Manufacturing Technology

4th Sem ME (Diploma)

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CUTTING TOOL MATERIALS

The cutting tool materials must possess a number of important properties to avoid excessive wear, fracture failure and high temperatures in cutting.

The following characteristics are essential for cutting materials to withstand the heavy conditions of the cutting process and to produce high quality and economical parts:

Tool failure modes identify the important properties that a tool material should possess:

- *Toughness - to avoid fracture failure.*
- *Hot hardness - ability to retain hardness at high temperatures.*
- *Wear resistance - hardness is the most important property to resist abrasive wear.*

Properties of cutting tool materials

1. **Red hardness or Hot Hardness:** It is the ability of a material to retain its hardness at high temperature
2. **Wear resistance:** It enables the cutting tool to retain its shape and cutting efficiency
3. **Toughness:** It relates to the ability of a material to resist shock or impact loads associated with interrupted cuts

Classification tool materials

1. Carbon-Tool Steels:

- 0.6-1.5% carbon + little amount of Mn, Si, Cr, V to increase hardness.
- Low carbon varieties possess good toughness & shock resistance.
- High carbon varieties possess good abrasion resistance

2. High Speed Steels (HSS):

- High carbon+ little amount Tungsten, Molybdenum, Cr, V & cobalt to increase hardness, toughness and wear résistance.
- High operating temperatures upto 600°C.

Cutting tools & its characteristics

Cutting tool is a device, used to remove the unwanted material from given workpiece. For carrying out the machining process, cutting tool is fundamental and essential requirement. A cutting tool must have the following characteristics:

•**Hardness:** The tool material must be harder than the work piece material. Higher the hardness, easier it is for the tool to penetrate the work material.

•**Hot hardness:** Hot Hardness is the ability of the cutting tool must to maintain its Hardness and strength at elevated temperatures. This property is more important when the tool is used at higher cutting speeds, for increased productivity.

•**Toughness:** Inspite of the tool being tough, it should have enough toughness to withstand the impact loads that come in the start of the cut to force fluctuations due to imperfections in the work material. Toughness of cutting tools is needed so that tools don't chip or fracture, especially during interrupted cutting operations like milling.

Jayeet Ghose, BIT, Mesra, Lecture notes on PE5005

ESSENTIAL PROPERTIES FOR CUTTING TOOL MATERIALS

- **High mechanical strength**; compressive, tensile, and TRA
- **Facture toughness** – high or at least adequate
- **High hardness** for abrasion resistance
- **High hot hardness** to resist plastic deformation and reduce wear rate at elevated temperature
- **Chemical stability** or inertness against work material, atmospheric gases and cutting fluids
- **Resistance to adhesion and diffusion**
- **Thermal conductivity** – low at the surface to resist incoming of heat and high at the core to quickly dissipate the heat entered
- **High heat resistance and stiffness**
- **Manufacturability, availability and low cost.**

Operating Characteristics of Cutting-Tool Materials

TABLE 22.3

General Operating Characteristics of Cutting-tool Materials

Tool materials	General characteristics	Modes of tool wear or failure	Limitations
High-speed steels	High toughness, resistance to fracture, wide range of roughing and finishing cuts, good for interrupted cuts	Flank wear, crater wear	Low hot hardness, limited hardenability, and limited wear resistance
Uncoated carbides	High hardness over a wide range of temperatures, toughness, wear resistance, versatile, wide range of applications	Flank wear, crater wear	Cannot use at low speeds because of cold welding of chips and microchipping
Coated carbides	Improved wear resistance over uncoated carbides, better frictional and thermal properties	Flank wear, crater wear	Cannot use at low speeds because of cold welding of chips and microchipping
Ceramics	High hardness at elevated temperatures, high abrasive wear resistance	Depth-of-cut line notching, microchipping, gross fracture	Low strength and low thermomechanical fatigue strength
Polycrystalline cubic boron nitride (cBN)	High hot hardness, toughness, cutting-edge strength	Depth-of-cut line notching, chipping, oxidation, graphitization	Low strength, and low chemical stability at higher temperature
Diamond	High hardness and toughness, abrasive wear resistance	Chipping, oxidation, graphitization	Low strength, and low chemical stability at higher temperatures

Source: After R. Komanduri and other sources.

Hand Tools

- Two Basic Types
- Noncutting
  - Include vises, hammers, screwdrivers, wrenches and pliers
  - Used basically for holding, assembling or dismantling parts
- Cutting
  - Includes Chisels, Saws (Hacksaws), Hand Files, Punches, Reamers, tap and dies,etc.

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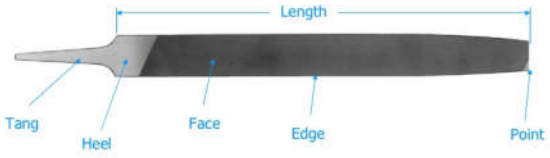
FILES

A file is a hand cutting tool made of **high-carbon steel**, having a series of teeth cut on its body by parallel chisel cuts.



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7. Cutting Tools

- These involve various types of files, scrapers, chisels, drills, reamers, taps, snip or shear and hacksaws.
- **Files.** There are different types of files such as flat, square, round, triangular, knife, pillar, needle and mill.
- **Scrapers.** These are flat, hook, triangular, half round types.
- **Chisels.** There are different types of chisels used in fitting work such as flat chisel, cross cut chisel, diamond point chisel, half round chisel, cow mouth chisel and side cutting chisel. The other cutting tools are drills, reamers, taps, snips, hacksaws (hand hacksaw and power hacksaw) etc.

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Difference between single point and multi point cutting tool

Single point cutting tool	Multi point cutting tool
1. It contains only one main cutting edge in the cutter body.	1. It contains more than one (even up to hundreds) cutting edges in the cutter body.
2. While machining with single point cutting tool, only one main cutting edge continuously remains in contact with workpiece.	2. While machining with multi point cutting tool, more than one cutting edges simultaneously engage in material removal action in a pass.
3. Rate of heat generation and subsequent rise in tool temperature is high.	3. Rate of heat generation and subsequent rise in tool temperature is low.
4. Design and fabrication of single point cutting tools are easier.	4. Design and fabrication of multi point cutting tools are quite difficult.
5. Usually low feed rate and depth of cut is employed when machining is carried out with single point cutting tools.	5. Higher feed rate can be employed when machining is carried out with multi point cutting tool.
6. Here material removal rate (MRR) and productivity are low.	6. It offers higher material removal rate (MRR) and productivity.
Examples: Turning tool, shaping tool, planing tool, slotting tool, fly milling cutter, etc.	**Examples:** Milling cutter, hob, broach, grinding wheel, reamer, knurling tool, etc.

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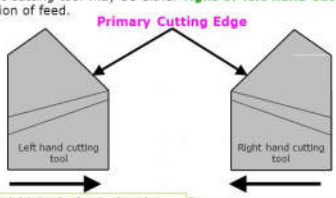
Cutting Tool Geometry

- Cutting tool is device with which a material could be cut to the desired size, shape or finish. So a cutting tool must have at least a sharp edge. There are two types of cutting tool. The tool having only one cutting edge is called **single point cutting tools**. For example **shaper tools, lathe tools, planer tools**, etc. The tool having more than one cutting edge is called **multipoint cutting tools**. For example **drills, milling cutters, broaches, grinding wheel honing tool** etc.
- A single point cutting tool may be either **right or left hand cut tool** depending on the direction of feed.



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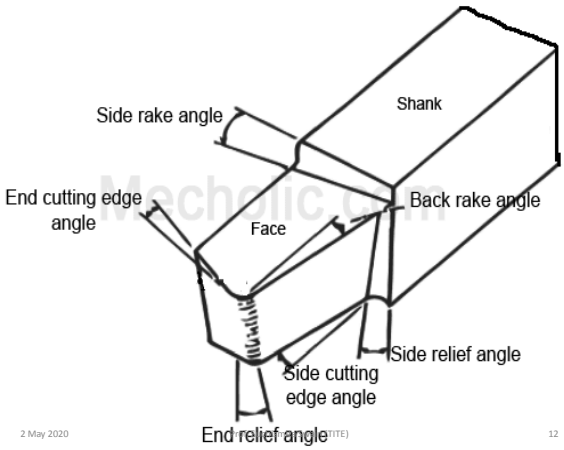

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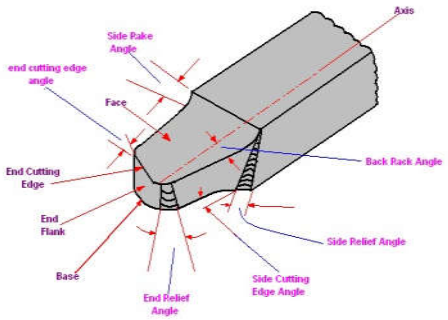
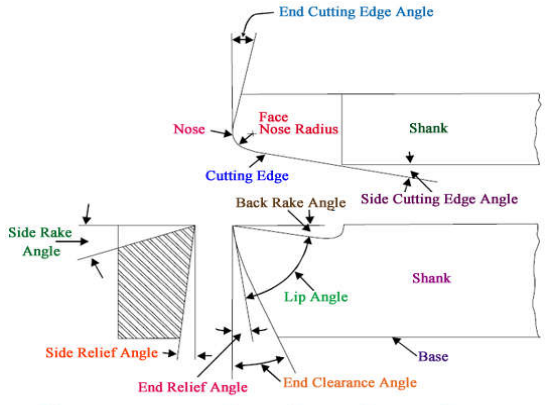
Terminology of Single Point Cutting Tool.





NOMENCLATURE OF SINGLE POINT CUTTING TOOL

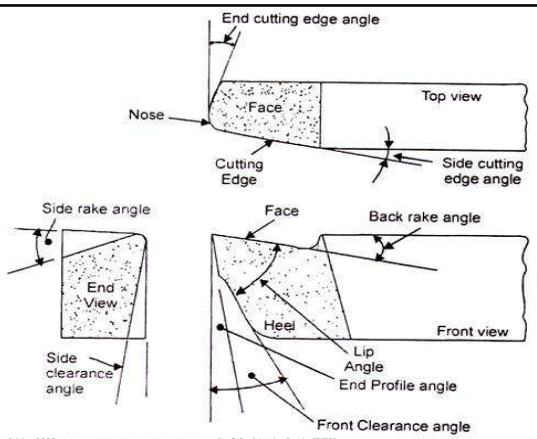


Fig. 14. (b) Tool Geometry of a Single point Cutting Tool.

