Chapter - 1

FITTING SHOP

1.1 Introduction

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

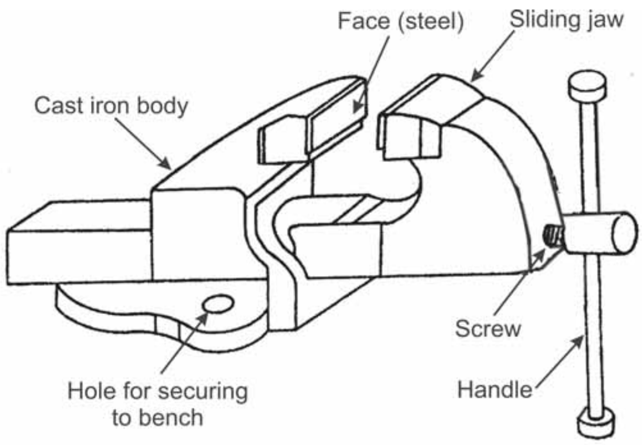
In all these processes, components are produced with the help of either machines or manual effort. The attention of a fitter is required at various stages of manufacture starting from marking to assembling and testing the finished goods.

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

1.2 Work Holding Tools

1.2.1 Bench Vice

The bench vice is a device commonly used for holding the work pieces. When the vice handle is turned in a clockwise direction the moving jaw forces the work against the fixed jaw. The greater the pressure applied to the handle, the tighter is the work held. The body of the vice is made of cast-iron. Hardened steel plates with

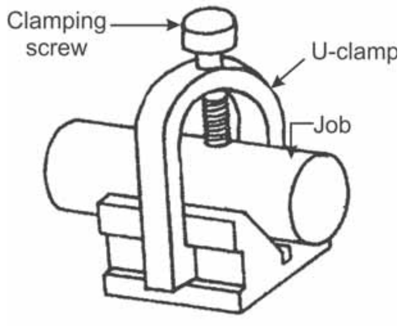


Bench Vice

serrations to ensure better gripping of the work are fixed on the faces of the two jaws. Jaw caps made of soft material such as aluminium or galvanised iron (G.I) sheet are used to protect finished surfaces of the work gripped in the vice. Vices are specified by the maximum width that can be held or the maximum opening between the jaws, varying from 75 mm to 300 mm.

1.2.2 V-block with clamp

The V-block is a rectangular or square block with a V-groove on one or both sides, opposite to each other. The angle of the V is usually 90°. V-block with a clamp is used to hold cylindrical work securely, during marking of measurements or for measuring operations.



V-Block

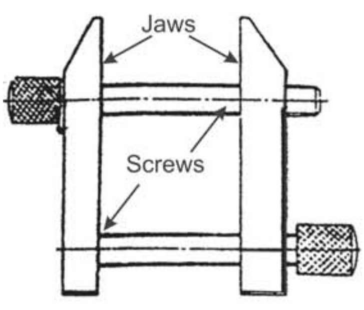
Material: C.I or hardened steel. Size: 50 to 150 mm.

Parallel Clamp

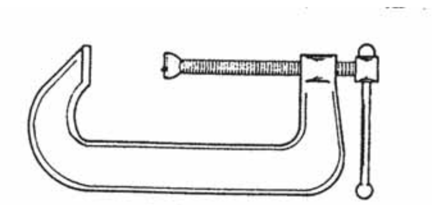
It is a simple screw clamp with parallel jaws to hold small jobs for working on them.

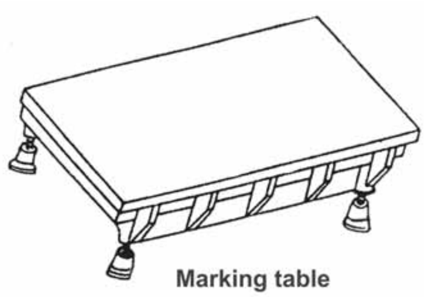
1.2.3 C-Clamp

This is used to hold work against an angle plate or V-block or any other surface, when gripping is required. It is also known as G-clamp.



Parallel clamp


C.clamp


Marking table

1.3 Marking Tools

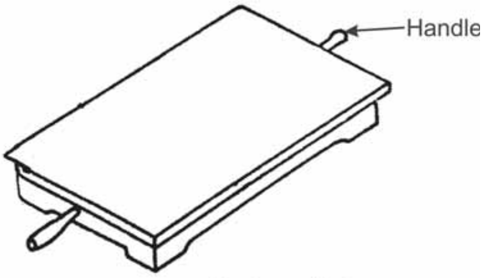
1.3.1 Marking table

A marking table is a heavily build cast iron table used for layout work on all sizes of jobs. This table provides a flat surface to mark lines with the help of height gauge, angle plate, V-block or surface gauge as per job requirements.

Surface plate

The surface plate is used for testing the flatness of the work piece and other inspection purposes. It is also used for marking on small works. It is more precise in flatness than the marking table.

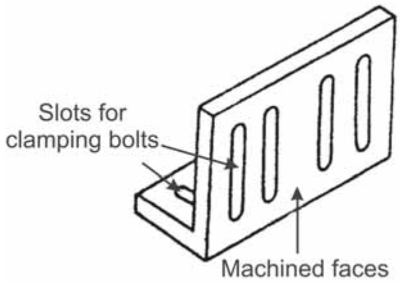
Surface plates are made of C.I. or hardened steel, ground and scraped to the required precision. Now-a-days surface plates made of special granite stone are manufactured in wide range of precision grades, colours and sizes. It is specified by length × width × height × grade. Example: 600 × 400 × 100 × grade A has a flatness upto 0.005 mm.



Surface plate

1.3.3 Angle Plate

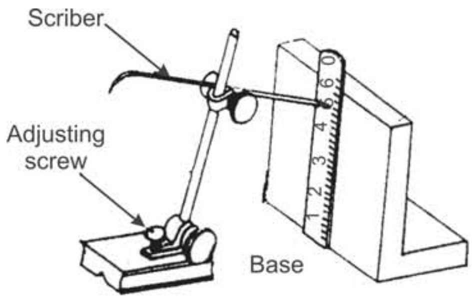
The angle plate is made of cast iron. It has two surfaces machined at right angles to each other. Plates and components which are to be marked out may be held against the upright face of angle plate to facilitate the marking or inspection.



Angle plate

1.3.4 Universal Scribing Block

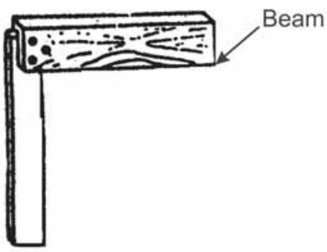
This is used for scribing lines for layout work and checking parallel surfaces.



Universal scribing block

1.3.5 Try-square

Try-square is used for checking the squareness of small works, when extreme accuracy as not required. The size of the try-square is specified by the length of the blade. Ex: l0 cm, 30 cm etc.

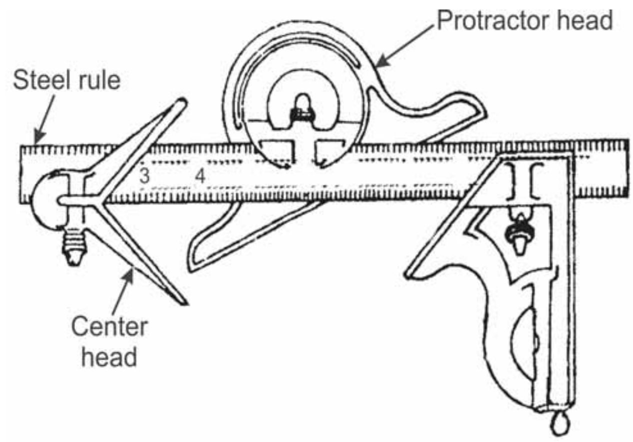


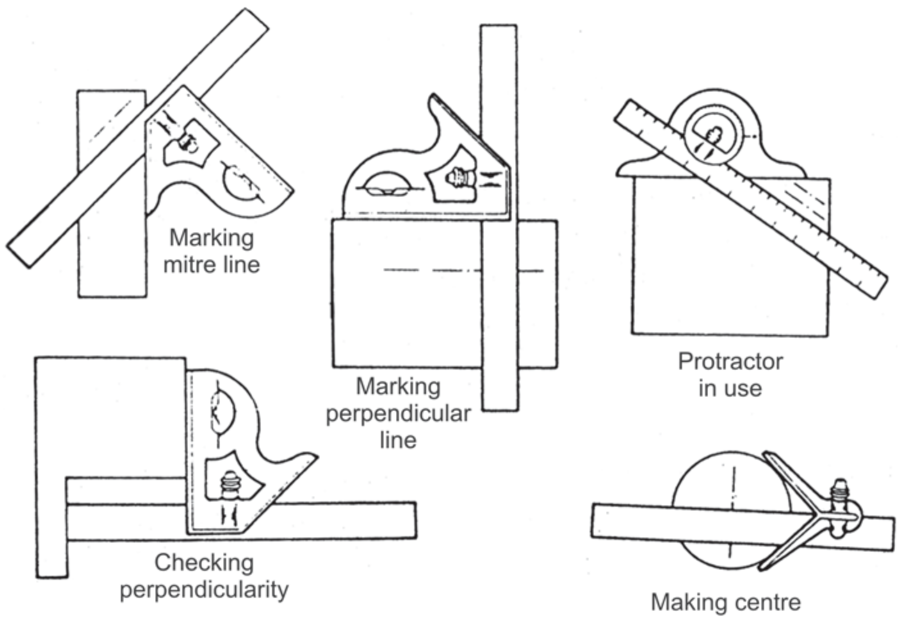
1.3.6 Scriber

A Scriber is a slender steel rod, used to scribe or mark lines on metal work pieces.

1.3.7 Combination Set

A combination set consists of a rule, square head, centre head and a protractor. This may be used as a rule, a square, a depth gauge, for marking mitres (45 degrees), for measuring and marking angles. The rule is made of tempered steel with grooves.





