

M2/1/1

LECTURE:- MACHINE OVERHAUL
LECTURER:~ GERRY HEYNI'S
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.

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.

M2/1/2

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

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:

LIST PARTS REQUIRED & HAND TO CUSTOMER



TITLE:- SPANNERS AND WRENCHESLECTURER:- GERRY HEYNISDATE:- 9-4-81EQUIPMENT:- 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.

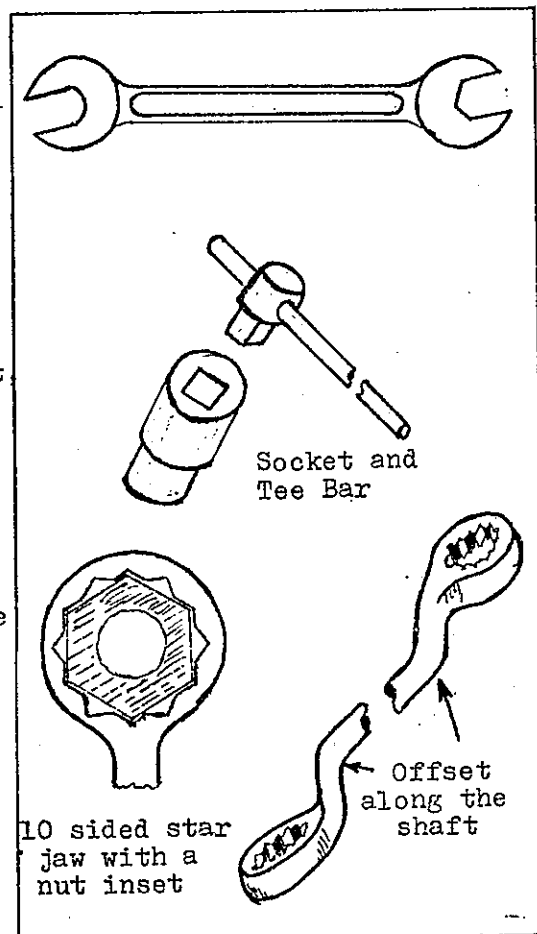
There is a choice of tools therefore, to perform the same task and a way to judge a good or bad tradesman by the tools owned and used. A good rule to apply is if you wouldn't like anyone to use a certain tool in a certain way on anything you own or value, then don't you use it that way on anything.

Types of Spanners and Wrenches

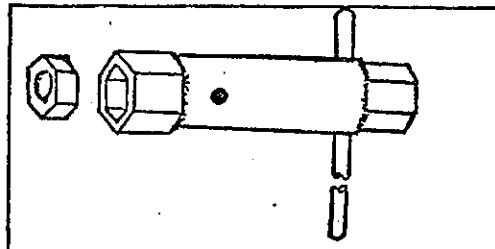
Open Ended Spanner: Most common in use, usually flat, double ended and with the jaws offset 15° for easy manipulation. Special thin jawed spanners are available for holding lock nuts.

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.

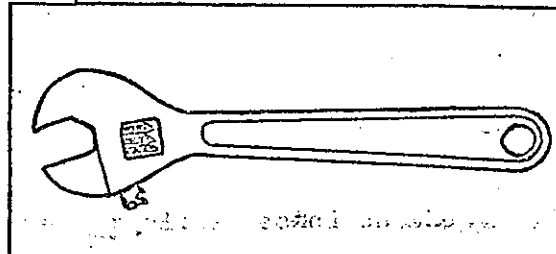
Ring Spanner: Usually offset along the shaft. Jaw a 10 sided star rather than hexagon, therefore grip half flat all round. Usually double ended, can be obtained in large sizes, single with a hammer pad on the other end. It is the best spanner to use.



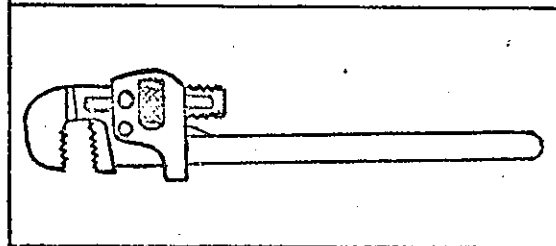
Tube Spanners: A length of jointless tube with a hexagon set in each end and a hole drilled to take a "Tommy" bar.



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.



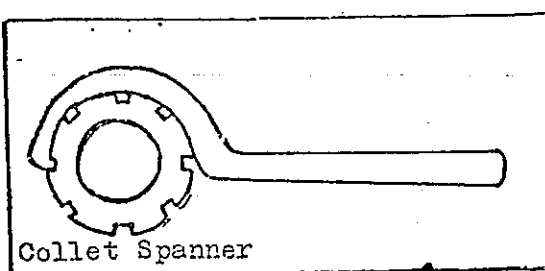
Stillson Wrench: Bottom jaw adjustable on a thread, teeth set into the jaws, should only be used for gripping round bar or pipe.



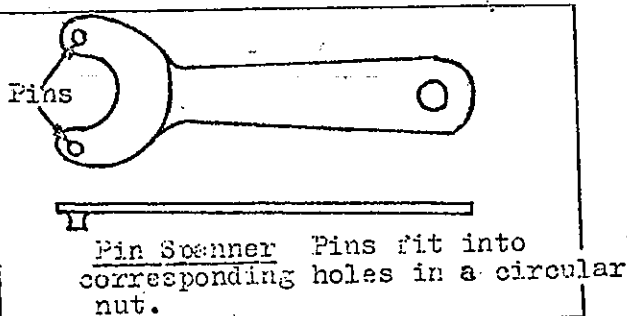
Pliers pressure grip, toothed jaws useful for gripping curved surfaces.

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.

M2/3/1

TITLE:- THREAD CHASERS & DIE NUTS

LECTURER:- GERRY HEWIS

DATE:- 23-2-81

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.

