

# Black Smithy Shop

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- "black" in "blacksmithy" refers to the black fire scale, a layer of oxides that forms on the surface of the metal during heating
- The word "smith" derives from an old word, "smite" (to hit)

# Topics to be Covered

- Introduction
- Forging materials
- Heating Devices
- Hand Tools and Appliances
- Smith Forging Operations
- Forging Process
- Defects in Forging

Black Smith or forging :work involves heating of metal stock to a desired temperature, enable it to acquire sufficient plasticity, followed by the operations like hammering, bending, pressing etc, to get desired shape and size.

*Blacksmiths produce objects such as gates, grilles, railings, light fixtures, furniture, sculpture, tools, agricultural implements, decorative and religious items, cooking utensils, and weapons.*

- **Hand forging**: done by hand tools.
- **Power Forging**: done by power hammers.
- **Drop forging**: done by drop hammers.
- **Machine forging**: done by forging machines.

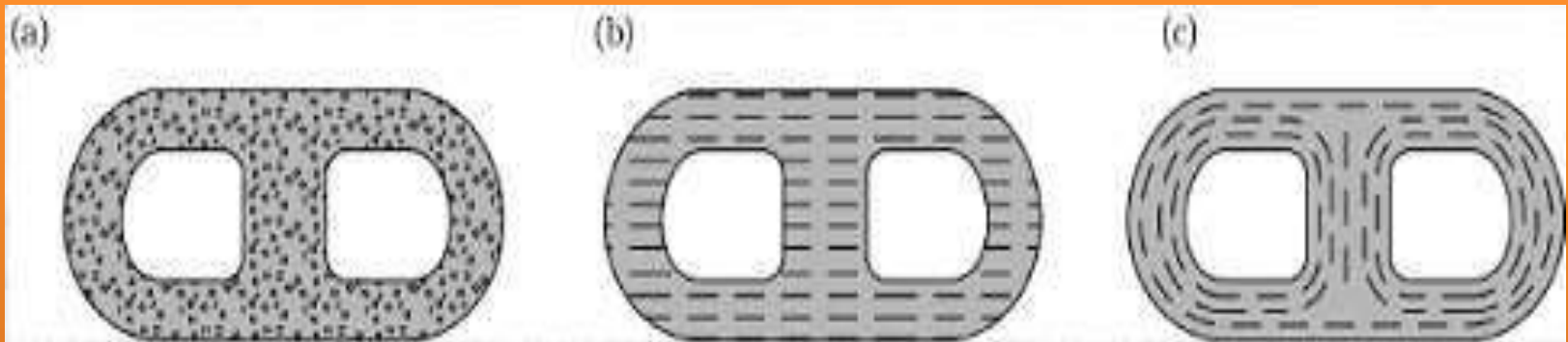
# Forging

- “Forging is defined as the controlled plastic deformation of metal into predetermined shapes by pressure or impact blows, or combination of both.”
- “Forgeability is the relative ability of a material to deform under a compressive load without rupture.”



# Grain Structure

- Parts have good strength
- High toughness
- Forgings require additional heat treating



grain flow (a) casting (b) machining (c) forging

# Forging Materials

Any metal or alloy which can be brought into plastic stage through heating can be forged.

*Means those material which have ductile or malleable property.*

Like wrought iron,  
carbon steel,  
stainless steel,  
copper based alloys, nickel-copper alloys,  
magnesium alloys etc.

# Forging Materials

1. Aluminium alloys
2. Magnesium alloys
3. Copper alloys
4. Low carbon alloy steel
5. Stainless steel
6. Nickel alloys
7. Titanium alloys
8. Iron based super alloys
9. Cobalt based super alloys
10. Tantalum alloys
11. Tungsten alloys
12. Beryllium



# Forging Process

## 1. Open Die Forging

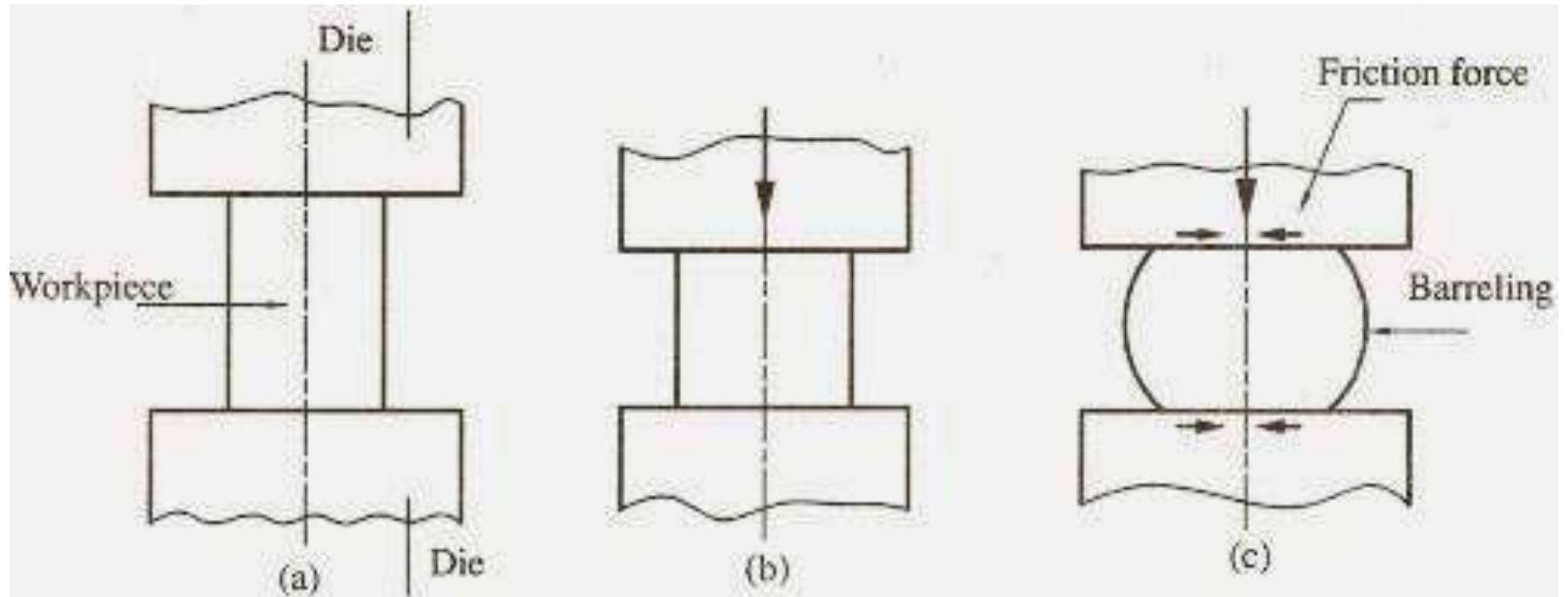


Fig. 4-2 (a) Solid cylindrical billet upset between two flat dies (b) Uniform deformation of the billet without friction (c) Deformation with friction

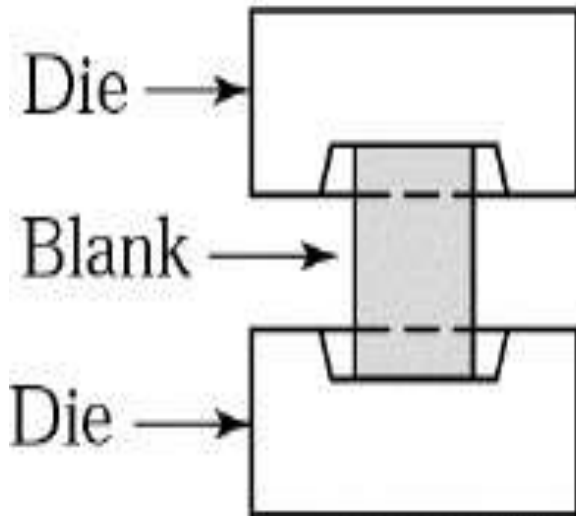
# TYPES OF OPEN DIE FORGING

- ***Hand forging:*** Hand forging is done by hammering the piece of metal, when it is heated to the proper temperature, on an anvil.
- ***Power forging***
  - ***Power Hammer:*** All power hammers employ the same general principle of operation, a falling weight striking the blow, with the entire energy being absorbed by the work.
  - ***Power Press:*** It is a machine tool which changes the shape of workpiece by using pressure rather than blow in previous case.

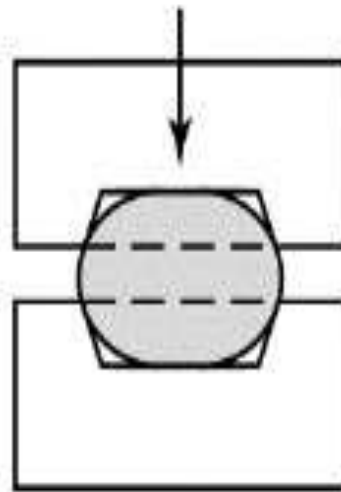
# Forging Process

## 2. *Impression Die Forging*

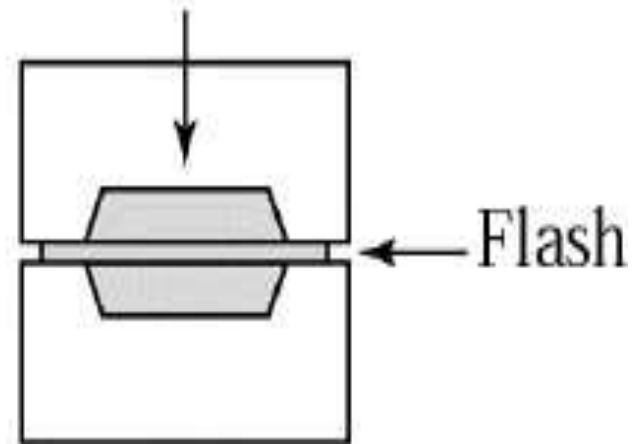
(a)



(b)

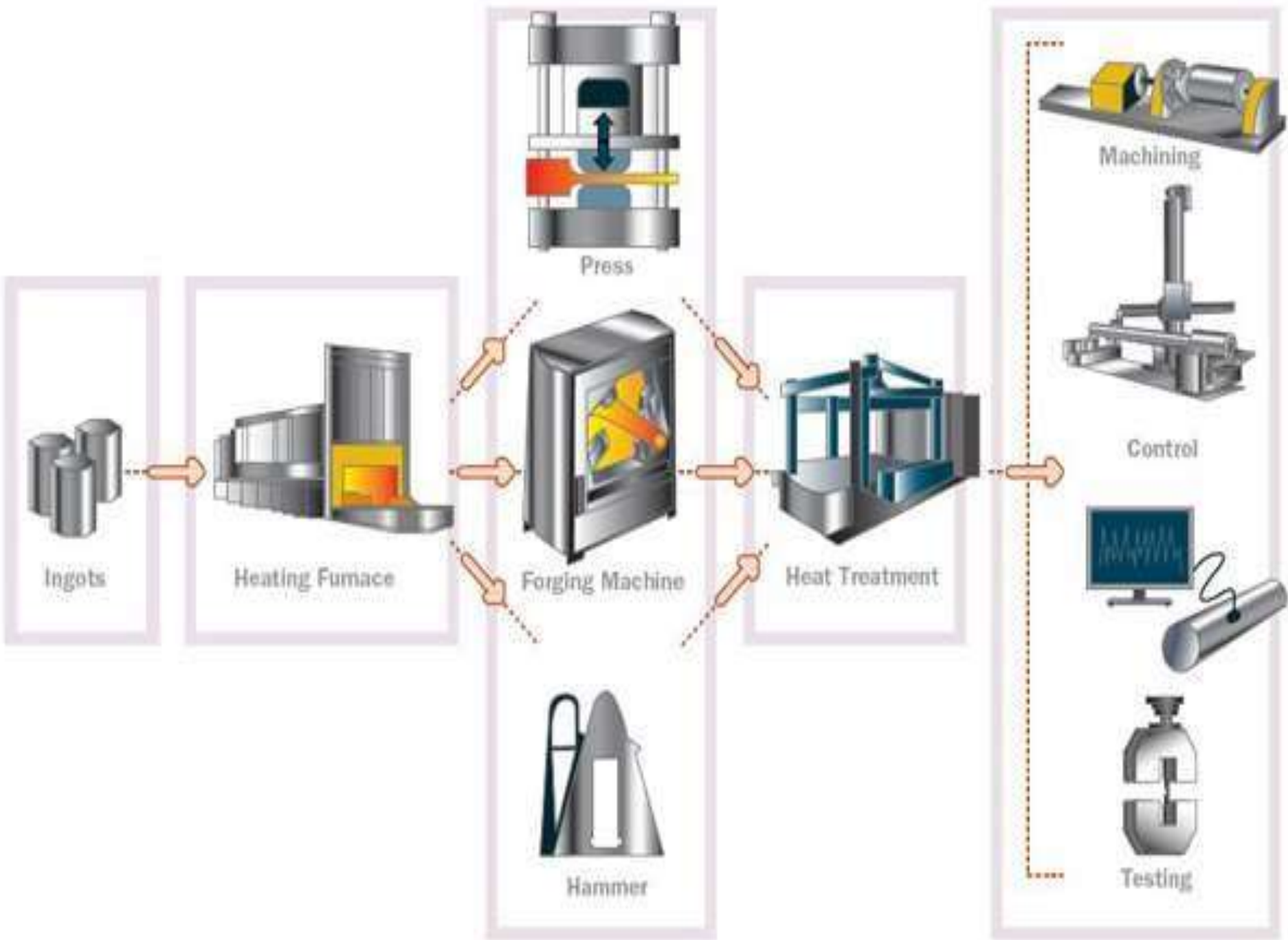


(c)



# TYPES OF IMPRESSION DIE FORGING

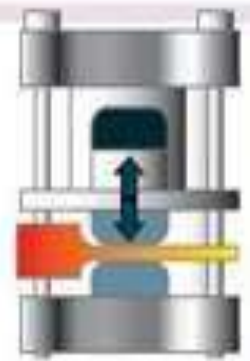
- ***Drop forging:*** It is done with help of three types of drop hammers. They are gravity hammer, air lift hammer and power drop or steam hammer.
- ***Press forging:*** It is done in presses rather than with hammers. The action is relatively slow squeezing instead of delivering heavy blows
- ***Machine forging:*** It consists of applying lengthwise pressure to a hot bar held between grooved dies to enlarge some section, usually the end.



