Study Material

On

Manufacturing Technology

Department of Mechanical Engineering

CAPITAL ENGINEERING COLLEGE

Mahatapalla, Khordha, Bhubaneswar, Odisha: 752060

(Affiliated to Biju Patnaik University of Technology, Odisha and SCTE & VT, Odisha, Approved by AICTE, New Delhi and Recognised by Govt. of Odisha)

Manufacturing Technology

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 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, types of machineing, quantity & quality of pred^{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. Dimond tool

1. Carbon tool steel :-

→ It's temperature range from 250°c

→ It is one of the inexpensive metal cutting tool use for the low speed machineing operations.

→ This carbon steel cutting tool have the composition 0.6 to 1.5 % carbon and very small amount of less than 0.5 % Mn & Si.

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

→ It doesn't prefer in a morden & machine operations.

→ Carbon tool steel used in twist drill, milling tools, 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 tungston, Mo, Cr etc to improve hardenability, toughness and wear resistance.

→ It gives a higher metal removal rate & it looses its hardness at a made rate temperature about 650°C.

Therefore a coolant should be used to increase tool life.

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

Surface treatment used in HSS :-

Superfinishing — reduce friction

Nitriding — Increase wear resistant

Chromium electric plating — reduce friction

Oxidation — reduce friction

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

'T' type – Tungston predominat type

'N' type — Mo predominant type

3. Cementite carbide tool :-

→ It is produce by powder metallurgy technique.

→ It consist of tungston, tantalum & titanium carbide with cobalt as a binder (when the binder is Ni & Mo then it is called cermet)

→ Cementite carbide tool are extremely hard, they can withstand very high speed cutting operations.

→ It doesn't loose thair hardness upto 1000°C

→ A high cobalt tool is used for a rough cut white low cobalt is used for finishing operations.

4. Ceramics :-

→ The most common ceramic material are Aluminium Oxide (AlO_2) silicon nitride. powder of ceramic material compacted in insert shape, then sintered at high temperature.

→ Ceramic tools are chemically innert & posess resistance to corrosion.

→ They have high compressive strength, they are stable upto temperature 1600°C

→ They are 10 time faster than HSS.

→ the friction betⁿ tool face & chip are very low and process low heat conductivity, usually no coolant is required. they provide a very excellent surface finish.

5. CBN :-

→ It is the second hardest material after diamond.

→ They are generally used in hand machine.

→ They often high resistance to abrassion & use as an abrassive in grinding wheels.

→ sharp edges are not recomended.

6. Diamond :-

→ It is the hardest material & it is also expensive

→ It poses a very high thermal conductivity & M.P.

→ The diamond accures a excellent abrassion resistance and low friction co-efficient and low thermal expansion.

→ It is use 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 material :-

→ cutting tool materials are the materials use to make cutting tool which are used in machining. (Drill, bits, tool bits, milling cutters etc.) but not other cutting tools like knifes & punches.

→ cutting tool material must be harder than the material of work piece, even at high temperature during the process.

→ The following properties required for cutting tool :

1. Hardness, hot hardness & pressure resistance.
2. Bending strength & toughness.
3. Inner bending strength
4. wear resistance

a. and^{n} resistance
b. edge strength
c. small prosperity to diffusion and adhesion.

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

Tool Material	cutting speed	Temperature (M^{p})	Hardness
Carbon tool steel		450°C	upto HRC 65
HSS (30-50 m/min cutting range)	30-5 m/min	650°C	upto HRC 67
Cementatie carbide	60-20 m/min	1000°C	upto HRC 90
Ceramics	300-600 M/min	1200°C	upto HRC 93
CBM	600-800 M/min	–	upto HRC 95
Diamond		600°C	

HRC High refturning capacity

Chapter-2

Cutting tools

Cutting action of various tools :-

1. Chisel :-

A chisel is a tool with a characteristically shaped cutting edges (such that coood chisel have part of their name to a particular grind) of blade on it's end, for carving or cutting hard materials such as wood, stone or metal by hand, struck with a mechanical power. The handle & blade of same types of chisels are metal or wood 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 angle when first made. The second angle (usually 30°) is called a cutting angle & alloyes for region sharping of the chieles it self.

2. Hacksaw :-

A hacksaw is a fine tool saw originally & mainly made for cutting metal. The equivalent saw for cutting wood is usually Bow low. most hacksaw are hand saw with a 'c' clamp bracme that holds a blade under tension, such hacksaw have a handel usually a piston greek, with pin for attecking narrow dispesable blade. The frames may also be adjustable to auomodable blade of different site. A screw or other mechanism is used to put the thin blade under tension.

On hacksaw, as it must frame such the blade can be mounted with the teeth facing toward are away from the handele resulting in cutting action an either push or pull stroke. (As normal use cutting vertically down wards which works held ina bench vice, hacksaw blade are let to be facing forward.

3. Dies :-

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

→ The common dies are notching, triming, savering, blanking etc.

→ Die cutting is typically refers the cutting action or a die crass.

→ Die cutting tool is fundamentally a combition of wood, steel blade & rubber prepared into a specific state and structure to anable compression of substrad materials & hence having a spesific shape.

What does a die do ? :-

A die is used to cut or from the male purtion of the malting pair (A bolt). The process of cutting or forming thread using a tap is called tapping whereas as the process using a die is called threading.

How does a die work ?

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

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

→ A gauge system that has a no. of different pins is 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 un matched.

4. Reamer :-

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

→ The back tapper reduce friction between reamers & hole surface.

Function :

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

→ Reamers are deign to a large size of hole than previously form hole by small amount but a high degree of

Why are reaming operation performe :-

→ Reaming perform using same type of machine like drilling.

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

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

Reamers & it's type :-

I. Hand reamer
II. machine reamer
III. checking 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 (act) the type of machineing process for the materials, the efficiency & economic 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 of turning tools :

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

Cutting tool may be classified according to the no. of major cutting edges (points) involve as follows.

i. single point tool

Ex :- Turning tools, shaping, planing & slotting

ii. Boring tool

iii. Double point

Ex :- Drill

iv. Multipoint (more than two)

Ex :- milling cutter, Broaching etc.

* Concept of rake angle of cutting tools :-

→ Rake angle is provided for each of chip flow & overal machining.

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

* Concept of clearance angle of cutting tools :-

→ clearance angle is essentially provided to avoid rubbing of the tool with the machine surface which cause less of energy & damage of both the tool and the surface.

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

* Terminology of single point cutting tool :-

Back rack angle

→ If view the side facing from the end of the work piece it is the angle from by the face of the tool and line parallel to the floor.

→ A positive back rack angle tilty the tool face back a negative back rack angles tilty it forward & up

* End cutting edge angle :-

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

* End relieve angle :-

If viewed from the side facing the end of the work piece. It is the angle formed by the end flank of the tool & a vertical line down to the floor.

* Face :-

The flats surface of single point tool into which the workpiece rotates during a turning operations.

* Flank :-

A flat surface of a single point tool i.e. Adjscent to the face of the tool. During turning the side flank faces the the direction that the tool is fed into the workpiece & the end flank passes over the neenly machine surface.

* Lead angle :-

A common name for the side cutting edge angle. If a tool holder is built with dimension that ship 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 and the center line of the work piece.

* Side relief angle :-

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

* Nose radius :-

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

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

→ A zero degree nose radius creates a shape point.

* Side cutting edge angle :-

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

* process of parameter :-

→ For any machining or metal cutting operation three relative motion bet^n the workpiece and the cutting tool are necessary for gradual removal of material from workpiece in fact, the simultaneous acting of all three relative motion causes advancement of cutting tool towards work material along the path generating a finish surface with the shape, size & tollarance.

→ This three relative motion are called cutting parameter

→ The process parameter in machining all those parameter that inherant to a any machining operations & should have a suitable finite value to smooth & efficient removal of material. Such as parameter directly effect machining performance process.

→ In machining three process parameters are

i. cutting speed or Cutting velocity

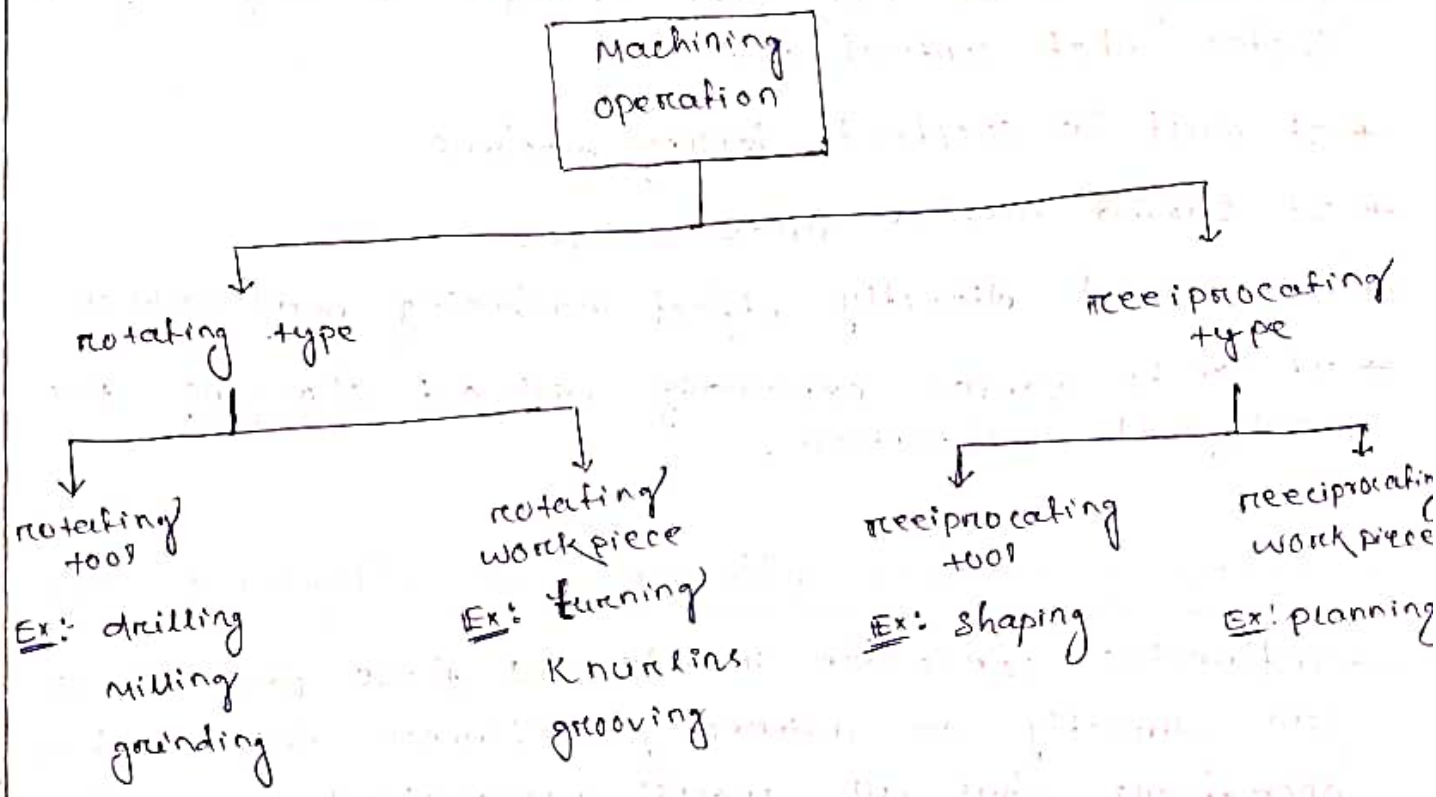
ii. feed rate

iii. depth of cut

i→ cutting velocity :-

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

→ It is dinoted by V_c.



ii→ Feed rate :-

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

→ usually the dirn of feed velocity is perpendicular to that of the cutting velocity. The primary objective of feed velocity is to advance cutter w.r.t the work piece to removal material from fuider surface.

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

iii * Depth of cut (t) :-

→ The tertiary cutting motion that provideds necessary depth with in work material i.e. intendeenate to remove by machining.

→ It is given in the third perpendiculare direction and the simultaneous action of three cutting parameters result in removal of excess material from work piece.

Features of process parameters :-

It must be,

→ primary factor i.e. there should n't be any any other factor that contocol it.

→ It must be supplied: drilling machine.

→ It should have a finite value.

→ It should directly effect machining performance

→ It can be varied externally with out changing the work tool combinition.

* process parameter differents from influencing parameters :-

→ Influncive parameter include all those parameters that can directly or indirectly influence the machinsy operations thus all process parameter's are influensive parameters a part from velocity, feed and depth of cut there are many other in parameters that can influnce performance considerably. how ever they are not in hernet to machining process.

→ A list of such parameter relevent to conventional machining

i - cutting environment
ii - Tool geomentry including nose radius.
iii - work material
iv - Tool material
v - Tool cutting

vi- work and tool setting.

* Coolant and lubricant in machining :-

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

3. straight oil (petroleum or vegitable oil)
4. Synthetic fluide
5. Semi synthetic fluids.

What are the main three property of coolant?
i. prevent freezing & boiling
ii. lubricates the water pump seal.
iii. Inhabbits corrosion

what are 3 different type of lubricant?
→ There are 3 different type of lubricant
i- boundary
ii- Mixed
iii - full film

→ each type is different bet^n they all realy on a lubricant and the additives with in the oil to protect agains to wear.

→ Full film lubricant can be break down in two forms
1 - Hydro dynamic
2 - Elasto Hydrodynamic

what are same example of lubricant ?

→ Lubricants included fatty alcohols, easter and wax etc.

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

→ The common example of external lubricants

I - paraffin

II - metal sap

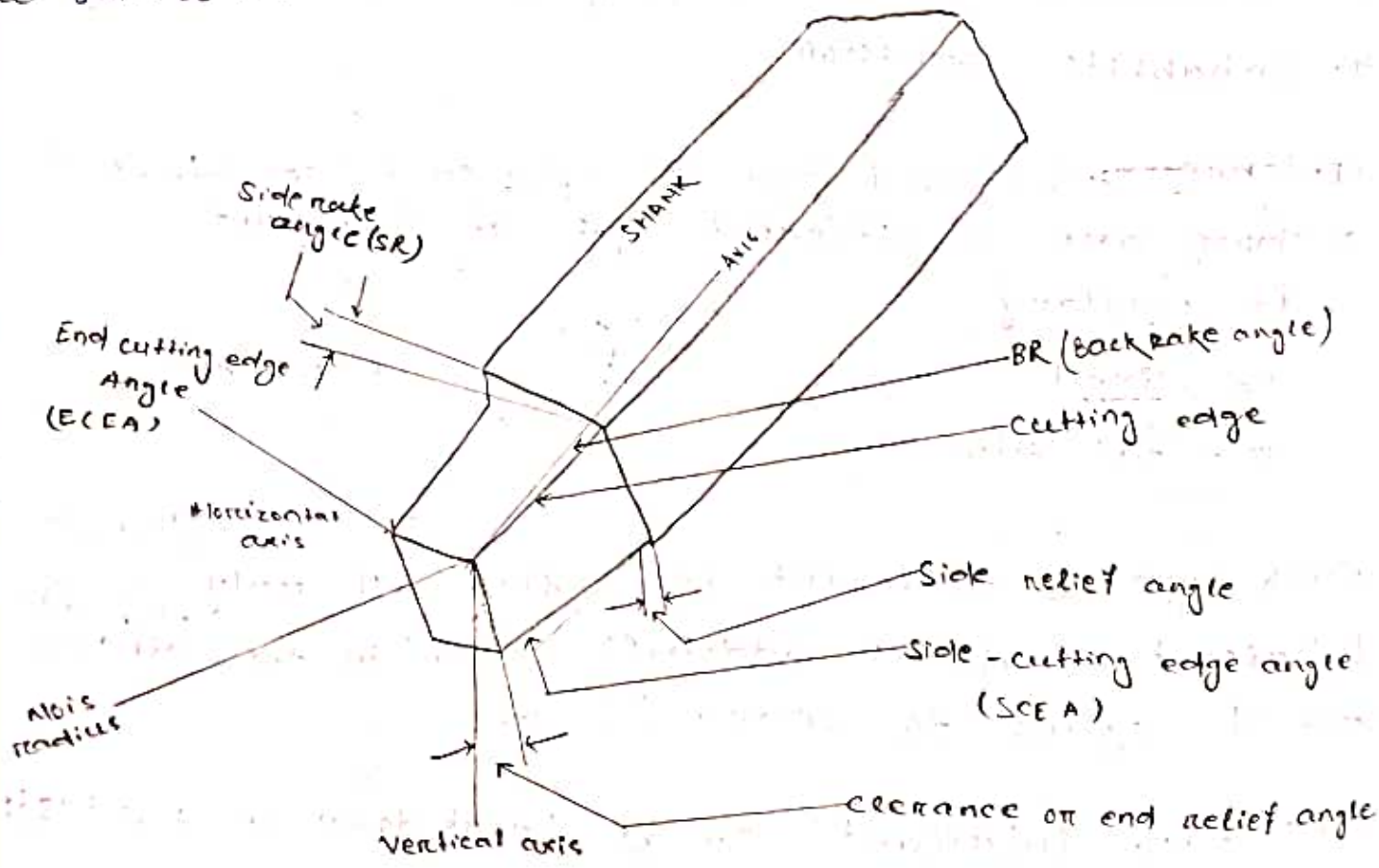
III - Amide

IV - fatty acid

Each coolant a lubricant ?

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

→ Oil are often used for application where water is un suitable.



α_e → i) Back rake angle

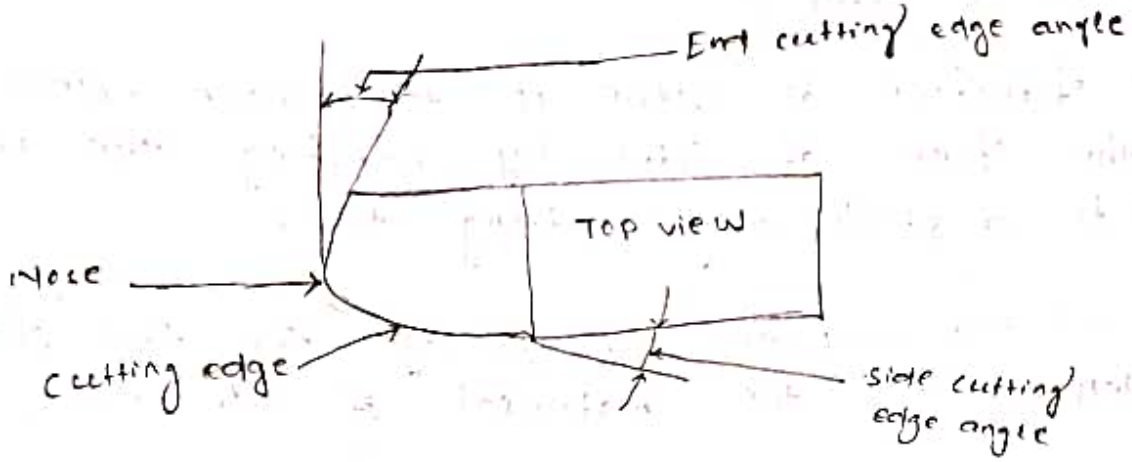
BR α_s → ii) side rake angle

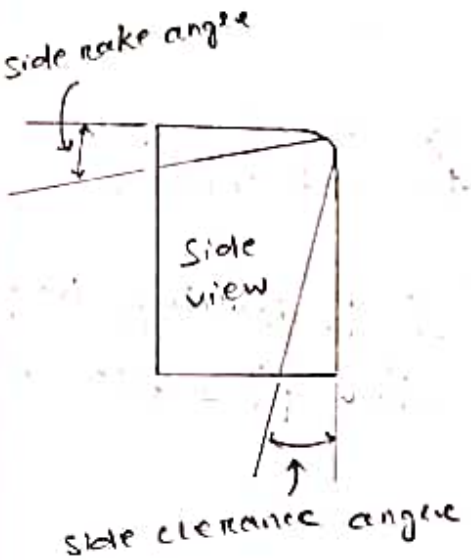
SR θ_e → i) end relief angle (clearance)

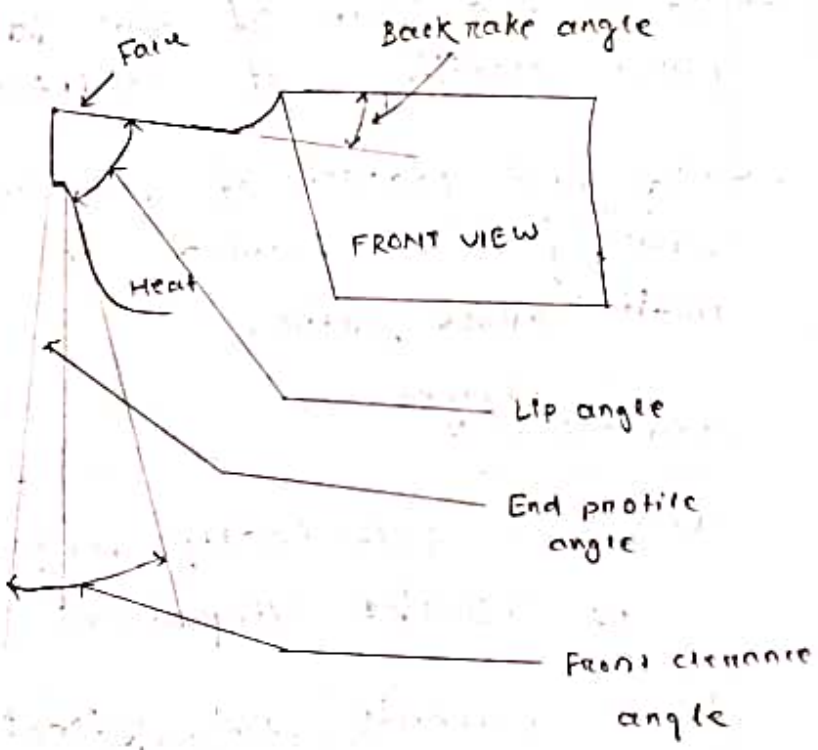
θ_s → ii) side relief angle (")

C_e → i) end cutting edge angle (ECEA)

C_s → ii) side cutting edge angle (SCEA)







* Construction & working of lathe & CNC lathe

Defination of lathe machine :-

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

→ It is also called as center 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 material in the form of chips by rotating the work piece against a stationary cutting tool.

→ To cut the material property 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 cutting of semisteel (chilled. cast iron).

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

Function :-

a → It is sufficiently rigid and good damping capacity to absorbe vibrations.

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

c → It supportes the head stock, carriage and other components of the lathe machine.

2. Head Stock :-

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

function :-

(a) It holds the job on its spindle nose having external screw threads and internally morse taper for holding the lathe center and it is rotating at a different speed by cone pulley or all 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 for thread cutting mechanism.

Accessories mounted on headstock spindle :-

1. Three jaw chauck
2. Lathe center & lathe dog
3. four jaw chauck
4. collect chauck
5. Face plate
6. magnetic chauck

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 operations and the lead screw is used for thread cutting operations.

3. Tail stock :-

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

Function :

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

(b) It holds the tool for performing different operations like drilling, reaming, tapping etc.

(c) used for a small amount of taper for a long job by off setting the tail stock.

4. Carriage :-

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

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

Function :

→ It holds, moves and control the cutting tool.

→ It gives rigid supports to the tool during operations.

→ It transfer power from feed rod to cutting rod through apron mechanism for longitudional cross feeding.

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

It consist 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 side movement.

① Saddle :-

→ It is 'L' shaped cutting.

→ It connects the pair of guide ways as a bridge.

→ It fits over the bed and slide 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 0.05mm

③ Compound Rest :-

→ It is a part with connected cross slide and compound slide.

→ It is mounted on the cross slide by young and groove joint.

Functions!

→ It supports the tool post and cutting tool in various position.

→ It is necessary for turning angles and boaring short tapers.

④ Tool post :-

→ It is the top most portion of the carriage and it is used to hold various cutting tool or tool holders.

types :-

a- single way screw tool past.
b- four way tool past.
c- quick change tool past.
d- British type tool past.

(v) Apron :-

→ It is the house of the feed mechanism.
→ It is fastened to 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 related to a micrometer sleeve & screw handle with the outer edge of screw.

→ This slide is only use for less long job taper turning.
→ Automatic feed is not possible in compound slide.

(3) Main spindle :-

It is hollow cylindrical shaft in which long jobs can pase through.

→ It's face has a standard moarse taper.
→ It is used for holding the live center.
→ The spindle rotates on two large bearings housed on the head stock casting.

(4) Lead screw :-

→ It is used to transmit power to carriage through gear and clutch arrangment in the carriage apron.
→ It converts rotational motion in to linear motion.

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.

Function :-

Dead center are typically fully harden to prevent damage to the important mating surfaces of the taper and to preserve the 60° angle of the hose.

⑨ Feed rod :-

Function :- 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 :-

Function :- It is used to held the work piece secured.

types :-

① 3 jaw self centring chuck

⑪ 4 jaw independent chuck

⑪ Leg :-

Function :- Leg carry the entire load of a lathe machine tool and transfer to the ground.

→ The leg are firmly secured to the floor by the foundation bolt.

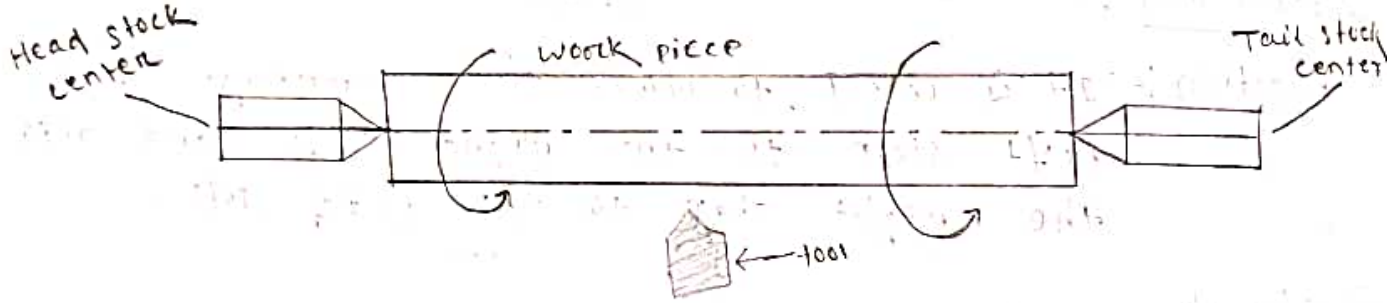
Working principle of Lathe machine

* Working principle :-

→ The lathe is machine tool which holds the workpiece b/w two rigid and strong supports called centers or in a chuck or face plate which revolves. The cutting tool is rigidity 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 an angle relative to the axis of the workpiece is produces a tapered surface and also called as taper turning.



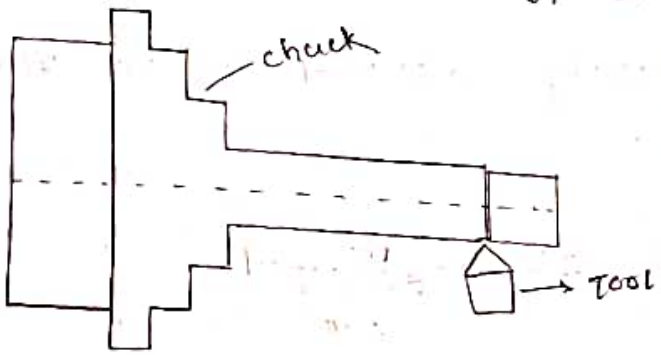
* Lathe operations :-

The engine lathe is an accurate & versatile machine on which many operations can be performed which a be as follow A:

① plain turning & step turning :-

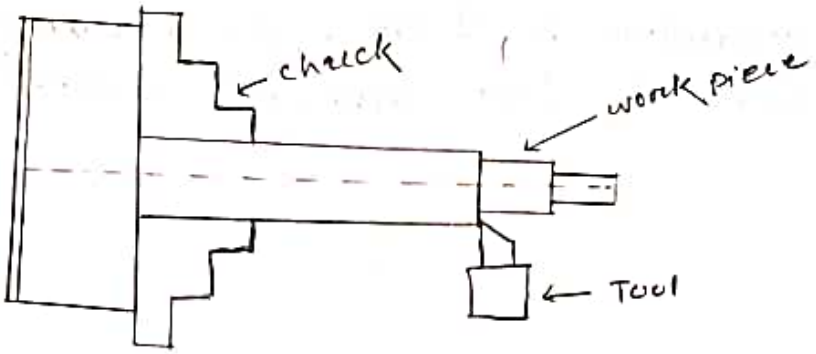
Plain turning :-

It is the operations of removing excess a amount of material from the surface of a cylindrical job.



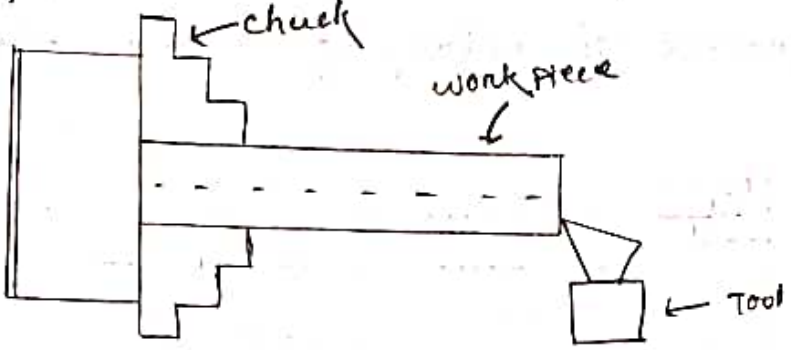
Step turning :-

It produces various steps of different diameters



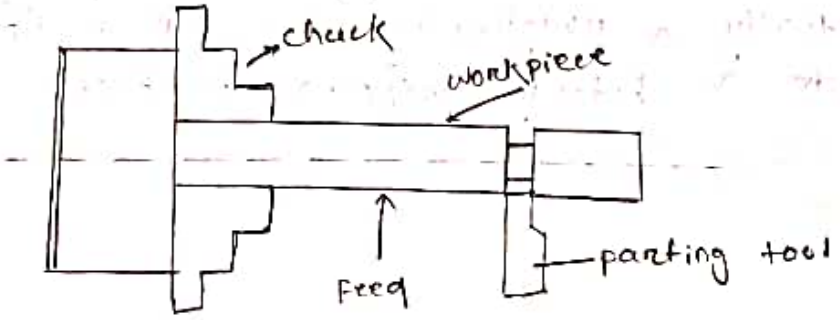
② Facing :-

It is machining operations by which the end surface of the work-piece is made flat by removing metal from it.



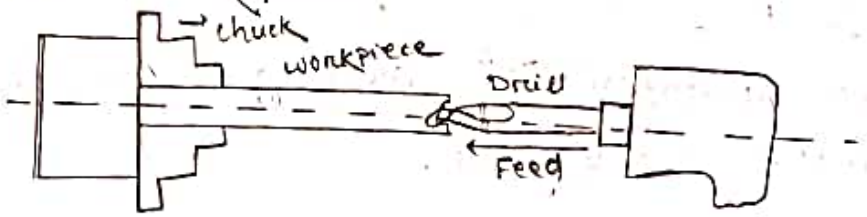
③ parting :-

parting or cutting off is the operations of cutting away a disjered length of the work piece i.e.



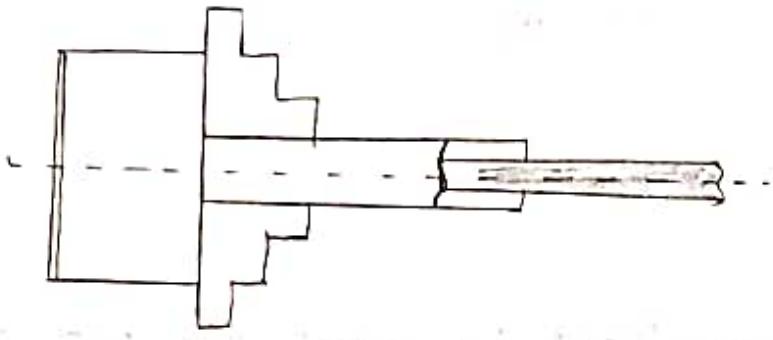
④ Drilling :-

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



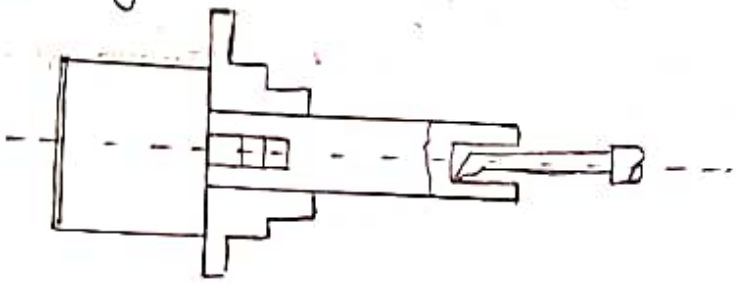
⑤ Reaming :

The holes that are produced by drilling are rarely straight & cylinder in form. The reaming operation finishes & size the hole already drilled into the workpiece.



