

Press forming or Sheet Metal working

Sheet metal forming processes are those processes in which force is applied to a piece of sheet metal to modify its geometry rather than remove any material. The applied force produces the stresses in the metal beyond its yield strength, causing the material to plastically deform, but not to fail. By doing so, the sheet can be bent or stretched into a variety of complex shapes.

Sheet metal working or forming processes are the processes used to give required shape and size to the metal sheets, using different operations.

Principle: The materials are sheared or formed between a die and punch without formation of chips.

Press: The press is a sheet metal forming machine tools designed to shape or cut the metal by applying mechanical force or pressure.

Details or construction of Press: It is a hand operated press. It has a fly wheel, with operating handle. The screw of the press operates in a nut, fixed in the vertical columns of press body. A ram is attached to the lower end of the screw. When the screw is operated by a handle; the ram moves in a vertical direction in the slides on the press column face. A punch is fixed in the ram. A die is fixed on a bolster plate which is mounted on the table.

A simple cutting die used for punching and blanking operation in the press is shown in the figure with different terms associated with press work and press machine:

- a) **Bed:** The bed is the lower part of the press frame that serves as a table to which a Bolster plate is mounted.

- b) **Bolster Plate:** This is a thick plate secured to the press bed, which is used for locating and supporting the die assembly.

- c) **Guide post and bushings:** To hold the punch and keep alignment.

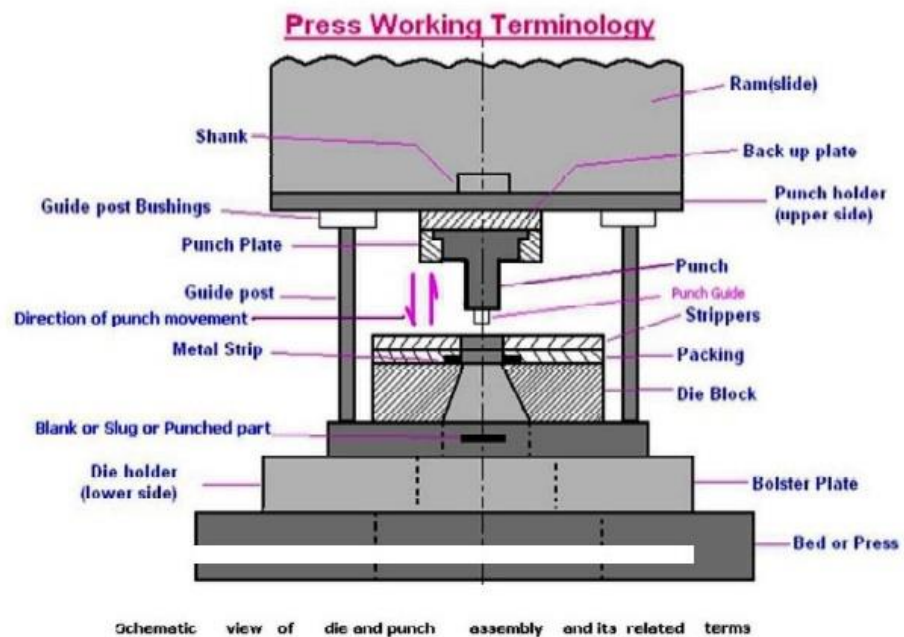
- d) **Die Block:** It is a block or a plate which contains a die cavity

- e) **Die holder:** This is generally mounted on the bolster plate of the press. The die block is mounted on it, also the guide post are mounted on it.

- f) **Punch:** This is male component of a die assembly, which is directly or indirectly moved by and fastened to the press ram or slide.

- g) **Punch holder & Plate:** The punch plate or punch retainer fits closely over the body of the punch and holds it in proper relative position.

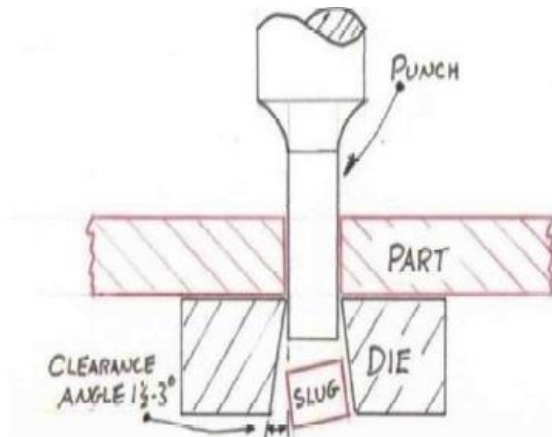
- h) **Stripper:** It is a plate which is used to strip the metal strip from Punch during returning.



