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Manufacturing Technology

Book followed :-

1. Manufacturing Technology (Vol. 1) By: P. N. Rao.
2. Manufacturing Technology (Vol. 2) By: P. N. Rao.
3. Machine & Machine Tools By: A. B. Chattopadhyay.
4. Workshop Technology (Vol. 1&2) By: HAJRA CHOUDHURY
5. Workshop Technology By: R. S. KHURMI

Introduction :-

What is Manufacturing Technology?

→ Manufacturing Technology meas techniques and processes designed to improve manufacturing quality, productivity, and practices, including quality control, shop floore management, inventory management, and worker traeing, as well as manufacturing equipments & software.

→ Manufacturing technology is a term that can refer to number of modern methods of science, production and engineering the assist in industrial production and various manufacturing processes.

→ Manufacturing technology means transforming raw materials into finished product through the use of Human labor, machinery, chemicals, formulation method & biological processes.

Unit-1 (Tool Material) :-

→ In order to remove excess or unwanted materials from a workpiece a cutting tool is required.

→ That's way the cutting tool material must be harder than the workpiece and must maintain a cutting edge at the temp. produced by the friction of cutting action.

Types Cutting Tool materials :-

→ Carbon steel
→ High speed steel
→ Cast alloy
→ Tungsten carbide
→ Oxides
→ Diamonds
→ High carbon steel

Composition of various tool materials :-

(1) Carbon steel :- Steel with a carbon content ranging from 1 to 1.2 percent was the earliest material used in machine tools. Tools made of this carbon steel are comparatively inexpensive but tend to lose cutting ability at temperatures at about 400°F (205°C).

(2) High Carbon steel :- In high carbon steel the carbon content ranging from 1.2 to 2 percent makes the result extremly brittle and of limited use, High carbon steel materials are extreme hardness and resistance to wear, and moderate ductility, a measure of a material's ability to tolerate being deformed without actually breaking. It is used in cutting tool because of its ability to keep very sharp edge under duress.

(3) High Speed steel :- In High Speed steel materials contains 18% tungsten, 4% chromium, 1% vanadium and only 0.5% to 0.8% carbon. High Speed steel tools comprises a set of tool steel alloys named for their capacity to cut material faster than High Carbon steel. This is on account of exeptional hardness, abrasion resistance and resistance against softening at high temp., owing to alloying metals and heat treatment used.

(4) Cast alloys :- A number of cast alloy cutting tool material have been developed; these nonferrous alloys contain cobalt, chromium and tungsten and are particularly effective in penetrating the hard surface on cast iron and retaining their cutting ability even when red hot.

(5) Tungsten Carbide :- Tungsten Carbide's principal ingredient is finely devided tungsten carbide held in a binder of Cobalt. Tungsten Carbide's hardness approaches that of a diamond. Tungsten Carbide tools can be operated at cutting speeds many times higher than those used with high speed steel.

(6) Oxides :- Ceramic or oxide tool tips are one of the newest devlopments in cutting tool matercials. They consist primarily of fine aluminum oxide grains, which are bonded togethen.

(7) Diamonds :- Diamonds have been used for many years for truing grinding wheels, in wire drawing dies, and as cutting tools. for cutting applications they are used largely for taking light finishing cuts at high speed or hard or abrassive matercials and for finish boring bronze and babbitt-metal bearings.

Physical Properties of Cutting Tool Matercials :-

(1) Hot or Red Hotness: It is the abcility of the cutting tools to with stand high temperatures without losing its cutting edge.

(2) Wear Resistance: It is the abcility of the cutting tools to resist wear due to adhesion and abrasion.

(3) Toughness :- A cutting tool matercial should have high toughness to handle impact load, shacks, and vibrations during machining.

(4) Thermal Conductivity :- Thermal Conductivity is the abcility of a matercial to conduct heat. The cutting tool should have high thermal conductivity to conduct heat

away from the chip tool interface.

⑤ Co-efficient of friction :- The co-efficient of friction of the cutting tool material should below so that there will be no friction between the tool and the chip are between the tool and the workpiece. If the friction is high between the tool and the chip then chips will stick to the tool and this will affect the quality of the machining process.

⑥ Thermal stability :- Thermal stability is defined as the ability of a material to resist breaking down under heat stress. The thermal stability of the cutting tool should be high so that it would not break down at high temperatures.

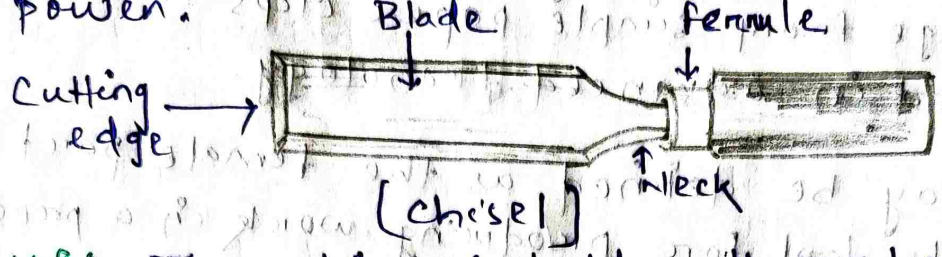
⑦ Cost :- The cost of the cutting tool should be optimum One should not buy a cheap cutting tool and ruin the machining process. These cheap tools prove much costlier in the long run compared to one which has a high initial cost but can not be operated for a longer time at high speed.

Uses of Cutting :-

Cutting tools materials are the materials of the cutting tool present in the machines which are used in different machining processes like turning, Milling, Shaping, slotting etc.

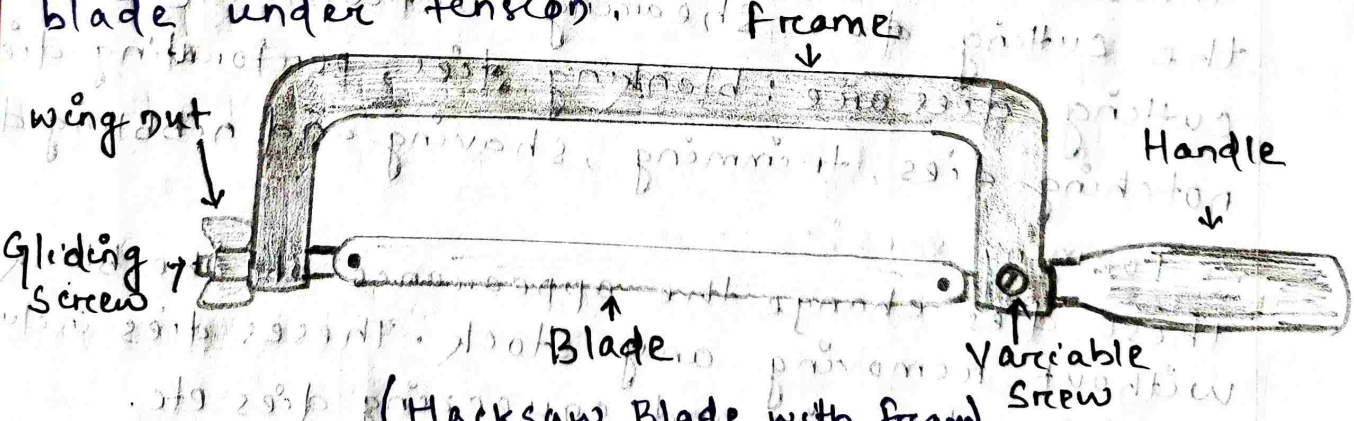
Unit-2

Chisel :- A chisel is a tool with a characteristically shaped cutting edge at blade on its end. for carving or cutting a hard material such as wood, stone or metal by hand, struck with a mallet or mechanical power.



Use: The chisel is held with one hand and struck with a hammer. The direction of the taper in the blade determines if the chisel cuts deep or runs shallow along the joint.

Hacksaw :- A Hacksaw is a fine-toothed saw, Generally and mainly made for cutting metals. The equivalent saw for cutting wood is usually called a bow. Most Hacksaws are hand saws with a C-shaped walking frame that holds a blade under tension.



(Hacksaw Blade with frame)

Use:- A Hacksaw is type of hand tool designed Specifically for cutting through materials such as plastic, steel and other metals. They are a variant of the traditional hand saw, typically used for cutting wood and have become a stable tool for professional and hobbyists alike.

Dies:- A die is a specialized machine tool used in manufacturing industries to cut and/or form material to a desired shape or profile. Like molds, dies are generally customized to the item range from simple paper clips to complex pieces used in advanced techology.

The die may be defined as the female part of a complete tool for producing work in a press. It is also referred to a complete tool consists of a pair of mating members for producing work in a press.

Types of dies:-

The dies may be classified according to the type of press operation and according to the method of operation.

1. Cutting dies:- (According to type of press)

These dies are used to cut the metal. They utilize the cutting or shearing action. The common cutting dies are: blanking dies, perforating dies, notching dies, trimming, shaving and nibbling dies,

2. forming dies:-

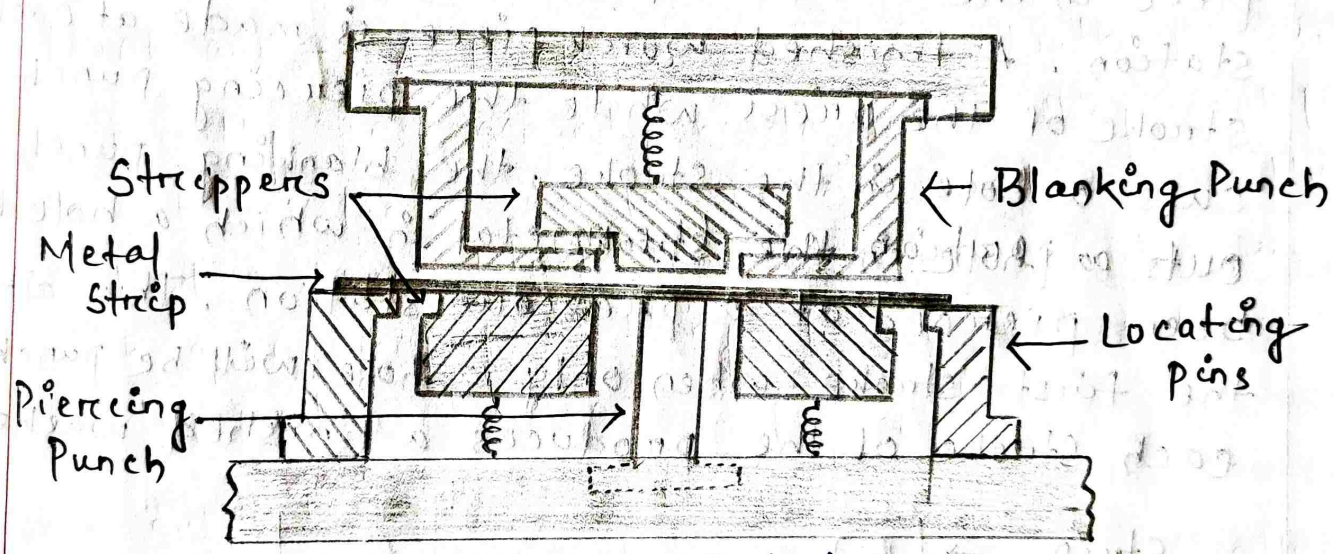
These dies change the appearance of the blank without removing any stock. Theses dies include bending, drawing and squeezing dies etc.

According to types of operation:-

According to this criterion, the dies may be classified as: single operation or simple dies, compound dies, combination dies, progressive dies, trasfer dies and multiple dies.

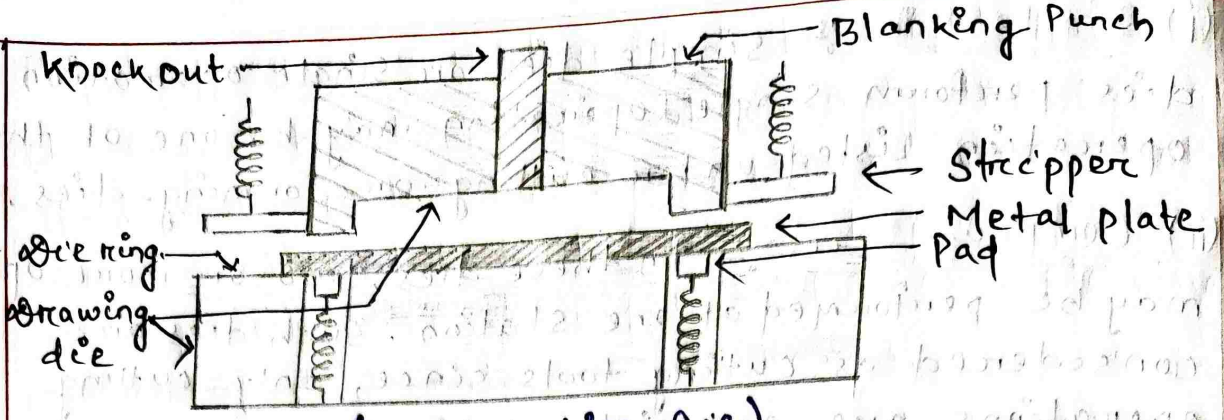
(i) Simple dies :- Simple dies or single operation dies perform single operation may be one of the operation listed under cutting or forming dies.

(ii) Compound dies :- In these dies, two or more operation may be performed at one station. Such dies are considered as cutting tools since, only cutting operations are carried out. In figure shows a simple compound die in which a washer is made by one stroke of the press. The washer is produced by simulation blanking and piercing operations. Compound dies are more accurate and economical in production as compared to single operation dies.



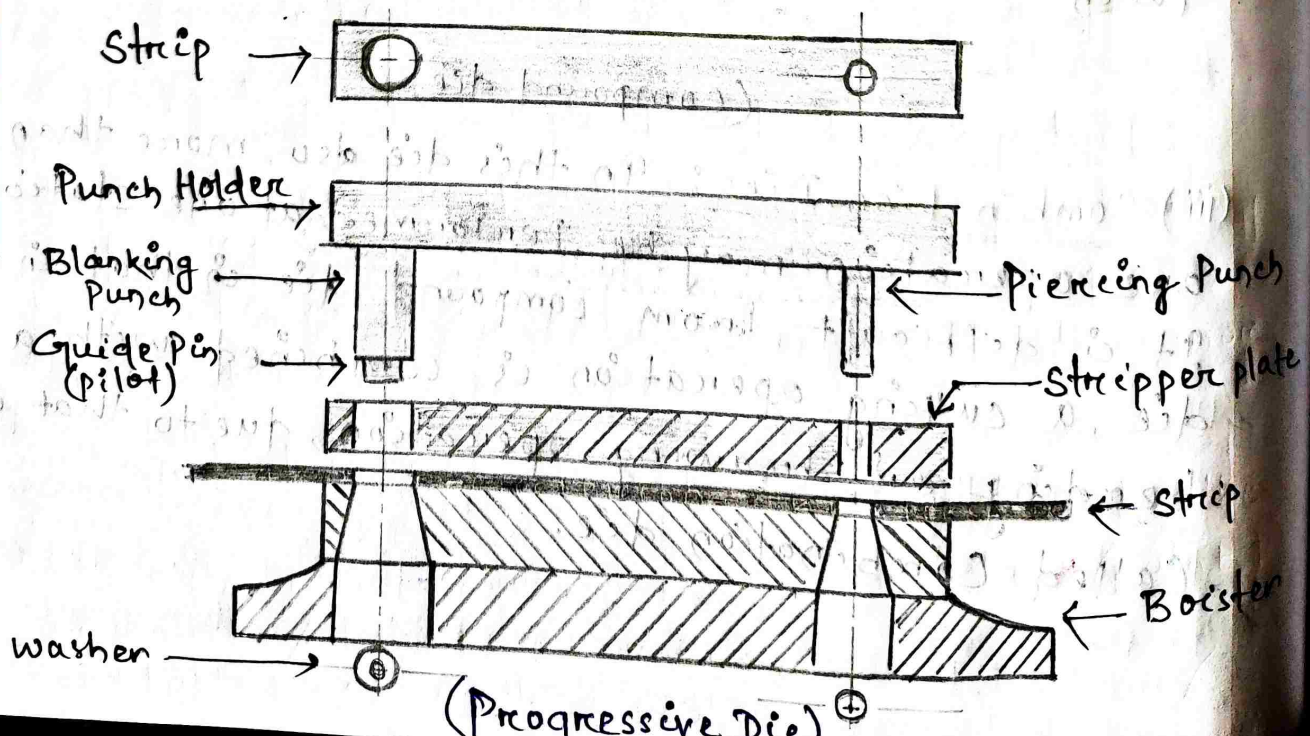
(Compound die)

(iii) Combination Dies : In this die also, more than one operation may be performed at one station. It is difficult from compound die in that in this die, a cutting operation is combined with a bending or drawing operation, due to that it is called combination die.



