Casting

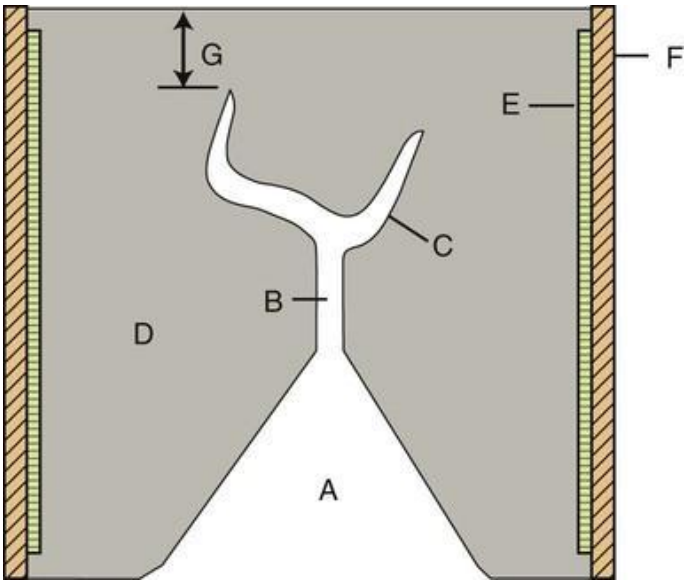
Casting is the technique or procedure by which molten metal or alloy is forced into a burnt out mould prepared from a wax pattern.

The force that is being used very commonly for quickly injecting the molten metal into the mould is the centrifugal force (the force that tends to throw a thing outward from a centre of rotation).

The centrifugal force is supplied by a casting machine having a cross arm that revolves around a pivot on an upright shaft. The casting ring, within which lies the mould, is placed on one end of this arm with a crucible containing metal or alloy and it is positioned in such a way that the metal or alloy can flow into the centre sprue. When propelled by the release of a coiled spring in the shaft, the machine attains enough power to rotate the arm rapidly. The resultant centrifugal force casts the molten metal from the crucible into the mould and keeps it there until it (metal) has solidified.

Sprue:

A sprue is an aperture through which molten metal flows into a mould to make casting.
The waste metal that fills up the aperture when the casting is over and undergoes solidification is also called a sprue.



Sprue former:

The wax (inlay wax) or metal form that is being used to make the aperture is called a sprue former.

The sprue former is attached with the pattern and later on invested along with the pattern. On removal of the sprue former. It forms a direct channel (sprue) connecting the mould through which molten metal enters into the mould.

Crucible former:

It is the base (sprue base) to which the wax or metal sprue is attached while the wax pattern is being invested with an investment material. It forms a crucible for the molten metal at the

base of the casting ring and is made up of investment material. The crucible fromer can be made of rubber, wood, wax or other polymers.

Casting ring

It is a metallic ring open at both the ends. Its main purpose is to confine the investment material. The wax pattern for casting is invested inside this ring with the investment material. One end of the casting ring fits on the sprue former to wich the main sprue is attached. Casting ring is also known as casting flask.

GENERAL PRINCIPLES OF CASTING

An outline of the general principles of casting includes the following steps. For a detailed account of the same, students are advised to consult standard books on dental mechanics or dental prosthetic techniques.

The general method of casting is as follows:

1. A pattern of the restoration or appliance to be cast in metal or allowy is first made with inlay casting wax..
2. One end of a metallic sprue pin or a wax sprue former is attached at the highest point of the pattern. It is very essential that the correct diameter of the sprue is to be used. The diameter of the sprue is related to the size of the sprue is to be used. The diameter of the sprue is related to the size of the sprue is to be used. The diameter of the sprue is related to the size of the casting. i.e., the wax pattern to be cast. For a very small inlay, a sprue of 1.3 mm will be sufficient. For most inlays the diameter of the sprue should be 2mm and for very large crowns, it should be 2.6mm. Casting of larger dimensions than inlays (metallic denture base or cast partial denture) requires multiple sprues to ensure that the mould will be filled up by the molten alloy before solidification of any part begins.

