

12.4 SHEET METAL OPERATIONS

The following are the various sheet metal operations :

- ❖ Measuring and marking
- ❖ Cleaning
- ❖ Laying out
- ❖ Cutting and shearing
- ❖ Bending
- ❖ Stretch forming
- ❖ Deep drawing
- ❖ Riveting
- ❖ Soldering
- ❖ Hollowing or Blocking
- ❖ Sinking
- ❖ Raising
- ❖ Planishing

12.4.1 Measuring and Marking

In order to cut the required sheet from the standard sheet (available in market). First measuring and marking is done *i.e.* how much sheet is required, it is marked. Measuring is done with the help of steel rule, steel tape, folding rule, steel circumference rule etc. After measuring the various dimensions, marking is done with the help of scribes, punches etc. While doing the marking, little allowance for cutting is always added to the overall size. Sometimes, the sheets are coated with a coloring media, so that the scribed lines are clearly visible. The procedure for marking straight lines, curved lines, indentation marks and transferring a pattern is as follows :

1. **Marking straight lines.** The straight edge or steel square is used to draw straight lines as discussed below. When straight edge or steel square is used, a sharp pointed scribe is held in one hand at an angle against the edge of the straight edge or steel square, then the lines are drawn by applying a little pressure to the scribe.
2. **Marking circles and arcs.** The circles and arcs are marked on the surface of a sheet metal with the help of a divider or a trammel point. One leg of the divider is placed at the centre of a circle or arc, the other end is moved with a little pressure on the divider to mark the circle or arc. In order to prevent slipping, the divider is inclined in the direction in which the circle or arc is drawn.
3. **Marking irregular curves.** Curves are drawn with the help of a French curve. The French curve is set in such a way that at least three points coincide with the curve, it is then

moved to coincide next three points. This process is repeated till the whole curve is marked. The irregular curves may also be drawn by a flexible rule made of spring steel.

4. **Marking indentation marks.** The indentation marks for drilling are made with a centre punch, whereas marks for centres for dividers or for transferring a pattern etc. are made with a prick punch. While using punches, first the location of punch is marked with two intersecting lines, then the punch is held at that point and head of the punch is given a light blow with the hammer.
5. **Transferring a pattern.** While transferring a pattern, the ends of the lines are marked by a prick punch and then remove the pattern and join the lines by a scribe in proper manner. Sometimes a sharp pointed pencil is used to draw the outline of the paper pattern on a sheet or scribe is used for metal pattern.

12.4.2. Cleaning

Sometimes, the blank surfaces need proper cleaning before being processed. For cleaning, pickling process is used. In this process, sheets are immersed in a hot bath of 1 part dilute sulphuric acid and 20 parts water. After allowing sufficient time for pickling, the blanks are thoroughly washed in a stream of water and then allowed to dry.

12.4.3. Laying out

While doing the marking of development of the surface of the component on the sheet, certain material for various allowances (such as overlapping, cutting, bending etc.) are added. Such a layout when made on the sheet is called laying out process.

12.4.4. Cutting and Shearing

The word cutting is normally used when the sheet metal is cut by means of a chisel and a hammer manually. The term shearing means cutting of sheet metal by two parallel cutting edges moving in opposite directions manually. Shearing is done by hand shears or snips or by means of machines. Shearing action has three basic stages : Plastic deformation, fracture and shear. When the metal is placed between the upper and lower blades of the shear and pressure is applied, first plastic deformation takes place. Then there is fracture and ultimately shearing takes place when further pressure is applied. General shearing (or cutting) process by hand shear is described below :

- ❖ Hold the snip in one hand and sheet in the other hand.
- ❖ Place the upper blade on the line of cut to be followed.
- ❖ Start the cut by exerting pressure on handles of snips. After cutting about 15 mm, open the blades again and push the snip forward. Repeat this until cut is completed.
- ❖ In order to maintain proper space for snip, curl the sheet.
- ❖ The inside curves such as circular holes (manually) are cut with curved snips. The holes are first cut roughly with a cold chisel and hammer. Then it is trimmed to the required size by the curved snip.

If punch and die set up is used for shearing operation, then the punch is of the same shape as that of die opening except that it is smaller on each side by an amount known as clearance.