Process of punching

Working of press: The sheet metal to be worked is placed over the die. Arm is pulled to give a quick rotation by means of handle. This enables the rotation of fly wheel to store kinetic energy, for giving further movement to the screw. These moves ram and punch downwards, which in turn, gives enough thrust on the sheet to do the required operation.

Sheet Metal Operations: The different sheet metal operations based upon operation can be classified as (another classification is based on type of dies a. Simple b. Progressive c. Combination and d. Compound):



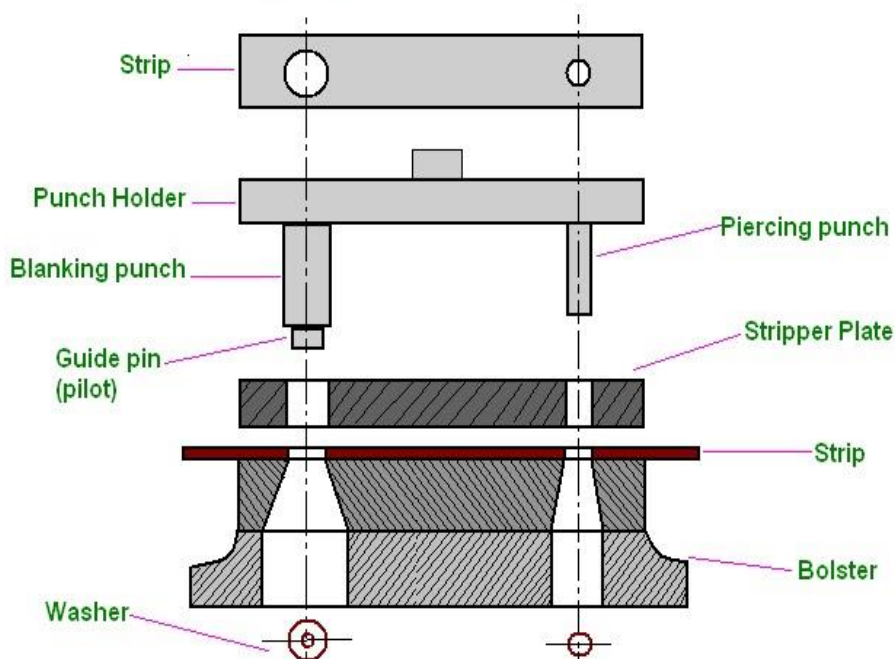
Press tools or dies are commonly used in hydraulic, pneumatic, and mechanical presses to produce components at high volumes. Generally press tools are categorized by the types of operation performed using the press tool or die, such as blanking, piercing, bending, forming, forging, trimming etc.

Type of Dies:

a. Simple Die are Blanking die, piercing die, trimming die etc.

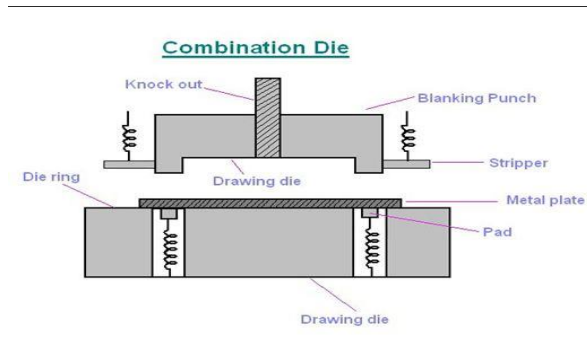
b. Progressive die: In a progressive die the final component is obtained by progressing the sheet metal or strip in more than one stage. At each stage the tool will progressively shape the component towards its final shape, with the final stage normally being cutting-off.

