JSS MAHAVIDYAPEETHA

FIRST YEAR B.E. WORKSHOP PRACTICE

(Common for all Branches)

DEPARTMENT OF MECHANICAL ENGINEERING

JSS SCIENCE AND TECHNOLGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING

MYSURU – 570006

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FIRST YEAR B.E. WORKSHOP PRACTICE

(Common for all Branches)

USN: ………………………………………………………………………………......

Name: ………………………………………………………………………………......

Class: ………………………………………………………………………………..

Roll No. : ………………………………………………………………………………

Year: ....

JSS MAHAVIDYAPEETHA

Sri Jayachamarajendra College of Engineering, Mysuru

Department of Mechanical Engineering

Vision of the Institution:

Be an international leader in engineering education, research and application of knowledge to benefit society globally.

Mission of the Institution:

- To synergistically develop high-quality manpower and continue to stay competitive in tomorrow's world.
- To foster and maintain mutually beneficial partnerships with alumni, industry and government through public services and collaborative research.
- To create empowered individuals with sense of identity

Vision of the Department:

Department of mechanical engineering is committed to prepare graduates, post graduates and research scholars by providing them the best outcome-based teaching-learning experience and scholarship enriched with professional ethics.

Mission of the Department:

M-1: Prepare globally acceptable graduates, post graduates and research scholars for their lifelong learning in Mechanical Engineering, Maintenance Engineering and Engineering Management.

M-2: Develop futuristic perspective in Research towards Science, Mechanical Engineering Maintenance Engineering and Engineering Management.

M-3: Establish collaborations with Industrial and Research organizations to form strategic and meaningful partnerships.

Program Outcomes (POs):

Engineering Graduates will be able to:

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

WORKSHOP PRACTICE

Subject Code	**ME16L/ME26L**	**No. of Credits**	**0 - 0 – 1.5**
No. of Practice Hours / Week	**3**	**Exam Hours**	**--**
Total No. of Contact Hours	**39**	**CIE**	**50**

Course objectives:

1. To identify tools, work material and measuring instruments useful for fitting, welding, carpentry and plumbing practice.
2. To handle tools and instruments and use them to prepare joints of specific shape and size.

Course Content

Practice sessions: **06 Hrs**
Identification of tools and equipments for bench work-practice, safety practice and general guidelines.

Fitting Practice: **03 Hrs**
Demonstration, usage of tools, finishing and sizing MS-flats.

Model-1 **03Hrs**
Cutting and Filing.

Filing, Measurement and Finishing. **03 Hrs**

Welding Practice: **03 Hrs**
Demonstration of tools and equipment for welding, safety practices and general guidelines.

Model-2 **03 Hrs**
Lap and Butt Joints.

Carpentry Practice: **03 Hrs**
Demonstration of power tools and equipment for carpentry, safety practices and general guidelines.

Model-3 **03 Hrs**
Cutting, Plaining and Sizing.

Measurement And Finishing. **03 Hrs**

Plumbing Practice: **06 Hrs**
Demonstration – plumbing tools, symbols and joints.

Model–4

Joining GI pipes by threading, PVC pipes by gluing and cementing. **03 Hrs**

Text Books:

1. Elements of Mechanical Engineering - Hajra Choudhury & others, Media Promoters 2010.
2. The Elements of Workshop Technology - Vol I & II, S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, 11th edition 2001 others, Media Promoters and Publishers, Mumbai.

Reference:

1. Workshop manual prepared by Department of Mechanical Engineering.

Course outcomes:

At the end of the course students shall have the ability.

CO1	To select suitable tools and equipment to prepare joints using bench-work tools.	PO1, PO3, PSO1, PSO2, PSO3
CO2	To produce joints using materials of specific shape and size by a suitable set of operations and check the accuracy of shape and dimensions using	PO1,PO3, PO5, PSO1, PSO2, PSO3

Course Articulation Matrix

CO s	CO %	**PO s and PSO s Mapping**														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3		3										3	3	3
CO2		3		3		3								3	3	3
Total																

CONTENTS

CHAPTER 4: CARPENTRY

CHAPTER 1

FITTING

Manufacturing processes are broadly classified into four categories; (i) Casting processes, (ii) Forming processes, (iii) Fabrication processes, and (iv) Material removal processes.

In all these processes, components are produced with the help of either machines or manual effort. The attention of a fitter is required at various stages of manufacture starting from marking to assembling and testing the finished goods.

Working on components with hand tools and instruments, mostly on work benches is generally referred to as 'Fitting work'. The hand operations in fitting shop include marking, filing, sawing, scraping, drilling, tapping, grinding etc., using hand tools or power operated portable tools. Measuring and inspection of components and maintenance of equipment is also considered as important work of fitting shop technicians.

The term "bench work" generally denotes the production of a part by hand on the bench. "Fitting" is the assembling of the parts together by removing materials from the parts to secure the necessary fit, and may or may not be carried out at the bench. There is no clear meaning between these two terms hence it is used rather loosely. Both these two types of work require the use of large number of tools and equipments and involve number of operations to finish the work piece to desired dimensions, shape.

The operations that are carried out on bench and fitting work may be classified as:

1. Marking out
2. Sawing
3. Chipping
4. Filing
5. Scraping
6. Grinding
7. Drilling
8. Reaming
9. Tapping
10. Dieing

1.2 Fitting Tools

The tools used in fitting work may be classified into the following groups.

1. Job Holding Device
2. Striking tools
3. Cutting tools
4. Measuring, marking and testing tools

1.2.1 Job Holding Device

VICES

The vice is the most common tool for holding work. Various types of vices are used for various purposes. They include bench vice, leg vice, pipe vice, hand vice, pin vice and toolmaker's vice.

Bench vice : The most commonly used is the engineer's parallel-jaw bench vice, Sometimes called fitter's vice. It must be firmly fixed to the bench with nuts and bolts. The vice essentially consists of cast iron body, a fixed jaw, a movable jaw-both made of cast steel, a handle, a square-threaded screw, and a nut-all made of mild of mild steel. Separate cast steel plates known as jaw plates are fixed to the jaws by means of set screws and they can be replaced when worn. The holding faces of the jaw plates have teeth for holding the work firmly but this has some disadvantage for soft metal which may be damaged when firmly held between the faces. Protective grips of 'clamps' which can be made of lead, fibre, tin-plate, etc. are, therefore, usually fitted over the jaws to prevent the serrations damaging the surface of the finished work. The movement of the vice is caused by the movement of the screw through the nut fixed under the movable jaw and the screw is provided with a collar inside to prevent it from coming out of the jaw when revolved.

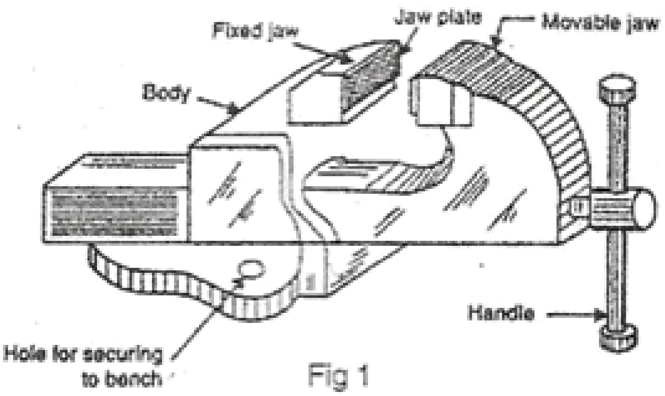


Fig 1

The height of the bench should be such that the top of the vice jaws is at about the same height as the operators elbow as shown in fig. (2). The size of the vice is given by the width of the jaws and the opening between the jaws. The width suitable for common work varies from 80 to 140mm, the maximum openings being 95 and 180mm.

Leg vice : The leg vice is used by blacksmiths but it is also suitable for heavy hammering, chipping and cutting in fitter's work. The vice is secured to the top of bench by a strap which is fastened to a plate bolted to the bench top. The leg of the vice is fastened to the bench leg with staples and its ends fit into a hole in the floor. This construction of the vice makes it suitable for heavy work. One disadvantage of this type is that jaws come together like the arms of a letter "V", and therefore don't provide such a firm grip as the parallel jaw type.

Pipe vice : The pipe vice shown in Fig. 3 is used for holding round section metal, tubes, pipes, etc. In this case, the screw is vertical and the movable jaw works vertically, it grips the work at four points on its surfaces.

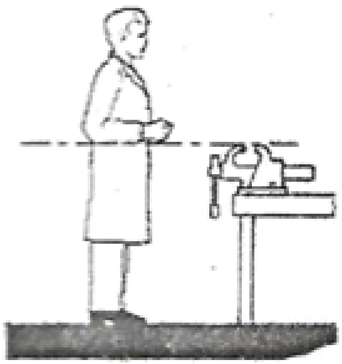


Fig. ^

Hand vice : The hand vice is used for gripping screws, revets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. This is made in various shapes and sizes. The length varies from 125 to 150mm and the jaw width from 40 to 44 mm.

A typical hand vice is shown in Fig. 4 It consists of two legs made of mild steel which hold the jaws at the top and are hinged together at the bottom. A flat spring held between the legs tends to keep the jaws open. The jaws can be opened and closed by a wing nut which moves through a screw that is fastened one leg and passes through the other.

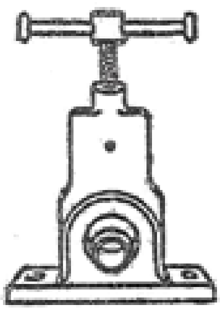


Fig. 3

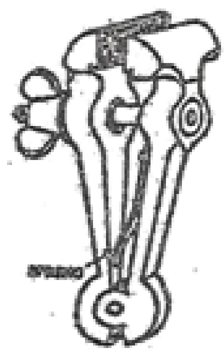


Fig. 4

Care of vice :-

The Following points should be kept in mind while using a vice.

1. The vice should be kept clean and free from dust and metal chips using a brush.
2. The threads and the nut should be occasionally oiled.
3. The vice should never be used as an anvil.
4. For holding tubes, temporary wooden blocks should be used. The serrated jaws should be covered with soft metal clamps when finished work is held.

1.2.2. Striking tools

HAMMERS

Hammers are used to strike a job or a tool. They are made of forged steel of various sizes (weights) and shapes to suit various purposes. A suitable range would be from 0.11 to 0.33 kg for light work such as clinching small rivets and dot punching; 0.45 kg for chiseling, 0.91 kg for heavier work such as chipping, the popular sizes for bench work being 0.33 and 0.45 kg.

A hammer consists of four parts namely peen, head, eye and face as shown in Fig. 5. The eye is normally made oval or elliptical in shape and it accommodates the handle or shaft. The face is hardened and polished well, and is slightly convex, instead of flat to avoid spoilage of the surface of the metal to be hammered by the sharp edge of the flat surface.

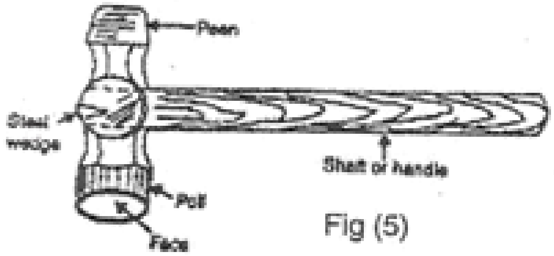


Fig (5)

1) Ball peen hammer

The ball peen hammer is the most common form of hammer used in fitting work. As shown in fig. (6). Here the peen has a shape of a ball which is hardened and polished. This type of hammer used for chipping and reverting. The size of this hammer varies from 0.11 to 0.91 kg.

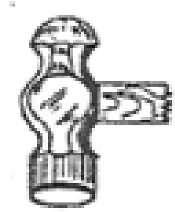


Fig. 6

2) Cross-peen hammer

The cross peen hammer as shown in fig. (7). is similar to ball peen hammer in shape and size except the peen is like a wedge which is perpendicular to the handle. This is mainly used for bending, stretching, hammering into shoulders, inside curves etc. The size of this hammer varies from 0.22 to 0.91 kg.

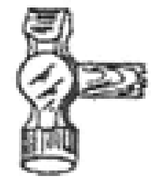


Fig. 7

3) Straight peen hammer

The straight peen hammer as shown in fig. (8), has its peen straight or parallel to the handle. The width of the peen is usually equal to the diameter of the face. This is used for stretching or penning the metal. The size of this hammer varies from 0.11 to 0.91 kg.

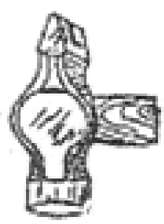


Fig. 8

4) Double faced hammer

The double faced hammer, as shown in fig. (9), it consists of a head which has two identical faces at both ends. It is used for striking up tools for riveting.

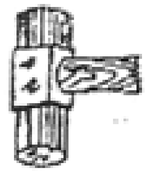


Fig. 9

5) Soft hammer

The soft hammer as shown in fig. (10), is necessary to strike metal, a blow with the minimum damage to the surface. The soft hammers are commonly known as mallet. The mallet heads go by the numbers or by the diameter of the head. They are made of raw hide, hard rubber, copper, brass, lead, wood etc.

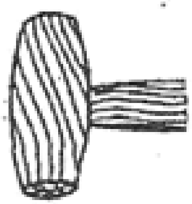


Fig. 10

1.2.3 Cutting tools : The chief cutting tools used in fitting are

1) Cold chisels

2) Files

3) Hacksaws

1) Chisels : There are two kind of chisels based on their use.

The chisels which are used to cut the metals in cold state is called cold chisels. The chisels which are used to cut the metals is hot state is called hot chisels.

a) Cold chisels

Fig (11)

The cold chisels is an important cutting tool used by the fitter as shown in fig. (11), These are used to cut the cold metal and are made by forging from cast tool steel usually rectangular, hexagonal or octagonal cross section. The lengths of the chisels is about 15cm to 20cm and the tapered part is from 5cm to 8cm long. 10mm to 25mm thick material. They are forged to shape, roughly ground, and then hardened and tempered. The cutting angle given to the chisel is determined mainly by the nature of the metal to be chipped. It varies between 35º and 70º, the less acute angles being for the harder and tougher metals. These are used to remove surplus metal from surfaces of metal.

There are various types of chisels commonly used for fitting are

1) Flat chisel

2) Cross cut chisel

3) Diamond point chisel

1. Flat chisels

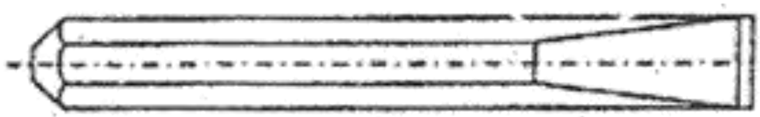


Fig (12)

The flat chisel as shown in fig. (12) which is used for most of the general chipping operations and it is the most common type of chisel used in fitting of jobs. It has a wide cutting edge about 16mm to 32mm and is slightly rounded to prevent the corners from digging into the metal the length of the chisel varies from 100 mm to 400mm. It is used for chipping flat surfaces, cutting of sheet metal, cutting bars and rivets.

2. Cross-cut chisel

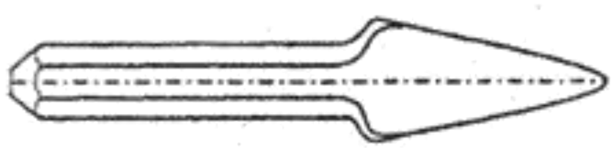


Fig (13)

The cross cut chisel as shown in fig. (13), it is sometimes called cape chisel. It has a cutting edge about 4mm to 12mm wide from the edge, the metal thickness tapers off slightly. This is to permit the chisel to clear when a groove is being cut. It is widely used for cutting groove in large surfaces before using the flat chisel. It is also used for cutting key ways in wheels and shafts.

3. Diamond pointed chisel :-

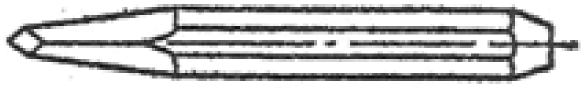


Fig (14)

The diamond pointed chisels as shown in fig. (14) has a cutting edge shaped like a diamond. The width of the cutting edge varies from 6mm to 10mm and length varies from 100mm to 400mm. It is used to cut v-grooves chip square corners and squaring small holes.

2) Files :-

The most widely used hand tool to be found in an engineering workshop is the file.

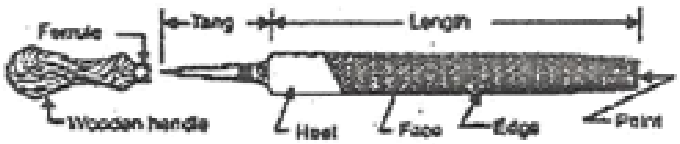


Fig (15)

A file is a hardened piece of high grade steel with slanting rows of teeth. It is used to cut smooth or fit metal parts. It cuts all metals except hardened steel and it cuts only on the forward stroke. It consists of body with a tang for fixing into the wooden handle. The teeth are cut on the body which are hardened and tempered. The tang is tempered to make is soft and tough the various parts of the file are shown in fig. (15), the metal ring on the file handle is called ferrule, in order to prevent splitting of the handle.

The size of the file is indicated by its length, it is distance from the point to the heel without tang. The length of the file, in general use, is 200mm to 450mm and 100mm to 200mm for finer work.

The files according to the cut of the teeth, are divided into 2 groups

1) Single cut files b) Double cut files

In single cut files, the teeth are cut parallel to each other running across the faces and at an angle of 60º to the centre line of the file as shown in fig. (16). These files are particularly used for very hard metals.

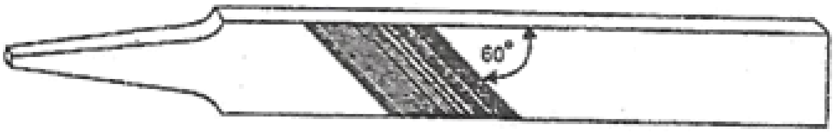


Fig. (16)

In double cut files, there are two sets of teeth. The first set of teeth are similar to those of single cut files that is at 60º to the centre line of the file while the second set of teeth are cut diagonally across the first set of teeth at an angle of about 80º to the centre line of the file as shown in fig. (17). It cuts only on the forward stroke. It removes metal faster and is used for general work.

Fig. (17)

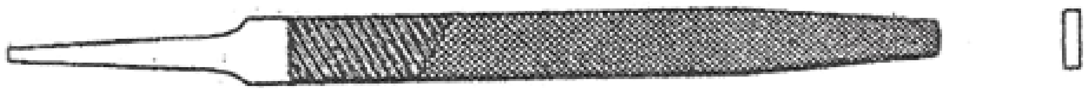
Single cut and double cut files are further divided according to the coarseness or spacing between the rows of the teeth. In descending order of roughness they are listed as :

1. Rough (R)
2. Bastard (B)
3. Second cut (SC)
4. Smooth (S)
5. Dead smooth (DS)
6. Super smooth (SS)

Types of files : The files, according to their shape or cross section are classified as

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

1) Flat file



Fi. (18)

A flat size as shown in fig. (18) is parallel for about two thirds of its length and then tapers in width and thickness. It has double cut on both faces and single cut on both edges. It is most widely used to general work and for filling flat surfaces.

2) Hand file

Fig. (19)

A hand file as shown in fig. (19) has its width parallel throughout, but it's thickness tapers. The both faces are double cut and one edge single cut. The uncut edge is called the safe edge and it prevents cutting into one face of a square corner the other face is being field. It is used for general surfacing working, more particularly for filling steps or shoulders to square work without touching and apoining the adjacent surface, already made rule.

3) Square file

Fig. (20)

A square file, as shown in fig. (20), is parallel for two-thirds of its length and then tapers towards the tip. It is double cut on all sides and is used for filling square corners and slots.

4) Triangular file

Fig. 21

A triangular file, a shown in fig. (21) has width either parallel through out or upto middle and then tapered towards the tip. It's cross section is triangular or equilateral and the 3 faces are double cut and edges single cut. It is used for filing square shoulders or corners and for sharpening wood working saws.

5) Round file

Fig. 22

A round file as shown in fig. (22) has round cross section. A file with width parallel throughout is called parallel round and the file with width parallel upto middle and then tapering towards the tip is called rat file. The round files are usually double cut. The round files are used for opening out holes, producing round corners, round-ended slots etc.

