Soldering

Objectives: At the end of this lesson you shall be able to
- **define 'soldering'**
- **state the different types of soldering processes.**

Soldering method: There are different methods of joining metallic sheets. Soldering is one of them.

soldering is the process by which metals are joined with the help of another alloy called solder without heating the base metal to be joined. The melting point of the solder is lower than that of the materials being joined.

The molten solder wets the base material which helps in binding the base metal to form a joint.

Soldering should not be done on joints subjected to heat and vibration and where more strength is required.

Soldering can be classified as soft soldering and hard soldering. Hard soldering is further divided as (a) brazing (b) sliver brazing.

The process of joining metals using tin and lead as a soldering alloy which melts below 420°C is known as soft soldering.

The process of joining metals using copper. zinc and tin alloy as filler material in which the base metal is heated above 420°C below 850°C is called brazing.

Silver brazing is similar to brazing except that the filler material used is a silver-copper alloy and the flux used is also different.

Soldering iron (soldering bit)

Objectives: At the end of this lesson you shall be able to
- **state the purpose of soldering iron**
- **describe constrictional features of soldering iron**
- **state different types of copper bits and there uses.**

Soldering iron: The soldering iron is used to melt the solder and heat metal that are joined together.

Soldering irons are normally made of copper of copper alloys. Sothey are also called as copper bits.

Copper is the preferred material for soldering bit because

- it is a very good conductor of heat

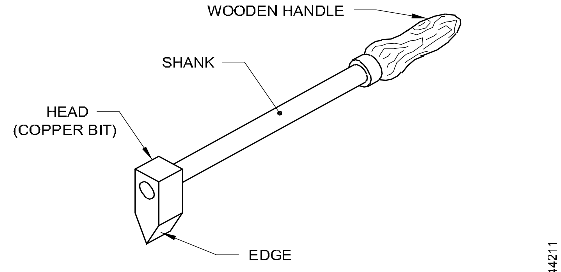
- it has affinity for tin lead alloy

- it is easy to maintain in serviceable condition

- it can be easi;y forged to the required shape.

A soldering iron has the following parts. (Fig)

Fig 1



SOLDERING IRON (HATCHET TYPE)

- Head (copper bit)

- Shank

- Wooden handle

- Edge

SOLDERING COPPER BIT

Type of soldering copper bits: There are 7 types of soldering copper bits in general use,

They are

- The pointed soldering copper bit.

- The electric soldering copper bit.

- The gas heated soldering copper bit .

- Straight soldering copper bit.

- Hatchet soldering copper bit.

- Adjustable copper bit

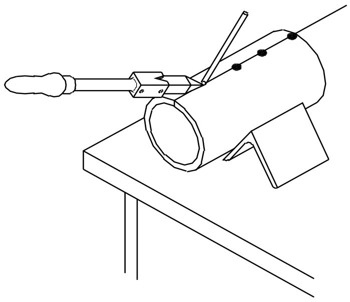
- Handy soldering copper bit.

The bits of soldering irons are made in various shapes and sizes to suit the particular job. They should be large enough to carry adepuate heat to avoid too frequnt reheating and not too heacy to be awkward to manipulate.

Solderingbits are specified by the weight of the copper head. For general soldering process, the shape of the head is a square pyramid but for repetition, or awkward placed, other shapes are designated.

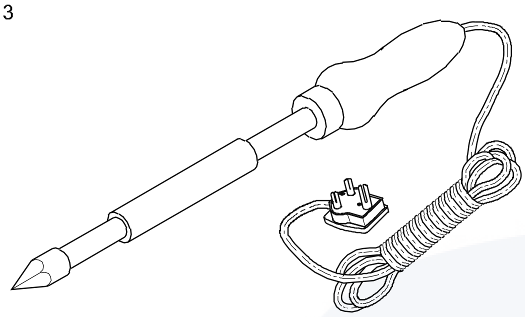
Point soldering copper bit: This is also called a square pointed soldering iron, The edge is shaped to an angle on four sides to from a pyramid. This is used for tacking and soldering. (Fig 2)

Fig 2



Electric soldering copper bit: The bit of the electric soldering ron is heated by an element. This type is perferred, if current is available because it maintains uniform heat. Electric soldering irons are available for different voltages and are usually supplied with a number of interchangeable tips. They can be made quite small and are generally used on electrical or radio assembly work (Fig 3)

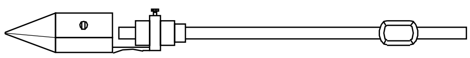
Fig 3



ELECTRIC COPPER SOLDERING

Gas heated soldering copper bit: A gas heated soldering copper bit is heated by a gas flame which ipinges on the back of the head. High pressure gas is used and the bits is large emough to have a good heat storage capacity. Liquified petroleum gas (L.P.G) flame is used extensively for this purpose. Soldering kit normally includes many sizes ans shapes of bits which can be used to make most kinds of soldering connections. (Fig 4)

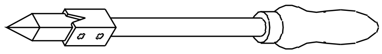
Fig 4



GAS HEATED SOLDERING COPPER BIT

Straight soldering copper bit: This type of soldering iron is suitable for soldering the inside bottom of a round job. (Fig 5)

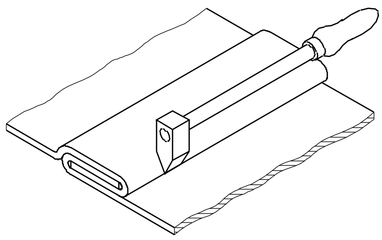
Fig 5



STRAIGHT SOLDERING COPPER WITH HANDLE

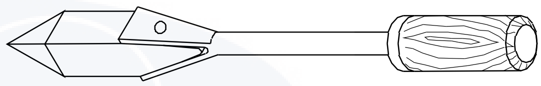
Hatchet soldering copper bit: This type of sodering iron is very much suitable for soldering on flat position lp or grooved joint outside round or square bottom. (Fig 6)

