Press Working/Sheetworking Operations

Pressworking
- Chipless manufacturing
- Cold stamping

Basic presswork operations
- Cutting
  - Forming
    - Blanking and punching
    - Piercing
    - Notching
    - Perforating
    - Shaving
    - Slitting
    - Lancings
    - Nibbling

Cutting operations
- Roll Bending
  - Beading
  - Bending
  - Dimpling
  - Punching
  - Flanging
  - Hemming
  - Slitting
  - Seaming
  - Roll forming

Forming Operations
- Bending
- Drawing
- Redrawing
- Squeezing
- Coining
- Ironing

Blanking: The process of cutting a flat shape from the sheet is called as blanking. The cut-out portion is useful.

Punching: Similar to the blanking provided that the cut-out portion is the waste.
Piercing and flanging

Piercing is a blanking operation in which the punch tears the sheet to make a desired shaped hole. Piercing does not produce any scrap.

In flanging the hole is enlarged by a conical indenter or punch with the result a flange is formed around the circumference of hole. The flange so formed will have cracks and may not be strong enough for the desired application. For obtaining a smooth edge of flange a hole should be punched before flanging.

Fine blanking: Fine blanking technique is used for punching or blanking high precision components such as gears and levers that are used in watches and instruments. The edge quality in blanking can be improved by gripping the sheet between die and v-shaped projection provided on the blank holding plate. The clearance or order of 0.1% is maintained between die and punch in fine blanking.
Notching—This operation removes metal from either or both edges of strip. Notches are created to shape the outer contours in a progressive die.

Perforating—The process of creating multiple holes which are small enough and close to each other.

Applications

- Sun protection and climate control → Good air ventilation.
- Noise reduction - Used as noise reduction wall
- Balustrade screening panels - used for balconies, stairways and balustrades screens.
- Food and beverages - Used as drain dryers and baking trays
- Chemical and Energy - filters
  Gas purifiers, mine cages, coal washers etc.
- Automotive - Oil filters, radiator grilles, engine ventilators, motorcycle silencers etc.
- Material development - Blast furnace screens, textile printers, cement slurry screens etc.
Shaving: Edge surface of cut sheet are usually rough. Shaving is a process to remove such unnecessary roughness at the edges. Here very close clearance (~1% of sheet thickness) is maintained between punch and die.

Slitting: Slitting is a mechanized shearing process to create wide sheets to narrow sheets. Here the sheet is fed through two sharp slitting wheels.

Lancing: This is a combined bending and cutting operation along a line in the work material. No metal is cut free during a lancing operation. The punch is designed to cut two or three sides and bend along the fourth edge.

Nibbling: This process involves cutting of sheet metal parts by using a series of overlapping punches. Complex shapes (up to 6mm thickness) can be created using this nibbling.
Deep Drawing: Deep drawing or cup drawing is a process of forming hollow shaped components from flat pieces of sheet metal or from already drawn components. A large variety of components such as kitchen wares, boxes of various shapes, components of car bodies, domestic gas cylinders etc. are made by deep drawing.

The equipment consists of a die stake with a central hole having a profile radius, a blank holding plate which keeps the sheet pressed flat on the die surface and a punch with a suitable diameter and corner radius.

The motion of punch pushes the bottom of cup into the die. The sheet around the punch pulls the remaining sheet into the die to form a cup. The flat sheet between die and blank holding plate move towards the die center against the frictional forces between sheet and die surfaces and between sheet and blank holding plate. The sheet then bends over die profile radius slips over it against the frictional forces and then unbends into the cup wall.
Each of the above processes increases tensile stresses in the cup wall. The maximum tensile stress occurs at the punch profile radius where the sheet bends over it under tension. Generally, the failure takes place near the punch profile radius since the tensile stress here is the cumulative stress due to drawing of flange bending and unbending of sheet at die profile radius, frictional effect on die profile radius and lastly due to bending to punch profile radius.

Redrawing:- Redrawing of already drawn cup is often necessary due to following objectives.
1. To reduce the diameter or to increase the length of a cup.
2. To reduce the wall thickness of a cup.

Modes of Redrawing
1. Redraw with retaining ring.
   This process is used for small diameters. The corner radius is progressively decreased after the first draw.
2. Redraw through conical die. The conical die surface is 45° with the vertical axis. In this process, the material flow is in better condition because there is less shear both at entry & exit of the die. This process requires lower forces.
21 Reverse Redrawing

In drawing the different layers material across the thickness & sheet surface different strain.

In reverse drawing, these layers suffer strain of opposite type because of Bauschinger effect, the material yields at a lower stress.
Hydroforming

Spinning

Aluminum

Mandrel

Lathe tool
Bending and spring back

In bending operation, surface layers of the sheet suffer maximum stress. The outer layers of the bend region suffer tensile stress and inner layers suffer compressive stress. The surface layers are first to reach the plastic state. As the bending proceeds, the layers below the surface successively reach the plastic state. However, in severe bends, the layers near the neutral section of sheet may remain elastic. On unloading, the elastic deformation tries to recover thus unbending the sheet by a small angle. This phenomenon is called as spring back.

Factors affecting the spring back

- Angle of bend
- Thickness of sheet
- Type of tooling
- Work-hardening characteristics of material

Minimization of spring back

1. By overbending the sheet so that on unloading, the sheet recovers to the desired angle of bend.
2. By setting (compression) the material at the bend region so that the recovery is minimum.
The shearing usually starts at the contact points of punch and die with the formation.

- The shearing usually starts with the formation of cracks at die and punch contacts and results in a rough fractured surface with fracture angle $\beta$. Smooth, shiny and burnished surfaces are formed due to rubbing of sheet against punch and die and exist in upper region in the sheared edges.

- The ratio of burnished to rough area increases with increasing ductility of the sheet metal and decreases with sheet thickness and clearance.

- The width of shearing zone depends on rate of shearing or punch speed. With higher punch speed, the heat generated is confined to a smaller zone and results in smoother sheared surface.

- The burr height increases with increasing clearance and ductility of sheet metal. Tooling with dull edges is a major factor in burr formation.
Cutting/punching mechanism

The cutting/punching mechanism involves shearing the sheet metal, as well as plates, bars, and tubing of various cross-sections into individual pieces using a punch and die. Important variables in shearing process are the punch force, speed of punch, edge condition of sheet and punch, die materials, the corner radii of punch and die, the punch-die clearance and lubrication.

Significance of clearance! - The clearance between die and punch is a major criterion parameter that determines the shape and edge quality. As clearance increases, the edge becomes rougher and deformation zone becomes larger. Furthermore, the metal-stream is pulled into the clearance area and the shear edges become more and more rounded. In fact, if clearance is too large, the sheet metal will bend and subjected to tensile stress. Clearance is smaller for softer materials and higher as thickness increases.

The optimum value of clearance is 2 - 8% of sheet thickness when used as it is 1% for fine blanking process.