Marking material

Objectives: At the end of this lesson you shall be able to
- **name the common types of marking material**
- **select the correct marking material for different applications.**

Common types of Marking Materials

The common marking materials are Whitewash, Cellulose Lacquer, Prussian Blue and Copper Sulphate.

Whitewash

Whitewash is prepared in many ways.

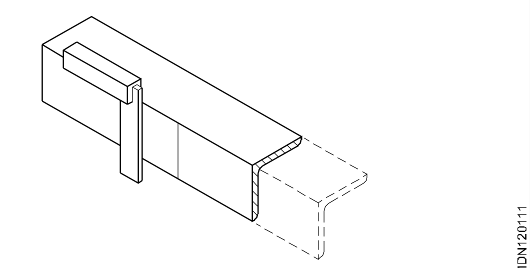
Chalk powder mixed with water

Chalk mixed with methylated spirit

White lead powder mixed with turpentine

Whitewash is applied to rough forgings and castings with oxidised surfaces. (Fig 1)

Fig 1



Whitewash is not recommended for workpieces of high accuracy.

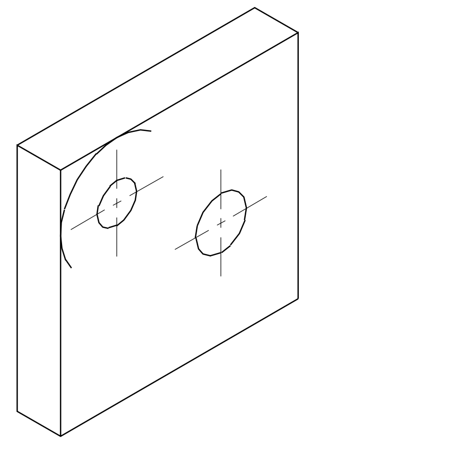
Cellulose Lacquer

This is a commercially available marking medium. It is made in different colours, and dries very quickly.

Prussian Blue

This is used on filed or machine-finished surfaces. This will give very clear lines but takes more time for drying than the other marking media. (Fig 2)

Fig 2



Copper Sulphate

The solution is prepared by mixing copper sulphate in water and a few drops of nitric acid. The copper sulphate is used on filed or machine-finished surfaces. Copper sulphate sticks to the finished surfaces well.

Copper sulphate needs to be handled carefully as it is poisonous. Copper sulphate coating should be dried well before commencing marking as, otherwise, the solution may stick on the instruments used for marking.

The selection of marking medium for a particular job depends on the surface finish and the accuracy of the workpiece.

Cleaning tools

Objectives : At the end of this lesson you shall be able to
- **state the different types of Cleaning Tools and their use**
- **state the precautions to be observed in the use of Cleaning Tools.**

Mechanical Cleaning Involves, brushing and abrasive Cleaning. It should be used very carefully on soft metals. Heavy deposits that exists even after chemical Cleaning can be removed by mechanical cleaning.

The General Cleaning Tools are

1) Wire brushes

2) Emery sheets.

Wire Brushes

Wire brushes are generally used for cleaning the work surfaces.

It is made of steel wires (or) Nylon bristles fitted on a wooden piece.

The steel wires are hardened and tempered for long life to ensure good cleaning action. Different types of wire brushes is shown in Fig 1.

Applications

1 Wire brushes can be used for cleaning uneven Surfaces

2 A hand wire brush can be used on exterior of the block and on the head.

3 A round wire brush fixed with a hand drill motor spindle can be used for cleaning of combustion chamber and parts of the head.

4 A wire wheel can be used to clean the valves.

5 Nylon bristles with impregnated abrasive brush can be used for Engine boring

6 A washing brush can be used to clean the cylinders by using Soap and Water.

7 Oil passages of cylinder block can be cleaned by running a long bottle type brush through all holes in the cylinder block.

8 It is used to clean work surface before and after welding

Safety precautions

Steel wire brushes should be used carefully on soft metals.

It should not make any scratches on the finished surface.

EMERY Sheet (Fig 2**)**

This is a type of paper used for sanding down hard and rough surfaces and also used for resistant technology purposes to give a smooth, shiny finish to manufactured products.

Emery paper is defined as a paper coated with abrasive particles in one side and used to produce smooth, shiny finish to manufactured products.

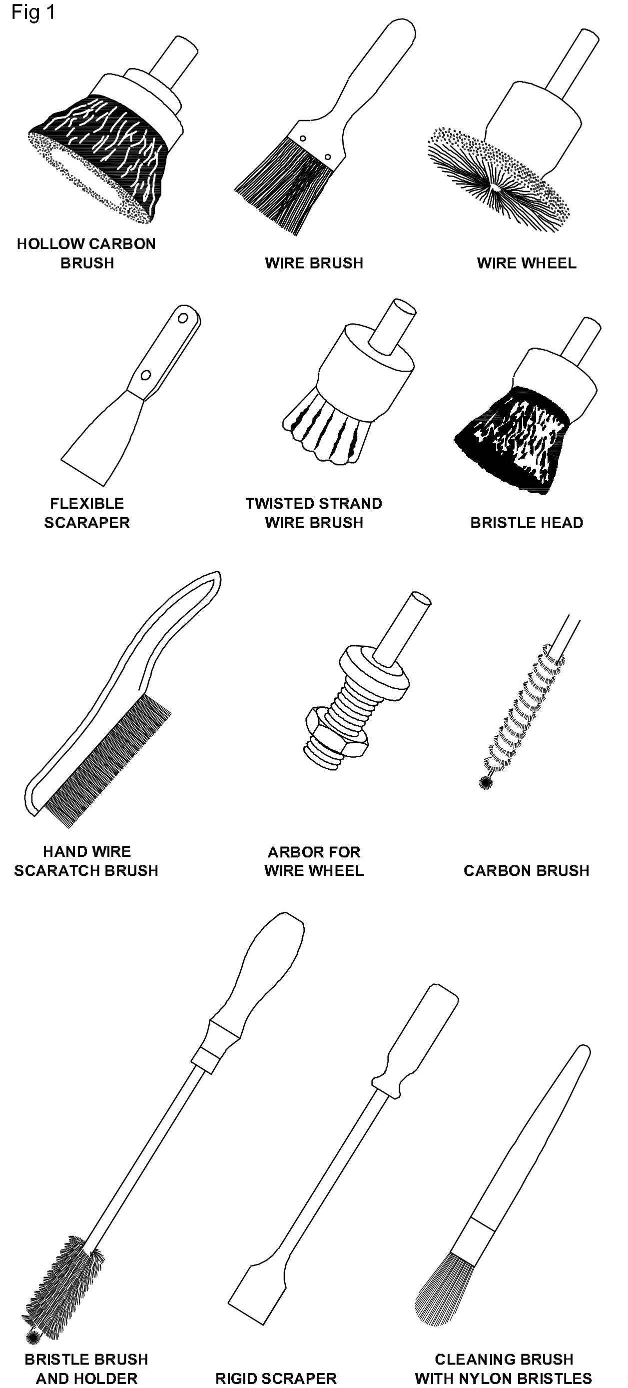
Description

The each and every abrasive particle act as a cutting edge. The emery is considered for a suitable abrasive for workshop practices and the final adjustment of steel parts for a perfect fit. The emery paper is also used for cleaning, to remove rust from polished metal components.

The emery is graded by numbers and the Common sizes are from coarse to fine: 40, 46, 54, 60, 70, 80, 90. 100. 120, F and FF.

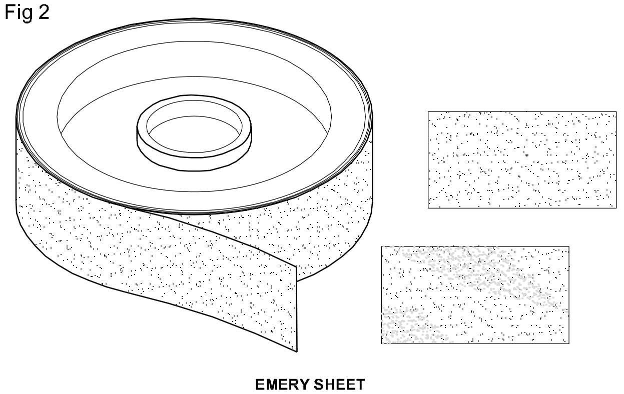
> **Safety Precautions**
>
> **After cleaning with emery paper, component should be rinsed properly.**

Fig 1



CLEANING TOOLS

Fig 2



EMERY SHEET

Scrapper

Objectives : At the end of this lesson you shall be able to
- **name the different type of scrappers**
- **state the features of each type of scrapper**
- **state the precaution to be observed while uses scrapper.**

Scraper is a hand tool which is used to scrap the workpiece surface by removing the smallest metal particles.

Application

It is used to obtain a smooth non scored and uniformly bearing surface which is required for sealing, sliding and guiding surface.

In automobiles it is used to remove carbon particles from cylinder head, piston head and manifold pipes

It is also used to scrap the bearings of cranks halt and sometimes the cylinder liner.

Type of scrapers

1. Flat scraper
2. Special scraper

Flat scraper

The cross section of this scraper is Flat. The cutting edge has Flat surface.

Use

It is used to scrap the high spots of a flat Surface

Special Scrapper

Special scraper is available for scraping and finishing curved surfaces.

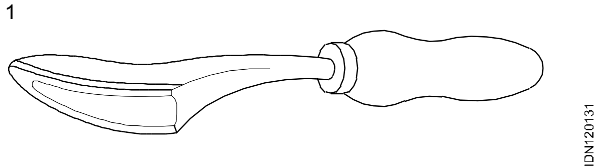
They are :

- half round scraper
- three-square scraper
- bull nose scraper

Half round scraper

The cross- section of this scraper is a segment and it tapers to a rounded point (Fig 1)

Fig 1

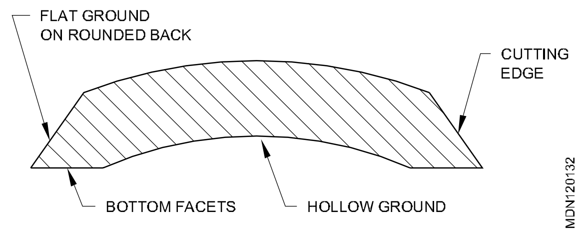


The round bottom face is curved and is hollow in the middle.

The bottom facet and the flat surfaces are ground along the edge to form the cutting edge. (Fig 2)

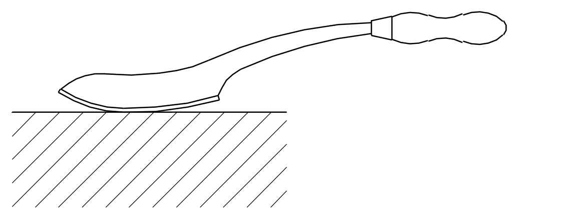
The cutting angle is between 45^0 and 65^0.

Fig 2



The curvature at the cutting edge helps to make point contact while scraping, and also helps to remove small spots. (Fig 3)

Fig 3

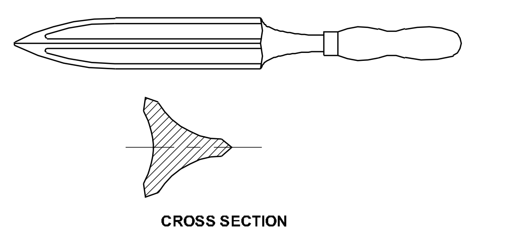


Three- square scraper (Fig 4)

This scraper is used for scraping small diameter holes and deburring the edges of holes.

The cross-section of this is triangular. This has more number of cutting edges and the hollow portion between the cutting edges helps in re-sharpening easily.

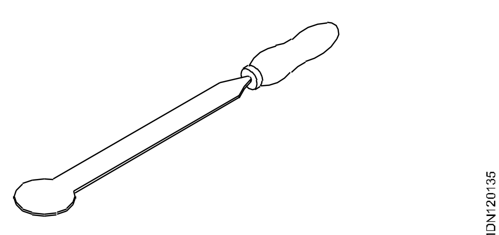
Fig 4



Bull nose scraper (Fig 5)

This scraper has the cutting edge shaped into a flat circular disc. The cutting edge forms about two thirds of the circle.

Fig 5



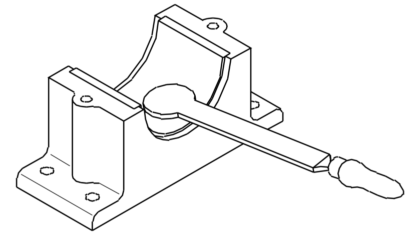
It is useful for scraping large bearings. (Fig 6) This scraper can be used in a longitudinal direction lika a flat scraper or with a circumferential movement like a half round scraper. This dual action helps to prevent ridges on the scraped surfaces.

Always use scrapers with firmly fitted handles.

Protect the cutting edges with a rubber cover when not in use.

Apply oil or grease on the cutting edges when not is use.

Fig 6



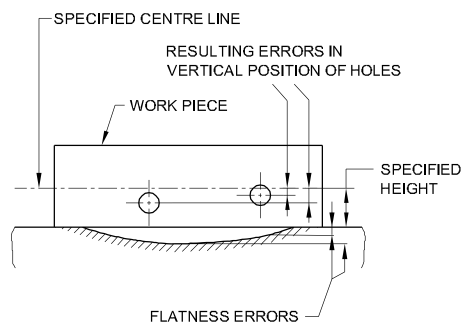
Surface plates

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of surface plates**
- **state the application of different grades of surface plates**
- **specify surface plates and state the uses of marking tables.**

Surface plates - their necessity

When accurate dimensional features are to be marked or to be checked it is essential to have a datum plane with a perfectly flat surface. Marking using datum surfaces which are not perfectly flat will result in dimensional inaccuracies. (Fig 1) The most widely used datum surfaces in machine shop work are the surface plates and marking tables.

Fig 1

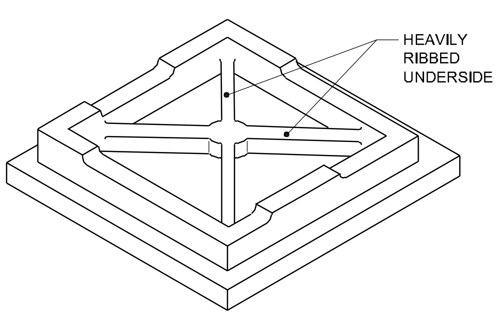


EFFECT OF MARKING-OUT FROM NON-FLAT SURFACE. NOTE THAT THE ERRORS IN THE HOLE POSITIONS ARE EQUAL TO THE FLATNESS ERRORS

Materials and construction

Surface plates are generally made of good quality cast iron which are stress-relieved to prevent distortion. The work-surface is machined and scraped. The underside is heavily ribbed to provide rigidity. (Fig 2)

Fig 2



CAST IRON SURFACE PLATE

For the purpose of steadiness and convenience in leveling. a three point suspension is given.

Smaller surface plates are placed on benches while the larger surface plates are placed on stands.

Other materials used

Granite is also used for manufacturing surface plates. Granite is a dense and stable material. Surface plates made of granite retain their accuracy, even if the surface is scratched. Burrs are not formed on these surfaces.

Classification and uses

Surface plates used for machine shop work are available in three grades - Grades 1, 2 and 3. The grade 1 surface plate is more acceptable than the other two grades.

Specifications

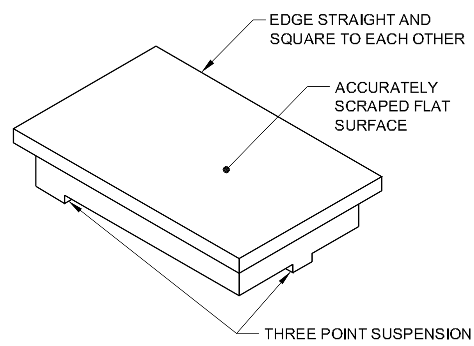
Cast iron surface plates are designated by their length, breadth, grade and the Indian Standard number.

Example

Cast iron surface plate 2000 x 1000 Gr1. I.S.2285.

Marking-off tables (Fig 3)

Fig 3



These are heavily ribbed cast iron tables fitted with strong rigid legs. The top surface is accurately machined flat, and the sides square.

These are used for carrying out marking on heavy components. On certain types-parallel lines are engraved in both directions at a set distance.

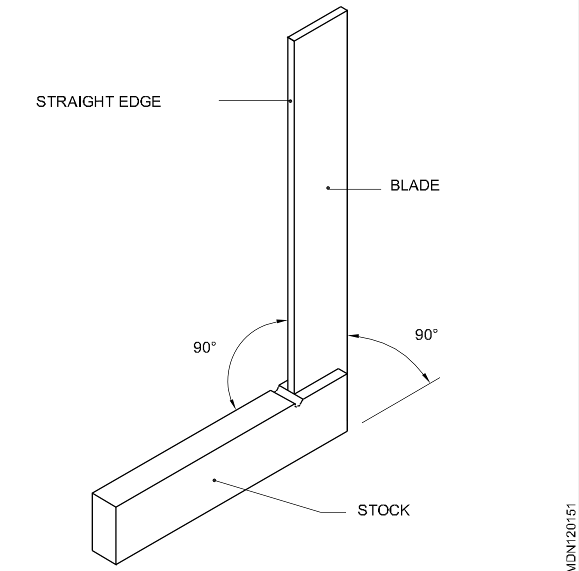
These lines serve as guides for positioning components while setting and marking.

Try square

Objectives : At the end of this lesson you shall be able to
- **name the parts of a try square**
- **state the uses of a try square.**

The try square (Fig. 1) is a precision instrument which is used to check squareness (angles of 90^0) of a surface.

Fig 1

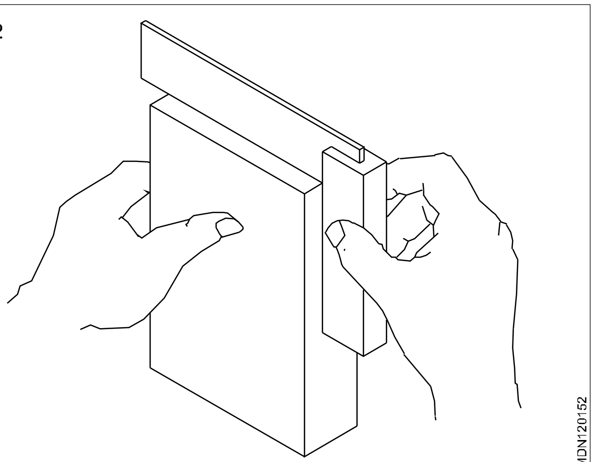


The accuracy of measurement by a try square is about 0.002 mm per 10 mm length, which is accurate enough for most workshop purposes. The try square has a blade with parallel surfaces. The blade is fixed to the stock at 90^0.

Uses

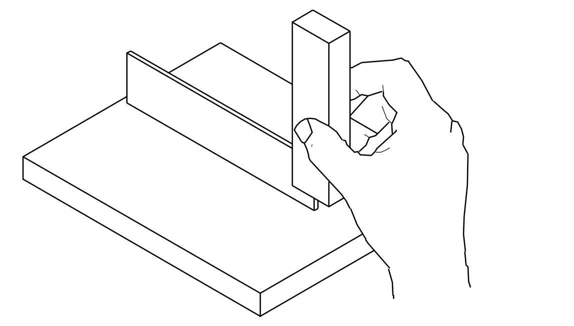
The try squareness is used (Figs 2 & 3)

Fig 2



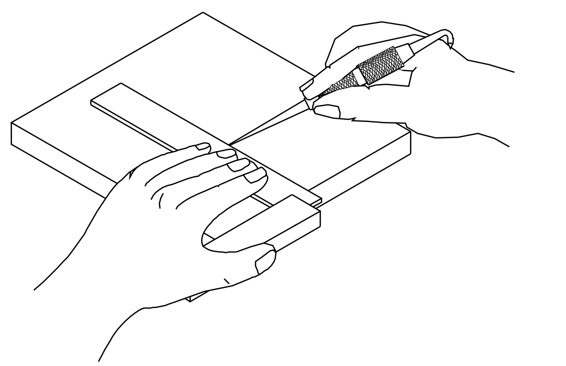
- check flatness of surfaces (Fig. 3)

Fig 3



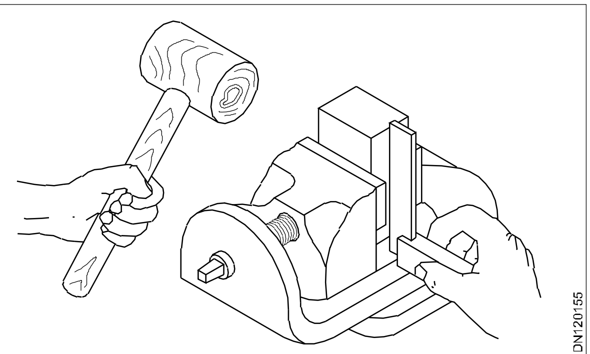
- mark lines at 90^0 to the edges of workpieces (Fig. 4)

Fig 4



- set workpieces at right angles on work. holding devices. (Fig. 5)

Fig 5



Try squares are made of hardened steel.

Try squares are specified according to the lengths of the blade, i.e 100 mm, 150 mm, 200 mm.

Use of a try square and steel rule.

Fig 6 shows the method of using a try square and a steel rule for accurate measurements.

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

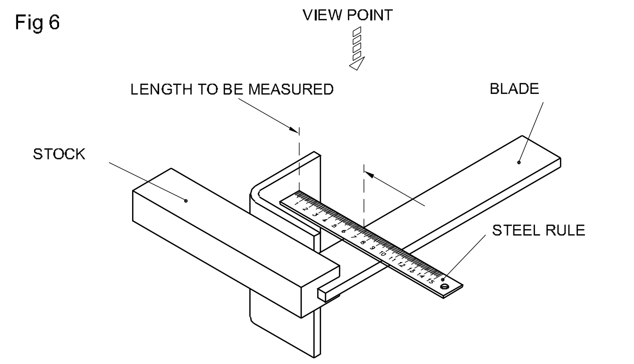
An experienced person can transfer measurements from a steel rule very accurately.

The steel rule graduations are accurately engraved, with the line thickness ranging from 0.12 to 0.18 mm.

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

For Accurate reading it is necessary to read vertically to avoid errors due to parallax

Fig 6



Types of calipers

Objectives : At the end of this lesson you shall be able to
- **name the commonly used calipers**
- **compare the features of firm joint and spring joint calipers**
- **state the advantage of spring joint calipers.**
- **state the uses of inside and outside calipers**

Calipers are simple measuring instruments used to transfer measurements from a steel rule to objects, and vice versa.

Calipers are of different types depending on the type of joint and the shape of leg.

Types of joint

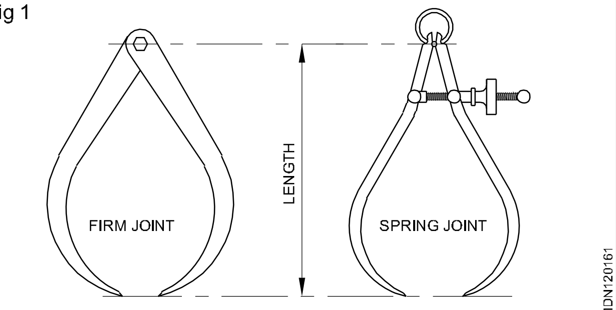
The commonly used calipers are:

- firm joint calipers
- spring joint calipers.

Firm Joint calipers (Fig. 1)

In the case of firm joint calipers, both legs are pivoted at one end. To take measurements of a workpiece. It is opened roughly to the required size. Fine setting is done by tapping the caliper lightly on a wooden surface.

Fig 1



Spring joint calipers (Fig. 2)

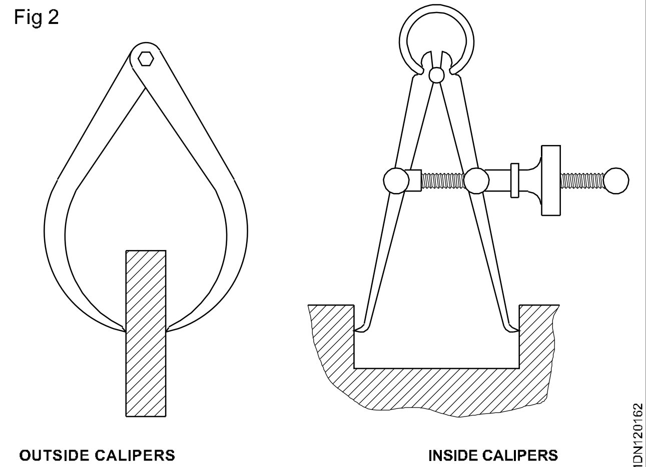
For this type of calipers, the legs are assembled by means of a pivot loaded with a spring. For opening and closing the caliper legs, a screw and nut are provided.

Spring joint calipers have the advantage of quick setting. The setting made will not change unless the nut is turned.

The size of a caliper is specified by its length - which is the distance between the pivot centre and the tip of the leg.

The accuracy of the measurement taken depends very much on the sense of feel an touch. While measuring the job, you should get the feel when the legs are just touching the surface.

Fig 2



Types of legs

Outside and inside calipers are differentiated by the shape of the legs.

Calipers used for outside measurements are known as outside calipers. The calipers used be internal measurements are known as inside calipers.

Calipers are use 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 a caliper.

Jenny calipers

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of jenny calipers**
- **name the types of jenny calipers**
- **state the uses of jenny calipers.**

Jenny calipers are used for marking and layout work.

These calipers are also known as hermaphrodite calipers, odd leg calipers, and leg and point calipers.

Jenny calipers have one leg with an adjustable divider point, while the other is a bent leg. The legs are joined together to make a firm joint.

USES

Jenny calipers are used for marking lines, parallel to inside and outside edges and for locating the centre of round bars.

These calipers are available with the usual bent leg or with a heel. The calipers, with ordinary bent legs, are used for drawing lines parallel along an inside edge, and the heel type is used to drawing parallel lines along outer edges (Figs 1 & 2).

The jenny calipers should be slightly inclined while scribing lines.

Fig 1

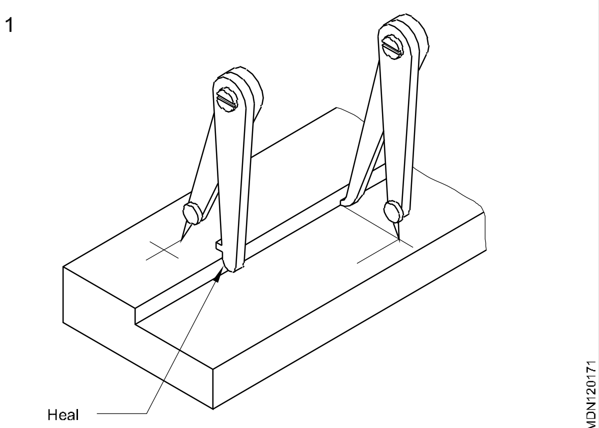
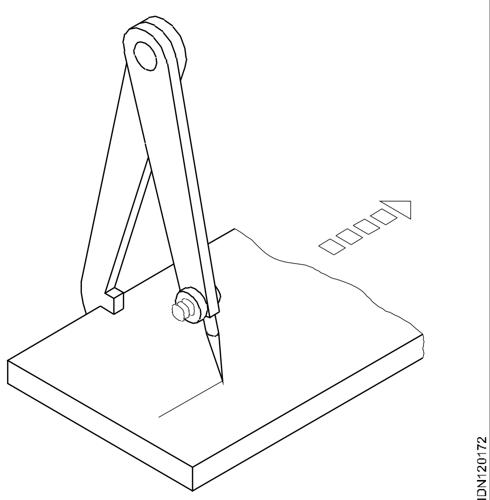


Fig 2



Jenny calipers can also be used for scribing lines along curved edges (Figs 3 & 4). While setting dimensions and scribing lines, both legs should be of equal length.

Fig 3

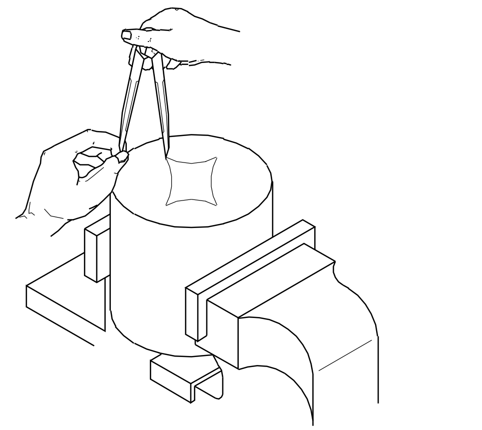
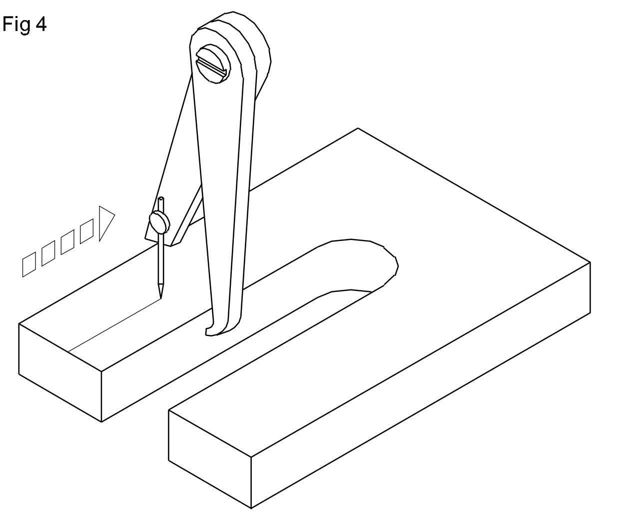
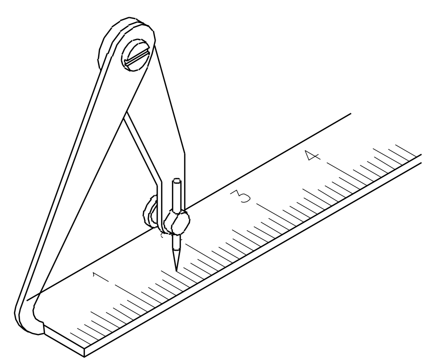


Fig 4



While setting dimensions for accurate setting the jenny caliper point should `click' into the graduation (Fig. 5).

Fig 5

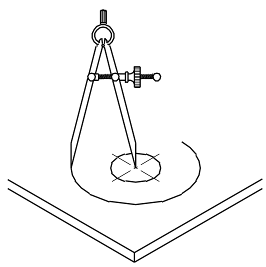


Dividers

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 aspects of be considered in respect of divider points.**

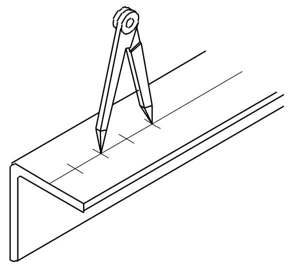
Dividers are used for scribing circles, arcs and transferring and stepping of distances. (Figs 1, 2 and 3)

Fig 1



SCRIBING CIRCLES

Fig 2



STEPPING DISTANCES

MDN120181

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

Fig 3

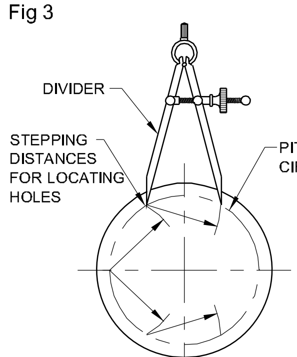
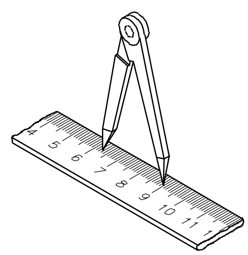


Fig 4



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The sizes of dividers range between 50 mm to 200 mm. The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 5)

For the correct location and seating of the divider legs, prick punch marks of 30° are used. (Fig 6)

Fig 5

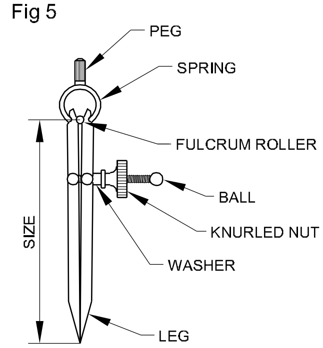
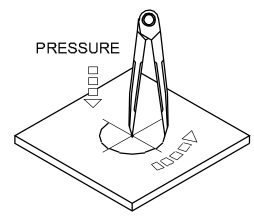


Fig 6



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Both the legs of the divider should always be of equal length.

Dividers are specified by the type of their joints and length.

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

Do not sharpen the divider points on grinding wheels.

Surface Gauges

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of surface gauges**
- **name the types of surface gauges**
- **state the uses of surface gauges**
- **state the advantages of universal surface gauges.**

The surface gauge is one of the most common marking tools used for.

scribing lines parallel to a datum surface

Types of surface gauges

- Surface gauges/scribing blocks are of two types.
- Fixed
- Universal (Fig. 1)

Surface gauge-fixed type (Fig. 2)

- setting jobs on machines parallel to a datum surface
- checking the height and parallelism of jobs
- setting jobs concentric to the machine spindle.

The fixed type of surface gauge consists of a heavy flat base and a spindle, fixed upright , to which a scriber is attached with a snug and a clamp-nut.

