

UNIT

1

Engineering Materials

Learning Objectives

On completion of this unit a learner will be able to

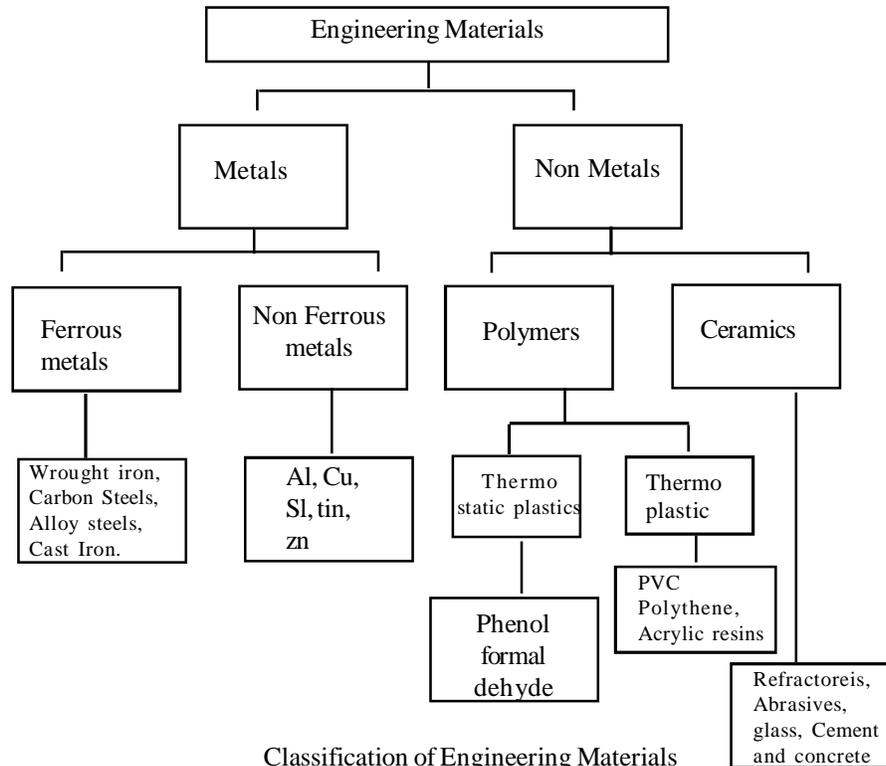
- Describe ferrous metals , non-ferrous metals and non-metals
- Know the properties and uses of ferrous and non ferrous metals
- Know the safety precautions to be followed in a work shop

1.0 Introduction

Engineering materials are those which are extensively used in various engineering applications such as used for construction of bridges, machine tools, automobiles, locomotives, ships, space crafts and many more. Steel is extensively used in construction of bridges. Iron is used for various machine tools. Aircrafts have aluminium bodies. Large number of household , industrial goods, electronics goods are made using plastics like TV cabinets computer bodies & toys.

Classification of Engineering Materials

Engineering materials are basically classified into two groups namely metals and non-metals, and their sub classification is given below.



Mechanical Properties of Metals

The mechanical properties that determine the behavior of metals under applied forces. These properties are most important for the designing point of view.

- 1. Strength :** Ability of a material to resist loads without failure.
- 2. Tensile Strength :** Ability of a material in tension to withstand stress without failure.
- 3. Shear Strength :** Ability of a material to withstand transverse loads without fracture.
- 4. Elasticity :** Property of material which enables it to regain its original shape after deformation with in the elastic limit.
- 5. Stiffness :** Property of material which enables it to resist deformation.
- 6. Plasticity :** Ability of material to be deformed permanently without fracture even after removal of force.

7. Ductility : Ability of a material to deform plastically without rupture under tensile load.

8. Malleability : Property which enables the metal to withstand deformation by a compressive load without fracture.

9. Brittleness : Property of the material of sudden fracture without any appreciable deformation.

10. Hardness : Property of the material which enables it to resist abrasion, indentation, machining and scratching.

11. Toughness : Ability of material to absorb maximum energy upto fracture takes place.

12. Fatigue : Failure of material under repeated (cyclic) loads or fluctuating loads.

13. Weldability : Ability of a material to be joined by welding

14. Castability : Property of a metal which indicates the ease with which it can be cast into different shapes and sizes from its liquid state.

Ferrous Metals

The metals which contain iron as base are called ferrous metals. Eg. Cast iron, Alloy steels etc. These are classified as

- 1) Pig iron 2) Cast iron 3) Wrought iron
- 4) Carbon Steel 5) Alloy steel.

The properties and uses of common engineering materials.

1.1 Cast Iron

Pig iron remelted and there by refined together with definite amount of lime stone, steel scrap and spoiled castings in cupola. It contain 2-4% carbon, a small percentage of silicon, sulphur, phosphorus and manganese.

Properties of Cast Iron

1. It has good fluidity
2. It can be easily machined
3. It is brittle in nature
4. It is resistance to deformation

5. It is wear resistant.

Uses of Cast Iron

1. It is used in making pipes
2. It is used for making machine bodies
3. It is used in making automotive industry parts.

1.2 Mild Steel

These are also called low carbon steels having carbon content of 0.15 - 0.3%.

Properties of Mild Steel

1. It has low fluidity.
2. It has good tensile strength.
3. It is ductile
4. It can be cold worked easily.

Uses

1. It is used for making structures
2. It is used for making nuts and bolts
3. It is used for making machine components.
4. It is used for making boiler plates.

1.3 High Carbon Steels

High carbon steels have more than 0.60% carbon i.e. 0.6 - 0.9% carbon . It is generally used for making parts requiring strength, hardness and wear resistance.

Properties of High Carbon Steels

- (1) It has good strength
- (2) It has high toughness
- (3) It has increased wear resistance.

Uses

1. It is used for making Drop hammers
2. It is used for making Screw drivers
3. It is used for making laminated Springs
4. It is used for making gears.
5. It is used for making piston rings

1.4 Alloy Steels

Steel is a metal alloy consisting mostly of iron, in addition to small amount of carbon, depending upon the grade and quality of the steel. Alloy steel is any type of steel to which one or more elements besides carbon have been added to produce a desired physical properties. The most common alloying elements added to steel are Chromium, Nickel, manganese, silicon, Vanadium etc. .

Properties of Alloy Steel

- (1) High Strength
- (2) High corrosion resistance
- (3) High wear resistance
- (4) Good toughness.

Uses

- (1) It is used for making Aeroplane parts
- (2) It is used for making automobile parts
- (3) It is used for railway track work
- (4) It is used for making locomotive parts

1.5 Stainless Steel

It contains 18% chromium, 8% nickle, 0.06% to 0.12% carbon. They are called stainless because in the presence of oxygen, they develop a thin adherent film of chromium oxide that protects the metal from corrosion.

Properties of Stainless Steel

1. It has high corrosion resistance.

2. It has high strength
3. Good toughness
4. It possesses non magnetic properties.
5. It can be rolled.

Uses

1. It is used for making surgical instruments.
2. It is used for making utensils
3. It is used for making containers for pharmaceutical industries.
4. It is used for making springs.

Non Ferrous Metals

The metal which do not contain iron as base Eg: Al, Cu, Lead, Zn and gold etc. All the non ferrous metals have common set of properties. The melting point of these metals are generally lower than ferrous metals.

1.6 Copper

Copper is easily identified from all other metals due to reddish in colour and is extracted from copper pyrites.

Properties of Copper :

1. It is relatively soft.
2. It is very malleable and ductile
3. It is very good conductor of heat and electricity.
4. It is very flexible.

Uses of Copper

1. It is used for making electrical cables.
2. It is used for making kitchen vessels
3. It is used for making pipes which are used in refrigerators.
4. It is used making for ornaments.

1.7 Brass

It is basically refers to a yellowish alloy of copper and zinc and it comprises of 65% copper and 35% zinc. There are various classes of brass, depending on the proportion of copper and zinc are available for various uses. The melting point of brass ranges from 800°C - 1000 °C.

Properties of Brass

1. It is non corrosive
2. Air, water and some acids do not affect it.
3. It is poor conductor of electricity.

Uses

1. It is used for making utensils.
2. It is used for manufacturing ornaments.
3. It is used in hydraulic fittings, pump lining, in making bearing and bushes.
4. It is used in making locks.

1.8 Bronze

It is alloy of copper and tin. The composition range is 5-25% tin and 75 to 95% copper. The corrosion resistance of bronzes are superior than brasses.

Properties of Bronze

1. It is comparatively hard
2. It is resistance to surface wear
3. It can be casted into wires and sheets
4. It has high strength.

Uses

1. It is used in hydraulic fittings, pump linings,
2. It is used in making utensils, bearings, bushes, sheets, rods, wire etc.

1.9 Tin

Although it is used in small amounts, tin is an important metal. Tin is used as protective layer on the sheet metal. It is obtained from tin stone.

Properties of Tin

1. It is white soft metal
2. Good resistance to acid corrosion
3. Low strength
4. It is malleable and ductile.
5. It does not corrode at both dry and wet climates.

Uses

1. It is used as a coating on steel containers for preservation of food products
2. It is used in making thin foils and as an alloying element in the manufacture of bearings.

1.10 Zinc

It is fourth most utilized industrially after iron, Aluminium and copper. It is used for galvanising the steel sheet or wire as it serves as anode to protect from corrosion attack.

Properties of Zinc

1. It is soluble in copper
2. Low melting point and high fluidity.
3. High corrosion resistance
4. It is ductile and malleable.

Uses

1. It is used for die casting
2. It is used for production of brass
3. It is used in battery cells for making dry batteries
4. It is used as protective coating in iron and steel against rusting

1.11 Gun Metal

Gun metal contains 10% tin, 88% copper and 2% zinc. Zinc is added to clean the metal and increase fluidity. It is not suitable for being worked in the cold state.

Properties of Gun Metal

1. It is highly anti corrosive
2. It has good machinability
3. It has good hardenability.

Uses

1. It is used for casting guns and cannons.
2. It is used for boiler fitting.
3. It is used for making bearings.
4. It is used for making glands in centrifugal pumps

1.12 White Metal

White metal contains copper-tin-antimony and it contain 88% tin, 8% antimony and 4 % copper.

Properties

1. It is a soft metal with low coefficient of friction
2. It has little strength

Uses

It is the most common bearing metal used into cast iron boxes when the bearing are subjected to high pressure and load.

1.13 Aluminium

Aluminium is most abundant metal in the earth crust. It is silvery white in colour. It makes up about 8% by weight of the earth's solid surface Aluminium is remarkable for its low density and ability to resist corrosion

Properties of Aluminium

1. It is a good conductor of heat and electricity.
2. It is very light in weight.
3. In pure state is very weak and soft.

Uses

1. It is used for making automobile parts
2. It is used for ornamental purpose
3. It is used for making aircraft parts
4. It is used for making bars, tubes&rivets

1.14 Non Metals

1. Wood : Another name given to wood is timber. It is obtained from trees after full growth and made suitable for engineering building process.

2. Plastics : The word plastic is common term that is used for many materials of a synthetic or semi synthetic nature. Now plastic materials are most widely used for domestic as well as industrial purpose due to its low cost, light weight and it looks decorative.

3. Rubber : Rubber is a polymer which is a word that is derived from the greek meaning "many parts". Natural rubber is formed in the latex which comes from the rubber trees. It is collected in a cup mounted on each tree. Rubber is used for making tyres, tubes, shock absorbers, rubber cushions, weather stripping around car's windshield and gaskets.

1.15 Safety Precautions

1. Never wear loose clothing, ties and shirts with long sleeves.
2. Keep the shop floor clean and free from oil and grease.
3. Do not use blunt or dull tool, it slips and causes injury.
4. While using chisels, see that cutting is performed in the direction away from the body.
5. Keep hands away from moving parts.
6. There must be sufficient light and ventilation at work place.
7. Exhaust fans should be provided to remove smokes and fumes.
8. Use proper tools according to the nature of the job.
9. Use of shoes and apron is essential.
10. Never carry tools in pocket.

11. Observe all the safety codes while working in the workshop.

Summary

1. All engineering materials are mainly classified into metals and non metals
2. Metals are further classified into ferrous and non ferrous metals.
3. The metals which contain iron as base are ferrous metals
4. Ferrous metals are classified into five types i) Pig iron ii) Cast iron iii) Wrought iron iv) Carbon steels v) Alloys steels.
5. The metals which do not contain iron as base are non-ferrous metals
6. All non ferrous metals have common set of properties
7. Steels are classified into i) low carbon steels ii) medium carbon steels iii) high carbon steels

Activity

1. A learner should collect a piece of cast iron and mild steel
2. A learner should collect a piece of copper, silver, aluminium and lead

Short Answer Type Questions

1. Classify Engineering materials
2. Write the properties of copper
3. What is the composition of gunmetal
4. What are uses of aluminium

UNIT

2**Fitting****Learning Objectives**

On completion of this unit a learner will be able to

- Explain various cutting tools used in fitting shop.
- Describe various work holding device used in fitting shop.
- List out various marking and measuring tools used in fitting.
- Explain about radial drilling machine.

2.0 Introduction

Although majority of the work can be finished to fairly good degree of accuracy through various machining operations, but still needs some hand operations to obtain desired finish and fit. These operations are usually carried on bench by fitter. Hence fitting is the process of assembling various parts manufactured in the machine shop. Also a fitter's task is unavoidable when different parts are to be assembled in position.

Hence various tools and equipments are required to perform operations to finish the work to the desired shape and size in assembling the unit.

Tools used in fitting:

Tools used in fitting is classified into following groups:

1. Cutting tools
2. Striking tools
3. Holding tools
4. Marking and measuring tools

In addition to the above tools, the fitter needs other miscellaneous tools such as screw drivers and spanners etc.

2.1 Cutting Tools

Cutting tools play a most important role in removing excess metal from the job to obtain desired finished part. The various cutting tools used in fitting are:

1. Chisels
2. Hacksaws
3. Files
4. Scrapers
5. Drill bits
6. Reamers
7. Taps
8. Dies and sockets

2.1.1 Chisels

Cold chisels are used for cutting thin sheets and to remove excess material from large surfaces. In this case the surface finish and accuracy are usually poor.

Parts of chisel: It consists of following parts

- a) Head
- b) Body or shank
- c) Point or cutting edge

Head : The head is tapered towards top and made tough to withstand hammer blows

Body or Shank : The cross section of the shank is made hexagonal or octagonal to have grip while working.

Point or Cutting Edge : The cutting edge is hardened and tempered and made to specified angle. The hardening followed by tempering makes the chisel to maintain its sharp edge.

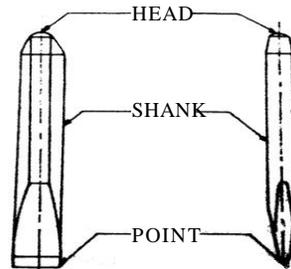


Fig. 2.1 Parts of Chisel

The shape of cutting edge is required to specify the chisel. The five most important types of chisels are:

1. Flat chisel
2. Cross cut chisel
3. Half round chisel
4. Diamond point chisel
5. Side chisel

Flat Chisel: It is most common chisel used for chipping large surfaces and cutting the sheets. It is also used to part off metal after chain drilling. The length of a flat chisel varies from 100mm to 400mm and the width from 16mm to 32mm.



Fig. 2.2 Flat Chisel

Cross Cut Chisel: The cross cut chisel or cape chisel is used for cutting grooves and channels and keys ways in shafts and pulleys. Its cutting edge wider than the supporting metal to provide clearance. The length of chisel varies from 100mm to 400mm and width varies from 4mm to 12mm.

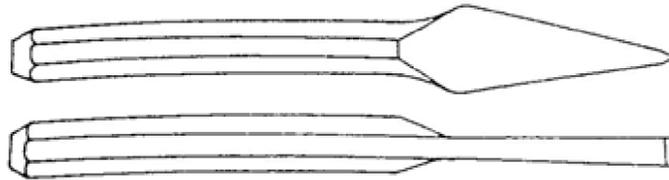


Fig. 2.3 Cross cut Chisel

Half Round Chisel : It is particularly useful for cutting oil ways ,cutting curved grooves in bearings ,bosses and pulleys .They are also used for setting over pilot holes. When a hole is to be drilled a pilot hole is drilled first.

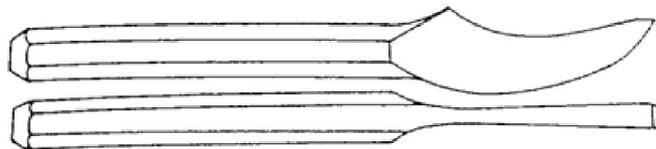


Fig. 2.4 Half Round Chisel

Diamond Point Chisel.: Its edge is in the form of diamond used for cutting V- grooves, cleaning corners and squaring small holes.

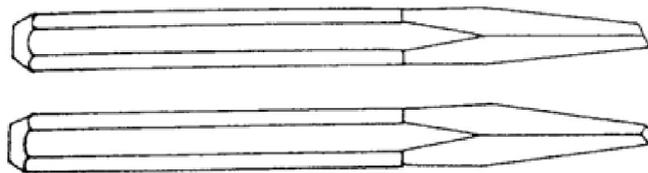


Fig. 2.5 Diamond Point Chisel

Side Chisel : This is used for chipping and removing the surplus metal in rectangular slots. The shank of the chisel is bent out a little side way and vertically down again.

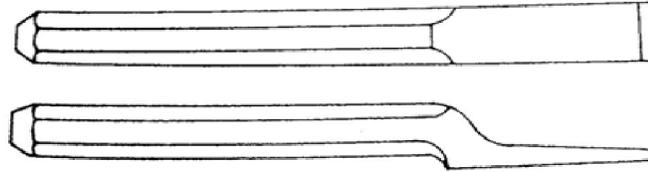


Fig. 2.6 Side Chisel

2.1.2 Hack Saw : It is a basic hand cutting tool used for cutting unwanted material. It is used for cutting metals and making recesses prior to filing or chipping. It is also used for cutting slots and contours.

Parts of Hack saw : It consists of the following parts.

1. Metal frame
2. Blade
3. Handle.
4. Wing nut
5. Screw

The frame is made to hold the blade tightly. They are made in two types.

a) The solid frame hack saw in which the length cannot be changed. b) The adjustable frame in which the frame can be adjusted to hold the blades of different lengths.

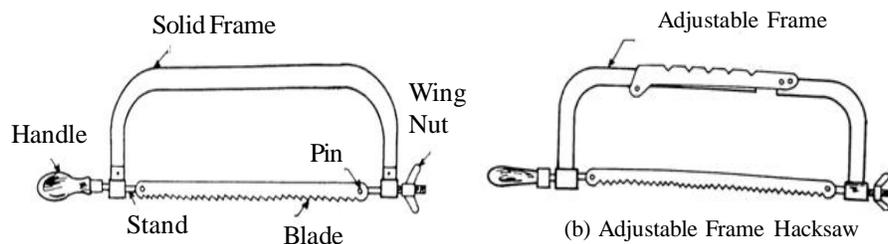


Fig. 2.7 Hack Saws

Hacksaw Blade : It is thin, narrow steel strip made of high carbon steel or low alloy steel or high speed steel. The blade has two pin holes at the ends which fits over two pins which project from the stand that slides in and out of the frame end. Tightening the wing nut at the front end tensions the blade sufficiently to prevent it from flexing when cutting. The blade must be fitted such that teeth point away from the handle so that cut takes on the forward stroke.

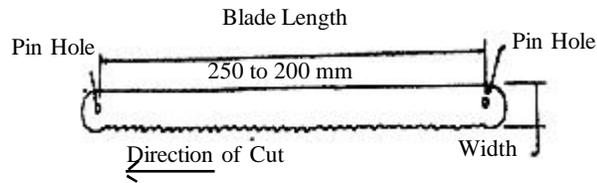


Fig. 2.8 Hack Saw Blade

2.1.3 FILES : File is a cutting tool with multiple teeth like cutting edges used for producing smooth surface. The accuracy that can be achieved from 0.2 to 0.05 mm.

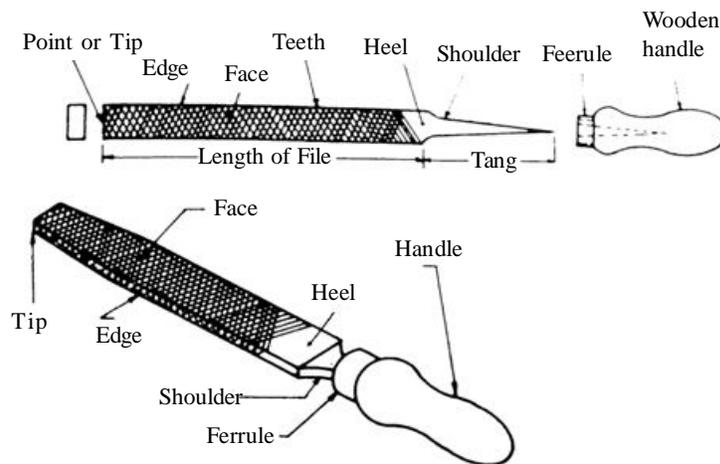


Fig. 2.9 Parts of File

Parts of the File

1. Tang
2. Tip or point
3. Face or side
4. Edge
5. Heel
6. Shoulder
7. Handle

1. **Tang :** It is the pointed part which fits in to the wooden handle.
2. **Tip or point :** It is the opposite end of the tang.
3. **Face or side :** This is the broad part of a file with teeth cut on it.
4. **Edge :** It is the safe edge of file which has no teeth.
- 5) **Heel :** The heel is next to handle of the file with or without teeth.
- 6) **Shoulder :** The curved part of the file separating the tang from the body.
- 7) **Handle :** The part which is fitted to the handle made of wood.

The files of different cross section or types are needed to suit the various job operations. The most commonly used files are (a) Flat file (b) Hand File (c) Square file (d) Round file (e) Half round file (f) Triangular file (g) Knife edge file (h) Pillar file.

(a) **Flat File :** This is tapered in both width and thickness used for heavy filing. This file is parallel to about two third of length, then tapers in both width and thickness.

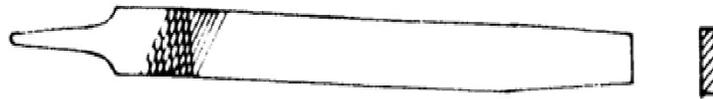


Fig. 2.10 Flat file

(b) **Hand File :** This is used where flat file is not suitable for filing flat surfaces and has rectangular cross section with parallel edges throughout, but thickness is tapered towards point.

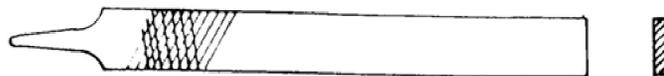


Fig. 2.11 Hand file

(c) **Square file :** This is in square cross section used for filing square and rectangular holes and for finishing the bottom narrow slots.



Fig. 2.12 Square file

(d) **Round File** : They are round in cross-section and usually tapered. They are used for filing circular holes, curved surfaces and finishing fillets.



Fig. 2.13 Round File

(e) **Half Round File** : This file is tapered double-cut and its cross-section is not a half circle but only one third of a circle. This file is used for round cuts and filing curved surfaces.

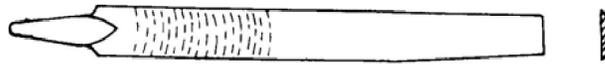


Fig. 2.14 Half Round File

(f) **Triangular File** : The cross section of file is like equilateral triangle used for filing grooves, slots, holes and sharp corners.



Fig. 2.15 Triangular File

(g) **Knife Edged File** : Its shape is like a knife used to file narrow slots, grooves and sharp corners. Its width and thickness are tapered towards point in the form of knife.

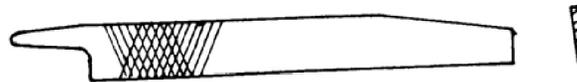


Fig. 2.16 Knife Edge File

2.1.4 Scrapers : These are used to shaving off thin slices of metal to make a fine and smooth surface which is not possible with a file or chisel. This is made of good quality forged steel and its cutting edge is usually made thin, made from old files.

Parts of Scrapers

1. Cutting edge with rounded corners.
2. Blade
3. Tang
4. Wooden handle.

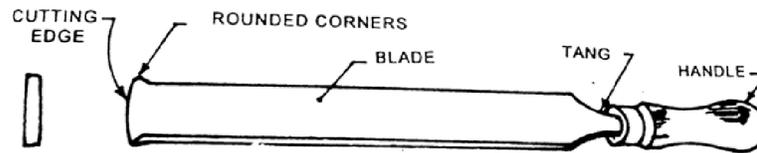


Fig. 2.17 Parts of Scrapper

1. Cutting edge with rounded corners : The cutting edge is hardened without tempered to make hard.

2. Blade : The broad part of a scraper

3. Tang : The narrow part which fits into wooden handle.

4. Wooden handle : That fits into tang to have grip while scrapping
According cross section, the scrapers are classified into three types. They are
(a) Flat Scraper (b) Triangular Scraper (c) Half round scraper.

