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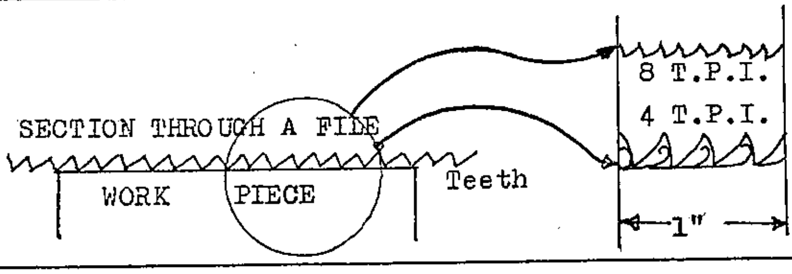
TITLE:- FILES

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.

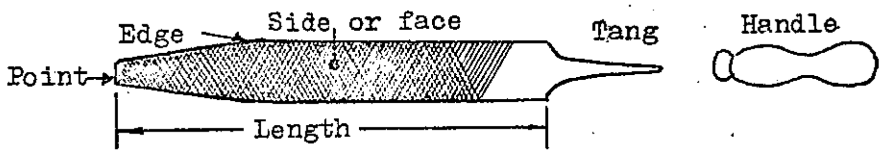


The teeth are set the full width of the file and, to prevent clogging up with cuttings, run diagonally, so that on the forward cutting stroke, the cuttings or filings are forced out of the side of the file.

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.

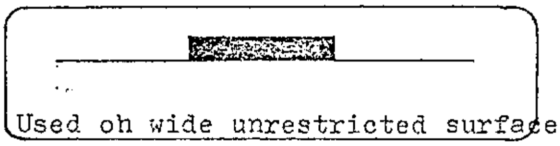
BELLY files are sometimes thicker in the middle than at the ends. This is to enable perfectly flat surfaces to be filed. The file is then said to have a belly or is bellied.

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.

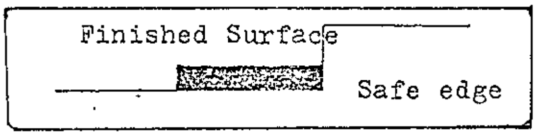
SHAPES OF FILES

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.

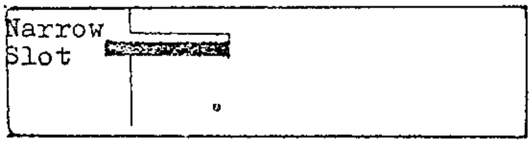
FLAT FILES Slightly tapered in width and thickness and has teeth on all sides and edges.



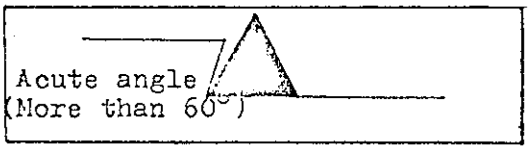
HAND FILES Parallel in width, tapered in thickness, usually one safe edge.



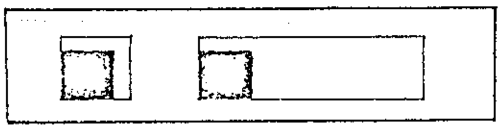
WARDING FILES Tapered in width, thin file used for filing grooves slots etc.



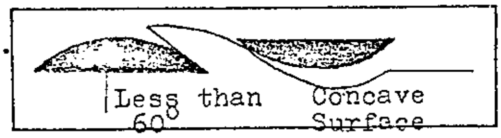
THREE SQUARE Equilateral cross-section, tapered along length, used for saw sharpening, filing acute angles.



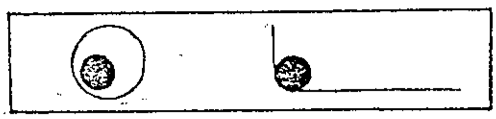
SQUARE FILE Tapered toward the tip. Used for slotted or square holes.



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

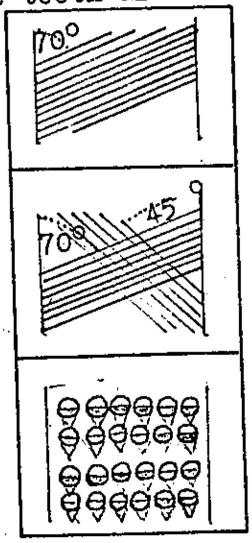
Files are graded according to the number of teeth per inch of length and are given names for various numbers. Main grades are:-

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.

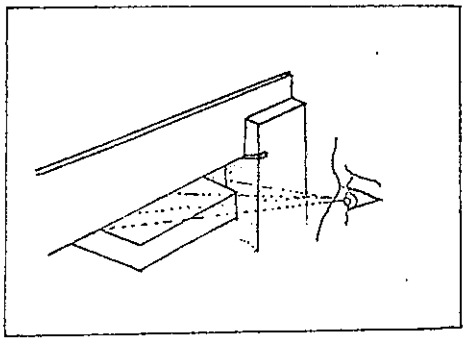
SOFT JAWS

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.

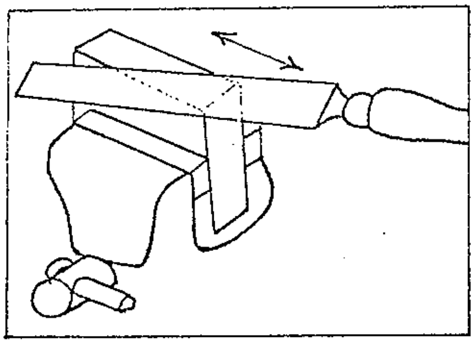


CHECKING FOR FLATNESS

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^{o} 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.

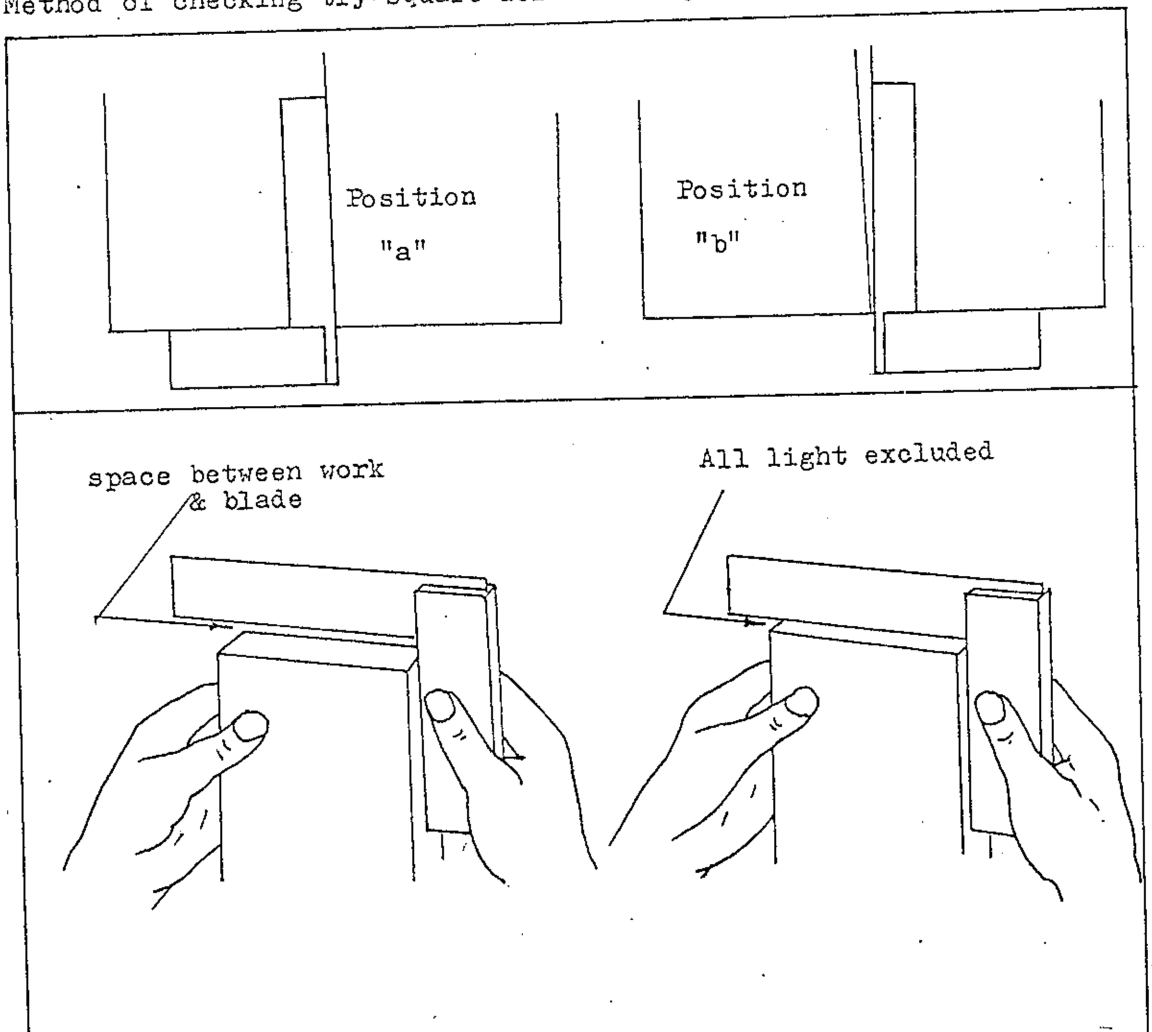
To guide in setting up work square.

To test the accuracy of surfaces 90^{o} to each other.

To check two surfaces being 90^{o}, 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:-

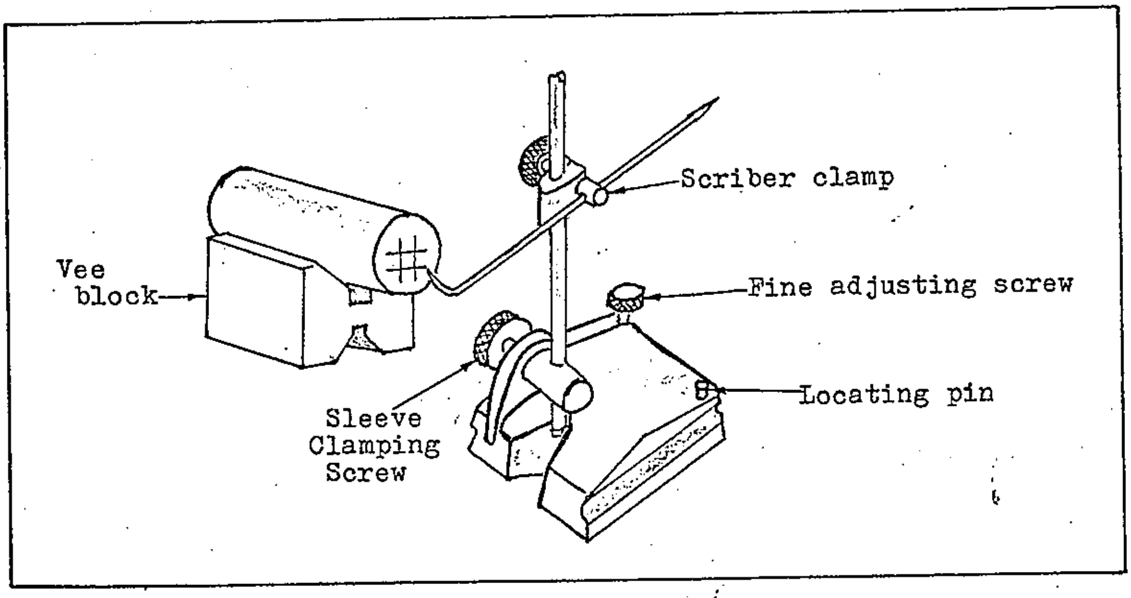
(a) Place the material on Vee blocks on a marking off table.

(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.

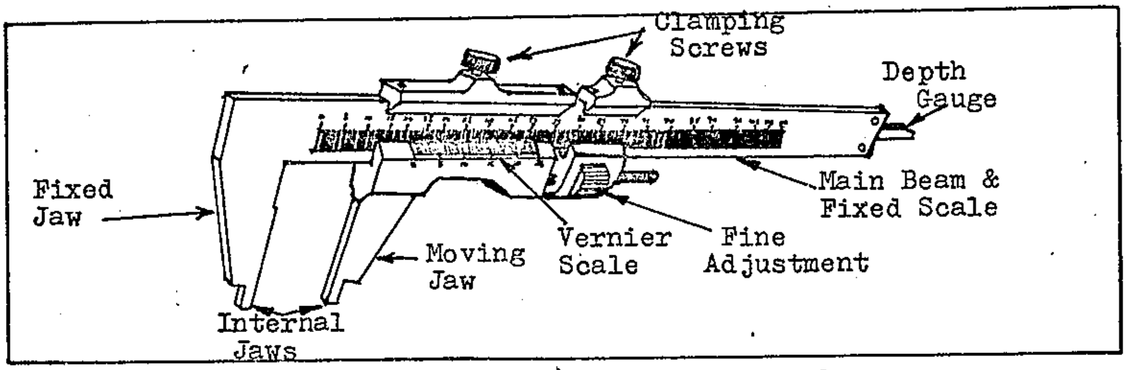


M1/3/1A

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.

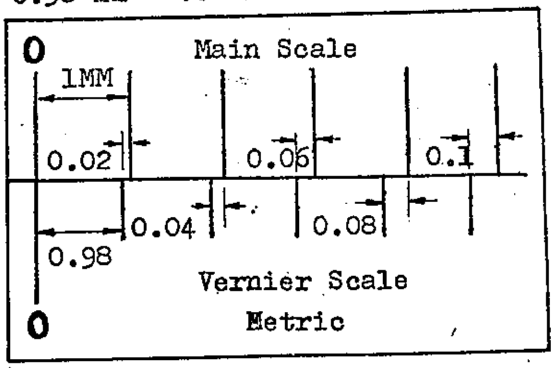


INCH SCALE The most common scale with the six inch vernier is the 1/1000th scale where the fixed scale is graduated down to fortieth parts of an inch (.025") and the moving scale spans a distance of 49/40 of an inch (1.225"). The moving scale is divided into 25 equal parts, each part measuring .049".

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.

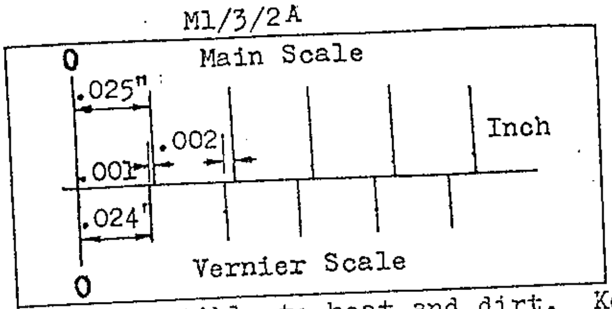
METRIC SCALE The most common metric scale is the one in which the fixed scale is graduated in millimetres and the moving scale spans a distance of 49 mm. The moving scale is divided into 50 equal parts, each part having a length of 49/50 mm (0.98mm).
The difference in size between these two therefore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

M1/3/2A



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.

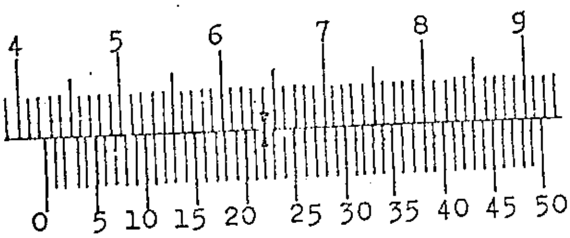
Make sure caliper is vertical when using depth gauge and shoulder is resting firmly and squarely on the edge of the hole.

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

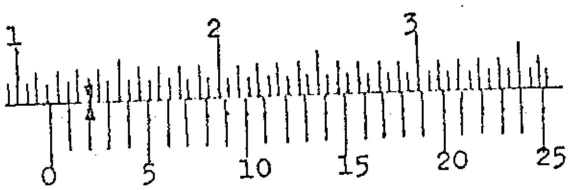
Do not apply excessive pressure. Only a light friction is needed for the correct reading.

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

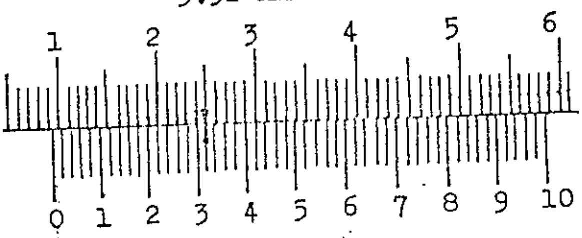
42.44 MM



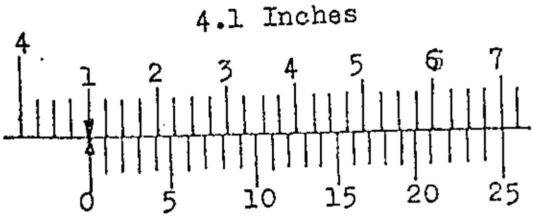
11.54 MM



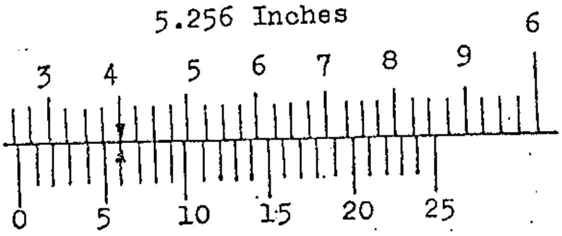
9.32 MM



4.1 Inches



5.256 Inches



TITLE:- PART 2. MICROMETER

LECTURER:- GERRY HEYNIS

DATE:- 19-2-81

EQUIPMENT:- Metric Micrometer, Inch Micrometer

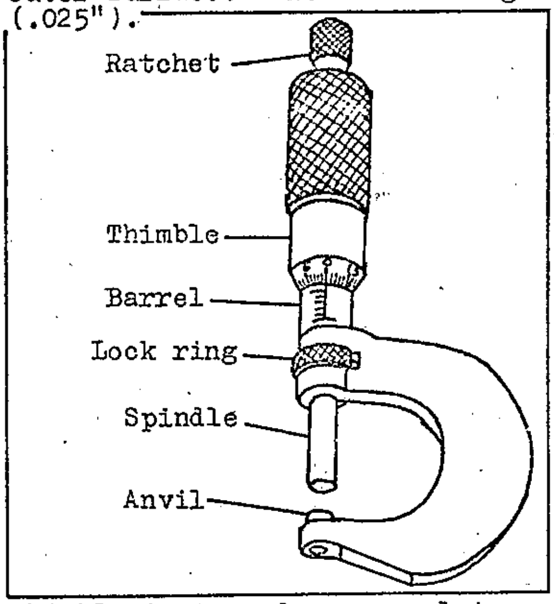
A Micrometer is a precision instrument used for measuring either external or internal diameters to an accuracy of .001" (.0001 in certain cases) or .01MM.

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).

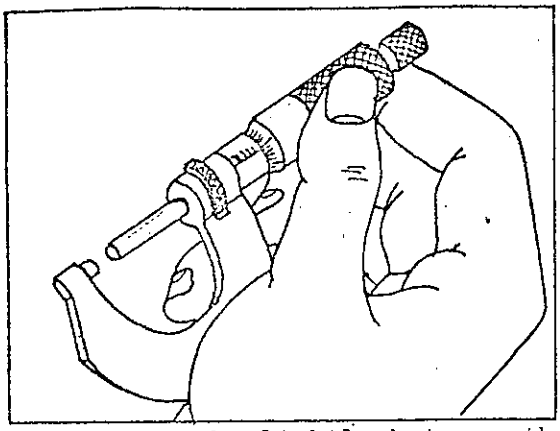
Metric Scale:- The screw with this type has 20 threads per centimetre, therefore if the thimble is turned through one complete revolution, it moves in or out .5 mm. The barrel with the metric type is graduated down to half millimetres.

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.

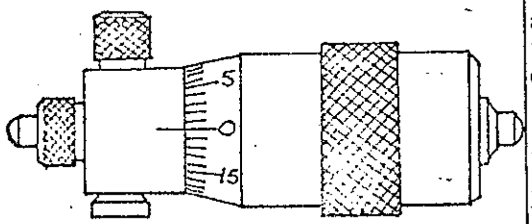
Note the number of the graduation on the thimble that is level with the datum line. Add the thimble reading to the barrel reading.

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.



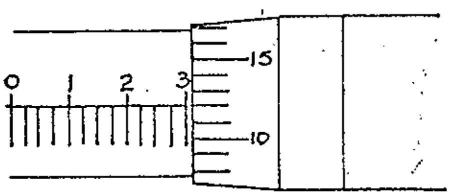
Inside Micrometer

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.

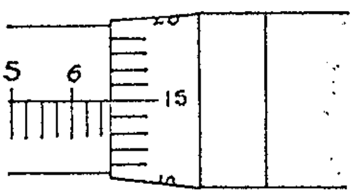
Follow these rules for accurate measurements.

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>.

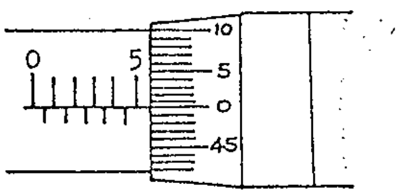
<u>Caution</u>:- Never try to obtain a reading from any moving object.



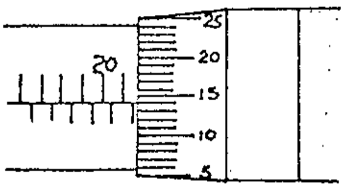
0.312 inches



0.665 inches



5.5 mm



21.64 mm

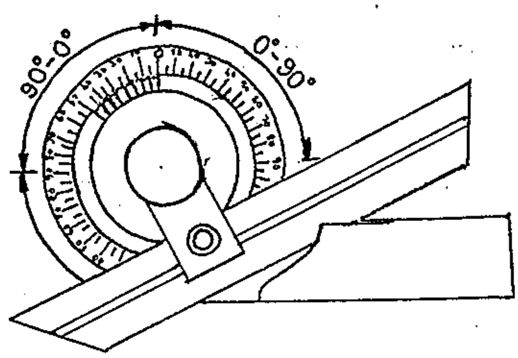
<u>TITLE</u>:- <u>VERNIER PROTRACTOR</u>

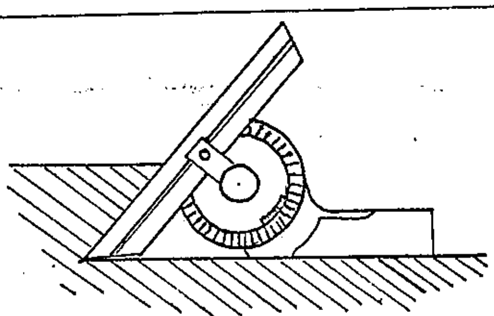
<u>LECTURER</u>:-

<u>DATE</u>:-

<u>EQUIPMENT</u>:- 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.





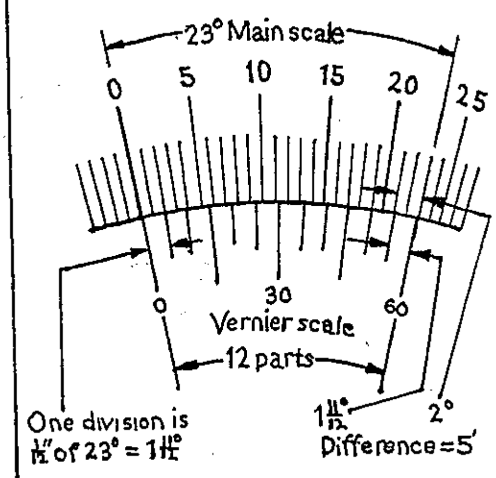
Checking an angular face

The principle of the vernier protractor is as follows:-
<u>The main scale</u> of the protractor is graduated into 360 degrees <u>reading from 0 to 90 to 0 then 90 back to 0.</u>
<u>The vernier scale</u> is made to cover an arc of 23 degrees of the main <u>scale.</u> 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. $2^\circ - 1\frac{11^\circ}{12} = \frac{1^\circ}{12}$

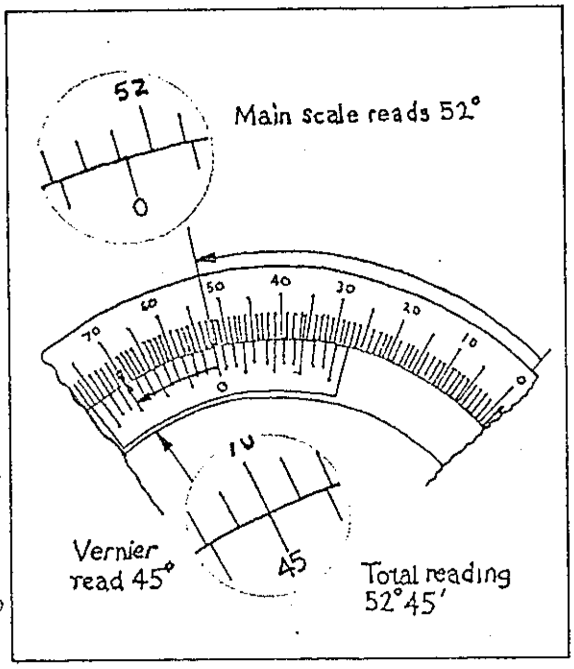
$= \frac{60'}{12}$

$= 5$ minutes



<u>Reading a vernier protractor</u> - 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:-

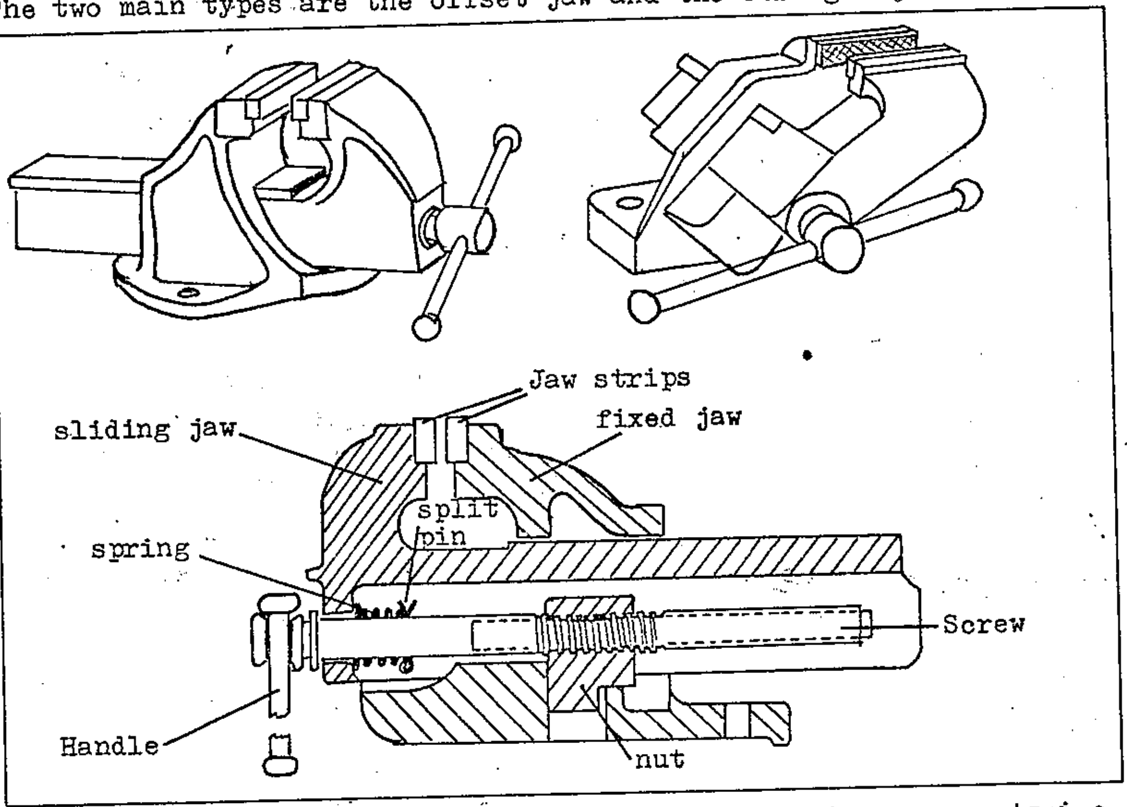
DATE:-

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.

