

FORGING

INTRODUCTION :

Forging is a manufacturing process. It is required as a process of plastically deforming metal or alloys to a specific shape by a compressive force exerted by some external agents like hammer, press, rolls or by an upsetting machine of some kind.

The portion of work in which the forging is done is termed as the forge and the work mainly performed by the heavy hammers, Forging machines and presses. Forging process is among the most important manufacturing techniques since forged items are used in small tools, roll road equipments and automobile industries.

Smithing is the art of forging metals as iron, into any desired shape. In this process, jobs are heated in open fire or hearth and subsequently hammered to get desired shape. In smithing, relatively small sized jobs are used and for the operations on them, small power hammers and hard hammers are used. The fuel used for furnace may be coal/choke or charcoal.

TOOLS USED IN SMITHY SHOP :

Tools used in Smithy shop is broadly classified as follows:

- Supporting tools
- Striking tools
- Holding tools
- Cutting tools
- Finishing and shaping tools

Teacher's Signature : _____

I. SUPPORTING TOOLS :-

As the name suggests, these tools are used to give support to the job while in operation.

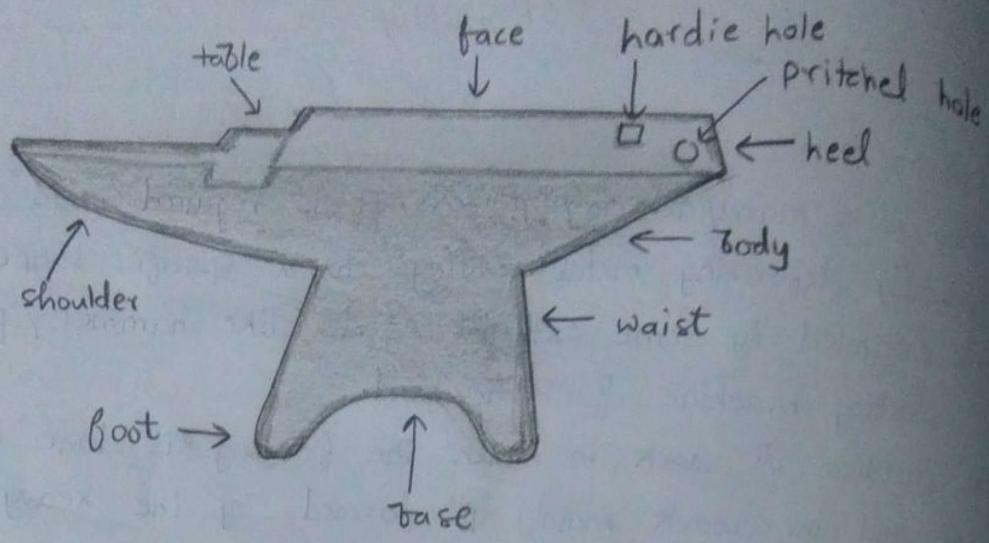
Some supporting tools are described below:

• Anvil

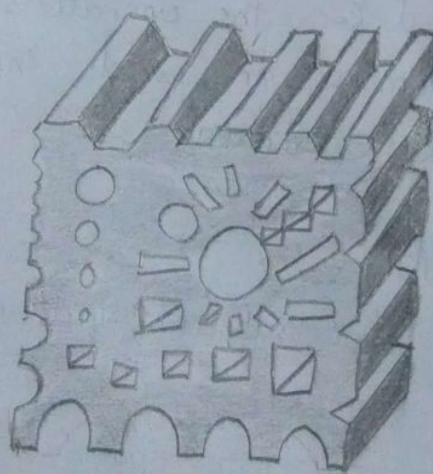
- (i) It is the most commonly used smithy tool without which we cannot perform any smithing operation.
- (ii) It is used as a support when hammering is performed. It is made up of wrought iron or cast steel.
- (iii) The top surface of anvil has some square and other round shaped holes. This is used when the hot pieces are inserted into them to get the desired shape. In particular it is used for bending operation.
- (iv) The round hole is called pritchel hole and is used for bending small workpieces and the hardie hole is used to hold square shank tools like hardies, swages and fullers.

