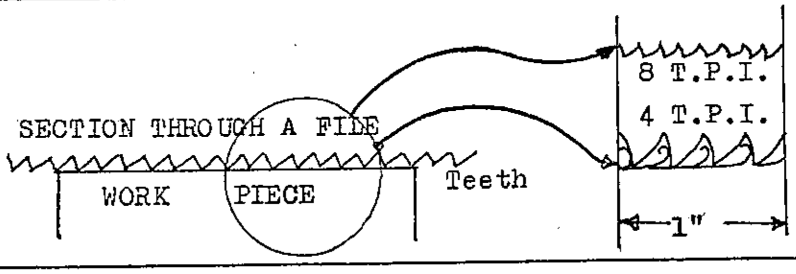
TITLE:- FILES

LECTURER:- Gerry Hennis

DATE:- 16-2-81

EQUIPMENT:- File Handles Square, Flat, Safe edge, Triangle, Round, Half Round, Warding, Rasp, Flat Double Cut and Flat Single Cut Files.

Files are cutting tools; they have many blades, wedge shaped and set along the file length, called teeth.
Files are used for material removal and making a smooth surface on an object.

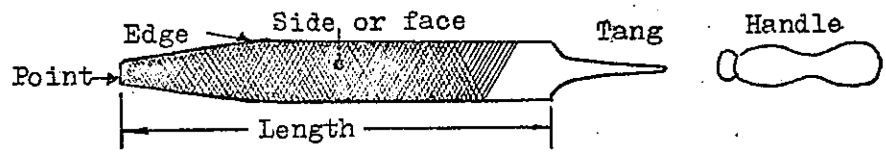


The teeth are set the full width of the file and, to prevent clogging up with cuttings, run diagonally, so that on the forward cutting stroke, the cuttings or filings are forced out of the side of the file.

Curved, as well as flat surfaces can be filed.

The amount of material removed and smoothness of finish depends on the size of teeth, given in teeth per inch of length, called the pitch of the file.

Parts of a file.



BODY: From the shoulder to the tip is called the body of the file; this part is made of hardened, cast steel and is very brittle. This is the only part taken into account when ordering files by length i.e. if you ask for a 10" (250mm) file then it will be 10" (250mm) from point to shoulder.

EDGE: The narrow side of the file is called the edge. This may or may not have teeth on it. If it has no teeth it is called a safe edge. When ordering files, safe edges must be asked for, either 1 or 2. They are called safe edges because if an angled surface is being filed on one face only, the safe edge will prevent the other face being marked.

THE TANG of the file is made of much softer material and is there only for fitting the handle. It is important that when a file is to be used it must always have a properly prepared handle fitted to the tang.

THE FACE of the file is the main cutting surface with the teeth set diagonally across it. There may be 2 sets of teeth, a second set running diagonally in the opposite direction, then the file is a double cut file.

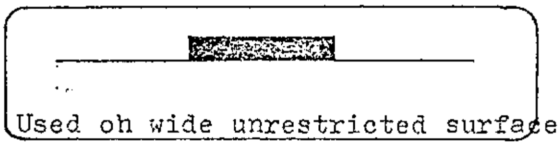
BELLY files are sometimes thicker in the middle than at the ends. This is to enable perfectly flat surfaces to be filed. The file is then said to have a belly or is bellied.

THE TIP or Point of the file. This is unmarked on a new file and should be still unmarked on the day the file is worn out. Files are not chisels, levers, hammers or anything else and if used as anything else are not only damaged but often damage the person using them.

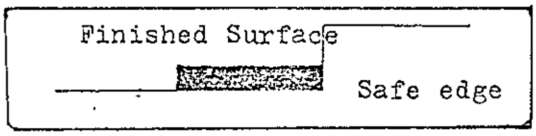
SHAPES OF FILES

Files come in various shapes as well as sizes for the different uses and surfaces the file is applied to. The main ones are:- FLAT, HAND, WARDING, THREE SQUARE, SQUARE, HALF ROUND AND ROUND OR RAT TAILED FILES.

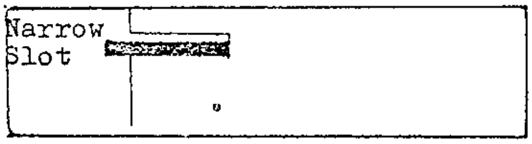
FLAT FILES Slightly tapered in width and thickness and has teeth on all sides and edges.



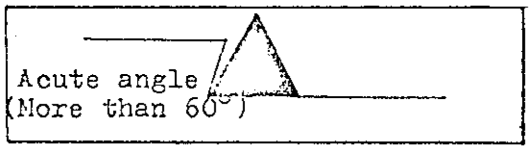
HAND FILES Parallel in width, tapered in thickness, usually one safe edge.



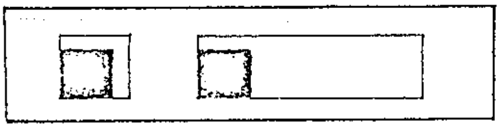
WARDING FILES Tapered in width, thin file used for filing grooves slots etc.



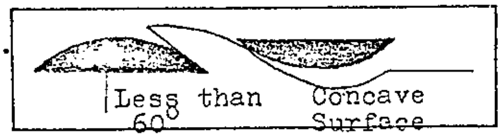
THREE SQUARE Equilateral cross-section, tapered along length, used for saw sharpening, filing acute angles.



SQUARE FILE Tapered toward the tip. Used for slotted or square holes.



HALF ROUND FILE Flat one side, usually double cut, rounded the other. Used for flat, concave or convex surfaces and sharp corners. Tapered.



ROUND FILE Tapered toward tip. Used for enlarging holes or concave surfaces.

GRADES OF FILES

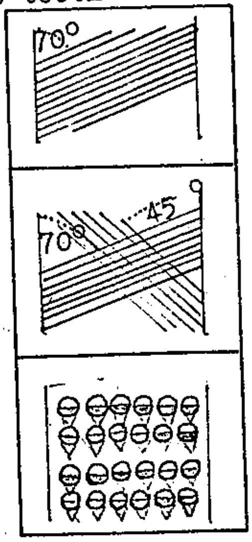
Files are graded according to the number of teeth per inch of length and are given names for various numbers. Main grades are:-

BASTARD CUT	20-26 Teeth/Inch (TPI)
SECOND CUT	30-40 TPI
SMOOTH CUT	50-60 TPI
DEAD SMOOTH	70-120 TPI

When filing, the harder the material the finer the file, and the finer the file the smoother the finish.

FILE CUT

File cut:- refers to the angle and manner in which the teeth are cut into the file.



Single Cut Has a single set of teeth cut at an angle of 65° to 85° for best cutting action and easy clearance of shavings. Much pressure must be applied to make the file cut.

Double Cut Has a double set of teeth at different angles giving more TPI and a better cutting action. The angles are 40° to 50° for the overcut, 70° to 80° uppercut.

Rasp Has small independent teeth punched into the face of the file. A very coarse file, only to be used on soft materials such as wood.

Millencut A very coarse single cut file with the teeth notched to prevent clogging, usually used on soft metals.

SELECTION

The first thing we want to know in selecting a file is the material to be filed, then what shape we are to file it and the amount we are to take off, then the finish required. So on most filing jobs we would probably use 2 or 3 different files in turn.

SAFE USE

As mentioned in the description of a file, the body is made of very brittle material. Glass is also a brittle material, and a file body has most of the properties of glass. If broken, they shatter and throw off very sharp splinters, so look after files by following these rules:-

1. Do not allow files to touch each other.
2. Do not bang or drop files.
3. Do not allow files to contact hardened vice jaws, hammers etc.
4. Do not allow files to overhang the edge of a bench.
5. Do not remove rust or scale from steel with the faces of a file - use a corner or an old worn file.
6. Clean the file regularly and properly.
7. File at the correct speed (50 strokes per min.).
8. Ensure that you have selected the proper file for the job you are doing.

KEEPING THE FILE CLEAN

When using a file, every so often, especially with soft materials or coarse files, a chip or shaving larger than normal will lodge in between the teeth. At that point on the next stroke a scratch will be engrained on the material being filed. This is called pinning. To prevent this, the file must be cleaned regularly with a file card. This is a strong wire brush with short wire bristles of spring steel. To use it the file tip is put onto the bench, the handle is held with the thumb pointing toward the tip of the file, and the file card is brushed along the grooves of the file. Any pins that cannot be removed this way are then poked out using a piece of soft copper or brass instead of the file card.

GREASE ON THE WORK

Any grease present on the surface to be filed must be removed before proceeding as the file will tend to skid or fly when it catches these spots.

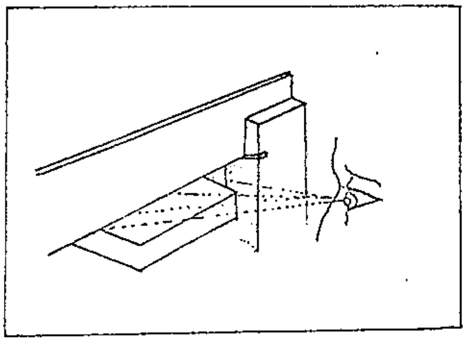
SOFT JAWS

When filing material held in the vice, a strip of aluminium or copper must first be bent over the jaws of the vice, so that the piece is held between 2 soft surfaces, preventing marking of the finished surfaces and the layer over the top of the jaws will prevent filing the hardened faces of the vice.

TESTING FOR SQUARENESS

Whilst in the process of filing a surface, a constant check must be kept that more material is not being removed from one side than from the other. We do this with a try-square.

The stock of the try square (thick portion) is pushed flat against a straight part of the work piece with the blade (thin part) well clear of the surface being filed. The blade is then lowered down onto the filed surface taking care that the stock is kept hard upto the straight part. By holding the piece between your eye and a light, any out of squareness will be seen. Lift the blade clear, move along the piece then lower the blade and try again, do not scrape the square along.

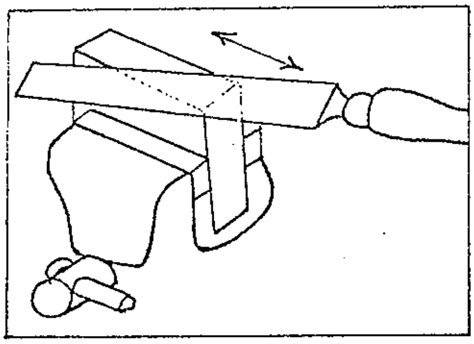


CHECKING FOR FLATNESS

We can check for flatness of the filed surface using the file. To do this we put the file on the surface being filed but 90° to the direction of filing; hold the file firmly onto the surface and take a short firm cut. Any raised up surfaces will be marked in the opposite grain and will show clearly. This can be done during the filing process by cross filing. Another way is as for checking for square but with the stock clear and the blade at an angle, check to the light, lengthwise across each corner and down the middle. All the light will never be excluded; an even light across the length is looked for.

DE-BURRING

Burrs must be removed whilst the piece is still held in the vice, wherever possible. Remove them by running the file lengthwise along the burr holding the file diagonal to the piece. using 2nd cut or triangular file.



CARE AND MAINTENANCE

Because files are brittle, they must be handled and stored with care. Look after your files by following these rules.

1. Do not allow files to touch each other.
2. Do not bang or drop files.
3. Do not allow files to contact hardened vice jaws, hammers etc.
4. Do not allow files to overhang the edge of a bench.
5. Do not remove rust or scale from steel with the face of a file- use a corner or an old file.
6. Clean the file regularly and properly.
7. File at the correct speed (50 strokes/min.).
8. Ensure that you have selected the proper file for the job you are doing.

USING A FILE

The following table indicates the main points to be remembered when filing.

What to do	Why	How
Keep the file level	To produce a flat surface	Adopt correct stance and grip
Develop a long stroke	To use the whole cutting surface of the file	(a) Use both arm & body movement (b) Move the file forward and sideward simultaneously
Apply sufficient pressure	To make the cut effectively	(a) Learn the properties of different metals (b) Develop the "feel" of correct cutting action of the file
Acquire a rhythmic pace	To develop economy of effort, and to be able to produce an accurate finish	(a) Practice repeatedly (b) Learn to recognise the pace appropriate for the type of filing.

TITLE:- MARKING OUT

LECTURER:-

DATE:-

EQUIPMENT:- Hammer, Prick punch, Centre punch, Steel rule, Scriber, Divider, Try-square, Marking medium, 12" Bastard file, 12" Second cut file.

Definition:- Marking out is ACCURATELY transferring the dimensions & details of an object from a plan, sketch or detailed drawing, onto the material from which it is made.

Marking medium:- This is used to enable scribed lines to become more clearly visible. Some mediums in use are - Chalk, White lead & turpentine, Kalsomine, Copper sulphate solution.

Prick punch:- Sometimes scribe lines become obliterated during filing, hacksawing, machining etc.

This can be overcome by making light witness marks along the line. These witness marks should never be made deep and they should be made in the exact centre of the line. Prick punch marks also serve as locating holes for divider points. The accurate method of using the punch is to hold it the same as a pencil at an angle of approx. 30°, this gives a clear view of the point on the scribed line, then the punch is brought to the vertical position and given a very light blow with the hammer. The point angle of the Prick punch is 30° and is not intended for heavy punch marks.

Centre punch:- Same construction as the Prick punch except the point angle is 60° and is used for making a deep indentation which acts as a guide for drilling.

Scribers:- This tool is used to mark off lines on metal surfaces. As these lines should be sharp and clear, the scriber should be hard and very sharp.

Pocket scriber:- The point can be reversed and set into the handle for safe carrying.

Brass scriber:- Used where lines are to be scribed on highly polished surfaces, which would be spoiled if a steel scriber were used.

Bent or hooked scriber:- This has one end bent at 90° which makes it useful for marking off through holes etc.

Knife edge:- Used for very fine scribing.

Use of scriber:-

(a) Should be held in the fingers the same as a pencil.
(b) It should be inclined so that the point will be close to the try-square or ruler.
(c) It should be inclined slightly in the direction of the stroke.
(d) Scribe only ONE firm line, as a retraced line is apt to cause two confusing markings.
(e) Always scribe in a direction ACROSS the body, never towards yourself

Steel rule:-

Hold vertical to the workpiece and read directly from above, do not take measurements from the end, because this is where damage and wear occurs.

Keyseat or Box square:-

Used for marking or measuring along the axis of round stock.

Squares:-

Engineers square or Try square consists of a rectangular blade set accurately at 90° to a solid stock.
This is a precision instrument; some of its general uses are:-

To guide the scriber when marking out lines at right angles to the edge of work.

To check the flatness of surfaces.

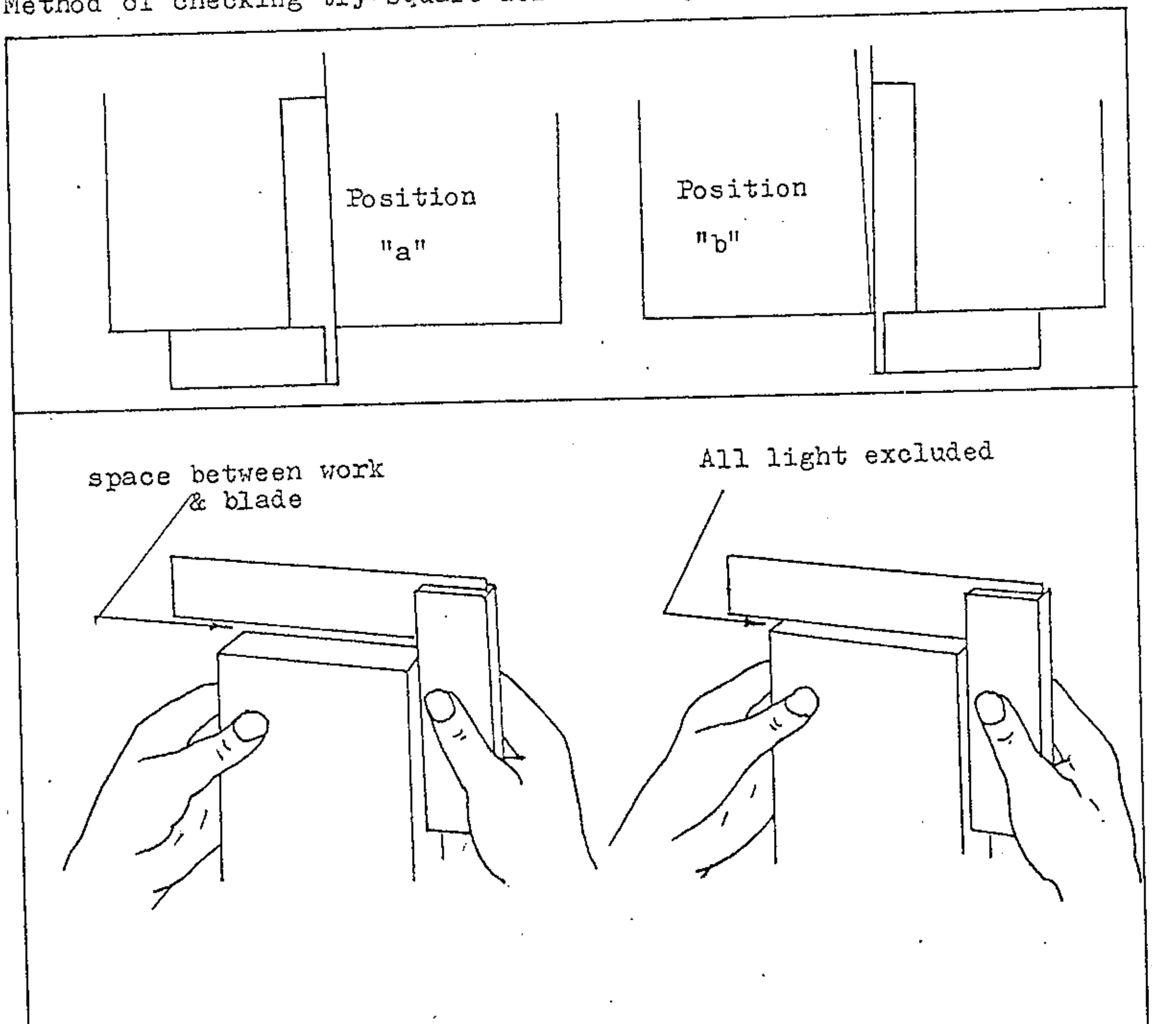
To guide in setting up work square.

To test the accuracy of surfaces 90° to each other.

To check two surfaces being 90°, hold the stock firmly against the finished surface of the work, facing the light so that it shines on the work. Now lower the blade onto the work surface noting the exclusion of light.

The more light excluded, the more accurate the work.

Method of checking try-square for accuracy:



Testing for squareness

Dividers:-

Can be plain or spring loaded. The points must be kept sharp - the inside being flat and the outside round. To set the divider, set one point in the rule graduation, move the other point until it sits in a graduation to the required measurement.

Hold and turn the divider with one hand only by placing the point in a previously prick-punched mark and rotating only once to avoid double lines.

Marking out procedure:-

(a) Ensure that all tools are clean, sharp and arranged neatly on the bench.

(b) Study the sketch or diagram.

