Workshop Safety Precautions

- Wear tight clothes. Loose clothing or long hair will bring danger
- Wear covered footwear. Never use sandals or chapels.
- Never use files, screwdrivers without a handle. Do not use a hammer without the wedge.
- Never operate a machine unless otherwise you thoroughly its mechanism.
- Wear goggles while chipping, welding or grinding.
- Always wear safety hand gloves, an apron or dungaree and leather shoes in the Workshop.
- Never touch overhead lines unless you are sure that it is properly earthed and dead.
- Don't touch /operate power tools without aid from instructors
- Do not throw water on the equipment. It will be harmful since water is a good conductor of electricity.
- Do not touch electrical circuits of welding machine

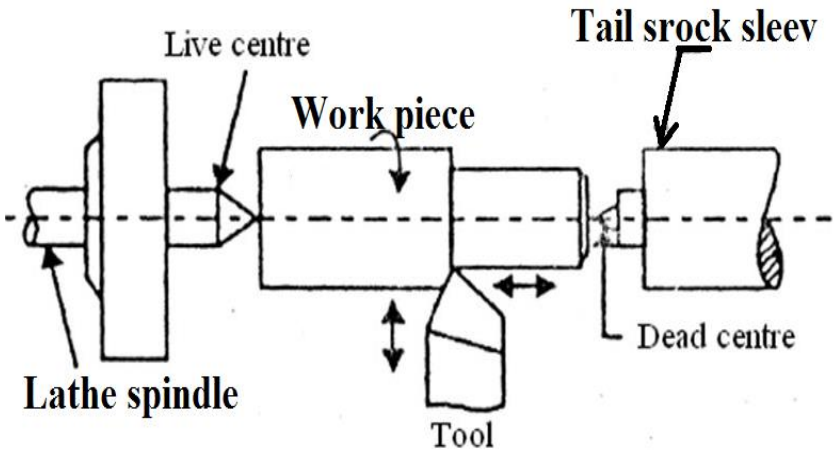
Machine Shop

Lathe Machine

A Lathe machine is a machine tool which is used to remove metal piece to give a desired shape and size. In other words, it is a machine tool that is used to hold the work piece to perform various metal removing operations.

Working principle:

The lathe machine holds a work piece between two rigid and strong supports called the centre or in the chuck or faceplate which revolves/rotates. The cutting tools feed either parallel or at right angles to the axis of the work piece or job.



Working principle of lathe machine

List of operation that can be performed on lathe machine:

1) turning
2) facing
3) grooving
4) parting
5) threading
6) drilling
7) boring
8) knurling
9) tapping

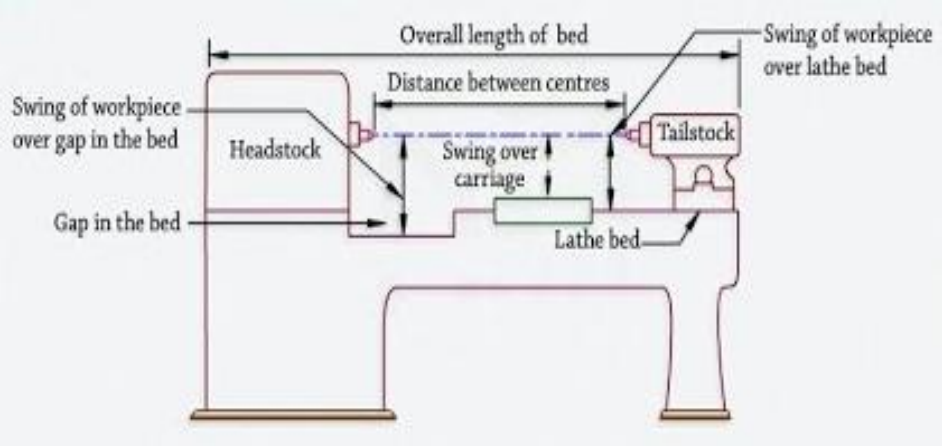
Types of Lathe Machines

1) Speed Lathe Machine.
2) Center Lathe or Engine Lathe Machine.
3) Turret Lathe Machine.
4) Toolroom Lathe Machine.
5) Bench Lathe Machine.
6) Automatic Lathe Machine.
7) Special Purpose Lathe Machine.
8) CNC Lathe Machine.

Lathe specification

A Lathe machine is specified by the following:

1) The height of the centers measured from the lathe bed.
2) Swing diameter over bed. This largest diameter of the workpiece which will revolve without touching the bed. It is equal twice the height of centers from the bed.
3) Swing diameter over carriage. It is the largest diameter that can revolve over the cross-slide. This always less than the swing diameter over the bed.
4) Maximum bar diameter. This is the maximum diameter that will pass through the headstock spindle.
5) Length of the bed.



Specification of lathe

The main parts of a lathe machine are:

- Head Stock
- Tail Stock
- Bed
- Tool post
- Legs

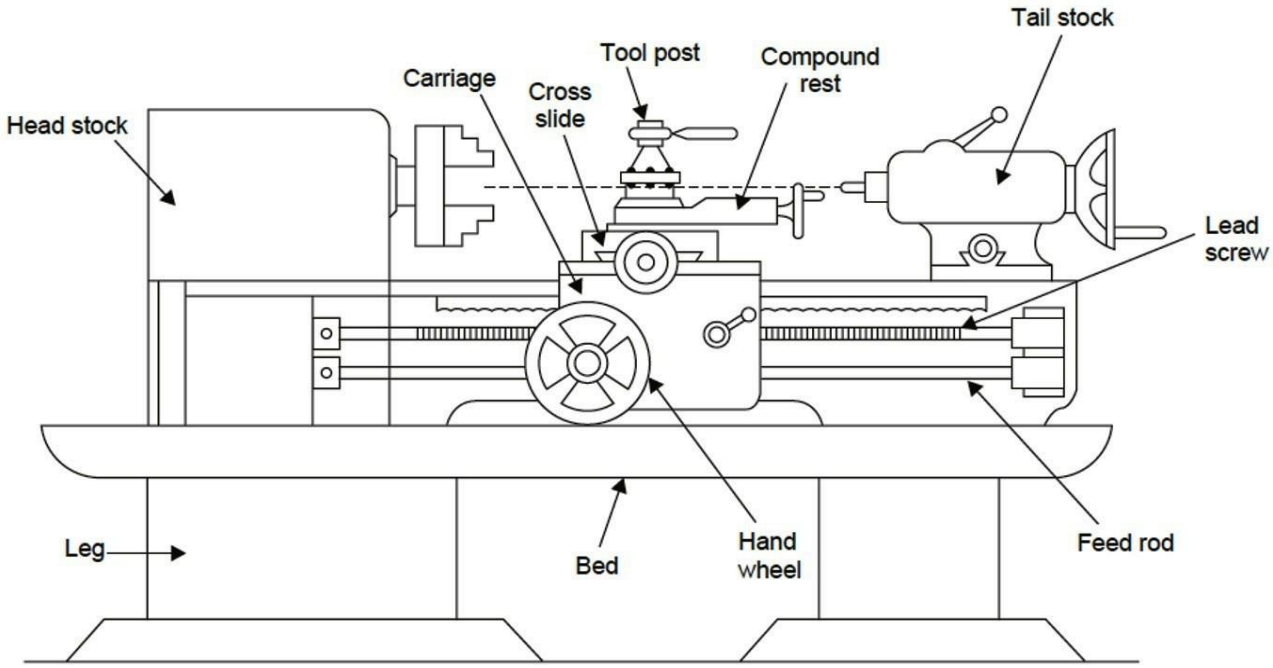
Head Stock: The head stock is clamped on the left side of the bed and it serves as housing for the driving pulleys, back gears, headstock spindle, live centre and the feed reverse gear.

Tail Stock: The tail stock is a movable casting located opposite the head stock on the ways of the bed. The tail stock can slide along the bed. A tail stock can be set at any desired position.

Bed: The bed is a heavy casting in which working parts of the table are mounted. It carries the head stock and tail stock for supporting the work piece and provides a base for the movement of carriage assembly which carries the tools.

Tool Post: The tool post is mounted on the compound rest and it rigidly clamps the cutting tools or tool holder at the proper height related to the work centre.

Legs: The legs carry an entire load of the machine and the firmly seared floor by foundation bolts.



Lathe Machine

Cutting Parameters

1. Cutting speed

It is defined as the speed at which the material is removed and is specified in meters per minute. Ti depends upon the work piece material, feed, depth of cut, type of operation and so many other cutting conditions. It is calculated from the relation,

Spindle speed (RPM) =cutting speed x 1000 / (πD), Where D is the work piece diameter in mm.

2. Feed

It is the distance traversed by the tool along the bed, during one revolution of the work. Its value depends upon the depth of cut and surface finish of the work desired.

3. Depth of cut

It is the movement of the tip of the cutting tool, from the surface of the work piece and perpendicular to the lathe axis. Its value depends upon the nature of operation like rough turning or finish turning.

Shaper Machine

A shaper machine is a vertical machine which is used to produce a flat plane surface which may be a horizontal or vertical or angular is also used to produce contour of concave/convex or a combination of these.

Working Principle:

In a shaper machine, the job is rigidly held in a machine vice tool. The ram reciprocates end to end so the forward stroke cuts while the return stroke is idle. The job is given index feed normal to the line of action of the cutting tool.

The main parts of a Shaper Machine:

- Base
- Ram
- Tool Head
- Cross Rail

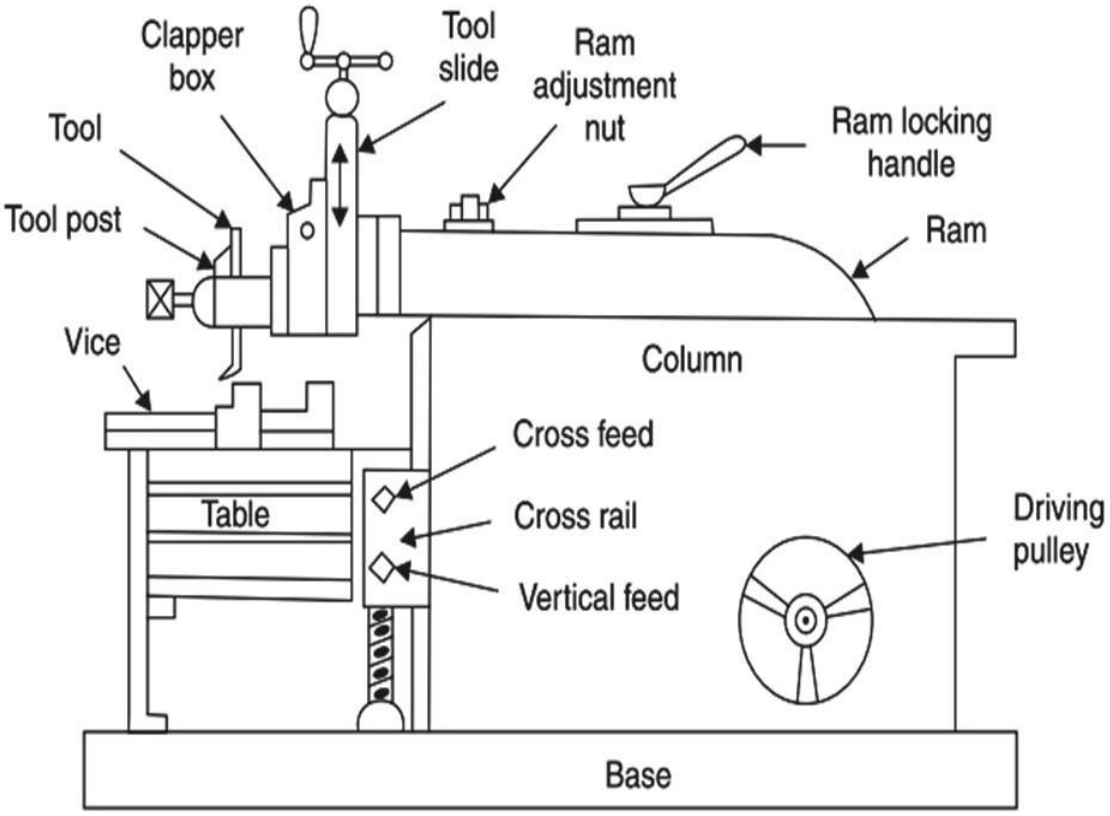
Base: It is the main body of the machine. It consists of all elements of the machine. It works as a pillar for other parts. The base is made of cast iron which can take all compressive leads.

Ram: It is the main part of the shaper machine. It holds the tool and provides the reciprocal motion to it. It is made of cast iron and moves over the ways of the column. It is attached by the rocker arm which provides its motion in a crank driven machine.

Tool head: It is situated at the front of the ram its main function is to hold the cutting tool. The tool can be adjusted by it using a clamp.

Cross Rail:

It consists of vertical and horizontal table sideways which allows the motion of the table to which it is attached with the same cross-movement mechanism.



Shaper Machine

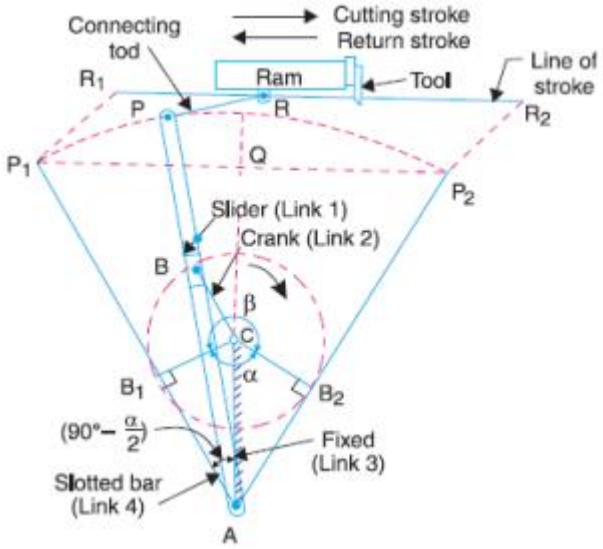
Specifications of Shaper Machine

A shaper machine can be specified on given parameters

1) Length of Ram
2) Adjustable stroke
3) Max. & Min. distance from Table to Ram
4) Max. table travel (Horizontal & Vertical)
5) Angular movement of table
6) Max. vertical travel of tool slide
7) Max. swivel of tool slide
8) No. of ram speeds & range of speeds
9) Range of table feed per stroke of ram
10) Overall dimensions (Length, Width, Height)
11) Net weight

Quick return mechanism of a shaper machine

A quick return mechanism is an apparatus that converts circular motion into reciprocating motion in presses and shaping machines, which are utilized to shape stocks of metal into flat surfaces. This mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. The word quick return indicates that the returning stoke is faster than the forward stroke which help the tool to retrieve back faster after doing a particular job. Quick-return mechanisms feature different input durations for their working and return strokes. The time ratio of a Quick Return mechanism is the ratio of the change in input displacement during the working stroke to its change during the return stroke

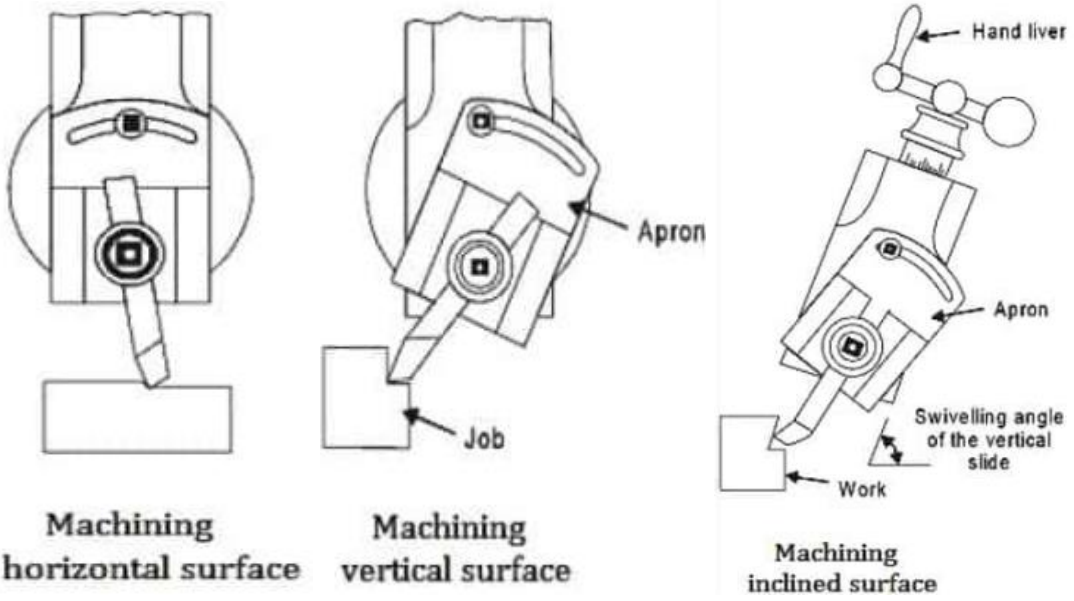


Quick return mechanism of a shaper machine

The different operations, which a shaper can perform, are as follows:

1) Machining horizontal surface.
2) Machining vertical surface.
3) Machining inclined surface.
4) Slot cutting.
5) Keyways cutting.
6) Machining irregular surface.

7) Machining splines and cutting gears



Machining horizontal surface

Machining vertical surface

Machining inclined surface

Drill Machine

Drilling is an operation of making/producing a circular hole by removing a volume of metal from the job with a cutting tool called a twist drill. A drill is a rotary end-cutting tool with lips and clusters for the passage of cutting fluids. A drilling machine tool is designed for drilling hole in metal.

List of operation that can be performed on drill machine:

1) Drilling operation.
2) Reaming operation.
3) Boring operation.
4) Counterboring operation.
5) Countersinking operation.
6) Spot facing operation.
7) Tapping operation.
8) Lapping operation.

Types of drill machine

Drill machines are usually following types

1) Portable drilling machine
2) Sensitive drilling machine
3) Upright drilling machine
4) Radial drilling machine
5) Gang drilling machine
6) Multiple spindle drilling machine
7) Automatic drilling machine
8) Deep hole drilling machine

Working principle of a drill machine:

The rotating edge of the drills exerts a large force on the work piece and the holes are generated. The removal of metal in a drilling operation is by shearing and extrusion.

Main parts of a Drill Machine:

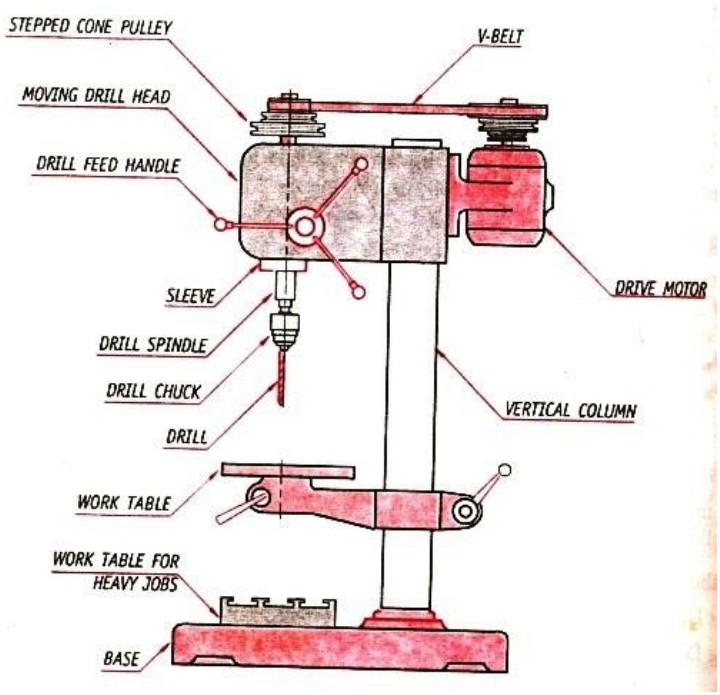
- Base
- Table
- Spindle
- Drill head

(1)Base: The base is used to support and stabilize the column or pillar drill.

(2)Table: The table supports the working material object and can be adjusted to the size of the work piece. The table is adjusted by rotating around the pillar.

(3)Spindle: The spindle holds and rotates the drill bit. Its speed is adjusted to control the depth and diameter of the hole being bored.

(4)Drill Head: The drill head houses the spindle and moves it upward or downward.



Drill Machine

Milling Machine

A milling machine is a machine tool in which cutting operation removes metal by feeding the work against a rotating cutter having single or multiple cutting edges flat or curved surfaces of many shapes can be machined by milling with well-finished accuracy. A milling machine may also be used for drilling, slotting, making a circular profile and gear cutting by having suitable attachments.

Working principle: The work piece is held on the worktable of the machine. The table movement controls the feed of the work piece against the rotating cutter. The cutter is mounted on a spindle or rotating a bar at high speed. Except that the rotating cutter has no other motion. As the work piece advances the cutter teeth remove the metal from the surface of work piece and the desired shape is produced

Main parts of a milling machine: milling machine has the following parts-

Base: It gives support and rigidity to the machine and also acts as a reservoir for the cutting fluids.

Column: The column is a main supporting frame mounted vertically on the base. The column is box-shaped, heavily ribbed inside and houses all the driving mechanisms for the spindle and the table feed.

Knee: The knee is a rigid casting mounted on the face of the column. The knee moves vertically along the guide ways and this movement enables to adjust the distance between the cutter and the job mounted on the table.

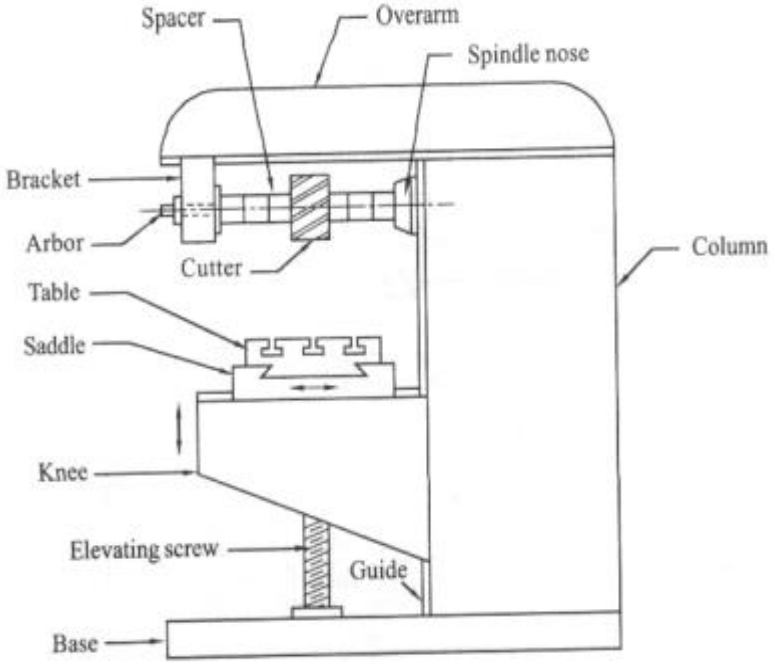
Saddle: The saddle rests on the knee and constitutes the intermediate parts between the knee and the table. The saddle moves transversely.

