(Part-A + Part B)
12.5 + 12.5

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04/01/2017 Assignment + Attendance

PART-B. (Production and Manufacturing)

Theory + Diagram (Must) + No Stories !!.

① Manufacturing Technology (P.N Rao)
② Workshop Practice → Hajra chaudhary.

Engineering Materials.

The substance which are useful in the field of engineering are called Engineering materials. A particular material is selected on the basis of following consideration:

(I) Properties of materials: (a) Mechanical properties: Strength, ductility, toughness, hardness.
(B) Physical properties: Density, specific heat & melting point.
(c) Chemical properties: Oxidation & corrosion.

(II) Cost Of Material (III) Availability of material

CLASSIFICATION OF ENGINEERING MATERIALS

- (I) Metals
  - Ferrous: iron, steel, cast iron
  - Non-ferrous: Aluminium, Lead, Tin, Nickel, copper
- (II) Polymers
  - Thermo plastic: Polyethene, Polypropylene, Polystyrene, PVC, Acrylic
  - Thermo setting: Bakelite, Epoxy
- (III) Ceramics
  - Glass, Alumina, Silica, Boron
- (IV) Composite material
  - PMC, MMC, CMC.
  - Metal matrix composite
  - Ceramic matrix.
- (V) Advanced material

Metals: These ~~met~~ materials are composed of one or more metallic elements such as iron, copper, titanium. Atoms in metals are arranged in a very orderly manner. Ferrous metal contain iron as their main constituent.

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Eg: steel, cast iron

② Non-Ferrous : It is made up of elements other than iron. Eg. Copper, Aluminium, Zinc, Lead

Q. What is difference b/w cast iron and steel.

(I) Cast Iron

① It finds large applications in industry because of ease of availability and good casting properties along with wide range of other desirable mechanical properties and cheap cost.

② Cast iron is produced in Cupola furnace. This is usable form of iron and it is produced by slow cooling of remelted pig iron.

③ There are different types of cast iron such as grey cast iron, white cast iron, malleable cast iron and alloy cast iron.

④ COMPOSITION OF CAST IRON : i) Carbon : It varies from 2 to 5%. The Carbon maybe available as free graphite or iron carbide. Carbon gives strength and hardness to cast iron and also carbon imparts good properties such as fluidity, high damping capacity and good machineability.

ii) Silicon : It varies from 1 – 3.5%. It softens the cast iron and keeps it in graphitic condition. It increases the availability of free (flakes) carbon and hence provide the fluidity to cast iron in molten state.

iii) Manganese : It varies from 0.5 to 1%. Presence of manganese helps to retain carbon in iron carbide form. This hardens the cast iron and also increases its wear resistance.

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iv) Phosphorus : It is present upto 1%. It imparts fluidity to the molten cast iron.

v) Sulphur : It is present in small quantity and varies from 0.02 to 0.15% and it makes cast iron hard and brittle.

Properties : ① Hard & Brittle.
② Low tensile strength.
③ Very good compressive strength
④ Very good vibrational and damping characteristics
⑤ It has good machinibility.

Applications : ① Machine frames and machine bed. (Cast iron absorbs high vibrations)
② ~~Cylinder~~ Automobile engine.

Types of Cast Iron → Grey, white, malleable, ductile, alloy.

*(Point where fractured appears grey/white inside)

① [Grey Cast Iron] ~~Slow cooling~~
① It is obtained by slow cooling of molten metal after it is melted in cupola furnace.
② Its composition : Carbon – 2.5 – 4%. Silicon – 1 to 3%. Phosphorus – 0.15 to 1%. It is named after grey as when fractured it appears grey inside due to presence of free graphite, dispersion of graphite accounts two important properties :
① Good vibration and damping characteristics.
② Internal lubricating qualities.
③ Applications : ① Machine bed & columns
② Engine cylinder block
③ Gear and pump housing.

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② # White cast Iron

When % age of silicon in cast iron is very low most of carbon in metal is in chemically combined form. When fractured surface has a white-crystalline appearance. The resulting cast iron is known as white cast iron. It is formed by more rapid cooling of molten carbon. In carbon percentage 1.75-3.0 0.85-1.5% silicon. The unique properties of white cast iron :

i) It has low fluidity and hence not suitable for general foundry work.

ii) It has good strength and corrosion resistance.