6) Half round file

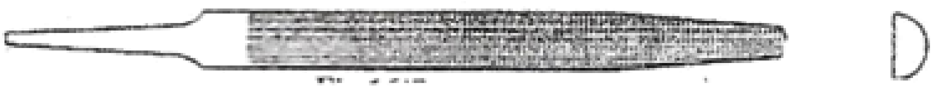


Fig. 23

The half round file as shown in fig. (23), is not a true half circle but is only about one-third of a circle the width of the file is either parallel throughout or upto middle and then tapered towards the tip. The flat side of this file is always double cut and curved side has single cut. It is used for filling curved surfaces.

Specification :- When ordering a file following informations should be given :

1. Length, say, 100mm
2. Shape, say, flat
3. Single or double cut
4. Roughness, say, bastard

Care of files :-

The following points should be kept in mind while using files.

1) The file should not be used without handle or with loose fitting handle.

2) A file should never be used on hardened steel, hard surface scale or allowed to strike against.

3) The new file should be used first on copper, brass and then on wrought iron and mild steel.

4) The file should not be allowed to rust and to prevent it, the file is coated with machine oil. Before using the file, the oil should be removed with carbon tetrachloride or caustic soda.

5) The worn-out files may be reused by dipping it in hydrochloric acid.

3) Hacksaw

The Hacksaw is the chief tool used by the fitter for cutting rods, bars and pipes into desired lengths. It is used for sawing all metal except hardened steel. It consists of a metal frame, which may be solid as shown in fig. (24), or adjustable as shown in fig. (25). The solid frame in which the length cannot be changed and the adjustable frame which has a back that can be lengthened or shortened to hold blades of different length. The blade fits over two pegs which project from the pins sliding in the ends of the frame. The wing nut at the front end to the frame is for tensioning the blade. The blades are made of carbon or high-speed steel and may be finished with the cutting edge only hardened or they may be hard all over. The blades are specified by its length and the point or pitch. The length of the blade is the distance between the outside edges of the holes which fit over the pins. The most usual blade for hand work is 250mm long and 12.5mm wide. The point or pitch is measured by the number of teeth per 25mm length.

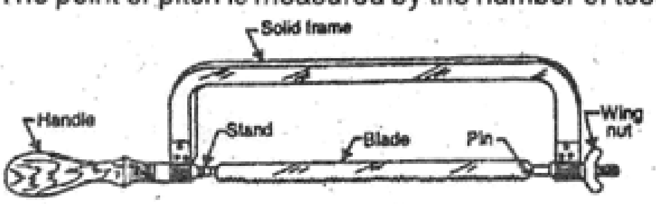


Fig. 24

The choice of the blade for any particular class of work depends upon the pitch of the teeth atleast two or three teeth should be in contact with the surface being sawn. The best allround blade for hand use is one with 16 to 18 teeth per 25mm.

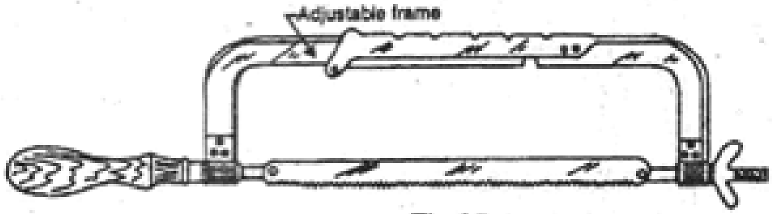


Fig 25

1.2.4 Measuring & Marking Tools :-

1. Calipers : Calipers are the devices used for measuring and transferring the inside or outside dimensions of components.

Four types of calipers generally used. The are

(i) Outside calipers

(ii) Inside calipers

(iii) Spring calipers

(iv) Hermaphrodite calipers

(i) Out side calipers

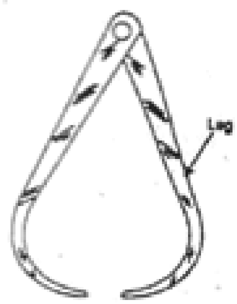


Fig 26 (a)

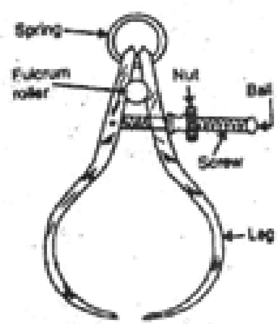


Fig 26(b)

An outside caliper . a two legged steel instrument with its legs bent inwards as shown in fig. 26(a). It is used for measuring or comparing thickness, diameters and other outside dimensions. A steel rule must be used in conjunction with them. If a direct reading is desired.

(ii) Inside calipers

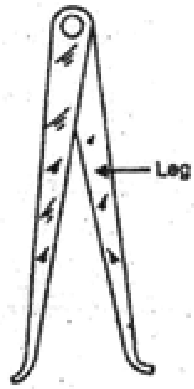


Fig 27(a)

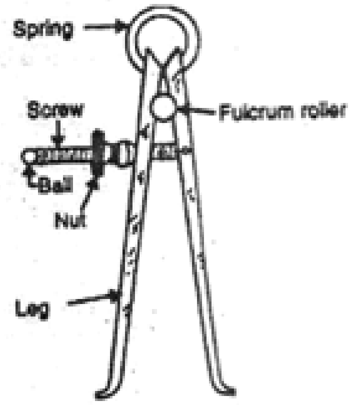


Fig (b)

These are similar to outside calipers, the only difference being that the legs are bent outwards. as shown in fig 27(a). These are used to set internal dimensions, to transfer them to work or check with standards. To obtain a specific reading steel scale must be used.

(iii) Spring calipers

For finer work the use of spring caliper (fig. 26(b) and 27(b) both outside and inside advocated. A loop spring on top of the joint between the two legs applies force bending to separate the legs at the bottom. An adjusting screw and nut keep the legs in position. When a spring caliper is applied to an object. It must make sure contact but not be forced.

(iv) Hermaphrodite caliper

It is also called odd-leg caliper. It has one pointed leg like a divider and one bent let as shown in fig. (28). The caliper is useful for scribing lines parallel to the edge of the work and for finding the centre of a cylindrical work.

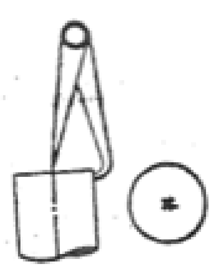


Fig. 28

2. Divider

A divider is an important instrument used for marking work. It is similar to calipers but it's legs have sharp points as shown in fig. (29). The most common type of the divider used in fitting have spring arrangement. The dividers are used for measuring the distance between two points dividing a given length in a definite ratio, drawing circles and arcs and transferring dimensions from scales to objects.

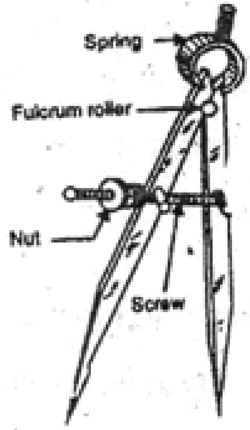


Fig. 29

3. Surface plate

The surface plate as shown in Fig. 30 is used for testing the flatness of work itself and is also used for marking-out work. This is used for small pieces of work while the marking-out table is used for larger jobs.

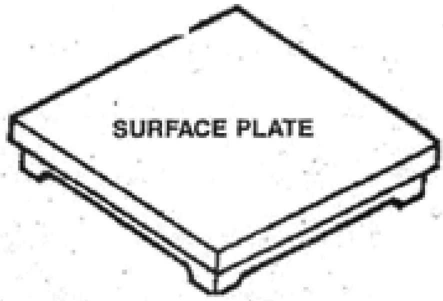


Fig. 30

Surface plates are made of grey cast iron. They should be well and reflection-free illuminated and rest horizontally on a firm support, the working height being about 800mm from the floor. The marking-out surface must be protected from rust and dirt and wiped clean and smeared with grease or oil after use. They are made in two grades of accuracy A and B grade. A surface plates are scraped to within. 0.005 mm of flatness while grade B plates are 0.02mm of flatness.

4) Scriber

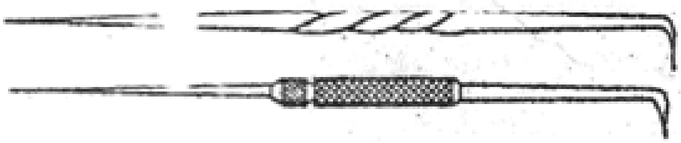


Fig. 31

The scriber as shown in Fig. (31) is a piece of hardened steel about 150 to 300mm and 3 to 5mm in diameter pointed one or both ends like a needle. It is held like a pencil to scratch or scribe lines on metal. The bent end is used to scratch line in places where the straight end cannot reach. The ends are sharpened on an oilstone when necessary.

5) Scribing blocks

These have round or rectangular base blocks made of cast iron. They are also known as universal surface gauge. It consists of a cast iron base perfectly machined and planed at the top, bottom and all sides. It carries a spindle which may be set at an angle. A scriber, which may be also be set at any angle or at any height, is clamped to the spindle as shown in fig. (32), normally used in conjuction with a surface plate to scribe line at specified heights. It is used for checking parallelism of work, for scribing lines at specified heights and for marking out parts that have to be fitted or machined.

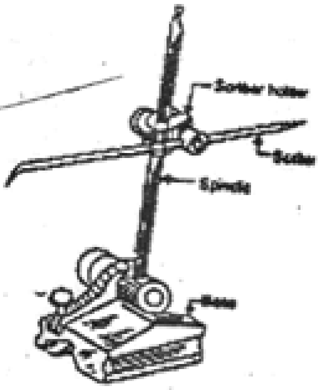


Fig. 32

6. Punches

A punch is used in a bench work for marking out work, locating centers, etc. in a more permanent manner. Two types of punches are used : (1) prick punch, and (2) centre punch. The prick punch fig. 33(b) is a sharply pointed tool. The tapered point of the punch has an angle of usually 40". It is used to make small punch marks on layout lines in order to make them last longer.

The centre punch [fig 33(a)] looks like a prick punch. Its point has an angle more obtuse than that of the prick punch point, this angle usually being 60º The centre punch is used only to make the prick-punch marks larger at the centers of holes that are to be drilled, hence the name centre punch. A strong blow of the hammer is needed to mark the point.

In this body portion the punch is a steel rod 90 to 150mm long and 8 to 13mm in diameter.

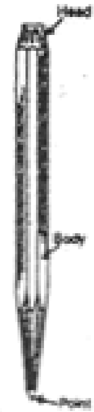


Fig. 33(a)

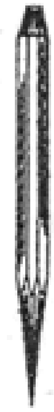


Fig. 33(b)

7. V-BLOCK :-

The V-block is a block of steel with V-shaped grooves (fig.34). 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. For cylindrical work, several blocks of the same size are used as set.

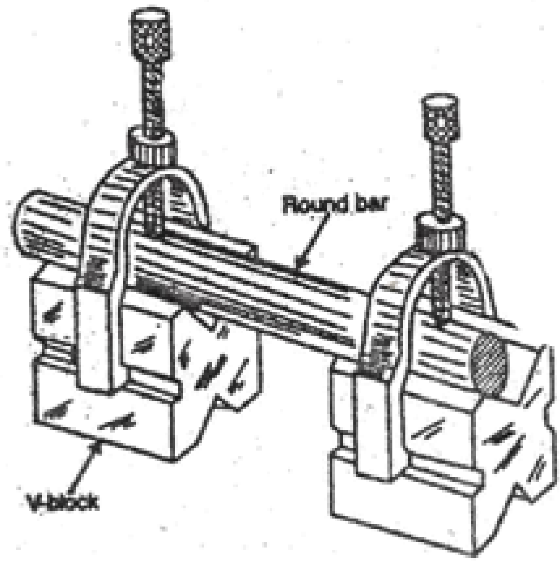


Fig. 34

8. ANGLE PLATE

The angle plate [fig(35)] which is made grey cast iron has two plane surfaces at right angles to each other. This is used in conjunction with the surface plate for supporting work in the perpendicular position. It has various slots in it to enable the work to be held firmly by bolts and clamps.

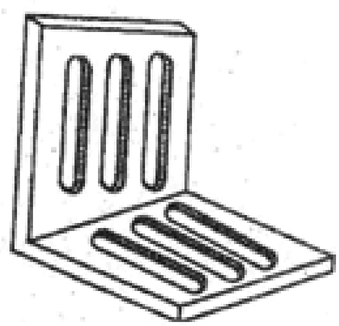


Fig. 35

9. TRY-SQUARE

The try square as shown in Fig. 36 is made in one piece, both blade and beam. This is used when it is necessary to get another edge or surface exactly at right angles to an already trued edge or surface and also for laying out work. The squares of any square may be tested by placing the beam of the square against a straight edge with the blade resting on a smoother surface. While in this position a line may be scribed along the edge of the blade.

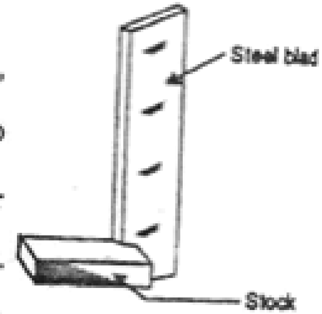


Fig. 36

10) Combination set

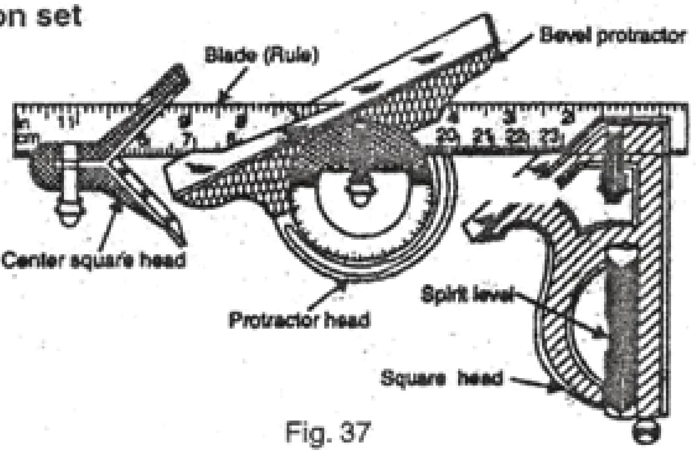


Fig. 37

It is an externally useful tool. It incorporates all the essential features of the try square, protractor, spirit level, steel rule and scriber. The combination set, as shown in fig. (37), consists of 4 parts i.e. square head, protractor head, centre square head and a blade or rule on which the other 3 parts slide. They are located in a groove in the blade and tongue in the head to which the clamping screw is attached. The protractor and square heads are usually provided with spirit levels. The square head has a small scriber concealed in the end. The square head can be used by moving the blade, as a try square, as a meter square or even as a depth gauge. The centre square head may be used to extend a line around a corner, to find centre of a round piece or to find the centre at the end of a shaft. The protractor head is used to measuring angles and can be clamped in any desired position. The scale is graduate in degrees.

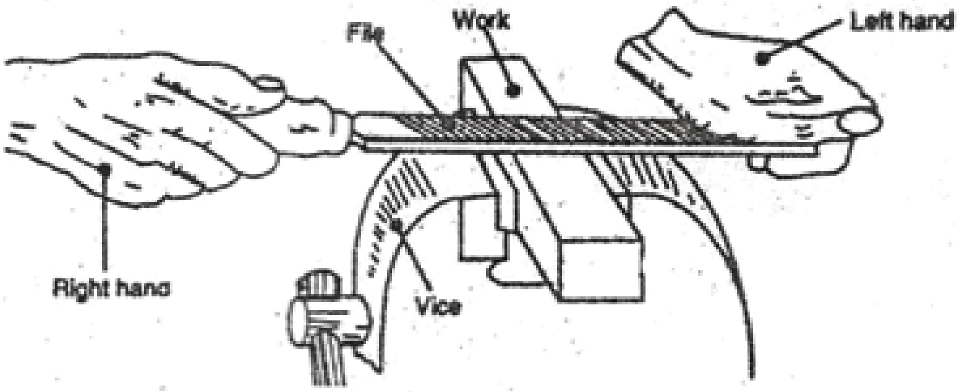


Fig 38

1.3 FILING :-

Filing is the most important operation that a metal worker has to learn. Filling is usually an after-treatment and usually done after chipping. It serves to remove the burr from the cuts and clean the face of the cuts, and to finish the final shape of a workpiece. In general no more that 0.6mm tooling allowance should be left for filling. Filling allows work to be made accurate to 0.05mm, in some cases to 0.02mm, and even to 0.01mm.

It should be noted that the file cuts only on the forward stroke, hence if required the file can be lifted off the work for the return stroke. As a rule, however, the file is allowed to remain on the work during the return stroke. But the pressure from the left hand is released. Filling should always be carried out with the file making the longest possible strokes so that all the teeth of the file receive even wear. The file should also be moved across the work with slow steady strokes (50 to 60 percent minute), taking care to keep it horizontal, and covering the whole of the filling area at each stroke.

1.3.1 Methods of filing

There are three main methods of using a hand-flat file.

(i) CROSS FILING :-

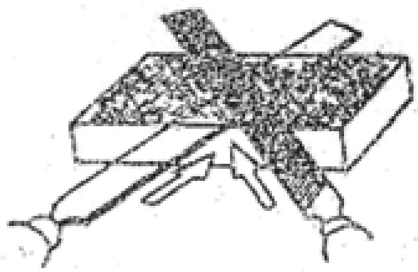


Fig. 39

In cross-filling the file strokes run alternately from the right and from the right to the left as shown in fig. 39. This is the commonest form of filling and the one used for general shaping. In this method the possibility of rounding is minimized, and the score marks made in the work by the file teeth are criss-crossed so that maximum amount of metal is removed. The aim in cross-filling is always to move the whole of the file surface across the whole of the work surface in one stroke.

(ii) STRAIGHT FILING :-

In straight-filing the file is pressed forward approximately at right angles to the length of work. On the back stroke, the file should be lifted clear of the work in order not to blunt the teeth straight-filing is specially useful on long and narrow piece of work whose width is less than that of the file.

(iii) Draw Filing :-

In draw-filing the handle of the file is not held. Instead, both hands are placed to close together on the blade as shown in Fig. 40. The file is placed at right angles across the work while the hands, and especially the thumbs, grip the file and move it up and down the length of the metal. It does not remove much material, but a smoother cutting action is achieved that with cross or straight-filing.

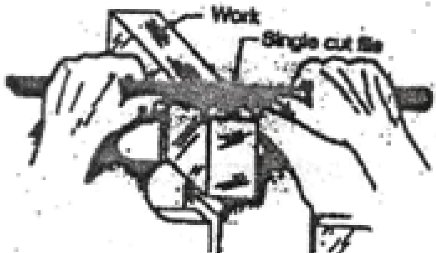


Fig. 40

Care of Files

Files are very brittle and should be placed thoughtfully in the bench well in such a way that do not rub or knock against other tools, especially those of cast steel. Similarly, the file should never be used on hardened steel, or hard surface scale such as cast iron skin, or allowed to strike against the hardened vice jaws. When not in use, the files are protected from rust by coating them lightly with machine oil. Before using the file, the oil should be removed with carbon tetrachloride or caustic soda. Make sure that the handle is firmly fixed to the file.

New files are generally first used on copper, brass, and later on wrought iron and mild steel.

1.4 Marking

The marking on a work is the most important operation in the bench work in order to obtain an accurately finished product. It consists of setting out the dimensions on a work from the working drawing. The marking operation consists of following steps.

1) First of all, the surface of the work is coated with a paste of chalk and allowed to dry.
2) If the work is flat, the uncoated face is normally supported against an angle plate keeping the surface to be marked at right angles to the surface of the surface plate.
3) Now the horizontal lines are fist scribed by means of scribing block or surface gauge. The vertical lines are draw by turning the work through 90º
4) The circles and arcs on a flat surface are market by means of a divider.
5) After the scribing work is over, light indentations are made along the scribed lines, centers of circles and arcs by means of a centre punch and a hammer. These punch marks serve as a guide for further operations like filing, chipping, drilling etc.

1.5 Sawing

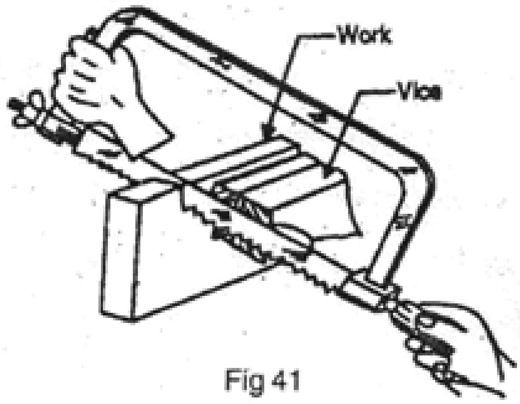


Fig 41

Hacksawing (fig.41) is the quickest method of severing, shaping and slotting cold metal. The work to be sawn should be held tightly in the vice. As a rule, the workpiece must be held in such a way that the marking line is situated a few millimeters to the left of the vice jaws. The blade is hung on two slightly hooked pegs projecting from pins which fit into each end of the frame. The blade is made tight by screwing a wing nut on the leading pin. The blades are fixed with the teeth facing forward for work on the forward stroke.

