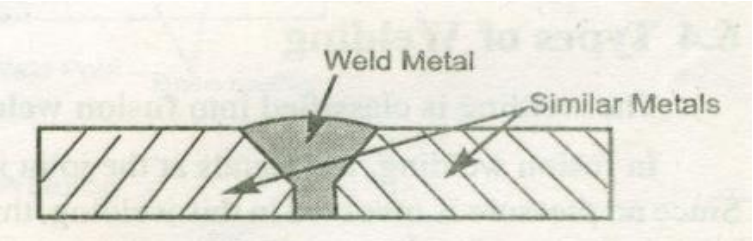
Welding, Soldering & Brazing

Welding

Welding is a process of joining two metal pieces by the application of heat, with or without the application of pressure and with or without the addition of filler material .



Applications:

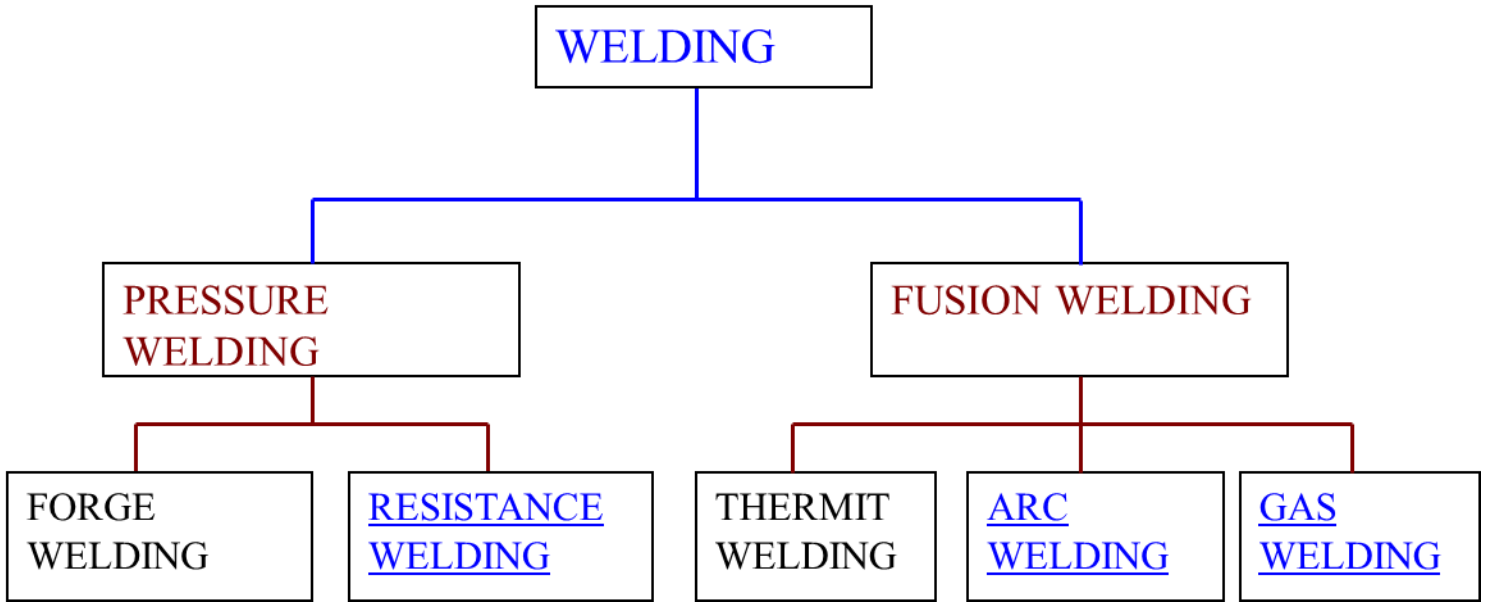
Fabrication work, Construction work, Repair work etc.

-wherein metal plates, rolled steel sections, castings of ferrous metals, broken metal parts are welded together.


HOT RODDING


How Welding Works
Electrode
Flux Jacket
Metal Filler
Clamp
Power Source
Grounding Wire
Stick Welding

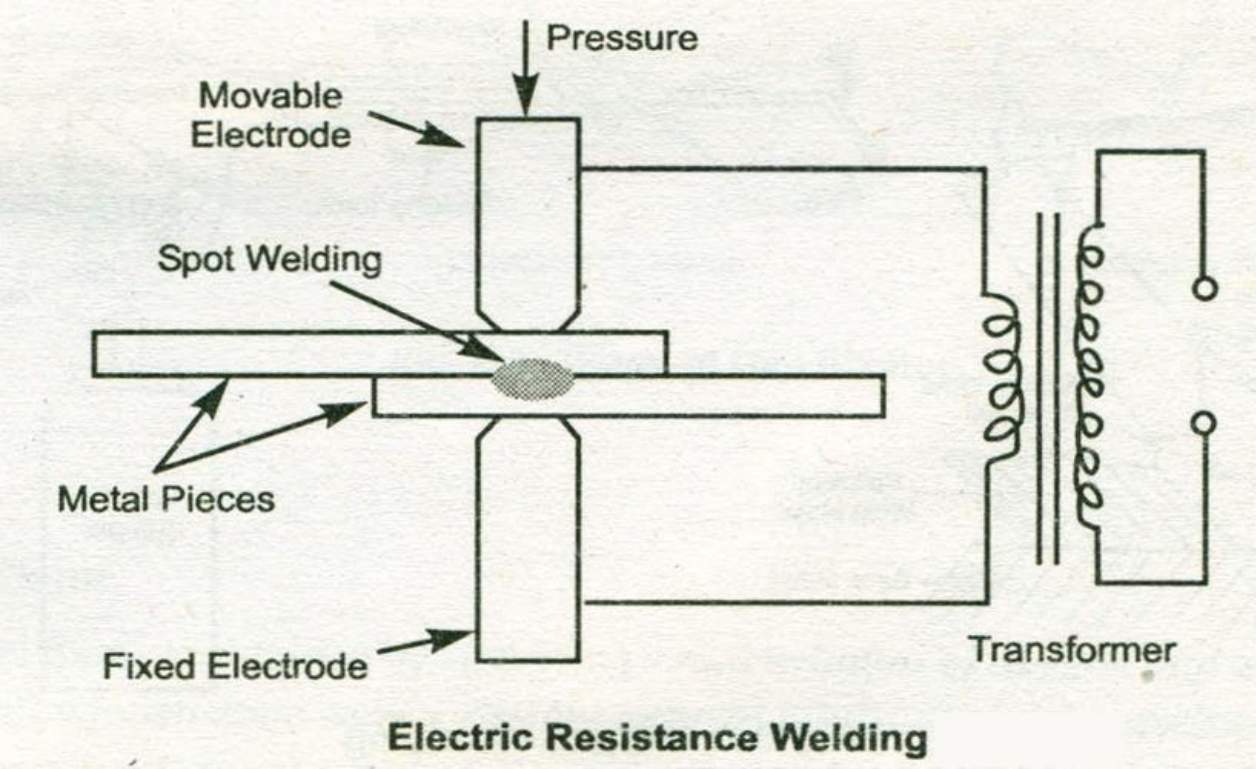
Classification:



