14.2 VICES

The vice is the most common tool for holding work. Various types of vices are used for various purposes. They include bench vice, leg vice, pipe vice, hand vice, pin vice and toolmaker's vice.

Bench vice. The most commonly used is the engineer's parallel-jaw bench vice, sometimes called fitter's vice (Fig. 14.1). It must be firmly fixed to the bench with coach screws, or with nuts and bolts. The vice essentially consists of cast iron body, a fixed jaw, a movable jaw—both made of cast steel, a handle, a square-threaded screw, and a nut—all made of mild steel. Separate cast steel plates known as jaw plates are fixed to the jaws by means of set screws and they can be replaced when worn. The holding faces of the jaw plates have teeth for holding the work firmly but this has some disadvantage for soft metal which may be damaged when firmly held between the faces. Protective grips or 'clamps' which can be made of lead, fibre, tin-plate, etc. are, therefore, usually fitted over the jaws to prevent the serrations damaging the surface of the finished work. The movement of the vice is caused by the movement of the screw through the nut fixed under the movable jaw and the screw is provided with a collar inside to prevent it from coming out of the jaw when revolved.

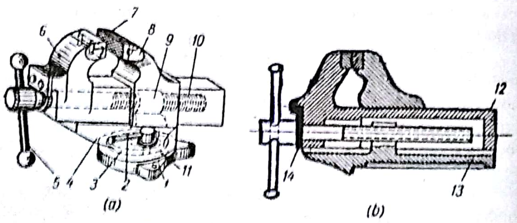

Figure 14.1 Parallel vice

(a) Swivel parallel vice, (b) Plain parallel vice,
1. Stationary support disk, 2. Turning lever, 3. Swivel plate, 4. Base plate, 5. Handle, 6. Movable jaw, 7. Jaw plates, 8. Fixed jaw, 9. Fixed nut, 10. Clamping screw, 11. Circular slot, 12. Prismatic shank, 13. Base, 14. Coupling plate

The size of a vice is known by the width of its jaws. The width suitable for common work varies from 80 to 140 mm, the maximum openings being 95 and 180 mm.

Leg vice. The leg vice is used by blacksmiths but it is also suitable for heavy hammering, chipping, and cutting in fitter's work. The vice is

secured to the top of bench by a strap which is fastened to a plate bolted to the bench top. The leg of the vice is fastened to the bench leg with staples and its ends fit into a hole in the floor. This construction of the vice makes it suitable for heavy work. One disadvantage of this type is that the jaws come together like the arms of a letter "V", and therefore don't provide such a firm grip as the parallel jaw type.

Pipe vice. The pipe vice shown in Fig. 14.2 is used for holding round section metal, tubes, pipes, etc. In this case, the screw is vertical and the movable jaw works vertically. It grips the work at four points on its surfaces.

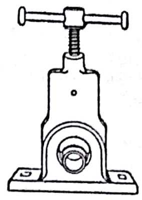

Figure 14.2 Pipe vice

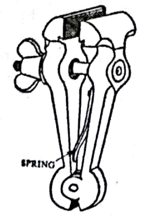

Figure 14.3 Hand vice

Hand vice. The hand vice is used for gripping screws, revets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. This is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 to 44 mm.

A typical hand vice is shown in Fig. 14.3. It consists of two legs made of mild steel which hold the jaws at the top and are hinged together at the bottom. A flat spring held between the legs tends to keep the jaws open. The jaws can be opened and closed by a wing nut which moves through a screw that is fastened to one leg and passes through the other.

Pin vice. The pin vice is used for holding round material of small diameter such as wire and pins, during working. It also forms a very useful handle for small files. This is illustrated in Fig. 14.4. It consists of a handle and a tapered nose covering a small collet chuck at its end. The chuck carries the jaws which are operated by turning the handle.

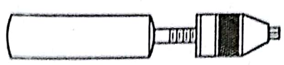

Figure 14.4 Pin vice

Toolmaker's vice. The toolmaker's vice as shown in Fig. 14.5 is particularly useful for holding small work which requires filing or drilling, and for such work as laying out small jobs on the surface plate. It is made of mild steel.

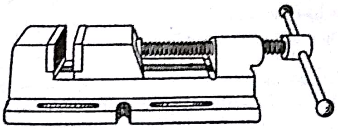

Figure 14.5 Toolmaker's vice

Care of vices. Vices should be kept clean and free from dust and metal chips, using a brush. Occasionally, the thread and the nut should be oiled. The vice should never be used as an anvil, and a hammer or other means must not be used to move the handle. It will only bend the handle and spoil the screw threads.

The serrated jaws are covered with soft metal clamps when finished work is held. When it is necessary to hold a screw or bolt in the vice a length of soft wire should be wound into the vee of the thread for protection. For holding tubing, temporary wooden "V" blocks are used.