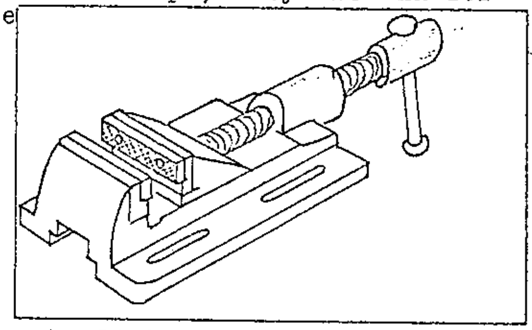
The offset vice has an advantage in that it can be used to grip long pieces without the guide of the sliding jaw causing obstruction. Both vices should be mounted so that the edge of the fixed jaw slightly overhangs the edge of the bench, also the height should be adjusted by adding wooden blocks so 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.

Machine Vices 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.

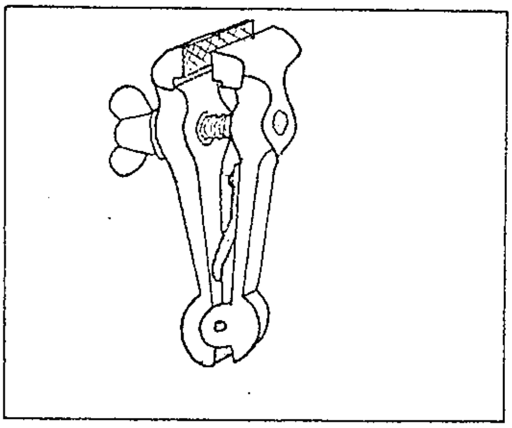


Because the threads are exposed, they should be cleaned of swarf and lightly oiled after use.

Hand vices 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.



Care and Maintenance 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.

Safety 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

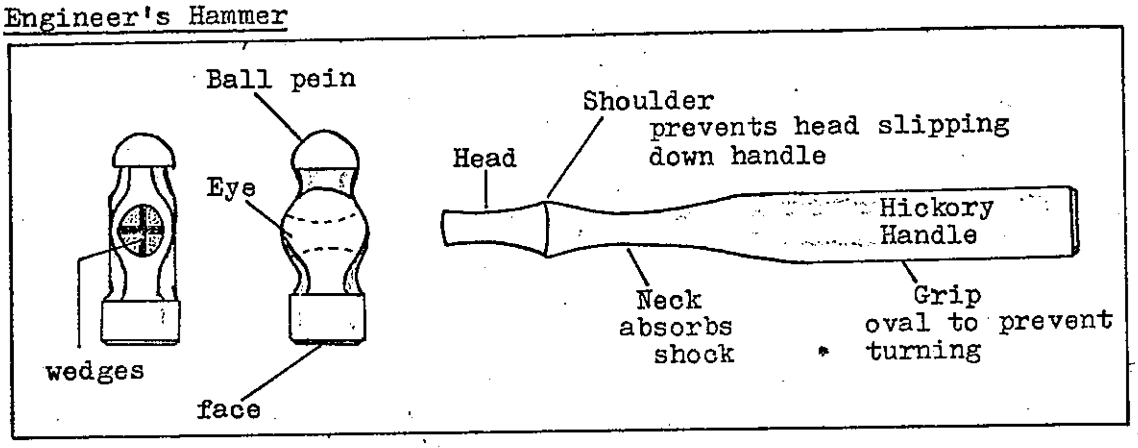
DATE:- 24-2-81

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:-

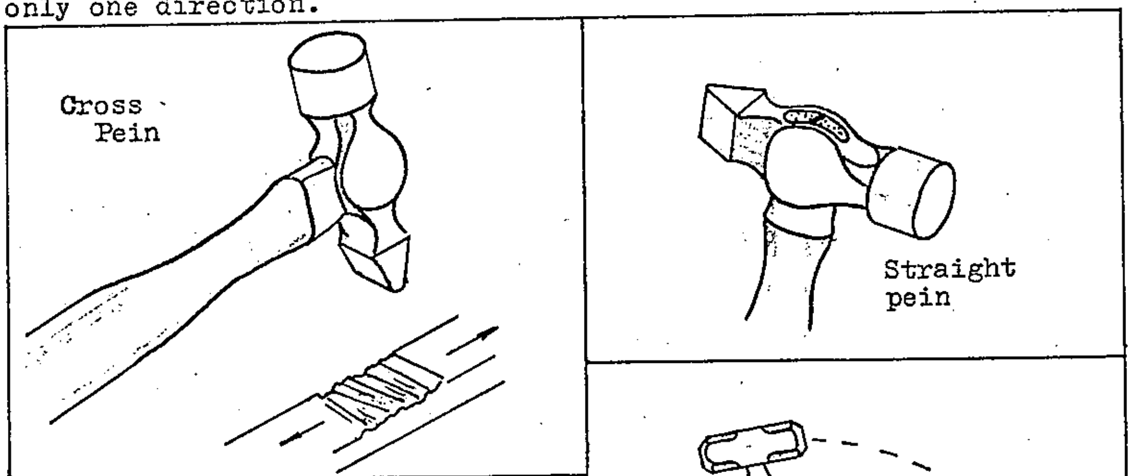
1. The TYPE of hammer
2. The WEIGHT of the hammer
3. The VELOCITY of the blow.

Engineer's Hammer

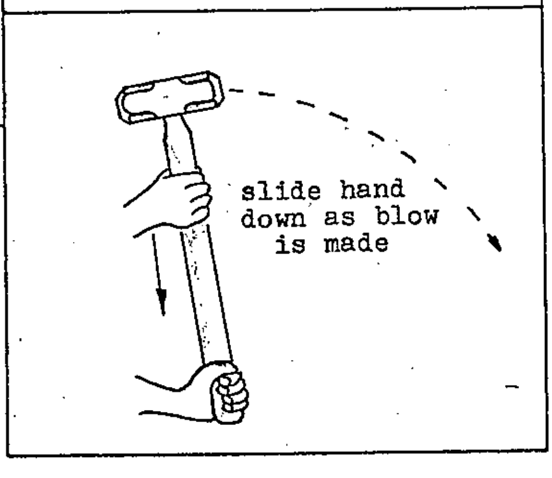


The engineer's hammer has a ball pein which is used to speed metal in all directions as with rivetting. Use fairly light blows and keep changing the position and direction of the force to allow the metal to spread evenly without splitting.

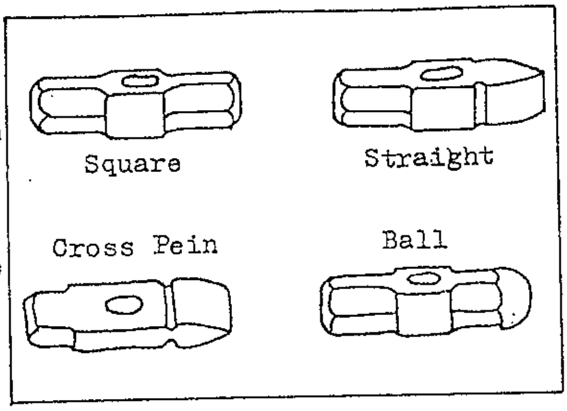
Cross pein and Straight pein hammers are used to spread metal in only one direction.



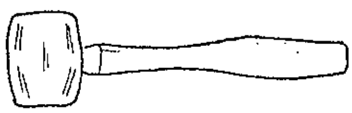
Sledgehammers have 4 types of head.
Square or double faced.
Straight pein.
Cross pein.
Ball pein or flogging.

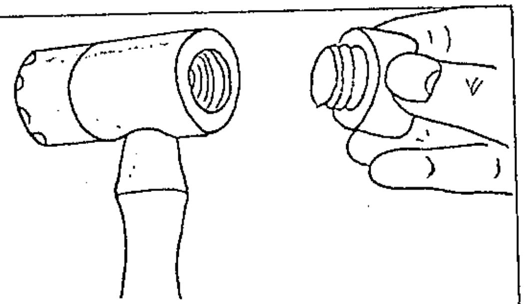


The head is made of steel having a higher carbon content than hand hammers.
Weights range from 3 to 6 kg. with handles of 900 to 1100 mm length.
They are used for very heavy work and are operated with two hands.
Grip as shown in the sketch, then as the strike is being made, slide the right hand along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



Lead, Rawhide, and Copper Mallets





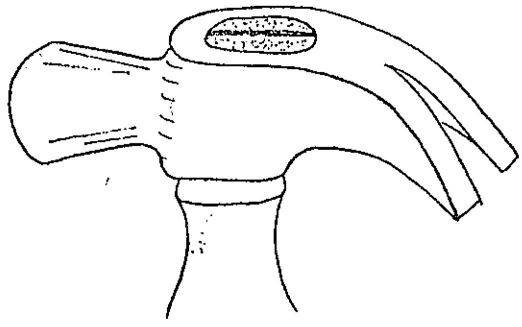
Plastic or copper inserts

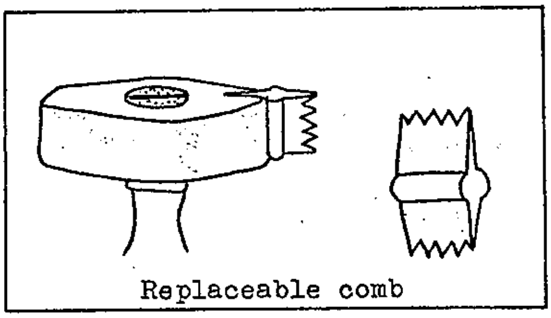
Rawhide mallets have Push-in inserts

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.





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.

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.

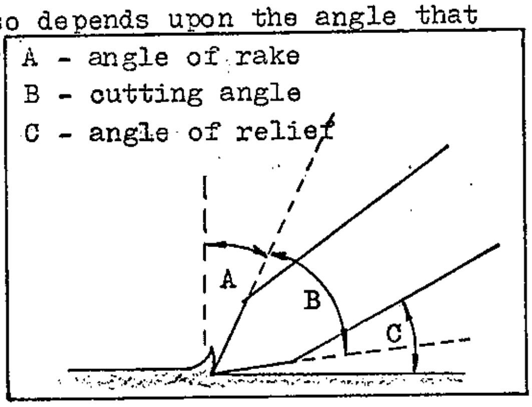
Point Angles The angle to which the chisel point is dressed depends on the hardness of the material it is to cut.

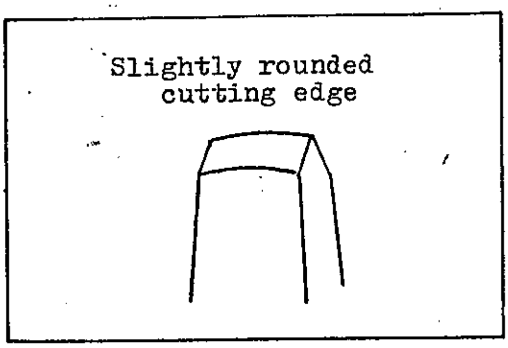
Metal	Cutting angle
Cast steel	70 - 80°
Cast iron	60 - 70°
Mild steel	50 - 70°
Brass	45 - 60°
Copper	45°
Aluminium	30°

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.

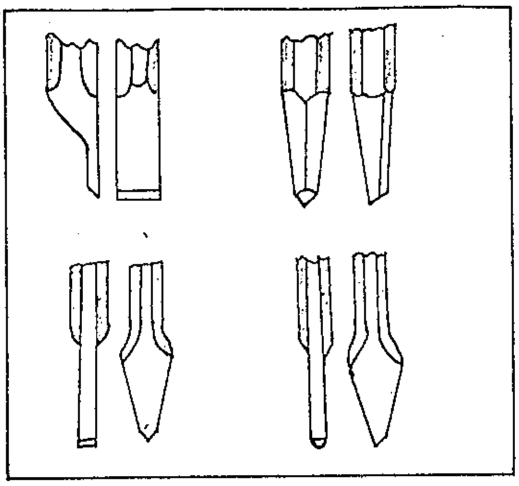
Rake angle determines how the chip will curl and break off. Too small an angle will cause the chips to build up in front of the chisel and not break off.





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.

CHISEL TYPES A number of specially shaped chisels have been designed for special purposes.



Side Cutting chisels have an offset point for cutting down the sides of slots.

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

Cross-cut chisels for making square or rectangular grooves for keyways.

Round-nosed chisel for enlarging holes or cutting oil grooves in bronze bushes.

Using a chisel safely

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

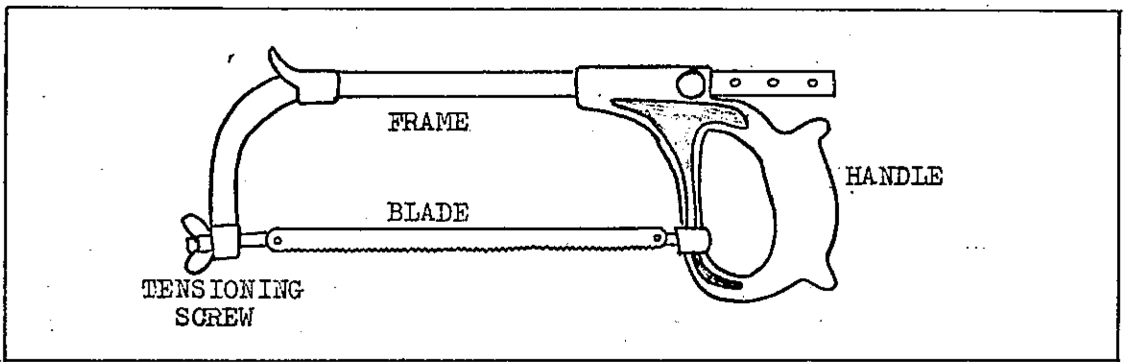
DATE:- 3-3-81

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.

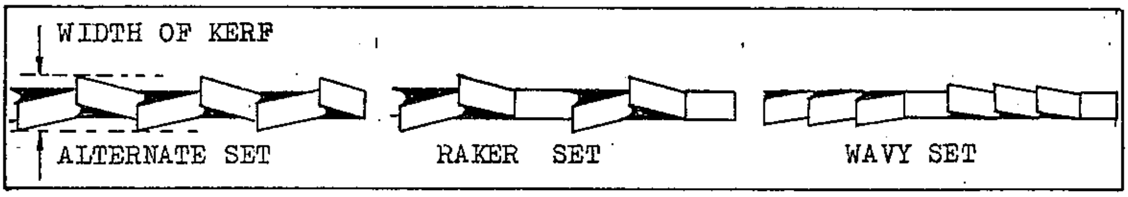
HACKSAW

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



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.

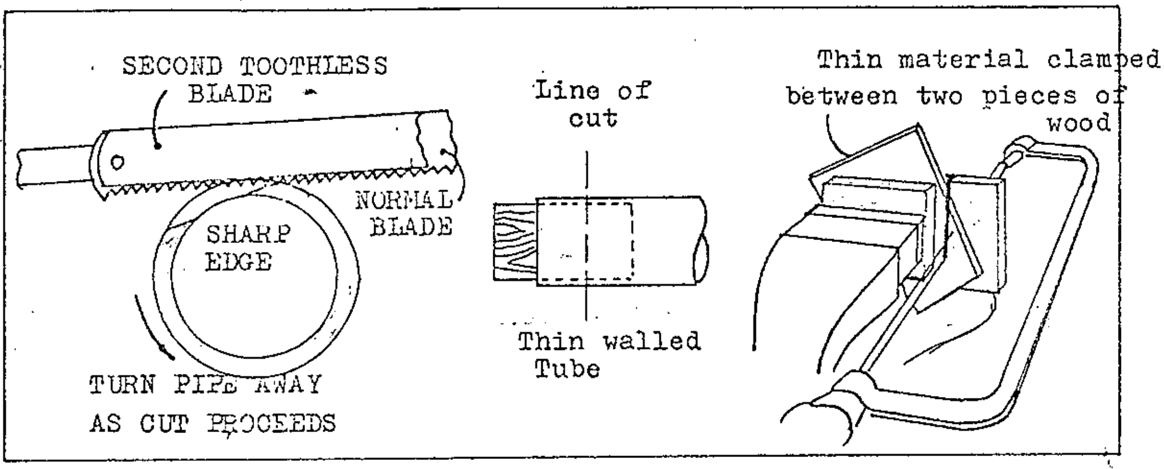
For cutting hard material or thin material, use a fine toothed blade, and for soft or thick material use a coarser blade.

On most hacksaws, it is possible to fit the blade at 90^{o} 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.

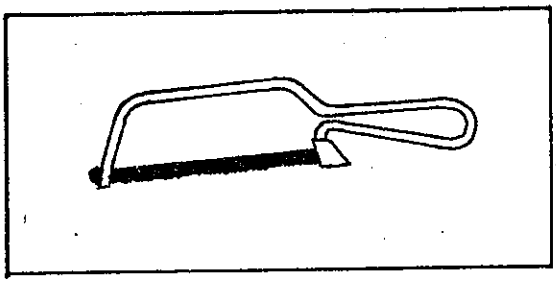
CAUSES OF BROKEN OR DAMAGED BLADES

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

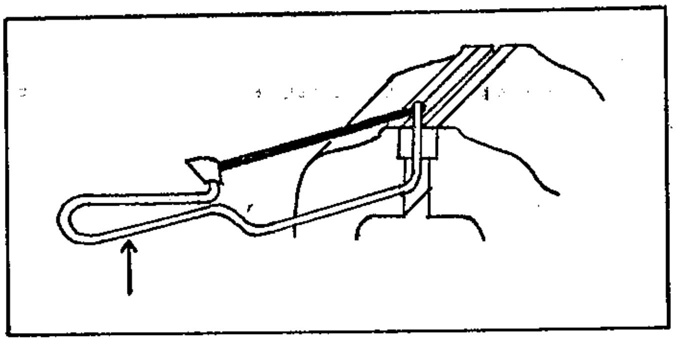
SPECIAL PURPOSE SAWS

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

JUNIOR SAW



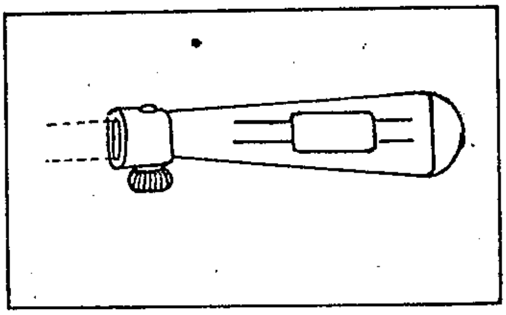
A small saw holding a 6" blade under spring tension.
It is useful for cutting small parts or for use in confined spaces.



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.

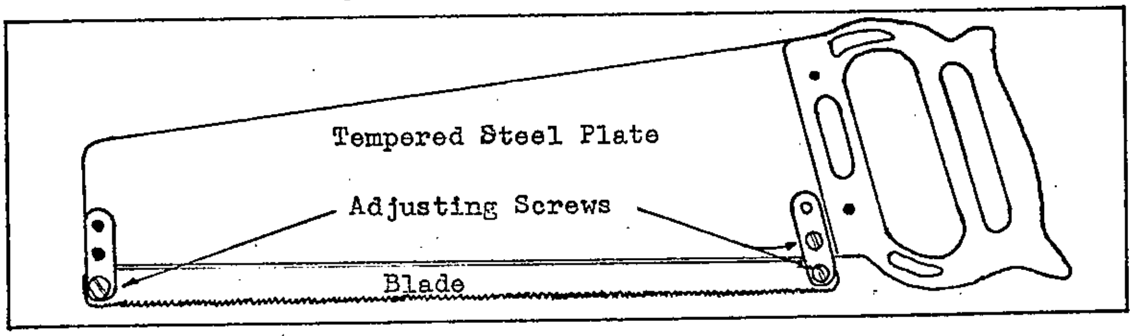
PAD SAW

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.

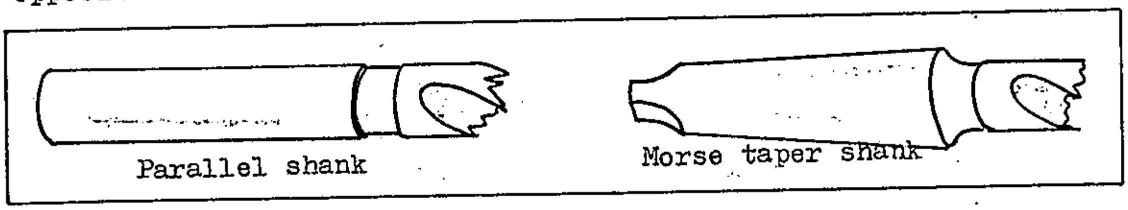
SHANK

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.

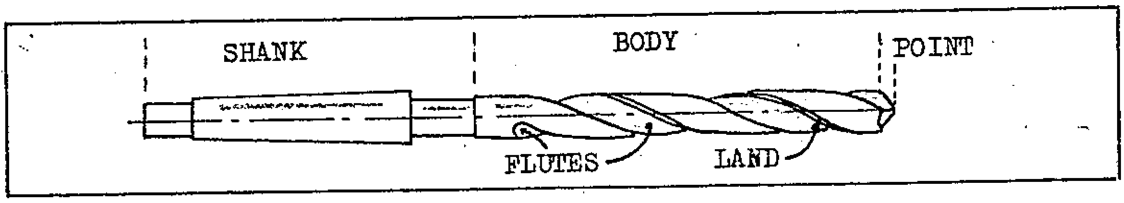
The taper shank, or Morse Taper, is used in the lathe or on larger drilling machines having a tapered sleeve to match that of the drill. The end of the shank has a tang which is visible through a slotted hole in the drilling machine sleeve. To remove the drill, a tapered steel wedge, or drift is forced 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.



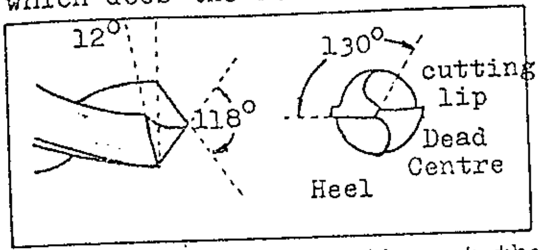
Body

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.

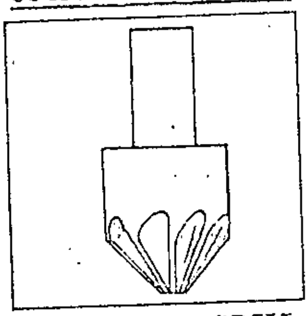
DRILL SIZES

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

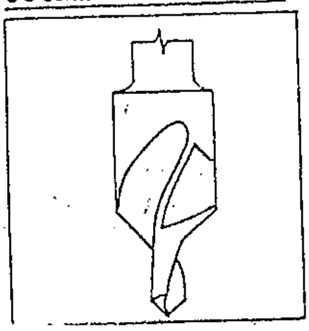


These drills are used for enlarging the mouth of a previously drilled hole to accept the head of a countersunk screw, or to remove burrs.

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.

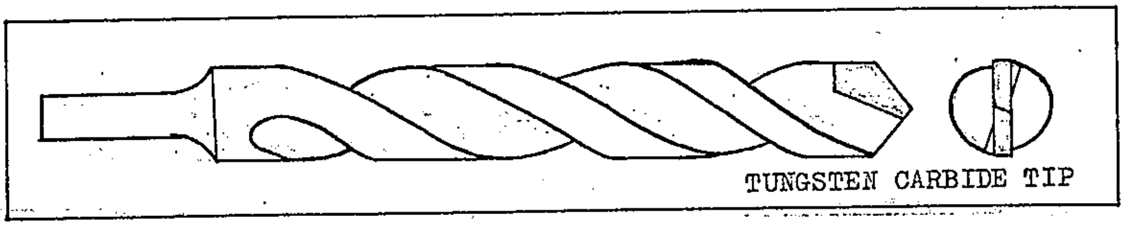
COUNTERBORE DRILL



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

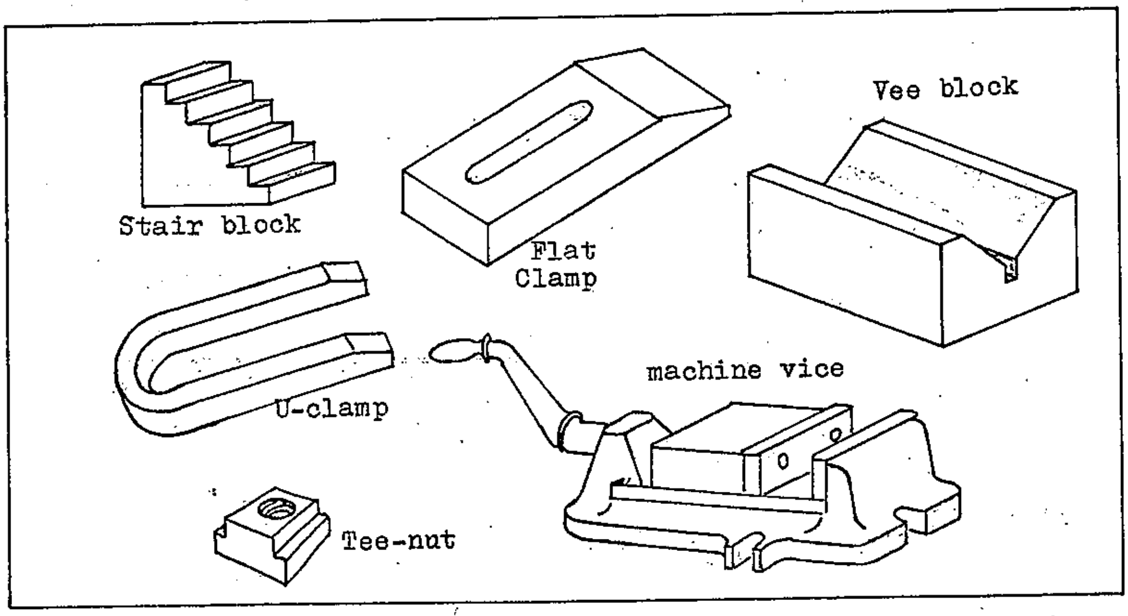
When holes over 4" diameter are required, a fly cutter may be used. This has an adjustable cutting tool (similar to a lathe tool) mounted on a horizontal arm, the end of which is secured by a hexagonal or circular shaped shank which fits into the drill chuck. As the drill rotates at a slow speed, the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

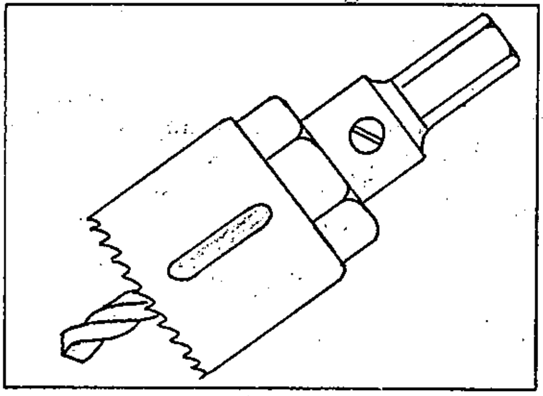
TITLE:- HOLE SAWS, WAD PUNCHES, REAMERS

LECTURER:- Gerrn Hennic

DATE:- 13-3-81

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

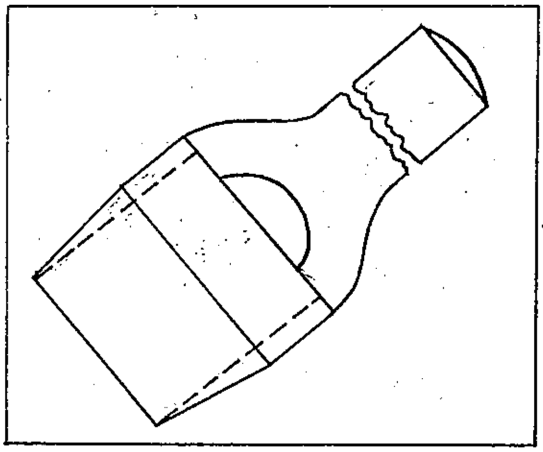
Holesaws are tools used in conjunction with drilling machines for cutting large diameter holes in sheetmetals or insulating materials. It is made up of 3 parts:-



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 ¼" 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.



