FITTING

INTRODUCTION

The term 'bench work' denotes the production of an article by hand on the bench. 'Fitting' is the assembling together of parts and removing metals to secure the necessary fit and may or may not be carried out at the bench.
However, all these two types of work require the use of a large number of tools and equipments and involve a number of operations to used in bench and fitting work may be classified as

1. Chipping
2. Filing
3. Scrapping
4. Grinding
5. Sawing
6. Marking
7. Drilling
8. Reaming
9. Tapping
10. Dieing

VICES

The vice is the most common tool for holding work

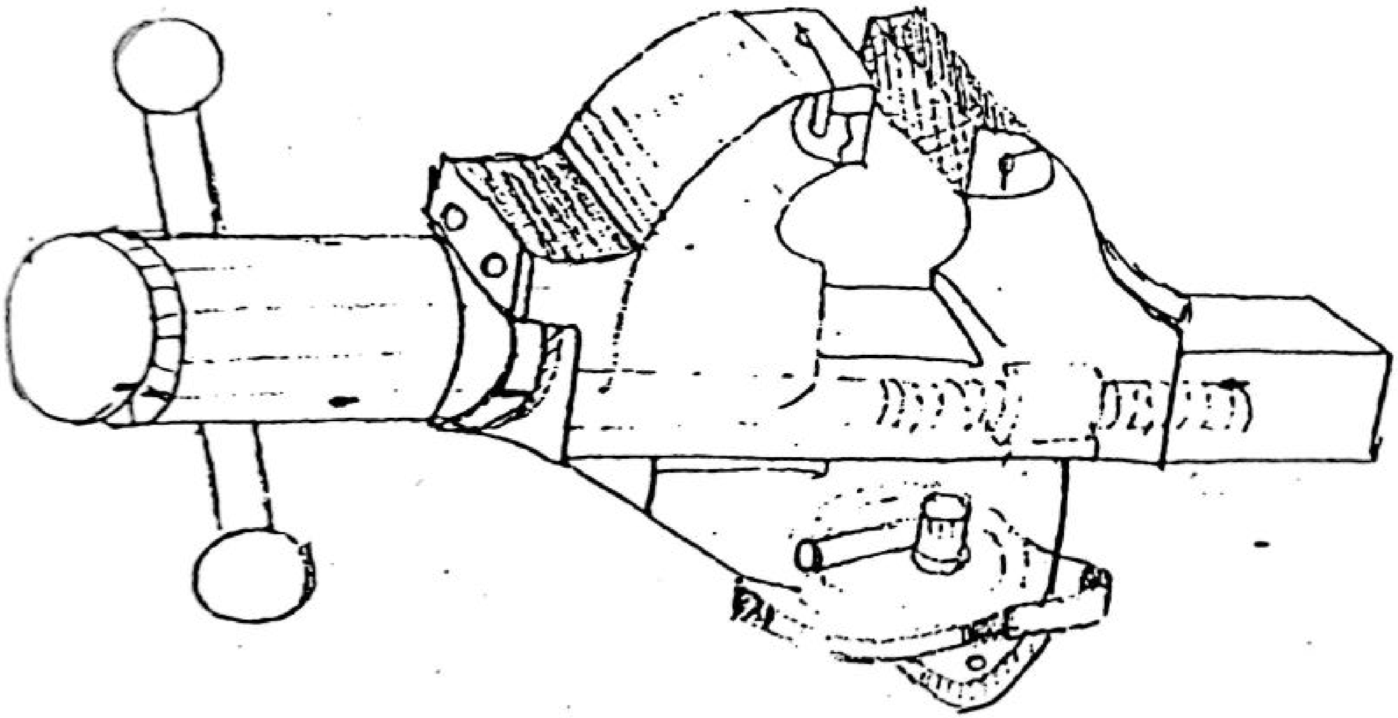
BENCH VICE

The most commonly used is the engineer's parallel jaw bench vice,

sometimes called fitter's vice. It must be firmly fixed to the bench with 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. 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, 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.

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. This construction of the vice makes it suitable for heavy work. One advantage 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.



SWIVEL PARALLEL VICE

PIPE VICE

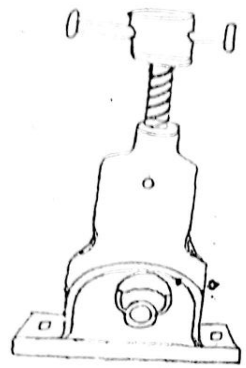
The pipe vice is used for holding round section metal, tubes, pipes, etc. In this case, the screw is vertical and the movable jaw works vertically. It grips the work at four points on its surfaces.

HAND VICE

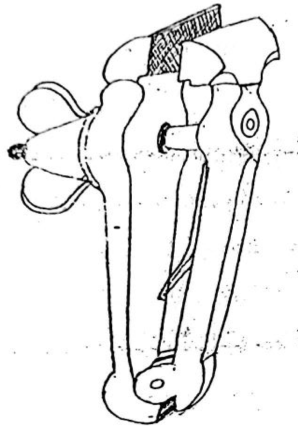
The hand vice is used for gripping screws, rivets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. The length varies from 125 to 150 mm and the jaw width from 40 to 44 mm.
It consists of two legs made of mild steel which hold the jaws at the top and are hinged together at the bottom. A flat spring held b/w 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

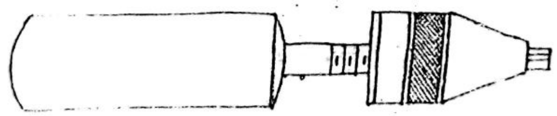
The pin vice is used for holding round material of small diameter such as wire and pins, during working. It also forms a very useful handle for small files. It consists of a handle and a tapered nose covering a small collet chuck at its end. The chuck carries the jaws which are operated by turning the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



PIPE VICE



HAND VICE



PIN VICE

TOOLMAKER'S VICE

The toolmaker's vice 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.

