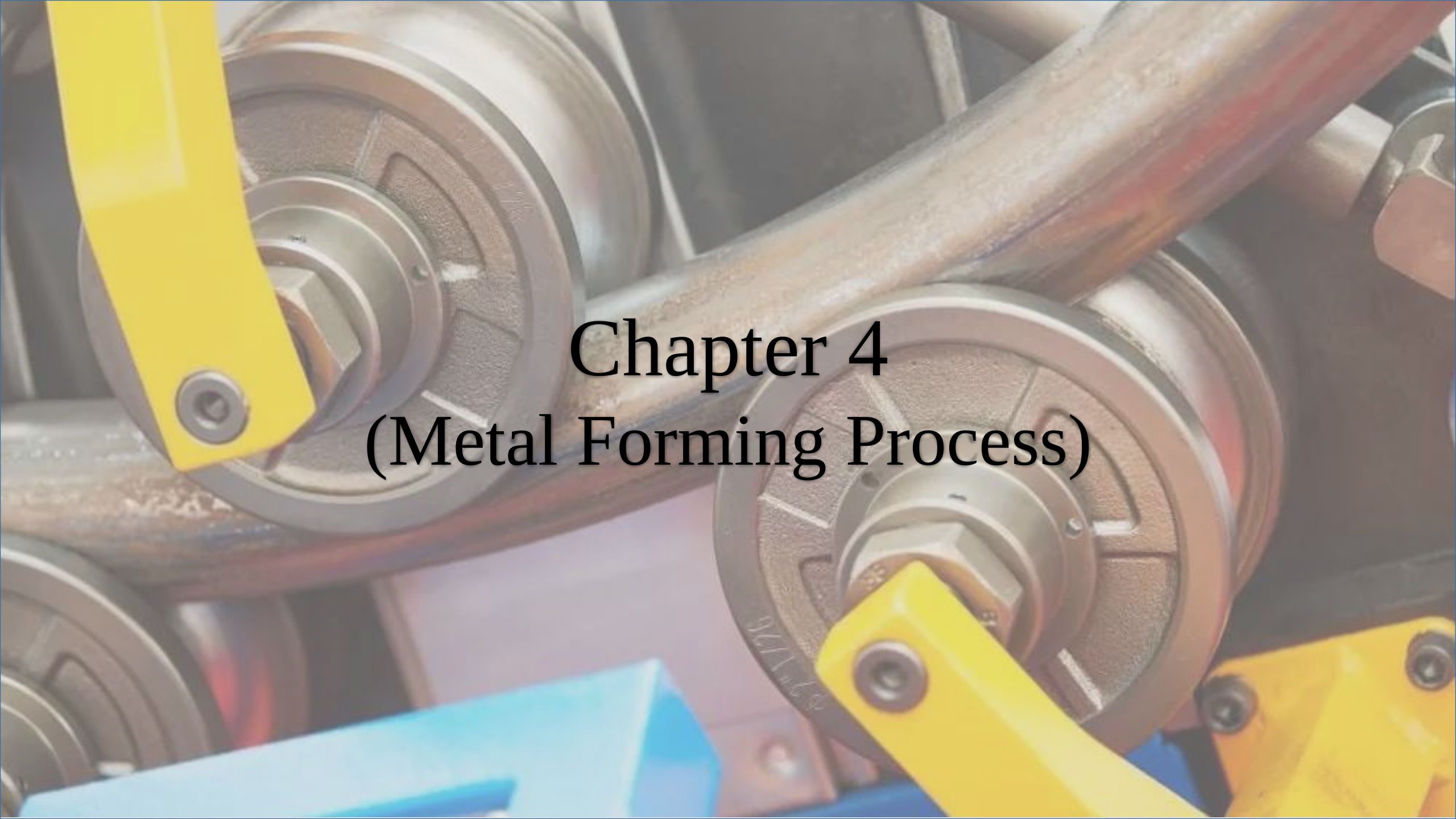
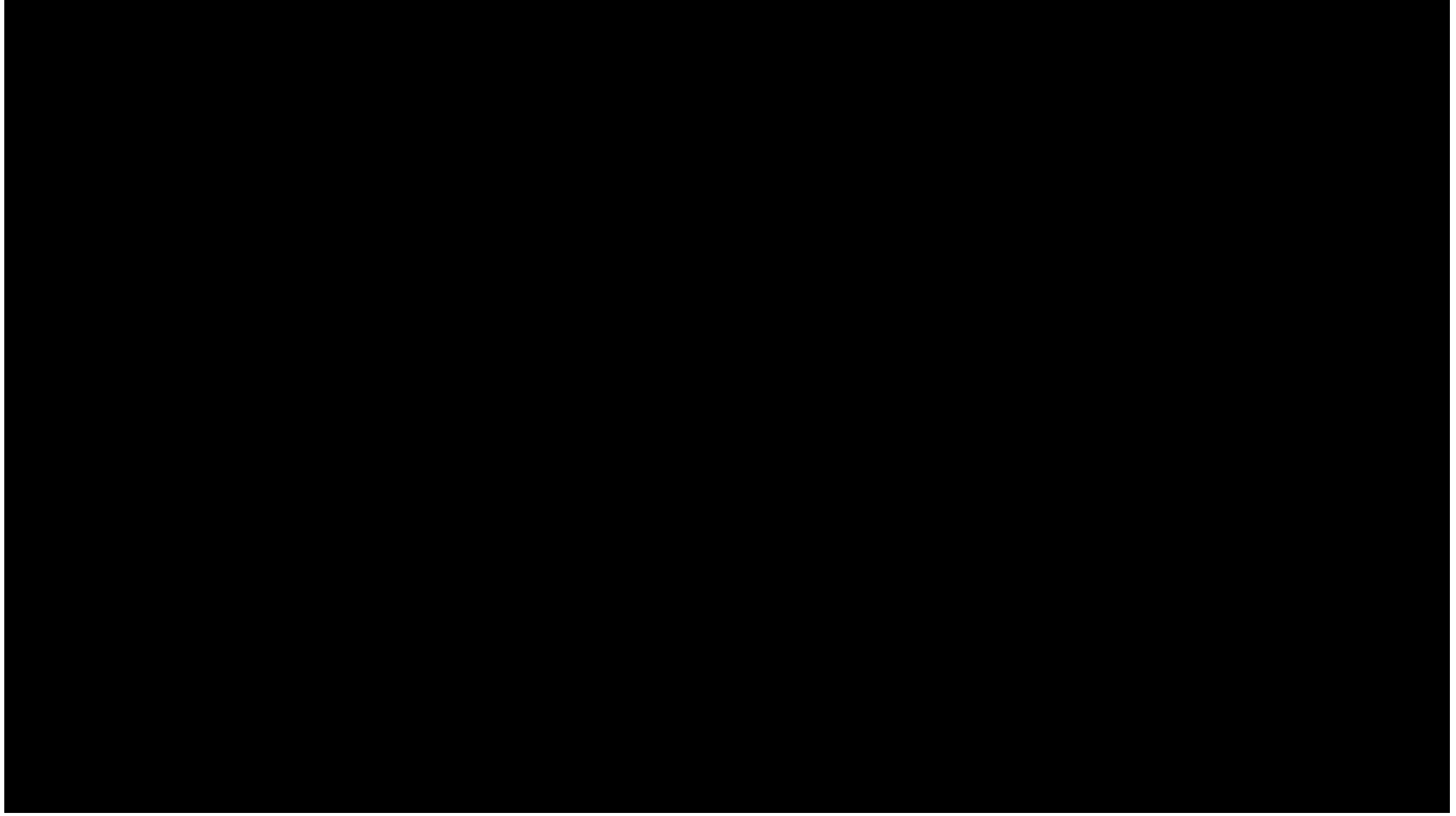


Chapter 4
(Metal Forming Process)



Press Working

Press working may be defined as, a manufacturing process by which various components are made from sheet metal. This process is also termed as cold stamping. The machine used for press working is called a press.

The main features of a press are:

- A frame which support a ram or a slide and a bed, a source of mechanism for operating the ram in line with and normal to the bed.
- The ram is equipped with suitable punch/punches and a die block is attached to the bed.
- A stamping is produced by the downward stroke of the ram when the punch moves towards and into the die block.
- The punch and die block assembly is generally termed as a “die set” or simple as the “die”

Press working operations:

The sheet metal operations done a press may be grouped into two categories.

1: Cutting operations

In cutting operations the work piece is stressed by its ultimate strength. The stresses caused in the metal the applied forces will be shear stresses. The cutting operations include:

(a) Blanking (b) Punching (c) Notching
(d) Perforating (e) Trimming (f) Shaving
(g) Slitting (h) Lancing

2: Forming operations

In forming operations , the stresses are below the ultimate strength of the metal , in this operation , there is no cutting of the metal but only the contour of the work piece is changed to get the desired product.

The forming operations include:

(a) Bending (b) Drawing (c) Squeezing

Sheet Metalworking Defined

Cutting and forming operations performed on relatively thin sheets of metal

- Thickness of sheet metal = 0.4 mm (1/64in) to 6mm (1/4 in)
- Thickness of plate stock > 6 mm
- Operations usually performed as cold working

Sheet and Plate Metal Products

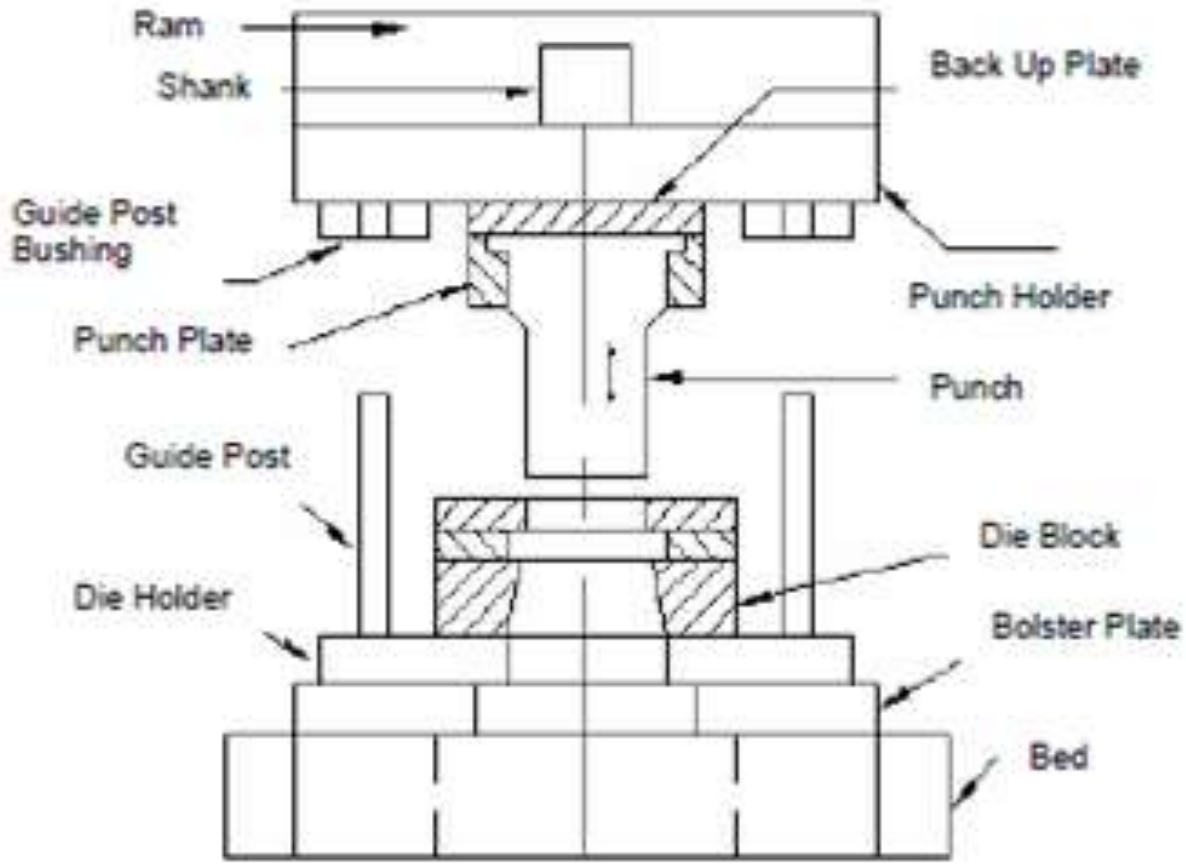
- Sheet and plate metal parts for consumer and industrial products such as
  - Automobiles and trucks
  - Airplanes
  - Railway cars and locomotives
  - Farm and construction equipment
  - Small and large appliances
  - Office furniture
  - Computers and office equipment

Advantages of Sheet Metal Parts

- High strength
- Good dimensional accuracy
- Good surface finish
- Relatively low cost
- Economical mass production for large quantities

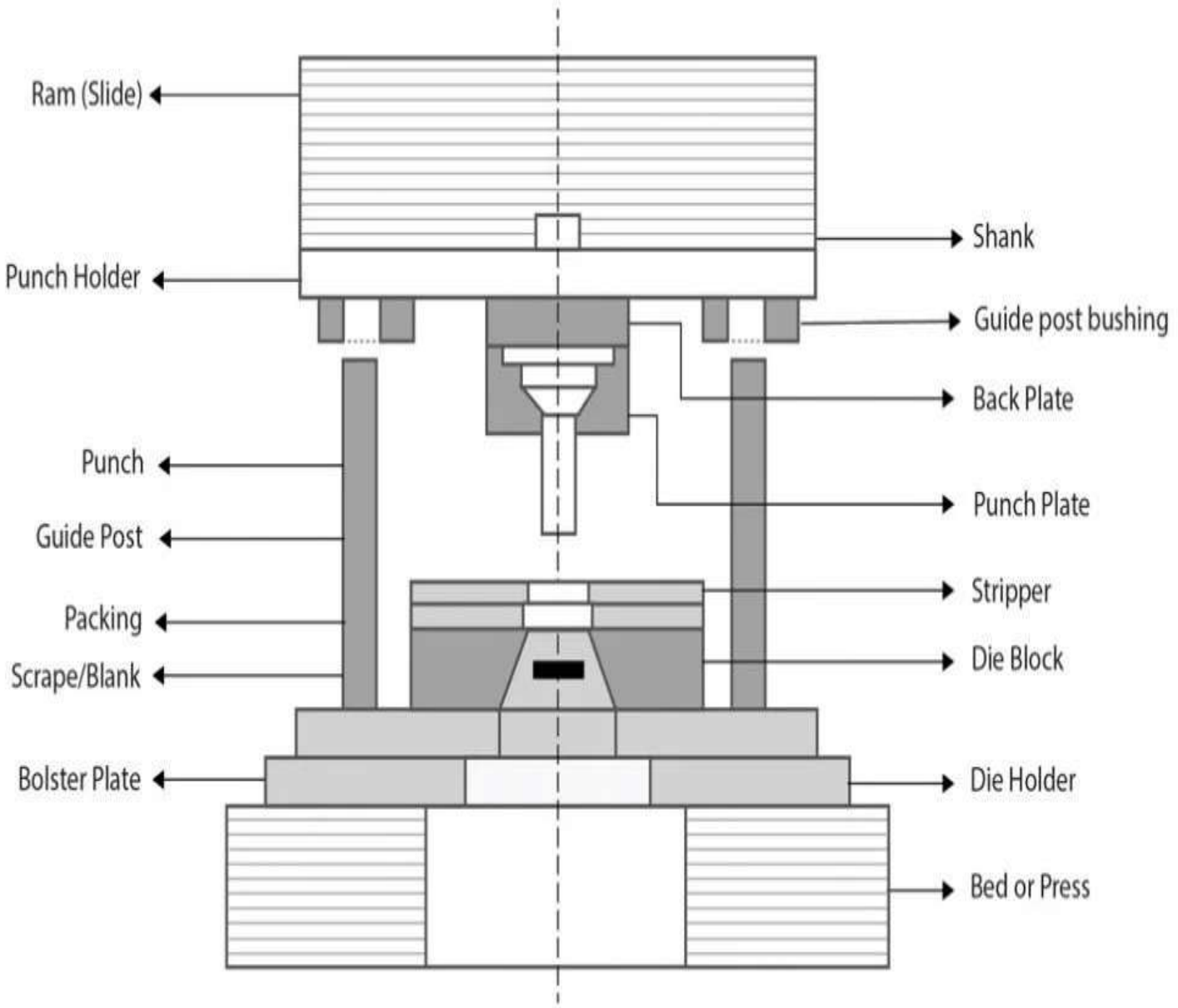
Basic terms used in Press working

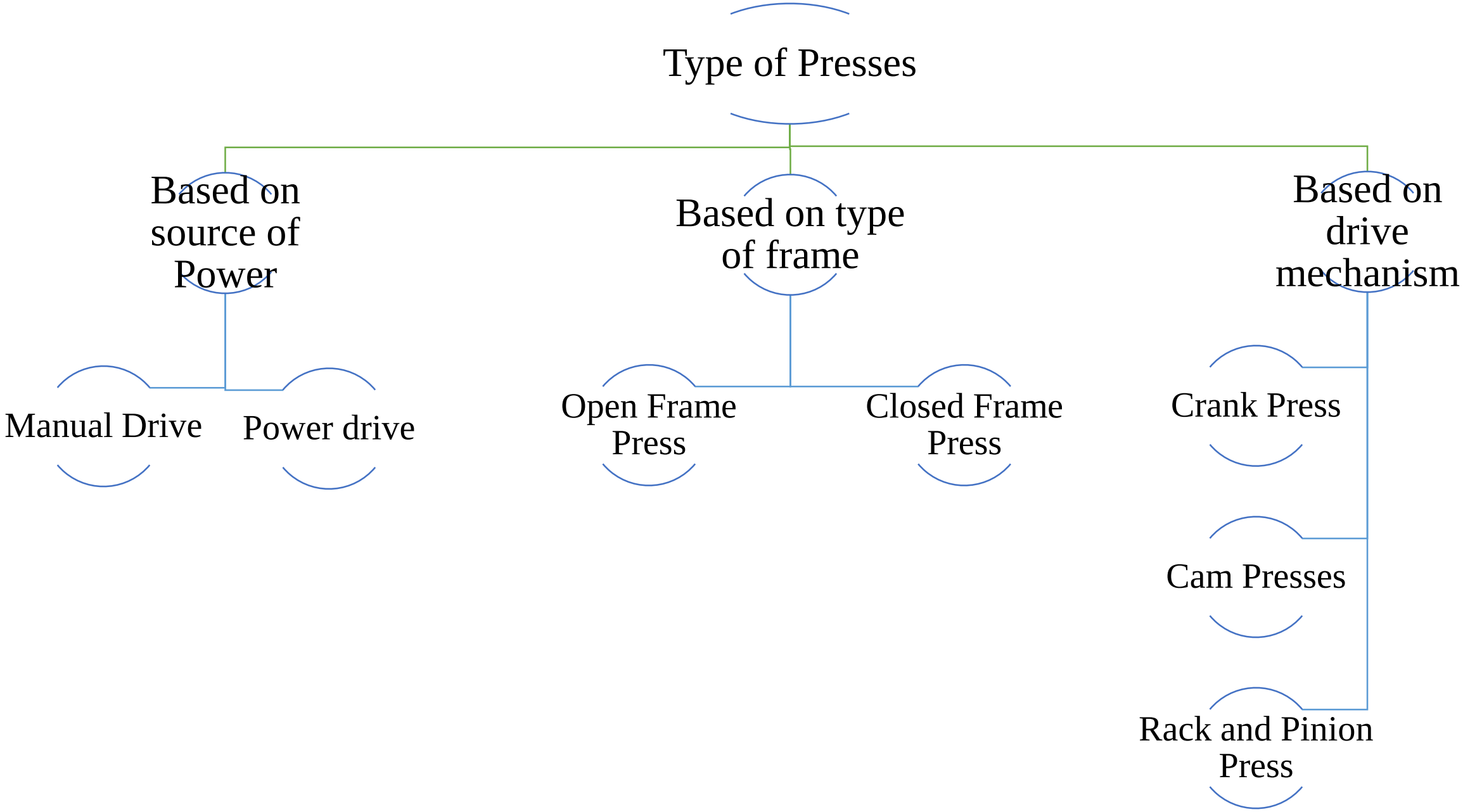
- **Press working or sheet metal working**
- **Spring back**
- **Press machine**
- **Press tool**
- **Punch-and-die**
- **Stroke**
- **Bolster plate**
- **Back Plate or Pressure Plate**



Press tool components

- **Working Components**
- **Structural Components**
- **Guiding Components**
- **Locating and locking components**
- **Feeding Components**
- **Fastening Components**




Type of Presses
Based on source of Power
Manual Drive
Power drive
Based on type of frame
Open Frame Press
Closed Frame Press
Based on drive mechanism
Crank Press
Cam Presses
Rack and Pinion Press

