3.9.1 Comparison between open – die and Closed- die Forging

Sr. No	Open-die forging	Closed-die forging
1.	In this method, the workpiece is compressed between the two flat dies.	In this method, the workpiece is compressed between the two impressed dies.
2.	The cost of dies is low.	The cost of dies is high.
3.	The process is simple.	The process is complex.
4.	During the process there is poor utilization of the material.	During the process there is better utilization of the material.
5.	After the process, machining of components is required.	After the process, machining of components is not required.
6.	The dimensional accuracy of obtained products is not good.	The dimensional accuracy of obtained products is good.
7.	This process is used for low quantity production.	This process is used for high quantity production.
8.	It is suitable only for production of simple components.	It is suitable for production of simple and complex components.

3.10 HAMMERS

Hammers are classified into different groups as show in Figure 3.12.

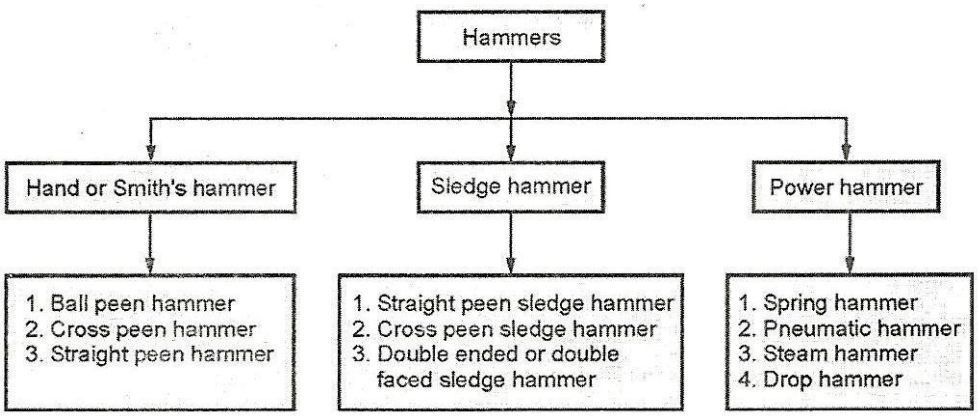

Fig. 3.12 : Types of hammers

The hammers are used by a Smith in order to give the desired shape to the heated metal piece.

3.10.1 Hand or Smith's Hammers

Smith's hand hammers are small in size and of following types:

1. Ball peen hammer
2. Cross peen hammer
3. Straight peen hammer

1. Ball Peen Hammer:

It is most suitable hammer for hand forging operations. It has a tough cast steel or forged steel head which is fitted to a wooden handle. One end of the head is flat called as face i.e. hardened and polished. It is used for general striking and hammering purpose. Another end is half ball shaped called as peen i.e. used for riveting or burring over purpose. Refer Figure 3.13 (a).

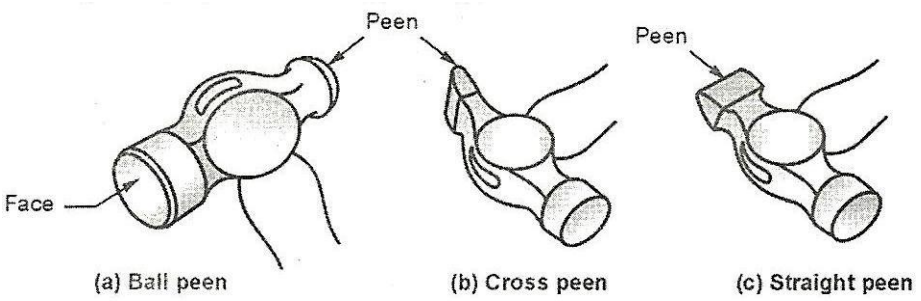

Fig. 3.13 : Hand or Smith's hammers

2. Cross Peen Hammer:

In this type of hammer, peen is at right angle to the axis of the handle of the hammer. It is used for heading, stretching and hammering into the inner portions of the component. Refer Figure3.13 (b).

