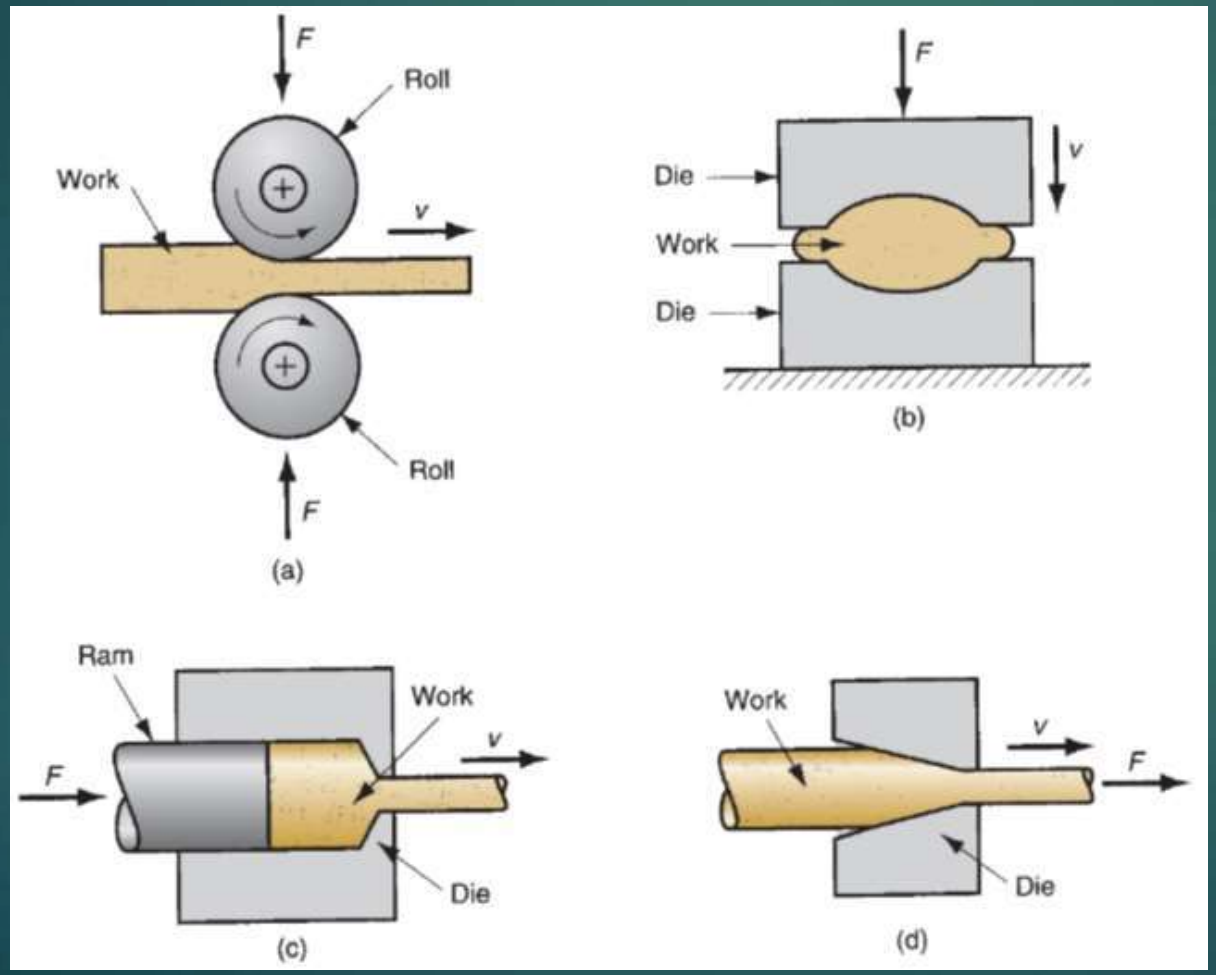
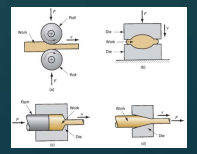
Principle of Metal Forming, bulk deformation and sheet deformation process

Somnath Chattopadhyaya



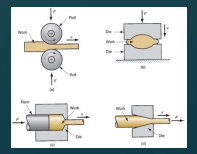
Learning Objective

- Introduction to Principle of Metal Forming, bulk deformation
- Introduction to sheet deformation process

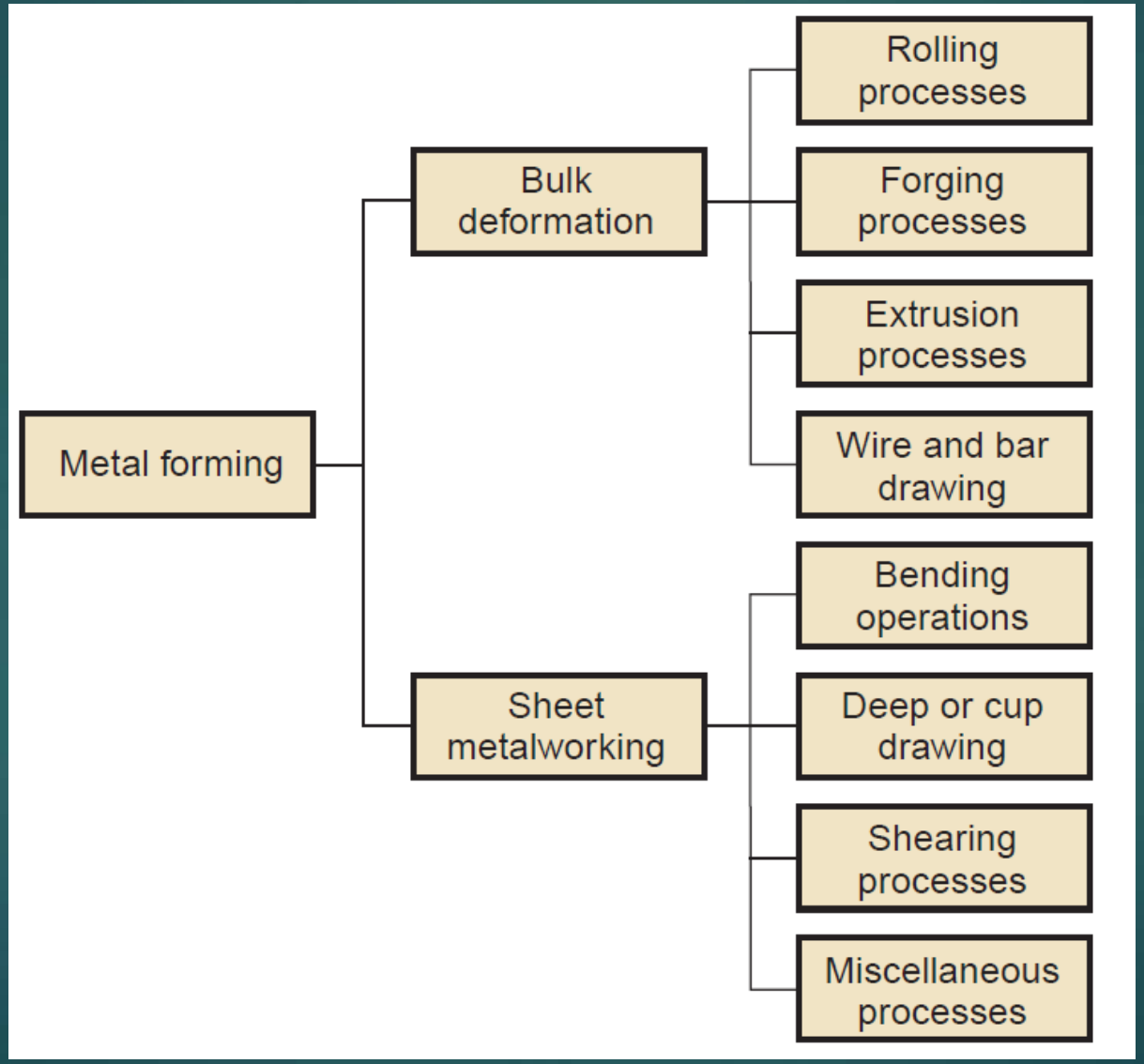


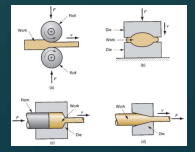
Introduction to Metal Forming

- ***Metal forming*** includes a large group of manufacturing processes in which plastic deformation is used to change the shape of metal workpieces.
- Deformation results from the use of a tool, usually called a ***die*** in metal forming, which applies stresses that exceed the yield strength of the metal.
- The metal therefore deforms to take a shape determined by the geometry of the die.
- Metal forming dominates the class of shaping operations



