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.

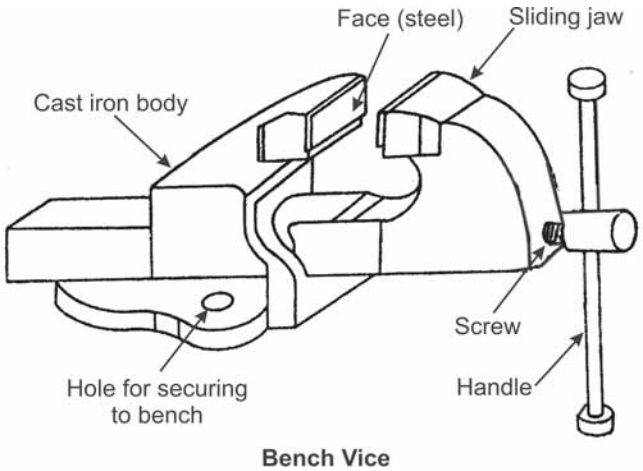
In all these processes, components are produced with the help of either machines or manual effort. The attention of a fitter is required at various stages of manufacture starting from marking to assembling and testing the finished goods.

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

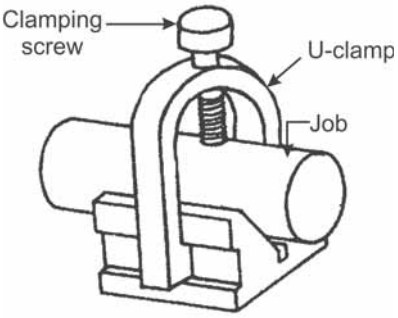
The bench vice is a device commonly used for holding the work pieces. When the vice handle is turned in a clockwise direction the moving jaw forces the work against the fixed jaw. The greater the pressure applied to the handle, the tighter is the work held. The body of the vice is made of cast-iron.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



V-Block

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 90º. V-block with a clamp is used to hold cylindrical work securely, during marking of measurements or for measuring operations.

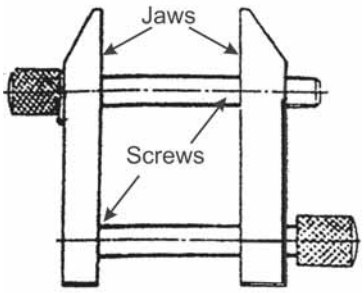
Material: C.I or hardened steel. Size: 50 to 150 mm.

Parallel Clamp

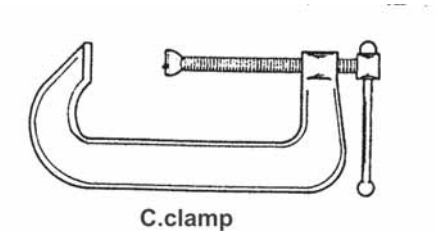
It is a simple screw clamp with parallel jaws to hold small jobs for working on them.

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.

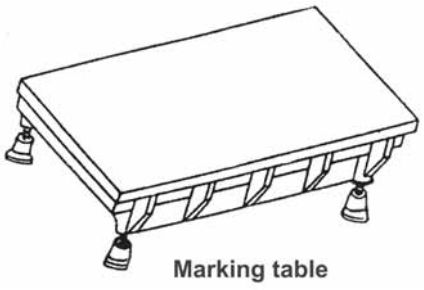


Parallel clamp


C.clamp

1.3 Marking Tools

1.3.1 Marking table

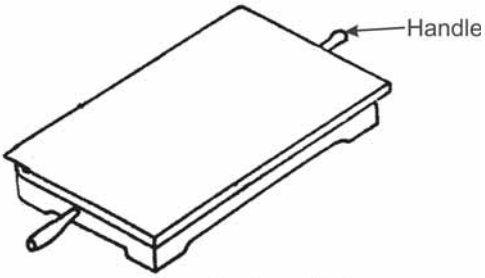

Marking table

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.