14.3 HAMMERS

Hammers are used to strike a job or a tool. They are made of forged steel of various sizes (weights) and shapes to suit various purposes. A suitable range would be from 0.11 to 0.33 kg for light work such as clinching small rivets and dot punching, 0.45 kg for chiselling, 0.91 kg for heavier work such as chipping, the popular sizes for bench work being 0.33 and 0.45 kg.

A hammer consists of four parts namely *peen, head, eye and face* as shown in Fig. 14.6. The eye is normally made oval or elliptical in shape and it accommodates the *handle* or *shaft*. The end of the handle which fits into the eye is spread or split by forcing a metal wedge into it to prevent the hammer head from flying off the handle during striking. The handle is made of elastic wood or bamboo and is so shaped and sized that when gripped it gives an easy feel to the hand. This "feel" is known as the "balance" of the hammer. A well balanced hammer "feels" just right when the handle is grasped at the correct point. The face is hardened and polished well, and is slightly convex, instead of flat to avoid spoilage of the surface of the metal to be hammered by the sharp edge of the flat surface. on an

average, the handle should be 250 to 325 mm long. The length of handles for light hammers is 200 to 260 mm, that for heavy hammers is 380 to 450 mm.

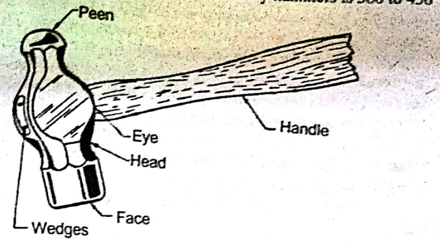

Figure 14.6 Hand hammer

Hammers are classified, according to the shape of the peen, as ball peen, cross peen and straight peen hammers.

Ball peen hammer. This is most common form of hammer and is sometimes called engineer's hammer, or chipping hammer. The peen has a shape of a ball which is hardened and polished. This is hammer is chiefly used for chipping and riveting. The size of this hammer varies from 0.11 to 0.91 kg (IS : 841-1957).

Cross peen hammer. This is similar to ball peen hammer in shape and size except the peen which is across the shaft or eye. This is mainly used for bending, stretching, hammering into shoulders, inside curves, etc. The size varies from 0.22 to 0.91 kg (IS : 841-1957).

Straight peen hammer. This hammer has a peen straight with the shaft, i.e. parallel to the axis of the shaft. This is used for stretching or peening the metal. The size varies from 0.11 to 0.91 kg.

Soft hammer. where is necessary to strike metal a blow with the minimum damage to the surface, a soft-hammer, called *mallet,* is used. Mallet heads go by the numbers or by the diameter of the head. They are made of raw hide, hard rubber, copper, brass, lead or most commonly—of wood.

14.4 CHISELS

Cold chisels are used for cutting and chipping away pieces of metal and are made of carbon steel usually rectangular, hexagonal or octagonal cross-section. They are forged to shape, roughly ground, and then hardened and tempered. Afterwards the edge is ground sharp to the correct cutting angle, care being taken not to overheat the steel and draw the temper. The making of cold chisel, its hardening and tempering are described in Art.8.7. The cutting angle given to the chisel is determined mainly by the nature of the metal to be chipped. It varies between 35 and 70°, the less acute angles being for the harder and tougher metals.

Table 14.1 will give the cutting angle of chisel for chipping various metals :

TABLE 14.1 CUTTING ANGLE OF CHISEL (*IS : 402-1964*)

Type of chisel	*Material to be cut*			
	Steel	*Cast iron*	*Copper and brass*	*Zinc and Aluminium*
Flat	70°	60°	45°	35°
Cross-cut	70°	60°	45°	35°
Diamond point	60°	60°	60°	60°
Half-round nose	45°	45°	45°	45°

The chisel is subdivided into cutting edge, shank and head, and this is generally specified by the length, and width of the cutting edge ; and particularly by the width of the cutting edge. A 25 mm cold chisel means a chisel with a 25 mm wide cutting edge. The shape of its cutting edge is also required to completely specify a chisel. The five most common types are the flat, the cross-cut, the diamond pointed, the half round and the side chisel. Apart from the cutting angle, other angles that can be specified for a chisel are : 1. rake angle, 2. forging angle, and clearance angle. Fig. 14.7 shows various angles of a chisel.

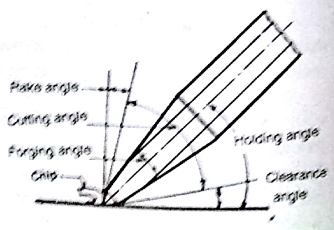

Figure 14.7 Chisel in operation

The rake angle is the angle which is made by the upper taper surface of the chisel point and a line perpendicular to the point of metal surface which the tip touches. The clearance angle is dependent of the way the operator drives it and this angle is kept more than 10° for proper digging the metal. Forging angle is kept around 25° to 30°.

Flat chisel. The flat chisel as shown in Fig.14.8 is the most common of all the chisels used in engineering. It is the chisel which is used for most of the general chipping operations. It may be used for removing surplus metal from surfaces of jobs.

