Q. What considerations are necessary while designing a pattern?

ANSWER:

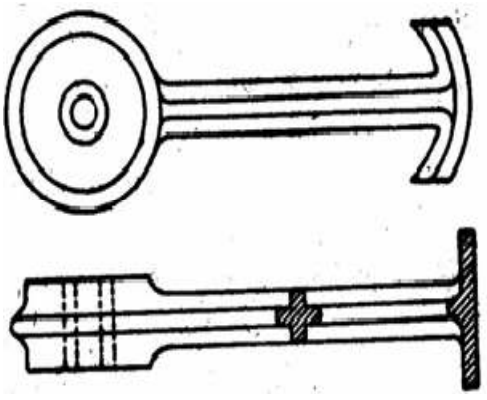
The following points should be considered, while designing a pattern:

1. Proper allowances should be provided, wherever necessary.
2. The parting line should be carefully selected so as to allow as small portion of the pattern in the cope as possible.
3. An endeavor should always be made to employ full cores instead of jointed half cores as far as possible. This will reduce cost and ensure greater dimensional accuracy.
4. The wall thickness and sections should be kept as uniform as possible. Abrupt changes should invariably be avoided.
5. The use of offset parting, instead of cores, should be encouraged to as great an extent as it is possible.
6. For large-scale production of small castings, the use of gated or match-plate patterns should be encouraged wherever the existing facilities permit.
7. All sharp corners and edges should be invariably provided with suitable fillets or otherwise rounded to enable an easy withdrawal of pattern, smooth flow of molten metal and ensure a sound casting.
8. All those surfaces of the casting which are specifically required to be perfectly sound and clean should be so designed that they will be molded in the drag.
9. The pattern should be given a high-class surface finish as it directly effects the corresponding finish of the casting.
10. If gates, runners and risers are attached to the pattern, they should be properly located and their sudden contraction or enlargement should be avoided.
11. Shape and size of the casting and that of the core should be carefully considered to decide the size and location of the core prints.

Q. shortly explain the following: (1) Segmental patterns (2) Core prints

Answer

(1) Segmental patterns:-These patterns are used for preparing moulds of large circular castings, avoiding the use of a solid pattern of the exact size. In principle they work like a sweep, but the difference is that a sweep is given a continuous revolving motion to generate the desired shape, whereas a segmental pattern is a portion of the solid pattern itself and the mould is prepared in parts by it. It is mounted on a central pivot and after preparing the part mould in one position, the segment is moved to the next position. The operation is repeated till the complete mould is ready. A typical example is shown in Figure.



(2) Core prints :
When a casting is required to have a hole, through or blind, a core is used in the mould to produce the same. This core has to be properly seated in the mould on formed impressions in the sand. To form these impressions, extra projections are added on the pattern surface at proper places. These projections are known as core prints.

Q. Write a short notes on following casting defects.
(1) Metal penetration
(2) Warpage

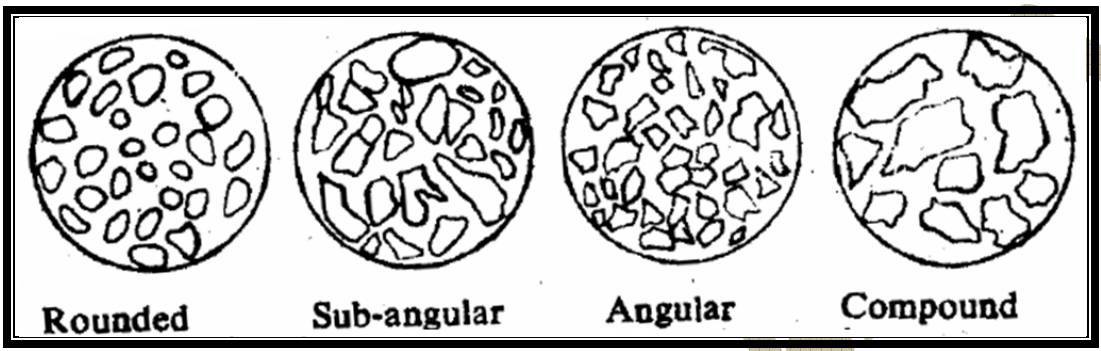
Ans.: (1) Metal penetration:
This defect occurs as a rough and uneven external surface on the casting. It takes place when the molten metal enters into the spaces between the sand grains and holds some of the sand tightly with it even after fettling. The principal causes for the promotion of this defect are the use of coarse sand, having high permeability and low strength, and soft ramming. Use of fine sand with low permeability and hard ramming will minimise this defect.
(2) Warpage:
It is an undesirable deformation in the casting, which may occur during or after solidification. The deformation takes place due to the internal stresses developed in the casting due to differential solidification in different sections. Such stresses are also developed and differential solidification occurs in case of castings having very large and wide flat surfaces. Both the causes can be attributed to faulty design of the casting, which needs modification to ensure proper directional solidification.

