MANUFACTURING PROCESS

ES-119 UNIT -3

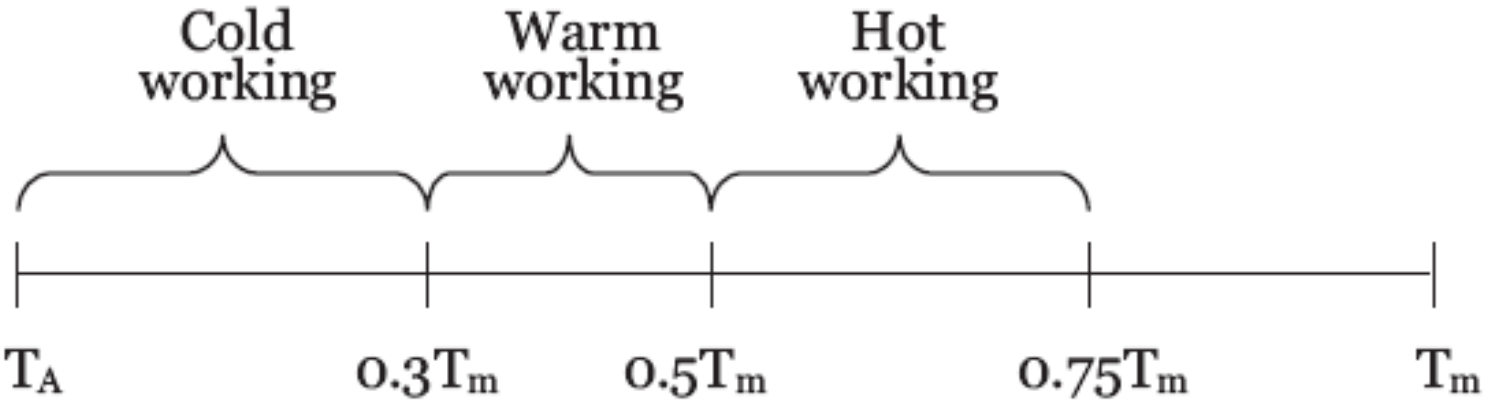
Department of Applied Sciences, BVCOE New Delhi

HOT WORKING
&
COLD WORKING PROCESS

RE- CRYSTALLISATION TEMPERATURE

METAL	TEMP. (degree Cel.)
ALUMINIUM	150
COPPER	200
IRON	450
NICKEL	590
ZINC	At room temp
LEAD	Below room temp
TIN	Below room temp

HOT AND COLD WORKING



Temperature range for different metal forming operations. T_A is the ambient (room) temperature, and T_m is the work metal melting temperature

Advantages of HOT WORKING

Large deformation can be obtained
In hot working process, the grain structure of the metal is refined and thus mechanical properties improved
Porosity of the metal is considerably minimized
If process is properly carried out, hot work does not affect tensile strength, hardness, corrosion resistance, etc
Concentrated impurities, if any in the metal are disintegrated and distributed throughout the metal

Disadvantages of HOT WORKING

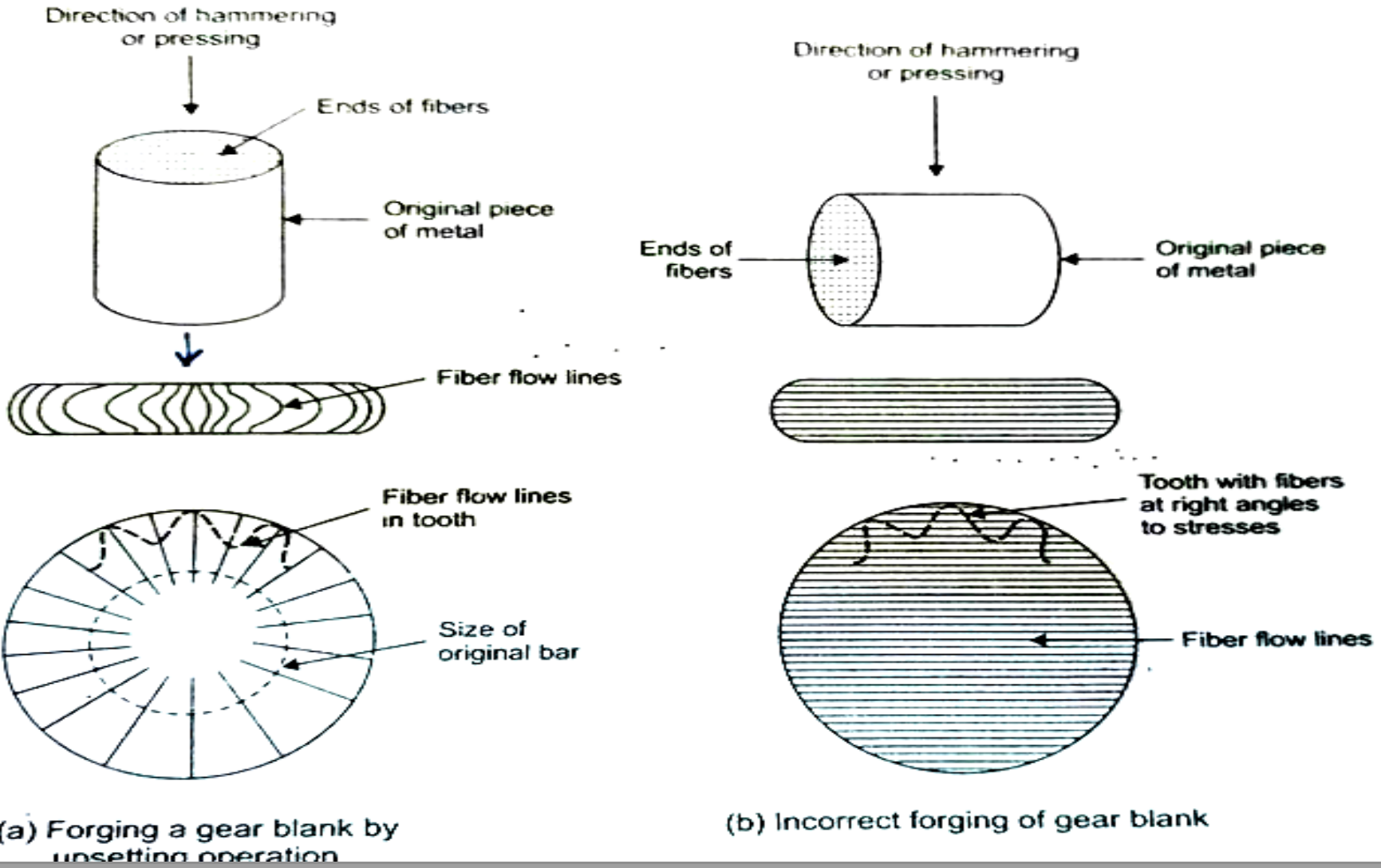
Some metals cannot be hot worked because of their brittleness at high temperatures.
Handling and maintaining of hot working setups is difficult and troublesome.
Because of the thermal expansion of metals, the dimensional accuracy in hot working is difficult to achieve.
Rapid oxidation of metals occurs

PRINCIPAL OF HOT WORKING

HOT WORKING

1.FORGING
2.ROLLING
3.EXTRUSION
4.HOT DRAWING

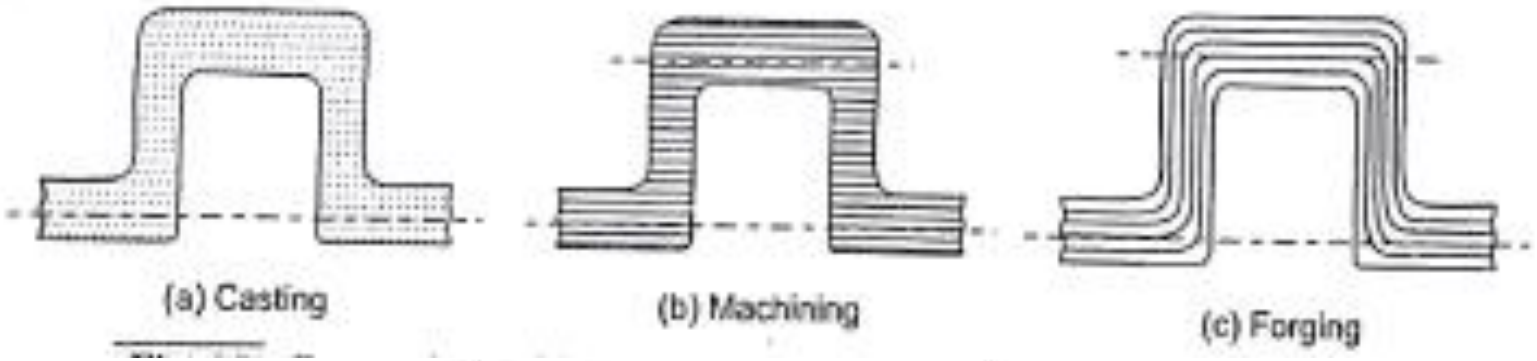
GRAIN FLOW

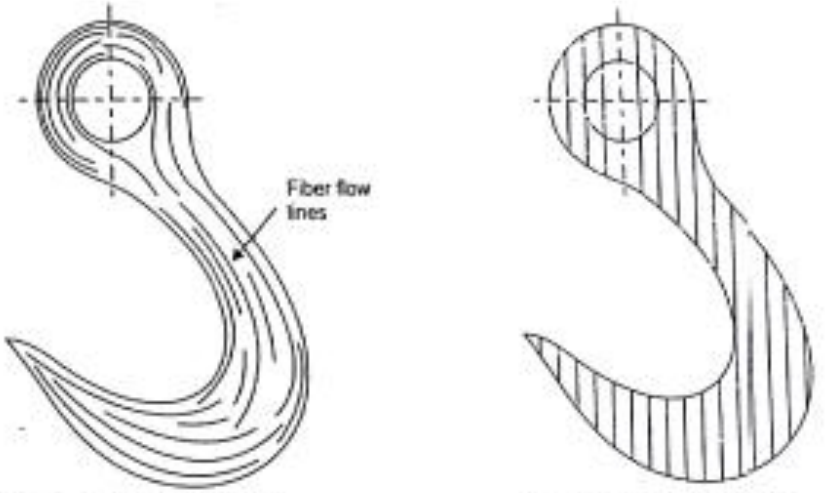


(a) Forging a gear blank by upsetting operation

(b) Incorrect forging of gear blank

GRAIN FLOW





(a) Crane hook produced by bending and drawing out operation. Fiber flow line are bent along the hook so provide better strength to crane hook

