

# WORKSHOP

DEPARTMENT OF MECHANICAL

ENGINEERING

LAB MANUAL

OF

BLACKSMITHY SHOP

**(ITS HOT, DON'T COME WITHOUT SHOES)**

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Department of Mechanical Engineering

**OBJECTIVES**

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The objectives of Blacksmithy Shop is-

- ✓ To demonstrate different tools required for forging.
- ✓ To practice making jobs through hand forging process.

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**OUTCOMES**

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The expected outcome of blacksmithy lab is that the students will be able

- ✓ To practically relate to concepts discussed in Manufacturing Process course.
- ✓ To understand the operating principles of forging process.
- ✓ To apply these learning to improve the performance of forged jobs.

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**Tutorial Assignments**

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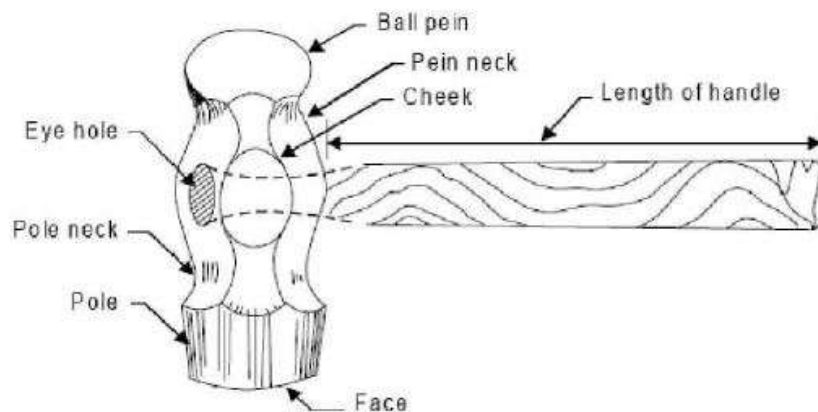
- ✓ To prepare a dog nail.

## INTRODUCTION

### Black smithy shop:

Blacksmithy or Forging is an oldest shaping process used for the producing small articles for which accuracy in size is not so important. The parts are shaped by heating them in an open fire or hearth by the blacksmith and shaping them through applying compressive forces using hammer.

Thus forging is defined as the plastic deformation of metals at elevated temperatures into a predetermined size or shape using compressive forces exerted through some means of hand hammers, small power hammers, die, press or upsetting machine. It consists essentially of changing or altering the shape and section of metal by hammering at a temperature of about  $980^{\circ}\text{C}$ , at which the metal is entirely plastic and can be easily deformed or shaped under pressure. The shop in which the various forging operations are carried out is known as the smithy or smith's shop.



### Ball Peen Hammer

Hand forging process is also known as black-smithy work which is commonly employed for production of small articles using hammers on heated jobs. It is a manual controlled process even though some machinery such as power hammers can also be sometimes used. Black-smithy is, therefore, a process by which metal may be heated and shaped to its requirements by the use of blacksmith tools either by hand or power hammer.

Forging by machine involves the use of forging dies and is generally employed for mass-production of accurate articles. In drop forging, closed impression dies are used and there is drastic flow of metal in the dies due to repeated blow or impact which compels the plastic metal to conform to the shape of the dies.

### Applications of forging

Almost all metals and alloys can be forged. The low and medium carbon steels are readily hot forged without difficulty, but the high-carbon and alloy steels are more difficult to forge and require greater care. Forging is generally carried out on carbon alloy steels, wrought iron, copper-base alloys, aluminum alloys, and magnesium alloys. Stainless steels, nickel-based super alloys, and titanium are forged especially for aerospace uses.

### FORGEABILITY

The ease with which forging is done is called forgeability. The forgeability of a material can also be defined as the capacity of a material to undergo deformation under compression without rupture.

Forgeability increases with temperature up to a point at which a second phase, e.g., from ferrite to austenite in steel, appears or if grain growth becomes excessive.