Ingots



Heating Furnace



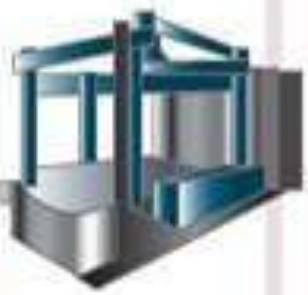
Press



Forging Machine



Hammer



Heat Treatment



Machining



Control



Testing



# Drop forging

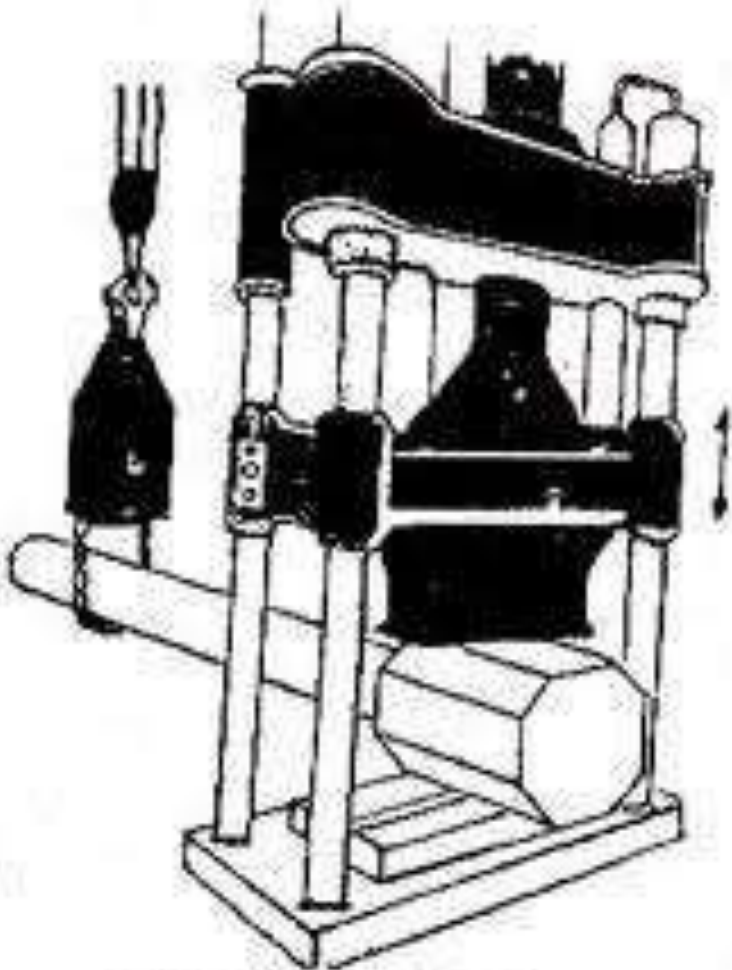
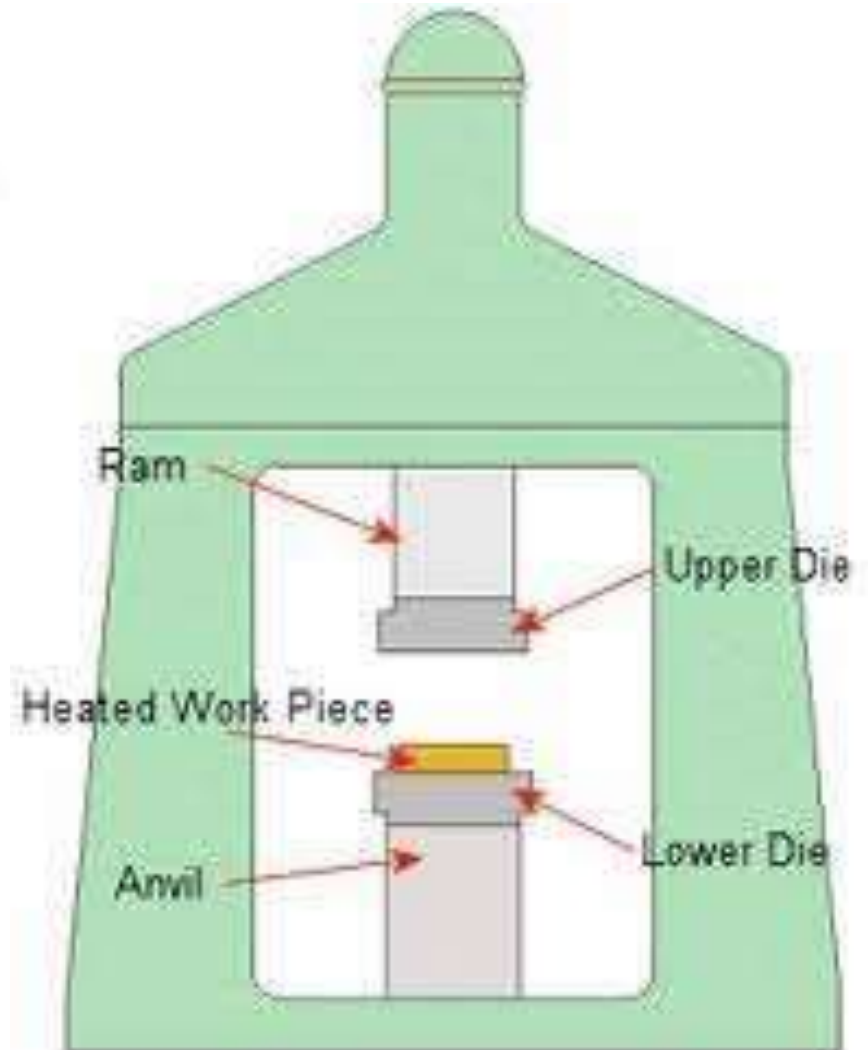
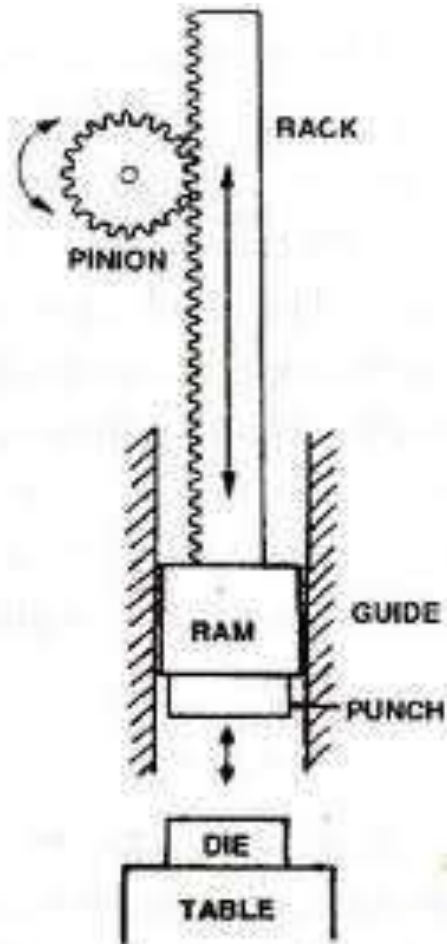


Fig 5.47 Drop Forging

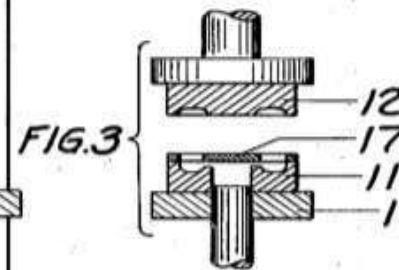
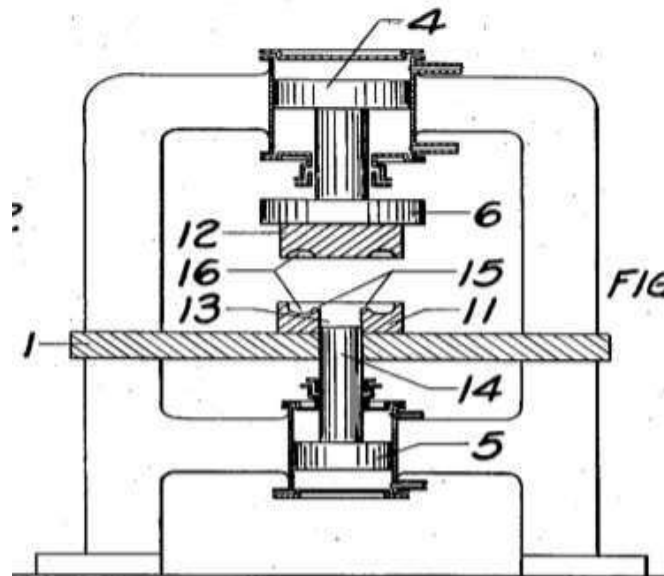
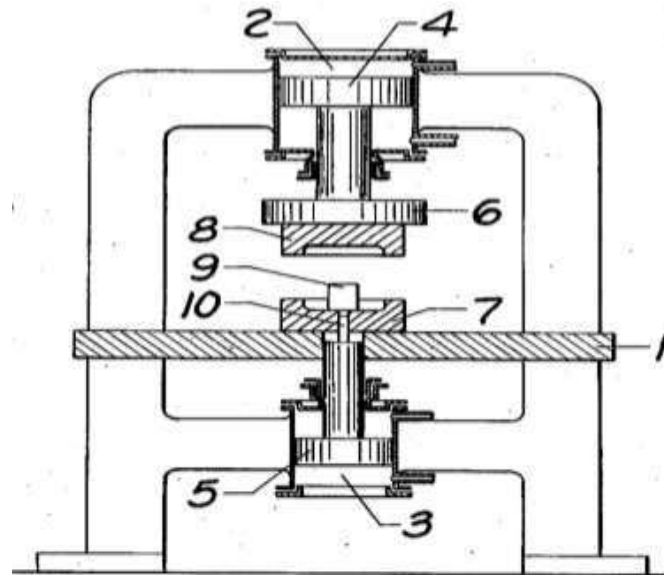


# *Press forging*



**Fig. 5.48 Press Forging**

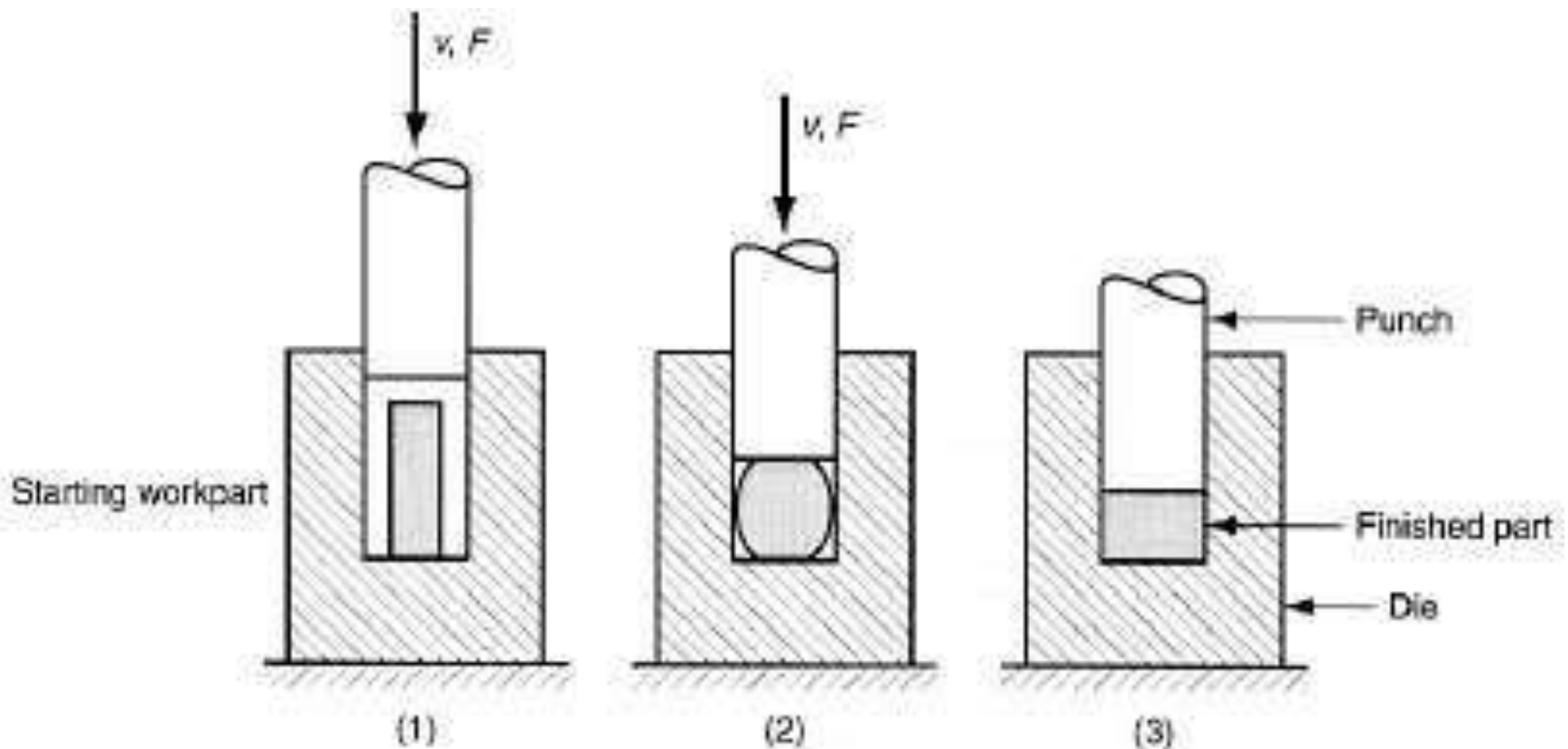
# Machine forging





# Forging Process

## 3. *Flashless / Closed Forging*



# Advantages of *Forging Processes*

Following are some of the major advantages of *forging processes*.