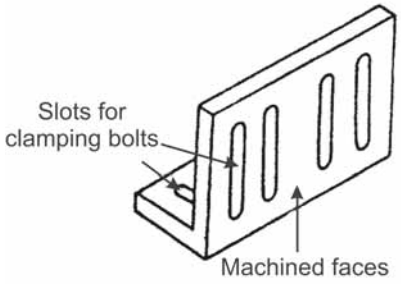
Surface plates are made of C.I. or hardened steel, ground and scraped to the required precision. Now-a-days surface plates made of special granite stone are manufactured in wide range of precision grades, colours and sizes. It is specified by length × width × height × grade. Example: 600 × 400 × 100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



Surface plate

1.3.3 Angle Plate

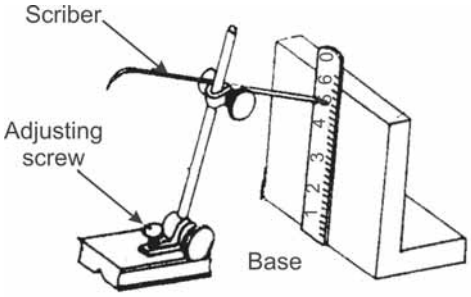
The angle plate is made of cast iron. It has two surfaces machined at right angles to each other. Plates and components which are to be marked out may be held against the upright face of angle plate to facilitate the marking or inspection.



Angle plate

1.3.4 Universal Scribing Block

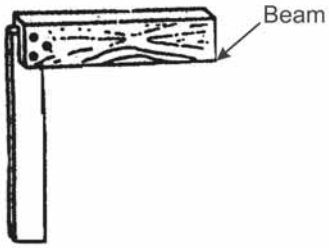
This is used for scribing lines for layout work and checking parallel surfaces.



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.