Q. Explain, how the grain size and shape affect the performances of foundry sand.

Answer:
Sand Grain:
The shape and size of the sand grains has a remarkable effect on the physical properties of the foundry sand. The sand grains may have smooth, conchoidal or rough surfaces. Out of these the first type i.e., smooth, is preferred for moulding for the reason that such a surface renders higher permeability, sinter point and plasticity to the sand mass, but the percentage of binder required is also equally high.
Similarly, the sand grains may have different shapes. The commonly formed shapes are rounded, sub-angular, angular, and compound. The rounded grains do not bind together two well when rammed, and hence, render the sand mould highly permeable but the strength of the mould is also reduced.
Sub-angular grains give a relatively stronger bond than above but the permeability is reduced.
Angular or sharp grains produce a much stronger bond and a low permeability when rammed.

Thus, they enable a mould of greater strength. Sand grains which are cemented together such that they do not separate when screened are called compound. They may consist of one, two or a combination of all the above three shapes. They are not much preferred.

Like the shape the size of sand grains also effects the mould structure and its characteristics. Large, regular and uniform grains increase permeability. Smaller grains increase smoothness on mould surfaces.



Q. What are the common materials used for pattern making? Discuss their relative merits and demerits.

Answer:
Pattern materials
The common materials of which the patterns are made are the following:

1. **Wood:** It is the most common material used for pattern making

It has following advantages:

1) It is cheap and available in abundance.
2) It can be easily shaped into different forms and intricate designs.
3) Its manipulation is easy because of lightness in weight.
4) Good surface finish can be easily obtained by only planning and sanding.
5) It can be preserved for a fairly long time by applying proper preservatives like shellac varnish.

On the other hand, it has certain disadvantages also as follows:

1) It wears out quickly due to its low resistance to sand abrasion. As such, a wooden pattern cannot stand a long constant use.
2) It is very susceptible to moisture, which may lead to its warping or splitting. This needs its careful storing in a dry place and the application of preservatives.
3) Its life, owing to the above reasons, is short as compared to other pattern materials. This confines its use to such cases only when a small number of castings are required.

2) Metals: Metals are used with advantage, as pattern material, only when the number of castings to be made is very high and a closer dimensional accuracy is desired. They have a much

longer life than wooden patterns and eliminate the inherent disadvantages of wood to a great extent. However, they also carry the following

Disadvantages:

1) They are costlier than wood and, therefore, cannot be used with advantage, where a smaller number of castings is to be made.
2) For giving different shapes and fine surface finish they need machining. This again adds to their cost.
3) Most of them are very heavy and in case of large castings the weight of the pattern always poses a problem in its manipulation.
4) A large number of them have a tendency to get rusted.

3) Plaster: Plaster of Paris or gypsum cement is advantageously used as a pattern material since it can be easily casted into intricate shapes and can be easily worked also. Its expansion can be easily controlled and it carries a very high compression strength. Its specific use is in making small patterns and core boxes involving intricate shapes and closer dimensional control. A marked feature of this cement is that contrary to the action of metals, it expands on being solidified. Thus, if a cement of proper coefficient of expansion is selected, the effect of shrinkage of casting can be automatically neutralised.

