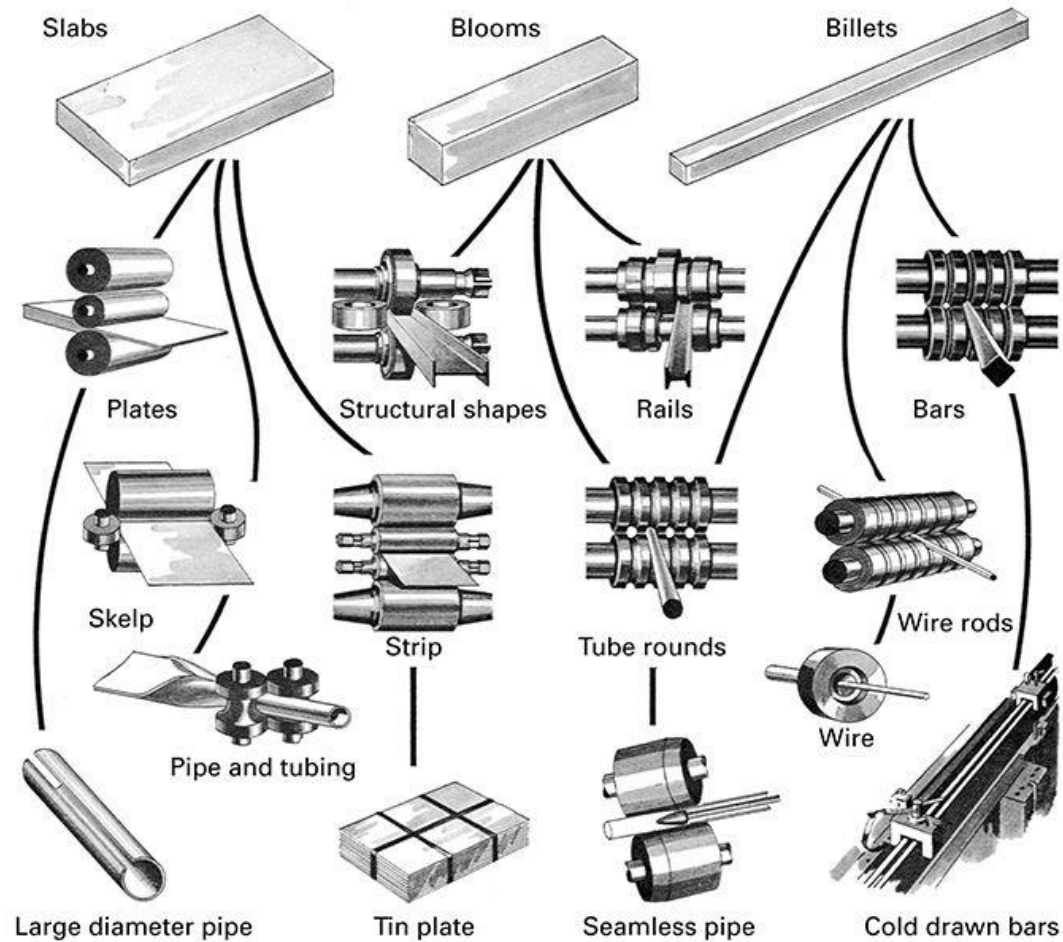


Bulk Forming Processes

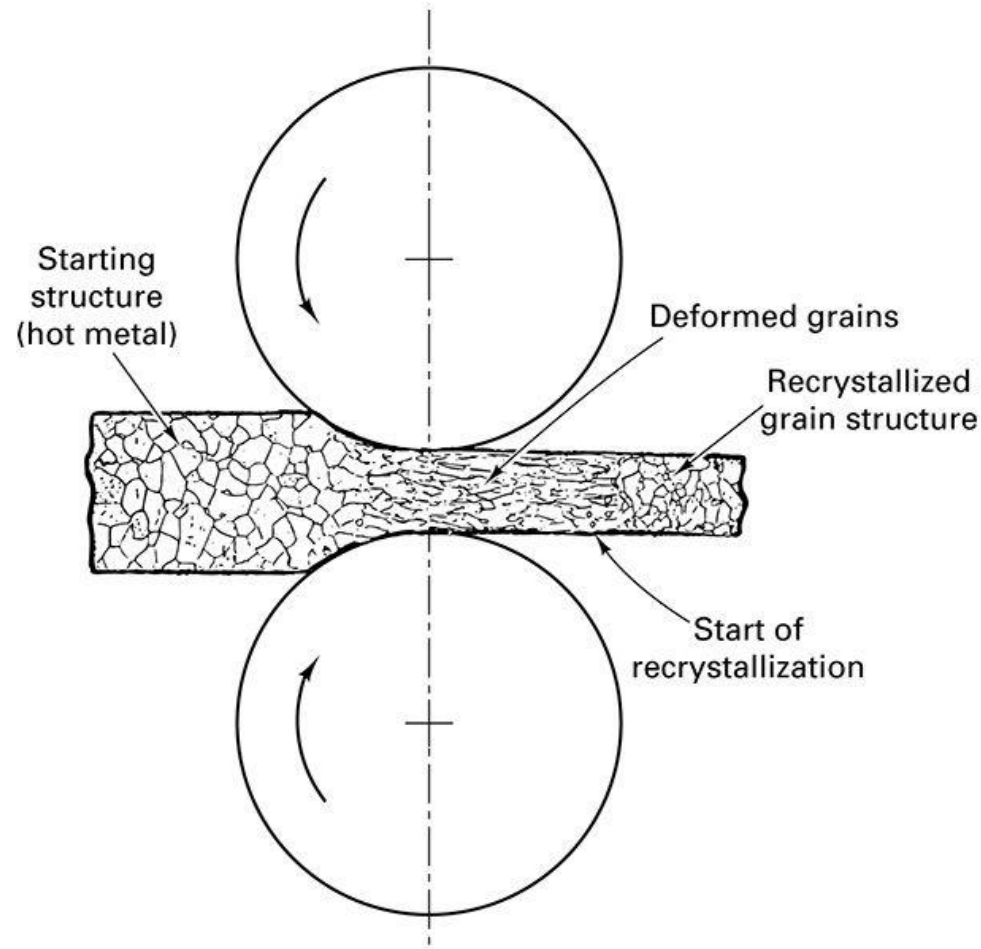
Basic Processes

- Rolling
- Forging
- Extrusion
- Wire, Rod and Tube Drawing
- Cold Forming, Cold Extrusion and Impact Extrusion
- Piercing
- Other Processes
- Surface Improvement by Deformation