⑥ Boring :-

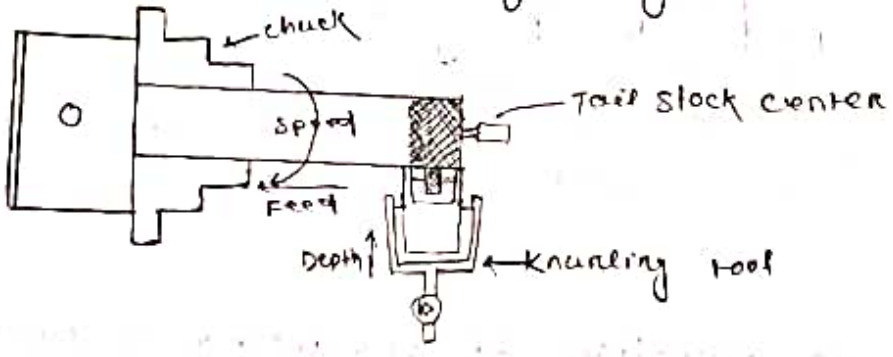
It is the process of enlarging a hole already produced by drilling.



⑦ Knurling :-

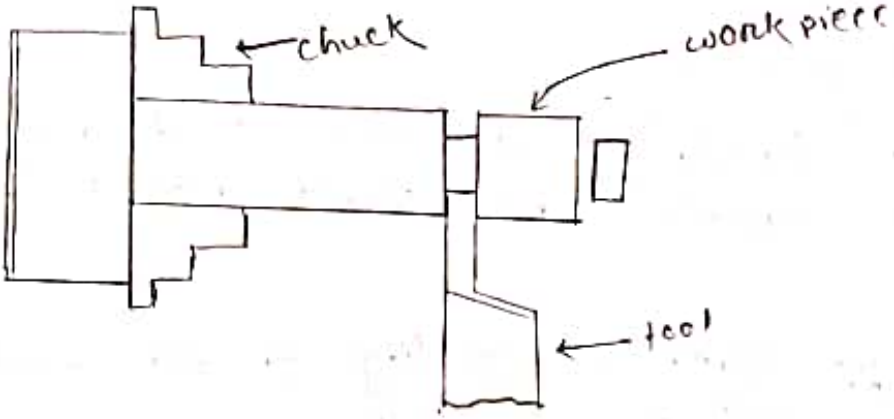
→ It is a process of impressing a diamond shaped or straight line pattern into the surface of workpiece.

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



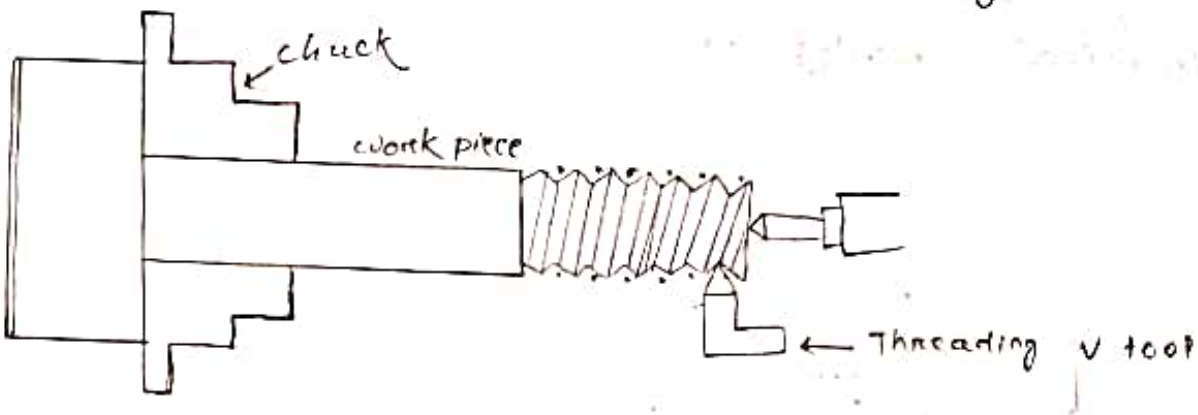
⑧ Grooving :-

It is the operation of making grooves of reduced diameter in the work piece.



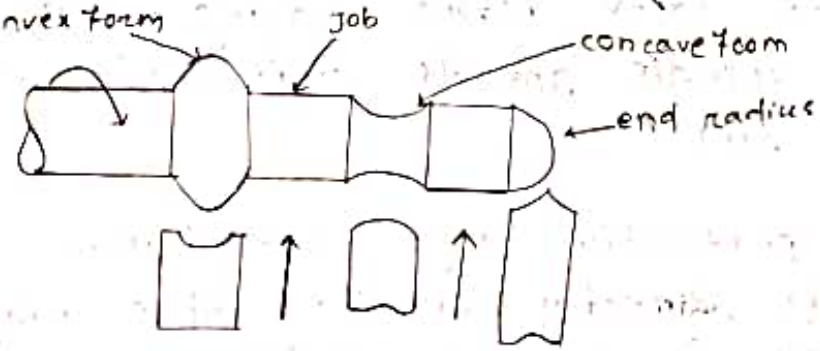
⑨ Threading :

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



⑩ Forming :-

It is an operation which produce a convent, concave or irregular profile on the work piece



⑪ Chamfering :-

- Chamfering removes the sharp edges and rough edge and makes the handling safe.
- Chamfering can be done by a form tool having angle equal to chamfer which is generally kept at 45°.

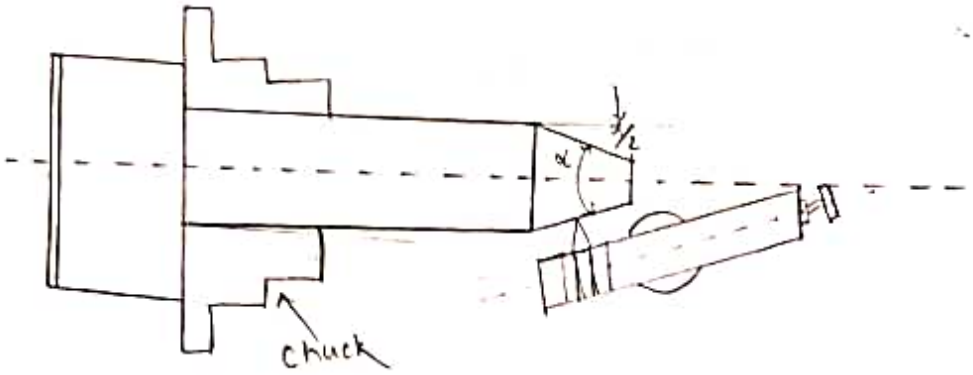
(12) Filling and polishing :-

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

→ After filling, the surface quality of the work piece is improved by polishing operations.

(13) Taper turning :-

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



* Safety measures during mechaning :-

→ Always stop the lathe before making adjustment.

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

→ Always weak protective eye protection.

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

→ use a two hands when standing the workpiece. Do not warp the sand paper or emry cloth around the workpiece.

→ remove rings & wathes.

→ Keep the floor from obstuction or slip hazards.

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

→ Stop lathe before taking measurement of any kind.

→ Keep working surface clean of scraps tools and material.

* Types of lathe machine :-

① Center (or) engine Lathe :-

It is the most widely use lathe machine.

parts: Bed, saddle, headstock & tailstock are

→ The headstock of an engine lathe is rigid and tailstock is moveable which is furthere used for knurling.

Function:- It feed the cutting tool in both directions i.e. Longitudional and lateral direction with the help of feed mechanism.

Mechanism:-

Driven by gear mechanism are pulley mechanism.

Type of driven mechanism

① Belt driven
② motor driven
③ Gear head type.

Turrette Lathe :-

It is the lathe form of metal working Lathe i.e. used repetitive prod" of duplicate parts, which by the nature of their cutting process usually interchanges

Capstan Lathe :-

A capstan Lathe is a processing machine used to are mounted on a rotatable turret known as capston,

which permits the client to rapidly change the intro the bite for slicing without needing to take of the first bit and after ward mount the second.

What is capstan lathe used for ?

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

→ These lathe are fast developed in USA in 1960.

→ capstan lathe one of the thy type of semiautomati lathe.

What is turette lathe :-

① Ram type

② Saddle type

① Ram type :-

In the ram type turrette lathe a slide or ram carryi the turrette moves back and 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 and the hole unit moves back and 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 work piece that a lathe is able to rotate with heating the bed

* Difference between capstan & turette lathe :-

Capstan	Turette
→ It is light weight mach.	→ It is a heavy weight mech.
→ In capstan lathe the turette tool head is mounted over the rams i.e. mounted over the saddle.	→ In turette tool head is mounted over the saddle like a single unit

Capstan	turrette
→ For providing feed to the tool ram is moved.	→ For providing feed to the tool the saddle is moved.
→ Because of no saddle display the moment of turrette tool head over the longitudional direction of bed is small alongwiz the ram.	→ Turrette tool head moves along with the saddle over the entire bed in longitudional direction.
→ use for center workpiece because of limited ram movement.	→ use for longer workpiece saddle movement on the bed.
→ It's working operations are fast because of lighter in construction.	→ It's working operations are slower because of heavier in construction.
→ Heavy cuts on the workpiece can't be given because of non rigid construction.	→ heavy cuts on the workpiece is given because of rigid construction.
→ The turrette head can't be move in the lateral direction of the bed.	→ The turretted head can be moved crossuise i.e. the lateral direction of bed.
→ In capstan lathe collect is used to grip the job	→ In turrette lathe power jaw chauck is used to grip the job.
→ use for machining work piece upto 60mm diameter.	→ use for machining workpiece upto 120 mm diameter.
→ These are usually horizontal lathe.	→ Turrttle ~~are~~ lathe are available in horizontal & vertical.

* Engine lathe :-

→ An engine lathe is a type of machinary, self horizontal and it is often to use cut material.

→ The metal is turned and the machine uses speical

cutting tool to creat the desired shape because of the lathe, it can create various spesific forms & comonly used to spin sheet metal.

Difference between turette lathe & engine lathe :-

Turette lathe are planed to act as production machine and engine lathe is planed machine various type of job with in limits. i.e. one time setting is moven you mustn't change the tool.

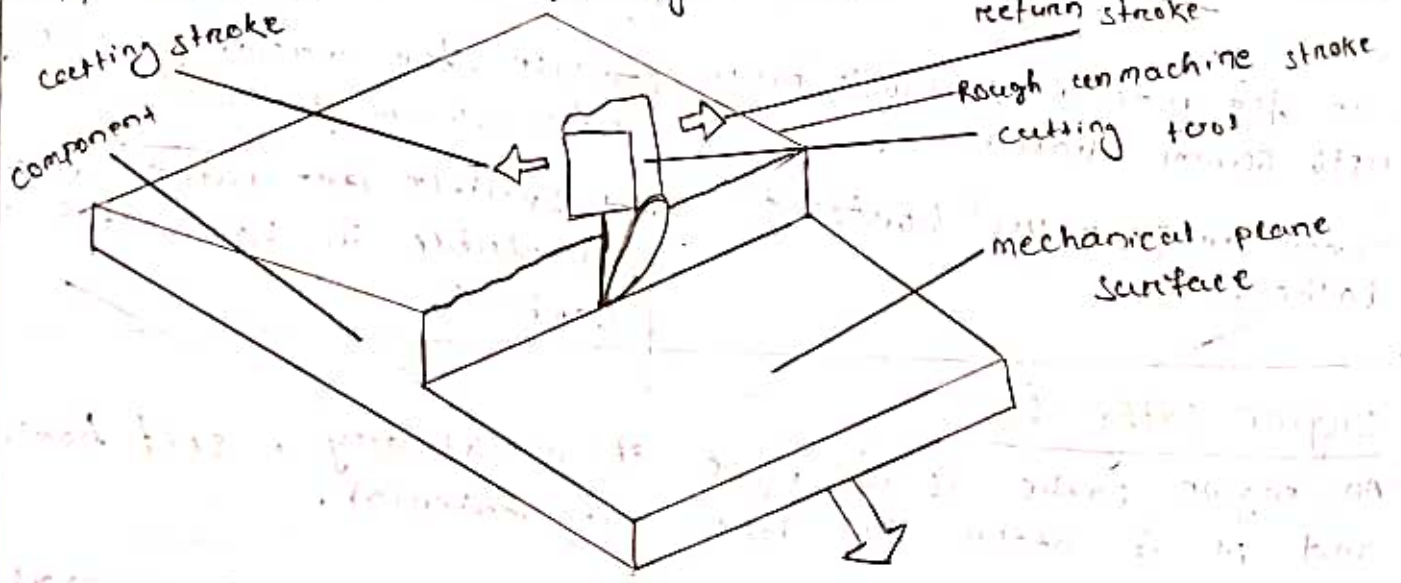
What is precission lathe ?

precission lathe are also known as standard manufacturing lathe and is used for all lathe operations such as turning, teaper turning, reaming etc and can be adepted for special milling operation with the apropriate fixture.

Shaping Machine or Shaper

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

* A shaping machine a reciprocating type of machine tool in which the ram moves the cutting tool backward and forward in a straight line.



process Capability :-

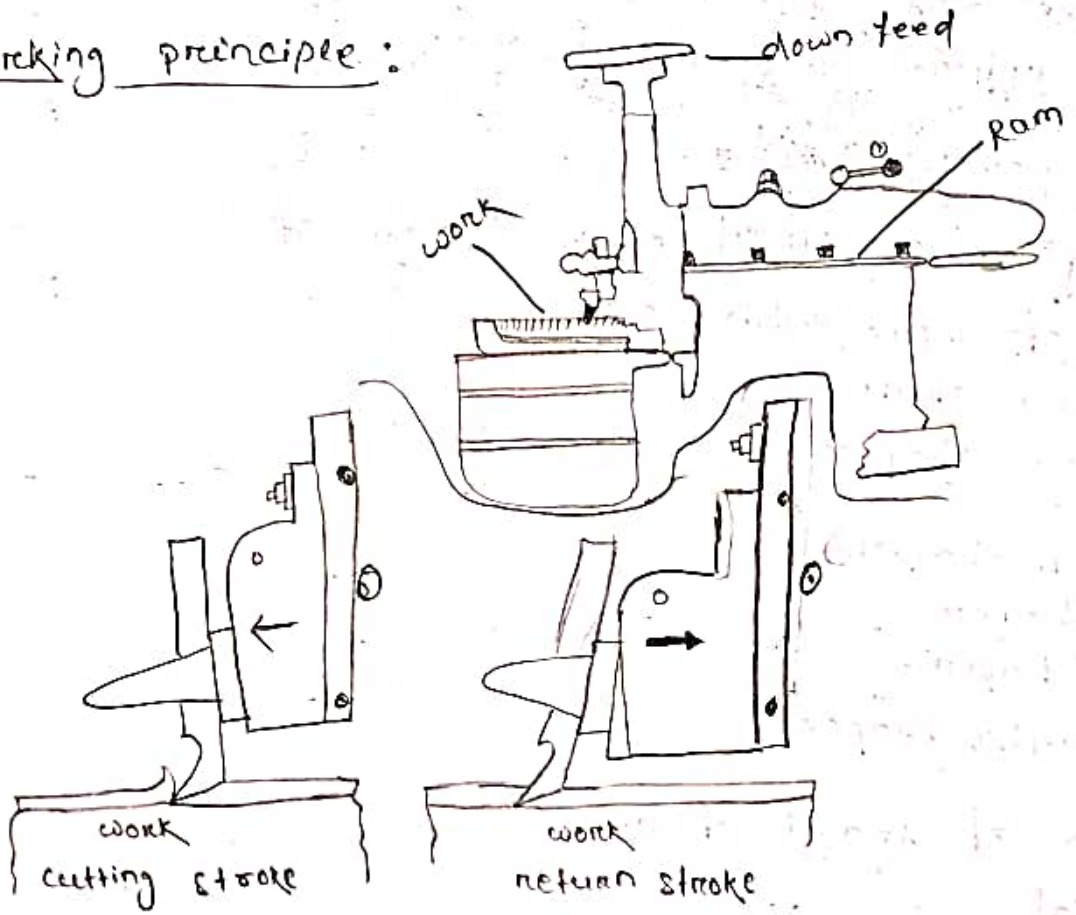
→ shaping process involves short setup time and uses relatively in expensive tools.

→ shaping is often use for emergency production of gears, rakes etc.

→ It is often possible to produce one upto such parts in a shaper in less time than is required nearly to setup for production on other, alternative equipment with a higher output rate.

→ How ever metal remove by shaping may be as much as 5 time that for removal by milling or grooching.

* Working principle :



→ The tool held in the tool holder mounted on the ram moves forward and 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 use the metal from workpiece. Each time the tool moves backward (cutting stroke of the tool) but move across by one cross transverse during the return (non cutting stroke)

→ ~~That~~ the appearance of the machine surface is a succesion of closely straight line curve.

→ The work remains stationary during the forward (cutting strock of the tool) but move across by one cross transverse during the return (non cutting stroke)

* Types of shaper :-

Shaper may be classified on the basic of

a) Design of work table as
   i. Standard shaper
   ii. Universal shaper

b) Driving mechanism as
   i. Crank shaper
   ii. Gear shaper
   iii. Hydraculic shaper

c) Direction of travel of ram
   i. Horizontal
   ii. Vertical
   iii. Travelix hand shaper

* Parts of shaper machine :-

1. Base

→ The base of shaper supports the column or pillar which supports all the working part such as Ram, Work-cable, drive mechanism etc.

→ Base is heavy C.I body.

2. column. pillon body :

→ The shaper has a column carryles the ram sideways, the table sideways are machined on the front on the casting.

→ The crank and slatted link mechanism ~~and~~ that drives the ram is contain within the column.

→ The driving motor, the variable speed gear box, lever and other control of the shaper are also contain in the column.

3. cross rail :

→ The cross rail carryres of horizontal table sideways and is mounted on the vertical sideways of the column.

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

→ The cross rail is heavy casting and it also carryies the table cross feed screw togather with the pawl and ratchet intermitant drive mechanism.

4. Saddle :

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

→ cross wise movement of the saddle causes the work table to move sideways.

5. Table :

→ The work table is a box shaped casting with 'T' slot in it's uppor surface & down one side. It also has a vee machted in the vertical side to carries cylindrical work.

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

→ The work table is bolted to the saddle and can move vertically and cross wise with the help of saddle and cross rail.

6. Ram :

→ Ram is rigidly braced casting and is located on the top of the column.

→ The ram is driven back and forth is it's slide by th slotted link mechanism.

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

7. Tool Head :

→ tool head slide is a dovetail as the front of the ram by means of T bolts.

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

→ The tool head can be raised or lower by hand feed for vertical cuts on the work piece.

→ The tool head holds the tool. The tool head impart the tool, the necessary vertical angular feed movemen

* The tool head and it's details :

→ The tool slides controls the in feed of the cutting tool into the work piece.

→ In other words it control the depth of cut and is adjuste by a lead screw.

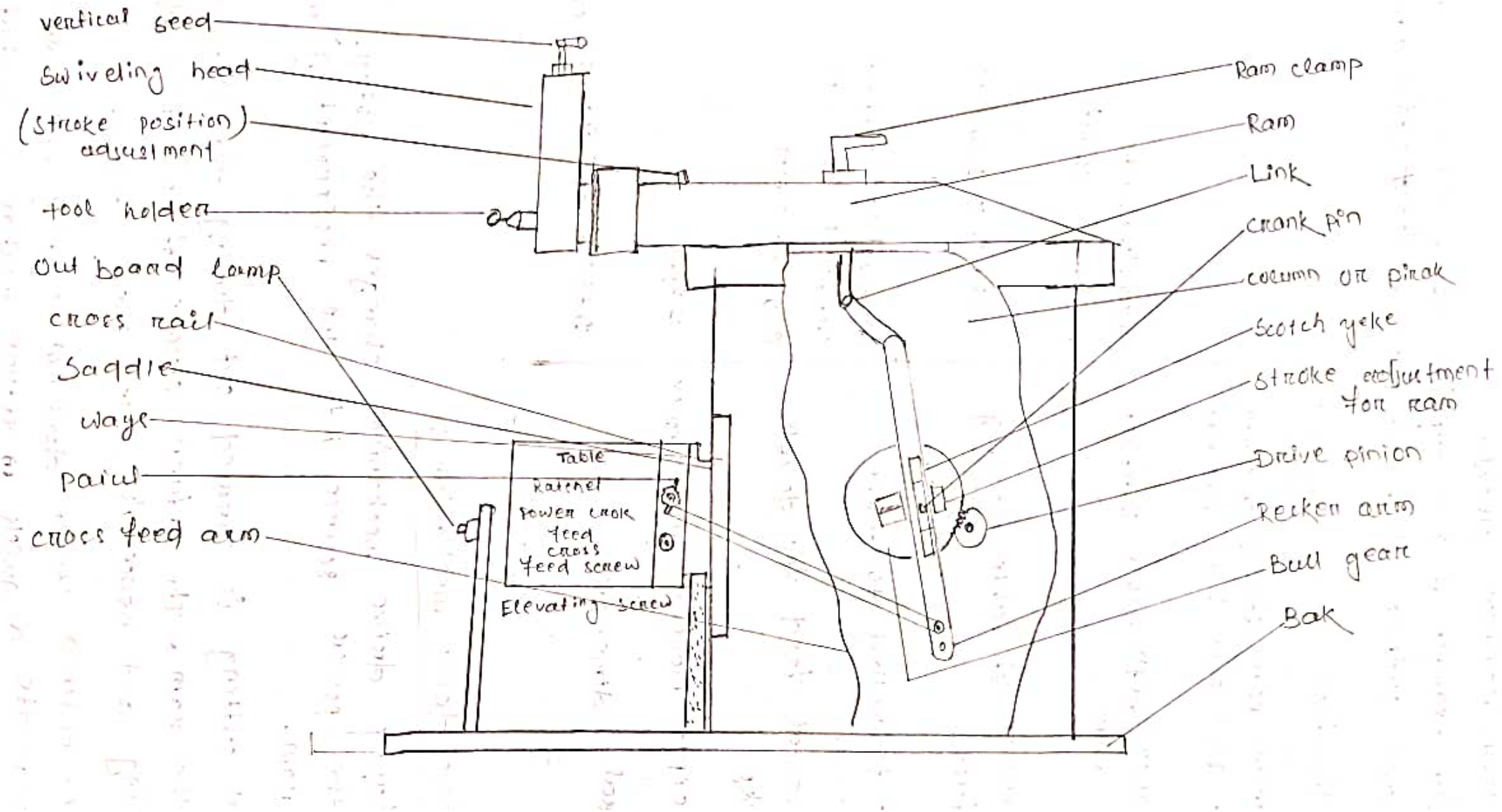
→ The clapper box always the cutting tool to leave on the return or ideal stock, so that the tool is not dragged back through the uncut workpiece & get damage.

* Shaper size and specification :

→ The size of shaper is classified according to the maximu length of stock.

→ push-cut shaper are made for work requirments upto 1.82 meters.

→ The maximum cross feed distance is generally equivelent to the maximum ram stroke distance. There fore a shaper of-


vertical feed
Swiveling head
(stroke position) adjustment
tool holder
Out board lamp
cross rail
Saddle
ways
pairl
cross feed arm
Table
Ratchet
Power cross feed
cross feed screw
Elevating screw
Ram clamp
Ram
Link
crank pin
column or pirak
Scotch yeke
stroke adjustment for ram
Drive pinion
Rocker arm
Bull gear
Bak

of 400mm maximum stroke.

For example it is a capable of machining a part a plane surface that measure at least 406 MM x 406 MM

* Specification of a shaper :

Maximum ram stroke 700 MM max. tool over hang 840 MM	
Distance betn table surface and ram	max. 400 MM minimum 80 MM
Dimension of table working surface	700 MM x 450 MM
Max. travelled to table	Horizontal 700 MM Vertical 320 MM
Horizontal feed for double stroke	0.25 → 5 MM
principle movement motor power	7 KW
Overal dimension	2785 x 1750 x 1780 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 and hence is called ideal stroke.

→ Since, return stroke does not cutting, the drive system in corporate a quick to return mechanism so that the

ram moves faster during return stroke in order to minimize the ideal time.

→ some of the shaper drive mechanism
  a. slotted link quick return mechanism
  b. with worth 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 and compact.

→ It converts the rotary motion of the electric motor and gear box into the reciprocating motion of ram.

→ The slotted link mechanism gives the ram a higher velocity during the return non-cutting stroke than its forward cutting stroke there by reducing the time wested during the return stroke.

→ The bull gear is given by a pining which is connected to a motor shaft through a gear box with 9.8 or more speed available.

→ The bull wheel has a slot, the crank pin 'A' is secured into the slot, at the same time it conside in the slotted crank 'B'.

→ when the bull wheel rotate, the crank pin 'A' also rotate and side by sides through the slot in the slotted crank 'B'.

→ This may the volted crank to oscilates about its one end 'C'. This oscilating motion of slotted crank (Through the link 'D') makes the ram to reciprocate.

→ The intermediate link 'D' is necessary to accomodate the rise and 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 slaper, furth it is away from the center of bull wheel, the longer is the stock.

→ The cutting stock of the ram is completed while the crank pin moves A to A, and the slotted link goes from left to right. similarly the return stroke the crank pin move from A to A & the slotted link changes it's position from right to left.

→ The time taken by the ideal and cutting stroke of the ram is propotional to the angle ∠AZA, and ∠A₁ZA respectively.

→ Since the crank pin 'A' rotates with uniform velity and is smaller, it is obvious that the ideal return stroke is quicker than the forewaard cutting stroke and hence the slotted link mechanism is known as "quick-return mechanism."

MILLING MACHINES

Q1 How the milling machine are classified and illustarate them accordingly ?

Ans: The usual classification according to the general design of the milling machine 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, profilling and traced controlled milling machine.

① column and knee type :-

For general shop work the most commonly wed 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 machine are classified according to the various method 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 type 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 relatively smaller in size then 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 machine are much more rigid and study then hand millers for accomodating heavy work piece. The milling machine 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 plain.

(c) Omniversal milling machine :-

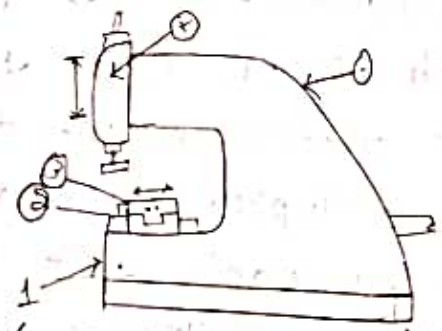
It the machine the table besides having all the movements of a universal milling machine, can be tilted in a vertical plain by providing a solved arrangement at the knee. Also the entire knee assembly is mounted in such a way that it may be fed in

longitudional direction horizontally. The additional survival arrangement of the table enables into machine taper spindel grooves are in remers, bevel grant etc. It is essentially as tool room and aperimental shop machine.

(d) Vertical milling machine :-

A vertical mill machine can be distinguished from the horizontel milling machine by the posctron of its spendle which is vertical on perpendicular to the work table. The machine may be of plain on universal type and has all the movemente of the table for proper setting and feeding the work. The spindle which is clamped to the vertical column may be swolveld at an angle permetting the milling cutter mounted on the to spindle to work on angular surface. In some machine, The spindle can also be adjusted up and down relative to the work. The machine is adopted for machining grooves, slots and flat surface. The end mills and face milling cutters are the usual tool. mounted on the spindle.

1. Base
2. Suddle
3. Table
4. Spindle head
5. column



(vertical milling machine).

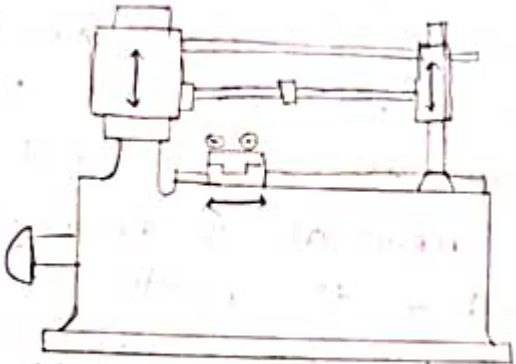
(e) Universal milling machine :-

It is most versatile of all the Milling machine, and after lathe it is the most useful machine tool as it is capable of performing most of the machining operations. with it application the use of largeer number of other machined tool can be avoiated. It diffens from the plain milling machine only in that the table can be given one more additional movement. Its table can be swivlled on the saddle

in the horizontal plain. for this, circular guideways are provided on the saddle along which it can be swivelled. A graduatted circular base in incorporated under the table with a datum mark on the saddle, to ready directly 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. It's over arm can be pusted back or removed and a vertical milling head can be fitted on a place of the orther to use it as a vertical milling machine.

② Manufacturing or fixed bed type :-

The fixed head type milling machine are: compation very large, heavy and rigid and differ radically from column and knee type milling machine by the construction of its table mounted. The table is mounted directly on the ways of fixed bed. The table movement is restricated to reciprocating at right angle to the spindle axis with no provision for cross of vertical adjustment. The cutter mounted on the spindle heads respectively. In a duplex machine, the spindle heads are arranged one on each side of the table. In trepex type the third spindle is mounted on across rail. The usual feature of these machine is the automatic cycle of operation for feeding the table, that is repeted in the regular sequence. The feed cycle of the table includes the following start, rappid approch, slow feed 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 repeatitive type of work.

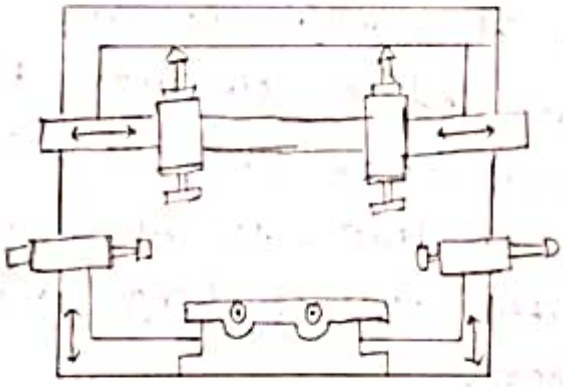


(Bed type milling machine)

(3) planner Type :-

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

It resemble 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 multipie cutter spindles enables number of woak surface to be machined simutanously. There by obtaining



great reduction in production time. The essential differences between a planner and plano-miller 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 feed.

Hence the table movement in a plano-milling machine is much slower than that of a planning machine. Modern plano millers are provide with higher power driven spindles powered to the exetent of 100 h.p and the rate of metal removal is tremendous. The use of the machine is limited to production work only and is considered ultimate in metal removing capacity.

(4) Special type :-

milling machine of non conventional design have been developed to suit ~~have~~ 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 direction. The following special type of machines of interest are discussed below :-

(a) Rotary table machine :-

The construction of the machine is a modification to a vertical milling machine and is adopted for machining flat surface at production rate. The face milling cutters 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 hight 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 is that its work supporting table which is called a drum, Rotates in a horizontal axis.

the face milling cutters mounted on three or four spindle heads rotate in horizontal axis and remove metal from work pieces counted on both the face of the drum. The finish machine parts are removed often on complete turn of the drum, and then the new ones are ~~clamped~~ clamped to it.

(c) planatory milling machine :-

In a planatory milling machine, the work is head stationary whell the revolving cutter or cutter move in a planatory path to finish a cylindrical surface on the work either in a ternally or extearm or simultaneously. The machine is particular adopted for milling internal or external threads of different pitches.

(d) pantograph milling machine :-

A pantograph machine can duplicate a job by using a pantograph machanism which permits the size of the workpieces reproduced to be smaller than, equal to or greater then the size of a template or model use for the purpose: A pantograph is a machinism that is generary construction of four bare or links which are joined in the form of a parallelogram. pantograph machine are available in two dimensonal or three dimensonal models. two dimensonal pantograph is used for engraving letters or other design, where as three dimensional models are employed for copying and shape and colour of the workpieces.

(e) profilling machine :

A profilling machine duplicates the full size of the tansplate attached to the machine. This is pratically a vertical milling machine of bed type in which

the spindle can be adjusted vertically on the cutter head horizontally across the table. The movement of cutter is regulated by a hardened guide p The pin in held againts and follows the outline or profile of a tamplate mounted on the table at the side of the job. The longitudional movement the table and crosswise movement of the cutter hea follows the movement of the guide pin on the template.

(f) Traced controlled milling machine :-

The traced controlled milling machine reproducess irregular or complex shapes of die, moulds etc. by synchronized movements of the cutter and tracing elements. The feeding motion of the machine is controlled automatically by means of a stylus that scats a profiled or a contured model which is to be produce. The movement of the stylus energizes an oil relay system which in turn operates the main hydrolic system of the table. The aerrangement is termed as servomechanism

Q:2 Explain the procedure of simple indexing ?

Ans: This method of condexing is used when the direct method of condexing can not be employed for obtaining the required no. of divisions on the work. For example, If the work is required to be devided in to 22 equal divisions the direct indexing can n be used, be cause 22 is not direct in dexing plate. For such cases simple indexing can easily be used.

