Sheet metal - marking and cutting tools - rivet joints

Objectives : At the end of this lesson you shall be able to
- **state the six types of metal sheets used in sheet metal work**
- **state how the plate and the sheet are differentiated from each other.**
- **state the different types of snips and their uses**
- **state the uses of solid cold punches**
- **state the uses of self tapping screw**

A large quantity of sheet metal used in the sheet metal industry is steel, rolled into sheets of various thicknesses and coated with zinc, tin or other metals. Other than steel, the worker uses sheets made out of zinc, copper, aluminium, stainless steel etc.

The term `sheet metal' generally applies to metals and alloys in sheets rolled into various thicknesses less than 5mm. Sheets over 5 mm thick are called plates.

Earlier, the sheets were specified by standard wire gauge numbers. Each gauge is designated with a definite thickness. (Table 1) The larger the gauge number, the lesser the thickness. Now the sheet thickness is specified in mm, say 0.40, 0.50, 0.63, 0.80, 0.90, 1.00, 1.12, 1.25 etc.

Table - 1

Sheet thickness		
Gauge No.	**Inch**	**mm**
18	0.048	1.22
19	0.040	1.02
20	0.036	0.91
21	0.032	0.81
22	0.028	0.71
23	0.024	0.61
24	0.022	0.56
25	0.020	0.51
27	0.0164	0.42
28	0.0148	0.38

Types of sheets

Sheet steel: It is an uncoated sheet with bluish-black appearance. The use of this metal is limited to articles that are to be painted or enamelled.

Galvanised iron sheet: The zinc-coated iron sheet is known as galvanised iron sheet, popularly known as GI sheet. The zinc coating resists rust. Articles like pans, buckets, furnaces, cabinets are made with GI sheet.

Copper sheets: Copper sheets are available either as cold-rolled or hot-rolled sheets. Cold-rolled sheets are worked easily in sheet metal shops. Gutters, roof flashing and hoods are common examples where copper sheet is used.

Aluminium sheets: Aluminium sheets are highly resistive to corrosion, whitish in colour and light in weight. They are widely used in the manufacture of a number of articles such as household utensils, lighting fixtures, windows etc.

Tin plates: Tin plate is sheet iron coated with tin to protect the iron sheet against rust. The size and thickness of the tin plate are denoted by special marks, not by gauge numbers.

Tin plates are used for food containers, dairy equipment, furnace fittings etc.

Brass sheet: Brass is an alloy of copper and zinc in various proportions. It will not corrode and is extensively used in craft.

Snips

A snip is a cutting tool and is used for cutting thin sheets of metal.

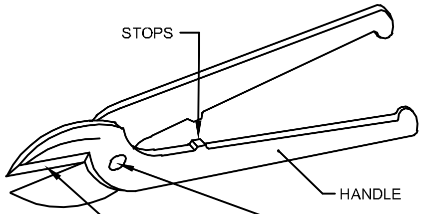
There are two types of snips.

- Straight snips
- Bent snips

Parts of a straight snip (Fig 1)

- Handle (1)
- Blade (2)
- Stops (3)

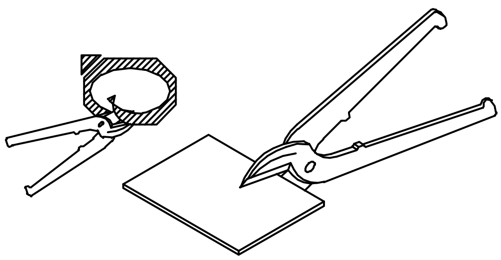
Fig 1



SNIP

Straight snips: A straight snip has straight blades for straight line cutting. It can also be used for external curved cuts.(Fig 2)

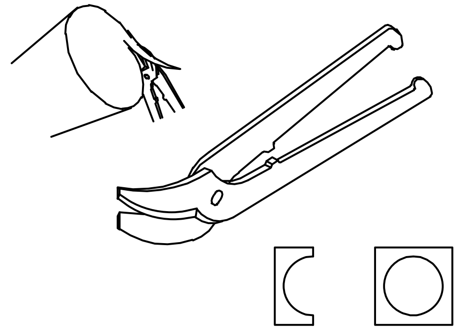
Fig 2



STRAIGHT SNIP

Bent snip: Bent snips have curved blades used for cutting internal curves. For trimming a cylinder keep the lower blade on the outside of cut. (Fig 3)

Fig 3



BENT SNIP

Solid cold punches

For making holes in sheet metal, cold punches can be utilized.

There are two types of cold punches used on sheet metal.

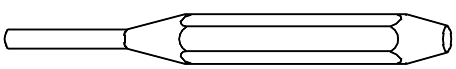
- Solid cold punch
- Hollow cold punch

In this lesson you will know about solid cold punches.

Solid cold punch: It is used to punch small holes in sheet metal (thin gauge).

Generally small holes can be made by this punch. (Fig 1)

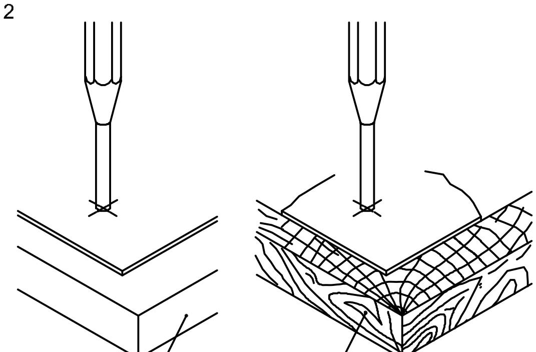
Fig 1



COLD PUNCH

Precautions to be observed while using a solid cold punch: The sheet should be kept on lead cake or on a hardwood block while punching (Fig 2).

Fig 2



METHOD OF PUNCHING SMALL HOLES

While striking, watch the cutting point, not the head of the punch.Hold the punch in a vertical positon on the correct locations.

Self-tapping screws

Self-tapping screws are used in assembly where thin section metal sheets are used. Joints made using these screws are vibration-resistant, and can be assembled and dismantled many times. The three types of self-tapping screws are:

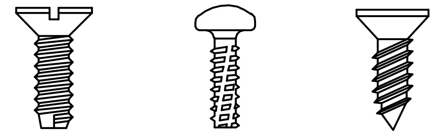
- thread forming (Fig 1a)
- thread cutting (Fig 1b)
- self-piercing. (Fig 1c)

Since these screws cut threads in mild steel and soft steel metal, they are called self-tapping screws.

The thread forming type (Fig 1a)**:** This type of metal screws produces the mating thread by displacing the material. These are useful for softer and thinner materials.

The thread cutting type (Fig 1b)**:** This type cuts the mating thread in the same way as the thread cutting tap. These screws will have projected ridges in the shape of thread for the cutting action. These are quite useful for self-tapping on hard or brittle materials with thin wall sections.

Fig 1



TYPES OFSELF TAPPING SCREWS

Self-piercing and tapping (Fig 1c)**:** These screws have a special piercing point and a twin-start thread. These screws are used along with a special gun. The sheet is pierced and the screw driven home.

Folding tools

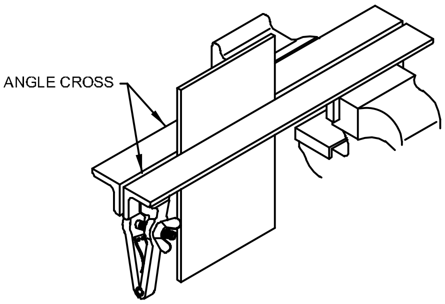
Objectives: At the end of this lesson you shall able to
- **list out the different folding tools**
- **state the uses of folding tools.**
- **state the types of notches and their uses**
- **state the types of hem and their application**

The common tools used in the folding of sheet metal are:

- angle steel and folding bar
- C clamp
- stakes
- mallet.

Angle steel: Two pieces of angles are used for folding at 90°. For longer sheets lengthy angles will be used along clamp (or) hand vice. (Fig 1)

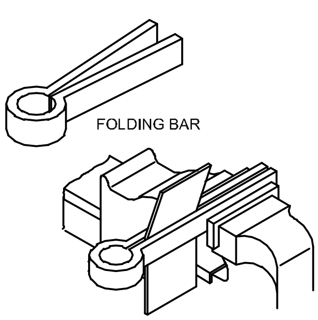
Fig 1



ANGLE STEEL

Folding bar: The sheet metal to be bent is clamped in the folding bars. The folding bars are clamped in the vice as shown in the figure. (Fig 2)

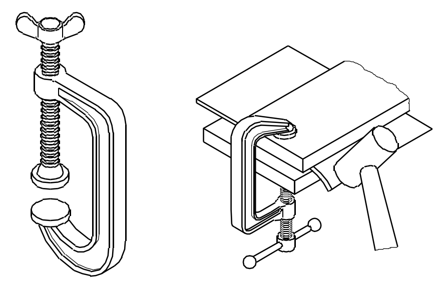
Fig 2



FOLDING BAR

**`C' clamp:** The shape of the clamp is in the form of the letter `C'. `C' clamp is a holding device. This clamp is used when the piece has to be securely fixed to another piece. It is available in different sizes according to the opening of jaws. (Fig 3)

Fig 3



`C' CLAMP / `G' CRAMP

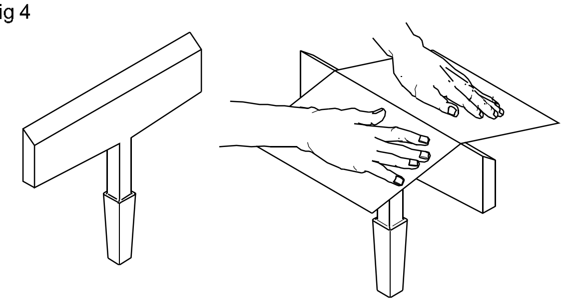
Stakes: Stakes are used for bending, seaming and forming of sheet metal that cannot be done on any regular machine. For the above purposes, different stakes are used. Stakes are made of forged steel or cast steel.

Types of stakes

- Hatchet stake
- Square stake
- Blow-horn square stake
- Bevel-edge square stake.