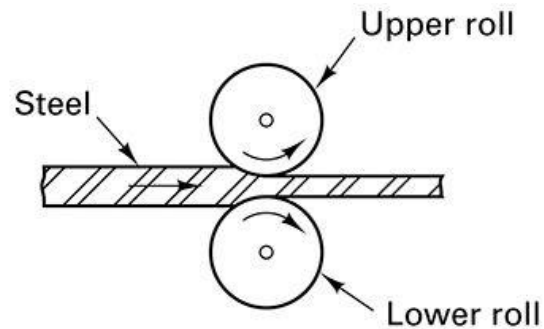
Starting Stock



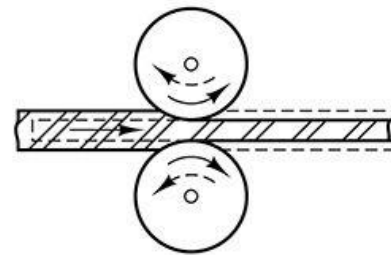
Massive Deformations without Annealing



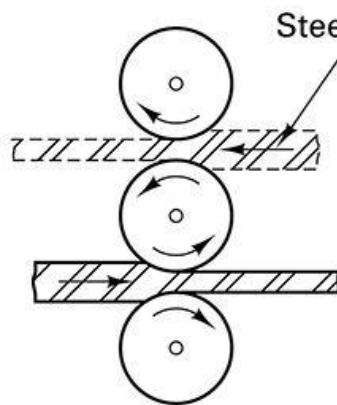
Configuration of Rolls



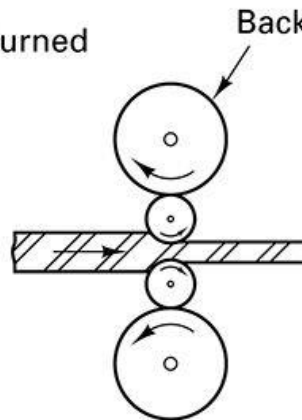
2 – High nonreversing



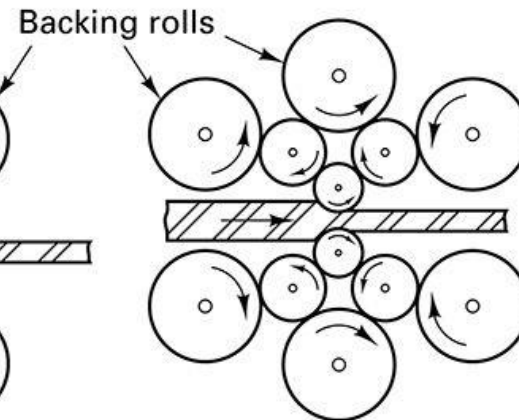
2 – High reversing



3 – High

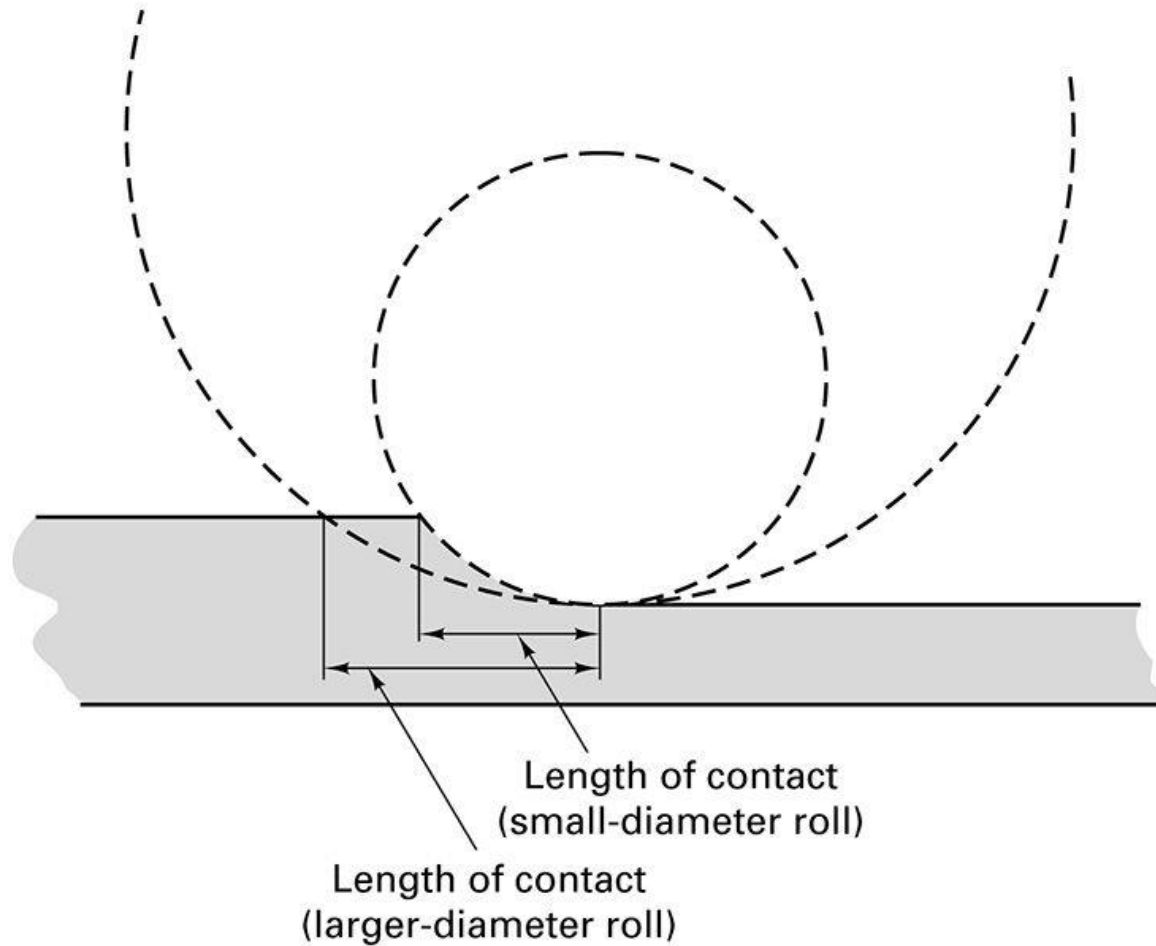


4 – High

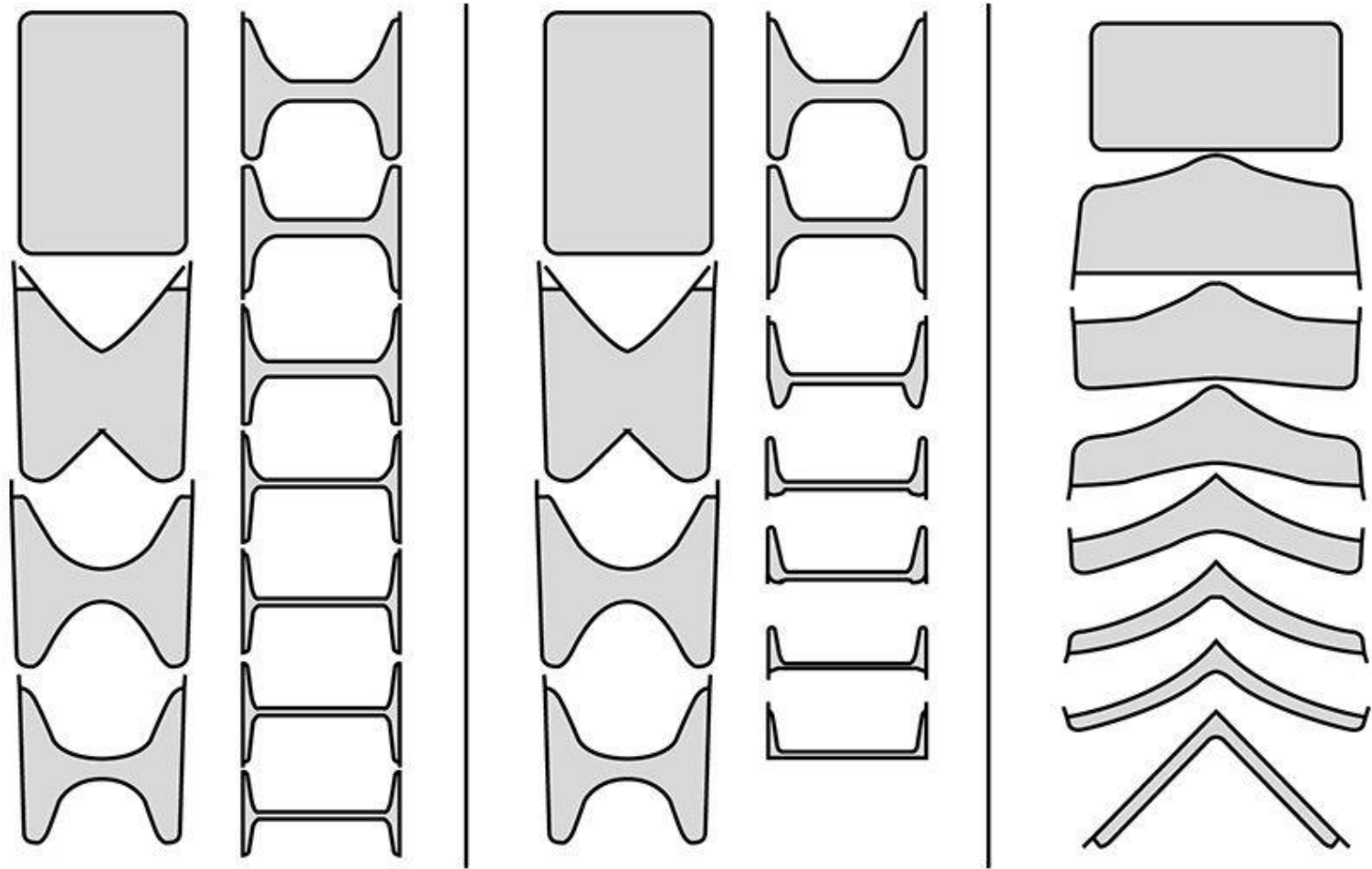


Cluster

Effect of Roll Diameter



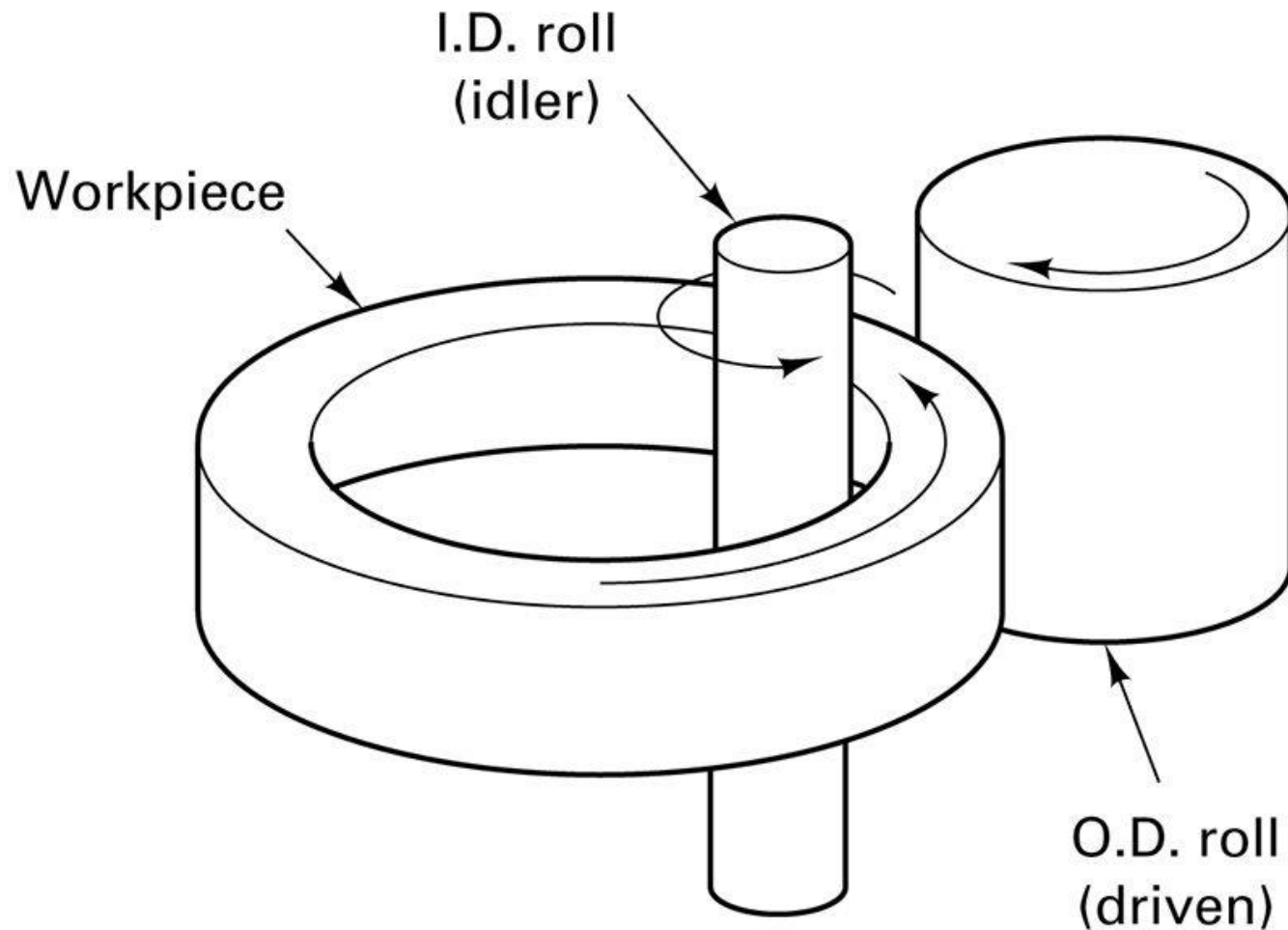
Structural Shapes from Multiple Contoured Rolls



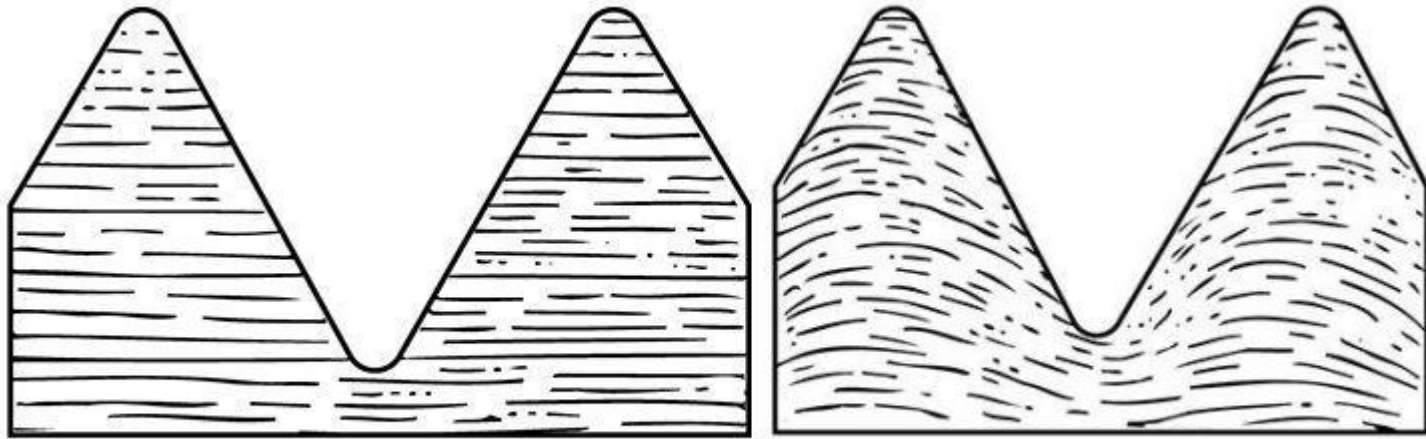


[Watch Video Here](#)

Ring Rolling



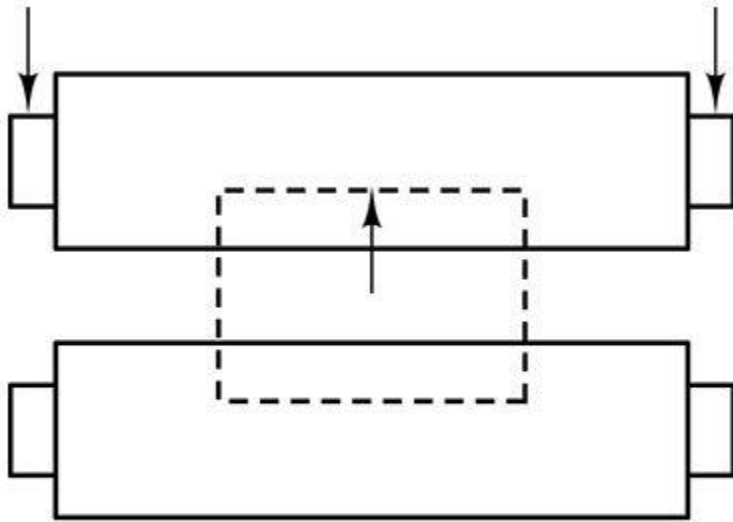
Thread Rolling



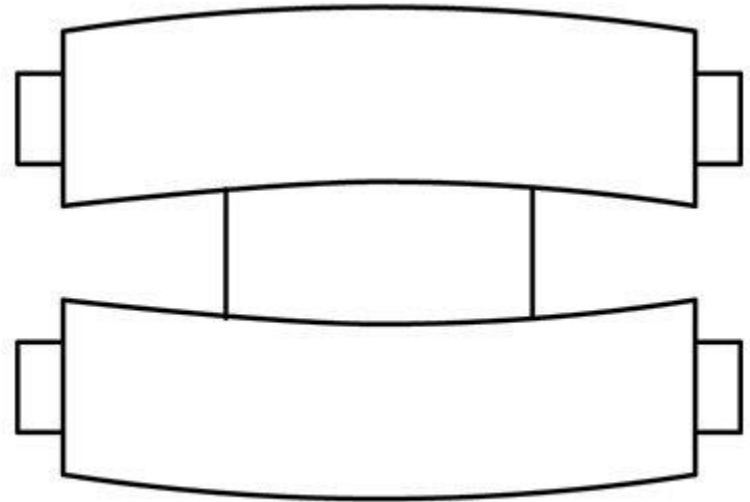
(a)

(b)

Loading a Rolling Mill Roll

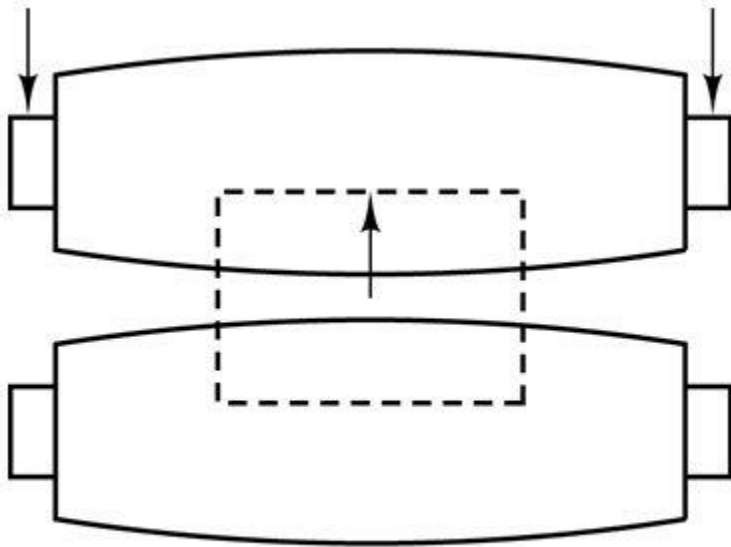


(a)

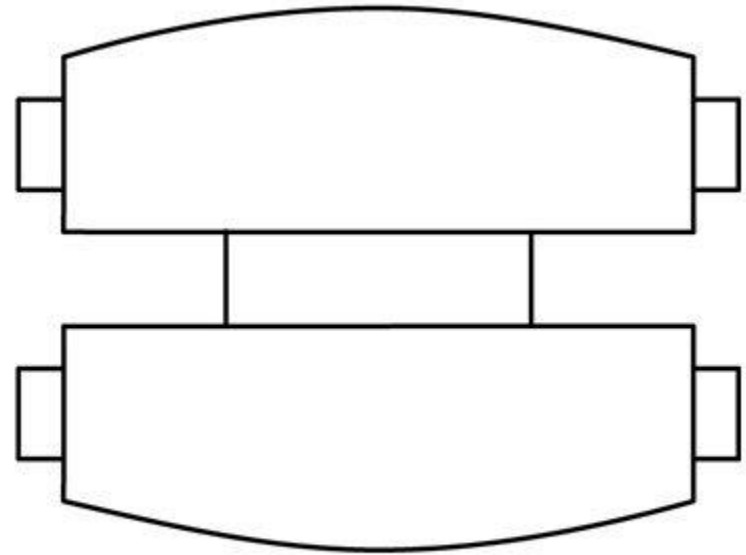


(b)

Use of Crowned Roll to Compensate for Roll Flexure

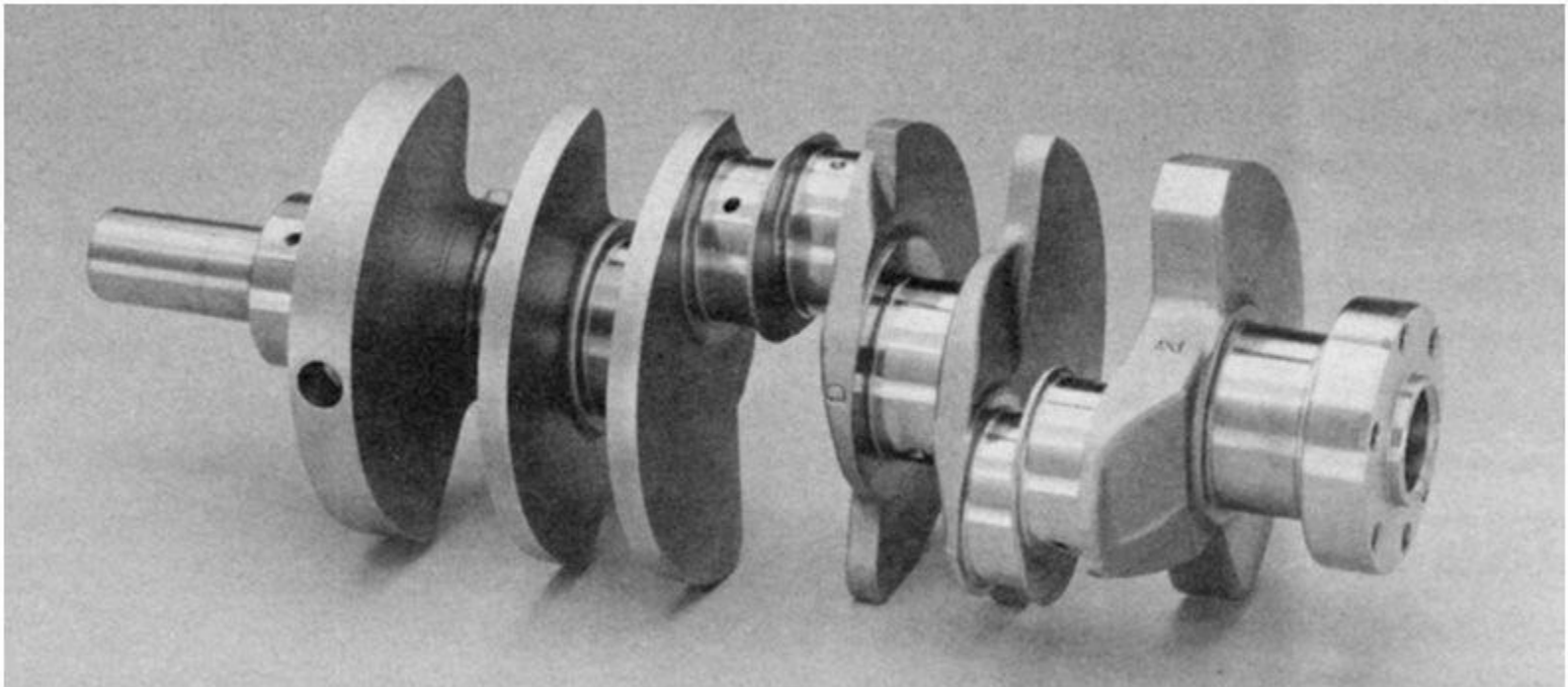


(a)



(b)

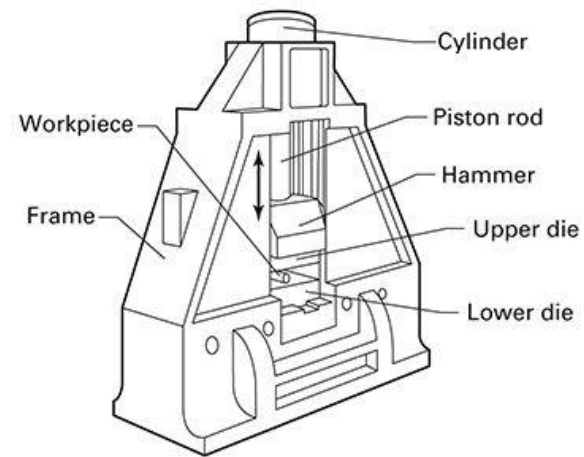
Forged Crankshaft



Open-Die Forging

[Watch Video Here](#)

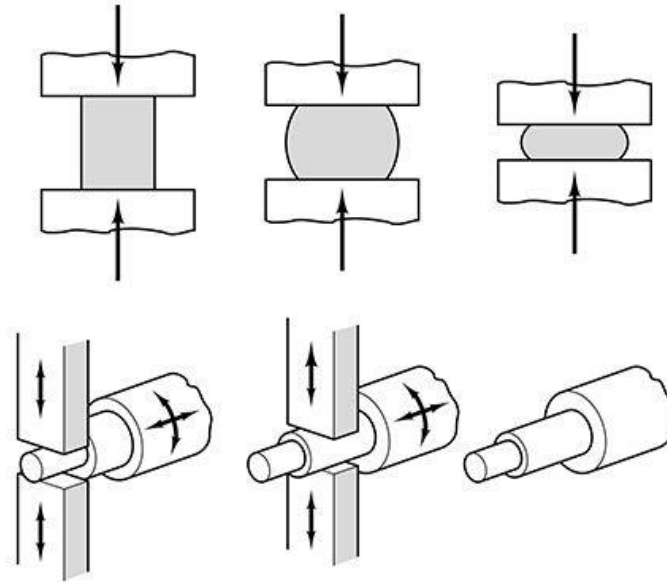
Hammer Forging Machine





March 1943. "Santa Fe R.R. shops, Albuquerque. Hammering out a drawbar on the steam drop hammer in the blacksmith shop."