Fig 1

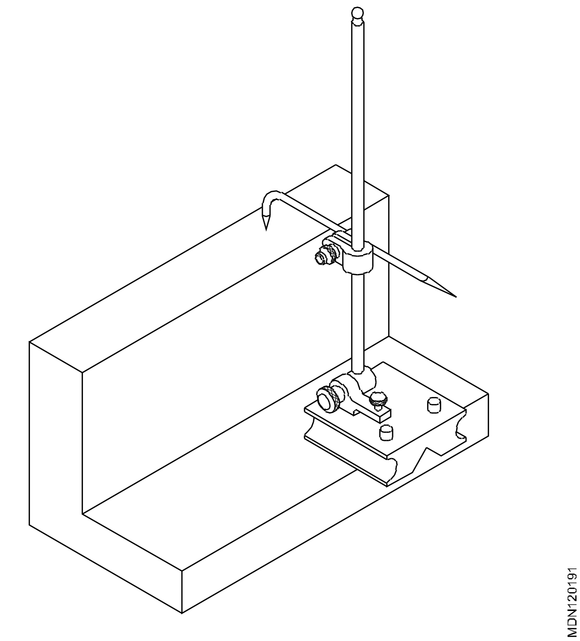
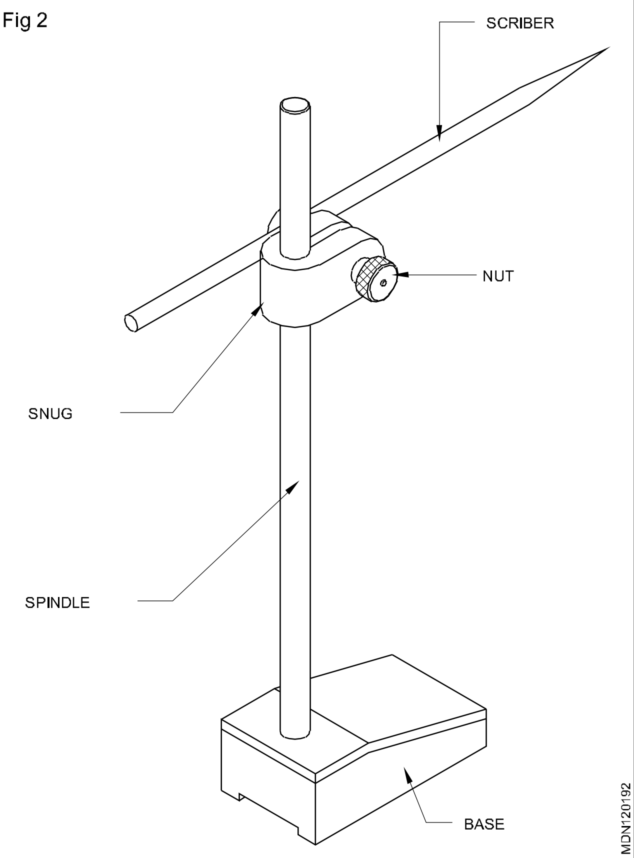


Fig 2



Universal surface gauge (Figs 3 & 4)

This has the following additional features.

- The spindle can be set to any position.
- Fine adjustments can be made quickly.
- can also be used on cylindrical surfaces.

Fig 3

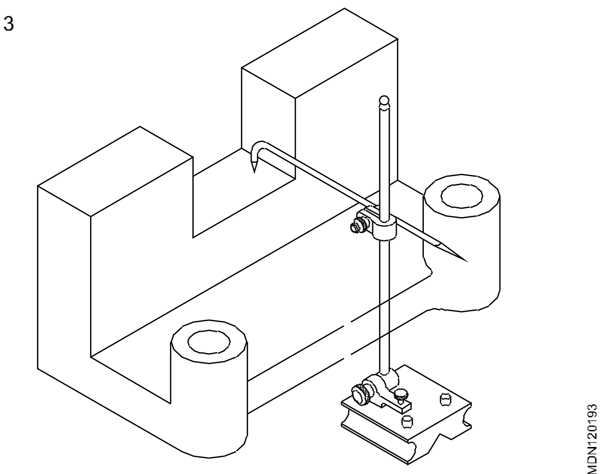
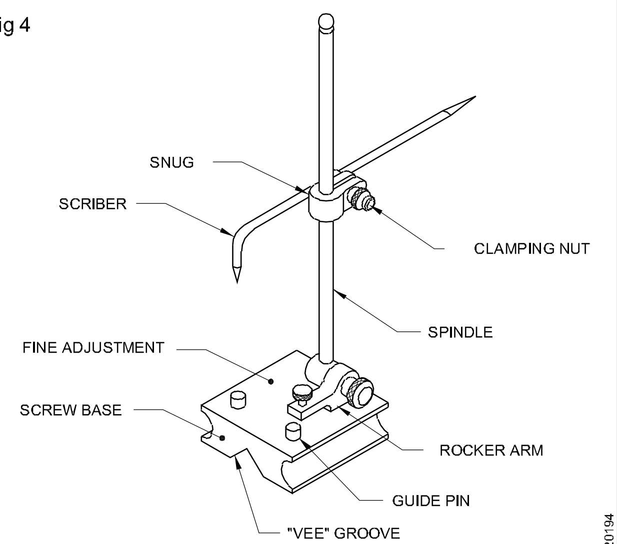


Fig 4



UNIVERSAL SURFACE GAUGE

Scriber

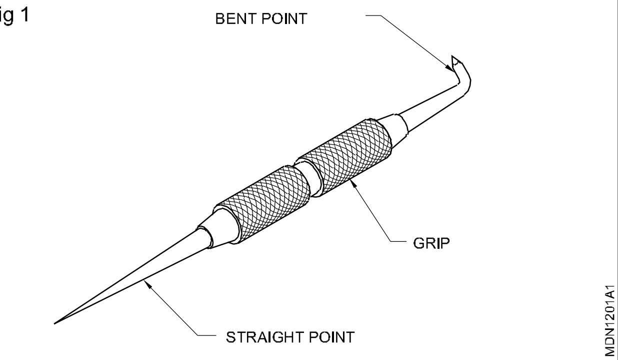
Objectives : At the end of this lesson you shall be able to
- **state the features of scribers**
- **state the uses of scribers.**

In layout work, it is necessary to scribe lines to indicate the dimensions of workpieces to be filed or machined .

The scriber is a tool used for this purpose. It is made of high carbon steel which is hardened. For drawing clear and sharp lines, a fine point is ground at one end.

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

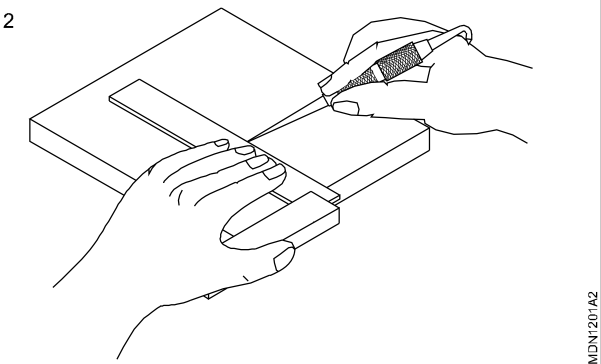
Fig 1



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

The point of the scriber should be ground and honed frequently for maintaining its sharpness.

Fig 2



Scriber points are very sharp, and they are to be handled very carefully. Do not put the scriber in your pocket. Place a cork on the point when not in use to prevent accidents.(when it is not in use)

Wheelbase, wheeltrack and measuring tape

Objectives: At the end of this lesson you shall be able to
- **define wheelbase**
- **define wheeltrack**
- **state measuring tape, its types and uses.**

The wheelbase of a vehicle equals the center distance between its front and rear wheels. (Fig 1)

Wheel/Track : The wheeltrack of a vehicle equals the center distance between its front wheels. As shown in the diagram. (Fig 4)

Measuring tape is a flexible ruler. It is made of ribbon cloth plastic fiber glass metal strip with lines for measurements. It is very common measuring tool used by many people. The available range are 3m, 5m and 10m.

Types

1. Plastic Tape (Fig 3)
2. Metal Tape (Fig 2)
3. Fibre glass
4. Ribbon cloth

Fig 1

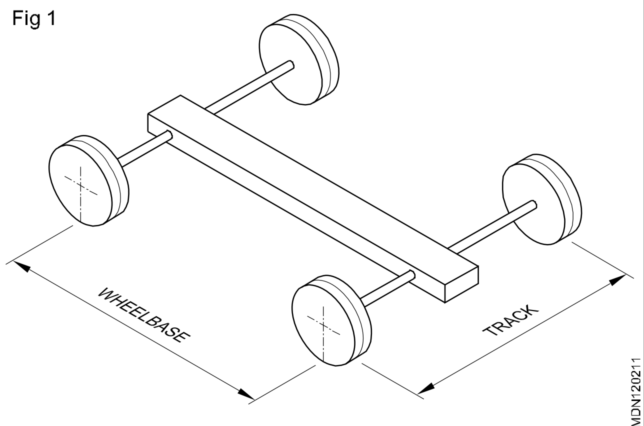


Fig 2

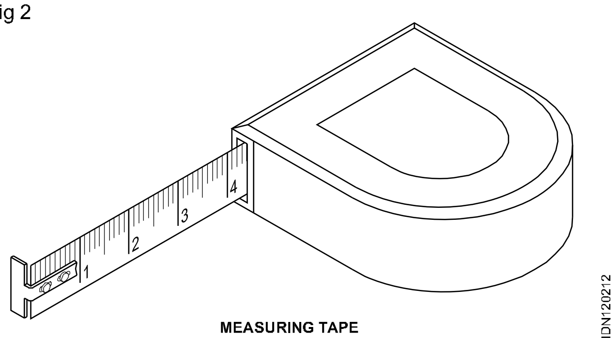


Fig 3

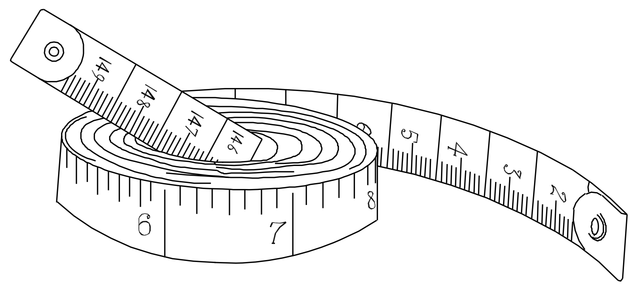
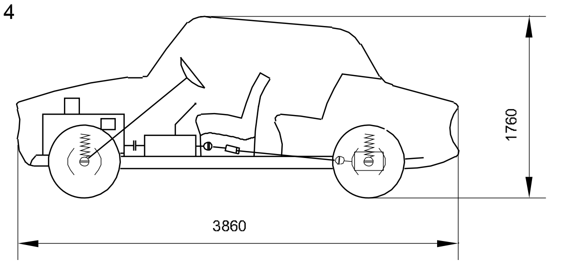


Fig 4



Application

Dress makers

Civil Engineers

Mechanical Engineers

Surveyors

Carpenters

Medical field

Accuracy

Measuring tapes are marks in metric and British system. The accuracy in metric system is 1mm and in British system is 1/8”.

Limitation: Accouracy is not possible, because the tape is flexible and likely to elongate while measuring long ranges and distances.

Length measurement

Objectives: At the end of this lesson you shall be able to
- **name the base unit length measurement as per the International system of units of measurement (SI)**
- **state the multiples of a metre and their values.**

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 the METRE Length SI UNIT and MULTIPLES

Base Unit

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

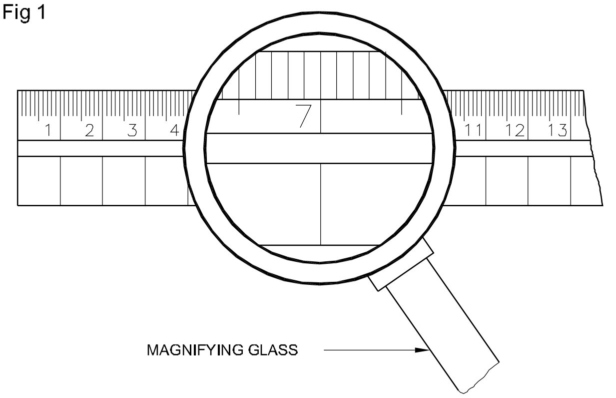
METRE (m)	=	1000 mm
CENTIMETRE(cm)	=	10 mm
MILLIMETRE (mm)	=	1000 mm
MICROMETRE (m)	=	0.001 mm

Measurement in engineering practice

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

Both large and small dimensions are stated in millimetres

Fig 1



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.

However in a regular Steel rule & in vernier caliper the main scale readings of metric in the bottom and imperial in inches in the top wih corrosponding vernier scales.

Engineer's steel rule

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of an engineer's steel rule**
- **explain the uses of a steel rule**
- **state the maintenance aspects to be considered in respect of steel rules.**

When dimensions are given in a drawing without any indication about the tolerance, it has to be assumed that measurements are to be made with a steel rule.

Steel rule are made of spring steel or stainless steel. The edges are accurately ground to form straight edges.

The surface of the steel rule is satin-chrome finished to reduce glare, and to prevent rusting.

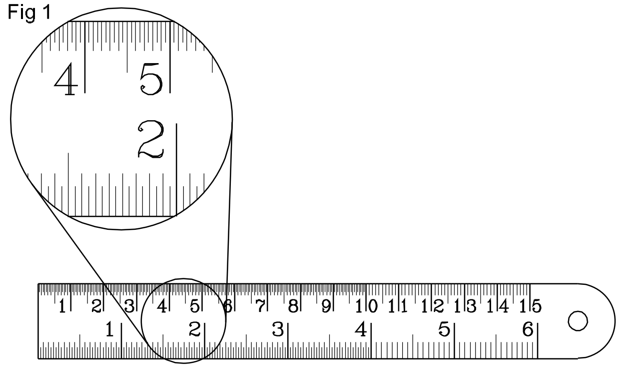
Sizes of steel rules (Fig. 1)

Steel rules are available in different lengts, the common sized being 150mm, 300 mm and 600 mm.

The engineer's steel rule is graduated in 10 mm, 5 mm, 1mm and 0.5 mm.

The reading accuracy of the steel rule is 0.5 mm.

Fig 1



Air impact wrench, air ratchet

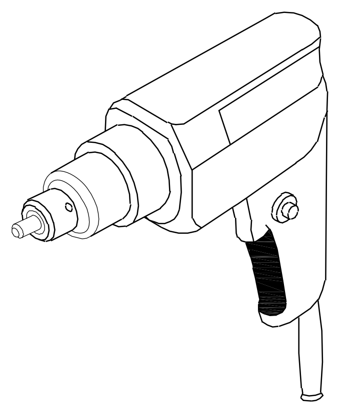
Objectives: At the end of this lesson you shall be able to
- **explain the use of air impact wrench**
- **explain the working principle of air impact wrench.**

Air impact wrench (Fig. 1)

Air Impact Wrench (also known as an impact or, Air Rattle Gun windy gun), Air wrench is a socket wrench power tool, which is used to deliver high torque. It works by storing energy in rotating mass and suddenly delivering it to output shaft.

Compressed Air is commonly used as the power source. Electric power can also be used as the source of power. cordless Electric devices are also used, and are very popular due to ease of working.

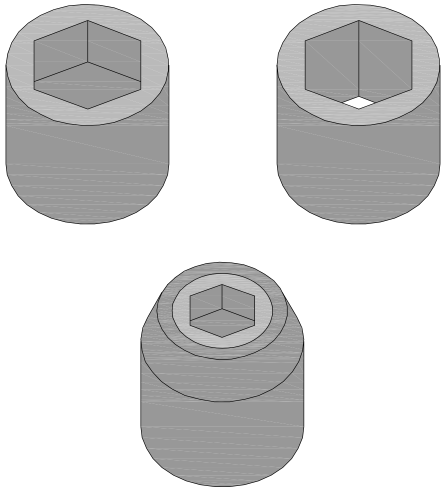
Fig 1



The Air impact wrench is to be used along with a specially hardened impact socket extension and joints to withstand sudden force.

Generally a special 6 inch pin socket is used with air impact wrench. (Fig. 2)

Fig 2



Air Ratchet (Fig.3)

An Air Ratchet is a quite identical to General ratchet wrench.

It is also having square drive at different sizes.

The socket drive is turned by a Air Motor. When we pull the trigger, Air motor gets activated it turns the socket drive.

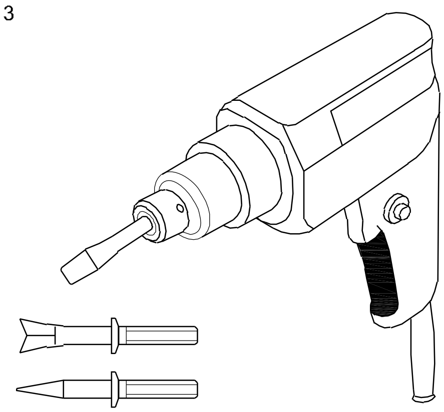
The direction of socket drive can be changed to clockwise (or) anti clockwise as per the user requirement.

Air Ratchet operates with more speed unless torque. In case where more torque is required we should use Air impact wrench.

Air Chisel

Air chisel is used for cutting the bolts to nuts of vehicle body sheet.

Fig 3



The compressed Air provides more force and much efficient than a hand chisel and Hammer.

Air chisel can be used with different types of chisel kit, depending upon the job.

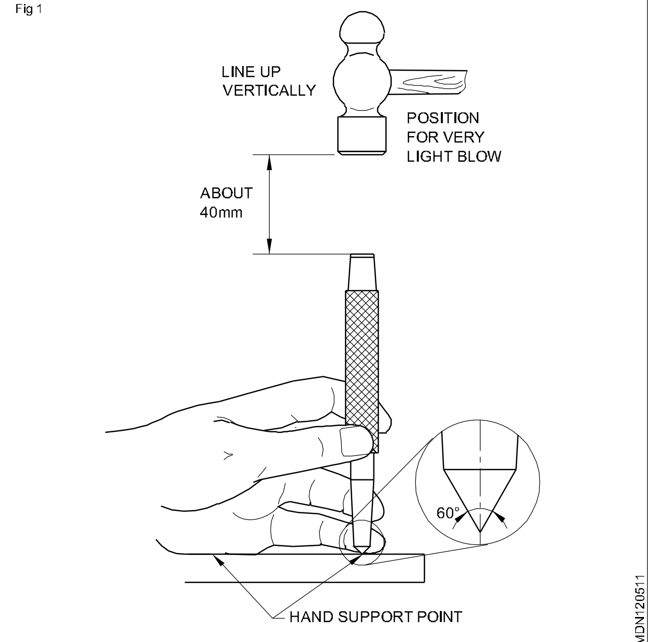
Hand tools

Objectives: At the end of this lesson you shall be able to
- **state the application of punches.**

Punches are used in sheet metals and other work to mark position on work. (Fig 1)

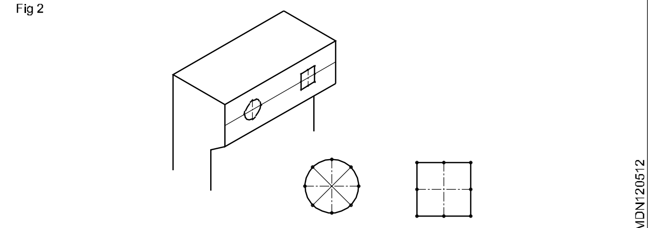
Prick punches

Fig 1



These punches are used to make witness marks on scribed lines. (Fig 2)

Fig 2



This makes it easier to see accurate marking out lines.

- to check the location of the centre positions before centre punching. (Fig 3)
- to locate the pivot points of compasses for scribing circles. (Fig 4)

A 100 mm prick punch with a 7 mm diameter body could have a 2.5 mm diameter point ground to an angle of 60° or 30°

Centre punches

These punches are similar to prick punch, and it is generally larger then prick punch.

A 100 mm centre punch could have a 10 mm diameter body and a 6 mm diameter point ground to an angle of 90°

Fig 3

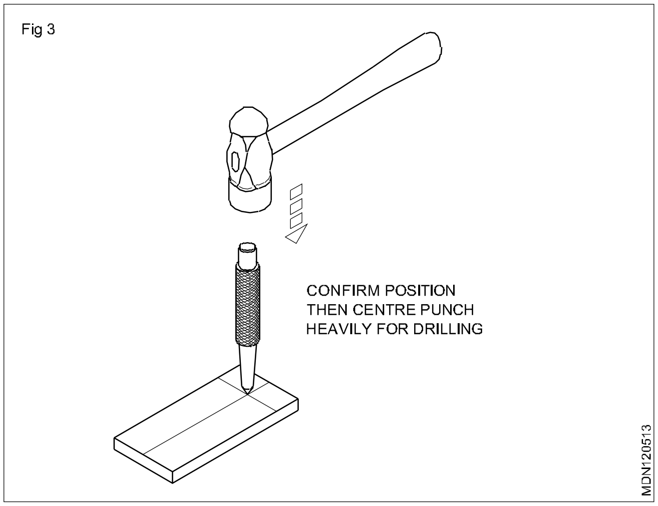
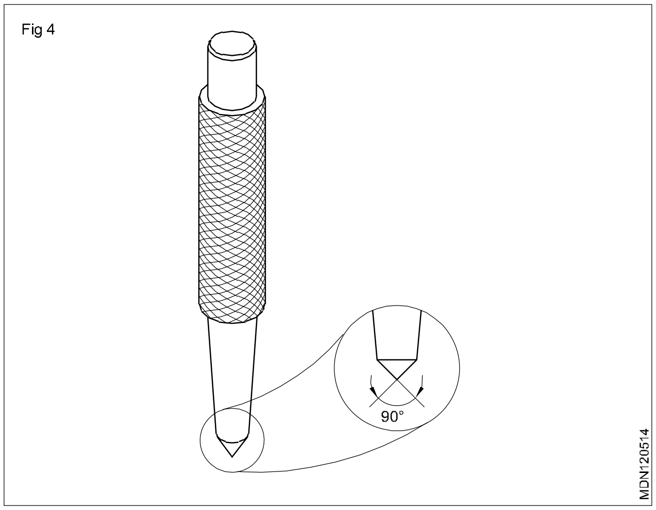


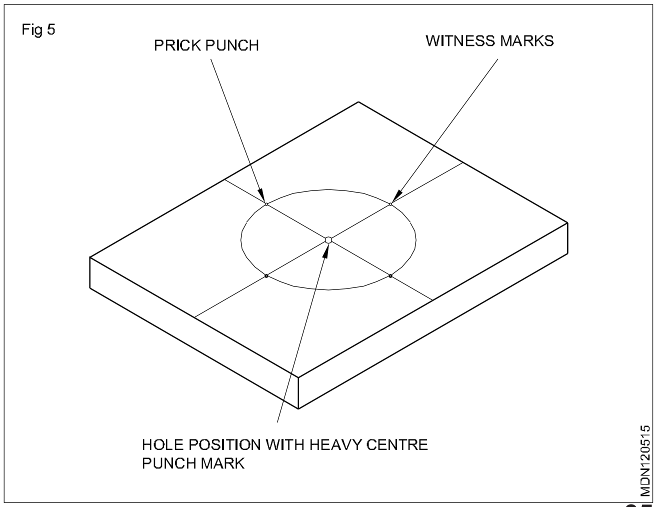
Fig 4



Centre punches are used:

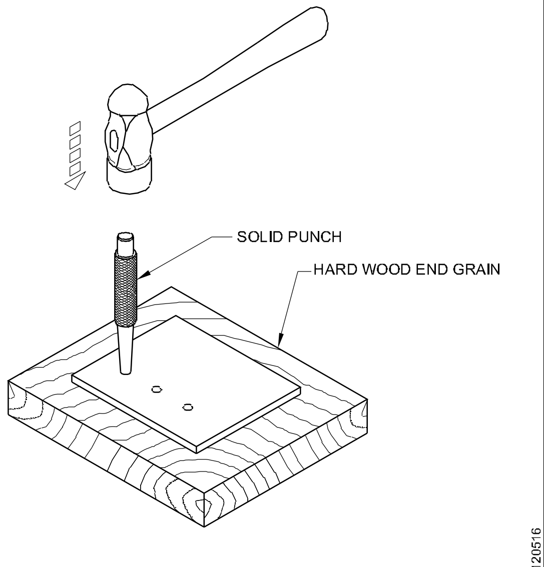
- to make deeper witness marks on scribed lines and to locate a centre position and make it easier for the drill to start correctly. (Fig 5)

Fig 5



Solid punch (Fig 6)

Fig 6



PUNCHING HOLES FOR RIVETS WITH A SOLID PUNCH

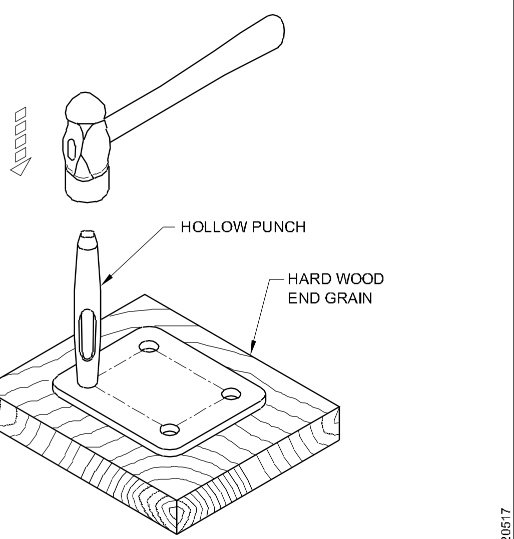
In riveting sheet metal, holes must be equally spaced and lined up. The holes in the metal are usually punched with solid punches.

Letter and number punches

Also known as letter stamps or number stamps, letter punches are used to emboss the impression of a letter of number into a workpiece. They are most common in the reverse image, this allows the end result to be immediately readable, however they may be made as a positive image. This is essential in the case of die or mold making and ensure that the finished product will be readable, as a die is a negative image.

Hollow punch (Fig 7)

Fig 7



USING A HOLLOW PUNCH

These punchase are also used to punch holes in thin sheet metal, leather, plastic cork etc. Gaskets, seals and spacers are made using hollow punches.

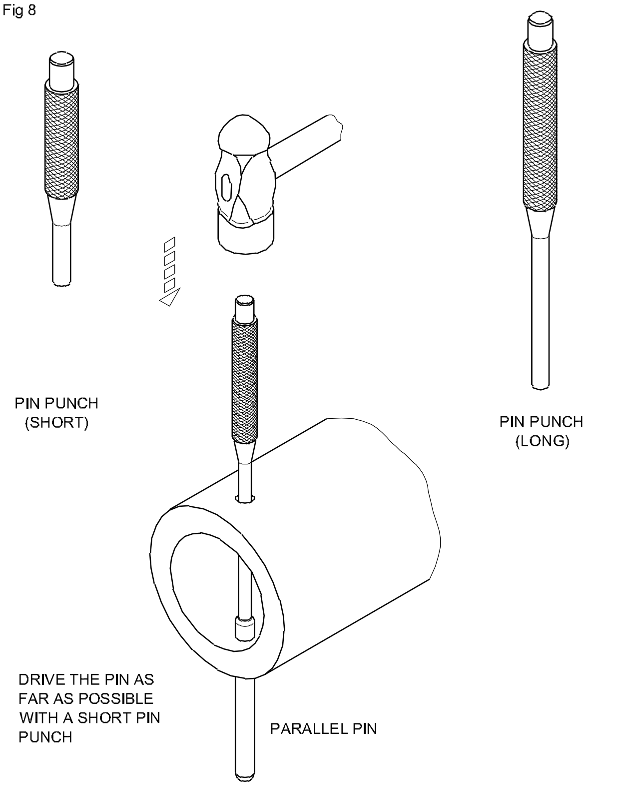
While using solid or hollow punches, the materials is rigidly supported with a block of wood (with the end of grain up) or lead. This will also avoid any damage to the tip of the punch while punching.

Pin punches (Fig 8)

Pin punches are used to drive locating or locking pins, dowels and rivets out of their holes.

Pin punches are available in a set of 5 pins of dia.3,4,5,6 and 8 mm with a knurled body to a length of approximately 150 mm.

Fig 8

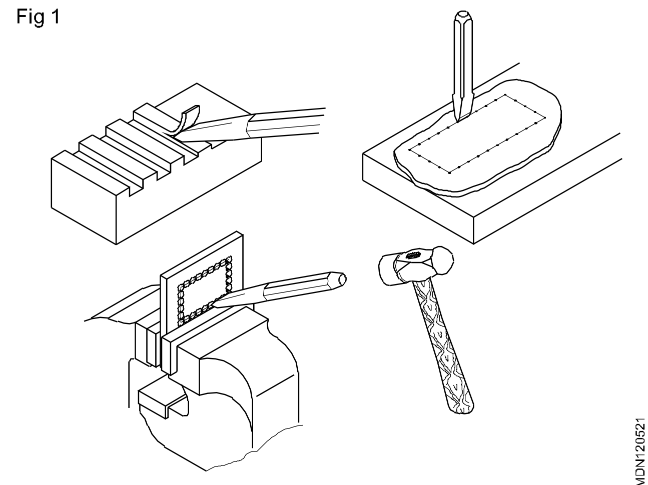


Chisel

Objectives : At the end of this lesson you shall be able to
- **list the uses of a cold chisel**
- **name the parts of a cold chisel**
- **state the different types of chisels.**

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig. 1)

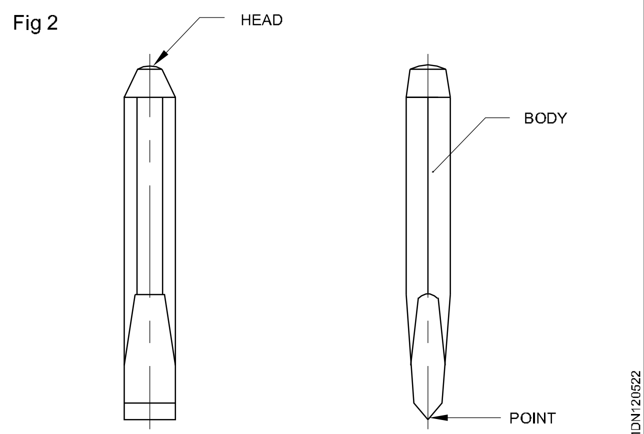
Fig 1



Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

Parts of a chisel (Fig. 2)

Fig 2



A chisel has the following parts.

Head

Body

Point or cutting edge

Chisels are made from high carbon steel or chrome vanadium steel. The cross-section of chisels is usually hexagonal or octagonal. The cutting edge is hardened and termpered.

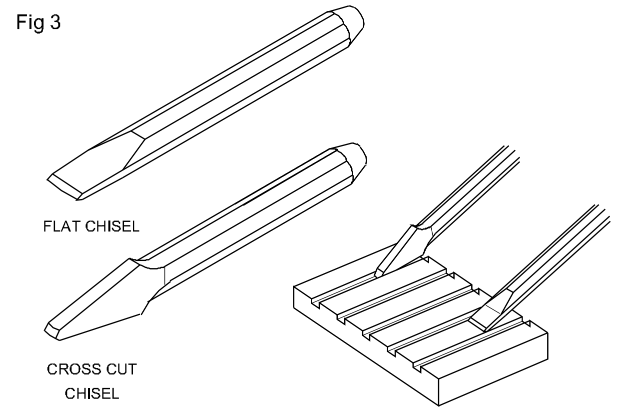
Common types of chisels

There are four common types of chisels

- Flat chisel (1)
- Cross-cut chisel (2)
- Hall round nose chisel
- Diamond point chisel

Flat chisels (Fig. 3)

Fig 3



They are used to remove metal from large flat surfaces and chip excess metal of weld joints and castings.

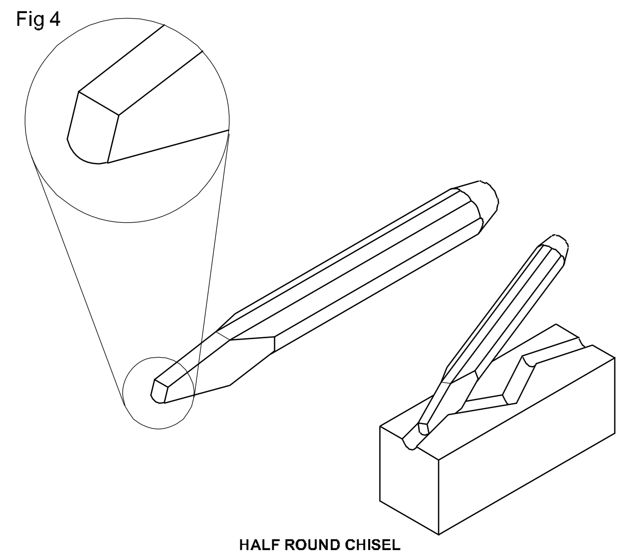
Cross-cut or cape chisels (Fig. 3)

These are used for cutting keyways, grooves and slots.

Half round nose chisels (Fig. 4)

They are used for cutting curved grooves (oil grooves)

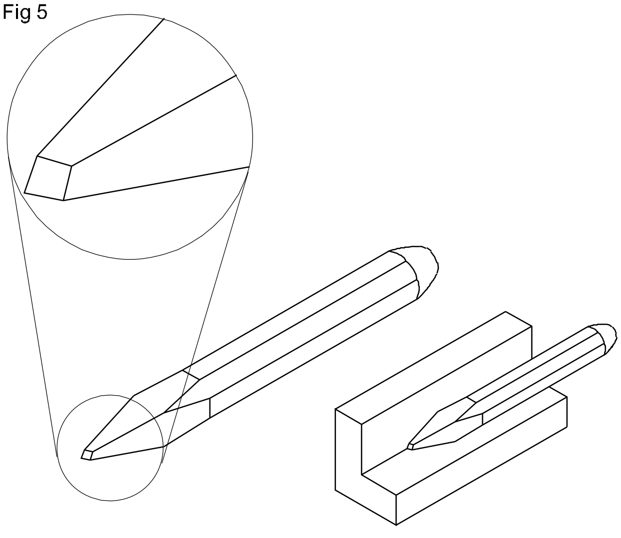
Fig 4



Diamond point chisels (Fig. 5)

These are used for squaring materials at the corners.

Fig 5



Web chisels/punching chisels (Fig. 6)

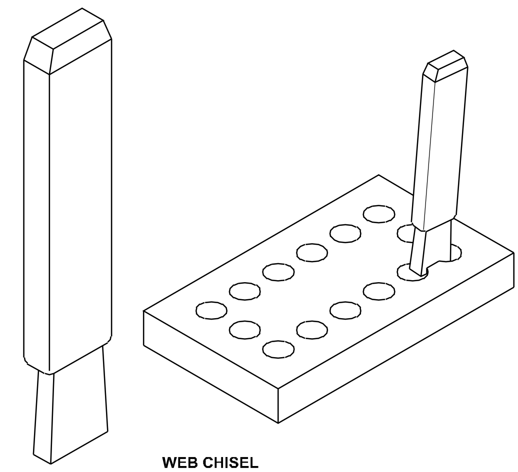
These chisels are used for separating metals after chain drilling.

Chilsels are specified according to their

- length
- width of cutting edge
- type
- cross-section of body

The length of the chisels ranges from 150mm to 400mm. The width of the cutting edge varies according to the type of chisels.