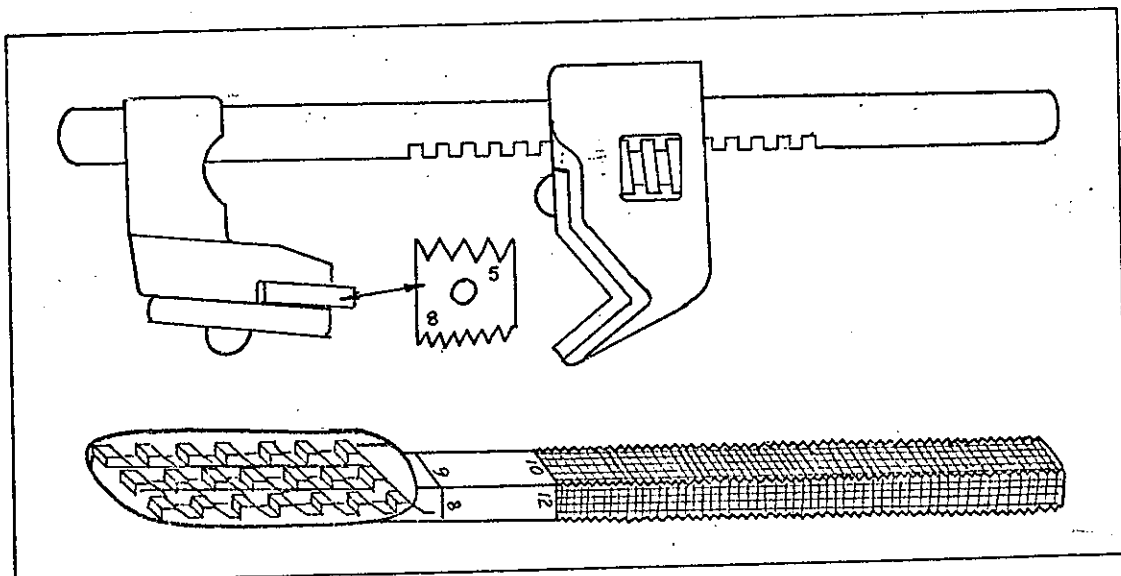
Preliminary cleaning Threads which are clogged with dirt, oil, rust, or paint should be cleaned with a chemical agent such as Transpo, or C.R.C. as far as possible followed by a vigorous brushing with a wire brush. Gloves must be worn when handling Transpo and care should be taken when using a wire brush 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.



M2/3/2

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 DEVICESLECTURER:-

YERLA HEWIS

DATE:-

7-5-21

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

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.

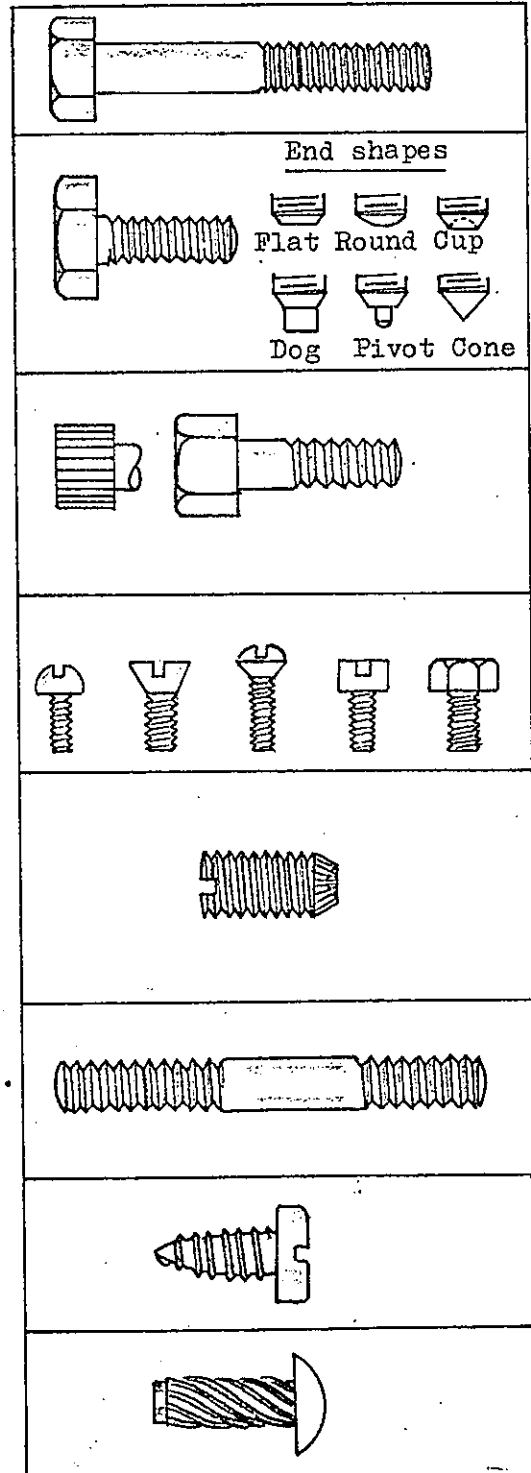
Metal threads are fully threaded and may be used with or without a nut. The heads may be round, countersunk, raised head, cheese-head, or hexagon, and are usually fitted with a screwdriver slot.

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 hole 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.



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

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

Carriage or Coach bolts 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.

Gutter bolts 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.

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

Terrier bolt 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.

Loxin 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.

