

CHAPTER – TWO

Measuring tools and Linear measuring equipment's /instruments

MEASURING TOOLS

1. Steel Rule

These are made up of stainless steel and are available in many sizes ranging from 1/2 ft. to 2 ft. These are marked in inches or millimetres. All the faces are machined true. The edges of steel rule should be protected from rough handling.



2. Callipers

These are generally used to measure the inside or outside diameters. Different types are:

- Outside Caliper: It is used to measure the outside dimensions.
- Inside Caliper: It is used to measure the inside dimensions.
- Spring Caliper: Spring is provided to apply the pressure and lock nut is provided to lock any desired position.
- Hermaphrodite, Jenny or Oddleg Caliper: One leg is bent at the tip inwardly and the other has a straight pointed end. It is used to scribe lines parallel to the straight edges.

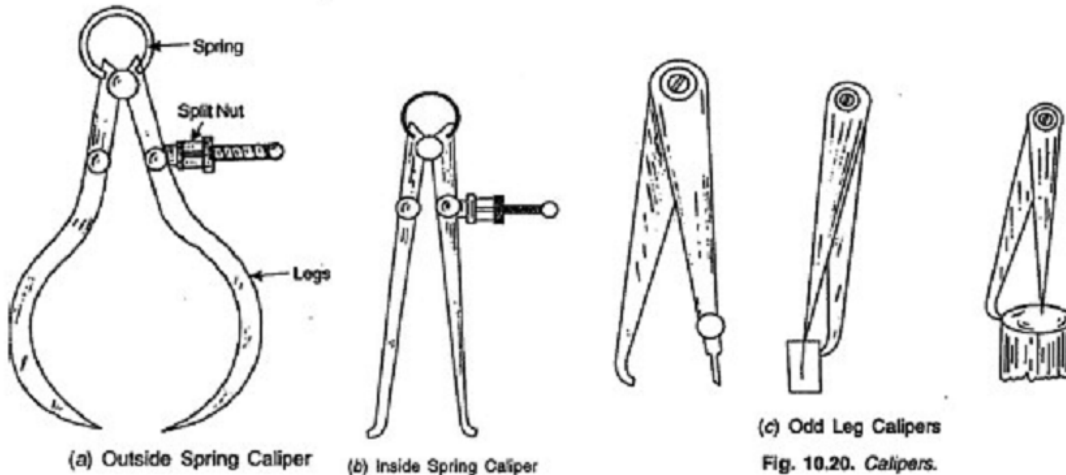


Fig. 10.20. Calipers.

3. Vernier Caliper: It is used for measuring the outer dimensions of round, flat, square components and also the inner size of the holes and bore. A narrow blade is used to measure the depth of bar slots etc. The reading accuracy in metric system is 0.02 mm and British system it is 0.001". It is made of stainless steel. Used for measuring inside, outside diameters & thickness of parts to an accuracy of 0.02mm. It consists of a beam with main scale, fixed jaw & movable jaw with vernierscale slides over the beam. The graduated beam of the metric vernier caliper is divided into centimeters & millimeters. The 49 divisions (49 mm) of 1 mm each on the main scale are equal to 50 divisions of the vernierscale. Thus the division on the vernier equals $49/50$ mm.

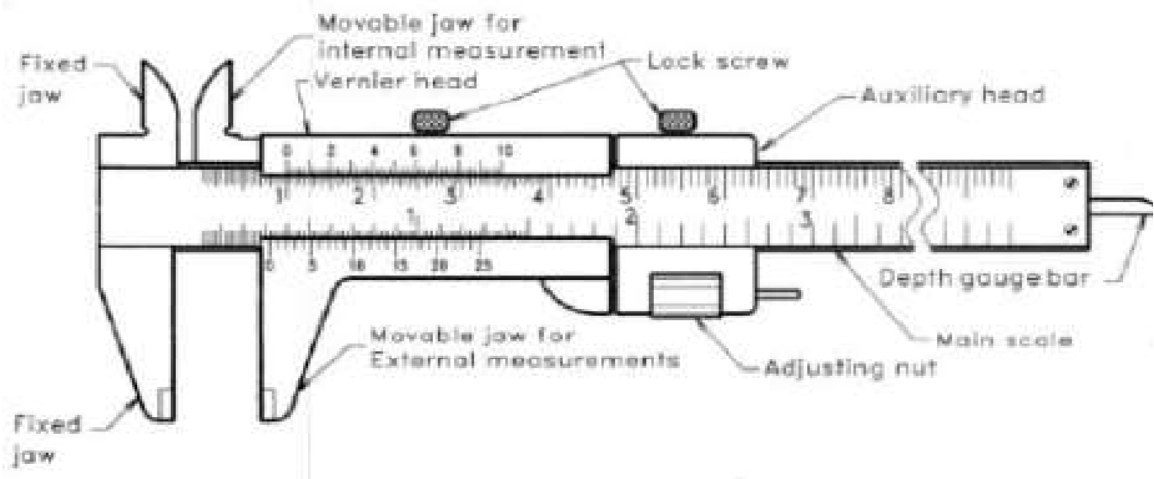
$$L.C = 1 \text{ m.s.d} - 1 \text{ v.s.d}$$

$$L.C = 1 - 49/50 \text{ mm}$$

$$L.C = 50 - 49/50 \text{ mm}$$

$$L.C = 1/50 \text{ mm}$$

$$L.C = 0.02 \text{ mm}$$



Micrometer:

Is one of the most widely used measuring instruments. An external micrometer is used for measuring external diameters & thickness of parts up to an accuracy of 0.01 mm. It is made up a frame, hardened anvil, screw spindle, graduated sleeve, thimble, friction stop & a spindle clamp.