Orienting Workpiece for Desired Shape

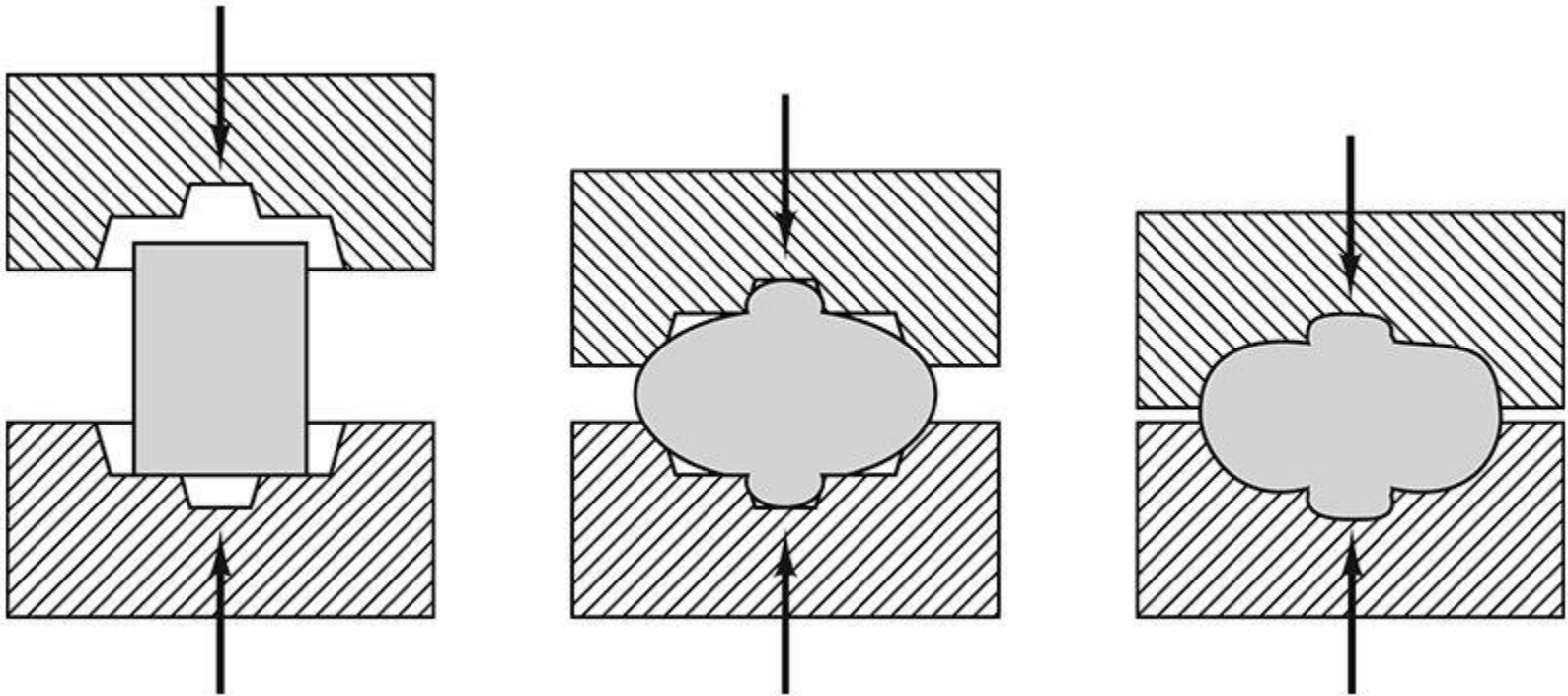


-
- The bottom row of diagrams illustrates the process of machining a ring. It shows four stages of a ring being machined on a lathe. In the first stage, the ring is mounted on a saddle/mandrel. In the second stage, metal displacement is used to reduce the preform wall thickness to increase the diameter. In the third stage, progressive reduction of wall thickness is used to produce ring dimensions. In the fourth stage, the ring is machined to near net shape.
- 1 Preform mounted on saddle/mandrel.
 - 2 Metal displacement—reduce preform wall thickness to increase diameter.
 - 3 Progressive reduction of wall thickness to produce ring dimensions.
 - 4 Machining to near net shape.

Impression-Die Forging

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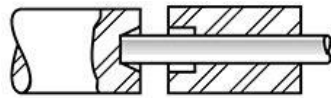
Impression-die (Closed-die) Hammer Forging



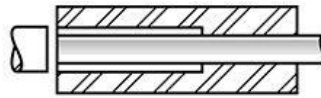
Impression Die Forged Connecting Rod



Rules Governing Upset Forging



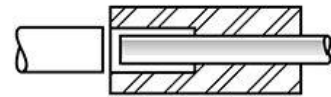
Applications of rule 1



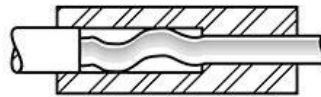
Applications of rule 2



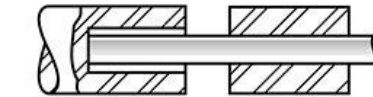
Applications of rule 3



Violation of rule 1



Violation of rule 2



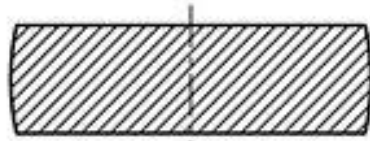
Violation of rule 3

1. The length of unsupported metal that can be gathered or upset in one blow without injurious buckling should be limited to three times the diameter of the bar.
2. Lengths of stock greater than three times the diameter may be upset successfully provided that the diameter of the upset is not more than 1 times the diameter of the bar.
3. In an upset requiring stock length greater than three times the diameter of the bar, and where the diameter of the cavity is not more than 1 times the diameter of the bar (the conditions of rule 2), the length of unsupported metal beyond the face of the die must not exceed the diameter of the bar.

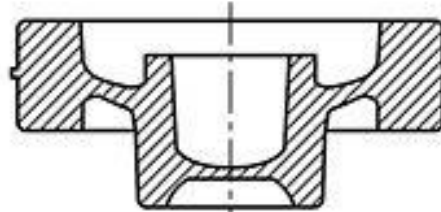
Automatic (high-speed) Hot Forging



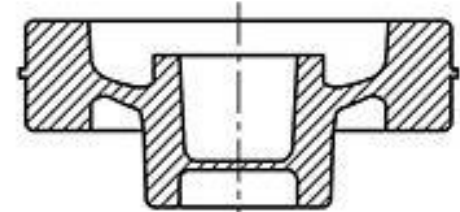
Sheared
billet



Upset pancake

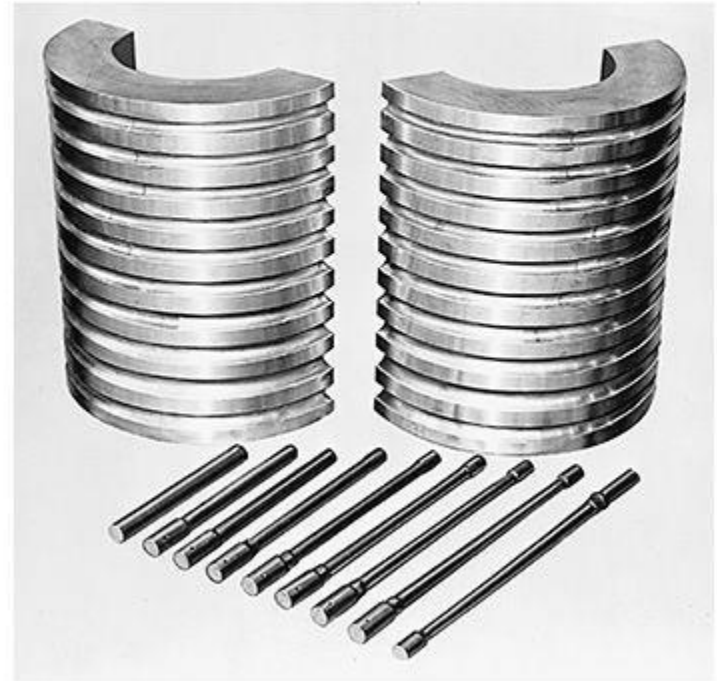
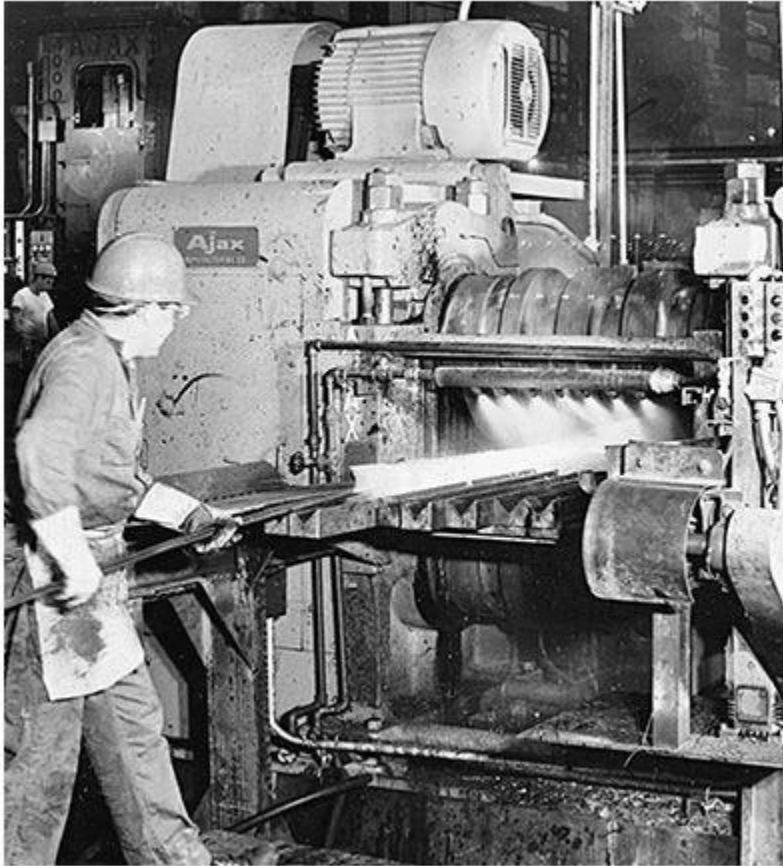


