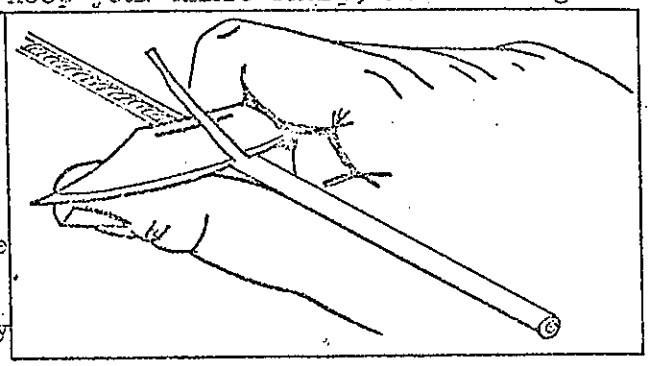
TITLE:- ELECTRICAL WIRING TOOLS AND THEIR USES

LECTURER:-

DATE:-

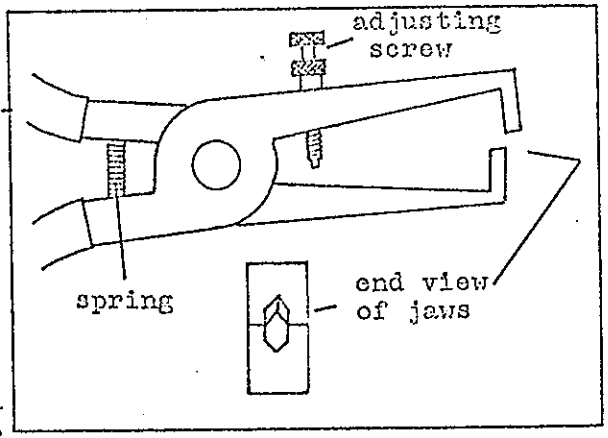
EQUIPMENT:- Knife, stripper, pliers, diagonal cutters, round nose pliers, screwdriver/spanner, crimping tool - 00, 20, Utilux combination, WZ11, WZ12, WZ13, cable cutter.

Knife
Not only a tool, but also a weapon. One of the tools that needs no explanation.
Use When using a knife always cut away from the body and any by-standers.
A blunt knife is more likely to cause accidents than a sharp one, besides making hard work. To keep your knife sharp, hone it regularly on an oil stone.



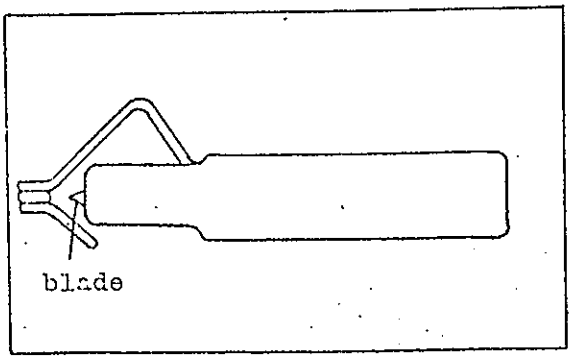
To strip the insulation from cables, hold the cable in the left hand. Hold the body and base of the knife in the palm of the right hand with the blade lying flat against the index finger, sharp edge toward the wrist. Put the blade behind the cable and almost flat to it. Draw the knife along using the thumb to apply pressure to the front of the cable. To cut off the insulation, bend it back, hold the bottom against the cable and cut off the loop thus formed.
Do not leave open knives lying around, especially with the sharp edge uppermost. Don't throw or lark about with knives; remember, in the eyes of the law, they are an offensive weapon.

Stripper Type 1 Plier Type
This is another type of plier. It consists of a plier type construction with a lockable adjusting screw which sets the closing of the jaws to any desired setting.
The jaws are at right angles to the handles with overlapping V-shaped blades.

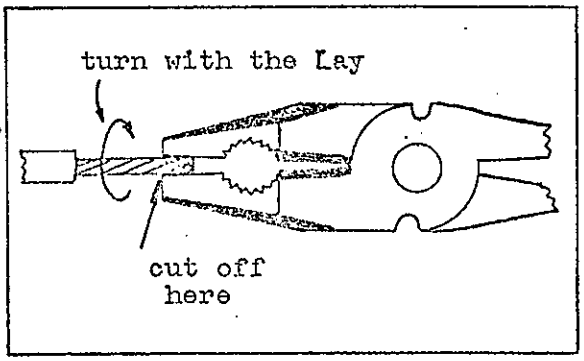


Operation Set the blades so that they cut part way through the insulation, open pliers, turn slightly, and pull off. Examine the conductors. If they have been nicked at all, cut off, reset the jaws and start again. Even a slight nick reduces the conductor's pliable strength considerably, and this is the part that is bent most.

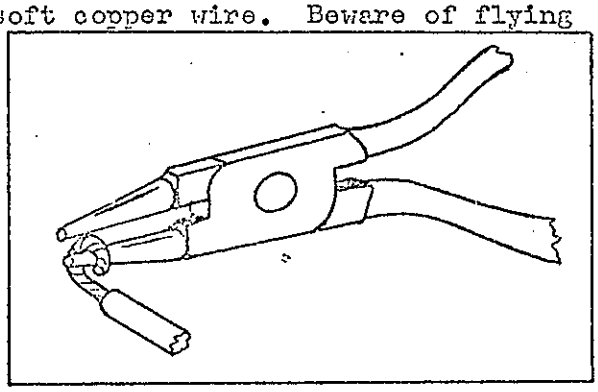
Type 2 Spring Loaded Type
This consists of a square handle with a spring loaded metal strip with a small blade in the handle: see diagram. To adjust, a screw at the base of the handle screws the blade in and out to give a deeper or shallower cut.
Very safe to use, but can do damage to the cores. Used mainly for stripping outer braiding.



Pliers
Previously described in detail.
Electrical Use - Used in electrical work as cutters and to grip objects, previously described. To twist conductors into shape for entry into connectors.
To do this correctly, grip the end of the conductors with the centre of the flat jaws, with the pliers in line with the conductor. Twist the strands by turning the pliers in the hand, in the same direction as the lay of the cable and pulling at the same time. Then snip off the end bit.



Diagonal Cutters These were previously described.
Electrical Use - To snip off the conductor ends as described in "Pliers". Also for cutting any soft copper wire. Beware of flying ends.



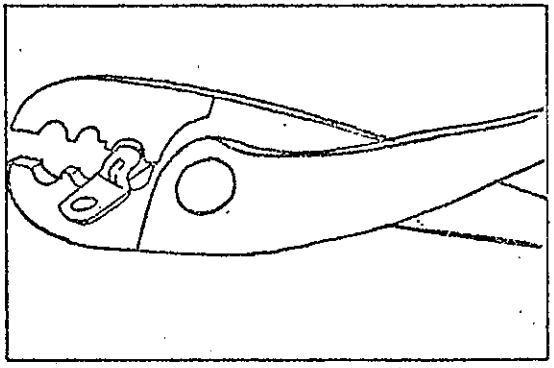
Round Nose Pliers are normal plier action, but are made with tapered, rounded conical shaped jaws.
Use - these are used to make bends, loops and other shapes in conductors.

Screwdrivers Previously described, but in electrical work, where small parts are involved, care must be taken not to pierce the hand. Put parts onto the bench to screw them, rather than hold in the hand.

Spanners Previously described. In electrical work care must be taken that nuts and bolts, made more to cater for their conductive properties than strength, are not sheared off.

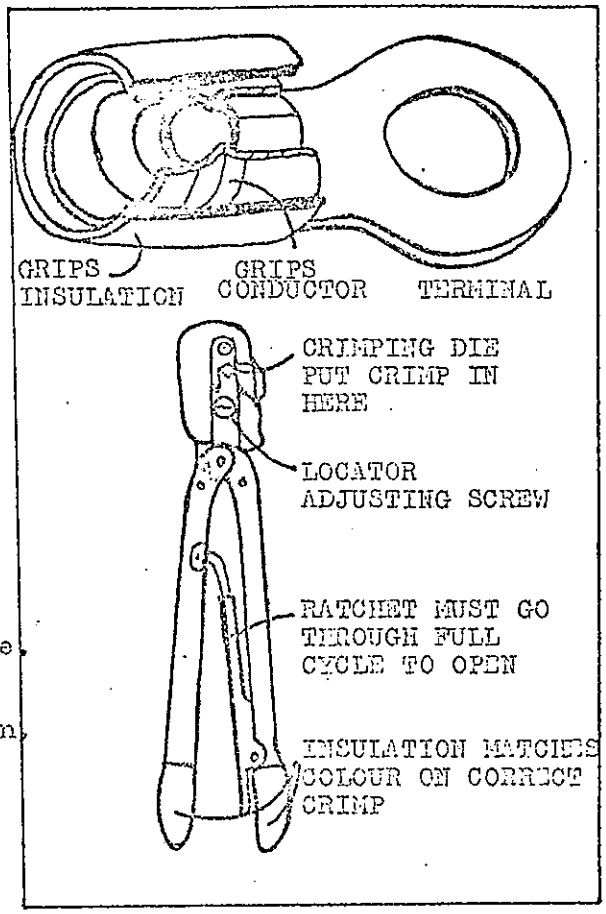
Crimping Tools Used for securing "crimp-lugs" to the ends of cables, to ensure a secure electrical and mechanical termination.
Use the correct size and type of crimp-lug (see Safety Handbook).
Use the correct size and type of crimp tool, and ensure that it is used in the proper manner with the proper pressure.