Hatchet stake: A hatchet stake has a sharp straight edge bevelled on one side. It is used for making sharp bends, for bending edges and for folding sheet metal. (Fig 4)

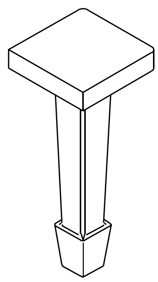
Fig 4



HATCHET STAKE

Square stake: A square stake has a flat and square-shaped head with a long shank. It is used for general purposes. (Fig 5)

Fig 5

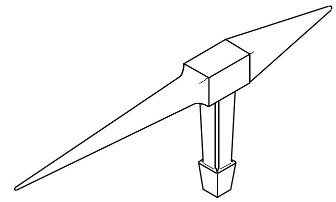


SQUARE STAKE

Blow-horn stake: It has a short tapered horn at one end, and a long tapered one at the other end. It is used in forming, riveting or seaming tapered, cone-shaped articles, such as funnels etc. (Fig 6)

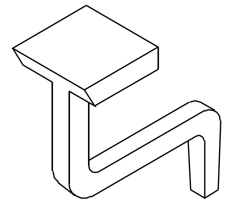
Bevel-edged square stake: A bevel-edged square stake is used to form corners and edges.(Fig 7)

Fig 6



BLOW HORN STAKE

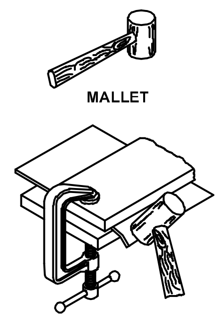
Fig 7



BEVEL-EDGED SQUARE STAKE

Mallet: A mallet is used for working on sheet metal. It will not damage the sheet surface while working. Mallets are made of wood, rubber, copper etc.(Fig 8)

Fig 8

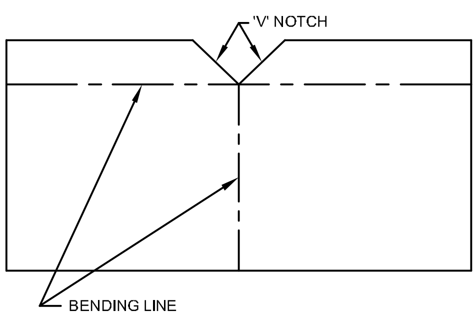


USE OF MALLET

Notches

Notches: Notches are the spaces provided for joining the edges when sheet metals are cut from the layout. (Fig 1)

Fig 1



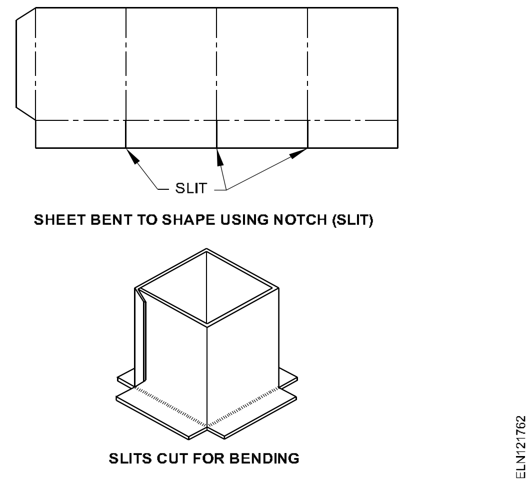
NOTCH

Purpose of notches

- To prevent excess material from overlapping and causing a bulge at the seam and edges.
- To allow the work to be formed to the required size and shape.

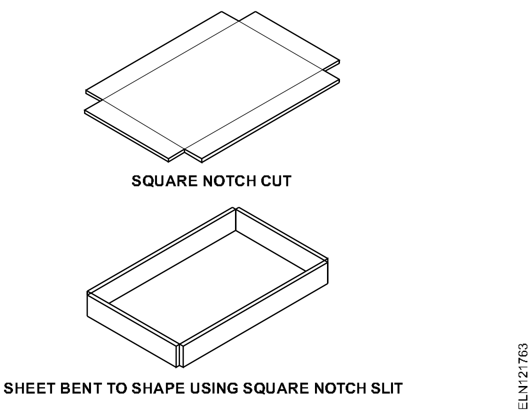
Types of notches: A straight notch or slit is a straight cut made in the edge of the sheet where it is to be bent. (Fig 2)

Fig 2



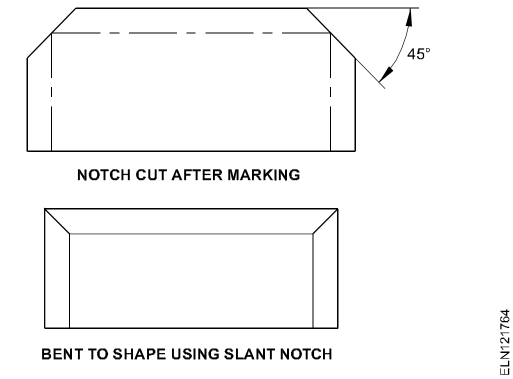
A square notch is used when forming a square or rectangular box. (Fig 3)

Fig 3



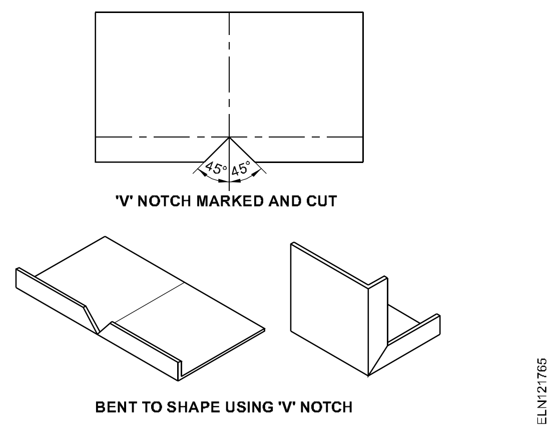
A slant notch is cut at an angle of 45° to the corner of the sheet. It is used when a single hem meets at right angles.(Fig 4)

Fig 4



In a `V' notch both the sides are cut at a 45°angle to the edge of the sheet. The sides of the notch meet at 90°. This notch is used when making a job with a 90° bend and an inside flange.(Fig 5)

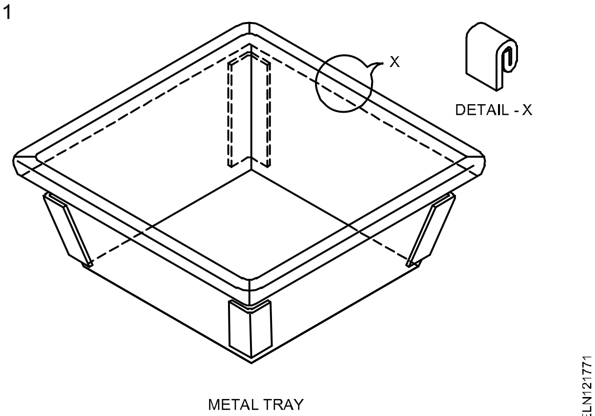
Fig 5



Edge stiffening

The edges of light gauge sheet metal articles are very sharp and are unsafe to handle. Safe edges are used to strengthen the sheet metal and to enhance the appearance of the finished article like metal tray. (Fig 1)

Fig 1



What is hem?: A hem is an edge or border made by folding.

It stiffens the sheet of the metal and does away with sharp edges.

It prevents the sheet from damage and wear of the edge.

Types of hems: There are three types of hems.

- Single hem
- Double hem
- Wired edge.

Single hem (Fig 2)**:** The single hem is made by folding the edges of the sheet metal with a single folding.

It makes the edge smooth and stiff and is done in the case of small articles.

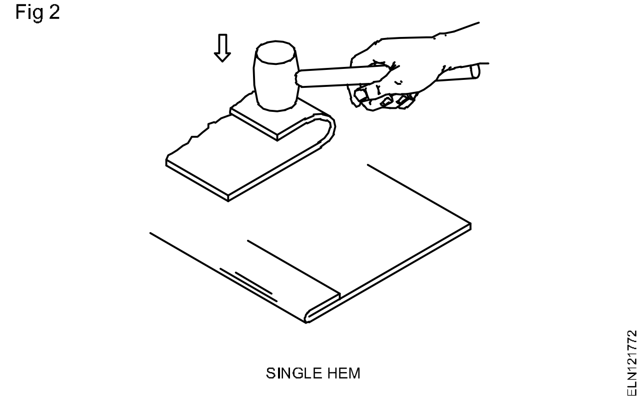


Fig 2

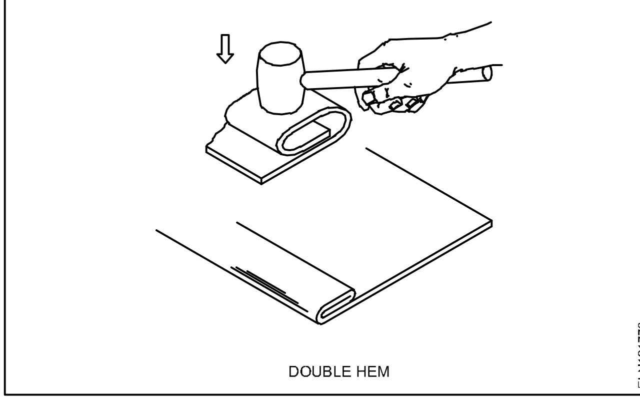


Fig 3

Double hem (Fig 3)**:** A double hem is made by folding the edges over twice to make it smooth, and this is done normally to strengthen the edges of lengthy articles.

Pattern development

Objectives: At the end of this lesson you shall able to
- **state about pattern development**
- **state the different types of pattern development.**

Before starting on any project in sheet metal, a pattern should be developed for the accuracy of the finished articles.

The pattern is nothing but a flat outline of the job. Most of the patterns are obtained from development of surfaces of some common geometrical solids such as cylinder, cone, prism, pyramid etc.

The pattern or outline of an object may be drawn on paper. Then it can be transfered to the sheet metal or it can be directly developed on the sheet and cut from the metal.

Generally there are three methods of development of patterns.

- Parallel line development
- Radial line development
- Triangulation

Methods of pattern development

There are three methods in general use.

The class of geometrical form of the object to be made must be taken into account when deciding on which method is to be used.

Parallel line method (Fig 1)**:** This method is used to develop patterns for shapes like boxes, prisms and cylinders.

Radial line method (Fig 2)**:** Objects like pyramids and cones can be developed using this method. These include all shapes which form parts of pyramids or cones.

All lines radiate from the apex.