Table: The table rests on guide ways in the saddle and provides support to the work. The table is made of cast iron. Its top surface is accurately matched and carries slots which accommodate the clamping bolt for fixing the works. The job fitted on it is given motion in three directions.

Over arm: The over arm is mounted at the top of the column and is guided in perfect alignment by the machined surface. The over arm is the support for the arbor.

Arbor support: The arbor support is fitted to the over arm and can be clamped at any location on the over arm.

Elevating screw: The upward and downward movement to the knee and the table is given by the elevation screw that is operated by hand or an automatic feed.



Horizontal milling machine

Types of Milling Machine:

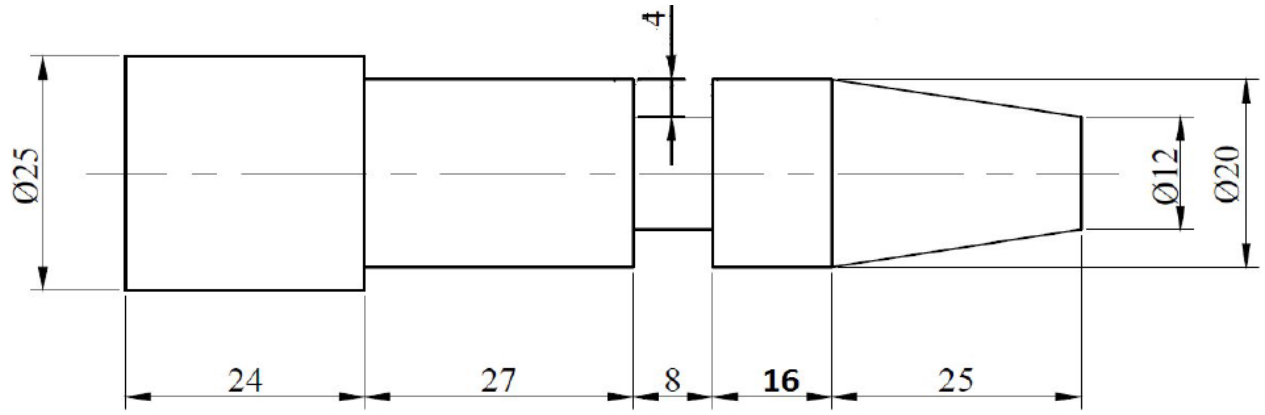
1) Horizontal milling machine.
2) Vertical milling machine.
3) Column and Knee Type Milling Machine
4) Simplex milling machine.
5) Duplex milling machine
6) Triplex milling machine.
7) Fixed Bed Type milling machine.
8) Universal Milling Machine

Milling Machine Operations

1) Face Milling Operation
2) Slot or Slab Milling Operation
3) End Milling Operation
4) Angular Milling Operation
5) Side and Face Milling Operation
6) Form Milling Operation
7) Slitting Operation
8) Keyway Milling Operation
9) Gear Cutting Operation
10) Profile Milling Operation
11) Helical Milling Operation

Machine shop Experiment No.1

Object: To study and perform various operations on a given mild steel job by a lathe machine.



Materials used: Mild steel rod of Ø 25 mm X 100 mm

Tool used: Lathe machine, single-point cutting tool etc.

Procedure:

(a) Place the round bar in the chuck (three jaws self – centring chuck) of the lathe machine and tighten the chuck using chuck key.

(b) Mount the single point cutting tool on the tool post with the help of the tool post key.

(c) Now face both the ends of the round bar by facing operation so that the length is brought to 100 mm. Check the length by vernier calliper.

(d) Start turning operation to obtain the different steps on the round bar, i.e. 100× ϕ 25 mm. Check the diameter and length by Vernier calliper.

(e) Set the cross slide to about 450 and give a small feed-in longitudinal direction. Move the tool using the cross slide to chamfer the ends.

(f) Mount another grooving tool on the tool post with the help of the tool post key.

(g) Start grooving operation to obtain the desired dimensions

Conclusion: Then the final job is prepared as shown in the figure.

Precaution:

a) Loose clothes should not be worn.

b) Job must be fixed tightly in the chuck using the chuck key.

c) Chuck key must be removed from the chuck before starting the machine.

d) Machine should not be left in the running position when the operation is not being done.

e) Use a brush for removing chips instead of using hand.

f) The last cut for facing and turning should be done with the smallest feed to ensure a smooth finish.

Carpentry Shop

Carpentry is an art or process of shaping timber, using hand tools. The products produced are used in building construction, such as doors and windows, furniture manufacturing, and patterns for moulding surfaces after shaping them. Hence, the term joining together wooden pieces and finishing the studying the fundamentals of woodworking has to know about timber and other carpentry materials , woodworking tools, carpentry operations and the method of making common types of joints.

Properties of good Timber:

- A good timber should possess the following properties
- A good timber should be free from any defects such as knots, cup and ring shake, twisted fibers, decay or any defects
- A good timber should be easily available A good timber should be low in lost
- A good timber should be quite suitable and soundproof construction A good timber should be easily workable
- A good timber should be strong and rigid but should be light in weight A good timber should have regular annual tings
- A good timber should be free from any natural defect A good should have a dark colour
- A good timber should be resistant to fire
- A good timber should possess straight fibers
- A good timber should not easily distort after seasoning
- A good timber should not easily split when nails are driven into it A good should give a good response after painting and polishing

Types of wood: the wood which can be converted into timber can be classified into two major categories

- Soft wood
- Hard wood

Soft wood: soft wood is very common in use. It is light in weight and colour. Soft wood has distinct annular rings and straight fibers and can withstand axial load but cannot with stand any stress across the fiber. Some common soft wood are pine, chirr, deodar, teak etc.

Hard wood: hard wood is very common in engineering use. They have their annular rings compact and less distinct. As compared to soft wood they are dark in colour. They can withstand a load. Some common hard wood is sal, babool, shisham, mahogany etc.

Differentiate between soft and hard wood:

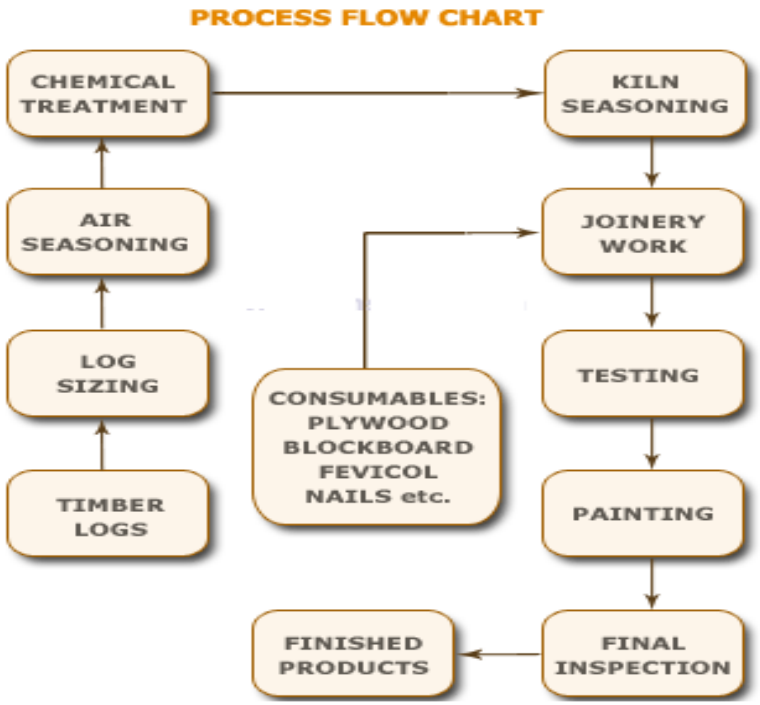
Soft wood	Hard wood
1. It is light in colour	1. It is dark in colour
2. It is weaker and less durable	2. It is stronger and more durable
3. It is light in weight	3. It is heavy in weight
4. It processes straight fiber and fine texture	4. It processes quite close and compact fiber.
5. It is easy to workable	5. It is difficult to workable
6. annual rings of soft wood are quite distinct	6. annual rings are not distinct
7. It gets spitted quickly	7. It does not spit quickly
8. It possesses good tensile resistance but weak across fiber	8. It possesses both good tensile as well as shear strength

Seasoning of timber:

Seasoning is one of the important processes to remove the moisture content from the timber. The basic object of seasoning is to remove or minimize the moisture particles from the timber. Once the moisture particles are removed from the timber/wood then any woodworking operation can be easily performed. If moisture particles are not removed from the timber/wood then more chance of twisting or warping, uneven shrinkage etc.

Objects of seasoning

1. To prevent injury by insects and decay before the timber is placed in service.
2. To increase the durability of timber in service.
3. To prevent shrinking and checking of the wood in service.
4. To increase the strength of the wood.
5. To decrease the weight of the wood and hence reduce shipping charges.
6. To prepare the wood for its injection with preservatives and other industrial uses.



Flow chart of seasoning process

Method of seasoning:

Different methods are used for the seasoning of timber. They are given below:

(a) Natural or air seasoning:

Timber is normally placed in a hut/building, with two sides open to allow air to circulate. The roof and two other sides keep the timber relatively dry. The circulation of the air slowly dries the timer. However, this technique does not give precise moisture content. This is because air circulates freely and carries moisture, depending on the weather and the time of year. The spacing sticks keep the seasoning boards a short distance apart. The air flows between each of the seasoning boards, allowing them to dry slowly. In this way, warping is kept to a minimum.

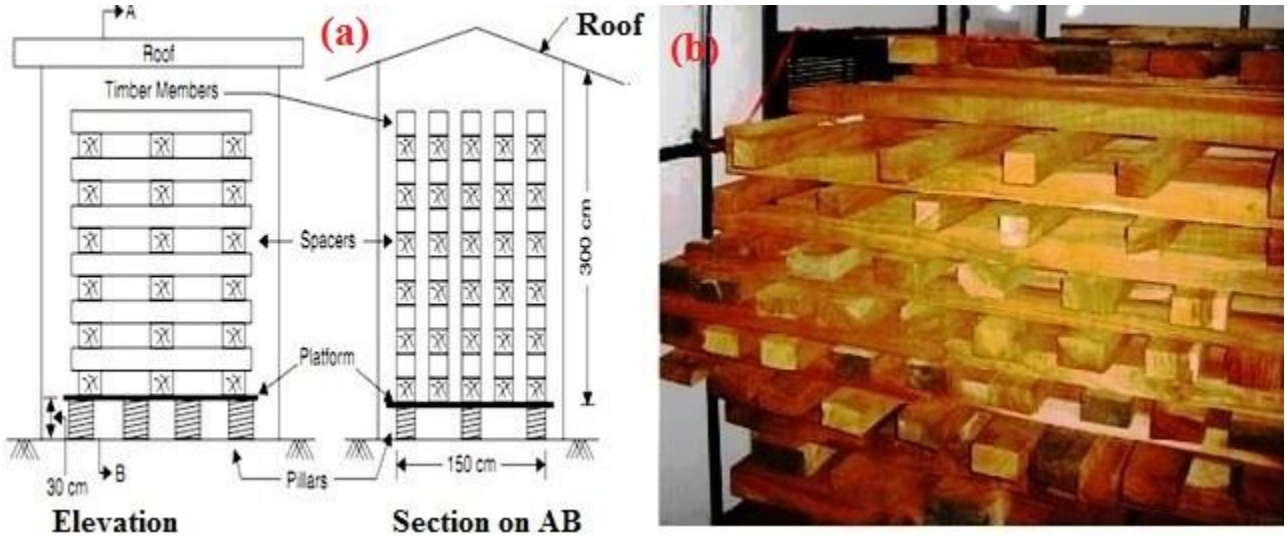
The seasoning time varies depending on the thickness of the wood boards and the time of year. Usually three to four months for 25 mm softwoods. The time is doubled, for wood is twice as thick. Hardwoods of 25 mm thickness require about six months and up to at least a year for 50 mm boards

Advantages of air seasoning

1. Simple and cheap process
2. Very less chance of damage to timber
3. Process not require too much attention

Limitations of air seasoning

1. Process is very slow taking over years
2. Huge Space is required for a very large stack
3. Rigid control cannot be exercised
4. Capital block for a long time
5. Timber may get damaged by insects and fungi during the seasoning period



Air seasoning of timber

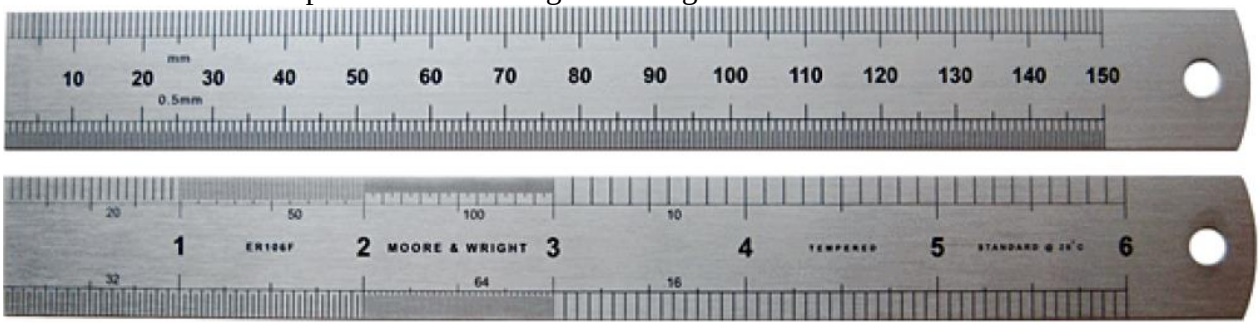
(b) Water seasoning
(c) Artificial or kiln seasoning
(d) Other methods of seasoning

Marking and measuring tools

- Rules
- Straight Edge and Squares
- Steel Tape
- Gauges
- Try Square

Steel Rule

It consists of a hardened steel strip having line graduation etched or engraved in it they are usually 150 mm or 300 mm long and is used to take line measurement to an accuracy of 1 mm or 0.5 mm. These are marked in inches or millimeters. All the faces are machined true. The edges of the steel rule should be protected from rough handling.

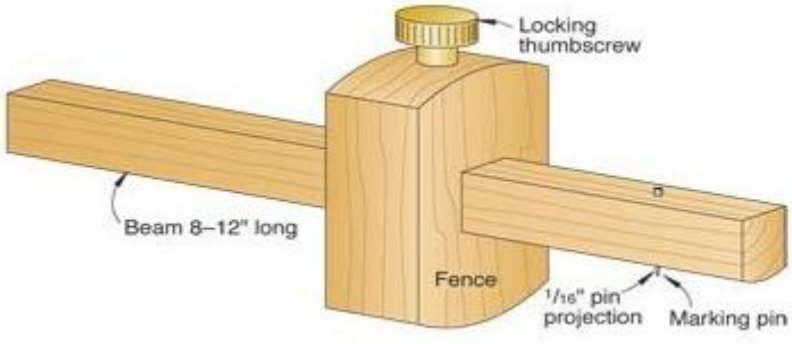


Engineering scale

Cutting Tools

Saws
Chisels

Gauges: Gauges are used to mark lines parallel to the edges of the wooden piece. It mainly consists of a wooden stem sliding inside a wooden stock. The stem carries a steel point for marking lines.



Mortise gauge

Try Square: Try Square consists of a rectangular steel blade fixed rigidly to cast iron stock. The length of the blade varies from 150mm to 300mm.

Try square

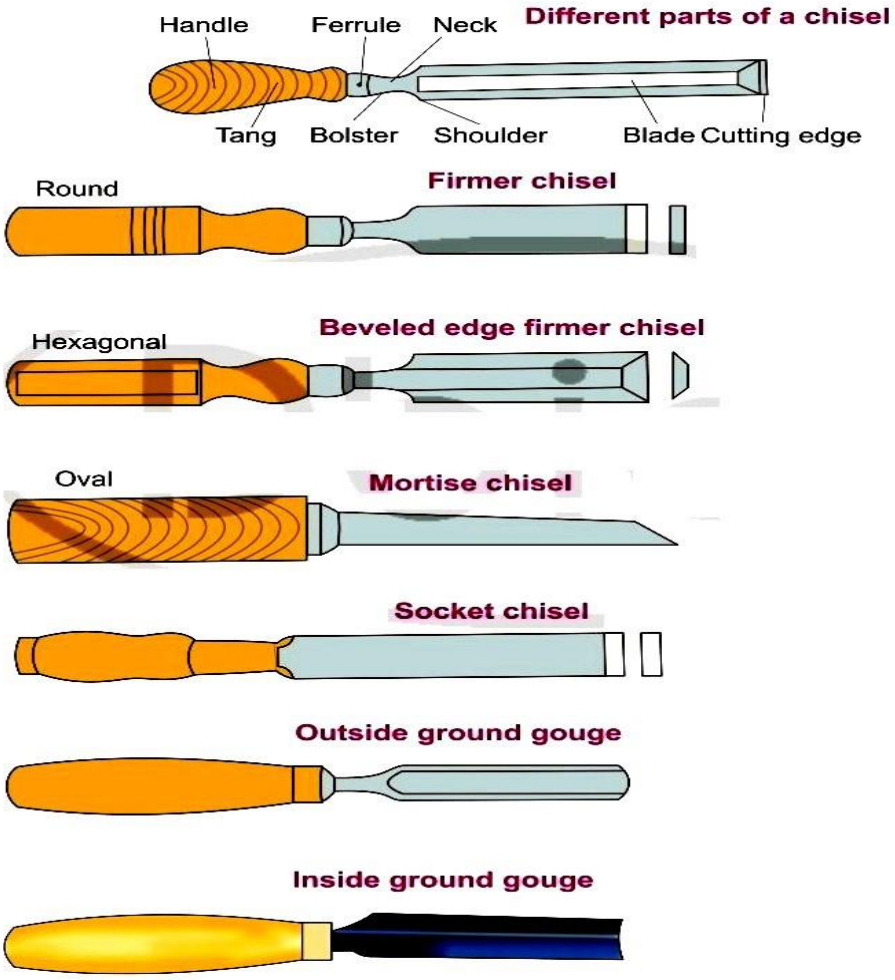
Chisel

Firmer chisel:

The firmer chisel is capable of doing heavy work and is used for jointing and shaping the wood, with or without a mallet. The chisel blade is made of a rectangular section with a bevelled edge length of the blade is about 125mm and the width of the edge varies from 3 to 5 mm.

Firmer chisel

- Socket Chisel
- Dovetail Chisel
- Outside Ground Gauge
- Inside Ground Gauge



Different types of carpentry chisels

Dovetail chisel:

It is similar to a firmer chisel but the sides are leveled so that it can cut sharp corners. It is used for cutting sockets where the angles are less than a right angle.

Mortise chisel:

These chisels are robust and can withstand heavy blows. It has a thick stock and narrow cutting edge. It is used for cutting mortises, and its width is ground to the exact size of the mortise to be out.

Planning tools

- Wooden Jack Plane
- Metal Jack Plane

Wooden jack plane: This is the most commonly used plane in the carpentry shop. The main part of a wooden jack plane is a wooden block called scale, in which a steel blade having a knife-edge is fixed at an angle with the help of a wooden edge. The angle of the blade is kept at about 45° to the bottom surface of the blade.

Wooden jack plain

Metal Jack Plane: It serves the same purpose as the wooden jack plane but facilities a smoother operation and better finish. The body of a metal jack plane is made from a grey iron casting with the side and sale machined and ground to a better finish.

Metal jack plane

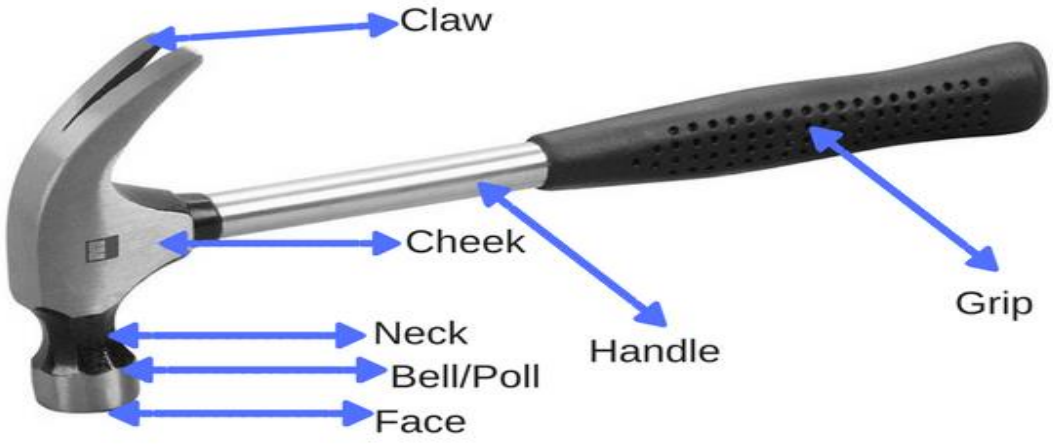
Striking Tools

1. Mallet
2. Claw Hammer
3. Pincer

Mallet: This is the wooden-headed hammer of a round or rectangular section. The striking face is made flat. Mallet is used for cutting tools and has a wooden handle.

Mallet

Claw hammer: This is a hammer having a steelhead and wooden handle. The flat face of the head and claw portion for extracting nails out of the wood.



Claw hammer

Pincer: It is made of two forged steel arms with a hinged joint and is used for pulling out small nails from wood. The inner faces of the pincer jaws are beveled and the outer faces are plain.