Applications

1. Railway break block.
2. Crushing Roller

③ # Malleable Cast Iron

It is obtained by giving long time heat treatment to white cast iron. The process involves heating white cast iron to 870°C keeping at this temperature for 25-60 hours depending on the size of casting and then cooling slowly. The resultant cast structure obtained is very ductile and has a very good impact resistance & can easily machine.

Application

1. Automobile and agriculture component
2. Gears housing and spanner
   ↳ like for opening bolts of tyre

④ # Ductile Cast Iron

It is obtained by controlling the composition of the

[Doubt?]

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① metal and also by adding magnesia in the molten metal. This addition results in transforming the graphite to condense in spheroide. This enhanance the strength carbon percentage (3.2 to 4.5 %) and silicon 1 to 4%. ②

Applications

i) Gear and pension (to shutter up)
ii) Camshaft (inside car).

5# Alloy Cast Iron

Normally cast iron is brittle and hard with good compressive strength. To impart other desirable properties to cast iron various alloying elements are added in different proportion to enhance properties common alloying elements are nicked, copper, molybdenum, vanidium, chromium. ③

Effect of alloying elements on Cast Iron

i) Nickel → This is usually added upto 5%. This improves machinability, hardness and corrosion resistance.
ii) Chromium → It is added upto 3%. It improves hardness, corrosion resistance, bear resistance and tensile strength.
iii) Molybdenum → It is added upto 1.5%. It improves strength and bear resistance but machinibility is decreased. It increases toughness.
iv) Vanadium → It is added upto 0.5% only. It increases strength and hardness.
v) Copper → It is added upto 2-2.5% and it improves corrosion resistance.

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(II) #

Steel.

Steel is the combination of (iron and carbon with varying quantities of phosphorus and sulphur) It has (carbon content upto 2%. As carbon content go up the tensile strength of steel increases.) Most of the steel produced now a days is plane carbon steel or simply carbon steel. Plane carbon steel have ~~co~~ carbon content varying from 0.05 – 1.6%.

Types of steel

1. Low carbon or mild steel (MS).
   Carbon less than 0.2%.

   Application
   i) Automobile sheet metal parts
   ii) Bridge component and boiler parts.

2. Medium carbon steel
   Carbon content 0.2 – 0.5%.

   Applications
   Engine parts, crank shaft & ~~conne~~ connecting rod.

3. High carbon steel
   Carbon greater than 0.5% (0.5 – 2%)
   For high strength application where high hardness is required.

19/01/2017 4. Stainless Steel
   A group of (highly alloyed steel design to provide high corrosion ~~resistan~~ resistance.) Principal alloying

element in stainless steel is chromium usually above 15%. This steel shows strength, toughness and corrosion resistance much superior to other metals in a very wide range of temperature.

5. Tool steel

Tool steel is used for making cutting tools used for machining of metals. It retains their strength, shape and hardness at high temperature. They must have high strength, hot hardness and bear resistance.

NON-FERROUS METALS

Aluminium and Its Alloy

The important factor in selecting Aluminium and its alloys are these high strength to weight ratio, resistance to corrosion by many chemicals, high thermal and electrical conductivity and ease of formability and machinability. They are also non-magnetic.

Principal use of Al and its alloys are containers and packaging, buildings and other types of construction, transportation (aerospace application and automobile application).

Copper and Its Alloys

Have properties somewhat similar to that of Aluminium alloys. In addition, they are among the best conductors of electricity and heat and have good corrosion resistance. Because of these properties, Copper and its alloys are among the important metals. They can be processed easily by various forming, machining, casting and joining techniques. Copper alloys are often attractive for application where combined properties

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Such as electrical, mechanical, non-magnetic, corrosion resistance, thermal conductivity and wear resistance are required.

Most ~~some~~ common Cu alloys are Bronze (Cu+Sn), Brass (Cu+Zn)

II POLYMERS

Polymers are rubber and plastics. They are organic compounds that are chemically based on Carbon, Hydrogen and other non-metallic elements.
(Eg. PVC, Teflon, nylon-6,6).

① Thermoplastics : They soften when heated and become hard when cooled. The process can be repeated many times. Eg. PVC, Polyethylene, teflon.

$-(CF_2-CF_2)_n-$

② Thermosetting : Once shaped cannot be recycled. Upon heating they get burnt but do not melt. Eg. Bakelite, Melamine, Epoxy.