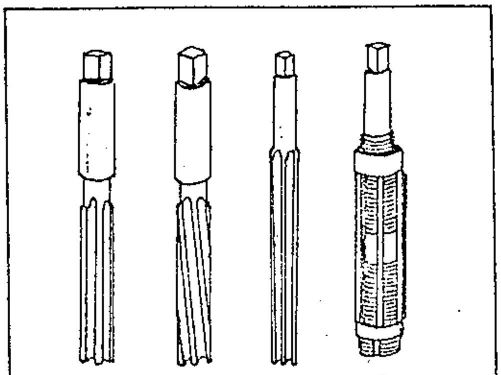
Wad Punches When holes are required in soft sheet materials such as rubber, cork etc., it is almost impossible to cut them with any sort of rotating drill bit, and they have to be punched.

The wad punch is available in a wide range of sizes from ¼" 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.



<u>Reamers</u> 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.

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

<u>Machine reamers</u> 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.

<u>Use of reamers</u> - 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.

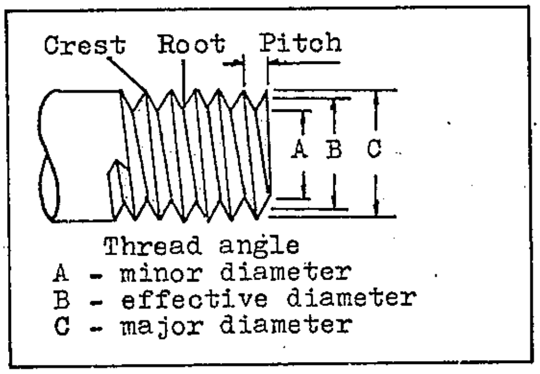
EDISON SCREW THREAD

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

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.

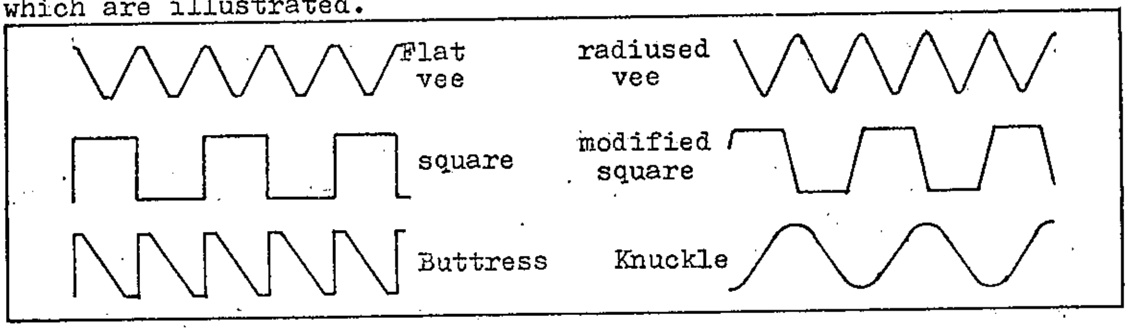
If it is cut on the outer surface it is termed a male thread, as is found on a bolt, and if it is cut on the inside surface of a hole, it is termed a female thread as found on a nut.



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.

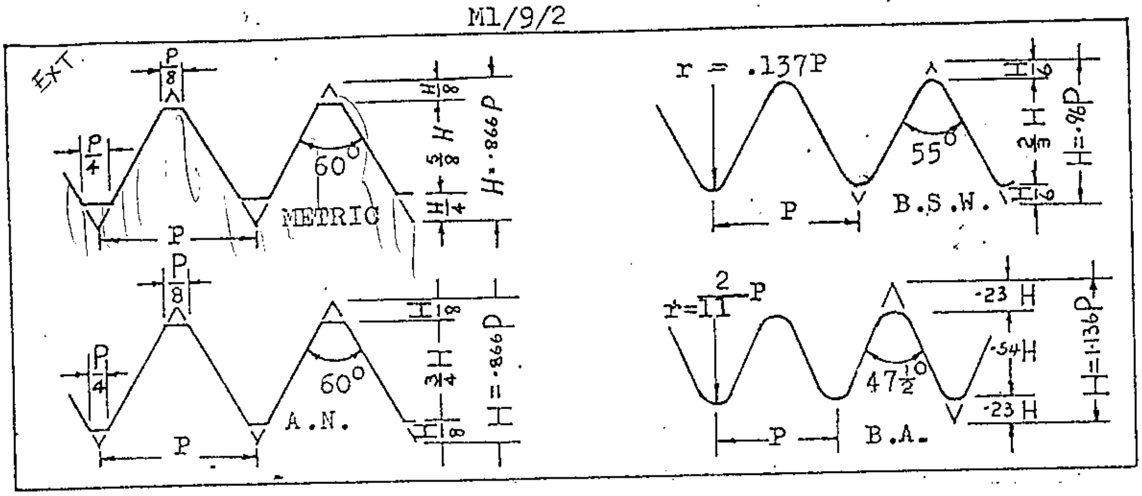


The vee thread is the most commonly used, and is the only one which may be cut by hand.
There are many variations of the Vee thread with respect to:-

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.



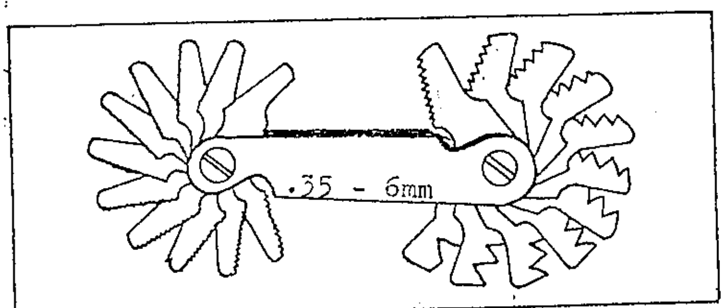
Some variations of these threads are:-
British Standard Pipe (BSP) same as B.S.W. but tapers $\frac{3}{4}$" in one foot and the last 3 threads are not fully cut.
American National Fine   A.N.F. or N.F.
Unified National Fine   U.N.F.
Society of Automotive Engineers   S.A.E.
American Society of Mechanical 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.

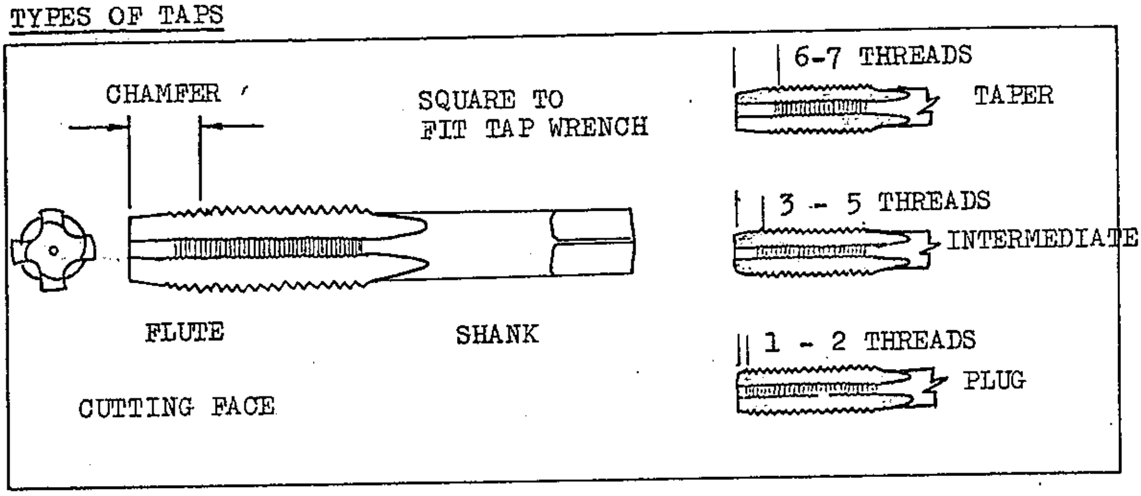


TITLE:- TAPS & TAPPING
LECTURER:- Gerry Heynis
DATE:- 16-3-81
EQUIPMENT REQUIRED:- Set of Taps, Tap Wrench, Tee Tap Wrench, Try Square, Safety Handbook.

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.

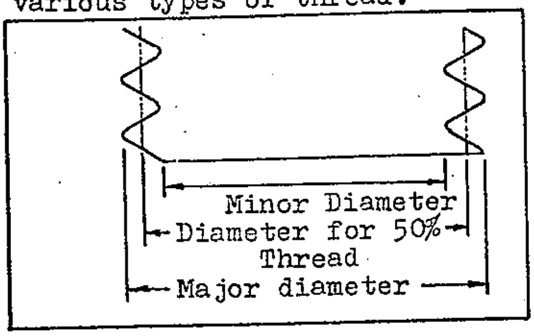
The major difference between them is the taper on the ends. Each has a body containing the cutting edges, flutes, thread relief angle, a web, and land, and a shank which is ground square on the end to accept a wrench for turning.

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
1/16	57
3/32	50
1/8	41
5/32	31
3/16	28
7/32	18
1/4	11
5/16	D
3/8	N
7/16	S
1/2	X
9/16	15/32
5/8	33/64
11/16	37/64
3/4	5/8
13/16	11/16
7/8	47/64
15/16	51/64
1	27/32

B.A. SIZE	TAPPING DRILL
0	11
1	18
2	25
3	30
4	33
5	39
6	44
7	47
8	51
9	53
10	55
11	56
12	61
13	64
14	69
15	71
16	74
17	76
18	77
19	1/64
20	80
21	
22	
23	
24	
25	

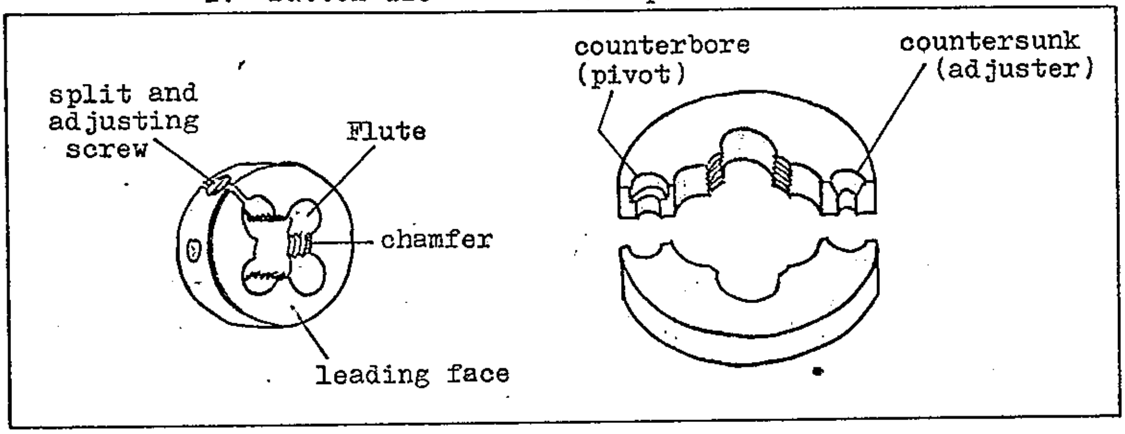
TITLE:- DIES

LECTURER:- GERRY HENNIS

DATE:- 23-3-81

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

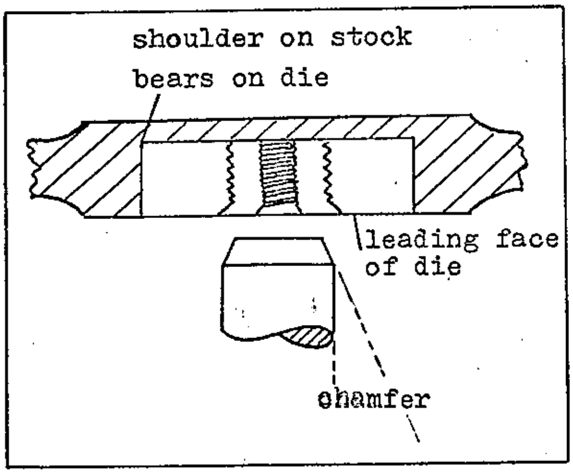
Dies are devices used in conjunction with a stock to form an external thread on roundstock, pipe and conduit. They are made of alloy tool steel and have accurately cut internal threads. Three or more flutes are formed into the die to form cutting edges on the internal threads, and to allow easy removal 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.

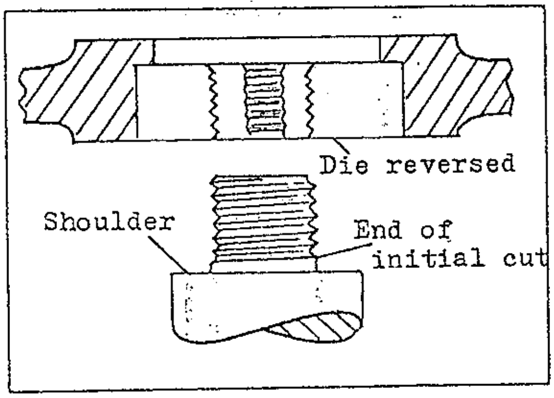
Adjust the die to its maximum diameter (minimum thread depth) and place it squarely on the material, with the chamfered cutting edges (throat) down. Apply fairly heavy pressure downwards, with the palm of the hand on the centre of the die, and rotate clockwise. When the die has started to cut, check 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 HENNIS

DATE:- 23-3-81

EQUIPMENT REQUIRED:- Steel, aluminium, copper, phosphor bronze, perspex.

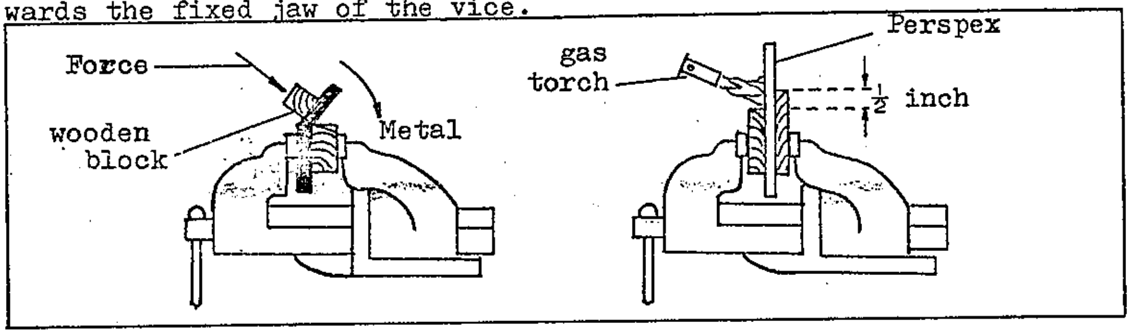
It is often necessary to form certain materials to the desired shape by bending. Materials must be ductile to allow them to be bent. Some materials are hard and brittle, but may be made ductile by suitable heat treatment, whereas other materials are readily bent when cold.

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.

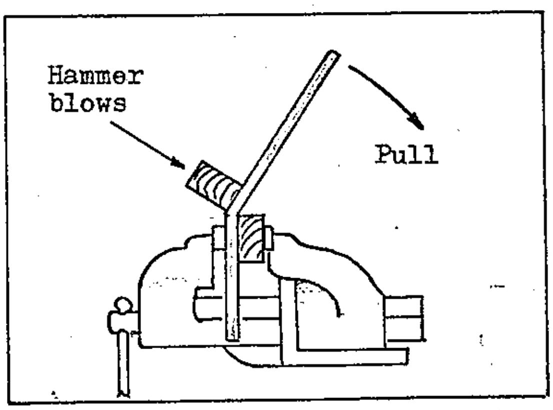


If perspex is being bent, a second piece of wood is required in front of the perspex with its top edge approximately ½" below the bending line.

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.

M1/14/1

TITLE:- MAKING JIGS

LECTURER:- GERRY HEYNIS

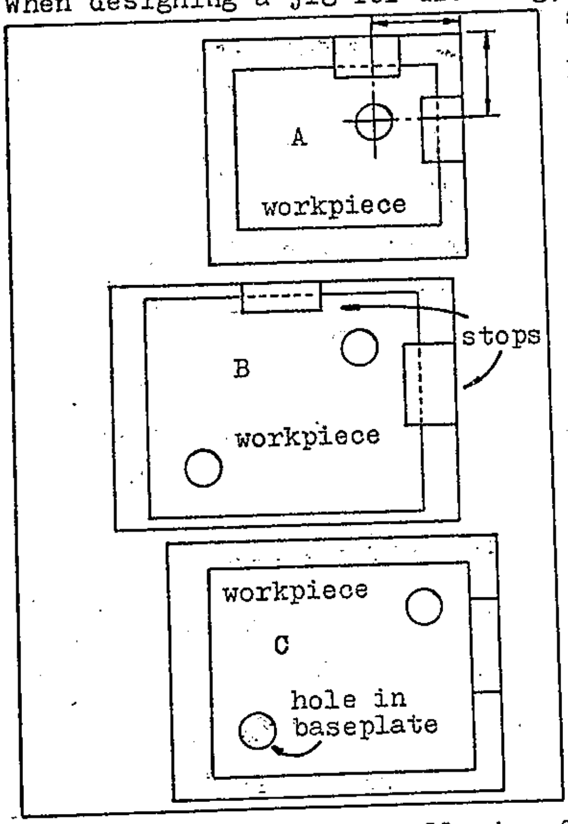
DATE:- 26-3-81

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.



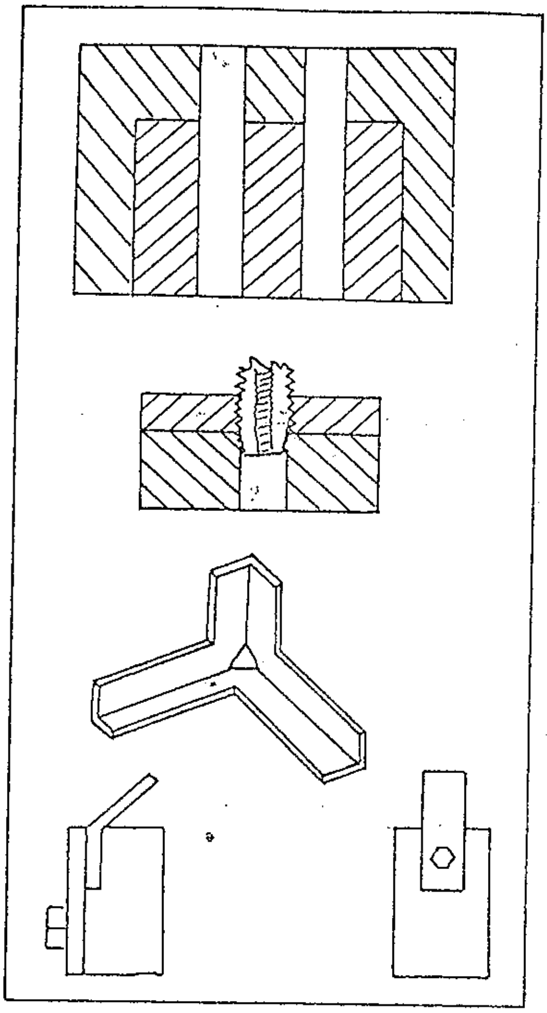
If two holes are to be drilled diagonally opposite, then consideration must be given to the most important dimension, i.e. is the distance from the edges most important or is the distance between them most important. The arrangement in Sketch B would give the first requirement and the arrangement in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

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.
Flux The flux used is mostly Borax and it serves the same purpose as flux in soft soldering.
Heating 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.
Preparation 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.

Procedure
- 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 small 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.

Safety
- 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 Hennis

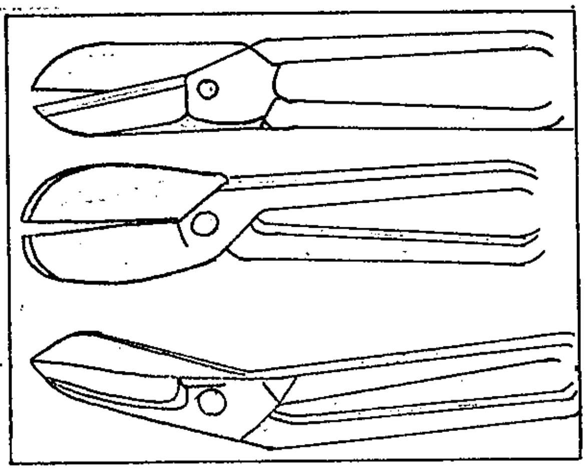
DATE:- 6-4-81

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

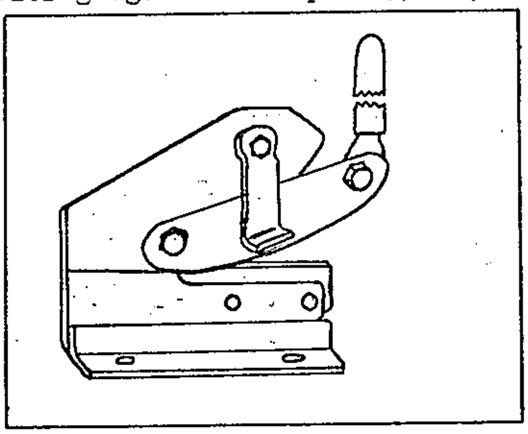
These are hand operated cutting tools used to cut sheet material up to about 1/16" thick. Many sizes, types and shapes are available, 3 of which are shown.



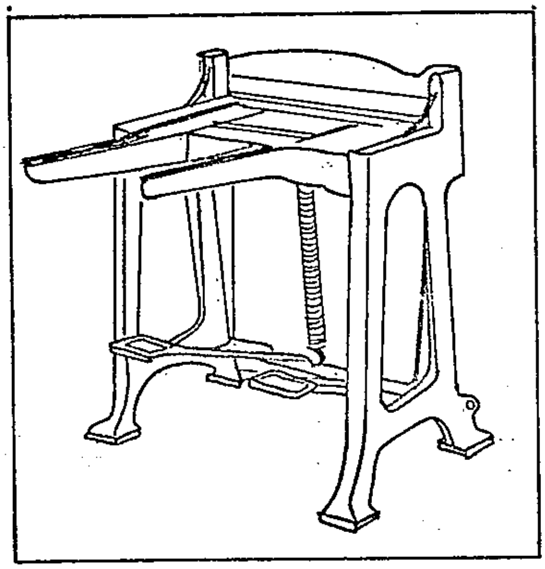
They may be used as a pair of scissors, or one handle may be clamped in a vice and the other used to apply pressure to cut. The straight snips will cut straight lines or slight external curves. The curved snips will cut internal or external curves and the universal snips will cut curved or straight lines.

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.

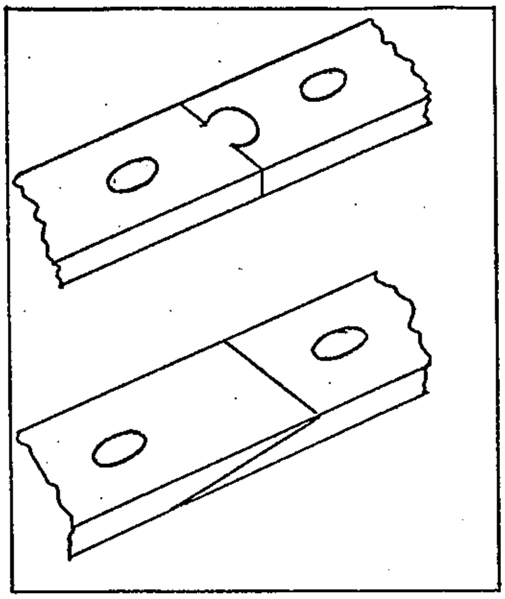
Leather is widely used for hydraulic systems where oil and high pressures are encountered. The leather fibres tend to swell in contact with oil to improve its sealing quality.

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.

LECTURE:- **MACHINE OVERHAUL**

LECTURER:- GERRY HEYNIS

DATE:- 6-4-81

EQUIPMENT REQUIRED:- Nil

Maintenance and repair of electrical equipment can be often a very complex operation especially where the equipment is made up of a large number of parts.

To simplify the overhaul of a piece of equipment and make re-assembly less difficult and time consuming, follow a set pattern from start to finish. from start to finish.

Inspection -

Before attempting to start disassembly, obtain as much data as possible on the equipment to be overhauled. 1. Find out what the symptoms are (running hot, blowing fuses, smoking, sparking, noise etc.) 2. Obtain manufacturers diagram, sketches etc. 3. Test for OPEN CIRCUIT or SHORT CIRCUIT, and for INSULATION FAILURE. 4. Check mechanical operation of parts (levers, shafts, buttons, switches etc.)

Record all relevant information, do not rely on memory. Your records should be clearly written so that they may be understood by some other person who may be assigned to complete the overhaul should you be unable to complete the job personally.

When all possible information has been determined and recorded, the equipment must be prepared for disassembly.

Preparation

With industrial machines, most equipment arrives for overhaul in a very dirty condition. Clean off as much dirt, grease, dust etc. as possible before opening any covers thereby eliminating the possibility of further damage due to ingress of this dirt to the more delicate parts of the machine.

Apply penetrating oil to rusted nuts and threads, and tap lightly with a hammer to break the rust yet not damaging the threads.

Some machines are filled with oil or compounds which must be drained off into a suitable container. The oil should be passed through a filter so that any parts of the machine broken off from inside will not be lost.

Any dirt, spillage etc. should now be cleaned up before disassembly.

Identification of parts

On most equipment, it is extremely important that all parts be replaced in exactly the same position. If there is more than one way that a part can be replaced, it must be marked by some indelible means. The most common method is to mark matching parts with a prick-punch, e.g. motor bearing caps, end housing, motor frame at one end would be marked with one prick punch mark on each piece, and at the other end with 2 prick punch marks on each piece.

A motor which has previously been overhauled would probably have been marked at the time of its last overhaul.

Aluminium labels securely wired to parts may also be used where punching is impractical.

It is also good practice to make sketches and diagrams showing how various parts are related, especially when there is no manufacturers data.

Disassembly

Using the proper tools and spanners, and using them in the proper manner, start removing cover plates etc.

Inspect each part as it is removed, including nuts and bolts etc, and note any damage to be repaired or replaced.

Carry out tests and checks and compare the results with those obtained on inspection. When any change is noticed, then it is possible that the source of trouble may have been removed. Examine the job and parts removed until the cause of the fault or faults is determined.

Whilst the machine is in a dismantled state clean and inspect every part. Protect cleaned or new parts from contamination by dust, moisture, heat etc. Carry out repairs as necessary or replace parts which cannot be repaired.

Reassembly

In most cases, reassembly is carried out in the reverse order of disassembly.

Ensure that all parts are clean, and that they are replaced in their proper place and sequence.

Stop and carry out checks and tests at various stages of reassembly to ensure that damage hasn't been caused and that errors have not been made.

Use new spring washers on all bolts and studs, and replace nuts and flat washers as necessary.

Make sure that all screws, nuts and bolts are fully tightened. On completion, test:- (1) Freeness of operation of all moving parts, (2) Conductivity, (3) Insulation, (4) Under normal working conditions.

NAME ____________ JOB NO. ____________ COY. NO. ____________ DIVISION NO. ____________

Y ORDER NO. ____________ DRIVE ____________ DATE ISSUED ____________ DATE COMP. ____________

SUSPECTED FAULTS

MEGGER TESTS BEFORE CLEANING

ROTOR TO EARTH

STATOR TO EARTH

STATOR BETWEEN PHASES
A–B A–C B–C

ROTOR RESISTANCE EACH PHASE
A–B A–C B–C

STATOR RESISTANCE EACH PHASE
A–B A–C B–C

CLEAN EXTERNALLY

CHECK

END FLOAT

SLIP RING ECCENTRICITY

SHAFT ECCENTRICITY

BEARING LIFT

POSITION OF COUPLING OR PULLEY

MARK MATCHING COMPONENTS

DISMANTLE AND CHECK

FRAME

J/BOX AND TERMINAL BLOCK

SHAFT

LEADS

COVERS

SLIP RINGS

BRUSH GEAR

BRUSH DATA AND SIZE

BEARING HOUSINGS

BEARING JOURNALS

BEARING CONDITION

BEARING DATA

D.E.