The flat chisel should be drawn down to the shape shown in the diagram. The cutting edge should be slightly curved as shown as this will prevent the corners digging in when it is being used.

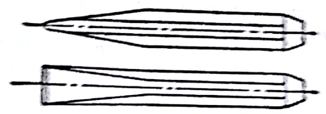

Figure 14.8 Flat chisel

The length of a flat chisel varies from 100 to 400 mm, while the width of the cutting edge varies from 16 to 32 mm (*IS : 402-1964*).

Cross-cut chisel. The cross-cut chisel (Fig.14.9) or *cape chisel* as it is sometimes called, is used for cutting grooves in large surfaces previous to using the flat chisel, and is also used in cutting key ways in wheels and shafts.

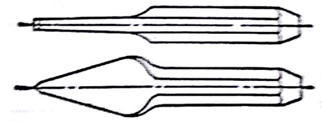

Figure 14.9 Cross-cut chisel

The cutting edge is slightly wider than the supporting metal to provide clearance. Length of this chisel varies from 100 to 400 mm, and width of the edge varies from about 4 to 12 mm (*IS : 402-1964*).

Half-round chisel. A half-round chisel is shown in Fig.14.10 and is particularly useful for cutting oil-ways or grooves in bearing, bosses and pulleys, etc. They are also used for setting-over pilot holes. When a hole is to be drilled a smaller or pilot hole is drilled first.

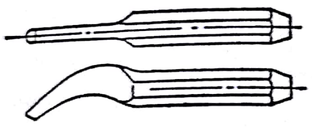

Figure 14.10 Half round chisel

The shank is reduced to a half-round taper, which is bevelled at the end to give a circular edge. Length varies from 150 to 250 mm and width of the cutting edge from 2 to 16 mm (*IS : 402-1964*).

Diamond-point chisel. The diamond-point chisel as shown in Fig.14.11 is used for cutting vee grooves, cleaning corners and squaring small holes.

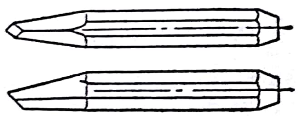

Figure 14.11 Diamond-point chisel

The chisel is drawn to a square section. The end is ground off at an angle producing the "diamond" shape. Length of this chisel varies from 100 to 400 mm and width of the cutting edge from 6 to 16 mm (*IS : 402-1964*).

Side chisel. A side chisel is shown in Fig.14.12. This is particularly useful in chipping and removing the surplus metal in cotter ways and slots, which may have to be cut by hand after having been drilled.

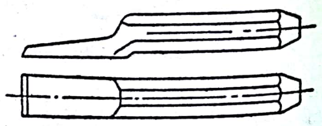

Figure 14.12 Side chisel

The shank of this chisel is bent out a little sideway, and then vertically down again.

14.5 CHIPPING

Chipping is the process of removing thick layers of metal by means of cold chisels. In chipping work, the lob is firmly held in a vice and the metal is removed by striking the chisel on to the surface of the workpiece by a hammer. When chipping, the chisel should be held chiefly with the second and third fingers, the index being relaxed. The hammer shaft should be grasped at the end, and when in use should be brought up square with the body and nearly to the shoulder to ensure sufficient power in the blows. The angle the chisel should be held at in relation to the work depends to some extent upon its cutting angle, but can be best determined by actual practice. This should be at such an angle with the work that an even chip of right depth can be obtained at ease.

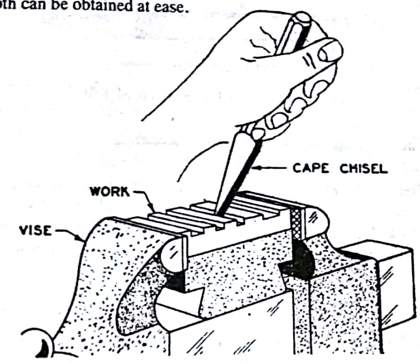

Figure 14.13 Chipping by a cross-cut chisel

If the surface to be chipped is too long it is advisable to cut grooves along the whole surface by a cross-cut chisel as shown in Fig. 14.13 and then chip away the rest of the metal. In removing large volume of metal frequent lubrication of the cutting edge will be necessary to ensure long tool life and to make the cutting action quicker and smoother. While chipping, the operator should always keep his eyes on the cutting edge of the tool and not on its head. The process includes cutting key ways, forming grooves, slots, oil channels, etc.

14.6 FILES

The most widely used hand tool to be found in an engineering workshop is the file. A file is a hardened piece of high grade steel with slanting rows of teeth. It is used to cut, smooth, or fit metal parts. It cuts all metals except hardened steel.

A file consists of the following parts as shown in Fig. 14.14. The *tang* is the pointed part which fitted into the handle. The *point* is the end opposite the tang. The *heel* is next to the handle. The *safe edge* or *side* of a file is that which has no teeth.

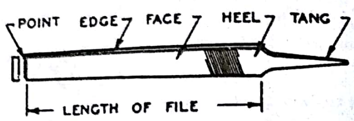

Figure 14.14 Different parts of a file

Files are classified and named according to the three principal factors—sizes, type or cut of teeth, and sectional form.