Fig 6



Adjustable soldering copper bit: This type of soldering iron is used for soldering where straight or hearchet bit cannot be used for soldering. Adjustable slodering bit can be adjusted in any position for soldering. (Fig 7)

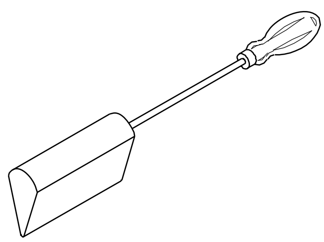
Fig 7



ADJUSTABLE SOLDERING BIT

Handy soldering copper bit: It is like a heatchet type but bigger in size than the hatchet. It is used for soldering heavy gauges of metal because additional heat will cause the metal to buckel. (Fig 8)

Fig 8



HANDY SOLDERING COPPER BIT

Solder

Objectives: At the end of this lesson you shall be able to
- **define a solder**
- **state the types of solders**
- **state the constituents of soft and hard solders.**

Solder is a bonding filler metal used in soldering process.

Pure metals or alloys are used as solders. Solders are applied in the form of wires, sticks ingots, rods, threads, tapes, formed sections, powder, pastes etc.

TYPES OF SOLDERS

There are two types of solders.

- Soft solder

- Hard solder

Soft solders: Soft solders are alloys of tin lead in varying proportions. They are called soft solders becuse of their comparatively low melting point. One distinguishes between soft solder whose melting points are 450°C and hard solders whose melting points lie above 450°C These are alloys of the materials tin, lead, anitimony,copper, cadmium and Zinc and are used for sodering heavy (thick) and ,etals. Table shows different compositions of solder and their application.

In the composition of soft solder, tin is always stated first.

WARNING

For cokking utensils, do not use solder containing lead. This could cause poisoning. Use pure tin only.

Hard solder: These are aloys of copper, tin, silver, zinc, cadmium and phosphorus and are used for soldering heavy metals.

SI.NO.	Types of solder	Tin	Lead	Application
1	Common solder	50	50	General sheet metal applications
2	Fine solder	60	40	Because of quick setting properties and higher sterngth,
3	Fine Solder	70	30	they are used for copper water electrical werk.
4	Coarse solder	40	60	Used on glavanised iron sheets
5	Extra fine solder	66	34	Soldering brass, copper and jewellery
6	Eutectic alloy	63	37	Similar to fine solder

Soldering Flux

Objectives: At the end of this lesson you shall be able to
- **state the functions of soldering fluxes**
- **state the criteria for the selection of fluxes**
- **distinguish between corrosive and non-corrosive fluxes**
- **state the different types of fluxes and their applications.**

All metal rust to some extent, when exposed to the atmosphere because of oxidation. The layer of the rust must be removed before soldering. For this, a chemical compound applied to the joint is called flux.

Function of the fluxes:

1 Fluxes remove oxides rom the soldering surface. It prevents corrosion.

2 It froms a liquid cover over the workpiece and prevents futher oxidation.

3 It helps molten solder to flow easily in the required place by lowering the surface tension of the molten solder.

Selection of flux: The following criterias are important for selecting a flux.

- Working temperature of the solder

- Soldering process

- Material to be joined

Differnt types of fluxes: Flux can be callsifed as (1) Inorganic or corrosive (Active) & (2) Organic or noncorrosive (Passive.)

Inorganic fluxes are acidic and chemically active and remove oxides by chemically dissolving them. They are applied by brush directly on to the surface to be soldered and should be washed immediately after the soldering operation is completed.

organic fluxes are chemically inactive. These fluxes coat the surface of the metals to be joined and exclude the air from the surface, to avoid further oxidation. They are applied only to the metal surfaces which have been previously cleaned, by mechanical abrasion. They are in the form of lump, powder, paste or liquid.

DIFFERENT TYPES OF FLUXES

A Inorganic fluxes

1 **Hydrochloric acid:** Concentrated hydrochloric acid is a liquid wich fumes when it comes into contact with air. After mixing with water 2 or 3 times the quantity of the acid, it is used as dilute hydrochloric acid. Hydrochlotic acid combines with zinc formaing zine chloride and acts as a flux. So it cannot be used as a flux for sheet metals other than sinc iron or galvanished sheet this is also knwo as muriatic acid.

2 **Zine chloride:** Zinc chloride is produces by adding small pieces of clean zinc to hybrochloric acid. It gives off hydrogen gas and heat after a vigorous bubbling action, thus producing zine chloride. The zinc chloride is prepared in heat resisting glass beakers in small quantities.(Fig1)

3 **Ammonium choride or sal-Ammoniac:** It is a solid white crystalline substance used when soldering copper, brass, iron and steel. it is used in the form of powder of mixed with water. It is also used as a clening agent in dipping solution.

4 **Phosphoric acid:** It is aminly used a flux for stinless stelel. It is extreme;y reactive. It is stored in plasic containers because it attacks glass.

B Organic fluxes

1 **Resin:** it is an amber coloured substance extracted from pine tree sap. It is available in paster or powder form.

Resin used for soldering copper, brass, bronze, tin plate, cadmium, nickel, silver and some alloys of these metals. This used extensively for eleitrical soldering work.

2 **Tallow:** It is a form of animal fat. It is used when soldering lead, brass and copper.

The following Table shows the nature nd type of flux used in soldering.