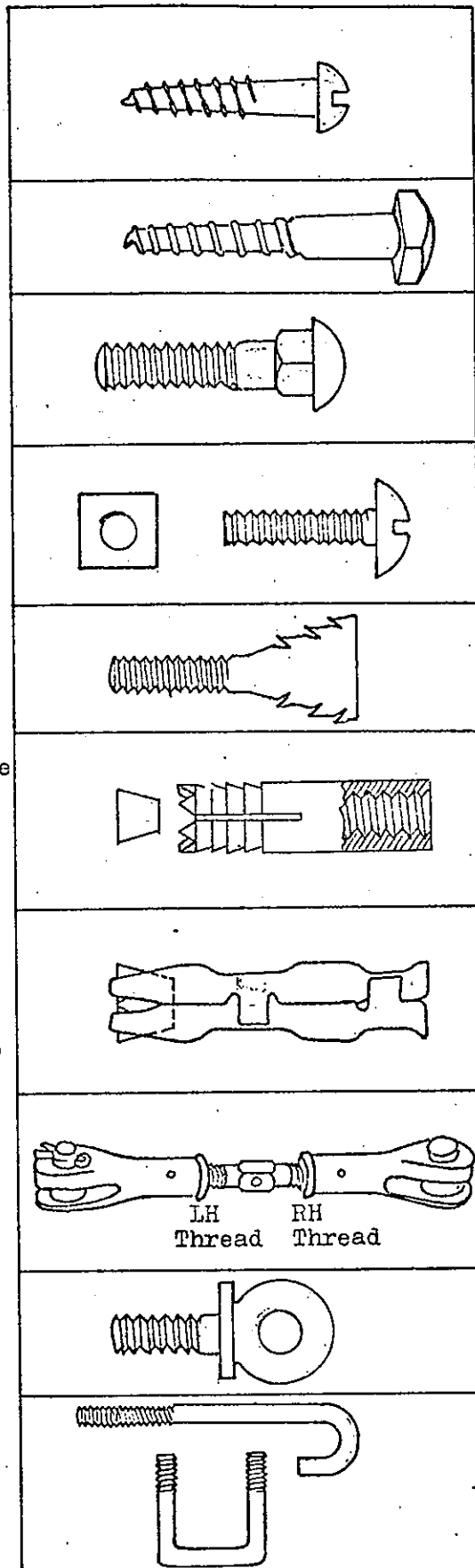
Turnbuckle - this is a device used for tensioning wire ropes. As the centre link is turned, the two threads (one left hand, one right hand) pull towards each other thereby applying tension to the wire rope.

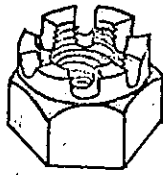
Eye bolt is a closed loop of steel with a thread protruding from one side. Used mainly for lifting purposes when screwed or bolted to machinery.

J bolt Used to attach components or corrugated sheeting to angle iron framework or building structures.

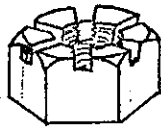
U bolt For the same purpose as the J bolt but used where there is no flange as with channel iron.

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.





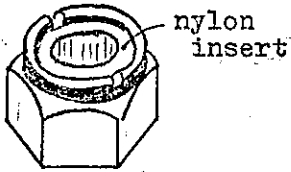
Castle nut



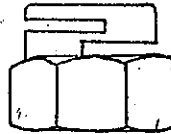
Slotted nut



Cotter hole



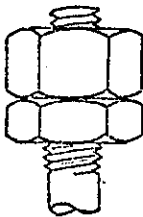
Simmonds nut



Philidas nut

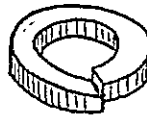


Pal locknut

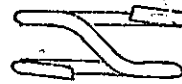


standard nut

$\frac{3}{4}$ nut



Spring Washer



Double coil spring washer



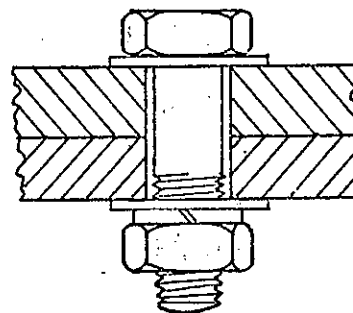
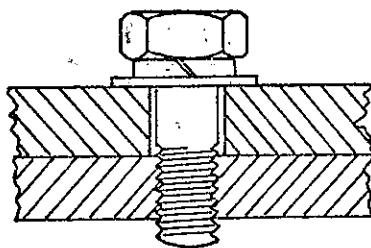
External star washer



Internal star washer



Dished washer



Applications

Note:- Clearance holes
Flat washers
Spring washers



M2/5/1

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.

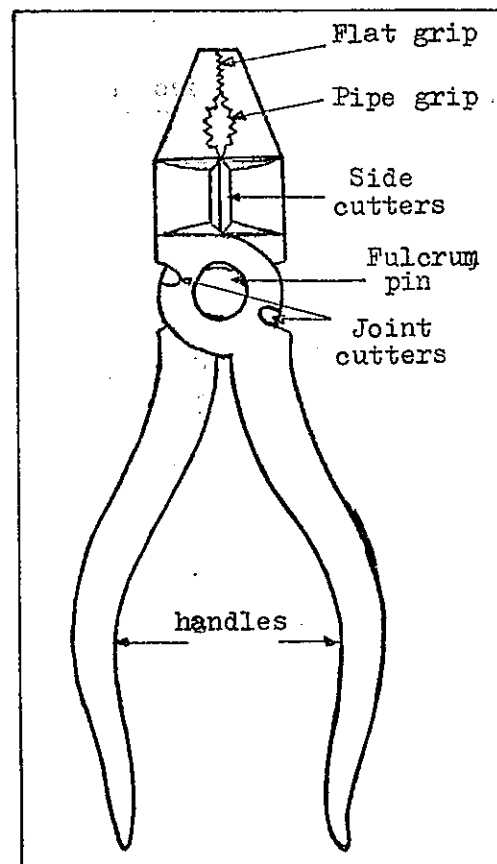
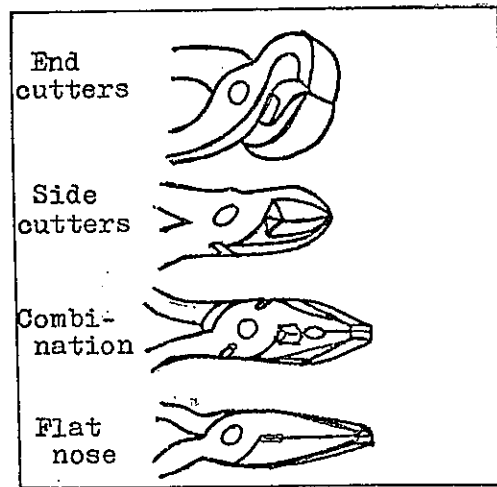
Side cutters - next comes a set of blades, recessed at the back for cutting soft wire etc.

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 guillotine.