Size. The size of a file is its length. This is the distance from the *point* to the *heel*, without the tang. Files for fine work are usually from 100 to 200 mm and those for heavier work from 200 to 450 mm in length.

Cut of teeth. Cuts of files are divided into two groups as shown in Fig. 14.15. These groups are : (1) single-cut (2) double-cut.

On *single-cut* files the teeth are cut parallel to other across the file at an angle of about 60^0 to the centre line of the file. Such files are frequently termed as "flats" and are chiefly used on very hard metal. *Double-cut* files have two sets of teeth, the over-cut teeth being cut at about 60° and the up-cut at 75 to 80° to the centre line.

Single-cut and double-cut files are further divided according to the coarseness or spacing between the rows of the teeth. In descending order of roughness they are listed as :

1. Rough (R)
2. Bastard (B)
3. Second cut (SC)
4. Smooth (S)
5. Dead smooth (DS)
6. Super smooth (SS)

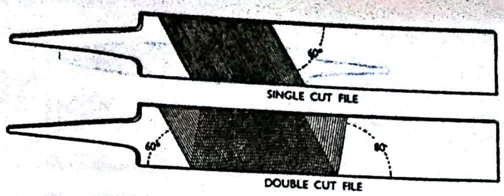

Figure 14.15 Single-cut and double-cut of a file

Table 14.2 will give a fair idea of the number of teeth or cut in each of the above grades over a length of 10 mm. It will be seen from the table that the coarseness of a file changes with its length. The larger the file, the coarser it is. Thus, a rough cut, on a small file may be as fine as a second-cut on a lager file.

TABLE 14.2 GRADE OF CUT IN A FILE

Type of cut	*Usual nominal lengths in mm*							
	100	150	200	250	300	350	400	450
	Number of cuts over a length of 10 mm							
Rough	10	8	7.1	6.3	5.5	5.3	4.8	4.5
Bastard	18	13	11	10	9	8	7	6
Second cut	21	17	16	15	14	13	12	11
Smooth	30	24	22	20	19	18	16	15
Dead smooth	35	33	31	30	28	—	—	—
Super smooth	63	49	45	40	—	—	—	—

Rough cuts are used for soft metals. They are often used for trimming the rough edges of castings of softer metals. Bastard is the standard cut used for general shaping work. Second cut is an excellent file for harder metals and gives a good finish for many pieces of fitting work. Other cuts are used to give a high degree of accuracy with a very high finish.

Shapes. The shape of a file is its general outline and *cross-section*. Files are made in hundred of shapes. Fig. 14.16 show the most commonly used shapes. They are :

Flat file : This is tapered in width and thickness, and one of the most commonly used files for general work. They are always double-cut on the faces and single-cut on the edges.

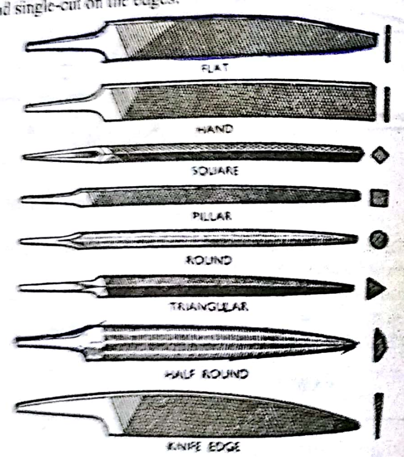

Figure 14.16 Shapes of file

Hand file : This is parallel in its width, and tapered in thickness. A hand file is used for finishing flat surfaces. It has one edge (*i.e.* it is uncut) and therefore, is useful where the flat file cannot be used. They are always double-cut.

Square file : This is square in cross-section, double-cut, and tapered towards the point. This is used for filling square corners, enlarging square or rectangular openings as splines and keyways.

Pillar file : Pillar files are double-cut, narrow and of rectangular section. It has one safe edge, and is used for narrow work, such as keyways, slots and grooves.

Round file : They are round in cross-section and usually tapered, when they are termed rat-tailed. When parallel they are described as parallel round. Round files are used for filing curved surfaces and enlarging round holes and forming fillets. They may be single-cut or double cut.

Triangular file : Three square or triangular file is tapered, double-cut, and the shape is that of an equilateral triangle. They are used for rectangular cuts and filing corners less than 90^0

Half-round file : This is tapered double-cut and its cross section is not a half circle but only about one-third of a circle. This file is used for round cuts and filing curved surfaces.

Knife edge file : This is shaped like a knife, tapered in width and thickness and double-cut. They are used filing narrow slots, notches, and grooves.

There are a number of other types of file in less common use. They are all used for special purposes and not in general use. They are wording file, needle file, riffier, etc. *A wording file* is a thin flat file having fine cut teeth, about 100 mm long. This is widely employed for all kinds of fine work. *A needle file* is made in sizes from 100 to 200 mm, of various shapes and cuts. They are extremely delicate and are used for fine work. *Rifflers* are curved upwards at the ends into an arc. They are used to reach the bottom of a sinking and for filing the insides of castings.

