WORKSHOP

TECHNOLOGY - III

CHAPTER - 1, Milling

1.1 Specification and working principle of milling machine.

1.2 Classification brief description and applications of milling machines.

1.3 Details of column and knee type milling machine

1.4 Milling machine accessories and attachment- Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment, rotary table.

1.5 Milling methods - up milling and down milling

1.6 Identification of different milling cutters and mandrels.

1.7 Working holding devices

1.8. Milling operations - Face milling, angular milling, form milling, straddle milling and gang milling.

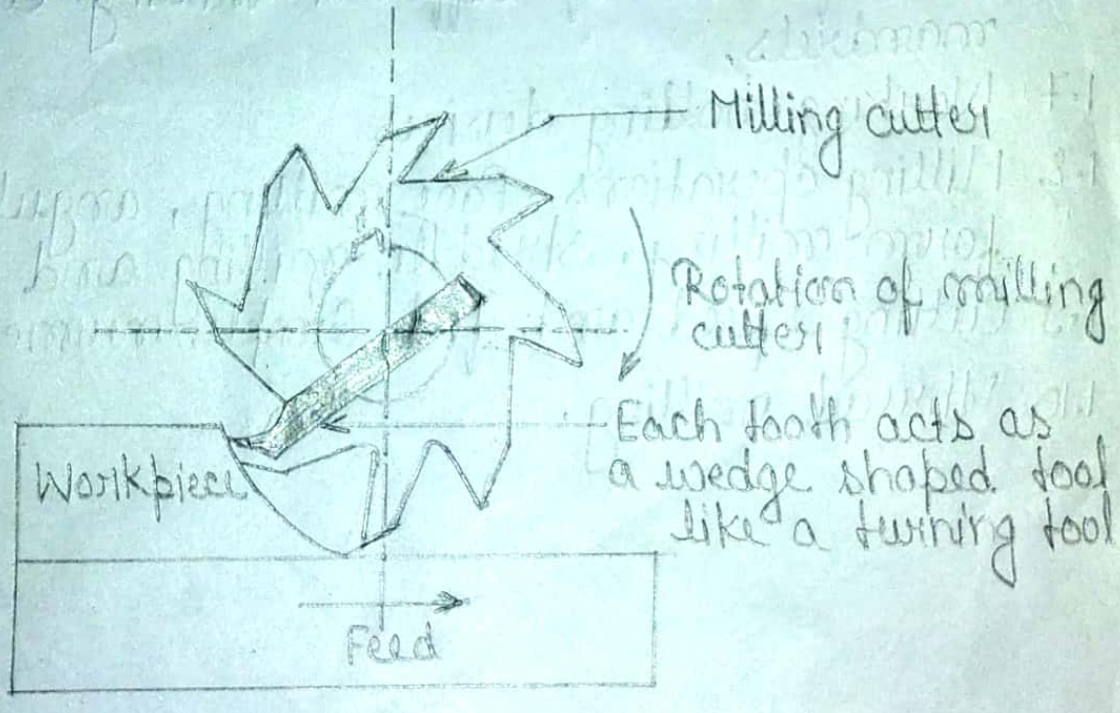
1.9 Cutting speed and feed, Simple numerical problems.

1.10 Thread milling.

Milling :- Milling may be defined as the machining process which is used to remove excess material from the workpiece with a rotating multi-point cutter. The milling cutter has a number of similar cutting edges equi-spaced from its rotating axis.

Principle of working of a milling machine :-

The job fixed on the table of milling machine is fed against the rotating multipoint cutter held on arbor or spindle. A milling cutter has a series of cutting edges on its circumference. Each cutting edge acts as an individual cutter during the cycle of operation.



Depending upon the type of milling operation, the cutters used on a milling machine have different shapes and sizes. These cutters are held on the arbor or attached directly on the spindle to carry out the The milling machine is the most versatile machine for machin flat or formed surfaces with

excellent finish and accuracy.

Specification of a milling machine :- The size of the milling machine is generally specified by the dimensions of work table of milling machine in mm i.e. Length of table x width of table. The other main specifications which need due consideration are longitudinal feed, cross feed, vertical feed, spindle speeds, type of drive and power of driving motor. The space required for the machine and weight of the machine should also be mentioned.

Classification of milling machines

The milling machines may be classified in a variety of ways as follow:

A. According to the drive :-

1 Cone-pulley belt drive, 2. Vertical milling machine

B. According to design :-

1 Knee and Column type milling machine :

(i) Horizontal milling machine,
(ii) Vertical milling machine,
(iii) Universal milling machine,
(iv) Omniversal milling machine.

2 Planer-type milling machines.

3 Production (Bed) type milling machines:

(i) Simplex milling machine,
(ii) Duplex milling machine,
(iii) Tuplex milling machine.

4. Special Milling machines :

(i) Rotary table milling machine,
(ii) Drum type milling machine,
(iii) Profile milling machine,
(iv) Planetary milling machine,
(v) Pantograph milling machine,
(vi) Off-set milling machine.

Application of milling machine :-

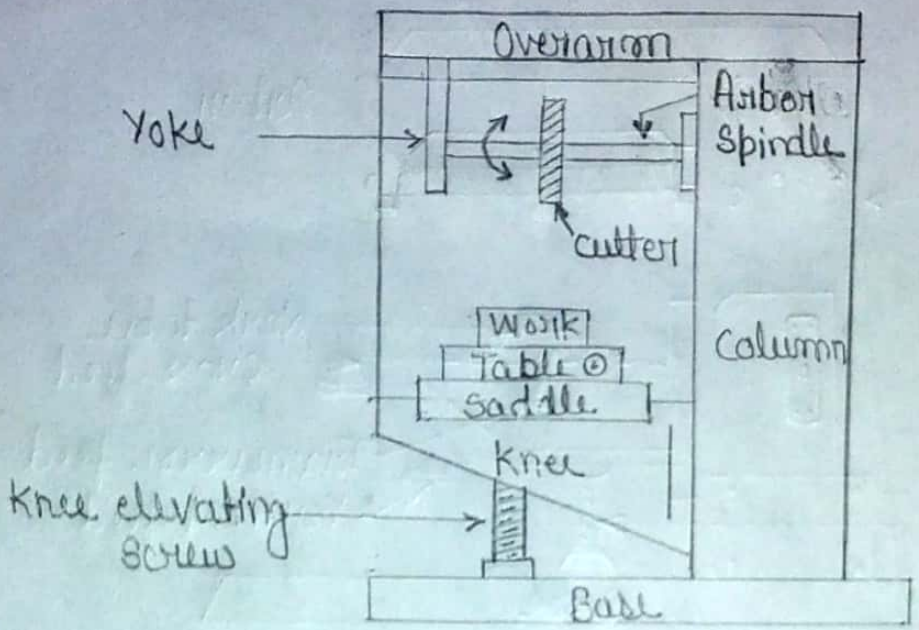
Milling machine are very versatile. They are usually used to machine flat surface, but can also produce irregular surfaces. They can also be used to drill, bore, cut gears and produce slots.

Knee and Column type milling machines :-

These are low production machines. These are the most commonly used machine in view of their flexibility and easier setup.
The knee can be moved up and down to accommodate various heights of works.

1. Horizontal milling machine :- A horizontal milling machine consists of a horizontal milling spindle. The spindle, the main feed drive, knee and milling table are supported on the column. The spindle rotates in sturdy antifriction bearing for smooth operation. The spindle head is provided with inside and outside tapers for mounting the milling cutters. Rotary motion to the spindle is provided by the main drive either through a stepped cone pulley drive or gear drive.

This machine is suitable for general milling work such as surface finishing, gear cutting, key-way cutting and slotting.

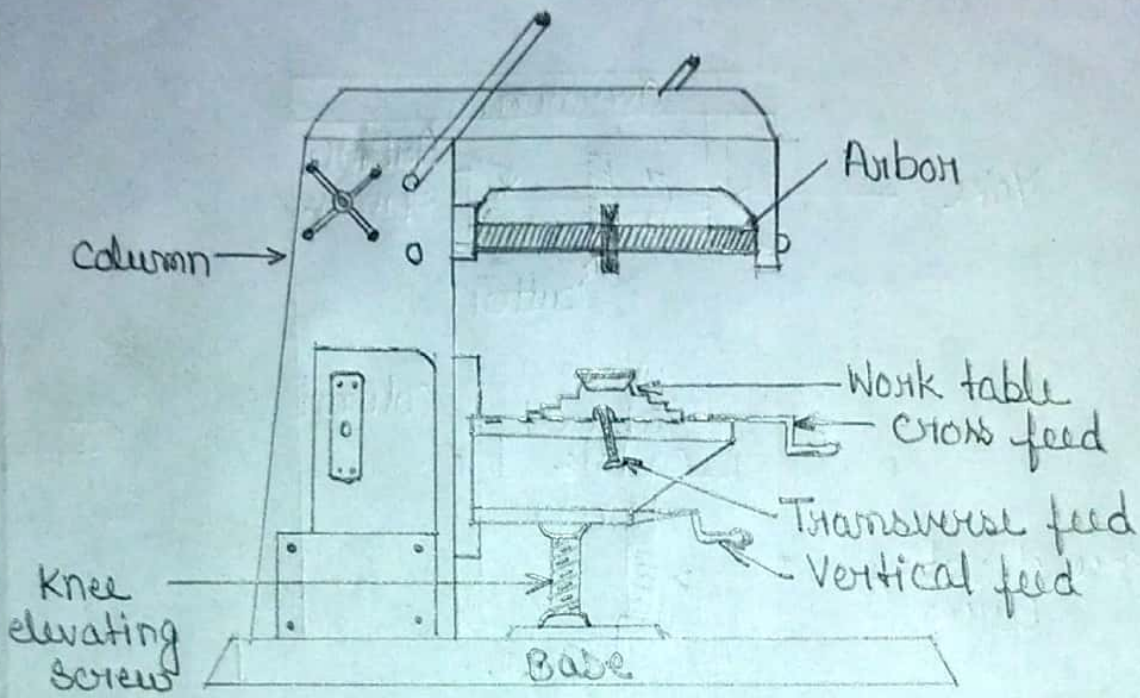


Horizontal Milling Machine

2. Vertical milling machine :- A vertical machine consists of milling spindle mounted vertically on the milling head. The milling head consists of a scale provided in degrees. The milling head can be swivell-ed at any oblique position. This machine is usually used for end milling work with end mill cutters and for producing flat surface.

3. Universal milling machine :- In appearance, the universal milling machine is similar to horizontal milling machine. The worktable of this machine is provided with extra swivel movement with an index or dividing head located at the end of the table. The swivelling attachments provided on these machines helps in cutting

Spirals, gears and cams in addition to normal milling operations.



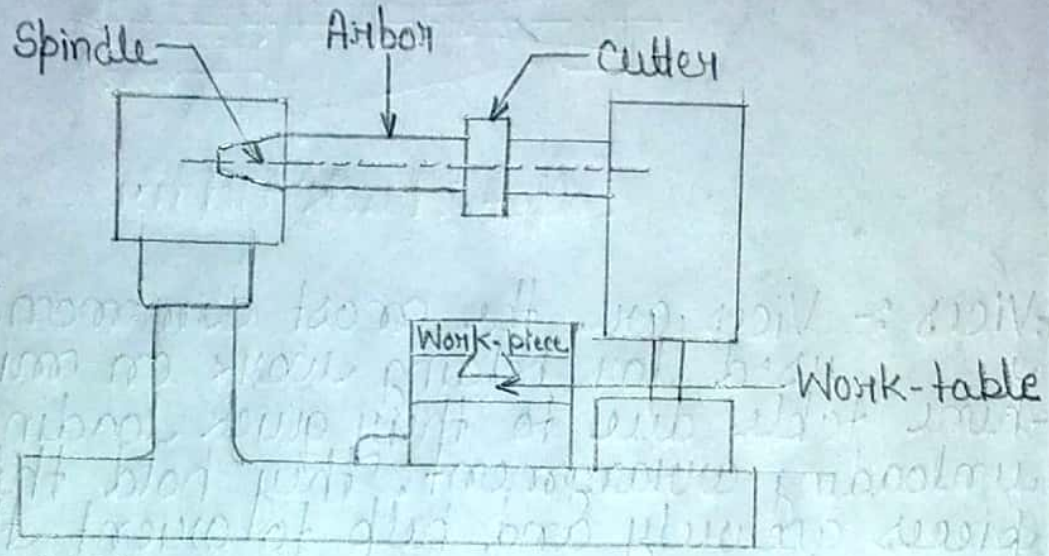
Universal Milling Machine

4. Omniversal milling machine: This machine is the modified from of a horizontal (plain) milling machine. It consist of two spindles, one of which is in the horizontal plane which the other is carried by a universal swivelling head. The latter can be set in a vertical position and swivelled upto 45° on both sides. The knee of this machine can also be swivelled in the horizontal plane, thus enabling it to carry out a large number of operations.

Milling machine accessories and attachments:-

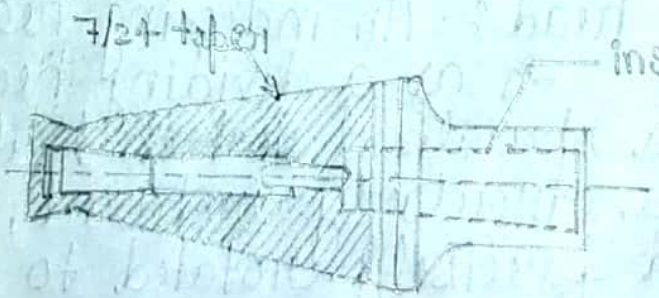
1. Arbor:- This is cutter holding device. An arbor is usually made with taper

shank for proper alignment with spindle having taper hole to at its nose.



Milling cutting Mounded on an Arbor

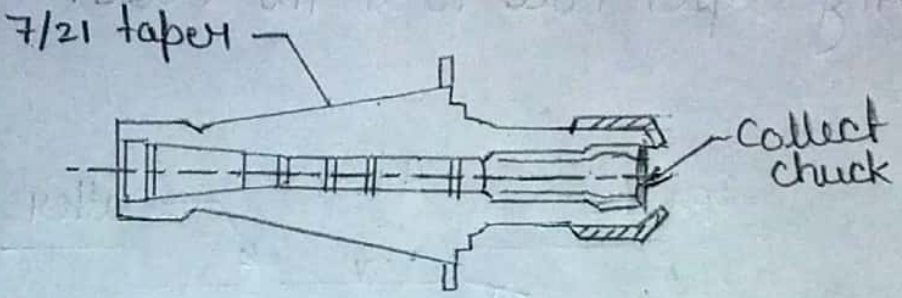
2. Collet :- A collet is an accurate, time saving cutter holding device used on milling machines. These are available in various design. The most commonly used collet is the spring type collet.



Adapter

3. Adapter :- An adapter is like a collet used on milling machine having standardized spindle end. Cutters having shanks are usually mounted on adapters. An adapter can be connected with the spindle by a draw

bolt on it may be directly bolted to it.



