## 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.

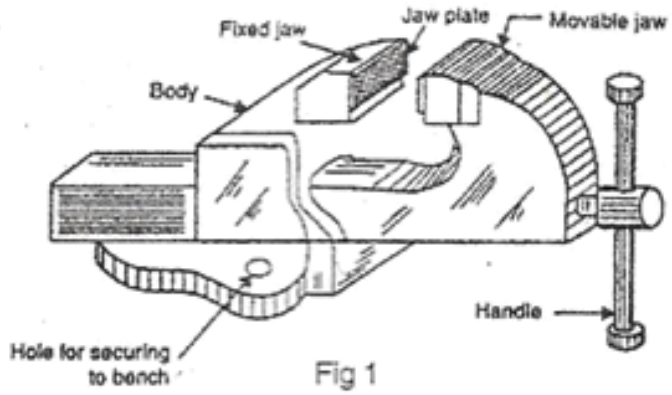


Fig 1

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.

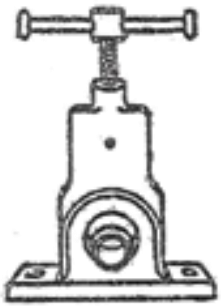

Fig. 3

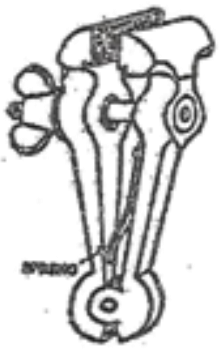

Fig. 4

**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.

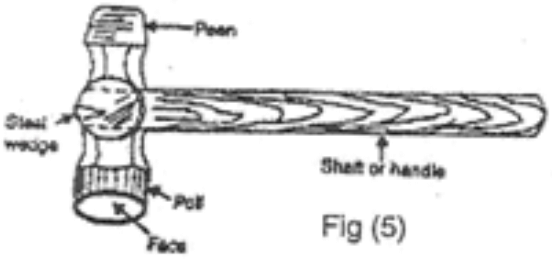

Fig (5)

### 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.

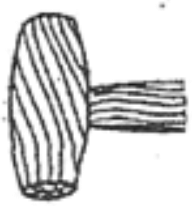

Fig. 10

**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

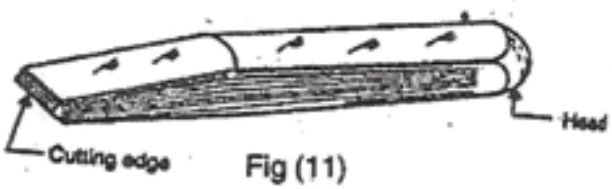


Fig (11)

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 filing are

1) Flat chisel

2) Cross cut chisel

3) Diamond point chisel

**1. Flat chisels**

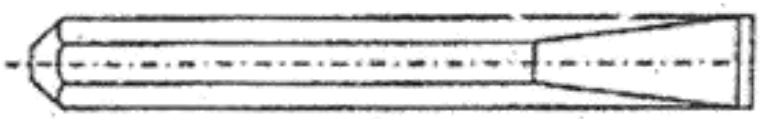

Fig (12)

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**

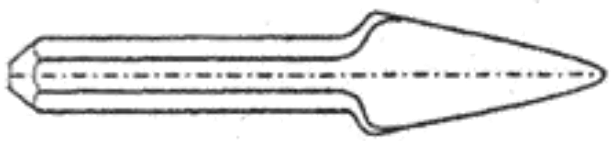

Fig (13)

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 :-**

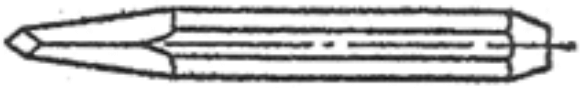

Fig (14)

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.