3. Straight Peen Hammer:

In this type of hammer, peen is parallel to axis of handle of the hammer. It is used for stretching the metal. Refer figure 3.13 (c).

3.10.2 Sledge Hammers

Sledge hammers are larger in size as compare to hand hammers and of following types:

1. Straight peen hammer
2. Cross peen hammer
3. Double ended or double faced hammer.

- Due to large size, weight of sledge hammers is also more than the hand hammers.
- These hammers are used when heavy blows are required to be imparted to the workpieces.

- To avoid the damage of workpiece surface, the striking surface of the sledge hammer is made slightly convex and smooth.
- The construction of straight peen and cross peen hammers is similar as discussed in hand hammers. Refer figure 3.14 (a) and (b).
- If the hammer has no peen formation and instead carries flat faces at both ends, then it is called d as double ended or double faced hammer. Refer figure 3.14 (c).

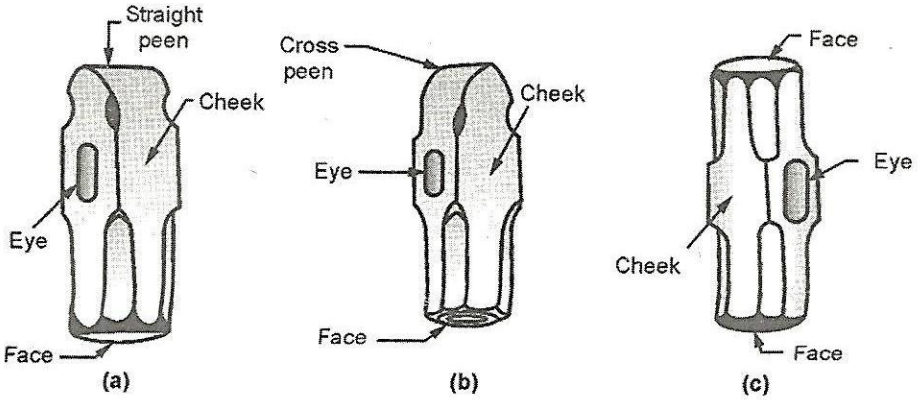

Fig. 3.14 : Sledge hammers

3.10.3 Power Hammers:

- During forging, heavy components require a great degree of deformation which is not possible by using hand hammers.
- When forging with power machines, the deformation of the heated metal takes place either under the action repeated blows or the action of gradually applied pressure.
- Machines which work on the principle of repeated blows are called as forging hammers or power hammers, whereas those apply gradual pressure are called as forging presses.

Forging or power hammers are of following types:

1. Spring hammer
2. Pneumatic hammer
3. Steam or air hammer
3. Drop hammer

1. Spring Hammer

- It has a simple design to regulate the speed and force of its blows.
- It is very light type of power hammer and suitable for small forgings.
- It consists of a heavy rigid frame carrying a vertical projection at its top which acts as a housing for bearing in which leaf or laminated spring oscillates.
- One end of this spring is connected to the connecting rod and other end is connected to a vertical tup which reciprocates between fixed guides. Refer figure 3.15.
- The connecting rod is attached to on eccentric sheave, which is further connected to the crank wheel.