Blocker forging

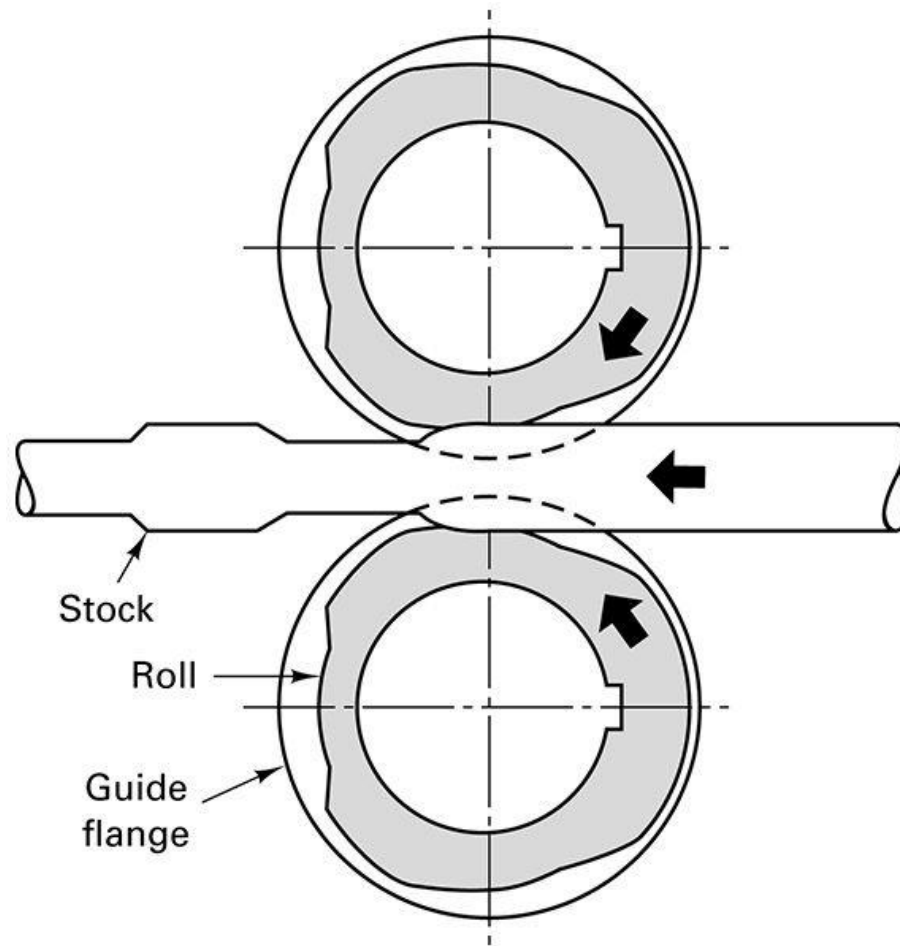


Finished gear blank

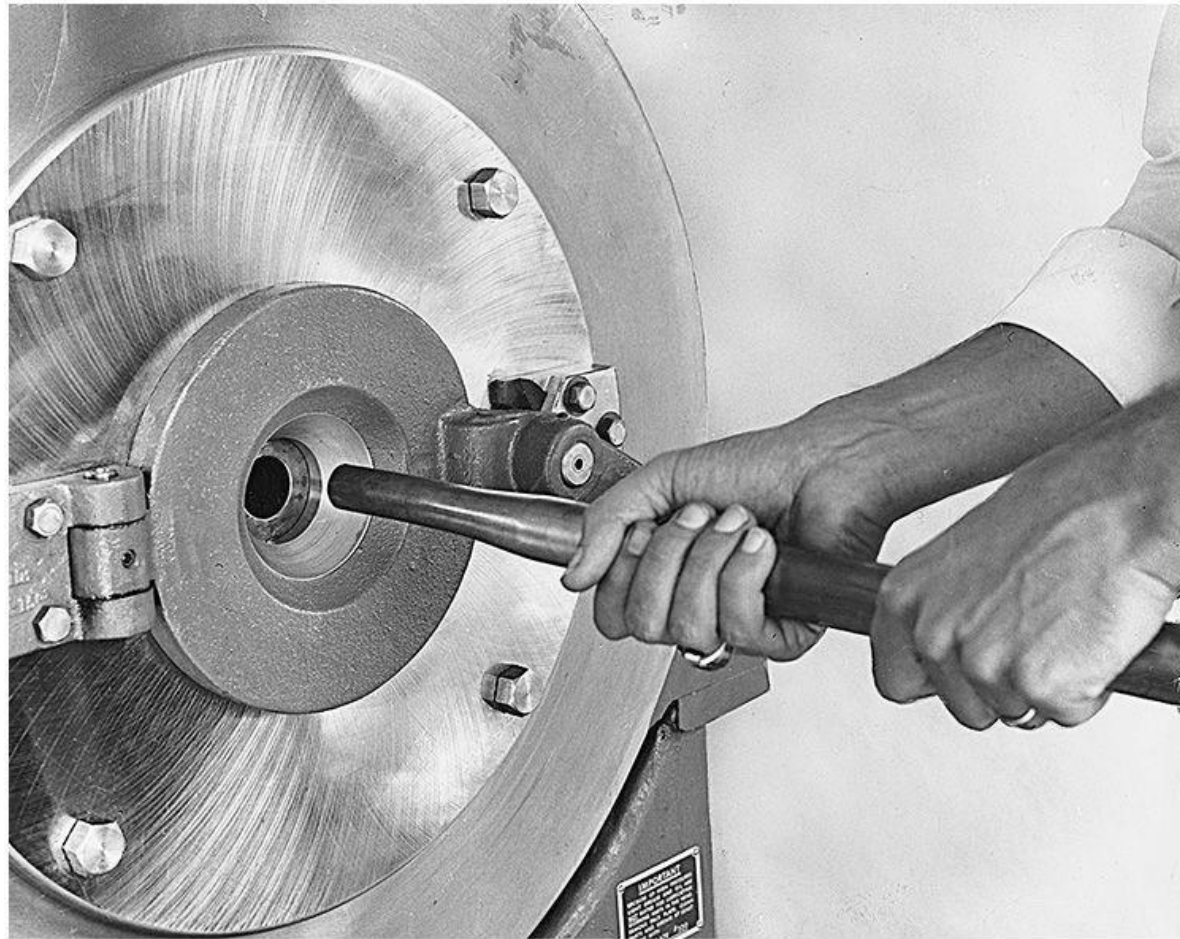
Roll Forging



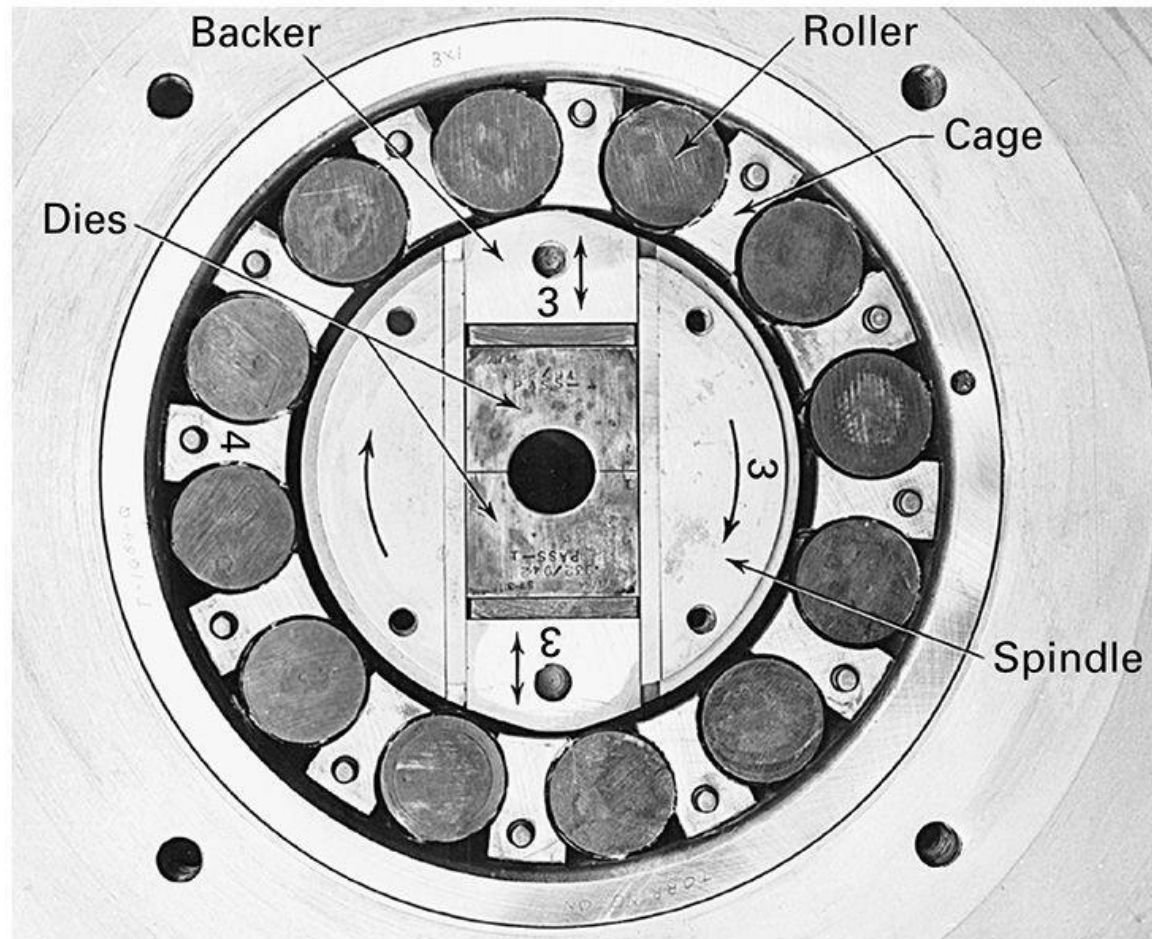
Roll Forging Contoured Shape



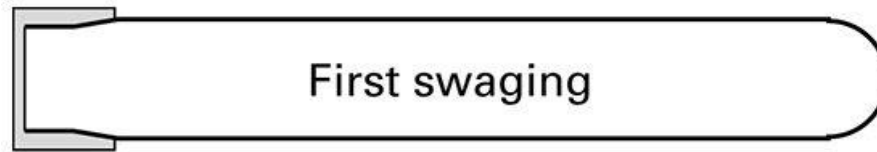
Rotary Hammer Swaging



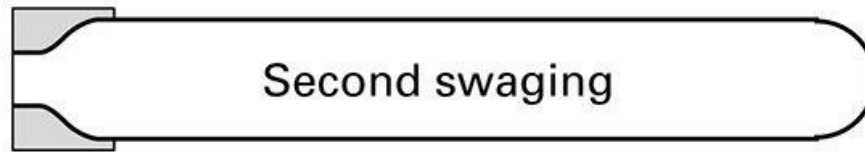
Rotary Swaging Machine



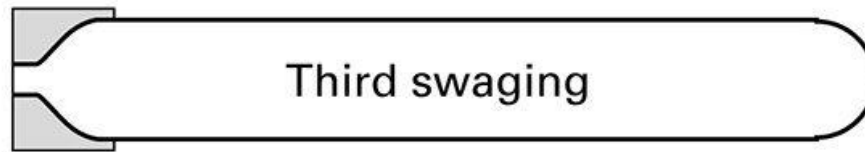
Tube Swaging a Neck for Gas Cylinder



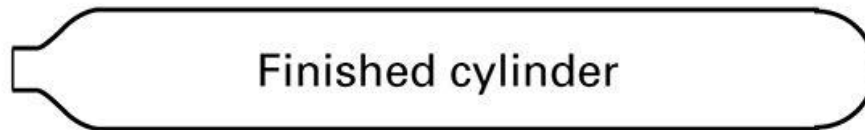
(a)



(b)

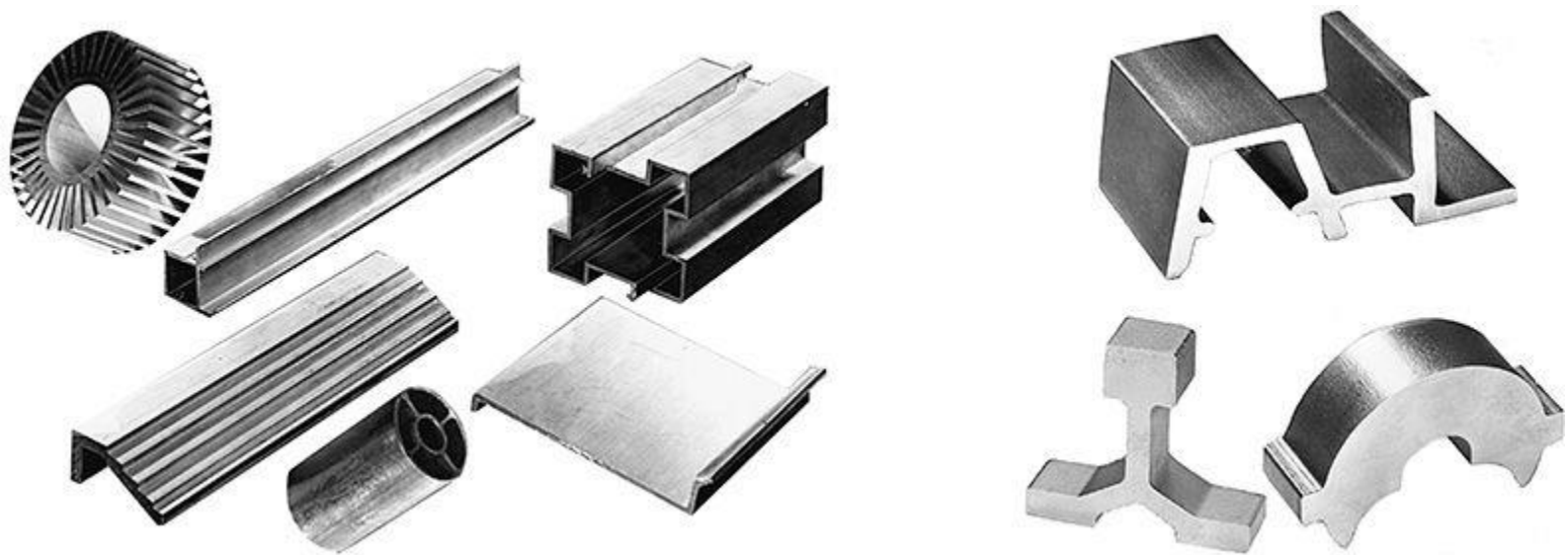


(c)

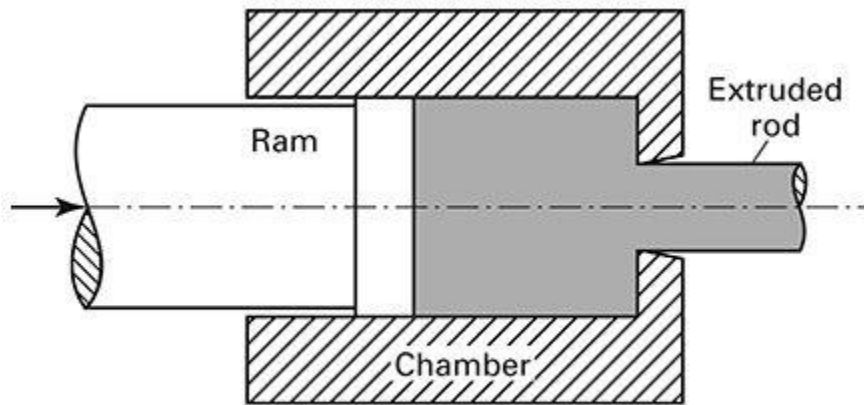


(d)

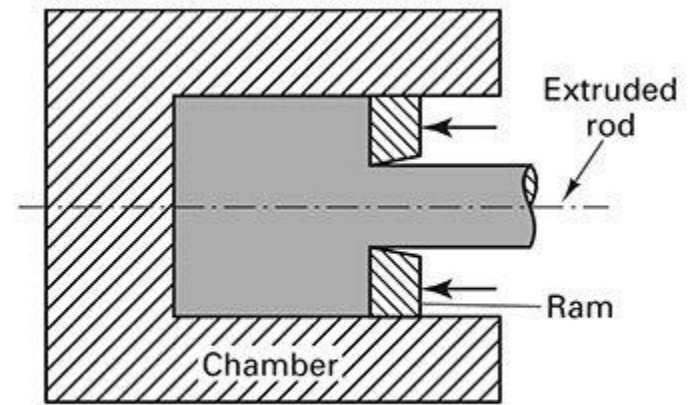
Extruded Shapes



Direct or Indirect Extrusion

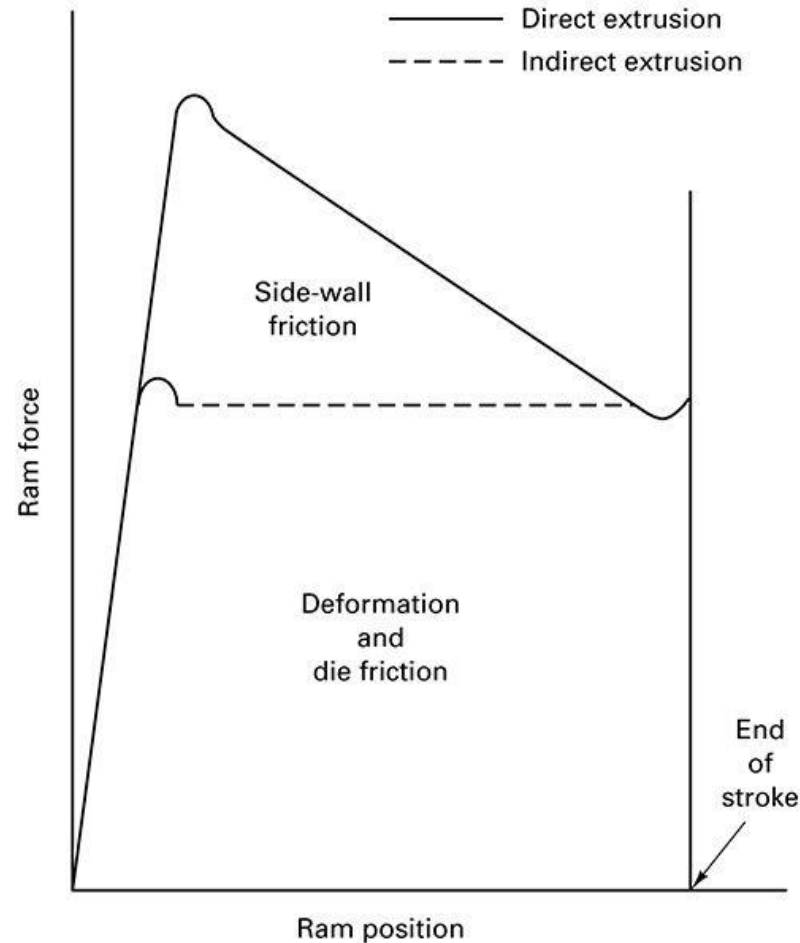


Direct extrusion

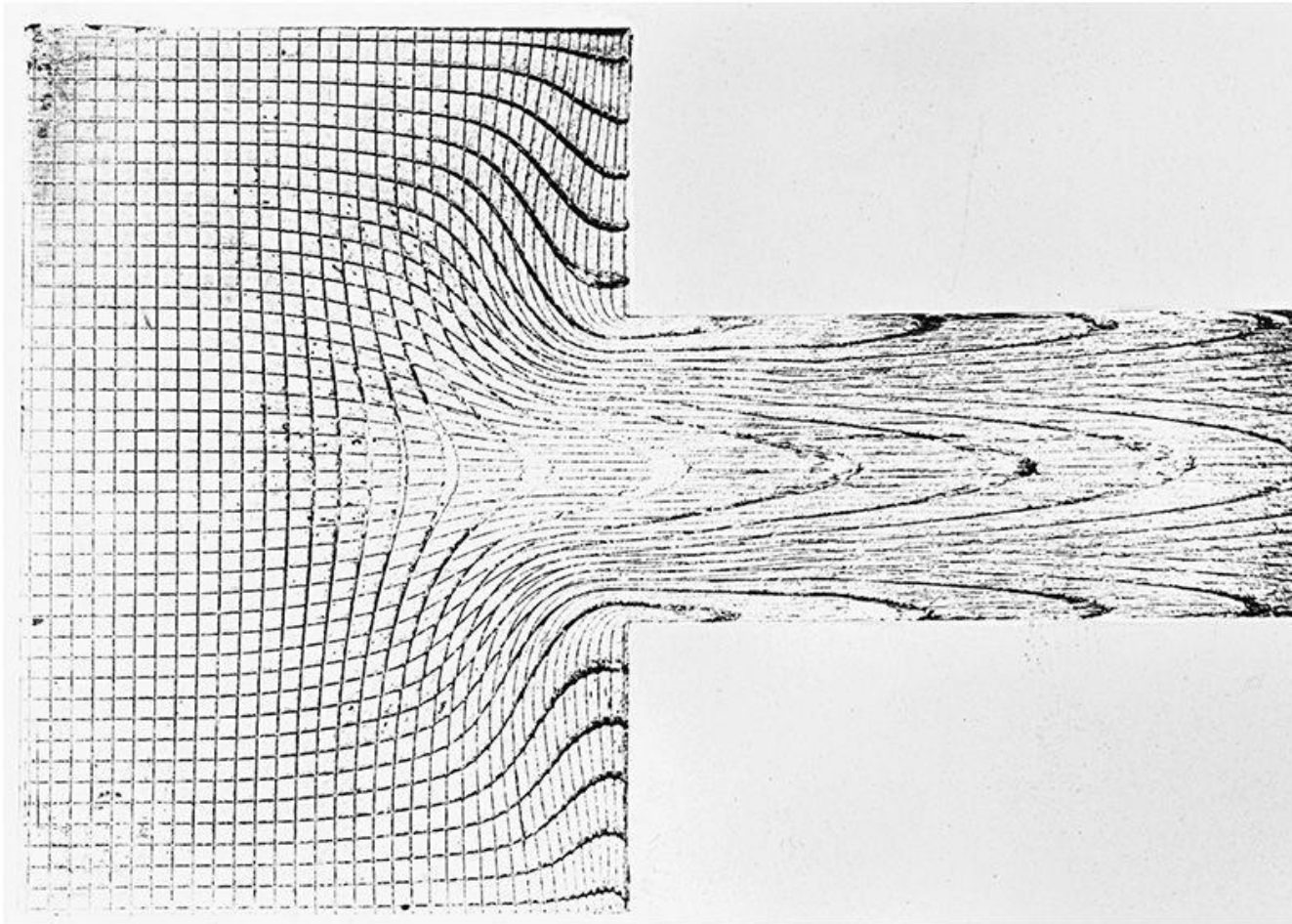


Indirect extrusion

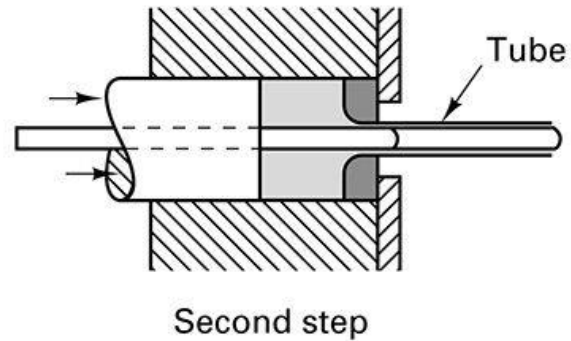
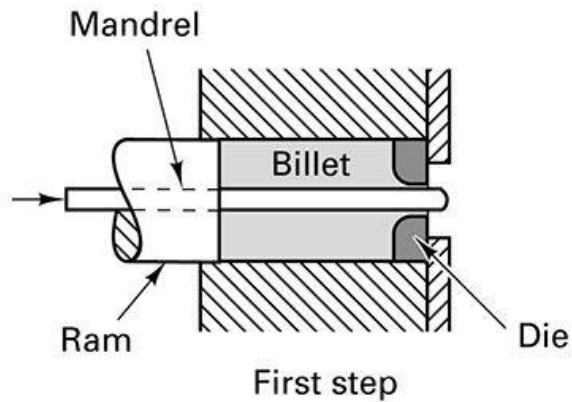
Work Comparison – Direct vs. Indirect Extrusion