(combination die)

(iv) Progressive Dies :- A progressive or follow on dies have a series of operations. At each station, an operation is performed on a work piece during a stroke of the press. Between stroke the piece in the metal strip is transferred to the next station. A finished work piece is made at each stroke of the press while the piercing punch cuts a hole in the stroke, the blanking punch cut a portion of the metal in which a hole had been pierced at a previous station. Thus after the first stroke when only a hole will be punched, each stroke of the produces a finished washer.



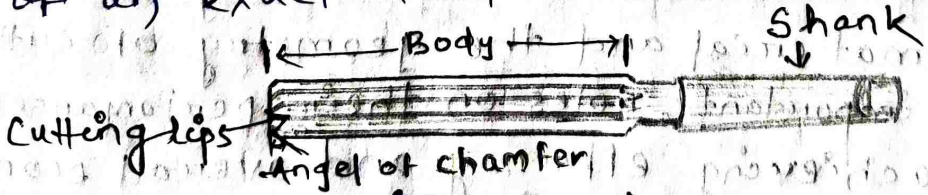
(Progressive Die)

(v) Transfer Dies :- Unlike the progressive dies where the stroke is feed progressively from one station to another. In transfer dies the already cut blanks are fed mechanically from one station to other station.

(vi) Multiple Dies :- Multiple or gang dies produce two or more work piece at each stroke of the press. A gang or number of simple dies and punches are ganged together to produced two or more parts at each stroke of the press.

Reamer tool :-

A reamer tool or bead reamer is a great tool that used to widen the size of a pre-existing hole in metal by small amout to leave smooth sides and edges - removing any burrs or rough edges. It is a pointed round file with a tip that's typically coated in diamond dust to creat a hard durable surface that's great for filing. Reamer tools are ideal for those who are looking for a more precise hole, as they take the pre-drilled hole made by a drill bit and make it truly round and of an exact diameter size.



(Reamer)

Tool Geometry :-

The word tool geometry is basically referred to some specific angles or slope of the salient faces and edges of the tools at their cutting point. Rake angle and clearance angle are the most significant for all the cutting tools.

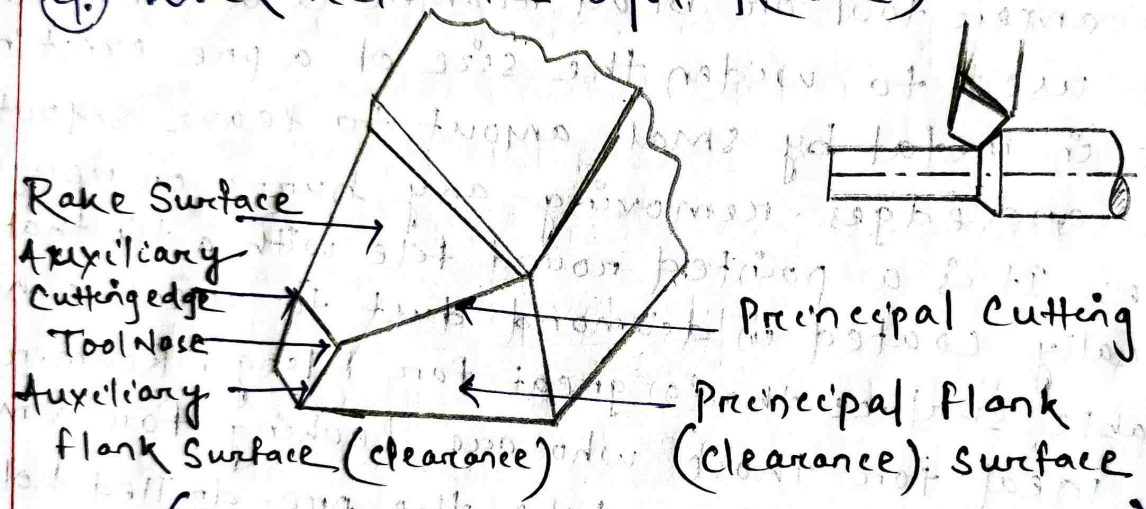
Systems of description of Tool Geometry :-

(1.) Tool in hand system :- where only the salient features of the cutting tool point are identified or visualized as indicated in figure. There is no quantitative information, for example, the value of the angle are not known.

(2.) Machine reference system :- ASA system

(3.) Tool reference system :-
- (a) Orthogonal rake system (ORS)
- (b) Normal rake system (NRS)

(4.) Work reference system (WRS)



(Basic features of a single point tool)

Geometry of Single point Turning tool :-

Both the material and the geometry of cutting tool play very important roles on their performances in terms of achieving effiency and overall economy of machining.

Cutting tool may be classified according to the number of their working cutting edges (points)
1. Single point cutting tools
2. Double / two point cutting tools
3. Multi point cutting tools

① Single Point Cutting tools :-

In this type cutting tools one cutting point or tip is available. The tool consists of a sharpened part called its point or tip.

Ex:- turning tool, shaping, planing, slotting tool & boring tool

② Double point Cutting tools :-

In this type cutting tools their are two cutting point available. The tool consists of two sharpened part is called its point.

Ex:- drill bit

③ Multipoint Cutting tools :-

In this type cutting tools their are more than two cutting point or tip available. The tool consists of more sharpened part.

Ex:- Milling cutters, broaching tools, hobs & gear shaping cutters.

(Grinding wheel is also multi point cutting tool.)

Concept of Rake & Clearance angles of Cutting tools

(i) Rake Angle :- It is the angle of inclination of the cutting tool's rake surface from the reference plane, that is the perpendicular to the velocity vector.

(ii) Clearance Angle :- It is the angle of inclination of the clearance or flank surface of the tool from the finished surface or the cutting plane.

NOTE: Rake angle is generally provided for ease of chip flow and it may be positive, negative or even zero But clearance angle must be greater than zero.

Machine Process Parameter :-

Machine Process Parameters are :-

(i) cutting speed / cutting velocity

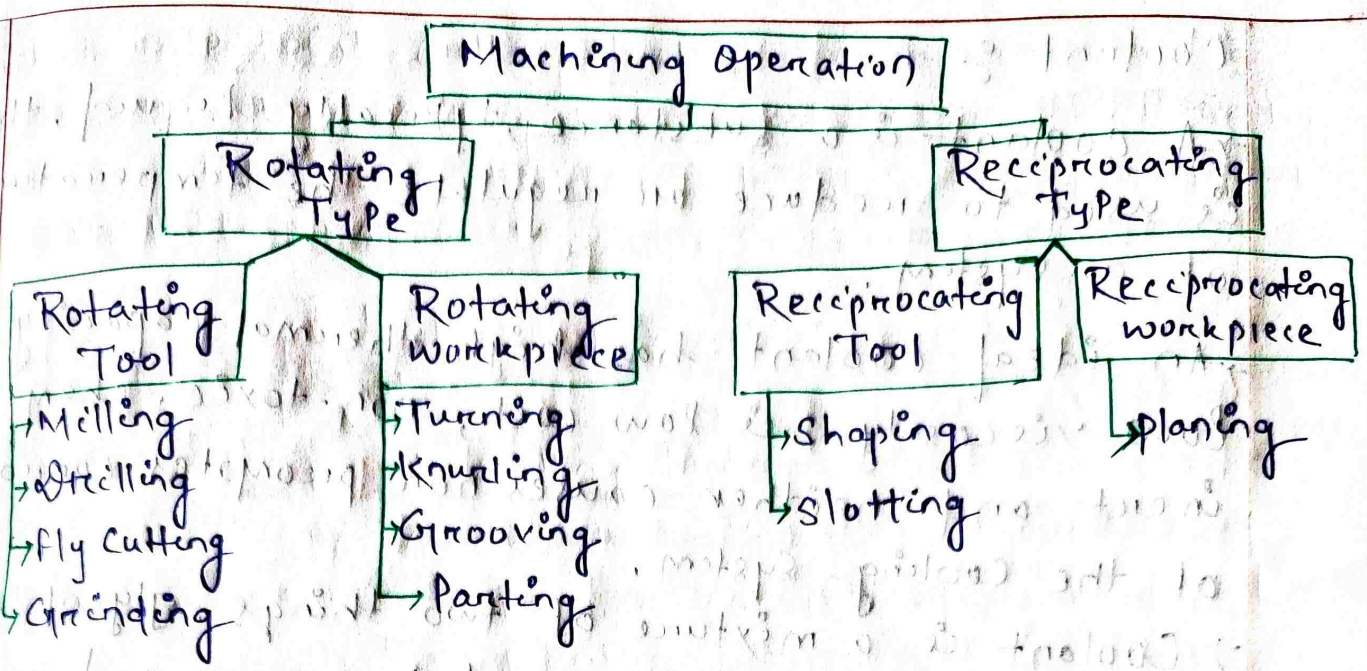
(ii) feed rate

(iii) depth of cut

for any machining or metal cutting operation, three relative motions between the workpiece and cutting tool are indispensably necessary for gradual removal of material from the workpiece. In fact, the simultaneous action of all three relative motions causes advancement of cutting tool towards work material along the intended path generating a finished surface with intended shape, size and tolerance. These three relative motions are called Machining Parameters.

(i) Cutting Speed / cutting velocity :-

Cutting velocity is the most important cutting parameter that provides necessary cutting motion (CM). In case of either rotating tool (such as milling, drilling, grinding) or rotating workpiece (such as turning), the peripheral velocity of cutter or workpiece (as the case) is considered as the cutting velocity. The rotational speed is called Speed (denoted by N and measured in rpm) where the tangential velocity is called cutting velocity (denoted by Vc and measured in m/min)



Feed Rate(s) :-

The auxiliary cutting motion is provided by the feed rate or feed velocity. Usually the direction of feed velocity is perpendicular to that of the cutting velocity; however not necessary. The primary objective of feed velocity is to advance the cutter with respect to the work piece to remove material from a wider surface. Basically it helps in covering the entire surface of the work piece by moving either cutting tool or workpiece. Feed rate can be imparted either on the cutter or on the workpiece.

Depth of cut (t) :

The tertiary cutting motion that provides necessary depth within work material that is intended to remove by machining. It is given in the third perpendicular direction and the simultaneous action of three cutting parameters results in removal of excess material from workpiece.

Coolant :-

→ A coolant is a substance, typically liquid, that is used to reduce or regulate the temperature of a system.

→ An ideal coolant has high thermal capacity, low viscosity, is low cost, non-toxic, chemically inert and neither causes nor promotes corrosion of the cooling system.

→ Coolant is a mixture of two things, glycol & water. Coolant is designed to remove and carry heat away from the engine to radiator.

→ Once this fluid cools down, it cycles back to the engine to remove more heat; Having the right coolant is critical for drivers traveling long distances & changing climates.

→ The main purpose of a coolant is to provide cooling effect on cutting tool & work piece at the time of machining process and also to lubricate the work piece surface.

Lubricant :-

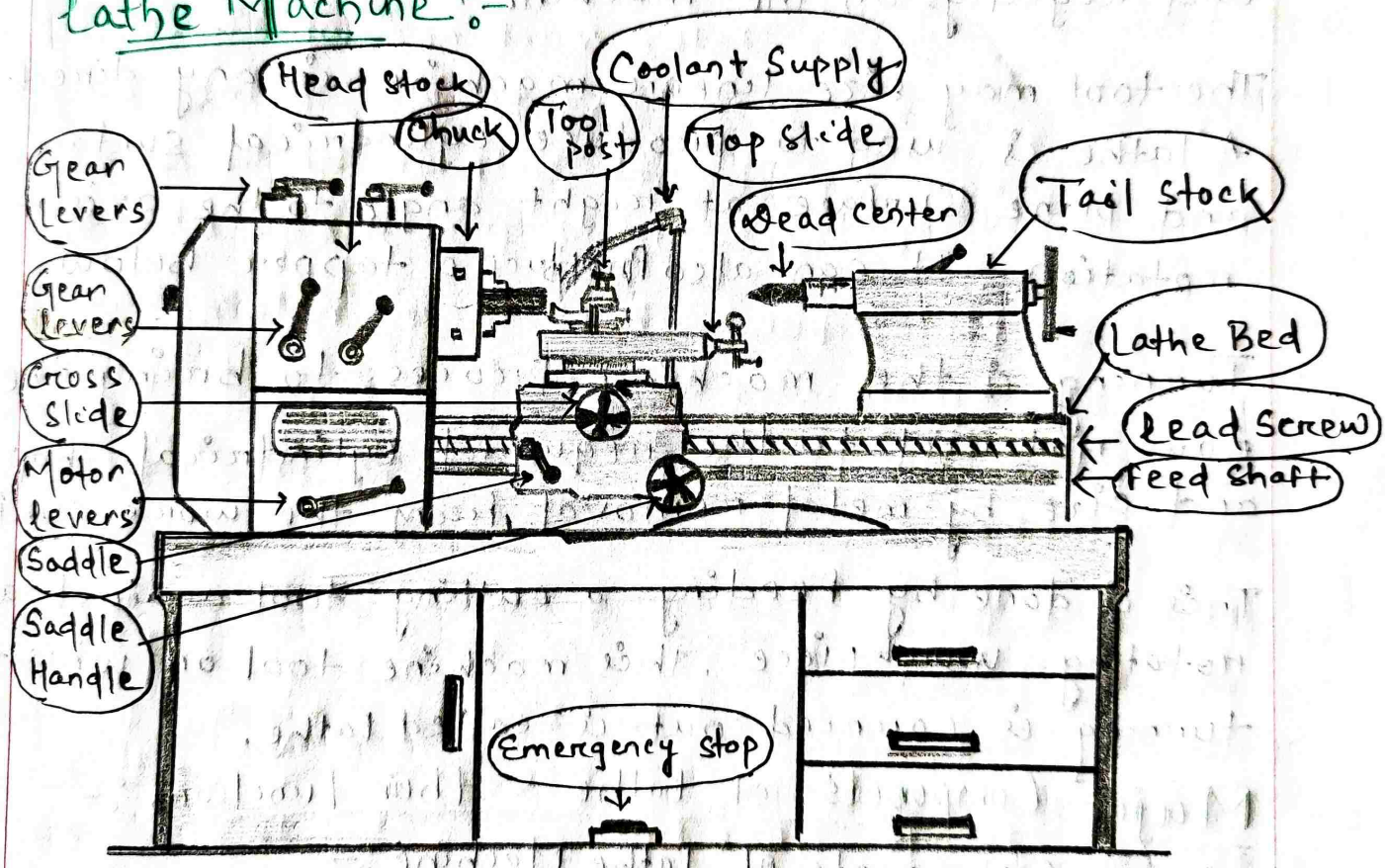
A lubricant is a substance, typically liquid & semi liquid, that helps to reduce friction between surfaces in mutual contact, which ultimately reduces the heat generated when the surface move. It may also have the function of transmitting forces, transporting foreign particles, or heating or cooling the surfaces.

→ A lubricant is a substance introduced to reduce friction between moving surfaces. It may also have the function of transporting foreign particles. The property of reducing friction is known as lubricity.

→ Generally lubricant oil or grease is used to reduce the friction, heat & wear between mechanical componets, machine beds & other Mechanical equipments are in contact with each other.