Collet chuck Holder

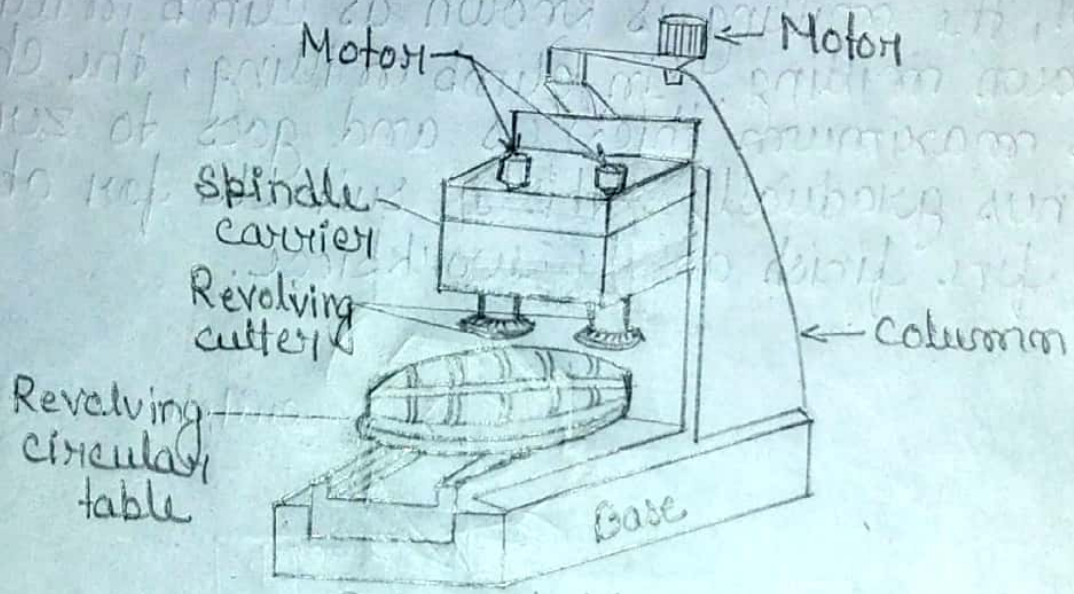
4. Vices :- Vices are the most common devices used for holding work on milling machine table due to their quick loading and unloading arrangement. They hold the work pieces securely and help to orient them accurately.

5. Circular table :- This attachment consists of a circular worktable containing T-slots for mounting workplaces. The circular table revolves on a base attach to the milling machine worktable.

6. Indexing head :- An indexing head, also known as a dividing head or spiral head, is a specialized tool that allows a workpiece to be circularly indexed, that is, easily and precisely rotated to present angles or circular divisions.

7. Tail stock :- A tailstock, also known as a foot stock is a device often used as part of an engineering lathe wood-turning lathe, or used in conjunction with a rotary table on a milling machine.

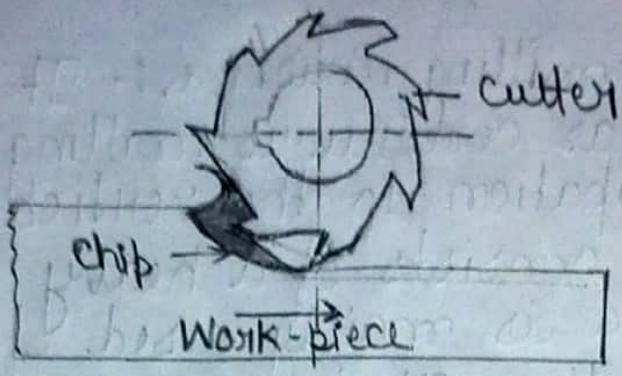
8 Rotary table milling machine :- It is also known as continuous milling machine. It is an adapation to the vertical milling machine. It consists of a heavy and robust structure and is mainly used for large scale production. It has two vertical spindles, each equipped with a facing mill.



Rotary table milling machine

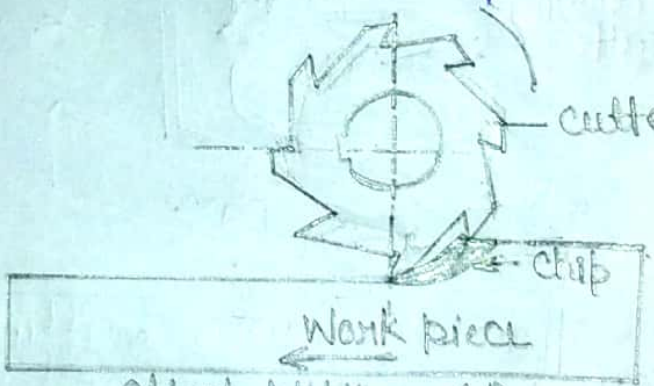
Milling Methods :- There are two types of milling :-

(i) Conventional milling :- In conventional milling, the cutting tool rotates in the opposite direction to the movement of table. In the conventional or up milling, the chip starts at zero thickness and gradually increases to the maximum size. The initial rubbing of the cutting edge during the state of cut in the milling tends to dull cutting edge and consequently:



Conventional Milling (Up milling)

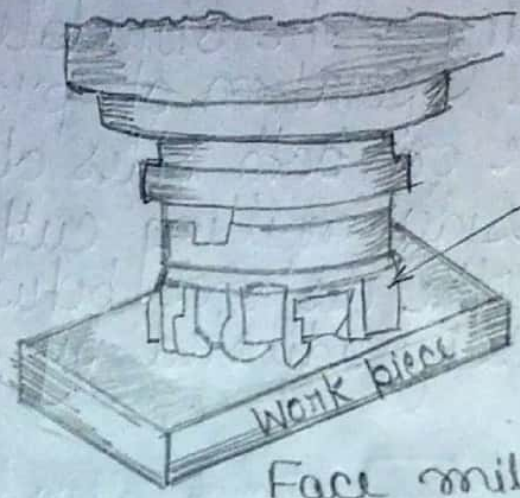
Climb Milling :- When the feed motion is the same direction as that of motion of cutter, the milling is known as climb milling or down milling. In climb milling, the chip stars maximum thickness and goes to zero thickness gradually. This is suitable for obtaining fine finish on the workpiece.



Climb Milling (Down Milling)

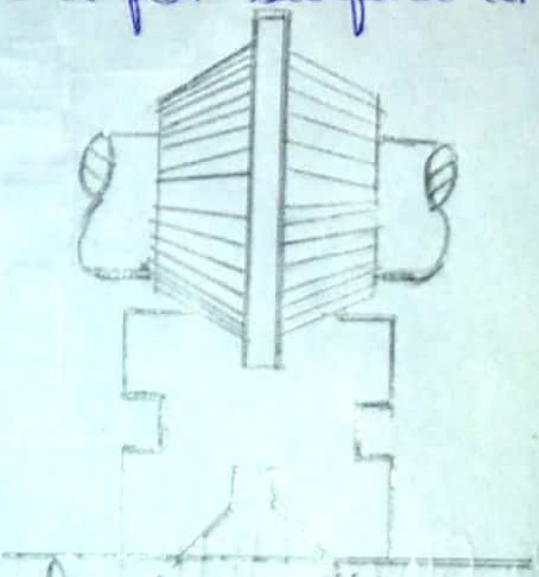
Milling operations :-

1. **Face milling :-** The milling operations employed for machining a flat surface which is at right angle to the axis of the rotating cutter is called face milling. The cutter used in this operation is the face milling cutter.



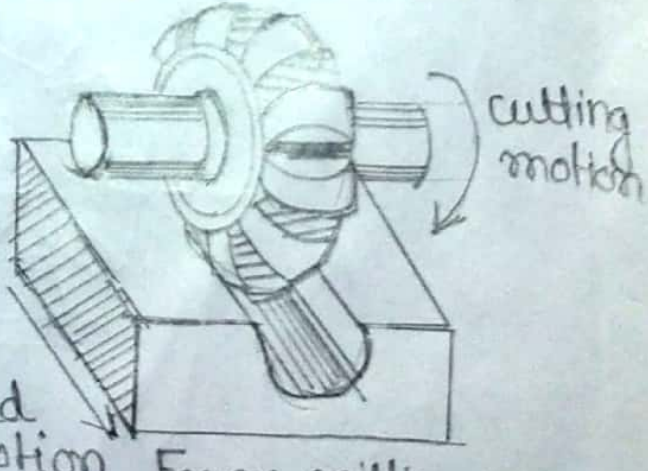
Face milling

2. Angular Milling :- This milling operation is used to machine a flat surface at on to the cutter axis other than at right angle. This uses a single or an angle cutter depending upon the requirement of job.



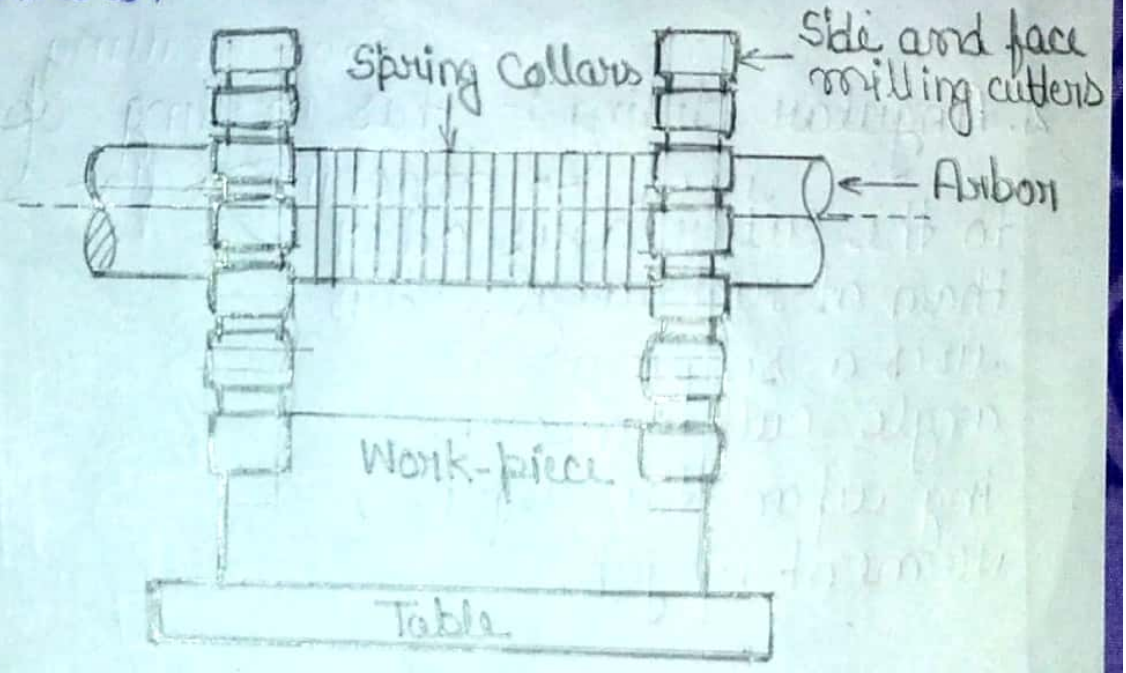
Angular milling

3. Form milling :- This milling operation is employed for machining those surfaces which are of irregular shapes. The cutter used called a form milling cutter has same profile of its cutter teeth that has to be produced on the surface of work-piece.



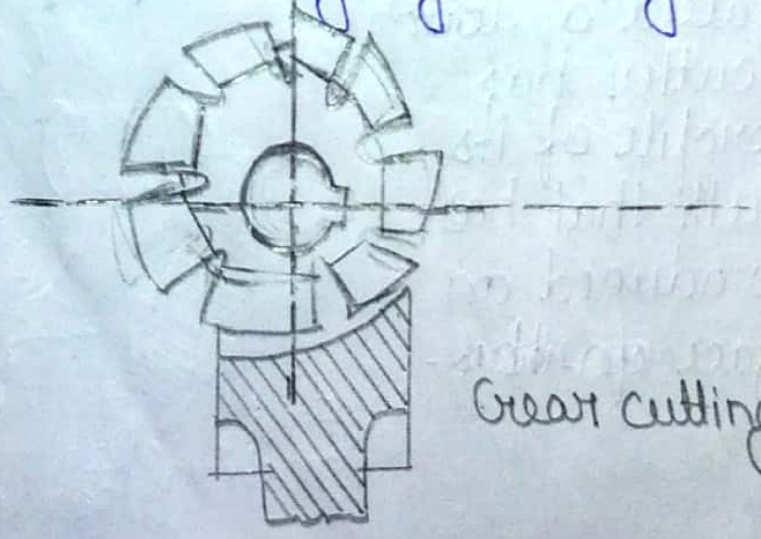
Form milling

4. Straddle Milling :- The straddle milling is the operation of producing flat vertical surface on both sides of a workpiece by using two sides milling cutter mounted on the same. The distance between the two cutters is correctly adjusted by using suitable spacial collars.



Straddle Milling

5. Gang Milling :- When two or more milling cutters are mounted on arbor so that each cutter produces its own distinctive surface as the workpiece is fed to it, the operation is called gang milling.



Gear cutting operation

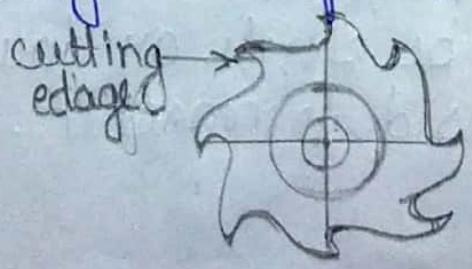
6. Thread milling :- This operation is used to produce internal or external threads by a single or multiple thread milling cutters. The operation is performed on a special thread milling machine to produce accurate threads in small or large quantities.

Types of milling cutters :-

There are various types of milling cutter. According to purpose or use, these can classified as follow :-

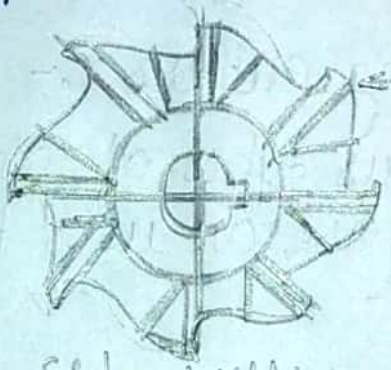
1. Plain milling cutter,
2. Side milling cutter,
3. Metal slitting saw cutter,
4. Angle milling cutter,
5. Form milling cutter,
6. End-mill cutter,
7. T-slot cutter,
8. Woodruff key seat cutter,
9. Fly cutter.

1. Plain Milling Cutter :- It is also called slab milling cutter and is basically cylindrical with the cutting teeth on its periphery. It is generally used for machining of the surface.



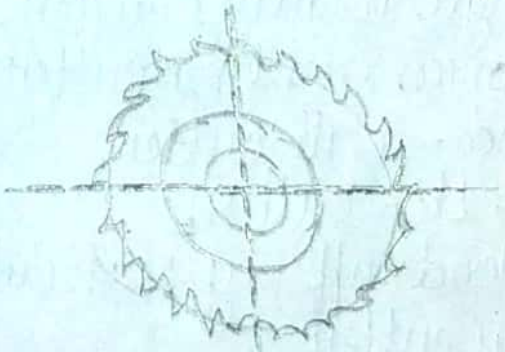
Plain milling cutter

2. Slide Milling Cutter :- This cutter is similar to plain milling cutter except that it has teeth on its sides also. These cutter may have straight, spiral or staggered teeth further these may be solid, inserted blade or tipped construction and may be profile sharpened from relieved.