- (1) It improves the structure as well as mechanical properties of the metallic parts.
- (2) Forging facilitates orientation of grains in a desired direction to improve the mechanical properties.
- (3) Forged parts are consistent in shape with the minimum presence of voids and porosities.
- (4) Forging can produce parts with high strength to weight ratio.
- (5) Forging processes are very economical for moderate to high volume productions.

# Heating Devices

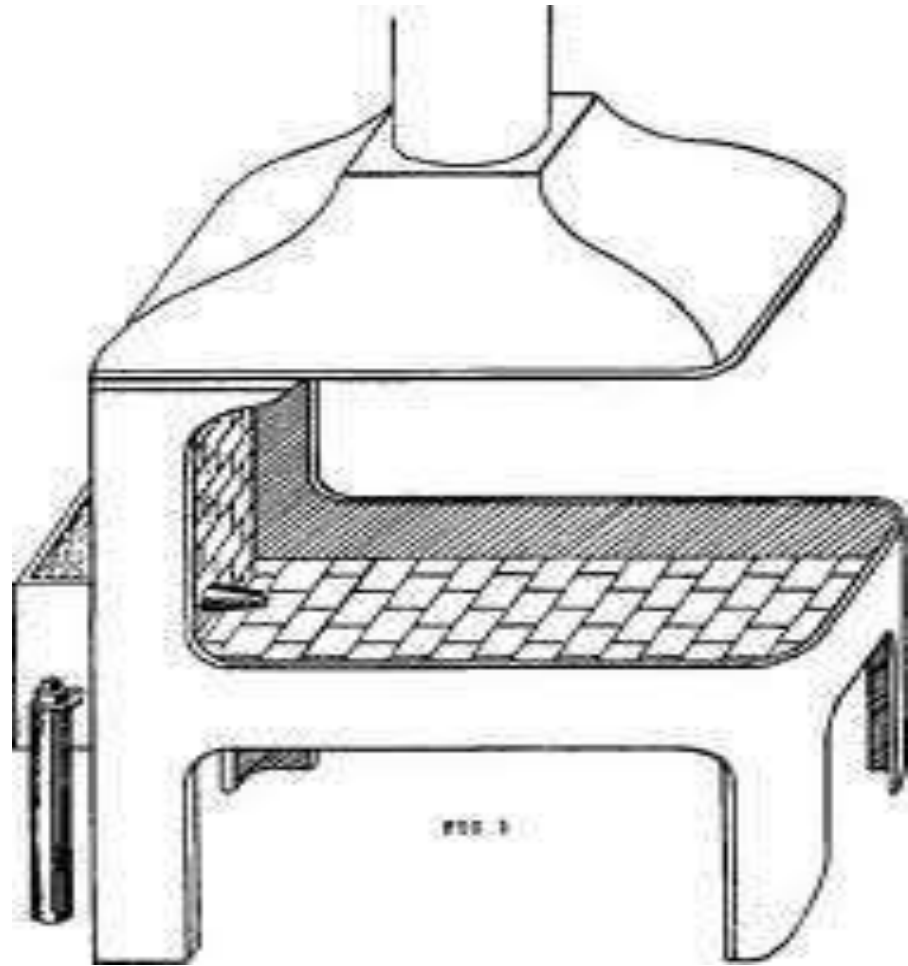
1. Smith's Hearth

2. Furnace

- (i) Box or Batch Type Furnace
- (ii) Continuous Type furnace
- (iii) Slot type furnace
- (iv) Rotary Hearth furnace
- (v) Induction Furnace
- (vi) Resistance Furnace

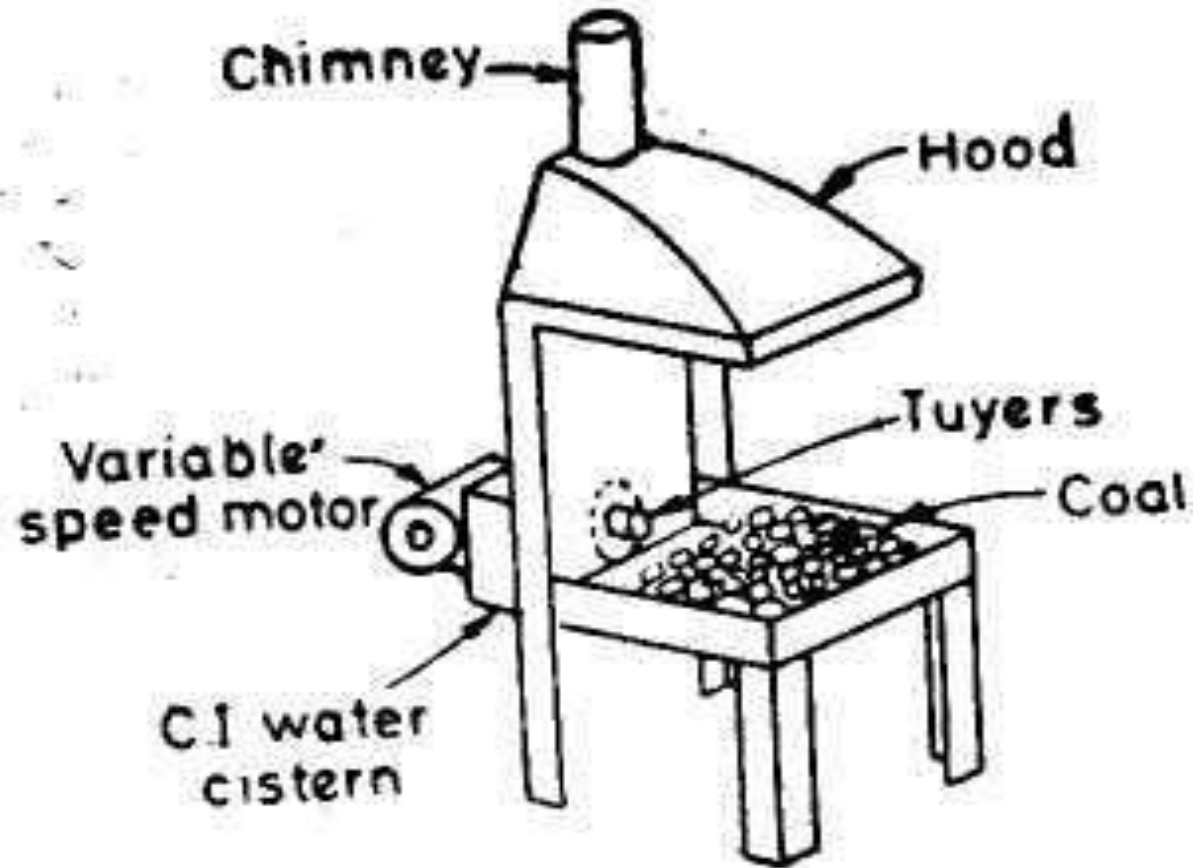
# ***Black Smith Forge Hearth***

- Hearth
- Tuyere (nozzle)
- Hood
- Water Tank
- Blower
- Chimney



# HEATING DEVICES

## FORGE:



(a) Hearth.

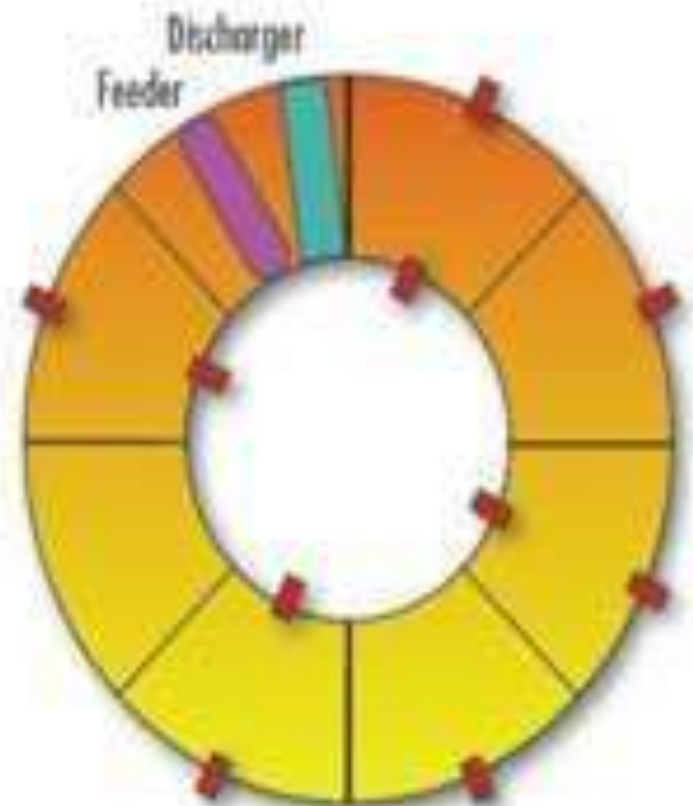
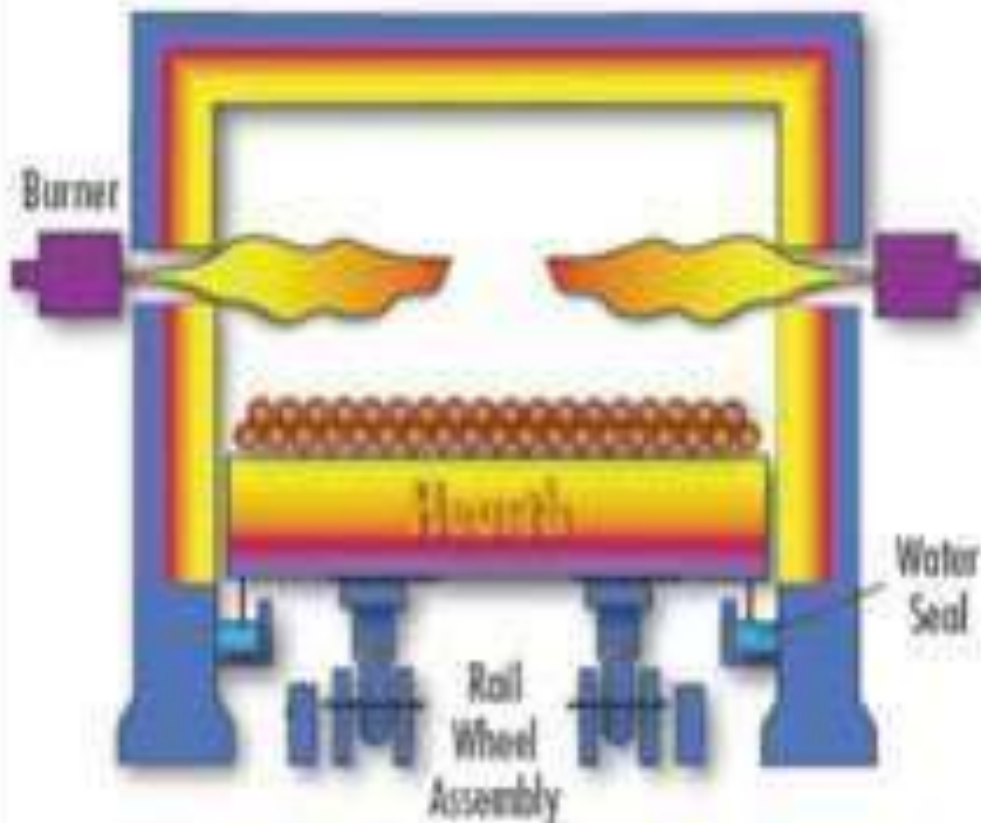
# Types of Furnaces

- **Box / Batch Type Furnace:** this type of furnace is used for heating small and medium size stock because they are least expensive. These furnaces are usually constructed of a rectangular steel frame lined with insulating and refractory bricks.
- **Rotary Hearth Furnace:** These are doughnut shaped and are set to rotate so that the stock is heated to the correct temperature during one rotation. These are heated by gas or oil.