Specification. When ordering a file following informations should be given :

1. Length, say, 100 mm.
2. Shape, say, flat
3. Single or double cut
4. Roughness, say, bastard

14.7 FILING

Filing is the most important operation that a metal worker has to learn. Filing is usually an after-treatment and usually done after chipping. It serves to remove the burr from the cuts and clean the face of the cuts, and to finish the final shape of a workpiece. In general no more than 0.6 mm tooling allowance should be left for filing. Filing allows work to be made accurate to 0.05 mm, in some cases to 0.02 mm, and even to 0.01 mm.

Working with the file requires some skill. Normally the work is held in a vice and should be level with the operator's elbow. He should place his left foot in the direction of the file stroke, and his right foot should be placed at an angle of 90^0 in relation to his left foot.

The proper handling of the file is also an important condition for satisfactory filing work. In principle, the worker should grip the file handle with his right hand, which is to guide the file. When working with large files, the ball of the left thumb should be placed on the end of the file blade which is clasped by the fingers. The left hand exerts an increasing pressure on the file in the forward motion. This is shown in Fig. 14.17. The right hand is to guide the stroke also when working with medium-size files, while thumb and forefinger of the left hand exert the necessary pressure. For very light work with small files it is better to point the first finger along the top of the handle to give more sensitive control and file is pressed against the workpiece with several fingers of the left hand.

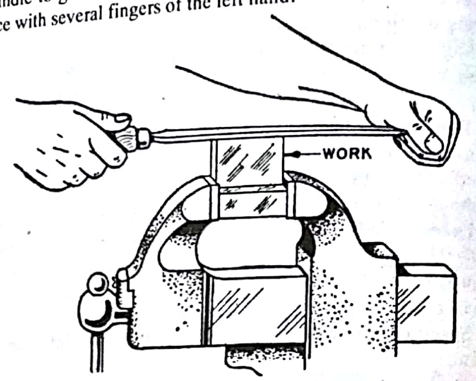

Figure 14.17 Filing a job

It should be noted that the file cuts only on the forward stroke, hence if required the file can be lifted off the work for the return stroke. As a rule, however, the file is allowed to remain on the work during the return stroke, but the pressure from the left hand is released. Filing should always be carried out with the file making the longest possible strokes so that all the teeth of the file receive even wear. The file should also be moved across the work with slow steady strokes (50 to 60 per cent minute), taking care to keep it horizontal, and covering the whole of the filing area at each stroke.

Methods of filing. Generally speaking, there are three main methods of using a hand-flat file :

In *cross-filing* the file strokes run alternately from the right and from the right to the left as shown in Fig. 14.18. This is the commonest form of filing and the one used for general shaping. In this method the possibility of rounding is minimized, and the score marks made in the work by the file teeth are criss-crossed so that maximum amount of metal is removed. The aim in cross-filing is always to move the whole of the file surface across the whole of the work surface in one stroke.

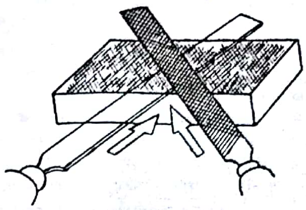

Figure 14.18 Cross-filing

In *straight-filing* the file is pressed forward approximately at right angles to the length of the work. On the back stroke, the file should be lifted clear of the work in order not to blunt the teeth straight-filing is specially useful on long and narrow piece of work whose width is less than that of the file.

In *draw-filing* the handle of the file is not held. Instead, both bands are placed to close together on the blade as shown in Fig. 14.19. The file is placed at right angles across the work while the hands, and especially the thumbs, grip the file and move it up and down the length of the metal. It does not move much material, but a smoother cutting action is achieved than with cross or straight-filing.

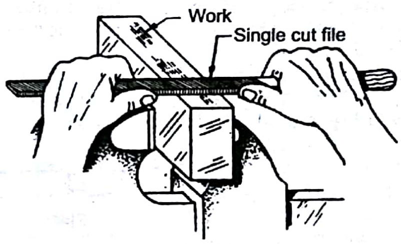

Figure 14.19 Draw -filing

Care of files. Files are very brittle and should be placed thoughtfully in the bench well in such a way that they do not rub or knock against other tools, especially those of cast steel. Similarly, the file should never be used on hardened steel, or hard surface scale such as cast iron skin, or allowed to strike against the hardened vice jaws. When not in use, the files are protected from rust by coating them lightly with machine oil. Before using the file, the oil should be removed with carbon tetrachloride or caustic soda. Make sure that the handle is firmly fixed to the file.

New files are generally first used on copper, brass, and later on wrought iron and mild steel. Filing , especially the filing of soft metals, causes the file teeth to become clogged with particles of metal. This is known as pinning and, unless the obstructions are removed they will make deep scores across the work and also the file will be unserviceable. Vigorous rubbing with a *file brush* or *file card* down the lines of the teeth will clean the file. After brushing the file, chalk may be rubbed into the teeth. Rubbing the file teeth with chalk will help to prevent pinning.

