AUM SAI INSTITUTE OF TECHNICAL EDUCATION

MANUFACTURING TECHNOLOGY

LECTURE NOTES

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There are many type of cutting process done in different condition. In such condition along with the general requirement of the cutting tools, they need some unique properties to To achive this properties the cutting tool are made up of different materials. The material choosen for a particular application depends on the material to be machined, type of machining, quantity & quality of prod^n etc.

According to the material the tools are classified into

1. Carbon tool steel
2. High speed steel (HSS)
3. Cymantite carbide
4. Ceramics tools
5. Cubic boron nitride tool (CBN)
6. Diamond tool

1. Carbon tool steel :-

→ Its temperature range from 250°C.

→ It is one of the inexpensive metal cutting tool use for the low-speed machining operation.

→ This carbon steel cutting tool have the composition 0.6 - 1.5% carbon & very small amount of (less than 2%) Mn & Si.

→ High carbon steel have the ability to mentain sharp cutting edge & it poses good machinability.

→ It doesn't prefere in a modern & machine operation.

→ Carbon tool steel used in twist drill, milling tool, turning use for shock material such as brass, Al, Mg etc.

2. High Speed Steel :-

→ This is a high carbon steel with a significant amount of alloying elements such as tungsten, Mo, Cr etc to improve hardenability, toughness & wear resistance.

→ It gives a higher metal removal rate & it loses its hardness at a moderate temperature about 600°C. Therefore a coolant should be used to increase tool life.

→ It can use many time by resharpening some heat treatment is done on the HSS to improve its properties.

Surface treatment used in HSS :-

Superfinishing - reduce friction

Nitriding - increase wear resistant

Chromium electro plating - reduce friction

oxidation - reduce friction

→ It is used in drills, milling, milling cutter, single point lathe tool.

T-type - Tungsten predominat type

M type - Mo predominant type

3. Cementite carbide tool :-

→ It is produced by powder metallurgy technique.

→ It consist of Tungsten, tantalum & Titanium Carbide with cobalt as a binder (when the binder is Ni & Mo then it is used cermet)

→ Cementite Carbide tool are extremely hard, they can withstand very high speed cutting operation.

→ It doesn't loose their hardness upto 800°C.

→ A high cobalt tool is used for a roughest while low cobalt is used for finishing operation.

4. Cermets :-

A. Ceramics :-

→ The most common ceramic material are alumina oxide (Al_2O_3) & Silicon nitride. Powder of ceramic material compacted in insert shape, then sintered at high temperature.

→ Ceramic tools are chemically inert & poses resistance to corrosion.

→ They have high compressive strength, they are stable upto temperature 1800°C.

→ They are 10 time harder than HSS.

→ The friction less tool have chip are very low & poses low heat conductivity, usually no coolant is required, they provide a very excellent surface finish.

5. CBN's
-> It is the second hardest material after diamond.
-> They are generally used in hard machine.
-> They offer high resistance to abrasion & wear as abrasive in grinding wheels.
-> Sharp edges are not recomended.
6. Diamond's
-> It is the hardest material & it is also expensive.
-> It poses a very high thermal conductivity & M.p.
-> The diamond occurs a excellent abrasion resistance low friction co-efficient & low thermal expansion.
-> It is used in machining very hard material such as Carbides, nitrides, glass etc.
-> Diamond tools give a good surface finish & dimensional accuracy.
-> They are not recomended for machining steel.

Properties of cutting tool materials

-> Cutting tools materials are the materials use to make cutting tools which are used in machine. (drill bits, tool bits, mining cutters etc.) but not with other cutting tools like Knives & punches.
-> cutting tool materials must be harder than the material or work piece, even at high temperature during the process.
-> The following properties required for cutting tool
1. Hardness, hot hardness & Pressure resistance.
II. Bending strength & toughness.
III. Inner bending strength
IV. Wear resistance
a. abrasion resistance
b. edge strength
c. Small propensity to diffusion & adhesion.

There is no material that shows all of the properties at the same time

Tool material	Cutting speed	Temperature (max)	Hardness
Carbon tool steel		450°C	up to HRC 65
HSS (30-50 m/min cutting range)	30-50 m/min	650°C	up to HRC 69
Cementite Carbide	60-200 m/min	1000°C	up to HRC 90
Ceramics	300-600 m/min	1200°C	up to 93 HRC 983
CBN	600-900 m/min	–	up to HRC 95
Diamond		800°C	

the High rupturing capacity

Chapter -2 :- Cutting Tools :-

Cutting action of various tools :-

1. Chisel :-

A chisel is a tool with a characteristically shaped cutting edge (such that wood chisel have parted their name to a particular grind) or blade on its end, for carving or cutting hard material such as wood, stone or metal by hand, struck with a mallet or mechanical power. The handle & blade of some types of chisels are metal cast used with a sharp edge with it.

Cutting angle of chisel :-

The angle which is usually set to 25° is called grinding angle as the chisel ground down to this angel when blade made. The secondangle (usually 35°) is called a cutting angle & allows for regrind sharpening of the chisel as well.

2. Hacksaw :-

A hacksaw is a fine tool to saw originally mainly made for cutting metal. (The equivalent saw for cutting wood is usually saw saw) most hacksaw are hand saw with a 'c' clamp frame that holds a blade under tension, such hacksaw have a handle usually a pistol grip, with pin for attaching narrow disposable blade. The frames may also be adjustable to accomodate blade of different size. A screw or other mechanism is used to put the thin blade under tension.)

On hacksaw, as it most frame such the blade can be mounted with the teeth facing toward or away from the handle resulting in cutting action on either push or pull stroke. (At normal use cutting vertically downwards which usually held in bench vice, hacksaw blade are set to be facing forward)

3. Dies :-

→ Cutting dies used to cut the metal to utilize the cutting or shearing action.

→ The common dies are notching, trimming, shaving, blanking etc.

→ Die cutting is typically refers the cutting action of a die cram.

→ Die cutting tooling is fundamentally a comb? or used steel blade & rubber prepared into a specific shape mixture to enable compression of fibrous material hence having a specific shape.

Different types of dies using in sheet metal :-

Compound die, multiple die

Comb? die, progressive die,

What does a die do? :-

A die is used to cut or form the male portion of the mating pair (Nut & bolt). The process of cutting or forming thread using a tap is called tapping whereas the process using a die is called threading.

How does a die work?

→ Tapping is when threads are cut into a cylinder (hole).

→ To use a tap or a die, they determine the no. of threads per inch (TPI) of the part to be tired.

→ A gauge system that has a no. of different pins it to be used to calculate the TPI of the bolt or nut.

Advantage :-

Die cutting yields a level of uniformity of a final product i.e. almost unmatched

Die

4. Reamer :-

→ The main cutting action of reamer is done by steering tapper, the sizing action is to guide the reamer & also smooth or size the hole.

→ The back tapper reduces friction between reamer & hole surface.

Function :-

→ A reamer is a type of rotary cutting tool used in metal working precision reamers

→ Reamers are design to a larger size of previously bored hole by small amount but a high degree of

Why are reaming operation performs :-

→ Reaming performs using same type of machine like drilling.

→ Reamer is a rotary cutting tool with one or more cutting elements use for a sanging like to control the previously hole.

→ It's principle support during cutting action of the workpiece.