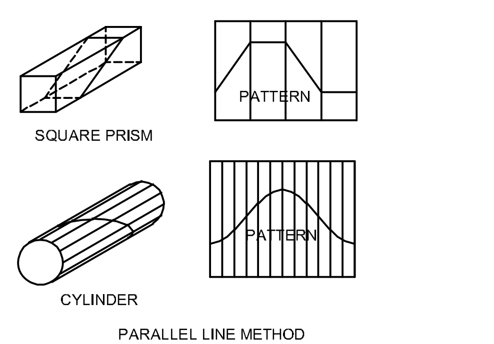


Fig 1

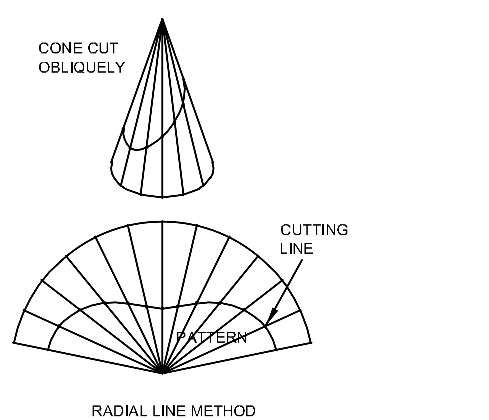
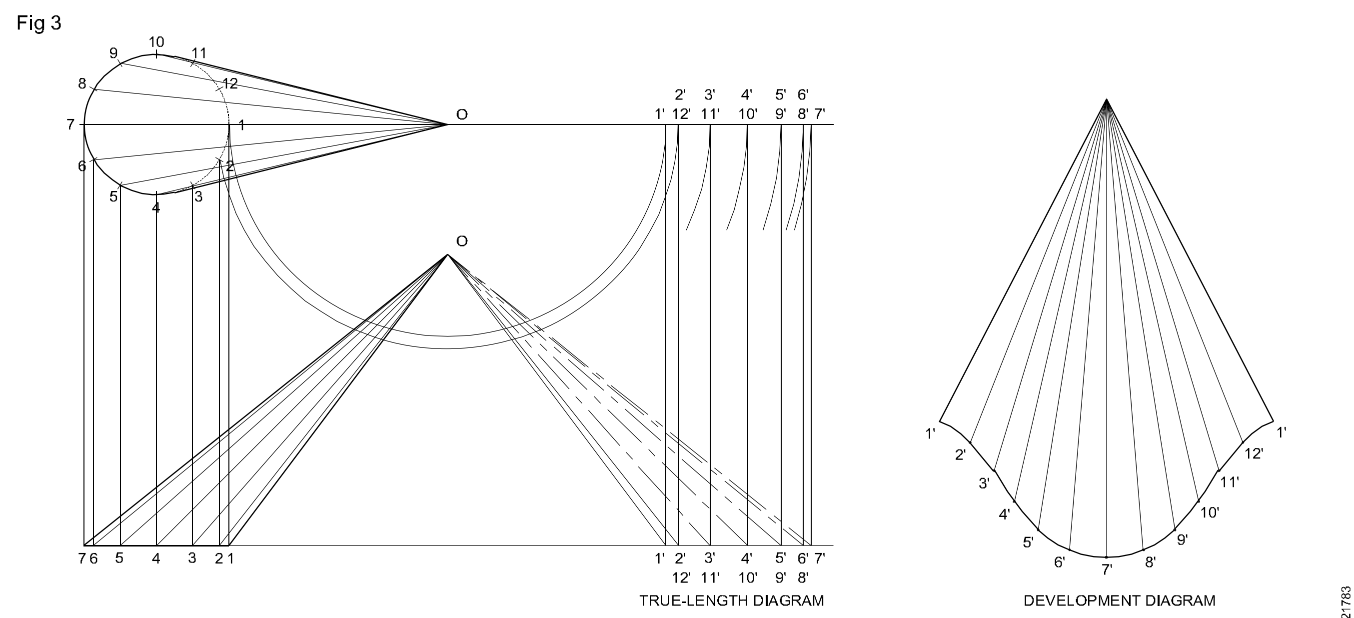


Fig 2

Triangulation (Fig 3)**:** This method is used to develop patterns for shapes having no apex and in which not all sides are parallel, i.e. Class 3.

While both the radial and parallel line methods cannot be applied to shapes shown in Fig 3, the method of triangulation can be used in the development of patterns for shapes depicted in Fig 1 and Fig 2.

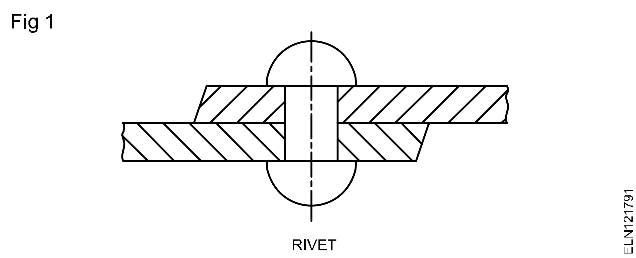


DEVELOPMENT OF AN OBLIQUE CONE BY TRIANGULATION

Rivets

Objectives : At the end of this lesson you shall be able to
- **define riveting and state their uses**
- **list out the different types of rivets and which materials the rivets are made.**

Riveting: Riveting is one of the satisfactory methods of making permanent joints of two pieces - metal snips. (Fig 1)



RIVET

It is customary to use rivets of the same metal as that of the parts that are being joined.

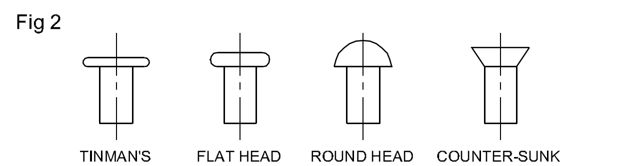
Uses: Rivets are used for joining metal sheets and plates in fabrication work, such as bridges, ships, cranes, structural steel work, boilers, aircraft and in various other works.

Material: In riveting, the rivets are secured by deforming the shank to form the head. These are made of ductile materials like low carbon steel, brass, copper and aluminium.

Types of rivets (Fig 2)

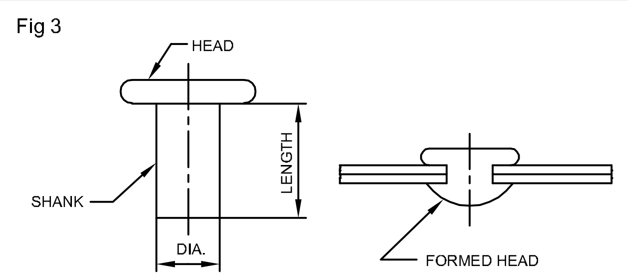
The four most common types of rivets are:

- tinmen's rivet
- flat head rivet
- round head rivet
- countersunk head rivet.



TYPES OF RIVETS

Each rivet consists of a head and a cylindrical body called as shank. (Fig 3)



HEAD AND SHANK

Sizes of rivets: Sizes of rivets are determined by the diameter and length of the shank.

Selection of rivet size: The diameter of the rivet is calculated by using the formula

$$D = \left(2\frac{1}{2} \text{ to } 3\right) x\, T$$ where T is total thickness.

The shank length is given by

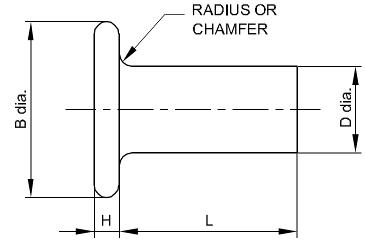
$$L = 2T + \left(1\frac{1}{2}D\right)$$

where `T' is the sheet thickness and `D' is the diameter of the rivet.

Normally tinmen's rivets are designated by numbers.

The dimension of the tinmen's rivets is given below. (Fig 4)

Fig 4



TINMEN'S RIVET
IS:866-1957

Method of riveting: Riveting may be done by hand or by machine.

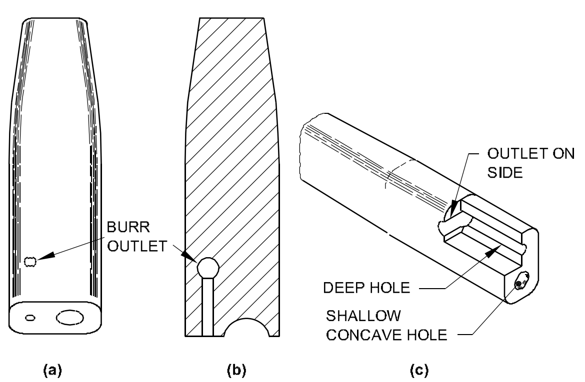
While riveting by hand, it can be done with a hammer and a rivet set.

Rivet set: A cross-section of a rivet set is shown in the figure 5a, b and c. The shallow, cup-shaped hole is used to draw the sheet and the rivet together. The outlet on the side allows the slug to drop out.

The cup shape is used for forming the rivet head.

The rivet set selected should have a hole slightly larger than the diameter of the rivet.

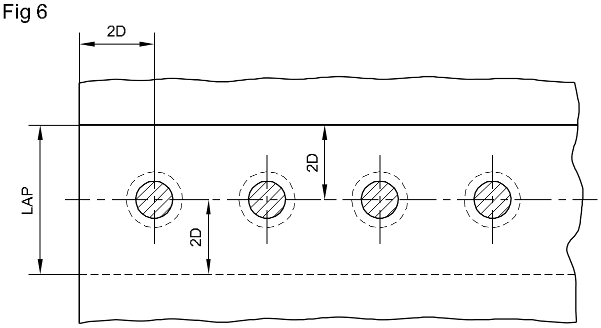
Fig 5



SECTION OF A RIVET

Spacing of rivets: The space or distance from the edge of the metal to the centre of any rivet should be atleast twice the diameter of the rivet to avoid tearing. The `Lap' distance (4D) is shown in Fig 6.

Fig 6

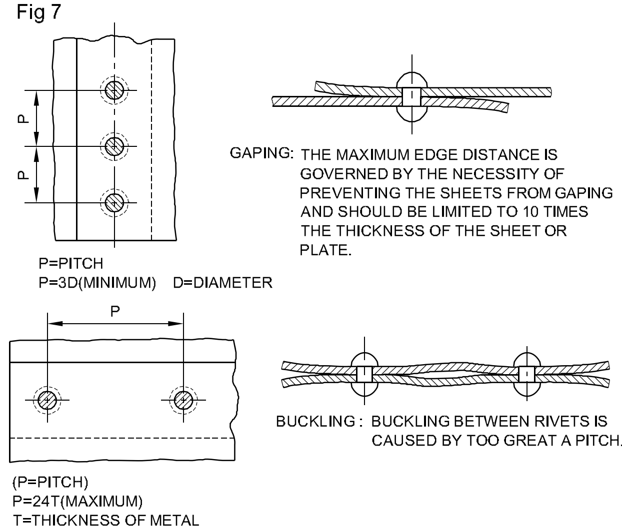


EDGE DISTANCE = TWICE THE DIAMETER OF RIVET (MINIMUM)
MNINIMUM LAP = FOUR TIMES DIAMETER OF RIVET

The minimum distance between the rivets (pitch) should be sufficient to allow the rivets to be driven without interference. The distance should be atleast three times the thickness of the sheet or above.