Resistance Spot Welding:

In resistance spot welding the metal pieces to be welded are heated to the plastic state over a limited area because of their resistance to the flow of electric current and external pressure is applied to complete the weld.

Resistance Spot Welding:



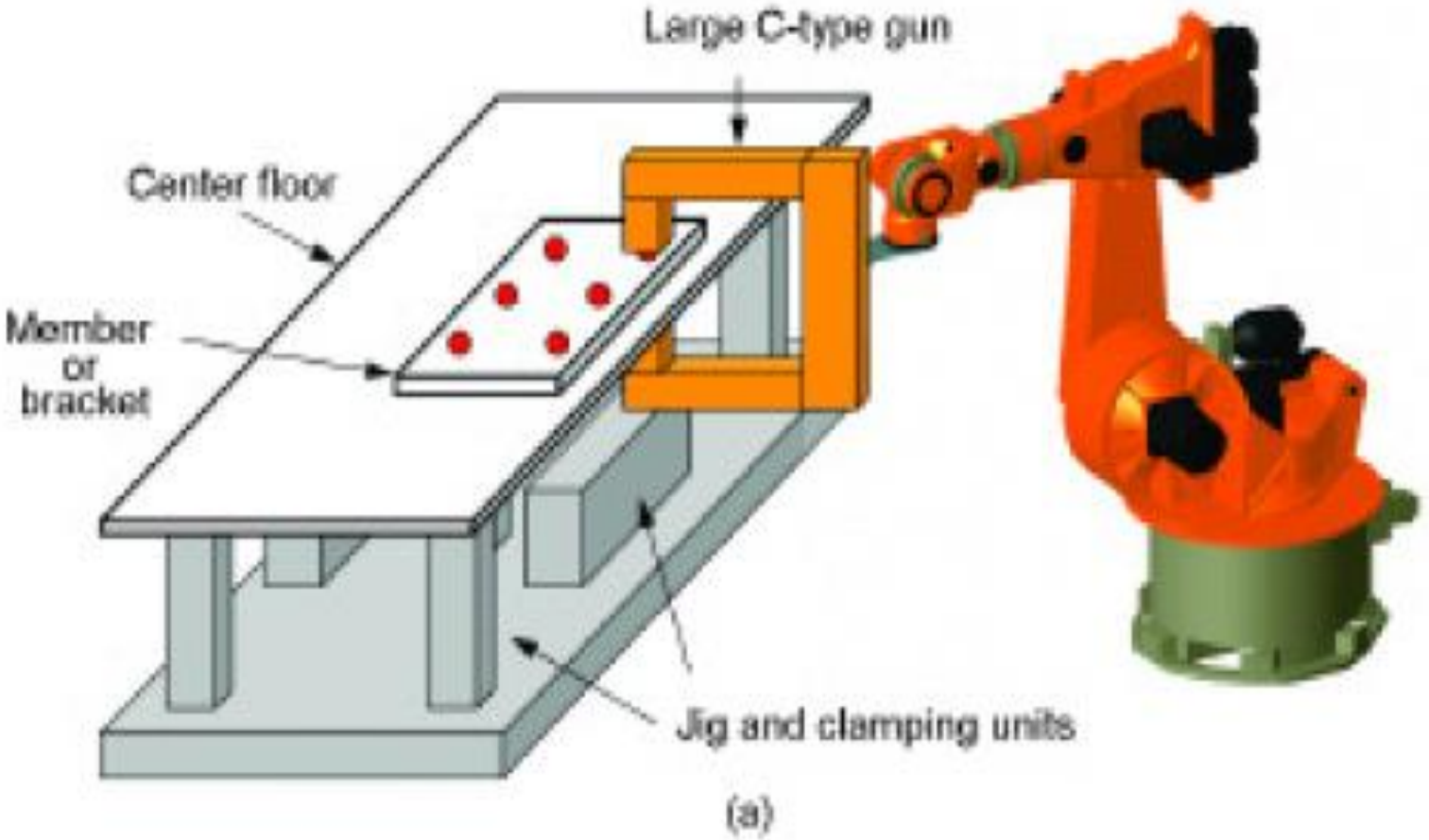
Electric Resistance Welding

Resistance Spot welding

- Uses the principle of pressure welding
- Electrodes are positioned on either side of the sheet metal to be welded
- Bottom electrode is fixed and the upper one is movable.
- External pressure applied through the movable electrode.
- Parts are heated by passing a heavy electric current.
- Current encounters very high resistance at the joint, as a result temperature at the joint increases.