(c) Prepare the material, e.g. remove burrs, file two sides to 90°, remove rust, scale etc.

(d) Apply suitable marking medium.

(e) Mark out the required shape.

(f) Check marking out.

(g) Prick punch witness marks.

(h) Centre punch drill centres.

Surface gauge:- Consists of a heavy machined Case, supporting an adjustable column, to which is attached a scriber.

Vee blocks:- Rectangular shaped blocks with one or more vee shaped grooves cut into the sides.

To find the centre of round stock:-

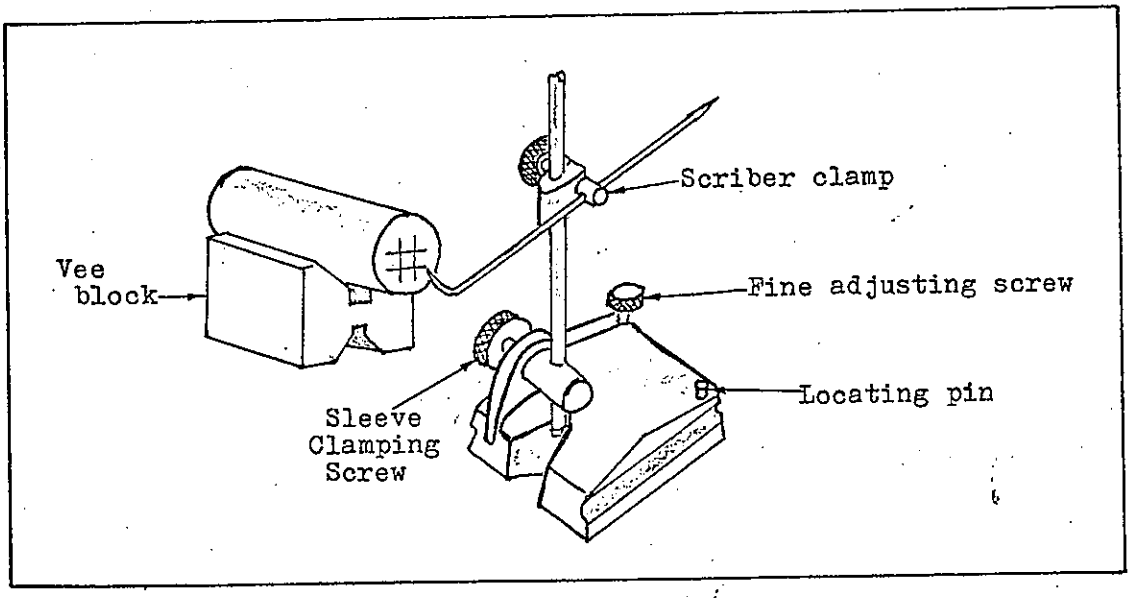
(a) Place the material on Vee blocks on a marking off table.

(b) Set the surface gauge scriber at approximately centre of the round stock and scribe a line across the material.

(c) Turn the material through approximately 90° and scribe another line.

(d) Repeat until a small square is formed.

(e) Scribe two diagonals across the square.



M1/3/1A

TITLE:- VERNIER CALIPER

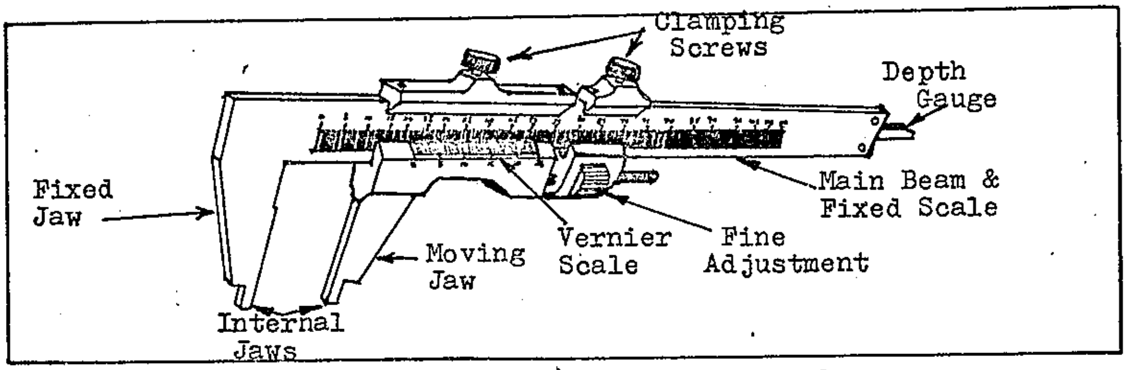
LECTURER:- GERRY HEYNIS

DATE:- 18-2-81

EQUIPMENT:- Vernier Caliper

A vernier caliper is a precision tool which can measure inside and outside distances and diameters, depths, and distances from a step or edge, with an accuracy usually of .001 inch or .02 mm.

There are two main parts of the caliper. One part is made up of the fixed jaws and the fixed scale. The other part is made up of the moving jaws, the vernier scale and the depth gauge.

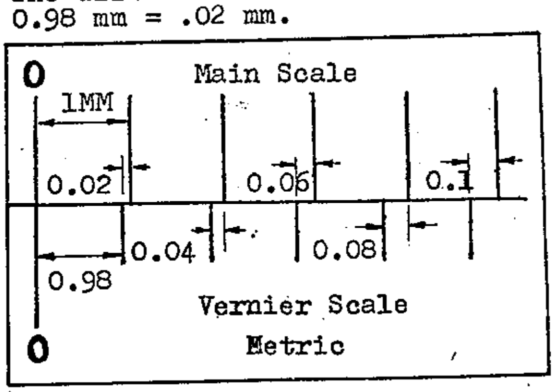


INCH SCALE The most common scale with the six inch vernier is the 1/1000th scale where the fixed scale is graduated down to fortieth parts of an inch (.025") and the moving scale spans a distance of 49/40 of an inch (1.225"). The moving scale is divided into 25 equal parts, each part measuring .049".

Two graduations on the fixed scale equal 2/40" or .05".
One graduation on the moving scale equals .049".

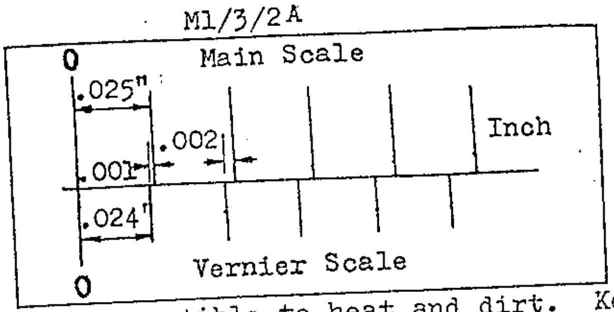
The difference is size between the two therefore equals .050" - .049" = .001" .
This difference gives the caliper its high degree of accuracy.

METRIC SCALE The most common metric scale is the one in which the fixed scale is graduated in millimetres and the moving scale spans a distance of 49 mm. The moving scale is divided into 50 equal parts, each part having a length of 49/50 mm (0.98mm).
The difference in size between these two therefore equals 1mm - 0.98 mm = .02 mm.



To obtain a reading from a vernier caliper, first look at the division on the fixed scale to the immediate left of the zero on the moving scale and note the reading, then look along the moving scale and note which division exactly lines up with a division on the fixed scale.
With the inch scale, each division on the moving scale represents a division that is .001" shorter than those on the main scale, so for each line on the moving scale add .001" to the original reading on the main scale, e.g. If line no. 15 lines up exactly with a graduation on the fixed scale then add .015" to the original reading.

With the metric scale the procedure is the same except that .02 mm is added for each line on the moving scale.



A vernier caliper is susceptible to heat and dirt. Keep it in its box or holster when not in use and when using it, handle it gently. Place the caliper on a soft pad or mat on the bench and keep away from heat, flame and direct sunlight.

Clean regularly and apply thin oil to sliding parts.

Make sure jaws are clean since grit etc. will cause errors in readings.

When measuring internal diameters, slight movement of the vernier will ensure maximum diameter is being read. Repeat to ensure accuracy.

Make sure caliper is vertical when using depth gauge and shoulder is resting firmly and squarely on the edge of the hole.

Take readings from directly in front of the scale to avoid errors due to the angle of parallax.

Do not apply excessive pressure. Only a light friction is needed for the correct reading.

Caution:- Due to stroboscopic effect from lighting, moving machinery can appear to be static. Never try to take a reading on any moving object such as on the lathe or drilling machine.

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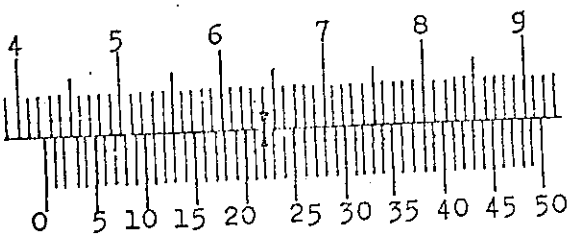
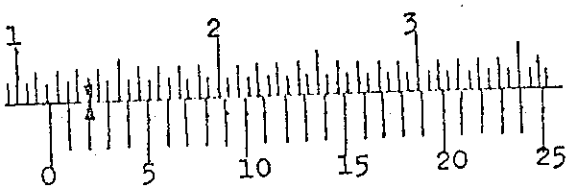
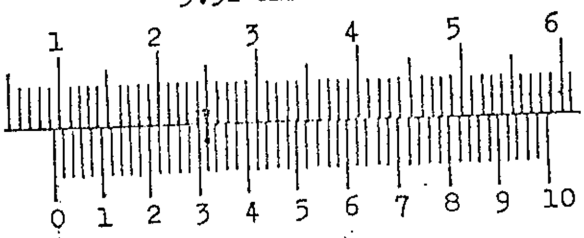


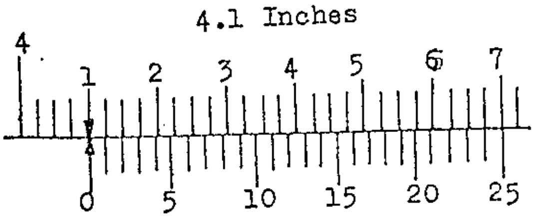
11.54 MM



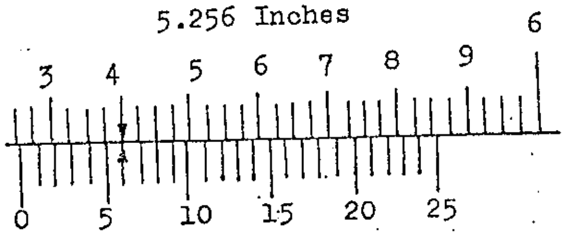
9.32 MM



4.1 Inches



5.256 Inches



TITLE:- PART 2. MICROMETER

LECTURER:- GERRY HEYNIS

DATE:- 19-2-81

EQUIPMENT:- Metric Micrometer, Inch Micrometer

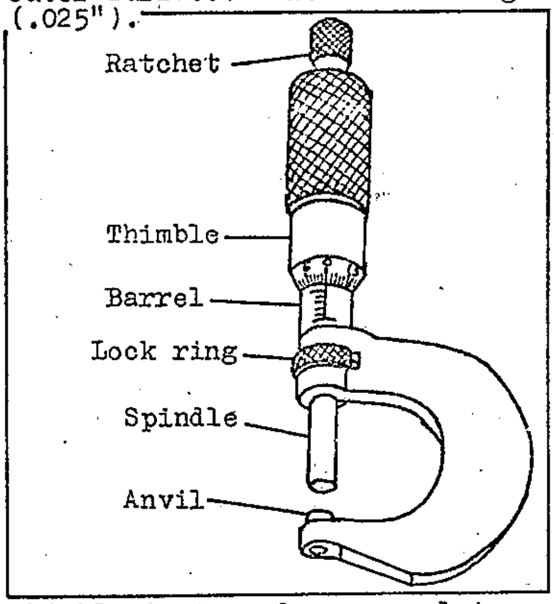
A Micrometer is a precision instrument used for measuring either external or internal diameters to an accuracy of .001" (.0001 in certain cases) or .01MM.

Micrometers are constructed in the following manner:-

Frame:- Available in various sizes and in certain cases interchangeable since the range is limited to the length of the thread. The frame supports the anvil and the spindle and barrel assembly.

Anvil:- Provides the fixed measuring face.

Main spindle nut:- Supports the graduated sleeve or barrel on its outer surface. The barrel is graduated to one fortieth of an inch (.025").



Spindle:- Provides a moveable measuring face. The principle of a screw provides control for the spindle movement.

Thimble:- Carries the graduated scale which measures partial revolutions of the screw.

Spindle nut:- Is used to locate the thimble on the spindle.

Locking Device:- Locks spindle movement. Some micrometers also have a ratchet to ensure correct pressure.

Inch Scale:- The principle is to use a screw which has 40 threads per inch, therefore if the thimble is turned one complete revolution, it moves in or out one fortieth of an inch(.025").
The thimble is graduated into 25 equal parts around its forward edge, so that movement of one graduation on the thimble gives a forward motion of .001" (1/25 of 1/40).

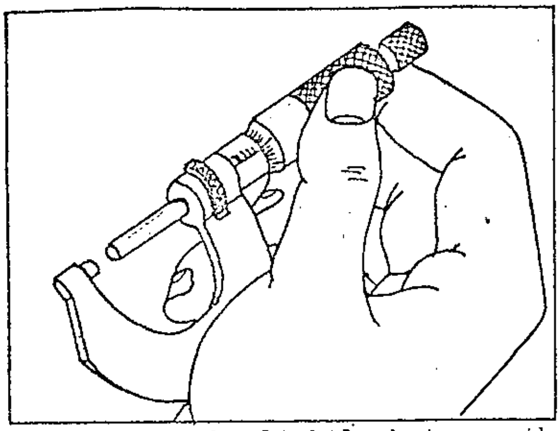
Metric Scale:- The screw with this type has 20 threads per centimetre, therefore if the thimble is turned through one complete revolution, it moves in or out .5 mm. The barrel with the metric type is graduated down to half millimetres.

The thimble in this case is graduated into 50 equal parts around its forward edge so that movement of one graduation on the thimble gives a forward motion of .01 mm.

To read a micrometer, read the part of an inch that is completely visible on the barrel scale.

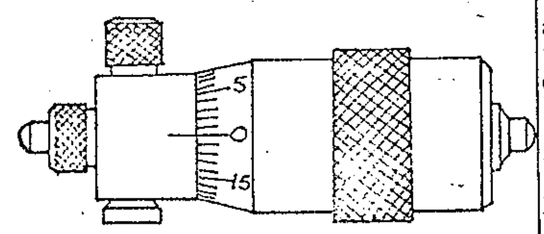
Note the number of the graduation on the thimble that is level with the datum line. Add the thimble reading to the barrel reading.

The procedure is the same for the metric micrometer except that a half millimetre, if completely visible, has to be added on the barrel reading before taking the thimble reading.



Measure with a micrometer as follows:-
Hold micrometer in right hand with graduations on main scale towards you.
Support the frame on the lower centre of the palm using little or third finger to hold the frame to the palm.
Place the middle finger behind and supporting the frame.
Keep first finger and thumb free to adjust the knurled thimble.
Close the anvils until you feel them touching the work.
Move the work slightly between the anvils. Make any further adjustment necessary until the right "feel" is obtained.

Another method is to support the frame in the palm of the left hand with the third finger holding the frame against the palm and the fourth and small fingers supporting it. The work can then be held between the thumb and the index finger. The right hand is used to make adjustments.



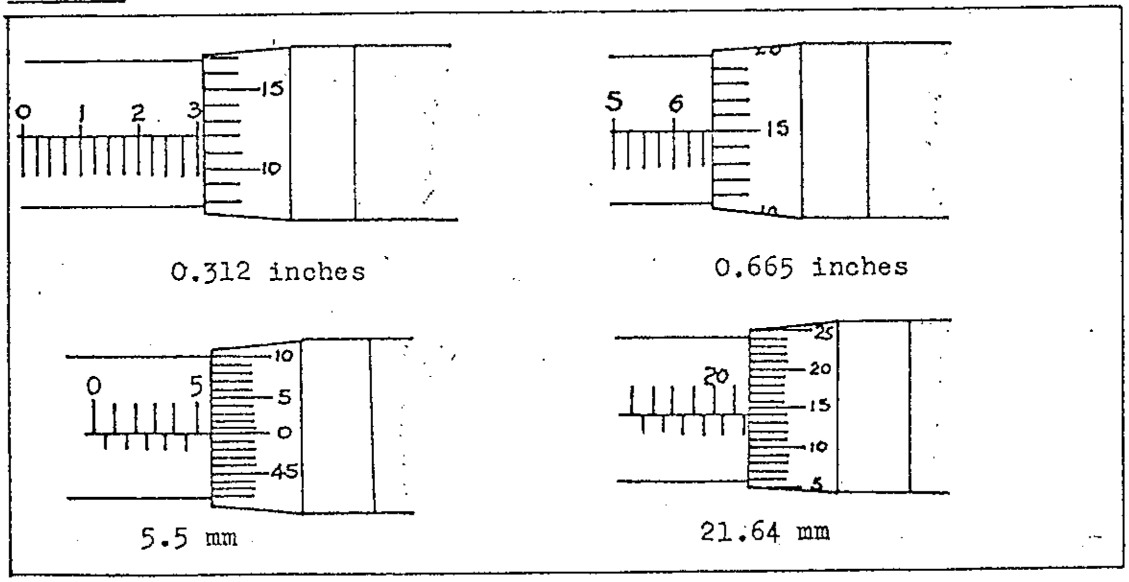
Inside Micrometer

Various sizes of frames are available for outside micrometers to enable virtually any size of outside diameter to be measured, the range with an individual frame however is limited to the thread length. Inside micrometers are limited to a minimum measurement of about 2 inches.

Follow these rules for accurate measurements.

1. Use correct pressure. Use ratchet if provided.
2. Keep anvil faces clean.
3. Move the micrometer sideways slightly to ensure that faces are sitting square to work surface.
4. Never rub the faces along the work.
5. Keep away from heat and direct sunlight. Even heat from hands can affect accuracy.
6. Handle gently and always keep in its box when not in use.
7. Store with contact faces <u>open</u>.

<u>Caution</u>:- Never try to obtain a reading from any moving object.