3. A reservoir for molten is made on the sprue. This is a piece of inlay casting wax attached to the sprue in the form of a bead about 1 mm away from the pattern. After investing the pattern, when the wax will be eliminated, the space occupied by the wax bead will form the reservoir, which helps to overcome porosity in a casting due to shrinkage. When molten metal enters the mould, it will shrink on solidification and thus will give rise to a space in the mould which has to be filled up by more flow of molten metal in the mould, else the casting will be an incomplete oe. The metal in the reservoir solidify later than the metal in the mould i.e. when the metal of the main casting is solidifying and undergoing shrinkage, the metal in the reservoir is still in a molten state (fluid). Due to capillary action the still fluid metal from the reservoir

enters through the sprue into the main casting and fills it up completely (i.e., fills up the space created by the solidification of metal in the main mould)

4. The other end of the sprue pin or sprue former is now attached to the crucible former (sprue base).
5. The casting ring is fitted on the crucible former and the pattern along with the sprue former is invested with the investment material. Greater detail of investing the pattern.
6. When the investment material has set hard the crucible former is removed and the casting ring is heated slightly to soften the wax that has attached the sprue pin with the wax pattern, the pin is now removed to provide a channel for the escape of molten wax from mould and entrance of molten metal therein.
7. The casting ring containing the investment is heated in a furnace to burn out the wax and expand the mould.
8. The aloy is now melted by gas (benzene or petrol) and air or gas and oxygen flames (torches).
9. The molten alloy is then forced into the mould by a centrifugal casting machine.

Alternatively, the metal can be forced into the mould by the use of air or steam pressure (by air pressure or steam pressure casting machines). But precision casting can only be done by centrifugal method.

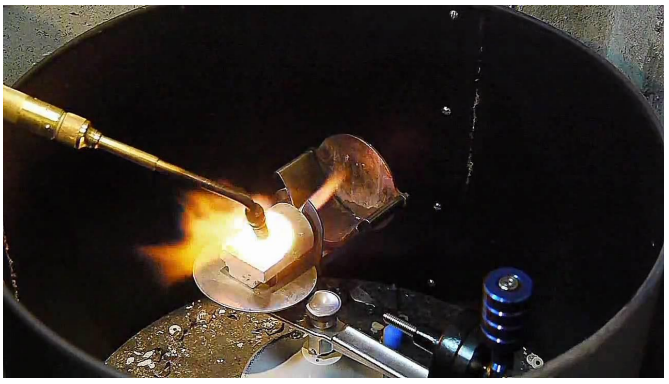
For the casting of cobalt-chromium alloy, melting of the alloy may be performed by an oxyacetylene flame or by an electrical method (induction heating).

Defects in Casting:

1. Surface roughness:

These are caused by-

a) Breakage of investment due to overheating of the mould or the alloy bubbles entrapment on the pattern, due to:
   i. Inadequate use of detergent, or,
   ii. Poor vacuum investment.



b. Weak investment surface, due to:
   i. Water film from too thin a mix of investment.
   ii. Use of too great a casting force.
   iii. Use of too much detergent (wetting agent).

2. Incomplete casting

This may be due to the following causes:

a) Use of insufficient alloy.
b) Metal not completely molten or allowed to cool before the application or of casting force.
c) Use of too low a casting force
d) The mould is too cold causing premature solidification of the alloy.
e) Back pressure of the gases in the mould.
f) Blockage of the sprues or of the mould cavity byforeign matter, e.g., dirt, broken pieces of investment material, particles of flux or unburnt wax.

3. Porosity:

It may be seen as a surface defect on the casting or may be detected with toe cast during filling.

a) Occluded gases

Alloys containing metals like gold, copper, silver, platinum and palladium liberate occluded gases when they solidify (i.e., on cooling), gaseous porosity occurs in the casting due to gas occlusion and appears as spherical voids that may affect any areas of the casting and may even involve the entire piece. This may be caused by:

i. Overheating of the alloy, or
ii. Prolonged heating of the alloy.