Reamers 4 it's types :-

i. Hand reamer
ii. machine reamer
iii. Chucking reamer
iv. fluting reamer
v. expandable reamer
vi. tapper reamer
vii. adjustable reamer

What is tool geometry :-

→ Geometry of a cutting tool are the shape & angle by which the cutting portion of a cutting tool are ground.

→ It influence (or) the type of machining process the material, the efficiency, economy, the quality of the finished part, & the life of the cutting tool.

What is Tool angle :-

The angle included between the top & front faces of the tool or an angle used to designate the form of a cutting edge of a tool.

Tool geometry or turning tools:-

→ Both material & geometry of the cutting tools play very important role on their performance on achieving effectiveness, efficiency and overall economy of machining.

→ Cutting tools may be classified according to the no. of major cutting edges (point) involve as follows.

i. Single point tool
   Ex: turning tools, shaping, planning & slotting

ii. Boring tool.

iii. Double point
   Ex: Drill

iv. Multipoint (more than two)
   Ex: milling cutter, broaching etc.

Concept of rake angles of cutting tools:-

→ Rake angle is provided for each of chips flow & overall machining.

→ Rake angle may be positive or negative or even zero.

Concept of clearance angles of cutting tools:-

→ Clearance angle is essentially provided to avoid rubbing of the tool with the machine surface which cause loss of energy & damage of both the tool & the job surface.

→ Hence the clearance angle is a must & must be positive (3° to 15°) depending upon the tool work material & type of machining operations like turning, drilling, boaring etc.

Terminology of single point cutting tool:-

Rake

Back rake angle

→ It viewed the side facing from the end of the work piece it is the angle form by the face of the tool & line parallel to the shank.

→ A positive back rake angle tilt the tool face back, a negative back rake angles tilt it forward tip.

end cutting edge angle:-

→ It viewed a from above looking down at the cutting tool, it is the angle formed by the end flank of the tool & the line parallel to the work piece centerline.

End relieve angle:-

It viewed from the side facing the end of the workpiece, it is the angle formed by the end flank of the tool & a vertical line down to the floor.

Face:-

The flank surface of a single point tool into which the workpiece rotated during a turning

operations.

Flank:-

A flat surface of a single point tool i.e. adjacent to the face of the tool. During turning the side flank faces the the dir" that the tool is fed into the workpiece & the end flank passes over the newly machined surface.

Lead angle:-

→ A common name for the side cutting edge angle. In a tool holder, it is built with a dimension that sets the angle of an insert, the lead angle takes this change into consideration.

Side rake angle:-

It is the angle formed by the face of the tool & the centre line of the work piece.

Side relief angle:-

It is the angle formed by the side flank of the tool & a vertical line down to the floor.

Nose radius:-

→ The rounded tip on the cutting edge of a single point tool.

→ The greater the nose radius, the greater the roundness of the tip.

→ A zero degree nose radius creates a sharp point

Side cutting edge angle:-

It is the angle formed by the side flank of the tool & a line perpendicular to the workpiece centerline.

Process parameter:-

* For any machining or metal cutting operation three relative motion bet" the workpiece & the cutting tool are necessary for gradual removal of material from workpiece in bact, the simultaneous action of all three relative motion causes advancement of cutting tool towards work material along the path generating a finish surface with the shape, sized tolerance.

→ This three relative motion are called cutting parameters.

→ The process parameter in machining all those parameter that inherent to a any machining operation & should have a suitable finite value to smooth & efficient removal of material. Each parameter directly effect machining performance operation process

→ In machining three parameters are

i. Cutting speed or Cutting velocity

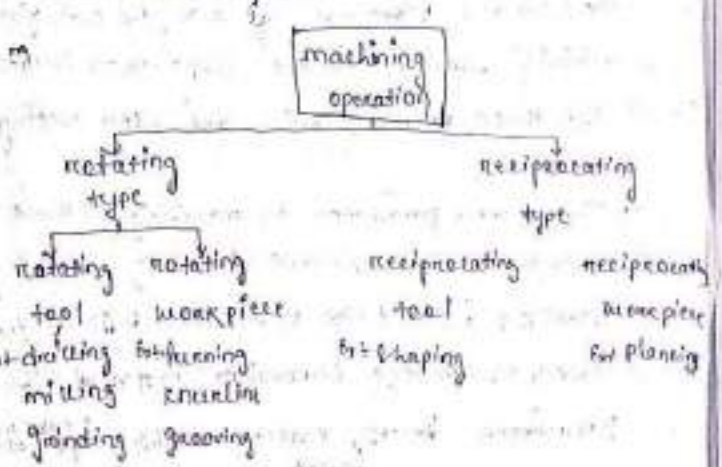
ii. feed rate

iii. depth of cut

1. Cutting velocity :- (V)

→ It is the most important cutting parameter that provide necessary cutting motion. In case of either rotating tool such as milling, drilling & grinding etc. or rotating workpiece such as turning, the peripheral velocity of cutter or workpiece is considered as cutting velocity. The rotational speed is called cutting speed where as the tangential velocity is called cutting velocity.

→ It is denoted by V_c.



2. Feed rate :- (f)

→ The auxilary cutting motion is provided by the feed rate or feed velocity.

→ Usually the dir^n of feed velocity is perpendicular to that of the cutting velocity. The primary objective of feed velocity is to advance cutter over the workpiece to remove material from a wider surface.

→ Basically it helps in covering the entire surface of the workpiece by moving either cutting tool or workpiece.

3. Depth of cut (t) :-

→ The tertiary cutting motion that provides necessary depth with in work material i.e. intended rate to remove by machining.

→ It is given in the third perpendicular dir^n of the simultaneous action of three cutting parameters results in removal of excess material from workpiece.

Features or process parameters :-

It must be,

→ A primary factor i.e. if there should be any
→ any other factor that control it
→ It must be supplied during machining
→ It should have a finite value.
→ It should directly effect machining performance.
→ It can be varied externally without changing the work tool combination.

process parameter different from influencing parameters:-

→ Influencive parameter include all those parameters that can directly or indirectly influence the machining operations thus all process parameters are influencive parameters apart from velocity, feed & depth of cut, there are many other parameters that can influence performance considerably, however they are not inherent to machining process.

→ A list of such parameters relevent to conventional machining

I. Cutting environment
II. Tool geometry including nose radius.
III. Work material
IV. Tool material.
V. Tool coating
VI. Work and tool setting.

Coolant and lubricant in machining

The basic purpose of coolant is to take away generated cutting heat from cutting zone; and thereby keep the cutting zone temp. low. The basic purpose of lubricant is to reduce co-efficient of friction bet^n rake surface of cutting chip and thereby minimize heat generation.

3. Straight oil (petroleum & vegetable oil)
4. Synthetic fluids
5. Semi synthetic fluid.

→ What are the three main properties of coolant?
i. Prevent freezing & boiling
ii. Lubricates the water pump seal.
iii. Inhabits corrosion

What are the different type of lubricants?

→ There are 3 different type of lubrications.
1. boundary
2. mixed
3. fluid film

→ Each type is different but they all rely on a lubricant and the additive with in the oil to protect against wear.

→ Fluid film lubrication can be broken down into two forms
i. Hydro dynamic
ii. Elasto Hydrodynamic

What are some examples of lubricants?

→ Lubricants include fatty alcohols, esters & wax esters etc.