For this, either a plain dividing head or a universal dividing head can be used this method of indexing involves the use of the crank, worm, worm wheel and index plate. As already described, the worm wheel carries 40 teeth and the worm is single start. The worm wheel is directly mounted on the spindle.

When the crank pin is pulled outwards and work is rotated, the worm will rotate which in turn, will rotate the worm wheel and the spindle and the work, since the worm has single start thread and the worm wheel 40 teeth, with one turn of the crank worm wheel rotates through one pitch distance, i.e. equal to 1/40 of a revolution. similarly two turns of crank will make the work to rotate through 1/20 and 3 turns through 3/40 of a revolution. Thus, the crank will be to be rotate through 40 turns in order to rotate the work through one complete turn. The holes in the index plate serve to subdevided to rotation of the index crank.

Now we want to devide the work into number of divisions, the corresponding crank movements will be as given below; for two division on the work, the crank will make

$$\frac{40}{2} = 20 \text{ turns of each division}$$

For 4 division on the work, the crank will make

$$\frac{40}{4} = 10 \text{ turns.}$$

For 10 division on the work, the crank will make

$$\frac{40}{10} = 4 \text{ turns}$$

Similarly for 'n' divisions on the work the crank will make $\frac{40}{n}$ turns.

Let us consider that the work has to be divided into 23 equal division, then the corresponding crank movements will be given by;

$$\text{Crank movements} = \frac{40}{23} = 1\frac{17}{23} \text{ turns.}$$

Now, in the obtained result, the whole number indicates the number of full turns the crank has to moves through, and the fraction represent the parts of the turns that the crank has to make, in addition to the above, in order to make the work to rotate through one required division i.e. $\frac{17}{23}$ of a revolution. In the fraction the numerator the no. of holes on the circle to be used. Thus for the above indexing for each division on the job, the crank will make, one complete revolution and will move further through 17 holes on 23 holes circle

To set the spacing on the indexing plate, and avoid error and confusion in counting the hole everytime, the sector arm should be used. These arm can be set such that they will contain between them only as many holes on a particular circles as are required. The spacing can be maintained for as many operations as desired. For giving full turn the crank, the pin can be withdrawn from the hole and the crank turned. For the remained should be moved from an arm to the other and then enguged. After engaging the pin the arms

can be moved farther to set the spacing for the next operations.

Example :-

It is required to divide to periphery of a job in to 60 equal division. Find the crank-movement ?

Solution :-

required movement = $\frac{40}{60} = \frac{2}{3}$

selecting is holes circle on plate no : 1, we get

$$\frac{2}{3} = \frac{2}{3} \times \frac{6}{6} = \frac{12}{18}$$

i.e. 12 holes on 18 hole circles (Ans)

Q.3 Explain the procedure for compound Indexing ?

Ans : The method of indexing is employed when the number of divisions required is out side the range that can be obtained by simple indexing, involves the use of to separate simple indexing movements and is performed in two stages :-

(1) By turning the crank a definite amount in one direction in the same ways as in simple indexing.

(2) By turning the indexing plate and the crank both, either in the same or reverse direction, thus adding further movement to or subtracting from that obtained in the first stage.

procedure :-

In order to obtained the required no of divisions through compound indexing proced as follows :-

(i) Factorise the no of divisions required.

(ii) Factorise the standard no 40.

(iii) select for trial any two circles on the same pl. and on its same side factorise their difference.

(iv) Factorise the no. of holes of one circle.

(v) Factorise the no. of holes of the other circle.

After obtaining these factors place them as follows :-

Factors are division required x factors of distance of holes circle.

First check :-

If suitable index circles have been selected then all the factors in the numinitor will be can called by those in the denominator. That is you will get unity in the numenator. If close not happen, select another set up circles and make another : attempt in the same ways as above. Repeat it till you get 1 in the numenator.

Now, isippose the above expression, after simplefical comes to the form $1/2$, where K may be any number. If a and b donate the number of the holes on the two circles, then the required indexing movement will be given by :-

$$\frac{K}{a} - \frac{K}{b} \text{ or } \frac{K}{b} - \frac{K}{a}$$

The positive parts of the indicates the movement of the crank in one direction and the negative part donates the movement of the plat in crank in the positive direction. It is always advisible to

to keep the backward motion as smaller of the two.

2nd check :-

After finding the above two expressions, check that the algebric sum of the two movements, i.e. of the crank in one direction and that the crank and plate in the opposite direction should be equal to $40/N$. where 'N' is no. of divisions required. or we can say that, if the correct reasult in obtained, then :- $\frac{K}{a} + \frac{K}{b} = \frac{N}{N}$

Example :- Compound indexing for 67 divisions.

solution :-

Suppose we selected circles of 29 and 33 holes. putting the relative factors in the relative factors in the form of the above stated expression and applying the first check we get :-

$$\frac{3 \times 29 \times 2 \times 2}{2 \times 2 \times 2 \times 5 \times 29 \times 3 \times 11} = \frac{1}{110}$$

i.e. we get - unity in the numination, indicating that the circles. selected are correct. therefore, the required indexing movement is given by.

$$\frac{110}{29} - \frac{110}{33} = 3\frac{23}{29} - 3\frac{11}{33} \quad \text{.... (i)}$$

$$\text{or } \frac{110}{33} - \frac{110}{29} = 3\frac{11}{33} - 3\frac{23}{29} \quad \text{.... (ii)}$$

Since there are three common complete turn in each case they councle out, leaving the required movement as :-

$$\frac{23}{29} - \frac{11}{33} \quad \text{or} \quad \frac{11}{33} - \frac{23}{29}$$

Since we keep the foreword motion of crank as thergere then the backward motion of the plate and crank path, we adopt the first expression for the required

indexing movement.

i.e. the movement - $\frac{23}{29} - \frac{11}{33}$

Or, In more elaborate terms, we can say that the work will be through 1/17 of of a revolution each time as the crank is moved forward 23 holes on 29 hole circle and the plate and crank backward 11 holes on 33 holes circle.

Now applying the second check,

$$\frac{23}{29} - \frac{11}{33} \text{ or } \frac{40}{87} - \frac{40}{N}$$

i.e. the algebraic sum of the two movements obtained is equal to 40/N, conforming that the movements obtained are correct.

* * * * *

GRINDING

Q:1 Define Grinding ?

Ans:- Grinding is a process of removing material by the abrasive action of a revolving wheel on the surface of a work piece, in order to bring it to the required shape and size. So far as the cutting action is concerned, grinding is very much similar to other machining operations since the microscopic examanition of the removed material reveals that the same is in the form of small chips, similar to thus obtained in other machining operations. The wheel for used for performing the grind operations is know as 'Grinding wheel'. It consists of sharp crystals, called abrasives, held together by a binding material or bond. The wheel may be composed of several segments of a abrasives block joined togather. In most case, It is a finishing operations and a very small amount of material is removed from the surface during the operations.

Q:2 Explain the manufacturing of Grinding wheel ?

Ans:- mainly this 'wheels' are made in many ways. Essentially they consist of a number of bonded abrassive block held togather by suitable means. A example of these will consist of a these block fastend of a metal metal wheel by a chuck specieres are always provided between the block. It mainly employed on vertical spindles grunders with resiprocating or rotary type table. They are mainly used in surface grinding and carrying the following main Advantages:-

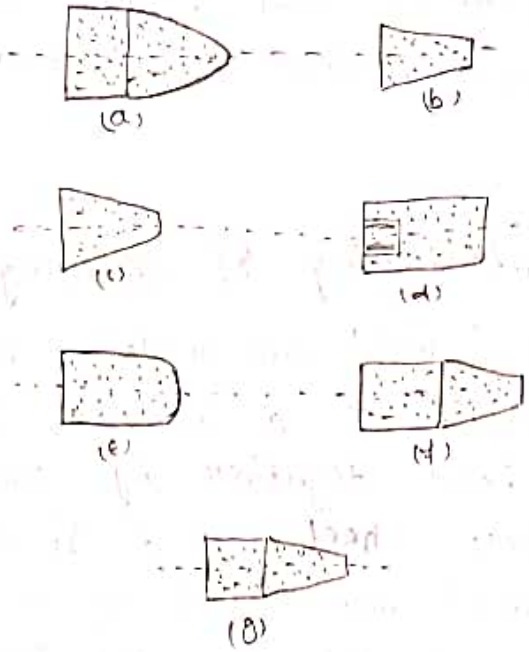
(i) It is easiar to manufacture these wheel in large size in compression to the solid wheels of same size.

(11) They cut intermittently, and hence cool grinding is the reasult. A segmental grinding wheel is show in the figure.

There is a special variety of grinding wheels which posses 'cone' and 'plug' shapes. they are employed to grind incrite shapes to which their outer surface suit.

(A segmented grinding wheel)

They carray threaded bushing on the mounting side as shown in down fig. This figure shows the standard.



Shapes of 'cone' and 'plug' grinders as per IS : 2324 (part 1) 1985. There detailed also given in this standard.

An important point to note is that in this type of wheel grinding is performed by all the surface except the flat surface on the mounting side.

Q.3 State criteria for selection of grinding wheels ?

Ans:- selection of a proper grinding wheel is vital necessity to obtained the best reasults in grinding work. A wheel may be required to perform various different function like quick removal of stock material, give a high class surface finished, maintain close dimensional tolerences and a single wheel will fail to meet all the requirements. It is necessary therefore, that proper grain size, bond, groove, strength, shape and size of wheel should be selected to meet the specific requirement of a job.

In selecting a grinding wheel there are four constant factors and four variables are illustrated below :-

(1) The material to be ground :-

This influence the selection of (a) a abrasive (b) grain size (c) grade (d) structure and (e) bond

(b) Aluminium oxide abroicve is recomended for material of high tensile strength and silicon carbide for low tensile strength.

(c) Fine grain is used for hard and brittle material and course grain for soft ductile metals.

(d) Fine grain is used for hard and brittle material and course grain for soft ductile materials.

(e) Hard steel is used for soft material and soft wheel for hard materials.

② Amount of stuck to be removed :-

This involves accuracy and finish. Course again is used for fast cutting and fine grain for fine finish wide spacing for rapid removal and does for fine finish, resinoid, rubber and shellal bond for high fin

③ Area of contact :-

Area of contact influences the selection of (a) grit size (b) grade and (c) structure number.

Fine grain and close grain spacing are usefull where other area of contact involved is small, and corse grain and specing are employed where a large area of contact is concerned.

④ Type of Grinding machine :-

Type of grinding machine determines to

rigidly constructed machine take softer wheel then the lighter more flexible types. The combination of speed and feed on sound precision machine may be affect the grade of wheel decribe for best reasult

(i) wheel speed :-

The wheel speed influence the selection of grade and bond. The higher the wheel speed with relation to work speed, the softer the wheel should be. vetrified bond is usually specified for speeds up to 2000 s.m.pm (or 6500 s.m. or pm) and the rubber, shellac or resenoid bonds for speed over 2000 s.m.pm (or 6500 s.m.pm).

(ii) Work speed :-

The work speed with relation to wheel speed determins the hardness of the wheel. The higher the work speed with relation to the wheel speed, the harder the wheel should be variable work speed are often provided on grinding machines to preserve the proper relative surface speeds between the work and wheel as the wheel diameter decreases because of water.

(iii) Condition of grinding machine :-

The condition of grinding machine loading on the grade of the wheel to be selected. spindle coole their bearings, and incure on shuky foundations would necessitate the use of harder wheels then would be the case If the machine were in hetter operating conditions.

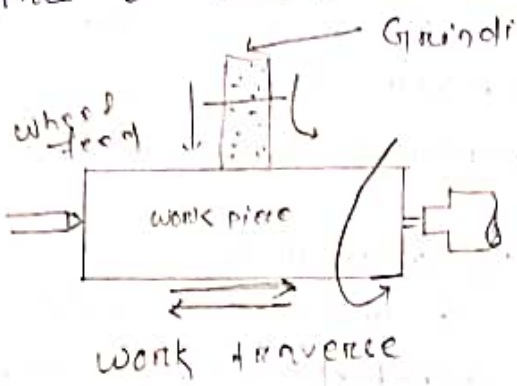
(iv) personal factor :-

The skill of workman is another variable factor which should be concidered in selecting the wheel, as for intance on off and grinding cost considerbely on the same work in the same factory.

Q.4 Explain the working principle of cylindrical grinders?

Ans : The principle of cylindrical grinding involves holding the work piece rigidly on centers, in a chuck or in a suitable holding fixture, rotating it about its axis and feeding a fast revolving grinding wheel against the same. If the work surface to be ground is longer then the face width of the grinding wheel, the work is traversed pass the wheel or the wheel past the work travelling of wheel or work is done either by hydraulic or mechanical power or by hand. The feed is given to the work or the wheel at the end of each travelling moment. In case the width of

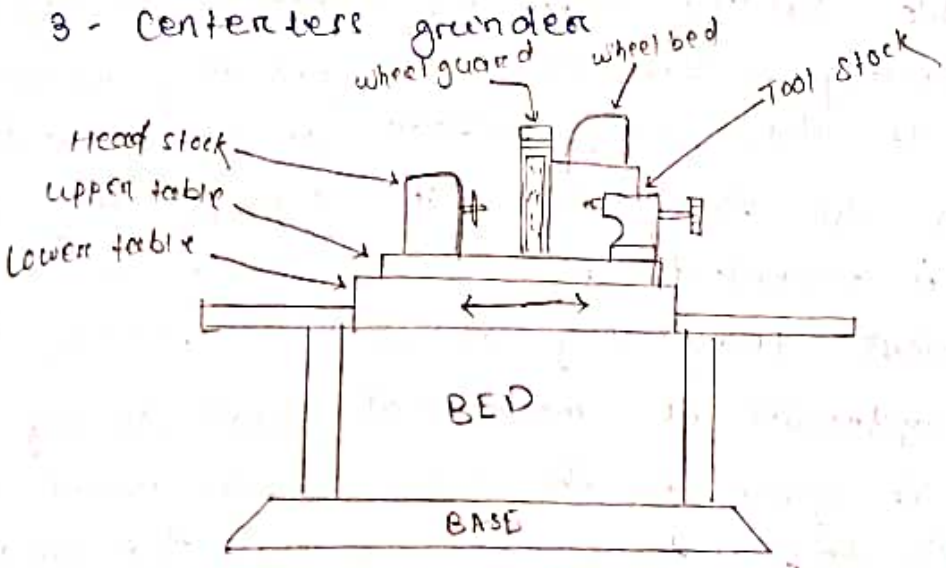
wheel face is more or equal to the length of the work surface to be ground, the wheel may be fed in which no traversing movement of it or that of the work. This is known as plug grinding.



The simplest and quit commonly used type of cylindrical grinder is a two post grinder use to lathes. when wheels of large axiemetets are used. They can be mounted directly on the motor shaft is provided, which run at a relatively much higher speed then the motor. Both external and internal diameter cylindrical grinding can be done on lath by this equipments.

cylindrical grinding machines are mainly of the following three types:-

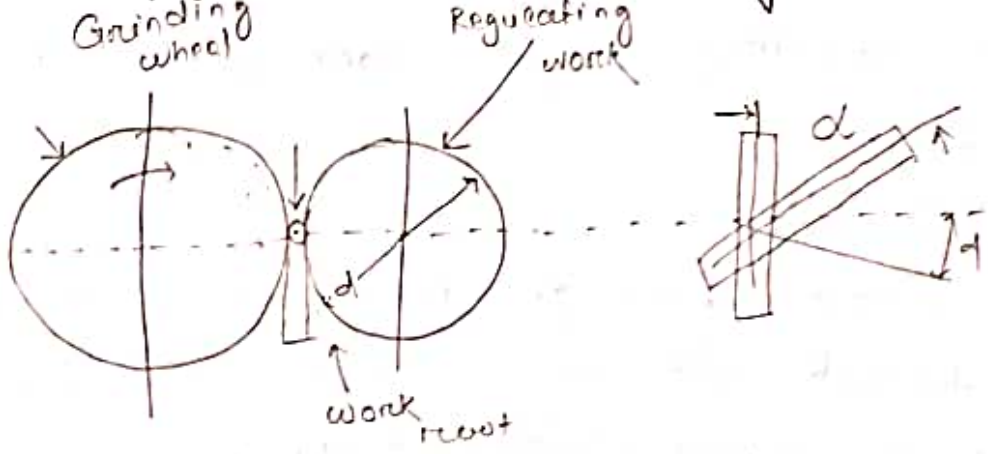
1- plain cylinder grinders.
2- Universal cylinder grind
3- Centerless grinder



(plain cylindrical cylinders)

In this case the workpiece is usually held between centers. one of these centers is in the head stock and othe in the tail stock. In operation, the rotating work is traverse & the wheel is fed into the work by amount in to the depth of cut. while mounting the work between centers, the head stock center is not disturbed. It is the tail stock center which moved in or out, mainly or hydraulically, to inset and hold the work. Jail stock and head stock both can be moved along the table to suit the work. Table is usually made in two parts. The table carries the tail stock, head stock and workpiece and can be swivelled in a horizontal plane, to maximum of 10° on the side, along the circular ways provided on the lower table. This enable grinding of taper surface. The lower table is mounted of a horizontal guide ways to provide longitudional traverse to the upper table and hence the work. The table movements can be both by hand as well as power. Hydraulic table drives are usually performed.

Q:5 with the help of a net diagram, explain the construction and working of a centerless grinder.



Centerless grinding is a method of grinding exterior cylindrical, tapered and from surface on workpiece that are not held and rotd on centers. The princip elements of a external centeless grinder are the grinding wheel, regulation wheel, and the work rest. both wheels are up rotated in some direction. The work rest is located between the wheels. The work is placed up on the work rest, and the latters, together with the regulating wheel, is fed forward forcing the work against the grinding wheel.

The axial movement of the work past the grinding wheel is obtained by tilting the regulating wheel at a slight angle horizontal. An angular adjustment of 0 to 8 or 10 degrees is provided in the machines for this purpose. The actual feed (s) can calculated by the formula.

$$S = \pi d n \sin \alpha$$

where S = Feed in mm per minute
n = revulation per minute
d = dia of regulating a in mm
γ = Angle of inclination of wheel

Centerless grinding may be done in one of the three ways;

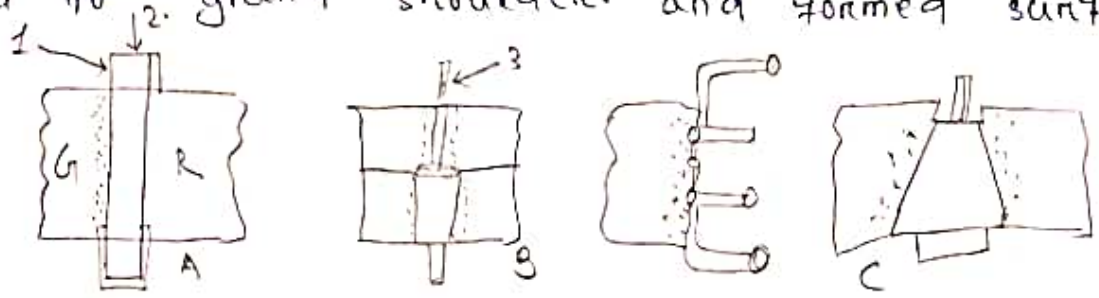
(a) Through feed :-

In through feed grinding, the work is passed completly through the space between the grinding wheel and regulating wheel, usualy with guides at

both end. This method is used when there are no shoulders or other forms to interfere with the passage of the work. It is useful for grinding long, slender shafts or bars.

(b) Infeed :-

In infeed grinding which is similar to plunge grinding or from grinding, the regulating wheels is drawn back so that work piece may be placed on the work ruse blade. Then al is moved into feed the work against the grinding wheel. This method is useful to grind shoulders and formed surface.



(c) End feed :-

In end feed grindings, use to produce taper, either the grinding wheel or regulating wheel or both are formed to a taper. The work is fed length wise between the wheels and is ground as it advances unitill it reaches the end stop.

→ The advantage of centerless grinding are :-

(i) The process is continous and adepted for production work.

(ii) The size of the work is easily controlled.

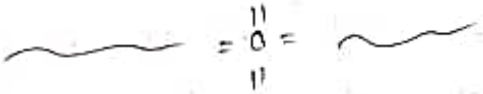
(iii) A low order of skill is ... the operation of the machine.

(iv) As the floting condition exists during the grinding process, less metal to be removed.

Some disadvantages are :-

(i) work having multiple diameter is not easily handled.

(ii) In hollow work there is no containty that the out-side diameter will be concentric with the inside diameter will be concentric with the inside diameter.



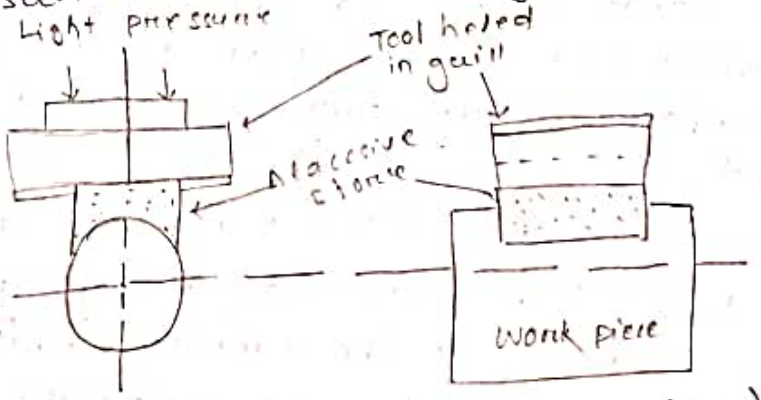
SURFACE FINISH LAPING

Q:1 with the help of net diagram, describe the process of surface finishing?

Ans:- Super finishing is more or less like a laping process with a specific difference that the abrasive used is a bonded abrasive, The abrasive are used in a particular way under controlled conditions to produce a high quality surface finish on the work surface. It should be particularly noted that it is not essentialy a metal removing operations and it is necessary therefore that in order to have rapid rate of production, all the components to be super finish should first finished through other operations, very nearly to the final size. In order to bring the work to suched a close dimensonal accuracy, grinding is usually employed prior to superfinishing.

principle of operations :-

The principle of superfinishing is shown schematically in fig (i): one face of the abrasive block is given the shape of the surface to be superfinished. This block is held in suitable holder or grill and placed in the work surface.



(principle of superfinishing Operation)

The grill is spring loaded to provide a light pressure on the work surface. The workpiece is rotated at a very slow surface speed of the order of 2 to 2m/min. As the work rotates the abrasive block resiprocates forward and backword at a rapid rate.

In order to cover the entere length of the workpiece, the block overruns by a amount 1.5 mm to 6 MM on both end of its stock. A suitable lubricate is used in this process. An oscitatory motion obtained due to the combination of rotary motion of the work and reciprocating motion of the abrasive block with ribbing on the stone against the work surface reasuelts in the production of a superfinished surface.

Although this operations can be performed as a small scale on some conventional machine tool like lathe, for performing superfinishing on large scale specially designed and built superfinishing machineshes are used.

Q:2 what is laping ? How is done ? How many type of Laping operations are there ?

Ans:- Laping is an a brooding process employed for improving the surface finished by reducing roughness, waviness and other irregularities on the surface. It is used on both heat treated and non heat treated metal parts. It should, however, be noted, that where good appearance of the job. Surface is the only requirment, it should not be employed, since there other finishing method, which will give the same desired result with low cast. It should be used only where accurancy is a vital consideration in addition to the surface finish. The basic purpose of basing is minimise the extremely minute irregulates lets on the job surface after some machining operations. in brief, we can say that laping is basically employed for removing minor surface impriti cation, obtaining geomatrically true surface, abtaing batter dimensonal accuracy and, thus faciliatte, a very close feet between two contacting surfaces.

The material to be selected for a lapping tool or lap largely depends upon the individual choice and the availability and no spectic rule can be laid for the same. The only consideration that has to made is that the material should used for making a lap be shaft so that the abrasive grain can be easily embedded in its surface. The commonly used for materials are soft can iron, copper, brass lead and sometimes hard wood.

Laping operations are can be broadly classified into the following two main groups.

1 → Equalising Lapping

2 → From lapping

It is the operation of running two matain parts or shapes together with an abrasive between them when two such surface run together in constant with be abrasive, theire deviation of shape corrected. Those results can be easily seen during seating of tapered valves in their sets or when gears are rotated together with this objectives.

Form Lapping :-

As is clear from the name itself, it is not merely rubbing of surfaces together but it is the shape of the lap that is responsible for finishing a corresponding work surface. Obviously the lap is used in the operation will be a form lap i.e., containing the shape to be lapped.

SLOTTER

Q:1 what is slotting machine and how they are classified;

Ans:- A slotting machine or slotter has its own importance for a few particular classes of work. It main use in cutting different types of slots. Its other uses are in machinging irregular shapes, circular surface etc.

The slotting machine falls under the category of reciprocating type of machine tool similar to a shaper or planner. It operates almost on the same principles as that of a shaper. The major difference between a slotter and shaper is that in a slotter the ram holding the tool reciprocates in a vertical axis. where is an a shaper the ram holding the tool reciprocates in a horizontal axis. A vertical shaper and a slotter are almost similar to each other as regard to their construction operations and use.

The slotter is used for cutting grooves, key ways and slots of various shape, for handling large and awkward workpieces, for cutting internal an external gears and many other operations which can't be conveniently machined in any other machine tool describe the before the slotting machine was developed by Burnel in the year 1856 much earlier than a shaper was invented.

There are mainly two classes - slotter :—

1- puncher slotter
2- precision slotter

(1) puncher slotter :—

The puncher slotter is a heavy, rigid machine designed for removal of large amount of metal from forging or casting the length of a puncher

slotter is sufficiently large as may be as long as 1800 to 2000 mm. The puncher slotter ram is usually driven by a spiral pinion meshing with the rake teeth cut on the under side of the ram. The pinion is driven by available speed reversible electric motor similar to that of a planner the feed is also controlled by electric gear.

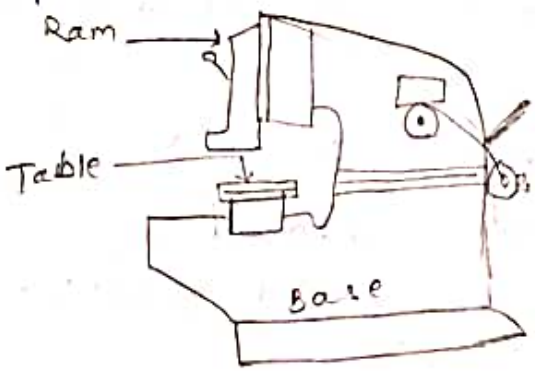
(3) precision slotter :-

The precision slotter is a lighter machine and is operated to a high speed. The machine is design to take light cuts giving accurate finish. using special jigs, the machine can handle a number of identical work on a production basic the precision machines are also used for general purpose work and usually fitted with whitworth quick return mechanism.

Q:2 what are the difference parts of a slotting machine. Described about the main part of machine ?

1. Base
2. column
3. saddle
4. cross slide
5. rotating table
6. ram and tool head assembly
7. Ram drive mechanism
8. Feed mechanism.

The main parts of a slotting machine are :-



(1) Base :-

It is a heavy cast-iron construction and is also know as 'bed'. It acts as a supports for the column, the driving mechanism ram, table and other

fittings. At its top it carries horizontal ways, along which the table can be traversed.

(2) Column :—

It is another heavy cast-iron body. which acts as a housing for the complete driving mechanism. At its front is carries vertical ways, along which the ram moves up and down.

(3) Table :-

Usually a circular table is provided on slotting machine. In some heavy duty slotters, either a rectangular or circular tables can be mounted. on the top of the table are provided T-slots to clamp the work or facilitate the use of fixtures, etc.

(4) Ram :-

In moves a vertical deraction between the vertical guide ways provided with infront of the column. At its bottom, It carries the tool post in which the tool is held. The cutting action takes place during the downword movement of the ram.

Q:3 what are the operations performed by the slotting machine ?

Ans: The operations performed by the slotting machine are:-

(i) machining flat surface

(ii) machining cylindrical surface

(iii) maching irregular surface

(iv) maching slots, keyways and grooves.

(i) machining flat surface :-

The external and internal flat surface may be generated on a workpiece easily on a slotting machine. The work to be machined is supported on

a parallel chips so that the toll will have clearance with the table when it is at the stroke. The work is the clamped properly on the table and the position and the length of stroke is adjusted. A clearance of 20 to 25 mm is left before the begining of cutting stroke. so that the feed movement may take place during this idle part of the stroke. The table is clamped to prevent any longitudional or rotary travel and the cut is started from one end of work the class feed is supplicated at the begining of the each cutting stroke & the work is complited by using a rough and finishing tool. while machining an internal surface; a hole is drilled in the workpiece through which the slotting tool may pass during the first cutting stroke. A second surface parallel to the first machined surface can be completed with out distrubiting the setting by simple rotating the table through 180° and adjusting the position of the saddle. A surface perpendicular to the first machined surface may be completed by rotating the table by 90° and adjusting the position of the saddle and crossside.

The external and internal surface of a cylinder can also be machined in slotting machine. The work is plaved centarally on the rotary table and packing prees and clamps are two hold the work securely on the table. The tool is set radily on the work and necessary adjustments of the machine and the machine is started. while machining the feeding is done by the rotary table feed screw which rotates the table through a small are at the begining of each cutting stroke.

The work is set on the table and necessary adjustment of the tool and the machine are made as detailed in other operations. By combining cross, Longitudinal

and rotary feed movements of the table any contoured surface can be machined on a work piece.

Internal and external grooves are cut very conveniently on a slotting maching. A slotter is specially intended for cutting internal grooves which are difficult to produce in other machines. External and internal gear teeth can also be machined in a slotter by cutting equally spaced grooves on the prephery of the work. The indexing or dividing the perepephey of the work is done by the graduations on the rotary table in an machining grooves or key ways. Hear internal and external grooves are cut very conveniently on a slotting machine.

* DRILLING *

Q.1 what do you understand by the term drilling ? How do you classifie different types of drills ?

Ans: The drilling machine is one of the most important machine tools in a workpiece of work . As regard its importance it a second only to the lathe. Although it was primarily design to originate a hole, it can perform a number of similar operations. In a drilling machine holes may be drilled quickly and at a low cost. The hole is generated by the rotating edge of cutting tool known as the drill which exerts large force on the work clamped on the table. As the machine tool exerts vertical pressure to originate a hole it is cossery called a drill press.

Drilling machine are manufactured in various size and varieties to suit the different type of work. They can, however, be bradly classified as follows :-

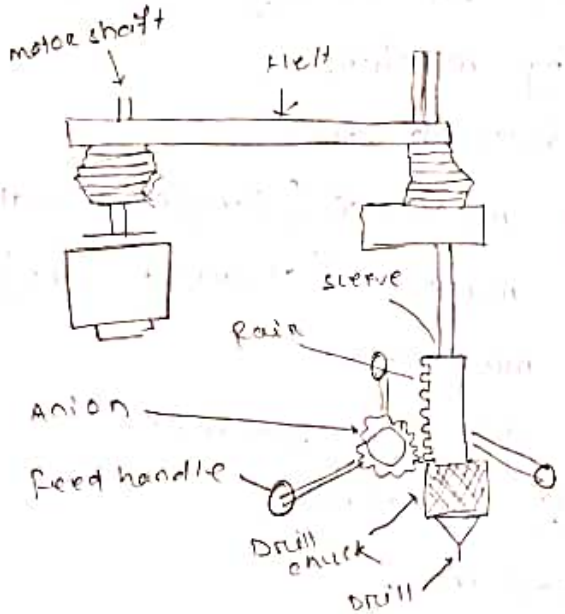
(i) Portable drilling machine
(ii) Sencative or bnench drill
(iii) Upright drilling machine (single spindle)
(iv) Upright drilling machine (Turret Type)
(v) Radial drilling machine
(vi) Multiple spindle drilling machine
(vii) Deep hole drilling machine
(viii) Gang drilling machine
(ix) Horizontal drilling machine
(x) Automatic drilling machine

Q.2 with net sketch descreibing the working of bench drilling machine ?

Ans: The type of drilling machine is used for very high work. Its construction is very simple and so is the operations.

It consist of a cast iron base living a fixed table over it. The vertical column carries a table, the height of which vertically along the former. also it can be swing to any desired positi At the top of the column is provided the drive, which consists of an endless bell runing over two v-pulleys. one of those pulleys is mainted on the motor shaft and other on machine spindle. No gears are used in the drive. vertically movemen to the spindle is given by the feed handle through a rack and pinion arrangement. The spindle usual carries no 1morse tapes. sencetive drills are normal manufactured having upto 80 MM drilling capacity in steel.

The drive mechanism of this machines is illustrated in this fig.



As the motor is switched on the motor shaft start revolving and hence, the v-pusley mounted over it. This through the v-belt, transmit motion and power to the other v-pulley mounted over the drill spindle. Thus the spindle starts rotating and therefore the cutti tool (drill). when the drill is required to be f

into the work. It is pressed against the work by mean of the feed bandle. As the handle is rotated, which is directly mounted on the pinion shaft, the pinion rotates it moves. the rake longitudionally and, hence, the spindle and the drill. The key weay cut along the spindle facilities vertical movemente of the spindle which it is rotating under power. different spindle speeds can be obtained by shifting the v-belt to different pairs of driving and drivven pulleys, while the motore continous to rotate on the same speed.