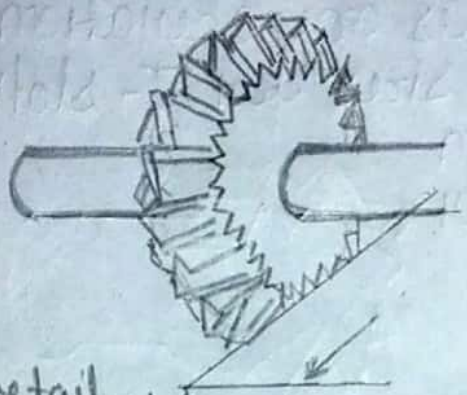
Side Milling Cutter

3. Metal Slitting Saw Cutter :- It is a very thin cutter varying in thickness from mm. It is used for cutting deep slots and parting off materials into piece is thinner at the centre than at the edge to provide clearance and reduce friction.



Metal Slitting Saw cutter

4. Angle Milling Cutting :- Any milling cutter which has cutting teeth at an angle to the axis of rotation is known as angle milling cutter. It may be single or double - angle cutter and it used to machine angle other than 90°.

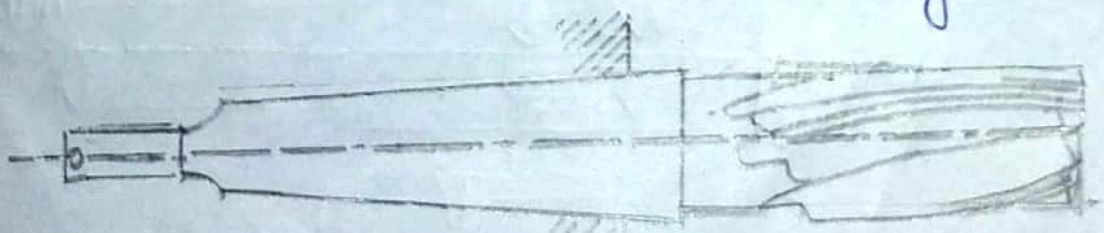


Angle Milling cutter

5. Form Milling Cutter :- Any milling cutter who -se teeth have been given a special is known as form milling cutter. This group of cutter consists of convex and concave cutters, fluting cutter corner cutters, rounding off cutters and cutters with any irregular.

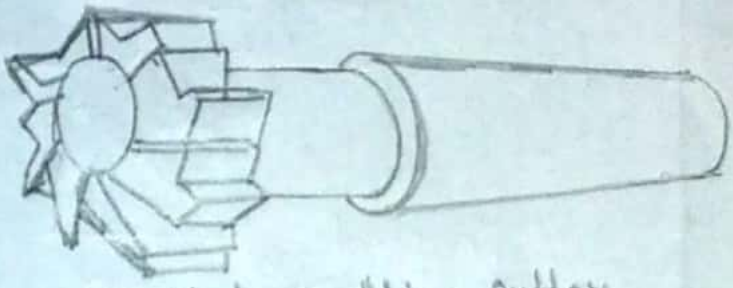
Form milling cutter to gear teeth

6. End Mill Cutter :- The end milling cutter has cutting teeth on the end as well as any periphery with a straight or taper shank. These are used to mill the horizontal, vertical, bevel, chamfer and slant surface, grooves and keyways and to cut the slot, recess such as die making etc.



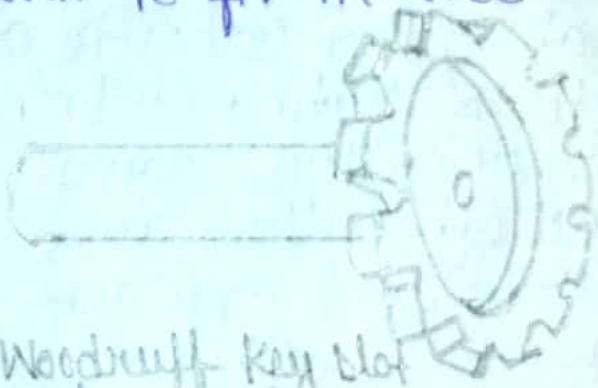
Taper shank Forged End Mill

7. T- slot Milling Cutter :- It is used for mill -ing T slot is one operation and is available in special sizes for T- slots. It resembles with plain or side milling cutter which has integral straight shank for driving.



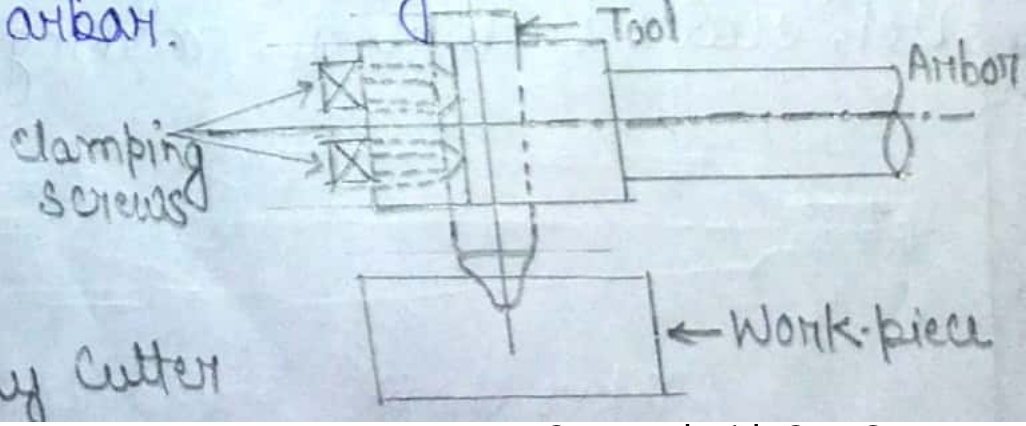
T- Slot milling cutter

8. Woodruff key slot Milling Cutter :- It is a small plain or side milling cutter with a solid shank to fit in the machine spindle. Smaller sizes generally have straight teeth on the periphery with the sides having a little clearance. This type of cutter is used for cutting key seats in the shafts for woodruff keys.



Woodruff key slot milling cutter

9. Fly cutter :- The fly cutter is the simplest form of cutter and is used in tool room works or experimental shops. It consists of single point cutting tool attached to the end of the arbar.



Fly Cutter

Cutting Speed, feeds

1 Cutting speed :- The cutting speed of milling cutter is its peripheral linear speed resulting from rotation. In simple words, we can say that the cutting speed of a milling cutter is travel of one cutting tooth It is expressed in metre per minute. The cutting speed can be derived from the following formula :

$$V = \frac{\pi DN}{1000} \text{ m/min}$$

2. Feed :- The feed in a milling machine may be defined as the rate with which the workpiece advances under the cutter. The feed is expressed in a milling machine by the following three different methods :

(i) Feed per minute :- The feed per minute may be define the distance by which the work advances in one minute. It is expressed in millimeters per minute.

(ii) Feed per tooth :- The feed per tooth may be define as the distance by which the work advances in the time between engag ement by the two successive teeth. It is expressed in mm/tooth of the cutter.

(iii) Feed per revolution :- The feed per revol- ution is the distance by which the advan- ce in the time when the cutter turns

through one complete revolution. It is expressed mm/rev. of the cutter.

The feed per tooth, the feed/cutter rev., and the feed per minute are related by the formula which is given below :-

$$\text{Feed/rev} = \text{Feed/tooth} \times T$$

Where T = No. of teeth in the cutter

and Feed/min = Feed per revolution $\times N$

where N = No. of rev. per min of the cutter.

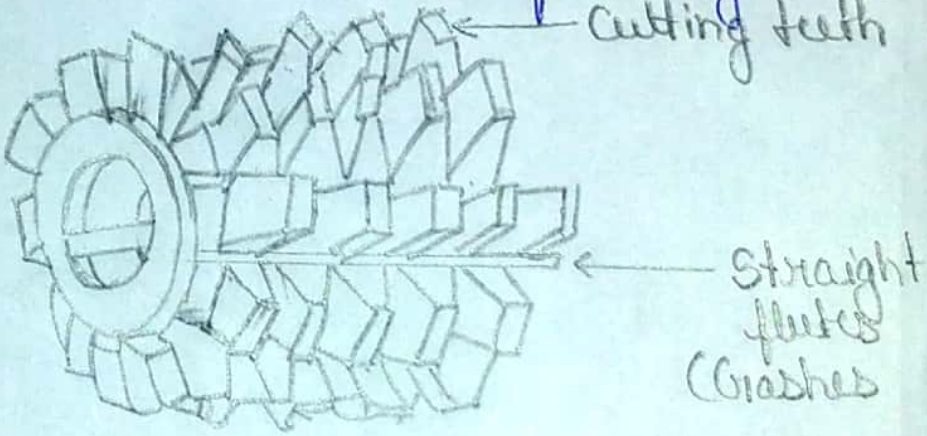
i.e. Feed/min = Feed per tooth $\times T \times N$

CHAPTER-02

Gear Manufacturing and Finishing Processes

2.1 Gear hobbing
2.2. Gear shaping
2.3 Gear finish Processes

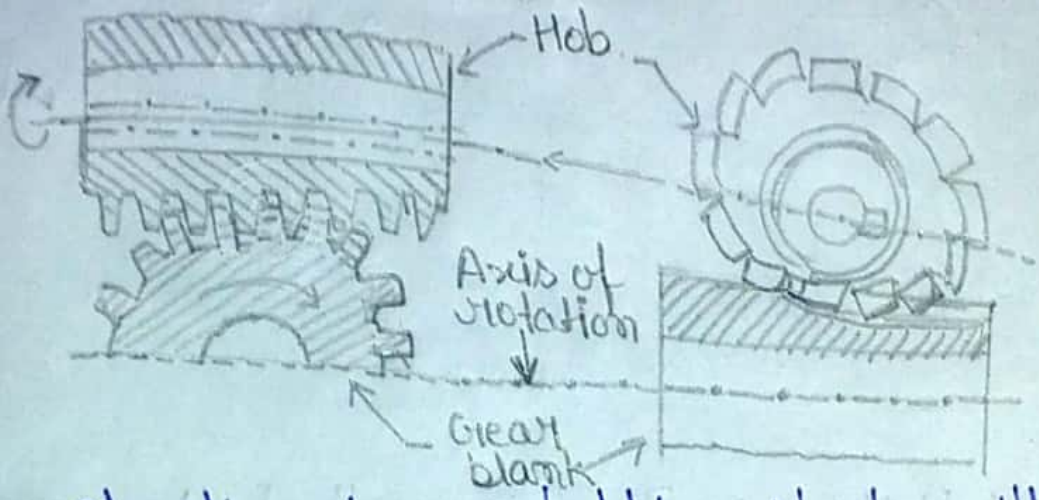
Gear Hobbing :- Hobbing is process of generating a gear by means of cutter called hob which revolves and cuts like a milling cutter. The hobs are either single threaded or multi-threaded. A single threaded hob completes one revolution for generation of one teeth. A double threaded hob generates two teeth in one revolution Thus, this hob takes less time in finishing the gear blank.



Gear Hob

In hobbing, the hob is rotated at a suitable speed and fed into the gear blank which also rotates. The speeds of the two are in such a way that the blank rotates through one pitch distance in one complete revolution of the hob. The hob teeth are just like screw threads having a definite helix angle. The hob is, therefore, tilted at its own helix angle for cutting gear so that the teeth are square with the blank and produce a true involute shape. Relative position of hob and gear blank during hobbing operation.

Relation Position of Hob and bank operation.

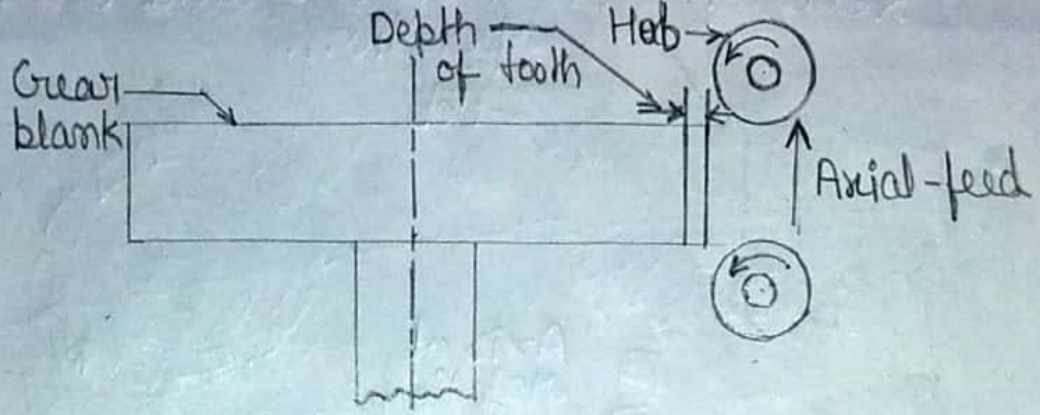


The operation of gear hobbing starts with moving the gear blank towards the hob and acquiring the desired depth of tooth. It is followed by feeding the hob in a direction parallel to the axis of rotation of rotating gear blank. This results in the formation of teeth on the periphery of the gear blank.

Types of Hobbing :- There are three types :-

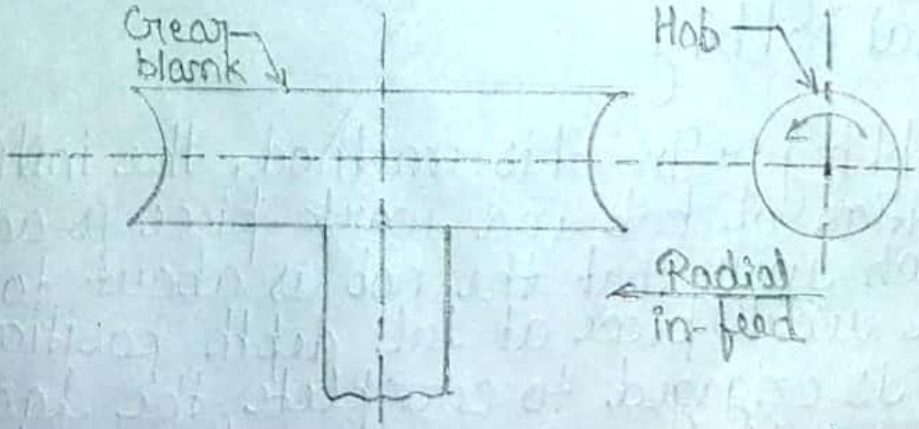
(1) Axial hobbing
(2) Radial hobbing
(3) Tangential hobbing

1 Axial hobbing :- In this method, the initial position of hob and work-piece is adjusted in such way that the hob is about to contact the work piece at full depth position. Axial feed is engaged to complete the face width. Axial hobbing, which is used to cut spur and helical gear can be climb hobbing or conventional hobbing.



