MODULE 6

- Transformation of Raw material from its original state to finished state by changing its shape, size and properties in a series of steps is called Manufacturing process.
- Broadly classified into **five**

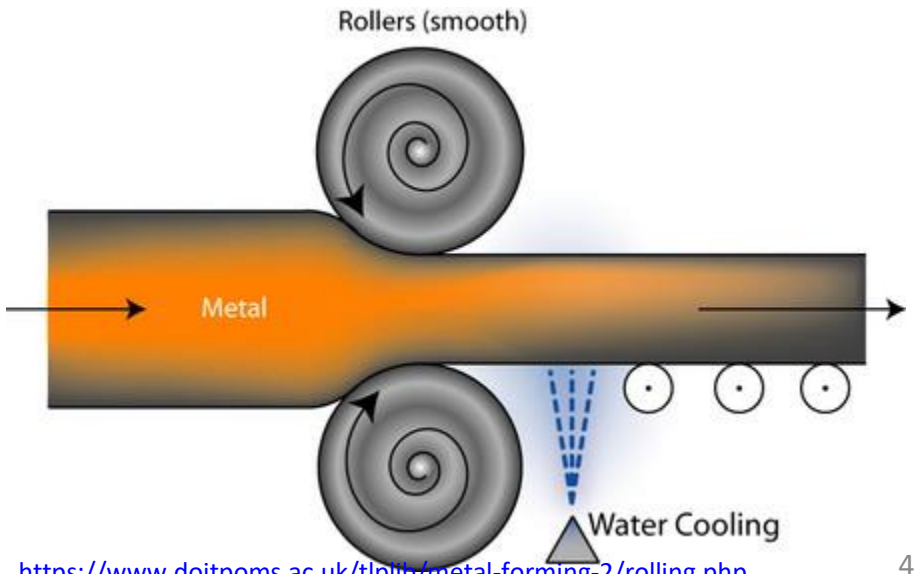
1. SHAPING PROCESS	2. MACHINING PROCESS	3. JOINING PROCESS	4. FINISHING PROCESS	5. PROPERTY CHANGING PROCESS
Process in which shape and size of the material is changed without removal of material. Eg: Casting, Forging, Rolling, Extruding	Process in which shape and size of the material is changed by removing the material from unwanted portions of the work piece. This process require cutting tool to remove the material. Eg: Turning, Drilling, Grinding, Milling	Process in which two or more parts are joined together, generally for fabrication work. Eg: Welding, Brazing, Soldering, Bolting, Riveting	Process in which required surface finish or protective coating is provided to the part. Small amount of material removal but not treated as machining process. Eg: Electroplating, galvanizing Honing, Lapping	Properties like hardness, ductility etc are changed so as to suit different applications. Eg: Heat treatment process

For better understanding watch this video before proceeding to slides

https://www.youtube.com/watch?v=ZD8gW_OzkCQ

Module 6

Rolling



https://www.doitpoms.ac.uk/tlplib/metal-forming-2/rolling.php

Rolling definition

Process of forming metals into desired shapes by passing the metal in between a pair of rolls. Rolls squeeze the cross section of the metal while increasing its length. The process of rolling basically consists of metal between two rolls rotating in opposite direction at same speed.

Types of Rolling

Hot rolling

- Hot rolling is the process in which metal is fed to the rolls after being heated above the recrystallization temperature.

Cold rolling

- Here metal is fed to the rolls when it is below the recrystallization temperature.

Application : *Bars, Plates, Sheets, Rails and other structural sections*

Advantages

1. More economical than forging when metal is required in long lengths of uniform cross section.
2. High rate of production.
3. Suitable for large reduction in size.

Disadvantages

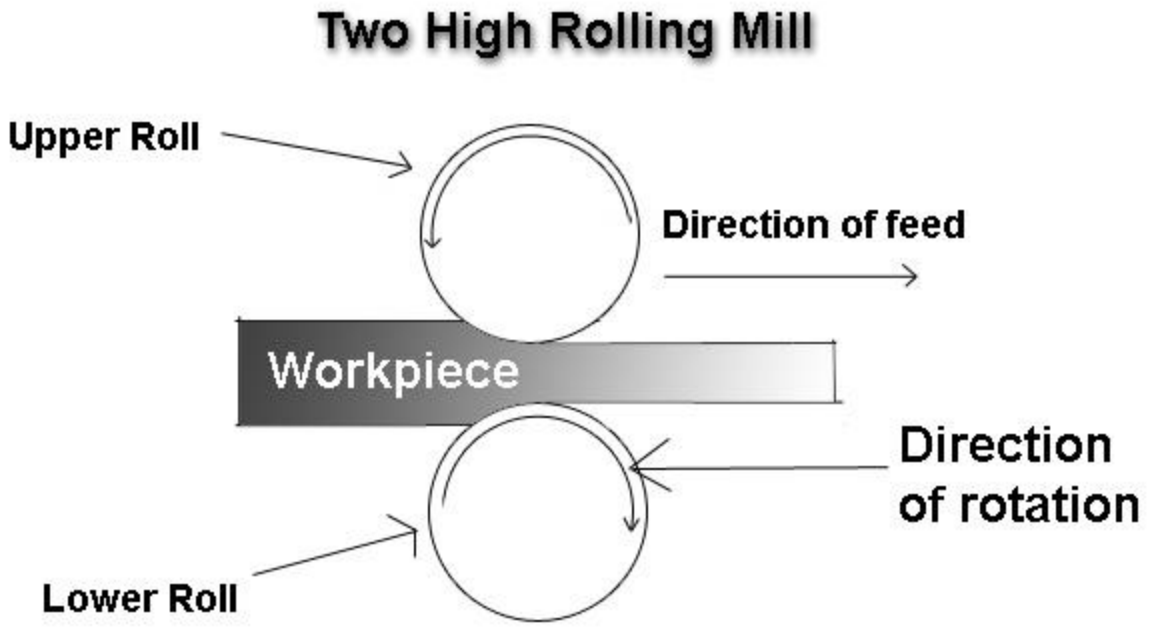
1. High cost
2. Poor surface finish
3. Less dimensional accuracy

Classification of Rolls (*Based on number of rolls and their arrangement*)

- Two High Mill
- Three High Mill
- Four High Mill
- Cluster Mill

1. Two High Mill

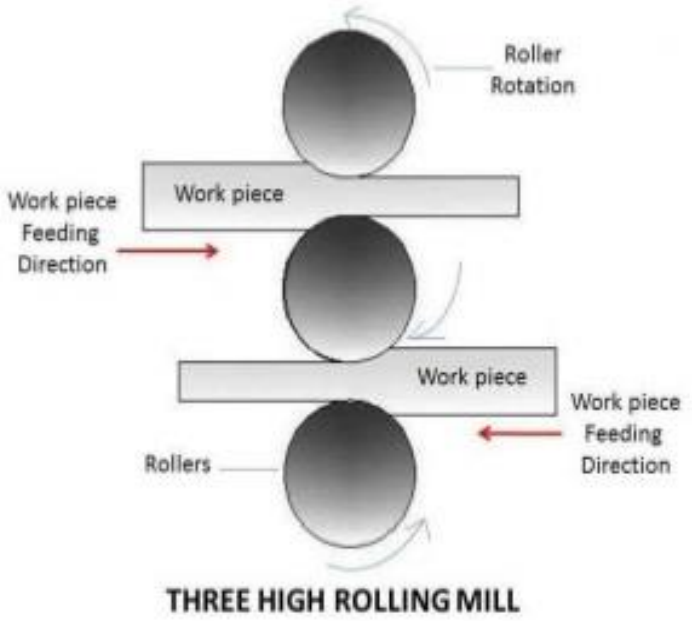
http://www.mechanicalwalkins.com/types-of-rolling-mills-with-detailed-information/



It consist of two heavy rolls placed exactly one over the other. Mostly the lower roll will be fixed in position. Upper roll can be moved to adjust the space between the rolls. Both rolls rotate at the same speed in opposite directions.

2. Three High Mill

https://www.slideshare.net/BasittiHitesh/conclave-of-rolling-processs

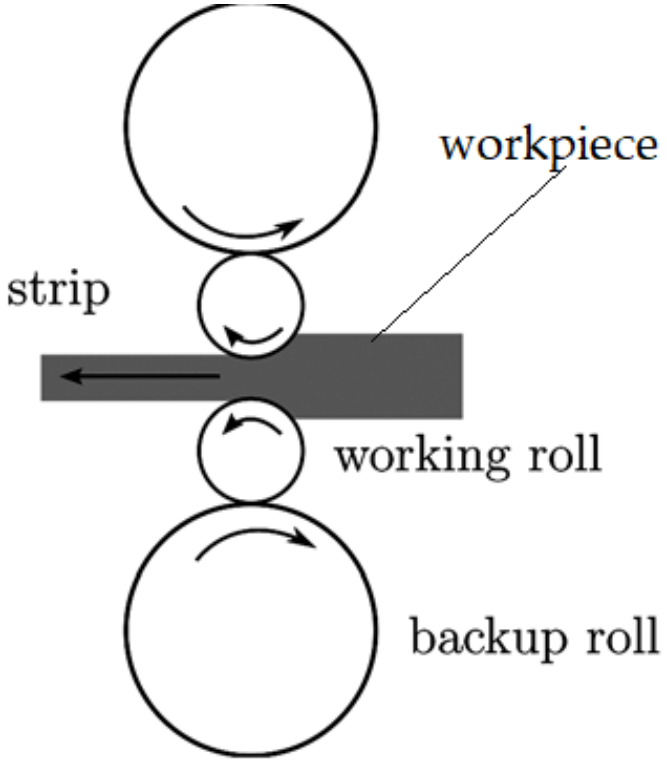


It consist of three rolls positioned one over the other as shown in figure. The upper and lower roll rotate in the same direction while the middle roll rotates in the opposite direction. Here the middle roll is kept fixed and the upper and lower rolls are moved to adjust the roll gap.

First pass	Second pass
The work piece is made to pass in one direction between the upper roll and middle roll.	The work piece is made to pass in opposite direction between the middle roll and lower roll.