(a) Flat Scraper

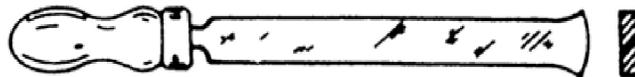


Fig. 2.18 Flat Scrapper

This type of scraper is used for scapping plane surfaces or slots and the cutting edge at the ends of the balde is curved. The corners are rounded to prevent deep scratches on finished surface. It also helps to scap the metal exactly at the desired spot.

(b) Triangular Scraper



Fig. 2.19 Triangular Scrapper

It has three cutting edges and is made from old triangular files used to scrap round or curved surfaces and to remove sharp corners.

(c) Half round Scraper :

It is used for finishing curved surfaces and chamfering holes and removing burrs.

2.1.5 Drill Bits

A drill is a cutting tool for making through hole in a metal piece and usually it has two cutting edges set an angle with axis. It does not produce accurate hole. There are three types of drills.

(a) Flat Drill (b) Straight Fluted Drill (c) Twist Drill

(a) Flat Drill : It is a simple drill used for producing holes in softer materials like wood and plastic. This is made of high carbon steel and has two cutting edges.

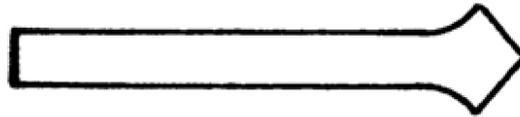


Fig. 2.20 Flat Drill

(b) Straight Fluted Drill : It has two cutting edges and two straight flutes used for drilling brass and non-ferrous metals.



Fig. 2.21 Straight Fluted Drill

(c) Twist Drill : This is most commonly used cutting tool in workshop. It has two cutting edges and two helical grooves which admits coolant and allows the chips to escape during the drilling. These are made of high speed steel.

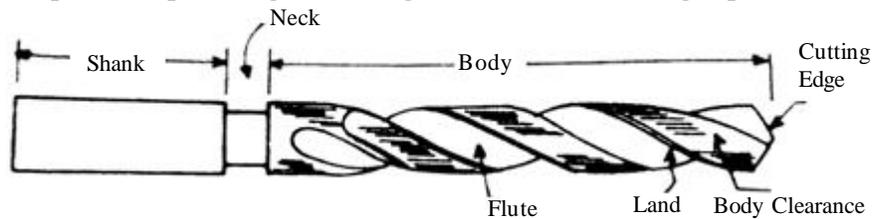


Fig. 2.22 Twist Drill

2.1.6 Reamers : A drill does not produce accurate hole and it must be finished by finishing tool called reamer. When an accurate hole with a smoother finish a required reamer is used. Hence the reamer can only follow the drilled hole and removes very small amount of metal to make it smooth

There are two types of reamers

- (a) Hand Reamers
- (b) Machine Reamers

(a) Hand Reamer : This reamer is turned by hand called hand reamer. The shank has a square tang so that a tap wrench can be used to turn the reamer in to work. These are available with straight or helical flutes.

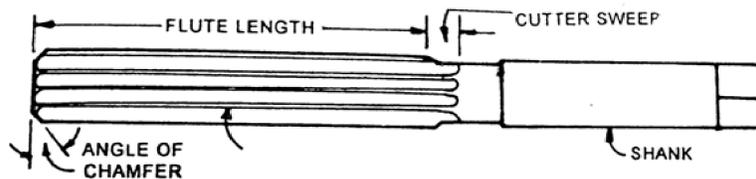


Fig. 2.23 Hand Reamer

(b) Machine Reamers : These are used to turn by the machine called machine reamers. Its shank is tapered which fits directly in the internal taper of the machine spindle. These are also available with straight shanks which are held and driven by drill chuck.

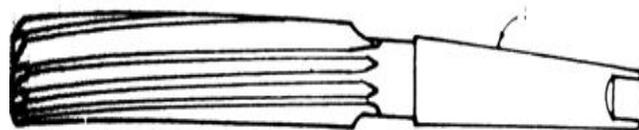


Fig. 2.24 Machine Reamer

2.1.7 Taps : A tap is a screw like tool which has threads like a bolt and three or four flutes cut across the threads which is used to produce internal threads. The edge of the thread formed by the flutes are the cutting edges. The lower part of the tap is somewhat tapered so that it can well attack the walls of the drill hole.

Hand taps are usually made in sets of three (1) Taper tap (2) Second tap (3) Bottom tap.

(1) **Taper Tap** : In this tap about six threads are tapered and is used to start the thread, so that the threads are formed gradually as the tap is turned into the hole.

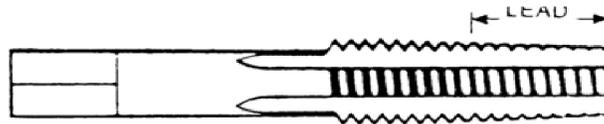


Fig. 2.25 Taper Tap

(2) **Second tap** : It is tapered back from the edge about three or four threads used after taper tap. It has been used to cut the threads as far as possible



Fig. 2.26 Second Tap

(3) **Bottom Tap** : It has full threads for the whole of its length. This is used to finish the work prepared by the other two taps.

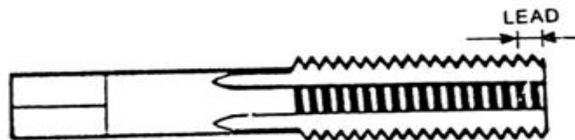


Fig. 2.27 Bottom Tap

2.1.8 Dies

It is a circular disc of hardened tool steel used to make external threads on a round rod or bolts with a die and stock. Die has a hole containing threads and flutes which form cutting edges. These are mainly two types

1. Solid Die
2. Adjustable Die.

1. Solid Die : It is one which has fixed dimension and cannot be adjusted for smaller or large diameter. It is used for recutting damaged threads and may be driven by suitable wrench.

2. Adjustable Die : It can be set to cut larger and smaller diameters. It has a split through one side and a slight adjustment is possible with the help of set screw.

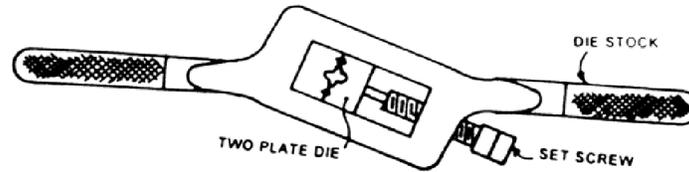


Fig. 2.28 Two - Plate Die

2.1.9 Sockets

It is used for the drills whose taper is larger than spindle hole taper. It is much larger than sleeve. Its taper shank conforms to the spindle hole taper and fits in to it.

2.2 Striking Tools --- Hammers

Hand hammers are also called striking tools used to strike the job. They are made of forged steel of various sizes and shapes to suit various purposes like punching, chipping, marking, bending and riveting.

2.2.1 Parts of Hammer

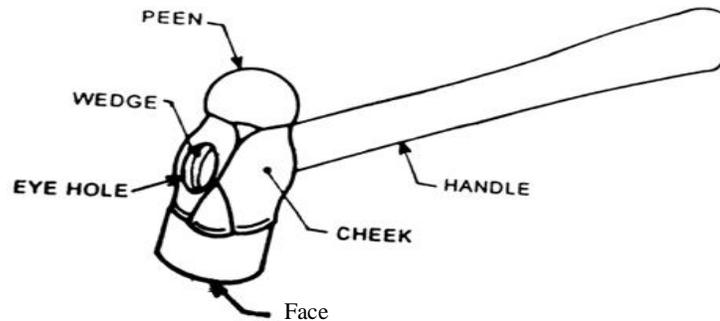


Fig. 2.29 Parts of Hand Hammer

A hammer consists of four parts namely Face, Peen, Cheek and eye hole.

Face : It is the striking portion polished well and is given slight convexity to avoid spoilage of the surface of the metal to be hammered.

Peen : It is the other end of the head and is made into different shapes to suit various operations.

Cheek : Middle portion of the hammer head.

Eye-Hole : It is made oval or elliptical in shape to accommodate the handle..

Depending upon the shape of the peen, hand hammers are classified as 1) Ball peen hammer 2) Cross peen hammer 3) Straight peen hammer.

1. Ball Peen Hammer : It has a flat striking face and ball shaped peen which is hardened and polished. This hammer is chiefly used for chipping and riveting.

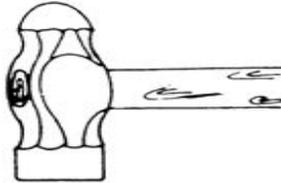


Fig. 2.30 Ball Pen Hammer

2. Cross - Peen Hammer : It has wedged shape peen across the eye. It is used for bending, stretching, hammering into shoulders.

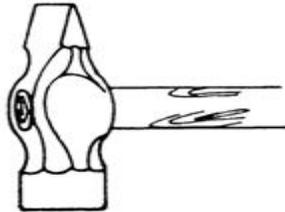


Fig. 2.31 Cross-Pen Hammer

3. Straight Peen Hammer : This is similar to cross peen hammer except that the peen in this case is parallel to eye. It is used for stretching and peening the metal.

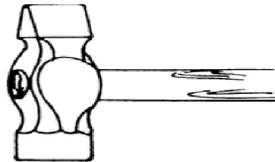


Fig. 2.32 Straight Peen Hammer

4. Soft Hammer or Mallet : These are soft hammers used give light blows where the work surface must not be damaged . They are made of either rubber, plastic or wood.

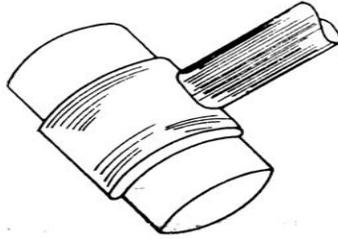


Fig. 2.33 Soft Hammer

2.3 Holding Devices or Vices

In most of the metal cutting operations quite a large number of forces will be involved. So it is necessary that the work must be secured highly so that it does not move when subjected to the cutting forces. Therefore, holding the job is an important aspect of all metal cutting operations. A vice is a work holding device used to grip the job tightly. Different types of vices are used for various purposes. They include

- a. Bench vice
- b. Pipe vice
- c. Hand vice
- d. Pin vice
- e. Tool maker's vice

2.3.1 Bench vice

This is most commonly used tool for holding the work. It has two jaws one of which is fixed to the bench and other slides with the aid of square screw and a box nut arrangement. The outer end of screw carries a handle, and a collar prevents the screw from coming out of the unit while rotating. The sliding jaw moves close to the fixed jaw to hold the work and the tightening force is exerted by further rotation of handle. The working faces of jaws are serrated to give additional grip.

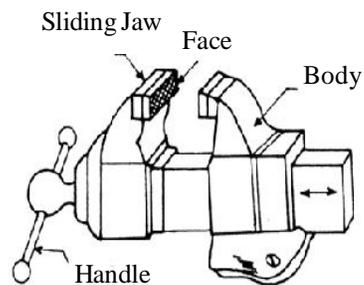


Fig.2.34 Bench Wise

2.3.2 Pipe Vice

It is generally used for holding round sections ,tubes and pipes etc.It has two serrated jaws,one is fixed and the is moved by rotation of handle.It is used in lumbing work and it grips the circular objects at four points on its surfaces.

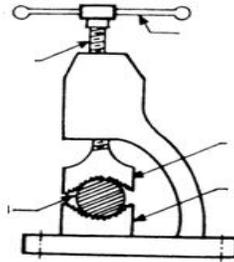


Fig. 2.35 Pipe Vice

2.3.3 Hand vice

It is used for gripping small objects like screw, rivets, keys when they are inconvenient to hold by the bench vice. It has two legs made of Mild steel which holds two jaws at the top and are hinged together at the bottom .A spring is provided between these legs to keep them away. The work is held between the serrated jaws by means of a wing nut and screw.

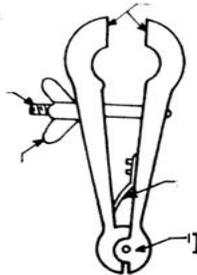


Fig. 2.36 Hand Vice

2.3.4 Pin vice

It is used for holding small parts such as wires ,nails and pins. It consists of three jaw self centering chuck which is operated by turning the handle to hold work.

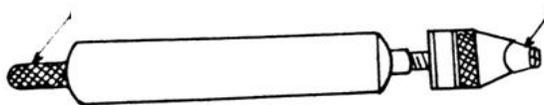


Fig. 2.37 Pin Vice

2.3.4 Tool makers vice

It is a small vice made of mild steel used for holding small jobs which requires fitting or drilling. It is used by tool and die makers and silver smiths to hold small jobs.

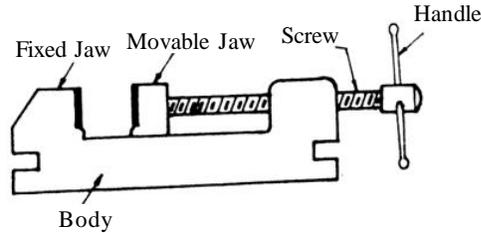


Fig. 2.38 Tool Maker's Vice

2.4 Marking Tools

- | | |
|------------------|-----------------|
| 1. Surface Plate | 2. V - Block |
| 3. Scribes | 4. Angle plate |
| 5. Punches | 6. Try - Square |

2.4.1 Surface Plate

Surface plate is made of grey cast iron of solid design. It is used for testing the flatness of work and also used for marking-out the work. A surface plate has a surface of proved flatness. When used for testing flatness, the top of the plate should be coated with their layer of red lead in oil. The surface to be tested must be cleaned, then place in contact with the plate and moved about. If it is reasonably flat, subsequent examination will show spot of blue or red all over the surface.

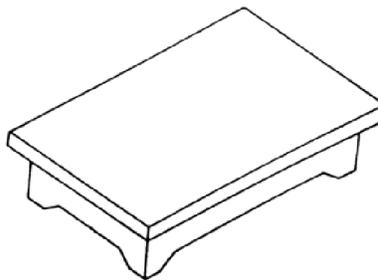


Fig. 2.39 Surface Plate

2.4.2 V - Block : It is made of hardened steel with V-shaped grooves on the top and bottom, and rectangular slots on two sides for the location of clamps. Roundly shaped workpieces which are to be marked or drilled are placed on V-supports. In this way, they are firmly supported in a horizontal position and cannot rotate easily.

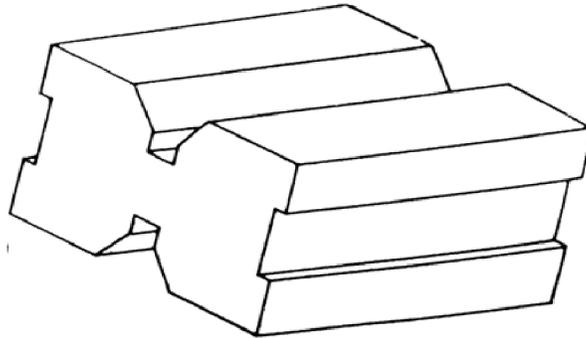


Fig. 2.40 Surface Plate

2.4.3 Scribes : It is made of tool steel with hardened and tempered points and knurled on the body to provide grip. Scribe is used for making straight lines on metal surface with the aid of steel rule, try square and templates. The bent end is used to scratch line in places where the straight end cannot reach. The ends are sharpened on an oil stone when necessary.



Fig. 2.41 Single point Scribe



Fig. 2.42 Double point Scribe

2.4.4 Angle plate : This is used in conjunction with the surface plate for supporting work in the perpendicular position. It is made of grey cast iron has two plane surfaces at right angles to each other. It has various slots in it to enable the work to be held firmly by bolts and clamps.

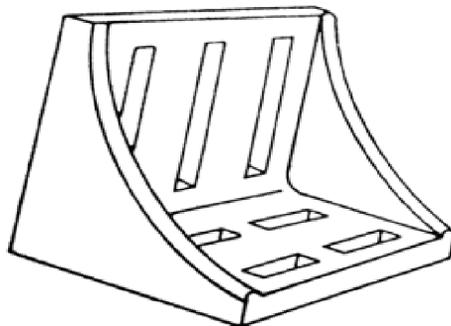


Fig. 2.43 Angle Plate

2.4.5 Punches : Punches are used in a bench work for marking out work, locating centres, etc in permanent manner. It is made of tool steel, hardened and tempered . The shank is knurled to provide grip.

Punches are two types

1. Prick punch 2. Centre punches.

Prick punch is sharply pointed tool used for marking small dots along the layout lines in order to make them last longer. Centre punch has an angle more than obtuse and used to mark the centres of holes to be drilled.

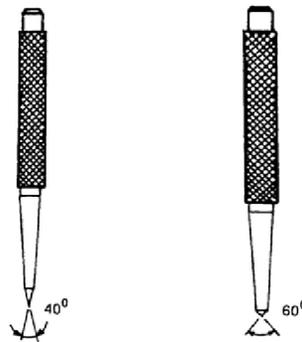


Fig. 2.44 Prick Punch Fig. 2.45 Centre Punch

2.4.6 Try Square : It is made of steel and consist of a blade and a stock made in one piece set at right angle to each other. It is used to test trueness of mutually perpendicular surfaces and for making straight lines at right angle to each other.

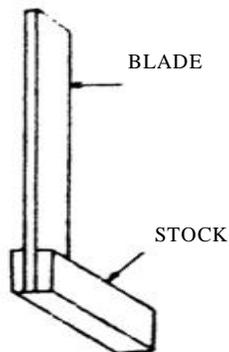


Fig. 2.46 Try Square

2.5 Miscellaneous Tools

In addition to the above tools, the following tools are widely used in fitting.

- 1) File Card
- 2) Screw driver
- 3) Spanner
- 4) Pliers

1. File Card

It is the short wire brush used to remove small chips called pins, and to clean the file. While filing these chips are deposited between the teeth of file which reduces cutting ability and causing scratches on work piece.

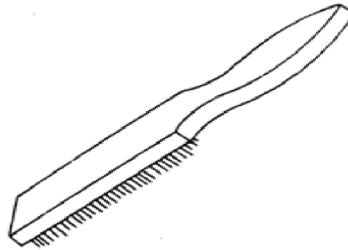


Fig. 2.47 File Card

2. Screw Driver

Screw driver is used for tightening and loosening the screws. It is made in variety of shapes to suit various job operations.



Fig. 2.48 Screw Driver

3. Spanners

These are also called wrenches, are used for tightening or loosening nuts and bolts. The following types of spanners are widely used in fitting.

- a. Single end Spanner
- b. Double end Spanner
- c. Adjustable Spanner
- d. Box Spanner

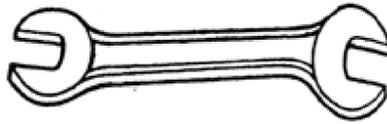


Fig. 2.49 Spanner

4. Pliers

These are used for holding small jobs which are difficult to held by hand. They are used for bending and cutting the wires. The following types of pliers are most common.

1. Cutting pliers
2. Nose Pliers

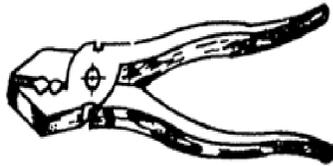


Fig. 2.50 Cutting Plier

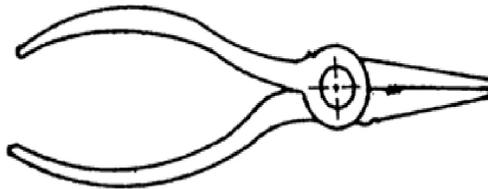


Fig. 2.51 Nose plier

2.6 Checking and Measuring Instruments

Measuring Instruments :

- | | |
|----------------|---------------------|
| a) Steel rule | b) Calipers |
| c) Depth gauge | d) Vernier Calipers |
| e) Micrometer | f) Gauge block |

a) Steel Rule

It is used for direct measurement of length which do not require great accuracy and also used to transfer the measurements from steel rule to calipers. These are available in 150 mm or 300 mm in length.

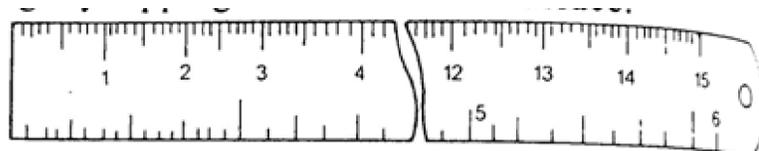


Fig. 2.52 Steel Rule

b. Calipers

These are used for measuring and transferring the inside or outside dimensions for components. These are also used for comparing the sizes with existing standards. The following types of calipers are most widely used in workshops

1. Outside Calipers

2. Inside Calipers

1. Outside Calipers

It is used for measuring outside dimensions of cylindrical shapes and the thickness of metal pieces. It has two steel legs bent inwards.



Fig. 2.53 Outside Calipers

2. Inside Calipers

It is used to measure the diameter of holes and width of key ways or recesses. Its legs are bent outwards.

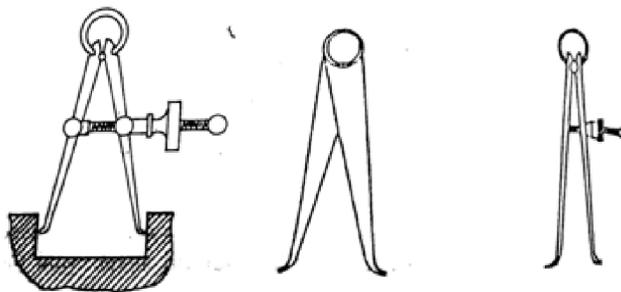


Fig. 2.54 Inside Calipers

3) Depth Gauge

It is used to measure the blind holes, slots, recesses and height of projections.

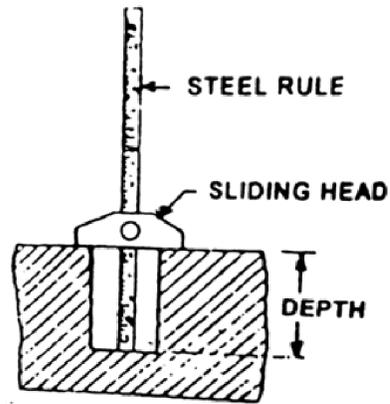


Fig. 2.55 Depth Gauge

4. Vernier Calipers

These are widely used for precision measurement of length, thickness, depth and inside and outside diameters. With vernier caliper we can achieve accuracy upto 0.02 mm.

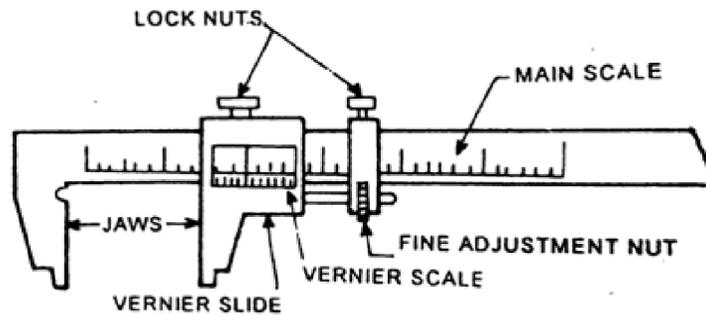


Fig. 2.56 Vernier Calipers

5. Micrometer

Micrometer is a precision tool used to measure external or internal dimensions such as diameters and thickness, with an accuracy upto 0.01 mm.

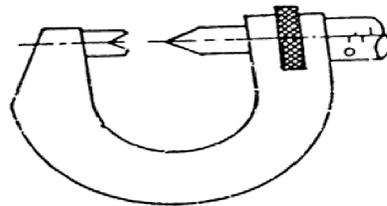


Fig. 2.57 Screw Thread Micrometer

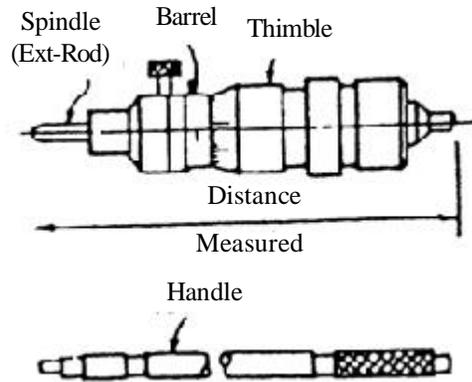


Fig. 2.58 Inside Micrometer

6. Gauge Block

They are used to check the accuracy of gauges to set comparators, sine bars and to make machine tool setups.