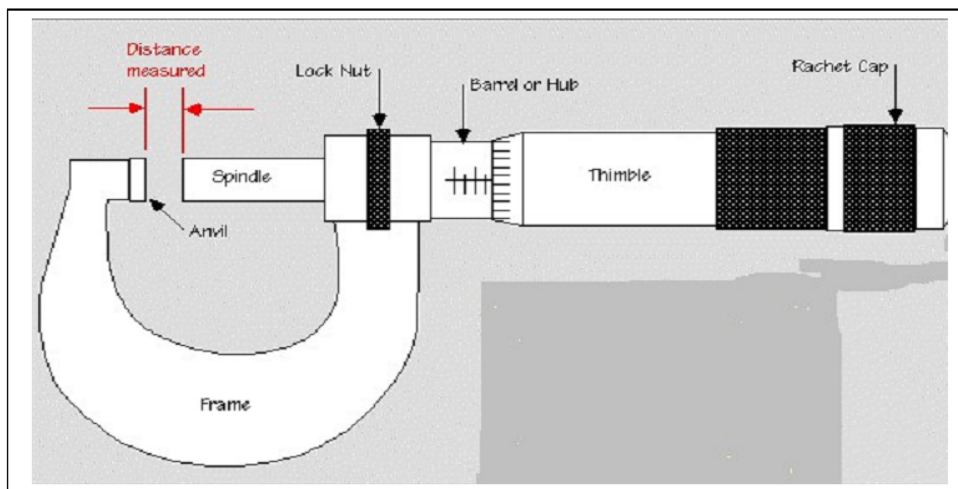
The metric micrometer has a spindle screw thread with a pitch of 0.5 mm. The upper set of graduation on the sleeve represent whole millimeter & the lower set divide each millimeter in to two equal parts or 0.5 mm. The thimble is graduated into parts.

$L.C = \text{Pitch of the screw on the barrel} / \text{no of divisions on the thimble}.$

$L.C = 0.5 / 50$

$L.C = 0.01 \text{ mm}.$

$\text{Total Reading} = \text{Reading on barrel} + \text{Reading on thimble} * L.C.$

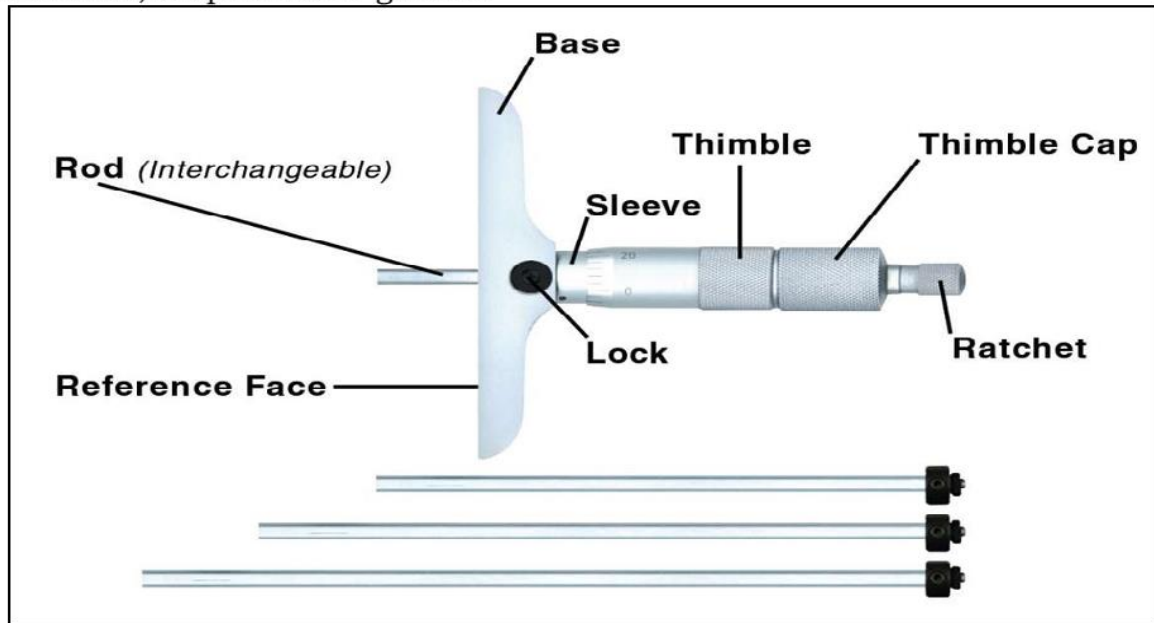


TYPES OF MICROMETER

There are three common types of micrometer; their names are based on their application:

- I. **Outside micrometer:** Outside micrometers are used to measure the thickness or the outside diameter of parts.
- II. **Inside micrometer:** An inside micrometer is used to measure inside diameters or between parallel surfaces.