On this machines, the drill rotate at very high speeds so that the required cutting speed can obtained on the perepheires of small drills used on these machines. The hand feed enables the operator to feed the gradual penetration of the drill into the work material and also since it the drills is cutting properly or hose become blunt and needs regriding, for this reasron only it is known as a sensitive drill.

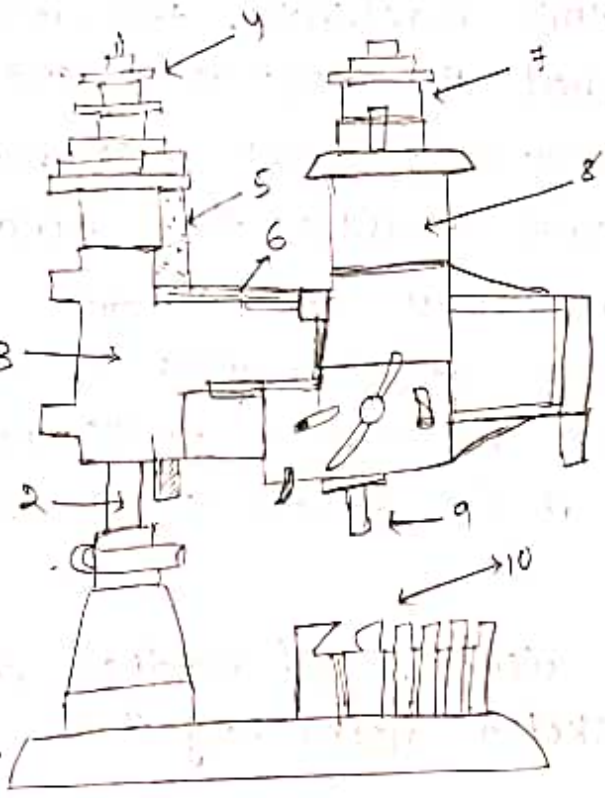
Q3 Explain the working of radial drilling machine? Draw net sketch necessary?

Ans:- These machine is very usefull because of its wide range of action. Its principle use is in drilling holes on such work which is difficult to be handled frequently. with the use of this machine, the tool is moved to the disered position insted of moving the work to bring the latter in position for drilling.

The machine consists of a heavy, vertical column, round, mounted on larege base. The column supports or radial arm which can be raised and lowered to accomodate

workpieces of different heights. The arm may be swung around to any position over the work bed. The drill head containing mechanism for rotating and feeding the drill is mounted on a radial arm and clamped at any desired arm and clamped at any desired position. These three movements on a radial drilling machine when combined together permit the drill to be located at any desired point on a large workpiece for drilling the hole.

1. Base
2. Column
3. Radial arm
4. rotor bar elevation the ram
5. Elevating screw
6. Guide ways
7. motor for driving the drill spindle
8. drill head
9. drill spindle
10. Table



~~Universal machine~~ :-

In universal machine, in addition to the above four movements, the arm holding the drill head may be rotated on a horizontal axis. All this five movements in a universal machine enables it to drill on a workpiece at any angle.

Based on the type and number of moments posible the radial drills can be brodely grouped as :-

plain radial drilling machine :-

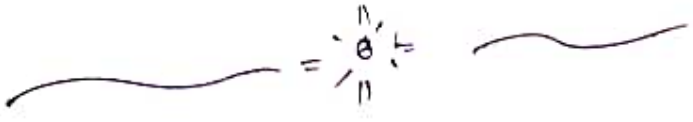
In a plain radial drilling machine provisions are made for vertical adjustment of an arm, horizontal movement of the drill head along the arm, and circular movement of arm in a horizontal plain about the vertical column.

Semi-universal machine :-

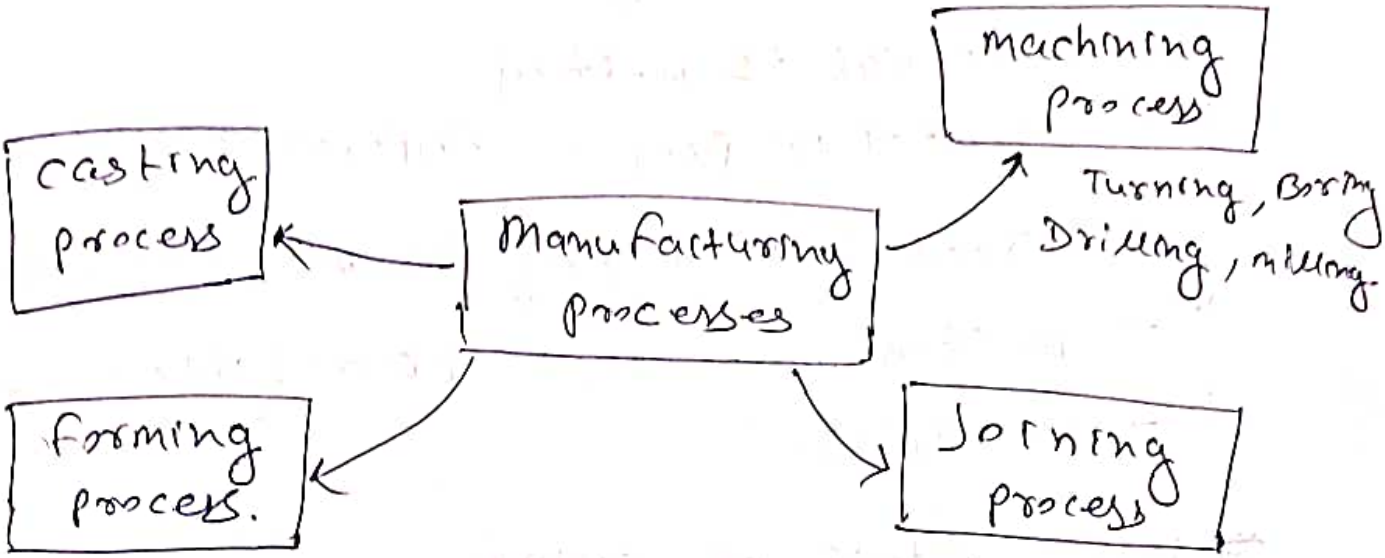
In a semi universal machine, in addition to the above three movements, the drill head can swing about a horizontal axis perpendicular to the arm, this fourth movement of drill head permits drilling hole at an angle to horizontal plane other then the normal position.

Universal machine :-

In universal machine, in addition to the above four movements, the arm holding the drill had may be rotated on a horizontal axis. All this five movements in a universal machine enables it to drill on a work piece at any angle.



Manufacturing Processes.

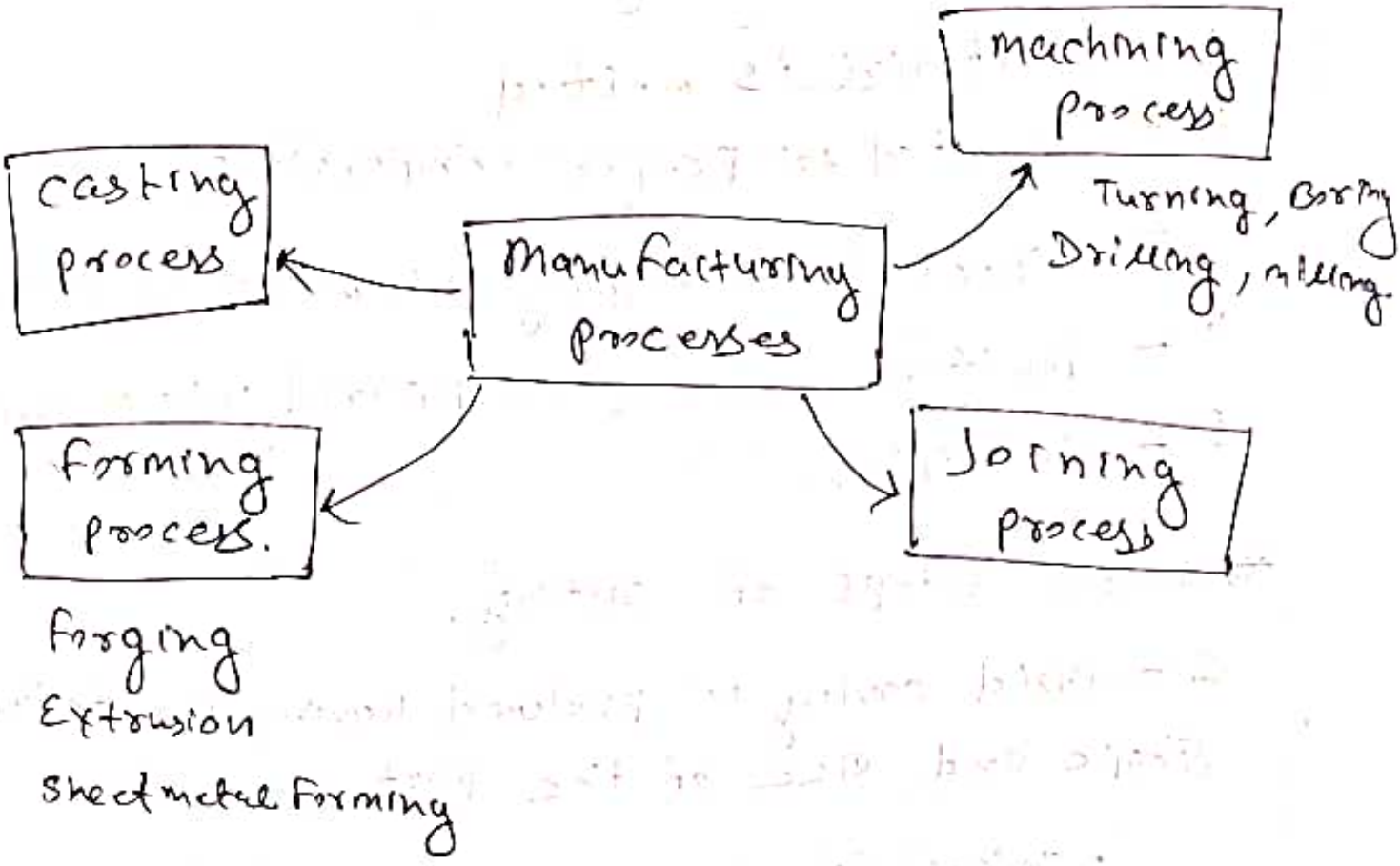


Forging
Extrusion
Sheetmetal Forming

* Four basic categories of manufacturing processes -

I - casting process
II - Material Removal Process.
III - Deformation process.
IV - Joining process.

Manufacturing Processes.



* Four basic categories of manufacturing processes -

I - casting process
II - Material Removal Process.
III - Deformation process.
IV - Joining process.

Casting

* Introduction to casting.

1 - material is melted
2 - Heated to proper temperature.
3 - Treated to modify its chemical makeup
4 - Molten material is poured into a mold
5 - Solidifies.

* Basic Steps of casting.

1 - Mold cavity is produced having the desired shape and size of the part.
   - Takes shrinkage into account
   - single-use or permanent mold.
2 - Melting process -
   - Provides molten material at the proper temp.
3 - Pouring technique.
   - molten metal is poured into the mold at a proper rate to ensure that erosion and or defects are minimized.
4 - Solidification process -
   - Controlled solidification allows the

product to have desired properties.

- mold should be designed so that shrinkage is controlled.

5- mold Removal.

- The casting is Removed from the mold
  -> single-use molds are broken away from the casting.
  -> permanent molds be designed so that Removal does not damage the part.

6- Cleaning, finishing, and inspection -

- Excess material along parting lines may have to be machined.

- Pattern - approximate duplicate of the part to be cast.
- molding material - material that is packed around the pattern to provide the mold cavity.
- Flask - Rigid frame that holds the molding aggregate.
- Cope - top half of the pattern.
- Drag - bottom half of the pattern.
- Core - Sand or metal shape that is inserted into the mold to created internal features
- mold cavity - combination of the mold material and cores.
- Riser - additional void in the mold that Provides additional metal to compensate for shrinkage.
- Gating system - network of channels that delivers the molten metal to the mold.
- Pouring cup - portion of the gating system that controls the delivery of the metal.

- Sprue – vertical portion of the gating system.
- Runners – horizontal channels.
- Gates – controlled entrances.
- Parting line – separates the cope and drag.
- Draft – angle or taper on a pattern that allows for easy removal of the casting from the mold.
- Casting – describes both the process and the product when molten metal is poured and solidified.

→ PATTERN -

It is a Replica of the object to be cast, used to prepare the cavity into which molten material will be poured during the casting process.

The pattern material should be

1 - Easily worked, shaped and joined.
2 - light ~~weight~~ in weight
3 - Strong, hard and durable.
4 - Resistant to wear and abrasion.
5 - Resistant to corrosion and to chemical Reactions.
6 - Dimensionally stable and ~~to chemical React~~ unaffected by variations in temperature and humidity.
7 - Available at low cost.

Pattern material -

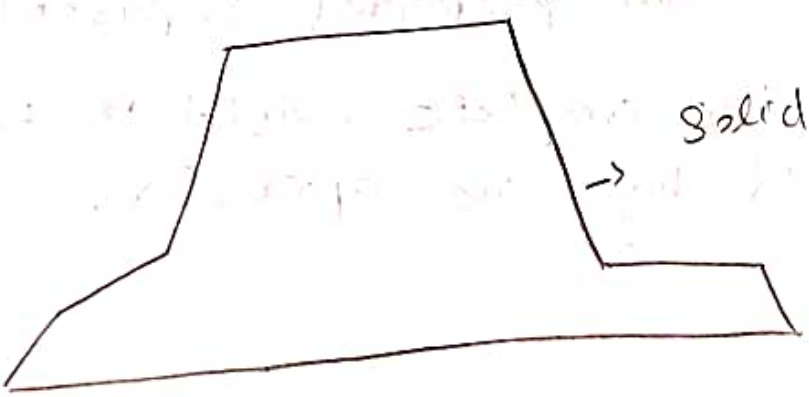
wood, metals and alloys, plastic, wax, Plaster of Paris, plastic and rubbers.

Types of Pattern-

I - Single-piece or Solid Pattern
II - Two piece or split pattern.
III - Cope and drag pattern.
IV - loose piece pattern.
V - match plate pattern.
VI - Follow board pattern.
VII - gated pattern.
VIII - sweep Pattern.
IX - Skeleton pattern.

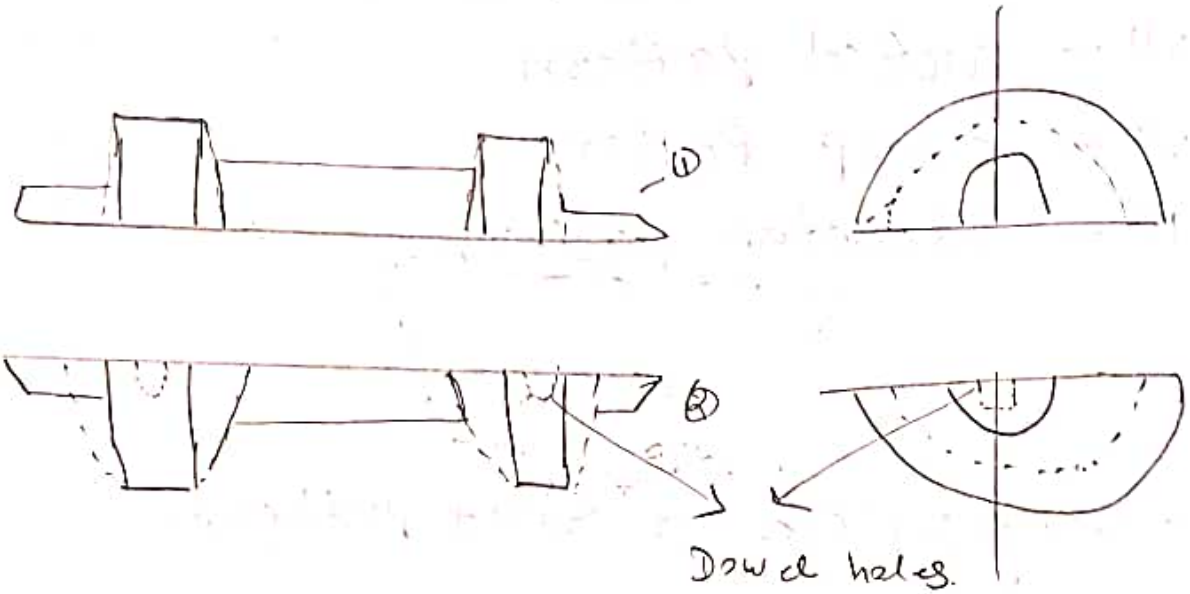
1 - Single piece or Solid pattern.

- Solid pattern made of single piece without joints, partings lines.
- It is the simplest form of the pattern.



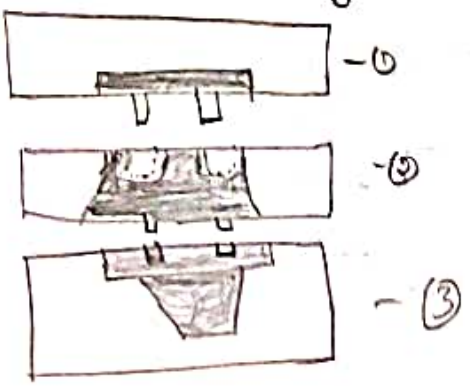
2- Two piece or split pattern.

- when solid pattern is difficult for withdrowal from the mould cavity, then solid pattern is splited in two parts.
- it made in two pieces which are joined at the parting line by means of dowel pins.



3- Cope and drag pattern.

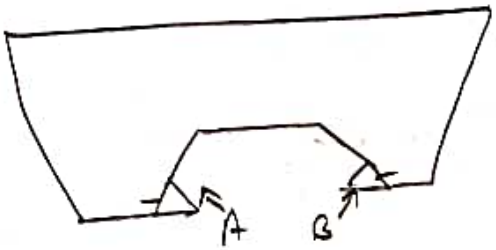
- In this case, cope and drag ~~pattern~~ part of mold are prepared separately.
- when the complete mould is too heavy to handled by one operator.



4- Loose - piece pattern -

It used when pattern is difficult for withdrawal from the mould.

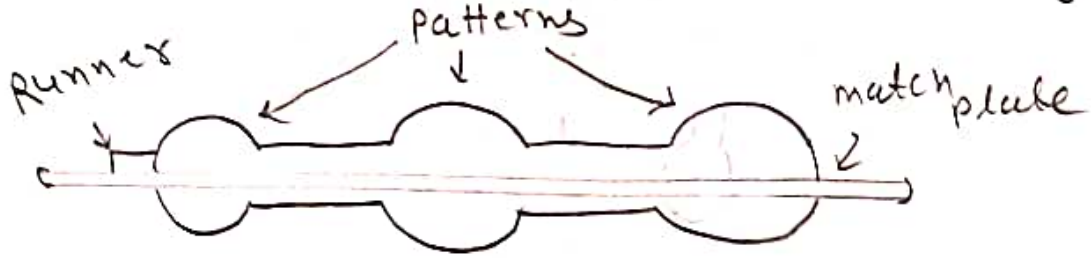
- loose - pieces are provided on the pattern and they are the part of Pattern
- The main pattern is Removed first leaving the loose piece portion of the pattern in the mould.
- At last the loose piece is withdrawl separately leaving the intricate mould.



5- match plate pattern -

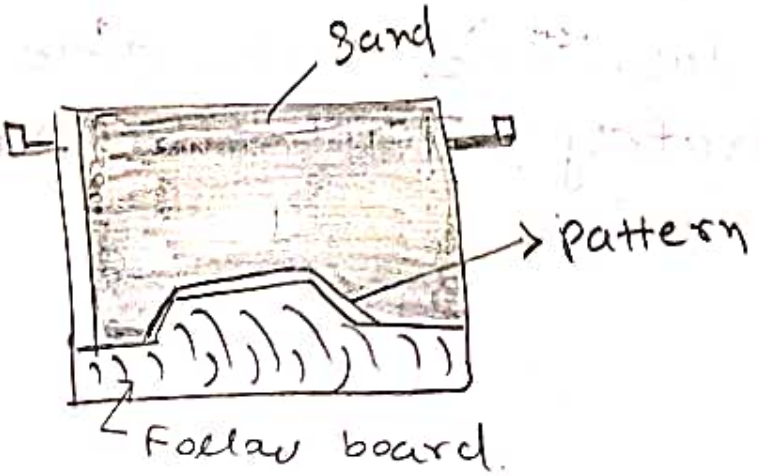
This pattern is made in two halves and on the opposite side of a wooden or metallic plate, know as match plate

- The gates and runners are also attached to the plate.
- The pattern is used in machine moulding



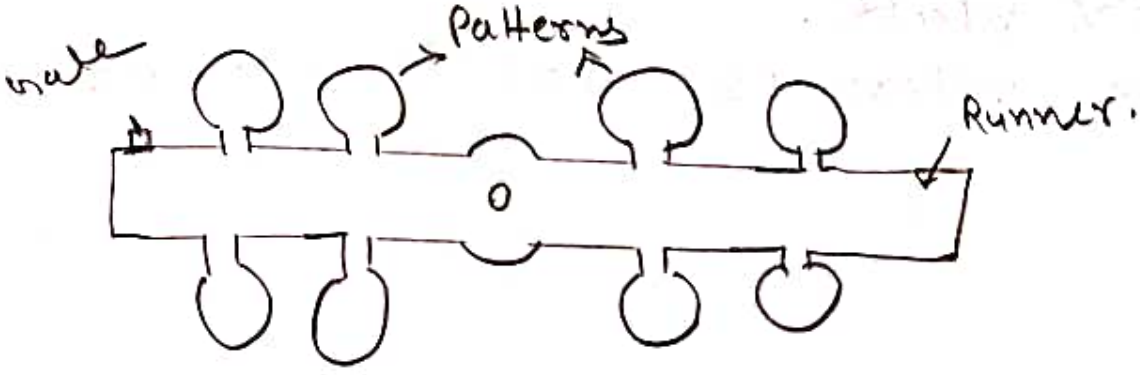
6- Follow board pattern.

when the use of solid or split patterns becomes difficult, a contour corresponding to the exact shape of one half of the pattern in a wooden board, which is called follow board and it acts as a moulding board for the first moulding operation.



7- Gated pattern-

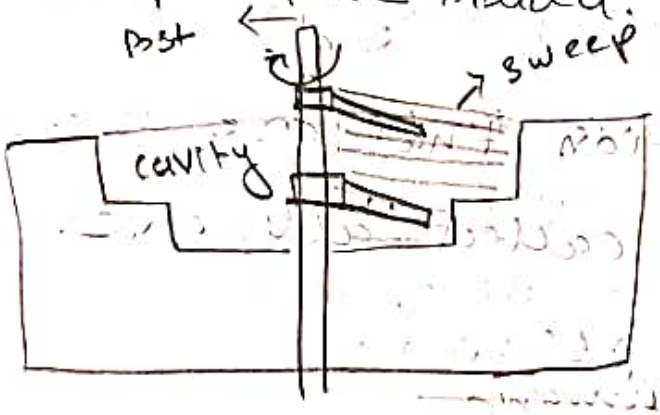
- In the mass production of castings, multi cavity moulds are used.
- The moulds are formed by joining a number of patterns and gates and providing a common Runners for the molten metal.



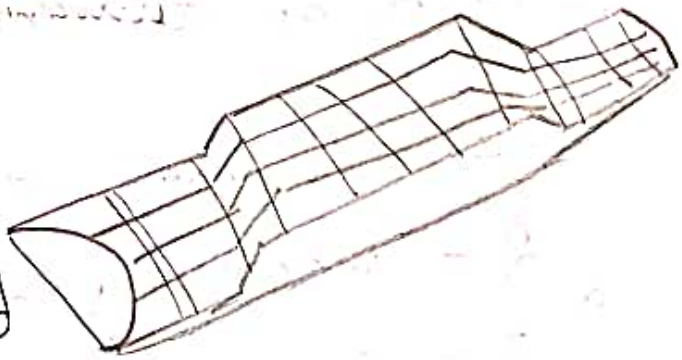
8- Sweep pattern -

It is used for forming large circular moulds of symmetric kind by Revolving a sweep attached to a spindle.

· sweep is a template of wood or metal and is attached to the spindle at one edge and the other edge has a contour depending upon the desired shape of the mould.



9- Skeleton pattern -



when only a small number of large and heavy castings are to be made, it is not economical to make a solid pattern. In such cases, however, a skeleton pattern may be used. The construction of wood which forms an outline of the pattern to be made.

NOTE -

Pattern is the replica of casting to be made with certain modification.

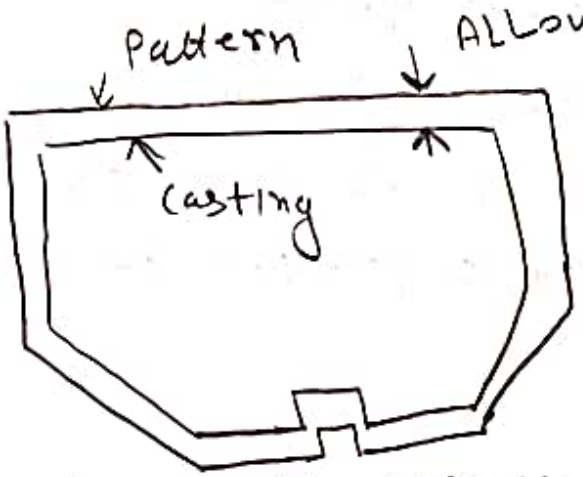
Pattern size = casting ± allowances

→ Allowance of pattern -

The modification that are incorporated in the pattern are called allowance.

→ Types of allowance

1 - Shrinkage allowance
2 - machining allowance
3 - Draft allowance.
4 - Distortion allowance.



Pattern with allowances.

→ Shrinkage allowance –

- Shrinkage of metal during casting will takes place in three stages.

1. Shrinkage of molten metal when Reducing from pouring temp to freezing temp.
2. Shrinkage of molten metal during freezing.
3. Shrinkage solid metal when Reducing from freezing temp. to Room temp.

Pouring temp = melting temp. + 150-200°C

→ Liquid Shrinkage –

- It is always specified by percentage over volume.
- Highest liq. Shrinkage – Aluminium 6.60 %.
- It is compensated by providing Riser during mould making.
- Metal in the Riser should solidify in the end.
- Riser volume must be sufficient for compensating Shrinkage in casting.

Solid Shrinkage.

Shrinkage allowance is provided on the pattern to compensate the solid shrinkages

Solid shrinkage $\propto \alpha$

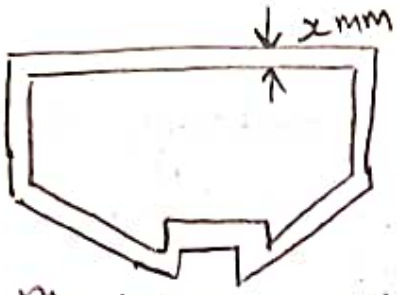
where α = coefficient of thermal expansion of metal.

- In case of internal dimensions the material has a tendency to contract towards the centre.

machining Allowance

- Extra dimension provided on the pattern to compensate the subsequent machining Required on casting.

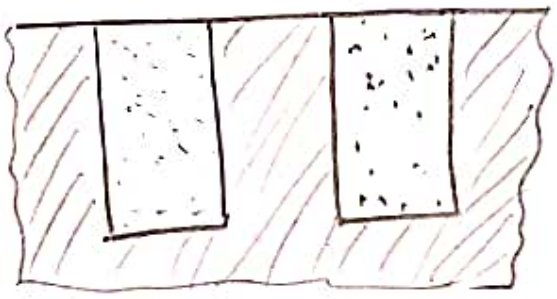
- Purpose
  - → To achieve the desired finish on the casting product.
  - → To accommodate the variation in dimensions due to variation in Room temp. during Solidification.
- machining allowance is specified by 'x' mm/side.



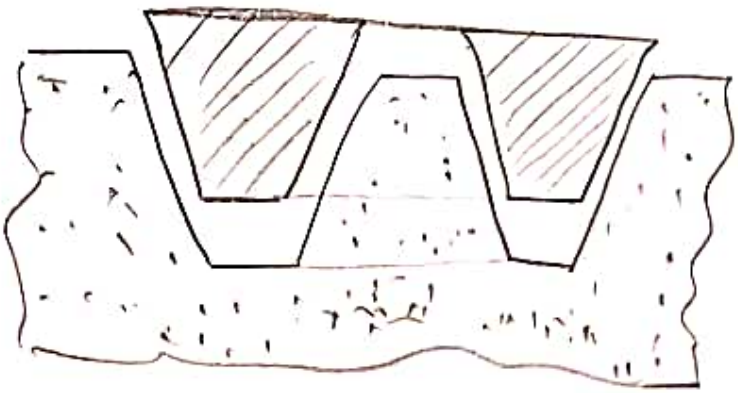
machining allowance.

→ Draft allowance

- Provision of inclination to the vertical surfaces of pattern is called draft allowance.
- It is provided for easy to Removal of pattern from mould.
- Draft allowance varies with the complexity of the job
- inner details of the pattern Require higher draft than outer surface.
- In casting process if the pattern is made by using wax. mercury ~~ten~~ then no draft allowance is Required.



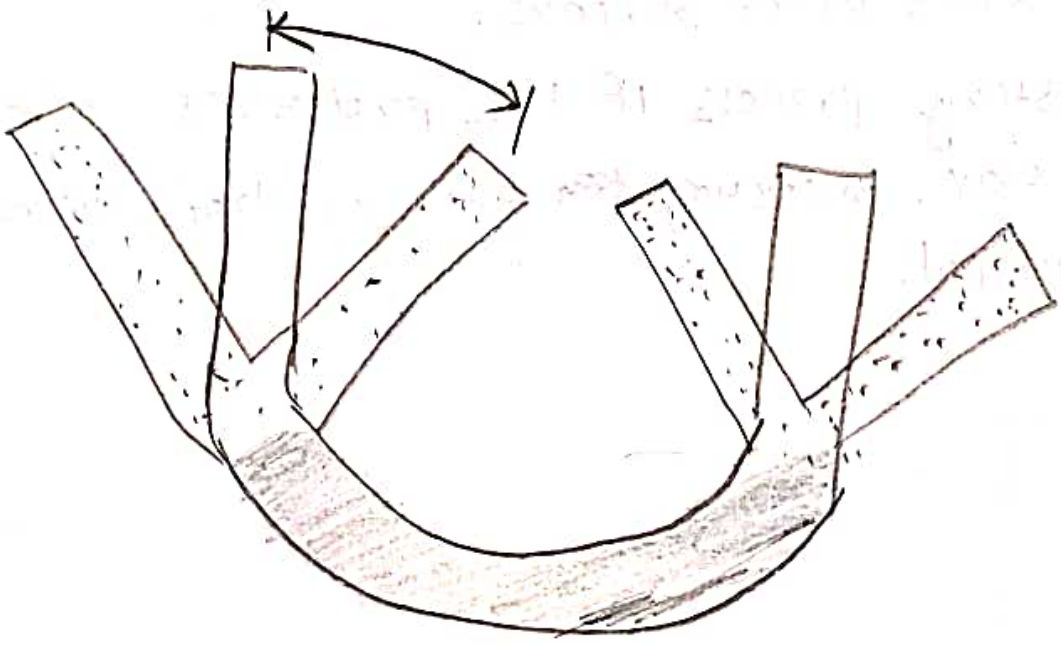
Pattern without draft



Pattern with draft.

→ Distortion Allowance

- Does not Required on all the castings. But it is mainly Required in casting of 'U' and 'V' shape
- In case of V and U shape casting bec of existence of differential shrinkages at different locations of cavity, the legs will bend outwards producing inclined legs.
- The shape of the pattern itself is given a distortion of equal amount in the opposite of the likely distortion direction.
- Done by trial-and error basis to get the distortion amount.



METAL JOINING METHODS

The art of joining metals is about 3000 years old The origin of welding is probably to be traced to the shaping of metals. In industry every worker is working for changing the shape of metal by different methods and machines, welding is a metal joining method.