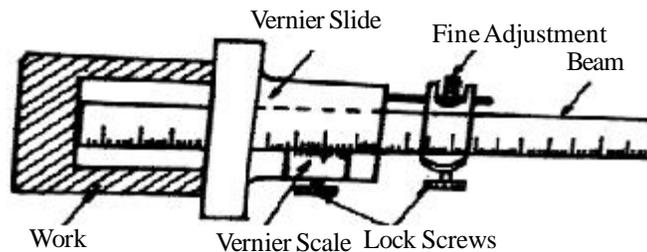


Fig. 2.59 Gauge Block

7. Dividers

These are used for transferring dimensions and scrubing circles and arcs on work surface. These are also used for dividing straight and curved lines.

2.7 Drilling Machines

Drilling is a process of making holes in a work piece and is carried out by driving a rotating tool called "drill" into a rigidly held work peice. To accomplish the drilling two things are required i.e. drilling macine and drilling tools. A drilling machine is used for drilling holes. However it can perform operations other than drilling such as reaming, boring, lapping etc.

Types of Drilling Machine

- 1) Portable drilling machine

- 2) Sensitive drilling machine
- 3) Radial drilling machine
- 4) Upright drilling machine
- 5) Gang drilling machine

2.7.1 Sensitive Drilling Machine

It is a small drilling machine mounted on a bench in which feed is hand operated, and the cutting force applied is determined by sense of feel of the operator. The parts of sensitive drilling machine as shown below. It consists of a vertical column, a work table, head supporting the motor and driving mechanism, and a vertical spindle for driving and rotating the drill.

The work is mounted on the work table which may be raised or lowered by the clamp to accommodate work pieces of different sizes. The driving mechanism consists of V-belt drive from machine spindle to drill spindle. Three or four speed stepped cone pulley is provided to give various speed ranges. The spindle is designed and mounted in a sleeve such that the spindle rotates and simultaneously moves up and down to provide feed for drill. This is achieved by a rack and pinion mechanism.

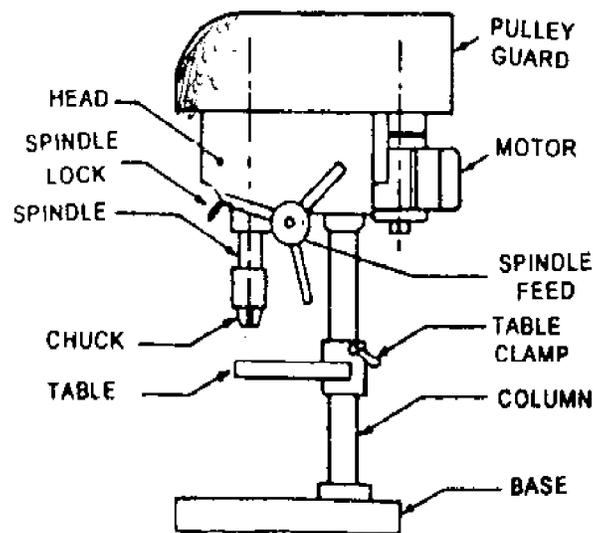


Fig. 2.60 Sensitive Drilling Machine

2.7.2 Radial Drilling Machine

Radial drilling machines are used for drilling heavy work pieces, where it is easier to move the drill rather than work and specially for the jobs where high degree of accuracy is required. It consists of base, column, radial arm, drill head and driving mechanism. The arm of radial drilling machine can be swing around the column to any position and angle. A wide range of spindle speeds, together with automatic feed of the spindle, makes the radial drilling machine suitable for drilling large castings. For lowering or raising the radial arm, a separate motor is provided. The work can be firmly champed on the table having T-slots. The table is fixed to the base. The radial arm and the spindle can be adjusted without disturbing the work setting.

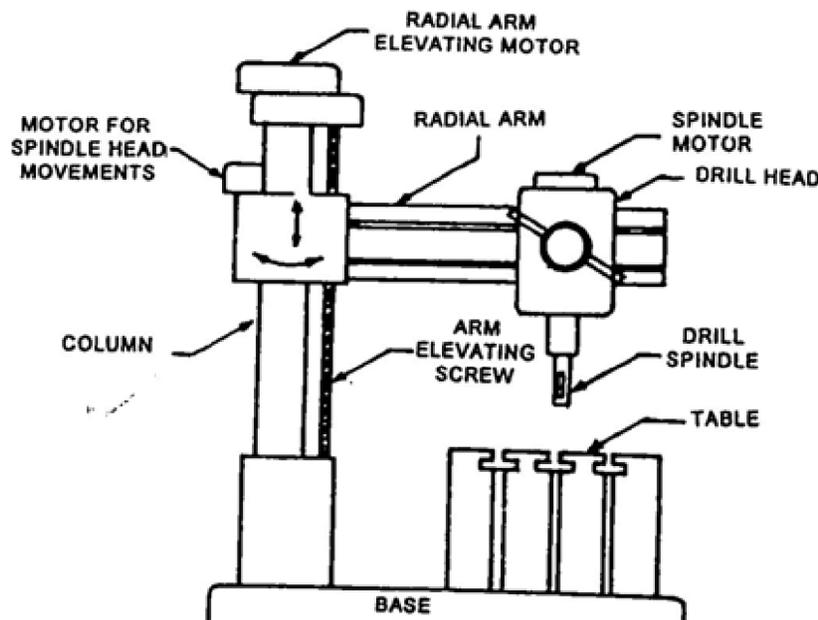


Fig. 2.61 Radial Drilling Machine

2.8 Drill Fittings

The following devices are used for holding the drills.

- a. Drill Chuck : It is designed to hold straight shank drills of different sizes. The jaws of the chuck are tightened around the drill by means of drill chuck key. These drill chucks have standard taper shanks.
- b. Machine spindle : These have morse taper holes. Standard taper drills are directly fitted in the spindle. The drill may be removed by driving the drift..

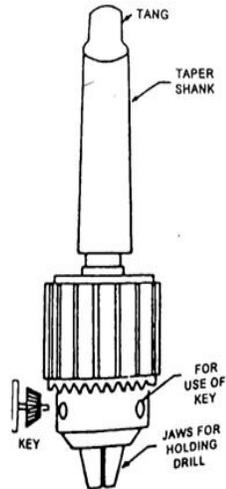


Fig. 2.62 Drill Chuck

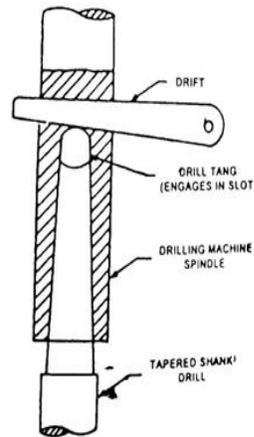


Fig. 2.63 Machine Spindle

c. Sleeve : It is used to hold the taper shank drills whose taper is less than taper hole of the spindle.

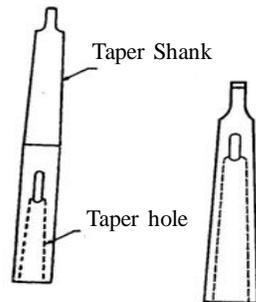


Fig. 2.64 Sleeve Fig. 2.65 Socket

d. Socket : It is used for the drilling whose taper is larger than spindle hole taper. It is much longer than sleeve. Its taper shank confirms to the spindle hole taper and fits into it.

2.9 Drilling Operations

The following operations are generally performed on drilling machine.

- a) Drilling b) Reaming c) Boring

d) Counter boring e) Counter sinking f) Tapping

a) Drilling : It is the process of making cylindrical hole by rotation of cutting tool.

b) Reaming : It is the process of making a hole smoothly and accurately by the tool called reamer.

c) Boring : It is the operation of enlarging a drilled hole to bring it to required size by using single point cutting tool.

d) Counter boring : This operation is used for enlarging only to a certain depth of already drilled hole in order to maintain alignment and true concentricity of the counter bored hole with the previously drilled hole and the tool is provided with a pilot at its bottom.

e) Counter Sinking : It is the operation of enlarging the end of a drilled hole to give a conical shape for a short distance. This is done for providing a seat to the counter sunk heads of screws.

f) Tapping : It is the operation of cutting internal threads by using a cutting tool called tap. In order to tap the hole, a special tapping chuck must be used.

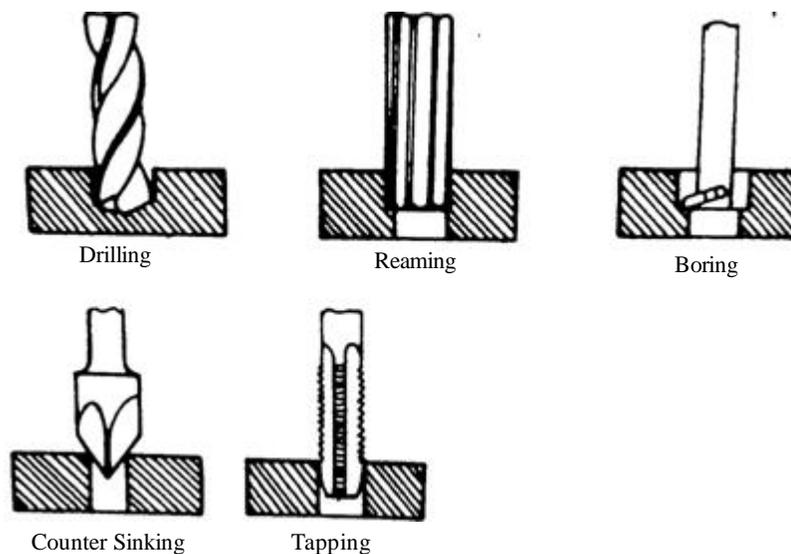


Fig. 2.66 Drilling Machine Operations

Summary

1. Fitting is the process of assembling various parts manufactured in the machine shop.
2. In fitting the hand tools are classified as cutting tools, marking tools, striking tools, holding tools, measuring and checking instruments.
3. Chisels are used to cut thin sheets and to remove excess material in the form of layers
4. Hacksaw is a basic hand cutting tool used to remove excess metal from the job
5. Files are used to remove excess metal from the job in the form of powder to make it smooth
6. Scrapers are used to remove excess metal in form of thin layers at selected spots to make it truly flat surface
7. Drilling is the process of making circular holes on the metal piece by rotating the tool against work piece
8. Reamer is a tool used to finish the already drilled hole on cylindrical holes
9. Tap is a cutting tool used to cut internal threads and dies are used to cut external threads on the cylindrical rods and pipes
10. Striking tools are hammers used to strike the work or tool
11. Holding devices are used to hold work tightly to prevent slipping during cutting operations.

Activity

1. A learner should collect L-shape M S flat.
2. A learner should collect T-shape MS flat.

Short Answer Type Questions

1. What is the use of a file.
2. What is the purpose of chisel.
3. Define scrapers.
4. Differentiate tap and die.

5. What are striking tools.
6. Define drilling and reaming.
7. What is the importance of holding devices.
8. Name different types of drilling machines.

Long Answer Type Questions

1. Define file and explain about any four files with sketch.
2. Explain about bench vice with neat sketch.
3. Define chisel and Explain about any two.

OJT Type Question

1. Prepare U,V,L& T Shapes from a given MS Flat

UNIT

3

Sheet Metal Work

Learning Objectives

On completion of this unit, a learner will be able to

- List out metals used for sheet metal work.
- List and explain various tools used in sheet metal work.
- Explain various sheet metal operations.
- List and explain various sheet metal joints commonly used.
- Explain various fastening methods.

3.0 Introduction

Sheet metal work is generally regarded as the working of metal from 16 SWG down to 30 SWG with hand tools and simple machines into various forms by cutting, forming into shapes and joining. Each gauge designates a definite thickness. Higher the gauge number and lesser the thickness. The common examples of sheet metal work are pipes, boxes, funnels, photoframes, buckets, and cans etc. In sheet metal work the knowledge of geometry, mensuration and properties of metal are most important for preparation of specific object.

3.1 Metals used in Sheet Metal Work

The following metals are used in sheet metal work.

1. Black iron
2. Galvanised iron
3. Copper
4. Aluminium
5. Tin
6. Stainless Steel

1. Black Iron :It has a bluish black appearance. It is cheapest metal and rusts rapidly . Its use is limited to fabrication of articles for general use and are to be painted with enamel for protecting them from rust. It is used for making tanks, stoves, pipes etc.

2. Galvanised Iron : Zinc coated iron is called galvanised iron. This is soft sheet is popularly known as G.I. sheet. The zinc coating resists rust, improves the appearance of the metal and permits it to be soldered with ease. It is used for making buckets, pans, cabinets, gutters etc.

3. Copper : Copper resist rust and have better appearance, but the cost is very high. It is used for ornamental work and making kitchen wear.

4. Aluminium : It is not used in pure form as it is very soft, but it is used with a small amount of copper, silicon, manganese etc. It is anti corrosive and has good appearance, relatively cheap and light in weight. It is used in making a number of articles like household appliances, refrigerator trays, light fixtures, windows, in the construction of aero plane parts etc.,

5. Tin : Steel sheets are coated with pure tin and have bright silvery appearance. This is used for nearly all solder work as it is easiest metal to join by soldering. The thickness of the tin plates are denoted by special marks not by gauge numbers. It is used for making buckets, pans, cans, etc.

6. Stainless Steel : Resists rust and has pleasing appearance. But the cost is high. This is alloy of steel with nickle, chromium and traces of other elements. It is used in canneries, food processing plants and chemical plants, kitchen wares etc.

3.1.1 Sheet Metal Hand Tools

A large number of hand tools used by sheet metal workers. Some of the important tools used are given below.

1. Measuring tools
 - (a) Steel rule
 - (b) Folding rule
 - (c) Circumference rule
 - (d) Vernier Calipers
 - (e) Micrometer
 - (f) Sheet metal guage
2. Straight edge
3. Scriber
4. Divider
5. Trammel point
6. Chisel
7. Punches
8. Hammers
9. Snips or Shears
10. Pliers
11. Stakes
12. Groovers
13. Rivetsets
14. Soldering Iron

3.1.2. Measuring Tools

(a) Steel Rule : It is used for measuring and layouting small works with an accuracy upto 0.5 mm.



Fig. 3.1 Steel rule

(b) **Folding Rule** : It is used for measuring and laying out larger work pieces accuracy upto 0.5 mm

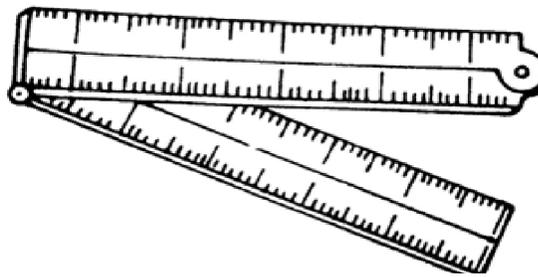


Fig. 3.2 Folding rule

(c) **Circumference Rule** : It is used to find out directly the circumference of a cylinder. One of the edge is marked with diameters and the values of circumference corresponding to each diameter is marked in the other edge.



Fig. 3.3 Circumference Rule

(d) **Vernier Caliper** : It is used for measuring dimensions upto 0.02 mm.

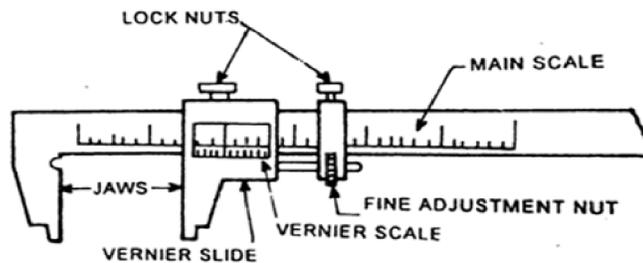


Fig. 3.4 Vernier Caliper

(e) **Micro Meter** : This is used to measure the thickness of the metal sheet accurately upto 0.01 mm.

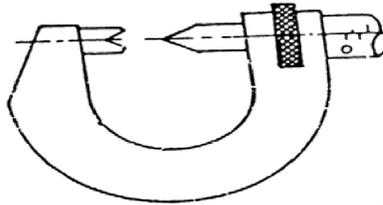


Fig. 3.5 Micrometer

(f) **Sheet Metal Gauge** : This is used to measure the thickness of the sheet.



Fig. 3.6 Sheet Metal Gauge

(2) **Straight Edge** : It is a steel bar has one long edge is bevelled and comes in variety of lengths. It is used for drawing long straight lines.

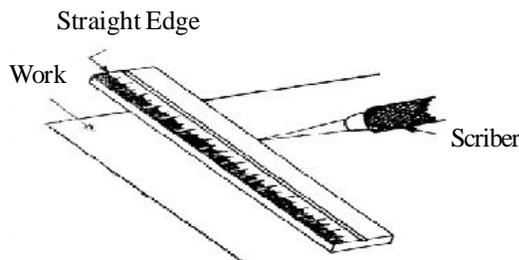


Fig. 3.7 Straight Edge

(3) **Scriber** : It is a steel wire and its one end is sharply pointed and hardened to mark layout lines on the sheet metal.



Fig. 3.8 Single point Scriber



Fig. 3.9 Double point Scriber

(4) **Divider** : Dividers are used to draw circle or arcs on sheet metal and to divide the lines into two equal parts.



Fig. 3.10 Divider

(5) **Trammel Point** : These are used to describe large circles and arcs beyond the limits of dividers.

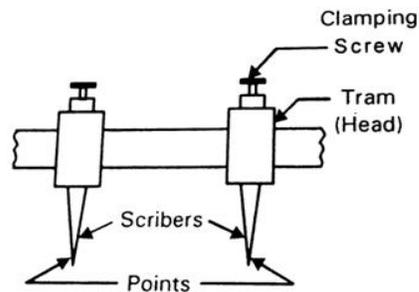


Fig. 3.11 Trammel point

(6) **Chisels** : These are used to cut sheets, rivets, bolts and for chipping operations.



Fig. 3.12 Chisels

(7) **Punches** : There are various types of punches used for making small indentation for locating centres in a more permanent manner. There are two most common types of punches are used 1) Prick punch, used for making small dots 2) Centre punch, used for making location of points and centre of holes to be drilled.

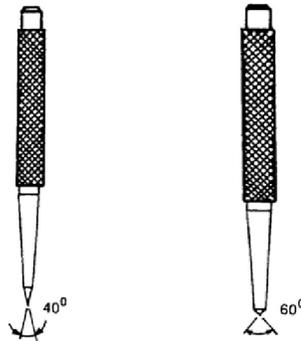


Fig 3.13 Punches

(8) **Hammers** : Hammers are used for forming shapes by hollowing, stretching or throwing off. The commonly used hammers are given below.

(a) **Ball peen Hammer** : It is a general purpose hammer

(b) **Rivet Hammer** : This is used for spreading rivets .



Fig 3.14 Rivet Hammer

(c) **Setting Hammer** : A flat face is used for flattening seams without damage to the sheet metal.

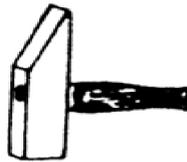


Fig 3.15 Setting Hammer

(d) **Raising Hammer** : This hammer is used for denting the metal down to shape.

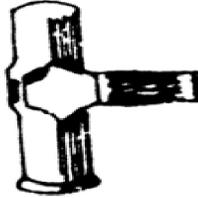


Fig. 3.16 Raising hammer

(e) **Mallet** : Mallets are used where ever light blows are required. These may be made of either fiber, plastic, wood or rubber.



Fig. 3.17 Mallet

(9) **Snips or Shears** : These are heavy scissors used for making straight or circular cuts. It is used only to cut 20 gauge or thinner metals. The most common types of snips are a) Straight snips, used for straight cuts, b) Bent snips, used to make curved cuts.

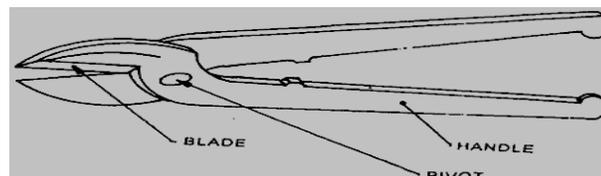


Fig. 3.18 Straight Snips

(10) **Pliers** : There are two pliers which are used in sheet metal work. They are flat nose plier and round nose plier. Flat nose pliers are used for forming and holding work while round nose pliers are used for holding and forming in to various shapes.



Fig. 3.19 Pliers

(11) Stakes : These are sheet metal worker's anvil used for bending seaming, forming using hammer or a mallet. They are actually work supporting tools while working. They are made in different shapes and sizes to suit the requirements of the work. The double seaming stake is used to make double seam. The break horn stake is used for riveting, forming round and square surfaces, bending straight edges and making corners. The bevel edged stake is used to form corners and edges. Hatched stake is used to make straight and sharp bends.

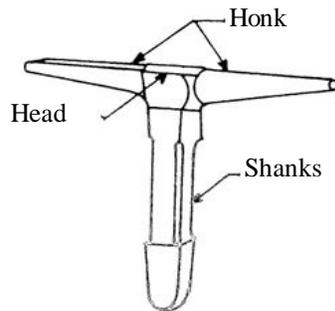


Fig. 3.20 Stakes

(12) Groovers : These are used for grooving and flattening a seam. These are available in many shapes.



Fig. 3.21 Groovers

13) Rivet Set : Rivetset has a deep hole in the bottom to draw a rivet through metal and a cup shaped hole to form the finished head of a rivet.

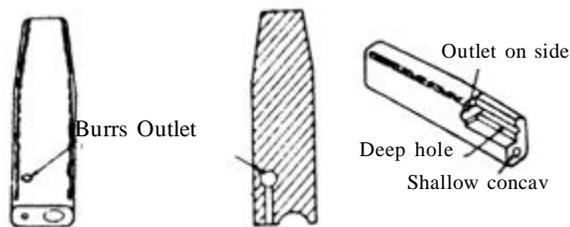


Fig.3.22 Sections of Rivet Sets

(14) Soldering Iron : It is used to join two pieces of sheet metal by soft soldering (al alloy of tin and lead). Soft solder is transferred to the joint by means of soldering iron.

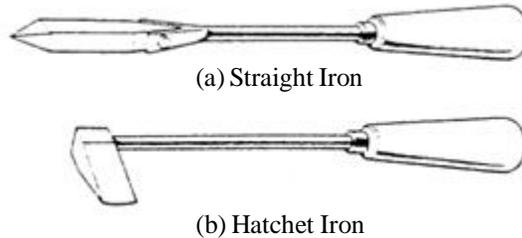


Fig. 3.23 Types of Soldering Irons

3.2 Sheet Metal Operations

The major types of sheet metal operations are given below.

- (1) Shearing
- (2) Bending
- (3) Drawing
- (4) Squeezing

(1) Shearing

Shearing is the process of cutting across a sheet or strip. The various shearing operations include

- | | |
|-----------------|--------------|
| (a) Cutting off | (b) Parting |
| (c) Blanking | (d) Punching |
| (e) Piercing | (e) Slitting |
| (g) Trimming | |

a. Cutting Off : It is the operation of shearing the piece from sheet metal with a cut along a single line.

b. Parting : This means that the strip is removed between the two pieces to part them.

c. Blanking : It is the operation of cutting the flat sheet to the required shape and size using punch and die.

d. Punching : It is the operation of making only circular holes in a sheet metal.

e. Piercing : It is the operation of making a hole of any shape in a sheet metal by punch and die.

f. Slitting : It is the operation of cutting the sheet metal in a line along the length.

g. Trimming : It is the operation of finishing the edges of a part by removing excess metal around it.

2. Bending : It is the folding operation by using suitable tools. It may be done over stakes. The common forms of bending the sheet metal is single bend and double bend etc.

3. Drawing : It is the process of producing thin walled hollow or vessel shaped parts from the sheet metal. Again this process can be divided into two types. a) Deep drawing and shallow drawing. In deep drawing, the height of the component is greater than the diameter or width. In shallow drawing the height of the component is less than the diameter or width.

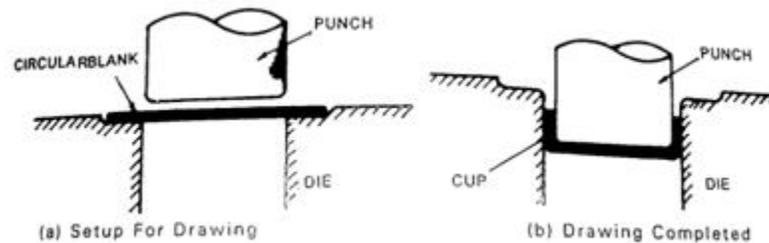


Fig. 3.24

(4) Squeezing : It is the quick and widely used method. The operation involves severe cold deformation and it requires a greater amount of pressure to deform the metal at cold state.