HAMMERS

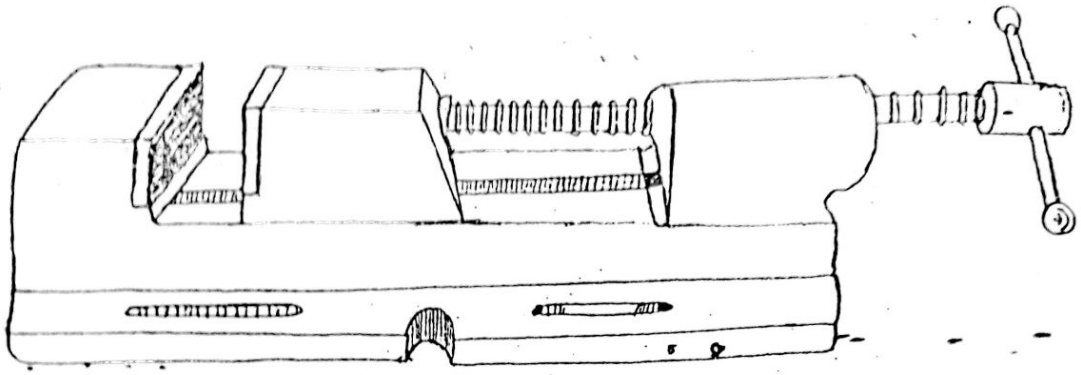
Hammers are used to strike a job or a tool. A hammer consists of four parts namely peen, head, eye and face. The eye is normally made oval or elliptical in shape and it accomodates the handle or shaft. The end of the handle which fits into the eye is spread or split by forcing a metal wedge into it to prevent the hammer head from flying off the handle during striking. Hammers are classified according to the shape of the peen, as ball peen, cross peen and straight peen hammers.

BALL PEEN HAMMER

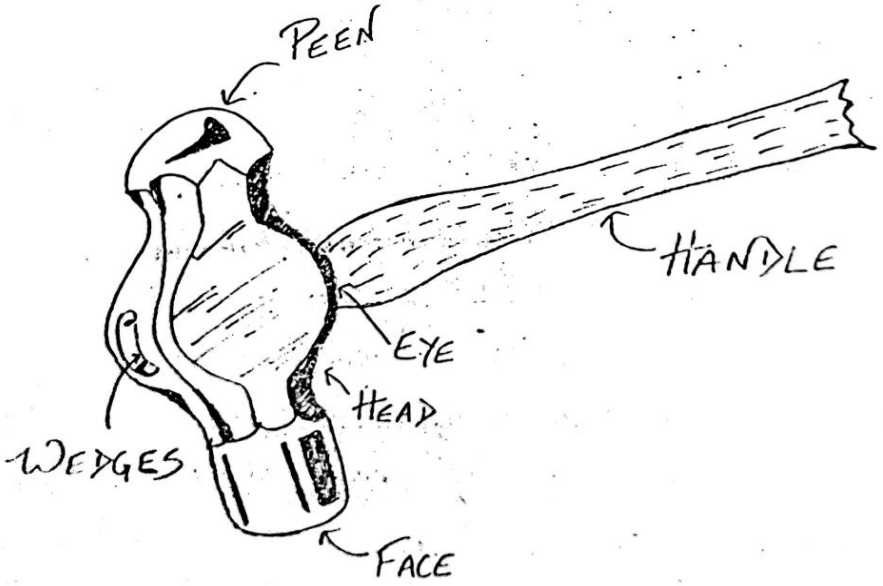
This is the most common form of hammer and is sometimes called engineer's hammer or chipping hammer. The peen has a shape of a ball which is hardened and polished. This hammer is chiefly used for chipping and riveting.

CROSS PEEN HAMMER

This is similar to ball peen hammer in shape and size except



TOOLMAKER'S VICE



HAND HAMMER

the peen which is across the shaft or eye. This is mainly used for bending, stretching, hammering into shoulders, inside curves, etc.

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.

SOFT HAMMER

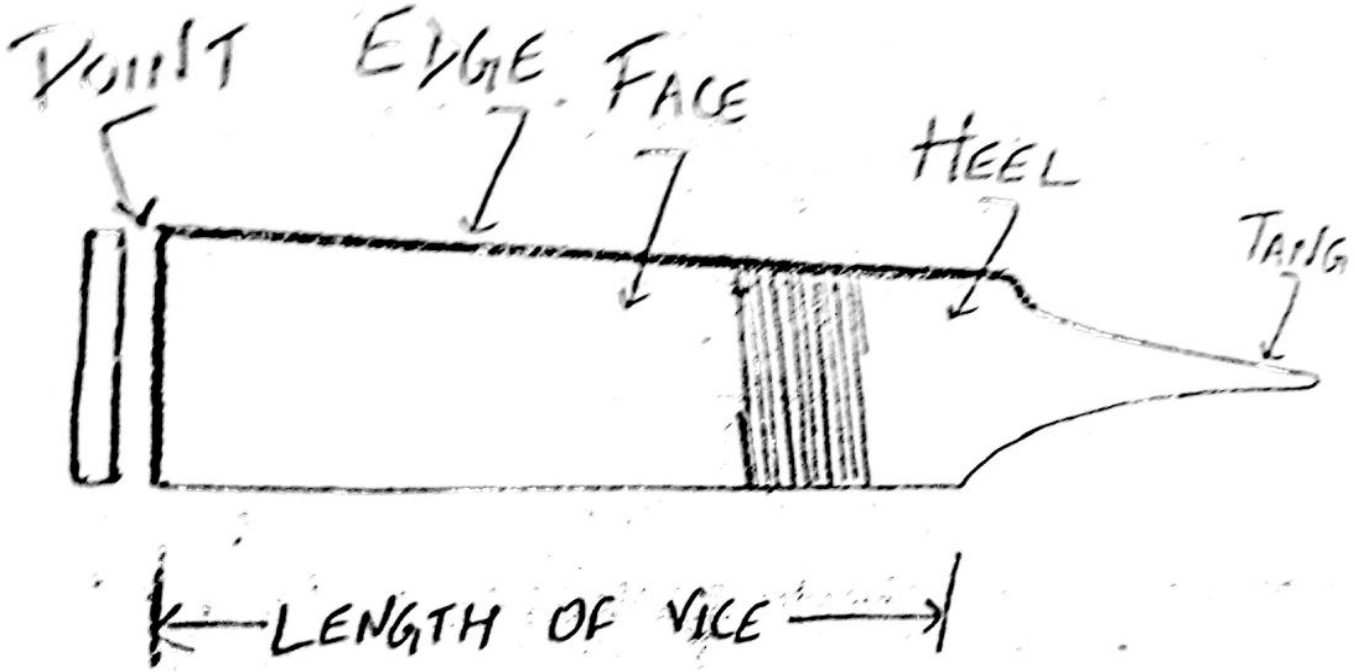
It is required where it is necessary to strike metal a blow with minimum damage to the surface. It is called a mallet. Mallet heads go by the numbers or by the diameter of the head. They are made of raw hide, hard rubber, copper, brass, lead or most commonly of wood.