4) Plastics: Plastics are gradually gaining favour as pattern materials due to their following *specific*

Characteristics:

1) Lightness in weight.
2) High strength.
3) High resistance to wear.
4) High resistance to corrosion due to moisture.
5) Fine surface finish.
6) Low solid shrinkage.
7) Very reasonable cost.

The plastics used as pattern materials are thermosetting resins. Phenolic resin plastic and foam plastic suit best for this purpose. For making the pattern, first the moulds are made, usually from plaster of Paris. The resin is then poured into these moulds and the two heated. At a specific temperature, the resin solidifies to give the plastic pattern.

5) Wax: Wax patterns are exclusively used in investment casting. For this a die or metal mould is made in two halves into which the heated wax is poured. The die is kept cool by circulating water around it. As the wax sets on cooling, the die parts are separated and the wax pattern taken out.

Q. What are crucible furnaces? Where are they preferred and why?

Answer:
These are the simplest of all the furnaces used in foundries. They are sparingly used in most of the small foundries where melting is not continuous and a large variety of metals is to be melted in small quantities. In these furnaces the entire melting of metal takes place inside a melting pot, called crucible, which is made of clay and graphite. The sizes of these crucibles vary from No.1 to No.400 each number representing a definite quantity of metal that can be held conveniently by the crucible.

Q. Explain in brief causes and remedies of the following casting defects

1) ***Blow holes***
2) ***Shrinkage***
3) ***Hot tears***

Ans.

Blow holes:

They appear as cavities in a casting. When they are visible on the upper surface of the casting, they are called open blows. These blows are normally rounded and have smooth walls. When they are concealed in the casting and are not visible from outside, they are known as blowholes. They are due to the entrapped bubbles of gases in the metal and are exposed only after machining.

Possible causes:

1) Excess moisture content in moulding sand-leading to the production of too much of steam and thereby rendering the permeability of the mould as inadequate.
2) Cores not sufficiently baked.
3) Use of rusted or highly moistened chills, chaplets or other metal inserts-giving rise to the production of a high amount of steam and gases.
4) Excessive use of organic binders-resulting in the production of high amount of gases.
5) Cores not adequately vented-resulting in their low permeability.
6) Moulds inadequately vented resulting in their low permeability.
7) Moulds rammed very hard-more addition to low permeability.

Remedies:

1) Moisture content in the moulding sand should be properly controlled.
2) Cores should be adequately backed.
3) Chills, chaplets and metal inserts used should be clean and free from rust or any other gas producing substance.
4) Organic binders should be used with restraint.
5) Cores and moulds should be adequately vented.
6) Moulds should not be rammed excessively hard.

Shrinkage:
During solidification of metal, there is a volumetric shrinkage. This should be adequately compensated by feeding failing which voids will be produced in the casting. These voids may exist on the surface as depression, called surface shrinkage, or within the casting called internal shrinkage. Too much shrinkage may lead to crack, known as hot tears. This defect occurs on account of inadequate and improper gating, risering and chilling so that proper directional solidification does not take place.

Hot tears:
They are also known as pulls or hot cracks. The main reasons of their occurrence is the low strength of metal after solidification, causing the metal to fail in coping up with the excessively high stresses set up by the solid shrinkage of the metal. These cracks may be external or internal. They are supposed to be more harmful when they are present internally, because in that case their occurrence is not revealed without machining or radiographic testing. Their presence is identified by an oxidised surface showing an irregular and ragged appearance on fracture. The main reasons of their occurrence are lack of collapsibility in the core and mould, faulty design leading to exceptionally high residual stresses at certain portions in the casting and very hard ramming of sand resulting in restricted contraction of casting. An improvement over these shortcomings will help limination of hot tears.