III CERAMIC

Whatever is not a metal or non-metal and organic polymer is called a ceramic. The properties of ceramic are : ① They are extremely brittle.
② High thermal stability.
③ High chemical stability.
④ High hardness
Eg. Silica and Alumina are most important ceramics

IV COMPOSITE MATERIAL

① Made to take advantage of diff. properties of metals, polymers and ceramics. These ~~metals~~ materials are

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manufactured by the combination of two or more materials. In composite material there is a matrix and reinforcing material. They are generally classified according to the types of matrix or the orientation of fibre. There categories

i) Polymer Matrix Composite : When an organic polymer like epoxy is used as matrix material, the composite is called polymer matrix composite. In this category, two most important composite are glass fibre reinforced plastic (GFRP), Carbon Fibre reinforced Plastic (CFRP)

ii) Ceramic Matrix Composite : They consist of ceramic fibre embedded in a ceramic matrix thus forming a ceramic fibre reinforced material. It include silicon carbide fibre fixed in a matrix made from a glass.

iii) Metal Matrix Composite : In this composite, there is a matrix of any ductile material. Eg. Aluminium, Magnesium, Titanium mixed with silicon carbide, Boron carbide and Alumina.

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02/02/2017 (4 topics).

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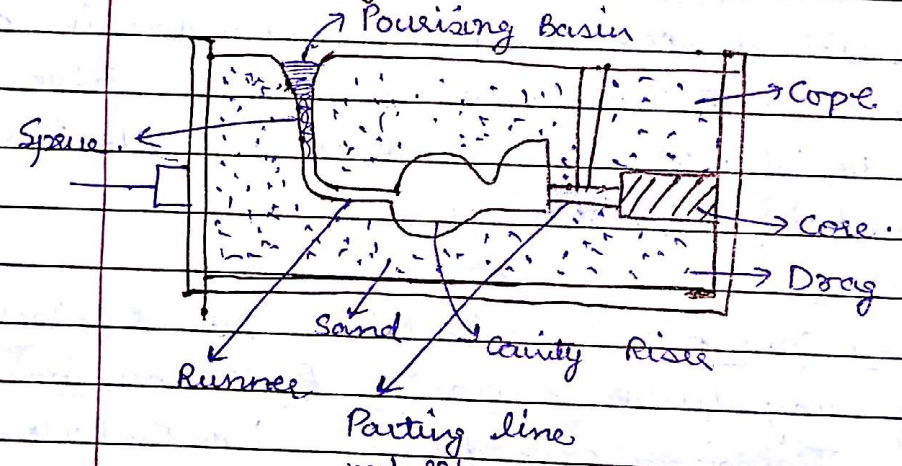
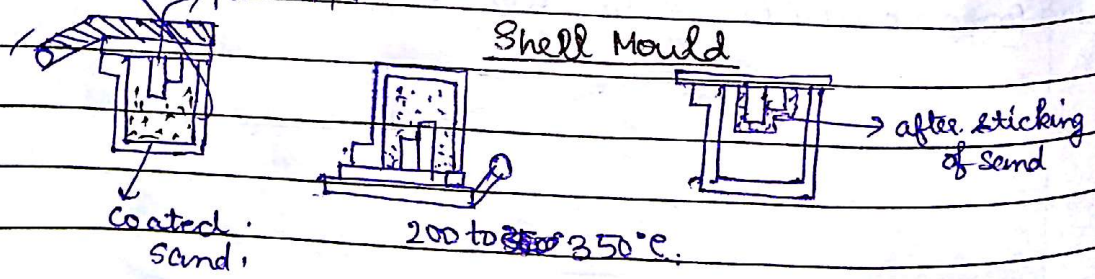
Classification Of Casting

- Temporary/(Expendable) Mould.
  - Sand casting
  - Shell mould
  - Investment mould
- Permanent mould
  - Centrifugal
    - True centrifugal
    - Semi centrifugal
    - Centrifugal
  - Die casting
    - Hot chamber die casting
    - Cold chamber die casting
  - Slush casting

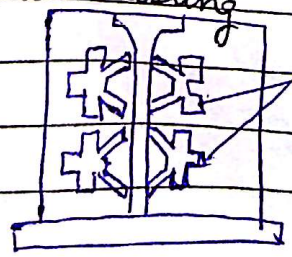
① Sand Casting



② Shell Mould



③ Investment Casting



→ pattern (wax pattern)

further ceramic content is added.