N.D.E.

LABYRINTHS

SEAL SIZES

LIST PARTS REQUIRED & HAND TO SUPERVISOR

FULL NAMEPLATE DATA

MANUF. ____________ H.P./K.W. ____________

R.P.M. ____________ SERIAL NO. ____________

FRAME ____________ VOLTS ____________

AMPS ____________

MOUNTING FOOT OR FLANGE

____

CLEAN WINDINGS

HEAT RUN

CLEAN PARTS

MEGGER TEST ROTOR TO EARTH

MEGGER TEST STATOR TO EARTH

VARNISH AND BAKE

REWIND. DETAILS

REASSEMBLE

LIST PARTS RENEWED

BEARINGS

GREASE

MEGGER TEST AFTER OVERHAUL

ROTOR TO EARTH

STATOR TO EARTH

STATOR BETWEEN PHASES
A–B A–C B–C

ROTOR RESISTANCE EACH PHASE
A–B A–C B–C

STATOR RESISTANCE EACH PHASE
A–B A–C B–C

TEST RUN

CURRENT PER PHASE A B C

R.P.M.

TEST REPORT NO.

REMARKS

Y ORDER NO. ____________ DRIVE ____________ DATE ISSUED ____________ DATE COMP ____________

SUSPECTED FAULTS

MEGGER TESTS BEFORE CLEANING

ARMATURE TO EARTH
SERIES FIELD TO EARTH
SHUNT FIELD TO EARTH
BETWEEN SERIES AND SHUNT
INTERPOLES TO EARTH
RESISTANCE OF SHUNT FIELD

CLEAN EXTERNALLY

CHECK

END FLOAT
COMMUTATOR ECCENTRICITY
SHAFT ECCENTRICITY C.E. O.C.E.
THREAD CONDITION
KEYWAY CONDITION
BEARING LIFT
POSITION OF COUPLING OR PULLEY
MARK MATCHING COMPONENTS

DISMANTLE AND CHECK

FRAME
J/BOX AND TERMINAL BLOCK
LEADS
COVERS
BRUSHGEAR
BRUSH DATA AND SIZE
BEARING HOUSINGS
BEARING JOURNALS
BEARING CONDITION
BEARING DATA
C.E.
O.C.E.
LABYRINTHS
SEAL SIZES
COILS
POLARITY TEST
DROP TEST

LIST PARTS REQUIRED & HAND TO

FULL NAMEPLATE DATA

MANUF. ____________ H.P./K.W. ____________
R.P.M. ____________ SERIAL NO. ____________
FRAME ____________ VOLTS ____________
AMPS ____________
MOUNTING FOOT OR FLANGE
____

CLEAN WINDINGS
HEAT RUN
CLEAN PARTS
MEGGER TEST ARMATURE TO EARTH
MEGGER TEST FIELDS TO EARTH
VARNISH AND BAKE

REWIND DETAILS

REASSEMBLE

LIST PARTS RENEWED

BEARINGS
GREASE

MEGGER TEST AFTER OVERHAUL

ARMATURE TO EARTH
FIELDS TO EARTH
BETWEEN SERIES AND SHUNT

TEST RUN

TEST REPORT NO.

REMARKS

OVERHAULED BY:

CHECKED BY:

TITLE:- SPANNERS AND WRENCHES

LECTURER:- GERRY HEYNIS

DATE:- 9-4-81

EQUIPMENT:- Ring spanners, O/E spanners, socket set, Stillsons, pliers, mole grips, tube spanners, crescent spanner, collet spanner.

Spanners are tools designed to fit one specific size of nut. Wrenches are usually adjustable to fit several sizes or use friction and pressure to grip an item.

A spanner is as good a fit as can be reasonably expected on the correct nut. With a good set of spanners, the length is designed so that a normal person will not be able to apply too much pressure, but to assure the correct size, a full set must be carried around.

A wrench will often cover all the sizes encountered, but the disadvantages are numerous:-

The same leverage is applied to large and small nuts and bolts alike; They are not solid, relying on hand pressure or an adjusting screw; pressure has a tearing effect on the metal; the adjusting screw tends to spring. Both take the corners off the nuts, making a tight nut even more difficult to remove. Both increase the risk of injury and indeed cause accidents continually.

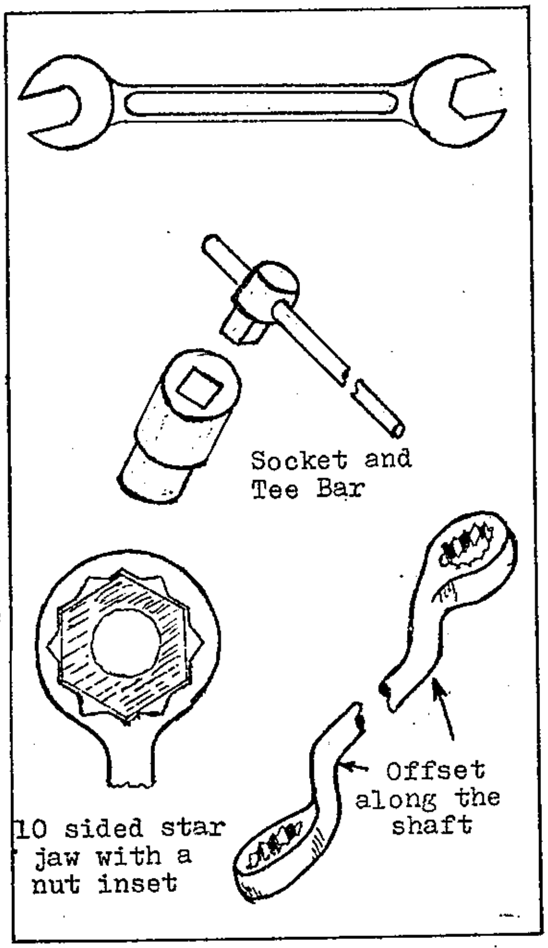
There is a choice of tools therefore, to perform the same task and a way to judge a good or bad tradesman by the tools owned and used. A good rule to apply is if you wouldn't like anyone to use a certain tool in a certain way on anything you own or value, then don't you use it that way on anything.

Types of Spanners and Wrenches

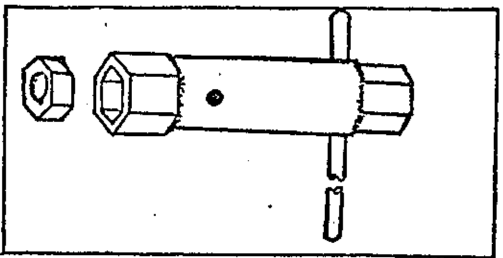
Open Ended Spanner: Most common in use, usually flat, double ended and with the jaws offset 15° for easy manipulation. Special thin jawed spanners are available for holding lock nuts.

Socket Spanner: This type uses a detachable socket for each nut size and separate leverages of different types e.g. T bar, ratchet, knuckle joints, brace, etc. Will usually fulfil most spanner requirements. Special care must be taken that too much pressure is not applied.

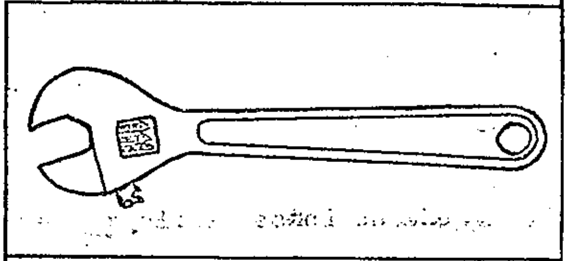
Ring Spanner: Usually offset along the shaft. Jaw a 10 sided star rather than hexagon, therefore grip half flat all round. Usually double ended, can be obtained in large sizes, single with a hammer pad on the other end. It is the best spanner to use.



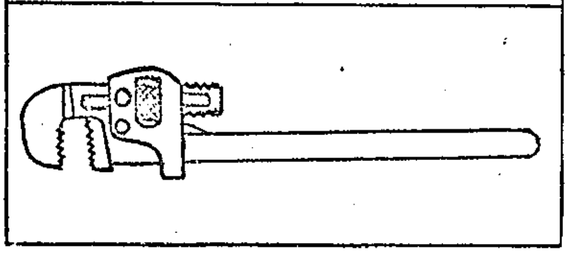
Tube Spanners: A length of jointless tube with a hexagon set in each end and a hole drilled to take a "Tommy" bar.



Crescent Spanner: Useful for odd size nuts, 15° offset on the jaws. Opened and closed by a knurled nut in the handle. Sometimes called a shifting spanner.



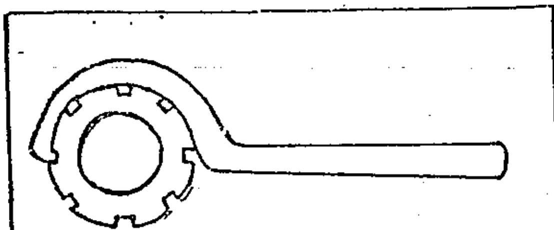
Stillson Wrench: Bottom jaw adjustable on a thread, teeth set into the jaws, should only be used for gripping round bar or pipe.



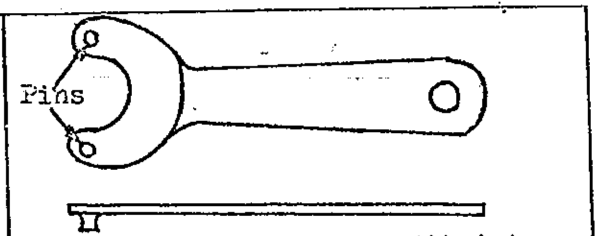
Pliers pressure grip, toothed jaws useful for gripping curved surfaces.

Mole grips: Has the same as above but handles are held together by a spring catch. Useful in that it will hold itself to a surface once put in position.

Miscellaneous: Collet spanncers, pin spanners etc.



Collet Spanner



Pin Spanner Pins fit into corresponding holes in a circular nut.

Correct Use of Spanners

Wherever possible, use a fixed jaw spanner of the correct size. Do not put extension levers onto other than socket spanners, and then only to give reach, not extra leverage. Apply de-rusting solvents or lubricants to rusted or tight fasteners.

Always try to pull on a spanner, or if pushing, open the hands. With offset spanners, apply the pressure with the short jaw on the same side as the direction of motion.

A quick jerk is often more effective than a sustained pull.

Where tightening into a blind hole, put a spring washer on the fastener first. It can be checked if the bolt is fully home by looking to see if the washer is flat.

TITLE:- THREAD CHASERS & DIE NUTS

LECTURER:- Gerry Hennis

DATE:- 23-3-81

EQUIPMENT:- Die nuts, spanners, thread gauges, thread chasers, molybond, wire brush.

Machines and equipment which have been in service on the plant are very often returned to the electrical shop for service in a poor condition. Very often the threads of bolts, studs etc. are dirty, corroded, covered with paint, or damaged. Replacement of all bolts, nuts and threads can be either too costly or impractical (as with the threads on the end of a motor shaft).

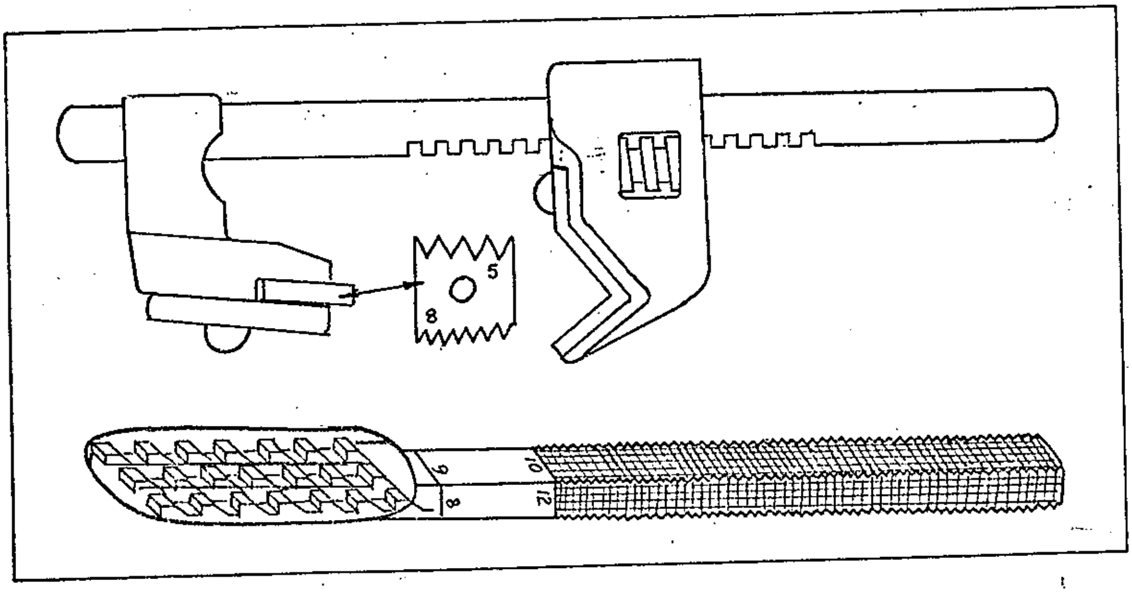
It is essential that these threads be restored to a safe useable condition before the equipment is returned to service, and a number of aids are available to assist in the restoration of these threads.

Preliminary cleaning Threads which are clogged with dirt, oil, rust, or paint should be cleaned with a chemical agent such as Transpo, or C.R.C. as far as possible followed by a vigorous brushing with a wire brush. Gloves must be worn when handling Transpo and care should be taken when using a wire brush to ensure that small particles are not ejected into the eyes. To minimise this risk, safety glasses must be worn.

Nuts and bolts which are badly corroded should be discarded at this stage and replaced with new ones of the same size and strength.

Die nuts
These are available to fit all common sizes of bolts and threads. They are usually hexagonal to allow them to be operated by a spanner. They are similarly constructed to dies except that they are non-adjustable.
When using a die nut, ensure that the correct size spanner is used - preferably a ring spanner, and use a suitable lubricant.
If the die nut becomes tight on a thread, it should be operated in the same manner as a die, i.e. reverse it frequently to break the chips.
A die nut must not be used to cut a new thread.

Thread chaser For larger diameters, die nuts are not available, and other devices must be used for cleaning threads.



Before a thread chaser is used, details of the thread must be determined, i.e. the type of thread, and the number of threads per inch. It is important that the teeth on the chaser are identical to the thread being cleaned.

Insert the detachable thread scraper into the stock and turn in the direction shown for the first chaser.

Select the correct T.P.I. on the second chaser and use as you would for a file.

To reduce the need for thread chasers, threads should be protected wherever possible. Where threads are exposed to the risk of corrosion, a coating of "Molybond" or similar protective coating should be applied during assembly of the machine.

LECTURE:- NUTS, BOLTS, WASHERS & FASTENING DEVICES

LECTURER:- Gerry Hennis

DATE:- 7-5-81

EQUIPMENT:- Bolt, set screw, cap screw, metal threads, grub screw, stud, self tapping screw, hammerdrive, wood screw, coach screw, coach bolt, gutter bolt, terrier bolt, loxin, eye bolt, J-bolt, U-bolt, locknuts & washers

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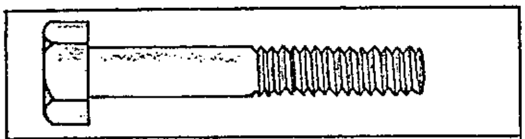
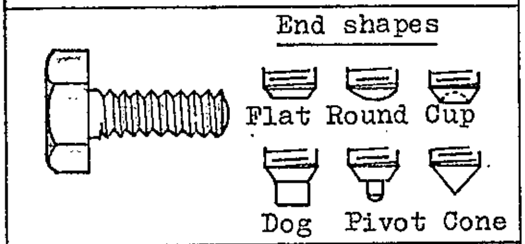
When two or more parts must be held rigidly together yet be readily dismantled, some form of threaded device is used. A wide variety of such devices have been developed to suit almost every application, some of which are:-

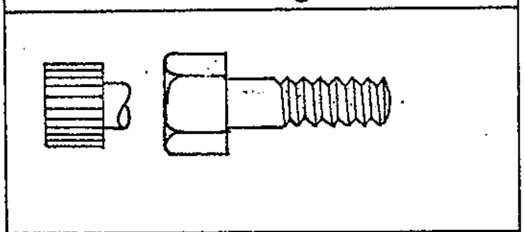
Bolts Have hexagonal or square heads and a shank which is partly threaded. It is used in conjunction with a nut.



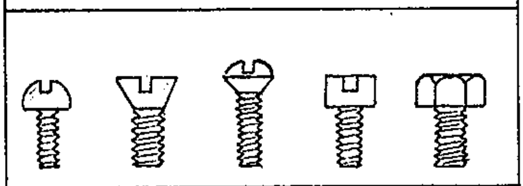
Set screws are usually shorter than bolts and are fully threaded, hardened and tempered for extra strength. Pressure is exerted by the end of the screw and not by the head. Its most common use is to hold sleeves, pulleys etc. onto shafts and spindles.



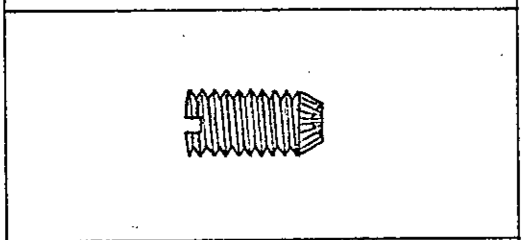
Cap screws are not fully threaded and are used to hold two parts together without a nut. One part would have a clearance hole, the other would have a threaded hole. The head may be hexagonal or recessed hexagonal to suit an allen key.



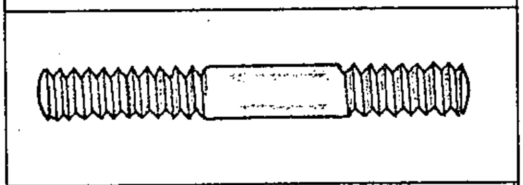
Metal threads are fully threaded and may be used with or without a nut. The heads may be round, countersunk, raised head, cheese-head, or hexagon, and are usually fitted with a screwdriver slot.



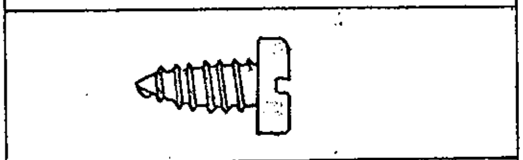
Grub screw is a headless form of set screw and is used for similar purposes. A screwdriver slot or a recessed hexagonal socket is provided for driving. The end which grips onto the work is usually shaped to one of the forms illustrated.



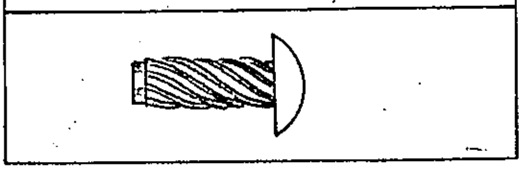
Stud - this is a cylindrical rod which has a thread formed at each end with a plain part in the middle. It is used where a nut and bolt cannot be fitted. Use a stud box for fitting and removal.



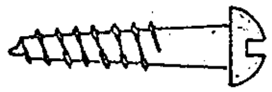
Self tapping screw used to fix components to sheetmetals. After a pilot hold is drilled, the hardened screw forms its own thread as it is driven in.



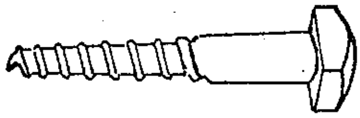
Hammerdrive screw used to hold on nameplates etc. A pilot hole is drilled, and the screw is driven in with a hammer. Usually, these screws cannot be removed.



<u>Wood screw</u> used for fixing components to timber. Available with round, or countersunk heads. Cup washers may be used with countersunk screws to improve appearance.

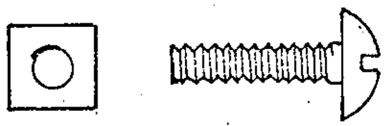


<u>Coach screw</u> is a stronger form of woodscrew used for heavier work. A hexagonal head allows the use of a spanner.

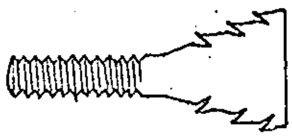


<u>Carriage or Coach bolts</u> used to bolt timber components together. The square part under the round head bites into the timber to prevent it turning. The rounded head gives a flush surface.

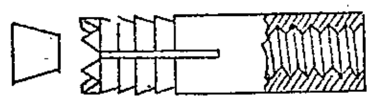
<u>Gutter bolts</u> are small galvanised steel bolts with a shallow round head with a larger than normal diameter. Used with a thin square nut, it is used on plumbing and light construction jobs.



<u>Lewis bolt</u> or rag bolt is a masonry anchor for securing equipment to concrete. They must be positioned in the concrete whilst it is still wet.



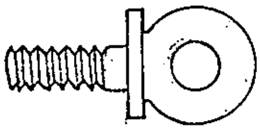
<u>Terrier bolt</u> is a masonry anchor used to fasten equipment to concrete and masonry. The end is serrated and hardened to allow the bolt to cut its own hole. It is held by a steel handle which is struck with a hammer.



<u>Loxin</u> is a masonry anchor which is fitted into a previously drilled hole in concrete or brickwork. As a bolt is screwed into it, a tapered nut in the base of the loxin causes the sides to expand and grip onto the sides of the hole.

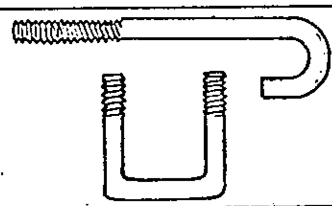
<u>Turnbuckle</u> - this is a device used for tensioning wire ropes. As the centre link is turned, the two threads (one left hand, one right hand) pull towards each other thereby applying tension to the wire rope.

<u>Eye bolt</u> is a closed loop of steel with a thread protruding from one side. Used mainly for lifting purposes when screwed or bolted to machinery.

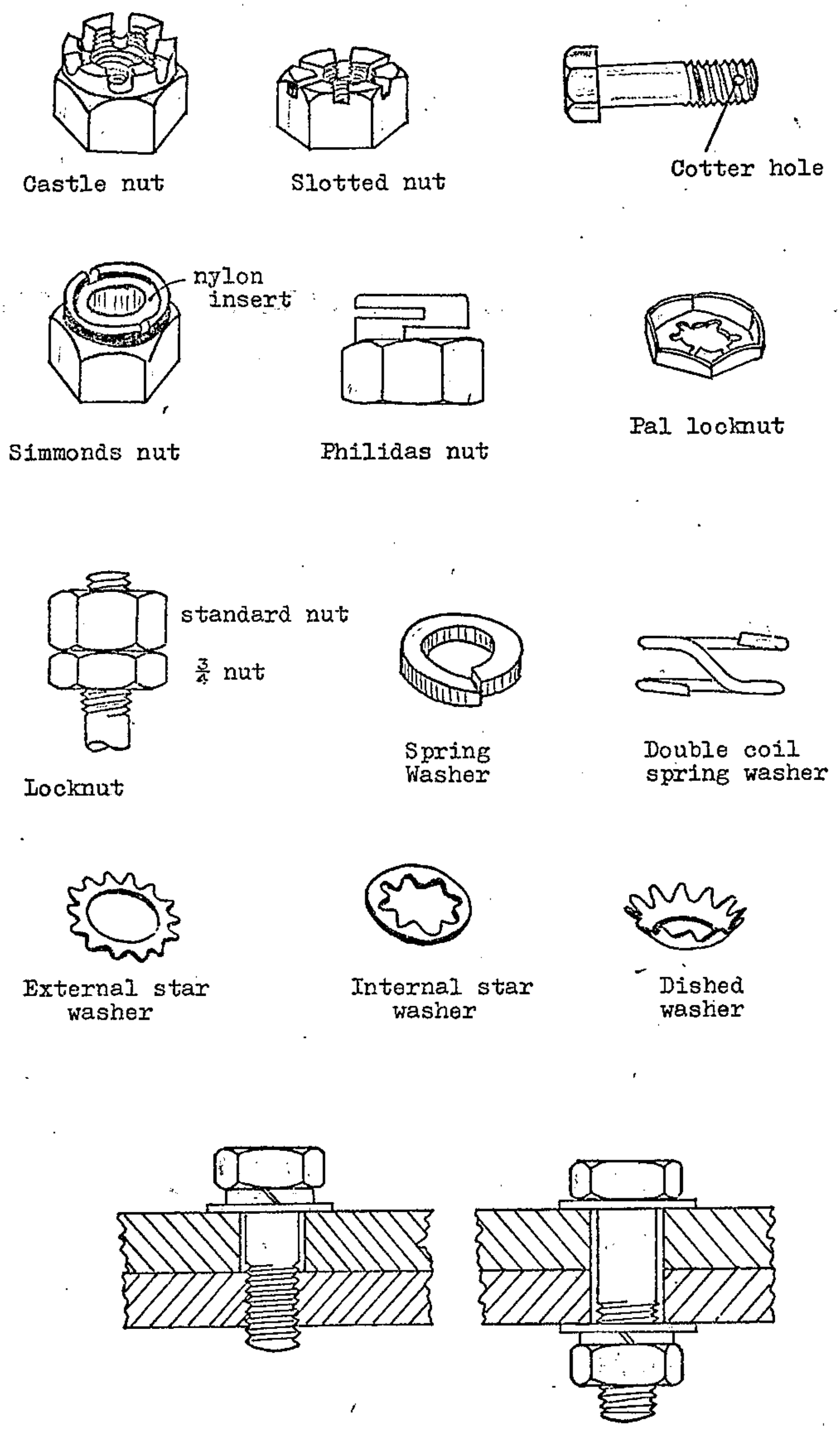


<u>J bolt</u> Used to attach components or corrugated sheeting to angle iron framework or building structures.

<u>U bolt</u> For the same purpose as the J bolt but used where there is no flange as with channel iron.



When a screw or bolt is fitted with a nut, some form of device must be used to ensure that the nut does not vibrate loose in service. Damage to equipment, injury, and lost production could result from such action. A selection of locking devices are shown below.



Applications

Note:- Clearance holes
Flat washers
Spring washers

TITLE:- PLIERS, SCREWDRIVERS AND CIRCLIP PLIERS

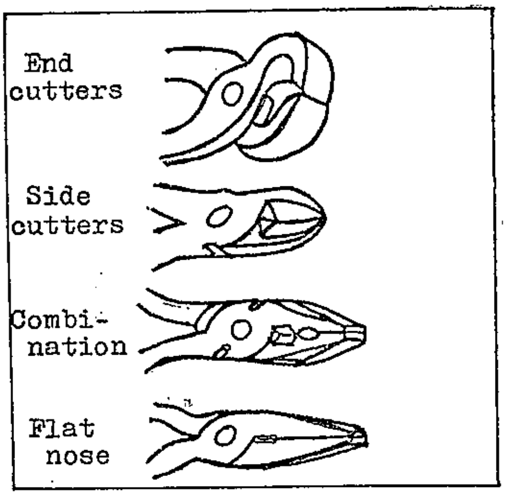
LECTURER:-

DATE:-

EQUIPMENT:- Combination, Long nosed, Circlip pliers, complete Philips and Standard Screwdriver Set, Side and End Cutters.

Part 1 - Pliers

Pliers consist of a pair of legs joined by a hinge or pivot to give a pair of long handles and short jaws, thus giving mechanical advantage to the jaws or gripping or cutting power. The jaws can have a variety of different shapes and uses. Below are shown the most common in general use.



End cutters - for cutting wire or removing split pins.

Side cutters - used on similar work to end cutters but more commonly in electrical work.

Combination pliers - the most common in use, dealt with separately below.

Flat nosed pliers - used to grip small items or in confined spaces.

Combination pliers - one of the handiest tools yet devised and as a result, get more use than most other tools in the toolbox.