III. Depth micrometer: A depth micrometer is used to measure the depth of holes, slots, counter bores, and recesses, and the distance from a surface to some recessed part. This type of micrometer is read exactly opposite from the method used to read an outside micrometer. The zero is located toward the closed end of the thimble. The measurement is read in reverse and increases in amount (depth) as the thimble moves toward the base of the instrument. The extension rods come either round or flat (blade-like) to permit measuring a narrow, deep recess or grooves.

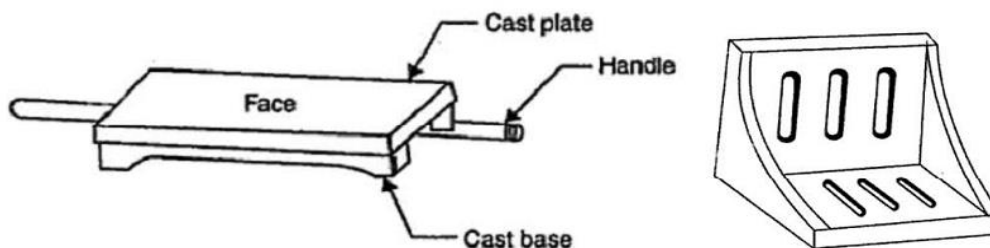


MARKING TOOLS:

1. Surface Plate

It is used for testing the flatness, trueness of the surfaces. It is made up of cast iron or graphite. Its upper face is planed to form a very smooth surface. It is also used in scribing work.

While not in use, it should be covered with a wooden cover.



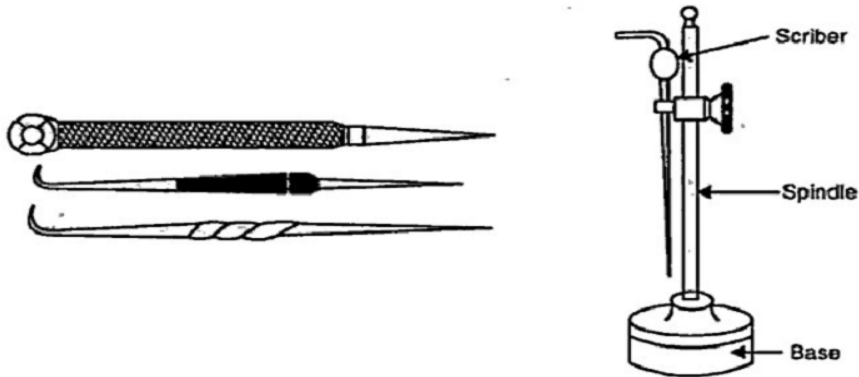
2. Angle Plate

It is made up of cast iron in different sizes; it has two planed surfaces at right angles to each other and has various slots in each surface to hold the work by means of bolts and clamps.

Never do hammering on the angle plate to fasten (tighten) the nuts and bolts.

3. Scriber and Surface Gauge

It consists of a cast iron base on the center of which a steel rod is fixed vertically. Scriber is made up of high carbon steel and is hardened from the front edge. It is used for locating the centres of round bars or for marking of the lines.



4. Punches

Punches are used for marking purposes. Dot punches are used for marking dotted line and centre punch is used to mark the centre of hole before drilling. Punches are made up of high carbon steel or high speed steels. One end is sharpened. Hammering is done on the second end while working. For dot punch, angle of the punching end is 60 degree while in centre punch; angle of punching end is 90 degree.

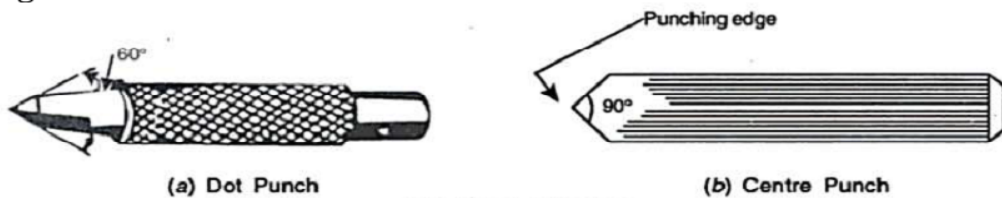
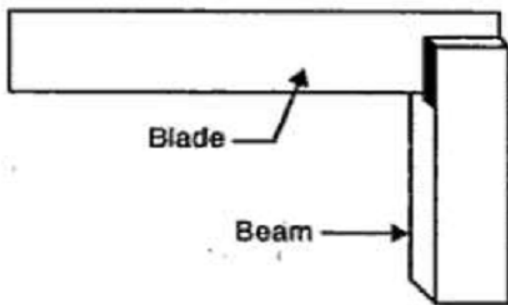


Fig. 10.14. Punches.

Try Square

It is used for checking squareness of two surfaces. It consists of a blade made up of steel, which is attached to a base at 90 degree. The base is made up of cast iron or steel. It is also used to mark the right angles and measuring straightness of surfaces. Never use try square as a hammer.



Vernier Height gauge:

A Vernier height gauge consists of a heavy base, a graduated beam, a sliding head with Vernier sliding jaws holding the scriber and a fine adjustment clamp. It is similar to large Vernier calipers in construction, except that it consists of a heavy base which allows the gauge to stand upright instead of a fixed jaw in a Vernier. The movable jaw of Vernier height gauge consists of a projection or extension which is levelled to sharp edge for scribing lines at any required height.