(I) Soldering -

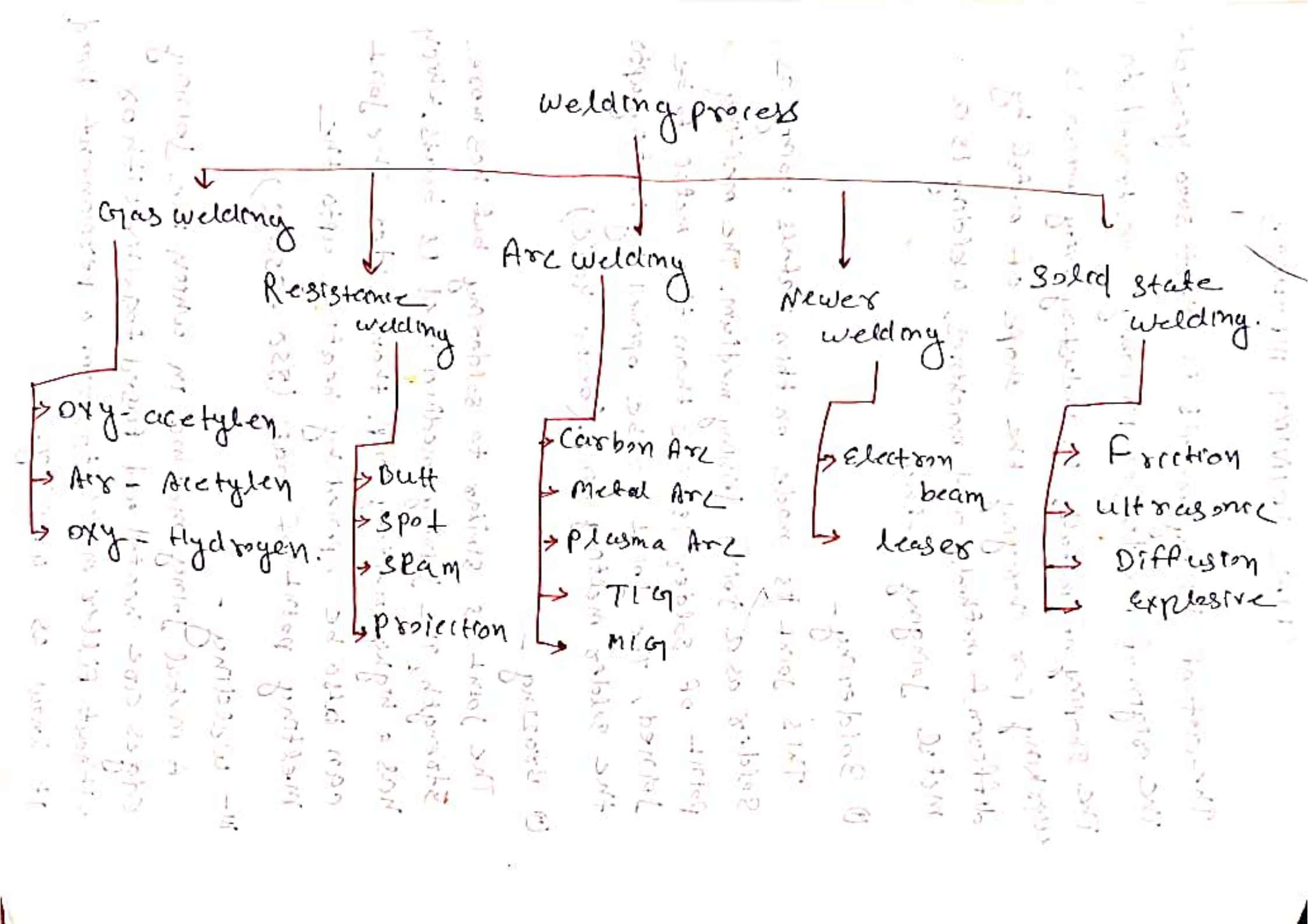
This joint is made on thin metals using as solder as a joining joining medium. The melting point of solder is less than the metal to be joined, The joint can be opened by heating upto the solder melting temp. (below 400°C)

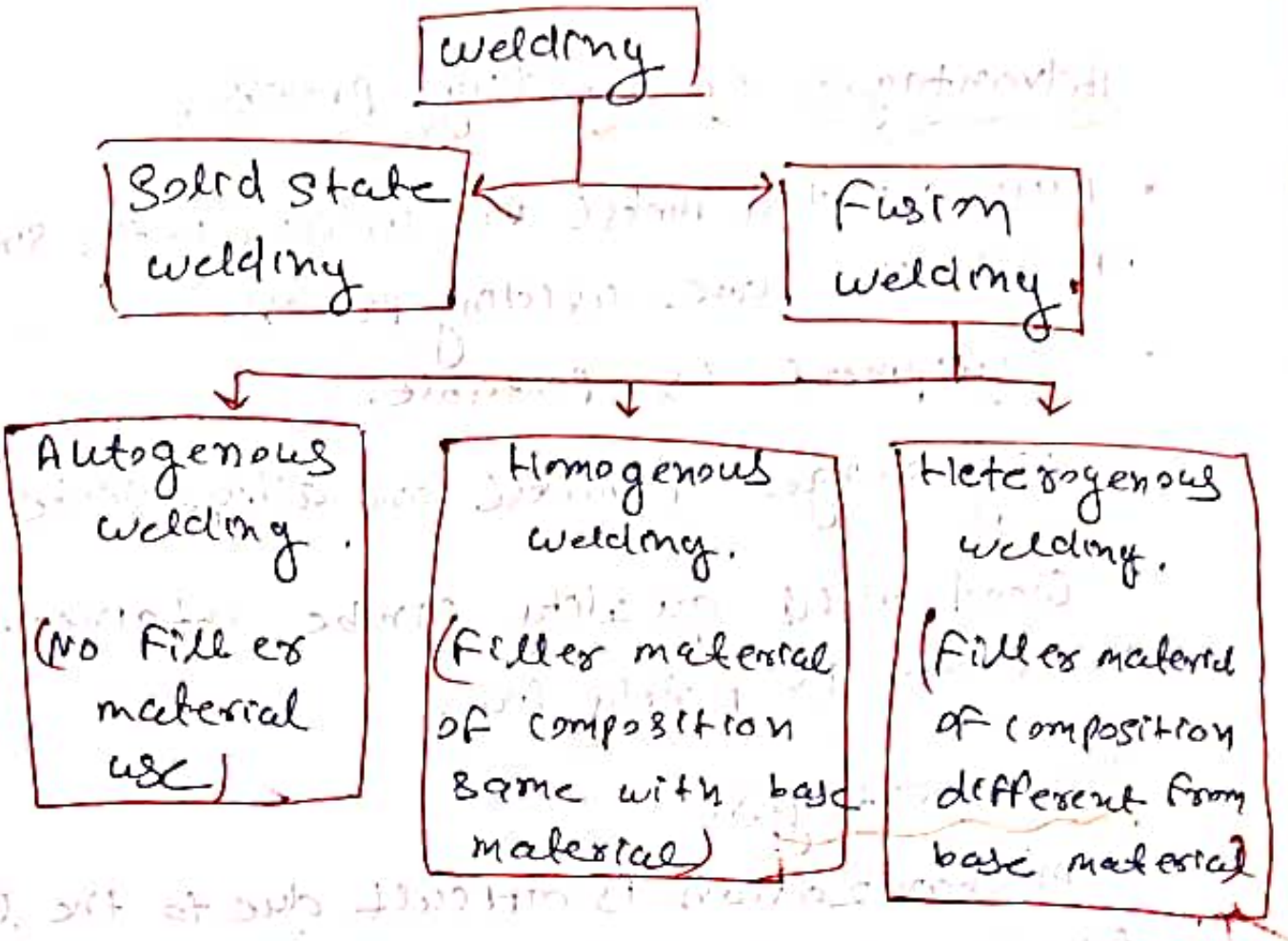
(II) Brazing -

The joint is similar to soldering but has more strength, The joining medium used is brass, which has a higher melting temp. than solder. The joint can also be opened by heating upto the melting point of brass (850 - 950°C)

III- Welding -

A metal joing method in which the joining edges are heated and fused together with or without filler metal to form a permanent bond it know as welding.


Welding process
Gas welding
Oxy-acetylen
Air - Acetylen
oxy - Hydrogen.
Resistance welding
Butt
spot
seam
Projection
Arc welding
Carbon Arc
Metal Arc
Plasma Arc
TIG
MIG
Newer welding.
Electron beam
Laser
Solid state welding.
Friction
ultrasonic
Diffusion
explosive



→ what is welding

welding is the process of joining metals

* Principle of welding.

It is a complex process that involves heat and liquid-metal transfer, Chemical Reactions. A gradual formation of the welding joint is obtained through liquid-metal deposition and subsequently there is a transformation from cooling into the solid state.

Advantages of welding process.

- Flux shielded metal Arc welding is the simplest of all the arc welding process.
- Equipment is portable.
- Big range of metal and alloys can be welded
- Good weld quality can be obtained.
- Cost is fairly low.

Dis Advantages:

- mechanization is difficult due to the limited length of electrode.
- Process is slow
- Metal transfer is not clear.

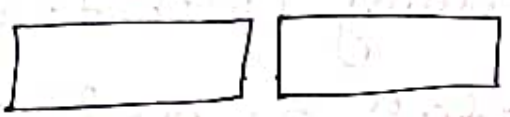
Application

- used for fabrication work and maintenance work.
- All commonly emplyed metals and alloys can be worked.

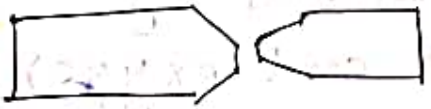
-> ship building
-> pipes and Penstock joining.
-> Building and bridge construction.
-> Automotive and Aircraft industry.

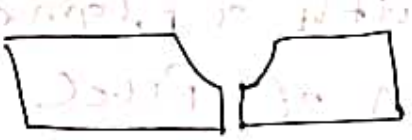
weld joints -

Butt welds.



Single vee





Double vee

Single u

Double U

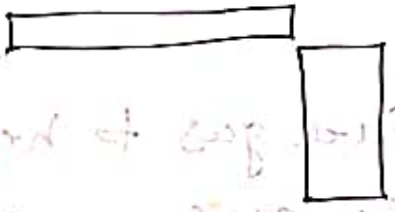
Tee welds

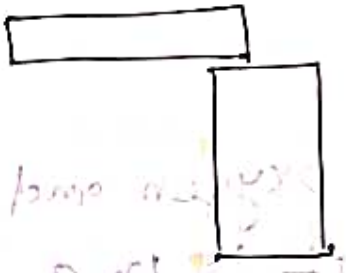
Single bevel

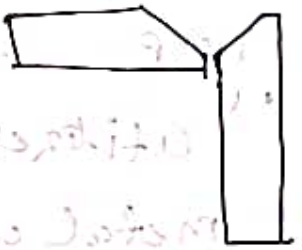
Double bevel

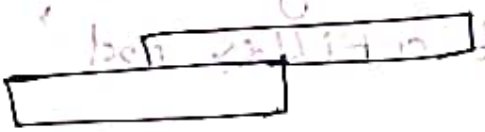
Single J

Corner welds

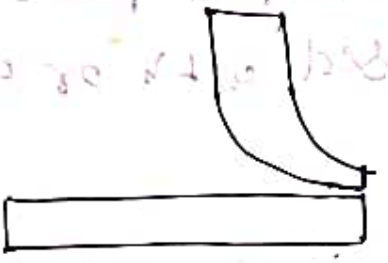








Lap joint



Edge weld.

GAS WELDING

- gas welding is a welding process that melts and joins metals by heating them with a flame caused by a reaction of fuel gas and oxygen.
- The most commonly used method is oxyacetylene welding, due to its high flame temp.
- The flux may be used to deoxidize and cleanse the weld metal.
- The flux melts, solidifies and forms a slag skin on the resultant weld metal.

NOTE

- " utilizes oxygen and a fuel gas to heat metal until is in a molten state and fuse multiple pieces of metal together. can be used with or without a filler Rod "

oxyacetylene welding.

- In this welding uses an oxyfuel gas flame
- can be applied with or without pressure
- can be applied with or with out use of filler materials.

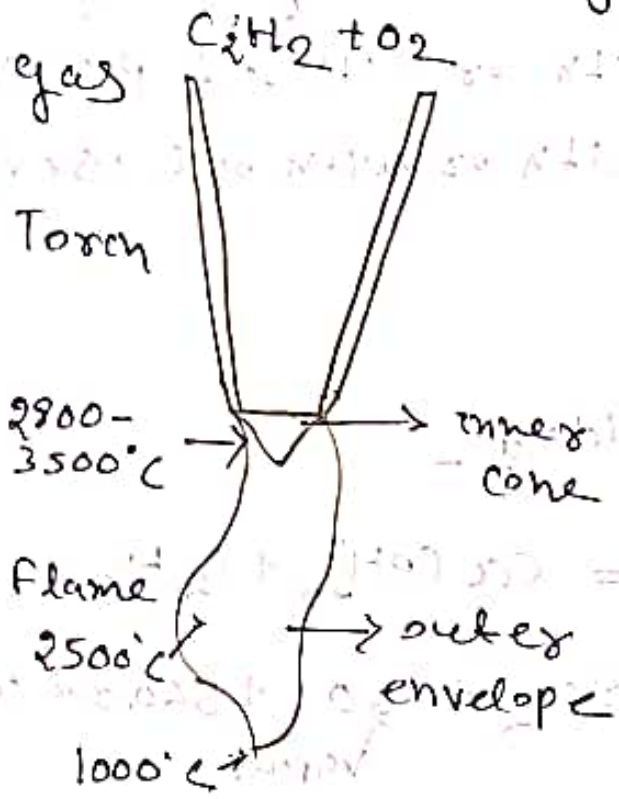
Oxy-acetylene welding -

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$$

$$C_2H_2 + 2.5O_2 = 2CO_2 + H_2O_{\text{vapour}} + 360.800 \text{ cal/mol}$$

- A number of welding processes use a flame produced by burning a mixture of fuel gas and oxygen. The gas usually used is Acetylene but other gases are also used.
- Separate cylinders and a hose pipe from each cylinder transforts the gases to a torch. gas and fuel mix in the torch.

Chemical Reactions and temp. distribution in a neutral oxyacetylene.



→ Primary combustion in inner core (2/3 total heat)

$2C_2H_2 + 2O_2 \rightarrow 4CO + 2H_2$

(From cylinder)

→ Secondary combustion in outer envelope (1/3 total heat)

$4CO + 2O_2$ From Air $\rightarrow 4CO_2$

$2H_2 + O_2$ From Air $\rightarrow 2H_2O$

The secondary combustion is also called the Protection envelope since 'co' and H_2 here consume the O_2 entering from surrounding air, thereby protecting the weld from oxidation.

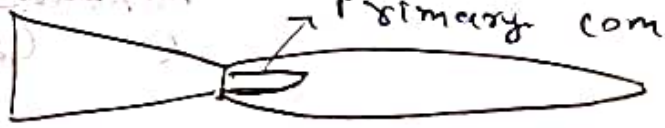
The oxy acetylene welding flame:

→ The oxy acetylene flame has two distinct zones.

* The inner zone (Primary combustion zone)

It is hottest part of the flame. The welding should be performed so as the point of the inner zone should be just above the joint edges.

$$C_2H_2 + O_2 \longrightarrow 2CO_2 + H_2$$



The outer zone the secondary combustion envelope performs two function.

- Preheats the joint edges.
- ~~Prevents~~ Prevents oxidation by using some of the surrounding oxygen from weld pool for combustion and gives off carbon dioxide and water vapour.

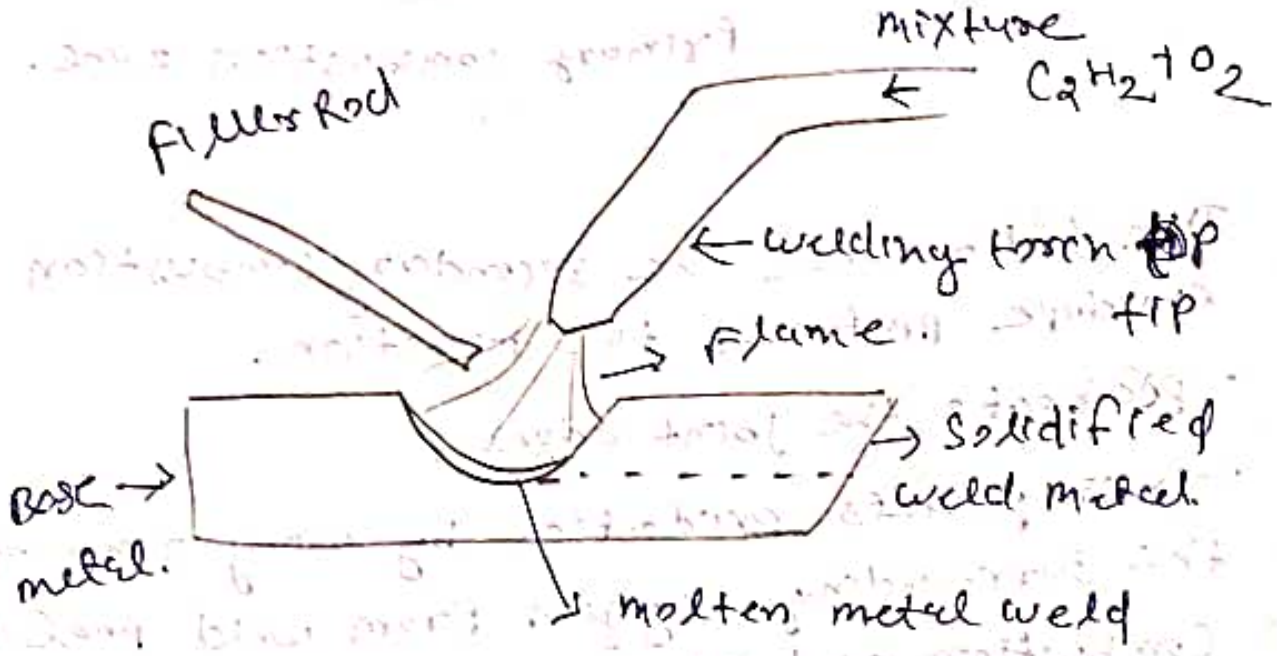
$$CO + H_2 + O_2 \longrightarrow CO_2 + H_2O$$

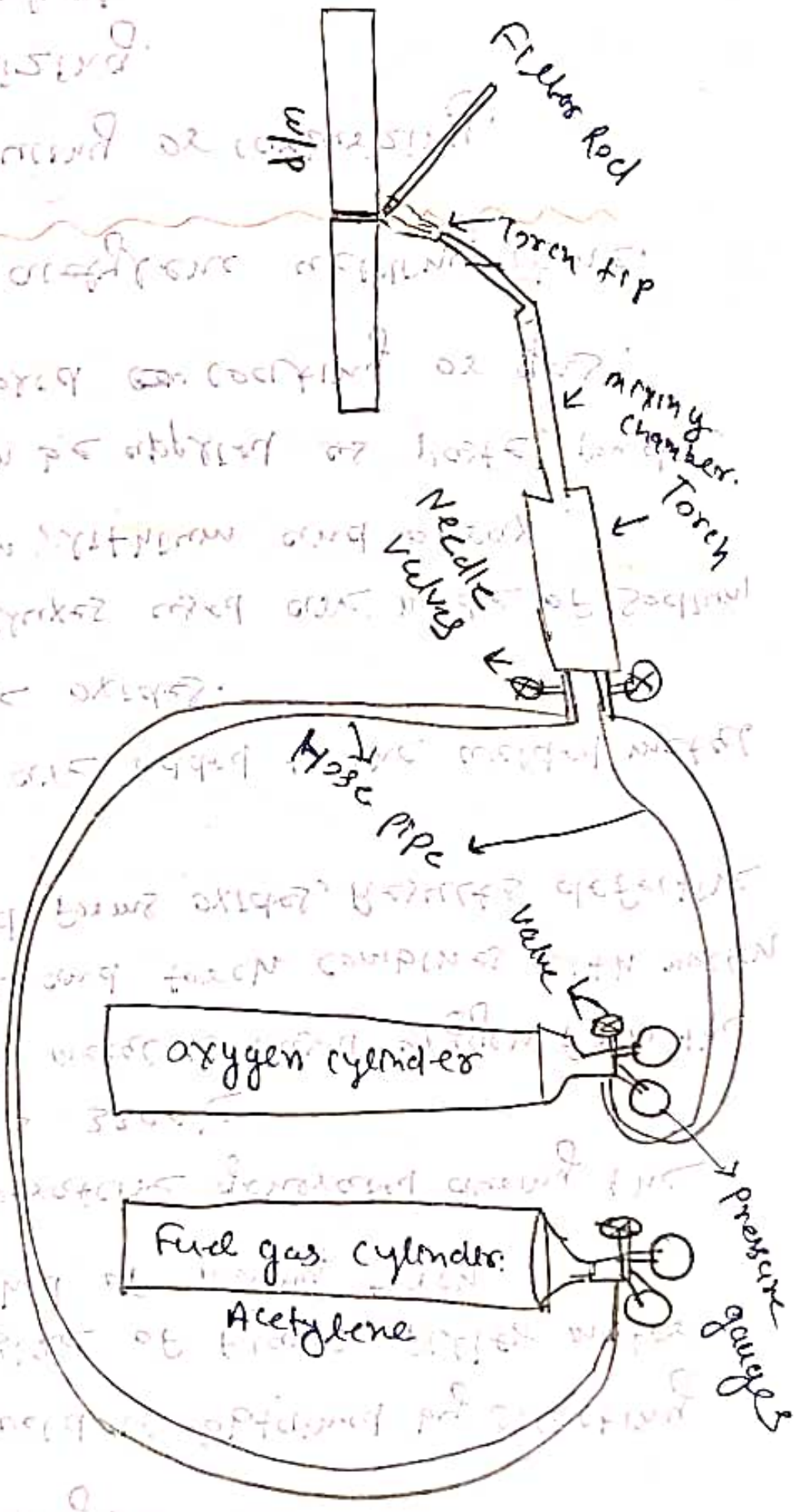
- Oxyacetylen welding.

→ Flame formed by burning a mix of acetylene (C_2H_2) and oxygen.

→ Fusion of metal is achived by passing the inner cone of the flame over the metal.

- oxyactylene can also be used for cutting metals.




Filler Rod
Torch tip
Mixing Chamber
Torch
Needle Valves
Hose pipe
Valve
oxygen cylinder
Fuel gas cylinder
Acetylene
Pressure gauges

→ Gas welding :-

- Sound weld is obtained by selecting proper size of flame, filler material and method of moving torch.
- The temperature generated during the process is 3300°C
- When the metal is fused oxygen from the atmosphere and torch combines with molten metal and forms oxides, Results defective weld.
- Fluxes are added to the welded metal to Remove oxides.
- Common fluxes used are made of Sodium Potassium, lithium and borax.
- Flux can be applied as paste, powder, liquid, solid coating or gas.

* The oxyacetylene welding flame.

(I) - Reducing or carburizing.

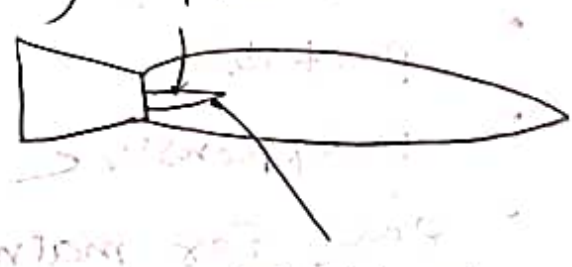
(II) oxidizing.

(III) - Neutral

- Carburizing.

Excess acetylene (0.9:1)

(Alloy steels and aluminium alloys)



- Oxidizing

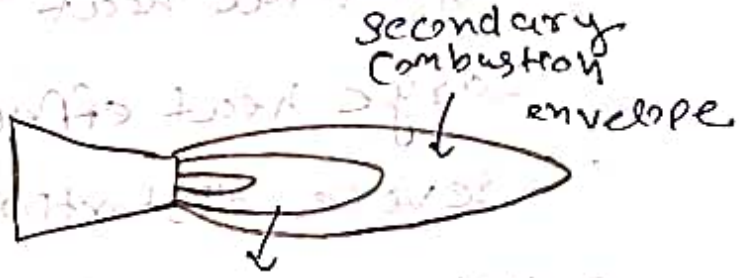
Excess oxygen (1.5:1)

(Brasses, Bronzes, Copper)

(1) - Neutral

Equal acetylene & oxygen

(low carbon steel, mild steel)



* Gas welding equipments.

① gas cylinders - pressure -

· oxygen - 125 kg/cm² · Acetylene - 16kg/cm²

② Regulators - (i) working pressure of oxygen 1kg/cm²

(ii) working pressure of acetylene 0.15 kg/cm²

③ Pressure gauges

4 - Hoses pipes.

5 - welding torch

6 - Non Return valve.

7 - valves

8 - lighter

9 - welding tip.

10 - goggles.

Gas welding - Advantages:

- Simple equipment
- portable
- inexpensive
- Easy for maintenance and Repair.

dis Advantages -

- Very low welding speed.
- High total heat input per unit length
- Large heat effected zone.
- Severe distortion.
- Not recommended for welding Reactive metals such as titanium and zirconium

Gas welding application.

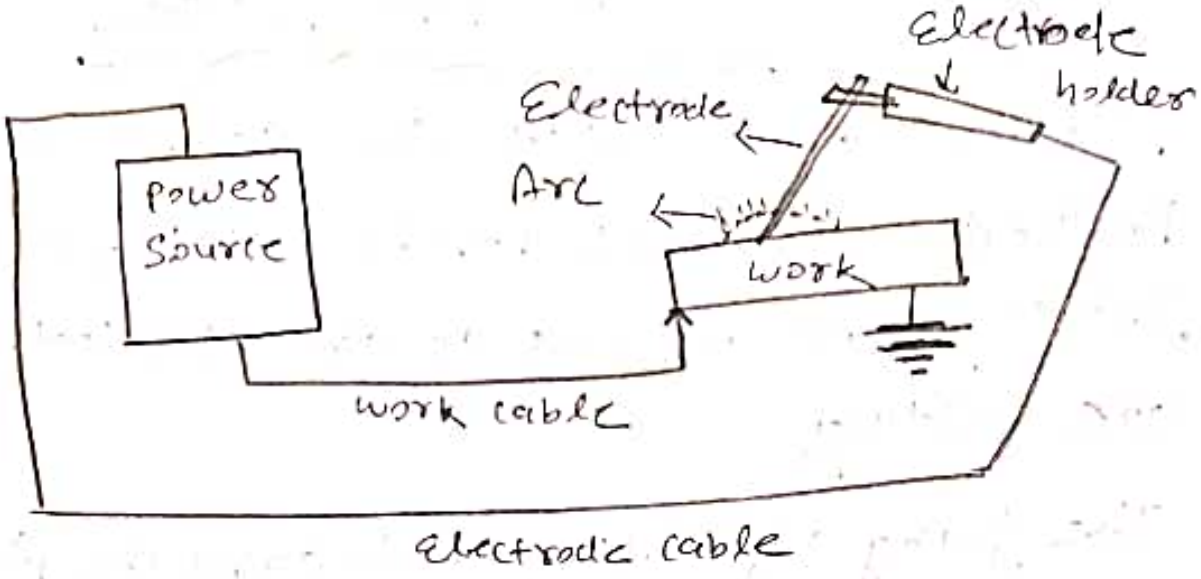
- For joing thin materials
- For joining most ferrous and non-Ferrous metal
- In automotive and air craft industries.

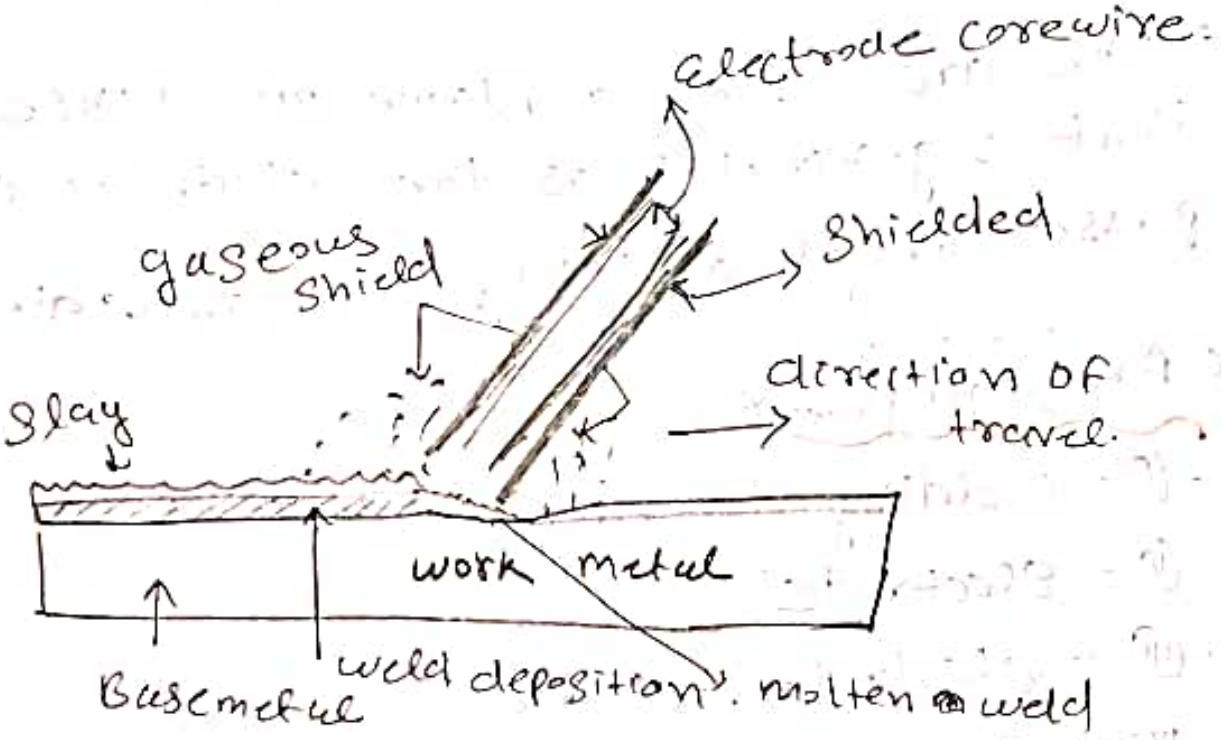
Electric Arc Welding

- The welding in which the electric arc is produced to give heat for the purpose of joining two surfaces is called electric arc welding.
- The joing by fusing of two or more pieces of metal together by using the heat produced from an electric arc.
- The arc is like a flame of intense heat that is generated as the electrical current passes through a highly resistant air gap...

* Arc welding equipment.

I - welding transformer
II - Electrode
III - Electrode Holder
IV - workpiece clamp
VI - Chipping hammer
VII - wire brush
VI - Protective Shield (helmet)


Electrode holder
Electrode
Arc
Power Source
work
work cable
Electrode cable


electrode corewire
gaseous shield
Shielded
direction of travel
Slag
work metal
Base metal
weld deposition
molten weld metal

ARC WELDING

- It is manual arc welding process that uses a consumable electrode coated in flux to lay the weld.
- An electric current, in the form of either alternating current or direct current from a welding power supply is used to form an electric arc between the electrode and the metals to be joined.
- Arc welding is a process that melts and joins metals by heating them with an established between a stick like covered electrode and the metals.
- The core wire conducts the electric current to the arc and provides filler metal for the joint.
- The electrode holder is essentially a metal clamp with an electrically insulated outside shell for the welder to hold safely.
- The heat of the arc melts the core wire and flux covering at the electrode tip into metal droplets.

- Molten metal in the weld pool solidifies into the weld metal while the lighter molten flux floats on the top surface and solidifies as a slag layer.

NOTE –

[In the welding uses an arc beth a covered electrode and the workpiece.

- Shielding is obtained from decomposition of the electrode cover.
- Pressure is not used.
- Filler metal is obtained from the electrode]

* Principle of Arc

- A suitable gap is kept beth the work and electrode.
- A high current is passed through the circuit.
- The electric energy is converted into heat energy, producing a temp. of 3000°C to 4000°C.
- This heat melts the edges to be welded and molten pool is formed.
- On solidification the welding joint is obtained.

Basic steps of arc welding.

- Prepare the base materials: Remove paint and Rust.
- Choose the right welding proces, and right filler material.
- Asses and comply with safety Requirement.
- use Proper welding techniques and be sure to protect the molten puddle from Contaminants in the air.
- Inspect the weld.

Advantages of Arc welding.