Placing the saw on the work with the right hand on the handle and the left hand on the other end of the saw frame firmly, the sawing should begin with a backward stroke. The pressure is applied on the forward stroke and a little life is necessary on the return stroke, because the blade cuts only on the forward stroke. Clean starting cuts can be achieved by first filing a notch close to the working ling (a distance of about 0.5mm therefrom) on the side of the piece which will fall off, using a triangular file to this end. Then the saw will be able to enter the material with some guidance. Further be sure to begin sawing with short stokes and to apply the saw in a position somewhat inclined to the workpiece. Make almost all the blade do the cutting and make about 50 strokes per minute.

1.6 Chipping

Chipping is the process of removing thick layers of metal by means of cold chisels. In chipping work, the Job is firmly held in a vice and the metal is removed by striking the chisel on to the surface of the workpiece by a hammer. When chipping, the chisel should be held chiefly with the second and third fingers, the index being relaxed. The hammer shaft should be grasped at the end, and when in use should be brought up square with the body and nearly to the shoulder to ensure sufficient power in the blows. The angle the chisel should be held at in relation to the work depends to some extent upon its cutting angle, but can be best determined by actual practice. This should be at such an angle with the work that an even chip of right depth can be obtained at ease.

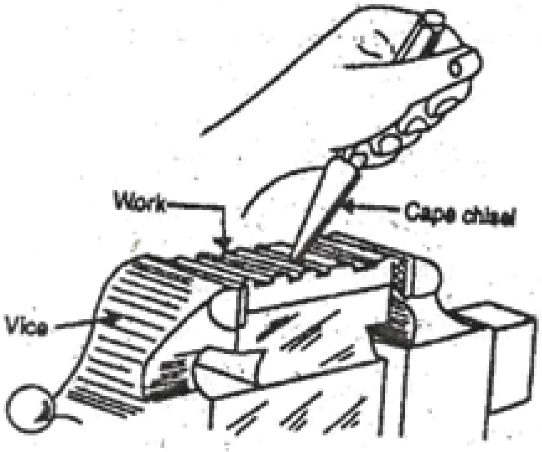


Fig 42

If the surface to be chipped is too long it is advisable to cut grooves along the whole surface by a cross-cut chisel as shown in Fig. 42 and then chip away the rest of the metal. In removing large volume of metal frequent lubrication of the cutting edge will be necessary to ensure long tool life and to make the cutting action quicker and smoother. While chipping, the operator should always keep his eyes on the cutting edge of the tool and not on its head. The process includes cutting key ways. Forming grooves, slots, oil channels, etc.

1.7. Material used in fi ng shop

Mild steel is a common material used in fitting shop. Steel is an alloy of iron and carbon steels and classified based on the amount of carbon they contain. There are 3 types of steel.

1) Low carbon steel 2) Medium carbon steel 3) High carbon steel

The medium carbon steels are called as mild steel.

1.8 Safe and correct practices in fitting shop

The following are some of the safe and correct work practices in bench work and fitting shop are

1) Position of the work piece area such that the cut to be made is close to the vice this practice prevents springing, saw breakage and personal injury.
2) Apply force only on forward stroke, relieve the force on the return stroke while sawing operation.
3) Cut a small groove with a file in sharp corners, where saw cut is to be started. The groove permits accurate positioning of the saw and also prevents stripping of the teeth.
4) Use a file with properly fitted tight, handle.
5) Examine the hammer each time before it is used. The handle must be securely wedged.
6) Remove sharp projecting edges and burns which produce inaccuracies in layout, measurement errors and improper fits.

1.9 Steps to prepare a model in fitting shop

1) Check the work piece for flatness and squareness using try square. If not size to the required dimension.
2) File gently the flat surface.
3) Apply the chalk powder on the flat surface.
4) Using marking tools mark all the dimensions.
5) Punch the marked line using centre punch and ball peen hammer.
6) Remove the unnecessary portion by using hacksaw blade and frame.
7) Chip the required portion if needed.
8) File to the required dimension and interminately check for dimension for a proper fit that is one metal should fit properly on the other metal.

CHAPTER-2

WELDING

2.1 INTRODUCTION

Welding is a process of joining similar metals by application of heat with or without application of pressure and addition of filler material. The results is a continuity of homogeneous material, of the composition and characteristics of two parts which are being joined together. Welding is extensively used in the fabrication work in which metal plates, rolled steel sections, castings of ferrous materials are joined together it is also used for repairing broken, wornout or defective metal parts.

2.2 Types of Welding

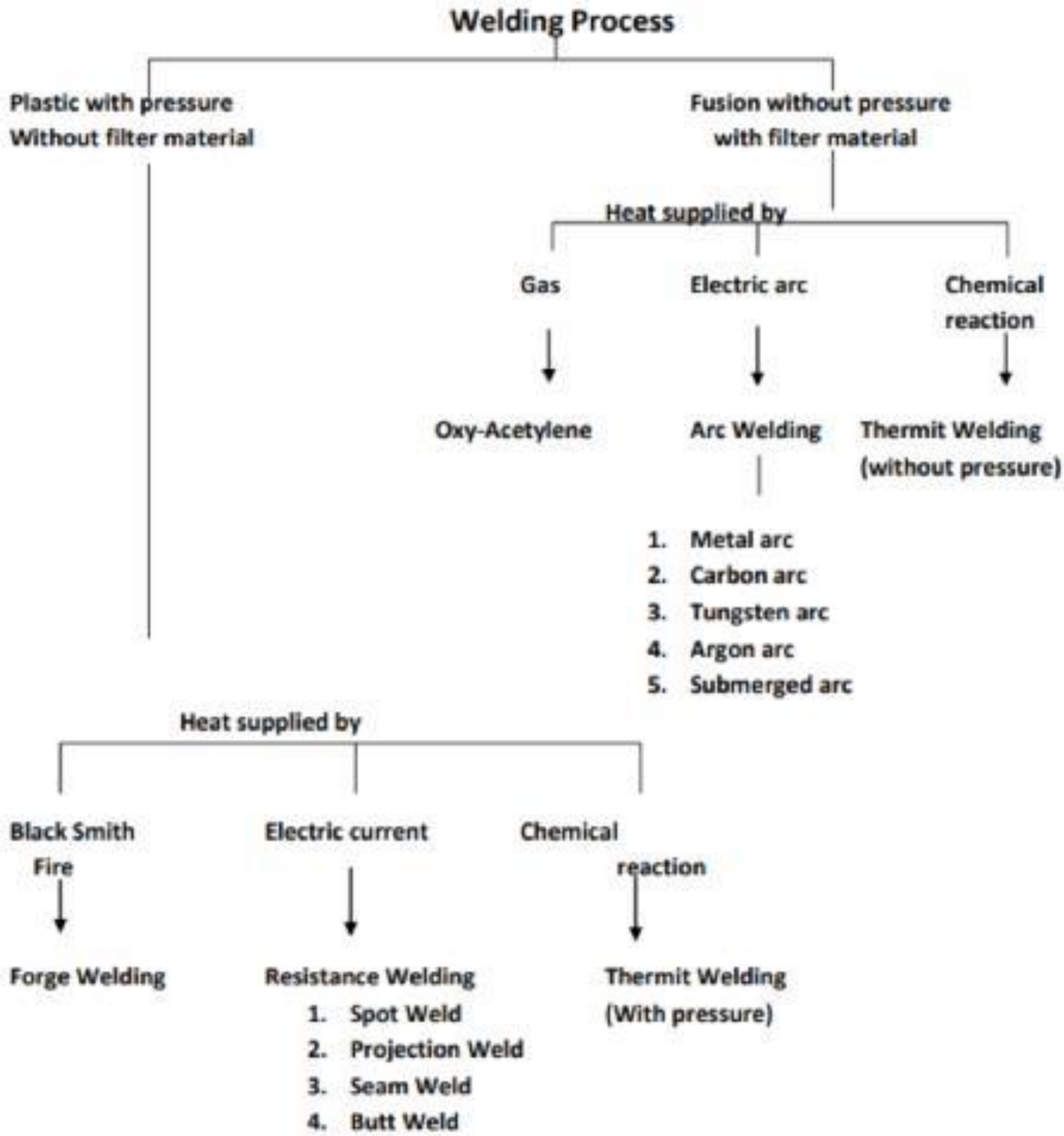
There are two main types of welding they are :

1. Plastic (Pressure) welding
2. Fusion (Non-Pressure) welding

In the 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. This procedure is used in forge welding, resistance welding, "thermit" welding, and gas welding, in which pressure is required.

In the fusion welding or nonpressure welding, the material at the joint is heated to a molten state and allowed to solidify. This includes gas welding, arc welding "thermit" welding, etc.

Classification of Welding



2.3 Arc Welding

Arc welding is metal jointing process, where the joint is produced by heating the work piece with a electric arc set up between an electrode and the work piece. The electrical energy is converted is into heat in the arc, which attains a temperature around 5500ºC, The electrode itself melts and supplies the necessary filler material.

2.3.1 Principle of Arc Welding

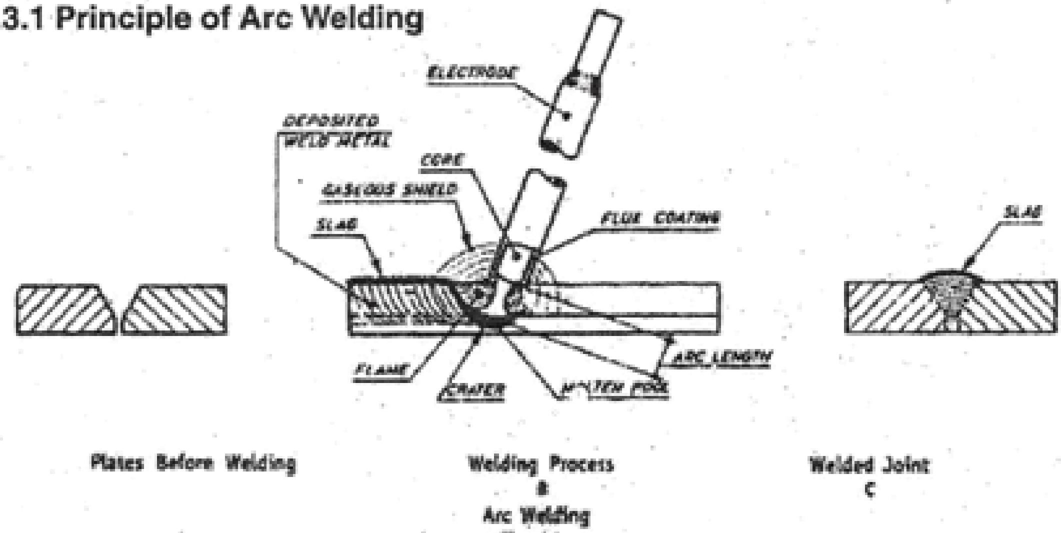


Fig. (1)

As shown in fig. (1) in arc welding metal rod is used as one electrode, while the work being welded is used as another electrode during welding operation, this metal electrode is melted by the heat of the arc and is fused with the base metal, thus forming a solid uniform weld, after the metal has been cooled. Both AC and DC may be used for this welding process.

2.3.2. Electric arc welding

The Process is illustrated by means of a schematic diagram the metal of the work piece to be joined is called base metal or parent metal and that provided by the electrode as filler metal. Arc welding is the most extensively employed method of joining metal parts. The source of heat is an electric arc.

The arc column is generated between an anode, which is the positive pole of dc (direct current) power supply, and the cathode, the negative pole. When these two conductors of an electric circuit are brought together and separated for a small distance (2 to 4 mm) such that the current continues to flow through a patch of ionized particles (gaseous medium), called plasma, an electric arc is formed. Heat is generated as the ions strike the cathode. However, electrical energy is converted to heat energy. Approximately 1 kWh of electricity will create 250 calories (1000J), the temperature at the center of the arc being 6,000 to 7,000ºC. the temperature of an electric arc, of course, depends upon the type of electrodes between which it is struck.

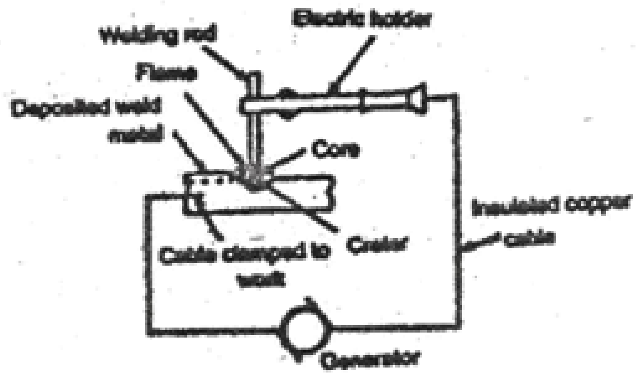


Fig. (2)

The heat of the arc raises the temperature of the parent metal which is melted forming a pool of molten metal. The electrode metal (in metal arc welding) or welding rod (in carbon-arc welding) is also melted and is transferred into the metal in the form of globules of molten metal. The deposited metal serves to fill and bond the joint or to fuse and build up the parent metal surface.

2.4 Arc Welding Electrodes

The 2 types of electrodes are used in Arc welding.

1. Consumable electrode

2. Non-consumable electrode

Consumable electrodes melts along with the work piece and fills in the joint.

When non-consumable electrodes are used, an additional filler material is used, the advantage using non-consumable electrode is the metal deposited by a filler rod can be controlled which is not possible in consumable electrode.

2.5 FLUXES

An electrode has metal core surrounded by flux coating. Flux coating is made up of ferrous alloys. The functions of flux coating are

1. It produces a gas which provides a shield around the arc to protect it from atmosphere.
2. It forms slag by mixing with impurities of the molten metal and, thus, refines the metal.
3. The slag, being lighter, floats over the surface of the molten metal and on solidification forms a thin layer over the weldment, which helps in gradual and uniform cooling of weld and prevents its oxidation during cooling.
4. In some cases, it also carried necessary alloying elements which are added to the molten metal.
5. It promotes conduction of electric current across the arc and helps in stabilizing the arc.
6. It also helps in controlling the bead shape by providing necessary materiels for this purpose.

2.6 Equipments used in Arc Welding

The most commonly used equipment for arc welding consists of

1. AC or DC machine (transformer or generator)
2. Electrode
3. Electrode holder.
4. Cables, cable connectors
5. Earthing clamps
6. Safety goggles
7. Welding helmet
8. Hand gloves

9. Aprons

10. Chipping hammer

11. Wire brush etc.,

1. Transformer :-

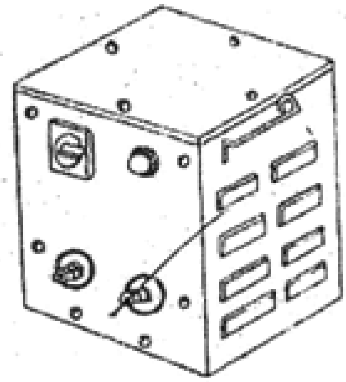


Fig. 3

The frunction fo a transformer is to generate a low voltage (10 to 50 V), and high amperage (50 A to 300 A) Electric Current. The current may be alternating current or direct current. Transformer converts Electrical energy into heat Energy which is requried for the welding process.

2. Electrode Holder

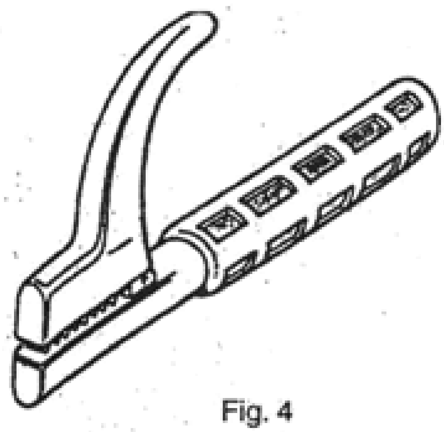


Fig. 4

The electrode holder is connected to the end of the welding cable and holds the electrode. It should be light strong and easy to handle and should not become hot while in operation. Fig. (3) shows one type of electrode holder. The jaws of the holder are insulated, offering protection from electric shock.

3. Electrode

Fig. 5

Welding rod as shown in fig. (4) is one of the electrode which acts as a filler material i.e., when the arc produced at the tip of electrode during welding process, the electrode itself melts and fills the gap between two base metals

Electrodes commonly used are of two types

(i) Coated electrodes (ii) Bare electrode

Coated electrodes carry a core of bare metallic coated wire provided with a flux coating wire provide with a flux coating or covering on the outside surface.

Mild steel is the most commonly used material for core wire.

The common ingredients of a flux which help in slag formation and metal refining are asbestos, mica, silica, fluorspar, stealite etc.,

Bare electrodes is one which does not have any coating. Bare electrodes are cheaper, but welds produced through these are of poor quality. It is used in inert gas metal arc welding (MIG).

3. Ground (earthing) Clamp

It is connected to the end of the ground cable and is clamped to the work or welding table to complete the electric circuit as shown in fig. (5). It should be strong and durable, and give low resistance connection.

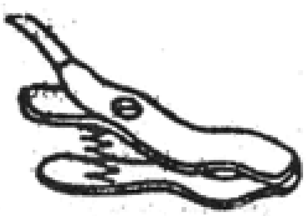


Fig. 6

4. Face or head shields

A face shields provide better protection and allow the welder the free use of both hands. It is mainly used to protect the eyes and face from the rays of the arc and from the spotter or flying particles of hot metal. It is available either in hand or helmet type as shown in fig. (6). The hand type is convenient to use wherever the work can be done with one hand. The helmet type though not comfortable to wear, leaves both the hands free for the work are made of light weight, non-reflecting fibre fitted with dark glass to filter

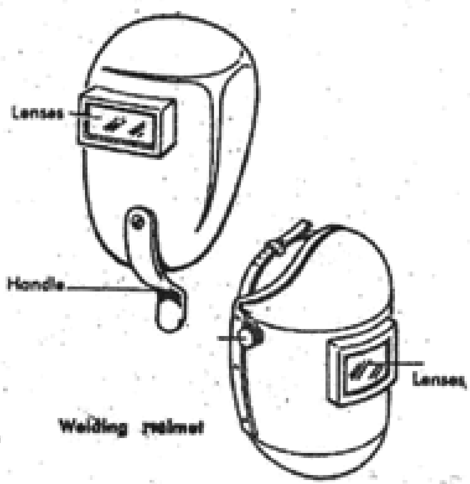


Fig. 7

out the harmful rays of the arc. A cover glass is fitted infront of the dark lens to protect it from spotter.

5. Goggles

Goggles with coloured glasses are used to protect the eyes from glare and flying bits of hot metal as shown in fig. (7).

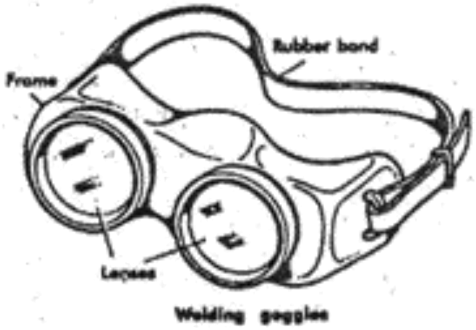


Fig. 8

6. Chipping hammer

Fig. 9

Chipping hammers as shown in fig. (8) is used for removing or chipping off the slag that forms on welded surface. A chipping hammer has two striking ends, one end of the head is sharpened like a cold chisel and the other flat end that turns parallel to the handle.

7. Wire brush

Wire brush as shown in fig. (9) is used after chipping. For further cleaning of the welded surface. The bristles are made from steel or stainless steel.

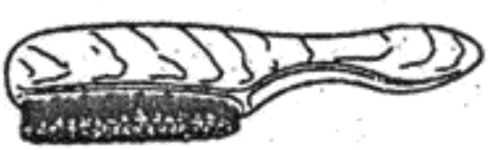


Fig. 10

8. Aprons and Hand Gloves

Aprons and hand gloves as shown in fig. are flame reardent outfits worm by a welder to protect the under clothing and the body from the sparks the molten metal and the hot metal being welded.