Swage Block

- (i) It is also a supporting tool used in a forge shop.
- (ii) It can be made of cast iron or cast steel.
- (iii) It is used for squaring, sizing, heading, bending and forming operations.
- (iv) It may be used either flat or edgewise in its position.
- (v) For general applications, width of the swage block is 0.25m or slightly more than 0.25m.



• ANVIL



• SWAGE BLOCK

2. STRIKING TOOLS :-

The different types of hammers used in forging operations are :

- (i) Hand hammer used by Smith
- (ii) Sledge hammer used by Striker

• Hand Hammers

Hand Hammers are classified as :

- (i) Ball peen hammer
- (ii) Straight peen hammer
- (iii) Cross peen hammer

The weight of these hammers vary from 0.5 kg to 2 kg. These hammer heads are made up of cast steel and ends are hardened and tempered. The striking surface is slightly convex.

• Sledge Hammer

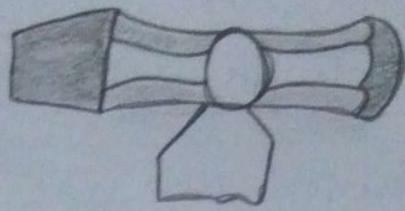
It is used for heavy works only. It has flat ends on both sides. The weight varies from 4.5 to 5.5 kg for ordinary work and around 9 kg for heavy work, the handle being about one meter long. Handle is made up of either cast iron or wood.

3. HOLDING TOOLS :-

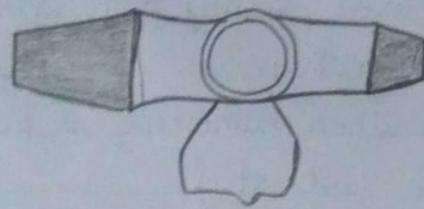
Generally tongs are used for holding purpose. It is made up of mild steel. Types of Tongs :

- (i) Flat Tong
- (ii) Grod Tong
- (iii) Ring Tong
- (iv) Straight - lip fluted Tong

Flat tongs are used for holding jobs with rectangular cross-section.



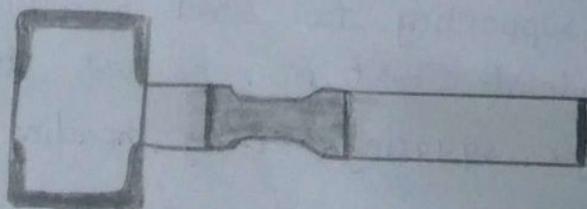
• Ball Peen Hammer



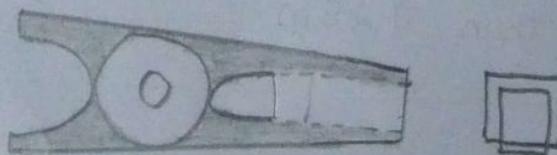
• Straight Peen Hammer



• Cross Peen Hammer



• Sledge Hammer



• Flat Tong

- Hand tongs are used for general purpose and for picking up work either straight or tapered.
- Ring tongs are for bolts, rivets, and other circular cross-section jobs.
- Straight lip fluted tong is used for square, circular and hexagonal bar strokes.

4. CUTTING TOOLS :-

Cutting tools are used for cutting and necking metals prior to breaking.

Chisels are cutting tools. They are of two types :

- Cold Chisel
- Hot Chisel

• Cold Chisel

It is made up of tool steel with a cutting angle of about 60° and its edge is hardened and tempered.

• Hot Chisel

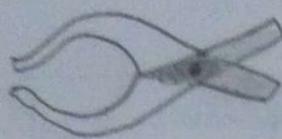
It is made up of low carbon steel and has a cutting of 30° (angle). Its edge doesn't require hardening.

5. FINISHING AND SHAPING TOOLS :-

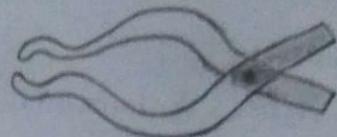
These tools are used to give desired forms and shapes.