Designations for a Right-Hand Cutting Tool

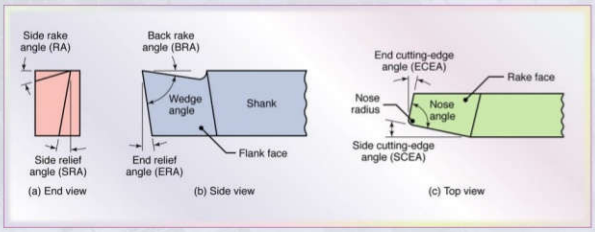
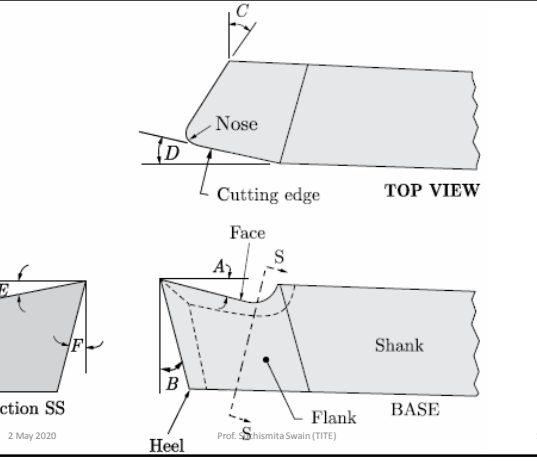


Figure 23.4 Designations for a right-hand cutting tool. Right-hand means the tool travels form right to left, as shown in Fig. 23.3.

Manufacturing, Engineering & Technology, Fifth Edition, by Serope



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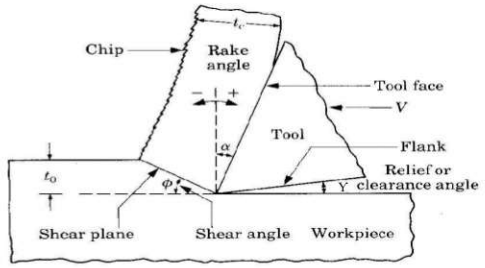
Single Point Cutting Tool Terminology-2D



1) What is tool signature ? And what are the different systems of specifying tool geometry?

In simple words The numerical code that describes all the key angles of a given cutting tool is called tool signature

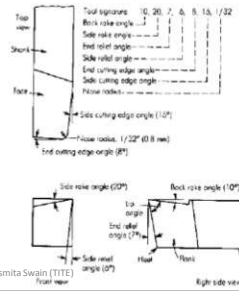
Convenient way to specify tool angles by use of standardized abbreviated system is known as tool signature or tool nomenclature. The tool signature comprises of seven elements and is specified in different systems .

TOOL SIGNATURE

Tool angles have been standardized by the American Standard Association (ASA)

Tool angles given in a definite pattern

- Back rake angle-
- Side rake angle-
- End relief angle
- Side relief angle-
- End cutting edge angle
- Side cutting edge angle
- Nose radius – 0.8 mm



ASA

✓ The system most commonly used is American Standards Association (ASA)

✓ Also called as Machine Reference System as the three planes for describing the angles based on configuration and axes of machine tool

✓ The single point tool is designated as:

$\alpha_b - \alpha_s - \theta_e - \theta_s - C_e - C_s - r$

- α_b – Bake rake angle
- α_s – Side rake angle
- θ_e – End relief angle
- θ_s – Side relief angle,
- C_e – End cutting Edge Angle Φ_e
- C_s – Side cutting Edge angle Φ_s
- r – Nose radius

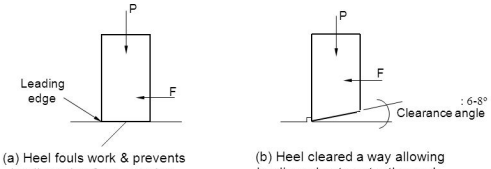
Tool Designation by American Standards Association (ASA) System

$\gamma_y; \gamma_x; \alpha_y; \alpha_x; \Phi_e; \Phi_s;$ r (inch)

- r → Nose radius
- Φ_e → End cutting edge angle
- Φ_s → Side clearance angle
- α_x → Back clearance angle
- α_y → Side rake angle
- γ_x → Approach angle
- γ_y → Back rake angle

3.1 Clearance Angle:

The clearance angle may be defined as the angle between the flank face of the tool and a tangent to the work surface originating at the cutting edge.



(a) Heel fouls work & prevents leading edge from entering.

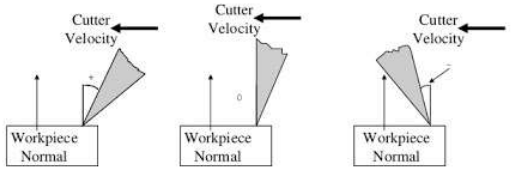
(b) Heel cleared a way allowing leading edge to enter the work.

Clearance necessary to allow cutting to take place.

GATEWAY

Rake Angle

Of particular importance is the rake angle that the tool makes with the workpiece normal



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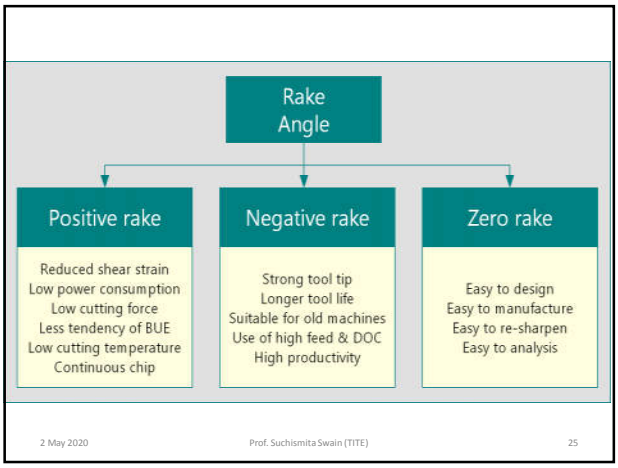

Lathe Operations

- **Turning:** produce straight, conical, curved, or grooved workpieces
- **Facing**: to produce a flat surface at the end of the part or for making face grooves.
- **Boring:** to enlarge a hole or cylindrical cavity made by a previous process or to produce circular internal grooves.
- **Drilling:** to produce a hole by fixing a drill in the tailstock
- **Threading:** to produce external or internal threads
- **Knurling:** to produce a regularly shaped roughness on cylindrical surfaces

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60-22

Depth of Cut

- Roughing cuts should be deep
  - Feed heavy as the work and machine will permit
  - May be taken with helical cutters having fewer teeth
- Finishing cuts should be light with finer feed
  - Depth of cut at least .015 in.
  - Feed should be reduced rather than cutter speeded up

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60-4

Cutting Speed

- Speed, in surface feet per minute (sf/min) or meters per minute (m/min) at which metal may be machined efficiently
- Work machined in a lathe, speed in specific number of revolutions per min (r/min) depending on its diameter to achieve proper cutting speed
- In milling machine, cutter revolves r/min depending on diameter for cutting speed

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Operating Conditions..

Cutting Speed

D – Diameter (mm)
N – Revolutions per Minute (rpm)

$$v = \frac{\pi D N}{1000} \quad \text{m/min}$$

The **Peripheral Speed** of Workpiece past the Cutting Tool

=Cutting Speed

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Types of cutting fluids

Cutting fluids can be broken into four main categories:

1. cutting oils,
2. water miscible fluids,
3. gasses, and
4. paste or solid lubricants.

- Water is the best fluid for cooling. It has the best ability to carry heat away. Water, however, is a very poor lubricant and causes rust.
- Oil is great for lubrication but very poor for cooling. Oil is also flammable.

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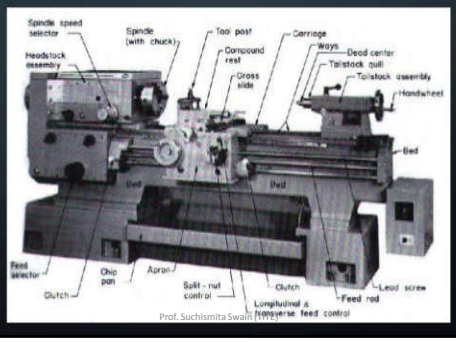
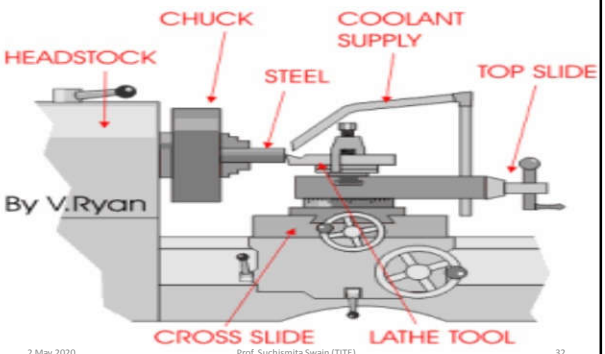
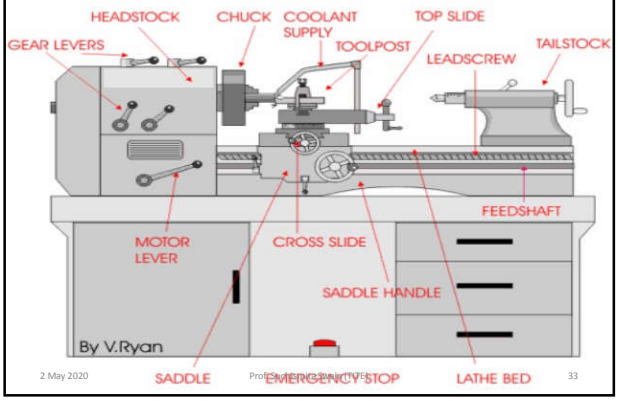
LATHE MACHINE



Lathe Parts



Lathe Parts



Machining

- It is a metal removing operation from the work piece with the help of machine tools and cutting tools. Metal is removed in the form of chip from the workpiece.

