

ELEMENTS OF MECHANICAL ENGINEERING

PART – B

UNIT – V

JOINING PROCESSES, LUBRICATION AND BEARINGS

Unit - III

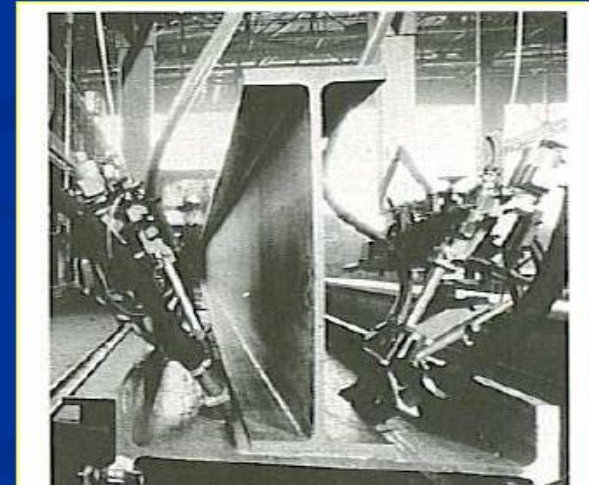
Objectives:

- 1.1 Definitions of Soldering, Brazing and Welding
- 1.2 Classification
- 1.3 Methods of Soldering, Brazing and Welding
- 1.4 Differences of Soldering, Brazing and Welding
- 1.5 Arc Welding and Oxy-Acetylene Welding
- 1.6 Lubricants, classification and Properties
- 1.7 Lubricators
- 1.8 Bearings and Classification of bearings.

Introduction to metal joining

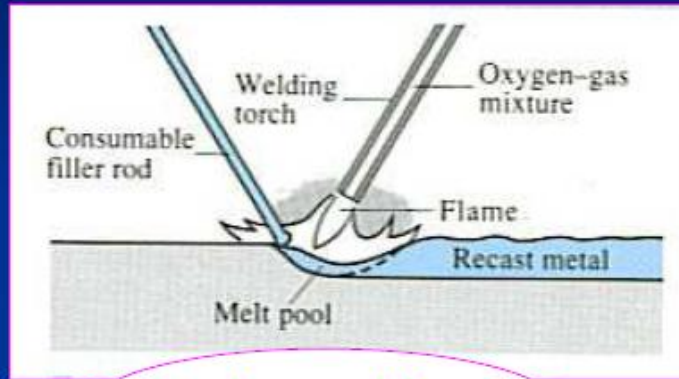
History of joining techniques

- During the **Bronze age**, metals were used for domestic tools, weapons etc. → but more complex shapes cannot be built in one piece.
- The first development of **forge welding** by the **Syrians** (1400 BC).
- Welding was then increasingly utilised in response to **military requirements** for example, riveting of suits of armour.
- A **commercial scale** for bolting, riveting, soldering and finally welding was introduced.

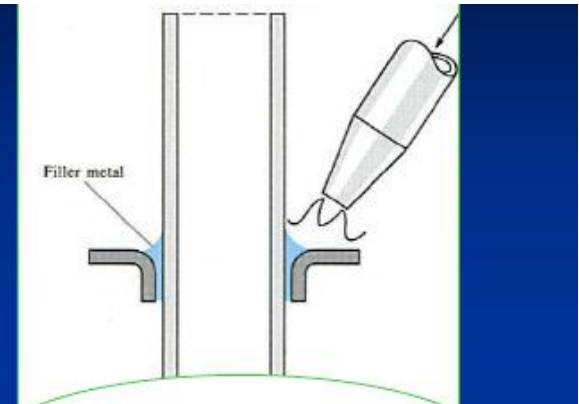


- ***Metal joining*** is required whenever the desired component cannot be made by means of simple fabrication processes such as casting, forging, rolling, extrusion, etc.
- ***Metal joining is indispensable*** to manufacturing industry because it is necessary in large constructions, components required for modern living.

There are different methods of metal joining:



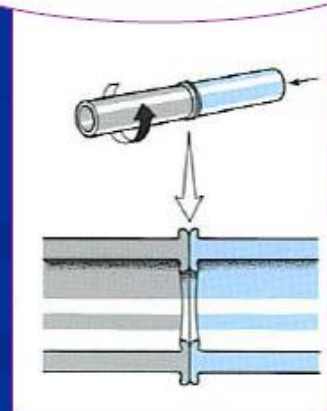
Fusion welding



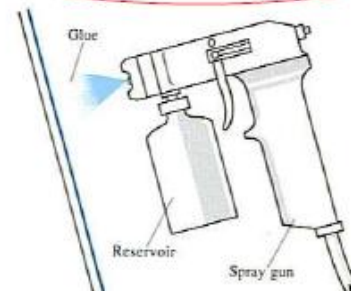
Brazing/Soldering

Metal joining processes

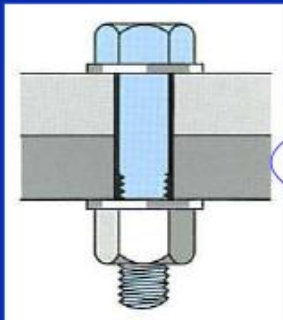
Friction welding



Adhesive bonding



Fasteners

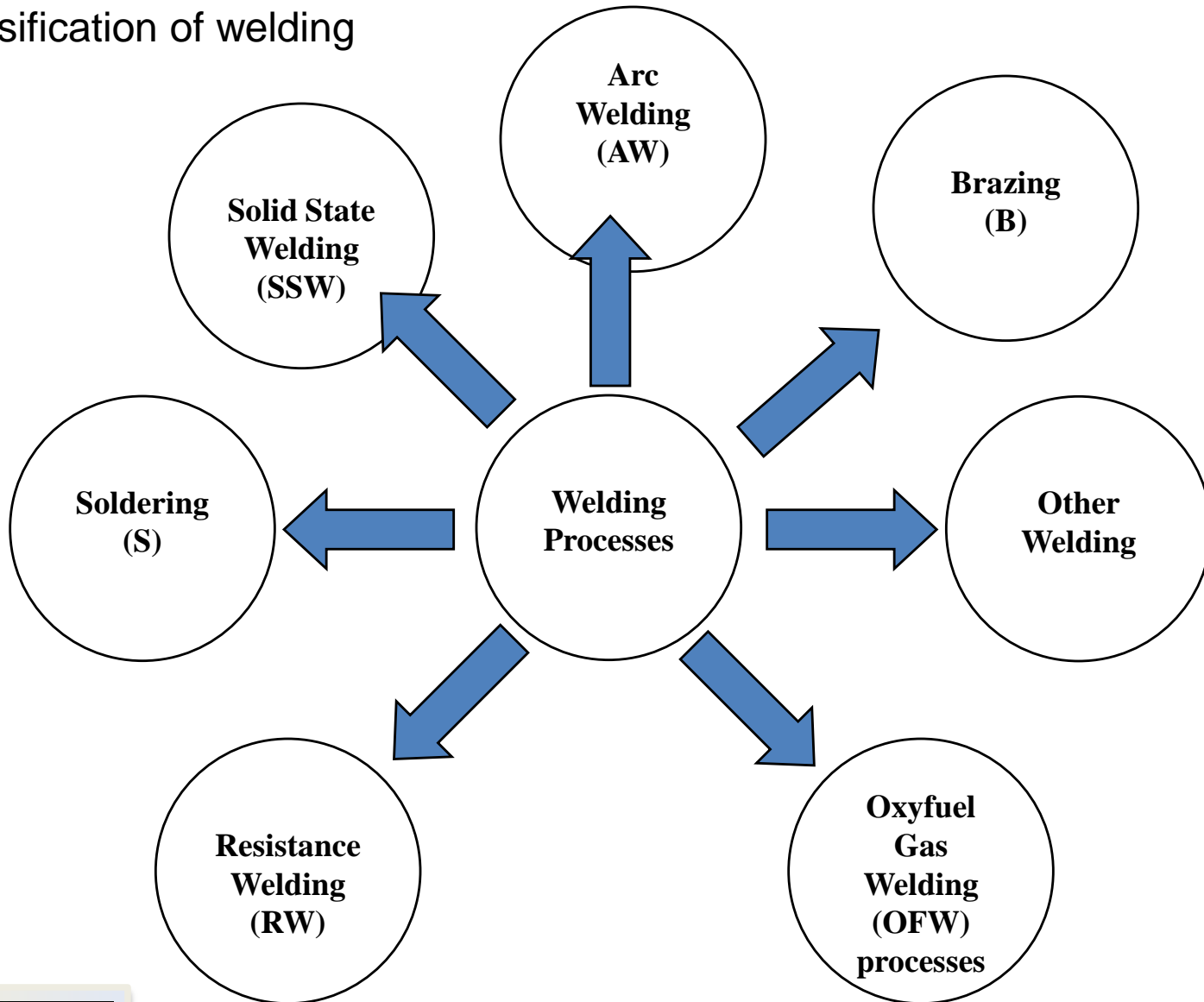


Note: it is important to choose the suitable methods of metal joining for each application.



Unit – V,
Classification of welding

Soldering, Brazing & Welding



Unit - V

- **Soldering:**
Bonding by melting a soft metal to the surface of pieces to be joined. Low temperature. Good for joining dis-similar materials. Most common solders are lead-tin alloys.
- **Tinning:**
A soldering process, where the surface of a metal is coated with solder.
- **Leading**
A form of soldering, solder is used to fill in the surface of metal.
- **Brazing:**
Similar to soldering, but uses a higher temperature to fuse the filler metal to the work pieces. Stronger bond. (Includes "Silver Soldering") Work heated to pre-melt temperatures.
- **Welding:**
Joining 2 similar work pieces by melting them together, usually with an additional filler rod of some sort to take up space. Materials must be similar.
- **Cutting:**
Work is heated to melting point and beyond, and "cut" by oxidizing metal. (Literally burning it away).
- **Shield:**
A barrier to keep oxygen away from heated work to prevent oxidation. Includes chemical coatings called flux (liquids, pastes, solids, which may be vaporized into a barrier gas when heated), and inert gasses. Oxidation of the surfaces will prevent proper bonding of the metals.

Soldering

Soldering is a method of joining two or more metal work-pieces by means of a third metal (solder) and Flux at a relatively low temperature (below 450 C), which is above the melting point of the solder but below the melting point of either of the materials being joined.

(flux is a cleaning agent used to prevent oxidation of the metals at soldering point. Zinc chloride, ammonium chloride, hydrochloric acid etc.)

Flow of the molten solder into the gap between the work pieces is driven by the capillary attraction.

The solder cools down and solidifies forming a joint.

The parent materials are not fused in the process.

TYPES : 1) Soft Soldering 2) Hard Soldering

Flux

Flux provides several benefits:

- Cleans the base metal (copper trace)
- Protects the solder and base metal from oxidizing during the soldering process.
- Promotes wetting action of the melted solder

But using flux represents some trade offs:

- Can become entrained in the joint
- Is corrosive and so must be removed

Tin-lead solders

Traditional lead containing solders consist of tin (Sn) and lead (Pb).

The most popular alloy in this group is composition of 63Sn-37Pb (commonly called 63/37).

The melting point of this alloy is lowest of all Sn-Pb alloys (183°C).

This solder is used for joining electronic components, to which minimum heat may be applied (computers, telecommunication devices).

Low tin solders such as 5Sn-95Pb (5/95), 10Sn-90Pb (10/90), 15Sn-85Pb (15/85) are used mainly for sealing containers and radiators, joining and coating metal parts working at increased temperatures (above 121°C).