Press based on source of Power

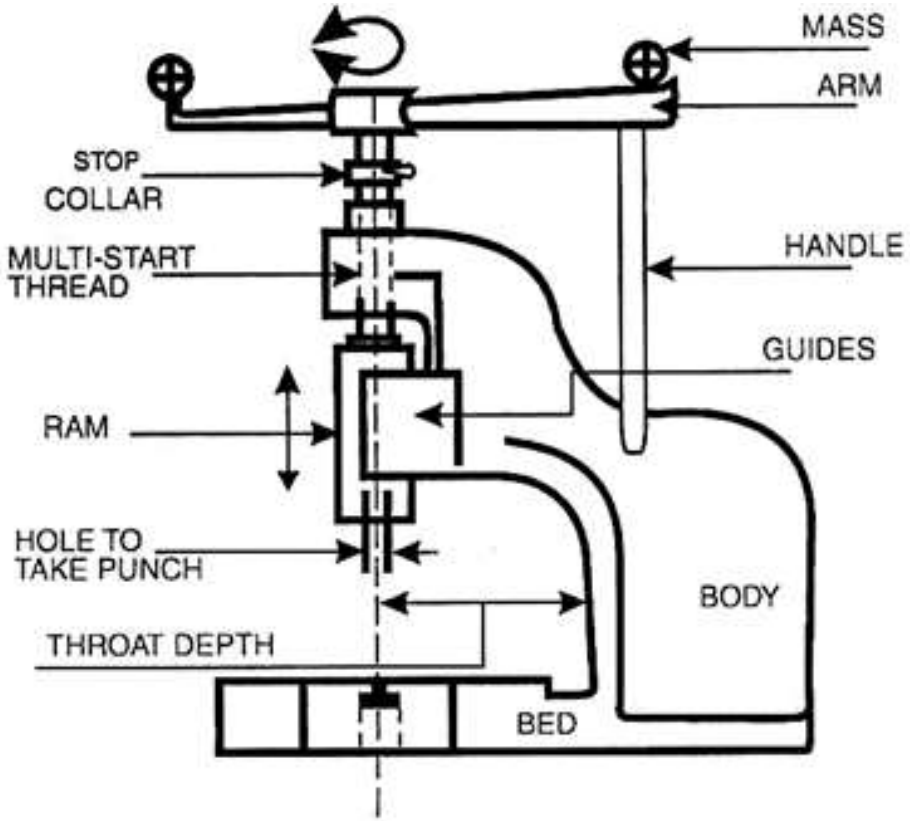
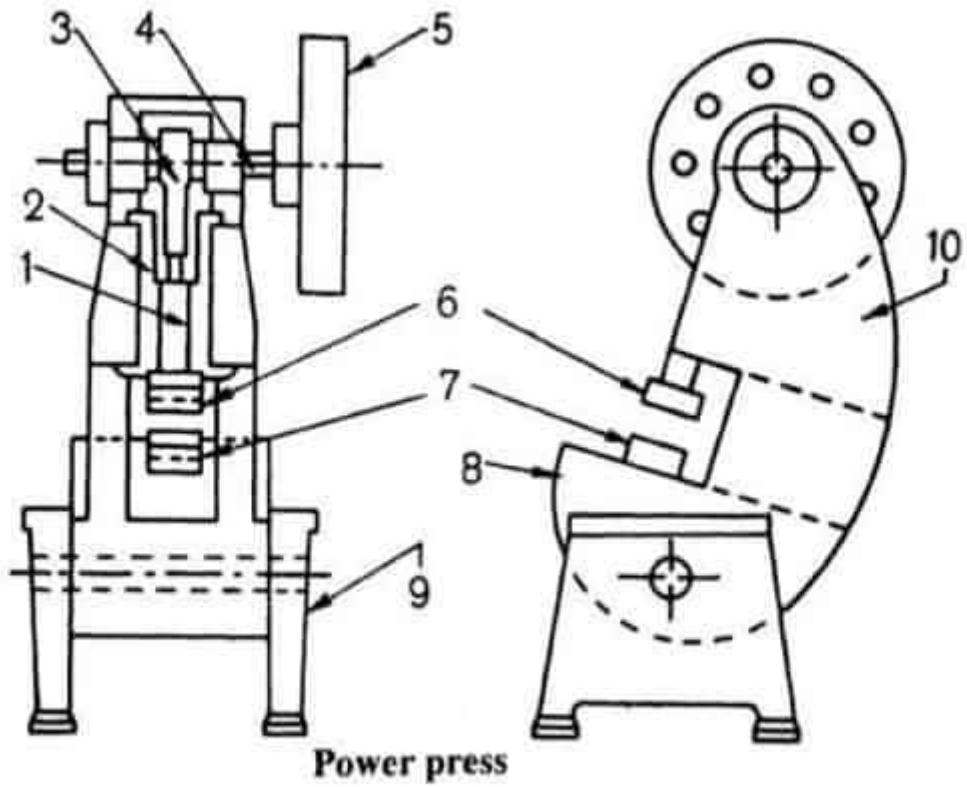


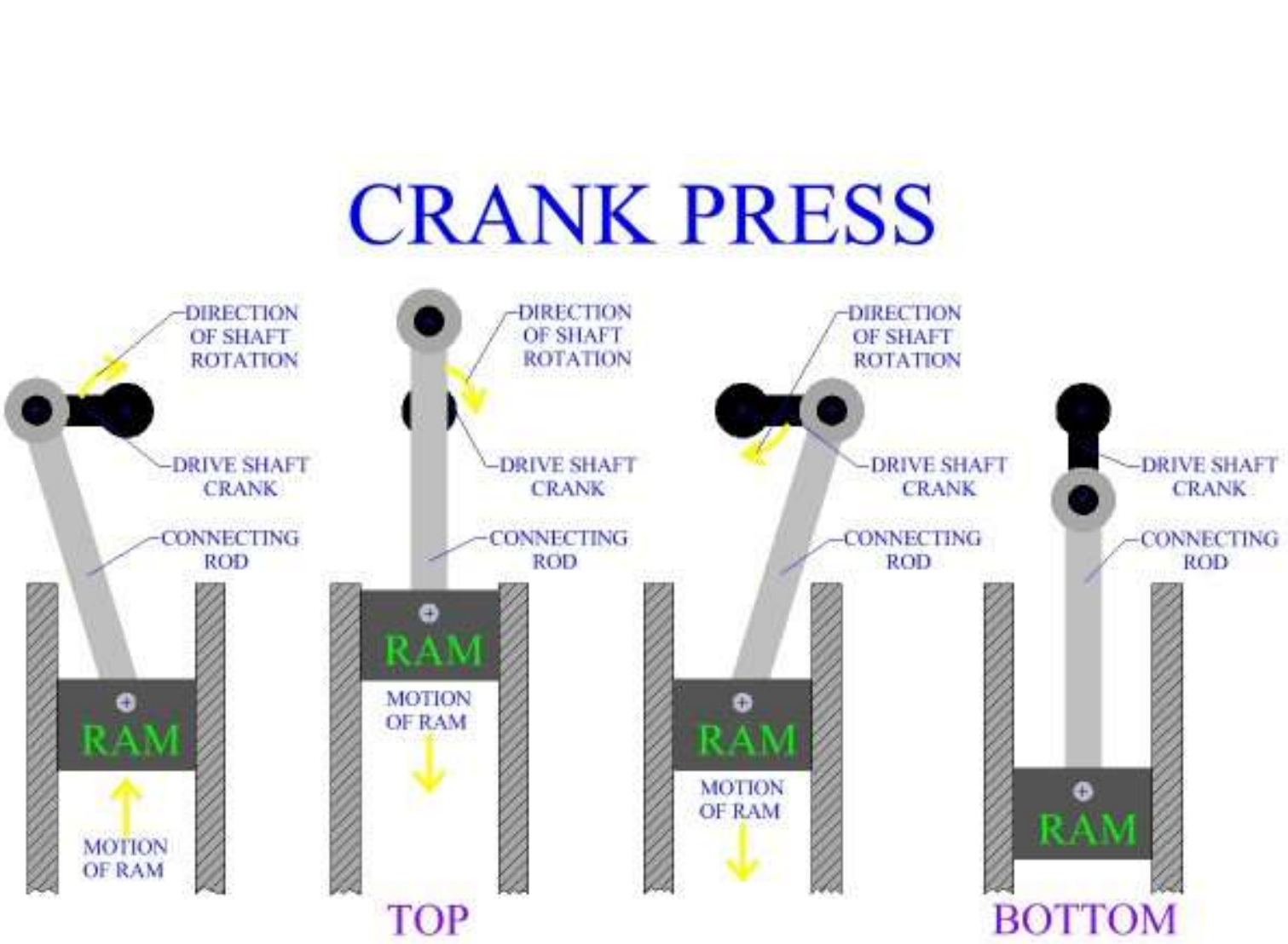
Fig. 6.2. A manually operated (Fly) Press.

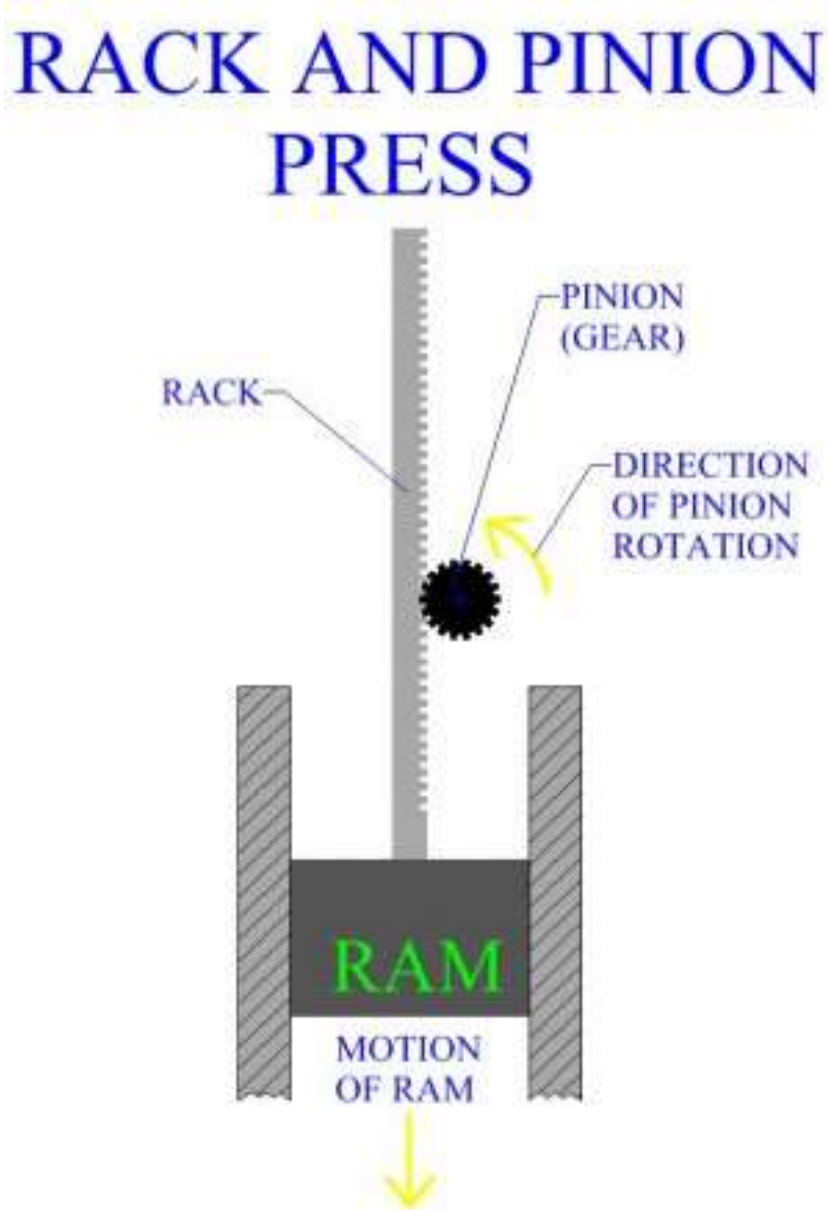


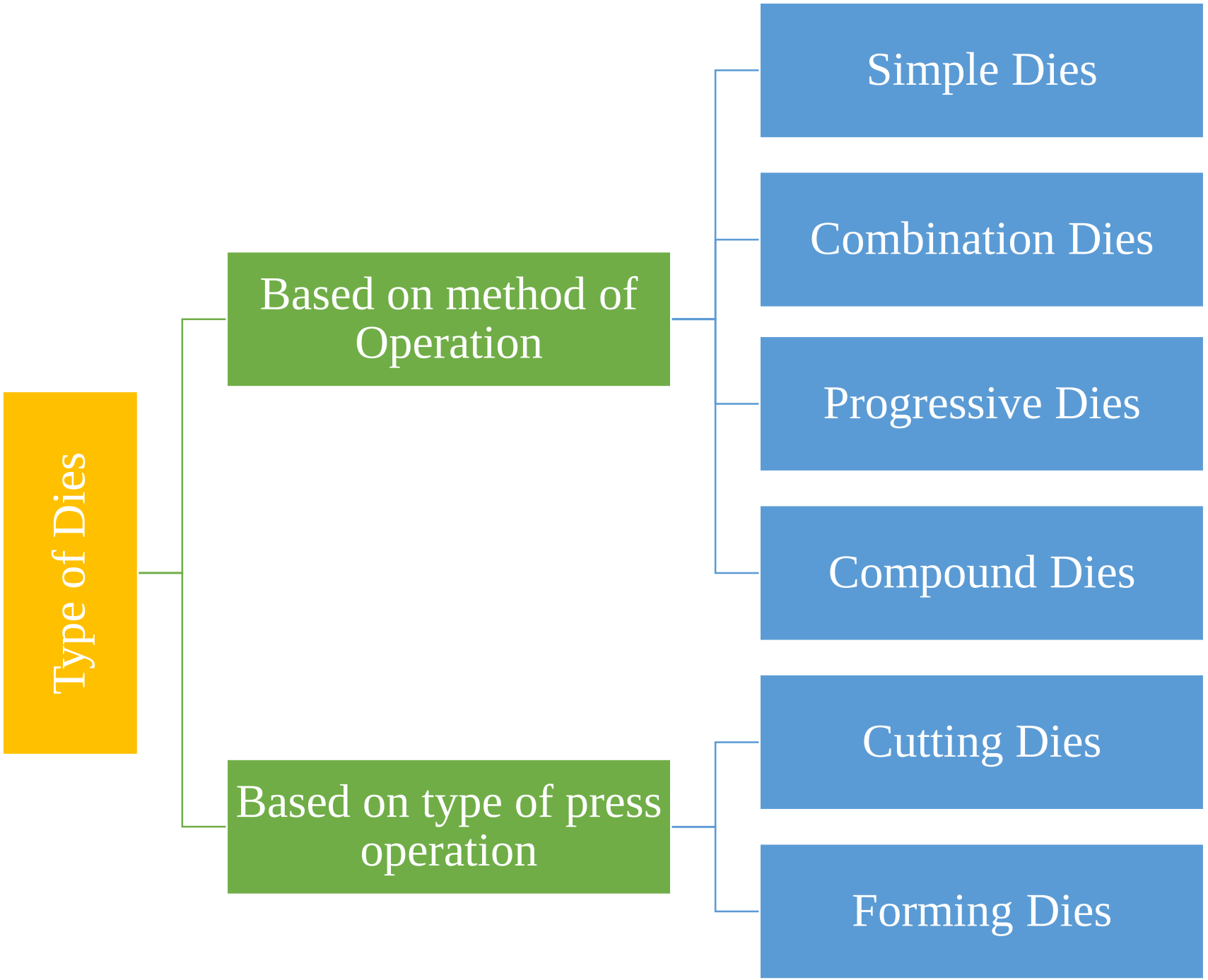
Power press

1. Ram 2. Ram guide, 3. Pitman, 4. Crankshaft. 5. Flywheel, 6. Punch, 7. Die, 8. Bolster plate, 9. Base, 10. Frame.

Press based on driving mechanism



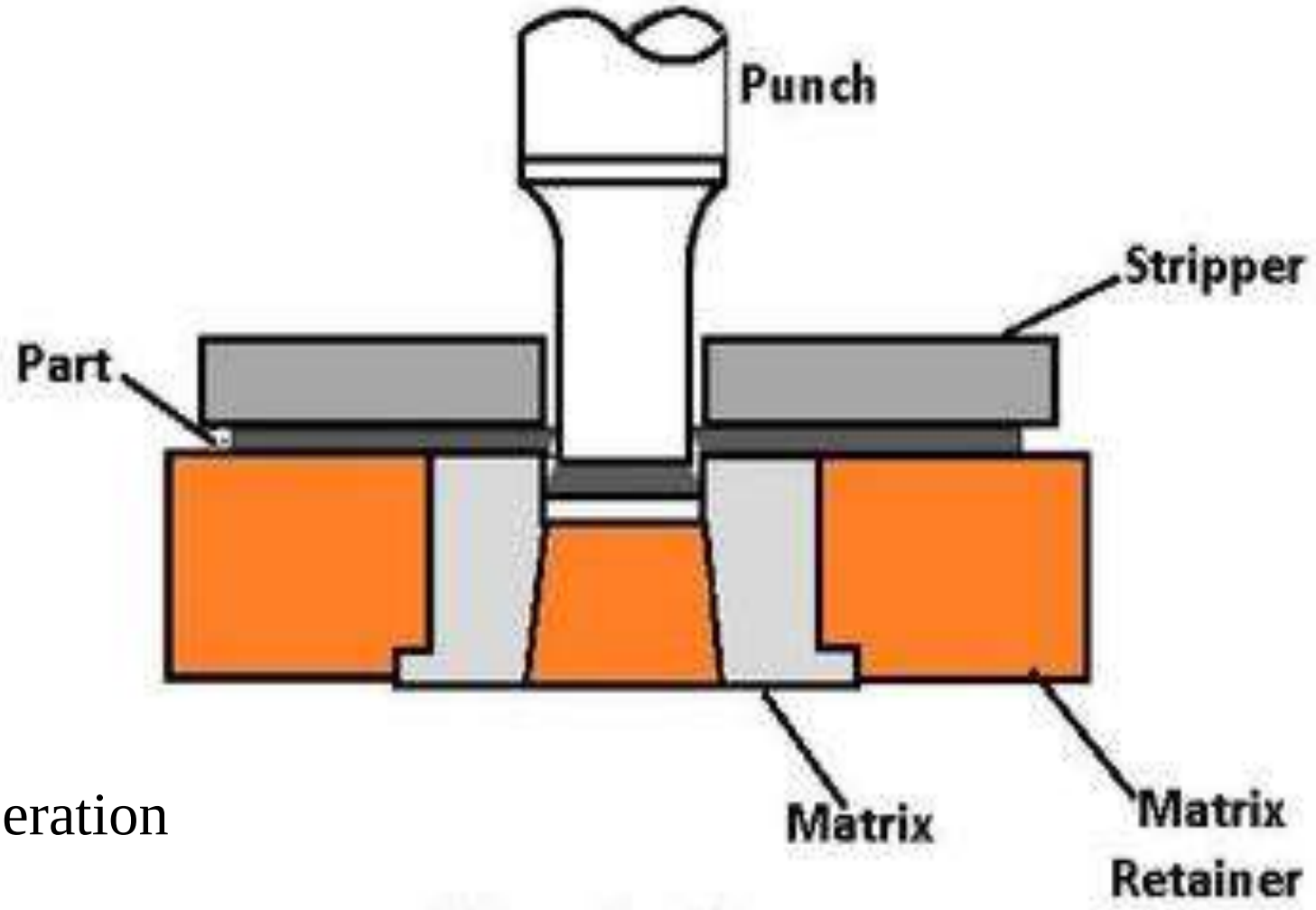



Type of Dies
Based on method of Operation
Simple Dies
Combination Dies
Progressive Dies
Compound Dies
Based on type of press operation
Cutting Dies
Forming Dies

Type of Dies

Based on method of Operation

Simple Dies



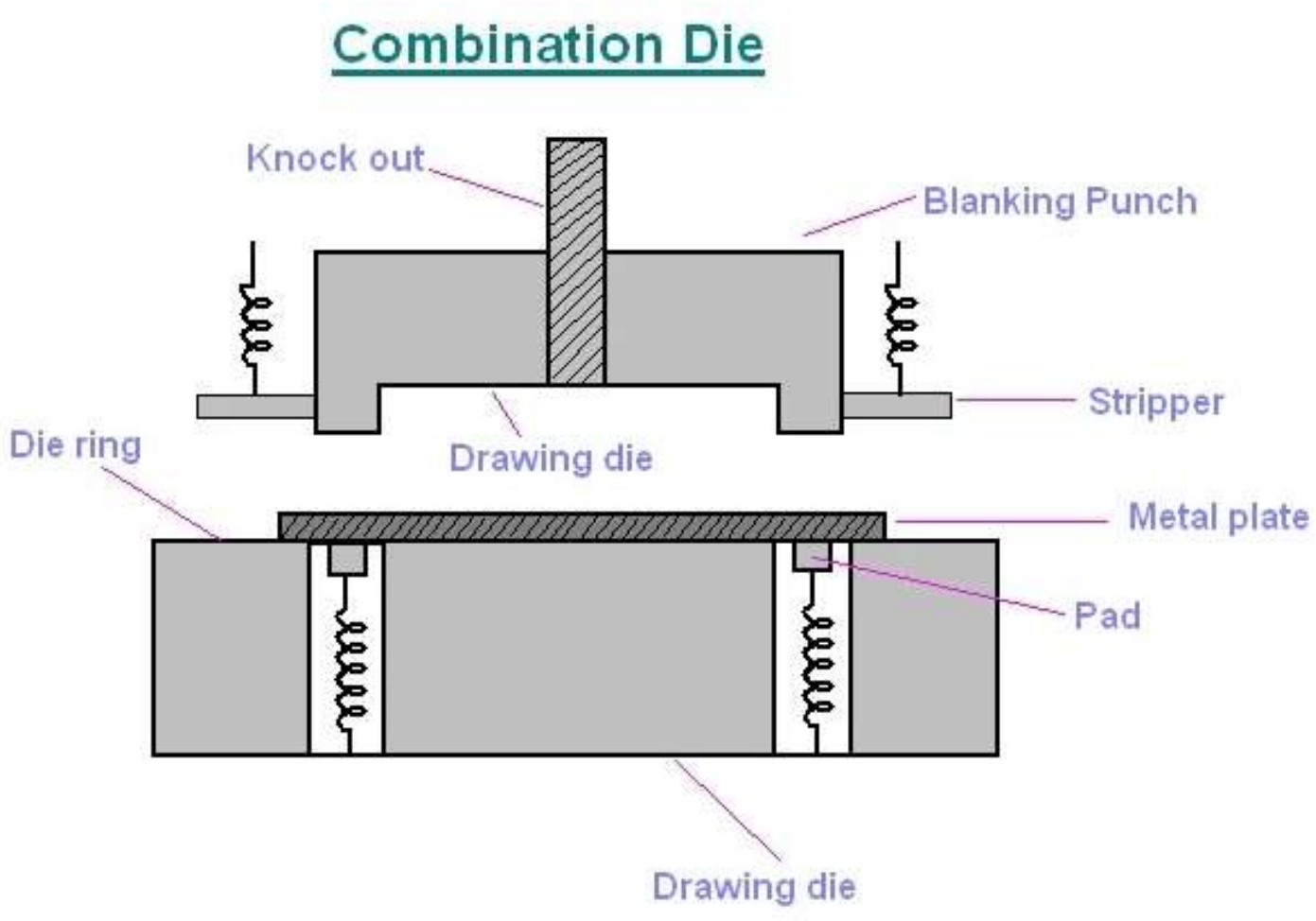
Perform single operation for each stroke.