Material -

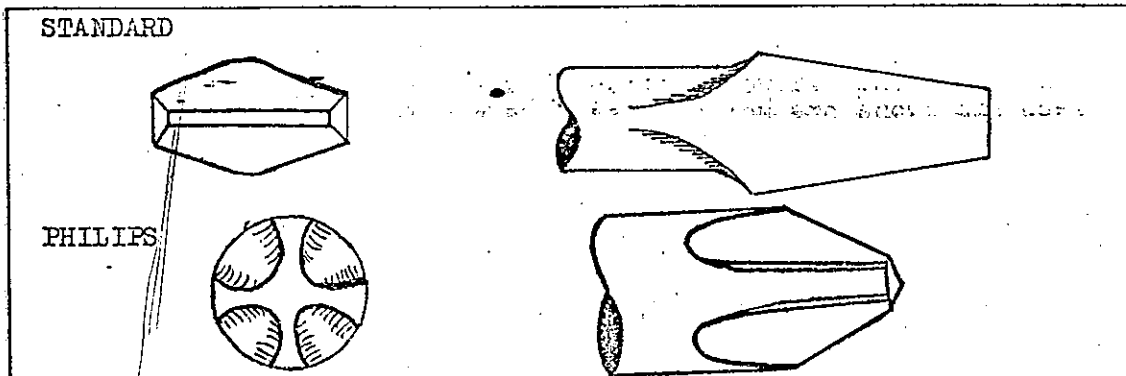
As described previously, pliers are a very versatile tool and consequently wear out very quickly at the fulcrum and become "sloppy", so to buy a cheap pair of pliers is much false economy. When buying pliers look for a good name, a



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.

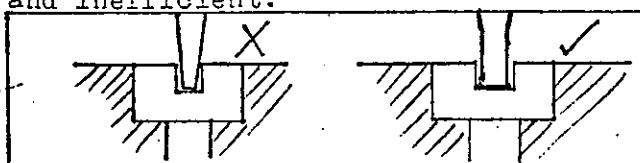


There are several more makes by particular firms for special uses, such as Pozidriv, Frearson clutch head etc. But these will rarely be encountered.

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

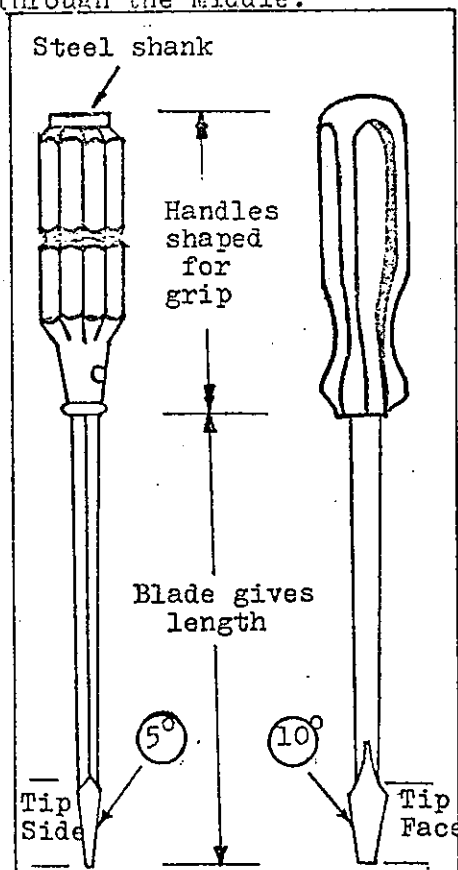
Blade - the length of the blade gives the size of the screwdriver and can be either square or round and made ideally of hardened and tempered carbon or alloy steel. They vary in length from 40mm to more than 350mm.

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 $\frac{3}{4}$ and $\frac{7}{8}$ 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

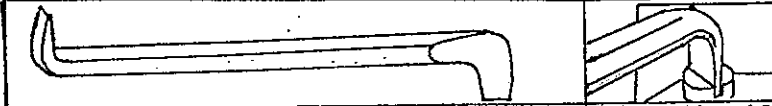
Socket Set Screwdriver Heads - most socket spanner sets have a screwdriver head included. These should only be used on large size



M2/5/3

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.

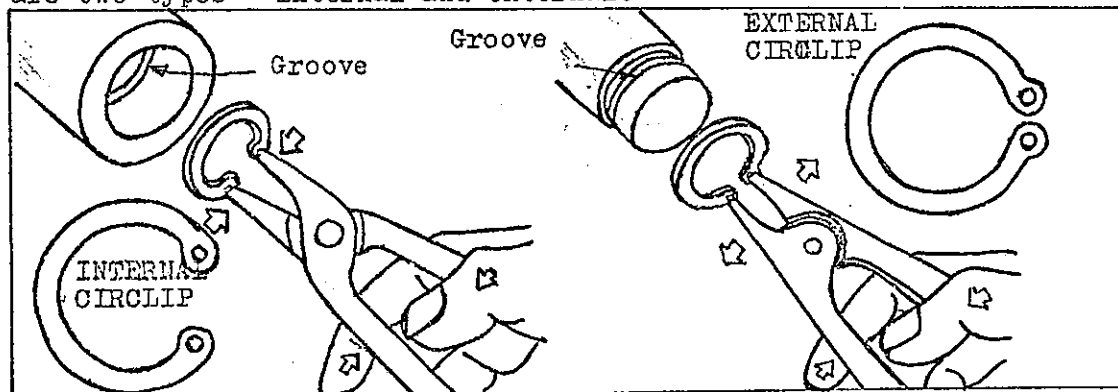
Spiral or Yankee Screwdriver - converts downward motion to turning motion, also incorporates a ratchet.

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.