(b) Crane hook produced by other manufacturing processes

FORGING METHODS

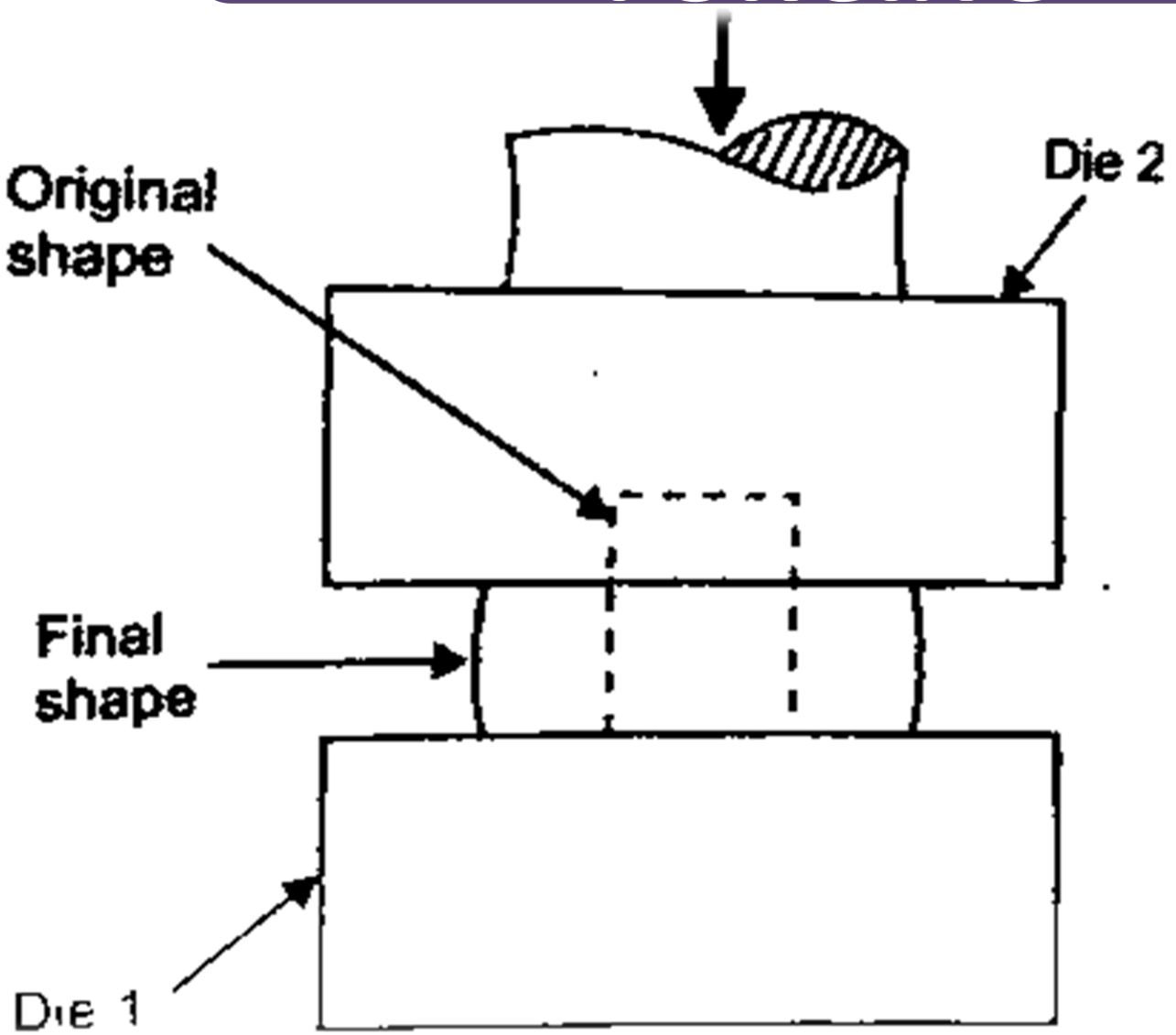
1.SMITH FORGING

2.DROP FORGING

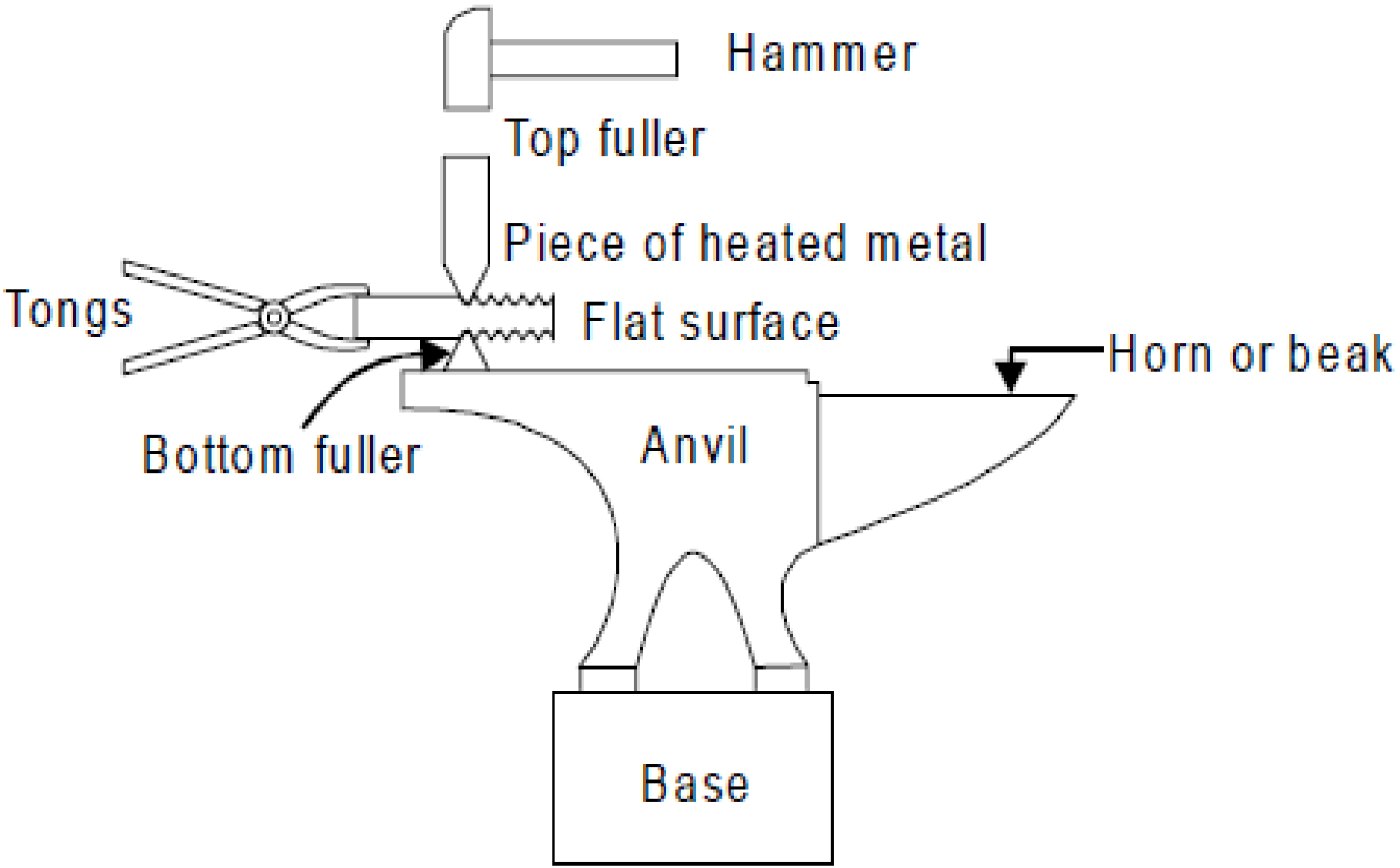
3.PRESS FORGING

4.MACHINE OR UPSET FORGING

SMITH OR HAND FORGING



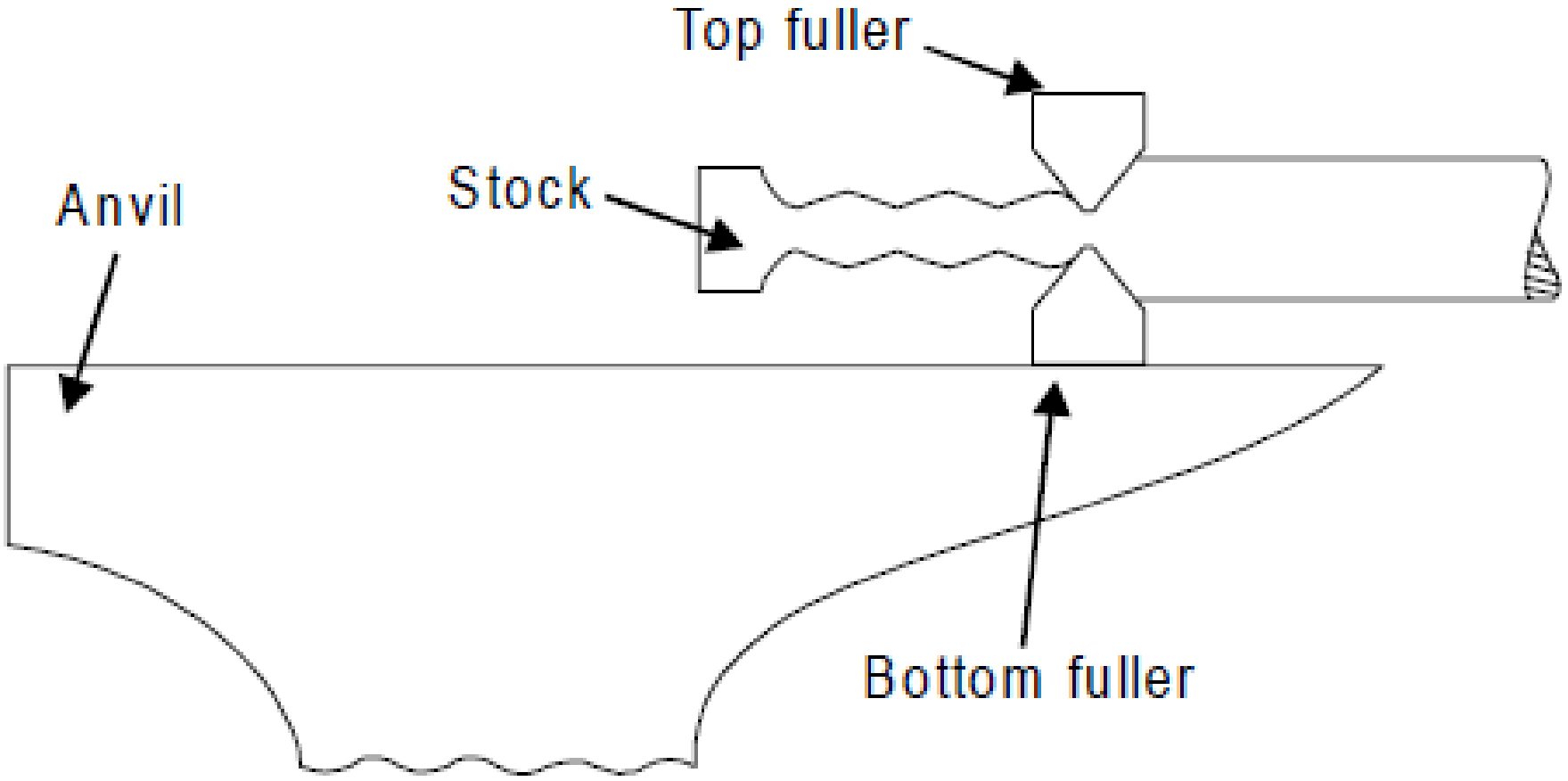
SMITH OR HAND FORGING



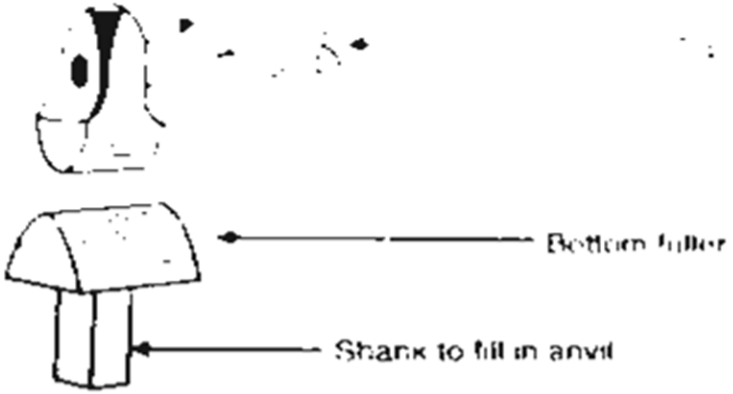
TYPES OF SMITH FORGING

1. FULLERING
2. FLATTENING
3. SWAGING
4. PUNCHING
5. DRIFTING
6. BENDING

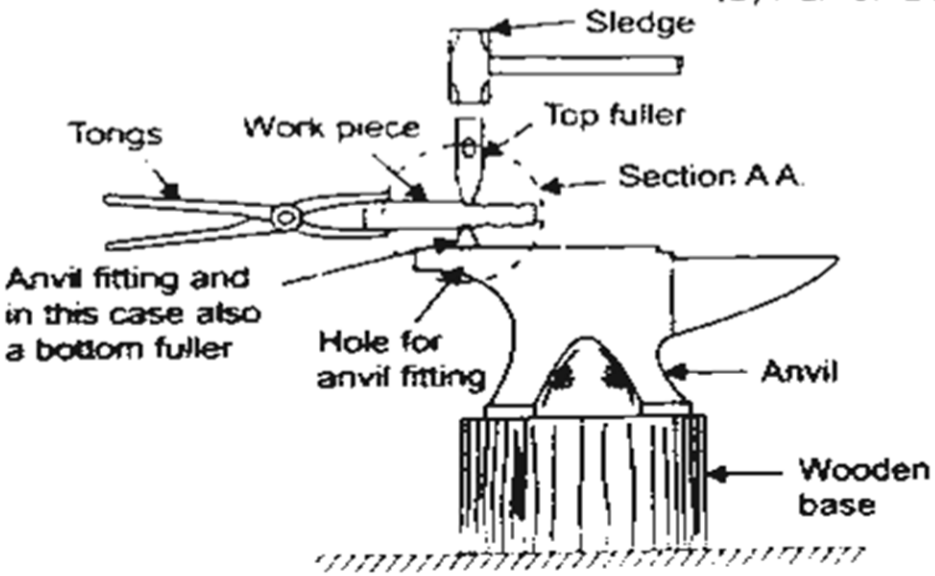
FULLERING



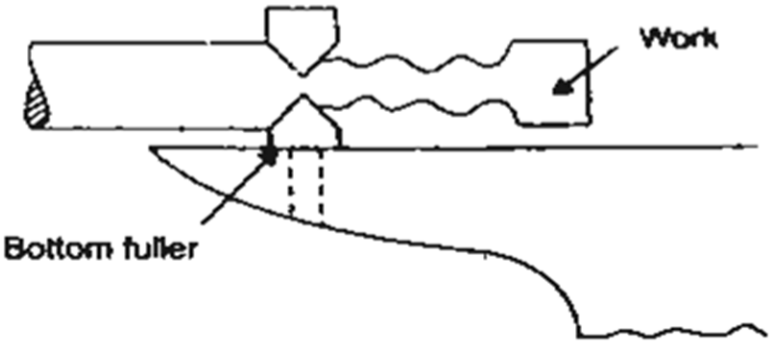
FULLERING



(a) Pair of fullers

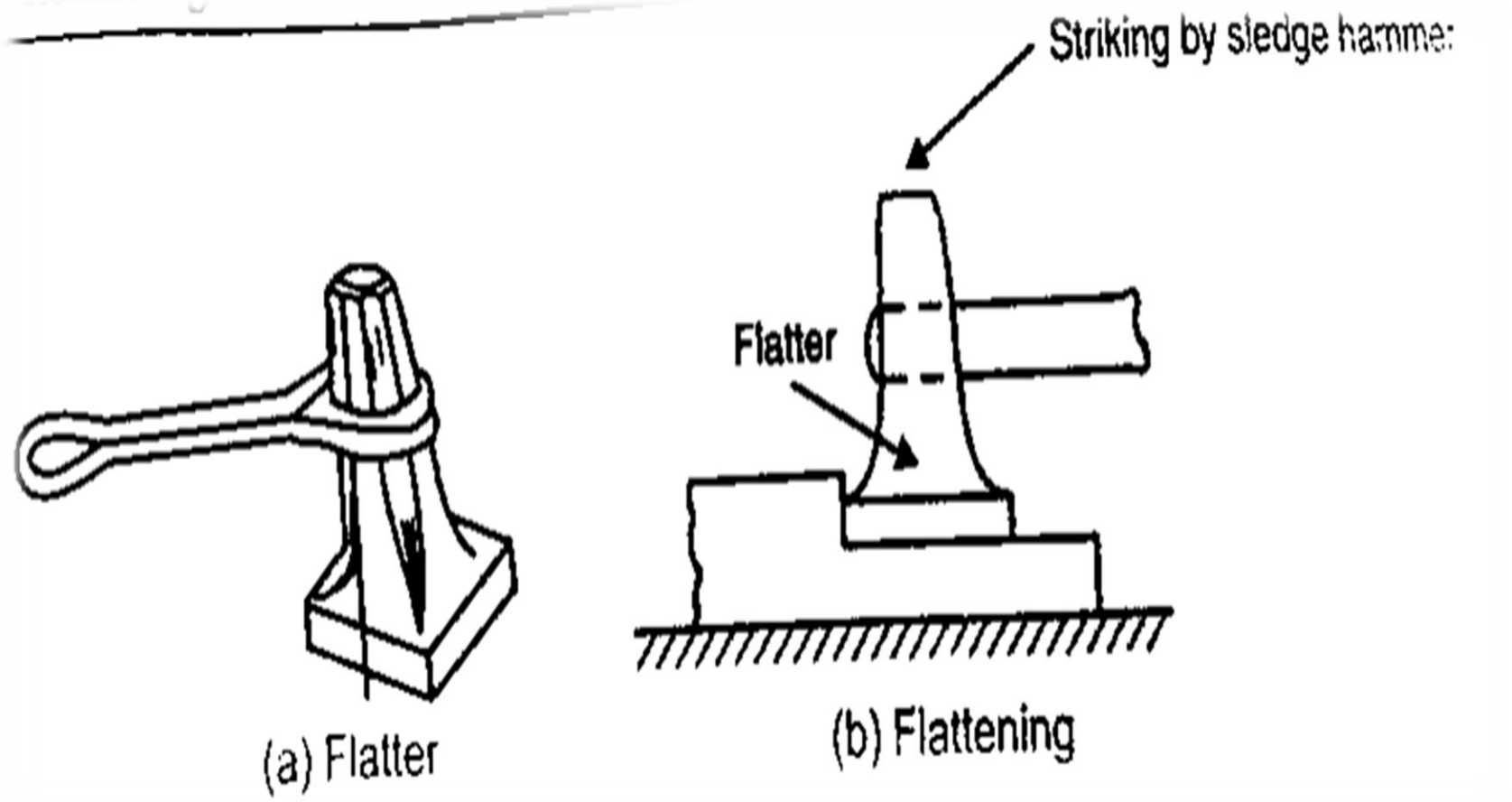