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① **Sand Casting** : (a) Moulding which is carried out in green sand, i.e ~~the~~ when pouring is done in the sand mould with the sand in its green or natural state is known as green sand moulding.

(b) First a green sand mixture is prepared consisting of silica sand (70-85%) clay (10-15%), then moisture (3-6%) and additives (1-3%)

↳ Sawdust, Aluminium oxide

② **Shell Moulding** : Process in which sand mixes with thermosetting resin is allowed to ~~solidify~~ come into contact with a heated metallic pattern so that a thin and strong ~~cell~~ shell of mould is formed around the pattern. Then the ~~cell~~ shell is removed from the pattern and cope and drag are removed together. So that a thin and strong shell of mould is formed around the metallic pattern. The metallic pattern plate is ~~heated~~ heated to a temperature of 200 – 350 °C depending on the types of pattern.

→ Used for complex patterns.

③ **Investment Casting** : It is a manufacturing process in which a wax pattern is coated with a refractory ceramic material. Once the ceramic material is hardened, its internal geometry take the shape of casting. The wax is melted out and molten metal is poured into the ~~cavity~~ cavity.

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Advantages : ① Complex shapes which are difficult to produce by any other method.

② Very fine and thin section can be produced by this process.

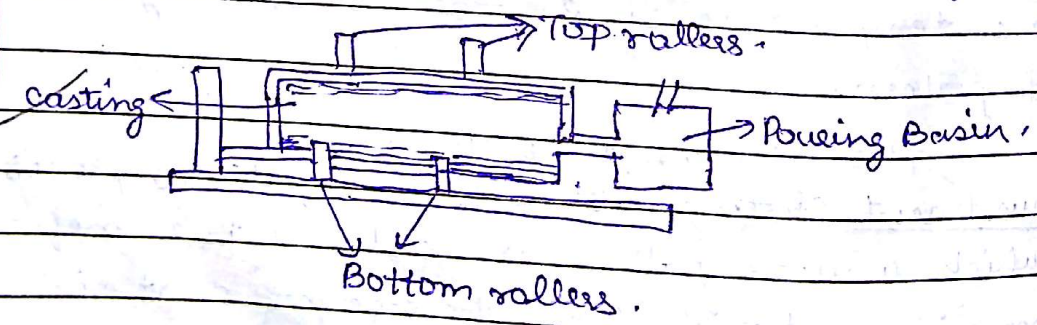
③ Very close tolerance and better surface finish can be produced.

(Jewellery and surgical instruments).

II PERMANENT MOULD.

① Centrifugal : This is the process where the mould is rotated rapidly about its central axes as the metal is poured into it because of the centrifugal ~~force~~ force a continous pressure will be acting on ~~the~~ the metal as it solidifies. There are three main types of centrifugal casting process :

i) True Centrifug casting : This is normally used for making of hollow pipes and tubes which are ~~axis~~ axis symmetric with ~~co~~ concentric holes since the metal is always pushed outwards because of the centrifugal force. The axis of rotation can be either horizontal or vertical or slanting angular. Very large pipes are normally cast with horizontal ~~co~~ axis whereas short pipes are more conveniently cast with a vertical axis.



Imp: Here no core is used to make hollow cylindrical casting unlike sand casting.