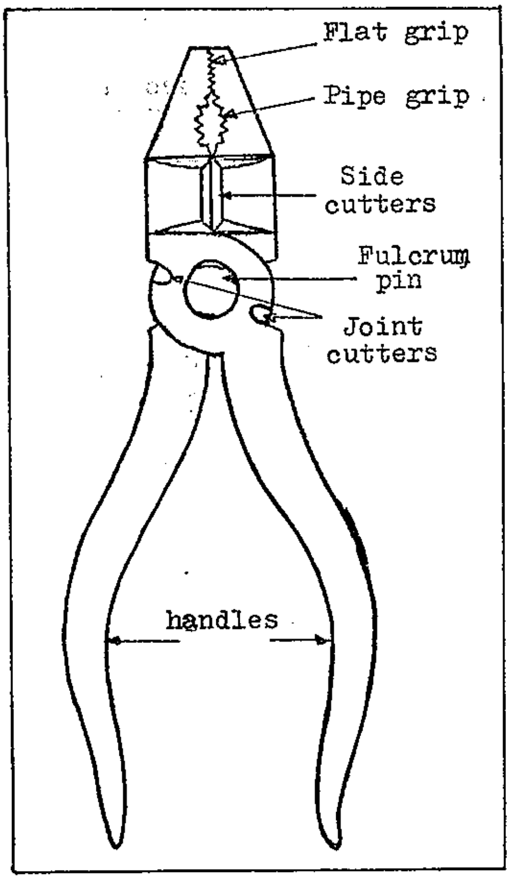
Description - starting from the top:-

Flat grip - the nose of the pliers have parallel serrated faces. This gives a flat grip for small items and wires.

Pipe grip - next there is an oval surface with a much coarser serrated surface. This is used to grip round surfaces.

Side cutters - next comes a set of blades, recessed at the back for cutting soft wire etc. Quality of a pair of pliers can be judged to some degree by holding these blades up to a light and seeing if there is an even, narrow gap.

Joint cutters - on the outside of the jaws, above and below the fulcrum, there is a slot cut into the side of the pliers. When opened, the slot on each side match up. If a piece of wire is put into this complete slot, on closing the jaws the wire will be sheared off, as with a guilotine.

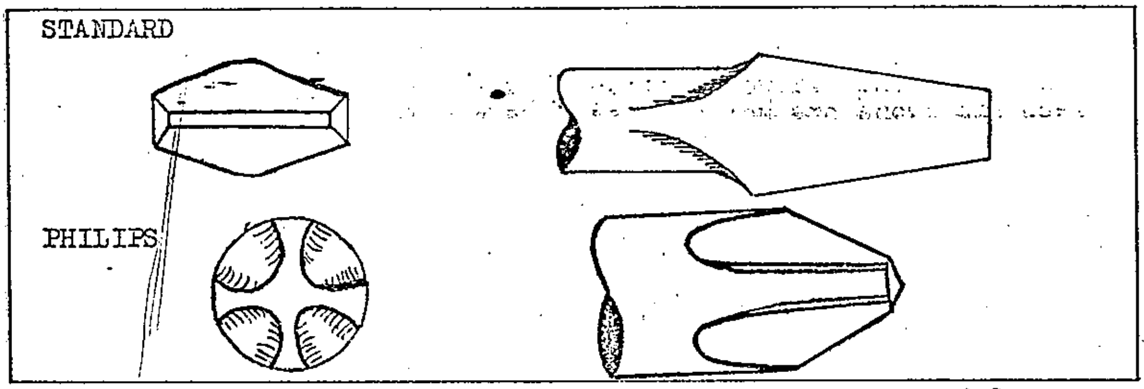


Material -

As described previously, pliers are a very versatile tool and consequently wear out very quickly at the fulcrum and become "sloppy", so to buy a cheap pair of pliers is much false economy. When buying pliers look for a good name, a good material; for instance, drop forged alloy steel. Price is usually a good indication. To check, take one handle in each hand and rock in opposite directions - any sign of side movement is bad. Note:- pliers should never be used to tighten or undo nuts at any time.

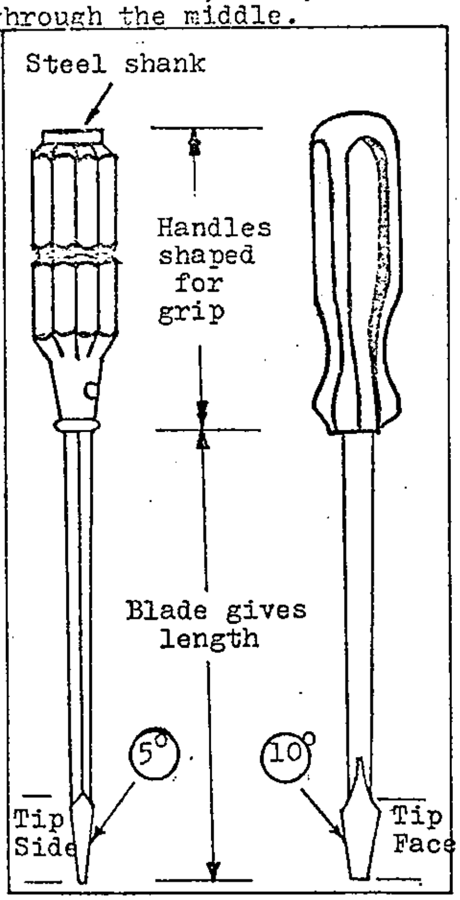
Part 2 - Screwdrivers

Screwdrivers are used to tighten or loosen screws. The two main types in general use are Standard and Philips. The names refer to the tip of the screwdrivers.



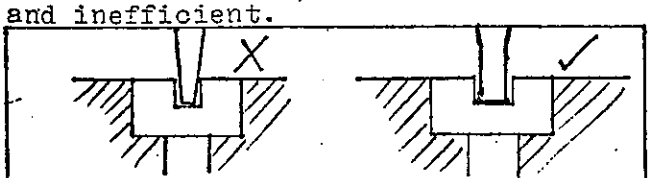
There are several more makes by particular firms for special uses, such as Pozidriv, Frearson clutch head etc. But these will rarely be encountered.

Handles - Screwdrivers are made with handles of metal, wood, moulded insulating material, or wood with metal through the middle.



Blade - the length of the blade gives the size of the screwdriver and can be either square or round and made ideally of hardened and tempered carbon or alloy steel. They vary in length from 40mm to more than 350mm.

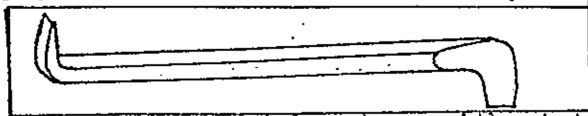
Tips - may be flared or parallel and usually vary in thickness with length and thickness of blade. Two exceptions are the "dumpy" screwdriver and the long thin electrical screwdriver. The tip should be hollow ground so that the turning motion is applied to the bottom of the slot. If the tip is tapered, then the screwdriver tries to ride up and more downward pressure must be applied to counteract this, which increases the effort required, the danger of personal injury, and damage to the work piece. Also, the effort is applied to the weakest part of the slot. The width of a screwdriver tip should be between 3/4 and 7/8 the length of the slot of the screw, any bigger will tend to damage the work piece, smaller will damage both screw and screwdriver. The tip should be square on all corners and flat along the bottom. If it is allowed to become rounded, then it is dangerous and inefficient.

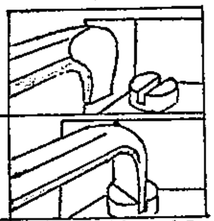


Special types of Screwdrivers

Socket Set Screwdriver Heads - most socket spanner sets have a screwdriver head included. These should only be used on large size screws or slotted bolts, as the leverage that can be applied would shear most screws.

Offset Screwdriver - used where a screw cannot be reached from above, double ended with tips at right angles so that when one end can't reach, the other can.





Ratchet Screwdriver - gives quick return without taking the blade off the screw.

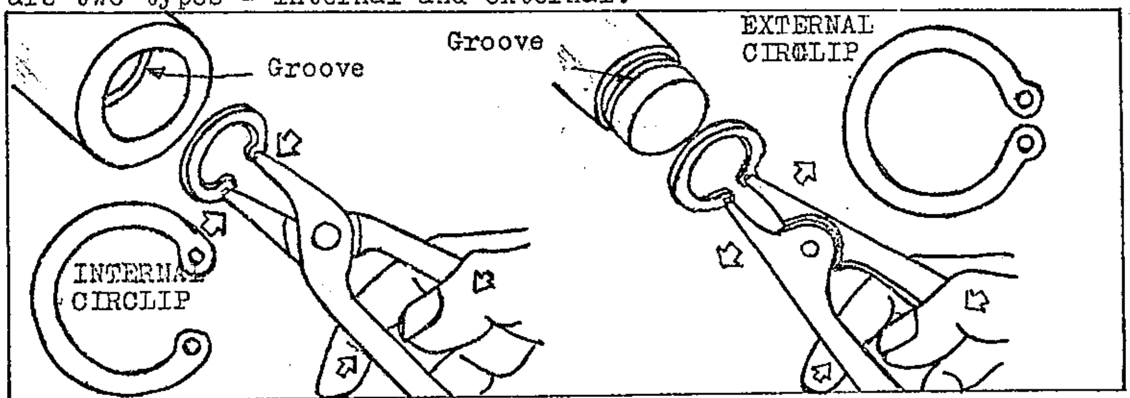
Spiral or Yankee Screwdriver - converts downward motion to turning motion, also incorporates a ratchet.

Impact Screwdriver - as above, but short and strongly made, with a short travel. Downward motion is produced with the aid of a hammer.

Part 3 - Circlip Pliers

Circlips

A circlip is a device for using a slot to prevent movement. There are two types - internal and external.



Circlip Pliers are especially designed to remove circlips. There are two types to correspond to the two types of circlip.

Compressing - with this type, closing the handles also closes the jaws, for internal circlips.

Expanding - with this type, closing the handles opens the jaws, for external circlips.

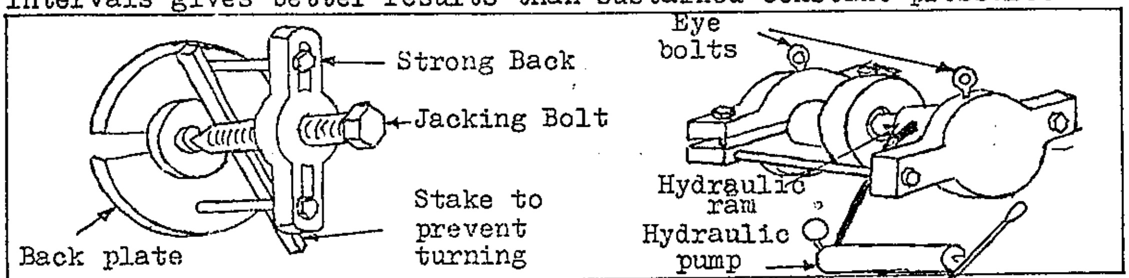
Jaws - both types have jaws, which consist of round, slightly tapered tips of small diameter.

M2/6/1

TITLE:- GEAR AND BEARING PULLERS
LECTURER:- GERRY HEUNIC
DATE:- 7-5-81
EQUIPMENT:- Various gear and bearing pullers

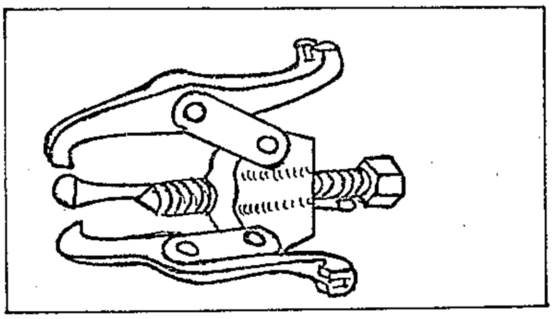
From the lecture on fits and tolerances we see that many items are fitted very tightly. Some common examples are - Bearings, Couplings, Fans, Gears. To remove such parts various methods are used. Some of the most common are covered below.

Types of Pullers
Most methods use the system in which a slotted back plate is placed behind the item to be removed. A strongback or slotted steel bar with a large, fine threaded and pointed jacking bolt through the centre is bolted to this plate. The jacking bolt is tightened onto the shaft. The back plate is staked to stop it rotating. Tightening of the jacking bolt will pull the item off the shaft. A smear of grease on the point of the jacking screw helps considerably to cut down friction. A sharp blow to the head of the jacking screw at intervals gives better results than sustained constant pressure.

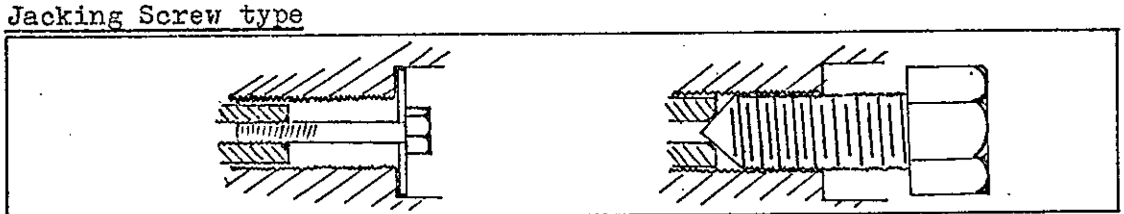


A variation of the same method is for the screw to be replaced by an hydraulic ram. In the illustration the back plate is this time a split type which bolts together on the side. Note the eye bolts on the front and back plates. With large items, the front and back plates can weigh several Kg. and should be supported by a crane, so that when the part comes off, the whole lot won't fall to the floor, and be damaged.

Bearing Puller This consists of three legs, double pivoted to a centre body and the usual jacking screw. The lip of the legs grip the outside of the bearing, and turning the jack screw increases the grip.
This type is very useful where space is limited.



Jacking Screw type



When fitting the part, a relatively small bolt screws into the shaft and pulls the part in place by means of a large washer butting up against the part.
To remove - a much larger bolt screws into the part to be removed and pushes against the shaft. This type is used where an easily damaged item has to be fitted such as an alternator pilot exciter armature.

TITLE:- HYDRAULIC AND SCREW PRESSES

LECTURER:-

DATE:-

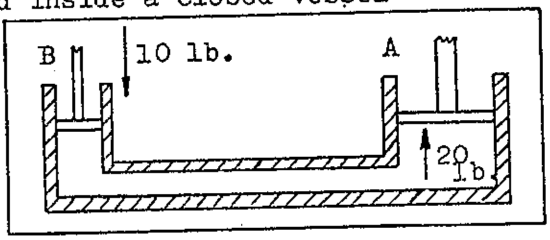
EQUIPMENT:- Hydraulic press, screw jack

In many instances of repair work or manufacturing jobs, high pressures are required to remove or re-fit, to bend or straighten items of equipment. Occasionally a large hammer would be sufficient, but where damage must be avoided, or where the use of hammers is restricted, other less violent methods of exerting a force must be used. Hydraulic or screw jacks, rams, or presses are used.

Hydraulic equipment

Hydraulic equipment uses the principles:-

1. That liquids are incompressible.
2. That the pressure of a liquid inside a closed vessel is constant throughout.



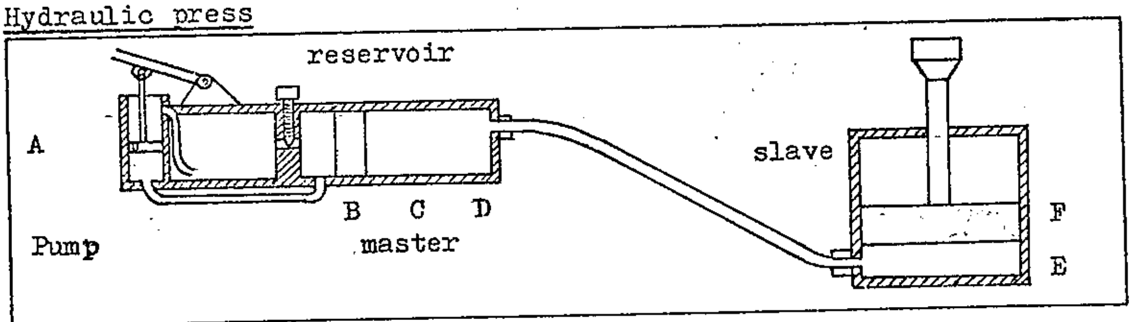
Consider the simple arrangement of the hydraulic machine shown. Piston A has an area which is twice that of piston B. If a pressure of 10 lb. is exerted on piston B having an area of 10 square inches, the force will create a pressure of 1 lb. per square inch in the liquid. This pressure is also exerted to ALL surfaces inside the machine. i.e. 2 pressure of 1 lb. per square inch will be exerted on piston A. Because the area of A = 2 x area of B = 20 square inches, the force on the piston will be 20 lb.

We have effectively increased force from 10 lb. to 20 lb. Any ratio of pressure may be achieved by varying the piston sizes. It should be remembered that the distance moved by piston A will be less than the distance moved by piston B.

The piston to which the initial pressure is applied is usually termed the MASTER, and the other piston(s) are termed SLAVE pistons.

In practical applications, the master and slave pistons and their cylinders are placed some distance apart and connected with a pipe or hole which must be sufficiently strong to withstand the high internal pressures.

Hydraulic press



A typical hydraulic press is shown. A pump (A) is used to pump the liquid (oil) into the master cylinder B. Piston C moves causing pressure in chamber D & E, which in turn causes piston F to rise.

Pressure is released by turning screw G which allows oil to return from chamber B to the reservoir.

This is a 3-stage press using 3 sizes of piston to achieve a higher pressure change. Typical figures could be that a 10 lb. pressure on the pump lever could cause a 10 Ton thrust on the slave piston.

Because of the high pressures involved, hydraulic gear can fail, or cause other components to fracture whilst in use. Follow these rules for your own safety and for the safety of others.

1. Check equipment for damage or loose fittings before use.
2. Do not lift loads in excess of the rated load of the press.
3. Display warning signs where equipment is being used.
4. Do not stand in front of motor shafts etc. when hydraulic gear is being used to remove pulleys, couplings, bearings etc.
5. Ensure that associated equipment (bolts, strong backs, back-plates etc) can withstand the applied pressures.
6. Do not work under a load supported by hydraulic jacks etc.
7. Release pressure slowly when work is completed.

Screw operated presses.

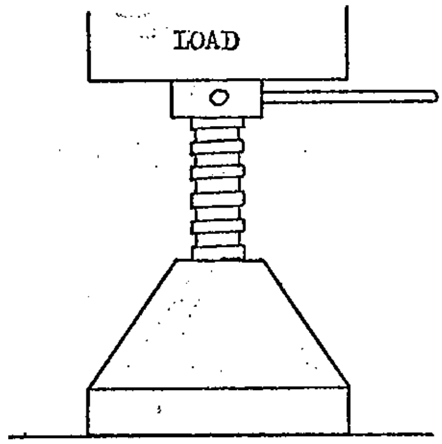
A screw thread is used to exert pressure along its axis as with a vice or a set screw. The force which can be exerted is many times greater than the force required to turn the screw.

A screw jack as illustrated has a handle 10" long, and a force of 10 lb. is applied to that handle.
In one revolution of the handle, the screw lifts the load by $\frac{1}{4}$" i.e. the screw has a pitch of $\frac{1}{4}$".

The work done in turning the handle is:-
Force x distance moved

i.e. 10 lb. x $2\pi r$ = 10 x 6.284 x 10
= 628.4 foot lbs.

The work done in lifting the screw thread is also:-
Force x distance moved
i.e. 628.4 = $\frac{1}{4}$ x force
force = $\frac{628.4}{\frac{1}{4}}$ = 2513.6 lb



SCREW JACK

i.e. the force has been increased from 10 to 2513 lb.

The screw press works on the same principle, but the screw is held in a framework which must be rigid enough to withstand the pressures exerted.

TITLE:- LIFTING TECHNIQUES

LECTURER:-

DATE:-

EQUIPMENT:-

Whether at home or at work, it will always be necessary to lift or move objects of various shapes and weights. Without using the proper lifting techniques, serious injury can result. By observing some simple rules, these injuries may be prevented.

Weight Don't under any circumstances attempt to lift large or excessively heavy objects alone - get help.

The industrial code sets down limits of weights that male and female employees may lift.

Female under 16 years	- 9 Kg.	(19.5 lb)
Female 16 to 18 years	- 11.5 Kg.	(25 lb)
Female over 18 years	- 16 Kg.	(35 lb)
Male under 16 years	- 14 Kg.	(30.5 lb)
Male 16 to 18 years	- 18 Kg.	(39.5 lb)
Male over 18 years	- No limit	

Grip Articles should be gripped using the palms of the hand in preference to fingers to prevent slipping. If the load has sharp corners or projections or is made of rough timber - wear leather gloves.

Use packings under boxes so that fingers don't become trapped.

Stance It is essential that the feet are placed apart to give balance but not so far apart as to cause strain on the groin and possible hernia.

Make sure that the ground is free of loose objects which may cause stumbling or slipping.

Lifting

Lifting is dome with the legs - not the back.
Bend the legs so that the body is low and in a squatting position.
Position hands under the load so that arms are straight.
Keep the back straight.
Straighten legs to lift the load.

The same principle applies when lifting from bench height. Do not over reach, keep the spine straight.

Where a load exceeds the capabilities of lifting by one person, obtain assistance or use a mechanical lifting device.

When more than one person is involved in a lifting operation, it it absolutely essential that those persons, perform the lift in unison.

Each person should take an even share of the weight. Serious injuries to the spinal area and hands can occur when one person is required to over exert himself by lifting more than his share of the load.

All persons involved in a lifting operation should indicate when they are ready to make the lift. This enables the lifting operation to be carried out with precision and a minimum of effort.

TITLE:- CRANES & MECHANISED HANDLING EQUIPMENT

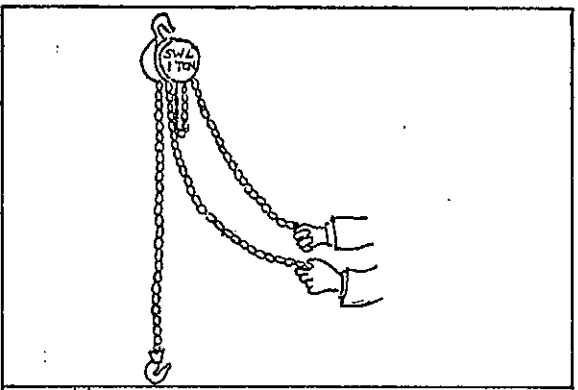
LECTURER:-

DATE:-

EQUIPMENT:- Pulley block, Hydraulic lift

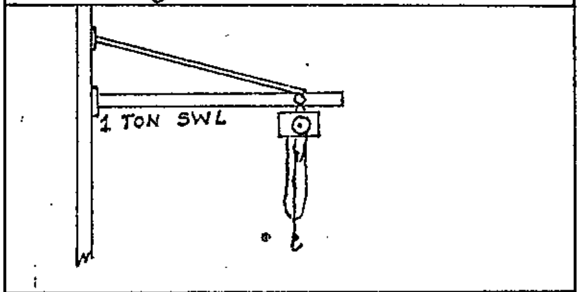
Pulley Blocks:-

These are marked to show their safe working load (S.W.L.). This figure MUST NOT BE EXCEEDED. They must be rigged from specified beams, not roof trusses or other insecure points. Lift only when the hook is fully engaged with the load. NEVER use the point of the hook only.

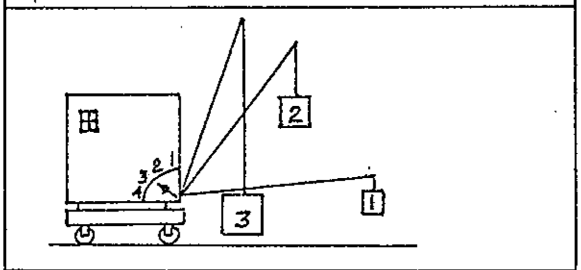


Jib cranes:-

Jib cranes are marked to show their safe working loads. Check the S.W.L. of the hoist because it may differ from that of the jib. Work to the lower figure.

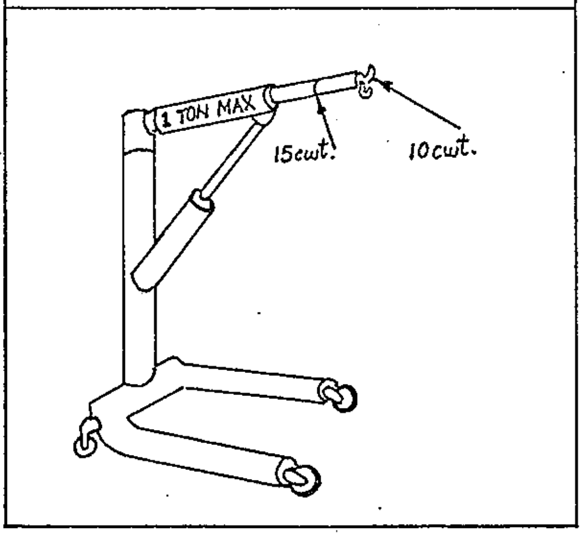


The steeper the jib, the greater the S.W.L. An indicator shows the S.W.L. at each angle of the jib. Always refer to it.



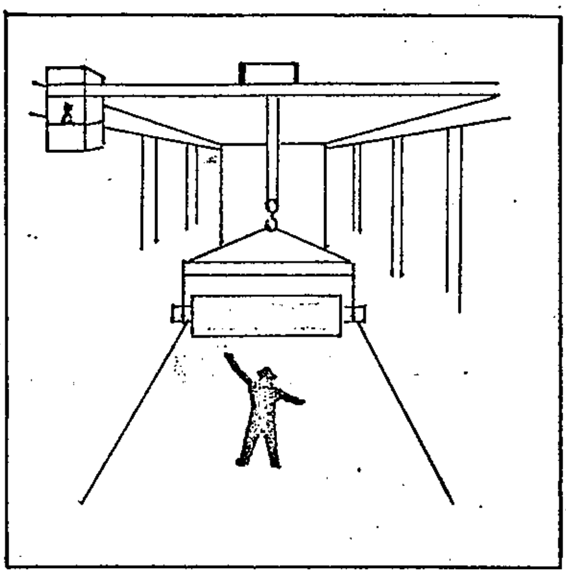
Hydraulic Lifts:-

Look for load figures or marks on the telescopic beam. A portable 1 ton hydraulic lift will raise only 10 cwt. at full extension.



Overhead travelling crane:-

When these are fitted with a driving cab, they must be operated by a trained driver. He works with trained slinger. Smaller travelling cranes are operated from ground level by an AUTHORIZED person, using a suspended push-button control box. All lifts must be in charge of one man, and he shall transmit STANDARD SIGNALS to the driver. If irregular or confused signals, or signals are being made by more than one man, a crane driver shall ground the lift until he ascertains who is in charge of the lift and signals are given by that man.

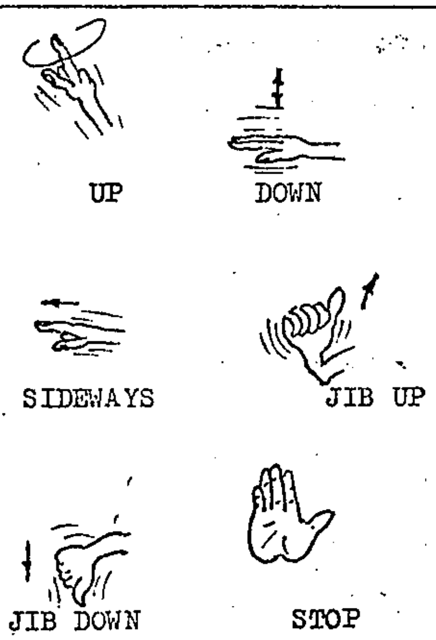


Safety:-

The most frequent cause of injuries, arise through the practice of men grasping a load about to be landed, or, retaining a hold of the load or sling, when the crane is tightening up the sling. This is a critical point in the safe operation of cranes. It is not a safe practice to handle a load until all movement has stopped.

If it is necessary to control movement, the safest practice is to use a piece of timber or a guide line.