3. Four High Mill

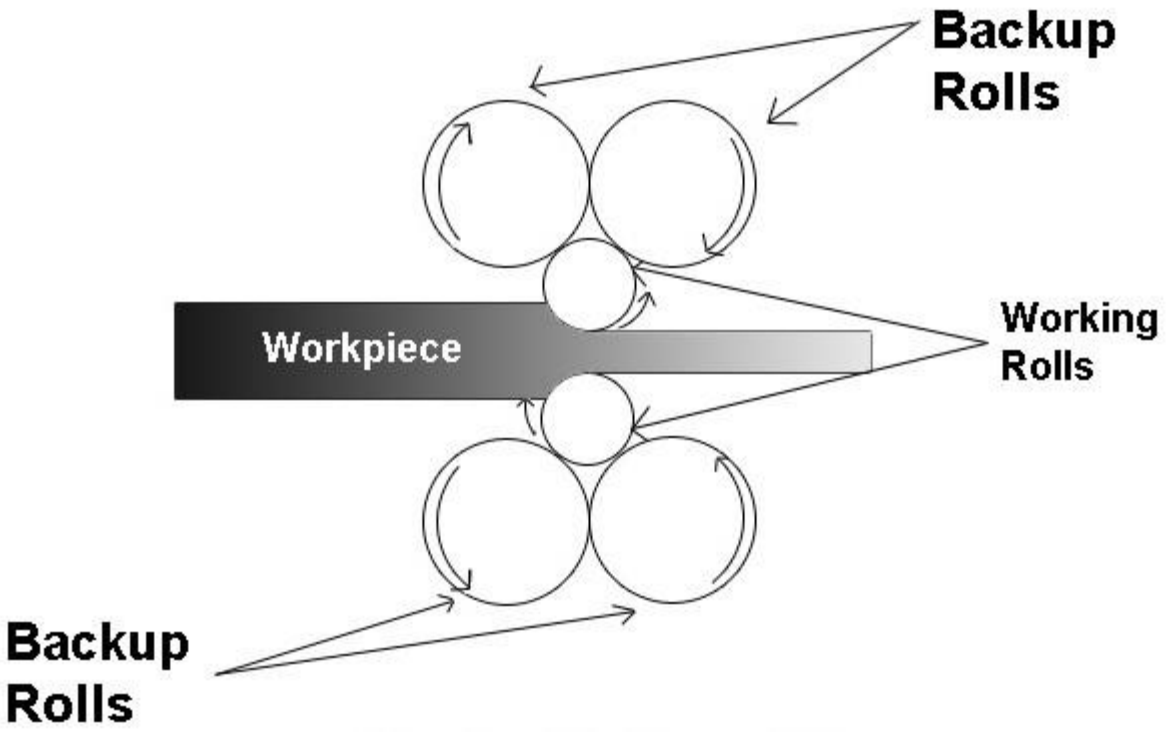
https://www.researchgate.net/figure/a-Schematic-diagram-of-a-four-high-rolling-mill-b-coordinate-system-and-c_fig1_270773160



It consist of four rolls, two of which are working rolls and the other two backup rolls. The back up rolls are larger in size and are required for preventing the deflection of working rolls.

4. Cluster Mill

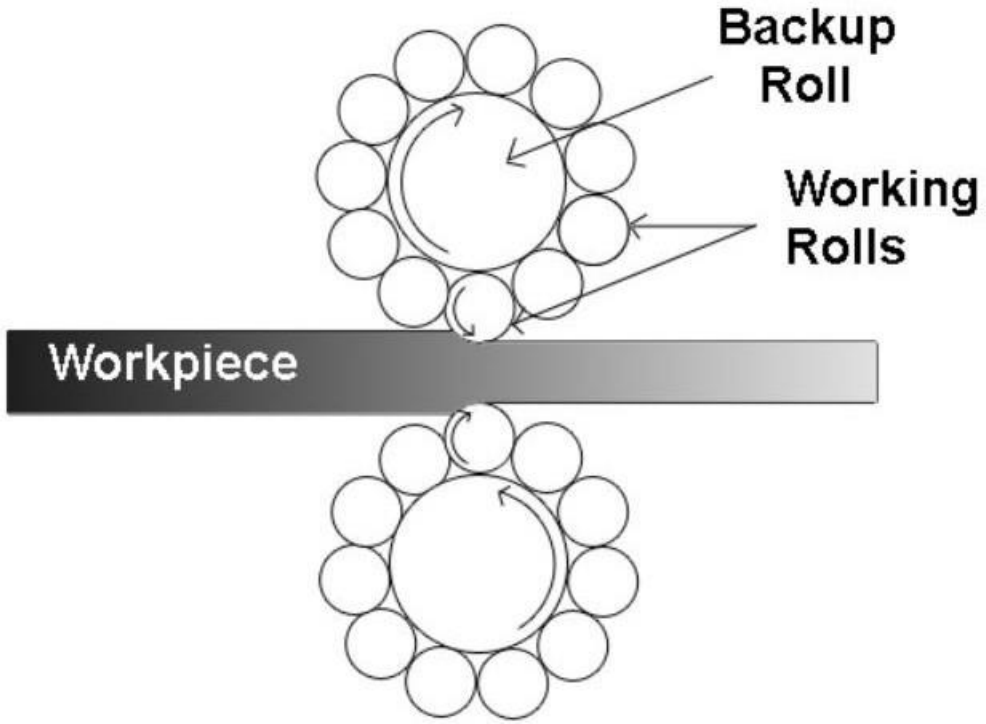
http://www.mechanicalwalkins.com/types-of-rolling-mills-with-detailed-information/



For rolling very thin sheet or foils, an arrangement of cluster mill is provided.
It consist of a pair of working rolls of very small diameter, supported by a number of back up rolls on either side.

5. Planetary mill (*optional*)

http://www.mechanicalwalkins.com/types-of-rolling-mills-with-detailed-information/



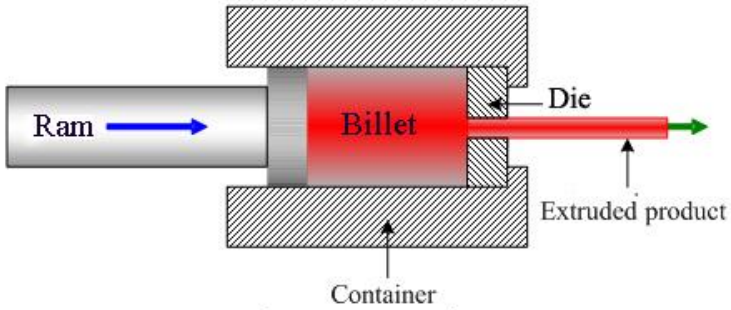
It is used to reduce large thickness of single pass of steel strip.

For better understanding watch this video before proceeding to slides
Look for direct extrusion and indirect extrusion only, ignore others

https://www.youtube.com/watch?v=743fHkOvOkA

Module 6

Extrusion



Direct Extrusion

https://techminy.com/extrusion/

Extrusion definition

Process of forming products of uniform cross sectional shapes in convenient length. It consists of compressing the metal inside a chamber and forcing it out through a die having an opening in the shape of the product. Compression is achieved either mechanically or hydraulically.

Based on operating temperature

Hot extrusion

- When extrusion is carried out at above recrystallization temperature.

Cold extrusion

- If extrusion is carried out at below recrystallization temperature. Metals such as *lead*, *tin* and *aluminium* are extruded at room temperature.

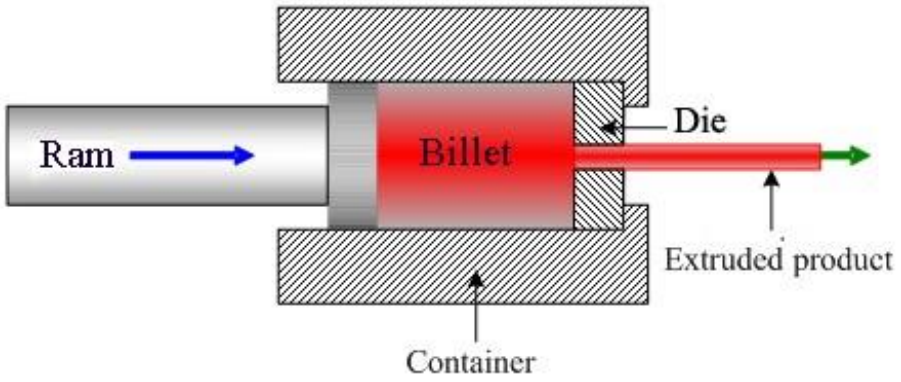
Based on working

1. Direct Extrusion
2. Indirect Extrusion

1. Direct extrusion(Forward Extrusion)

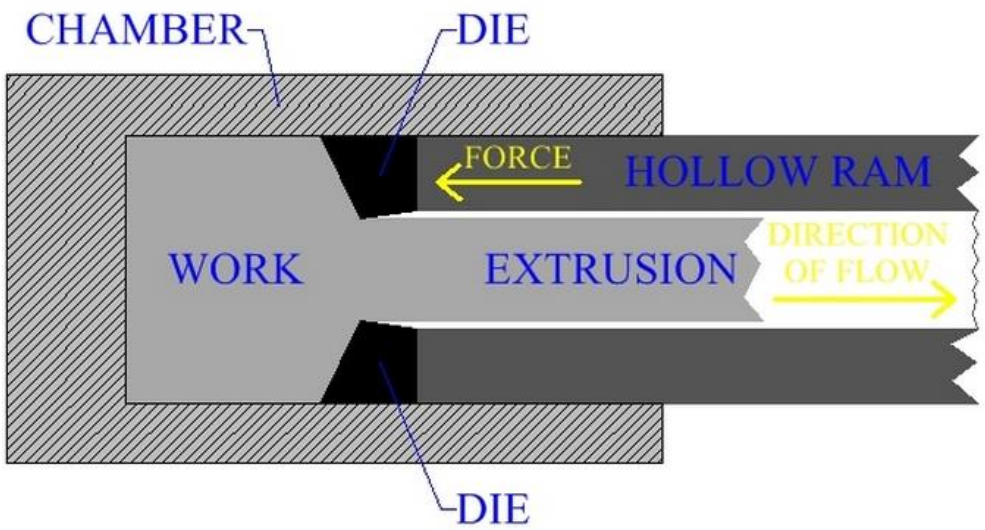
- Here metal(also called billet) is placed in the die chamber and the metal is forced through the die opening by applying pressure on the ram. The extruded part coming out through the die is then cut into required length.

https://techminy.com/extrusion



2. Indirect Extrusion(Backward extrusion)

- In this process the extruded part which is forced out of the die is taken out through the ram (plunger), which is made hollow. Here extruded product comes out in opposite direction to that of the ram movement



http://www.wiredrawingdies.co.in/indirect-backward-extrusion/

Application: Rods, Tubes, Structural shapes

Advantages

- High production volume
- Surface finish obtained is good.
- Many type of raw materials can be used

Disadvantages

- High initial cost
- Only one type of cross section can be obtained at a time

For better understanding watch this video before proceeding to slides

https://www.youtube.com/watch?v=7L4wnXz_JYI

Module 6

Forging

https://www.steelavailable.com/en/what-is-steel-forging/

Forging definition

Process of changing the shape of metals when it is in the plastic state, by applying compressive force. Generally employed for those components which require high strength and other mechanical properties.

Based on operating temperature

Hot Forging

- When forging is done above recrystallization temperature.

Cold Forging

- If forging is carried out below recrystallization temperature.

Application: bolts, spanners, nails, axles, connecting rod, crankshaft

Advantages

- Always have better mechanical properties than casted components.