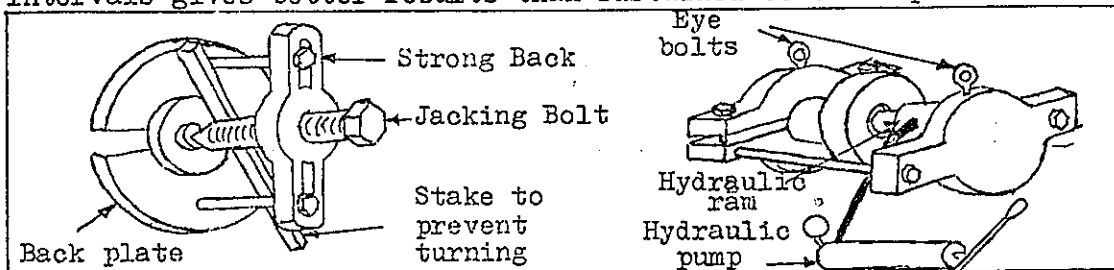
M2/6/1

TITLE:- GEAR AND BEARING PULLERS
LECTURER:- GERRY HEWITT
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

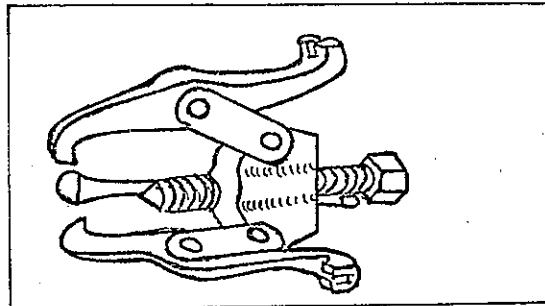
Most methods use the system in which a slotted back plate is placed behind the item to be removed. A strongback or slotted steel bar with a large, fine threaded and pointed jacking bolt through the centre is bolted to this plate. The jacking bolt is tightened onto the shaft. The back plate is staked 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.



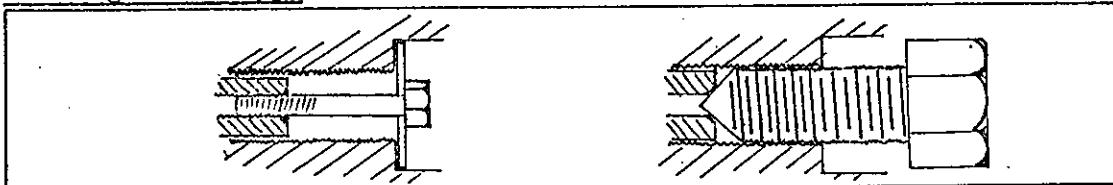
A variation of the same method is for the screw to be replaced by an hydraulic ram. In the illustration the back plate is this time a split type which bolts together on the side. Note the eye bolts on the front and back plates. With large items, the front and back plates can weigh several Kg. and should 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.

0

0

0

0

M2/7/1

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

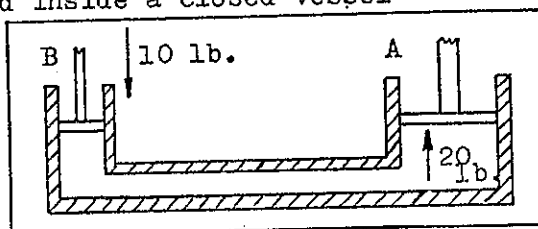
Hydraulic equipment uses the principles:-

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.

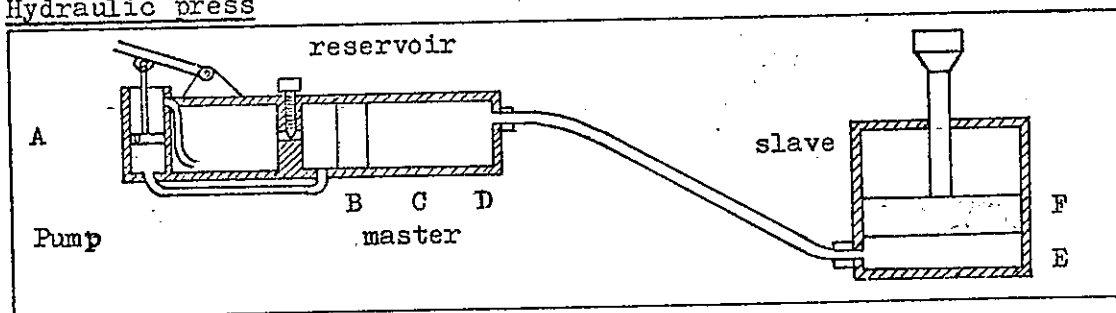


We have effectively increased force from 10 lb. to 20 lb. Any ratio of pressure may be achieved by varying the piston sizes. It should be remembered that the distance moved by piston A will be less than the distance moved by piston B.

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:-

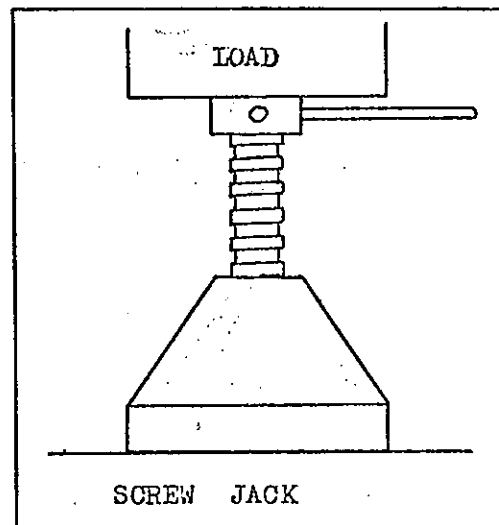
Force x distance moved

$$\begin{aligned} \text{i.e. } 10 \text{ lb.} \times 2\pi r &= 10 \times 6.284 \times 10 \\ &= 628.4 \text{ foot lbs.} \end{aligned}$$

The work done in lifting the screw thread is also:-

Force x distance moved

$$\begin{aligned} \text{i.e. } 628.4 &= \frac{1}{4} \times \text{force} \\ \text{force} &= \frac{628.4}{\frac{1}{4}} = 2513.6 \text{ lb} \end{aligned}$$



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.

M2/8/1

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 done 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 is 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.



M2/9/1

TITLE:- CRANES & MECHANISED HANDLING EQUIPMENT

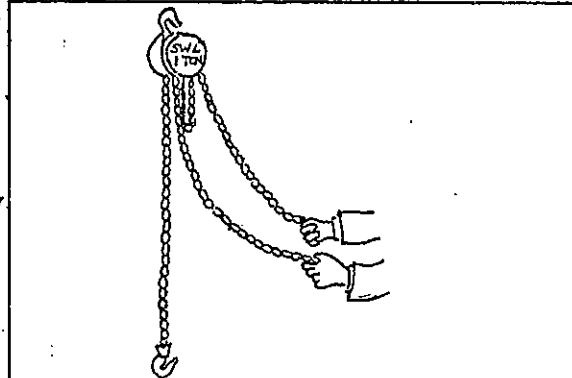
LECTURER:-

DATE:-

EQUIPMENT:- Pulley block, Hydraulic lift

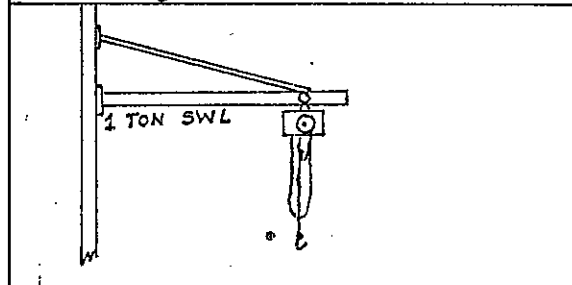
Pulley Blocks:-

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.