Unit-3 :-

Lathe Machine :-



(Lathe Machine with Parts)

A lathe, basically consists of a bed to provide support a head stock across side to transvers the tool and tool post mounted on the across the spindle is driven by a motor through the gear box to obtain a long speed to carriage move over the bed side which is parallel to work piece and spindle provides transverse,

It was the modern engine lathe which is equiped well, all necessary accessories for accurate tool room work. It is generally bed driven machine with considerable range is spindle and feeds.

Lathe removes considerable material from rotating workpiece in the form of chips with the help of tools, which is feed against the rotating workpiece. The tool material should be harder than the workpiece and the lathe had surely and rigidly on the machine.

The tool may size linear machine in any direction. A lathe is used to produce cylindrical surface and plane surface at right angle to the axis of rotation. It can also Produce a tapper below.

Turning is the maching process to bring the raw material to the required cylindrical shape and size by metal removal from the work surface. This is done by feeding a cutting tool against a rotating workpiece. This machine tool on which turning is carried out is called lathe,

Major Components of Lathe & their functions :-

Major Components of lathe Machine :-

a) Head stock
b) Tail stock
c) Carriage
d) Cross slide
e) Compound slide
f) Bed
g) Feed shaft
h) Legs
i) Lead Screw
j) Quick change Gear Box

Head stock :-

It is otherwise known as Live centre. Head stock is fitted on the lathe bed on the left hand side of the lathe operator. The required gear and cone pulley is fitted in it for driving the lathe spindle. There are two types head stock such as: All geared and cone pulley head stock.

Tail stock :-

The tail stock is otherwise known as Dead Centre. It is fitted on the lathe machines bed on the right hand side of the lathe operator, It can be moved any desired space on the lathe bed in case of need. It is used for centre to centre turning of lengthy workpiece.

Carriage :-

Literal meaning of "carriage" is to carry. Through carriage, a job can be brought in contact with the cutting tool or withdrawn from such a contact. It operates on bed ways between tail stock and head stock.

Cross slide :-

It is provided by terminal dove tail in one side and assembles in the top of the saddles with its tool dove tail. A taper grip is provided with saddle and cross slide dovetail to permit required but full movement of cross slide section is provided with T-section to enable fixing of gear tool parts. attachment from side is generated in degree to facilated swiveling the compound next is movement on cross-section side, which is directly assembles with cross slide and be swivelled on either side to give desire angle to compound next.

Compound Slide :- It supports the tool post and cutting tools in its various positions. It may be swivelled on the cross slide to any angle in the horizontal plane, as its has being graduated suitably. It's necessary in turning.

Bed :- All the parts of the lathe machine are fixed to the bed. The saddles of the carriages slide on the beds. There are three types of beds such as 'V' Bed, Flat Bed and Combination Bed.

Lead screw :-

It is a part of lathe machine, which is used for thread cutting operation. It has 'acme' thread having angle 29°. By the help of the lead screw the power trasmits from gear box to chucky.

Feed shaft :- feed shaft means nothing it's a normally a rod. By this rod trasmits power from the headstock to the carriage for feeding operation.

Leg : legs are carrying an entire load of a lathe machine tool and transfer to the ground. The legs are firmly secured to the floor by the foundation bolt.

Quick change gear box :-

The quick-change gear box mechanism consists of a cone-shaped group of change gears. One can instantly connect any single gear in the gear train by a sliding tumbler gear controlled by a lever.

Lathe Accessories :-

a) Lathe centre (live centre & dead centre)
b) Chuck
c) Catch Plate
d) Carriers
e) face plate
f) steady Rest
g) Mandrels

Lathe Centre :-

To provide support to lengthy jobs on lathe machines, centres are used. These are fitting them into tail stock's spindle and head stock's spindle. These can be devided into two parts such as : Live centre & dead centre.

Live centre :- These are fitted in head stock's spindle These are driven with the power of the machine.

Dead centre :- These are fitted in the centre tail stock spindle and they provide support to the other end of the job

Chuck :-

Chuck is normally used to provide a strong grip to catch the job on the lathe machine. These are easily fitted on the threading to the end of head stock spindle. Generally these are two types such as : Three jaw & four jaw chuck.

Catch Plate :-

The catch plate is also known as driving plate. It is round ordinary plate of castiron. Grooves facing each other are cut in this plate, Bent tail type job carrier is put in it and job is revolved. Threads exist in its centre and with their help head is fixed in the spindle.

Carriers :- The carriers is also known as Dog. It is used with the catch plate. The job is tied in the carrier and fitted in the catch plate.

Face plate :-

There are a number of jobs of such as shape that these can not be fitted into the centres or clamped with the help of chucks for the purpose of turning. Such jobs are gripped by the face plate This plate is also like the catch plate but it has a number of grooves on it.

Steady Rest :-

Steady Rest is used for such cylindrically long jobs which are likely to get resilient at the time of turning. These are two types such as fixed steady Rest & Travelling steady Rest.

fixed steady Rest :- A fixed steady rest is used to support long workpiece held in chuck, to perform operations at the overhanging end.

Travelling steady Rest :- The travelling steady Rest is a steady that is fixed to the saddle and moves along either just in front or just behind the cutting tool. It function is to stop thin workpieces bending under the pressure from the cutter.

Mandrels :-

The mandrels like a long straight stake of steel. It has a rounded face for the greater portion of its length, terminating in a short portion of its length, terminating in a short flat anvil. It has drill holes at both the ends

and its surface which comes into contact is hard and smoothly finished.

Operations Carried Out in Lathe :-

a) Facing
b) Turning
c) Thread cutting (internal & External)
d) taper turning
e) Step turning
f) parting off (grooving)
g) internal Machining (Boring)
h) knurling
i) step turning
j) Chamfering
k) drilling (only center of the workpiece)

Facing :-

The act of making equal and plain ends of a job in their actual length is called facing. facing operation is carried out before any other operations are done on the job.

Turning :-

Turning operation is done on the entire length of the job according to its maximum diameter. By this operation decreasing the diameter of a cylindrical job.

Taper turning :-

when one side of a job with parallel diameter, is cut turned completely or partially, to reduced its diameter, lathe operation is called taper turning. The angle of the taper is made according to the need, more or less inter or outer.

Step turning :-

To make smaller diameter on a plain round shaft than the diameter of the shaft is called step turning. step turning is done after facing and turning operation.

Thread cutting :- In the workshops where there is need for cutting tapers frequently, taper turning is used, this operation did for make thread on workpiece both inside & outside according to the tool & need.

Parting off (grooving) :-

Parting off or grooving operation is the process where by a part that has been made, or is wanted for another operation, on the end of a bar is cut off from the rest of the bar, which is usually being held in the chuck.

Internal operation :-

Internal operation means in lathe machine by the help of internal cutting tool, Internal turning is the process on lathe that enlarging the inner hole of the workpiece, this process also known as boring.

Knurling :-

Drawing slanting or square projecting lines on the surface of a job in order to have better grip is known as knurling. for this purpose special knurling tool is used.

Chamfering :-

Tapering of a small part of a job at its edge or corner is known as chamfering. chamfering is done after boring, knurling & other operation etc.

Drilling :-

This drilling operation done in lathe using a drill bit according to the required size & need

In tail stock a drillbit is placed in the place of dead center, then the tail stock part slidingly come to the chuck then the chuck rotates & with the help of a drill bit Hole can be occured in the centre of the job/workshop.

Safety Measures during Machining (lathe) :-

(i) Correct dress/Tight dress is important, remove rings, watches and any kind hand band, roll sleeves above elbows.

(ii) Always stop the machine before making any adjustment.

(iii) Don't change spindle speeds until the lathe comes to a complete stop.

(iv) Always wear protective eye protection.

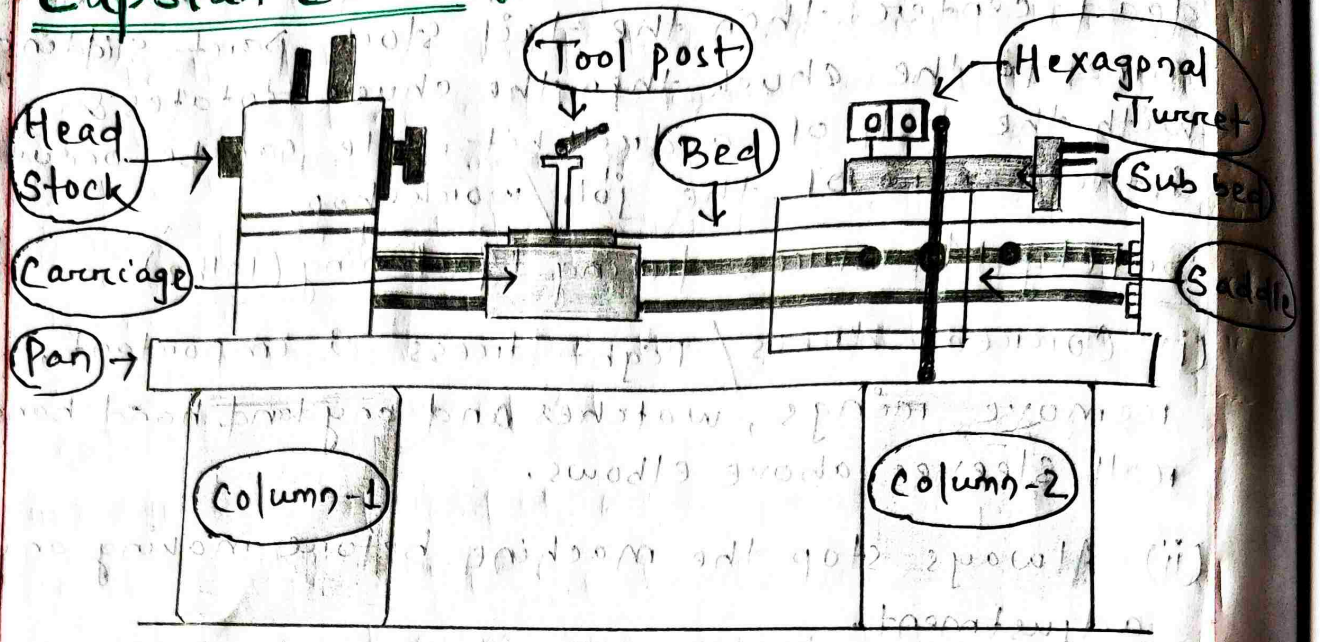
(v) Machining operating time don't touch your job directly and don't strip of emery cloth for being finished.

(vi) Never lay tools directly on the lathe ways. If a separate table is not available, use a wide board with a cleat on each side to lay on the ways.

(vii) Use two hands when sanding the workpiece. Do not wrap sandpaper or emery cloth around the workpiece

(viii) Don't operate the machine without sufficient knowledge. First perfectly learn and then only operate the machine with presence of instructor/Sir.

Capstan Lathe :-



(Capstan lathe with Parts)

Capstan lathe :-

A capstan lathe is a production lathe. It is used to manufacture any number of identical pieces in the minimum time. The capstan lathe is one of the types of semi automatic lathe.

In semi-automatic lathes machining operations are done automatically.

functions other than machining like loading and unloading of a job, the positioning of tools coolant operations are done manually.

The turret head is mounted on the ram fitted with turret slides longitudinally on the saddle.

The turret head has a hexagonal block having six faces with a bore for mounting six or more than six tools at a time. The threaded hole on these faces is used to hold the tools.

In Capstan lathe, the hexagonal turret is mounted on a short slide or ram, which again fitted with a saddle. The saddle can be move accordingly through out the bed ways and can be fixed to the bed if necessary. This can done generally for bar type jobs.

Major Components & their functions :-

a) Head stock
b) Carriage
c) Pan
d) Column 1 & 2
e) Tool post
f) Bed
g) Hexagonal Turret
h) Sub bed
i) Saddle

Head Stock :-

Head stock is a large casting located at the left-hand end of the machine. the head stock of a capstan and turret lathe may be following type.

(i) Step cone pulley driven Head stock
(ii) Electric Motor driven Head stock
(iii) All Geared Head stock

(i) Step Cone Pully Driven Head Stock :-

This is the simplest type of the head stock and its fitted with small capstan lathes where the lathe is engaged in machining small and almost constant diameter of workpieces. Only three or four steps of the pulley can cater to the needs of the machine. The machine requires special counter shaft unlike that of an engine lathe, where starting, stopping, and reversing of the machine spindle can be affected by simply presenting a foot pedal.

(ii) Electric Motor Driven Head stock :-

In this type of head stock the simple the spindle of the machine and the armature shaft of the motore are the same. Any speed varciation and reversal is affected by simply controlling the motore. Three or four speed are available and the machine is suitable for a smaller diameter of workpiece rotated at high speed.

(iii) All Geared Head stock :-

On the larger lathe, the head stock is geared and different mechanism are employed for speed changing by actuating levers. The speed changing may be affected without stopping the machine.

Bed :

The bed is a long box like casting with accurate guide ways on which carriage and turret Saddle are mounted. The bed is designed to ensure strength, rigidity and permanency of alignment under heavy duty services. Carriage is mounted over the bed and travels longitudinally.

Hexagonal Turret :-

The Hexagonal turret replaces the tailstock of a center lathe. It is mounted directly on the lathe bed on the same side as a tailstock in the center lathe. It can be of two types one is that which travel longitudinally along with the tool when it is fed into the job and the turret head carrying the tool is mounted

directly on it. In the other type, it is provided with a slide that moves in the guide ways made in it. In this type the Hexagonal turret head is mounted on the slide. As the overhang of the slide is kept limited, the saddle can be moved along the bed and secured at the desired position.

Saddle :-

In small Capstan lathe, hand-operated cross slide and saddle are used which are clamped on the lathe bed at the required position.

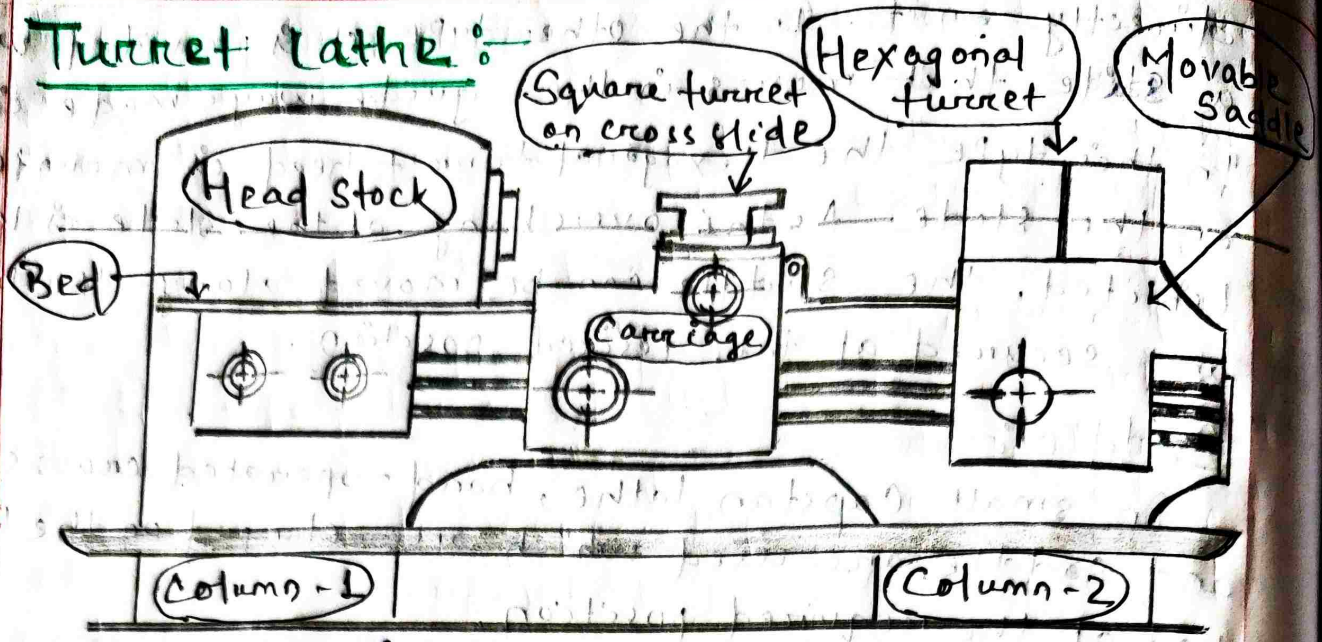
Advantages of Capstan lathe :-

(i) The rate of production is higher
(ii) Different ranges of speed are obtained
(iii) A number of tools can be accommodated
(iv) Chucking of larger work piece can be done.
(v) Operators of less skill are required hence lower the labor cost.
(vi) Higher rigidity so can withstand heavy load.