Disadvantages

- Operation is costly
- Difficult to maintain dimensional accuracy
- Atmost care to be taken in temperature control

Types of Forging

Watch this video

https://www.youtube.com/watch?v=dFnN1YtomNc

1. Hand forging
2. Drop forging
3. Press forging
4. Machine forging

1. Hand Forging

- Traditional work carried by a blacksmith in a smithy shop.
- Heating of metal is done in open fire and for various operation hand tools are used.
- Its purely skilled work and can be done for low production volume only.

2. Drop Forging

- Forging operation which is done in closed impression dies.
- Dies will be having two halves and inside the same required shape of the product will be there in the form of a cavity.
- Drop hammers are used for applying force.
- This can be applied for mass production small and medium sized, simple and complex shapes are possible.

3. Press Forging

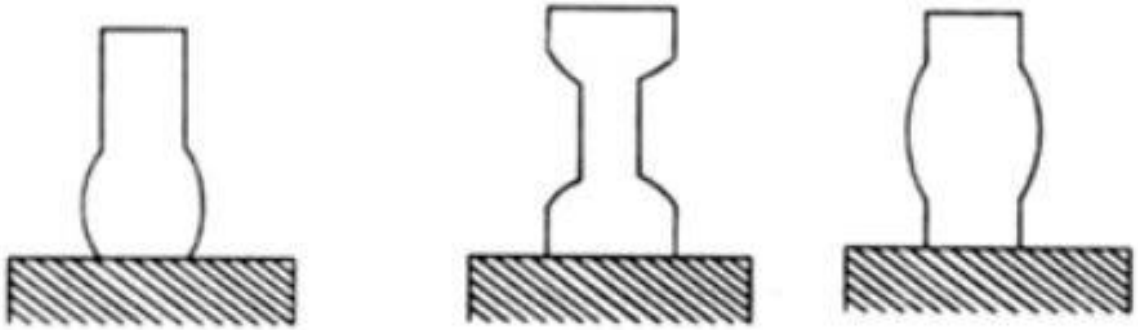
- Similar to drop forging but here force is applied by a continous squeezing operation by means of a hydraulic press.
- Applications are similar to drop forging

4. Machine Forging

- Here forging machines are used to get the required product.
- Dies are used which contain the impression of the required product.
- Bolt heads, small shafts, rivets are widely made using machine forging.

In Forging to obtain the desired shape of material a number of operations are to be performed. Some common forging operations are given following

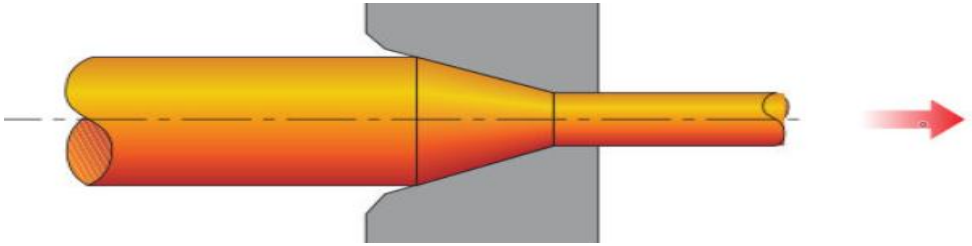
http://www.yourarticlelibrary.com/metallurgy/operations-employed-in-open-die-forging-metallurgy/95428



1. Upsetting

Process of incresing cross sectional area of the desired portion of workpiece at the expense of its length. The portion where the cross sectional area is to be increased is heated at first and blown with hammer axially.

https://mechatronicsly.com/learn/manufacturing/wire-drawing-and-extrusion/



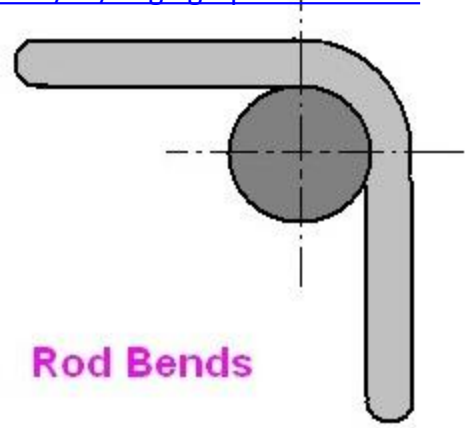
2. Drawing down

Process of reducing the cross sectional area of the workpiece by increasing its length

3. Swaging

Forging operation by which required cross section is obtained. Two swage blocks namely top swage and bottom swage are used for swaging operation. The job is held in between top and bottom swage and then hammered.

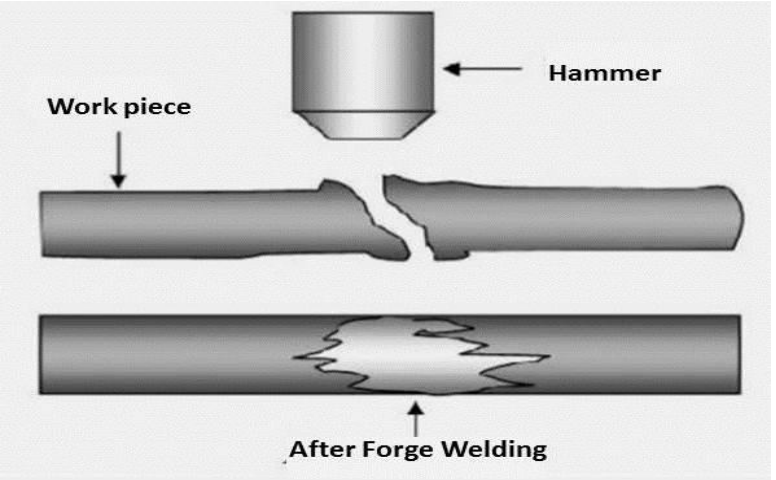
http://engineeringhut.blogspot.com/2010/10/forging-operations.html



4. Bending

Operation by which bars and rods are bent to form rings, hooks etc

https://www.mech4study.com/2017/04/forge-welding-principle-working-application-advantages-and-disadvantages.html

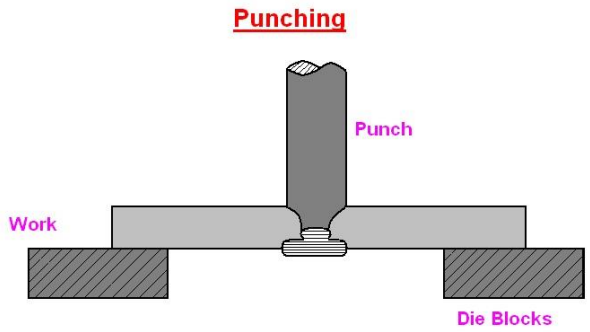


5. Forge welding

Here two metallic surfaces are joined without using a filler materials. The portion to be joined are heated to higher temperature less than melting point and joined together by hammering.

6. Cutting

Process of removing pieces of metal from a billet by using chisel.



http://engineeringhut.blogspot.com/2010/10/forging-operations.html

7. Punching

Process in which a punch is forced through a workpiece to produce a hole. The work piece is heated and supported on a block as shown in figure.

8. Drifting

Process of increasing the diameter of a punched hole. A drift which has tapered end is made to pass through the punched hole to produce a finished hole of required size.

9. Setting down

Local thinning operation performed by set hammer.

For better understanding watch this video before proceeding to slides

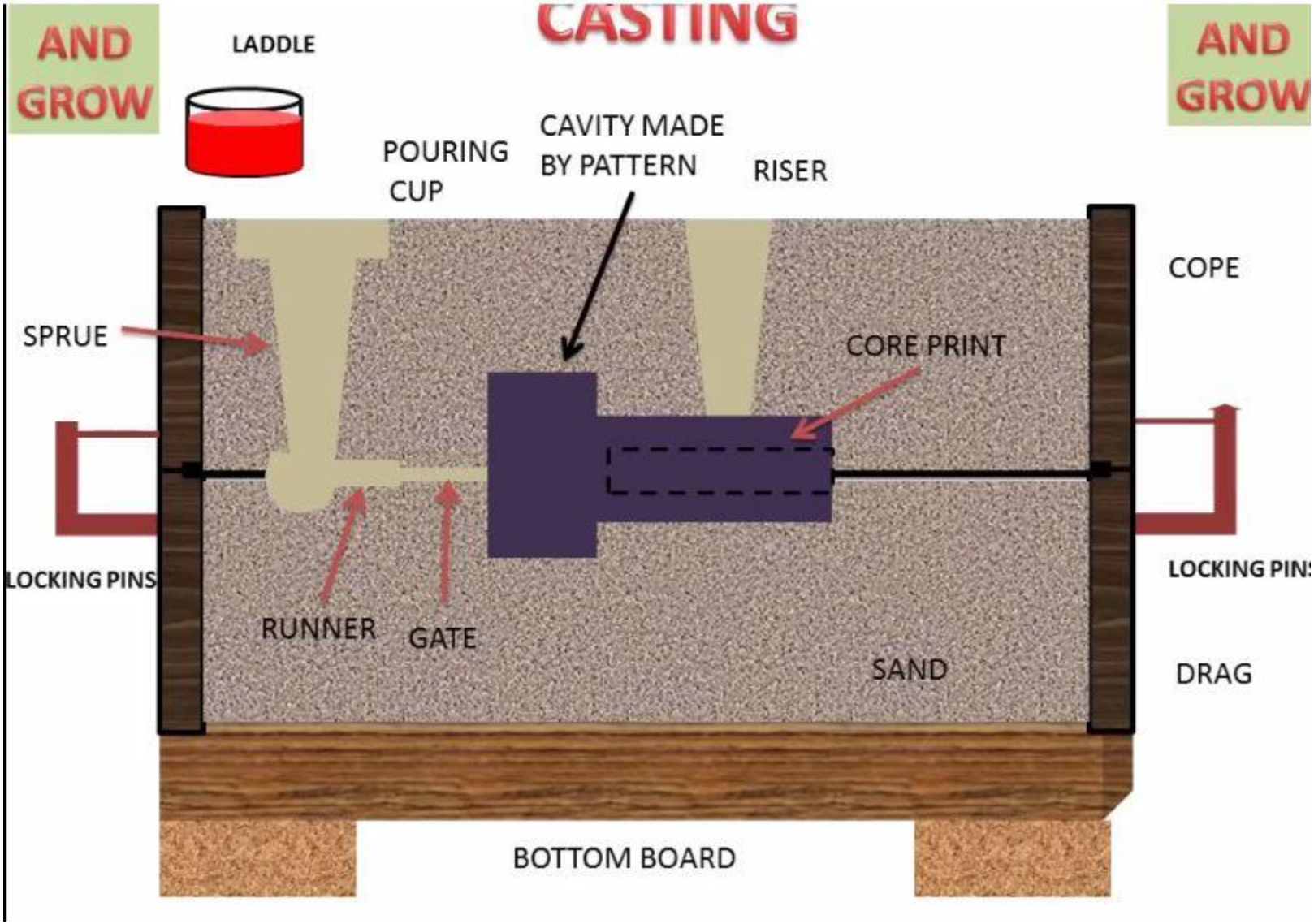
https://www.youtube.com/watch?v=cjebklLgrf8&list=PLSWRPBzGkib_GAPASbMnBZ9uKsKcS7w9z