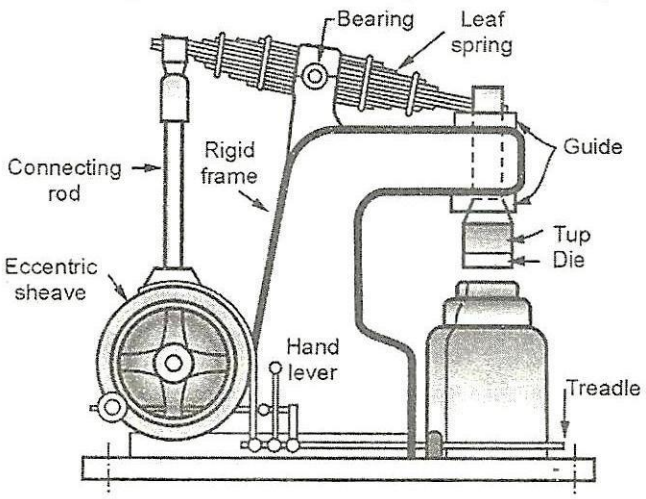

Fig. 3.15 : Spring hammer

- To operate the hammer, treadle is pressed downwards that makes the sheave to rotate through the crank wheel and hence, leaf spring starts oscillating in the bearing.
- This oscillation of spring causes the reciprocating motion of the tip and thus, required blows are provided on the work piece.
- To adjust the stroke of the connecting rod and intensity of blows, hand lever is used.

2. Pneumatic Hammer

- Design of pneumatic hammer varies with the different manufacturers.
- Figure 3.16 shows a commonly used design of pneumatic hammers which consists of a compressor cylinder and ram cylinder.

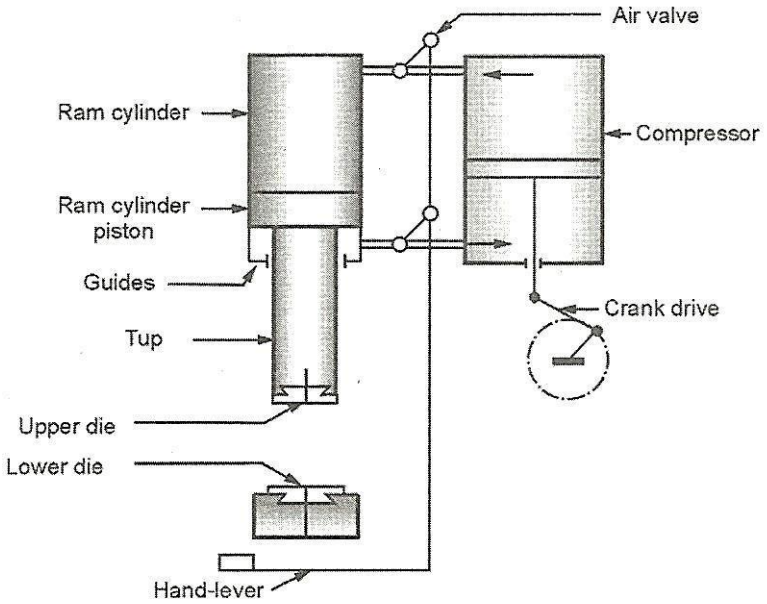

Fig. 3.16 : Pneumatic hammer

- In these hammers, the compressor cylinder compresses the air and delivers it to the ram cylinder. By using this compressed air pressure, the ram cylinder piston is actuated.

- A hand lever operates an air valve provided on the air passage from compressor cylinder to ram cylinder.
- Piston of ram cylinder carries tup at it bottom which can slide inside the fixed guides.
- The compression of the reciprocating cylinder is obtained with the help of crank drive which is operated by a reduction gear drive.
- Pneumatic hammer can produce 70 to 200 blows/minute.

3. Steam Hammer

- Steam or air hammers are similar in design to the pneumatic hammers.
- Steam or air hammers are normally consists of double acting cylinder i.e. steam or air is admitted on both sides of the piston.
- Hence, both the strokes are initiated and performed by the pushing action of compressed air or steam.
- In this type of hammer, compression of air or steam takes place separately and not within the hammer.
- Figure 3.17 (a) and (b) shows the working principle of single acting and double acting steam or air hammers.