Saw:

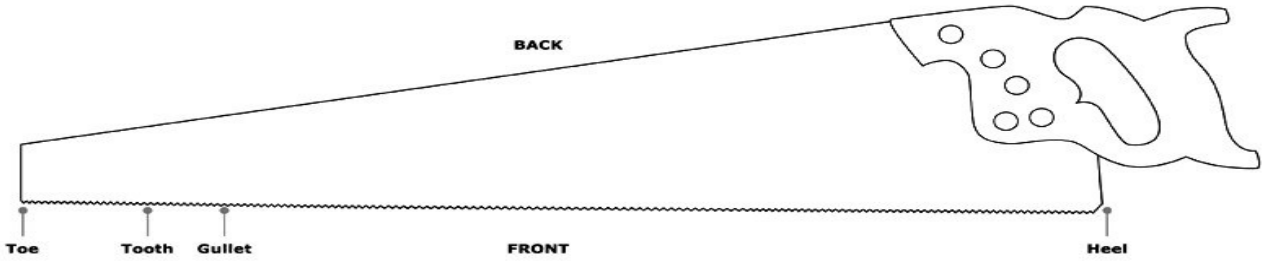
A saw is used for cutting wood. It consists of a handle, which is made from wood, plastic or aluminium. The blade is made up of high carbon steel or spring steel. The points of the teeth are bent in a zig-zag fashion, to cut a wide groove and prevent the body of the blade from rubbing or jamming in the saw cut. The teeth of the blades are generally forward cut so in this case, pressure is applied in the forward direction only.

Depending upon the direction of cut, blades are classified as:

- Forward cut
- Backward cut.

Types of saw:

(1) Rip saw: It is a hand saw from 30 cm to 75 cm long containing one to one-half teeth per cm. It should not be called a hand saw but a rip saw only cutting of the wood is done along the grains nearly the entire length of the saw blade is used for cutting.

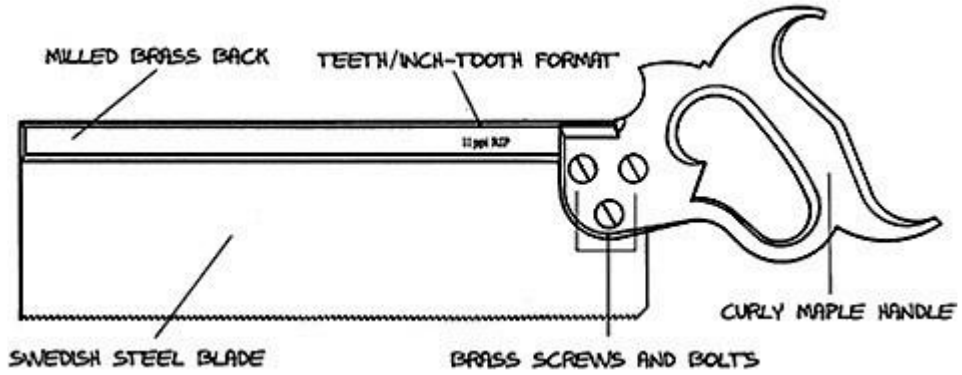


Rip saw

Keyhole saw or pad saw: It is used for cutting thick internal curves other it is impossible to use other saws.

Keyhole saw

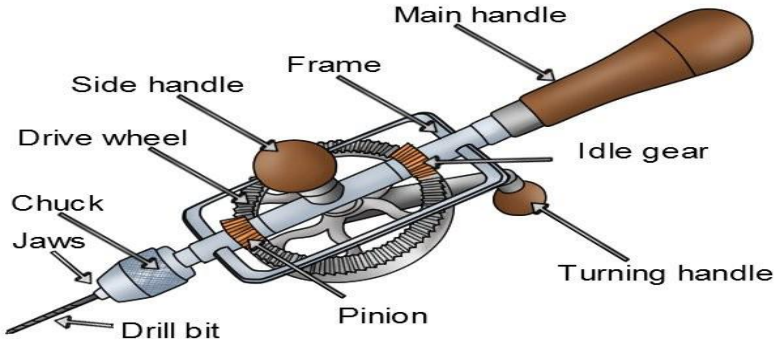
Tenon Saw: It derives its name from the Tenon form of joint. It is a thin saw ranging from 20 cm to 40 cm in length and is supported by the back of wrought iron or brass; hence it is also called a black saw. It contains teeth. It is used primarily for shortcuts such as Tenon. So the blade is provided with a reinforcing strip or back at the top so that blade is prevented from bending during operation.



Tenon saw

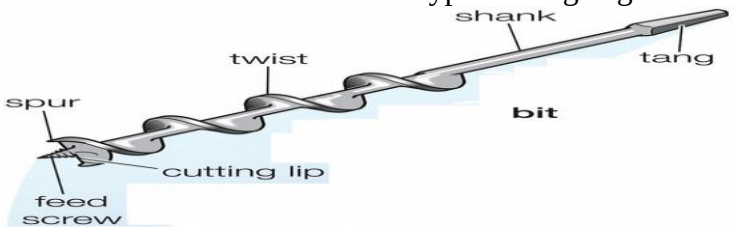
Coping saw: It is used for cutting quick or sharp curves either internal or external. For cutting the surface first drilling is done and then the saw blade is inserted in the hole for cutting.
Double ended saw: It is a saw provided with two handles. One at each end is used for cutting heavy timber across the grains.

Drilling and boring tools
Hand drill Machine: The hand drill consists of a spindle, drill chuck, crank handle and two bevel gears. Bevel gears are fitted on the body. The drill is held in a chuck and rotation to the spindle is given through gears with the help of a crank.



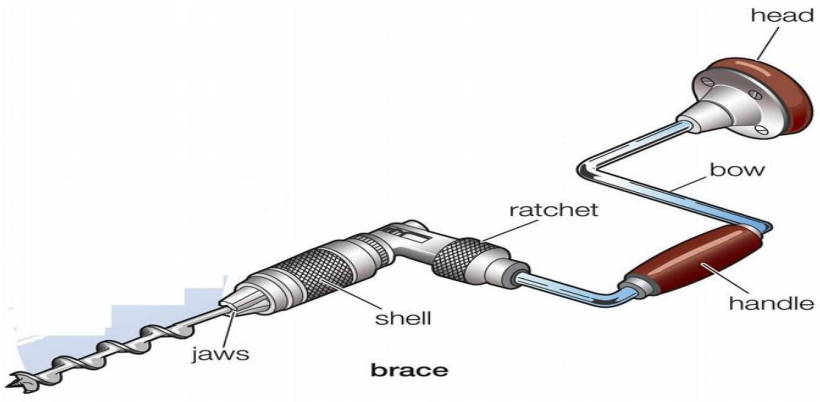
Hand drill machine

Gimlet drill: Gimlet Drill is a very simple type of drilling tool. It consists of two parts. One is a gimlet and the second one is a handle. It has a screw-type starting edge.



Gimlet drill

Ratchet brace: It consists of a crank, a head, a ratchet, and a chuck for holding the drill. The head is pressed with one hand and the crank is rotated with the other hand.



Ratchet type hand drill machine

Wood rasp files:

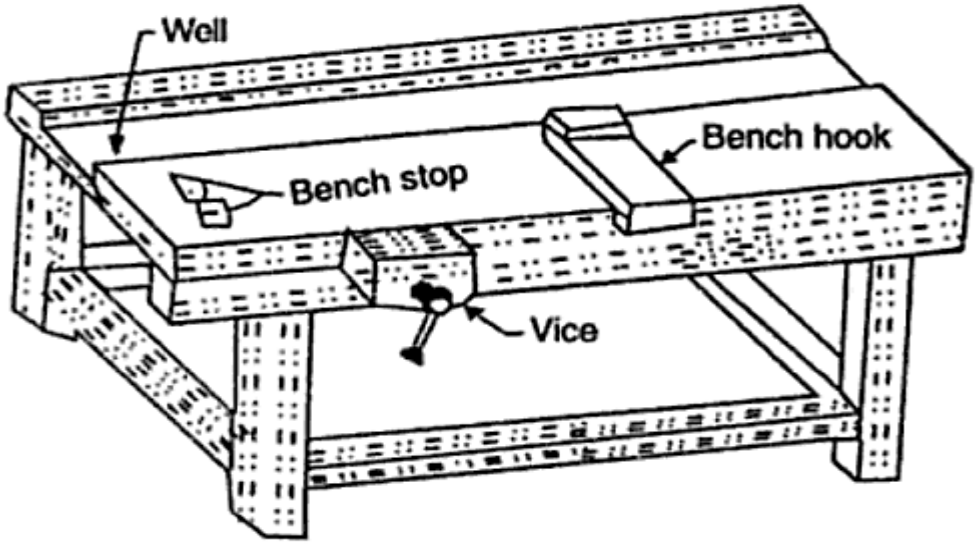
It is a finishing tool used to make the wood surface smooth, remove sharp edges, and finish fillets and other interior surfaces. Sharp cutting teeth are provided on its surface for the purpose. This file is exclusively used in woodwork.

Rasp

Holding tools

- Work Bench

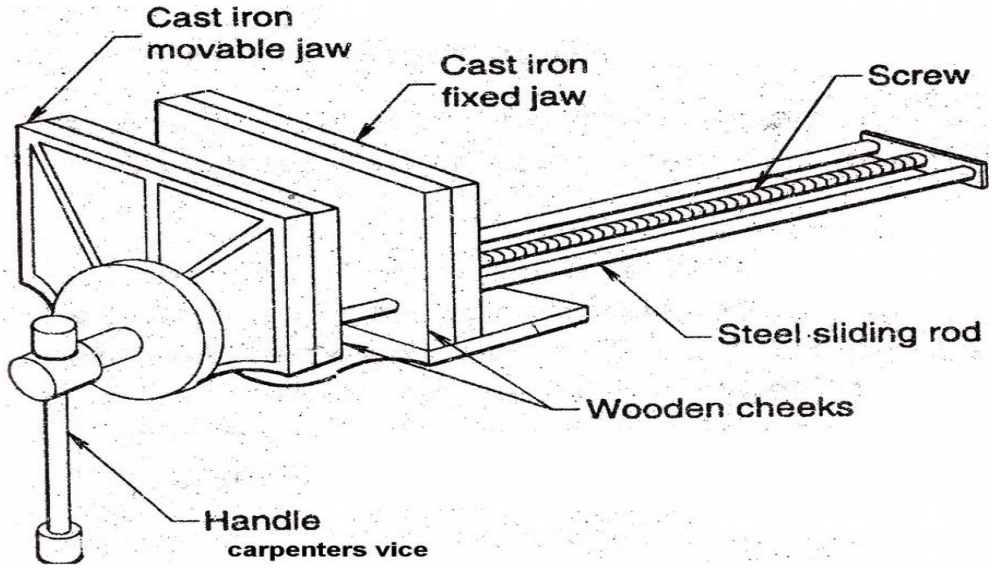
This is a table of having a size and raised construction made of hardwood. The size ranges from 50- 80 cm in length and about 90 cm in width. Two or four carpenters can work at a time on the workbench.



Workbench with a bench hook

Workbench table: It is a table which is made of Sal or sneasour wood. The size of the table is 6'x3'. Two-four carpentry vice can be fixed at the four corners of the table. This table acts as a base for all carpentry or woodworking operations.

Carpentry bench vice:



Carpentry bench vice

Carpentry shop Experiment No.1

Object:

To make a roller in a carpentry shop with the help of carpentry tools and machines as per the given dimensions.

Tools used:

Engineering scale or steel scale

Machine used:

Circular saw and woodworking lathe machine.

Material used:

Soft wood (Kail wood)

Procedure:

a) First of all, take the soft wood and move on it with a pencil and cut it with the help of a circular saw or sip saw.
b) Then put the wood piece in the middle of the woodworking lathe machine and with the help of a gauge chisel round the wood and give it the proper shape.
c) After that finishing with sandpaper is obtained.

Precautions:

1. Listen to the teacher carefully when he is describing about machine and use it properly.
2. Use the machine carefully and take care of your hands while cutting wood.
3. Shape the order properly, otherwise, it will not be round.

Carpentry shop Experiment No.2

Object:

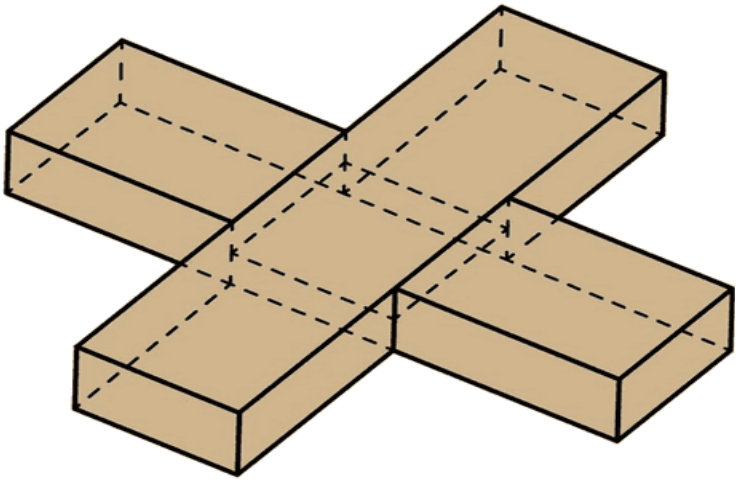
To make a cross lap joint final carpentry shop with the help of carpentry tools as per given dimensions.

Tools used:

Inch scale, Try square, Rip saw, firmer chisel, iron Jack planner, rasp, workbench, clamping vice, and mallet.

Materials Used:

Soft wood (Kail) of a given size.



Cross lap joint

Procedure:

- First of all we take the soft wood and cut the wood in a given length from a rip saw then mark the dimensions on the wood with the help of an inch scale and try square.
- After marking and cutting, the iron Jack plane is used for a better finish.
- Then cut the wood into two pieces equally.
- Again with the help of a scale, mark the centre and cut help both the pieces inside.
- Then a firmer chisel finishes the inside groove.
- Then with the help of a mallet strike the joints cross too joint is obtained.

Precautions:

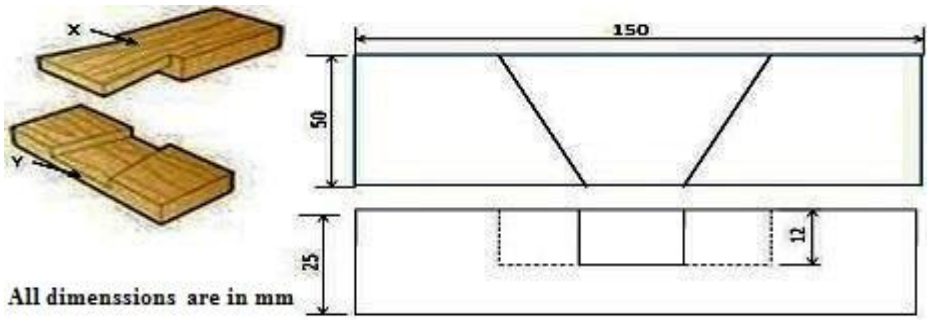
- Take care of your hands while cutting the wood.
- Cut the grooves properly so that both wood pieces can fit together to make a cross lap joint.
- Measure everything carefully so that cross lap joints can be made properly.

Or

Carpentry shop Experiment No.3

Object: To make a dovetail lap joint with the help of carpentry tools as per the given dimensions.

Materials required: Teak wood (30 mm x 150 mm x 50 mm)



Tools and equipment used:

- Steel rule
- Try square
- Marking gauge
- Rip saw
- Tenon saw
- Mortise chisel
- Mallet
- Jack plane
- Wood rasp file

Operations to be carried out:

- Planning
- Marking
- Sawing
- Chiseling
- Finishing

Procedure:

1. The wooden pieces are made into two halves and are checked for dimensions.
2. One side of the pieces is planned with a jack plane for straightness.
3. An adjacent side is planned and checked for squareness with a try square.
4. The marking gauge is set and lines are marked at 40-50 mm to make the thickness and width according to the given figure.
5. The excess material is planned to the correct size.
6. Using a tenon saw, the portions to be removed are cut into both the pieces
7. The excess material in X is chiselled with a mortise chisel.
8. The excess material in Y is chiselled to suit X
9. The end of both the pieces is chiselled to exact lengths.

Precautions:

- Wood should be free from moisture
- Marking is done without parallax error
- Care should be taken while chiselling
- Matching of X and Y pieces should be tight.

Result: The dovetail lap joint is fabricated successfully.

Carpentry machines:

Circular Saw:

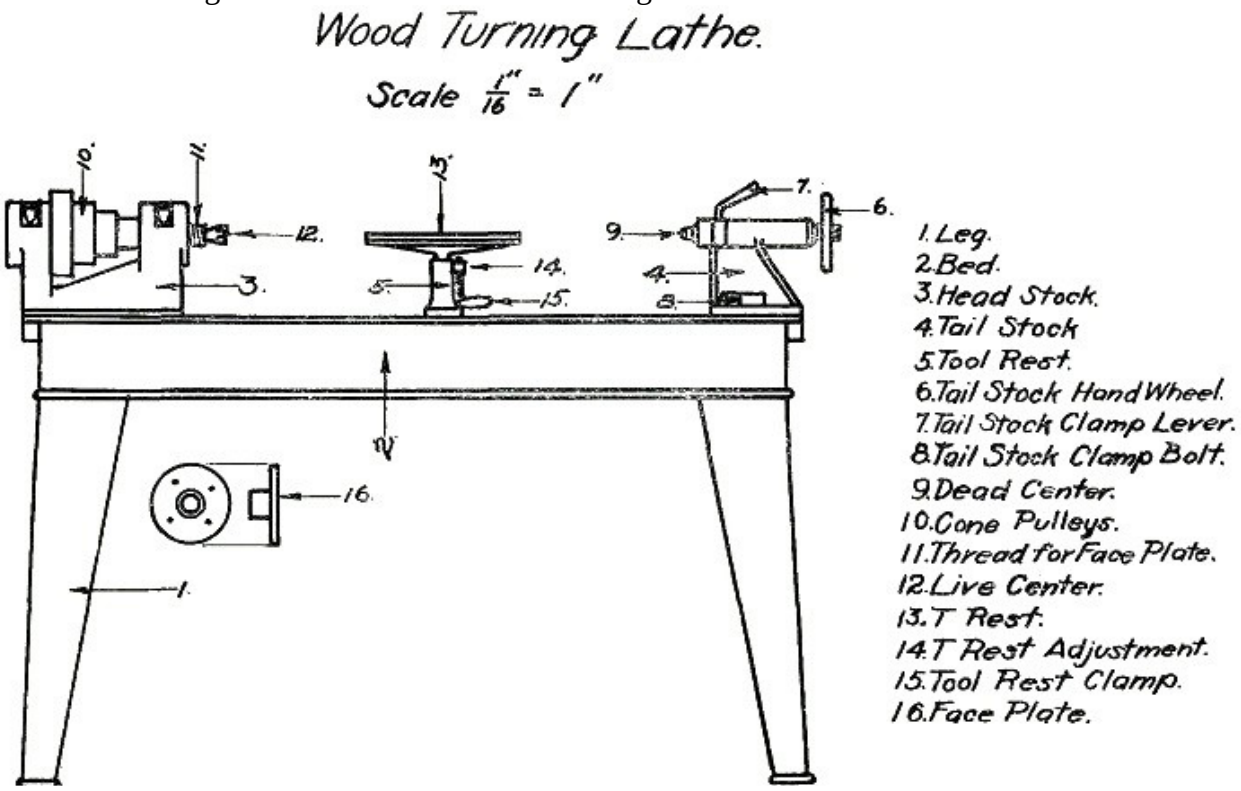
Circular saw machines are usually used in grooving, mortising, tenoning and cutting the length, width and thickness of surfaces and edges flattened parts to the desired dimensions and angles in machining of wood and wood-based materials. Various machines and saw blades that have many different types and technical specifications are used for many operations. These are single or doubled circular saws. Parts are one by one in single sawed type, and one or more in doubled type depending on the size of the parts.

Power band saw:

A band saw consists of a table guide, pulley belt and tension adjusting screw. It is used to saw the wooden pieces lengthwise fence is used to adjust the thickness of cutting stop. A bland type cutter revolves over two pulleys as illustrated in the figure.

Woodworking lathe:

A woodworking lathe consists of a coalition bed, a head stock, tail stock, tool rest, live and dead centre and driving mechanisms. It is used for producing round symmetrical jobs scrapping tools. Chisel and turning tools are used on a woodworking lathe.



Carpentry lathe machine

Tools:

Gauge:

It is used to finish curved holes. Gauge chisels are of two types I.e. inside and outside.

Skew: A skew chisel is a tool with a characteristically shaped cutting edge blade on its end for carving or cutting a hard material such as wood, stone or metal. The handle of the blade is made of metal or wood with a sharp edge on it.

Flat chisel: A flat chisel of hardened tempered steel is used to obtain a flat and finished surface (as on wood or stone).

Sheet Metal Shop

Introduction: Sheet metal work has its own significance in engineering work. Many products, which fulfill the household needs, decoration work and various engineering articles, are produced from sheet metal. A common example of sheet metal is hoppers, canisters, guards, covers, pipes, hoods, bends, boxes, etc.

Such articles are found less expensive and lighter in weight and in some cases, sheet metal products replaced the use of casting or forgings.

Advantages of the sheet metal:

1. High strength
2. Good dimensional accuracy
3. Good surface finish
4. Economical mass production (low cost).

Parts made by Sheet Metal Forming

- Car bodies
- • Aircraft fuselages
- • Trailers
- • Office furniture appliances
- • Fuel tanks
- • Cookware

Sheet metal operations:

Various types of operations are performed in sheet metal.

- Shearing
- Blanking
- Punching (Piercing)
- Bending
- Stamping
- Drawing
- Deep Drawing
- Embossing
- Spinning
- Roll Forming

Metals used sheet metalwork:

A metal plate of thickness less than 4mm is considered a sheet. The size of the sheet is specified by its length, width and thickness in mm. In the British system, the thickness of the sheet is specified by a number called Standard wire gauge (SWG). The commonly used gauge numbers and the equivalent thickness in mm are given below.

S.No.	**SWG No.**	**Thickness(mm)**
1	10	3.20
2	12	2.60
3	14	2.30
4	16	1.62
5	20	1.00
6	22	0.71
7	24	0.65
8	26	0.45
9	30	0.30

The following metals are generally used in sheet metalwork:

Block Iron Sheet: It is the cheapest among all. It has a bluish-black appearance and is an uncoated sheet. Being uncoated it corroded rapidly. It is prepared by rolling to the desired thickness then annealed by placing in a furnace and then set aside to cool gradually.

Galvanized Iron: It is a soft sheet coated with molten Zinc. This coating resists rust, improves appearance, improves solderability and improves water resistance. It is popularly known as GI sheets.