When the punch travels downward it pushes the material into die opening causing tensile and compressive stresses in the workpiece. When the stress reaches upto breaking point, shearing takes place. Stresses in shearing operation are shown in figure 12.22.

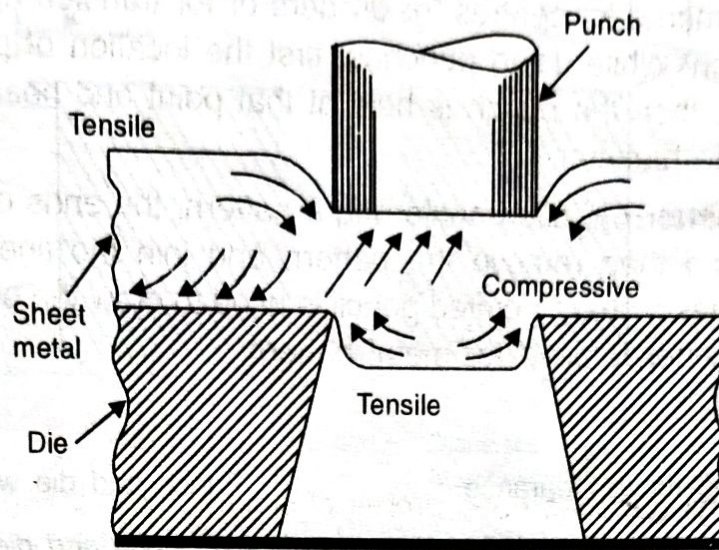


Fig. 12.22. Stresses in shearing operation.

Deformation of workpiece with punch travel is shown in Figure 12.23. When the strain in the workpiece along AB reaches upto limiting value, the fibre of the workpiece material ruptures. After this, further movement of the punch causes the fracture along BC. A similar crack also propagates from the die corner DC.

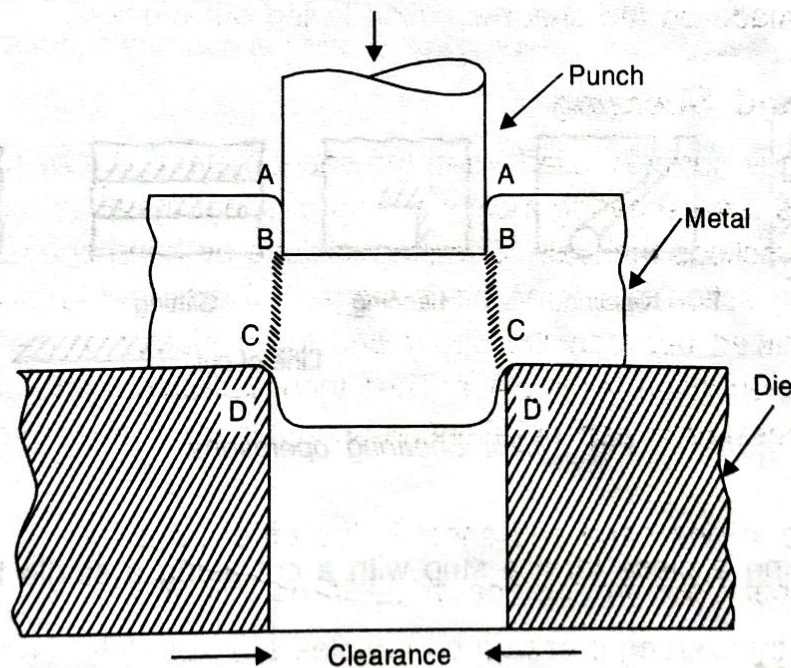


Fig. 12.23. Deformation of workpiece.

Clearance between punch and die plays an important role in shearing operation. If the clearance is too small then the fracture lines do not meet and secondary deformation takes place causing an unclean edge. If the clearance is too large fracture lines do not meet and material is being dragged in the space between the punch and die.