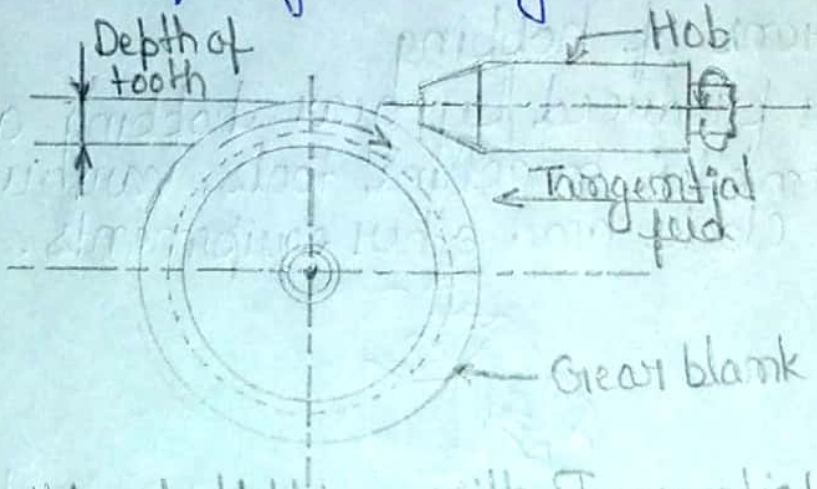
(a) Climb Hobbing

2. Radial Hobbing :- In this method, the work-piece is plunged with radial feed till the full depth is reached. Axial feed is automatically switched on and face width is completed. In this method, small portion of hob length is cutting at any time, so the wear of hob is not uniform. This has an adverse effort on the tooth profile accuracy. This method has high production rate and suitable for producing worm wheels.



Principle movement of Hob and blank in cutting a worm wheel using Radial in-feed.

3. Tangential Hobbing :- In this method, the job is initially at cutting the full depth of tooth and is then fed into the gear blank by an axial feed motion. This method is generally used for generating worm wheels.



Principle of Hobbing with Tangential feed.

Advantages of hobbing :-

1. It gives a high rate of production.
2. It is rapid and economical and high degree of accuracy can be maintained on the prod-cuts over a large period.
3. This method is suitable for large and medium batch production of all shapes.
4. Long shaft and splines can be easily accommodated on hobbing machines.
5. All types of spur and helical gear can be cut on metal and non-metals.
6. Gap type herringbone gear can be generated only through this process.

Disadvantages of Hobbing :-

1. Internal gears cannot be cut.
2. Gears which have shoulders and flanges cannot be cut.

Applications of hobbing

The gear produced by gear hobbing are used in automobiles, machine tools, various instruments, clocks and other equipments.

Cutting Hexagonal Ends of spindles

Gear Shaping :- A machine tool designed mainly for cutting teeth on a rotating gear blank by means of a reciprocating and rotating cutter is known as a gear shaper and the process is known as gear shaping. Gear shaping method is based on generation action which is achieved by the movement of two meshing gears. One of them is pinion, which is a cutter and the other is a blank. The cutter is mounted on a vertical ram which reciprocate just as in a shaper through a crank ram mechanism. At the same time, the cutter also rotates about its vertical axis. The work-piece, however, has the rotary motion.

Advantages of Gear shaping

Some of main advantages of gear shaping are as follow :-

1. It can be used for cutting spur gears, helical gear, racks, splines and many others.
2. Internal gear can be cut at fast rate.
3. One cutter can be used for all gears of the same pitch.
4. It can also cut gear upto a shoulder when only a slight recess has been provided.
5. Some non-conventional types of gears such as elliptical gears, duster gears, face gears can only be cut by gear shaping.
6. It is suitable for medium and large batch production.

Disadvantage of gear shaping :-

1. Only one gear can be cut at a time.
2. To cut helical gears, separate guides are requi-red.
3. It is not suitable for gears with wider flanks because the length of cut is shorter.

Gear Finishing Processes

For the gear to operate efficiently and to have satisfactory life, the tooth profile must be very accurate and the teeth should be hard and smooth. Gear made by cold rolling meth-od may not need further finishing, but gears made by other methods often need further

Finishing. The various finishing operations for gears are explained below :-

1 Shot-peening,
2. Lapping,
3. Honing,
4. Gear burnishing,
5. Gear grinding,
6. Gear shaving.

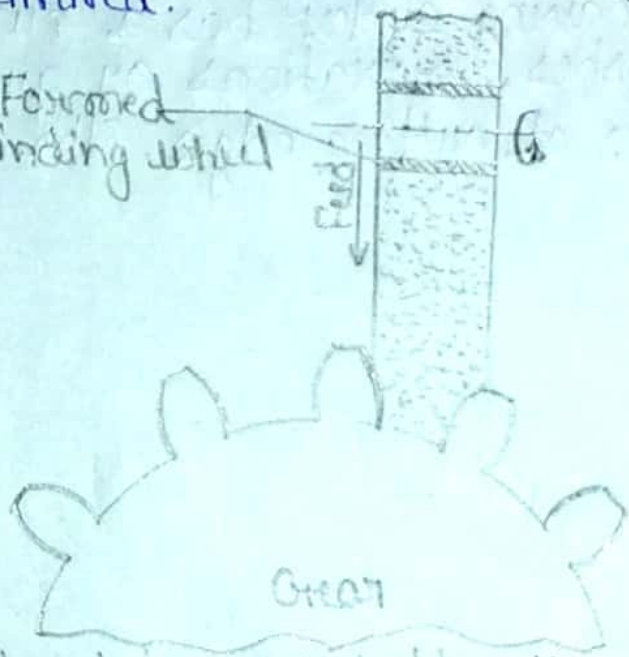
1. Shot-Peening :- Large unhardened gears are often shot-peening. Metal shots of 0.25 mm diameter are discharged at high velocity in large volume on the gear surface It improves fatigue strength of gear by about 60%.

2. Lapping :- The lapping process only corrects minute heat treatment distortion error in hardened gears. The gear to be finished is run in mesh with a gear shaped lapping tool or another mating gear (cast-iron).

3 Gear Burnishing :- Burnishing is a cold working process which is again used on unhardeners gears. The material from the non-desired region is plastically moved out by rolling a standard and highly hardened gear over the work gear.

4. Honing :- Honing is employed mainly to remove burrs and nicks and thus for improving the surface finish. In this method, the honing tool (made of plastic material with abrassive material embedded in it) is run in mesh at crossed axes with the gear.

5. Gear Grinding :- Hardened gears are very difficult to finish by shaving and burnishing method. Since the heat treatment may cause severe distortion and oxide film formation on teeth, therefore, there is a necessity of removing considerable stock from the teeth. With the grinding method, it is possible to finish the heat-treated gears. Through the method is slower and more expansive, but it guarantees highest quality gears. Therefore, its use is very limited.



Principle of form grinding the gear teeth

6. Gear Shaving :- The process of finishing gear teeth by running the gear at high speed in mesh with a gear shaving tool in the form of a rack or pinion is called gear shaving.

It is mostly used for finishing spur and helical gears after machining. This process is suitable for unhardened gear. It is a rapid and economical method of finishing. The tool

used is a helical gear type rotary cutter with serrations. There are two main methods of gear shaving :-

(i) Rotary gear shaving,
(ii) Rack gear shaving.

(i) Rotary gear shaving :- In rotary shaving, the cutter and the gear run in mesh As they rotate the gear is traversed longitudinally across the saving cutter or vice-versa. The rotary shaving cutter has a number of peripheral gashes, serrations or grooves to form a series of cutting edges. The usual angle is 10° to 15°.

CHAPTER-03
Grinding

3.1 Purpose of grinding
3.2 Various elements of grinding wheel - Abrasive, Grade, structure, Bond
3.3 Common wheel shapers and types of wheel- built up wheels and diamond wheels. Specif -ication of grinding wheels as per BIS.
3.4. Truing, dressing, balancing and mounting of wheel.
3.5 Grinding methods - Surface grinding, Cylindrical grinding and centreless grinding.
3.6 Grinding machine. - Cylindrical grinder, Surface grinder, internal grinder, centerless grinder, tool and cutter grinder.
3.7 Selection of grinding wheel
3.8 Thread grinding

Grinding :- A process of material removal in the form of small chips by means of rotating abrasive particles bonded together in a grinding wheel to produce flat, cylindrical or other surface is known as grinding.

Purposes of grinding :-

Grinding is mainly used for the following purpose :-

(i) It is used for shapening the cutting tools.
(ii) It is used for grinding threads in outer to have close tolerances and better finish
(iii) It is used to produce surface with a higher degree of smoothness.
(iv) It is used to machine materials which are too hard for machining by other method using cutting tools.
(v) It is used to remove a very small amount of metal from the workpiece.
(vi) Sometimes, it is also used for higher material removal rate.

Element of grinding wheel :-

(1) Abrasive :- A substance used for the removal of material by abrasion (ie. scratching or grinding) is known as abrasive. An abrasive is a hard material used for making grinding wheels. Abrasive are small particles bonded together in different shapes.

Abrasives used for make grinding wheel may be classified as follow:

(i) Natural abrasives,
(ii) Artifical abrasives.

(i) Natural abrasives :- The commonly used natural abrasives are as follow:
(a) Sand stone or quartz,
(b) Emery,
(c) Corundum,
(d) Garnet,
(e) Diamond.

(ii) Artifical Abrasives :- The abrasive used these days for making grinding wheel and products of electric furnace are artifical abrasives. They posses better cutting properties and higher efficiency than natural abrasives commonly used artifical abrasives are as follow :-

(a) Silicon Carbide :- The chemical formula of Silicon carbide is SiC. It is used in a variety of colour. Bluish green is the most suitable for grinding very hard materials like carbide tools in the market, it is sold in various trade name e.g. Carborundum.

(b) Aluminium Oxide :- The chemical formula of aluminium oxide is Al_2O_3. It is brilize white in colour. In the market, it is sold as alexide, alundum or boralon.

2. Grade :- The grade is also called the hardness of the wheel. It designates that forces which hold the grains. The grade of a wheel depends on the type of bond, structure of wheel is amount of abrasive grain. The grad is denoted by letter as indicated below:

Very soft: A B C D E
Soft: F G H I J K
Medium: L M N O
Hard: P Q R S
Very Hard: T U V W X Y Z

Soft wheels are generally used for hard materials and wheels for soft materials.

3. Structure :- The structure of a grinding wheel represents the grain spacing. The spacing between the grain allow for chips to collect. Open structures are used for high stock remove and consequently, produce a rough finish. Dense structure are used for precision and prod grinding.

4. Bond :- A bond is an adhesive material employed for holding abrasive grains together and giving the desired shape to grinding wheel. The bond commonly used for the manufacture of grinding wheels are as follow:

(i) Vitrified bond (denoted by V),
(ii) Silicate bond (denoted by S),
(iii) Shellac bond (denoted by E),

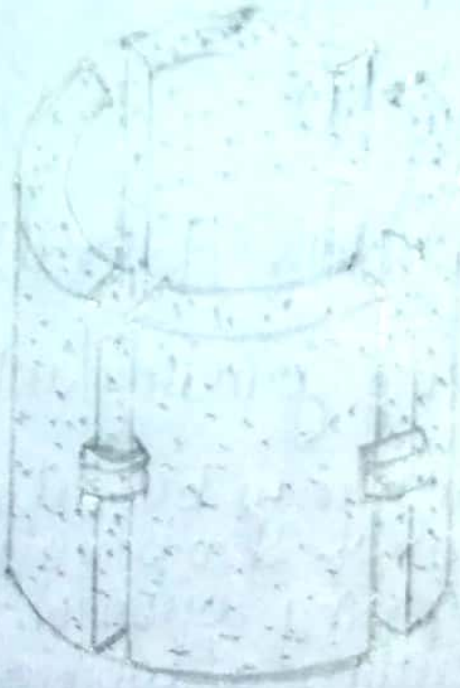
(iv) Rubber bond (denoted by R),
(v) Bakelite or resinoid bond (denoted by B),
(vi) Oxychloride bond.

Types of grinding wheel :-

1. Built-up-wheels :- These wheels are made in many ways. Essentially, these consist of number of bonded abrasive blocks held together by suitable means. A typical example of this wheel consists of blocks fastened to metal by means of wedges.
These wheels are mainly used in surface grinding and have following advantages :-

(i) It is easier to manufacture these wheels in large sizes in comparision to the solid wheels of the same sizes.

(ii) These cut intermittently and Hence cool grinding is the result.



Segment Grinding wheel

2. Diamond wheels :- These wheels are also made in almost similar shapes as those of aluminium oxide or silicon carbide wheels. These wheels are made with three different types of bonds : Resinoid, Vitrified, and metallic. Each has particular applications with some overlapping. In order to conserve diamond, wheel large than 25 mm in distance are produced with the a border diamond layer at the cutting surface.

Specifications of grinding wheels as per B.I.S.

I.S. : 551 - 1996 lays down the rules for the making system of grinding wheels. The making system comprise of six symbols. These are as follow :

1. Type of abrasive
2. Grain size of abrasive
3. Grade of abrasive
4. Structure (optional)
5. Type of bond
6. Identification mark (optional)

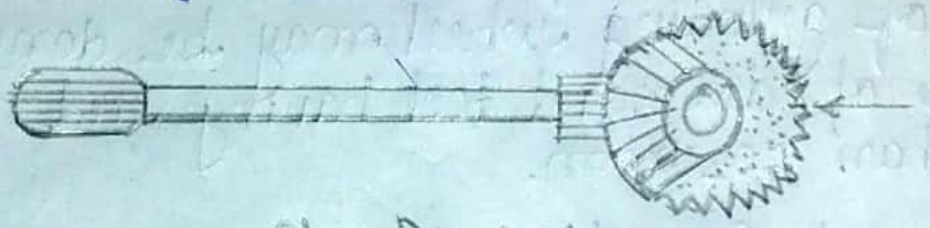
Dressing and truing grinding wheels

1. Dressing :- Dressing may be defined as the operation of sharpening dull abrasive grains or exposing fresh sharp grains on the face by cutting a position of the wheel is known as dressing of the grinding wheel.

These are various types of dressing tools as follow :-

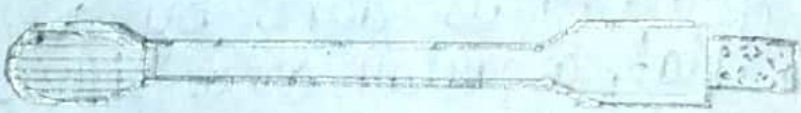
1. Wheel dressers,
2. Abrasive stick dressers.
3. Abrasive wheel dressers

1. Wheel Dressers :- For dressing wheels for coarse grinding, fluted steel wheels are used. These dressers form a very common group of wheel dressers.



Star Dresser

2. Abrasive stick dressers :- These are made with square and round section. Square section sticks are used for hand dressing in toolroom work. Round section sticks are used shaping the wheel faces, ing and dressing thin wheels.