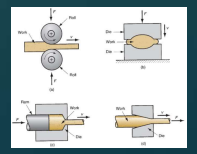
Classification of Metal Forming





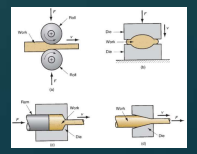
Introduction

- Stresses applied to plastically deform the metal are usually compressive.
- However, some forming processes stretch the metal, while others bend the metal, and still others apply shear stresses to the metal.
- To be successfully formed, a metal must possess certain properties.



Introduction

- Desirable properties include low yield strength and high ductility.
- These properties are affected by temperature.
- Ductility is increased and yield strength is reduced when work temperature is raised.

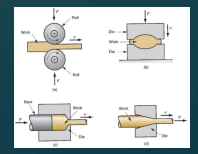


Introduction

- The effect of temperature gives rise to distinctions between cold working, warm working, and hot working.
- Strain rate and friction are additional factors that affect performance in metal forming.

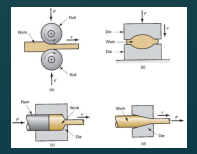
Bulk Deformation Processes

- Bulk deformation processes are generally characterized by significant deformations and massive shape changes, and the surface area– to–volume of the work is relatively small.
- The term ***bulk*** describes the work parts that have this low area–to–volume ratio.
- Starting work shapes for these processes include cylindrical billets and rectangular bars.
- ➢

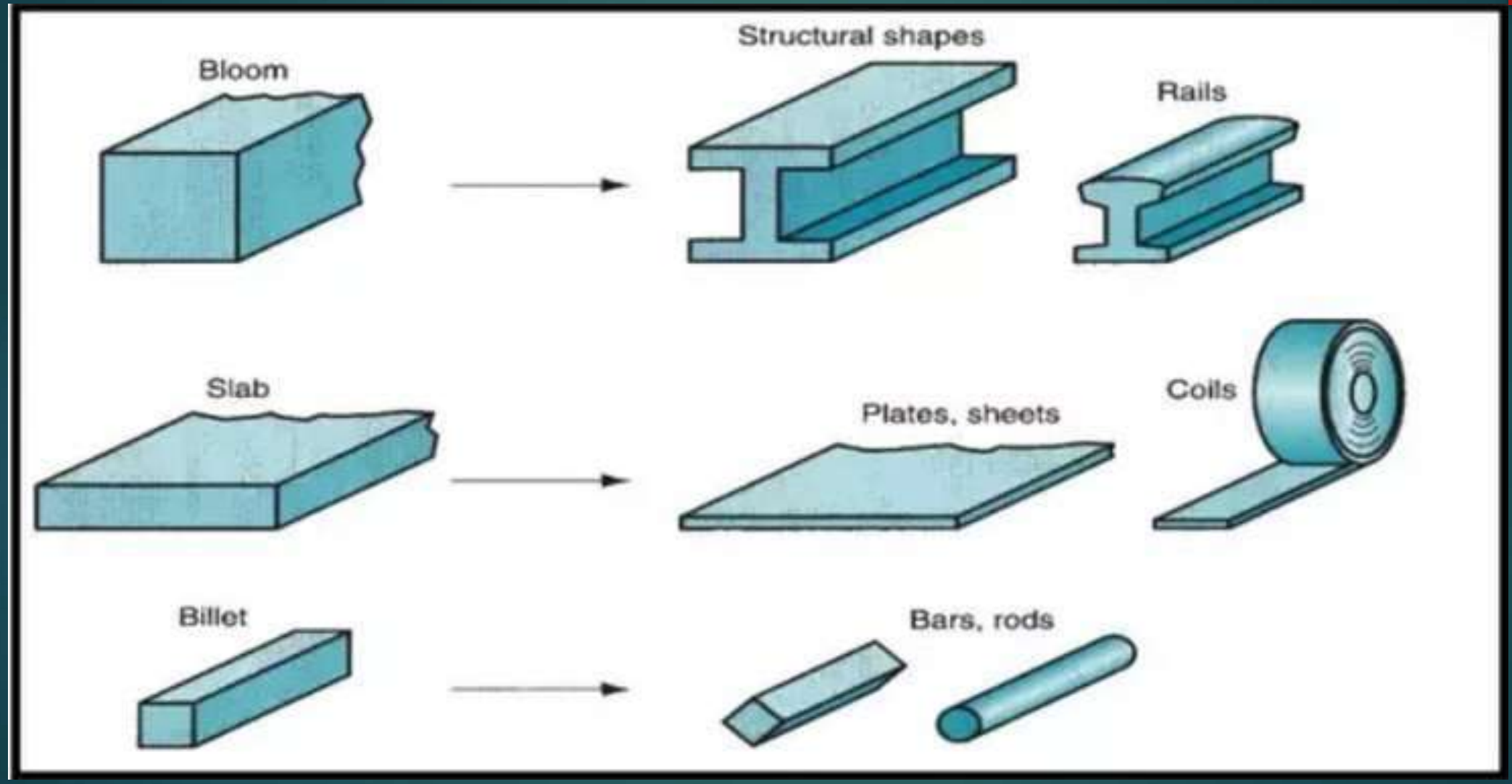


Rolling

- This is a compressive deformation process in which the thickness of a slab or plate is reduced by two opposing cylindrical tools called rolls.
- The rolls rotate so as to draw the work into the gap between them and squeeze it.



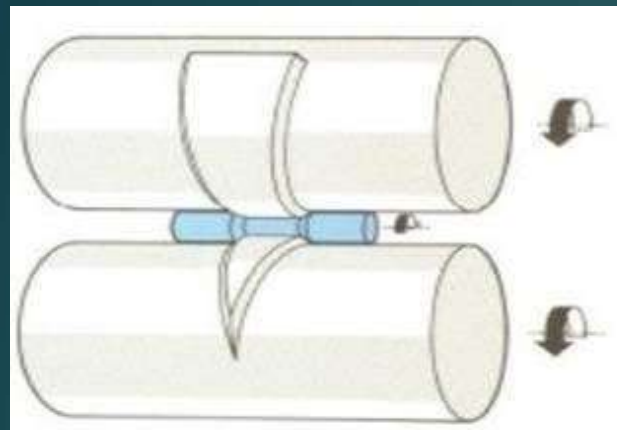
Blooms, Slabs and Billets



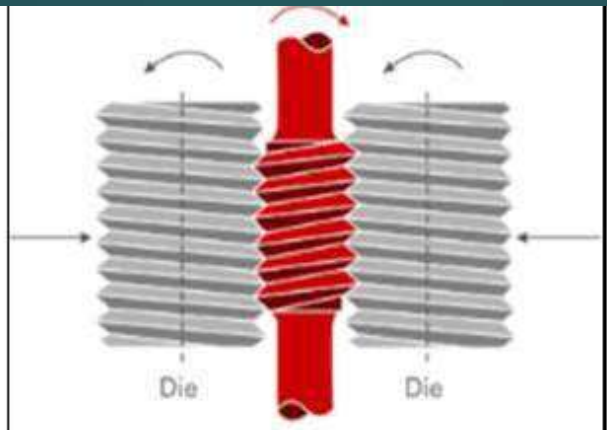
Blooms, Slabs and Billets

- A bloom is a rolled steel workpiece with a square cross section of about 150 mm by 150 mm. ...
- A slab is rolled from an ingot or a bloom and has a rectangular cross section of about 250 mm by 40 mm.
- A billet is rolled from a bloom and has a square cross section of about 40 mm by 40 mm.