- Simple welding equipment.
- welders use standard domestic current
- Proces is fast and Reliable.
- Short learning curve.
- used multiple function.
- Electric arc is about 5,000 C

Dis Advantages

- Not clean enough for reactive metals such as aluminium and titanium.
- deposition rate is limited.
- limited electrode length and changing

TIG Welding (GAS TUNGSTEN ARC Welding)

- Gas tungsten arc welding is an arc welding process that uses a non-consumable tungsten and an inert gas for arc shielding. (It also know as GTAW)

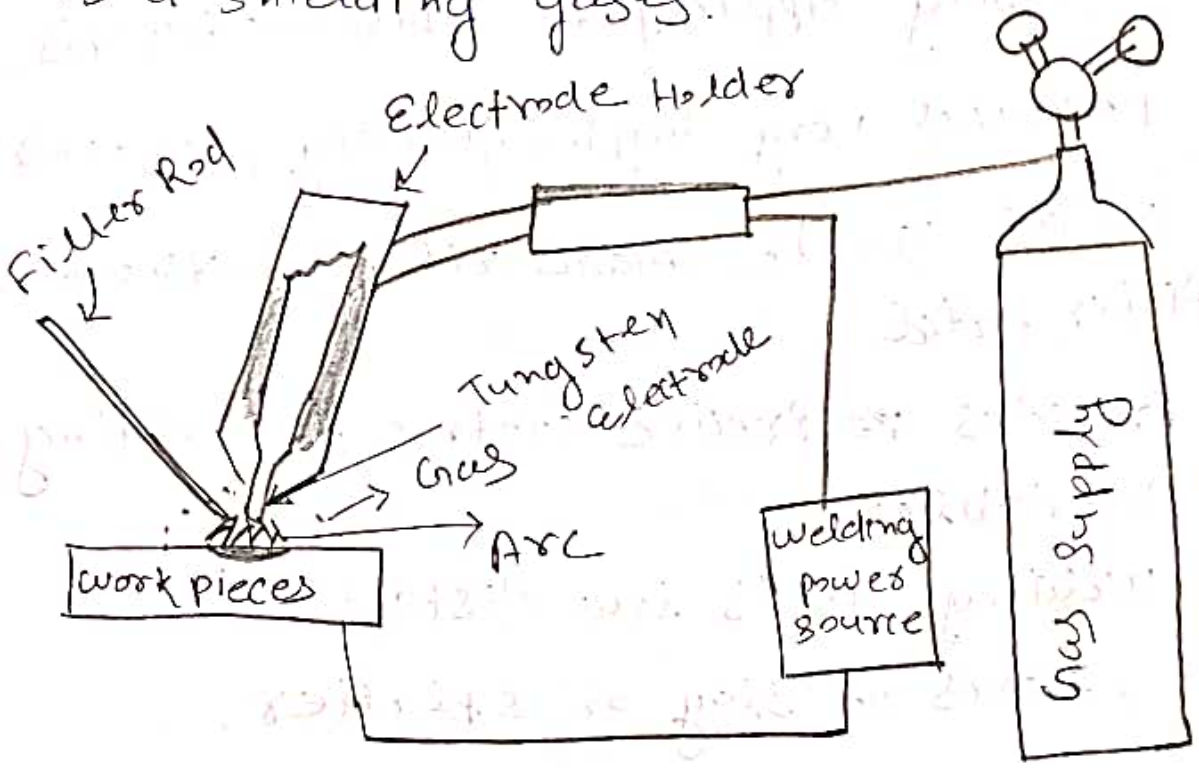
Equipments used in TIG

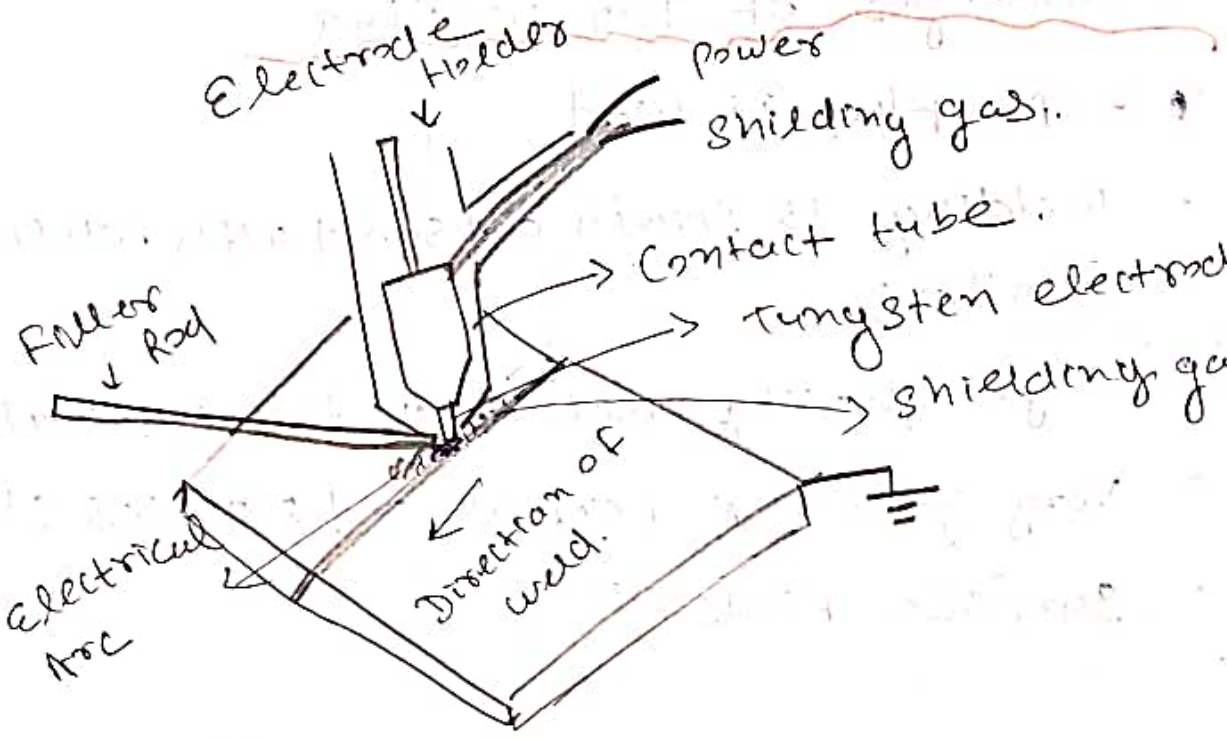
- Gas supply (Cylinder)
- Electrical power source (AC/DC)
- Electrode holder, torch or gun.
- Connection cables.
- Hose pipe
- Tungsten electrode.
- Coolant
- Filler Rods.

Working principle -

- An arc is established b/t^n the end of a tungsten electrode and the parent metal at the joint line.

- A constant - current welding power supply is used to produces energy which is conducted across the arc through a column of highly gas and metal vapors known as a 'plasma'.
- Argon and helium are are most commonly used shielding gases.





Characteristics of the TIG welding

- uses a non-consumble tungsten electrode during the welding process.
- uses a number of shielding gases including helium(He) or Argon(Ar)
- is easily applied to thin materials.
- Produces very high-quality, superior welds
- welds can be made with or without filler metal.
- Provides ~~pe~~ Precise control of welding variables
- welding yields low distortion.
- leaves no slag or splatter.

Advantages of TIG welding

- No flux is used.
- welding is smooth and sand with fewer scatters.
- High quality welding in thin materials
- Very good for ferrous and stainless steels
- Surface finish is good.

Limitations -

- Tungsten inclusion is hard and brittle
- High cost
- Slow and Experiance worker Requered.
- Filler Rod end. if by chance comes out then inert gas shield can cause weld metal contamination.

Applications -

- Steel (Stainless) industry,
- non ferrous metals weld (AL, Mg, Cu)
- Aerospace industry.
- Bicycle, turbine blead industry,

METAL INERT GAS (MIG) Welding.

- It is a semi automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are feed through a welding gun.

] an electric arc forms beth the consumable wire eletrode and the w/p metals, which heats the w/p metals causing them to melt and join.

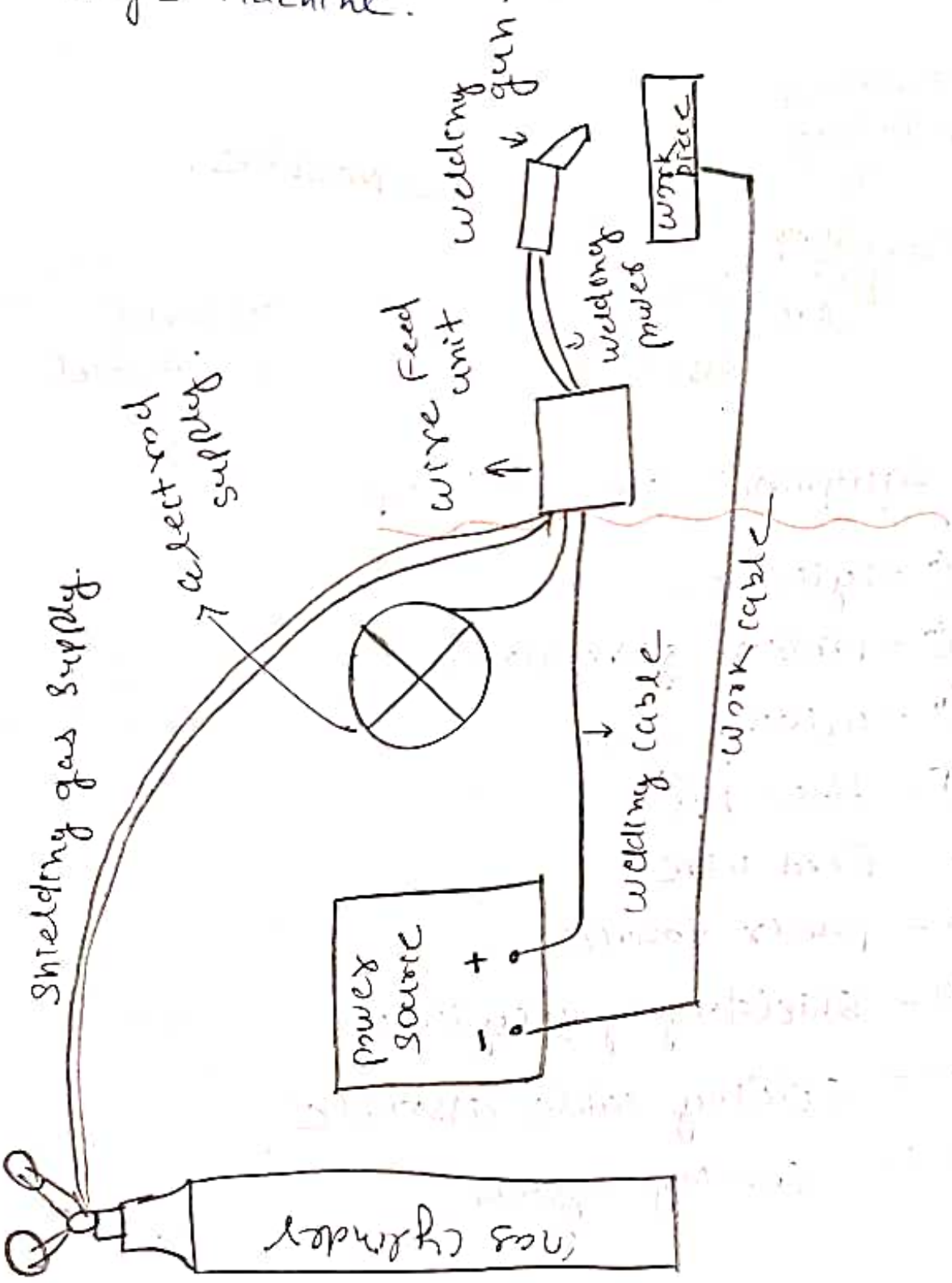
Mig welding process -

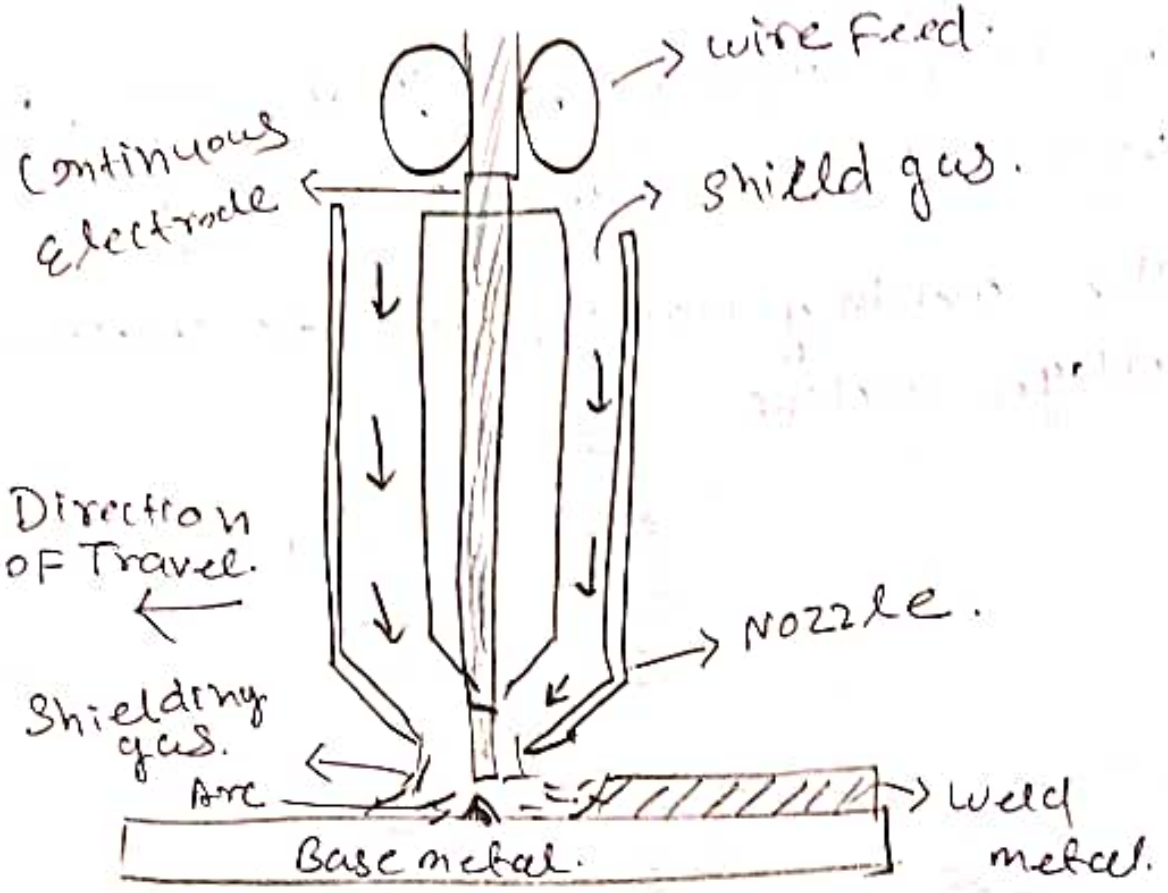
- Mig welding is a gas shielded metal arc welding process using the heat of an electric arc beth a continuously fed, consumable wire and the material to be welded.

- A wire of copper coated mild steel is fed continuously from a reel through a gun with a melting Rate up to 5m/min.

- Current through the wire Ranges from 100 to 400 A depending upon the diameter of the wire.

- CO_2 is principally used apart argon or argon-helium mixture as shielding gas
- The welding machine is a dc constant voltage machine.





* Equipment and set up.

(I) - Cylinder.
(II) - Pressure regulator.
(III) - welding gun.
(IV) - Hose pipe.
V - Feed wire.
V - power source.
VI - Shielding gas cylinder.
VII - welding cable assemble
VIII - Cooling system.

Advantages of MIG Welding -

- high quality welds can be produced much faster.
- flux is not used.
- little amount loss of alloying element.
- used to variety of metals and alloys.
- Semi and Fully automatic process.

disAdvantages

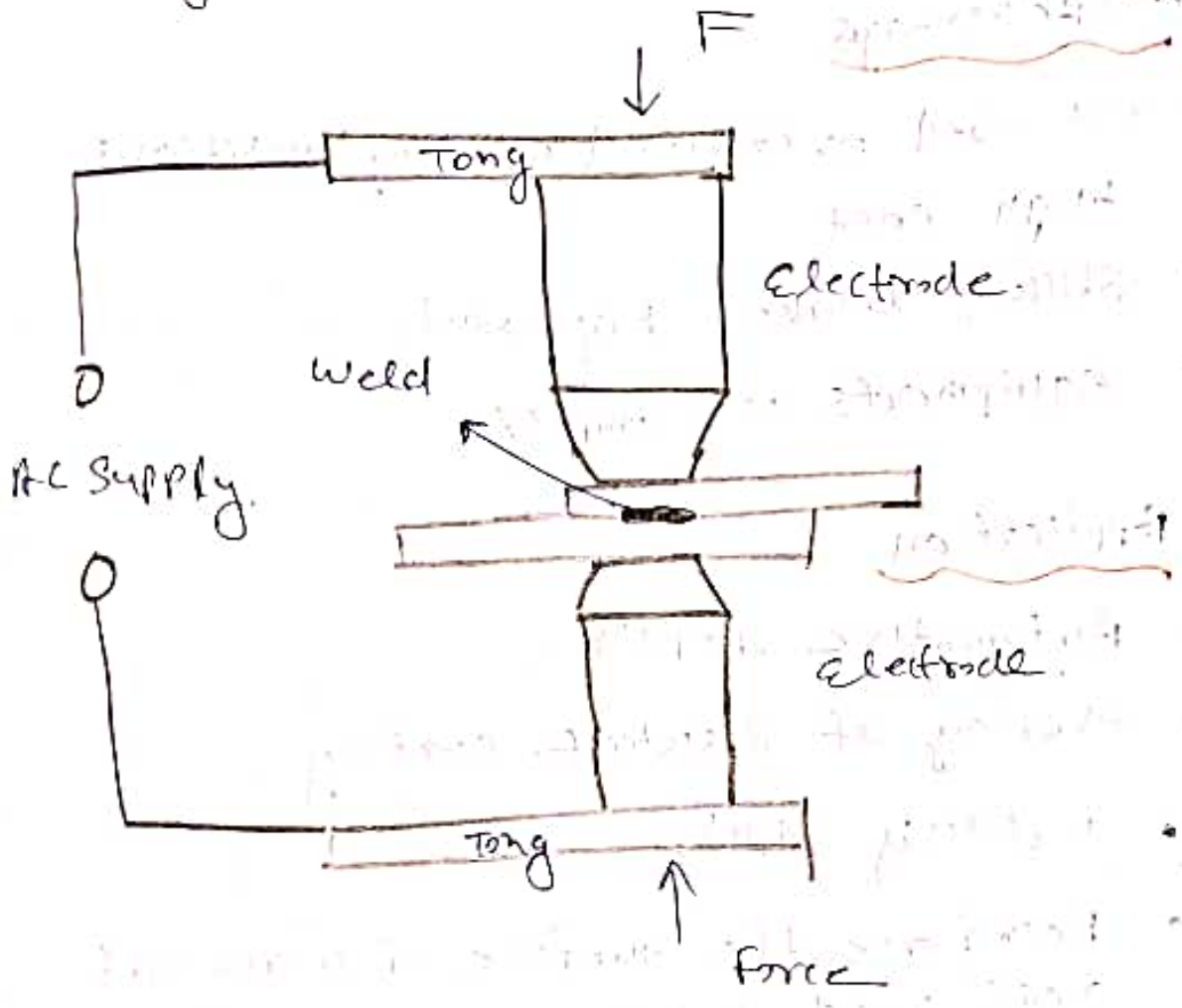
- not used over head welding positions
- High cost.
- Skilled worked Required.
- Equipments is complex.

Application

- Automotive Repair.
- overlay of Resistant coating.
- welding pipes,
- Reinforce the surface of worn out rail road track.
- Aerospace plant.

RESISTANCE WELDING

Resistance welding is a welding process in which work pieces are welded due to a combination of a pressure applied to them and a localized heat generated by a high electric current flowing through the contact area of the weld.



- A liquid state welding process.
- Is a thermo-electric process.
- Uses electric Resistance to generate heat.

Working principal.

- Heat is generated by passing current through a electric Resistance.
- Amount of heat produced is depend on.
  - Resistivity of the material.
  - Surface conditions.
  - Current supplied.
  - Time.

$$H = I^2RT$$

Type of Resistance welding.

1. Spot welding
2. Seam welding.
3. Projection welding.
4. Flash Butt welding.

- **Spot welding -**

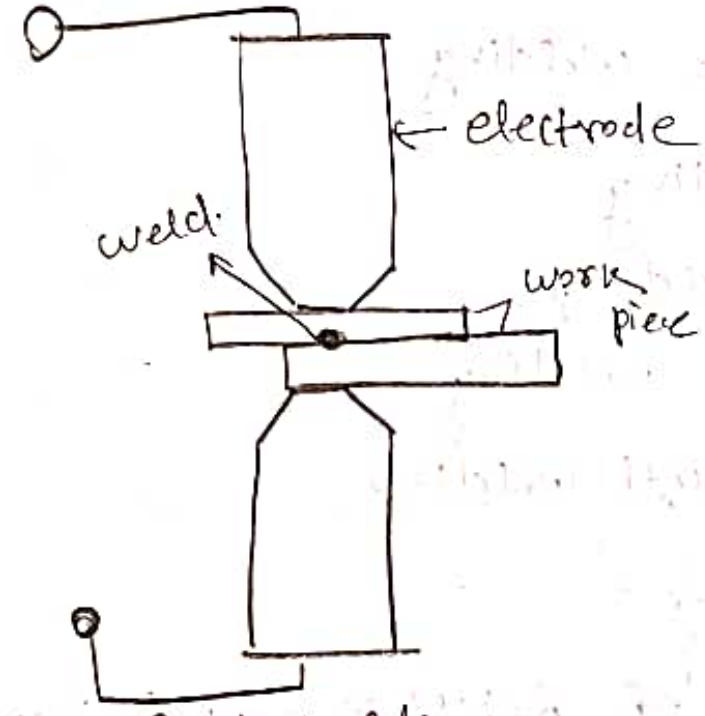
→ Simplest type of Resistance welding.

→ Two copper electrodes with anvil faces

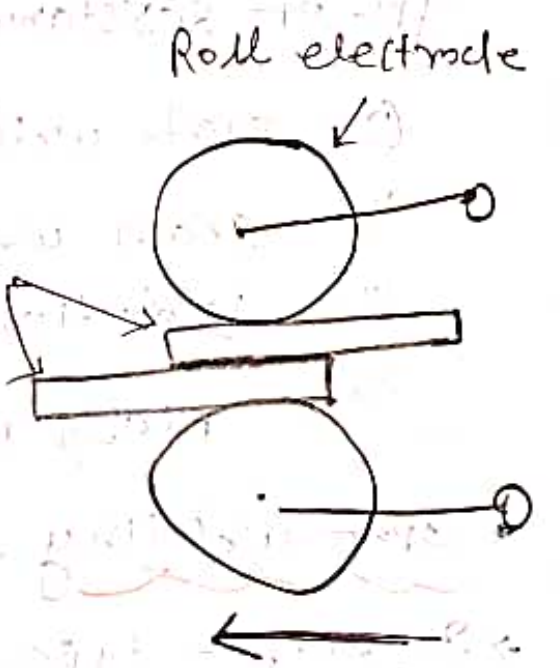
→ Create a circular nugget (4-7) mm

Seam welding -

- Also know as continuous spot welding.
- A roller type electrodes are used.
- Create a continuous weld joint.
- The time and movement of electrode is controlled.
  - → weld overlap and work piece does not get too hot.
- Used to create air tight joints.



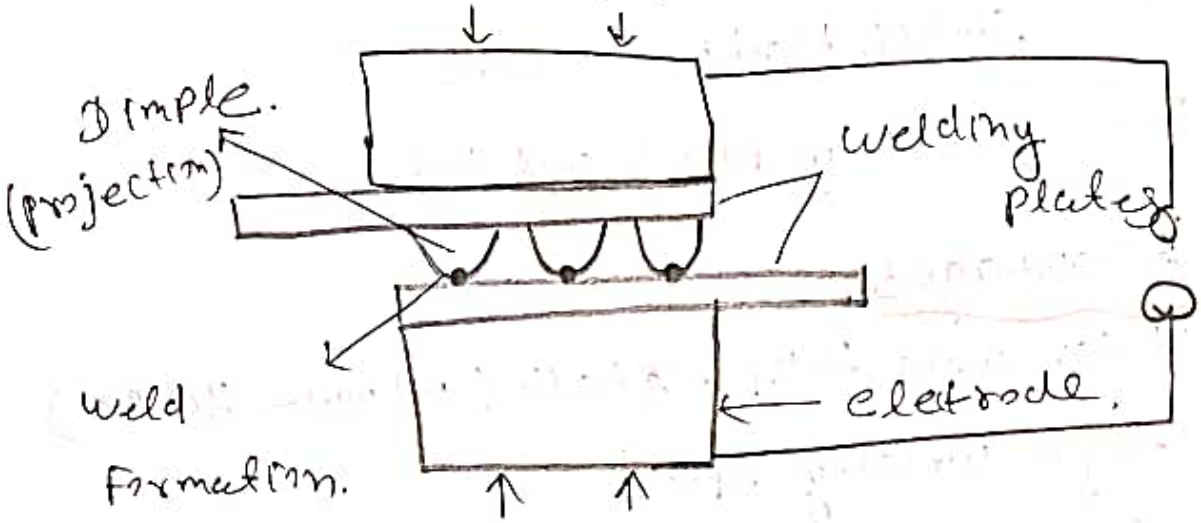
(I) Spot welding



(II) Seam welding.

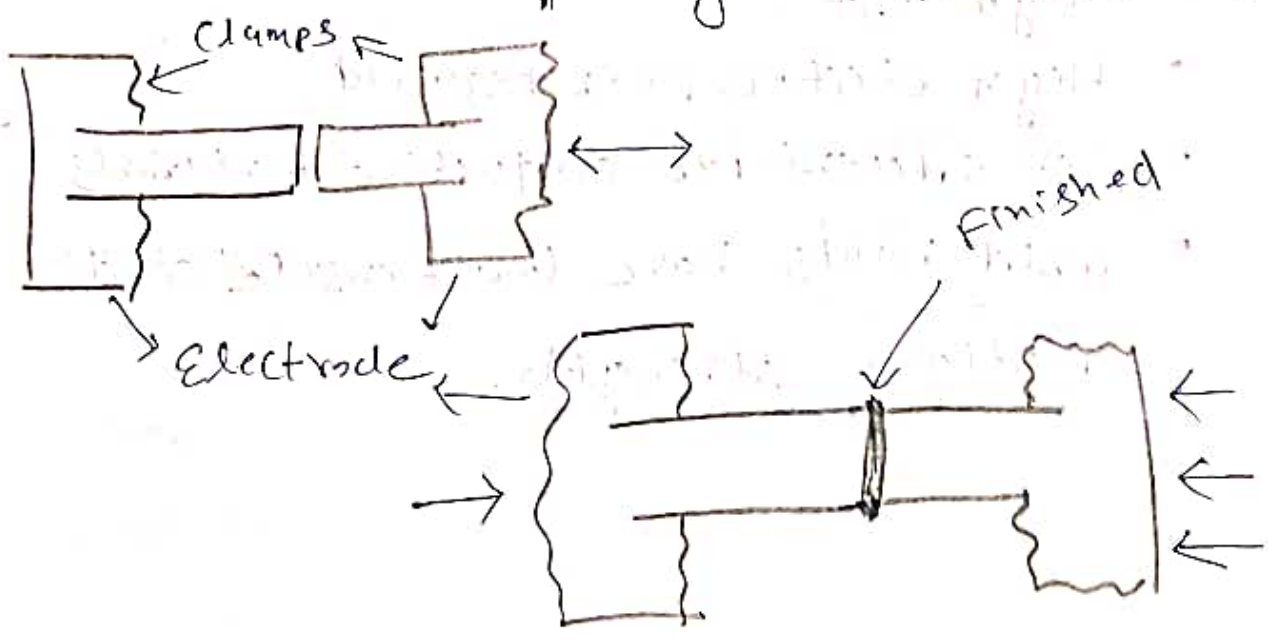
III - Projection welding.

- Dimple is produced on workpiece
- Flat electrodes.



Flash butt welding.

- used to weld tubes and Rods in steel industries
- work pieces are clamped in the electrode holders.
- high pulsed current in the Range of 100000 A
- Electrodes - one is moving and other is fixed.



Application -

I - automotive industries.
II - production of nut and bolt
III - Small tanks, boilers
IV - welding pipes and tubes.

* Advantages

- It can weld thin metals (0.1 mm - 20. mm)
- High welding speed
- Easily automated.
- High production Rate, eco friendly Prices
- not Require any filler metal, flux and shield gass
- Both similar and dissimilar metal use.

DisAdvantages

- High cost.
- High electric pwer Required.
- Less effient for conductive materials.
- weld joints have low tensile and fatigue strength.

THERMIT WELDING

- It is a fusion welding process.
- This process used to welding a heavy and large structures.
- Not Required electrode and power supply.

→ In this process, welding is done by pouring superheated liquid steel around parts to be joined.

→ Short ~~con~~molding process is to be done before welding

NOTE

* A mixture of fine Aluminum powder and iron oxid that produces a very high temp. on combustion used in welding and for incendiary bombs.

→ 75% iron oxide and 25% of fine aluminum powder.

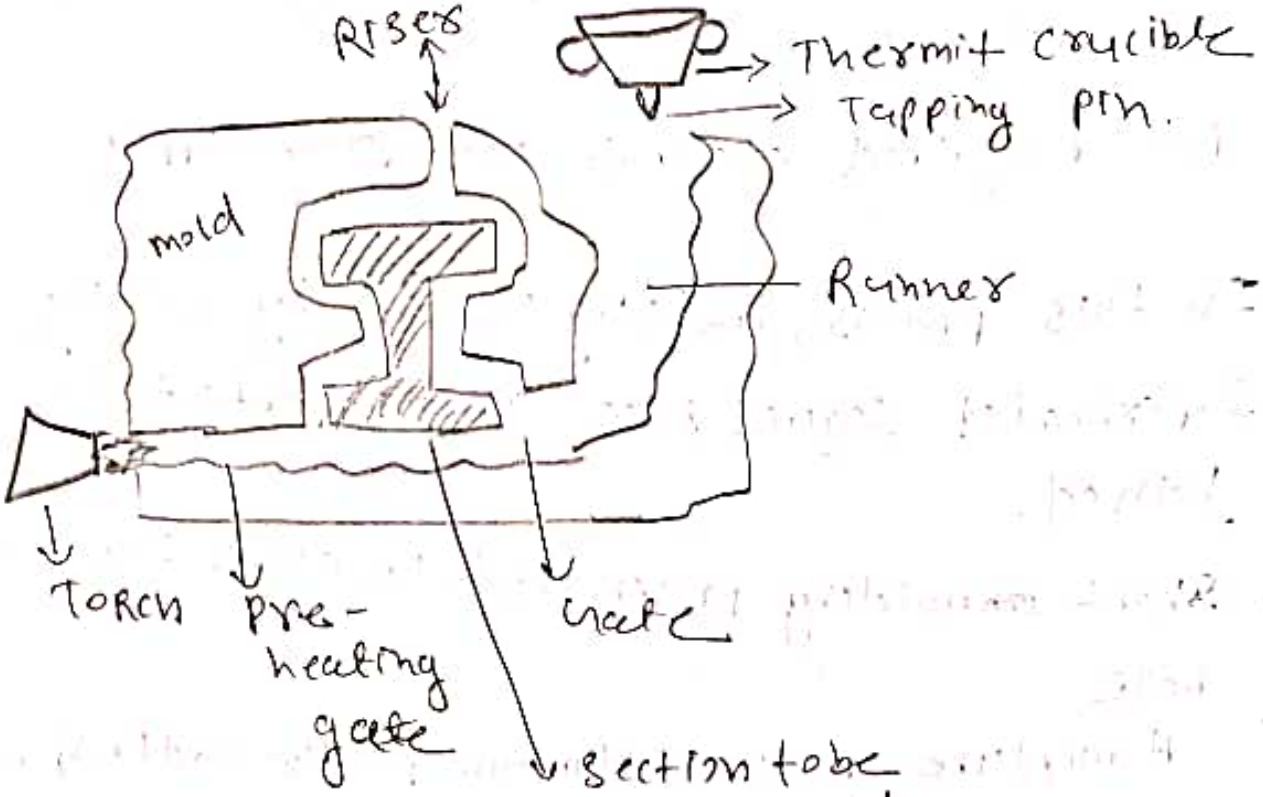
1:3 Ratio by weight

→ we can use copper or chromium.

→ Working -

- The ends of parts to be joined are kept parallel with a uniform gap beth them.
- That gap is filled with wax which becomes the pattern.

- Molding sand is Rammed around wax pattern. pouring gate, heating gate and Risers are cut.



- Joints to be welded are preheated by a flame (External source). Due to preheat wax melts and goes out.
- After melting of wax, weld joints are preheated due to flame.
- Then heating is stopped and heating is closed.

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe + Heat$$

Application –

→ Used very large works like Joining of Rails Pipes, broken teeth on large gears, large Frame

→ Mostly used Ferrous metals.