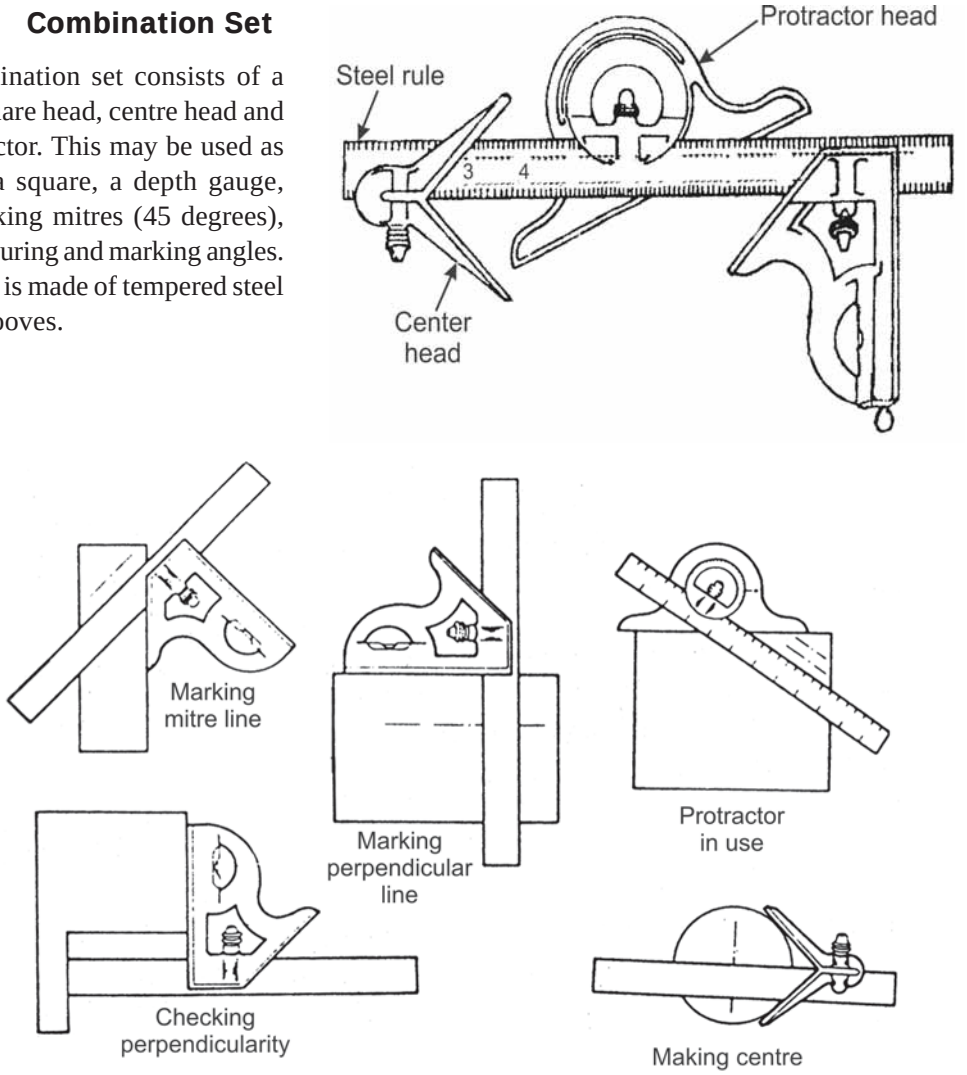


1.3.6 Scriber

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.



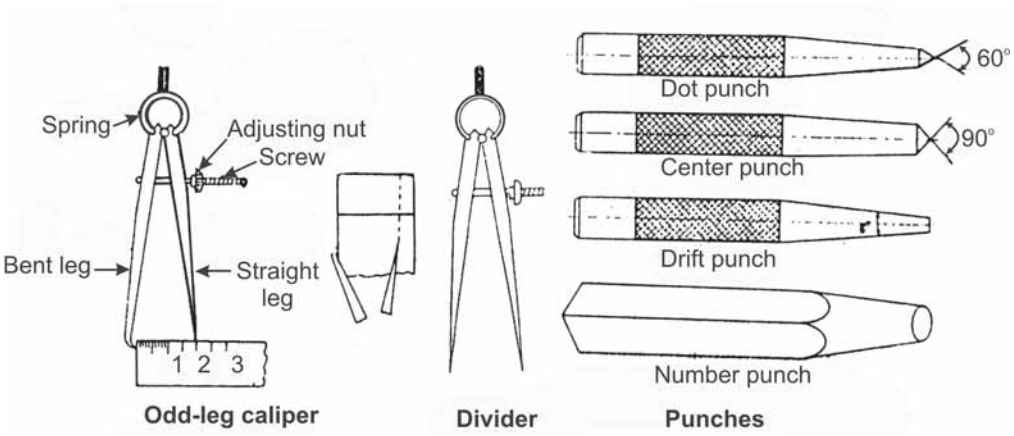
Uses of combination set

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.

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.



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.

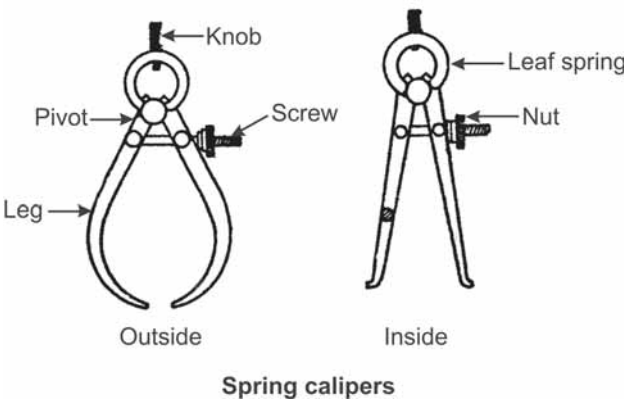
Number punch

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

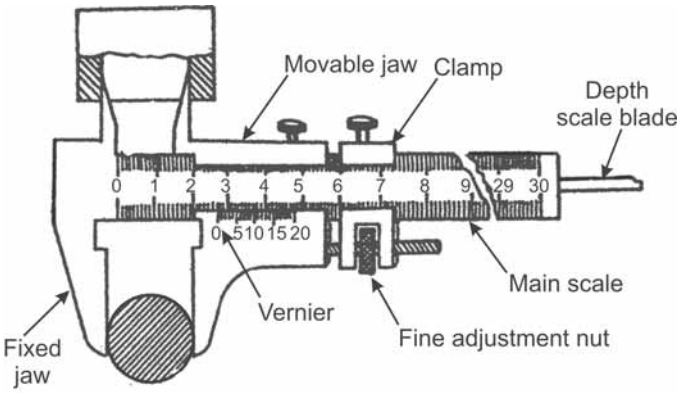
These are used with the help of steel rule to check outside and inside measurements. They are specified by the maximum length measured. Sizes vary from 100 mm to 300 mm.



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.