METHOD OF MARKING

Marking means setting out dimensions with the help of a working drawing or directly transferring them from a similar part. The procedure of marking is as follows:

1. The surface to be marked is coated with the paste of chalk or red lead and allowed to dry.
2. Then the work is held in a holding device depending upon shape and size. If it is flat, use surface plate, if it is round use V block and clamp, else use angle plate etc.
3. Lines in horizontal direction are scribed by means of a surface gauge. Lines at right angles can be drawn by turning the work through 90 degree and then using the scriber. If true surface is available, try square can also be used.
4. The centre on the end of a round bar can be located by using an odd leg caliper, surface gauge etc.
5. The circles and arcs on a flat surface are marked by means of a divider.
6. After the scribing work is over, indentations on the surface are made using dot punch and hammer.

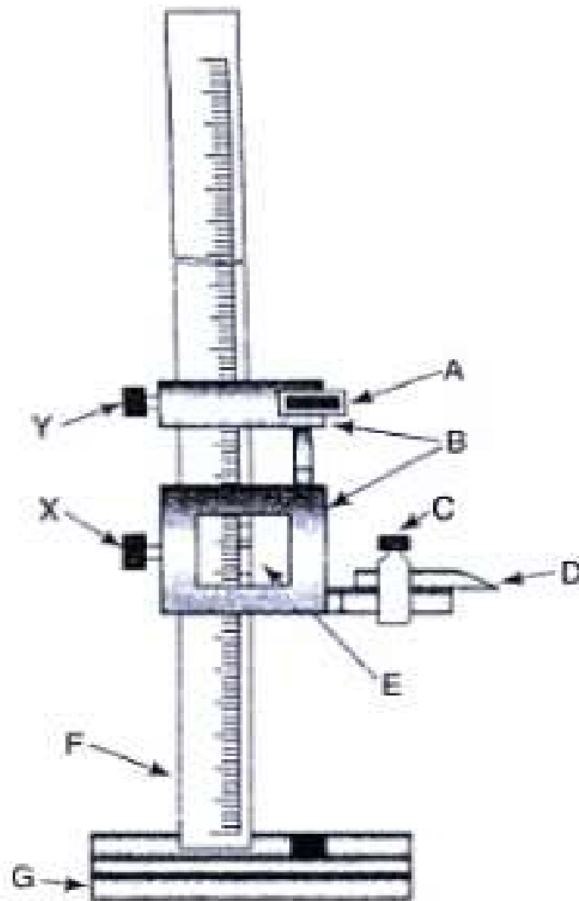


Fig. 3.17 Vernier height gauge

- | | |
|--------------------------|------------------|
| A—Fine adjustment of nut | B—Vernier slide |
| C—Scriber clamp screw | D—Scriber |
| E—Vernier scale | F—Main scale |
| G—Base | X, Y—Lock screws |

Bench Working Operations

- 3.1 Laying out
- 3.2 Hand sawing
- 3.3 Filing
- 3.4 Chiselling

LAYING OUT

Laying out is the operation of scribing center locations, straight lines, arcs, circles, or contour lines **on the surface** of a piece of metal to show the machinist the finished size and shape of the part to be manufactured.

The information regarding the size and shape of part is taken **from a technical drawing**. The care and accuracy of the layout plays an important role in determining the accuracy of finished parts, since the machinist uses these layout lines as a guide for machining.

Layout Tools and Accessories

Tools & Accessories	Details
Surface Plate or Marking Table	Is a plate or a table made of cast iron or of granite. It must be adjusted absolute horizontally. Its surface must be perfect plane to ensure accurate scribing. To bring workpieces to the correct position on the marking table there are some other devices like prism, angle plate, V-Blocks and Parallels.
Steel Rule	Steel rules are the most common linear measuring tools and are available in the metric or inch system. Metric rules are graduated in both millimeters and half-millimeters. Some rules are available with both inch and millimeter graduation.
Scriber	A scriber is a layout tool used for drawing layout lines on a workpiece. They are made of tool steel with hardened and tempered points. It is important that the point of the scriber be as sharp as possible to produce clear, thin, layout lines.
Center Punch	Normally ground to an angle of 90 degree. Before drilling a hole the center must be punched. To make a line more visible for cutting or oxy-acetylene cutting it is helpful to punch the line.
Solid Square or Try-Square	Is used for laying out workpiece in combination with steel rule and scriber. It is also used to check the angles and the surfaces for flatness.
Divider	The divider is used to transfer length or circles to the workpiece. Dividers are available with and without fixing devices.
Protractor	A simple protractor has a measuring range from 0 to 180 degree. The measuring error is around 1 degree.
Surface Gauge or Vernier Height Gauge	Is normally used in combination with a surface plate and an angle plate to mark parallel lines. Using the simple type, the height can be adjusted with a steel rule.