The second important safety point involves the feet, which are injured through standing too close to a load as it lands; this is due to a load "spreading" as it settles on the ground. Movement about crane runways is hazardous and nobody is permitted to climb to a runway before notifying the driver of his intention and receives the driver's permission. Finally, NEVER walk under any suspended load, because the impetus of a pulley block has caused fatal injuries.



STANDARD HAND SIGNALS

TITLE:- SLINGS

LECTURER:-

DATE:-

EQUIPMENT: Endless wire sling, double ended sling, dee shackle, eye bolt, length of hemp rope, short lashing chain.

Types of slings and their uses
There are three main categories of sling - (1) Manila or Sisal fibre rope slings, (2) Steel wire rope slings, (3) Steel chain.

Manila Slings are generally used because of their lightness and suppleness which make them very convenient, but they are very limited in the weight they can safely lift. Also, they are seriously affected by sharp corners and heat, and must not be used on work over 67°C. Chemicals also can have a detrimental effect on rope slings, so, before using one, check that it has no strange marks or signs of rot anywhere in the sling. Open up the strands and check for broken strands or powder like dust which are signs of internal wear. Ideally, the inside should be as bright and clean as new.
Remember, a welding spark can burn right through a manila sling.
Never pass near to someone welding or grinding with an item slung on a Manila sling or weld an item whilst it is slung on a Manila sling. In fact, only use Manila slings as a last resort, as a guid rope, or where an item is to be manoeuvered rather than lifted.
Types of Manila sling obtainable are:- the endless sling or strop, the double ended sling, and guide rope.

Double ended sling — Endless sling or strop

Note:- A direct lift, using a reaved double ended rope sling 63.5 mm Circumference (2"), should be no more than 200 kg. (4 cwt.)

Steel wire rope slings - similar to manila slings, except that they are made of wire rope of 6/24 construction, that is to say, there are 6 "lays" of 24 strands of wire rope each surrounding a hemp core. Each lay in turn has also a hemp core. The more strands per lay - the more flexible the rope is.
Sling ropes are constructed from 80/90 tensile strength steel.
Using Although much stronger and more robust than fibre rope, it is subject to damage from sharp edges, therefore sharp edges must be packed with soft material such as wood.
It is susceptible to rust, abrasives, molten metal, corrosives and any heat over 93°C.
Inspection Look for broken wires, no more than 15 for a length of 8 times the diameter of a sling, that is ten per cent of the total number of wires. Any under sockets require immediate attention.
Wear - No more than 33 per cent of the diameter of the outside wires.
Corrosion - Particularly dangerous near sockets. It is more dangerous than wear, as it penetrates the wire. Salt water corrodes steel quickly.
Damage - Crushed or jammed strands, dangerous due to deformation placing strands under excess load.
Kinks also weaken a sling.
Splices, look for stretching or corrosion.

<u>Lubrication</u> - ropes are lubricated by the hemp core, they tend to dry out. They can be lubricated by first cleaning by scrubbing and then soaking in warm viscose oil.

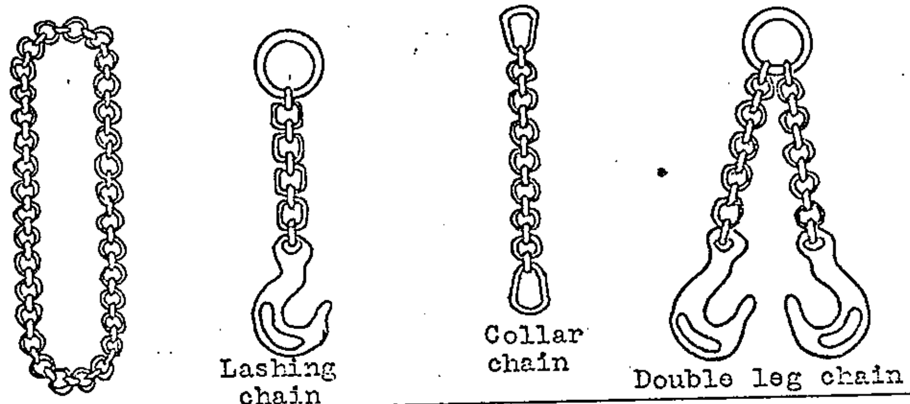
<u>Types of steel wire rope slings</u> - Endless, double ended and "lashing" (a long straight length).

<u>Gloves should be used at all times when handling steel wire rope slings.</u>

<u>Chains</u> are the most durable of the lifting devices, tending to be less effected by heat, wear and sharp edges. They are used where objects have sharp corners and for rough usage, such as handling plates, beams etc., and are also capable of handling hot jobs up to 260°C. and even higher but their capacity must be taken to be only 2/3 of their normal capacity.

<u>Disadvantages</u> - A steel chain; when it breaks, will snap without warning; they give no sign of overloading at all. Care must be taken that links do not lodge or get twisted, then straighten out with a jerk at an inapportune moment.

<u>Types</u> - Steel chain slings are made up in a variety of different shapes and forms and can be used in a wide variety of combinations with special lifting devices. A few of the different chain slings are shown. "A" is an endless sling, "B" a single chain or lashing chain, "C" is a buckling chain or collar chain and "D" a double leg chain. Three and four leg slings are also made in which three or four chains and hooks hang from one ring.



<u>Rigging Aids and Special Purpose lifting devices</u>
There are nearly as many special purpose lifting devices as there are objects to be lifted, so here we will only deal with the more common ones.

<u>Shackles</u> - These are used to connect slings to eye bolts, holes in jobs, connecting slings for lengthening purposes or to couple slings together which would be too bulky to place in a crane hook.

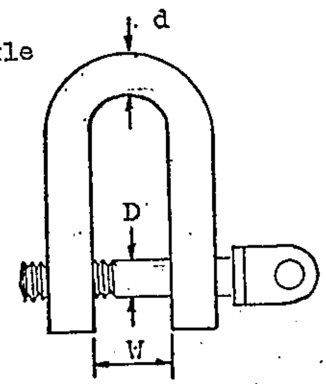
Shackles must not be:-

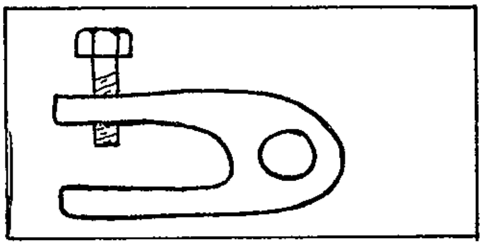
1. Repaired
2. Welded
3. Rebent to original shape
4. Substitute bolts or pins must not be fitted.

Defective shackles must be REPLACED.

d	D	W	SWL	
Ins. mm	Ins. mm	Ins. mm	Tons	Cwts.
5/8	3/4	1 1/4	1	2
3/4	7/8	1 1/2	1	12
7/8	1	1 3/4	2	5
1	1 1/8	2	3	-
1 1/8	1 1/4	2 1/8	3	15
1 1/4	1 3/8	2 3/8	4	10
1 3/8	1 1/2	2 5/8	5	10
1 1/2	1 5/8	2 3/4	6	10
1 5/8	1 3/4	3	7	10
1 3/4	1 7/8	3 1/4	8	10
1 7/8	2 1/8	3 5/8	11	

'd' shackle





Screw Grab This is a "G" clamp type arrangement with a hole drilled in it to allow it to be attached to a sling by way of a shackle. It is invaluable in handling fabrications and is useful because it can be so easily moved to change the balance of an object.

Eye bolts are used to screw into tapped holes in machine tools and any object which has a suitable tapped hole. A typical example is the electric motor which nearly always has a tapped hole in the centre of the top of the carcase.

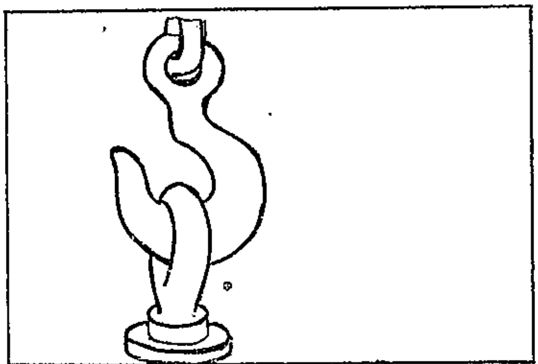
Types There are two types, plain and collar.

The plain eye bolt should be used for vertical lifts only.

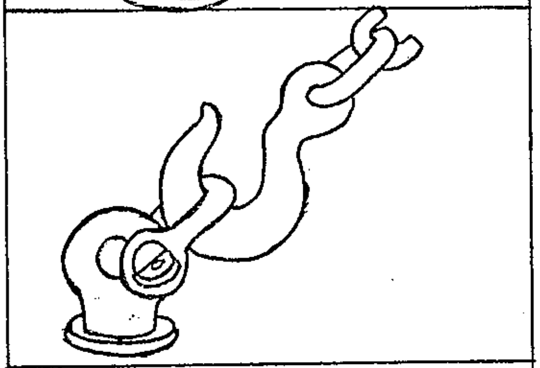
The collar type is designed to prevent bending if side loading is applied. A collar is machined above the thread. The seating upon which the eyebolt is tightened should also be machined.

The Collar type is split up into three separate kinds:-

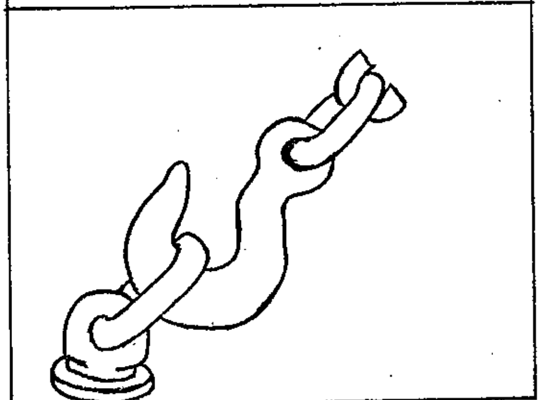
Diamond Eyebolts:-
This eyebolt, (1) has an eye large enough directly to take a hook of comparable safe working load. It should be used ONLY FOR AN ACCURATE VERTICAL LIFT.



Service Eyebolts:-
A "service eyebolt" (2) should be used for inclined loading; here the eye is too small to take the hook direct, and a shackle must be used.



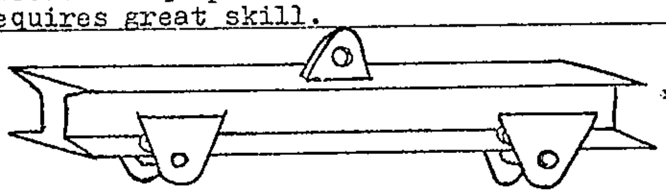
Eyebolt with link:-
In this type of eyebolt (3) a link is permanently attached to the eye, the link being able to take the hook direct. This arrangement may be used for inclined loading.



Note:- Eye bolts must not be used unless stamped with the S.W.L. (safe working load).

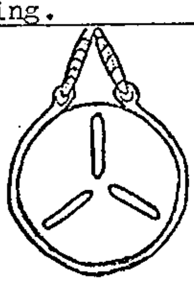
NOMINAL SIZE OF EYEBOLT	SAFE LOADS FOR EACH EYEBOLT AT VARYING ANGLES IN TONS & CWTS.							
INS.	TONS	CWT	TONS	CWT	TONS	CWT	TONS	CWT
$\frac{1}{2}$		10		$5\frac{3}{4}$		$3\frac{3}{4}$		$2\frac{1}{2}$
$\frac{3}{4}$	1	8		16		$10\frac{1}{2}$		7
1	2	15	1	11	1	0		$13\frac{1}{2}$
$1\frac{1}{4}$	4	10	2	11	1	13	1	2
$1\frac{1}{2}$	6	10	3	14	2	8	1	12
$1\frac{3}{4}$	9	0	5	2	3	6	2	4
2	12	0	6	16	4	8	3	0
$2\frac{1}{4}$	15	0	8	10	5	10	3	14
$2\frac{1}{2}$	20	0	11	7	7	7	4	19
3	30	0	17	0	11	0	7	8

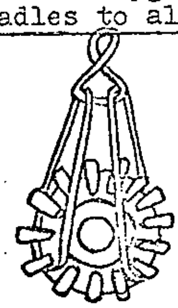
Lifting Beams are used to lift long slender jobs which would bend or cause the angle of sling to be too great to allow safe handling. Also used where large ungainly loads have to be lifted or, more important, lowered into position. Lifting beams can be complex pieces of equipment and correct use of them requires great skill.



Cradles These are generally made up to suit a specific job and can be made to suit most types of jobs which are either awkward to handle or safer to handle with a cradle. Cradles are used extensively to handle lathe chucks which are difficult to sling safely in the vertical position. They are also often made up to carry races and gears etc. which have to be handled hot. Oxygen and acetylene cylinders are also handled in special cradles to allow faster and safer handling.

Chuck Cradle



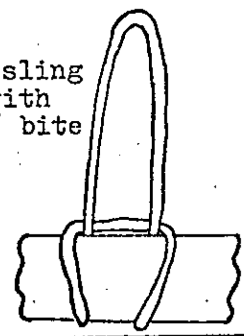


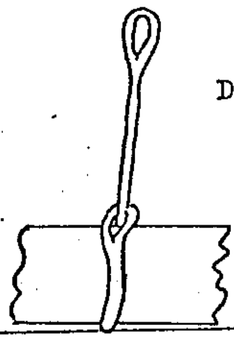
Mitre Cradle

Slinging Techniques

When a sling is fed through itself to give "bite" onto an object, or is what is known as reaved, then the safe working load of the sling is halved. Always check SWL of sling against weight of object, remembering above.

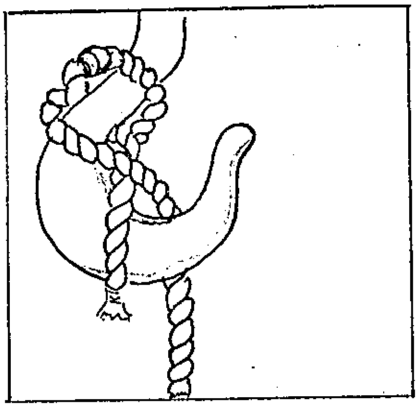
Endless sling reeved with a single bite





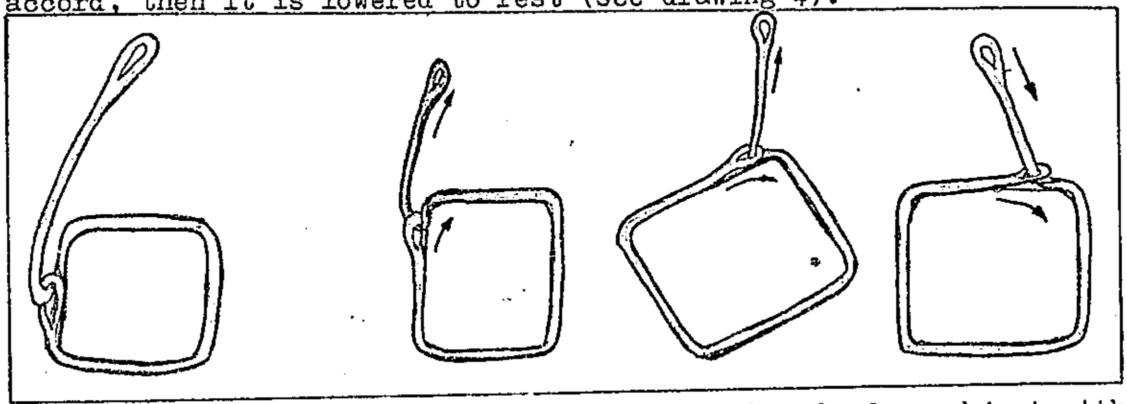
Double ended sling reeved with a single bite

Double Blackwall Hitch

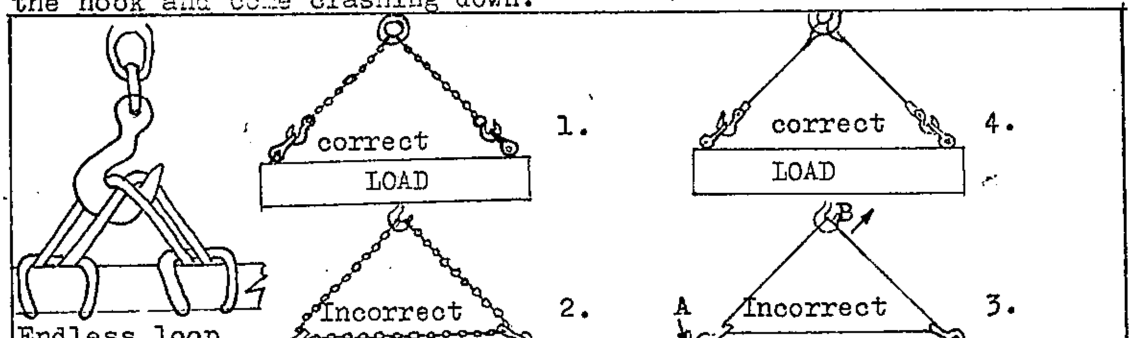


Where a loose end of a sling is to be fastened to a hook, then the "Dead" end of the sling is put over the hook. The "Live" (end going to the load) end is wrapped over the dead end, round the hook twice then fed over the hook in the opposite direction to the dead end. See illustration.

Turning a shaft using a sling A double ended sling is wrapped round the item to be turned, twice. The end which comes round in the opposite direction to the direction of turn is fed through the other loop. This loop is then nocked up tight to the shaft as shown below in drawing 1. The sling is then lifted - drawings 1 to 3. If the item is of irregular shape or will continue on its own accord, then it is lowered to rest (see drawing 4).



When a single endless loop is attached to each end of an object with either a bite or shackles, it must be crossed in the hook to prevent it from slipping. Never feed through two shackles and then onto the hook, it only needs the load to strike something at A in the diagram 3 below, for the load to slide vertical, pull the loop B off the hook and come crashing down.



Endless loop crossed in the hook

Where slings over fill the hook, couple them together with a shackle and then place shackle in the hook. Always ensure that the spring loaded safety catch on crane hooks, where fitted, is in its correct position, over slings before taking a lift.

Balance is of the utmost importance and it must always be ensured that a load is in perfect balance before the full weight is taken. After the load is slung, have the crane just take the weight, then check the balance and security of slings, tighten bites at this time. Lower and adjust slings and repeat until perfect balance is acquired.

Slings must be protected at sharp corners with soft packing or rounded hard packing.

Always ensure suitable dunnage is provided in new locations to ensure adequate clearance for the removal of slings before positioning load. When lowering load, make sure they clear the dunnage and where possible, have dunnage inside slings to allow slings to be slipped off the ends of the job.
Avoid pulling slings from under loads with the crane and remember wire slings are very springy and may fly out when nearly clear of the load.
Only ONE, 1, person is to direct the crane. Always tell the crane chaser what you want and allow him to direct the crane. If, as a tradesman you wish to direct the positioning of an intricate job, inform the crane chaser and crane driver to ensure that you have complete control - several persons directing the crane only confuse the driver.
Home made gear is not to be used without approval from the crane engineer.

TITLE:- MAINTENANCE OF TOOLS

LECTURER:-

DATE:-

EQUIPMENT:

Introduction - There are two factors which affect the ability of a tradesman or apprentice to carry out his job in an efficient manner to produce a top quality performance.
They are knowledge and skill in the use of tools. Knowledge of the trade is gained by education and experience. Skill can be learned from experience and other persons in the trade, or it can be a product of the tradesman's or apprentice's own thought and initiative. However, if a person is to perform skilfully with his tools of trade, then those tools must be in excellent condition all of their working life. A second-grade tool or one in poor condition will produce a low quality job. Therefore, it is essential that a tool kit be maintained properly in top condition to enable a job to be carried out effectively.

Storing Tools - The first requisite for keeping tools in good condition is that they be stored properly. A suitable toolbox or cupboard will provide sufficient room so that the tools are not packed on top of each other, thus causing damage.

Files - Use a file card regularly to clean a file, to prevent "pinning". Do not store files on top of each other as the teeth will be blunted and render them useless. Ensure the handle is free from splits and splinters - a light sanding and a coat of linseed oil will preserve the handle.

Marking-Out Tools - Scriber, steel rule, dividers, square, vernier caliper, punches - because of their fragility, these tools must especially be treated with care and not roughly used or stored.
When finished with a scriber, ensure that it is replaced in toolbox with the point either covered or, in the case of a pocket scriber, the point replaced in its sleeve. Should the point become blunt or broken, it can be sharpened on a suitable grinding wheel and then finished off on an oilstone.
Steel Rules should be kept in a plastic sleeve when not in use - if it is not stored properly, the edges can become rounded and the graduations can be erased.
As in the case of a scriber, dividers can be sharpened on a grinding wheel and then an oilstone. When storing dividers, ensure that the points are suitably covered (plastic, rubber, cork).
A vernier caliper is an expensive, delicate and accurate tool, and special care must be taken to maintain it in top condition. When storing a vernier caliper -

(1) Keep it in a protective plastic pouch.
(2) Never close the jaws - heat expansion will cause it to be inaccurate.
(3) Keep it free from dust etc.

A light smear of oil is necessary on the slide from time to time to ensure a free moving caliper.
Making out tools can be stored in a toolbox on a lightly oiled felt pad to prevent them from rusting.

Spanners - to keep spanners in good condition, use them in the correct manner and when not in use keep them in a suitable box or spring clip.

Pliers & Sidecutters - use in the proper manner (e.g. do not use pliers as a spanner) and oil the centre pivot regularly.

Knives - replace the blades in their sockets when not in use. They can be sharpened on a grinding wheel but it is preferable to use an oilstone to give a sharp, keen cutting edge.

Screwdrivers - Should a screwdriver point become damaged, then it can be restored by filing with a suitable fine grade file. Avoid grinding, because the tip may overheat and lose its hardness.

TITLE:- BENCH DRILLING MACHINES

LECTURER:- GERRY HEYNIS

DATE:- 13-3-81

EQUIPMENT:-

Introduction - a drilling machine is a device used in a workshop for the purpose of drilling holes in various materials, of all shapes and sizes. Use in the correct manner and with the appropriate accessories, a high degree of accuracy and finish can be obtained on drilling work, thus saving time and manual effort, with less need for excessive filing and hacksawing.

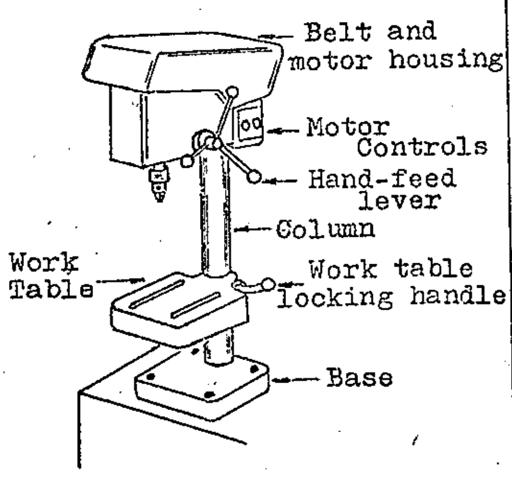
Parts

(1) Head - this is made up of several parts -
- (a) the motor and belt housing - in some cases a gearbox is provided in place of belts and pulleys to give various speeds.
- (b) motor controls - usually a push button stop and start control. In the case of a gearbox type machine, a selector switch is also provided to select the different speeds.
- (c) spindle and chuck - the part which does the actual "work". The spindle is driven either by belted pulley or a gearbox and the chuck is fitted onto the spindle, allowing a twist drill to be placed in the chuck and rotate when switched on.
- (d) Hand feed lever - moves the spindle and chuck vertically which in turn feeds the twist drill into the material. The lever has a spring return, allowing the spindle to resume its normal position when not in use.

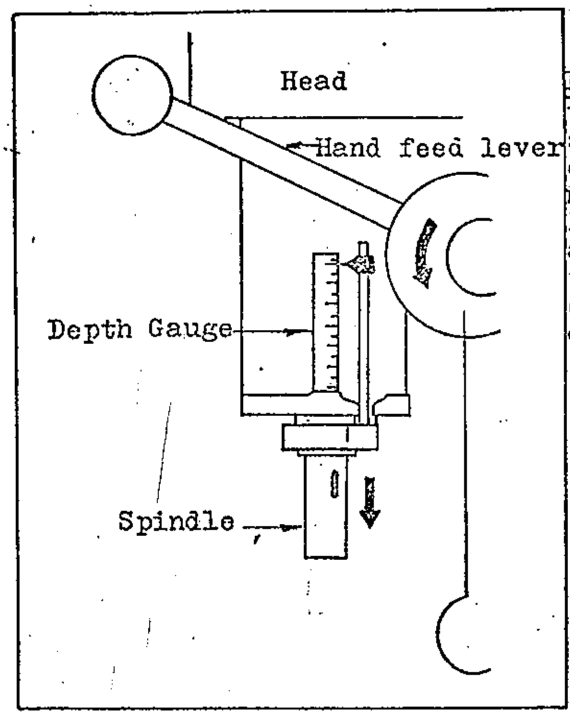
(2) Column - a large diameter shaft which supports the head to the base.

(3) Base - large, strong plate which is bolted to a bench or onto the floor to stabilise the machine.

(4) Work Table - a machined-surface plate on which the work is placed. It is clamped to the column by a locking handle and can be moved vertically along the column to any desired position. Slots are provided in the table to allow the clamping of work onto it (heavier drilling). When adjusting the height of the work table, ensure that the drill is not the chuck nor is there any workpieces on the table - the weight of the table makes it difficult to support it and a vice with a workpiece in it. A locking ring on the column will assist in adjusting the table height.



BENCH DRILLING MACHINE



Depth Gauge - where it is required to drill a "blind hole" to a specified depth, the depth gauge can be used. A graduated scale is mounted on the main body of the Head. A pointer, which is attached to an arm, which is in turn connected to the spindle, enables the operator to see the distance travelled.

Changing Speeds - on the belt driven machines, there is a certain procedure to be followed when changing speeds.

(1) Switch off power supply - accidental switching on while changing belts could result in loss of fingers etc.
(2) Release the belt tension locking screws.
(3) Select the desired pulley and place the belt in position.
(4) Adjust the tension of the belt and lock the screws.
(5) Replace cover.
(6) Switch on and check the speed.

TITLE:- LATHES
LECTURER:- CRAIG, JEFFY, SMUS, TREV, ME, SMITHY, STEVE
DATE:-
EQUIPMENT:-

Introduction -

The lathe, while being the most important machine shop tool, is also one of the simplest in construction. The function of the lathe is the removal of material by means of a suitably formed cutting tool. The general lathe operations are straight turning, facing, taper turning, drilling, boring, reaming and thread cutting.

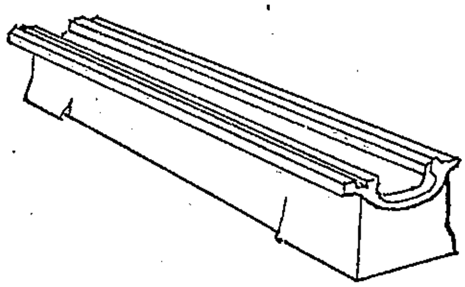
Special lathes of a variety of patterns and sizes are made for different kinds of work, the most notable example being the turret lathe, which is used for quantity production.

Parts of the lathe -

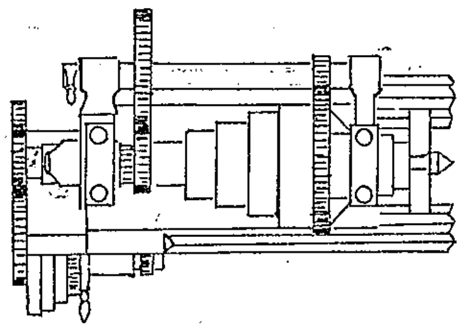
The lathe is comprised of six essential features -

(1) The Bed
(2) The Headstock
(3) The Tailstock
(4) The Carriage
(5) The Feeding mechanism
(6) The Thread cutting mechanism.