Q. Describe the following types of sands in respect of their composition, particular properties and uses

Answer:
Loam Sand: It is a mixture of clay and sand with water to a thin plastic form and from which moulds are built. It contains moisture 18-20% and the loam is dried very slowly. It is used for producing larger castings.
A typical mixture of loam sand consists of

Floor coke	10 Vol	
Loam sand	10 Vol	
New sand	6 Vol	80% mixture + 20% moisture
Silica sand	22 Vol	
Clay	5 Vol	
Other gradients	5 Vol	

1. ***Parting Sand :-*** Conventionally, mould is prepared into two or more boxes. These boxes are to be separated without adhering to each other's sand. For this purpose parting sand is used. One of the parting compounds is lycopedium, which is used when oil is mixed with moulding sand. Very fine brick powder can also be used.
2. ***Green Sand :-*** It is the sand in green condition and after preparing the mould, casting (pouring of molten metal) is done in moist state. While preparing the mould, the rammed sand is dense but porous and further the structure is made porous by venting. Green sand is generally used for small or medium sized casting.

(a) Mixture of green sand for light work purpose contains
Floor sand 80%
New sand..... 13.5%
95% mixture + 5% moisture
Super fine coal dust ... 6.5%

(b) Mixture of grey n sand for general purpose contains
Floor sand..... 60%
New sand .... 30% 95% mixture + 5% moisture
Coal dust 10%

(c) Mixture of green sand for high finish castings contains
Floor sand 51%
New sand 23%
Coal dust ..... 8.5% 95% mixture + 5% moisture
Carbon blacking ... 8.5%
Talc 2.8%

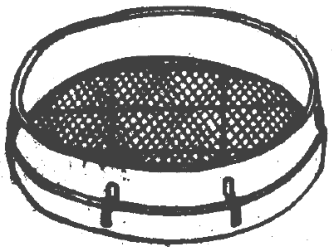
3. ***Backing Sand :-*** Backing sand or floor sand is used to back up the facing sand and to fill the whole volume of the flask. Old, repeatedly used moulding sand is mainly employed for this purpose. The backing sand is sometimes called black sand because of the fact that old, repeatedly used moulding sand is black in colour due to the addition of coal dust and burning on coming in contact with molten metal.

Q. Describe the utility of following moulding tools and give neat sketches of each.

Ans. ***Bellows :-*** A hand operated bellow is shown in Fig. It is used to blow but the loose or unwanted sand from the surface and cavity of the mould.

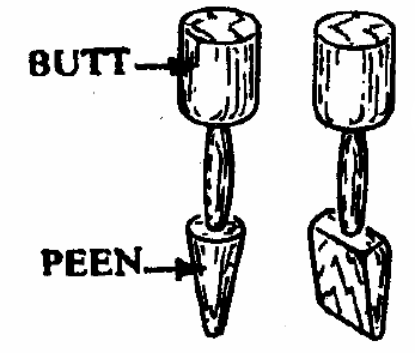
Bellow.

Hand Riddle :- It consists of a wooden frame fitted with a screen of standard wire mesh at its bottom. It is used for hand ridding of sand to remove foreign material from it.



Riddle.

Rammer:- A hand rammer is a wooden tool used for packing or ramming the sand into the mould. One end, called the peen, is wedge shaped, and the opposite end, called the butt, has a flat surface. Floor rammers are similar in construction but have long handles. Pneumatic rammers are used in large moulds saving considerable labor and time.



Q. What do you understand by casting? List the merits and demerits of casting process.

Ans. Casting is one of the most versatile form of mechanical process for producing components; casting is a replica of pattern, in metal which is obtained by pouring molten metal into the mould.
Principal of casting consists of introducing the molten metal into a cavity or mould of the desired shape and allowing it to solidify. When it is removed from mould, the casting is of same shape but slightly smaller due to contraction of metal. The molten metal passes through the four stages i.e. liquid stage, musy stage, plastic stage, and solid stage till the solidification takes place. Today we have a variety of moulding processes and melting equipments, thus we are capable to produce castings of different, materials and their alloys. Though, there is a tremendous improvement in the production methods, but the basic principles are still the same. One can realise the importance of castings and their role in modern development. It is difficult to visualise any product which do not have one or more casted parts in different sizes. Though there are other metal shaping process such as metal-machining, metal-forging, stamping which can fulfil the needs of the community. But casting caries inherent advantages, which have made it as the backbone of industrial production.