Stainless Steel: It is an alloy of steel with nickel, chromium and traces of other metals. It has good corrosive resistance. The cost of stainless steel is very high but tougher than GI Sheets.

Copper: It is a reddish colored metal and is extremely malleable and ductile. Copper sheets have good corrosion resistance as well as good appearance but cost as high as compared GI and Stainless Steel. Because of its high thermal conductivity. It is used for the radiator of automobiles, domestic heating appliances, etc.

Aluminium: Aluminum cannot be used in its pure form, but is used in alloy form. Common additions are copper, silicon, manganese and iron. It has many qualities like high the ratio of strength to weight, corrosion-resistant qualities and ease in fabrication and whitish in colour.

Hand tools

For measuring, marking, cutting and forming various types of hand tools are used in sheet metal works.

- Measuring tools
- Marking tools
- Cutting tools
- Forming tools
- Joining tools

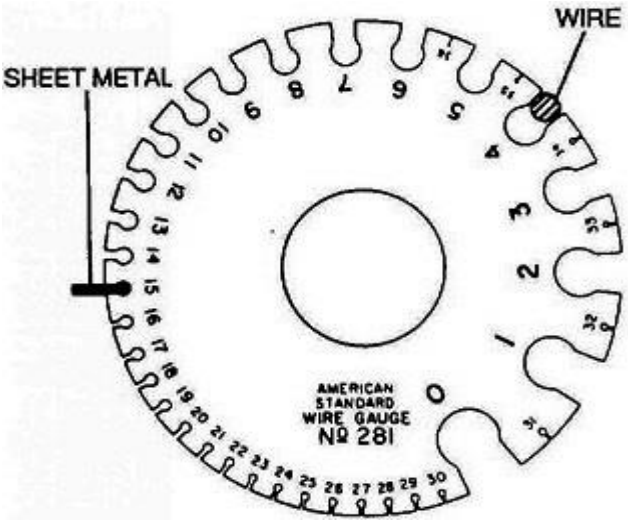
Measuring tools

The following types of tools are commonly used in sheet metal shops to measure the dimensions of work pieces:

- Sheet rule
- Vernier calipers
- Micrometer
- Sheet metal gauge

Sheet metal gauge

It is a disc-shaped piece of metal having several slots on the outer side edge as shown in the figure. The slots are of various widths and each corresponds to a certain standard wire gauge (SWG) number. The gauge is placed over the edge of the sheet to be measured and a slot is found that will slip over the metal with a light fit pressure.

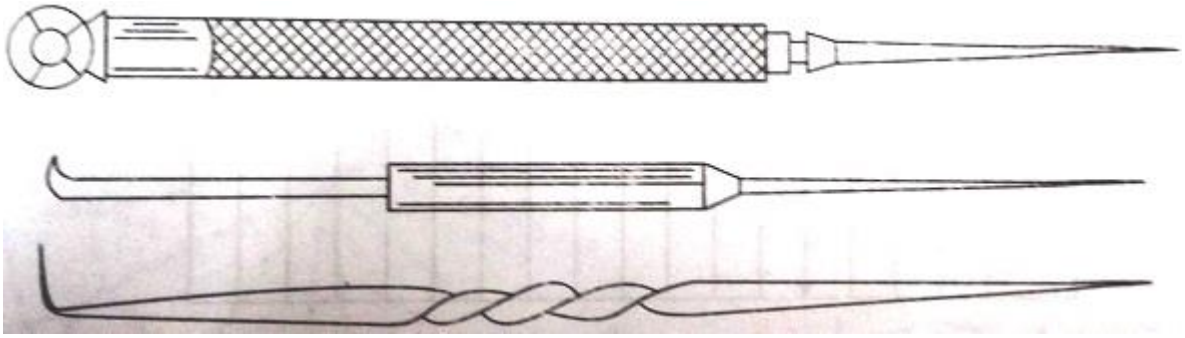


Standard wire gauge (SWG)

Marking tools:

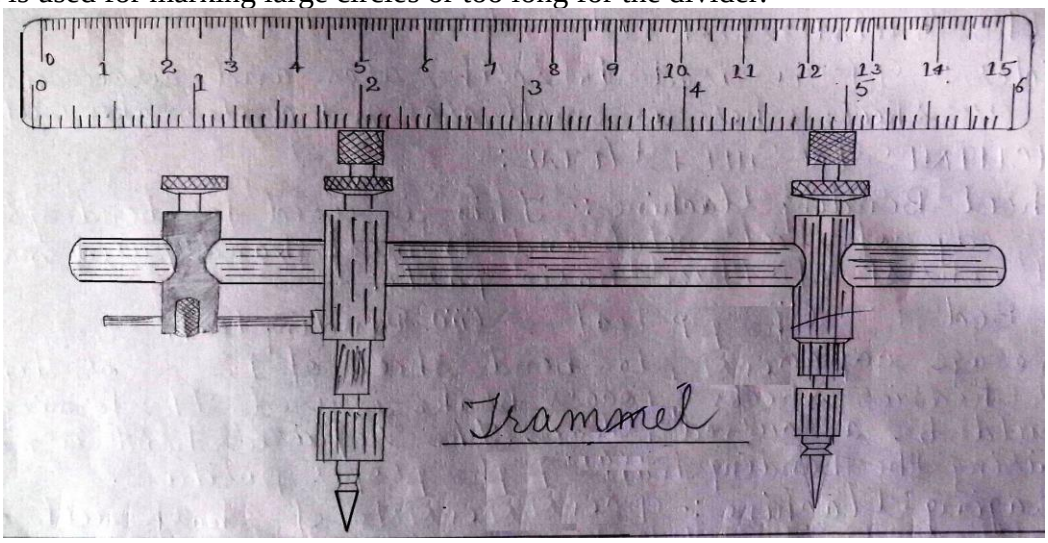
Scriber:

It is used to scribe or mark a line on a metal surface for a variety of purposes. It is a metal worker's pencil.


Different types of scriber

Trammel:

It is a long rod known as a beam on which two sliding heads are mounted, used to hold scribing points for scriber work on a sheet. The points are adjustable by nature and can be replaced by a pencil. It is used for marking large circles or too long for the divider.



Trammel

Punches:

It is used in sheet metal work for marking on the sheet and locating centres.

- Dot punch
- Prick punch cutting tools:

Snips:

Snips are hand shears varying in length from 200 mm to 600 mm. The 250 mm length is the commonly used one.

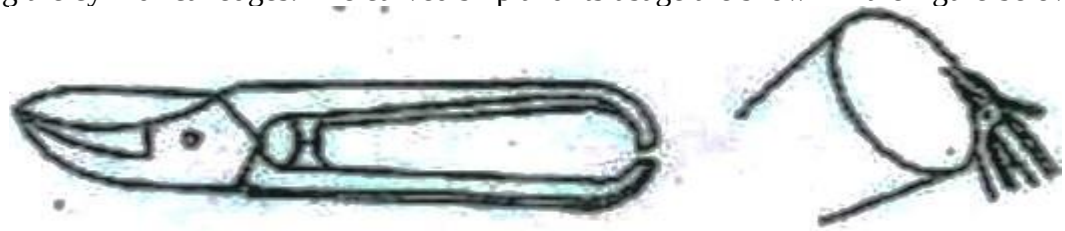
Types of snips:

Straight snip: It has a straight blade and is used for cutting along straight lines and for trimming the edges. The straight snip and its usage are shown in the figure below:

Straight snip

Bent or curved snip

It is having a curved blade and is used for cutting circles and irregular shapes. It is also used for trimming the cylindrical edges. The curved snip and its usage are shown in the figure below:



Bent or Curved Snip

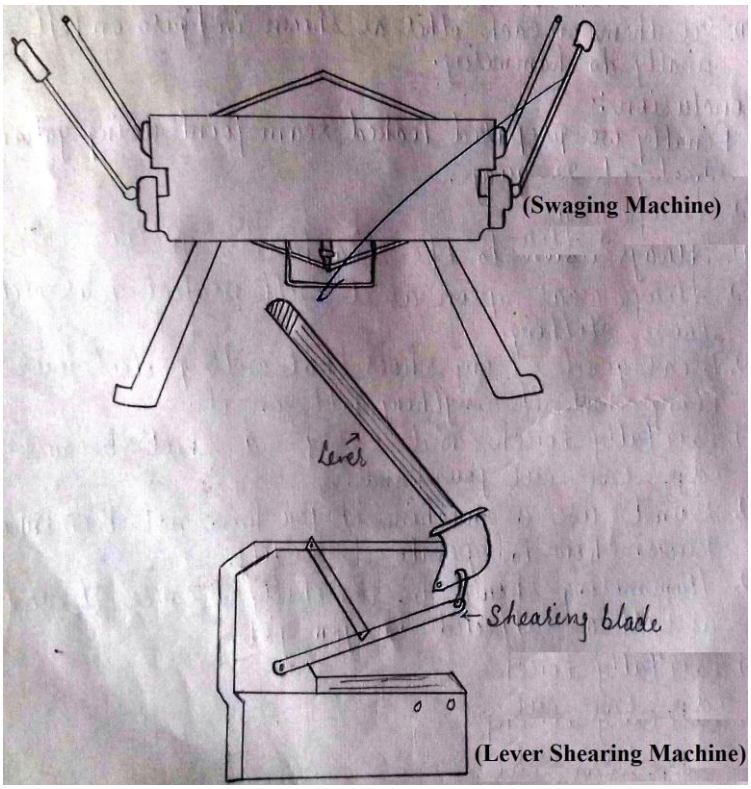
Hammers:

The sheet metal is shaped by hammering or striking with a mallet after keeping the metal on a suitable form of stake. The hammers used for sheet metal work are:

- Setting Hammer
- Raising Hammer
- Riveting Hammer
- Mallet

Lever sharing machine:

Lever shearing machine is very common in a sheet metal shop. It is a universal shearing machine it is used for sheet cutting, flat shearing, round bar shearing any iron cutting.



Swaging machine:

The swaging machine consists of sharp teeth black that can be moved through a handle. The joint gets pressed and locked. This machine is used for pressing I.e. looking at the grouse joint or seam joint.

Miscellaneous tools

1. Folding rule
2. Semi-circular protector
3. Hollowing hammer
4. Teflon hammer
5. Riveting hammer
6. Planishing hammer

Stakes:

1. Hand stake
2. Half- round stake
3. Taper stake

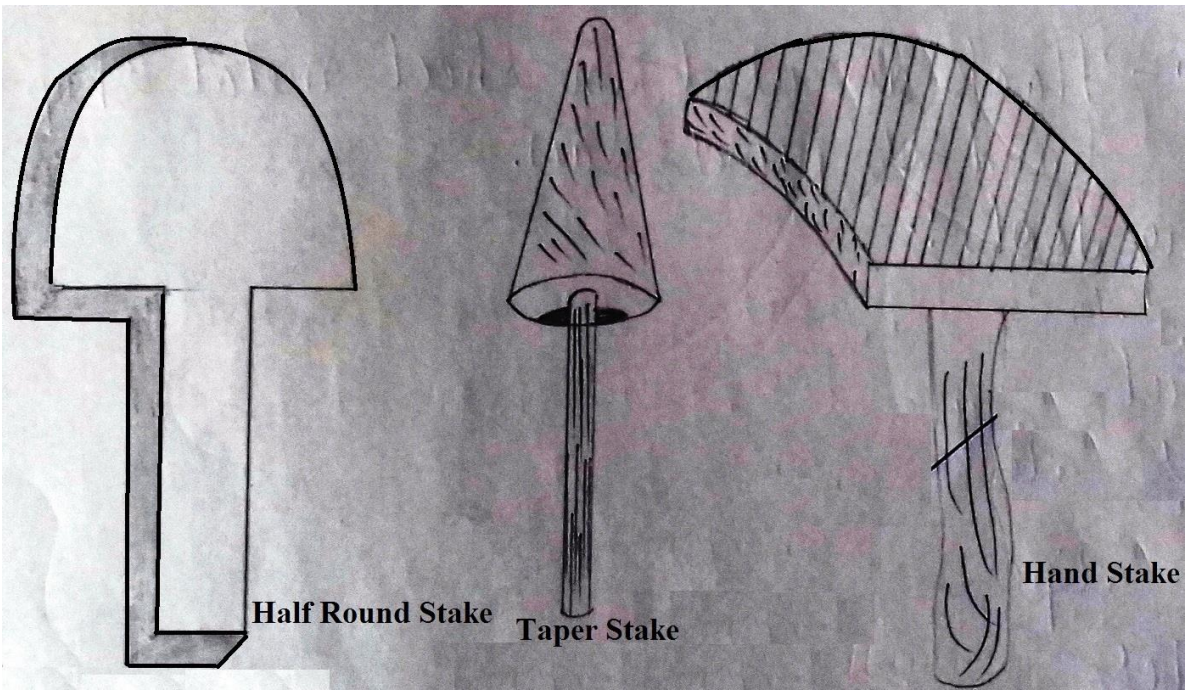
Hand stake: It is handly with a flat face and two straight edges one concave edge and another convex edge and is used for pressing the inner sides of straight joints.

Half- round stake:

It is used for pressing round seam joint and inner side.

Taper stake:

It is used for rounding of tapering jobs such as conical jobs etc.



Stakes

Stakeholder

It is a rectangular cast iron plate that has competently arranged taper holes so that the various stakes may fit in and may be used in a different position for tacking the sheet metal job for a particular work.

Different types of seems for joining

According to requirements, many different types of joints are used in sheet metal work. Some very commonly used forms of these are:

- Lap joint
- Seem joint
- Locked seam
- Item
- Wire edge
- Cup or circular
- Flanges
- Angular
- Cap

Lap seam: This is the simplest seam used in sheet metal work Figure (a). This consists of one edge lapping over the other and the joint is made by soldering or riveting.

Grooved seam: A grooved seam is made by hooking two-folded edges together and then offsetting them as shown in Figure (b). This joint is self-locking and stronger to some extent than the lap seam.

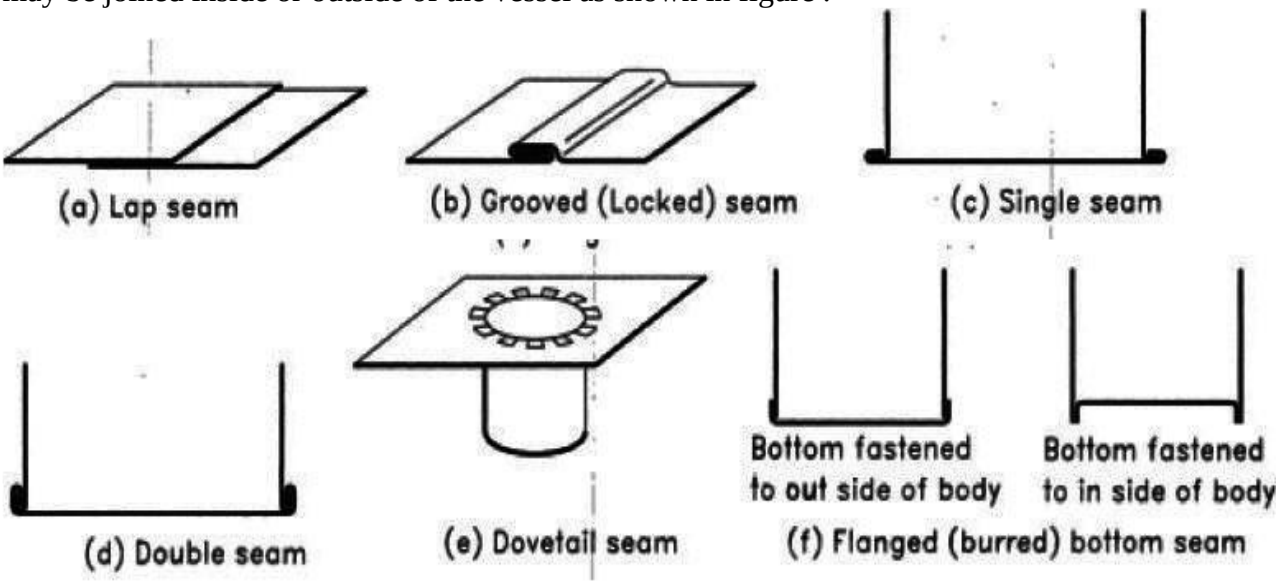
Single seam: This seam is used to join a bottom portion to a vertical body as shown in Figure (c). The bottom edge is hooked over the bent edge of the vertical body. This method of the joint can be used for square, rectangular or round containers.

Double seam: This seam is similar to a single scam with the difference that the formed edge is bent upwards against the body as shown in Figure (d).

Dove-tail seam: This seam is used to connect a cylindrical piece to a flat as shown in Figure (e). The edge of the cylindrical part to be joined is slit at a short distance and is bent so that alternate

pieces come inside and outside of the joint. The permanent joint is obtained by soldering or riveting.

Flanged (burred) bottom seam: This seam is used to fasten the bottom of a container to its body. The flange of a cylindrical job is often called a burr. The joint consists of a narrow flange which may be joined inside or outside of the vessel as shown in figure .



Different sheet metal joints

Sheet metal shop experiment No.1

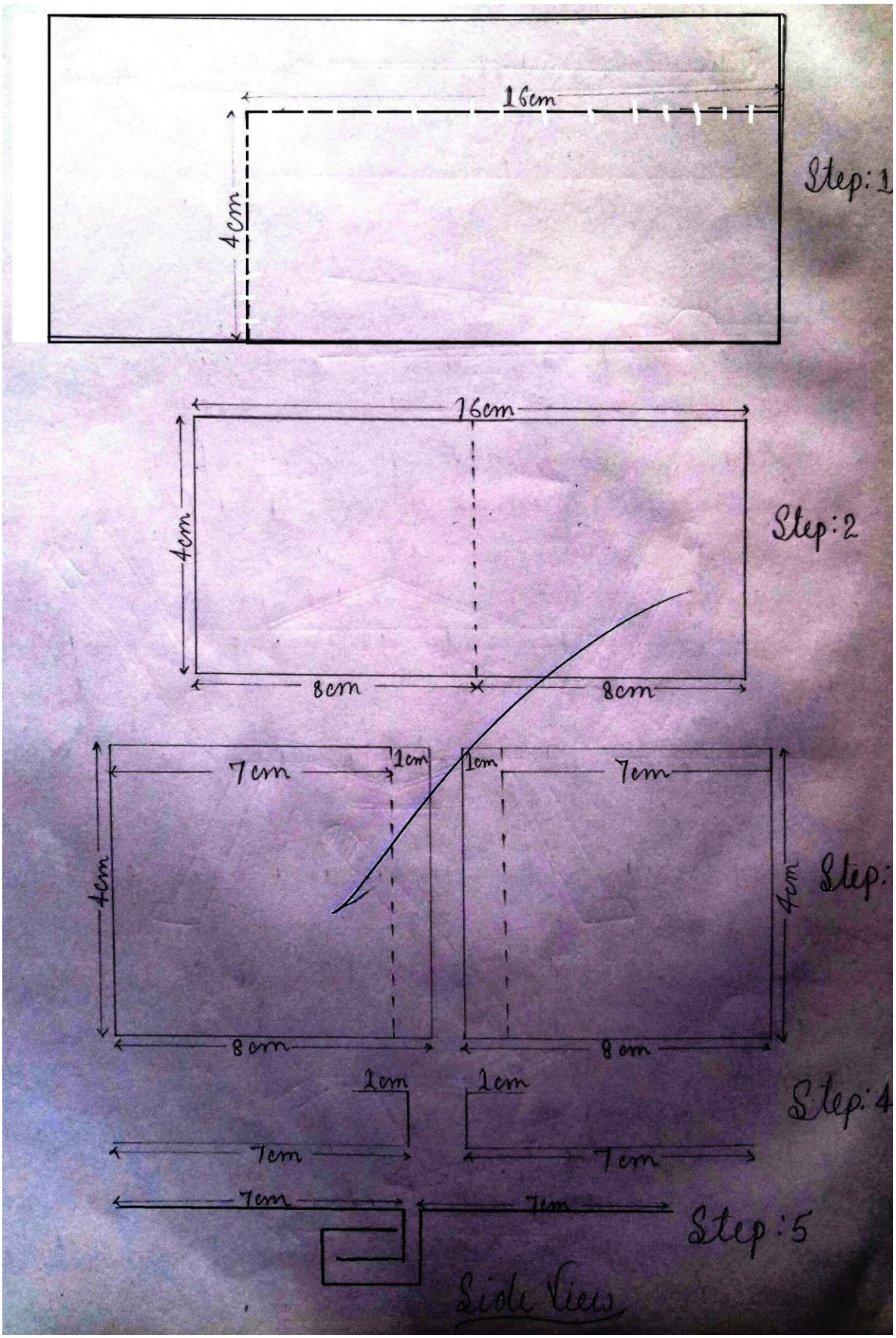
Object: To make a locked seam joint by using a GI sheet.

Materials used: Galvanized Iron (GI) Sheet.

Tool used: Steel scale, scriber, mallet, ship, anvil, etc.

Procedure:

- First of all tools a GI Sheet.
- Measuring the sheet by 50 mm.
- Marking the sheet by scriber.
- Cutting the sheet at the marking edge.
- Now we have two sheets.
- Again measure the two sheets by 10 mm.
- Again mark after measuring
- Now bent at 10 mm of the sheet by a mallet.
- Then bend by hammer to the required form.



Conclusion: Then the final job locked seam joint is formed as shown in the figure.

Precautions:

- Avoid using any tool whose edges are blunt or out of order.
- For cutting sheets appropriate cutting tools or machines must be selected based on the thickness of the material to be cut.
- Always use an apron and shoes while working.
- Hammering should not be in a lazy mood.
- Tools should be placed properly.

Black smithy shop

Introduction: The process of the desired shape of a metal piece by heating and hammering is known as forging. The metal piece is heated up to the desired temperature known as forging temperature. The pressure involved in forging and hammering pressure, bending flattening, etc. When the forging is done by the hand tools manually then it is called power forging. In case it is a drop stand then it is called drop forging. The metal pieces are heated to the plastic style either in smithy forging or in a furnace. Forging is widely done in the auto and bicycle industries. It has the following advantages over the other machine process.

- It refines the strength.
- It increases strength.
- It saves time, material and labour.