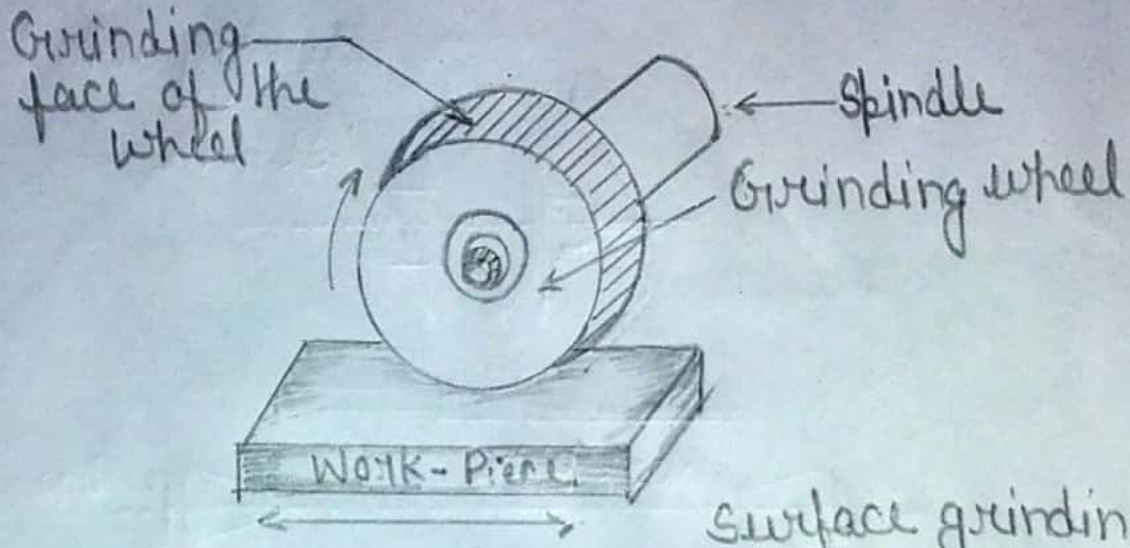
Abrasive Stick Dresser

3. Abrasive wheel Dressers :- It is a silicon carbide grain wheel with vitrified bond a vastly used on cylindrical and centreless grinders used for grinding camshafts, crankshaft pistion etc.

Truing :- Truing is the process of changing the shape of grinding wheel from the original shape when it becomes worn due to breaking of abrasive and bond. Truing of grinding wheel may be done with the help of diamond tool having feed not more than 0.02 mm.

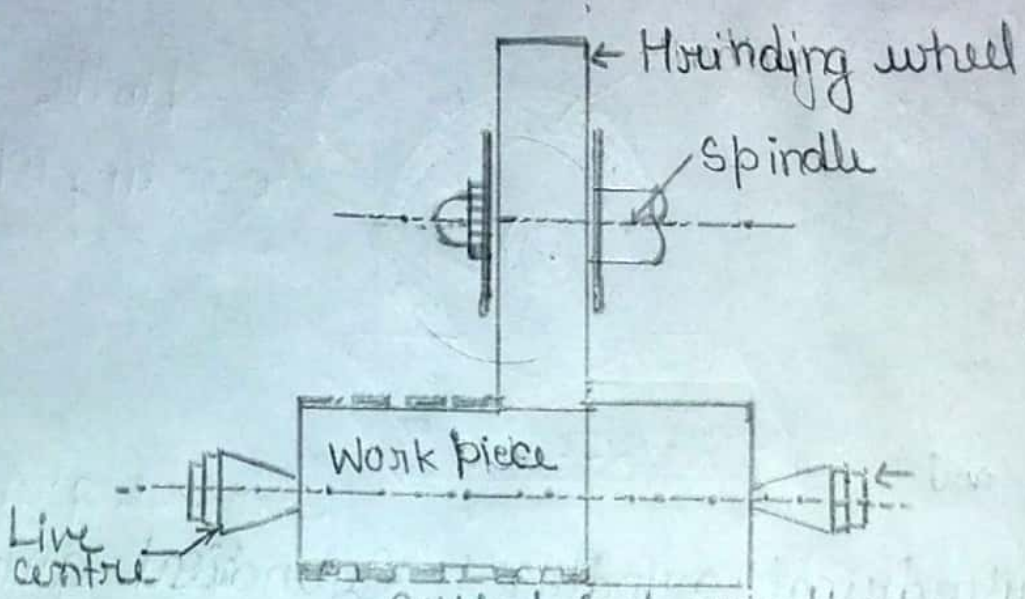
Methods of Grinding :-

1. Surface grinding :- It is an operation of grinding a flat surface in a horizontal position. It produces flat surfaces during operation. The work may be ground by either the periphery or by the end face of grinding wheel. The workpiece is reciprocated at a constant speed below or on the end face of the grinding wheel. Surface grinding is done by a surface grinder, flat, angular and irregular surfaces may be produced by surface grinding. Steel pallets, precision V-blocks, pistern rings gauge faces, precision washer and formed surfaces on hard materials are ground by this method.



Surface grinding

2. Cylindrical grinding :- Cylindrical grinding is the process of grinding the curved surface of a cylindrical piece. These surfaces may be straight, taper or contoured. The workpiece is mounted between two centres, one is the tail-stock centre and the other is the head stock centre. The tailstock centre is the dead centre and the head-stock centre may or may not revolve during grinding. When high accuracy is required, the two supporting centres must remain stationary while the workpiece revolves. When both centres are dead, precision size and good finish can be obtained because there is no possibility of run out from the head stock spindle. The workpiece and the table reciprocate while the grinding wheel in contact with the workpiece removes the material.



Cylindrical grinding

3. Centreless grinding :- It is an operation of grinding the diameter of work holding between centres. During operation, work piece pass between two grinding Centreless grinding method is also employed for grinding the curved surface of long slender on which cannot be ground by cylindrical grinding due to the lateral thrust of the wheel on the workpiece. The rotation of the grinding wheel pushes the workpiece down on the work-rest blade and against the regular wheel. The regulating wheel, usually made up of a rubber bonded abrasive, rotates in the same direction as the grinding wheel and controls the longitudinal feed of the workpiece.

Grinding machines :-

1 Cylindrical grinders :
(i) Centre-type,
(ii) Chucking type,
(iii) Centreless.

2. Surface grinders:
(i) Reciprocating table,
  (a) Horizontal spindle
  (b) Vertical spindle
(ii) Rotating table.
  (a) Horizontal spindle
  (b) Vertical spindle

3. Internal grinders :
(i) chucking
  (a) Plain
  (b) Universal
(ii) Planetary
(iii) Centreless

4. Tool and cutter grinders :
(i) Universal
(ii) Special.

Selection of grinding wheel

The proper selection of grinding wheel is important to ensure rapid work, good surface finish and increased wheel life. To get optimum result, the various elements which influence the selection of a grinding wheel can be classified as follow:

1. Constant factors,
2. Variable factors.

The various factors which need consideration while selection of a grinding wheel are abrasive, grain size and shape, type of bond, bond strength and hardness. A brief description of these element are as follow:

1. Selection of Abrasive: The selection of abrasive depends upon the material to be ground silicon carbide (SiC) and aluminium oxide (Al_2O_3) are abrasive commonly used. For grinding soft material, aluminium oxide is used.

2. Selection of grain size: The convention followed in grinding is to use coarse grained wheels for soft materials and grained wheels for hard materials. For fine finish, soft wheels are preferred. The mesh number denotes the number of meshes per linear inch (25.4 mm) of the screen through which the grains pass.

3. Selection of grade: The grade refers to the hardness of a wheel. A hard material resists wear and tear and increase wheel life. Grain are held together by bind -ing materials. The binding material must hold the abrasive until it is completly used.

4. Selection of structure: The structure of a grinding wheel represents the voids between the abrasive. The struc -ture is denoted by the number 1 to 15.

5 Selection of area of contact :- The area of contact between the grinding wheel and the workpiece largely affected the grain size and grade.

6. Selection of wheel speed :- The speed of a grinding wheel is influenced by the grade and the bond. The higher the speed of a grinding wheel, the softer it is.

7. Selection of work speed :- The speed at which the workpiece traverse across the wheel face is known as the work speed. The higher work speed, the greater is the wear and tear of the wheel.

8. Selection of Bond :- The class of work usually designates the type of bond to be used. The wheel speed also influen- ces the selection of bond.

Thread grinding :- Thread grinding is used either as a finishing operation or as a forming operation on many screw threads where smooth finish and accuracy are required. Thread grinding may be carried out in the following two ways:

(i) Single wheel grinding method,
(ii) Plunge cut grinding method.

(i) Single wheel grinding method :- This method is used for blanks of large lengths In this method, a thin disc type grinding wheel is used. The wheel while running keeps traversing the length of the thread.

(ii) Plunge cut grinder method :- This method is used for threads of small lengths and finishing at the shoulder. The length of grinding wheel is large than the length of threads to be formed.

CHAPTER → 04
Modern Machining Processes

4.1 Mechanical process - Ultrasonic machining (USM) : Introduction, principle, process, advantage and limitations, application.

4.2 Electro chemical processes - Electro chemical mechining (ECM) - Fundamental principle, process, applications.

4.3 Electrical discharge machining (EDM) - Introduction, base EDM circuit, principle, metal removing rate, dielectric fluid, application.

4.4 Laser beam Machining (LBM) - Introduction, machining process and applications

4.5 Plasma arc machining (PAM) and welding - introduction principle process and applications

Ultrasonic Machining (USM)

Introduction :- The term 'ultra-sonic' is used to describe vibrational waves having a frequency above the hearing range of normal ear i.e beyond 18KHz. The process of material removal by repetitive impacts of abrasive particles of an abrasive slurry vibrating at an ultrasonic frequency between the tool and the workpiece.

Principle of USM :- A slurry of small abrasive particles is forced against the work by mean of a vibrating tool. The material is removed due to action of abrasive grains which are hammered into the work surface by tool oscillating at high frequency normal to the work surface. For this purpose, the tool oscillation frequency in the range of 20KHz

Ultrasonic are produced by feeding high frequency electric current to a transducer which converts it to high frequency mechanical vibration.

Element of the process

(i) Cremerator :- The generators for machining should have following properties:-

(a) Compact, reliable and easy to operate
(b) Controlled power output over a wide range
(c) Absence of high harmonics in the output voltage.

2. Transducer :- Transducer used in ultrasonic machining works on the principle of magnetostriction. A magnetostrictive transducer is a basically a magnetized rod which has a coil wrapped around it in which a voltage is induced by tension or compression. On returning to its original position, the bar induces a voltage of opposite polarity. The amplitude of vibrations is proportional to voltage applied. The transducer used in ultrasonic machining works on this later principle and the range of frequency is 0-60 H_z. The magnetostrication materials used for these transducer and nickel, alfer peramfandur etc.

3 Concentrator :- Tool cone (or horn) focuses the mechanical energy produced by the transduce to the workpiece in such a manner that its utilization is optimum. The main purpose of the concentrator is to increase the amplitude upto the level needed for cutting. The concentrators used are of various shapes and designs such as exponential, conical and stepped type.

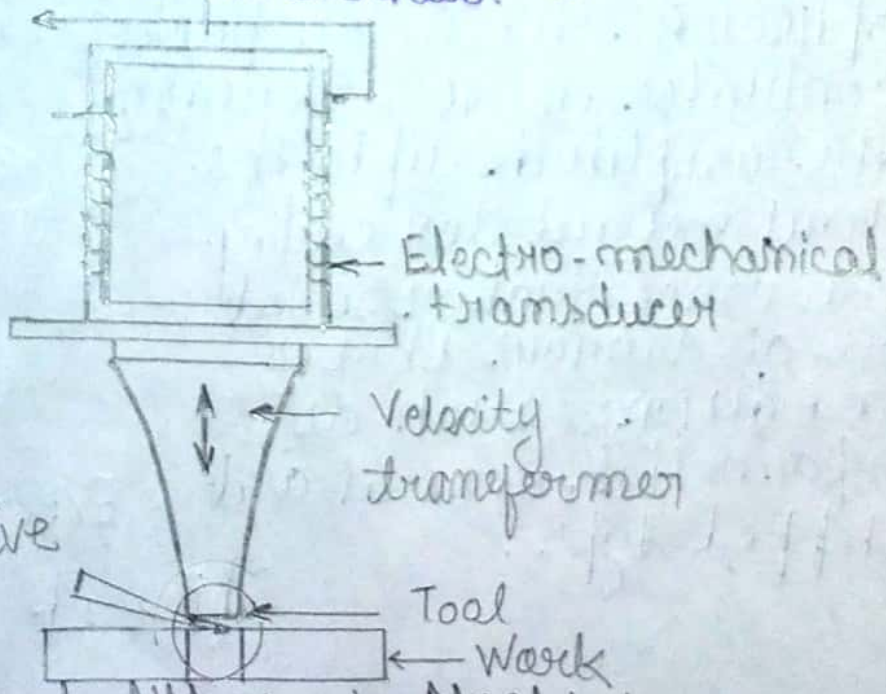
Exponential

Types of concentrator

4. Abrasive :- The most common abrasives are : (i) Boron carbide (B_4C), (ii) Silicon carbide (SiC), (iii) Corundum (Al_2O_3), (iv) Diamond and (v) Boron silicarbide. The slurry of abrasive is supplied at high pressure using pump through nozzle at the cutting zone. The basic purpose of supplying slurry are as follow :-

(i) It acts as cutting machine
(ii) It acts as tool to fracture metal.
(iii) It acts as coolant.

5. Tool :- The shape of tool has an important effect on the rate of tool penetration in ultrasonic machining. Tool with smaller contact area yields better penetration rate allowing efficient flow of abrasive underneath. Tough malleable materials such as stainless steels, alloy steels are suitable for tool materials.



Principle of Ultrasonic Machining

Advantages of ultra sonic machining :-

(i) Hard and brittle materials can be easily machining.
(ii) The workpiece produced by this method is free from stresses.
(iii) The operation is generally noiseless.
(iv) The physical properties of the work material do not change.
(v) Highly skilled operator is not required to operate this machine.
(vi) Cost of production is low.

Disadvantages of USM :-

(i) The cost of the equipment is high.
(ii) The cost of tooling is also high.
(iii) Power consumption in the machining is high.
(iv) It is not suitable for heavy metal removal.
(v) The metal removal rate is also low.
(vi) The size of the cavity that can be machined is limited.

Application of USM :-

(i) It is used for cutting operation.
(ii) It is used for surface finishing.
(iii) It is used in forming of plastics.
(iv) It is used for generating round, irregular holes and impressions.

Principle of Electro-chemical Machining.

Electro-chemical machining is a new field of metal removal which has been developed on two well known principles given by ohm and Faraday. According to the first law of electrolysis, the amount of any substance dissolved or deposited is proportional to the quantity of electricity that it passed through the electrolyte.

According to the second law of electrolysis the amount of any substance dissolved or deposited by the same quantity of electricity it proportional to the chemical equivalent weight of the electrolyte.

Electro-chemical Machining Process

The process consists of the following steps:-

(i) The job to be machined is fixed in the vice, in the machining chamber.

(ii) The tool which act as a cathode in the electrolytic cell is brough near the job with the help of press buttons provided on the control panel and table lifting arrangement for maintaining particular gap.

(iii) Then the process is [illegible] in the presence of the an electrolyte that is circulated with the help of pump filling the gap b/w anode (job) and cathode (tool). Generally the gap is taken b/w 0.05 to 0.3 mm.

(iv) When the current is switch on, the electrolyte (say $NaCl + H_2O$) gets ionised according to the relationship given below:

$$NaCl \rightarrow Na^+ + Cl^-$$

$$H_2O \rightarrow H^+ + OH^-$$

As hydrogen ions reach the cathode, they combine with the free electrons resulting into evolution of H_2 gas

$$2H^+ + 2\bar{e} - H_2 \uparrow$$

(v) The tool is fed at controlled rate and when desired depth of machining has been achieved, hooter gives an indication of completion of the process.

(vi) After this, the tool is taken to its initial position, then workpiece is taken out, & cleaned the job.

Application of Electro-Chemical Machining:-

(i) It can be used for various metals except non conductive metals.