Plain Crimping Tools & Lugs
Utilux type used on non-insulated lugs - several sizes covered by each size set of pliers. Straightforward pliers action.
The crimp lugs are provided with small holes at the opposite end to the cable entry hole. Push the lug onto the wire until you can see the end of the wire through the hole; this will be the correct position.
Sizes - The size of crimp-lugs are given by the size of lug and hole diameter.



Insulated Crimp Lugs and Crimping Tools

Insulated Crimp Lugs have 3 sections instead of 2. The top portion fits onto the terminal. The second portion grips the conductor and the third portion grips the insulation. An insulation sleeve is around the cable entry section, the colour of which corresponds to the colour of similar sleeving on the handles of the crimping tool.



Crimping Tools This type of tool is much more complex than the plain type. They are double pivoted to give more leverage. To ensure correct crimping pressure, they are fitted with a ratchet so that the lug cannot be removed from the tool until the crimping cycle is complete. The crimping jaws for the insulation part can be adjusted for 3 different settings by removing a pin in each section and positioning it in a separate hole. The conductor jaws are set and, cannot be adjusted. A spring loaded positioning anvil is often, but not always fitted.

To operate - Put the cable into the lug so that the conductor or conductors protrude through the hole at the terminal end and the insulation is upto the narrow section. Cut off excess conductor. Put the lug and conductor into the crimping tool so that the terminal end goes through the anvil and the conductor part butts up to it. Close the handles.

Make sure you don't trap a portion of skin in any part of the tool, because to get it out, the crimpers have to be stripped into pieces or the crimpers pressed through the full cycle.

Cable Cutters

Special cable cutters are available that will cut through even welding cable in one cut. They are straightforward pliers action. These cutters must not be used for any other purpose than cutting standard copper conductors.

Whilst using all these tools, bear in mind the following:-

(a) Avoid cutting or damaging the conductor.
(b) Avoid cutting or damaging the insulation.
(c) Avoid injury to yourself or others.
(d) Use the proper tool for the job.
(e) If in doubt, ask.

TITLE:- WIRING PRACTICE

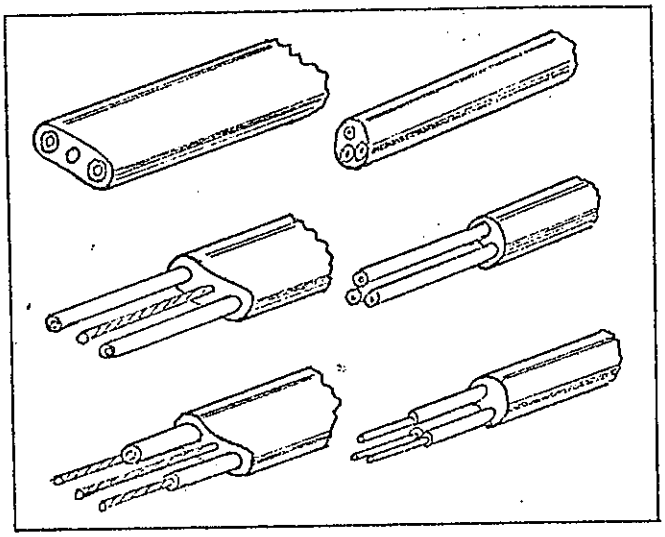
LECTURER:-

DATE:-

EQUIPMENT:- Cable, terminals, crimp lugs, crimp links, crimp tools, claw-washer, shell clamp, rowco strip, blew point, utilux terminal, cable forms.

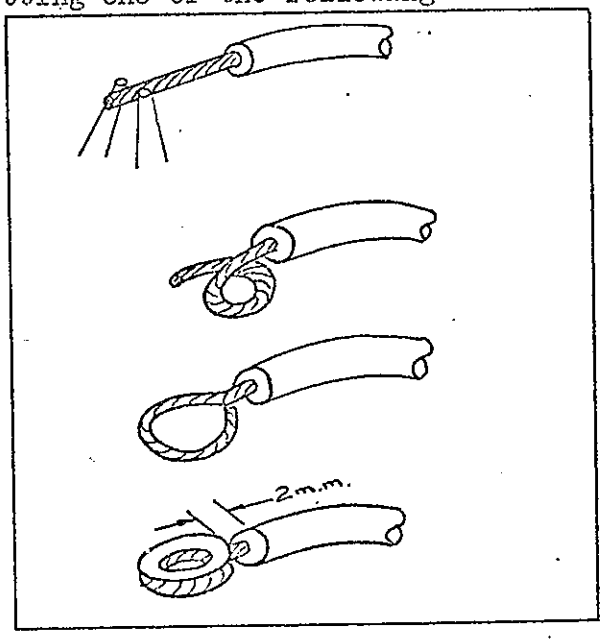
Once it is learned how to use the electrical tools, the next logical step is to apply the use of these tools into electrical practice, i.e. terminating, jointing, installing of cables, wires, and equipment associated with electrical practice.

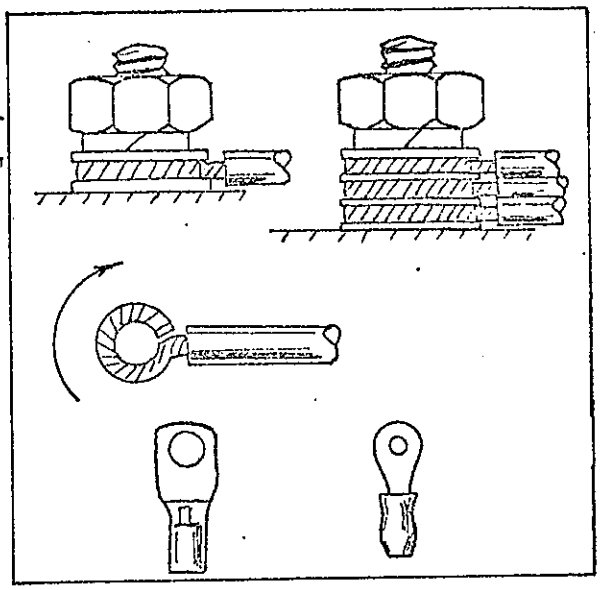
Terminations - a termination is the name given to the connection made between a cable or wire and an item of electrical equipment. Before the termination can be made, the cable end must be properly prepared.



(1) Measure the length of cable required.
(2) Cut off cable leaving approx. 1" extra length to that required.
(3) Remove the cable sheath to the desired length.
(4) Remove cable insulation to required length (use wire stripper on flexible wire, and knife on stranded wire) Do not damage copper conductors.
(5) Twist the strands of wire to tighten the "lay" (Use pliers on stranded wire, and fingers on flexibles).
The cable end is now ready for fitting one of the following terminating devices.

Wire Loop
The simplest form of termination is the wire loop. No extra equipment is required, and it is therefore the least expensive. The end of the wire is gripped with the round nosed plier, it is then twisted for approx. half a turn. The pliers are then re-positioned further along the wire. The process is repeated until a full loop or more is formed. The remaining straight part of the wire is then bent in the opposite direction, and excess wire is cut off. The loop must not overlap itself, and sufficient length must be left between the end of the insulation and the loop for washers.
A space of approx. 2mm should exist between the edge of the washer and the insulation.
This type of termination is used where "bolt type" terminals are used.

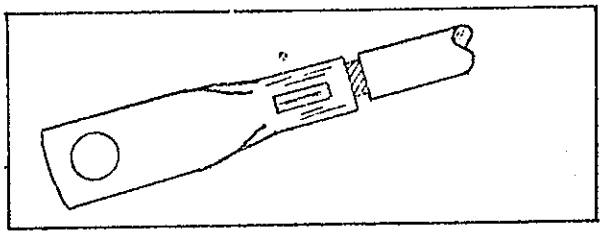




Washers should be placed on each side of the loop, with a spring washer and nut being used to secure the termination.
Where several loops are "stacked" on a bolt, then a washer must be placed between each loop, and the loop must be a snug fit on the bolt. It must be fitted so that as the nut is tightened, the loop will also tighten, i.e. clockwise.