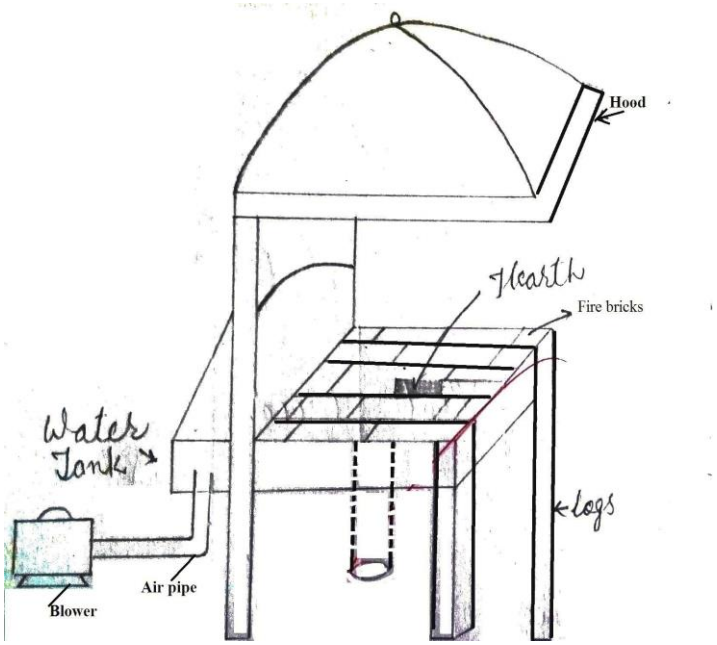
The normal plastic range for steels and high-strength alloys is from about 1038°C to about 1260ºC; for brasses and bronzes, from about 593°C to about 926°C; and for aluminium and magnesium alloys, from about 343°C to about 510°C

Forging tools and equipments:

The following tools and equipment are used in a smith shop.

1. Furnace or Hearth
2. Anvil
3. Tongs
4. Chisels
5. Swages Block
6. Hammers
7. Punches and Drifts
8. Set hammers
9. Clamping Devices
10. Flatters
11. Fullers

Furnace or Hearth: A black Smith uses a furnace for heating the metal pieces furnace consists of 4 legs. A cast iron or steel body iron bottom a chimney and a blower. The main features of a furnace are shown:



Open heath furnace

Hearth: The iron bottom where the fire is lightened is known as the hearth. It is provided with fire brick lining.

Tuyere: A coming from the bottom.

Chimney: Chimney is filled on the upper end of the hood and its main function is to easy escape of exhaust gases and smoke.

Water Tank: A small iron tank is attached to the hearth of the furnace it is used for dipping purposes.

Accessories for forging furnace

- **Shovel:** It is used to place the coal into the furnace hearth.
- **Blower:** It is used to supply air at high pressure to the hearth.
- **Poker:** It is a bend rod used to strike the fire. Poker is made of mild steel.
- **Regulator:** It is used to control the supply of air to the hearth. Its supply is controlled by increasing or decreasing the passage of air.
- **Rake:** Rake is used to putting coal pieces on Tuyers.

Shovel: It is a tool resembling a spade with a broad blade and typically upturned sides, used for moving coal, earth, snow, or other material as well is used to dig, move loose, granular materials (like dirt, gravel, grain, or snow) from one spot to another.

Shovel

Poker: It is a tool used to adjust wood and coals in a fire pit. It helps keep the fire going. Also known as a fire iron, it is a metal rod typically made from fire proof material.

Poker

Fuels used in blacksmith shop/Forging shop

Fuel: 1. Solid (coal) 2. Liquid (oils) 3. Gas (Natural Gas, Producer gas)

The fuels in common use are steam coal coke and charcoal. A good fuel should have the following essential properties:

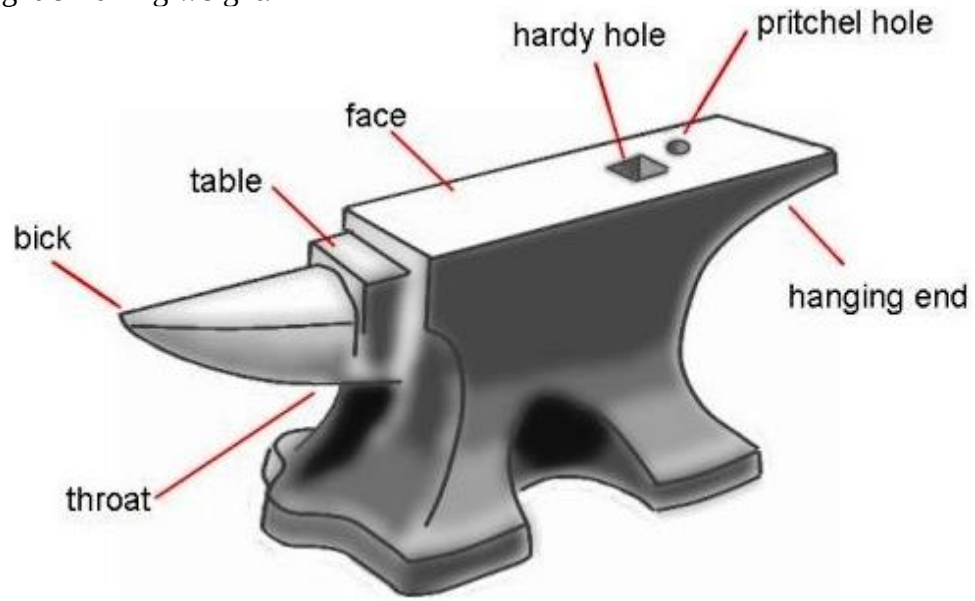
1. It should be able to maintain the required forging temperature.
2. It should be cheap and easily available.
3. It should not produce excess smoke and fly ash. Method of lightening the furnace:

The space inside the hearth is filled with soft wood.

Anvil: A back on which forging work is done is known as anvil. An anvil having the following main parts:

(A) Body (B) Horn or Beak (C) Chippy block (D) face (E) Hardy hole (F) Round hole (G) Base (H) Pritchel hole

- Size and shape of the job.
- Falling weight of the hammer.
- Height of falling weight.



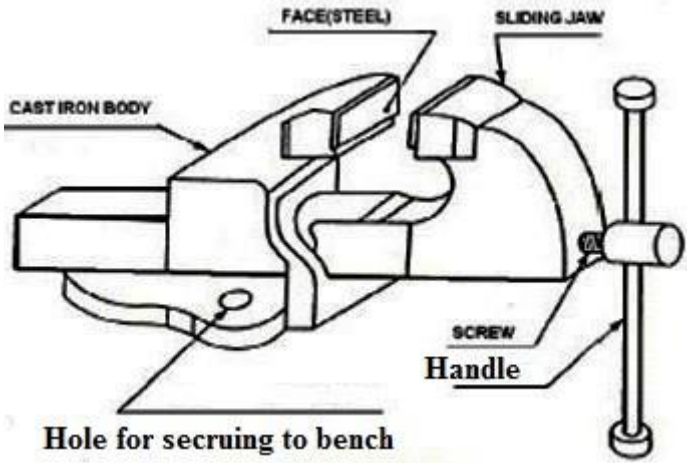
Anvil

Bench vice:

The vice used for bench work is called bench vice. The bench work includes filing, sawing, and threading operations. The bench vice is a device commonly used for holding the work pieces. When the vice handle is turned in a clockwise direction the moving jaw forces the work against the fixed jaw. The greater the pressure applied to the handle, the tighter is the work held.

It consists of a cast iron body carrying a fixed jaw and a movable jaw. Both the jaws are made of cast steel and are brought together using a hand-operated screw. Separate cast steel plates known as 'jaw plates' are fixed to the jaws using set screws which can be replaced when worn out. The face of the jaw plates has teeth (serrations), which help in gripping the workpiece firmly.

Specification: - the width of the jaws determines the size of the vice.



Parts of a bench vice

Tongs:

Tongs are used for holding and turning hot metal pieces depending on their use. Tongs are classified into many types. All types of tongs have similar construction except the mouth. It has the two legs from a suitable mild steel metal after their hardening and both legs are joined by a hinge. Various types of tongs are given by the following:-

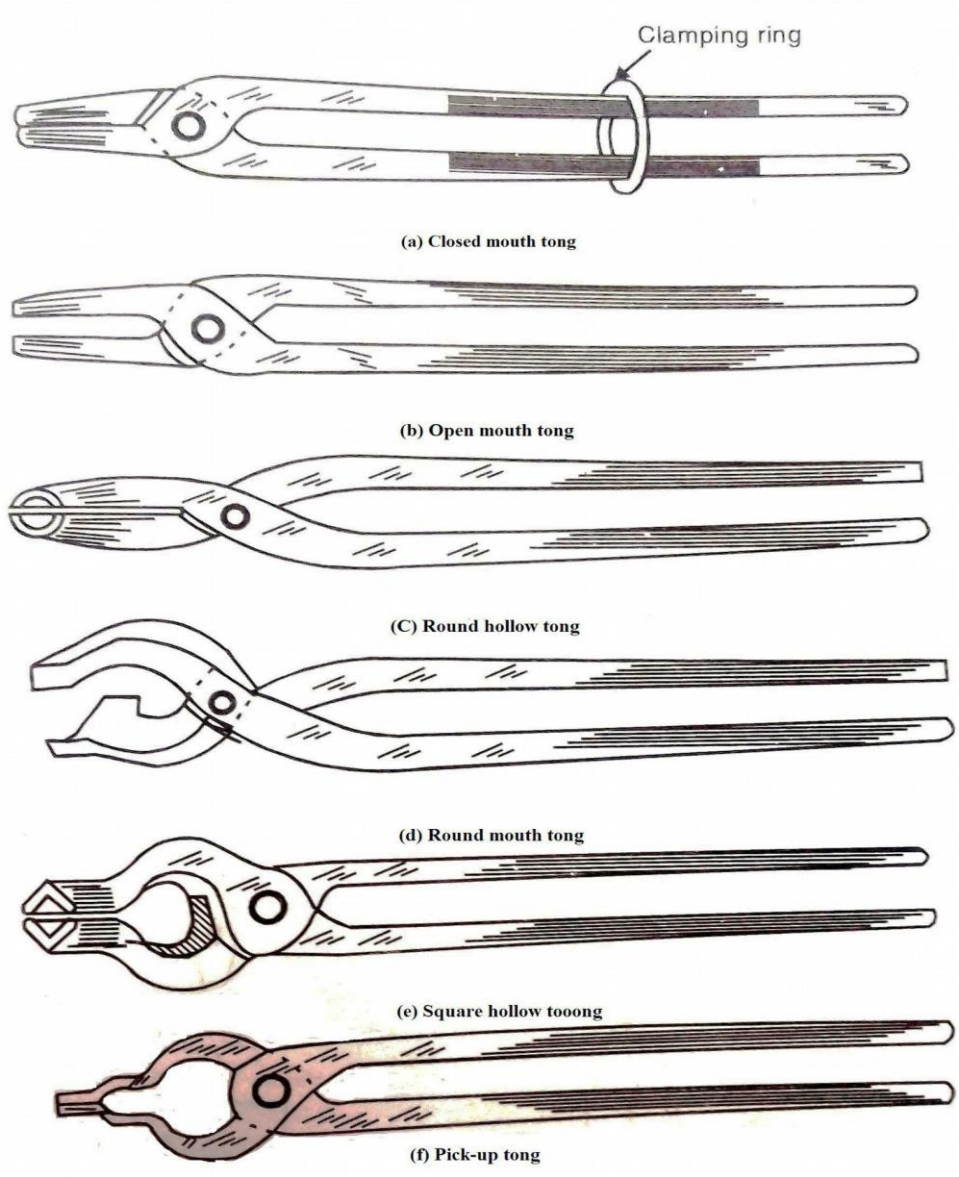
Closed mouth tong: A closed mouth tong is used to holding the thin sections.

Open mouth tong: An open mouth tong is suitable for holding heavier stock.

Round hollow tong: A round hallow tong is used for holding square, hexagonal and orthogonal work.

Square hollow tong: A square hollow tong is used for holding square, hexagonal and octagonal sections.

Pick-up tong: A pick-up tong is used for picking up round bars, but not for holding work during forging.



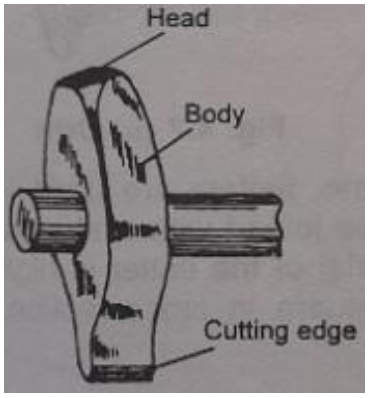
Tongs

Chisels: Chisels are used to cut the metal pieces in hot and cold condition. Chisels are usually three types:-

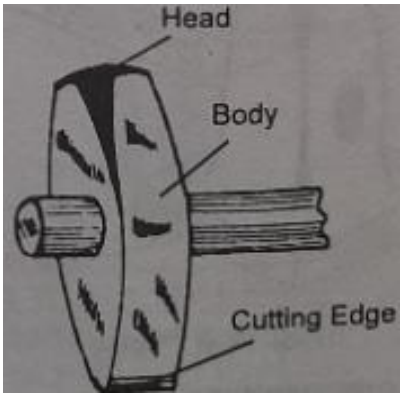
1. Hot chisel
2. Cold chisel
3. Hardie set

A hot chisel is used to cut the metal in a hot state and a cold chisel to cut the metal in a cold state.

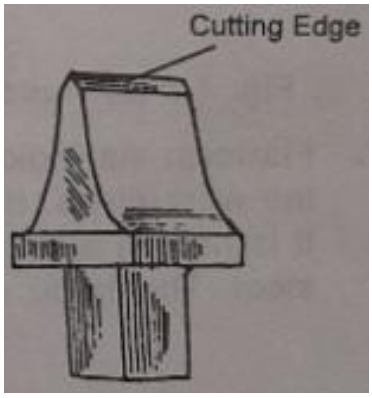
- Shank
- Body
- Cutting edge



Hot chisel



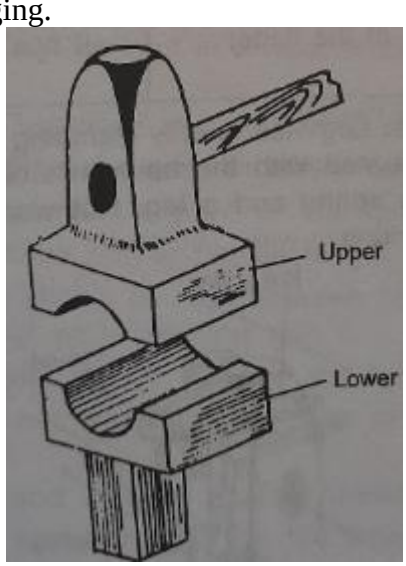
cold chisel



hardie chisel

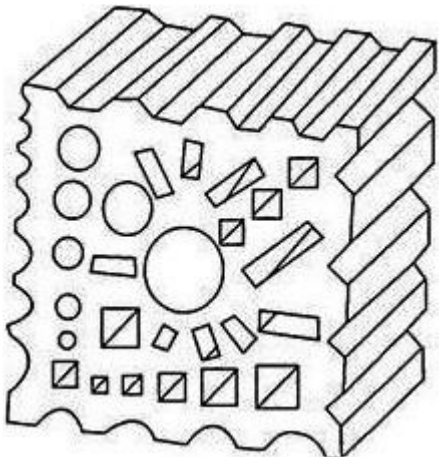
Punches and drifts: Punches are made up of high carbon and are used for making holes in metal pieces.

Swages: Swages are used for giving various shapes to the work pieces. They are made out of high carbon steel. Usually they are used for increasing the length of a circularrod or for finishing the circular surface of a job after forging.



Swage

Swage block: It is a block of cast steel consisting of several slots of different shapes and sizes along with its four side faces. It has through holes from the top face to the bottom face which vary in shape and size and are used for mainly squaring, sizing, heading, bending, punching and forming operations. The swage block is supported on a cast iron base. It is specified according to the size of the block or by weight

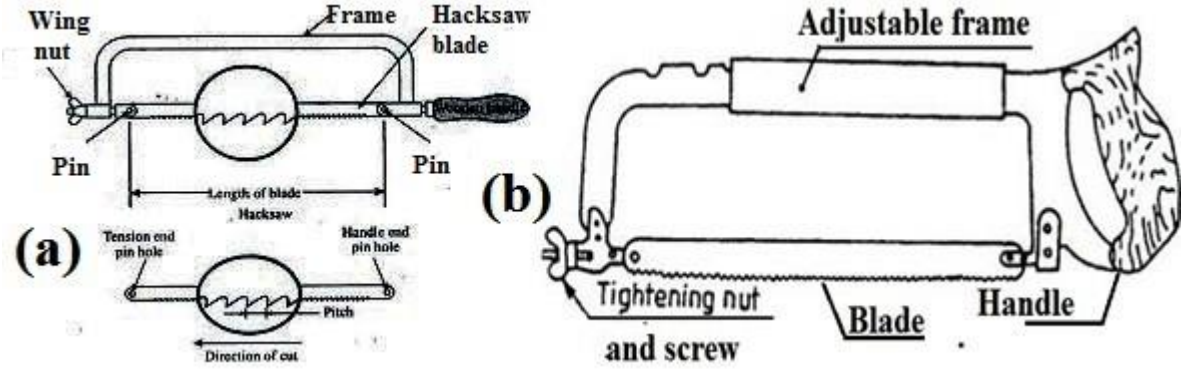


Swage block

Hacksaw

A hacksaw is a cutting tool and used to cut the metal by hand. The hacksaw blade has teeth ranging from 5 to 15/CM. lesser number of teeth is used for cutting materials like Aluminium, Brass and Bronze and a large number of teeth is used for cutting hard materials like steel, C.I etc. Hack saw blades are fitted either in a solid frame or adjustable frame to accommodate different lengths of the blade.

A hacksaw blade is made out of high-speed steel and hacksaw blades are specified by their material, length, width, thickness and pitch of the teeth. The common dimensions are length 250-300 mm, width 13 mm-16 mm, thickness 0.6 to 0.8 mm, and pitch 1 to 1.8 mm. The blades are fixed with teeth facing forward and the teeth are staggered, which are known as 'set of teeth'. These make slots wider than blade thickness, preventing the blade from jamming

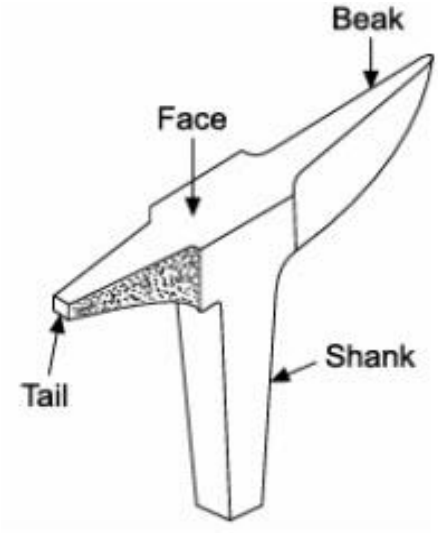


Fixed frame and adjustable type frame hack saw

Types of hack saw: Hack saw is usually two types:

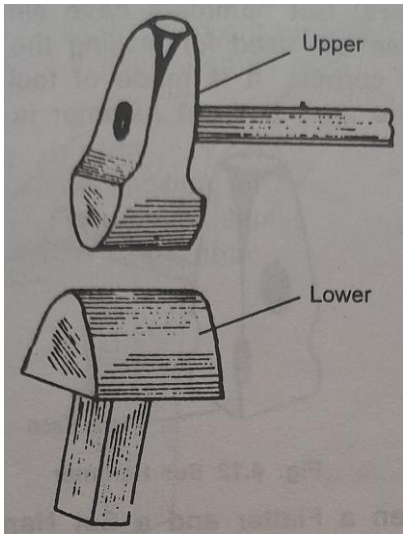
a) Fixed hack saw/ solid hack saw
b) Adjustable hack saw

Bick iron: It is also known as small anvil made of forged steel. Its upper front end consists of horn and upper back end comprises of flat tail. Its taper shank is inserted into the hardie hole of the anvil. It is commonly used as anvil for small forge work.



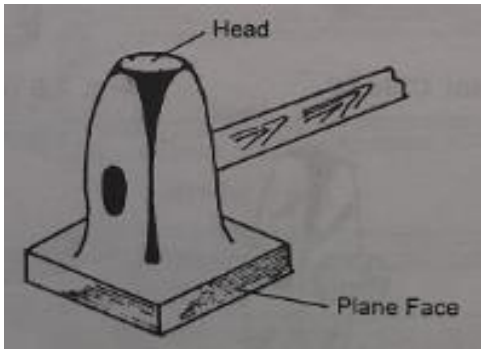
Bick iron

Fuller: These tools are made of high carbon steel in different sizes to suit the various types of jobs. They are usually used in pairs, consisting of a top and bottom filler. Their working edges are normally rounded. They are employed for making necks by reducing the cross-section of a job and also in drawing out. These are made in two pieces (lower and upper).



Fuller

Flatter: as the name shows they are used to flatten the surfaces. It has a plane jointed with a straight shank. It looks like a strange square hammer, but is really **a tool that is held on the iron and struck with a hammer**. It is used to smooth out bumps and hammer marks from the finished iron.



Flatter

Hammers: Hammer is a striking tool.

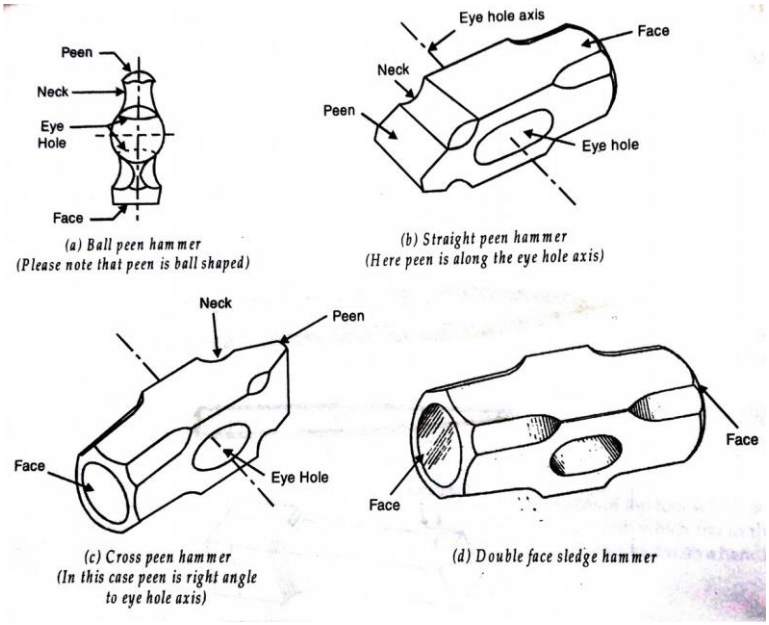
Ball-Peen hammer: Ball-Peen hammers are named, depending upon their shape and material and specified by their weight. A ball-peen hammer has a flat face which is used for general work and a ball end, particularly used for riveting.