(b) Fullering operation

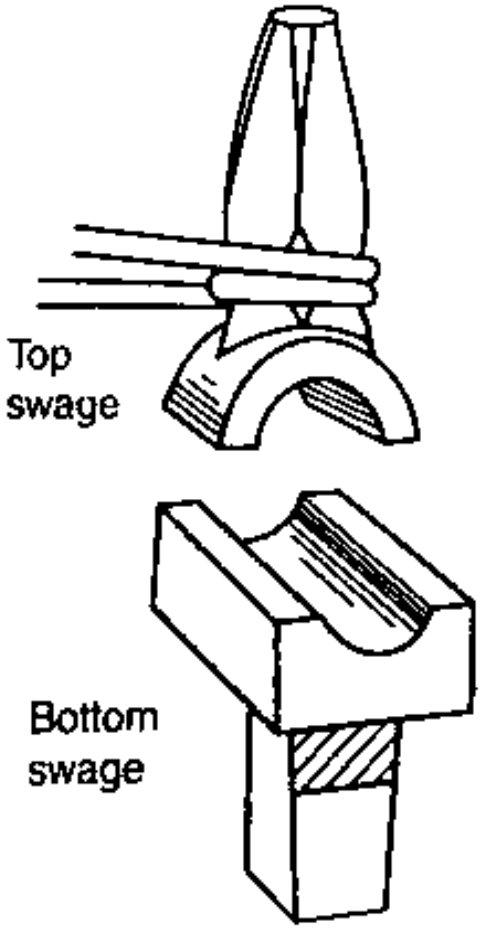


(c) Enlarged view AA

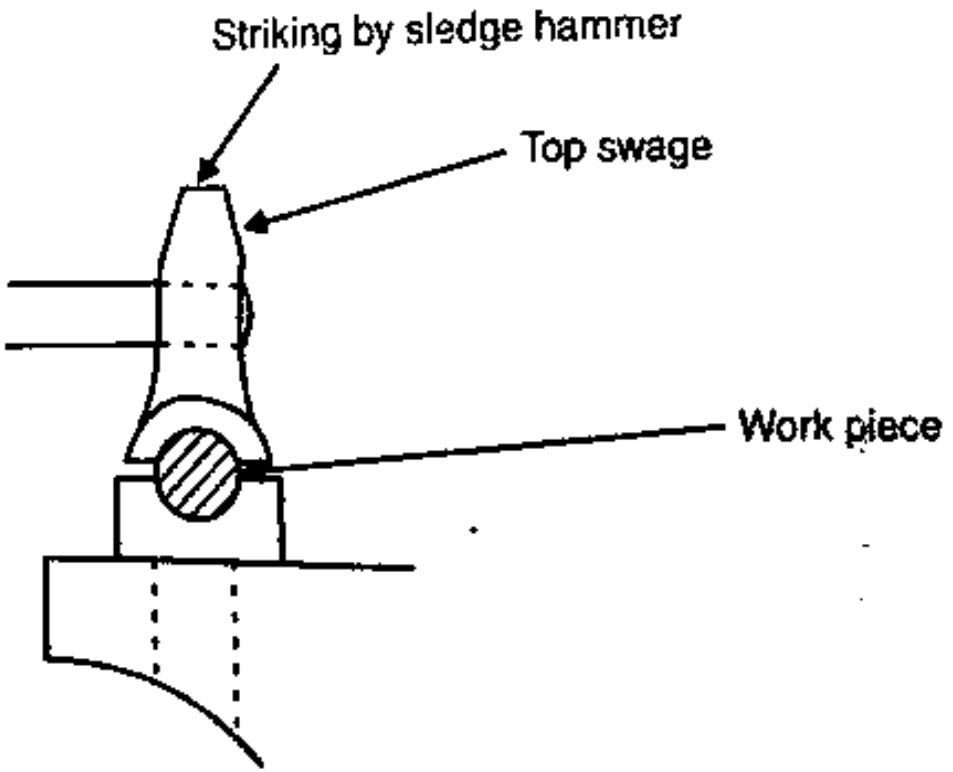
FLATTENING



SWAGING

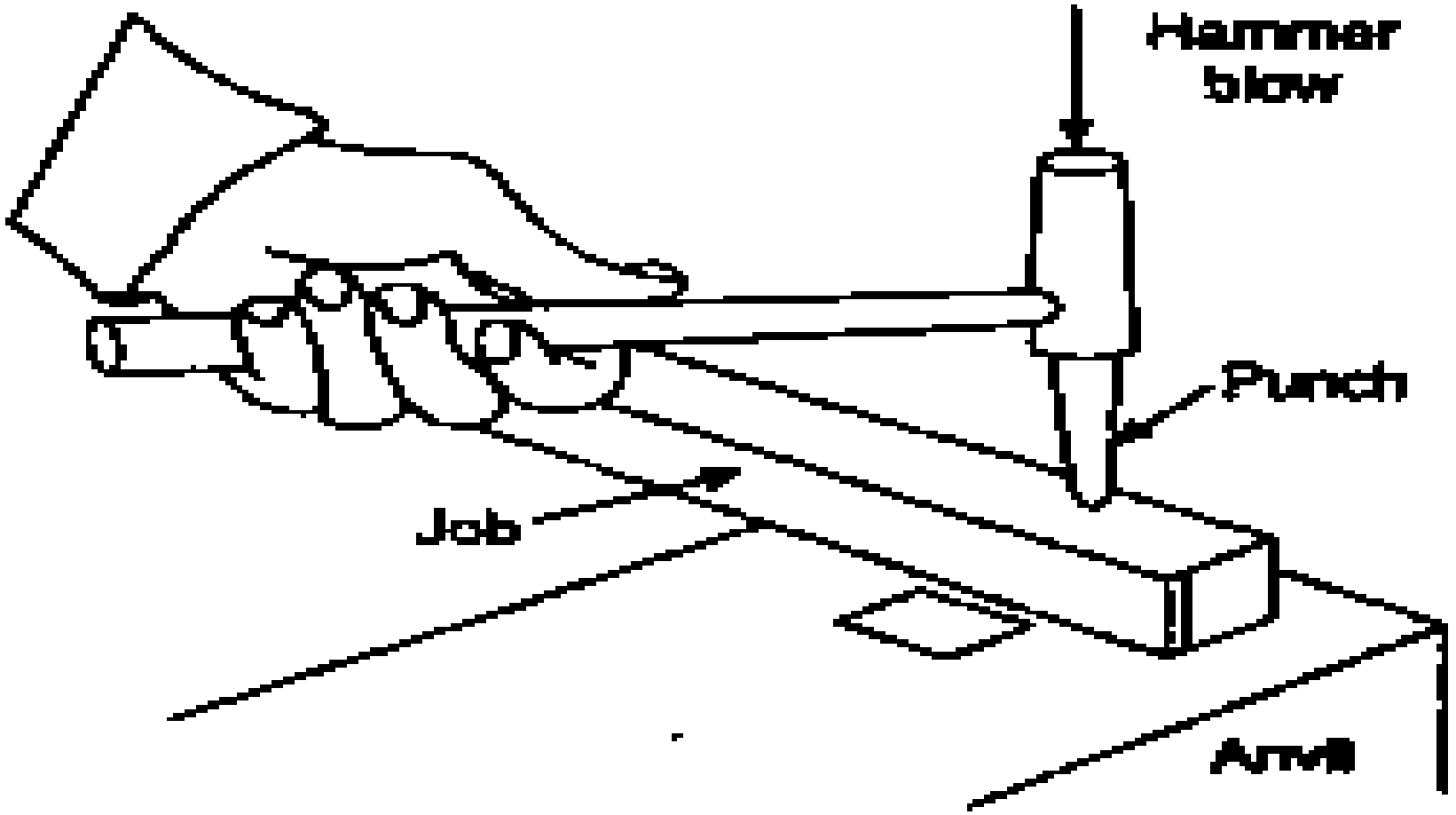


(a) Pair of swages



(b) Swaging operation

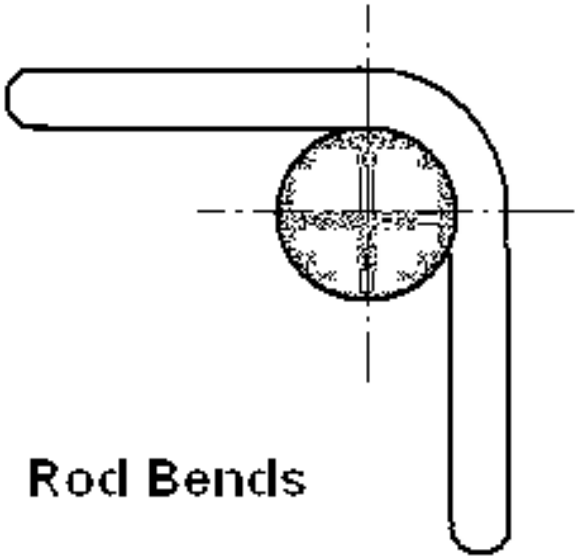
PUNCHING



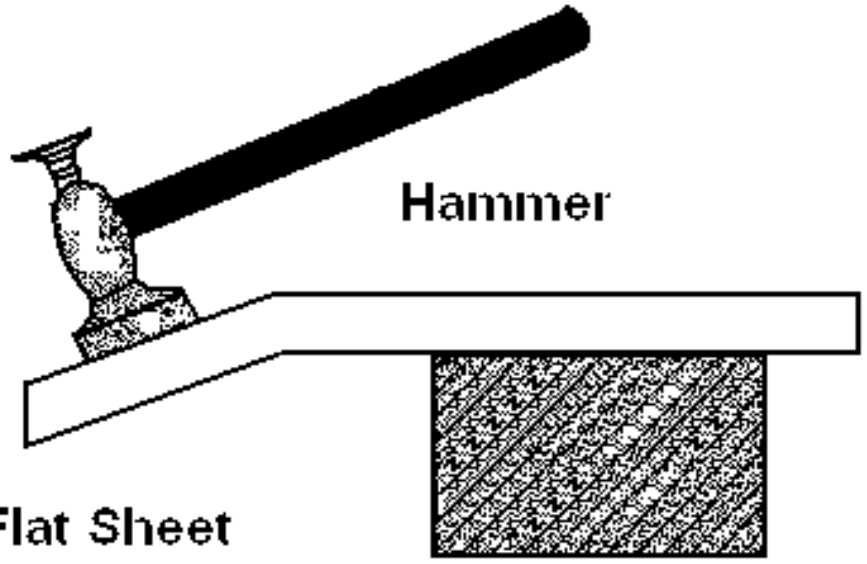
Punching a hole with punch and hammer.

BENDING

Bending

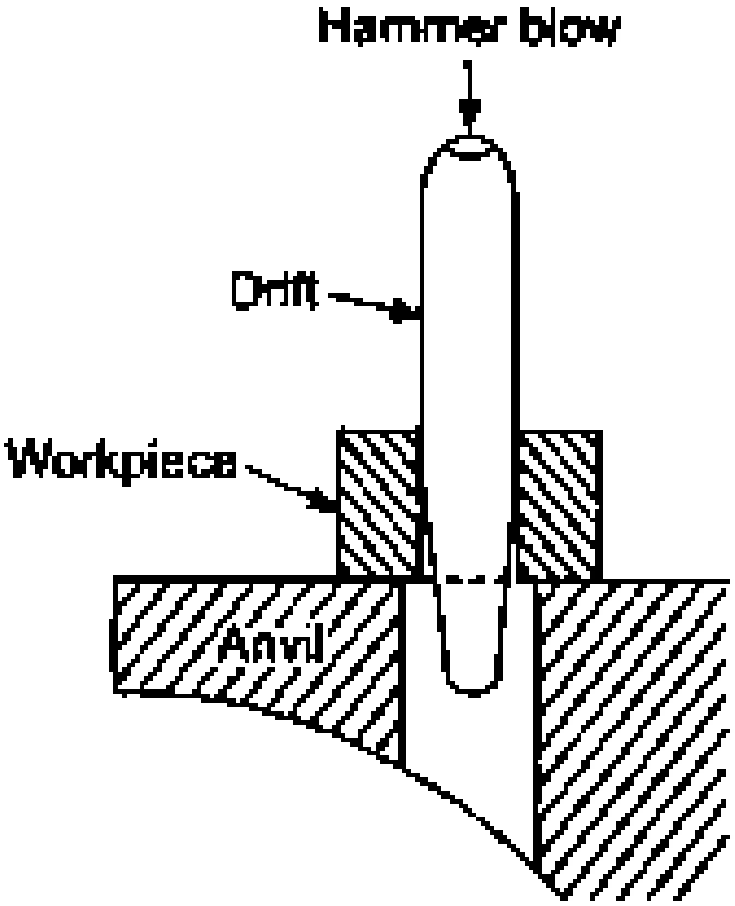


Rod Bends



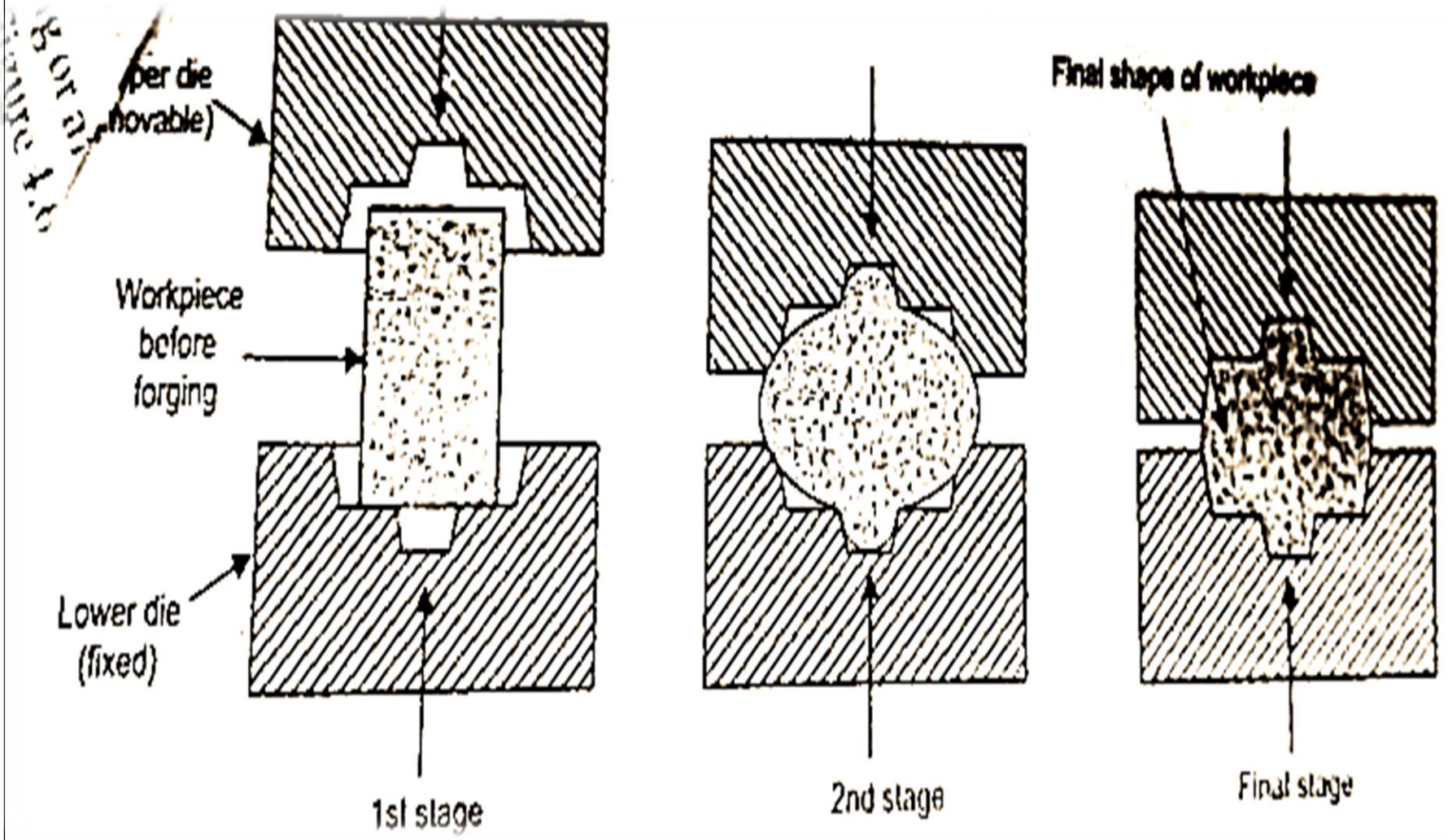
Flat Sheet Bend

DRIFTING

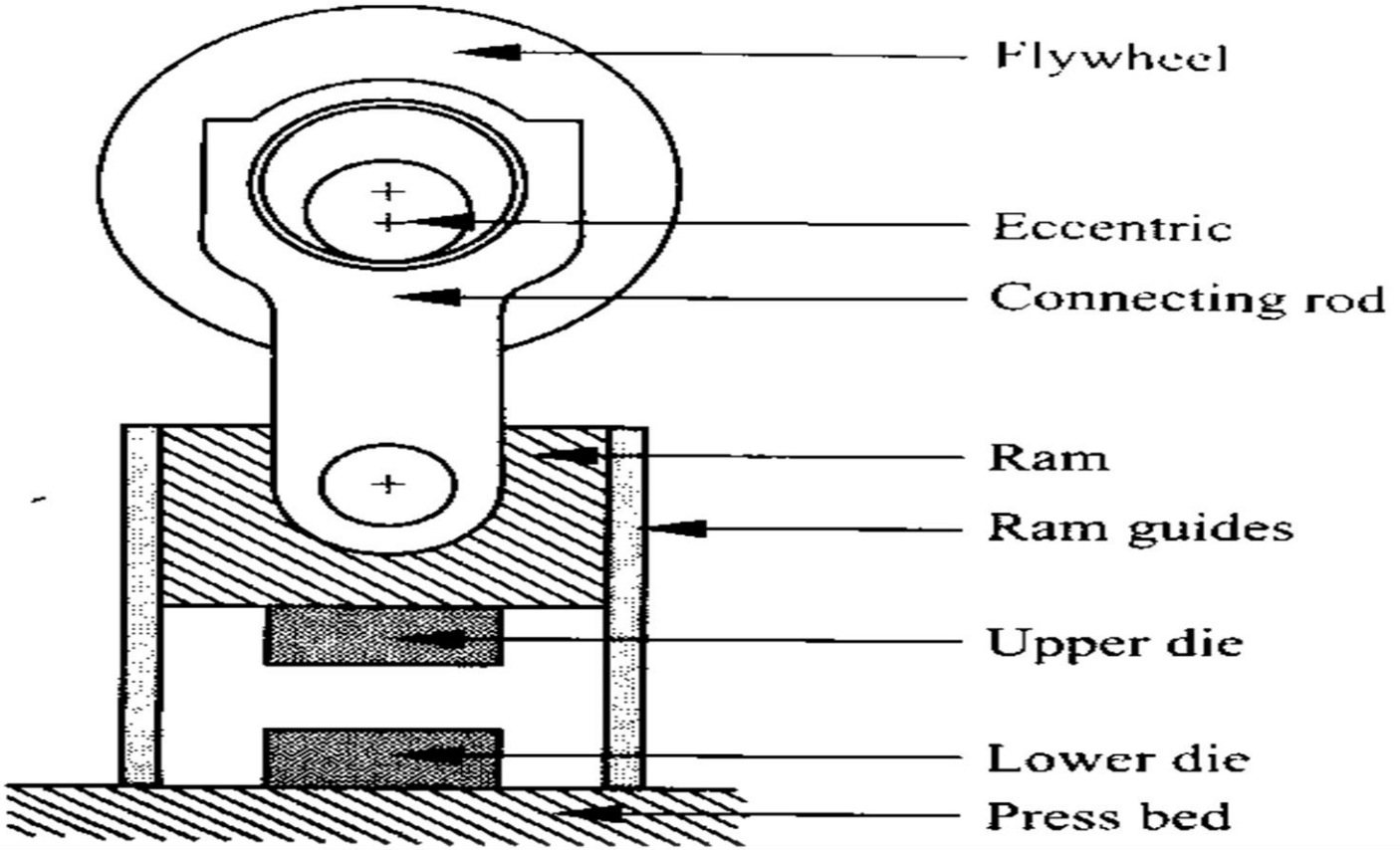


Drifting or enlarging a punched hole using a drift and hammer.