Design Advantages
(a) ***Size*** – Casting can be prepared upto 200 weight and the least size that can be made is weighing few grams. Its advantage lies with the production of massive objects in one piece.
(b) ***Complexity*** – Most simple/complex shaped products can be prepared by casting easily. Such production depends on the preparation of pattern and mould. Complicated shapes cannot be easily produced by other shaping methods.
(c) ***Weight Saving –*** Since the metal can be placed at the exact location where it is needed, thus lot of metal can be saved by adopting this process.
(d) ***Production of Prototype*** – It is capable to produce prototype models/exact product as desired.

(e) ***Wide Range of Properties*** – This process offers a large range of mechanical and physical properties in the castings as per requirement. Usually the use the metalalloys is one variable.

Advantages of Casting Process

(a) ***Low cost*** – It is usually found to be the cheapest method of metal shaping.
(b) ***Dimensional Accuracy*** – Tolerances as close as ±0.1 mm can be achieved depending on metal to be casted, casting process, shape and size of casting. Surface finish can also be controlled from 5 microns to 50 microns.
(c) ***Versatility in Production*** – This process is adaptable to all types of production.

Metallurgical advantages

(i) Fibrous structure.
(ii) Controlled grain size,
(iii) Uniform density.

Merits of casting:-

1. Versatile form of mechanical process for producing components.
2. There is no limit to the size and shape of the articles that can be produced by casting.
3. Casting offers one of the cheapest methods and gives high strength and rigidity even to intricate parts, which are difficult to produce by other methods of manufacturing.

Demerits :-

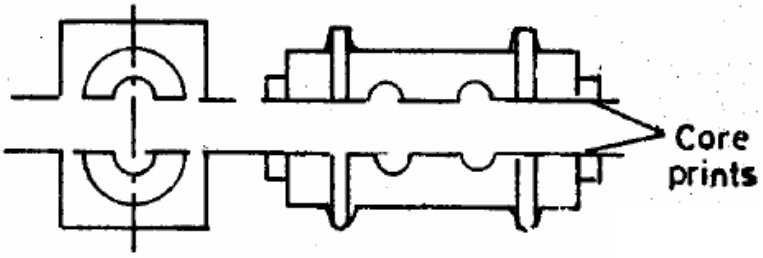
1. Casting is not always the best method of the various production techniques.
2. Metals having good fluidity and small shrinkage can only be casted in a best way.

Q. Which factors need to be considered in selecting a particular type of pattern? Explain split pattern, sweep pattern and match-plate pattern with the help of neat sketches.

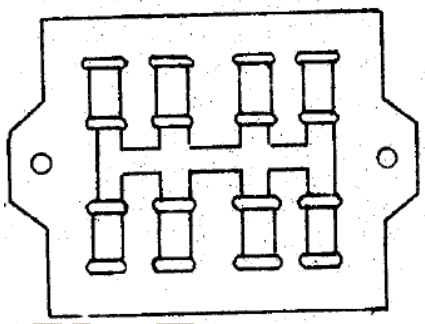
Ans. Factors affecting selection of a particular tape of pattern. The type of pattern to be used for particular casting depends upon many factors like

1. The bulk of casting i.e. whether a small or large number of casting is wanted.
2. Ease or difficulty of moulding operation.
3. Type of moulding process.

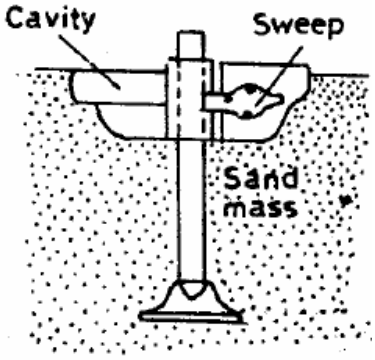
Split pattern :- Many times the design of casting offers difficulty in mould making and withdrawal of pattern, if a solid pattern is used. For such castings, split or two piece patterns are employed. They are made in two parts, which are joined at the parting line by means of dowels. While moulding one part of the pattern is contained by the drag and the other by the cope.