• Swages

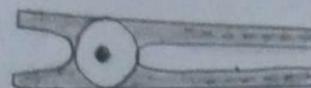
Swages are used for work which has to be reduced and finished to round, square or hexagonal form. It is made up of high carbon steel. The swages may be in separate top and



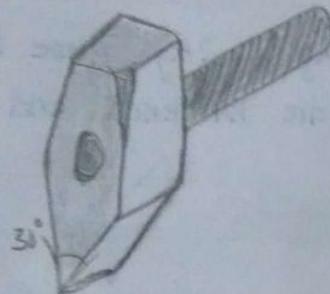
• Grad Tang



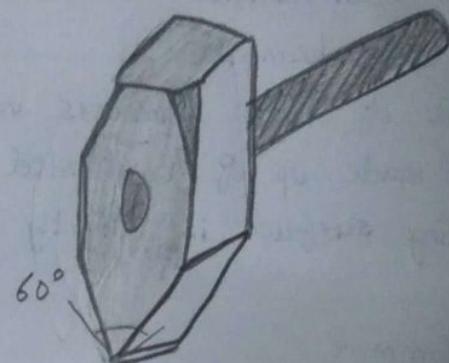
• Ring tang



• straight - lip fluted tang



• Hot Chisel



• Cold Chisel



• Swages

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Bottom halves. These are made with half grooves of dimensions to suit the work being reduced. Swage consists of two parts: the top part consists of a handle and bottom part consists of square shank which fits in handle hole in anvil face.

• Flatters

The flatter is used after the job has been forged into shape with hammer and the hammer marks can be seen on the job surface.

Flatter is used to achieve better surface finish especially when the surface area is large. It is used to provide smoothness and accuracy to the job or work.

• Fullers

Fullers are a set of tools, the top tool and the bottom tool. The top tool is provided with a handle and the bottom tool has a square shank which fits into the square hole of the anvil. Fullers are used to form grooves. They spread the metal and can reduce the thickness of the workpiece.

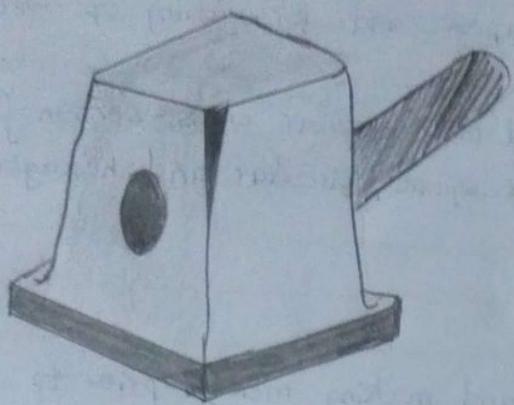
• Set Hammers

A set hammer is used for finishing off surfaces to a good smooth surface in restricted area such as corners, undercuts. A set hammer is useful for working hot metal and forcing it into corners and narrow places.

Punch

Punch is used for making holes in the heated component. Holes of any shape such as round, oval or square shapes may be made

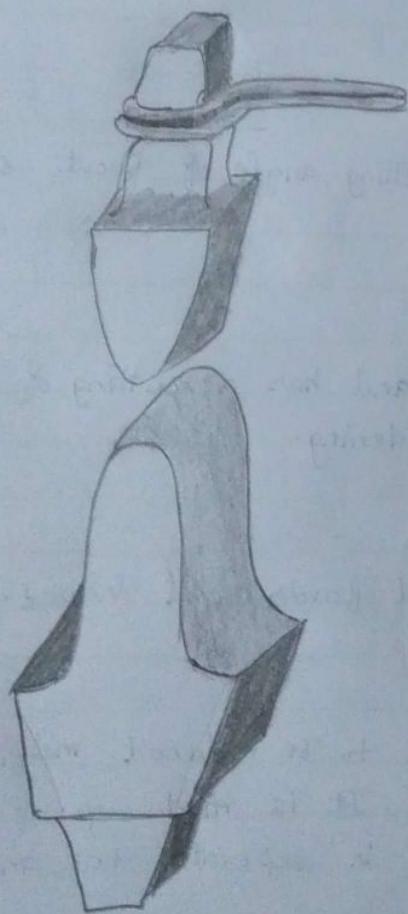
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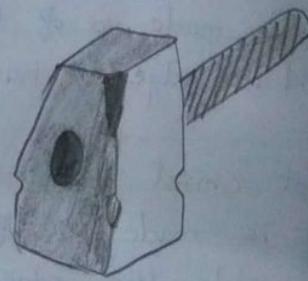
• Flattener



• Punch



• Fullers



• Set Hammer

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with punches of different shapes.