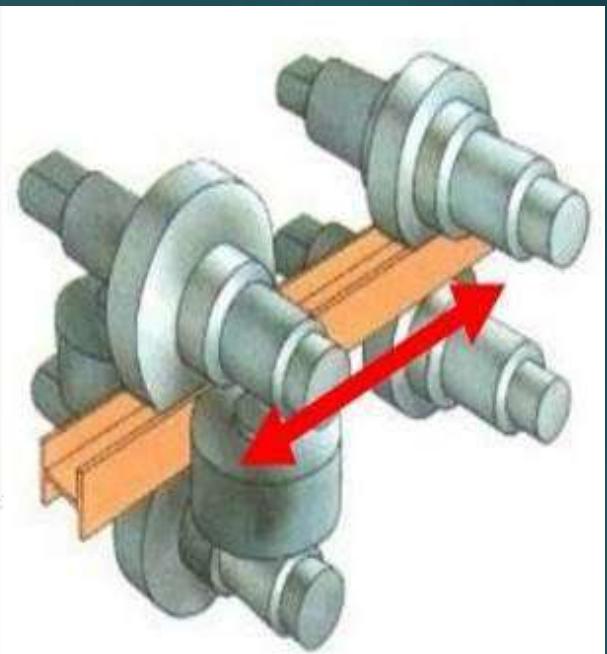
Type of Rolling



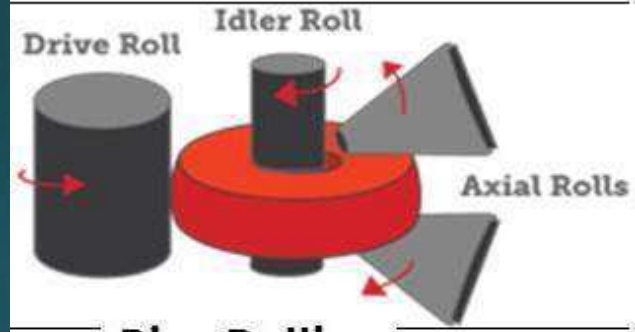
Transverse Rolling



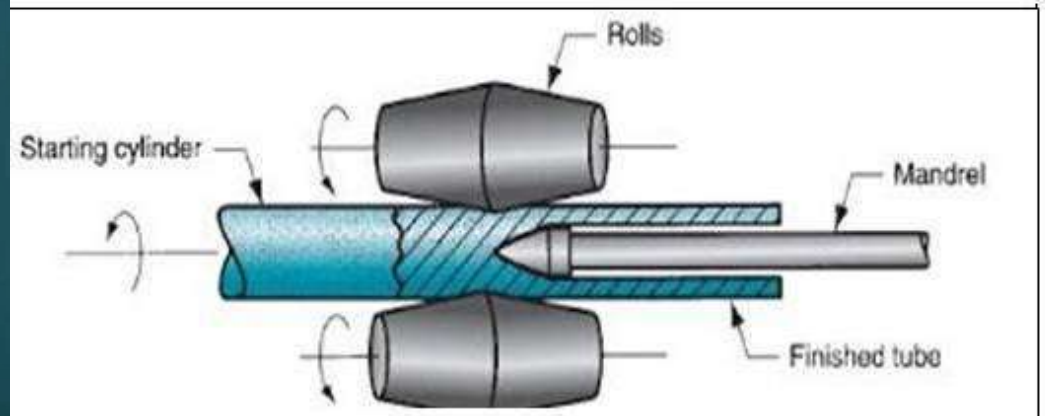
Thread Rolling



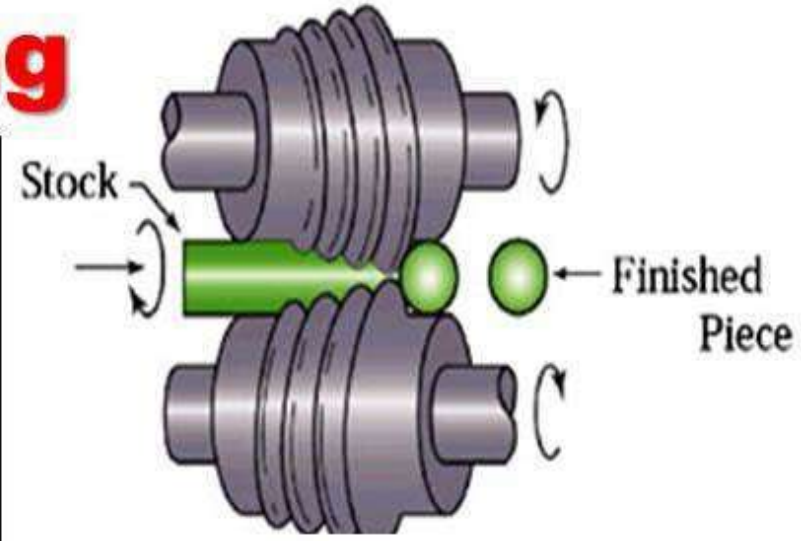
Shape Rolling



Ring Rolling

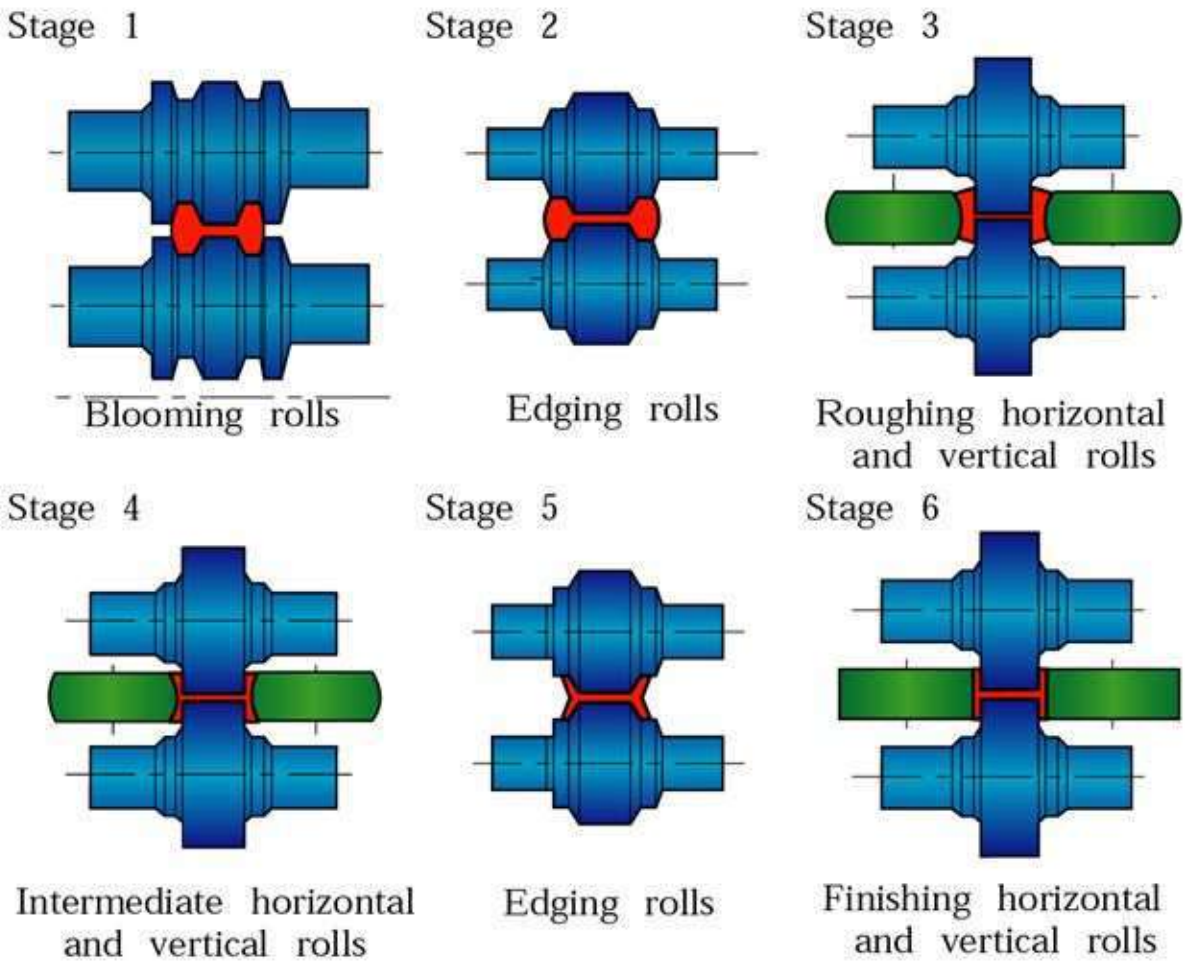


Tube Piercing



Skew Rolling

Shape Rolling



Shape Rolling

- Shape rolling of steels is a process which requires a lot of heat and a lot of force.
- Reheating is carried out to around 1200°C and then the metal is continuously fed through rollers to draw the desired dimensions.
- Popular shapes have good application in the construction business as I, H, and U shaped beams or girders can be produced for structural integrity.

Shape Rolling

- Steel is a strong material that is highly resistant to shaping at normal temperatures but this resistance lessens considerably at higher temperatures.
- For that reason the billets, blooms and slabs from the steelmaking process are shaped into basic products at carefully controlled elevated temperatures.

Shape Rolling

- The method that is most commonly used for shaping is to heat the steel to around 1,200°C in a reheat furnace and roll the steel, squeezing it between sets of cylinders or rolls.
- Rolls are arranged in pairs and housed in a 'stand'.

Shape Rolling

- To change the shape of a material as strong as steel the rolls must exert forces measured in thousands of tones, and must also draw the steel continuously through the rolls while reducing the thickness.