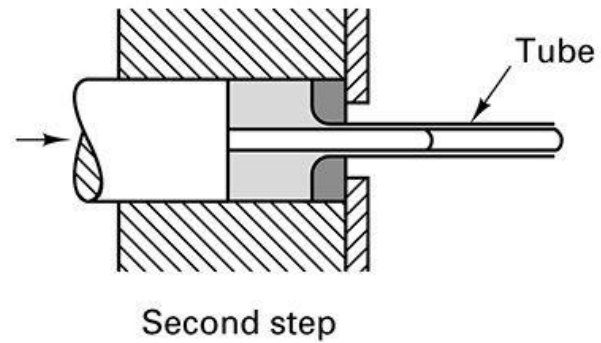
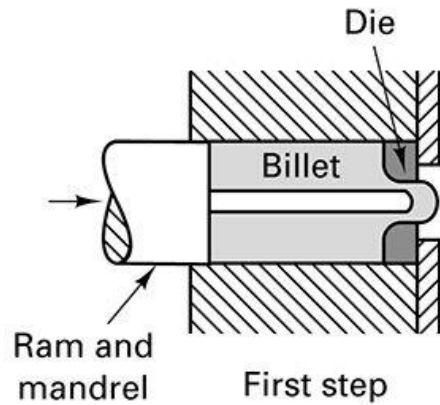
Metal Flow in Extrusion



Hollow Shapes Extruded

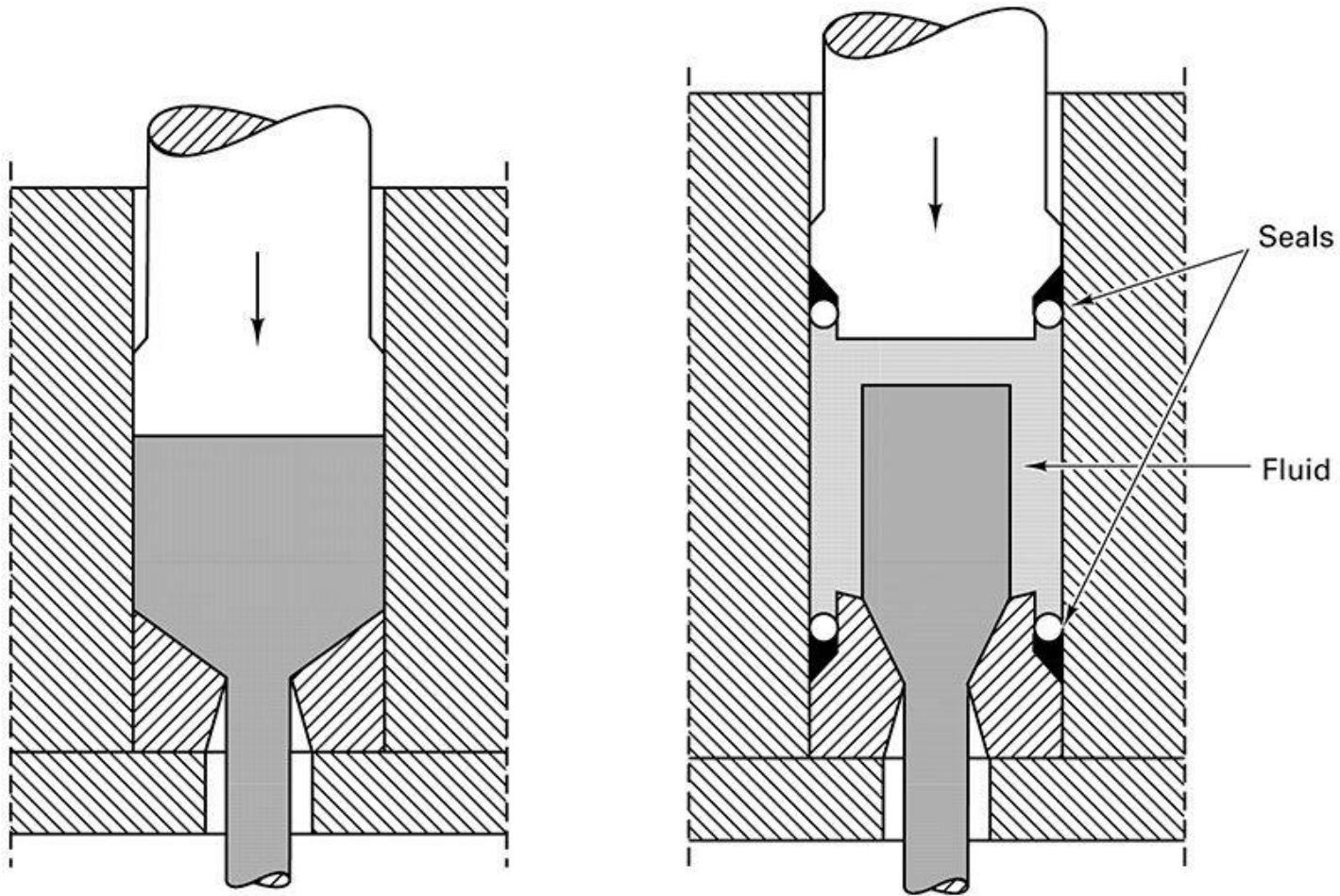


(a)

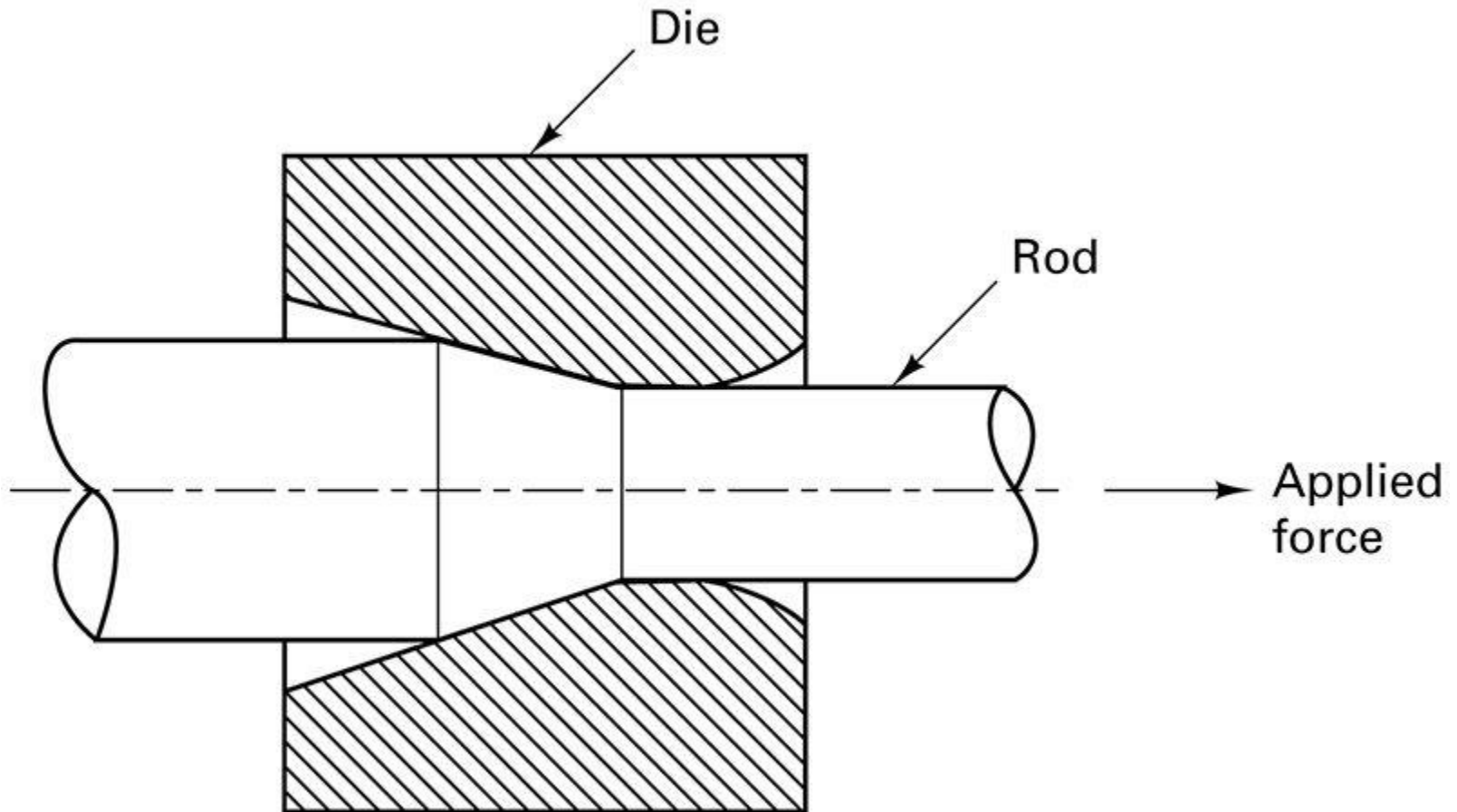


(b)

