Linear measurement

Objectives: At the end of this lesson you shall be able to
- **name the base unit of linear measurement as per the International System of units of measurement (SI)**
- **state the multiples of a metre and their values**
- **state the purpose of steel rule**
- **name the types of steel rule**
- **state the precautions to be followed while using a steel rule.**

When we measure an object, we are actually comparing it with a known standard of measurement.

The base unit of length as per SI is METRE.

Length - SI UNITS and MULTIPLES

Base unit

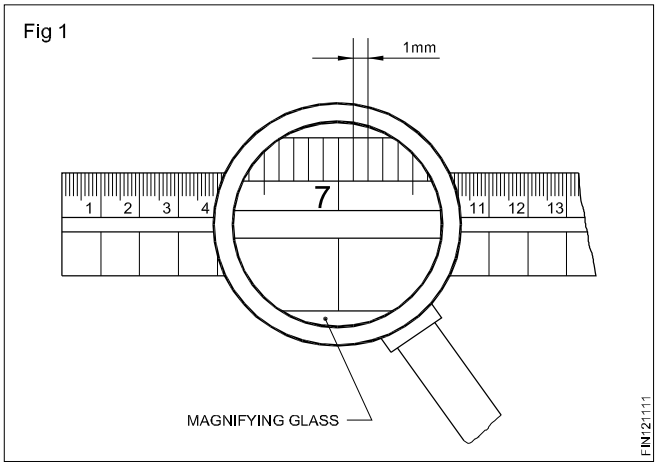
The base unit of length as per the Systems International is metre. The table given below lists some multiples of a metre.

METRE(m)	= 1000 mm
CENTIMETRE (cm)	= 10 mm
MILLIMETRE (mm)	= 1000µ
MICROMETRE (µm)	= 0.001 mm

Measurement in engineering practice

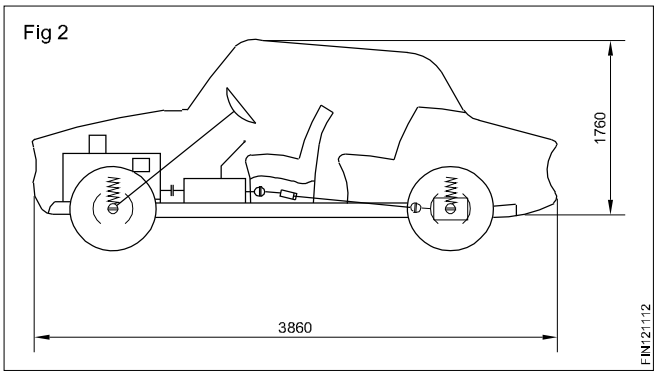
Usually, in engineering practice, the preferred unit of length measurement is millimetre. (Fig 1)

Fig 1



Both large and small dimensions are stated in millimetres. (Fig 2)

Fig 2

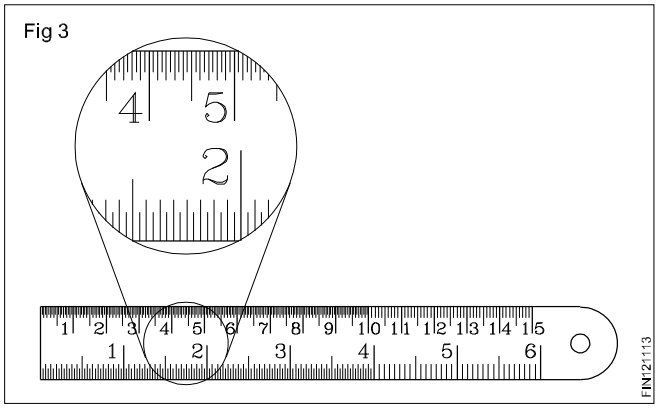


The British system of length measurement

An alternative system of length measurement is the British system. In this system, the base unit is the Imperial Standard Yard. Most countries, including Great Britain itself, have, however, in the last few years, switched over to SI units.

Engineer's steel rule (Fig 3) are used to measure the dimensions of work pieces.

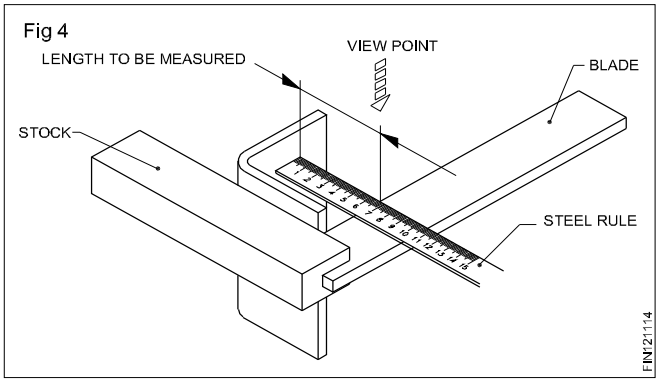
Fig 3



Steel rules are made of spring steel or stainless steel. These rules are available in length 150mm, 300mm and 600mm. The reading accuracy of steel rule is 0.5 mm and 1/64 inch.