- Drift

Once the punch has made a hole in the heated metal workpiece, the drift can be employed to enlarge this hole to a particular shape and size.

COMMON SMITH FORGING OPERATIONS

So many operations can be carried out by means of heating the workpiece and hammering operations.

The typical Smith Forging operations are :

1. Upsetting or Jumping
2. Drawing down
3. Setting down
4. Punching and drifting
5. Bending
6. Forge welding
7. Cutting
8. Fullering

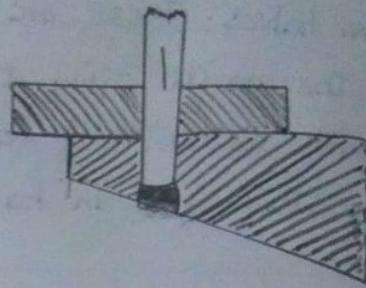
- Upsetting or Jumping

It is one of the processes of increasing the thickness of a bar at the expense of its length and is brought about by end pressure.

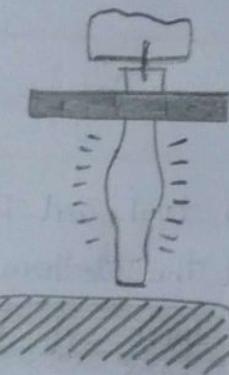
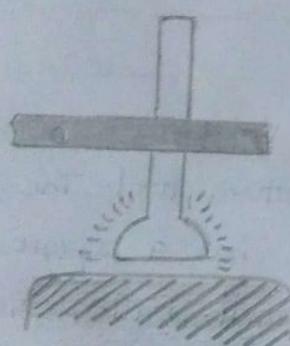
The pressure may be obtained by driving the end of the bar against the anvil by supporting on anvil and hitting with hammer or damping with the wire and hitting with hammer.

- Drawing down or Swaging

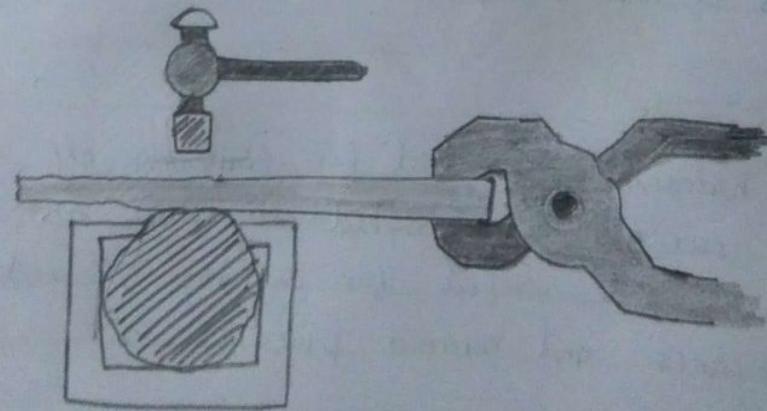
It is the process of increasing the length of bar at the expense of its width or thickness or both. Associated figure explains this.



• Drift



• Upsetting



• Drawing down

- Setting down

It is localised drawing down or swaging operation. In other words, it may be said as the process of local thinning down effected by set-hammer or set. Usually the work is fullered at the place where the setting down commences.