Advantages –

- Very large size structure can be easily weld

→ No power supply & electrode used

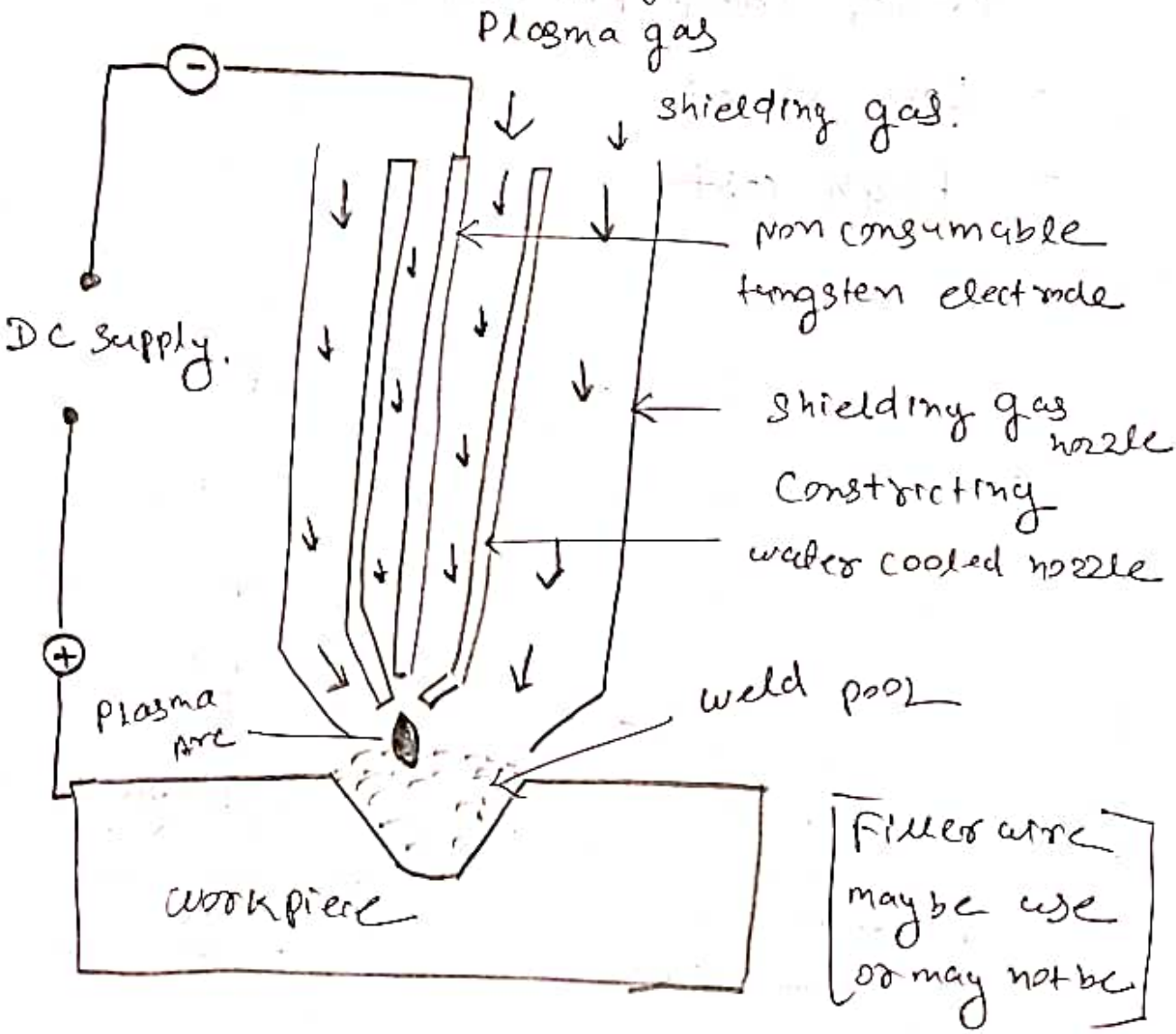
Dis Advantages –

- Skilled labor Required.
- Long process –
- High cost

PLASMA ARC WELDING

→ welding is initiated by an electric arc transferred from a torch body to the workpiece, via a high temp., high velocity plasma jet forced through a constricting nozzle. Hence delivering a high concentration of heat to a very small area to melt the weld material and fuse the weld joint.

- Plasma, A gaseous mixture of positive ions electrons and neutral gas molecules.

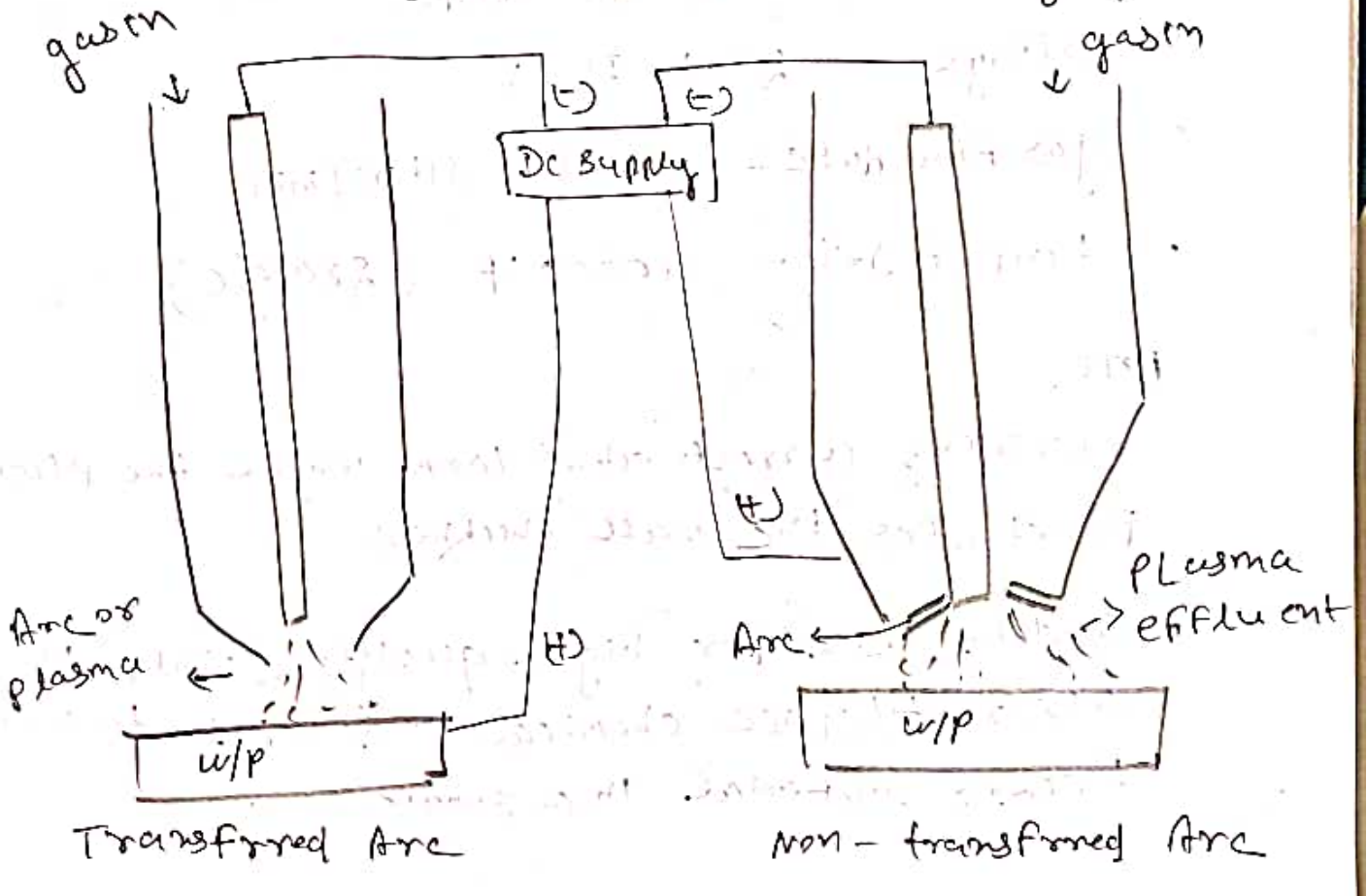


Plasma

- gas which is heated to an extremely high temp. and ionized so that it become electrically conductive.
- PAW process use this plasma to ~~transform~~ Transfer an electric arc to the work piece.
- The metal to be welded is melted by the intense heat of the arc and fuses together.

Objective of PAW

- To increase the energy level of the arc Plasma in a controlled manner.
- This is achieved by providing a gas nozzle around a tungsten electrode operating on DCEN.



Equipment

-> Power supply - DC power supply
-> High frequency generator and current limiting resistors (used for arc ignition)
-> Plasma torch -
-> Shielding gases (Helium, Argon - Hydrogen • Argon - helium)
-> Current and gas decay control.
-> Fixture - (To avoid atmospheric contamination of the molten metal under bead.)

Welding parameters -

- Current - 50 to 350 Amps.
- Voltage - 27 to 31 V
- gas flow Rate - 2 to 40 liters/min
- temp of jet - 50000°F (28000°C)

NOTE -

- Welding current about 100 A. where the Plasma Arc Penetrates the wall thickness.
- Widely used for high-quality joints in aircraft/space chemical industries to weld thicker material in a single pass.

Advantages -

- High welding Rate is possible.
- Stability of arc and Excellent weld quality.
- used for automatic and semi automatic process.
- very fast and clean.
- less operator skill.
- High penetrating capability

Dis Advantages -

- UV Radiations is produced.
- Consumption of inert gas is high.
- High power electrical equipment.
- Expensive equipment.

Application -

- Aerospace industries, Automobiles and Railways
- Ship construction,
- Tank equipment and pipe line construction.

LASER BEAM WELDING

LASER —

"Light amplification by Stimulated Emission of Radiation"

- Leaser beam is a powerful, narrow, monochromatic and directional beam of electromagnetic Readiation.

→ Properties of Leaser Beam

- highly intense in nature
- Strictly monochromatic.
- Laser light is high powerful and capable of Propagating over along distance & are not easily absorbed by water.

LASER BEAM WELDING PROCESS

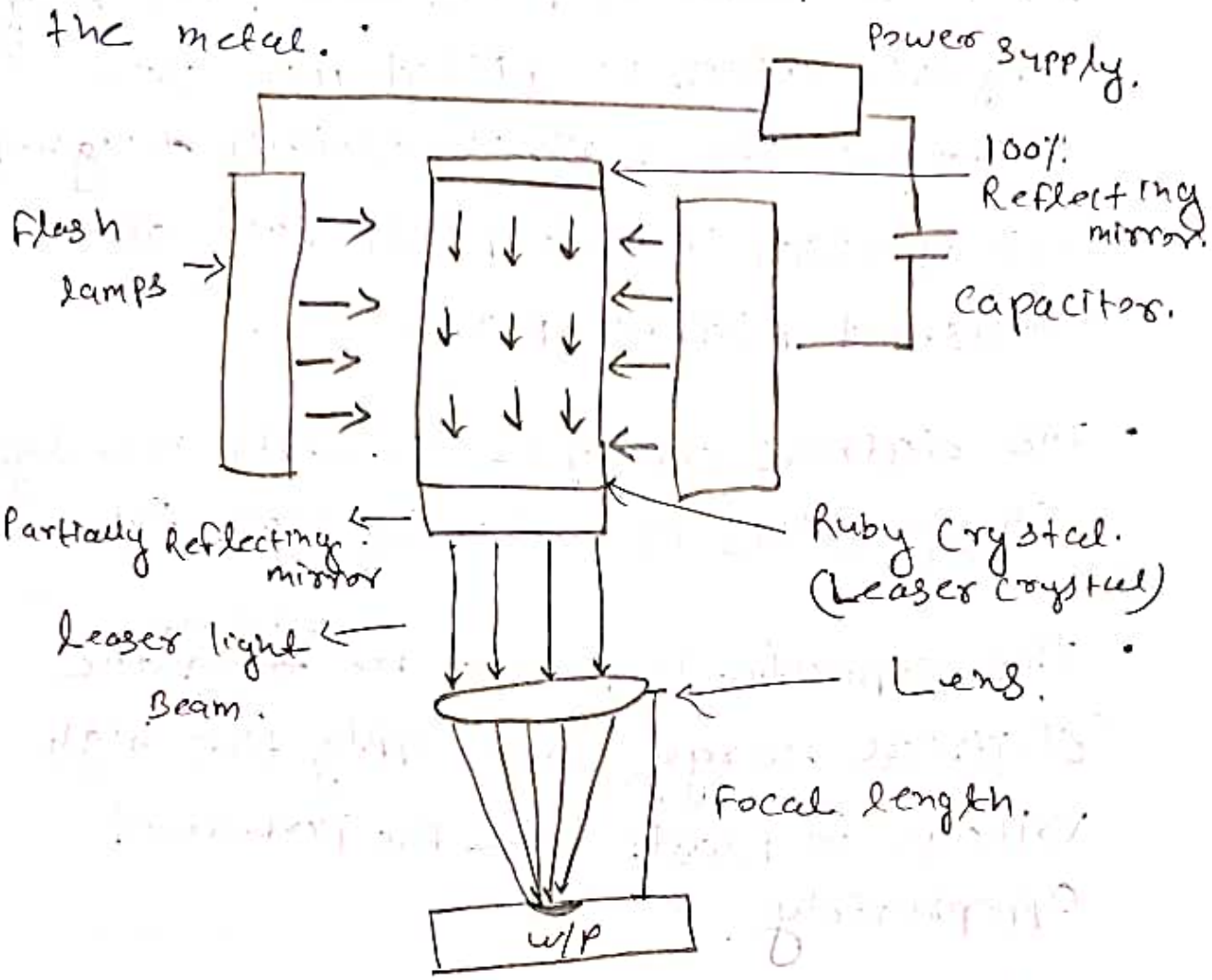
1- Interaction of leaser beam with work material

2- Heat conduction and temp. rise.

3- Melting vaporization and joining.

when using the leaser beam for welding, the electromagnetic radiation impinges on the surface of the base metal with such a concentration of energy that the temp

of the surface is melted vapor and melts the metal.



PRINCCIPLE OF LBM

- Leaser is produced inside of the Ruby crystal The Ruby crystal is made of aluminium oxide with chromium dispersed through out it. Silver coated mirrors are fitted internally in the both sides of crystal, The one side of mirror has a tiny hole, a beam is come out through this hole.

- A flash tube is placed around the Ruby Crystal, which is filled with xenon inert gas. The flash is specially designed such as which is made flash Rate about thousand flashes per second.

- The electrical energy is converted into light energy, this is worked by flash tube.

- The capacitor is provided for ~~strong~~ storage the electrical energy and supply the high voltage to flash tube for performed appropriately.

- Flash light Rate of 1/1000 per second.

- This narrow beam is focused by a optical focusing lens to produce a small intense of leaser on the job.

LBM Advantage

- Works with high alloy metals without difficult
- Can used open air.
- Narrow heat affected zone.
- No secondary Finishing, Extreanely accurate.

- Produced deep and narrow welds.

Limitation

- Rapid cooling Rate may cause cracking in Some metals.
- High capital cost for equipment.
- High maintenance costs.
- optical Surface of the laser are easily damaged

Applications

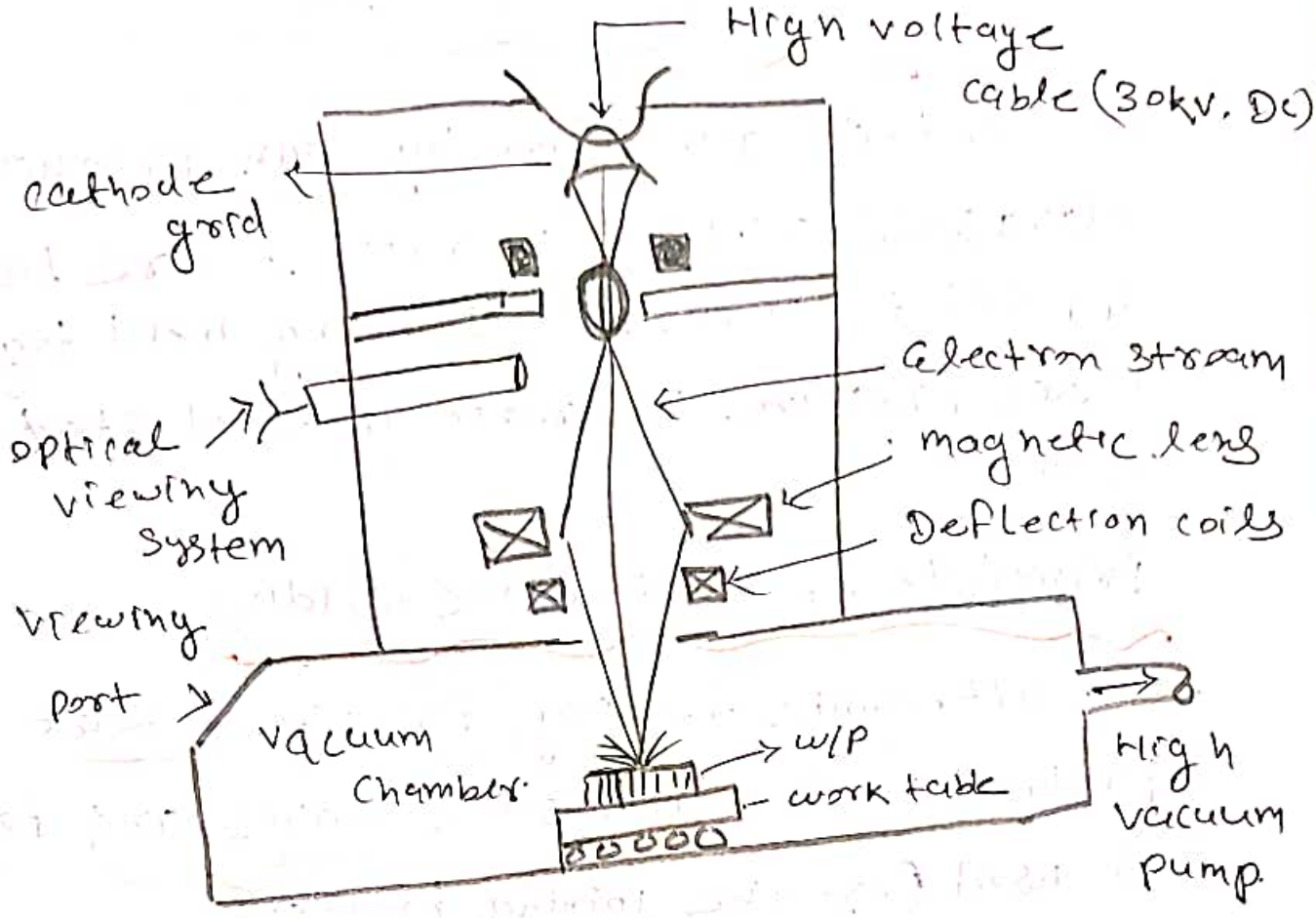
laser welding of thin work pieces like foils, wires, thin tubes, enclosures etc.

Electro Beam welding

- In this welding process, heat is generated by high velocity narrow beam electrons.
- when they strikes to workpiece, their kinetic energies chang into heat.
- The process Requires Speical equipment to Focus the beam on the work piece. In a vacuum. Higher vacuum beam penetrate more depth generater than the depth to width Ratio.
- This is used to weld tin foil to thick section. EBM process have small heat affected zone, By this method 150mm thick section can be weld.

Advantages

- High penetration to width can be obtained.
- High welding speed.
- material of high melting temp. can be welded.
- Superior weld quality due to welding in vacuum.
- less heat affected zone.
- small thickness sheet can be joined.



Dis Advantages -

- Transportation of equipment is not easy.
- Vacuum Required.
- Skilled person is needed.
- High cost.
- X-rays generated during welding.

Application -

- Joining of Refectory materials like columbium, tungsten, ceramics.
- welding nuclear Fuel Plant, Jet engines, Rocket vessels.
- Similar metals & Dis similar metals.
- Titanium medical implants.

ULTRASONIC WELDING

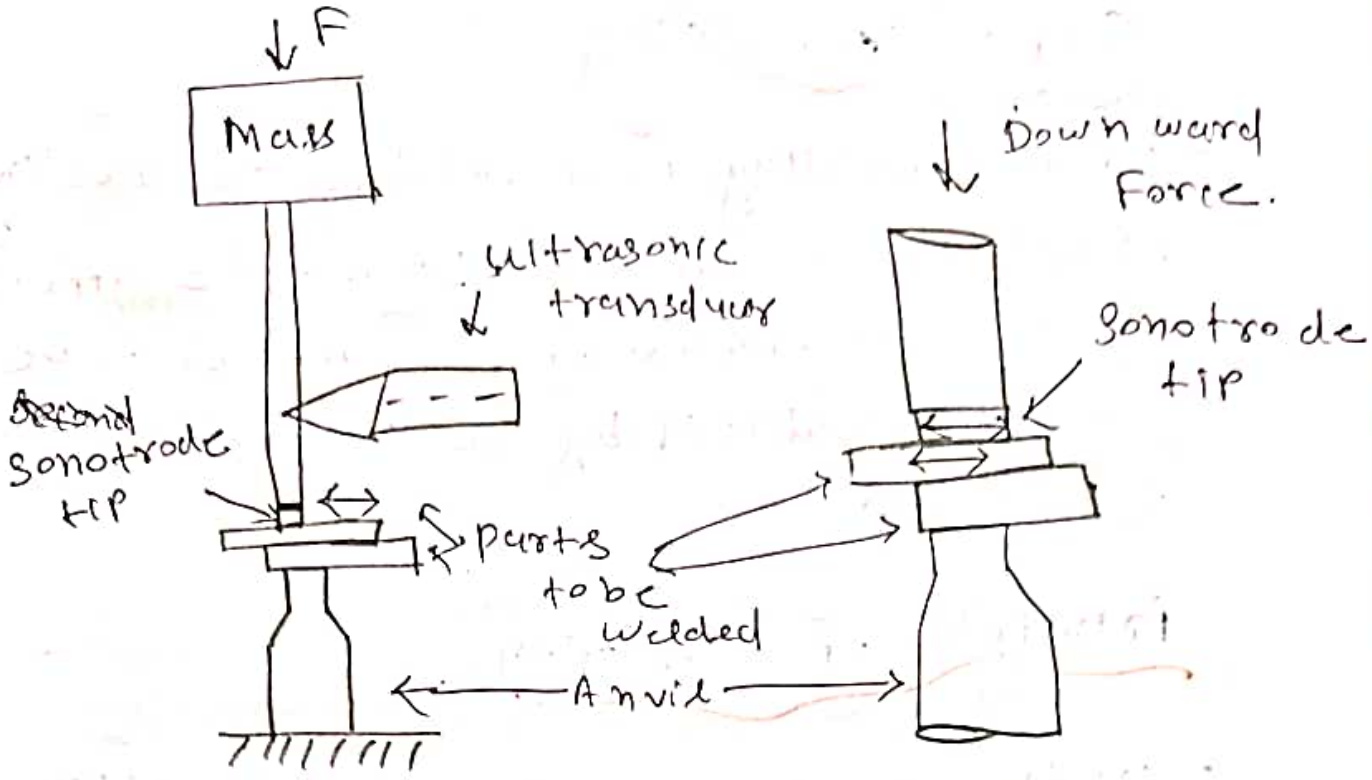
In this technique where by high frequency ultrasonic acoustic vibrations are locally applied to work pieces being held together under pressure to create a solid state weld.

Principle of ultrasonic welding.

- In ultrasonic welding, Frictional heat produced by the ultrasonic waves and force is used for the joining process.
- Ultrasonic waves (15 to 60 KHz) are transferred to the material under pressure, with a Sonometer.
- Welding times are lower than 3s. The welding can proceed with or without the application of external heat.

Advantages -

- Heat affected zone is minimized.
- very thin materials can be welded.
- glass is also welded.
- Dissimilar materials can be joined.
- Surface deformation is minimum.



Dis Advantages -

- Restricted to joint thin materials.
- Competitively not economical.
- materials being welded may tend to weld to the tip and anvil.

Application -

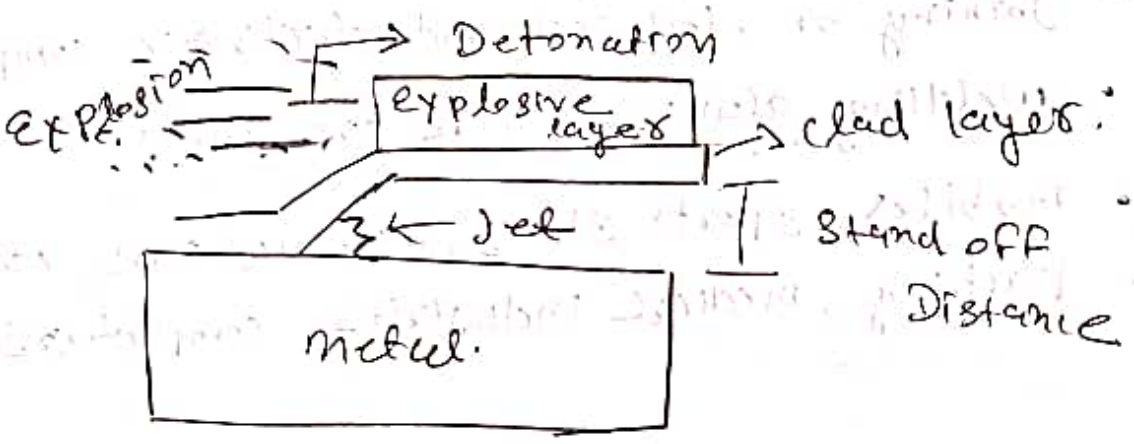
- manufacturing of toys.
- Joining of electrical and electronic components.
- Welding aluminium wire and sheet.
- mobiles, sports shoes, laminations, cars,
- Packing, medical industries, computers.

Explosive welding

- In this welding is a solid state welding process in which coalescence is affected by high movement of the metal to be joined produced by a controlled detonation.

Principle of Explosion.

- in this process, a controlled detonation of explosive is used on the welding surface
- flyer metal can be placed parallel or inclined to the base plate.
- Explosive material is distributed over top of cladder metal.
- upon detonation. cladder plate collides with base plate to form weld.



Advantages –

- Both similar and dissimilar materials can join.
- Simple in operation and handling.
- large surface can be weld in single pass.
- High metal joining Rate.
- Doesn't affect on properties of welding material.
- Not used any filler, flux etc.

Dis Advantages.

- weld only ductile metal with high toughness
- large noise and Air pollution.
- High safety Precautions involved dere to explosive.
- Designs of joints are limited.

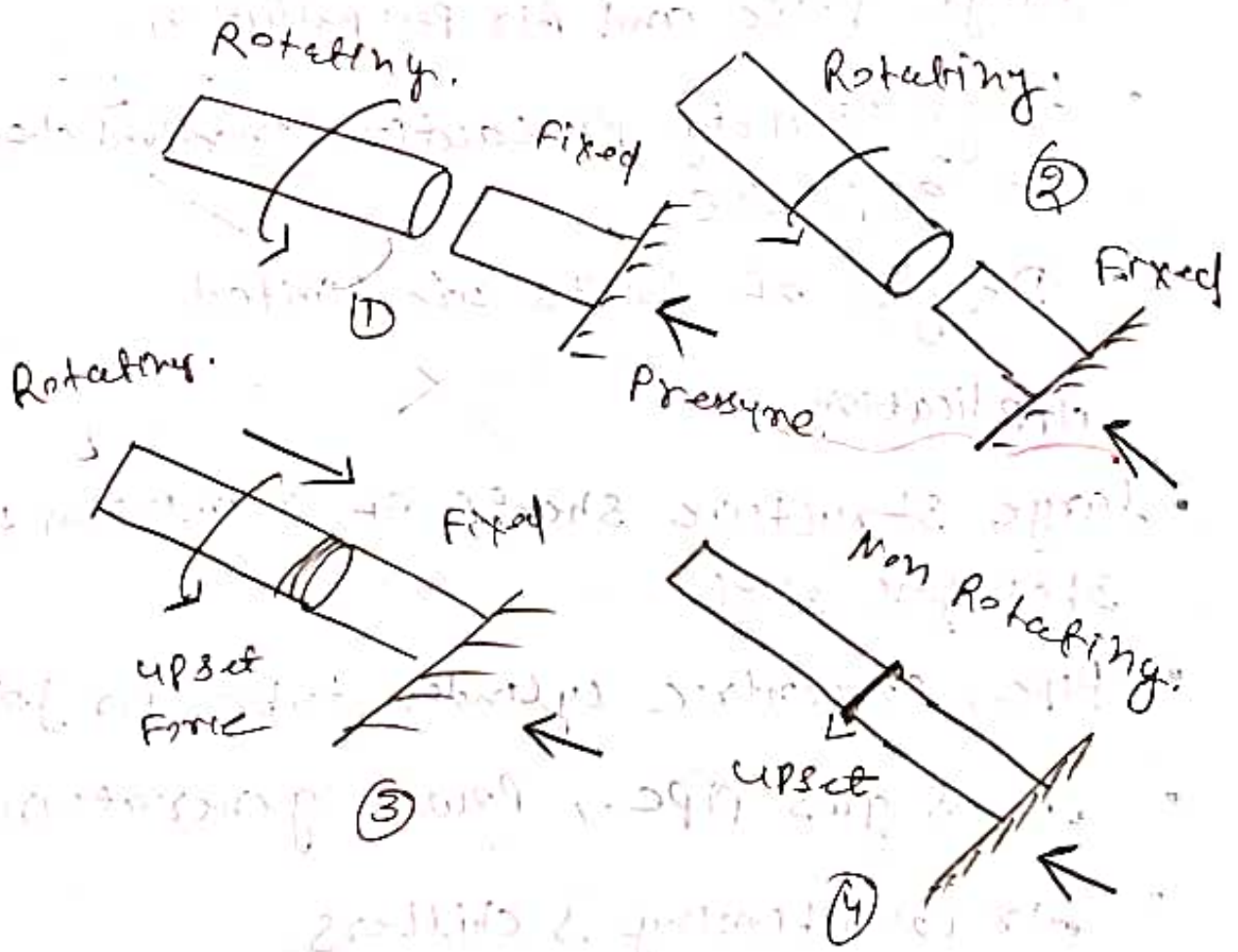
Application

- large structure sheets of aluminium to stainless steel
- Pipe, concentric cylinder, tube for joining.
- Oil & gas pipe., Power generation,
- Air conditioning & chillers.
- Metal production.

FRICTION WELDING

It is a solid state joining process that produces a coalescence by the heat developed beth two surface by mechanically induced surface motion

- Mechanical friction beth a moving work piece and a stationary components
- Lateral force (upset) is applied to plastically displace and fuse the materials.



Type of friction welding -

(I) Spin welding.

(II) - Linear Friction welding.

(III) - Friction Surfacing.

Advantages -

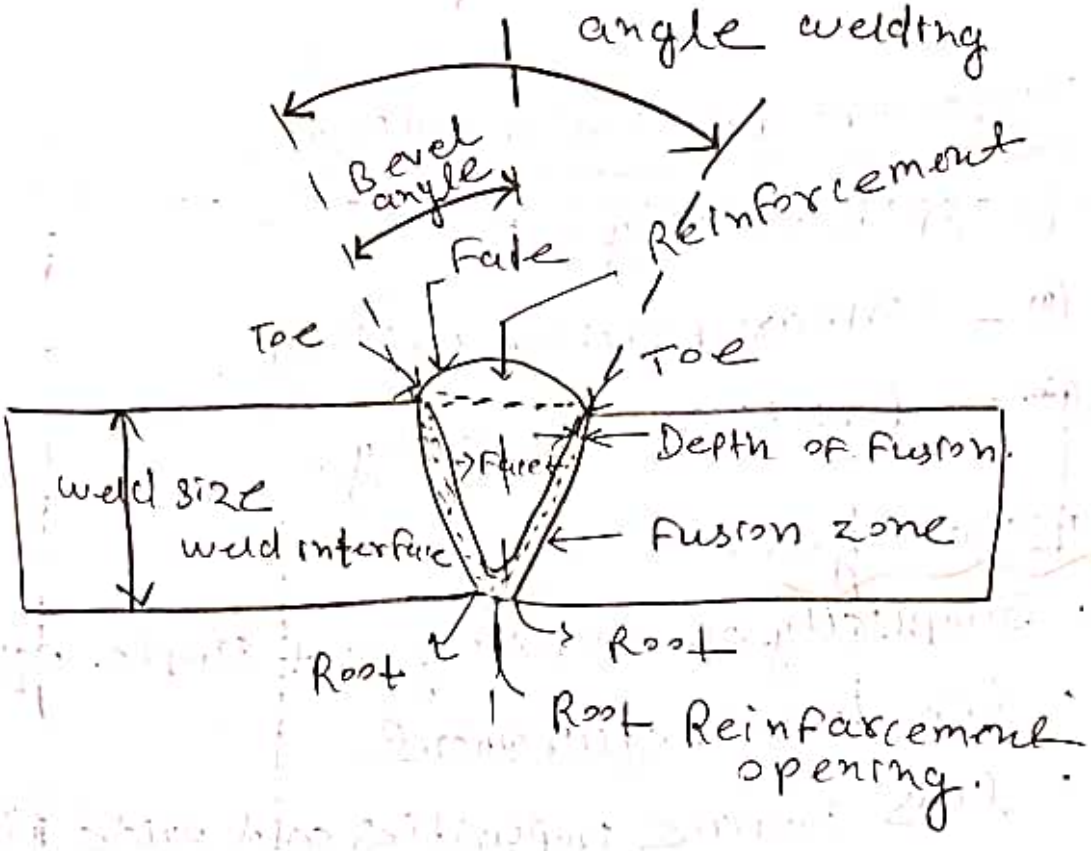
- Simplicity of operating and simple equipment.
- less time Requirement.
- less surface impurities and oxide films.
- Heat affected zone less,
- Speed and lower cost, less electric current.
- No flux, gas, Filler metal used.