FILES

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.

CUT OF TEETH

Cut of files are divided into two groups namely single-cut and double-cut.



DIFFERENT PARTS OF A FILE

On single-cut files, the teeth are cut parallel to other across the file at an angle of about 60° 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.

SHAPE

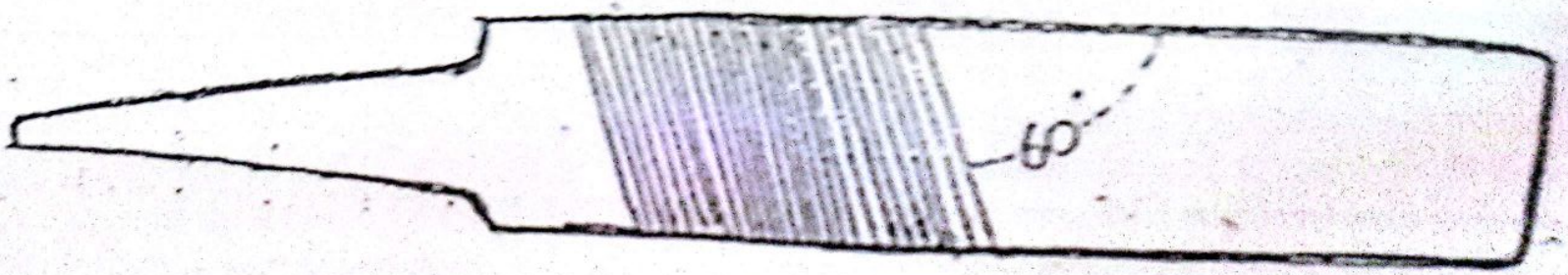
The shape of a file is its general outline and cross-section.

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.

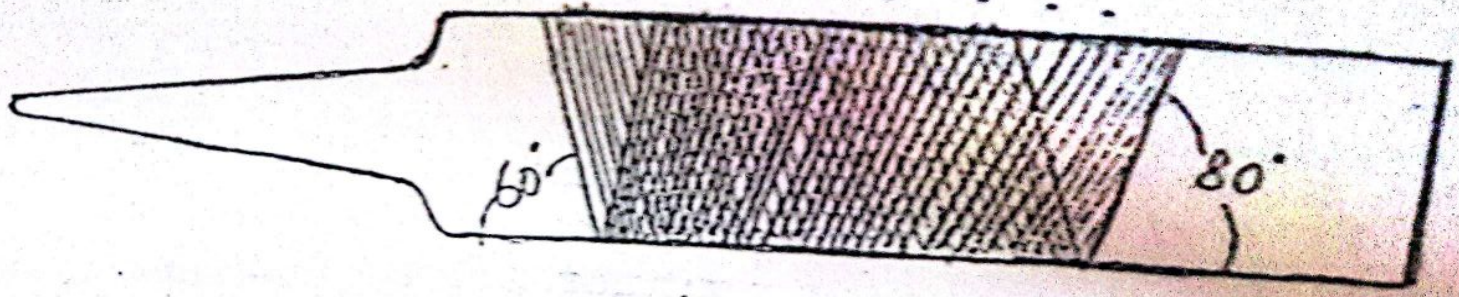
HAND FILE → This is parallel in its width and tapered in thickness. A hand file is used for finishing flat surfaces. It has one edge and therefore, is useful where the flat file cannot be used. They are always double cut.

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.



SINGLE CUT FILE



DOUBLE CUT FILE

ROUND FILE → They are round in cross-section and usually tapered, when they are termed rat-tailed. 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 → These square or triangular file is tapered, double-cut and the shape is that of an equilateral triangle.

HALF ROUND FILE → This is tapered double-cut and its cross-section is not 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 for filing narrow slots, notches and grooves.

METHODS OF FILING

Broadly there are four methods of filing.

STRAIGHT FILING

In straight filing, the file is pressed forward at right angles to the length of the work. Straight filing is especially useful on long and narrow piece of work whose width is less than that of the file.

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DRAW FILING

In draw filing, the handle of the file is not held. Instead, both hands are placed closed together on the blade. 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.

CROSS FILING

In cross filing, the file strokes are run alternatively from the right and from the right to the left. This is the most common method of filing and is used for general shaping. In this method, the possibility of rounding is minimized and the score mark is made in the work by the file teeth are criss-crossed so that the maximum amount of metal is removed. The aim of cross-filing is always to move the whole of the file surface across the complete work surface in one stroke.

CUTTING METHODS

Hack sawing is the quickest method of severing, shaping and slotting cold metal. The saw is placed on the work surface with the right hand on the handle and the left hand on the other end of the saw frame firmly. The sawing should begin with the

backward stroke. Pressure is applied on the forward stroke and a little lift is necessary on the return stroke because the blade cuts only on the forward stroke. Begin sawing with short strokes and apply the saw in a position somewhat inclined to the work piece.