# Box / Batch Type Furnace

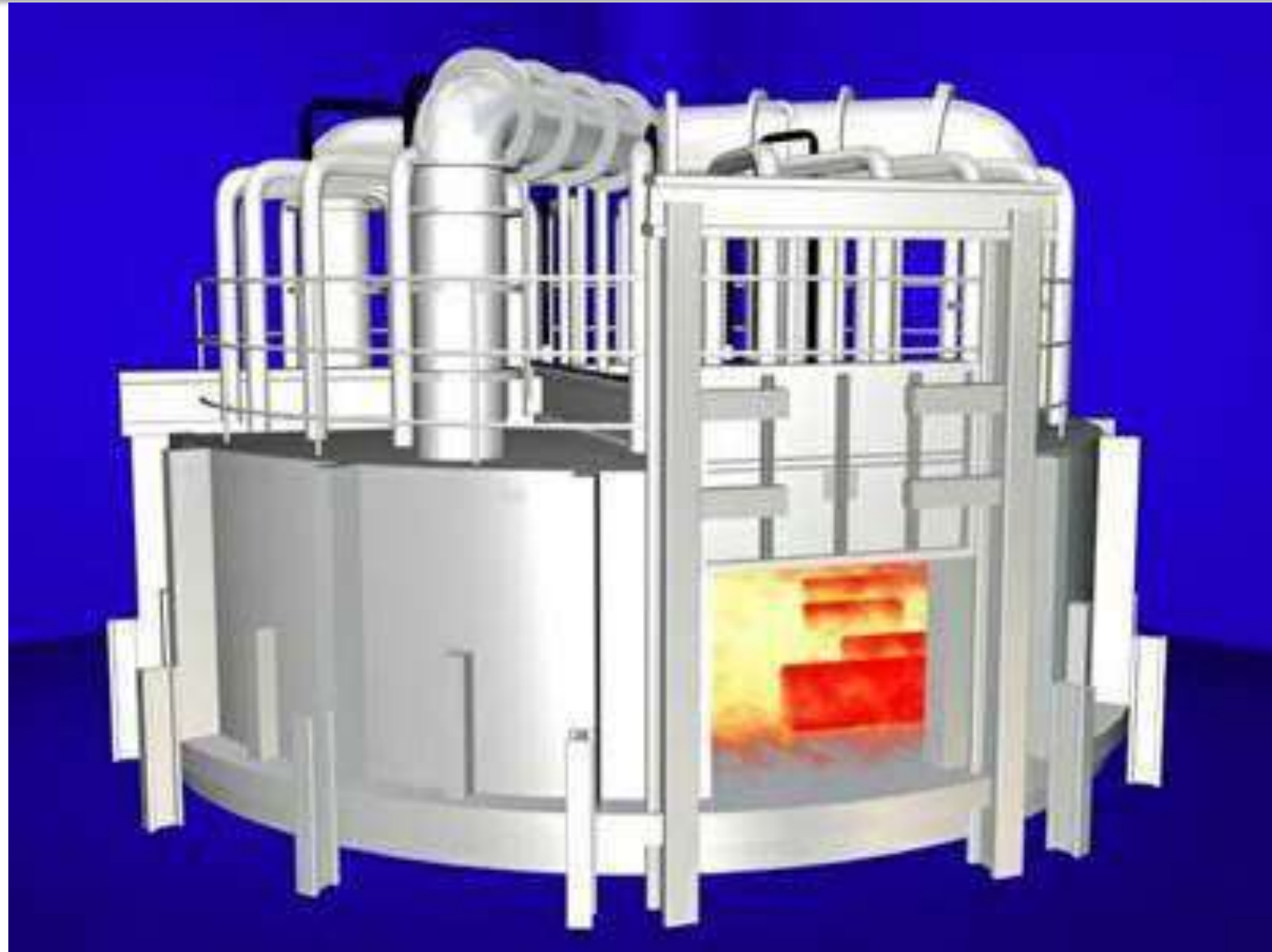


# Rotary Hearth Furnace





# Rotary Hearth Furnace



# Types of Furnaces

- **Continuous/ Conveyor Furnace:** They are generally used to heat one end of the larger workpiece. They had an air or oil operated cylinder to push stock end to end through a narrow furnace.
- **Induction Furnace:** In induction furnace the stocks are passed through induction coils in the furnace. An induction furnace greatly reduces scale formation due to oxidation.
- **Resistance Furnace:** These furnaces are faster than induction furnace and are often automated. In this furnace the stock is connected into the circuit of step down transformer and is heated due to resistance in circuit.

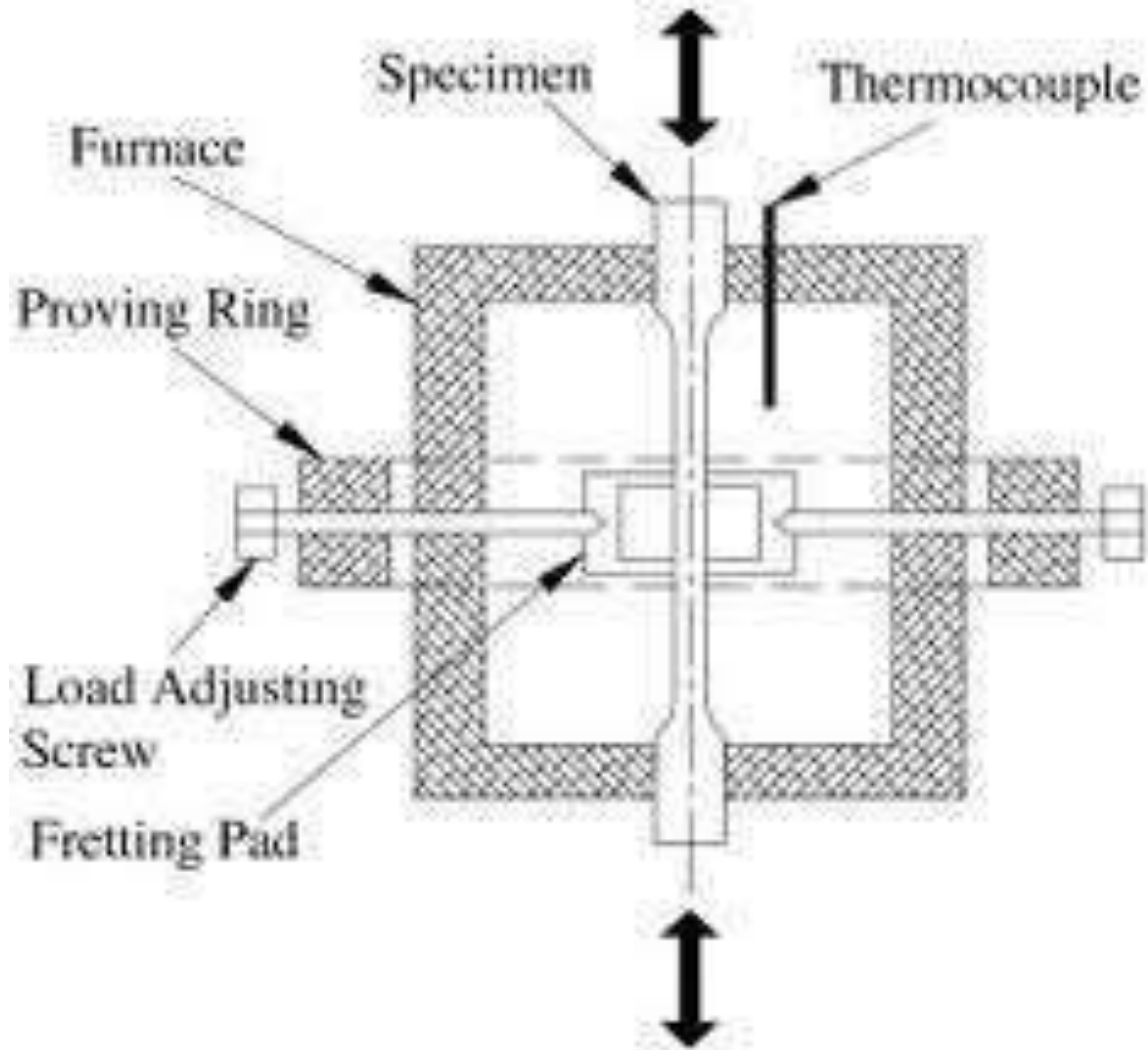
# Continuous/ Conveyor Furnace



# Induction Furnace



# Resistance Furnace



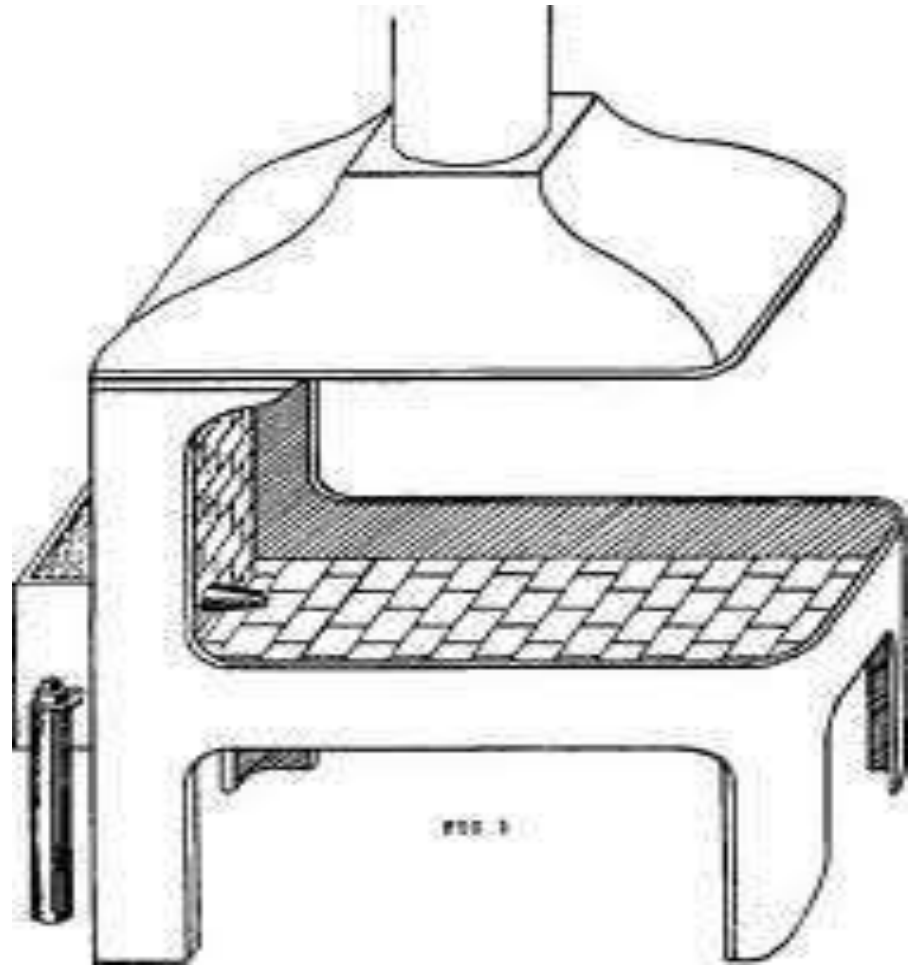
- Heating: Hearth or in Furnace
- Holding: Tongs
- Beating : by Hammers over Anvil
- Portable tools: Fullers, Chisels, Swages etc

# Tools and Equipments required for Hand Forging

- *Black Smith Forge Hearth*
- *Anvil*
- *Swage Block*
- *Hammers*
- *Tongs*
- *Chisels*
- *Punches*
- *Drifts*
- *Fullers*
- *Swages*
- *Flatters*
- *Set Hammers*

# ***Black Smith Forge Hearth***

- Hearth
- Tuyere (nozzle)
- Hood
- Water Tank
- Blower
- Chimney





# Anvil

**The London Anvil** (*Peter Wright, 100 lbs.*)

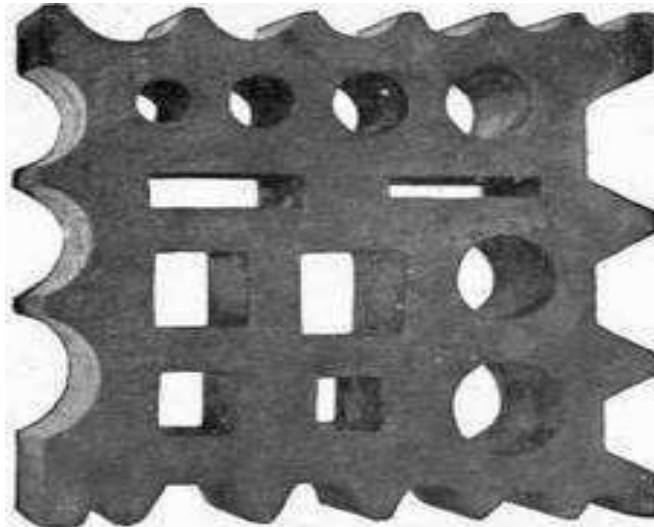


Information Source: Alex W. Boner, *The Art of Blacksmithing*

# ***Swage Block***

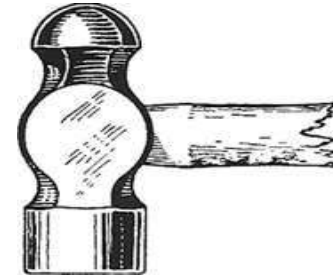
*( made of cast iron or cast Steel)*

- It carrying a number of slots of different shapes and sizes along its four side faces. The job is to be given a desired shape is kept similar shaped slot.