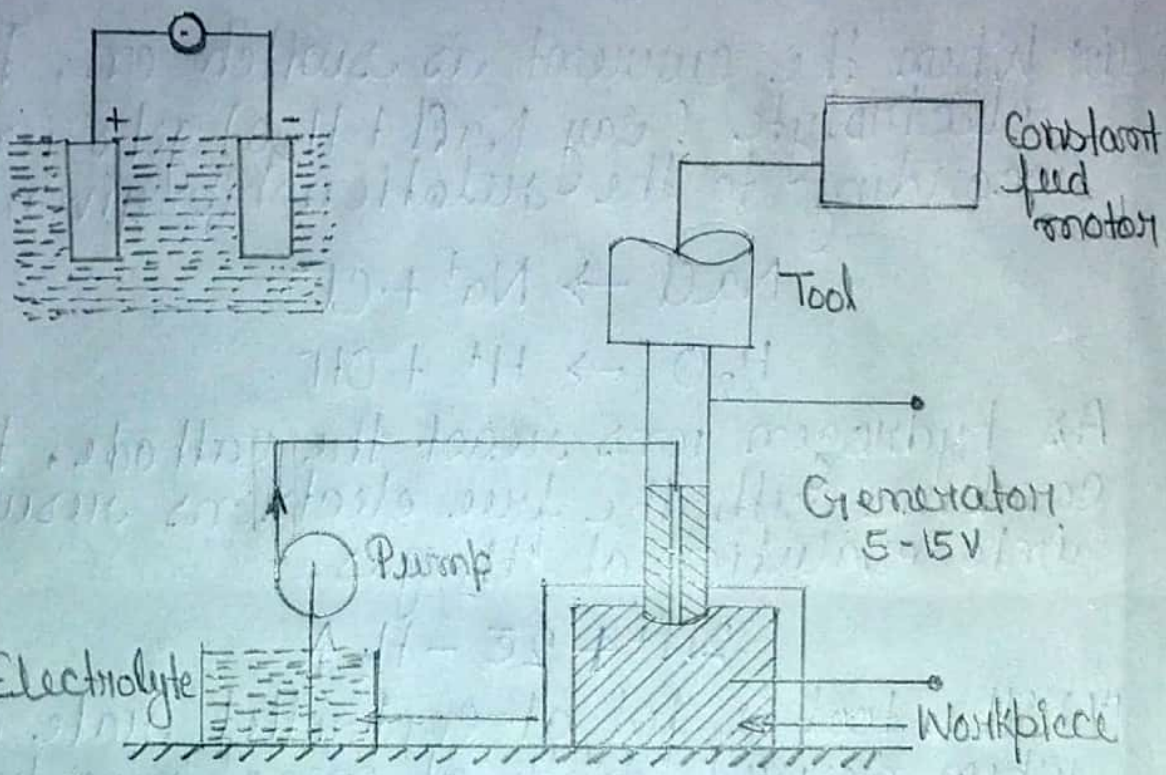
(ii) Machining of blind holes and pockets such as in forging dies.

(iii) Machining of cavities and holes of irregular shapes

(iv) It can be used for machining harder metals and fragile parts.

(v) Machining of aerospace components.

(vi) Drilling small deep holes such as nozzles.



Principle of Electro-chemical Machining

Electric Discharge Machining (EDM)

Introduction:- This process is also known as spark erosion machining. In this process, the metal is removed due to erosion caused by rapidly recurrying spark discharge between the tool and work. The concept of EDM was developed in USSR in 1943. The main aim of this process is controlled removal of material from the work piece. The rate of metal removal and the surface finish can be controlled by proper variation in the energy and the duration of spark discharge.

Principle parts of EDM

(i) Dielectric-fluid and circulation system.
(ii) D.C power supply.

(iii) Reduction gear box,
(iv) Rack and pinion,
(v) Base
(vi) Capacitor
(vii) Permanent magnet servometer.

Principle of EDM :- The basic principle of electric discharge machine shown fig. In this process, when a discharge takes place b/w two point of the Anode and Cathode which are separated by a gap called spark gape, the intense heat generated near the zone melts and evaporates the materials in the sparking zone. As the electric connected to the positive terminal generally erodes at a faster rate, the workpiece is made anode

Metal removing rate (MMR) in EDM :- The metal removing rate is proportional to the working current value. It is generally described as the volume of metal removed per ampere which then yield a basis for the output comparison of different machines. The machining rate during roughing the steel with a graphite electrode with a 50 A generator is about 400 mm^3/min. and with a 400 A generator is about 4800 mm^3/min.

Dielectric fluid used in EDM :- The dielectric fluids generally used are minerals oil, white spirit, transformer oil, Silicon oil or Kerosense.

These have the following function :-

(i) It removes the eroded material from the surface of the tool and workpiece continuously.

(ii) It provides the effective cooling to the system.

(iii) It maintains the suitable condition for effective sparking.

Application of EDM :-

(i) Cutting of slots in diesel fuel injection nozzles.

(ii) Machining of intricate shapes, blind cavities and narrow slots.

(iii) It is used for resharpening of cutting tools and broaches.

(iv) It is also for trepanning of holes with straight or curved axes.

Laser Beam Machining (LBM)

Introduction :- The word LASER stand for "Light Amplification by stimulated Emission of radiations". In Laser beam machining, the mono-frequency stimulated beam of light of order 10^5 KW/mm2 is focused on the surface of workpiece to remove the metal by melting and evaporation.

Process of Laser Beam Machining :-

(i) The work-piece is held in work holding device below the laser mechanism.

(ii) As the xenon filled flash lamp is fired by discharge of a large capacitor through it intense radiation from the lamp excite the fluorescent impurity atom to a higher energy.

(iii) When the atom falls back to original energy level, an intense beam of visible light is emitted.

(iv) When this light is reflected back again and again more atoms are excited and stimulated to return to ground level.

(v) The stimulated light is transmitted through the reflective coating and when this light is focused with ordinary lens at spot on the work piece, high energy density is obtained which will melt and vaporize the metal.

(vi) In this way, laser beam machining works.

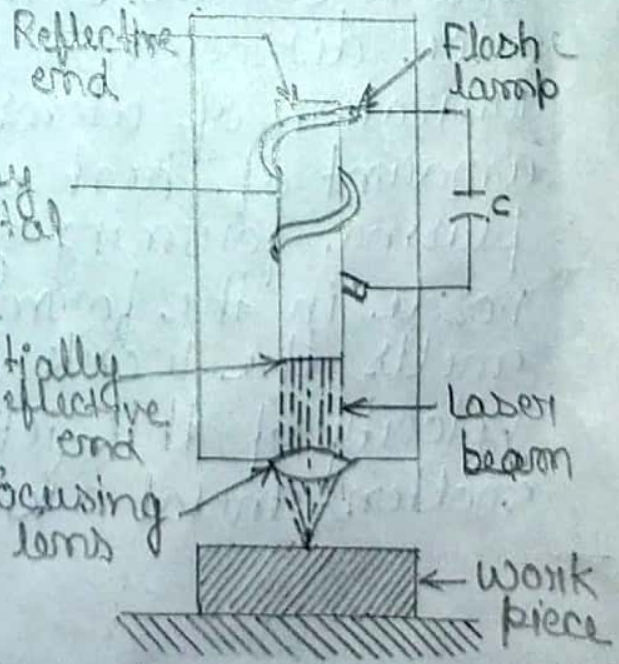
Application of LBM :-

(i) It is used for micro welding and micro drilling work.

(ii) A holes as small as 0.005 mm in diameter can be produced

(iii) Drilling the holes in rubber baby bottle nipple

(iv) Relief holes in pressure plugs.



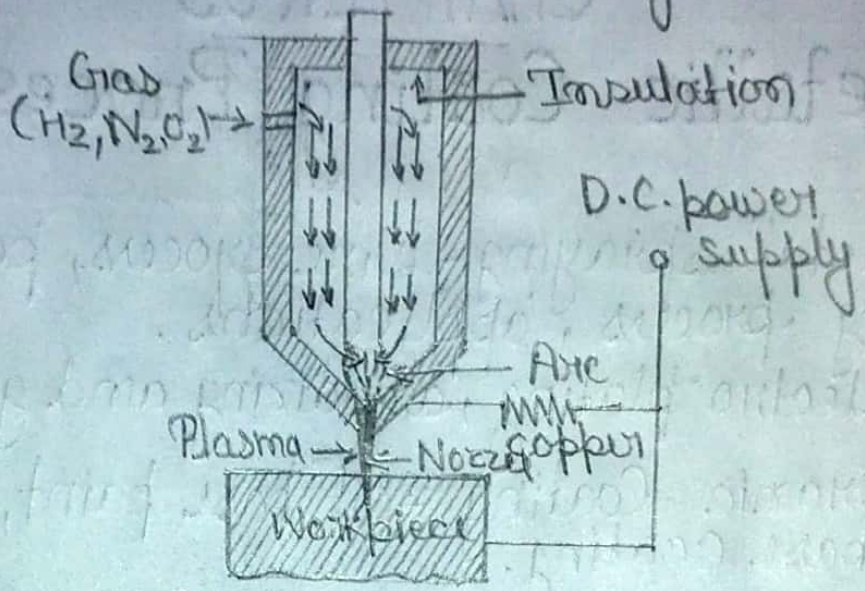
Laser Beam Machining

Plasma arc machining (PAM) :- When a following gas is heated to a sufficient high temp. to become partially ionized, it is called plasma. Plasma arc machining is a material removal process in which material is removed by directing a high velocity jet of plasma (11000°C to 30000°C) on the work piece.

Principle and Working of Plasma arc Machining :-

The principle of plasma arc machining shown in fig. In this plasma torch, a volume of gas as hydrogen, nitrogen, oxygen etc is passed through a small chamber in which a high frequency spark is maintained b/w tungsten electrode (cathode) and copper nozzle (anode). Both the electrode are water cooled. The high velocity electrons produced by the spark collide with the gas molecules and produce dissociation of the gas resulting in ionization of atoms. Due to this, a large amount of heat energy is generated. This plasma forming gas is forced through the nozzle in the form of jet. This plasma jet melts the work-piece material and high velocity of this jet effectively blows the molten metal away.

Plasma Arc Mechining



Application of Plasma arc machining.

(i) Cutting stainless steel and alluminium alloys.
(ii) Turning and milling of materials which and hard and difficult to machine.

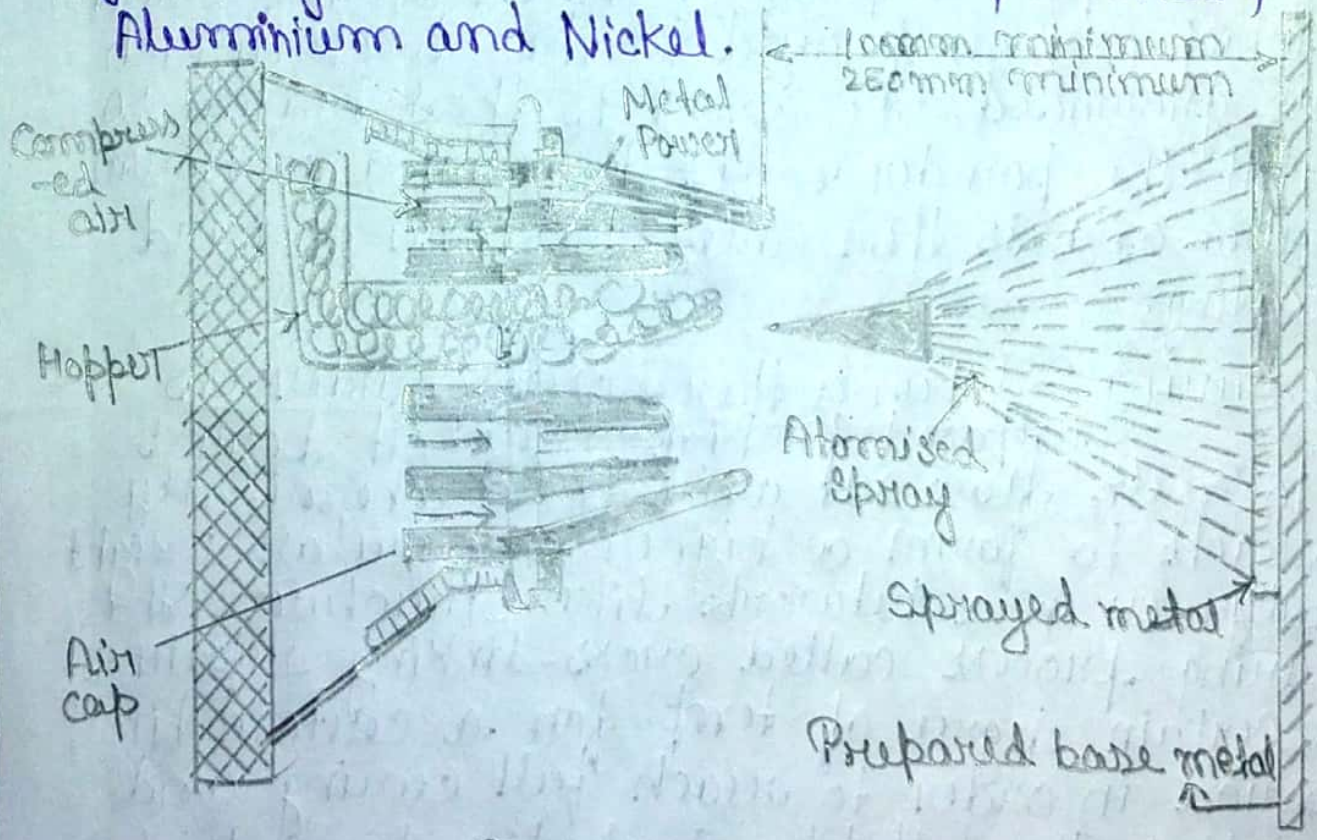
CHAPTER-05
Metallic Coating Processes

5.1 Metal spraying - Wire process, powder coating process, applications.

5.2 Electro plating, anodizing and galvanizing

5.3 Organic Coating - oil base paint, rubber base coating.

Wire gun method :- In this method, special type of spray gun is used which carries a gas torch. This torch is attached with oxygen and acetylene cylinder. The schematic diagram of wire gun method is shown in fig. In this method, the wire is drawn through the gun and nozzel by a pair of rollers and melted by an oxy-acetylene flame. Then a blow of compressed air is used with a high velocity to atomize the molten metal and deposite it uniformly on the prepared surface. Through any metal that can be drawn into wire can be used in this gun, but generally used metals are steel, bronze, Aluminium and Nickel.