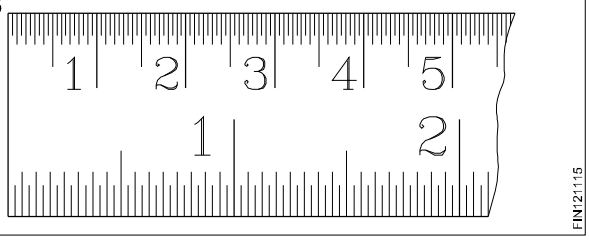
For accurate reading it is necessary to read vertically to avoid errors arising out of parallax. (Fig 4)

Fig 4



Steel rule in English measure, they can also be available with metric and English graduation in a complete range of sizes 150, 300, 500 and 1000 mm. (Fig 5)

Fig 5



Other types of rule

– narrow steel rules

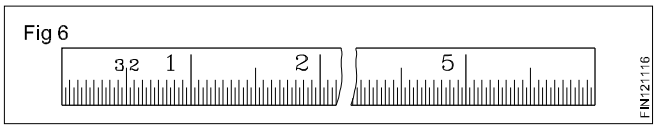
– short steel rules

– full flexible steel rule with tapered end.

Narrow steel rule

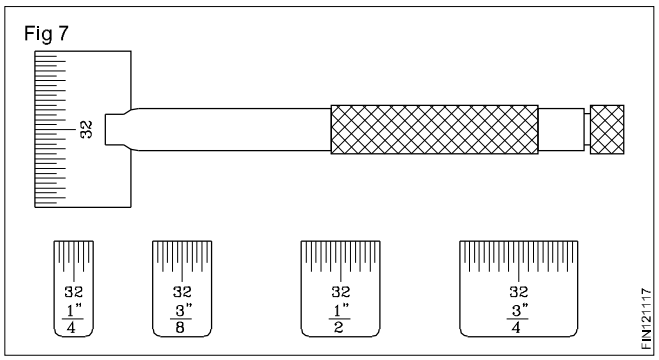
Narrow steel rule is used to measure the depth of key-ways and depth of smaller dia, blind holes of jobs, where the ordinary steel rule can not reach. Its width is approximately 5 mm and thickness 2 mm. (Fig 6)

Fig 6



Short steel rule (Fig 7)

Fig 7



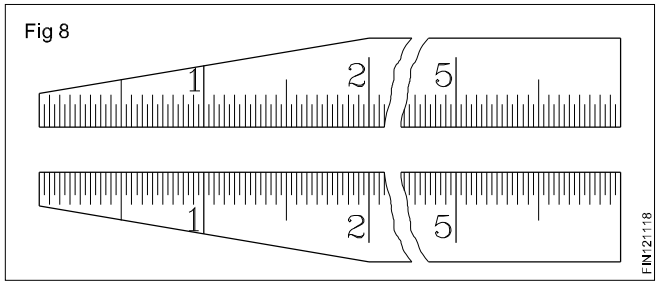
This set of five small rules together with a holder is extremely useful for measurements in confined or hard to reach locations which prevent the use of ordinary steel rules. It is used suitably for measuring grooves, short shoulder, recesses, key ways etc. in machining operation on shapers, millers and tool and die work.

The rules are easily inserted in the slotted end of the holder and are rigidly clamped in place by a slight turn of the knurled nut at the end of the handle. Five rule lengths are provided 1/4", 3/8", 1/2", 3/4" and 1" and each rule is graduated in 32^{nds} on one side and 64ths on the reverse side.

Steel rule with tapered end

This rule is a favorite with all mechanics since its tapered end permits measuring of inside size of small holes, narrow slots, grooves, recesses etc. This rule has a taper from 1/2 inch width at the 2 inch graduation to 1/8 inch width at the end. (Fig 8)

Fig 8



For maintaining the accuracy of a steel rule, it is important to see that its edges and surfaces are protected from damage and rust.

Do not place a steel rule with other cutting tools. Apply a thin layer of oil when not in use.

Angular measurement

Angular measurement of angles of an object is usually expressed in degrees, minutes and seconds. One degree is divided into 60 minutes and one minute is to 60 seconds.