Fig 6



Angles of chisels

Objectives : At the end of this lesson you shall be able to

- **select the point angles of chisels for different materials.**
- **state the different cutting angles of a chisel**
- **state the effect of rake and clearance angles.**

Point angles and materials (Fig 1)

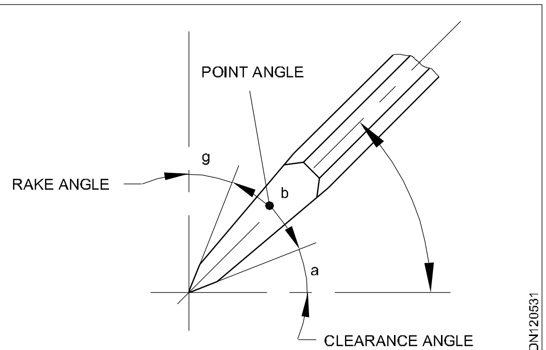
Correct point/cutting angles of the chisel depends on the materials to be chipped. Sharp angles are given for soft materials, and wide angles for hard materials.

The correct point angle and angle of inclination generate the correct rake and clearance angles.

Rake angle (Fig. 1)

Rake angle `γ' is the angle between the top face of the cutting point, and normal to the work surface at the cutting edge.

Fig 1

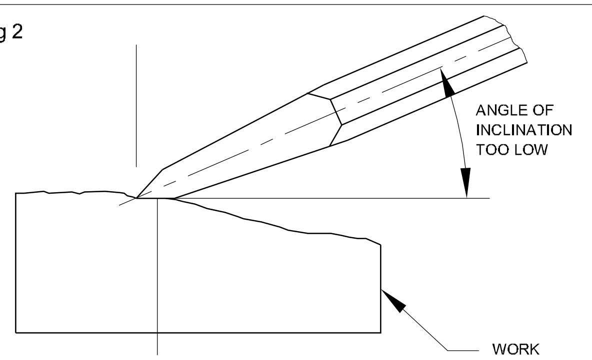


Clearance angle (Fig. 1)

Clearance angle `α' is the angle between the bottom face of the point and tangent to the work-surface originating at the cutting edge.

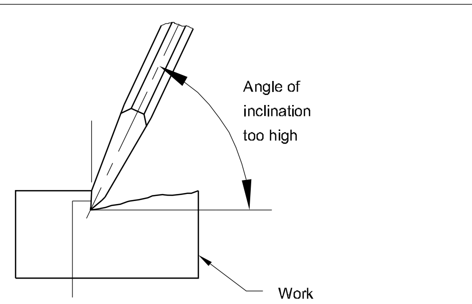
If the clearance angle is too low or zero (Fig. 2), the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip.

Fig 2



If the clearance angle is too great (Fig. 3), the rake angle reduces. The cutting edge digs in, and the cut progressively increases.

Fig 3



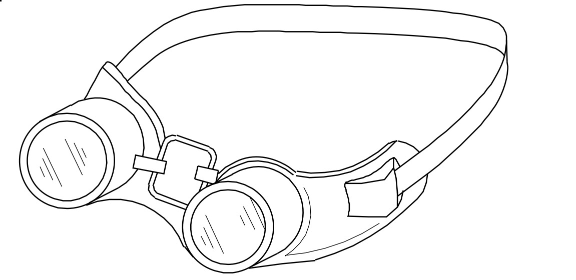
Material to be cut	Point angle	Angle Inclination
High carbon		
steel	65°	39.5°
cast iron	60°	37°
Mild steel	55°	34.5°
Brass	50°	32°
Copper	45°	29.5°
Aluminium	30°	22°

Chipping goggles (Fig. 4): It is used to protect the eyes while chipping the slag or grinding the job.

It is made of Bakelite frame fitted with clear glasses and an elastic band to hold it securely on the operator's head.

It is designed for comfortable fit, proper ventilation and full protection from all sides.

Fig 4



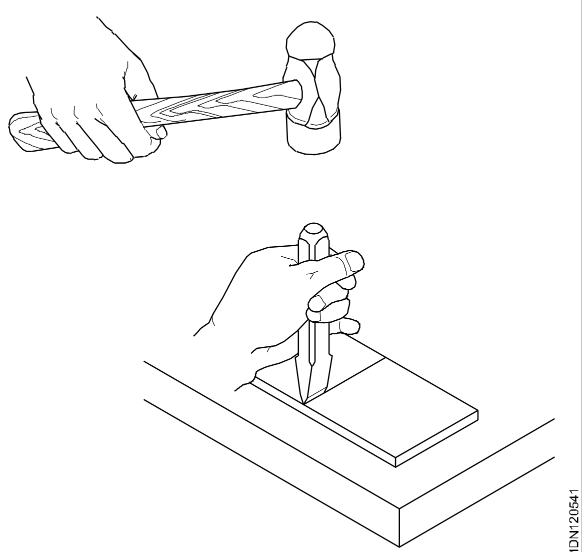
Hammers

Objectives : At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **list the parts of an engineer's hammer and state their functions**
- **name the types of engineer's hammers**
- **specify the engineer's hammer,**

An engineer's hammer (Fig. 1) is a hand tool used for striking purposes while

- punching
- bending
- straightening
- chipping
- forging
- riveting

Fig 1

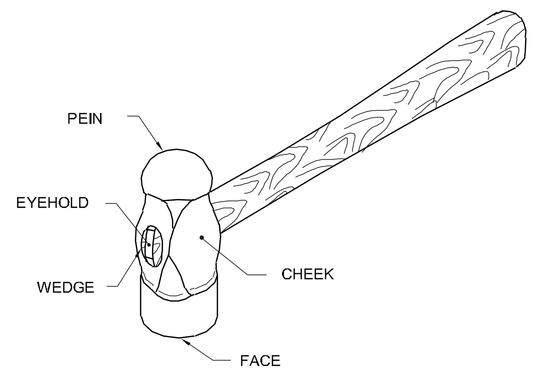


Major parts of a hammer (Fig. 2)

The major parts of a hammer are a head and a handle.

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

Fig 2



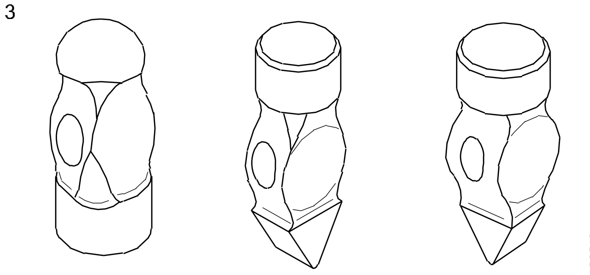
The parts of a hammer head are the

- face (1)
- pein (2)
- cheek (3)
- eyehole (4)
- wedge (5)

The face is the striking portion. Slight convexity is given to it avoid digging of the edge.

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 like the (Fig. 3)

Fig 3



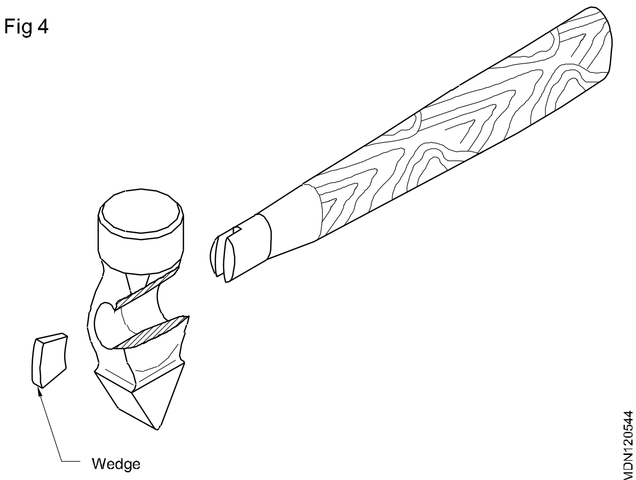
- ball pein
- crosspein
- straight pein

The face and the pein are hardened.

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

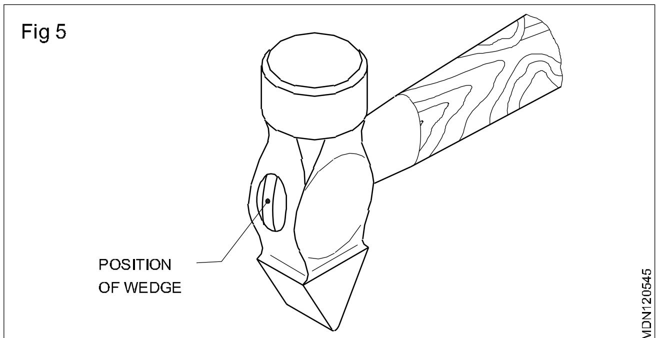
This portion of the hammer-head is left soft.

Fig 4



An eyehole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eye hole. (Fig 4,5)

Fig 5



Specification

An engineer's hammers are specified by their weight and the shape of the pein. Their weight varies from 125 gms to 1.5 kg.

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

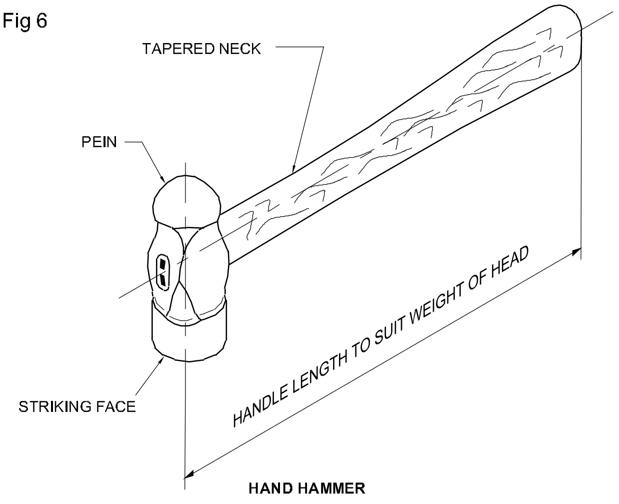
select a hammer with the correct weight suitable for the job

check the head and handle for any cracks

ensure the face of the hammer is free from oil or grease.

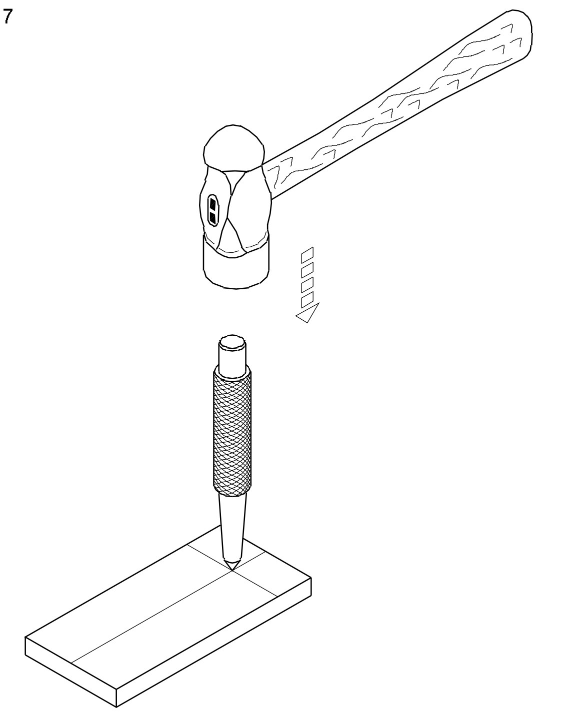
The figure shows the different parts of a hammer (Fig. 6). The handle is fitted in the eye-hole of the hammer.

Fig 6



The face of the hammer is used for general work, such as striking chisels and punches and levelling and working over joints. (Fig. 7)

Fig 7



Ball pein hammer (Fig. 8)

A ball pein head is used to spread metal in all directions.

This hammer has a semi-spherical pein suitable for riveting. (Fig. 9)

It is used for shaping the cylindrical end of a metal rivet to form a rivet head.

Cross pein hammer (Fig. 10)

A cross pein head is used to spread metal in one direction in the line of striking.

This has a blunt wedge-shaped pein at right angles to the axis of the handle.

Fig 8

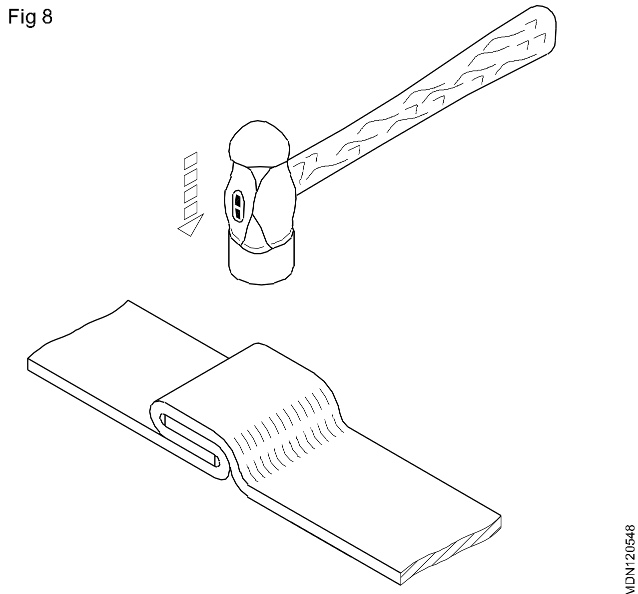


Fig 9

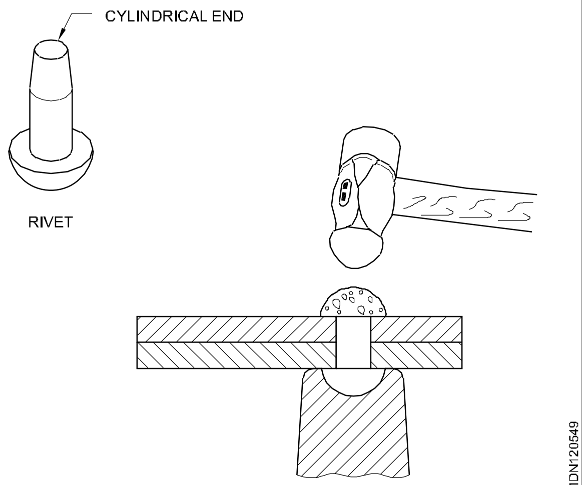
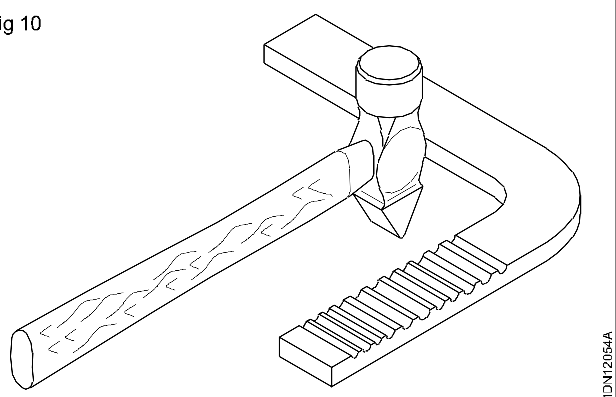


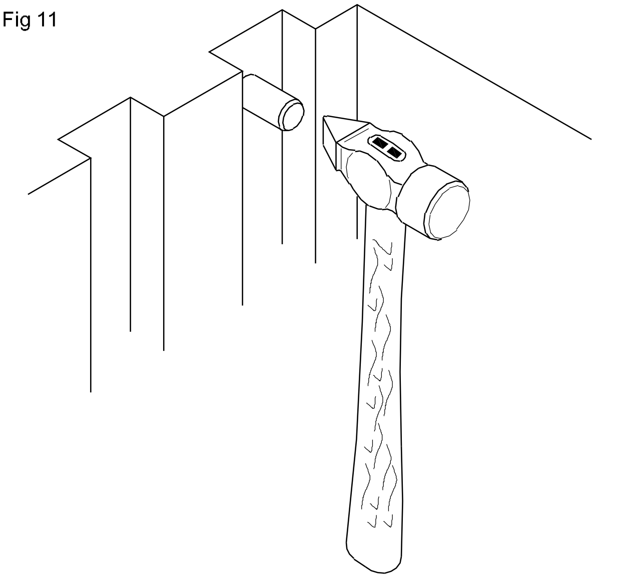
Fig 10



Straight pein hammer

A straight pein hammer is used to spread metal in one direction at right angles to the line of striking (Fig. 11)

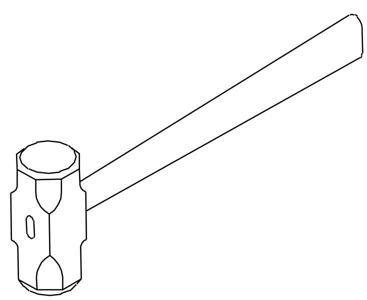
Fig 11



This hammer has a blunt wedge-shaped pein in line with the axis of the handle.

A lump hammer or club hammer is a small sledgehammer (Fig. 12) whose relatively light weight and short handle allow single-handed use. It is useful for light demolition work, driving masonry nails, and for use with a steel chisel when cutting stone or metal. In this last application, its weight drives the chisel more deeply into the material being cut than lighter hammers.

Fig 12



Wooden Mallet

Objectives : At the end of this lesson you shall be able to
- **name the different types of mallets**
- **state the uses of each type of mallets.**

Mallets

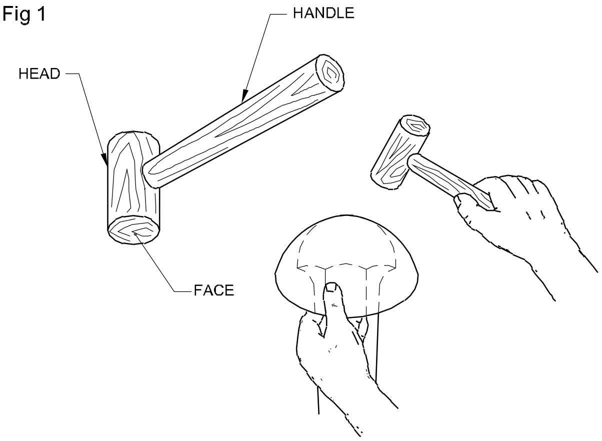
Mallets are soft hammers and are made of raw hide, hard rubber copper, brase, lead or wood, and are used to strike a soft and light blow on the metal.

Types and uses

Standard wooden mallets (Fig. 1) are used for general purpose work like flattening, bending etc.

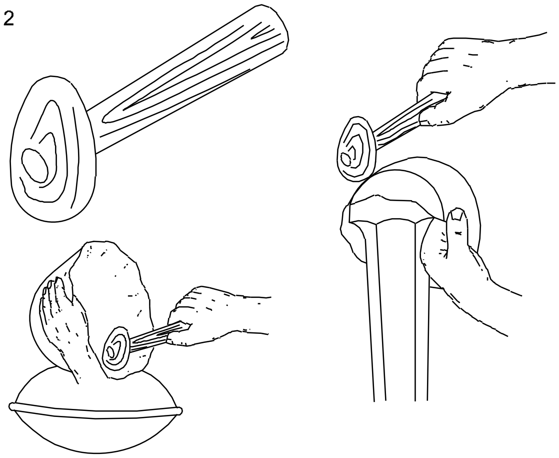
Bossing mallets (Fig. 2) are used for hollowing panel beatings etc.

Fig 1



STANDARD WOODEN MALLET

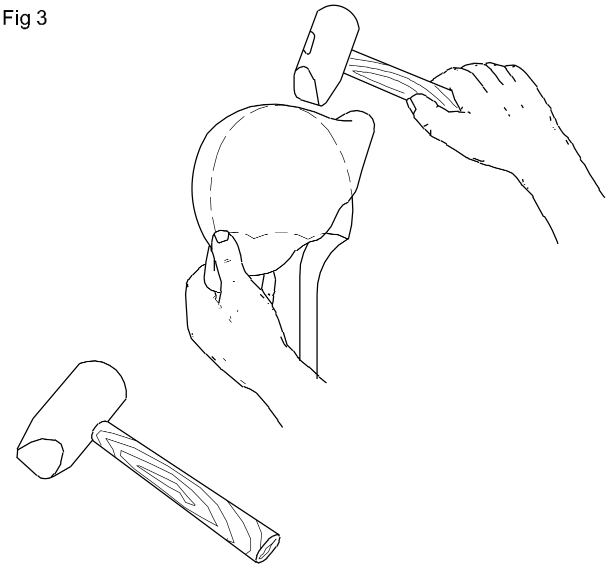
Fig 2



SHAPING THE HEMISPHERICAL BOWL BY RAISING BOSSING MALLET

An end-faked mallet (Fig. 3) is used for stretching, hammering etc.

Fig 3



Screwdrivers

Objectives : At the end of this lesson you shall be able to
- **classify the hand-held screwdrivers**
- **state the features of standard screwdrivers**
- **list out the different types of special screwdrivers and their specific uses**
- **specify standard screwdrivers.**

Screwdrivers are used to tighten or loosen screws which are fixed in the machine element.

Classification

- Standard type with tips to suit recessed head screw slots.
- Special type with tips to suit recessed head screws

Features of Standard screwdrivers (Fig. 1)

Screwdrivers must have:

- tips (1) of turn screws with slotted heads
- handles of metals, wood or moulded insulating material(2), shaped to give a good grip for turning (3).
- blades of hardened and tempered carbon steel or alloy steel
- round or square blade with length (4) ranging from 40mm to more than 350mm.
- flared tips which vary in length and thickness with the length of the blade.

Standard Screwdrives

Standard screwdrivers are classified as:

- heavy duty screwdrivers
- light duty screwdrivers
- stumpy screwdrivers

Heavy duty screwdrivers (Fig 2 & 3)

This screwdriver has a square blade for applying extra twisting force with the end of the spanner. Heavy duty screwdrivers of London pattern have a flat blade and are mostly used by carpenters.

Fig 1

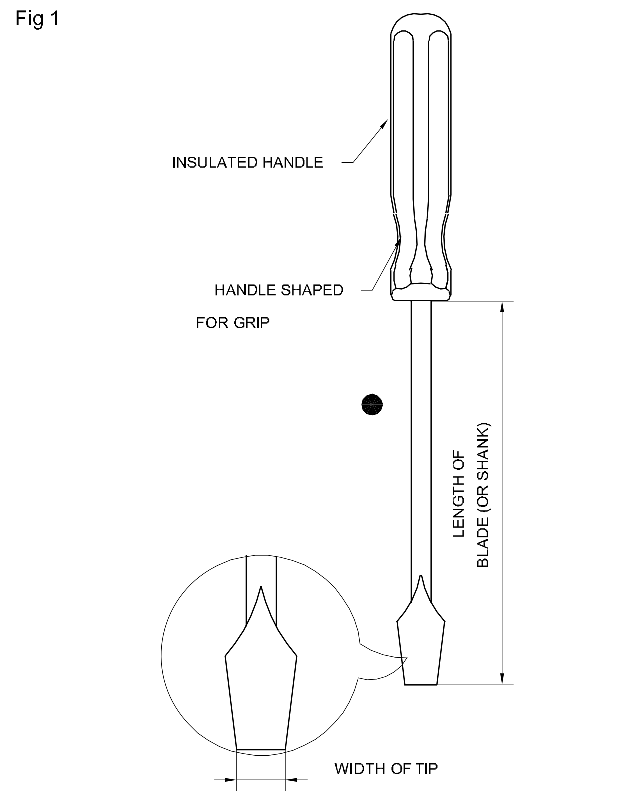


Fig 2

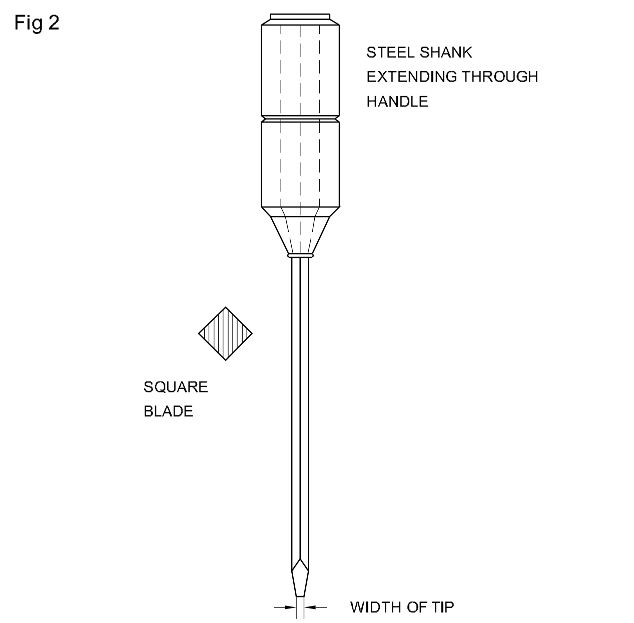
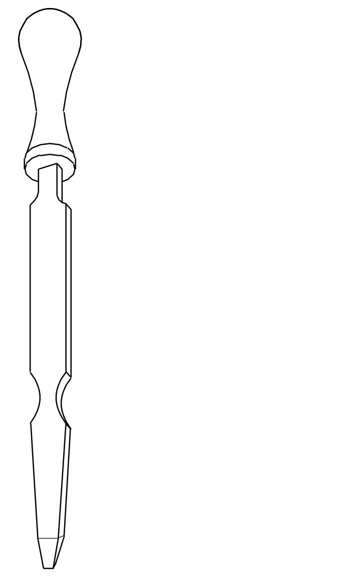


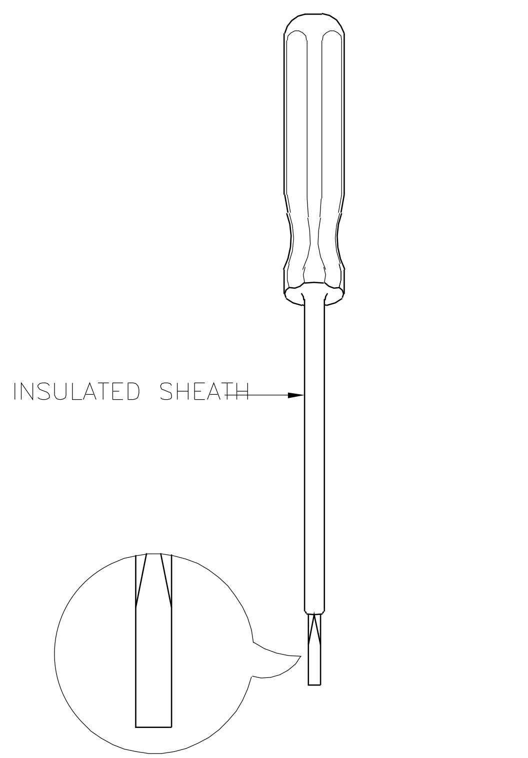
Fig 3



Light duty screwdrivers (Fig. 4)

This screwdriver has a round blade with parallel tips. This screwdriver is used by electricians. The blades are sheathed in insulation to avoid short circuting live parts.

Fig 4

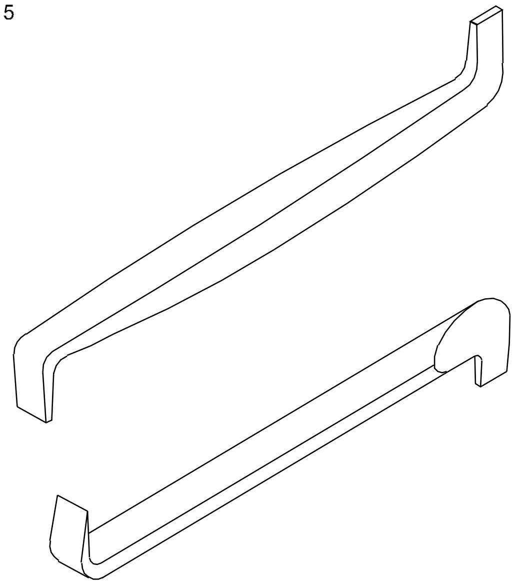


LIGHT DUTY SCREW DRIVER

Stumpy screwdrivers (Fig. 5)

These are small sturdy screwdrivers. They are used when other types of screwdrivers cannot be used due to the space limitations.

Fig 5



Special screwdrivers and their uses

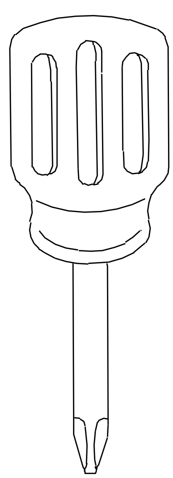
Offset screwdriver (Fig. 6)

Offset screwdrivers are used on screws which are placed in blind spaces.

They are made with short blades and with the tips at right angle.

Greater turning force can be applied on screws by these screwdrivers because of their leverage.

Fig 6



STUMPY SCREW DRIVER

Ratchet screwdriver (Fig. 7)

The following are the features of ratchet screwdrivers.

These screwdrivers are made with a three-position ratchet contol for screwing, unscrewing of a screw and also providing a neutral position.

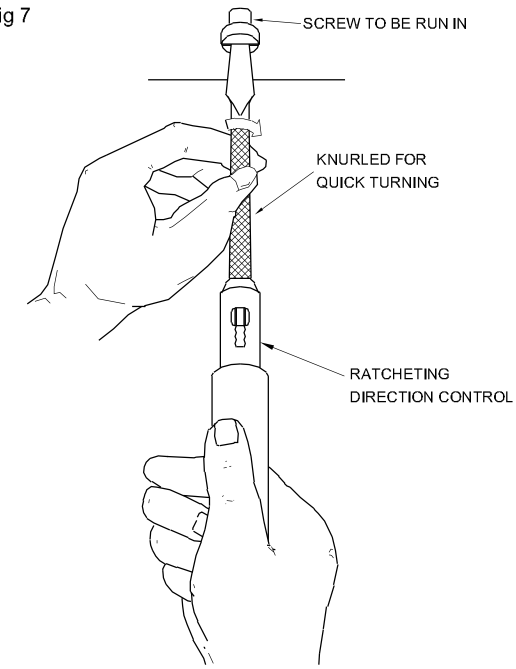
They are used for tuning screws in confined spaces.

They can be operated without changing the hand grip.

They are used for slackening or tightening with a medium force.

They are used in mass production.

Fig 7



RATCHET SCREWDRIVER

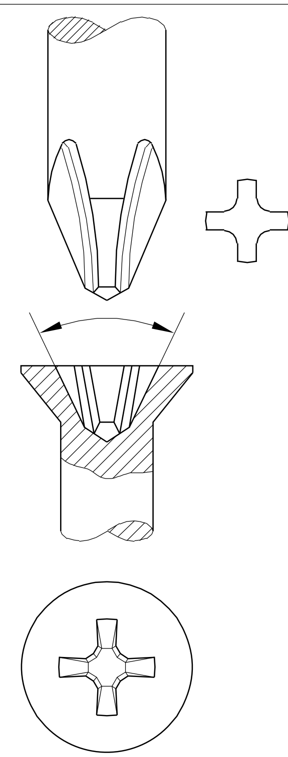
Phillips (cross-recess) screwdrivers (Fig. 8)

Phillips screwdrivers have cruciform or cross-shaped tips that are unlikely to slip from the cruciform slots in Philips recessed head screws.

The end of the four flats is tapered to an angle of 53°

The extreme end is ground to 110°.

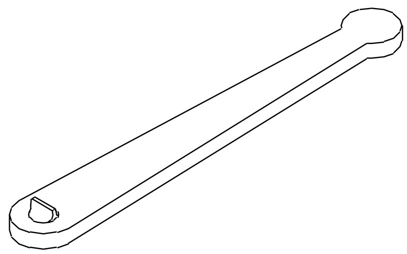
Fig 8



Four different sizes to cover the full range of screws are available. These are specified by point sizes 1,2,3 & 4 which correspond to the size of the Phillips screw heads.

For quicker application ratchet offset screwdrivers are also available with renewable tips. (Fig. 9)

Fig 9



Specification

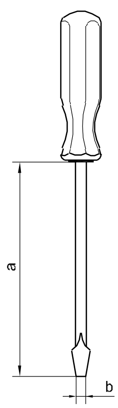
Screwdrivers are specified (Fig. 10) according to the

- length of the blade (a)
- width of the tip (b).

Normal blade length : 45 to 300mm. Width of blade : 3 to 10mm.

The blades of screwdrivers are made of carbon steel or alloy steel, hardened and tempered.

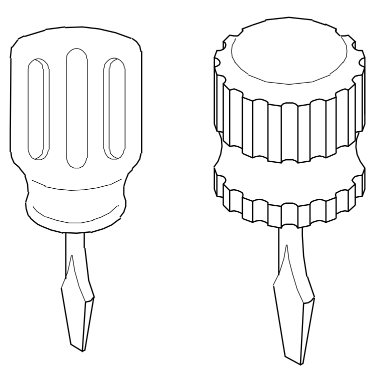
Fig 10



Screwdrivers for special uses

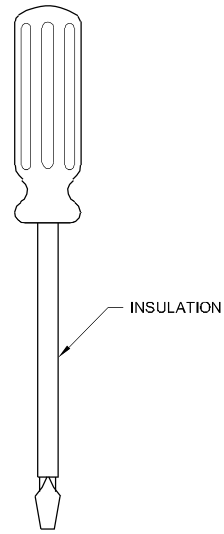
Small sturdy screwdrivers (Fig. 11) are available for use where there is limited space.

Fig 11



Screwdrivers with blades sheathed in insulation are available for the use of electricians (Fig. 12)

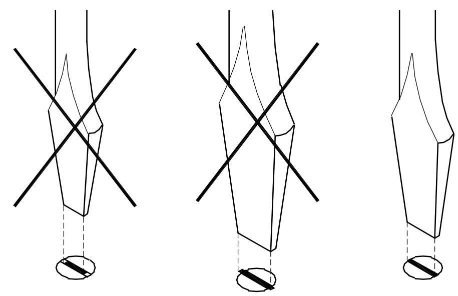
Fig 12



Precautions

Use screwdrivers with tips correctly fitting into the screw slot. (Fig. 13)

Fig 13



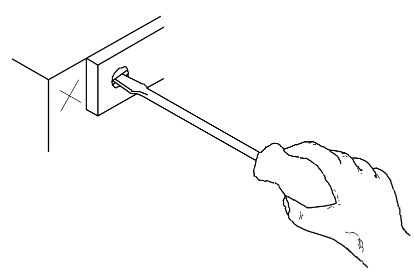
Make sure your hand and the handle are dry.

Hold the screwdrivers axis in line with the axis of the screw.

While using a Philips screwdriver apply more downward pressure.

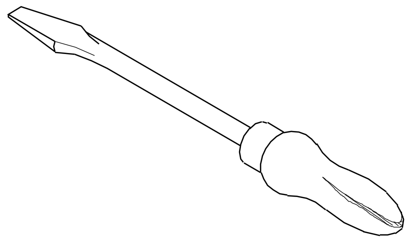
Keep your hand away to avoid injury due to slipping of the screwdriver. (Fig. 14)

Fig 14



Do not use screwdrivers with split or defective handles. (Fig. 15)

Fig 15



In the case of damaged screwdrivers, the blades can be ground (the faces will be parallel with the sides of the screw slot) and used. While grinding ensure the end of the tips is as thick as the slot of the screw.