LATHE OPERATIONS

The various operations that can be performed on a lathe are:

1. Turning.
2. Step turning.
3. Taper turning.
4. Thread cutting.
5. Facing.
6. Knurling
7. Chamfering.
8. Parting off

Cutting Operations

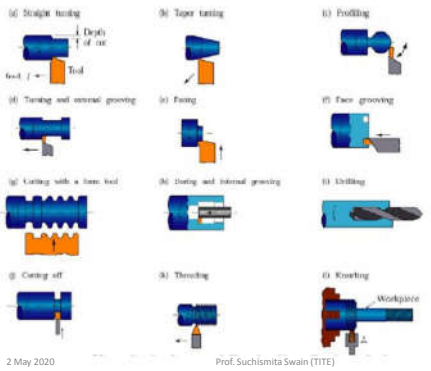
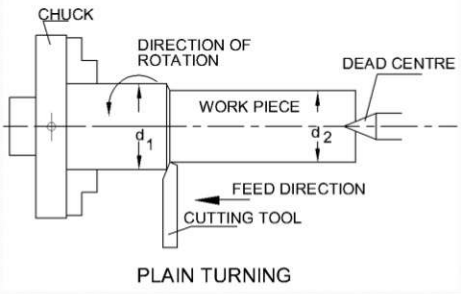


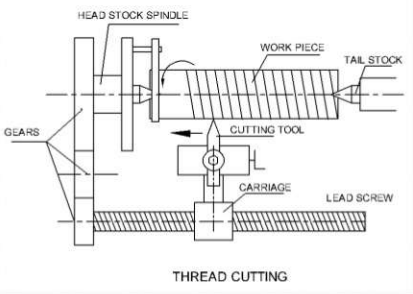
Fig : Various cutting operations that can be performed on a late. Not that all parts have circular symmetry

Plain turning on lathe machine



PLAIN TURNING

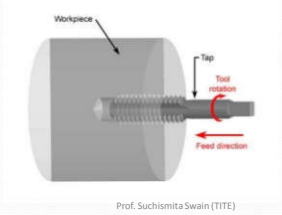
Threading on lathe

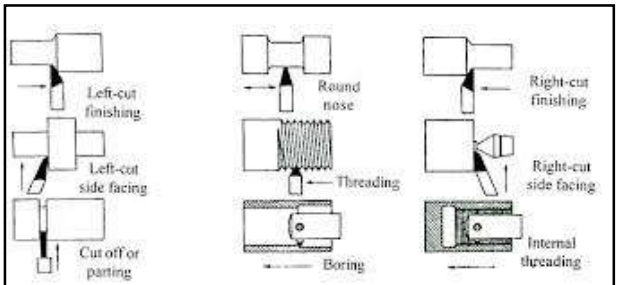


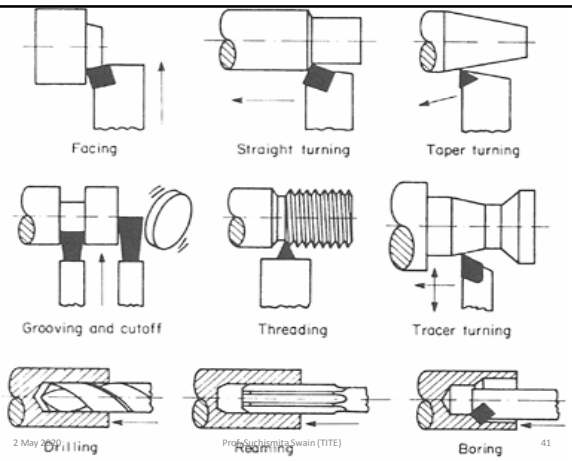
THREAD CUTTING

Tapping

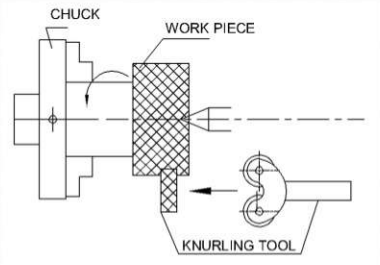
- A tap enters the workpiece axially through the end and cuts internal threads into an existing hole. The existing hole is typically drilled by the required tap drill size that will accommodate the desired tap.





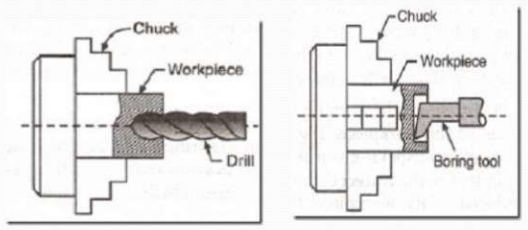


Knurling on lathe machine



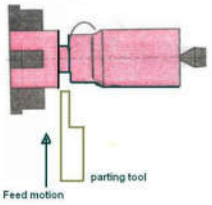
KNURLING OPERATION

FIG.- DRILLING AND BORING



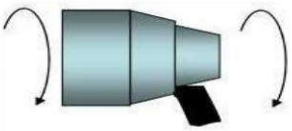
Parting off

- Also know as cutting off operation, Useful in cutting away the required length from the bar stock.
- Tool used is parting off tool (HSS)
- Job is held in chuck & rotated at relatively high speed



- Tool is fed in a direction normal to axis of rotation of job.
- High feed rate is given
- Abundant supply of coolant should be used

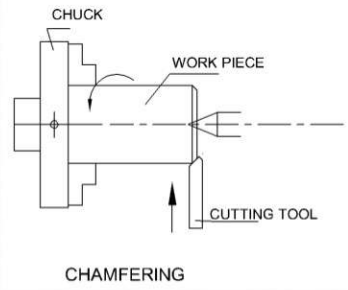
TAPER TURNING



Taper turning

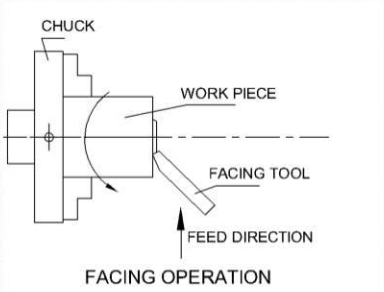
An operation performed on a lathe that feeds a tool at an angle to the length of the work piece in order to create a conical shape. This tapering operation has wide range of use in construction of machines. Almost all machine spindles have taper holes which receive taper shank of various tools and work holding devices.

Chamfering on lathe machine



CHAMFERING

Fig.- Facing on lathe machine



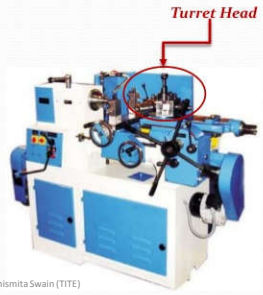
FACING OPERATION

Safety on the Lathe

- The lathe is a machine that is used for producing cylindrical work.
- Safety is a method or process put in place to prevent injury from happening.
- The lathe machine can cause serious injury therefore safety rules on the machine must be observed.

Capstan lathe

- It is production lathe
- Used for light duty work pieces
- Small in size as compared to turret lathe
- It also have turret that replaces tailstock
- Multiple tools set to machine part
- Still may require some operator skill



CAPSTAN AND TURRET LATHE

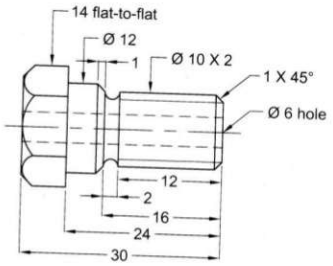
- Conventional Lathes or Engine Lathes are versatile and suitable for Small Size Batch Production, but not suitable for Mass Production
- The time to setup various tools (for different operations) on the Engine Lathe is very large
- Capstan and Turret Lathes meet this purpose.
- These have a Tool-holder that can hold large number of tools, typically six (Hexagonal Turret)
- Every tool can be indexed very rapidly.
- In short, Capstan and Turret Lathes are Semi-automatic Lathes that help in making the Auxiliary motions quick and accurate

Comparision of turret & engine lathe

Turret lathe	Capstan lathe
• Turret lathes are relatively more robust and heavy duty machines .work on chucking type jobs held in the quick acting chucks	• Capstan lathes generally deal with short or long rod type blanks held in collet,
• The heavy turret being mounted on the saddle which directly slides with larger stroke length on the main bed	• In capstan lathe, the turret travels with limited stroke length within a saddle type guide block, called auxiliary bed, which is clamped on the main bed
• One additional guide rod or pilot bar is provided on the headstock of the turret lathes to ensure rigid axial travel of the turret head	• External screw threads are cut in capstan lathe, if required, using a self opening die being mounted in one face of the turret,
• whereas in turret lathes external threads are generally cut, if required, by a single point or multipoint chasing tool being mounted on the front slide and moved by a short leadscrew and a	

Tool layout:

- *Schematically showing the type and configuration of cutting tools and their location and mounting.*
- *To draw tool layout for hexagonal headed mild steel bolt (below drawing).*



- *Hot rolled hexagonal mild steel bar of standard size is selected.*

7.	Threading	Threading Die	HT (6)	56	2	20	Y
8.	Parting	Parting Tool	VS	640	0.05	12	Y

N - spindle speed; S - Feed; L - Tool Travel; CF - Cutting Fluid; HT - Hexagonal Turret; RS - Rear Slide; FS - Front Slide; VS - Vertical Slide;

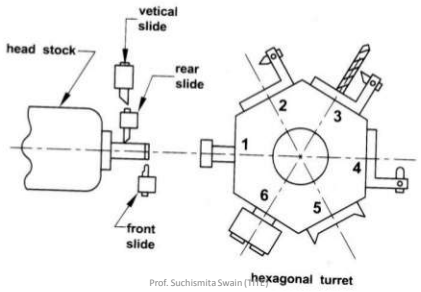
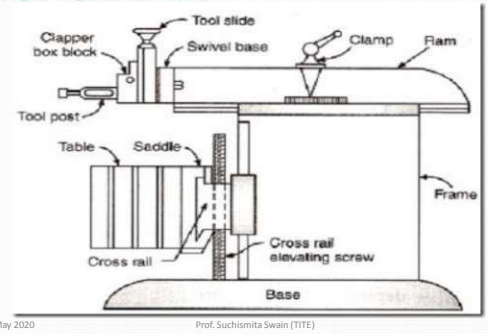


FIG.- SHAPER



PARTS OF SHAPER

BASE made of cast iron. Provides support for other parts of machine.

COLUMN- box type casting mounted vertically on top of base.

- It has 2 guide ways. One vertical guideway in the front over which a cross slide moves up and down.
- 2nd horizontal guide ways on top over which ram reciprocate.
- The reciprocating mechanism is housed inside the column

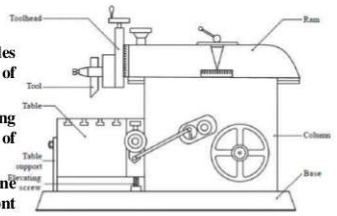


Fig 3.2 Shaping machine

Parts of shaper machine

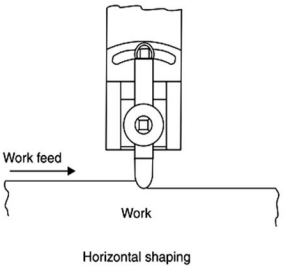
1. base - it is a heavy structure of cast iron which supports other part of machine
2. Column – it is box like structure made of cast iron & mounted upon the base
3. Ram – it is reciprocating member which reciprocates on the guidway provided above the column.it carries a tool slide on its head and a mechanism for adjusting the stroke length
4. Tool head – it is attached to the front portion of the ram . It is used to hold the tool rigily also provid the vertical& angular movements to the tool for cutting
5. cross rail – it is attached to the front vertical portions of the column
6. Table - it is used for holding the workpiece

WORKING PRINCIPLE OF SHAPER

- A single point cutting tool is held in the tool holder, which is mounted on the ram.
- The work piece is rigidly held in a vice or clamped directly on the table.
- The ram reciprocates and thus cutting tool held in tool holder moves forward and backward over the work piece.
- In a standard shaper, cutting of material takes place during the forward stroke of the ram. The backward stroke remains idle and no cutting takes place during this stroke.