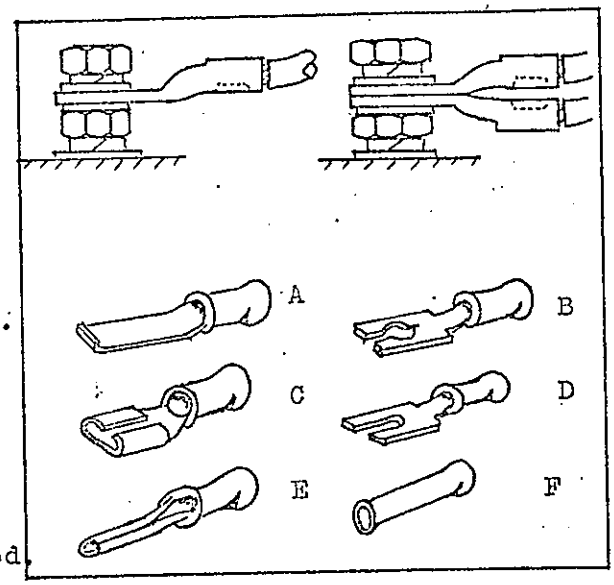
Crimp lug
Two types of crimp lug are available. One is the "Utilux" non-insulated type, the other is the A.M.P. insulated lug. A tool known as a "Crimping Plier" is used for fitting these lugs. It is extremely important that the proper tool is used on each type and/or size of lug. The table below gives the necessary information.
(See Page M7/2/2A)

Further information on crimp lugs may be found on pages 95 & 96 of the Electrical Safety Handbook. The method of using the crimp tools is illustrated in the diagram. Note that the Utilux tool is used so that the indentation is on the opposite side to the letters printed on the lug.



mm^2	Cond. Size	Max. Current	No. Cores	Core Colours	Cable Type	A.M.P. lug	Hole Size
.75	24/.2	7.5	1	Bk	Flexible		
"	"	"	"	R	"		
"	"	"	"	Bl	"		
"	"	"	"	W	"		
"	"	"	"	G	"	RED	
"	"	"	3	Bn, Bl, G	Flex.Cord		
"	"	"	2	W, W	Fig. 8	31885	1/8
						31890	5/32
1	32/.2	10	3	Bn, Bl, G	Flex.Cord	31891	3/16
"	"	"	5	Bn,Y,Bk,Bl,G	" "	31894	1/4
"	1/1.13	14	1	Bk	Panel Wire		
"	"	"	"	R	" "		
"	"	"	"	Bl	" "		
"	"	"	"	W	" "		
"	"	16	2	R, Bk	Bldg.Cable		
"	"	13	4	R, W, Bl, G	" "		
1.5	30/.25	15	1	Bk	Flexible		
"	"	"	"	R	"		
"	"	"	"	Bl	"		
"	"	"	"	W	"		
"	"	"	"	G	"		
"	"	"	5	Bn,Y,Bk,Bl,G	Flex.Cord	BLUE	
"	1/1.38	20	2+E	R, Bk	Bldg.Cable		
"	"	17	3+E	R,W,Bl	" "		
"	"	20	2+E	Bk, W	" "		
"	"	"	"	R, W	" "	32442	1/8
						31901	1/8
2.5	7/.67	23	1	Bk	Panel Wire	31902	5/32
"	"	"	"	R	" "	31903	3/16
"	"	"	"	Bl	" "	31906	1/4
"	"	"	"	W	" "	31907	5/16
"	"	"	"	G	" "		
"	"	28	2	R, Bk	Bldg.Cable		
"	"	"	2+E	R, Bk	" "		
"	"	23	3+E	R,W,Bl	" "		
"	"	"	4+E	R,W,Bl,Bk	" "		
"	50/.25	20	4	Bn,Bl,Bk,G	Flex. Cord		
4	56/.3	25	1	Bk	Flexible		
"	"	"	"	R	"		
						YELLOW	
6	88/.3	44	2	R, Bk	Flex.Cable		
"	"	41	3	R,Bk,G	" "	35109	3/16
"	"	"	4	R,W,Bl,G	" "	35110	1/4
"	7/1.04	39	1	Bk	Panel Wire	35111	5/16
"	"	"	"	R	" "	35112	3/8
"	"	"	"	Bl	" "		
"	"	"	"	W	" "		
"	"	"	"	G	" "		
"	"	47	2+E	R, Bk	Bldg.Cable		
"	"	40	3+E	R,W,Bl	" "		

The handles must be squeezed as tightly as possible. The AMP tool has a ratchet to ensure that correct pressure is used. Be sure that the lug is placed in the tool in the proper direction.

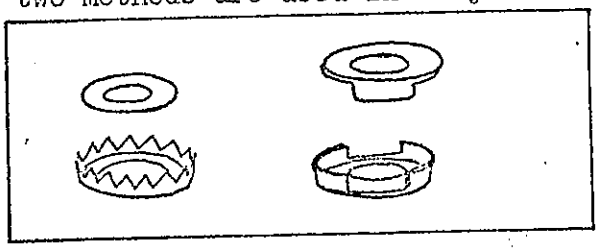


Crimp lugs are usually fitted to bolt type terminals, and should be mounted as illustrated. Other types of lugs are:-

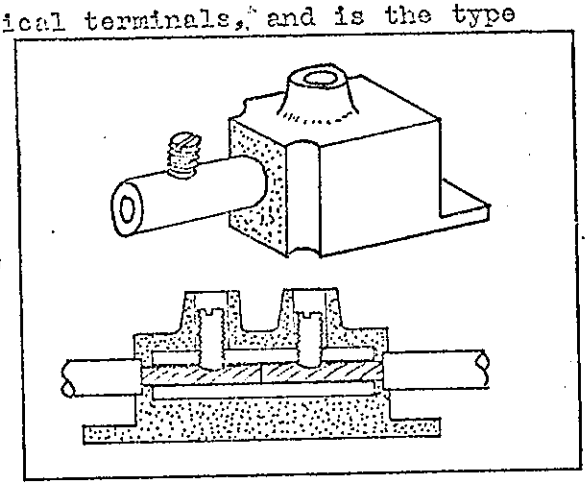
Lip blade - - - - A
Spring blade - - B
Faston - - - - - C
Spade - - - - - - D
Pin - - - - - - - E
Link - - - - - - F

An example of each is illustrated.

Claw-washer & Shell clamp These two methods are used in conjunction with the wire loop, and are more secure than the wire loop.
Both types have mostly been replaced by the crimp-lug, but some may still be in use.
Examples of both are illustrated.



Tunnel connectors
This covers a wide range of electrical terminals, and is the type where the wire or wires are inserted into a brass tube and secured by one or more screws. The brass tube is usually covered with p.v.c. or bakelite insulation.
The wire strands must be tightly twisted and pushed as far as possible into the tube or "tunnel" to ensure proper grip. If the wire is small in comparison to the hole in the tunnel, it should be doubled or tripled so that the screw grips properly. This reduces the risk of the screw squashing or cutting the wire.



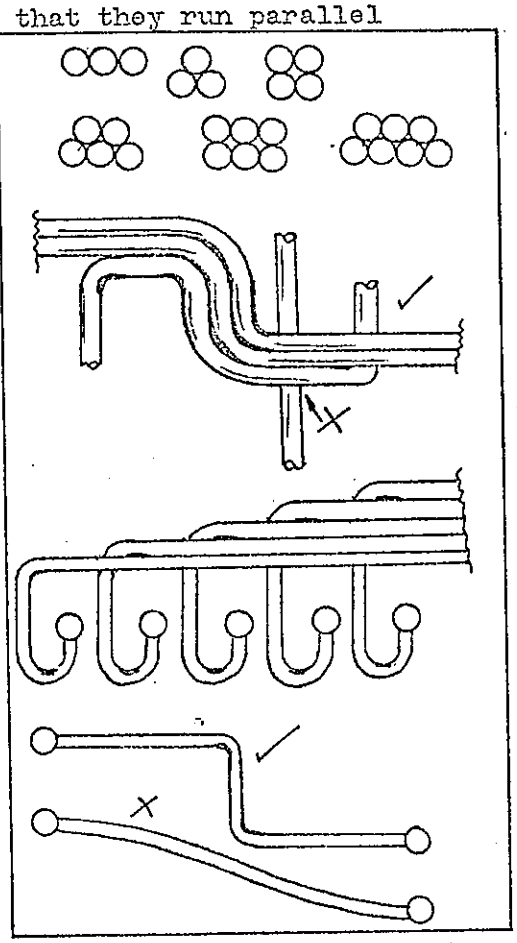
Installation of wiring and cable
Factors which must be considered when an installation is being made are:-

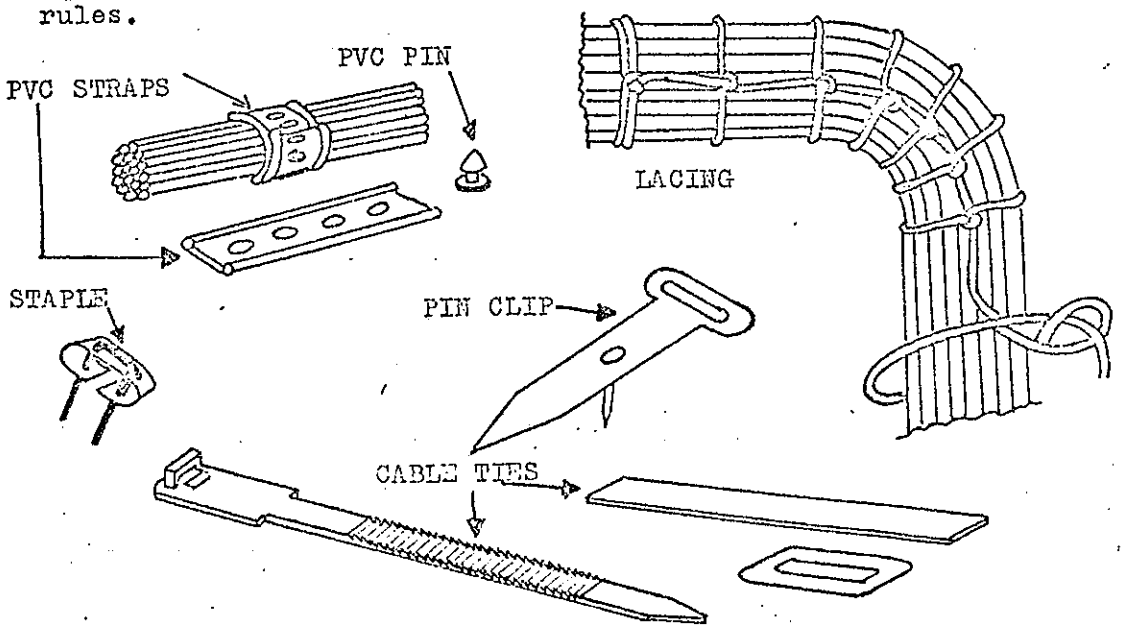
1. The correct circuit
2. Neatness of wiring and cabling
3. Economical planning of wire and cable routes
4. Proper size and colour of wires.