While using screwdrivers on small jobs, brace the job on the bench or hold them in a vice.

Specification of a screwdriver

Screwdrivers are specified according to the

- length of the blade
- width of the tip

The normal blade length varies from 45mm to 300mm and the width of the blade varies from 3mm to 10mm.

Screw driver (Fig 16): There are several different size of screw drivers of the standard, reed & prince & phillips types.

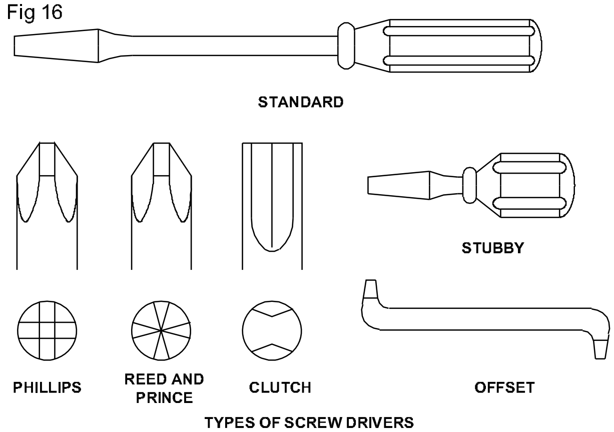
The offset screw driver is useful in tight quarters where even a "Stubby" cannot be used.

Safety:

1 Always use correct type and size screw drivers.

2 Don't do repair work by holding the job on the hand with the help of screw driver, if may slips it pierce the hand.

Fig 16



Allen keys

Objectives : At the end of this lesson you shall be able to
- **state the features and uses of hexagon socket screw keys**
- **specify hexagon socket screw keys**.

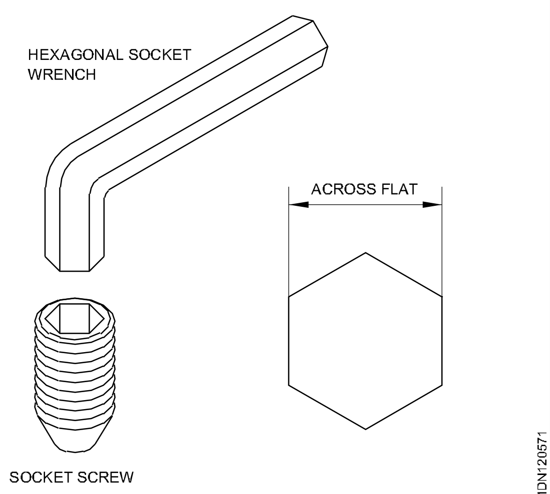
Hexagon socket screw keys/Allen keys are made from hexagonal section bars of chrom vanadium steel.

These are hardened and tempered. These are bent to `L' shape. The size of an Allen key is identified by the size across the flat of the hexagon.

Uses

They are used to tighten or loosen screws having internal hexagon sockets, (Fig.1)

Fig 1



Allen keys, available in different sets in plastic wallets, surprise of a set of 8 (2 to 10mm)

2,3,4,5,6,7,8 and 10mm

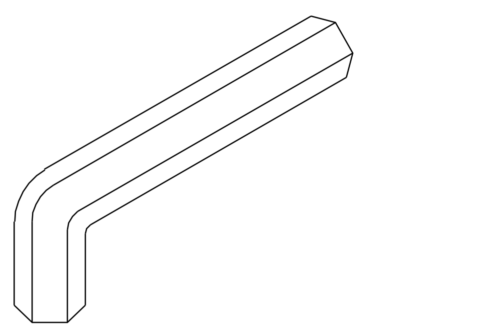
Sizes of Allen keys (Fig. 1)

Individual pieces are available as follows.1, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 14, 17, 19, 22, 24, 27, 32 and 36.

Designation of Allen keys (Fig. 2)

A hexagonal socket screw key of width across flat 8 mm shall be designated as Key 8 IS:3082.

Fig 2



Bench vice

Objectives : At the end of this lesson you shall be able to
- **name the parts and uses of a bench vice**
- **specify the size of a bench vice**
- **state the uses of vice clamps.**

Vices are used for holding workpieces. They are available in different types. The vice used for bench work is called as bench vice or (Engineer's vice)

A bench vice is made of cast iron or cast steel and it is used to hold work for filling, sawing, threading and other hand operations.

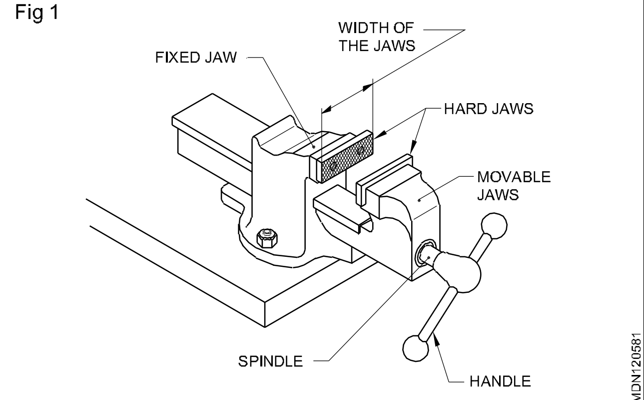
The size of the vice is stated by the width of the jaws.

Parts of a bench vice (Fig.1)

The following are the parts of the vice

The Vice is generally bolted and secured in a wooden work table, and is useful for operations like filing, chipping, hacksawing, bending sheetmetal etc.

Fig 1



Fixed jaw, movable jaw, hard jaws, spindle, handle, box-nut and spring are the parts of vice.

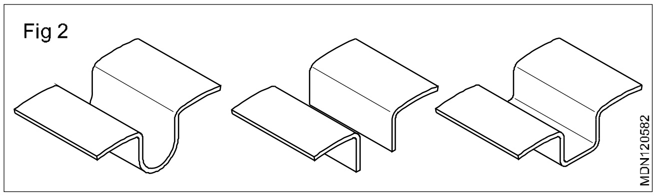
The box-nut and the spring are the internal parts.

Vice clamps or soft jaws (Fig. 2)

The hold a finished work use soft jaws (vice clamps) made of aluminium over the regular jaws. This will protect the work surface from damage.

Do not over-tighten the vice as, the spindle may get damaged.

Fig 2



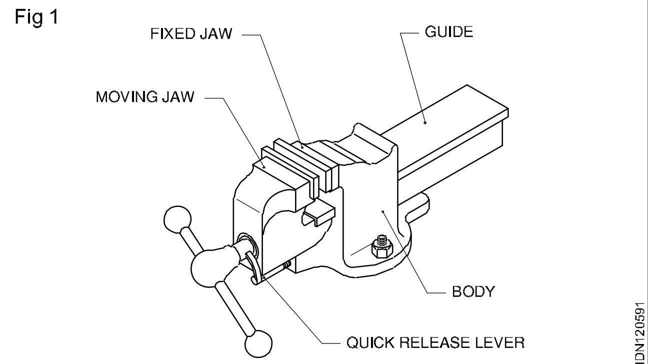
Types of vices

Objectives : At the end of this lesson you shall be able to
- **state the construction and advantages of a quick releasing vice**
- **state the uses of pipe vice, toolmakers vice, hand vice and pin vice.**

There are different types of vices used for holding workpieces. They are quick releasing vice, pipe vice, hand vice pin vice and toolmaker's vice.

Quick releasing vice (Fig 1)

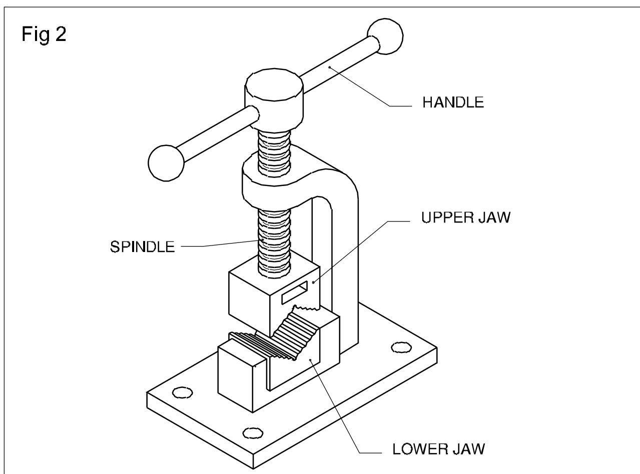
Fig 1



A quick releasing vice is similar to an ordinary bench vice but the opening of the movable jaw is done by using a trigger (lever). If the trigger at the front of the movable jaw is pressed, the nut disengages the screw and the movable jaw can be set in any desired place quickly.

Pipe vice (Fig 2)

Fig 2

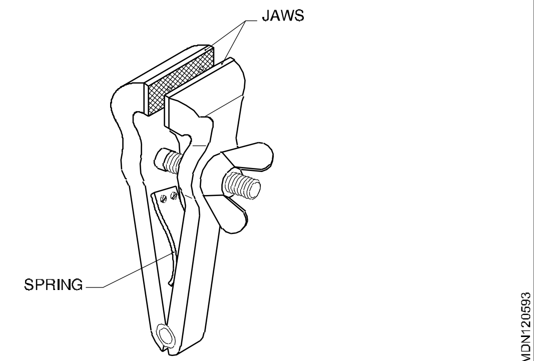


A Pipe vice is used for holding round sections of metal, and pipes. In this vice, the screw is vertical and movable. The jaw works vertically.

The pipe vice grips the work at four points on its surface. The parts of a pipe vice are shown in Fig. 2.

Hand vice (Fig 3)

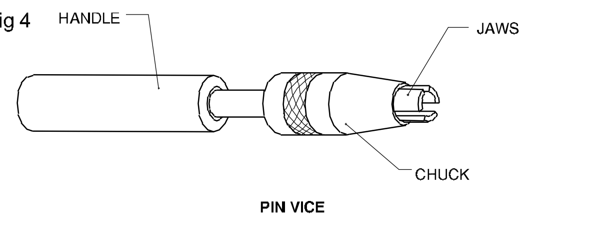
Fig 3



Hand vices are used for gripping screws, rivets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. A hand vice is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 to 44 mm. The jaws can be opened and closed using the wing nut on the screw that is fastened to one leg, and passes through the other.

Pin vice (Fig 4)

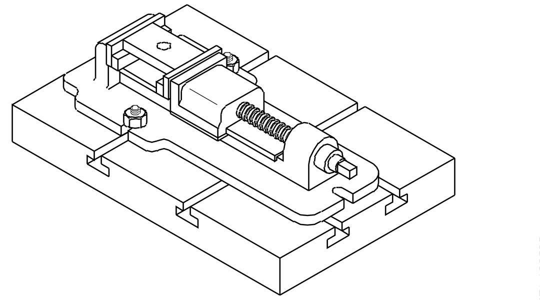
Fig 4



The pin vice is used for holding small diameter jobs. It consists of a handle and a small collet chuck at one end. The chuck carries a set of jaws which are operated by turning the handle.

Toolmaker's vice (Fig 5)

Fig 5



The toolmaker's vice is used for holding small work which required filing or drilling and for marking of small jobs on the surface plate. This vice is made of mild steel.

Toolmaker's vice is accurately machined.

C- Clamps and toolmaker's clamps

Objectives : At the end of this lesson you shall be able to
- **state the purpose of using clamps**
- **specify the requirements of the clamping devices**
- **state the features and uses of 'C' clamps**
- **state the features of Toolmaker's clamps.**

Purpose of using clamps

Clamps are used for preventing the movement of work, and for holding the job tight.

Requirements of clamping devices

Should be able to manipulate for easy loading.

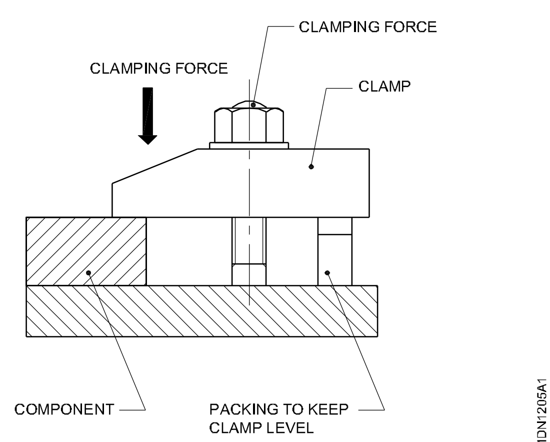
Should provide the required clamping force.

Should be capable of locking with minimum movement.

Should accommodate a range of sizes of jobs.

(Fig 1) shows a typical clamping device, employing a screw and nut to provide the clamping force.

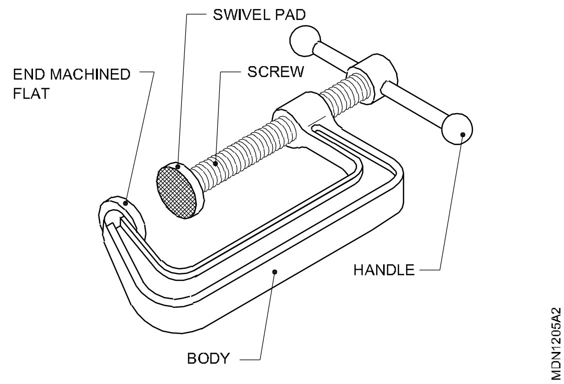
Fig 1



'C' Clamps

These clamps are in the shape of a 'C'. The 'C' clamp has its body forged or cast. One end of the clamp is machined flat. The other end is drilled and threaded to accommodate a screw-rod which is operated by a handle. The screw-rod carries a swivel pad which is free to revolve. The clamp is hardened and the face is serrated. (Fig 2)

Fig 2



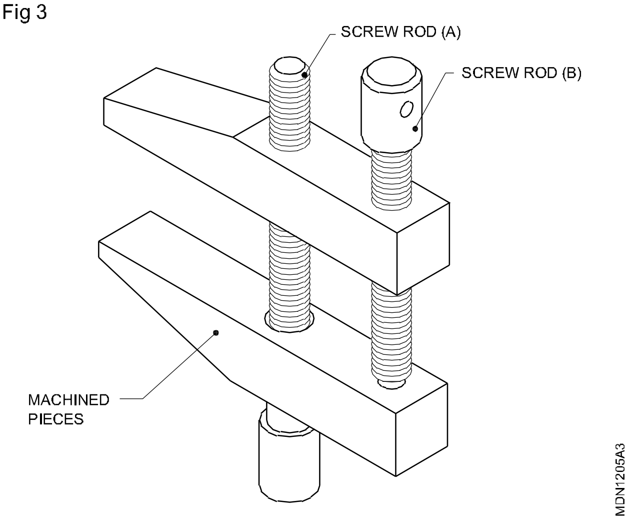
These clamps are used to hold work, on an angle plate or a drill press table, and also, for holding two or more workpieces together.

The swivel pad on the end of the clamping screw helps in clamping surfaces which are not parallel. 'C' clamps are available for light and heavy duty work.

Toolmaker's clamps

This is the type most commonly used by toolmakers for holding small, machined, flat pieces for further operations. They have two rectangular pieces of steel perfectly machined. The inner faces which come in contact with the workpiece are perfectly parallel. They are assembled by means of two threaded rods. The screw-rod (A) is rotated in one direction to adjust the gap between the two holding faces. The other screw (B) when tightened maintains the required pressure. (Fig 3)

Fig 3



The head of the screw-rod (B) is provided with a hole through which a cylindrical pin may be passed for tightening purposes. The toolmaker's clamps are for holding a previously machined work which is flat and parallel.

The toolmaker's clamp is not suitable for doing any heavy operations on the workpiece since the contacting and holding area of the clamp is limited. It is meant for holding light jobs. It is also called as parallel clamp.

'U' Clamps

These are clamps used along with 'V' Blocks as an accessory. These clamps serve the purpose of holding the round work securely in the 'V' groove for layout operations as well as for machining operations.

Spanners and their uses

Objectives : At the end of this lesson you shall be able to
- **state the necessity of spanners**
- **identify the different types of spanners**
- **specify the spanners**
- **list out the parts of adjustable spanners**
- **state the features of 'C' spanners and their uses.**

Spanners are used for operating threaded fasteners, bolts and nuts. They are made with jaws or opening that fit square on hexagonal nuts and bolts and screw heads. They are made of high tensile or alloy steel. They are drop-forged and heat-treated for strength. Finally they are given a smooth surface finish for ease of gripping.

Spanners are considerably in shape to provide ease of operation under different conditions.

The basic types of spanners are : (Fig. 1)

- Open end spanners (1)
- tube or tubular box spanners (2)
- Socket spanners (3)
- Ring spanners (4)

The correct spanner fits exactly and allows room for use. They should also permit the job to be done in a shorter time.

The following are the points to be noted for using spaners in a safe way. (Fig. 2)

Use open end and ring spanners by pulling on the shank. It is safest to pull as there is less chance of hitting your knuckles if the spanner or nut slips suddenly. If you are forced to push the spanner, use the base of your hand and keep your hand open.

Use both hands for large spanners.

Keep yourself balanced and firm to avoid slipping yourself, if the spanner slips suddenly, Hold on to some support, if there is any chance of falling.

Fig 1

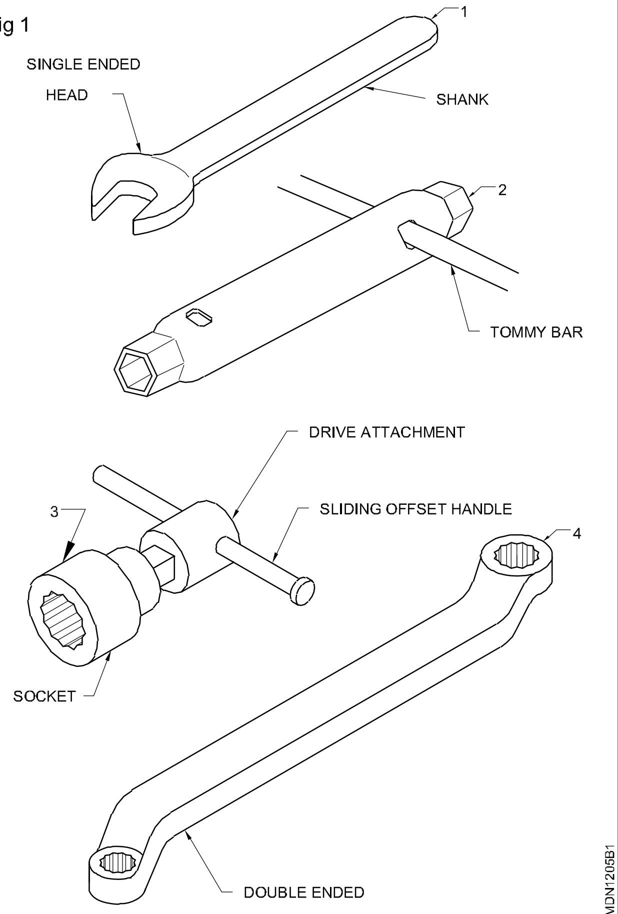
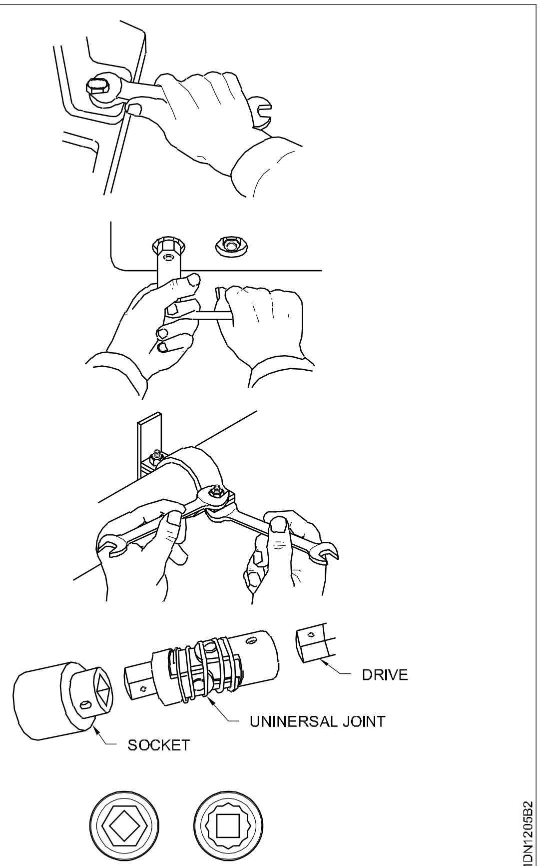


Fig 2



Use both hands as shown in the figure, when using tubular box spanners. (Fig. 2)

Use two spanners as shown in the figure to stop the head of the bolt rotating as the nut is operated. (Fig. 2)

Socket spanners may be turned by accessories which have square driving ends. (Fig. 2)

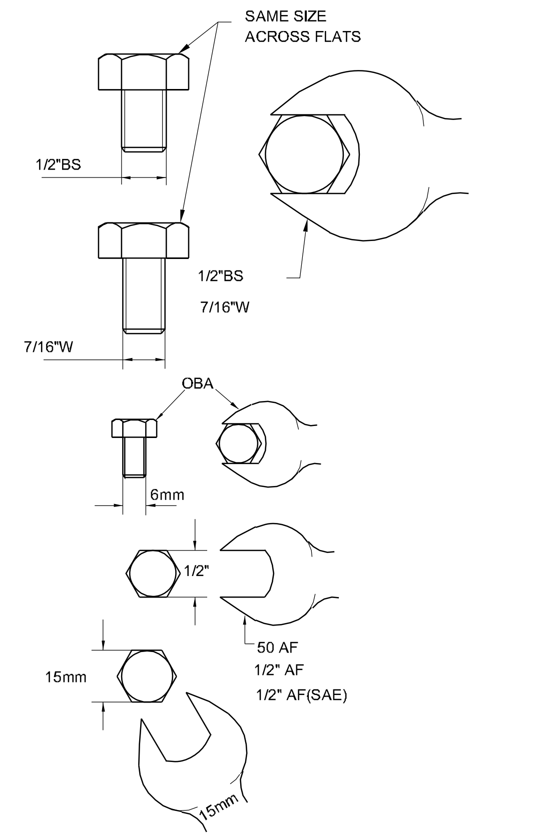
Size and identification of spanners

The size of a spanner is determined by the nut or bolt it fits. The distance across the flats of a nut or bolt varies both with the size and the thread system. (Fig 4)

In the British system the nominal size of the bolt is used to identify the spanner. (Fig. 3)

In the unified standard system (Fig. 3), the spanners are marked with a number based on the gas requirement decimal equivalent of the nominal fractional size across the flats of the hexagon, following the sign A/F or with the fractional size across the flats following the sign A/F. In the metric system, spanners are marked with the size across the jaw opening followed by the abbreviation 'mm'.

Fig 3



To fit exactly, a spanner must be :

- of the correct size
- placed correctly on the nut
- in good condition.

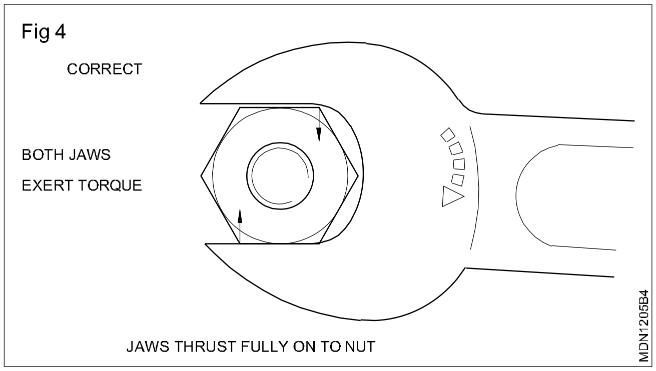
Spanners have their jaws slightly wider than the width of the nut so that they can be placed into position easily. Any excess more than a few hundredths of a millimeter clearance could cause the spanner to slip under pressure.

Place the spanner so that its jaws bearfully on the flats of the nut.

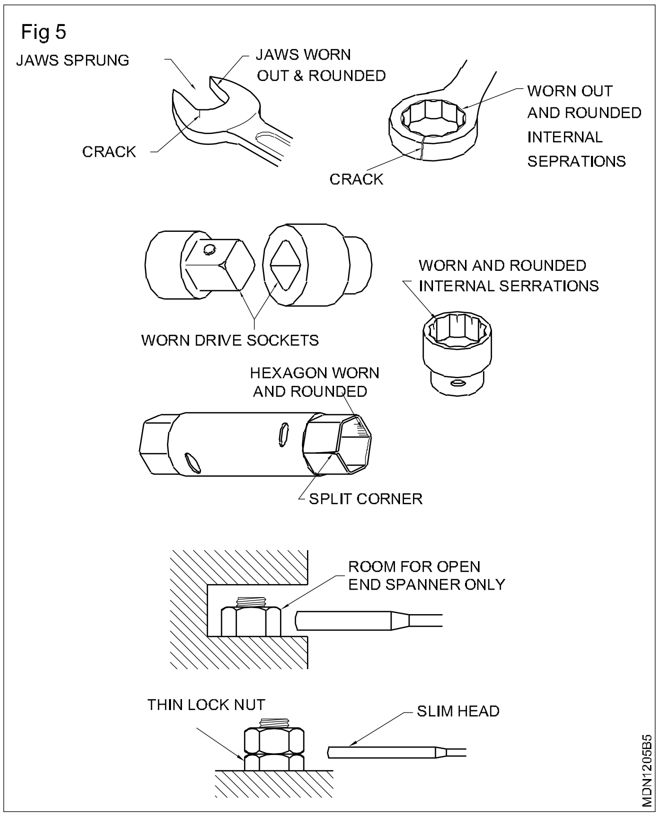
Incorrect use damages the spanners & the nuts too.

Discard any defective spanners. The spanners illustrated here are dangerous for use.

Choose spanners that allow room for use.



Nuts in inaccessible positions may be reached with socket spanners, with special drawing accessories. (FIg 5)



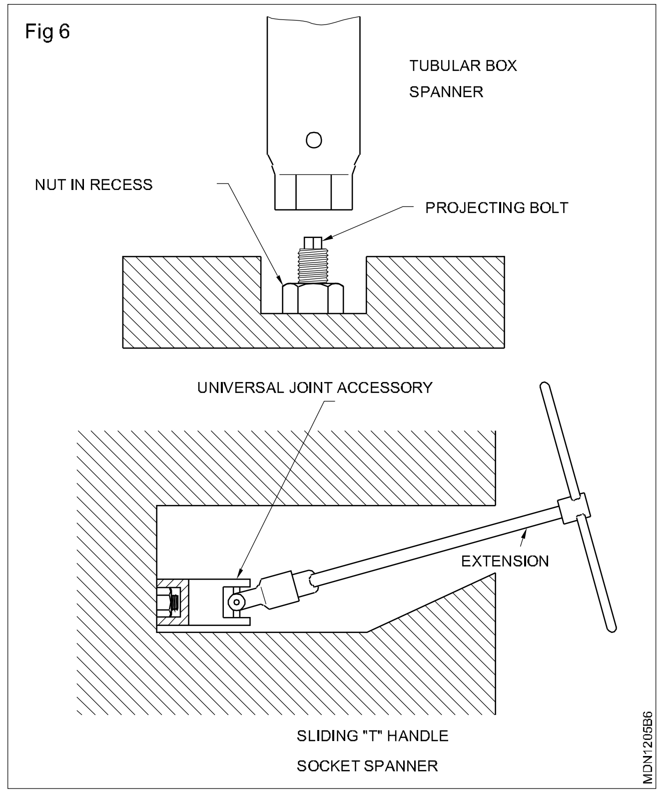
Length of spanners (Fig. 6)

Normally spanners have a length that is about ten times the width of the jaw opening.

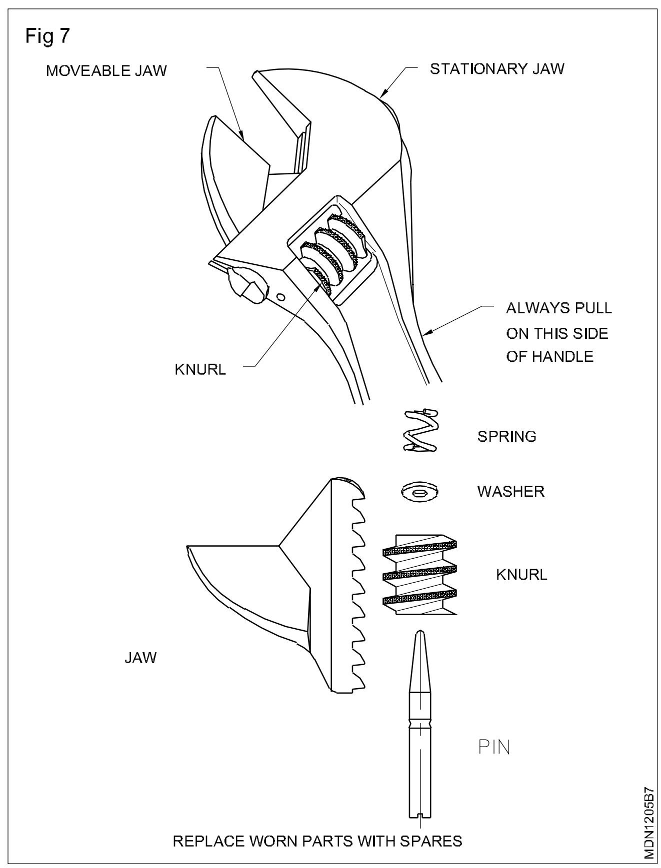
Never exert excessive pull on a spanner, particularly by using a pipe to extend the length of a spanner.

Excess turning effect of the spanner could result in :

- striping the thread
- shearing the bolt
- straining the jaws of the spanner
- making the spanner slip and cause an accident.

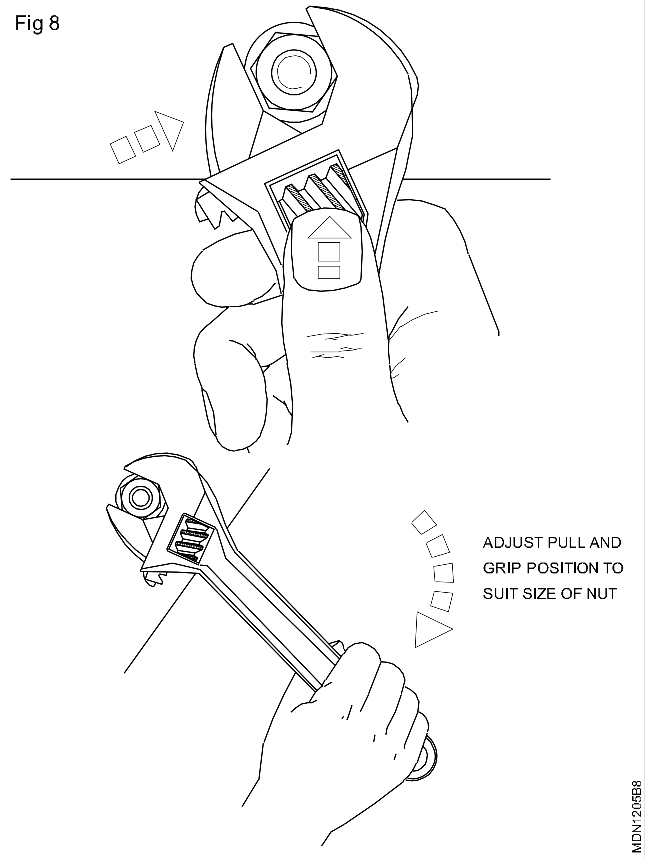


Adjustable spanners (Figs 7 & 8)



Most common types of adjustable spanners are similar to open and spanners, but they have one movable jaw. The opening between the jaws of a typical 250 mm spanner can be adjusted from zero to 28.5 mm. Adjustable spanners may range in length from 100 mm to 760 mm. the type illustrated has its jaws set an angle of 22 1/2^0 to the handle. Adjustable spanners are convenient for use where a full kit of spanners cannot be carried about. They are not intended to replace fixed spanners which are more suitable for heavy service. If the movable jaw or knurled screw is cracked or worn out, replace them with spare ones.

Fig 8



When using the adjustable spanner follow the steps given below.

Place it on the nut so that the jaw opening points in the same general direction the handle is to be pulled. In this position the spanners are less liable to slip and the required turning force can be exerted without damage to the moving jaw and knurl.

Push the jaws into full contact with the nut.

Use the thumb to tighten the adjusting knurl so that the jaws fit the nut strongly.

Pull continuously. The length of the handle is designed to suit the maximum opening of the jaws. With small nuts, a very small pull on the handle will produce the required torque.

'C' spanners (Hook spanners) (Fig. 9)

It has a lug that fits in a notch, cut in the outer edge of a round nut. The 'C' section is placed around around the nut in the direction in which it is to be turned. In adjustable hook wrenches, part of the 'C' section pivots to fit nuts with a range of diameters. A set of three spanners is needed to cover diameters from 19 mm to 120 mm.

The applications of 'C' spanners are shown in the figure.

C' Spanners are also used for zero - selfing of micrometer.

With socket spanners (Fig. 10), use the reversible ratchet handle for doing fast work, where turning space is restricted.