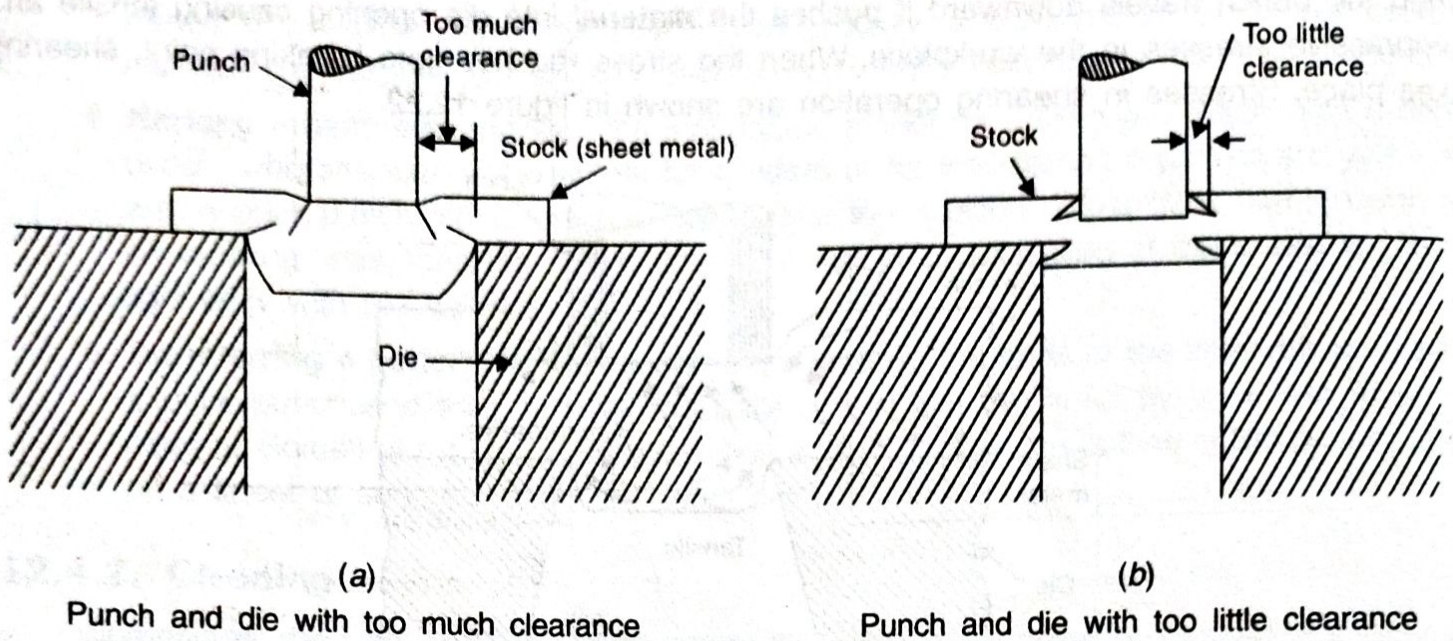


Fig. 12.24. Effect of clearance between punch and die.

The basic shearing operations are as follows :