1. The correct circuit may be achieved regardless of its complexity, by approaching the job in a logical manner.
   1) Learn the electrical symbols used.
   2) Obtain or make a "WIRING DIAGRAM".
   3) Study the diagram.
   4) Obtain all materials and equipment before starting.
   5) Use cable markers to identify the ends of each wire as it is installed.
   6) Test each wire for continuity as it is connected.
   7) Ensure that all terminals are FULLY tightened as they are installed.

2. Neatness of wiring & cabling is sometimes difficult to achieve for the apprentice, but with practice, it is possible to achieve the desired standard on every installation. Some factors which go towards a neat installation are:-

1) Install all wires and cables so that they run parallel to each other.
2) Arrange bundles of wires into neat formations as illustrated.
3) Bend single wires over the thumb, not with any tool.
4) Do not allow gaps to appear between adjacent wires - especially on bends.
5) Where wires must cross from one side of a loom of wires to the other, run that wire for a short distance with the loom, and do not make direct cross-over.
6) Leave a small loop at the end of each wire as it is "peeled" off of the loom onto a terminal strip.
7) As each wire is peeled off from the loom, it should be looped underneath the loom, not on top.
8) Where bends are made in wires, endeavour to make 90° changes of direction.
9) Earth wires to individual components must originate at an EARTH BAR, i.e. no looping.
10) Neutral wires to individual components must originate at a NEUTRAL LINK, i.e. no looping.
11) Active wires to individual components may NOT be looped unless the terminal size limits the number of wires originating at that terminal in which case looping is permitted providing that the addition of the load currents and the cable's current carrying capacity are within the limits.
12) Secure the looms of wire using one of the following methods - Lacing, P.V.C. straps and pins, cable ties, pin clips, staples. Whichever method is used, the spacing should be equal and conform with the requirements of the SAA wiring rules.





3. Economy Copper wire is expensive and should not be wasted. The route which wires and cables take should be as short as possible but in a manner which ensures neatness.
Allow sufficient "spare wire" at each end to ensure that the termination can be neatly fitted, and so that it can easily be removed for testing.
Think before installing a wire or cable or cutting the wire or cable as mistakes can prove to be expensive.

4. Size & Colour of Wires The wire size is determined by the current which it must carry and the voltage drop along its length. Current carrying capacities of cables are tabled in the Safety Handbook. Pages:-
Voltage drop must not exceed 5% (SAA rules).
Wire colours are in the process of being changed to a new standard. So far, flexible cords are covered by the new code, although many are still in use made to the old code.
A comparison is shown below.

		No. of Cores									
	Old Code	1	1	1	2	3	3	4	4	5	5
Active	R	Bn			Bn	Bn	Bn	Bn	Bn	Bn	Bn
Active	Y						Bl	Bl	Blk	Blk	Y
Active	Bl						Blk	Blk	Y	Y	Or
Active											Blk
Neutral	Blk		Bn		Bl	Bl			Bl	Bl	Bl
Earth	Gr			Gr/Y							

R - Red, Y - Yellow, Bl - Blue, Blk - Black,
Gr - Green, Or - Orange, Bn - Brown

All standard cables at present are made to the old code and their colours are as shown in the first column above.

IMPERIAL	METRIC (mm²)	STRANDED	FLEXIBLE	WELDING FLEXIBLES	CURRENT(A
1/.044					8
3/.029					10
3/.036					15
1/.064					15
	1	7/0.4	32/0.2		16
	1.5	7/0.50	30/0.25		19
1/.029					20
	2.5	7/0.67	50/0.25		27
	4		56/0.30		36
7/.036					45
	6	7/1.04	88/0.30		46
7/.044					55
	10		77/0.40		62
7/.052					70
	16	7/1.70	126/0.40	511/0.20	83
7/.064					90
19/.044					105
	25		209/0.40		110
19/.052					120
	35	19/1.53	285/0.40		140
19/.064					165
	50	19/1.78	308/0.40	703/0.3	180
19/.072					190
19/.083					225
	70	19/2.14	203/0.67	988/0.3	230
37/.064					250
	95				280
37/.072					290
	120		336/0.67		320
37/.083					350
	150	37/2.25			370
37/.093					405
	185				435
37/.103					460
	240	61/2.25			510
61/.093					545
	300				600
61/.103					620
	400				680
91/.093					690
	500	61/3.20			790
91/.103					800
127/.093					860
	630	127/2.52			900
127/.103					950

FLEXIBLE CORDS

IMPERIAL AREA IN^2	METRIC AREA MM^2	IMPERIAL STRANDING	METRIC STRANDING	IMPERIAL CURRENT	METRIC CURRENT
.0006	0.5	14/.0076	16/.02	2	3
.001	0.75	23/.0076	24/.02	7.5	7.5
.0017	1.0	40/.0076	32/.02	10	10
.003	1.5	70/.0076	30/.25	15	15
.0048	2.5	110/.0076	50/.25	20	20
.007	4	162/.0076	56/.30	30	25

TITLE: Conduit

LECTURER:

DATE:

EQUIPMENT: Steel and PVC Conduit
Bending Spring
Conduit Benders
Jointing Cement

Conduit is the name given to the tubing used to house and protect cables in electrical installation. Two types of rigid conduit are available:

1. Steel screwed conduit
2. PVC Conduit (Poly Vinal Chloride)

Each type will be used according to the required situation.

Steel Screwed Conduit

This is manufactured in three standard finishes of black-enamelled, galvanised and orange-enamelled.

All steel conduit size is specified by it's outside diameter (0.1).

The range of conduit available is 16.20.25.32.50 mm. With a thread pitch of 1.5 mm.

Welded steel conduit is manufactured from hot rolled carbon steel strip. The strip is first shot blasted to remove all scale. It is then rolled and the edges of the seam are raised to welding temperature (usually by high frequency heating and welding by squeezing the edges together).

The most used steel screwed conduit is the galvanised type.

Steel conduit has approximately ten times the tensile strength of PVC conduit. This allows it's use where exposed to severe mechanical injury and insituations described in S.A.A. Rule 3.25.1.

It is extremely rigid in the allowable distance between support being 2 m (Rule 3.25.10.). It's melting point is about 1341°C which is higher than the temperature at which cable insulation failure occurs

It is not flammable and it's coefficient of expansion is relatively low. If done properly, the threaded joint method of coupling is both electrically and mechanically sound.

Steel conduit also provides an earthed screen for the conductors enclosed.

Conduit should be so installed that it can be readily dismantled and reassembled if alterations or extensions are necessary.

Whether the conduit is used for surface wiring with inspection fittings or for concealed wiring with "draw-in" boxes.

The cables are drawn-in after the conduit has been installed as part of a new installation or replaced at any later time if repairs or alterations are necessary.

Rule 3.25.2. allows the substitution of steel piping for steel conduit provided that the condition listed in the rule are followed.

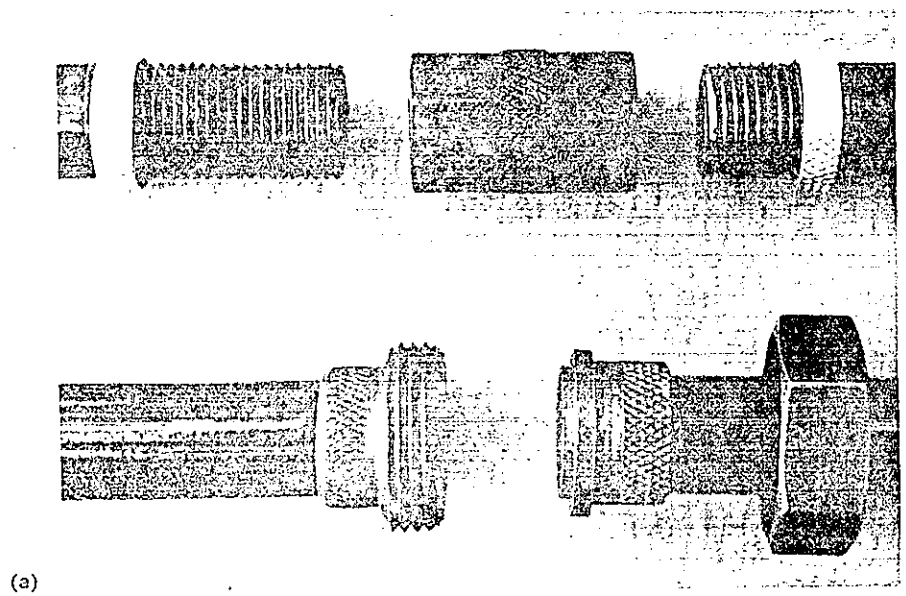
Conduit is cut by holding it firmly, preferably in a "pipe vice" and using a hacksaw with a 32TPI blade.

Threading is effected by holding it firmly in a pipe vice and using a block type stock and die or a stock with four individual adjustable dies. Lubrication must be provided when threading.