The maximum distance should never exceed 24 times the thickness of the sheet. Otherwise buckling will take place as shown in Fig 7.

Fig 7



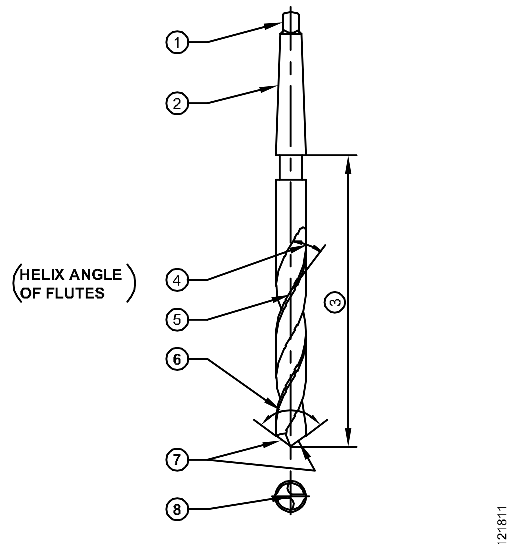
Drills and drilling machines - Internal and external threads

Objectives : At the end of this lesson you shall be able to
- **state the functions of drills**
- **name the parts of a drill**
- **name the drill bit holders**
- **state the uses of countersunking bits**

Drill: Drilling is a process of making holes on workpieces by using a drill.

Parts of a drill (Fig 1)

Fig 1



DRILL

- Tang (1)
- Shank (2)
- Body (3)
- Flute (4)
- Land (5)
- Point angle (6)
- Cutting lip (7)
- Chisel edge (8)

Tang: Tang is the part that fits into the slot of the drilling machine spindle.

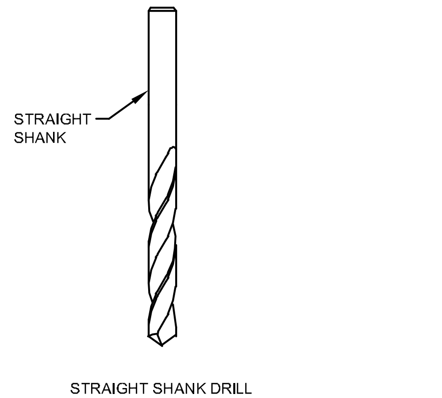
Shank: This is the driving end of the drill which is fitted on the machine. Shanks are of two types.

- Taper shank: for larger diameter drills.
- Straight shank: for smaller diameter drills.

The shank may be parallel or tapered.(Figs 2 and 3) Drills with parallel or straight shanks are made in small sizes, up to 12mm (1/2 in) diameter and the shank has the same diameter as the flutes.

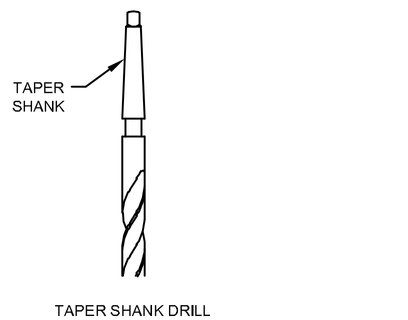
Taper shank drills are made in sizes from 3mm (1/8 in) diameter up to 50mm (2 in) diameter.

Fig 2



STRAIGHT SHANK DRILL

Fig 3



TAPER SHANK DRILL

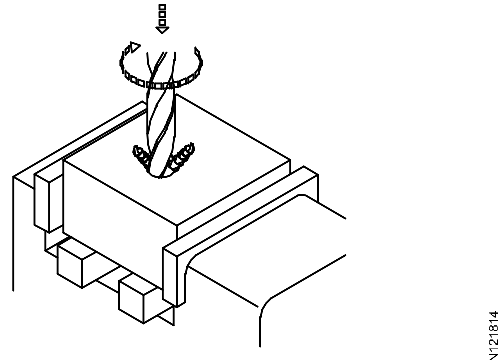
Body: The body is the portion between the point and shank.

Flutes: Flutes are the spiral grooves which run to the length of the drill.

The flutes help:

- to form the cutting edges
- to curl the chips and allow them to come out (Fig 4)
- the coolant to flow to the cutting edge.

Fig 4



DRILLING BY DRILL BIT

Land/margin: Land/margin is the narrow strip which extends to the entire length of the flutes. The diameter of the drill is measured across the land/margin.

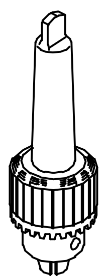
Body clearance: Body clearance is the part of the body which is reduced in diameter to cut down the friction between the drill and the hole being drilled.

Web: Web is the metal column which separates the flutes. It gradually increases in thickness towards the shank.

Drill bit holder

Drill chuck: Drill chuck is attached to the main spindle for straight shank basis. (Fig 5)

Fig 5



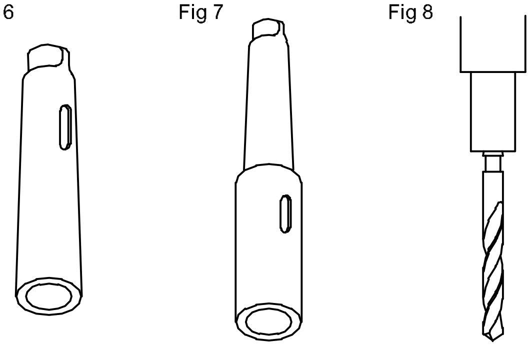
DRILL CHUCK

Sleeve: This is used to match bit tapers and the spindle taper holes. (Fig 6)

Socket: This is used when the main spindle length is too short, and the bit is changed frequently. (Fig 7)

Taper shank drills are held in taper sockets in the machine.(Fig 8)

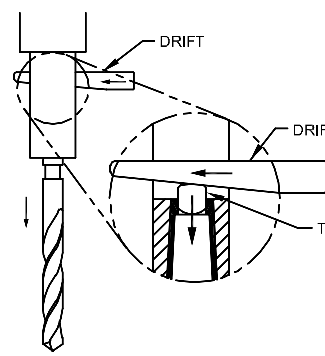
Fig 6 Fig 7 Fig 8



PARTS OF DRILL HOLDERS

The tang on a taper shank drill enables easy removal of the drill from the socket at the end of the drilling work. This is done using a drift. (Fig 9) The tang also serves to prevent the drill from rotating in the socket.

Fig 9



TANG ON A TAPER SHANK

Use of a coolant: A coolant is used to cool the cutting tool and the job.

Drilling machines

Objectives: At the end of this lesson you shall be able to
- **state the types of hand drilling machines and their uses**
- **state the parts of bench and pillar drilling machine**
- **explain the features of machine vice**

Making holes in sheet metal by using solid punches is a slow and inefficient process.

It is necessary to drill holes when working with heavy material.

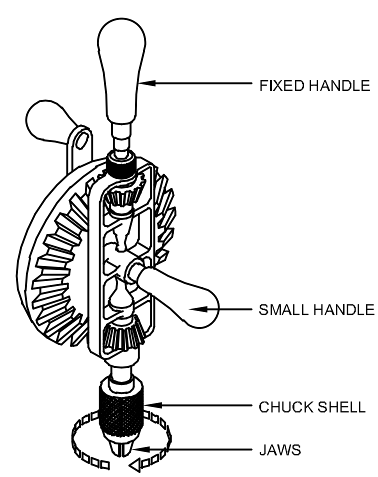
The holes can be drilled by hand or by machine. When drilling by hand, a hand drilling machine (Fig 1) or the electric hand drilling machine (Fig 2) is used.

Twist drills are used as a cutting tool for drilling holes. The hand drill is used for drilling holes up to 6.5 mm diameter.

The portable electric hand drilling machine is a very popular and useful power tool. It comes in different sizes and capacities.

The handle shown in Fig 2 is called a pistol grip handle.

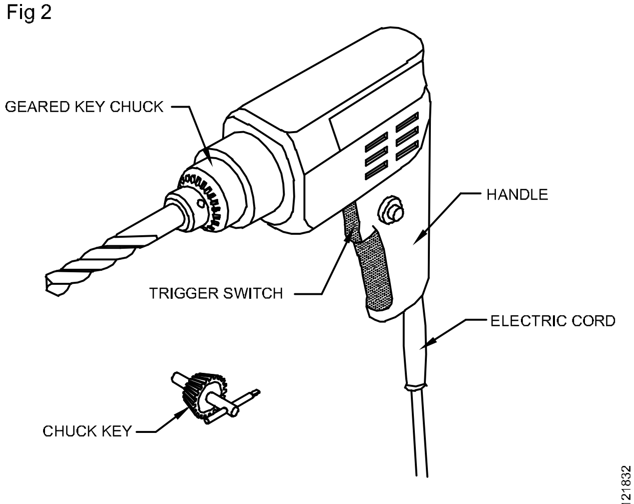
Fig 1



HAND DRILLING MACHINE

The parts of an electric hand machine are shown in Fig 2.

Fig 2



ELECTRIC - HAND DRILLING MACHINE

Precautions to be observed : Make sure the holes are properly located and punched with a centre punch.

Check the drill size. If the markings on the drill are not clear, use a drill gauge.

Be sure the drill is properly centred in the chuck by turning (rotating).

Be sure the work is mounted properly in a holding device such as a vice or `G' clamp.

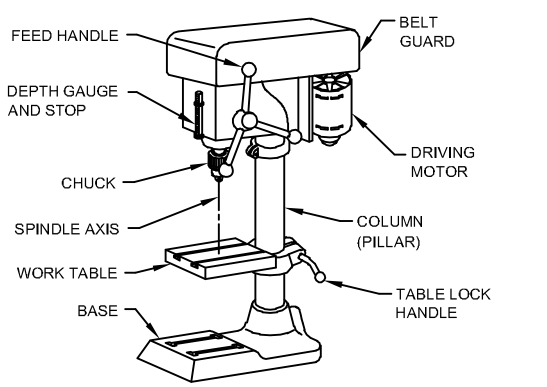
Check the centering of the drill after the point has just started in the metal. Relocate the hole with a centre punch, if necessary. Feed the drill with a light, even pressure.

Types of Electric Drilling Machines: Some of the electric drilling machines are listed here.

- The sensitive bench dilling mchine
- The pillar drilling machine
- The radial arm drilling machine. (Radial drilling machine)

(As you are not likely to use the column and radial type of drilling machines now, only the sensitive and pillar type machines are explained here.)