Uses of combination set

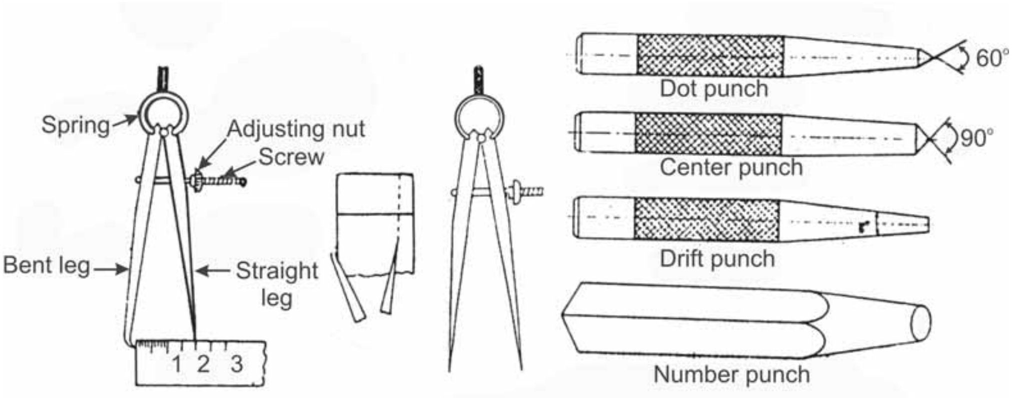
1.3.8 Odd-leg caliper

This is also called ‘jenny caliper’ or ‘hermaphrodite’. This is used for marking parallel lines from a finished edge and also for locating the centre of round bars. They are specified by the height of the leg upto the hinge point. Example: 100 mm, 150 mm etc.

Genius begins great works, labour alone finishes them.

1.3.9 Divider

This is used for marking circles, arcs, laying out perpendicular lines, bisecting lines, etc. Size ranges from 100 mm to 300 mm.



Odd-leg caliper Divider Punches

1.3.10 Dot Punches

This is used to locate centre of holes and to provide a small centre mark for divider point etc. For this purpose, the punch is ground to a conical point having 60º included angle.

Centre punch

This is similar to the dot punch, except that it is ground to a conical point having 90° included angle. It is used to mark the location of the centre where holes are to be drilled. The centre punch mark facilitates easy location of the drill tip and centre accurately.

Drift punch

A drift punch is a long tapered tool used to align holes in two or more pieces of material that are to be joined together, so that bolts or rivets can be easily placed in the holes.

Letter punch

It has square body with a tapered end. At this end, a projection, corresponding to the replica of the letter to be marked is made. The letters used are A to Z, and symbol totaling 27 numbers.

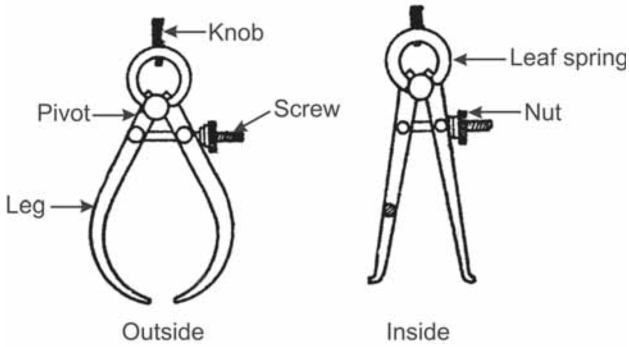
Number punch

It is similar to letter punch in construction but has numbers at its end. The numbers used are from 0 to 8 (six used as nine also). Punches are made of tool steel, hardened and tempered.

1.4 MEASURING TOOLS

1.4.1 Calipers

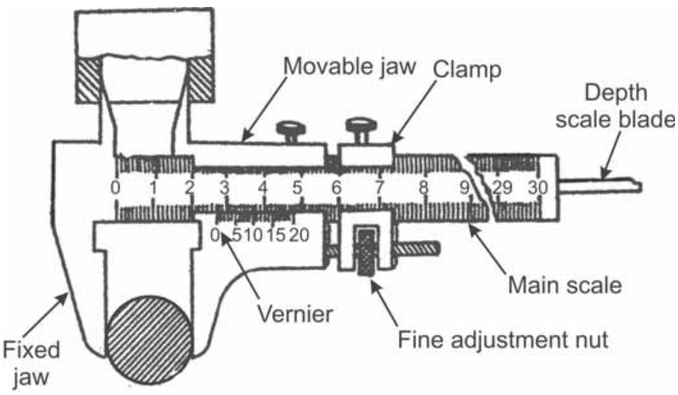
These are used with the help of steel rule to check outside and inside measurements. They are specified by the maximum length measured. Sizes vary from 100 mm to 300 mm.



Spring calipers

1.4.2 Vernier Calipers

These are used for measuring outside as well as inside dimensions accurately. It may also be used as a depth gauge. In the figure shown, 19 main scale divisions are divided into 20 equal parts in the vernier scale. Hence, least count of the vernier = 1 main scale division – 1 vernier scale division = 1 – 19/20 = 0.05 mm.

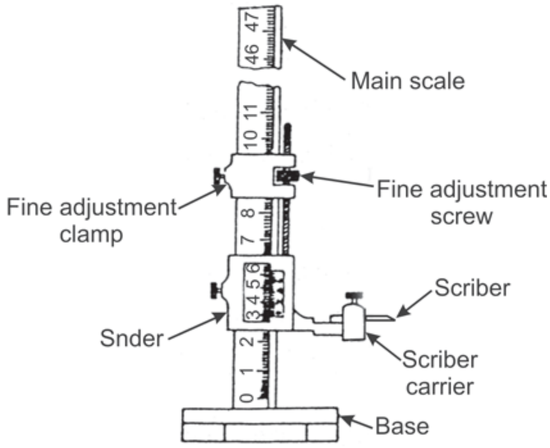


Vernier calipers

The size is specified by the maximum measurement it can make ranging from 150 to 300 mm. The accuracy of the instrument depends on the least count, varying from 0.1 to 0.02. Other types of verniers include dial vernier, digital vernier with more accuracy etc.

1.4.3 Vernier Height Gauge

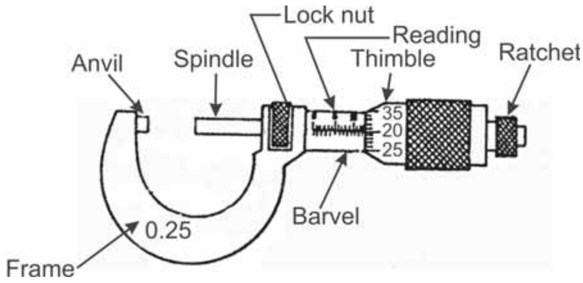
The vernier height gauge, clamped with a scriber, is shown in figure. It is used for layout work. An offset scriber is used when it is required to take measurements from the surface, on which the gauge is standing. The accuracy and working principle of the gauge are the same as those of the vernier caliper. The capacity of the height gauge is specified by the maximum height it can measure. It varies from 150 mm to 1000 mm.



Vernier height gauge

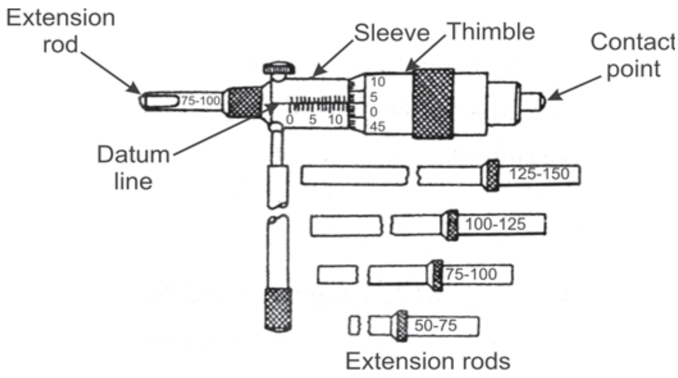
1.4.4 Outside Micrometer

This is used for measuring external dimensions accurately. Figure shows a micrometer of 0 to 25 mm range with an accuracy of 0.01 mm. These are available in different ranges with interchangeable anvils varying from 0-25 mm to 2000 mm in sizes and 0.01 to 0.001 in accuracy. There are many types of micrometers designed for special purpose use. They include thread micrometers to measure thread dimensions, tube micrometers to measure wall thickness of tubes, etc.



1.4.5 Inside micrometer

This is used to measure inside dimensions accurately. Figure shows an inside micrometer of range 25 to 150 mm with

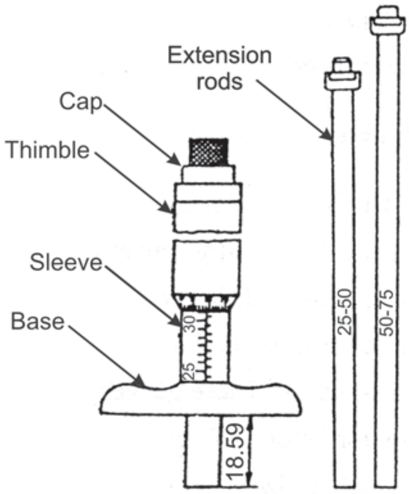


Inside micrometer

extension rods. These are available in different ranges and. accuracies.

1.4.6 Depth Micrometer

It is designed to measure the depth of holes, slots, recesses etc. The working principle of this is similar to the outside micrometer. Its base is hardened ground and lapped to reduce wear. These are available upto a range of 300 mm and accuracy of 0.01 mm. In this the reading is taken from the thimble end (right to left), unlike the outside micrometer where reading is taken from left to right.



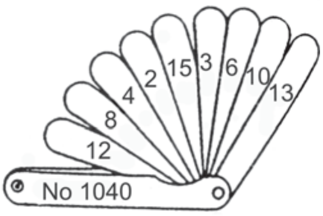
Depth micrometer

1.4.7 Feeler Gauges

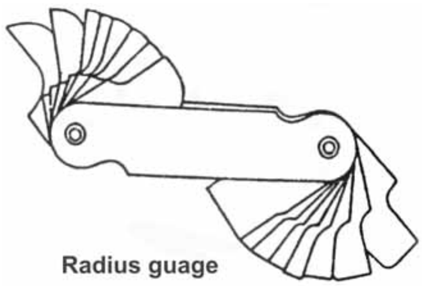
The thickness gauges or feeler gauges are a set of gauges consisting of thin strips of metal of varying thickness. They are widely used for measuring and checking bearing-clearance, adjusting tappets, spark plug gaps, and so on. The thickness varies from 0.05 to 0.5 mm.

1.4.8 Radius Gauges

Also known as fillet gauges, these are of thin flat steel tool used for inspecting and checking,



Feeler guage


Radius guage

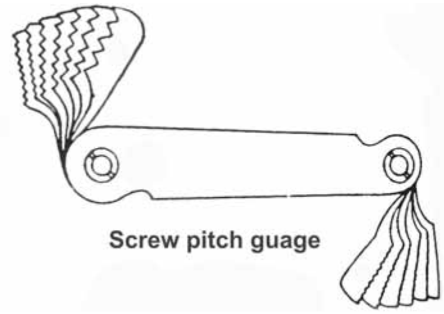
or laying out work having a given radius. Such a gauge is made in sets of individual gauges for measuring concave (internal) or convex (external) radius.