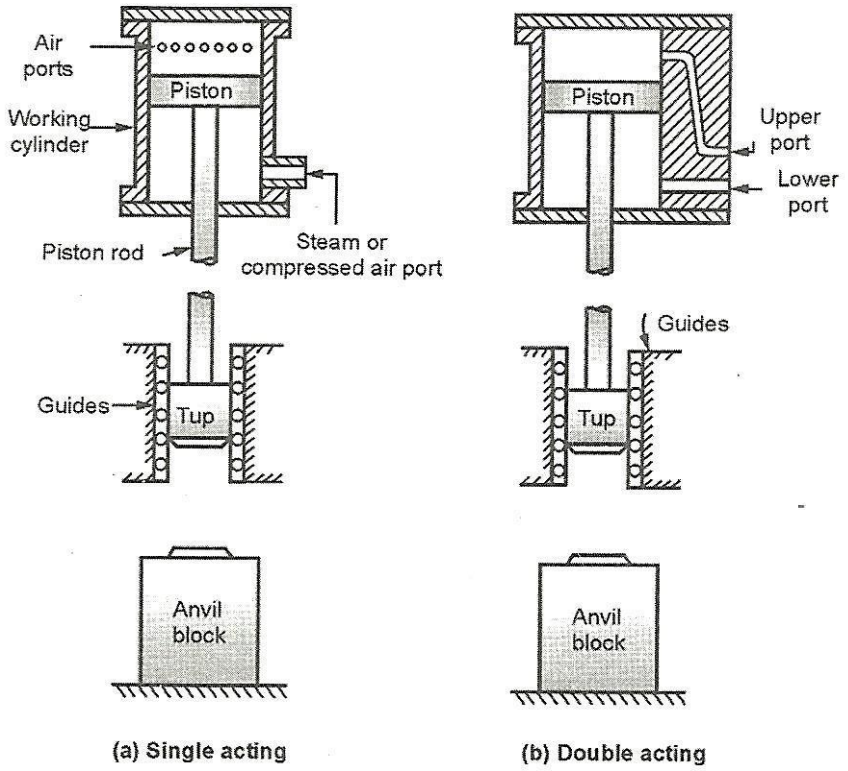

Fig. 3.17 : Steam or air hammers

- In single acting type, the air or steam is admitted into the cylinder through a part near its bottom which pushes the piston upwards.

- The steam supply is then cut off when the piston attains the required height and the tup falls under the gravity on the anvil.
- Before the end of upward stroke, air from atmosphere is admitted into the cylinder through the air ports, which provides cushioning action and lowers the speed of upward moving piston.
- In case of double acting type, steam or air is admitted under pressure on both sides of the piston and both the strokes are operated by the fluid.

4. Drop Hammer

- Drop hammer is a type of power hammer which is generally used in mass production of identical products.
- Drop hammers are similar in design and arrangement to steam or air hammer.
- Figure 3.18 shows the working principle of drop hammer.
- It consist of two halves of accurately made steel dies. One half is attached to the tup or hammer head and other half is fastened to anvil block at the bottom.
- The tup carrying upper die half is raised to a suitable height with the help of friction rolls or belt or rope as show in figure 3.18 (a).

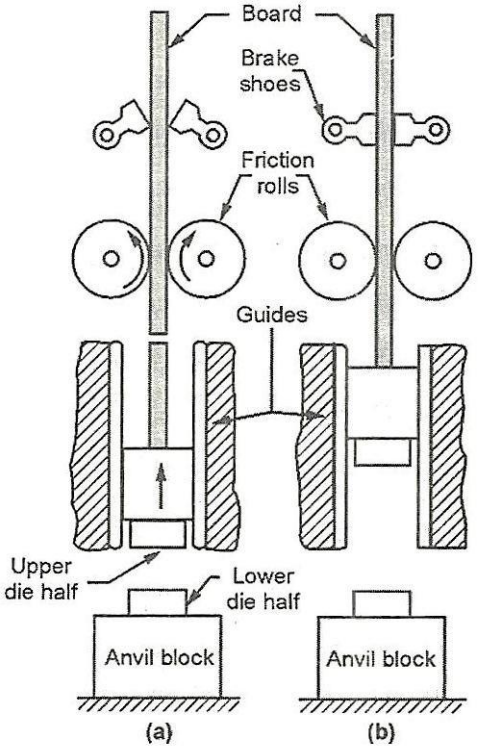

Fig. 3.18 : Drop hammer

- The heated metal is then placed on the lower die half.
- The hammer along with the upper die half is allowed to fall abruptly under gravity and its own weight hence known as drop hammer.