Resistance Spot welding

- When temperature reaches plastic temperature of the parts external mechanical pressure is applied.
- It is widely used in automobile industry for fabrication of car bodies, Sheet metal fabrication, ventilating ducts, domestic refrigerators etc.


Large C-type gun
Center floor
Member
or
bracket
Jig and clamping units
(a)

Advantages:

- Less pollution
- Efficient energy use
- High production rates

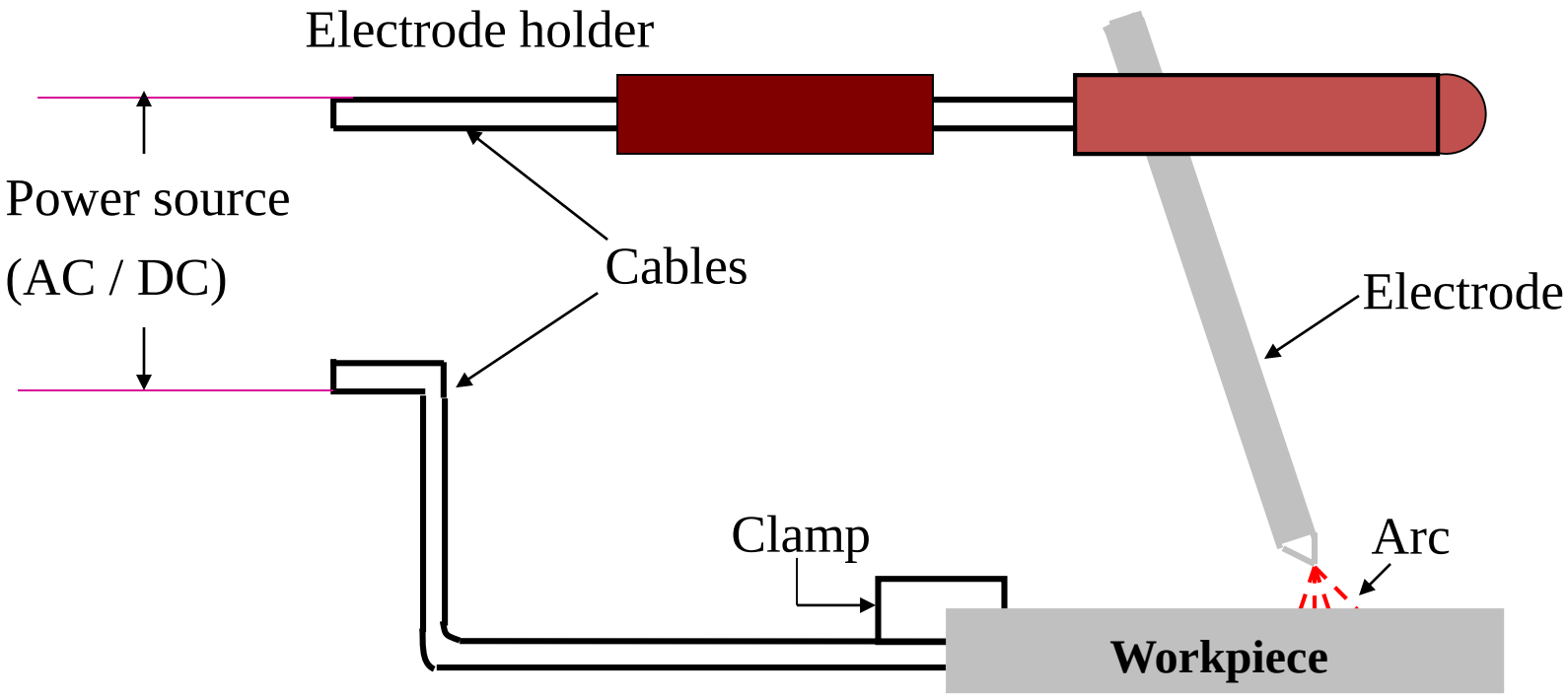
Disadvantages:

- Not suitable for joining thick metals
- Equipment is costly

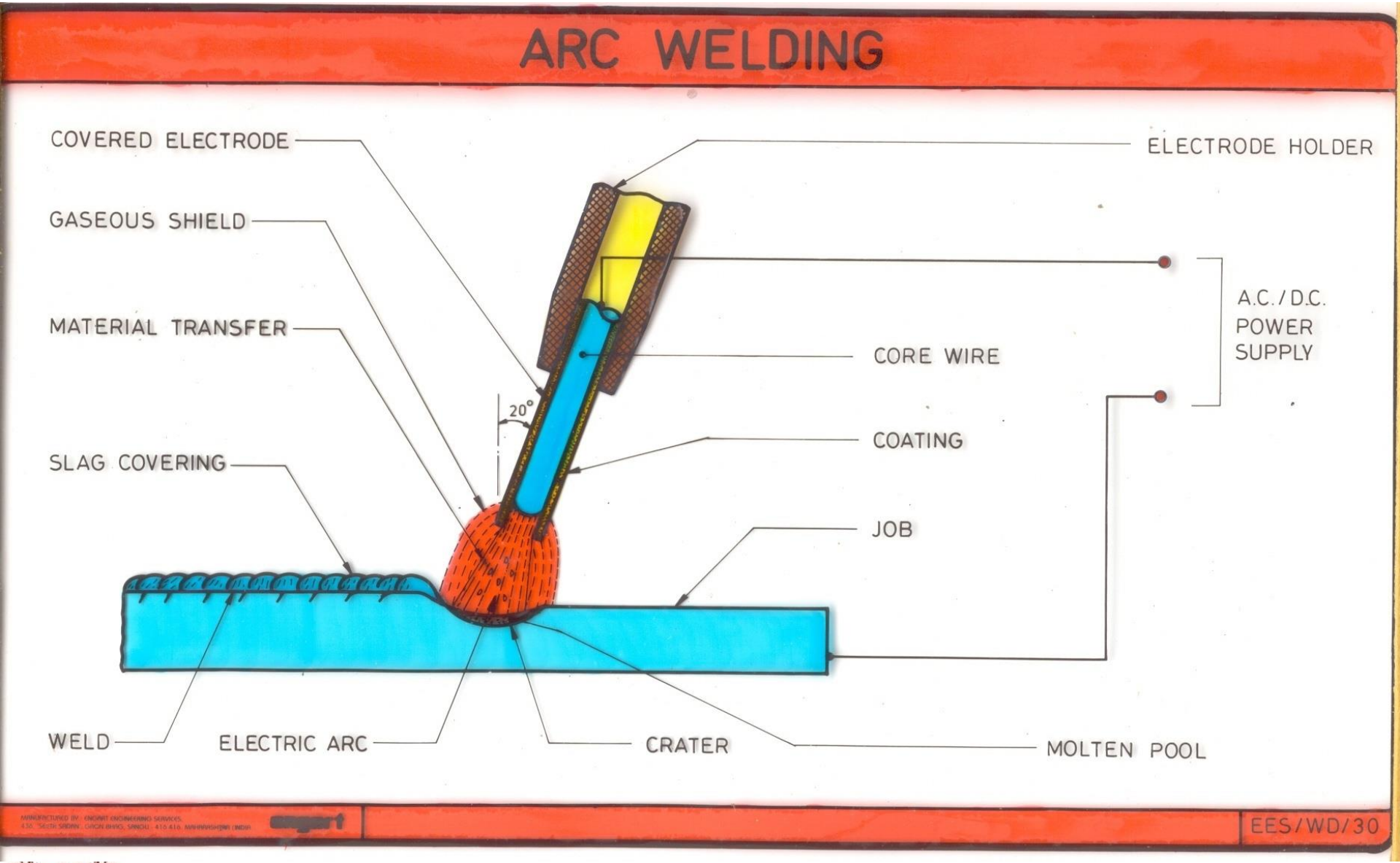
Electric Arc welding:

Arc welding is a fusion welding process in which welding is carried out by producing heat from an electric arc maintained between the work pieces and the electrode. External pressure is not applied in arc welding process. The electrode acts as the filler metal which is heated to its molten state and gets deposited on to the joint to complete the weld.

Electric Arc welding:



Arc Welding Circuit


ARC WELDING
COVERED ELECTRODE
GASEOUS SHIELD
MATERIAL TRANSFER
SLAG COVERING
ELECTRODE HOLDER
A.C./D.C. POWER SUPPLY
CORE WIRE
20°
COATING
JOB
WELD
ELECTRIC ARC
CRATER
MOLTEN POOL
EES/WD/30

Electric Arc welding:

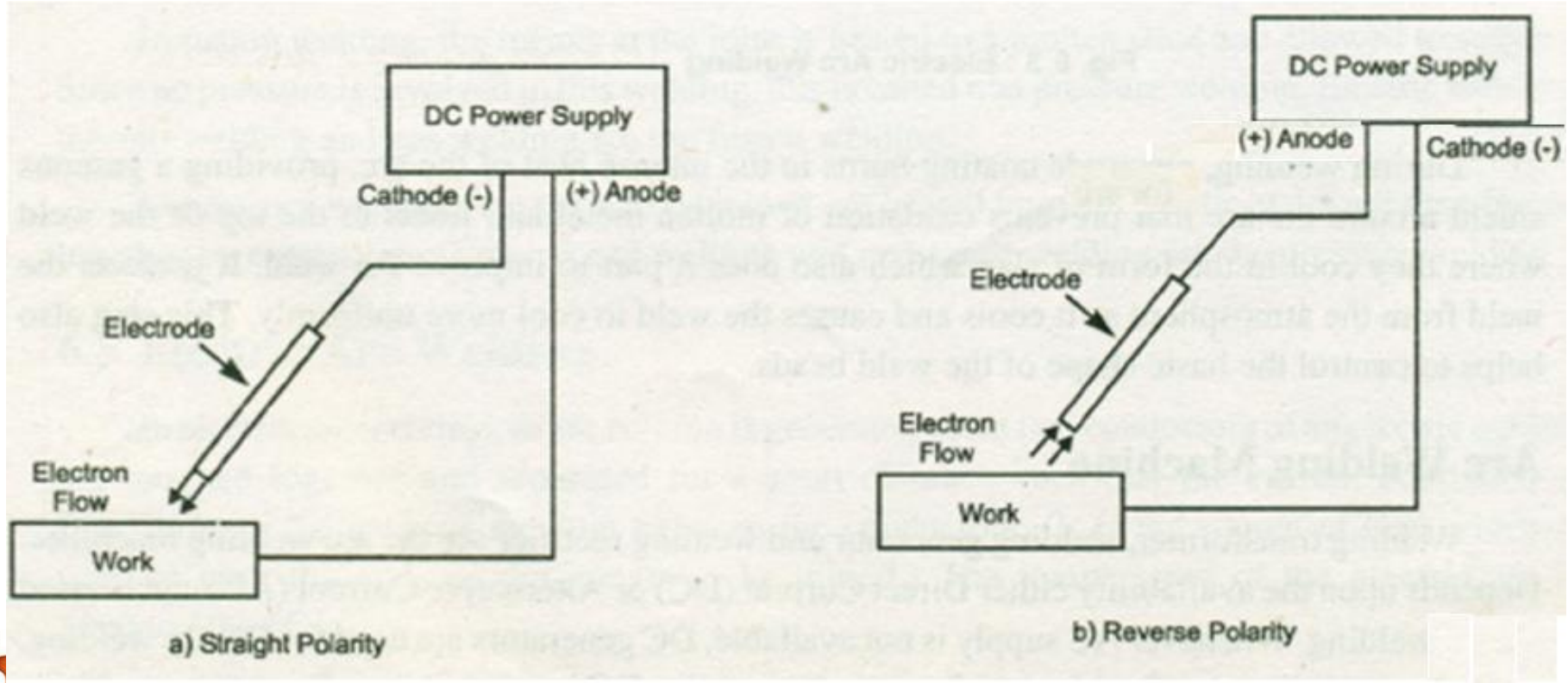
- Plates to be welded will act as one pole of the electric circuit.
- Electrode held by the operator forms the other pole.
- When electrode comes in contact with the plates and separated by a small distance an electric arc is formed.
- Intense heat of the arc melts the edges of two plates & creates a small molten metal pool.
- Electrode tip also melts and filler metal enters the pool.
- Strong joint is formed when molten metal cools & solidifies.