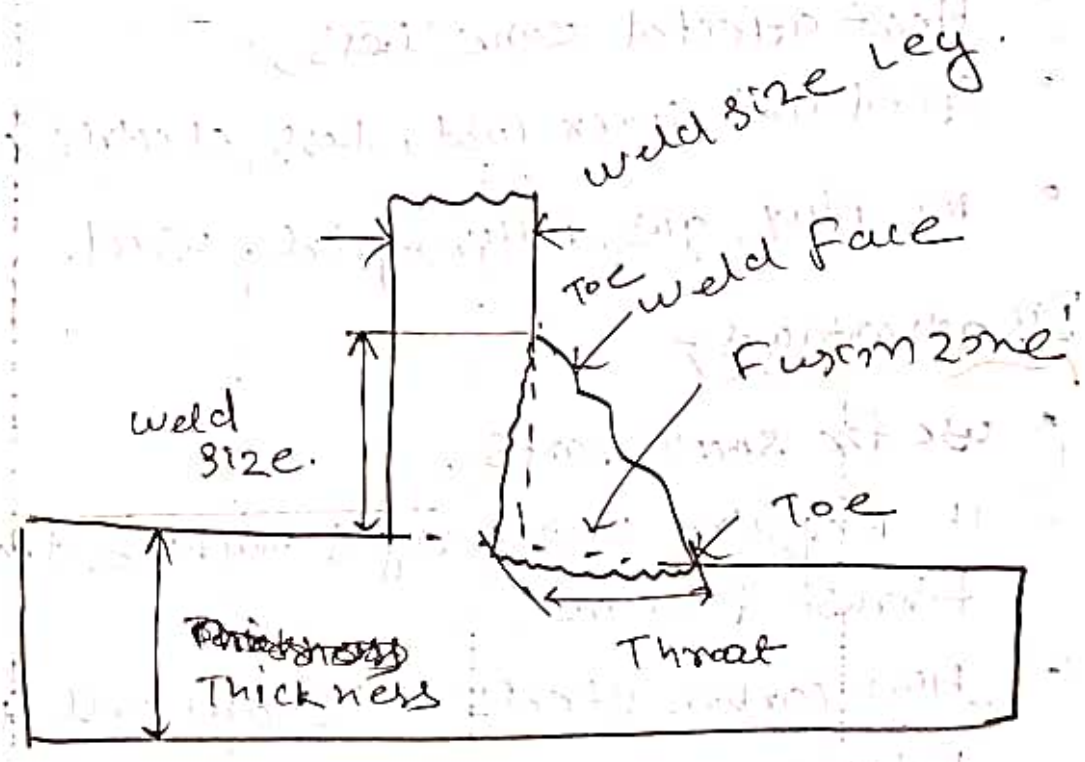
Disadvantages -

- use for small parts.
- It Require heavy rigid machine due to high thrust pressure.
- High carbon steels it is difficult to Remove flash.
- In tub welding process becomes, complicated.

Applications -

- Automobile, Aerospace industry
- Hydraulic equipments.
- Shipping industry.
- used for Hand tool, sports equipment.


angle welding
Bevel angle
Reinforcement
Face
Toe
Toe
Depth of Fusion
Face
weld size
weld interface
Fusion zone
Root
Root
Root Reinfarcement
opening.


weld size Leg.
Toe
weld Face
Fusion zone
weld
size.
Toe
Thickness
Throat

* The differences b/t soldering, brazing & welding

WELDING	SOLDERING	BRAZING
1- In welding Filler metal melting point is same as that of base metal	The filler metal is solder and melting point is below 450°C	In brazing the filler metal is brass and melting point is above 450°C
NO capillary action b/t the base and filler metal and the joint takes place due to fusion of metals	Joint takes place due to capillary action b/t the base m and filler metal.	Joint takes place due to capillary action b/t the base and filler metal.
These are the strongest joint used to bear the load.	These are the weakest joint out of three.	These are stronger than soldering but weaker than welding.
Temp. required is upto 3800°C of welding zone	Temp Requirement is upto 450°C or below welding zone.	It may go from 450°C to 600°C in brazing.
workpiece to be joined need to be heated till their melting point.	No need to heat the workpieces till melting point.	workpieces are heated but below their melting point.

Mechanical properties of base metal may change at the joint due to heating and cooling.	No Chang in mechanical properties after joining.	almost negligible properties Change after joing.
Heat treatment is Required.	No heat treatments Required.	No heat treatments Required.
No preheating of w/p is Required before welding as it is carried out at hrgh temp.	Preheating of w/p before soldering is good for making good quality joint	Preheating is desirable to make strong joint as brazing is carried out at relatively low temp.
Used For Joing Steel mild Steel, Aluminium	used For electrical applications, radiator tubes,	used for carbide tools Pipe fittings, dissimilar metals, etc.
Distortion is more	Distortion is least	Distortion is less.

Welding Defects -

- **weld porosity:**

This is due to entrapment of atmospheric gasses inside the molten weld pool due to this the strength of the weld is Reduced.

Remedies -
This can be Reduced by proper selection of filler metals by preheating the weld Area by proper cleaning the weld zone and by Reducing the welding speeds.

- **Slag inclusion.**

Inclusion may be caused by compounds such as oxides. Fluxes and electrode coating materials, which are trapped in the weld zone.

Remedies -
use inert gases to protect the molten weld pool increased of flux coating, submerged arc inside the molten metal.

- **Incomplete fusion -**

It is usally caused by insufficient heat and too fust travel of torch or electrode.

Remedies - This can be ovoided by Raising the temp. of the base metal, cleaning the weld area, providing enough shielding gas.

weld spatter

This is due to high welding current and too low welding speed and arc blow.

- ## Cold Cracking -

This is due to different in shrinkage rates and hydrogen entrapment and variation of weld composition.

Remedies - Pre heating, constant weld pool composition.

Hot cracking -

This is due to hydrogen embrittlements and high temp. gradients and high heat affected zone.

Remedies - By Preheating.

welding Inspection and testing.

- method of weld testing and analysis are used to assure the quality and correctness of the weld after it is completed.
- To ensure development of quality weld by collecting qualitative and quantitative data. asses suitability of welding for specific application.

How to test.

Stages of inspection –

- Before welding (Cleaning, edge prepration)
- During welding (Selection of current & voltage welding speed, gases)
- After welding
  - Removal of the slag
  - Peening (Stress Removal)

Testing Techniques –

- Destructive
- Non Destructive.

Destructive

- Physical damage to w/p and welded join
- Quantitative data obtained.

Two types tests ① workshop test
② Laboratory test.

- Tensile test
- Bend test

] — workshop.

- Hardness test
- Toughness testing (Impact test)
- Fatigue Behavior.

— Laboratory.

- Defects occur during welding which affect the quality and hardness of the plate.
- other defects occur through Lack of knowledge of and skill of the welder.

Non Destructive Testing.

It is wide group of analysis techniques used in science and technology industry. to evaluate the properties of a material, component or system without causing damage.

Types of NDT

- Visual inspection
- magnetic particle inspection.
- fluorescent Dye penetrant inspection.

(For surface flaws) (Cracks/holes)

- Radiography
- Ultrasonic Testing (Put sand waves)
- Eddy current Testing.

(Internal flaws)

Powder metallurgy process. -

* INTRODUCTION -

- In conventional m/f process such as forming, casting, machining etc, the raw materials used are often in form of solid material or solids melted to liquid state.
- A New class of m/f process, called powder metal forming has emerged in recent time. powder forming utilized metal or alloy powders as raw materials in order to obtain finished parts of high precision and accuracy, at competitive costs.
- Powder metallurgy is m/f of shaped components or semi finished products from metal powders.
- Powder metallurgy is preferred due to its product cost effectiveness.
- Powder metallurgy process involves metal powders compacted into desired shapes and sintered to form a solid piece, [PRESSING AND SINTERING]

→ 1- Lower energy consumption

2- Higher material utilization

3- Production of complex shapes.

→ Powder metal processing -

- Powder are very small particles having dia from 0.1 to 200 micrometers. powders of nano size are possible. (Less than 200 nano meters)

- Powder metallurgy involves production of metal or alloy powders and compacting them to required shape in green condition, followed by sintering at high temp. to achieve the required strength. The general steps involved in powder metallurgy process -

(I) - Production of metal powders.

(II) - Powder mixing or blending.

(III) - Powder compaction.

(IV) - Sintering

(V) - Post - Sintering operation / Finishing operation.

* Production of metal powders.

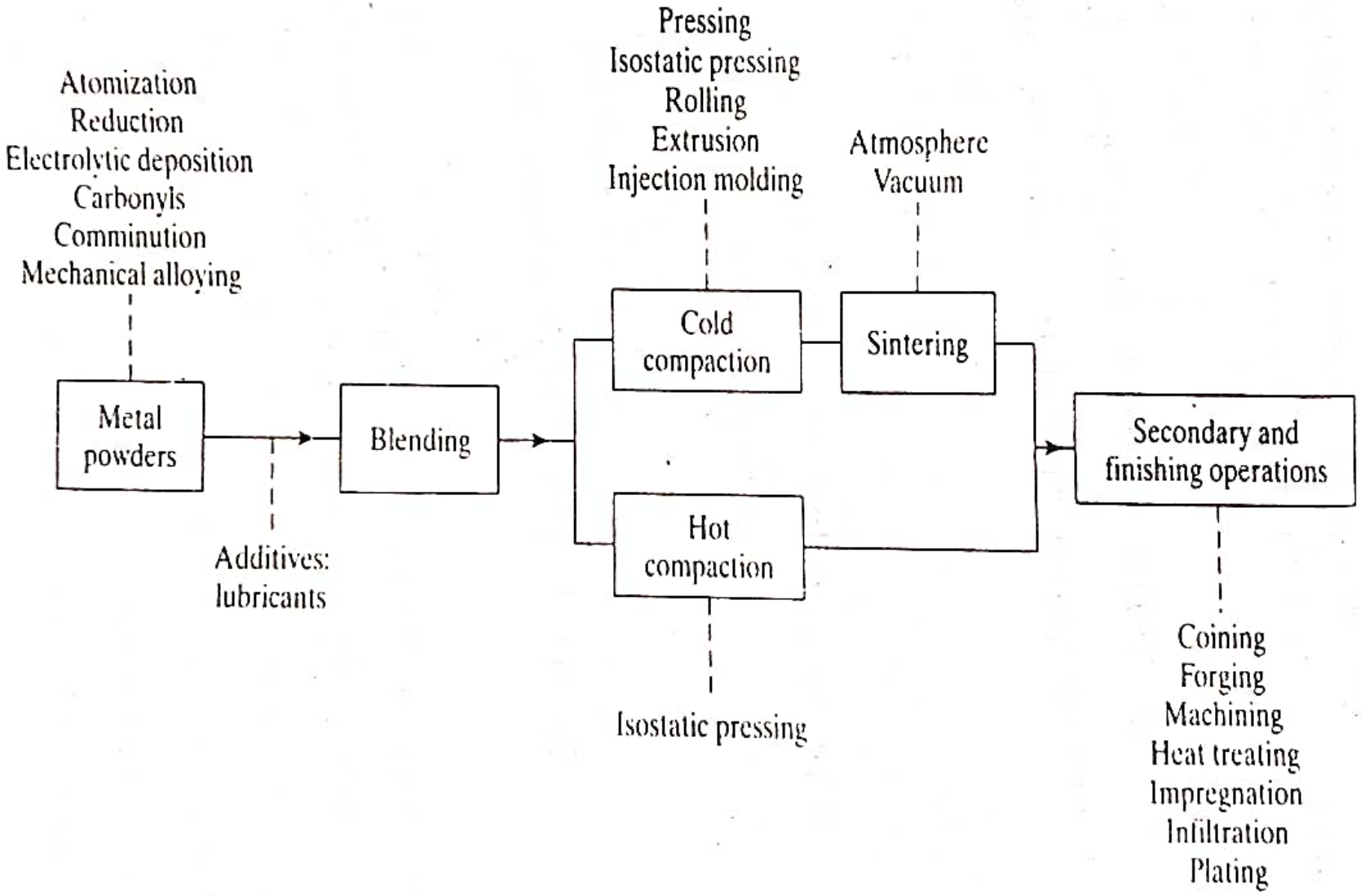
The Raw material for the production of metal powders may be the bulk metal, compounds of the metal, salts and oxids of the metal. The nature of the powder produced and its characteristics such as particle shape, size, composition etc, depends on the method of production of the powder.

A - The commonly employed methods.

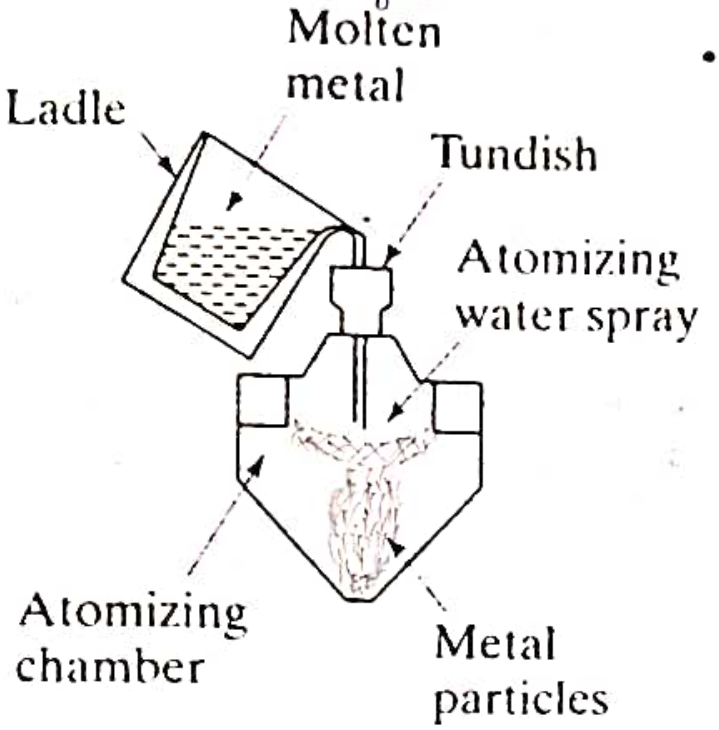
I - atomization
II - reduction
III - mechanical alloyny.
IV - electrolytic deposition etc.

I - atomization -

- involves a liquid - metal stream produced by injecting molten metal through a small orifice.
- Stream is broken up by jets of inert gas or air or ~~water~~ water known as gas or water atomization.

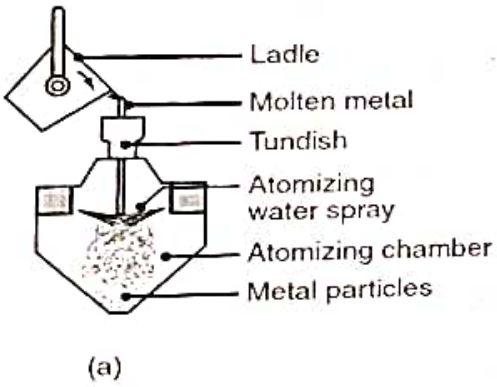

Atomization
Reduction
Electrolytic deposition
Carbonyls
Comminution
Mechanical alloying
Metal powders
Additives: lubricants
Blending
Pressing
Isostatic pressing
Rolling
Extrusion
Injection molding
Cold compaction
Hot compaction
Isostatic pressing
Atmosphere
Vacuum
Sintering
Secondary and finishing operations
Coining
Forging
Machining
Heat treating
Impregnation
Infiltration
Plating

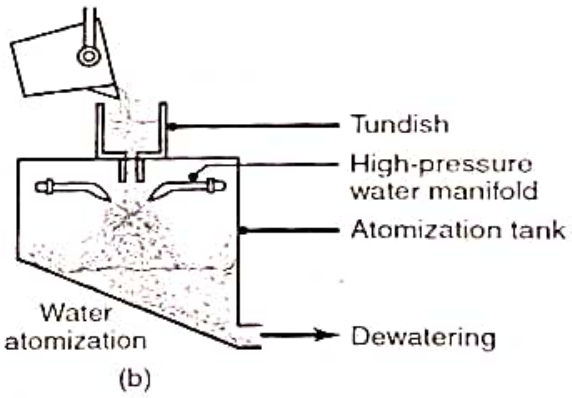
- In this process the molten metal is forced through an orifice into a stream of high velocity air. steam or inert gas.



- This causes rapid cooling and disintegration in to very fine powder particles.
- The use of the process is limited to metals with relatively low melting pon.

Atomization





There are three types of Atomization.

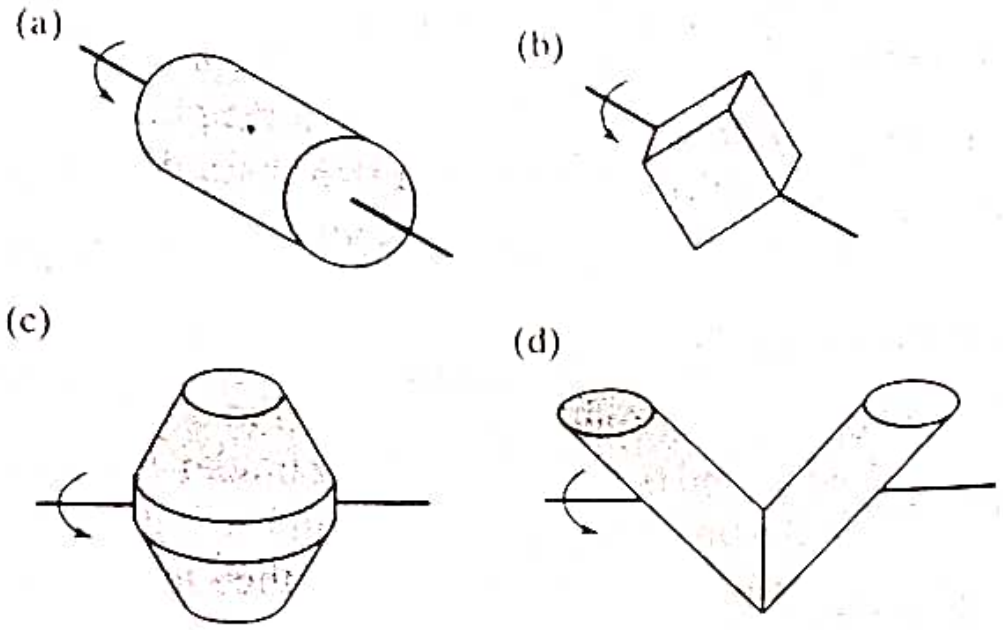
1 - Liquid

2 - Gas

3 - Centrifugal

- Powder blending is done due to following reasons:
  - → Blending imparts uniformity in shapes of the powder particles.
  - → facilitates mixing of different powder particles to improve physical and mechanical properties.
  - → Lubricants can be added to during blending to improve the flow and Reduce friction both powder and dies.
  - → Binders can be added to improve the green strength of material during compaction process.

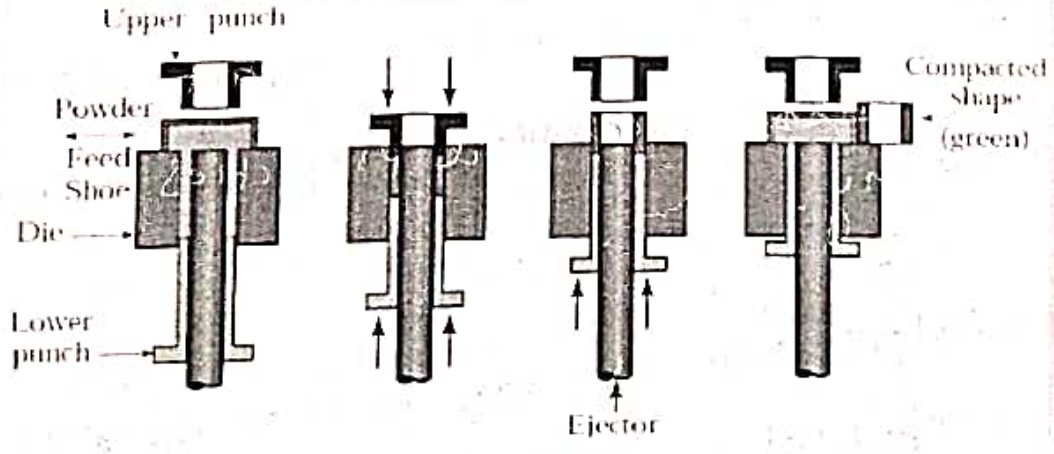
- Powders of different metals and other materials may be mixed in order to impart special physical and mechanical properties through metallic alloying.
  - → Binders such as wax or thermoplastic polymers are added to improve green strength.
  - → Sintering aids are added to accelerate densification on heating.



Some common equipment geometries used for blending powders

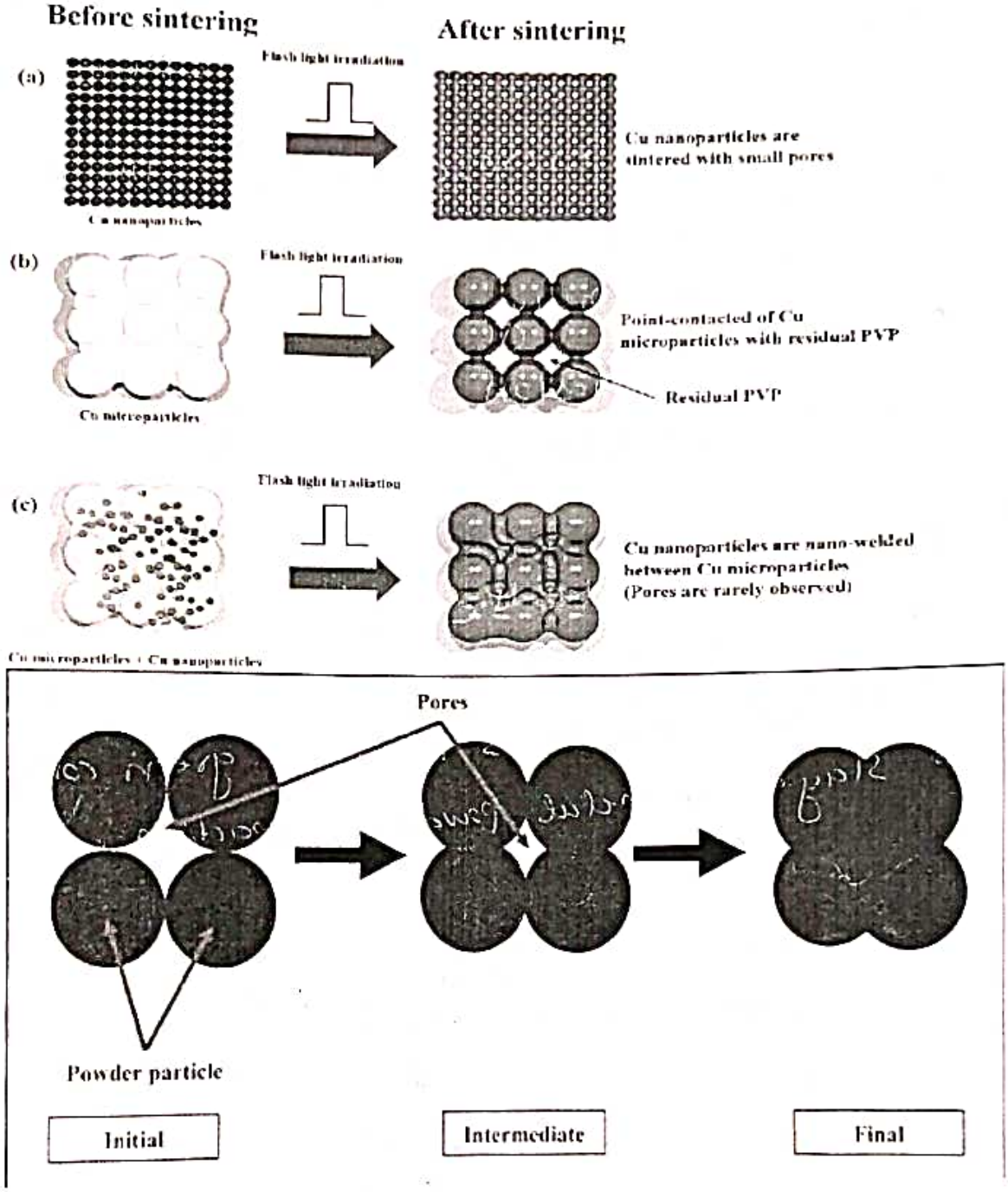
(A) Cylindrical, (b) rotating cube, (c) double cone, (d) twin shell

3- Powder compaction -



Compaction of metal powder to form bushing

4. SINTERING



- The sintering process consists of heating the compacted green mold in a furnace to a temp. below the highest melting point from the constituents.
- Sintering is applied to achieve all possible final strength and hardness required for finished product

* Powder compaction.

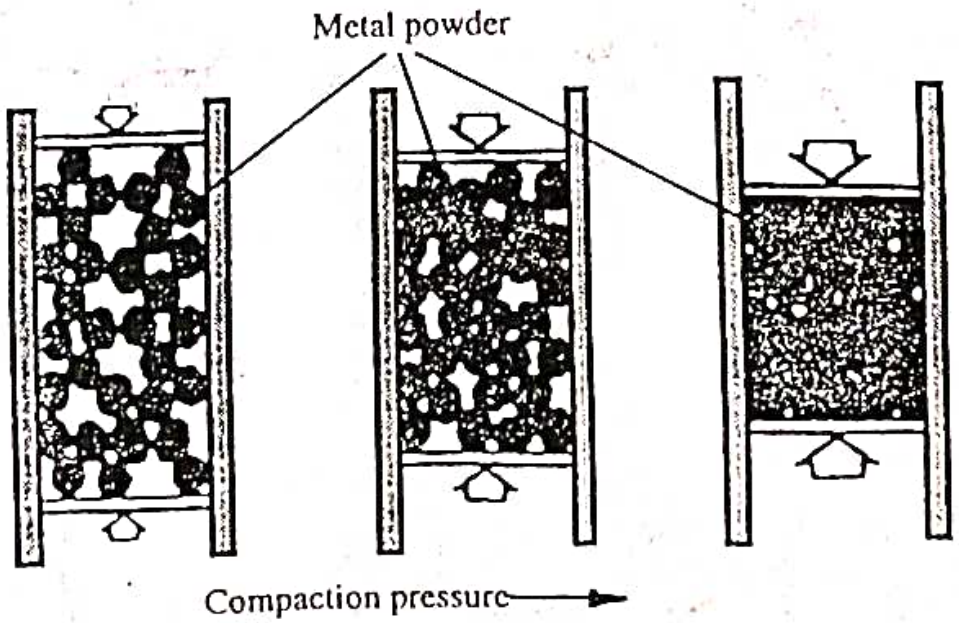
-> It is the process of compacting metal powder in a die through the application of high pressures.

> The compaction exercise imparts the following:

- Reduces voids b-eh the powder particles and enhances density.
- Produces adhesion and bonding between the powder particles to improve green strength.

* Press powder into the desired shape and size in dies using a hydraulic or mechanical press.

- Pressed powder is know as green compact.
- Stages of metal powder compaction.



Compaction

- The time, temp. and furnace atmosphere are the three critical factors that control the sintering process.

[Transforms compacted mechanical bonds to much stronger metallic bonds]

5- FINISHING OPERATIONS

- After sintering, some finishing operations such as repressing and machining are carried out to further improve final quality of parts.
- Parts are also subjected to other finishing operations such as heat treatment, machining and finishing according to the requirements.

→ To improve properties, finishing processes are -

- cold restriking, resintering, and heat treatment
- Impregnation of heated oil.
- infiltration with metal
- machining to tigher tolerance.

* APPLICATIONS -

- Electrical contact materials
- Heavy-duty friction materials
- Self-Lubricating porous bearings.
- P/M Filters
- Carbide, Alumina, Diamond cutting tools.
- Structural parts.

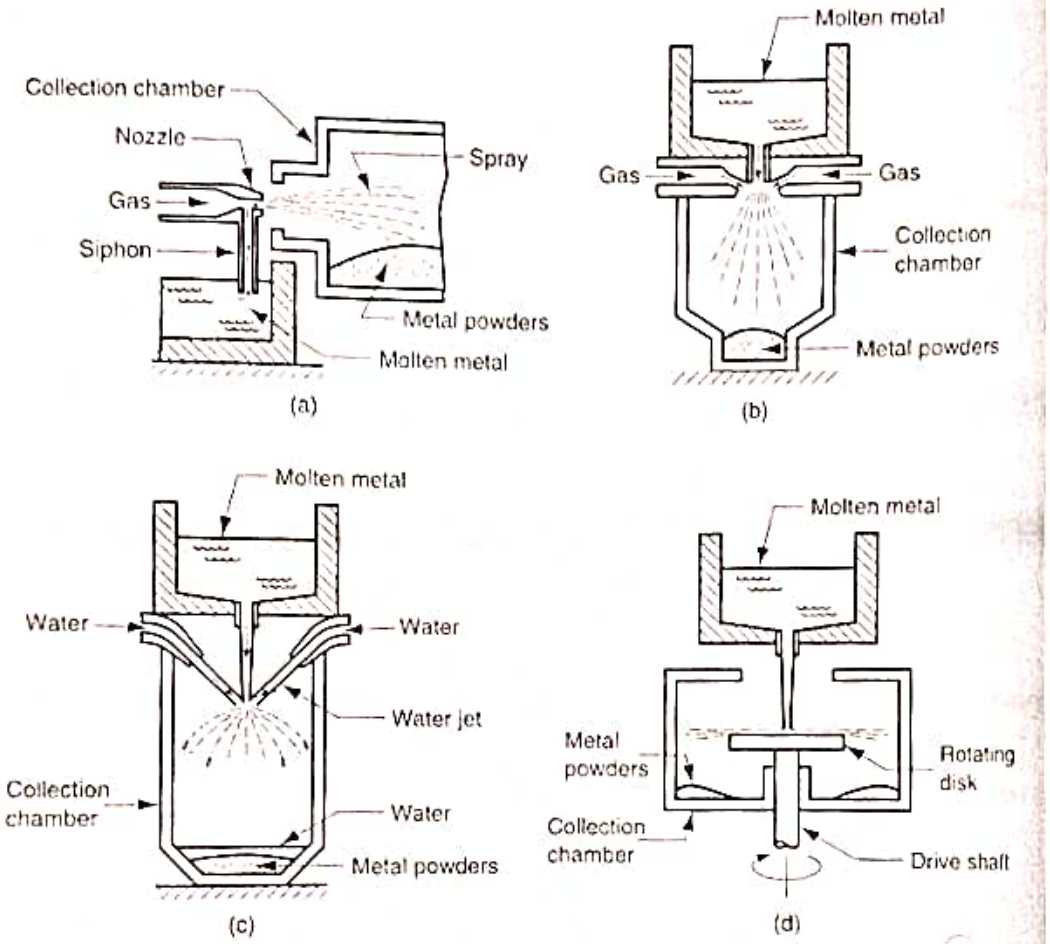
* Advantages -

- Reduction of machining
- High production Rates
- Complex shapes can be produces.
- wide composition variations are possible
- wide property variations are possible
- scrap is reduced.

* DIS Advantages -

- inferior Strength properties
- Relatively high die. cost.
- High material cost.

FIGURE 18.5 Several atomization methods for producing metallic powders: (a) and (b) two gas atomization methods; (c) water atomization; and (d) centrifugal atomization by the rotating disk method.



POWDER MIXING OR BLENDING -

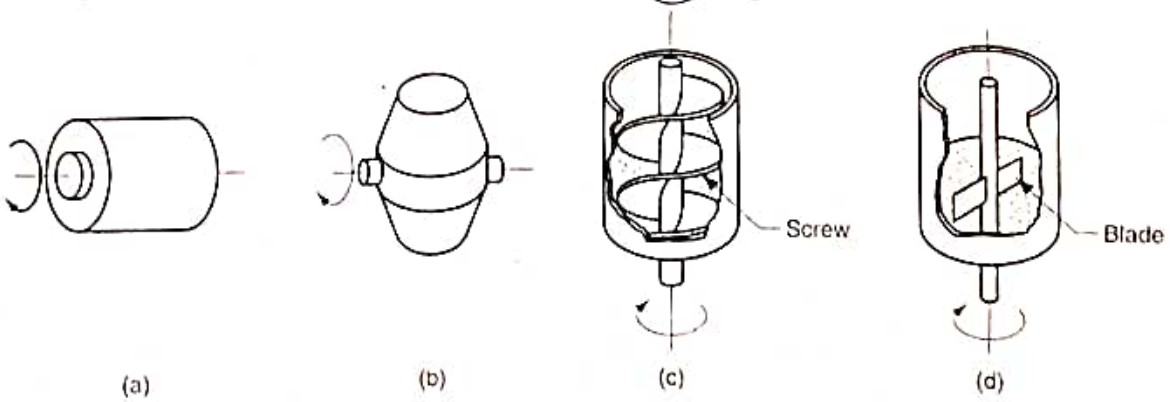


FIGURE 18.8 Several blending and mixing devices: (a) rotating drum, (b) rotating double cone, (c) screw mixer, and (d) blade mixer.

- BLENDING - combining powder of the same material but possibly different particle size.

- mixing - combining powders of different materials.