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 coconut, 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[illegible]le it which becomes the cambium layer.

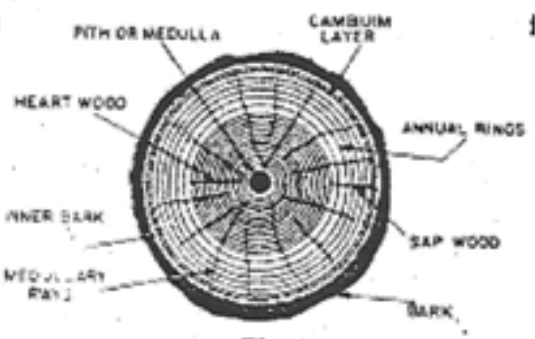


Fig 1

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 rings. 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.

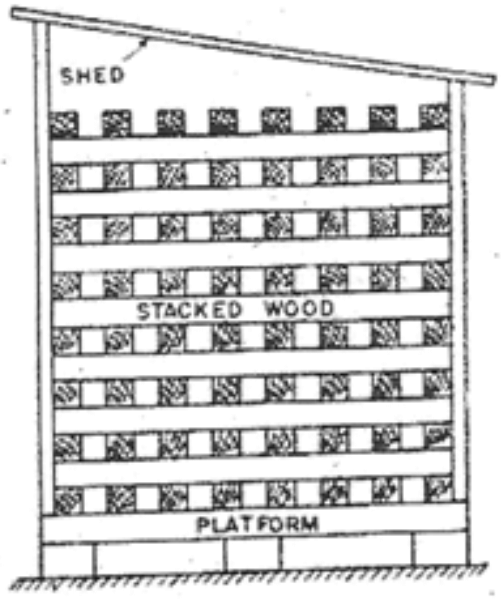


Fig 2

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

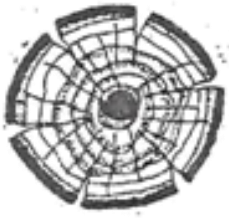


Fig 5 Star shakes

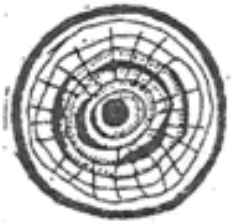


Fig 6 Cup shakes

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 dry quicker than the outer, setting the internal stresses thereby. This causes circular and radical cracks in the

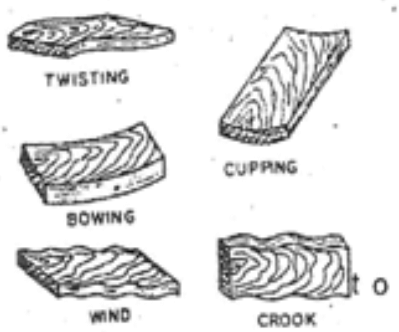


Fig 9 Defects in timber

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 tc white ants and durable. It seasons slowly, is hard to work and does not take a higl

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 :

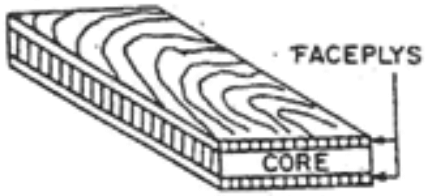


Fig 10 A 3- plywood piece.

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.

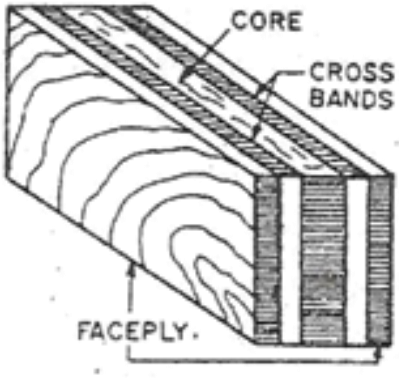


Fig 11 5-plywood

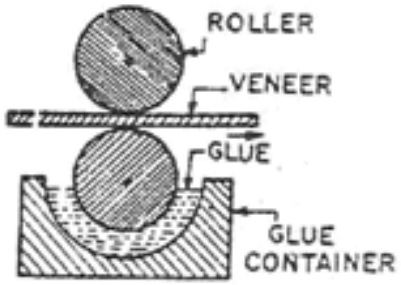


Fig 12 Glueing

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.