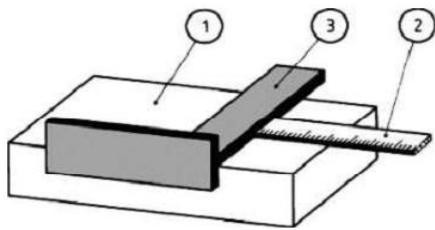
Angle Plate	An angle plate is a precision L-shaped tool usually made of hardened steel. All its surfaces are ground to an accurate 90-degree angle and are square and parallel. It is used to support workpieces on a 90-degree angle during the layout process.
V-Blocks or Prism	It is an accurate fabricated layout device to hold cylindrical workpieces during the layout process. They have one or more accurate 90-degree V-slots.

Layout Procedure

Laying out with Try-Square and Steel Rule

1. Remove all burrs from the workpiece and clean it properly.
2. Start the layout from a square machined (or filed) surface.
3. Use a try-square and a steel rule.

4. Place the point of the scribe on the workpiece against the try-Square edge. Hold the scribe 15 degree inclined away from the workpiece and in the direction in which it is to be drawn.

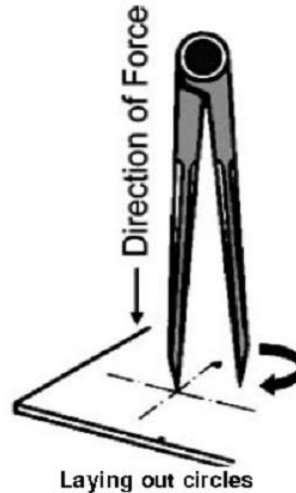
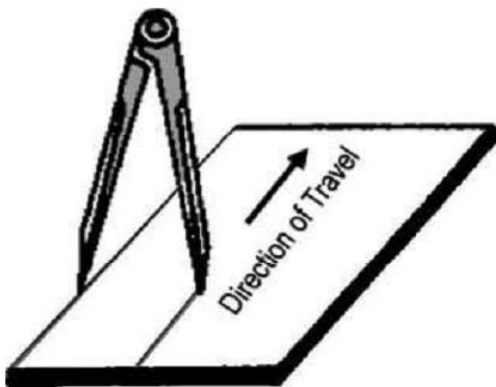


1. Workpiece
2. Steel Rule
3. Try-Square

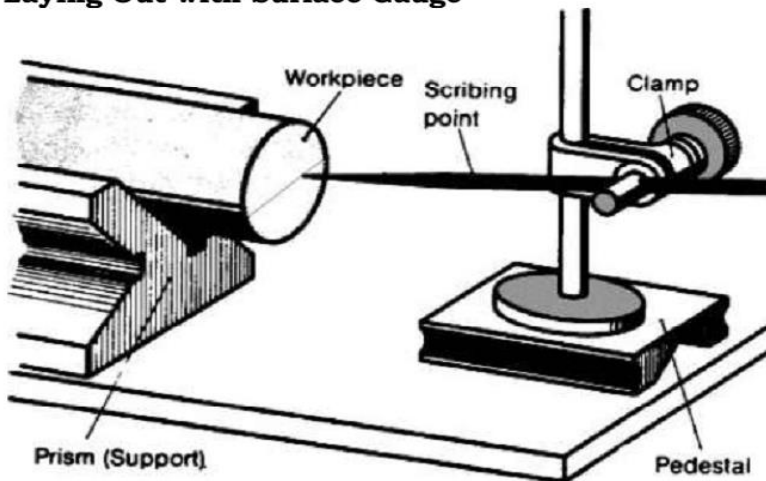


Laying Out Circles with the Divider

1. Lay out the center of the circle
2. Punch the center of the circle
3. Adjust the divider to the proper radius while using a steel rule or a vernier caliper
4. Place one point of the divider in the center punch hole and give some force to this leg.
5. Move around the fixed leg and scratch the surface.



Laying Out with Surface Gauge



FITTING

The term *fitting*, is related to assembly of parts, after bringing the dimension or shape to the required size or form, in order to secure the necessary fit. The operations required for the same are usually carried out on a work bench, hence the term *bench work* is also added with the name *fitting*.

The bench work and fitting plays an important role in engineering. Although in today's industries most of the work is done by automatic machines which produces the jobs with good accuracy but still it (job) requires some hand operations called fitting operations. The person working in the fitting shop is called fitter

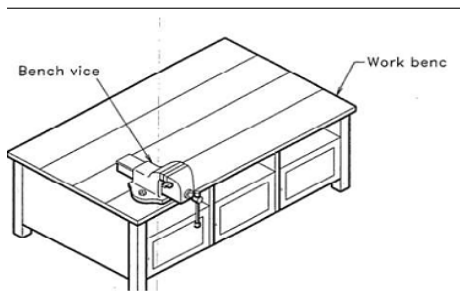
FITTING TOOLS:

Fitting shop tools are classified as below:

- Work Holding Devices/ Clamping Tools.
- Measuring and Marking Tools.
- Cutting Tools.
- Striking Tools.
- Drilling Tools.
- Threading Tools.

I. WORK HOLDING DEVICES /CLAMPING TOOLS:

1. Work Bench



A fitting process can be done at various places, but most of the important operations of fitting are generally carried out on a table called *work bench*.

