface composed of straight line elements.



TYPES OF SHAPER

- **Shapers are classified in number of ways depending upon the general feature of design or the purpose of which they are intended.**

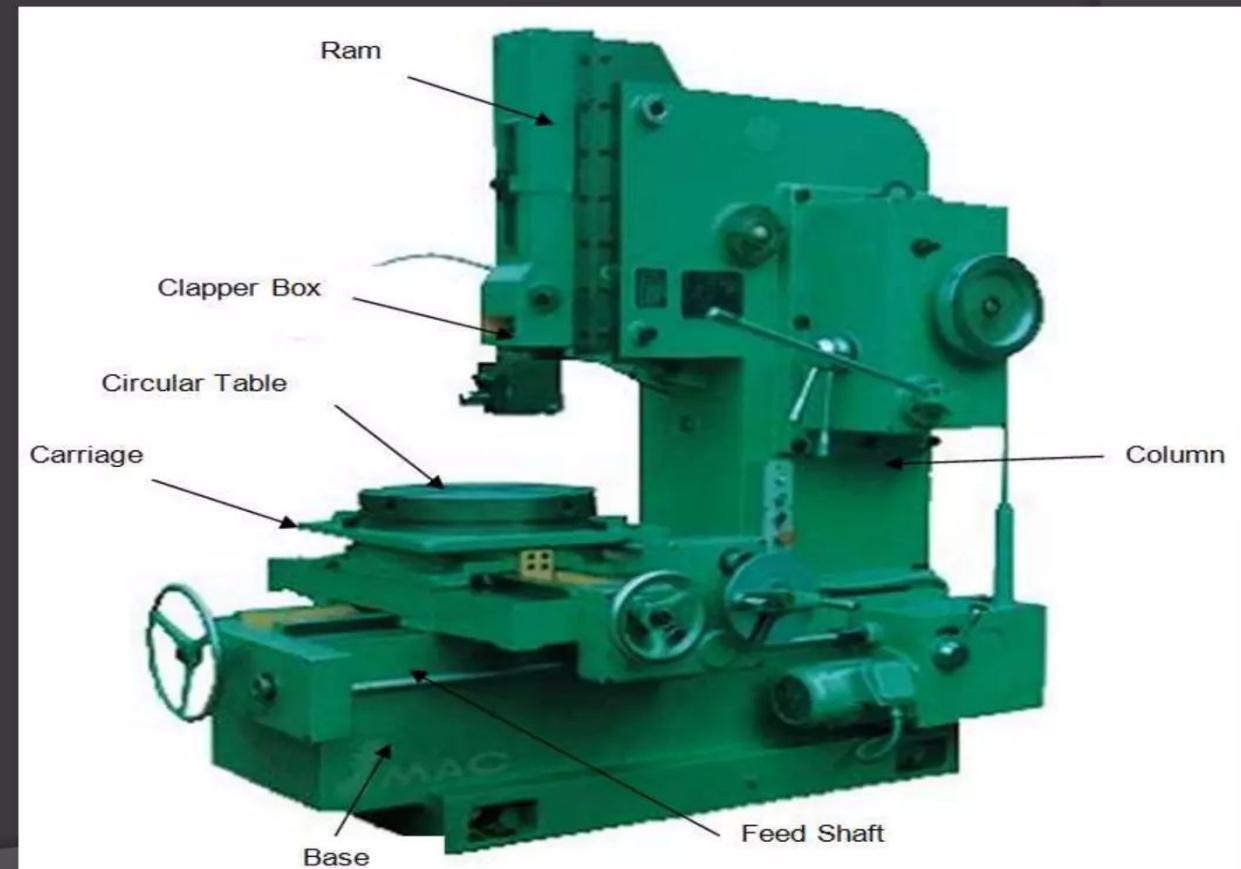
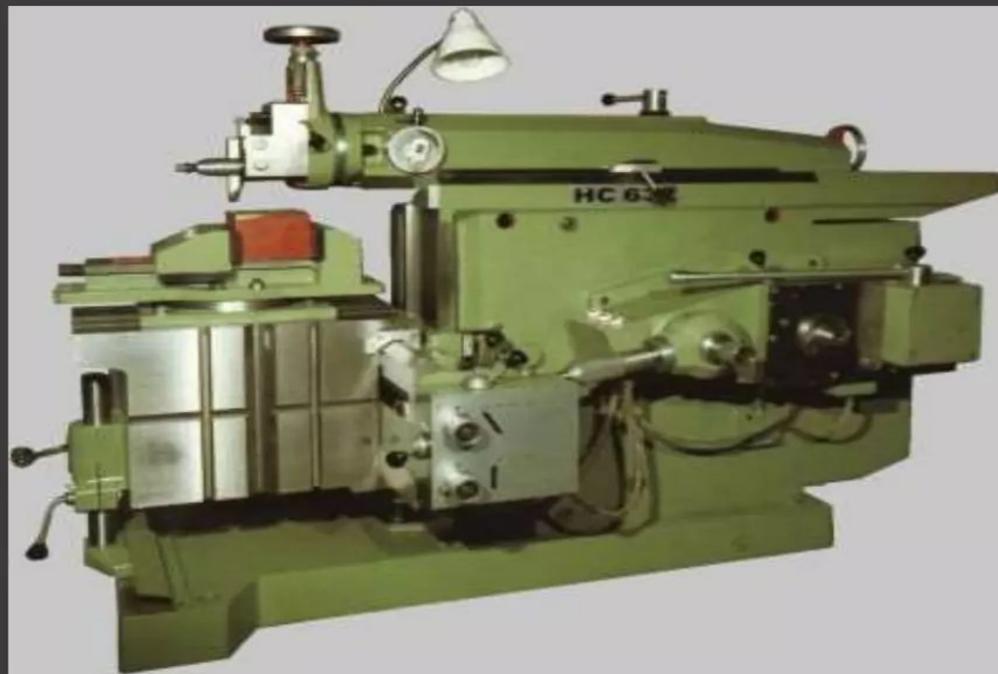
Shapers are classified under following headings.

- 1) According to the type of mechanism used –
 a)Crank type b)Geared type c)Hydraulic type
- 2) According to the position and travel of ram-
 a)Horizontal type b)Vertical type
- 3) According to type of design of table-
 a)Standard shaper b)Universal shaper

- **Crank shaper:** Shapers whose ram reciprocates with the help of a crank mechanism
- **Geared shaper:** The ram reciprocates with spur gear mechanism. this type of shaper carries a rack under the ram for to and fro motion.
- **Hydraulic shaper:** the movement of the ram is provided by hydraulic pressure



- **Horizontal shaper:** The ram reciprocates in horizontal direction.
- **Vertical shaper:** The ram reciprocates in vertical direction. It is also known as slotter.



Unconventional Machining Processes

- 1) Abrasive Jet Machining
- 2) Ultrasonic Machining
- 3) Electro chemical Machining
- 4) Electro Discharge Machining
- 5) Electron Beam Machining
- 6) Laser Beam Machining
- 7) Plasma Arc Machining

Automation in Material Removal Processes

Use of Robots