Measurements of fundamental, derived units

Measurement of length

Metric			British	
Micron	1μ	= 0.001 mm	Thousandth of an inch	= 0.001"
Millimetre	1 mm	= 1000μ	Inch	= 1"
Centimetre	1 cm	= 10 mm	Foot 1 ft	= 12"
Decimetre	1 dm	= 10 cm	Yard 1yd	= 3 ft
Metre	1 m	= 10 dm	1 furlong 1 fur	= 220 yds
Decametre	1 dam	= 10 metre	1 mile	= 8 fur

Scribers

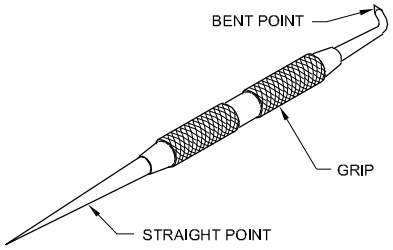
Objectives: At the end of this lesson you shall be able to
- **state the features of scribers**
- **state the uses of scribers.**

Scribers

In lay out work it is necessary to scribe lines to indicate the dimensions of the workpiece to be filed or machined. The scriber is a tool used for this purpose. It is made of high carbon steel and is hardened. For drawing clear and sharp lines, the point should be ground and honed frequently for maintaining its sharpness.

Scribers are available in different shapes and sizes. The most commonly used one is the plain scriber. (Fig 1)

Fig 1

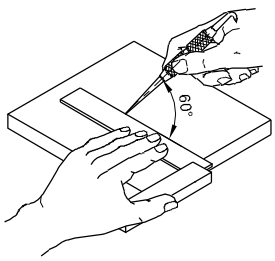


While scribing lines, the scriber is used like a pencil so that the lines drawn are close to the straight edge. (Fig 2)

Scriber points are very sharp; therefore, do not put the plain scriber in your pocket.

Place a cork on the point when not in use to prevent accidents.

Fig 2

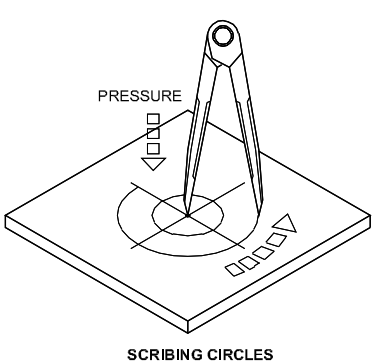


Dividers

Objectives: At the end of this lesson you shall be able to
- **name the parts of a divider**
- **state the uses of dividers**
- **state the specifications of dividers**
- **state the important hints on divider points.**

Dividers are used for scribing circles, arcs and for transferring and stepping off distances. (Fig 1,2 and 3)

Fig 1



Dividers are available with firm joints and spring joints. (Figs 1 & 4). The measurements are set on the dividers with a steel rule. (Fig 2)

The sizes of dividers range between 50 mm to 200 mm.

Fig 2

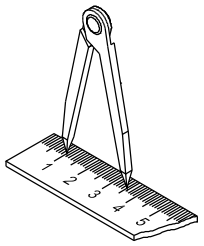
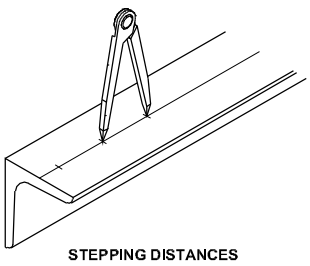
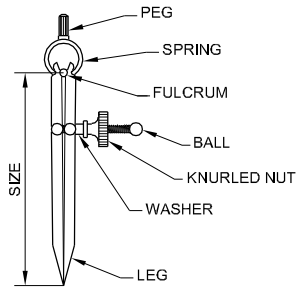


Fig 3



The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 4)

Fig 4



SPRING JOINT DIVIDER

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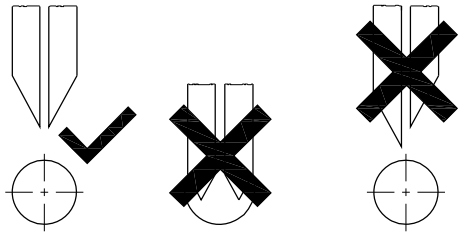
For the correct location and seating of the divider point prick punch marks of 30° are used.

The two legs of the divider should always be of equal length. (Fig 5) Dividers are specified by the type of their joints and length.

Fig 5



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The divider point should be kept sharp in order to produce fine lines. Frequent sharpening with an oilstone is better than sharpening by grinding. Sharpening by grinding will make the points soft.

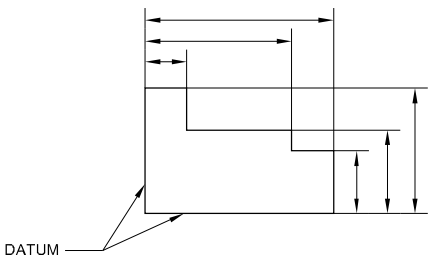
Datum

Objectives: At the end of this lesson you shall be able to
- **state the need for datum while marking**
- **name the different datum references.**

Say, the height of a person is measured from the floor on which he stands, the floor then becomes the datum or the common basis for measurement.