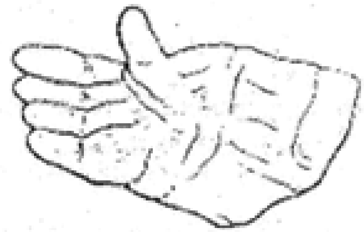


Fig. 11

2.7 Types of welded joints

The relative positions of the two work pieces being joined determine the type of joint. The following are the give basic types of joints commonly used in fusion welding are :

1. Lap joint
2. Butt joint
3. Corner joint
4. T-joint
5. Edge joint

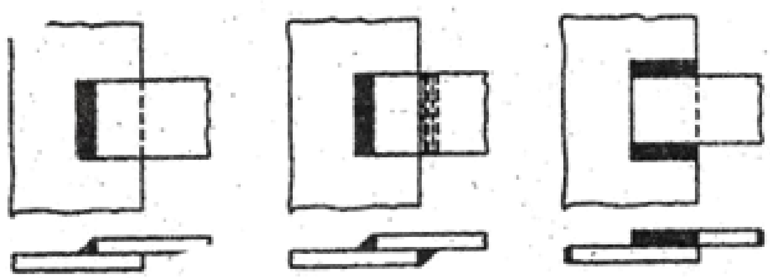


Fig. 12

Single transverse Double transverse Parallel lap joint

1. Lap joint : The lap joints is obtained by over lapping the plates and then welding the edges of the plates. These joints are employed on plates having thickness less than 3 mm. The lap joints may be

1. Single transverse
2. Double transverse
3. Parallel lap joint

A shown in fig. (12), the single transverse lap joints has the disadvantage that the edge of the plate which is not welded can buckle or warp out of shape.

2. Butt joint

The Butt joint is obtained by welding the ends or edges of the two plates which are approximately in the same plane with each other as shown in fig. (13). In Butt welds, the plate edges do not require beveling if the thickness of plate is less than 5 MM, on the other hand, if the plate thickness is 5 mm to 12.5 mm, the edges should be beveled to V or U - groove and plates having thickness above 12.5 mm should have a V or U - groove on both sides.

The butt joints may be

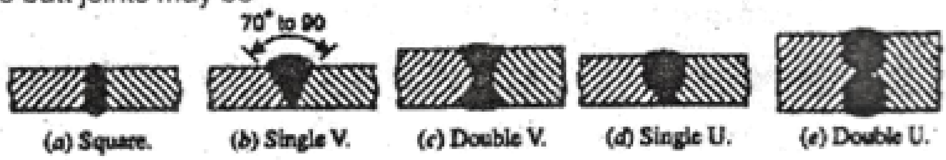


Fig (13)

1. Square butt joint
2. Single V-butt joint
3. Double V-butt joint
4. Single U-butt joint
5. Double U-butt joint

These joints are shown in fig. (13)

3. Corner Joint

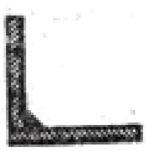


Fig. 14(a)

The corner joint, as shown in fig. 14(a) is obtained by joining the edges of two plates whose surfaces are at an angle of approximately 90º to each other. It is used for both light and heavy gauge sheet metal. In some cases corner joint can be welded; without any filler material, by melting of the edges of the parent metal.

4. Edge joint

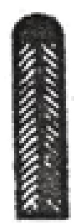


Fig. 14(b)

The edge joint as shown in fig. 14(b), is obtained by joining two parallel plates. It is economical for plates having thickness less than 6 mm, this joint is unsuitable for members subjected to direct tension or bending.

5. T-Joint

The T-Joint, as shown in fig. 14(c) is obtained by joining two plates whose surfaces are approximately at right angles to each other. It is widely used to weld siffeners in air craft and other thin walled structures. These joints are suitable upto 3 mm thickness.

Fig. 14(c)

2.8 Comparison between A.C. and D.C arc welding

Following is the comparison between A.C. and D.C arc welding

Use of A.C in arc welding	Use of D.C in arc welding
1. AN A.C. welding transformer is cheaper and simpler in operation	A.D.C. generator set is costlier and more cumbersome in operation.
2. Maintenance of an A.C transformer is easier and more economical since it has no moving parts	A.D.C. generator carries many moving parts and its maintenance cost is higher
3. It is less suitable for use at low current with small dia. Electrodes	It is better suited for use at low amperages with small dia. Electrodes
4. Except in case of iron powder electrodes, maintenance of a Small arc is difficult	Maintenance of short arc is easier with D.C.
5. It is preferred for welding at very large distances from the power supply, because voltage drop in long leades is much less as compared to	In D.C. the voltage drop is relatively higher and therefore, only short cables are used, prohibiting its use for welding at long distances from power supply D.C
6. Striking of arc, particularly with electrodes is relatively difficult	In D.C it is easier to strike an arc, even with thin electrodes.
7. Bare electrodes cannot be used in A.C. Only specifically designed coated electrodes with coverings containing stabilizers can be used.	Both bare and coated electrodes can be used.

8. Though it can be used for welding positions but selection of proper electrode has to be made carefully and used of a better skill is needed.	It is easier to use D.C. even for out-of-position welding and for thicker sections because lower currents can be used.
9. It is generally not preferred for welding of sheet metal due to the difficulty in starting the arc.	It is more preferred because starting of arc is easier and the arc remains steady.
10. There is hardly any problem of arc-blow in A.C	With D.C. there is always a likelihood of arc-blow, unless proper corrective measures are not adopted.
11. Different fixed polarities are not available. Hence it is not suitable for welding all metals, particularly non-ferrous ones.	Distinct fixed polarities can be used for welding almost all metals and different thickness
12. It can be used only when A.C mains supply is available	An engine driven D.C. generator set can be used even in absence of A.C mains supply

2.9 Preparation of the work before welding :-

Before welding, the work pieces must be thoroughly cleaned of rust, scale and other foreign materials. Thin pieces of metal are generally weld without beveling the eldges. However thick work pieces should be bevelled to ensure adequate penetration and fusion of all parts of the weld. But, in either case, the parts to be welded must be separated slightly to allow better penetration of the weld.

2.10 Advantages of welding

1) A properly made weld can be stronger than the part on which it is used.

2) It is a permanent joint.

3) The equipment is inexpensive.

4) The joint produced by welding is as strong as base metal.

5) No patterns are used as in castings.

6) The equipment can be portable.

7) The process allows considerable freedom in design.

2:11 Disadvantages of welding

1) A good welding job requires skilled operator.

2) Fixtures are often needed to hold parts in position for welding.

3) Each part of weldment must be cut to size and shape before it can be welded.

4) Presence of residual stresses and distortion in the welded joints.

2.12 Common defects in welding

The common defects of welded joints are as follows :

1) Cracks

Cracks may be microscopic scale or macroscopic scale depending upon their size. Cracks in the welded joint may arise from localized stresses set up by uneven heating and cooling, presence of high percentage of sulphur and carbon in the base metal.

2) Porosity

Porosity is a group of small voids, whereas blow holes or gas packet is a comparatively bigger isolated hole or cavity. They occur mainly due to entrapped gasses.

3) Poor fusion

It is lack of thorough and complete union between the metal deposited by the electrodes and parent metal.

4) Inclusions

The presence of non-metallic substances in the metal is called inclusion. Inclusion lowers the strength of the joint.

5) Undercut

In undercut, a groove gets formed in the base metal along the sides of the welded joint. The reasons for under cutting are non-uniform feed of the welding rod, improper of the electrode or excessive heating.

2.13 Safe welding practices

1) Never look at the arc with naked eye. The arc can burn your eyes severely. Therefore always use a face or head shield or goggles, while welding.
2) Always wear the safety hand gloves apron and shoes.
3) Ensure proper insulation of the cables and check for openings.

2.14 GAS WELDING

Gas welding is done by burning a combustible gas with air or oxygen in a concentrated flame of high temperature. As with other welding methods, the purpose of the flame is to heat and melt the parent metal and filler rod of a joint. It can weld most common materials. Equipment is inexpensive, versatile, and serves adequately in many job and general repair shops.

2.14.1 Oxy-acetylene welding

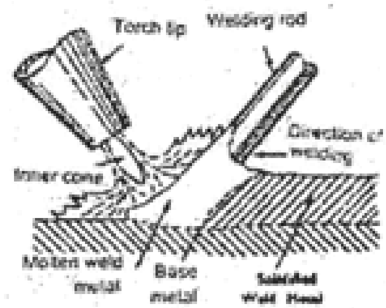
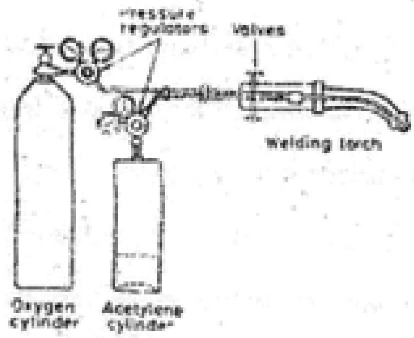


Fig. 15

Oxy-acetylene gas welding is accomplished by melting the edges or surface t be joined by gas flame and allowing the molten metal to flow together, thus forming a solid continuous joint upon cooling. This process is particularly suitable for joining metal sheets and plates having thickness of 2 to 50 mm. With material thicker than 15 mm, additional metal called filler metal is added to the weld in the form of welding rod. The composition of the filler rod is usually the same or nearly the same as that of the part being welded. To remove the impurities and oxides present on the surfaces of metal to be joined and to obtain a satisfactory bond a flux is always employed during the welding.

Various gas combination can be used for producing a hot flame for welding metals. Common mixture of gases are oxygen and acetylene, oxygen and hydrogen, oxygen and other fuel gas, and air and acetylene. The oxygen-acetylene mixture is used to a much greater extent than the other and has a prominent place in the welding industry. The temperature of the oxy-acetylene flame in its hottest region is about 3,200°C.



The oxygen cylinder and acetylene cylinder are connected through regulating valves and pressured into flexible hoses attanced to a welding torch. A typical arrangement is shown in fig. 15 (a). The welding torch mixes the oxygen and acetylene inthe proportions set by the pressure regulators and the final adjustment is done manually at the torch.

The acetylene gas must be handled very carefully as it is explosive at 172 KPa.

Therefore, acetylene is stored by dissolving it inacetone which is held in asbestos. In this way it can be stored at 1.4 MPa. Because mixture of acetylene and oxygen are highly explosive, precautions must be taken to avoid mixing the gases improperly. All fitting connecting acetylene gas are left hand treaded, and the hoses are coloured red. For oxygen, the hoses are green or black with right hand threaded fittings. This prevents the making of any improper connections.

2.14.1.1 GAS FLAME:-

Neutral flame :

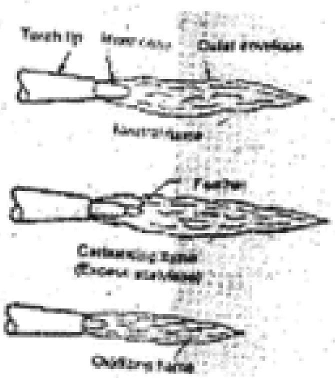


Fig. 16

The Correct adjustment of the flame is important for reliable work. When oxygen & acetylene are supplied to torch in different volumes, Three types of flames are produced. They are Neutral flame : when equal volumes of oxygen & acetylene are supplied to forch a neutral flame is produced having a maximum temperature of 3200°C.

A neutral flame has two definite zones : (1) a sharp brilliant cone extending a short distance from the tip of the torch, and (2) an outer cone or envelope only faintly luminous and of a bluish colour. The first one develops heat and the second protects the molten metal from oxidation, because the oxygen in the surrounding atmosphere is consumed by the gases from the flame. The neutral flame is widely used for welding steel, stainless steel, cast iron, copper, aluminium etc.

A carburizing flame is one in which there is an excess of acetylene. This flame has three zones : (1) the sharply defined inner cone (2) an intermediate cone of whitish colour, and (3) the bluish outer cone. The length of the intermediate cone is an indication of the proportion of excess acetylene in the flame. When welding steel, this will tend to give the steel in the weld a higher carbon content than the parent metal, resulting in a hard and brittle weld.

An oxidizing flame is one in which there is an excess of oxygen. This flame has two zones : (1) the small inner cone which has purplish tinge and (2) the outer cone or envelope. In the case of oxidizing flame the inner cone is not sharply defined as that of neutral or carburizing flame. This flame is necessay for welding brass. In steel, this will result in a large grain size, increased brittleness with lower strength and elongation.

Advantages :-

(i) The equipment is portable, & is comparatively inexensive & requires little maintenance.

(ii) Practically all metals may be welded and the equipment can be used for cutting.

Disadvantages :-

(1) Gas welding is slower than electric arc welding.

(2) Not suitable for heavy section

(3) Gas cylinders should be handled carefully since they are highly explosive.

CHAPTER-3

SHEET METAL WORK

3.1 Introduction

Sheet metal work is generally regarded as the working of metal from 16 gauge down to 30 gauge with hand tools and simple machines into various forms by cutting forming into shape and joining. It has its own significance as a useful trade in engineering works and also for our day to day requirements.

The sheet metal shop is very important for every engineering concern. It deals with the working of metal sheets. It requires a through knowledge of the projective geometry particularly the development of surfaces, because the laying out pattern and cutting of metal sheets to correct sizes and shapes entirely depends upon the knowledge of the workman. The various operations performed in a sheet metal shop are cutting, shearing bending etc. Allowance should be given in the drawing stage for folding and bending.

Common examples of sheet metal work are to prepare boxes, hoppers, cannisters, covers, funnels, cylinders, ducts, prisms, cones, pyramids, etc. from a flat sheet metal.

3.2 Metals use in sheet metal work

A variety of metal used in a sheet metal shop such as

Black Iron

The cheapest sheet metal is black iron, which is sheet iron rolled to the desired thickness, annealed, by placing in a furnace until red hot, and then set aside to cool gradually. It has a bluish-black appearance and is often referred to this metal is limited to articles that are to be painted or enameled such as tanks, pans, stove pipes, etc.

GALVANISED IRON

Zinc-coated iron is known as "galvanized iron". This soft steel sheet is popularly known as GI sheet. The zinc coating resists rust, improves the appearance of the metal and permits it to be soldered with greater ease ; but welding is not so easy as zinc gives toxic fumes and residues. Because it is coated with zinc, galvanized sheet iron withstands contact with water and exposure to weather. Articles such as pans, buckets, furnaces, heating ducts, cabinets, gutters etc. are made mainly from GI sheets.

STAINLESS STEEL

This is alloy of steel with nickel, chromium, and traces of other metals. It has good corrosive resistance and can be welded easily. The cost of stainless steel is very high. Stainless steel used in the sheet metal shop can be worked as galvanized iron sheets, but is tougher than GI sheets. This is used in canneries. dairies, food processing and chemical plants, kitchenwares, etc.

COPPER

Copper sheets are available either as cold-rolled or hot-rolled sheets. Cold-rolled sheets being worked easily are commonly used in sheet metal shop, and are resistant to corrosion. They have a better appearance than other metals. Copper being a costly metal, cost of copper sheets is higher in comparison of GI sheets. Gutters, expansion joints, roof flashing and hoods are some of the common examples of copper sheet.

ALUMINIUM

Aluminium cannot be used in pure form, but is used with a very small amount of copper, silicon, manganese and iron. It is highly resistant to corrosion and abrasion, whitish in colour and light in weight. It is now widely used in the manufacture of a number of articles such as household appliances, refrigerator trays, lighting fixtures, windows, in the construction of airplanes, in the fitting and fixtures use in doors, window and building requirements, and in many electrical and transport industries.

TIN PLATE

Tin plate is sheet iron coated with the tin to protect it against rust. This is used for nearly all soldered work, as it is the easiest metal to join by soldering. The size and thickness of tin plates are denoted by special marks, not by gauge numbers, and can be very, confusing to the uninitiated. If larger or heavier sheets of tinned iron are required, the material uses is known as "tinned steel", and this may be obtained in all sizes and gauges in which sheet iron is obtainable.

However, this metal has a very bright silvery appearance and is used principally in the making of roofs, food containers, dairy equipments, furnace fitting, cans and pans etc.

LEAD

Lead sheets are used in highly corrosive acid tanks. Lead is very soft and heavy. Lead sheet can be worked by hand without the use of any mechanical device.

3.3. HAND TOOLS

There is a fairly large number of hand tools used by sheet metal workers. The tools most commonly used are

1. Trammels :

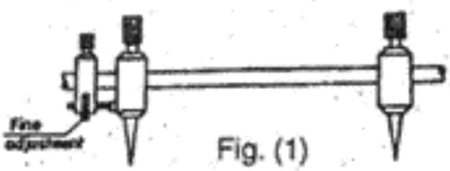


Fig. (1)

Sheet metal layout requires marking of arcs and circles. This may be done using the trammels as shown in fig. 1. The length of the beam decides the maximum size of the arc that can be scribed.

2. Wire Gauge

Fig. 2

The wire gauge as shown in Fib (2), is used to check the diameter of wires or thickness of sheet metal. The commonly used wire gauge is imperial standard wire gauge known as SWG. It has slots to indicaté different width sizes. The most common wire gauge used in sheet metal has 21 slots with gauges varying from 4 to 24. The following table shows the imperial standard wire gauge sizes.

SWG No.	Size in mm	SWG No.	Size in mm	SWG No.	Size in mm
4	6.0	11	3.0	18	1.25
5	5.5	12	2.7	19	1.05
6	4.8	13	2.4	20	0.95
7	4.5	14	2.1	21	0.85
8	4.0	15	1.9	22	9.72
9	3.6	16	1.65	23	0.62
10	3.3	17	1.45	24	0.58

3. Snips

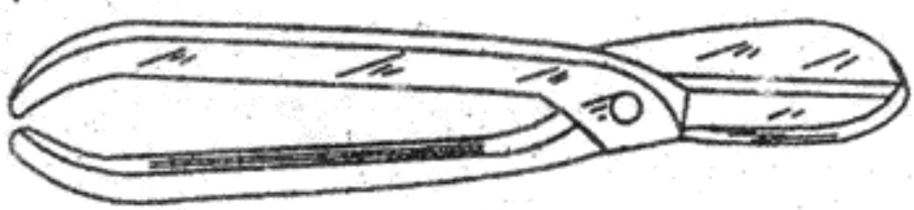


Fig. 3(a)

A snip, also called a hand shear is use 1) Like A PAIR OR SCVSSORS To cut thin soft metal. It should be used only to cut 20 gauge or thinner metal. There are several types of snips available for making straight or circular cuts, the most common being straight snips and curved snips.

The straight snip as shown in Fig 3(a) have straight blades for straight line cutting while curved or bent snips have curved blades for making circular cuts.

Fig. 3 (b)

The curved snips, as shown in fig. 3 (b) have curved blades for making circular cuts. They are available for either right hand or left hand cuts.

4. Hammers

Light weight hammer and mallets used in sheet metal work. Ball peen hammer has a cylindrical, slightly curved face and a ball head. It is a general purpose hammer, sued mostly for riveting in sheet metal work. The cross peen hammer has a tapered peen and is perpendicular to the handle. Because of this, it can reach backward corners.

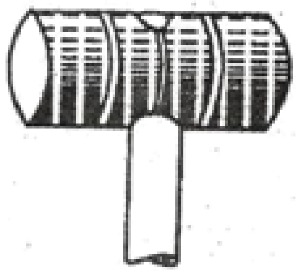


Fig. 4

Straight peen hammer has the peen end similar to the cross peen, but it is positioned parallel to the handle which can be used conveniently for certain operations of folding.

The mallets may be made from hide, fibre or word. The best size of mallet is 5 cm diameter. These may be obtained in various shapes to suit specific work as shown in fig. (4) mallet is used for bending and folding work. It is light in weight, covers more area and does not produce dent on sheet metal.

5. Stakes

Stakes are the sheet metal worker's anvils used for bending, seaming or forming, using a hammer or mallet. They actually work a supporting tools as well as forming tools. They also help in bending operation. They are made in different shapes and sizes to suit the requirements of the work. The beakhorn stake is used for riveting, forming around and square surfaces, bending straight edges, and making corners. The hatchet stake is used to make straight, sharp bends and for folding and bending edges.