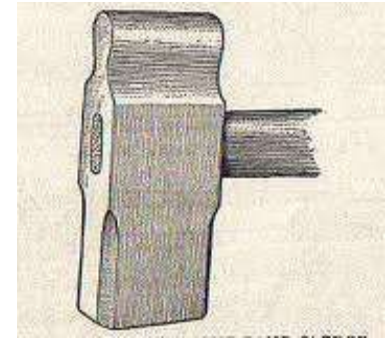
# Hammers

➤ Ball Peen Hammer



➤ Sledge Hammer

(i) straight peen sledge Hammer



(ii) Cross peen sledge Hammer



(iii) Double Faced Sledge Hammer



# Tongs

*Tongs are used for holding and turning hot metal pieces. Depending upon their use tongs are classified as below*

- Square Hollow tong
- Pincer tong
- Close flat tong



- Chisel tong



- Pick up tong



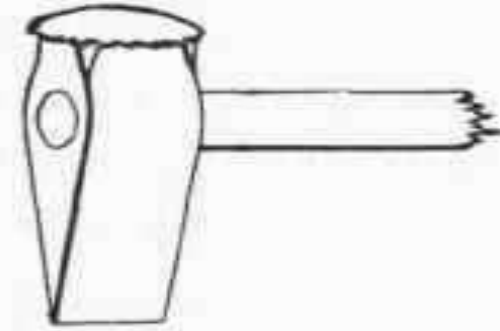
- Round hollow tong



# Chisels

*Chisels are used for cutting the metal pieces in hot and cold state.*

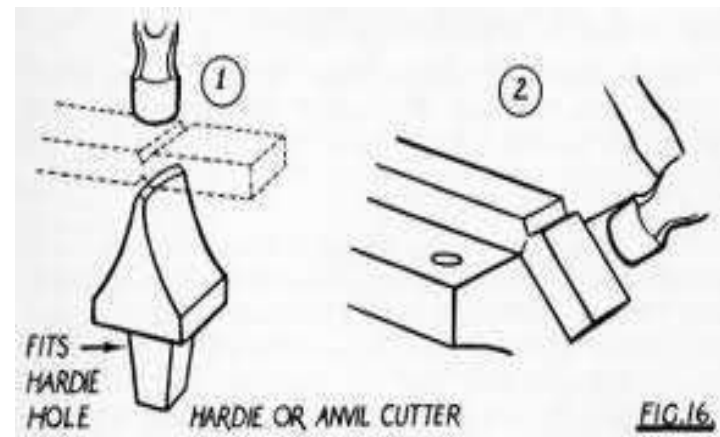
(a) Hot Chisel



(b) Cold Chisel



(c) Hardie Set



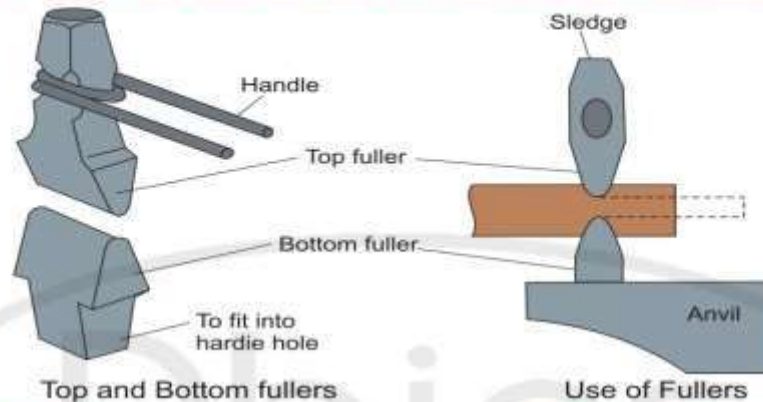
**Punches:** are made up of high carbon steel and are used for making rough holes in hot metal pieces

**Drift:** is a large size punch used to enlarge a hole.

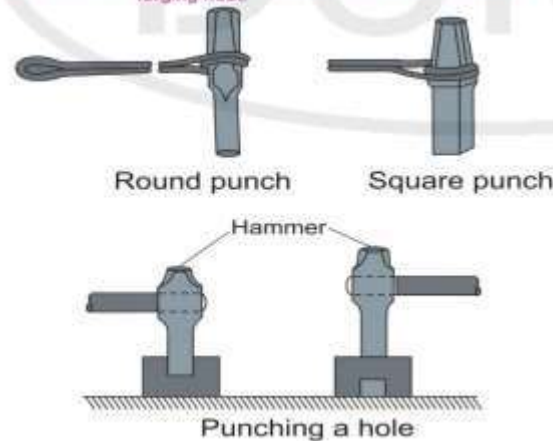
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## BLACKSMITH'S HAND TOOLS -II

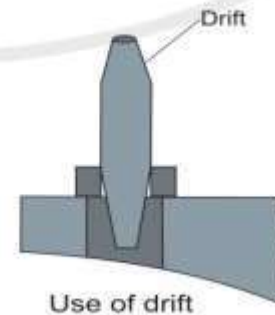
**Fullers :** Used for necking down piece of work and to reduce the metal while making shoulders.



**Punching :** Used for making holes when the metal is at forging heat.



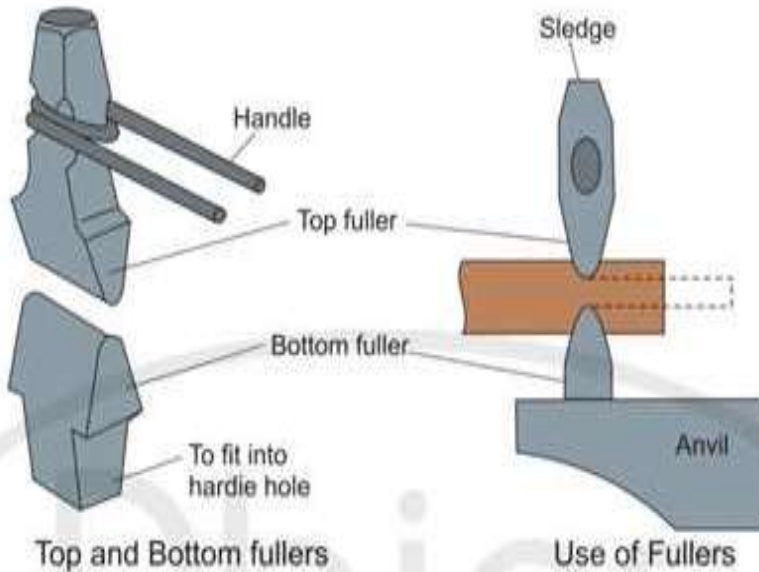
**Drift :** Used to finished the size of the punched holes.



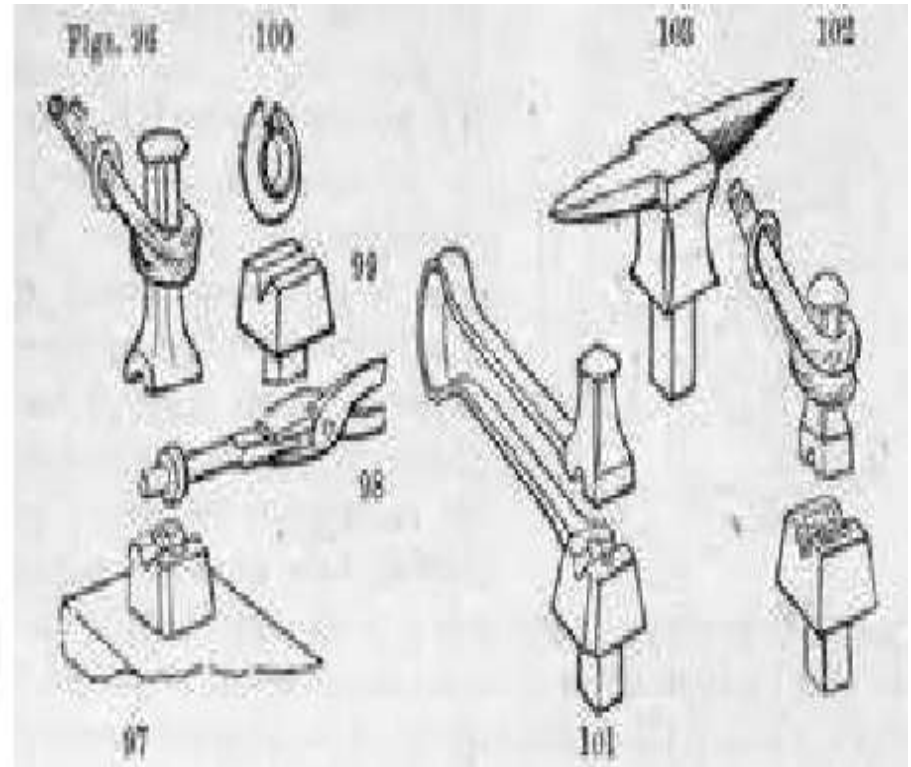
# Fullers

**Fullers are used for necking down, grooving and drawing a piece of work. These are made in two pieces (Lower and Upper). Lower piece is mounted on anvil and upper is held in and from a wire handle. These are made of high carbon steel and medium carbon steel. These are used for hot work only.**

Fullers : Used for necking down piece of work and to reduce the metal while making shoulders.



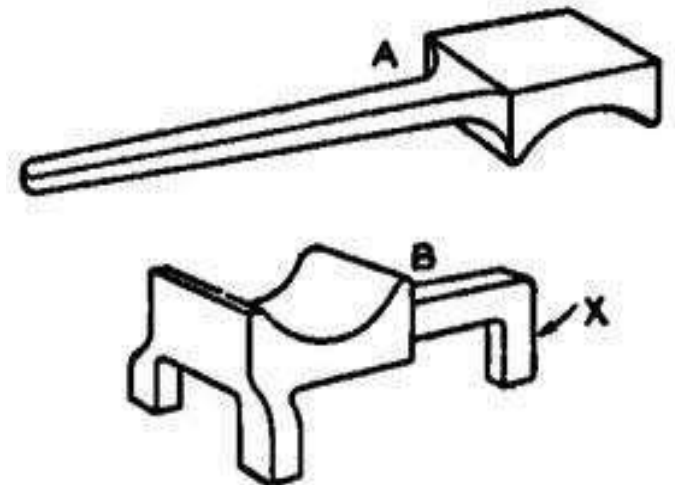
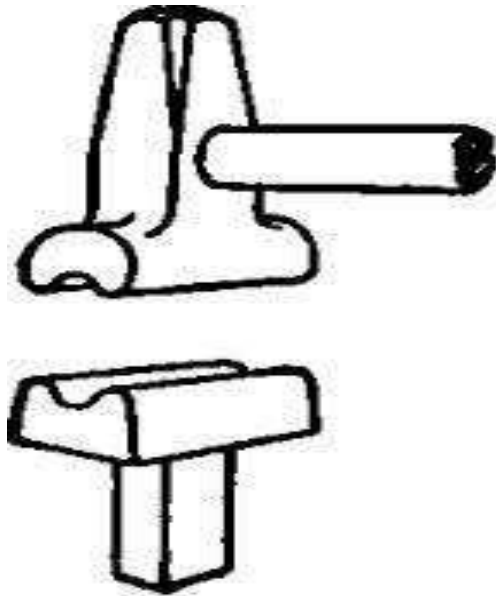
Drift : Used to finished the size of the punched holes.