Power Metal Method

Process of Powder Coating

The powder coating process involves the following three steps :-

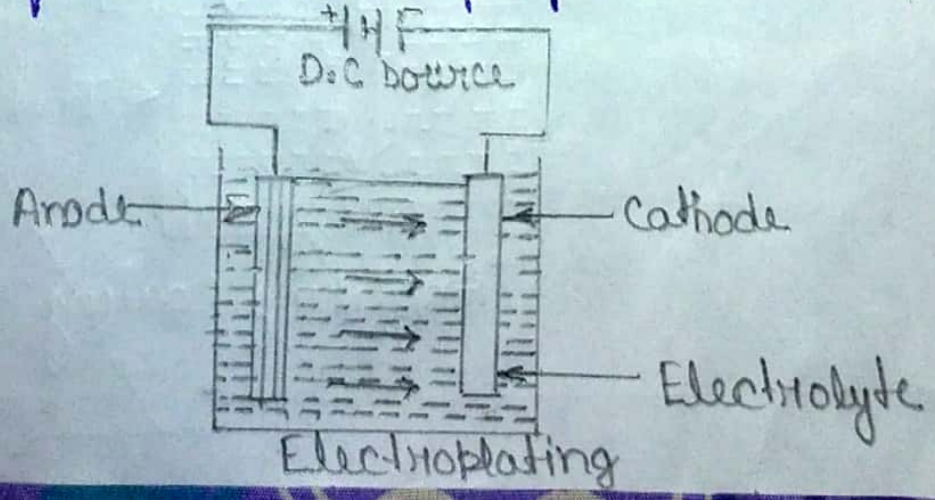
1. Part Preparation :- Removal of soil, oil, grease, metal oxide, welding scale etc. essential prior to powder coating. It can be done by a variety of chemical and mechanical methods.

2. Powder Application :- The most common way of applying powder coating to the metal objects is to spray the powder with the help of an electrostatic gun. The gun impact a positive charge on the powder which is then sprayed to the object which is grounded. The object is then heated so that the powder melts to form a uniform film and is then cooled to form a hard coating.

3. Curing :- When a thermoset powder is exposed to high temp., it begins to melt, flow out and then chemically reacts to form a higher molecular weight polymer in a network like structure. The curing process called cross-linking requires a certain degree of temp. for a certain time period in order to reach full curing and establish the full film properties for which the material was designed. Normally, the powder cure at 200°C in 10 minutes.

Electroplating :- Electroplating is a very popular process of providing metallic coating by means of electrolysis.

The principal involved in electroplating of all the metals is the same. The main elements involved in this process are in electrolyte, a tank containing this electrolyte an anode (+ve terminal), a cathode (-ve terminal) and low voltage direct current supply. The electrolyte is nothing, but a metallic salt solution. The workpiece to be electro-plated is suspended into the electrolyte filled in the tank. Electrically, it is connected to the negative terminal and the material to be coated is connected to the positive terminal so as to act as anode.
When plastic are to be plated, primary coat of an electrically conductive material is first provided over them and then they are electroplated.
Chromium and nickel plating provided sufficient corrosion resistance and are extensively used for decorative purpose.



Electroplating

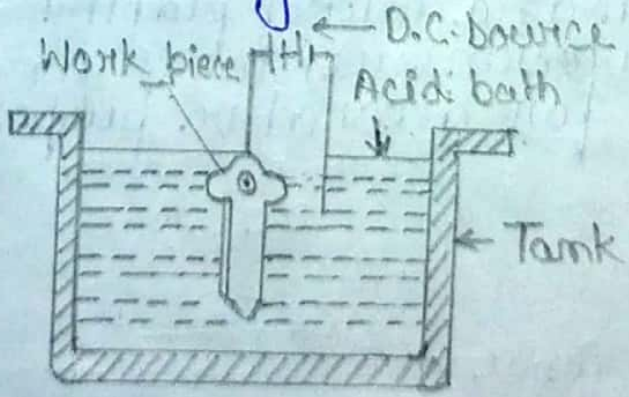
Anodizing Coating :- Anodising is an oxidation process developed for aluminium. An electrolyte of sulphuric acid, oxalic acid, chromic acid or phosphoric acid is employed with the part to be anodised which act as anode.

The process is generally completed in three different stages. The first stage consists of cleaning and preparation of surface. The second stage consists of anodizing i.e converting the metal surface into an oxidised film. The third stage consists of providing desired colour and stability of the anodised film.

Process of Anodizing Coating

(i) When an electric current is supplied to electrolyte, hydrogen is produced at the cathode and oxygen at the anode.

(ii) Oxygen instantly tries to combine with any material brought in contact with it.



Anodizing Coating

Galvanizing :- Galvanizing is a commercial term used to designate a process by which a zinc coating is provided on steel by immersion in molten zinc to protect the steel from corrosion.

The application of zinc coating to steel surface used for protection against corrosion has been in practice for many years.

The galvanizing process for covering metal product with metal coating is very simple in theory. First of all, the work is cleaned by pickling with dilute sulphuric acid to remove any scale, rust and impurities. After washing and drying, the work is completely dipped in the molten metal and withdrawn with enough of the molten metal adhering as a surface film to give it the desired coat. The duration of immersion in zinc bath depend upon the size of work-piece to be coated. The quality of the coating produced depend on following factors:

(i) The preliminary cleaning of the metal product to be coated.

(ii) The regulation of the bath temperature.

Advantages of galvanizing :-

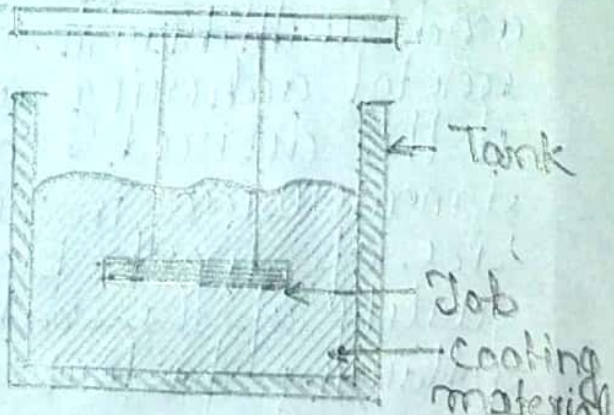
(i) It is very simple in nature
(ii) It is best suitable for irregular shape products.
(iii) It takes less time.

Disadvantages of galvanizing :-

(i) It is used only for limited metal.
(ii) As zinc gets dissolved in dilute acid to form highly toxic compound, therefore, the galvanised utensils should not be used for preparing and storing food stuffs especially acidic ones.

Applications of galvanizing :-

(i) It is used for roofs and walls of buildings,
(ii) Structural parts
(iii) Fencing material,
(iv) Pipes
(v) Containers.
(vi) Wires etc.



Principle of galvanizing

Organic Coating :-

1. Oil Base Paint :- It may be defined as a dispersion of pigment in a drying oil with the addition of driers and thinner, the former to accelerate film formation and hardening and the latter

to allow uniformity in brushing and spraying.

Ingredients of An Oil paint :-

(i) Base :- This is the main ingredient of a paint. It is a metalli oxide in the form of a powder. It function is to create a film which can resist abrasion and prevent cracks formed in the film during drying.

(ii) Pigment :- Pigment are the colouring agent which are usually available and mixed in the paint in powdered form.

(iii) Vehicle :- The Vehicle in an oil paint acts as a binder and enables suspension of base and pigment so as to facilitate even application and adherence on the surface of work.

(iv) Solvent :- A solvent is mixed in the paint to reduce its consistency and increase fluidity so that it can be easily spread over the surface.

(v) Drier :- The drier used in the paint increases the rate of drying of the solvent through oxidation, which is the main reason of quick drying of the paint, although some drying does take place by evaporisation also.

(vii) Inter-filler :- It is an adulterant usually mixed in an oil paint (a) To modify its weight, (b) To improve its durability and (c) To affect economy in the cost of base used.

(viii) Plasticizer :- Plasticizer is used to give elasticity to the film and this minimizes or prevents cracking.

Characteristics of a good paint :-

(i) It should dry quickly
(ii) It should not crack on drying
(iii) It should have long life.

2. Rubber Base Coating :- Rubber is a polymeric material with high elastic yield strain. It is also known as elastomer. Three important types of rubber are :-

(i) Neoprene :- This coating consists of neoprene dissolved in a solvent After the application, the solvent evaporates and a film of neoprene is left behind on the metal surface.

(ii) Hypalon :- It is a chlorosulfonated polyethylene. The most outstanding feature of this is to resist to oxidizing agent.

(iii) Chlorinated Rubber :- High resistance to water is the outstanding feature of this rubber. It is used for only protective purpose and not for decorative one as it is very limited in colour.

CHAPTER-06
Metal Finishing Processes

6.1 Purpose of finishing surfaces.
6.2 Surface roughness - Definition and units.
6.3 Horning Process, its applications
6.4 Description of hones
6.5 Brief idea of honing machines.
6.6 Lapping process, its application.
6.7 Description of lapping compounds and tools.
6.8 Brief idea of lapping machines.
6.9 Polishing
6.10 Buffing
6.11 Burnishing

Purpose of finishing Surfaces

The main purpose of finishing surfaces of metal parts are as follow :-

(i) To improve the functional, properties of the machine parts such as wear resistance, corrosive resistance, fatigue resistance etc.
(ii) To remove fine and scale from parts.
(iii) To improve micro finish.
(iv) To reduce the friction between mating surface.
(v) To make higher contact area
(vi) To lower down the heat generation between mating parts.
(vii) To increase the surface life of parts.

Surface Roughness :- It may be defined as fine irregularities in the surface It is known to us that no surface is perfectly smooth. Even the surfaces produced by super finishing processes show micro irregularities when they are seen under microscope. These irregularities affect the functional qualities of mating parts and are called surface roughness.

Surface roughness unit :- Microns.

Honing :- Honing is a finishing process. It is an grinding process used for finishing various shapes by means of bonded abrasive stone called hone.

Honing Process :-

(i) The work piece is clamped rigidly on the work table. Care must be taken to keep the bore exactly parallel to axis of the hone spindle.

(ii) The abrasive sticks of aluminium oxide or silicon carbide are mounted on a mandrel or fixture.

(iii) A floating action between the work and the tool prevails so that any pressure exerted on the tool is transmitted equally on all sides.

(iv) The stroke and working length must finally be adjusted which the hone must follow in order to obtain a good cylindrical bore.

(v) The honing tool is given a slow reciprocating motion as it rotates having resultant honing speed from 10 to 30 m/s. This action results in rapid removal of stock and at the same time, generation of a straight and round surface.

(vi) The hole to be honed is flooded with a lubricant like paraffin, hand oil mixed with kerosene, while the honing stick act as metal removal. Lubricant is used for following

two purposes :
(i) To carry away the heat,
(ii) To flush away the chips.
Both internal cylindrical and flat surfaces can be honed. But the process of honing is largly applied to internal cylindrical surfaces only.

Applications of Honing Process :-

(i) Hydraulic cylinders,
(ii) Refrigerator compressors,
(iii) Roller bearing races,
(iv) Bores of carthons.

Hone :- Hone is a metal frame which holes the abrasive sticks during honing operation. It is also know as honing tool. Hones may be of two types :
1. Internal hones
2. External hones

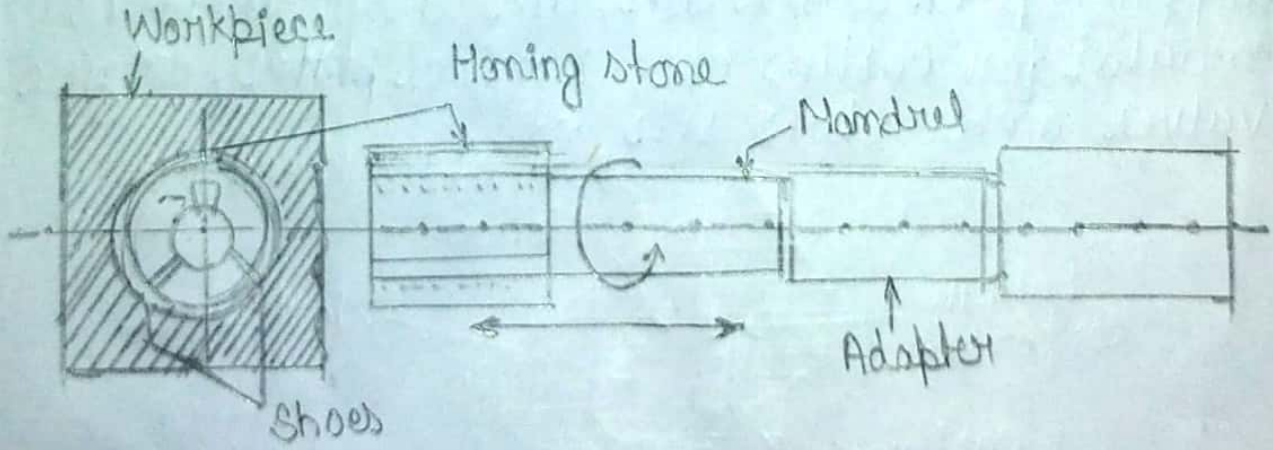
1 Internal hones :- When a hone is used to finish an internal cylindrical surface, it is called internal hone.

2. External Hones :- When a hone is used to finish an external cylindrical surface, it is called external hones.

Machine Honing :- The honing process can be done on many general purpose machines such as laths and drilling machines by holding tool in tailstock of lathe or by mounting the tool in place in drill. Generally, two types of honing machines are used :-

(i) **Horizontal honing machine :-** This machine is available in single and multi-spindles. This machine is mostly used for longer job such as gun barrels.

(ii) **Vertical Honing Machine :-** Vertical honing machine is similar to drilling machine. Hence the honing tool is held in chuck and rotated as well as reciprocated up and down.



Hand Honing Tool and Honing Process.

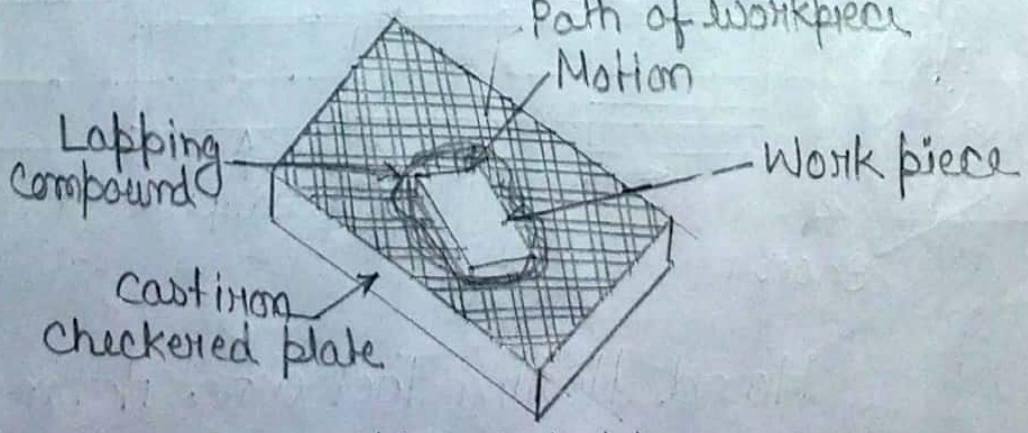
Lapping :- It is the finishing process in which abrassives are rubbed against a surface to be lapped by lapping tool with certain pressure.

Lapping process / Types of Lapping methods

Lapping methods are broadly classified into two groups :-

(1) Hand lapping,
(2) Machine lapping.

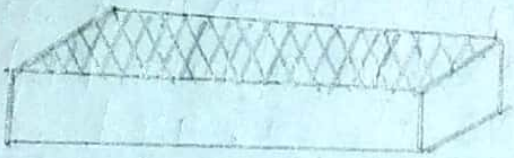
1 Hand lapping :- This is carried out by the operator himself. He can hold the small workpiece in one hand and by another hand, he can do the lapping. If the work piece is large, heavy then it can in a fixture and he can do lapping by hand. The work is turned frequently to obtained uniform cutting action. This method is used for lapping press work dies, dies and metallic moulds for casting etc, surface plates, engine valves and valves sets etc.