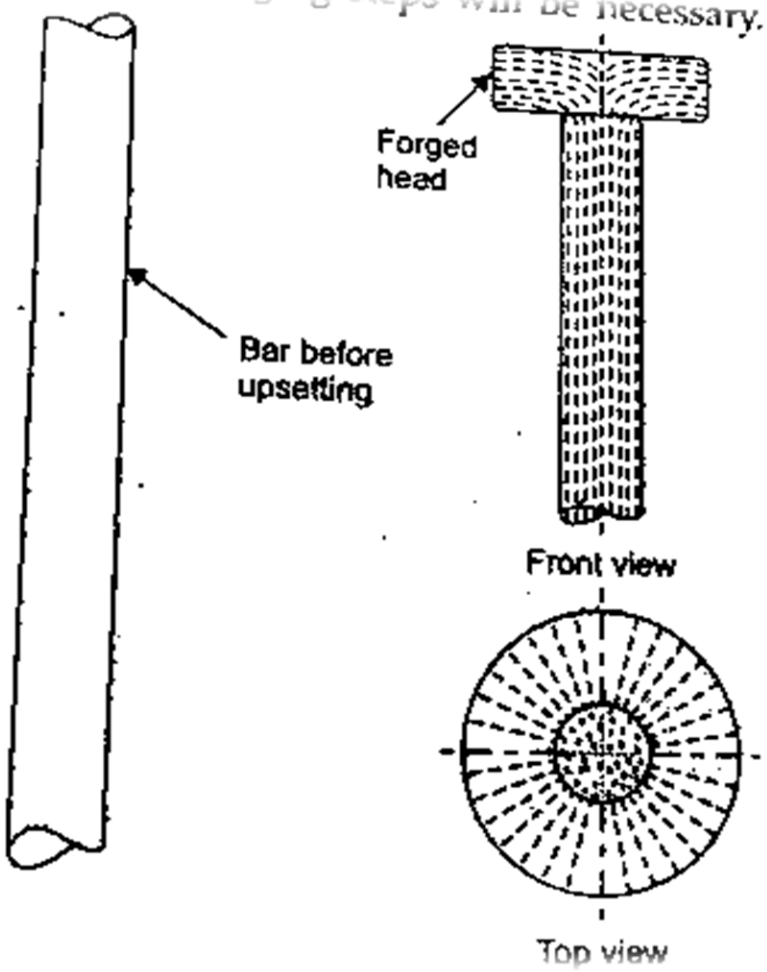
DROP FORGING



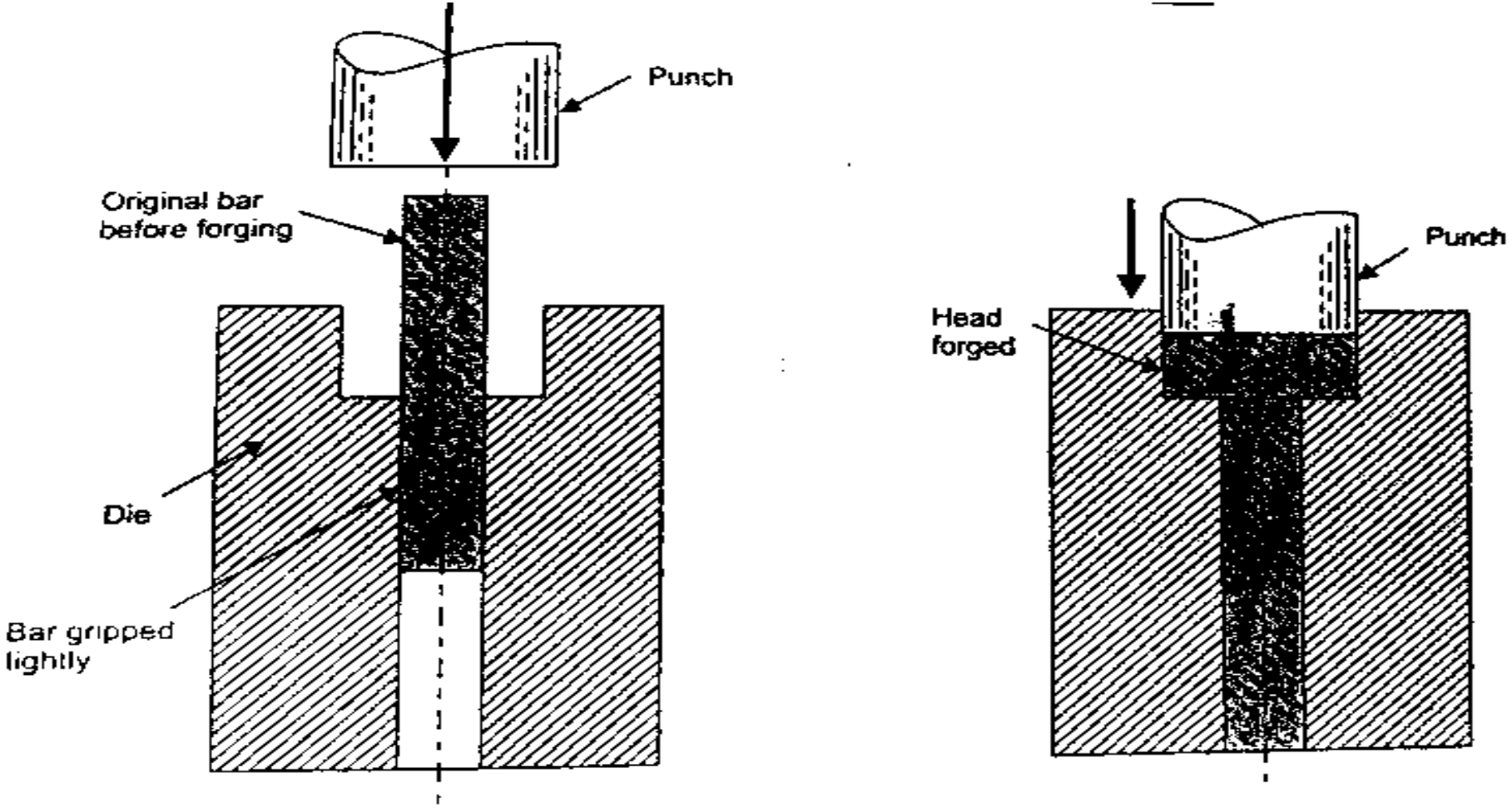
PRESS FORGING



UPSET OR MACHINE FORGING

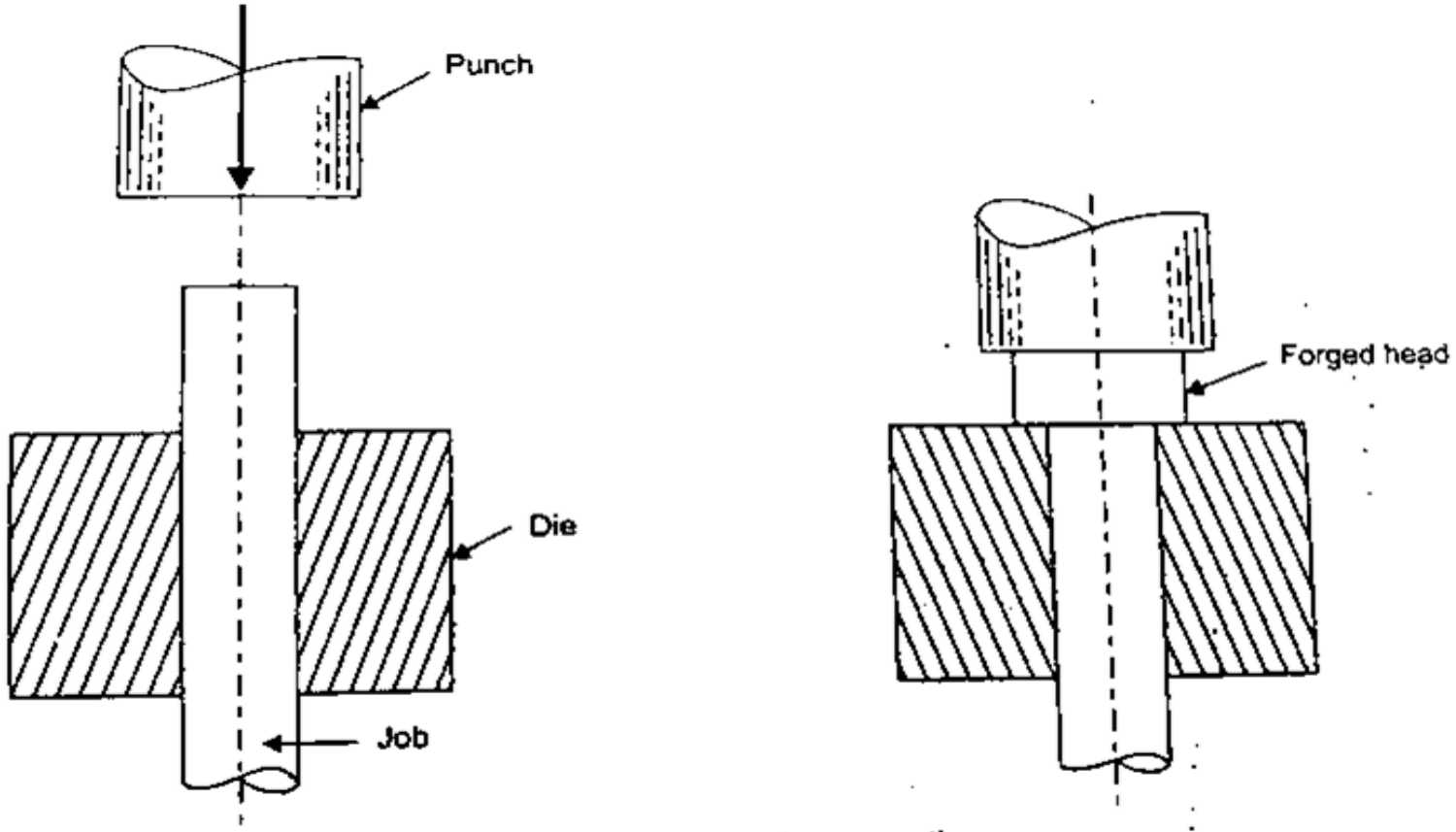


UPSET OR MACHINE FORGING (CLOSE)



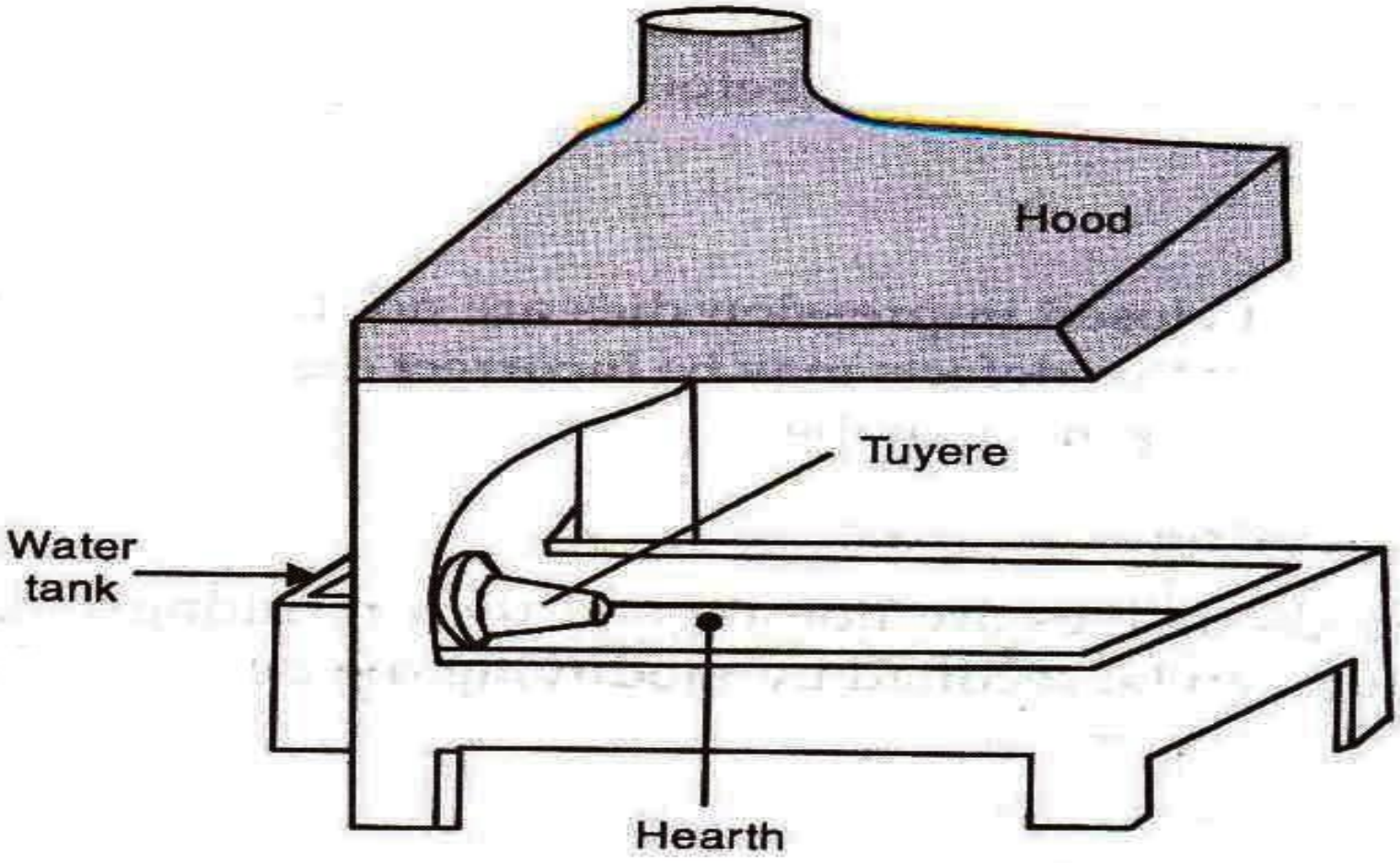
(a) Closed upsetting to produce bolt head on one end of the bar.