Metal to besoldered	Inorganic flux	Organic flux	Remarks
Aluminium Aluminium-bronze			Commercially prepared flux and solder required
Brass	Killed spirits Sal ammoniac	Resin Tallow	Commercial flux availlable
Cadmium	Killed spriits	Resin	commercial flux available
Copper	Killed spirits sal-ammoniac	Resin	Commercial flux available
Gold		Resin	
Lead	Killed Spirits	Tallow Resin	
Monel			Commercial flux required
Nickel	Killed spriits	Resin	commercial flux available
Silver		Resin	commercial flux available
Stainless steel	Phosphoric acid		commercial flux available
Steel	Killed spriits		
Tin	Killed spriits		commercial flux available
Tin -bronze	Killed spriits	Resin	
Tin-lead			
Tin-zinc	Killed spriits	Resin	
zinc	Muriatic acid		

Soft soldering

Objectives: At the end of this lesson you shall be able to
- **explain soft soldering process**
- **state the melting characteristics of soft solders**
- **state the essential features of the soldering technique**
- **explain the importance of the attitude of the bit**
- **state the importance of movement of the bit in soldering**
- **state the characteristics of the soldered seams to be observed while inspection.**

Soft soldering involves the process.

- Preparing the workpiece.

- Select the correct soft solder.

- Preparing the soldering iron.

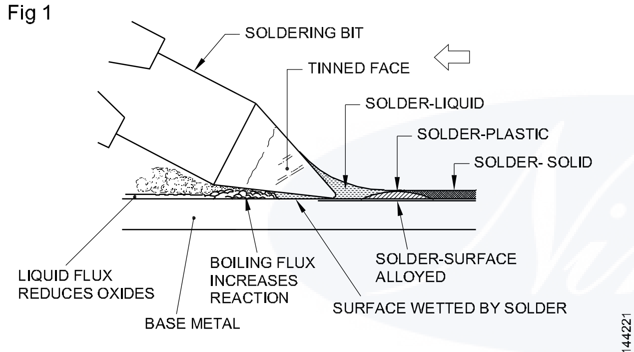
- Select and apply suitable flux.

- heat the soldering iron bit and the workpiece to the correct temperature.

- manipulating the soldering iron on the workpiece skillfully as shoun in Fig 1.

- Complete the job to a satisfactory standard.

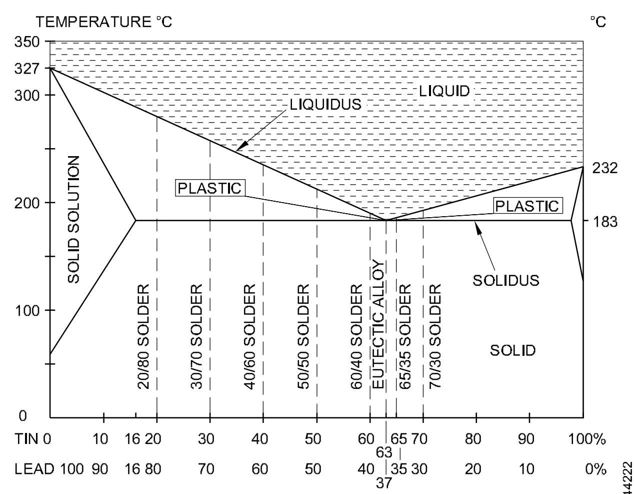
Fig 1



THE SOFT SOLDERING PROCESS

Melting characteristics of soft solders: The eutectic alloy of tin lead solder is a mixture of 63% tin and 37% lead. 63/37 solder melts at 183°C and is the lowest melting point of all oy series as shown in fig 2.

Fig 2



MELTING CHARACTERISTICS OF TIN-LEAD SOLDER

Soldering Techniques: The following features are essential to do soldering.

- Correct joint design

- Preparation of the joint

- Selection of the solder

- Selection and preparation of the soldering iron.

- Copper bit heating

- Soldering bit maniulation

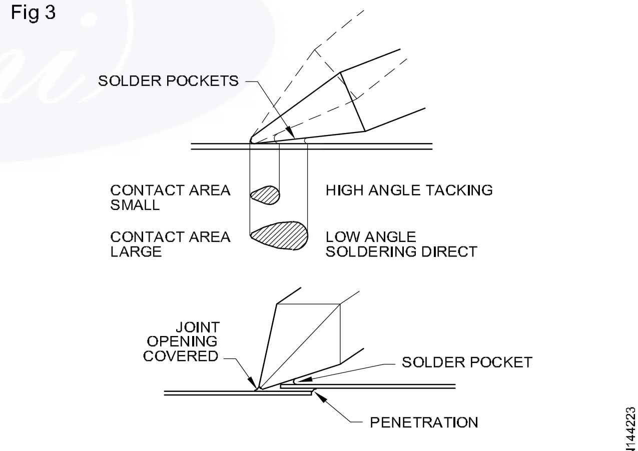
- Cleaning after soldering

- Inspection of the seam.

Attitude of the bit: The soldering iron bit should be placed in a position that enables sufficient heat and solder to flow into the joint.

The angle between a working face of the bit and the joint surface should be filled with a pocket of solder. (Fig 3)

Fig 3



ATTITUDE OF BIT

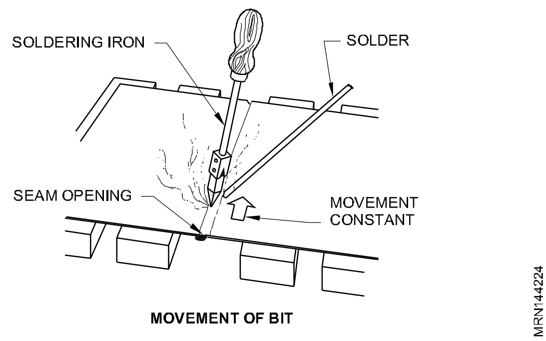
Any variation of this angle will control the amount of heat and solder which is transferred onto the lapped surfaces.