Fig 3



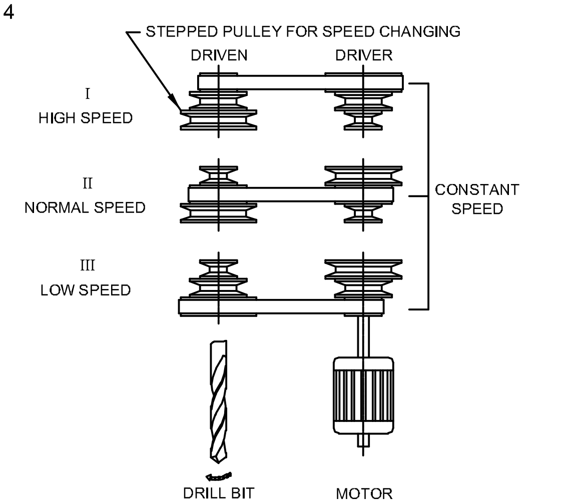
BENCH DRILLING MACHINE

Sensitive bench driling machine: The simplest type of sensitive bench drilling machine is shown in the (figure 3) with its various parts marked. This machine is used for light duty work. (Fig 3)

This machine is capable of drilling holes up to 12.5mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

Different spindle speeds are achieved by changing the belt position in the stepped pulley (Fig 4).

Fig 4

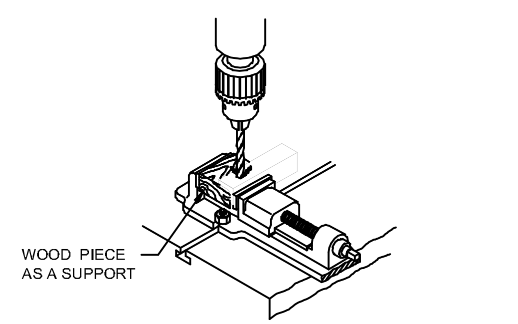


BELT ARRANGEMENT IN BENCH DRILLING MACHINE

For normal drilling, the work surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.

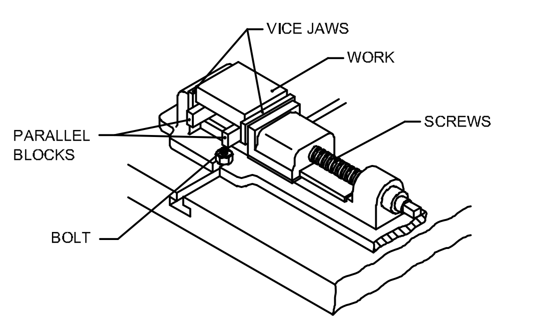
The pillar drilling machine: This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and are driven by more powerful electric motors. They are used for heavy duty work. Pillar drilling machines are available in different

Fig 5



WORKPIECE SUPPORT WITH WOODENPIECE

Fig 6



PARTS OF MACHINE VICE

sizes. Large machines are provided with a rack and pinion mechanism for moving the table for setting the work.

The machine vice: Most of the drilling works can be held in a vice. Ensure that the drill does not drill through the vice after it has passed through the work. For this purpose, the work can be lifted up and secured on parallel blocks, providing a gap between the work and the bottom of the vice. (Fig 6) Workpieces which are not accurate may be supported by wooden pieces. (Fig 5)

Parallels: The workpiece can be set on parallels to raise it off the reference surface, and still maintain parallelism. Parallels are made in pairs to precisely the same dimensions, from hardened steel, finish-ground, with the opposite faces parallel and adjacent faces square. A variety of sizes is available.

Cutting speed and RPM (Revolutions Per Minute)

Objectives : At the end of this lesson you shall be able to
- **define cutting speed and rpm**
- **state the factors for determining cutting speed**
- **determine rpm/spindle speed**

Cutting speed and r.p.m.: For a drill to give satisfactory performance, it must operate at the correct cutting speed and feed.

Cutting speed is the speed at which the cutting edge passes over the material while cutting, and is expressed in metres per minute.

Cutting speed is also sometimes stated as surface speed or peripheral speed.

Selection of the correct cutting speed for drilling depends on the materials to be drilled and the tool material. The recommended cutting speeds for different materials are given in the table. Based on the cutting speed recommended, the r.p.m. at which a drill has to be driven is determined.

Materials being drilled	Cutting speed m/min.
Aluminium	70 - 100
Brass	35 - 50
Bronze	20 - 35
Cast iron (grey)	25 - 40
Copper	35 - 45
Steel (mild)	30 - 40
Steel (medium carbon)	20 - 30
Steel (alloy-high tensile)	5 - 8
Thermo-setting plastic (Low speed due to abrasive properties.)	20 - 30

RPM

The r.p.m. will differ according to the diameter of the drills. The cutting speed being the same, larger diameter drills will have lesser r.p.m., and smaller diameter drills will have a higher r.p.m.

Calculating r.p.m.

$$CS = \frac{N\pi d}{1000}$$

$$N = \frac{1000 \times CS}{\pi d}$$

N = r.p.m.

CS = Cutting speed m / min

d = dia of drill in mm; π = 3.14

Example

Calculate the spindle speed (r.p.m.) for a high speed steel drill of 24mm dia. to cut mild steel.

$$N = \frac{1000 \times 30}{3.14 \times 24} = 398 \text{ r.p.m.}$$

The spindle speed is 400 r.p.m.

Feed of drill = Penetration of drill in a job per revolution of drill.

Angle of chisels

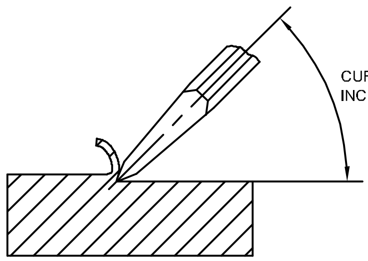
Objectives : At the end of this lesson you shall be able to
- **state the point angles of chisels for different materials**
- **state the different cutting angles of a chisel**
- **state the effect of rake and clearance angles.**

Point angles and materials

The coreect point/ cutting angles (b) 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. (Fig 1)

Fig 1



CUTTING ANGLE OF INCLINATION

ELN121851

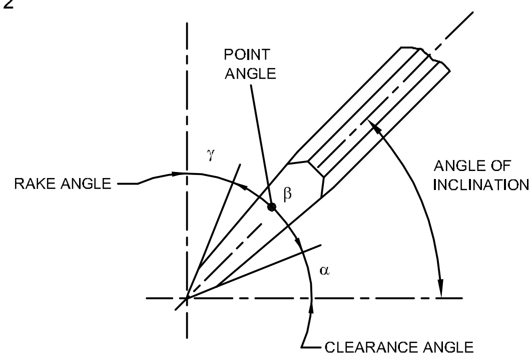
Rake angle

Rake angle (g) is the angle between the top face of the cutting point and normal to the work surface at the cutting edge. (Fig 2)

Clearance angle

Clearance angle (a) is the angle between the bottom face of the point and tangent to the work surface originating at the cutting edge. (Fig 2).

Fig 2



RAKE AND CLEARANCE ANGLE

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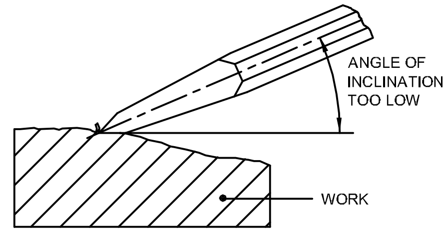
If the clearance angle is too low or zero, the rake angle increases. the cutting edge cannot penetrate into the work. the chisel will slip. (Fig 3)

Fig 3



CLEARANCE ANGLE TOO LOW

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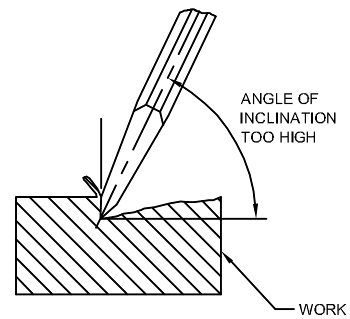
If the clearance angle is too great, the rake angle reduces. The cutting edge digs in and the cut progressively increases. (Fig 4)

Fig 4



CLEARANCE ANGLE TOO HIGH

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Table

Material to be cut	Point angle	Angle of inclination
High carbon Steel	65°	39.5°
Cast iron	60°	37°
Midld steel	55°	34.5°
Brass	50°	32°
Copper	45°	29.5°
Aluminium	30°	22°

Vee threads - Tap and die set

Objectives : At the end of this lesson you shall be able to
- **state the types of threads**
- **describe the designation of ISO threads.**
- **state pipe thread, parallel female thread and tappered thread**

Types of vee threads

Vee threads are available in different forms and standards. The different types of vee threads used for general engineering threaded fasteners are:

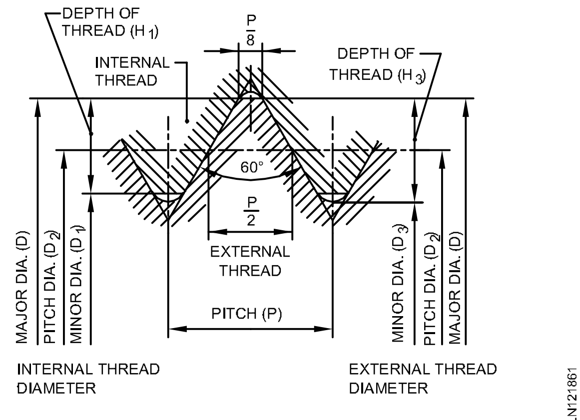
- ISO metric thread
- British Standard Whitworth thread
- British Standard fine thread.

ISO metric thread (Fig 1)**:** This is the form of thread indicated by B.I.S. for threaded fastening. The standard identifies two series of threads.

- ISO Metric coarse
- ISO Metric fine

The thread angle is 60°. The root of the external thread is rounded. The crest of the external thread is flat, but sometimes is rounded depending on the type of manufac-

Fig 1



ISO METRIC THREAD

turing process. The root of the internal thread is cleared beyond the width equal to one eighth of the pitch, and is rounded. The crests of the internal threads are left flat.

Designation of ISO metric thread: ISO metric course threads are designated as, for example - M12.

The symbol M indicates that it is ISO metric thread and 12 is the diameter of the thread. For coarse series the pitch of the threads is standardized for each diameter.

ISO metric fine threads are designated as, for example - M12 x 1.25.

The addition of 1.25 in this case indicates the pitch of the thread.

ISO inch (unified) thread: The ISO inch system (unified) is a recognized standard for interchangeability with the American National Thread.

These threads are used for general purpose engineering threaded fastening and are of two types, namely

- unified coarse (UNC)
- unified fine (UNF).

For unified threads the angle is 60°. The thread profile is similar to that of the ISO matric thread.