The most commonly used squeezing operation are sizing, coining, hobbing, riveting.

(a) Sizing : This operation is used for surfacing or flattening. A special die is needed for every job.

(b) Coining : This is a process of making impressions or raising of images by a plastic flow by using a punch and die.

(c) **Hobbing** : It is the process of producing cavities into surface of material by pressing with a special punch called hub.

(d) **Riveting** : It is the process of fastening the two metal sheets by inserting metal pin in to the sheets and spreading out by hammering to form the rivet head.

3.3 Sheet Metal Joints

3.3.1 Hem and Seam Joints

(1) **Hem Joint** : Hem is an edge or border made by folding. It strengthens the edges and eliminate the sharp edges. Hems are three types a) Single hem b) Double hem c) Wired edged hem

(a) **Single Hem** : It is made by single folding of the edge of sheet metal.

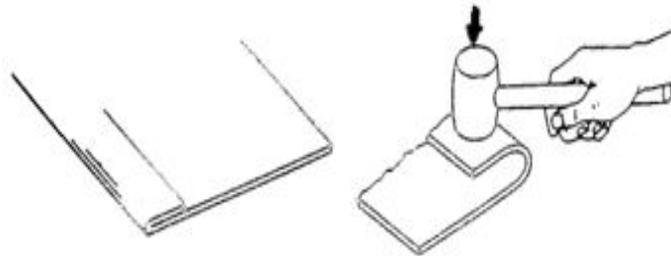


Fig. 3.25 Single Hem

(b) **Double Hem** : It is made by folding the edge over twice to make it smooth. It provides much greater strength than single hem.

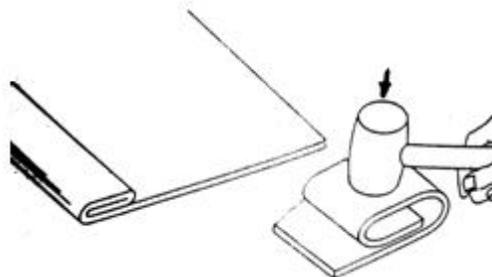


Fig. 3.26 Single Hem

c) **Wired Edged Hem** : It consists of holding a piece of sheet metal around a wire of given diameter.

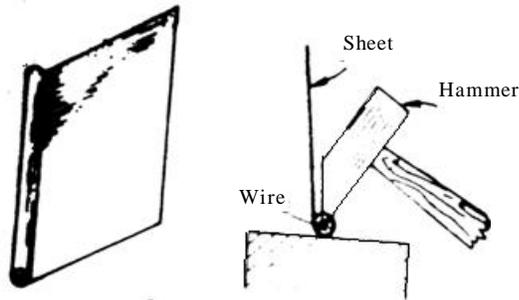


Fig. 3.27 Wired Hem

(2) Seam Joint : It is the joint formed by two edges of sheet metal. The process of joining the edges are called seaming. Different kinds of seams are given below. a) Lap seam b) Groove seam c) Single seam d) Double seam e) Dovetail seam f) Flanged Seam

a) Lap Seam : It is a simple type of seam which consists of lapping the edge of one sheet over the other and the joint is made by soldering or riveting.

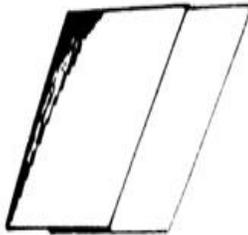


Fig. 3.28 Lap Seam

(b) Grooved Seam : It is made by hooking two single hems together

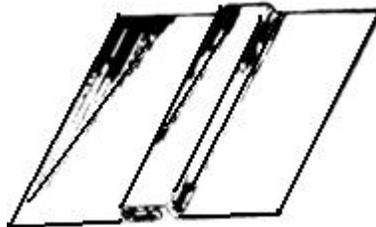


Fig. 3.29 Grooved Seam

(c) Single Seam : Single seam is used to join a bottom to vertical bodies of various shapes.

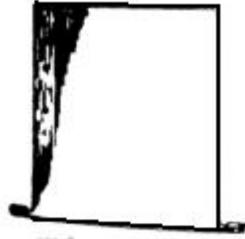


Fig. 3.30 Single Seam

(d) **Double Seam** : It is similar to single seam with the difference that its formed edges bent upwards against the body.



Fig. 3.31 Double Seam

(e) **Flanged Seam** : It is used to join the bottom of a container to its body.



Fig. 3.32 Flanged Seam

(f) **Dovetail Seam** : It is used to join sections such as one pipe to another pipe or a sheet to pipe. It consists of narrow strips of metal which are formed by slitting the end of pipe.

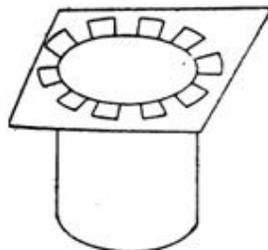


Fig. 3.33 Dovetail Seam

3.3.2 Fastening Methods

The following fastening methods are widely adopted in sheet metal work.

- (a) Riveting (b) Soldering (c) Brazing (d) Welding.

(a) Riveting : It is a permanent fastening method by using rivet. Rivet consists of head, shank and tail are generally made of same metal as the parts that are being joined. The required holes must be either punched or drilled before riveting.

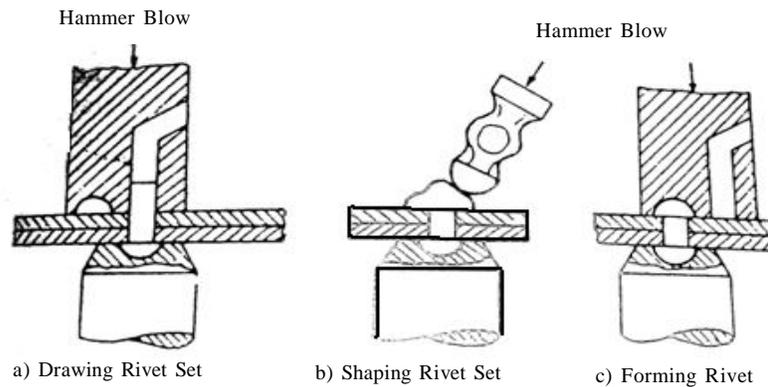


Fig. 3.34 Rivet Sets

(b) Soldering : It is the process of joining two or more metal pieces by means of an alloy. This alloy is called solder made of lead and tin. The melting point of solder is less than the metal to be joined. For soldering, the base metal is heated by soldering iron which also melts solders and flux. the flux (zinc chloride paste) is used to dissolve the oxide film on the surface and also prevents oxidation during soldering. The molten solder fills the space between mating surfaces. It solidifies and forms a strong joint.

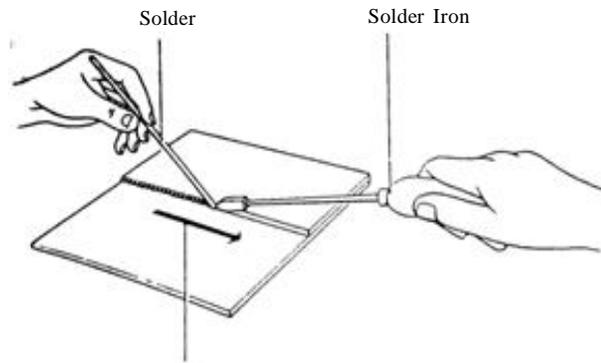


Fig. 3.35 Solder

c) Brazing : It is similar to soldering, but it gives much stronger joint. The major difference is that use of a harder filler material called spelter and its melting point is higher than solder., but lower than the metal being joined. In brazing operation the two metal pieces are to be joined must be cleaned. Flux (Borax) is applied on the joint and heated to a temperature just above the melting point of the spelter. The liquid spelter is distributed between the surfaces by capillary action. After solidification it forms strong joint.

d) Sport Welding : The spot welding is used for joining the sheets by application of heat and pressure at specific locations called spots. In this, the sheets to be joined together are held between two electrodes at required located sports. Normally a high amperage current and low voltage is passed through electrodes causing local heating at that spots. The pressure applied on the electrodes squeezes the sheet metal at various locations thus joining the two sheets together to form a joint.

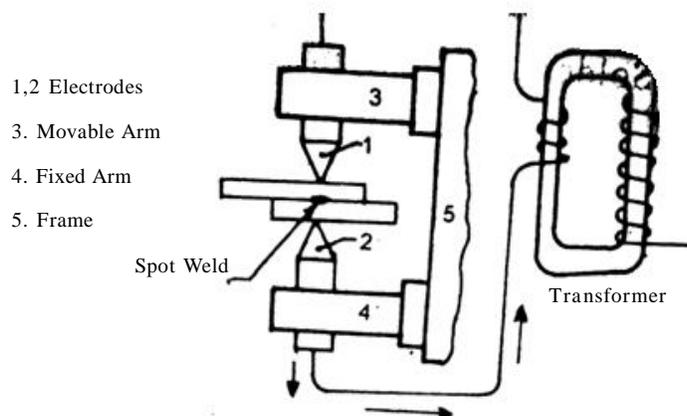


Fig. 3.36 Sport Welding

Summary

1. Sheet metal work is the process of making useful articles for household as well as industrial.
2. Commonly used sheet metals are black iron, galvonised iron, copper, aluminium, stainless steel etc.
3. Tools used in sheet metals are measuring tools and operational tools.
4. Most common sheet metal operations are shearing, bending, drawing, squeezing etc.
5. Important fastening methods in sheet metal are riveting, soldering, brazing and spot welding.

Activity

1. A learner should collect funnel made of sheet metal.
2. A learner should collect a square tray
3. A learner should collect riveted joint sheet metal piece.
4. A learner should collect soldered joint sheet metal piece.

Short Answer Type Questions

1. Name different tools used in sheet metal work.
2. Define Seam in sheet metal work.
3. What is the purpose of mallet ?

Long Answer Type Questions

1. Explain about any four important sheet metal operations.
2. Explain different sheet metal joints with sketches.
3. Explain brazing and soldering.

OJT / Related Questions

1. Prepare a rectangular tray from a given G.I. sheet
2. Prepare a funnel of given dimensions from G.I. Sheet metals.
3. Join the given two sheet metal pieces by soldering.
4. Join the given sheet metal pieces by riveting.

UNIT

4

Carpentry

Learning Objectives

On completion of this unit a learner will be able to

- Explain various hand tools used in carpentry
- Know the importance of holding devices
- Explain about various carpentry joints
- Know the different carpentry processes

4.0 Introduction

Carpentry deals with the processing of wood to obtain desired shapes and sizes. Strictly speaking carpentry deals with all works of a carpentry such as roofs, floors, partitions etc of a buildings. While joining deals with the making of doors, windows, cupboards, dressers stairs and all interior fitments for a building.

Timber is the basic material used for any type of wood work. It is available in a wide choice of weights, strengths, colours and textures. Wood having good machining characteristics.

4.1 Markings and Measuring Tools

Marking is one of the most important features of wood work and the job accuracy depends upon marking and measuring. These tools are used in wood work for marking, measuring and checking the work at various stages.

Measuring Tools

The following tools are commonly used in wood work.

1. Steel rule
2. Wooden folding rule
3. Steel tape

(1) **Steel Rule** : It is simplest and direct measuring instrument. Various sizes and designs are available for measuring and setting out dimensions. This is graduated on both sides as millimeter and centimeter.

(2) **Wooden Folding Rule** : This is graduated both in centimeters and inches. The most commonly used wooden rule is form fold wood rule. It is made of pieces of each 150mm length.

(3) **Steel Tape** : This is used to measure longer dimensions. They are available in different lengths ranging from 0.6 m to 2.5 m.

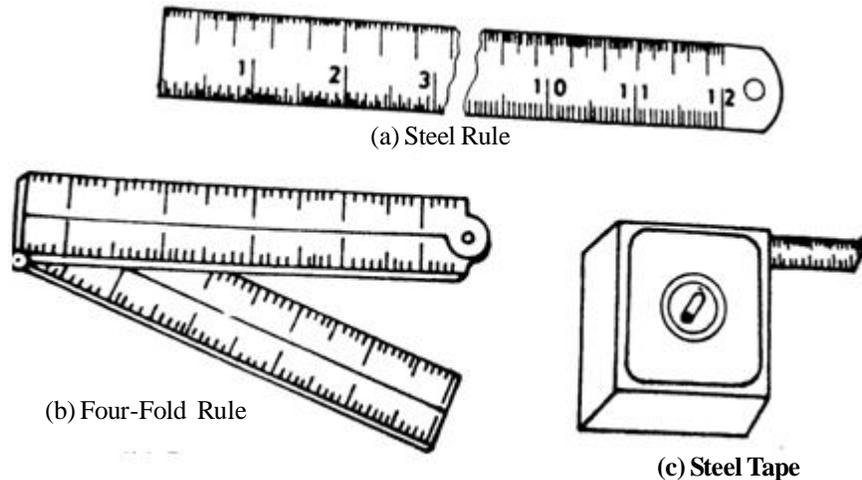


Fig. 4.1 Measuring Tools

Marking Tools

The following tools are used for marking in wood working.

- (1) Straight Edge
- (2) Try square
- (3) Marking guage
- (4) Divider
- (5) Marking knife

(1) Straight Edge : The straight edge is a machined flat piece having truly straight and parallel edges. One of the longitudinal edge is generally made bevelled. It is used for testing trueness of surface and straightness of edges.

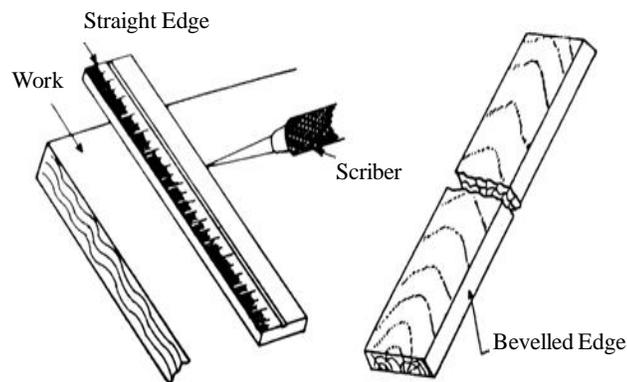


Fig. 4.2 Straight Edge

(2) Try Square : This is used for marking and testing angles of 90° . It consists of a steel blade, rivetted to a hard woodstock which has a protective brass plate on the working surface.

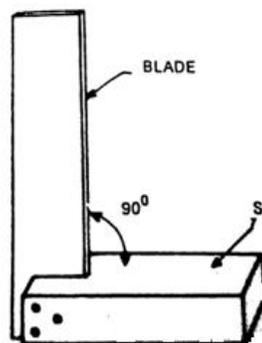


Fig. 4.3 Try square

(3) **Mitre Square** : It is used for marking and testing 45° . It consists of a steel blade fitted in a wooden or metal stock at an inclination of 45° with horizontal.

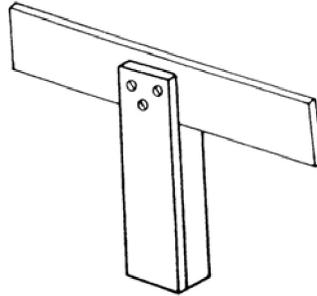


Fig. 4.4 Mitre Square

(4) **Marking Knife** : All the dimensional lines marked with pencil are cut with marking knife. It has a chisel edge at one end and sharp point at other end. It is made of steel.



Fig. 4.5 Marking Knife

(5) **Marking Gauge** : It is commonly used when absolute accuracy is required. It has a stem with a sharp point pin at one end. It is used to cut line along the grains and parallel to an edge. The distance can be adjusted by sliding the stock.

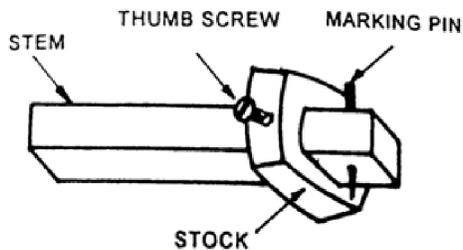


Fig. 4.6 Marking Gauge

(6) **Divider** : It has two pointed legs and hardened to prevent wear. It is used for transferring dimensions and scribing curves or circles.



Fig. 4.7 Divider

4.2 Cutting Tools

Cutting tools are used to cut the wood to approximate size. The following cutting tools are used in carpentry.

(a) Saw or Hand Saw : The saw is most commonly used cutting tool in wood working section. All saws used in wood work essentially consists of two main parts - the blade which carries the cutting teeth and the handle used for holding during the cutting operations to apply pressure. The classification of saws is according to their teeth and the direction of grains of the wood to be cut.

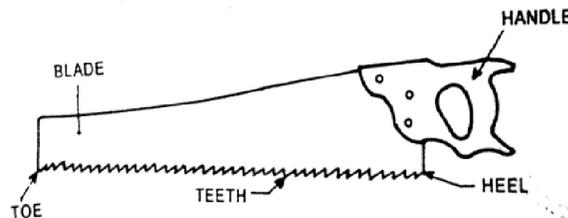


Fig. 4.8 Hand Saw

The following types of saws are used in wood working.

(b) Rip Saw : Rip saw is used to cut the wood along the grains. The cutting action starts from near the tip and gradually the whole length.

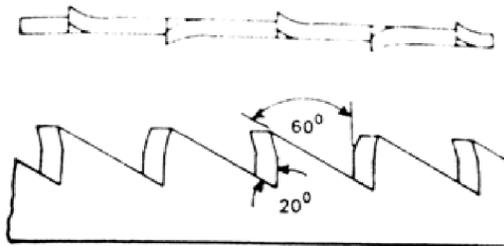


Fig. 4.9 Rip Saw

(b) **Crosscut Saws** : It is used for cutting the wood across the grains. The action of the teeth is that of a series of knives which sever the fibre and force out the waste wood in the form of saw dust.

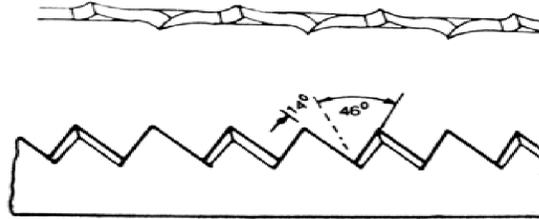


Fig. 4.10 Cross-cut saw

(c) **Panel Saw** : It has a finer blade and is used for fine work, mostly on the bench. This is often used for ripping as well as cross cutting. The teeth have slightly more hook than those of a cross cut saw.

(d) **Tenon Saw** : This saw is mostly used for cross-cutting when a fine and more accurate finishing is required. The blade is very thin and reinforced with a rigid steel back.

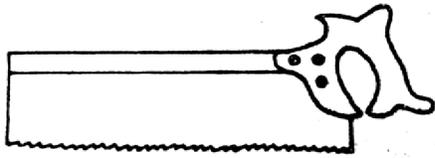


Fig. 4.11 Panel Saw

(e) **Dovetail Saw** : It is a smaller version of tenon saw, this saw is used where the greatest accuracy is needed and fine shallow cuts are to be needed.

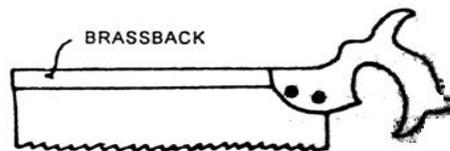


Fig. 4.12 Dovetail Saw

(f) **Bow-Saw** : It has a narrow blade which is held in tension by twisting the string with a small wooden lever. These saws are used for cutting quick curves

and the handles can revolve in their sockets. The blades can be adjusted to any desired position when in use.

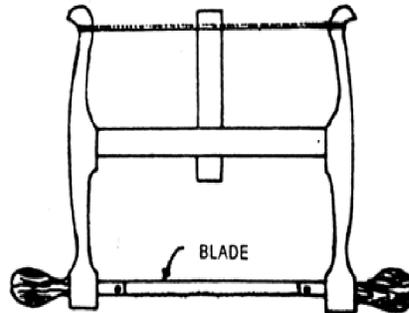


Fig. 4.13 Bow Saw

(g) **Key Hole Saw** : It is smallest saw. It has a tapered blade fixed into the handle by screws. It is used for cutting key holes and is very useful for internal and intricate work.

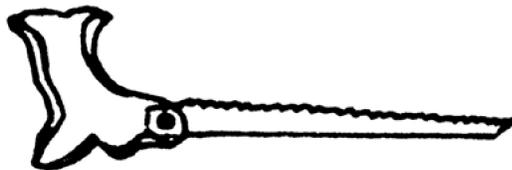


Fig. 4.14 Key hole Saw

Chisels : A fairly large number of chisels are used in wood work for cutting in different manners to produce desired shapes and cavities. The chisel consists of these parts irrespective of their size and use. The common types of chisels are used in carpentry work are the following.

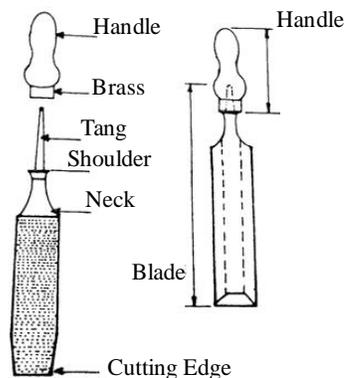


Fig. 4.15 Chisel

(i) **Firmer Chisel** : This chisel is capable of doing heavy work and is used for joining and shaping the wood with or without mallet. The blade is made of rectangular section with bevel edge.

(ii) **Paring Chisel** : These chisel have a long blades used to cut the deep corners with hand pressure. These are mostly used for pattern making.

(iii) **Mortise Chisel** : It is used for taking heavy and deep cuts resulting in more stock removal as in case of making mortises.

(iv) **Socket Chisel** : It is provided with socket instead of tang. The wooden handle is inserted into this socket. This prevents splitting of handle while removing heavy stock.

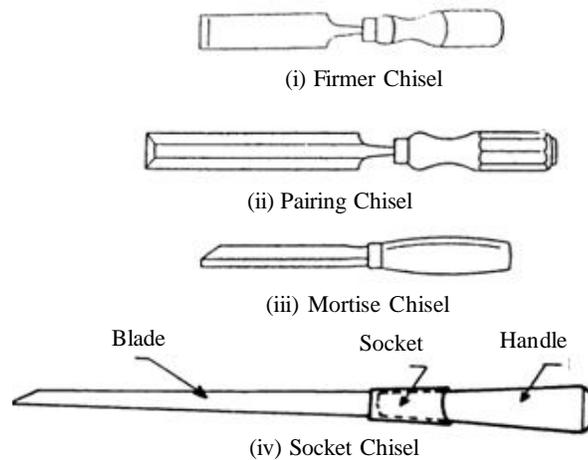


Fig. 4.16 Types of Chisels

Planes

Planes are used in producing flat and smooth surfaces by cutting thin layers of wood. The plane consists of these parts - Body, cutting blade, handle, knob and other controls. The common types of planes used in carpentry are

(a) **Jack Plane** : It consists of a wooden body or stock in which blade or cutter is fastened at an angle 45° to the sole. The plane iron and cap iron are assembled and inserted in a mouth of plane along with the wedge. The back iron supports the cutting edge and also breaks the shavings so that curl away from the blade. The blade can be set for taking deeper or shallower cuts.

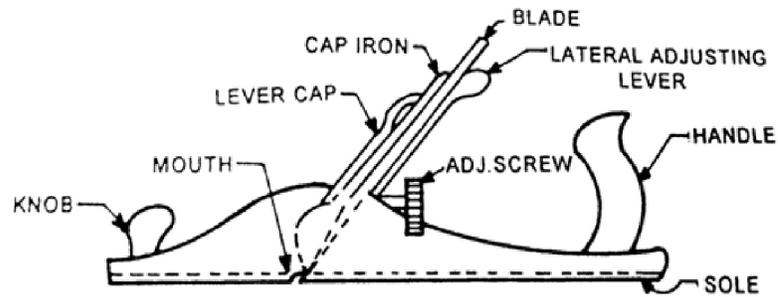


Fig. 4.17 Wooden Jack Plane

(b) **Trying Plane** : These are used to make a true flat surfaces which are formed by jack plane. It is longer than jack plane.

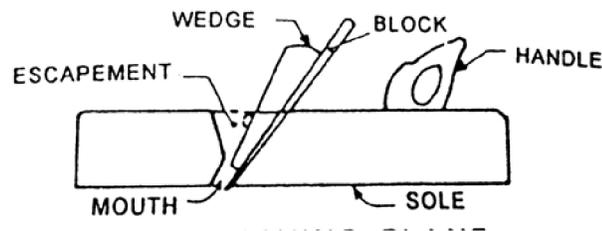


Fig. 4.18 Trying Plane

(c) **Smoothing Plane** : It is nothing but a smaller wooden jack plane without handle. In operation its stock itself is held in both hands. It is used for better finish and smoothness to the surface already plane by a jack plane.