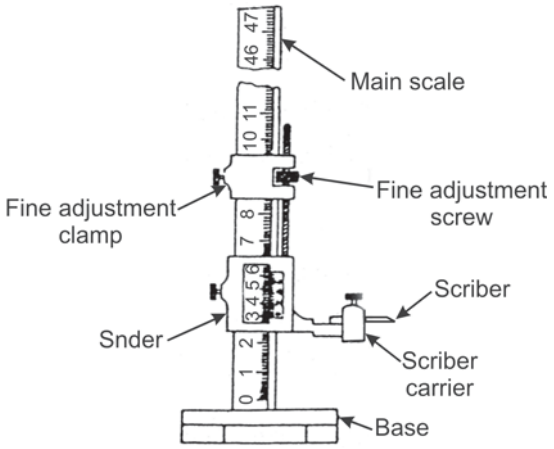


Vernier calipers

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

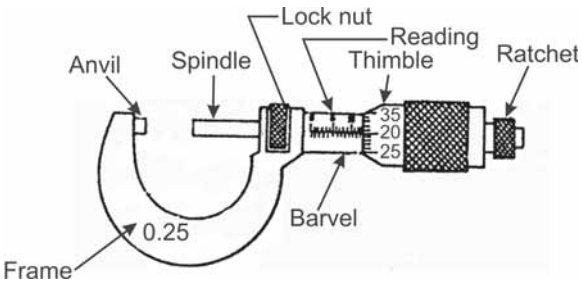
The vernier height gauge, clamped with a scriber, is shown in figure. It is used for layout work. An offset scriber is used when it is required to take measurements from the surface, on which the gauge is standing. The accuracy and working principle of the gauge are the same as those of the vernier caliper.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

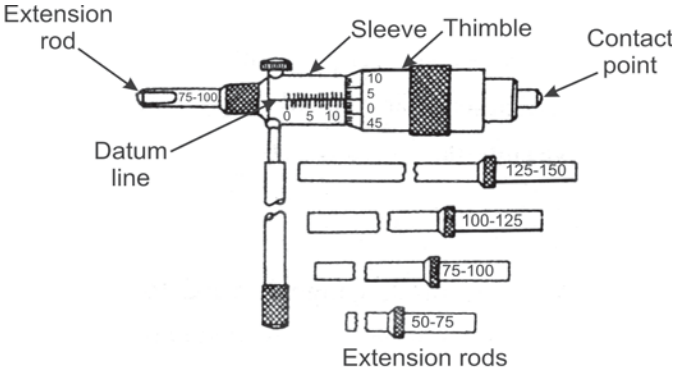
1.4.4 Outside Micrometer

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

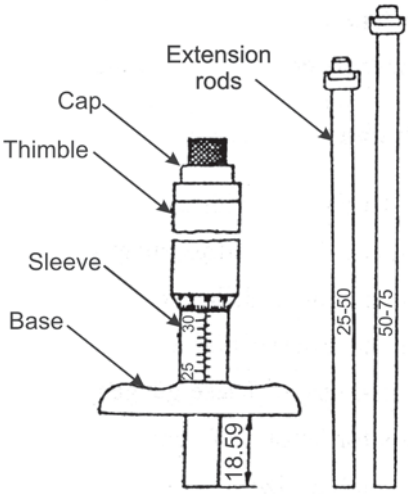


Inside micrometer

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.



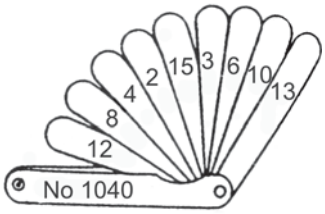
Depth micrometer

1.4.7 Feeler Gauges

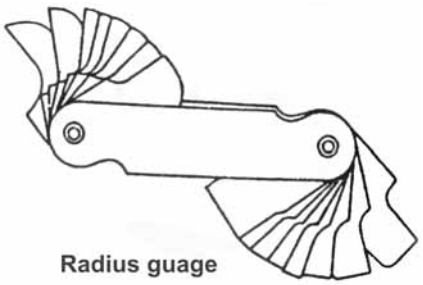
The thickness gauges or feeler gauges are a set of gauges consisting of thin strips of metal of varying thickness. They are widely used for measuring and checking bearing-clearance, adjusting tappets, spark plug gaps, and so on. The thickness varies from 0.05 to 0.5 mm.