Cross-Peen hammer: It is similar to a ball-peen hammer, except for the shape of the peen. This is used for chipping, riveting, bending and stretching metals and hammering inside the curves and shoulders.

Sledge hammer: It has double faces on both ends as shown in the figure. Sledgehammers are comparatively heavier than hand hammers. Therefore, they are used for a heavy type of forging work when heavy blows are needed.

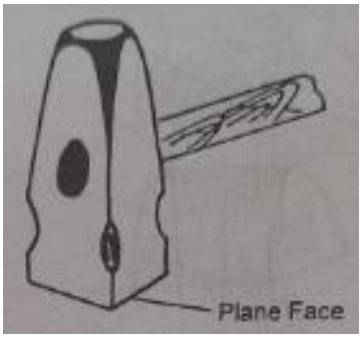
Straight-Peen hammer: This is similar to a cross-peen hammer, but its peen is in-line with the hammer handle. It is used for swaging, riveting in restricted places and stretching metals. Its weight varies from 1 to 9 Kg.

Power hammer: when the quality of the job to be produced is very high, then power hammers are used. They are generally driven by electric power. Power hammers are usually heavy weight.



Hammers

Set hammer: set hammer have similar shapes as that of flatters. They are used for producing the plane surface, forming and producing the corners. It is made of tool steel. The work piece is supported on the anvil and set hammer is hammerd on it.



Set hammer

Precautions while using forging tools and equipment

The following points must be kept in mind while forging the tools:

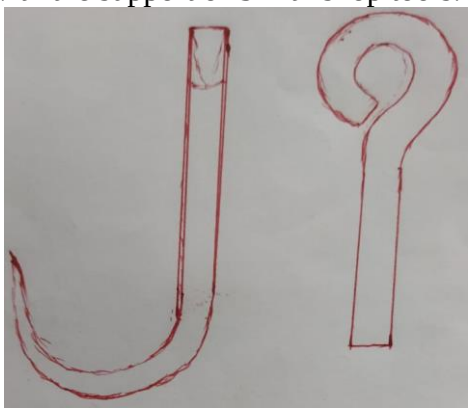
1. The following points must be kept in mind while working with the forging tools:
2. The hearth should be lightened properly.
3. Hammering should not be done in a lazy mood.
4. Heavy blows should not be given on the tail of the anvil.
5. Hammers should have proper handle length.
6. The length of the tong should be kept between 15” to 18” and tong should be kept cool while working with it.
7. Blunt chisels should not be used in the forging shop.
8. Mushroom should not remain on the face of the flatter, punch or chisel.
9. Never use fullers and swages for cold metal.
10. While working on the furnace, keep the fire small but deep.
11. Do not let the fire burn hollow.
12. Keep the fire clear from clinkers, particularly while welding.
13. Do not add fresh coke on the top of the fire, put it at the side and pull in later when required.

Compression between flatter and set hammer

S.No	Flatter	Set hammer
1.	It has a wide face	It has a small face
2.	It has a wire handle	It has a wooden handle
3.	the edges of a flatter are blunt	It has sharp edges

Black Smithy shop experiment No.1

Object: To make a fan hook with the support of Smith shop tools.



Fan hook

Materials used: Mild steel rod

Mild steel diameter (Φ) = 10 mm, length= 100 mm.

Tools used:

Poker, shovel, Anvil, hammer, tong, hack saw, steel scale, open heart furnace.

Procedure:

- First of all take a mild steel rod of 10mm diameter
- Hold the rod in a bench vice and measure by steel rule
- Cut it by hack saw as per the prescribed dimensions.
- If one part of the cutted is sharp
- Then hammered on the sharp part to make the sharp end round.
- Put the rod in an open hearth furnace at the desired temperature and hold it for the desired time.
- Now withdraw the red hot rod from the furnace and put it on the anvil and hammered the same.
- One half of the rod towards the pointed end is heated in the forge to red hot condition and then bent into a circular shape as shown.
- The straight portion of the rod is finally heated and bent into circular shape as required via the backside hole of the anvil.

Result:

Fan hook prepared.

Precautions:

1. Hold the job carefully while heating and hammering
2. Job must be held parallel to the face of the anvil.
3. Wear steel-toed shoes.
4. Wear a face shield when hammering the hot metal
5. Use the correct size and type of tongs to fit the work
6. All the exhaust, gases and smoke should go to the chimney.
7. Never try to touch the job with the hand which can damage the skin.

Welding Shop

Introduction: Welding is a process for joining two similar and dissimilar metals by fusion. It joints different metals with or without the application of pressure and with or without the use of filler metal. The heat may be either generated either from the combustion of gases, electric arc, electric resistance or by chemical reaction. Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post-weld heat treatment for most of the critical components and welding is widely used as a fabrication and repairing process in industries. Some are easier to weld than others, to compare this case in welding term “weldability" is often used.

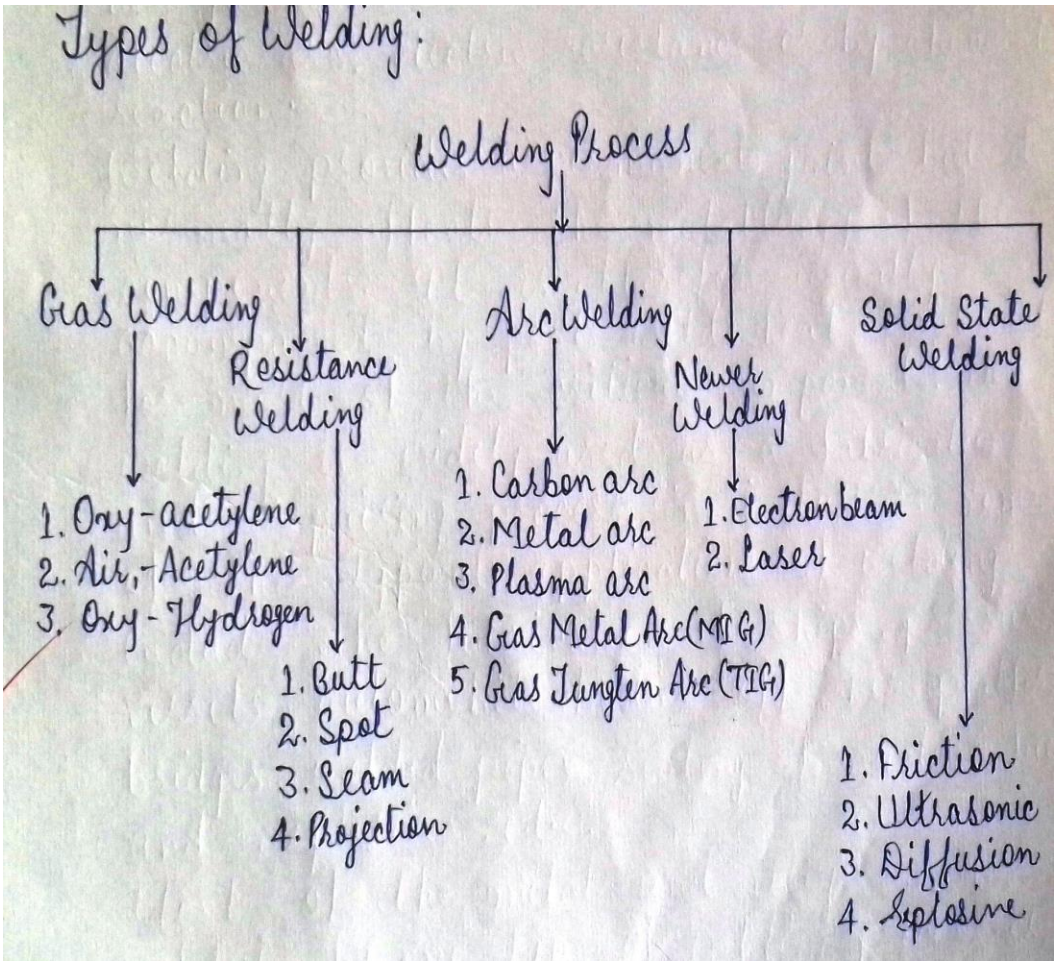
There are a wide variety of welding methods.

The selection of a particular method depends on the

(a) The material to be joined, (b) thickness of material, (c) its design, and (d) quantity to be welded.

The welding processes can be broadly categorized as follows:-

1. Electric arc welding methods
2. Gas Welding Methods
3. Resistance welding methods
4. Solid State welding methods(Friction welding)
5. Miscellaneous welding methods.



Block diagram of welding

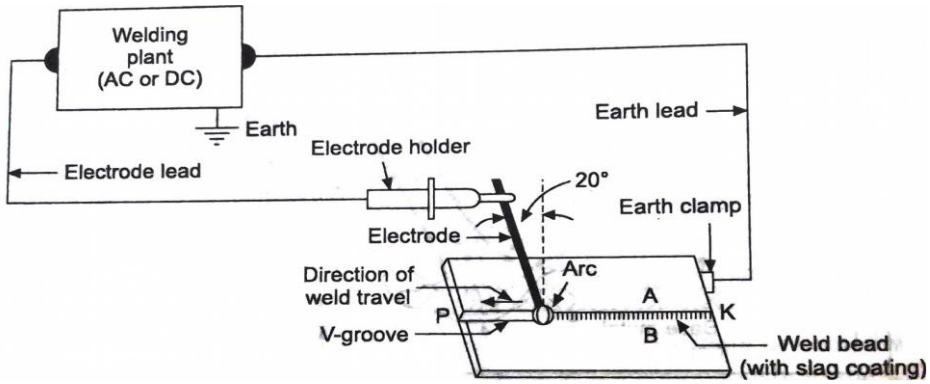
Electric arc welding: In arc welding, the intense heat needed to melt metal is produced by an electric arc.

Arc: sustained electric discharge through the ionized gas column, called plasma, between the two electrodes.

When the circuit is energized, the flow of electric current through the electrode heats the electrode by virtue of its electric resistance. When the electrode tip is touched to the work piece and then withdrawn to leave a gap between the electrode and work piece, the arc jumping the short gap presents a further path of high electric resistance, resulting in the generation of an extremely high temperature in the region of the sustained arc. The potential difference between the two electrodes must high enough to allow electrons to move across the air gap.

The temperature reaches about 6000^{o}C, which is more than adequate to melt. This heat melts both the base metal and the electrode, producing a pool of molten metal sometimes called a "crater".

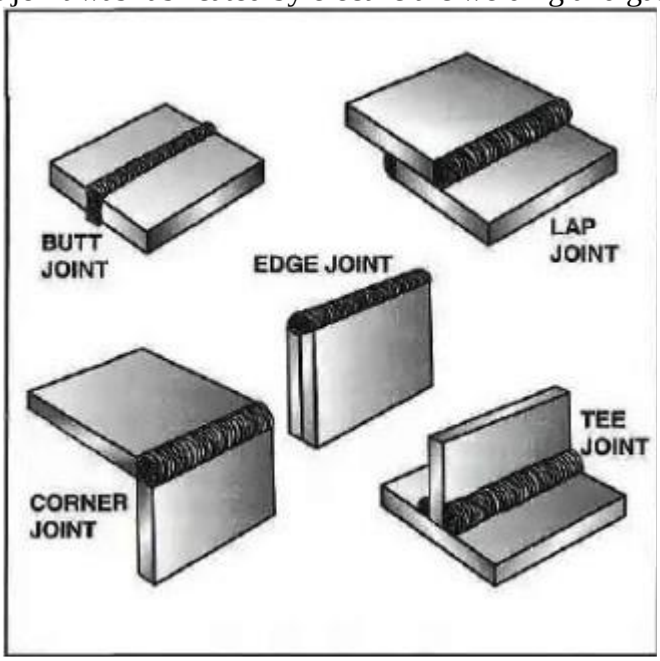
Working principle of electric arc welding



Electric arc welding set-up

Welding joint: welding joints are usually five types and they are given below:

In the welding shop butt joint was fabricated by electric arc welding and gas welding process.



Different types of welding joints

Edge Preparations: For welding, the edge of joining surfaces of metal is prepared first, different edge preparations may be used for welding but joints, which are given in the figure.

1. **Lap joint:**

Single lap joint: This joint is made by overlapping the edges of the plate and is not recommended for most work

Double lap joint: This is similar to a single lap joint but has the disadvantage that it requires twice as much welding.

2. **Butt weld joint:**

Single "V" Butt weld: It is used for plates up to 15.8 mm thick. The angle of the "V" depends upon the technique being used.

Double "V" Butt weld: It is used for plates over 13mm thick when the welding can be performed on both sides of the plate. The top "V" angle is either 60° or 30° while the bottom angle is 30° depending upon the technique being used.

Arc welding Process: The process in which an electric arc between an electrode and a work piece or between two electrodes is utilized to weld base metals. Arc welding is shown in the figure. Arc welding equipment: Arc welding equipment set up and related tools accessories are shown in figure.

Arc welding equipment

AC welding power source: Bothe direct current (DC) and alternating current (AC) is used for electric arc welding, each having its particular applications. DC welding supply is usually obtained from generators driven by an electric motor or if no electricity is available by internal combustion engines.

Electrode holder: The electrode holder is used for holding the electrode manually and conducting current to it. These are usually matched and conducting current to it. These are usually matched to the size of the lead, which in turn is matched to the amperage output of the arc welder electrode holders are available in sizes that range from 150 to 500 ampere.

Welding electrodes: 1. Consumable electrodes 2. Bare electrode 3.Coated electrodes 4. Non-consumable electrodes 5.Carbon or Graphite electrode 6. Tungsten electrodes

Hand Screen/face shield: Hand screen used for protection of eyes and supervision of weld bead.

Face shield

Chipping hammer: A chipping hammer is used to remove the slag from the weld bead by striking and it is also used to remove the spatters.

Chipping hammer

Wire brush: A wire brush is used to clean the surface (job) to weld.

Wire brush

Electrode holder: It is a device used for mechanically holding the electrode and conducting current to it. Jaws are made to hold the bare end of the electrode in either vertical or an angular position. These are fully insulated and the jaws are made of metals having high heat conductivity.

Electrode Holder

Leather Gloves:

This is a flame-retardant outfit worn by a welder to protect them under clothing and the body from the sparks, the metal and the hot metal being welded.

Leather Gloves

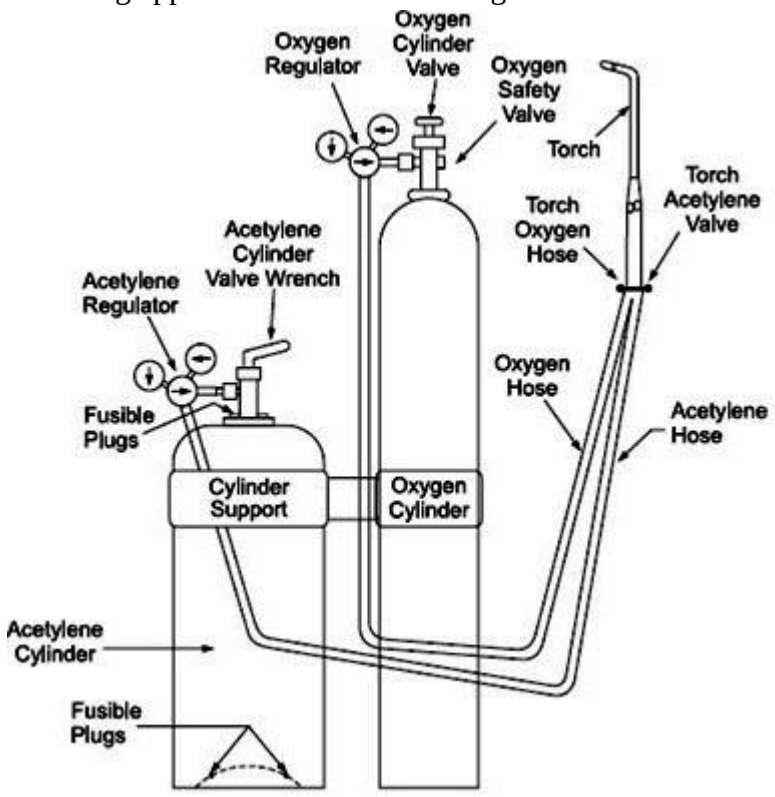
Tongs: Tongs are used to hold the hot metal-welding job while cleaning; they are also used to hold the metal for hammering.

Tongs

Gas welding: It is a process of construction that involves the use of gases as well as oxygen to weld metals together with other norms for gas welding.

Fuels for gas welding: As the name suggests acetylene is one of the preferred fuels in gas welding, Called oxidation though many people will also refer to the process as combustion.

Gas welding equipment: The welding equipment has an oxygen source as well as a fuel gas source which helps to begin the welding process with two hoses and two pressure regulators for each source. The gas welding apparatus is shown in the figure with the torch to weld.

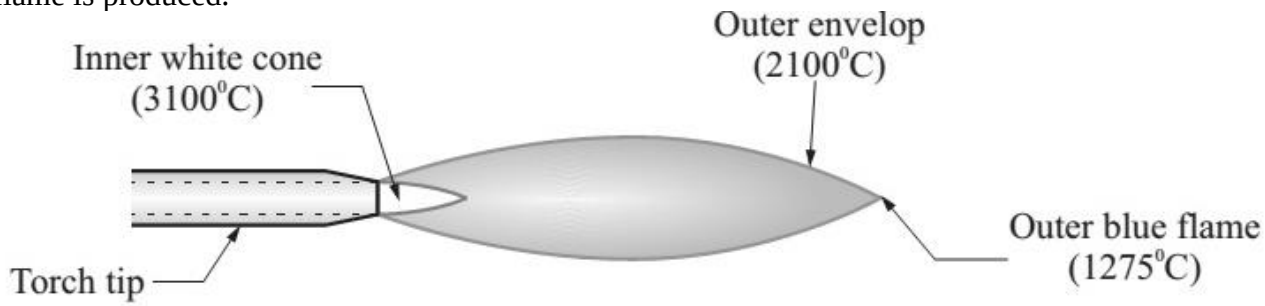


Gas welding arrangement

Gas welding flame: During the gas welding usually three types of flames are produced.

1) **Neutral flame**

When the equal parts of O_2 burn with the equal part of acetylene gas at the torch of tip then neutral flame is produced.



Neutral flame

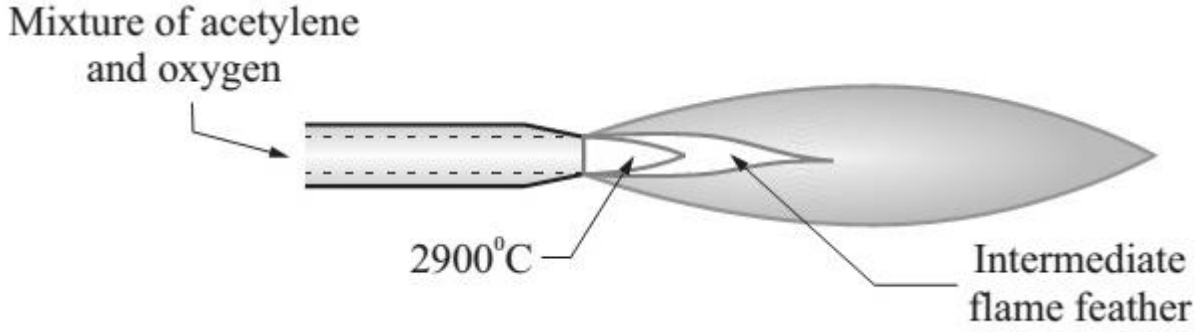
2) **Carburizing flame:**

When more than the one part of C_2H_2 gas burn with the one part of O_2 gas burn with at the torch tip then a neutral flame is produced.

Carburizing flame is recognized by three flame zones;

a) A clearly defined bluish-white inner cone
b) White immediately cone indicating the amount of excess acetylene
c) A light blue outer flare envelope.

This flare burns with a coarse rushing sound. The inner cone tip temperature is approximately 3700°C. If a carburizing flame is used for welding, carbon absorbs from the flame, causing metals to boil. This metal is not clear as it boils, obtains high carbon steel, becomes brittle and is subject to cracking.



Carburizing flame

3) Oxidizing flame:

In this oxidizing flame, the content of oxygen is more than the content of fuel gas by volume. It has two zones or two cones; the first one is called the inner cone and is white in colour. The inner zone is very bright. The second one is called outer cone and is blue in colour. The size of the inner cone in the oxidizing flame is very small as compared to its size in a natural or neutral flame. It has more heat than a neutral flame.

The temperature of the inner cone is from 3300 °C to 3500 °C and the temperature of the outer cone is nearly 1200°C.

If more heat is required to weld then we use oxidizing flame in which the temperature of inner cone is very high.

Applications of oxidizing flame:

- Oxidizing flame is used to weld copper alloys like brass, bronze, etc.
- Oxidizing flame should not be used to weld metals like zinc, copper, manganese steel, cast iron etc.
- When an oxidizing flame is applied to steel, the oxidizing flame causes the molten metal to foam and give off sparks. The excess oxygen in oxidizing flame combines with steel and burns it.