1.4.9 Screw Pitch Gauges

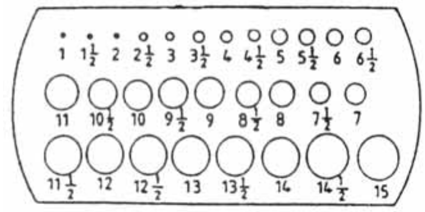
A screw pitch gauge is used for quickly determining the pitch of a threaded part or tapped hole. The gauge consists of a set of templates of teeth, each confirming to a standard pitch.

1.4.10 Drill Gauges

Thin sheets with holes drilled accurately to the size marked are used as drill gauges for easy selection and checking of drill size. This is very much useful when the drill size marked on the drill wears out over repeated usage. These guages are also available as stands for letter drills and number drills which are verysmall in size.



Screw pitch guage

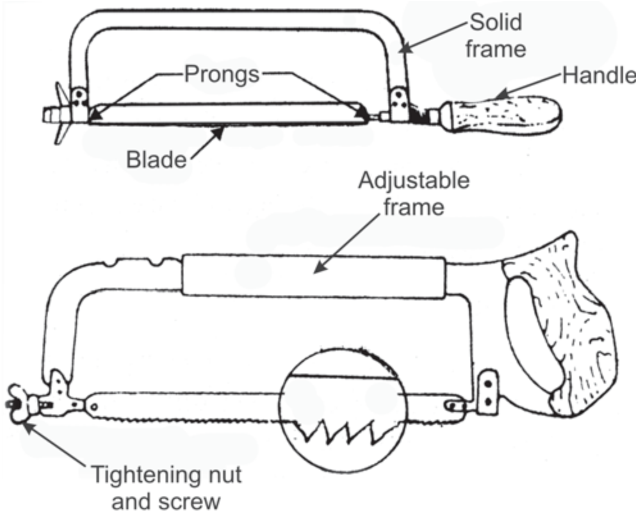


Drill guage

1.5 Cutting Tools

1.5.1 Hacksaw

The hacksaw is used for cutting metal by hand. It consists of a frame which holds a thin blade, firmly in position. The blade has a number of cutting teeth. The number of teeth per 25 mm of the blade length or teeth per inch (TPI) is selected on the basis of the work material and thickness (Table 1) being cut. Figure shows two types of hacksaw frames with a blade fixed.



Hacksaw frame with blade

The teeth of the hacksaw blade are staggered, as shown in figure which is known as "set of teeth". These make the slots wider than the blade thickness, preventing the blade from jamming.'

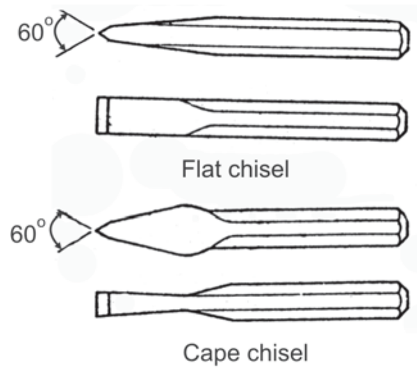
Set of teeth

1.5.2 Chisels

Chisels are used for removing surplus metal or for cutting thin sheets. These tools are made from 0.9% to 1.0% carbon steel of octagonal or hexagonal section. Chisels are annealed, hardened and tempered to produce a tough shank and a hard cutting edge. Annealing relieves the internal stresses in the metal. The cutting angle of the chisel for general purpose is 60 degrees.

A flat chisel is a common chisel used for chipping and cuffing off thin sheet-metal.

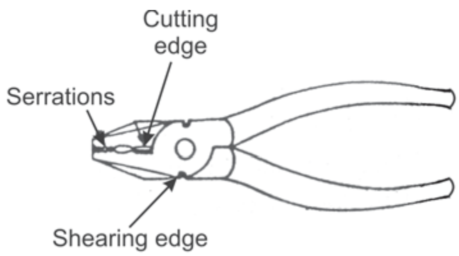
A cape chisel is narrow shaped tool. It is cased mostly for the chipping grooves and keyways.



Chisels

1.5.3 Combination Cutting Plier

This is made of tool steel and is used for cutting as well as for gripping the work. The handles of the pliers used by electricians are insulated with PVC covering to protect from electric shocks.



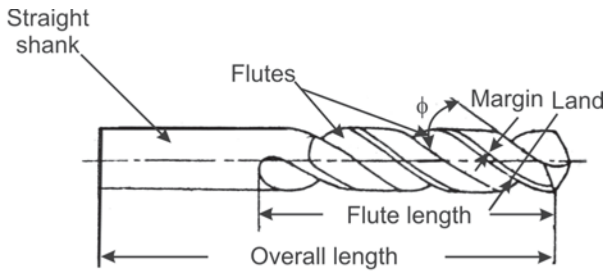
Combination cutting edge

1.5.4 Twist drill

Twist drills are used for making holes. These are made of high speed steel. Both straight and taper shank twist drills are used with machines. The following are the types, sizes and designations of twist drills:

1. Straight shank.

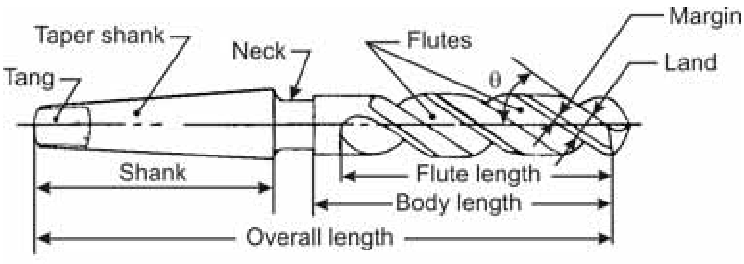
Millimetres	from 0.4 mm onwards
Inches	from l/64" onwards
Letter drills	A to Z
Number drills	60 to 20



ϕ = Helix angle

2. Taper shank

Millimetres	3 to 100 mm
Inches	1/8" to 4"

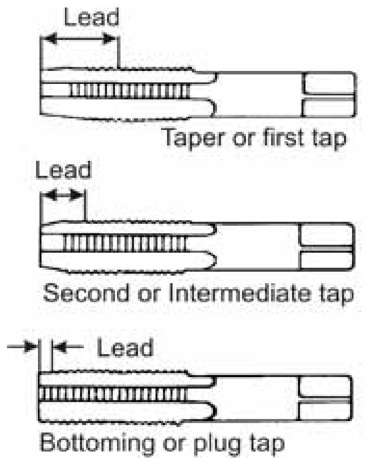


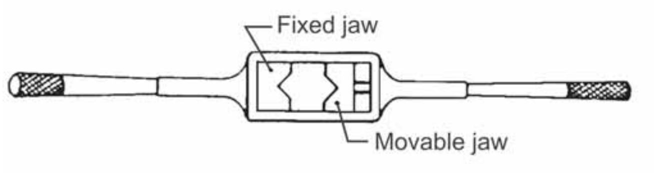
Twist drills

1.5.5 Taps and Tap Wrenches

A tap is a hardened steel tool, used for cutting internal threads after drilling a hole. Hand taps are usually supplied in sets of three for each diameter and thread pitch. Each set consists of a taper tap, intermediate tap and plug or bottom tap. The following are the stages involved in tapping operation:

1. Select the correct size tap, with the desired pitch. A thread is specified by its shape, size and pitch. Ex: M20 × 2.5 (nominal dia 20 mm, pitch 2.5 mm Metric thread).
2. Select the correct size tap drill, usually indicated on the tap.
3. Drill the hole.
4. Secure the tap in the tap wrench.
5. Insert the first or taper tap in the drilled hole and start turning clockwise, by applying downward pressure.



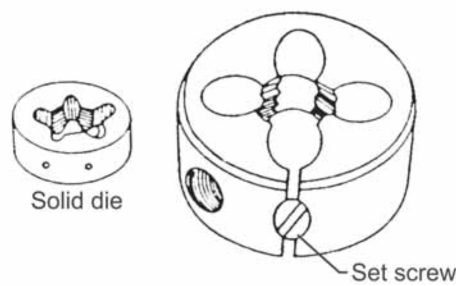


Taps and tap wrench

6. Check the alignment of the tap with the hole axis (verticality) with a try-square and correct it if necessary, by applying sidewise pressure while turning the tap.
7. Apply lubricant while tapping.
8. Turn the tap forward about half a turn and then back until chips break loose. Repeat the process until threading is completed with intermediate and bottom taps.
9. Remove them carefully. If it gets stuck, work it back and forth gently to loosen.

NOTE

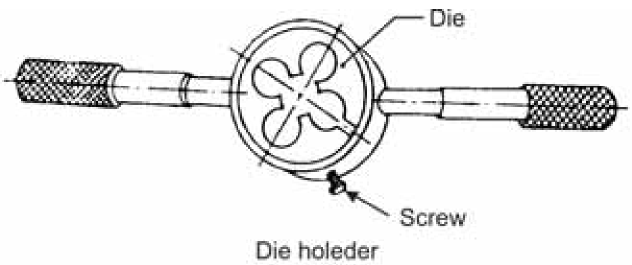
1. It is good practice to drill a small countersunk, about the depth of one thread to ensure that a base is not thrown up while tapping the hole.
2. While tapping in a blind hole, remove the tap and clear the chips often so that the tap can reach the bottom of the hole.



Adjustable splitdie

1.5.6 Dies and Die-holders

Dies are cutting tools used for making external threads. Dies are made either solid or split type. They are fixed in a die holder for holding and adjusting the die gap. They are made of tool steel or high carbon steel. The following are the stages in producing external threads:



Dis and die handles

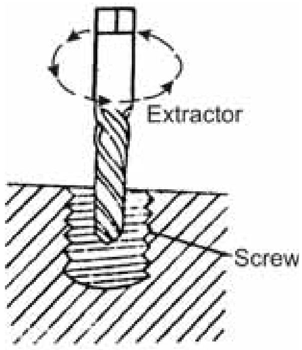
1. Prepare the work with chamfer at its end.
2. Select the correct size die.
3. Position the die in the die holder. Tighten the set screw so that the die is held firmly in its place. In case of adjustable die, set the die to cut oversize threads first.
4. Fasten the work firmly in a vice.
5. Place the die over the chamfered end of the work and start cutting threads by turning it clockwise while applying downward pressure. Apply cutting fluid while threading in steel.
6. Turn back the die for the chips to break loose. Continue until threading is completed.
7. Check the threaded work to see if it fits the tapped hole or nut. If the fit is too tight. adjust the die for a slight, deeper cut and complete the threading again.

NOTE: A tap is not adjustable, so it is better to tap first and then cut the external threads to fit the tapped hole.