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

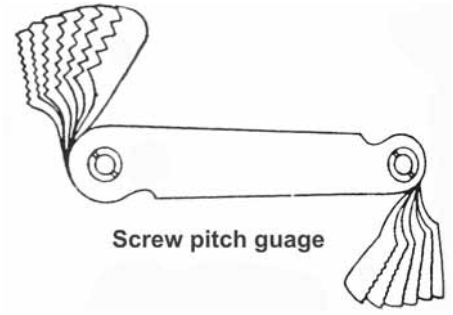
or laying out work having a given radius. Such a gauge is made in sets of individual gauges for measuring concave (internal) or convex (external) radius.

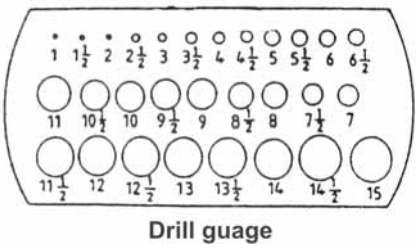
1.4.9 Screw Pitch Gauges

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.



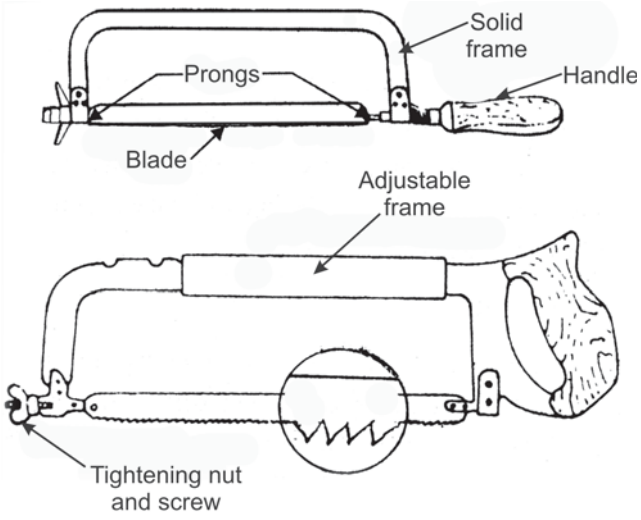


Drill guage

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.'

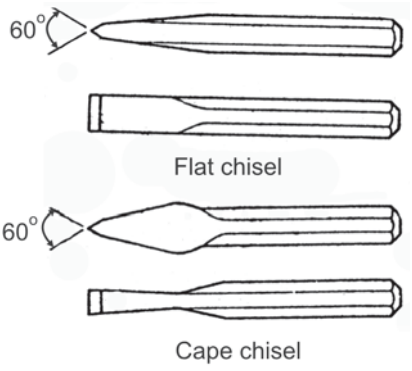

Set of teeth

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.

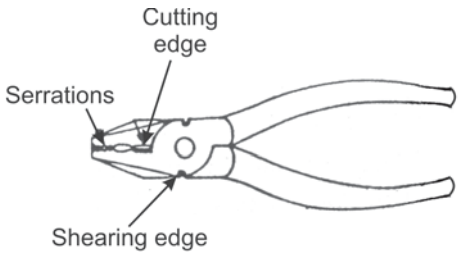
A cape chisel is narrow shaped tool. It is cased mostly for the chipping grooves and keyways.



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.



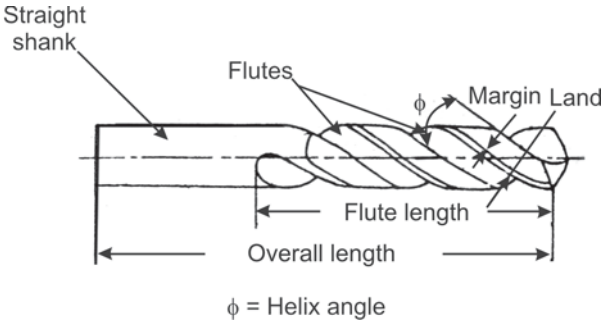
Combination cutting edge

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.