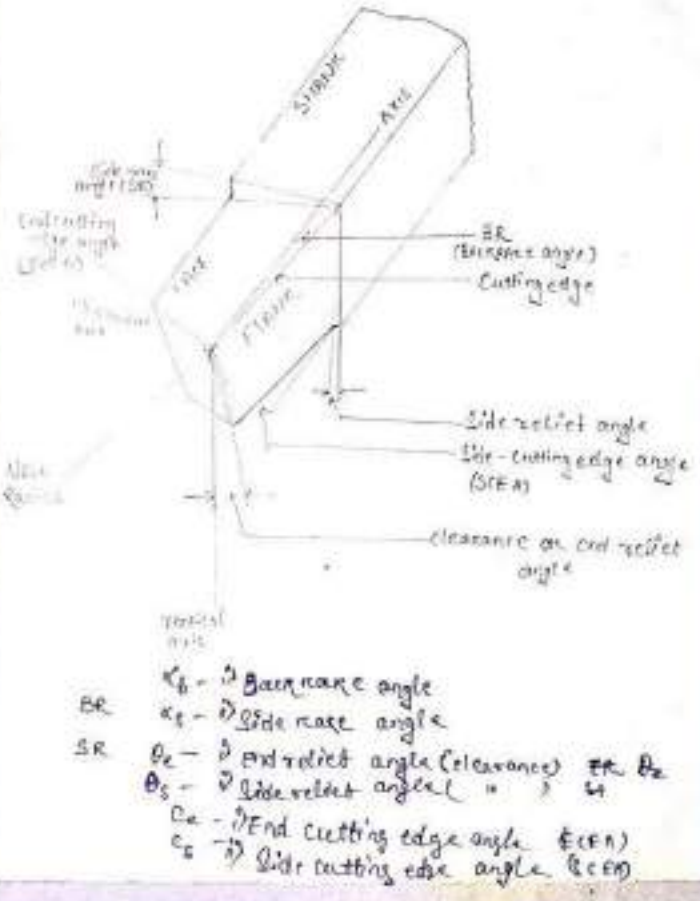
→ External of lubricants provides metal release & help to reduce temperature.

→ The common example of external lubricants
i. Paraffin
ii. metal soap.
iii. Amide
iv. Fatty acid.

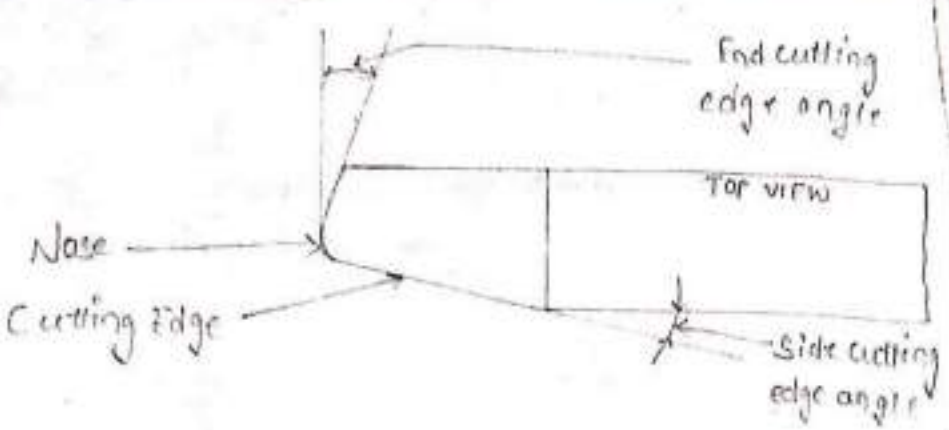
Each coolant a lubricant?

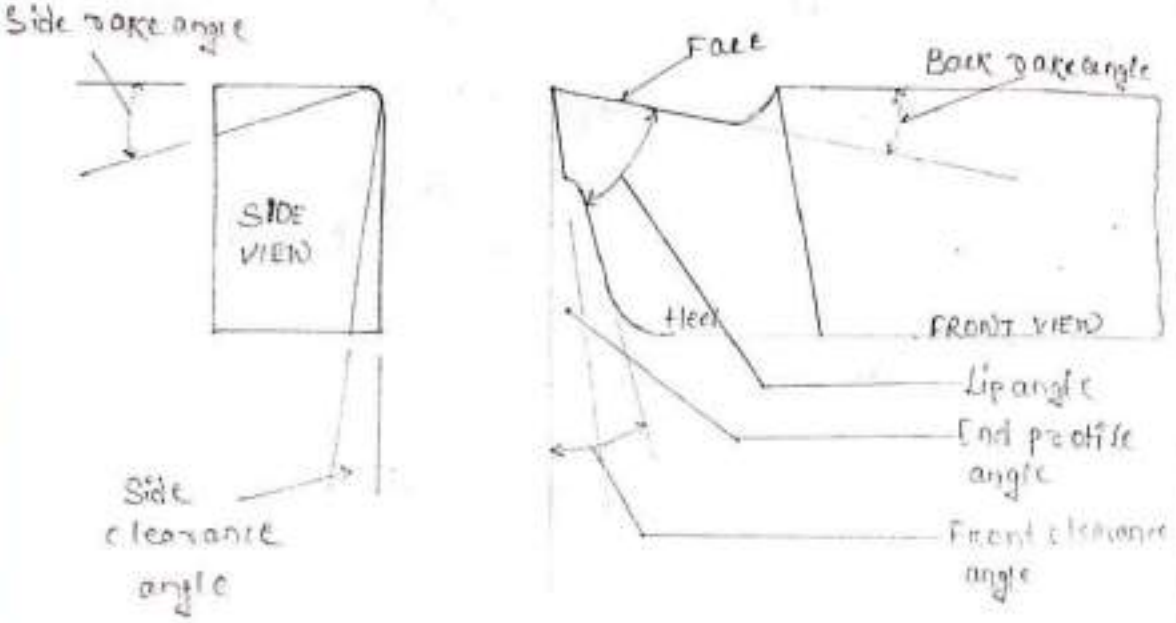
→ Cutting fluid is a coolant that also serves as a lubricant for metal shaping machine tools.

→ Oils are often used for application where water is unsuitable.



BR γ_b - Back rake angle
SR α_s - Side rake angle
θ_e - End relief angle (clearance) ER
θ_s - Side relief angle (") SR
C_e - End cutting edge angle (ECEA)
C_s - Side cutting edge angle (SCEA)





Construction & working of lathe & CNC lathe.

Definition of lathe machine :-

→ A machine tool that is used to remove unwanted metals from the work piece to give the desired shape and size is called lathe machine.

→ It is also called as centre lathe because of two centres b/w which the job can be held & rotated.

Functions of lathe :-

→ Main function of lathe is to remove excess materials in the form of chips by rotating the workpiece against a stationary cutting tool.

→ To cut the material properly the tool should be harder than the material of the work piece.

Main parts of lathe machine :-

1. Bed :-

→ It is the base of the lathe machine made up of single piece casting of semi steel (alloy cast iron).

→ The bed consists of two heavy metal slides running length wise with 'v' formed on them and rigidly supported with cross girts.

functions :-

a. It is sufficiently rigid and good damping capacity to absorb vibration.

b. It prevents the deflection produced by the cutting forces.

c. It supports the headstock, tail stock, carriage and other components of the lathe machine.