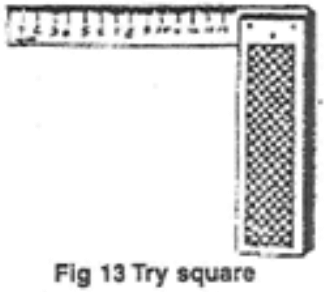


Fig 13 Try square

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.

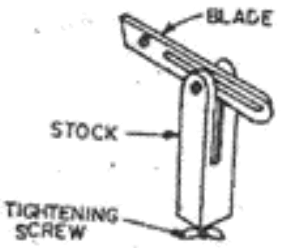


Fig 15 Bevel square

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.

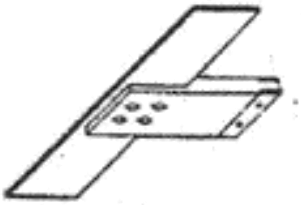


Fig 16 Mitre square

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.

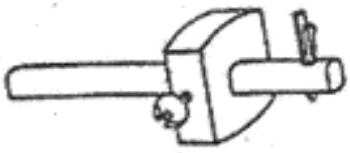


Fig 18 Gauges

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.

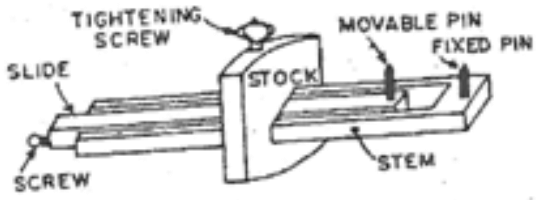


Fig 19 Mortise gauges

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.

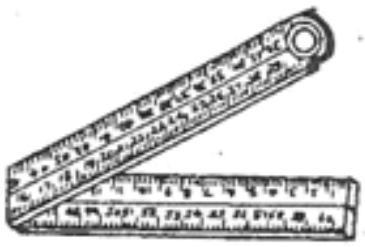


Fig. 10.1. Folding rule.

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.

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.