Arc Welding Power Source

AC arc welding –Step down transformer is used (200-440V to 80 -110 V)

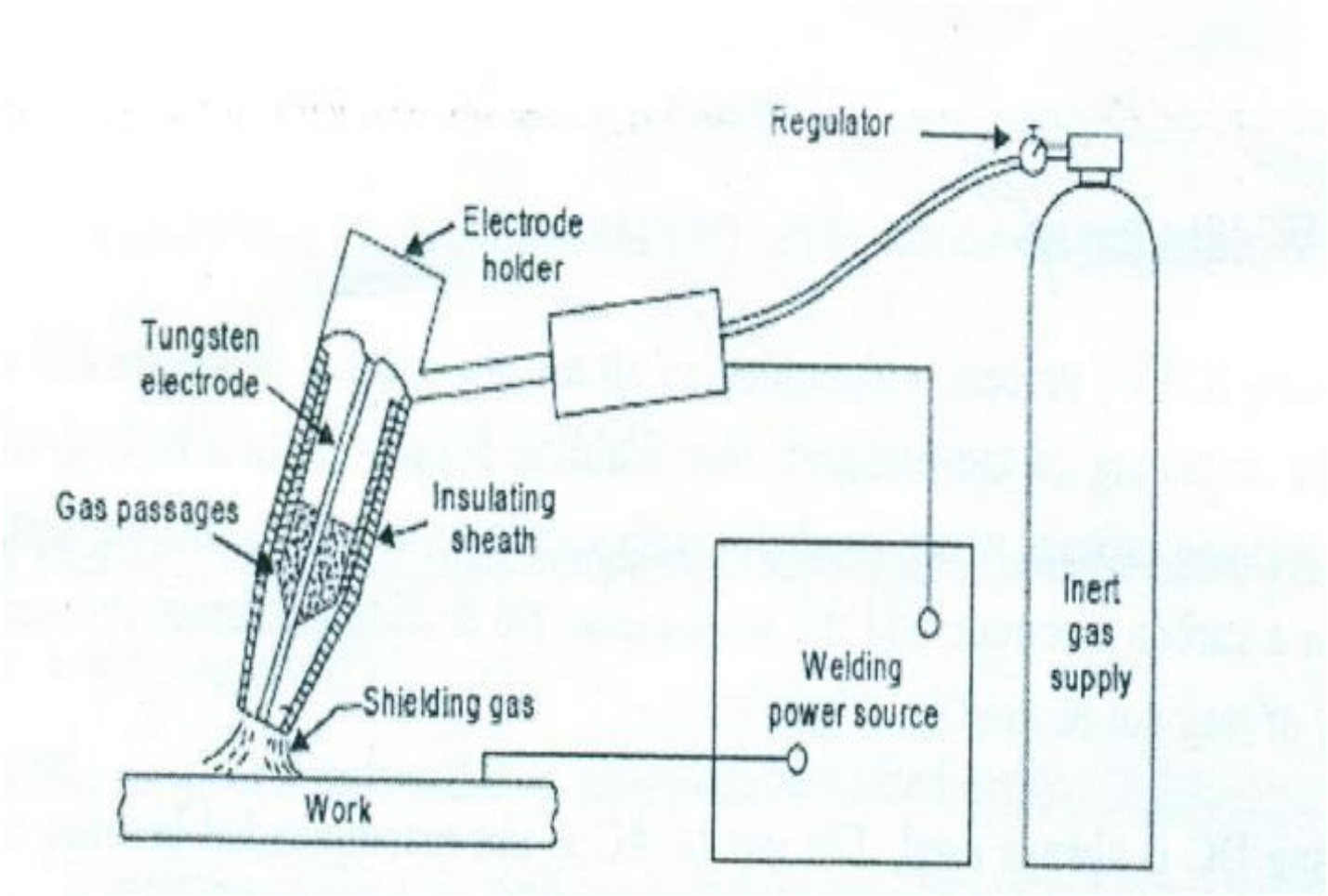
High current (100-400 A)

DC arc welding – DC generator is used where direction of flow of electrons can be changed by using either Straight polarity or Reverse Polarity



MANUFACTURING TECHNOLOGY

Tungsten Inert Gas welding: (TIG)/ (GTAW)



Tungsten Inert Gas welding: (TIG)/ (GTAW)

- This arc welding process uses the intense heat of an electric arc between a non-consumable tungsten electrode and the material to be welded.
- The shielding is obtained from the inert gas such as helium or argon or a mixture of two.
- Filler metal may or may not be used. When filler metal rod is used, it is usually fed manually into the weld pool.
- Electrodes used in this process are made of tungsten or tungsten alloys.
- The tungsten electrode is used only to generate an arc.
- The arc doesn't melt the tungsten, which has a melting point of over 3300°C .