1.5.7 Extractors

Screw extractor (Ezyout)

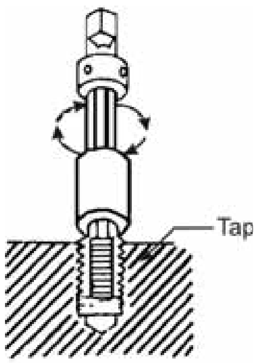
Bolts, screws, studs, and other threaded parts may be sheared off, leaving a portion behind in the tapped hole. This portion can be removed by using a screw extractor. It is made of high-carbon steel, and has a tapered shape and left-hand threads for removing right-hand screws. A screw extractor of a size smaller than the broken screw is chosen from a range.



Screw extractor

Tap extractor

This tool is used to extract parts of taps that are broken, in a hole. An extractor has prongs that fit into the flutes of a tap. The extractor is turned counter clockwise with a tap wrench to remove a broken right-hand tap.

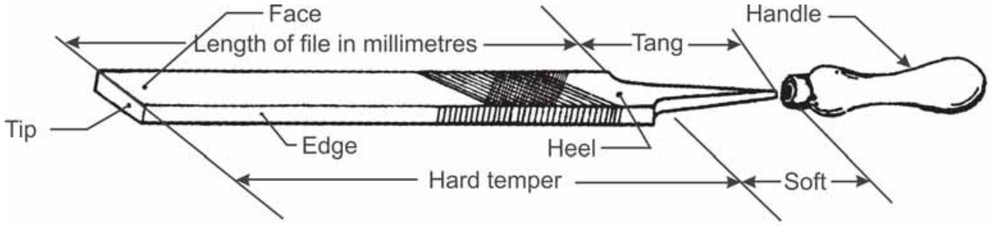


Tap extractor

1.6 Finishing Tools

1.6.1 Files

Filing is one of the methods of removing small amounts of material from the surface of a metal part. A file is a hardened steel tool, having slant parallel rows of cutting edges or teeth on its surfaces. On the faces the teeth are usually diagonal to the edge. One end of the file is shaped to fit into a wooden handle. Figure shows the parts of a hand file.



Hard temper

The hand file is parallel in width and tapering slightly in thickness, towards the tip. It is provided with double cut teeth on the faces, single cut on one edge and no teeth on the other edge, which is known as the safe edge.

1.6.2 Types of files

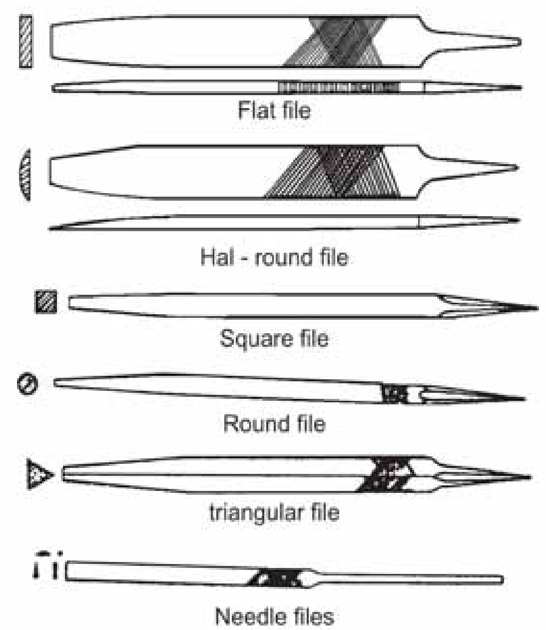
Files are classified according to their shape, cutting teeth and pitch or grade of the teeth, Figure shows the various types of files in use based on their shape.

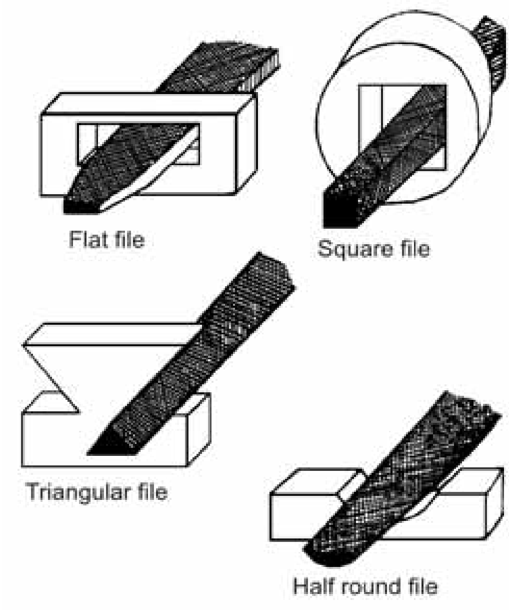
Type of file	Description and Use
1. Hand file	Rectangular in section and tapered in thickness but parallel in width. The faces carry double cut teeth and one of the edges single cut. The other edge, known as safe edge, does not have any teeth and hence this file is also known as safe edge file. It is useful in filing a surface which is at right angles to an already finished surface.
2. Flat file	It is rectangular in section and tapered for 1/3 length in width and thickness towards the tip. The faces carry double cut teeth and the edges carry single cut teeth. It is a general purpose file.
3. Square file	It is square in section and carry double cut teeth on all the four faces. It is tapered for 1/3 of its length towards the point. Square files are used for filing corners and slots. It is also used to cut keyways.
4. Three square file	It is of equilateral triangular in section and tapers towards the tip. The faces are double cut and the edges sharp. These files are used to file angular hole, and recesses. Used for sharpening wood saws.
5. Round file	It is tapered for 1/3 length with double cut on large coarse grades. Used for filing out round, elliptical and curved openings.

6. Half round file The half round file has one flat and one curved side. The flat side is double cut and the curved side is single cut. It is not a semicircle but only about 1/3 of circle. Second cut and smooth grades are used. This is an extremely useful double purpose file for flat surfaces and for curved surfaces which are too large for the round file to be used.

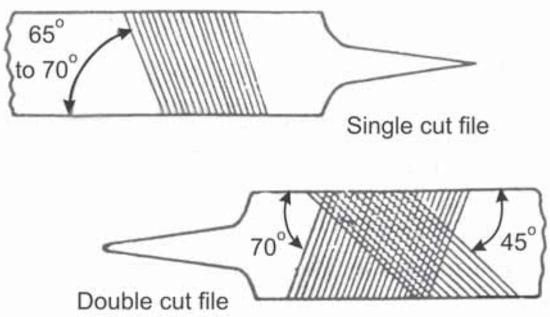
7. Swiss or Needle files 150 mm long with double cut teeth. Used for filing corners, grooves, narrow slots, etc.

Cut refers to 'single cut' and 'double cut' files. Single cut files have rows of teeth running in one direction, across their faces and double cut files have a second row of teeth cut diagonally to the first row as shown. Single cut files are used with light pressure to produce smooth finish. These are widly used for finishing over turning jobs. Classification of files based on the grade or the pitch of the teeth, is shown in figure.





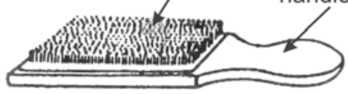
Files in use

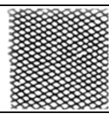
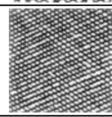
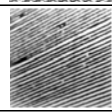
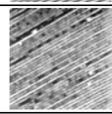
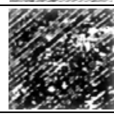


Cut of files

1.6.3 File Card

It is a metal brush used for cleaning the files, to free them from filings, clogged in between the teeth.



Type	Form	No of teeth/cm
Rough		8
Bastard		17
Second cut		16
Smooth		20-24
Dead smooth		40

Grades of files

1.7 Miscellaneous Tools

1.7.1 Hammers

Hammers are named depending on their shape and material and specified by their weight. A ball peen hammer has a flat face which is used for general work and the ball end particularly used for revetting. They weigh from 200 gm to 1.5 kg.

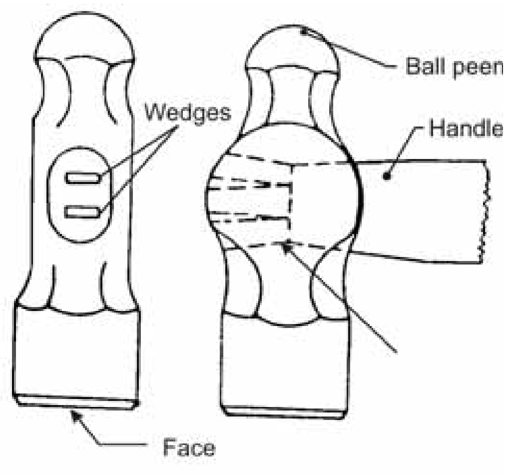
The hammer consists of a hardened and tempered steel head varying in mass from 0.1 kg to about 1 kg, firmly fixed on a tough wooden handle.

The flat striking surface is known as the face, and the opposite end is called the peen. The most commonly used is the ball-peen, which has a hemispherical end and is used for rivelting over the ends of pins and rivets.

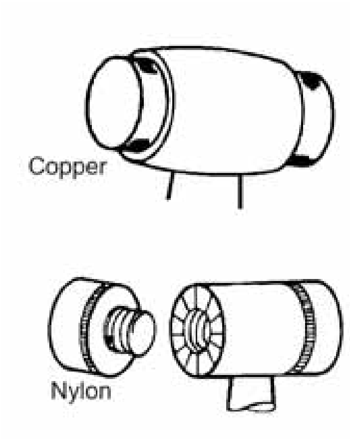
For use with soft metals such as aluminium or with finished components where the workpiece could be damaged if struck by an hammer, a range of hammers is available with soft faces, usually hide, copper, or tough plastics such as nylon. The soft faces are usually in the form of replaceable inserts screwed into the end or forced into a recess in the face.

Always use a hammer which is heavy enough to deliver the required force but not too heavy to be tiring in use. The small masses, 0.1 kg to 0.2, are used for centre punching, while the 1 kg ones are used with large chisels or when driving large keys or collars on shafts. The length of handle is designed for the appropriate head mass, and the hammer should be gripped near the end of the handle to deliver the required blow. To be effective, a solid sharp blow should be delivered and this cannot be done if the handle is held too near the hammer head.

Always ensure that the hammer handle is sound and that the head is securely fixed.