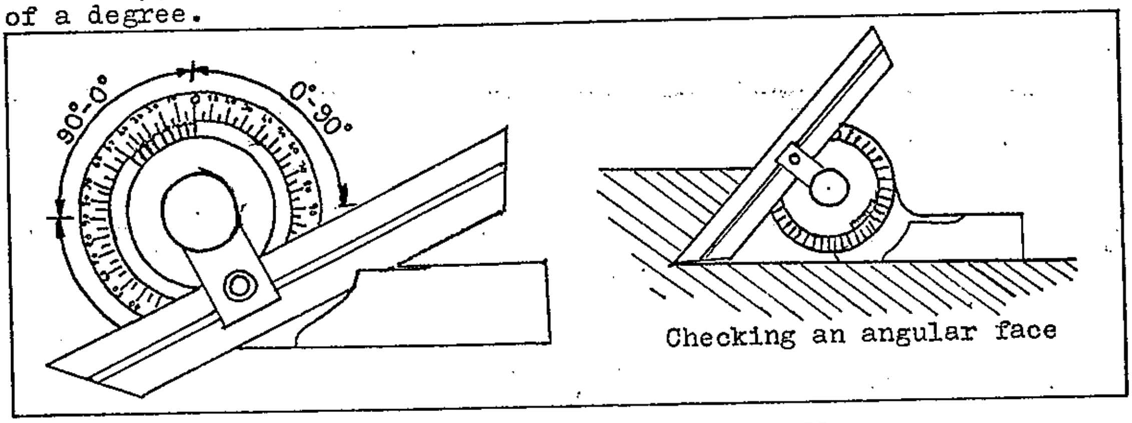
TITLE:- VERNIER PROTRACTOR

LECTURER:-

DATE:-

EQUIPMENT:- Vernier Protractor

Vernier protractors are protractors that have a vernier on their graduated scale to enable them to be set to much greater accuracy. Generally, they give an accuracy of 5 minutes which is one twelfth of a degree.



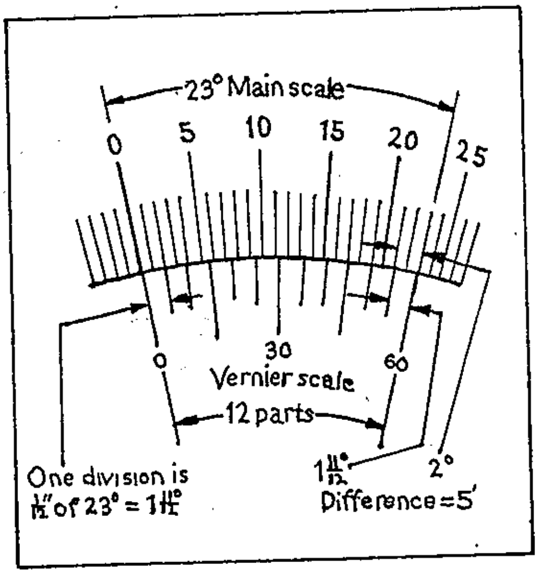
The principle of the vernier protractor is as follows:-
The main scale of the protractor is graduated into 360 degrees reading from 0 to 90 to 0 then 90 back to 0.
The vernier scale is made to cover an arc of 23 degrees of the main scale. It is then divided into 12 equal parts.
The length or angle of each division is therefore one twelfth of the total arc of 23 degrees i.e. $\frac{1}{12}$ of $23^{\circ} = \frac{23}{12}$ is $1\frac{11}{12}^{\circ}$.

The length of the corresponding divisions on the main scale is 2 degrees.
Therefore, the length of the vernier divisions is one-twelfth of a degree shorter than the length of the corresponding divisions on the main scale. $2^{\circ} - 1\frac{11^{\circ}}{12} = \frac{1^{\circ}}{12}$

$$= \frac{60'}{12}$$

$$= 5 \text{ minutes}$$

Reading a vernier protractor - The vernier scale is duplicated to read either side of the zero. If you read the main scale as an anti-clockwise, continue, reading the vernier scale in an anti-clockwise direction from zero. If you read the main scale in clockwise direction, continue, reading vernier scale in a clockwise direction.



Always make sure the vernier reading adds to the main scale reading.

Read a vernier protractor to one twelfth of a degree as follows -

Read the degrees of the main scale up to the zero of the vernier.

Continue reading on the appropriate vernier scale.

Note the number of the line on the vernier scale that is directly opposite a line on the main scale.

As each line of the vernier scale represents an arc of five minutes, multiply the number of this line by five, and add the result in minutes to the degrees of the main scale. Some vernier scale may be calibrated in minutes.

The first sketch shows a vernier protractor set to an angle.

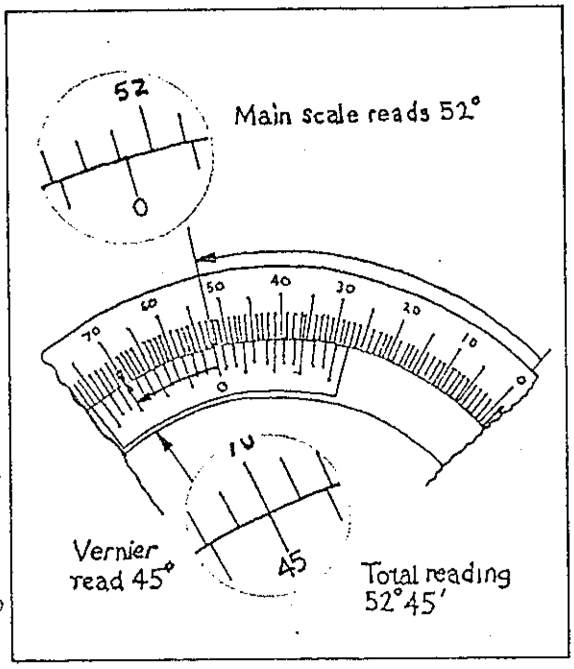
The main scale reads 52 degrees up to the zero of the vernier.

Continued reading shows that the ninth line on the vernier is opposite a line on the main scale.

9 x 45 = 45 minutes.

Add this to the main scale reading of 52 degrees.

Total Vernier protractor reading is 52°45'.



TITLE:- VICES

LECTURER:-

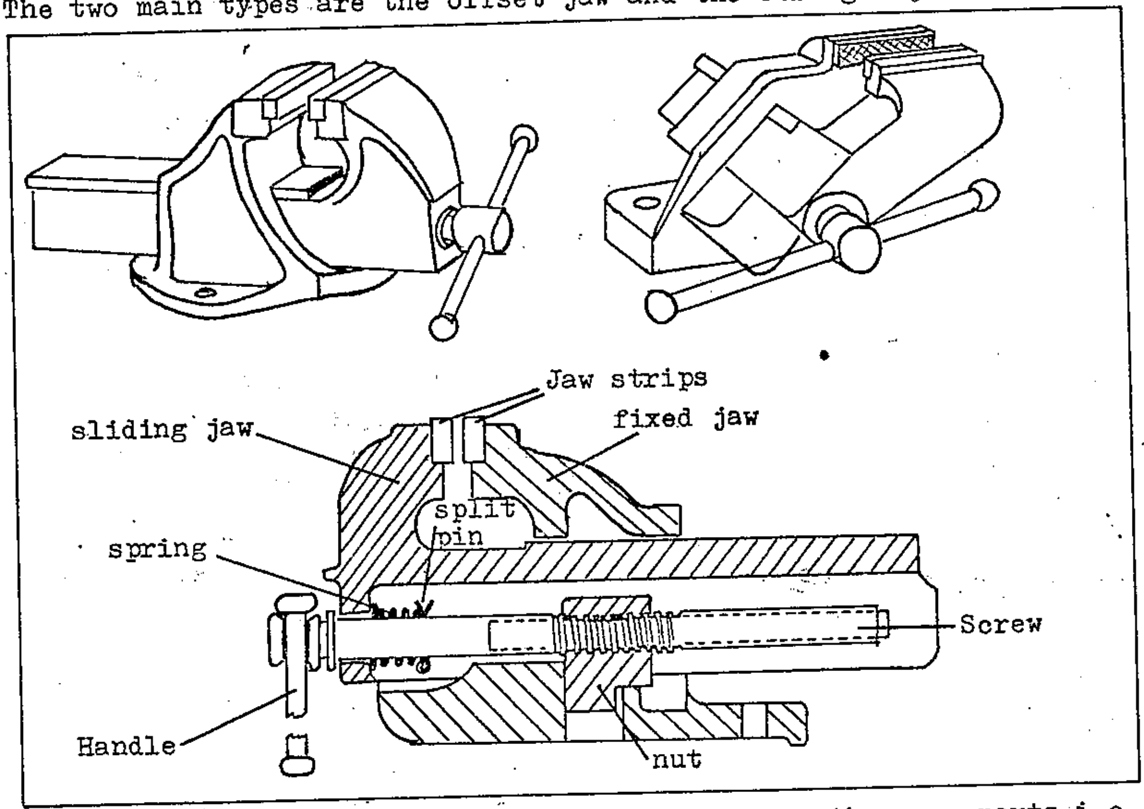
DATE:-

EQUIPMENT:- Bench vice, machine vice, hand vice, pin vice, soft jaws.

A vice is an aid for tradesmen to hold jobs rigid whilst work is carried out such as filing, hacksawing, drilling etc. A variety of vices are available depending on the purpose for which they are required. They can be grouped into 3 categories:-

1. BENCH VICES 2. MACHINE VICES 3. HAND VICES.

Bench vices are those which are permanently bolted to a workbench. The two main types are the offset jaw and the straight jaw vice.



They are constructed similarly in that they have the same parts i.e.

Fixed jaw - which is bolted to the bench, usually cast iron
Moving jaw - slides into the fixed jaw, also cast iron
Lead screw - passes down the inside of the moving jaw for adjustment
Nut - fitted into the fixed jaw, but can be removed
Handle - passes through the end of the lead screw
Jaw strips - one fastened to each of the fixed & moving jaws. They are hardened to resist wear, are grooved on their faces for grip, and are machined to ensure that they are parallel.

Some vices are fitted with a "quick release" lever. This opens a split nut to allow the thread of the lead screw to be withdrawn without turning.

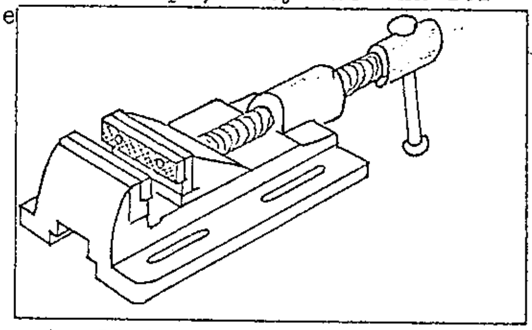
The offset vice has an advantage in that it can be used to grip long pieces without the guide of the sliding jaw causing obstruction.
Both vices should be mounted so that the edge of the fixed jaw slightly overhangs the edge of the bench, also the height should be adjusted by adding wooden blocks so that the top of the vice is level with the base of the forearm when held horizontally.
Incorrect vice height will cause unnecessary strain on the back, and also contributes to inaccurate work.

Small articles should be gripped in the centre of the jaws, and vee blocks should be used on pipes and roundstock.
Aluminium soft jaws should be used to protect finished surfaces from the rough jaw-strip surfaces.

Tightening of the vice should be carried out with pressure from one hand only; over-tightening will cause the cast-iron to fracture.

A vice must not be used as an anvil, although hammering work may be carried out on material clamped in the jaws provided that pressure is directed towards the fixed jaw. By mounting the vice above one of the bench support legs, maximum strength and rigidity is obtained.

<u>Machine Vices</u> Although varied in size and shape, they are all for the purpose of bolting onto the table of a drilling machine shaper, milling machine etc. so that work can be securely held for machining.
These vices should be carefully positioned and protected before machining so that they do not become damaged from cutting tools.
Usually a piece of timber is placed beneath the workpiece to protect the vice whilst drilling.

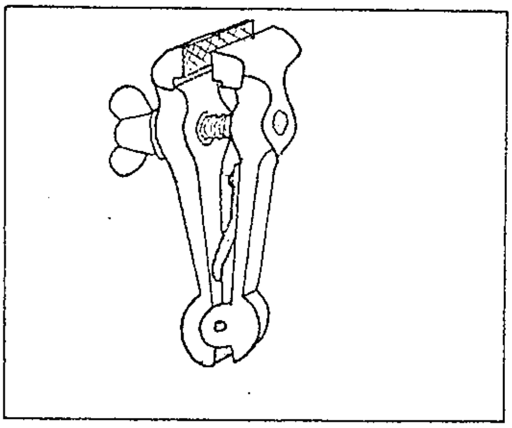


Because the threads are exposed, they should be cleaned of swarf and lightly oiled after use.

<u>Hand vices</u> are designed so that small objects may be held in the vice and the vice held in the hand for drilling, polishing or grinding etc.

Usually the hand vice is hinged. This causes the jaws to grip unevenly on most positions and should therefore be used with great care as there is a danger of the work slipping.

A pin vice is used to hold small diameter rod or wire. It has a 3 jaw chuck with a hole along the centre of the handle for carrying long pieces.



<u>Care and Maintenance</u> To ensure the long life of a vice, it should be dismantled, cleaned and lubricated regularly, don't apply heat to a vice, and protect it from damage from machines.

<u>Safety</u> Beware of handle dropping and trapping skin.

Beware of heavy workpiece dropping from vice when placing work into, or removing work from jaws.

Ensure firm grip when dismantling.

LECTURE:- HAMMERS, MALLETS AND CHISELS

LECTURER:- GERRY HEYNES

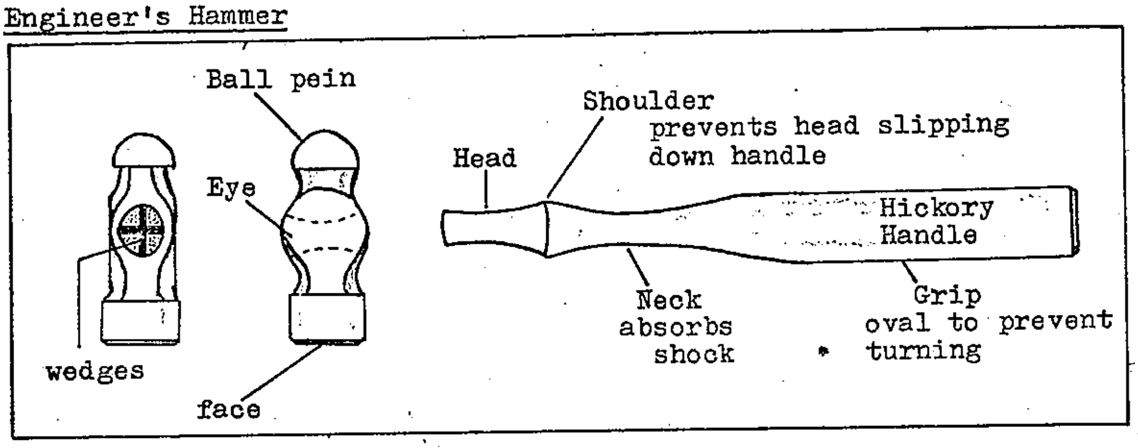
DATE:- 24-2-81

EQUIPMENT:- Ball pein hammer, Cross pein hammer, straight pein hammer, sledge hammer, rawhide mallet, lead hammer, copper faced mallet, claw hammer, comb hammer, Flat, diamond point, round nosed and cross cut chisels.

Hammers are a means of increasing the force applied by a person's arm to change the position or shape of an object.
The effectiveness of a hammer blow is dependant upon several factors:-

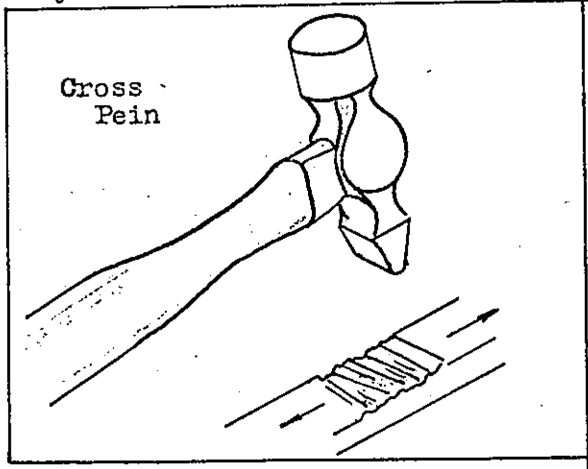
1. The TYPE of hammer
2. The WEIGHT of the hammer
3. The VELOCITY of the blow.

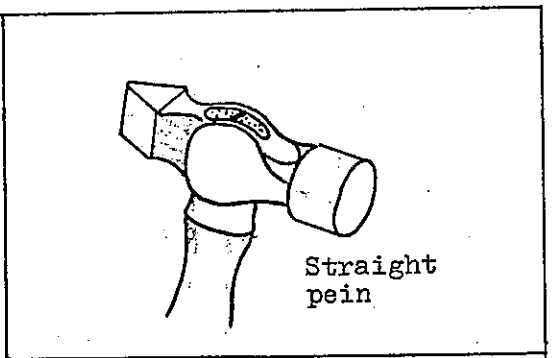
Engineer's Hammer

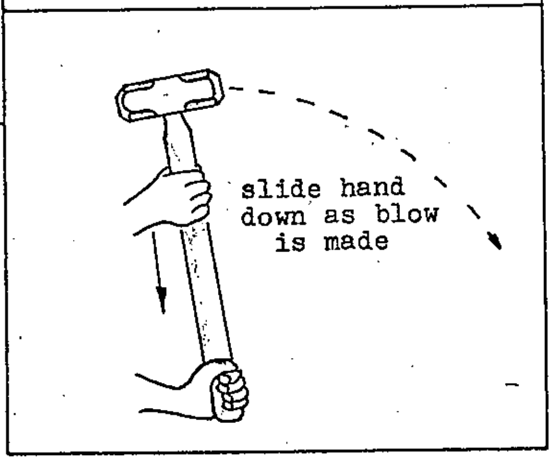


The engineer's hammer has a ball pein which is used to speed metal in all directions as with rivetting. Use fairly light blows and keep changing the position and direction of the force to allow the metal to spread evenly without splitting.

Cross pein and Straight pein hammers are used to spread metal in only one direction.

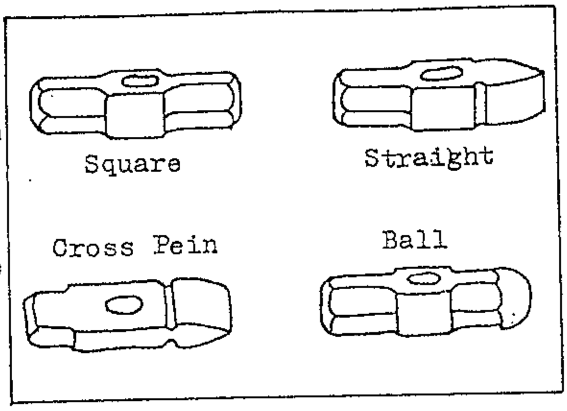




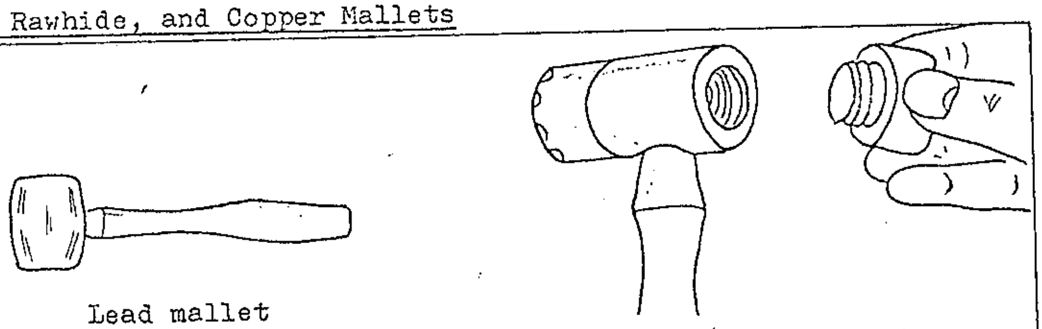


Sledgehammers have 4 types of head.
Square or double faced.
Straight pein.
Cross pein.
Ball pein or flogging.