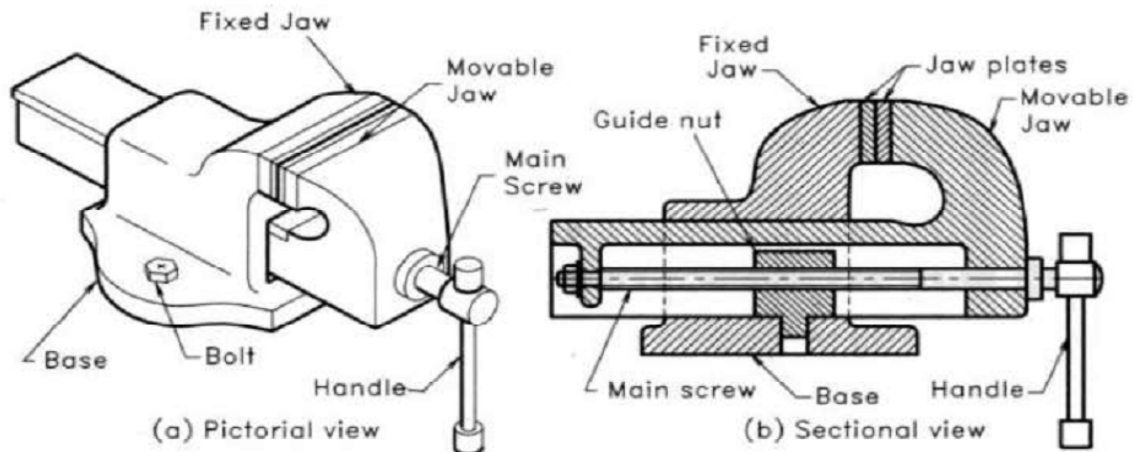
The work bench is a strong, heavy and rigid table made up of hard wood.

The size of the work bench required is about 150 to 180 cm length, nearly 90 cm width and approximately 76 to 84 cm height.

2. BENCH VICE:

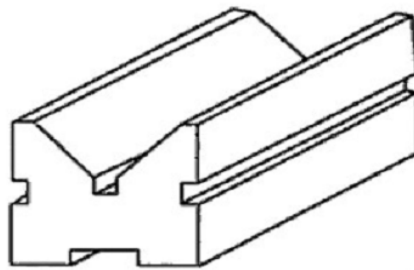
It is firmly fixed to the bench with the help of nuts and bolts. It consists of a cast Iron body and cast iron jaws. Two jaw plates are fitted on both the jaws. The holding surface of the jaw plates is knurled in order to increase the gripping. Jaw plates are made up of carbon steel and are wear resistant. One jaw is fixed to the body and the second slides on a square threaded screw with the help of a handle.

The jaws are opened upto required length; job is placed in the two jaws and is fully tightened with the help of handle. Handle is used to move the movable jaw

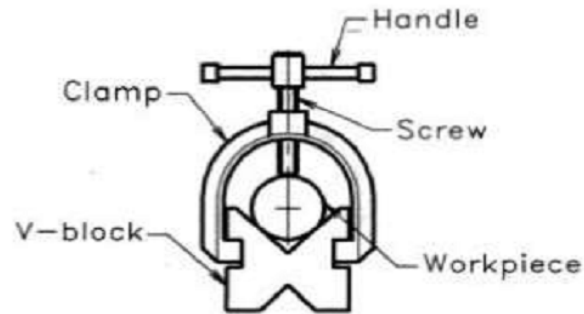


V Block

In V Block, V grooves are provided to hold the round objects longitudinally. The screw of the clamp applies the holding pressure. When the handle is rotated there is movement in the screw.



(a) V Block



CUTTING TOOLS

1. Hacksaw

Hacksaw is used for cutting of rods, bars, pipes, flats etc. It consists of a frame, which is made from mild steel. The blade is placed inside the frame and is tightened with the help of a flange nut. The blade is made up of high carbon steel or high speed steel.

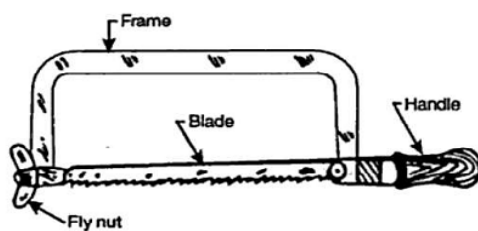
The points of the teeth are bent in a zig-zag fashion, to cut a wide groove and prevent the body of the blade from rubbing or jamming in the saw cut. The teeth of the blades are generally forward cut so in the case, pressure is applied in the forward direction only.

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

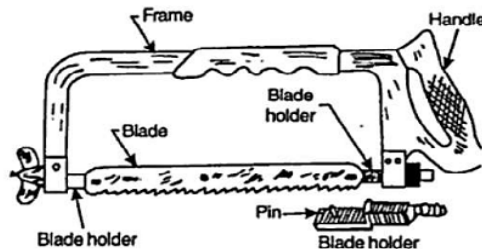
- ✓ Forward cut
- ✓ Backward cut.