Applications :-

(i) Automobile Industries
(ii) Big Big Manufacturing Unit
(iii) Air craft Assembly unit
(iv) Large Production field

Turret lathe :-



(Turret lathe)

A turret lathe is a manual lathe having a hexagonal tool-holding turret in place of the tail stock of an engine lathe.

The head stock in most cases is geared with provision for 6 to 16 spindle speeds and may double this capability with a two speed motor.

Some turret lathe are designed and equipped for working on barstock and are called bar type machines.

The name screw machine or hand screw machines has been used for such machines, particularly in the smaller sizes. Other turret lathes are equipped for chuck work.

Types of turret lathe :-

1. Horizontal Turret lathe
2. Ram type Turret lathe
3. Saddle Type turret lathe
4. Vertical type turret lathe

In Contrast to Center lathes, Capstan and turret Lathe:-

- Are semiautomatic.
- possess an axially movable indexable turret (mostly Hexagonal) in place of tail stock.
- Holds a large number of cutting tools. up to 4 in indexable tool post on the front slide, one in the rear slide and up to 6 in the turret (if hexagonal) as indicated in the schematic diagram.
- Are more productive for quick engagement & overlapped functioning of the tools in addition to faster mountings and feeding of the job and rapid speed change
- Enable repetetive production of the same job requiring less involvement, effort and attention of the operator for pre-setting of work-speed and feed rate and length of travel of the cutting tools.
- are relatively costlier
- are suitable and economically viable for batch production or small lot production.

Different between Capstan and turret lathe:-

- The essential components and operating principle of Capstan and turret lathes are illustrated schematically in figure Capstan lathes are mainly used for bar work, where as turret lathes are applicable for large work in the form of castings and forgings
- In a capstan or ram-type lathe, the hexagonal turret is mounted on a slide that moves longitudinally in a stationary saddle. During the set up of the machine, the saddle is positioned along

the bed to give the shortest possible stroke for the job.

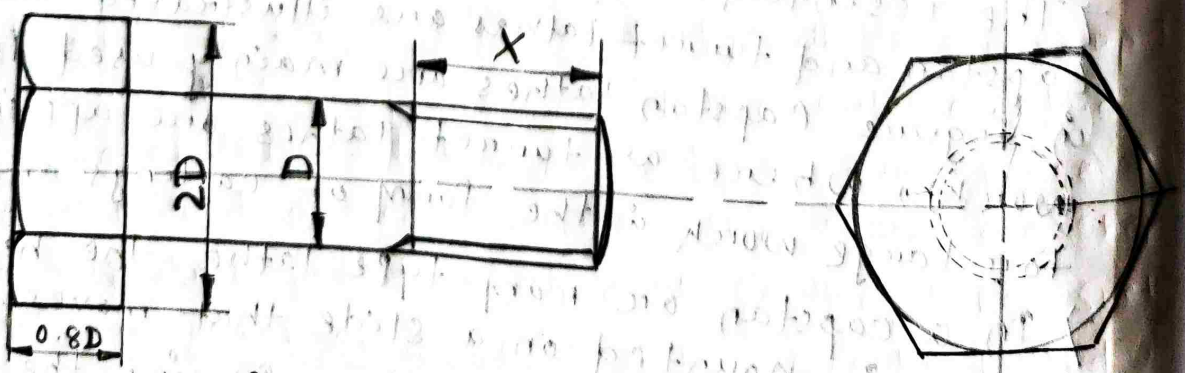
→ The advantage of the capstan lathe is that the operator has less mass to move, resulting in easier and faster handling.

→ The disadvantage is that the hexagonal turret slide is fed forward such that the overhang is increased, resulting in the deflection of the ram slide, especially at the extreme of its position, which produces taper and reduces accuracy

→ In the turret or saddle-type lathe, the turret is mounted directly upon a movable saddle, furnished with both hand and power longitudenal feed.

→ The machine is designed for machining chuck work, in addition to bar work. Owing to the volume of the swarf produced, the guideways of the machine bed are flame-hardened and provided with covers that protect the sliding surfaces. The bed must be designed to allow free and rapid escape of swarf and coolant.

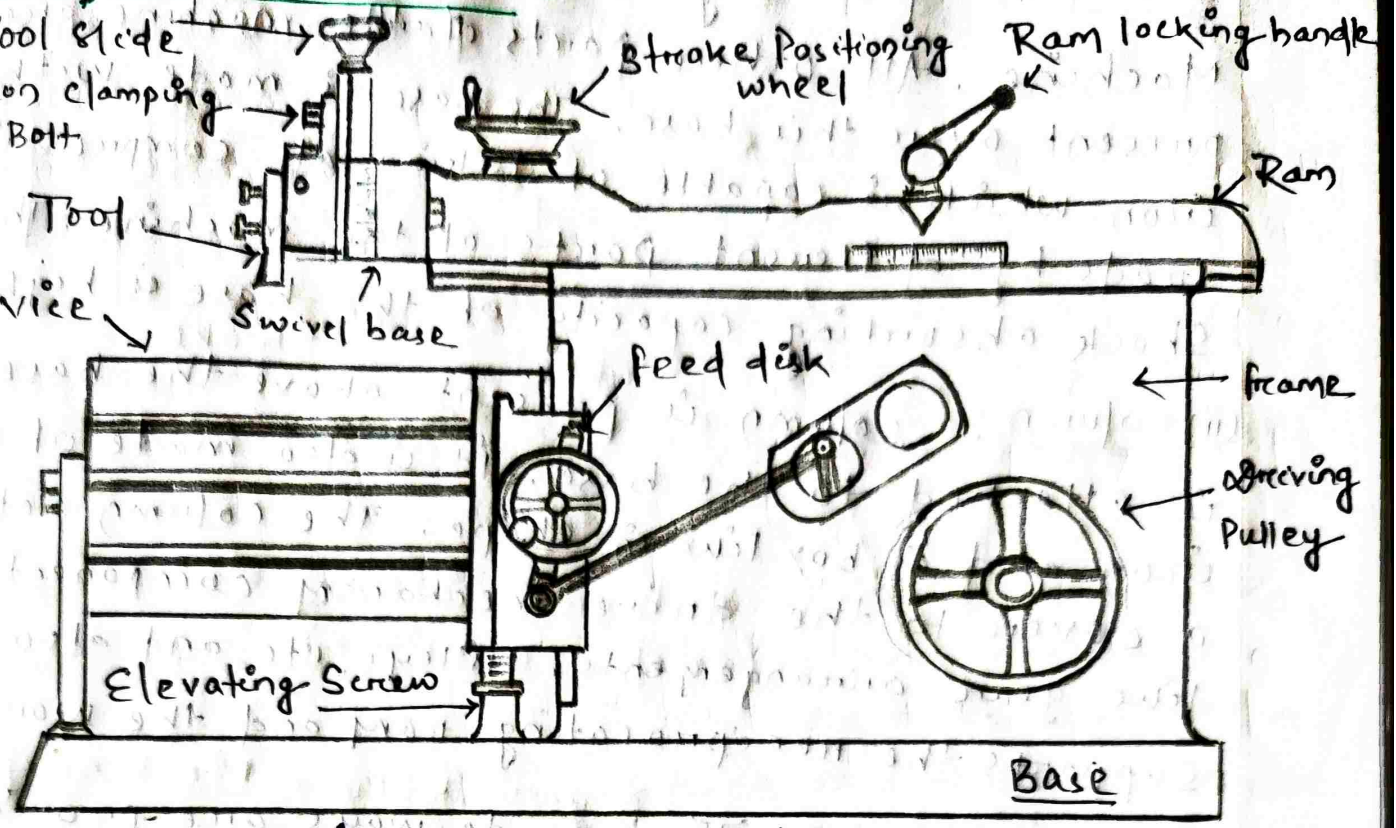
The tooling layout for preparation of hexagonal bolt & bush



(Hexagonal-headed bolt)

Unit-4

Shaper Machine :-



(Shaper Machine)

What is Shaper Machine :-

A shaper Machine is a special kind of manufacturing Machine that uses liner, reciprocating motion of single point cutting tool to generate a linear tool path.

The shaper Machine is used to give different shapes to the workpiece. shaper Machine is commonly used to produce flat surfaces, grooves, slots, etc.

In shaper Machine a single point cutting tool is used which reciprocates and rubs the workpiece and removes unwanted metal from the workpiece in the form of chips.

Parts of shaper Machine :-

i) Base
ii) Column
iii) Guideways
(iv) Table support
(v) Table
(vi) vice
(vii) Ram
(viii) Tool Head.
(ix) clapper Box
(x) Ram clamp
(xi) Tool post.

(i) Base :- Generally it is the base of the shaper machine. All other parts of the machine are present over this base. The base is made with cast iron which is capable of taking all compressive loads by different parts of the machine. The shock absorbing capacity of the base is high.

(ii) Column :- Column is present above the base and is attached to the base. It is also made of cast iron and is box like in shape. The column act as a cover to the drive mechanism components like gear arrangements, pulleys, etc and also supports the reciprocating ram and the worktable.

(iii) Guide ways :- Two guide ways are provided on the top and side of the column. The ram reciprocate on one guide way which is present at the top of the column and the table move up and down in the other guide way which is present at the side of the column.

(iv) Table Support :- Table sliding support is present near the base in front of the table which supports the table while sliding up and down in the guideway of the column.

(v) Table :- Table is a metal body which slides up and down on the guide way of the column. Main function of the table is to hold the workpiece and vice is placed over this table. The table is in shape of a box and T-slots are cut on the table. such that any machine vice can be easily fitted on that T-slot and fitted in it properly through the help of Nut & bolt.

(vi) Vice :- Vice is present over the table and is used to hold or clamp the workpiece properly. the vice has two jaws, one is movable and another is fixed. As one of the jaws is movable, so workpiece of different sizes can be clamped in between the two jaws.

(vii) Ram :- Ram is the main part of the shaper machine. Ram is made with cast iron and slide left and right in the guide way of the column. It holds the tool & provides receprocating motion to it. In the crank driven machine, Ram is connected with the rocker arm which provide motion to the Ram. In the hydraulic driven machine, Ram is connected with the hydraulic housing which provides motion to the Ram. Single point cutting tool, is used as a tool in the shaper machine which is most commonly made of high speed steel or sometimes high carbon steel.

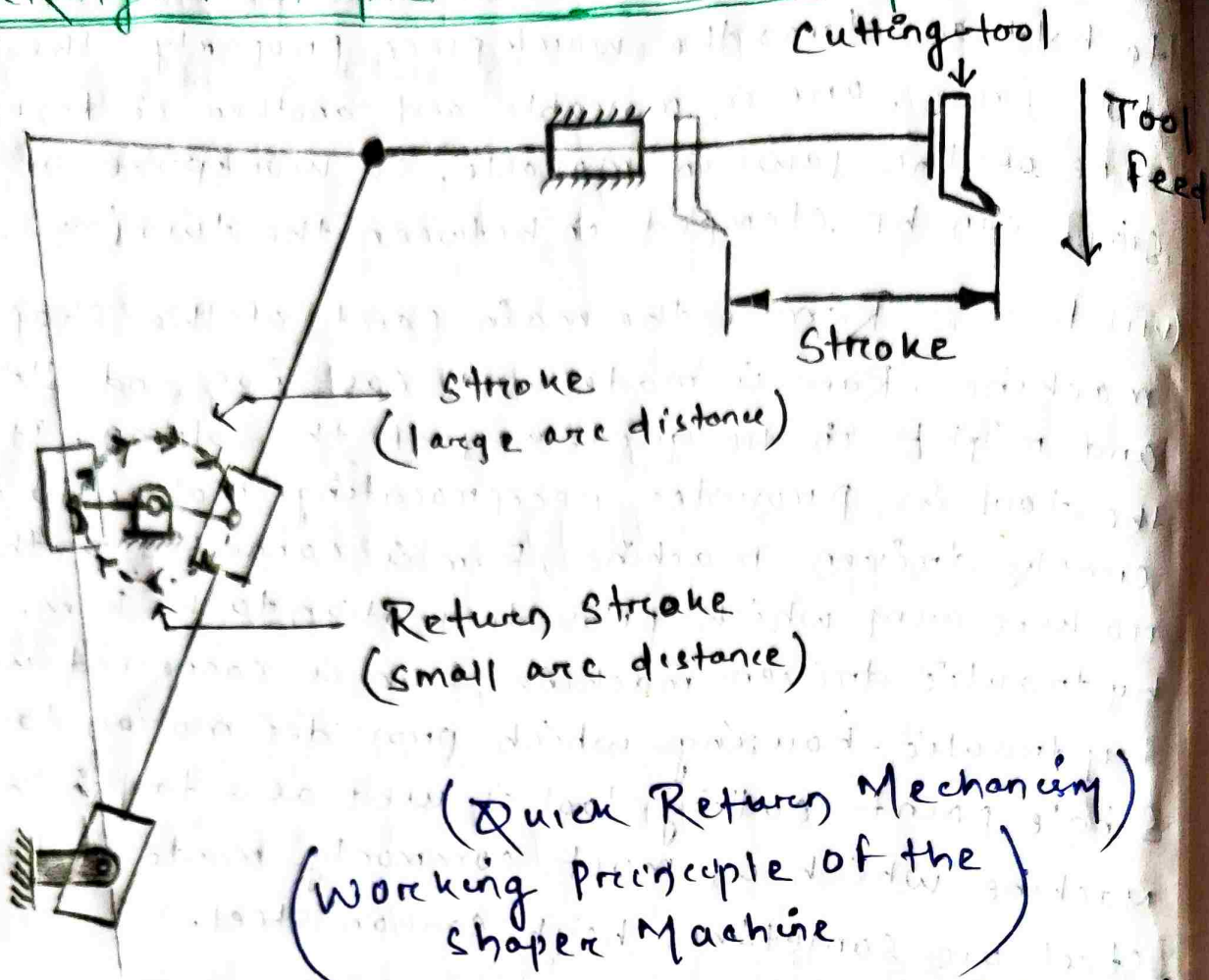
(viii) Tool Head or Vertical Slide :- Tool Head or Vertical slide can move up & down with the help of a handle. Also it can be rotated to any angle. The handle of the tool head is called tool feed Handle.

(ix) Clapper Box :- Clapper Box helps the tool to fit inside the Tool post. The main function of the clapper box is to provide clearance for tool in return stroke. It also prevents the cutting edge dragging on the workpiece in the return stock and prevent tool wear.

(x) Ram clamp :- Ram clamp is used to set the position of the ram.

(xi) Tool Post :- Tool post is used to hold the tool properly and it is connected directly with the swivel base.

Working Principle of the shaper Machine :-



(Quick Return Mechanism)

(Working Principle of the shaper Machine)

→ In the shaper machine a single point cutting tool is rigidly mounted on the tool holder, which is mounted on the ram. The work piece is held rigidly in a vice (or clamped directly on the table.)

→ The ram reciprocates and thus cutting tool held in tool holder moves backward and forward on the work piece.

→ In a standard shaper, cutting takes place during the forward stroke of the ram and the backward stroke remains idle.

→ The forward and backward motion is obtained by "Quick Return Mechanism."

→ The depth of cut is adjusted by moving the tool downwards towards the work piece.

There are two types of traversing wheel in shaper Machine :-

(i) Hand Traversing wheel
(ii) Cross feed Handle

(i) Hand Traversing wheel :-

Hand traversing wheel is used to move the table up and down.