The head is made of steel having a higher carbon content than hand hammers.
Weights range from 3 to 6 kg. with handles of 900 to 1100 mm length. They are used for very heavy work and are operated with two hands.
Grip as shown in the sketch, then as the strike is being made, slide the right hand along the shaft towards the left hand to increase the force and reduce "jarring".



Lead, Rawhide, and Copper Mallets



Lead mallet

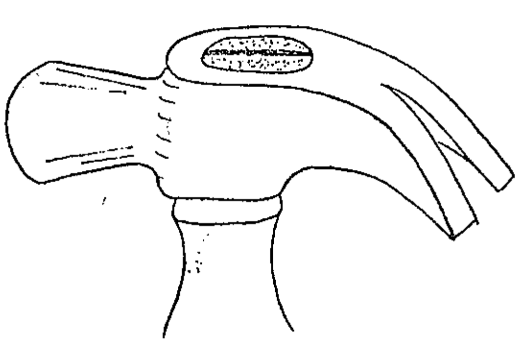
Plastic or copper inserts

Rawhide mallets have
Push-in inserts

Where a soft or finished surface must be hammered into place without damage, one of the above mallets should be used. The mallet head should be softer than the material being struck.
The disadvantage of these mallets is that they have a very short life compared with steel hammers. Heads that are worn or split should be replaced, and burred heads should be dressed with a file.
Some examples of their uses are:- bearing and bush installation fitting copper coils into a motor, bending aluminium, assembly of machines.

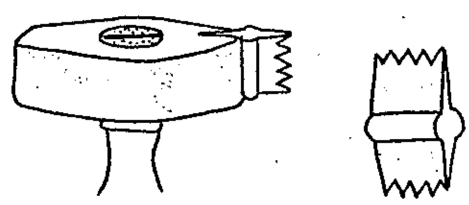
Claw Hammer

Although the claw hammer is basically a carpenter's tool, uses are found in the electrical trade when installing electrical equipment in buildings. The claw is used for removal of nails as in floorboards.



Claw
Hammer

Comb Hammer This tool is used for the removal or chasing of plaster on walls to allow cables to be installed. A replaceable hardened steel comb is slotted into the steel head. Light blows are usually sufficient to remove the plaster. Care should be taken in directing the blow to ensure that the groove being cut is straight and that a minimum amount of damage is caused to surrounding plaster.



Replaceable comb

Safety

When using hammers, there is always a tendancy for pieces of material to fly off. To avoid injury, observe these rules:-

1. WEAR SAFETY GLASSES.
2. Focus eyes on point to be hit.
3. Ensure that handle is not chipped, split, or splintered.
4. Ensure that the handle is free from oil and grease.
5. Ensure that the head is properly fitted.
6. Ensure that the head is not chipped or cracked.
7. Grip the hammer firmly.
8. Strike squarely to work.
9. Keep hands and fingers clear of contact area.

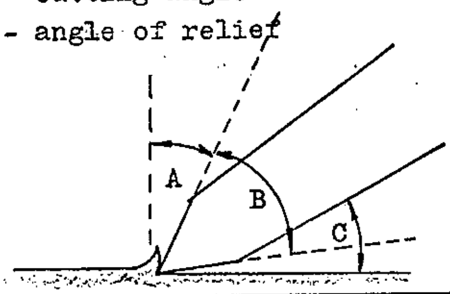
Chisels A chisel is a complementary tool to the hammer, and is used to cut and remove metal where machines cannot be used, or for removal of siezed nuts and rivets etc.
They are made of high carbon tool steel and tempered to the proper degree. Do not attempt to heat treat a chisel as this may cause hairline fractures.

Point Angles The angle to which the chisel point is dressed depends on the hardness of the material it is to cut.

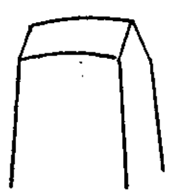
Metal	Cutting angle
Cast steel	70 - 80°
Cast iron	60 - 70°
Mild steel	50 - 70°
Brass	45 - 60°
Copper	45°
Aluminium	30°

The cutting action of the chisel also depends upon the angle that the chisel is presented to the work.
Relief angle determines the depth of cut and prevents the chisel digging in or glancing off.
Rake angle determines how the chip will curl and break off. Too small an angle will cause the chips to build up in front of the chisel and not break off.

A - angle of rake
B - cutting angle
C - angle of relief

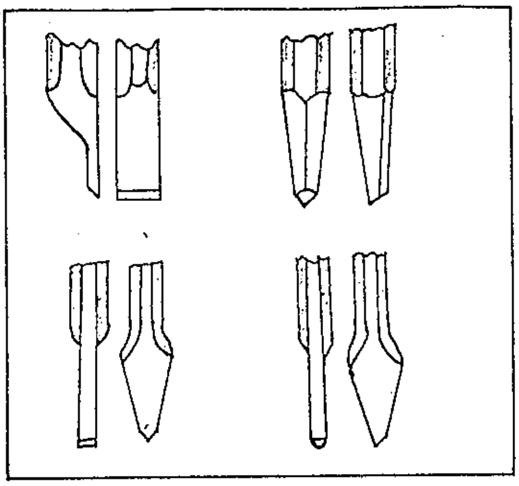


Slightly rounded cutting edge



The chisel point should be dressed with a file. A grinder would tend to overheat the cutting edge causing it to lose its temper and become dull quickly. The point should be slightly rounded to help keep it centralised when in use.

<u>CHISEL TYPES</u> A number of specially shaped chisels have been designed for special purposes.



<u>Side Cutting</u> chisels have an offset point for cutting down the sides of slots.

<u>Diamond point</u> chisels for finishing internal square corners, cutting vee grooves etc. and for chipping out welds.

<u>Cross-cut</u> chisels for making square or rectangular grooves for keyways.

<u>Round-nosed</u> chisel for enlarging holes or cutting oil grooves in bronze bushes.

<u>Using a chisel safely</u>

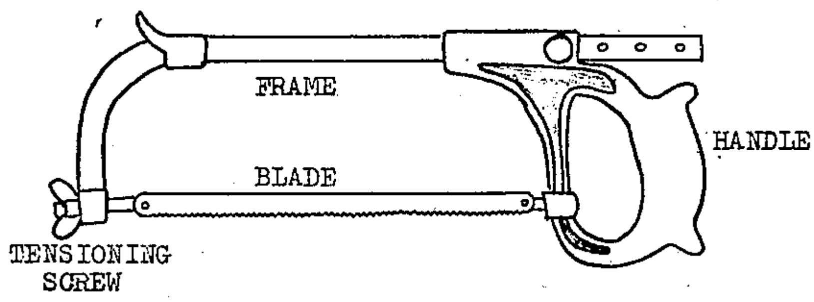
1. Grip the work securely in a vice with packing underneath.
2. Grip the chisel firmly near the head with the full hand.
3. Grip the hammer close to the end of the handle.
4. Swing from the elbow with solid blows.
5. Maintain the chisel at the correct angle.
6. Keep the chisel pressed firmly into the cut.
7. Grip sheetmetal with the cutting edge close to the vice.
8. Focus eyes on the chisel point.
9. Wear safety glasses.
10. Use a chip shield to protect workmates.
11. Remove mushroom heads.
12. Discard chipped or cracked chisels.
13. Remove burrs after chiseling.
14. Re-dress chisels with file only.
15. Do not apply your personal mark or initials etc. to a chisel.
16. Chisels should be marked B.H.P.-D.G.

TITLE:- SAWS
LECTURER:- GERRY HEYNIS
DATE:- 3-3-81
EQUIPMENT REQUIRED:- Hacksaw, blades, Junior saw, Pad Saw, Sheetmetal saw.

Saws are used to cut materials to the shape and sizes required. In the electrical trade, the most commonly used is the hacksaw.

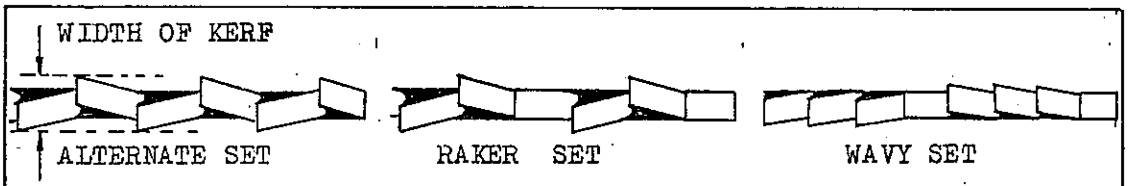
HACKSAW

This tool is designed to cut most metals using a blade which is discarded when it becomes blunt, thereby saving time and money for resharpening.



It consists of a frame, handle, blade, and tensioning screw.
The frame is adjustable to accomodate 10" or 12" blades.
The handle is shaped to give maximum comfort and ease of operation.
Blades are available with different teeth spacing, to suit various materials, the most common being 14, 18, 24, and 32 T.P.I. (teeth per inch).

The teeth of a saw blade are SET, i.e. they are not all in line, but bent to the left and right so that the width of cut made is wider than the thickness of the blade. This extra width is known as the KERF.
Three types of SET are shown:-



When selecting a saw blade, consideration must be given to:-
1. The hardness of material to be cut.
2. Thickness of material to be cut.

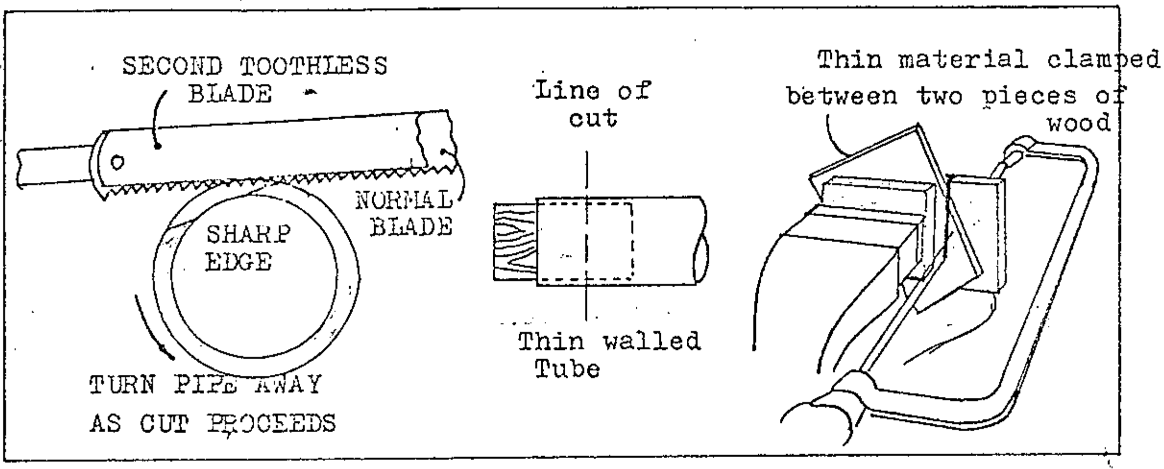
For cutting hard material or thin material, use a fine toothed blade, and for soft or thick material use a coarser blade.

On most hacksaws, it is possible to fit the blade at 90° to the frame, this allows for cutting off long strips.

When fitting a blade, ensure that the teeth are pointing away from the handle, that it is pressed firmly onto the tensioning pins, and that the tensioning wing nut is tightened firmly.

CUTTING VARIOUS CROSS-SECTIONS

To minimise damaged and broken blades, never allow teeth to strike a sharp edge, or straddle thin work, cut straight lines, cut at the proper speed (50 strokes per minute), and do not exert excessive downward pressure (none on return stroke).



An old hacksaw blade with the teeth removed may be used as a depth gauge for thin walled tube when clamped beside the cutting blade on the hacksaw.

Fit a wooden plug inside a tube for support, and cut through both.

When cutting thin sheet metal, use a piece of wood clamped to each side of the work for added support.

Always make cuts in a vertical plane.

USING A HACKSAW

Stand with the feet apart for proper balance, grip the handle firmly in the hand with the forefinger pointing along the frame and rest the thumb on top.

Use the thumb of the other hand to guide the blade when starting a cut, then grip the end of the saw to hold it steady and to apply pressure.

Cut on the forward stroke only, reduce pressure on the return stroke.

Reduce pressure, speed, and length of stroke when cut is almost through.

If a blade breaks in a cut, re-start the cut from the opposite side with a new blade.

Cut on the R.H. side of the vice to avoid damaging fingers.

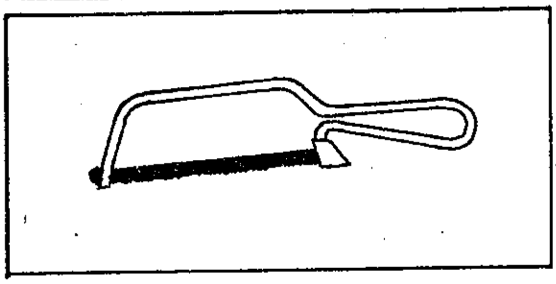
CAUSES OF BROKEN OR DAMAGED BLADES

Allowing blade to twist or tilt
Excessive or insufficient tension
Excessive pressure or speed
Using new blade in old cut
Coarse blade on thin sections
Blade fitted wrongly
Loose work
Improper grip
Lack of concentration

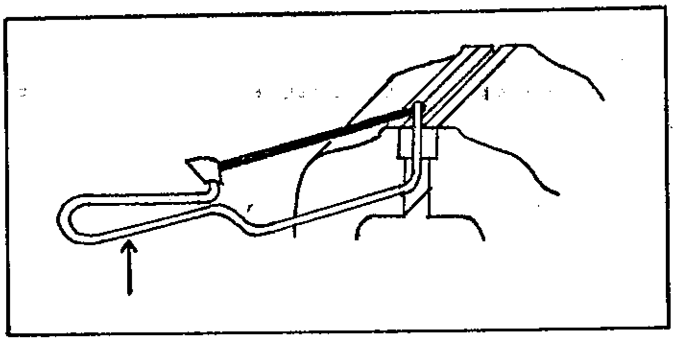
SPECIAL PURPOSE SAWS

Although the hacksaw is quite versatile, it has limitations to its use making it necessary to use other saws for special jobs.

JUNIOR SAW



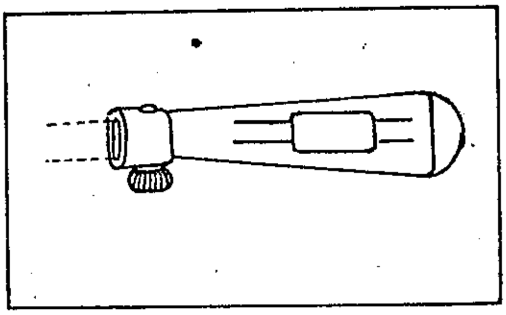
A small saw holding a 6" blade under spring tension.
It is useful for cutting small parts or for use in confined spaces.



A good method which can be used to change blades is to hold in vice as shown and apply pressure in upward direction to release tension on blade.

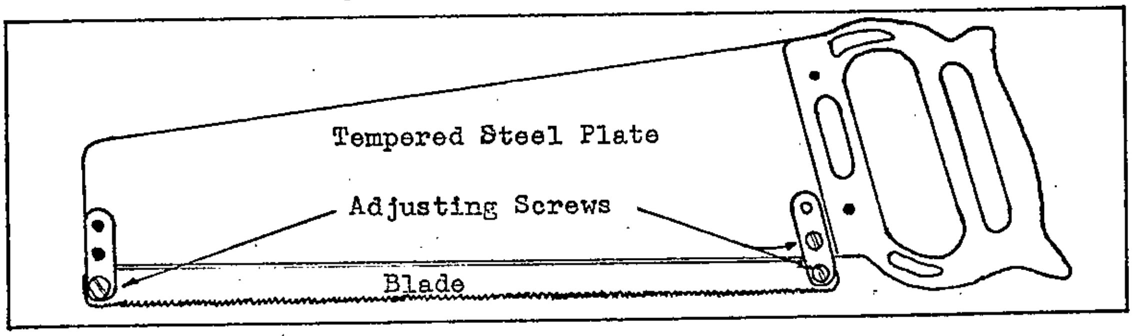
PAD SAW

Makes use of broken hacksaw blades which fit into the handle and are held in place by a knurled screw. Its main purpose is for cutting back the insulation between motor commutator segments (undercutting). In some cases it is advantageous to fit the blade into the handle with the teeth pointing towards the handle.



SHEETSAW

This has a tempered steel plate which is fitted with a handle and tensioning screws. Standard hacksaw blades are fitted allowing the saw to cut through large sheetmetals with ease.



SAFETY

1. Wear safety glasses.
2. Clamp the work securely.
3. Grip the hacksaw properly.
4. Use the correct speed, pressure, length of stroke and stance.
5. Ease off on the pressure when almost through.
6. Use a handbroom to clean away shavings.
7. Remove burrs from edges of cut.

TITLE:- DRILLS & DRILLING

LECTURER:- Gerry Heunis

DATE:- 5-3-81

EQUIPMENT REQUIRED:- Twist drill, parallel shank drill, Morse taper shank drill, tapered square shank drill, Safety Handbook, Countersink drill, counterbore drill, masonry drill, flycutter, G-clamp, Stair block, Vee block, U & flat clamp, teebolts, machine vice.

A drill is a device which is designed to cut circular holes in almost any material whilst being rotated by some electrical or mechanical device.

The most common drill used in the electrical trade is the twist drill.

TWIST DRILL

The name given to this drill "BIT" is obtained from its appearance, it appears to have been twisted to its shape. In actual fact, two spiral grooves or "flutes" are ground into a circular section piece of steel alloy. A plain section is left at one end of the flutes for holding purposes, and a point is made at the other end for cutting.

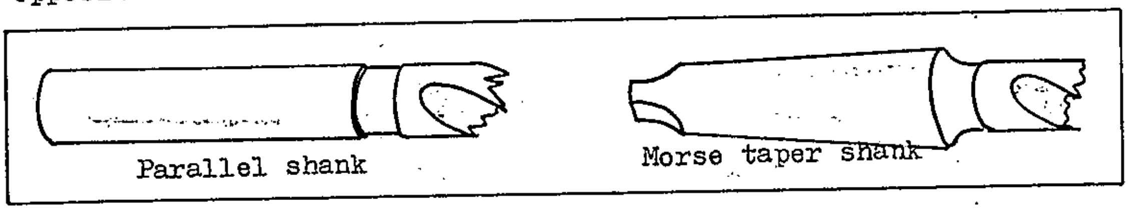
SHANK

This is the name given to the plain part of the drill. It can be shaped to fit 3 different holding devices, i.e. the shank can be parallel (up to ½" diameter) or it can be tapered (3/64" to 4" diameter), or it may have a tapered square shank as used on carpenter's drills.