Progressive Die



c. Combination Die:

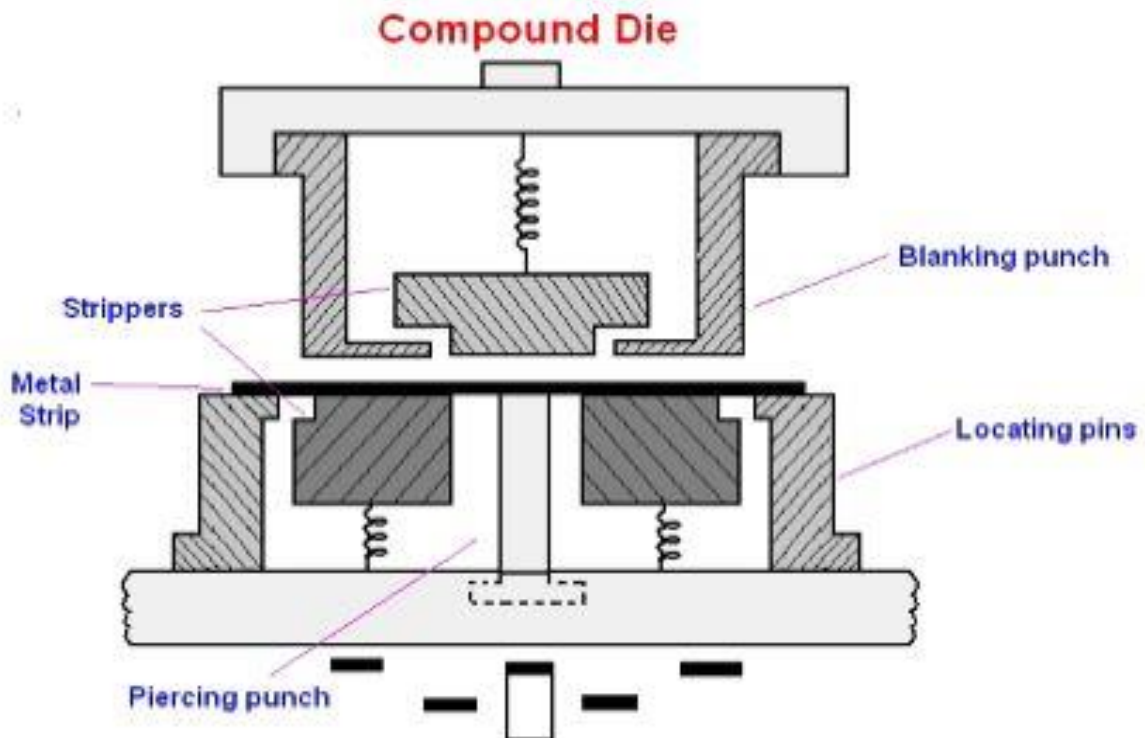
Combination Die

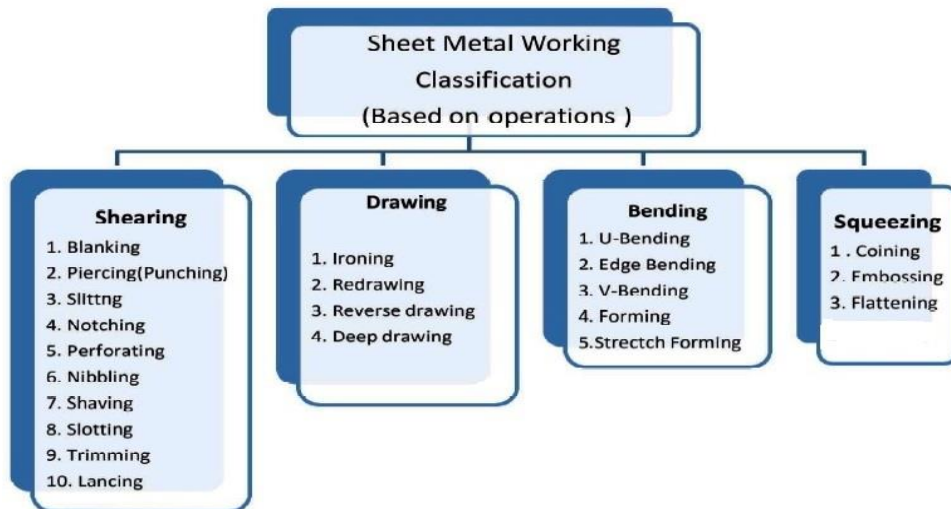


- ▶ In this die also , more than one operation may be performed at one station.
- ▶ It is different from compound die in that in this die, a cutting operation is combined with a bending or drawing operation, due to that it is called combination die.

d. Compound Die:

The compound Die differs from progressive die by the arrangement of the punch and die. It is an inverted tool where blanking and piercing takes place in a single stage