Operations performed on Shaper Machine

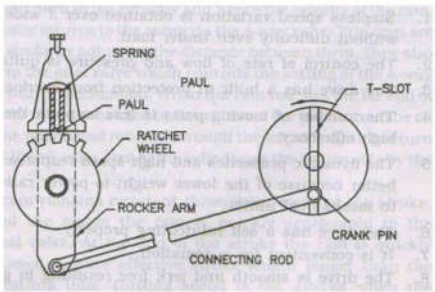
- The cutting tool reciprocates in horizontal direction while the work is fed towards the tool thus removing material on each stroke.
- In case of shaping, the cutting force acts parallel to the work piece support.



Horizontal shaping

Shaper Feed Mechanism

Automatic feed Mechanism



➢**Tool Head-** It holds the cutting tool and is fastened to the front of the ram. The tool is held in a tool holder/tool post similar to the lathe tool post. The tool post and the tool block fit snugly in the clapper box and is hinged at the upper edge.

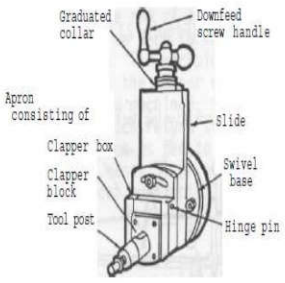
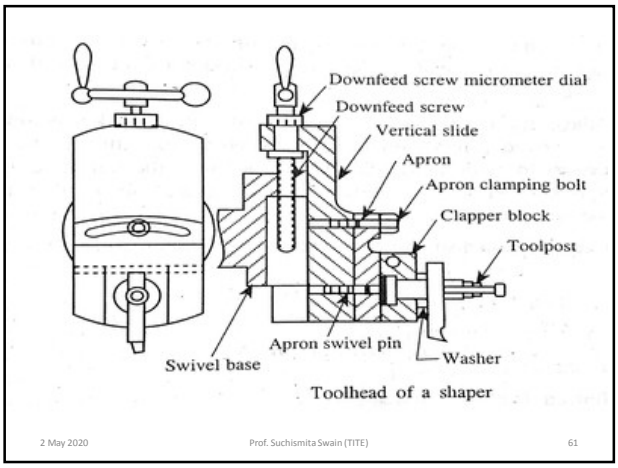


Figure 3 Shaper toolhead



Toolhead of a shaper

QUICK RETURN MECHANISM

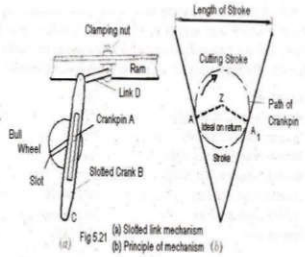
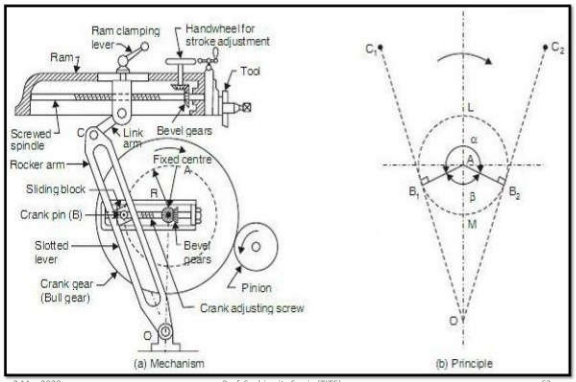
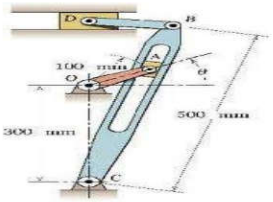


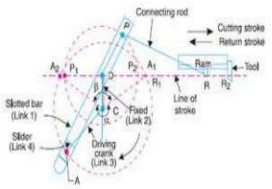
Fig 5.21 (a) Slotted link mechanism (b) Principle of mechanism

In order to reduce the time wasted during the return non-cutting stroke, **shaping machines** are fitted with a **quick-return mechanism**, usually of the crank and slotted-link design.

Quick return mechanism







In **Quick Return Mechanism**, the ram is driven by a slotted link which pivots at its lower end and is attached to the ram by a loose connecting link at its upper end. The slotted link engages with the crank pin mounted on the driving wheel which rotates at constant speed and causes the link to oscillate and the ram to reciprocate. A gearbox controls the speed of the driving pinion, thus providing a range of speeds for the ram.

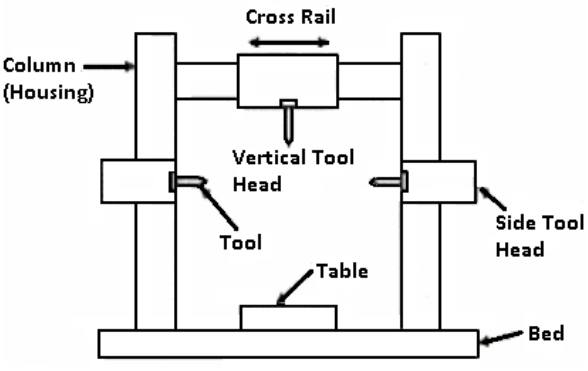
Specifications of Shaping Machine

- Max.length of Stroke of Ram
- Type of Drive
- Power input
- Floor Space required
- Weight of the Machine
- Cutting to Return Stroke ratio
- Feed

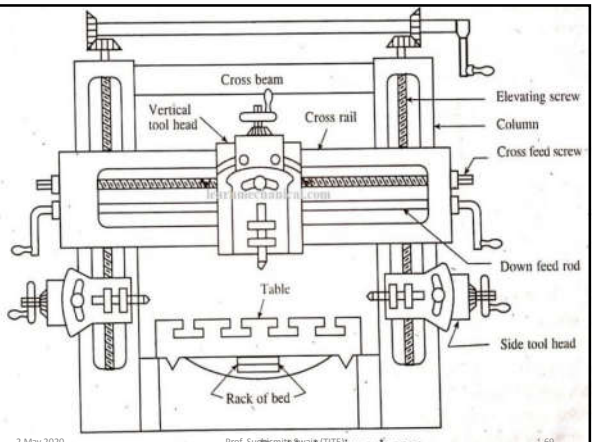
Specifications of Shaper Machine

- Adjustable stroke
- Length of Ram
- Max. & Min. distance from Table to Ram
- Max. table travel (Horizontal & Vertical)
- Angular movement of table
- Max. vertical travel of tool slide
- Max. swivel of tool slide
- No. of ram speeds & range of speeds
- Range of table feed per stroke of ram
- Overall dimensions (Length, Width, Height)
- Net weight

Planing machine



PLANER MACHINE



Double housing planner

Planer Machine?

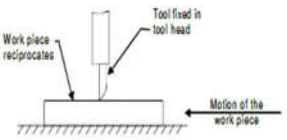
A Planer is the largest machine tool. It is one of the main reciprocating machine tool which is used industrial purposes .

Advantages :-

1. ***Large work can be handled .***
2. ***Capable of taking much heavier cuts.***
3. ***No overhanging parts.***
4. ***Maximum support is obtained for workpiece***

Working Principle

- In a planer, the work which is supported on the table reciprocates past the stationary cutting tool and the feed is imparted by the lateral movement of the tool.
- The tool is clamped in the tool holder and work on the table.



PLANER DRIVING MECHANISM

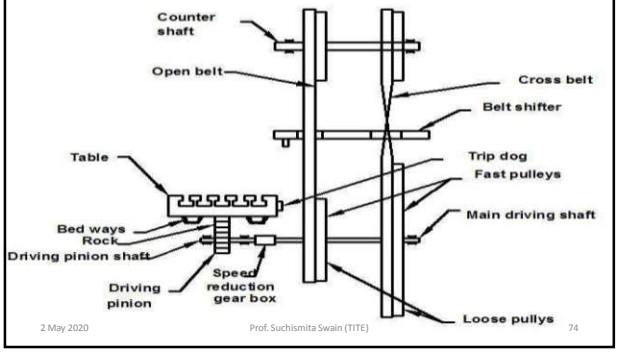
A planer driving mechanism provides the longitudinal to and fro motion of the planer worktable. The following methods are employed for the said purpose.

(a) Open and cross belt drive.
(b) Gear drive
(c) Reversible motor drive.
(d) Hydraulic drive.

OPEN AND CROSS BELT

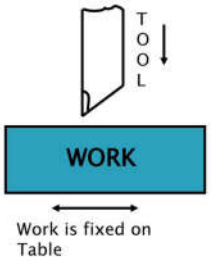
- Crossed belt drive mechanism permits operation of the gear train in such a manner that the table will travel slowly on the cutting stroke and travel faster on the return stroke. Pulleys keyed to the drive pinion shaft are called tight pulleys and those which turn freely on the shaft are called loose pulleys.
- There are two tight pulleys and two loose pulleys. Larger tight pulley - Cutting stroke smaller tight pulley – quicker return stroke.

Open & Cross Belt Drive



Planer – working principle

- The table on which work is clamped is imparted a reciprocating movement
- Cutting takes place during the forward stroke of table
- During return stroke the cutting tool is slightly lifted
- Tool is fed for each forward stroke



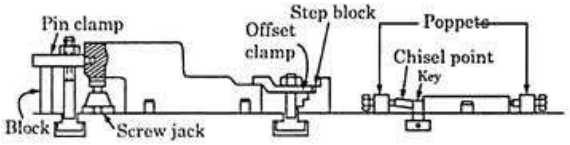


Fig. 15.8

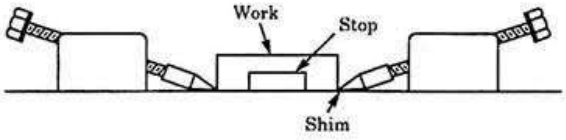
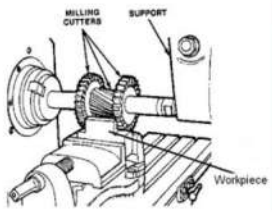


Fig. 14.17

Milling Machines

Milling is the process of machining flat, curved, or irregular surfaces.

parts made by milling machine.



MILLING

Milling: is a metal cutting operation in which the excess material from the work piece is removed by rotating multipoint cutting tool called milling cutter.

Milling machine: is a power operated machine tool in which work piece mounted on a moving table is machined to various shapes when moved under a slow revolving serrated cutter.