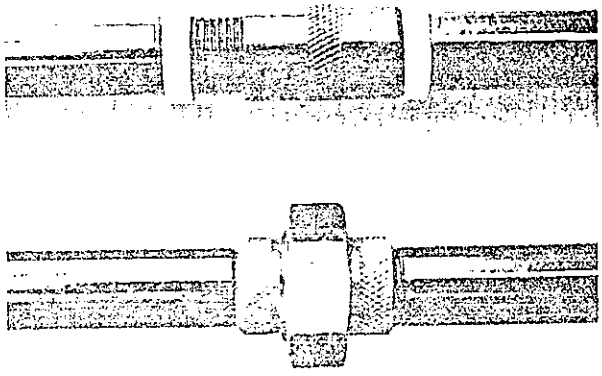
After threading, all internal burrs must be removed to prevent damage to cable insullation. A round file or similar tool is used for this purpose.

The thread should be clean, be a firm fit in an accessory and be half the length of a standard coupling.

Ideally, when screwed into an accessory, there should be no exposed thread except where locknuts are used with a "Running Thread".



(a)



(b)

Fig. 8.2 (a) (b) Joining metal conduit using a "running thread" or a manufactured "union"

It is important to realise that where the protective coating of the conduit has been removed, it is necessary to restore this protection by applying some sort of protective coating (Rule 3.25.6), (Lead compound, graphite compound).

Where conduit is used for concealed wiring, use of tees and elbows should be avoided. Change of direction is accomplished by large radius sets or by using conduit bends, thus permitting easy drawing-in of the cables.

On surface work inspection fittings are used. Wherever possible conduit sets should also be used as they are "labour-saving" and make drawing-in easier.

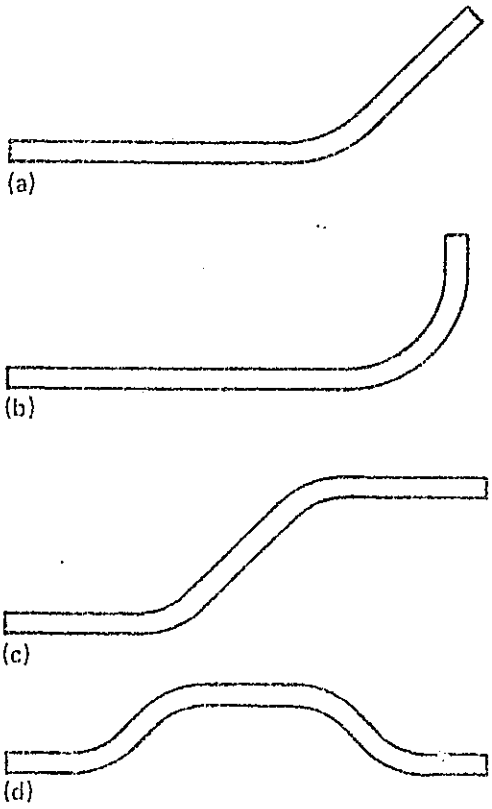


Fig. 8.3 Four sets used commonly in conduit work: (a) Set; (b) 90° set or bend; (c) Double set or offset; (d) Double offset

Bending of conduit must be in such a way that it will not cause distortion of the conduit wall, open a weld or reduce the inside diameter of the conduit (Rule 3.25.8).

Bending can be done using:

1) Setting Block: consisting of a piece of hardwood, with a clearance hole for the conduit near one end with the hole entrance chamfered. The conduit is set in a series of short bends shifting the conduit position in the hole after each bend.
2) A commercial bender
3) Automatic bending machine
4) Any two fixed smooth objects as long as they are not going to be damaged in the process.

Installation

When planning a conduit installation remember these points:

Plan the route

Minimise the number of bends, elbows etc.

Run a draw wire through the conduit

Take care when bending

(No kinks, split conduit, sharp bends)

No burrs

Comply with the S.A.A. rules

1. Continuity
   Rule 5.3.3. 5.4.
2. Corrosive Atmosphere
   Rule 3.25.5.2. 3.25.5.3.
3. Fixing
   Rule 3.25.10. 3.25.11(1.19).
4. Drawing-in Cable
   Rule 3.26.2. 3.26.3.

PVC Conduit

PoliVinyl Chloride is made to an Australian Standard specification as C 173.

Standard colours are grey, orange. This conduit is much lighter and more flexible than steel conduit, but has a very poor mechanical strength and must be supported at a maximum of 1m between fixing (Rule 3.25.3.2.).

Standard sizes are from 20mm to 50mm.

The end of the conduit is belled, thus eliminating the need for a coupling when joining.

The conduit is now used in a wide variety of applications. It's major advantages being that if used with PVC accessories, it forms a double insulated system of wiring.

It will not support combustion, but is highly resistant to chemicals and easily set in a variety of bends. Because of this and the simple method of joining, the labour time for it's installation is considerably less than that required for steel.

All sizes are easily cut by a fine-tooth hacksaw. The conduit being hand-held if possible using the knee as a "steady-rest" for the conduit.

Rule 3.25.3.1. specifies the use of an "abhesive cement" for joints. The liquid used is actually a PVC solvent (normally available from the manufacturer). It is advisable to use only this liquid for joining.

With solvent welding, it is important that both the outside of the conduit and the inside of the fitting are perfectly clean and dry. The solvent must be applied to both surfaces, jointing must be done within one minute of applying the solvent. All excess solvent is wiped off.

Bending

All bending is made with the help of an internal mandrel in the form of a metal spring. A particular spring is available for each size of conduit.

A 20mm PVC conduit may be bent cold if the ambient temperature is not below 16°C. At lower temperatures and for larger sizes, he must be applied to the conduit:

1) A stream of hot air is ideal if available.
2) A low pressure gas torch. When using a gas torch, care must be taken not to overheat the conduit or to burn it. Keep

the flame clear of the conduit, warming only the air around the bending area. A minimum radius of six times the conduit diameter is recommended.

The following characteristics should be known when using PVC conduit.

1) Expansion fitting must be used (Rule 3.25.3.2)
2) The conduit softening point is approximately 75°C and even at lower temperatures than this it may deform or lose it's rigidity.
3) Rule 3.25.3.3.(d) restricts it's use to temperature below 60°C.
4) It should not be exposed to the following chemicals:
   a) Organic Solvent - Acetone and other ~~ketones~~ Alkanones, amyl acetate and other esters, benzene and aromatic hydrocarbons and their compounds.
   Trichloroethylene and other chlorinated solvents and carbon disulphide.
   b) Oxidising Acids - Concentrated or warm solutions of nitric acid and mixtures of nitric and sulphuric acids.
   c) Never to be used where subject to severe mechanical abuse and cases defined in rule 3.25.3.3.
   d) Use only manufacturer's adhesive cement, Rule 3.25.3.1.
   e) Ultra-violet component of sunlight causes discoloration, and may cause 10% loss in impact strength.
   If PVC conduit is installed outdoors, it should be painted with a protective coat of PVA or acrylic based paint.

It is possible you may encounter a third type of conduit, "Aluminium Tubing". It's uses are very limited.

The manufacturers claim that it has three advantages:

1) Lower transport costs due to lower weight.
2) Ease of handling on site, especially people working on ladders at considerable heights.
3) Ease of threading and cutting.

The Australian Standard Association Book has no provision at this time for this type of conduit. It's acceptance or rejection is left to the inspecting authority.

Flexible Conduit

There are two types of flexible conduit:

1) Steel flexible conduit
2) PVC flexible conduit

Steel Flexible Conduit

This is made from interlocked spirals of pressed metal. It is not normally used as a complete wiring system, but is used in positions where movement could occur, like between the end of a conduit run and a motor where adjustment of the motor position is a requirement.

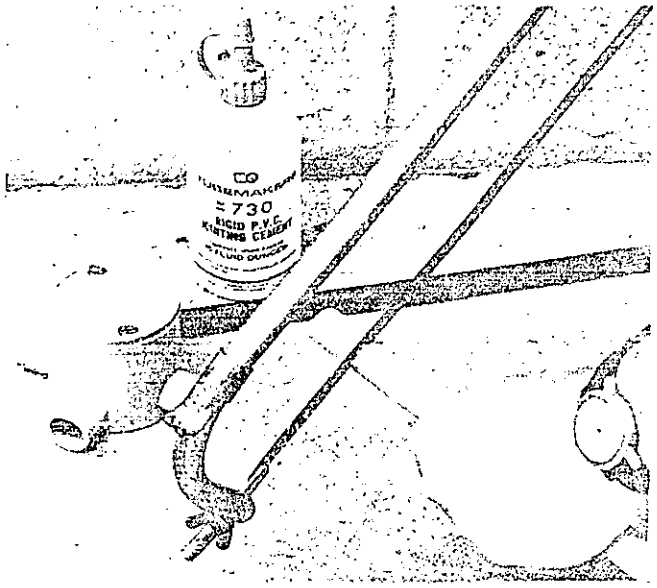
Because the diameter of flexible conduit reduces as it is stretched,a special grip type fitting must be used.