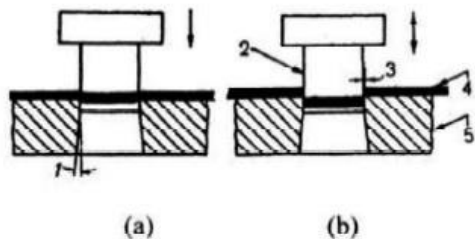


1. Shearing: Shearing is a sheet metal cutting operation without formation of chips or the use of burning or melting.

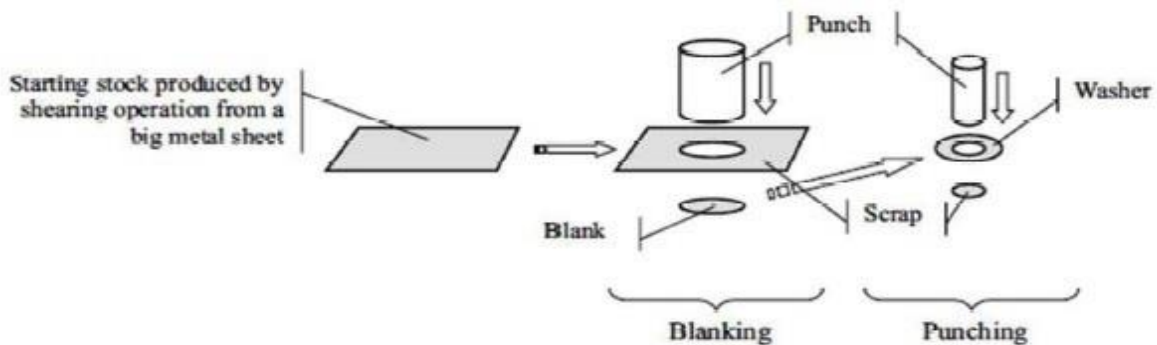
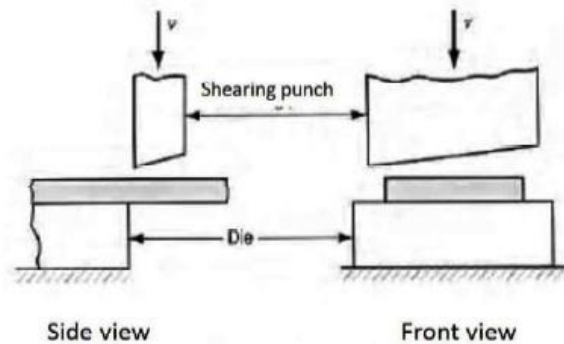
1.2. Piercing: The piercing is the operation of production of hole in a sheet metal by the punch and the die. The materials punched out to form the hole constitute the waste.

1.3. Blanking and punching (Difference)

Blanking and punching are similar, sheet metal operations that involve cutting the sheet metal along a closed outline. If the part that is cut out is the desired product, the operation is called blanking and the product is called blank. If the remaining stock is the desired part, the operation is called punching. Both operations are illustrated by the example of producing a washer.



(a). Plastic deformation. (b). Shear
1. Die clearance, 2. Punch, 3. Punch clearance.
4. Plate, 5. Die.

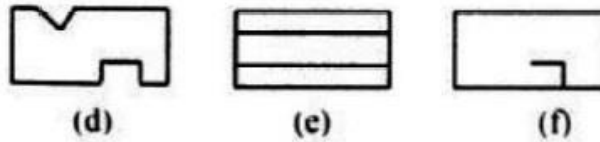
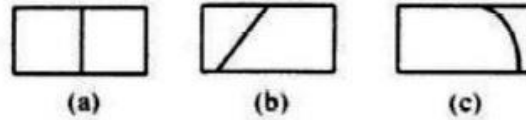


Steps in production of washer

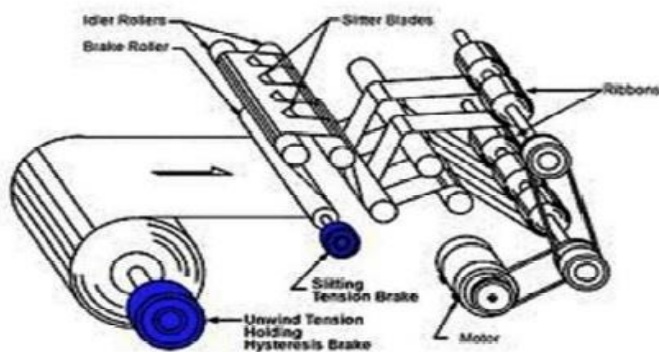
1.4. Cutting off: The cutting off is the operation of severing a piece from a sheet of metal or a bar with a cut along a single line. The cutting off operation illustrated in Fig. a) (b) (c) can be performed along a straight line or a curve.