UPSET OR MACHINE FORGING (OPEN)



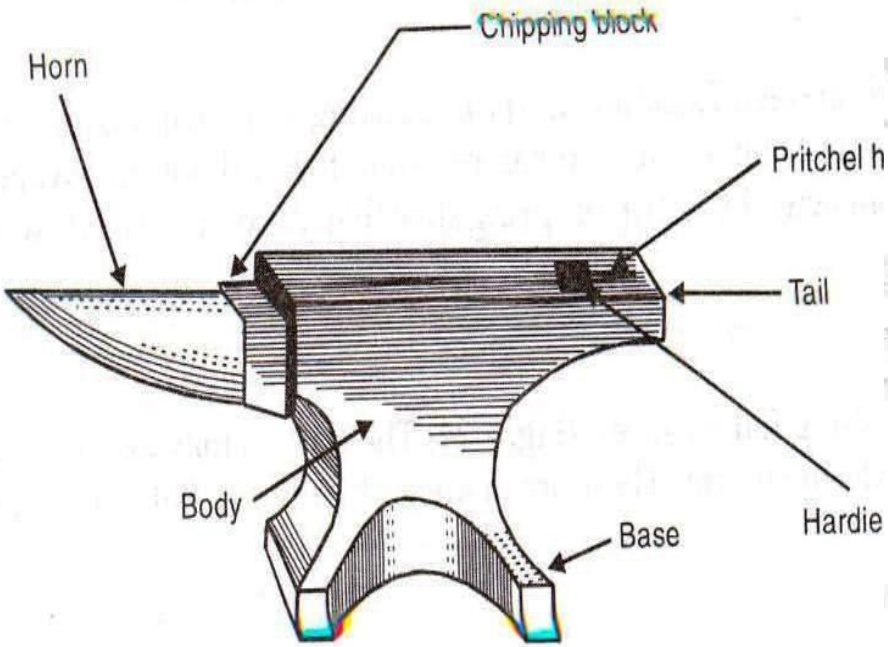
(b) Open upsetting operation

FORGING TOOLS

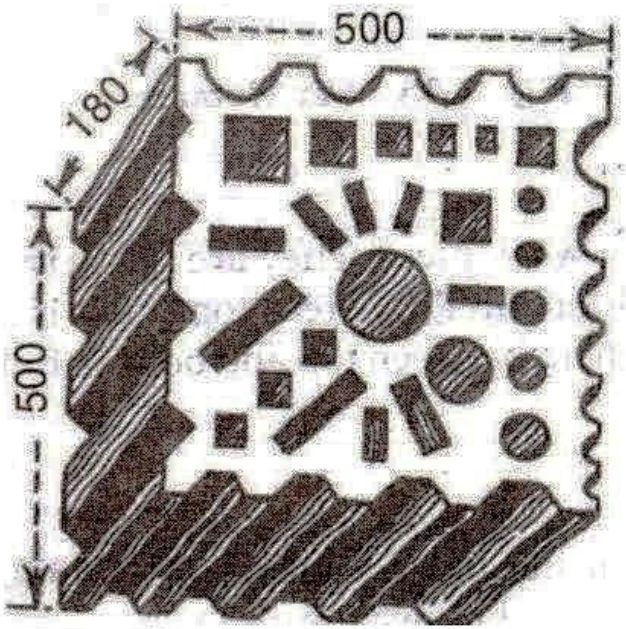


Black Smith's Forge

FORGING TOOLS

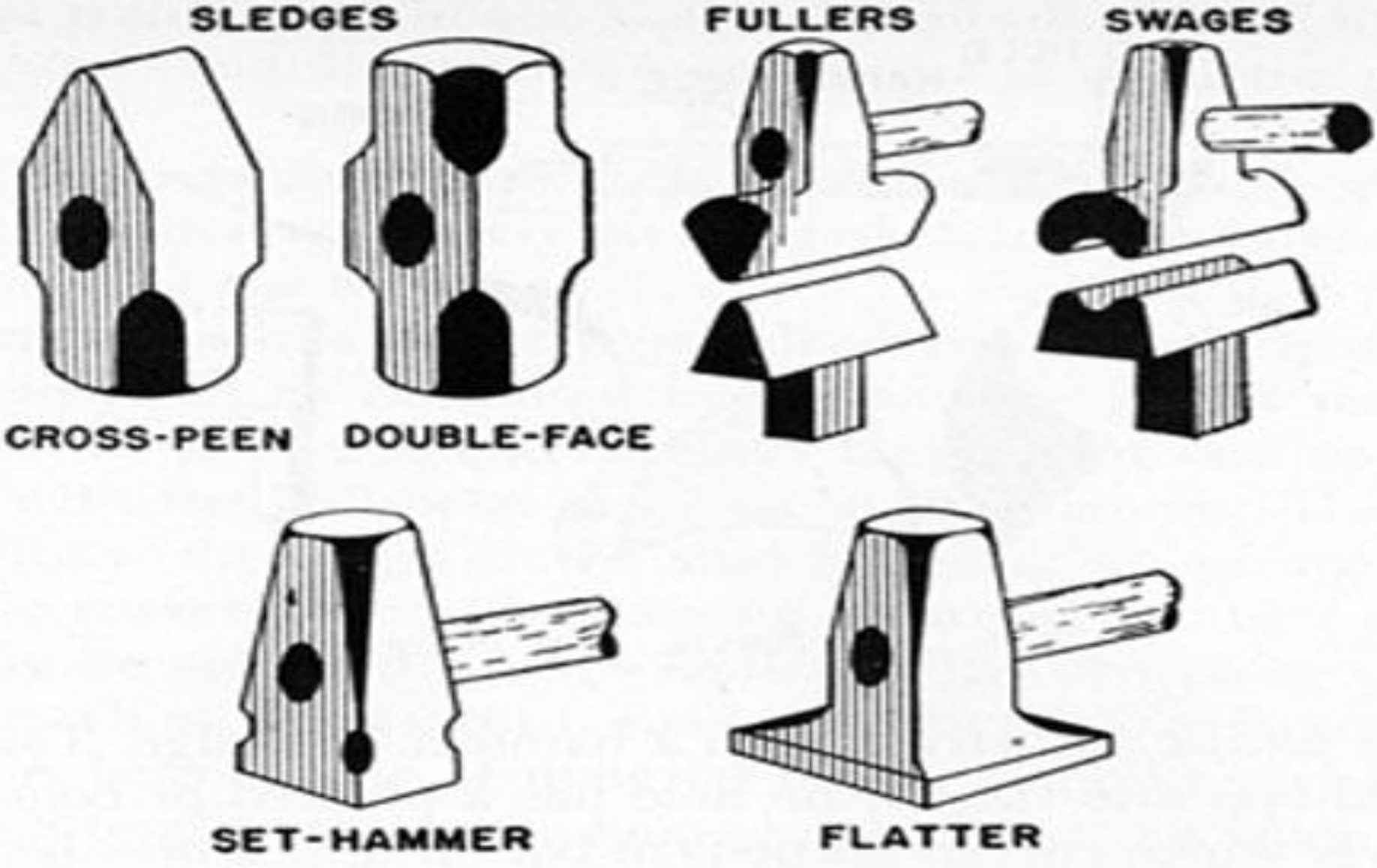


Anvil.

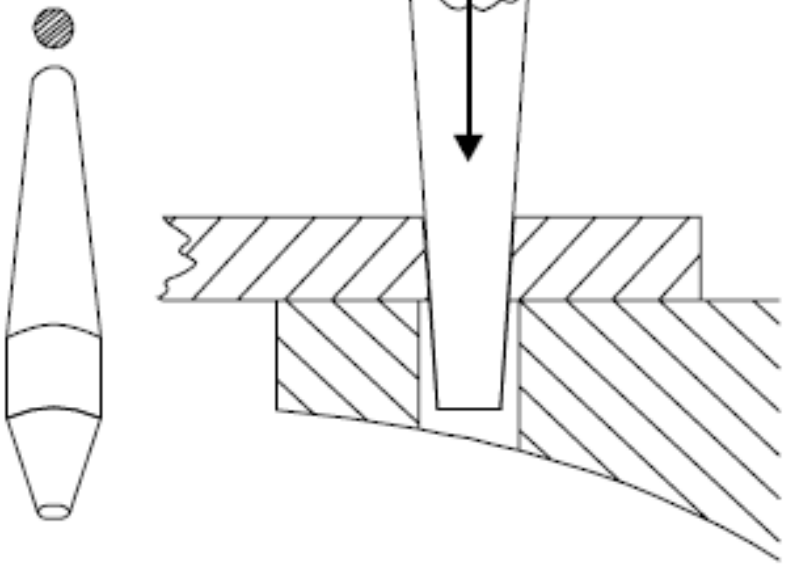


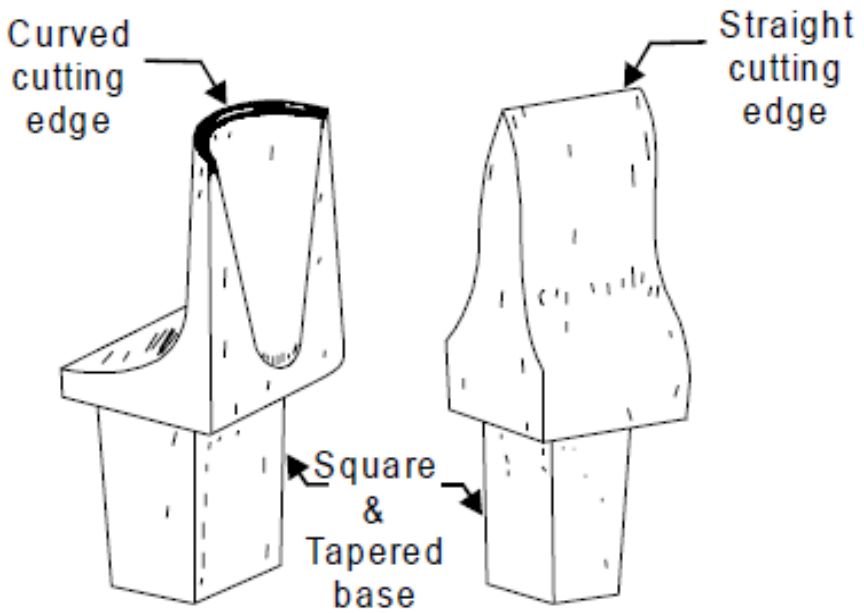
Swage Block.

FORGING TOOLS

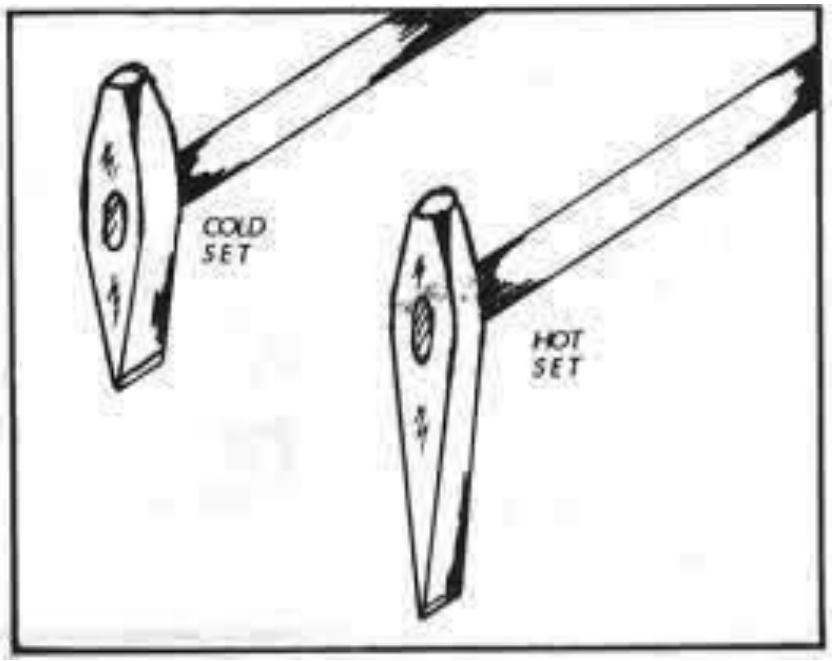


FORGING TOOLS



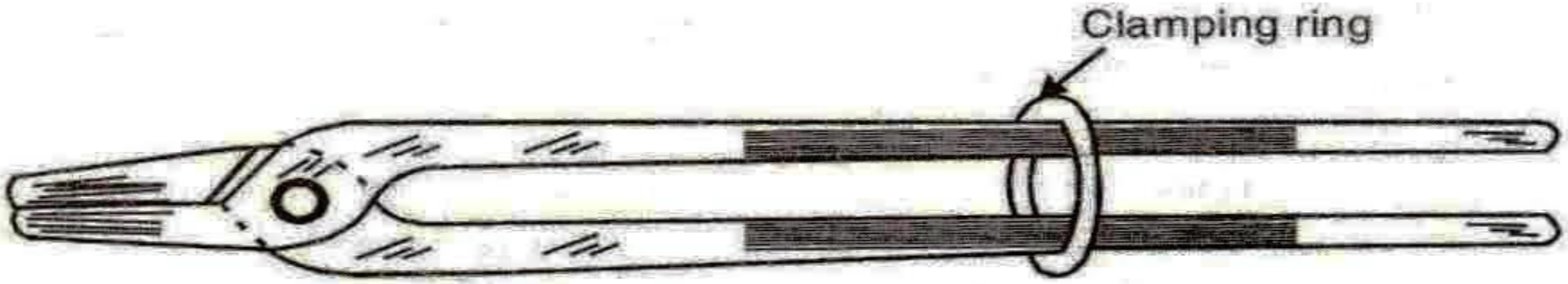


FORGING TOOLS



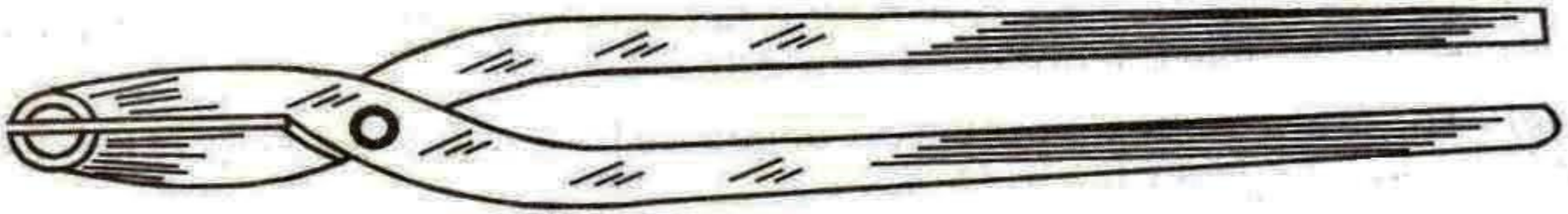
COLD & HOT CHISEL

FORGING TOOLS



(a) Closed mouth tong.

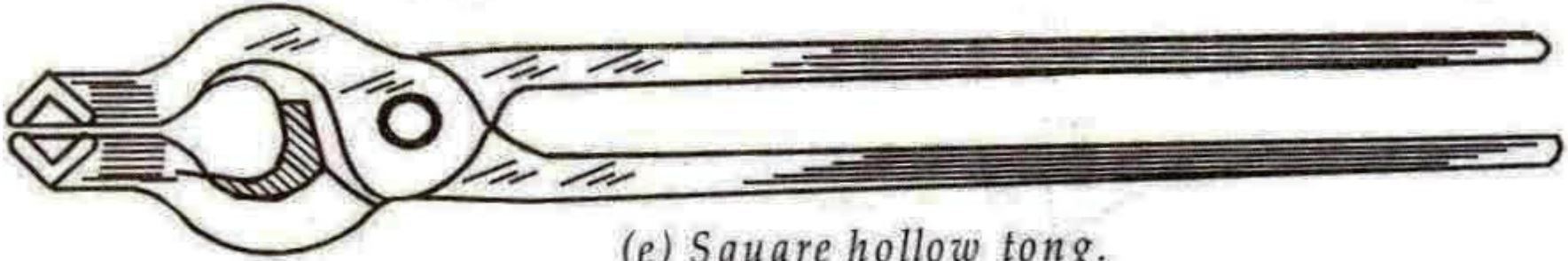
(b) Open mouth tong.