- Two main classes of product are produced – flat products, sheets or strips of uniform thickness, and long products - lengths of a particular cross section, ranging from rectangular bars to double flange H sections.
- For flat products, two horizontal rolls are set one above the other in an open housing.

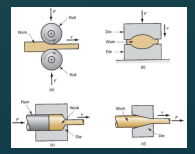
Shape Rolling

- For long products, a series of specially shaped and angled rolls (referred to as stands) are used to transform the section to the required shape. The figure shows the stand used to create open sections.

- British, European and International standards define dimensions for a wide variety of open section shapes, notably I and H shaped sections, angle sections and channels.

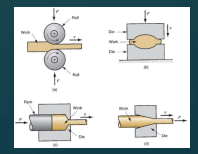
Forging

- ➢ In forging, a workpiece is compressed between two opposing dies, so that the die shapes are imparted to the work.
- Forging is traditionally a hot working process, but many types of forging are performed cold.



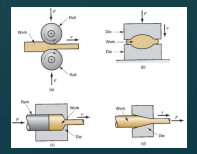
Extrusion

- ➢ ***Extrusion***. This is a compression process in which the work metal is forced to
- flow through a die opening, thereby taking the shape of the opening as its own
- cross section.



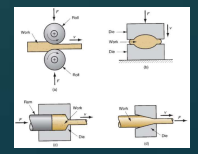
Drawing

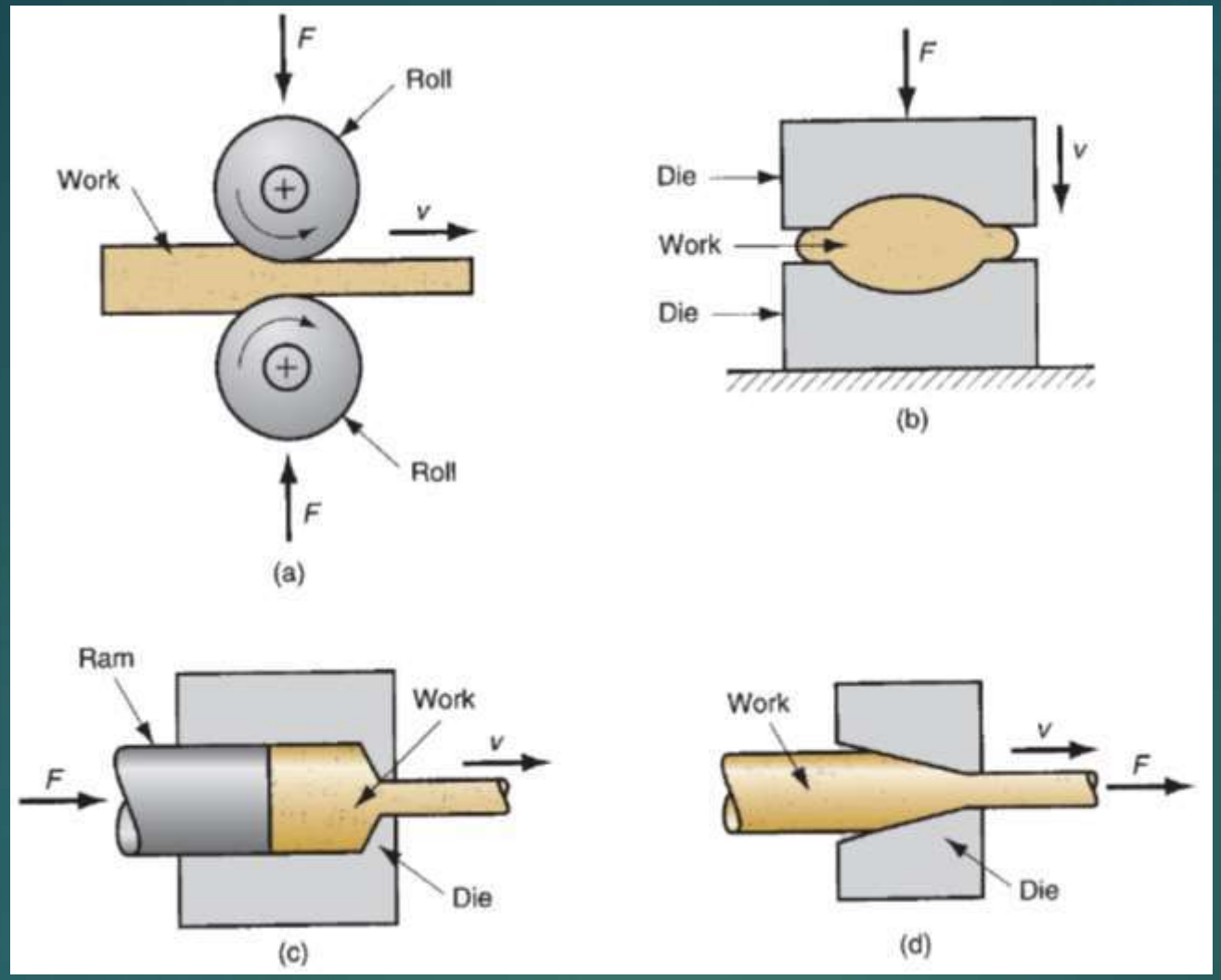
- In this forming process, the diameter of a round wire or bar is reduced by pulling it through a die opening.