Match plate patterns :- These patterns are used where a rapid production of small and accurate castings is desired on a large scale. Their construction cost is quite high, but the same is easily compensated by a high rate of production, greater dimensional accuracy and minimum requirement for machining in the casting. These patterns are made in two pieces; one piece mounted on one side and the other on the other side of a plate, called match-plate. The plate may carry only one pattern, or a group of patterns mounted in the same way on its two sides. The plate may be of wood, steel magnesium or alluminium. Gates and runners are also attached to the plate alongwith the pattern.



Sweep pattern :- Sweeps can be advantageously used for preparing moulds of large symmetrical castings, particularly of circular cross-section. This effects a large saving in time, labour and material. The full equipment consists of a base, suitably placed in the sand mass, a vertical spindle and a wooden template, called sweep. The outer end of the sweep carries the contour corresponding to the shape of the desired casting. The sweep is rotated about the spindle to form the cavity. Then the sweep and spindle are removed, leaving the base in the sand. The sweep and spindle are removed, leaving the base in the sand. The hole made by the removal of spindle is patched up by filling the sand.



Q. What is pattern? How does it differ from the actual product to be made from it?

Ans. A pattern may be defined as a replica or facsimile model of the desired casting which, when packed or embedded in a suitable moulding material, produces a cavity called mould. This cavity, when filled with molten metal, produces the desired casting after solidification of the poured metal. Since it is a direct duplication, the pattern very closely conforms to the shape and size of the desired casting, except for a few variations due to the necessary allowances. The ways in which a pattern differs from an actual component are :

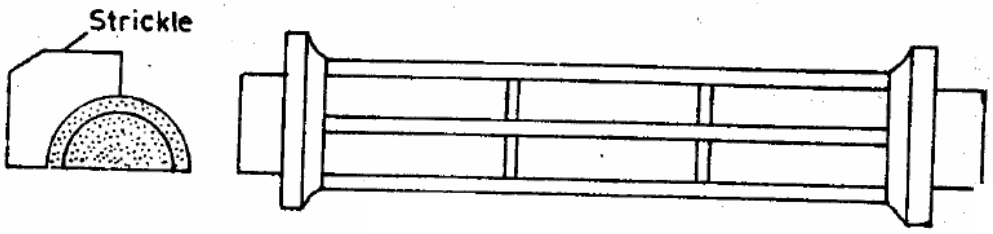
1. It carries an additional allowance to compensate for metal shrinkage.
2. It carries additional allowances over those portions, which are to be machined or finished otherwise.
3. It caries the necessary draft to enable its easy removal from the sand mass.
4. It carries additional projections, called coreprints, to produce seats for cores.

Q. What is permeability? What is the effect of Moisture and clay content permeability?

Ans. It is also termed as porosity. It is that property of the sand, which allows the gases and steam to escape through the sand mould. When the hot molten metal is poured in the mould a very large volume of gases and steam is formed due to heating to moisture, coal dust, oil and similar other materials present in the sand. If these gases are not allowed to go out they will either make the casting unsound or blast the mould. Therefore, this is very important property required in the moulding sand. It largely depends upon the same grain size and shape and the proportion of moisture and clay present in the sand. Rounded grains of uniform size lead to a high permeability. This property is also effected by ramming of sand. A soft ramming will increase the permeability and hard ramming will reduce it. In practice it is further increased by applying vent wires in the prepared mould.

Q. Write note on Skeleton pattern

Ans. ***Skeleton pattern :-*** When the size of the casting is very large, but easy to shape, and only a few numbers are to be made, it is uneconomical to make a large solid pattern of that size. In such cases, a pattern consisting of a wooden frame and strips is made, called skeleton pattern, it is filled with loam sand and rammed. The surplus sand is removed by means of a strickle. The core can be prepared separately, either with the help of a core box or another skeleton made for that, and assembled in position in the mould.