Ball peen hammer



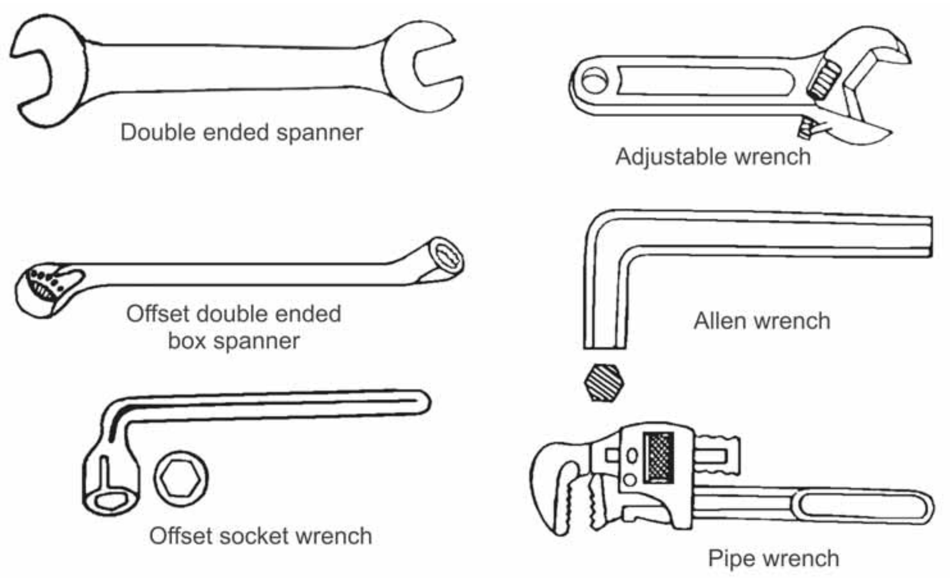
Soft hammers

1.7.1 Spanners

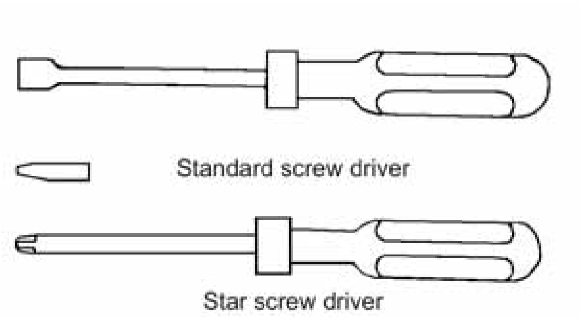
A spanner or wrench is a tool for turning nuts and bolts. It is usually made of forged steel. There are many kinds of spanners as shown in figure. They are named according to the shape and application. The size of the spanner denotes the size of a bolt on which it can work.

1.7.2 Screw Drivers

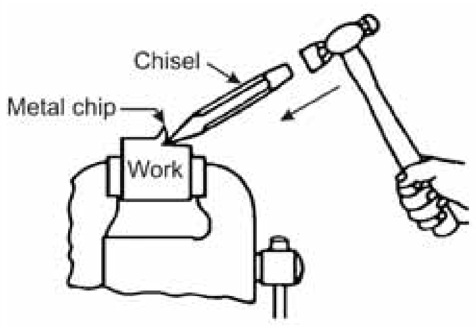
A screw driver is designed to turn screws. The blade is made of steel and is available in different lengths and diameters. The grinding of the tip of the blade to correct shape is very important. Screw driver is specified by the length of the steel rod. Screw drivers with small diameter rods are known as connectors. For better grip on screws which are small and at not easily accesable depths, philips (star) screw drivers are used. The end of the blade is fluted. Screw driver is specified by its length, for example 100 mm, 200 mm, etc.



Spanners



Screw drivers



Chipping

1.8 Fitting Operations

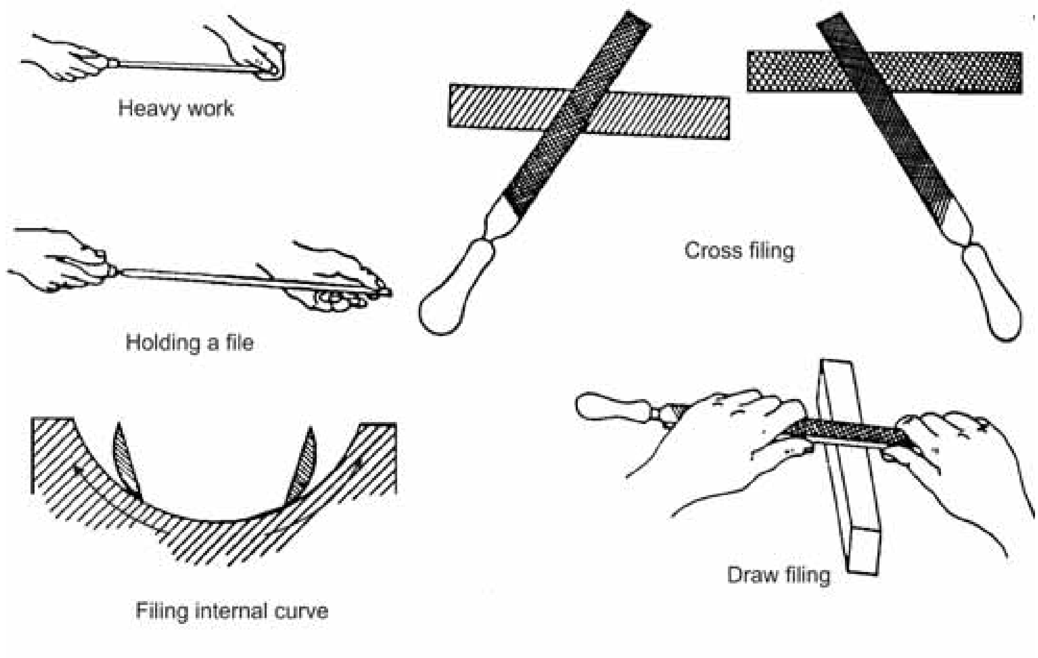
1.8.1 Chipping

Removing the metal with a chisel is called chipping and is normally used where machining is not possible. While chipping, safety goggles must be put on to protect eyes from the flying chips. To ensure safety of others, a chip guard is placed in position. Care should be taken to see that the chisel is free from mushroom head.

1.8.2 Filing

There are several methods of filing, each with a specific purpose. With reference to the figure, the following may be noted:

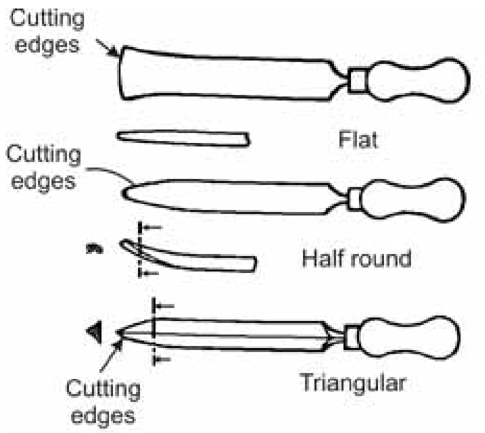
1. ***Holding the file:*** For heavy work and to remove more metal, a high pressure is used. For light and fine work, a light pressure is applied.
2. ***Filing internal curves:*** A part of half round file only makes contact as shown during filing operation. Movement of the file is indicated by arrows.
3. ***Cross filing:*** It is the most common method of filing. Cross filing is carried out across two diagonals, to produce medium surface finish. It is used when large amounts of metal is to be removed. By cross filing 'rounding' the surface is reduced.
4. **Straight filing:** When a short length of workpiece is required to have a flat surface, straight filing is used. File marks made during cross filing may be removed, to produce a relatively smooth surface.
5. **Draw filing:** It is done to get a finely finished surface. It produces a smoother surface finish than straight filing. A smooth or dead smooth flat file is used for this.



Filing

1.8.3 Scrappers

These sharp edged tools are used to remove uneven spots on the surfaces. They are of different shapes.



Scrapers

Flat scraper

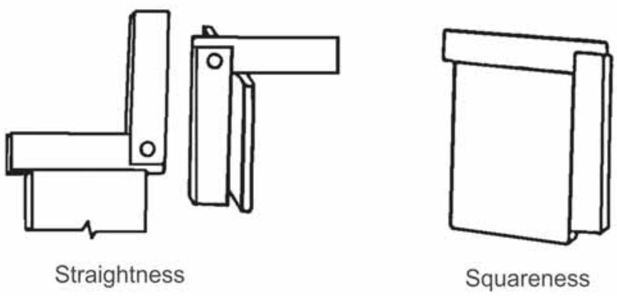
It is used for removing metal from flat surfaces. The blade must have a slight curvature at the cutting edge. The corners are rounded to help the user, scrape at the exact spots.

Half round bearing scraper

This is used for scraping curved and cylindrical surface – split bearings, big bush bearings etc.

Triangular scraper

This is used for scraping curved surfaces, holes and bores. Specification is by length. Example: 200 mm, 300 mm etc.



Use of try - square

1.8.4 Pinning of Files

This is caused by soft metals, clogging the file teeth and scratching the surface of the work. The pins are removed with a file card. Pinning may be prevented by rubbing chalk into the teeth before filing.

1.8.5 Checking Flatness and Squareness

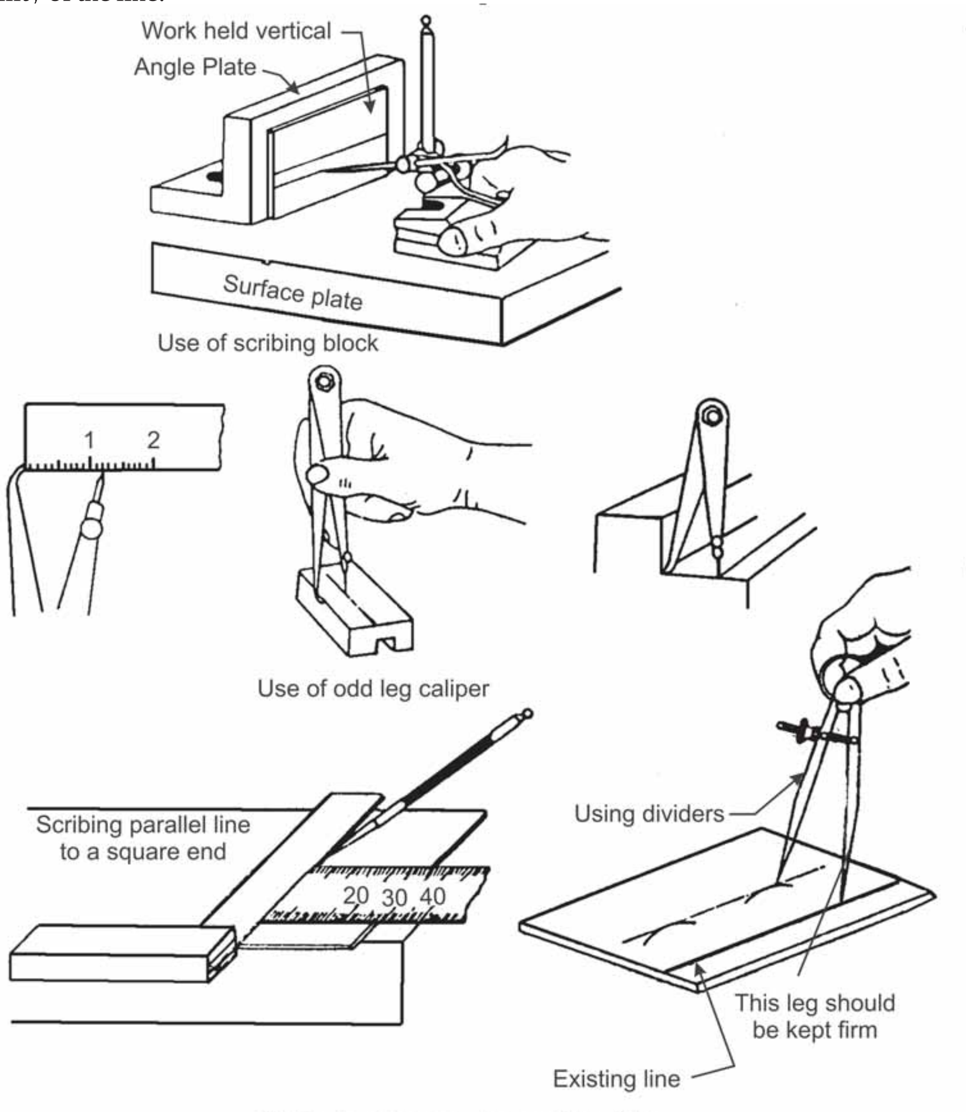
To check flatness, the try square is placed as shown in figure. Day light should not be seen between the bottom edge of the square and the top surface of the work piece, when both are held against light. Similarly, the flatness across thickness of plate is tested as shown.