Fig 9

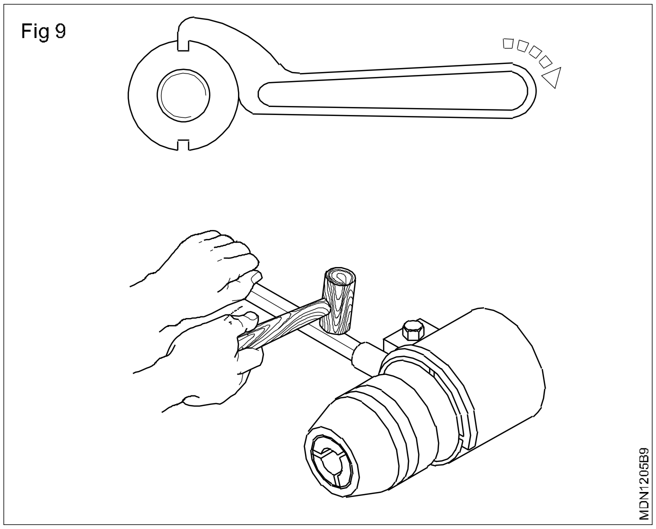
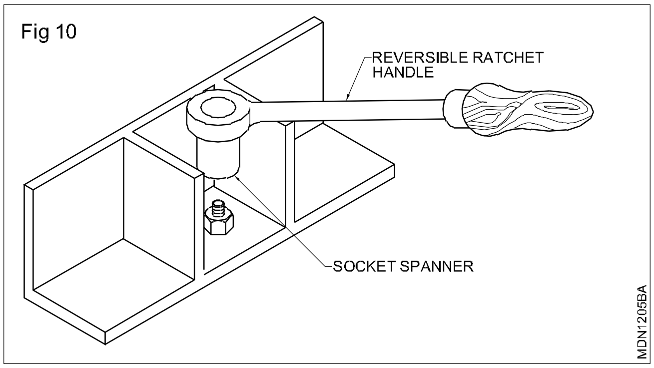
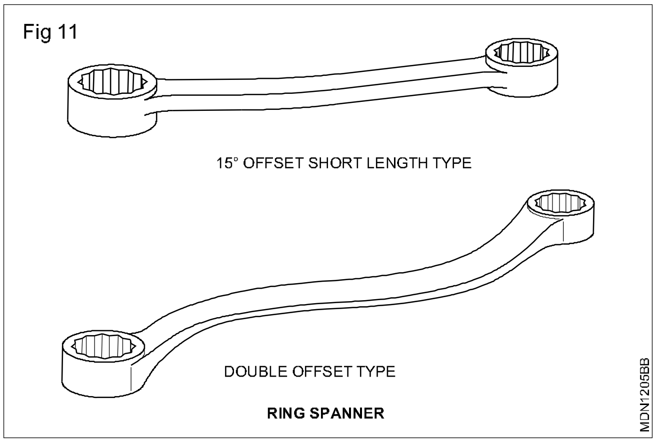


Fig 10



Ring or box spanner (Fig 11)**:** For critical tighting and loosening of nuts. For multi contact on bolts and nuts.

Fig 11



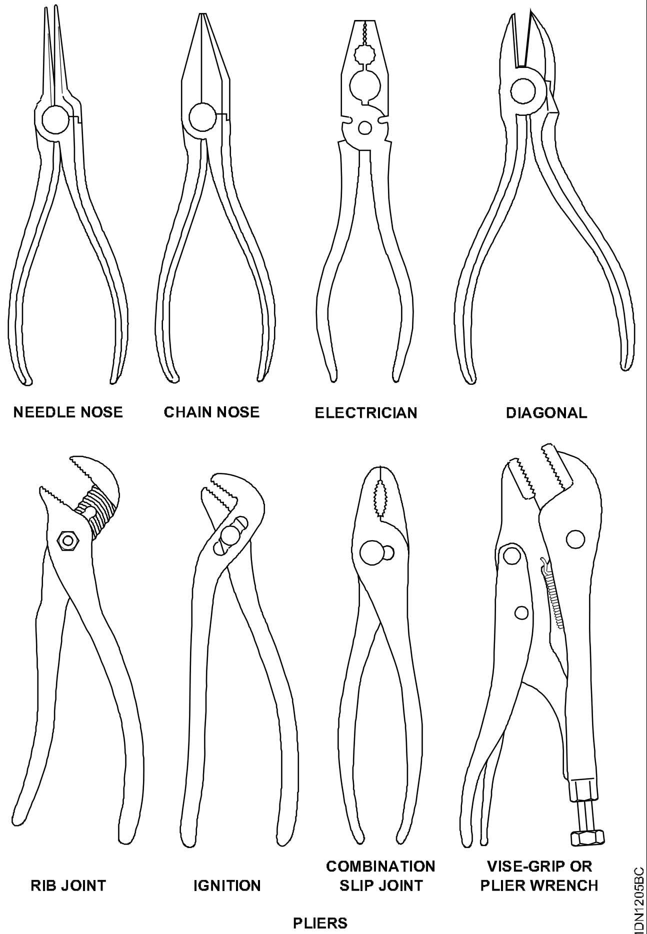
Pliers (Fig 12)**:** Pliers are commonly used for cutting wires, holding parts, crimping electrical connections and bending cotter pins.

Safety:

1 Avoid cutting hardened objects.

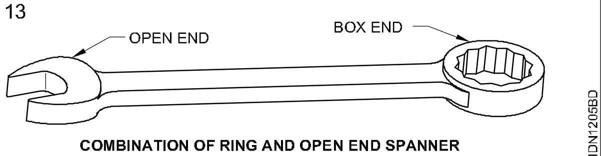
2 Never use pliers to turn nuts, bolts or tubing fitting.

Fig 12



Combination of ring and open end spanner (Fig 13)**:** This tool has a box end on one end and an open end on the other. Both ends are of the same size.

Fig 13



Socket spanners (Fig 14)**:** The socket is one of the fastest and most convenient of all the spanners. Sockets come in two sizes; standard and deep.

Standard sockets will handle the most of the works, while the extra reach of the deep socket is occasionally needed.

Swivel socket (Fig 15)**:** The swivel socket allows the user to turn fasteners at an angle.

Socket handles: Several different drive handles are used. The speed handle (Fig 16 & 17) is used whenever possible as it can be turned rapidly.

Fig 14

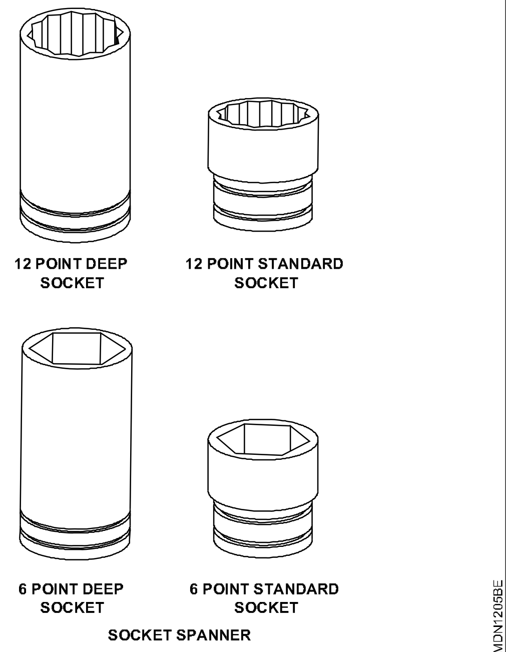


Fig 15

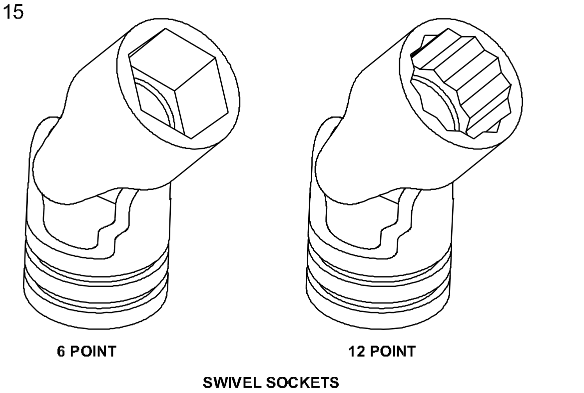


Fig 16

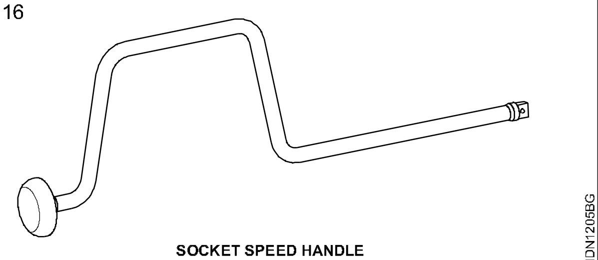
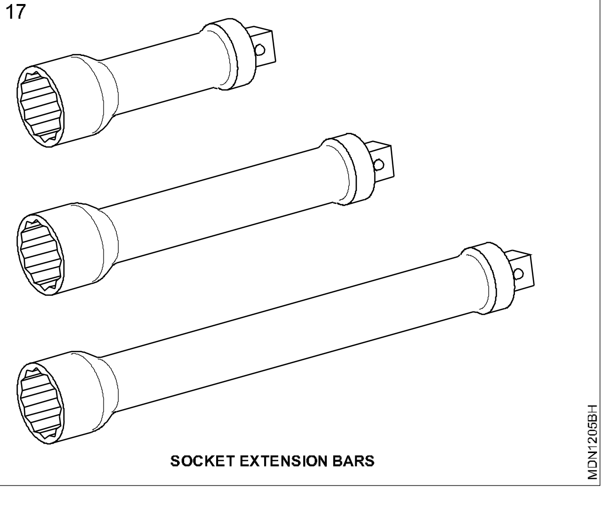


Fig 17



Pliers

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

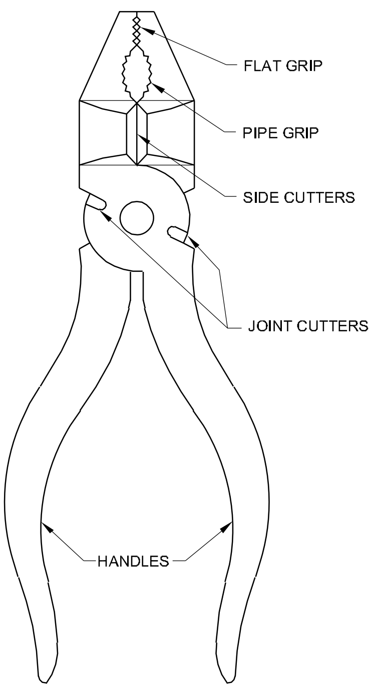
Features

Pliers have a pair of legs joined by a pivot, hinge or fulcrum pin. Each leg consists of a long handle and a short jaw.

Elements of pliers with two joint cutters (Fig. 1) **(Combination pliers)**

- Flat jaw
- Pipe grip
- Side Cutters

Fig 1



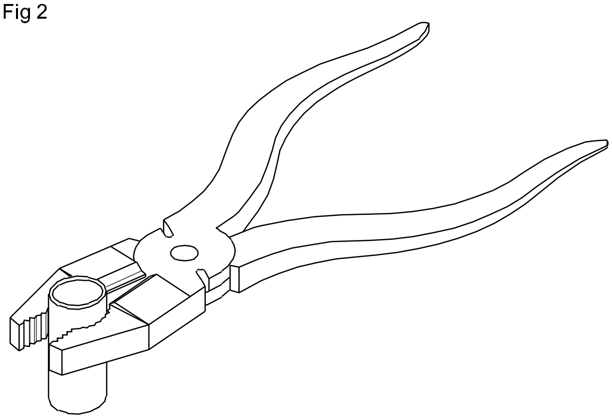
- Joint cutters
- Handles

Features

Flat jaw tips are serrated for general gripping.

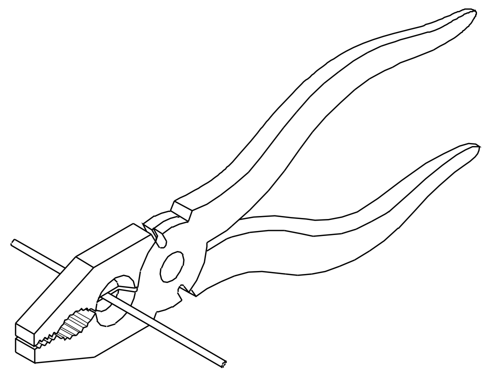
Pipe grip is serrated for gripping cylindrical objects. (Fig 2)

Fig 2



Cutters are provided for cutting off soft wires. (Fig 3)

Fig 3

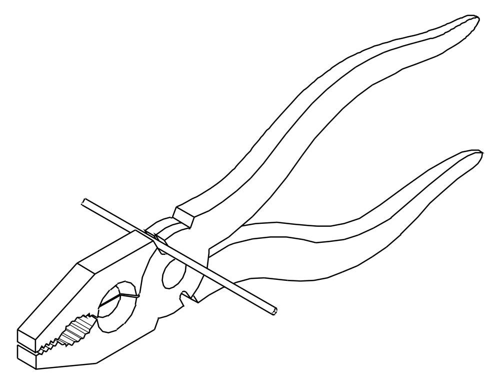


Two joint cutters are provided for cutting or shearing off steel wires (Fig 4)

Handles are used for applying pressure by hand.

Pliers are available in sizes from 150 mm to 230 mm. (Size = Overall length)

Fig 4

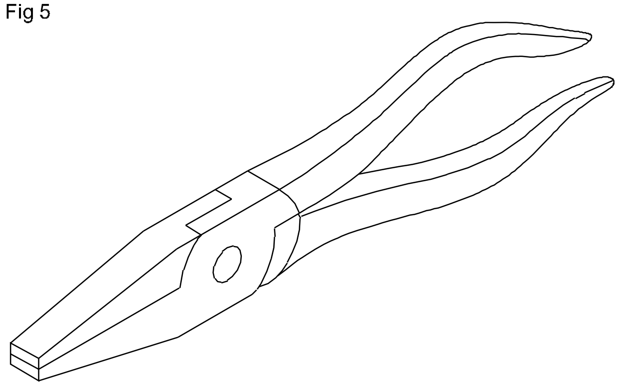


Other types of pliers

Flat nose pliers

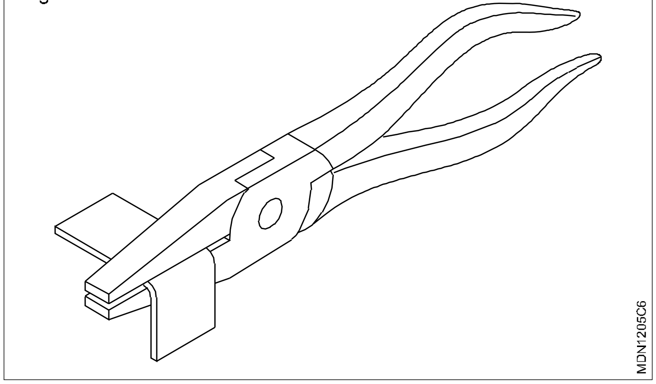
It has tapered wedge jaws with flat gripping surfaces which may be either smooth or serrated. (Fig 5)

Fig 5



It is used for bending and folding narrow strips of thin (Fig.6)

Fig 6



Roundnose Pliers

This type of pliers is made with tapered round shaped (Fig.7) They are used to shape loops in wires and the form curves in light metal strips (Fig.8)

Fig 7

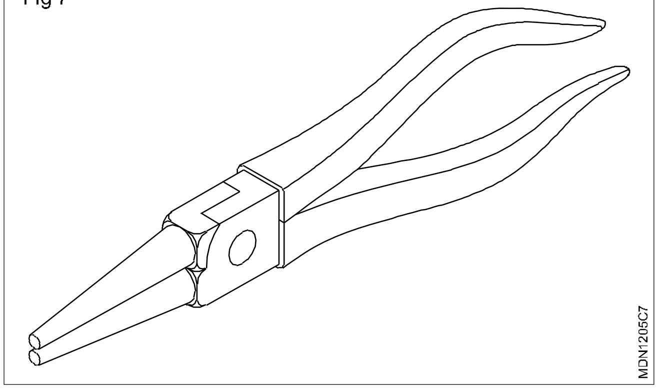
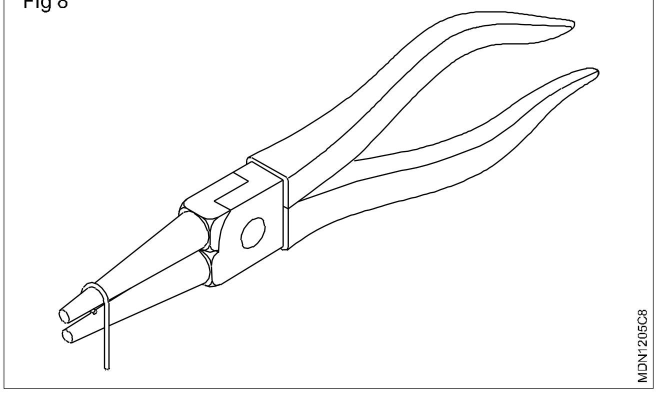


Fig 8

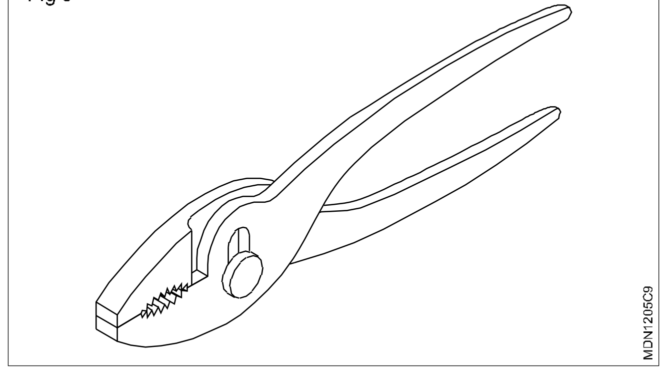


Slip-joint pliers

These pliers are available in various ranges of positions with different shapes of pivot pins so that they have various ranges of jaw opening.

Mainly used for gripping. (Fig 9)

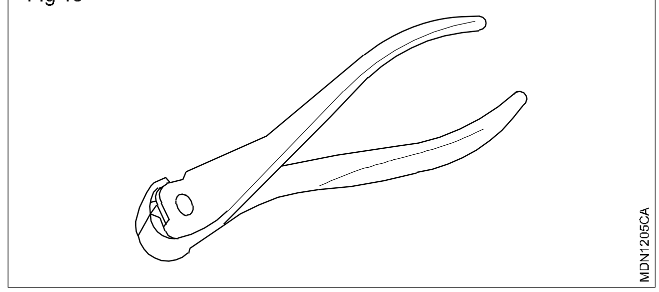
Fig 9



End cutting pliers

These pliers have the same uses as the side cutting pliers. (Fig 10)

Fig 10



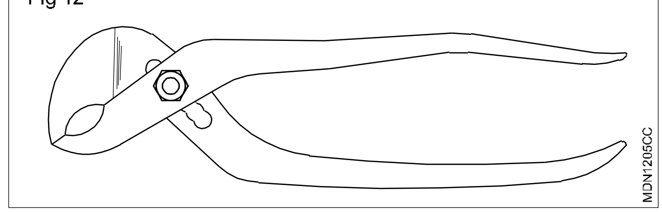
Circlip pliers

Circlip pliers are used for fitting and removing circlips in assembly works.

Internal circlip plier

It is used to fit and remove the internal circlip in the groove of the bore. (Fig 11)

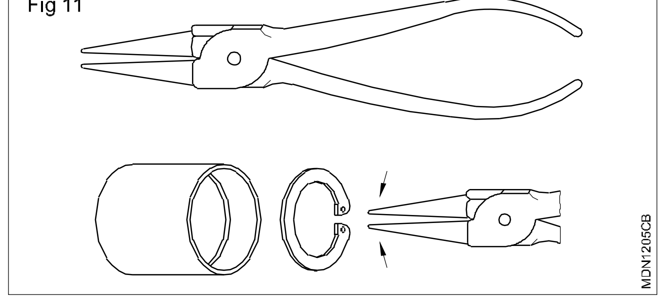
Fig 12



Slip-joint, multi-grip pliers

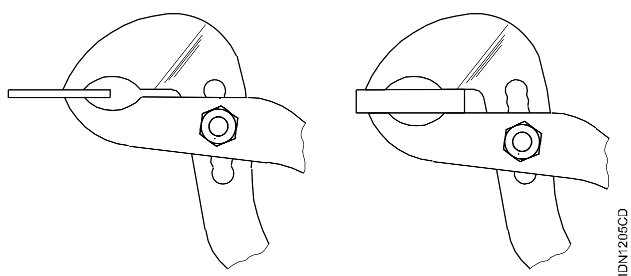
It is similar to the grip pliers but has more openings in the legs. It gives a range of jaw openings. It allows parallel gripping by the jaws in a number of positions. (Fig 12)

Fig 11



The shape and length of the leg are different from those of the slip-joint pliers. (Fig.13)

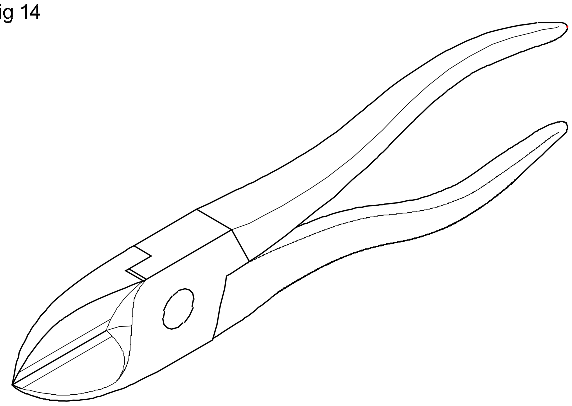
Fig 13



Side cutting pliers

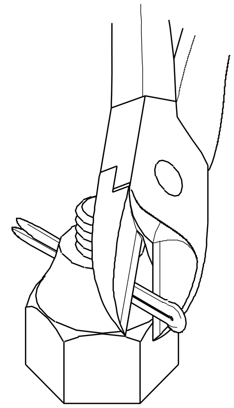
It is made with jaws set at an angle. (Fig.14)

Fig 14



They are used for shearing off wires in confined spaces and cutting off wires close to the surface level. (Fig.15)

Fig 15



They are also used for spreading the cotter pin.

External circlip pliers.

External circlip pliers are used to fit and remove the external circlip in the grooves of the shafts.

Locking pliers

The locking lever of the locking pliers is attached with a movable handle which clamps the jaws on to an object of any shape.

It has high gripping power.

The screw in the handle enables adjustment of the lever action to the work size.

SNIPS (Straight & Bent)

Objectives : At the end of this lesson you shall be able to
- **state the uses of straight and bent snips**
- **state the features and use of lever shears**
- **state the uses of circle cutting machines.**

A snip, also called a hand shear ans it is used like a pair of scissors to cut thin, soft metal sheets. Snips are used to cut sheet metal upto 1.2mm thickness.

Types of snips (shears)

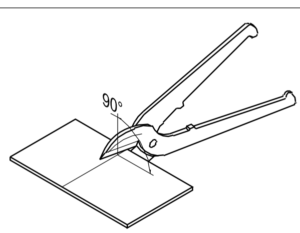
There are several types of snips available for making straight or circular cuts, the most common being straight snips and curved snips.

The choice of shears (snips) depends on the shape and type of the cut required.

Straight snips (Figs 1& 2)

These are used for making straight cuts and large external curves.

Fig 1



Straight snips have thin blades which are only strong on a vertical planes. They are, therefore, only suitable for straight cuts and external curves when surplus waste has to be removed.

While cutting, the blade of the snips should not cover the marking.

Bent snips (Fig. 3)

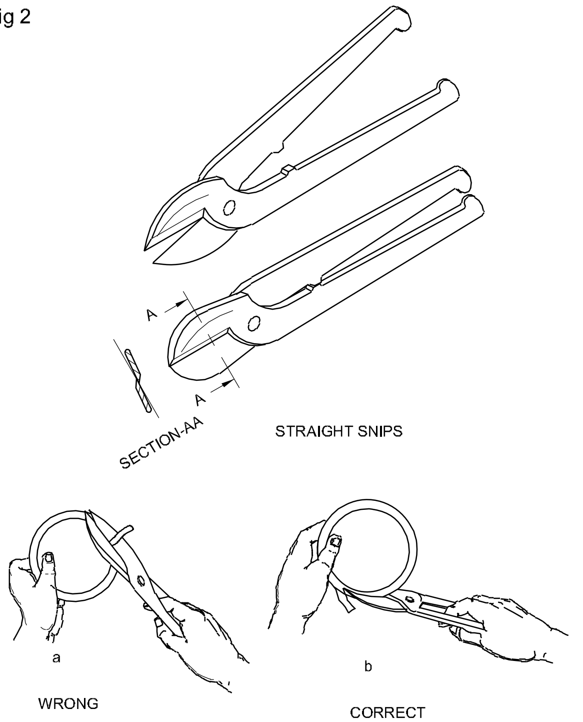
These snips have curved blades for making circular cuts. They are also used for trimming cylindrical or conical work in sheet metal.

Snips are specified by the overall length and the shape of the blade.

Example

200mm straight snip (Fig.4)

Fig 2



CUTTING OUT A CIRCULAR DISC

Fig 3

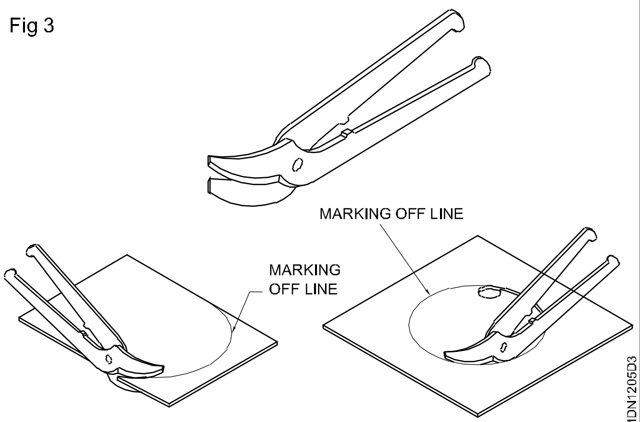
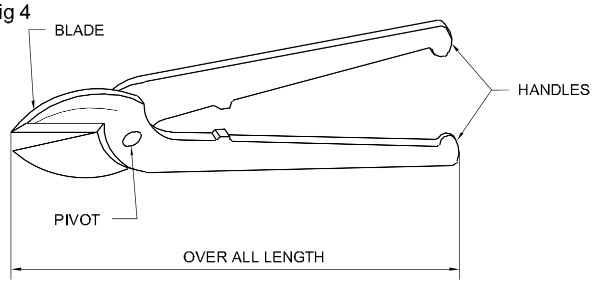


Fig 4



Lever shears (Fig 5)

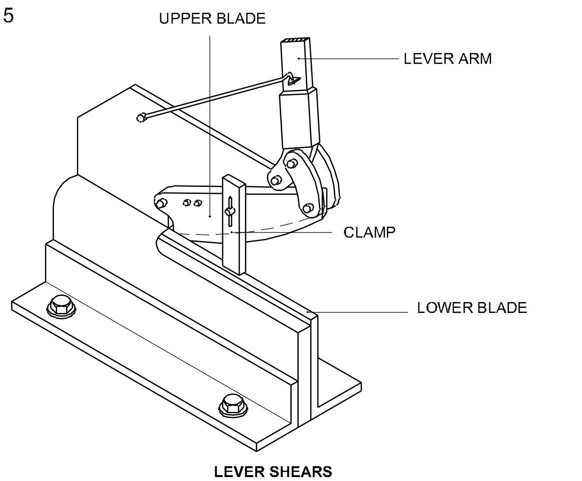
Lever shears are used to cut sheets which cannot be cut with hand shears.

The lever shear possesses a fixed lower blade and a moving upper blade. The sheet being cut is prevented from tilting by a clamping device which can be adjusted to the thickness of the sheet. The knife-edge cutter of the upper blade is curved so that the opening angle at the point of cut remains constant.

Circle cutting and curve cutting machines (Fig 6)

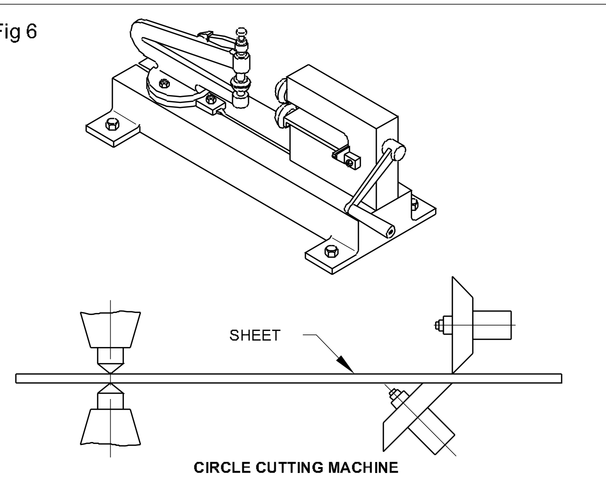
These machines are used to cut circles and curves of the desired shapes. When cutting curves, the sheet must be guided by the hand.

Fig 5



LEVER SHEARS

Fig 6



CIRCLE CUTTING MACHINE

Wrenches

Objectives : At the end of this lesson you shall be able to
- **name the different wrenches used**
- **state the features of each type of wrenches.**

Types of wrenches

- **Stillson pipe wrench**
- **Footprint pipe wrench**
- **Tension wrench**
- **Hexagon socket wrench**

Stillson pipe wrenches (Fig 1 & 2)

These are used for gripping and turning pipes of a wide range of diameters.

The parts and their names are shown in the (Fig 1).

A jaw is fixed to the handle with outward facing teeth. Attached to the handle by a pivot pin is a spring-loaded casing that carries a knurled adjusting nut. This engages with a thread on the adjustable arm of a jaw with inward facing teeth.

Fig 1

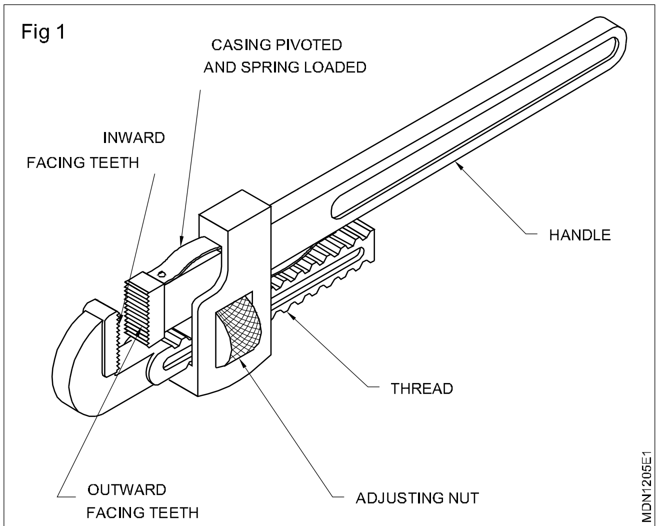
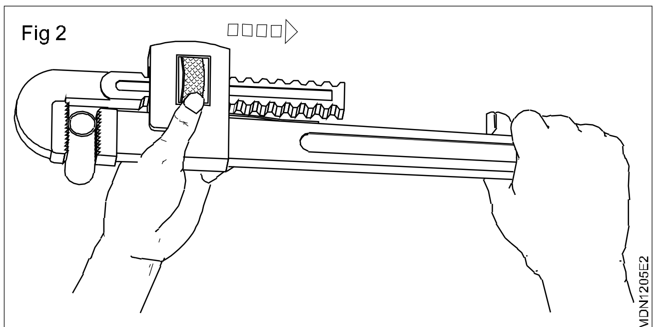


Fig 2



Once the jaws are adjusted, the spring loading keeps them in contact with the work, and the toggle action causes the hardened serrations to bite into the work.

The jaws will mark the work. File off any burrs. Never use them on polished or plated surfaces. Never grip hardened materials with this type of wrench as this will damage the serrations.

Footprint pipe wrenches (Fig. 3)

These are used for gripping and turning pipes and round stock, particularly in confined spaces.

Adjust the size by fitting the removable pin in the hole that allows the pipe to be gripped, with the handles a comfortable distance apart. Thrust the jaws fully on to the pipe. Squeeze the handles firmly. Pull on the folded steel handle to turn the pipe. Stop squeezing and slide the jaws back round the pipe, squeeze and pull again.

File off any burrs raised by the jaws on the pipe.

Tension wrench (Fig 4)

A tension wrench acts as a torque limiting device for turning (rotating) nuts to a predetermined degree of tightness. This avoids breaking the fasteners. It is also essential to avoid warping or springing components held by multiple fasteners that could be unevenly or excessively tightened, cylinder heads of engines, for example.

Some tension wrenches have direct reading indicators that you must watch as you pull the handle to the desired extent. With others, you preset to the desired graduation and pull until you detect a signal which may be an audible click, the release of a trigger pin or an automatic release within the wrench mechanism.

To apply the correct torque with a tension wrench :

- check that the threads of the nut and the bolt are clean and well formed.
- pull slowly with evenly increasing effort on the hand grip of the handle.

Fig 3

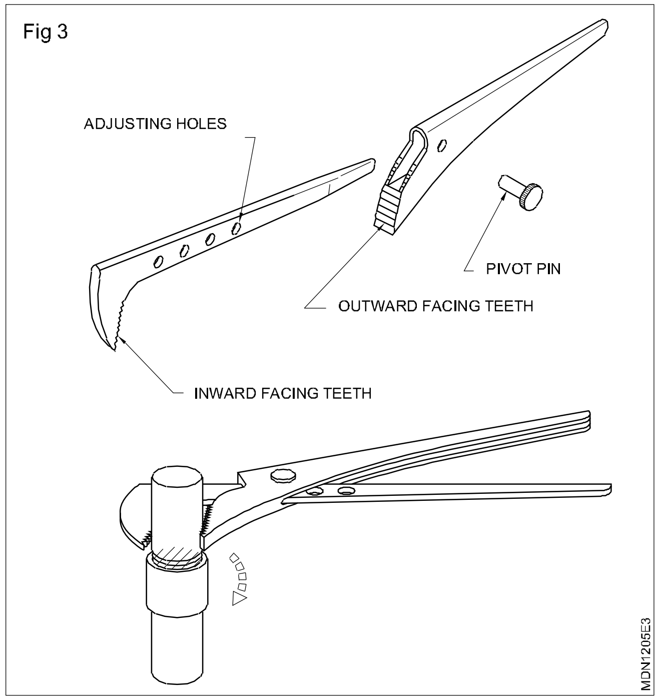
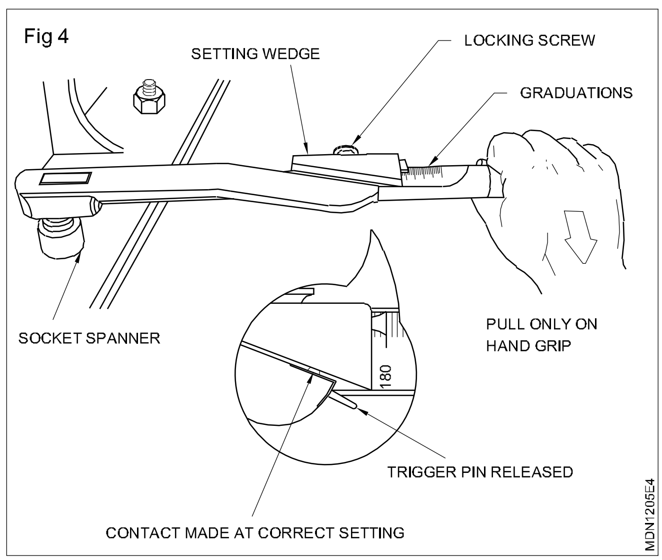
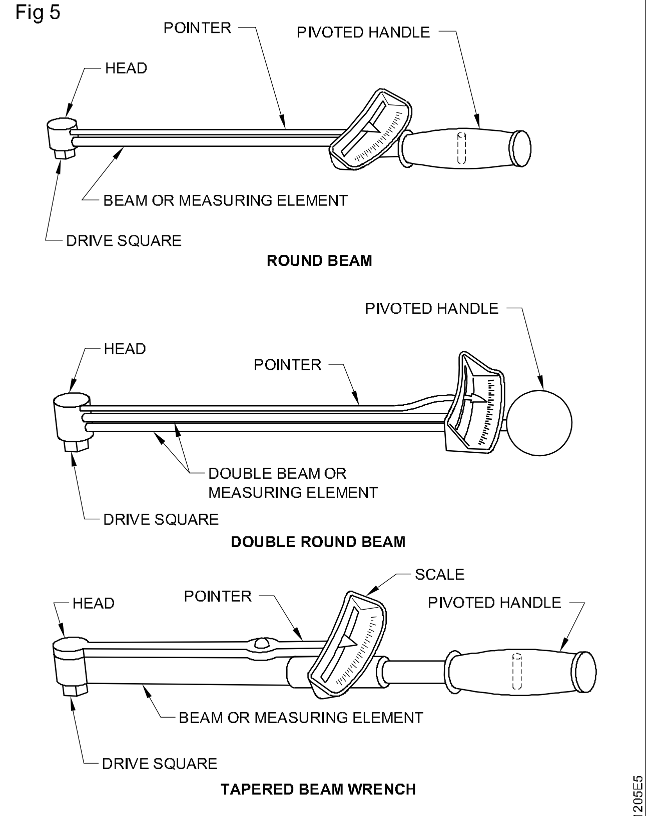


Fig 4



Torque wrench (Fig 5)**:** Torque wrench is used to tighten the bolts/nuts at recommended ended torque. The torque wrench will meausre the torque (twisting force) applied to the fastener. E.g. Cylinder head nuts, bearing cap nuts etc. (N.m; Kg m or Ib-ft)

Fig 5



TORQUE WRENCHES

Flaring, flare fittings and testing the joints

Objectives : At the end of this lesson you shall be able to
- **illustrate necessity, types of flaring methods**
- **list the types and applications of flare fittings**
- **pressurise the joint system and test for leaks.**

Flaring necessity: When connecting tubing to fittings, it is common practice to flare the end of the tube and to use fittings designed to grip the flare for a vapour tight seal. Special tools are used for making flares.