MODULE 6

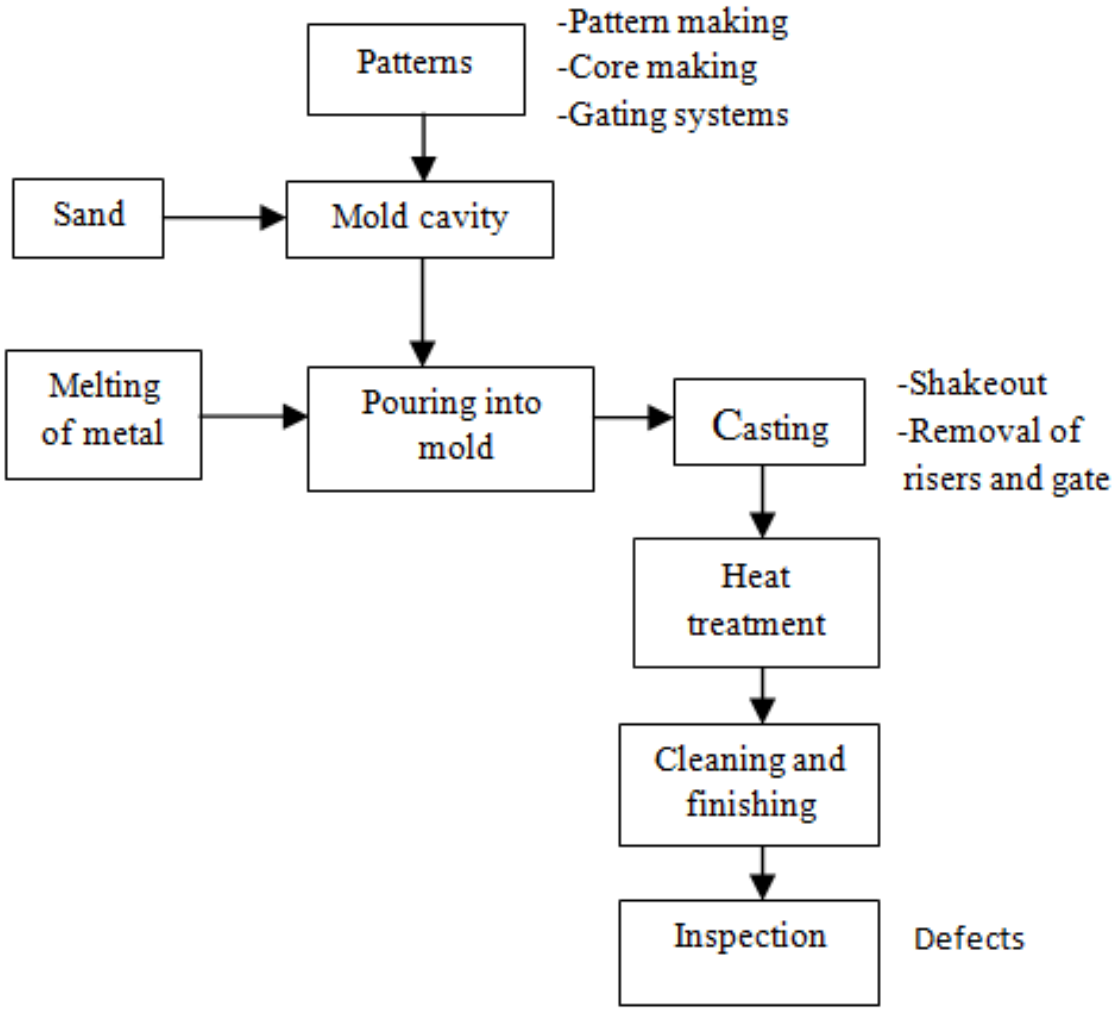
Sand Casting

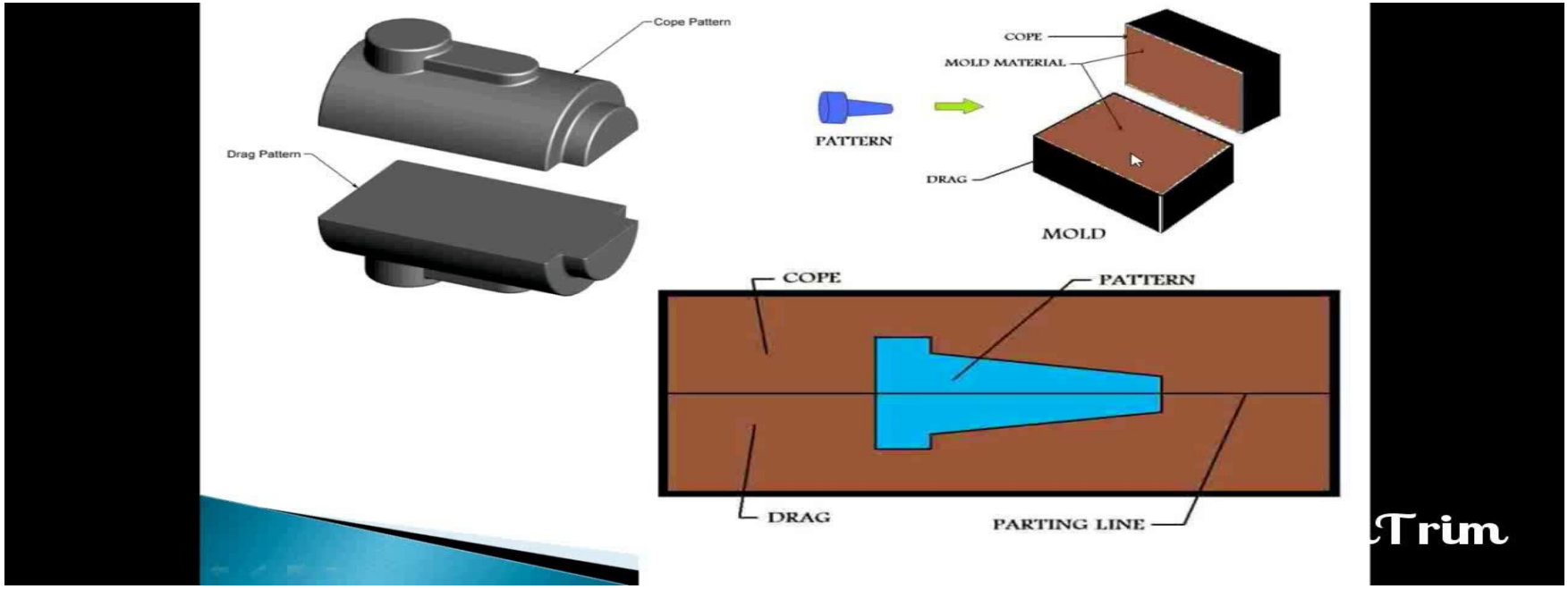
Definition

Casting is a process in which the liquid molten metal is poured into the casting cavity whose shape remains same as that of casting to be produced. Allowing to solidify and after solidification the casting will be taken out by breaking the mould.


AND GROW
CASTING
AND GROW
LADDLE
POURING CUP
CAVITY MADE BY PATTERN
RISER
COPE
SPRUE
CORE PRINT
LOCKING PINS
LOCKING PINS
RUNNER
GATE
SAND
DRAG
BOTTOM BOARD

Steps in Sand Casting





Pattern

Pattern is a replica of the casting to be produced. Replica means the shape of the pattern remains same as that of the casting to be produced.

Properties of pattern materials

- No or low moisture absorption
- Low density
- Good surface finish
- Easiness of fabrication
- Cheaper

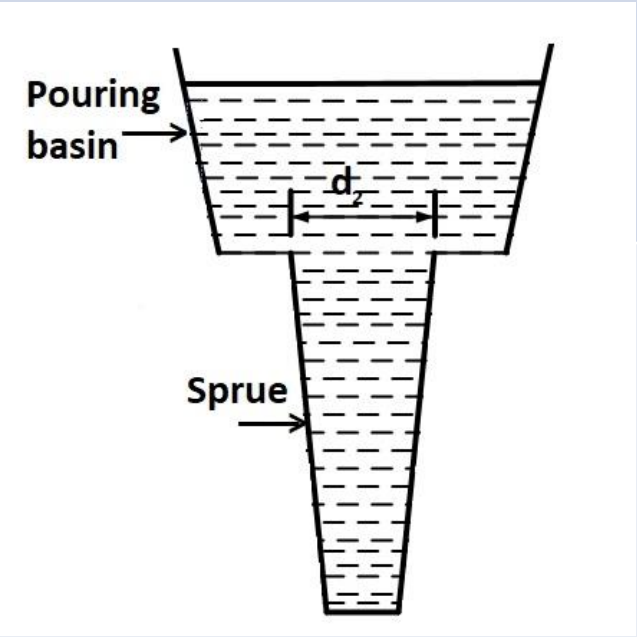
Materials used for making pattern

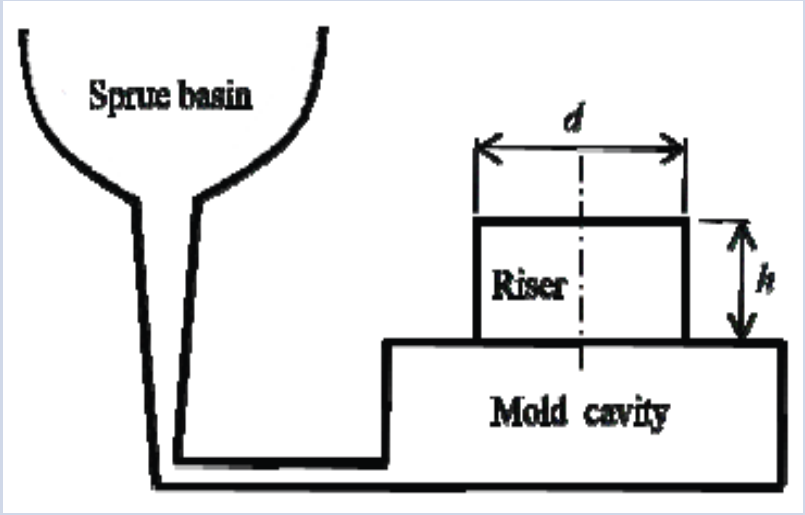
- Wood
- Metal
- Plastics
- Wax

Gating system

The passage of bringing the molten metal into the mould cavity is known as gating system. It consists of a pouring basin , sprue and gate

Part	Function
Pouring basin	Help to maintain the required rate of flow of molten metal into the mould cavity.
Sprue	Sprue is the vertical passage that passes through the cope and connects the pouring basin with the gate.
Gate	Gate is the passage through which molten metal flows through the sprue base to the mould cavity.