INTRODUCTION

A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The milling cutter rotates at high speed and it removes metal at a very fast rate with the help of multiple cutting edges. One or more number of cutters can be mounted simultaneously on the arbor of milling machine. This is the reason that a milling machine finds wide application in production work. Milling machine is used for machining flat surfaces, contoured surfaces, surfaces of revolution, external and internal threads, and helical surfaces of various cross-sections. In many applications, due to its higher production rate and accuracy, milling machine has even replaced shapers and slotters

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9878866320

Milling Machines

- Used to produce one or more machined surfaces accurately on workpiece
  - One or more rotary milling cutters
- Workpiece held on work table or holding device and brought into contact with cutter
- Vertical milling machine most common
- Horizontal milling machine handles operations normally performed by other tools

TYPES OF MILLING MACHINE

- The milling machine may be classified in several forms, but the choice of any particular machine is determined primarily by the size of the workpiece.
- According to general design, the distinctive types of milling machines are:

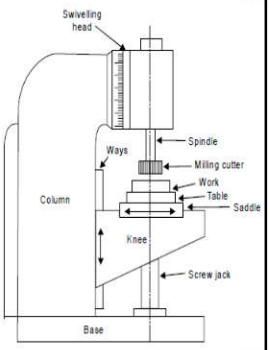
1. Column and knee type milling machines
2. Planer milling machine
3. Fixed-bed type milling machine
4. Special types of milling machines

CLASSIFICATION OF MILLING MACHINES

- ***KNEE-AND-COLUMN MILLING MACHINE***
  - ***HORIZONTAL AND VERTICAL TYPES***
  - ***UNIVERSAL AND RAM TYPES***
- ***BED-TYPE MILL***
- ***-PLANER-TYPE MILLS – THE LARGEST CATEGORY***
  -ROTARY TABLE TYPE MILLING
- ***CNC MILLING MACHINE***

COLUMN AND KNEE TYPE

- It is the most commonly used milling machine used for general shop work.
- The table is mounted on the knee which in turn is mounted on the vertical slides of the main column.
- The knee is vertically adjustable on the column so that the table can be moved up and down to accommodate work of various heights.



2. Fixed-bed type milling machine

•Comparatively large, heavy and rigid and differ from column and knee type milling machines.
•Table is directly mounted on fixed bed.
•No provision is provided for cross or vertical adjustment of the table.
•The cutter mounted on the spindle head may be moved vertically on the column and the spindle may be adjusted horizontally to provide cross adjustment.
•Three types
1. Simplex 2. duplex 3. triplex

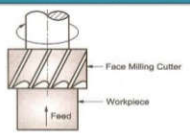
(C) UNIVERSAL MILLING MACHINE

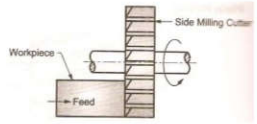
Difference from plain horizontal machine is addition of table swivel housing Permits table to be swiveled 45° in either direction in a horizontal plane

Used for milling of helical grooves in twist drills, milling cutters, and gears

OPERATIONS PERFORMED ON MILLING MACHINE :

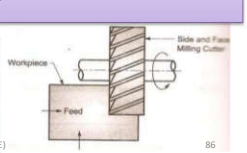
Face milling:
•Machining is done by the teeth on the flat surface of the cutter, Finished surface is perpendicular to the axis of the cutter.



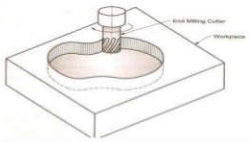


Side milling:
•Machining is done by the teeth on the cylindrical surface the cutter, Finished surface is parallel to the axis of the cutter.

Side and face milling:
•Machining is done by the teeth on the flat as well as cylindrical surface of the cutter, finished surfaces are perpendicular as well as parallel to the axis of the cutter.

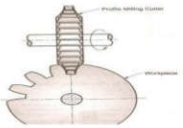


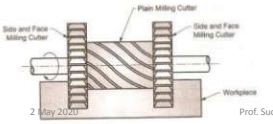
OPERATIONS PERFORMED ON MILLING MACHINE :



End milling:
•The machining is done by the cutter teeth on the end as well as periphery of the cutter. It is used for machining of complicated profiles.

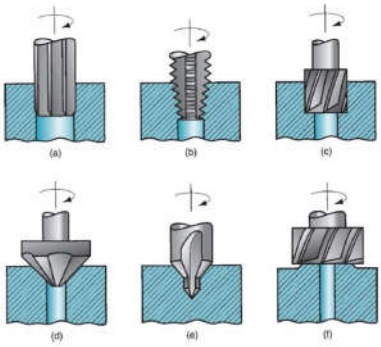
Profile milling:
•The cutter has outline same as that of the shape of the profile. It is used for gear teeth manufacturing.





Gang milling:
•Two or more milling cutters are mounted on the arbor. Horizontal and vertical surfaces are machined simultaneously.

OPERATIONS DONE ON DRILLING MACHINE



Machining operations related to drilling:

(a) Drilling,
(b) Reaming,
(c) Boring,
(d) Counter-boring,
(e) Counter-sinking,
(f) spot facing and
(g) Tapping.

1.3 Theory of CNC Milling Machine

1.3.1 Characteristics of CNC Milling Machine Tools

- Work part machining on CNC machine tools requires controllable and adjustable infeed axes which are run by the servo motors independent of each other.
- CNC- milling machines (Figure 1.7) on the other hand have at least 3 controllable or adjustable feed axes marked as X, Y, Z.

1.2 Introduction

- Milling is a cutting operation with a geometrically specified cutting edge in which the tool makes the rotating main movement, and the feed as well as the infeed movement are generally made by the work part.
- Milling operations are classified according to the position of the milling axis towards the work part, i.e. between face milling and peripheral milling. In case of face milling, the milling axis is located vertically to the machining.
- The work part surface is machined by the main cutting edges. Also, the work part surface is further finished with auxiliary cutting edges

CNC Milling Machines

- Has 3 to 5 axes.
- Used for wood, metal and plastic.
- Used to make 3D prototypes, moulds, cutting dies, printing plates and signs.

Play

Application

1. This CNC machine can be used in the production of many different items, such as door carvings, interior and exterior decorations, wood panels, sign boards, wooden frames, moldings , musical instruments, furniture, and so on.
2. It is perfect way to create prototypes using aluminum, foam, wood and plastics. Using the right software and efficiently create prototypes and reproduction parts.
3. There are one of the most versatile tools for any woodworking operation. Cut to size, rout, chamfer, rabbet, v-groove, dado, pocket, carve and more.
4. With the development of powerful, easy-to-use software and a CNC machine, just about anyone can carve beautiful parts, even if he is not a world-class hand carver

Conclusion

1. With the increasing demand for small scale high precision parts in various industries, the market for small scale machine tools has grown substantially.
2. Using small machine tools to fabricate small scale parts can provide both flexibility and efficiency in manufacturing approaches and reduce capital cost, which is beneficial for small business owners.
3. In this thesis, a small scale three axis CNC milling machine is designed and analyzed under very limited budget.

Work holding Devices

- Various work holding attachments such as three jaw chucks, collets, and centers can be held in the spindle.
- Work is held in the lathe with a number of methods,
- Between two centres. The work piece is driven by a device called a dog; this method is suitable for parts with high length-to-diameter ratio.
- A 3 jaw self-centering chuck is used for most operations on cylindrical work-parts. For parts with high length-to-diameter ratio the part is supported by center on the other end.
- Collet consists of tubular bushing with longitudinal slits. Collets are used to grasp and hold bar stock. A collet of exact diameter is required to match any bar stock diameter.
- A face plate is a device used to grasp parts with irregular shapes.

ACCESSORIES

- **Chucks :**
  - Three jaw chuck
  - Four jaw chuck
  - Collet chuck
- **Centres:**
  - Live centre
  - Dead centre
  - Tipped centre
  - Ball centre
- **Mandrels :**
  - Plain mandrel
  - Stepped mandrel
  - Collared mandrel
  - Screwed mandrel

Mandrels

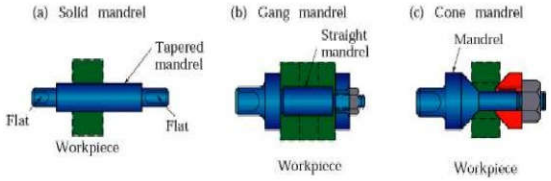
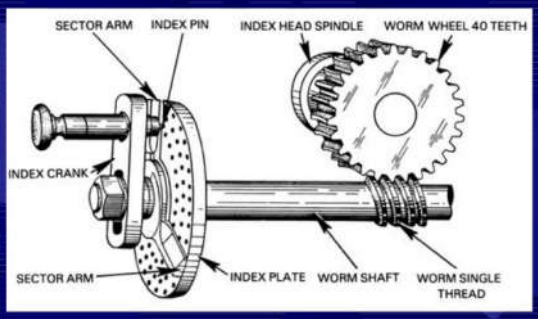


Fig : Various types of mandrels to hold work pieces for turning. These mandrels are usually mounted between centers on a lathe. Note that in (a) both the cylindrical and the end faces of the workpiece can be machined, whereas in (b) and (c) only the cylindrical surfaces can be machined.

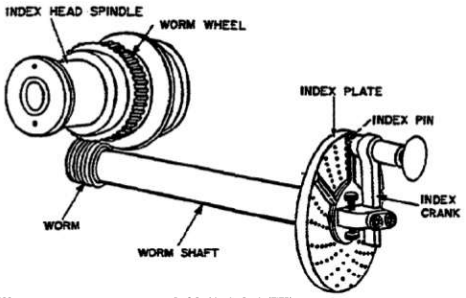
Indexing (Dividing) Head

- Once one of the more important attachments for milling machine
- Used to divide circumference of workpiece into equally spaced divisions when milling gear teeth, squares, hexagons, and octagons
- Also used to rotate workpiece at predetermined ratio to table feed rate

Index Head Parts



Simple Indexing Mechanism



Indexing methods

1. •Simple or Plain indexing
2. • Direct or Rapid indexing
3. •Compound indexing
4. •Differential indexing
5. •Angular indexing

Mr. Chaudhari M.M (Mech. Dept)

Indexing of Milling Machines

- Indexing is the process of evenly dividing the circumference of a circular work piece into equally spaced divisions.
- It is used in cutting gear teeth, cutting splines, milling grooves in reamers and taps, and spacing holes on a circle.

Indexing or Dividing head

- The indexing head of the indexing fixture contains an indexing mechanism which is used to control the rotation of the index head spindle to space or divide a work piece accurately.
- A simple indexing mechanism consists of a 40 teeth worm wheel fastened to the index head spindle, a single – cut worm, a crank for turning the worm shaft, an index plate and a sector.

Simple Indexing

- Work positioned by means of crank, index plate, and sector arms
- Worm attached to crank must be engaged with worm wheel on dividing head spindle
- 40 teeth on worm wheel
- One complete turn on index crank cause spindle and work to rotate one-fortieth of a turn (ratio of 40:1)

Differential Indexing

- Sometimes, a number of divisions is required which cannot be obtained by simple indexing with the index plates regularly supplied.
- To obtain these divisions, a differential index head is used. The index crank is connected to the wormshaft by a train of gears instead of a direct coupling as with simple indexing.