Contact between the molten solder and the joint opening is essential for the penetration of the solder into the joint as shown in figure.

Successful use of the soldering iron is influenced by the attitude of the bit and the movement of the bit on the workpiece.

Movement of the bit: The bit movement along the line of the eam, must be constant and consistent with a smooth flow of solder. When sweating wide overlaps, in addition to the progressive movement along the seam, it is required to move the bit back and forth across the seam. (Fig 4)

Fig 4



MOVEMENT OF BIT

The pattern of the bit movement ensures successful heating of the solder deposited, when the point of the bit covering the joint opening penetrate through the lap as shown in figure.

Flux residues and stains should be removed from the seam, to keep clean dry surfaces for paint finishes.

Inspection of the seam: A soldered seam should have the following characteristics.

- The solder has penetrated the lapped surface.
- The joint gap is sealde with a neat smooth fillet of the solder.
- The upper surfaces of the seam must be smooth, thin coating of solder, with tidy solder margins with uniform width.

Visual inspection is good to rectify the faults of the solder. However, physical testing for air or water tight seam is specified often. Leaks, detected by the tests are corrected by re-cleaning, re-fluxing and re-soldering of the faulty are in the soldered seam.

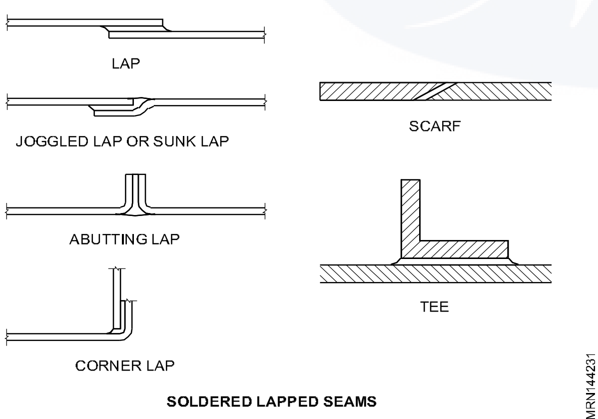
Soldered joint

Objectives: At the end of this lesson you shall be able to
- **state the types of the soldered joints**
- **state the points to be considered for correct joint design.**

Types of soudered joints: Sheet metal components are joined together by soldered joints. In the many cases, the edges are joined by sheet metal mechanical joints and then soldered to make the joint stroger and leak proof.

Fig 1 shows soldered lap joints.

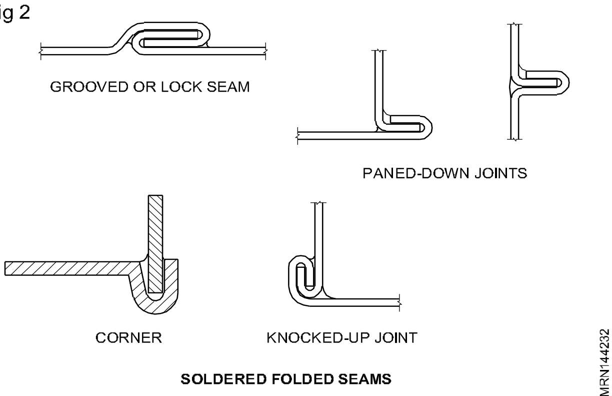
Fig 1



SOLDERED LAPPED SEAMS

Fig 2 shows soldered seams.

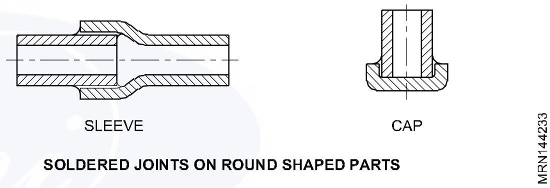
Fig 2



SOLDERED FOLDED SEAMS

Fig 3 shows soldered joint on round shaped parts.

Fig 3



SOLDERED JOINTS ON ROUND SHAPED PARTS

Correct joint design: Sheet metal joints with overlapping surfaces are ideal for joining or sealing with solder. Close fitting of lapped sufaces are essential for the flow of moilen solder in into the joint by capillary action.

Joint design suitable for silver brazing or soldering mainly depends on the type of assembly and its intended use following conditions.

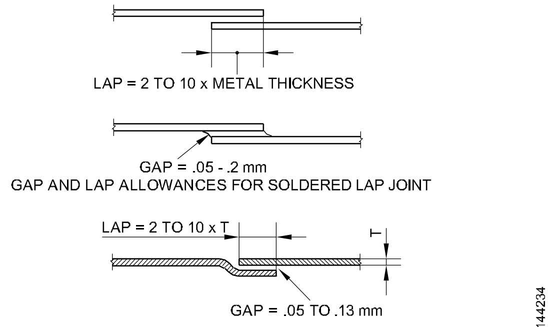
Maximum strength can be achieved by observing the following conditions.

- A suitable filler alloy must be used. Component metal is of major consideration.
- Joint clearances should be minimum. Close fitting surfaces helps capillary flow and gaps between 0.05 and 0.13 mm should be used.
- The solder must contact lapped surface suficiently. Lap width is commonly made 2 to 10 times the component metal thickness. IN case of unqual thickness, the lap size is based on the thinner materials.
- Workpieces must be firmly supported. It is essential to prevent the movement for the control of the solder application, alignment and accuracy of the componet assembly.

Sheet metal joints both lapped and folded, are suitable for silver soldering application as shown in fig 4.