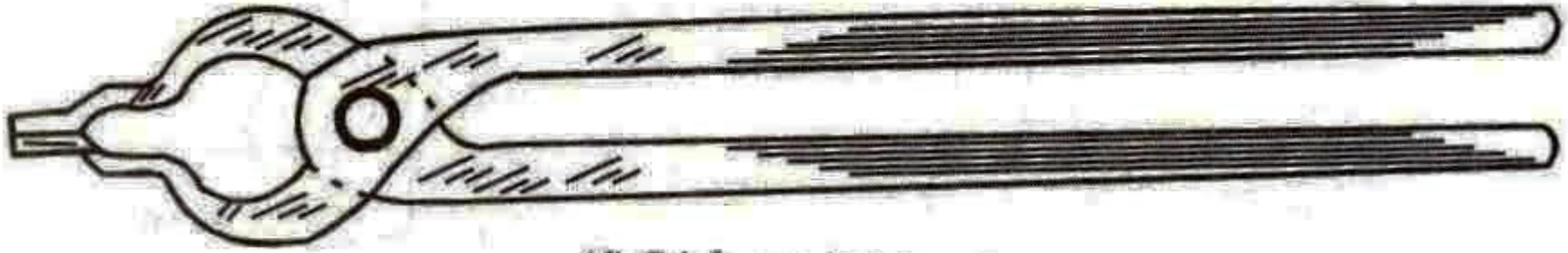
(c) Round hollow tong.

FORGING TOOLS

(d) Round mouth tong.

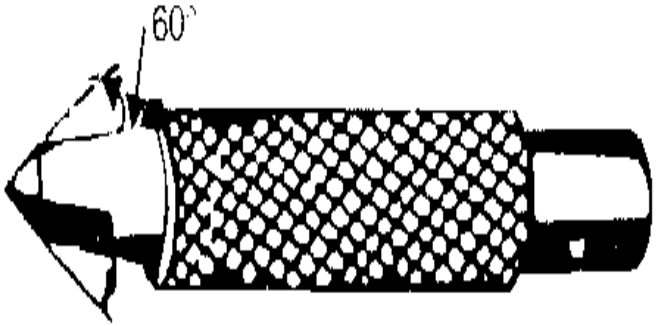


(e) Square hollow tong.

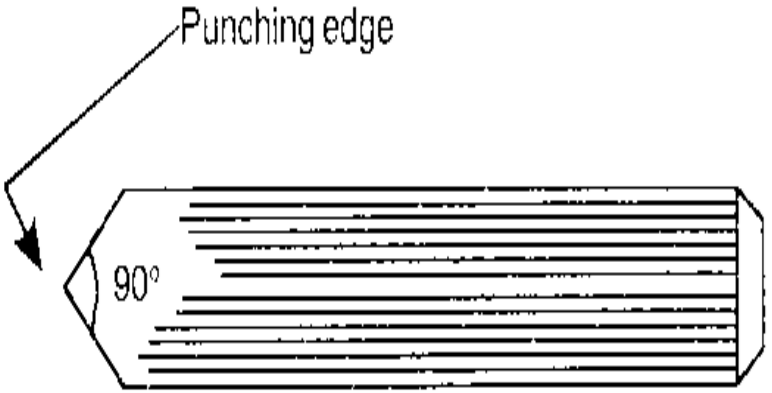


(f) Pick-up tong.

FORGING TOOLS

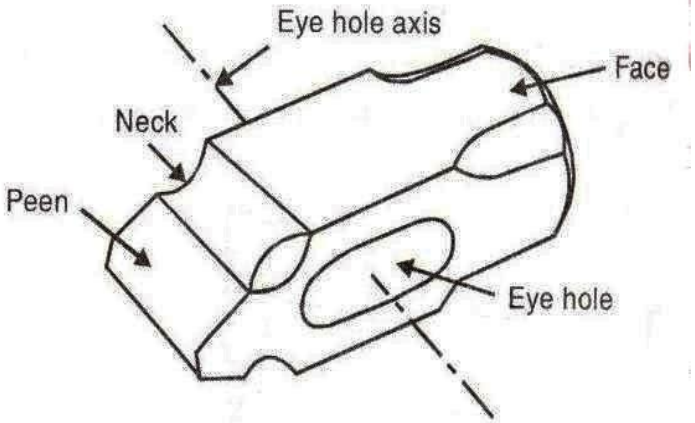


(a) Dot Punch

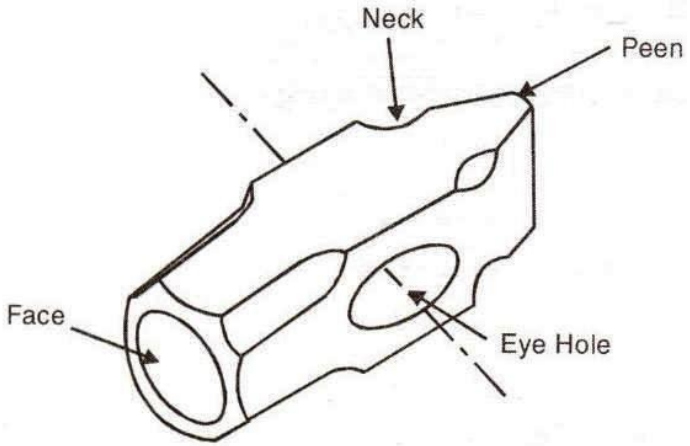


(b) Centre Punch

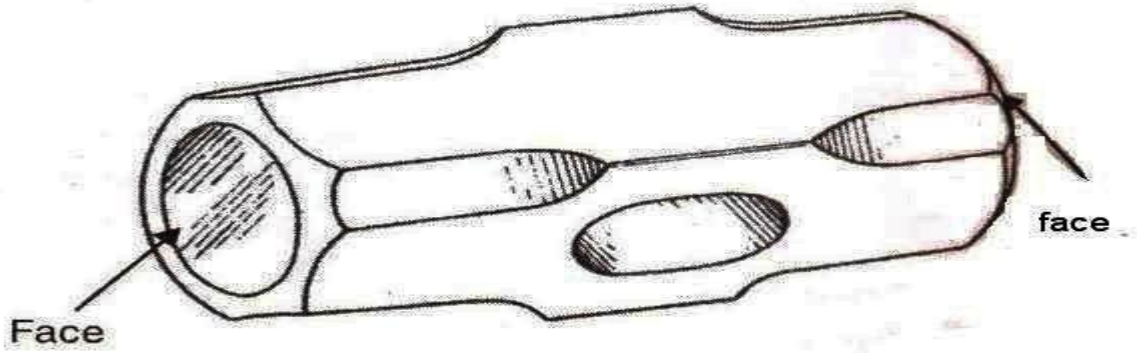
FORGING TOOLS



Straight Peen Hammer



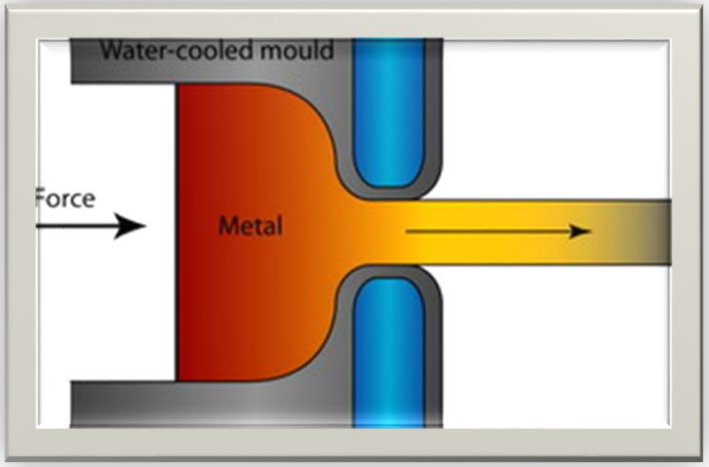
Cross peen Hammer

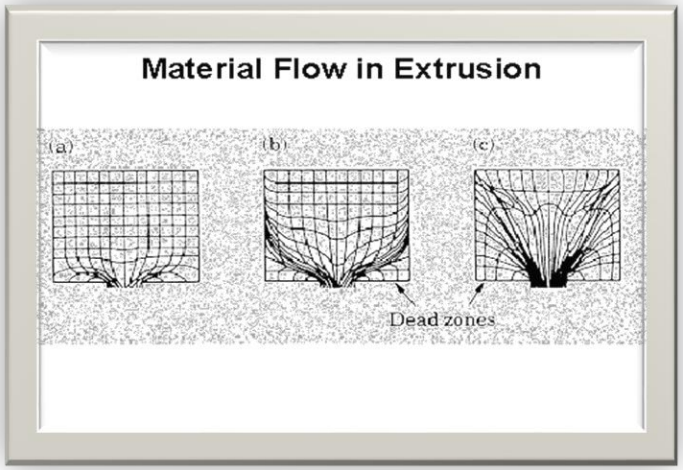


Double Face Sledge Hammer

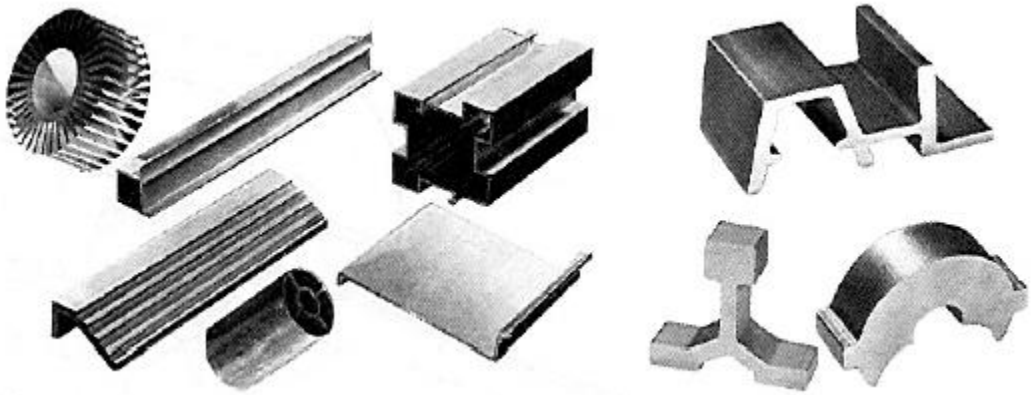
WHAT İS EXTRUSION

A material is pushed or drawn through a die of the desired cross-section .Any solid or hollow cross-section may be produced by extrusion, which can create essentially semi-finished parts. The metal can forcing through a die in the same direction or opposite direction.





Extrusion



Typical use: ductile metals (Cu, Steel, Al, Mg), Plastics, Rubbers

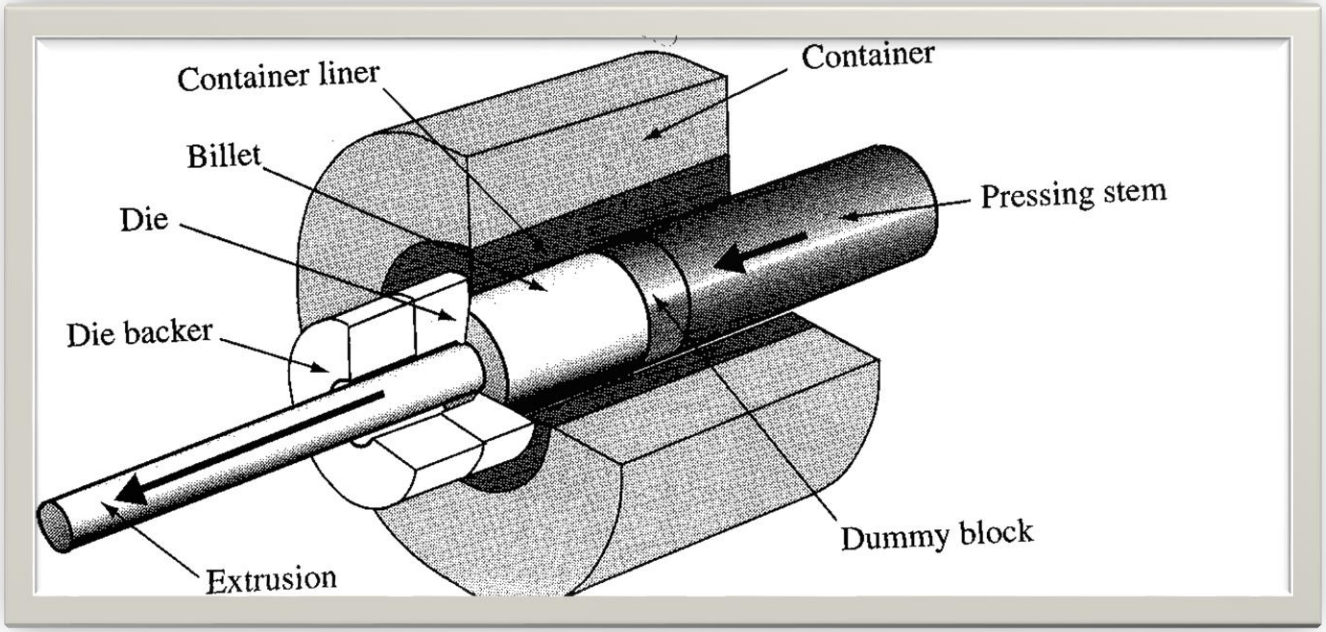
Common products:

Al frames of white-boards, doors, windows, …

The cross-sections that can be produced vary from solid round, rectangular, to L shapes, T shapes.

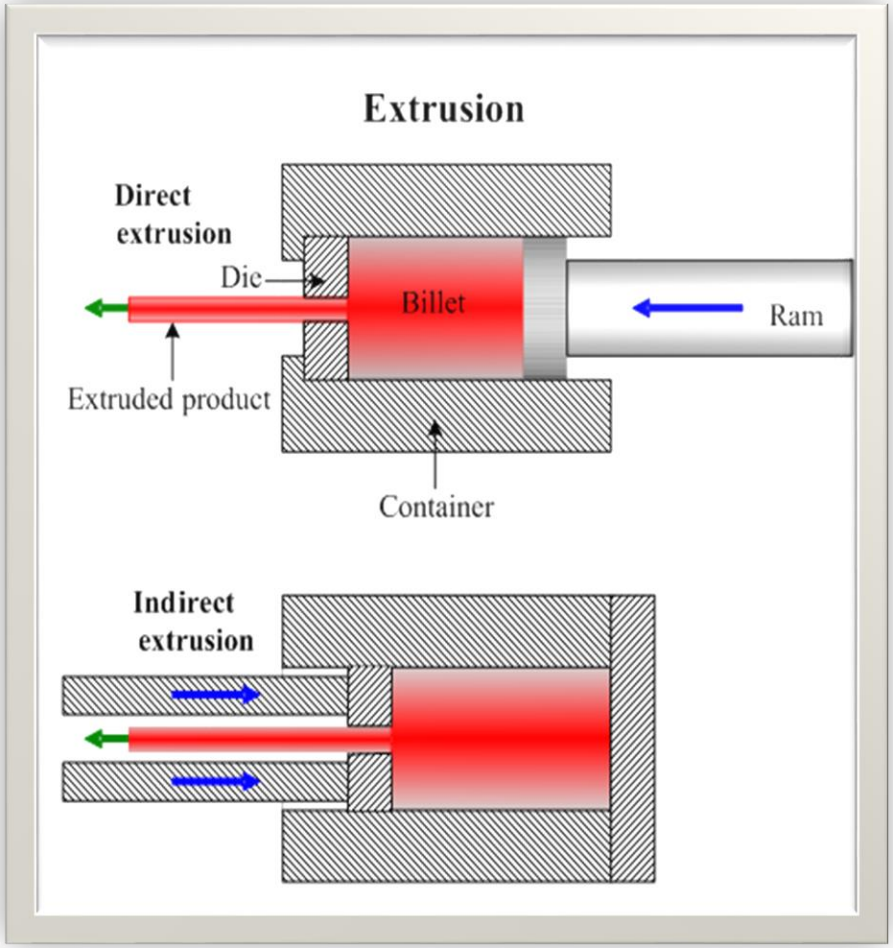
Extrusion may be continuous (theoretically producing indefinitely long material) or semi-continuous (producing many pieces). Extrusions can be done with the material hot or cold.