A datum is a reference surface, line or point, and its purpose is to provide a common position from which measurements may be taken. The datum may be an edge or centre line depending on the shape of the work. For positioning a point, two datum references are required. (Figs 1, 2 and 3)

Fig 1



EDGE DATUM

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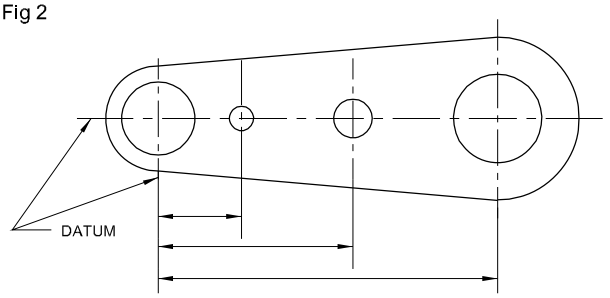
Fig 2



CENTRE LINE DATUM

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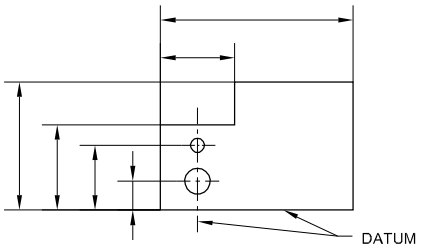
Marking tables, surface plates angle plates, 'V' blocks, and parallel blocks serve as a datum. (Figs 4 & 5)

Fig 3



EDGE DATUM AND CENTRE LINE DATUM

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Fig 4

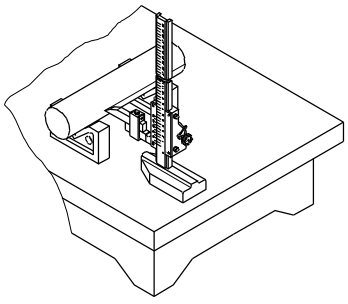

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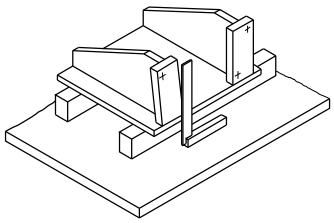
Fig 5



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The datum references are indicated in the drawing. The same datum references must be used for transferring dimensions to the work-piece.

Calipers

Objectives: At the end of this lesson you shall be able to
- **name the commonly used calipers**
- **state the advantages of spring joint calipers.**

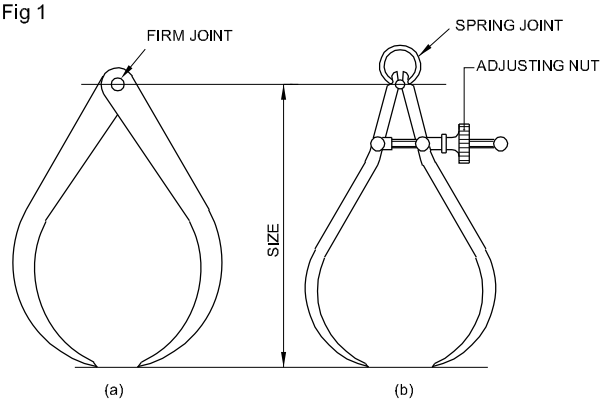
Calipers are indirect measuring instruments used for transferring measurements from a steel rule to a job, and vice versa.

Calipers are classified according to their joints and their legs.

Joint

– Firm joint calipers (Fig 1a)
– Spring joint calipers (Fig 1b)

Fig 1



Legs

– Inside caliper for internal measurement. (Fig 2)
– Outside caliper for external measurement. (Fig 3)

Fig 2

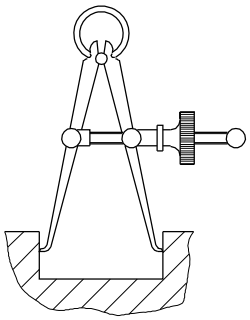
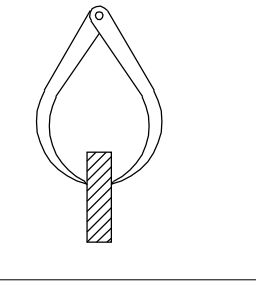


Fig 3



Calipers are used along with steel rules, and the accuracy is limited to 0.5 mm; parallelism of jobs etc. can be checked with higher accuracy by using calipers with sensitive feel.

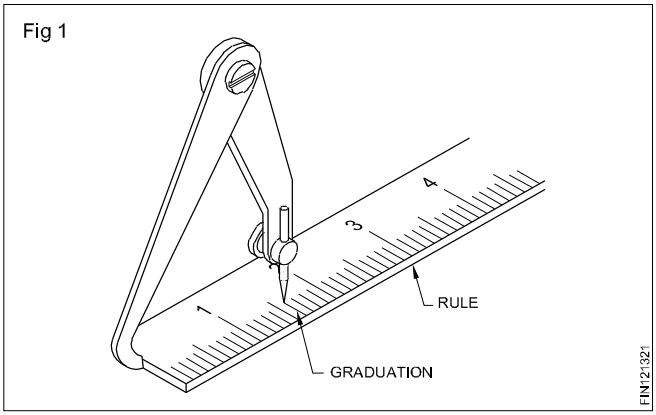
Spring joint calipers have the advantage of quick setting with the help of an adjusting nut. For setting a firm joint caliper, tap the leg lightly on a wooden surface.