Tungsten Inert Gas welding: (TIG)/ (GTAW)

Advantages:

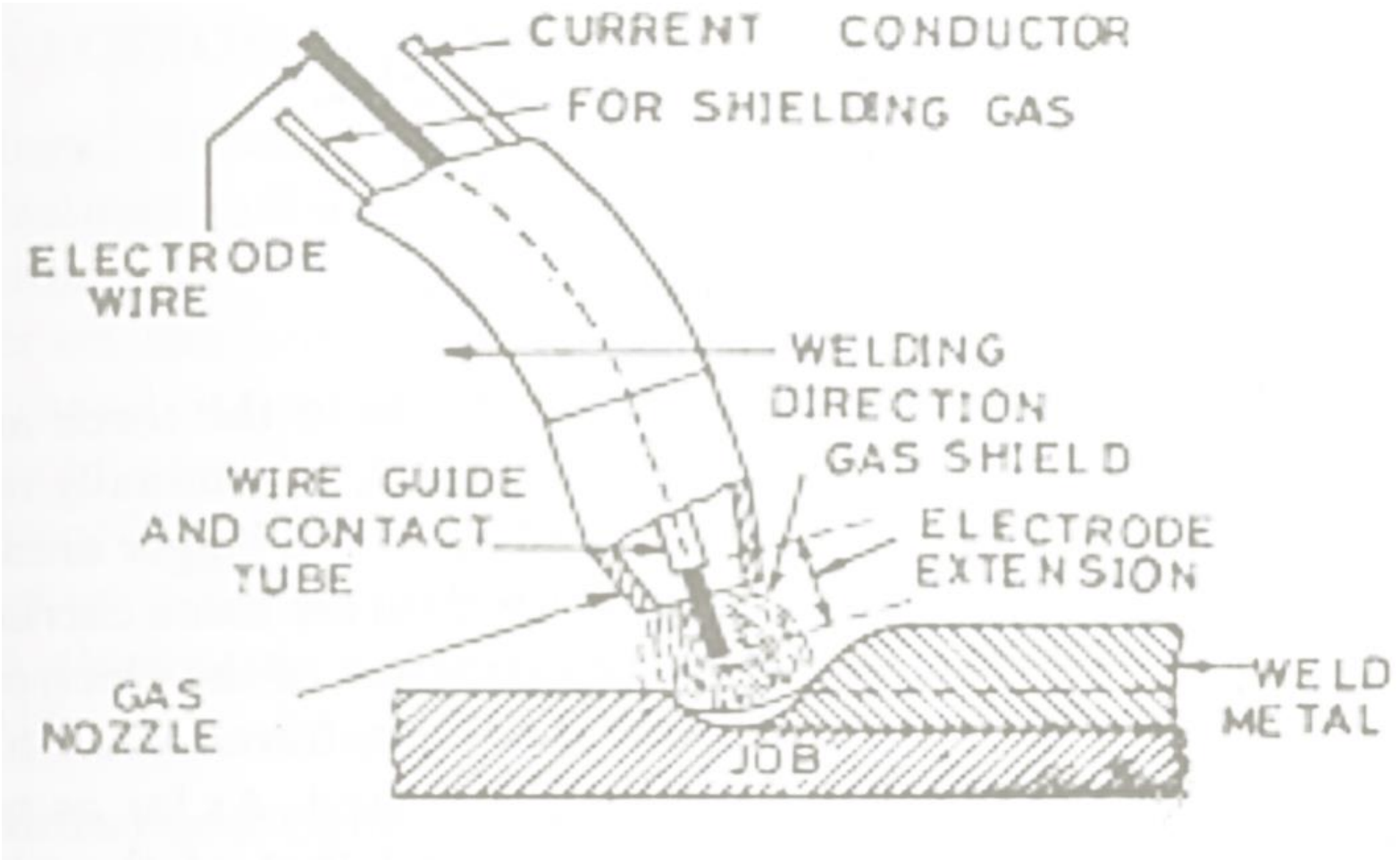
- No flux is required, hence no special cleaning is required.
- It produces high quality welds in nonferrous metals.
- TIG weld joints are stronger, more ductile, more corrosion resistance.
- Dissimilar metals can be welded.

Tungsten Inert Gas welding: (TIG)/ (GTAW)

Disadvantages:

- Process is comparatively slow
- There exists possibility of electrode contamination
- Inert gases are expensive
- High equipment cost
- Skilled operators are required
- Welder manually feeds the filler metal into the weld area with one hand while manipulating the welding torch in the other.

Metal Inert gas welding (MIG)/ (GMAW)



Metal Inert gas welding (MIG)/ (GMAW)

- Gas metal arc welding is a gas shielded, metal arc welding process which uses a high heat of an electric arc between a continuously fed, consumable electrode wire and the material to be welded.
- In this process the wire is fed continuously from a reel, such that feeding rate of the electrode to the arc is equal to the melting and deposition rate of it on the base metal.
- The continuously fed bare electrode melts and acts as filler rod.