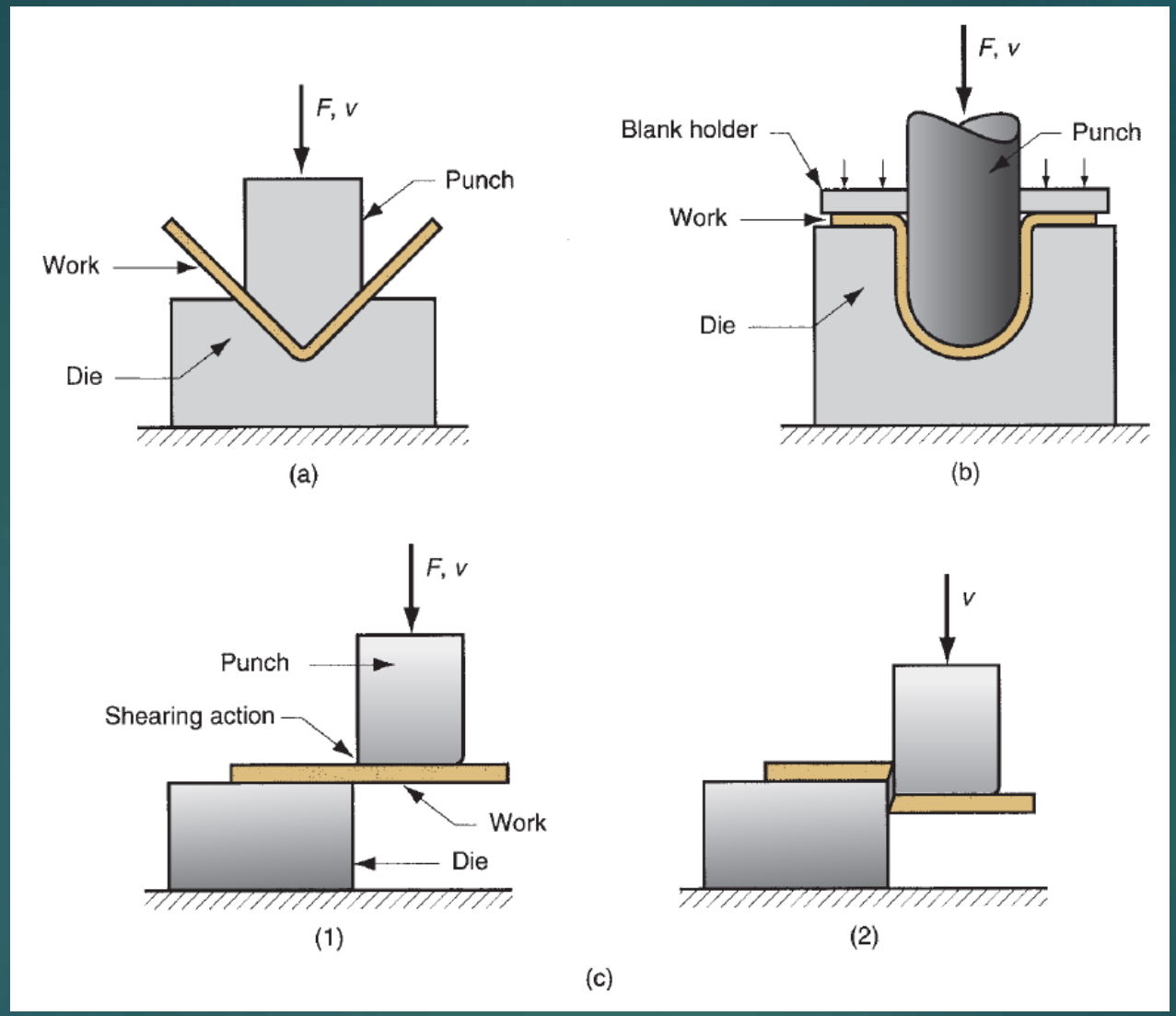
Sheet Metalworking

- **Sheet Metalworking** Sheet metalworking processes are forming and cutting
- operations performed on metal sheets, strips, and coils.
- The surface area–to–volume ratio of the starting metal is high; thus, this ratio is a useful means to distinguish bulk deformation from sheet metal processes.

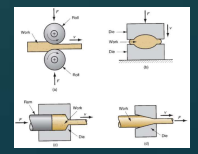




(a) rolling, (b) forging, (c) extrusion, and (d) drawing.



sheet metalworking operations: (a) bending, (b) drawing, and (c) shearing: (1) as punch first contacts sheet, and (2) after cutting.

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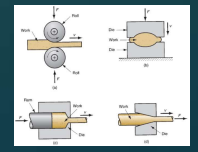
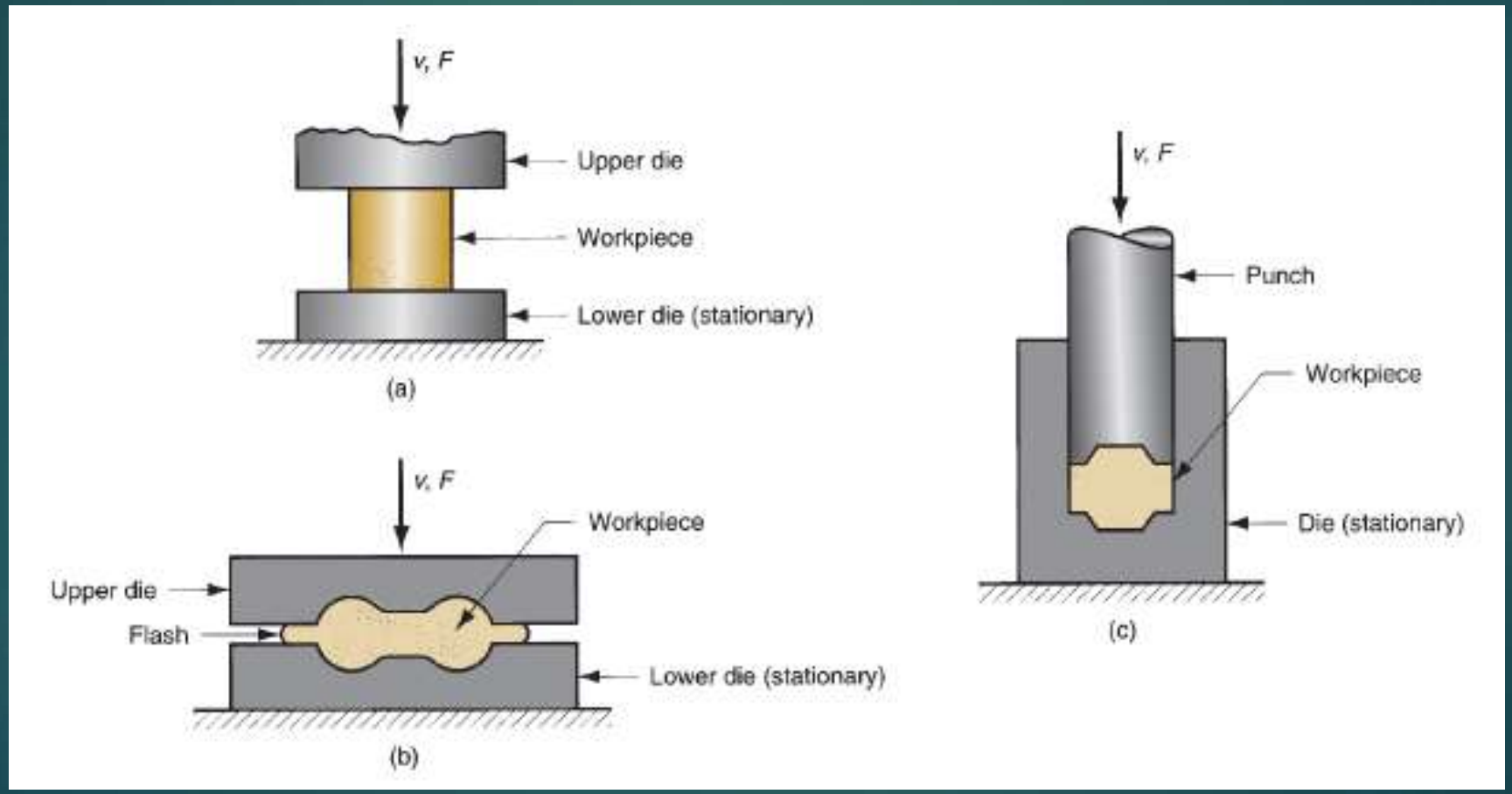