2. Head stock :-

Head stock is situated at the left hit of the lathe bed and it is the house of the driving mechanism and electrical mechanism of a lathe machine tool.

functions :-

a. It holds the job on it's spindle nose having external screw threads and internally morse taper bore holding the lathe center and it is rotating at a different speed by cone pulley or a geared drive. There is a hole through out the spindle for handling long bar work.

b. Head stock transmits power from the spindle to the feed rod, lead screw & thread cutting mechanism.

Accessories mounted on headstock spindle :-

① Three jaw chuck
② Four jaw chuck
③ Lathe center & lathe dog
④ collect chuck
⑤ face plate
⑥ Magnetic chuck

Note :-

→ A separate speed change gearbox is placed below headstock to reduce the speed in order to have different feed rates for threading & automatic lateral movement of the carriage.

→ The feed rod is used for most turning operation and the lead screw is used for thread cutting operation.

3. Tail Stock :-

Tail stock is situated on the right side above the lathe bed.

functions :-

a. Support the long end of the job for holding & minimize it's sagging.

b. It holds the tool bar performing different operations like drilling, reaming, tapping etc.

c. Used for a small amount of taper for a long job by offsetting the tail stock.

4. Carriage :-

→ It is located b/w headstock & tail stock on the lathe bed guide guide ways.

→ It is used to support, guide & feed the tool against the job when the machining is done.

functions :-

→ It holds, moves & control the cutting tool.

→ It gives rigid supports to the tool during operations.

→ It transfers power from feed rod to cutting tool through apron mechanism for longitudinal cross feeding.

→ It simplifies the thread cutting operation with the help of lead screw & half nut mechanism.

It consists of
① Saddle
② Cross-slide
③ Compound rest
④ Tool post
⑤ Apron
⑥ Compound slide

It provides three movements to the tool
(1) Longitudinal feed - through carriage movement.
(2) cross feed - through cross slide movement
(3) Angular feed - through top slide movement

① Saddle :-
→ It is 'U' shaped casting
→ It connects the pair of bed guide ways as a bridge.
→ It sits over the bed and slides along the bed b/w head stock & tail stock.

② Cross slide :-
→ It is assembled on the top of the saddle.
→ The top surface of the cross slide is provided with T slot.
→ The cross slide hand wheel is graduate on its rim to enable to give known amount of feed as accurate as 0.05 mm.

③ Compound Rest :-
→ It is a part which connects cross slide and compound slide.
→ It is mounted on the cross slide by tounge and groove joint.

functions :-
→ It supports the tool post and cutting tool in various position.
→ It is necessary for turning angles and bearing short tapers.

④ Tool post :-
It is the topmost portion of the carriage and it is used to hold various cutting tools or tool holders.

Types :-

a. Single way / screw tool post
b. Four way tool post
c. Quick change tool post
d. British type tool post.

(V) Apron :-

→ It is the house of the feed mechanism.
→ It is fastened to the saddle & hangover in front of the bed.

(VI) Compound slide :-

It is a T-shaped rounded slot, which is fixed with cross slide upper surface by two bolts, which is clamped to a circumferential sleeve & screw handle with the outer edge of screw.
→ This slide is only used for less long job taper turning.
→ Automatic feed is not possible, in compound slide.

5. Main spindle :-

It is a hollow cylindrical shaft in which long jobs can pass through.
→ It's nose has a standard morse taper.
→ It is also used for holding the live centers.
→ The spindle rotates on two large bearings housed on the head stock casing.

6. Lead screw :-

→ It is used to transmit power to carriage through gear and clutch arrangement in the carriage apron.
→ It converts rotational motion into linear motion.
→ It is used for thread cutting operation.

7. Live center :-

→ It is mounted on bearings and rotates with the work.
→ It is used to hold or support a work piece.

8. Dead center :-

→ It is used to support the work piece at either the fixed or rotating end of machine.

Functions :-

Dead centers are typically hardened to prevent damage to the important mating surfaces of the taper and to preserve the 60° angle of the head.

9. Feed rod :-

fun^{n} :- It is used to move the carriage from the left side to the right side and also from the right side to the left side.

10. Chuck :-

fun^{n} :- It is used to hold the workpiece securely.

Types :-

(I) 3 jaw self centering chuck
(II) 4 jaw independent chuck

11. Leg :-

fun^{n} :- Legs carry the entire load of the lathe machine tool and transfer to the ground.
→ The legs are firmly fixed to the floor by the foundation bolt.

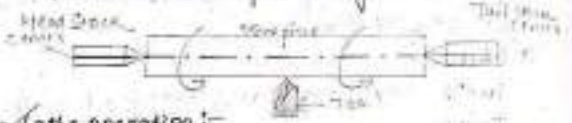
:- Working principle of lathe machine :-

Working Principle :-

→ The lathe is a machine tool which holds the workpiece b/w two rigid and strong supports called centers on in a chuck on face plate which revolve. The cutting tool is rigidly held and supported in a tool post which is fed against the revolving work.

→ When the cutting tool is fed parallel to the workpiece a cylindrical surface is formed.

→ When the cutting tool is fed on angle relative to the axis of the workpiece, it produces a tapered work and also called as taper turning.



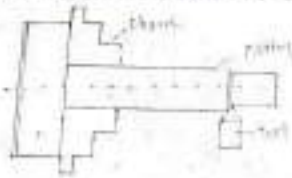
Lathe operation :-

The engine lathe is an accurate & versatile machine on which many operations can be performed, which are as below :-

① plain turning, steep turning :-

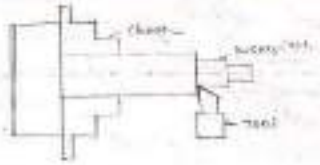
Plain turning :-

It is the operation of removing excess metal of material from the surface of a cylindrical job.



Step turning :-

It produces various steps of different diameters

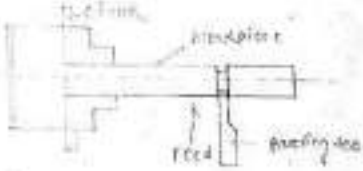


② Facing :-

It is a machining operation by which the end surfaces of the workpiece is made flat by removing metal from it.

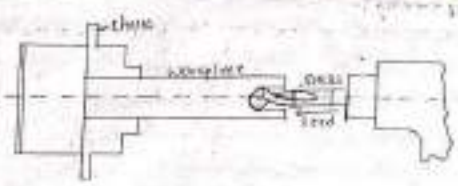
③ Parting :-

Parting or cutting off is the operation of cutting away a finished length of the workpiece.



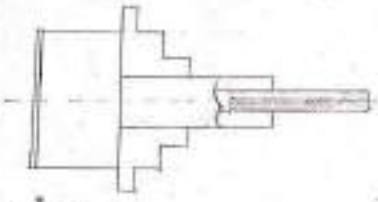
④ Drilling :-

Drilling is the operation of producing a cylindrical hole in the work piece.



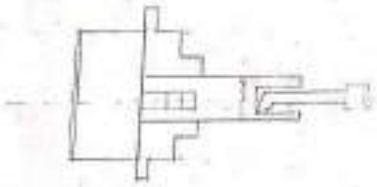
⑤ Reaming :-

The holes that are produced by drilling are never straight & cylindrical in form. The reaming operation finishes & sizes the hole already drilled into the workpiece.