5) Stakes :-

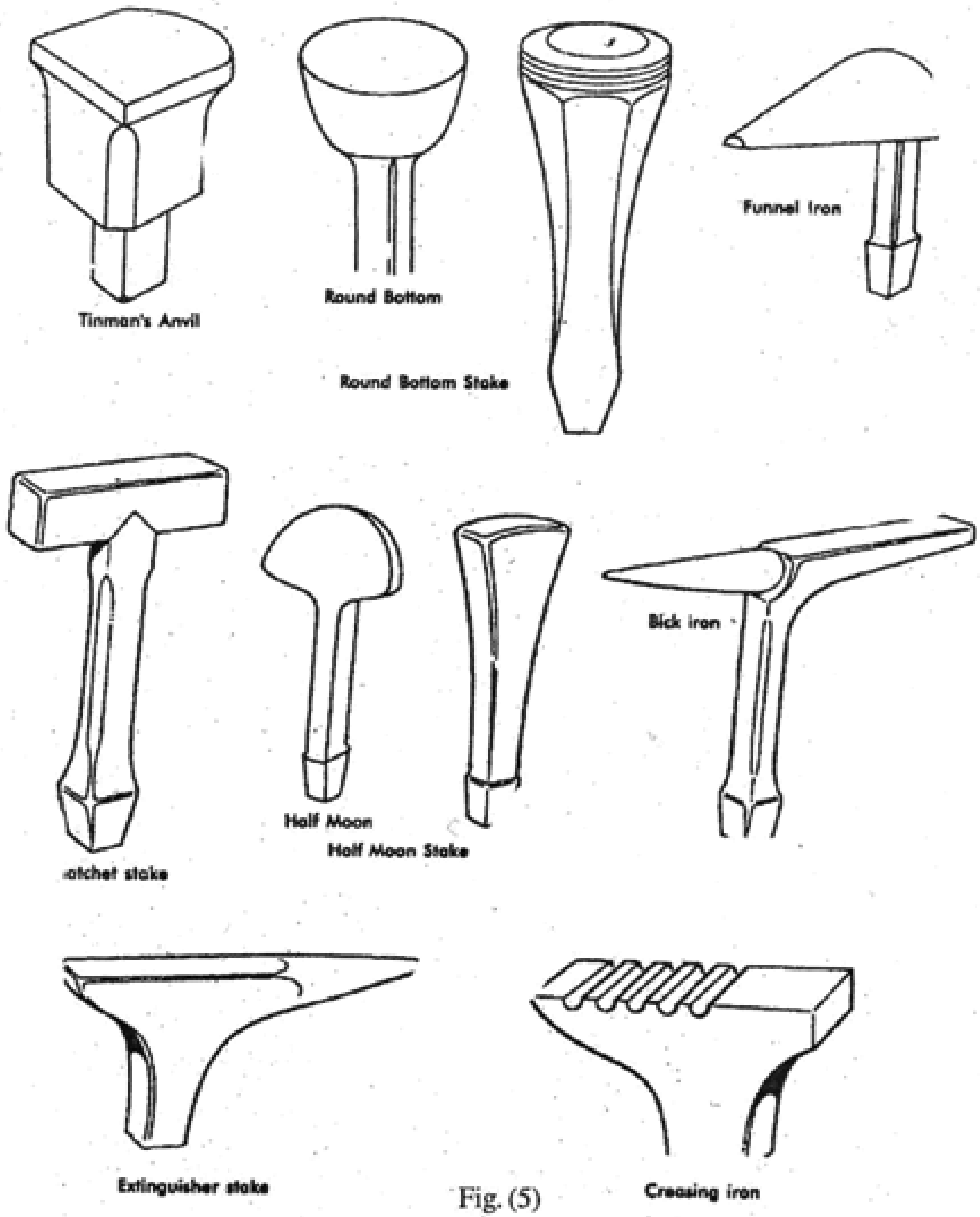


Fig. (5)

3.4. Steel metal joints

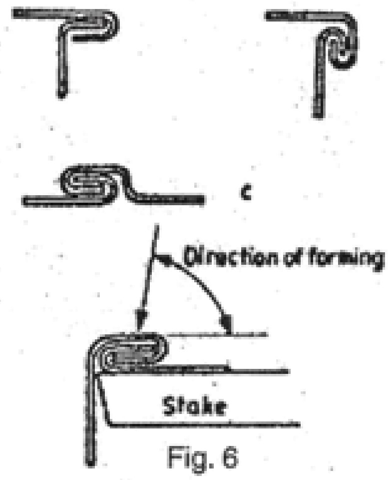


Fig. 6

Various types of joints are sued in sheet metal work, to suit the varying requirements. Some commonly used sheet metal joints and folded edges are shown in fig. (6).

These are self secured joints formed by joi ing together. Two pieces of sheet metal and using the metal itself to form the joint. These joints are to be used on shee' ; of less than 1.6 mm thickness. Usually in workshop the commonly used sheet metal are soldering by using adhesives, riveting or mechanical joint.

3.5 SOLDERING

Soldering is one method of joining two pieces of metal with all alloy that melts at a lower temperature than the metals to be joined. For a good job, the metals to be joined must be free from dirt, grease and oxide* solder is made of tin and lead, usually in equal proportions. It comes in the form of wire.

Capillary action between the solder and the base metal will not take place unless the base metal is clean, A flux is used with the solder to remove oxides and thus permit good solder wetting. An acid flux is used for black iron and galvanized iron. A rosin flux is used tin plate. Copper and electric wire.

Soldering is advantageous as similar and dissimilar metals can be joined by this process.

3.5.1 Soldering Iron

Soldering requires a source of heat. A common method of transmitting heat to the metal surfaces is by using a soldering iron. Figure (7) shows the soldering iron used for the purpose. The working end of this tools is made of copper, which is a good conductor of

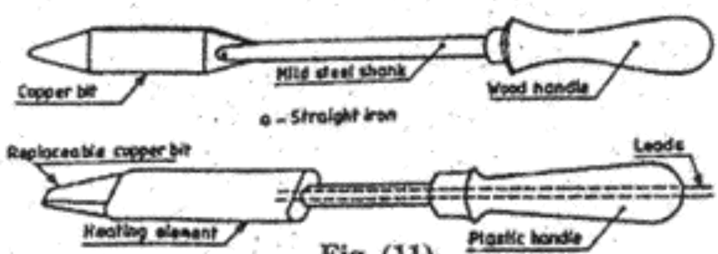


Fig. (11)

3.5.2 Method of soldering

The following are the stages involved in soldering work :

1. Clean the surfaces to be soldered.
2. Keep the surfaces to be joined, close together.
3. Apply a thin layer of flux with a brush.
4. Heat the soldering copper to proper temperature.
5. Tack the seam by applying solder at several points.
6. Begin at one end and move the copper bit slowly, adding solder as needed.
7. Allow the joint to cool.

3.5.3 Reasons for using Soldering Flux

1. To clean the surface of the base metal during heating.
2. To eliminate impurities present in metals.
3. To break down the surface tension of the metal and enable the solder to flow.
4. To prevent the formation of fresh oxides. by forming a protective layer on the solder.

3.5.4 Uses of Soldering

Soldering is used to join the following :-

1. Electrical components in television, radio, transistor and tape recorders
2. Electronic components like printed circuit boards
3. Automobile parts like radiators
4. Sheet metal works
5. Utensil repairs

3.6. BRAZING

Brazing is a process of joining two metal pieces by the addition of non terrous filler metal. By definition, brazing employs a filler metal with melting temperature above 150ºC. Copper an copper alloys, silver and silver alloys and aluminium alloys are the most commonly used filler metals for brazing.

The surfaces to be joined must be cleaned first, by removing all grease and oxide. After cleaning, a flux is applied to all surface where the filler metal is a flow. Fluxes are used to prevent oxidation of the base metal and filler metal during brazing and promote the free flowing of the filler metal by capillary attraction. The commonly used flux for brazing are borax, boric acid, borates, fluorides, and chlorides.

In brazing the parts to be joined and the filler metal are brought too temperature which is below the melting point of the parts to be joined, but above the melting point of the brazing material. The filler metal flows throughout the joint by capillary attraction and allowed to solidify. Since fluxes are corrosive in nature, they should be removed after brazing. Brazing is used for the fastening of pipe fittings, tanks, radiators, heat exchangers, carbide tips on tool holders, etc.

Braze welding is similar to ordinary brazing except that the filler metal is not distributed by capillary attraction. In this process, filler metal is melted and deposited at the point where the weld is to be made.

3.6.1 Advantage of Brazing

1. Dissimilar metals and parts having thin sections can be joined easily.
2. Brazing may avoid the metallurgical damage to the metal.
3. Strong join can be obtained by brazing.
4. Properly brazed joints are pressure tight.
5. It is an economical and quick process.
6. Less heating is required than for welding.

3.6.2 Disadvantages of Brazing

1. Large areas cannot be brazed easily due to the possibility of lack of uniform heating of internal surfaces.
2. Joints have poor strength compared to welded joints.
3. Require tightly mating parts.
4. Brazing fluxes may produce toxic fumes.

3.6.3 Uses of Brazing

1. To Join carbide tips with steel shanks.
2. To fasten pipe fittings, tanks, heat exchanges and electrical repair work.
3. To join cycle parts and steam turbine components.

3.6.4 Difference between Brazing soldering

	Brazing	Soldering
1.	Melting point of the filler material is above 450ºC	Melting point of the filler materials is below 450ºC.
2.	Dissimilar metals can be joined easily.	Only similar metals can be joined
3.	Good surface finish.	Does not yield a good surface finish
4.	Stronger joints.	Less stronger joints
5.	The strength of the brazed joint is a function of the attraction forces between the molecules of the brazing material.	The solder acts as a metal solvent by meting small amounts of the base metal, and these form a chemical bond with one of the solder constituents. Thus the strength of the joint is function of the alloy formed.

CHAPTER - 4

CARPENTRY

4.1 INTRODUCTION

Carpentry and Joinery are common terms used with any class of work with wood. Strictly speaking, carpentry deals with all works of a carpentry such as roofs, floors, partitions, etc. of a building, while joinery deals with the making of doors, windows, cupboards, dressers, stairs, and all the interior fitments for a building.

Timber is the basic material used for any class of wood working. The terms 'timber' is applied to the trees which provide us with wood. Wood is one of the most valuable biodegradable raw materials of industry and daily uses.

4.2 ADVANTAGES OF TIMBER

Timber carries a number of advantages over other materials used in construction work. A few important ones are given below:

1. It is very easy to be worked on with tools to give it a desired shape and size.
2. Structural connections and joints can be easily made in timber.
3. It is lighter than most of the materials used in construction work and at the same time stronger too.
4. In framed structures it suits equally well to both load bearing and non load bearing members.
5. In timber work the cost of material as well as construction both are minimized as compared to the other materials of similar use.
6. It has a fairly good resale value in case it is not needed.
7. It responds very well to polishing and painting etc.
8. It suits very favourably to doors, windows, cabinet work, furniture and decorative designs and fittings.
9. It is reckoned that a heavy timber construction is not so quickly damaged by fire as a steel construction.
10. It is quite suitable for making soundproof construction.

11. It, being a non-conductor of heat, is favoured for the construction of houses. Such houses will remain warm in winter and cool in summer.

12. It provides an indispensable combination of strength, durability, lightness and economy as compared to other materials of construction.

4.3 STRUCTURE OF WOOD

4.3.1 GROWTH AND CLASSIFICATION

The tree consists of mainly three parts viz, roots, trunk (including branches) and leaves, and each of these has a distinct function in the growth of the tree. In spring season the roots of the tree suck the requisite food for it from the soil in the form of sap which is nothing but a dilute solution of mineral salts in the subsoil water. This sap rises through the cells of the wood to reach the branches and leaves to provide the nourishing food. The leaves release moisture from sap and in turn absorb carbon-di-oxide which, under the action of sun, forms a dense chemical compound ; also turned a sap. This denser sap descends downwards in autumn and gets deposited under the bark to form what is known as cambium layer. It hardens gradually and thus a fresh layer of wood is added to the tree, called the annual ring. The function of the trunk of a tree is to provided adequate support to the branches and leaves of the tree and enough strength and rigidity to its structure.

According to the manner of growth the timber trees can be broadly classified as:

1. Exogenous or Outward growing.
2. Endogenous or Inward growing.

Exogenous trees are those which grow outward from the centre adding almost concentric layers of fresh wood every year, known as annual rings. It is this variety or trees which yields the timber suitable for building and other engineering uses. The exogenous trees are further classified as;

(i) Conifers or evergreen trees.

(ii) Deciduous or brad leaf trees.

The conifers give soft woods and the deciduous class hard woods. Some common examples of hard woods are Sal, Teak, Shisham. Oak, Beach, Ash, Ebony, Mango, Neem and Babid (Babool), etc. against this, the soft woods include Kail, Pine, Deodar, Chir, Walnut, Semal, Toon and Spruce, etc.

Against this, there are other trees which grow inwards, i.e., every fresh layer of sap wood is added inside instead of outside. These trees are known as Endogenous and their common examples include cane, bamboo and coconút, etc.

4.3.2 STRUCTURE OF A TIMBER TREE

Cross-section of an exogenous tree is shown in Fig.1. The main features illustrated are as follows:

1. **Pith or medulla.** It is the dark central part of the tree. It feeds sap from the roots to the growing tree is its early age and is one of the earliest formation of the tree. The annual rings are added around this every year.

2. **Heart wood.** The portion of wood near and around the pith is called heart wood. It is darker in colour, harder and stronger than the remaining wood in the tree and it is the most matured part of the tree. It carries less moisture than the sap wood surrounding it and it, therefore, less likely to decay in comparison to the latter.

3. **Sap wood.** The portion of wood between the cambium layer and the heart wood is known as sap wood. As compared to heart wood it is softer, weaker and lighter in colour and carries a very high percentage of moisture content. For this reason the chances of decay are more in it and also it is less suitable for engineering purpose in comparison to the heart wood. It has been mostly used as fuel wood. However, the modern developments in wood seasoning have enabled its use also in engineering works to a considerable extent.

4. **Cambium layer.** The annual ring just under the bark, i.e., the latest addition, or to say the annual ring which is in the process of formation, is called cambium layer. It carries a cellular construction and with the passing of time it is gradually-converted into sap woods whe ... le it which becomes the cambium layer.

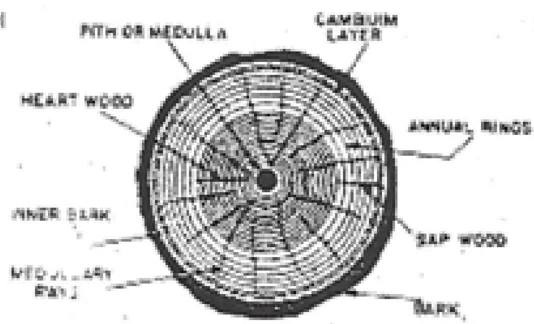


Fig 1

5. **Bark or cortex.** It is a sort of anchor sheet on the outside surface of the tree to protect the cambium layer from the attack of insects and frosts. It has a fibrous

construction usually and the nourishing food from the leaves to the cambium layer is fed through its inner surface which is known as inner bark.

6. **Medullary rays.** These are the radial rays or thin layers running between the pith and cambium layer, as shown. They are or cellular construction and help in binding the annual rings together to provide a solid structure to the tree. Also the sap food to the growing parts of the tree is supplied through them.

7. **Annual rings.** These are the concentric rings or layers of wood all around the pith. As described earlier, one such layer is added every year and that is why they are known as annual rinos The innermost annual rings from the heartwood ad the outer ones sap wood.

4.3.3 SOFT AND HARD WOODS

As described earlier the softwood is obtained from trees having needle shaped leaves or conifers and hardwood from those having broad leaves or deciduous trees. The main characteristics of these two types of woods are given in Table 1 below:

Table 1 Characteristics of soft and hard woods.

Soft wood	*Hard wood*
1. It is a resinous wood having a fragrant smell and regular texture	It is a non-resinous wooed containing a fairly good amount of acid.
2. It carries straight fibers and fine texture.	Its fibres are quite close and compact.
3. It is light in colour	It is dark in colour.
4. It is light in weight	It is heavier.
5. The annual rings are quite district in it.	The annual rings are not distinct in it.
6. It has a good tensile resistance but is weak across the fibres.	It has both good tensile as well shear resistance.
7. It gets splitted quickly	It does not split quickly.
8. It is relatively weaker and less durable.	It is stronger and more durable.
9. It may catch fire soon and cannot withstand high temperatures.	It has an added advantage in its refractoriness.
10. It is easy to be worked.	It is difficult to be worked.

4.4 SELECTION OF TIMBER

The main factors which influence the selection of timber for a particular use are the following:

1. Durability
2. Workability
3. Weight.
4. Hardness.
5. Cohesiveness.
6. Elasticity
7. Type of texture
8. Type of grains.
9. Resistance to fire.
10. Resistance to various stresses.
11. Ability to retain shape
12. Suitability for polishing

4.5 SEASONING OF TIMBER

Object of seasoning. The main object of seasoning is to reduce the moisture content in the wooed to the extent it is desirable so as to make it suitable for various purposes. It this excess or unwanted amount of moisture is not taken out of the wood its presence will render the wood unsuitable due to uneven shrinkage, warping or twisting etc.,

Advantages of seasoning. The main advantages of seasoning the wood are the following:

1. Wood becomes hard.
2. It becomes more durable.
3. Its resistance to shock and stresses are increased.
4. Its workability is improved.
5. Its density is reduced.
6. It does not warp after seasoning.
7. Shrinkage does not occur after seasoning.
8. Defects like twisting, bowing and splitting do not occur.
9. Its ability for taking up polishing and painting is improved.
10. its resistance to fire is increased.

4.6 METHODS OF SEASONING

The following methods are commonly used for seasoning of timber.

4.6.1.Natural or air seasoning. In this method the balks of timber are stacked in a shed such that they are not directly exposed to sun and rain but a free circulation about 30 to 40 cm high, and is perfectly levelled at the top, Usually a layer of cinder ash or sand is put over the levelled floor so as to prevent the effect of moisture on the wood from the bottom. A proper arrangement of drainage should always be made. The shed is erected over this platform and the timber stacked as shown in Fig. 2. They are then allowed to undergo various temperature charges by allowing to remain under this shed for a considerable long period. The stacked balks should be periodically turned upside down so as to accelerate the rate of drying. Due to the circulation of free air through the stack the excess moisture content in the wood is evaporated and the wood gets dried. This method give the best seasoned wood and is, at the same time, cheapest also, but the time taken is too much i.e., 1 to 5 years. The actual time required depends largely on the type of wood and its section. Harder wood and thicker sections take more time than softer wood and thinner sections.

4.6.2.Water Seasoning. This process consists of immersion of timber balks in flowing water for a period of 2 to 3 weeks. During this time the flowing water drives away the sap of the wood with it. The timber is then taken out of the water and air seasoned in the usual way. In this case platform is made tapered instead of flat, but the rest of the process is the same as described above for air seasoning. This method takes relatively less time than the former but the strength of the wood is reduced.

4.6.3 Artificial or Kiln Seasoning. This process is the quickest of all the commonly used process for wood seasoning. In this the timber balks are stacked over large trolleys which are, then, driven into hot chambers or ovens called Kilns. Inside these Kilns the stacked balks are allowed to remain, under controlled conditions of temperature and humidity, for nearly a fortnight or so. The exact time again depends upon the quality of wood and the amount of moisture it contains originally. Hot air or dry steam is pushed into the chamber wherein the temperature rises gradually. With the result, drying or evaporation of moisture from wood is slower in the beginning and it gradually increases with the rise in temperature. This method enables seasoning at a much faster rate but the quality of the wood is inferior to that seasoned through natural seasoning. Also, this method involves more recurring expenditure.

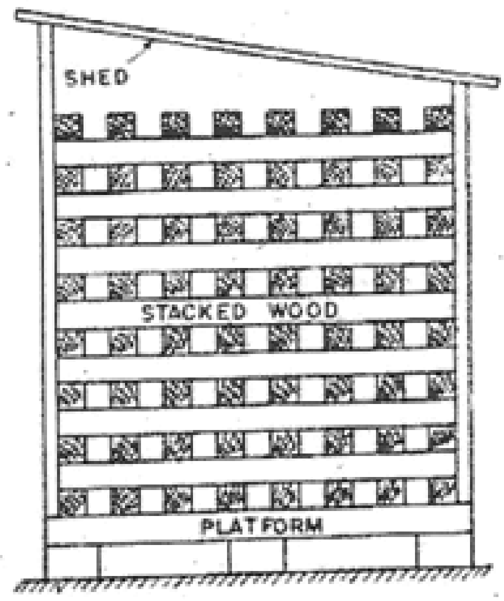


Fig 2

4.6.4 Other processes. The other processes used for seasoning of timber include boiling, electric seasoning, chemical seasoning and a combination of air and Kiln seasoning. These processes, particularly the chemical seasoning, are costlier that the former processes and therefore, their use is not so common. For detailed study, some standard text-books on timber work or building materials may be consulted.