The squareness of one edge with respect to another reference edge is checked as shown in figure.

1.9 Marking and Measuring

Accurate marking is the first step; and the methods and instruments used are common in all fitting works. Measurements are taken either from a finished edge or from a centre line.

Scriber lines on non-ferrous materials and oxide coated steels are readily visible but bright steel needs coating with copper sulphate solution or engineers blue (persian blue), for the visibility of the line.



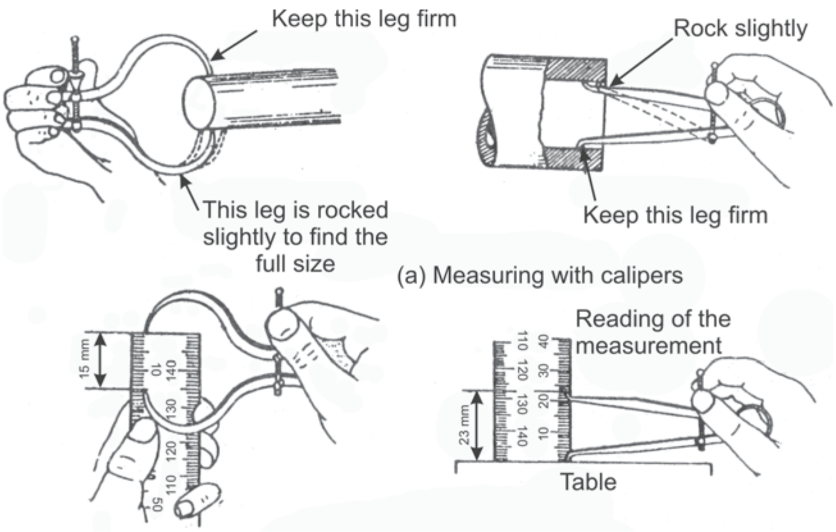
Methods of measuring and marking

Sow a character reap a destiny. So destiny is in your hands.

Measuring and testing are continuous processes throughout the manufacturing, whether working with hand tools or machines. Degree of accuracy is specified on the drawing. The following are the measuring methods in the order of increasing accuracy:

(a) Direct measurement from a rule, (b) Caliper set to a rule, (c) Caliper set to a plug gauge, (d) Vernier calipers, (e) Micrometer, (f) Dial indicator

Figures, A to D show some methods of measuring and marking. Firm joint or spring calipers are used for transferring the dimensions, both external and internal, as shown in figure



(b) Reading the measurement

Measuring with calipers

1.10 Marking and Measuring Angles

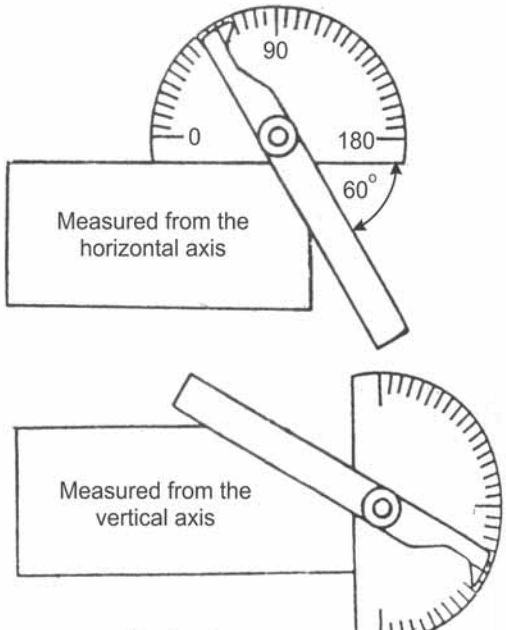
1.10.1 Protractor

Protractor is used to measure angles. However, it is essential to position the protractor to the correct face of the component, as shown in figure. Engineers protractor is marked in degrees and with care, reading to the nearest half degree may be made.

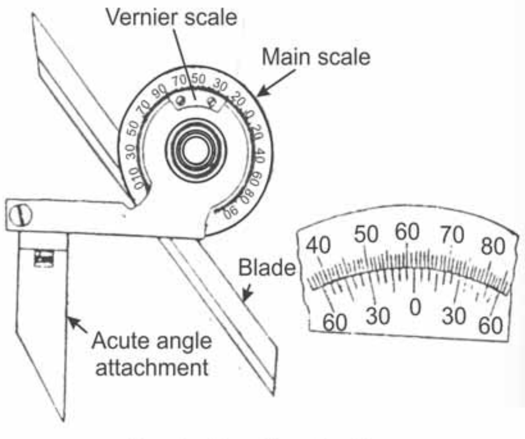
A true leader does whatever he wants. Others may be inspired to follow his example.

1.10.2 Vernier Bevel Protractor

A vernier protractor is used to measure angles up to an accuracy of 5 minutes. The vernier scale is divided into 24 parts, 12 on either side of the zero, each representing 5 minutes as shown in figure.



Protractor

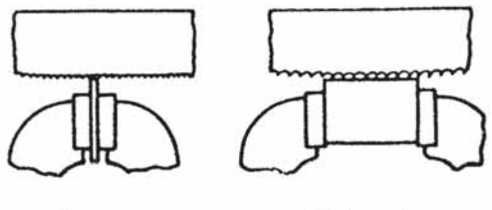


Vernier bevel protractor

1.11 Principles of Sawing

Hacksaw blades are specified by their total length, the width, thickness and the teeth provided per 25 mm length called the pitch. Example: 300 × 12.7 × 0.65 × I8TPI. The correct choice of pitch should ensure that at least three teeth are in contact with the section under the saw. Blades should be inserted with the teeth pointing forward, as the saw cuts on the forward stroke only. Hacksaw blades are made in (i) All hard low alloy steel, (ii) High speed steel (HSS), and (iii) Flexible HSS. Little downward pressure is needed in sawing, as the teeth are designed to pull themselves into the work. About 40 strokes per minute is the correct sawing speed. HSS flexible blade manufactured by Bipico Eclipse India is ideal for students (beginners) as it cuts even hard steel easily and does not break at all. It has long life too for the extra cost paid.

Table 1 gives the application of the blades with respect to the pitch of the blade and material thickness. Table 2 shows the shapes or sections of some common raw materials available in the market.



Sawing

Table 1.1 Hacksaw blades application.

Teeth per 25 mm	Material Thickness, mm	Application
32	Upto 3	Thin sheets and tubes, hard and soft material (thin sections)
24	3 to 6	Thicker sheets and tubes, hard and soft materials (thicker sections)
18	6 to 12	Heavier sections made of mild steel, cast iron, aluminium, brass, copper and bronze
14	12 to above	Soft materials of heavy sections, such as aluminium, brass, copper and bronze

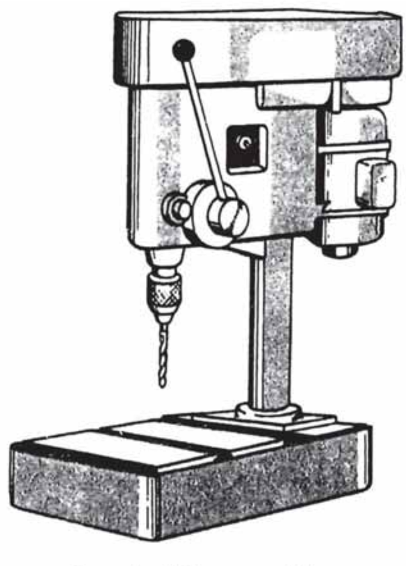
1.12 Drilling Machines

1.12.1 Bench Drilling Machine

Generally it is fixed on the work bench and is suitable for drilling holes with a diameter up to about 10 mm.

It is a light and high-speed machine and used for light duty work. It can be used for drilling holes from 1.5 to 15 mm diameter. It is mounted on a bench and hence the name, "Bench-drilling machine". In this, the drill is fed into the work piece by hand only. Here, the operator can feel or sense the travel of the drill. Hence, this machine is rightly called, "Sensitive drilling machine".

Figure shows a bench-driling machine. The main parts of this machine are: Base, column, portable, spindle head, and drive mechanism.



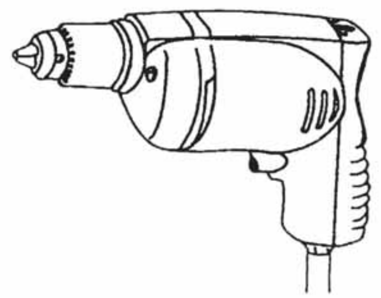
Bench drilling machine

A leader finds out what more can be done. He is never out of a job.

1.12.2 Portable Power Drill

Portable power drills are available with double insulation. The range vary from 6 mm to 20 mm drill diameter.

It is the most useful of all kinds of drilling equipment. It is readily portable and convenient for use. It can be used for drilling holes in any position which is not possible with conventional drilling machines. An individual motor drives this machine. The entire drilling mechanism is enclosed in a compact case, as shown in figure. The motor is generally a universal type and can be operated both on A.C and D.C supply. Since the diameter of the holes to be drilled is small; the portable electric drill is operated at high speeds. The capacity of the portable electric drill is designated by the maximum diameter of the hole it can drill in steel.