Type of Dies

Based on method of Operation

Combination Dies

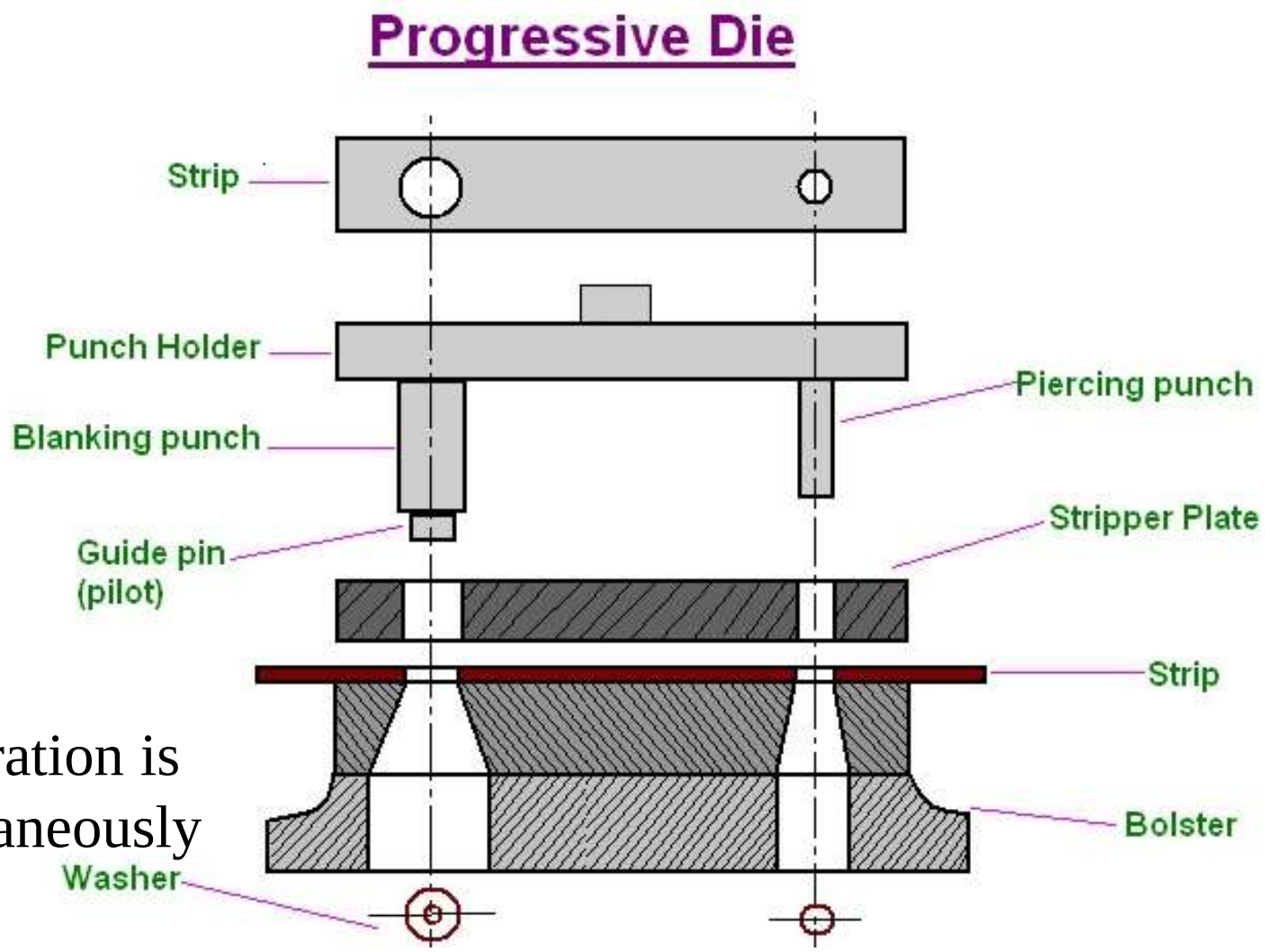
A cutting operation is combined with a bending or drawing operation



Type of Dies

Based on method of Operation

Progressive Dies

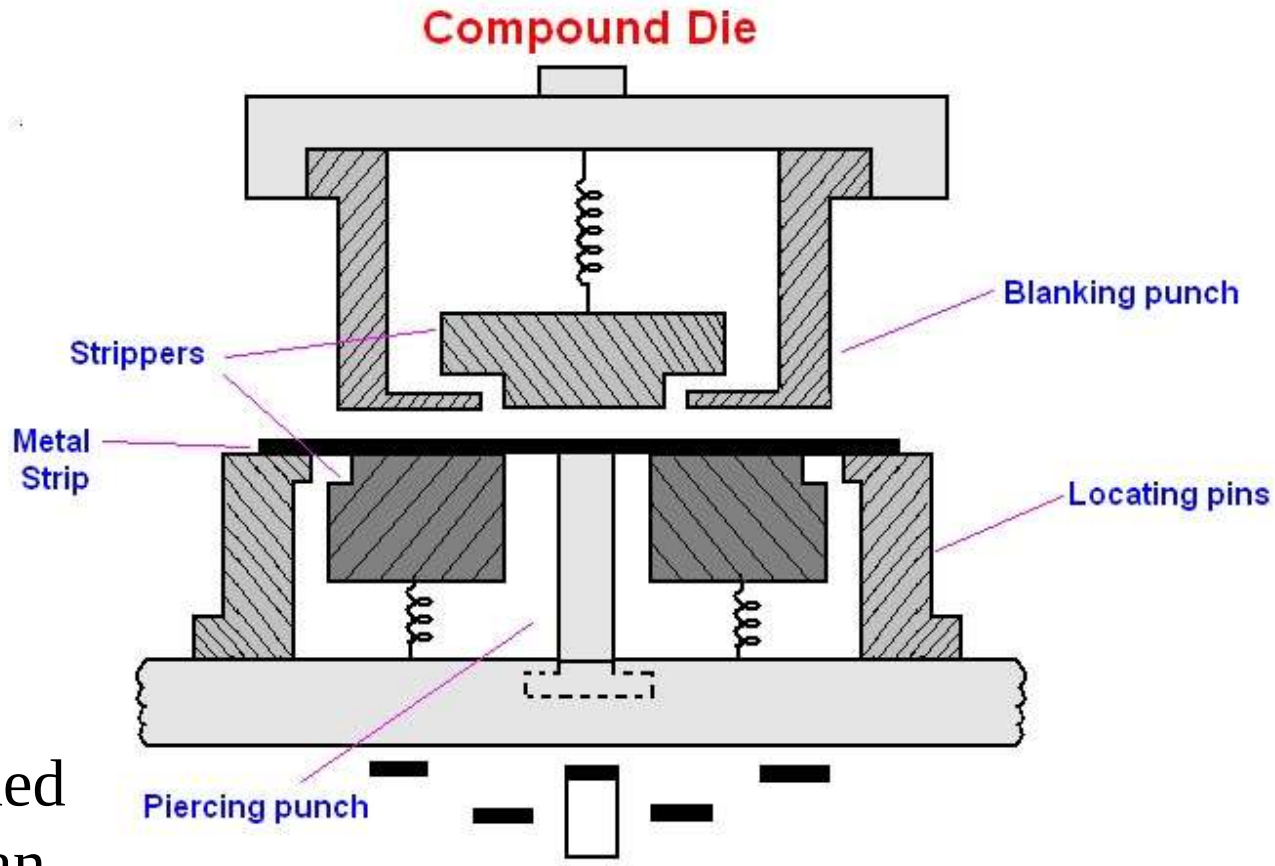


Two or more operation is performed simultaneously

Type of Dies

Based on method of Operation

Compound Dies



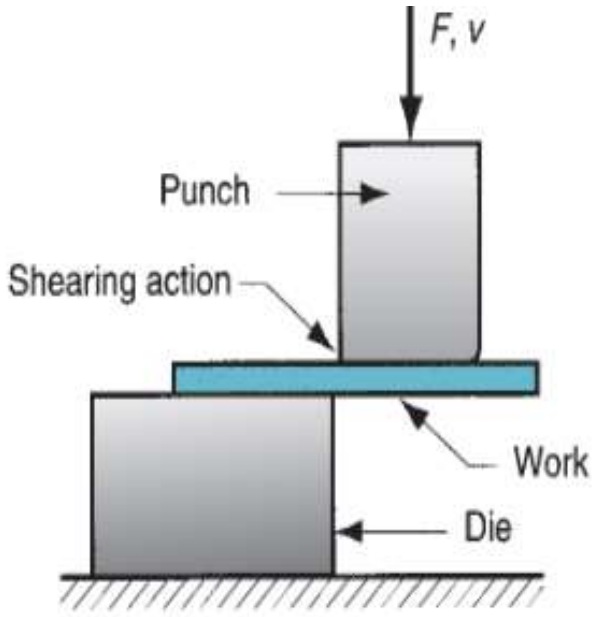
Two or more operation is performed simultaneously but it is slower than progressive dies

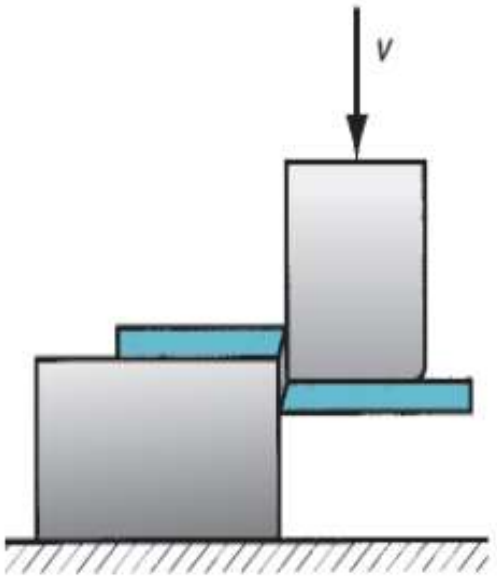
Type of Dies

Based on type of press operation

Cutting Dies

Dies are used for cutting metal pieces



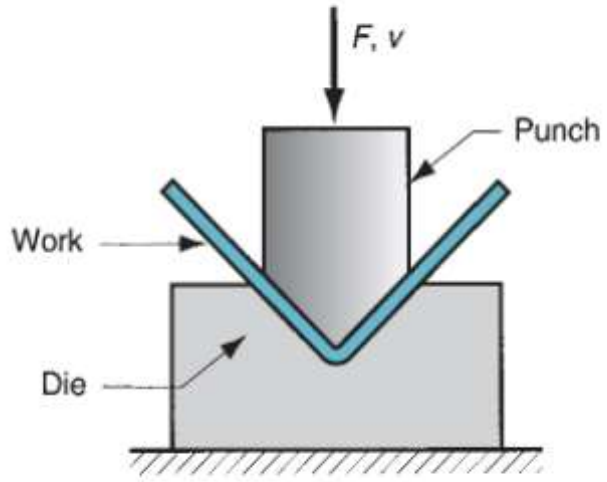


shearing

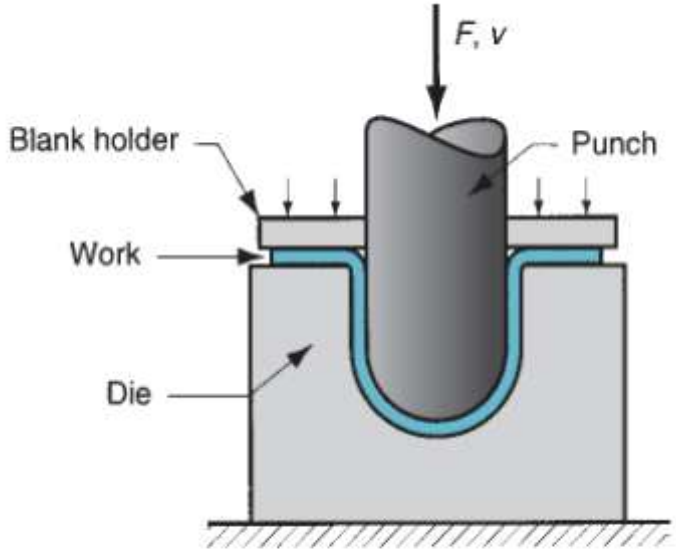
Type of Dies

Based on type of press operation

Forming Dies



Bending



Deep drawing

Dies are used to change the shape of the blank without removing the material from the blank

Type of Punches

Cutting Punches

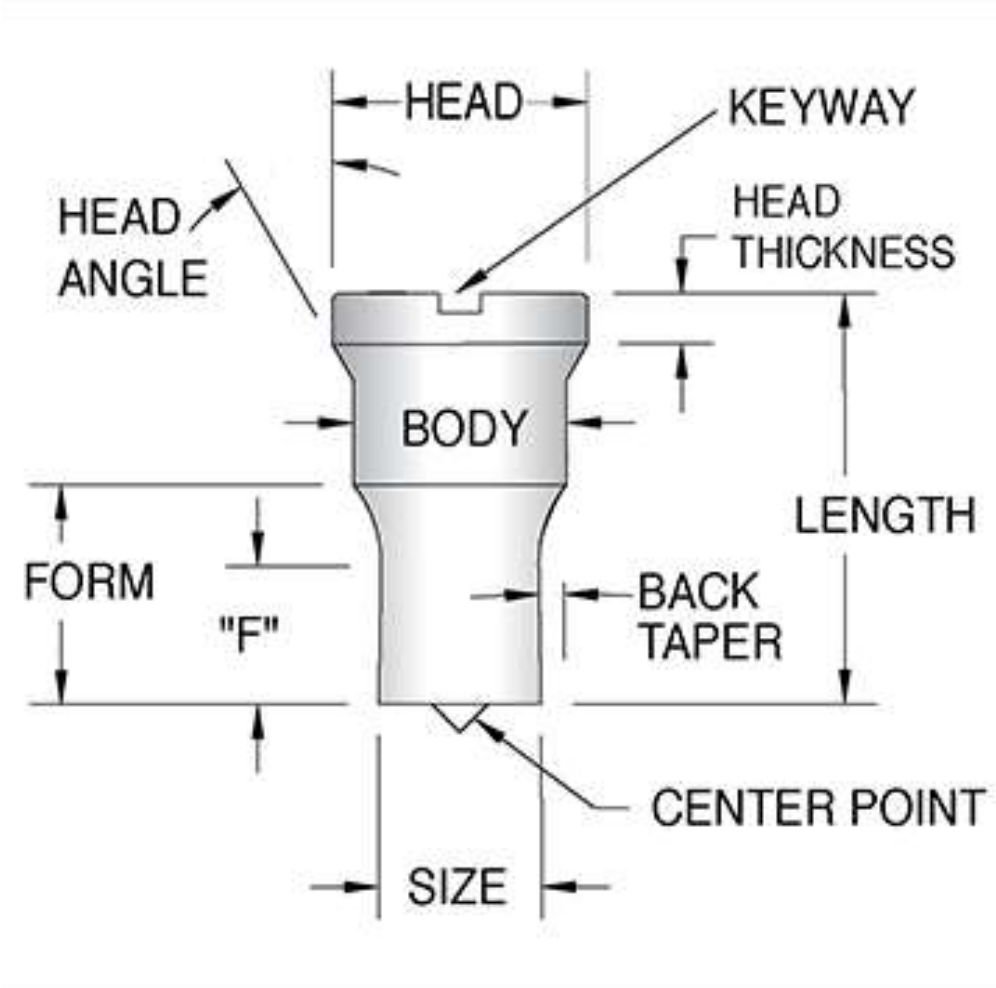
It can perform Blanking, Piercing, Trimming

Non-Cutting Punches

It can perform bending, drawing forming

Hybrid Punches

It can perform both cutting and non-cutting operation



Selection of Press Dies

- They should retain their hardness at elevated temperature
- They should have resistance to wear
- The steel should have adequate machinability
- These steels should have characteristics that their properties can be changed by heat treatment

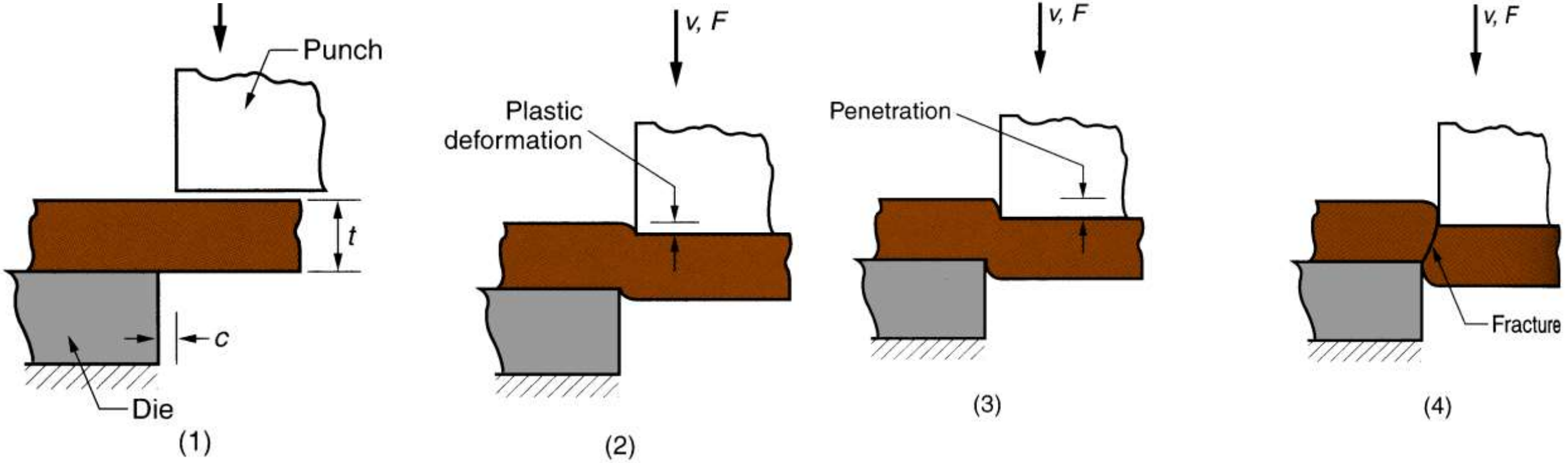
Die Material

- Cold work tool steel
- Hot worked tool steel
- High speed tool steel
- Special Purpose tool steel

Press Operations

- Shearing
- Piercing
- Trimming,
- Punching,
- Notching,
- Shaving,
- Gearing,
- Embossing,
- Stamping.