Depending upon the pitch of the teeth (Distance between the two consecutive teeth) blades are classified as:

- ❖ Coarse (8-14 teeth per inch)
- ❖ Medium (16-20 teeth per inch)
- ❖ Fine (24-32 teeth per inch)

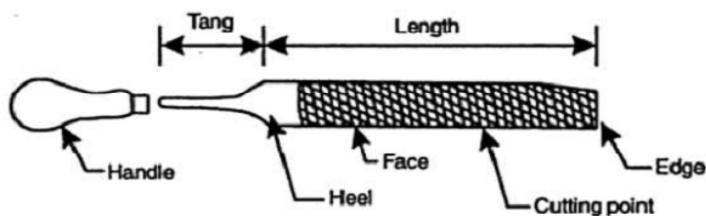


(a) Fixed Frame



(b) Adjustable Frame

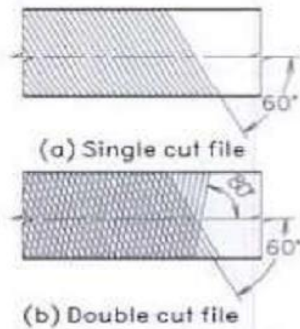
Fig. 10.27. Hand Hacksaws.



Nomenclature of a File

2. Files

Files are multi points cutting tools. It is used to remove the material by rubbing it on the metals. Files are available in a number of sizes, shapes and degree of coarseness.



Classification of files

i. On the basis of length 4",6",8",12"

ii. On the basis of grade:

- ✚ Rough (R)(20 teeth per inch)
- ✚ Bastard (B)(30 teeth per inch)
- ✚ Second cut (Sc) (40 teeth per inch)
- ✚ Smooth file (S)(50 teeth per inch)
- ✚ Dead smooth (DS)(100 teeth per inch)

Rough and bastard files are the big cut files. When the material removal is more, these files are used. These files have bigger cut but the surface produced is rough. Dead smooth and smooth files have smaller teeth and used for finishing work. Second cut file has degree of finish in between bastard and smooth file.

iv. On the basis of number of cuts:

- ✓ Single cut files.
- ✓ Double cut files.
- ✓ Rasp files.



(c) Rasp cut file



(g) Knife edge file

In single cut files the teeth are cut in parallel rows at an angle of 60 degree to the face. Another row of teeth is added in opposite direction in case of double cut files. Material removal is more in case of double cut files.

iii. On the basis of shape and size:

The length of the files varies from 4' to 14". The various shapes of cross-section available are hand file, flat file, triangular, round; square, half round, knife-edge, pillar, needle and mill file.



(a) Flat file



(b) Hand file



(c) Square file



(d) Round file



(e) Half round file



(f) Triangular file



(h) Diamond file

Flat file: This file has parallel edges for about two-thirds of the length and then it tapers in width and thickness. The faces are double cut while the edges are single cut.

Hand file: for a hand file the width is constant throughout, but the thickness tapers as given in flat file. Both faces are double cut and one edge is single cut. The remaining edge is kept uncut in order to use for filing a right-angled corner on one side only.

Square file: It has a square cross-section. It is parallel for two-thirds of its length and then tapers towards the tip. It is double cut on all sides. It is used for filing square corners and slots.

Triangular file: It has width either parallel throughout or upto middle and then tapered towards the tip. Its section is triangular (equilateral) and the three faces are double cut and the edges single cut. It is used for filing square shoulders or comers and for sharpening wood working saws.

Round file: It has round cross-section. It carries single cut teeth all round its surface. It is normally made tapered towards the tip and is frequently known as rat-tail file. Parallel round files having same diameter throughout the length are also available. The round files are used for opening out holes, producing round comers, round-ended slots etc.

Half-round file: Its cross-section 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 a double cut and curved side has single cut. It is used for filing curved surfaces.

Knife edge file: It has a width tapered like a knife blade and it is also tapered towards the tip and thickness. It carries double cut teeth on the two broad faces and single cut teeth on the edge. It is used for finishing sharp corners of grooves and slots

Diamond file: Its cross-section is like a diamond. It is used for special work.

Needle file: These are thin small files having a parallel tang and a thin, narrow and pointed blade made in different shapes of its cross-section to suit the particular need of the work. These are available in sizes from 100 mm to 200 mm of various shapes and cuts. These files are used for filing very thin and delicate work.

Methods of filing

The following are the two commonly used methods of filing:

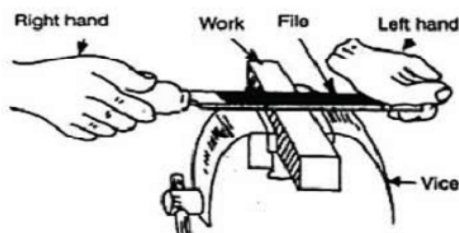
1. Cross-filing
2. Draw filing

Cross - filing. Refer Fig. (a).

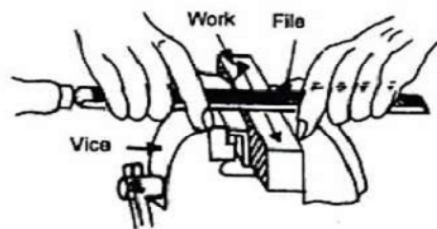
This method is used for efficient removal of maximum amount of metal in the shortest possible time. It may be noted that the file must remain horizontal throughout the stroke (long, slow and steady) with pressure only applied on the forward motion.

Draw filing. Refer Fig. (b)

This method is used to remove file marks and for finishing operations. Here, the file is gripped as close to the work as possible between two hands. In this filing method, a fine cut file with a flat face should be used.