The parallel shank drill is used in fixed and portable drilling machines which are fitted with a chuck.

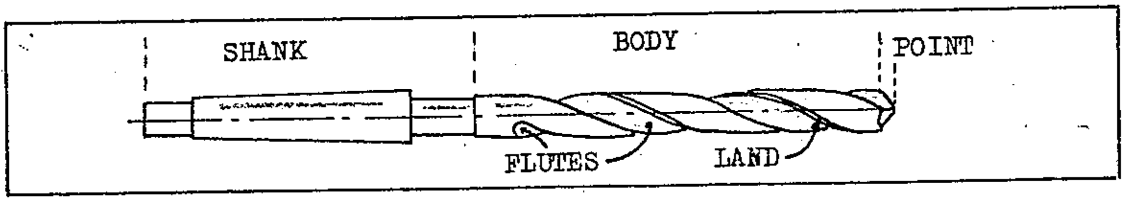
The taper shank, or Morse Taper, is used in the lathe or on larger drilling machines having a tapered sleeve to match that of the drill. The end of the shank has a tang which is visible through a slotted hole in the drilling machine sleeve. To remove the drill, a tapered steel wedge, or drift is forced into the slot, pushing out the drill. The advantage of this type of shank is that it is a good fit, has a positive drive, and is accurately aligned.

The square shank is fitted into a carpenter's brace which has a two jaw chuck, the jaws of which have vee notches ground to match two opposite corners of the shank.



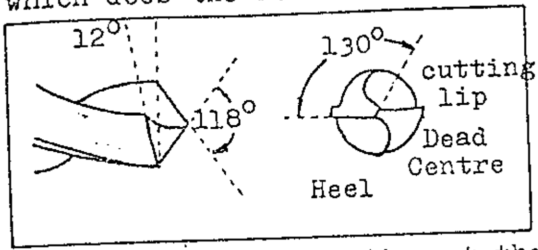
Body

The body of the drill is the section between the shank and the point. The main parts of the body are the FLUTES, which are the spiral grooves which are there to allow shavings to escape, and to allow the point to be lubricated; The LAND or margin which is the raised part along the edge of the flutes, which reduces friction when drilling deep holes; and the WEB which is the backbone of the drill. This is the section of steel between the flutes which becomes progressively thicker between the point and the shank.



The Point

This is the conical shaped part on the end of the end of the drill which does the actual cutting. It must be carefully ground to ensure an efficient cutting action.



The POINT ANGLE for general use should be 118°.

The LIP CLEARANCE angle is the angle at which the face of the drill slopes away from the straight cutting lip and should be approximately 12° for general purpose use. The section at the end of the web and between the two cutting lips is called the DEAD CENTRE and takes no part in the cutting operation. The angle of the dead centre is an indication of whether there is sufficient lip clearance. It should be 130° to one of the cutting lips.

The trailing edge of the face of the drill is called the heel.

Incorrectly ground drills will be noticeable by one or more of the following faults:-

- Oversize hole, Non-circular hole, chips on the cutting lips, squealing of the drill during drilling, only one shaving appearing from the flutes, or overheating (blueing).

PILOT HOLE

Because of the dead centre, it becomes necessary to drill a small pilot hole prior to using the larger drills. The diameter of this pilot hole must be as close as possible to the width of the dead centre and in no case should it be larger.

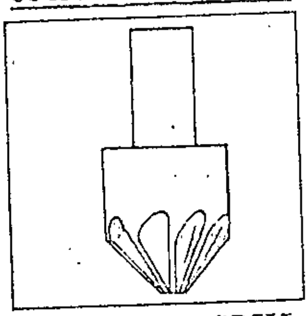
DRILL SIZES

Twist drills are available in fractional sizes ranging from 1/64 dia. to 4" dia. in 1/64 steps. They are also available in metric sizes or where intermediate sizes are required, NUMBER and LETTER drills are available.

Page 121 in the Electrical Safety Handbook lists these sizes which range from No.1 (0.228) to No.60 (0.04) and from A (0.234) to Z (0.413).

Although twist drills are the most commonly used, it occasionally becomes necessary to select a different type of drill for drilling special materials or large or unusual holes. A number of other special drills are available.

COUNTERSINK DRILL

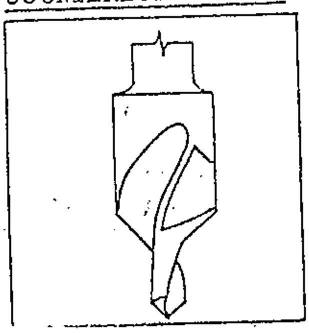


These drills are used for enlarging the mouth of a previously drilled hole to accept the head of a countersunk screw, or to remove burrs.

It has a point angle of 90° to match that of a countersunk screw, and it has 4, 6, or 8 cutting edges.

Always use a slow speed.

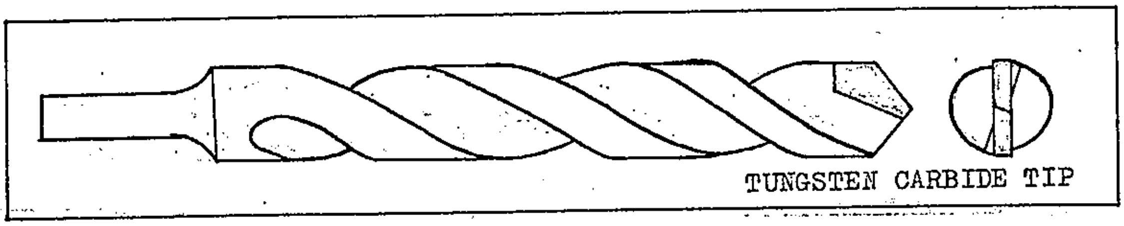
COUNTERBORE DRILL



This is sometimes known as a "peg drill". It is used for drilling two different diameter holes to different depths and ensuring that both are on the same axis. They would be used to provide a recess for the head of a screw, or a rivet etc.

MASONRY DRILL

When holes are required in bricks or concrete, the normal twist drill is too soft and weak. The masonry drill is similar to a twist drill except that it has a thicker web, and it has two tungsten tips cemented onto the cutting lips, and is able to withstand the rough and hard effects of masonry.



FLY CUTTER

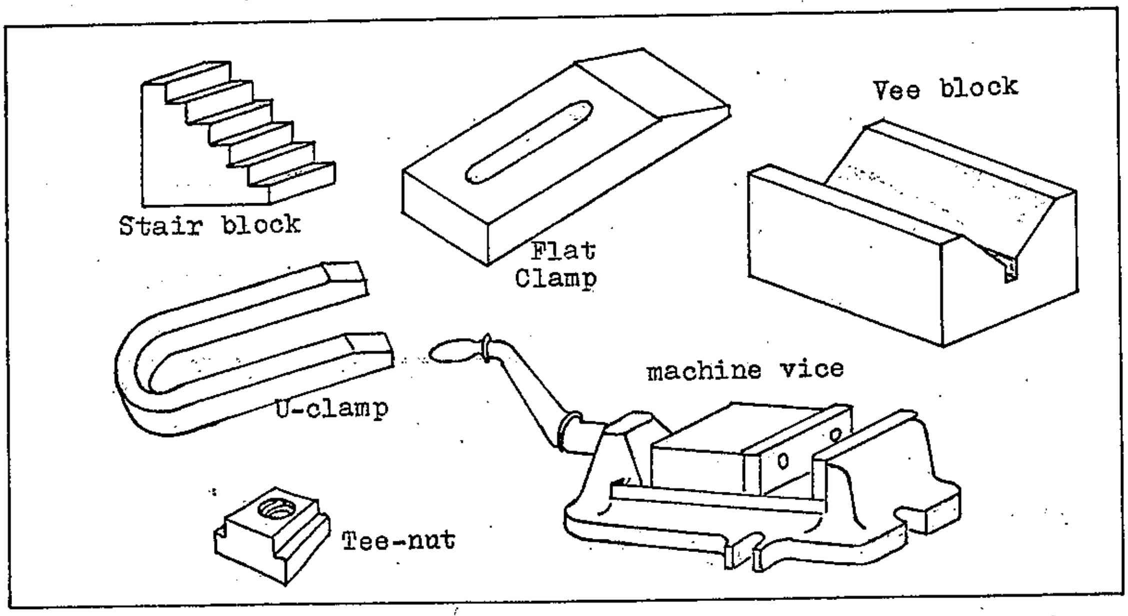
When holes over 4" diameter are required, a fly cutter may be used. This has an adjustable cutting tool (similar to a lathe tool) mounted on a horizontal arm, the end of which is secured by a hexagonal or circular shaped shank which fits into the drill chuck. As the drill rotates at a slow speed, the cutting tool cuts out the circle to the size required. It is mostly used on softer sheet materials.

CLAMPING

When a drill is in operation, it will tend to lift and turn the workpiece. For this reason, work must NEVER be held in the hand. Various methods of clamping the workpiece are available and the choice will depend on several factors:-

1. The size of the work,
2. The shape of the work,
3. The type of drill being used,
4. The type of material being drilled,
5. The size of drill used.

The following are methods of clamping which may be employed. They may be used alone or in conjunction with others.
G-Clamp, stair block, vee block, U clamp, flat clamp, tee bolts, & machine vice.



When clamping work prior to drilling, ensure that the work is set squarely to the drill, that the work cannot slip, lift, or rotate, that the drilling head and table are clamped in position, and that the drill will not damage the drill table or any of the clamping devices used, i.e. use wooden packing under the workpiece.

SPEED

For maximum efficiency, the drill must operate at the correct speed. Factors which determine the drill speed are:-

1. Hardness of material to be drilled
2. Diameter of the drill
3. Lubrication used.

The hardness of a material determines the speed at which it can be cut. It is expressed in feet or metres per minute.

CUTTING SPEEDS FOR HIGH SPEED STEEL DRILLS		
Mild Steel	80/100 fpm	25 - 30
Cast Iron	60/100 fpm	20 - 30
Brass	125/200 fpm	40 - 60
Aluminium	200/300 fpm	60 - 90

To calculate speed in r.p.m., the following formula is used.

$$\text{r.p.m.} = \frac{\text{Cutting speed} \times 12}{\pi \times \text{dia: of drill(fraction)}} \quad \text{or} \quad \frac{\text{Cutting speed} \times 1000}{\pi \times \text{Drill dia: (mm)}}$$

FEED

This is the rate at which the point of a drill penetrates the work.

When drilling hard materials or drilling small holes, the feed must be reduced.

Too slow a feed will reduce the cutting action causing the drill to overheat whereas too great a feed will cause the drill to split or chip and wear near the dead centre.

LUBRICATION

Lubricants perform two important functions when drilling,

1. Cooling the drill to prevent cutting edges overheating and becoming dull,
2. Reduce friction in the hole when the flutes remove the shavings.

Various materials require different lubricants as shown in the table.

Mild Steel	Soluble oil, or oil
Stainless steel	Dry
Cast Iron	Dry
Brass	Dry
Bronze	Soluble oil
Copper	Soluble oil or kerosene
Aluminium	Soluble oil or kerosene

PROCEDURE FOR DRILLING

1. Centre-punch where hole is to be drilled.
2. Insert drill into chuck to within $\frac{1}{8}$" of flutes.
3. Tighten chuck with Right Hand from all 3 positions.
4. Clamp workpiece securely.
5. Adjust drill speed to suit drill and material.
6. Reduce FEED when drill is almost through.
7. Remove BURRS from both sides of hole.
8. Remove drill using Left Hand on chuck key.
9. Clean up and replace all equipment used.

SAFETY To avoid injury to yourself or others, and to avoid damage to equipment, the following safety rules must be observed.

1. Wear Safety Glasses.
2. Wear a hairnet if necessary.
3. Do not smoke.
4. Do not exert excessive pressure on the drill.
5. Switch off before removing guards.
6. Replace guards before switching on.
7. Use a handbroom only to remove shavings.
8. Beware of Hot drill tip.
9. Beware of burrs.
10. Only one person to operate a machine.

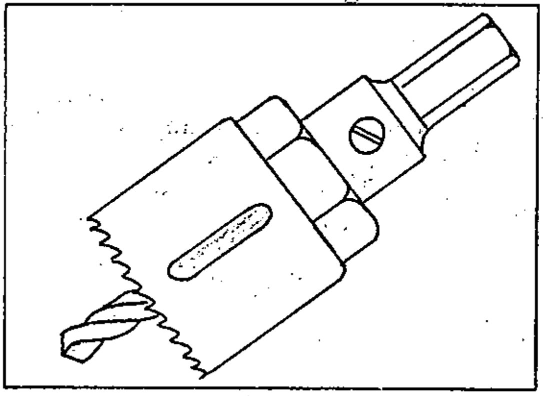
TITLE:- HOLE SAWS, WAD PUNCHES, REAMERS

LECTURER:- Gerry Hennig

DATE:- 13-3-81

EQUIPMENT:- Hole saw, mandrel, wad punch, parallel reamer, taper reamer, expanding reamer.

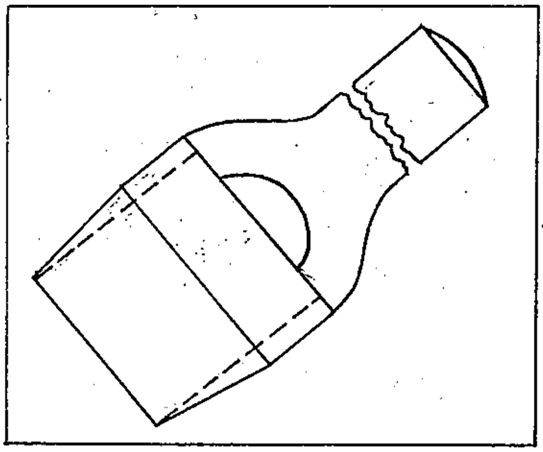
Holesaws are tools used in conjunction with drilling machines for cutting large diameter holes in sheetmetals or insulating materials. It is made up of 3 parts:-



1. The hole-saw which is a tubular section with teeth around one edge and a plate with a threaded hole at the opposite end of the tube.
2. The Mandrel onto which the hole saw is screwed. It has a hollow shaft into which is fitted a drill, and which is also used to fit into the chuck of a drill. The shaft is usually triangular or hexagonal to match the 3 jaws of the drill chuck.
3. The pilot drill - usually a $\frac{1}{4}$" twist drill which has a longer shank to allow a grub screw in the Mandrel to grip. The drill's purpose is to keep the hole saw on centre.

Work to be drilled should be clamped securely to the drill table to prevent it lifting and turning - especially thin sheetmetals. Wooden packing must be placed beneath the work to prevent damaging the drill table.

Speed Because of the great number of cutting edges, the hole saw must be operated on a slow speed. Suitable lubricant should be used depending on the material being drilled, and a constant feed applied sufficient to make the saw cut, yet not too great to cause the teeth to sieze and break.



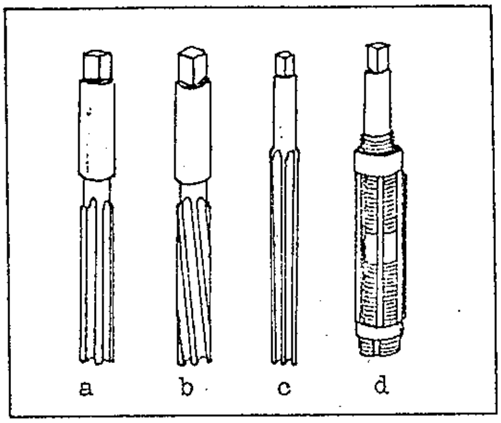
Wad Punches When holes are required in soft sheet materials such as rubber, cork etc., it is almost impossible to cut them with any sort of rotating drill bit, and they have to be punched.

The wad punch is available in a wide range of sizes from $\frac{1}{4}$" to approximately 4" in 1/16" steps.

The cutting edge is very thin and weak and must NEVER come into contact with metals or other hard materials. The material should be placed on a heavy block of timber with the end grain uppermost for the most effective cutting. Hold the punch vertical and apply a forceful blow from a hand hammer.

Some wad punches are made in two parts, i.e. a holder and a series of interchangeable heads. On no account should the heads be used without the holder.

When cutting rubber or cork washers, it is advisable to cut the larger size first, the smaller size is then easier to centre.



Reamers are used for expanding the diameter of a previously drilled hole to very high accuracies.
A reamed hole may be necessary where a sliding fit is required, or where a tapered hole is required to fit a taper pin.

Hand reamers are designed for turning with a tap wrench and the end of the shank is ground square.

Machine reamers have morse taper shanks to suit the morse taper sleeve on a drilling machine.
The 4 types of hand reamer illustrated are (a) parallel reamer with straight flutes (b) parallel reamer with spiral flutes, (c) taper reamer and (d) expanding reamer where adjustment is made by adjusting two nuts so that the cutting blades move up or down in tapered slots.

Use of reamers - Drill the hole to within 1/64 of the size required, Keep the reamer vertical in the hole, apply even pressure with both hands on the wrench, Turn the reamer in a CLOCKWISE DIRECTION ONLY evey when removing the reamer. Use lubricants as you would when drilling.

EDISON Screw THREAD

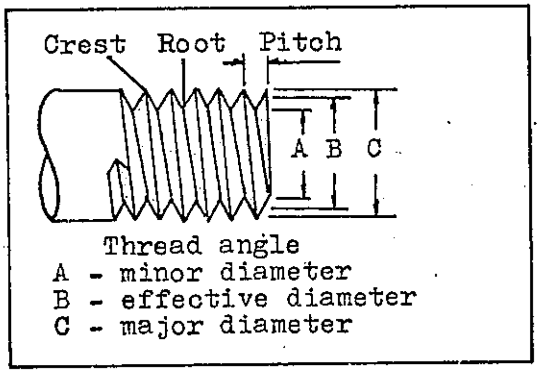
GES	(Goliath)	USED ON 250v	1500 w
ES		250 V	200 W
SES	(SMALL)	130 V	40 W
MES	(Miniature)	24 V	
LES	(LILIPUT)	12 V	

M1/9/1

TITLE:- THREADS
LECTURER:- Gerry Heynis
DATE:- 16-3-81
EQUIPMENT:-

A Thread is the name given to the spiral groove which is cut into the outer surface of cylindrical material, or the inside surface of a cylindrical hole.

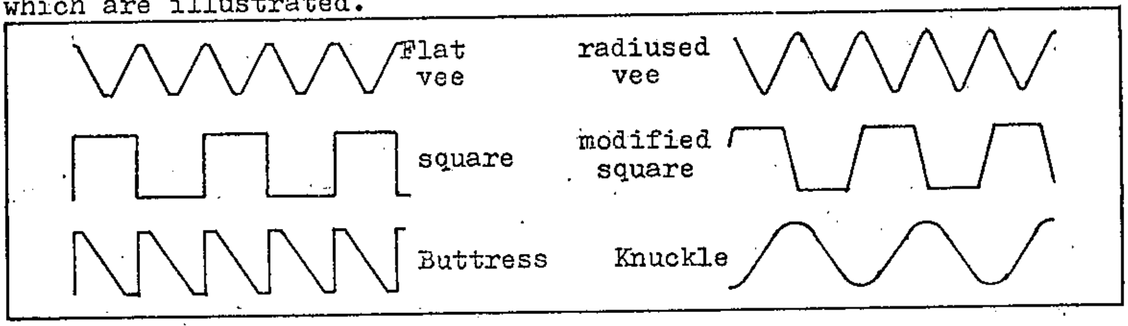
If it is cut on the outer surface it is termed a male thread, as is found on a bolt, and if it is cut on the inside surface of a hole, it is termed a female thread as found on a nut.