Part	Purpose
Riser 	Riser is the passage made in the cope to permit the molten metal flow after the mould cavity is filled up. If the molten metal does not appear in the riser, it indicates that mould cavity is not filled up completely. Riser also act as a reservoir and feed molten metal into the mould cavity to compensate for the solidification of shrinkage of castings.
Core	Core is the element used in the casting process for producing hollow cross sectioned castings. By placing the core inside the cavity the molten metal is filled into the cavity and allowing to solidify.

Properties of Moulding sand

Cohesiveness property : The ablity of formation of bond between same material particles. Should have sufficient sufficient cohesive strength.

Adhesive property : The ability of formation of the bond by the sand particles with other materials such as pattern, mould boxes etc. Should have sufficient adhesive strength.

Refractoriness : The ability of withstanding higher temperature without losing its strength and hardness is called refractoriness property.

Flowablity : The ablity of flowing of moulding sand into each and every corner of a mould box is called as flowablity.Porosity or Permeablity : The property that allows passage of gases through the mould is termed as porosity or perm,eablity. The moulding sand must be sufficiently porous to allow the gases and steam generated to escape.

Plasticity : The property of acquiring predetermined shape under pressure and to retain it when the pressure is removed is termed as plasticity. Moulding sand should have sufficient plasticity to get a good impression of the pattern.

Chemical stability : The property of sand to resist chemical reaction with molten metal is termed as chemical stability. A good moulding sand must have sufficient chemical stability to withstand chemical reaction so that the reusability of moulding sand is possible.

Sand casting

Advantages

- Complex shapes can be made
- Wider material choice
- Good design flexiblity

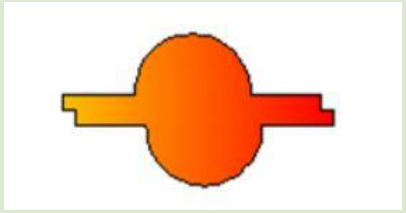
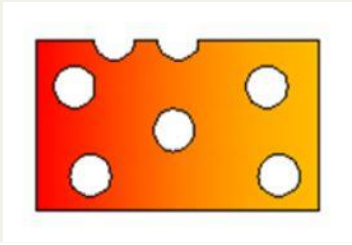
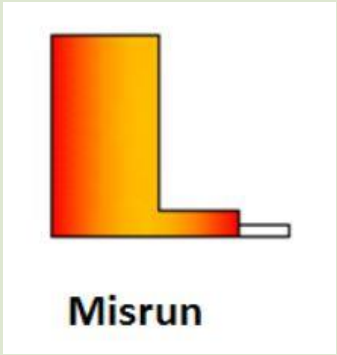
Disadvantages

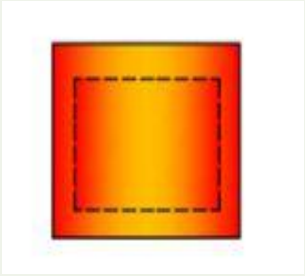
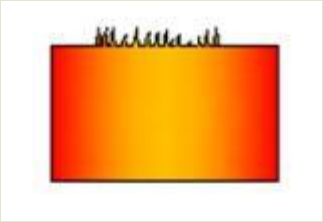
- It gives poor surface finish and so mostly require surface fininishing operations.
- Strength of casted components is less compared to forging.
- Casting defects involves

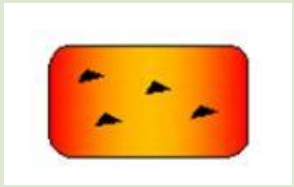
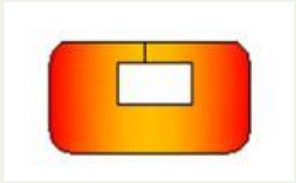
Applications

- Automobile parts
- Machine tools
- Heavy equipments

Casting Defects

Sl.No	Defect	Figure	Cause of Defect	Remedy
1	Shift or Mismatch		Due to mismatch present in the cavities of cope and drag box	Proper use of dowel pins
2	Blow hole (Air or gas bubble present inside the casting)		Low porosity propertyof moulding sand	Proper ramming
3	Misrun (Non filling of projected portion)		Solidification has been started before complete filling of molten metal	Reduce the pouring time, Increase the degree of superheat

Sl.No	Defect	Figure	Cause of Defect	Remedy
4	Shrinkage cavity or voids		Due to non availability of molten metal for compensating liquid shrinkages.	Eliminated by providing chills
5	Swell (Localized or overall enlargement of casting)		Caused by loose ramming of sand	Proper ramming of sand
6	Fins (Thin projection of metal, which is not a part of the required casting)		Improper clamping of mould boxes	Proper care in clamping

Sl.No	Defect	Figure	Cause of Defect	Remedy
7	Slag inclusion		Presence of foreign particles in the form of oxides, slag, dirt	Should be prevented from entering the cavity
8	Cold shut (Two streams of molten metal establish a physical contact between them, but fail to fuse together)		Due to low fluidity of molten metal	Increase degree of heat

For better understanding watch this video before proceeding to slides

https://www.youtube.com/watch?v=jF4F8Zr2YO8

Module 6

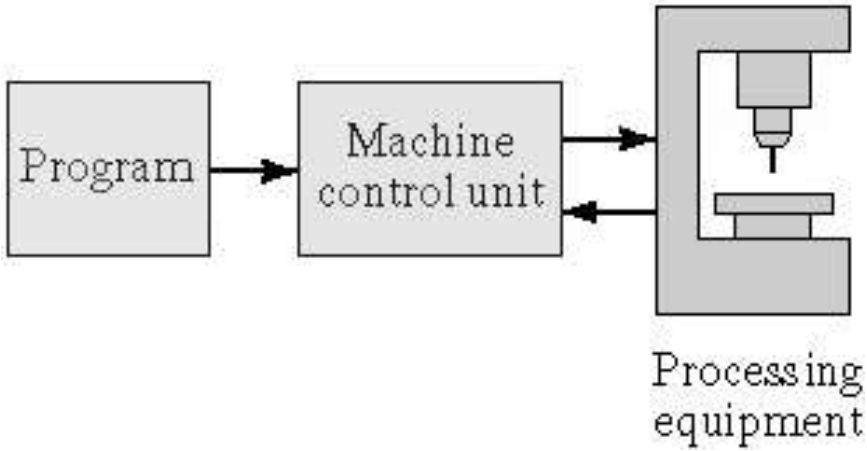
CNC

https://www.indiamart.com/proddetail/cnc-lathes-tl-20-machine-18718028433.html

About Numerical Control

Operation of machine tools using numerical data. It is a technique for automatically controlling machine tools, equipment or process. Numerical control can be defined as a **form of programmable automation in which the manufacturing process is controlled by numbers, letters and symbols. These are logically organized(NC program) to perform a specific task (say for example turning, drilling).**

Thus a numerically controlled machine tool is basically a machine tool where the operator is replaced by a NC program



Computer Numerical Control(CNC)

CNC is a NC system in which a dedicated computer is used to perform some or all the NC functions in accordance with control programs stored in the memory of the computer. Such a machine having a computer assigned to one particular task or a group of related tasks is known as Computer Numerical Control machine.

Application: Advanced industries where high rate of production is done, especially in automobile industry

Advantages

- Saving of job setting time and process time.
- Eliminate human error
- Increased consistency and quality
- Flexiblity(possiblity to incorporate changes by editting the program)

Disadvantages

- Programming skill required
- High initial cost
- Not economic for low production volumes

Module 6

CAD and CAM

https://www.youtube.com/watch?v=ETz67OUsXC0

Watch this video

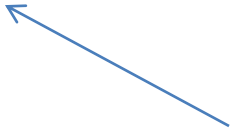
CAD (Computer Aided Design)

Use of computer systems to help in the creation, modification, analysis or optimization of a design problem. Computer system consist of hardware and software to perform a particular task.CAD is used by architects, engineers, drafters, artists, and others to create precision drawings or technical illustrations. CAD software can be used to create two-dimensional (2-D) drawings or three-dimensional (3-D) models.

Some CAD soft wares are following

- Auto CAD
- Solid works
- CATIA

https://www.youtube.com/watch?v=FdipJNG_vV8



Watch this video

CAM (Computer Aided Manufacturing)

Use of computer systems to plan, manage and control the operations of a manufacturing process.

CAM is used for :

- Higher speed of production
- Greater accuracy
- Greater consistency
- Greater efficiency

Some CAM softwares are following

- Solid CAM
- PowerMILL
- Work NC

Module 6

Rapid Manufacturing

https://www.indiamart.com/proddetail/cnc-lathes-tl-20-machine-18718028433.html

About Rapid Manufacturing

It is the use of software automation and related manufacturing equipments to rapidly accelerate the manufacturing processes. This is highly flexible and very cost effective than conventional manufacturing.

Advantages

- Don’t require a specific product tool.
- Any prototype model can be produced in a computer system. ie. Unlimited virtual freedom
- New products can be defined

Disadvantages

- Computer skill required
- High cost
- Economic for higher production volumes only

Rapid Prototyping

Also called Desktop manufacturing. Is a process by which a solid physical model of a part is made directly from a three dimensional CAD drawing.

WOW! Amazing 3D Printer | Artillery Sidewinder - YouTube

Watch above link for working of a 3D printer

Module 6

Additive Manufacturing

Additive Manufacturing

It is the Industrial production name for 3D printing. It is a computer controlled process in which three dimensional objects are formed by depositing layer by layer through fused deposition of work material.

Any Design can be done through computer software and the corresponding file is fed into 3D printer for obtaining required product.

Thermoplastic, biochemical materials are examples for work materials used.

Applications : Automotive components, Medical and Dental related components

Advantages

- Design flexiblity
- Complicated shapes
- No requirement of pattern as in casting for making a product

Disadvantages

- Limited material choice
- Costly equipment
- Skilled labour required

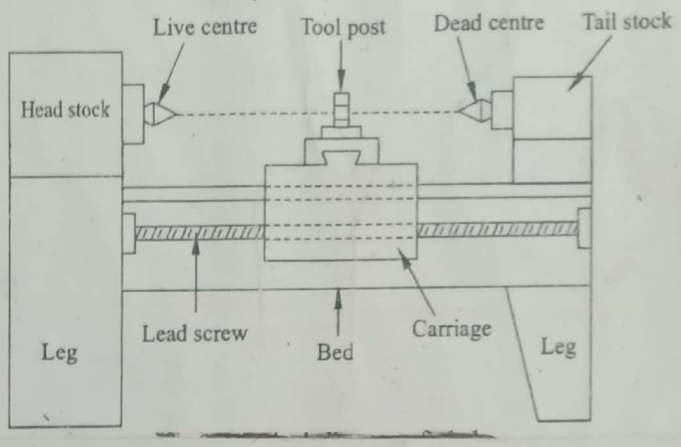
Reference

[1] Basic Mechanical Engineering by J. Benjamin

[2] Internet(*links attached*)

LATHE

Lathe machine is found in almost all workshops. And it is the most general purpose machine tool in which workpiece is held and rotated against suitable cutting tool for obtaining required surface.