Press Operation- Shearing



Shearing of sheet metal between two cutting edges:

(1) just before the punch contacts work;

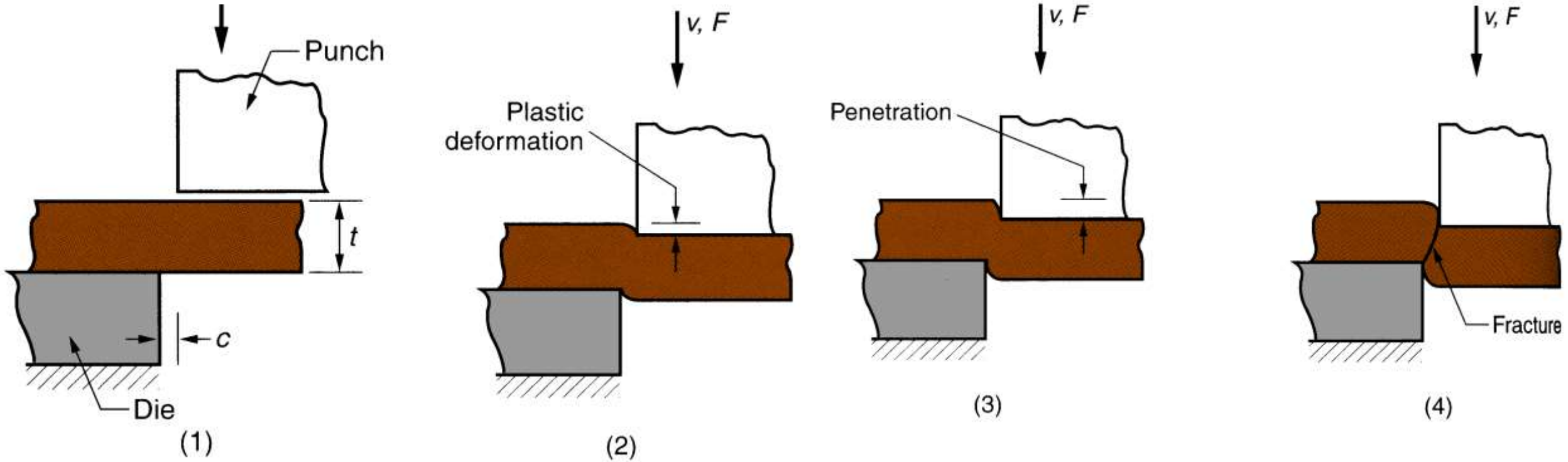
(2) punch begins to push into work, causing plastic deformation;

(3) punch compresses and penetrates into work causing a smooth cut surface;

(4) fracture is initiated at the opposing cutting edges which separates the sheet.

Press Operations

Shearing



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(2) punch begins to push into work, causing plastic deformation;

(3) punch compresses and penetrates into work causing a smooth cut surface;

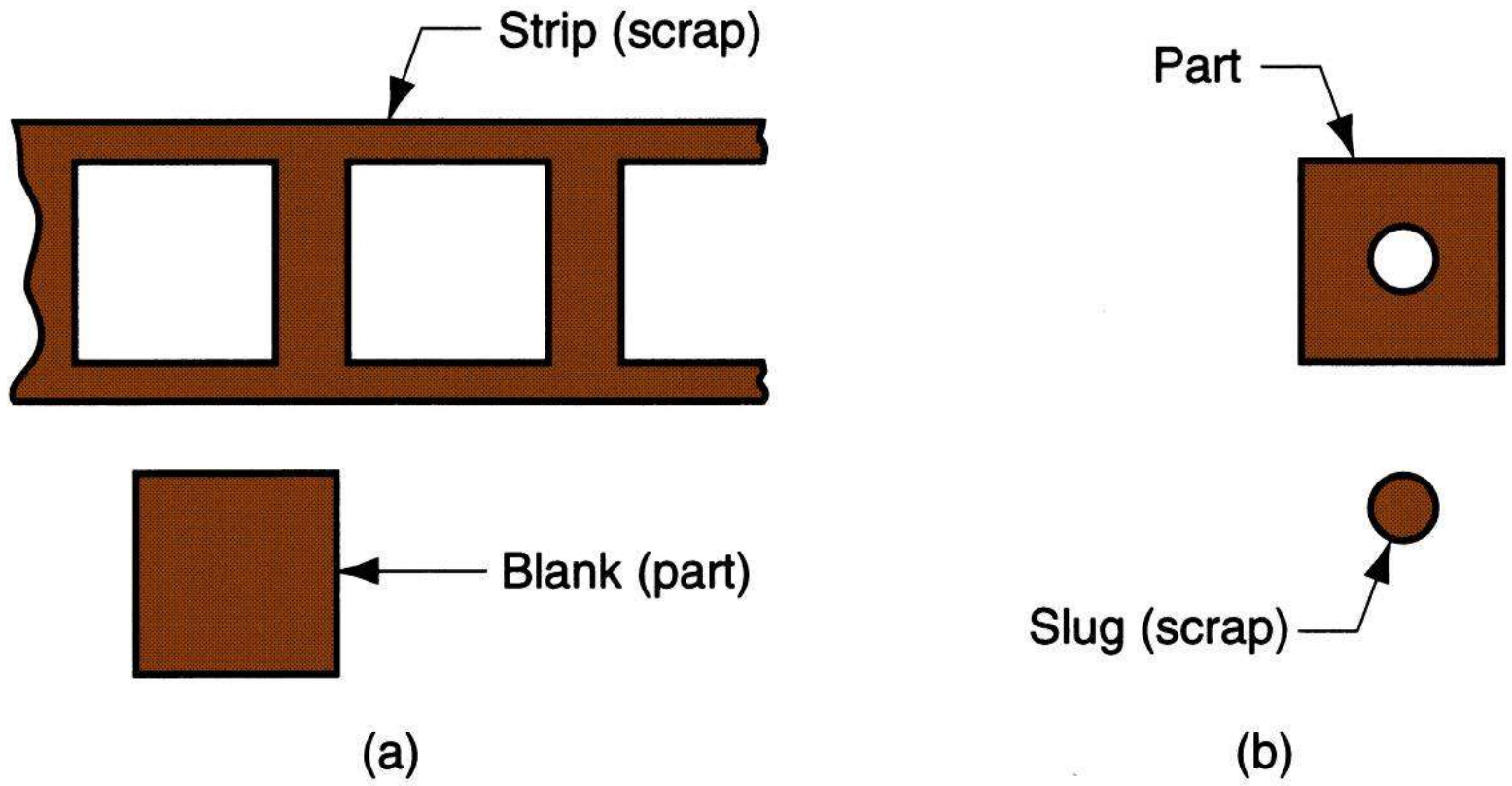
(4) fracture is initiated at the opposing cutting edges which separates the sheet.

Press Operations

Blanking and Punching

Blanking - sheet metal cutting to separate piece (called a *blank*) from surrounding stock

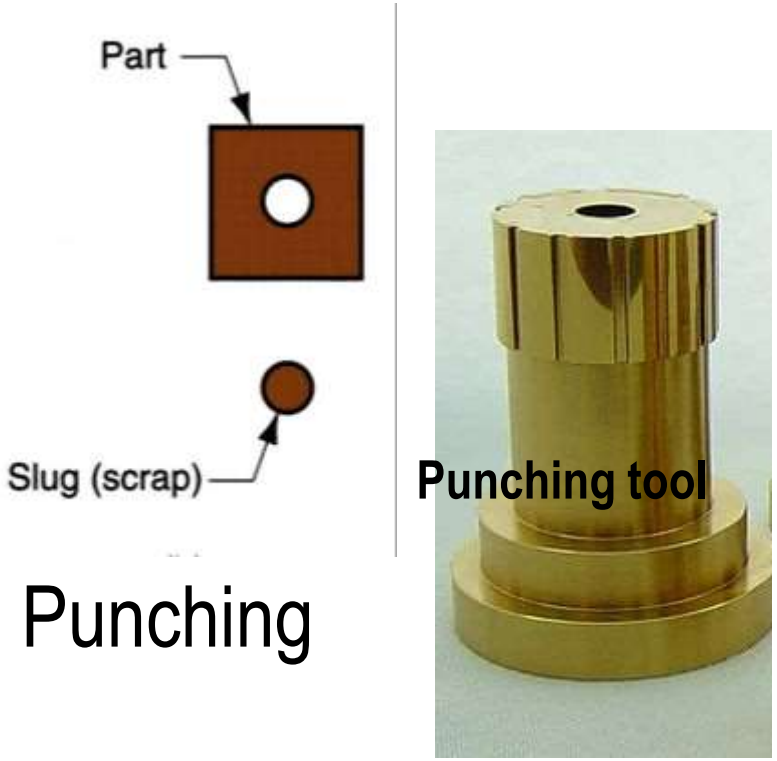
Punching - similar to blanking except cut piece is scrap, called a *slug*



(a) Blanking and (b) punching.

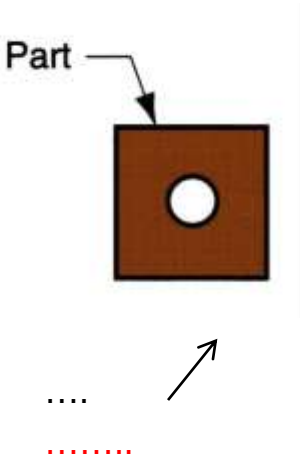
Press Operations

Punching and Piercing



Punching

Slug is cut and bur is minimum



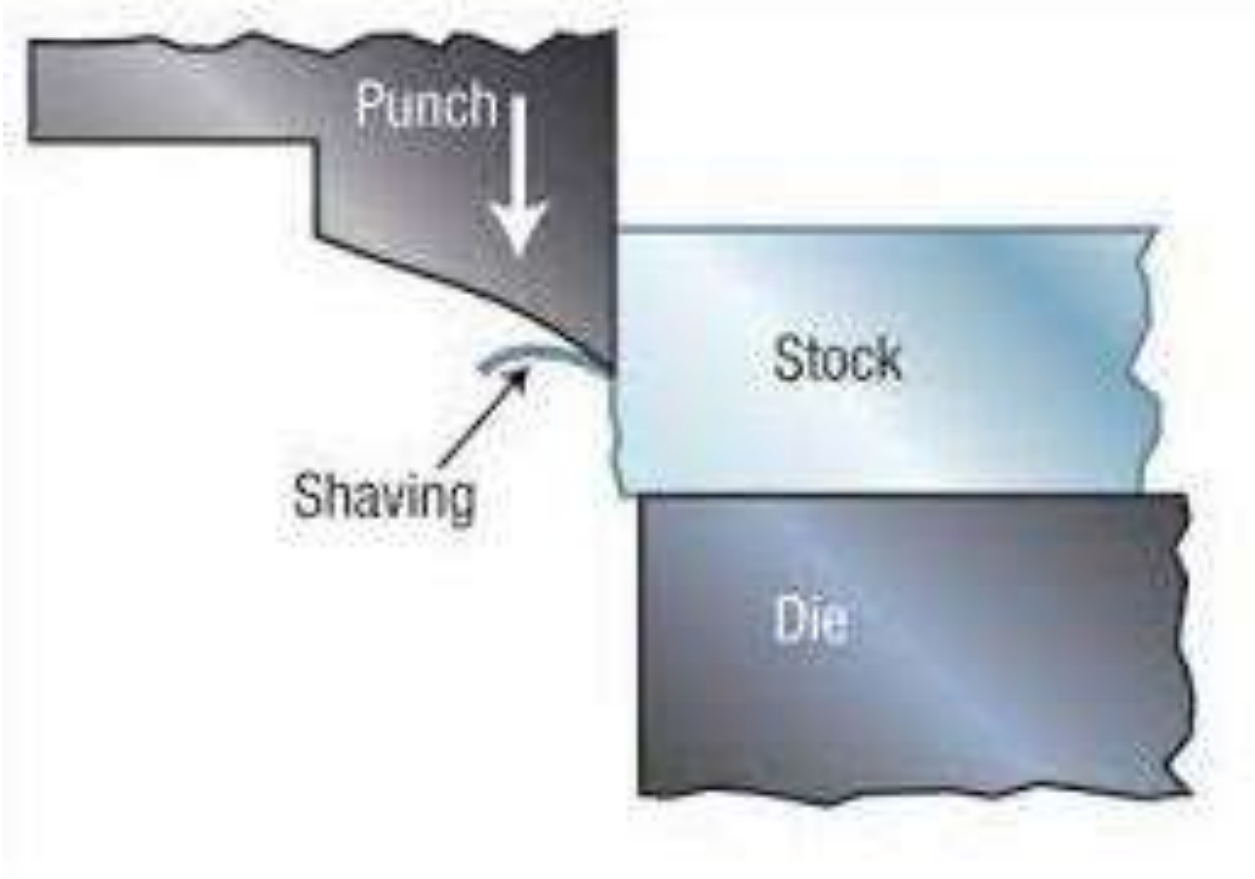
Piercing

No slug is cut, only bur

Press Operations

Shaving

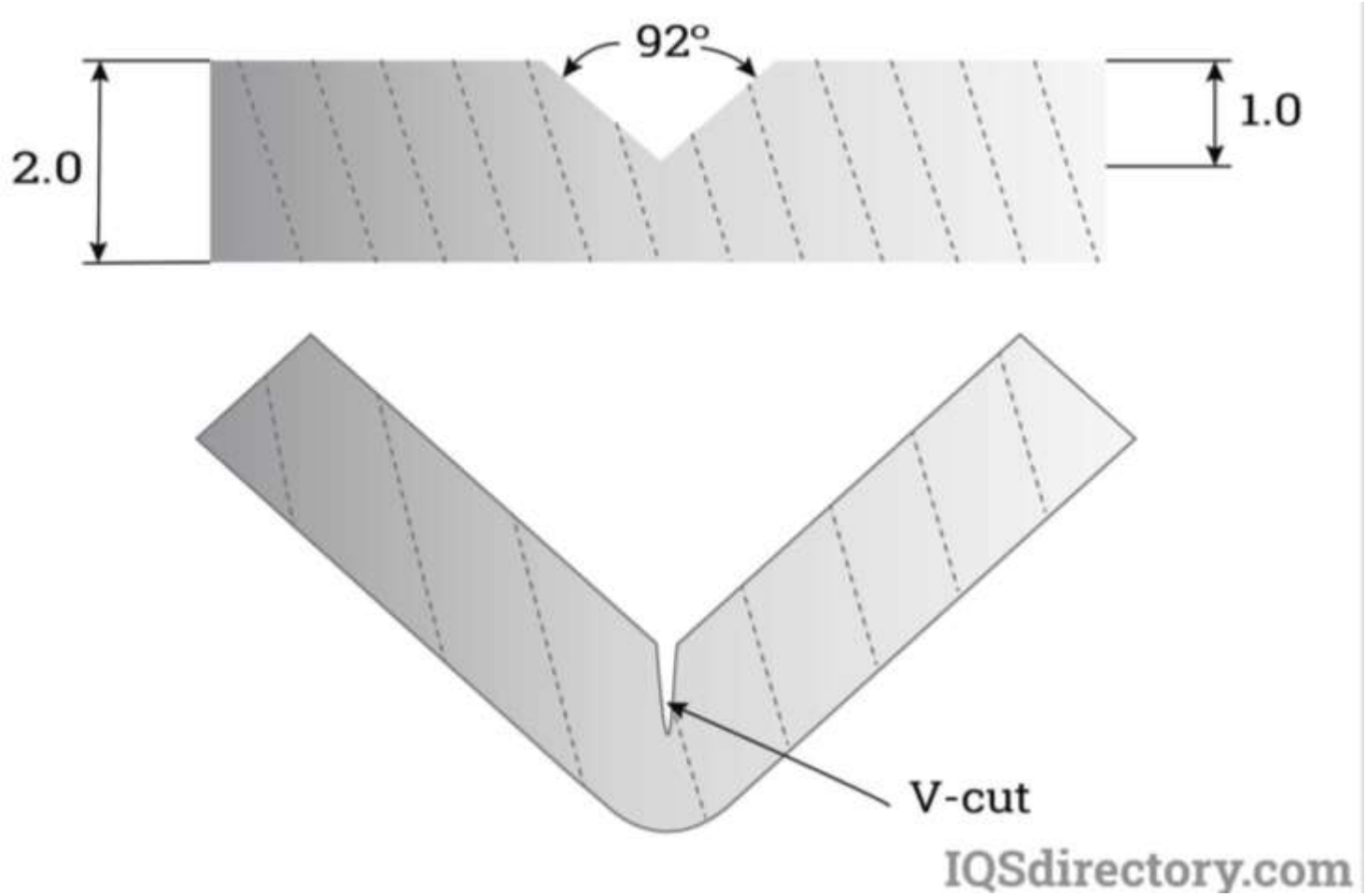
In blanking or piercing, the edge of blank or hole is not perfect due to presence of burr which can be removed by shaving process



Press Operations

Notching

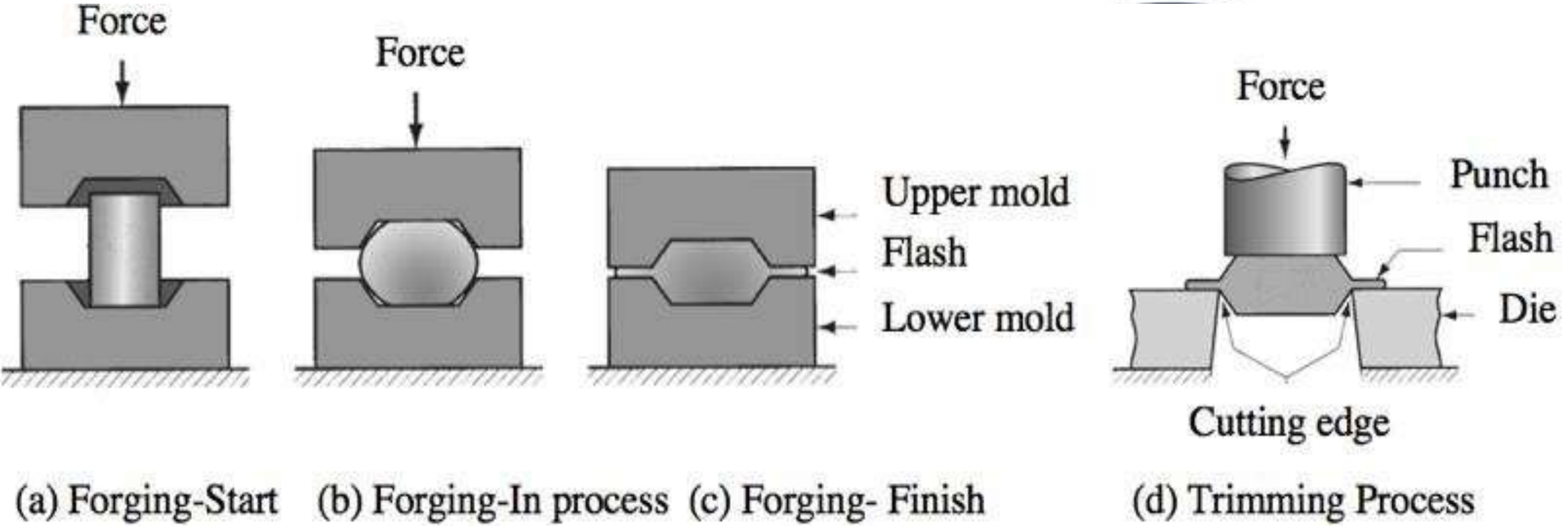
It is the method to cut a specific portion of metal from the edge of the metal



Press Operations

Trimming

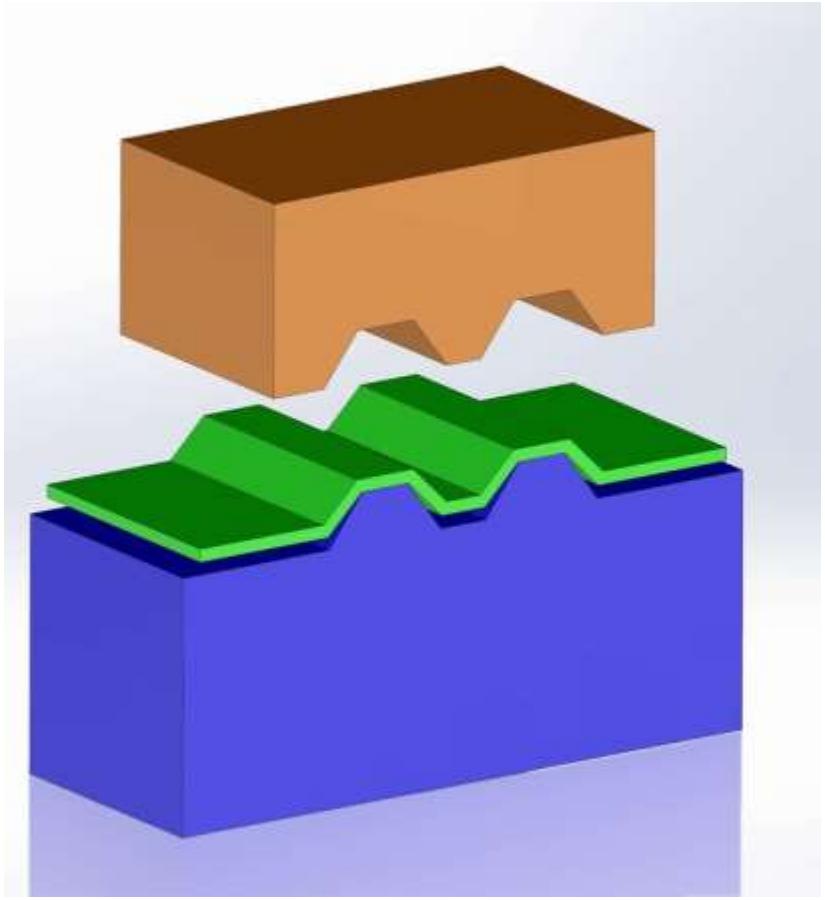
It is the method to cutting of the excess metal that is spread out during operation such as casting and drop forging.