Parts of a thread

The diagram shows a thread and the names designated to its various parts.
Major diameter is the outside diameter of the thread and is also called the NOMINAL diameter of the thread e.g. ½", 1".
Minor diameter is the diameter of the 'CORE' of the thread measured across the bottom of the thread groove.

Thread forms A variety of thread forms are available, some of which are illustrated.

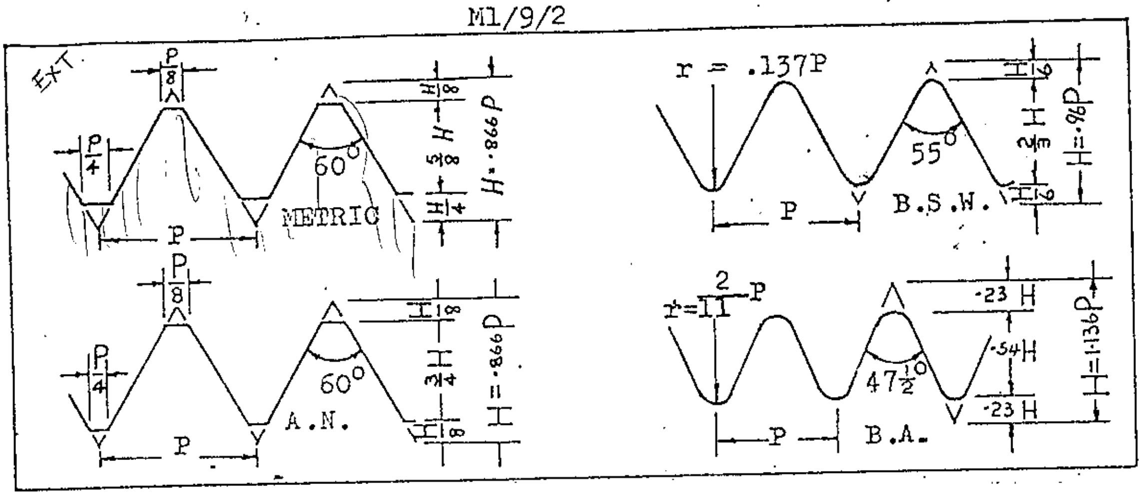


The vee thread is the most commonly used, and is the only one which may be cut by hand.
There are many variations of the Vee thread with respect to:-

Starts - threads may be made as single start or multiple start, i.e. instead of having 1 continuous spiral groove, there may be 2, 3 or 4.
On a single start, lead = pitch
On multiple start, lead = pitch x number of starts
The action of a multiple start thread enables much faster travel of the two mating parts.

Hand - This refers to the direction in which a nut must be turned to screw onto the bolt.
Right Hand threads screw clockwise
Left Hand threads screw anticlockwise
The purpose of the two is to allow for rotation of pulleys, wheels etc. to prevent nuts loosening by the turning action of the parts they are securing.
Almost all threads used are Right Hand types.

Thread form - is the shape of the thread, the thread angle, the depth of thread, and the pitch.
4 common types are shown.
Each type is available in a coarse or a fine series.



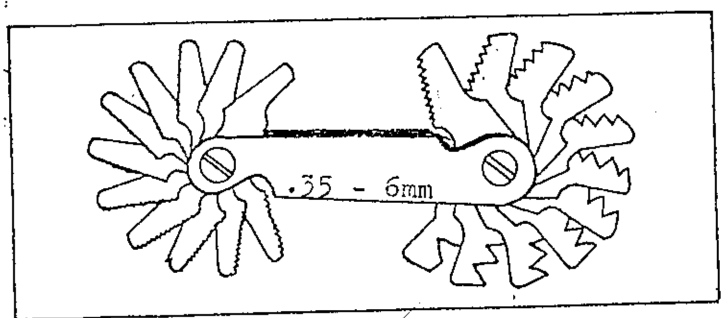
Some variations of these threads are:-
British Standard Pipe (BSP) same as B.S.W. but tapers ¾" in one foot and the last 3 threads are not fully cut.
American National Fine A.N.F. or N.F.
Unified National Fine U.N.F.
Society of Automotive Engineers S.A.E.
American Society of Mechanical Engineers A.S.M.E.
These are all the same as American National Coarse (A.N.C. or N.C.) or Unified Coarse (U.N.C.) except that the pitch is finer.
British Standard Brass B.S.B. used for thin walled tubing, using a B.S.W. thread form but has 26 TPI irrespective of tube diameter.
British Standard Conduit B.S.C. has a BSW thread and is measured on the outside diameter of the pipe. Water and other pipes are measured on the inside.

A threaded screw or bolt may be required to perform one or more of these functions:-

1. To fasten parts together.
2. To allow movement of parts.
3. To exert pressure (as in a vice).
4. To provide means of measurement.

If we know the properties of certain threads, the decision as to which to use is made easier.
Coarse pitch threads have a greater lead, faster operation, but less holding power than fine pitch threads and would therefore tend to vibrate loose more easily.
Fine pitch threads are slower in operation, have greater holding power, and because they are not cut as deeply into the material, the bolt is stronger.
Materials used also affect the choice of thread.
Brass - used for electrical connections.
Steel - used where strength is required.
High tensile steel - used where the bolt is subjected to stresses.
Special Threads which can only be cut or rolled by machines are:-
Buttress thread - used where a high pressure is applied in one direction only as with a vice.
Modified square - used on lathes for lead screws.
Knuckle thread - a quick, easy operating thread used mostly on light globes.

To determine which type of thread is formed on a bolt, Thread Pitch Gauges are available.
A comprehensive list of screw threads is on P118-120 of the Safety Handbook.

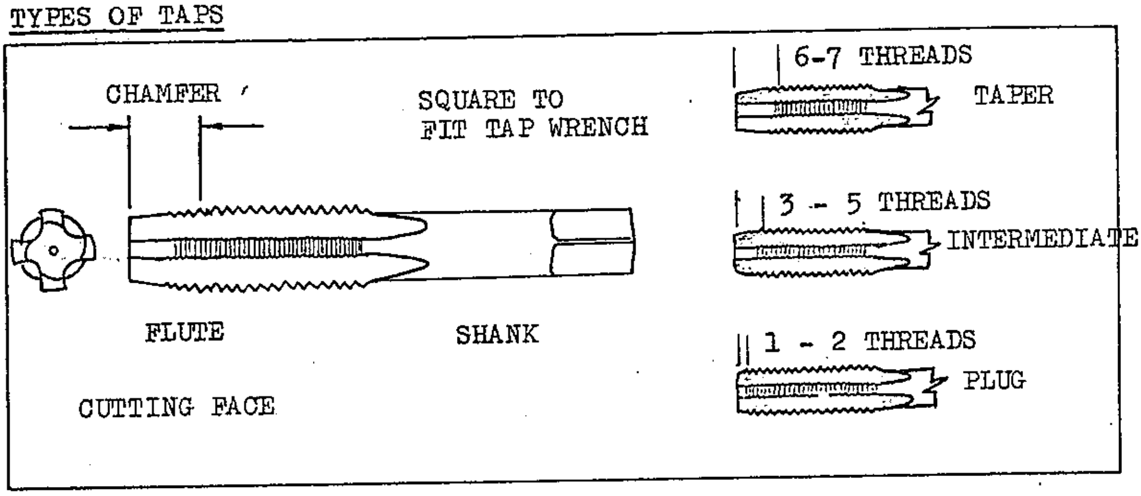


TITLE:- TAPS & TAPPING
LECTURER:- GERRY HEYNIS
DATE:- 16-3-81
EQUIPMENT REQUIRED:- Set of Taps, Tap Wrench, Tee Tap Wrench, Try Square, Safety Handbook.

Taps are devices used for cutting a thread on the inside of a hole drilled in a piece of material, as with nuts, i.e. taps cut internal threads.

Although there are numerous sizes of taps, for any particular thread, there is always a set of 3.

TYPES OF TAPS



The 3 taps in a set are:- 1 - taper tap, 2 - intermediate tap, 3 - bottoming or plug tap.

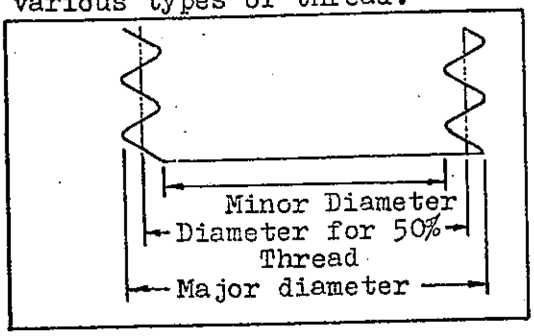
The major difference between them is the taper on the ends. Each has a body containing the cutting edges, flutes, thread relief angle, a web, and land, and a shank which is ground square on the end to accept a wrench for turning.

The purpose of the three taps is for progressively threading a BLIND hole using them in the order:- 1 - taper, 2 - intermediate, 3 - plug. A nut screwed onto the tap will act as a stop to prevent tap breakage.

A taper tap only is required for tapping through holes.

PREPARATION FOR TAPPING

The first consideration must be given to the size of hole which must be drilled. Tables setting out "Tapping Drill Sizes" are set out in the Electrical Safety Handbook on pages 118 to 120 for various types of thread.



Although the minor diameter of a thread is theoretically the size which should be drilled to obtain 100% thread form, for most purposes a thread of 60% is considered sufficient. For example, the minor diameter of a 1" BSW thread is 0.84", but the tapping drill size is 55/64" (0.859"), i.e. it is .019" larger.

Once the hole has been drilled, the mouth where the thread is to be inserted should be countersunk to accept the taper on the tap. This makes starting easier and prevents a ridge forming around the hole.

TAPPING

Fit the taper tap into a suitable size tap wrench and insert end into hole.
Press onto the top of wrench with both thumbs and turn in a clockwise direction. When tap starts to cut (after about 2-3 turns) remove the wrench and check for squareness in two directions. Correct squareness by exerting pressure more on one side than the other until the tap is square.

If it is not corrected at this stage, it cannot be corrected later and may result in a broken tap.
Remove the tap, apply cutting compound and continue tapping. Reverse the tap frequently to break off the chips and prevent the tap siezing.

Apply even pressure with both hands to the wrench. If resistance can be felt to increase when tapping, stop, reverse the tap or remove and clean out swarf.

On completion, remove the tap, clean out the hole and tap, then check with a screw to ensure that a proper thread has been cut.

BROKEN TAPS

If a tap breaks whilst tapping, unless there is a large portion protruding from the hole, it is almost impossible to remove. The easiest remedy is to ensure that the proper method is used for tapping and eliminate broken taps.

Some common causes of broken taps are:-

Material being tapped is too hard,
Wrong or no lubricant,
Clogged flutes,
Hole too small,
Loose tap wrench,
Continuing pressure when tap grips,
Tapping in awkward positions,
Inattention,
Tap not square.

Hole to cut
DIA - $\frac{1}{TPI}$ - IMP
DIA - PITCH - MET

B.S.W. SIZE	TAPPING DRILL	B.A. SIZE	TAPPING DRILL
1/16	57	0	11
3/32	50	1	18
1/8	41	2	25
5/32	31	3	30
3/16	28	4	33
7/32	18	5	39
1/4	11	6	44
5/16	D	7	47
3/8	N	8	51
7/16	S	9	53
1/2	X	10	55
9/16	15/32	11	56
5/8	33/64	12	61
11/16	37/64	13	64
3/4	5/8	14	69
13/16	11/16	15	71
7/8	47/64	16	74
15/16	51/64	17	76
1	27/32	18	77
		19	1/64
		20	80
		21	
		22	
		23	
		24	
		25	

TITLE:- DIES

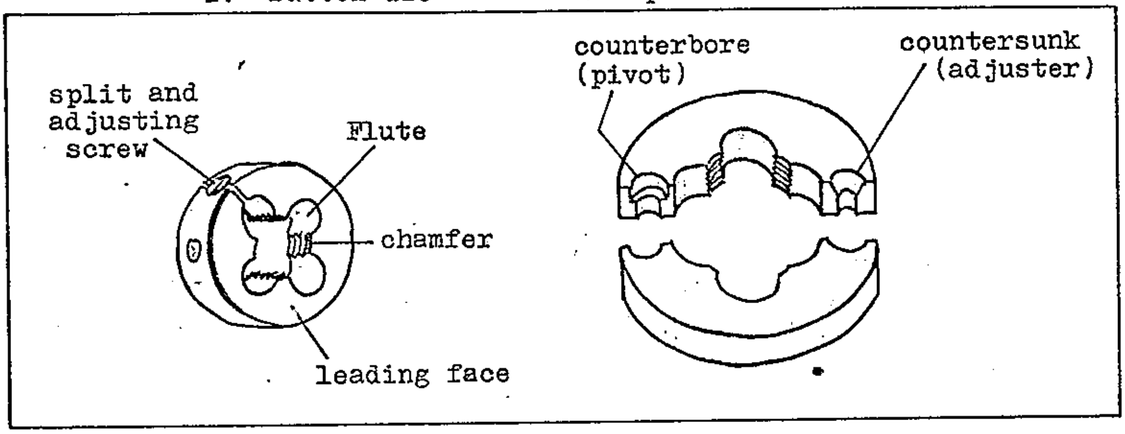
LECTURER:- GERRY HEUNIS

DATE:- 23-3-81

EQUIPMENT REQUIRED:- Button die, split die, stock, die nut

Dies are devices used in conjunction with a stock to form an external thread on roundstock, pipe and conduit. They are made of alloy tool steel and have accurately cut internal threads. Three or more flutes are formed into the die to form cutting edges on the internal threads, and to allow easy removal of shavings. Chamfers are ground on the first 3-4 threads to allow for easy starting. This chamfered part is called the throat. There are 2 main types of dies -

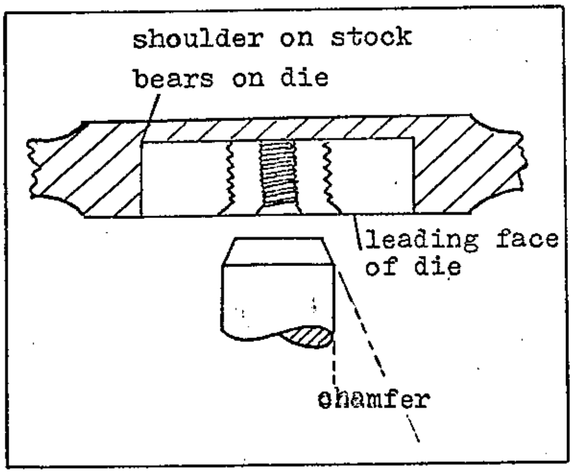
1. Button die 2. Split die.



Button Dies are a single piece disc-shaped die with a split on one side to provide a small amount of adjustment. The die is located in a solid stock, with the split in line with a pointed adjusting screw. Two locking screws are provided either side of the adjusting screw to retain the die firmly in the stock. By loosening the 2 locking screws, the adjusting screw can be moved either in or out to provide different thread depths.

Split Dies are made up of 2 equal halves, each being marked with the type and thread size. A cheese-head pivot screw is located on one side, with the adjustment provided by a countersunk adjusting screw on the other side of the die. By releasing the locking screw in the split stock, the adjusting screw can be turned to give the required thread depth. Because of its greater adjustment, this type of die is used when an accurate thread depth is required.

Preparation of work - Starting a thread - Methods

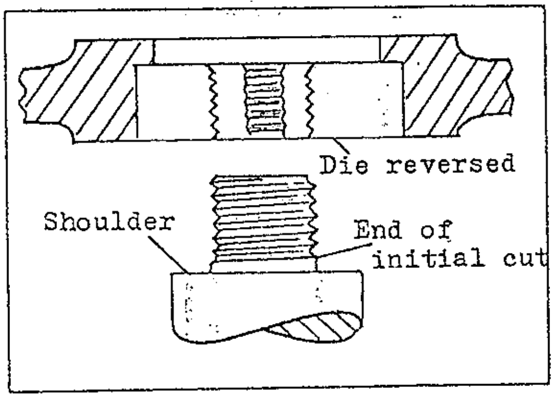


Material to be threaded must be of the same diameter as the major diameter to be cut. e.g. $\frac{1}{4}$" BSW - $\frac{1}{4}$" diameter material. (In some instances, a slightly smaller diameter material may be used - but never larger, because it could cause damage to the die. To allow easier starting, a chamfer should be filed or ground on the end to be threaded.
Hold the material firmly in a vice, using vee-blocks, with a minimum length of material above the vice jaws. (Too greater length above the jaws could result in a "bent" thread). If threading conduit or pipe, a pipe vice may be preferable to vee-blocks.

Select a suitable lubricant and apply it to the material. (Brass requires no lubrication - shavings are only very small). Lubrication makes for easier cutting, better finish and clears shavings from the cutting edges.

Adjust the die to its maximum diameter (minimum thread depth) and place it squarely on the material, with the chamfered cutting edges (throat) down. Apply fairly heavy pressure downwards, with the palm of the hand on the centre of the die, and rotate clockwise. When the die has started to cut, check to make sure the stock and die is square to the material. Continue cutting in clockwise direction, making sure to reverse the direction every half-turn to break off the shavings.

Cutting thread to a shoulder



Because the first 3-4 threads are chamfered on a die, a full thread depth cannot be cut to a shoulder. To overcome this simply reverse the die in the stock.

DO NOT turn the stock over and cut the thread - there will be no support for the die in the stock.

After usage, the stock and die should be cleaned thoroughly to remove all swarf and lubricant and then stored in a proper manner.

Die Nuts

Made of hardened steel, they are a hexagonal nut with similar cutting edges and flutes to the die. Used in conjunction with a suitable spanner, their main use is for re-cutting damaged threads. They are not to be used as a substitute for a stock + die.

Safety

Newly cut threads are sharp and so are the chips produced by threading.

1. Keep your hands clear of sharp edges and burrs - use a file to remove the burrs.
2. Use a brush, not your hands, to clear away shavings.
3. Do not use compressed air to blow away shavings - danger of serious eye injury.

TITLE:- FERROUS AND NON FERROUS METALS AND ALLOYS

LECTURER:- GERRY HENNIS

DATE:- 26-3-81

EQUIPMENT:- Cast iron, wrought iron, mild steel, medium carbon steel, high carbon steel, copper, aluminium, tin, lead, brass, phosphor bronze.

It is important that the Electrical Mechanic has a sound knowledge of the various metals with which he must work, and that he understands the properties, limitations, and uses for each of these metals.

Properties

HARDNESS - the power of a metal to resist penetration.

TENSILE STRENGTH - the degree of loading to which a piece of metal can be subjected in line with its axis without fracturing.