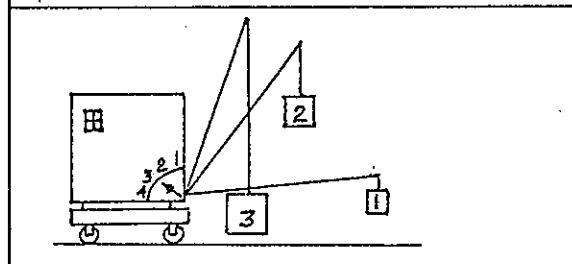


Jib cranes:-

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.

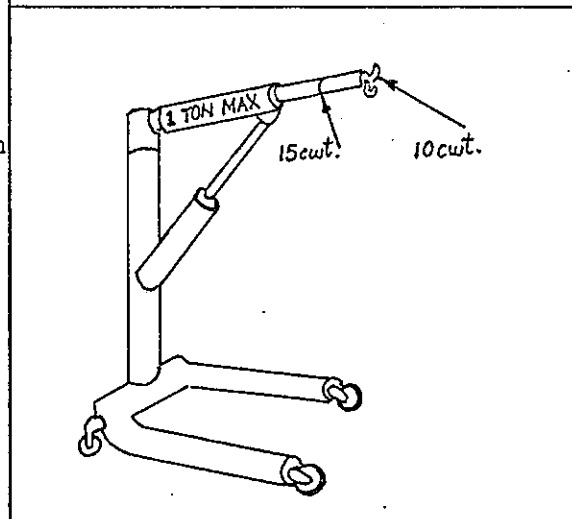


The steeper the jib, the greater the S.W.L. An indicator shows the S.W.L. at each angle of the jib. Always refer to it.



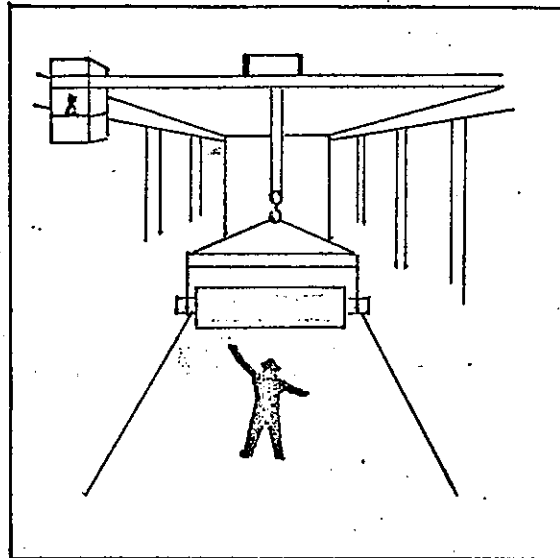
Hydraulic Lifts:-

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:-

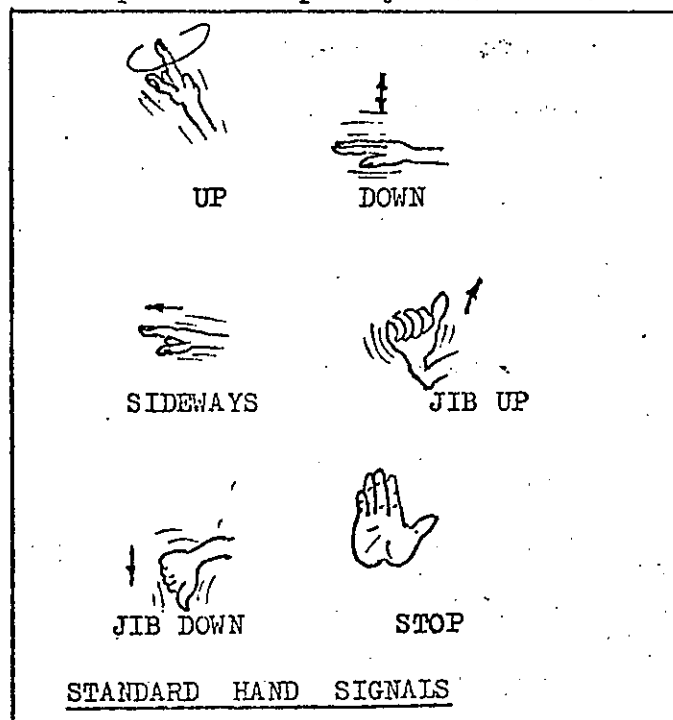
When these are fitted with a driving cab, they must be operated by a trained driver. He works with trained slinger. Smaller travelling cranes are operated from ground level by an AUTHORIZED person, using a suspended push-button control box. All lifts must be in charge of one man, and he shall transmit 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.



M2/10/1

TITLE:-

SLINGS

LECTURER:-

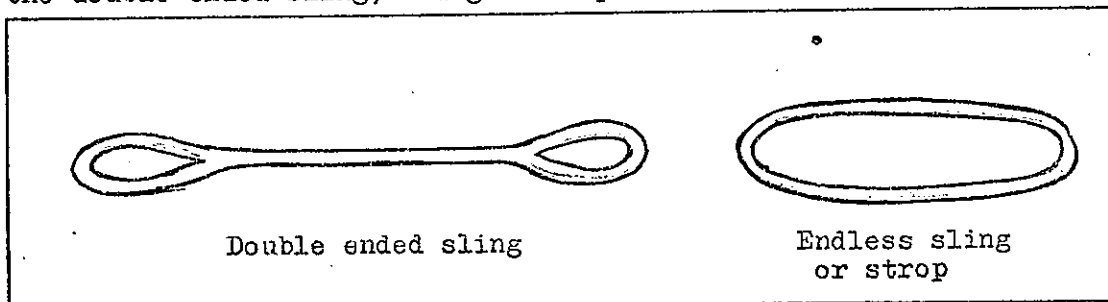
DATE:-

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 guide rope, or where an item is to be manoeuvred rather than lifted. Types of Manila sling obtainable are:- the endless sling or strop, the double ended sling, and guide rope.