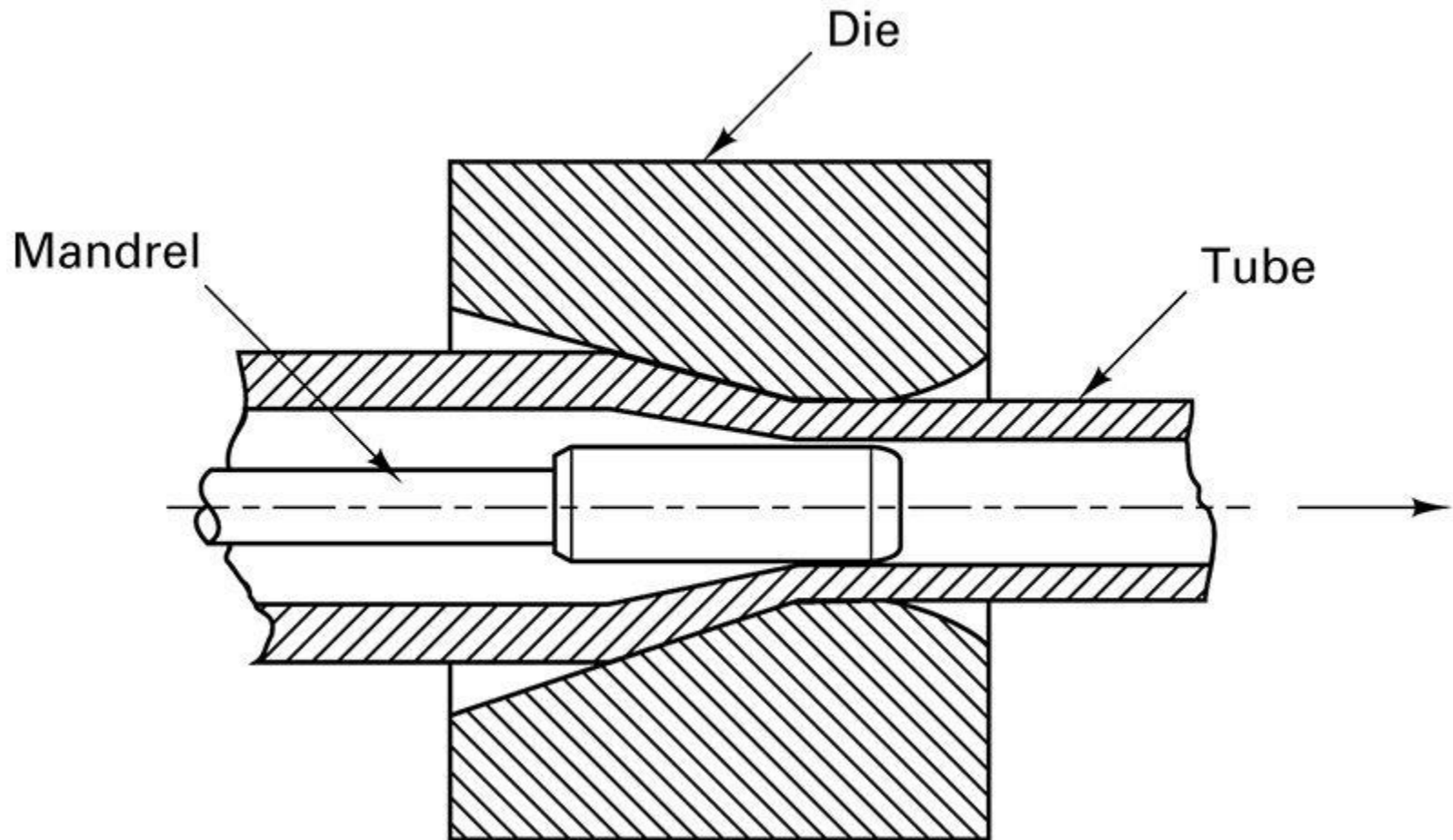
Conventional vs. Hydrostatic Extrusion



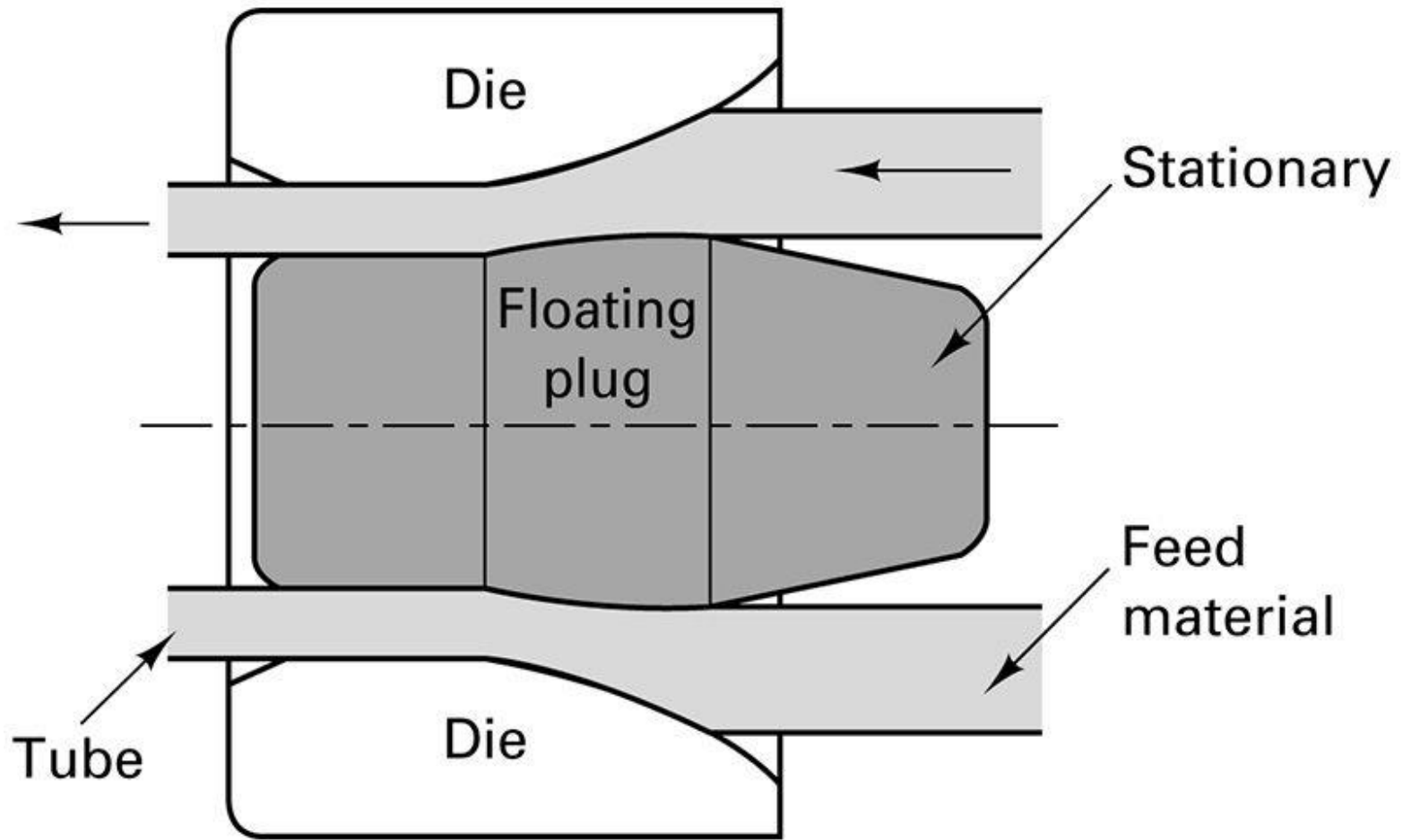
Rod (Bar) Drawing



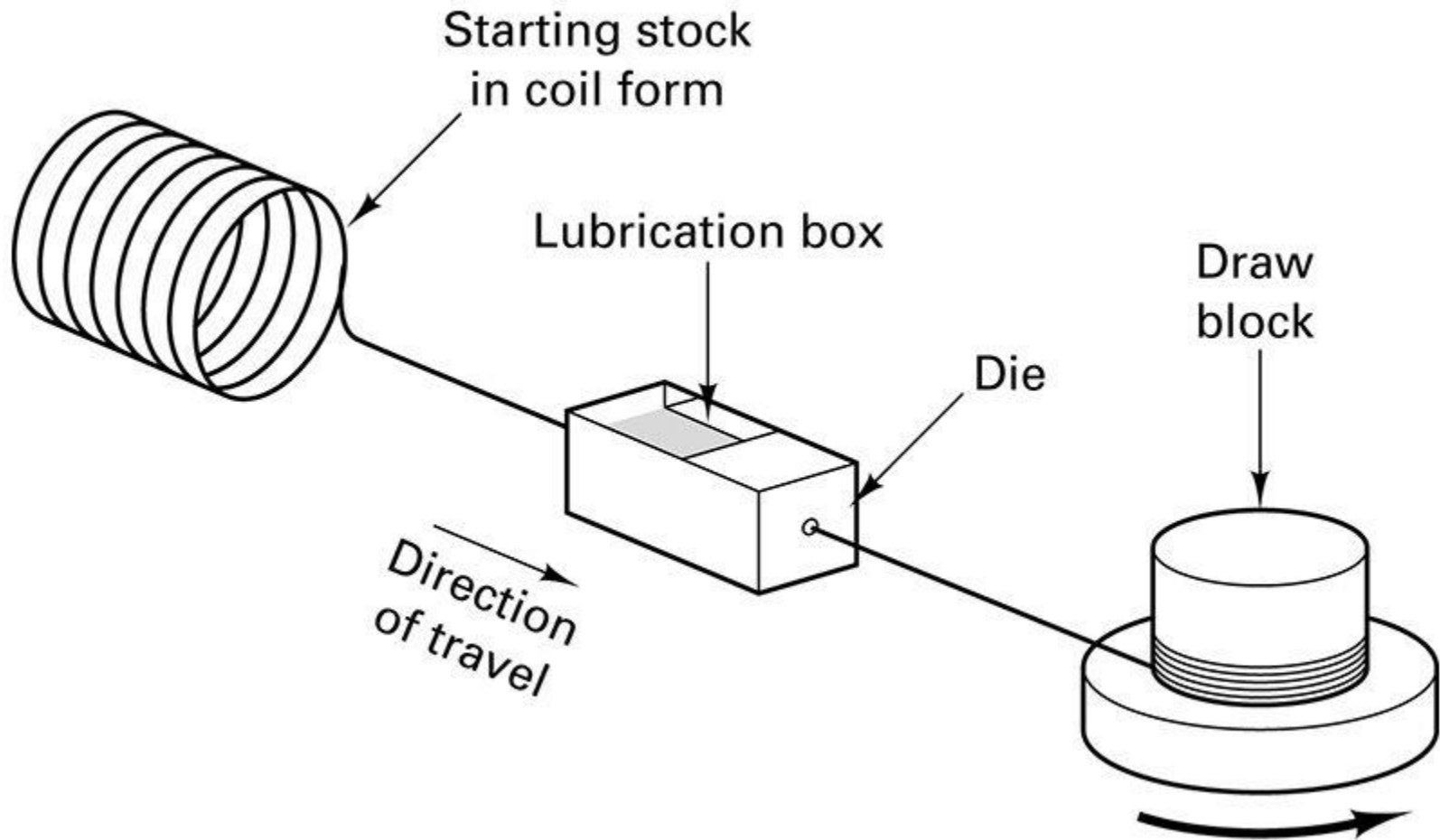
Tube Drawing



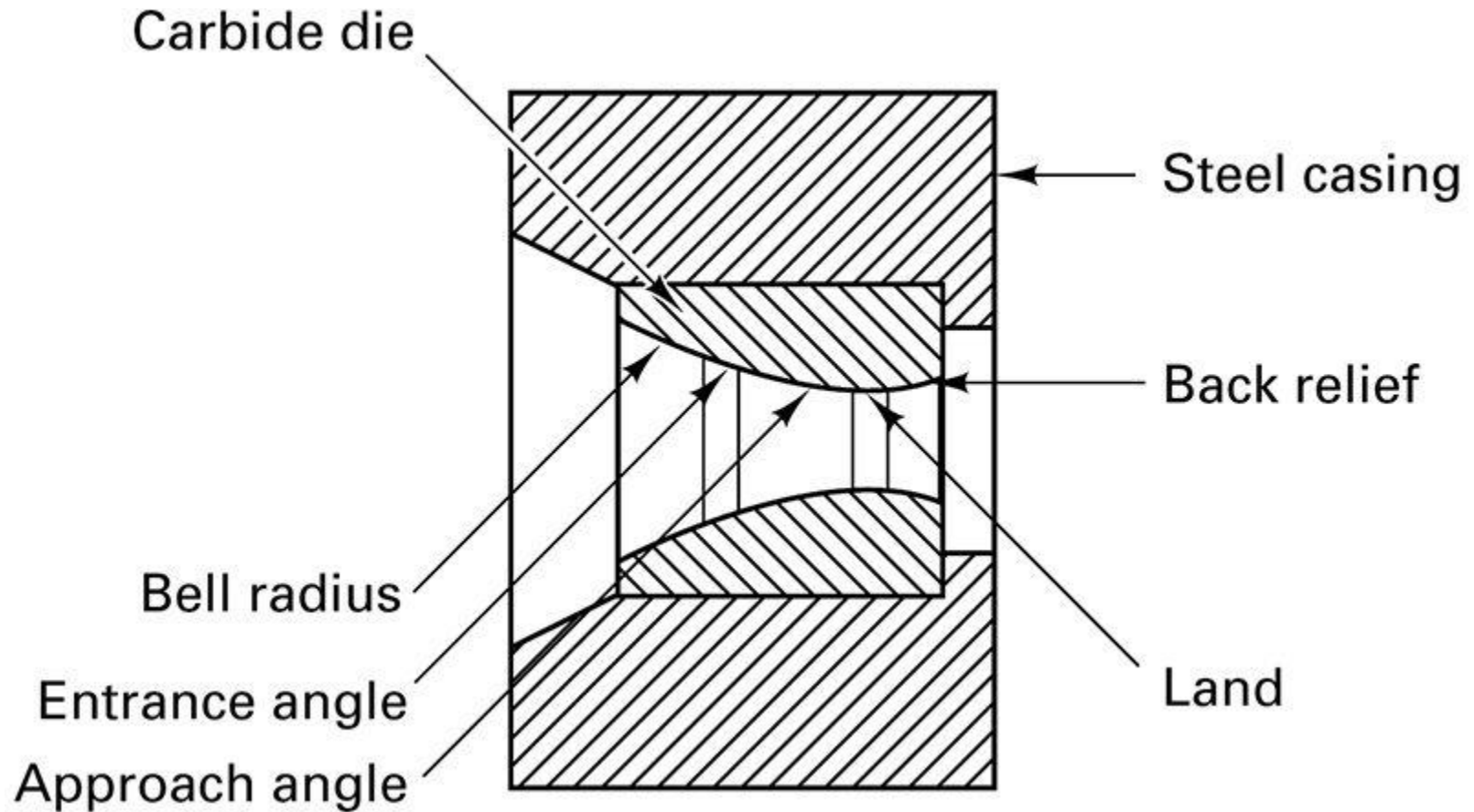
Tube Drawing with Floating Plug



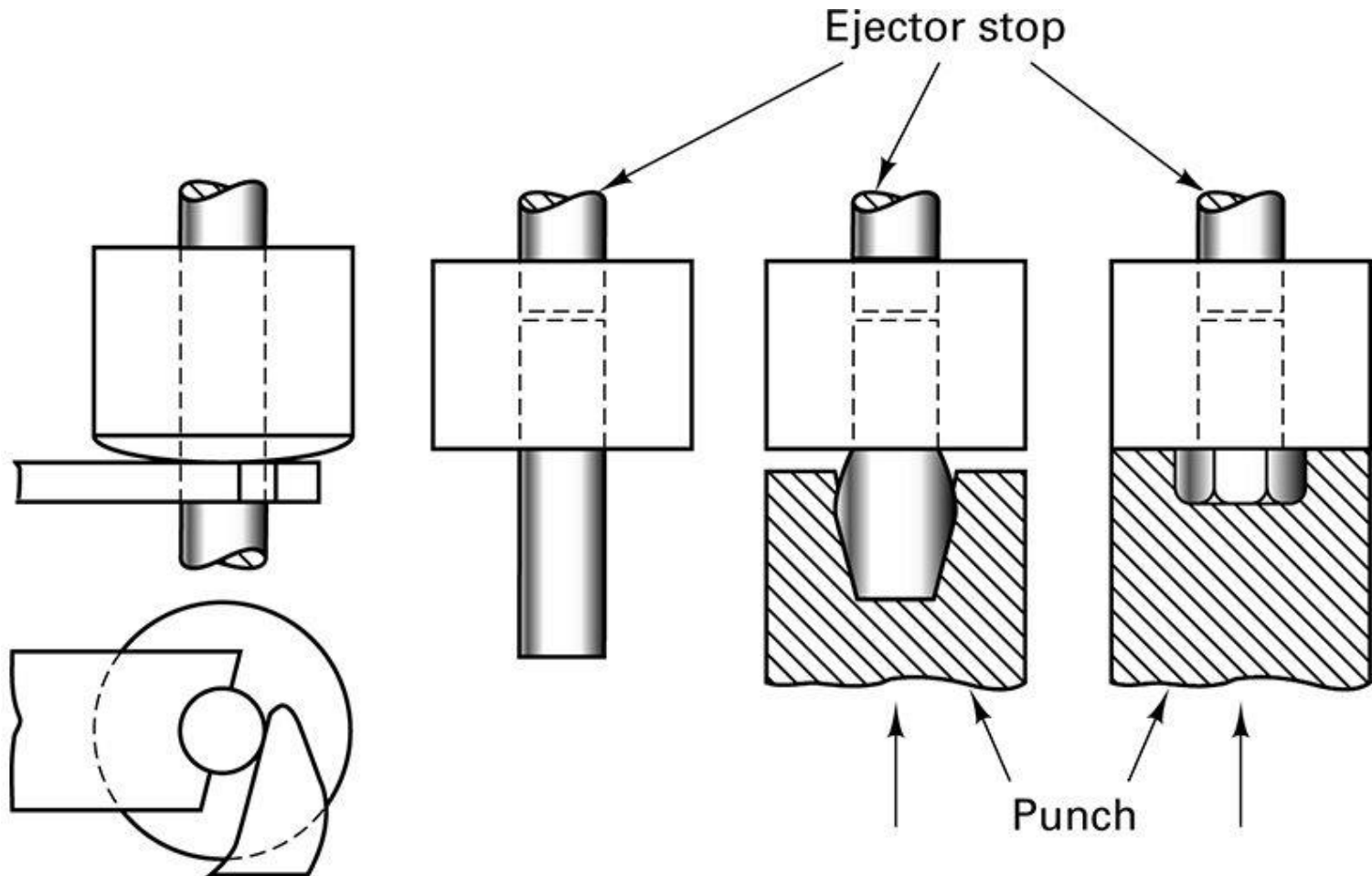
Wire Drawing Process



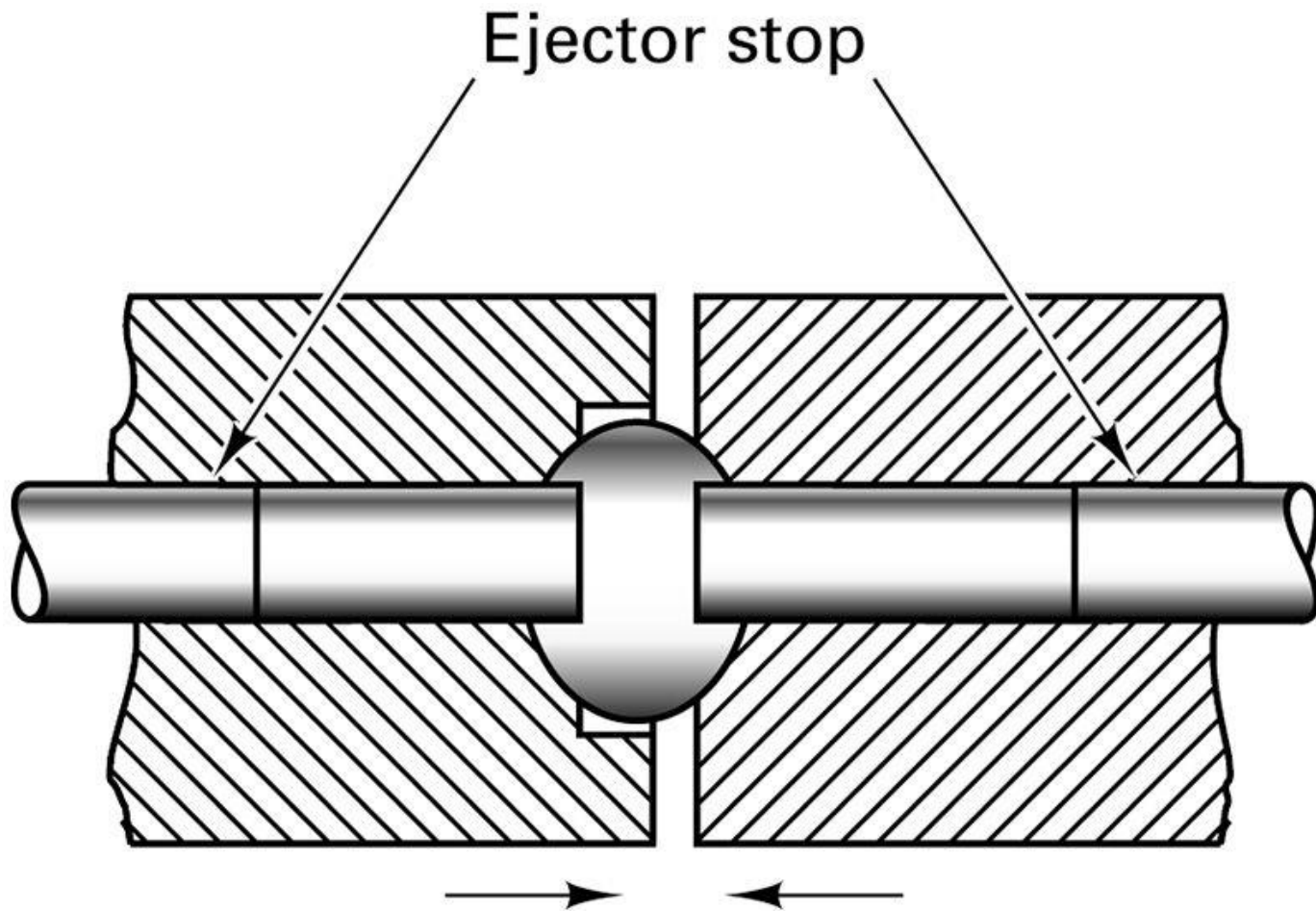
Carbide Wire-Drawing Die



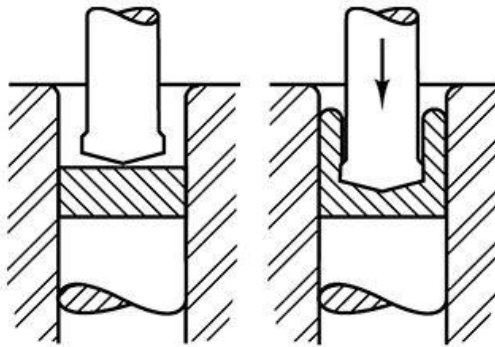
Cold Heading Steps



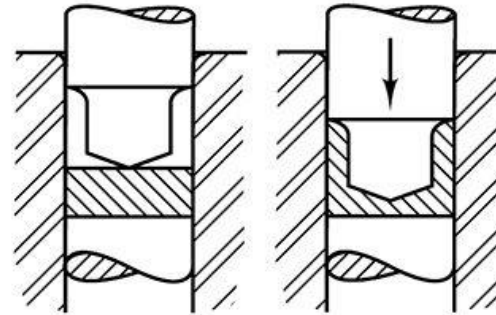
Upsetting Process



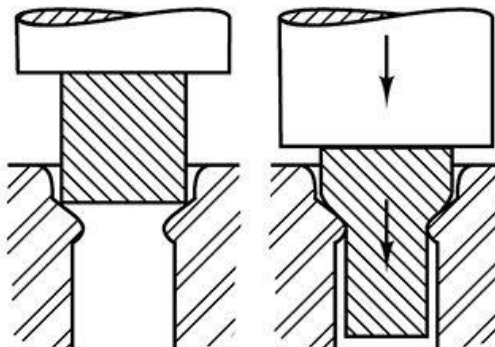