Silver solder effects the union of lapped joints and seals the seam openings of the interlocking folded joints.

Fig 4



LAP AND GAP ALLOWANCES FOR SOLDERED SUNK LAP JOINT

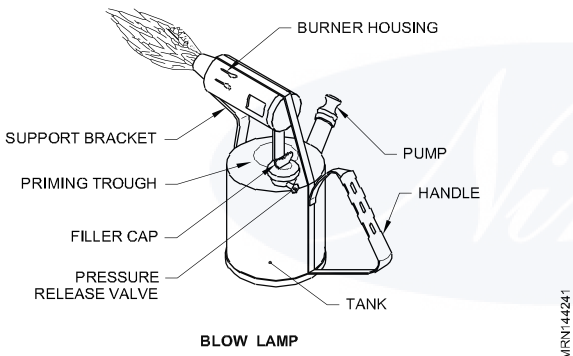
Blow lamp

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

- **state the constructional feature of blow lamp**
- **identify the parts of blow lamp**
- **describe the operation of blow lamp.**

In blow lawp (Fig 1) the kerosene is pressurized to pass through pre-heated tubes, thus becoming vaporised. The kerosene vapour continuse through a jet to mix with a air and when ignited directed through a nozzle, producing a forceful flame.

Fig 1



BLOW LAMP

The flame within the housing procides the heat tomaintain vaporisation of the kerosene. The free flame at the nozzle ourlet is used to heat the soldering bit.

Blow lamp is a portable heating appliance used as a direct source of heat for soldering irons or other parts to be soldered. Fig 1 shows [arts of blow lamp.

It has an tank made of brass, filler cap is fitted at its top to fill kerosene. A pressure relief valve is connected to the zzmouth to switch ON/OFF and control the falme.

Priming trough is provided for filling methylated spirit for lighting the blow lamp. Set of nozzle is provided to direct the kerosene vapiur to produce forceful flame. Burner housing is mounted on support brackets on which soldering iron is placed for heating as shown in figure.

Pump is provided to pressurise the kerosene in the tank.

Factors considered while soldering

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

- **state the constructional feature of blow lamp**
- **identify the parts of blow lamp**
- **describe the operation of blow lamp.**

Soldering is joining two metal parts with a solder, i.e., a third metal that has a lower melting point.

Before soldering the following conditions must be met.

1 The metal must be clean.

2 The correct soldering device must be used and it must be in good condition.

3 The correct solder and flux or soldering agent must be chose.

4 Proper amount of heat must be applied. If you follow these conditions, you could get a good solder joint.

Cleanliness: Solder will never stick to a dirty, oil or oxide conted surfae. Beginners often ignore this simple point. If the metal is dirty, clean it with a liquid cleaner. it it is black annealed sheet remove the oxide with an abrasive cloth, and clean it until the surface is bright.

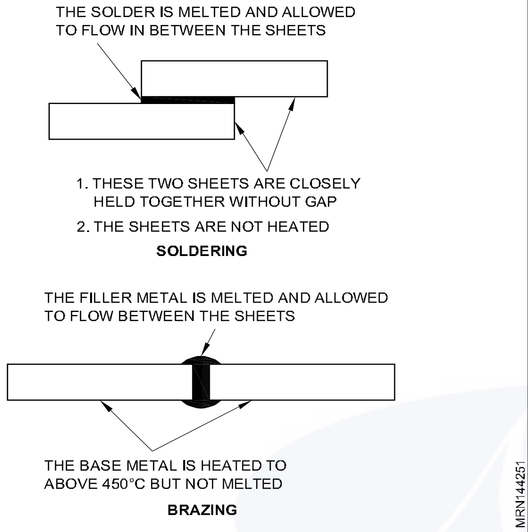
A bright metal, such as coper, can be coated with oxide even though you cannot wee it. This oxide can be removed with any fine abrasive.

Soft soldering, brzing and silver brazing

Objectives: At the end of this lesson you shall be able to
- **explain soft soldering and hard soldering**
- **describe the method of soft soldering, brazing and sliver brazing**
- **describe the difference between brazing and soldering**
- **explain the various methods of brazing**
- **explain the problems in brazing and the remedies.**

Soldering amd brazing: The soldering and brazing processes differ from welding in the sense that there is no direct melting of the base metal(s) being welded. In brazing or soldering, the filler alloy flows between two closely adjacent surfaces by capillary action.fig.1

Fig 1



Soft soldering: The filler metals used in soldering have a melting point below **427°C**

The alloys used for soft soldering are:

- tin-lead (fog general purpose soldering)
- tin-lead-antimony
- tin-lead-cadmium,

The process is referred to as 'soft soldering'. The heat required for 'soft soldering' is supplied by a soldering iron, whose copper tip is heatd either by a forge of electrically.

Composition of soft solder

Usually soft solder is an lloy of lead and Tin in different ratios depending on the base metals soldered and the purpose of soldering.

Soft solders are available in different shapes and forms such as stick, bar, paste, tape or wire etc.

TYPES OF FLUXES

Corrosive: in this type the solution contains inorganic substances like zinc chloride. ammonium chloride, hydrochloric. This type of flux leaves a corrosive deposit on the base metal surface which must be throughly washed off after soldering. This type of flux is not used on electrical works or where the joints cannot be effectively washed.

Non-corrosive: These are fluxes based on resin. These leave a non-corrosive residue. They are used on electrical wprks, instruments like pressure gauges, and parts where washing is dificult.

Suitable fluxes for various materials

Steel - zinc chloride

Zinc and galvanized iron - hydrochloric acid

Tin - Zin chloride

Lead - tallow resin

Brass, copper, brose - Zinc chloride, resin.