⑥ Boring :-

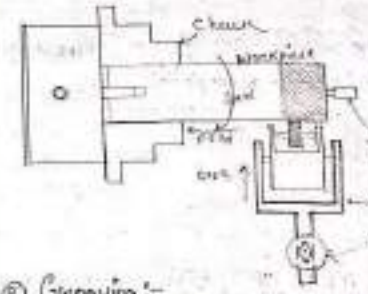
It is the process of enlarging a hole already produced by drilling.



⑦ Knurling :-

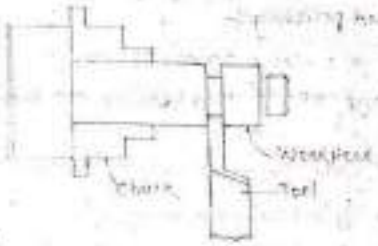
→ It is a process of impressing a diamond-shaped or straight line pattern into the surface of workpiece.

→ It is essentially a roughening of the surface and is done to provide a better gripping surface.



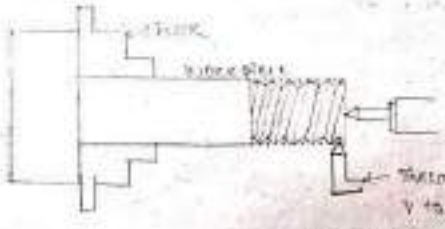
⑧ Grooving :-

It is the operation of making grooves of reduced diameter in the workpiece.



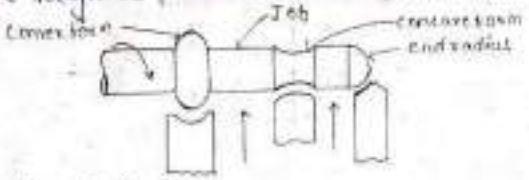
⑨ Threading :-

It is the operation of cutting of the required form of threads on the internal & external cylindrical surfaces.



⑩ Forming :-

It is an operation, which produces a convex, concave or irregular profile on the workpiece.



⑪ Chamfering :-

→ chamfering removes the sharp edges and rough edges and makes the handling safe.

→ chamfering can be done by a form tool having angle equal to chamfer which is generally kept at 45°.

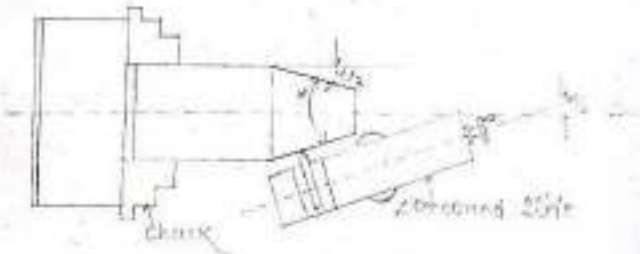
⑫ Filing and polishing :-

→ Filing is the finishing operation that removes rough edges, sharp corners and feed marks from the workpiece.

→ After filing, the surface quality of the workpiece is improved by polishing operation.

⑬ Taper turning :-

It is the operation of producing a conical surface by gradual reduction in the diameter of a cylindrical workpiece.



Safety measures during machining :-

→ ① Always stop the lathe before making adjustment.

② Do not

→ Do not change spindle speeds until the lathe comes to a complete stop.

→ Always wear protective eye protection.

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

→ Use two hands when standing the workpiece. Do not wrap the sand paper or emery cloth around the workpiece.

→ Remove rings and watches.

→ Keep the floor free from obstructions or slippages.

→ Follow job specifications for the speed, feed & depth of cut for materials being turned. Make sure all work is true and centred.

→ Stop lathe before taking measurements or any kind.

→ Keep working surface clean of scraps, tools & materials.

Types of lathe machine :-

① Centre (or) engine lathe :-

It is the most widely used lathe machine.

Parts :- Bed, saddle, headstock & tailstock etc.

→ The headstock of an engine lathe is rigid & tailstock is movable which is therefore used for knurling.

function :- It feed the cutting tool in both directions i.e. longitudinal and lateral directions with the help of feed mechanism.

mechanism?

Driven by gear mechanism or pulley mechanism.

Types of driven mechanism

① Belt drives

② motor driven

③ Gear head type.

Turrette Lathe :-

It is a lathe form of metalworking lathe is used repetitive prodⁿ of duplicate parts which by the nature of their cutting process usually interchangeable

Capstan Lathe :-

A capstan or lathe is a precutting machine used to make the same parts again & again. The cutting bits are mounted on a rotatable turret known as capstan, which permits the client to rapidly change the intent the bits for slicing without needing to take off the first bit & bits used mount the second.

What is capstan lathe used for?

→ A capstan or turrecte lathe is used to manufacture any no. of identical pieces in the minimum time.

→ These lathes are first developed in USA in 1960.

→ capstan lathe is one of the type of semi automatic lathe.

what is turrette lathe?

1. Ram type
2. Saddle type

1. Ram type :-

In the ram type turrette lathe a slide or ram carrying the turrette moves back & forth on a saddle which is clamp to the machine bed.

2. Saddle type :-

In this type the hexagonal turretted is rigidly mounted on the saddle & the hole unit moves back & forth on the bed ways.

what is swing of a lathe?

The swing of a lathe machine is actually the dimension that measures the max. diameter of the workpiece that a lathe is able to rotate without hitting the bed.

diff. betⁿ capstan & turrette lathe

Capstan	Turrette
→ It is a light weight machine	→ It is a heavy weight machine
→ In capstan lathe the turrette tool head is mounted over the ram & i.e. mounted over the saddle.	→ In turretted tool head is mounted over the saddle like a single unit.
→ for providing feed to the tool ram is moved.	→ for providing feed to the tool the saddle is moved
→ because of no saddle displa. the movement of turrette tool head over the longitudinal dirⁿ of bed is longer as ram.	→ Turrette tool head moved along with the saddle over the entire bed in longitudinal dirⁿ.
→ use for center workpiece bge of limited ram movement	→ use for longer workpiece saddle movement on the bed.
→ It's working operation are fast bge of lighter in construction.	→ It's working operation are slower bge of heavier in construction.
→ heavy feed cuts on the workpiece can't be given bge of non rigid construction	→ heavy cuts on the workpiece is given bge of rigid construction

→ For indexing turret tool head of the ram is reverse & turret tool index automatically

→ The turret head can't be moved in the lateral dir^n of the Bed

→ In capstan lathe collet is used to grip the job

→ Use for machining work piece upto 60mm diameter.

→ These are usually horizontal lath.

→ For indexing turrette tool head the turret is rotated manually after releasing the clamping lever.

→ The turreted head can be moved crosswise i.e. the lateral dir^n of Bed.

→ In turrette lathe power jaw chuck is used to grip the job.

→ use for machining work piece upto 120mm diameter.

→ Turrete lathe are available in horizontal & vertical.

Engine lathe:-

→ An engine lathe is a typical machinary, left horizontally & it is often to use cut metal.

→ The metal is turned the machine uses special cutting tool to create the desired shape because of the lathe, it can create various specific forms & comonly used to spin sheet metal.

difference bet^n turrette lathe & engine lathe.

Turrette lathe are planed to act as production machine & engine lathe is planed machine various type of job with in limits. i.e one time setting is moved you must not chang the tool.