Designation of ISO inch (unified) threads

Examples

(a) $\frac{1}{4}$ 20 UNC

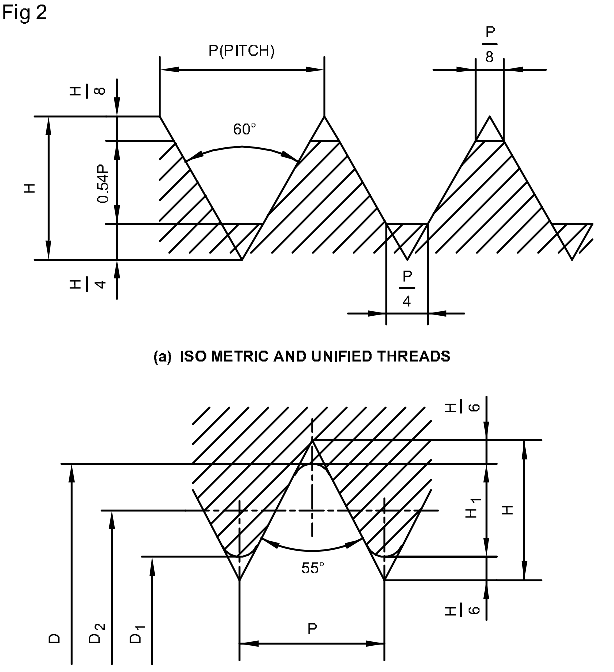
(b) $\frac{1}{4}$ 28 UNF

Example

This indicates that the diameter of the thread is 1/4", that it has 20 threads per inch (TPI). The ISO thread series is UNC (unified coarse). Example (b) has 28 TPI and is of UNF series.

British Standard Whitworth (BSW) thread (Fig 2)**:** This thread is being replaced by ISO metric thread. However the application of this thread is still being continued in a limited manner, particularly in the production of spare parts and repair works.

Fig 2



(a) ISO METRIC AND UNIFIED THREADS

(b) INTERNAL THREAD

BSW THREADS

These threads have 55° angle and are rounded at the crest and root. There are a definite number of threads per inch for a particular diameter.

The threads are designated by the diameter in inches followed by the abbreviation of the thread series.

Example - 1/2" BSW

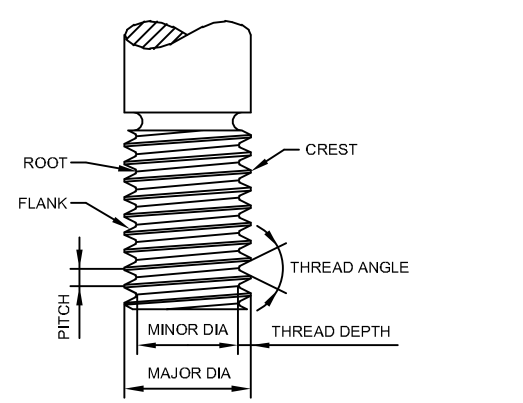
British Standard fine (BSF) thread: This thread has the same form as BSW, but with finer pitches.

The threads are designated by the diameter in inches followed by the thread series.

Example - 3/8" BSF

Screw thread - terms: It is important that the terms used in describing threads are clearly understood. The following diagram shows how the terms used relate to a screw of V form (Fig 3).

Fig 3



SCREW THREAD

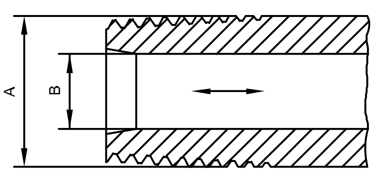
Pipe threads

Pipe threads on iron pipe are tapered, so that they form a water-tight joint when tightened securely. (Fig 1)

BSP-Whitworth threads for pipes

BSP-Pipe sizes of DIN 2999 (inside)(B)	Threads/ inch	Outside diameter/ mm of the pipe (A)
1/2"	14	20.955mm
3/4"	14	26.441
1"	11	33.249
1 1/4"	11	41.910
1 1/2"	11	47.803
2"	11	59.614
2 1/2"	11	75.184
3"	11	87.884
4"	11	113.030

Fig 1



IRON PIPE THREAD

*(BSP - and DIN - pipes meet ISO/P7 standards.)

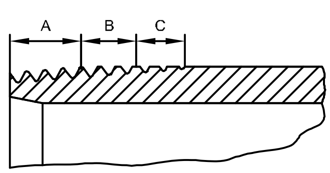
BSP - British Standard Pipe

DIN - German Industrial Norm

ISO - International Organization for Standardization

The illustration shows a galvanized steel pipe with several full form threads on the end (A) the next two threads have full form bottoms but flat tops (B) and the last four threads have flat tops and bottoms (C).(Fig 2)

Fig 2



TAPPERED IRON PIPE THREAD

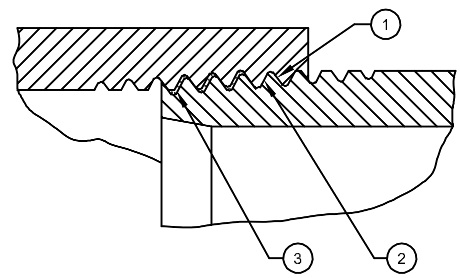
The actual work of assembling galvanized steel pipe consists of screwing together lengths of pipes with pipe fittings. Sealing material must then be applied to fill the space between the male and female threads in order to make the joint absolutely water-tight. The Fig 3 shows a galvanized steel pipe joint.

– Parallel female thread (1)

– Tapered male thread (2)

– Hemp (3)

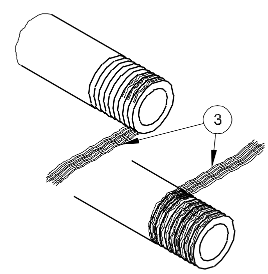
Fig 3



GALVANIZED STEEL PIPE JOINT

Hemp packing is used to ensure that any small space between two metal threads (male and female threads) is filled up.(Fig 4)

Fig 4



HEMP PACKING

Hand taps and wrenches

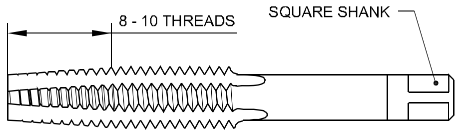
Objectives: At the end of this lesson you shall able to
- **list the uses of hand taps**
- **state the different types of tap wrenches, and state their uses.**
- **distinguish right and left hand thread**
- **solve the problems related tap drill sizes**

Taps: A tap cuts an internal (female) thread either left or right hand. Taps are usually made in sets of three.

- First tap or taper tap
- Second tap or intermediate tap
- Plug or bottoming tap.

The taper tap is tapered off for 8 to 10 threads and is used first, cutting to the full thread gradually. (Fig 1)

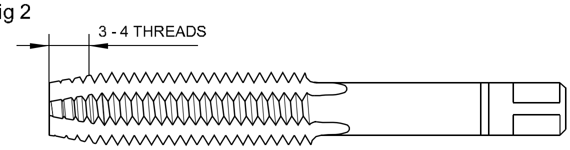
Fig 1



TAPER TAP (OR) 1ST TAP

The intermediate tap usually has three or four threads chamfered. This second tap can finish a through hole. (Fig 2)

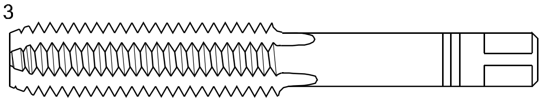
Fig 2



INTERMEDIATE TAP (OR) 2ND TAP

The plug tap has a full-sized untapered thread to the end, and is the main finishing tap. In the case of a blind hole, a plug tap must be used. (Fig 3)

Fig 3



PLUG TAP (OR) BOTTOMING TAP

Beware of the cutting edges of taps when handling them.

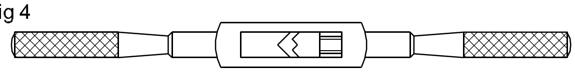
Tap wrenches: Tap wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

Tap wrenches are of different types.

- Double - ended adjustable wrench
- T-handle tap wrench
- Solid type tap wrench

Double-ended adjustable tap wrench (Bar type tap wrench) (Fig 4)

Fig 4



DOUBLE ENDED ADJUSTABLE TAP WRENCH

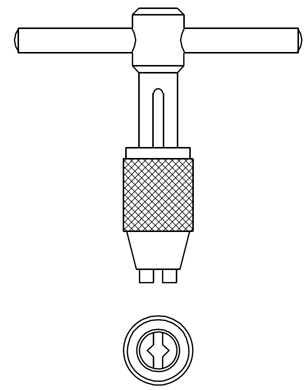
This is the most commonly used type of tap wrench. These tap wrenches are available in various sizes. They are more suitable for large diameter taps, and can be used in open places where there is no obstruction to turn the tap. It is important to select the correct size of the wrench.

T-handle tap wrench (Fig 5)**:** These are small adjustable chucks with two jaws and a handle to turn the wrench.

This tap is useful for working in resctricted places and is turned with one hand only.

This wrench is not available for holding large diameter taps.

Fig 5



T - HANDLE TAP WRENCH

Soild type tap wrench (Figs 6a and 6b)**:** These wrenches are not adjustable.

They can take only a certain size of a tap. This eliminates the use of a wrong length of tap wrenches, and thus prevents damage to the taps.

Fig 6a

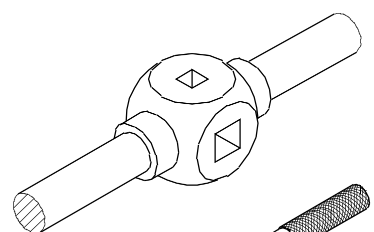
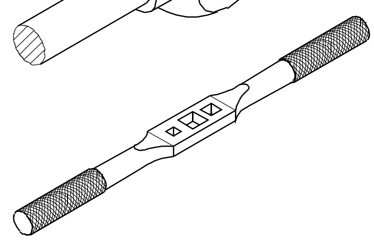


Fig 6b



SOLID TAP WRENCH

Tap drill size

Before a tap is used for cutting internal threads, a hole is to be drilled. This hole diameter should be such that is should have sufficient material in the hole for the tap to cut the thread.

Tap drill sizes for different threads

Tapping drill size for M10 x 1.5 thread

Minor diameter	=	Major diameter – (2 x depth)
Depth of thread	=	0.6134 x pitch of a screw
2 depth of thread	=	0.6134 x 2 x pitch
	=	1.226 x 1.5 mm = 1.839 mm
Minor dia.(D1)	=	10 mm – 1.839 mm
	=	8.161 mm or 8.2 mm.

This tap drill will produce 100% thread because this is equal to the minor diameter of the drill. For most fastening purposes a 100% formed thread is not required.