1.5. Notching: The notching is the operation of removal of the un-desired shape from the edge of a plate. The operation is

illustrated in Fig. d. The punch and the die set up are similar to the piercing or punching operation.



1.6. Slitting: The slitting is the operation of cutting a sheet metal in a straight line along the length. Generally used for making many coils of small width from one wide coil of the metal. The slitting operation is shown in Fig. e above and below.

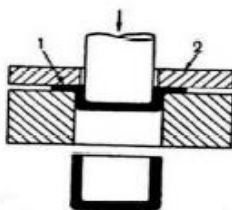
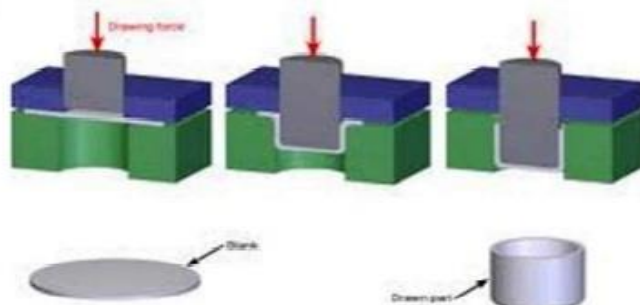
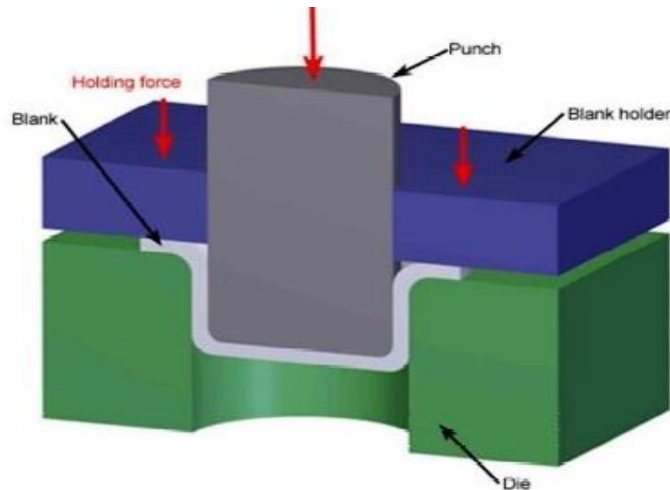


1.7. Lancing: The lancing is the operation of cutting a sheet metal through part of its length and then bending the cut portion. The operation is illustrated in Fig. f and below.