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.

Lubrication - 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.

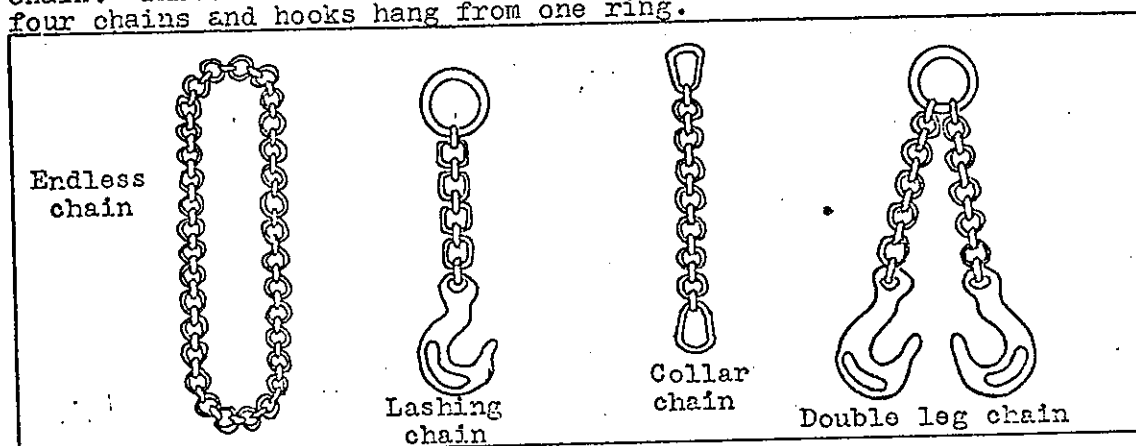
Types of steel wire rope slings - Endless, double ended and "lashing" (a long straight length).

Gloves should be used at all times when handling steel wire rope slings.

Chains 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.

Disadvantages - 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 inopportune moment.

Types - 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.



Rigging Aids and Special Purpose lifting devices

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.

Shackles - 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.

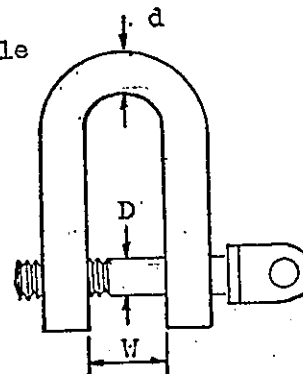
Shackles must not be:-

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

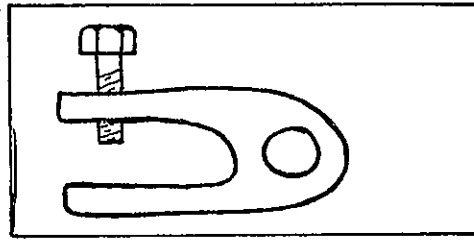
Defective shackles must be REPLACED.

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 5/8	2 3/8	4	10
1 3/8	1 7/8	2 5/8	5	10
1 1/2	2	3	6	10
1 5/8	2 1/4	3 1/4	7	10
1 3/4	2 1/2	3 1/2	8	10
1 7/8	2 3/4	3 3/4	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 carcass.

Types There are two types, plain and collar.

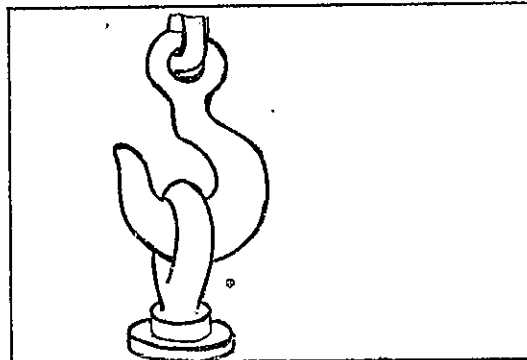
The plain eye bolt should be used for vertical lifts only.

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:-

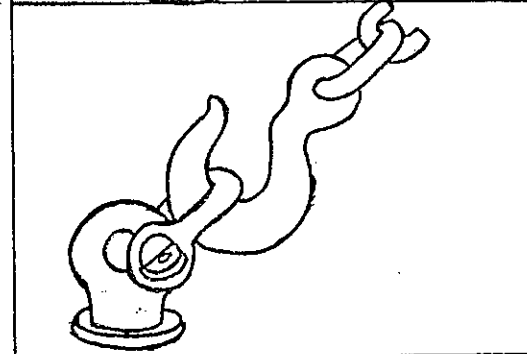
Diamond Eyebolts:-

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.



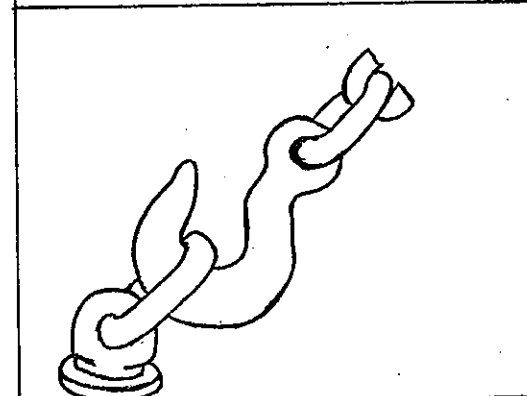
Service Eyebolts:-

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.






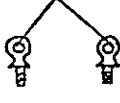
Eyebolt with link:-

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.