Types of flaring : There are two types of flaring

Single thickness flare

Double thickness flare

Single thickness flare : It can be made on smaller size copper tubing (Fig.1)

Double thickness flare : Double thickness flares are recommended for only the larger size tubing 5/16 inch (9mm) OD and over. Such flares are not easily formed on smaller tubing. The double flare makes a stronger joint than a single flare.

The Fig (2 & 3) shows some defects and correctly made flare. This also shows how defective flare made the fitting mismatched.

Fig 1

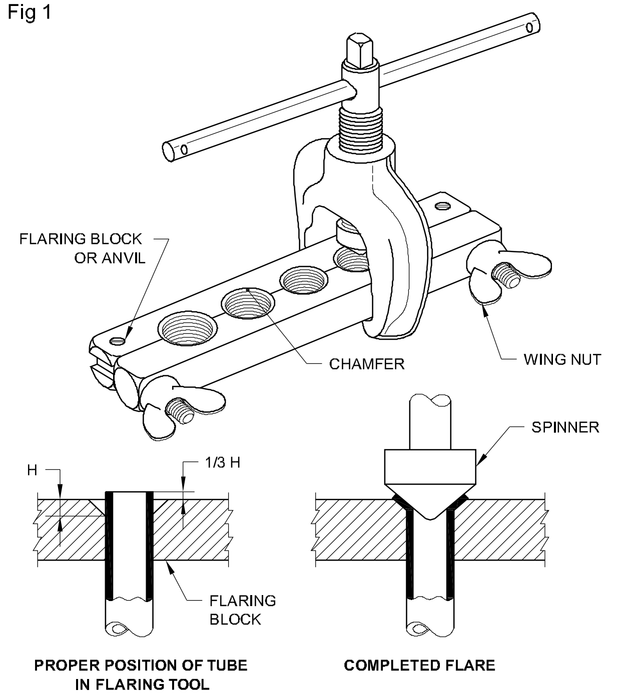
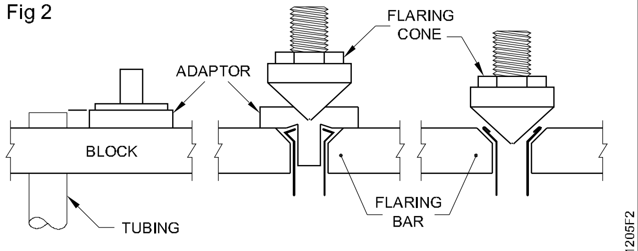
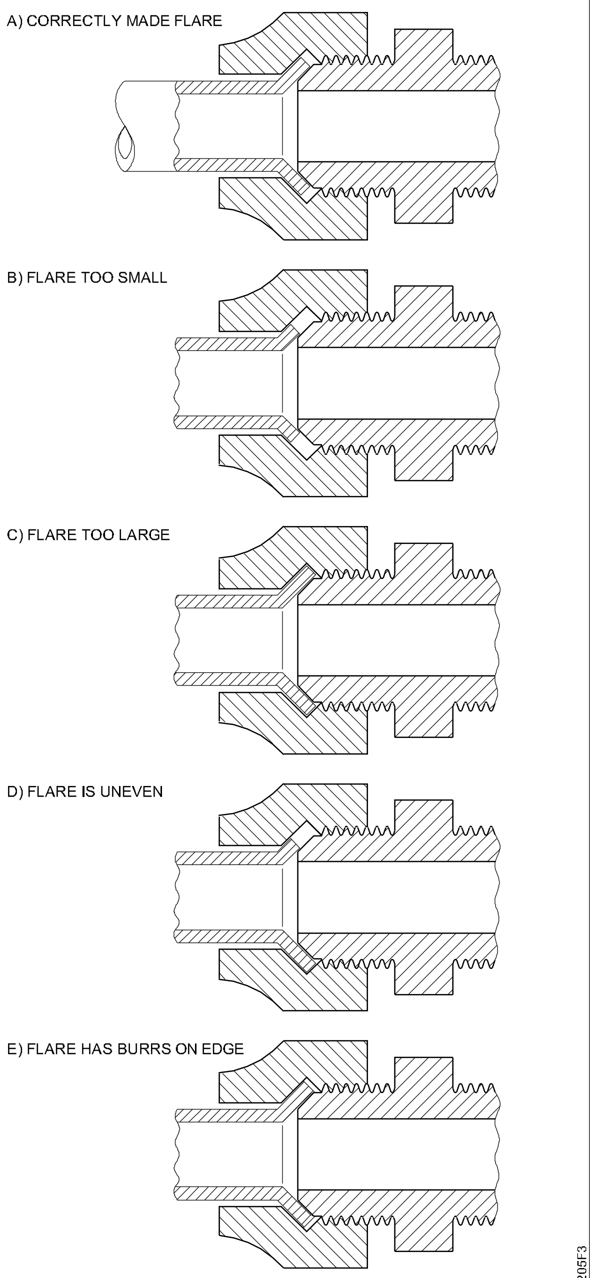


Fig 2



CORRECT PROCEDURE FOR FORMING DOUBLE FLARE

Fig 3



FLARED FITTINGS

Flared tubing fittings : To attach a fitting to soft copper tubing, a flared type connection is generally used.

The following are some of the more common flared type fittings. (Fig. 4, 5 & 6)

Pressurising the joint on tubing : A flared joint or brazed joint needs to be tested for its firm. If it leaks while working it will put the whole system into problem. Before putting the joint into a system after it is made pressure test must be done.

Air pressure from

Air compressor - 150 PSI

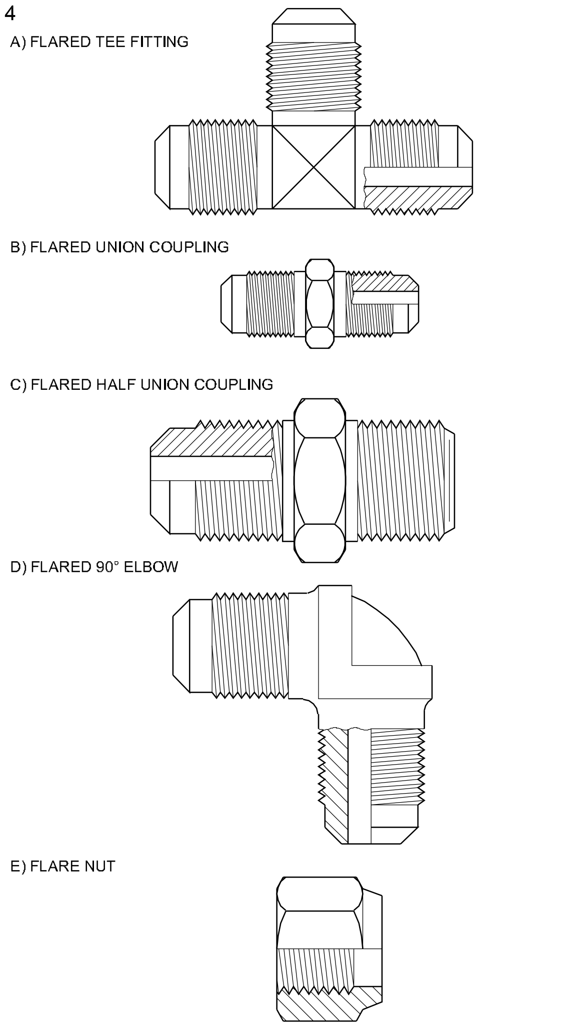
or - 10Kg/cm^2

The gas which is employed can be used for testing.

Leak can be detected with the use of soap solution. There are also other methods for leak detection.

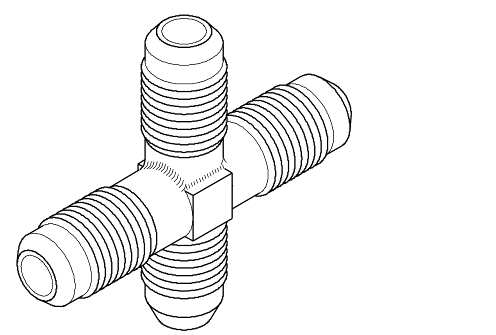
Pressure tests are usually made on the joints above the working pressure.

Fig 4



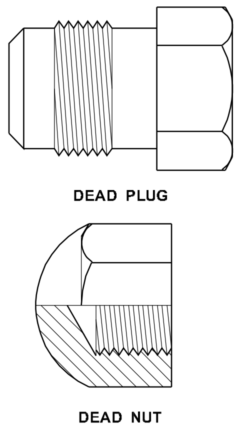
FLARED TYPE FITTINGS

Fig 5



CROSS

Fig 6



A pipe cutter is more convenient and better than a saw when cutting pipes and metal tubing. (Fig. 7)

The sharpened wheel does the cutting. As the tool turns around the pipe the screw increases the pressure, driving the wheel deeper and deeper through the pipe until it finally cuts rights through. (Fig. 8)

Fig 8

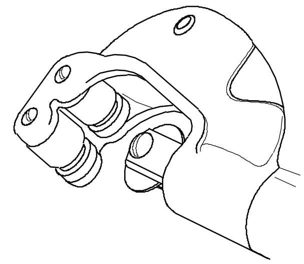
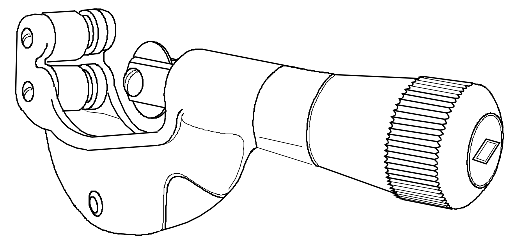


Fig 7



Puller

Objectives : At the end of this lesson you shall be able to
- **state the function of puller**
- **state the types of puller.**

Puller

The puller is a General Workshop tool which is used to remove Gears, bearings pulleys, flanges, bushes.

The puller is made out of steel material, generally with two or three legs and they are adjusted to hold the outside of the gears or bearing sleeves while the central threaded shaft is screwed forward exerting force on the gear/bearing. This enables to remove the bearing without damaging the shaft.

Pullers are classified according to the application and the number of leg.

Another classification is bsed on the power utilised i.e. Mechanical puller and Hydraulic puller.

Two legs puller is generally used for removing the gears. Where as puller with three legs are for removing pulleys. flanges and bearings. It is also called gear puller. Special pullers: These are mainly used for specialised application such as crank shaft bearing removal brake drum, removal pilot bearing removal.

Hydraulic puller : These pullers eliminate time consuming and unsafe hammering, heating or prying. Damage to past is minimised through the use of Hydraulic. pullers.

Safety

To avoid personal injury during system operation,

Always wear proper PPE gear

never use a tool to strike a puller

make sure that items are pulled is well and adequately supported

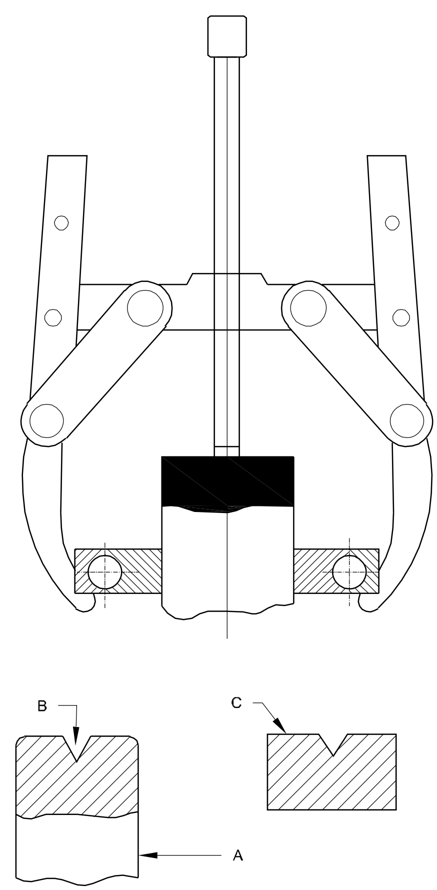
do not apply heat to a puller

before every use lubricate the centre bolt threads, with graphite - based lubricant

use puller only with recommended attachment

do not over load a pulley which may cause to break

Fig 1



Important: Always keep the guide parts of the lifting plate greased.

Hydraulic pullers are derigned to help you extend bearing life in your applications through proper installtion, removal and service.

Hydraulic pulling systems are available with capacity ranging from 4 tons to 30 tons, and are ideal for removing all kinds of shaft filled parts.

Hydraulic pulling system comprises of integrated pump. clyinder, hose, puller with safety-release valve. The pullers have self-contained hydraulic pump and are compact, handy. There are ideal for pulling variety of press-fit parts including bearing, wheels bushings, gears, pulleys.

In Automobiles Hydraulic Puller especially used for memoring Engine Liner from the cylinder block during engine Reconditioning Work.

Mechanical Puller Operation: (Figs 1 & 2)

1 Ensure that the spindle is clean and applied grease before use.

2 The Shaft (A) must have a center hole (B) as shown in the figure. If it does not, use a shaft protector (C) as shown in (fig 1)

3 Tighten strap bolts to hold jaws lightly in place

4 Position the puller that the spindle as shown in fig 2.

5 Tighten the spindle slightly by turning the spindle nut with proper wrench

6 Check that the jaws are fully contacting the part to be pulled.

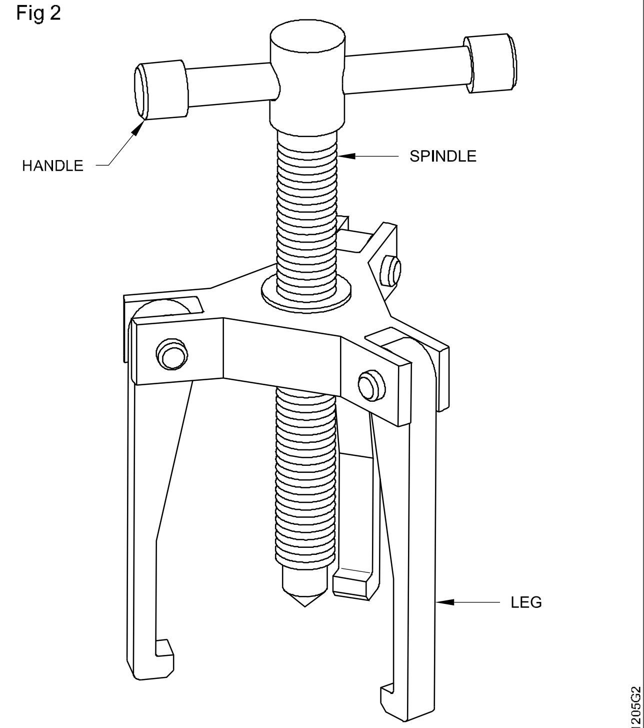
7 Tighten the strap bolts.

8 Apply pulling force by turning the spindle.

Post lock puller operation (Manual pullers)

1 Make sure that all items being pulled are supported by a means other than the puller. NO LOOSE PIECES!!!

Fig 2



PULLER

2 Before each use, lubricate the center bolt of the puller with a graphite-based lubricant.

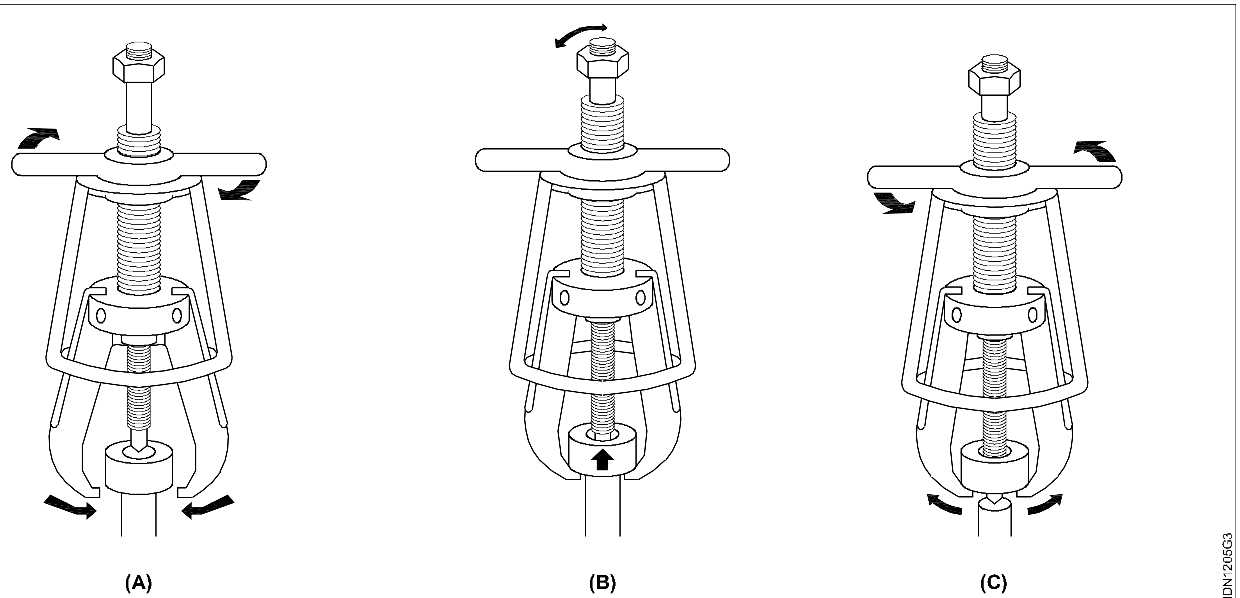
3 To operated the puller, grasp the puller with one hand and and turn the T-handle counter-clockwise with the other hand until the jaw opening is big enough to fit over the component to be pulled

4 Turn the T-Handle clockwise with the other hand until the jaw firmly onto the component. (Fig.3A)

5 Make sure that the center of the puller is aligned with the center of the component to be pulled. Using hand tools only, tighten the center bolt to pull the component off of its shaft. Never exceed the maximum torque ratings of the puller’s drive bolt. (Fig.3B)

6 Turn the T-handle counter-clockwise to remove the puller from the component. (Fig.3C)

Fig 3



(A) (B) (C)

Hydraulic Puller Operation: (Fig. 4)

1 Make sure that all items being pulled are supported by a means other than the puller. NO LOOSE PIECES!!!

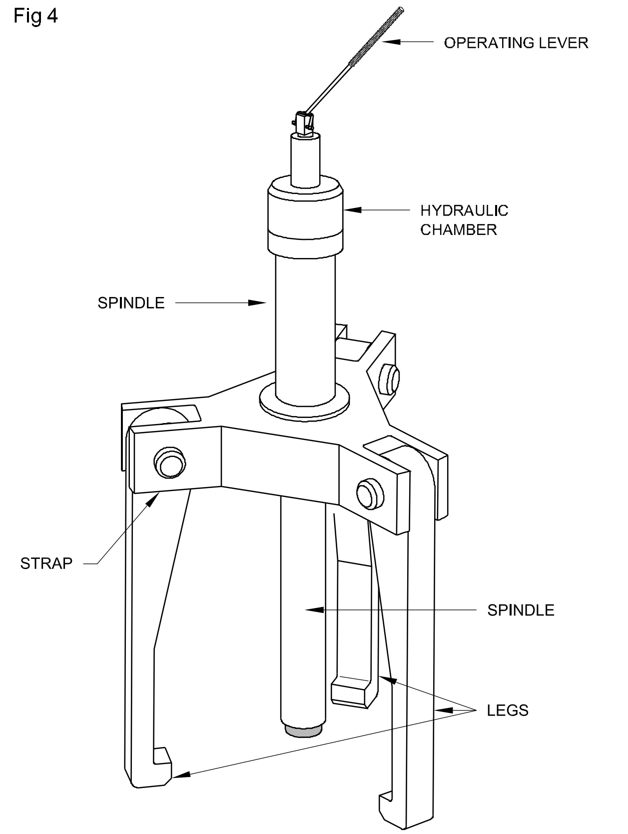
2 Install the cylinder into the puller by threading collar threads clock-wise into the jawhead assembly. Make sure that the puller collar threads are fully engaged in the puller. Attach lift plate to the coupler end of the cylinder. Remove the saddle from the cylinder and insert the ram point into the plunger. Select the ram point that will provide the maximum contact with the shaft.

3 To operate the puller, grasp the puller with one hand and turn the T-handle counter-clockwise with the other hand until the jaw opening is big enough to fit over the component to be pulled.

4 Turn the T-Handle clockwise to tighten the jaw firmly onto the component.

5 Make sure that the puller is square with the component to be pulled. Advance the plunger until the ram point contacts the shaft to insure correct alignment. The center point of the puller must be aligned with the center point of the shaft. Continue to advance the plunger slowly to pull the component off of the shaft. Never try to retighten the T-handle during the pulling operation.

Fig 4



PULLER

Least count calculation, care and use of micrometer

Objectives : At the end of this lesson you shall be able to
- **name the principal parts of an outside micrometer**
- **derive the least count of metric micrometer**
- **determine the reading by using a metric micrometer**
- **solve the reading and give the measurement**
- **state the features of a large micrometers.**

The purpose of a metric micrometer is to read an accuracy of 0.01 mm of an object. It is available in various sizes. However, the measuring range is limited to the length of the threaded spindle.(Fig 1)

Fig 1

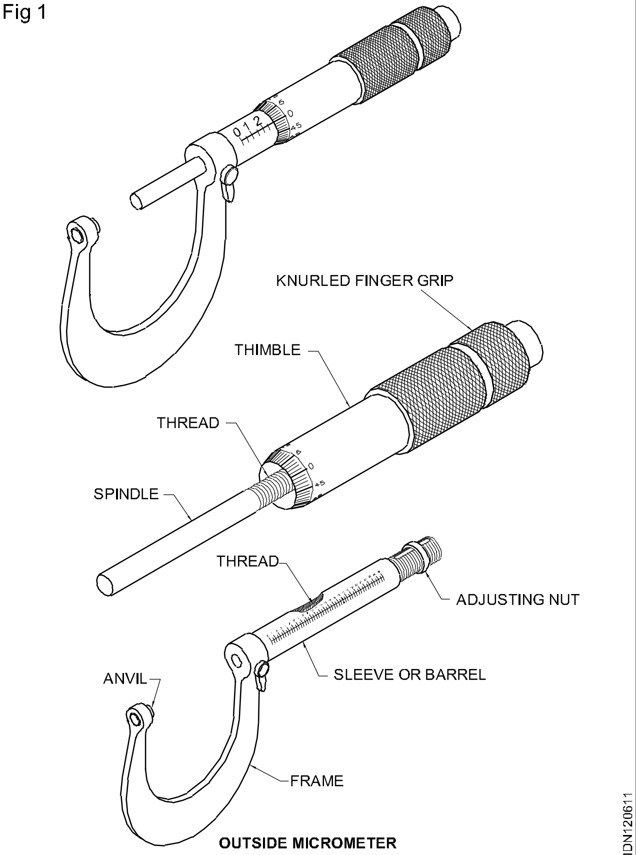
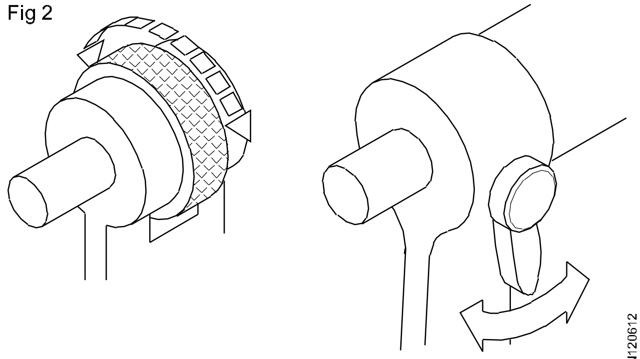


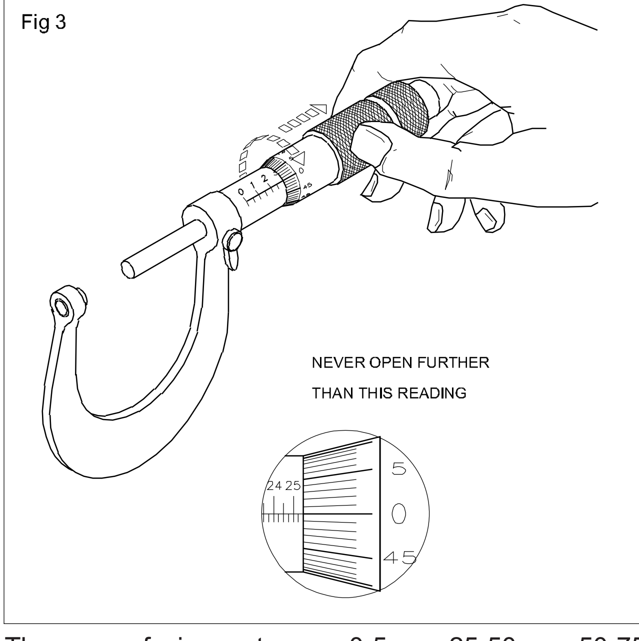
Fig 2



The principal parts of a micrometer are the frame, anvil, spindle and the thread, sleeve or barrel and the thimble, there is a knurled collar or small lever on the frame to lock the spindle in the barrel.(Fig 2) In addition to this, a ratchet stop is provided to the spindle in order to prevent a possible excess pressure on the screw treads.

The sleeve or barrel is marked (Fig 3) with the main scale in full mm and half mm. The thimble bevel end is graduated with the thimble scale. Fifty equal divisions are made on the circumference of the thimble bevel end. Every 5th division of the graduation is indicated with the number. Normally, the spindle face is fitted with a carbide tip to resist the wear. The spindle with the screw is attached to the thimble of the micrometer. The corresponding threaded nut is fitted to the barrel or sleeve of the micrometer. The other measuring face of the micrometer is the anvil, which is normally fitted with a carbide tip to resist the wear.

Fig 3



The range of micrometers are 0-5 mm, 25-50 mm, 50-75, 75-100 mm etc. The spindle can be easily screwed down in the barrel. In order to have the reference point for reading the micrometer, the datum or index line is marked on the sleeve.

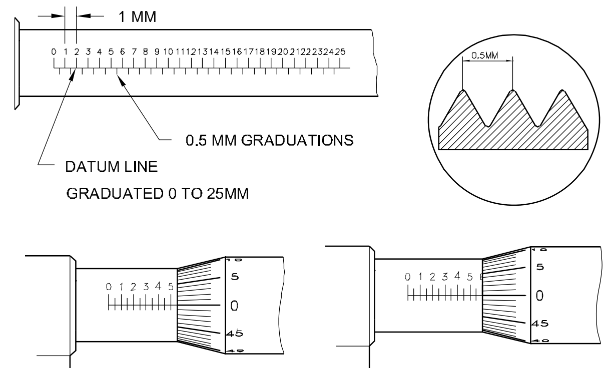
When the face of the anvil and the face of the spindle are in contact, the O graduations of the index line and O graduation of the thimble coincide with each other.

The spindle may be withdrawn by rotating the thimble in an anticlockwise direction. The thimble portion is knurled to provide a good grip for holding as well as for rotating the spindle.

Deriving the least count of a metric micrometer

The main scale is graduated in ½ mm. Every 5th mm is shown with the reading. The pitch of the screw thread is accurately maintained to ½ mm.(Fig 4)

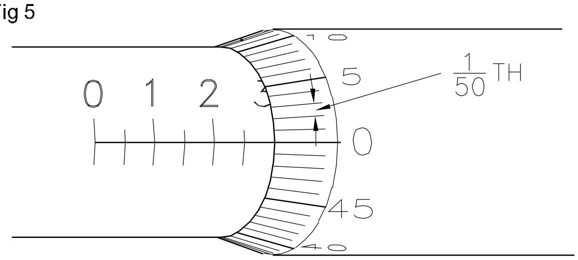
Fig 4



NOTE RELATIVE POSITIONS OF SLEEVE GRADUATIONS

MDN120614

Fig 5



THIMBLE GRADUATED INTO 50 PARTS

MDN120615

By turning one complete revolution of the thimble in a clockwise or an anticlockwise direction, the spindle moves exactly ½ mm in the forward direction or the reverse direction. As the circumference of the thimble graduated into 50 equal divisions, the advancement of the spindle for each division of the thimble scale is ½ mm - 50 i.e. 1/100 mm or 0.01 mm. Therefore, the least count of a metric micrometer is 1/100 mm or 0.01 mm.(Fig 5)

Determining the reading of a metric micrometer

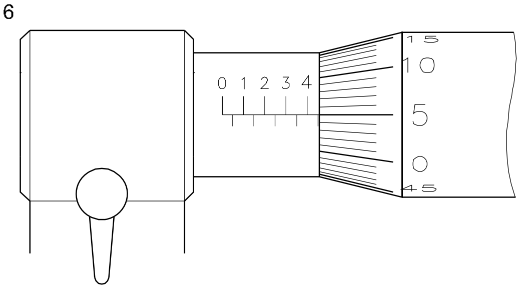
Before using the micrometer for measurement, it is necessary to ascertain that there is no error in the micrometer.

The faces of the anvil spindle must be free from dust.

While reading the micrometer, the spindle must be locked with the reading.

Method of reading

Fig 6



EACH MAJOR DIVISION ON BARREL =1 MM READING IS 4 = 4 MM

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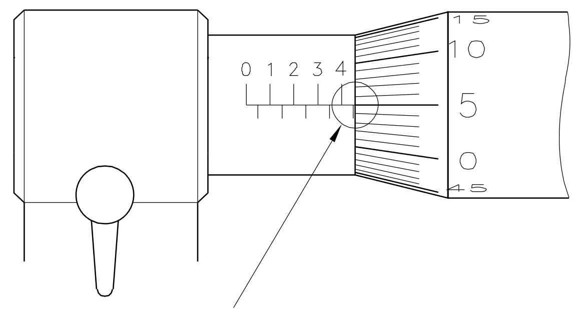
Read on the barrel scale the number of whole millimeters that are completely visible from the bevel edge of the thimble. It reads 4 mm. (Fig 6)

Add to this any half millimeters that are completely visible from the bevel edge of the thimble.

The figure reads ½ = 0.5 mm

Add the thimble reading to the two earlier readings.(Fig 7)

Fig 7



PLUS ADDITIONAL MINOR DIVISIONS. READING IS 1=0.5 MM

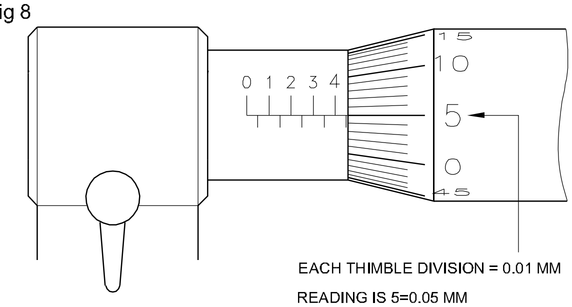
MDN120617

The figure shows the 5th division of the thimble is coinciding with the index line of the sleeve. Therefore the reading of the thimble is 5 8 0.01 mm = 0.05 mm. The total reading of the micrometer.(Fig 8)

a 4.00 mm

b 0.50 mm
c 0.05 mm
Total reading 4.55 mm

Fig 8

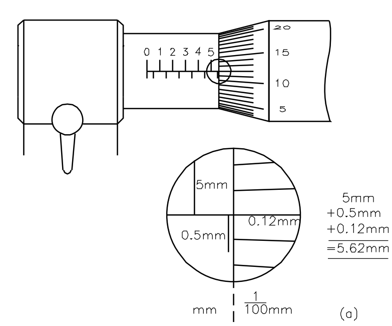


EACH THIMBLE DIVISION = 0.01 MM
READING IS 5=0.05 MM
TOTAL READING = 4.55 MM

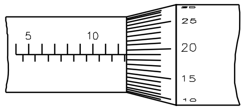
MDN120618

Some examples of metric micrometer readings and their solution.

i)	5.00 mm
	0.50 mm
	0.12 mm
Total	5.62 mm

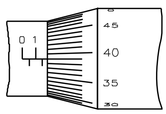


ii) 12.00 mm
0.50 mm
0.19 mm
Total 12.69 mm



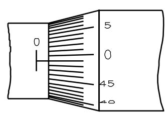
12.69 mm (b)

iii) 23.00 mm
0.50 mm
0.49 mm
Total 23.99 mm



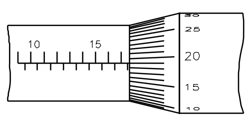
1.89 mm (d)

iv) 1.00 mm
0.50 mm
0.39 mm
Total 1.89 mm



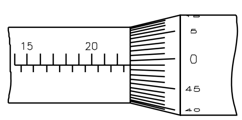
0.50 mm (f)

v) 5.00 mm
0.50 mm
0.00 mm
Total 5.50 mm



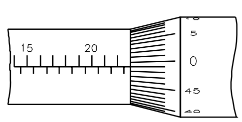
19.55 mm (h)

vi) 0.00 mm
0.50 mm
0.00 mm
Total 0.50 mm



21.14 mm (j)

vii) 7.00 mm
0.00 mm
0.22 mm
Total 7.22 mm

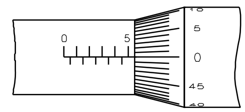


23.99 mm (c)

Outside micrometers have limited reading capacity as they are dependent upon the length of the spindle which itself is limited and fixed.