Press Operations

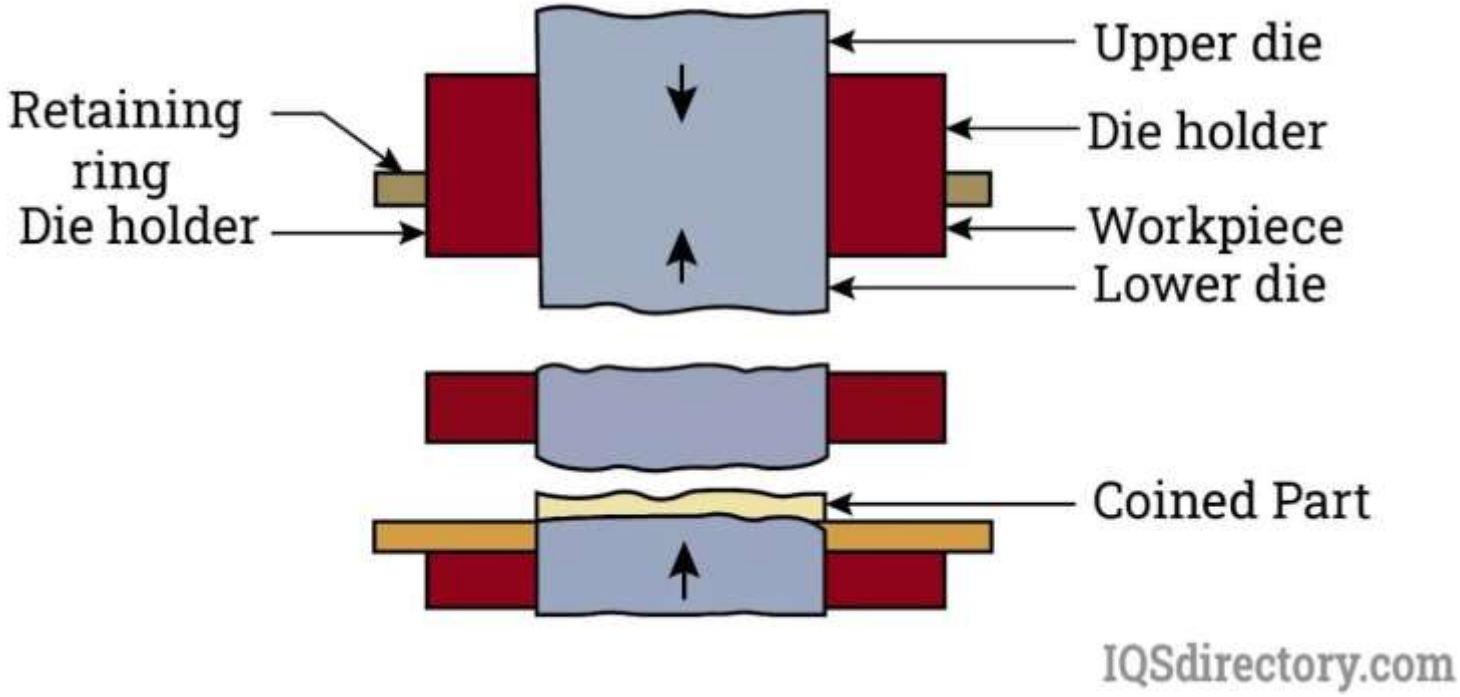
Embossing

Embossing is the operation of producing raised design with almost no change in thickness.



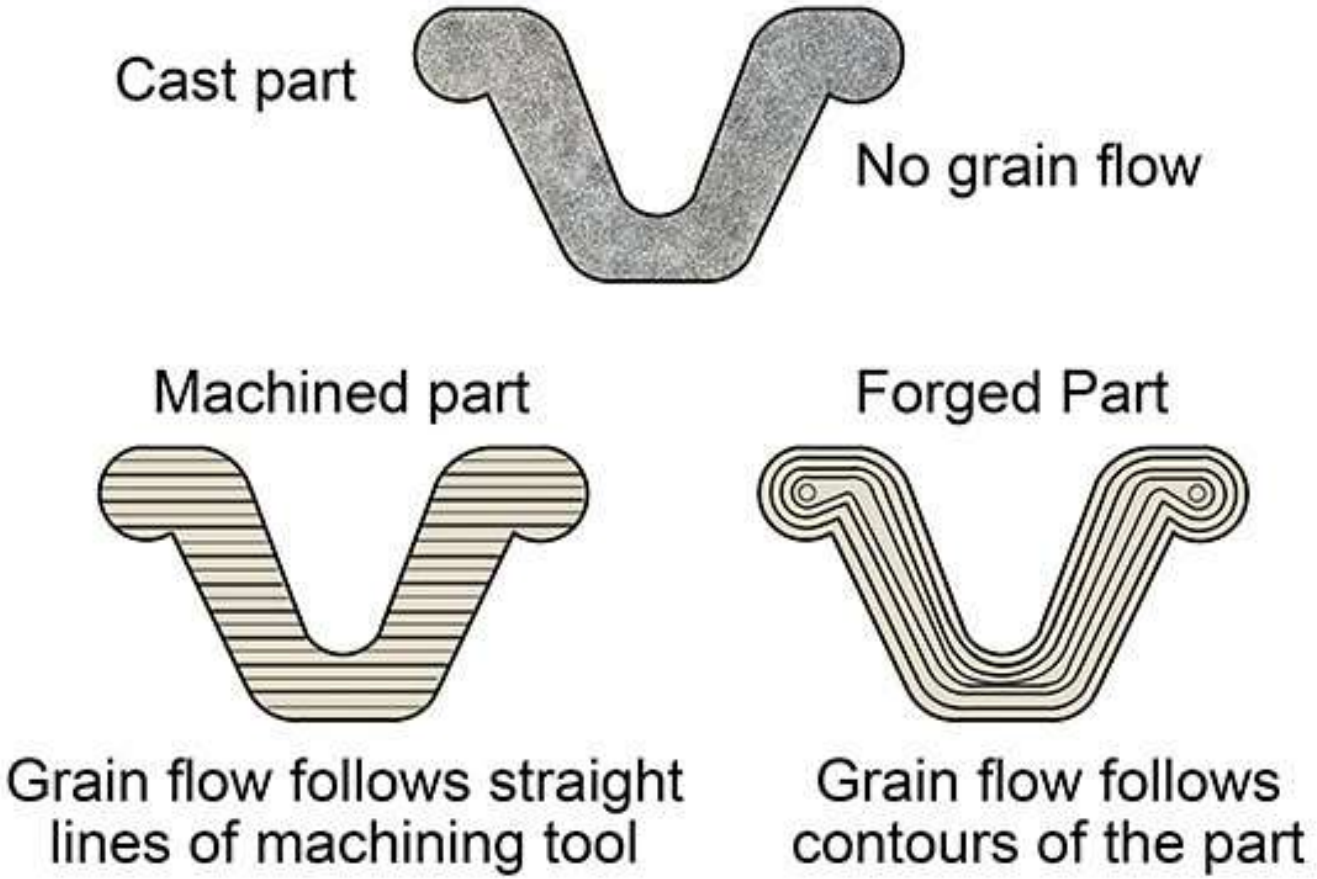
Coining

Coining is the process used to make coins and medals. In this thickness is changed



Forging

Forging is the process in which metals and alloys are plastically deformed plastically to get the desired shaped by the application of compressive forces at elevated temperature.



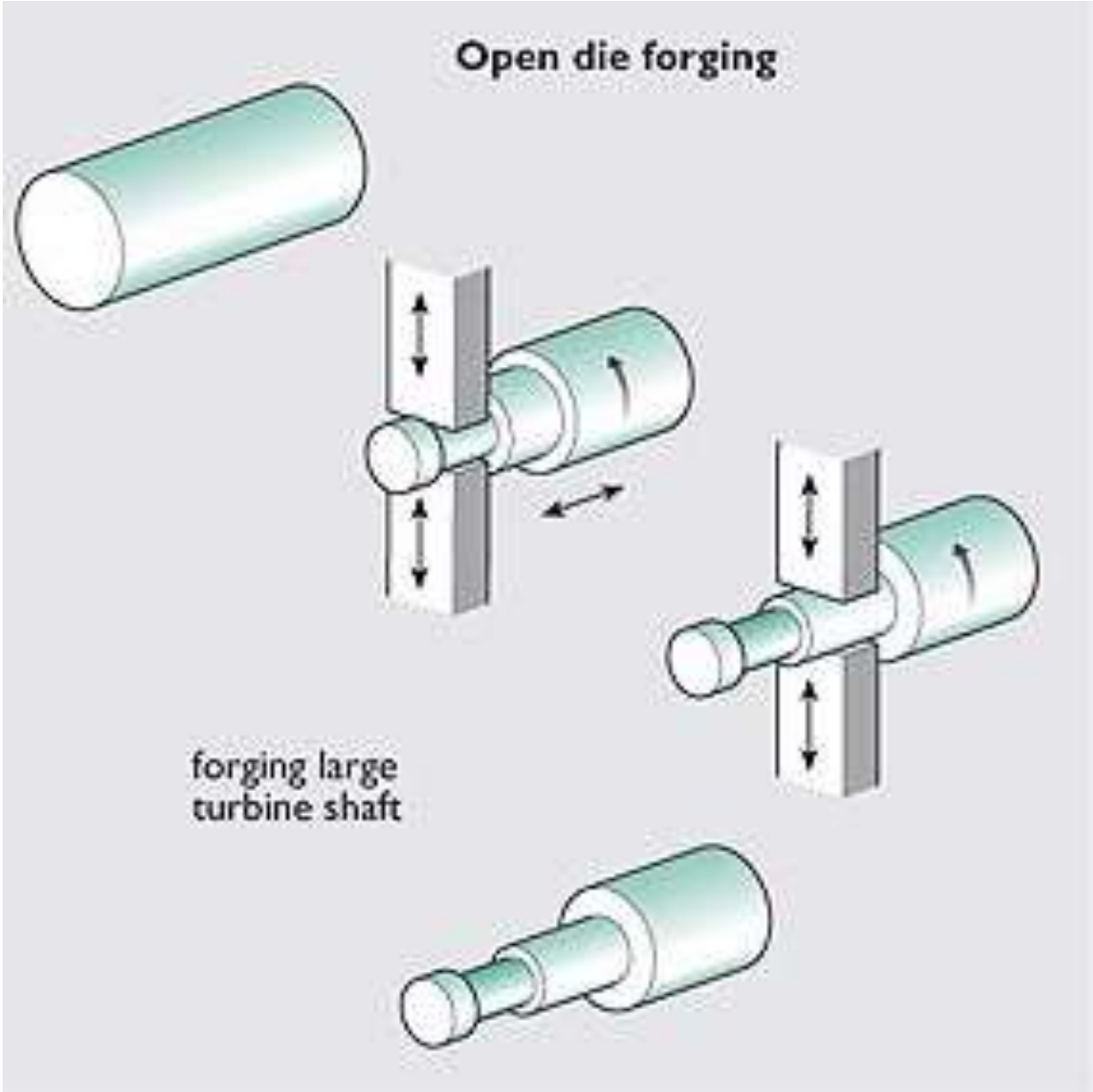
Forging

Forgeable Materials

Sr. No.	Materials	Forging temperature (C)
1	Aluminium	345-485
2	Coper, Brass, Bronze	600-950
3	Mild steel	750-1300
4	Medium Carbon steel	750-1250
5	Wrought Iron	900-1300
6	Stainless steel	940-1180

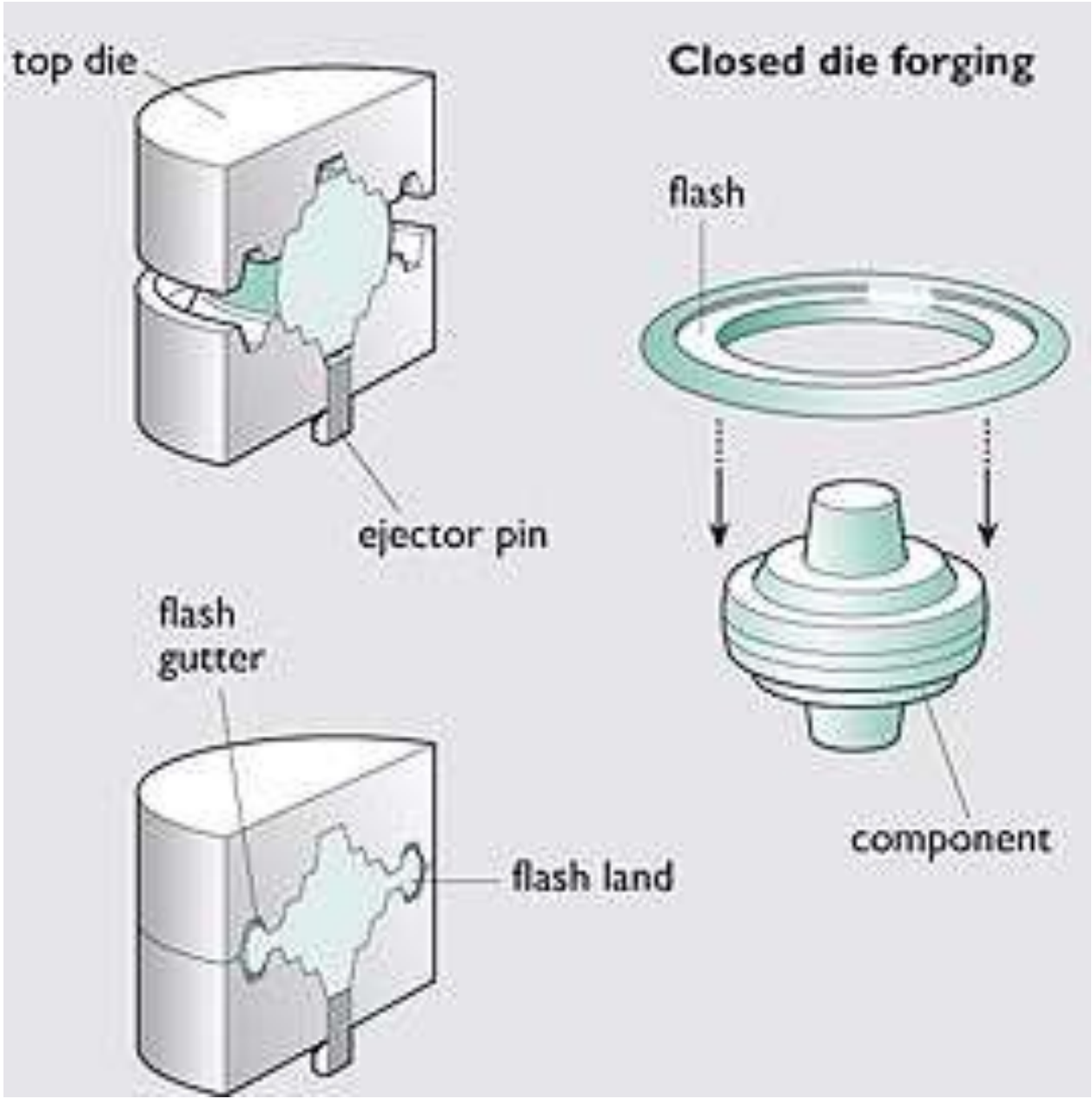
Forging

Open die forging:
It is also known as hammer forging.
It is simples process.
It is used for small components
It is restricted to simple shape.
No control over dimension



Forging

Closed die forging:
In this forging cavities or impression or cut in dies.
It provides dimensional accuracy.
It can produce complicated shape.
Cost of tooling is high.



Forging

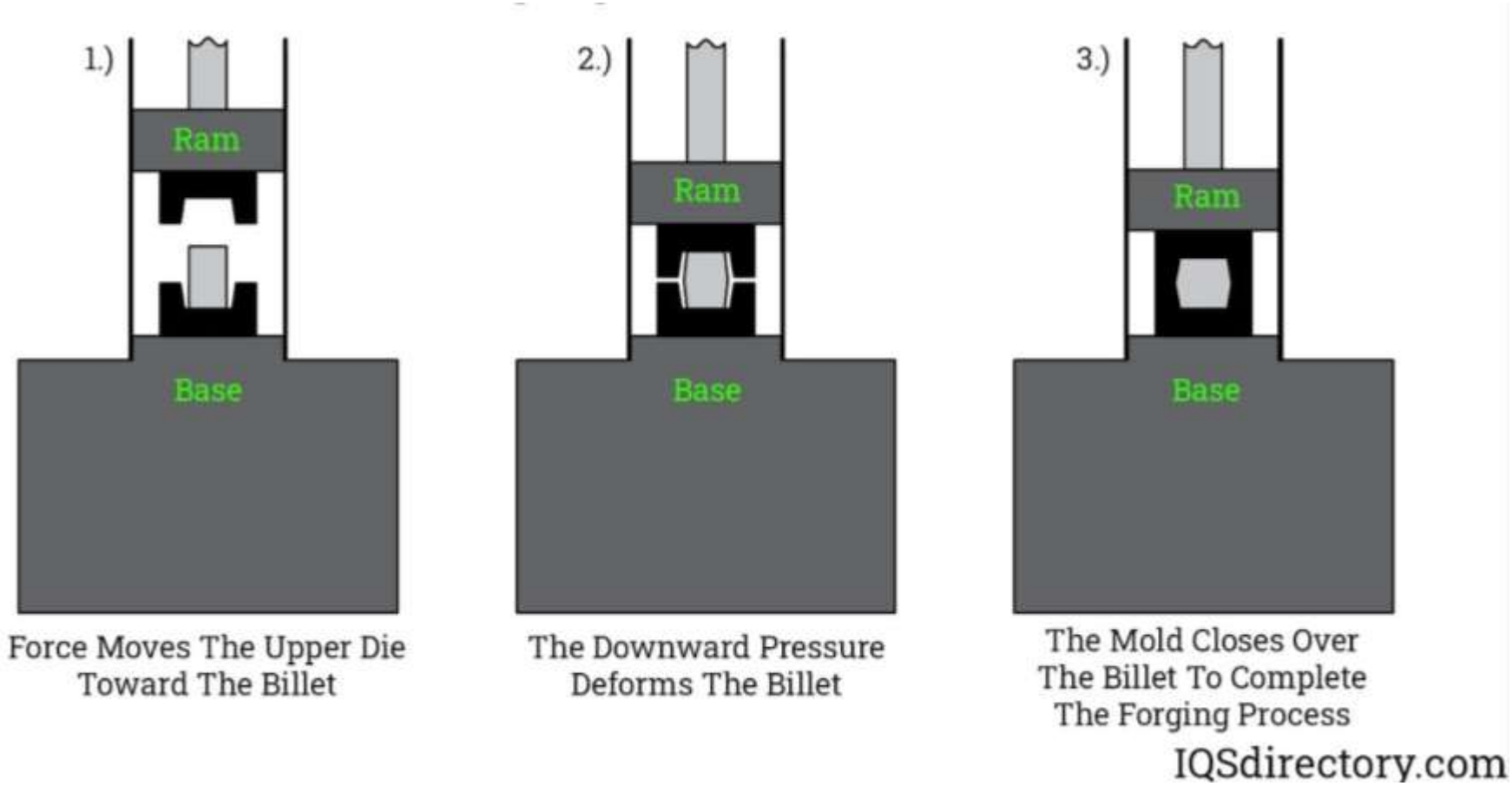
Press forging:

It uses the close impression dies where slow and steady force is applied on the workpiece by the use of press machine.

Materials gets uniformly deformed.