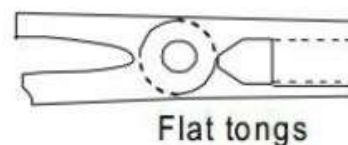
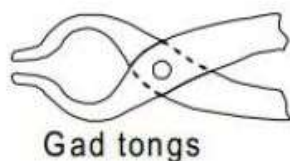
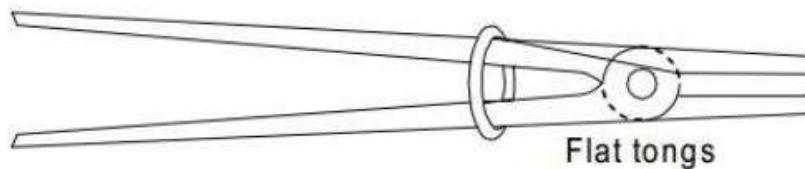
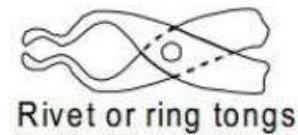
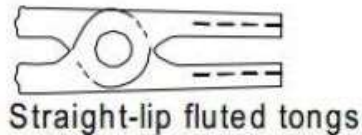
## COMMON HAND FORGING TOOLS

For carrying out forging operations manually, certain common hand forging tools are employed. These are also called blacksmith's tools, for a blacksmith is one who works on the forging of metals in their hot state. The main hand forging tools are as under.

### Tongs

The tongs are generally used for holding work while doing a forging operation. Various kinds of tongs are shown in Figure.

- a) Straight-lip fluted tongs are commonly used for holding square, circular and hexagonal bar stock.
- b) Rivet or ring tongs are widely used for holding bolts, rivets and other work of circular section.
- c) Flat tongs are used for mainly for holding work of rectangular section.
- d) Gad tongs are used for holding general pick-up work, either straight or tapered.
- e) Side bit tong are used for holding iron parallel to tongs.
- f) Pincer tong are used to handle delicate objects.
- g) Chisel or belt tong are designed to fit the tool hole in the anvil



### Flatter

It is commonly used in forging shop to give smoothness and accuracy to articles which have already been shaped by fullers and swages.

### Swage

Swage is used for forging work which has to be reduced or finished to round, square or hexagonal form. It is made with half grooves of dimensions to suit the work being reduced. It consists of two parts, the

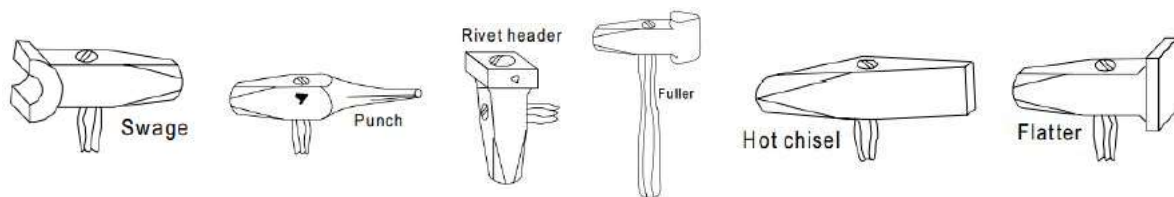
top part having a handle and the bottom part having a square shank which fits in the hardie hole on the anvil face.

### Fuller

Fuller is used in forging shop for necking down a forgeable job. It is made in top and bottom tools as in the case of swages. Fuller is made in various shapes and sizes according to needs, the size denoting the width of the fuller edge

### Punch

Punch is used in forging shop for making holes in metal part when it is at forging heat.



### Rivet header

Rivet header is used in forging shop for producing rivets heads on parts.

### Chisels

Chisels are used for cutting metals and for nicking prior to breaking. They may be hot or cold depending on whether the metal to be cut is hot or cold. The main difference between the two is in the edge. The edge of a cold chisel is hardened and tempered with an angle of about  $60^\circ$ , whilst the edge of a hot chisel is  $30^\circ$  and the hardening is not necessary. The edge is made slightly rounded for better cutting action.