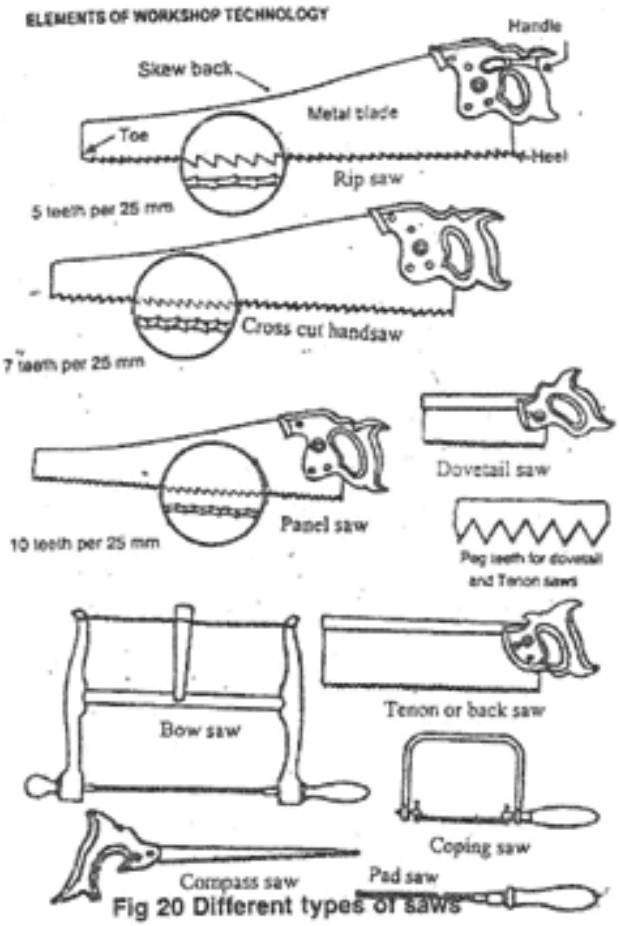


Fig 20 Different types of saws

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

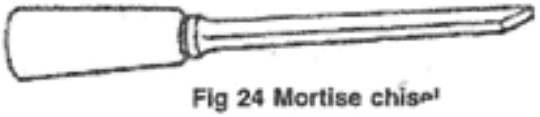


Fig 24 Mortise chisel

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.

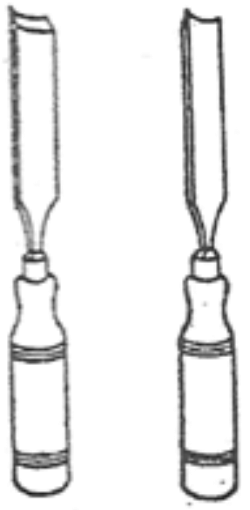


Figure 25 Gouges

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.

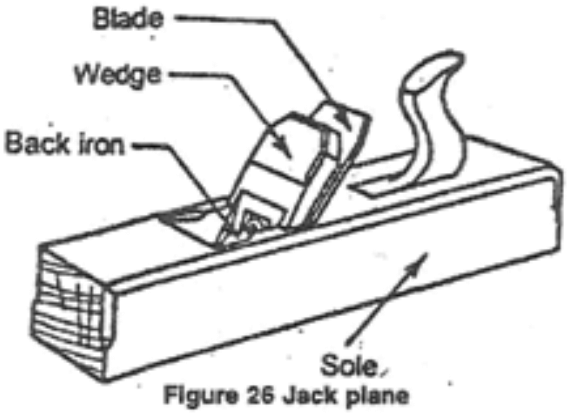


Figure 26 Jack plane

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.

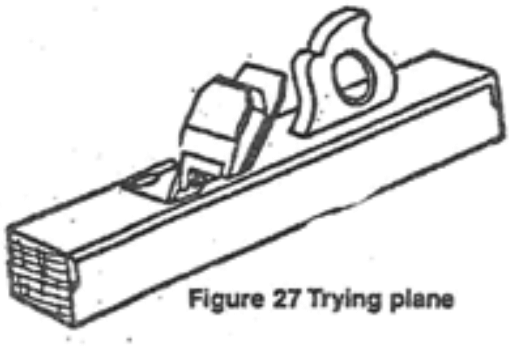


Figure 27 Trying plane

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

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

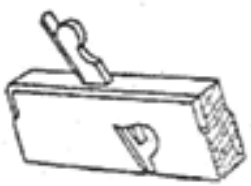


Fig 29
Rebate Plane

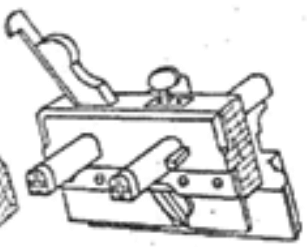


Fig 30
Plough Plane

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

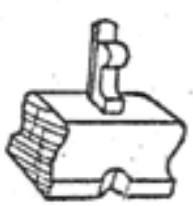


Fig 32 Router

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.

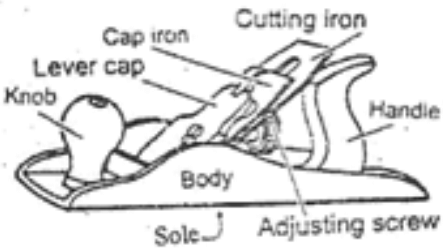


Fig 33 Metal jack plane

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 mouiding.