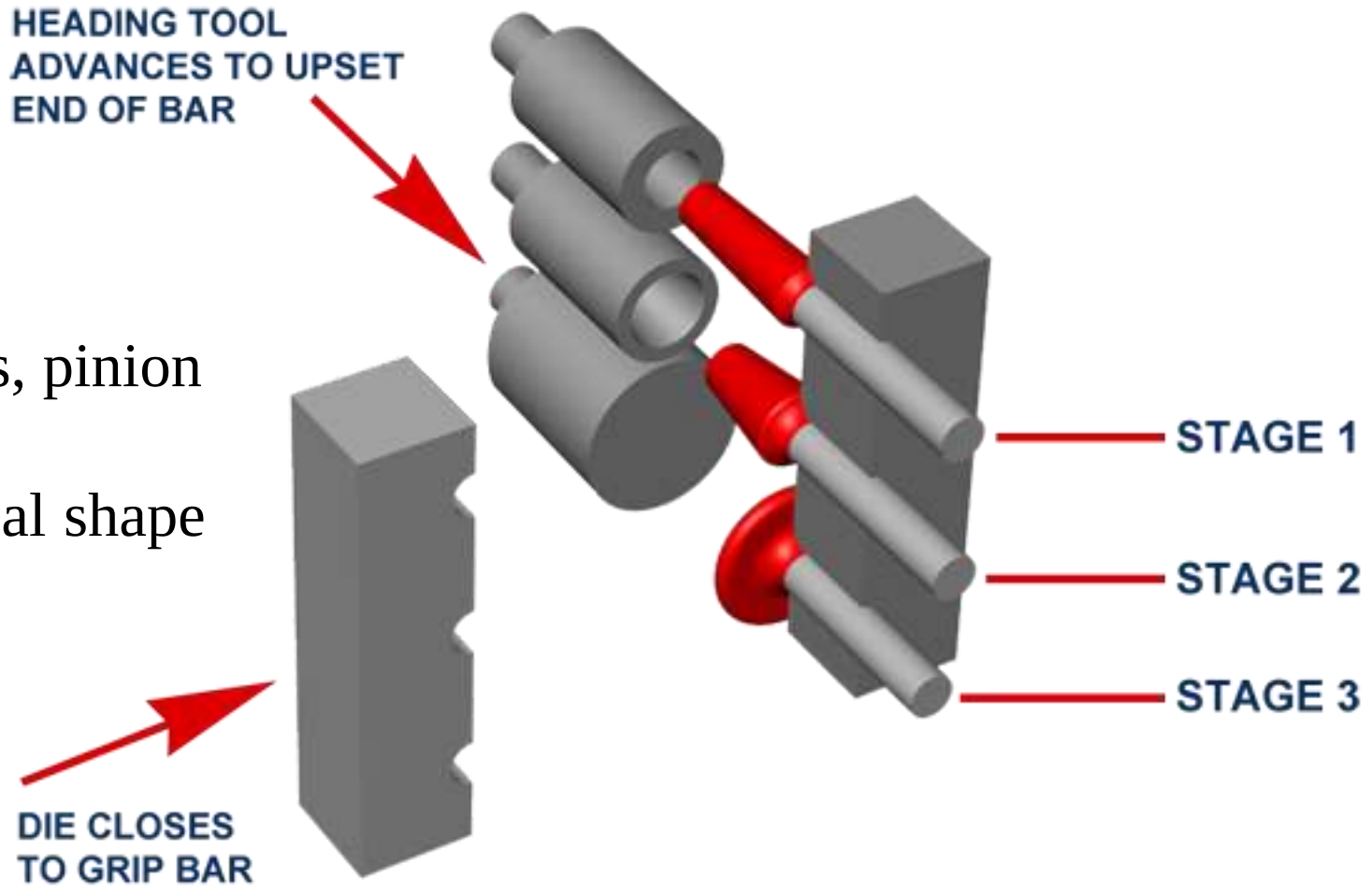
Better dimensional accuracy and finish

High initial investment



Forging

Upset forging:
It is the process of increasing the cross section of the metal.



It provides high production rate.
Can make nut, bolts, washers, collars, pinion gear at high rate.
It is difficult to make non-symmetrical shape
Cost of tooling is high.

Forging

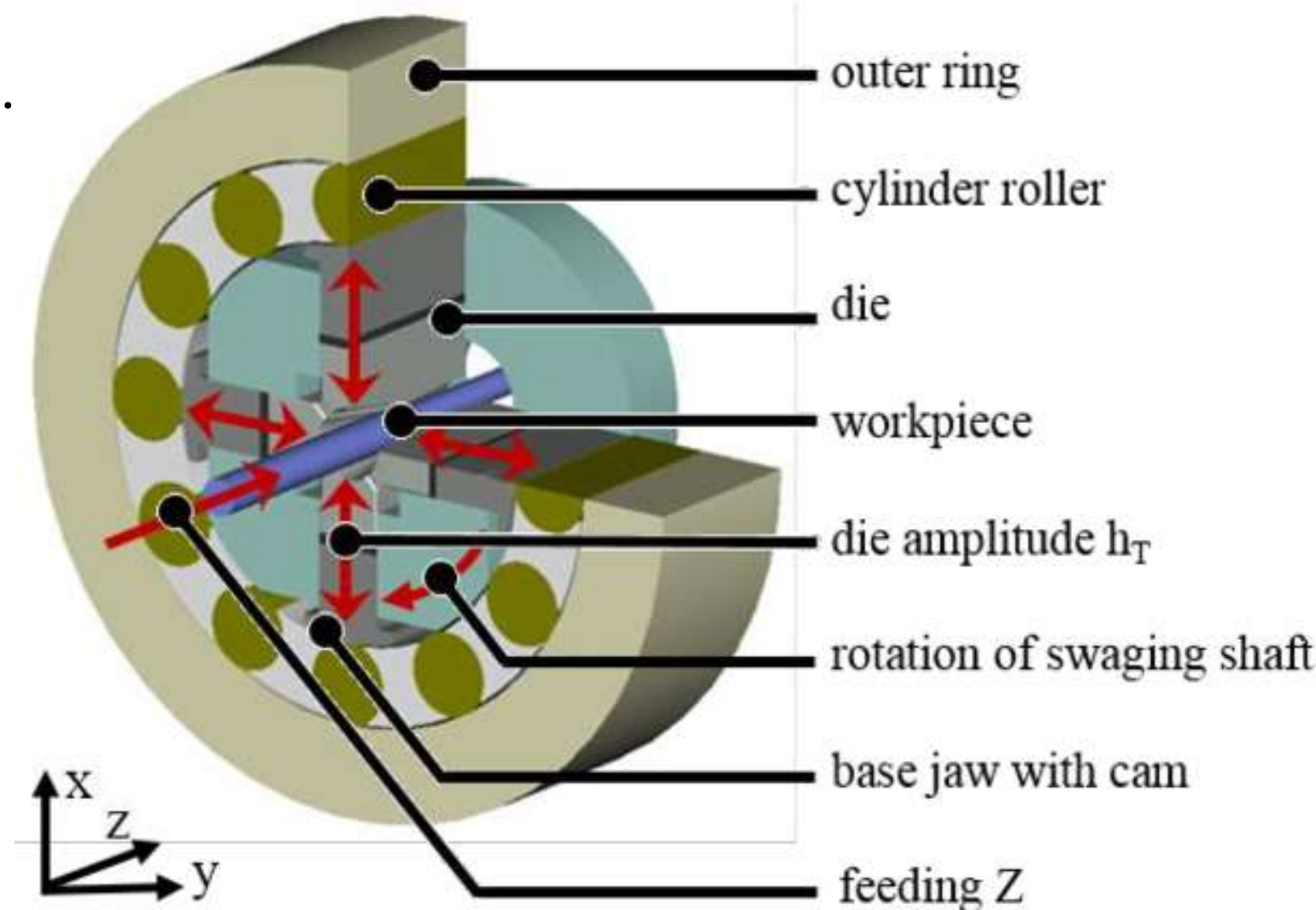
Swaging:

It is the process of reducing the diameter of bars or tubes.

It provides high dimensional accuracy.

High production rate.

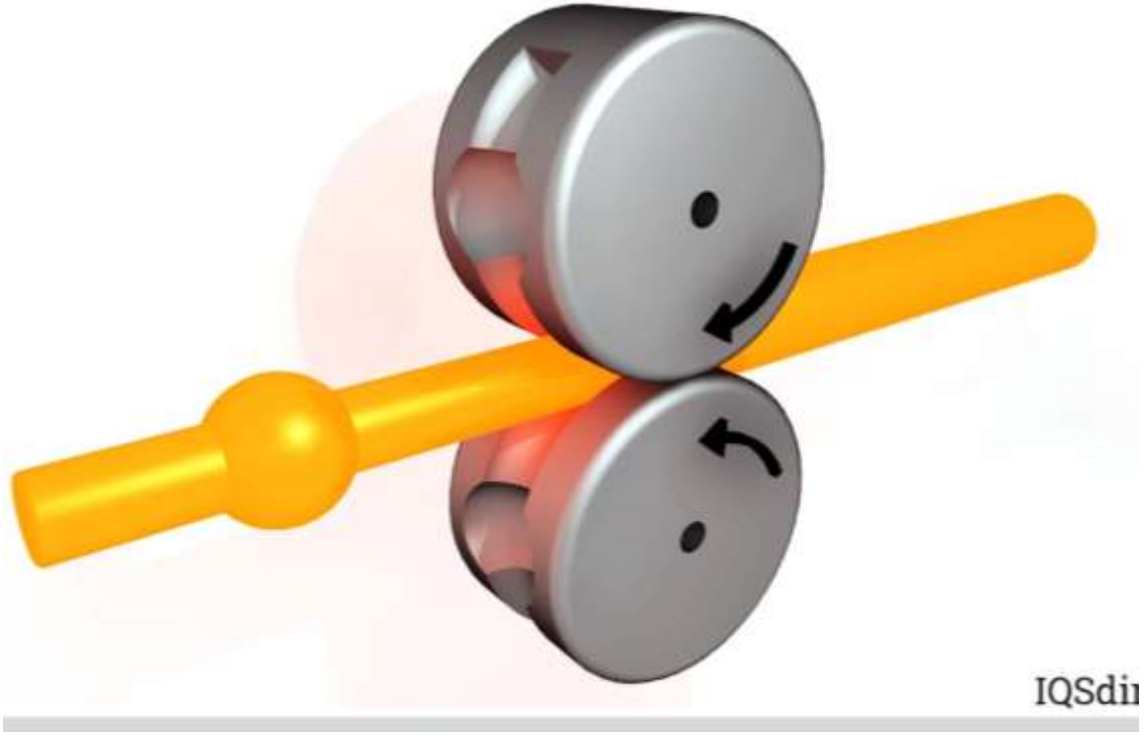
Only symmetrical shape can be made.

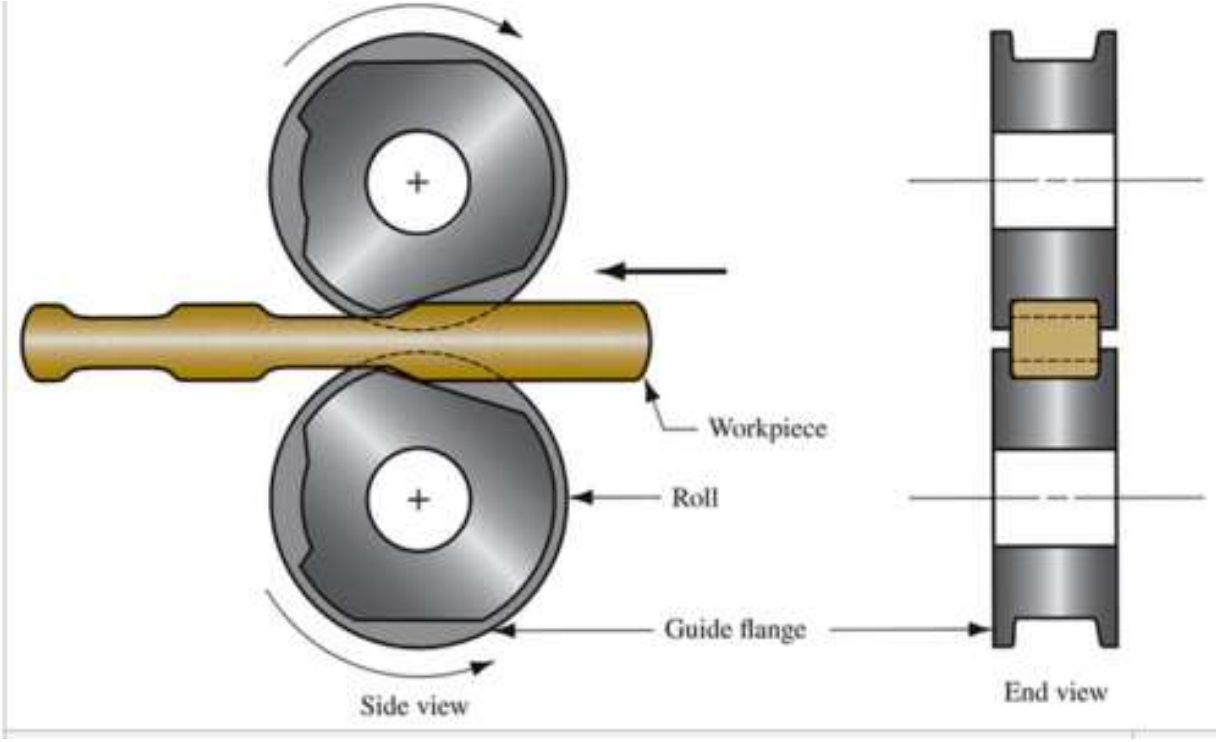


Forging

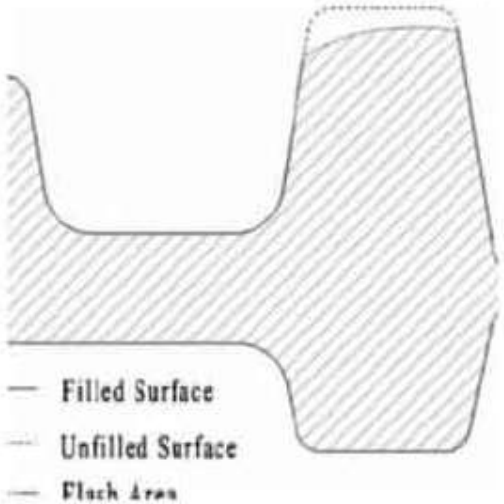
Roll forging:

It is used to produce components of varying cross-section.





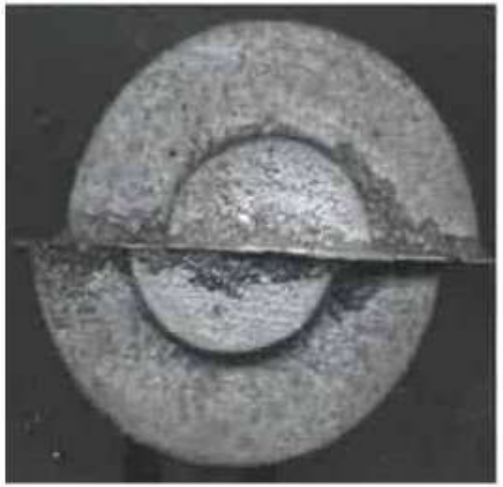
Forging Defects



Unfilled Section

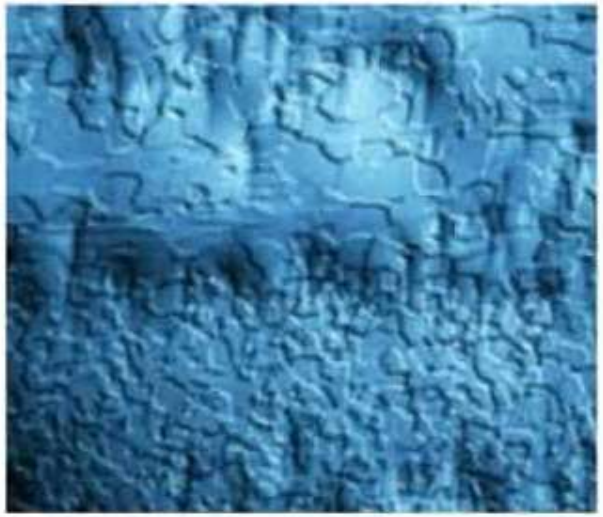
Scale Pit

Cold Shut



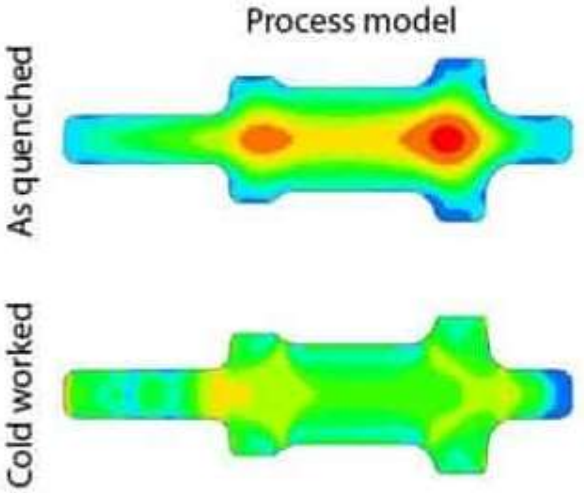
Die Shift

Flakes



Grain Growth

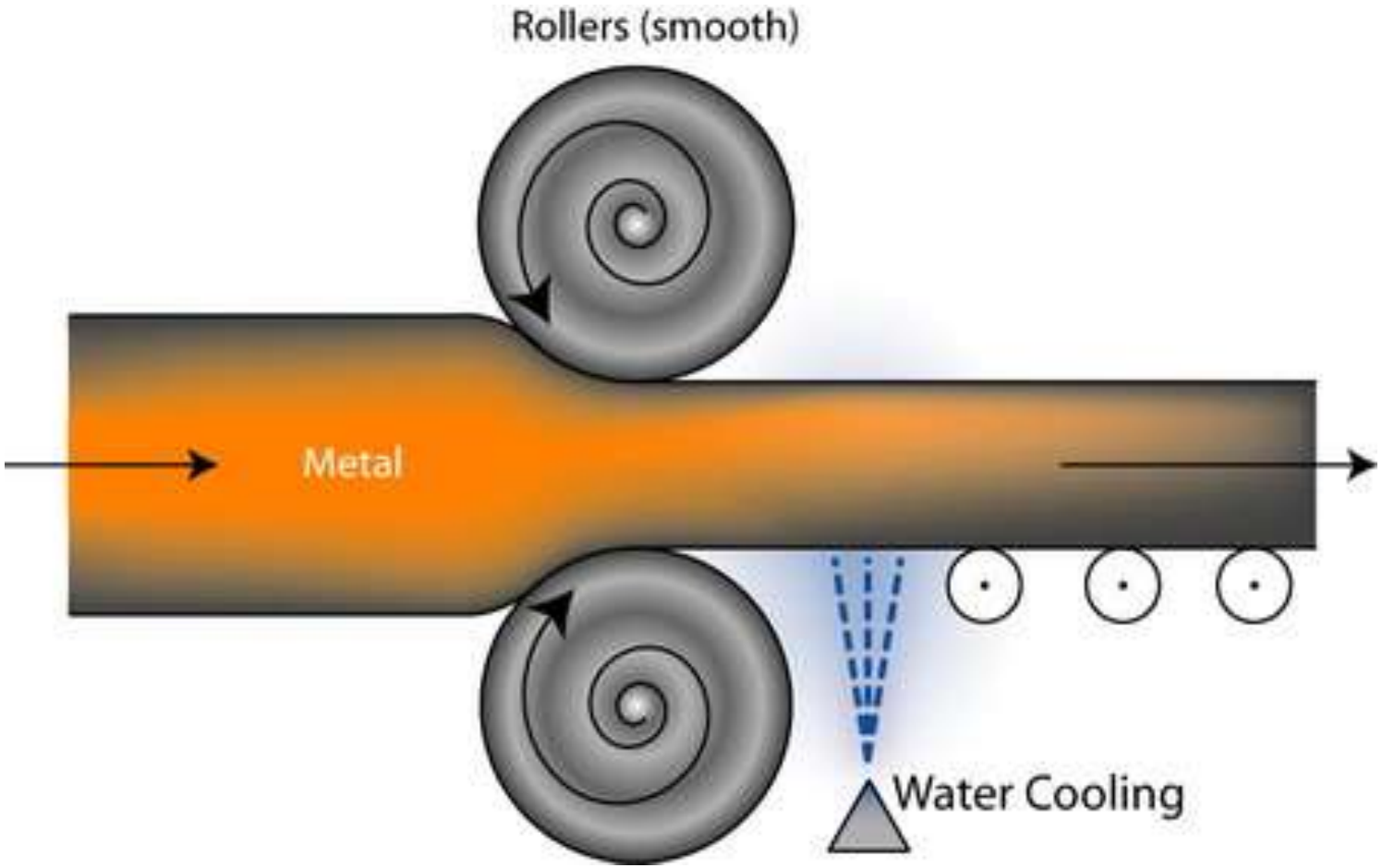
Surface Cracking



Residual Stress

Rolling

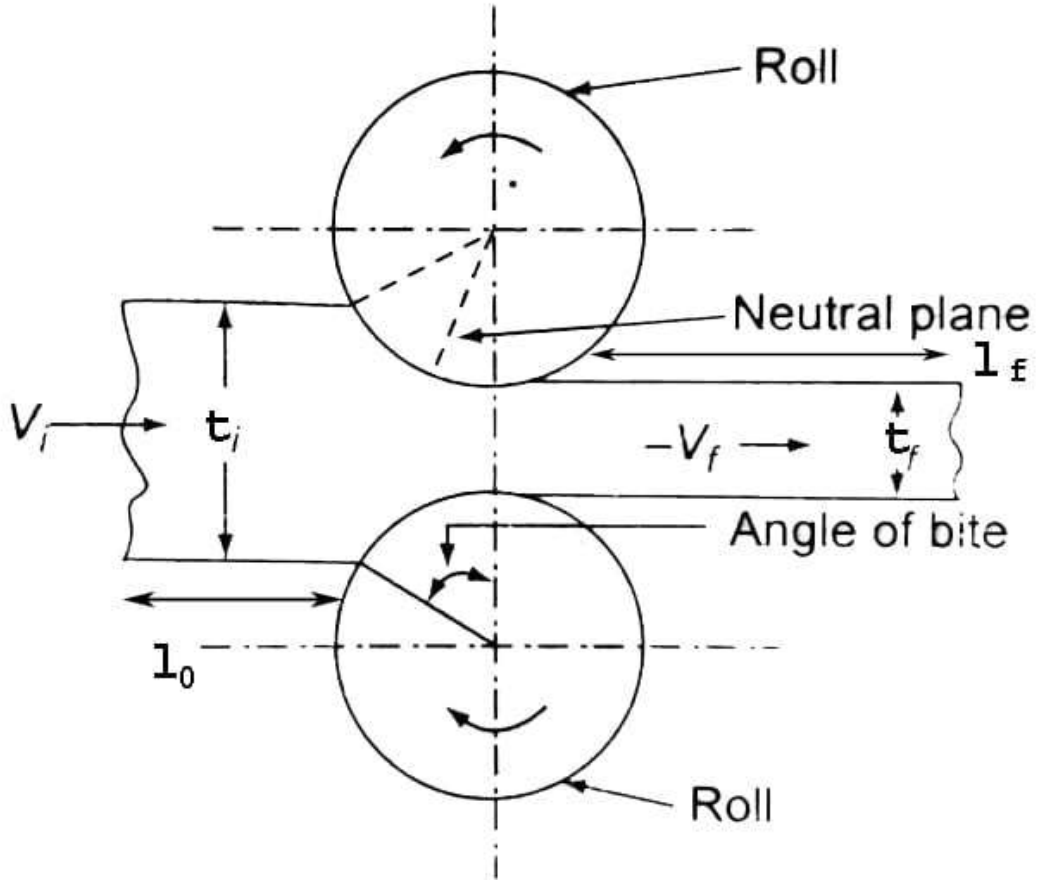
Rolling is the process of reducing the thickness or changing the cross section of a long workpiece by compressive forces applied through a set of rolls