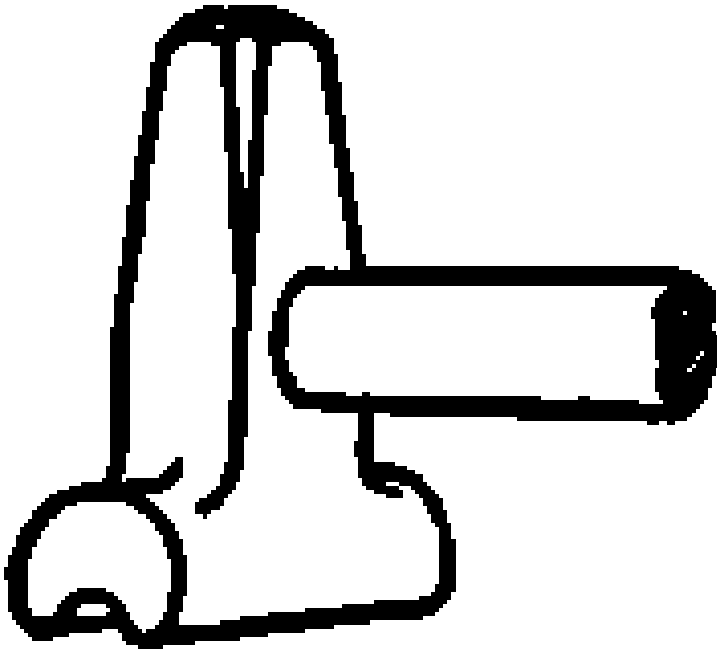


# Swages

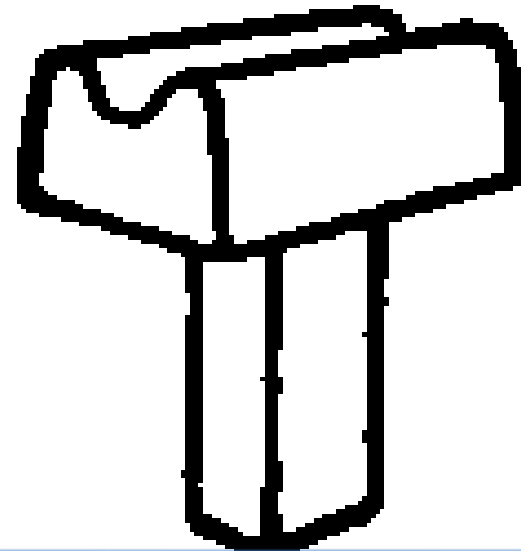
swages are used for increasing the length of a circular rod or for finishing the circular surface of job after forging. Swages are made of high carbon steel in two parts called top and bottom swage. Their working faces carry circular grooves to suit the size of work



# SWAGES



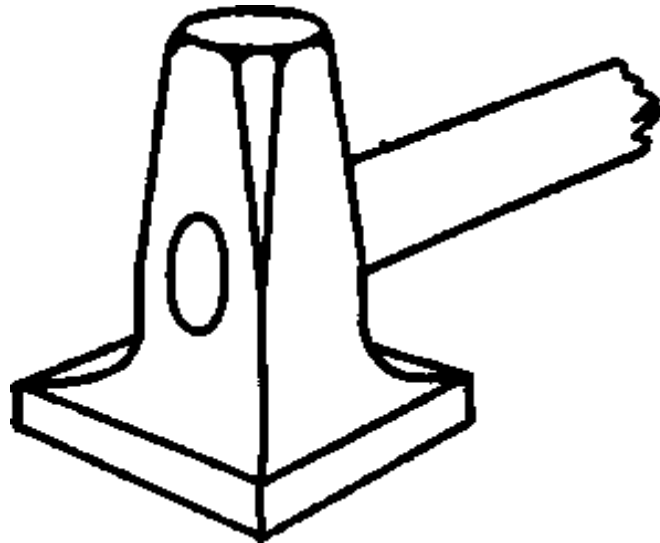
A) Top Swage



B) Bottom Swage

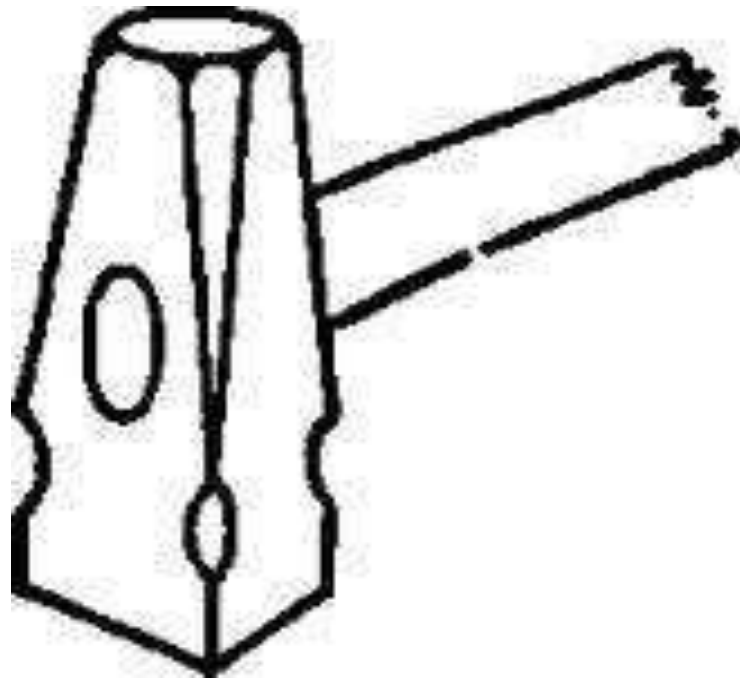
# Flatters or Smoothers

Flatters are used for levelling and finishing a flat surface after drawing out or any other forging operation. They are made of high carbon steel and consist of a square body, fitted with a handle and a flat square bottom (face).



# Set Hammers

it is used for the finishing the corners, formed by two adjacent surfaces at right angles. The job is supported on the anvil and tool is hammered from the top.



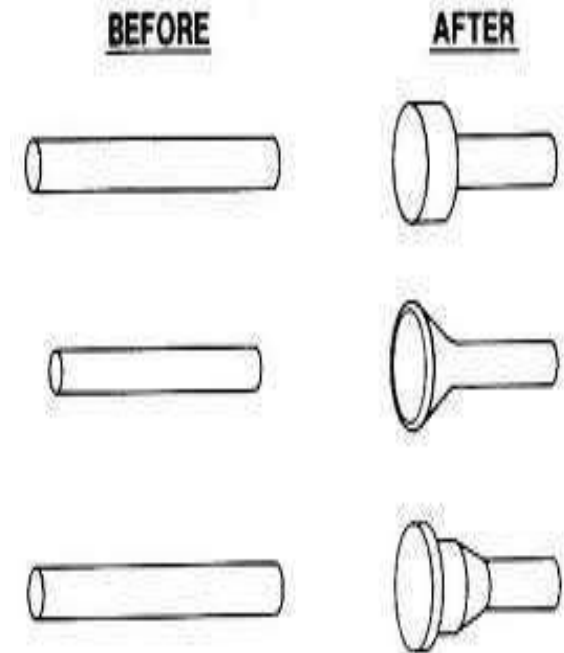
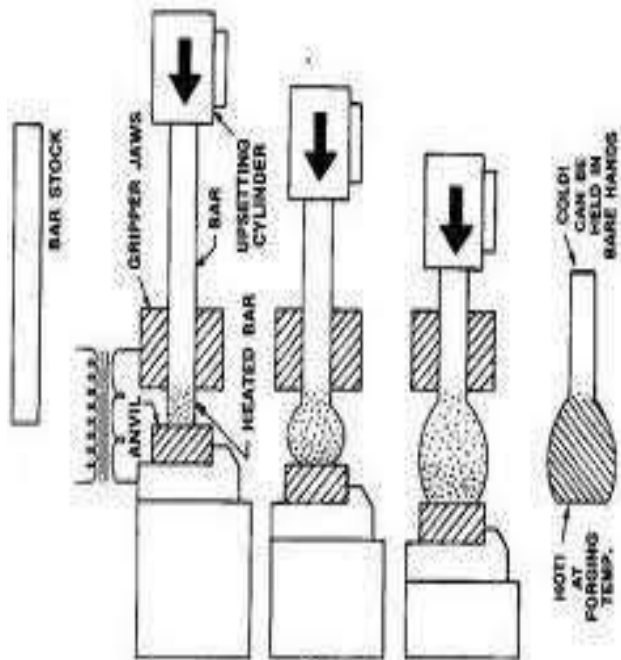
# Forging Operations

- 1. Upsetting
- 2. Drawing Down
- 3. Setting Down
- 4. Punching
- 5. Drifting
- 6. Bending
- 7. Fullering
- 8. Flattening
- 9. Swaging
- 10. Forge Welding
- 11. Cutting
- 12. Drop Forging

# Upsetting

***Upsetting is the process through which the cross-section of metal piece is increased with a corresponding reduction in length.***

In this process first of all the work is heated to the required temperature then heavy blow is given by hand hammer. The swelling of work takes place at the hot portion.



# Cogging/Drawing Down/Drawing out

*It is the process of reducing the crosssection of a bar and increasing its length.*

The operation of is carried out in three steps:-

(a) first Hammering with Cross peen Hammer

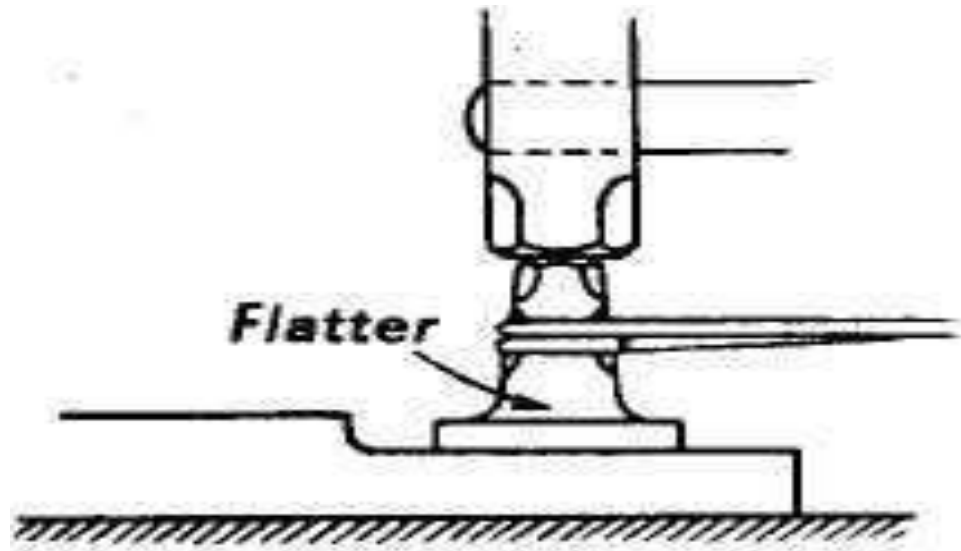
(b) then pair of Fullers used

(c) Then the curved top of work is leveled off with set hammers and finally finished with flatters



# Setting Down

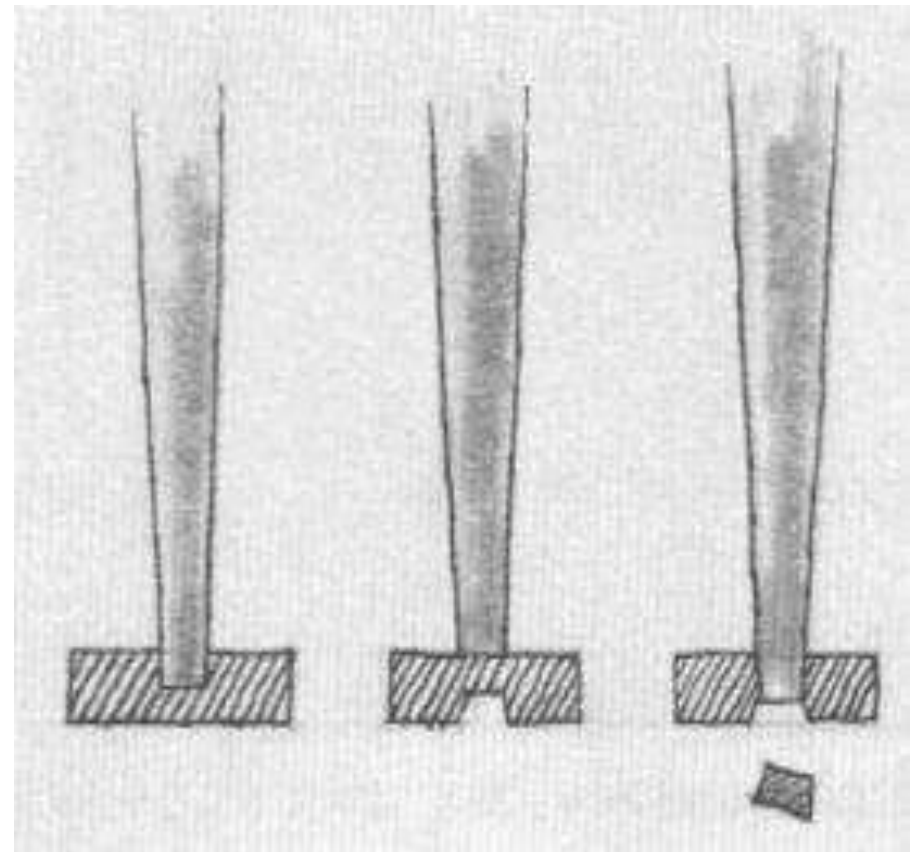
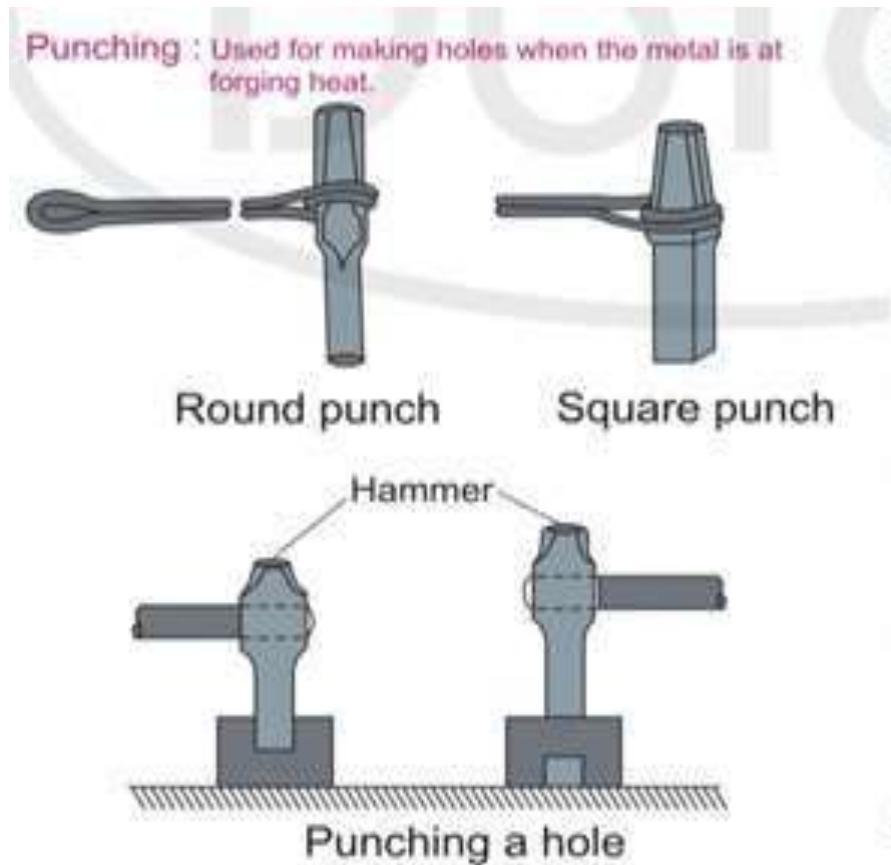
It is the process of local thinning down effect by the set hammers.