The alloy 70Sn-30Pb (70/30) is used for coating parts before soldering.

TYPES : 1) Soft Soldering 2) Hard Soldering

- 1) Composed of Lead & Tin, melting point – 150 to 300⁰C, low melting point by adding bismuth & cadmium, join wires, sheet metal work – light loads and slight shocks. Plain soldering iron, electric soldering iron, a soldering gun is used to heat metal pieces. Uses soft solder.
- 2) Composed of copper & zinc 4:1 ratio, silver & tin added- quality (silver solder), mel. Pt 350 to 900⁰C - flux in paste form- blow torch used to heat metal – strong joint- plumbing, heavy sheet metal- hard solder.

Tools and Supplies

- Soldering iron
 - Wet sponge
 - Solder
 - “Helping hand” (or scotch tape)
 - Needle nose pliers
 - Side cutters
 - Flux remover
 - Acid brush
- ‡ **BURN CREAM**

Soldering Recipe

- Prepare joint
 - Tin wires and connectors when needed
 - Make a good mechanical connection
 - Install heat sinks if required
 - Apply flux if required
 - Clean soldering iron tip
- Solder
 - Apply heat to both parts to be bonded
 - Apply solder sufficient to coat joint
- Clean joint (remove flux)
- Inspect

Advantages of tin-lead alloys

Non-expensive.

Simple equipment.

Low skill of operator is enough.

Low melting point.

Note: The main disadvantage of these alloys is toxicity of lead.

Soldering Methods

Hand Soldering

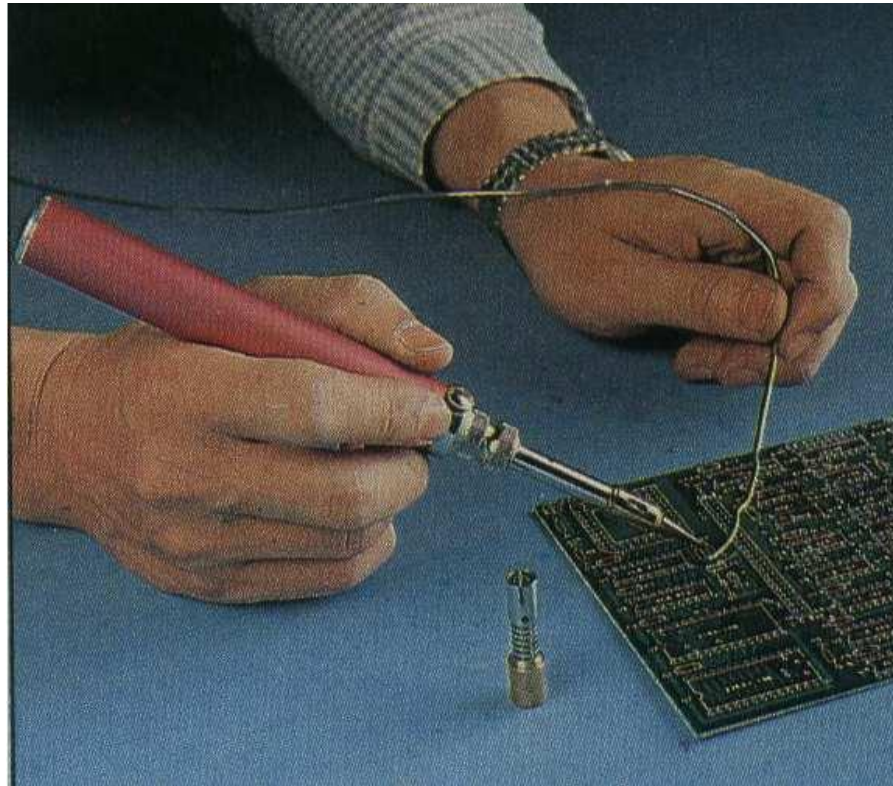
Iron soldering utilizes a heat generated by a soldering iron.

Torch soldering utilizes a heat of the flame from a torch. The torch mixes a fuel gas with oxygen or air in the proper ratio and flow rate, providing combustion process at a required temperature.

The torch flame is directed to the work pieces with a flux applied on their surfaces. When the work pieces are heated to a required temperature, solder is fed into the joint region. The solder melts and flows to the gap between the joined parts.

Hand soldering is used in repair works and for low volume production.

Soldering



Soldering Technique

1. Cleaning the parent material.
2. Applying flux on the joint.
3. Heating the joint.
4. Adding necessary filler metal.
5. Cleaning flux residue from the welded joint.

Advantages of Soldering

Low power is required.

Low process temperature.

Simple, Economical, Rework- desoldered & resoldered.

Base metals are safe against metallurgical damages.

No thermal distortions and residual stresses in the joint parts.

Microstructure is not affected by heat.

Easily automated process.

Dissimilar materials may be joined.

High variety of materials may be joined.

Thin wall parts may be joined.

Moderate skill of the operator is required.

Disadvantages of Soldering

Careful removal of the flux residuals is required in order to prevent corrosion.

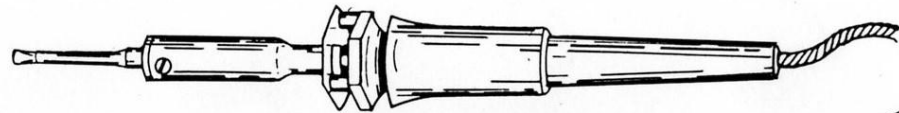
Large sections cannot be joined.

Fluxes may contain toxic components.

Soldering joints can not be used in high temperature applications.