Commonly extruded materials include metals, polymers, ceramics, and foodstuffs.

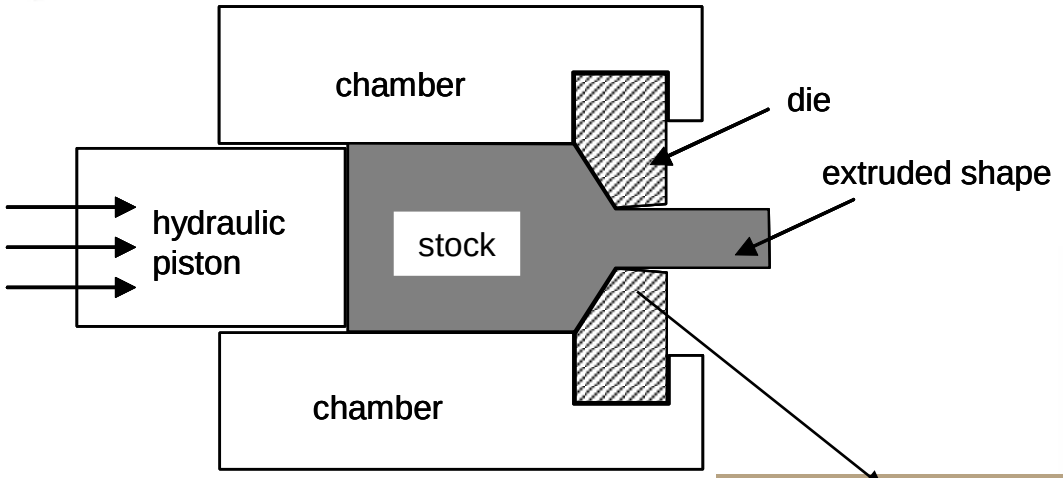


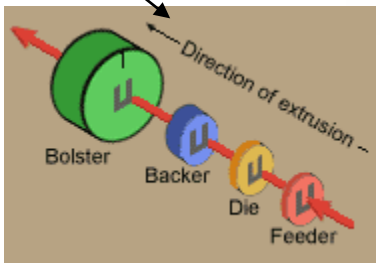
Direct extrusion: A metal billet is located into a container, and a ram compresses the material, forcing it to flow through one or more openings in a die at the opposite end of the container.

Indirect extrusion: The die is mounted to the ram rather than at the opposite end of the container. One advantage of the indirect extrusion process is that there is no friction, during the process, between the billet and the container liner.



Extrusion: Schematic, Dies

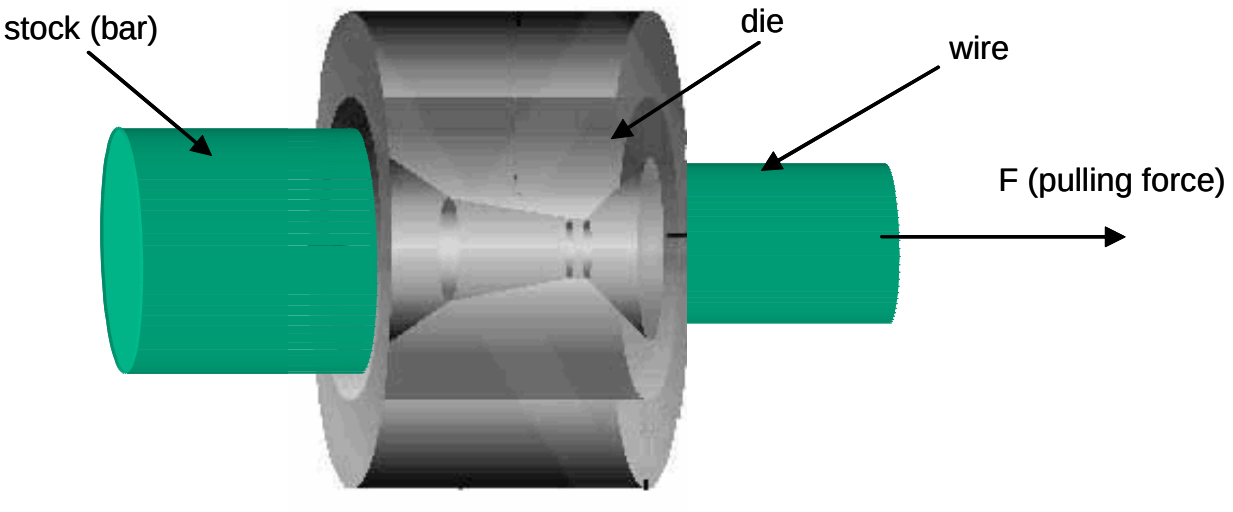




Exercise: how can we get hollow parts?

Drawing

Similar to extrusion, except: ***pulling force*** is applied

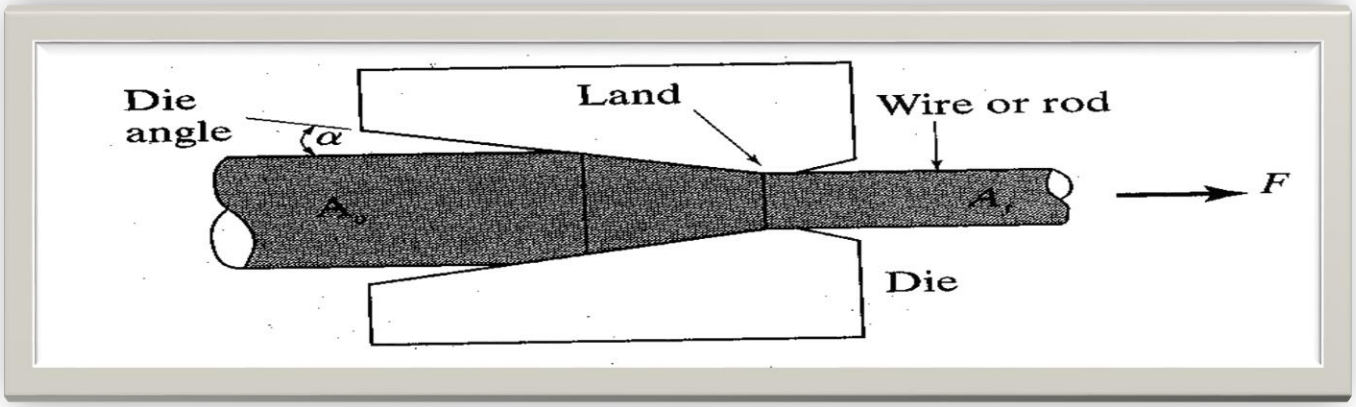


Commonly used to make wires from round bars

WHAT is DRAWING?

Drawing is an operation in which the cross-section of solid rod, wire or tubing is reduced or changed in shape by pulling it through a die.

The principle of this procedure consist of reducing the thickness of a pointed ,tapered wire by drawing it through a conical opening in a tool made of a hard material.The wire will take shape of the hole.
Drawing improves strength and hardness when these properties are to be developed by cold work and not by subsequent heat treatment.
This process is widely used for the production of thicker walled seamless tubes and cylinders therefore; shafts, spindles, and small pistons and as the raw material for fasteners such as rivets, bolts, screws.



SHEET METAL WORKING

SHEET METALWORKING

1. Cutting Operations
2. Bending Operations
3. Drawing
4. Sheet Metal Operations Not Performed on Presses

Sheet Metalworking Defined

- Cutting and forming operations performed on relatively thin sheets of metal
- Thickness of sheet metal = 0.4 mm (1/64 in) to 6 mm (1/4 in)
- Thickness of plate stock > 6 mm
- Operations usually performed as cold working

Metals used for sheets

There are many different metals that can be made into sheet metal, such as aluminum, brass, copper, steel, tin, nickel and titanium. For decorative uses, important sheet metals include silver, gold, and platinum (platinum sheet metal is also utilized as a catalyst.)

Steel (American Wire Gauge in inch)

Gauge	Thickness
28	0.015”
26	0.018”
24	0.024”
22	0.030”
20	0.036”
18	0.048”
16	0.060”
14	0.075”
12	0.105
11	0.120”
10	0.134”
8	0.160”
7	0.1874”

Aluminium (AWG in inch)

Gauge	Thickness
22	025”
20	0.032”
18	0.040”
16	0.050”
14	0.063”
12	0.080”
11	0.090”
10	0.100”
	0.125”
	0.160”
	0.190”

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

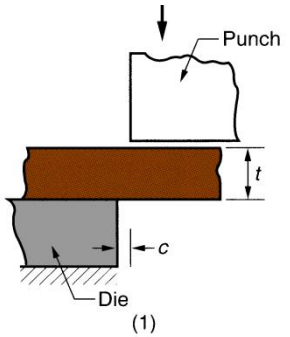
- High strength
- Good dimensional accuracy
- Good surface finish
- Relatively low cost
- For large quantities, economical mass production operations are available

Sheet Metalworking Terminology

1. "Punch-and-die"
   Tooling to perform cutting, bending, and drawing
2. "Stamping press"
   Machine tool that performs most sheet metal operations
3. "Stampings"
   Sheet metal products

Three Major Categories of Sheet Metal Processes

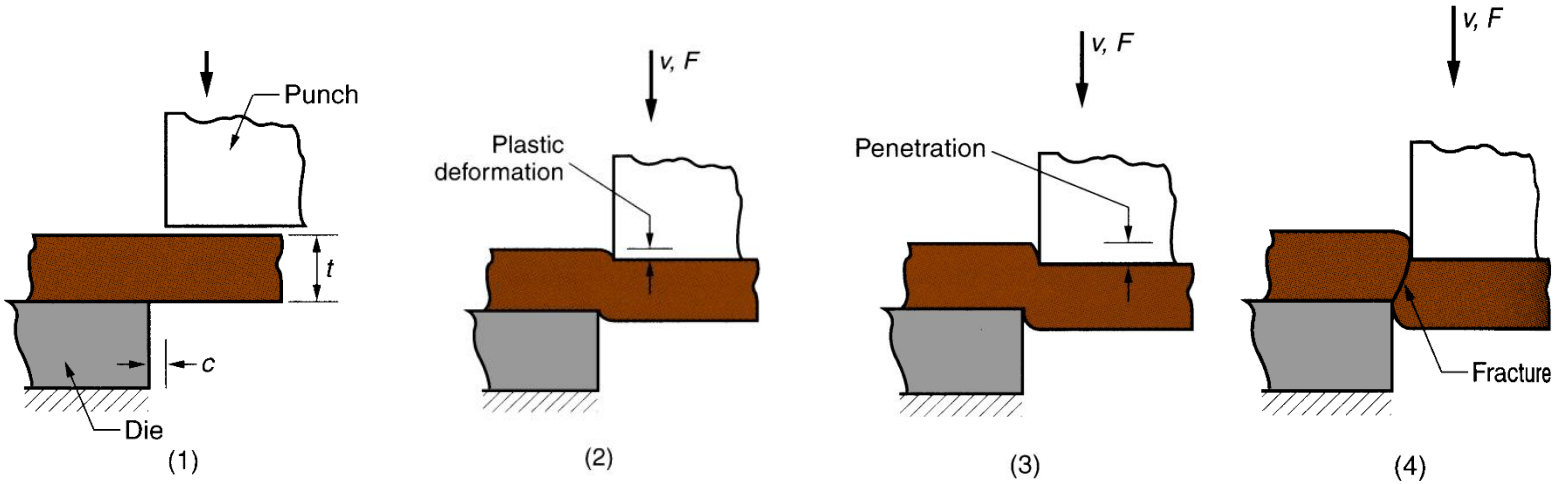
1. Cutting
   - Shearing to separate large sheets; or cut part perimeters or make holes in sheets



2. Bending
   - Straining sheet around a straight axis

3. Drawing
   - Forming of sheet into convex or concave shapes

Cutting



Shearing between two sharp cutting edges

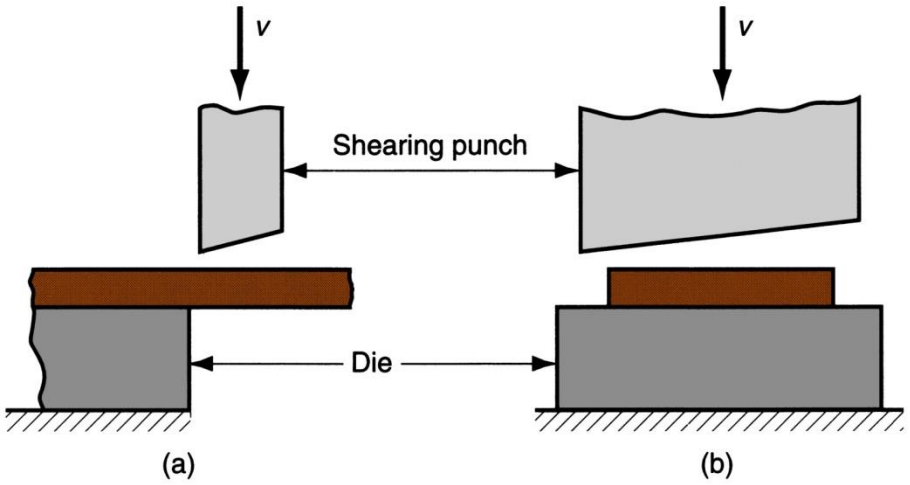
Shearing, Blanking, and Punching

Three principal operations in press working that cut sheet metal:

- Shearing
- Blanking
- Punching

Shearing

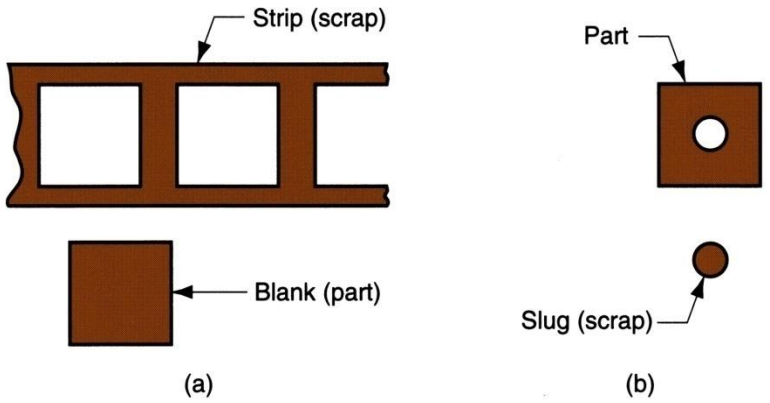
- Sheet metal cutting operation along a straight line between two cutting edges
- Typically used to cut large sheets into smaller sections for subsequent operations



Blanking and Punching

Blanking - sheet metal cutting to separate piece from surrounding stock
Cut piece is the desired part, called a *blank*

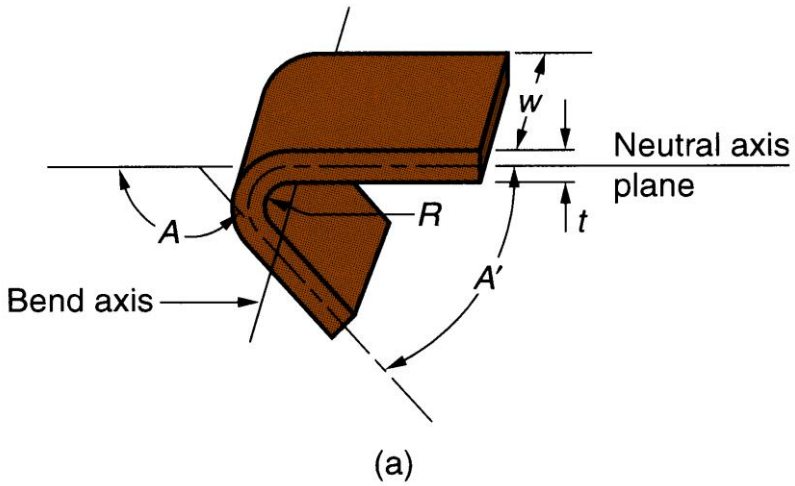
Punching - sheet metal cutting similar to blanking except cut piece is scrap, called a *slug*
Remaining stock is the desired part