Compound Indexing

- Two separate movements of index crank in two different hole circles of one index plate to obtain crank movement not obtainable by simple indexing

Two movements

- One of index crank as in simple indexing
- Second of index plate – after locking the plate with plunger

Compound indexing

- ***Steps for Compound Indexing:-***
  - i. Factories the number of divisions required.
  - ii. Factories the standard number 40
  - iii. Select for trial any two circles on the same plate and on its same side.
  - iv. Factories their difference
  - v. Factories the number of holes of one circle.
  - vi. Factories the number of holes of the other circle. After obtaining these factors place them as one by one.

Mr. Chaudhari M.M (Mech. Dept)

1

Slotting machine (SLOTTER)

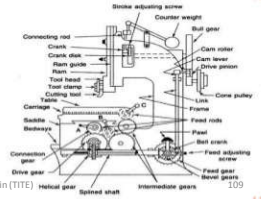
SLOTTING MACHINE

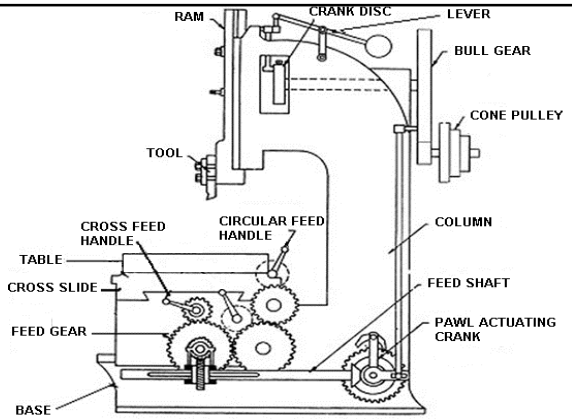
Basic features

- Vertical shaping machine where the single point tool reciprocates vertically
- Cutting on the downward stroke & upward stroke being idle
- Work table specified for transverse, longitudnal or rotary movement
- Longer stroke length
- Wide range of operations for internal surfaces as splines, keyways & teeth

PRINCIPAL PARTS OF SLOTTER

- Base
  - Bottom most part
  - Made of Cast Iron
- Column
  - Vertically mounted on the base
  - Has guide ways on which Ram slides
- Ram
  - Reciprocating vertically up and down
  - It carries Tool Head /cutting tool
- Tool Post
  - It is attached to bottom end of ram
  - Carries Tool post on it
- Table
  - A circular casting with T-slots on its top
  - Movement of table can be linear or rot
- Saddle
  - It is mounted on guide ways of bed
  - Using saddle longitudinal feed is given
- Cross slide
  - Circular work-table is mounted on top.
  - Using cross slide cross feed is given



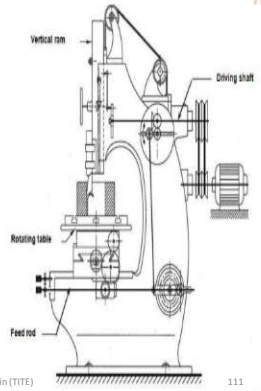


SLOTTER MACHINE

KINEMATICS OF SLOTTER

Steps

- Vertical slide reciprocated by crank-connecting rod mechanism
- Quick return absent
- Intermittent rotation provided by four bar linkage
- The work table rotated by feed rod connected to worm-worm wheel drive
- Working speed(number of strokes per minute) can be changed by belt pulley ratio/gear box



MECHANISM

Crank and slotted lever Quick return mechanism

- The ram of the shaper may be driven by mechanical drive or hydraulic drive.
- Since cutting take place only once in a double stroke and the other stroke is idle, the shaper ram should be provided with a quick return feature.
- Mechanically driven shaper make use of the slotted arm quick return mechanism.

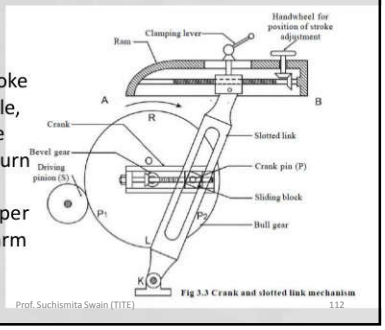
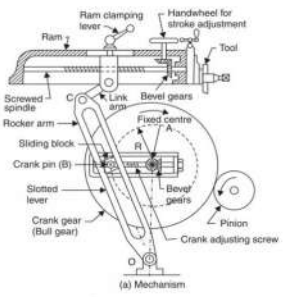


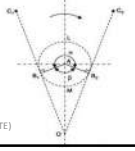
Fig 3.3 Crank and slotted link mechanism

2. Crank & slotted link quick return Mechanism

- The crank AB (of adjustable length R) rotates with a uniform angular speed.
- The crank pin B is in the shape of a die block which is free to slide inside the slot in the slotted lever OBC.
- This slotted lever is pivoted at O and the other end C is connected to the ram by a short link arm.



(a) Mechanism

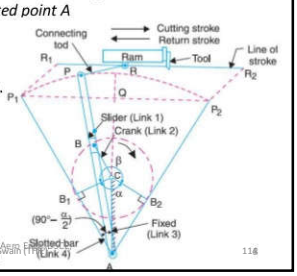


Crank and slotted lever quick return motion mechanism.

- *This mechanism is mostly used* in shaping machines, slotting machines and in rotary internal combustion engines.
- In this mechanism, the link *AC (i.e. link 3) forming the turning pair is fixed, as shown in Fig.* The link 3 corresponds to the connecting rod of a reciprocating steam engine.
- The driving crank *CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank* pin at *B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A*

A short link *PR transmits the motion from AP to the ram which carries the tool and reciprocates along the* line of stroke *R*1 *R*2.

The line of stroke of the ram (*i.e. R*1 *R*2) is perpendicular to *AC produced.*



Types of slotter

- There are four types of slotter

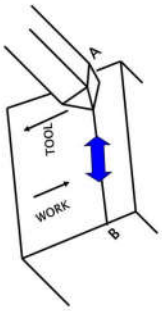
1. **Puncher slotters**
2. **General production slotter**
3. **Precision tools room slotter**
4. **keyseaters**

Specifications of Slotting machine

- Max. length of Ram Stroke
- Diameter of work table in mm.
- Type of Drive
- Maximum table travel.
- Power input
- Floor Space required

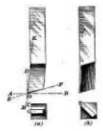
Slotter – working principle

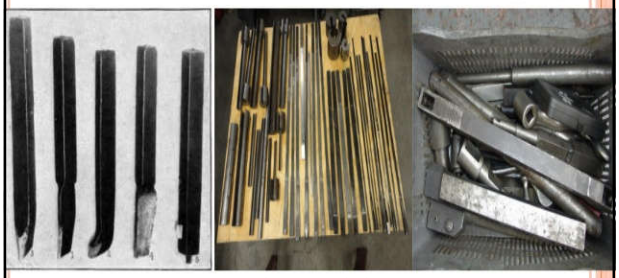
- Cutting Tool repeatedly travels along line A B
- Work is fed a small distance each time
- Feed of work & line of tool motion are in same plane but perpendicular



SLOTTER TOOLS

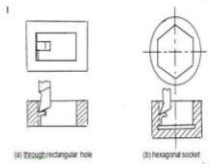
- Forged from solid tool steel bar, or
- In the form of tool bit held in the tool holder.
- Fig. shows square shank tool





SLOTTING APPLICATIONS

- Internal recess of circular, concave & convex surfaces
- To cut slots, splines, keyways both internal external
- To machine internal & external gears
- Internal machining of blind holes



GRINDING MACHINE

Read Here

PARTS | TYPES | OPERATIONS

GRINDING

In grinding process an emery or corundum wheel is used as the cutting tool. Emery and corundum are naturally found abrasives and are impure form of aluminium oxide Al2O3. A grinding wheel is made up of thousands of tiny abrasive particles embedded in a matrix called the 'bond' An abrasive is an extremely hard material second in hardness only to diamond.

Grinding

- Grinding is a process which utilizes the use of abrasive particles bounded together to produce superior surface finishing
- An abrasive: is a small, nonmetallic hard particle having sharp edges and an irregular shape

Introduction

- A **grinding machine,** often shortened to **grinder,** is any of various power tools or machine tools used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the work piece via shear deformation.
- Grinding is used to finish work pieces that must show high surface quality (e.g., low surface roughness) and high accuracy of shape and dimension. As the accuracy in dimensions in grinding is on the order of 0.000025 mm, in most applications it tends to be a finishing operation and removes comparatively little metal, about 0.25 to 0.50 mm depth. However, there are some roughing applications in which grinding removes high volumes of metal quite rapidly. Thus, grinding is a diverse field.

BASIC FUNCTIONS OF A GRINDING WHEEL:-

1. Removal of stock
2. Generation of cylindrical, flat and curved surfaces
3. Production of highly finished surfaces
4. Cutting off operations
5. Production of sharp edges and points.

Grinding Wheel

- Consists of abrasive particles and bonding material. The bonding material holds the particles in place and establishes the shape and structure of the wheel. These two ingredients and the way they are fabricated determine the five basic parameters of a grinding wheel:
  - **Abrasive material**
  - **Grain size**
  - **Bonding material**
  - **Wheel structure**
  - **Wheel grade**
- To achieve the desired performance in a given application, each of the parameters must be carefully selected.

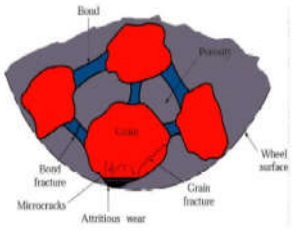
Selection of Grinding Wheel

1. Properties of the material to be machined i.e hardness, toughness, strength
2. Quality of surface finish required
3. Grinding allowance provided on the work-piece i.e the amount of stock to be removed
4. Dimensional accuracy
5. Method of grinding i.e wet or dry
6. Rigidity, size and type of machine
7. Relative sizes of wheel and job
8. Type of grinding to be done
9. Speed and feed of wheel

CONSTRUCTION OF GRINDING WHEEL:-

Grinding wheel consists of-

i. Abrasives
ii. Bond
iii. Grit/grain size
iv. Grade
v. Structure of wheels



Bond

- This is used to hold the abrasive particles together to form the wheel. The six common types used to manufacture grinding wheels are:
- Vitrified
- Resinoid
- Rubber
- Shellac
- Silicate
- Metal bond

Grit size

- The size of the abrasive grains determines the coarseness of fineness of the grinding wheel.