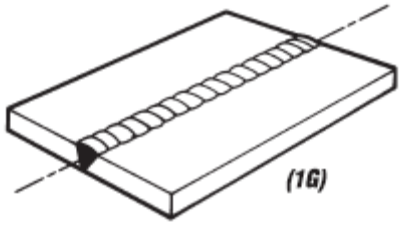
Oxidizing flame

Welding positions

Welding positions are usually four types:

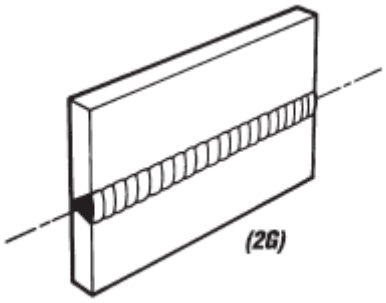
1.Flat position: Flat position is a very common position mostly shop welding is usually done in a flat welding position .intricate fixture is used in this welding position so that work piece rotates

while in welding condition. This type of welding position is very common as it requires less skill to produce a sound weld



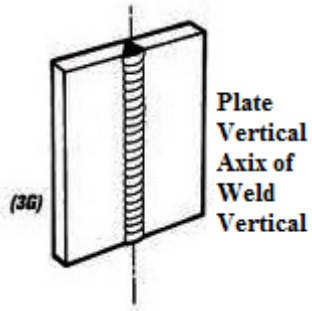
Flat position

2. Horizontal position: Horizontal welding position is another important welding position and is commonly used. It is extensively used due to large metal deposition. The manipulation of the electrode can be made with the same movement that is used flat position. C, J, and O are the preferred movement. The angle of the electrode should be between 5^o to 25^o



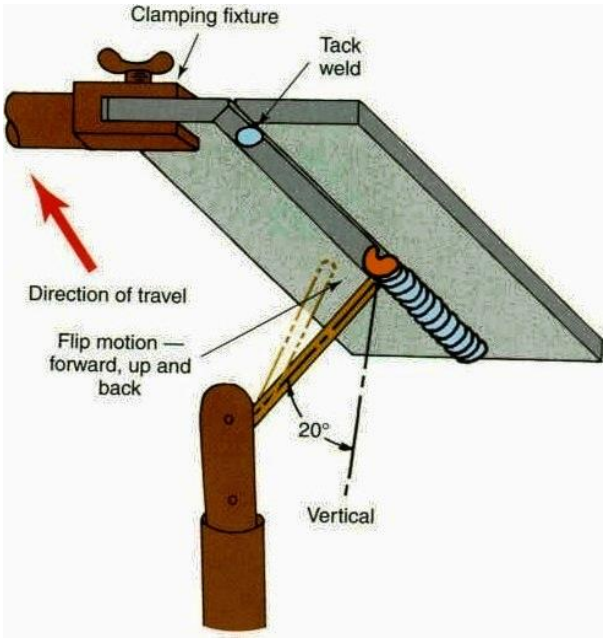
Horizontal position

3. Vertical position: The welding position in which welding is done on a vertical surface. Vertical-position welding is more difficult than flat- or horizontal-position welding. A "vertical weld" is defined as a weld that is applied to a vertical surface or one that is inclined 45 degrees or less



Vertical position

4. Overhead position: Overhead welding is the most difficult position in welding. Not only do you have to contend with the force of gravity but the majority of the time you also have to assume an awkward stance. Nevertheless, with practice, it is possible to make welds equal to those made in the other positions. It is a position in which the electrodes hold vertically over your head to the surface you are welding. This is one of the most difficult positions to weld.



Overhead position

Differentiate between electric arc welding and gas welding:

S.No	Electric arc welding	Gas welding
1	In arc welding, electricity is used to generate heat.	In gas welding, fuel gases like acetylene, and hydrogen are used to generate heat.
2	This welding generates a higher temperature than gas welding and temperature is about 6000^{o}C.	This welding generates a lower temperature than arc welding and temperature is about 3600^{o}C.
3	This welding generates stronger joint compared to gas welding.	It gives weaker joints.
4	It gives a poor surface finish.	This welding gives a good surface finish.
5	In arc welding, a consumable electrode is used.	In gas welding, a non consumable electrode is used.
6	The electrode is combined with the filler metal.	A filler rod is used separately if required.
7	It can be used in welding alone.	It can be used in welding, brazing and soldering.
8	There is a risk of explosion due to high voltage.	There is a risk of explosion due to high pressure.
9	It is mostly used to join similar materials.	It is mostly used to join both similar and different metals.
10	The heat is concentrated in arc welding.	The heat is distributed according to the flame. There is a higher loss of energy.
11	It is more efficient.	It is less efficient.
12	Speed of welding is high.	Speed of welding is low.

Welding shop Experiment No.1

Aim: To make a lap or butt joint with the help of electric arc welding as given dimensions.

Tools used:

- Mild steel plates
- Welding power supply
- Bench vice Flat file
- Welding rod
- Measuring scale
- Chipping hammer
- Try Square
- Electrode holder
- Wire brush
- Hack saw
- Gloves and apron
- Earthing clamps
- Shield and goggles

Materials used: Mild steel flat Length= 75 mm, width = 50 mm, and thickness= 6 mm.

Theory - Metal transfer in SMAW:

Metal transfer refers to the transfer of molten metal droplets from the electrode tip to the weld pool in consumable arc welding processes. Metal transfer in SMA welding is primarily affected by the surface tension of molten metal at the electrode tip.

The presence of impurities and foreign elements in molten metal lowers the surface tension which in turn facilitates easy detachment of molten metal drop from the electrode tip. Therefore, the type and amount of coating on the electrode and the effectiveness of shielding of arc zone from the atmospheric gases appreciably affect the mode of metal transfer. Acidic and oxide type electrodes produce molten metal with a large amount of oxygen and hydrogen. The presence of these impurities in the molten weld metal lowers the surface tension and produces spray like metal transfer.

Rutile electrodes are primarily composed of TiO_2 due to which molten metal drop hanging at the tip of the electrode is not much oxidized and therefore surface tension of the molten weld metal is not reduced appreciably. Hence, rutile electrodes produce more drops and less spray transfer.

The basic electrode contains deoxidizers and at the same time moisture is completely driven off to render low hydrogen electrodes. Therefore, melt droplets at the tip of the electrode are of killed steel type having high surface tension. Since high surface tension of molten metal resists the detachment of the drops from the electrode tip and hence the size of drop at the tip of the electrode increases to a great extent before it is detached under the effect of gravitational and electro-magnetic pinch forces. These conditions result in globular transfer with the basic electrode.

In the case of light coated electrodes with incomplete de-oxidation (due to lack of enough flux), CO is formed which remains with a single molten weld metal droplet until it grows to about half of electrode diameter. Eventually, drops with the bubble of CO burst which in turn result in metal transfer in form of fine drops and spatter.

In the case of the basic electrode, metal transfer occurs by short-circuiting mode if molten metal drop touches the weld pool and melt is transferred to weld pool by surface tension effect.

Procedure:

1) Clean the mild steel flats to be joined by a wire brush. Remove any layer of oxide by filing. Prepare the edge of the work-pieces at 45^o.

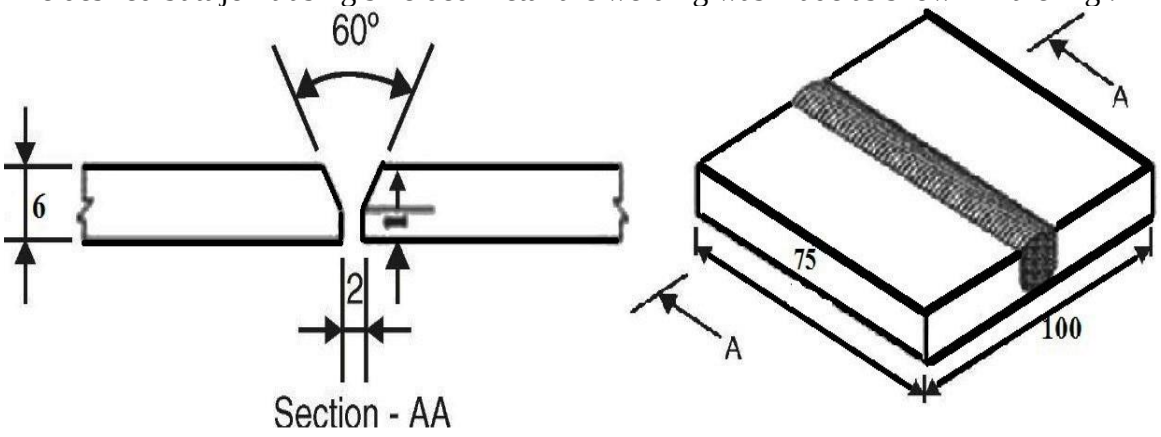
2) Arrange the flat pieces properly providing the gap for full penetration for the butt joint (gap ½ thicknesses of flats).
3) Practice striking of arc, speed and arc length control.
4) Set the welding current, and voltage according to the type of metal to be joined.
5) Strike the arc and make tacks at both ends to hold the metal pieces together during the welding process.
6) Lay beads along the joint maintaining proper speed and arc length (Speed 100-150 mm/min).
7) Welding should be done by maintaining a 3 mm gap between the electrode and mild steel flat (Work piece).
8) Use tongs to lift the welded plates and immerse them in water to cool.
9) Clean the welded zone using a wire brush and chipping hammer.

Precautions:

1) Before you start welding, ensure that the welding machine frame is grounded, that neither terminal of the welding generator is bonded to the frame, and that all electrical connections are secure. The ground connection must be attached firmly to the work, not merely laid loosely upon it.
2) Keep welding cables dry and free of oil or grease.
3) Keep the cables in good condition and always take appropriate steps to protect them from damage. When it is necessary to run cables some distance from the machine, lay them overhead, if at all possible, using adequate support devices.
4) When you are using portable machines, make sure that the primary power cable is separate from the welding cables so they do not become entangled. Any portable equipment mounted on wheels should be securely blocked to prevent accidental movement during welding operations.
5) When stopping work for any appreciable length of time, be sure to de-energize the equipment. When the equipment is not in use, completely disconnect it from its source of power.
6) Keep the work area neat and clean. If at all possible, make it a practice to dispose of the hot electrode stubs in a metal container.

Result:

The desired butt joint using shielded metal arc welding was made as shown in the Fig .



Before the metal plates were welded and after the metal plates were welded

Welding shop Experiment No.2

Aim: To make a lap or butt joint with the help of gas welding as given dimensions.

Tools used:

- Gas welding arrangement
- Bench vice
- Flat file
- filler rod
- Measuring scale, Try Square
- C_2H_2 cylinder + O_2 cylinder
- Hack saw
- Gloves, apron, and Goggles

Materials used: Mild steel flat Length= 50 mm, width = 20 mm, and thickness= 4 mm.

Procedure:

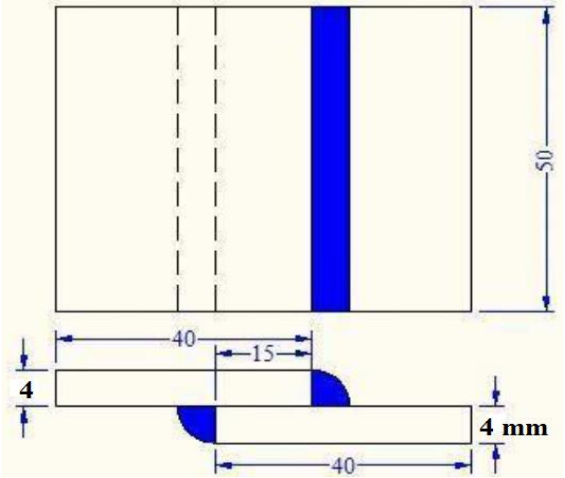
1) First take the piece of mild steel and measure the dimension of above mentioned.
2) Mark the measured dimension and fixed it in a bench vice.
3) Cut the mild steel flat with the help of a hacksaw as per the mark.
4) Clean the mild steel flats cutted pieces by wire brushes that are to be joined. Remove any layer of oxide by filing. Prepare the edge (V-shape) of the work-pieces at 45^o with the help of file and make sure that all angles are of 90^o with the help of a try square.
5) Arrange the flat pieces properly providing the gap for full penetration for the butt joint (gap ½ thicknesses of flats).
6) During the gas welding process first burn the gas at the tip of the welding torch and manage the flame and then take it ahead to the mild steel flat. When the place of welding becomes red hot then put the brazing rod between them. The brazing rod (filler rod) starts to melt and fill the V-groove and in such a way joint is formed.
7) Use tongs to lift the welded plates and immerse in water to cool.
8) Clean the welded zone using a wire brush and chipping hammer.
9) After completing the gas welding, blow out the welding torch by switch off the gas cylinders.

Precautions:

1) Before you start welding, ensure that the gas welding arrangement is properly or not.
2) Check the hose (Pipe) for any crack or damage.
3) Keep the hose pipe in good condition and always take appropriate steps to protect them from damage.
4) Rolling of the gas cylinder should be avoided.
5) Use the lighter for spark purposes.

Result:

The desired butt joint using shielded metal arc welding was made as shown in Fig.



Lap joint by gas welding

Fitting Shop

The term fitting is related to the assembly of parts after bringing the dimensions or shape to the required size or form to secure the necessary fit.

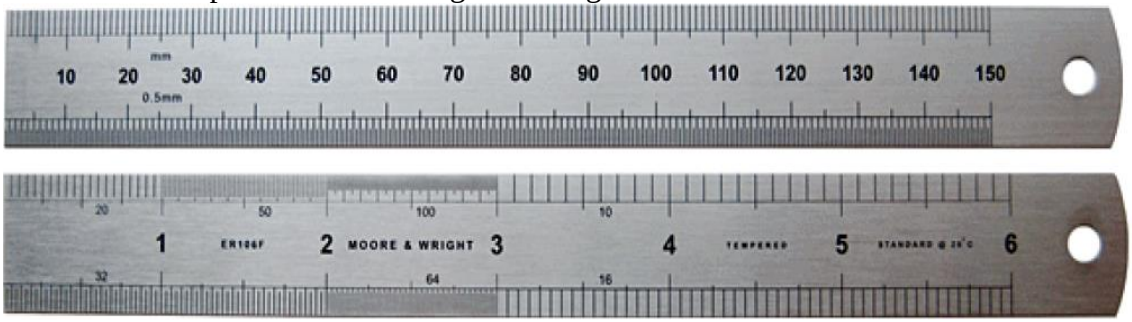
Types of tools used in the fitting shop:

Measuring tools: the basic function of a measuring tool is to measure the size of a job and they are the following types:

1. Steel rule
2. Try square

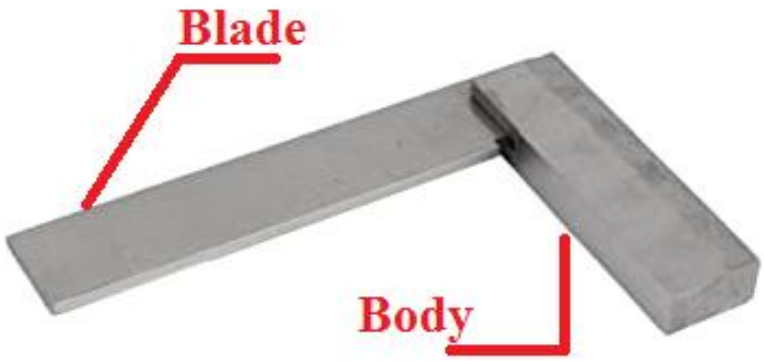
1. Steel rule

It consists of a hardened steel strip having line graduation etched or engraved in it they are usually 150 mm or 300 mm long and is used to take line measurement to an accuracy of 1 mm or 0.5 mm. These are marked in inches or millimeters. All the faces are machined true. The edges of the steel rule should be protected from rough handling.



Engineering scale

2. Try Square: The basic function of a try square is to measure/check the right angle (90º) of a job and to draw the parallel line on the job surface. Try square consists of a rectangular steel blade fixed rigidly to cast iron stock. The length of the blade varies from 150 mm to 300 mm.



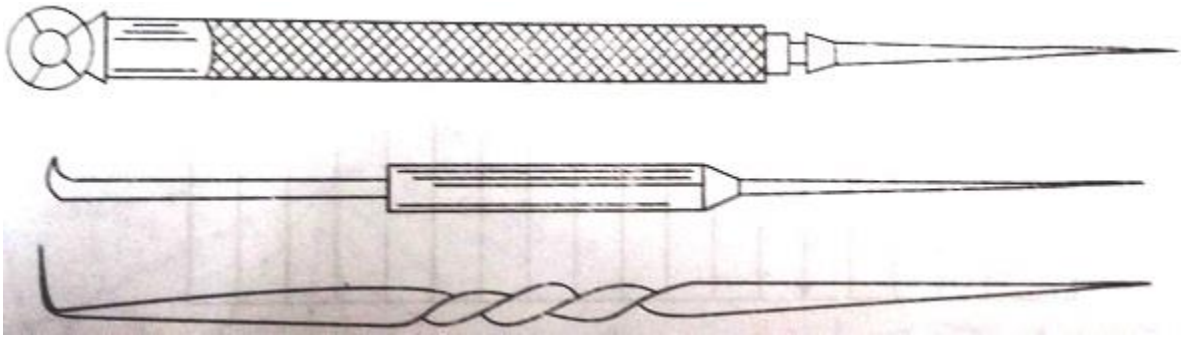
Try square

Marking tools: the basic function of marking tools is marking on the job and they are the following types:

1. Scriber
2. Dot punch
3. Centre punch
4. Divider
5. Inside caliper
6. Outside caliper
7. Odd leg caliper

Scriber:

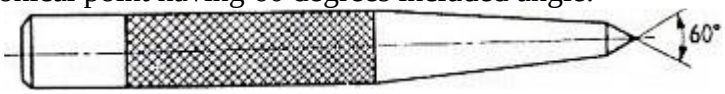
It is used to scribe or mark lines (permanent) on a metal surface for a variety of purposes. It is a metal worker's pencil.



Different types of scriber

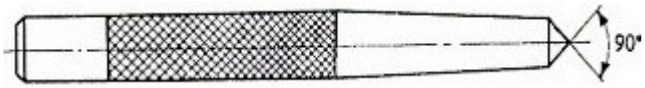
Types of punches:

1) **Dot punch:** This is used to lightly indent along the layout lines, to locate centre of holes and to provide a small centre mark for divider point, etc. For this purpose, the punch is ground to a conical point having 60 degrees included angle.



Dot punch

2) **Centre punch:** This is similar to the dot punch, except that it is ground to a conical point having 90 degrees included angle. It is used to mark the location of the holes to be drilled. It is used to mark the location of the centre where holes are to be drilled. The centre punch mark facilitates the easy location of the drill tip and centre accurately.

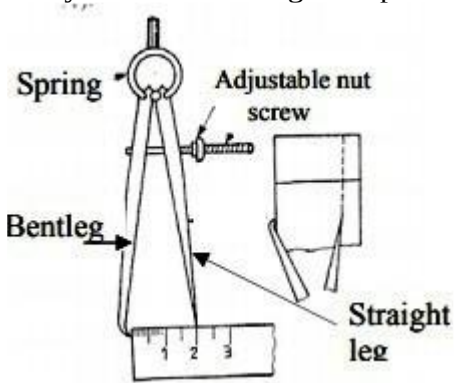


Centre punch

1) **Prick Punch:** It is a sharply pointed tool. The tapered point of punch has an angle of usually 400. It is used to make small punch marks on layout lines.
2) **Divider:** It has two straight legs sharpened at one end, hinged at the other ends. This is used for marking circles, and arcs, laying out perpendicular lines, bisecting lines, etc.
3) **Hollow punch**
4) **Split punch**

Types of caliper:

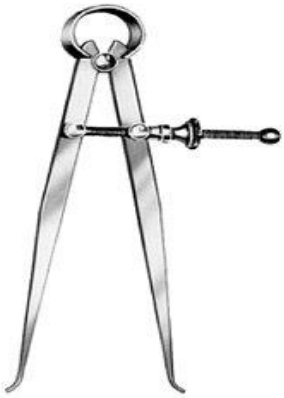
1) **Leg caliper:** It is made of steel tapered strip, which is hinged between washers at one end, one leg is bent at the tip inwardly and the other has a straight pointed end. It is used to find the centre of a bar. It is extremely used for scribing lines parallel to the edge of work.



2) **Outside Caliper:** These are also of two type's ordinary, and spring types. It has two steel legs that are bent inward. These are used to measure the outside dimensions of round objects.

Outside caliper

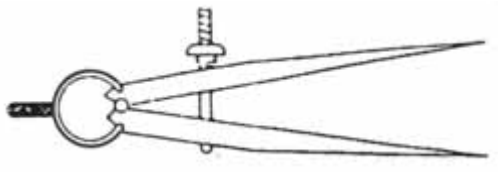
3) **Inside caliper:** These are also of two types ordinary, spring type. It has two steel legs, which are bent outward. These are used to set internal dimensions and to transfer them to work.



Inside caliper

Divider:

This is used for marking circles, arcs, laying out perpendicular lines, bisecting lines, etc. Size ranges from 100 mm to 300 mm.



Divider

Cutting tools

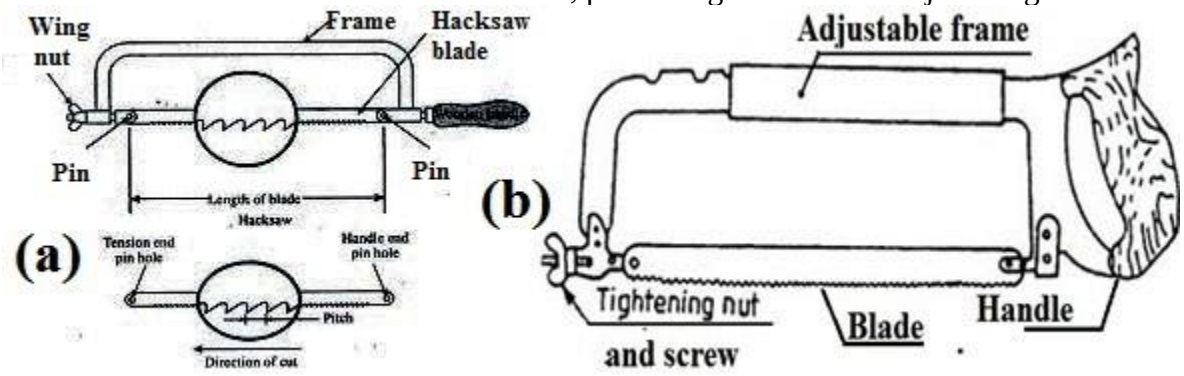
a) Hack saw b) Chisel c) Drill d) Tap

Hack saw

A hacksaw is a cutting tool and used to cut the metal by hand. The hacksaw blade has several teeth ranging from 5 to 15 / cm. Lesser number of teeth is used for cutting materials like Aluminium, brass and Bronze and a large number of teeth is used for cutting hard materials like steel, C.I etc. Hack saw blades are fitted either in a solid frame or adjustable frame to accommodate different lengths of blade.