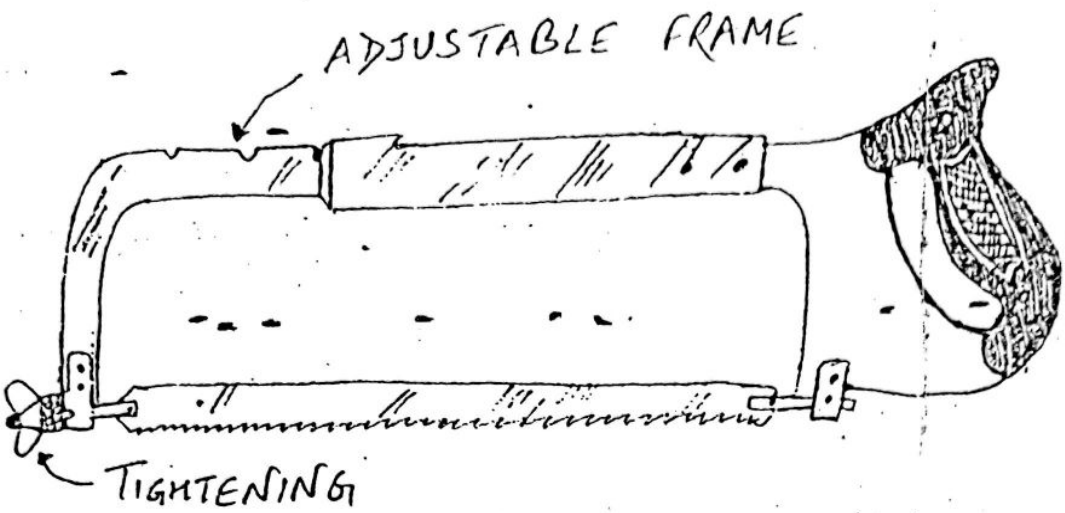
HACKSAW

The hacksaw is used for sawing all metal except hardened steel. A hand hacksaw consists of a frame, handle, prongs, tightening screw and nut.

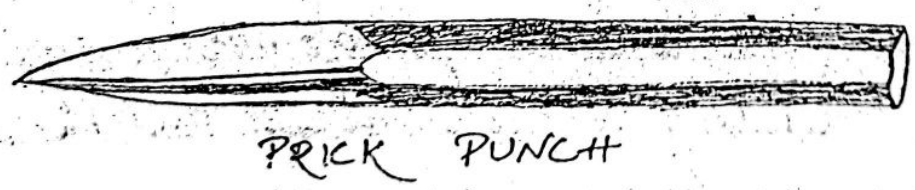
Hacksaw blades are made of special steels. For hand saws either high carbon steel, low alloy steel or high speed steel is used. The blades may be hard throughout or of the more flexible type, which has a soft back and a hard cutting edge. All hard blades made of high speed steel are used for cutting the harder metals, such as alloy steels, while flexible blades are good for use by unskilled or semi-skilled operators or where work is inconveniently placed. These flexible blades are less liable to break and are used for general work.

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 is a sharply pointed tool. The tapered point of the punch has an angle of



DIFFERENT PARTS OF A HACKSAW



PRICK PUNCH

CENTRE PUNCH

PUNCH

usually 40°. It is used to make small punch marks on layout lines in order to make them last longer.

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°.

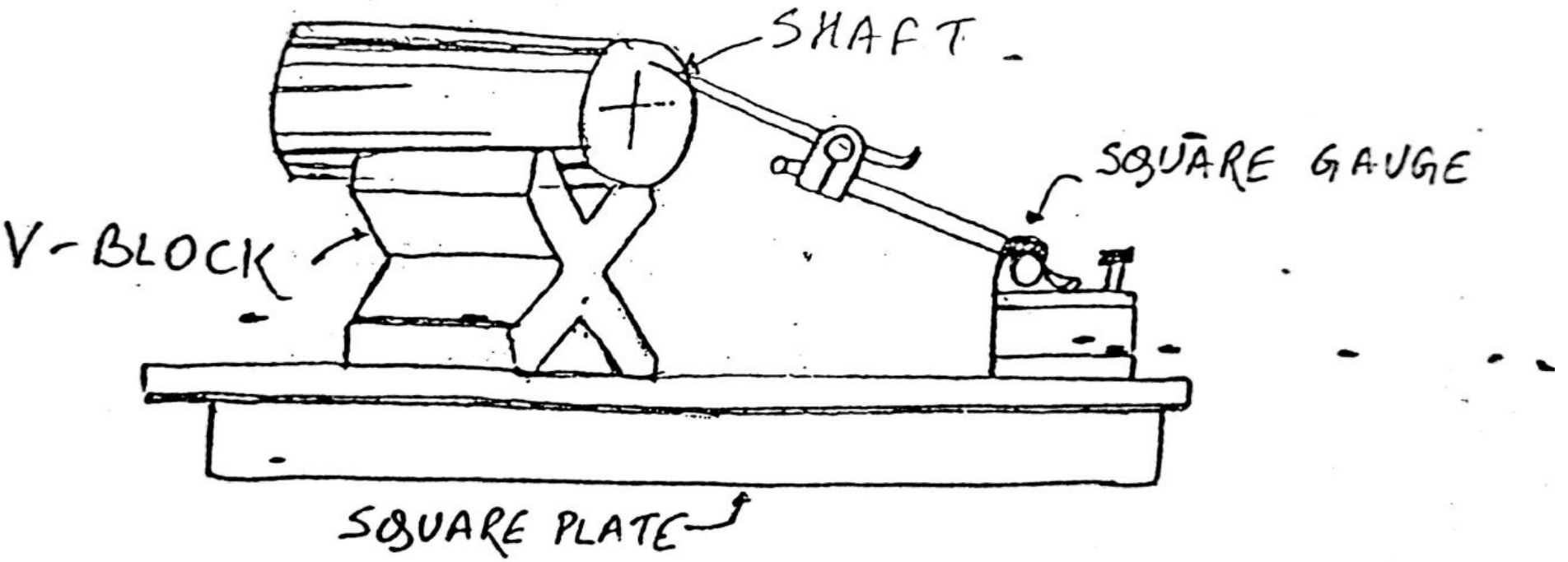
The centre punch is used only to make the prick-punch marks larger at the centre of holes that are to be drilled, hence the name centre punch. A strong blow of the hammer is needed to mark the point.

V-BLOCK

The V-block is a block of steel with V-shaped grooves. 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.

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.



USE OF A V-BLOCK

TRY SQUARE

The try square 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 true edge or surface and also for laying out work.