Grit	Sizes	Uses
Coarse	8-20	Roughing
Medium	30-60	General purpose
Fine	80-180	Finishing
Very fine	200-400	Jewelers

Coding of a Grinding Wheel

The Indian Standard Coding system of grinding wheel is IS : 551-1954. It provides uniform system of coding of grinding wheels to designate their various characteristics. It gives a general indication of the hardness and grit size of any wheel as compared with another. Coding of a grinding wheel consists of six symbols as described below

W	:	Symbol for Manufacturer's Abrasive Type (Prefixed)
C	:	Name of Abrasive
30	:	Grain Size
L	:	Grade
5	:	Structure Type
R	:	Bond Type
17	:	Manufacturer Symbol for Record (Suffix)

Specification of Grinding Wheel …

Marking System for Conventional Grinding Wheel

The standard marking system for a conventional abrasive wheel is as follows:

51 A 60 K 5 V 05

- First and last numbers '**51**' and **05** are **manufacturer's identification numbers** (secret codes) indicating exact kind of abrasive etc. Need not be revealed to the user.
- The letter '**A**' denotes that the **type of abrasive** is aluminium oxide.
  A : alumina (Al_2O_3)
  B : boron carbide (B_4C)
  C : silicon carbide (SiC)
  D : Diamond

Abrasive Material

Ranges of Knoop Hardness for Various Materials and Abrasives			
Common glass	350–500	Titanium nitride	2000
Flint, quartz	800–1100	Titanium carbide	1800–3200
Zirconium oxide	1000	Silicon carbide	2100–3000
Hardened steels	700–1300	Boron carbide	2800
Tungsten carbide	1800–2400	Cubic boron nitride	4000–5000
Aluminum oxide	2000–3000	Diamond	7000–8000

Table : hardness of various materials & Abrasives

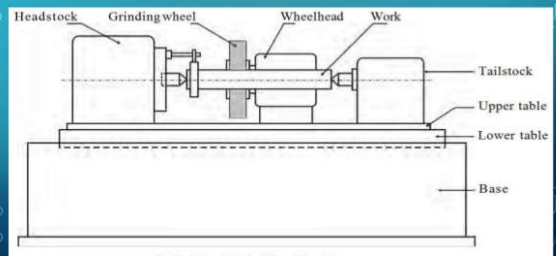
Similarities & Dissimilarities between Grinding & Milling/Advantages/Applications

SIMILARITIES	DISSIMILARITIES
Cutting occurs on either the periphery or the face of the grinding wheel, similar to peripheral and face milling.	Smaller grains with more teeth, high cutting speeds, randomly oriented grits with high negative rake angle on average, Self-sharpening nature, new grains are exposed as old cutting edges wear & pulled out.

ADVANTAGES
A grinding wheel need only two types of specification , Dimensional accuracy, Good surface finish, Good form and locational accuracy , applicable to both hardened and unhardened material

APPLICATIONS
Surface finishing, slitting and parting, descaling, deburring, stock removal (abrasive milling), finishing of flat as well as cylindrical surface, Grinding of tools and cutters and resharpening of the same.

CYLINDRICAL GRINDING MACHINE LAYOUT



Cylindrical Grinding Machine

CYLINDRICAL GRINDING MACHINE

Principle:
The work piece is held between two centers & and the rotating grinding wheel is fed against it.

External Grinding machine

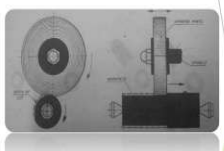


FIG. PRINCIPLE OF CYLINDRICAL GRINDING

Work Piece Type: Cylindrical surfaces may be straight, curved or contoured.

Parts of the Universal Cylindrical Grinder

- Base
  - Heavy cast-iron construction for rigidity
  - Top of base machined to form ways for table
- Wheelhead
  - Mounted on cross-slide at back of machine
  - Mounted on ways right angle to table way
  - May be swiveled to permit grinding of steep tapers by plunge grinding

SURFACE GRINDING MACHINE

Principle: The work piece is fed against a constantly rotating abrasive wheel so that a thin layer of material is removed from the it.

Work Piece Type: Flat, Angular & Irregular surfaces

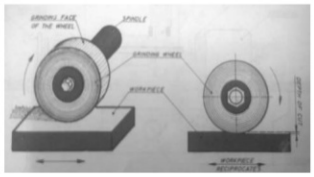
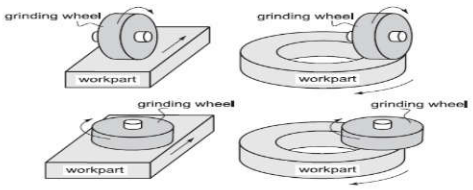


FIG. PRINCIPLE OF SURFACE GRINDING

Manufacturing Technology

Surface grinding

- In surface grinding, the spindle position is either *horizontal* or *vertical*, and the relative motion of the work piece is achieved either by *reciprocating* the work piece past the wheel or by *rotating* it. The possible combinations of spindle orientations and work piece motions yield four types of surface grinding processes illustrated in the figure



Four types of surface grinding with horizontal or vertical spindles, and with reciprocating linear motion or rotating motion of the workpiece.

CENTERLESS GRINDING MACHINE

Principle: The work piece is placed on work rest blade between two wheels namely grinding & regulating wheel, which are rotating in clockwise & work piece rotates counter clockwise. Grinding wheel remove material from W/P surface & regulating wheel regulates the W/P.

Centerless: Means work piece is not held between centers.

Work Piece Type: Curved or Cylindrical surfaces of long slender rods which cannot be ground on cylindrical grinding.

FIG. PRINCIPLE OF CENTERLESS GRINDING

Internal Machining Operations
Chapter-9

DRILLING MACHINE

CONTENT

- Introduction
- Working Principle
- Construction
- Types Of Drilling Machine
- Operation Of Drilling Machine

INTRODUCTION

- *Drilling* is a metal cutting process carried out by a rotating cutting tool to make circular holes in solid materials.
- Tool which makes hole is called as drill bit or twist drill.

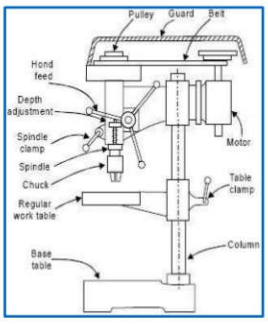
Introduction

Drilling machine

- The drilling machine is one of the most important machine tools in a workshop.
- In a drilling machine holes may be drilled quickly and at a low cost.
- The hole is generated by the rotating edge of cutting tool is known as "drill".
- Holes were drilled by the Egyptians in 1200 B.C. about 3000 years ago by bow drills.
- The bow drill is the mother of present day metal cutting drilling machine.

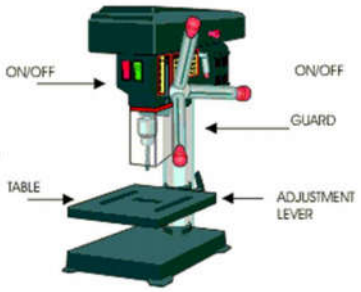
TYPES OF DRILLING MACHINE

- Portable Drilling Machine
- Sensitive or Bench Drill
- Upright Drilling Machine(Single Spindle)
- Upright Drilling Machine(Turret Type)
- Radial Drilling Machine
- Multiple Spindle Drilling Machine
- Deep Hole Drilling Machine
- Gang Drilling Machine
- Horizontal Drilling Machine
- Automatic Drilling Machine



1. Bench Drills

- Used for drilling holes through woods, plastics and metals.
- It is normally bolted to a bench so that it cannot be pushed over



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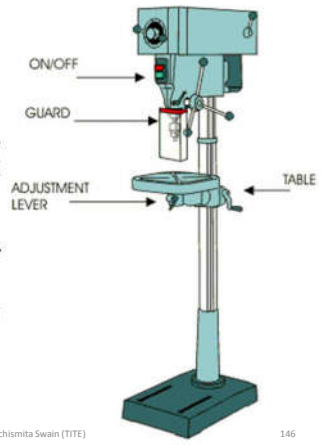
2. Pillar Drills

- The Pillar drill is a larger version of the bench drill
- This has a long column which stands on the floor
- Because of its larger size it is able to drill larger pieces of materials and produce larger holes.



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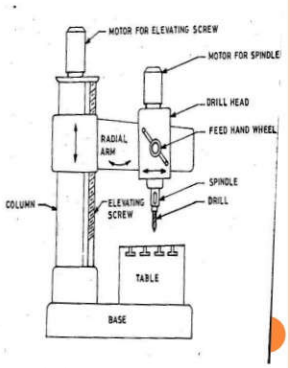
RADIAL DRILLING MACHINE

- It the largest and most versatile used fro drilling medium to large and heavy work pieces.
- It can be radially adjusted around the column in any position over the work to get different size and shapes of work.
- The moments may be either manual or power driven.
- The table is to be rotated through 360 deg.
- The wide rang of power are as well as sensitive and geared manual feeds.



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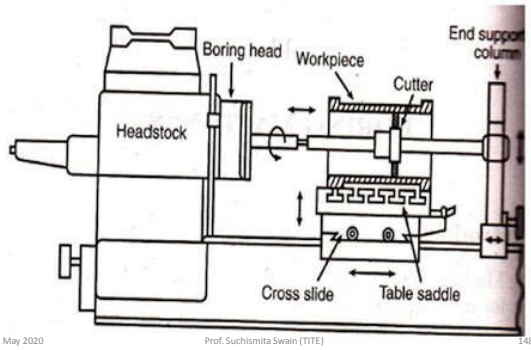
BORING MACHINE



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Boring Machine

Boring machine is used to bore holes in large & heavy parts such as engine frame ,steam engine cylinders ,machine housing etc. which are practicaly impossible to hold and rotate in an engine lathe or drilling machine .

By using simple attachments boring machine can be used for screw cutting ,turning ,planetary grinding , gear cutting .

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Boring machine

- The boring machine is one of the most versatile machine tools used to bore holes in large and heavy parts like as engine frames , steam engine cylinders, machine housings , etc.
- Which are practically impossible to hold and rotate in an engine lathe or a drilling machine.

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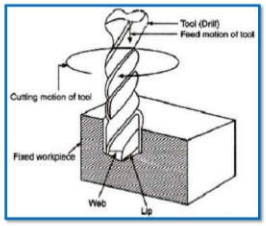
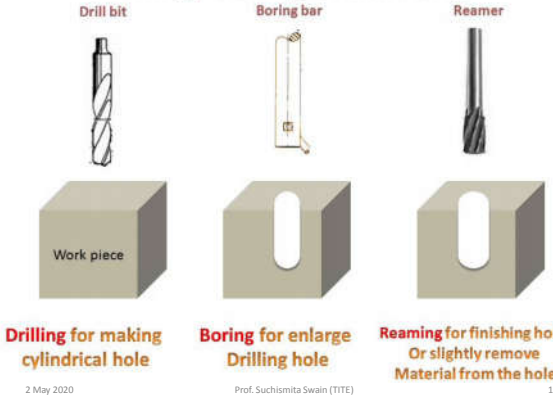
WORKING PRINCIPLE

- The rotating edge of the drill exerts a large force on the work piece and the hole is generated. The removal of metal in a drilling operation is by shearing and extrusion.
- **Use:-** Drilling machine is used to drill blind and through holes in work pieces.