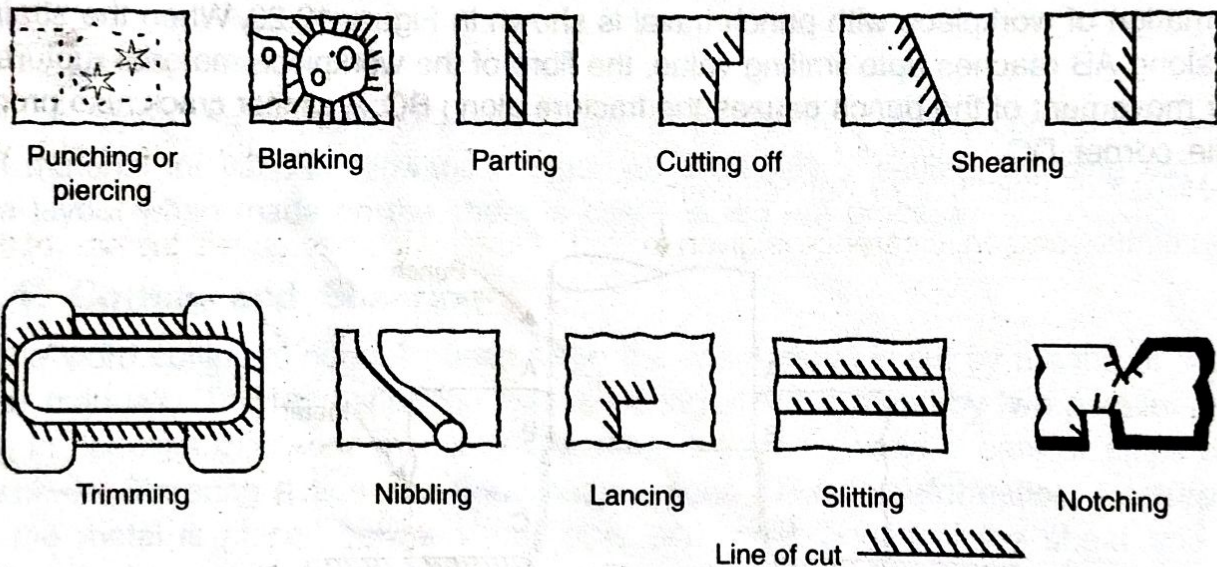


Fig. 12.25. Shearing operations.

- Cutting off

This means severing a piece from a strip with a cut along a single line.

- Parting

Parting signifies that scrap is removed between the two pieces to part them.

- Blanking

This means cutting a whole piece from sheet metal. Around this piece, there is enough scrap left all around this piece. The piece which is cut from the sheet metal is our objective. The size of the blank (cutting part) is our requirement and the remaining sheet is scrap.

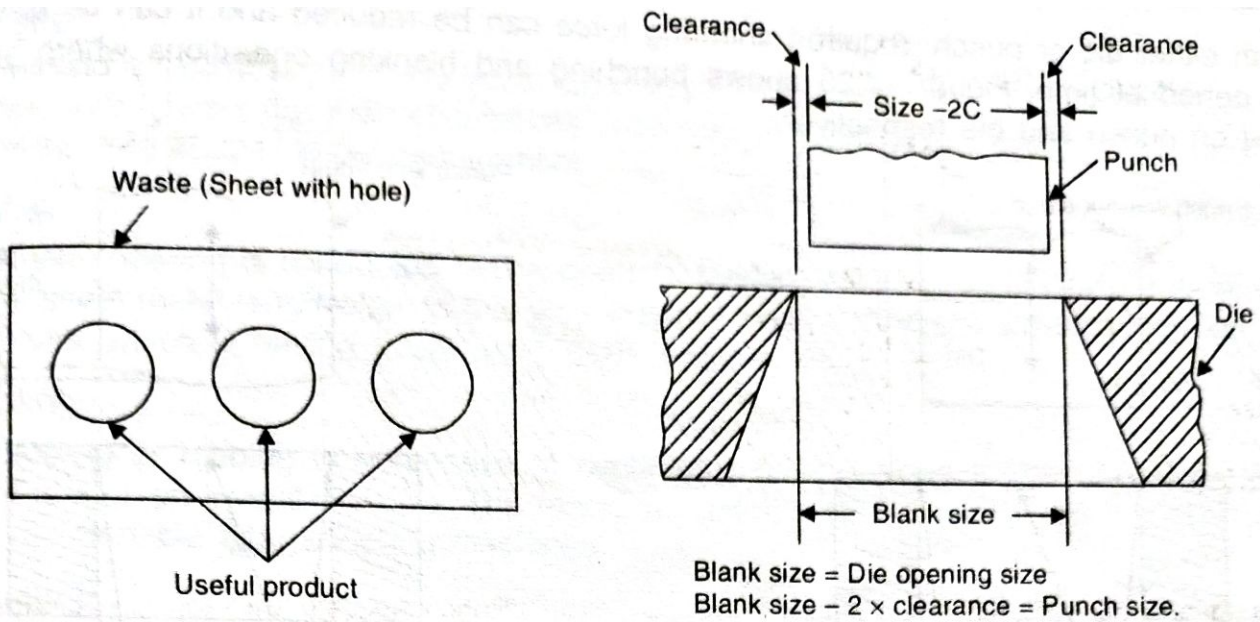


Fig. 12.26. Blanking operation.

Blank is then further processed to produce desired part. In blanking operation clearance is given to the punch whereas die opening size equals the blank size.