Jenny calipers

Objectives: At the end of this lesson you shall be able to
- **state the uses of a jenny caliper**
- **state the two types of legs of a jenny caliper.**

Jenny calipers have one leg with an adjustable divider point, while the other is a bent leg. (Fig 1) These are available in sizes of 150 mm, 200 mm, 250 mm and 300 mm.

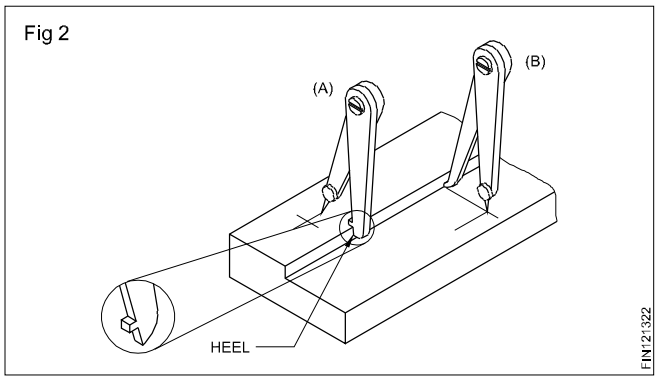
Fig 1



Jenny calipers are used

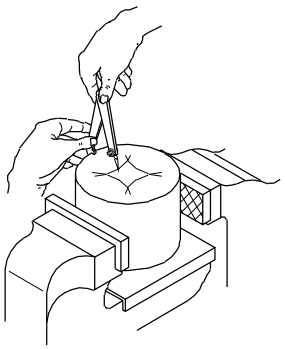
– for marking lines parallel to the inside and outside edges (Fig 2)

Fig 2



- for finding the centre of round bars. (Fig 3)

Fig 3



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These calipers are available with the usual bent leg or with heel.

Calipers with bent leg (Fig 2B) are used for drawing lines parallel along an inside edge, and the heel type (Fig 2A) is used for drawing parallel lines along the outer edges.

The other names for this caliper are:

- hermaphrodite calipers
- leg and point calipers
- odd leg caliper

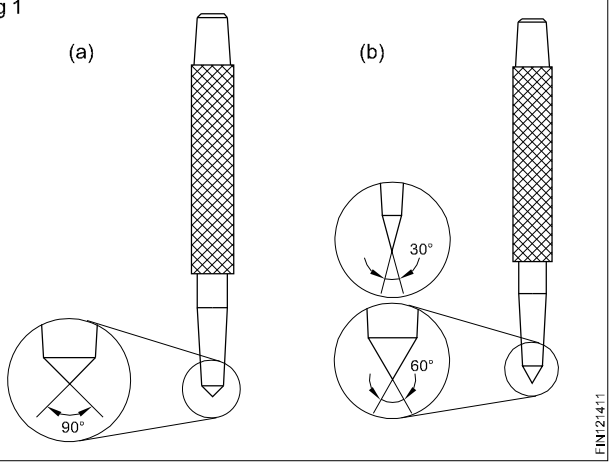
Types of marking punches

Objectives: At the end of this lesson you shall be able to
- **name the different punches in marking**
- **state the features of each punch and its uses.**

Punches are used in order to make certain dimensional features of the layout permanent. There are two types of punches. They are centre punch and prick punch made of high carbon steel, hardened and ground.

Centre Punch: The angle of the point is 90° in a centre punch. The punch mark made by this is wide and not very deep. This punch is used for locating centre of the holes. The wide punch mark gives a good seating for starting the drill. (Fig 1a)

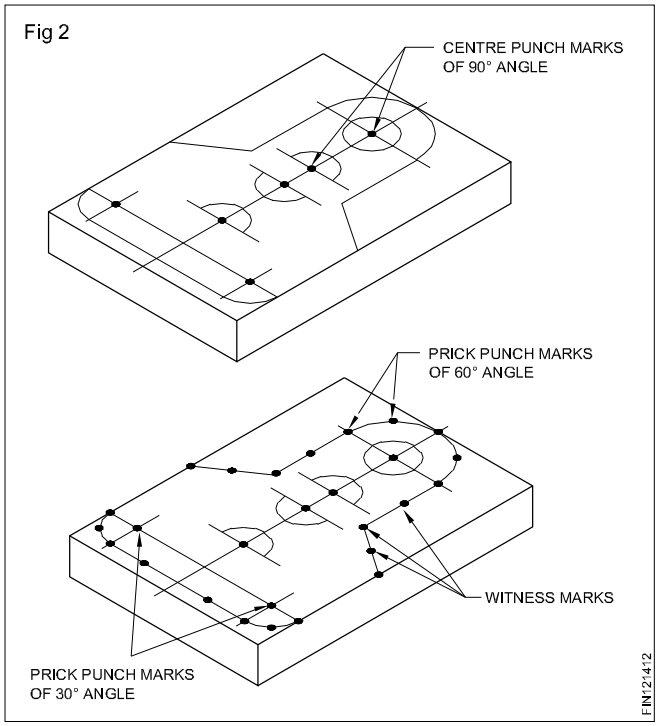
Fig 1



Prick Punch/Dot punch: The angle of the prick punch is 30° or 60°. (Fig 1b) The 30° point punch is used for making light punch marks needed to position dividers. The divider point will get a proper seating in the punch mark. The 60° punch is used for marking witness marks and called as dot punch. (Fig 2)

The witness marks should not be too close to one another.