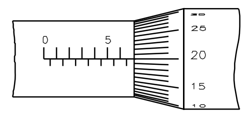
A 0-25 mm capacity outside micrometer can read a maximum dimension of 25 mm. For measuring sizes over and above this, we have to change to the next capacity micrometer 25-50 mm, then 50-75 mm and so on depending on the size of the job. As such, a good number of micrometers will have to be used for finishing jobs of various dimensions. In order to eliminate this problem, a large micrometer is used for measurements.

viii) 19.00 mm
0.50 mm
0.05 mm
Total 19.55 mm



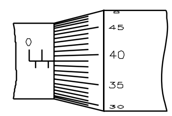
5.50 mm (e)

ix) 2.00 mm
0.50 mm
0.25 mm
Total 2.75 mm



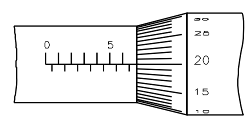
7.22 mm (g)

x) 21.00 mm
0.00 mm
0.14 mm
Total 21.14 mm



2.75 mm (i)

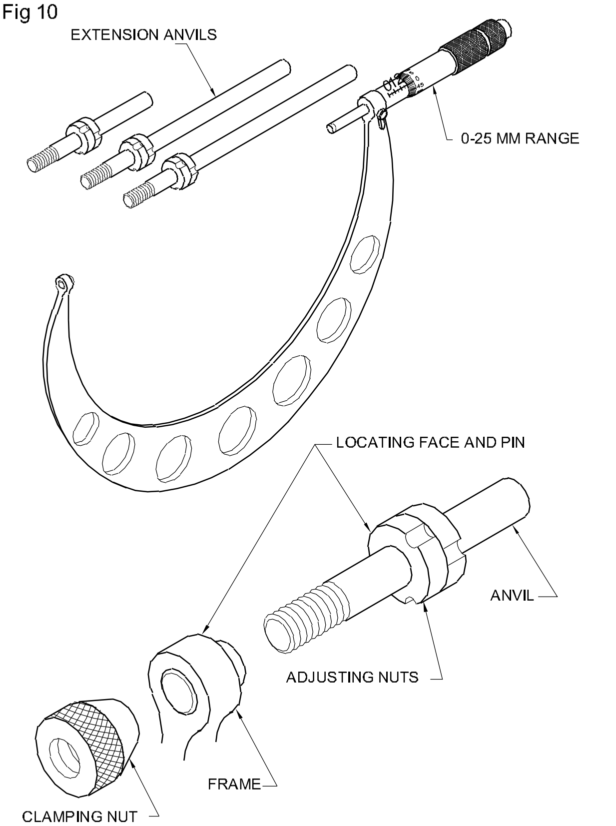
xi) 9.00 mm
0.00 mm
0.10 mm
Total 9.10 mm



9.10 mm (k)

Large micrometers (Fig 10)

Fig 10



Skill Information

Precision Measuring Instruments - Outside Metric Micrometer

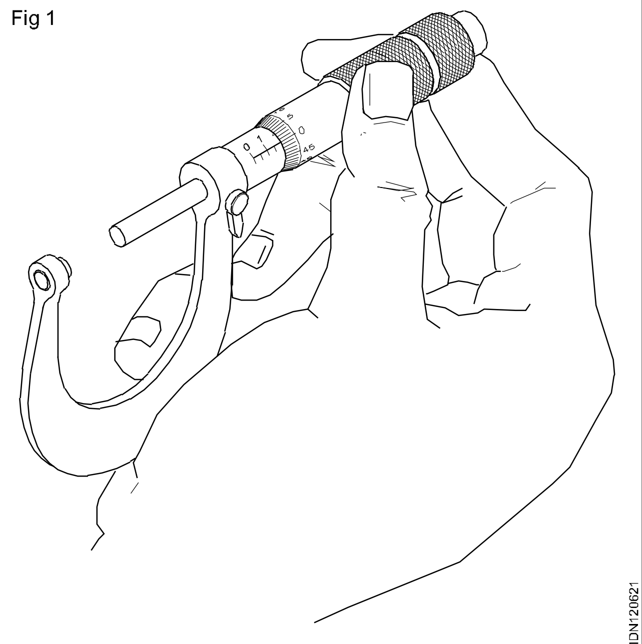
Objectives At the end of this lesson you shall be able to
- **hold the micrometer for measurement**
- **set the micrometer on work for measurement**
- **read the measurement.**

Holding the micrometer for measurement

The micrometer may be held either in one hand or both the hands.

Holding In one hand (Fig 1)

Fig 1



Hold the outside micrometer in your right hand, keeping the graduations on the main scale towards you.

Support the frame on the lower centre of your palm. Use your little or third finger to hold the frame in the palm.

Place the middle finger behind the frame to support it.

Keep the first finger and thumb free to adjust the knurled thimble.

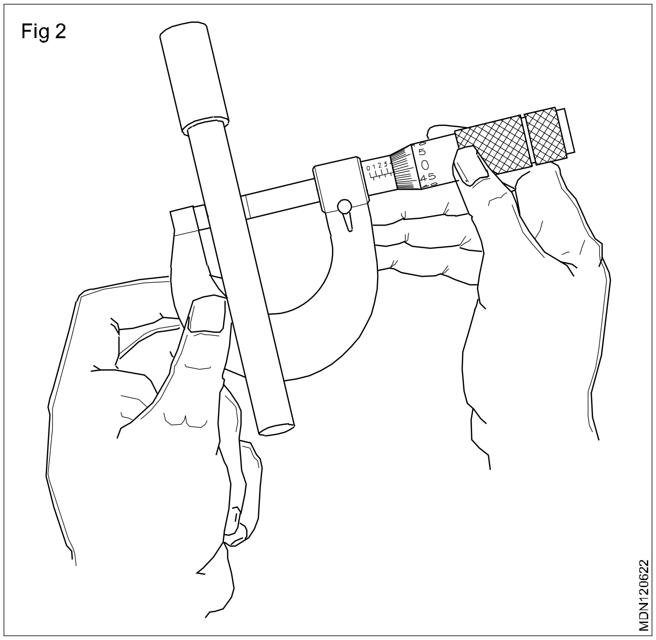
Holding by both the hands (Fig 2)

Sometimes, it may be more convenient to hold the micrometer with both the hands.

Support the frame between the fingers and the thumb of your left hand.

Use the thumb and finger of your right hand to adjust the thimble.

Fig 2



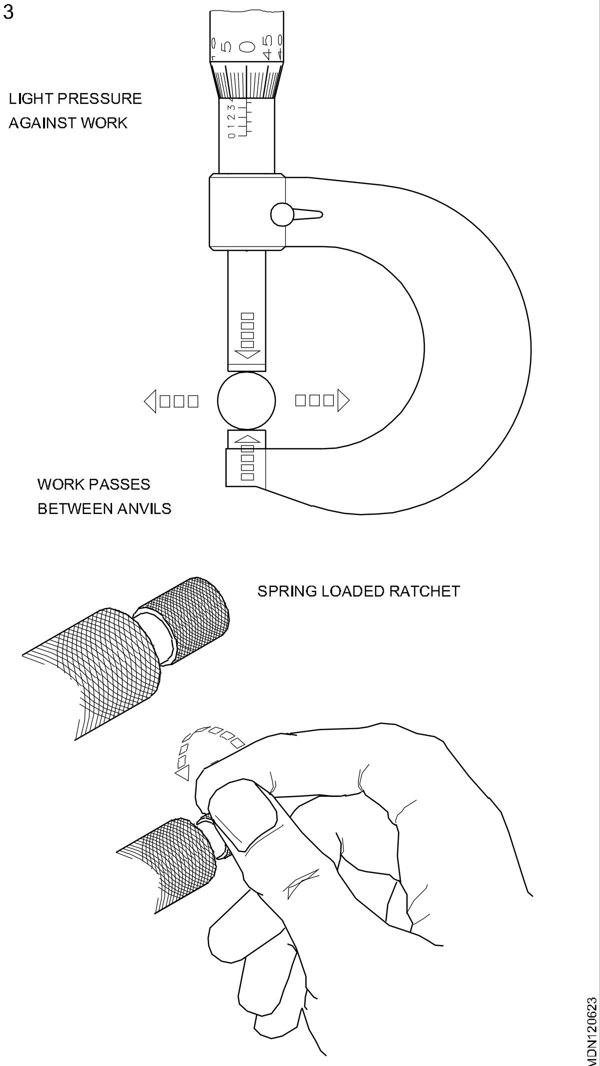
Setting the micrometer on the workplace for measurements (Fig 3**)**

High skills needed for obtaining accurate measurements with the outside micrometer. A wrong setting of the micrometer over the workplace may cause:

- inaccurate reading
- excessive strain on the screw thread
- distortion in the frame.

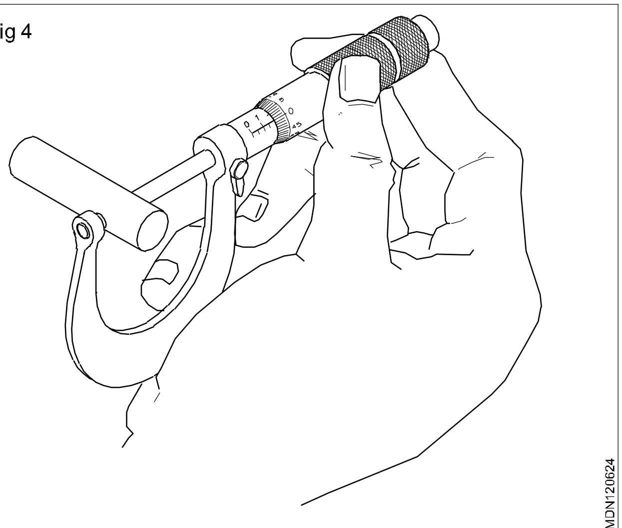
Figure shows the adjustment of the spindle and anvil over workplace. As you adjust the workplace between the spindle and the anvil, you should feel a light pressure or resistance against the workplace surface. Use the spring loaded ratchet stop to ascertain the feel.

Fig 3



While using only one hand: (Fig 4**)**

Fig 4



- Close the anvil and spindle until you feel them just touching the work
- Move the work slightly between the spindle and the anvil or pass the micrometer over the workplace by moving your wrist
- Make further adjustments of the thimble as required until you obtain the right 'feel'
- When satisfied with the feel, remove the fingers from the thimble
- Turn the micrometer towards you
- read the measurement

Method of reading the micrometer 0-25 range (Fig 5)

Look at the reading which has been taken from the workplace.

Read on the barrel scale the number of whole millimeters that are completely visible from the bevel edge of the thimble. Figure 'a' shows 4 divisions = 4 mm.

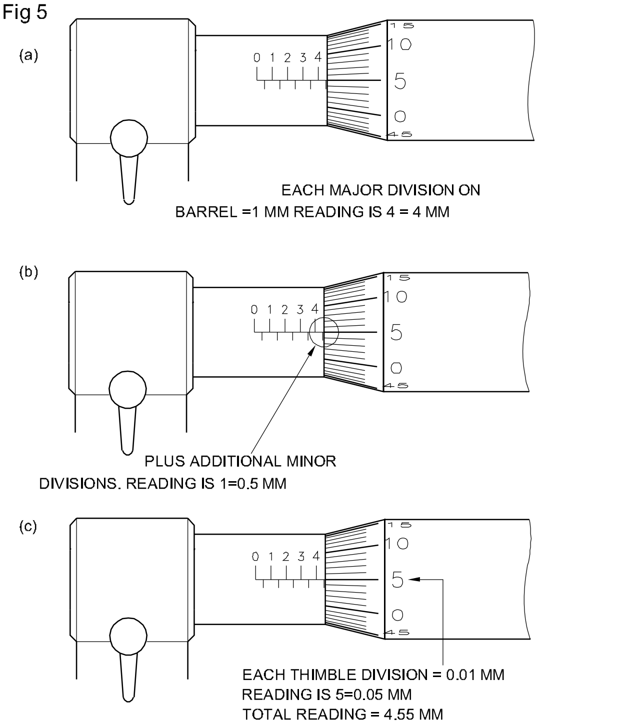
Add any half millimeters that are completely visible from the bevel edge of the thimble.

Figure 'b' shows 1 division = 0.5 mm.

Add the thimble reading to the main scale reading which has already been taken. Figure 'c' shows the 5th division of the thimble scale is coinciding with the index line. So thimble reading = 5 * 0.01 = 0.05 mm.

	4. 00 mm
	0.50 mm
	0.05 mm
Total reading	4.55 mm

Fig 5



Depth micrometer

Objectives: At the end of this lesson you shall be able to
- **name the parts of a depth micrometer**
- **state the constructional features of a depth micrometer**
- **read the depth micrometer measurement.**

Constructional features (Fig 1)

A depth micrometer consists of a stock on which a graduated sleeve is fitted.

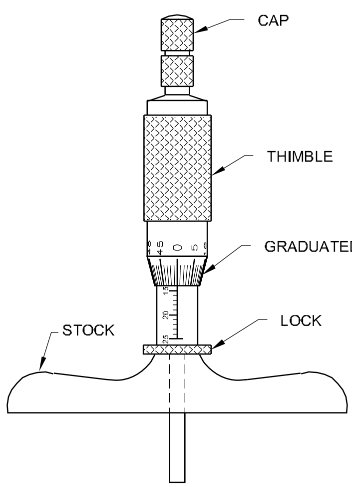
The other end of the sleeve is threaded with 0.5 mm pitch 'V' thread.

A thimble, which is internally threaded to the same pitch and form, mates with the threaded sleeve and slides over it.

The other end of the thimble has an external step machined and threaded to accommodate a thimble cap.

A set of extension rods are generally supplied. On each of them, the range of sizes that can be measured with that rod is engraved as 0-25 mm, 25-50 mm, 50-75 mm, 75-100 mm, 100-125 mm and 125-150 mm.

Fig 1



These extension rods can be inserted inside the thimble and the sleeve.

The extension rod has a collar head which helps the rod to be held firmly. (Fig 2)

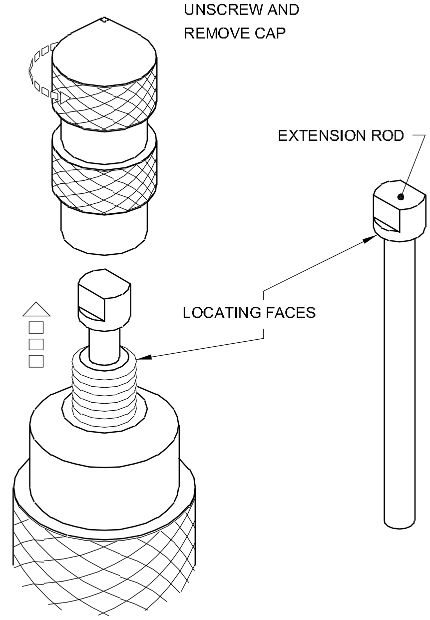
The measuring faces of the stock and the rods are hardened, tempered and ground. The measuring face of the stock is machined perfectly flat.

The extension rods may be removed and replaced according to the size to be measured.

Graduation and least count

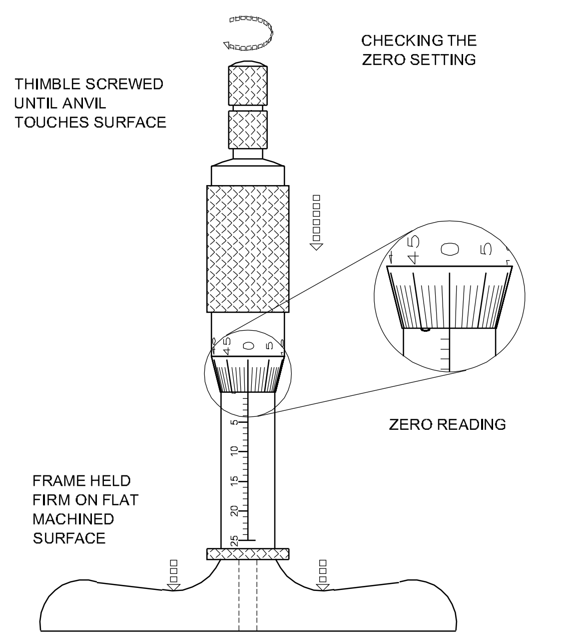
On the sleeve a datum line is marked for a length of 25 mm. This is divided into 25 equal parts graduated. Each

Fig 2



line represents one millimeter. Each fifth line is drawn little longer and numbered. Each line representing 1mm is further subdivided into two equal parts. Hence each subdivision represents 0.5 mm. (Fig 3)

Fig 3

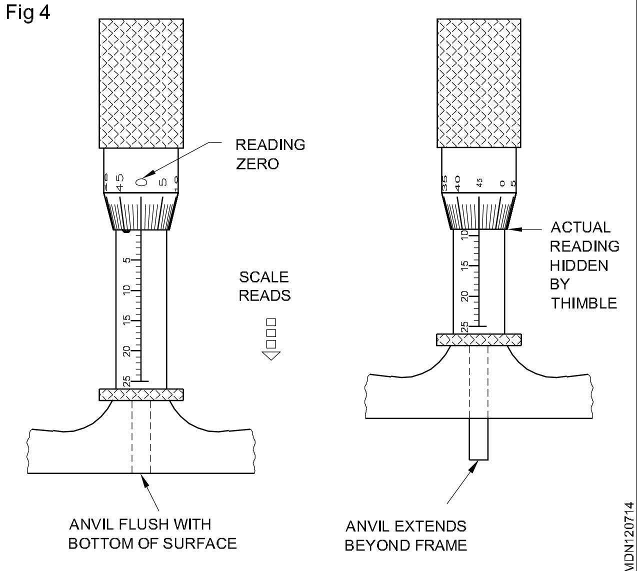


The graduations numbered are in the reverse direction to that marked on an outside micrometer.

The zero graduation of the sleeve is one the top and the 25 mm graduation is near the stock.

The bevel edge of the thimble is also graduated. The circumference is divided into 50 equal parts and every 5th division line is drawn longer and numbered. The numbering is in the reverse direction and increases from 0 to 5, 10, 15, 25, 30, 35, 40, 45 and 50 (0). (Fig 4)

Fig 4



The advancement of the extension rod for one full turn of the thimble is one pitch which is 0.5 mm.

Therefore the advancement of the extension rod for one division movement of the thimble will be equal to 0.5 / 50 = 0.01 mm.

This will be the smallest measurement that can be taken with this instrument, and so this is the accuracy of measurement of this instrument.

Uses of a depth micrometer

Depth micrometers are special micrometers used to measure:

- Depth of holes
- depth of grooves and recesses
- heights of shoulders and projections.

Description least count, calculation, care and use of vernier caliper

Objectives: At the end of this lesson you shall be able to
- **state the principle of vernier**
- **define least count**
- **derive the least count of vernier scales.**

The vernier principle

The basic principle of the vernier is that the smallest unit of size to which a vernier can be read is equal to the difference in the length between the divisions of the two scales.

The magnification on the vernier scale is given by two scales sliding over each other; the eye can detect which divisions on one of them are smaller than those on the other. The eye can detect which of these divisions are in line with each other, and it is this fact which enables us to read a vernier to 0.02 mm accuracy.

Fig 1

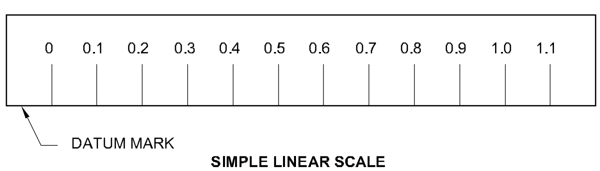


Figure 1 show the vernier principle being used to determine the reading. Figure 1 shows the main scale with the datum line marked.

Fig 2

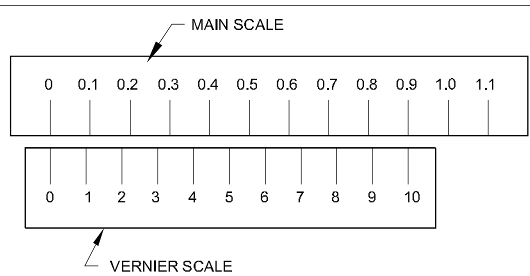


Figure 2 shows the main scale and vernier scale with graduations. The value of 1 main scale is 0.1 unit. In vernier scale 9 such units are taken and divided into 10 equal parts. Hence the value of 1 vernier scale is

$$0.9/10=0.09 \text{ units}$$

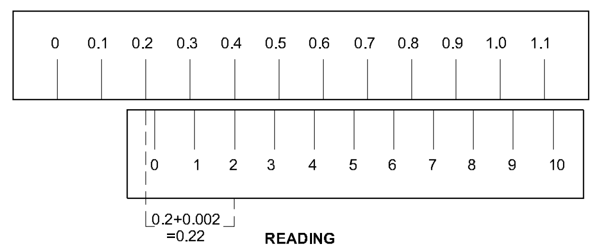
Now, by applying the vernier principle, the smallest unit of size is 1 M.S.D. - 1 V.S.D. (i.e.) 0.1 - 0.09=0.01 unit.

Definition of the least count

The least count is the smallest possible measurement that can be taken with the precision instrument.

Figure 3 shows the method of reading the vernier scale. The zero of the vernier scale is between 0.2 to 0.3 units

Fig 3



on the main scale and number 2 graduation of the vernier scale is coinciding with the 4th division of the main scale. Thus the reading is 0.2 + 2 * 0.01=0.22.

Fig 4

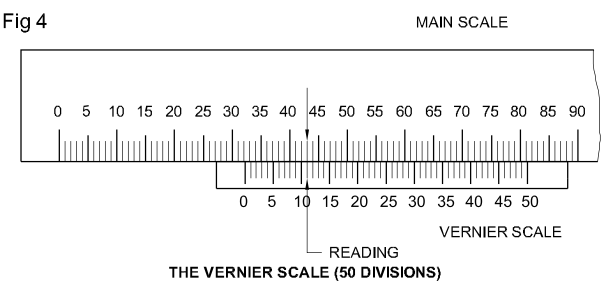
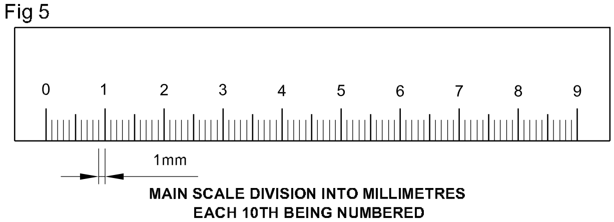


Figure 4 shows a typical 50 division vernier scale as used in modern metric measurements.

Fig 5



The main scale of this instrument is graduated in mm.

The purpose of a vernier 49 such divisions are … divided into 50 equal divisions. So the value of vernier scale division works out to 49/50 mm (Fig 6).

Fig 6

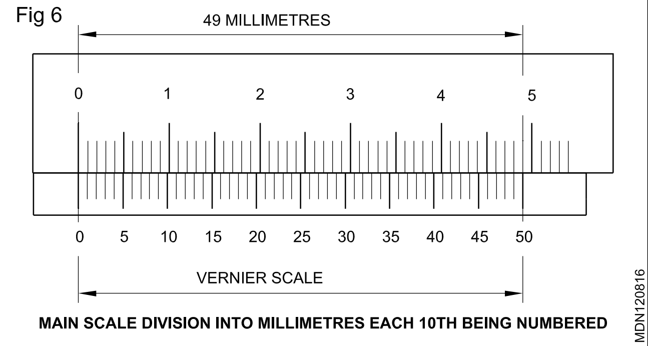
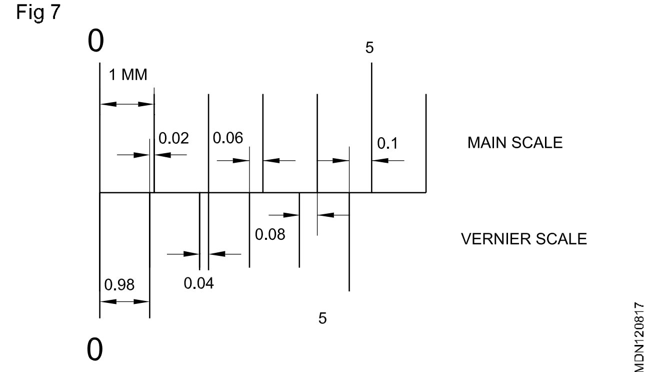


Fig 7



Least count is 1 main scale division - 1 vernier scale division (Fig 7).

which is $1\text{mm} - \frac{49}{50}\text{mm} = \frac{50 - 49}{50} = \frac{1}{50} = 0.02\,\text{mm}$

In that case of 150 mm capacity vernier calipers the main callers graduated in ½ mm instead of in 1 mm. For the purpose of the vernier scale 24 such divisions are taken and divided into 25 equal divisions. So the value of 1 vernier scale division is

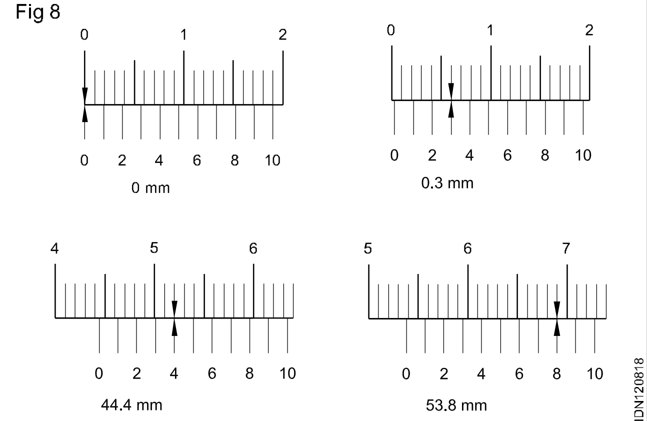
$$\frac{1}{2} \times \frac{24}{25} = \frac{12}{25}\text{mm}$$

Least count = 1 M.S.D. - 1 V.S.D.

$$\frac{1}{2}\text{mm} - \frac{12}{25}\text{mm} = \frac{25 - 24}{50} = \frac{1}{50} = 0.02\text{mm}$$

Measurement of reading (Fig 8)

Fig 8

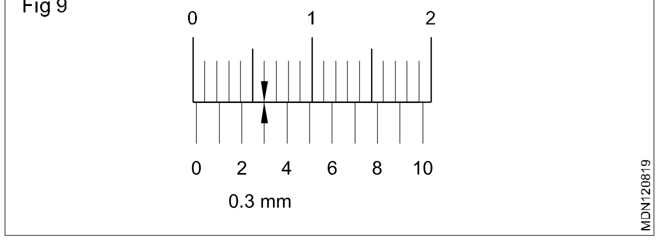


It is 0 mm as 'O' of vernier scale and 'O' of the main scale if that coincide.

Measurement of reading (Fig 9 & 10)

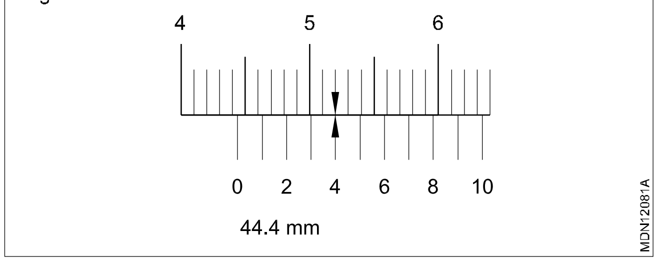
'O' of vernier is to the right of the main scale and lies between 'O' and 1st division of the main scale. The 3rd division of the vernier scale coincides with a division on the main scale.

Fig 9



Hence measurement is 0 mm + 3 * 0.1 mm = 0.3 mm.

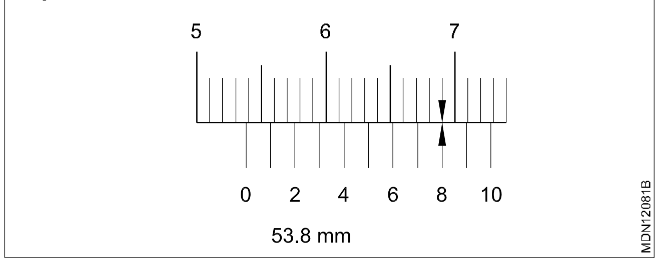
Fig 10



Measurement of reading (Fig 11)

'O' of the vernier scale lies between the 44th and 45th divisions of the main scale and the 4th division of the vernier scale coincides with a division of the main scale. Hence the measurement is 44 mm + 4 * 0.1 mm = 44.4

Fig 11



Measurement of reading

'O' of the vernier scale lies between the 53rd and 54th divisions on the main scale, and the 8th division of the vernier scale coincides with a division on the main scale. Hence measurement is 53 mm + 8 * 0.1 mm = 53.8 mm.

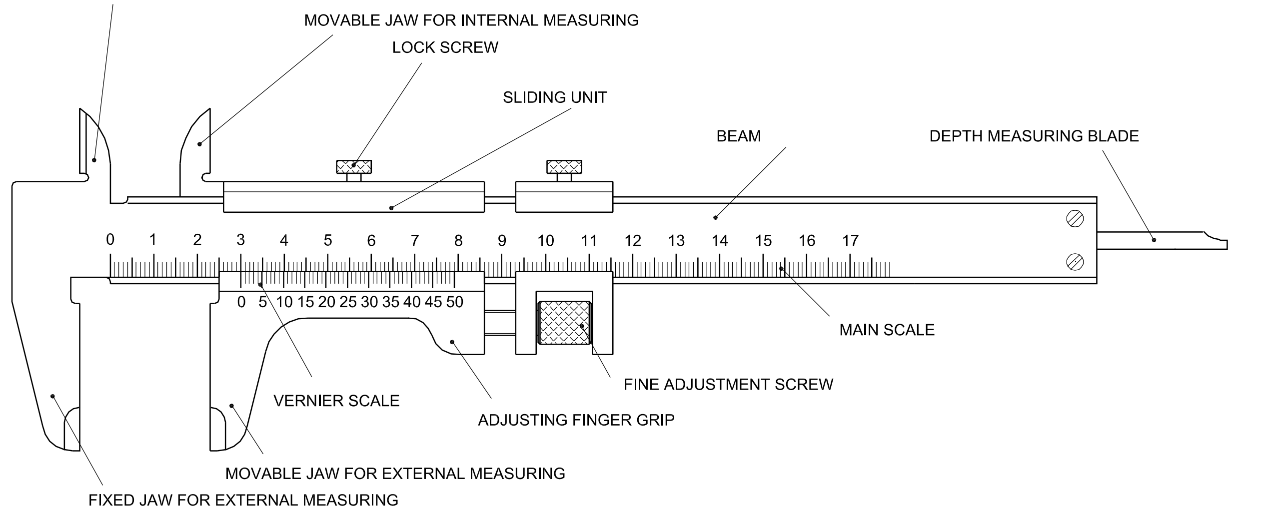
The least count of the vernier caliper used for the above readings is 0.1 mm.

The universal vernier caliper and its application

Objectives: At the end of this lesson you shall be able to
- **list out the parts of a universal caliper**
- **state the constructional features of the universal vernier caliper**
- **state its functional features**
- **list out the points for taking the measurements.**

One of the precision instruments having the principle of vernier applied to it is the universal vernier caliper. It is known as a universal vernier caliper because of its application to take outside, inside and depth measurements. Its accuracy is 0.02 mm.

Fig 1



A universal vernier caliper consists of a:

- Beam
- Fixed jaw for external measurements
- Movable jaw for external measurements
- Movable jaw for internal measurements
- Blade for depth measurement
- Main scale
- Vernier scale
- Fine adjustment screw
- Set of locking screws.

All parts are made out nickel-chromium steel, heat-treated and ground. They are machined to a high accuracy. They are stabilized to avoid distortion due to temperature variations.

Constructional features (Fig 1)

The beam is the main part and the main scale graduations are marked on it. The markings are in millimeters and every tenth line is drawn a little longer and brighter than the other graduations and numbered as 1,2,3 ….

To the left of the beam the fixed jaws for external and internal measurements are fixed as integral parts., The vernier unit slides over the beam.

At the bottom face of the beam a keyway-like groove is machined for its full length, permitting the blade to slide in the groove.

At the bottom right hand end, a unit is fixed serving as a support for the blade when it slides in the groove.

The vernier unit has got the vernier graduations marked on it. The movable jaws for both external and internal measurements are integral with this.

The fixed and movable jaws are knife-edged to have better accuracy during measurement. When the fixed and movable jaws are made to contact each other, the zero of the vernier scale coincides with the zero of the main scale.

At this position in the blade will be in line with the right hand edge of the beam.

When the vernier scale unit slides over the beam, the movable jaws of both the measurements as well as the blade advance to make the reading.

To slide the vernier unit, the thumb lever is pressed and pulled or pushed according to the direction of movement of the vernier unit.

Least count

In the vernier scale illustrated here, 19 mm are divided into 10 equal parts on the vernier scale. The value of 1 vernier scale division will then be

$$\frac{19}{10} = 1.9\text{mm}$$

The difference of the two main scale divisions and 1 vernier scale division gives the least count and it is equal to 2*1m -1.9 mm = 0.1 mm.

For better accuracy, a 49 mm space is divided into 50 equal parts on the vernier scale so that one vernier scale division value will be

$$\frac{49}{50} = 0.98\,\text{mm}$$

Here the least count will be 1 main scale division - 1 vernier scale divisions = 1 mm-0.98 mm= 0.02 mm.