- Punching

Punching is the operation of producing circular holes on a sheet metal by a punch and die. The material punched out (small circular sheet) is removed as waste and the sheet, which is having holes, is our objective or our requirement.

In punching operation, clearance is given to the die and punch size equals the size of the hole.

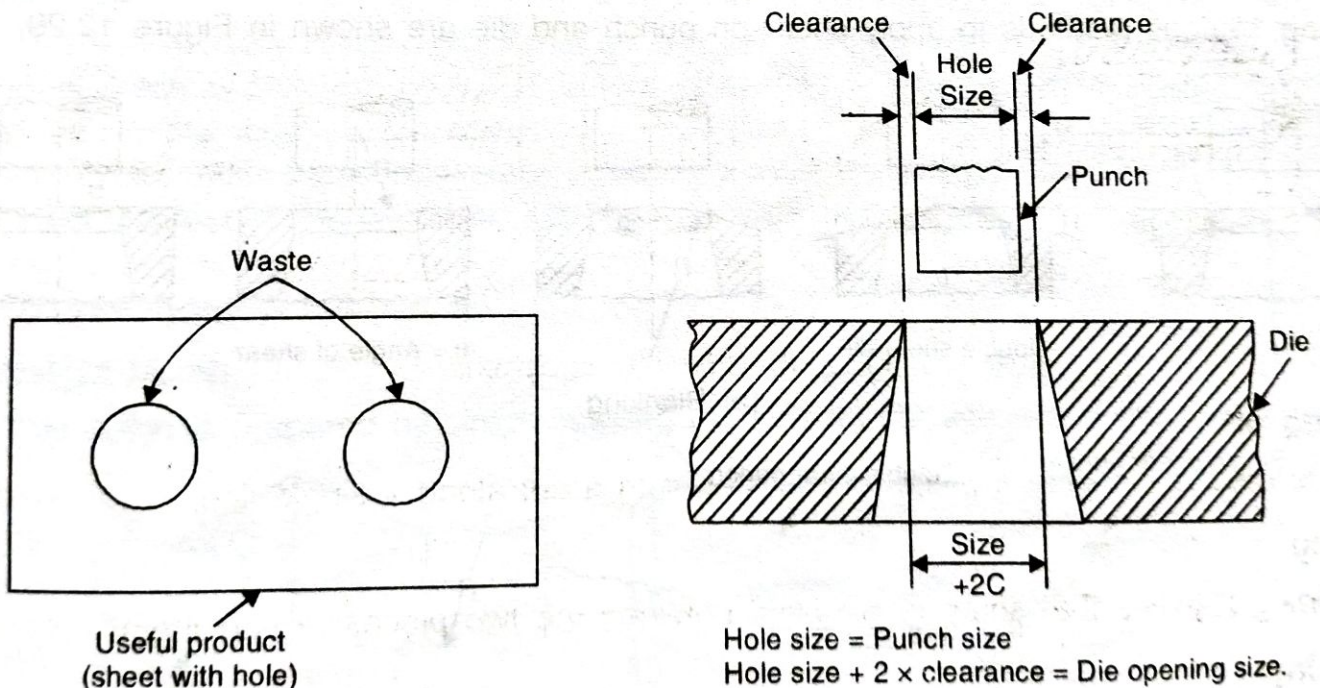


Fig. 12.27. Punching operation.

- Piercing

Piercing is similar to punching but in punching, circular holes are produced in a sheet whereas in piercing, holes other than circular are produced in a sheet. The sheet, which is having the holes of desired shape, is our requirement.

12.4.7 Deep Drawing

In sheet metal, drawing is a process by which hollow shapes are formed from the sheet metal. Die and punch is used in drawing operation. But in this case the die and punch corners are round and also there is large clearance between punch and die as compared to sheering. If the depth is one or more times the diameter, the process is called deep drawing. In deep drawing, a parallel walled cup is created from a flat blank. The blank may be circular, rectangular or of a more complex outline. Drawing operation is performed in successive steps.

$$\% \text{ Reduction} = \frac{D-d}{D} \times 100$$

where, D = blank diameter

d = punch diameter.