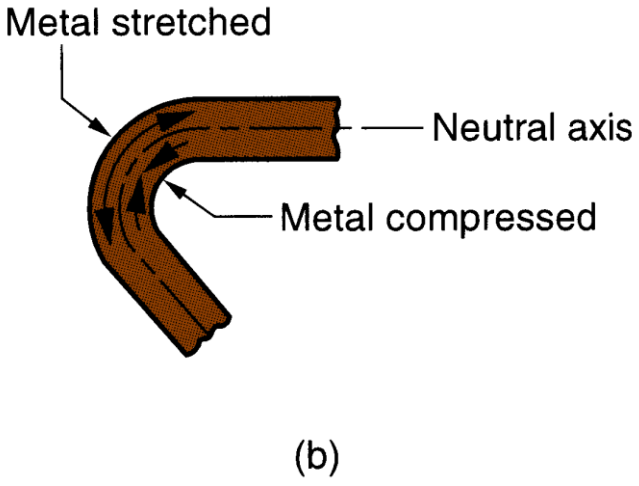


(a) Blanking and (b) punching

Bending

Straining sheetmetal around a straight axis to take a permanent bend





(a) Bending of sheet metal

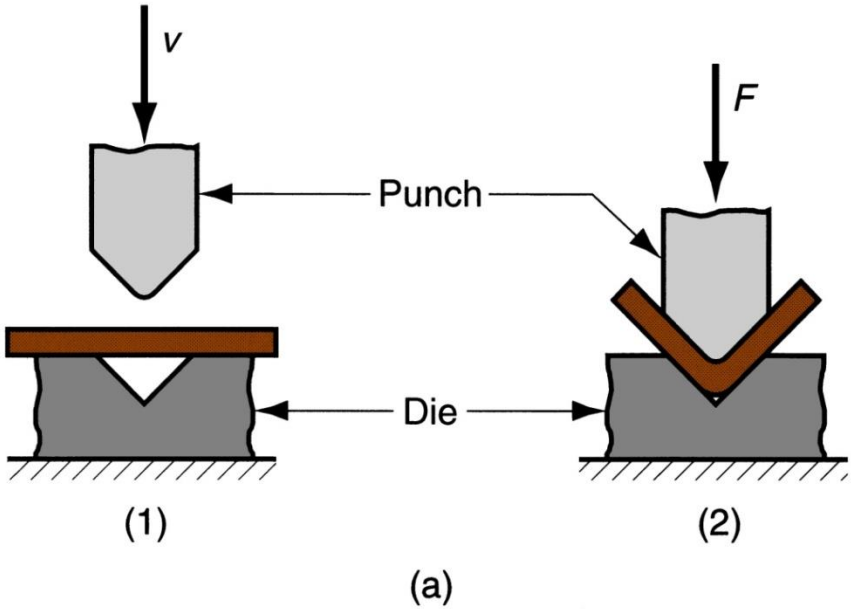
(b) both compression and tensile elongation of the metal occur in bending

Types of Sheetmetal Bending

- *V-bending* - performed with a V-shaped die
- *Edge bending* - performed with a wiping die

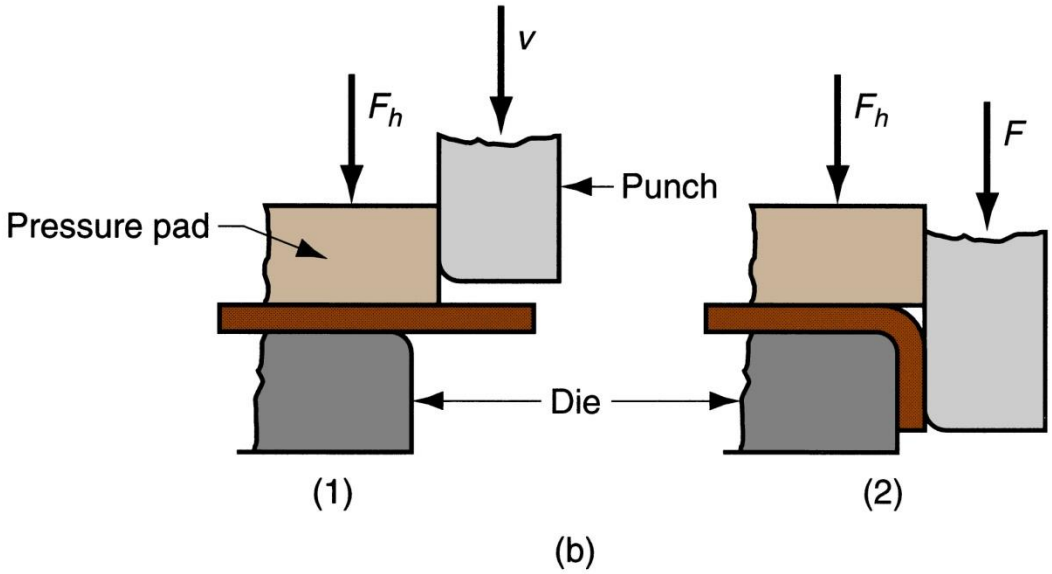
V-Bending

For low production
Performed on a *press brake*
V-dies are simple and inexpensive



Edge Bending

For high production
Pressure pad required
Dies are more complicated and costly

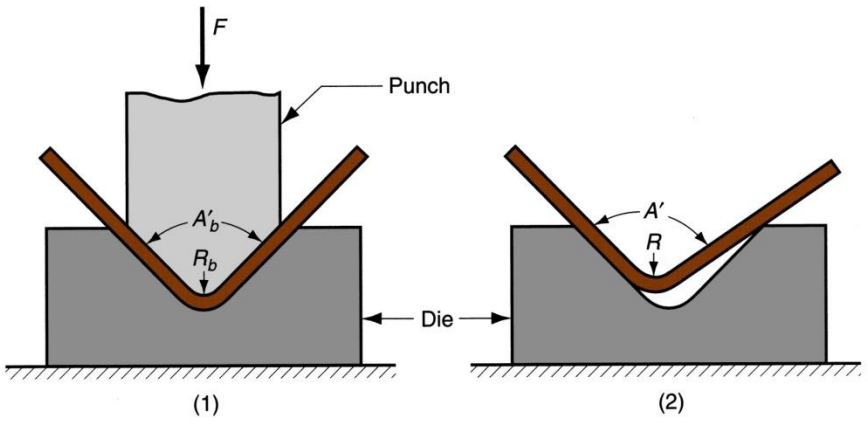


Springback in Bending

Springback = increase in included angle of bent part relative to included angle of forming tool after tool is removed

Reason for springback:

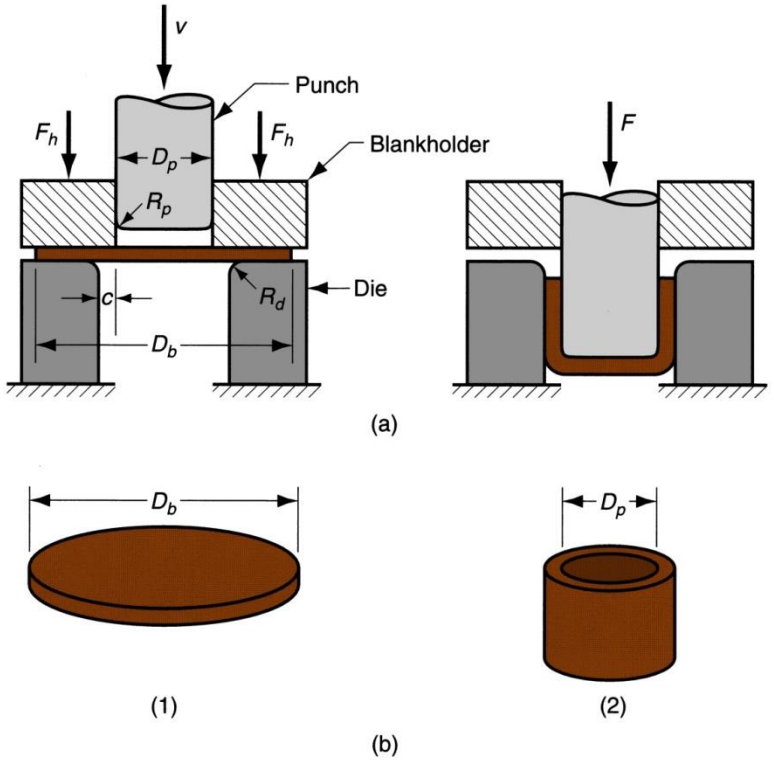
When bending pressure is removed, elastic energy remains in bent part, causing it to recover partially toward its original shape



Drawing

Sheet metal forming to make cup-shaped, box-shaped, or other complex-curved, hollow-shaped parts

Products: beverage cans, ammunition shells, automobile body panels



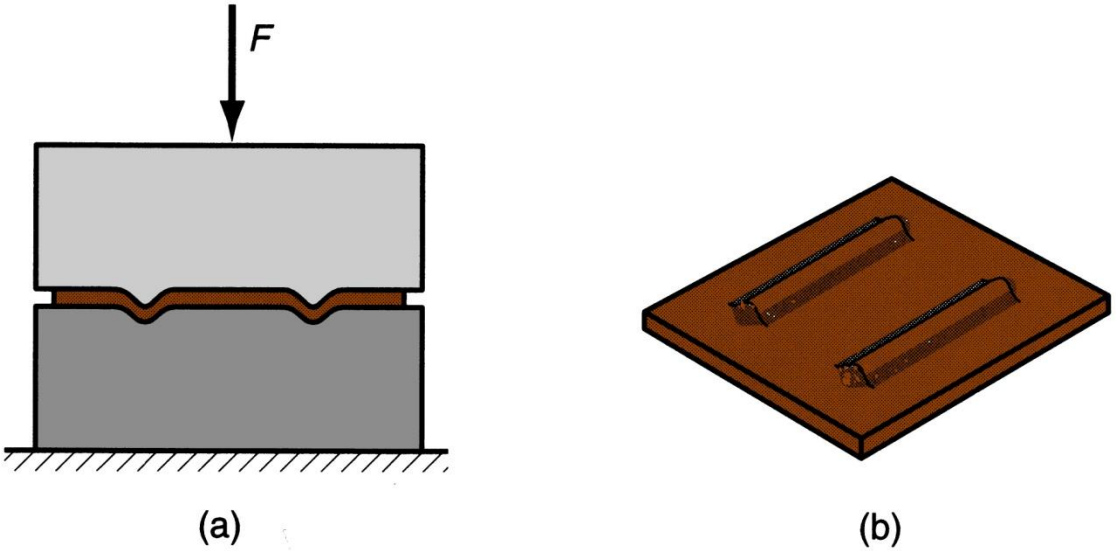
Shapes other than Cylindrical Cups

Square or rectangular boxes (as in sinks),
Stepped cups,
Cones,
Cups with spherical rather than flat bases,
Irregular curved forms (as in automobile body panels)

Each of these shapes presents its own unique technical problems in drawing

Embossing

- Used to create indentations in sheet, such as raised (or indented) lettering or strengthening ribs



Embossing: (a) cross-section of punch and die configuration during pressing; (b) finished part with embossed ribs

Power and Drive Systems

Hydraulic presses - use a large piston and cylinder to drive the ram

- Longer ram stroke than mechanical types
- Suited to deep drawing
- Slower than mechanical drives

Mechanical presses – convert rotation of motor to linear motion of ram

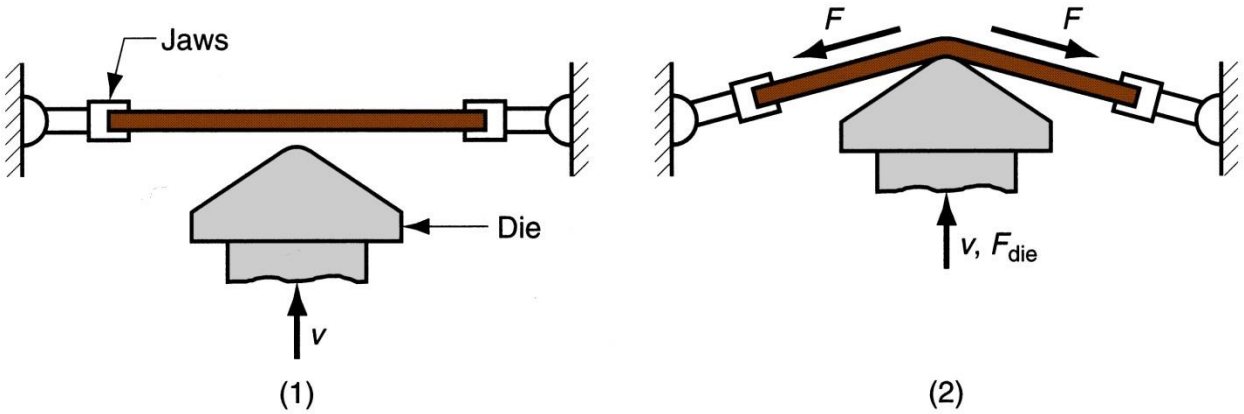
- High forces at bottom of stroke
- Suited to blanking and punching

Sheet Metal Operations Not Performed on Presses

- Stretch forming
- Spinning

Stretch Forming

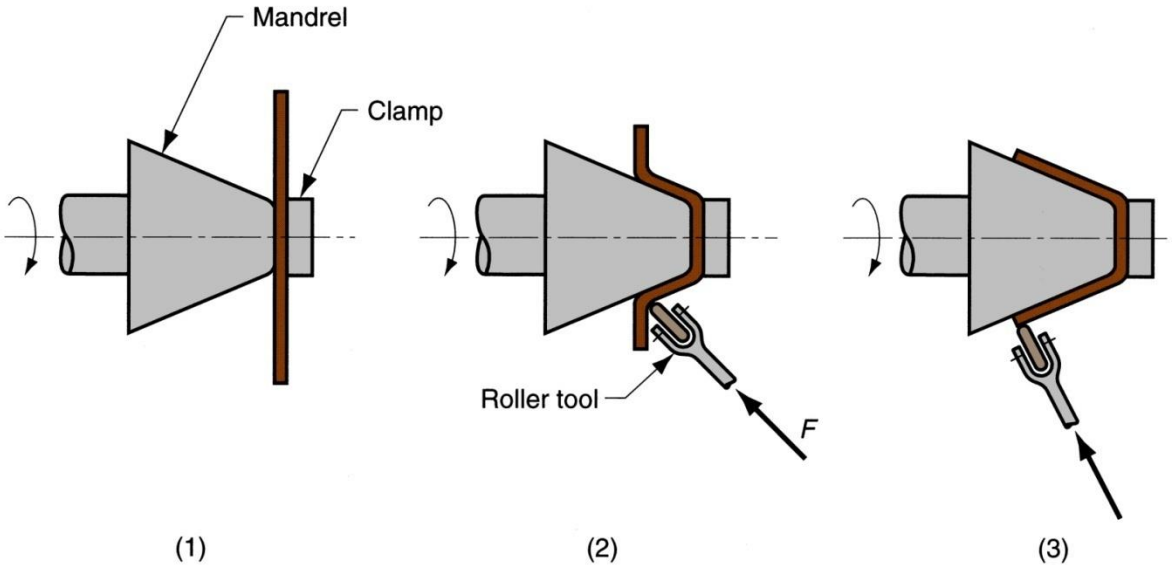
Sheet metal is stretched and simultaneously bent to achieve shape change



Stretch forming: (1) start of process; (2) form die is pressed into the work with force F_{die}, causing it to be stretched and bent over the form. F = stretching force

Spinning

Metal forming process in which an axially symmetric part is gradually shaped over a rotating mandrel using a rounded tool or roller



Conventional spinning: (1) setup at start of process; (2) during spinning; and (3) completion of process