The application of the universal vernier caliper is taking external, internal and depth measurements is shown in (Fig 2)

Advantages

No need to have separate precision instruments for taking external, internal and depth measurements.

Disadvantages

Accuracy of reading depends on the skill of the operator.

Loses its accuracy by constant usage as slackness in the sliding unit develops.

Cannot be used to measure components having deviations less than +/-0.02 mm.

Possibility of parallax error during noting down the coinciding line may cause the reading of the measurement to be wrong.

To read a measurement

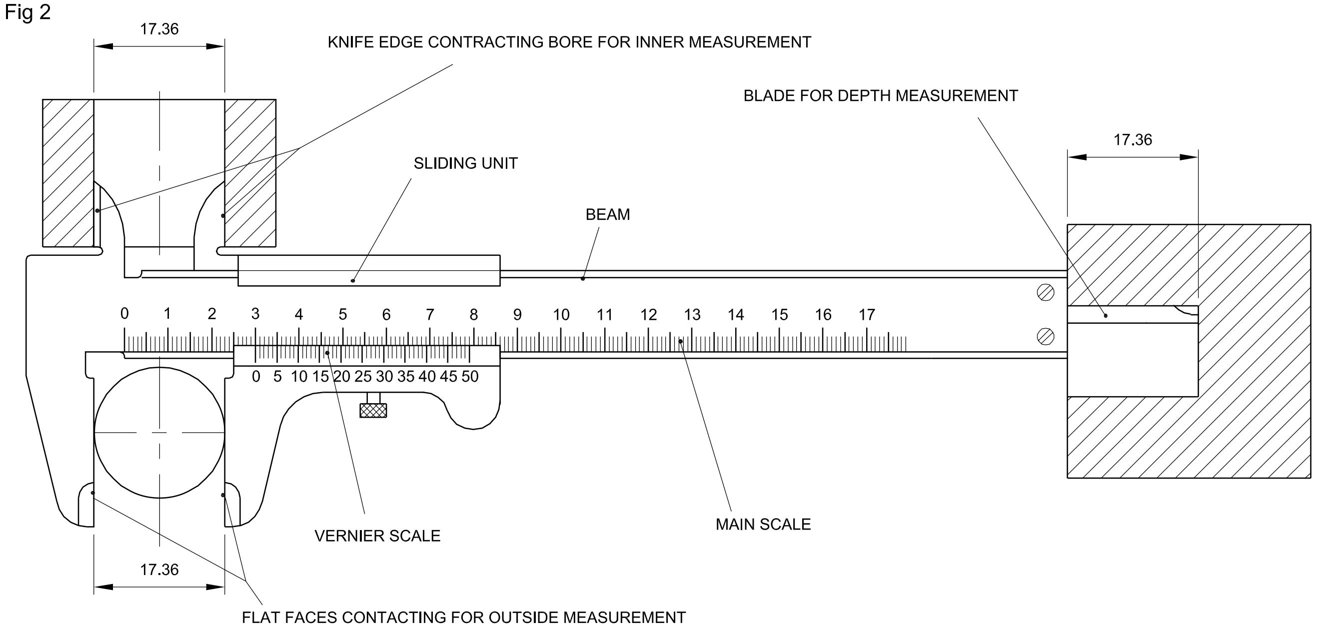
Note the number of graduations on the main scale passed by the zero of the vernier. This gives the full mm.

Note which of the vernier scale division coincides with any one line on the main scale.

Multiply this number with the least count.

Add the multiplied value to the mainscale reading.

Fig 2



Telescope gauge

Objectives: At the end of this lesson you shall be able to
- **name the parts of telescope gauge**
- **Measuring technique how to telescope gauge reading on outside micrometer**

Telescopic Gauge (Fig 1) **:** This is an instrument used for measuring the inside size of slots or holes. It consists of a handle and two plungers, one of which telescopes into the other. Both the plungers are kept under spring tension. In order to lock the plungers in position, a knurled screw at the end of the handle is tightened. If the diameter of a hole is to be measured, the plungers are first compressed and then locked. The plunger end is put into the hole and the end is allowed to expand so that the plungers touch the opposite edges.

Then the plungers are locked in position and taken out of the hole. The diameter is measured with the help of an outside micrometer. The telescopic gauge does not have graduations of its own.

The precaution to be taken in the telescopic gauge in that they should be inserted squarely on to the bore and centralised properly.

Measuring Technique

(a) Compress the fixed and telescopic legs and lock them by locking screw.

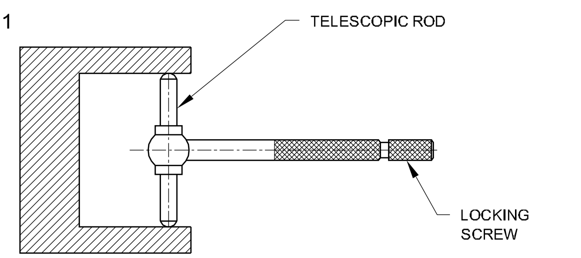
(b) Insert the gauge ends into the hole to be measured.

(c) Unlock the legs by unscrewing the locking screw for expanding the legs to the inner diameter of the hole.

(d) Measure with feel and lock the legs in position.

(e) Transfer the measurement to an outside micrometer for reading.

Fig 1



TELESCOPIC GAUGE

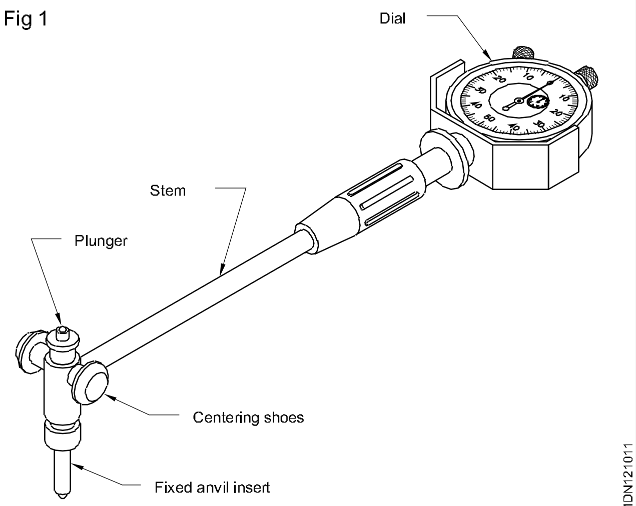
Dial bore gauge

- **name the parts of a bore dial gauge**
- **state the features of a bore dial gauge**
- **read the measurement using a graduated dial.**

This is a precision measuring instrument used for measuring the internal dimensions. The dial bore gauge is normally available as a two-point, self-cantering type

Dial bore gauge (Fig 1) **:**

Fig 1



Stem

This holds all the components together and contains the mechanism for transmitting the plunger motion to the dial.

Fixed anvil/inserts

These anvils are interchangeable. The selection of the anvil is made depending on the diameter of the bore to be measured. For certain types of bore dial gauges, extension rings/washers are provided for extending the range of measurement.

Sliding plunger

This actuates the movement of the dial for reading the measurement.

Centering shoes/spherical supports

Certain types of bore dial gauges are provided with a pair of ground discs. (Fig 2)

This maintains the alignment of the measuring faces in the centre of the bore. For some types, two spherical supports which are spring-loaded are provided.

Dial Indicator (Fig 3)

This has graduations marked on the dial. The graduations has marked in clockwise and anticlockwise directions.

Bore dial gauges are available in various sizes with different measuring ranges. These are interchangeable measuring rods (external rods or combination washers) for measuring different sizes. (Fig 4)

Fig 2

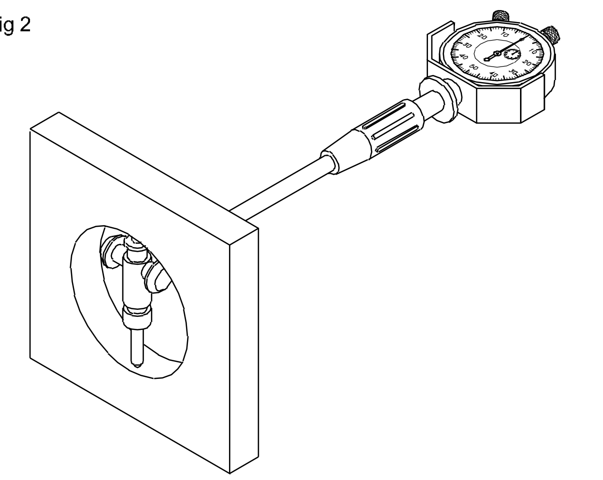


Fig 3

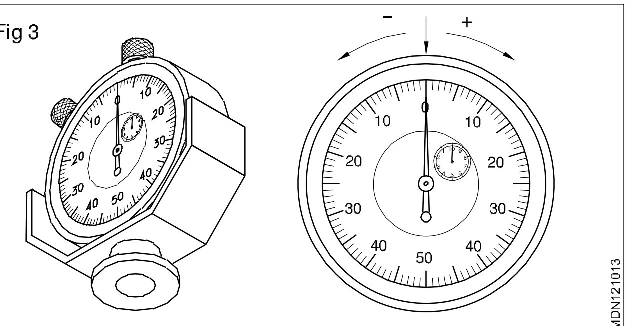
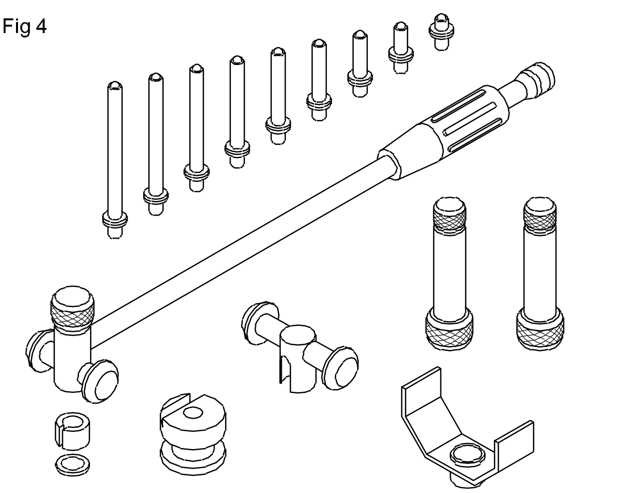


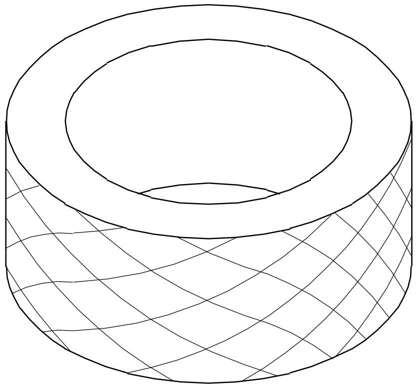
Fig 4



The accuracy of the instrument depends on the type of graduations on the dial. The most frequently used instruments have accuracies of 0.001 mm and 0.01 mm.

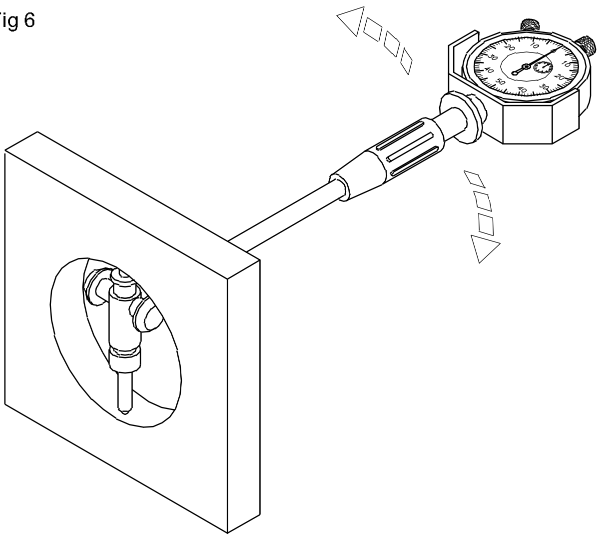
The dial gauge should be set to zero before taking measurement. Setting rings are available for zero setting. (Fig 5)

Fig 5



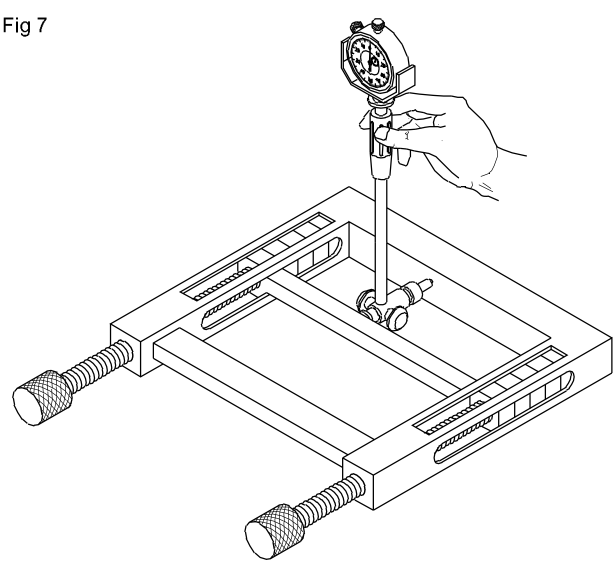
While taking measurements press the spring-loaded end (plunger) as it enters into the setting device or in the bore being measured. Slightly rock and steady the device for keeping the measuring faces in position. (Fig 6)

Fig 6



Slip gauges fixed in a setting fixture can also be used for zero setting. (Fig 7)

Fig 7

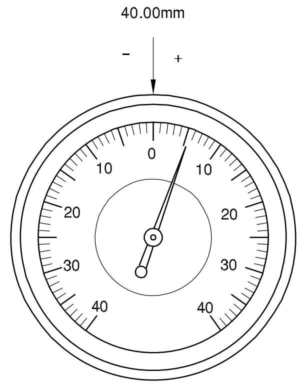


Reading the dial indicator (Fig 8)

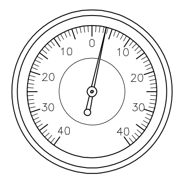
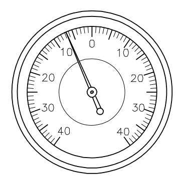
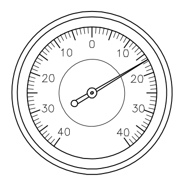
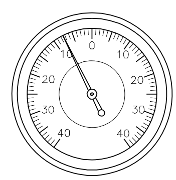
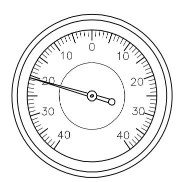
When taking the reading, first check the measuring range and the subdivisions of the scale. The indicator in the figure has a range of 0.8 mm and is graduated 0-40 in both directions. Thus the value of each division is 0.01 mm.

The indicator shows positive deviations in the clockwise direction and negative deviations in the anticlockwise direction.

Fig 8



Classroom assignment

Basic measurement		Value measured	
30.0 mm		29.97 - 29.98	☐
		30.02 - 30.03	☐
		30.03 - 30.04	☐
		30.04 - 30.05	☐
23.0 mm		22.92 - 22.93	☐
		22.93 - 22.94	☐
		22.94 - 22.95	☐
		22.96 - 22.97	☐
47.8 mm		47.86 - 47.87	☐
		47.88 - 47.89	☐
		47.92 - 47.93	☐
		47.96 - 47.97	☐
53.0 mm		52.92 - 52.93	☐
		52.93 - 52.94	☐
		53.96 - 53.97	☐
		53.97 - 53.98	☐
65.0 mm		64.75 - 64.76	☐
		64.79 - 64.80	☐
		64.83 - 64.84	☐
		64.87 - 64.88	☐

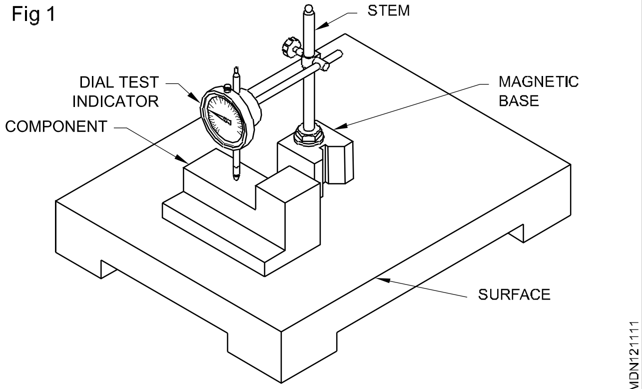
Dial test indicators

Objectives: At the end of this lesson you shall be able to
- **state the principle of a dial test indicator**
- **state the types of dial test indicator**
- **identify the parts of a dial test indicator**
- **state the important features of a dial test indicator**
- **state the functions of a dial test indicator**
- **identify the different types of stands.**
- **state the important of straight edge**

Dial test indicators

Dial test indicators are instruments of high precision, used for comparing and determining the variation in the sizes of a component. These instruments cannot give the direct reading of the sizes like micrometers and vernier calipers. A dial test indicator magnifies small variations in sizes by means of a pointer on a graduated dial. This indirect reading of the deviations gives an accurate picture of the conditions of the parts being tested. (Fig 1)

Fig 1



Principle of working

The magnification of the small movement of the plunger or stylus is converted into a rotary motion of the pointer on a circular scale.

Types

Two types of dial test indicator4s are in use.

They are the

- Plunger type (Fig 2)
- Lever type. (Fig 3,4 & 5)

The plunger type dial test indicator

The external parts and features of a dial test indicator are as shown in the (Fig 2).

Pointer (A)

Rotatable bezel (B)

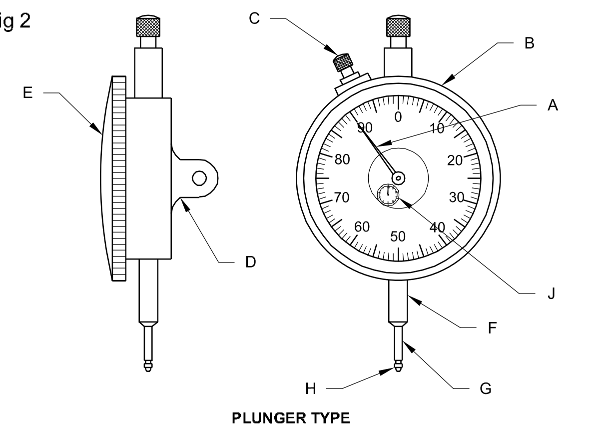
Bezel clamp (C)

Back lug (D)
Transparent dial cover (E)
Stem (F)
Plunger (G)
Anvil (H)

Revolution counter (J)

For converting the linear motion of the plunger, a rack and pinion mechanism is used.

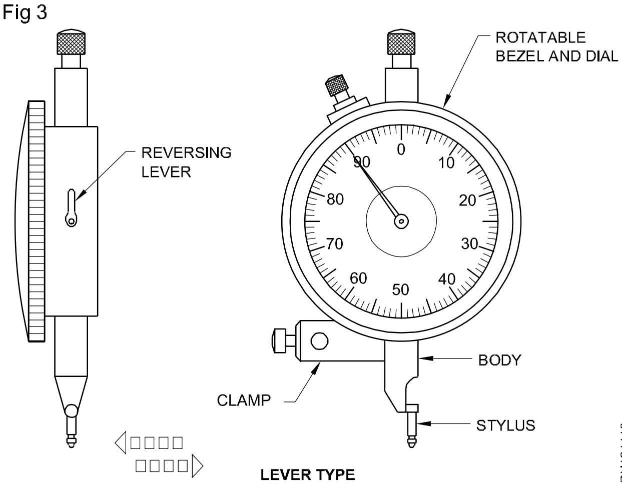
Fig 2



The lever type dial test indicator (Fig 3,4,5)

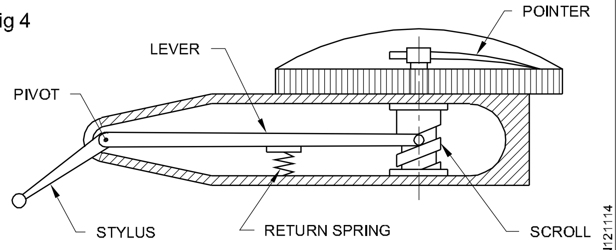
In the case of this type of dial test indicators, the magnification of the movement is obtained by the mechanism of the lever and scroll.

Fig 3



It has a stylus with a ball-type contact, and it has an oscillating movement as against the reciprocating movement in the plunger type indicator.

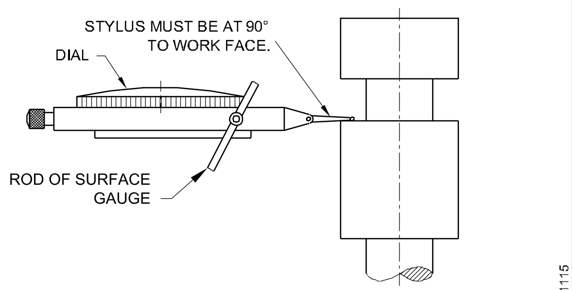
Fig 4



MECHANISM OF THE LEVER TYPE DIAL TEST INDICATOR

This can be conveniently mounted on a surface gauge stand, and can be used in places where the plunger type dial test indicator application is difficult.

Fig 5



WORK PIECE WITH RECESS INACCESSIBLE TO PLUNGER TYPE DIAL INDICATOR

Important features of dial test indicators

An important feature of the dial test indicator is that the dial can be rotated by a ring bezel, enabling the zero to be get in any position.

Many dial test indicators read plus in the clockwise direction from zero, and minus in the anticlockwise direction so as to give plus and minus indications.

Uses

- To compare the dimensions of workpiece against a known standard, eg. Slip gauges.
- To check plane surfaces for parallelism and flatness.
- To check straightness of shafts and bars.
- To check concentricity of holes and shafts.

Indicator stands (Fig 6 & 7)

Dial test indicators are used in conjunction with stands for holding them so that the stand itself may be placed on a datum surface or machine tool.

The different types of stands are:

- Magnetic stand with universal clamp
- Magnetic stand with flexible post
- General purpose holder with cast iron base.

Fig 6

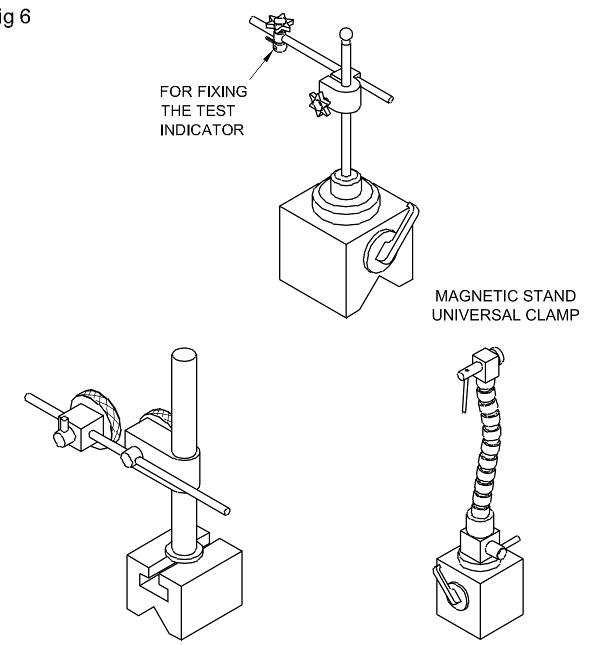
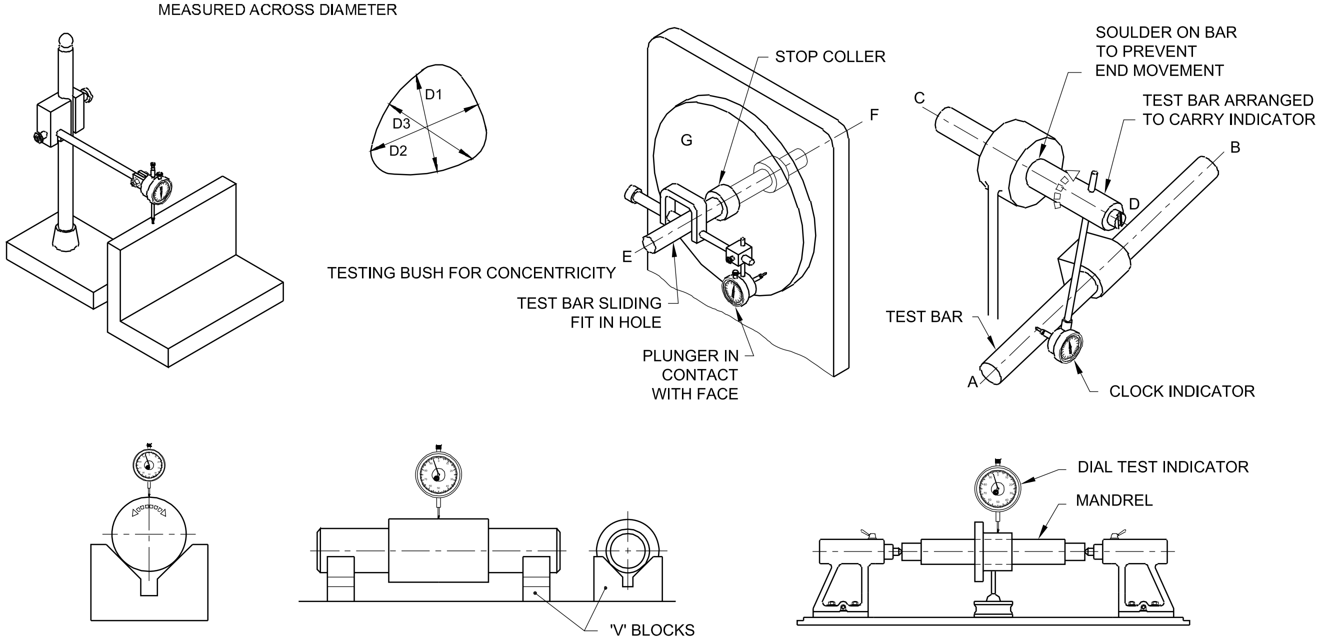


Fig 7



Straight edges

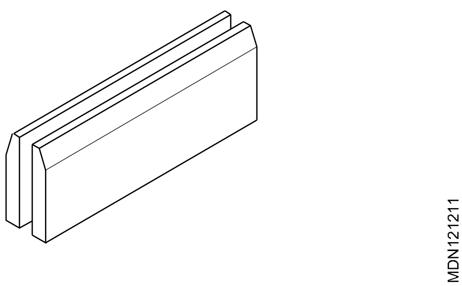
Objectives: At the end of this lesson you shall be able to
- **name the different types of straight**
- **state the straight edge uses edge**
- **state the different method of testing straightness.**

For testing straightness and to use a guide for marking long straight lines. Straight edges made of steel or cast iron are used.

Steel straight edges.

These are usually available up to 2 meters in length and may be rectangular in cross-section or have one edge beveled (Fig 1)

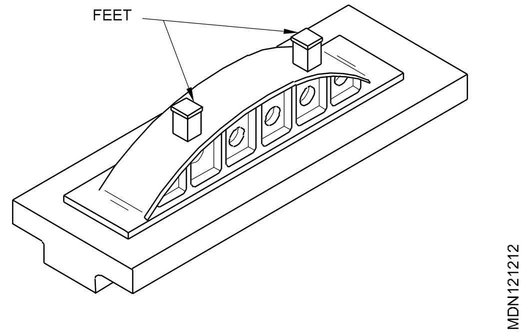
Fig 1



Cast iron straight edges (Fig 2)

These are made from close- grained, grey, cast iron and can be considered as narrow surface plates. They are available up to 3 meters length and are used for testing machine tool sideways, cast iron straight edges have ribs, and bow-shaped tops to prevent distortion. These straight edges are-shaped tops to prevent distortion. These straight edges are provided with feet to prevent distortion under their own weight.

Fig 2

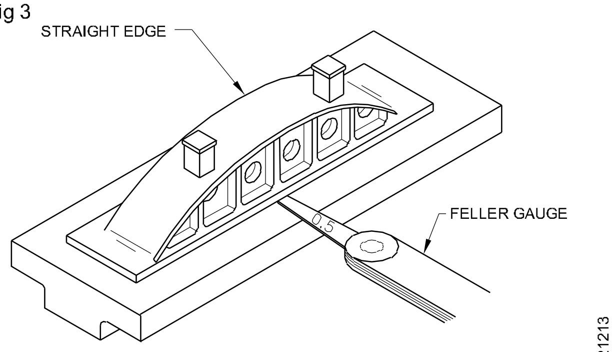


Use of straight edges

Checking with feeler gauges

In certain situations when the gap between the surface and the straight edge is more. a feeler gauge can be used (Fig 3) to determine the extent of deviation.

Fig 3



USE OF STRAIGHT EDGE -FELLER GAUGE

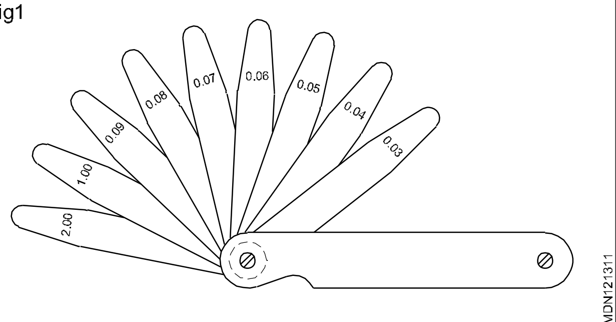
Feeler gauge & uses

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of a feeler gauge**
- **state the method of indicating different ranges of**
- **state the method of setting a feeler gauge**
- **state the different uses of feeler gauges.**

Features

A feeler gauge consists of a number of hardened and tempered steel blades of various thicknesses mounted in a steel case.

Fig1



The thickness of individual leaves is marked on it. (Fig 1)

The sizes of the feeler gauges in a set are carefully chosen in order that a maximum number of dimensions can be formed by building up from a minimum number of leaves.

The dimension being tested is judged to be equal to the thickness of the leaves used. When a slight pull is felt while with drawing them. Accuracy in using these gauges requires a good sense of feel.

B.I.S

The Indian standard establishes four sets of feeler gauges Nos.1,2,3 and 4 which differ by the number of blades in each and by the range of thickness(minimum) is 0.03mm

Example

Set No.4 of Indian standard consists of 13 blades of different thicknesses.

0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.010, 0.015, 0.20, 0.30, 0.040, 0.50.

USES

Feeler gauges are used:

- to check the gap between the mating parts
- to check and set the spark plug gaps and tappet clearance in an engine etc.
- to set the clearance between the fixture (setting block) and the cutter/tool for machining the jobs. (Fig 2,3)
- to check and measure the bearing clearance, and for many other purposes where a specified clearance must be maintained.

Fig 2

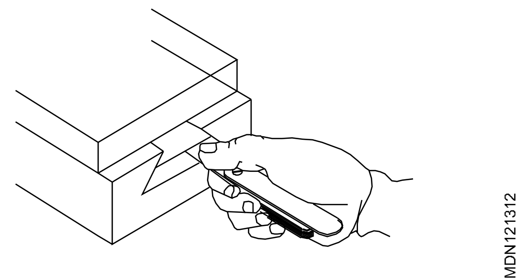
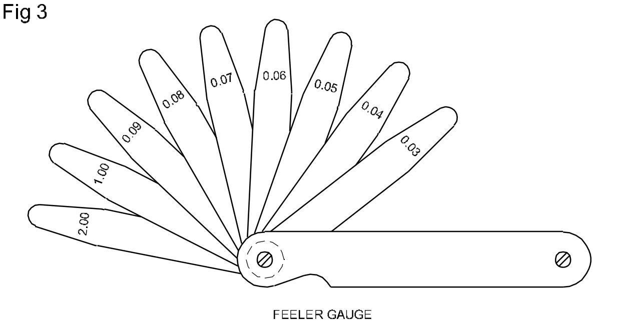
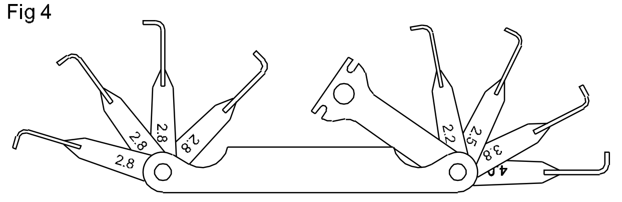


Fig 3



Wire gauge (Fig 4): The plug wire gauge is a thickness gauges using wires of varying diameter instead of thin flat strips of steel. It is used fir checking spark plug gap.

Fig 4



WIRE GAUGE SET FOR CHECKING SPARK PLUG GAP

Types of feeler gauge.

1 universal master gauge

2 standard feeler gauge

3 ignition and wire gauge

Classification of feeler gauge

- Universal master gauge containing 25 leaves
- Standard feeler gauge containing 10 leaves
- Go and No Go type feeler gauge containing 15 step-grand leaves
- Overhead valve feeler gauge containing 16 offset blades
- Ignition feeler gauge containing 12 leaves
- Piston gauge containing and leaves
- Spark plug wire gauge containing are electrode bender 8 wire gauge

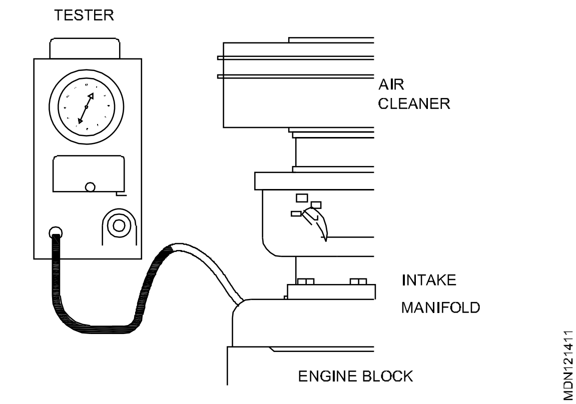
Vacuum gauge

Objectives: At the end of this lesson you shall be able to
- **state the purpose of vacuum gauge**
- **state the vacuum gauge attachment in an engine.**

A vacuum gauge (Fig 1) is a useful diagnostic and time-up tool.

It is used to detect vacuum leaks at idle speed, sticking valves, worn rings, clogged exhaust, incorrect timing and positive crank case ventilation (PCV)

Fig 1



Attaching Vacuum Gauge

At normal operating temperature connect the vacuum gauge to the intake manifold. Some manifolds incorporated a plug that may be removed so that vacuum line adopter may be installed.

- A relative study high vacuum reading indicate an absence vacuum leak in the system (i.e) values and rings are in good sealing.
- Fairly study vacuum reading indicate vacuum leak in the system (i.e) value and rings are not in good sealing.
- Vacuum reading indicate uneven, valve are burned or sticky and damaged piston or blown gasket.