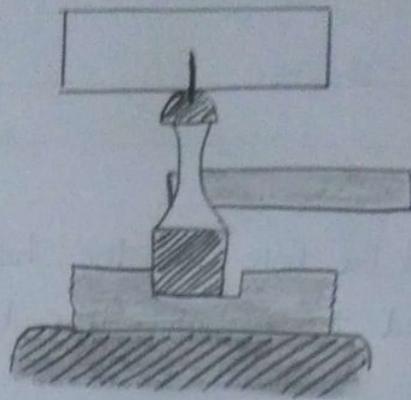
- Punching

It is a process of producing holes generally cylindrical by using hot punch over the pitcher hole of anvil, over a cylindrical die, or over a hole of correct size in sewage attack.

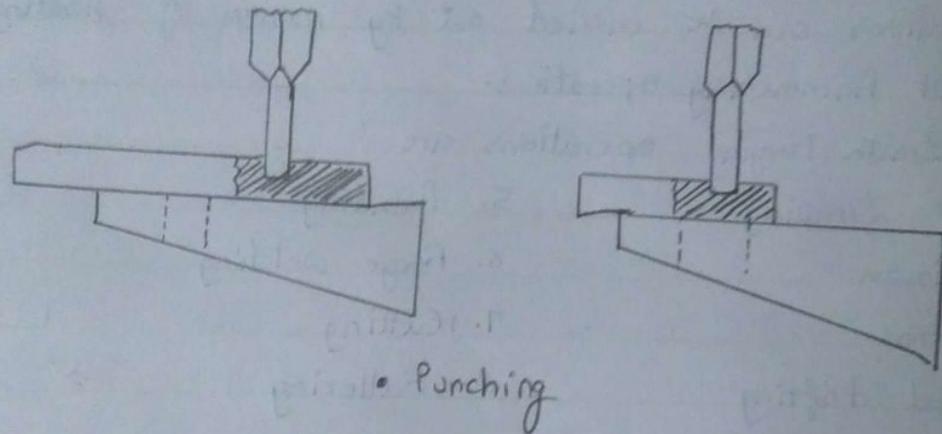
- Bending

It is one of the main operations to bend the workpieces as we required. It is an important operation in forging and is one very frequently used. This may be classified as angular or curvilinear. It may be done over the anvil face, over the anvil horn, in special form such as swage block edges or for bar stocks, by inserting the end in the pitched hole and bending the bar with a tetch or tong.

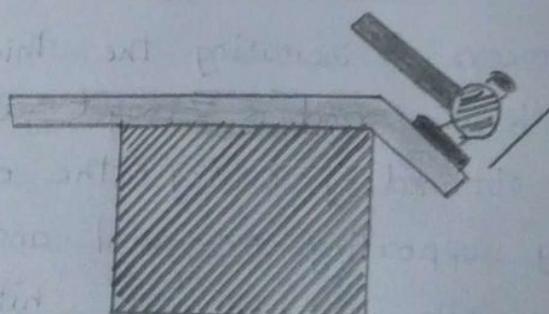
When metal is bent, the layers of metal on the inside are shortened and those on the outside are stretched. This causes a bulging outside at the bulging of sides at the inside, and a radius on the outside of bend. If a perfect square is required, additional metal must be worked to the place where the bend occurs when this is bent. The additional metal will go to the corner. Gradual bends may be used by using the back of the anvil as a former or metal may be bent around the bar of correct radius held in a vice.



• set down



• Punching



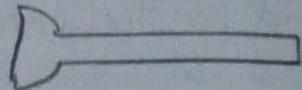
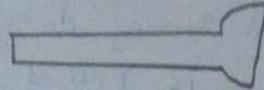
• Bending

• Welding or Shutting

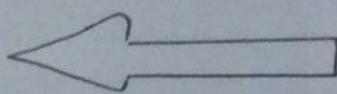
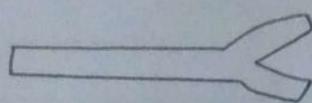
It is perhaps the principal operation by the smith. The metal which remains pliant over a wide range of temperature is most easily welded, and in this respect wrought iron and mild steel have some advantages over other metals. The first essential to the production of sound weld is that the surface in contact with, must be perfectly clean, both mechanically and chemically so that cohesion will take place when the metal is in a plastic state. A protection to the metal is coating of flux which covers the surface of the metal and supports the prevention of air. Fluxes which we commonly used in forge welding consist of clean quartz sand, calcined borax or a mixture of 4 parts of borax with 1 part of sal-ammoniac. A forge weld is made by hammering together the ends of the two bars which have been formed to connect shape and heated to the welding temp. in a forge fire. The method of preparing the pieces of metal for welding known as scarfing. This involves the shaping of the ends of the pieces to be welded so that they will unite at the center. Four forms of welded joint commonly employed are :