Forging Sheet Metal Working Principle and applications

Somnath Chattopadhyaya



Learning Objective

- **Introduction to Forging and Sheet metal Working**
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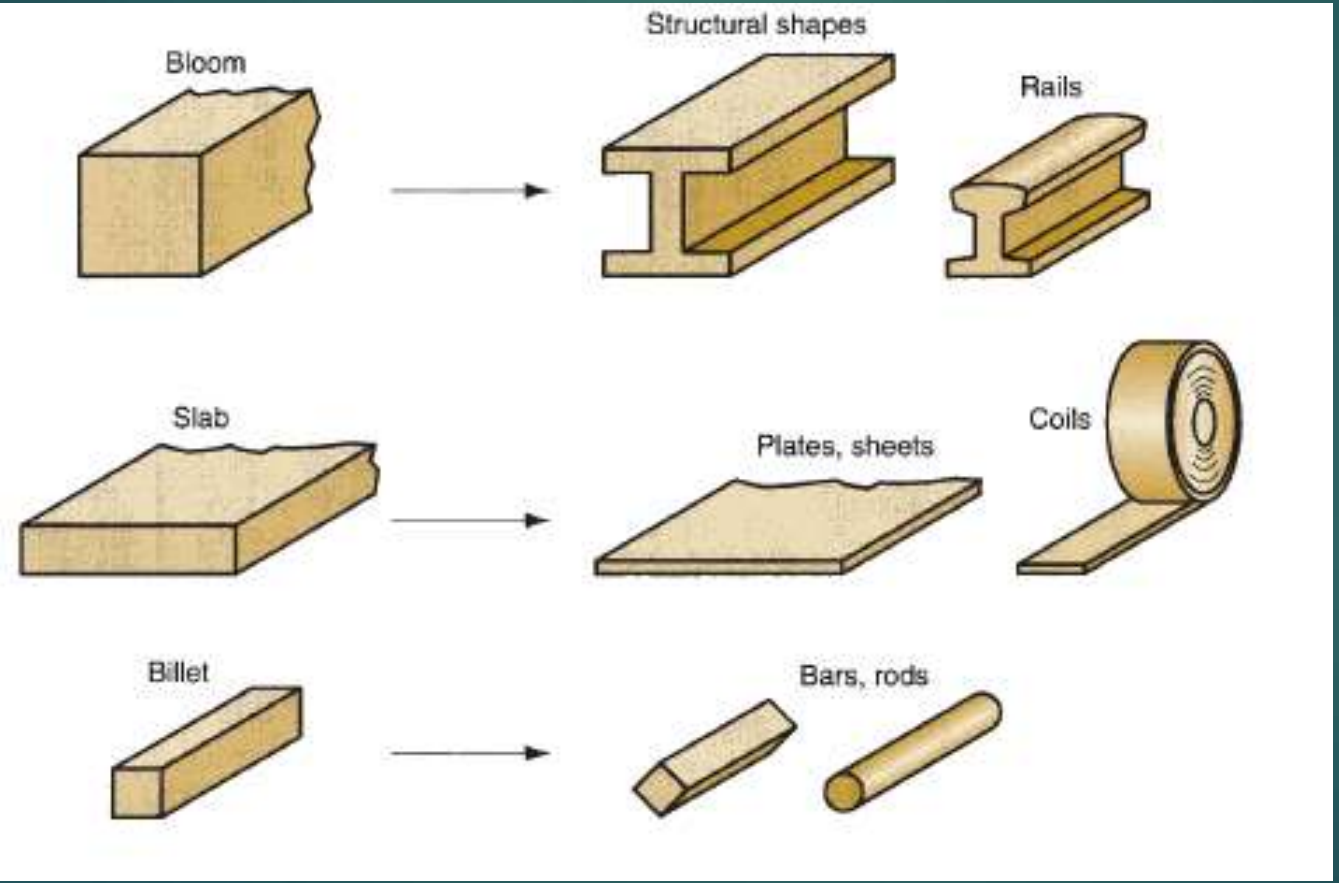
Hot Working


Structural shapes
Bloom
Rails
Slab
Plates, sheets
Coils
Billet
Bars, rods

Forging

- Forging is a deformation process in which the work is compressed between two dies, using either impact or gradual pressure to form the part. It is the oldest of the metal forming operations, dating back to perhaps 5000 B.C.E.
- Today, forging is an important industrial process used to make a variety of high-strength components for automotive, aerospace, and other applications.

Forging

- These components include engine crankshafts and connecting rods, gears, aircraft structural components, and jet engine turbine parts.
- In addition, steel and other basic metals industries use forging to establish the basic form of large components that are subsequently machined to final shape and dimensions.

Forging

- Forging is carried out in many different ways.
- One way to classify the operations is by working temperature. Most forging operations are performed hot or warm, owing to the significant deformation demanded by the process and the need to reduce strength and increase ductility of the work metal.
- However, cold forging is also very common for certain products. The advantage of cold forging is the increased strength that results from strain hardening of the component.
- Either impact or gradual pressure is used in forging