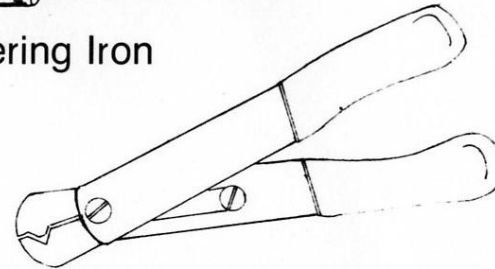
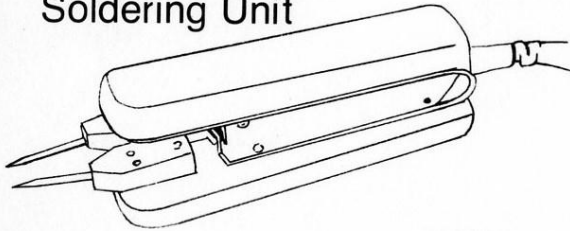
Low strength of joints.

Typical Soldering Tools



Pencil Soldering Iron

Resistance Soldering Unit



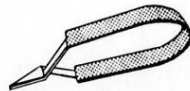
Mechanical Wire Stripper



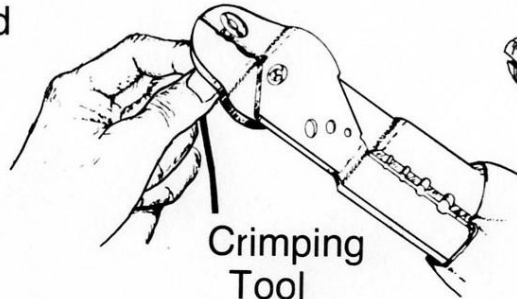
Soldering Aid



Nail Nippers



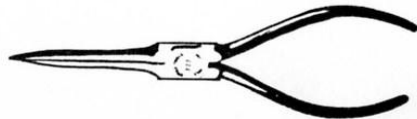
Heat Sink



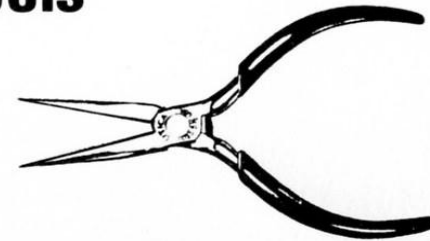
Crimping Tool

Typical Soldering Tools

(Continued)



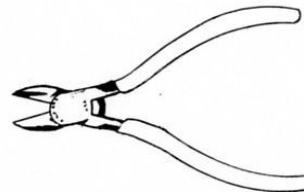
Long Needle Nose Pliers



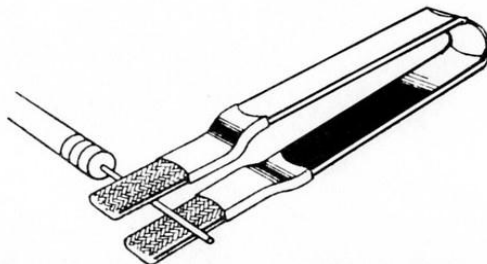
Long Chain Nose Pliers



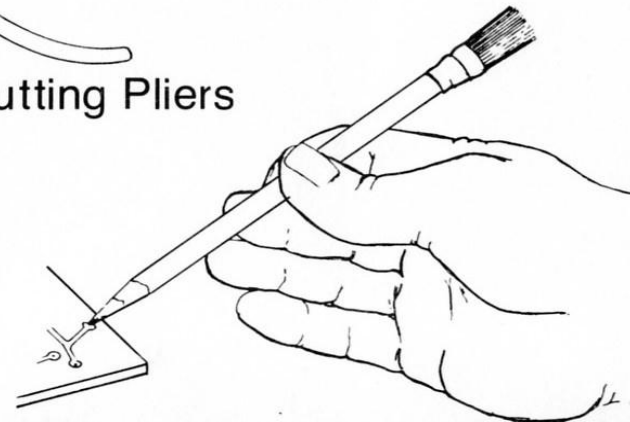
Electrician's Standard Size Cutting Pliers



Diagonal Cutting Pliers



Component Lead Cleaner



Typewriter Eraser Used To Mechanically Clean Parts To Be Soldered

Brazing

Brazing is defined as a joining process of metals with non-ferrous filler material at a melting temperature above 450 C, but below the melting temperature of the metals being joined.

It is one of the hard soldering method. Alloy filler materials are brass, silver alloy in the form of spelter & Flux like borax, ash etc. Spelter is hard filler material having melting point around 600 to 900⁰C. – Two groups – 1 Copper base alloys 2) Silver base alloys.

The bond is due to wetting of the parent metal by the brazing metal and alloying of the brazing metal with the solid parent metal.

A brazed joint derives its strength from a combination of the brazed metal and the parent material as an alloy which is formed and penetration of the viscose brazed metal into the grain boundaries of the parent material.

The strength is also a function of clearance between the parts being brazed for capillary attraction to the work.

Brazing

Types: Based on heating

- 1) Blow/Torch Blazing
- 2) Furnace brazing
- 3) Electric brazing
- 4) Dip brazing



Brazing Filler Materials

Copper filler alloys used for brazing Copper alloys, Steels and Nickel alloys (the melting point about 1083 C).

Aluminum filler alloys used for brazing Aluminum alloys (the melting point range 570 – 640 C).

Magnesium filler alloys used for brazing Magnesium alloys (the melting point about 650 C).

Nickel filler alloys used for brazing Nickel alloys, cobalt alloys, Stainless steels (the melting point about 1450 C).

Silver filler alloys used for most of metals and alloys except aluminum and magnesium alloys (the melting point range 630 – 850 C).

Brazing Fluxes

A brazing flux has a melting point below the melting point of the filler metal, it melts during the heating stage and spreads over the joint area, wetting it and protecting the surface from oxidation.

It also cleans the surface, dissolving the metal oxides.

It is important that the surface tension of the flux is:

1. Low enough for wetting the work piece surface.
2. Higher than the surface tension of the molten filler metal in order to provide displacement of the flux by the fused brazing filler. The latter eliminates the flux entrapment in the joint.

The flux is applied onto the metal surface by brushing, dipping or spraying.