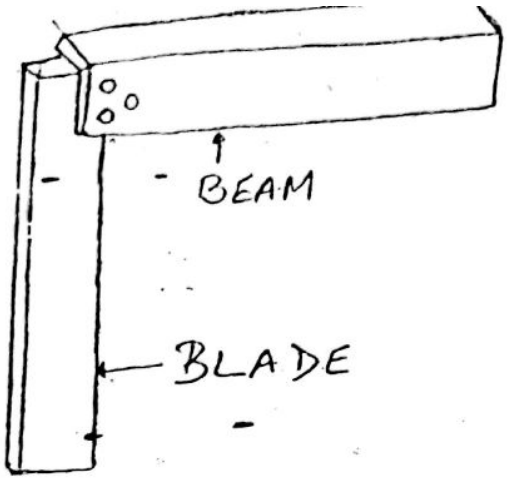
DRILL

A drill is a tool for making holes in a metal piece. It usually consists of two cutting edges set at an angle with the axis. There are three types of drills:

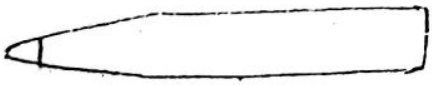
1) Flat drill
2) Straight fluted drill
3) Twist drill

The use of flat drill and straight fluted drill has many disadvantages and they are not generally used in a fitter's shop.

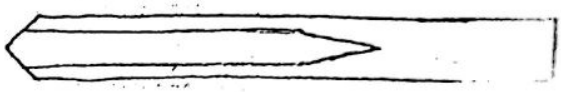
For rapid and accurate work twist drills are now universally adapted. The best cutting angle is 118 and to obtain the correct diameter of the hole, the drill should be ground with both lips at 59° to the axis of the drill, with the lengths of the cutting edges exactly equal. A drill having unequal cutting edges and the point angles not symmetrical will probably result in a large hole running out of line.



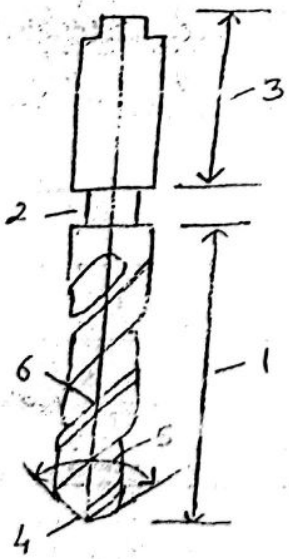
TRY SQUARE



FLAT-DRILL



STRAIGHT FLUTE



1. LENGTH
2. NECK
3. SHANK
4. LIP
5. LIP ANGLE
6. HEEL

TWIST DRILL

SURFACE PLATE

The surface plate is used for testing the flatness of work itself and is also used for marking-out work. This is used for small pieces of work while the marking-out table is used for larger jobs.

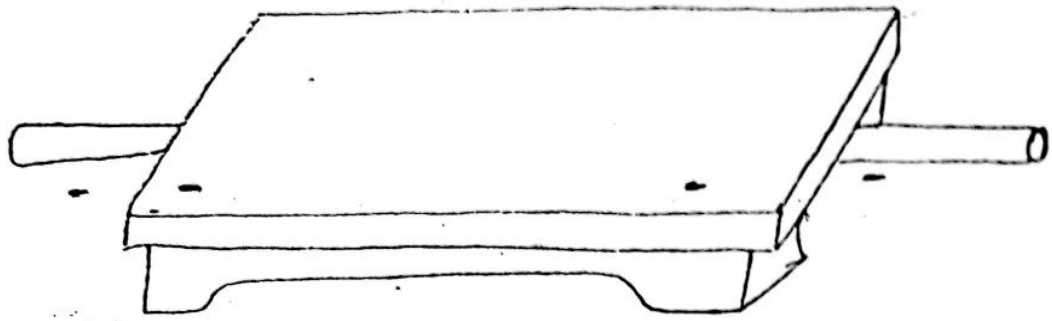
Surface plates are made of grey cast iron and of solid design or with ribs. They should be well and reflection-free illuminated and rest horizontally on a firm support, the working height being about 800 mm from the floor. The marking-out surface must be protected from rust and dirt and wiped clean and smeared with grease or oil after use.

TAPS

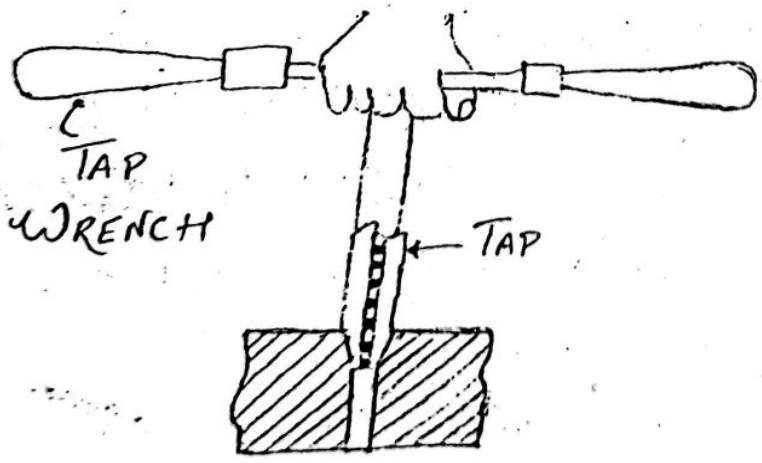
A tap is a screw-like tool which has threads like a bolt and three or four flutes cut across the thread. It is used to cut threads on the inside of a hole, as in a nut. The edges of the thread formed by the flutes are the cutting edges. The lower part of the tap is somewhat tapered so that it can well attack the walls of the drill hole. The upper part of the tap consists of a shank ending in a square for holding the tap by a tap wrench. This is a two-handled wrench and it may be either fixed or adjustable.