Drilling, Boring & Reaming



Drilling for making cylindrical hole

Boring for enlarge Drilling hole

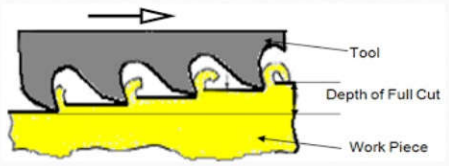
Reaming for finishing holes Or slightly remove Material from the hole

BROACHING MACHINES

- Cutting tool used in this process is known as "BROACH".
- Broach is a tapered tool on which teeth are cut.
- Material is removed by pushing or pulling action of tool.
- Material with C40 rockwell hardness can be machined.
- Key ways, splines, clutch plates etc can be machined by broaching.

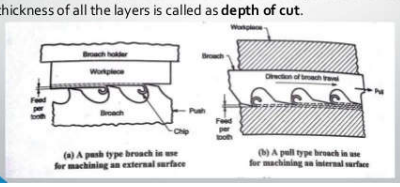
BROACHING

- Broaching is a maching process that uses a toothed tool,called a broach ,to remove material.
- Broaching is a similar technique to shaping with a long multiple-tooth cutter.



Principle of Broaching

- When the broach is fed in a straight line, metal is cut in **several successive layer** with the help of broach.
- The thickness of each layer is same and called as **feed per tooth** and sum of the thickness of all the layers is called as **depth of cut**.



WORKING

- Uses a single pass for finished shapes or sized.
- Uses a multipoint cutting tool (broach) .
- T
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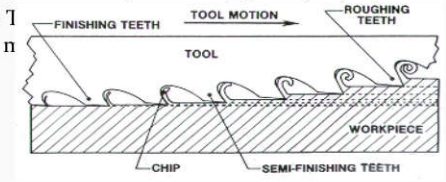
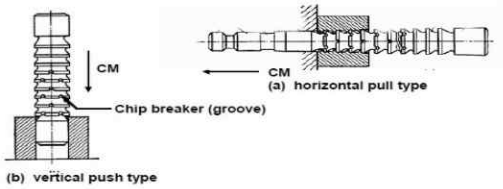


Principle of Broaching



- Broaching is a machining process for removal of a layer of material of desired width and depth usually in one stroke by a slender rod or bar type cutter having a series of cutting edges with gradually increased protrusion as Indicated.

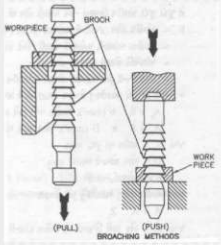
Types of broaching machines:-

According to direction of broach travel.
1) Horizontal broaching machine
2) Vertical broaching machine

B)According to Method of operation.
1) Pull broaching machine
2) Push broaching machine
3) Surface broaching machine
4) Continuous broaching machine

C)According to Method of drive.
1) Mechanical Drive machine
2) Pneumatic drive machine
3) Hydraulic drive machine

D)According to type of operation.
1) External broaching machine
2) Internal broaching machine



Broaching Methods

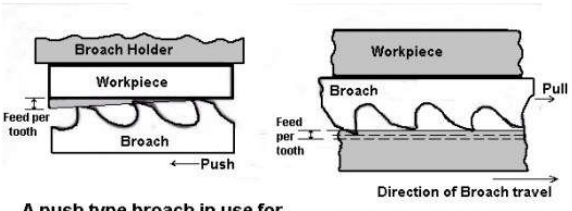
On the basis of method of broaching the operation of broaching is classified as discussed below.

1.Pull Broaching
Workpiece is clamped to the broaching machine in stationary position and the broach is pulled through the work. Broaches are usually long and are held in a special head. Pull broaching is mostly used for internal broaching.

2.Push Broaching
Workpiece is held in the broaching machine in stationary position and broach is pushed through the portion of workpiece to the machined. Normally push broaching is done by hand and arbor presses (hydraulic press). This method is also recommended for internal broaching like for sizing and finishing the holes, cavities, and key ways.

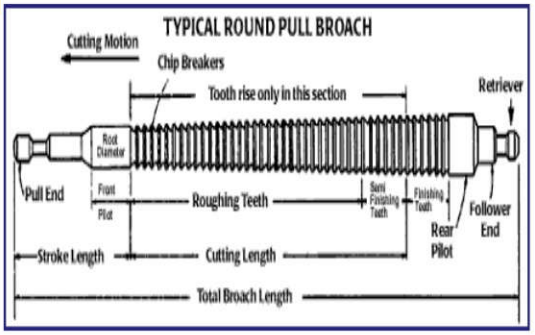
PULL TYPE AND PUSH TYPE BROACHES

- During operation a pull type broach is subjected to tensile force, which helps in maintaining alignment and prevents buckling.
- Pull type broaches are generally made as a long single piece and are more widely used, for internal broaching in particular.
- Push type broaches are essentially shorter in length (to avoid buckling) and may be made in segments.
- Push type broaches are generally used for external broaching, preferably, requiring light cuts and small depth of material removal.



A push type broach in use for machining an external surface

A pull type broach in use for machining internal surface



Advantages of broaching:-

1)High production rate.
2)Job is prepared in one stroke
3)High tool life
4)Internal and external machining can be done
5)0.8micron finishing can be obtained
6)Interchangeability of components can be done due to tolerances obtained in range.
7)Roughing and finishing can be done in single stroke

Advantages and Disadvantages

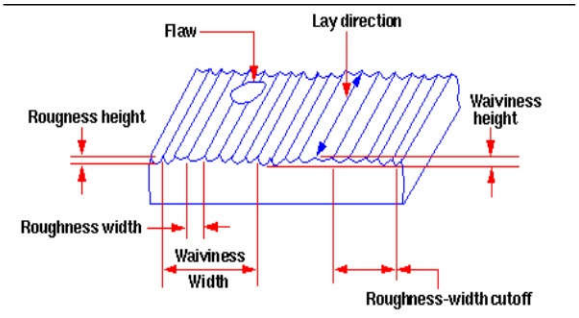
- Broaching requires that the geometry be two dimensional with a straight profile.
- Broaching requires that the tool be able to pass fully through the part.
- Broach designs require that the tool be stiff enough for the work required, small geometries are a challenge.

Surface Finish

Surface Finish

- An engineering component may be cast, forged, drawn, welded or stamped, etc.
- All the surfaces may not have functional requirements and need not be equally finished
- Some surfaces (owing to their functional requirements) need additional machining that needs to be recorded on the drawing

Terms used in surface roughness measurements



Surface characteristics (Courtesy, ANSI B46.1 - 1962)

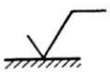
INDICATION OF SURFACE TEXTURE

The **basic symbol** consists of two legs of **unequal** length inclined at approximately **60 degrees** to the line representing the considered surface
The symbol must be represented by thin line

If the removal of material by **machining** is required, a bar is added to the basic symbol,

If the **removal of material is not permitted**, a circle is added to the basic symbol.

When **special surface characteristics** have to be indicated, a line is added to the longer arm of any of the above symbols,



1. Roughness :
Roughness consists of **surface irregularities** which result from the **various machining process**. These irregularities combine to form surface texture.
2. Roughness Height :
It is the **height of the irregularities** with respect to a reference line. It is measured in millimeters or microns or micro inches. It is also known as the height of unevenness.
3. Roughness Width :
The roughness width is the **distance** parallel to the nominal surface **between successive peaks** or ridges which constitute the predominate pattern of the roughness. It is measured in millimeters.
4. Roughness Width Cut Off :
Roughness width cut off is the greatest spacing of respective surface irregularities to be included in the measurement of the average roughness height. It should always be greater than the roughness width in order to obtain the total roughness height rating.

FACTORS AFFECTING SURFACE FINISH

- Material of the work piece
- Type of machining
- Vibrations
- Cutting tool
- Rigidity of the system
- Cutting conditions like speed ,feed and depth of cut.
- Type of coolant used.

Manufacturing Technology

- Finishing Operations
  - Lapping
  - Buffing
  - Honing
  - Super finishing
  - Wire brushing
  - Polishing
  - Electro polishing
  - Magnetic-field-assisted polishing

Lapping

- **Lapping** is a machining process, in which two surfaces are rubbed together with an abrasive between them, by hand movement or using a machine.
- This can take two forms. The first type of lapping involves rubbing a brittle material such as glass against a surface such as iron or glass itself with an abrasive such as aluminum oxide, jeweller's rouge, optician's rouge, emery, silicon carbide, diamond, etc., between them.
- This produces microscopic conchoidal fractures as the abrasive rolls about between the two surfaces and removes material from both.
- The other form of lapping involves a softer material such as pitch or a ceramic for the lap, which is "charged" with the abrasive.

What is Lapping?

Lapping is a mechanical precision finishing operation done to achieve **high dimensional accuracy**

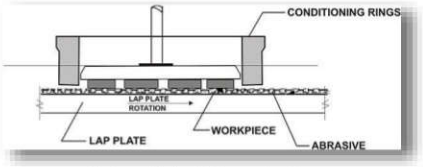
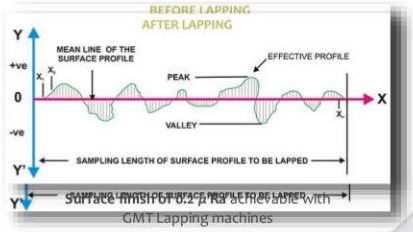


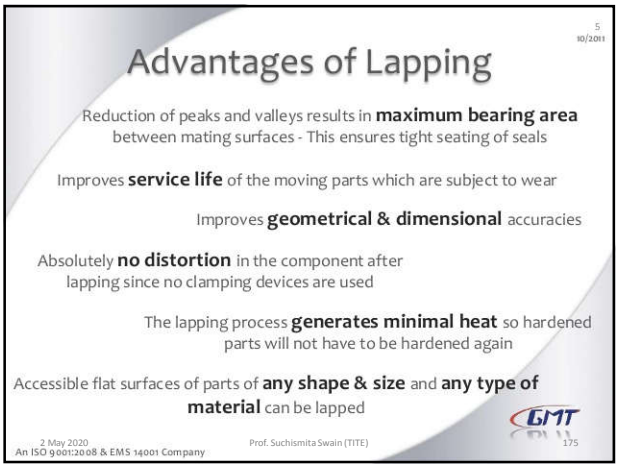
Diagram of the lapping process in action

The Lapping Process

Lapping improves surface finish by **reducing peaks & valleys** on a surface



Surface finish of 0.2 µ Ra achievable with GMT Lapping machines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Advantages of Lapping
Reduction of peaks and valleys results in maximum bearing area between mating surfaces - This ensures tight seating of seals
Improves service life of the moving parts which are subject to wear
Improves geometrical & dimensional accuracies
Absolutely no distortion in the component after lapping since no clamping devices are used
The lapping process generates minimal heat so hardened parts will not have to be hardened again
Accessible flat surfaces of parts of any shape & size and any type of material can be lapped
GMT
2 May 2020
An ISO 9001:2008 & EMS 14001 Company
Prof. Suchismita Swain (TITE)
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