A standard nut with 60% thread is strong enough to be tightened until the bolt is held firm without stripping the thread. Further it also requires greater force of turning the tap if a higher percentage formation of thread is required.

Considering this aspect a more practical approach for determining the tap drill sizes is

tap drill size = (major diameter) – pitch

= 10 mm – 1.5 mm = 8.5 mm.

Compare this with the table of tap drill sizes for ISO metric threads.

ISO inch (Unified) threads formula

Tap drill size

$$= \textbf{(Major diameter)} - \frac{1}{\text{No. of teeth per inch (pitch)}}$$

For calculating the tap drill size for $\frac{5"}{8}$ UNC thread

$$\text{Tap drill size} = \frac{5"}{8} - \frac{1"}{11}$$

$$= 0.625" - 0.091"$$

$$= 0.534"$$

The next drill size is $\frac{17"}{32}$ (0.531 inches).

Compare this with the table of drill sizes for unified inch threads.

What will be the tapping size for following threads?

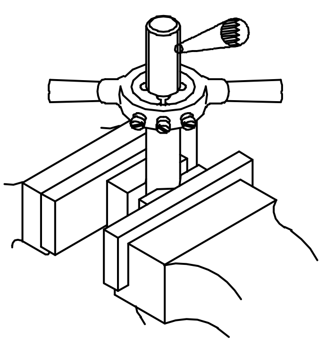
a M 20 b UNC $\frac{3}{8}$

Die and die stock

Objectives: At the end of this lesson you shall be able to
- **state the use of each type of die**
- **state the type of diestock for each type of die.**
- **list the different types of dies**
- **state the uses of 'Vee' blocks**

Uses of dies: Threading dies are used to cut external threads on cylindrical workpieces. (Fig 1)

Fig 1



EXTERNAL THREADING

ELN121891

Types of dies: The following are the different types of dies.

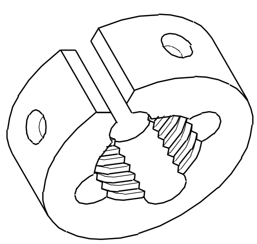
Circular split die (Button die)

Half die

Adjustable screw plate die

Circular split die\ button die (Fig 2)**:** This has a slot cut to permit slight variation in size.

Fig 2

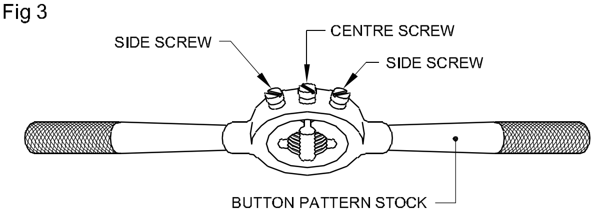


CIRCULAR SPLIT DIE / BUTTON DIE

ELN121892

When held in the diestock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly. (Fig 3) For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

Fig 3



DIE STOCK & DIE FOR BUTTON DIE

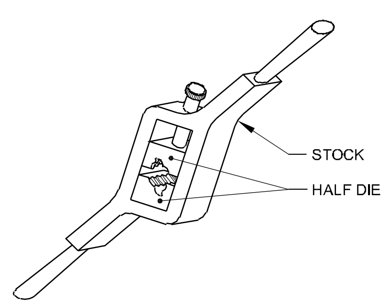
ELN121893

Half die (Fig 4)**:** Half dies are stronger in construction.

Adjustments can be made easily to increase or decrease the depth of cut.

These dies are available in matching pairs and should be used together.

Fig 4



HALF DIE WITH STOCK

ELN121894

By adjusting the screw of the diestock, the die pieces can be brought closer together or can be moved apart.

They need a special die holder.

Adjustable screw plate die (Fig 5)**:** This is another type of a two piece die similar to the half die.

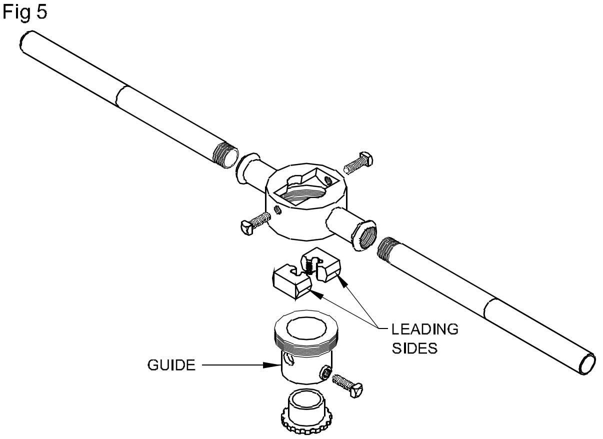
This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading (Fig 5)

When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held.

The die pieces can be adjusted, using the adjusting screws on the collar.

Fig 5



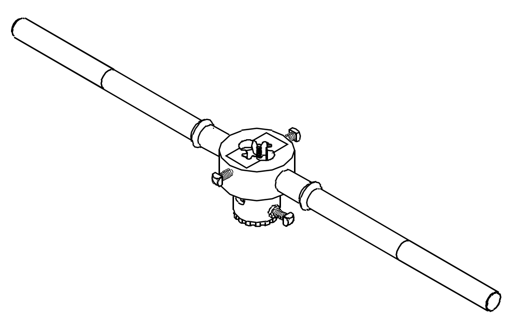
QUICK CUT STOCK

This type of die stock is called quick cut diestock.(Fig 6)

The bottom of the die halves is tapered to provide the lead for starting the thread. On one side of each die head, the serial number is stamped.

Both pieces should have the same serial numbers.

Fig 6



ASSEMBLED VIEW OF QUICK CUT DIESTOCK

Different types of threads (Fig 7)

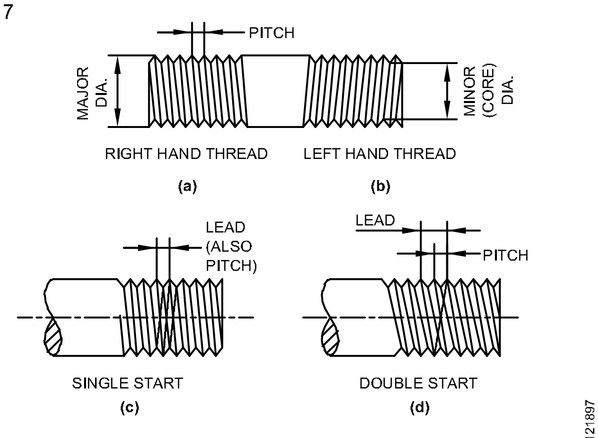
Right hand thread: The shape of thread from right to left (a).

Left hand thread: The shape of thread from left to right (b).

Single start thread: The pitch and lead are equal or identical (c).

Double start thread: The lead is twice the pitch (d).

Fig 7

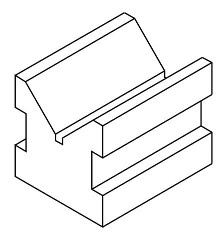


TYPES OF THREADS

`V' Block

Generally Vee blocks are made of cast iron and have a large vee on the top surface and a flat bottom or a smaller vee on the bottom surface.(Fig 1)

Fig 1

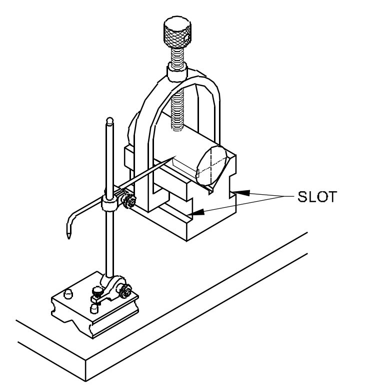


VEE BLOCK

Vee block with clamp for marking round bar (Fig 2)**:** This Vee block has a slot machined on each side so that a clamp, which is supplied with the block, can be used to clamp small workpieces for light drilling operations etc.

A pair of Vee blocks can be used when the length of bar is big for the drilling operation.

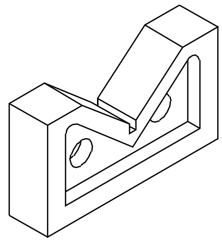
Fig 2



VEE BLOCK HOLDING A ROUND BAR FOR MARKING

Larger sizes are made of cast iron and have one vee only, machined on the top surface.(Fig 3) These are intended for supporting larger workpieces, and are not provided with slots for a clamp. Vee blocks of this type are available in different sizes.

Fig 3



LARGER SIZED VEE BLOCK

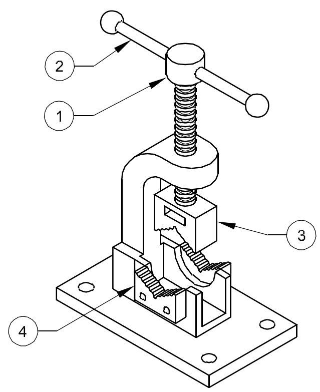
Pipe vices

Objectives: At the end of this lesson you shall be able to
- **name the parts of pipe vice**
- **state the types and uses of pipe vice**

Pipe vices are used to hold pipes, conduits for cutting in length, thread forming and assembly.

Open pipe vice (Fig 1)**:** This type of pipe vice is opened and closed by turning a spindle with a handle. The movable jaw is attached to the end of the spindle.

Fig 1



OPEN PIPE VICE

Parts

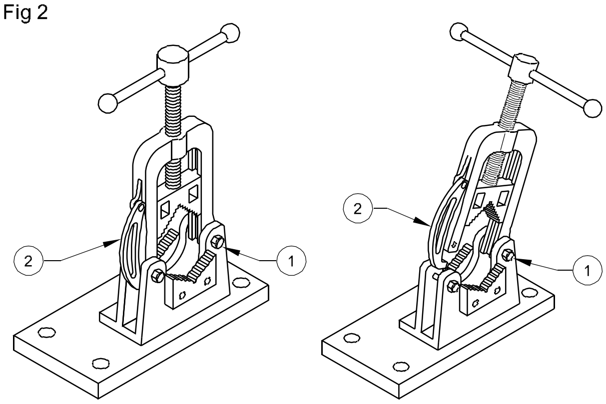
1. Spindle
2. Handle
3. Movable jaw
4. Fixed jaw

Several sizes of one side or open pipe vices are available. They are mainly specified by the maximum outside diameter of the pipe they can hold and by the maximum opening of the jaws. Three sizes are listed below as an example.

Maximum opening of jaws	Maximum outside diameter of pipe
60 mm	50 mm
90 mm	75 mm
120 mm	100 mm

Self-locking hinged pipe vice (Fig 2a)**:** To place the pipe between the jaws of a self locking hinged pipe vice, the hinged frame is opened as shown in Fig 2b. A self-locking hook locks the frame, and the pipe is then gripped between the jaws by turning the spindle of the vice.