Rolling

Elementary Theory of Rolling:

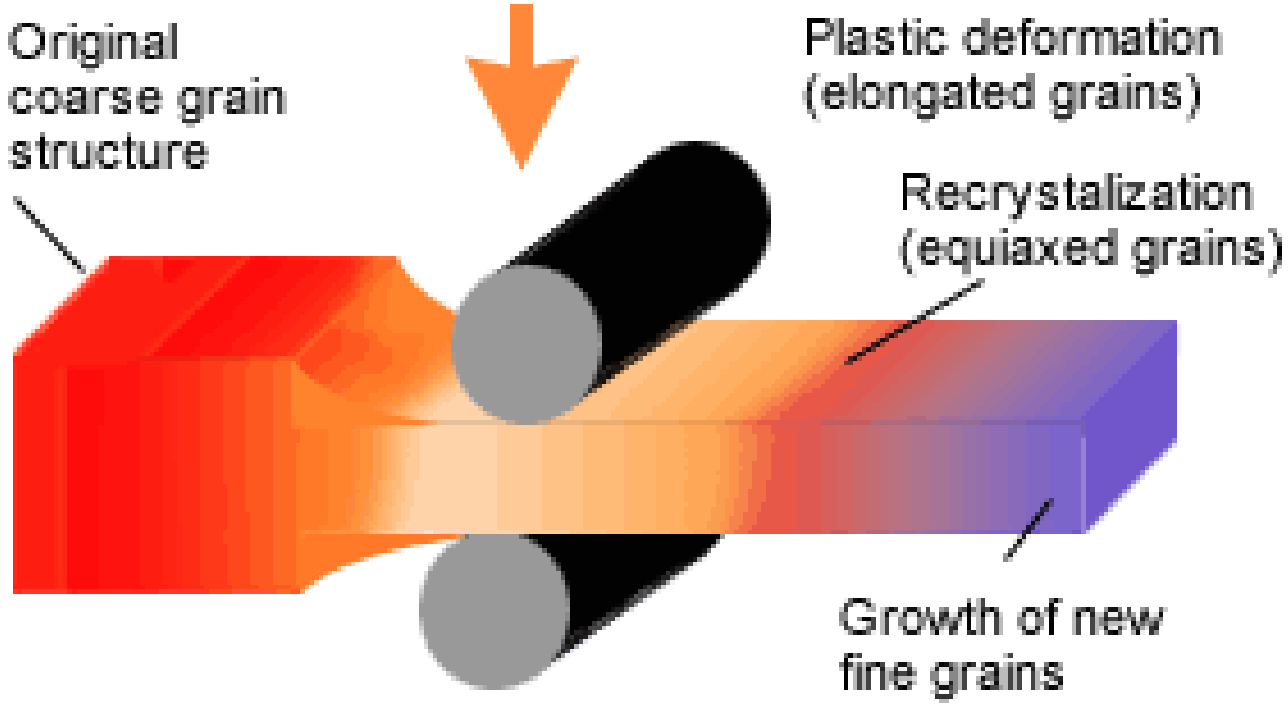
In rolling metal is taken into rolls by friction and then it is compressed by rolls to get the final shape. The thickness of metal that can be drawn into roll depends on the roughness of roll surface.



Rolling

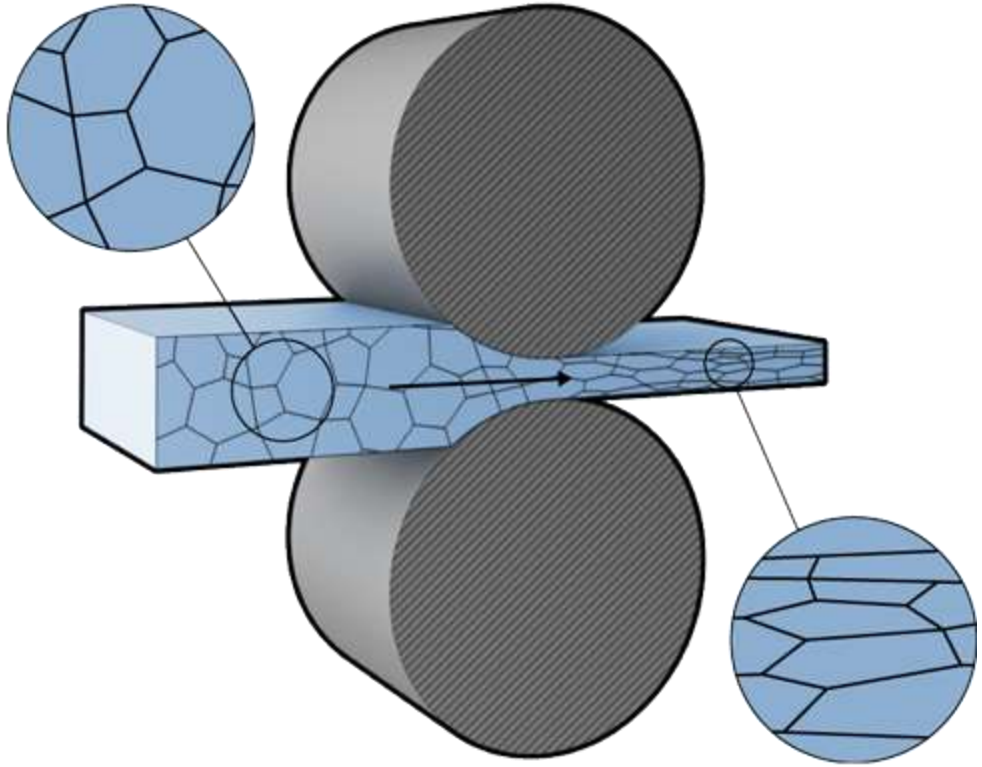
Type of Rolling process:

Hot Rolling



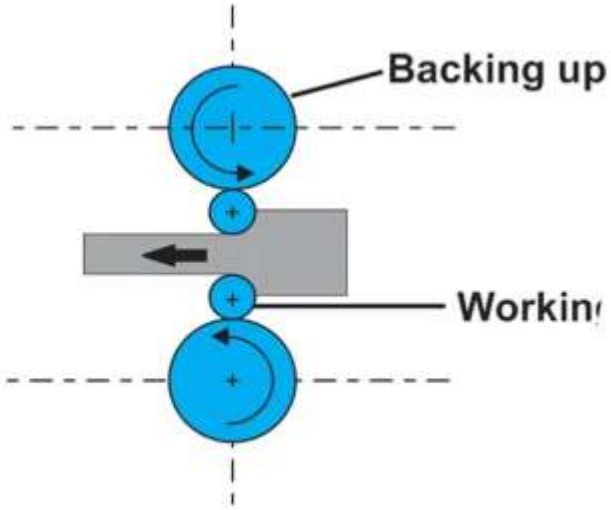
Ingot is heated above recrystallization temperature before passing through rolls.