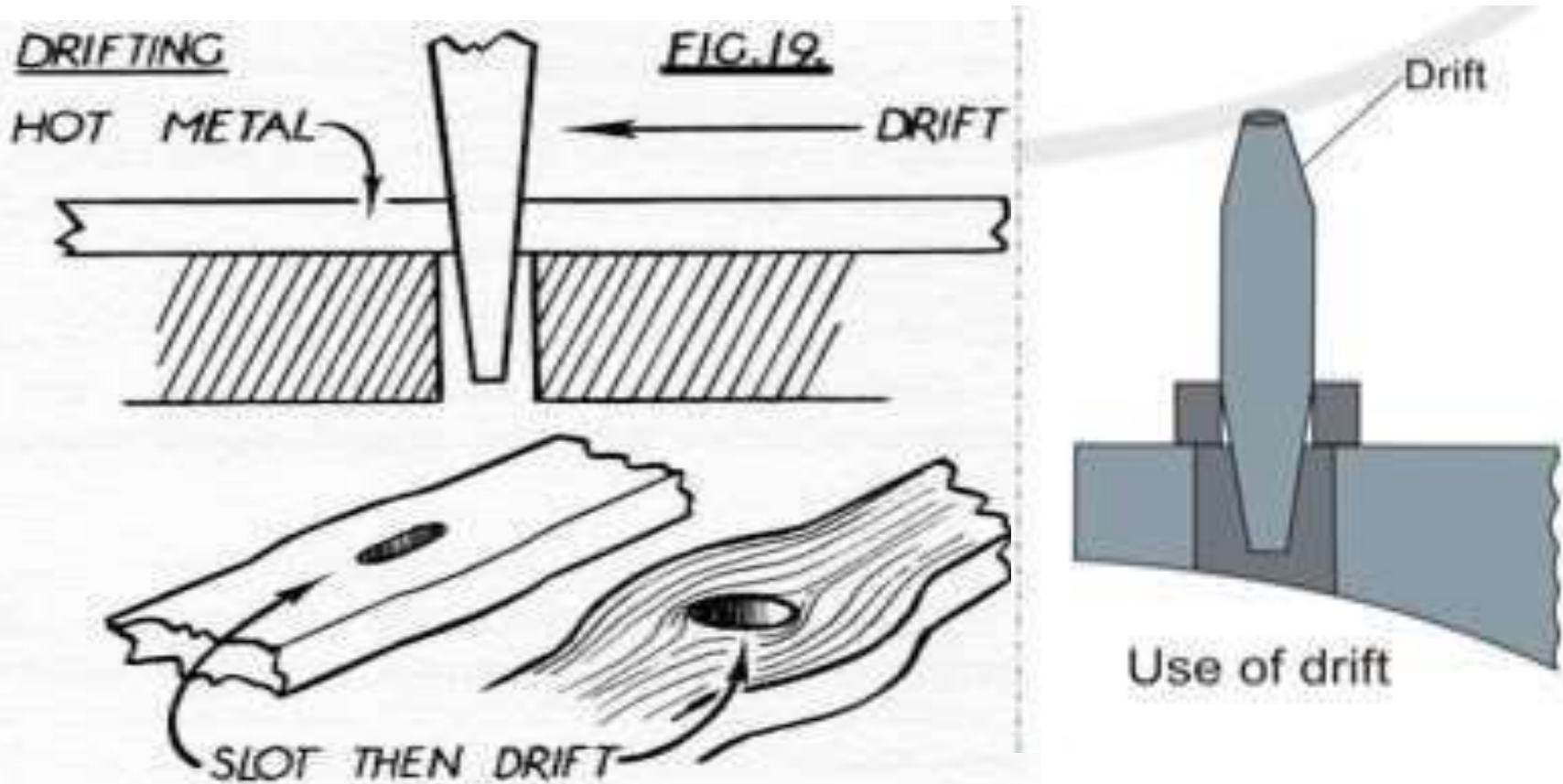
# Punching

It is the process of producing the holes by forcing the punch through the work.



# Drifting

*By this process punched hole enlarged*



# Bending

It is an important operation in forging and is very frequently used. The bends may be either sharp cornered, angle bends or they may be composed of more gradual curve. The angle bend may be made by hammering the metal over the edge of the anvil, or over a block of metal held in the hardie hole

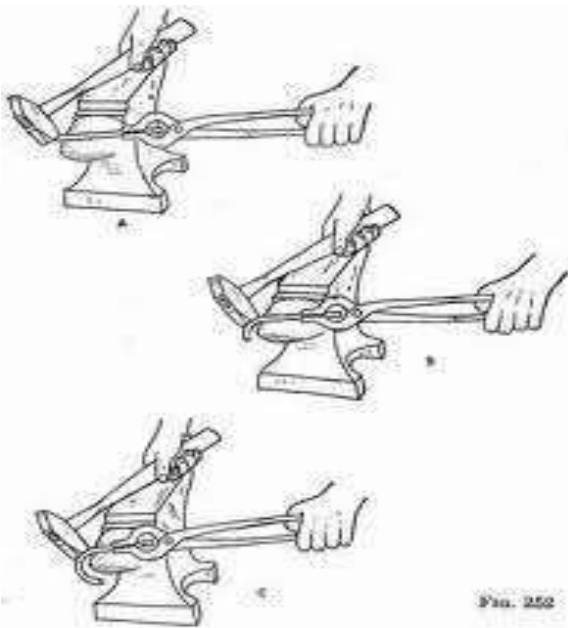


Fig 1

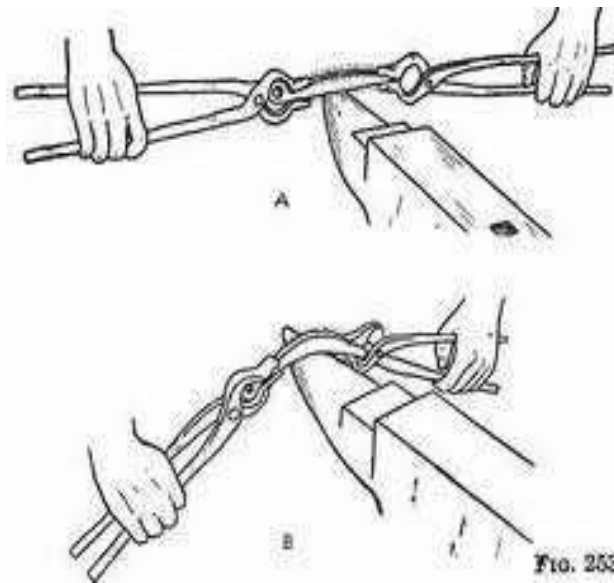


Fig 2

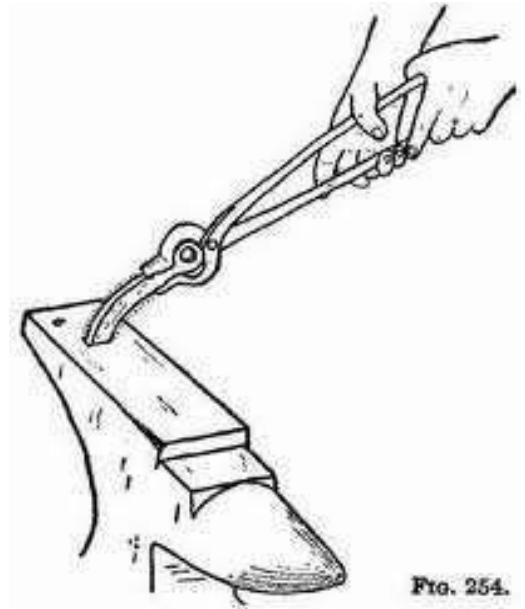
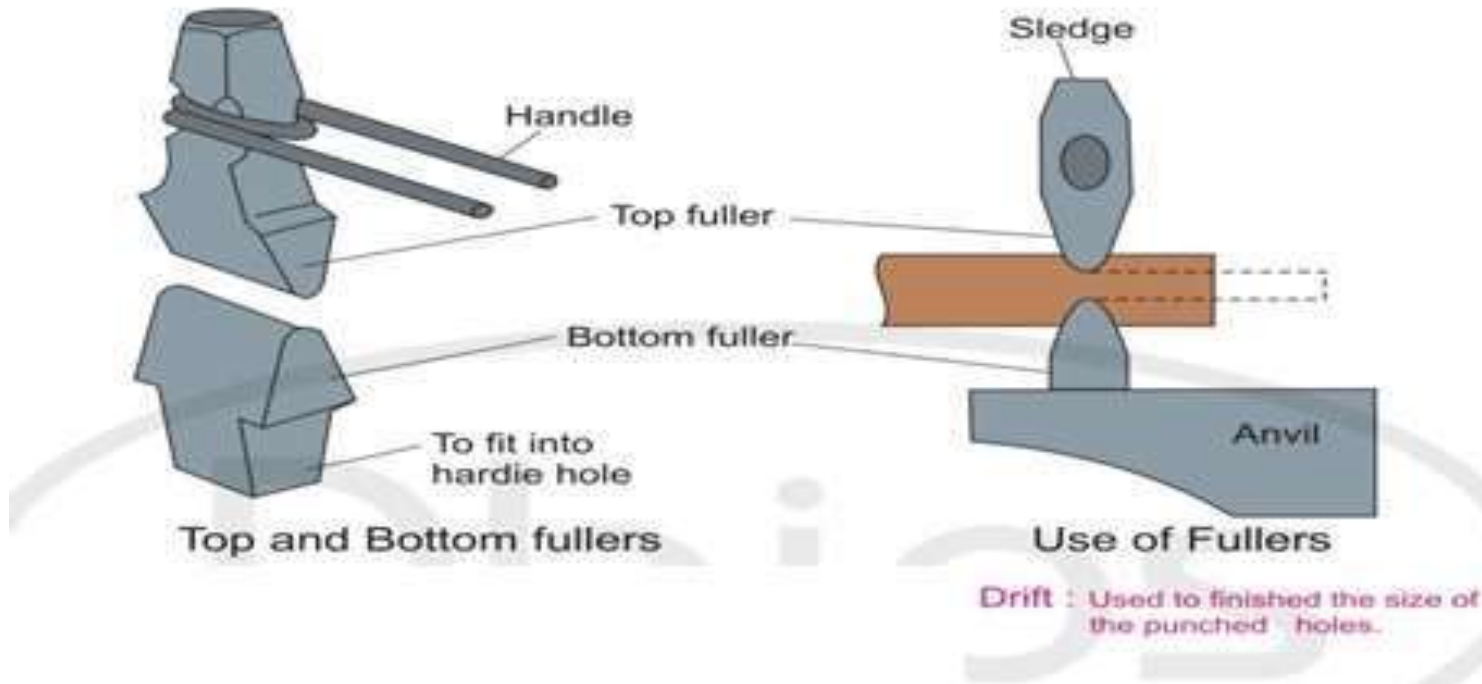


Fig 3

# Fullering

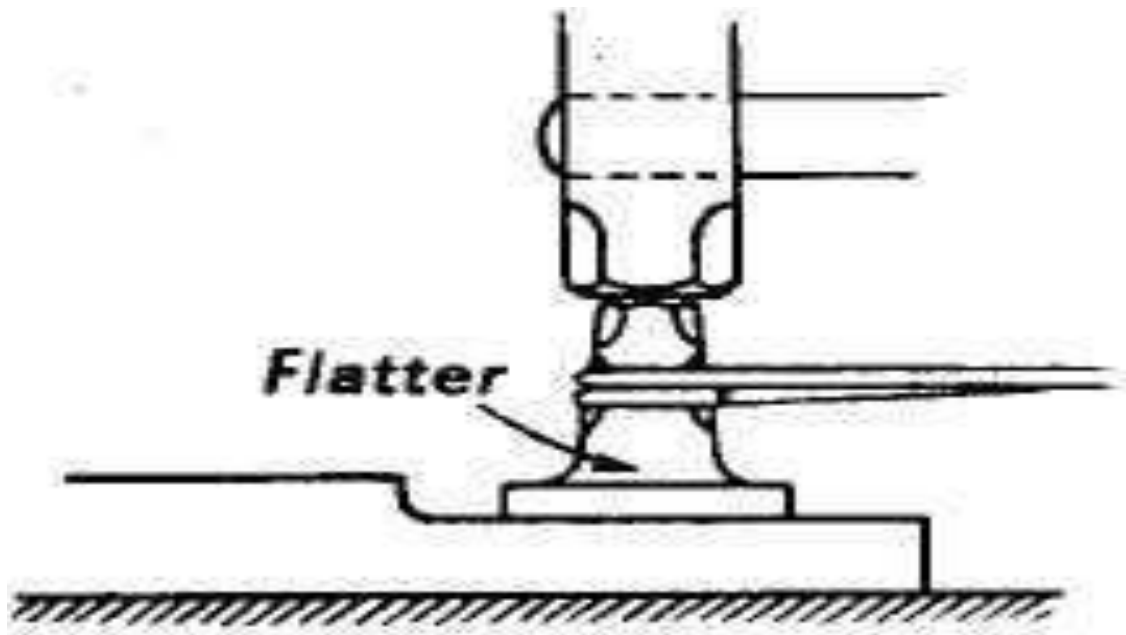
In Fullering operation material cross section is decreased and length is increased. The fullering operation is carried out with the help of pair of fullers and anvil. Bottom fuller is kept in anvil hole and heated work peice is kept in between bottom and top fullers. The fullers locate and concentrate the hammer blow , causing the metal to be drawn out more rapidly.