The hacksaw blade is made out of high-speed steel. The hacksaw blades are specified by its material, length, width, thickness and pitch of the teeth. The common dimensions are length 250-300 mm, width 13 mm-16 mm, thickness 0.6 to 0.8 mm, and pitch 1 to 1.8 mm. The blades are

fixed with teeth facing forward and the teeth are staggered, which are known as ‘set of teeth’. These make slots wider than blade thickness, preventing the blade from jamming



Fixed frame and adjustable type frame hack saw

Types of hack saw: Hack saw is usually two types:

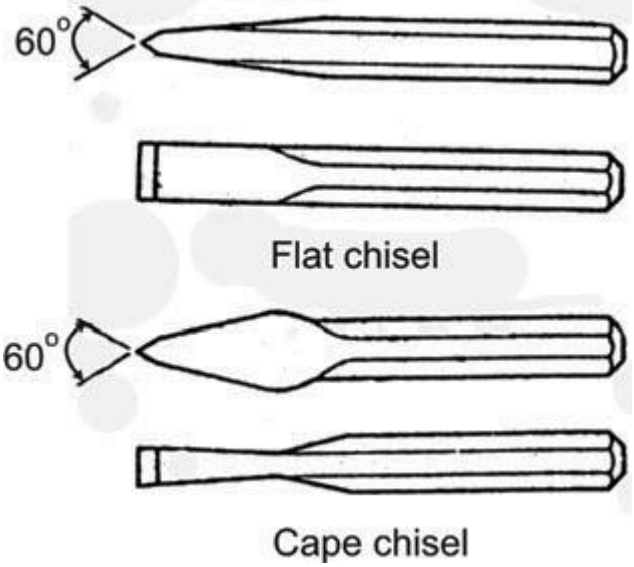
a) Fixed hack saw/ solid hack saw
b) Adjustable hack saw

Chisels

Chisels are used for removing surplus metal or for cutting thin sheets. These tools are made from 0.9% to 1.0% carbon steel of octagonal or hexagonal sections. Chisels are annealed, hardened and tempered to produce a tough shank and a hard cutting edge. Annealing relieves the internal stresses in the metal. The cutting angle of the chisel for general purpose is 60 degrees.

A flat chisel is a common chisel used for chipping and cuffing off thin sheet-metal.

A cape chisel is a narrow shaped tool and it is mostly used for the chipping grooves and keyways.



Chisels

Finishing tools

a.) Files

1) Hand file
2) Flat file
3) Square file
4) Triangular file
5) half round file
6) Round file

Striking tools

a) Ball peen hammer
b) Straight peen hammer
c) Cross peen hammer

Files

A file is a cutting tool used to remove a small amount of material from the surface of the work piece and also helps in giving a smooth surface finish. Several teeth, parallel and inclined at a suitable angle are cut on the flat surface of the file. The various parts of a file are shown in the figure the main parts of the file include:-

Tang-It is the pointed part that fits into the wooden handle.

Heel – It is end of the tang that forms a curved edge.

Face -It is the portion of the file on which cutting teeth are formed.

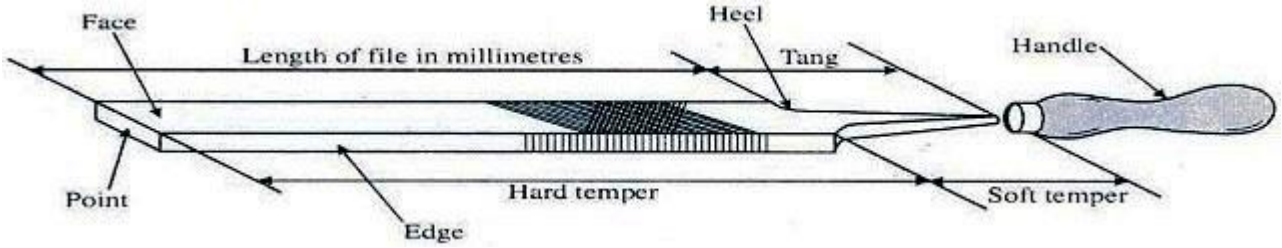
Point – It is the end opposite the tang

Files are often tapered along their length but they may also be parallel.

Material -tool steel (hardened)

Specification- length, single cut /double cut, shape and pitch. Example length (say 400 mm) Single cut /Double cut

Shape (say square cross–section) Pitch or grade (say smooth)



Parts of a file

Classification of file:

- According to size
- According to shape
- According to cut
- According to grade
- According to size: When the file is 100 mm to 450 mm in the length.

According to shape:

1) Flat file
2) Hand file
3) Round file
4) Half round file
5) File
6) Triangular file
7) Knife edge file

According to cut:

1. Single cut file
2. Double cut file
3. Covered cut file
4. Rasp cut file
5. Parallel cut file

According to grade:

- Rough file (R)-5
- Bastard (B)-9
- Second cut file (Sc) -14
- Smooth file (S)-18
- Super smooth file (SS)-28 (No. of teeth count for the grade in 10 mm.)

Flat File:

Rectangular in section and tapered for 1/3rd length in width and thickness. The faces have double cut teeth and edges single cut. Used for general purpose filing.

Square File:

Square in section and tapered for 1/3rd length in all faces. All the faces have double cut teeth. Used for filling corners and slots and also to cut keyways.

Triangular File:

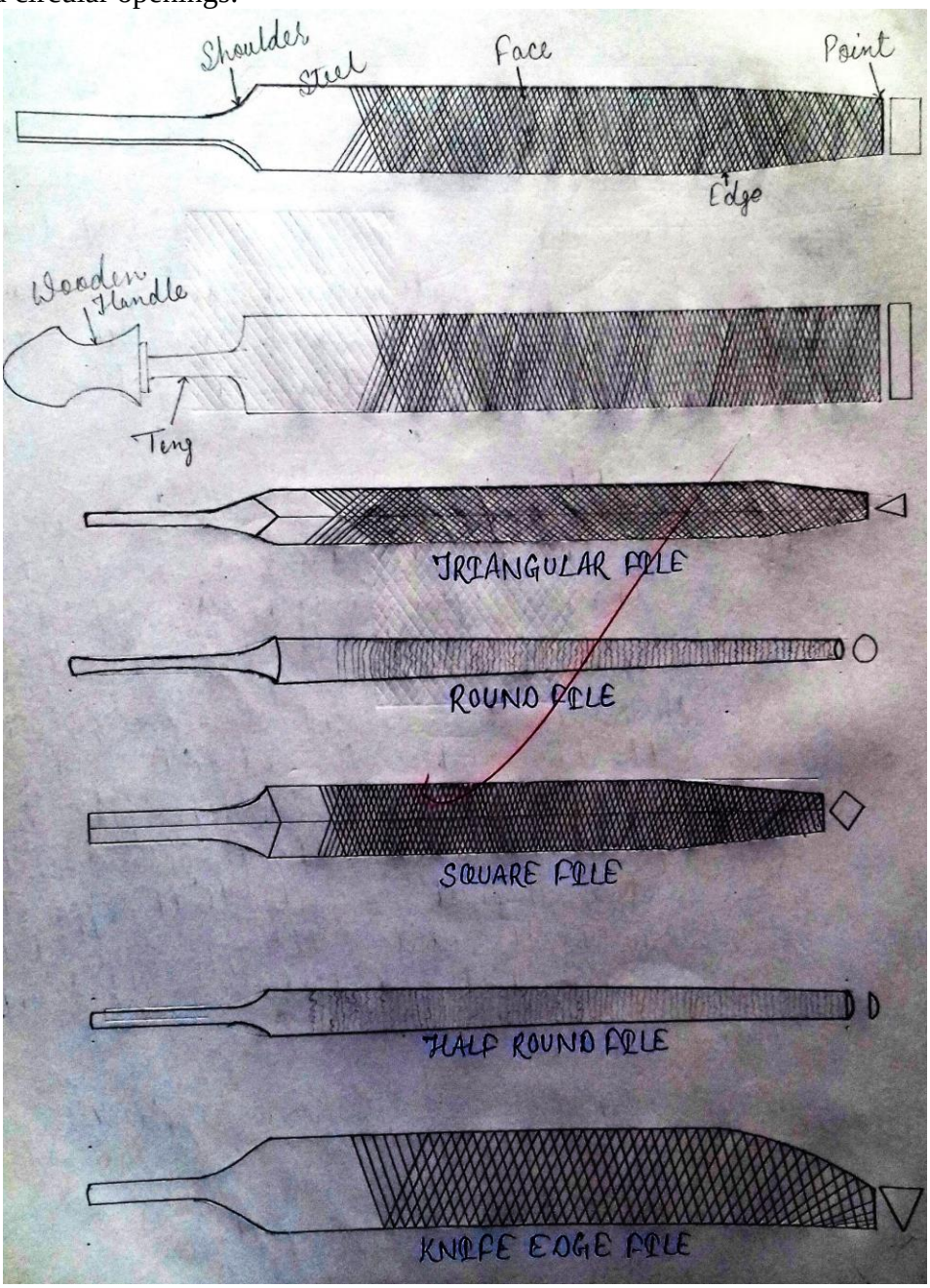
Equilateral triangular in section and tapered for 1/3rd length on all faces. All the faces have double cut teeth. Used for filing internal corners.

Half Round File:

It has one flat face, connected by a curved face and tapered for 1/3rd length. The curved face is not exactly semi-circular but only a part of the circle. The flat face has double cut teeth and the curved face has a single cut. Used for filing concave surfaces and internal corners.

Round File:

Circular-cross section and tapered for 1/3rd length. It has double-cut teeth. Used for filing concave surfaces and circular openings.



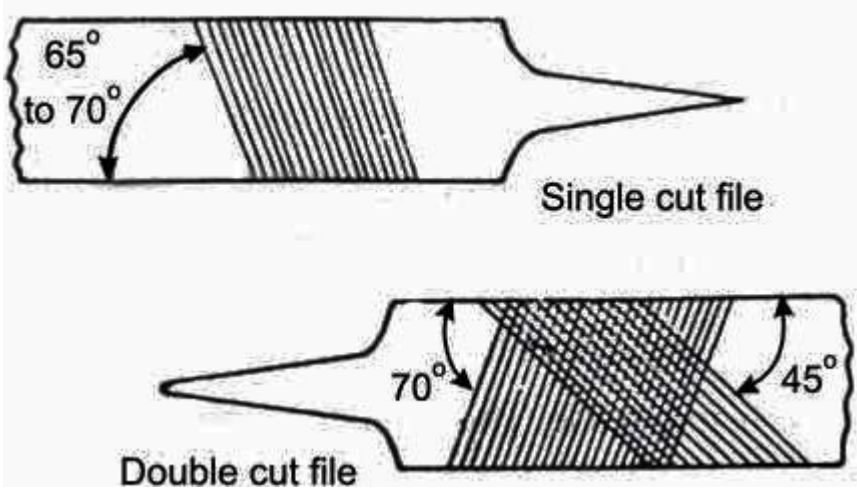
Different types of files

Grades of files:

Rough having:	8 teeth/cm
Coarse:	10 teeth/cm
Bastard:	12 teeth/cm
Second cut:	16 teeth/cm
Smooth:	20 to 24 teeth/cm
Dead smooth:	40 teeth/cm

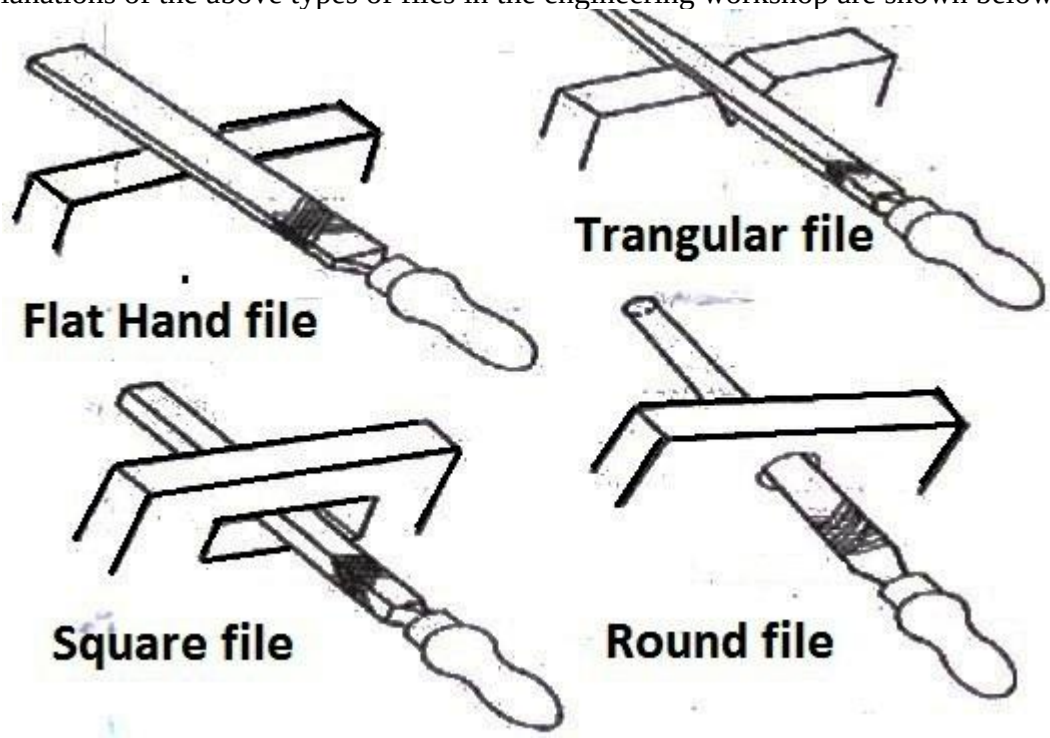
Cut of files cut of files are usually two types (1) single cut (2) double cut

Single cut files have rows of teeth running in one direction, across their faces while double cut files have a second row of teeth, cut diagonally to the first row.



Cut of file

The explanations of the above types of files in the engineering workshop are shown below:



Methods of Filing:

There are two methods of filing.

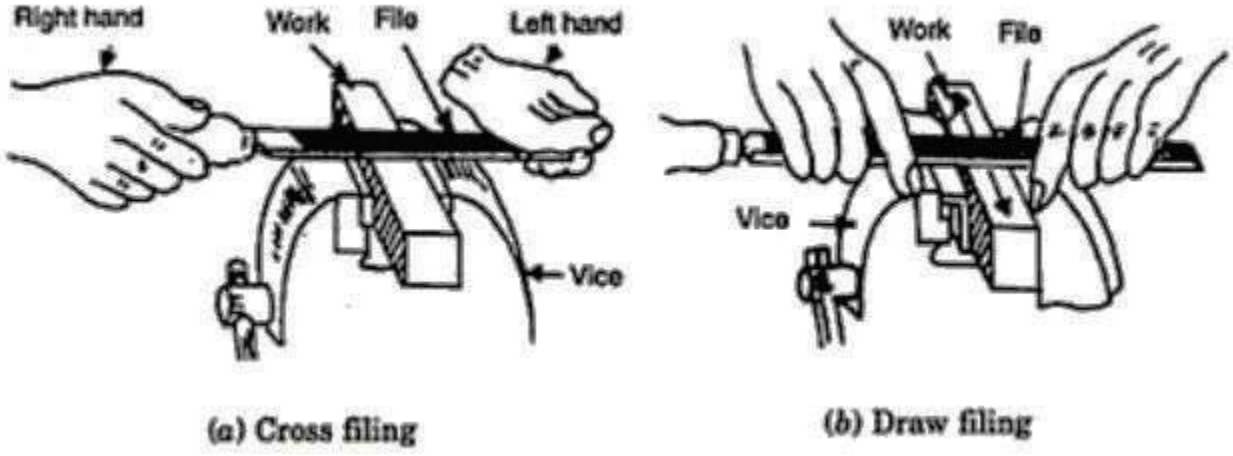
- Cross Filing
- Draw Filing

Cross Filing:

Filing in a direction perpendicular to the axis of a component is called cross filing. This filing method is used mostly in the fitting workshop.

Draw Filing:

Filing in a direction parallel to the axis of a component is called draw filing.



Method of filing

Holding tools

1) Bench vice
2) C-lamp

Types of Vice:

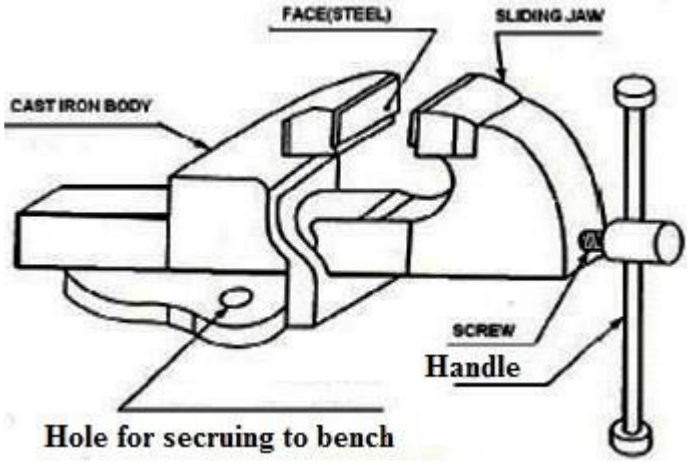
1. Bench vice
2. Machine vice
3. Pipe vice
4. Hand vice
5. Pin vice

Bench vice:

The vice used for bench work is called bench vice. The bench work includes filing, sawing, and threading operations. The bench vice is a device commonly used for holding the work pieces. When the vice handle is turned in a clockwise direction the moving jaw forces the work against the fixed jaw. The greater the pressure applied to the handle, the tighter is the work held.

It consists of a cast iron body carrying a fixed jaw and a movable jaw. Both the jaws are made of cast steel and are brought together using a hand-operated screw. Separate cast steel plates known as 'jaw plates' are fixed to the jaws using set screws which can be replaced when worn out. The face of the jaw plates has teeth (serrations), which help in gripping the workpiece firmly.

Specification: - the width of the jaws determines the size of the vice.



Parts of a bench vice

Pipe vice

It is used for holding round section parts such as pipes, and tubes.

Hand vice

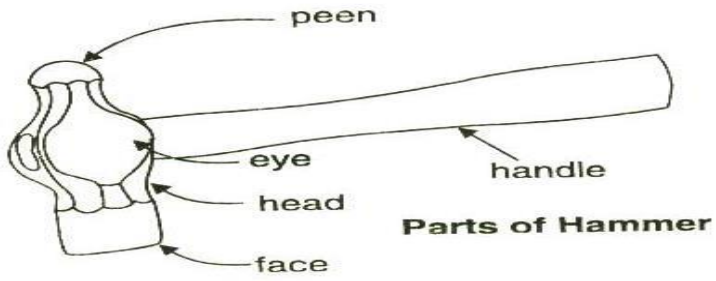
It is used for carrying work on small jobs, such as screws, keys, rivets etc., which cannot be held in the Bench vice. It consists of two jaws that can be operated using a wing nut.

Types of hammer:

1) Ball peen Hammer
2) Cross peen Hammer
3) Straight peen Hammer

Ball peen hammer:-

This is the most common type of hammer which has a ball-shaped end of the head opposite to the striking face. It is used for all kinds of engineering work. The ball end is useful for sheet metal forming and it is made in weights from 1000 gm to 1.5 kg. It is used for riveting and chipping.



Ball peen hammer

Cross–peen and straight peen hammer:-

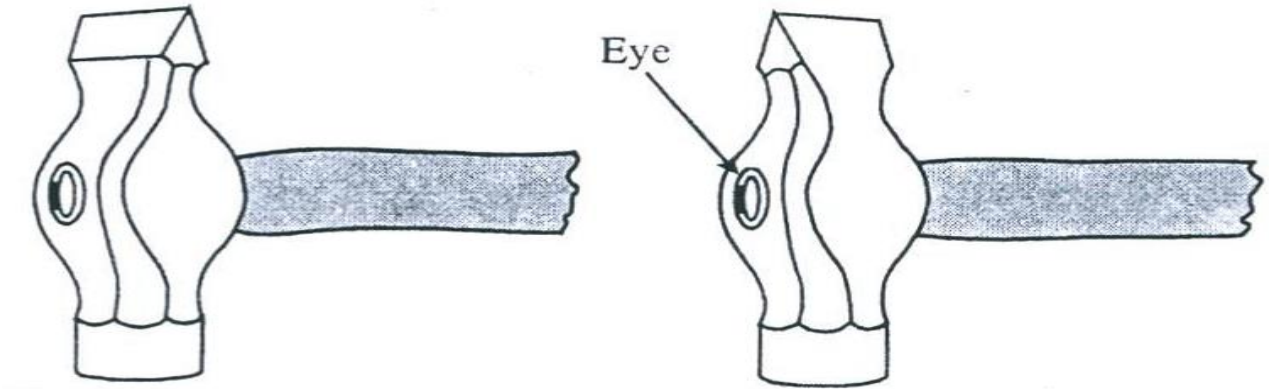
These have blunt, chisel-shaped ends on the head opposite to the face. It has the peen of the shape of a ball. It is the most common type of hammer and is mostly used for riveting, bending, stretching, and hammering into shoulders, and curves.

Cross-peen hammer:

It is used for hammering into shoulders, inside curves for bending.

Straight peen hammer:

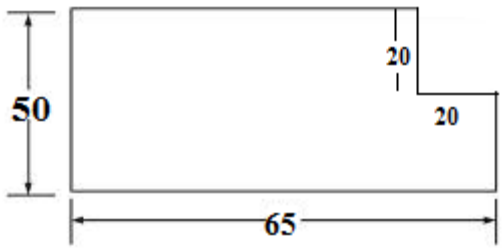
It has a flat and tapered peen. The width is usually equal to the diameter of the face. It is used for stretching the metal by hammering.



Cross peen hammer and straight peen hammer

Fitting shop Experiment No. 1

Object: To make a rectangle and cut one side corner 20 mm X 20 mm with hack sawing and filling.



Material and measurement:
Mild steel flat of 65 mm X 50 mm X 6 mm size.

Tools used:
Bench vice, hack saw, Jack file rough, ball peen hammer, dot punch, jenny caliper.

Procedure:

1. Hold the job in a bench vice.
2. Perform filing operation on all sides and check that the adjacent sides are at right angles using try square.
3. Maintain the finished job after filing to the dimension of 65 mm X 50 mm X 6 mm.
4. Mark areas using a scriber, punch and hammer on one corner of the job.
5. Using a hacksaw cut the job from one edge as per drawing and filled to straightness with a rough and smooth file and checked with a try square.

Result:
The square cutting is done successfully.

Precautions:

1. Job should be held tightly in a vice while doing fitting operations like filing and cutting.
2. While filing by a file and cutting by a hacksaw pressure should be applied during the forward stroke.
3. Cutting should be done accurately along the lines drawn after measurement.