~~Diff bet^n turret~~

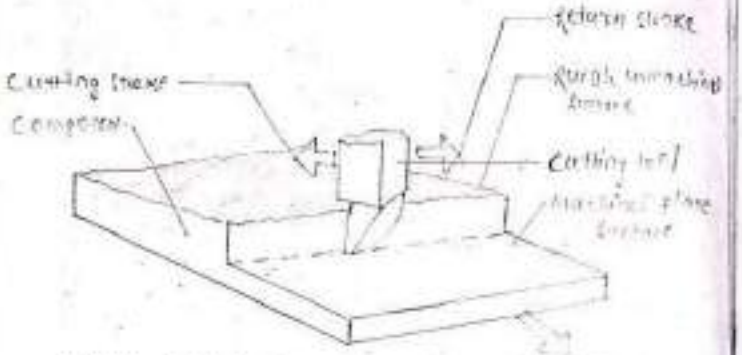
what is precision lathe?

Precision lathe are also known as standard manufacturing lathe & is used to used for all lathe operation such as turning, taper turning, knurling, reaming etc and can be adopted for special milling operation with the appropriate fixture

Shaping machine or shaper

-> A shaping machine or shaper is used to generate flat (plane) surfaces by means of a single point tool similar to a lathe tool.

-> A shaping machine is a reciprocating type of machine tool in which the ram moves the cutting tool backward & forward in a straight line.



Process capability:-

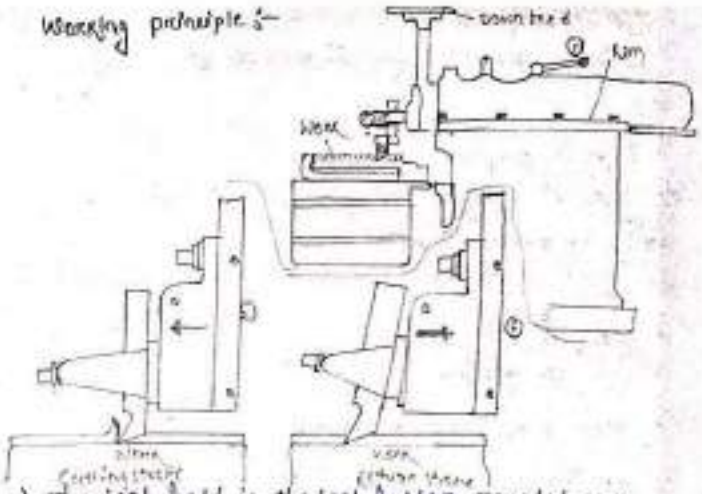
-> Shaping process involves short setup time & uses relatively inexpensive tools.

-> Shaping is often use for emergency production of gears, racks etc.

-> It is often possible to produce one or such parts in a shaper in less time than is required mainly to setup for production on other, alternative equipment with a higher out-put rate.

-> However metal removal by shaping may be as much as 5 times that for removal by milling or planing.

Working principle :-



-> The tool held in the tool holder mounted on the ram moves forward & backward in a straight line over the workpiece rigidly held in a vice clamped over the work table.

-> Each time the tool moves forward, it cuts the metal from workpiece. Each time the tool moves backward the tool the leaves clear of the workpiece.

-> The work remains stationary during the forward (cutting stroke of the tool) but move across by the cross transverse during the return (non cutting stroke).

-> That the appearance of the machine surface is of a succession succession of closely straight line wave.

Types of

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Types of shaper :-

Shaper maybe classified on the basis of

a) design of worktable as

i. Standard shaper

ii. universal shaper

b) Driving mechanisms

i. Crank shaper

ii. Gear shaper

iii. Hydraulic shaper

c) Direction of travel of Ram

i. Horizontal

ii. vertical

iii. Travelling head shaper

d) Nature of cutting stroke as

i. Push cut shaper

ii. Draw cut shaper

Parts of a shaper machine :-

1. Base :-

→ The base of shaper supports the column or pillar which supports all the working parts such as ram, worktable, drive mechanism etc

→ Base is a heavy C.I body.

2. column, pillar or body :-

→ The shaper has a column which is ribbed casting of semilar construction.

→ The top of the column carryies the ram sideways, the table sideways are machined on the front of the casting.

→ The crank & the slotted link mechanism that drives the ram is contain within the column.

→ The driving motor, the variable speed gearbox, levers & other control of the shaper are also contained in the column.

3. Cross rail :-

→ The cross rail carryies of horizontal table sideways. It is mounted on the vertical sideways of the column.

→ The cross rail can be raise or lowered by means of an elivating screw, in order to compensate for different thickness of work.

→ The cross rail is a heavy casting it also carryies the table cross feed screw together with the power ratchet intermittent drive mechanism.

4. Saddle :-

→ Saddle is ribbed to the cross rail & supports the table. If the table is removed the work can be bolted or clamped to the T-slot in front of the saddle.

→ Crosswise movement of the saddle causes the worktable to move sideways.

5. Table :-

→ The worktable is a box shaped casting with T-slots in it's upper surface & down one side. It also has a vee machined in the vertical side to carryies cylindrical work.

→ The upper surface of the worktable is machined after assembly to ensure that the working surface of the table is a true datum for work testing.

→ The worktable is bolted to the saddle & can move vertically & cross wise with the help of saddle & cross rail.

6. Ram :-

→ Ram is rigidly housed casting & is located on the top of the column.

→ The ram is driven back & forth in its slide by the slotted link mechanism.

→ The ram contains a stroke positioning mechanism & the down feed mechanism.

7. Tool Head :-

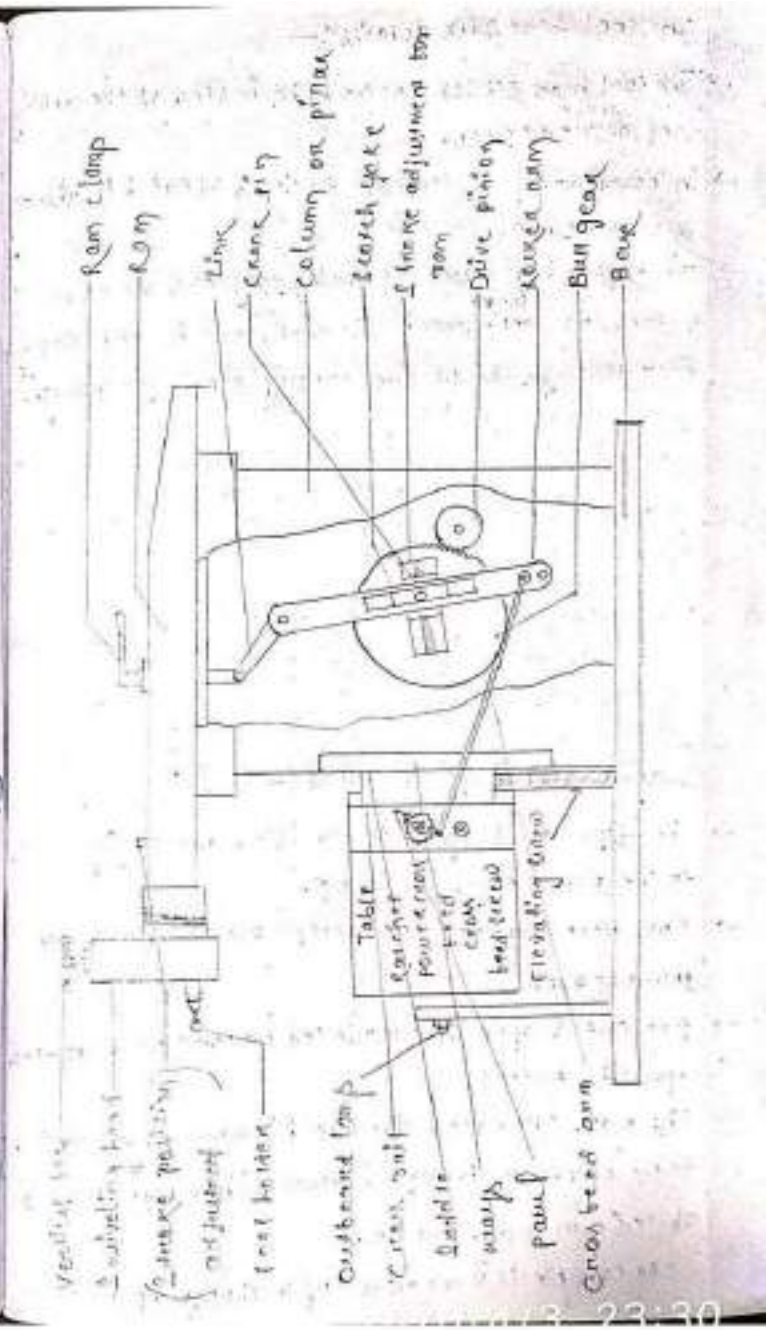
→ Tool head slides in a dovetail at the front of the ram by means of T bolts.