Metal Inert gas welding (MIG)/ (GMAW)

- No pressure is applied for welding purpose.
- Arc is shielded by an inert gas. Shielding gases may be carbon dioxide or Helium or Argon, generally CO_2 is used as it is cheap and is used for welding steels.

Metal Inert gas welding (MIG)/ (GMAW)

Advantages

- No flux is required.
- High welding speed.
- Increased corrosion resistance.
- Easily automated welding
- Applicable to both ferrous and nonferrous metals

Metal Inert gas welding (MIG)/ (GMAW)

Disadvantages

- High equipment cost

Applications: shipbuilding, car body, pressure vessels, etc.

GAS WELDING (Oxy-Acetylene Welding)

Gas welding is a fusion welding process in which high temperature gas flame is used to raise the temperature of the work pieces so as to melt them at the junction and a filler material is used to complete the weld.

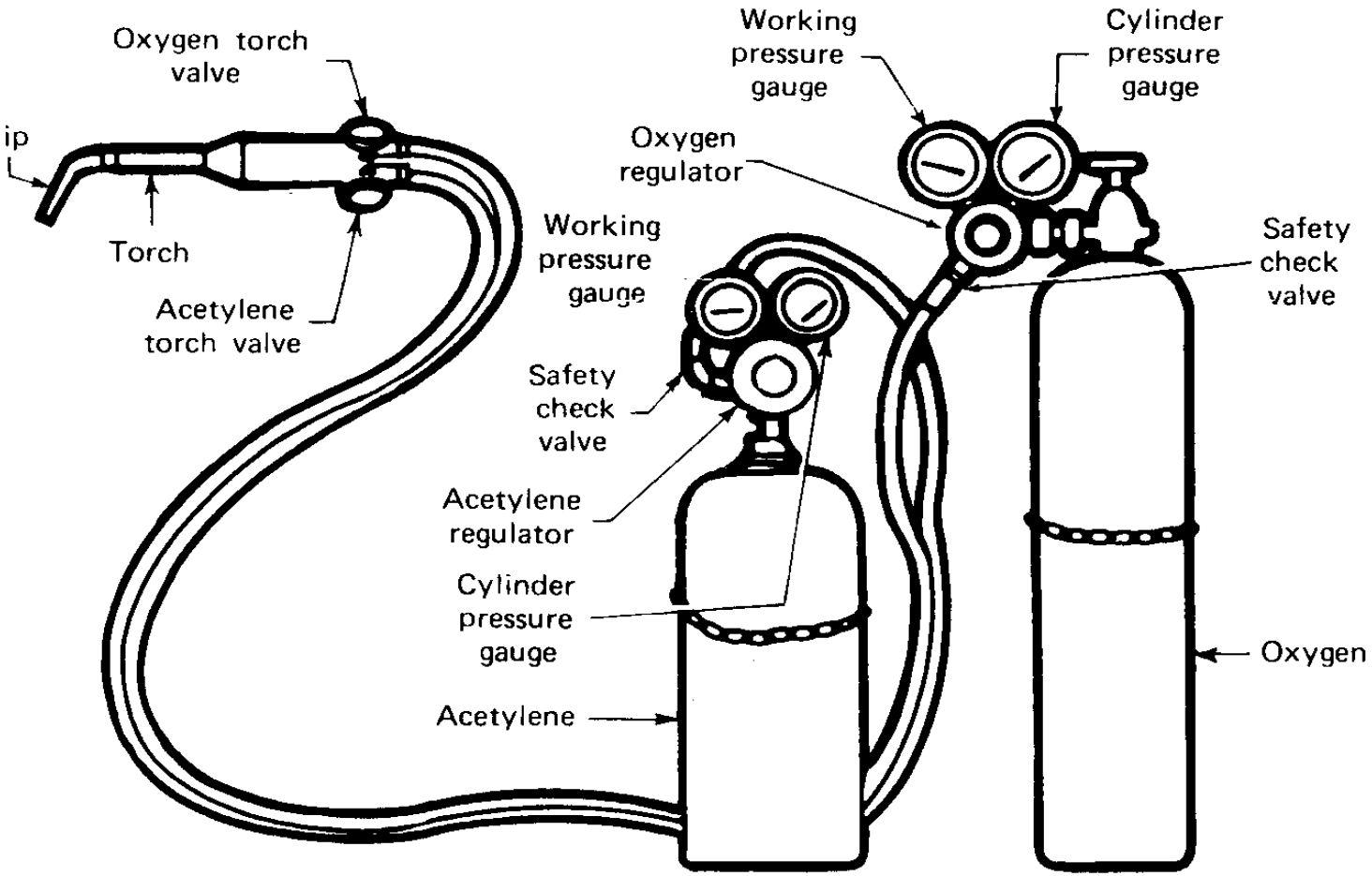
Commonly used gas mixtures are

1) oxygen and acetylene mixture