Taps are made from carbon steel or high speed steel and are hardened and tempered. Hand taps are usually made in sets of three:

(1) taper tap
(2) second tap called plug tap
(3) bottoming tap



SURFACE PLATE



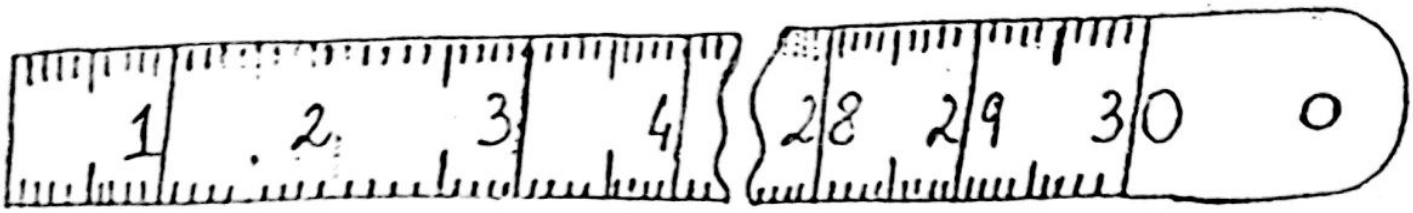
TAP WRENCH

STEEL RULE

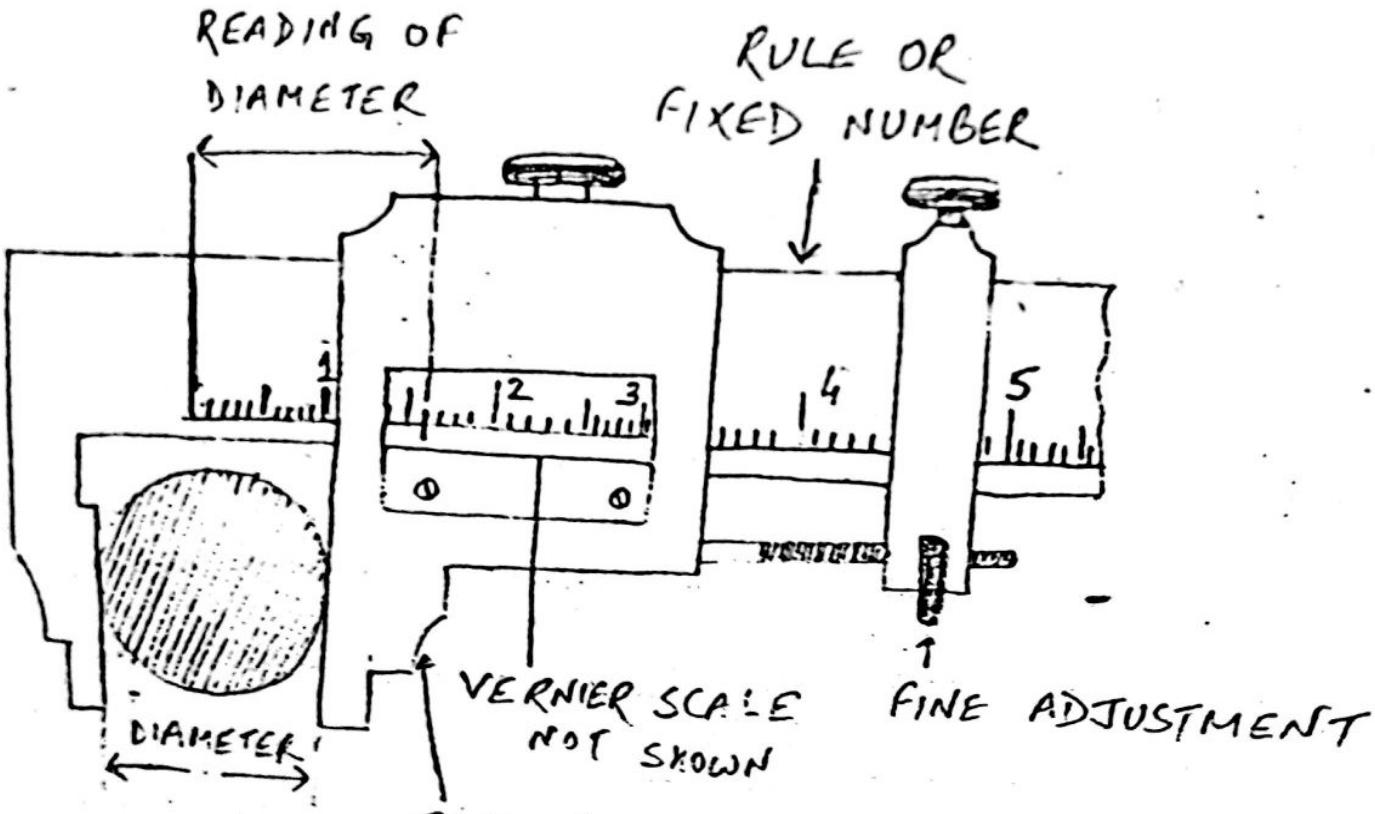
The steel rule is one of the most useful tool in the shop for taking linear measurements of blanks and articles to an accuracy of from 1.0 to 0.5 mm. It consists of a strip of hardened steel having line graduations etched or engraved at interval of fraction of a standard unit of length. There are scales which have got some attachments and special features with them to make their use more versatile. They may be made in folded form so that they can be kept in pocket also. Certain scales, called shrink or contraction rule, are virtually steel rules and they are used in foundry and pattern making shops.

VERNIER CALIPER

The vernier caliper is primarily intended for measuring both inside and outside diameters of shafts, thickness of parts, etc to an accuracy of 0.02 mm by a vernier scale attached to the caliper. The instrument comprises a beam or main scale which carries the fixed graduations, two measuring jaws, a vernier head having a vernier scale and head having a vernier scale engraved on it and an auxiliary head of a vernier clamp which is used for a specified dimension by a micrometer screw. The vernier head and the auxiliary head can be locked to the main scale by the knurled screw attached to each head.