(ii) Cross feed Handle :-

Cross feed Handle is used to feed the tool in forward and backward direction, while the hand traversing wheel helps to move the table up and down, cross feed Handle helps the table to move in cross direction.

Types of Shaper Machine :-

1. On the Basic of cutting Stroke :-
   - draw cut type
   - push cut type
2. On the Basic of table design :-
   - Universal shaper
   - standard shaper
3. On the Basic of ram travel :-
   - vertical shaper
   - Horizontal shaper
4. On the Basic of driving Mechanism :-
   - Hydraulic shaper
   - Geared shaper
   - Crank shaper

Applications of shaper Machine :-

- To generate straight and flat surfaces
- To smooth rough surface
- To make internal splines
- To make gear teeth
- To make dovetail slides
- To make keyways in pulies or gear.

Advantages of shaper Machine :-

- low tooling cost
- Easy to use

Disadvantages of shaper Machine :-

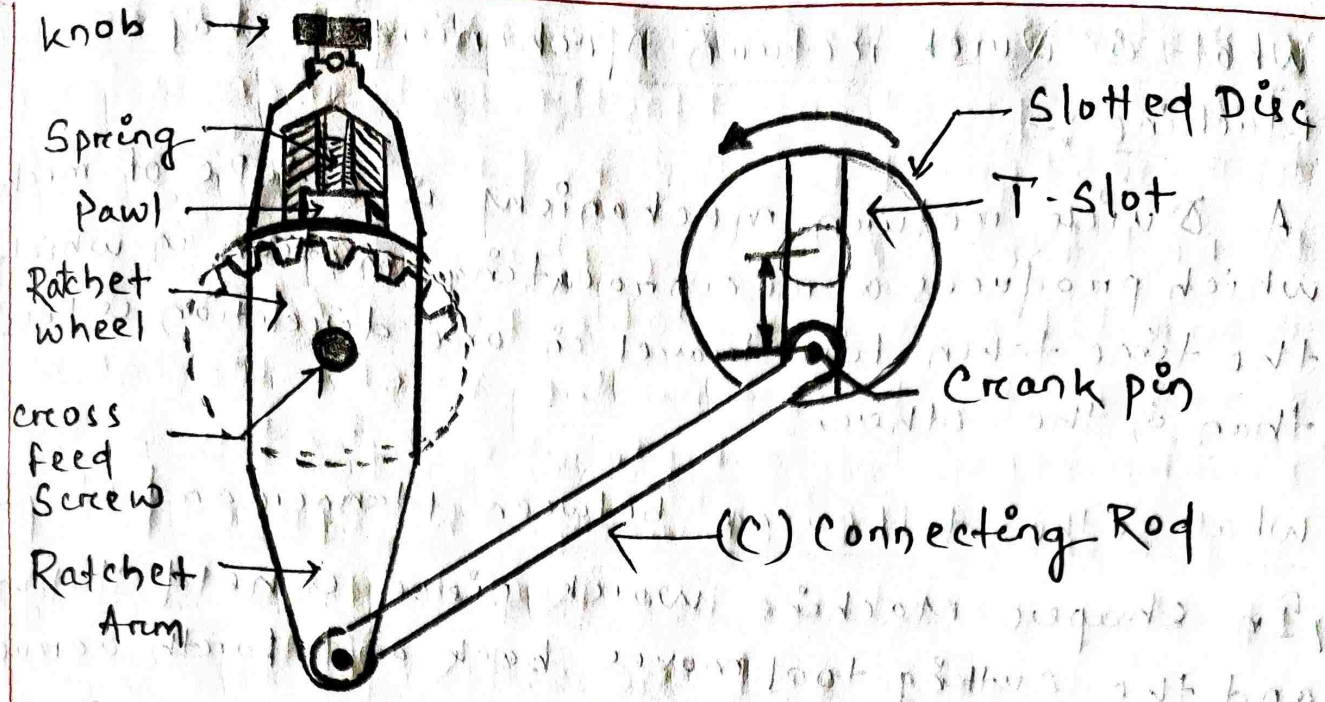
- They are slow
- They are inefficient

Automatic table feed Mechanism :-

The automatic feed mechanism of the table is very simple. This is done by rotating a ratchet wheel, mounted at the crossfeed screw. This enables a corresponding equal rotation of the crossfeed screw after each stroke.

Working :-

- The lower end of the pawl is bevelled on one side. This arrangement helps the power feed to operate in either direction, but the same should be set to operate during the return stroke only.



→ Variation in the feed can be provided by varying the distance R between the disc centre and the centre of the adjustable pin. The larger the said distance greater will be the feed and and vice versa.

→ The amount of feed to be given depends upon the type of finish required on the job.

→ for rough machining, heavier cuts are employed, and thus, a coarse feed is needed. Against this, a finer feed is employed in finishing operations.

→ The slotted disc at its back carries a spur gear which is driven by the bull gear. As the disc rotates through this gear the adjustable pin, being eccentric with the disc centre,

→ This causes the connecting rod to reciprocate. This, in turn makes the rocker arm to swing about the screw C to move the pawl over one or more teeth. Thus transmit an intermittent motion to the crossfeed screw which moves the table.

What is Quick return Mechanism in shaper Machine :-

A Quick return mechanism is a type of mechanism which produces a reciprocating motion in which the time taken for travel in one direction is less than in the other.

What is the difference between planner and shaper :-

→ In shaper Machine work piece is held stationary and the cutting tool moves back and forth across the work.

→ In a planar machine, the tool is stationary and work piece travels back and forth under the tool.

How the size of shaper is specified :-

The size of a shaper is specified by the maximum length of stroke or cut it can make.

What is a shaping process (or operation) ? →

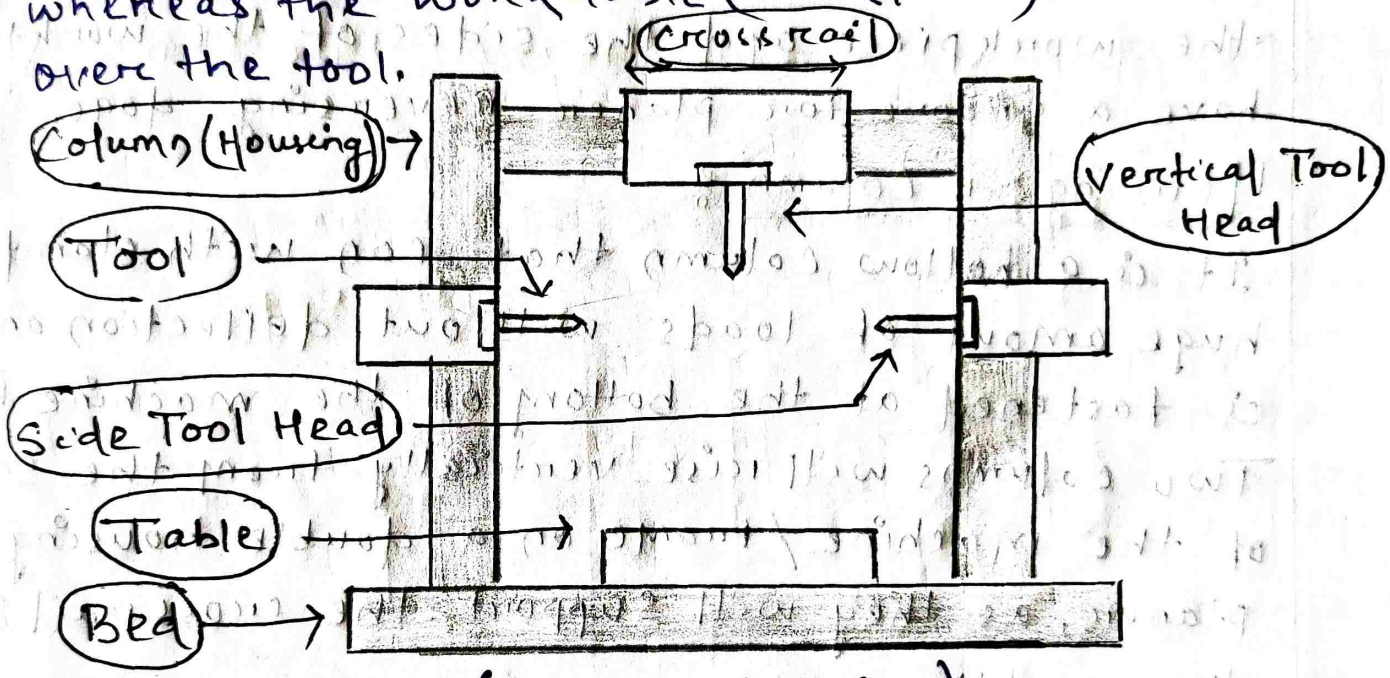
Generating a straight tool path with the help of a single point cutting tool (reciprocating) is known as shaping process (or operation).

Unit - 5 :-

Planning Machine :-

planning :-

A planner is a machine tool which is just like a shaper machine designed to produce flat surface or planes by means of a single point cutting tool employed for machining heavy jobs which are not possible by shaper machine. The tool is fixed whereas the work table (workpiece) reciprocates over the tool.



(Planer Machine)

Major Components and their functions :-

(i) Bed
(ii) Work table
(iii) Housing or column
(iv) Cross rail
(v) Vertical Toolhead
(vi) Saddle

(i) **Bed** :- The bed of a planer machine is prepared by means of the casting process and as it is a large component we can not prepare them by the machining process. So always the larger components undergo casting only. The bed was prepared in such a way that it has the ability to absorb the

vibrations induced in the machine during various operations. Mostly cast iron is taken as a material for the bed part of the planner

Worktable :- As in the planner machine, the worktable is a movable part and the tool is fixed part, therefore the worktable can be run by means of a hydraulic cylinder or by a pinion gear mechanism. The upper surface of the worktable has T slots for clamping the workpiece and the sides of the worktable have a groove for planer reversing dogs.

Housing or Column :-

It is a hollow column that can withstand a huge amount of loads without deflection and is fastened at the bottom of the machine bed. Two columns will rise vertically from the sides of the machine/frame on a double housing planer, as they will support the cross rail & the saddle.

Cross rail :- As discussed, it is mounted on the top of the housing. It slides up and down on the flat ways which are controlled either by hand or by machine.

The weight of cross-rails was very high and that's the reason they are counter weighted by means of hydraulic cylinders or cast iron weights.

Vertical Toolhead :- The tool head contains a tool post which holds the cutting tool to do the

machining operations.

Saddle :- On the ways of cross rail, the saddle is fitted. There are two saddles located on the planer machine, one is for the right tool head and the other is for the right tool head and the other is for the left tool head.

Working Principle :-

To machine wider work pieces, time taken will be very high by the usage of the shaper machine. Therefore, to minimize this time, more than one cutting tool will be used for removing the material simultaneously from one workpiece it self.

But for mounting more than one tool, more than one ram is required and it is nothing but more than one shaping machine will be placed parallel and is not at all preferable.

More than one cutting tool will be fixed onto a beam and allow the workpiece to reciproeate with variable speed (like optimum speed is forward-ing stroke and maximum speed is return stroke.) This process is called as planing Operation or planing Machine.

In this planer, the workpiece will be under reciprocating motion and the tool is stationary and due to this, the material removal takes place.

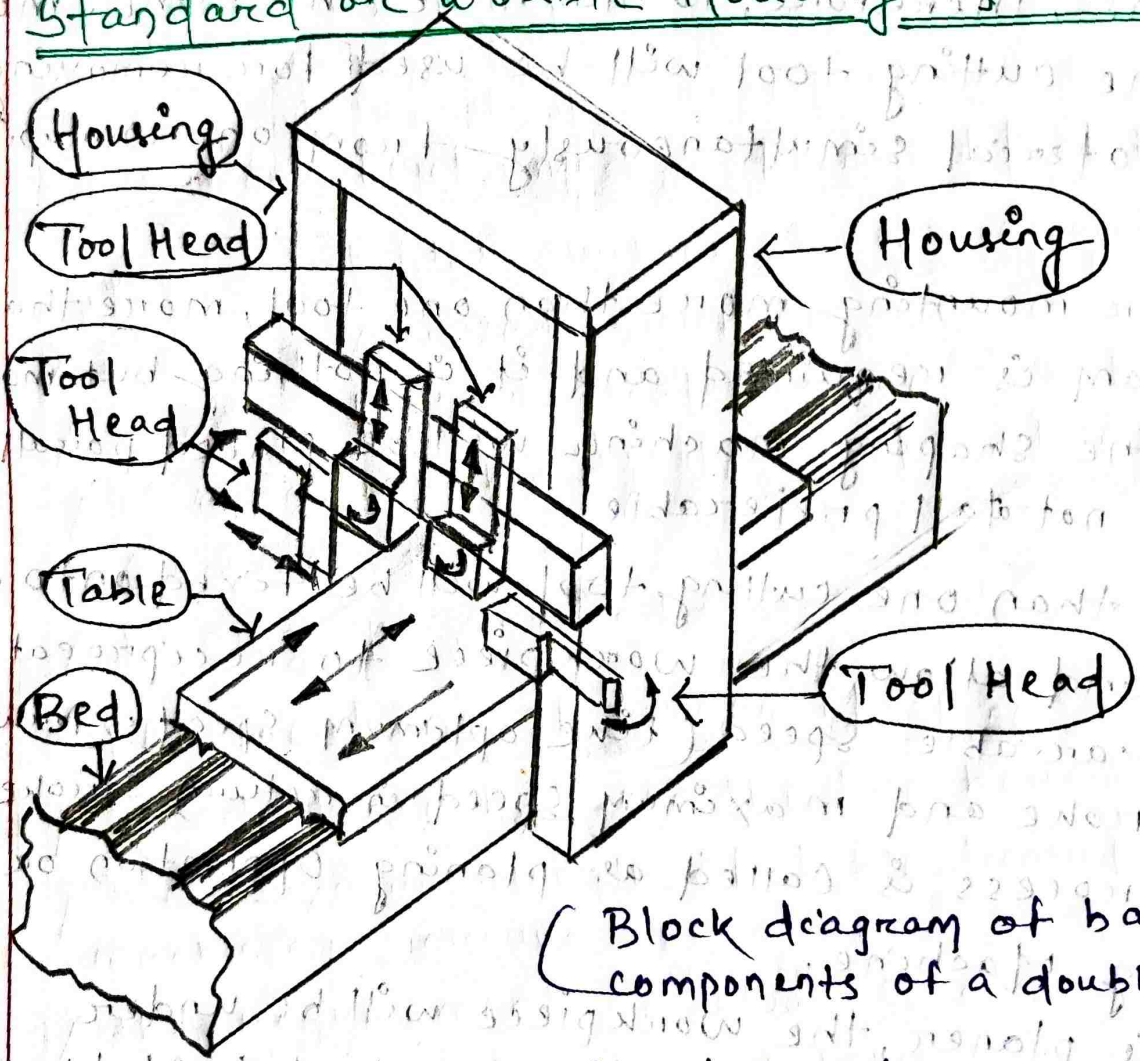
The return stroke will be the idle stroke and it is due to the mechanism called whitworth

Quick return motion mechanism.

Types of planer Machine :-

1. Standard or Double housing type planer.
2. Pit Type planer
3. Open side planer
4. Edge planner Machine
5. Divided Table planer

Standard or Double Housing Type Planer :-



Block diagram of basic components of a double-housing planer

The Double housing type planer consists of two upright vertical columns which can support a cross-rail. They are employed for machining of guiding surfaces, dovetails, large beds of machines, etc.

due to the longer planing length, a large number of components will be machined in a short period of time.

It is a old type of machine which is widely used in various workshops.

Pit Type Planer :-

It is massive in construction compared to the double housing planer. In this machine, the column which carries the cross-rail reciprocates on the horizontal rails.

It can able to machine large surfaces that are not possible by standard type planer.

Open Side Planer :-

This is used for machining wider workpieces

It has only one column or housing that was present on one side of the base and a cross rail was mounted.