- (i) The lap or scarf weld, in which the ends are prepared so that they may be welded one upon the other, with the joint in an inclined direction.
- (ii) The butt weld in which ends of pieces are joint and are butted together, the weld being between the ends at right angle to the length of pieces.
- (iii) The 'T' or jump weld, in which one piece is placed at the centre of another right angle to each other in form of inverted 'T'.

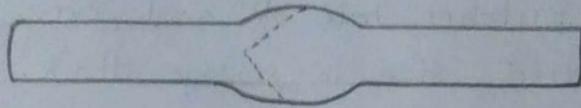
Step - 1



Step - 2



Step - 3



• Forge Welding

(iv) The split, fork or 'V' weld or splice, in which the ends are brought to the shape of fork and tang respectively.

• Cutting

The cutting-off is a form of chiseling whereby a long piece of stock is cut into several specified lengths, or a forging is separated (cut-off) from its stock. For hot chiseling, steel must be heated in a Blacksmith's hearth or furnace to be light cherry red heat i.e. from 850°C - 950°C . When cutting with chisels, the hammer blows are directed on to the chisel's head, which must be slightly rounded.

A notch is first made about one-half the thickness or diameter of stock. After the stock is to be cut-off has been notched, the work must be turned through an angle of 180° and the chisel is placed exactly opposite the notch.

TYPES OF FORGING

Based on the machine used for operations, it is classified as

- (i) Hand Forging
- (ii) Machine Forging
- (iii) Drop Forging

APPLICATIONS OF SMITH FORGING

- (i) It is used to fabricate components like bolts, nuts, hooks, keys, tongs and spring.
- (ii) It is also used to fabricate agricultural tools and links used in various mechanisms.
- (iii) Strength: It reduces the risk of part failures. The process

• Forging Temp. for different metals

S.No.	Metal / Alloy	Forging Temp. (°C)	
		Starting	Finishing
1.	High carbon steel	1150	825
2.	Aluminium & Magnesium alloys	500	350
3.	Mild steel	1300	800
4.	Copper, Brass and Bronze	950	600
5.	Medium carbon steel	1250	750
6.	Wrought iron	1275	900

yields parts with high strength -to- weight ratio.

ADVANTAGES OF SMITH FORGING

- (i) The Smith Forging components high strength and give great resistance to impact and fatigue loads.
- (ii) It improves the grain structure of metal so that its mechanical properties are also improved.
- (iii) Better surface finishing can be easily achieved.
- (iv) Raw material loss is almost nil.
- (v) Close tolerances.
- (vi) High rate of production is possible.
- (vii) Parts can be welded easily due to fibrous structures.
- (viii) Uniformity of quality of parts.