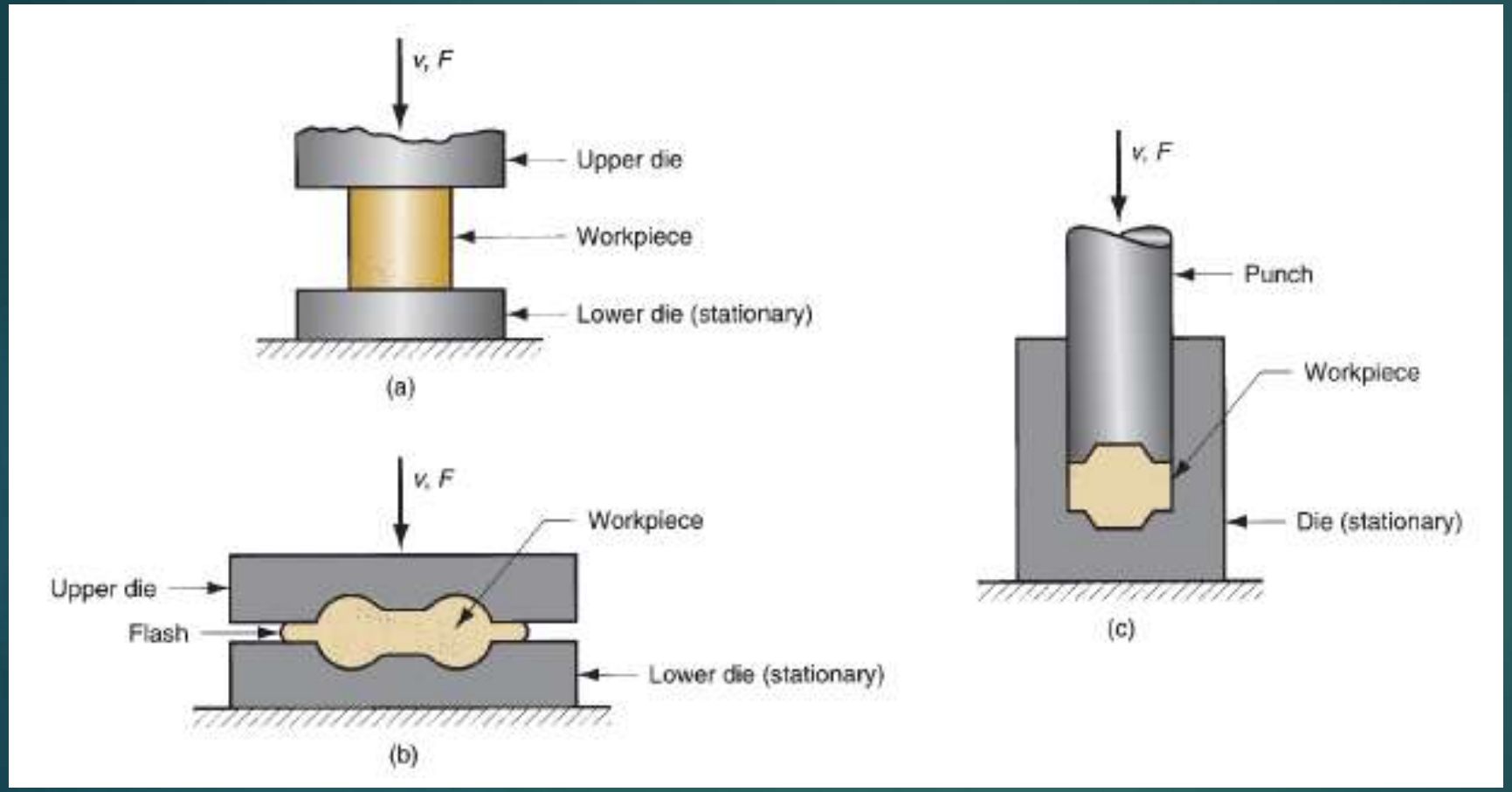
Forging

- The distinction derives more from the type of equipment used than differences in process technology.
- A forging machine that applies an impact load is called a ***forging hammer***, while one that applies gradual pressure is called a ***forging press***.
- Another difference among forging operations is the degree to which the flow of the work metal is constrained by the dies.

Forging

- By this classification, there are three types of forging operations,
- (a) open-die forging,
- (b) impressiondie forging,
- and (c) fl ashless forging.

Three types of Forging (a) open-die forging, (b) impression-die forging, and (c) flashless forging.



Open-die forging

- In ***open-die forging***, the work is compressed between two flat (or almost flat) dies, thus allowing the metal to flow without constraint in a lateral direction relative to the die surfaces.

Impression-die forging

- In ***impression-die forging***, the die surfaces contain a shape or impression that is imparted to the work during compression, thus constraining metal fl ow to a signifi cant degree

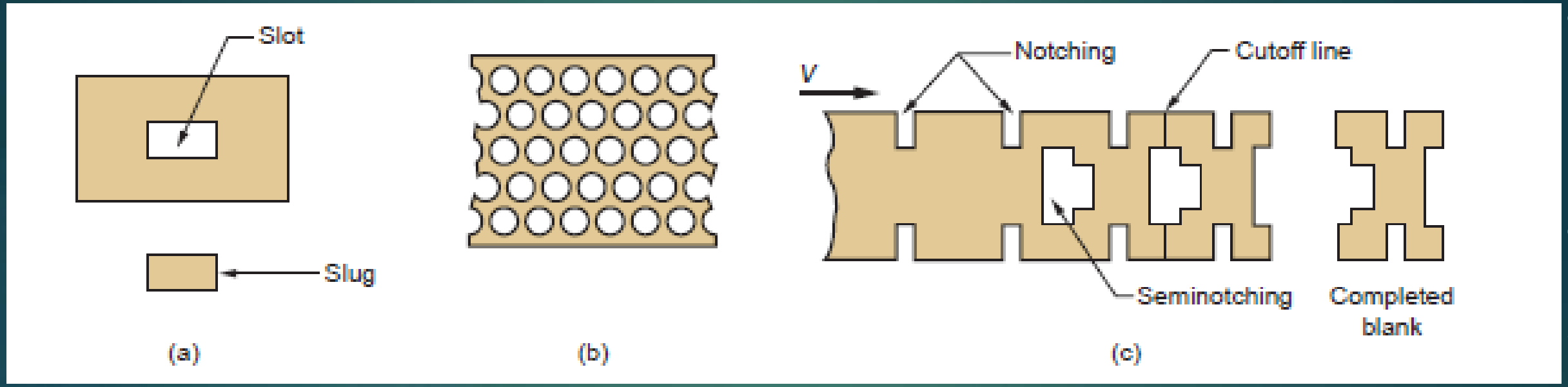
Impression-die forging

- In this type of operation, a portion of the work metal flows beyond the die impression to form *flash*.
- Flash is excess metal that must be trimmed off later.

Flashless forging

- In *flashless forging*, the work is completely constrained within the die and no excess flash is produced.
- The volume of the starting work-piece must be controlled very closely so that it matches the volume of the die cavity

(a) Slotting, (b) perforating, (c) notching and seminotching. Symbol *v* indicates motion of strip



Slotting

- Slotting is the term sometimes used for a punching operation that cuts out an elongated or rectangular hole.

Perforating

- ***Perforating*** involves the simultaneous punching of a pattern of holes in sheet metal.
- The hole pattern is usually for decorative purposes, or to allow passage of light, gas, or fluid.

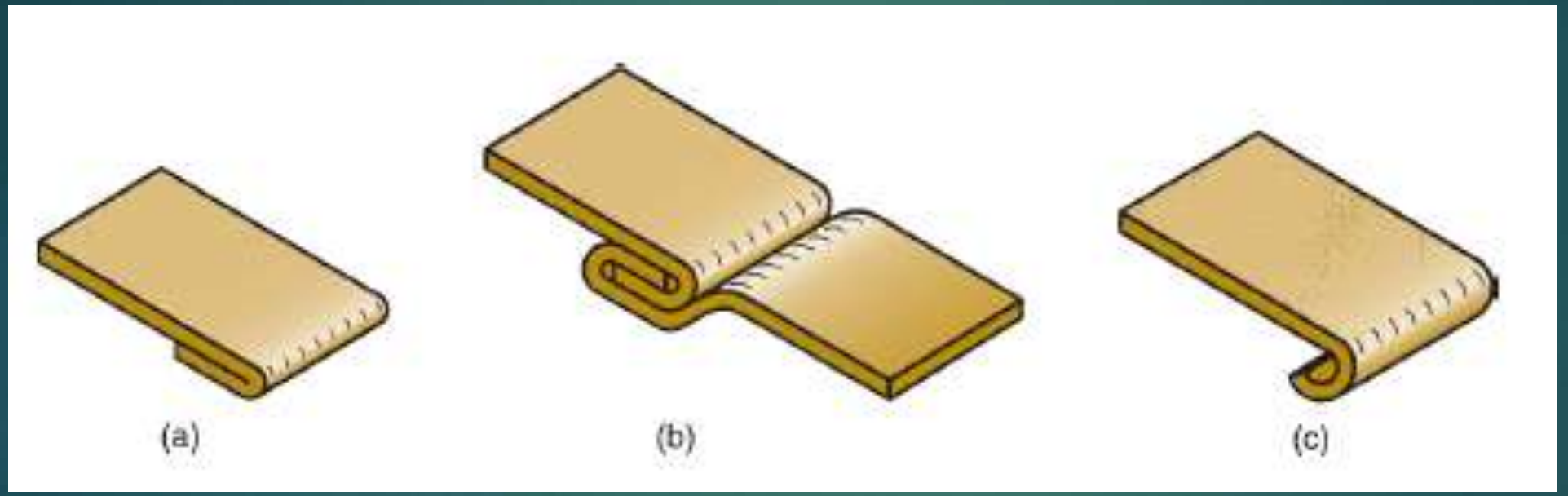
Notching

- To obtain the desired outline of a blank, portions of the sheet metal are often removed by notching and semi-notching.
- ***Notching*** involves cutting out a portion of metal from the side of the sheet or strip.