Three steps to show the lancing process

2. Drawing

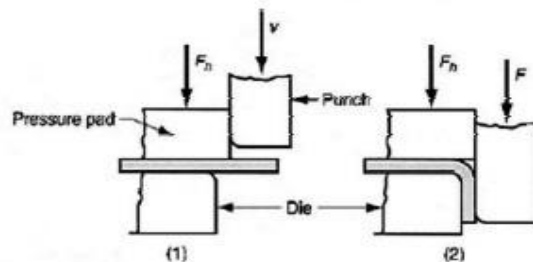
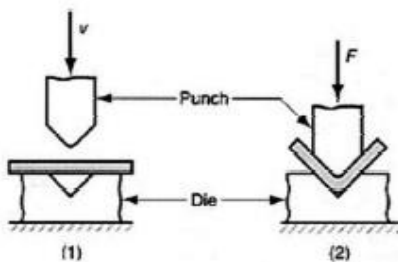
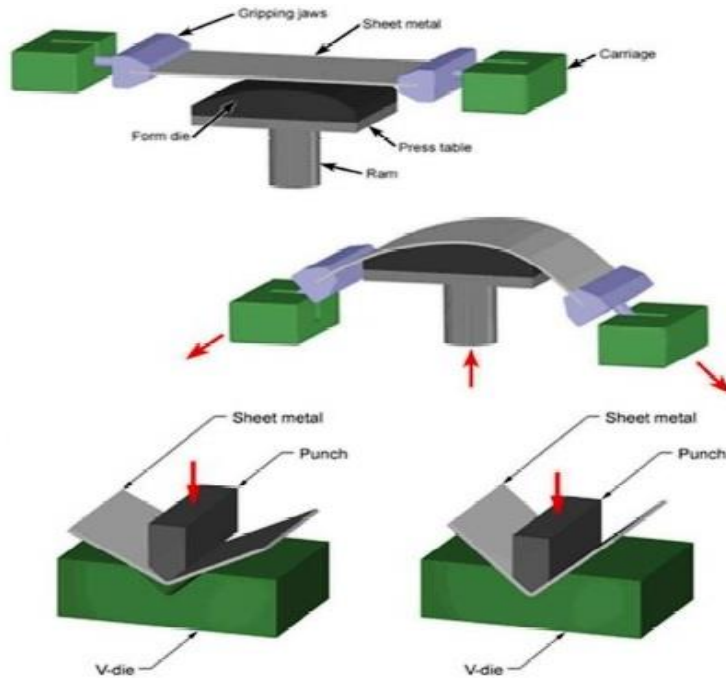
Drawing is a sheet-metal operation to make hollow-shaped parts from a sheet metal such as cup. The drawing is the operation of production of cup shaped parts from flat sheet metal blanks by bending and plastic flow of the metal. The operation is also known as **cupping**. Different drawing operations are: **Deep drawing** operation is performed to draw very deep parts (When the depth is more than the diameter) from the metal strips through plastic deformation (example of deep drawing is the aluminum cap of the electric bulbs, **ironing** is the operation of reducing the wall thickness), **redrawing** (drawing is performed many times to reduce the diameter of earlier drawn cup shape), **Reverse drawing** (the drawn cup is subjected to force in opposite direction). The drawing operation is illustrated in below Fig.



Drawing operation
1. Blank, 2. Pressure pad.

3. Bending

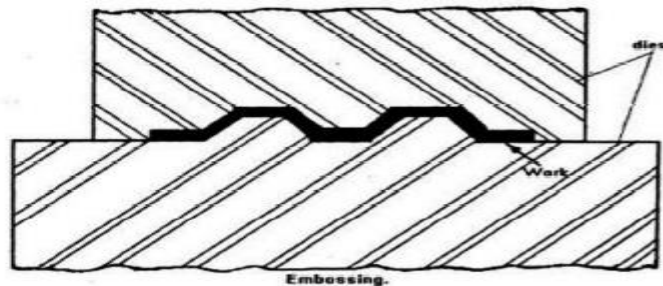
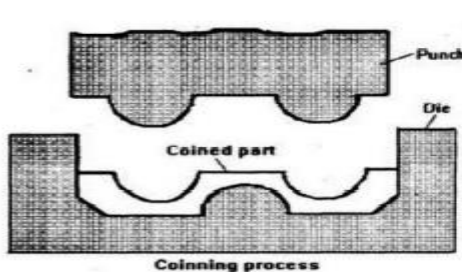
Bending is defined as the plastic deformation about a linear axis with little or no change in the surface area. Figure illustrates the bending operation on a metal sheet. The different bending operations may be angle or simple bending, edge bending, U & V bending, forming and stretch forming. Stretch forming is a metal forming process in which a piece of sheet metal is stretched and bent simultaneously over a die in order to form large contoured parts.



4. Squeezing: In the squeezing operation large amount of pressure is required to squeeze a metal which is made to flow in a cold state within the cavity of the die and the punch to attain the desired shape. For this reason the squeezing operation is performed in a hydraulic press. The metal may be in the bulk or sheet form. Rolling is also a squeezing operation. The different squeezing operations are described below:

4.1 Coining: The coining is the operation of production of coins, medals or other ornamental parts by squeezing operation.

4.2 Embossing: The embossing is the operation of giving impressions of figures, letters or designs on sheet metal parts. The punch, or the die, or both of them may have the engravings which are marked on the sheet metal by squeezing and plastic flow of the metal. Figure below illustrates the coining and embossing operations.



Applications of sheet metal working

Coin and medal making, Sheets for Roofs, Air conditioning Ducts, and Vehicles body buildings like 3 wheelers, 4 wheelers, ships, aircrafts, Furniture, Household utensils, pans, and Railway equipment

References:

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2. 'Production Technology' by R K Jain, Laxmi Publisher
3. Ghosh A. and Mallik A. K., Manufacturing Science, EWP Pvt. Ltd
4. <http://nptel.ac.in/courses>