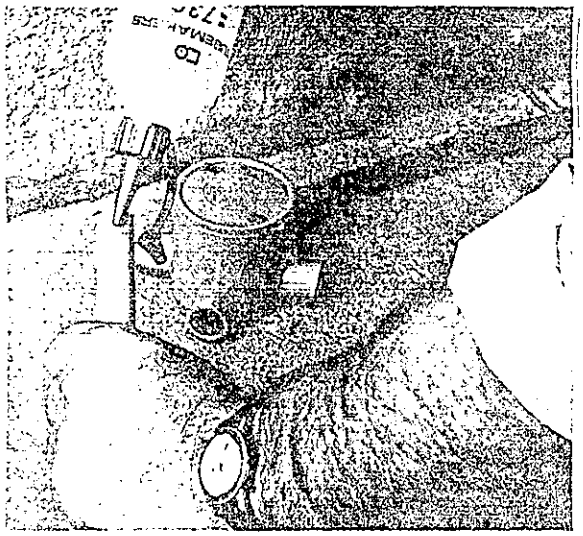
P.V.C. Flexible Conduit

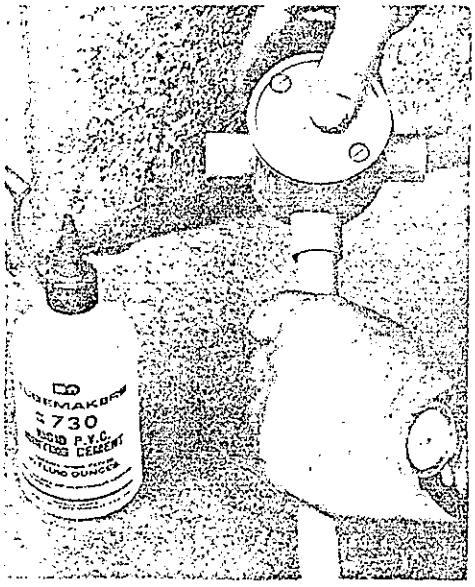
This has superseded flexible metal conduit in similar application, for example, in situations where flexibility is essential to take up movement due to vibration.

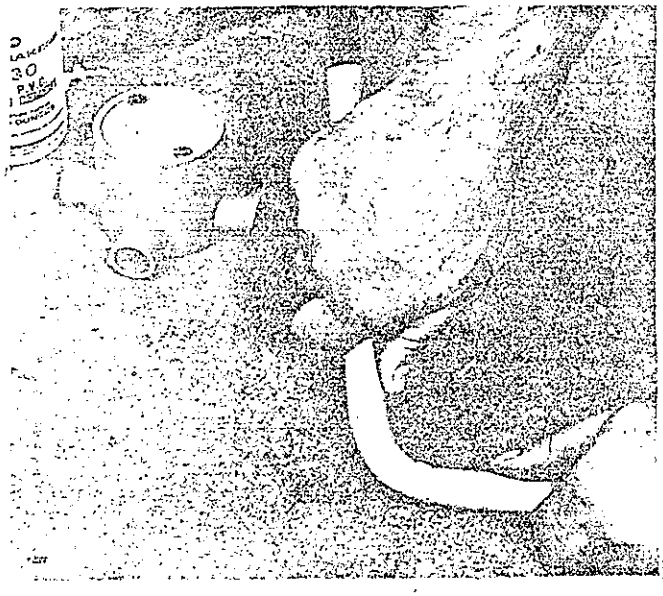
Anchoring of PVC flexible conduit must be made according to S.A.A. Rule 3.27.

Neta connectors as well as hose clips are permissible anchors.









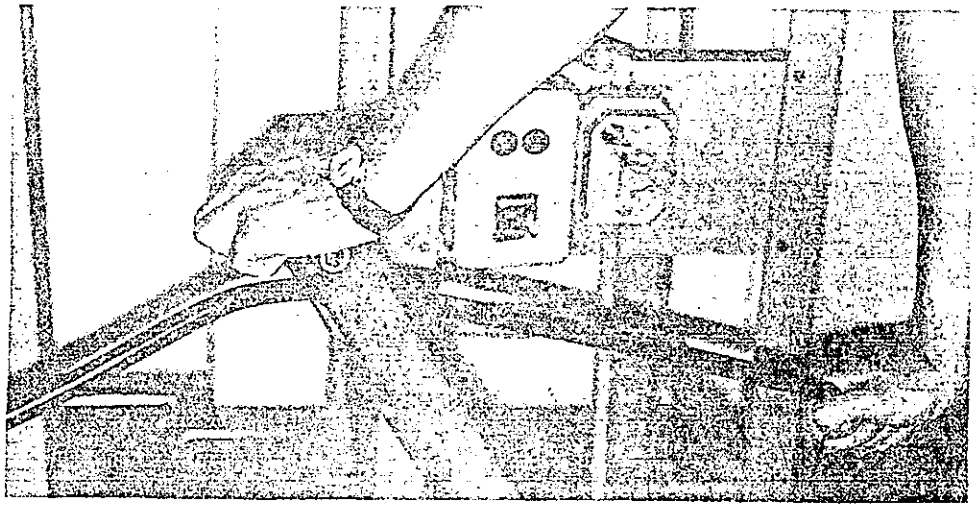
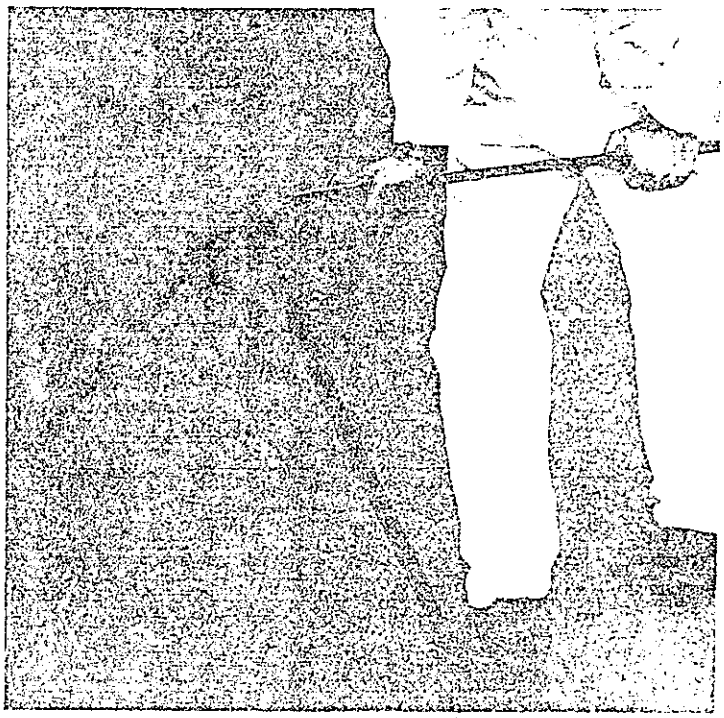