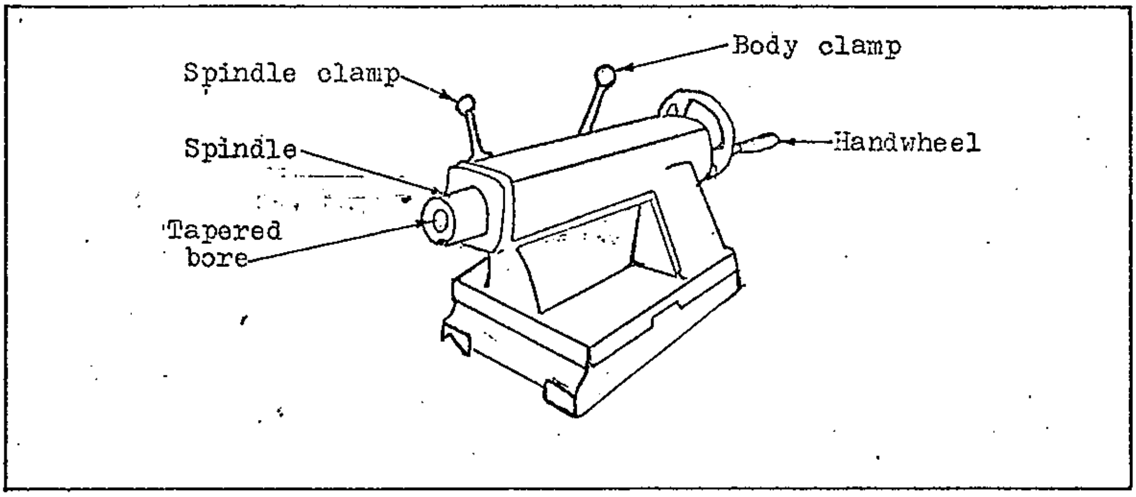
The Bed:- A strong casting which is a base for supporting and aligning the rest of the machine.



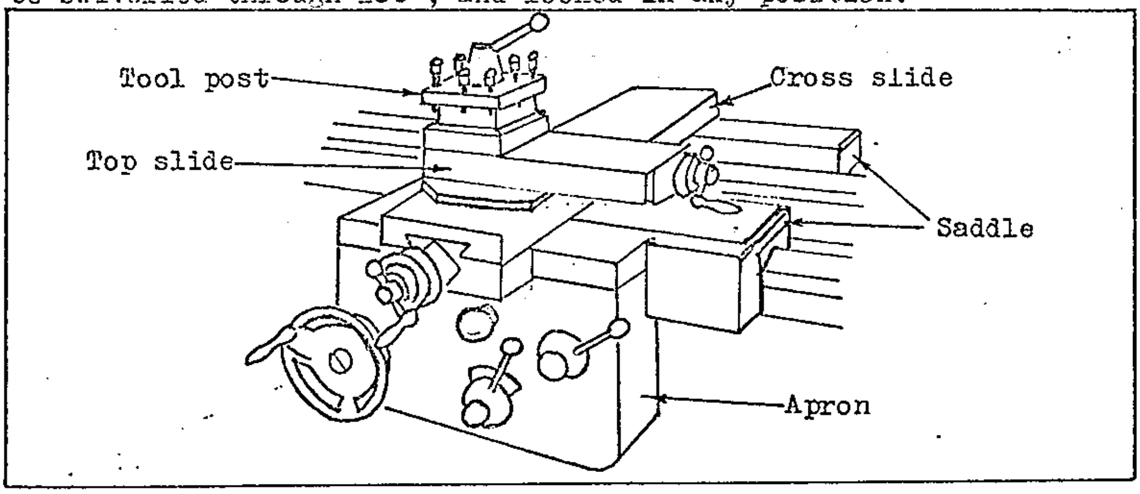
The Headstock:- This is the driving end of the lathe and consists of a strong casting which forms the support for a pair of accurately bored bearings whose axes are exactly parallel to the ways of the lathe. These bearings mount a true running hollow spindle, which enables long work to be held short in the lathe.



The Tailstock:- This is situated on the right hand when facing the lathe. Its function is to support the bearing for one end of work, turned between centres, and to mount tools for certain operations such as drilling, reaming and tapping. The tailstock may be clamped in position anywhere along the bed, by a clamping arrangement. There is no vertical adjustment of the tailstock, but it may be adjusted transversely by means of adjusting screws.



The Carriage:- This is the unit which carries the cutting tool. It includes the saddle, apron, compound rest & tool post, and is moved at uniform speed along the lathe bed. The saddle is in the form of the letter H, and is bridged across the lathe bed to carry the cross slide and tool post. Attached to the front wing of the saddle is the Apron, which carries the mechanism which engages the feed mechanism to drive the carriage.
On top of the saddle, is the compound rest, upon which the tool post is mounted. The compound rest slide is built so that it may be swivelled through 180°, and locked in any position.



Necessity for cleaning the lathe:-

The lathe is a precision machine and the successful continued operation of it depends largely upon the care it receives. There are three reasons why it is important to learn how to clean machines properly.

(1) It forms the habit of cleanliness, which is essential for good work.
(2) You learn the safe ways of cleaning the machine thus avoiding personal injury.
(3) While cleaning the machine it is necessary to manipulate the controls, this leads to better knowledge of the construction and operation of the machine.

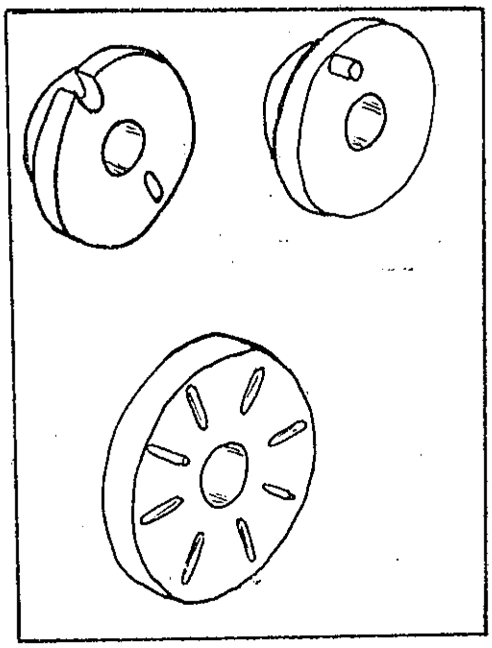
Types of accessories:-

The accessories fitted to the headstock spindle, are used for holding or driving the work.

The accessories are:-
1. The drive plate
2. The face plate
3. Chucks
4. The headstock centre

1. The drive plate:-

The plate is used to drive work that has been set up between centres. The plate rotates the work. It does not support it in any way. A lathe carrier is used to connect the work with the plate.



2. The face plate:-

The face plate is used to hold and drive work that cannot be held between centres or in a chuck. Slots in the face plate allow the work to be bolted in position. Counter balances must be used, when large work is mounted out of centre on the face plate.

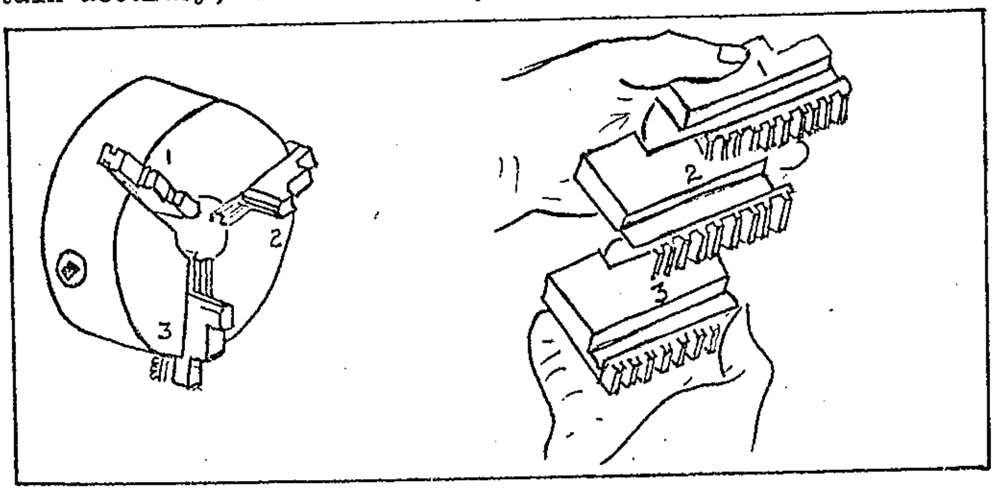
3. Chucks:-

Chucks are work holding devices, which grip work of various size & shape - by means of adjustable jaws. There are many types of chucks used. The most commonly used are:-

(a) The 3 jaw self-centring chuck
(b) The 4 jaw independent chuck

(a) The 3 jaw self-centring chuck:

This chuck is used to hold round, or hexagonal work. A chuck key is used to rotate a scroll, that moves the three jaws simultaneously. Generally, two sets of jaws are provided, one set is used for holding work externally, the other set is for holding work internally. The jaws are marked, and must be fitted in the correct order, in order to maintain the self-centring features of the chuck. The chuck is easily distorted when gripping irregular work such as castings, black and hot rolled steel, or when taking heavy cuts. To maintain accuracy, use chucks only in the proper manner.

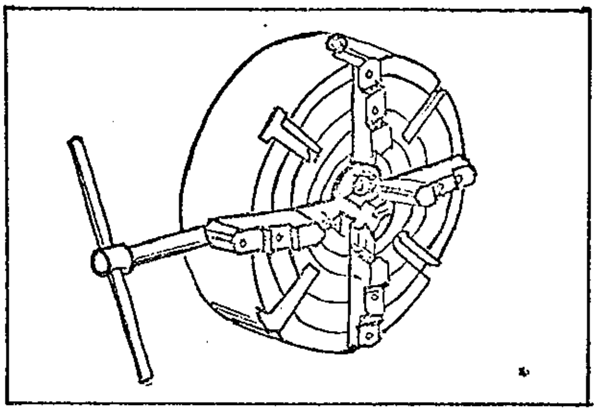


(b) The 4 jaw independent chuck:

This chuck has 4 jaws that can be moved independently of each other. The chuck is used to hold regular or irregular and odd shaped work.

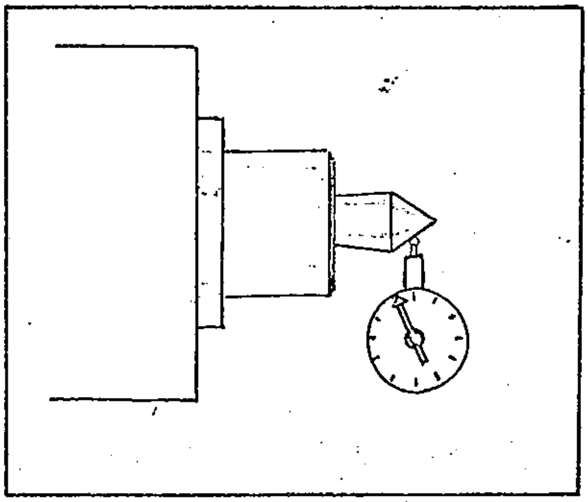
Advantages -

1. Each jaw can be moved independently, by turning a screw with a chuck key.
2. Work can be held very firmly, because each jaw opposes the others.
3. Work can be set up to run very true by adjusting the jaws & checking with a dial indicator.
4. Each jaw can be reversed independently, to enable odd shaped work to be held.
5. Concentric circles marked on the face, assist in locating work centrally.



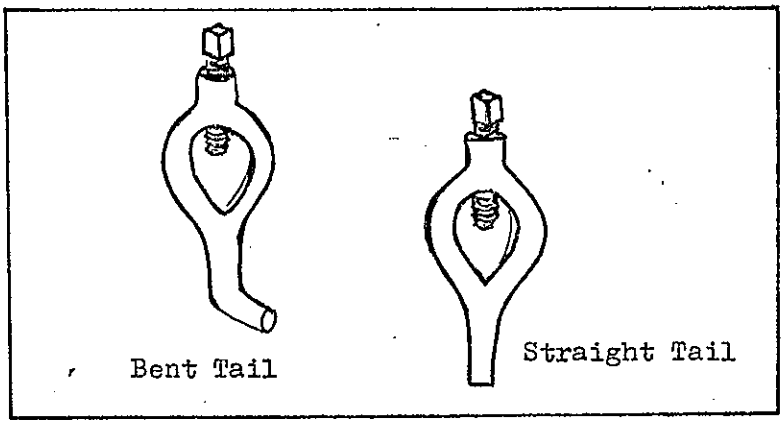
4. The headstock centre:-

The headstock spindle is bored out to a standard taper, to receive the headstock centre. On a lathe that has a large spindle bore, a sleeve is required, to reduce the size of the taper. The headstock centre is machined, to a 60° included angle point. This locates in a mating centre hole, drilled into the end of the work. The centre supports and rotates with the work. Because it rotates with the work, the centre must run perfectly true. A hardened headstock centre must be checked with a dial indicator, to test if it is running true.



Lathe carriers:

Work to be turned between centres, is driven by a clamp, attached to the work, this clamp (or carrier), has a "leg" or "tail", which locates against the pin of the driving plate.



Tailstock centres:

The tailstock centre is held in the tapered bore of the tailstock spindle. It supports the right hand end, of work to be turned between centres.

Plain centres:

The work rotates on this centre, therefore, the mating surfaces between the centre and the work must be lubricated.

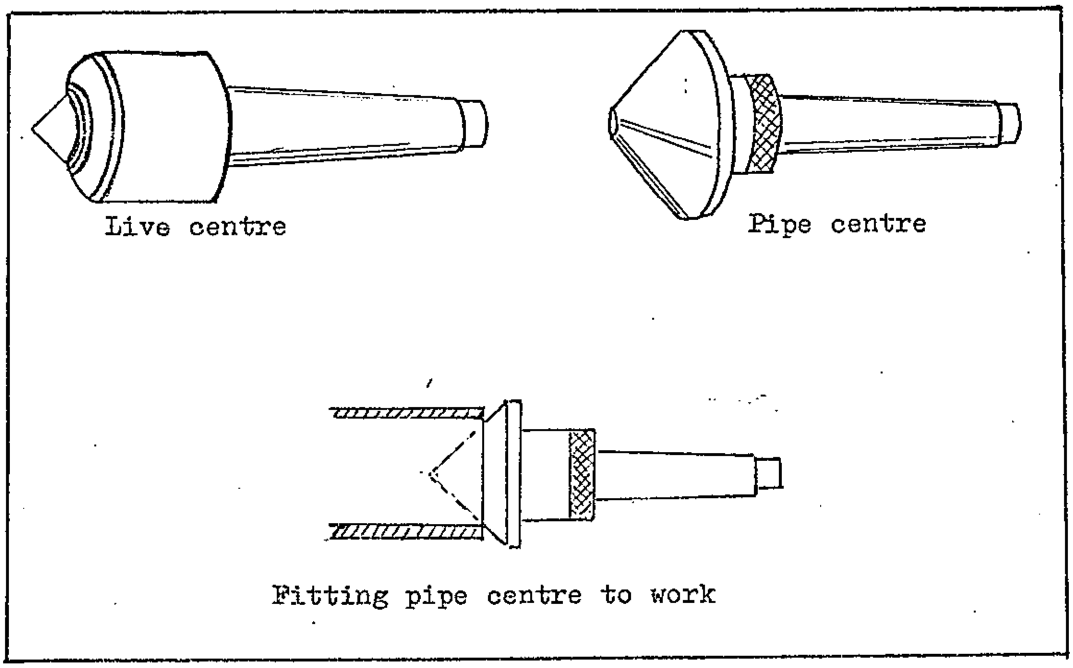
Live centres:

These are tailstock centres, that run on roller or ball bearings. This enables the point of the centre to rotate with the work. Excessive pressure on the centre would cause the bearings to overheat and become damaged. Live centres have the following advantages:-

1. The work can be rotated at higher speeds.
2. Lubrication is not needed, between the centre and the work.
3. Heavy cutting loads can be carried by the centre.

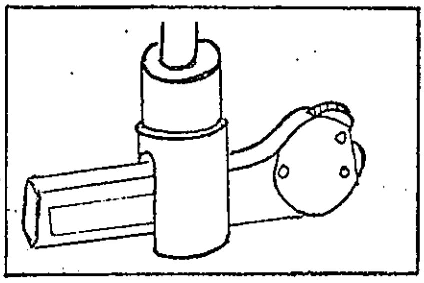
Pipe centres:-

These are similar to live centres. Cones can be attached, to enable the centre to support work which has a large bore. Pipe centres would not normally be run at as high a speed as live centres.



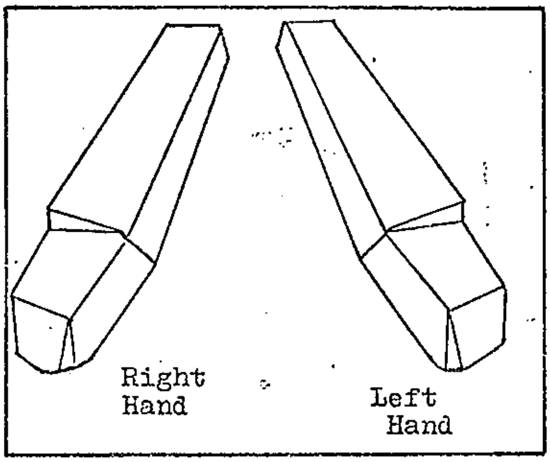
Knurling tools:

Knurling is a displacement process, not a cutting process. The knurling tool produces a raised diamond shape, or straight lined figure, on the circumference of cylindrical work. The tool consists of a body, on which knurl rolls are mounted on hardened steel pins. The knurling rollers are cylindrical discs of high grade tool steel, which have formed teeth cut in their circumference. The rollers produce a fine, medium or coarse knurl.



Tool terms:

Cutting tools used on a lathe, are usually of the single point type. The same common terms are used to describe the parts of all lathe cutting tools.



Right hand tool:

A tool which cuts on the right hand side when viewed from the point end, with the face up and the shank pointing away.

Left hand tool:

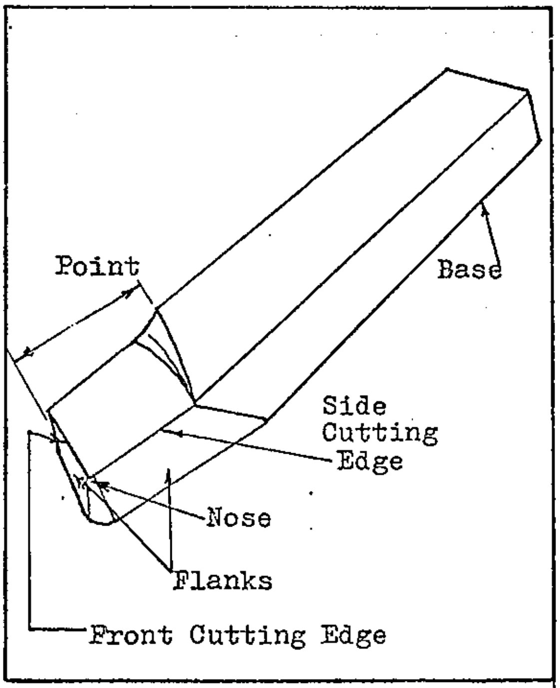
Cuts on the left hand side when viewed from the point end, with the face up and the shank pointing away.

Shank:

The part of the tool on which the tool point is formed, or a tip fixed. It provides the means for securing the tool in a tool post or tool holder.

Point:

The end section of the tool, on which the cutting edges, faces & flanks have been ground.



Cutting edge:
The leading edge of the tool, which does the cutting. It consists of the side cutting edge, front cutting edge, and nose of the tool.

Face:
The upper surface of the tool point, on which the chips bear, as they leave the workpiece.

Base:
The bottom surface of the tool.

Flanks:
The sides of the tool point, below the cutting edges.

Nose:
The curve of the tool, formed by, the junction of the front and side cutting edges.

Tool angles:

Shape is an important factor in determining the cutting properties of a tool bit. The tool should be ground, so that it is sharp enough to force its way into the work. It must also retain sufficient material behind the cutting edge, to make the tool bit strong enough to withstand the pressure imposed on it when cutting. The operation the tool is to perform, also determines its shape.

Angles of rake:- Rake, is the angle at which the tool slopes away from the cutting edge.

Top rake:- The slope of the tool face, from the nose, to the back of the tool point.

Side rake:- The angle at which the face of the tool slopes sideways from the cutting edge.

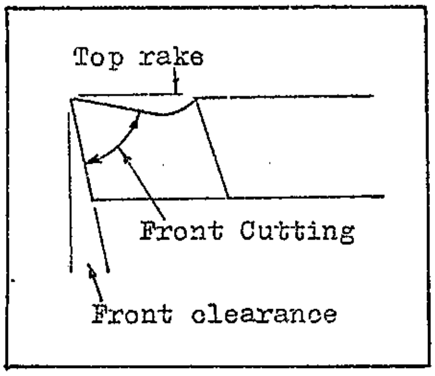
Clearance angles: Clearance is the angle necessary to clear the work as the tool is fed into it. It is necessary because, the cutting edge is the only part of the tool to touch the work when cutting commences.

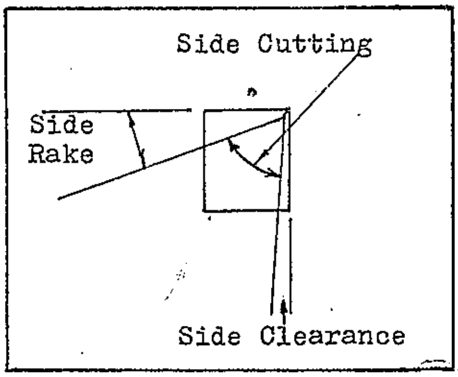
Front clearance: The angle on the front flank of the tool point below the front cutting edge.

Side clearance: The angle on the side flank of the tool point below the side cutting edge.

Front cutting angle: Is the included angle of the tool.

Side cutting angle: Is the sectional angle of the tool point.





The speed & efficiency with which the metal is removed, and the finish produced on the work, depend upon the lathe cutting tool. It is the responsibility of the operator to keep the tools sharp. Since the tool is held by hand whilst being ground, the accuracy to which it is ground, is totally dependent on the operator. The following chart gives the recommended tool angles for various metals, and serves as a guide for sharpening high speed steel tools.

Material	Front Clearance	Side Clearance	Top Rake	Side Rake	Front Cutting Angle	Side Cutting Angle
Low Carbon Steel	8°	12°	15°	17°	67°	61°
Medium Carbon Steel	8	10	12	15	70	65
High Carbon Steel	8	10	8	12	74	68
Cast Iron	8	8	5	12	77	70
Brass	8	10	0	0	92	80
Bronze	8	10	0	0	92	80
Aluminium	8	12	35	15	47	63

Safety

Most accidents are avoidable. A good tradesman has the knowledge and skill to avoid accidents, to himself, his workmates, his work, and to the equipment he is using. Do not attempt to use any machine until you are familiar with its operation.
Carelessness, negligence, thoughtlessness and over-confidence on the part of the operator, may result in serious personal injury, or damage to a costly machine.

Causes of accidents -

(a) Carelessness:- Every second accident in the workshop is caused by carelessness. Concentration on the work being carried out, eliminates the possibility of most accidents. Skylarking often causes accidents.
(b) Ignorance:- An operator must understand the uses and functions of his machine. If you don't know, ASK.
(c) Unsuitable clothing:- Loose sleeves, unbuttoned or torn sweaters, long hair, incorrect footwear, finger rings, have all been the cause of serious accidents.
(d) Untidiness:- Keep cotton waste, rags etc. away from any moving parts. Off-cut materials, especially round stock is very dangerous under foot. Do not use old cotton waste to wipe the hands with; it may contain metal cuttings.
(e) Machinery:- See that all guards are in position.
Remove the tool post, when filing work.
Switch machine off before making adjustments, cleaning or lubricating etc.
Do not attempt to clear away shavings while the machine is in operation.
Never re-set the tool post while the machine is running.
Always allow the chuck to stop of its own accord.
Remove chips with a brush, pliers or a stick - never use your hands.
Stop the machine before attempting to measure a job.
Never allow someone else to operate the start switch.
Do not distract a person who is operating a machine.
(f) Lathe-machine safety:- (1) When operating a machine for the first time, check controls for direction of operation with free movement in all directions.
(2) Do not throw tools on machines or finished surfaces.
(3) Never engage or dis-engage the back gears while the lathe is running, nor connect or disconnect gears.
(4) Make sure the tail-stock is locked before starting.
(5) Always put the lead screw in neutral, when filing, polishing, drilling, reaming or whenever the feeds are not being used.
(6) Never use the lathe bed, for hammering etc.
(7) Never leave any machine running unattended.
(8) When filing, use the file left-handed and lean towards the tail-stock - this places the body away from the machine.
(9) Do not leave the key in the chuck.
(10) Keep the ways free from grit and shavings, and clean the machine after use.
(11) Report any faults or unsatisfactory operation.
(12) Never tighten the automatic feed too tight.

TITLE:- BUFFING MACHINES

LECTURER:-

DATE:-

EQUIPMENT:-

Buffing is the name given to the process of polishing with rotating fabric buffs, sewn or clamped together in the form of a wheel, and loaded with an abrasive compound.

These buffs are placed on a high speed machine, much the same as a bench grinder. Usually there is a wire wheel attached to the other end of the machine - this wheel is used for initial preparation of material before the buffing process.

The buff is charged with abrasive by pressing a bar of polishing compound (abrasive set in grease or other base) against the buff while it is rotated at high speed.

The workpiece is then held against the rotating buff and moved systematically at right angles to the buff to give a scratch-free, polished surface. It may be necessary to charge the buff with polishing compound at intervals, particularly on larger workpieces - never use a buff without compound because it will tear the fabric.

When buffing sheet material, do not use the thin edge as the leading edge, or the job will be wrenched from the operator's grip, thus causing damage to the job and the operator.

Small jobs should be held with pliers, to prevent the risk of hand injury and being burnt with the material, which, due to friction, reaches high temperatures very quickly.
Gloves should never be worn when using a buffing machine, the reason being that the operator's hands could be "dragged" into the wheel, causing serious injury.

TITLE:- GRINDING MACHINES
LECTURER:- Gerry Heynis
DATE:- 25-5-81
EQUIPMENT:-

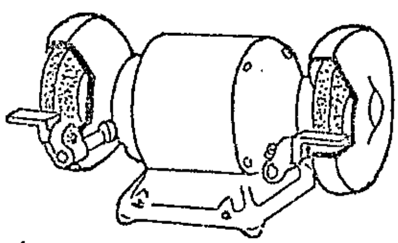
Introduction - "Off hand" grinding is the term used to describe the process where workpieces are held in the hand and material is removed by a rotating abrasive wheel, which is called a grinder.

A grinder has a variety of uses in the workshop, including rough shaping, removing excess material, preparation of surfaces for welding etc., smoothing surfaces and sharpening tools such as drills, punches, chisels and lathe cutting tools.

There are 3 main types of off-hand grinding machines.

1. Pedestal -, consists of a heavy base, which is mounted on the floor, supporting the motor. The spindle, upon which there are 2 abrasive wheels, is driven by belts. This type of machine is commonly used for heavy work and rough shaping.

2. Bench - may be mounted directly to bench or to a stand fixed on the floor. Abrasive wheels are fixed directly to the ends of the motor shaft. Bench grinders are used mainly for tool sharpening.



BENCH GRINDER

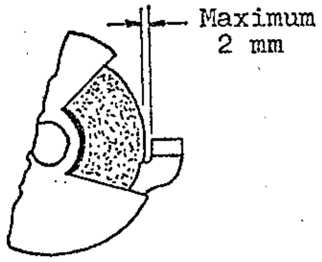
Both pedestal and bench type grinders are usually fitted with a coarse grit wheel for roughing and a fine grit wheel for finishing.

3. Portable - used where it is impracticable to use either a pedestal or bench grinder. The portable grinder is held in the hand and passed over the work. It is difficult to keep this type of grinder steady, and consequently a poor finish results.

Note - portable grinders should never be placed with the abrasive wheel down on the bench when not in operation. The wheel could crack, causing it to disintegrate when next used. There is also the possibility of accidental starting, which would cause the machine to "snake" wildly, thus causing damage to persons or equipment.