Major components are

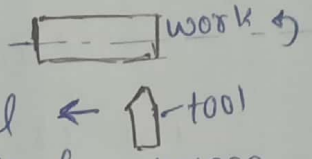
① Head stock
② Tail stock
③ Bed
④ Carriage
⑤ Lathe centres
⑥ Tool post
⑦ Lead screw
⑧ Feed mechanism

Component	Function
Bed	Head stock, tail stock, carriage and other components are mounted on the bed. It provides required strength and rigidity to the machine by forming a structure.

→ Head stock	- Mounted on the bed at the left end. It contains spindle for obtaining rotation, chuck for work holding and gear box for changing the speed as required.
→ Tail stock	- Mounted on the bed at the right end. It supports one end of the work piece. For performing operation like drilling and reaming in lathe drill bit, reaming tool are holded by tail stock part.
→ Carriage	- Support and action of cutting tool is served by carriage. It can be moved along the bedways provided at the top of the bed ⟷
→ Lathe centres	- Lathe centres are provided in the head stock and tail stock. Live centre ↓ Centre connected to head stock Dead centre ↓ Centre connected to tail stock
→ Tool post	- Mounted on carriage. It holds the cutting tool and enables the cutting tool to be adjust to @ requirements.

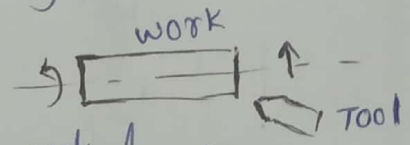
→ Lead screw	Long threaded shaft which is brought into action only when threads have to be cut on the workpiece.
→ Feed mechanism	The movement of tool relative to the workpiece is termed as feed. Three types of feed possible are:

1) Longitudional feed



- Tool is moved parallel to axis of rotation of workpiece
- Done for turning operation

2) Cross feed



- Tool is moved perpendicular to axis of rotation of workpiece
- Done for facing operation.

3) Angular feed

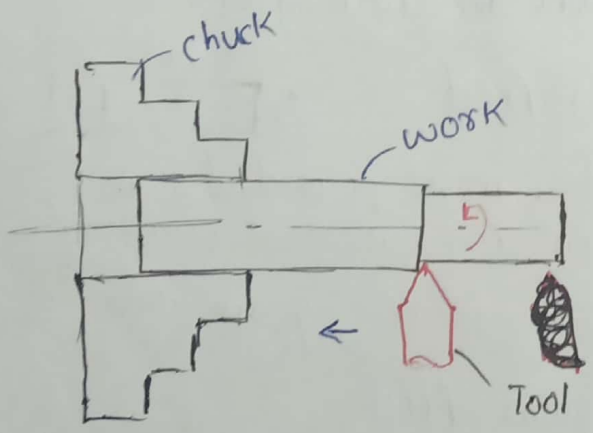
- when tool is moved at an angle to the axis of rotation of workpiece
- Done for taper turning

- Work holding device used in lathe is known as chuck.
- Operations that can be performed in lathe are Turning, Taper turning, Facing, Thread cutting, Drilling, Boring, Reaming, Grinding etc.

→ Turning

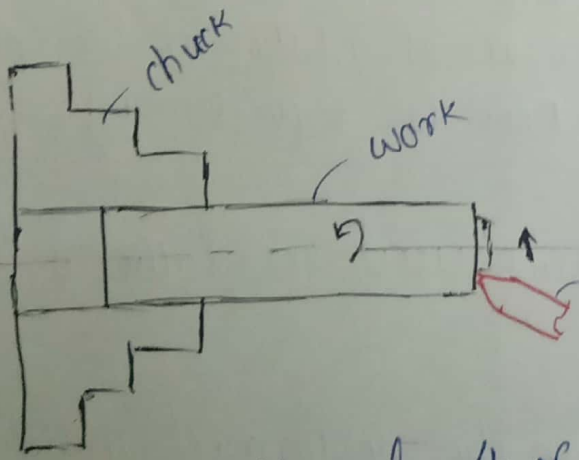
Turning is the removal of material from the periphery of a workpiece to obtain a cylindrical surface. It is the most common operation done in lathe.

In Turning operation workpiece is held in chuck. On receiving power from the spindle workpiece keeps rotating. During this time a sharp single point tool is fed into the workpiece either parallel or perpendicular to the axis of work.



If tool is moved parallel to the axis of rotation of the work then a cylindrical surface is produced as shown.

Here diameter of the work reduces.



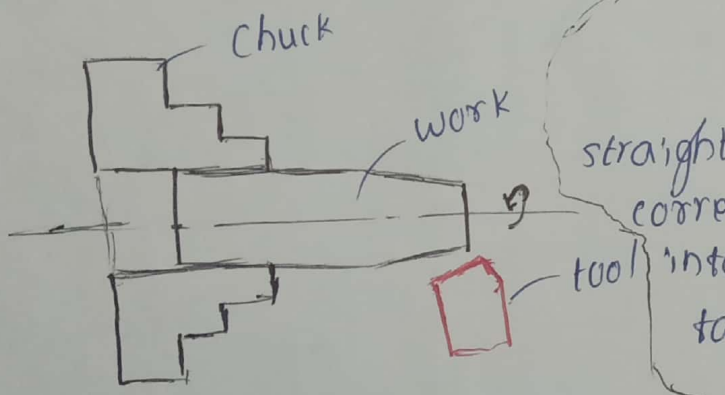
If tool is moved perpendicular to the axis of rotation of the work, then a flat surface is produced at the end of the workpiece.

Here length of workpiece get reduced. Also known as Facing operation.

→ Taper turning

Some machine elements and other parts are required to be turned with a taper. Taper turning means producing a conical surface by gradual reduction in diameter from a cylindrical workpiece. Following methods are used for taper turning.

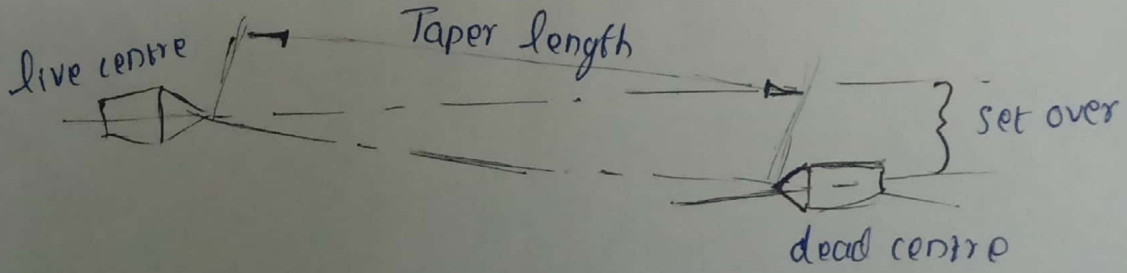
① Forming tool method



The tool having a ~~str~~ straight cutting edge is set at correct angle and is fed straight into work to generate the tapered surface. This method is limited to turn short external tapers only.

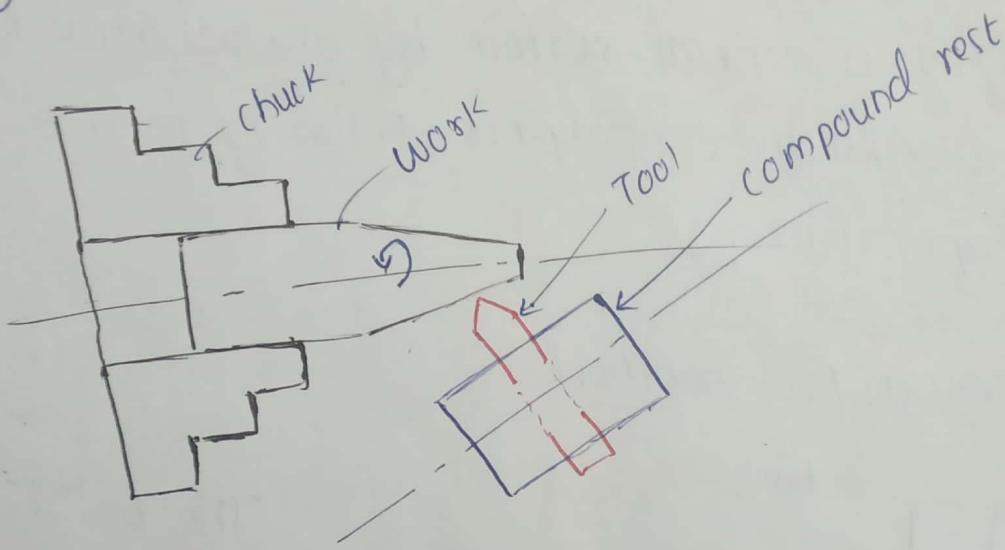
② Tailstock set over method

Shift the axis of rotation of the workpiece at an angle to the lathe axis and feeding the tool parallel to lathe axis. The tool will cut a taper on the work.



③ Compound rest method

By swiveling compound rest, it can be set at any desired angle



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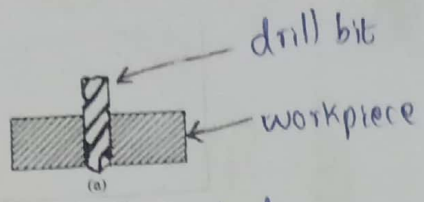
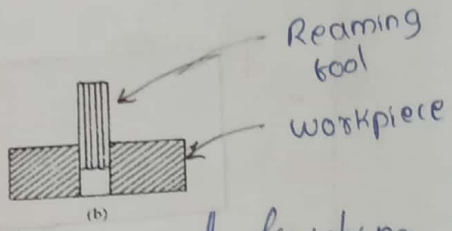
Drilling



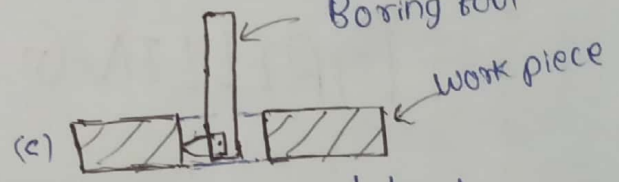
Operation of producing a circular hole using a drill by removing metal from the workpiece (fig (a))

If required following operations are followed after drilling operation.