Brazing Methods

Torch brazing utilizes a heat of the flame from a torch. The torch mixes a fuel gas with oxygen or air in the proper ratio and flow rate, providing combustion process at a required temperature.

The torch flame is directed to the work pieces with a flux applied on their surfaces. When the work pieces are heated to a required temperature, filler alloy is fed into the flame. The filler material melts and flows to the gap between the joined parts. Torch brazing is the most popular brazing method.

Torch brazing equipment:

- Fuel gas cylinder with pressure regulator.
- Oxygen cylinder with pressure regulator.
 - Welding torch.
 - Blue oxygen hose.
 - Red fuel gas hose.
- Trolley for transportation of the gas cylinders.

Torch brazing



Vacuum Brazing



Dip Brazing



Advantages of Brazing

Low thermal distortions and residual stresses in the joint parts.

Microstructure is not affected by heat.

Easily automated process.

Dissimilar materials may be joined.

High variety of materials may be joined.

Thin wall parts may be joined.

Moderate skill of the operator is required.

Disadvantages of Brazing

Careful removal of the flux residuals is required in order to prevent corrosion.

Large sections cannot be joined.

Fluxes and filler materials may contain toxic components.

Relatively expensive filler materials.

Difference between soldering & brazing.

Soldering

Solder-used- process

Joints are not strong

Costs less

Flux-

chlorides of zinc/ammonia

Temp- 200-400

Soldering iron/small torch

Thin similar sheet metals

Soldered parts – cleaned with H₂O

Brazing

Spelter

Strong Joints

Costs more

Borax/Ash

high temp – 900

Furnace/heavy blow torch

thicker similar or dissimilar

allowed to cool slowly.

Welding

A joining process that produces a coalescence of metals (or non-metals) by heating them to the welding temperature,

- with or without the application of pressure, or by pressure alone, and

- with or without the use of filler metals

Welding is the process of joining two metal pieces as a result of significant diffusion of the atoms of the welded pieces into the joint (weld) region. Welding is carried out by heating the joined pieces to melting point and fusing them together (with or without filler material) or by applying pressure to the pieces in cold or heated state.

Welding: Is a process of joining two similar or dissimilar metal pieces permanently with or without filler material using i) Only Heat or ii) heat & pressure at plastic state.

Weldments: The metal pieces to be welded are called weldments.

Weldability: It is the capacity of the metal to be welded successfully under desired conditions.

Advantages of welding:

- Strong and tight joining;
- Cost effectiveness;
- Simplicity of welded structures design;
- Welding processes may be mechanized and automated.

Disadvantages of welding:

- Internal **stresses**, distortions and changes of **micro-structure** in the weld region;
- Harmful effects: light, ultra violet radiation, fumes, high temperature.

Difference between welding & Brazing

Welding

Gas/ Electricity

Many equipments

Flux – Sodium carbonate

Temp – 3000 to 7000

Filer rod/wire

Weld slag to be cleaned

Safety Precautions

Costly

Strong Joints

Skill of operator is reqd.

Brazing

Blow torch

Few

Borax

600-900

Spelter

No Slag

Less

Economical

Weak

Moderate skill/less

Arc welding is the welding process, in which heat is generated by an electric arc struck between an electrode and the work piece.

Electric arc is luminous electrical discharge between two electrodes through ionized gas.

Any arc welding method is based on an electric circuit consisting of the following parts:

- Power supply (AC or DC);
- Welding electrode;
- Work piece;
- Welding leads (electric cables) connecting the electrode and work piece to the power supply.

Electric arc between the electrode and work piece closes the electric circuit.

The arc temperature may reach 10000°F (5500°C),

which is sufficient for fusion the work piece edges and joining them.

When a long join is required the arc is moved along the joint line.

The front edge of the weld pool melts the welded surfaces

when the rear edge of the weld pool **solidifies** forming the joint.