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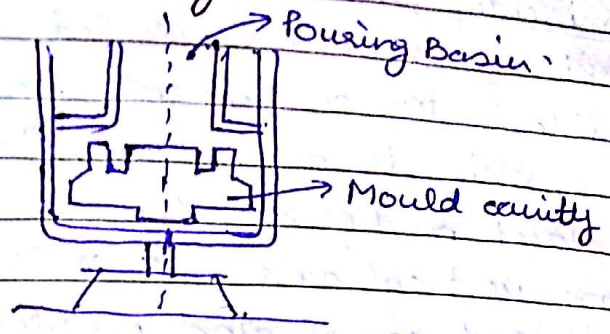
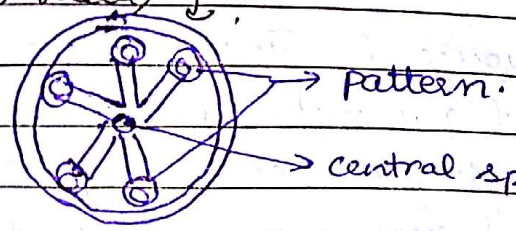
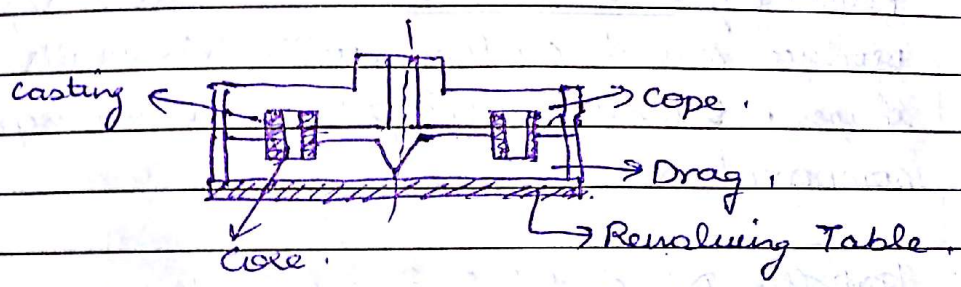
(b) Semi centrifugal casting



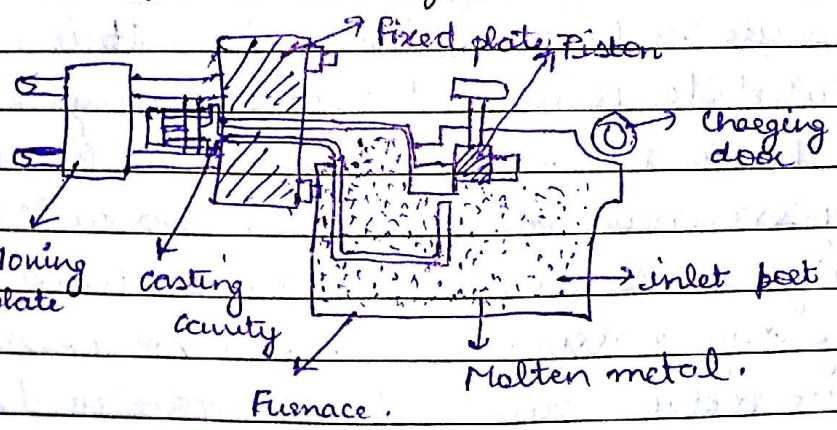
(c) Centrifuging (Top view)



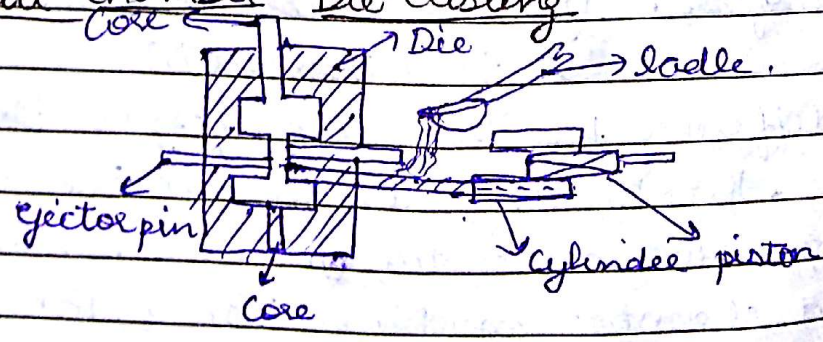


Hot Chamber Die Casting (Furnace is an integral part of chamber)

(a)



(b) Cold Chamber Die Casting



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by, to, for, into word — word

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(ii) Semi centrifugal casting: is used for the component which are more complicated than those not possible in true centrifugal casting but are axis symmetric in nature. In this process mould is placed on horizontal plane and it is rotated along vertical axis. It is used for short pipes and complicated profiles.

(iii) Centrifuging: This process is used in order to obtain higher metal pressure during solidification when casting shapes are not axis symmetrical. The centrifuging process is used.
Relatively low rotational speed are required to produce sound casting with thin walls and intricate shapes. Used for irregular and non-symmetrical components.