Worn files may be reused to a certain extent by dipping in hydrochloric acid but of course there is a limit to the number of times this etching process can be carried out. Worn files are useful for making scraper, punches chisels, etc. They are also useful on the soldering bench when re-tinning soldering irons.

14.8 SCRAPER

Scraping means shaving or paring off thin slices or flakes of metal to make a fine, smooth surface. This is done with tools called scrapers which have very hard cutting edges. The material is a good quality forged steel and the cutting edge is usually left very hard. Old files make excellent scrapers. The teeth of the file must first be ground off on all sides. They are then heated and bent to the desired shape and ground to have the cutting edge, followed by hardening and tempering. Scrapers are fitted with short, round handles that fit handle snugly.

Since a scraper removes very thin chips, the scraping allowance should be small. These allowances depend upon the width and length of the surface to be scraped or on the diameter and length of the hole to be scraped. Table 14.3 gives the allowances for scraping the plane surfaces and holes.

Scraper are made in a variety of lengths from 100 mm upwards and in many shapes, as shown in Fig. 14.20, depending on the work to be done. These are : triangular, and' half round.

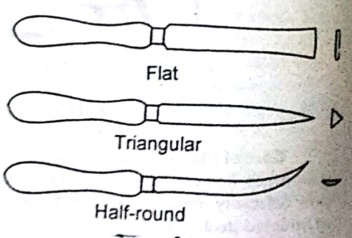

Figure 14.20 Types of scraper

Flat scraper. The flat scraper is the most common and also the most easily made. The cutting edge is at the end. It should be curved a little looking at the broad side. This is done to keep from taking too broad a cut and to prevent the corners of the scraper from coming in contact with the surface being scraped and marking deep scratches. A flat scraper is used for producing a perfectly flat surface. Flat single-ended scrapers vary in length from 100 to 250 mm, double-ended scrapers having no handles can

be 350 to 400 mm long. Scrapers for rough work are 20 to 30 mm wide. For accurate work they are made 16 to 20 mm wide, and for extra-accurate work 5 to 10 mm wide. The thickness at the cutting end varies from 1 to 3.5 mm. The lip angle of scrapers for rough scraping is 60 to 75 degrees, for finish scraping 90 degrees.

TABLE 14.3 PLANE SURFACE SCRAPING

Surface width, mm	*Scraping allowance (mm) for the surface lengths (mm)*				
	100-500	500-1000	1000-2000	2000-4000	4000-6000
Upto 100	0.10	0.15	0.15	0.25	0.30
100-500	0.15	0.20	0.25	0.30	0.40

Triangular scraper. The triangular scraper has three cutting edges and is made from a triangular file. It is used to scrape round or curved surfaces and to remove sharp corners and burrs. The blade is usually 150 mm long.

Half-round scraper. A half-round scraper is, in shape, like a half-round file. In fact, they are often made from old half-round files. They are used to scrape round or curved surfaces. The length of the blade from the handle should be at least 150 mm.

Care of scraper. Scrapers have very sharp cutting edges. When, not in use, therefore, these scrapers should be stored so that the blades are protected from damage. Either it should be kept in a special case or wrapped in a piece of cloth. If the edges of the scraper requires sharpening, the blade must be ground on the grinding wheel and then finished on the oilstone.

14.9 SCRAPING

Scraping is used for obtaining a truer flat surface than can be produced by machining or filing. So scraping often follows filing. Having got the surface of the block reasonably flat with the file, the block should first be tested on the surface plate, which is of cast iron and has a perfectly flat upper surface.

The top of the surface plate is covered with a very thin film of *Prussian blue. Red lead* may be used instead of Prussian blue. The surface to be scraped is then laid on the surface plate and moved back and forth.

Thus the high spots on the work will be marked with Prussian blue. If a thick coat is put on the surface plate, the low spots on the work will be marked as well as the high ones. The high spots are scrapped down, the scraper being worked with a small circular motion. The work is wiped clear of scrapings before each testing . The process is repeated until the colour is spread evenly over the surface.

During scraping the handle of the scraper is held in the right hand with the first finger extended. The left hand is placed on the lower end of the scraper and controls the cutting action.

For scraping cylinder surface of a bearing either the curved or triangular scraper is used, with the handle in the right hand and the left controlling the cutting edge.

Frosting or flowering. This is a finish which is an imitation of frost, patch work, or checker-board design. frosting is made by scraping off high spots as explained above. Strokes should be very short about 6 to 12 mm and the direction should be changed after each marking. This is intended only to give a better appearance as it does not in anyway increase the accuracy.

14.10 GRINDING AND POLISHING

Grinding is the process of removing mental usually 0.25 to .50 mm in most operations, by the use of grinding wheel. It may be used to finish almost any surface, which has been previously rough shaped by some other method or to remove the surplus from material which is too hard to be worked by other methods. The accuracy in grinding is in the order of 0.000025 mm.