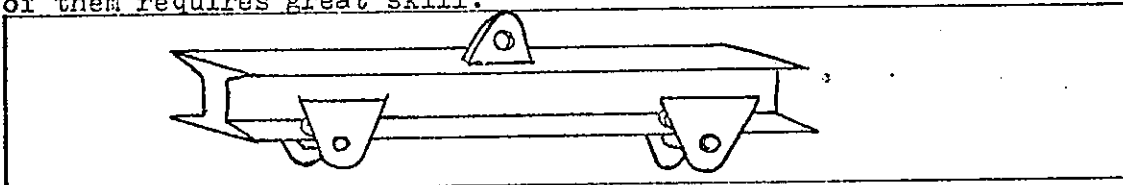


Note:- Eye bolts must not be used unless stamped with the S.W.L. (safe working load).

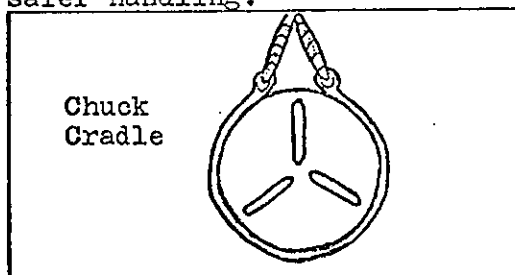
M2/10/4

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	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.



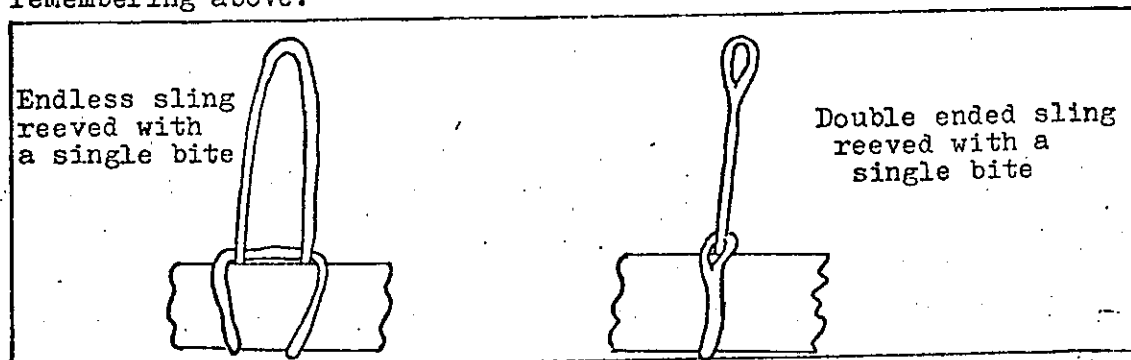
Chuck
Cradle



Mitre
Cradle

Slinging Techniques

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

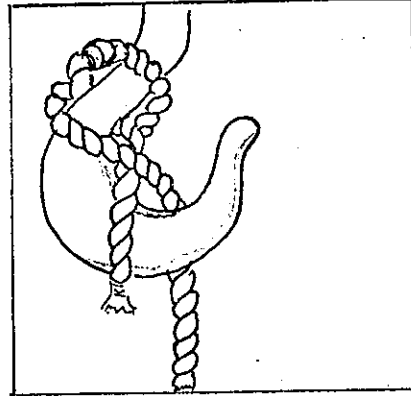


Endless sling
reeved with
a single bite

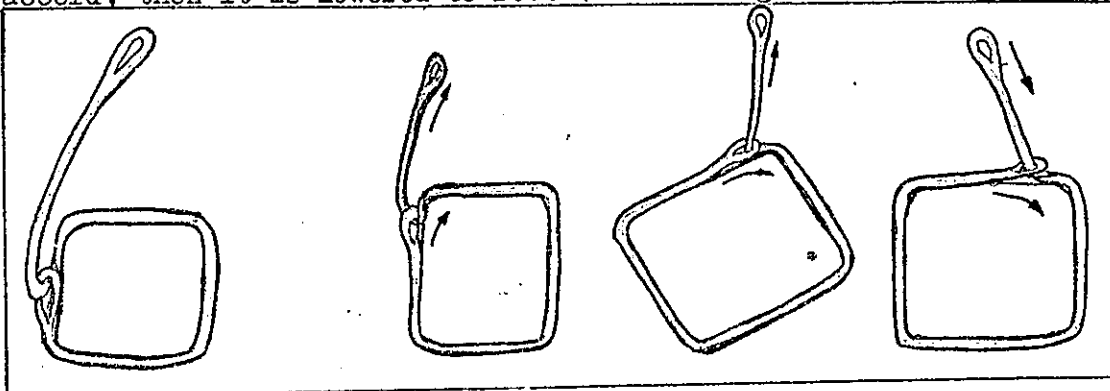
Double ended sling
reeved with a
single bite

Double Blackwall Hitch

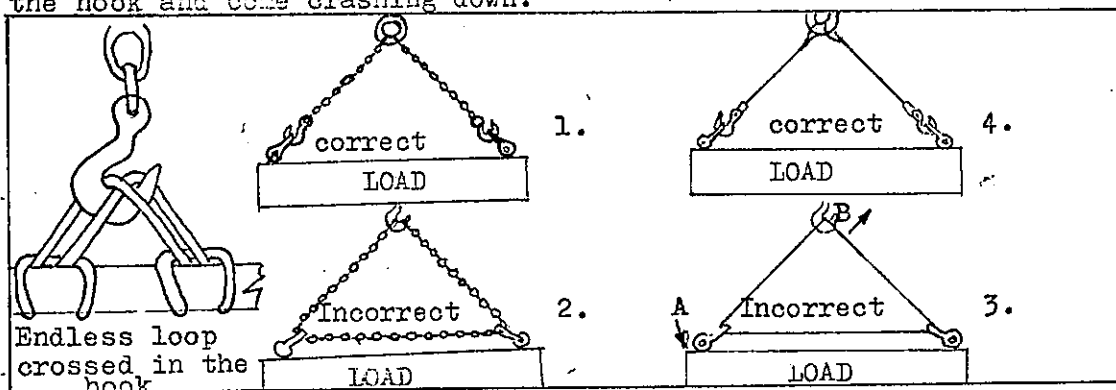
Where a loose end of a sling is to be fastened to a hook, then the "Dead" end of the sling is put over the hook. The "Live" (end going to the load) end is wrapped over the dead end, round the hook twice then fed over the hook in the opposite direction to the dead end. See illustration.



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.



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.

M2/10/6

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.

M2/11/1

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.

M2/11/2

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.