Backward and Forward Extrusion



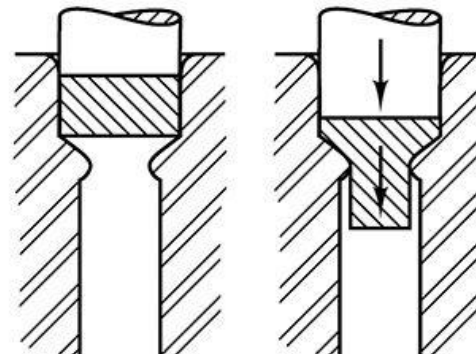
Backward extrusion
open die



Backward extrusion
closed die

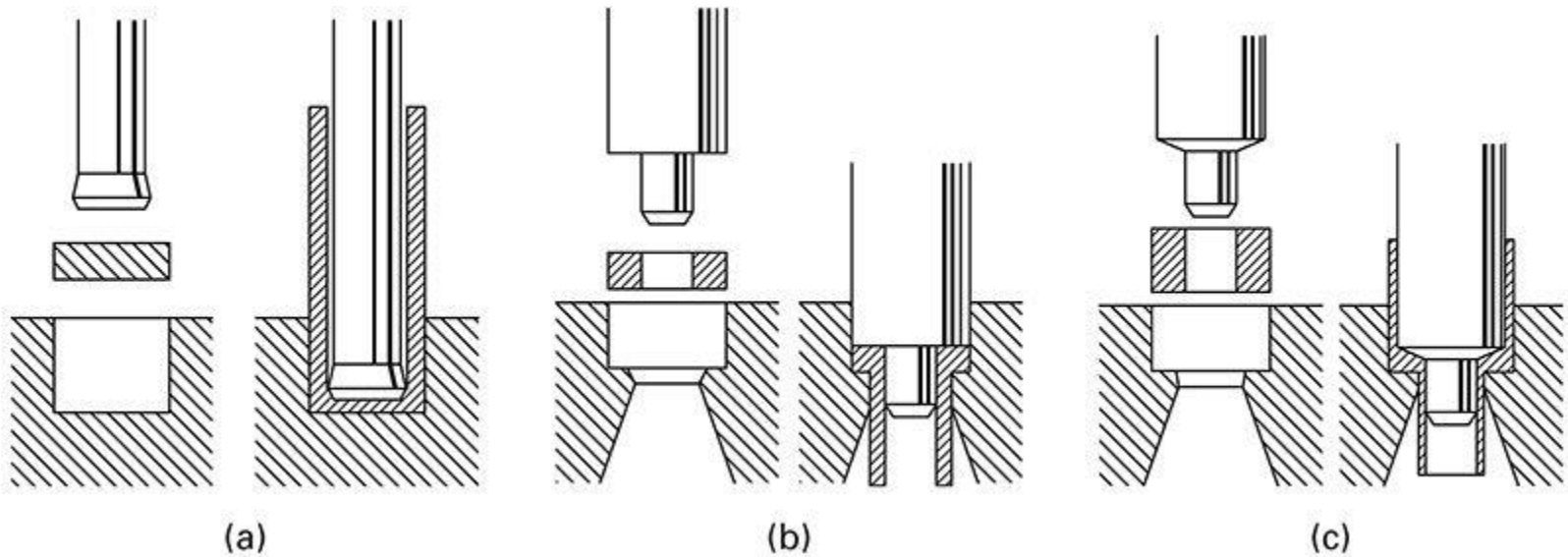


Forward extrusion
open die

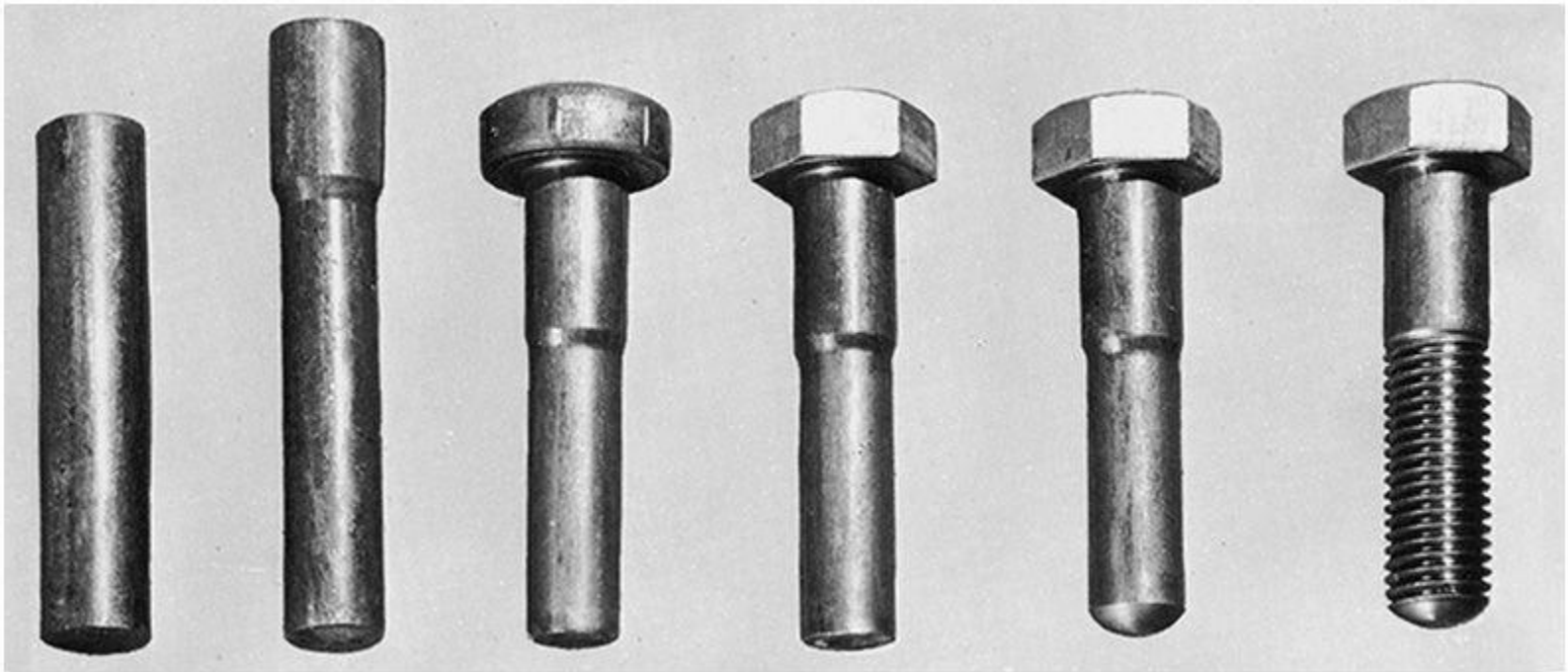


Forward extrusion
closed die

Backward and Forward Extrusion



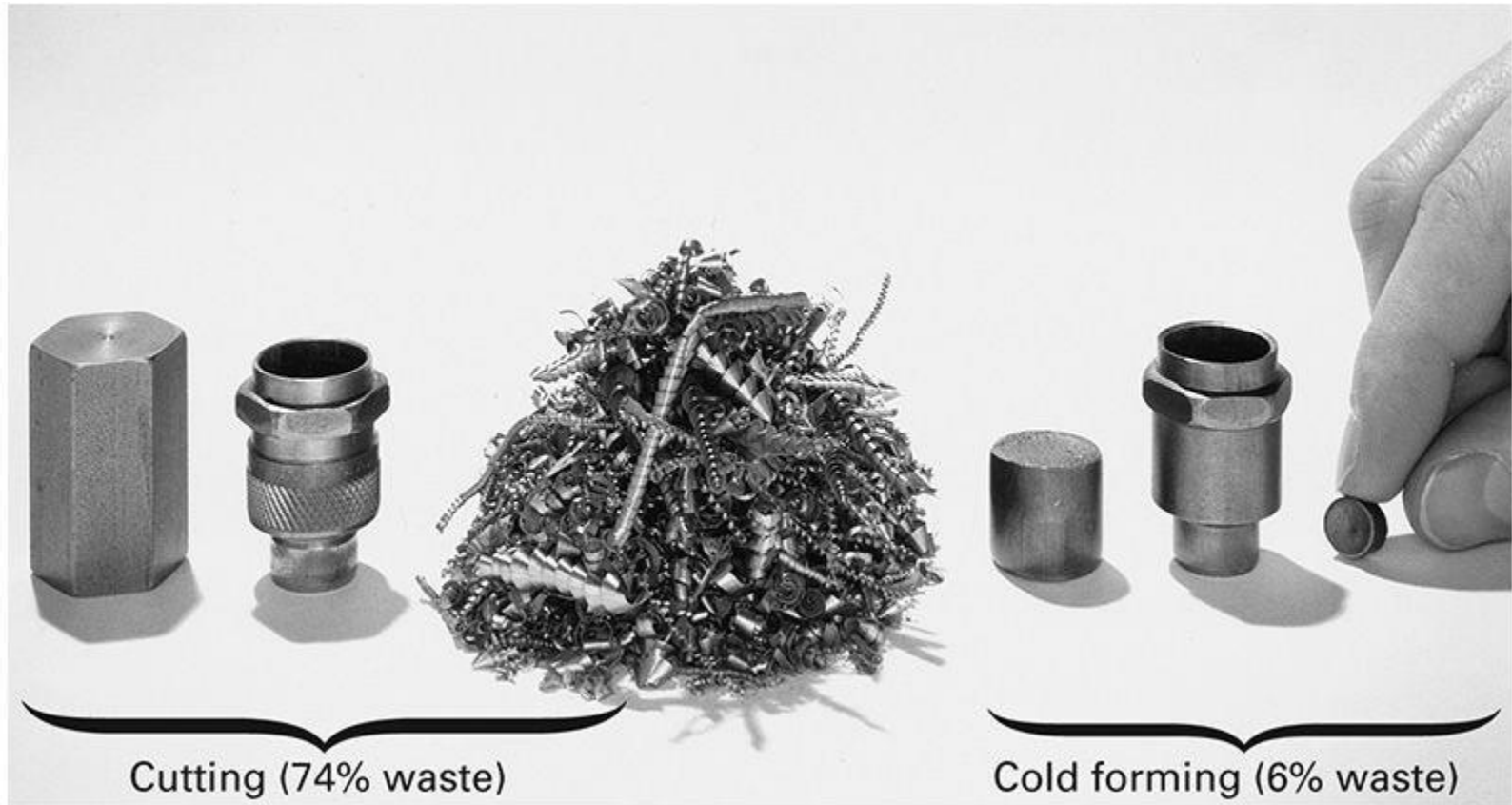
Cold Extrusion, Cold Heading, Thread Rolling



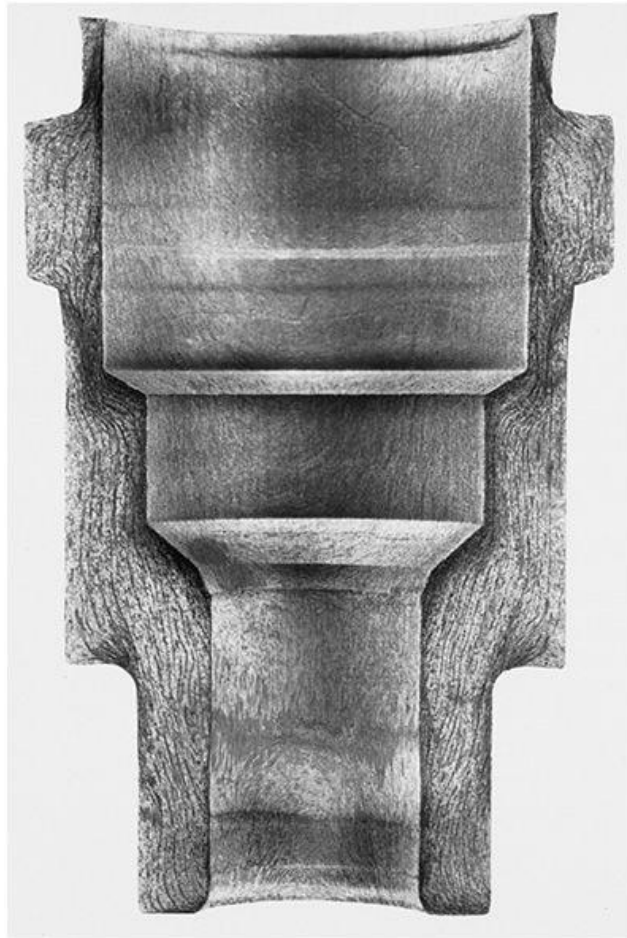
Cold Forming Sequence



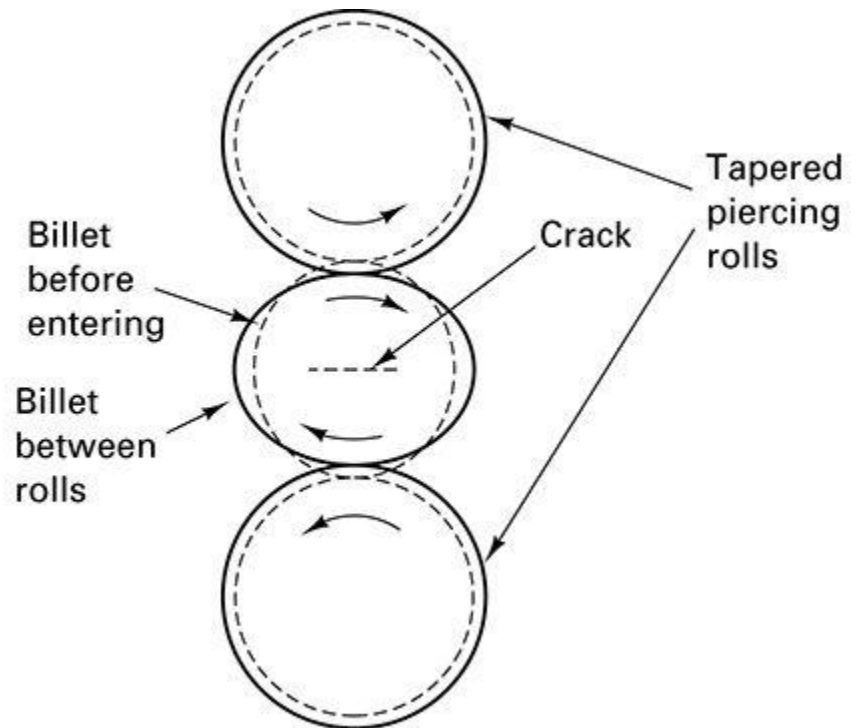
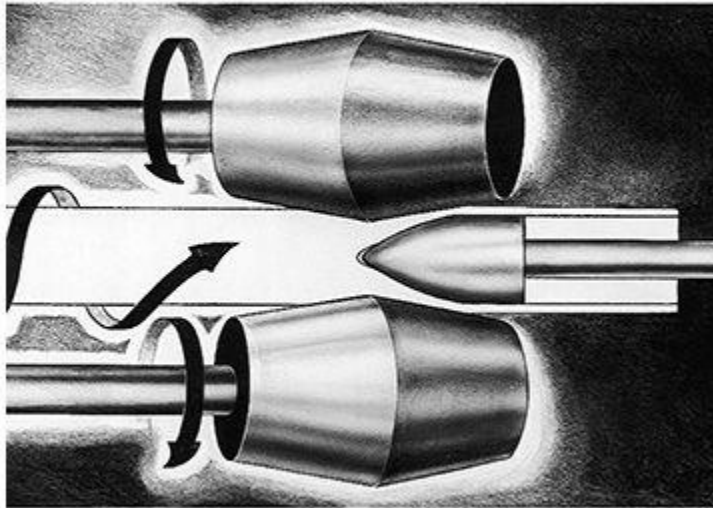
Forming Spark Plug Body