STEEL RULE



VERNIER CALIPER

VERNIER HEIGHT GAUGE

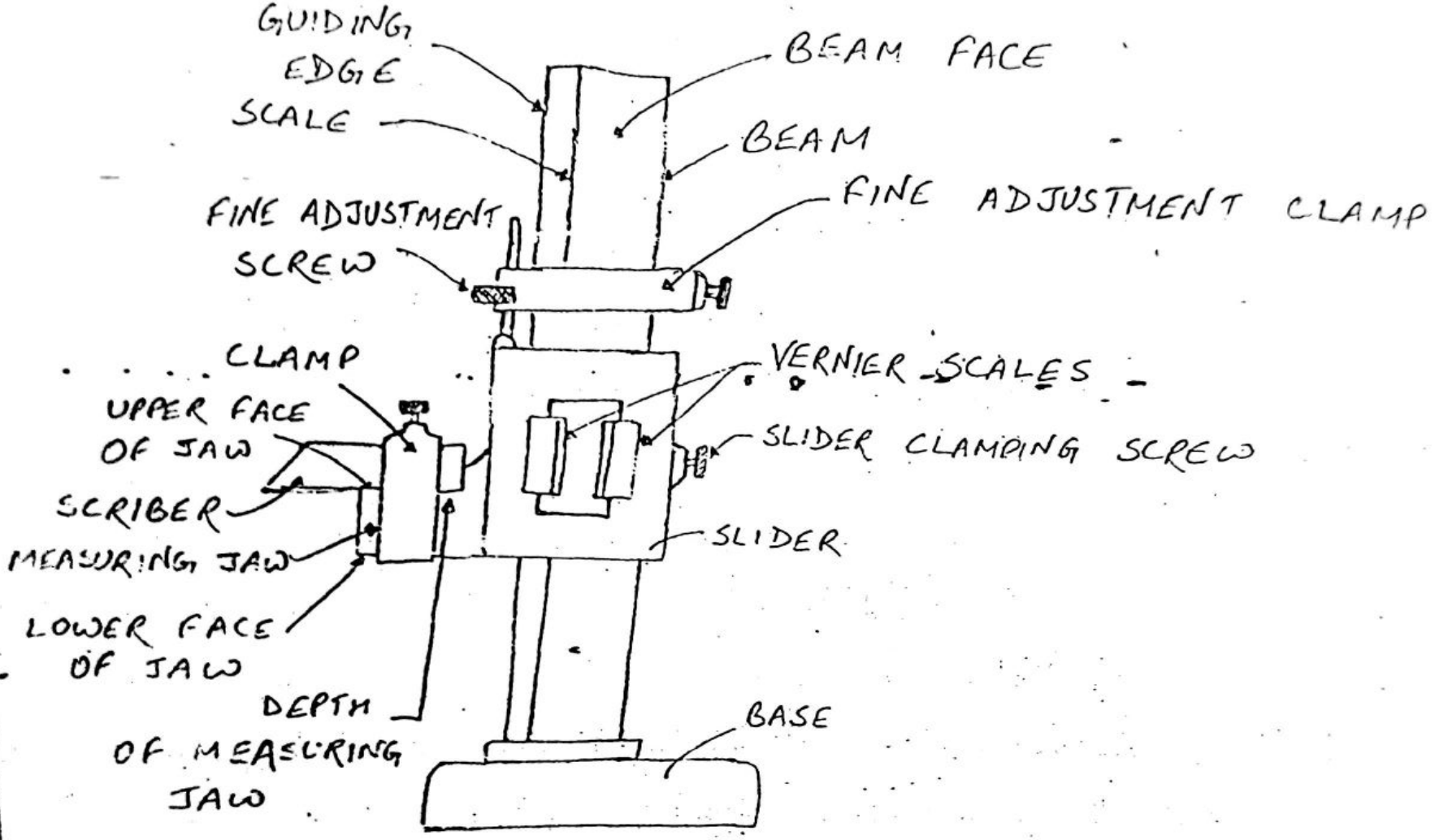
The vernier height gauge is used to measure the height of parts to an accuracy of 0.02 mm in metric measurement. The essential parts of the instrument are:

1. Instrument base with a lapped undersurface.
2. Graduated beam or main scale.
3. Sliding head with vernier.
4. Sliding jaw holding the scriber.
5. Vernier clamp which moves with the sliding head.
6. Fine adjustment screw in the vernier clamp.
7. Two knurled screws which lock the vernier head and clamp to the rule at any desired setting.

EXTERNAL MICROMETER

The external micrometer is primarily used to measure external dimensions like diameters of shafts, thickness of parts, etc to an accuracy of 0.01 mm. The essential parts are-

1. FRAME:- The frame is made of steel, cast steel, malleable cast iron or light alloy.
2. HARDENED ANVIL - The anvil shall protrude from the frame for a distance of at least 3mm in order to permit the attachment of a measuring wire support.
3. SCREWED SPINDLE - This spindle does the actual measuring and possesses thread of 0.5 mm pitch.
4. GRADUATED SLEEVE OR BARREL - It has datum or fiducial line and fixed graduations.