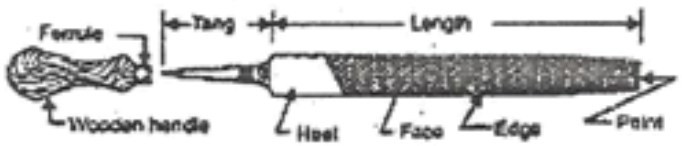


Fig (15)

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.

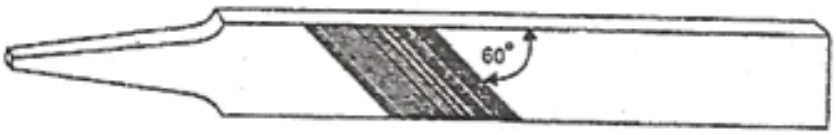


Fig. (16)

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.

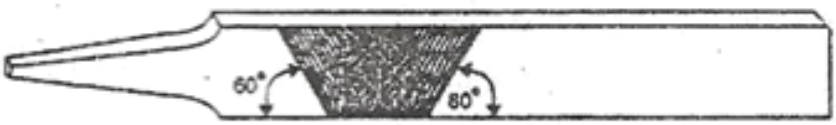


Fig. (17)

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.

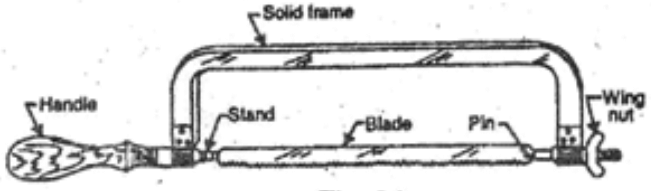


Fig. 24

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.

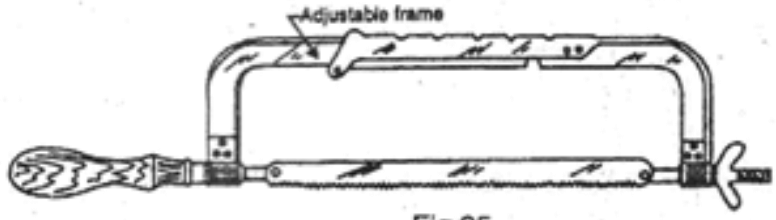


Fig 25

## 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)

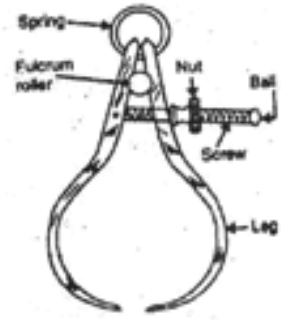


Fig 26(b)

An outside caliper is 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

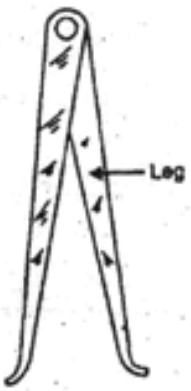


Fig 27(a)

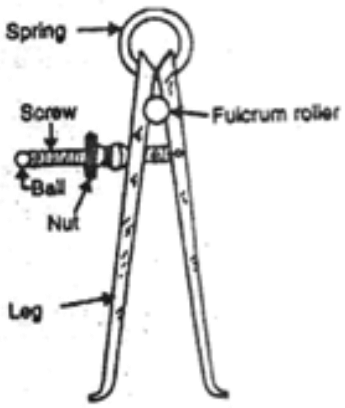


Fig (b)

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.

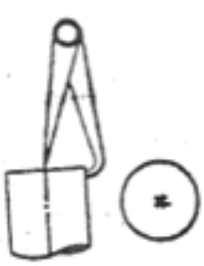

Fig. 28

## 2. Divider

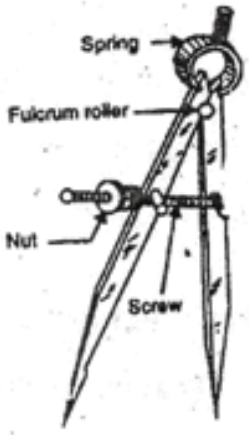

Fig. 29

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.