- The sudden fall of hammer causes the metal to shaped according to the formed cavities in the dies.
- Drop hammers are used for mass production of parts of steel or non-ferrous metals weighing upto 3500N.

3.10.4 Hand forgoing Tools:

To carry out hand forging operations, certain tools are used. They are also called as blacksmith's tools. The different hand forging tools are categorised as follows:

a) Anvil b) Swage block c) Tongs
d) Hammers e) Chisel and hardie f) Swages
g) Fullers h) Flatters i) Punches and drifts j) Set hammer, etc.

a) Anvil

For performing forging operation successfully, a proper supporting device is required which a proper supporting device is required which should be capable of withstanding heavy blows applied to the workpiece. For this purpose anvil is used. Refer figure 3.19.

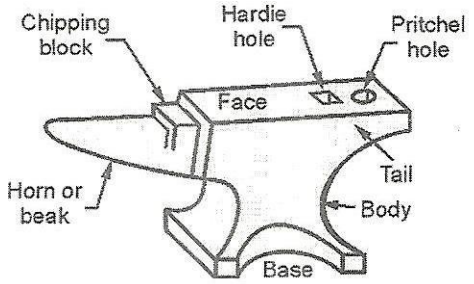

Fig. 3.19 : Anvil

Generally it is made of cast steel, mild steel or wrought iron provided with hardened top. The horn or beak is sued in bending the metal or for forming curved shapes. The flat step between the top and horn called as chipping block is sued to support workpiece while cutting. Tail is the flat projecting piece at the of anvil. It carries a square hole for accommodation of square shank of the bottom part of different hand tools like fullers, swages, etc. This square hole is called as hardie hole. Near the hardie hole a circular hole is provided which is called as pritchel hole.

b) Swage block

It is a solid rectangular block made up of either cast steel of forged steel. Refer figure 3.20. It carries a number of slots of different shapes and sizes (along it four side faces) and through holes (from its top face to bottom face) which also vary in shapes and sizes. It is used as a support in punching holes and forming various shapes. The workpiece to be given a required shape is kept on a similar shaped slot which acts as a bottom swage and then top swage is kept on another side of the workpiece. The holes provided in the top and bottom face are

used for punching. It prevents the punch from damage by striking against a hard surface when the hole has been punched.

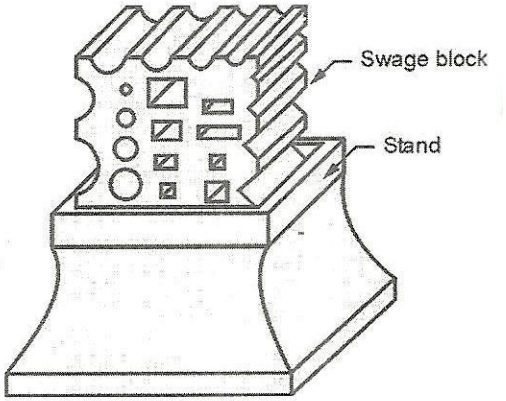

Fig. 3.20 : Swage block on stand

c) Tongs

Tongs are used by the smith for gripping and turning hot metal workpieces during forging. They have wide varieties of bit (mouth) shapes to hold different sized and shaped workpieces. Refer figure 3.21.