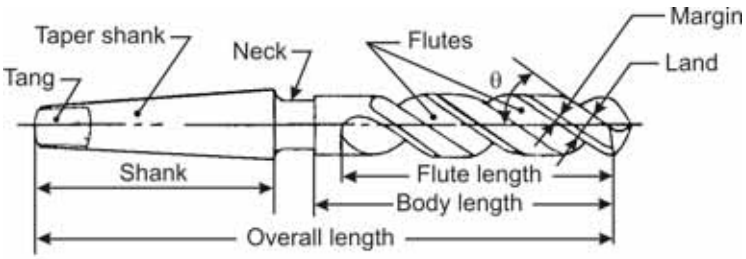
Millimetres	from 0.4 mm onwards
Inches	from l/64" onwards
Letter drills	A to Z
Number drills	60 to 20



ϕ = Helix angle

2. Taper shank

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

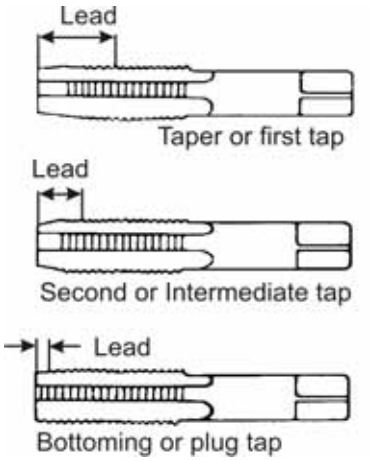


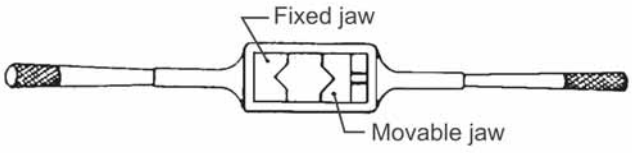
Twist drills

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.



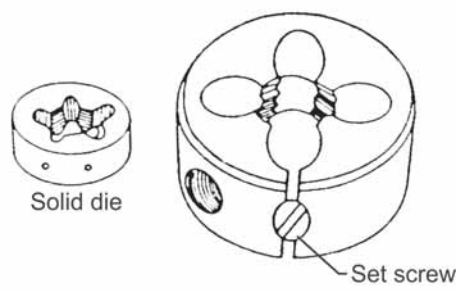


Taps and tap wrench

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

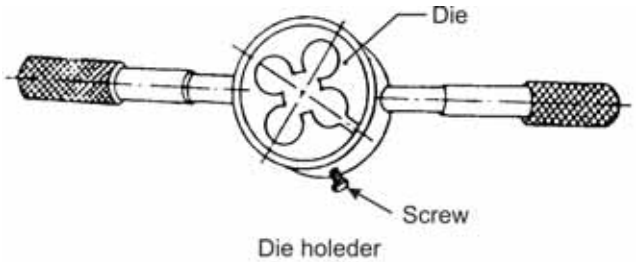
1. It is good practice to drill a small countersunk, about the depth of one thread to ensure that a base is not thrown up while tapping the hole.
2. While tapping in a blind hole, remove the tap and clear the chips often so that the tap can reach the bottom of the hole.



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:



Die holeder

Dis and die handles

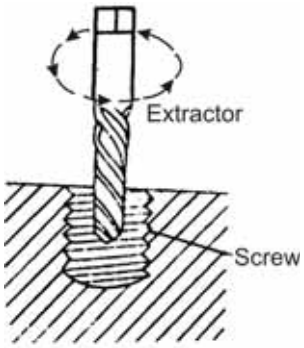
1. Prepare the work with chamfer at its end.
2. Select the correct size die.
3. Position the die in the die holder. Tighten the set screw so that the die is held firmly in its place. In case of adjustable die, set the die to cut oversize threads first.
4. Fasten the work firmly in a vice.
5. Place the 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)

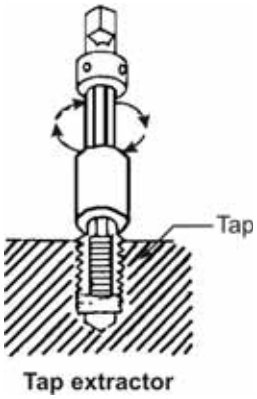
Bolts, screws, studs, and other threaded parts may be sheared off, leaving a portion behind in the tapped hole. This portion can be removed by using a screw extractor. It is made of high-carbon steel, and has a tapered shape and left-hand threads for removing right-hand screws. A screw extractor of a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