## 3. Surface plate

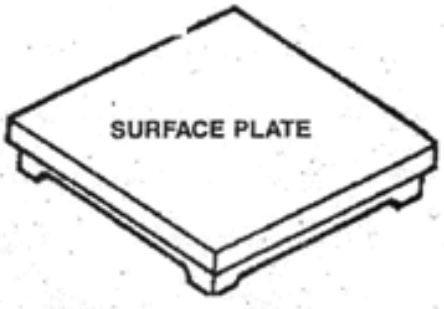

Fig. 30

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.

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

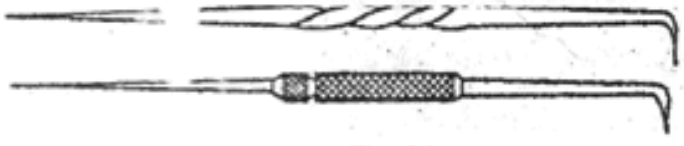
Fig. 31

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

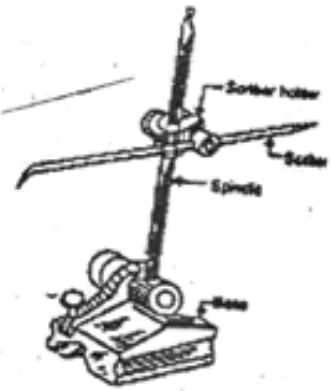

Fig. 32

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.

### 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.

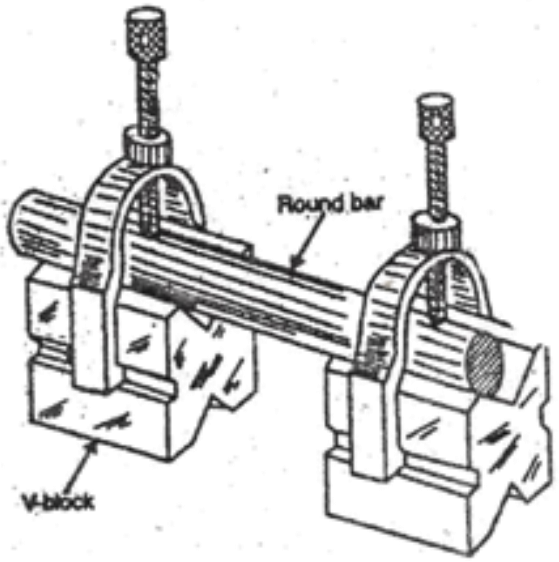


Fig. 34

## 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.

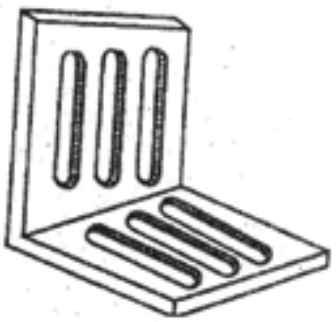

Fig. 35

## 9. TRY-SQUARE

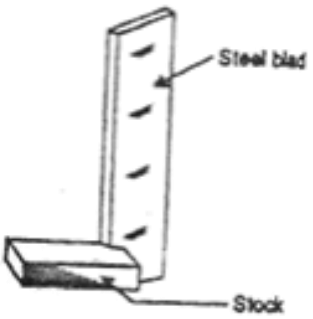

Fig. 36

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.

## 10) Combination set

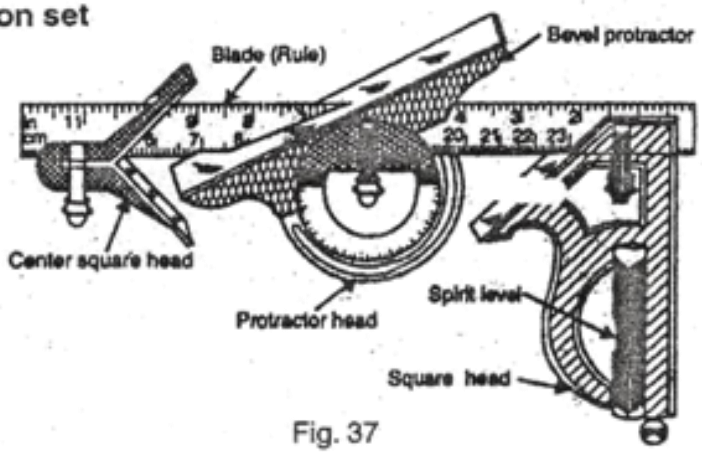

Fig. 37

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.