The work for grinding is held pressed against the wheel which revolve at a high speed and the metal gets reduced by abrasion. A grinding is made up of particles of hard substance called the *abrasive*. Embedded in a matrix called the *bond*. These abrasives form the cutting points in a wheel and are termed as *grains*. There are two kinds of abrasives : (1) natural and (2) artificial. *Emery* and *corundum* are two natural abrasives, while *carborundum* and *aloxite* are artificial abrasives. They are described in Vol. II.

A surface grinder having an emery wheel is generally used in a fitting shop. It is very useful in removing waste metal and sharpening drills, chisels, and other cutting tools. The hardness or softness of the wheel is dependent on the amount and kind of the bonding material used. Generally, hard wheels of aloxite are used for grinding soft materials and soft wheels of carborundum for grinding hard materials. When heavy reduction is necessary, coarse-grained wheel is used but for light reduction a fine-grained one may be employed. Wet grinding, which provides a large amount of coolant over the work, wheel face, and sides is generally employed. This dissipates the heat normally generated during grinding, promotes long wheel life, and produces high finish.

The cutting face of a grinding wheel must be kept in a true, clean, sharp condition, to obtain efficient cutting. *Glazed* and *loaded* wheels are reconditioned by dressing with suitable dressers. "Dressing" is the periodical cleaning of the grinding surface which becomes blunt or glazed.

Polishing is the process of making a flat, scratch-free, mirror-like finish. The polishing procedure generally consists of rough grinding, intermediate grinding, rough polishing, and fine polishing. The first step is carried out on an emery surfacer or similar grinder to remove deep cut off marks. The intermediate grinding is done with fine emery or silicon carbide (Carborundum) papers decreasing in grit size in three to four stages to remove grinding marks. Emery papers are graded from "fine' to "coarse", the numbers being from 0 to 4. Each succeeding paper will produce a finer scratch on the surface of the material. This operation may be done by hand or mechanically, using rotating disks.

Fine polishing in ordinary work is usually done by No.2 or e emery cloth. This may be wrapped round either a flat file or conveniently shaped block of wood or metal. The motion in polishing should always be straight and the strokes should cover the whole length of the surface being polished. After the first grade of emery cloth has completed its work a finer grade should be submitted and so on until the desired finish is obtained. The final applications may be assisted by use of oil on the emery cloth, or for a very high finish, ordinary metal polish alone may be used with the cloth. A silicon-carbide cloth may be used with greater advantage but this is more expensive than emery cloth.

14.11 HACKSAW

The hacksaw is used for sawing all metal except hardened steel. A hand hacksaw consists of a *frame, handle, prongs, tightening screw* and *nut,* and *blade* as shown in Fig. 14.21. The frame is made to hold the blade tightly. They are made in two types : The *solid frame* in which the length cannot be changed and the *adjustable frame* which has a back that can be lengthened or shortened to hold blades of different length.

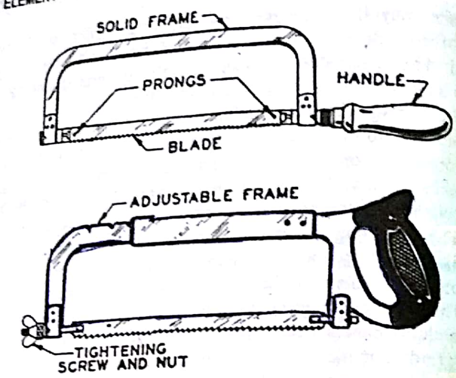

Figure 14.21 Different parts of a hand saw

Hacksaw blades are made of special steels. For hand saws either high carbon steel, low alloy steel or high speed steel is used. The blades may be hard throughout or of the more flexible type, which has a soft back and a hard cutting edge (Fig. 14.22). *All hard* blades made of high speed steel are used for cutting the harder metals, such as alloy steels, while *flexible blades* are good for use by unskilled or semiskilled operators or where the work is inconveniently placed. These flexible blades are less liable to break and are used for general work. Blades are measured by the ; (1) length, (2) width, (3) thickness, and (4) pitch of teeth.

The length of the blade is the distance between the centres of the holes at each end. For hand operation, the common lengths are 250 and 350 mm, widths are 13 and 16 mm, and thickness are 0.63 and 0.80 mm respectively (*IS : 2594*). According to the distance between two corresponding points on adjacent teeth, the saw may have a coarse, medium or fine pitch. A coarse teeth saw has 1.8 mm pitch, medium teeth saw, and 1.4 mm pitch and fine teeth saw 1.0 mm pitch. For general work the blade and fine teeth saw, 1.0 mm pitch For general work the blade with 1.8 mm and 1.4 mm pitch is used. Generally, soft metals, plastic, and synthetic materials are

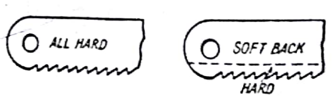

Figure 14.22 All hard and flexible type of blade

being cut by coarse-tooth saw ; tool steel, medium-hard steel, hard light alloys, copper alloys, and thicker sections or tubes are cut by medium tooth saws ; materials of small thickness are cut by fine-tooth saws.