Hand Lapping

Hand lapping is further sub-classified as follow:-

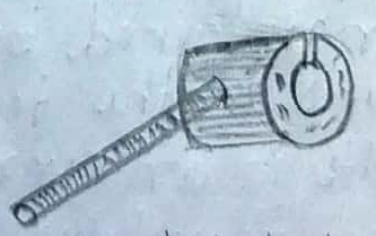
(i) Flat Lapping: The suitable lapping compound is spread on lapping plate. Then for finishing of the work-surface either the lap is held by one hand and the irregular rotary motion of the other by the second hand, enables the abrasion of the two surface in contact.



Laps for for lapping

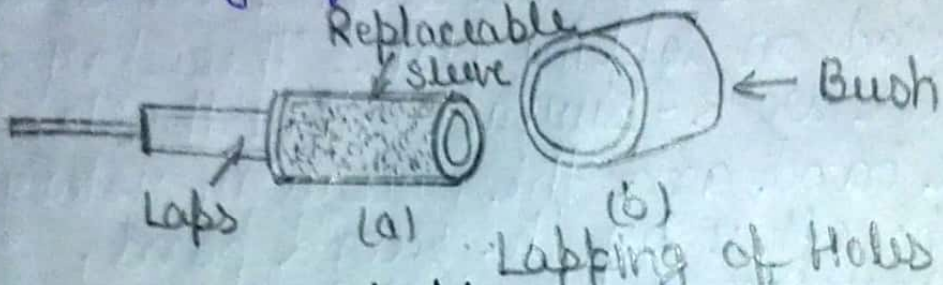
(ii) Lapping Cylindrical Work (External Lapping)

An external lap for external round work piece. It is also known as ring lapping. The external surfaces of pin of shaft type work can be lapped on ordinary lathes with hand laps. During the process, the ring lap is reciprocated by hand over the work piece surface.



Hand lap for external lapping

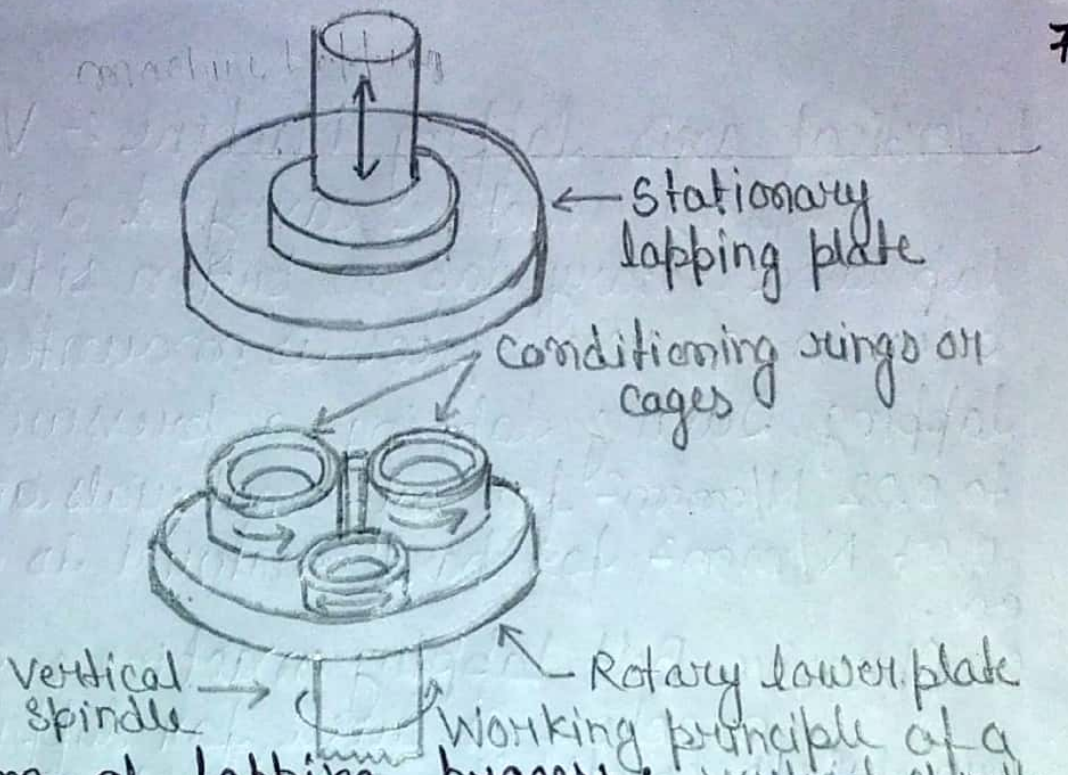
(iii) Lapping of Holes (internal Lapping) :- This makes uses of a rod like lap for lapping of holes.



Lapping of Holes

2. Machine Lapping :- In this, either the work-piece or the lap is given the rotation by machine, while the other one is held stationary. It uses a motion driven lap and is used to obtain highly finished surfaces on races of ball and roller bearings, worm gear, cam shaft, piston pins and gauges, injection pump parts, spray nozzles etc.

It consist of two circular plates, one above the other. The workpiece which are to be lapped are placed between these two plates and the loose abrasive grains with vehicle are fed. The parts to be lapped are confined into cages that impart rotary and gyratory motion at the same time, due to which the entire surface of the two plates are covered. Parallelism is maintained by having stationary lapping plates on the top of the work-piece. This results in an even wear of the plate surface and therefore, its flatness is maintained.



Working principle of a vertical spindle lapping machine

Application of lapping process :-

(i) Jig and fixture bushes.
(ii) Holes and pins
(iii) Tapered surface of bulg cocks.
(iv) Pump parts.
(v) Measuring instruments.
(vi) Spray nozzles.

Lapping Machines

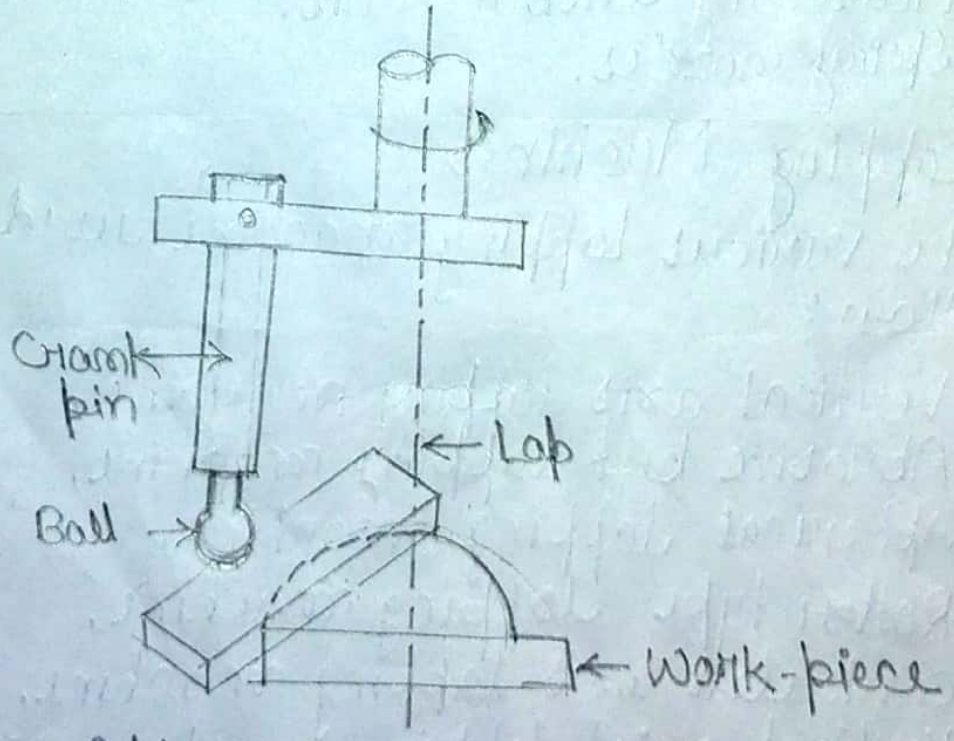
The various lapping machine used are as follow :

(i) Vertical axis lapping machine,
(ii) Abrasive belt lapping machine,
(iii) Spherical lapping machine,
(iv) Roller type lapping machine,
(v) Centreless axis lapping machine,
(vi) Vertical axial lapping machine with bonded abrasive wheels as laps.

1. Vertical axis lapping Machine :- Vertical axis lapping machine carryind a stationary lap and rotary lap on button side and in between, a work-piece is mounted for lapping. During lapping, a pressure of 0.007 to 0.02 N/mm^2 for soft materials and upto 0.07 N/mm^2 for hard material is maintained.

2. Abrasive Belt Lapping machine :- This machine is used for lapping of crank pins camshafts, aeroplane engine cams etc. It is a horizontal axis machine.

3. Spherical lapping Machine :- It is used for spherical surface lapping and works similar to drill press.

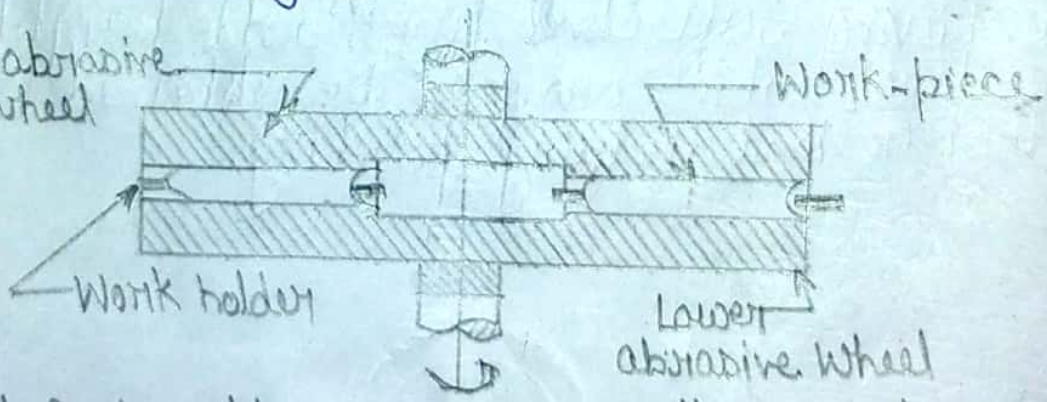


Spherical Lapping Machine

4. Roller type Lapping Machine :- Roller type rolling machine consists of two rollers, one is lapping roller and other is regulating rollet.

5. Centreless lapping Machine :- This machine is used for lapping small parts such as piston pins, ball bearing races etc. The special feature of wheels used in this machine is that they have grain size of much fine grit.

6. Vertical Axis Lapping Machine with Bonded Abrasive wheel As Laps :- This machine consists of two abrasive wheels. The required lapping can be obtained by rotating lower abrasive wheel.



Vertical Axis Lapping machine with Bonded Abrasive Wheels as Laps.

Advantages of Lapping process :-

(i) Any surface can be lapped,
(ii) It is cheaper than honing.

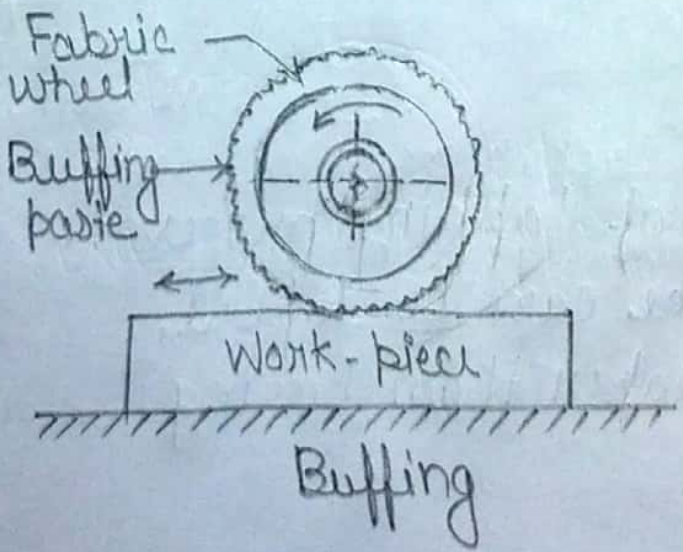
Polishing :- It is used for removing scratches, tool market, surface pits and such other defects which might have been left after working of the job on various machine and with various tool.

Purpose of Polishing :-

(i) To remove scratches, nicks, discolouration etc
(ii) To make metal smoother
(iii) To make lustrous appearance.

Buffing :- Buffing is a smoothening and brightening process on a surface by the rubbing action of fine abrasives in a lubrication binder applied intermittently to a moving wheel of wood, cotton, fabric, felt or cloth.

Purpose of Buffing :- Buffing is used for archieving reflective finish and brightening surfaces which cannot be obtained by any other method including polishing.



Buffing

Buffing Process :- Buffing is a polishing operating in which the work-piece is brought in contact with a revolving cloth buffing wheel which has been charged with very fine abrasives. Buffing wheels are built up of layer of linen, felt, cotton or wool. These are charged with loose abrasive powder in much the same way as lap is charged. Buffing wheel are mounted generally on buffing laths or simply buffing machines which are run by belt drives from motor at the back. Wheel are mounted on both sides on such machined.

Some of the main application of buffing are as following :-

(i) Commercial and residential hardware
(ii) Sporting items.
(iii) Store fixtures.

Burnishing :- Burnishing is an operation of producing bright polished finish on the surface of metal by the rubbing action of burnishers which are made of very hard material having highly polished surfaces.

Uses of Burnishing :-

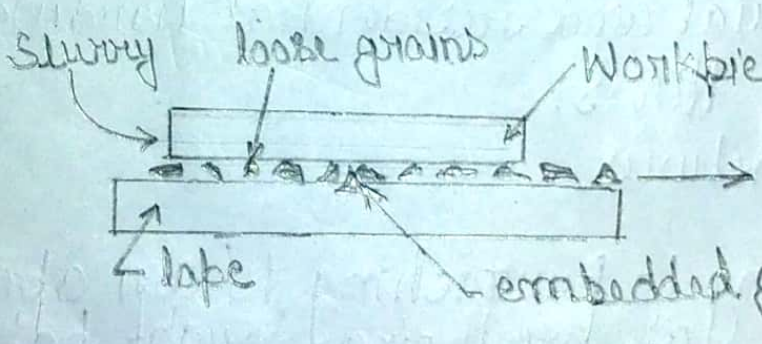
(i) Burnishing is generally used to produce a decorative finish. Gold leaf and brass

can be burnished by rubbing an agate burnisher over the surface.

(ii) Burinishing is used to produce a finish which will give better wearing qualities than those left by a cutting tool.

Lapping compounds and tool :-

Lapping :- is a machining process in which two surfaces are rubbed together with an abrasive between them, by hand movement or using a machine. This can take two forms. The other form of lapping involves a softer material such a pitch or a ceramic for the lap, which is "charged" with the abrasive.



Lapping tool :- Laps and lapping tools are used for precision surface finish-ing, often in conjunction with loose abras-ive compound. Laps is soft material that is charged with an abrasive and is used for cutting harder material. A lapping machine uses a charged lead piece as lap of cutting a hardened steel piece.