4.7 COMMON DEFECTS IN TIMBER

The common defects found in timber can be broadly classified into the following three groups:

(a) Natural defects or defects due to abnormal growth of the tree.

(b) Defects occurring during conversion, seasoning or use.

(c) Defects due to the actions of fungi and insects.

4.7.1 NATURAL DEFECTS.

The following defects commonly occur in the wood due to the abnormal growth of the tree:

1. **Knots.** The impressions left behind by the broken limbs or branches later appear as knots. The annual rings in these knots will be found in a plane normal to those in the stem. This offers difficulty in working and reduces the strength of wood. When the separation of branches or limbs takes place before the tree is cut, the knots formed are called dead knots. Against this, if the above separation occurs after felling of the tree, the knots formed are known as live knots. These knots are as hard as the remaining wood in the stem. In due course, due to decay in outer tissues, the dead knots become loose and fall out leaving a cavity in the wood. But the live knots are normally free from decay and, therefore, their chances or becoming loose are very rare. They will, therefore, not be of any harm to the wood except offering difficulty in working. (Fig 3).

Fig 3 A Knot

2. **Shakes.** When tree is not cut even after attaining full maturity the cohesion amongst the wood grains is lost due to evaporation of gums, moisture, resins and oils etc. Also burning or tissues and shrinkage of interior parts take place, which cause radial or circular ruptures in tissues and create cavities which are known as shakes.

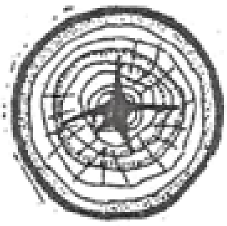


Fig 4 Heart shakes

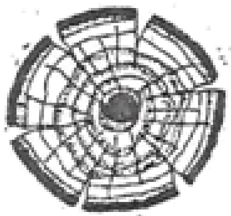


Fig 5 Star shakes

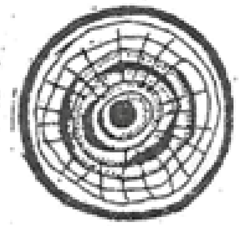


Fig 6 Cup shakes

When these cavities are in a direction from pith towards the sapwood, they are called heart shakes (Fig. 4). Against this, when these cavities emanate from the side of the bark and extend towards the pith they are known as star shakes (Fig. 5). If these cavities appear in between the annual rings, they are known as cupshakes (Fig. 6): Cupshakes are also produced sometimes due to excessive wind pressure which overcomes the adhesion between successive annual rings, causing the said cavity.

3. **Irregular grains or twisted fibres.** When the fibres of the wood have different inclinations with its axis or they are twisted.

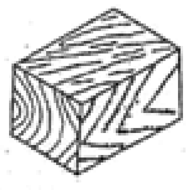


Fig 7 Innegular grains

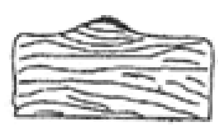


Fig 8 Rind gall

Called diagonal grains, so that they are no more parallel to the axis of the wood inspite of the fact that the piece is cut out of a straight grained log, defects occur. They mainly offer difficulty in working and a smooth surface cannot be obtained (Fig. 7). Such defects occur due to twisting of tree in different directions due to the blowing wind.

4. **Ring galls or burls.** These are the wounds created by the irregularly broken or cut branches at the place where they part off. At his point the new sapwood grows which does not unite with the parent wood, thus creating a sort of cavity between the two, where the decay takes place. (See Fig. 8)

4.7.2 DEFECTS OCCURRING DURING CONVERSION, SEASONING AND USE.

The following are the main defects which occur during conversion, seasoning and use of timber.

1. **Shakes.** Sometimes it happens that when the tree falls on the ground, during felling a heavy impact takes place between the two. This separates the adjoining layers of wood or causes cracks readily. Also during seasoning if the outer portion of the wood dries quicker than the internal an uneven shrinkages takes place. This also leads to the occurrence of shakes. The shakes produced due to the above are also of the same type as described earlier.

2. **Distortion.** It is reckoned that shrinkage starts in most of the woods when their moisture content falls below 25 percent. As such, if seasoning is not uniform and if such wood is swan into thinner sections, distortion takes places in the sawn sections due to shrinkage. As result of this distortion. some common defects like twisting, bowing cupping, end splitting, wind, crook, warping, etc., appear in the wood. These defects are shown in fig. 9

3. **Case hardening.** It is also an effect of uneven drying during seasoning. As stated above, the outer portion of the wood dries earlier and quicker than the inner one, causing shrinkage in the outer tissues and setting up drying stresses thereby. As a result of the same, the outer surface of the wood gets hardened.

4. **Honey-combing.** It is also a seasoning defect which occurs in chemical seasoning. It occurs due to the presence of the hygroscopic substance in the outer tissues of the wood, which makes the interior wood to dry quicker than the outer, setting the internal stresses thereby. This causes circular and radical cracks in the

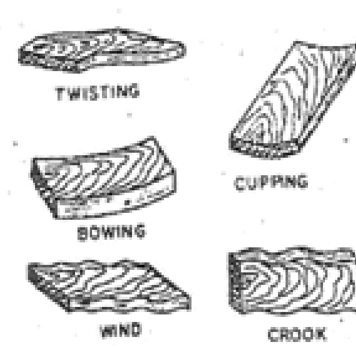


Fig 9 Defects in timber

wood which interest to produce the honey-comb structure in the wood.

4.7.3 DEFECTS DUE TO THE ACTIONS OF FUNGI AND INSECTS.

Fungi act on the wood tissues and cells to cause what is known as decay. They use the wood and cell contents as their food and destroy the same. The defect can be in two forms viz, Dryrot – caused by the attack of fungi on dry wood and wetrot - caused by the attack of fungi on living trees.

Generally, two types of insects cause defects in the wood. They are known as Beetle Termites and Marine borers. The former use wood as their food whereas the latter only produce holes in the wood to find shelter for living. Beetles are commonly found in temperate regions and termites in tropical and sub-tropical regions. White ants are the common termites found in our country. They attack the wood and reduce it to powdered from and make it hollow from inside. With the result, the colour and strength of wood are lost and it gets decayed.

4.8 CLASSIFICATION AND CONVERSION OF WOOD

4.8.1 CLASSIFICATION

Timbers, for commercial purposes, are divided into two classes : (1) soft wood, and (2) hard wood. These two terms however, have no reference to the hardness of the wood and they are only two botanical classifications.

Soft woods belong to conifers which have long narrow leaves. They contain turpentine and resinous matters in their cells. The average soft wood contains about 42 percent cellulose, 25 per cent hemicellulose, 30 per cent lignin and 3 per cent miscellaneous items. Lignin also known as 'wood glue' holds the other items together in the wood. It can be converted into vanillin or other resinous materials useful for foundry mould. Soft woods are light in weight and light coloured, have distinct annual rings but no visible medullary rays, and the colour of the sapwood is not distrinctive from their heartwood. The fibres are generally coarse but straight coarse but straight, and hence, capable of resisting direct axial stresses; but they cannot resist any kind of stress developed across their fibres and the timber gets splitted easily.

Hard woods belong to broad-leaved trees. An average hard-wood consists about 45 per cent cellulose, 25 per cent hemicellulose, 23 per cent lignin and 7 per cent miscellaneous items. The annual rings are more compact, thin and less distinct, but the medullary rays are visible in most, and in some cases very pronounced. Hard woods are darker in colour, comparatively heavy. The fibres are fine grained, compact, properly bonded, and often found very straight. So hard woods are nearly equally strong both along and across the fibres and can resist axial stress as well as transverse strain, shock and vibration quite satisfactorily.

Non-resinous or hard woods like Sal, Pyingads and Ash, which do not readily catch fire, are sometimes classed as refractory ; and the resinous or soft wood like Deodar. Pine, and Fir, which readily catch fire and burn because of the presence of resinous matter, are classed as non-refractory.

4.8.2 CONVERSION

After a tree is felled it is stripped of its branches and is then known as "log". The cutting of the log into usable pieces of timber is called conversion. The following are the common market forms of timber:

Log is the felled tree after being trimmed.

Black is the log squaring up.

Planks	:	275 to 450 mm wide and 75 to 150 mm thick.
Deals	:	Unto 225 mm wide and 50 to 100 mm thick.
Batten	:	Unto 135 mm thick and over 150 mm wide.
Quartering	:	25 x 25 mm2 unto 150 x 150 mm2 stuff.
Scantling	:	Odd-cut stuff, such as 75 mm x 50 mm, 100 mm x 50 mm, 100 mm x 75 mm, etc.

4.8.3 COMMON VARIETIES OF INDIAN TIMBERS

Indian timbers most commonly used for various wood-works are as follows .

Babul. The wood is pale red to brown in colour, close-grained, hard and tough, but elastic, and takes a good polish, they grow abundantly all over India and are used for bodies of cards and wheels, agricultural implements, tool-handles, etc.

Mahogany. The wood is of red brown colour, very durable when kept dry. Usually, it has fine, wavy grains, and uniform colour, It contains resinous oil which prevents attack of insects. They are available in Himalayas and used for pattern-making and cabinet work.

Mango. The wood is of inferior quality, coarse and open grained and of deep gray colour. They decay readily when exposed to moisture and are greedily eaten by white ants. They are largely found all over India, and being plentiful and cheap, widely used for common doors, windows and furniture.

Sal. The wood is of a dark brown colour, hard, close-grained heavy, resistant to white ants and durable. It seasons slowly, is hard to work and does not take a high polish. They grow abundantly in the forests at the foot of the Himalayas —also in Central India and South India and largely used for constructional purpose.

Sissu. They wood is dark brown in colour, tough, durable and has well-marked coarse grains. It is one of the best Indian woods for joiner's work—tables, chairs, and other furniture and is widely distribute in Northern and Northern and Central India.

Teak. The wood is brown in colour, Straight-grained, and is fragrant when freshly cut, very strong and durable, yet light and easily worked. It shrinks little, takes an smooth polish, and can be seasoned quickly. They are available in large quantities in Burma, Malabar and Central India, and suitable for practically every description of work.-

4.8.4 PLYWOOD

Plywood is made up of three or more layers. Out of these the central layer, called core, is usually thicker and of relatively inferior wood than the face veneers. The veneers glued at the top and bottom are known as face-plays. (See Fig. 10). The surface grains of adjacent layers are kept at right angles to each other. This arrangement prevents the plywood from warping and shrinkage. In case of 5-plywood two more plys are incorporated as shown in Fig. 11. They are known as cross-bands. The outer (i.e., top and bottom) plys in the plywood are always called face plys and the total number of plys, including the core, is always an odd number i.e., 3,5,7 and 9 etc. The common methods of joining the plys for obtaining the plywood are the following :

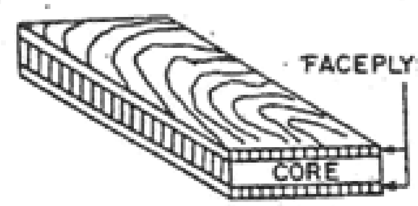


Fig 10 A 3- plywood piece.

1. Cold pressing method.
2. Hot pressing method.

For both the methods the surfaces of the cross bands are first made smooth by hand scraping and sanding. Then the glue is spread over both sides of these parts as shown in fig. 12. Core, cross bands and face plys are then arranged as shown in Fig. 11, and placed finally between the press boards for pressing. In cold pressing the adhesives are allowed to set at room temperature and no additional heat is provided. In hot pressing the arranged components are placed in a hydraulic press, of which the levers are heated elected components are placed in a hydraulic press, of which the levers are heated electrically. The corresponding pressure and temperature employed are about 7 to 14 kg per sq. cm and 150°C respectively.

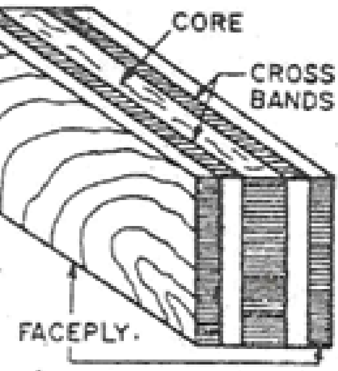


Fig 11 5-plywood

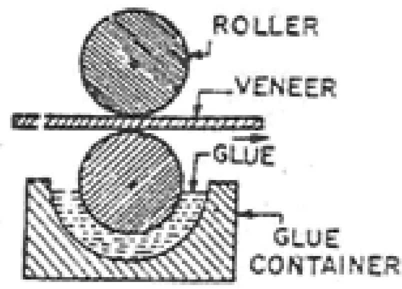


Fig 12 Glueing·

4.9 CARPENTRY TOOLS

In order to successfully work different forms to accurate shapes and dimensions, the wood-worker must know the use of a large number of tools. The principal types which are manipulated by hand are described and illustrated below :

1. Marking & Measuring tools.
2. Cutting tools
3. Planning tools
4. Boring tools
5. Striking tools
6. Holding & miscellaneous tools.

4.9.1 MARKING AND MEASURING TOOLS

Marking and measuring tools have been developed in order that true and accurate work may be assured. The commonest of such tools are :

Rules. Rules of various sizes and designs are used by wood workers for measuring and setting out dimensions, but they usually work with a four-fold box-wood rule ranging from 0 to 60 cm. This is graduated on both side in millimetres and centimetres, and each fold is 15 cm long. All the four pieces are joined with each other by means of hinged joints which make the scale folding.

For larger measurements carpenters use a flexible measuring rule of tape. Such rules are very useful for measuring curved and angular surfaces. When not in use, the blade is coiled into a small, compact, watch-size, case.

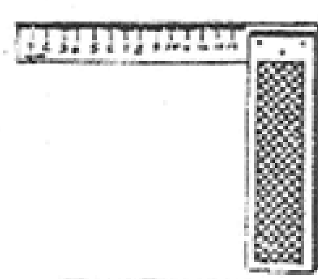


Fig 13 Try square

1. **Try square.** It is used for measuring and setting out dimensions, testing the finish of a planed surface, draw parallel lines at right angles to a place surface, draw mutually perpendicular lines over a plane surface and test the squareness of two adjacent surfaces. It

consists of a steel blade fitted into a wooden or metallic stock at fight angles to it. The inner surface, i.e., the surface which runs against the job during its used, is provided with a brass liner. The blade carries graduations either in inches and their parts or centimetre and millimetres (see fig. 13)

2. **Straight edge.** It is used for testing the trueness of surfaces and edges. It is made of either seasoned wood or steel, and its edge is made bevelled as shown in Fig. 14. It should be ensured that this edge is perfectly true and straight as it is this edge which is used for testing the trueness of other surfaces.

Fig 14 Straight edge

3. **Bevel square.** It is used for setting, duplicating, testing and comparing angles and bevels. It consists of a wooden or metallic stock fitted with a slotted blade. The blade can be adjusted at any point along the slot and at any angle from 0° to 180° with respect to the stock. The screw at the bottom is used to tighten the blade in position after it is set. A common type of bevel square is shown in Fig. 15.

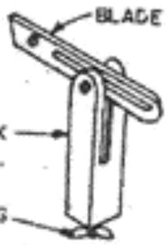


Fig 15 Bevel square

4. **Mitre square.** Mitre squares (Fig. 16) are used to measure an angle of 45°. They are made of all metal with a nickel - plated finish or with a steel blade, and an ebony or rose-wood stock. The blade varies from 200 mm, 250,, and so on to a maximum of 300 mm long.

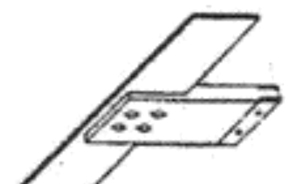


Fig 16 Mitre square

5. **Scriber or marking knife.** It is a steel rod having a sharp point at one end and a flat blade at the other, as shown in Fig: 17. It is mainly used for locating and marking points and scrubbing lines on wood surface.


Fig 17 Scriber

6. **Gauges.** Gauges are used to mark lines parallel to the edge of a piece of wood. It consists of a small stem sliding in s stock. The stem carries one or more steel marking points or a cutting knife. The stock is set to the desired distance from the steel pint and fixed by the thumbscrew. The gauge is then held firmly against the edge of the wood and pushed along the sharp steel point marking the line.

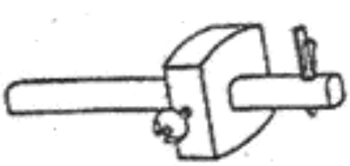


Fig 18 Gauges

6 a) **Marking gauge.** It is made of wood and is a very prominent tool for making. The stem is a long bar of wood of square or rectangular cross-section. The side faces are made a little curved as shown in Fig. 17. One of the curved side faces carries graduations. A sliding piece, called stock, also made of wood, carries brass liner at that face of it which is towards the scrubbing pin fitted in the stem. It is this face of the stock which remains in contract with the job surface during marking. The thumb screw helps in tightening the stock over the stem at any distance from a finished face or edge.

Marking gauge

7. **Mortise gauge.** It is an improved from of marking gauge. In addition to the provisions of a marking gauge, it carries a significant feature in that instead of only one scrubbing pin it has two, one of which is fixed as usual and the other in movable. The movable pin can be adjusted at any point between the stock and the fixed pin by means of a thumb screw provided at the end of the stem (see Fig. 19). Thus the two pins can be set at any desired distance apart. This enables scribing to tow parallel lines, at a required distance from one another and at a desired distance from an edge or surface, in a single operation. Its specific use is in making mortises and tenons and other similar joints requiring such parallel lines.

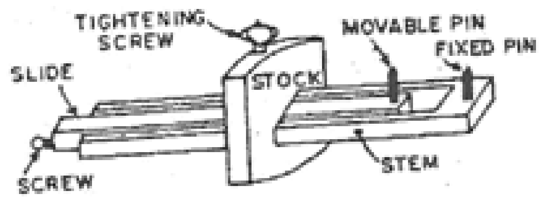


Fig 19 Mortise gauges

8. **Cutting gauge.** It is similar in construction to a marking gauge with the difference that it carries a steel cutter fitted in place of the marking pin of the marking gauge. It is mainly used for cutting parallel strips out of thin sheets of wood, upto 3 mm thickness, and for marking deep lines across the gains of the wood in thicker sections.

9. **Wing compass**. Wing are composed of two finely pointed steel legs which are set to the desired position and held by a set screw and quadrant. They are used when stepping off a number of equal spaces, marking circles or arcs, and when scrubbing parallel lines to straight or curved work.

10. **Trammel.** The trammel is a form of beam compass, with a wooden beam, to take in work that is beyond the scope of a compass.

11. **Divider.** Divider have both points sharpened in needlepoint fashion for dividing out centres.

12. **Calliper.** Callipers are used for measuring outside and inside diameters etc., especially where the sectional measurements cannot be taken.

Spirit level and plumb bob. These are used for testing the position of large surfaces. The spirit level tests for horizontal position. The plumb bob tests for vertical position. A combination of these two gives a right angle, and they are used where a try square be far too small.

13. **Carpenter's folding rule.** It is a wooden scale consisting of our pieces, each 6 inches or 15 cm long, joined together by means of hinged joints to make it folding. When opened out, its total length measures 2 feet or 60 cm and on being folded it measures equal to one piece length i.e., 6 in. or 15 cm. The inches graduations are divided further into eights and 16ths, whereas the centimetres. A good form of this rule is shown in Fig. 10.1. It is mainly used for measuring and setting out dimensions.

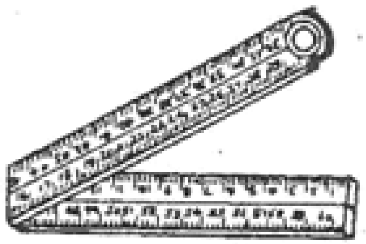


Fig. 10.1. Folding rule.

4.10 CUTTING TOOLS

CUTTING TOOLS INCLUDE SAWS, CHISELS, AND GOUGES.

Saws. The saw is probably the most abused of woodworking tools, chiefly because inexperienced users force it too much. When cutting across the gain, a different action is required from the saw teeth than when ripping with the gain. Therefore, different types of saws are used, as one type cannot do both jobs successfully. A saw is generally specified by the length of its blade measured along the toothed edge, and pitch of teeth length of its blade measured along the toothed edge, and pitch of teeth, expressed in mileometers. Fig. 20 shows the different types of saws in common use.