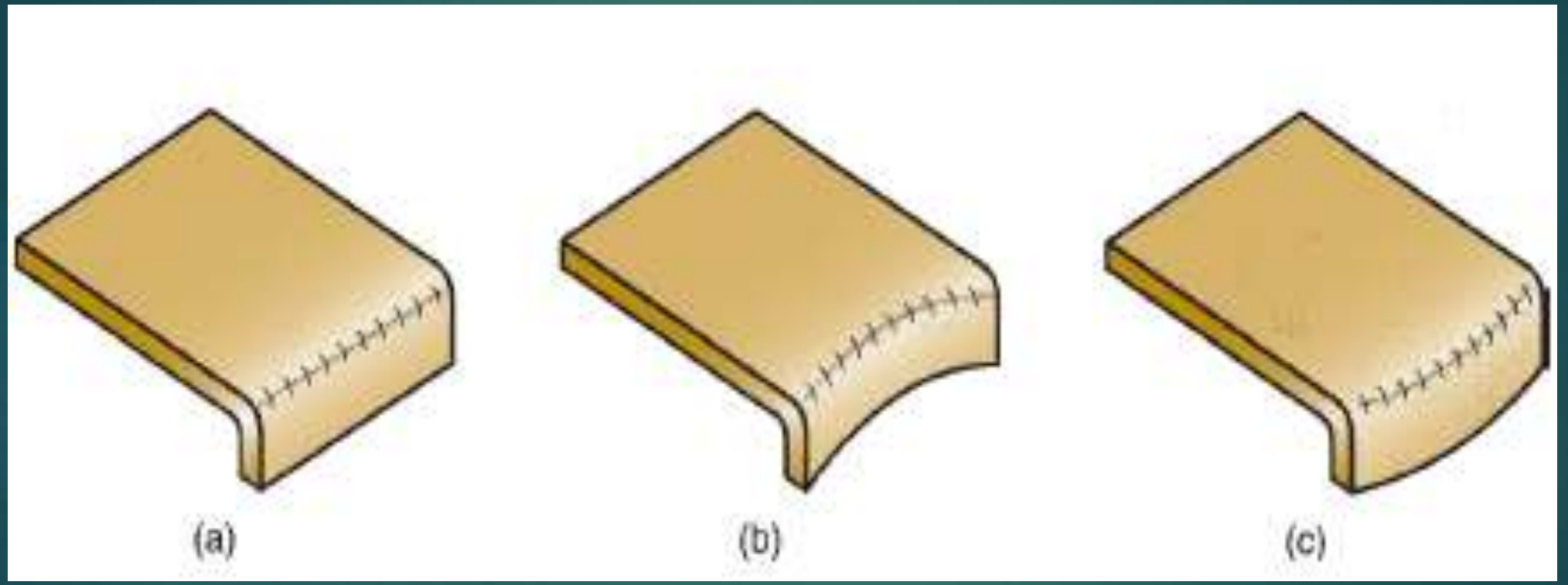
Semi-notching

- ***Semi-notching*** removes a portion of metal from the interior of the sheet.
- Semi-notching might seem to be the same as a punching or slotting operation.
- The difference is that the metal removed by seminotching creates part of the blank outline, while punching and slotting create holes in the blank.

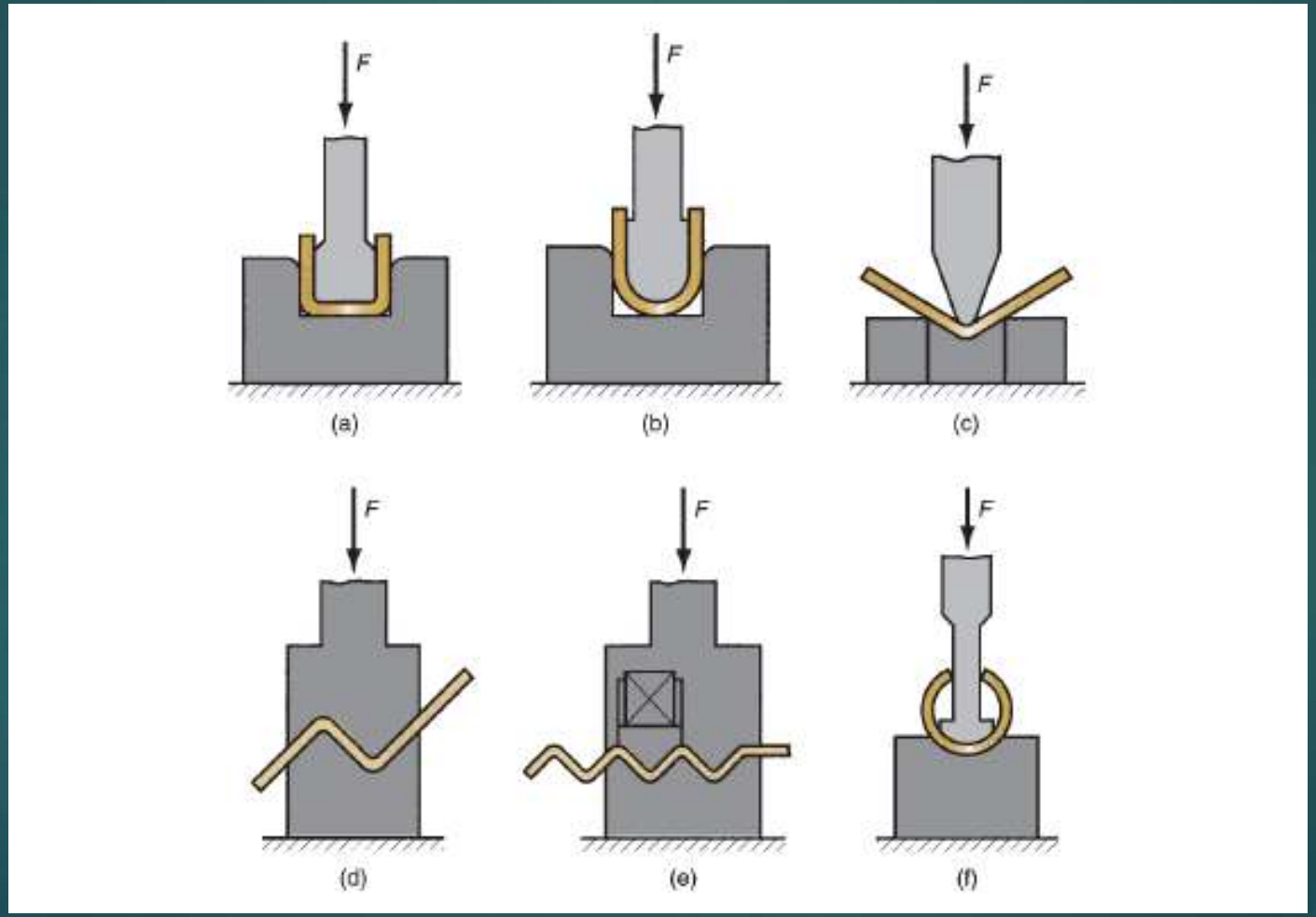
a) Hemming, (b) seaming, and (c) curling.



Flanging: (a) straight flanging, (b) stretch flanging, and (c) shrink flanging.



Miscellaneous bending operations: (a) channel bending, (b) U-bending, (c) air bending, (d) offset bending, (e) corrugating, and (f) tube forming. Symbol: *F* applied force.

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