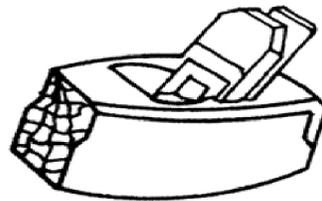


Fig. 4.19 Smoothing Plane

(d) **Rebate Plane** : It is small in size and is used to cut the recess along the edge of a work piece. In rebate plane the edges of cutting iron is in line with the side of plane.

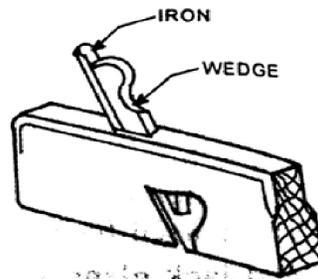


Fig. 4.20 Rebate Plane

(e) **Plough Plane** : It is used for making deep grooves of standard size. A deep gauge is fixed on the body, and is operated by thumb screw. It allows the plane to make a groove of constant depth.

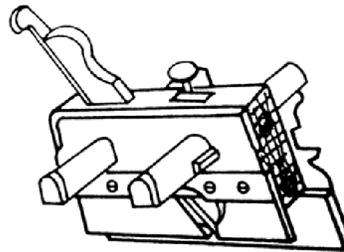


Fig. 4.21 Plough Plane

(f) **Router Plane** : These planes are used for finishing the grooves to a constant depth which are formed by chisel or saw.

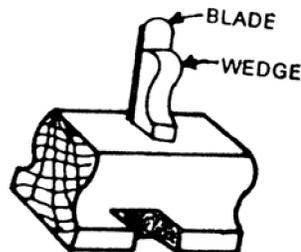


Fig. 4.22 Plough Plane

Boring Tools

Boring tools are necessary to make holes in wood. The various types of boring tools used are as follows

(1) **Bradawl** : It is used for boring small holes for inserting the screws and nails. It has chisel like point and it is operated by hand.

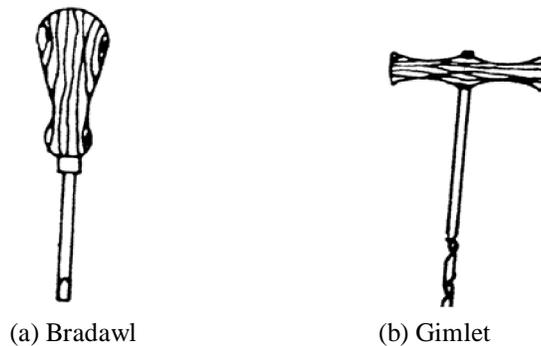


Fig. 4.23

(2) **Gimlet** : It is hand operated tool used for making small holes for screws. It has a spiral flutes with screw like point.

(3) **Brace** : It is a boring tool used for making holes. It holds and rotates various types of bits for producing holes and is operated by hand. The most commonly used braces are ratchet brace and wheel brace. These are used for making larger holes of different sizes.

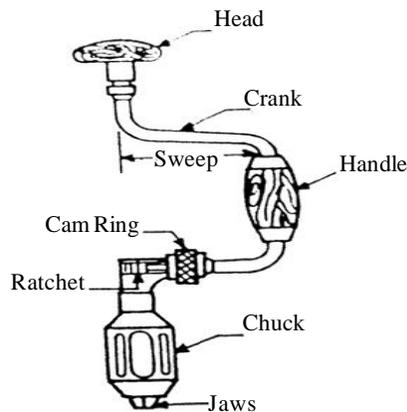


Fig. 4.24 Ratchet Braces

(4) **Auger bit** : It is used for producing long deep holes of diameter ranging from 6 to 40 m. It is steel bar , an eye at top to which the handle is fitted. The bottom end is provided with a screw point.



Fig. 4.25 Auger

Striking Tools

Striking tools are called hammers used to drive in nails and to operate chisels. The most common striking tools used in carpentry are hammers and mallets.

(a) **Warrington hammer:** It is used for bench work and light work. It is made of cast steel with tempered face and peen. The wooden handle fits in the eye and steel wide is driven in to form a rigid joint.

(b) **Claw Hammer:** It is dual purpose hammer and face is used to drive in nails, and claw at the other end for pulling out nails.

(c) **Mallet :** It is used for operating the chisel and gauges. it is made of hard wood and is provided with handle.

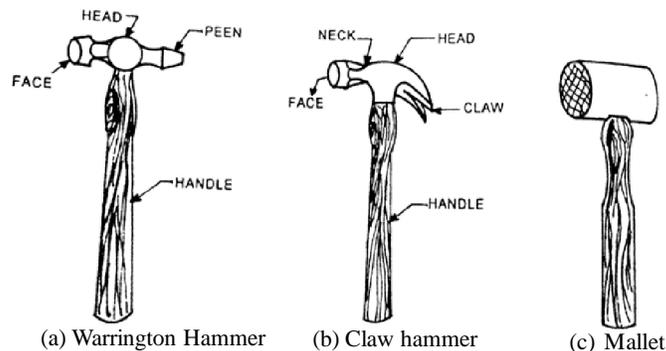


Fig. 4.26 Striking Tools

4.3 Holding Devices

To enable the wood worker to cut the wood accurately, it must be held steady. There are number of devices to hold the job

(a) **Bench vice :** it is made of steel. It has the jaws, one is fixed to the side of the table while the other is kept movable by means of a screw and handle.

The job tab is held between the two jaws. The faces of jaws are lined with hard wood to prevent damage of work surface.

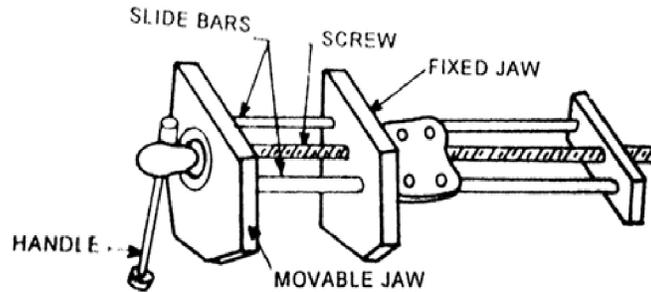


Fig. 4.27 Bench Vice

(b) **Bench Stop** : It is simply a block of wood projecting above the top surface of the bench. This is used to prevent the wood from moving forward when being planed.

(c) **Bench hold Fast** : It consists of a cast iron pillar, steel arm and screw with a handle. It is used for securing the work to the bench. The pillar drops into a hole bored in the bench and the screw operates the arm to hold work on the table.

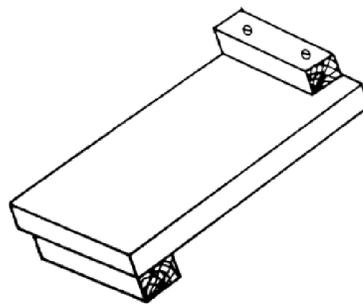


Fig. 4.28 Bench Hook

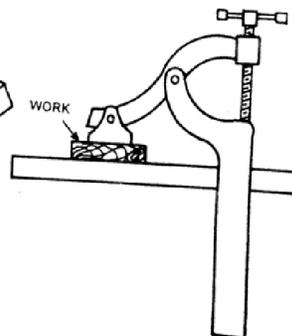


Fig. 4.29 Bench Holdfast

(d) **Bench hook** : It is used to support work while planing or cutting. It is made of wood and can be placed conveniently on the work table.

(e) **Sash Cramp** : This is used for holding wide work such as frames or tops. It consists of a steel bar fitted with two jaws one of which is movable by a screw and other is fixed into one of the spaced holes by a fastening pin.

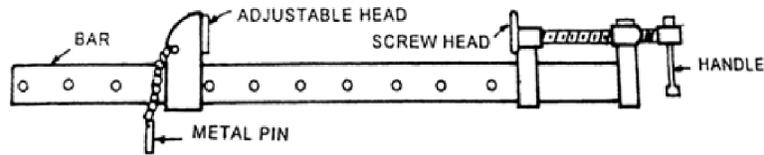


Fig. 4.30 Sash Cramp

(g) **G-Clamp** : It is used to hold small works and it consists of frame with a fixed jaw at one end and movable jaw is operated by a screw and a thumb nut at the other end. It is also used to hold small parts for gluing.

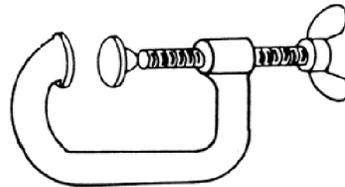


Fig. 4.31 G-Clamp

4.4 Miscellaneous Tools

(1) **Rasp or File** : It is used for finishing the wood surface. It has sharp cutting teeth and it is used for finishing small curved surfaces.

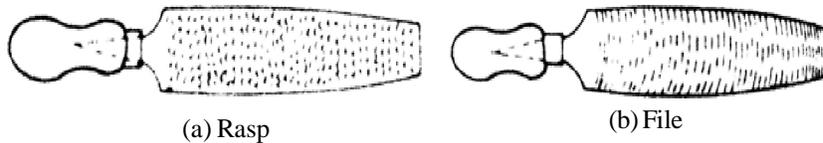


Fig. 4.32 Rasp and File

(2) **Scraper** : It has a fine edge which cuts fine shavings and removes plane marks.

(3) **Glass paper** : Where a surface is having very small imperfections that the no other cutting tool will do, then glass paper is used. It consists of small particles of glass struck to sheet of paper. Its sharp edges cuts the wood.

(4) **Ratchet Screw Driver** : It is very useful for turning screws through a few degrees in.

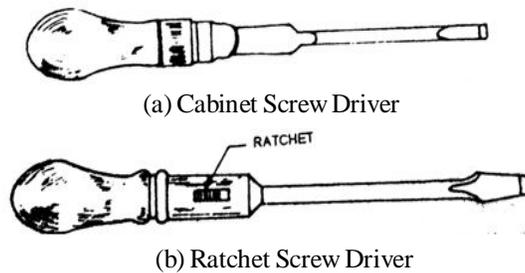


Fig. 4.42 Types of Screw Driver

(5) Screw Driver : These are used for screwing or unscrewing for the screws used in wood work.

4.5 Carpentry Processes

1. Marking : It is one of the most important operation of wood work and the success of completing a job depends on accurate and orderly marking. These dimensions can be measured from an existing model and can be set out from the drawing prepared for the purpose. The dimensions are marked with respect to the finished edge or finished face of a work.

2. Sawing : Sawing is one of the basic cutting operation carried out in a carpentry shop. To start the cut, the thumb of left hand is placed against the blade. This steadies the blade and enabling it to start in the right place. One or two short movements are given first, taking care that the saw works in the right direction. And then full, easy strokes are applied to cut the wood in a forward direction only. A point to note in all sawing work that the cut is made on one side of the line already marked and that is on waste side

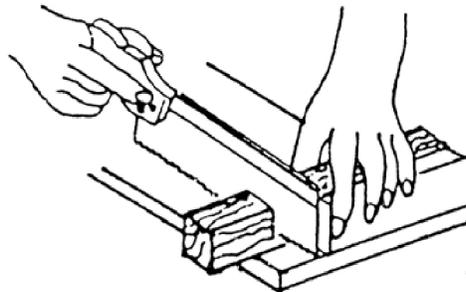


Fig. 4.33 Sawing

3. Planing : It is the operation of tuning up a piece of wood by a planner. The work for planing is supported by the bench stop in the vice. The pressure is applied during forward stroke and released on the returned stroke. It is important to move plane in straight line to avoid rounding at the ends and to

obtain smooth surface. Planing is done along the grains. The surface planed are tested for flatness in all directions using a try square.

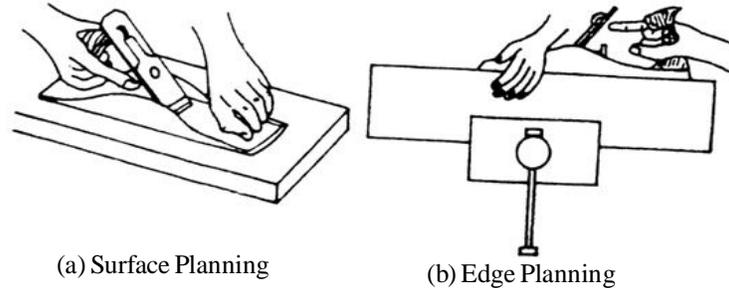


Fig. 4.34 Planning

4. Chiselling : It is the process of cutting excess wood with chisel to obtain desired shape. In chiselling hard pressure is applied to remove thin layers. Mallet is used when cuts are made across the grains.

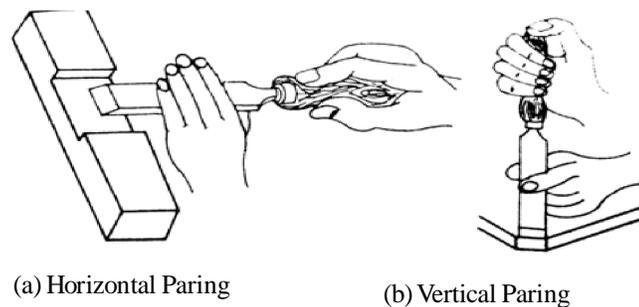


Fig. 4.35 Chiselling

5. Boring : It is the process of making holes in wood. The work is secured to suitable vice and the hole position is marked with punch. The hole is provided by turning and feeding the bit into work.

6. Rebating : It is the process of cutting a recess along the edge of wood by a rebate plane. While rebating, the plane must be kept pressed into the side of the wood.

7. Polishing : It is the process of producing a smooth reflecting surface with only the minimum removal of material. To obtain such a finish it is necessary to incorporate a suitable abrasive within the polishing composition.

4.6 Carpentry Joints

Terms joinery involves connecting of different wooden parts together by means of properly made joints. In order to achieve good results, the joint made

in wood work are usually secured firmly by means of suitable fasteners such as glues, dwels, screws, bolts and butts etc.

1. Halving Joint : The purpose of this joint is to reuse the corners and inter sections of the framing and at the same time keep all the face flush that in the same plane. These joints are used in construction of frames. Marking and cutting of any joint must be accurate, so that it can shed together with the final extreme surface level.

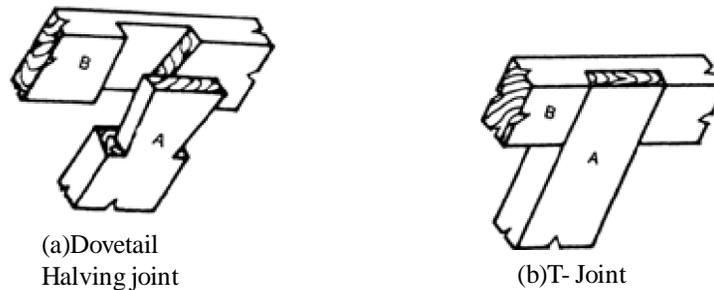


Fig. 4.36 'T' Halving Joint

2. Mortise and Tenon Joint : It is strongest joint and is used for the construction of doors windows and frames. The tenon (tongue) fits into a mortise (mouth).

3. Mitre Joint : It is formed by cutting the ends at an angle. The two ends are joined by nails or screws. This joint is used in photo frames.

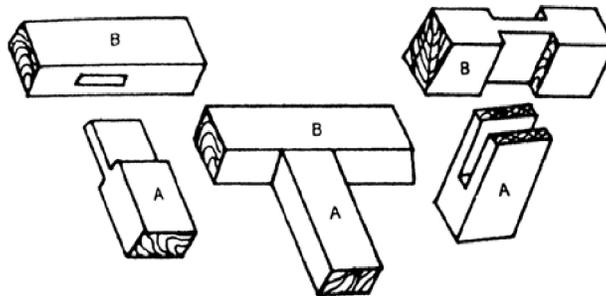


Fig. 4.37 Mortise & Tenon Joint

4. Dovetail Joint : This is strongest joint used for construction of boxes and cup boards.

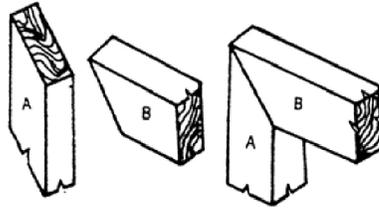


Fig. 4.38 Mitre Joint

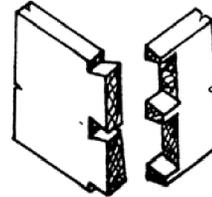


Fig. 4.39 Dovetail Joint

5. Butt Joint : The fastening of boards edges to edges is frequently necessary to give a wider board. eg. Drawing board. In butt joint two true edges are joined with glue. If it is properly done this joint is very strong.

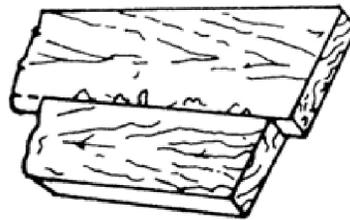


Fig. 4.40 Butt Joint

4.7 Wood Working Machines

Wood working machine plays a vital role in the modern wood work particularly where large scale production of wooden articles is carried out. Modern development in wood working machinery with regard to the greater safety for the operator, easy operation and greater accuracy. These developments led to higher output.

The commonly used wood working machines are as follows.

1. Wood Turning Lathe : It is one of the important and oldest machine used in carpentry shop. This is employed primarily for turning jobs in making cylindrical parts. It resembles the engine lathe most frequently used in the machine shop and consists of a cast iron bed, head stock, tail stock, tool rest, live and dead centres and speed control device.

In practice the work piece is either clamped between two centres or on the face plate. Long jobs are held between the centres and turned with the help of

gauge, chisel, parting tools. Generally the lathe is supplied together with a number of accessories for making it useful for a variety of jobs.

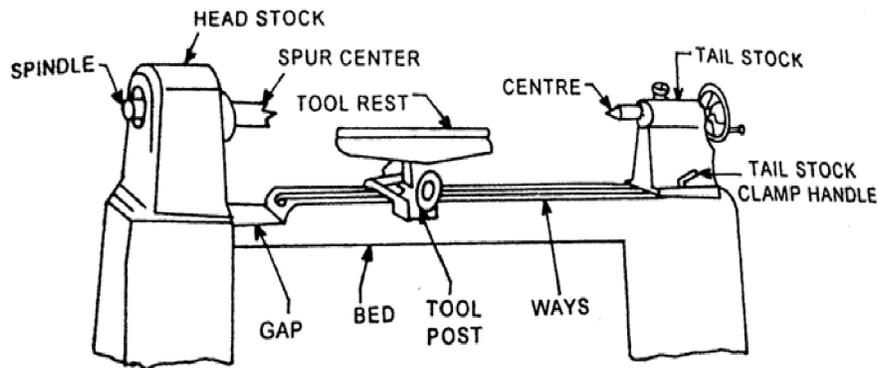


Fig. 4.41 Wood Turning Lathe

2. Circular Saw : It can be used for ripping, cross cutting, bevelling and grooving. This saw has flat table upon a which the work rests while being cut, a circular cutting blade, cut-off guide and a ripping fence that acts as a guide while sawing along the grain of the wood. The circular saw usually has provisions for tilting the table upto 45° to enable the machine to cut at different angles required during mitering and levelling.

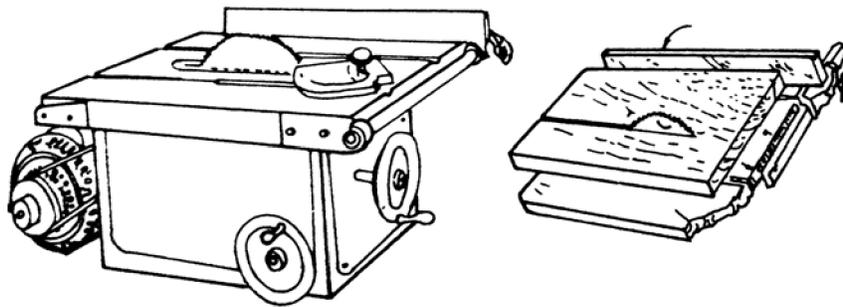


Fig. 4.42 Circular Saw and Its Use

3. Band Saw : It means that an endless metal saw band that travels over the rims of two or more rotating wheels. Other parts of band saw are frame, table, saw guide, saw tensioning arrangement. It is most useful for making curved or irregular cuts in wood. The band saw is available in two models vertical and horizontal. In horizontal band saw, two wheels are arranged side by side and the table is mounted underneath. In the vertical band saw the wheels are arranged one over the above in a vertical plane below the table, angular cuts are obtained by tilting the saw table.

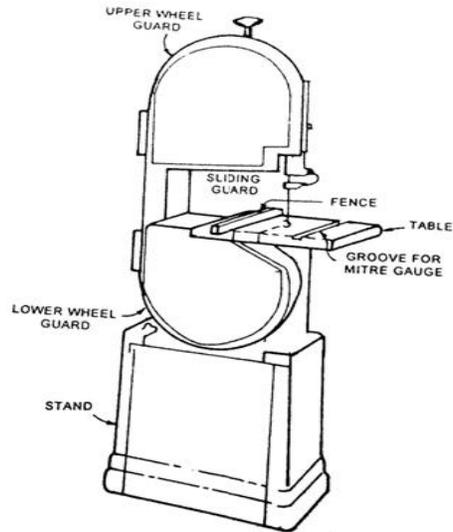


Fig. 4.43 Band Saw

4. Wood Planer : It is used for planing large work pieces and capable of producing true surface with enough accuracy at a faster rate. It consist of table over which the work is fed against a revolving cylindrical cutter head carrying 2-3 knives. The cutter is mounted on a over head raft and the table can raised or lowered to attain desired thickness.

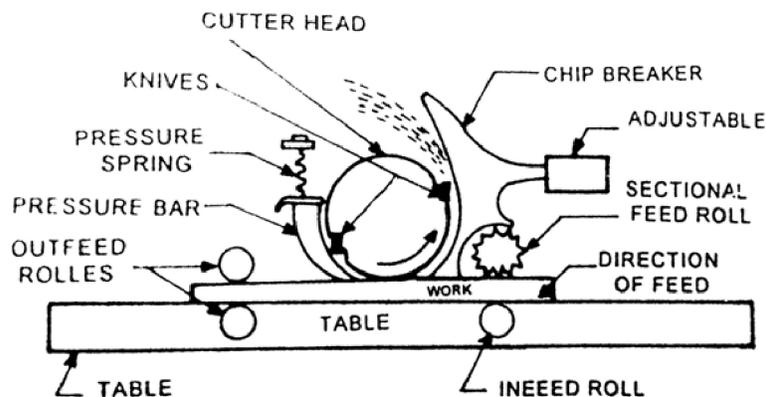


Fig. 4.44 Principle of Wood Planer

5. Sanding Machine : The sanding machine are used for producing smooth surface after planing the wood. It seems a surface suitable for painting. The action of sanding machine is some as the sand paper producing the smooth

surface. In sanding an abrasive is rubbed over the surface of wood to wear down hills by friction and thus present a smooth, uniform surface.

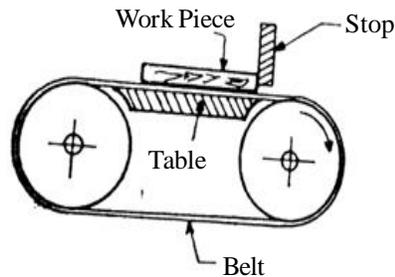


Fig. 4.55 Belt Sander

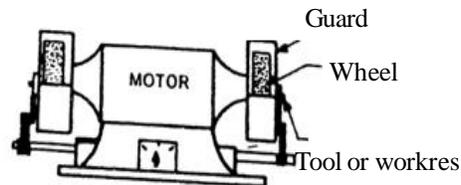


Fig. 4.56

Summary

1. Carpentry is the processing of wood to obtain desired shape and size
2. In carpentry hand tools are classified in to five types ie marking tools , cutting tools ,boring tools ,striking tools and holding devices.
3. The wood working operations includes marking, sawing, planing, chiseling, boring and rebating.
4. The successful construction of wood depends on satisfactory joining. The most common carpentry joints are halving joint,mortise joint tenon joint,mitre joint,dovetail joint,and butt joint.
5. Wood working machines are primarily intended to increase the productivity with higher accuracy which includes wood turning lathe,band saw,circular saw, sanding machine.

Activity

1. A learner should collect T-halving joint.
2. A learner should collect plain tenon joint.
3. A learner should collect dovetailbridge and bridge cornerjoint.

Short Answer Type Questions

1. Name different cutting tools used in carpentry.
2. What is the use of pincer.
3. Name different types of planes.

4. List out carpentry joints.

Long Answer Type Questions

1. Explain about any four carpentry processes.
2. Explain about wood turning lathe with neat sketch.

OJT Questions

1. Make saw practicing.
2. Make Plane practicing.
3. Make boring practice.
4. Prepare a corner , T , butt joints etc., from a given wooden piece.