A percentage reduction of 48% is considered excellent on the first draw. For a second draw it would be about 30% and about 20% for a third draw. Lubricants will be used to reduce the friction between the metal and die.

12.4.8 Riveting

It is a process of joining the two pieces of sheet metal permanently by means of rivets. These rivets are made of soft iron and are usually coated with tin.

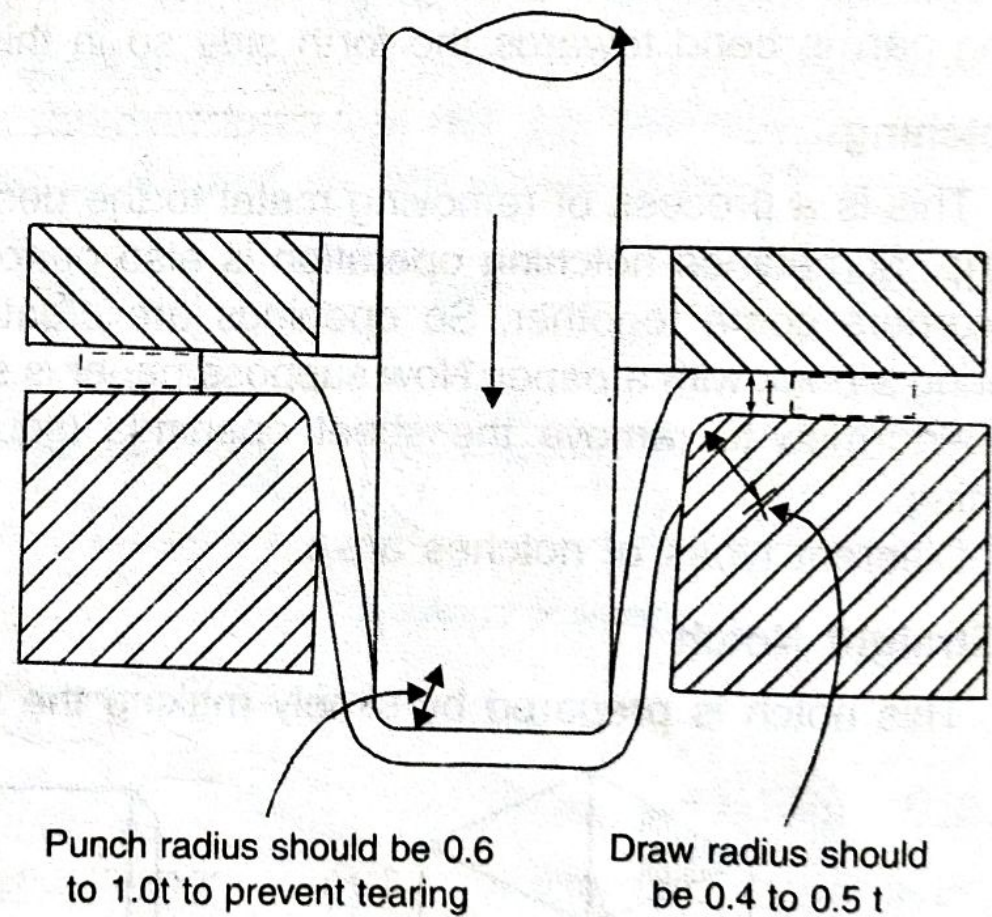
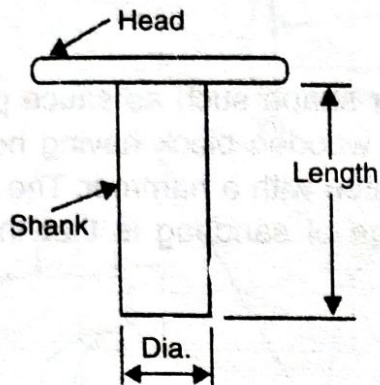
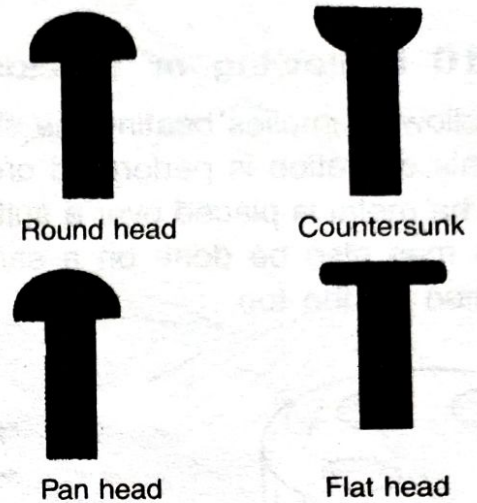


Fig. 12.32. Deep Drawing.