Rip saw. Rip saws are used for cutting along the grain in thick wood. The blade is made of high grade tool steel, and may be either straight or skew backed. It is fitted in a wooden handle made of hard wood by means of rivets or screws. Rip saws are about 700 mm long with 3 to 5 points or teeth per 25 mm.

The front or leading edge of the tooth forms a right angle with a line joining the points, and should be filed squared across the saw, with no bevel in front or back of the tooth. The action of these teeth is that of a series of chisels, which tear out shavings each equal to the width of a tooth. The teeth are bent alternately, one to the right, the next to the left. Bending the teeth in this manner is called 'setting in saw'. The set of a saw provides clearance to prevent the blade from binding during the sawing operation.

Cross-cut saw. Cross-cut saws, or 'Hand saws' as they are sometimes called, are used for cutting across the grain in thick wood. They are 600 to 650 mm long with 8 to 10 teeth per 25 mm. The action of the teeth is that of a series of knives which sever the fibres and force out the waste wood in the form of saw dust.

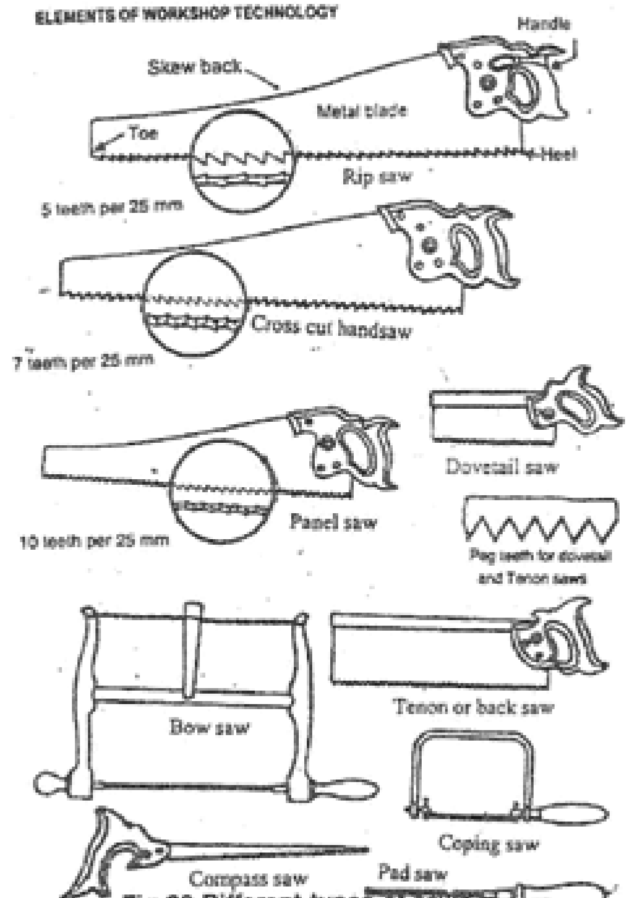


Fig 20 Different types of saws

Panel Saw. A panel saw is about 500 mm long with 10 to 12 teeth per 25 mm and is very much like the cross-cut 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.

Tenon or back saw. This saw is mostly used for cross cutting when a finer and more accurate finish is required. The blade being very thin, is reinforced with a rigid steel back. Tenon saw blades are from 250 to 400 mm in length and generally have 13 teeth per 25 mm. The teeth are shaped in the form of an equilateral triangle and are sometimes termed 'Peg' teeth.

Dovetail saw. A smaller version of the tenon, this saw is used where the greatest accuracy is needed and fine shallow cuts are to be made. The number of teeth may be from 12 to 18 per 25 mm, while the length may vary from 200 to 350 mm.

Bow saw. The Bow saw consists of a narrow blade, 250 to 350 mm long held in a wooden frame. The blade is held in tension by twisting the string with a small wooden lever. These saws are used for cutting quick curves and as the handles revolve in their sockets, the blade can be adjusted to any desired position when in use.

Coping Saw. The Coping saw has a very similar blade, held rigid in spring metal frame. The blade is tensioned by screwing the handle. This saw is used for small radius curves.

Compass saw. The Compass saw is used for sawing small curves in confined spaces and has a narrow tapering blade about 250 to 400 mm long, fixed to an open type wooden handle. There are two types of compass saw, one having a fixed blade and the other with three interchangable blades of different widths.

Pad or Keyhole saw. This is the joiners smallest saw, the blade being about 250 mm long. The blade of the pad saw is secured to the handle, through which it passes, by two screws. This arrangement allows the blade to be adjusted to the best length required according to the work. This saw is used for cutting key holes or the starting of any interior cuts.

Chisels. Wood chisels most commonly in use include firmer chisels, either square or bevel edged, paring chisels and mortise chisels

They are usually specified by length and width of the blade.

Firmer chisel. The firmer chisel (Fig. 21) is the most useful for general purpcses and may be used by hand pressure or mallet. It has a flat blade about 125 mm long. The width of the blade varies from 1.5-50 mm.

Fig 21 Firmer Chisel

Beveled edge firmer chisel. The beveled edge firmer chisel (Fig. 22) is used for more delicate or fine work. They are useful for getting into corner where the ordinary firmer chisel would be clumsy.

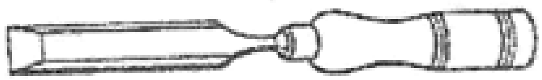


Fig 22 Beveled edge firmer chisel

Paring chisel. Both firmer and beveled edge chisels when they are made with long thin blades are known as paring chisel (Fig. 23). This is used for shaping and preparing the surfaces of wood and is manipulated by the hands. The length ranges from 225 to 500 mm and width from 5 -50 mm.

Fig 23 Paring chisel

Fig 24 Mortise chisel

Morstise chisel. The mortise chisel shown in Fig. 24, as its name indicates, is used for chopping out mortises. These chisels are designed to withstand heavy work. They are made with a heavy deep (back to front) blade with a generous shoulder or collar to withstand the force of the mallet blows on the oval -sectioned handle. Many mortise chisels are fitted with a leather washer at the shoulder to absorb the hard shocks of the mallet blows. Blades vary in width from 3-16 mm.

Gouges. Gouges (Fig. 25) are chisels with curved sections and may be either inside or outside ground. Inside ground gouges are used in exactly the same way for inside curved edges as a chisel would be for straight one ; outside ground gouges are used for curving hollows. Outside ground gouges are known as firmer gouges and inside ground gouges are called scribing gouges. When the later are made long and thin they are paring gouges. Gouges are made to large number of different curves for different work, and the size ranges from 6 mm, with intermediate sizes to a maximum of 40 mm wide.

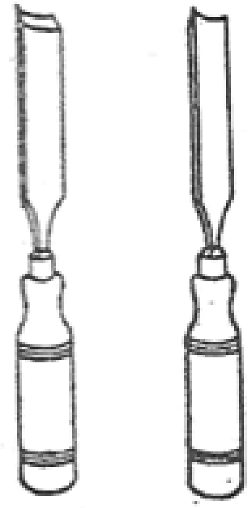


Figure 25 Gouges

4.11 PLANES

The place can be likened to the chisel fastened into a block of metal or wood, and its blade cuts exactly like a wide chisel. The planes, in general use, are the jack, trying, and smoothing planes, and are known as bench places, Besides, there are other planes which are used for special work.

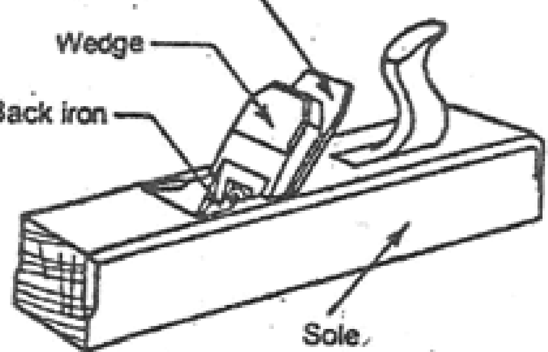


Figure 26 Jack plane

Jack plane. A jack place shown in Fig. 26 is the commonest and is used for the first truing-up of a piece of wood.

It consists of a block of wood into which the blade is fixed by a wooden wedge. The blade is set at an angle of 450 to the sole. On the cutting blade another blade is fixed called cap iron or back iron. This does not cut, but stiffens the blade near its cutting edge to prevent chattering and partially breaks the shaving as it is made. It is the back iron which causes the shavings to be curled when they come out of the plane. Some types of planes do not have a cap iron. Jack planes are obtainable from 350 to 425 mm in length and with blades 50 to 75 mm wide.

Trying plane. The trying plane (Fig. 27) is a finishing place, and is set with a very fine cut. It is used for producing as true surface or edge as possible, and is set to cut a shaving as thin as the smoothing plane. The length of

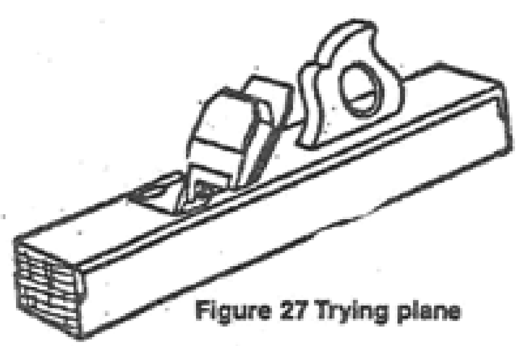


Figure 27 Trying plane

the plane varies from 550 to 650 mm and the section of the body is 85 mm by 85 mm, with irons 60 mm wide.

Smoothing plane. The plane (Fig. 28) is similar in action to a jack plane, except that it is set to cut a much thinner shaving. A smoothing plane, as its name indicates, is used for smoothing or finishing after a jack plane. The cutting edge of the latter is slightly curved, but a smoothing plane has a straight cutting edge. It is 200 to 250 mm long having a blade of 70 mm wide.

Rebate plane. A rebate is a recess along the edge of a piece of wood ; this forms a ledge which is used for positioning glass in frames and doors. The rebate plane shown in Fig. 10.19 is used for sinking one surface below another, and shouldering one piece into another. The blade is open at both sides of the plane, and must be perfectly straight at the cutting edge. Widths range from 12 to 50 mm.

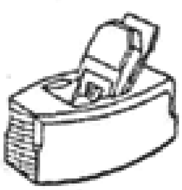


Fig 28
Smooting Plane

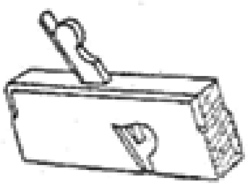


Fig 29
Rebate Plane

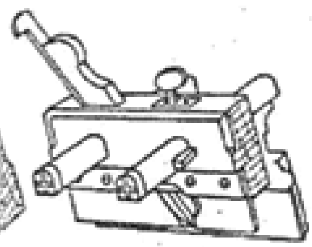


Fig 30
Plough Plane

Plough plane. Where a panel is needed in a door it is used to fit is into a groove, not into a rebate. The plough plane illustrated in Fig. 30 is used to cut these grooves. The dept the groove is controlled by t a depth gauge which is fixed on the body of the plane and operated by a thumbscrew. These planes are usually supplied with eight to nine blades, vary in width from 3 to 15 mm and, of course, they are all interchangeable.

Spokeshave. This is a form of small plane used for cleaning up quick curves (See Fig. 31). There are two types one which has a flat sole for outside curves and one which has a curved sole for inside curves.

Now-a-days, spokeshaves are made of iron, and some have a screw adjustment for the amount of cut.

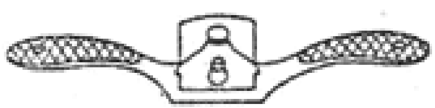


Fig 31 Spokeshave

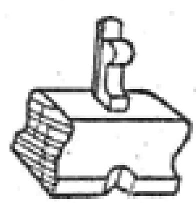


Fig 32 Router

Router. The router plane (Fig. 32) does not resemble other planes. This is used for cleaning out and levelling the bottom of grooves or trenches to a constant depth, after the bulk of the waste material has been taken out with saw and chisel.

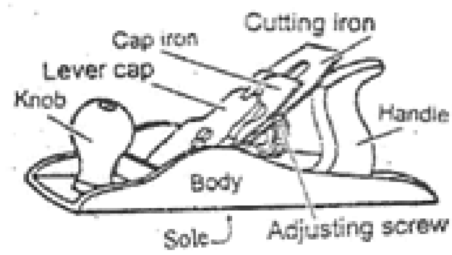


Fig 33 Metal jack plane

Metal Plane. Metal planes serve the same purpose as the wooden planes but facilitate a smoother operation and better finish. The body of a metal plane is made from a gray iron casting, with the side and sole machined and ground to a bright finish. The thickness of the shaving removed is governed by a fine screw adjustment, and a lever is used for adjusting the blade at right angels. A metal jack plane us shown in Fig. 33.

Special plane. In addition to those described above there are a number of special planes used by the woodworker to do special work. They include compass or circular plane for planning curves ; bull nose rebate plane for cleaning into rebates and corners inaccessible with other planes ; shoulder plane for planning across the end grain or hardwood shoulders; block plane for planning small parts, especially when model making; and moulding plane for producing a particular size and shape of moulding.

4.12 BORING TOOLS

Boring tools are frequently necessary to make round holes in wood, and they are selected according to the type and purpose of the hole. They include bradawl, gimlet, brace, bit and drill.

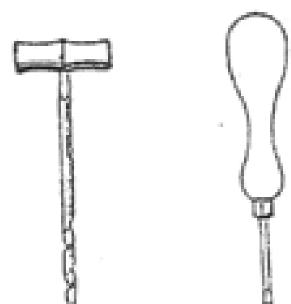


Fig 34 Bradawl & Gimlet

Bradawl and Gimlet. The bradawl and the gimlet illustrated in Fig. 34 are hand-operated tools, and are used to bore small holes, such as for starting a screw or large nail.

Brace. The brace is a tool used for holding and turning a bit for boring holes. It has two jaws, which grip the specially shaped end of the bit. There are two types of braces in common use – ratchet brace and wheel brace. The ratchet brace is most useful for turning bits and drills of all kinds, being adaptable (a) for working in confined situation, and (b) for when the cut is particularly heavy and it is desirable to pull the handle through a quarter-turn only. A ratchet brace is shown in Fig. 35


Fig 35
Ratchet brace

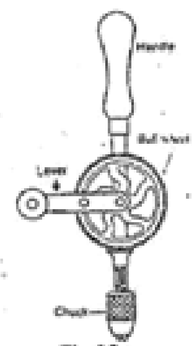


Fig 36
Wheel brace

The wheel brace (Fig. 36) is used to hold round and parallel-shanked drills. This tools is invaluable for cutting small hole, accurately and quickly.

Bit. Most other forms of boring tools consists of "bits". The common types of bits used are shown in Fig. 37 and described below:

Shell bit. This bit is used for boring holes unto 12 mm diameter and which do not require a high degree of finish or size.

Twister bit or auger bit. It has a screw point and a helical or twisted stem. This bit produces a long, clean, and accurate hole either with or across the grain. This may be obtained in sizes from 6 to 35 mm diameter. The shorter type is called "dowel" bits and is used for preparing true and accurate holes to receive dowels.

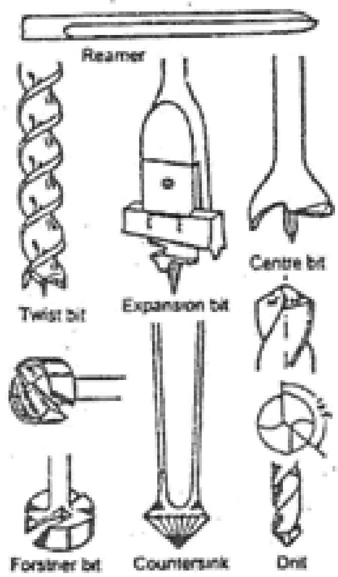


Fig 37 Types of bits

Expansive bit. In an expansive bit the min cutter can be adjusted to varying diameter within a certain range. It is fixed to the desired mark on the scale, and clamped in position by the plate and screw. Expansive bits are made in four sizes with interchangeable cutter for boring holes from 12 to a maximum of 125 mm diameter.

Centre bit. The centre bit is the most common. It is used for forming shallow holes across the grain. Centre bits produce and accurate and clean hole and may vary from 3 to 35 mm in diameter.

Forstner bit. It is extremely useful for sinking clean hole partly through a piece of wood and for cleaning out recesses. It has a small centre point for commencing and is then guided by its outer rim.

Countersink bit. It is used to shape a hole to fit the head of a countersunk headed screw.

In addition to the foregoing there are, of less importance, nose bit, spoon bit, lip and spur bit, screw driver it, etc.

Drill. Morse drills very convenient for making screw holes, especially when used with a wheel brace. This is adapted for drilling holes when wooed working bits wood be spoiled.

Reamers are tapered bits shaped like shell bits and used for enlarging holes.

CARPENTRY POWER TOOLS

These days, power tools have largely replaced hand tools, because they allow site carpenters and bench joiners to work with increased speed, more efficiency and greater accuracy. Power tools are available with a variety of power sources including mains power, battery and compressed air. Carpenters use a range of power tools to cut, shape and install timber in building construction and fit-out. There are several categories of power tools, each designed to carry out specific functions. They're usually available in a range of shapes and sizes.

JIGSAW

Although jigsaws cut more slowly than circular saws, they can cut curved shapes into materials such as timber, metal and plastic. They're commonly found in joinery workshops but can also be useful on site for cutting holes in, for example, kitchen worktops for sinks. Most models now have a variable speed control so that you can select the best speed for the job. Fast speeds are more suitable for cutting timber and slower speeds for cutting metal. The base plate of a jigsaw can be tilted to allow bevelled cuts. The teeth of a jigsaw point upward, so the cutting is done during the up-stroke. This can result in damage to the surface of the timber, especially on sheet materials such as plywood. If necessary, clearance must be allowed for the edges to be cleaned up afterwards. There are blades available with teeth which point downwards and these are useful when cutting material such as plastic laminates. However, you must take extreme care when using this type of blade as it can cause the saw to 'lift' away from the work surface. To prevent this, always maintain downward pressure on the saw. Some models have a mechanism which produces an orbital motion in the blade. This means that the blade moves forward on the up-cut and pulls back for the down-cut which results in a faster (but possibly rougher) cut. A control allows the orbital motion to be reduced to zero for clean cutting.

POWER PLANES

Electric planes are regularly used on construction sites for planing the edges of doors during the fitting process. They can also be used to perform operations such as chamfering (removing the corner of a piece of timber on an angle) and rebating (taking a square recess out of the corner of a piece of timber). Although electric planes vary from model to model, they are all very similar in appearance and have many of the same features.

CIRCULAR SAW

No other power tool has given carpenters a greater advantage over old hand‐ powered methods than the portable circular saw (also known as a skill saw). It’s widely used on construction sites for cutting timber and sheet materials such as plywood and chipboard.

The circular saw is used primarily for ripping and cross‐ cutting, but it can also be adjusted to perform a number of other operations such as grooving, rebating and trenching as well as making bevelled and compound cuts.

ROUTER CUTTER OR BIT

There are many different router cutters and/or bits available. Some are used for forming rebates and grooves for jointing and other practical purposes, and others are used for forming decorative mouldings. All router bits are secured into the router with a collet – a sleeve with a split in the side. When the chuck is tightened, the collet is squeezed tight and grips the shaft of the bit. Incorrect fitting of the collet or bits can result in very serious injury to the operator. Most router bits have a 6 mm or 12 mm shaft. A 12 mm shaft fits directly into the chuck, but a 6 mm shaft needs a reduction sleeve.

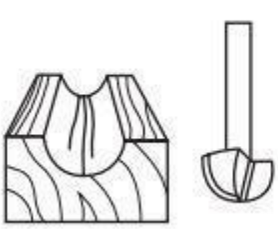
Straight bit

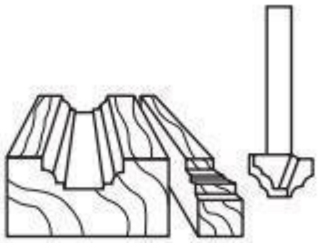
Straight bits cut grooves, trenches and rebates.

They can be used to form:

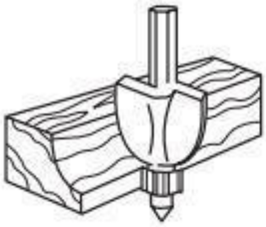
•housings for shelving and stair construction

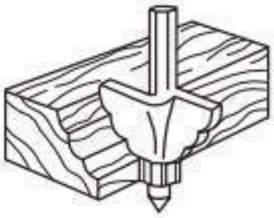
•grooves for drawer bottoms
•rebates in doors and windows for plywood or glass.
They're available with different ends for forming a variety of shaped grooves such as those shown here.