→ It can swivel from 0° to 90° in a vertical plane.

→ The tool head can be raised or lowered by hand feed for vertical cuts on the workpiece.

→ The tool head holds the tool. The tool head imparts the tool, the necessary vertical, angular feed movement.

~~Tool Head :- Its detail :-~~



The tool head & its details :—

→ The tool head slides controls the in feed of the cutting tool into the workpiece.

→ In engineering it controls the depth of cut & is achieved by a lead screw.

→ The clapper box allows the cutting tool to leave on the return or idle stroke, so that the tool is not dragged back through the uncut workpiece & get damaged.

Shaper size & specifications :—

→ The size of shaper is classified according to the max length of stroke.

→ Push-cut shapers can accept work sizes from 150 to 915 mm.

→ Pull-cut shaper are made for a wider requirement upto 1.8 meters.

→ The max. cross feed distance is generally equivalent to the max. ram stroke distance. Therefore a shaper of 406 mm max. stroke.

for example it is a capable of machining a part with a plane surface that measures at least 406 mm x 406 mm square.

Specification of a shapers :—

Max. ram stroke 700 mm	
max. tool overhang 150 mm	
Distance bet table surface & ram	Max. 400 mm Min. 50 mm
Dimension of table working surface	700 mm x 500 mm
Max. travel of table	Horizontal 700 mm Vertical 320 mm
Horizontal feed for double stroke	0.05 → 2 mm
principle movement motor power	4 kW
Overall dimension	2385 mm x 1750 x 1580 mm

Shaper drive mechanism :-

-> A shaper drive mechanism changes the rotary motion of the power source into the reciprocating motion of the ram.

-> Metal cutting is carried out during the forward stroke of the ram, the return stroke of the ram does no cutting & hence is called ideal stroke.

-> Since, return stroke does no cutting, the drive system incorporate a quick return mechanism so that the ram moves faster during return stroke inorder to minimize the ideal time.

-> Some of the shaper drive mechanism

a. Slotted link quick return mechanism
b. Reciprocating & quick return mechanism
c. Hydraulic mechanism

a. Slotted link quick return mechanism :-

-> Slotted link mechanism is very common in mechanical shaper.

-> The mechanism is simple & compact.

-> It converts the rotary motion of the electric motor & gear box into the reciprocating motion of the ram.

-> The slotted link mechanism gives the ram a higher velocity during the return non-cutting stroke than the forward cutting stroke thereby reducing the time required during the return stroke.

-> The Bull gear is driven by a pinion which is connected to a motor shaft through a gear box with 9 to 18 or more speed available.

-> The Bull wheel has a slot, the crank pin 'A' is screwed into the slot, at the same time it can slide in the slotted crank 'B'.

-> When the bull wheel rotate, the crank pin 'A' also rotated side by side rides through the slot & the slotted crank 'B'.

-> This makes the slotted crank to oscillate about its one end 'C'. This oscillating motion of slotted crank (through the link 'D') makes the ram to reciprocate.

-> The intermediate link 'D' is necessary to accomodate the rise & fall of the crank.

-> The position of the crank pin 'A' in the slot in the bull wheel decides the length of the stroke of the shaper, further it is away from the centre of

Bull wheel the longer is the stroke.

→ The cutting stroke of the ram is completed during the crank pin moves A to A_1 & the slotted link goes from left to right. Similarly the return stroke of crank pin move from A_1 to A & the slotted link changes its position from right to left.

→ The time taken by the ideal & cutting stroke of the ram is proportional to the angle $\angle AZA_1$ & $\angle A_1ZA$ respectively.

→ Since the crank pin 'A' moves at a uniform angular velocity & is greater, it is obvious that the ideal return stroke is quicker than the forward cutting stroke & hence the slotted link mechanism is known as "quick-return mechanism."

* MILLING MACHINES *

Q.1 → How the milling machines are classified and illustrate them accordingly?

Ans:- The usual classification according to the general design of the milling machines are:-

1. Column and Knee type:—
   (a) Hand milling Machine
   (b) Plain milling Machine.
   (c) Universal milling Machine.
   (d) Omniversal milling Machine.
   (e) Vertical milling Machine.
2. Manufacturing of fixed bed type
   (a) Simple milling Machine.
   (b) Duplex milling Machine.
   (c) Triplex milling Machine.
3. Planer Type.
4. Special Type
   (a) Rotary table milling Machine.
   (b) Drum milling Machine.
   (c) Planetary milling Machine
   (d) Pantograph, profiling and tracer controlled milling Machine.

(1) Column and Knee Type:— For general shop work the most commonly used is the column and knee type where the table is mounted on the kneecasting which is 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 ... to accommodate work of various heights. The column and knee type milling machines are classified according to the various methods of supplying power to the table, different movements of the table and different axis of rotation of the main spindle.

(a) Hand Milling Machine:— The simplest of all types of milling machine is the hand miller in which the feeding movement of the table is supplied by hand control. The cutter is mounted on a horizontal arbor and is rotated by power. The machine is relatively smaller in size than that of other types and is particularly suitable for light and simple milling operations such as machining bolts grooves and key ways.

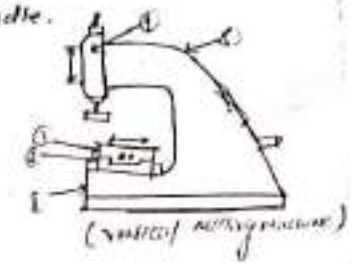
(b) Plain milling Machine:— The plain milling machines are much more rigid and heavy than hand millers for accommodating heavy workpiece. The milling machines table may be fed by hand or power against a rotating cutter mounted on a horizontal arbor. A plain milling machine, having horizontal spindle, is also called horizontal spindle milling machine. In a plain milling machine the table may be fed in a longitudinal cross or vertical directions. The feed is longitudinal when the table is moved at a right angle to the spindle, it is cross when the table is moved parallel to spindle, and the feed is vertical when the table is adjusted in the vertical plane.