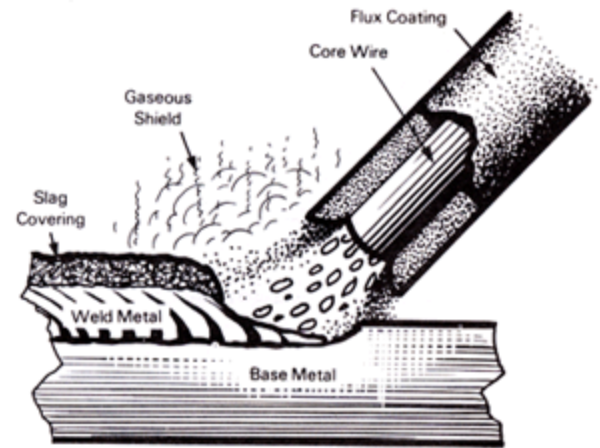
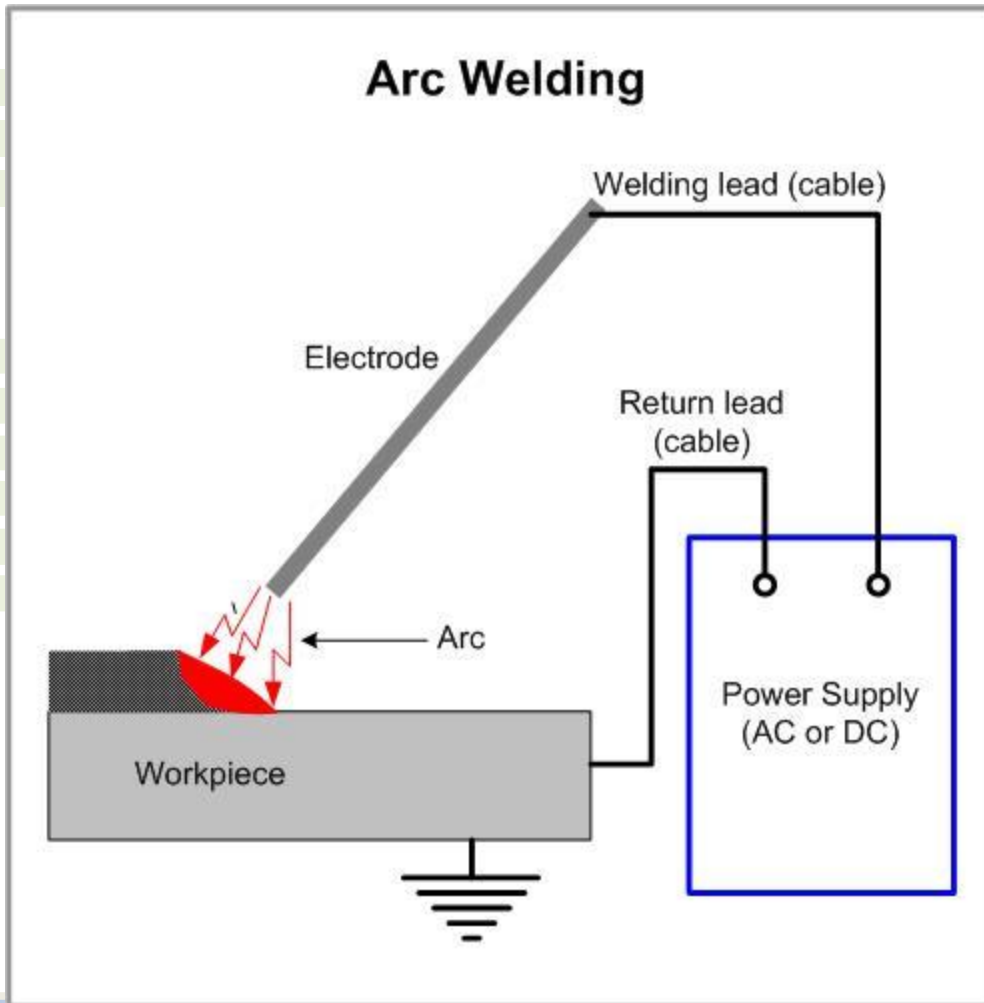
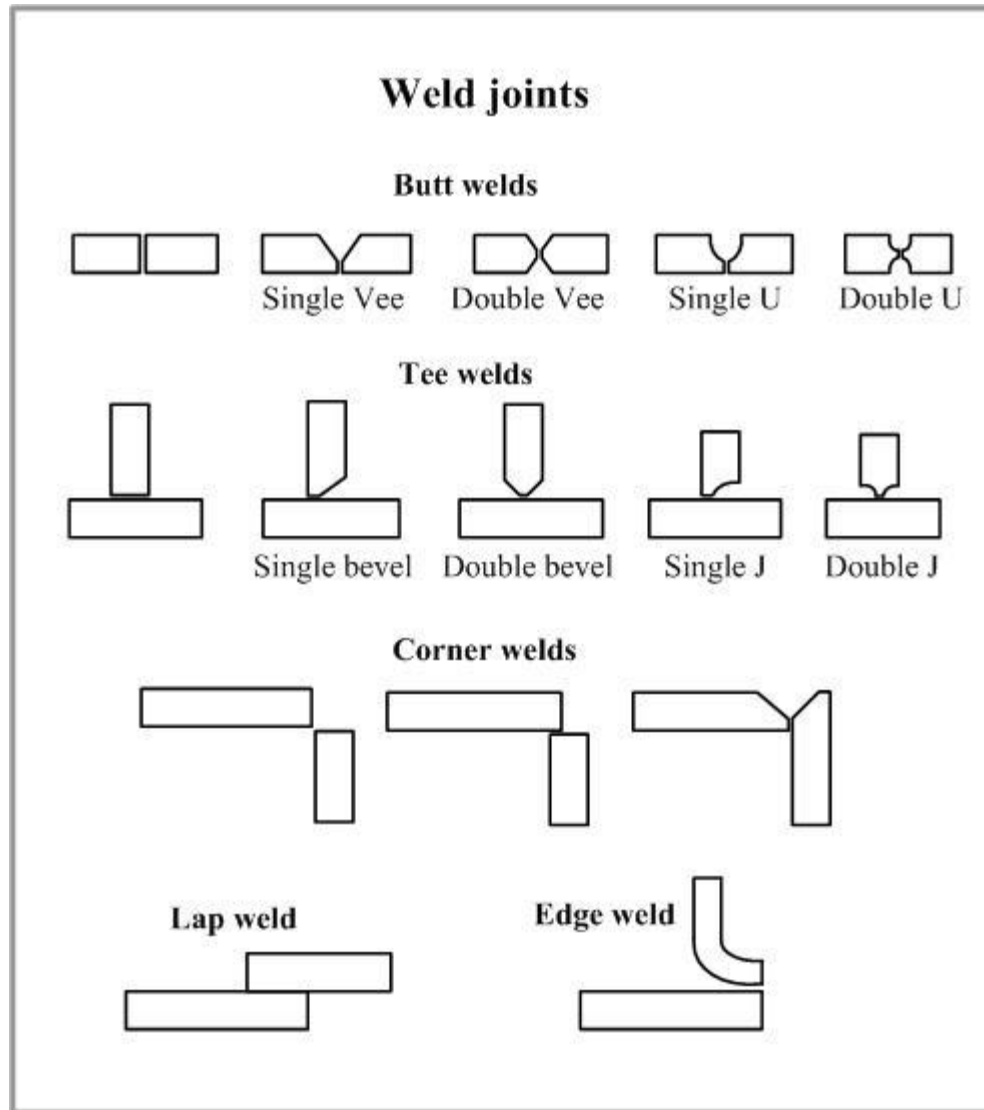


Fig. 6



Unit – V,

Soldering, Brazing & Welding



Unit - III

Sequence of operations n welding.