Fig 2



Hammers

Objectives: At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **identify the parts of an engineer's hammer**
- **name the types of engineer's hammer**
- **specify the engineer's hammer.**

An engineer's hammer is a hand tool used for striking purposes while punching, bending, straightening, chipping, forging or riveting.

Major parts of a hammer: The major parts of a hammer are the head and the handle.

Hammer is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

The parts of a hammer-head are the face (1), pein (2), cheek (3) and the eyehole (4).

Face: The face is the striking portion. A slight convexity is given to it to avoid digging of the edge. It is used for striking while chipping, bending, punching, etc.

Pein: The pein is the other end of the head. It is used for shaping and forming work like riveting and bending. The pein is of different shapes such as:

– ball pein (Fig.2a)

– cross-pein (Fig.2b)

– straight pein. (Fig 2c)

Fig 1

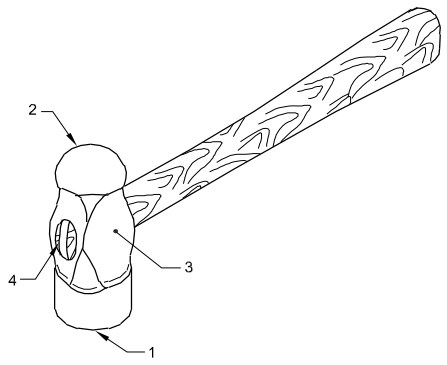


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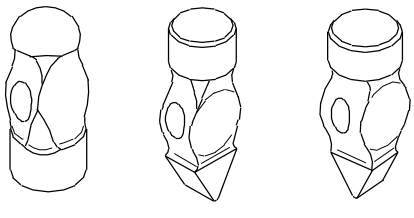
Fig 2



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The face and the pein are case hardened.

Cheek: The cheek is the middle portion of the hammer-head. The weight of the hammer is stamped here.

This portion of the hammer-head is left soft.

Eyehole: The eyehole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eyehole. (Figs 3 and 4)

Fig 3

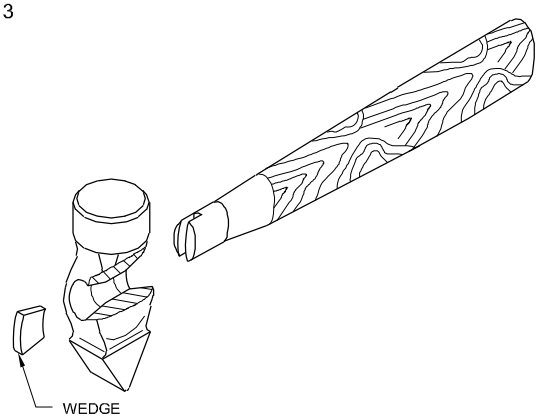

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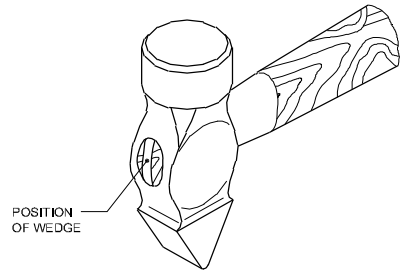
Fig 4



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Application of hammer pein: The ball pein is used for riveting. (Fig 5)

The cross-pein is used for spreading the metal in one direction. (Fig 6)

Fig 5

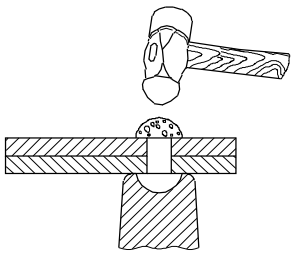

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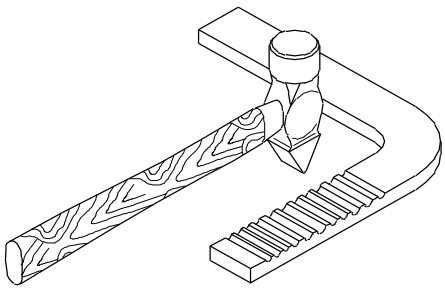
Fig 6



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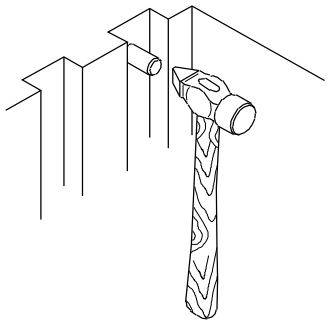
The straight pein is used at the corners. (Fig 7)

Fig 7



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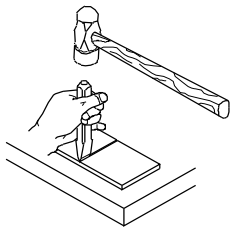
The ball pein hammer is used for driving a chisel in parting metal. (Fig 8)

Fig 8



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Specification: An engineer's hammers are specified by their weight and the shape of the pein. Their weight varies from 125 gms to 750 gms.