The single housing or column must be rigid because it has to carry the entire load during machine

Edge planer Machine :-

As the name indicates the edge planer machine is used to bevel the edges of steel plates which are used in the applications of shipbuilding works and pressure vessels.

The table which carries the workpiece remains stationary.

There are two clamps as shown in the figure which clamps the work piece during machining.

The tool head moves along the guideways for Quick machining of the workpiece

Divided Table Planer :-

A divided table planer is used for continuous mass production.
The machine bed consists of two tables which may be reciprocated individually or together. While setting the work on the planer machine, it saves the idle time.
for the preparation of large or heavy jobs, both tables are clamped together and are given the reciprocating motion under the action of a cutting tool.

Operations Performed in Planer Machine :-

→ Horizontal flat surface planing operation
→ planing curved surfaces
→ planing flat vertical surfaces
→ planing machining dovetails and angular surfaces
→ planing grooves and slots

Specifications of planer Machine :-

→ The distance between the two housings of planer
→ The maximum length of table travel during machining various operations
→ The requirement of floor space
→ length of bed and work table
→ Driving mechanism of a machine
→ Number of speeds and feeds available;
→ Power input and net weight of the machine

Applications of planer Machine:-

→ It is used in various industrial and Institutional application.
→ It is used for providing flat surfaces
→ It is used for creating keyways (cutting slots.)
→ planers are used in tool and die shops.

Advantages of planer Machine:-

→ Because of the multiple tools present in the shaper, the MRR will be very high compared to the shaper.
→ A high surface finish can be obtained.
→ Applicable for wider workpieces
→ High accuracy is maintained.
→ This machine exhibits low maintenance.

Disadvantages of planer Machine:-

→ These planers are replaced by milling machines, surface grinding machines, broaching machines, etc.
→ The installation cost is very high.
→ The power consumption will be more as it has to remove large material from the materials compared to the shaper Machine.
→ The cost of the machine is high & machining cost also high
→ Highly skilled operators are required to operate these machines.

What does a planer Machine do :-

A planer is a machine tool which is just like a shaper machine designed to produce flat surfaces or planes by means of a single point cutting tool employed for machining heavy jobs which are not possible by shaper Machine.

What is different between shaper and planer Machine :-

In shaper machine the work piece is fixed and tool reciprocates where as in the planer Machine, the tool is fixed and the workpiece kept on the worktable reciprocates.

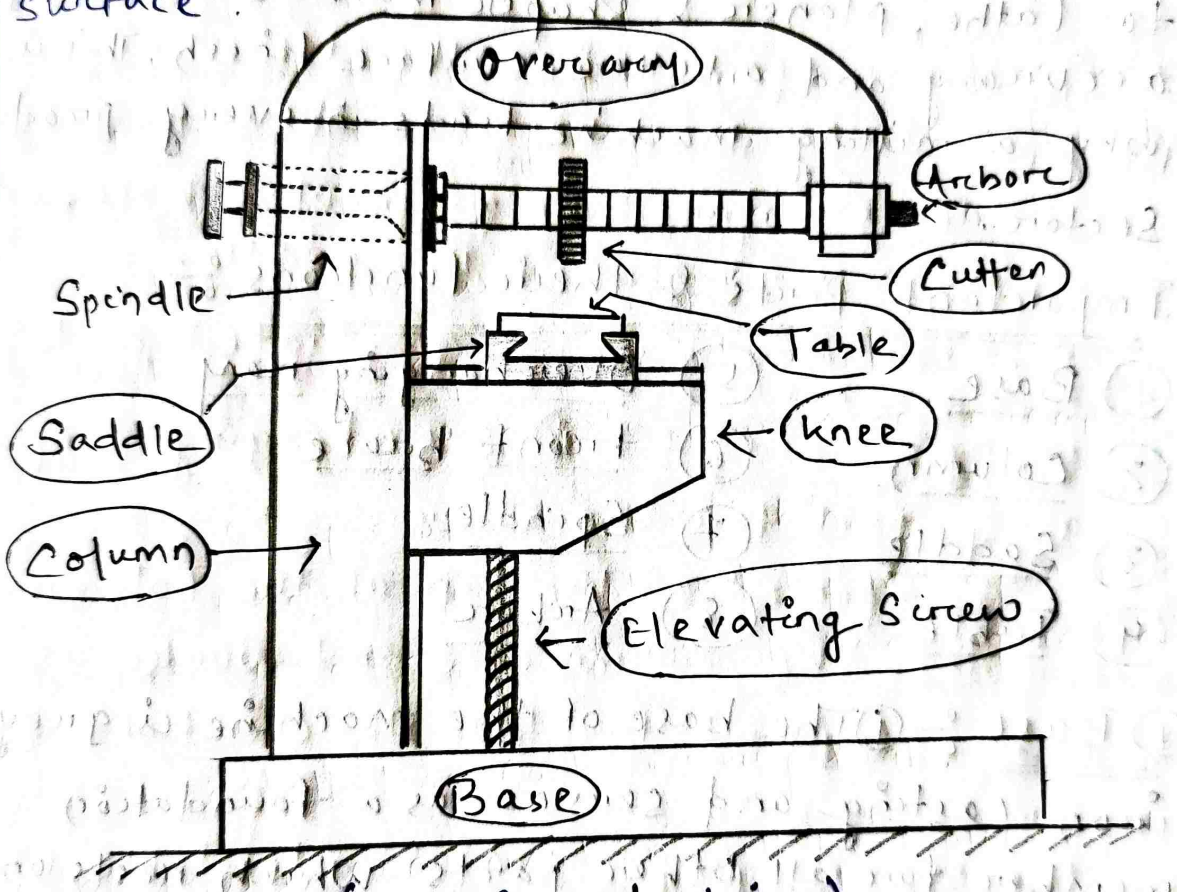
planer Machine works on which principle :-

The planer machine works on the principle of whitworth Quick returning motion mechanism.

Unit - 6 :-

Milling Machine :-

Milling Machine is machine tool that uses a multi-point cutting tool for removing a layer of material in the form of grooves from the surface of the workpiece. Generally it is used to remove the extra unwanted material from flat and irregular surface.



(Milling Machine)

Milling is the machining process in which the removal of metal takes place due to the cutting action of rotating milling cutter. In a milling machine, the cutter is rotating due to workpiece is fed against it.

The machine can hold more than one tool at a time. The cutter rotates at high speed and because of the many cutting edges, it removes

metal at a very fast rate. The machine can also hold one or a number of cutters at a time. Thus, the milling machine is one of the most important machines in the workshop. In this machine all the operations can perform with high accuracy.

The metal removal rate is high as compared to Lathe, planer & shaper machine. It has good accuracy and a better surface finish. This is why a milling machine finds in every producting sector.

Important parts & their functions :-

1. Base
2. Column
3. Saddle
4. Table
5. Overhanging ram
6. front brace
7. Spindle
8. Arbor

① **Base** :- (i) The base of the machine is grey iron casting and serves as a foundation member for all other parts which rests on it.

(ii) The base carries the column at its one end. In some other machines, the base is hollow and works as a reservoir for cutting fluid.

② **Column** :- (i) The column is the main supporting frame mounted on the base.

(ii) It is box-shaped and houses all the driving mechanism for the spindle and feed table.

(iii) The front vertical face of the column is

precisely machined and is equipped with dovetail guide ways for supporting the knee.
(iv) The top of the column is finished to hold an overarm that extends beyond the front of the machine.

Knee :- (i) The knee is a fixed grey iron casting that slides up and down on the vertical ways of the column face.
(ii) The adjustment of height is affected by an elevating screw, mounted on the base that also supports the knee.
(iii) The knee houses the feed mechanism of the table and controls to operate it.
(iv) The top face of the knee forms a slide way for the saddle that gives cross travel to the table.

Saddle :- (i) On the top of the knee is placed the saddle, which slides on guide ways set exactly at 90 degrees to the column face.
(ii) A crossfeed screw near the top of the knee engages a nut on the bottom of the saddle to move it horizontally, by hand or power to apply cross-feed.
(iii) The top of the saddle is precisely machined to provide guideways for the table.

Table :- (i) It rests on guideways on the saddle and travels longitudinally.
(ii) The top of the table is finished accurately and T-slots are provided for clamping the

work & other fixtures.

(iii) A lead screw is provided under the table that engages with a nut on the saddle, it helps to move the table horizontally by hand or power.

(iv) The longitudinal travel of the table possibly limited by fixing trip dogs on the side of the table.

(v) In universal machines, the table may also be swivelled horizontally. for this purpose, the table is mounted on a circular base, which in its turn is mounted on the saddle.

(vi) The circular base is graduated in degrees.

Overhanging arm :- (i) Over hanging arm act as a support for the arbor.

(ii) It is mounted on the top of the column extends out wards the column face and works as bearing support for the other end of the arbor.

(iii) The overhanging arm is adjustable so that the bearing support may be provided nearest to the cutter.

(iv) More than one bearing support can be provided for the arbor.

Front brace :- (i) It is extra support, which provides rigidly to the arbor and the knee.

(ii) The front base is fitted between the knee and overarm.

(iii) The front brace is slotted to allow for the adjustment of the height of the knee relative to the overarm.

Spindle :- (i) The spindle of the machine is located in the upper part of the column and received power from the motor through belts, gears, and clutches and transmit it to the arbor.

(ii) The front end of the spindle just projects from the column face and is provided with a tapered hole into which various cutting tools and arbor may be inserted.

(iii) The accuracy in metal machining by the cutter depends on the strength, accuracy and rigidity of the spindle.

Arbor :- (i) Arbor is an extension of the machine spindle on which milling cutters are securely mounted and rotated.

(ii) These are made with taper shanks for proper alignment with the machine spindles having taper holes at their nose.

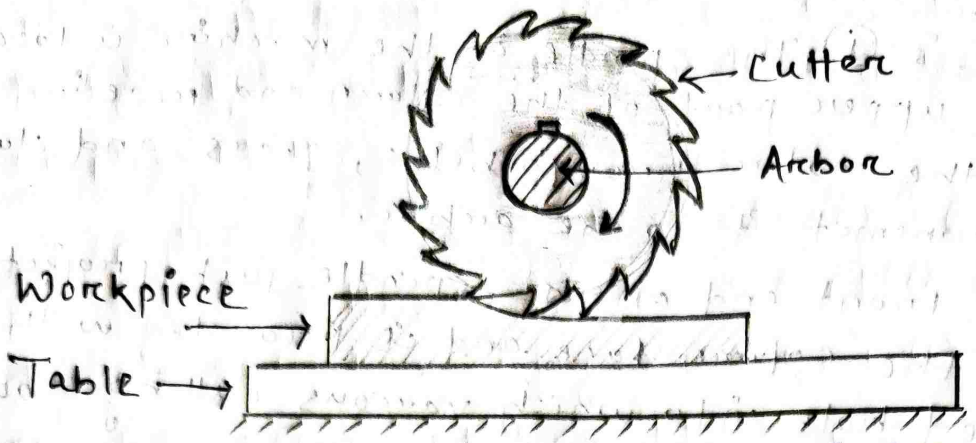
(iii) The taper shank of the arbor match to the Morse taper or a self-release taper whose value is 7:24.

(iv) The arbor may be supported at the farthest end from the overhanging arm or it may be of cantilever type which is called stub arbor.

Working Principle of Milling Machine :-

The working principle of the milling machine, applied in the metal removing operation on a milling machine. The work is rigidly clamped

on the table of the machine and revolving multi teeth cutter mounted either on a spindle.



The cutter revolves at a normal speed and the work fed slowly past the cutter. The work can be fed in a longitudinal, vertical or cross direction.

As the work progress further, the cutter teeth remove the metal from the work surface to produce the desired shape.

Types of Milling Machine :-

(I) Horizontal milling Machine
(II) Vertical milling Machine
(III) Column and knee Type Milling Machine
(IV) Simplex milling Machine
(V) Duplex milling Machine
(VI) Triplex milling machine
(VII) Fixed Bed Type milling Machine
(VIII) Universal Milling Machine

(I) **Horizontal Milling Machine :-** A horizontal Milling machine is a type of machine which can hold and rotates the spindle in the

horizontal orientation which can remove the material from the surface of a stationary workpiece.

Horizontal Milling machine have shorter and thicker cutting tools.

Vertical Milling Machine :-

A Vertical Milling machine is a type of machine which can hold and rotates the spindle in the vertical orientation which can remove the material from the surface of a stationary workpiece.

Vertical Milling machine have longer and thinner cutting tools.

Column and Knee Type Milling :-

In this column & knee type milling machine, a vertical column is attached to the bed which consists of gear drives that can rotates saddle and knee.

A knee is situated on the vertical column which can move up and down by means of elevating screw which can raise or lower the workpiece.

A saddle is placed on the top of the knee which can move in transverse directions and which can make the worktable to move along it.

Simplex Milling Machine :-

In this simplex milling machine, the spindle or the spindle head can travel only in one direction and mostly it can travel in the vertical direction only.

Duplex Milling Machine :-

In this duplex milling machine, the spindle or the spindle head can travel in two directions that is horizontal and vertical directions.

Triplex Milling Machine :-

In this triplex milling machine, the spindle or the spindle head can travel in three direction that is along X-axis, Y-axis and Z-axis

Fixed Bed Type Milling Machine :-

As the name indicates that the bed of the machine is fixed type and there is no arrangement of saddle and knee in transverse and vertical directions.

And the worktable is situated on the fixed bed.

The spindle is mounted in a spindle head which can move along horizontal and vertical direction to perform machining operation.

Universal Milling Machine :-

It is similar to horizontal milling machine but there is an arrangement of swing up the table upto 45 degrees in X and Y directions.

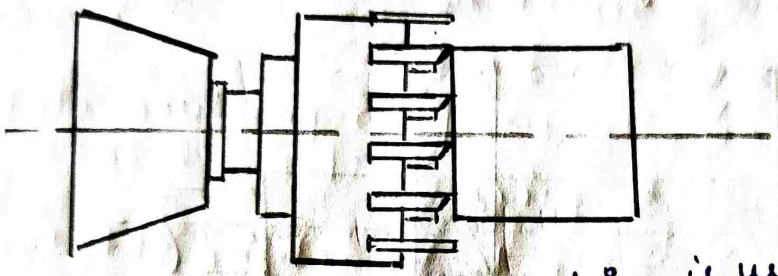
There are the different types of Milling machines that can be used to perform various operations.

Milling Machine Operations :-

1. Face Milling operation
2. Slot or slab Milling operation

3. End Milling Operation
4. Angular Milling operation
5. Side and face Milling operation
6. form Milling Operation
7. Slitting Operation
8. keyway Milling operation
9. Gears Milling operation
10. Profile Milling operation
11. Helical Milling Operation

Face Milling Operation :-



If the Milling Operation is used for removing a layer of material from a complete surface of the workpiece, is called a face Milling Operations.

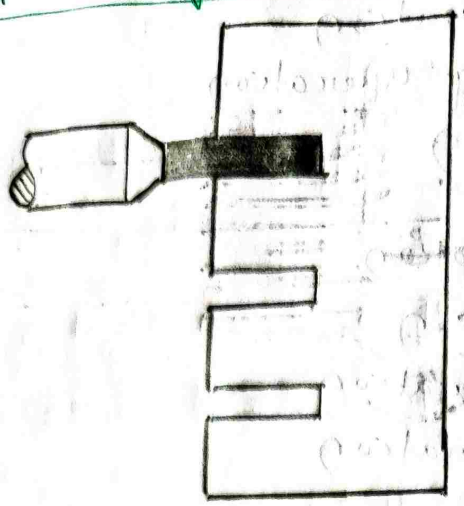
Slot/Slab Milling Operation :-

If the Milling Operation is used for producing slot in the component is called a slab or slot Milling Operations.

In general, both the types of milling operations will be performed by using both the type of milling cutters but it is preferable to perform face Milling Operation with end mill cutter and slab Milling Operation with a peripheral milling cutter.