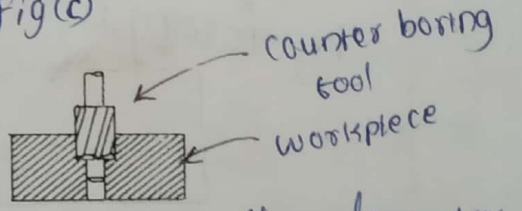
① Reaming

Reaming is the operation of sizing and finishing a hole by means of a reaming tool. It just follows a already drilled hole and remover a very small amount of metal. (fig (b))



② Boring

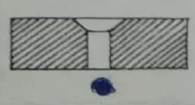
Boring is the operation of enlarging a hole by meany of an adjustable single point tool. fig(c)



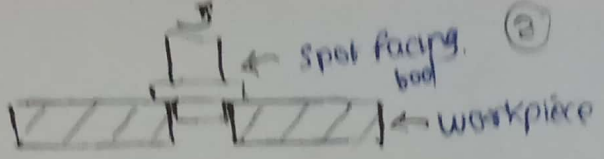
③ Counter boring

It is the operation of increasing the diameter of a hole for a certain distance down. It is done with a special cutter as shown in fig (d)

④ ~~Spot~~ Counter sinking

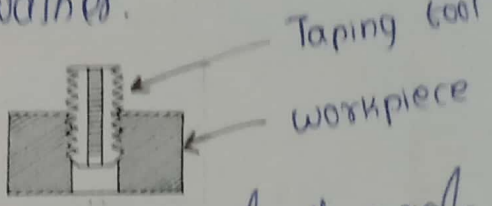


It is the operation by which a cone shaped enlargement is made at the end of a hole.



⑤ Spot facing

It is the operation of smoothening and squaring the surface around a hole drilled in a rough surface. It provides a flat seating for nut and washer.

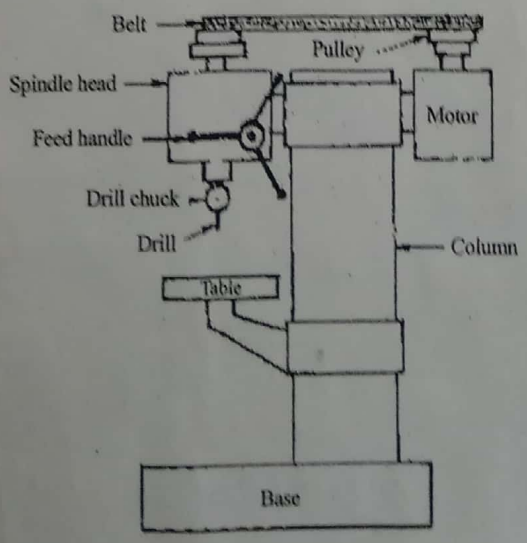


⑥ Taping

It is the operation of cutting internal threads by means of a tool called tap. Generally done to obtain internal threads to a drilled hole.

DRILLING MACHINE

working : Making holes in a fixed workpiece by forcing a rotating tool called drill against it.



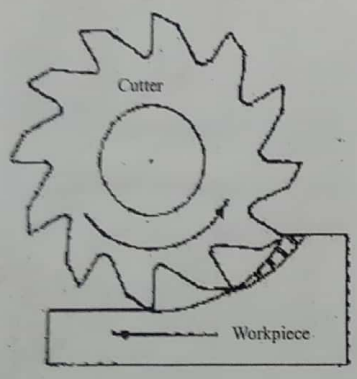
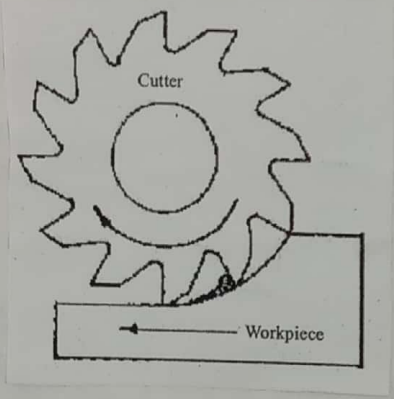
→ Principal parts of a drilling machine

	PART	FUNCTION
①	Base	Is a rectangular casting on which column is mounted.
②	Column	Vertical member of the machine which supports a table. The head supporting the motor and spindle is mounted on the top of the column.
③	Table	Work piece and work holding devices are supported by table. It can be moved [up] and [down] as well as various position in horizontal plane
④	Drill head	Mounted on the top of column and consist of spindle head and motor It houses drill holding and rotating device. A hand wheel is provided for upward and downward movement of the spindle A drill chuck is mounted in the spindle for holding the drill Spindle recieves power from motor, connected through belt pulley arrangement

Milling

Process of removing ~~the~~ metal by feeding the workpiece against a rotating multipoint cutter. As the cutter rotates, each cutting edge removes a small amount of material from the advancing workpiece for each rotation of the cutter. ~~The~~ Higher rate of material removal is possible.

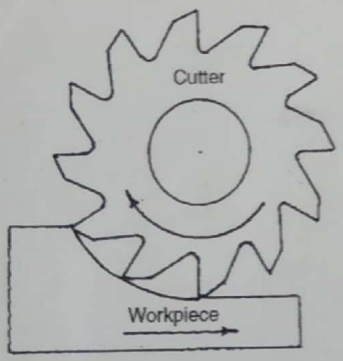
→ Based on the direction of cutter motion and work piece feed milling operation can be classified into

Upmilling	Down milling
- Also known as conventional milling	
	
- In Upmilling direction of rotation of milling cutter and feed of workpiece are in opposite direction	- Rotation of milling cutter and workpiece feed are in same direction.
- Chip thickness vary min at the begining to max at the end of operation	- Chip thickness vary max at the begining to min at the end of operation.

- Due to opposite direction tool will try lifting the workpiece, so strong workholding devices are required	- strong work holding devices are not required
- Poor surface finish	- Better surface finish

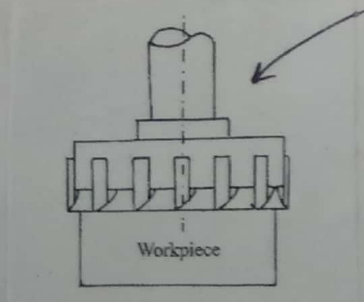
→ Various milling operations

① Slab or plain milling



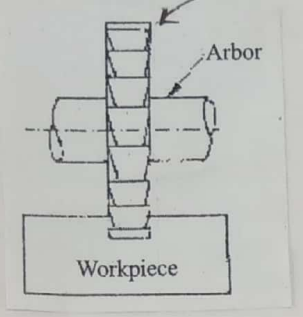
Process by which flat, horizontal surfaces parallel to the axis of cutter can be produced. Plain milling cutter is used as shown in figure.

② Face milling



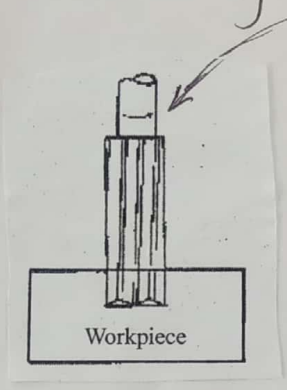
Process by which flat surfaces perpendicular to the axis of cutter is produced.

③ Side milling



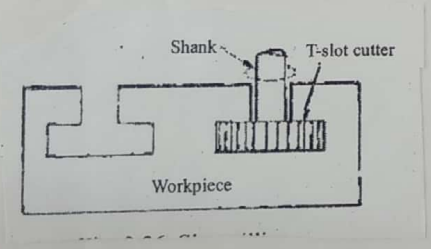
Process by which flat vertical face is produced at the side of a workpiece. Side milling cutter is used.

④ End milling



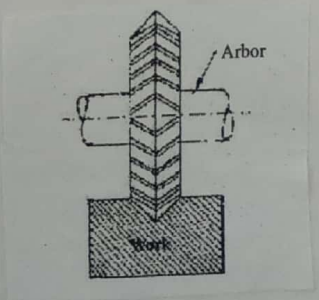
End milling is used for producing slots, Keyways etc using an end milling cutter. Here flat surface may vertical or horizontal.

⑤ T-slot milling



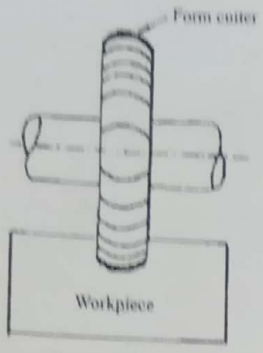
Here first a plain slot is cut on the workpiece using an endmilling cutter. Then T-slot cutter is fed from one end of the workpiece. The neck portion of the T-slot cutter passes through the already milled plain slot.

⑥ Angular milling



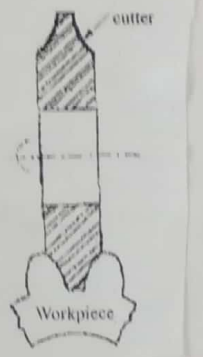
Here angular surfaces are produced using angular milling cutter.

⑦ Form milling



Milling process by which profiles on the workpiece are produced. Shape of form milling cutter corresponds to profile of the surface to be produced.

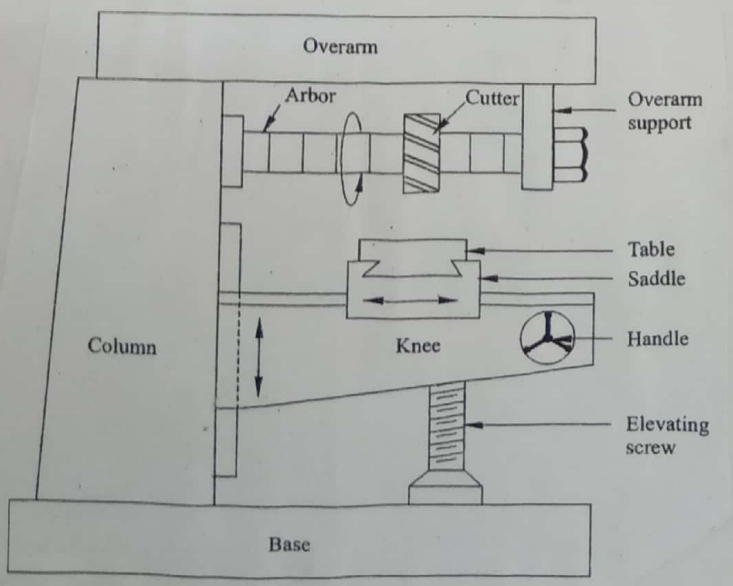
⑧ Gear cutting



Milling process by which gears are produced using form cutters. The profile of the cutter corresponds to tooth space of the gear.

→ MILLING MACHINE

Working: Removal of material (metal) by feeding the same to a rotating multi point cutter.