The weight of an engineer's hammer, used for marking purposes, is 250 gms.

The ball pein hammers are used for general work in a machine/ fitting shop.

Before using a hammer

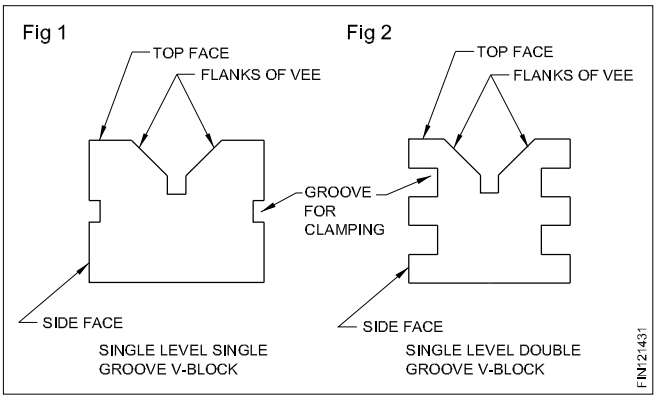
- make sure the handle is properly fitted
- select a hammer with the correct weight suitable for the job
- check the hammer head and handle whether any crack is there
- ensure that the face of the hammer is free from oil or grease.

'V' Blocks

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of 'v' blocks**
- **name the types of 'v' blocks and state their uses**
- **specify 'v' blocks as per B.I.S standard.**

Constructional features

'V' Blocks are devices used for marking and setting up work on machines. The features of the common type of 'V' Blocks are as given in Figs 1 and 2.



The included angle of the VEE is 90° in all cases. 'V' Blocks are finished to a high accuracy in respect of dimension, flatness and squareness.

Types

Different types of 'V' blocks are available. As per BIS, there are four types, as listed below.

Single level single groove 'V' Block (Fig 1)

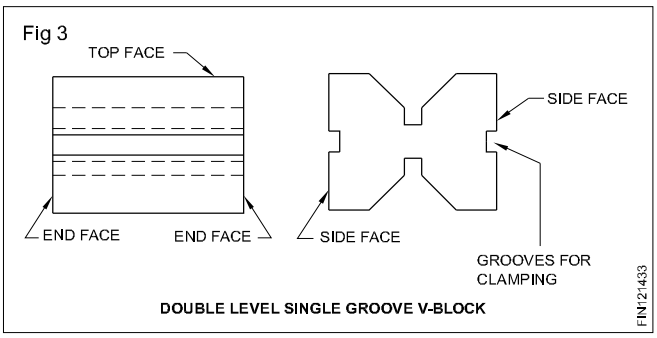
This type has only one 'V' groove, and has single groove (slots) on either side. These grooves are for accommodating the holding clamps.

Single level double groove 'V' Block (Fig 2)

This type will have one 'V' groove, and two grooves (slots) on either side for clamping in two positions.

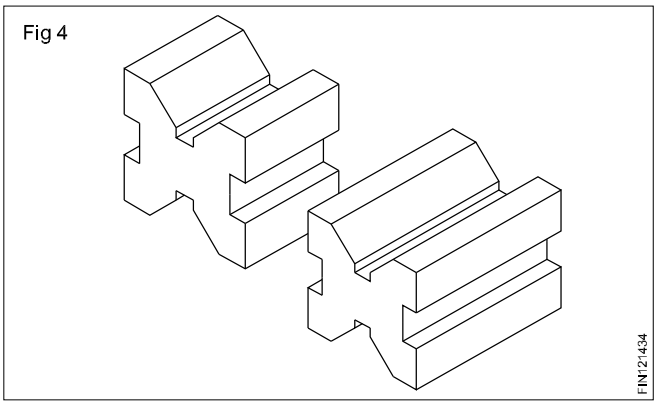
Double level single groove 'V' Block (Fig 3)