**Fullers :** Used for necking down piece of work and to reduce the metal while making shoulders:



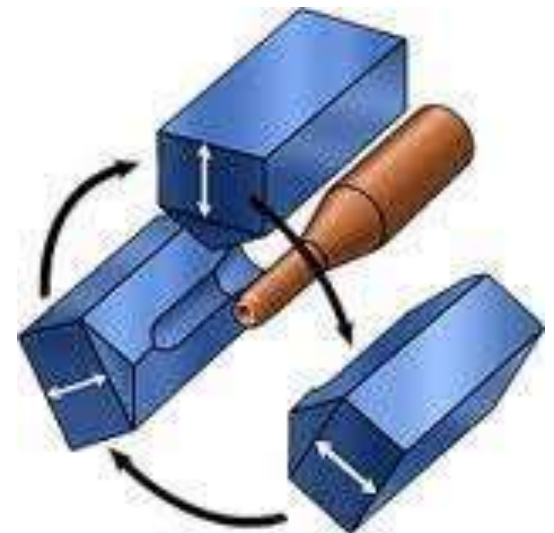
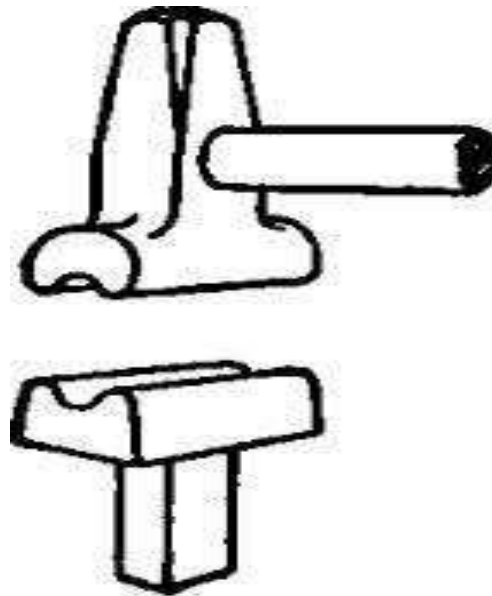
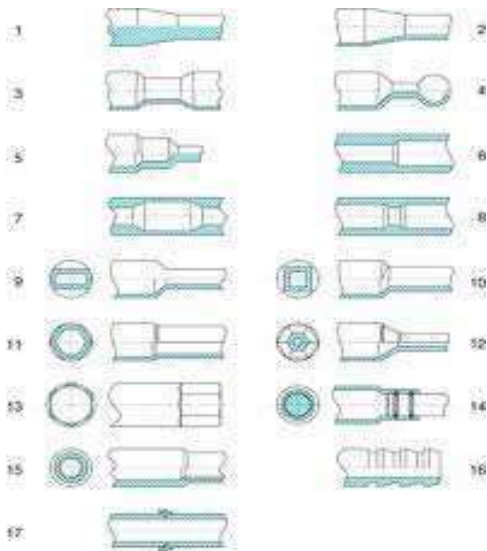
# Flattening

The flattening is carried out after drawing out, fullering or any other operation to remove the fullering marks for leveling and finishing flat surfaces



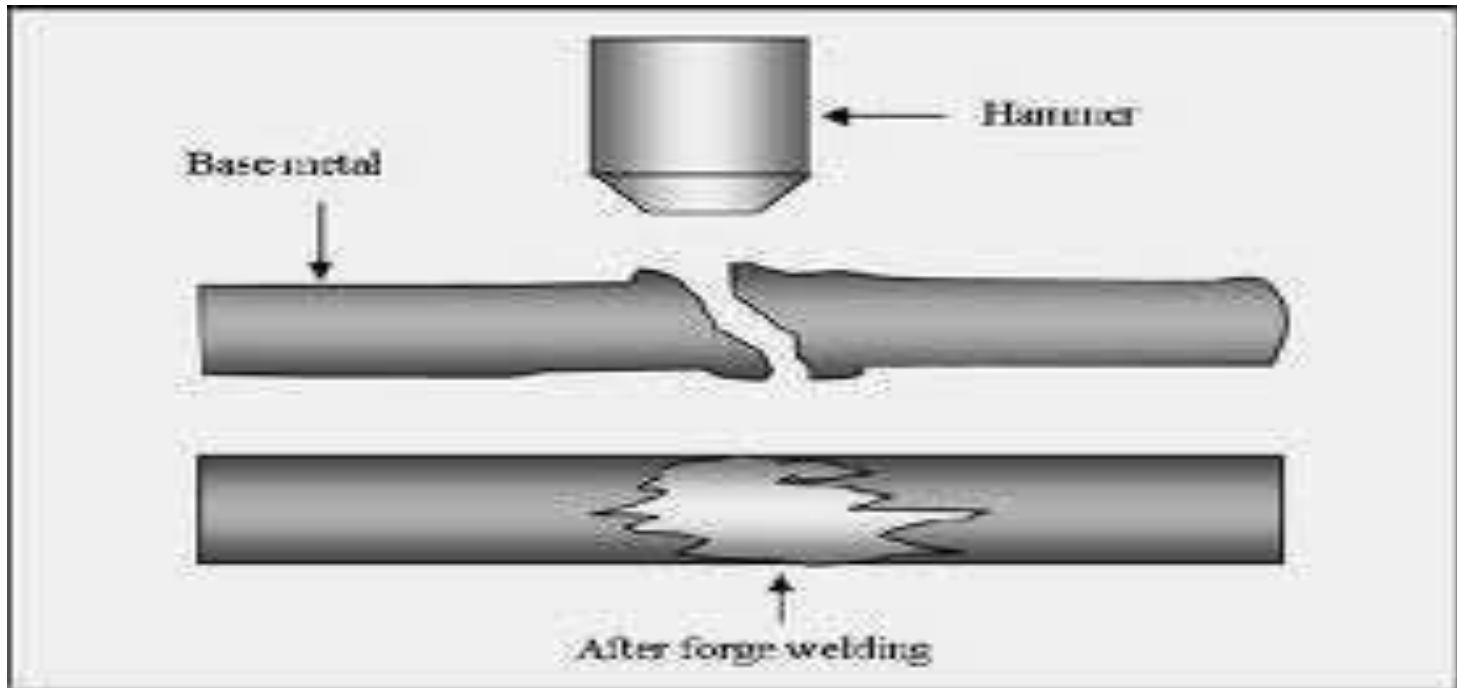
# Swaging

- Swaging is the operation of changing the shape of cross-section of job to some specific shapes such as round, square, hexagonal etc. Swaging operation is carried out with pair of swages or by swage block.



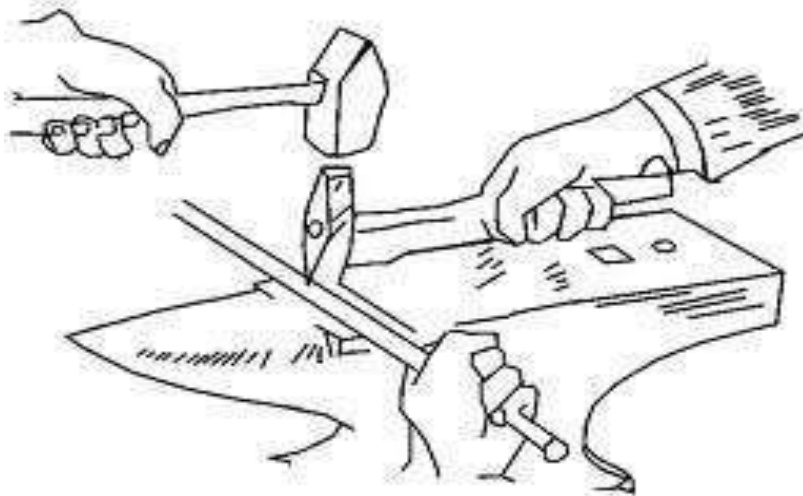
# Forge Welding

It is the process of joining the two surfaces of metal under pressure after they are heated to the correct temperature.



# Cutting

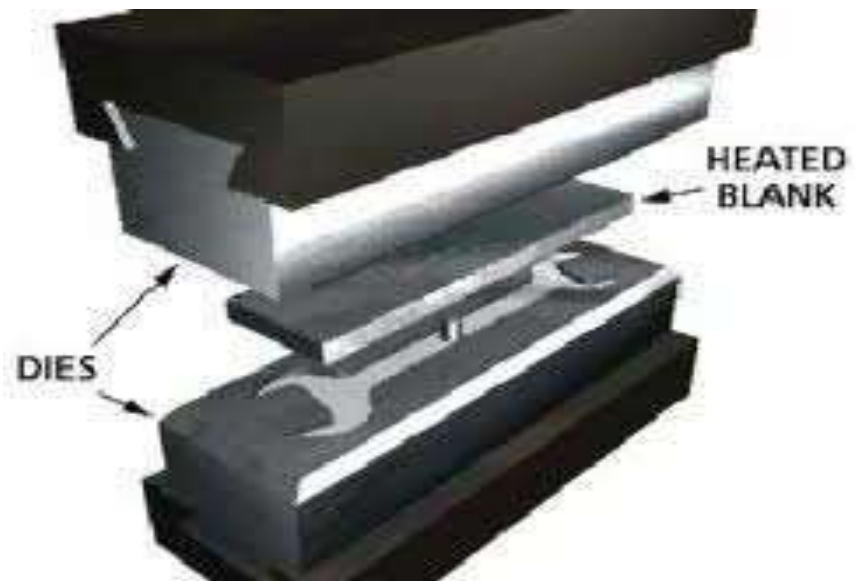
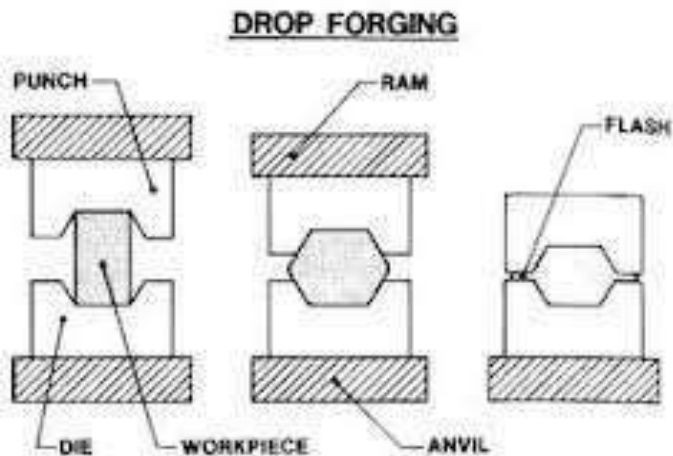
- It is a form of chiseling where a long piece of stock is cut into several required lengths.
- Notches is made and chisel is placed over notch then hammered then turn 180 Degree and chisel placed opposite the metal cut-off in two pieces.





# Drop Forging

- When mass production of identical articles is required by forging, the method of drop forging or stamping is used. This is performed by a special type hammer known as drop hammer or drop stamp. Accurately made steel dies are used for this purpose.



# Defects in Forging

- 1. Cold Shut or Lap
- 2. Cracks
- 3. Scale Pits
- 4. Unfilled Sections
- 5. Mismatch Sections
- 6. Ruptured Fibers Flow lines
- 7. Fins and Rags
- 8. Burnt and Overheated Metal

# Forging Defects

- **Unfilled Section:** In this some section of the die cavity are not completely filled by the flowing metal.
- **Cold Shut:** This appears as a small cracks at the corners of the forging.
- **Scale Pits:** This is seen as irregular depurations on the surface of the forging.
- **Die Shift or Miss-match Forging :** This is caused by the miss alignment of the die halve, making the two halve of the forging to be improper shape.

# Forging Defects

- **Flakes:** These are basically internal ruptures caused by the improper cooling of the large forging.
- **Improper Grain Flow or rupture fiber flow lines:** This is caused by the improper design of the die, which makes the flow of the metal not flowing the final intended direction.

# Forging Defects

- **Fins and rags** : These are small projections or pieces of loose metal driven into metal surface.
- **Burnt and Overheated Metal**: heating the metal at high temperature or for too long time burn the metal