Forging and Welding

Learning Objectives

On completion of this unit, a learner will be able to

- Know different types of hand tools, and their usage.
- Describe important smithy operations.
- Explain various machine forging operations.
- Know the safety precautions to be followed while doing welding.
- Get the knowledge about arc welding and gas welding procedure and proper handling of equipment used for the purpose

5.0 Introduction

Forging is the process of deforming the metal into different shapes by heating up to plastic state and by hammering or pressing at red hot condition. The process is usually carried out above re-crystallization temperature. Therefore this process is called hot working process. The term usually preferred to the production of heavy parts and in large scale.

5.1 Hand Tools used in Forging

The following hand tools are used in forging.

- | | | |
|-----------------|----------------|-----------------|
| 1) Anvil | 2) Swage block | 3) Tongs |
| 4) Hammer | 5) Chisel | 6) Hardie Tools |
| 7) Swages | 8) Fullers | 9) Flatters |
| 10) Set Hammers | 11) Punches | 12) Drifts |

1. Anvil : The anvil forms a good support for black smith's work when hammering. Its body is made of mild steel. These are made in different forms to provide the means for other forging operations. The usual form of anvil has a round hole called pitchel hole for bending rods and a square hole called hardie hole for holding square shanks of various tools such as swages, fullers, hardies, chisels.

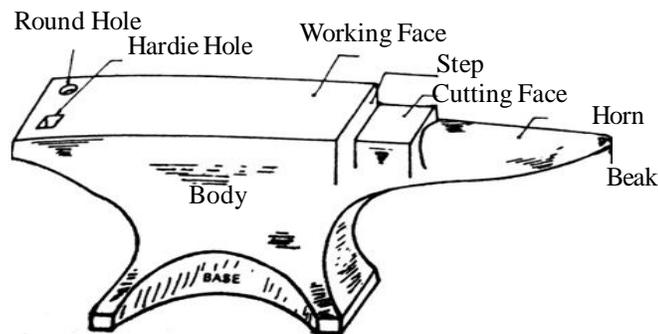


Fig. 5.1 Anvil

2) Swage Block : It has different sizes and shapes of slots like half round, square and rectangular along its four sides. It is made of cast iron. This is used as a support in punching holes and forming different shapes.

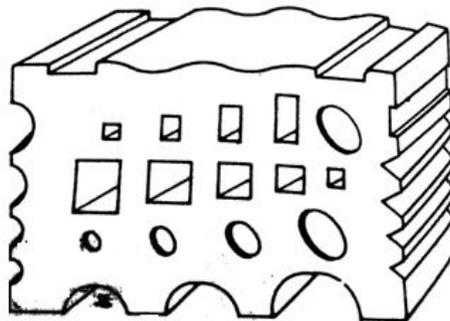


Fig. 5.2 Swage Block

3. Tongs : Blacksmith requires tongs to handle the job while forging. These are used to hold the job in position and turning over during forging. The commonly used tongs are

- (a) Closed mouth (b) Open mouth
(c) Round hollow tong (d) Square tong

(a) Closed Mouth : This is used for holding thin sections.

(b) Open Mouth : This is suitable for holding heavier stock,

(c) Round Hollow Tong : This is used for holding round, hexagonal, and octagonal shapes.

(d) Square Tong : This is used for holding square work.

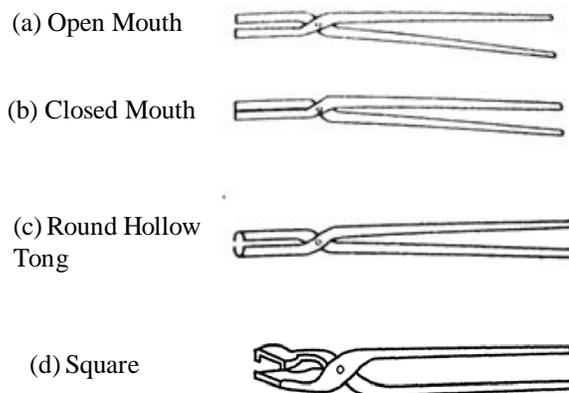


Fig. 5.3 Types of Tongs

4. Hammers : These are two kinds. a) The Sledge hammers are used by smith's helper used for heavy blows weighs from 4 kg to 10 kg. b) Hand hammer are used by smith himself used for light blows

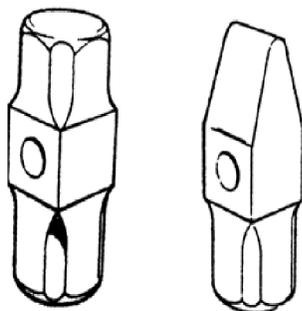


Fig. 5.4 Sledge Hammers

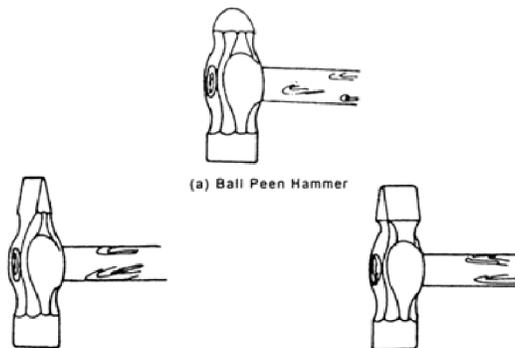


Fig. 5.5 Hand Hammers

5. Chisels : These are used for cutting metals and for necking prior to breaking. They may be hot or cold depending on whether the metal to be cut is hot or cold. The hot chisel is used for cutting the metal when hot and its edge is at an angle of 30° . The cold chisel is used to cut cold materials.

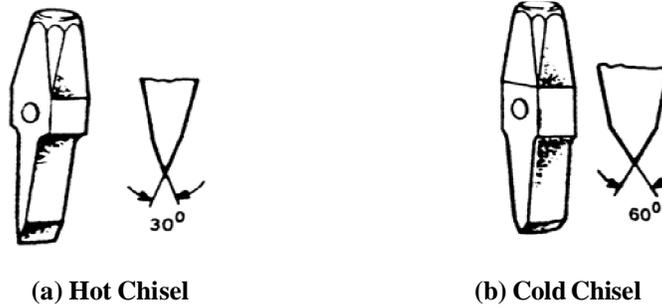


Fig. 5.6 Types of Chisels

6. Hardie Tools : It is a cutting tool with square shank to fit in the square hole of the anvil. It is used in combination with hot or cold chisel.



Fig. 5.7 Hardie Tools

7. Swages : Swages are used for reducing and finishing the round, square, and hexagonal shapes. A set of swages are designed for round shapes and square shapes

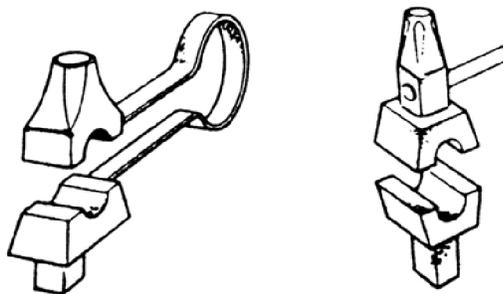


Fig. 5.8 Swages

8. Fullers : These are used in pair for necking down a piece of work. The bottom fuller has square shank to fit in the hardie hole and top one is provided with handle.

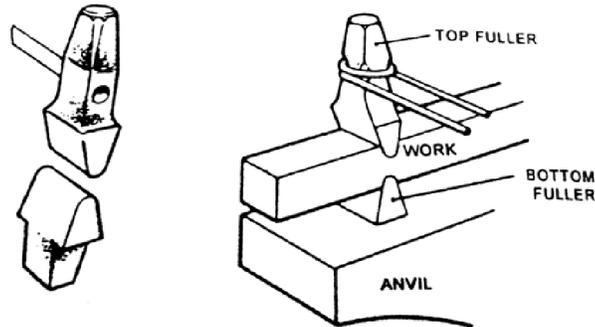


Fig. 5.9 Fullers and Their Use

9. Flatters : These are used to obtain smooth and finished flat surfaces which have already been shaped by fullers and swages.

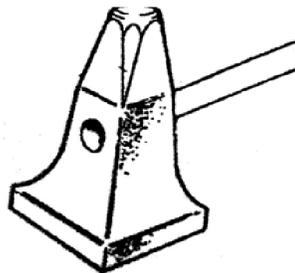


Fig. 5.10 Flatter

10. Set Hammers : It is really a form of flatter. A set hammer is used for finishing corners in shouldered work where the flatter would be inconvenient to use



Fig. 5.11 Set Hammer and Its Use

11. Punches : A punch is used for making holes in metal parts when it is at forging heat.

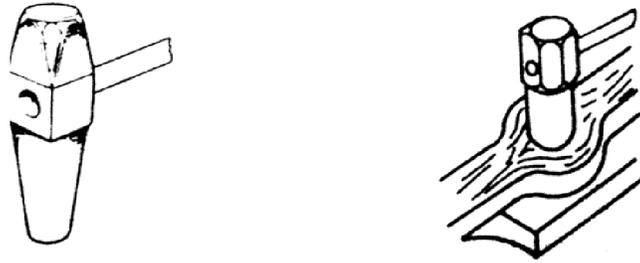


Fig. 5.12 Punch and Its use

12. Drifts : It is a tool for enlarging the hole made by punch. They are driven right through the punched hole.

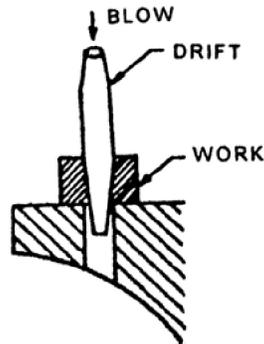


Fig. 5.13 Use of Drift

5.2 Heating Devices

The stocks are heated to the correct forging temperature in a smith's hearth or in a furnace. Gas oil or electric resistance furnaces are induction heating classified as open or closed hearths. Gas and oil are economical, easily controlled and mostly used as fuels. A common form of smith's hearth is made of thick steel sheets. It is lined with fire bricks. It holds the coke and provides with tuyere and a tank containing water. Air is supplied through a fan or blower to hearth. The air is admitted into the hearth may be regulated by a suitable valve arrangement. The hood at the top collects the fumes from the fire. Smoke and gas are finally removed into atmosphere. After firing the hearth the work piece is kept under the fire. When it becomes sufficiently hot it is removed from the hearth for shaping.

5.3 Smithy Operations

For giving desired shape to the metal, number of operations are performed in a smithy shop. They are listed here under.

- | | |
|-----------------|-----------------|
| a) Upsetting | b) Drawing down |
| c) Setting down | d) Bending |
| e) Fullering | f) Swaging |
| g) Flattering | |

a. Upsetting : It is the process of increasing cross-sectional area at the expense of its length. It is achieved by heating the bar at the middle and striking the end with hammer as shown in diagram.

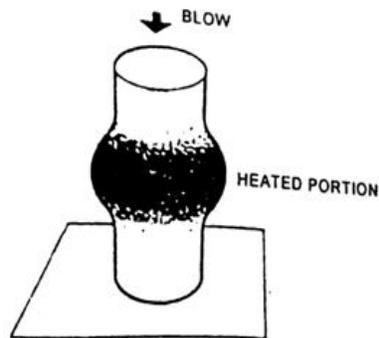


Fig. 5.14 Upsetting

b. Drawing Down : It is the process of decreasing the cross section area with a corresponding increase in length of a bar. The operation is carried by using the edge or horn of the anvil or fullers. The bar is finally finished by flatters.

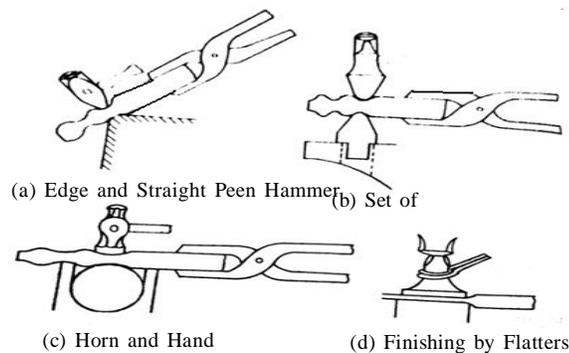


Fig. 5.15 Drawing Down

c. Setting Down : It is the process of decreasing thickness rather than general reduction of area. It is initiated with fullers and finished with flatters.

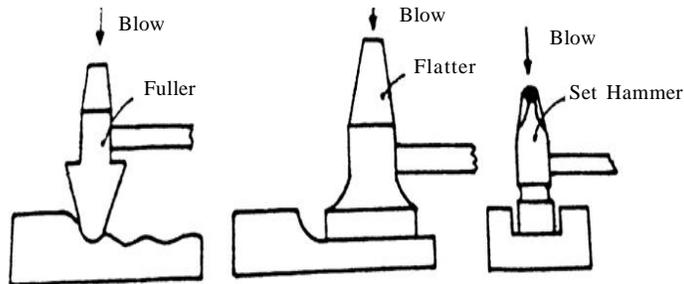
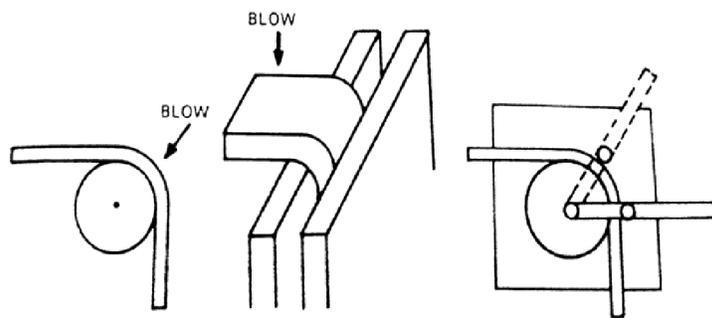


Fig. 5.16 Setting down

d. Bending : This can be performed to produce different types of bent shapes such as angles, ovals and circles etc. for making a bend at that particular part of job.



a. Bending of Horn b. Angular bending in a vice c. Bending in a fixture for mass production

Fig. 5.17 Bending

e. Fullering : It is the process of increasing the length by necking the bar between two fullers.

f. Swaging : It is an operation through which desired shapes are obtained on the job by placing it in a similar shape slot on the swage block and then applying top swage on the other side of the job.

g. Flattering : It is an operation through which the surface of job shaped by fullers and swages are usually finished.

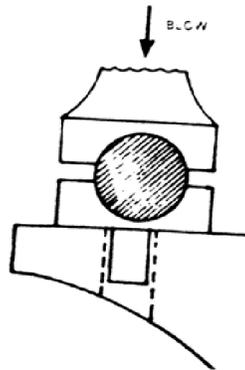


Fig. 5.18 Swaging

5.4 Machine Forging

Heavy and medium forgings are made in machine forging where as in hand forging only a limited quantities of light forgings are produced. In machine forging sledge hammer is replaced by power driven forging hammers or presses. Because sledge hammers are unable to produce required degree of deformation of metal during forging.

5.5 Forging Hammers

The forge hammers are classified as

- (1) Mechanical
- (2) Drop Hammers

(1) Mechanical Hammers are classified as

Mechanical hammers are classified as

- a) Spring hammer
- b) Pneumatic Hammer

(a) Spring Hammer : It is a light weight power hammer and is adopted for small forgings. It has a heavy rigid frame carrying a vertical projection at its top. This projection acts as housing for the bearing in which the laminated spring oscillates. The rear end of this spring is pinned to small end of connecting rod and its front end is connected to a vertical top to which the die is fixed. The bottom end of the connecting rod is attached to an eccentric sheave. This in turn connected to the crank wheel that is driven by an electric motor. The bottom die is keyed to the anvil block.

To operate this, the treadle is to be pressed down. This causes the eccentric sheave to rotate through the crank wheel and thus the laminated springs start oscillating in the bearing. This oscillation of the spring causes tip to move up and down and thus the required blows are delivered on the job which is placed between die and hammer.

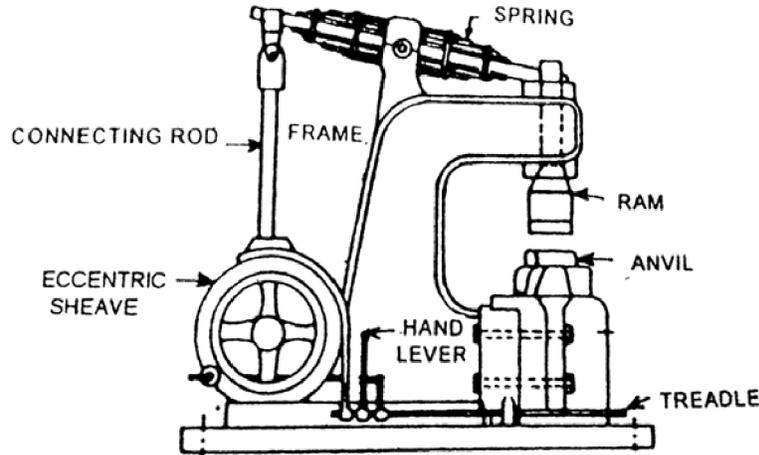


Fig. 5.19 Spring Hammer

(b) Pneumatic Hammer : A common form of pneumatic hammer carries compressor cylinder. A piston works inside this cylinder is connected to the main motor shaft by means of a crank and connecting rod mechanism. A hand lever operates an air valve provide air passage from the compressor cylinder to Ram cylinder. Ram piston carrying the tip at its bottom works inside the ram cylinder. The tip is made to slide inside fixed guide.

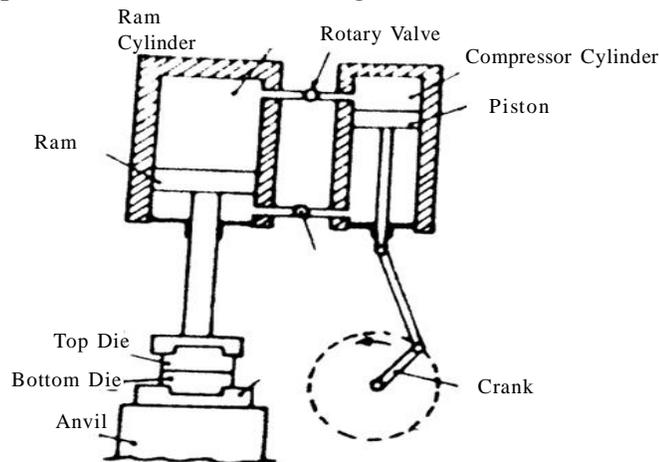


Fig. 5.20 Pneumatic Hammer

Air is compressed on both upward and downward strokes of the piston in compressor cylinder. This air enters into the ram cylinder through a control valve.

Hammer falls by imparting blow to work piece due to its own weight when the air pressure exerted above the piston. The upward stroke of the hammer is obtained by exhausting the air above the piston and admitting in beneath the piston.

(2) Drop Hammer

The drop hammer is suitable for production of large number of identical forging components also. High quality components are by made this process. There are two types a) Steam or Air drop hammer b) Board Drop or Gravity drop hammer

(a) Steam or Air Drop Hammer : These hammers are run by steam or compressed air. These are similar to pneumatic hammer except that they do not have a built in compressor. The generation of compressed air or steam takes place separately and not within the hammer. There are two types of steam hammers in common use i) Single acting and ii) Double acting

In single acting steam (or air) hammer, the steam (or air) is admitted through bottom part which lifts the ram upwards and then the ram is allowed to fall down under gravity to provide required blow.

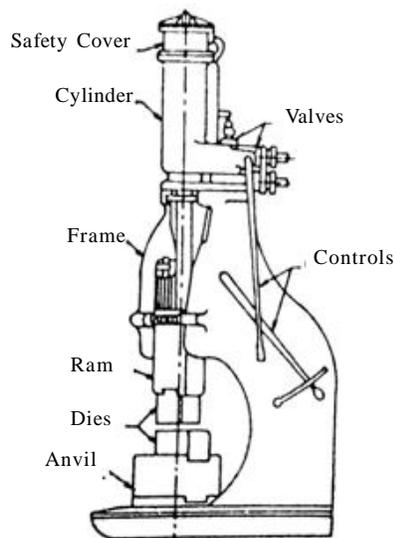


Fig. 5.21 Steam Hammer

(b) Board Drop (Gravity drop Hammer) : In this case the energy blow is entirely depends upon the weight of the hammer. The ram is attached to the

board which passes between two rockers which are in continuous motion. The ram moves up with the help of routers and is held at desired height by clamps until they are released by the operator. At a preset height the board is rebased so that it strikes the die which is fixed to the anvil. The work is deformed by the force of blow. If the weight of the ram and the height from which it falls is greater, the impact of blow will be more.

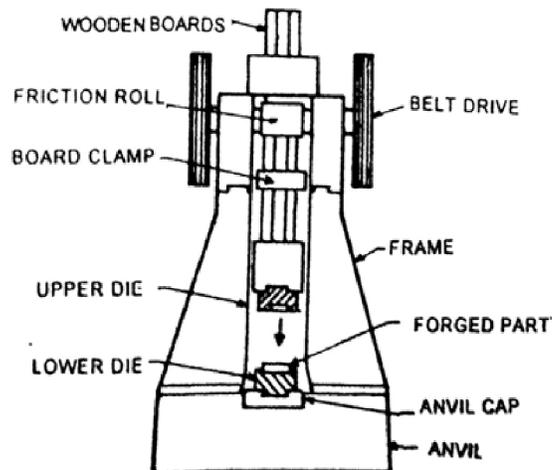


Fig. 5.22 Board drop Hammer

5.6 FORGING PRESSES

In press forging, the metal is shaped by squeezing it into the die cavities by pressing. Presses of 500 to 6000 tonnes capacities are in common use. Normally two types of presses are used a) Hydraulic presses are used for heavywork b) Mechanical presses are used for light work.

Mechanical presses operate at faster speed than hydraulic presses, but hydraulic presses provide greater squeezing force than mechanical presses.

Welding

Introduction

Welding is the process of joining two or more metals by application of heat with or without application of pressure and addition of filler rod. Now the basic purpose of welding is to provide a means to join pieces by raising their temperature to the fusion point so that they forms a pool of molten metal at the ends to be joined and if needed supplement their pool with a filler metal which is normally same metal as the metal pieces to be joined.

Types of Welding

The modern methods of welding may be classified under two broad headings.

a) Plastic welding b) Fusion Welding

In plastic welding or pressure welding, the pieces of metal to be joined are heated to a plastic state and then forced together by external pressure. eg forging

In fusion welding or non pressure welding, the material at the joint is heated to a molten state and allowed to solidify. eg. Gas welding and arc welding etc.

1. Gas Welding : It is a fusion welding or non pressure welding method in which a strong gas flame is used to raise the temperature of the ends of the pieces to be joined to a heat sufficient to melt them. The metal thus melted starts flowing along the ends to be joined and forms a strong weld joint after solidifies. So many different combination of gases may be used, but the most common of these are oxygen and Acetylene, O_2 & H_2 . Oxygen and hydrogen gas welding is used for metal for low melting point like non ferrous metal.

5.6.1 Oxygen - Acetylene Welding

This welding can be used for welding almost all metals and alloys used in engineering practice. The highest temperature that can be produced by a flame of oxygen and acetylene is nearly $3200^\circ C$. The correct adjustment of the flame is important for reliable works. When oxygen and acetylene are supplied to torch in nearly equal volumes, a neutral flame is produced having a maximum temperature of $3200^\circ C$.

This neutral flame is widely used for welding steel, Stainless steel, Cast iron, copper, Aluminium etc. An oxydising flame in which there is an excess of oxygen used for welding brass. A carburising flame is one in which there is an excess of acetylene compared to oxygen used for welding cast iron

Gas Welding Equipment

The most commonly used tools and equipment for oxy acetylene welding consists of following.

- a) Welding torch
- b) Pressure Regulator
- c) Welding tip
- d) Hose and Hose fittings
- e) Goggles, gloves and spark lighter
- f) Gas cylinders

a) Welding Torch : This is a tool for mixing oxygen and acetylene in required proportions and burning the mixture at the end of its tip.

(b) Welding Tip : It is that portion of the welding apparatus through which the gases pass just prior to their ignition and burning. These tips of different shapes and sizes are governed by the diameter of opening. The diameter of the tip opening used depends upon the types of metal to be welded.

(c) Pressure Regulator : The function of a pressure regulator is to reduce the cylinder pressure to required working pressure and also to produce a steady flow of gas regardless of the pressure variation at the source.

(d) Hose and Hose Fittings : The hose for welding torches should be strong, durable, nonporous and light. The most common method of piping both oxygen and acetylene gas is the reinforced rubber hose. The colour of oxygen pipes is black and acetylene is red.