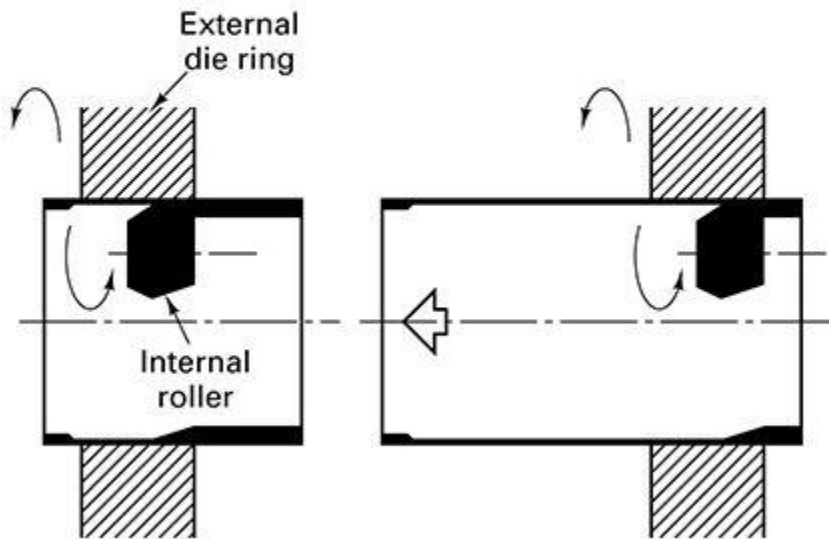
Grain Flow in Spark Plug Body



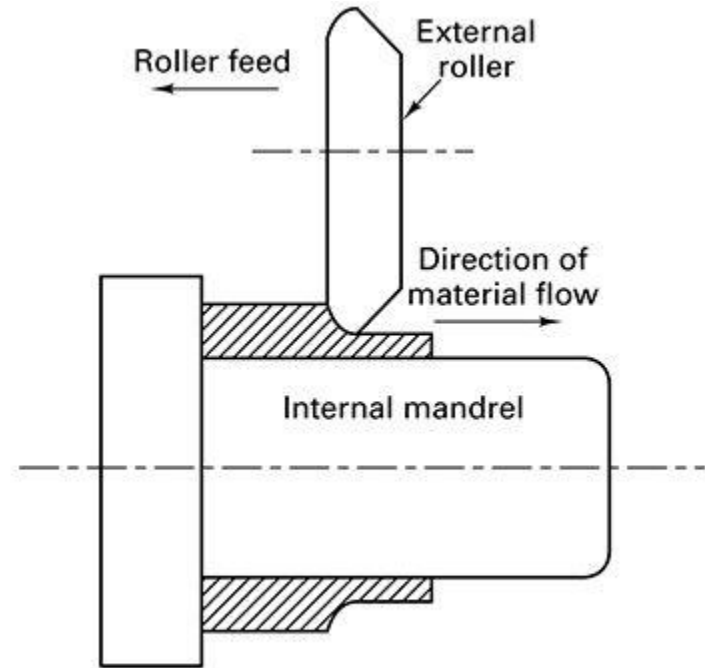
Thick-Walled Seamless Tubing by Piercing



Roll Extrusion

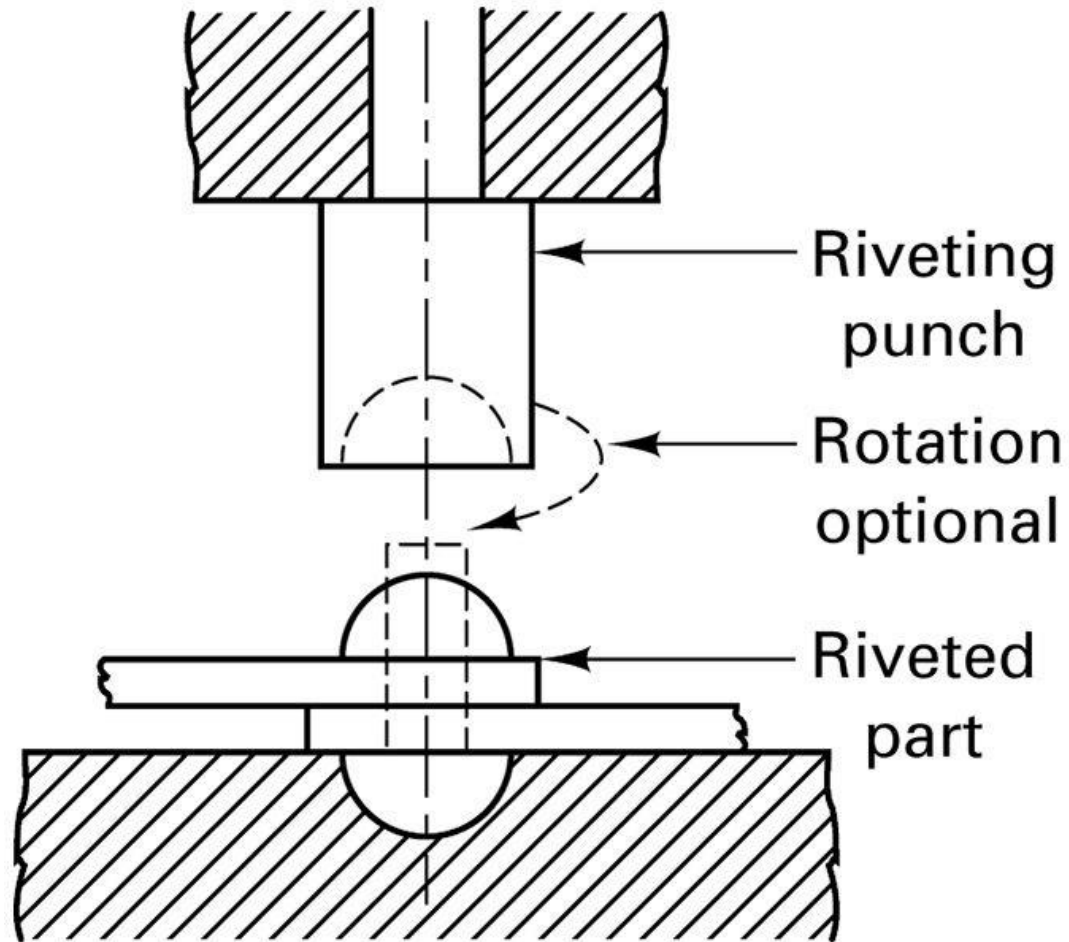


(a)

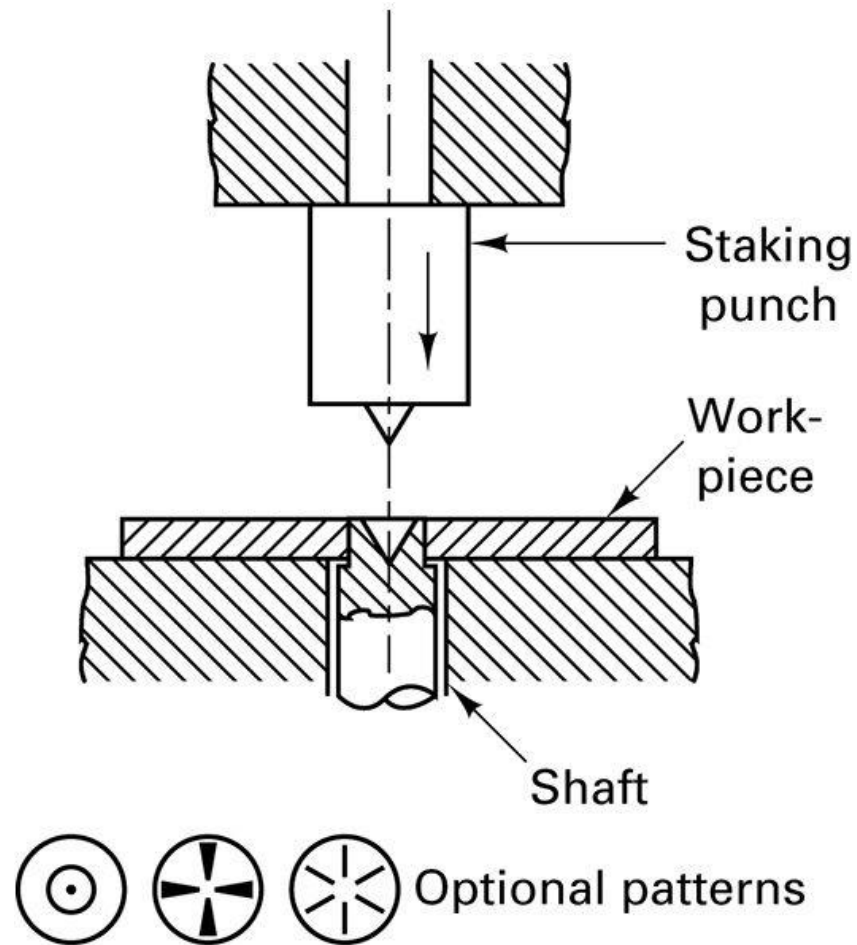


(b)

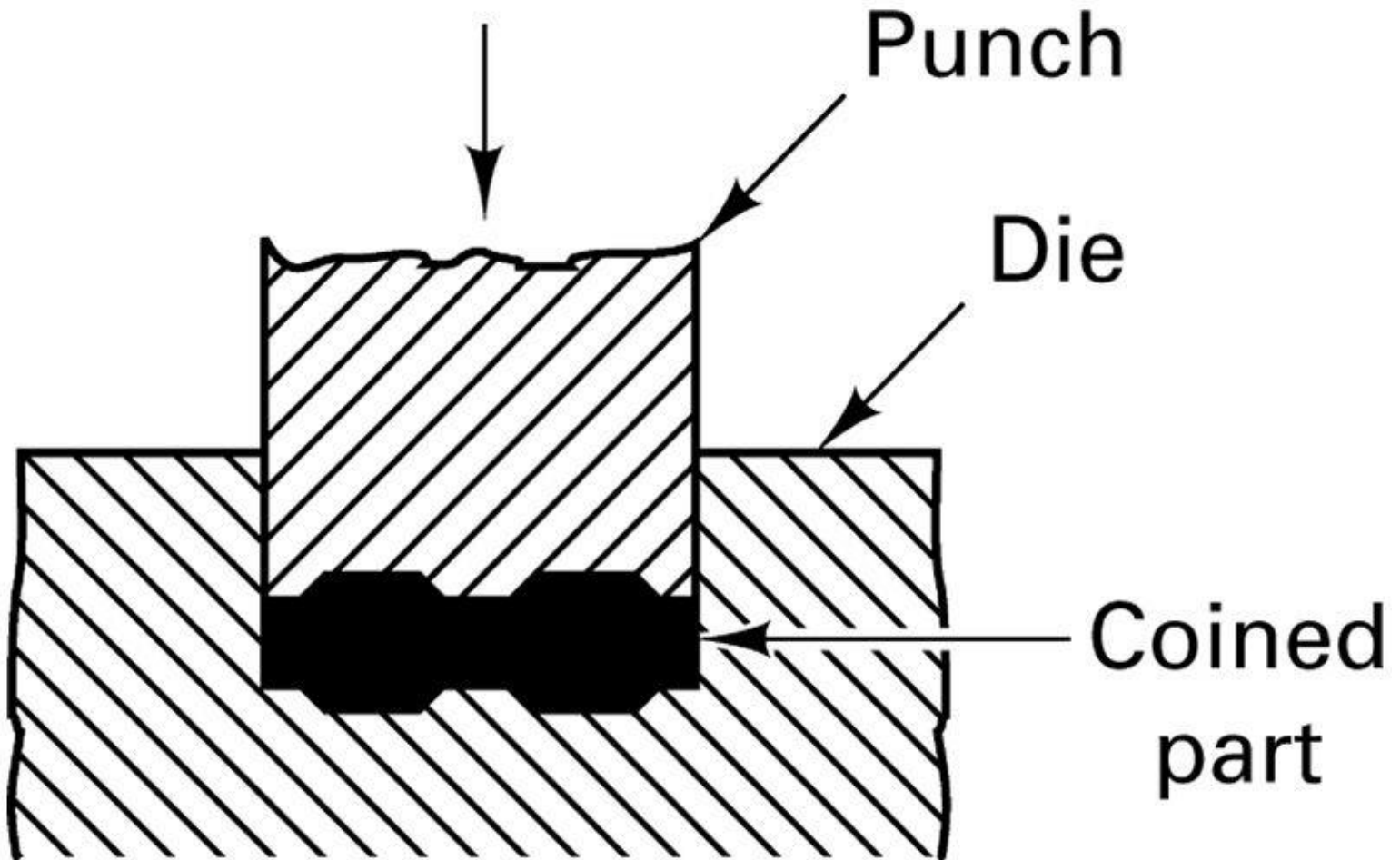
Riveting



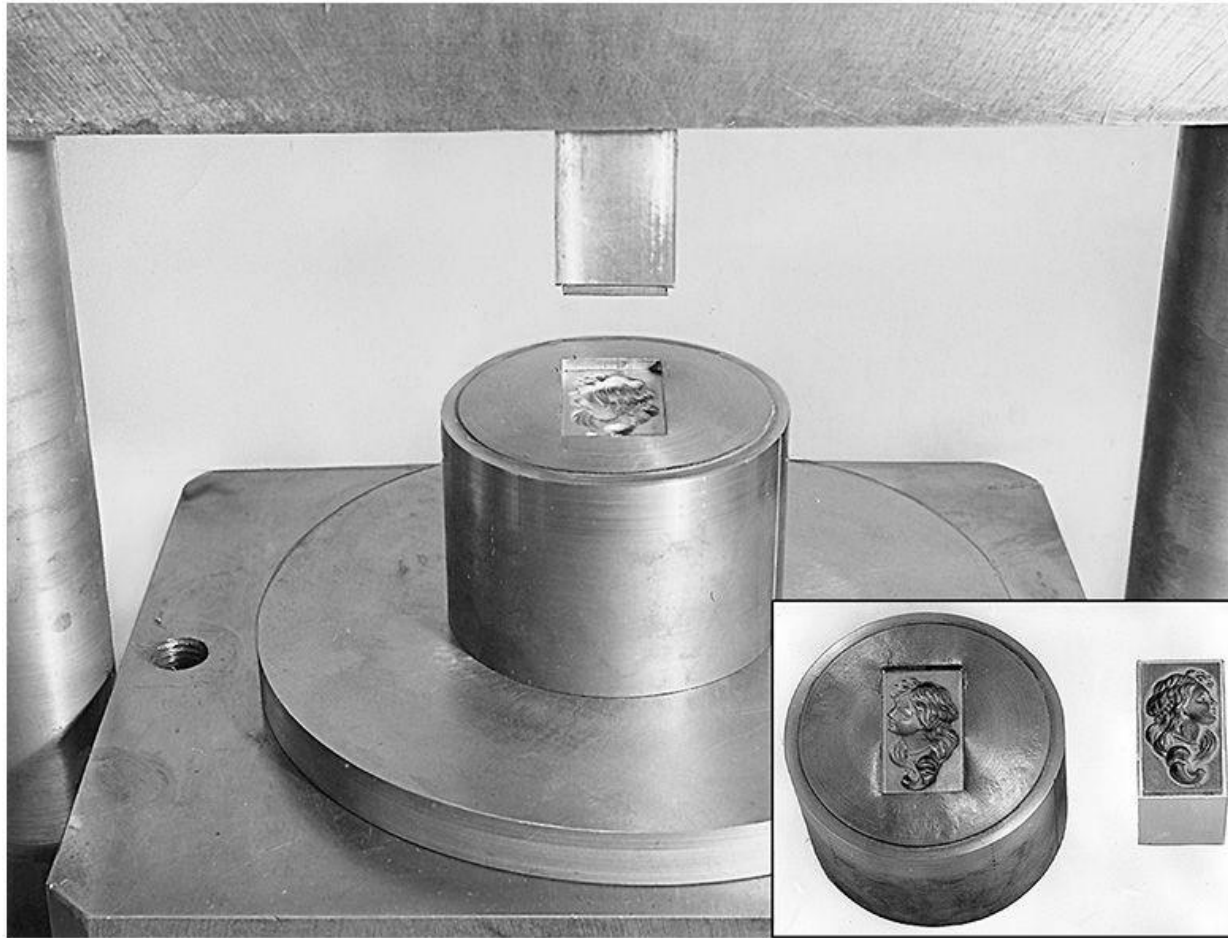
Staking



Coining



Hubbing



Roller Burnishing