Portable drill

Steps in drilling, using a portable electric drill

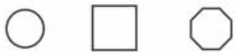
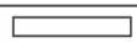
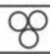
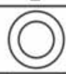
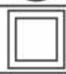
1. Layout and mark the centers of each hole, with a center punch.
2. Select propert size drill bit and fix it in the chuck properly.
3. Clamp the work in a vice or to the bench.
4. With the power-off position the drill point at the center punch mark. Make sure that the tool is square with the surface.
5. Hold the drill with one hand and steady it with the other. Put-on the power and apply pressure steadily.
6. Release the pressure slightly, when the point of the drill pierces the lower surface of the metal.
7. Remove the tool from the hole and put it off.

1.13 Safe Work Practices

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

1. Position 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. Use soft jaws when holding finished work surfaces in a bench vice.
3. Position the work in a vice so that it does not overhang into an aisle of other area where a person might accidentally brush against it.
4. Select the hacksaw blade pitch and set, most suitable for the material and the nature of the cutting operation.

5. Apply force only on the forward (cutting) stroke, relieve the force on the return stroke.
6. Start a new blade in another place when a blade breaks during a cut. This prevents binding and blade breakages.
7. Cut a small groove with a file in sharp corners, where a saw cut is to be started. The groove permits accurate positioning of the saw and also prevents stripping of the teeth.
8. For cutting thin metal strips, clamp them between two pieces of wood. Cutting through both the wood and the metal prevents the saw teeth from digging in and bending the metal.
9. Wear safety goggles or a protective shield when chipping and driving parts. Flying chips and other particles may cause eye injury.
10. Grind-off any mushroom that may form on the head of the chisel.

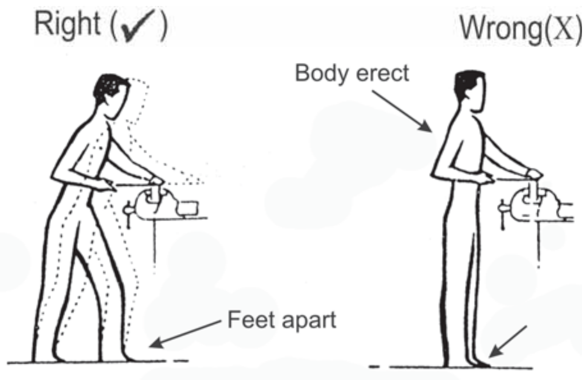
Description	Section
Sheet up to approx .7 mm thick	
above 7 mm thick	
Bars – Round, Square, Octagonal	
Flats	
Wires	
Cable	
Angles (equal or enequal)	
Tees	
Channels	
H Section - beams	
Extrusion (any type)	
Tubes (seamed or unseamed)	
Hollow square or rectangular	

Forms of materials

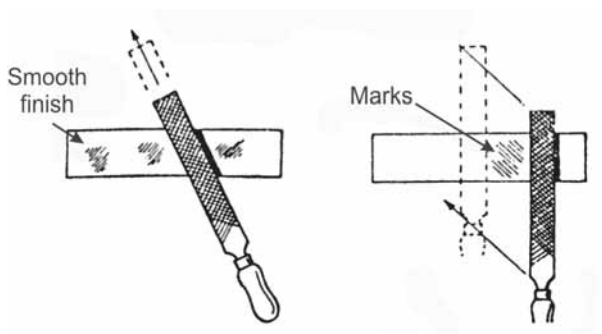
11. Use a file with a properly fitted, tight handle.
12. Examine the hammer each time before it is used. The handle must be securely wedged.
13. Select a screw driver with a tip which is only slightly smaller than the diameter of the screw head. The blade should fit snugly against the slot.
14. Select the type, shape and size of wrench opening, most suitable for the application. Position the wrench jaws as close to the work as possible, to prevent slipping.
15. Remove sharp projecting edges and burrs which produce inaccuracies in layout, measurement errors and improper fits.

1.13.1 Right and Wrong Working

The following figures illustrate right and wrong ways of doing certain fitting operations and use of tools.



(a) Posture in fitting shop



(b) Filling flat surfaces

(a) With left foot set forward the whole of the body is in action and the filing or cutting stroke with pressure is done without much strain to hands or legs. In the second case with body movement the arm would tire soon.

(b) With filing diagonally across the work, smooth finish is obtained. Note that the file moves in the direction of the length of the file as shown. In the second case cut of the file teeth are produced on the work.

(c) Keep the work as low in the vise as possible. Work too high means lack of rigidity and too much vibration.

(d) Hold work within the width of the vice jaws, using the full grip of the vice. Avoid unnecessary overhang resulting in poor surface finish.

(e) Work across at an angle, left and right. It is a mistaken idea that filing along the length

Do only what you know to be right to gain real happiness.

of the work produces a flatter surface.

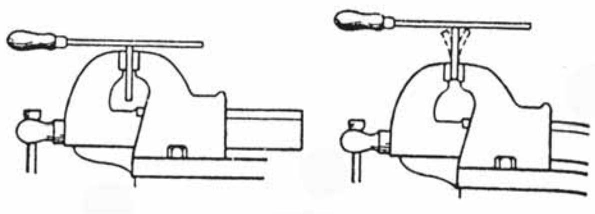
(f) Clamps protect the surface of the finished job. Without clamps jaw impressions are made on the finished surfaces.

(g) Body action applies pressure on forward stroke and relief on return. Blde must be fitted to cut on forward stroke.

(h) There must be more than one tooth in action.

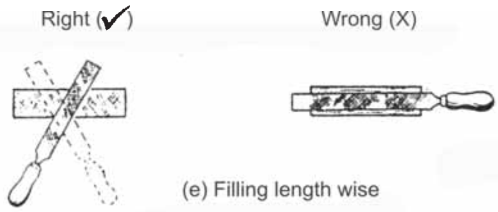
(i) Commence cutting with saw blade slightly inclined to the horizontal, picking up the line at far edge of work and proceed to horizontal position. In the second case it is difficult to pick up line accurately with blade engaging full width of the work. Blade too steeply inclined results in broken teeth.

1.13.2



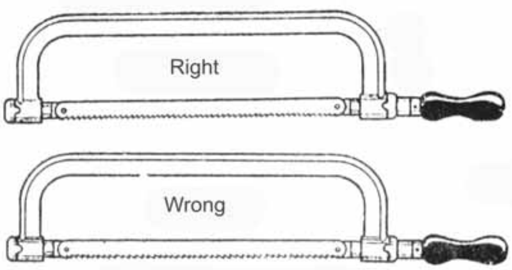
© Holding work in vice

(d) Filling with overhanging job

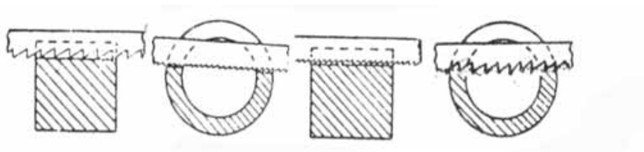


(e) Filling length wise

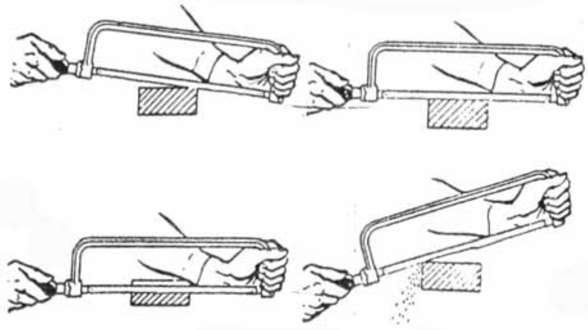
(f) Use of soft clamps



(g) Fixing hacksaw blade



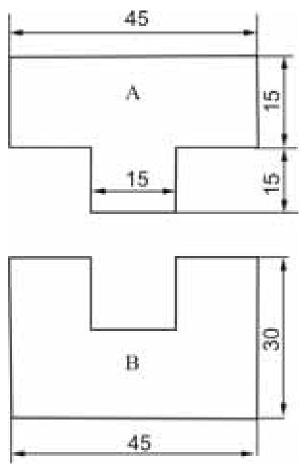
(h) Selection of blade pitch

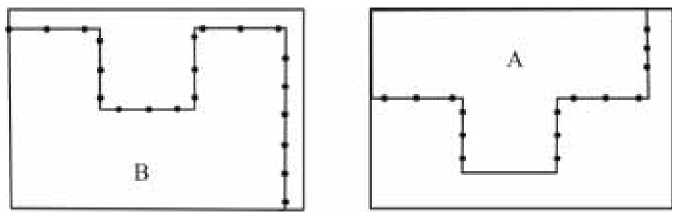


(I) Method of sawing

1.14 Model Record Sheet

Aim: To make a step fitting as shown below:





Marked and punched pieces

Material: Ms Flat : 32 mm × 50 mm × 3 mm thick. 2 Nos

Tools required: 150 mm steel rule, 150 mm try square, 200 gm ball peen hammer, dot punch. odd- leg caliper, 300 mm hacksaw frame with 300 × 12.7 × 0.65 18 TPI hacksaw blade, 250 mm rough and smooth flat files with safe edge, 10 mm square file smooth, 150 mm flat chisel.

Sequence of operations

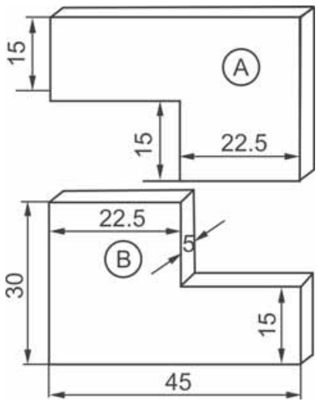
1. The given m.s flat sizes are checked.
2. The side with 50 mm is filed first with a rough flat file of size 300 mm and then with a smooth file and
3. The flatness of the side in checkned with the help of a 150 mm precision Ery-square.
4. The side 32 mm in filled abd its squareness with the other side in checked with try-square.
5. The suides 45 mm and 30 mm and steps are marked with the help of odd-leg caliper.
6. Dot punches are marked along the lines a shown in sketch.
7. With the help of hacksaw flame and blade 300 × 12.7 × 0.65 × 18 TPI cattings is done along the punch dots.
8. Fitting is done on the sudes to trysquare on the male part A.
9. Now holes are drilled in part B to remove excess material.
10. Filling is done on all sides to suit A.
11. Now both A and B are fitted together and held in the vice to file and finish on both faces.
12. The required fittings in obtained.

1.15 Exercises

Aim : To make a straight fitting. **Ex. No. :**

Date :

Sketch :



Material : MS flat

size 50 × 32 × 5 mm : 2 Nos.