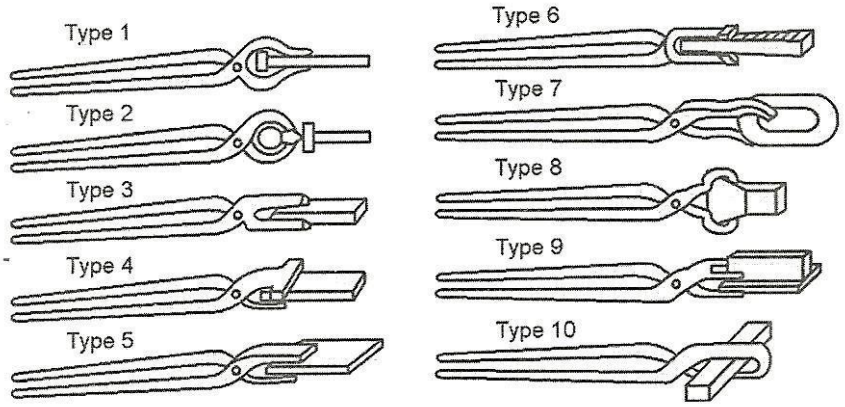

Fig. 3.21 : Types of tongs

Usually tongs are made of mild steel and they are made in two pieces, riveted together to form a hinge. The size of tongs vary as per the size and shape of the workpiece but commonly used lengths of tongs vary from 400 mm to 600 mm with the jaw opening (bit length) from 75 mm to 140 mm.

d) Hammers

For detail explanation of hammers and its types refer section 3.10.

e) Chisels and Hardie

Chisels are used to cut metals in hot as well as cold state. The chisels which are made for cutting the metal in hot state are called as hot chisels or hot set. Refer figure 3.22 (a). Similarly, the chisels which are made for cutting the metal in cold state are called as cold chisels or cold set. Refer figure 3.22 (b).

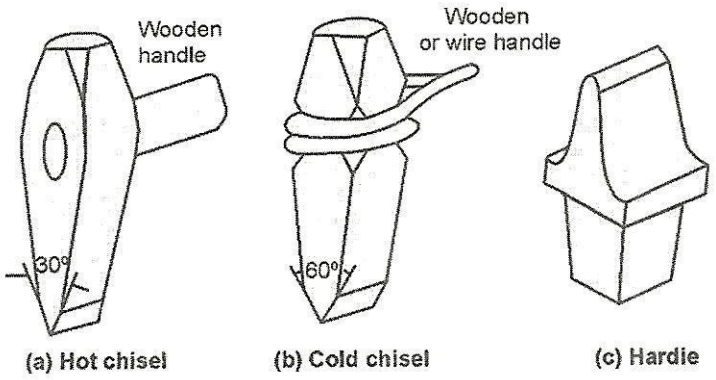

Fig. 3.22 : Chisels and hardie

Hot chisels are ground to an angle of 30°-35° whereas cold chisels are ground to an angle of 45°-60° for cutting the metals. Both hot and cold chisels are made of high carbon steel. These chisels are generally used together with a bottom cutting tools which is called as hardie. Refer figure 3.22 (c).

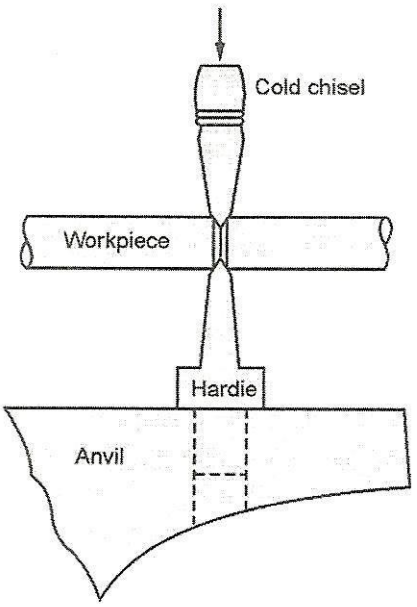

Fig. 3.23 : Cutting with chisel and hardie

It has a square shank and wedge shape which is mounted in the hardie hole of the anvil. Refer figure 3.23.

f) Swages

It consist of two parts called as top part and bottom part. These parts are either separate or connected by a steel strip handle. Refer figure 3.24.