Cold Rolling

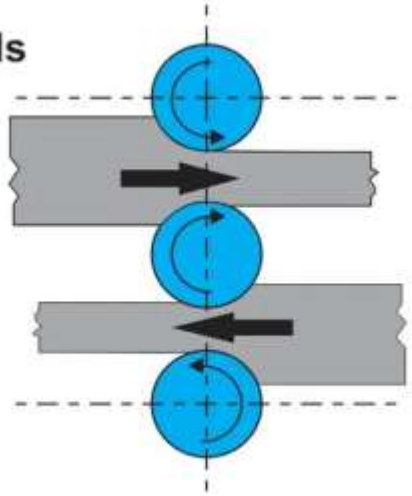


Ingot is heated below recrystallization temperature before passing through rolls

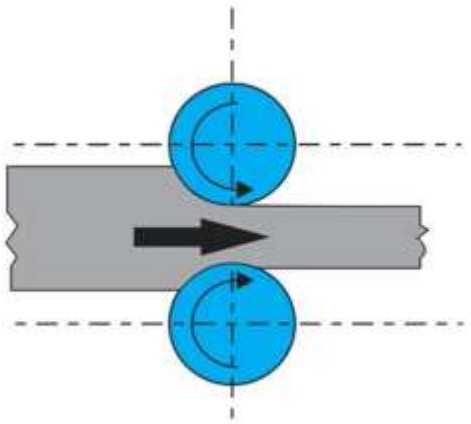
Rolling



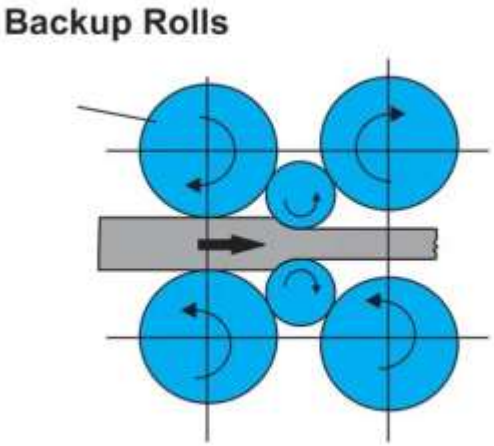
Four-High Rolling Mill



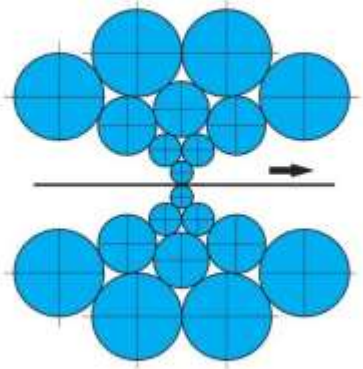
Three-High Rolling Mill



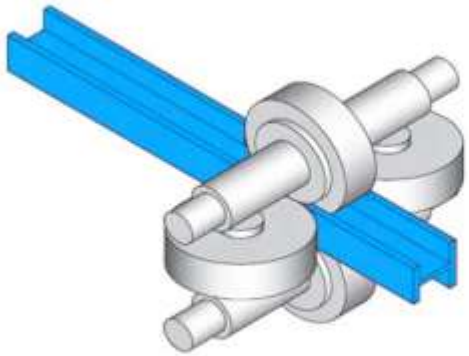
Two-High Rolling Mill



Cluster Mill

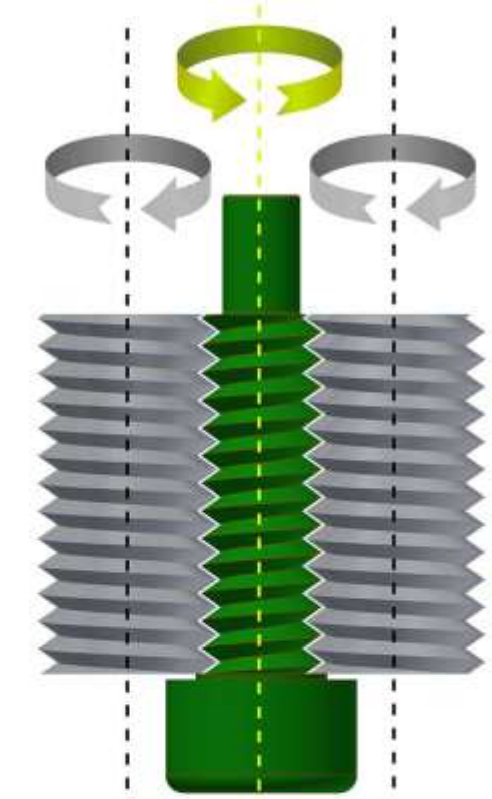


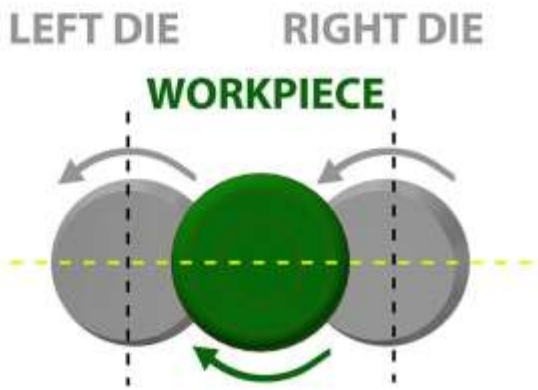
Multi-High Roll Mill

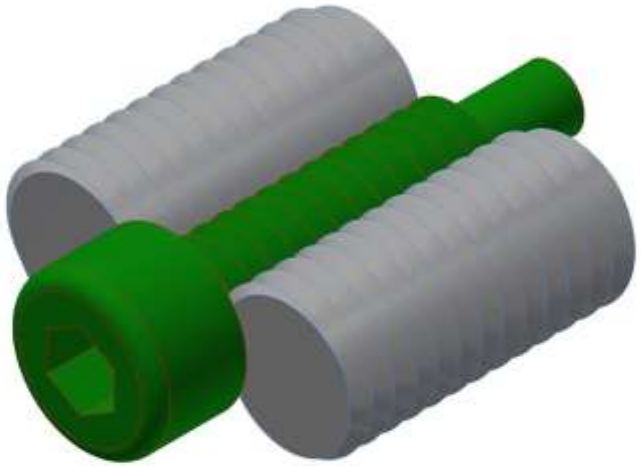


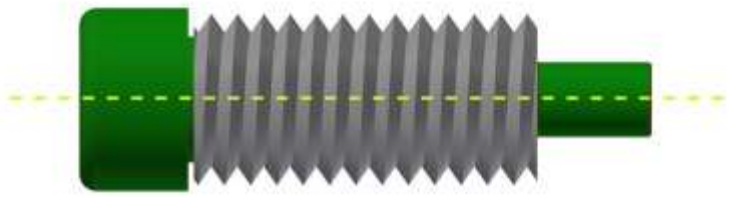
Universal Rolling Mill

Thread Rolling

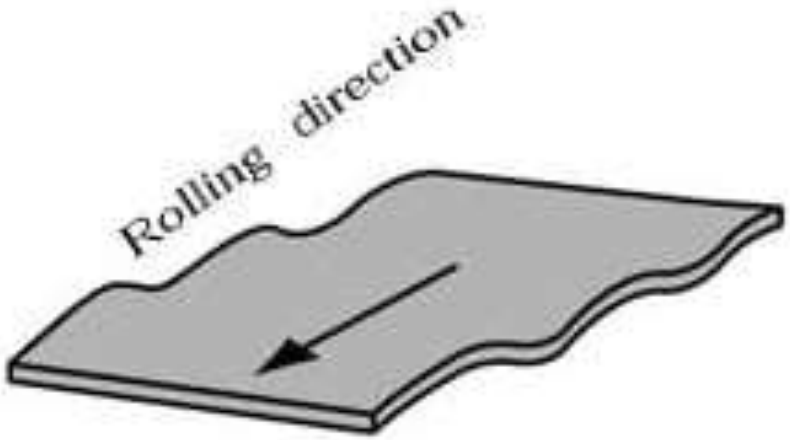




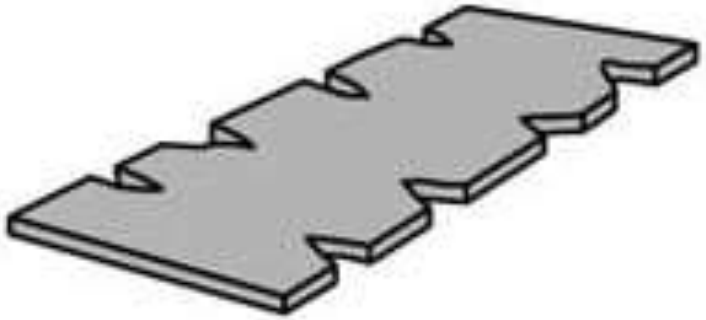




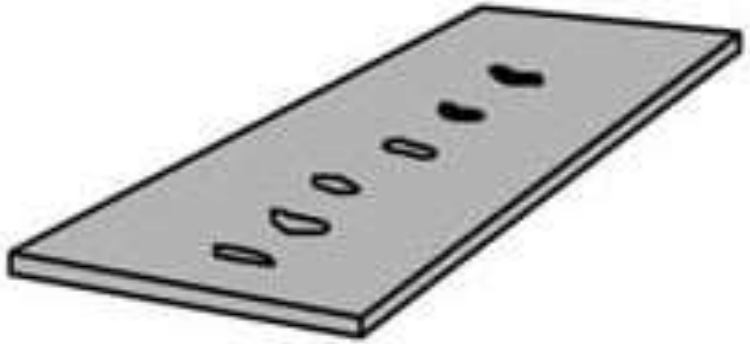
Rolling Defects



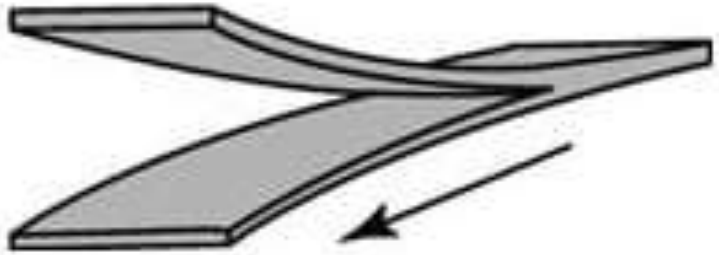
(a) wavy edges



(c) edge cracks



(b) zipper cracks in the center of the flat rolling



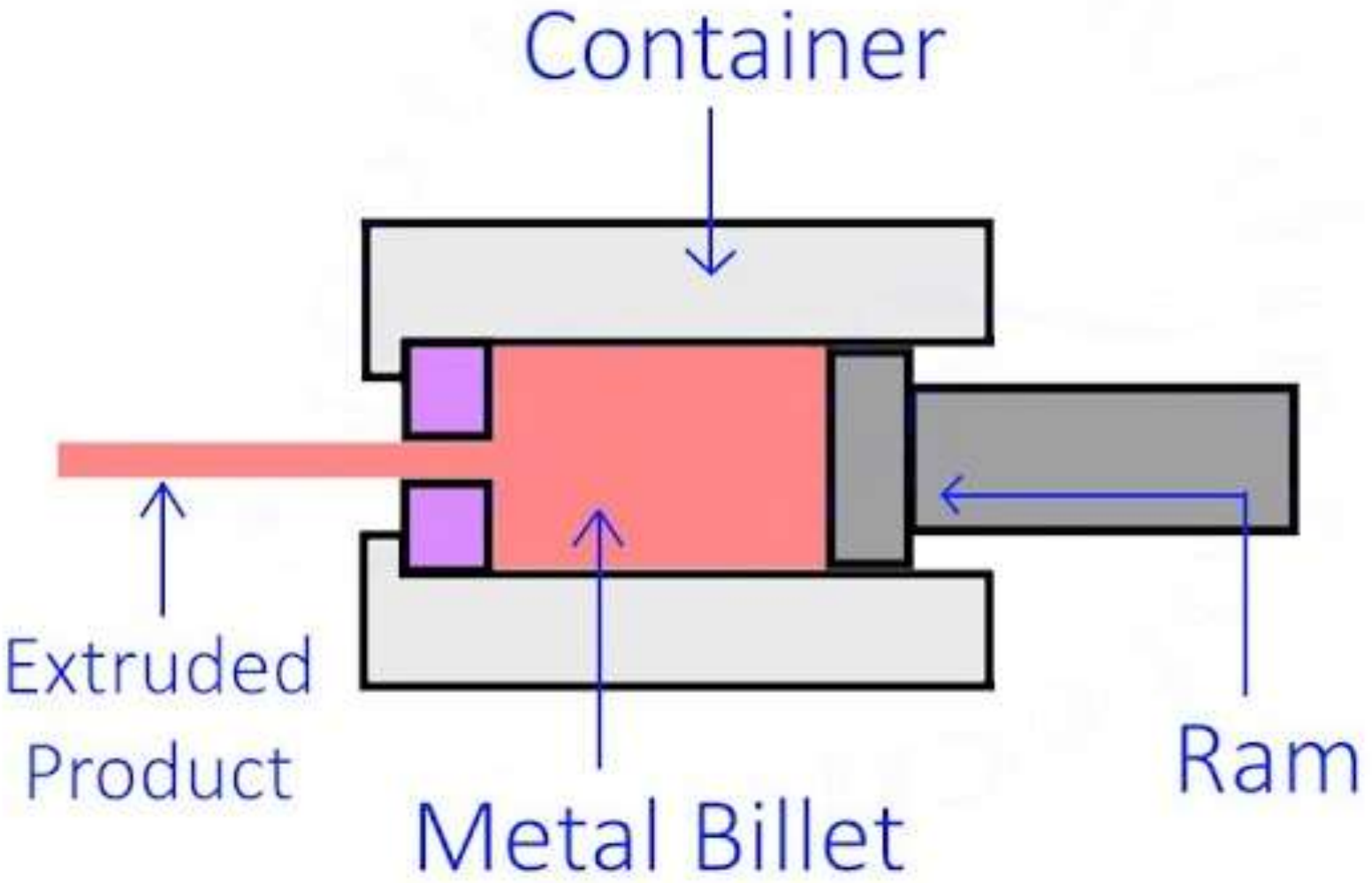
(d) alligatoring

Extrusion

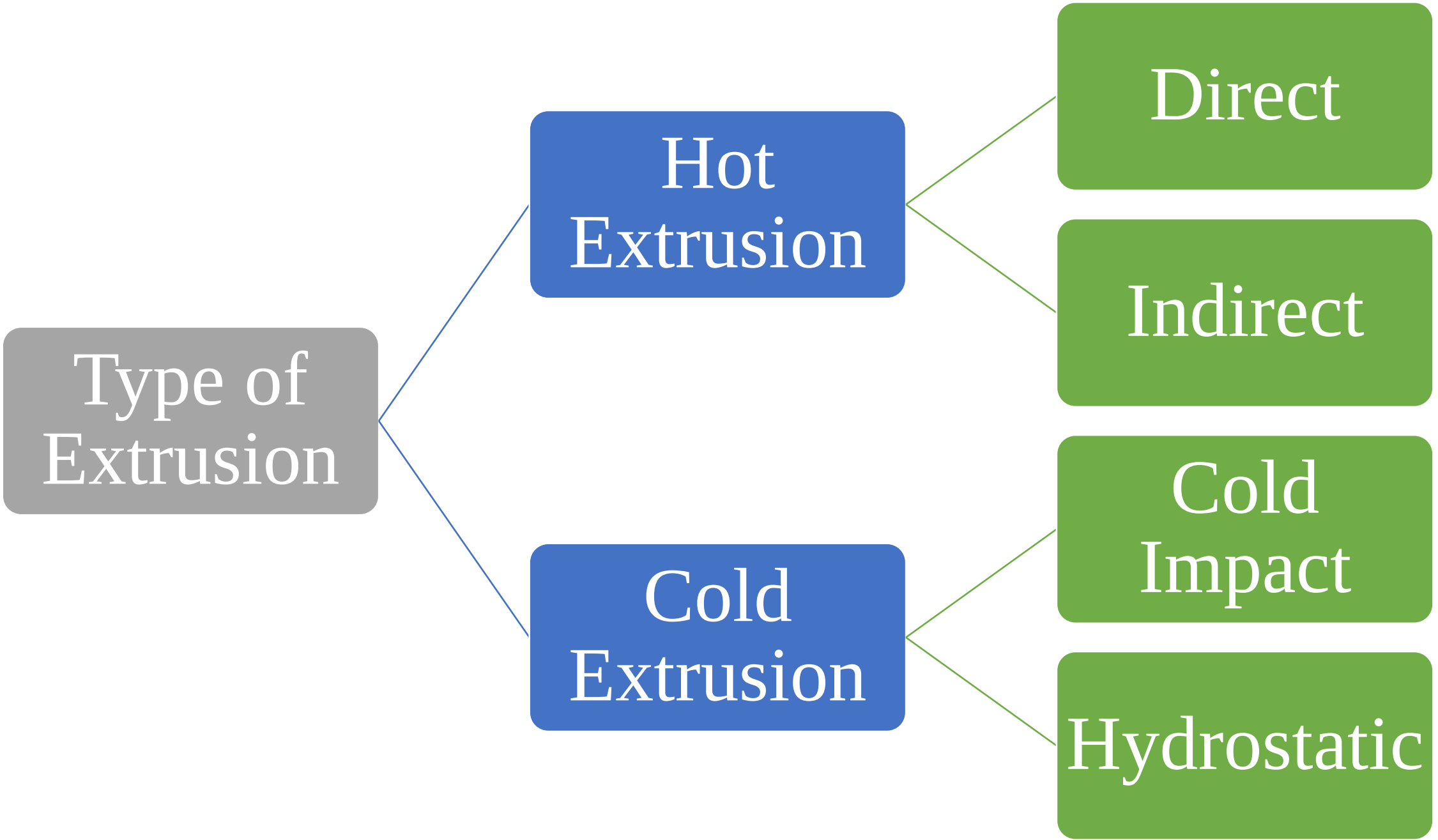
Extrusion is the process which produces lengths of uniform or non-uniform cross section area from a metal billet. The metal is allowed to flow from only one restricted opening under high pressure die.

- It is single pass operation.
- Complex part can be made easily
- Amount of reduction in extrusion is large compared to rolling

- Extremely thin sections are difficult to extrude.
- Tooling cost is high



Extrusion


Type of Extrusion
Hot Extrusion
Cold Extrusion
Direct
Indirect
Cold Impact
Hydrostatic

Extrusion

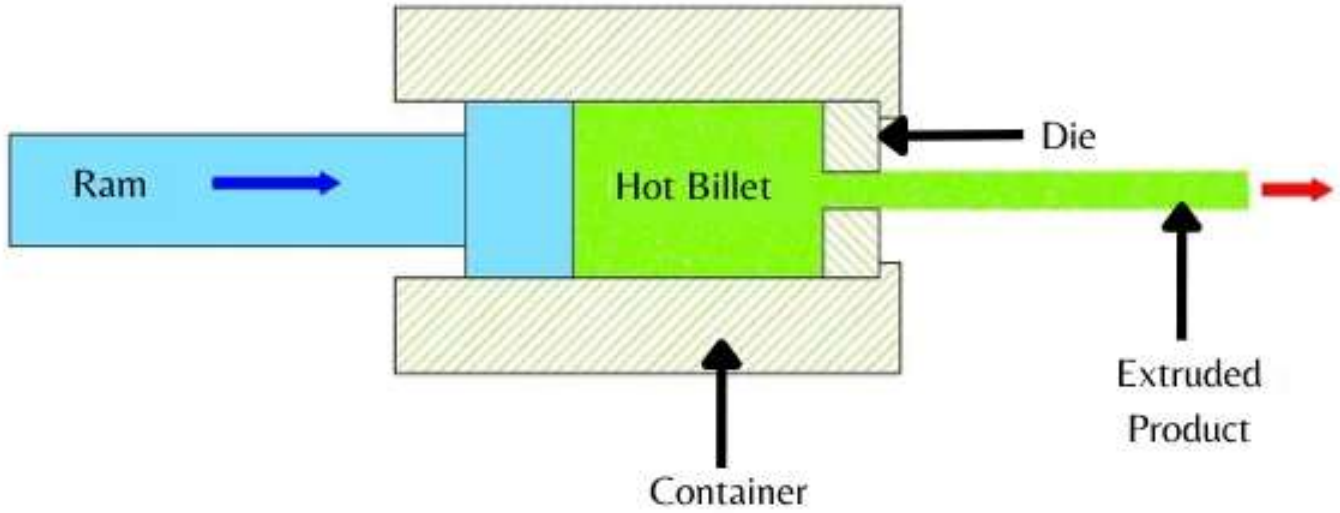
Type of Extrusion

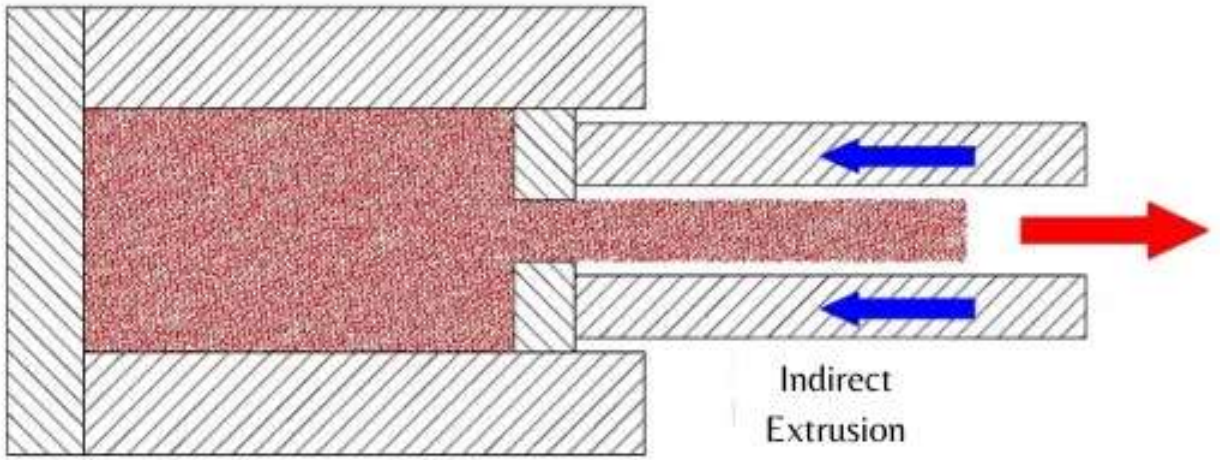
Hot Extrusion

- Direct
- Indirect

Cold Extrusion

- Cold Impact
- Hydrostatic





Extrusion

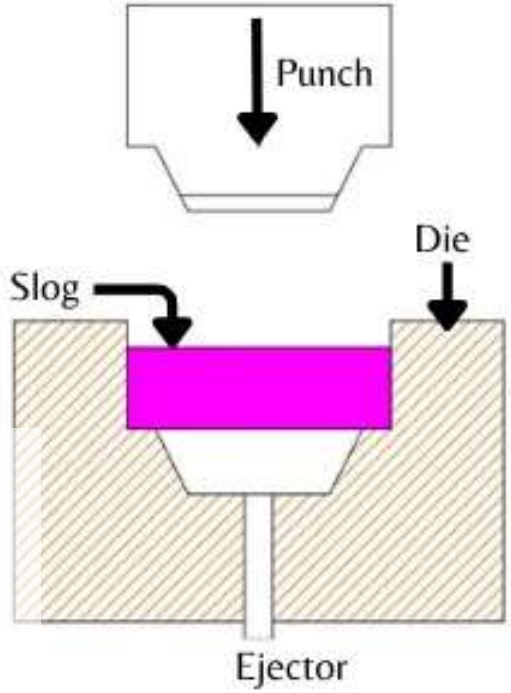
Type of Extrusion

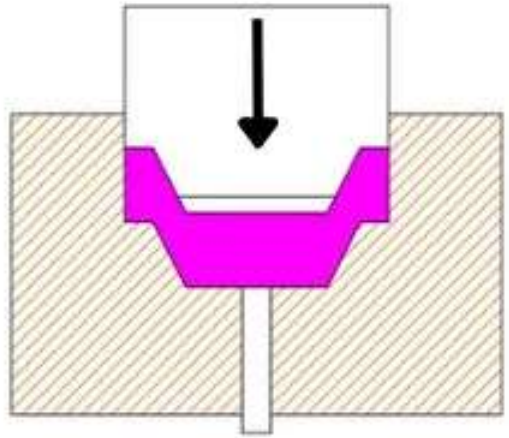
Hot Extrusion

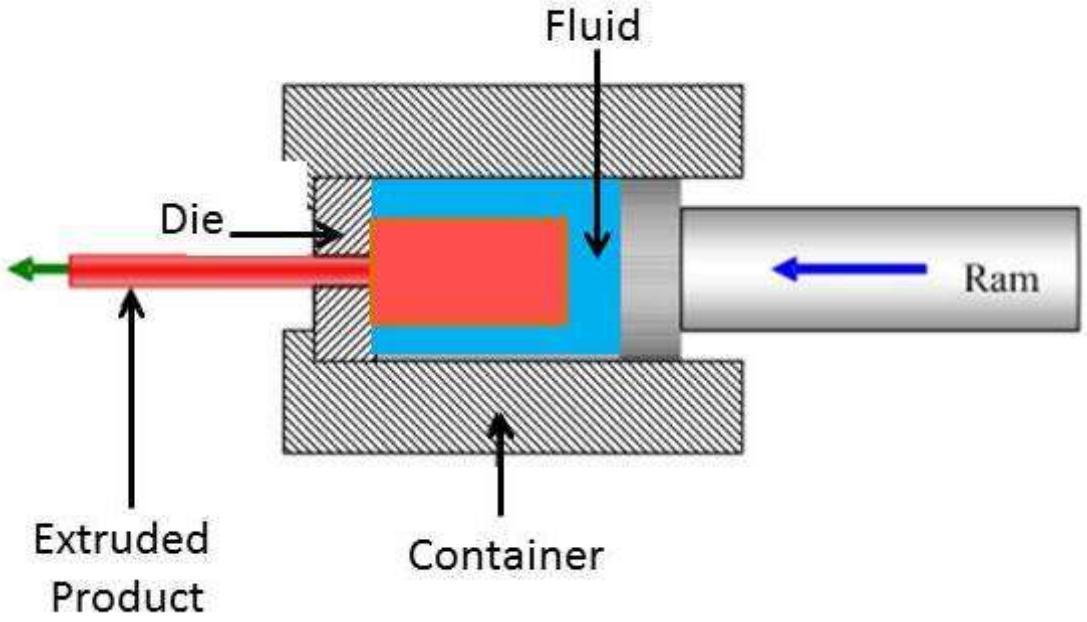
- Direct
- Indirect

Cold Extrusion

- Cold Impact
- Hydrostatic

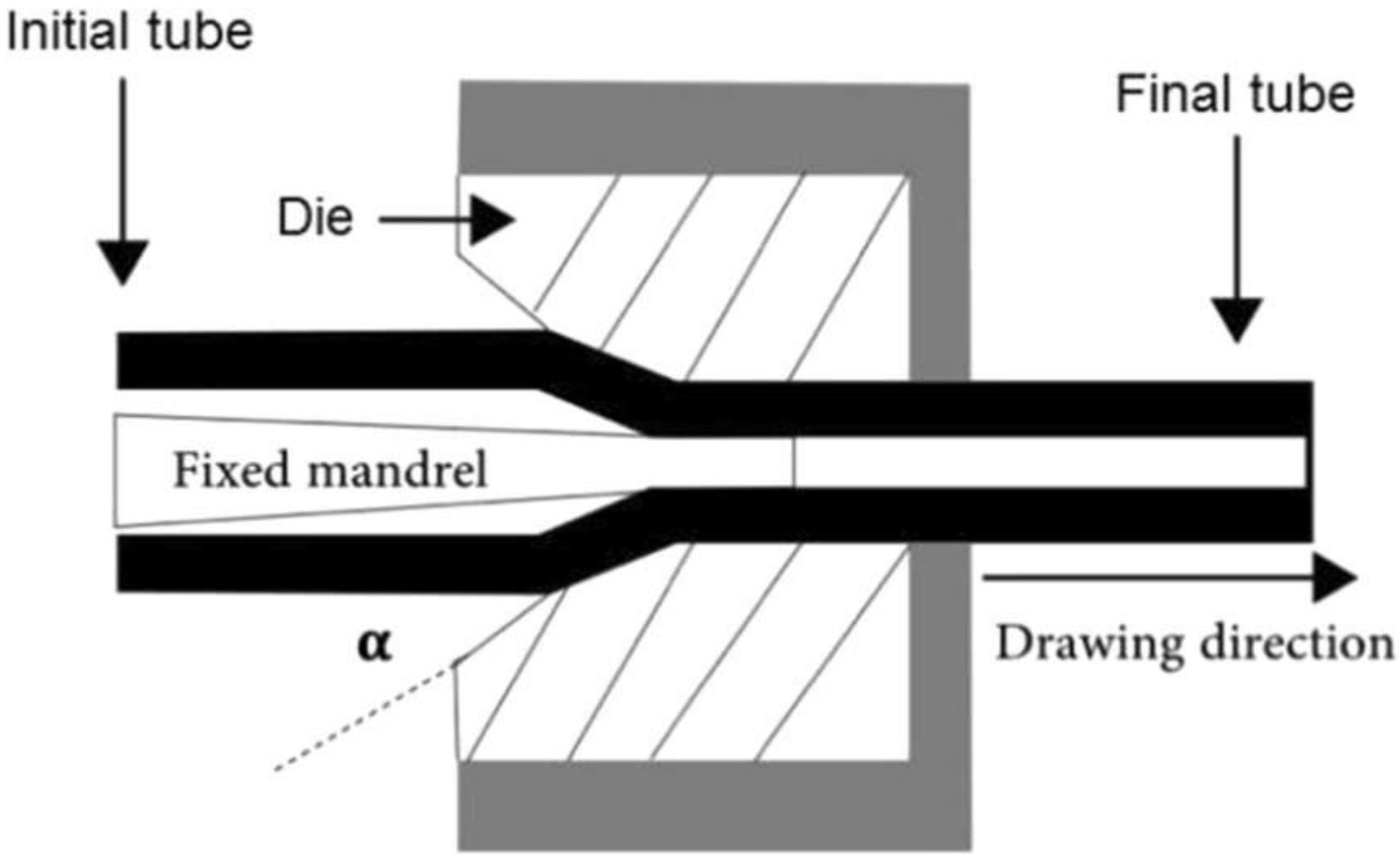




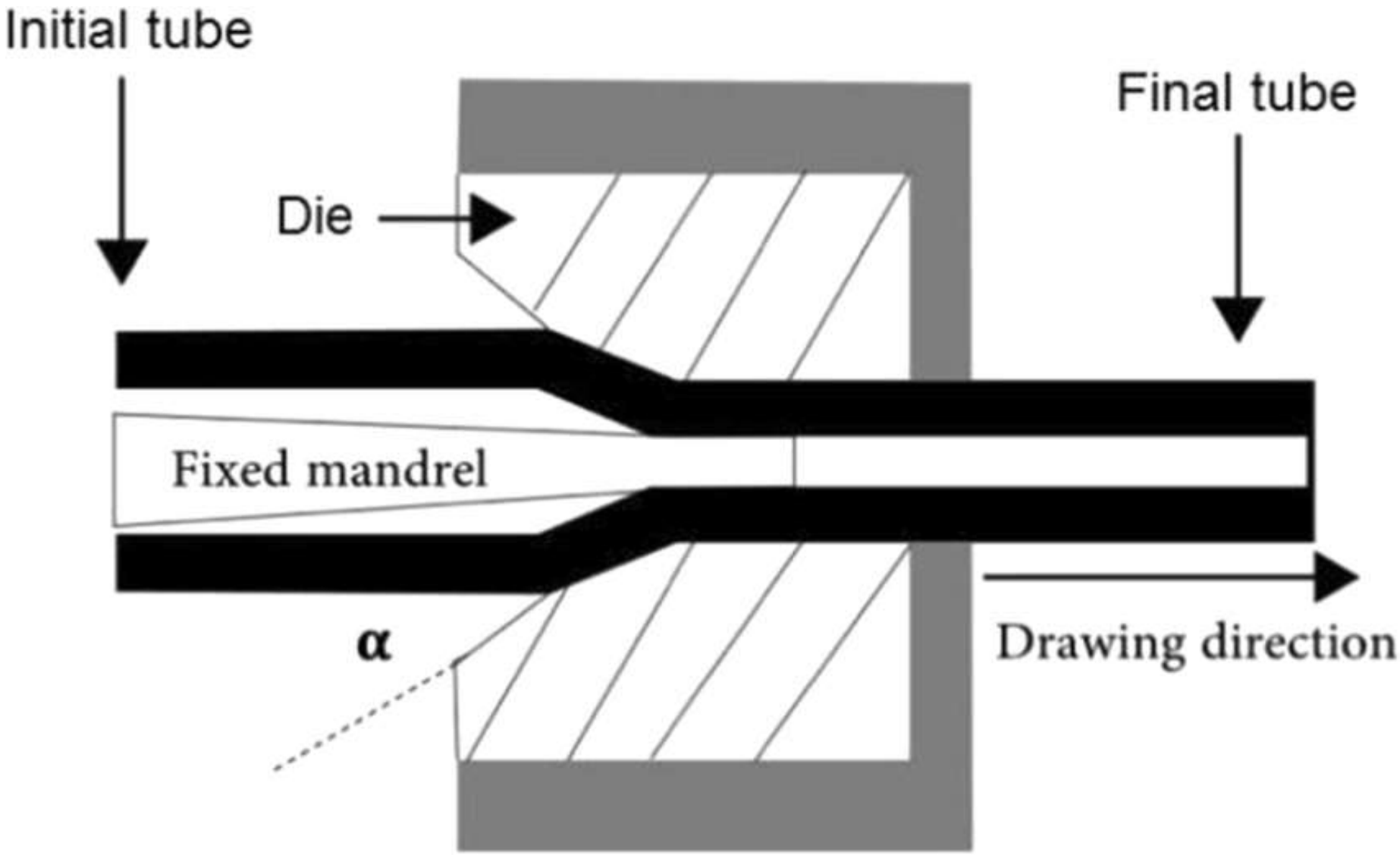


Drawing

Extrusion is the process involving pulling of metal through a die by means of a tensile force. Tensile force is applied to the exit side.



Tube Drawing



Wire Drawing