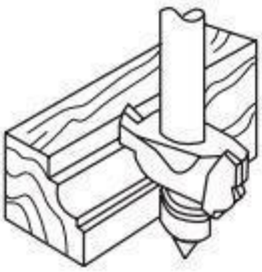


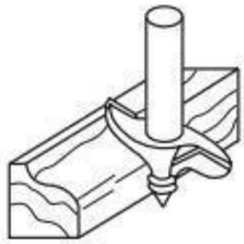


Edge-forming bit
Edge-forming bits produce a shaped edge to timber or manufactured boards such as MDF.









ORBITAL SANDER

Orbital sanders (also known as finishing sanders) sand in a circular motion, and are used to achieve a fine, smooth finish on timber surfaces. They are not suitable for 'flushing off' joints or removing wood quickly. A reciprocating sander is very similar to the orbital sander but its motion is back and forth rather than circular. The base of the sander has a soft rubber pad and the abrasive paper is held to it by a spring clip. This paper can be bought in packs of pre-cut pieces or cut to size from standard sized sheets or rolls. The base of the sander rotates in a circular motion at approximately 12 000 rpm. The circular motion of the abrasive paper can leave swirl marks on the timber surface, which may only become visible after you've stained or polished the timber. If a very fine finish is required, you should carry out a final sanding by hand in the direction of the grain.

FITTING POWER TOOLS

A power tool is a tool that is actuated by an additional power source and mechanism other than the solely manual labor used with hand tools.

The most common types of power tools use electric motors. Internal combustion engines and compressed air are also commonly used. Other power sources include steam engines, direct burning of fuels and propellants or even natural power sources like wind or moving water. Tools directly driven by animal power are not generally considered power tools.

Power tools are used in industry, in construction, and around the house for purposes of driving (fasteners), drilling, cutting, shaping, sanding, grinding, routing, polishing, painting, heating and more.

Power tools are classified as either stationary or portable, where portable means hand-held. Portable power tools have obvious advantages in mobility. Stationary power tools however often have advantages in speed and accuracy and some stationary power tools can produce objects that cannot be made in any other way. Stationary power tools for metalworking are usually called machine tools.

The term machine tool is not usually applied to stationary power tools for woodworking, although such usage is occasionally heard, and in some cases, such as drill presses and bench grinders, exactly the same tool is used for both woodworking and metalworking

Benefits of Portable Power Tools

With the increasing number of individuals interested in performing home improvement projects by themselves, portable power tools are also becoming more available in local hardware stores. These gadgets, which look like miniature construction machineries for homeowners, are very beneficial for you.

For one, they can let you save time because they can instantly hammer nails, quickly drive screws, and rapidly cut wood and virtually other materials effortlessly. With traditional tools, you have to do everything manually and more often than not, your project would not get finished in just a few days. Aside from reducing project time significantly, the use of portable power tools also allows you to finish your task with minimal energy. Thus, after doing the job, you still have strength to do more important projects or to spend quality time with your family.

You can also save money when using portable power tools because these gadgets can drive screws and nails flawlessly, drill holes accurately, and cut wood and metals neatly. This means that you reduce the occurrence of wasted materials due to inappropriate drilling or cutting as well as doing your projects all over again because you are not satisfied with how the nails or screws are driven.

Moreover, many portable power tools are designed to allow you to do various tasks conveniently even in limited spaces where using traditional tools can be difficult. Among these tasks include driving nails in tight corners.

Various Types Power Tools

IMPACT DRIVER:

An **impact driver** is a tool that delivers a strong, sudden rotational and downward force. In conjunction with toughened screwdriver bits and socket sets, they are often used by mechanics to loosen larger screws (bolts) and nuts that are corrosively "frozen" or over-torque. The direction can also be reversed for situations where screws have to be tightened with torque greater than a screwdriver can reasonably provide.

CHAIN SAW:

A **chainsaw** (or **chain saw**) is a portable mechanical saw, powered by electricity, compressed air, hydraulic power, or most commonly a two-stroke engine. It is used in activities such as tree felling, limbing, bucking, pruning, by tree surgeons to fell trees and remove branches and foliage, to fell snags and assist in cutting firebreaks in wild land fire suppression, and to harvest firewood. Chainsaws with specially designed bar and chain combinations have been developed as tools for use in chainsaw art. Specialist chainsaws are used for cutting concrete.

ANGLE GRINDER:

An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing.

Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be used as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired.

Angle grinders may be used both for removing excess material from a piece or simply cutting into a piece. There are many different kinds of discs that are used for various materials and tasks, such as cut-off discs (diamond blade), abrasive grinding discs, grinding stones, sanding discs, wire brush wheels and polishing pads. The angle grinder has large bearings to counter side forces generated during cutting, unlike a power drill, where the force is axial.

Angle grinders are widely used in metalworking and construction, as well as in emergency rescues. They are commonly found in workshops, service garages and auto body repair shops.

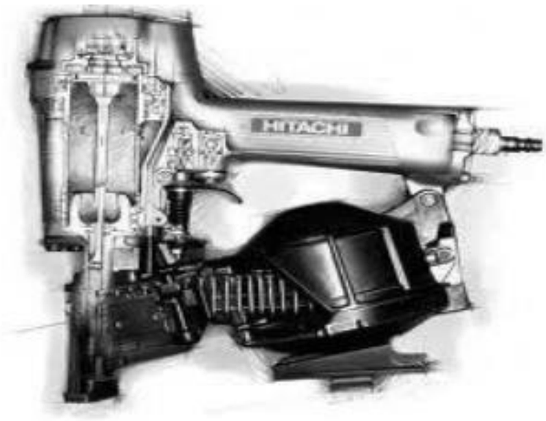
DRILLING MACHINE:

A drill is a tool fitted with a cutting tool attachment or driving tool attachment, usually a drill bit or driver bit, used for drilling holes in various materials or fastening various materials together with the use of fasteners. The attachment is gripped by a chuck at one end of the drill and rotated while pressed against the target material. The tip, and sometimes edges, of the cutting tool does the work of cutting into the target material. This may be slicing off thin shavings (twist drills or auger bits), grinding off small particles (oil drilling), crushing and removing pieces of the work piece, countersinking, counter boring, or other operations.

Drills are commonly used in woodworking, metalworking, construction and do-it-yourself projects. Specially designed drills are also used in medicine, space missions and other applications. Drills are available with a wide variety of performance characteristics, such as power and capacity.


NAIL GUN:

A nail gun, nailgun or nailer is a type of tool used to drive nails into wood or some other kind of material. It is usually driven by electromagnetism, compressed air (pneumatic), highly flammable gases such as butane or propane, or, for powder-actuated tools, a small explosive charge. Nail guns have in many ways replaced hammers as tools of choice among builders.

IMPACT WRENCH:

An impact wrench (also known as an impactor, air wrench, air gun, rattle gun, torque gun, windy gun) is a socket wrench power tool designed to deliver high torque output with minimal exertion by the user, by storing energy in a rotating mass, then delivering it suddenly to the output shaft.

Compressed air is the most common power source, although electric or hydraulic power is also used, with cordless electric devices becoming increasingly popular in recent times.

Impact wrenches are widely used in many industries, such as automotive repair, heavy equipment maintenance, product assembly (often called "pulse tools" and designed for precise torque output), major construction projects, and any other instance where a high torque output is needed.

CUT OFF MACHINE:

An abrasive saw, also known as a cut-off saw or metal chop saw, is a power tool which is typically used to cut hard materials, such as metals. The cutting action is performed by an abrasive disc, similar to a thin grinding wheel. The saw generally has a built-in vise or other clamping arrangement, and has the cutting wheel and motor mounted on a pivoting arm attached to a fixed base plate.

They typically use composite friction disk blades to abrasively cut through the steel. The disks are consumable items as they wear throughout the cut. The abrasive disks for these saws are typically 14 in (360 mm) in diameter and 7⁄64 in (2.8 mm) thick. Larger saws use 410 mm (16 in) diameter blades. Disks are available for steel and stainless steel.

Power Tool Safety Tips

1. Safety glasses: These prevent dust, debris, wood shavings, shards from fiberglass, etc from getting into the eyes. Safety glasses are one of the most basic pieces of safety equipment that must be used when working with power tools.

2. Protection for the ears: Power tools can generate a lot of noise, which may sound louder in the cloistered environment of a workshop; in order to minimize damage to the ears, it is advisable to wear earplugs.

3. Knowing the right tools for the job: It is important to know the right tools for the job in order to avoid injury to oneself and damage to the materials. To this end, it is advisable to thoroughly read the instruction manuals provided with the equipment and get familiar with the recommended safety precautions.

4. Correct method of using tools: Tools should not be carried by their cords; tools that are not in use should be disconnected; and while handling a tool connected to a power source, fingers should be kept away from the on/off switch.

5. The right clothes: Long hair should be tied and loose clothing should be avoided. Ideally, clothing that covers the entire body should be worn and heavy gloves should be used in order to avoid sharp implements and splinters from hurting the hands. Masks prevent inhalation of harmful minute particles of the material that is being worked upon. Steel-toed work boots and hard hats can also be worn.

6. Tool inspection: Power tools should not be employed in wet environments and should never be dipped in water; they should be checked periodically for exposed wiring, damaged plugs, and loose plug pins. Nicked cords can be taped but if a cut appears to be deep, a cord should be replaced. Tools that are damaged or those that sound and feel different when used should be checked and repaired.

7. Cleanliness in the work area: This should be maintained because accumulated dust particles in the air can ignite with a spark. Of course, flammable liquids should be kept covered and away from the place where power tools are being used. An uncluttered work area also makes it easy to maneuver the power tool; often distractions caused by a tangled cord can result in an accident.

8. Care with particular tools: Miter saws and table saws should be used with a quick-release clamp and a wood push-through, respectively. Extra care should be taken while using nail guns and power belt sanders.

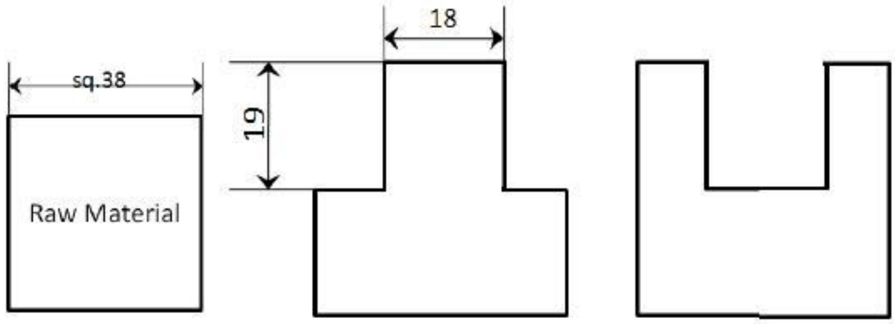
9. Keep tools in place: Power tools should be returned to their cabinets after use to prevent them from being used by an unauthorized and incapable person.

10. Lighting: It is important to use proper lighting while working with power tools, particularly when working in the basement and garage where lighting may not be satisfactory.

EXPT.NO: 01

SQUARE CUTTING

AIM: To make a Square fit from the given mid steel pieces.
MATERIALS REQUIRED: mild steel flat (40*40*3mm).
TOOLS AND EQUIPMENT REQUIRED:
1.6"try square
2. 6"sriber
3. Odd leg caliper
3.12"hack saw Frame



5. 10"rough file
6. 10"smooth file
7. 10"Square file
8. Dot punch
9. Ball peen hammer (0.5Ib).
10. Steel Rule

SEQUENCE OF OPERATIONS:
1. Filling
2. Marking
3. Punching
4. Sawing
5. Filling
6. Finishing

PROCEDURE:
1. The given mild steel flat piece is checked for given dimensions.
2. One edge of given is filled to straightness with rough and smooth files and checked with try square.
3. An adjacent is also filled such that is square to first edge and checked with try square.
4. Wet chalk is applied on one side of the flat and dried for making.
5. Lines are marked according to given figure, using odd leg caliper and steel rule.
6. using the dot punch are made along the marked lines.
7. The excess materials removed from the remaining two edges with try square level up to half of the marked dots.
8. Finally buts are removed by the filling on the surface of the fitted job.

PRECAUTIONS:
1. The perpendicularity of face ends edges is checked perfectly by using try square.
2. Finishing is given by using only with smooth files.
3. Marking is done without parallax error.

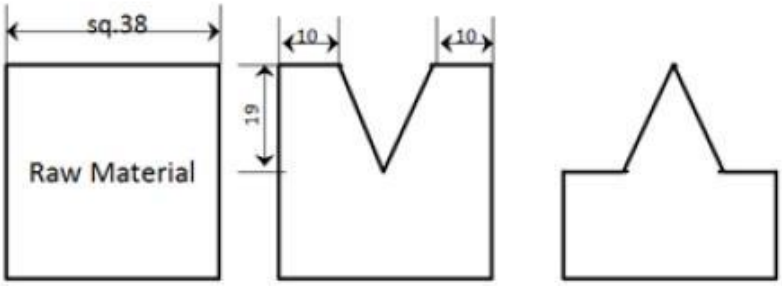
RESULT: The Square cutting is done successfully

EXPT.NO: 02
V-FITTING

AIM: To make a V-Fit from the given mid steel pieces.
MATERIALS REQUIRED: Mild steel flat (40*40*3mm).
TOOLS AND EQUIPMENT REQUIRED:

1.6"try square
2. 6"sriber
3. Odd leg caliper
3.12"hack saw Frame

5.10"rough file
6.10"smooth file
7.10"triangle file
8. Knife Edge file
9. Dot punch
10. Ball peen hammer (0.5 Ib)
11. Steel Rule



SEQUENCE OF OPERATIONS:

1. Filling
2. Marking
3. Punching
4. Sawing
5. Filling
6. Finishing

PROCEDURE:

1. The given mild steel flat piece is checked for given dimensions.
2. One edge of given is filled with rough and smooth files and checked with try square for straightness.
3. An adjacent edge is also filled such that it is square to first edge and checked with try square.
4. Wet chalk is applied on one side of the flat and dried for marking.
5. Lines are marked according to given figure, using odd leg caliper and steel rule.
6. Using the dot punch, punches are made along the marked lines.
7. The excess materials removed from the remaining two edges with try square level up to half of the marked dots.
8. Finally buts are removed by the filling on the surface of the fitted job.

PRECAUTIONS:

1. The perpendicularity of face ends edges is checked perfectly by using try square.
2. Finishing is given by using only with smooth files.
3. Marking is done without parallax error.

RESULT: The V-fit is done successfully.

SAFETY PRECAUTIONS

Safety Precautions

When operator enters into the workshop he should first observe safety to save himself and others.

Precautions when using machines

i) Do not lean against the machine, it is a bad practice and also a dangerous one.

ii) Do not work on a machine in bad light.

iii) Never switch on a machine unless or otherwise you know all mechanism and operation of machine.

iv) When using any grinding parts, protect the eyes by wearing goggles or using shields.

v) Do not clean metal chips by hand, use wire brush for cleaning.

vi) Be in a habit of cleaning the machine, equipments and tools regularly.

Precautions in workshop

i) Keep the workshop neat and tidy. Many accidents are caused due to people tipping over things left, trying over gangways.

ii) Do not run on in the workshop. Walk carefully.

iii) See that the floor is free from slippery substances.

iv) Keep gangways clean and clear.

v) Everything should be in place and wasting should be provided to throw waste metal pieces.

vi) Workshop should have proper lighting and ventilation.

Precautions while using hammer

i) There should be no grease or oil on the handle.

ii) Hammer head should not be projecting outward.

iii) Handle should not be too long or too short.

Precautions while using chisel

i) It should be handled carefully and must be grounded.

ii) Goggles must be used while chipping.

Precautions while using file

i) The finger of left hand must not be crooked under file as this may injure the fingers.

ii) Metal chips must not be removed while doing job by bare hands where brush is used.

iii) Files without handles or those with crook must not be used

Precautions during welding

i) We should never use oxygen cylinders near inflammable substances.

ii) Acetylene or oxygen cylinder must be kept separately.

iv) Do not weld in continued space without adequate ventilation.

v) We should always use goggles while welding.

vi) Make sure that connection are air tight by using soap water.

vii) Never use matches for lighting while welding.

viii) When welding is to be stopped, close the cylinder value and release all the gas pressure from regulators and holes by opening torch. When regulator shows zero, release pressure, adjusting screw and closing values.

Precautions on clothing

i) Tight fitting coats are safer than loose fitting coats.

ii) Avoid wearing rings, long sleeved shirts and watches while working.

iii) Clear covered footwear having thick soles and tough above.

iv) Hair must be combed well and kept away from danger.

Viva Questions

1. Fitting

1. What is meant by fitting ?
2. Name the commonly used material for preparing fitting models ?
3. Specify the composition of M.S.
4. What are commonly used tools in fitting shop ?
5. What is a vice ? Name the different types of vices ?
6. What is file ? Name the different types of files ?
7. Define filling ? Name the materials used in the manufactures of files.
8. What is meant by single cut & double out files.
10. Name different types of Hammers ?
11. What are hard & soft Hammers ?
12. What is a chisel ? Name the different types of chisel ?
13. Define chipping ?
14. Differentia e between cold chisel & hot chisel ?
16. What is a Hacksaw ? Name the material of hack saw blade
17. Define sawing ? Sho, you seleet different hacksaw bladss for cutting different materials or only one blade is sufficient to wt all materials ?
18. Name the different types of marking tools used in fitting ?
19. Name the different types of measuring tools used in fitting ?
20. Name the devices used for holding the components while marking ?.
21. Mention the use of inside callepers, outside callipers and divider ?
22. Mention the use of V-block ?
23. Mention the use of try square
24. What is suface plate & what is its use.

2. Welding

1. Define welding ?
2. What are the applications of welding ?
3. How are welding classified ?
4. Define Arc welding ? Descrise the principle of are welding with suitable weeding circvit diagoam
5. Name types of electrodes used in are welding ?
7. Describe the features of nevtral, oxidizing, & reducing flames
8. What are the advantages of oxidisins & reducing flames.
9. Name some of the tools and equipments used in arc welding ?
10. Differentiate between AC are welding and DC are welding ?
11. Name some of the welding defects ?
12. What are the advantages and disadvantages of welding ?
13. Name the different welding joints ?
14. Mention the use of chipping hammer in welding ?

3. Sheet metal

1. Describe the process of sheet metal work ?
2. What are the engineering applications of sheet metal work ?

3. Mention the different materials used in sheet metal work ?
4. What are the different methods of joining the sheet metal ?
5. What is a G. I. Sheet ? What is the propose of wire gaze ?
6. What is a galvanisation ? Why it is required ?
7. Name the different types of stakes used in sheet metal work ?
8. Define soldering ?
9. What are the applications of soldering ?
10. What is a sloder ?
11. What kinds of solders are commonly used ?
12. Why lead is used as a solder in soldering ?
13. What is a flux and why it is used ?
14. Which is the most important operation in soldering
15. What is the purpose of using soldering iron ?
16. Define brazing ? Classify the different types of brazins.
17. What are advantges of brazing.
18. Different atc b/w soldering & Brazing.

4. Carpentry

1. What do you understand from the term joinery ?
2. What are the advantages of timber ?
3. With a neat sketch, explain the structure of wood.
4. Differentiate between Soft wood and Hard wood.
5. Name the factors to be considered for selection of wood.
6. Define seasoning of wood.
7. Explain different methods of seasoning.
8. What are the common defects in wood ?
9. How do you classify wood ?
10. Name the different types of wood.
11. How are the wood working tools classified according to their use
12. Give a list of markinh and measuring tools.
13. Differentiate between Tri Square and Mitre Square
14. Differentiate between Marking gauge and Mortise gauge
15. List different types of saws used in carpentry
16. Differentiate between Rip Saw and Cross cut saw.
17. What is setting of saw teeth ?
18. Describe the construction and use of
    (1) Tenon Saw (2) Bow Saw (3) Dovetail Saw
    (4) Compass Saw (5) Pad Saw
19. Name the different planes used in wood working
20. Explain different parts of a metal Jack Plane.
21. List different Boring tools used in wood working
22. What are the principal striking tools used in wood work ?
23. What is Rachet Brace ? What is the advantage of Rachet brace in it ?
24. Describe the process of marking and laying out and state its significance.
25. What are the different joints used in wood working ?

Model No. ....

Date	Time	
		Signature of the Instructor .... Signature of the Staff Incharge ....