Fig 2



a) SELF-LOCKING HINGED PIPE VICE b) SELF-LOCKING HINGED VICE

- Hinge to open the frame of the vice. (Refer (a) of Fig 2)
- Self-locking hook. (Refer (b) of Fig 2)

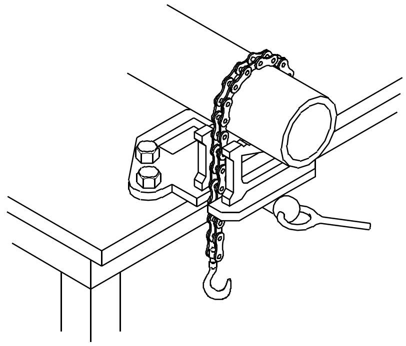
Self-locking, hinged pipe vices are available in a number of sizes to hold pipes and conduits up to an outside diameter of 150mm.

Chain pipe vice (Fig 3)**:** A chain pipe vice has only a set of fixed jaws which are mounted on to a table top or a metal stand. A strong chain made from high quality steel holds the pipe to the jaws. The chain is then tightened by turning the tightening lever of the vice.

Chain pipe vices can hold pipes to an outside diameter of 200mm.

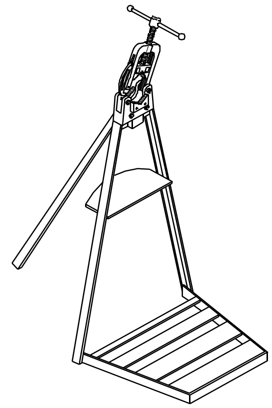
Self-locking hinged pipe vice mounted on tripod stand (Fig 4)**:** This is a self-locking, hinged pipe vice, mounted on to a foldable metal tripod stand. This kind of arrangement is very practical as a mobile work-place for use at building sites, etc.

Fig 3



CHAIN PIPE VICE

Fig 4



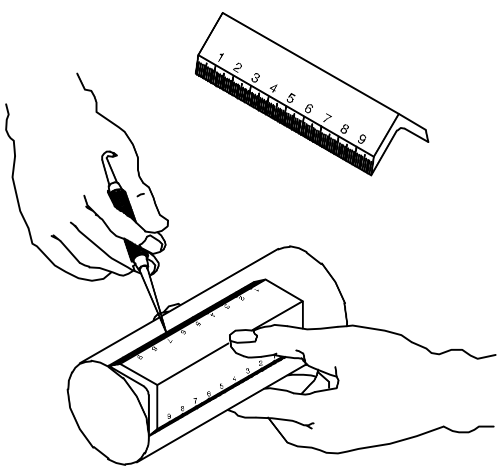
PIPE VICE WITH THE TRIPOD STAND

Marking accessories

Objectives : At the end of this lesson you shall be able to
- **state the uses of a box square**
- **state the uses of a surface plate**
- **state the uses of an angle plate.**

Box square (Fig 1): A box square, or key-seat rule, is used for marking lines on round bars or tubes.

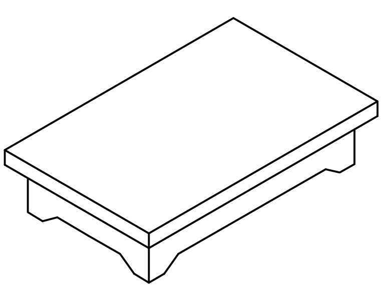
Fig 1



BOX SQUARE

Surface plate (Fig 2)**:** This plate with a flat surface of great accuracy is used for testing the flatness of other surfaces together with other instruments for measuring, testing and marking out purposes.

Fig 2

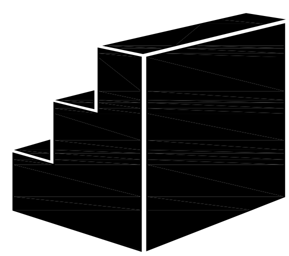


SURFACE PLATE

The surface plate is usually made of cast iron or granite.

Angle plate: It is made of cast iron. Granite angle plates are also available.(Fig 3)

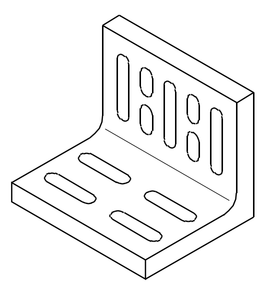
Fig 3



GRANITE ANGLE PLATE

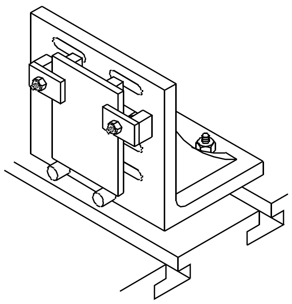
It is used as a fixture for holding the work to be laid out and machined. Faces are right angles, may have slots and may be fitted with clamps for holding workpieces. (Figs 4 and 5)

Fig 4



CAST IRON ANGLE PLATE

Fig 5



WORKPIECE CLAMPED WITH ANGLE PLATE

ELN1218C5

Limit gauges

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

- **state the principle of the Go and No-Go gauges and their features**
- **list out the common types of limit gauges**
- **state the uses of each type of limit gauges.**

When a number of components have to be checked it is not necessary to meassure their sizes exactly but only check that the component's sizes lie within the limits of tolerance. The most economical method of checking a component is with a limit gauge.

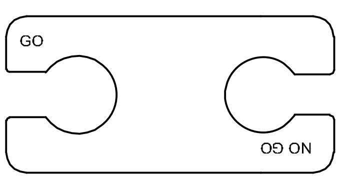
These gauges are used in inspection because they provide a quick means of checking a specific dimension.

'Go' and 'No-Go' end principle

The dimensions of the 'Go' and 'No-Go' ends of gauges are determined from the limits stated on the dimension to be gauged.

The 'Go' and 'No-Go' principle of gaguing is that the 'Go' end of the gauges must go into the feature being checked and the 'No-Go' end must not go into the same feature. The dimension of the 'Go' end is equal to the maximum permissible dimension and that of the 'No-Go' end is equal to the minimum permissible dimension of the component for external measurements. (Fig 1)

Fig 1



EXTERNAL MEASUREMENT

ELN1218D1

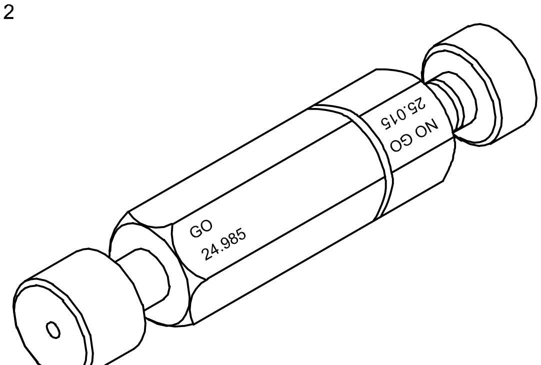
For internal measurements the 'Go' end of the gauge is equal to the minimum limit and that of the 'No-Go' end is equal to the maximum limit of the component. (Fig 2)

Essential features

These gauges must be easy to handle and accurately finished. They are generally finished to one tenth the tolerance they are designed to control. For example, if the tolerance is to be maintained at 0.02mm, then the gauge must be finished to within 0.002mm, of the required size.

They must be resistant to wear, corrosion, and expansion due to temperature.

Fig 2



INTERNAL MEASUREMENT

ELN1218D2

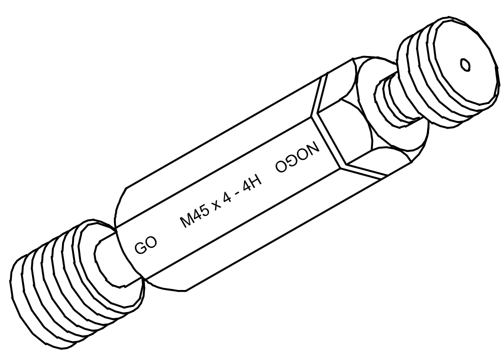
Their production cost must be lower.

The 'Go' end is made longer than the 'No-Go' end for easy identification. Sometimes a groove is cut on the handle near the 'No-Go' end to distinguish it from the 'Go' end. This applies to plug gauges. The dimensions of these gauges are usually stamped.

Thread plug gauges (Fig 3 and 4)

Internal threads are checked with thread plug gauges of 'Go' and 'No-Go' variety which employ the same principle as cylindrical plug gauges.

Fig 3



THREAD PLUG GAUGES

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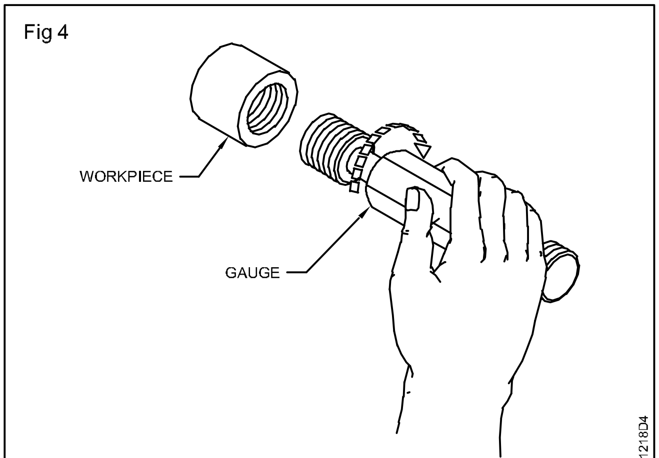
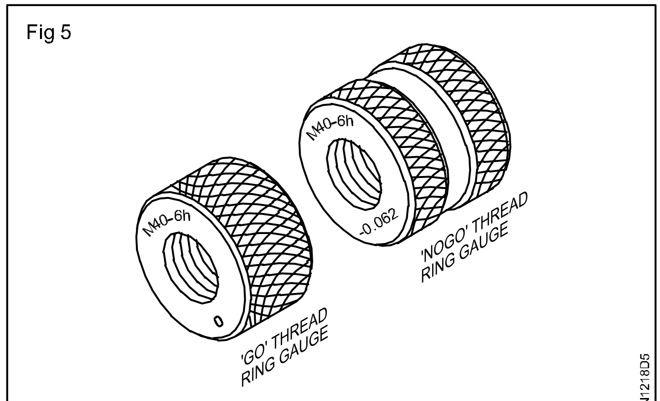


INTERNAL THREAD PLUG GAUGES



THREAD RING GAUGES

Thread ring gauges (Fig 5)

These gauges are used to check the accuracy of an external thread. They have a threaded hole in the centre with three radial slots and a set screw to permit small adjustments.