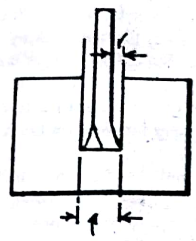

Figure 14.23 Clearance of saws

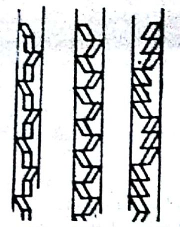

Figure 14.24 Various settings of teeth
(a) Raker, (b) Alternate, (c) Wavy

The points of the teeth are bent to cut a wide groove and provide clearance as shown in Fig. 14.23 for the blade to prevent "binding". This binding of the teeth to the sides is called the set of the blade.

The setting is done in three ways ; (1) raker, (2) alternate, and (3) wavy (undulated)

In raker setting one tooth is bent on one side the next is kept flat and the third on the opposite side of the first. In alternate setting one tooth of the blade is bent on one side while the often on the opposite side. In wavy type of setting, the teeth-arrangement looks like a wave. Figure 14.24 shows the setting.

Power hacksaw. The power hacksaw is very similar to the hand hacksaw with the addition of a suitable driving mechanism. The drive is given either by a belt from a line shaft or by an enclosed motor. Suitable mechanisms are provided whereby the length of the stroke and the weight applied may be varied. On many metals cutting fluid is used during the sawing and this is pumped on to the blades while the machine is working.

This machine uses a much heavier blade than that in a hand hacksaw and can cut diameters up to 150 mm or more. The length varies from 300 to 600 mm, width from 20 to 50 mm, thickness from 0.8 to 2.5 mm, and pitch from 1.4 to 6.3 mm (*IS : 2594*). The machine is so made that it stops automatically when the cut is finished. Another advantage with the power hacksaw is that an unskilled operator can work on these machines and the metal is cut accurately to length but this has the disadvantage that it can only be used for the simplest of sawing operations.

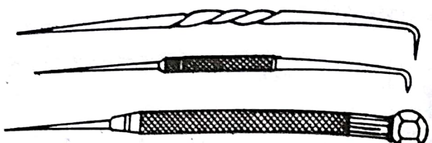

Figure 14.27 Scriber

14.16 PUNCH

A punch is used in a bench work for marking out work, locating centres, etc. in a more permanent manner. Two types of punches are used : (1) prick punch, and (2) centre punch. The prick punch (Fig.14.28) is a sharply pointed tool. The tapered point of the punch has an angle of usually 40°. It is used to make small punch marks on layout lines in order to make them last longer.

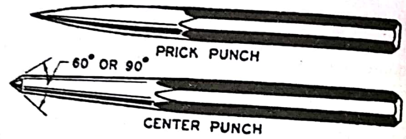

Figure 14.28 Punch

The *centre punch* looks like a prick punch. Its point has an angle more obtuse than that of the prick punch point, this angle usually being 60°. The centre punch is used only to make the prick-punch marks larger at the centres of holes that are to be drilled, hence the name centre punch. A strong blow of the hammer is needed to mark the point.

In its body portion the punch is a steel rod 90 to 150mm long and 8 to 13mm in diameter.

14.17 V-BLOCK

The V-block is a block of steel with V-shaped grooves (Fig. 14.29). Roundly shaped work pieces which are to be marked or drilled are placed on V-supports. In this way they are firmly supported in a horizontal position and cannot rotate easily. V-blocks of the following sizes are found to be most useful : length from 50 to 250 mm width and height from 50 to 100

mm. For long cylindrical work, several blocks of the same size are used as set.

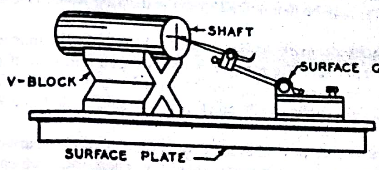

Figure 14.29 Use of a V-block

14.18 ANGLE PLATE

The angle plate which is made of grey cast iron has two plane surfaces at right angles to each other. This is used in conjunction with the surface plate for supporting work in the perpendicular position. It has various slots in it to enable the work to be held firmly by bolts and clamps.

14.19 TRY-SQUARE

The try square as shown in Fig. 14.30 is made in one piece, both *blade* and *beam*. This is used when it is necessary to get another edge or surface exactly at right angles to an already trued edge or surface and also for laying out work. The squares of any square may be tested by placing the beam of the square against a straight edge with the blade resting on a smoother surface. While in this position a line may be scribed along the edge of the blade.

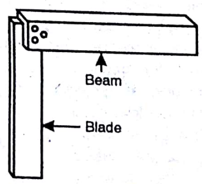

Figure 14.30 Try square

14.20 MARKING OUT

Marking out consists of marking on the job a series of definite lines or positions. These lines act as a guide to the fitter who will have to work on