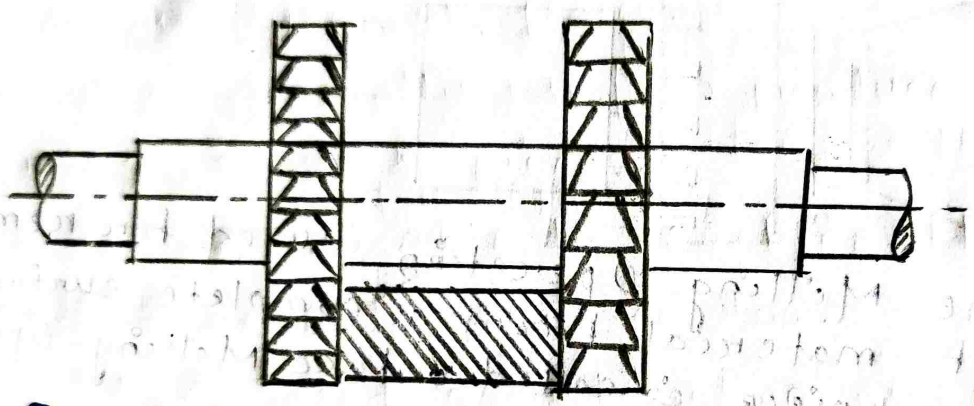
When peripheral milling cutter is used for performing the milling Operation there are two methods of milling will be used.

End Milling Operation :-



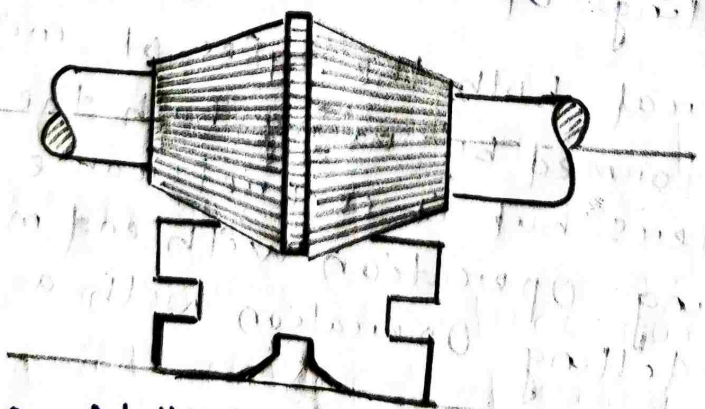
(i) By end milling cutter, we can perform End Milling operation.
(ii) for Machining slots, pockets, keyway etc.

Side & face Milling Operation :-



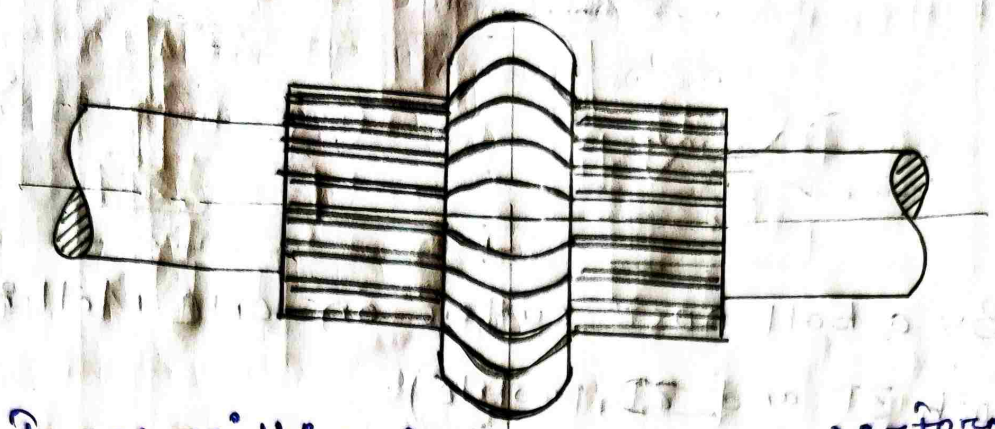
By Side and face milling cutter, we can perform this operation.

Angular Milling Operation :-



Angle Milling Cutter are fitting Spindle head is vertical.

Form Milling Operation :-



By form milling cutter, we can perform this type operation.

Slitting Operation :-

By the metal, slit saw.

Key way Milling Operation :-

By plain milling cutting operation using plain Milling cutter we can perform this operation.

Gear Cutting operation :-

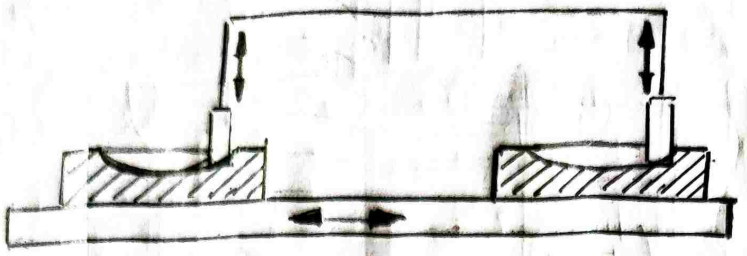
By using formed tooth cutter with dividing head we can perform this operation.

Helical Milling Operation :-

Produces grooves and prospercity of Cylendrical work.

These Milling Operation are performed on various Milling Machines.

Profile Milling Operation :-



By a ball nose cutter on CNC Milling Machine. (Both 3D and 2D profile)

Applications of Milling Machine :-

(i) The milling machine is used for making various types of gears.
(ii) It is generally used to produce slot or groove in work pieces.
(iii) It can be able to machine flat surface and irregular surface too.
(iv) It is used in Institution or Colleges to conduct lab tests on milling Machine.
(v) It is rapidly used in production or Manufacturing Industries to produce complex shapes.

Advantages & Disadvantages of Milling Machine :-

Advantages :-

(i) It can able to produce complex shapes with multi-point cutting tool very easily.
(ii) The production rate is also high.
(iii) The lead time will be reduced.
(iv) Highly accuracy of the component can

be obtained.

(v) With the help of various milling cutters, the operator is able to do the work fastly.

(vi) It can also be controlled by C.N.C. machines.

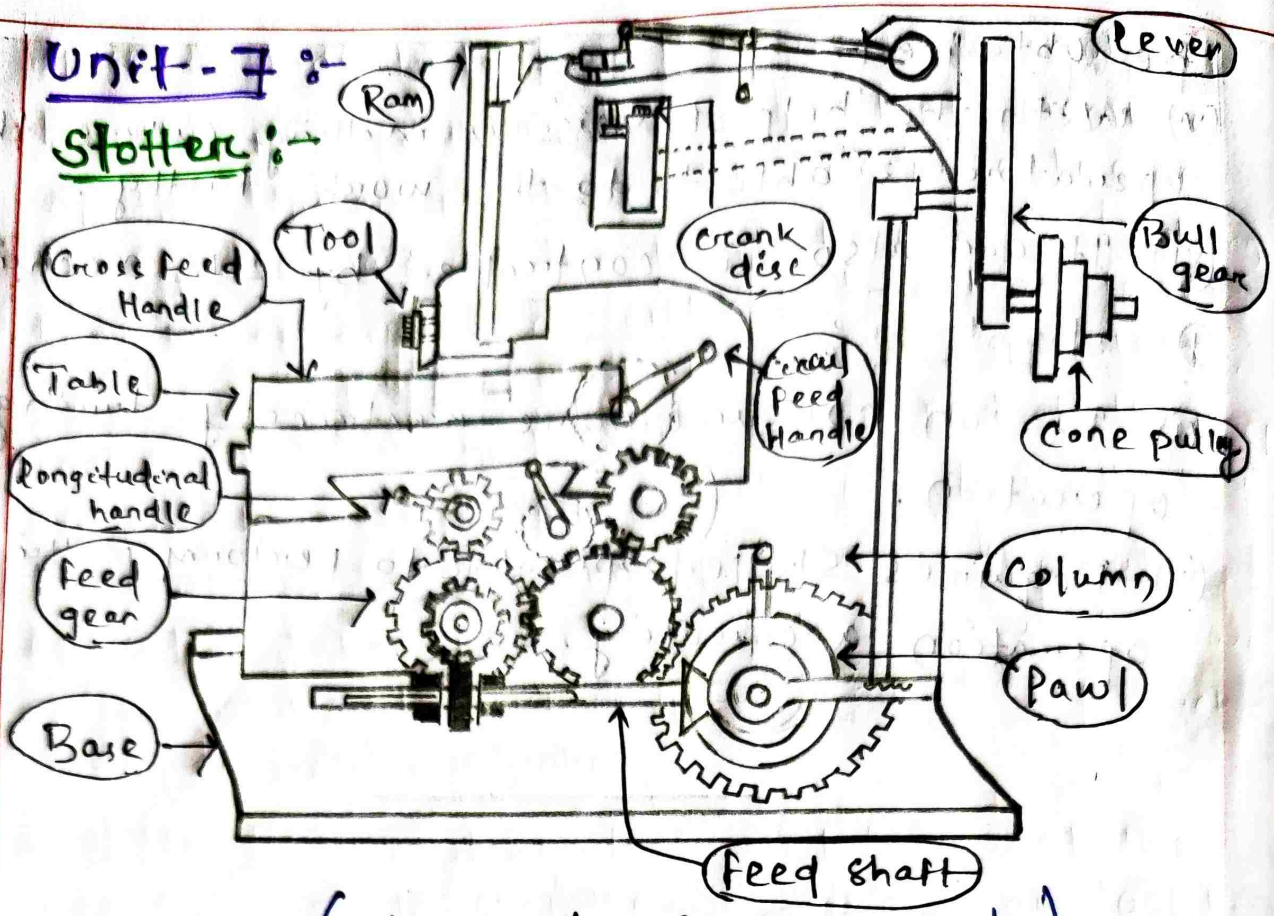
Disadvantages :-

(i) It can consume more electricity during operation.

(ii) Requires skilled operator to perform milling operation accurately.

Unit-7 :-

Slotter :-



(Slotter Machine & its parts)

Slotter Machine :-

It is a reciprocating type of machine tool in which the ram that holds the tool moves in the vertical axis. It is almost similar to the shaper machine.

In the machine the ram reciprocates in the horizontal direction, and in the slotter machine the ram reciprocates in the vertical direction.

The cutting action in the slotter takes place during the downward stroke of the ram. and there is no cutting in the return stroke and called an idle stroke.

Major Components & their functions :-

1. Base or Bed
2. Column
3. Saddle
4. Cross Slide
5. Rotating or Circular Table
6. Ram
7. Tool Head
8. Ram drive
9. Feed drive

Base or Bed :- The base of the slotter machine should be very rigid and strong since it holds all the loads and vibration of the machine. So the base is made with cast iron because it has high rigidity as well as vibration-absorbing capacity as compared with other metal. It supports all the parts of the machine such as column, table, saddle, cross slide, etc.

Column :- It is the vertical part of the slotter that contains all the drive mechanism for the ram and feed. At the front face of the column, It has guideways on which the ram moves reciprocating motion (to and fro motion). Same as the base it is also made from cast iron.

Saddle :- The saddle is mounted on the base of the slotter machine and it is used to give longitudinal feed to the table. In other words, it allows the table to move towards and away from the column.

Cross Slide :- It is present on the saddle and used to move the table in cross direction to the saddle movement. To understand the movement of the cross slide lets us assume that we are standing at the wheel of cross slide, than it moves away from us and towards us when we rotate its wheel either in clockwise or anticlockwise direction. It can be operated either manually or automatically to give crossfeed.

Circular Table :- It is mounted over the cross slide. It is used to hold the workpiece. It has T-slot that help to hold the workpiece firmly during the slotting operation. The table can also be rotated according to the requirements of the operations. It can be either operated manually or power to

give it longitudinal and transverse motion.

Ram :- Ram is the most important member of the slotter machine. It reciprocates on the guide ways at the front face of the column. Ram reciprocates in vertical direction that is upward and downward during the operations. Tool head is attached to the lower end of the ram on which a single point cutting tool is attached to perform the slotting operations. The cutting operation takes place during the forward stroke of the ram and there is no cutting during backward or return stroke.

Tool Head :- Tool head is used to mount the cutting tool. In a slotter machine the tool head is present at the lower end of the ram. According to the requirement, different types of cutting tool is attached to the tool head.

Ram Drive :- The ram reciprocates in the vertical direction and cuts the metal workpiece in forward stroke only. Now a question come in our mind that what is responsible for this vertical motion of the ram. So there is some driving mechanism in the column of the slotter that drives the ram. The ram reciprocates on the guide ways at the front face of the column.

Feed Drive :- It is an arrangement made in the slotter to gives longitudinal movement to the saddle, cross movement to the cross slide and up and down movement to the table. circular

Mechanism Used in Slotter Machine:-

In the slotter machine, a quick return mechanism is used to drive the ram for cutting the metals from the workpiece. It is called a quick return mechanism because here the time taken by the ram on return stroke is less as compared with the forward stroke that is return stroke move quicker than the forward stroke. The cutting takes place in forward stroke and no cutting in the return stroke.

There are various types of Quick Return Mechanism and most commonly used are:-

1. Crank and Slotted lever Quick Return Mechanism
2. Whitworth Quick Return Mechanism
3. Slotted Dise Quick Return Mechanism
4. Hydraulic Quick Return Mechanism.

Working Principle of Slotter Machine:-

The working of the slotter machine is the same as that of that shaper machine but the difference is that shaper cuts the metal horizontally and slotter cuts the metal vertically! Let's try to understand the working of the slotter machine in detail:-

(i) First, the workpiece that is to be slotted mounted on the table, The table has t-slots that helps the w/p to hold firmly on it.

(ii) After clamping the workpiece on the table. An appropriate cutting tool is inserted in to the tool head for cutting the metal. Here the tool is made of HSS (High-Speed-steel).

(iii) And then the machine is ON that allows the ram to move upward and downward in a vertical direction.

(iv) As the ram moves downward called a downward stroke, It cuts the metal from the workpiece and then return quickly (called as return stroke) without cutting the metal. so we can say that the slotter machine cuts the metal in down stroke and remains idle that is does not cut any metal in return stroke.

(v) Feed in slotter can be worked automatically or manually. There is mechanism inside it that allows the movement of the table, cross slide according to the ram movement automatically. The movements of each part are interlinked with each other and there is no chance of any error in the feed.

Types of Slotter Machines :-

1. Punch stotter
2. Precision Toolroom slotter
3. Production slotter
4. Special purpose slotter Machine

1. Punch Stotter :-

It is very heavy in weight and used to remove large amounts of metal from the workpiece. It is mainly used to remove metals from large casting or forgings. The length of the puncher slotter is quite large and it ranges from 1800 mm to 2000 mm.

The ram of the punch slotter has rack teeth that are cut on the underside of it. The ram is driven by a spiral pinion gear meshing with the rack teeth of the ram. A variable speed reversible electric motor is used to drive the pinion.

2. Precision Toolroom slotter :-

A precision slotter is a light weight machine that is used for light cuts and accurate surface finish. It works on high speed and uses whitworth quick return mechanism for its working.

3. Production slotter :-

As the name indicates, this slotter is used for production work. It is used for machining tapered jobs since ram in these types of slotter can swivel to 10-30 degrees.

4. Special purpose slotter Machine :-

Special purpose slotter machine is used for large volume production of any part with high accuracy and at low cost. key seater is an example of special purpose slotter machine that is used to cut keys on the gear hub and wheel.

Operations Performed on slotter :-

1. Grooves
2. Slots
3. Keyways

① Grooves :- (i) It is a narrow cut or depression on the circular and flat surface. The operation performed to create grooves is called grooving.
(ii) It is used to produce grooves in the machine parts.

② **Slots :-** (i) An Enlongated hole on a flat surface is called slots and the operation is done for cutting slots is called slotting operation.

(ii) When two parts are needed to be mesh together with correct orientation then a key is used for it. So a key is required in both the parts and it is produced with the help of a slotter machine.

③ **Keyways :-** (i) It is defined as a slot cut in a part (shaft or hollow shaft) to make a correct orientation with another part that is to be fitted with a key.

(ii) It is used to produce slots of various sizes in the required machine parts.