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

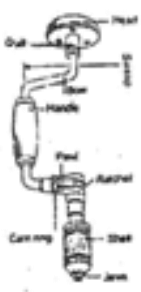


Fig 35 Ratchet brace

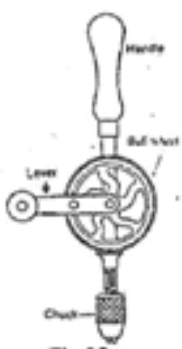


Fig 36 Wheel brace

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.

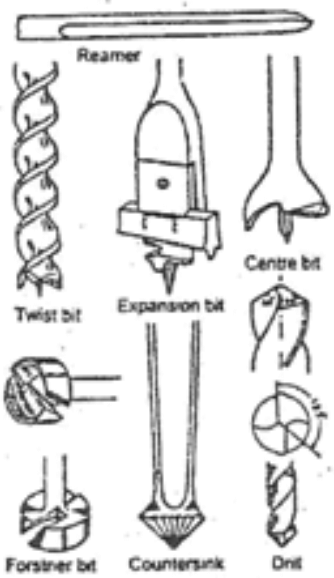


Fig 37 Types of bits

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.

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.

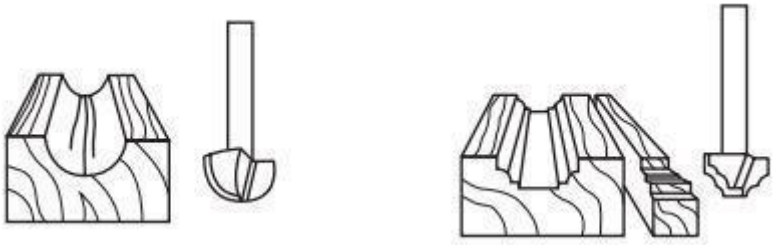
Straight bit

Straight bits cut grooves, trenches and rebates.

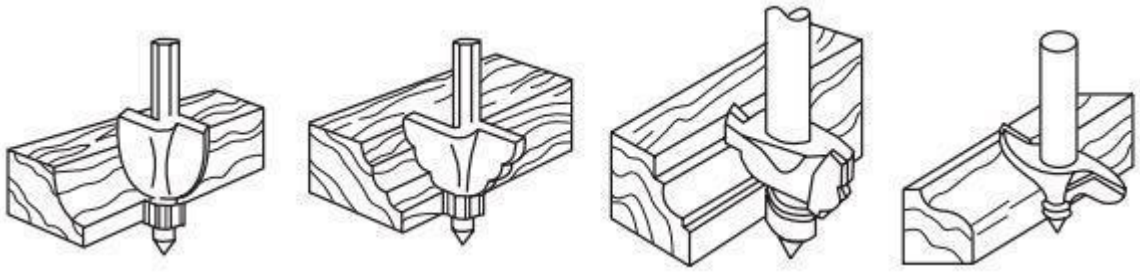
They can be used to form:

•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.

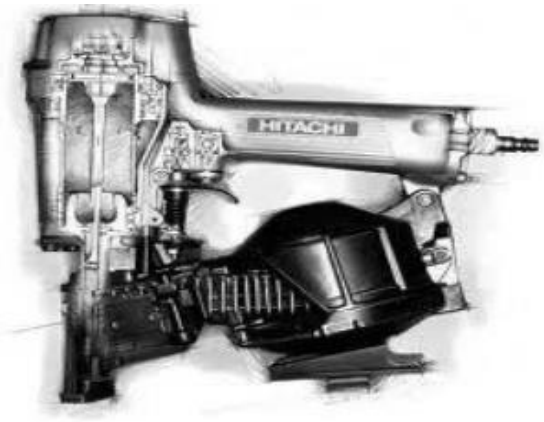
DRILLING MACHINE:

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.