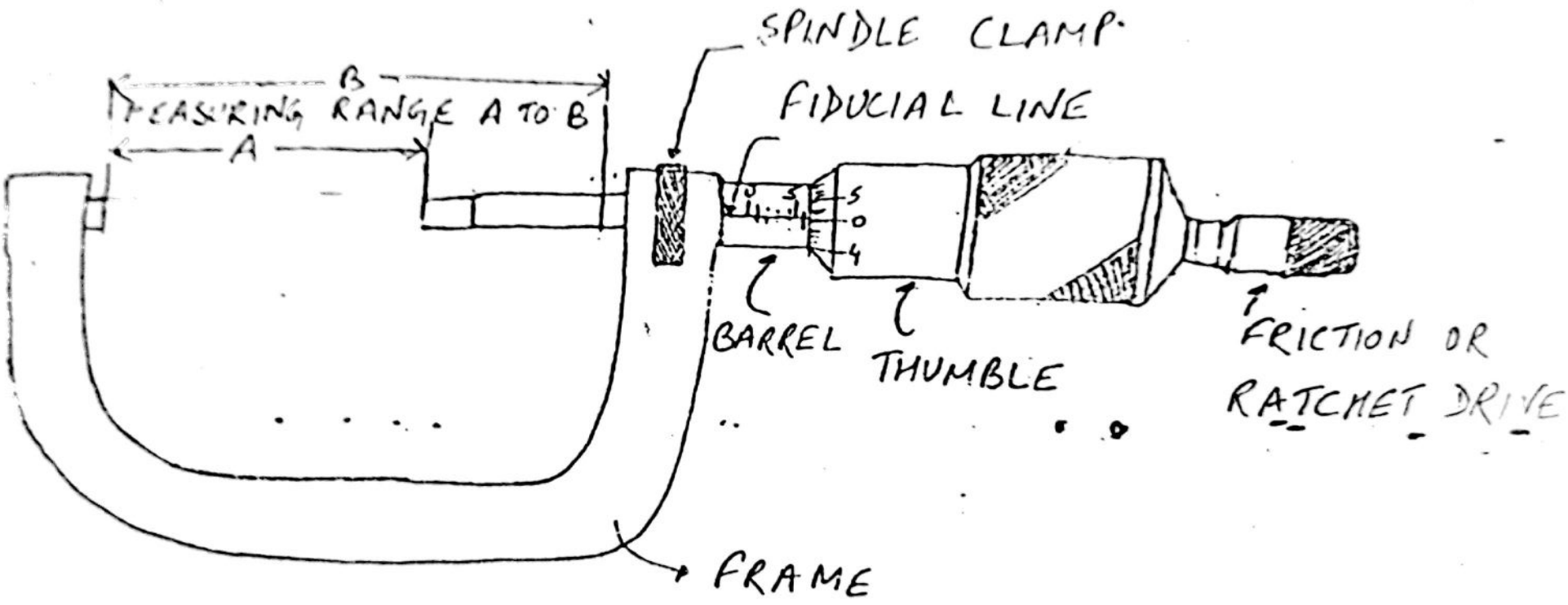


VERNIER HEIGHT GAUGE

5. THIMBLE - This is tubular cover fastened with the spindle and moves with the spindle. The bevelled edge of the thimble is divided into 50 equal parts, every fifth being numbered.

6. RATCHET OR FRICTION STOP - This is a small extension to the thimble. The ratchet slips when the pressure on the screw exceeds a certain amount. This produces uniform reading and prevents any damage or distortion of the instrument.

7. SPINDLE CLAMP OR CLAMP RING - This is used to lock the instrument at any desired setting.



DIFFERENT PARTS OF AN

EXTERNAL MICROMETER

EXPERIMENT: NO-1

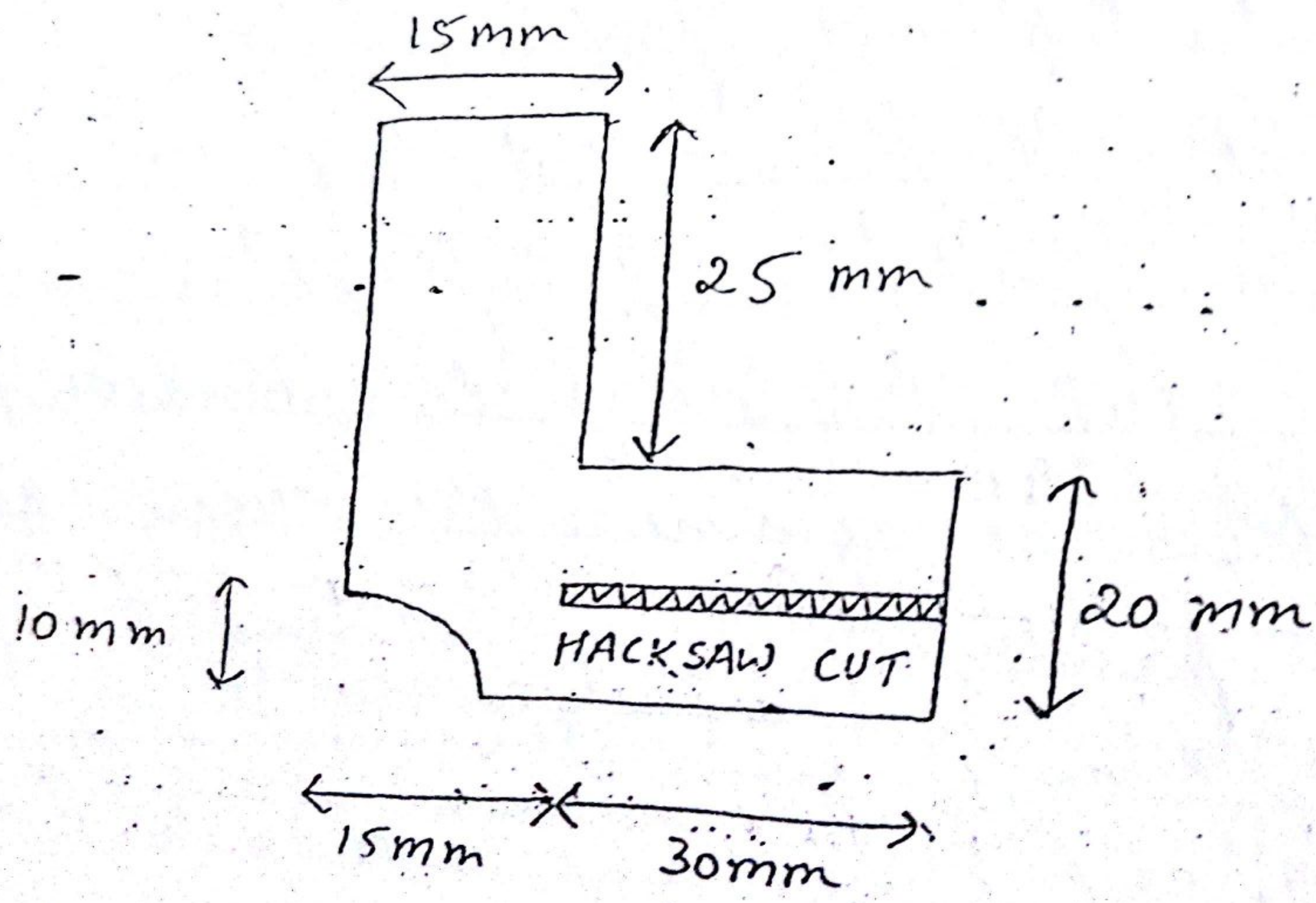
AIM→ To get the desired workpiece in the fitting workshop.

TOOLS REQUIRED→ Mild steel, hacksaw, files, try square, vernier height gauge

PROCEDURE:

1) Cut out a rectangular piece of mild steel of required dimensions using a hacksaw.
2) Now file one of its faces and two perpendicular edges using a flat file.
3) Make the necessary markings on the work-piece using a vernier height gauge.
4) After cutting out the required shape, file all the edges using a flat file while the quarter circle should be filed using a triangular file.

RESULT→ The workpiece obtained was as per the required diagrams.



WORK-PIECE