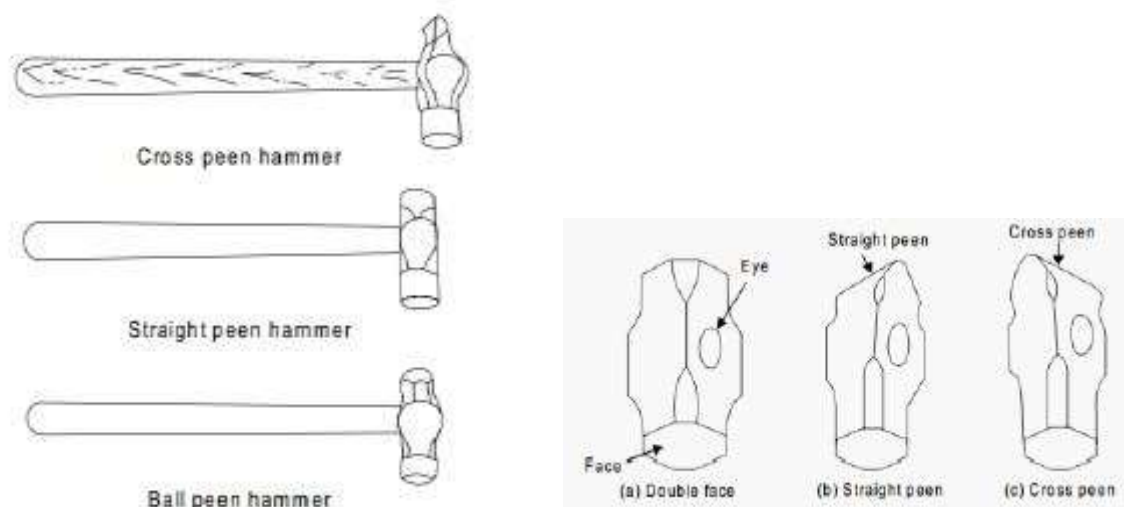
### Hand hammers

There are two major kinds of hammers are used in hand forging:

- The hand hammer used by the smith himself and
- The sledge hammer used by the striker.

Hand hammers may further be classified as (a) ball peen hammer, (b) straight peen hammer, and (c) cross peen hammer.

Sledge hammers may further be classified as (a) Double face hammer, (b) straight peen hammer, and (c) cross peen hammer. Hammer heads are made of cast steel and, their ends are hardened and tempered. The striking face is made slightly convex. The weight of a hand hammer varies from about 0.5 to 2 kg whereas the weight of a sledge hammer varies from 4 to 10 kg.



### Set hammer

A set hammer is used for finishing corners in shouldered work where the flatter would be inconvenient. It is also used for drawing out the gorging job.

Color	Forging temp.
Dark red	700°C
Cherry red	760°C
Orange red	980°C
Yellow red	1090°C
White	1300°C

### Anvil

An anvil is a most commonly tool used in forging shop which is shown in. It acts as a support for blacksmith's work during hammering. The body of the anvil is made of mild steel with a tool steel face welded on the body, but the beak or horn used for bending curves is not steel faced. The round hole in the anvil called pritchel hole is generally used for bending rods of small diameter, and as a die for hot punching operations. The square or hardie hole is used for holding square shanks of various fittings. Anvils in forging shop may vary up to about 100 to 150 kg and they should always stand with the top face about 0.75 mt. from the floor. This height may be attained by resting the anvil on a wooden or cast iron base in the forging shop.

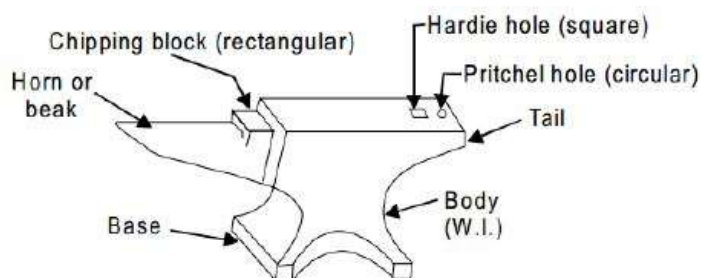


Fig. Anvil

### Swage block

Swage block generally used in forging shop is shown in figure. It is mainly used for heading, bending, squaring, sizing, and forming operations on forging jobs. It is 0.25 mt. or even more wide. It may be used either flat or edgewise in its stand.