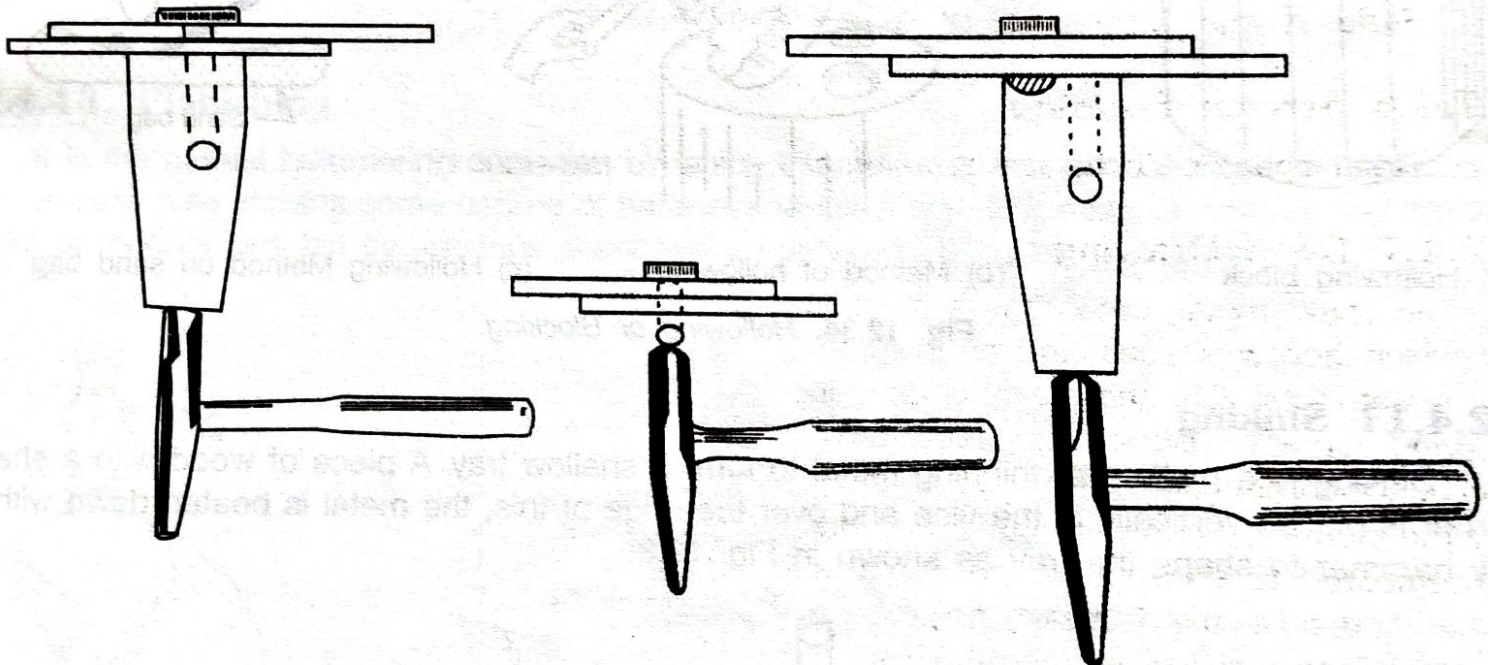
In order to join the two pieces of sheet metal, first a hole is drilled in the pieces. The hole should be of correct size. Then the rivet will be inserted in the hole. After that the rivet head will be placed on some metal bar or stake. Joint will be produced by hammering the shank of the rivet i.e. head is also formed on the other side. In this way riveting operation is performed.



(a) Rivet



(b) Rivet Heads



(c) Riveting

Fig. 12.33. Rivets and Riveting.