(c) Omniversal Milling Machine:— In the machine the table besides having all the movements of a universal milling machine, can be tilted on a vertical plane by providing a swivel arrangement at the knee. Also the entire knee assembly is mounted on such a way that →

it may be fed in longitudinal direction horizontally. The cross-traversal transverse arrangement of the table enables it to machine taper spiral grooves and helical gears etc. It is essentially a tool room and experimental shop machine.

(-I) Vertical milling machine:—

A vertical mill machine can be distinguished from the horizontal milling machine by the position of its spindle which is vertical or perpendicular to the work table. The machine may be of plain or universal type and has all the movements of the table for proper setting and feeding the work. The spindle carrying the cutter may be adjusted up and down relative to the work. The machine is adopted for machining grooves, slots and flat surfaces. The end mills and face milling cutters are the typical tool mounted on the spindle.



(vertical milling machine)

1. Base
2. Saddle
3. Table
4. Spindle head
5. Column

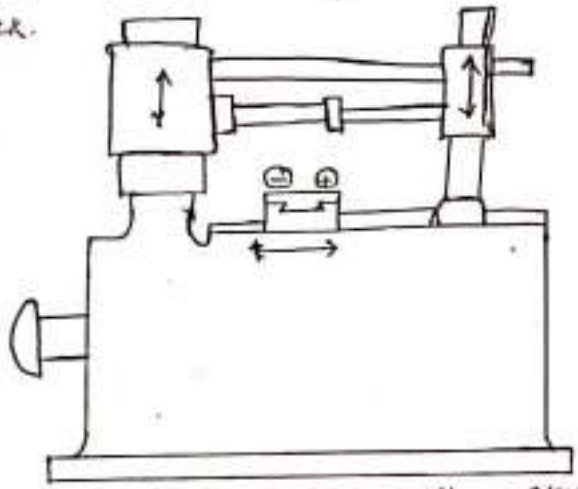
(c) Universal Milling Machine:—

It is most versatile of all the milling machines, and after lathe it is the most useful machine tool as it is capable of performing most of the machining operations. With its application the use of longer number of other machined tools can be avoided. It differs from the plain milling machine only in that the table can be given one more traversal movement. Its table can be rotated on the saddle on the horizontal plane. For this, circular guideways are provided on the saddle along which it can be swivelled. A graduated circular base is incorporated under the table, with a datum mark on the saddle, to readily decide the angle through which the table has been swivelled. The special feature enable the work should be set an angle with the cutter for milling helical and spiral flutes and grooves. Its oven cam can be pushed back or removed and a vertical milling head can be fitted on a place of the other to use it as a vertical milling machine.

(2) Manufacturing or Fixed bed type:—

The fixed bed type milling machines are comparatively large, heavy and rigid and differ mainly from column and knee type milling machines by the construction of the table mounting. The table is mounted directly on the ways of fixed bed. The table movement is restricted to reciprocate at right angles to the spindle axis within →

provision for cross or vertical adjustment. The cutter mounted on the spindle heads respectively on a duplex machine, the spindle heads ~~respectively~~ are arranged one on each side of the table. In triple type the third spindle is mounted on across rail. The usual feature of these machines is the automatic cycle of operation for bevoling the table, that is repeted in the regular sequence. The bevel cycle of the table includes the following start, rapid approach, slow bevel for cutting, rapid traverse to next workpiece, quick return and stop. This auto matic control of the machine enables it to be used with advantage in repeative type of work.

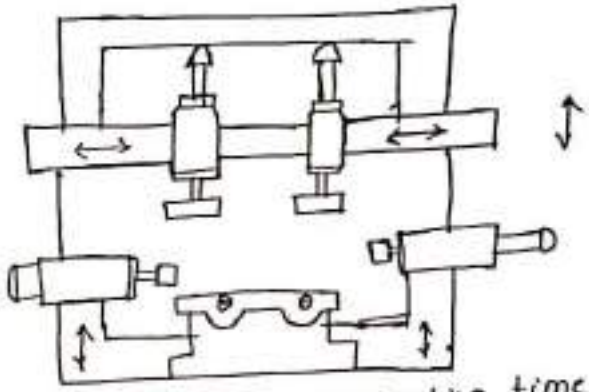


(Bevel type milling machine)

③ Planner Type:-

It is also called plano-miller milling machine. The plano miller, is a massive built up for heavy duty work, having spindle heads adjustable in vertical in traverse direction.

It resembles a planner and like a planning machine, it has across rail capable of being raised or lowered carrying the cutter their heads and the saddles, all supported by rigid uprights. There may be number of independent spindles carrying cutter on the rail as well as two heads on the upright. This arrangent of independently multiple cutter spindles enables number of work surface to be machined simultaneously. There by obtaining great reduction in production time. The essential difference bet^n a planer and plano-miller lies in the table movement. In a planer, the table moves to give the cutting speed, but in a plano milling machine the table movements gives the bevel. Hence the table movement in a plano-milling machine is much slower than that of a planning machine. Modern plano miller are provided with higher power driven spindles powered to the extent of 100 h.p. and the rate of metal removal is tremendous. The use of the machine is limitted to production work only and is considered ultimate in metal removing capacity.



④ Special Type:- Milling machines of non-conve-

tional design have been developed to suit special purpose. The features that they have in common are the spindle for rotating the cutter and provision for moving the tool or the work in different directions. The following special type of type machines of interest are described below:-

(a) Rotary table Machine:-

The construction of the machine is a modification to a vertical milling machine and is adopted for making blat surfaces at production rate. The face milling cutter are mounted on two or more vertical machine spindles and a number of work pieces are clamped on the horizontal surface of a circular table which rotate about a vertical axis. The cutters may be set different height relative to the work so that when one of the cutter is roughing the pieces, the other is finishing them.

(b) Drum milling machine:-

The drum milling machine is similar to a rotary table milling machine in that its work supporting table, which is called a drum, rotates on a horizontal axis. The face milling cutters mounted on three or four spindle heads rotate in horizontal axis and remove metal from workpieces mounted on both the face of the drum. The finished machined parts are removed after one complete turn of the drum, and then the new ones are clamped to it.

(c) Planetary milling machine:-

In a planetary milling machine, the work is held stationary while the revolving cutter or cutter move in a planetary path to mill a cylindrical surface on the work either in a tangential or circumferential or simultaneously. The machine is particularly adapted for milling internal or external threads of different pitches.

(d) Pantograph milling machine

A pantograph machine can duplicate a job by using a pantograph mechanism which permits the size of the workpiece reproduced to be smaller than, equal to or greater than the size of a template or model used for the purpose. A pantograph is a mechanism that is generally constructed of four bars or links which are jointed in the form of a parallelogram. Pantograph machines are available in two dimensional as three dimensional models. Two dimensional pantograph is used for engraving letters or other designs, whereas as three dimensional models are employed for copying any shape and contour of the workpiece.

(e) Profile milling machine:- A profile milling machine duplicates the full size of the template attached to the