- 1) Cleaning of weldments
- 2) Edge preparation
- 3) Fixing in position using suitable clamps, gigs, fixtures
- 4) Viewing thro face shield
- 5) Tack welds
- 6) Applying weaving motions
- 7) Intermittent 7 final weld
- 8) Removal of excess filler material using tongs & chipping hammer
- 9) Cooling of weldments.

Welding machines:

- a) Welding Transformer AC: supplies high electric current at low voltage – electrode (filler rod)– arc – current density – thickness of w/p- 20 to 3000 A (100 to 400 A) - 15 to 100 V (80 to 90 V) – 60 Hz- arc length 3 to 4 mm.
- b) Welding Generator- DC- for non ferrous metals – low current welding- changing of polarity – w/p +ve – electrode –Ve.
- c) Welding Rectifier – Consists Transformer, Current regulator, rectifier. For both ferrous & non ferrous metals – sheet metal & pipe welding

Differences bet AC & DC Welding

AC

DC

Unit - III

GAS WELDING: It is a process of burning a combustible gas with air or oxygen in a concentrated flame of high temperature. Flame helps to melt the parent metal and filler rod of joint. Flux is used to remove oxides & impurities. – Fusion Welding method.

Applications.

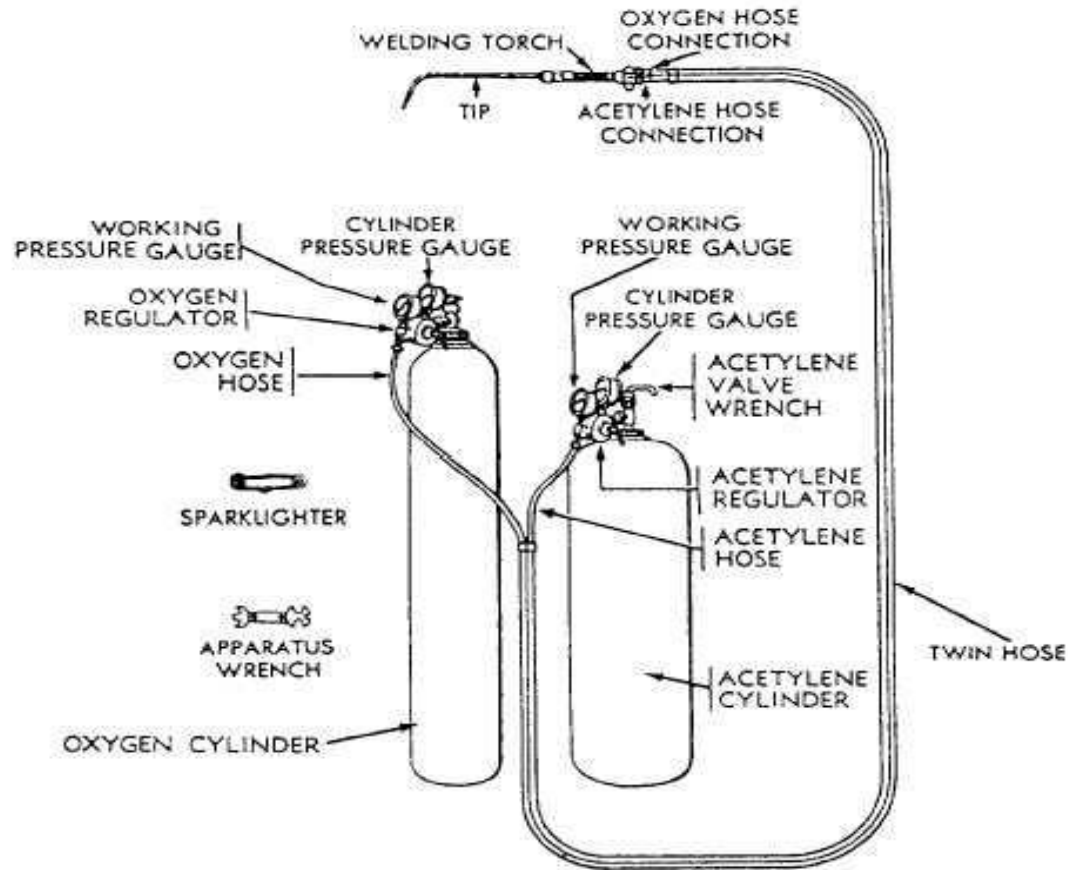
w/p thickness – 3 to 50 mm- general & repair works.