List of tools used :

Sequence of operations :

Safety precautions :

Staff signature

OBJECTIVE QUESTIONS

Fill in the blanks or answer the following in one word

1. The body of a bench vice is made of _____________ material.
2. _____________ are provided on the jaws of the bench vice to ensure good grip.
3. Jaw caps are made of _____________ material to protect finished surfaces
4. _______________ are used to support round jobs for layout and inspection
5. ________________ clamp is used to hold work.
6. For marking on heavy and big jobs _____________ is used
7. For marking or inspection of small jobs _____________ are used
8. _______________ is used to clamp jobs for marking or inspection
9. _____________ is used to scribe lines on the job
10. Try square is used to check _____________
11. Try square is specified by the _____________
12. Mitre of a combination set marks _____________ degrees on the work
13. _____________ is used to check squareness.
14. Odd-leg caliper is also called as _____________ and _____________
15. Drift punch is used to _____________
16. The point angle of a centre punch is _____________ degrees.
17. The point angle of a dot punch is _____________ degrees.
18. Before making fine adjustment of vernier _____________ clamp is locked.
19. Main scale readings of a micrometer are marked on the _____________ and Vernier readings on the _____________
20. Final pressure of the spindle of the micrometer on the job should be applied only by _____________ and not by thimble.
21. Can inside micrometer read from zero?
22. How do you change the range of the inside micrometer?
23. How is an outside / inside micrometer specified.
24. What is a least count?

25. Where is a feeler gauge used?
26. How is a thread specified?
27. How do you check the pitch of a thread?
28. What is the use of radius gauge?
29. Name few chisels.
30. When is a cape chisel used.
31. ___________ is used to cut and shear wires.
32. Twist drill may be of _____________ or _____________ shank.
33. ________________ drills are marked A to Z.
34. Each size of a tap consist of _____________ number of taps.
35. The finishing tap is known as _____________ tap.
36. A _____________ is drilled on a job before taping
37. _____________ is used to make exeternal threads.
38. File is _____________ tool
39. The hand file is _____________ width.
40. The flat file is _____________ for 1/3 length in width and thickness.
41. A square file is used to file _____________
42. _____________ is used to file angular recesses.
43. The flat side of a half round file is ____________ cut and half round _____________ cut.
44. The section of a half round file is ____________.
45. _____________ are used to file grooves and narrow slots.
46. What, is the difference between double cut and second cut?
47. _____________ cut file is used for finishing turning work.
48. For cleaning files _____________ are used.
49. A hammer is specified by _____________ and _____________
50. Soft hammers are used on ____________ work.
51. _____________ used to secure the handle well to the hammer.
52. _____________ end decides the name of the hammer.
53. Material used for soft hammer is _____________

54. A screw driver is specified by _____________
55. A connector has a _____________ diameter.
56. While chipping, the chisel head should be free from _____________
57. While chipping _____________ are put on to the eyes.
58. Clogging of a file is termed as _____________
59. _____________ applied to prevent pinning of a file.
60. Flatness and straightness are checked by means of _____________
61. Hacksaw blade with coarse pitch is used to cut _____________ sections,
62. Thin sections are cut by hacksaw with a _____________ pitch of teeth.
63. Hacksaw blade is fixed in such a way that it cuts on the _____________
64. To prevent binding of teeth the teeth of hacksaw are _____________
65. The edge of a file that does not have teeth on it is called a _____________ _____________
66. Twist drill is made of _____________ material.
67. Mild steel has a carbon content of _____________ percent.
68. The cutting edge of a chisel is _____________ after hardening.
69. The one millionth of a metre is known as _____________
70. The size of a bench vise gives _____________

Answers

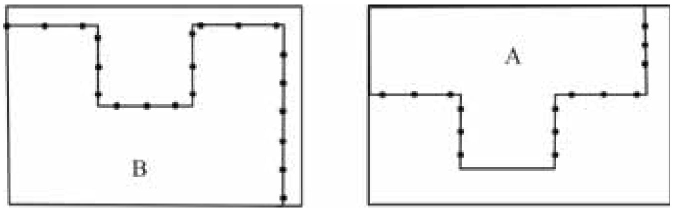
1. Cast iron 2. Hardened steel plates 3. Soft 4. V-blocks 5. C-clamp 6. Marking tables 7. Surface plate 8. Angle plate 9. Scribing block 10. Flatness and squareness 11. Length of the blade 12. 45 degrees 13. Square head 14. Jenng caliper 15. Align holes 16. 90 degrees 17. 60 degrees 18. Screw on 19. barrel and thumble 20. Ratchet 21. No 22. Extension rods 23. Range 24. Maximum reading its instrument can measure (accuracy) 25. To check the clearances 26. Nominal diameter and pitch 27. Pich gauge 28. To check fillets 29. Flat, cape 30. Chipping grooves and keyways 31. Combination cutting plier 32. Straight of toper shank 33. Letter drills 34. Three 35. Bottoming 36. Hole 37. Die 38. Finishing 39. Parallel 40. Tapered 41. Corners 42. Triangular 43. Double cut, single cut 44. Not semi circular 45. Needle files 46. One is cut of a file, the other is grade 47. Single 48. File cards 49 Weight and shape 50. Finished 51. Wedges 52. Peen end 53. Hide, copper, plastic 54. Length 55. Small 56. Mushrooms 57. goggles 28. Pinning 59. Chalk powder 60. Try square 61. Heavy 62. Fine 63. Forward stroke 64. Staggered 65. Safe edge file 66. High speed steel 67. 0.2 68. Tempered 69. Micron 70. Maximum size of job that can be fixed in it.

Sequence of Operations

1. The mild steel (MS) flats raw material given are checked for the dimensions.
2. The 50 mm side is filed first with 250 mm rough file and then with smooth flat file.
3. Its adjacent side of 35 mm is also filed with both rough and smooth files.
4. The flatness and squareness of the edges to one another is checked with try square (see page 1.19)
5. Both pieces are marked using angle plate, steel rule and scribing block (page 1.20) or odd leg caliper.
6. Both pieces are punched with dot punch along the marking lines.
7. The excess material over and above 30 and 45 mm is removed on both pieces using 300 mm hack saw.
8. First the female piece (A) is cut by drilling holes within the marked lines and using chisel.
9. The edges are now filed to get the flatness and finish.
10. Final finishing is done using square files.
11. The male piece (B) is cut along the dot punches. Then it is filed first with rough file and then with smooth file until it fits with the female groove.
12. After fitting both pieces the top surfaces are filed to remove any burrs present.

Answers

1. Cast Iron (C.I) 2. Serrations 3. Soft sheet metal 4. V-blocks 5. U-clamp 6. Marking table 7. Surface table 8. C-clamps 9. Sribring block 10. Flatness and sowareness 11. length of the blade 12. 90º 13. Square head 14. Jenny caliper 15. Align holes 16. 90º 17. 60º 18. Screw on 19. Barrel and Trimble 20. Rat chet 21. No 22. Extension rods 23. Least count and range 24. The dimensional accuracy to which the instrument can measure 25. To check clearances 26. Nominal diamter and pitch 27. Screw pitch gauge 28. To check radii 29. Flat, cape 30. to cut key ways 31. Cutting plier 32. Tapered or straight 33. Letter drills 34. Three 35. Plug tap 36. Hole 37. Tap 38. Finishing 39. Tapered in thickness and parallel in width 40. Tapered 41. Keyways and slots 42. Triangular 43. Double, single 44. Semi circular 45. Needle files 46. Teeth cut in single row and double row diagonally 47. Single cut 48. File cards 49. Shape and weight 50. Finished components 51. Wedges 52. Peen end 53. Nylon 54. Length 55. Small 56. Mushroom 57. Goggles 58. Pinning 59. Chalk powder 60. Try square 61. Thick 62. Fine 63. Hand, forward stroke 64. Set 65. Safe edge files 66. High speed steel (HSS) 67. 0.2 68. Tempered 69. mm 70. The jaws opening size.



Marked and punched pieces

Tools required: 150 mm steel rule, 150 mm try square, 200 gm ball peen hammer, dot punch. odd- leg caliper, 300 mm hacksaw frame with 300 × 12.7 × 0.65 18 TPI hacksaw blade,

Sequence of Operations

1. The mild steel (MS) flats raw material given are checked for the dimensions.
2. The 50 mm side is filed first with 250 mm rough file and then with smooth flat file.
3. Its adjacent side of 35 mm is also filed with both rough and smooth files.
4. The flatness and squareness of the edges to one another is checked with try square (see page 1.19)
5. Both pieces are marked using angle plate, steel rule and scribing block (page 1.20) or odd leg caliper.
6. Both pieces are punched with dot punch along the marking lines.
7. The excess material over and above 30 and 45 mm is removed on both pieces using 300 mm hack saw.
8. First the female piece (A) is cut by drilling holes within the marked lines and using chisel.
9. The edges are now filed to get the flatness and finish.
10. Final finishing is done using square files.
11. The male piece (B) is cut along the dot punches. Then it is filed first with rough file and then with smooth file until it fits with the female groove.
12. After fitting both pieces the top surfaces are filed to remove any burrs present.

Objective Questions

Fill in the blanks or answer the following in one word

1. The body of a bench vice is made of _____________ material.
2. _____________ are provided on the jaws of the bench vice to ensure good grip.
3. Jaw caps are made of _____________ material to protect finished surfaces
4. _______________ are used to support round jobs for layout and inspection
5. ________________ clamp is used to hold work.
6. For marking on heavy and big jobs _____________ is used
7. For marking or inspection of small jobs _____________ are used
8. _______________ is used to clamp jobs for marking or inspection
9. _____________ is used to scribe lines on the job
10. Try square is used to check _____________
11. Try square is specified by the _____________
12. Mitre of a combination set marks _____________ degrees on the work
13. _____________ is used to check squareness.
14. Odd-leg caliper is also called as _____________ and _____________
15. Drift punch i used to _____________
16. The point angle of a centre punch is _____________ degrees.
17. The point angle of a dot punch is _____________ degrees.
18. Before making fine adjustment of vernier _____________ clamp is locked.
19. Main scale readings of a micrometer are marked on the _____________ and Vernier readings on the _____________
20. Final pressure of the spindle of the micrometer on the job should be applied only by _____________ and not by thimble.

Answers

1. Cast Iron (C.I) 2. Serrations 3. Soft sheet metal 4. V-blocks 5. U-clamp 6. Marking table 7. Surface table 8. C-clamps 9. Scribing block 10. Flatness and sawareness 11. length of the blade 12. 90º 13. Square head 14. Jenny caliper 15. Allign holes 16. 90º 17. 60º 18. Screw on 19. Barrel and Thimble 20. Ratchet