(iii) For cutting external and internal gear and profile.

Applications of Slotter Machine :-

(i) Slotter machine is used to produce slots, keyways, and gear teeth.

(ii) It is used for machining internal and external flat surfaces and circular surfaces.

(iii) If there is a need for shaping external and internal types of profiles then slotter is the best choice.

(iv) It is used for machining irregular surfaces, blind holes, dies and punches, external and internal gear teeth.

Advantages & disadvantages of slotter machine :-

Advantages :-

(i) It is a light weight machine and can be easily transportable.

(ii) It uses a single point cutting tool which is economical.

(iii) It gives you an accurate surface finish.

(iv) The cost of this machine is low as compared with other machines in this category.

Disadvantages :-

(i) A very skilled worker is required to operate the slotter.

(ii) Rigid in construction

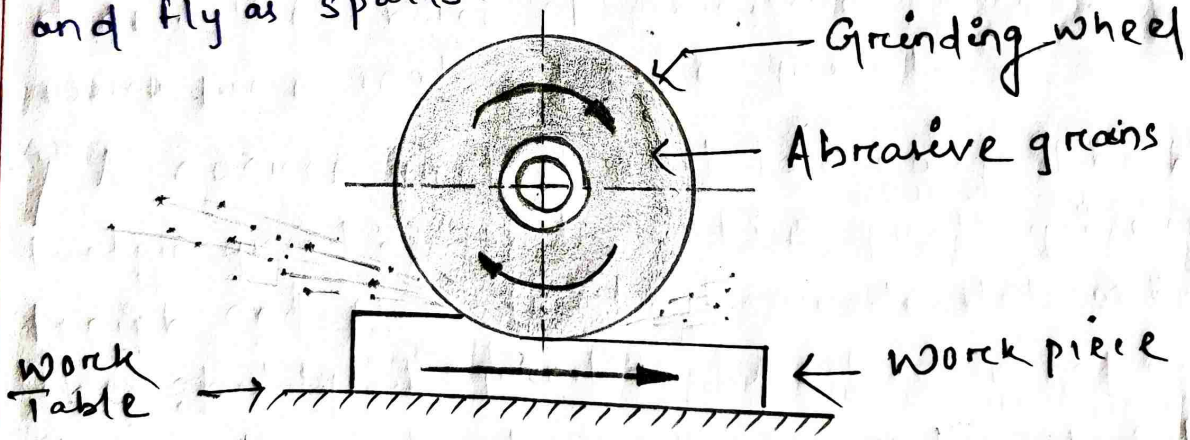
Unit-8 :-

Grinding :-

Grinding or abrasive machining is a chip-forming metal cutting operation. All we know about the grinding wheels, used to sharpen knives and other cutting tool materials and sand paper / emery sheet which is used to smoothen surface and sharp corners.

For grinding, generally a rotating grinding wheel is used as a tool. The grinding wheel & sand paper consist of bonded abrasives.

The abrasive grains have sharp edges that project out and cut the chips. In grinding, the high circumferential speed of the grinding wheel causes high friction and chips became red hot and fly as sparks.



Machine tool used for grinding are called grinding machines. In grinding and other abrasive machining processes, a very large number of tiny cutting edges simultaneously cut the surface, each taking a very hence grinding can produce surface finish upto 2 microns and dimensional tolerances as small as 0.0025 mm

Grinding forces are much smaller than the cutting forces involved in the other metal cutting processes. Grinding is used on the harder material for machining them and for obtaining better dimensional accuracy.

Manufacturing of grinding wheels :-

The tiny abrasive particles are bonded together to form the grinding tool known as the grinding wheel. Because each abrasive grain can remove only a very small amount of material at a time, high rates of material removal can be obtained only if a large number of these grains get together. This done by bonding abrasive particles in the form of a grinding wheel of the desired shape.

→ The abrasive grains or grits are held together by a bonding material that acts as the supporting post between the grains. Some porosity is essential in bonded wheels to provide clearance for the minute chips being produced and to provide cooling.

→ A simple cylindrical grinding wheel and its enlarged structure are shown in fig. The grits which get worn out or lose sharp edges may fracture to expose fresh sharp edges.

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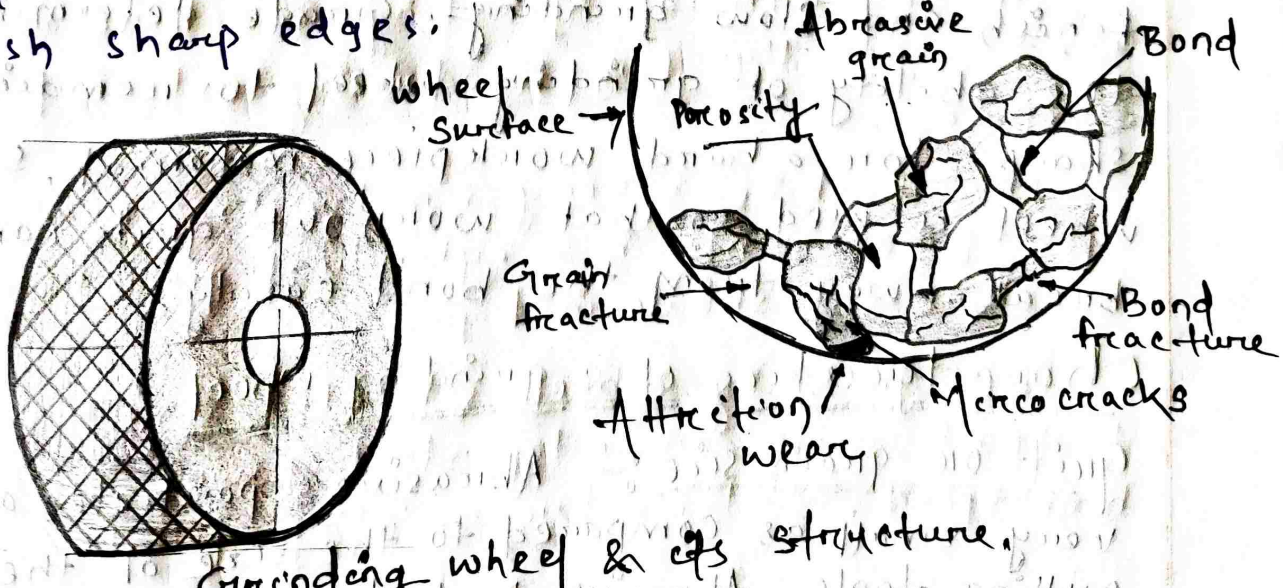


Grinding wheel & its structure.

→ During the process of grinding, the grinding wheel is mounted on a grinding machine and made to rotate at a very high speed.
→ A 300 mm diameter wheel can be run at about 2000 rpm. the feed and depth of cut involved in the grinding process is very less. The process of grinding is used when good surface quality, accuracy, and dimension are to be obtained. This process removes a very small amount of material the maximum depth of cut is of the order of 0.25 - 0.5 mm.

Selection of a grinding wheel :-

→ The selection of a grinding wheel for a particular application depends on various factors. The size and shape of the grinding wheel is directly dependent on the job to be done. The choice of abrasive depends on the work piece material to be ground.

→ A coarse grit is used for rough finish and faster grinding while a fine grit gives smooth finish and slow grinding. Grade determines the ability of grinding wheel to remain sharp. for a hard workpiece material, soft wheel is used so that worn out grits can break away from the bond easily.

Characteristics of a grinding wheel :-

Grit or grain size :- Abrasives particles are very small as compared to the size of the other cutting tools. Abrasive particles have sharp edges.

thus allows the removal of very small quantities of material from the workpiece surface. Consequently, very fine surface finish and dimensional accuracy can be obtained.

A number identifies the size of an abrasive grain size. the larger is the number. for example, a grain size of 10 is regarded as very coarse, 100 as fine and 600 as very fine. The size is the number of the finest sieve through which the grains pass.

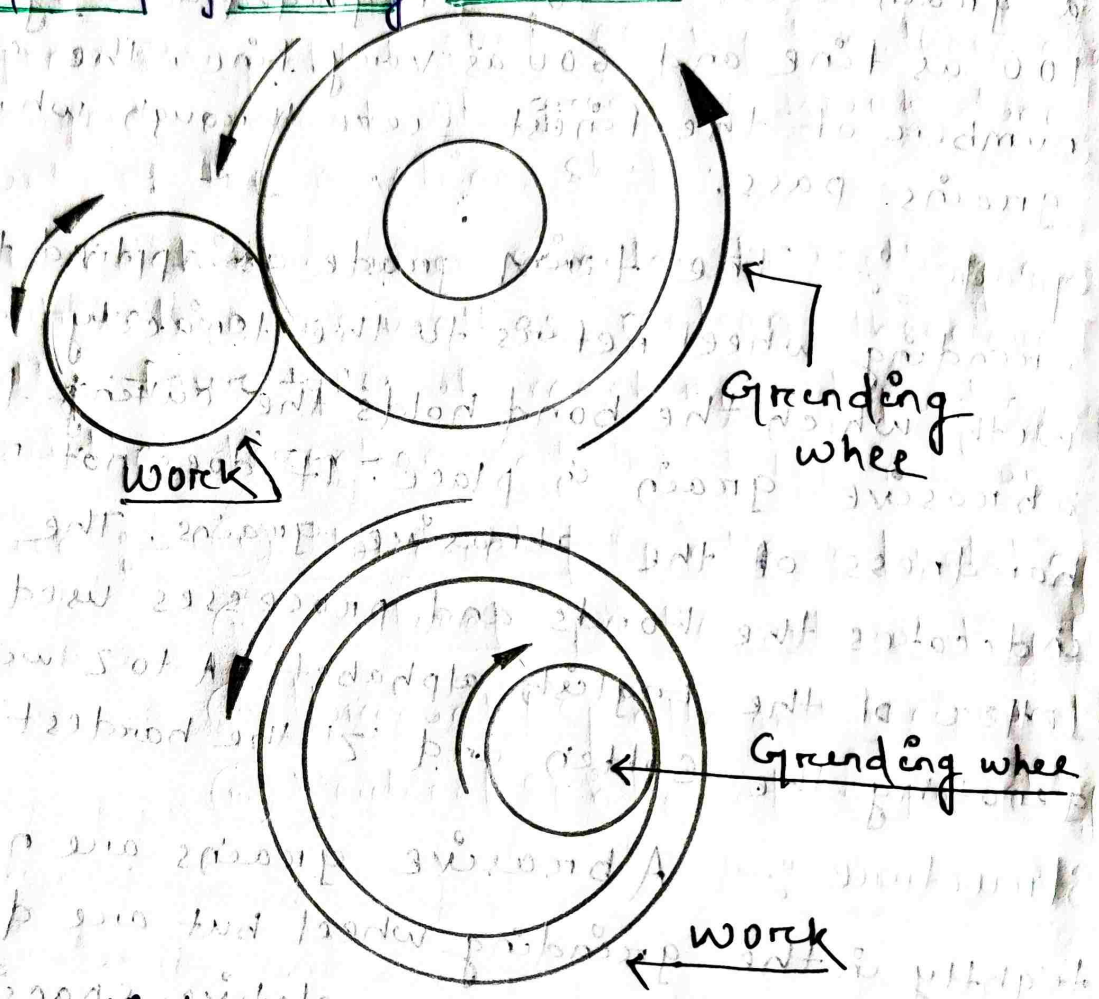
Grade :- The term grade as applied to the grinding wheel refers to the tenacity or hardness with which the bond holds the cutting points or abrasive grain in place. It does not refer to the hardness of the abrasive grains. The grade indicates the bonds and processes used by a letter of the English alphabets A to Z with 'A' denoting the softer and 'Z' the hardest grade.

Structure :- Abrasive grains are not packed tightly in the grinding wheel but are distributed throughout the bond. The relative spacing is referred as the structure and denoted by the number of cutting edges per unit area of wheel face as well as by the number and size of void spaces between grains. The primary purpose of structure is to provide chip clearance. It also provide space for the coolant to flow.

Types of Grinding Machine :-

1. Cylindrical grinding Machine
2. Surface grinding Machine
3. Centerless grinding Machine

Cylindrical grinding Machine :-

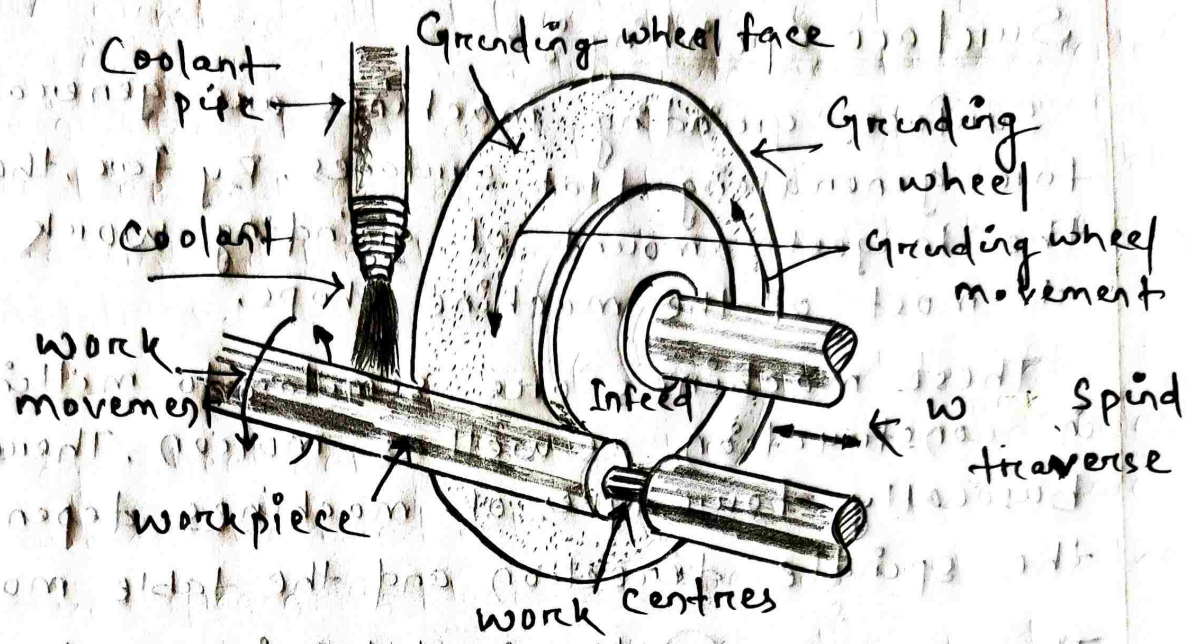


The cylindrical grinding machine is used generally for producing external cylindrical surfaces.

The machine is very similar to a centre lathe. Typical movements in a cylindrical grinding machine are shown in figure,

The grinding wheel is located similar to the toolpost, with an independent power driven at high speed, suitable for grinding operation.

Both the work and the grinding wheel rotate counter clockwise. The work that is normally held between centres is rotated at much lower speed compared to that of the grinding wheel.



If the finished section to be ground is wider than the wheel, the wheel is fed in the transverse direction. plunge grinding is done if the part is the same size as or less than the width of the wheel.

Very fine finishes are obtained with cylindrical grinding. It is possible to get accuracies to within 0.25 μm with extreme care.

Work piece are normally mounted between centres and are driven by a dog. If necessary, the work should be supported by work rests, placed opposite side of the wheel to prevent deflection.

The traverse feed of the workpiece, past the grinding wheel, is provided by using a hydraulic arrangement. In feed is provided by

by the movement of the grinding wheel head into the workpiece. Economical grinding allowances that can be left are about 0.1 to 0.3 mm.

Surface Grinding :-

Surface-grinding machines are generally used for generating flat surfaces. By far, these are the largest amount of grinding work done in most of the machine shops.

These machines are similar to milling machines in construction as well as motion. There are basically four types of machines depending upon the spindle direction and the table motion.

They are :- (I) Horizontal Spindle and rotating table
(II) Vertical Spindle and rotating table
(III) Horizontal Spindle and reciprocating table
(IV) Vertical Spindle and reciprocating table