Fig. 8.5 Using a hardwood setting block to set conduit



) A commercial conduit bender being used to set steel conduit

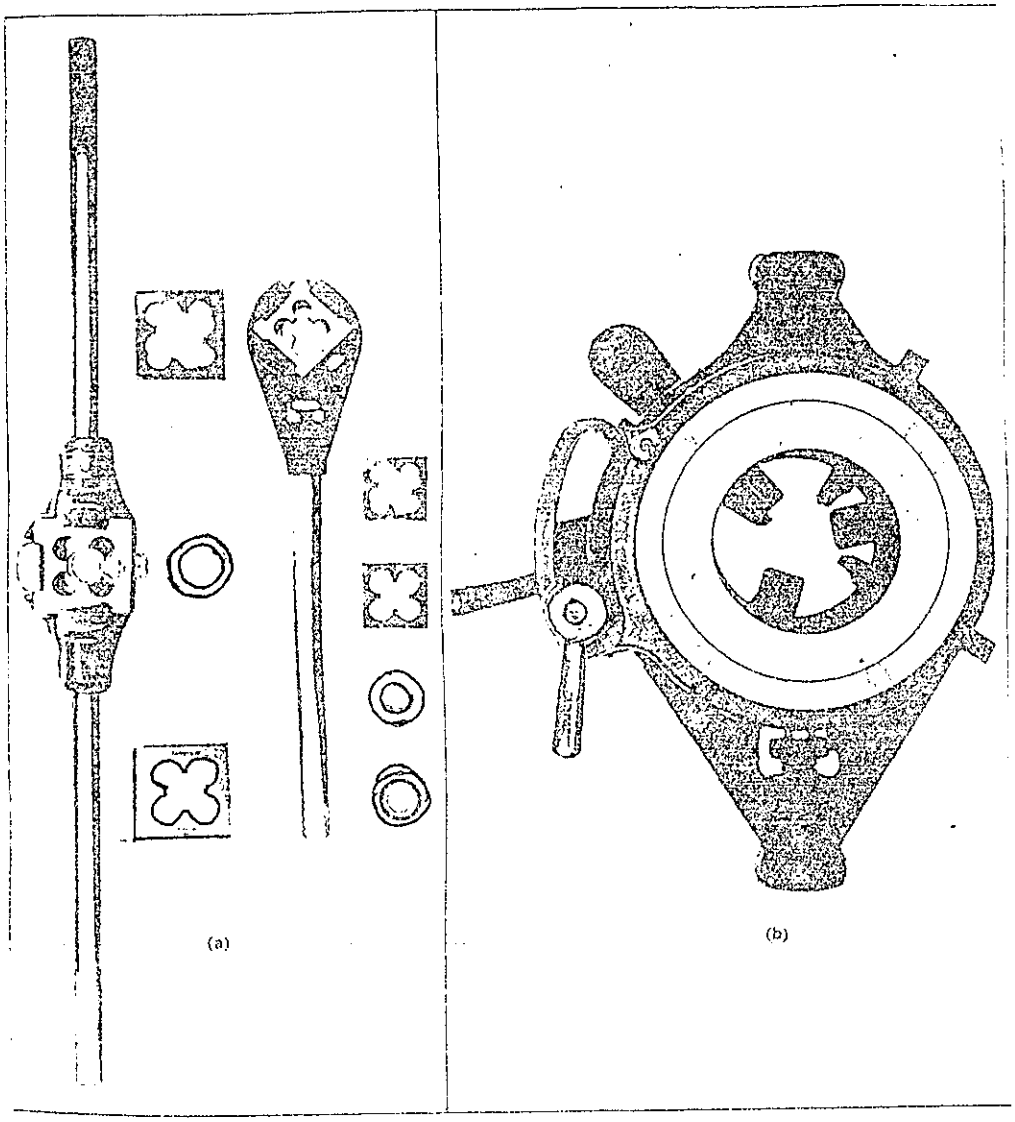
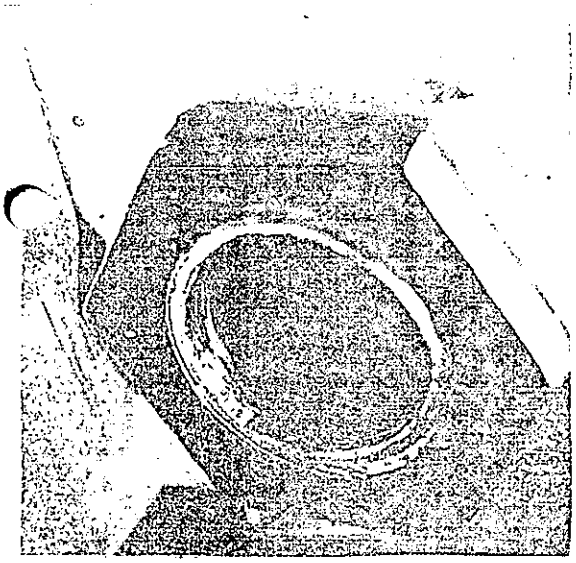
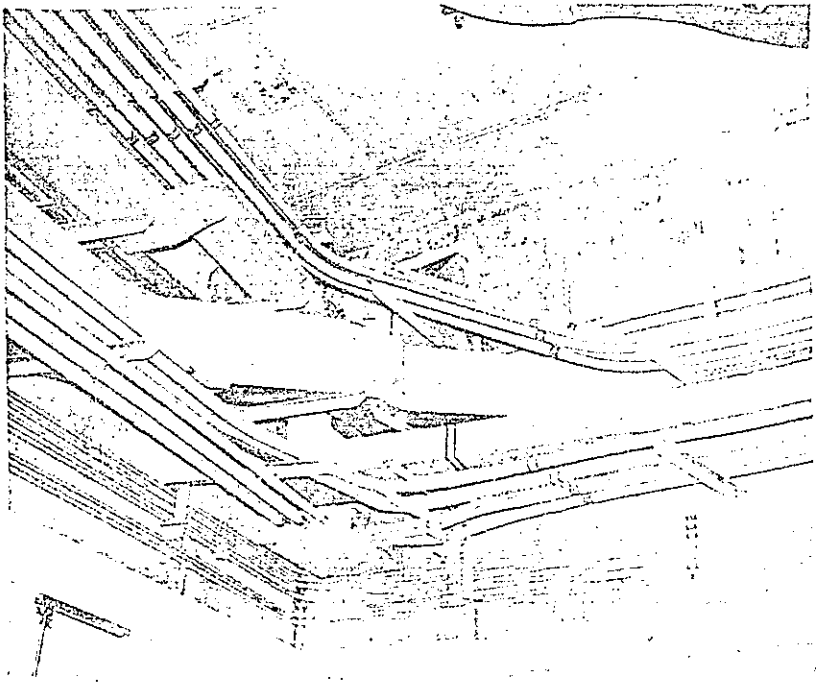


Fig. 8.1 Stock and die sets
(a) "Warragul" single block type; the set on the right has a ratchet stock
(b) "Austec 4R" adjustable type; the one illustrated is suitable for screwing conduit in the range 16 mm to 51 mm (when metrication is complete a metric die of 1.5 mm pitch will be used)

MacPhersons



Termination of steel conduit at an accessory.



The large square draw-in box facilitates installation of cables after the conduit is erected.

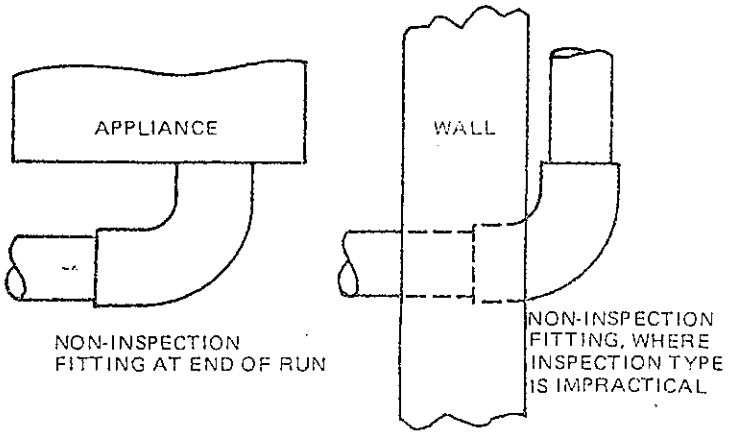
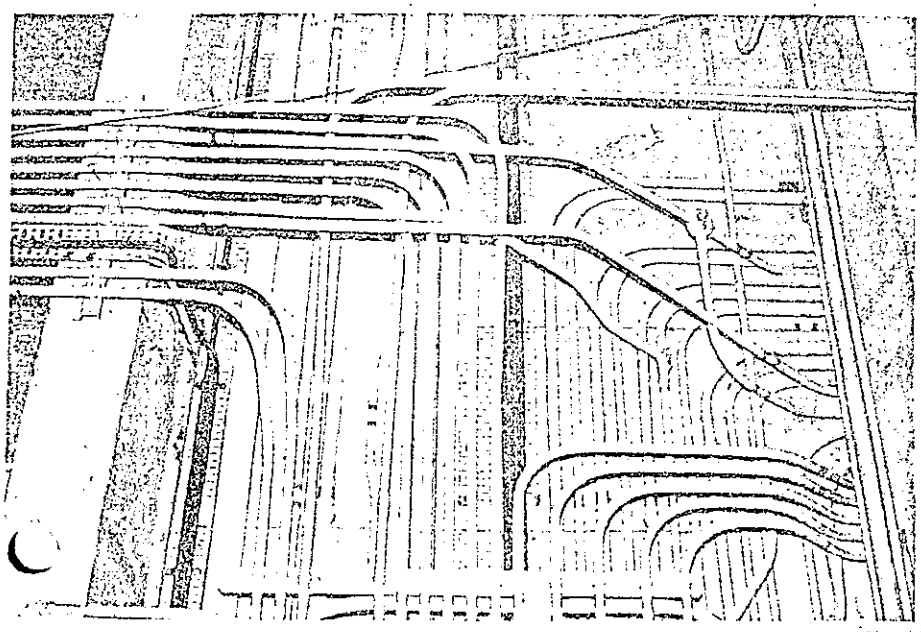


Fig. 8.11 Where non inspection elbows are permitted



.4 Large radius bends and sets have been used in this galvanised conduit work at the Sydney Opera House to facilitate easy drawing-in of cables

TITLE:- SOLDERING ELECTRICAL JOINTS

LECTURER:-

DATE:-

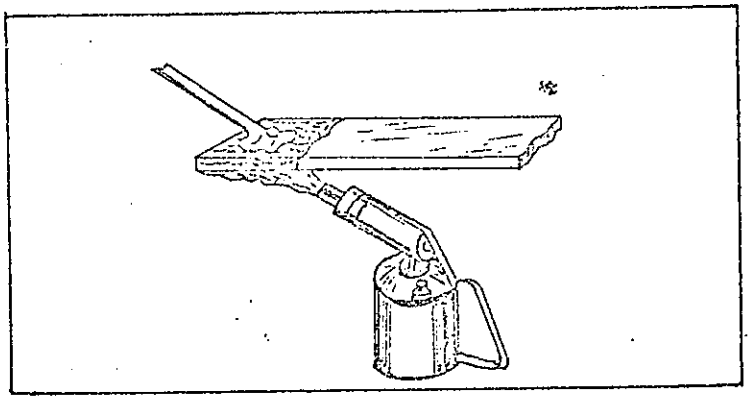
EQUIPMENT:- Copper wire, copper bus bar, resin, methylated spirit, cloth, resin cored solder, stick solder, solder lugs, heat sink.

In electrical work, it is most important that joints in a circuit be of low resistance, and that there is no increase in this resistance, due to oxidisation or tarnishing of the contact surfaces.

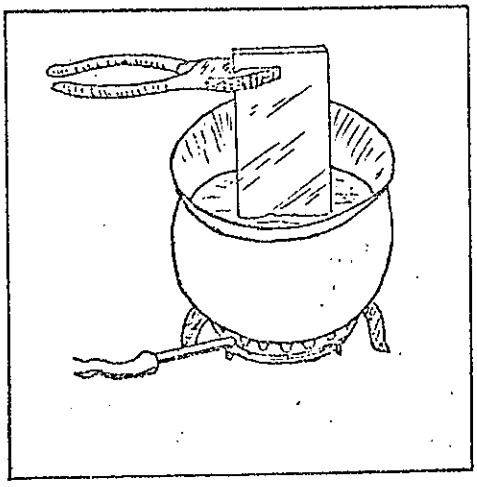
Two clean wires may be twisted together to make a low resistance joint, but after a short period of time, the surfaces will tarnish and the resistance of the joint will increase. This will result in the generation of heat when electricity is passed, since heat is developed proportionally with the square of the current and the resistance (I^2R), and this heat will cause further tarnishing. It is evident that such a joint, will progressively deteriorate and might ultimately start a fire. This type of joint is termed a HIGH RESISTANCE JOINT.