(e) Goggles, Gloves and Spark Lighter : Goggles are fitted with coloured lenses are provided to protect the eyes from harmful heat , ultraviolet and infrared rays.

Gloves : These are used to protect the hands from any burnings or injury.

Spark Lighter : Provides a convenient and instant means for lighting the welding torch.

Gas Cylinders : Oxygen cylinders are usually charged with about 40 litres of oxygen at a pressure of 154 kgs/ cm² at 21°C. A full cylinder has a weight of about 80 kgs. Oxygen cylinder is painted with black. A safety valve is provided to release the oxygen before there is any danger of excess pressure.

Acetylene Cylinder : These cylinder carry a porous mass inside soaked in acetone which has a capacity to dissolve 25 times its own volume of acetylene for every atmosphere of pressure applied. These cylinders are usually filled to a pressure of 16 kgs to 21 kg/ cm². It is painted with maroon colour

Gas Welding Procedure :

1. Arrange the two cylinders (O₂ & C₂ H₂) in proper position (upright).
2. Blow out both cylinder valves before fitting the regulators so that all dirt may be cleaned out and this operation should be done quickly.
3. The regulator and valve fitting should be thoroughly checked that there is no oil or grease.
4. Fix the oxygen and acetylene regulator and pressure gauges to cylinders.
5. Connect or check hose fittings of O₂ and C₂ H₂.

6. Open the cylinder valves gradually to avoid abrupt strain.
7. Check out for leakages at all joints before starting the work.
8. To start the work turn on the acetylene first and allow it to pass through the nozzle. Then turn on the oxygen slightly and allow the mixture to flow through hoses and blow pipes are full and cleared off air.
9. Adjust the required pressure of the two gases and light the mixture.
10. Adjust the flames by regulating the supply of the gasses in correct proportions.
11. After the work is completed the oxygen valve should be closed first followed by the acetylene valve.
12. Care should be taken always that oil and grease do not present at any fittings may lead to an explosion.

5.6.2 Arc Welding

Arc welding is the most extensively employed method of joining metal parts. Here the source of heat is an electric arc. It is a fusion welding process in which no mechanical pressure is applied for joining the metal. In this, the metal pieces to be joined are heated locally to the melting temperature by creating an electric arc and then allowed to solidify to form the welded joint.

Arc Welding Equipment

1. AC or DC welding machine
2. Electrode
3. Electrode holder
4. Cable, Cable connectors
5. Cable lugs.
6. Chipping hammer
7. Earth Clamps
8. Wire brush
9. Helmet
10. Safety goggles
11. Hand gloves
12. Apron and sleeves.

1. Welding Machine : Both AC and D.C's are used for arc welding. When welding is employed the current is generated by a D.C generator. This generator can be driven by means of an electric motor or by means of petrol or diesel engine. With the result D.C arc welding processes can be employed irrespective of whether main A.C supply is available or not.

For A.C arc welding a step down transformer is used which receives current from the supply mains at 200-440 volts and transforms it to the required voltage for welding i.e 40-100 volts. Arc welding machine consists of a steel tank mounted on three tyred wheels and the front wheel is steerable by means of a draw bar. An oil cooled, double wound step down transformer reduces the supply mains

voltage to a welding voltage of 80 volts. All windings are totally enclosed in the steel tank. The output of transformer can be varied by rotating a hand wheel which alters the air gap in the core of the choke resulting in stepless regulation of the current between 50-400 amps. The welding setting can be directly read at the window on the top cover.

(2) Electrode : Both non consumable and consumable electrodes are used for arc welding. Non consumable electrode, may be made of carbon, graphite or tungsten which donot consume during the welding operation. Consumable electrode may be made of various metals depending upon their purpose and the chemical composition of the metal to be welded. These consumable electrodes may be bare or coated. Bare electrodes are cheaper but the weld produced through these are poor quality and it needs high degree of skill on part of welder, if satisfactory results are expected. Therefore bare electrodes are rarely used in modern welding practice, where as more popularly used in metal arc welding are the coated electrodes which carry a core of bare metallic wire, provided with a coating on the outside surface. Main advantage in using coating electrode is to protect the molten metal from the oxidisation and nitrogen , to the establishment and maintenance of the arc. Mild steel is the most commonly used material for the core wire. Some of the other metals and alloy are also used as core wire material. The electrode covering the flux coating perform many functions that reducing atmosphere to prevent oxidation, forming stage with metal impurities, establishing arc, providing necessary alloying elements to the weld metal. The common ingredients of a flux are asbestos, mica, silica, flour spar, stealite, mg carbonate etc.

Arc Welding Procedure

Before starting the welding, the joint should be prepared well and thoroughly cleared to remove dirt, grease, oil, oxide etc. from the work surface. Edges of thickened section should be bevelled . The work pieces should be firmly held. Make sure that connection are given properly to main supply as well as electrode rod and work piece to be welded. The arc column is generated between anode which is positive pole of power supply and the cathode (-ve pole). When these two conductors of an electric circuit are brought together and separated for a small distance i.e. 2-4 mm such that an electric arc is formed. Heat is generated as the ions strike the cathode. The temperature of an electric arc, depends upon the type of electrode between which it struck. The heat of the arc raises the temperature of the parent metal which is melted forming a pool of molten metal. The electrode rod is also melted and transferred between metal pieces to be welded. Two thirds of heat is generated near the positive pole and one third is developed near the negative pole. As a result an electrode that is connected to

the positive pole will burn away approximately 50% faster than when connected to the negative pole. The electrode of suitable size should be held at an angle of 60-80° with work piece. Then the welding may be proceeded by maintaining a gap 2-4 mm between the electrodes. After desired length has been welded the electrode holder should be lifted quickly to break the arc.

Summary

1. Forging of a heated metal by hammering or pressing.
2. Different tools used in forging are classified as
 - a) Heating Devices
 - b) Supporting tools
 - c) Holding tools
 - d) Cutting Tools etc.
3. Most of the forging work is done with hot metal and heating of metal is carried out in a hearth or furnace are two types
 - a) Open hearth
 - b) Closed hearth.
4. Supporting tools are used to support the work while hammering.
5. Most important forging operations are upsetting, drawing down, setting down, bending, fullering, swaging and flanging.
6. Machine forging is suitable to produce large number of identical forgings and is carried out by forcing the metal into die cavities by repeated hammer blows.

Activity

1. A learner should collect a round bar made from square rod.
2. A learner should collect S-hook
3. Collect a crane hook
4. Collect T-bolts
5. Collect arc welded, T-Joint, Lap joint, Butt joint.
6. Collect gas welded, T-joint, lap joint, and butt joint.

Short Answer Type Questions

1. Define forging.
2. What is meant by upsetting ?
3. What are Tongs ?
4. Write about supporting device in forging

Long Answer Type Questions

1. Explain about any four smithy operations ?
2. Name different types of machine forging hammers and explain about any one them

OJT Questions

1. Make the practice of usage of forging tools.
2. Prepare a round bar from a square bar.
3. Make a crane hook, S-hook.
4. Make a butt joint by arc welding process.
5. Make a lap joint by Gas welding process.

UNIT

6

Foundry

Learning Objectives

On completion of this unit a learner will be able to

- Describe various hand moulding tools used in foundry.
- Explain about pattern making and different type of patterns used
- Classify moulding sands and their properties.
- Know the purpose of core and core making.
- Explain about various casting methods.
- Know about various defects in casting.

Introduction

Manufacturing is the art of transforming the raw material into finished product. This chapter deals with manufacture of products from molten metal and the products obtained are called Casting. Casting are produced when the molten metal is poured into the mould cavity and left to solidify. This is cheapest method of producing parts to a given shape.

6.1 Advantages and Limitation of Casting

Advantages of Casting

1. Size is not a limitation
2. There are several metals which can be cast.
3. Intricate components with cavities can be casted with accuracy and good surface finish.
4. Casting, in general resists creep under high temperature.
5. Metal casting can be adopted for job work as well as for mass production.

Disadvantages

1. The process is not suitable for the metals having high melting point and low fluidity.
2. Casting do not exhibit directionality of properties . The strength and toughness of castings are usually inferior to forgings.

6.2 Foundry Equipment and Hand Mould Tools

Foundry tools and equipment may be classified into three groups namely hand tools, flasks and mechanical tools.

Hand Tools in Moulding

(1) **Shovel** : It is used for mixing and tempering the moulding sand and loading the sand into flask.

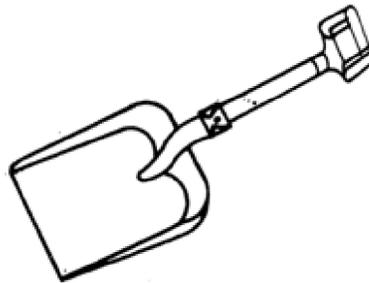


Fig. 6.1 Shovel

(2) **Riddle** : It is a wire mesh fitted in to a wooden frame used for screening the sand and to scatter the fine moulding sand over pattern.

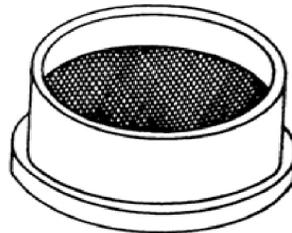


Fig. 6.2 Riddle

(3) **Rammer** : These are used for packing the sand around the pattern in a flask. This is made of hard wood with one end flat and other wedge.

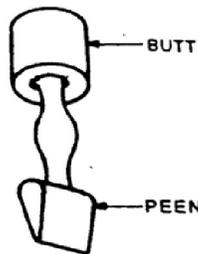


Fig. 6.3 Rammer

(4) **Trowels** : These are used for cleaning, smoothing and patching the flat surface of the mould.

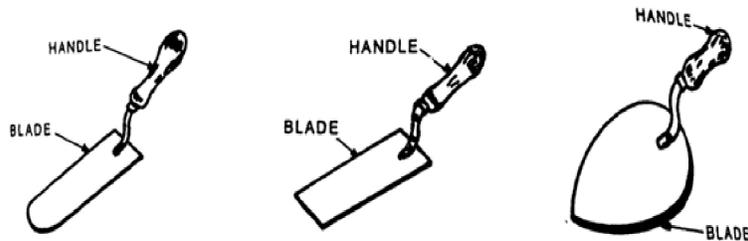


Fig. 6.4 Types of Trowels

(5) **Slick** : It has a flat on one end and spoon on the other end. It is used for patching and smoothing the mould after the pattern has been drawn.



Fig. 6.5 Slick

(6) **Lifter** : It is used for removing the sand particles from the mould.

(7) **Strike of bar** : This is used to cutting off extra sand after ramming and bringing it to level with the surface.



Fig. 6.7 Strike of Bar

(8) **Bellow** : These are used to blow excess parting material from the pattern and also to blow loose sand particles from the mould.

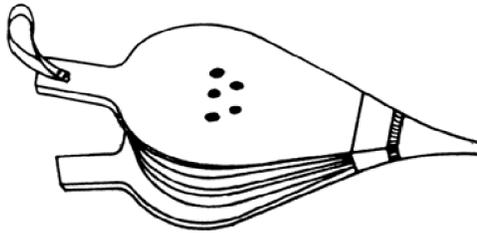


Fig. 6.6 Bellow

(9) **Sprue Pin** : Pin used to make riser hole called riser pin.

(10) **Swab** : It is soft brush used for moistening the sand around the pattern.

(11) **Gate Cutter** : It is a piece of steel sheet bent in the form used to cut gates.

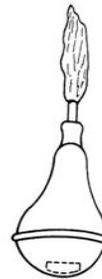


Fig. 6.7 Sprue Pin Fig. 6.8 Gate Cutter Fig. 6.9 SWAB

(12) **Mallet** : It is used to loosen the pattern to withdraw it from the mould and for stripping the core box from the cores.

(13) **Vent rod** : It is used to make series of small holes to permit gasses to escape while molten metal in being poured.

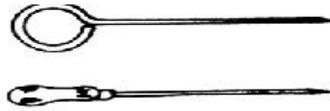


Fig. 6.10 Vent Rods

(14) **Draw Spike or Screen** : It is used to rap and draw patterns from the sand.

(15) **Water Sprinkle** : It is a device used for wetting and tempering the mould sand.



Fig. 6.11 Water Sprinkle

(16) **Spirit Level** : It is used for aligning flasks and adjusting the straight edges in pit moulding.

Moulding Boxes : Sand moulds are prepared in specially constructed boxes called flasks. The purpose of flask is to impart the necessary strength to the sand in moulding. Moulding flask is generally made into two parts. The Cope (Top section) and the drag (bottom section). These two are held in position by dwel pins. The common types of moulding boxes are

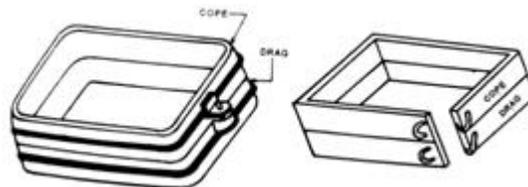


Fig. 6.12 Moulding Boxes

(a) **Snap flask** : It is a small flask with open form. It is made with hinge on one corner and a lock on the opposite corner. It can be removed from the mould before it is poured.

(b) Box Flask : It is suitable for small and medium size castings, it is removed from the mould only after solidification of casting.

(c) Wooden moulding boxes : Wooden boxes are often used for making relatively large castings.

Mechanical Tools: These tools in the foundry include the many types of moulding machines that will ram the mould, roll it over, and draw the pattern. Besides there are power operated riddles sand mixtures and sand conveyers etc.

6.2 Types of Sands and Properties

The common sources of collecting foundry sands are from rivers, lakes, sea and deserts. The principal ingredients of moulding sands are silica sand grains, clay, moisture and miscellaneous materials. Moulding sand is classified as under

- (1) Natural sand
- (2) Synthetic sand

Natural Sand : Natural sand containing required proportion of clay (5-20%) is referred as green sand. It requires only to mix water. The clay develops the strengths and plasticity for moulding. They are less refractory than synthetic sand.

Synthetic: These are obtained by crushing and mixing soft yellow sand stone, carbon ferrous rocks. This sand essentially high silica grains containing no clay in natural form. They are mixed with clay (3-5%) and water 3-4% to develop required moulding properties.

Properties of Moulding Sand

Proper moulding sand must possess six important properties.

(1) Porosity : The sand should have sufficiently porous to provide a passage for steam and gases otherwise the gases penetrate into metal which leads to the formation of gas cavities in casting.

(2) Plasticity : It is the ability of a sand to acquire shape from the pattern that is moulded and retain it during casting.

(3) Flowability : It is the ability to flow under externally applied forces in to deeper sections of pattern and uniformly fill the flask.

(4) Collapsability : It is the property of sand that permits it to collapse easily during its knockout from the casting.

(5) Adhesiveness : It is the ability of sand to stick to the surfaces of moulding boxes. This enables the mould to retain in a box during handling.

(6) Cohesiveness : It is the ability of sand particles to stick each other. It refers to the strength of moulding sand to hold the grains together.

(7) Refractiveness : It is the ability of sand to withstand the heat of molten metal without fusion.

6.3 Pattern : Classification and Making

The type of pattern used depends upon the design of casting, complexity of shape, the number of castings to be produced. The following types of patterns are in common use.

- (1) Solid Piece
- (2) Split pattern
- (3) Match plate pattern
- (4) Gated pattern
- (5) Sweep pattern
- (6) Cope and drag pattern etc.

(1) Solid Pattern : It is made in single piece and is best suited for limited production.

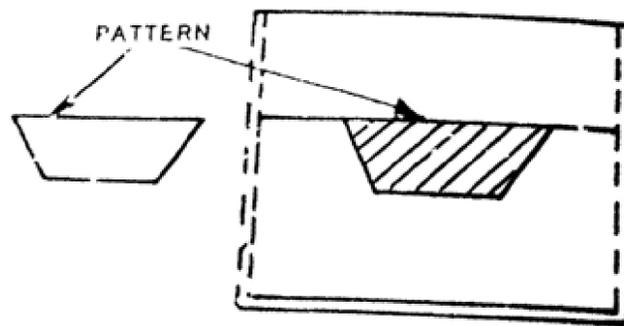


Fig. 6.13 Solid Pattern

(2) Split Pattern : It is used for intricate casting of unusual shapes. split pattern may be two or three piece.

(3) **Match plate Pattern** : These patterns are mostly used in machine moulding as well as for producing large number of small castings by hand moulding.

(4) **Gated Pattern** : These patterns include gates and risers for producing casting. The use of gated pattern eliminates the time required to cut the gating system by hand.

(5) **Sweep Pattern** : The template made of wood or metal revolving around a fixed axis in the mould shapes the sand to the desired contour. It is suitable for production of symmetrical castings.

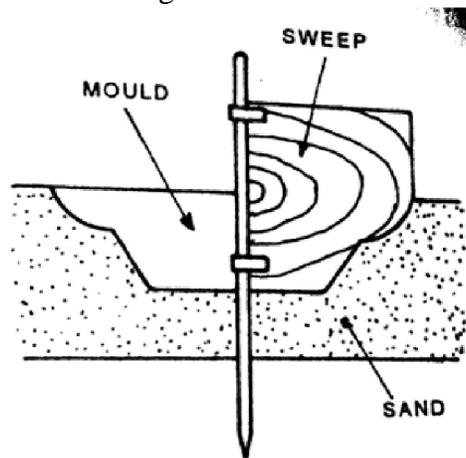


Fig. 6.13 Sweep Pattern

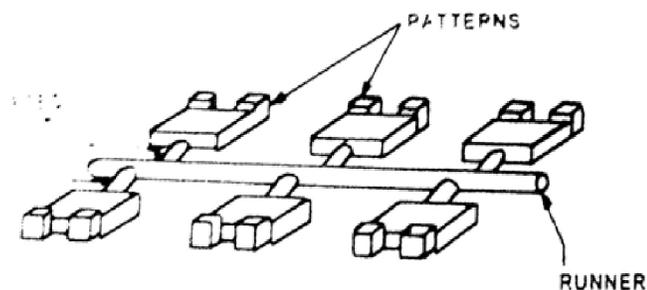


Fig. 6.14 Gated Pattern

(6) **Cope and Drag Pattern** : This pattern is made of two halves which are mounted on different plates. In this case, cope and drag parts of the mould are made separately..

Pattern Making

A pattern may be defined as a replica or facsimile model of the desired casting which, when packed in a suitable moulding material, produces a cavity called mould. This cavity when filled with molten metal produces desired casting.

A pattern size is slightly larger than the finished casting by an amount called allowance. 1) Shrinkages allowance : The pattern must be made over size to compensate for contraction of liquid metal on cooling. 2) Machining allowance : It necessary to produce the finished surface of casting by machining. The excess in the dimensions of the casting over the finished casting called machining allowoance. 3) Draft Allowance : When a pattern is removed from a mould, the tendency to tear away the edges of the mould is greatly reduced if the vertical surfaces of the pattern are tapered inwards. 4) Distorsion Allowance : This allowance is applied to the castings of irregular shapes that are distorted in cooling because of metal shrinkages. The material selected for a pattern should be easily workable, durable and should maintain dimensional accuracy. The common material used for making pattern are wood, metal, plastic and wax.

The pattern maker, before making pattern should study the blue print. Reproductions of the blue print laid out to full size scale on a flat smooth wooden board. Select a working face and place a working edge straight, smooth and square with the face of the board. Start the layout of a symmetrical pattern from centre line. Select the proper contraction rule for making layout measurements. Mark straight line with knife edge and circles with divider. colour the layout marks and preserve the layout until the pattern has been constructed.

After preparing the layout proceed for pattern construction. Study the layout and decide the location of parting lines. As per the layout, try to visualize the shape of the pattern and determine the number of separate pieces to be made. Start the construction of pattern from main part of its body. Cut and shape different parts providing adequate draft on them. Check all the prepared parts finally by placing them over the prepared layout. Assemble different parts in position by glueing or by means of dowels pin. Finally check the whole of the completed pattern for accuracy.

6.4 Core and Core Making

Cores are separate shapes of sand that are generally required to form the hollow interior of the casting or a hole through the casting. These are placed in the mould cavity before pouring to form the interior surface of the casting and are removed from finished part during shakeout and further processing.

Core Making

Core making consists of the following operations 1) Core Sand preparation 2) Core moulding 3) Baking 4) Core finishing

(1) Core Sand Preparation : The first consideration in making a core is to mix and prepare the sand properly. The mixing must be homogenous so that the core will be of uniform strength throughout.

(2) Core Moulding : Core is then made manually or with machines. Normally a core box is required for the preparation of cores.

(3) Core Baking : After the cores are prepared and placed on metal plate or core carriers, they are backed to remove the moisture and to develop the strength of the binder in core ovens at temperatures from 150°C - 400°C depending upon the types of the binder used, the size of the cores and the length of baking time.

(4) Core Finishing : All rough places and unwanted fins are removed by filing some cores are made in two or more pieces which must be assembled usually by pressing together with dextrin. The last operation in making of a core is to apply a fine refractory coating to the surfacing.

6.5 Green Sand Moulding

These moulds are prepared with natural moulding sands or with mixture of silica sand, bonding clay, and water. These materials are thoroughly mixed in proportions which will give desired properties for the class of work being done. The clay has been added to withstand the forces as the molten metal poured into the mould. These are widely used for small and medium castings. In this case no dry process of mould is necessary and the molten metal is poured as soon as mould is prepared. The term green refers to the moisture and not the colour of the sand. To prevent the sand from burning on the face of the mould, a layer of facing sand is given to surrounding pattern.

6.5.1 Dry Sand Moulding

These sand moulds are prepared in similar way as in green sand moulds except that the mould is dried before pouring molten metal. Drying is usually carried out in oven at about 240°C. The time of backing is depending on the binders used in the sand mixture and the amount of mould surface to be dried. The removal moisture makes the mould stronger, improves erosion resistance and surface condition. Dry sand moulds are used in preference to green sand moulds for making medium to large size castings of cast iron and steel.

6.6 SHELL MOULDING

It is basically a sand moulding in which the clay is replaced by resin bonding agent. it consists of the following steps.

(a) Preparation of thin shell made of a mixture of sand and thermo setting resin around a heated metal pattern.

(b) Separating the shell from the metal pattern

(c) Clamping two halves of the shell to form the mould.

(a) Preparation of Thin shell : Silica sand is thoroughly mixed with about 5% thermo setting resin binder such as phenolformaldehyde and placed in a container. The metal pattern plate is heated to about 250°C in a oven and is clamped to the top of the box. The dump box is inverted so that the sand resin mixture covers the pattern. After 30 seconds, the resin cures causing the bonding of sand grains to form a shell around the pattern.

(b) Separating Shell : The dump plate is returned to its original position and the surplus sand mixture falls back into the box. The pattern plate is removed and the shell is released by the ejector pins. The shells are light and thin usually 5-10 mm thick.

(c) Mould Formation : Shell is hardened by final curing for a few minutes at about 320°C. The two halves of shell are joined together by adhesives to form the mould. This is placed in suitable box and is supported by coarse sand or steel shots held in a box . The mould is ready.

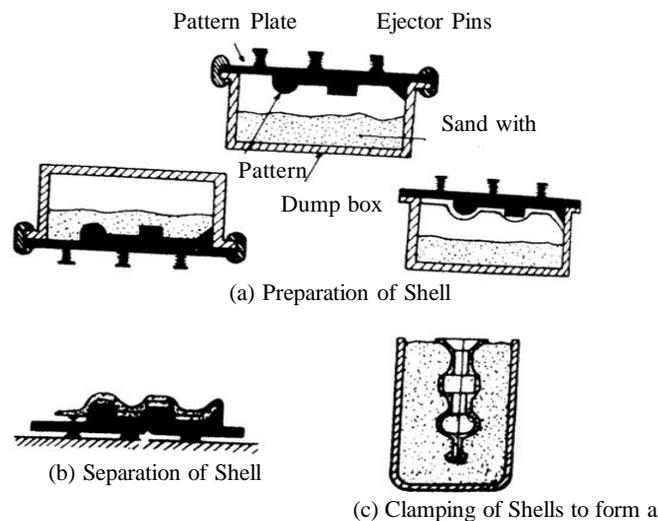


Fig. 6.15 Shell Moulding Process

6.7 Ceramic Moulding

This technique employs a metal pattern and the pattern is kept in a flask. A thick slurry of refractory material is applied to expose pattern surfaces. The coating becomes tacky almost on contact and is ready to receive backing material. This coarse slurry is poured over the facing coat until the flask is filled. It sets in about 3-5 minutes. The pattern is then withdrawn and the ceramic mass removed from the flask is treated with catalyst to stabilise it chemically. The mould is then heated at about 980°C in a furnace to expel the liquid binders completely. The molten metal is then poured and the moulds are allowed to cool down slowly.