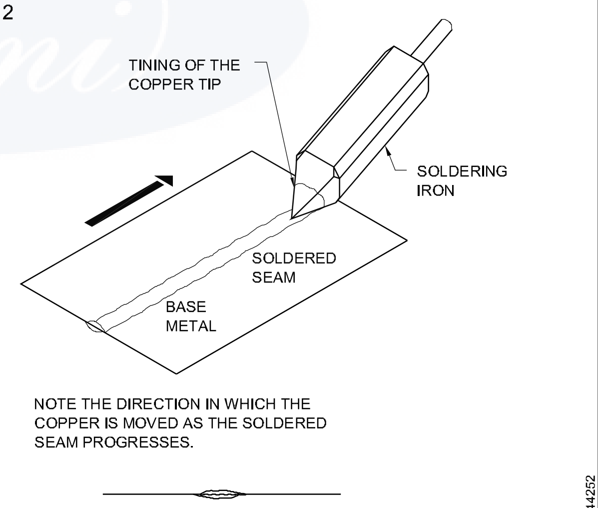
Basic operations in soldering

The parts to be soldered are fitted closely.

Paint, rust, dirt or thick oxides are removed by filling scraping or by using emery paper or steel wool.

The surfaces to be soldered are coated with flux to remove the films of oxide. (Fig 2)

Fig 2



SOLDERING WITH A SOLDERING IRON

The solder is applied with a copper soldering bit. (Figs 3a, b and c) The joining takes place due to "sweating' of the bint the hot and tinned copper tip of the soldering iron.

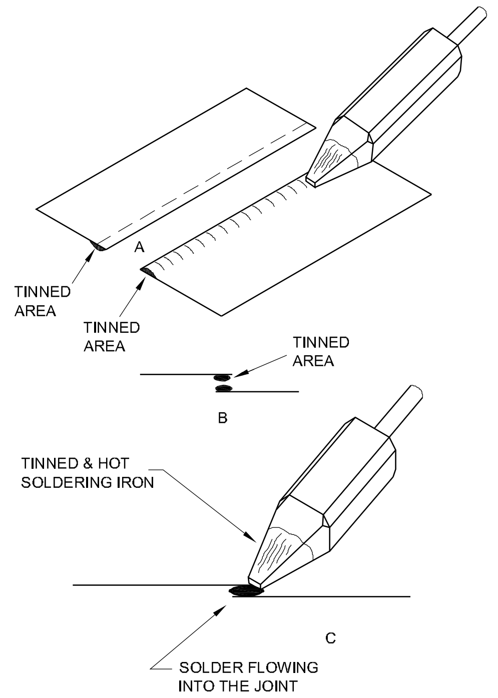
The two sheets to be soldered are adhering to each other due to sweating and bonding of the tinned area.

The excess solder present on the surfaces is removed and the joint is allowd to coo;.

Brazing: Brazing is a metal joining process which is done at a temperature of above 450°C as compared to soldering which is done at blow 450°C

So brazing is a process in which the following steps re

Fig 3



uaed.

- Clean the area of the joint thoroughly by wire brushing, emerying and by chemical solutions for removing oil, grease, paints etc.

- Fit the joints tightly using proper clamping. (Maximum gap permitted between the two joining surfaces is only 0.08 mm)

- Apply the flux in paste form (for brazing iron and steel a mixture of 75% borax powder with 25% boric acid (liquid form) to form a paste is used. Usually the brazing fux contains chlorides, fluorides, borax, borates, flurodorates, boric acid, wetting agents and water. So suitable flux combination is selected based on metal being used.

Brazing is employed where a ductile joints is required.

Brazing filler rods/ metals melt at temperature from 860°C to 950°C and are used to braze iron and its alloys.

Brazing fluxes: Fused borax is the general purposed flux for most metals.

It is applied on the joint in the form of a paste made by mixing up with water.

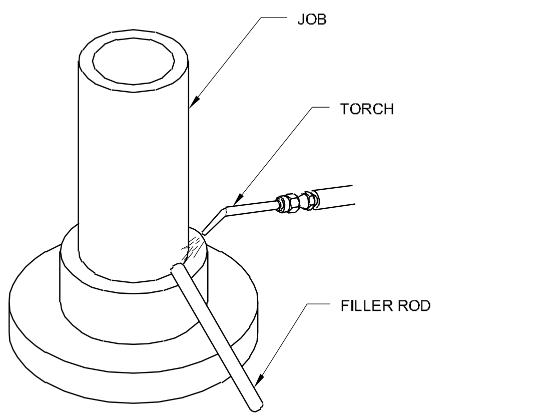
If brazing is to be done at a lower temperature, fluorides of alkali materials are commoly used. These fluxes will remove refractory oxides of aluminium, chromium, silicon and berrylium.

VARIOUS METHODS OF BRAZING

Torch brazing: The base metal is heated to the required temperature by the application of the oxy-acetylene flame. (Fig 4)

Furnace brazing: The parts to be brazed are aligned

Fig 4

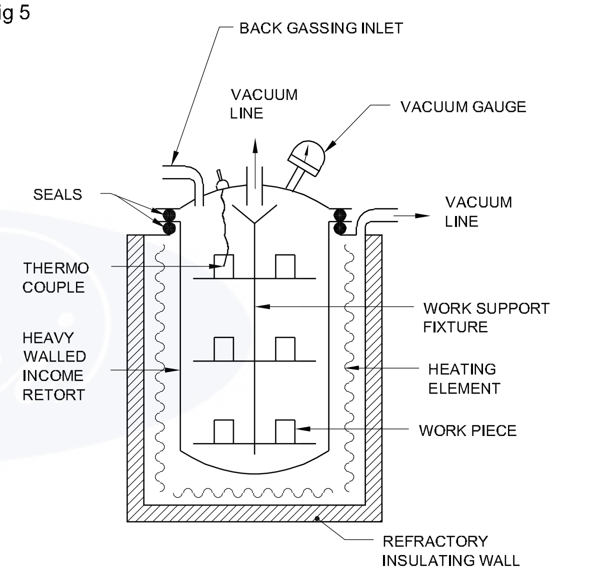


TORCH BRAZING

with the brazing material placed in the joint. The assembly is kept in the furmace. The temperature is controlled to provide uniform heating. (Fig 5)