After cleaning a cable, wire, bus-bar etc. in preparation to tinning, remember that touching the material with the fingers imparts a film of grease onto it and prevents proper tinning.

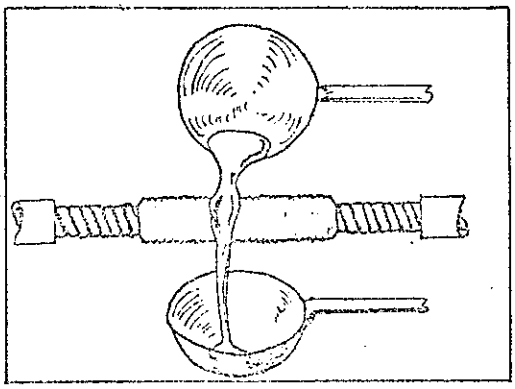
Tinning with an open flame:-
Sometimes it is necessary to tin a surface which conducts heat away too fast for the largest copper bit available, i.e., section wire for armatures, an open flame may be used to heat the job. The flame is best applied below the surface to be tinned, or back from it if possible. Flux the cleaned surface, apply the heat and melt the solder directly on the fluxed surface - do not let the flame melt the solder. When the surface is properly tinned, re-heat and wipe off the surplus solder with a clean cloth. Do not over-heat the job or the tinning will be burnt off.



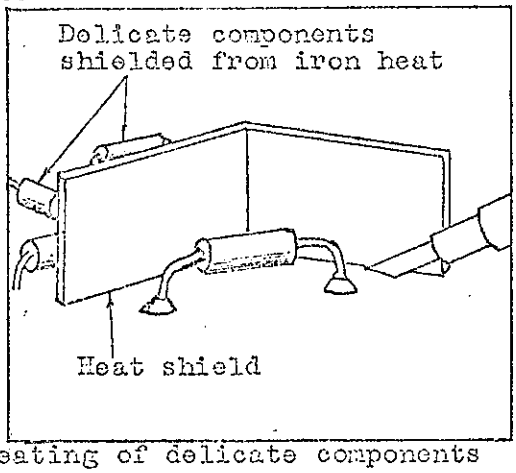
Tinning by immersion:-
Small articles (contacts etc.) may be tinned by immersion in a pot of molten solder, as follows:- Clean the metal thoroughly, then dip into a flux of resin and methylated spirits; the metal is then dipped into the molten solder and left there for a few seconds. When the metal has been withdrawn, use a clean cloth to wipe off any surplus solder. This must be done while the metal is hot.



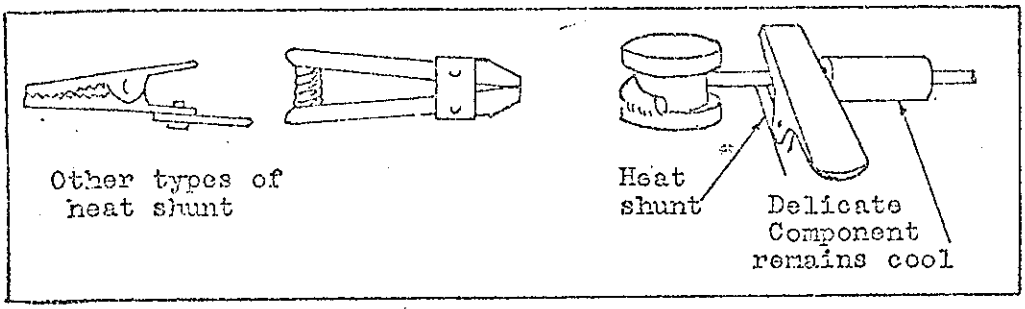
Tinning with ladles:-
Heat can be transferred to a large job, by pouring molten solder over the job. Two ladles are needed, one containing hot solder, and the other heated ladle is used to catch the solder as it flows off the job. By repeated pourings, the job temperature will finally rise to above the melting point of the solder, which will then tin the clean, fluxed surface. This method is often used to solder joints in heavy cables.



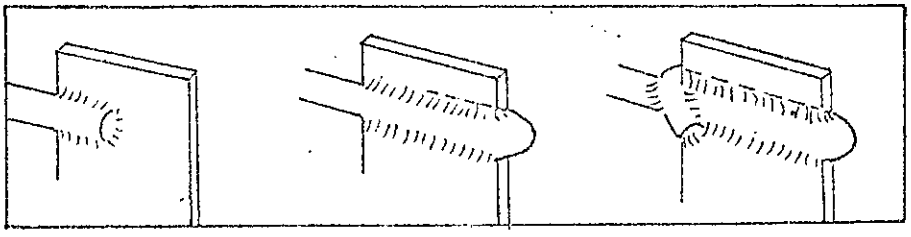
Heat shields:-
Use a heat shield where necessary to shield adjoining components from the heat of the soldering iron.



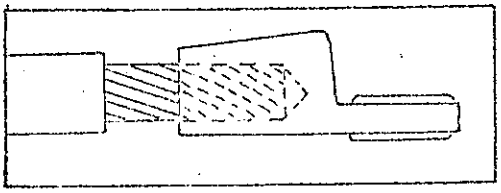
Heat shunt:-
Use a heat shunt to prevent overheating of delicate components being soldered.



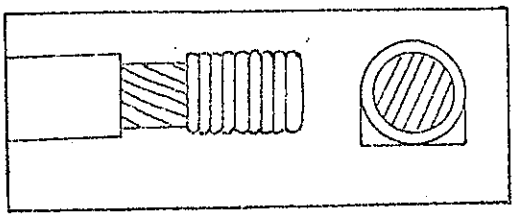
Good joints:-
A good joint is one which has excellent electrical contact between the parts joined, and has good mechanical strength. It should be smooth with no "spikes", bright and shiny, without rough patches. The joint should have a concave surface, and the outline of the wire should be visible, under the surface of the solder.



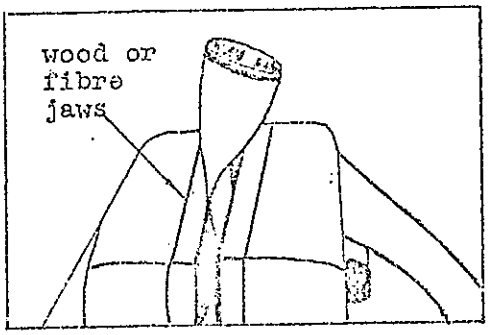
Soldering cable sockets:-
Bare the cable, to allow the conductor to reach the bottom of the socket, with $\frac{1}{16}$" of the conductor showing.

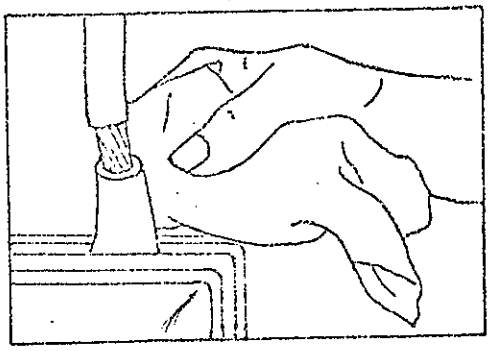


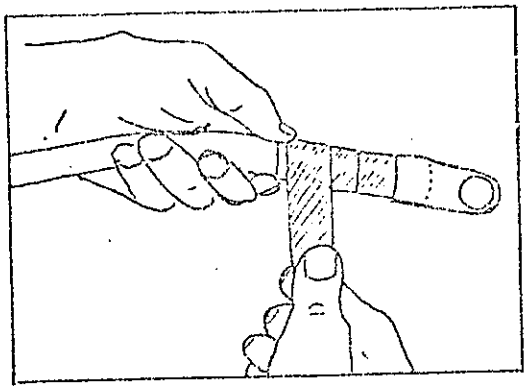
Ensure that the cable conductor fits snugly into the cable socket. (Bind small conductors with copper wire until they fit the socket.)



Clean the cable socket, then place upright in a vice; use wood or fibre jaw inserts to save heat transferring to the vice. Apply resin flux and heat the lug with a copper bit or naked flame. Apply the stick of solder to the inside of the socket and melt sufficient solder to half fill the socket. Apply flux to the cable conductor. Dip the conductor into the socket, apply heat to ensure the solder remains molten, withdraw the tinned cable. Reheat the socket and fill with solder, insert the cable, wiping away surplus solder from outside the socket. Allow to cool naturally until the solder sets, avoid any movement. Pare away any charred insulation. Wrap the conductor with pure rubber tape, to give the same diameter as the cable insulation. Apply black adhesive tape over the rubber tape.







Safety precautions:-

1. Inspect the soldering iron regularly, for physical damage, especially to the lead.
2. Keep the iron in a stand when not in use. Do not subject the iron to rough treatment.
3. Keep the iron away from its lead.
4. Never flick excess solder off the bit. The hot solder may burn someone, or fall into part of the work and cause a short circuit.
5. At all times make sure that the hands cannot be burnt, wear gloves if necessary, hold the job with pliers.
6. Make sure molten solder cannot drip into boots.
7. Have overall sleeves down, and fastened at the wrist, chest covered.
8. Wear a protective face shield. The application of solid metal and a wet flux will often cause the molten solder to explode.