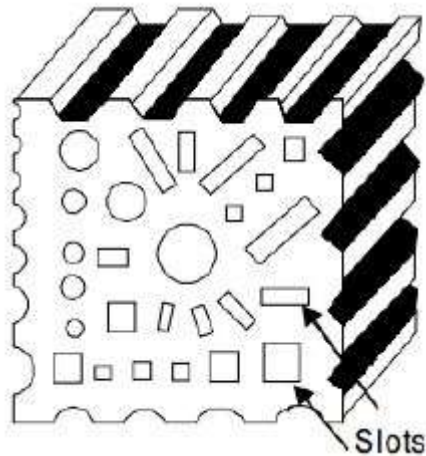


Fig. Swag block

### FORGING OPERATIONS:

The following are the basic operations that may be performed by hand forging:

#### 1. Drawing-down:

Drawing is the process of stretching the stock while reducing its cross-section locally. Forging the tapered end of a cold is an example of drawing operation.

#### 2. Upsetting:

It is a process of increasing the area of cross-section of a metal piece locally, with a corresponding reduction in length. In this, only the portion to be upset is heated to forging temperature and the work is then struck at the end with a hammer. Hammering is done by the smith (student) himself, if the job is small, or by his helper, in case of big jobs, when heavy blows are required with a sledge hammer.

#### 3. Fullering:

Fullers are used for necking down a piece of work, the reduction often serving as the starting point for drawing. Fullers are made of high carbon steel in two parts, called the top and bottom fullers. The bottom tool fits in the hardie hole of the anvil. Fuller size denotes the width of the fuller edge.

#### 4. Flattering:

Flatters are the tools that are made with a perfectly flat face of about 7.5 cm square. These are used for finishing flat surfaces. A flatter of small size is known as set-hammer and is used for finishing near corners and in confined spaces.

#### 5. Swaging:

Swages like fullers are also made of high carbon steel and are made in two parts called the top and swages. These are used to reduce and finish to round, square or hexagonal forms. For this, the swages are made with half grooves of dimensions to suit the work.

**6. Bending:**

Bending of bars, flats, etc., is done to produce different types of bent shapes such as angles, ovals, circles etc. Sharp bends as well as round bends may be made on the anvil, by choosing the appropriate place on it for the purpose.

**7. Twisting:**

It is also one form of bending. Sometimes, it is done to increase the rigidity of the work piece. Small piece may be twisted by heating and clamping a pair of tongs on each end of the section to be twisted and applying a turning moment.

Larger pieces may be clamped in a leg vice and twisted with a pair of tongs or a monkey wrench. However, for uniform twist, it must be noted that the complete twisting operation must be performed in one heating.

**8. Cutting (Hot and Cold Chisels):**

Chisels are used to cut metals, either in hot or cold state. The cold chisel is similar to fitter's chisel, except that it is longer and has a handle. A hot chisel is used for cutting hot metal and its cutting edge is long and slender when compared to cold chisel. These chisels are made of tool steel, hardened and tempered.

**9. Forming:**

It is done to change size and shape to the required form by progressive hammering with different tools and implements.

**10. Punching:**

Marking a hole in the job with the help of anvil and hammer strokes on the required spot.

**11. Drifting:**

Drifting is enlarging a hole by driving a proper punch in the job by hammering.

**12. Welding (forge):**

The pieces are heated to a very high temperature. Then the iron pieces are quickly taken out from the fire and rubbed against clean dry sand. Place one piece end over other on anvil and then rapidly hammer to join the two pieces together.

**NOTE:** The forging produced either by hand forging or machine forging should be heat treated.

The following are the purposes of heat treatment:

- i. To remove internal stresses set-up during forging and cooling.
- ii. To normalize the internal structure of the metal.
- iii. To improve machinability.
- iv. To improve mechanical properties, strength and hardness.



**SAFETY PRECATIONS:**

1. Hold the hot work downwards close to the ground, while transferring from the hearth to anvil, to minimize danger of burns; resulting from accidental collisions with others.
2. Use correct size and type of tongs to fit the work. These should hold the work securely to prevent its bouncing out of control from repeated hammer blows.
3. Care should be exercised in the use of the hammer. The minimum force only should be used and the flat face should strike squarely on the work; as the edge of the hammer will produce heavy bruising on hot metal.
4. Wear face shield when hammering hot metal.
5. Wear gloves when handling hot metal.
6. Wear steel-toed shoes.
7. Ensure that hammers are fitted with tight and wedged handles (all dims are in mm).

Assignment:

Size may depend upon the raw material.