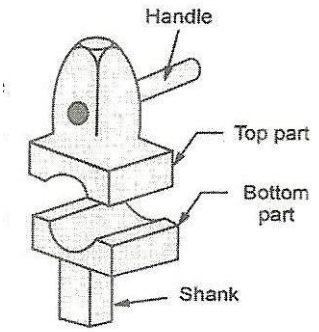

Fig. 3.24 : Swages

Swages are used to reduce and finish the workpiece to the size and shape (generally round or hexagonal). Usually swages are made of high carbon steel.

g) Fullers

Like swages, fullers are also made of high carbon steel in two parts called as bottom part and top part. Fullers are used to form grooves in the workpiece. They spread the metal and can reduce the thickness of workpiece. Like swages the top part of the fullers is provided with a handle and the bottom part has a square shank that fits into the square hole of the anvil. Refer figure 3.25.

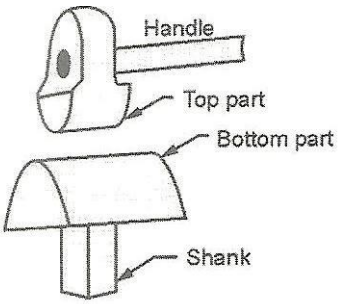

Fig. 3.25 : Fullers

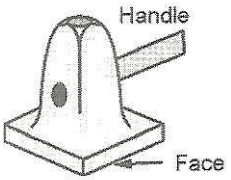

Fig. 3.26 : Flatter

h) Flatters

It is also called as flatteners or smoothers. It is made of high carbon steel and it has square body fitted with a handle as show in figure 3.26. It is used to finish off surfaces to a good surface especially when the surface area is large.

i) Punches and drifts

Punches are tapered tools available in different shapes and sizes. It is used for producing holes in the heated workpieces. Refer figure3.27 (a). A drift is a large sized punch used to expand the hole to the required size and shape after the punching is over. It carries a small taper near its tip only and the remaining part is of uniform cross section. Refer figure 3.27 (b).

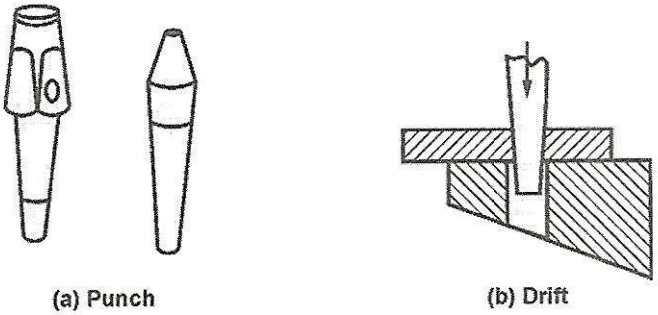

Fig. 3.27 : Punch and drift

j) Set hammer

It is used to finish off surfaces to a good smooth surface in restricted areas like corners. It is made of hardened tool steel. Its construction is similar to flatter but smaller in size and its bottom is also small.

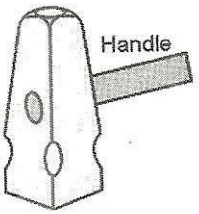

Fig. 3.28 : Set hammer

3.11 Drop Forging

- Drop forging differs from smith's forging as in drop forging closed impressions rather than open face of flat dies are used.
- This process utilises closed impression die to obtain the required shape of the component.
- The dies are matched and separately attached to the movable ram and the fixed anvil.
- The forging is produced by impact or pressure, which compels hot and pliable metal to confirm to the shape of the dies.
- During the operation, there is a drastic flow of metal in the dies caused by repeated blows of hammers on the metal.
- To ensure proper flow of the metal during the intermittent blows, the operation is divided into a number of steps.
- Each step changes the metal form gradually, controlling the flow of the metal until the final shape is obtained.
- The number of blows required varies according to the size and shape of the part, forgoing quality and required tolerances.
- The equipment used for applying the blows is called as drop hammer.