(2) (iv) Die casting: Involves the preparation of components by injecting molten metal at higher pressure into a metallic die. It is closely related to permanent mould casting. In die casting as the metal is forced in under pressure compared to permanent mould, it is also called pressure die casting. Because of high pressure involved in die casting any narrow section, complex shapes and fine surface details can easily be produced. Such machines are of two types: i) Hot Chamber D.C.
ii) Cold Chamber DC.
Main difference b/w these two types is that in hot chamber, the holding furnace for the liquid metal is integral with die casting machine whereas the cold chamber machine. The metal is melted

Melting unit is in the machine itself That is why it is called Hot Chamber DC.

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in a separate furnace and then poured into die casting machine with a ladle for each casting cycle.

The hot chamber process is used for most of low melting temperatures material such as Zinc, Lead & Tin.

(2) Cold Chamber Die Casting : In this machine, the metal is melted separately furnace. and transferred to these by means of small hand laddle. After closing the die, the molten metal is forced into die cavity by a hydraulic operated plunger (piston). and pressure is maintained till solidification. These machines are widely used for casting aluminium alloys.

(3) Slush Casting : This method has special application of permanent mould casting in which hollow cast are produced without the use of core. In this method the molten metal is poured into metallic mould and allowed to solidify upto the required thickness.

Normally small thickness casting of lead, zinc, low melting point material are used.

FORMING PROCESS.

It may use of stresses like tension, shear and combined stresses to plastic deformation of the material to produce desired shape.

In forming no material is removed they are deformed and displaced

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Pattern : Pattern is a replica of casting required has same shape & size to the final product and is placed in suitable sand for mould formation.

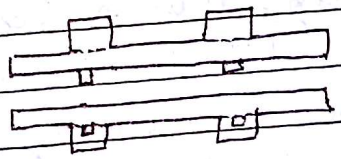
Pattern materials : Wood, Plaster of Paris, Metals, Plastics, and Wax.

cheap, light, easily available.

Types of Pattern

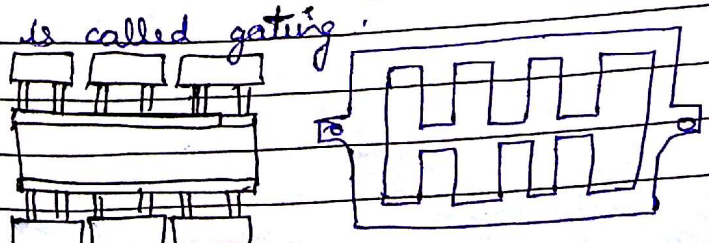
① Single Piece Pattern : It is used for very simple and large casting.
If Patterns are made without joint ~~etc~~. then called single piece pattern

② Split Pattern : It is used when complexity of parts is more and withdrawal of pattern is difficult.
Sometimes patterns cannot be made in single piece. because of difficulties encountered in moulding or difficulty in withdrawal from the mould, so split piece pattern is used



③ Gated Pattern : It is used when small component in mass production is required. To produce good casting it is necessary to ensure full supply of molten metal flow into every part of the mould.
Provision for easy passage of flowing metal in the mould is called gating.

Gated Pattern



→ Match Plate Pattern.

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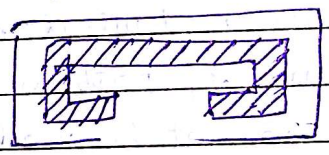
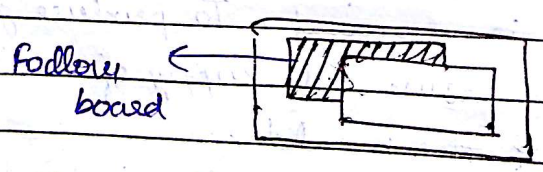
④ Match Plate Pattern : It is used for production of small size casting in mass production. like piston ring.

Advantages : ⓐ mass production
ⓑ greater dimensional accuracy
ⓒ Minimum machining requirement

⑤ Loose Piece Pattern : It is used when parts with internal web. ~~Parts with internal webs or~~ Withdrawal of pattern is difficult from the mould in order to overcome this we will make the pattern in form of loose pieces so that we can easily withdraw the pattern in form of loose piece.



⑥ Follow Board Pattern : Used when thin or overhanging section in casting is required.
During ramming, thin section or overhanging section of pattern are distorted because of the ramming force which is applied in moulding process.
To support such structures, follow board is used which may fit inside the pattern.



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