6.8 Special Casting Methods

Most of the moulds are destroyed after solidification of castings and hence cannot be reused. This is not suitable for mass production. Now these special castings are used for large scale production of castings with close dimensional tolerances and has a smooth surface finish. The principle of special casting methods such as die casting and centrifugal castings.

Die Casting : This is nothing but permanent metal moulds or dies. This die is made in two pieces are closed to form cavity. The die castings are two types
1) Pressure die casting 2) Gravity die Casting

1) Pressure Die Casting : It involves the forcing of molten metal into die cavity under pressure and maintain this pressure until it solidifies.

2) Gravity Die Casting : In gravity die casting in which molten metal is poured to the cavity by gravity. Therefore it is known as gravity die casting. Here the moulds are coated with refracting materials and are closed.

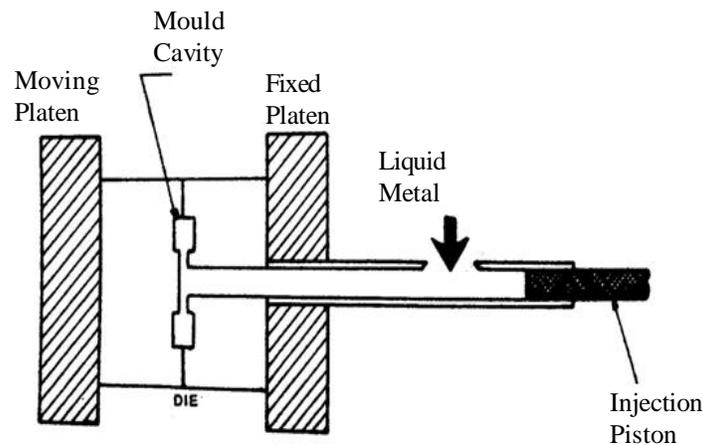


Fig. 6.15 Pressure Die Casting

Centrifugal Casting

It is the variety method of producing castings in a rotating mould. The molten metal is poured in to the mould which is rotating at a speed of 1500 rpm and the centrifugal force spreads the molten metal uniformly along the entire length of the mould and holds it there until solidification is completed.

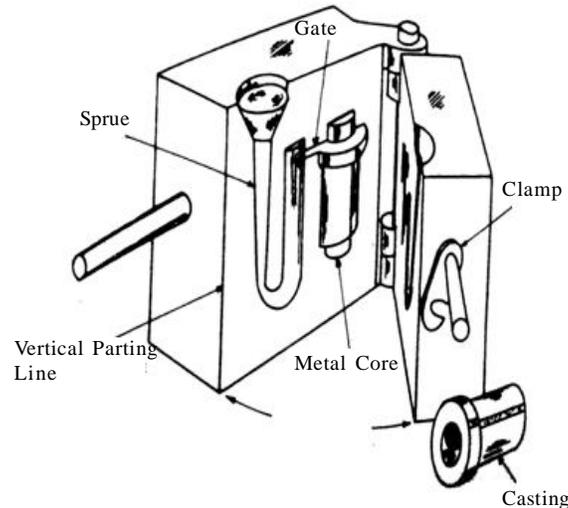


Fig. 6.15 Permanent Mould Casting

6.9 Defects in Casting

The various defects which are commonly occur in castings.

(1) Blow holes : These are appear as cavities in a casting. When they are visible on the upper surface of the casting, they are called open blow holes. When they are concealed in the casting are called blow holes. These are formed due to the trapped bubbles of gases in the metal and are exposed only after machining.

(2) Porosity : This defects occur in the casting in the form of pin holes. These are caused by the gases absorbed by the molten metal. The gases commonly observed are O_2 , H_2 , and N_2 . The later two forms oxides and nitride respectively.

(3) Shrinkage Allowance : It is a void or depression in the casting caused mainly due to uncontrolled solidification of the metal.

(4) Hot Tears : They are internal or external cracks having ragged edges occuring immediateley after metal has solidification. These are produced due to poor design and sudden sectional changes.

(5) **Shift** : This is an external defect in a casting caused due to core misplacement or mismatching of top and bottom parts.

(6) **Shell** : It is an enlargement of the mould cavity by metal pressure resulting in localised or overall enlargement of casting.

(7) **Scabs** : These are lumps of excess metal on the casting as a result of erosion of mould by the stream of molten metal.

Summary

1. Foundry is the process of forming unfinished metal product by melting the raw material and pouring it in to mould cavity
2. Foundry tools are classified in to three groups namely hand tools ,flasks and mechanical tools
3. Moulding sand in foundry is classified in to natural and synthetic
4. Proper moulding sand must posses six important properties such as porosity, flowability, collapsability, adhesiveness, cohesiveness and refractiveness
5. Pattern is the full size model of the desired casting
6. Core is the body of the sand design to form holes and cavities in the castings. These cores are two types, green sand cores and dry sand cores.
7. Common defects occur in castings are blow holes ,cold struts and misruns ,hot tears,mismatch,shrikages cavities and swells ect.,.

Short Answer Type Questions

1. Define Pattern.
2. What is the purpose of Core.
3. Name different types of hand moulding tools used in foundry.
4. Give names of different moulding Sands.
5. What is Mould.

Long Answer Type Questions

1. Explain Dry Sand Moulding.
2. Explain about different hand moulding tools with sketch.
3. Write about common Casting Defects.

Mechanical Working of Metals

Learning Objectives

On completion of this unit a learner will be able to

- Explain about hot working process
- Explain about cold working process

7.0 Introduction

Mechanical working of a metal is the plastic deformation performed to change dimensions, properties, and surface condition by means of mechanical pressure. Mechanical working may be either hot working or cold working. Cold working is done below recrystallization temperature where no transformation of grain structure takes place. Hot working often allows more extensive deformation which is done above the recrystallisation temperature.

7.1 Hot Working Process

The plastic deformation of metals above the recrystallisation temperature is called hot working. However this temperature should not be too high because that gives rise to grain growth. In addition to more change of shape, hot working has profound effects on metal characteristics or properties.

The main hot working processes are

- | | | |
|--------------|---------------|-------------|
| (1) Rolling | (2) Piercing | (3) Drawing |
| (4) Spinning | (5) Extrusion | |

(1) **Rolling** : It is the most efficient method of reducing the cross sectional area of large sections. The plastic deformation of metal takes place as its passes through a pair of rollers rotating in opposite direction. The hot rolling is used to produce bars, plates, sheets, rails and other structural sections.

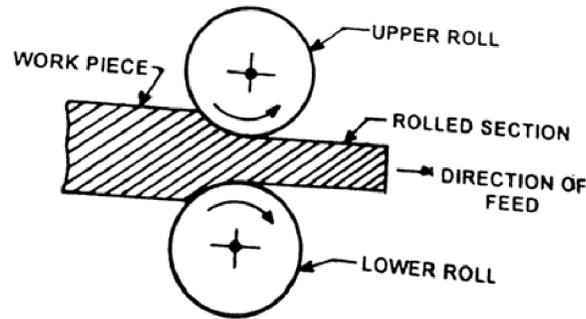


Fig. 7.1 Principle of Hot Rolling

(2) **Piercing** : Hot piercing is used to produce seamless tubes which is the natural form from which is made any thin-walled round objects. A small hole is made at the end of heated billet. It is pressed between two piercing rolls rotating in the same direction.

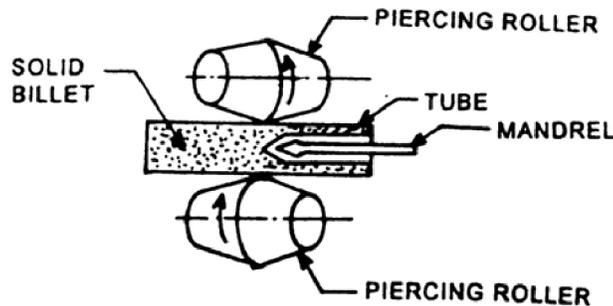


Fig. 7.2 Piercing Process

(3) **Drawing or Cupping** : It is the process of making cup shaped articles from flat circular blanks. The heated blank is placed over the die. The punch forces the metal through a die to form a cup shaped article.

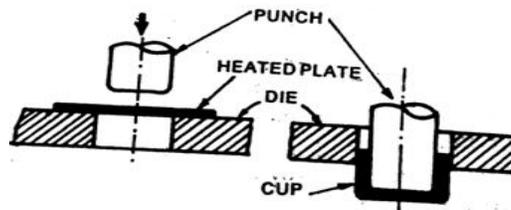


Fig. 7.3 Hot Drawing or Cupping

(4) **Spinning** : Spinning is a highly specialized art for producing lamp reflectors, cooking utensils, funnels and containers used in chemical plants. The blank is held between former and the adopter. The blank rotates with the former. A specially shaped tool is then pressed against the blank and slowly move to cover the former. This process is suitable for ductile materials.

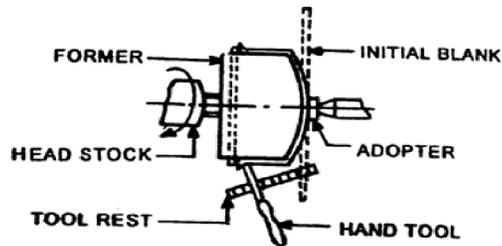


Fig. 7.4 Spinning Process

(5) **Extrusion** : Hot extrusion is used to produce long lengths with desired cross section which is very difficult by any other process. Basically the extrusion process is like squeezing tooth paste of a tube.

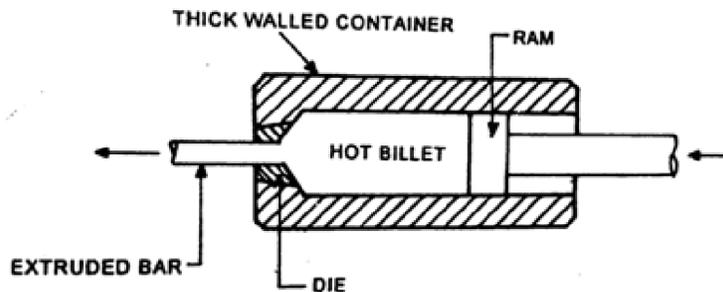


Fig. 7.5 Direct Extrusion

7.2 Cold Working Process

The plastic deformation of metals below the recrystallization temperature is called cold working. Cold working processes are usually carried at room temperature. During cold working operation the metal hardens, becomes stronger and its ductility is reduced. The principal methods of cold working are as follows.

- 1) Rolling
- 2) Bending
- 3) Drawing
- 4) Spinning
- 5) Extrusion
- 6) Squeezing
- 7) Riveting

(1) **Rolling** : Cold rolling is performed at room temperature. In cold rolling,, metal is deformed into long lengths between heavy rollers. It is also used to improve surface quality and dimensional accuracy.

(2) **Bending** : Cold Bending is the process by which a straight length is transformed into a curved length. It is one of the most widely used forming process for changing plates into drums and curved channels.

(3) **Drawing** : Long components of uniform cross section can be produced by drawing. Drawing operation involves the forcing of metal through a die by means of a tensile force to the exit side of the die. Cold drawing require high ductility in the metal. It is used in the production of rod of various cross sections, wires and fuses.

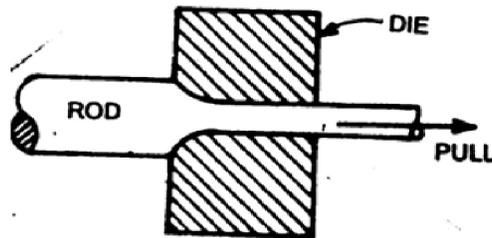


Fig. 7.6 Wire drawing

(4) **Spinning** : It is the process of forming thin metal by pressing against a form which is in rotation. It is similar to hot working except that the process takes place at room temperature. This process is suitable for soft metals.

(5) **Extrusion** : The process of cold extrusion is similar to that of hot extrusion except that the process takes place at room temperature. The metal which is to be extruded must possess the necessary ductility even at room temperature. The most popular method of cold extrusion is impact extrusion. In impact extrusion cold metal billet is placed in the die and ram drives the punch into die cavity as a result extruded part is formed.

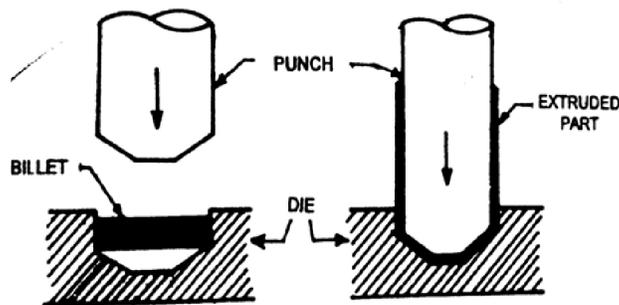


Fig. 7.7 Cold Extrusion

(6) Squeezing Operation : Squeezing operation involves the severe cold deformation. It requires greater amount of pressure to attain the desired shape which is confined to cavity of die and punch. The following squeezing operations are commonly used in metal working.

(a) Cold Heading (b) Cold reeding

(a) Cold heading : Basically it is a cold forging process for manufacture of headed components from ductile material. These components include bolts, screws, rivets and similar items.

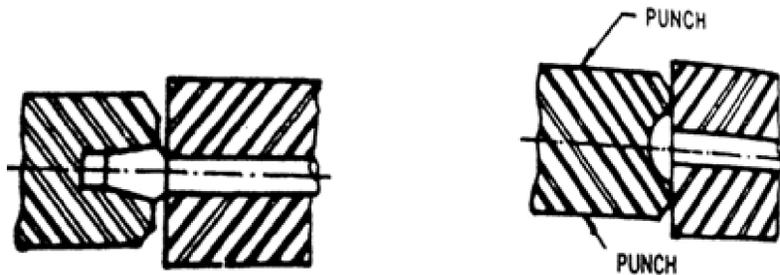


Fig. 7.8 Process of Cold Heading

(7) Reeding : It is process of indenting large quantities of steel shorts into the surface of metal. This is done by air blast or same mechanism means. Due to this indentation favorable compressive stresses are developed at outer layer. This increases fatigue strength of metal and at the same time its surface is slightly hardened and strengthened.

7.3 Advantages of Hot Working

- (1) Internal residual stress are not developed in the metal.
- (2) Mechanical properties are improved.
- (3) Maximum deformation is possible because of increased plasticity.
- (4) Power requirement for the process is less.

Disadvantages

- (1) Surface finish is poor
- (2) Close dimensional tolerance can be minimized.
- (3) Tooling cost is high.

Advantages of Cold Working

- (1) No oxidation and scaling results.
- (2) Smooth finish is possible.
- (3) Closer dimensional tolerances can be maintained.
- (4) Strength and hardness are increased.

Disadvantages

- (1) Internal stresses are relieved in the metal.
- (2) There is possibility of crack formation.
- (3) It requires high power
- (4) Only suitable for ductile materials.

Summary

1. Large number of parts are manufactured by metals forming techniques which involves the severe plastic deformation under the action of applied forces.
2. Hot working is done above recrystallisation temperature
3. Cold Working is done below recrystallisation temperature are usually at room temperature.
4. Important hot working processes are hot rolling, Extrusion, hot piercing etc.,
5. The coldworking processes are rolling, drawing, bending, squeezing, shearing

Short Answer Type Questions

1. Define hot and cold working
2. Define cold spinning
3. Explain hot extrusion

Long Answer Type Questions

1. Explain about any four hot working processes.
2. What are advantages and disadvantages of hot working over cold working ?

UNIT

8

Lathe

Learning Objectives

On completion of this unit a learner will be able to

- Know the working principle of lathe
- Draw the lathe diagram and identify its parts, and various operations
- State working principle of grinding
- Explain the application of grinding

8.1 Introduction

A lathe is one of the old and most important machine tools used in production. It operates on the principle of excess metal removal by using a cutting tool which is fed in to rotating work piece and can be given linear motion in the desired direction. The undesired excess material from the job is removed in the form of chips to obtain required shape and size.

Types of Lathe

- (1) Speed lathe
- (2) Engine Lathe
- (3) Bench Lathe
- (4) Capston and turret lathe
- (5) Tool room lathe
- (6) Automatic lathe

8.1 Lathe Main Parts

The main parts of lathe are a) Bed b) Head stock c) Tail stock
d) Carriage e) Tool post f) Lead Screw g) Feed rod.

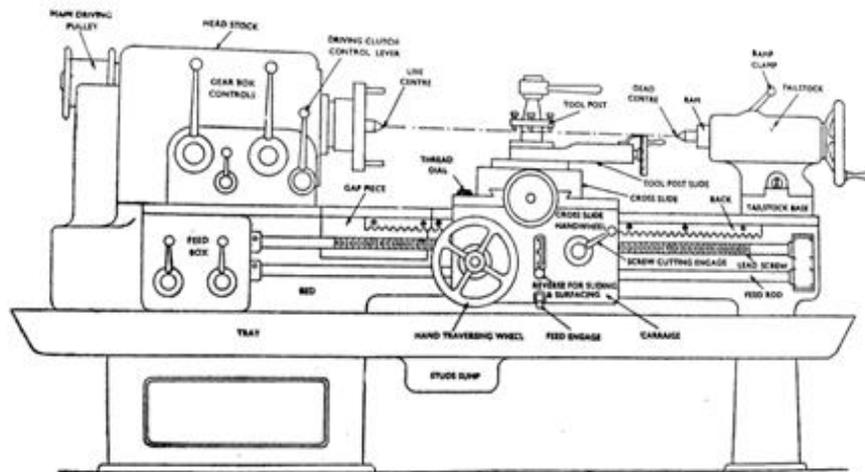


Fig. 8.1 Lathe Machine

(a) Bed

It forms the base of the machine and gives support to all the mountings of lathe and provides ways to facilitate movement of carriage and the tail stock. It has V-ways and flats surfaces are accurately machined to the give true alignment to the head stock, tail stock and carriage throughout length of the bed.

(b) Head Stock

Head stock is located permanently at the left side of the lathe bed. It contains lathe spindle, cone pulley, speed change gears, back gear and spindle driving mechanism.

(c) Tail Stock

The tail stock is located at the right hand end of the bed and consists of a body fastened to the base and the base is mounted on bed guide ways. The base can slide to facilitate the holding of work pieces of different lengths.

(d) Carriage

The carriage consists of a saddle and apron. The saddle slides on the guide ways and support the cross slide and compound rest. The apron is the part of the carriage facing the operator. It contains gears and feed clutches that transmits motion from the lead screw to carriage and cross slide. Compound rest is mounted on the cross slide and can be swiveled to required angle to produce taper.

(e) Tool Post

Tool post is located on the compound rest to hold the cutting tool.

(f) Lead Screw

The lead screw is used for thread cutting operation and it will be in the front side of the machine passing through carriage.

(g) Feed Rod

It is used for employing automatic feed.

8.2 Lathe Operations

The following operations are most common on lathe machines.

- | | | |
|-------------|-------------|-----------------|
| a) Turning | b) Facing | c) Reaming |
| d) Drilling | e) Knurling | f) Tapertuning. |

(a) Turning

Turning in a lathe is to remove excess material from the work piece to produce a cone shaped or a cylindrical surface. The various types of turning made in lathe work are 1) Straight turning 2) Shoulder turning 3) Step turning.

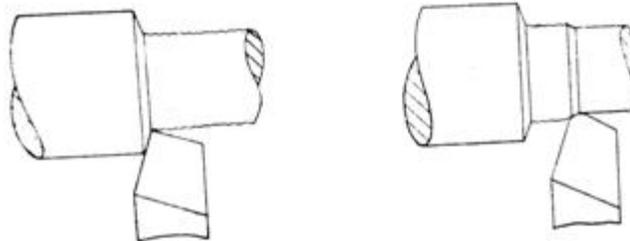
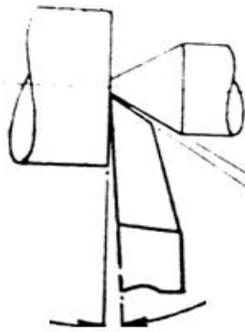


Fig. 8.2 Turning

(b) Facing

Facing is the operation of producing flat end surfaces that is normal to the axis of rotation. The movement of tool is perpendicular to the axis of work piece.

**Fig. 8.3 Facing****(c) Reaming**

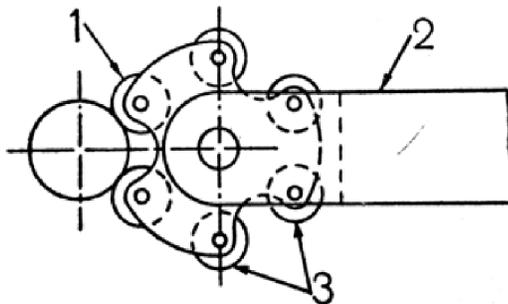
It is the operation of finishing and sizing a drilled or bored hole. The reamer is held in a tail stock spindle is fed slowly into the work which is revolving at very low speed.

(d) Drilling

It is the process of making holes on work pieces. The drill is held in tail stock spindle and fed slowly in to the work piece which is revolving in a chuck of the head stock

(e) Knurling

It is the process of indenting the various forms on cylindrical work surfaces by using a knurling tool which is pressed against the rotating work and the design of the knurl rolls over the work and will be reproduced on the work

**Fig. 8.4 Knurling**

(f) Taper Turning

A taper may be defined as an uniform increase or decrease in the cross section of a work piece measured along its length. A conical surface produced on lathe. In taper turning tool moves at an angle to the axis of rotation.

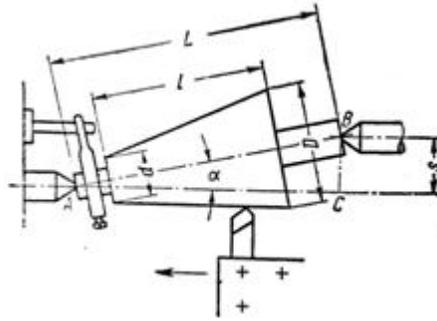


Fig. 8.5 Taper Turning

8.3 Grinding Machines

Working Principle

Grinding is a metal cutting operation performed by means of a rotating abrasive wheel that acts as a cutting tool. This is used to finish work piece which shows a high surface quality, accuracy of shape and dimension.

8.4 Grinding Wheel Materials

A grinding wheel is a multitooth cutter made up of many hard particles known as abrasives. The abrasive grains are mixed with a suitable bond, which acts as a holder when the wheel is in use. Abrasives may be classified in two principal groups a) Natural b) Artificial or manufactured.

(a) Natural : The natural abrasives include sand stone or solid quartz, emery, corundum and diamond. Sandstone or solid quartz is one of the natural abrasive stones from which grind stones are shaped. The quartz or cutting agent is relatively soft so that materials harder than quartz cannot be abraded rapidly.

(b) Emery : It is a natural aluminium oxide. It contains 55 to 65% of alumina, the remaining consists of iron oxide and other impurities.

Corundum : It is a natural aluminium oxide. It contain from 75 to 95% aluminium oxide. Both emery and corundum have a greater hardness and better abrasive action than quartz.

Diamonds : Diamonds of less than gem quality are crushed to produce abrasive grains for making grinding wheels.

Artificial :

- a) Silicon Carbide
- b) Aluminium Oxide

(a) **Silicon Carbide** : It is manufactured from 56 parts of silica sand, 34 parts of powdered coke, 2 parts of salt and 12 parts of saw dust in a along.

(b) **Aluminium oxide** : It is manufactured by heating mineral bauxite, a hydrated aluminium oxide clay containing silica, iron oxide, titanium oxide mixed with ground coke iron borings

8.5 Applications of Grinding

Applications of grinding include the grinding of external and internal cylindrical grinding, tapered and formed surfaces, gear teeth, threads and other using appropriate wheels.

Summary

1. Lathe operates on the principle that the excess metal is removed by using a cutting tool which is fed in to a rotating work piece.
2. According to design and construction the lathes are classified as i) Speed lathe ii) engine lathe iii) Tool room lathe iv) capston and turret lathe
3. Operations which are performed on the lathe are turning, facing, taper turning, drilling, boring and knurling
4. Grinding machine is used to finish the work piece to much higher accuracy and is performed by means of a rotating abrasive wheel that acts as a cutting tool.
5. Grinding wheel materials are two types ie natural and synthetic

Short Answer Type Questions

1. Explain the working principle of lathe
2. Name different lathe operations
3. Define knurling
4. Explain the principle of grinding
5. Name grinding wheel materials

Long Answer Type Questions

1. Draw a neat sketch of lathe and name the parts
2. Explain about any four lathe operations