DUCTILITY - If a metal can be extended by a pulling force and drawn into wire, it is said to be ductile.

MALLEABILITY - A metal is malleable if its shape can be changed by hammering, rolling or pressing without fracturing.

ELASTICITY - The ability of a metal to return to its original shape after it has been deformed by force.

TOUGHNESS - The ability of a metal to withstand shock and sudden heavy loading without fracturing.

BRITTLENESS - A metal that is brittle will break easily with very little deformation.

Ferrous Metals (containing iron)

PIG IRON is the product of the blast fornace and is used in the manufacture of cast iron, wrought iron and steels.

CAST IRON A hard brittle metal used in the manufacture of bases, frameworks, engine beds etc. because of its rigidity and cheapness. It is a product of heating pig iron, scrap iron and steel, coke and limestone in a cupola.

WROUGHT IRON is relatively soft yet tough and ductile. It resists shock loads without permanent damage and is therefore suitable for chains and hooks etc. Its surface may develop a hard brittle property necessitating annealing. It is virtually pure iron with very little carbon content.

STEEL Can be classified into 3 groups, each having a different carbon content combined with iron.

Mild Steel	-	0.1 to 0.3%
Medium Carbon	-	0.3 to 0.7%
High Carbon	-	0.7 to 1.7%

Due to these varying amounts, each type of steel has different properties and uses.

MILD STEEL is ductile, tough, malleable and has good tensile strength making it suitable for structural sections, plates, nuts, bolts etc. It cannot be hardened, only the skin may be case hardened.

MEDIUM CARBON STEEL Stronger, harder, less ductile or malleable than mild steel. Its hardness and toughness may be increased by suitable heat treatment. It is used for shafts, axles, springs, wire ropes etc.

HIGH CARBON STEEL is harder than medium carbon steels, but is not as ductile, tough or malleable although suitable heat treatment will improve its hardness and toughness. Its main use is for cutting tools such as chisels, drills, files, taps, dies etc.

ALLOY STEELS

Improvement in the various properties of steel may be achieved by alloying certain elements.

COBALT - increased hardness especially at high temperatures.
CHROMIUM - increased hardness and resistance to corrosion.
MANGANESE - higher tensile strength, toughness and wear resistance.
MOLYBDENUM - similar to tungsten.
TUNGSTEN - greater hardness especially at higher temperature, improved tensile strength and resistance to wear.
NICKEL - increased tensile strength, toughness, hardness and resistance to fatigue.
VANADIUM - increased toughness and resistance to fatigue.

It is necessary to apply correct heat treatment to these alloys to develop the properties listed.

Non Ferrous Metals

COPPER is a soft, tough, malleable, ductile, and corrosion resistant metal, and is a good conductor of heat and electricity. Its hardness is increased by cold working, but its ductility and malleability may be restored by annealing. Its major use is in electrical conductors, pipes, and electrical switchgear, transformers etc.

ALUMINIUM is a very lightweight metal that is soft, malleable, and resistant to corrosion. It also is a good conductor of electricity. Being lighter and cheaper than copper makes it suitable for overhead power cables. As it is soft, it is unsuitable for most uses until it is alloyed with one or more other elements such as copper, nickel, chromium, magnesium, silicon, and zinc. Because aluminium oxidises quickly, it is difficult to solder, special fluxes must be used.

TIN has a low melting point and is ductile, malleable and corrosion resistant. Pure tin is only used as a coating on thin steel (tinplate) but is used widely as an alloying agent with other metals.

LEAD is soft and malleable and is extremely corrosion resistant. It is used for pipes, cable sheaths, battery plates, roofing, for chemical containers, and when alloyed with tin it produces soft solder.

ZINC Used mainly for galvanising steel because of its excellent anti-corrosion property, and as an alloying agent.

BRASS is an alloy of copper and zinc. It is harder than copper and may be cast, machined, brazed or soldered. It is a good conductor of electricity and is widely used in electrical equipment.

PHOSPHOR BRONZE is an alloy of tin, phosphorus (.3%) and copper. Because it is highly wear resistant, it is most suitable for bushes and bearings. When cold rolled into sheets or drawn into wire, it becomes hard and springy. In sheet form, a grain is developed and any bench made along this grain would tend to fracture.

TITLE:- BENDING VARIOUS MATERIALS
LECTURER:- Gerry Heunis
DATE:- 23-3-81
EQUIPMENT REQUIRED:- Steel, aluminium, copper, phosphor bronze, perspex.

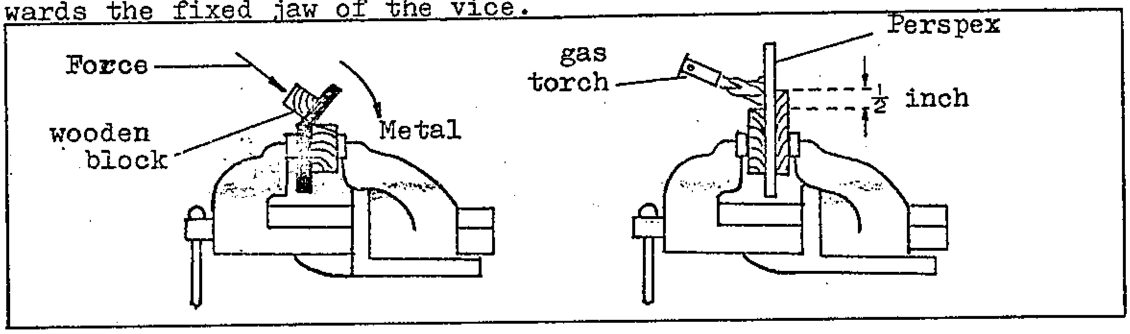
It is often necessary to form certain materials to the desired shape by bending. Materials must be ductile to allow them to be bent. Some materials are hard and brittle, but may be made ductile by suitable heat treatment, whereas other materials are readily bent when cold.

Whether bent hot or cold, stresses are set up in the material at the bend due to stretching on the outside of the bend and compressing on the inside. It is therefore necessary to relieve these stresses in some materials by annealing or normalising after bending is completed.

Preparation

The position where the bend is to be made must be clearly marked. This may be done by scribing a line with a brass scriber (a steel scriber may cause a fracture on the line when bending), or a pencil, or a series of prick punch marks punched lightly along the line. The marks should be made on the inside radius of the bend.

When setting up the work, a solid piece of steel or hardwood with a smooth straight edge should be placed exactly in line with the marks, (check with a try-square to ensure accuracy) and clamped in a vice as close to the jaws as possible. Arrange the workpiece so that the greater part is below the vice jaws and so that the bend is made towards the fixed jaw of the vice.

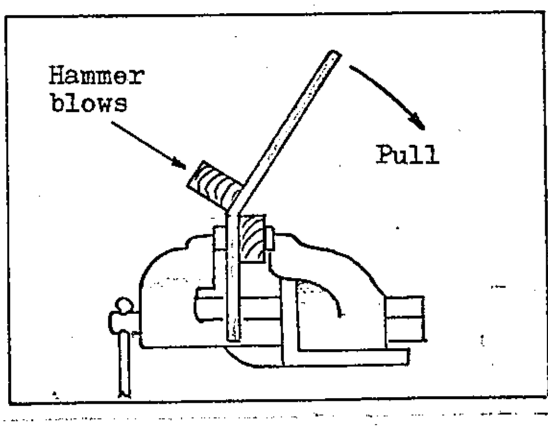


If perspex is being bent, a second piece of wood is required in front of the perspex with its top edge approximately ½" below the bending line.

Bending

To prevent damage or bruising to the workpiece, direct blows with a hammer should be avoided. Use a block of hardwood, brass, or copper between the hammer and the work. On softer materials, lead hammers, rubber mallets, or rawhide mallets may be used. Bending or folding machines are the most suitable and accurate means of bending sheets and pipes, but may not always be available.

The work should be struck as close as possible to the bending line, this will avoid making a large curved bend. If the piece to be bent is large, then a constant pressure should be exerted onto the work by an assistant to prevent "springing".



Phosphor bronze develops a "grain" as it is rolled during manufacture. Any bending along that grain will tend to fracture.

If a large number of identical bends are to be made, it is advisable to make a "jig" to ensure accuracy & consistency.

When thick steel is to be bent, it is usual to heat the area of the bend. This must be done BEFORE the work is clamped into the vice. Suitable tongs and asbestos gloves must be worn when handling hot metal. The work should be quenched as soon as possible after bending

Perspex bending requires the application of heat, but not to the same extent as that of steel. It may therefore be clamped prior to heating. An L.P. gas torch set on a low flame should be used to heat up the perspex SLOWLY along the bend line. When it is soft enough to be bent without cracking, it should be bent with a piece of wood to ensure evenness, and should be cooled with a wet cloth along the bend whilst it is still held in position.

Tubes and Pipes

Difficulties may be encountered in bending tubular sections due to the tube flattening at the bend. This is especially so when bending rigid PVC tubing (conduit). Two methods may be used to eliminate flattening.

1. Use a bending spring. Heat the tube in boiling water, or by blowing hot air onto the bend area, insert the spring, make the bend and allow to cool.
2. By sand filling. Fit a wooden plug tightly into one end of the conduit. Fill with dry sand and pack tightly. Fit a second plug in the open end then proceed to heat and bend as before.

If a number of bends are to be made on the one piece of tube, a template, usually of wire, is made to show the angles and positions of the bends.

Annealing

When a metal is to be bent, it is often advantageous to anneal it in the bend area. This will make bending easier and reduce the risk of fracturing.

Some metals will also require annealing after bending as the bending process tends to work harden the metal, and cause stresses.

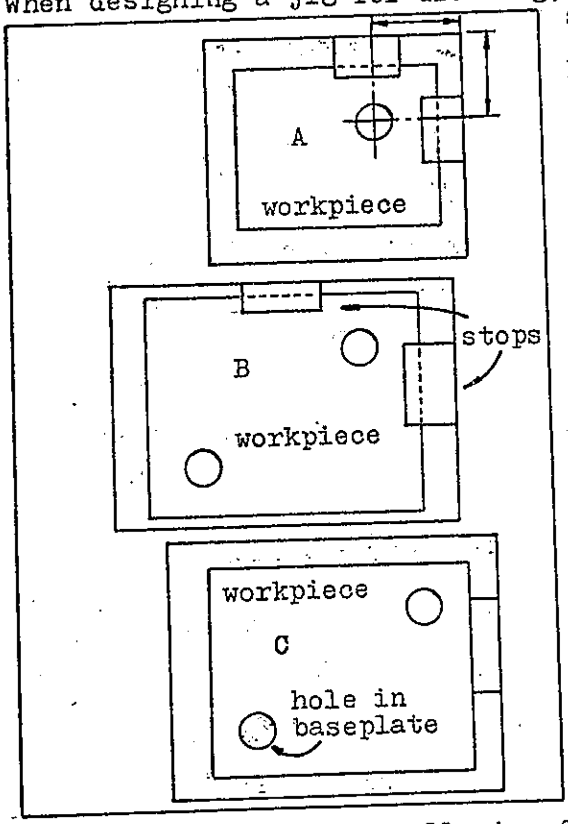
Safety

Wear asbestos gloves when working with hot metals.
Do not use wet or damp sand as packing for pipes as steam pressure may be created during heating.
Wear safety glasses when bending with hammers or mallets etc.

TITLE:- MAKING JIGS
LECTURER:- GERRY HEYNIS
DATE:- 26-3-81
EQUIPMENT:

A jig is a device used to assist in ensuring consistent accuracy when carrying out repetitive drilling, stamping, welding, threading, etc.

It is a device which holds the workpiece in one specific position whilst one or more of the above jobs are carried out on it. When that work is completed, further identical workpieces are located in exactly the same place and the drilling or threading etc. is carried out. This method ensures that all workpieces are identically drilled, threaded etc., it makes the job easier for the operator, and time and costs of manufacture are greatly reduced, as it is unnecessary to mark out or set up the work.



When designing a jig for drilling, allowance should be made for slight variations in the dimensions of the workpiece, i.e. if the hole is to be drilled, say, in a corner of a plate 20mm from 2 adjacent sides, then the stops, or locating points should touch those two sides as in Sketch A.

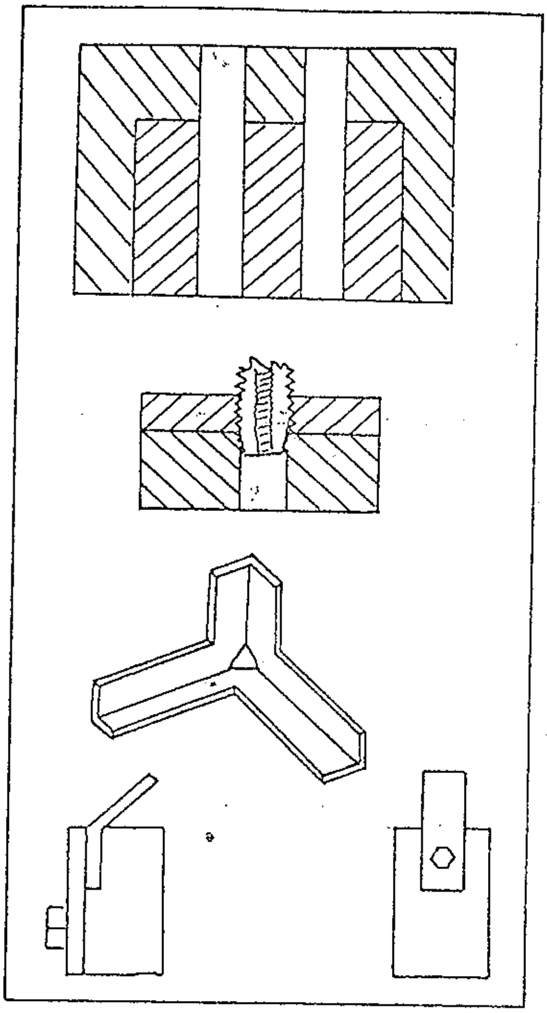
If two holes are to be drilled diagonally opposite, then consideration must be given to the most important dimension, i.e. is the distance from the edges most important or is the distance between them most important. The arrangement in Sketch B would give the first requirement and the arrangement in Sketch C would give the second.

A hole in the baseplate at "D" drilled and tapped to accept a screw would locate the exact dimension between the two hole centres.

It can be seen that the principle of making a jig is to reduce the possibility of error which could be caused by slight fluctuations in overall dimensions.

The jig should be made allowing for:-

(a) clamping to a machine.
(b) easy changes of workpieces.
(c) removal of shavings.
(d) slight dimensional variations.
(e) accurate alignment of workpieces.
(f) prevention of the work from lifting or turning.



Drilling

Where possible a guide hole should be made in the jig to locate and retain the drill on centre. If it is to be used for a large number of jobs, it is advisable to harden the sides of the hole to prevent wear. A chamfer on the edge of the hole would assist in entering the drill in the hole.

Tapping

When tapping a large number of holes, it is better to use a thread guide plate to ensure that the threads are square to the hole.

Welding

A jig for welding lengths of flat steel or angle iron can be simply made as shown to ensure that all corners are at right angles.

Bending

Jigs for making bends may also be made to ensure that a bend is relative to a hole or to a flat surface. Care should be taken to prevent the material being bent from bulging outward near the bending line.

TITLE:- HEAT TREATMENT

LECTURER:- Gerry Heynis

DATE:- 6-4-81

EQUIPMENT REQUIRED:- Heating medium, tongs, water, case hardening powder, oil.

Metals are heat treated so that they may be more easily worked, or offer greater resistance to general wear. The most common methods used are:-

(a) Annealing
(b) Hardening
(c) Tempering
(d) Case hardening
(e) Nitriding
(f) Heating by Induction

(a) ANNEALING

This means to soften materials to allow work to be carried out on them, or, to relieve internal stresses, set up by previous working, or use.

For instance, when a bandsaw blade is welded, the welded section is very hard and brittle, and would snap if used, therefore it must be annealed, or softened to allow it to carry out its function.

Copper, Phosphor bronze, Brass etc. must be annealed, after hammering, rolling, bending, in order to relieve internal stresses.

This is done by heating to red heat then quenching in water.

Iron & Steel are annealed by heating to red heat and then allowed to cool slowly.

Tin & Lead are annealed by heating in boiling water and then cooling in the air.

(B) HARDENING

Cast steel is the only metal that can be readily hardened and tempered sufficiently to cut other metals. If pure iron is heated and then cooled it becomes soft, but the presence of carbon in the metal entirely reverses this, with the result that, upon the sudden immersion of steel into water, the metal immediately becomes extremely hard and brittle.

(C) TEMPERING

This process reduces the brittleness, to the degree required, for a certain class of work and much of the original strength and toughness is restored by heating to a specific temperature, and then quenching rapidly.

(D) CASE HARDENING

This is hardening the skin, or casing, of the steel to a depth of a few thousandths of an inch. The surface is then highly resistent to wear, yet the body retains its strength and toughness.

To carry out this process it is necessary to heat the steel to about 950°C (Red heat) in the presence of some material having a high carbon content, such as charcoal, coke etc. Two methods are employed:-

(1) By packing the steel into an iron case along with the charcoal etc. and sealing it to prevent gas from escaping. The box is then placed in a furnace, where it is heated for several hours. The depth that the carbon penetrates the steel depends on the time it is heated; Usually 8/1000 of an inch per hour.

(2) By heating the steel to 950°C and covering with powdered carburising agent. This gives a very thin layer of carbon penetration and the process has to be repeated several times.

NITRIDING (E)

This is the case hardening process employed with steel alloys, which cannot be case hardened in the previously explained manner. It involves placing the steel in a container of gas (Ammonia) at a temperature of about 540°C for several hours.

Nitrogen gas is absorbed by the steel, giving it a hardened surface.

(F) HEATING BY INDUCTION

When we have an alternating current associated with a coil, an alternating magnetic field is set up. When the coil is fitted with an iron core, the work involved in setting up the alternating magnetic field in the core creates heat.

The heat is due to Eddy currents flowing in the core and to molecular friction, caused by the molecules constantly changing their direction in sympathy with the alternating current.

Four factors affect this heating:-

(1) Type of material:- A good conductor with low resistivity will heat less readily than one with a high resistivity. Steel will more readily heat than copper, as it is a ferrous material as well as a poorer conductor.

(2) Power supplied:- The greater the power concentration, the greater the surface temperature attained.

(3) Frequency:- The higher the frequency, the shallower the heated layer.

(4) Time:- The longer the time, the greater the heat build up. (Depends on various cooling factors such as ventilation, conduction, radiated heat losses etc.).

Smaller intricate shapes can be fully or partially heated to temperatures around 1500°C for purposes such as hardening case hardening, brazing, soldering etc. with little or no waster energy.

Cooling medias:-

Water is the most common, as it is the least expensive. It must be clean and cool, the rate of cooling is increased by the addition of salt.

Oil is used, when a lesser degree of hardness is required, and where tempering is not required. Almost all classes of springs are treated in this way.

Mercury has a more rapid cooling action and is used for quenching smaller articles when extreme hardness is required.