Q. Give reason for Rat-tails or buckles in casting.

Ans. 1) Continuous large flat surface on casting.
2) Excessive mould hardness.
3) Lack of combustible additives in moulding sand.

Q. What care is to be taken in operating cupola?

Ans. *The following considerations should be made for operating the cupola successfully:*

1. A superior refractory lining should be used to withstand high temperature produced inside the furnace.
2. The man who fires the coke and charge should place the metal charge in the centre.
3. The molten metal should be tapped out well before its level rises too high in the well.
4. The tap hole should be property closed by means of a well-prepared clay bolt or plug.
5. In closing the tap hole care should be taken to press the plug downward in the hole so That the splash of the molten metal does not fall on the hands.
6. The amount of air supply should be property controlled. An excess amount of air will result in lowering to temperature inside.

Q. Define: (i) Pattern (ii) Mould (iii)Casting

Ans:

I. ***Pattern :*** Pattern is a model of anything which is used to prepare moulds by placing it in sand.
II. ***Mould :*** A mould is a cavity so prepared that it can be used to make castings by molten metal into it.
III. ***Casting :*** The molten metal poured into mould, on cooling is known as casting.

Q. What do you understand by gravity die-casting? State its advantages.

Ans. ***Advantages:***

1) It is a very speedy process and each cast takes between 2 to 4 minutes time only.
2) Permanent moulds have a very long life in as much as one mould can be conveniently used for producing between 3,000 to 10,000 castings in cast iron and between 10,000 to 25,000 castings in alluminium.
3) Surface finish through this method is better than sand castings but inferior than pressure die-castings.
4) Dimensional tolerances of the order of ±0.508 per 100 mm. can be conveniently obtained.
5) For the same amount of production it requires less floor area than sand casting.
6) Less skill is required of the operator than in sand casting.
7) Many of the defects found in sand castings are eliminated totally.
8) Castings produced through this method are found to have a finer grain structure.
9) Castings in large quantities can be produced more economically.
10) A minimum thickness of 2.4 mm. Can be easily cast.

Q. Explain with the help of neat cross sectional sketch of cupola, indicating its various zones.

Ans. Various zones of cupola are shown in Figs. A number of chemical reaction take place in these zones which are explained below :

1. ***Well:*** **-** It is the space between the bottom of the tuyeres and the sand bed. The metal, after melting,, trickles down and collects in this space before it is tapped out.

2. ***Combustion zone :-*** It is also known as oxidising zone. It is located between the top of the tuyeres and a theoretical level above it. The total height of this zone is normally from 15 cm. To 30 cm. The actual combustion takes place in this zone, consuming all free oxygen from the air blast and producing a lot of heat, which is sufficient enough to meet the requirements of other zones of cupola. More heat is evolved due to oxidation of silicon and manganese. A temperature of about 15400C to 18700C is produced in this zone. The exothermic reactions taking place in this zone can be represented thus.

3. ***Reducing zone :-*** It is also known as the protective zone. It is located between the top of the combustion zone and the top level of the coke bed. CO2 is reduced to CO in this zone through an endothermic reaction, as a result of which the temperature falls from combustion zone temperature to about 12000C at the top of this zone.

4. ***Melting zone :-*** The first layer of metal charge above the coke bed constitutes this zone. The solid metal charge changes to molten state in this zone and trickles down through the coke to the well.

5. ***Preheating zone :-*** It extends from above the melting zone to the bottom level of the charging door and contains a number of alternate layers of coke and metal charges.
The function of this zone is to preheat the charges from atmospheric temperature to about 10930C before they settle downwards to enter the melting zone. This preheating takes place due to the upward advancing hot gases, from which the solid metal also picks up some sulphur content.

6. ***Stack :-*** The empty portion of cupola above the preheating zone, which provides the passage to hot gases to go to atmosphere, is known as stack.