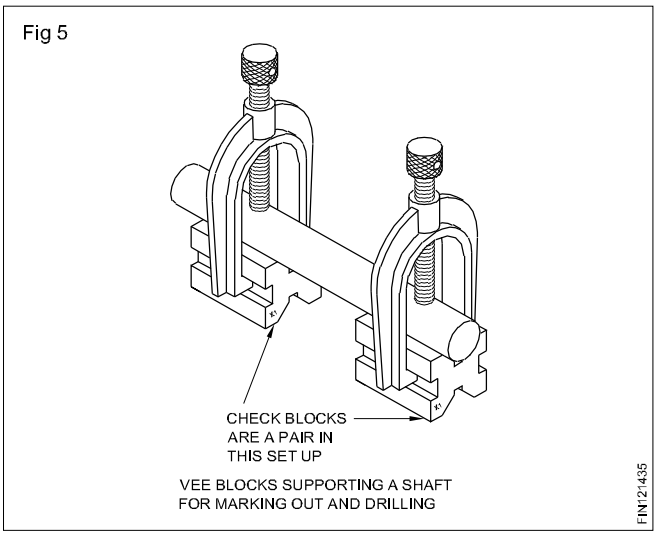
In this case, the 'V' Block will have two 'V' grooves on the top and bottom, and a single groove for clamping on either side.



Matched pair 'V' Block (Figs 4 and 5)

These blocks are available in pairs which have the same size and the same grade of accuracy. They are identified by the number or letter given by the manufacturer. These





sets of blocks are used for supporting long shafts parallel on machine tables or marking off tables.

Grades and materials

'V'Blocks are available in Grade A and Grade B.

Grade A 'V' Blocks

These are more accurate, and are available only up to 100 mm length. They are made of high quality steel.

Grade B 'V' Blocks

These blocks are not as accurate as the ones in Grade A. These blocks are used for general machine shop work. These blocks are available up to 300 mm length. These 'V' Blocks are made of closely grained cast iron.

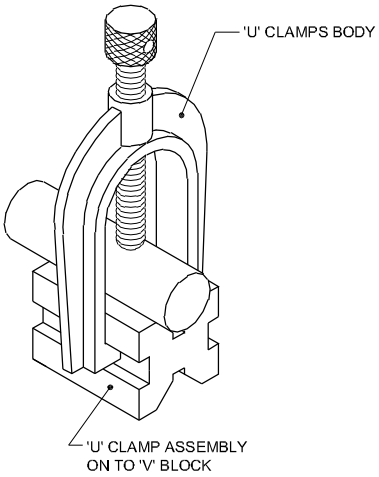
Clamping devices for `V'-Blocks

'U' clamps are provided for holding cylindrical jobs firmly on 'V' Blocks. (Fig 6)

Designation

'V' Blocks are designated by the nominal size (length) and the minimum and maximum diameter of the workpiece capable of being clamped, and the grade and the number of the corresponding B.I.S. standard.

Fig 6



In the case of matched pairs, it should be indicated by the letter M.

For 'V' Blocks with clamps it should be indicated as, 'WITH CLAMPS'.

Example

A 50 mm long (nominal size) 'V' Block capable of clamping workpieces between 5 to 40 mm in diameter and of Grade A will be designated as

'V' Block 50/5-40 A - I.S.2949.

In the case of a matched pair, it will be designated as

'V' Block M 50/5-40 A I.S.2949.

For 'V' Block supplied with clamps, the designation will be

'V' Block with clamp 50/5 40 A I.S. 2949.

Care and maintenance

- Clean before and after use.
- Choose the correct size of 'V' block according to the job requirement.
- Apply oil after the use.

Marking off and marking off table

Objectives : At the end of this lesson you shall be able to
- **state why marking off is necessary**
- **state the function of witness marks**
- **state the features of marking tables**
- **write the uses of marking tables**
- **state the maintenace aspects concerning marking tables.**

Marking off

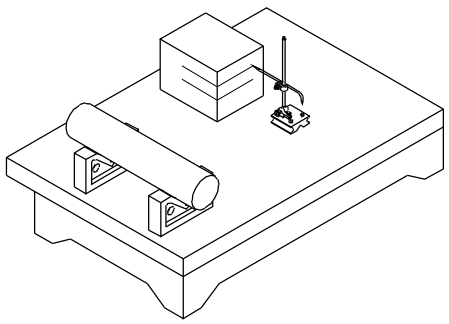
Marking off or layout is carried out to indicate the locations of operation to be done, and provide guidance during rough machining or filing.

Witness marks

The line marked on metal surfaces is likely to be erased due to handling. To avoid this, permanent marks are made by placing punch marks at convenient mark intervals along the marked line. Punch marks act as a witness against inaccuracies in machining and hence, they are known as witness marks.

Marking off table (Figs 1 and 2)

Fig 1



A marking table (marking-off table) is used as a reference surface for marking on workpieces.

Marking tables are of rigid construction with accurately finished top surfaces. The edges are also finished at right angles to the top surface.

Marking tables are made of cast iron or granite, and are available in various sizes. These tables are also used for setting measuring instruments, and for checking sizes, parallelism and angles.

Care and maintenance

A marking table is very precise equiment, and should be protected from damage and rust.

After use, the marking table should be cleaned with a soft cloth.

The Surface of the marking table, made of cast iron, should be protected by applying a thin layer of oil.

Fig 2