TITLE:- GASES & HEATING
LECTURER: GERRY HEYNIS
DATE:- 23-3-91
EQUIPMENT REQUIRED:

Characteristics of L.P. gases

L.P. (Liquified Petroleum) gases are marketed under such trade names as Handigas, Portagas, Essogas etc. This gas is almost twice as heavy as air and should it escape, it will settle in low places; as a result it may collect in a hollow, or at the bottom of a confined space.

A mixture of air and L.P. gas is highly dangerous and should a spillage occur, water jets should be used to disperse the spilled liquid and/or gas.

It is important to understand the behaviour of L.P. gas in closed containers.

The lower section of the container holds the liquid and the upper section holds the vapour.

As the boiling point of propane liquid is minus 44°F at atmospheric pressure, whenever gas is withdrawn and used in service, the remaining liquid rapidly vapourises until the vapour pressure of the gas and liquid in the cylinder reach equilibrium.

L.P. gas has no smell, so in order to be able to detect leaks, a stenching chemical is added. Should supplies be found not to have the characteristic smell, they should NOT be used, but returned to the supplier.

While an escape of L.P. gas represents a hazard, an escape of liquid is a more serious matter, because one volume of liquid represents about 270 volumes of gas.

Precautions

When using L.P. gas, make sure the area is well ventilated, especially if working in a hollow or in a confined space at a low level.

Liquid L.P. gas evaporates readily under atmospheric pressure, absorbing heat from its surroundings. It will freeze the hand on contact even through gloves.

If leakage occurs, shut the nearest valve upstream from the leak, remove all sources of ignition and ensure that the area is well ventilated, especially at ground level.

Liquid L.P. gas is a good solvent of petroleum products and natural rubber. Use only special sealing compounds, sealing rings and hoses.

Oxygen

This is a colourless, odourless gas and under pressure it can cause oil and grease to explode. For this reason, always keep cylinders and fittings away from oil and grease, even assembling oxygen equipment with oily hands can be dangerous.

Oxygen does not burn itself, but it supports combustion, ie. materials which burn sluggishly in ordinary atmosphere, will burn vigorously in oxygen enriched atmosphere.

The primary hazards in working in the presence of oxygen are - fire or explosions.

Oxygen must never be used as a substitute for air i.e. compressed air.

(a) Oxygen lines must not be attached to pneumatic tools, there is a possibility of the tool exploding or bursting into flames on contact of oxygen with lubricated parts.

(b) Oxygen must not be connected to spray guns.

(c) Oxygen must not be used to clean areas or to dust down clothing.

Carbon Monoxide (C.O.)

This is the most dangerous gas, as far as the works are concerned, as the presence of this gas in the air one breathes, paralyses the nerve sense and muscles which control breathing.

The exact proportion of c.o. which constitutes a danger, varies with the individual's physical condition.

Persons with chronic bronchitis or asthma, resist the effect very poorly, and the resistance to carbon monoxide is unfavourably influenced by alcoholism, obesity and chronic diseases of the heart, fatigue and undernourishment.

Carbon monoxide is odourless, tasteless, and non-irritating, and little warning is given unless the exposure is in a highly concentrated area.

Most likely sources of this gas on our plant:-

1. Blast Furnace.
2. Coke producer gas.
3. Boilermakers coke rivet heating forges.
4. Possibility of unburnt CO in all products of combustion such as flue gases from furnaces and exhaust gases from diesel and petrol driven engines.
5. Oxy-acetylene and arc welding with covered electrodes in enclosed spaces.

Acetylene:-

Colourless highly inflammable gas. A small percentage (as little as 2.6%) mixed with air is an explosive mixture. Should an acetylene cylinder become accidentally heated:-

Close the cylinder valve (if not possible, leave the immediate area and inform your supervisor).
Clear everybody from the area.
Cool the cylinder with water from a hose, make sure that the person directing the water is behind a suitable shelter.

Distinguishing cylinder colours:-

L.P. gas	-	SILVER
Oxygen	-	BLACK
Acetylene	-	RED

TITLE:- SOFT AND SILVER SOLDERING

LECTURER:- GERRY HEMNIS

DATE:- 23-3-81

EQUIPMENT:- Soft solder, multicore solder, fluxes, solder irons, L.P. gas equipment, tinned copper, sweated joint, heat shield, gloves, tongs, silver solder, borax, wire brush, glasspaper, steel wool.

In the electrical trade, it is often that permanent joints must be made between two or more metallic objects. It may be necessary for the joint to be electrically sound, physically strong or both. Soldered joints will give us these properties.

SOFT SOLDERING

This is a process used for jointing copper conductors or metallic containers to make them water or airtight.
Soft soldered joints should not be made where the joint would be subjected to high temperatures.

Composition:- Soft solder is an alloy of tin and lead in various proportions. It is termed a EUTECTIC alloy because its melting point is lower than that of tin or lead alone, i.e. tin melts at 450°F, lead melts at 620°F yet a solder of 50% tin and 50% lead melts at 414°F.

Three solders are available depending on the use for which it is required.
50/50 - melts at 414°F and is used for electrical work.
60/40 - (tin/lead) melts at 365°F is used where added protection against corrosion is required. It is termed a fine solder, it leaves a bright surface finish and it sets quickly.
40/60 - (tin/lead) melts at 460°F and is used in jointing lead pipes, cable sheaths. It stays molten longer allowing working of the joint to be carried out for a longer period. It is termed a coarse solder.

Heating:- To carry out soft soldering, the metallic parts to be jointed must be heated to at least the melting point of the solder being used.
This is accomplished by using an electric solder iron or a copper tip which is pre-heated by a gas torch or a blow lamp.

The size of the joint determines the size of the solder iron to be used. For a large joint, use a large solder iron, for a small joint use a small solder iron. If a large tip is used on a small joint the excess heat may cause damage to components or insulation whereas if a small tip is used on a large joint then the solder will not flow as it should. This produces a "dry" joint.

FLUXES Fluxes are used to prevent oxidation of the metals being soldered. Solder will not "wet" an oxidised surface. They may be in a liquid, paste, or solid form.

Some fluxes will react with metallic oxides and remove them, others will only cover an oxide free surface and prevent re-oxidation.

Hydrochloric acid is a very corrosive acid which is used in a diluted form as a flux for soldering galvanized iron, zinc, or dirty joints. It is important that the joint be washed after soldering to remove all traces of acid. It must NEVER be used on electrical joints.

Zinc Chloride or Killed spirits is a solution obtained by dissolving zinc in hydrochloric acid. It is a good flux for soldering copper, brass, tin, and zinc coated metals. Again, it must NEVER be used on electrical joints.

Ammonium Chloride or Sal Ammoniac is a good flux for cleaning iron and steel surfaces prior to soldering. It is available in block form as a powder which is used to make a paste with sweet oil, or water. It should NOT be used for electrical joints.

Resin is a non-corrosive hydrocarbon, which may clean off oxides from some metals, but only to a small extent. The surfaces to be soldered should be thoroughly cleaned prior to applying flux. It is not a conductor of electricity, and is ideal for making electrical joints as it is unnecessary to remove excess resin after soldering although it can be removed with meths.
Multicore solder usually has one or 3 holes running through it which are filled with flux. This makes it unnecessary for the application of flux prior to soldering.
Resin may be used in block or powder form or the powder may be dissolved in meths to form a paste.

TINNING:- This is a process of applying a thin layer of solder to a solder iron tip or the workpiece.
Before a solder iron is used, its tip must be tinned so that the solder will flow from the iron to the workpiece. When two parts must be joined, it is better to tin both parts separately before placing them together for soldering. This ensures that the solder flows right through a joint and not just around the edges.
To tin a solder iron or workpiece, firstly clean off all dirt, grease, scale, or oxides. Apply a thin layer of suitable flux. Heat the part to be tinned to at least the melting point of solder. Apply solder to the surface, then wipe quickly with a cloth to remove excess solder and produce a smooth, even surface.

SWEATING This is a process where two tinned pieces of metal are placed together and heated until the solder on each melts and runs together forming a solid joint.
Solder is not physically strong, nor is it a good conductor. For these reasons, solder thickness should be kept to a minimum, and other mechanical means should be used to give strength to a joint.

PROCEDURE FOR SOLDERING

Clean the workpieces and solder iron tip using file, glass-paper (not emery paper or tape), steel wool, or wire brush.
Apply the proper flux to tip and work pieces.
Tin the solder iron.
Tin the parts to be soldered, or place them in their final position.
Apply the hot solder iron underneath the joint.
Apply solder to the tip and workpiece.
Retain the heat until solder runs through the joint.
Wipe off excess solder.
Allow to cool in air (do not quench).

SAFETY

Wear safety glasses.
Place workpieces on dry heat resistant material.
Do not allow molten solder to touch water.
Beware of hot solder iron or workpieces.
Wear gloves if large pieces are being heated.
Use flint gun only to ignite gas torch.
Do not inhale poisonous fumes - use adequate ventilation.

SILVER SOLDERING

This is also called Hard Soldering. It is carried out at higher temperatures (over 850°F) and produces joints which are stronger, which can withstand higher temperatures, and which have a higher conductivity than soft soldered joints.
Composition Silver solder is made up of copper, silver, and zinc with lead being used in some special types. The percentage of

silver varies from 2.5% to 92% silver but the higher the content of silver, the harder the joint.
<u>Flux</u> The flux used is mostly Borax and it serves the same purpose as flux in soft soldering.
<u>Heating</u> Because of the higher temperatures required, heat must be supplied by a direct flame from either a blowlamp, an L.P. gas torch or an oxy-acetylene set.
<u>Preparation</u> The workpiece is prepared in much the same manner as before, i.e. the surfaces must be cleaned, flux must be applied, and the surfaces placed and held in position.

<u>Procedure</u>
- Clean the surfaces to be joined.
- Apply Borax flux to both parts.
- Clamp the joint securely together.
- Heat the joint slowly until the flux dries (This helps hold the joint together).
- Increase the heat until the flux boils.
- Apply a <u>small</u> amount of solder to the joint.
- Retain heat until solder is drawn along or through the joint by capillary action.
- Allow solder to cool in air until it solidifies (signified by a change in appearance from a shiny to a matt colour).
- Quench the joint in water to remove flux and harden the joint.

<u>Safety</u>
- Wear safety glasses.
- Beware of hot joints - wear gloves on large pieces.
- Place joint on fireproof material (not a bench or vice).
- Use flint gun only to ignite LP gas or acetylene.
- Ensure that gas pressures are properly set.
- Use heat shield to prevent heat from damaging surrounding equipment.
- Remove all flammable material from work area.
- Quench gas nozzle in water after use.
- Replace torch in rack after use.
- Place warning notice on hot bench area.

TITLE:- GUILLOTINE & TINSNIPS

LECTURER:- Gerry Hemnis

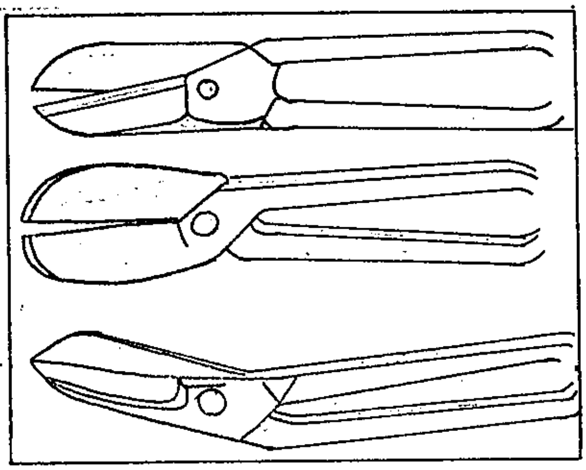
DATE:- 6-4-81

EQUIPMENT:- Tinsnips, bench shears, gloves, guillotine

Cutting thin sheets of metal or insulation material requires the use of tools having a shearing action. Thin materials tend to bend or tear using other conventional cutting tools. Guillotine, and tinsnips operate on the shearing principle but must be handled carefully to eliminate the risk of injury or damage to machine or material.

Tinsnips

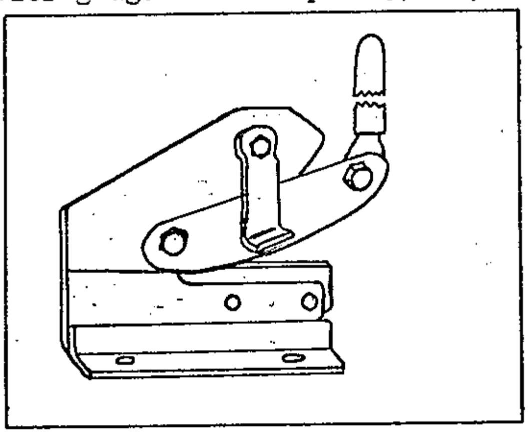
These are hand operated cutting tools used to cut sheet material up to about 1/16" thick. Many sizes, types and shapes are available, 3 of which are shown.



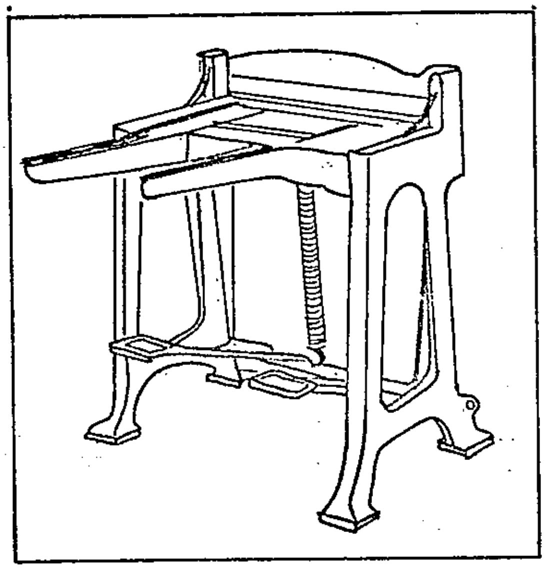
They may be used as a pair of scissors, or one handle may be clamped in a vice and the other used to apply pressure to cut. The straight snips will cut straight lines or slight external curves. The curved snips will cut internal or external curves and the universal snips will cut curved or straight lines.

Ensure that the blades are kept sharp and that the rivet is tight. Do not use the full length of the blade to cut, otherwise small ridges will appear along the cut. The blade will become chipped if wire is cut with tinsnips due to the concentration of pressure in a small area.

Bench Shears are designed to cut heavier gauge sheets up to 3/16", and must be bolted to a bench for stability. A moving blade or cropper is pivoted to the shear frame and operated by a long handle and toggle assembly to give increased leverage. A hole in the middle of the blade will act as a shear for cutting round stock. As with tinsnips, the blade must be kept sharp, the rivet properly tightened, and the cut must not be made with the full length of the blade.



Guillotine These may be either foot operated or power driven machines. They are constructed of a rigid heavy frame which supports a fixed blade, guide bars and tension springs. A moving blade is attached to a cross-head which slides up and down in the guide bars. When pressure is applied to the foot pedal, the cross-head is pulled downwards via a connecting rod. When foot pressure is released, the



springs pull the cross-head upward.

Do not cut sheet steel on a guillotine. Aluminium up to 1/16 thick may be cut, and all thin insulating materials may be cut.

Guides at the side of the top surface allow work to be accurately cut at 90° to the edge.

Ensure that the safety bar at the front of the guillotine is in position. This prevents fingers from being placed between the blades, and prevents material which is too thick from being cut.

Safety

Beware of the pincer action on the handles of tinsnips.
Always leave the handle of bench shears in the "down" position.
Keep fingers clear of cutting edges.
Only one person to work on a guillotine at any one time.
Beware of sharp edges after cutting sheetmetal.
Wear gloves when handling sheetmetal.
Remove rough sharp edges from sheetmetal.

TITLE:- GASKET MAKING

LECTURER:- GERRY HEYNIG

DATE:- 6-4-81

EQUIPMENT:- Copper, rubber, cork, Klingerite, leather, silastic, wad punches.

When two metal bodies are clamped or bolted together, the joint made between them can never be perfect. If the joint is part of a container which must retain oil, water, chemicals, gas, petrol, etc., considerable leaks would occur. To prevent these leads a soft material is placed in the joint and compressed to form a seal. This is termed a gasket.

Gasket materials

When selecting a suitable material to make a gasket, a number of factors should be considered about the fluid or gas which is to be sealed.

1. Is it corrosive
2. Will it dissolve the gasket
3. What temperature will the gasket have to withstand
4. Will the seal be permanent or frequently opened
5. What pressure will be placed on the gasket.

When these factors have been determined, then the choice of gasket may be made.

Copper is used where high temperatures and pressures exist and where the two parts forming the joint are rigid and precisely machined as in the case of a motor car engine.

Rubber suitable for low pressure and temperature applications where water is to be sealed. A thin layer of fabric sandwiched between two layers of rubber will increase strength as is found in rubber insertion.

Cork has similar uses to rubber but is better as a petrol, oil, or chemical sealant. It also may be made with a layer of fabric in its centre to increase its strength.

Asbestos is useful as a gasket where high temperatures are encountered as with the exhaust manifold of a car engine. Klingerite is the trade name of an asbestos based gasket material suitable for high temperature applications.

Leather is widely used for hydraulic systems where oil and high pressures are encountered. The leather fibres tend to swell in contact with oil to improve its sealing quality.

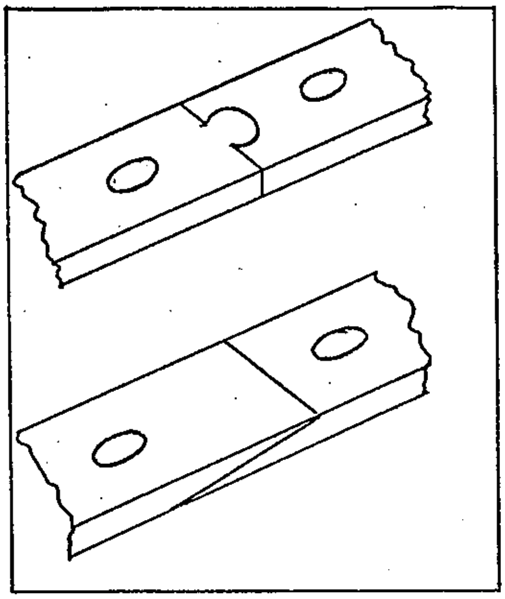
Once the gasket material has been selected, it must be shaped to suit the joint.

Making gaskets

For most straight cuts a steel straight edge and a sharp knife are all that are required. Thicker gaskets may require the use of a guillotine. Holes in the gasket may be made with wad punches but care must be taken to ensure accuracy.

Another way in which holes may be cut in gaskets is by placing it in its final position, then using a punch through the bolt holes. This method is quicker and more accurate.

Where strips of gasket material are to be jointed, the joint must retain the sealing quality and should be made in one of the ways illustrated.



Circular shapes may be cut out by fixing the oversize gasket in place then using the face of a hammer, lightly tap along the edge. This will cause the corner of the job to cut through the gasket making an accurate fit.

In some cases, an additional liquid sealing compound should be used on the gaskets to complete the seal.

A rubberised caulking compound is now available for sealing joints without the use of gaskets, but this is mainly for sealing against the ingress of dust and moisture.