Machine Features

Work Rests - adjustable work rests are provided to steady and guide the work.
They are positioned as close to the working face as possible - the distance between the rest and the wheel must never be greater than 2 millimetres, because the work could get jammed between the rest and the wheel. Abrasive wheels are reduced in diameter due to wear, and work rest adjustments are required constantly.



WORK REST ADJUSTMENT

Wheel Guards - All grinding machines should have protective guards mounted around the abrasive wheel and machines should not be operated unless these guards are in place and secure. The guards serve 3 main purposes -

1. To retain the fragments of the wheel should it break.
2. To protect the operator from coming in contact with the rotating wheel.
3. To prevent the fitting of a wheel that is too large for the machine.

As an added precaution and safety measure, most machines are fitted with a glass eye shield, which is attached to the wheel guard. This shield prevents sparks from the abrasive wheel being "thrown" into the face of the operator. Whilst the eye shield is a sensible precaution, safety glasses should also be worn to give the operator double protection from eye injury.

Wheel Speed - The recommended maximum safe speed of abrasive wheels is specified on the wheel by the manufacturer - DO NOT EXCEED THIS SPEED. Increased spindle speed will cause the wheel to run at a high surface speed, thus presenting a very dangerous situation because the wheel may fly apart.

Wheel Rotation - The rotation of the abrasive wheel should be downwards against the work rest. The nuts holding the wheels on the spindle should tend to tighten against the direction of rotation.

Wheel Conditions - During normal operations, certain conditions may develop in regard to the abrasive wheel. These are -

(1) Loading - small particles of material become embedded in the grain of the wheel. The surface of the wheel becomes "clogged" or "loaded", and reduces the efficiency of the wheel. Loading is a result of using the wrong type of wheel for the material being ground.

(2) Glazing - caused by grinding hard materials on a wheel that has too hard a grade of bond. The abrasive particles become dull due to cutting the hard material and the bond will not allow them to break out. The surface of the wheel takes on a smooth glassy appearance. Glazing may be prevented by selecting a wheel with a softer grade of bond.

(3) Grooving - grooves are worn in the surface of the wheel by pressure being applied in the one position. It can be prevented by moving the work across the full face of the wheel - avoid grinding on the outside edges of the wheel.

(4) Out-of-Round - uneven application, bumping or vibration of the work against the wheel, will cause an out-of-round condition. Apply even pressure to the work on the wheel and make sure the work is solidly supported by the work rest.

Maintenance - Abrasive wheels become worn, grooved and sometimes cracked because of constant use, mis-use and, in some cases, abuse and lack of care.

Grooved and out-of-round wheels are "trued" by means of a "dresser"- this is a job for a grinding specialist.

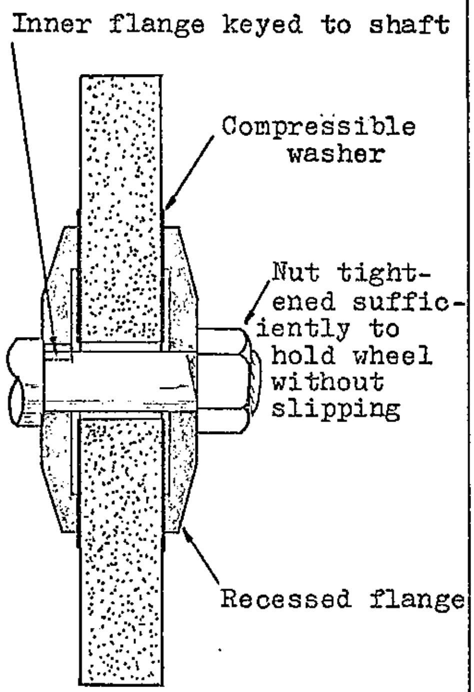
Cracked wheels are usually also changed by the specialist, but there may be occasions when wheels will have to be changed by electrical tradesmen or apprentices. In this case there are a few points which have to be considered. -

1. Ensure that the replacement wheel is the same as the wheel that is being replaced.
2. Check that the lead bush on the new wheel is free from burrs.
3. Never force a wheel on to the spindle - the bush can be cleaned out to enable a "push-on" fit onto the spindle. A loose-fitting wheel will cause a dangerous out-of-balance condition.
4. Abrasive wheels must be mounted on the spindle between steel flanges of equal sizes. (½ the diameter of the wheel, never less than 1/3). These flanges locate the wheel centrally on the spindle and give positive drive.

5. Compressible washers of blotting paper or hard rubber must be used between the flanges and the wheel to even up the clamping pressures.

6. Tighten the nut sufficiently to hold the wheel firmly without slipping. Excessive tightening will cause damage to the wheel.

7. When the new wheel has been fitted and all guards have been replaced securely, the machine must be given a test run. Check that the speed of the motor does not exceed the maximum safe speed of the wheel. Stand to one side of the new wheel and switch on for approximately ½ minute. (Do not stand directly in front of the wheel, in case it should shatter). If the wheel is not out-of-balance, the machine is now ready for operation.



CORRECTLY MOUNTED WHEEL

TITLE:- BELT SANDER

LECTURER:-

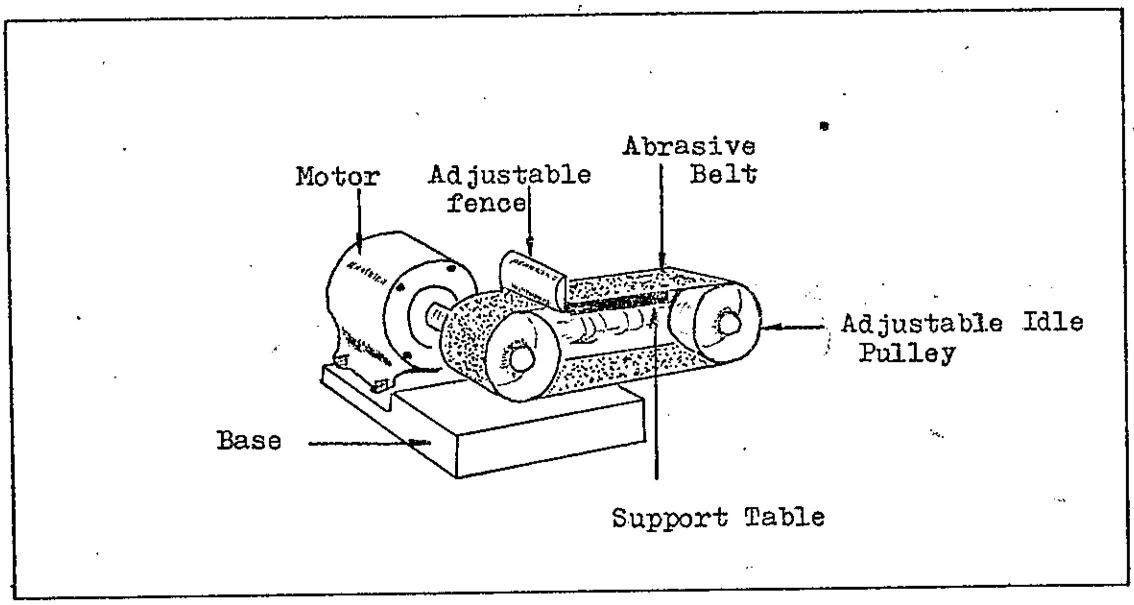
DATE:-

EQUIPMENT:

A belt sander is basically another form of grinding machine and is used mainly for shaping and surfacing insulating materials and metals, such as copper, brass and mild steel. It is ideal for rough shaping, because it eliminates the time-consuming filing process.

Construction:- an endless, cloth backed, abrasive belt is stretched between a pair of pulleys, one of which is power driven. The idle pulley is adjustable, so that tension can be placed on the belt. An adjustable fence acts as a stop for the material being ground and can be set at any angle to the belt table. A flat support table lies below the upper portion of the belt. This support enables flat surfaces to be ground fairly accurately.

Safety:- because there are no guards on the sander, there is a high risk of injury, especially to the hands. Ensure that the workpiece is gripped firmly, otherwise, due to the rotation of the belt, it could be wrenched from the hands and "thrown" from the machine.



TITLE:- BANDSAW

LECTURER:-

DATE:-

EQUIPMENT:- Bandsaw blades, Push stick, Blade guides.

Preparation:-

Select the correct blade for the job (as for hacksaw).
Cut blade to the correct length (approx. 10'6").
Adjust the settings for welding, then weld the ends and anneal the weld.
Select the appropriate speed, adjust guard and guide, ensure that all clearances are adequate, and there are no materials underfoot.

Operation:-

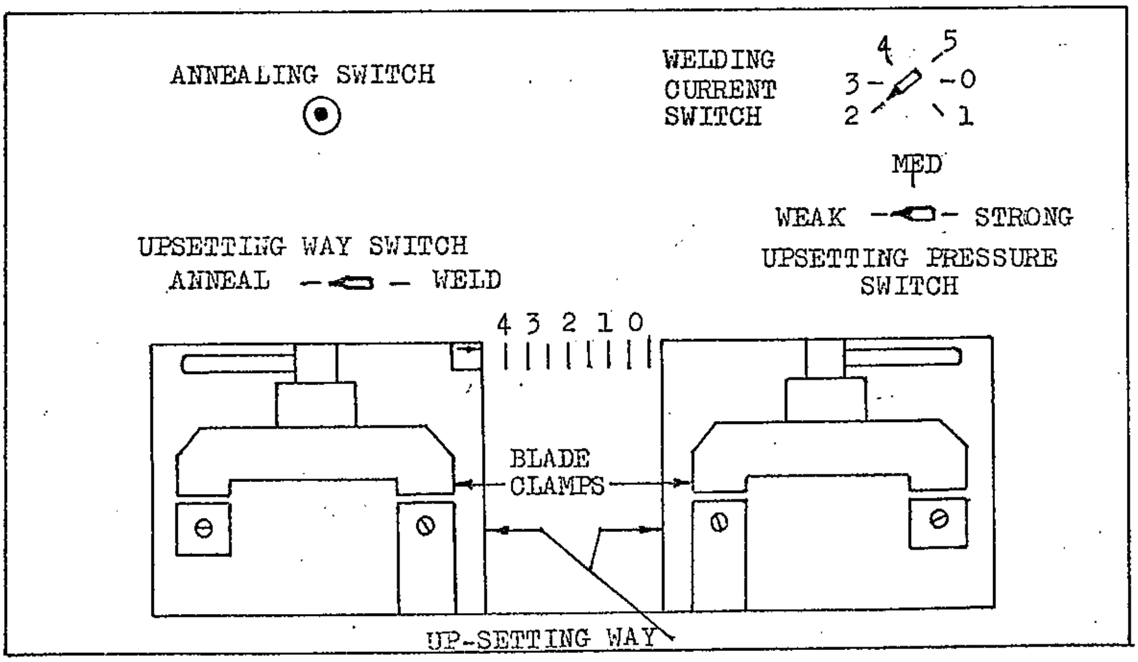
Adjust goggles, position material to the line of cut, then switch "ON". Commence cutting using a steady pressure. Towards the end of the cut, use a piece of scrap material to feed the workpiece onto the blade. Similar to hacksawing, the pressure is eased off before the end of the cut.

Finishing:-

Switch "OFF", place off-cut material in the appropriate bin.

Safety:-

(1) Isolate supply at the main switch, before making any adjustments.
(2) Wear goggles.
(3) Keep fingers clear of the cutting line.
(4) Don't attempt to cut sharp bends.
(5) Use a stick to clear off-cut material.
(6) Check for clearances before commencing.
(7) Get assistance with awkward sized material.
(8) Ignore any distraction while cutting.
(9) Dispose of worn blades as shown.
(10) Always switch "OFF" before attempting to clear jammed off-cuts.



Method of welding & annealing blade:-

BLADE WIDTH	WELDING CURRENT	UP-SETTING PRESSURE	UP-SETTING WAY
Up to 5 mm	1	WEAK	1
" " 10 mm	2	MEDIUM	2
" " 12 mm	3	MEDIUM	2
" " 16 mm	4	STRONG	3

(a) Adjust welding current switch, to the setting indicated by the table.
(b) Adjust up-setting pressure switch.
(c) Adjust up-setting way.
(d) Place the blade in the clamps, with the teeth forward and against the front stop of the clamps.
(e) Butt the two ends together in the centre of the up-setting way and clamp down.
(f) Turn up-setting way switch to WELD position and hold down, until the joint welds and returns to it!s normal colour.
(g) Release clamps then turn the up-setting way switch to the ANNEAL position.
(h) Position the welded joint in the centre of the up-setting way & clamp down.
(i) Press the annealing switch and hold in until the weld glows red, then release.
(j) Release clamps, remove blade, then grind off excess weld from the joint.

n.b. Upsetting pressure:- Is the pressure exerted between the blade ends during the weld.
Upsetting way switch:- This varies the distance over which the upsetting pressure is exerted.
Upsetting way:- Is the variable gap between the clamps.

M3/7/1

TITLE:- HAND DRILLS

LECTURER:- Gerry Hemmis

DATE:- 25-5-81

EQUIPMENT:- Hammer Drill, 5/16 Portable Drill, S.C.R. control

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General operating rules:-

Usually, portable electric tools in use on the plant operate on either 32V or 110V, and are double insulated. It is the responsibility of the operator to check the condition of the machine cables and attachments before use. The following points should be checked: faulty plugs & extension sockets, damaged cables, faulty, loose, corroded or broken parts and attachments, listen for unusual noises, look for abnormal operation (sparking at the brushes, sluggish operation).

Switch off if you observe anything unusual, or smell burning insulation. Always plug in the machine, and any extension cables, before switching on the power, and switch off before disconnecting. Always disconnect before making any adjustments or alterations to the machine, or attachments. Do not allow extension cables to cross over walkways, or any place where they could create a hazard. Don't allow cables to be placed in a position where they could be subjected to any damage i.e., near moving parts, in an area where welding or cutting are taking place, near hot bodies or where they may be run over by vehicles. Where this is not possible, every effort should be made to provide adequate protection for the cables. The workpiece should be clamped securely in a vice, or to a bench, unless it is large enough to overcome the necessity for clamping. Drill bits, blades and other attachments, should be removed after use, to prevent breakage. Where a number of people are involved in using a portable machine, one person should be elected to operate, control and give instructions. This will avoid confusion, and possible injury.

Drilling machines are the most common of portable power tools. Holes up to ½" diameter may be drilled safely in most materials. Machines which are fitted with trigger locks, should be handled with caution, i.e. do not operate the lock if there is any possibility of the machine twisting. Some machines are multi-speed i.e., they have a 2 or 3 speed selection. Others may require a speed reduction. As a general rule for speeds,

Large drills require slow speeds
Small drills require fast speeds.

Hammer drill:-

This particular machine requires special care during use. It has a ½" chuck, but the hole saw attachments are capable of drilling up to 4" diameter holes in masonry etc. There is a collar adjustment on the machine for selecting the hammer, or ordinary drilling, also a two speed selector.

Due to the very high torque of this machine, it is essential to maintain a firm grip especially when drilling steel.

Note:- It is most important to remember that the hammer adjustment must NEVER be used for drilling steel or other metals.

M3/8/1

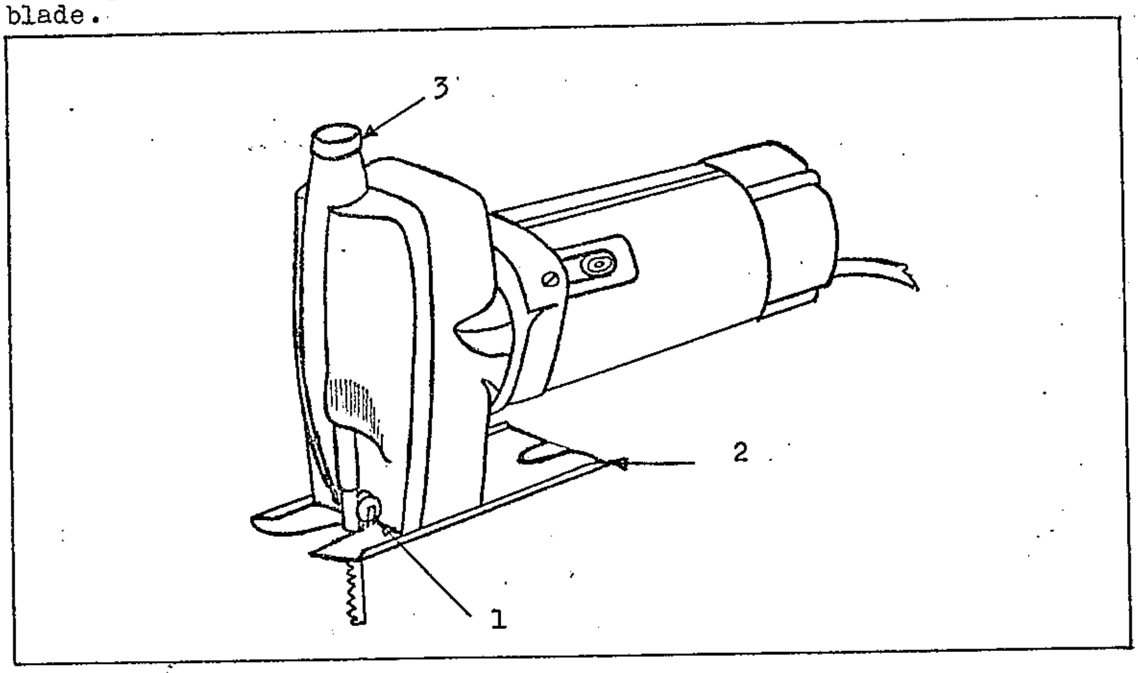
TITLE:- JIG SAW
LECTURER:- Jerry Heyni's
DATE:- 25-5-81
EQUIPMENT:- Jig saw, blades

This is a machine which operates on the principle of a reciprocating blade, and is a simple means of making long cuts in sheet metal, where the use of a bandsaw or hand-saws is difficult or impossible. It is not to be used on small jobs which can be cut by hand.

It may be necessary to use a speed controller when cutting through thick material. A number of blades are available for use on varying thickness of material. A coarse blade would be used on thick material and a fine blade on thin material. To change the blade, insert a screwdriver into the hollow of the drive shaft, locate and turn the grub screw until the blade can be turned 90°. Withdraw the blade. Reverse this procedure for fitting a new blade. The machine must be disconnected for this operation.

Material must be clamped or otherwise held down onto a bench with the cutting line overhanging the bench edge by about ½"
Hold the machine with both hands behind the blade-line, press the foot-plate of the machine onto the material and switch on. Advance the blade slowly towards the edge of the material until it starts to cut, then apply steady forward pressure to cut, and heavy downward pressure to prevent lifting. Assistance will be required to support the off-cut. Under no circumstances should anyone place a hand or finger in front of the moving blade.

When stopping, switch off and retain downward pressure until the machine is completely stopped, otherwise blade breakage will occur. Cutting sharp corners or small circles will also tend to break the blade.



1. Roller Blade Guide, adjustable by the centre screw on the foot. Should be tight upto the blade or breakages will occur.
2. Foot reversible by 3 screws underneath.
3. Grub screw for locking the blade located inside a tube under this cover. Tighten grub screw before storing without the blade.

Due to the set of the teeth, the chips tend to travel upwards. It is essential to use adequate eye protection.

TITLE:- DISC GRINDERS

LECTURER:-

DATE:-

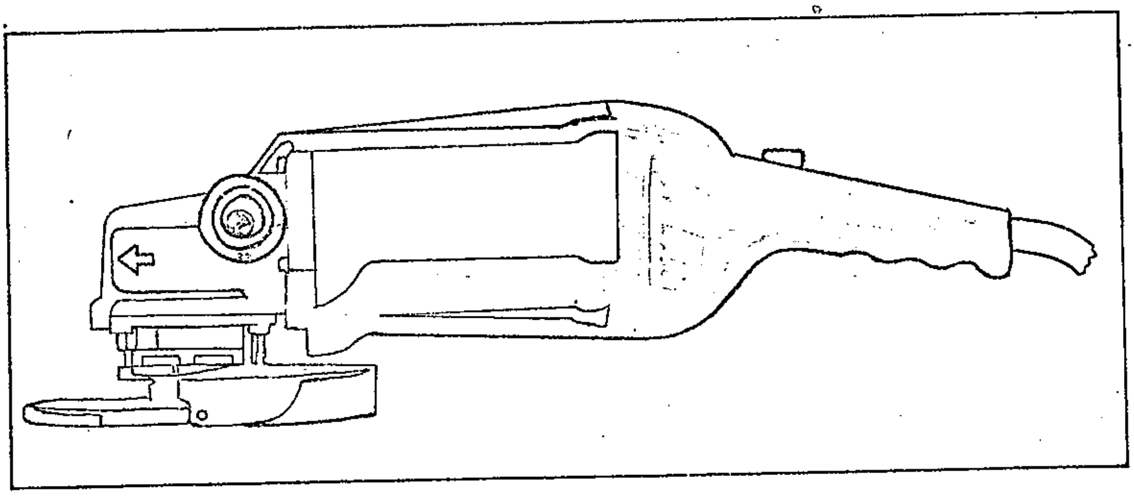
EQUIPMENT:- Large and small disc grinders

Disc Grinders run at very high speeds (8500 RPM and more) and are designed to remove metal more rapidly than grinders. Sparks travel greater distances (over 30 ft.) and are more hazardous in this respect than grinders. Guards and shields must be used to prevent accident or injury. Allow the machine to stop before placing it down on the bench or floor.

Ensure that the disc is used on the material for which it is designed, e.g. if a wheel designed for hard material is used on copper or other soft material, it will become clogged and unusable.

New types of disc grinders are available which are in effect abrasive circular saws. They may not look as dangerous as a circular saw because they don't have teeth, but these machines can cut through solid steel and would easily therefore remove a hand. Treat these machines with as much caution as you would a circular saw.

Ear muffs must be worn when using a disc grinder and anyone working within 2 metres of a disc grinder in use must wear ear muffs.



TITLE:- SPEED CONTROL, SPEEDS AND FEEDS

LECTURER:-

DATE:-

EQUIPMENT REQUIRED:-

The selection of proper cutting speeds and feeds is an important part of a machine operator's work, since it enables him to use his machine for the most rapid production possible without over-taxing it. No advantage is gained by running a machine below its correct speed. The high finish that can be obtained from a slow speed can also be obtained at the correct cutting speed.

Definition of cutting speed and cutting feed

Cutting speed and cutting feed are inseparable in practice since they are always dependant on one another.

(a) Cutting speed is the number of feet of metal that passes the tool in one minute, measured round the outside of the work. If, for example, a material is said to have a cutting speed of 100 f.p.m., then 100 ft. of the material will rotate past the cutting tool in one minute.

(b) Cutting feed is the distance which the tool advances along the face of the work for each revolution in the case of a lathe, and the distance the drill advances into the work in the case of a drill. It can be regarded as the thickness of chips. If for example, a feed of 1/64" is used, it will take 64 revolutions to advance the tool 1".

Factors determining cutting speeds

Cutting speed is dependant upon several factors:-

(a) The cutting tool material - a high speed steel cutting tool can be safely used at twice the cutting speed of a carbon steel cutting tool.

(b) Type of material being machined - In general, the harder the material, the slower the speed.

(c) Cutting lubricant - Cutting speeds for any material may be increased by the use of proper lubricant which keeps the tool from overheating at higher speeds.

(d) Rate of feed - The greater the feed, the slower the speed.

MATERIAL	SPEED FPM	LUBRICANTS
Aluminium	200 - 300	Kerosene
Bakelite	100 - 150	Dry
Brass or Bronze	150 - 250	Dry
Copper	80	Kerosene
Mild Steel	60 - 70	Soluble Oil
Stainless Steel	30 - 40	Soluble Oil
Wood	300 - 400	Dry

To calculate the speed of a Lathe/Drill for a particular job, the following information is necessary -

(a) Cutting speed, which is obtained from a table of speeds.

(b) Diameter of the (1) work, in the case of a lathe
(2) drill, when drilling.

$$\text{R.P.M.} = \text{Cutting Speed} \times \frac{12}{\text{Dia. in inches}} \times \frac{7}{22}$$

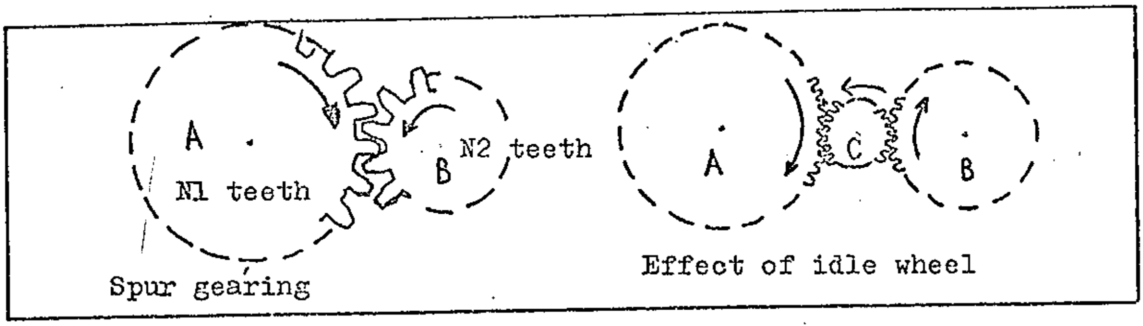
Speed control of machines

Gears - Many machines employ toothed wheels to transmit force and motion and to modify the speed in order to obtain a mechanical advantage or for some other reason.

Consider two gears, A & B. Suppose that A (called the "driver") has 24 teeth and B (called the "follower") has 12 teeth. For one revolution of A, the gear B will have turned through an angular amount corresponding to 24 teeth also. It will have turned $\frac{24}{12}$ turns or 2 turns.

In general, if A has N_1 teeth and B has N_2 teeth, then:-

$$\frac{\text{Speed of follower}}{\text{Speed of driver}} = \frac{N_1}{N_2} \quad \text{thus:- Speed of follower} = \text{Speed of driver} \times \frac{N1}{N2}$$



Spur gearing

Effect of idle wheel

The effect of an "idle" wheel C between A & B is to cause B to rotate in the same direction as A instead of in the opposite direction, but it does not alter the speed of B.
Gearing is widely used to convert a small torque moving through many revolutions to a much larger torque moving through fewer revolutions.

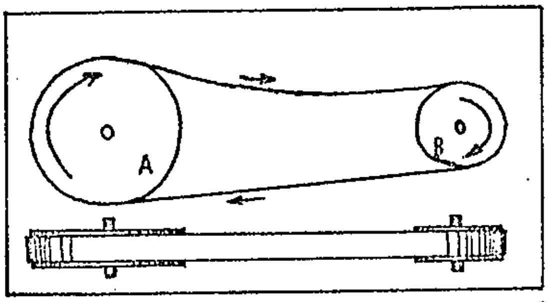
Belt driving

The greatest difference between gear driven and belt driven machines is that it is necessary to depend on friction for the transfer of motion between the pulley and the belt.
Neglecting all slip and creep, the velocity or movement ratio of "driver" to "driven" pulley is easily found from the fact that the belt and the outside surfaces of both pulleys will all be moving together through the same linear distances for any particular movement of the pulleys. If dA and dB be the diameters of the driver and the driven pulley respectively, and if B turns through Nb revolutions when A turns through Na revolutions, then since the linear distance travelled by the rims is the same for the two pulleys,

$$\pi, dB, Nb = \pi, dA, Na$$

$$\therefore \frac{Nb}{Na} = \frac{dA}{dB}$$

$$\frac{\text{Speed of driven}}{\text{Speed of driver}} = \frac{\text{Dia. of driver}}{\text{Dia. of driven}}$$



This is true whether the belt is open or crossed, but in the case of the open belt, the driven pulley rotates in the same direction as the driver, while in the case of the crossed belt it rotates in the opposite direction to the driver.

S.C.R. Speed control

Stepless speed control can be obtained from low speeds up to full speed with portable power tools by using an electronically controlled speed regulator. These are made for specific voltages, and must only be used on the voltage for which the particular controller is designed.