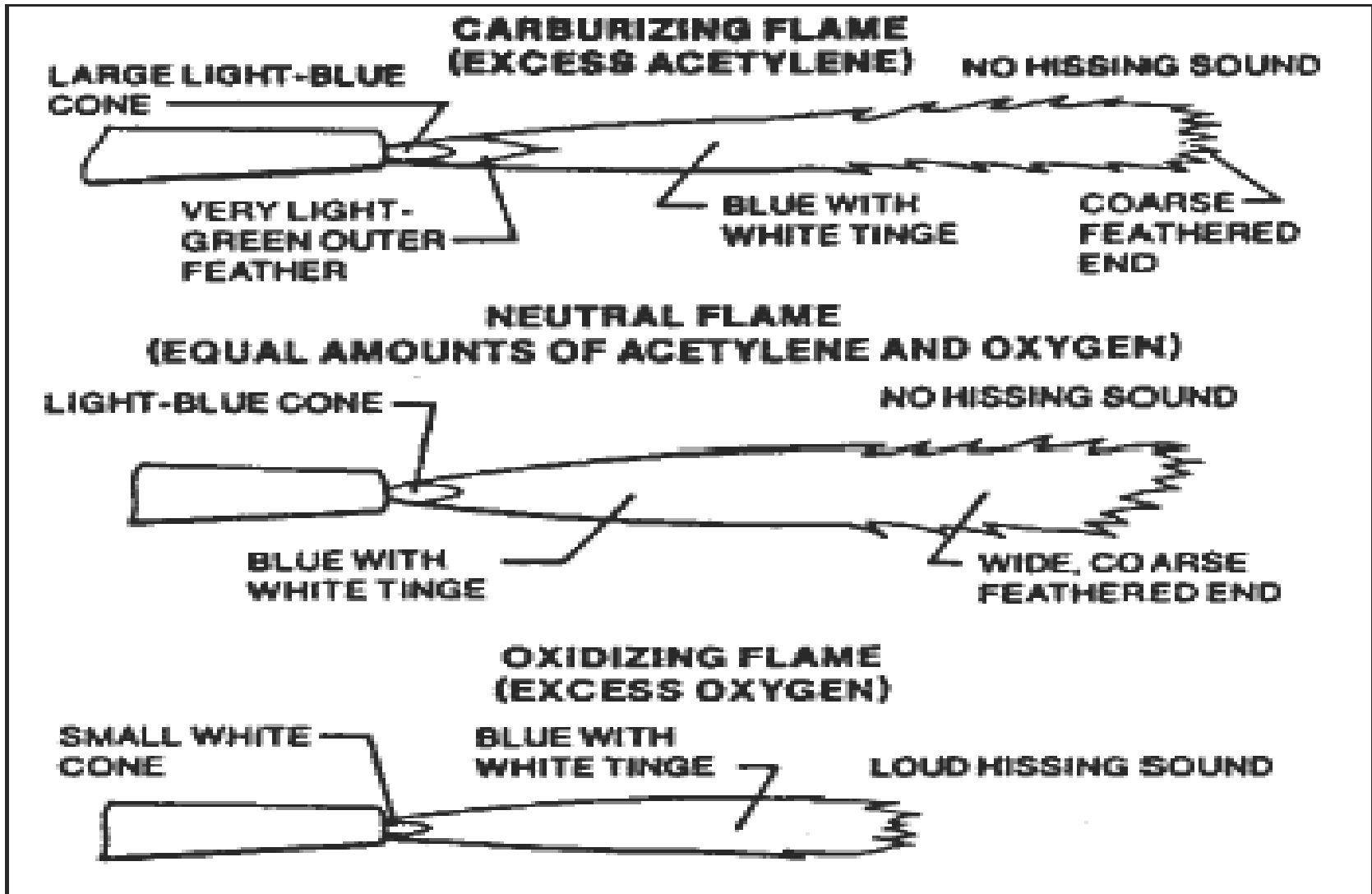
Classification

Basis	Name
Pressure	High & low pressure welding
Combustible gases	Oxy-Acetylene, Oxy Hydrogen

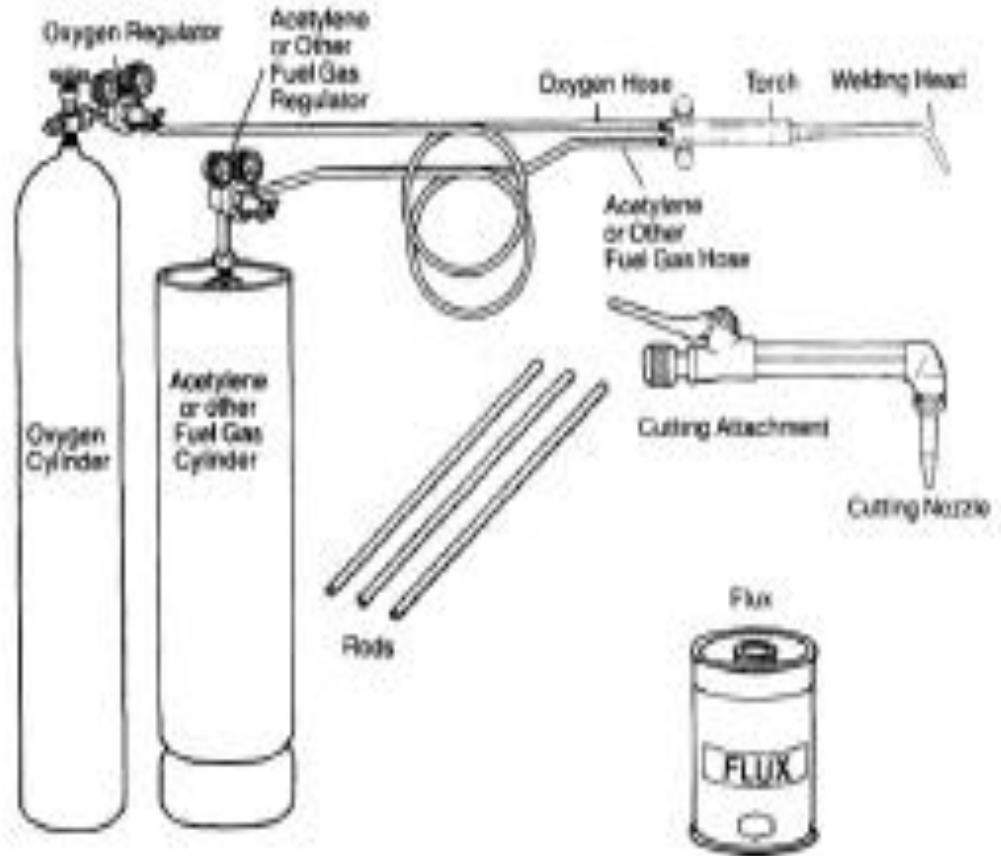
Oxy-Acetylene Welding: combustion of oxygen & Acetylene – in torch- hot gas flame – 3300⁰C.

First





2.8 Gas welding with oxygen and acetylene gases is one of the oldest forms of welding, and is still used today in construction, muffler chops and farm repairs. Its versatility lies in the ability to cut and weld, on thick and thin materials, and to do braze-welding as well. The flux shown is only used for brazing. Note the different size and shape of the two gas cylinders.



Unit – V,

Soldering, Brazing & Welding

Unit - III