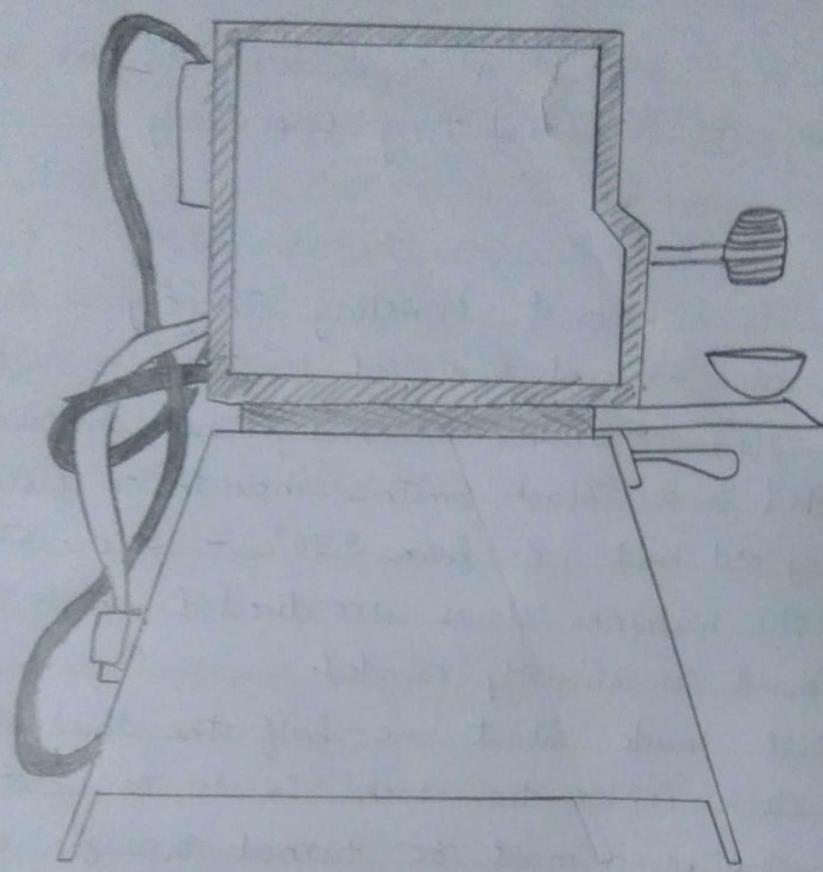
DISADVANTAGES OF SMITH FORGING

- (i) Very difficult to achieve accurate dimensions.
- (ii) Some metals may break while forging.
- (iii) There is no limitation to achieve the shape and size of the job.
- (iv) High tool maintenance.

SAFETY PRECAUTIONS FOR SMITHY

Safety should be in every demonstrator's mind, not only for the audience but for self as well.

- (i) Work slow and always be aware of the audience.
- (ii) Always wear your safety gloves and if possible, have your viewers also.
- (iii) Wear an apron. Not only it could negotiate but it could



• Induction Heater

prevent injuries.

- (iv) Talk about safety and be warned of sparks, sharp edges and hot items. No matter how sincere he/she is, don't let others pick up tools or pieces you are working on.
- (v) Keep all the hot pieces (cut-offs etc.) under the forge and away from people. It may be best to quench all pieces to be on the safe side.
- (vi) Have a first-aid kit handy, you never know when you might burn or cut yourself.
- (vii) Forge welding is always fascinating to watch, hot can be very dangerous. It is best not to forge weld if possible.
- (viii) When using hardy, never cut off through stock (completely). Use tongs to break end off.

JOB

Aim : To make a chisel from a square headed rod.

Material : Square headed rod.

Tools Required :

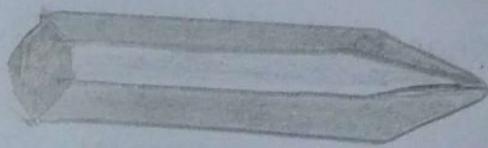
- 1) Blacksmith furnace
- 2) Tongs
- 3) Anvil
- 4) Hammer
- 5) Other relevant tools

Sequence of Operation :

- 1. Heating
- 2. Hammering
- 3. Forming octagonal shape
- 4. Tapering one end
- 5. Finishing
- 6. Checking
- 7. Cooling

Teacher's Signature : _____

Exp



• Chisel shape

Working steps :

- 1) Half length of bar stock was heated.
- 2) The heated end is put on the anvil, by holding the other end by tongs.
- 3) Hammering was carried out to convert the square head to a circular shape. This can be done by hammering at a small angle and then constantly rotating the bar stock with tongs.
- 4) Now the remaining part of the bar was heated. Constant hammering on each edge, so as to form an octagonal shape is done.
- 5) The blows were altered, so as to form a structure similar to a regular octagon.
- 6) Slowly hammering the top and bottom parts to give it an more regular and cleaner shape is done.
- 7) Finishing the top part of the chisel, and cooling.

Result

The desired chisel is obtained.