Principle parts of a Milling machine

Part	Function
① Base	Foundation member for all other parts of the milling machine. It provide required rigidity and strength
② Column	Main supporting frame mounted vertically on the base. The front face of the column has vertical guide ways.
③ Knee	Rigid casting that slides up and down ↕ on the vertical guideways on top surface. It supports the saddle and the table. The height of knee is adjusted through elevating screw.
④ Saddle	The saddle supports and carries the table. It is adjustable on the guideways of the knee.
⑤ Table	The table rests on guideways on the saddle and can be moved longitudionally. It supports and holds the workpiece.
⑥ Elevating screw	The height of the knee is adjusted by the elevating screw. It also supports the knee.
⑦ Spindle	The spindle obtain its power from the motor and transmits it to an arbor. The spindle has a tapered socket for inserting the arbor.

(8) Overarm	Mounted on top of the column. Overarm support is provided at the free end of overarm.
(9) Arbor	It is the rod on which cutter is mounted. It is tapered at one end to fit into the spindle. The other end of the arbor is mounted in a bearing provided in the overarm support.

WELDING

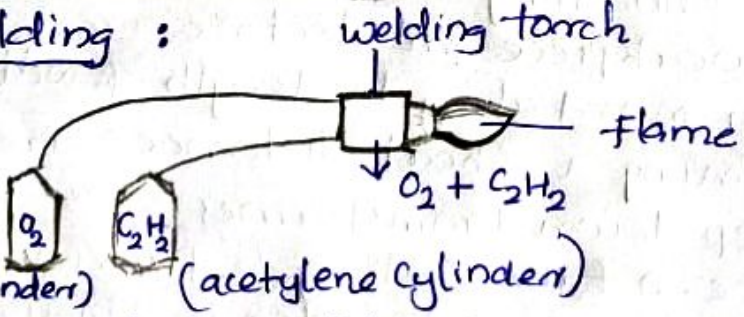
Welding is the process of joining metals by the aid of heat with or without application of pressure, with or without filler material. For the purpose of welding we make use of a welding machine. Welding provides excellent strength properties. Based on the source of heat used wedding can be classified as following.

Heat source

Electric	Gas fumes	Electric Resistance	Exothermic	Smith's hearth
• Arc welding	• Gas welding	• Resistance welding	• Thermit welding	• Forg welding

1. → Electric Arc Welding : Here, an electric arc is obtained by means of a stepdown transformer.
   eg: Arc welding

2. → Gas welding :



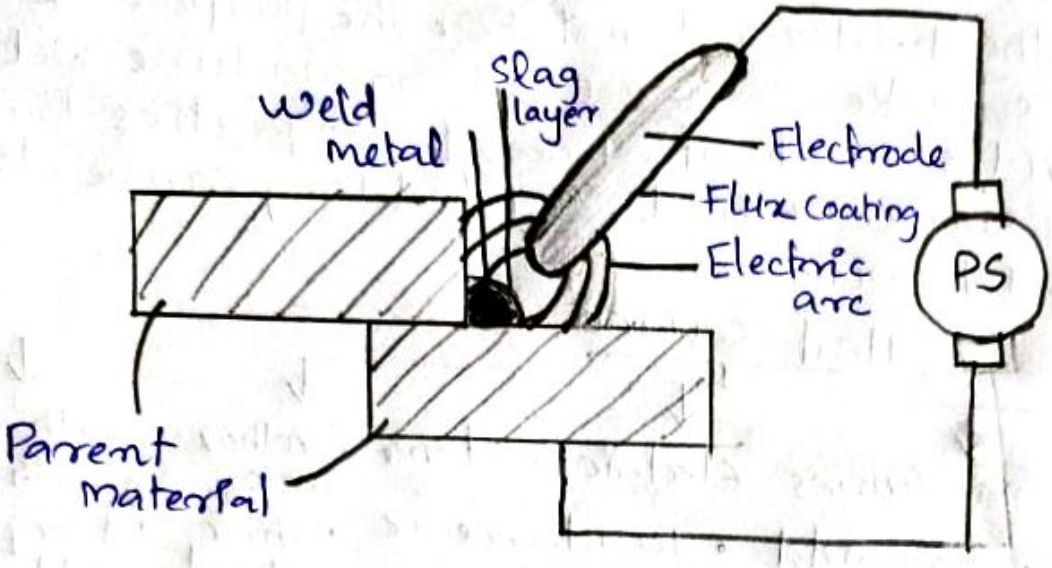
   eg: Oxyacetylene welding

3. → Electric Resistance : Here electric current is passed over the work piece to be joined. The Resistance at the mating portion results in generational heating ($H = I^2Rt$) After sufficient amount of Pressure is applied for obtaining the required weld. eg: Electric Resistance weld

4. → Exothermic : In welding like thermit weld, heat source is taken from the chemical reaction happening in a thermit mixture.

5. → Smith's hearth : welding can also be done by doing required forging operation eg: Forge welding

Arc Welding



Flux + Gangue → slag

An Arc welding essentially consist of workpiece, electrode, Electrode holder, Power house, earthing Mechanism and connecting cable. Here When the electrode touches the workpiece an electric arc is formed which is then moved along the length of weld required by maintaining a short distance (arc length). Usually a step down transformer is used as the Power source. A flux coating is provided over the electrode Surface Inorder to obtain a Sound weld (Flux coating provides a protective environment at the weld area by avoiding oxidation). And also avoiding impurities entering.)

APPLICATIONS:

→ Metal Fabrication

→ Repair work

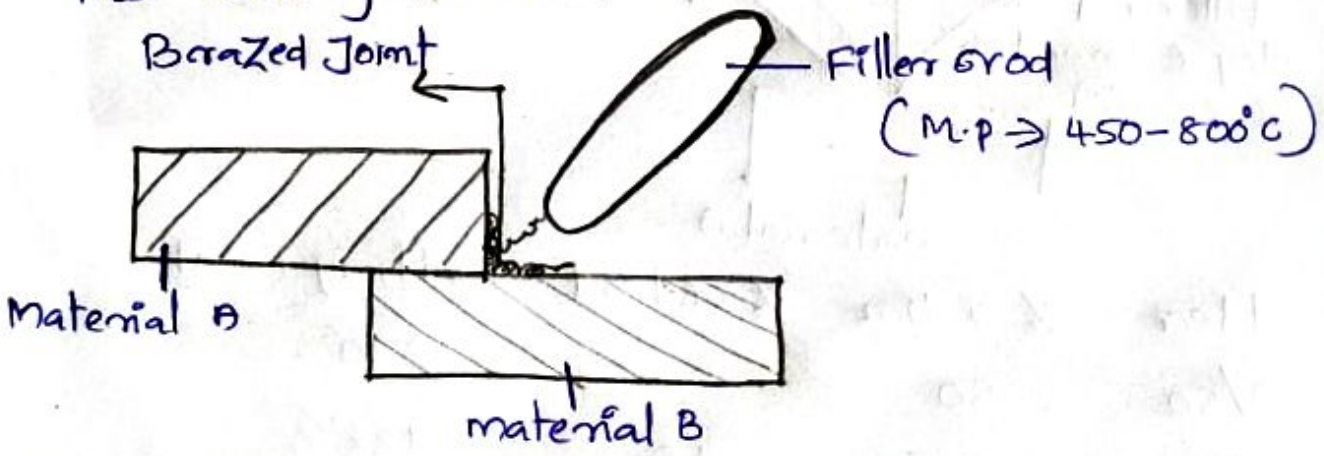
Brazing

Brazing is a metal joining process ideal for joining of dissimilar metals. Here the parent materials to be joined doesn't melt. A compac tible filler rod (Generally with melting point 450° - 800°) is used. For the purpose of necessary heating Induction method, Resistance method is are used.

A flux is used (Borax) for obtaining clean bra zed joint. Brazed joint are known for provi ding better leak proof joints also it will be having good electrical conductivity.

Applications:

Gas pipe joint, joining of cooling fins in engine. The melting point of filler rod will be less than the melting point of parent material.



★ [Mechanism of Joint Formation is surface ~~melting and alloy formation~~]

Welting and alloying

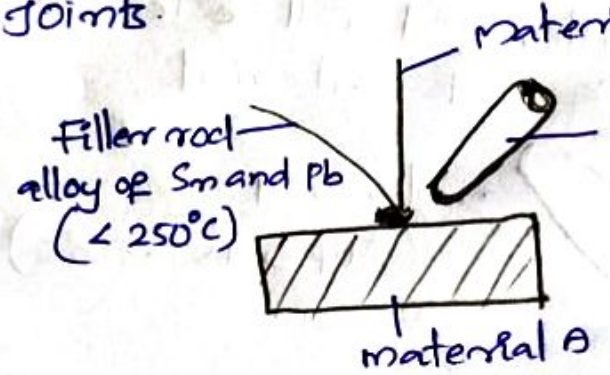
Soldering

It is generally done in electronic circuit joining works. It essentially consist of a soldering iron, filler material of M.P in range of less than 250°C usually fillering material is a alloy of ~~met~~ Tin and lead. A flux will be used to obtain clean solder ~~Rosin Light~~ (Rosin type)

A soldering iron is heated to red hot condition and is introduced at the point of required joint, filler material melts and a soldered joint is obtained. As in brazing, here also Parent material ~~will~~ won't be melting

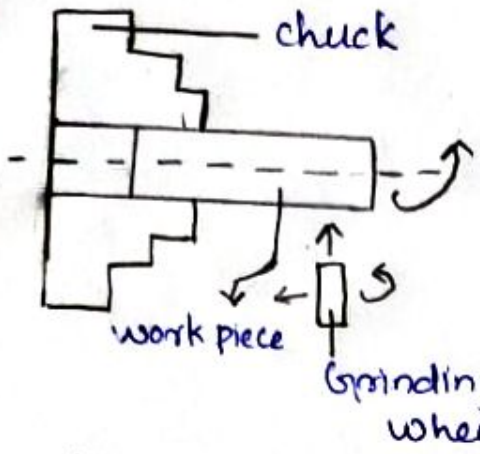
Application:

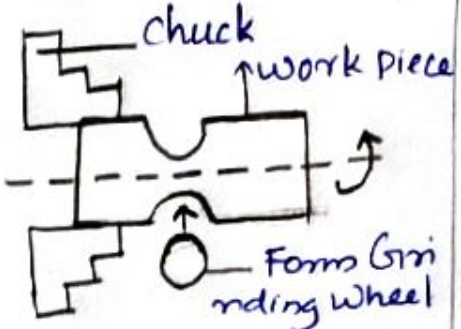
> Joining works in electronic circuits, wiring joints.



Solder	% of tin	% of lead	Melting Point
50/50	50	50	220°C
60/40	60	40	188°C
63/37	63	37	183°C

Grinding





*Surface Grinding.

*Form Grinding

*Cylindrical Grinding

Grinding is a machining process done inorder to obtain following requirments.

1. To obtain excellent surface finish
2. For sharpening of cutting tools
3. Two machine surface which are otherwise different to perform with other manufacturing operations.

In Grinding process, material removal will be in the order of micrometres. Grinding operation essentially consist of an abbresive wheel (large no of tiny and small abbressive particle are held together in the form of a wheel.