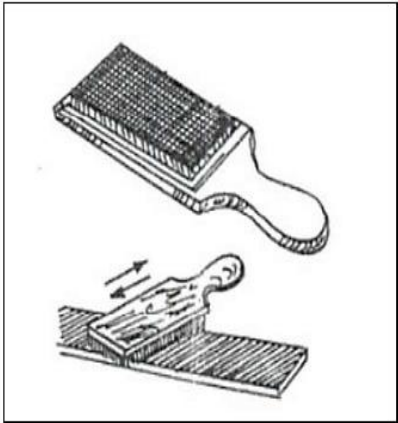


(a) Cross filing



(b) Draw filing

FILE CARD:



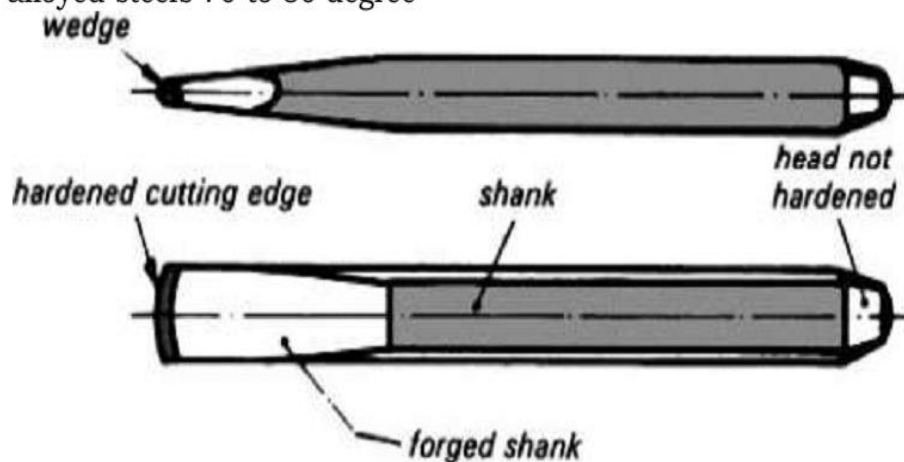
It is a device fashioned like a wire brush used to clean dirt and chips from the teeth of a file. When particles of metal clog the teeth the file is said to be *pinned*, a condition that causes scratching of the surface of the work. Files, therefore, require cleaning by means of a file card or by dislodging the material between the teeth by means of a piece of soft iron, copper, brass, tin plate and so on, sharpened at the end. Hardened steel should *never* be used.

Chisel Tools

In chiseling the cutting edge of a chisel is driven into a work piece by impact. A chisel must be harder than the piece being worked. Most chisels are made of alloyed tool steels.

Flat Chisel

Wedge angle for soft materials 30 to 50 degree; for mild steel 60 to 70 degree; for alloyed steels 70 to 80 degree



Work Process

The work piece must be properly clamped when chiseling.

- The chisel must be struck on the center of the head, in the direction of the axis of the chisel.
- The correct wedge angle must be maintained when grinding the chisel (measure with an angle gauge). The tool must be cooled frequently when sharpening, so that it does not lose its temper.

Project 2:

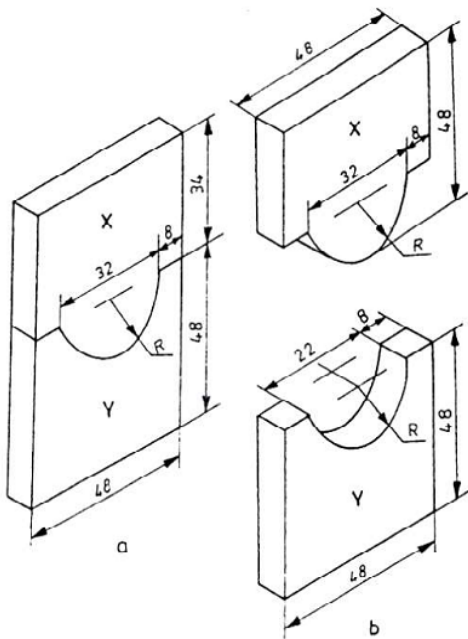
Aim: Half-Round Joint, To Prepare a given Fitting Model as per given sketch.

Material Required: Mild Steel Plate of 50 x 50 x 5 mm = 02 no's.

Students need to write

- Tools Required:
- Procedure:
- Result: Thus the Half-Dove Tail Joint is obtained with required dimensions

Sl. No.	Dimension Required	Actual Dimension	Error	Sl. No.	Dimension Required	Actual Dimension	Error
1.				1.			
2.				2.			
3.				3.			
4.				4.			
5.				5.			
6.				6.			
7.				7.			
8.				8.			



Project 3:

Aim: Half-Dove Tail Joint, To Prepare a given Fitting Model as per given sketch.

Material Required: Mild Steel Plate of 50 x 50 x 5 mm = 02 no's.

Students need to write

- a) Tools Required:
- b) Procedure:
- c) Result: Thus the Half-Dove Tail Joint is obtained with required dimensions

Sl. No.	Dimension Required	Actual Dimension	Error	Sl. No.	Dimension Required	Actual Dimension	Error
1.				1.			
2.				2.			
3.				3.			
4.				4.			
5.				5.			
6.				6.			
7.				7.			
8.				8.			