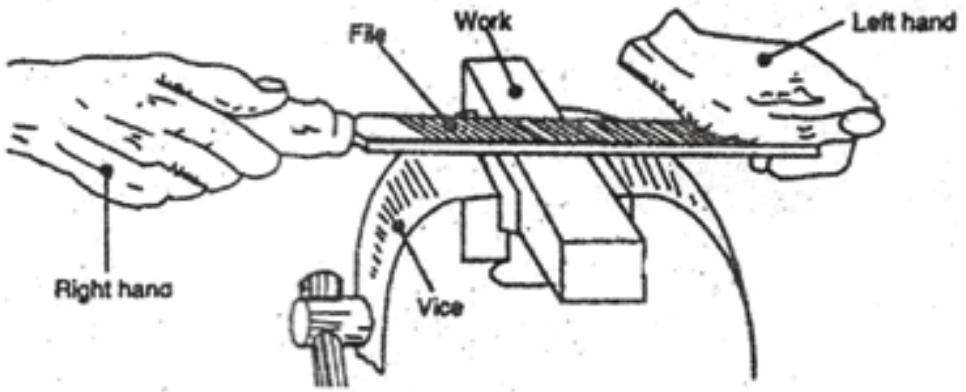


Fig 38

**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 :-**

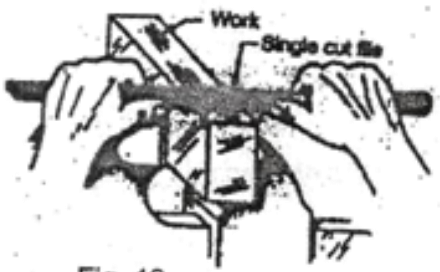


Fig. 40

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.

## 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

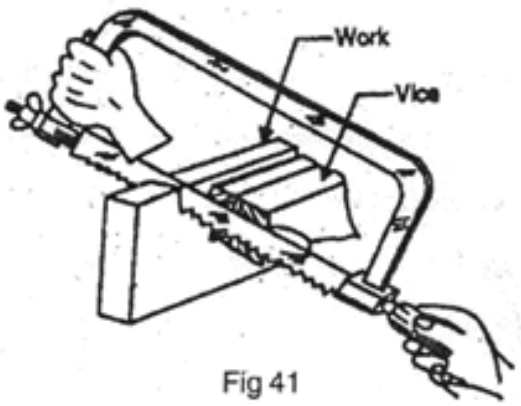


Fig 41

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.

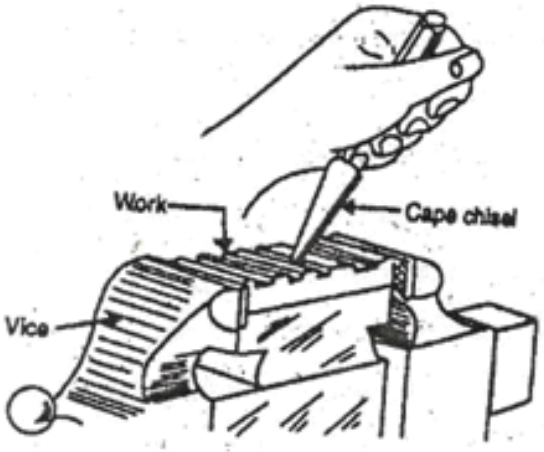


Fig 42

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.