Dip brazing: The parts to be brazd are submerged in a

Fig 5

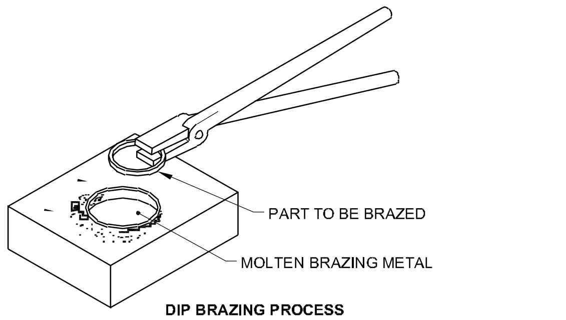


VACUUM FURNACE FOR BRAZING

molem metal or chemical bath (Fig 6) Of brazing filler metal.

Induction brazing: The parts to be brazed are heated to

Fig 6

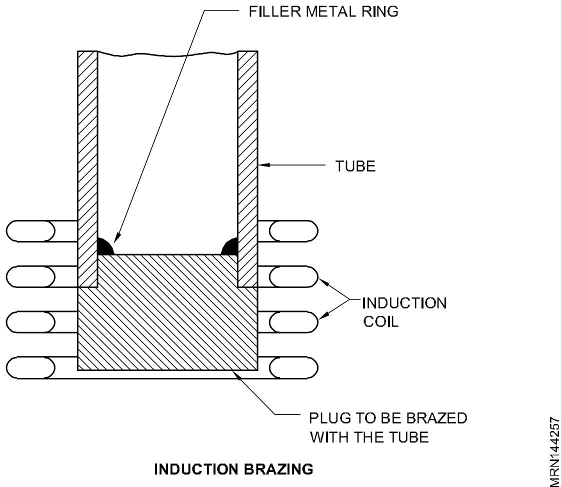


DIP BRAZING PROCESS

the melting point of the brazing material by means of a high frequency electric current. This is done by encircling the joint with a water cooled iduction coil. (Fig 7)

Conditions to obtain satisfactory brazed or soldered joint

Fig 7



INDUCTION BRAZING

Wet the base metal.

Spread the filler metal and make contct with the joint surfaces. The solder will be drawn into the joint by capillary action.

Suggested joint designs for solidering and brazing are shown in Fig 8

Adventages of brazing

The completed joint requires little or no finishing.

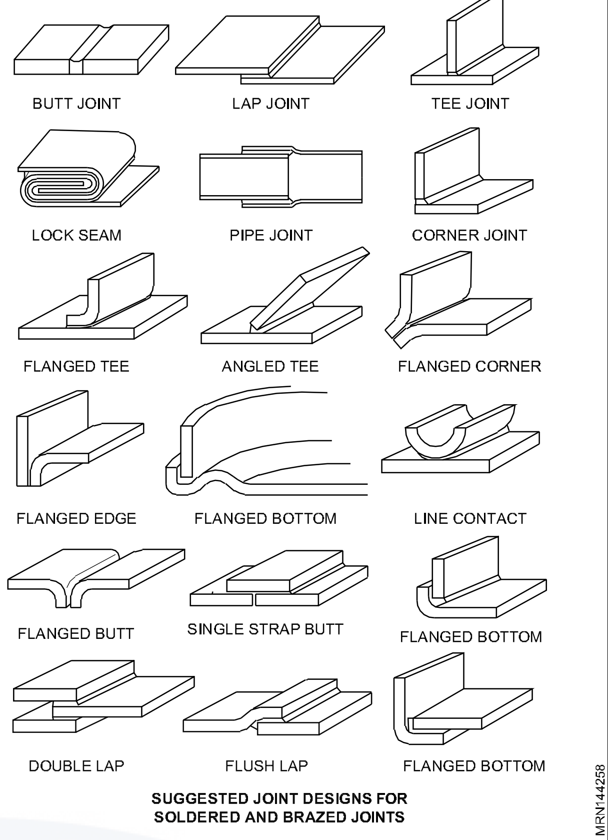
The relatively low temperature at which the joint mde minimizes distortion.

There is no flash or weld spatter.

The brazing technique does not require as much skill as the technique for fusion welding.

The process can be easily mechanised.

Fig 8



SUGGESTED JOINT DESIGNS FOR SOLDERED AND BRAZED JOINTS

The process is economical owing to the above advantages.

Disadvantages of brazing

If the joint is exposed to corrosive media, the filler metal used may not have the required corrosive resistance.

All the brazing alloys loose strength at an elevated temperature

The colour of the brazing alloy which ranges from silver white to copper red may not match the base metal very closely.