b) Cooling shrinkage

Porosity due to cooling shrinkage (contraction porosity) appears as irregular voids in the casting. It is generally found in the thicker section of the casting. It is caused by:

i. Use of too thin sprues.
ii. Sprues not placed at the bulkiest section of the pttern.
iii. Placing the reservoir too far from the pattern to be effective or making it too small (reservoirs should be twice the bulk of the nearest portion of the casting and should be only 1-2 mm along the sprue).
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c) Flux, dirt or investment particles embedded in the metal

d) Back pressure effect

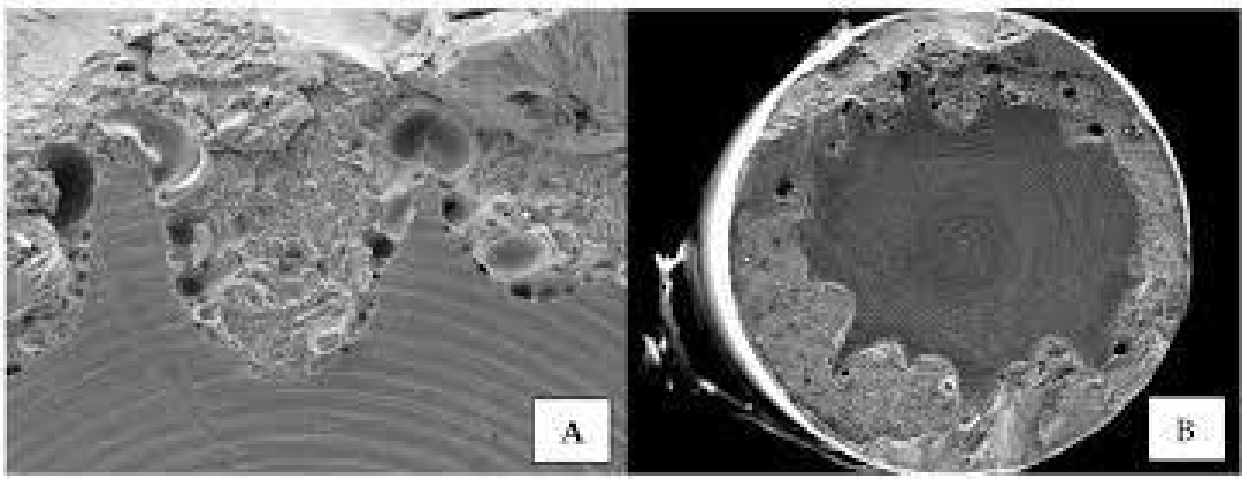
This is causes by air which cannot escape from the mould when the molten alloy enters in it. Porosity due to back pressure effects gives rise to rounded margins on the casting or regular large voids within it. It may be avoided by:

i. Using investment of adequate porosity.

ii. Em[oying correct casting force.

iii. Ensuring that no residue of wax pattern is left which might block the pores of the investment and interfere with the escape of air or gas.

iv. Placing the pattern not more than 6 to 8 mm away from the end of



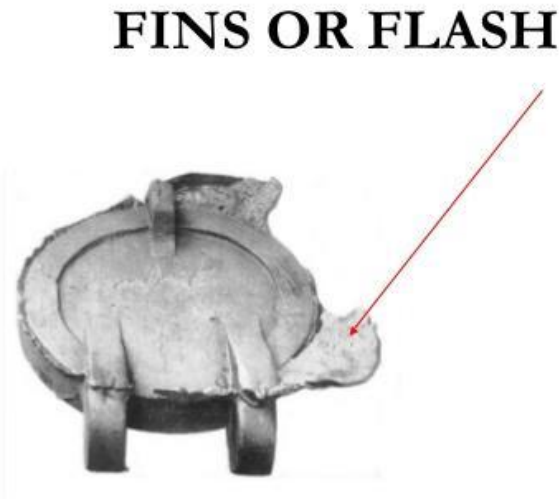
the casting ring (too great a thickness of the investment will resist the escape of air or gas from the mould)

4. Fins on casting

These are caused by cracks in the investment material during casting. These may occure:

a) When the investment heated up too rapidly in the furnace, or,

b) When two different mixes of investment (of different powder/water ratio) are used.



5. Contamination of casting

Contamination of castings may occur due to:

a) Oxidation, caused by:
   i. Using oxidizing zone of the flame.
   ii. Overheating of the alloy.
   iii. Failure of using sufficient flux.

b) Sulphur compounds, which are the products of investment break down due to overheating of the investment materials.

6. Poor fit of castings

a) Too large casting

It is due to excessive expansion of the mould, which may be caused by:

i. Too high a temperature, or,
ii. Use of wrong type of investment material.

b) Too small casting

It is caused if the mould is insufficiently heated.

c) Distorted casting

The causes of distorted casting are:

i. If the wax pattern distorts due to stress relief, or,
ii. If the pattern is not placed in a central position in the casting ring.