Silver brazing: Silver brazing is also sometimes called silver soldering. It is one of the best methods used to

Brazing: Problems and remedies

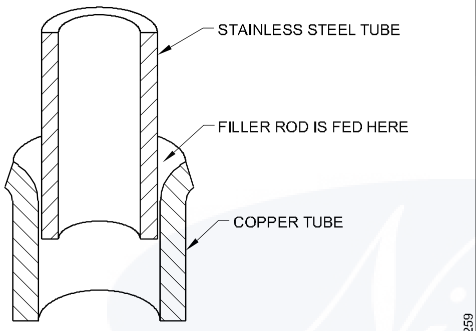
Problem	Remedy
Filler metal 'balls up', does not melt and flow into the joint.	Use more flux. Pickling or additional mechanical cleaning to remove oxides, oils, or other surface coatings must be done, Add fresh flux. Also check for contaminated pickling acid or 'dirty' grinderwheels that could spread impurities instesad of removing them.
Filler metal melts but does not flow completely through joint.	Longer preheating period required. the base metal may not be hot enough. More thorough cleaning required. A wider or narrower joint gap shuld be provided. Joint must not be too tight or too loose. Also check for gaps or spaces where capillarity is interrupted. Apply more flux to both filler and base metal. Use a different flux compound. Impriper flux may be breaking down due to too much heat. Eliminate this fault.

Problem	Remedy
Filler metal runs out of , instead of into the joint.	Re-position (tilt) the joint so that gravity helps the filler metal to run into the joint. Making a small reservoir in the joint to start the capillary ction will help. Feeding the filler metal into the joint from above rather than horizontally or from below is recomended.
Filler metal melts but will not flow.	Additional cleaning of filler metal to remove oxides is required. more flux on both filler and base metal is requird.

connect/join parts which are to be leak proof and has to give maximum strength of the joint. It is a very useful and easy process for joining copper brass, bronze parts as well as for joining dissimilar metal tubes like copper to stainless steel tubes etc. The melting point of silver brazing alloy filler rods will be around 600 to 800°C which is always less than that of the base metals joined. Fig 9 shows silver brazing of stinless steel tube with a copper tube.

The process is similar to other brazing processes. The points to be remembered while silver soldering are:

Fig 9



SILVER BRAZING OF STAINLESS STEEL TUBE WITH COPPER TUBE

- The joint must be thorough;y cleaned both mechanically and chemically.

- Fit the joint closely/tightly without any gap and support the joint. (The maximum permissible gap between the parts to be silver brazing is 0.08mm)

- Apply proper flux at the joint and on the filler rod.

- Heat the joint to the brazing temperature depending on the composition of the silver brazing filler rod. The brazing temperature may varybfrom 600°C to 800°. Use an ocy-acetylene blow pipe for heating.

- Apply the silver braing filler rod coated with the pasty f;ux at the joint using leftward techique. Heat the filler rod to the "flow temperature" which is usually 10 to 15° more than its melting temperature. i.e, for the filler metal to flow easily into the joint and for getting the wetting and capillary action, it is necessary to heat the molten filler metal to 10 or 15° more than its melting temperture.

Allow the joint to cool without removing the support given to the joint.

Clean the joint thoroughly to remove all residual flux.

Fluxes used fo silver brazing may be chlorides or borax made into a paste with water.

Brazing and braze welding; Both brazing and braze welding are metal joining processes which are performed at temperatures above 840°F (450°) as compared to soldering which is performed temperatures below 840°F (450°C)

The American Welding soceity defines these processes as follows:

Brazing-" A group of welding processes which produces coalescence of materials by heating them o a suitable temperature and by using a filler metal having a liquidus above 840°F (450°C) and below the solidus of the base

metal . The filler metal is distributed between the closely fitted surfaces of the joint by capillary action" coalescence is a joining or uniting of materials.

Braze welding-" A welding process variation in which a filler metal, having a liquidus above 840°F (450°C) and below the solidus of the base metal, is used. Unlike brazing, in braze welding the filler is not distributed in the joint by capillary action"

Brazing has been used for centuries. Blacksmiths, jewelers, armorers and other crafters used the process on large and small articles before recorded history. This joining method has grown steadily both in volume and popularity. It is an important industrial process, as well as jewlry making and repair process. The art of brazing has become more of a science as the knowledge of chemistry, physics and metallurgy has increased.

The usual terms Brazing and Braze welding imply the use of a nonferrous alloy. These nonferrous alloys consist of alloys of copper. tin, zinc, aluminum, beryllium, magnesium, silver, gold and others.

Brass is an alloy consisting chiefy of copper and zinc. Broze is an alloy consisting chiefly of copper and tin. Most rods used in both brazing and braze welding on ferrous metals are bress alloys rather than broze. The brands which are called bronze usually contain a small percent (about one percent) of tin.

Brazing and braze welding principles: Brazing is an adhesion process in which the metals being joined are heated but not melted: the brazing filler metal melts and flows at temperatures above 840°F (450°C). Adhesion is the molecu;ar attraction exerted between surfaces.

A brazed joint is stronger than a soldered joint because of the strength of the alloys used. In some instances it is as strong as a welded joint. It is used where machanical strength and leaproof joints are desired. Brazing and braze welding are superior to welding in some applications, since they do not affect the heat treatment of the original metals as much as welding.

Brazing and braze welding wrap the original metals less and it is possible to joint dissimilar metals. For example, steel tubing may be brazed to cast iron, copper tubing brazed to steel and tool steel brazed to low carbon steel.

Brazing is done on metals which fit together tightly. The metal is drawn into the joint by capillary action. (A liquid will be drawn between two tightly fitted surfaces. This drawing action is known as Capillary action). Very thin layers of filler metal are used when brazing. The joints and the material being brazed must be specially designed for the purpose. When brazing, poor fit and alignment result in poor joints and in inefficient use of brazing filler metal.

In braze welding, joint designs used for oxyfule gs or arc welding are satisfactory. When braze welding, thick layers of the brazing filler metal is used.