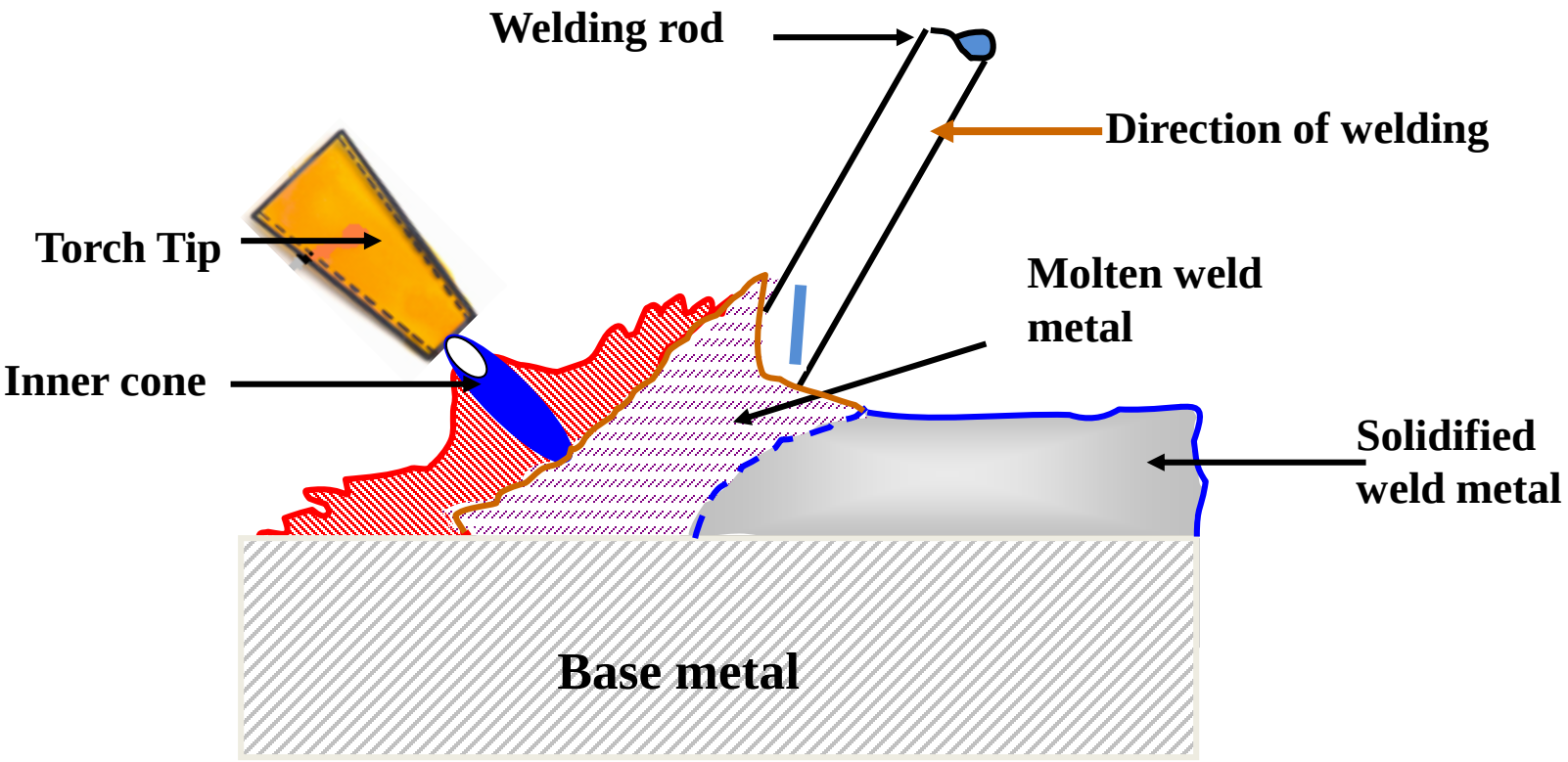
2) oxygen and hydrogen mixture

Of which oxygen and acetylene mixture is widely used.

GAS WELDING EQUIPMENT



Oxy-Acetylene Gas Welding



Oxy-Acetylene Gas Welding

- First the metal pieces to be welded are properly cleaned and placed near each other
- The supply of oxygen and acetylene gases is regulated using the welding torch so as to get the desired flame.
- The metal pieces are then heated to the melting temperature at the joint surface using the gas flame.

Oxy-Acetylene Gas Welding

- A filler rod is brought very near to the joint and the flame.
- Finally the filler rod and the torch tip are slowly advanced along the desired length of the joint to complete the weld.

GAS FLAMES

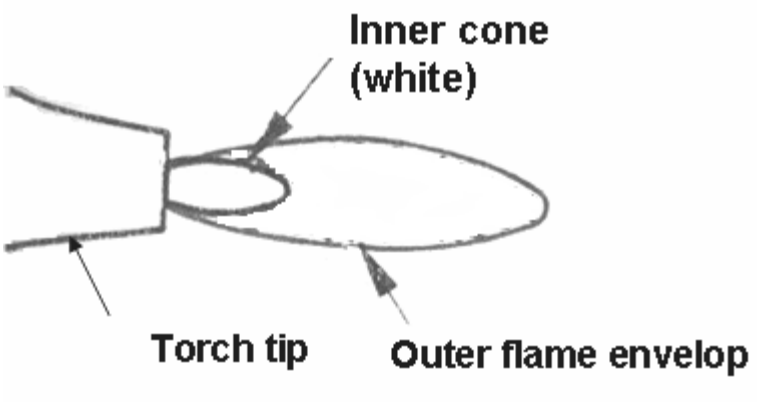
By regulating the flow of Oxygen and acetylene gases three gas flames can be obtained.

1) Neutral flame

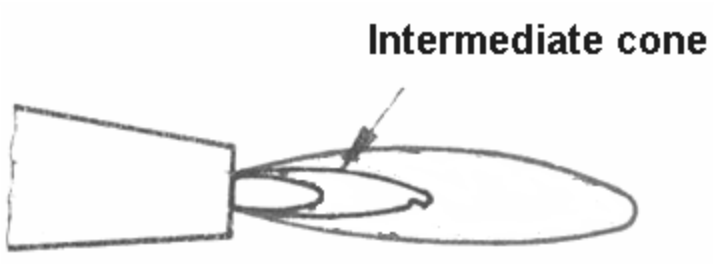
2) Carburising flame

3) Oxidising flame

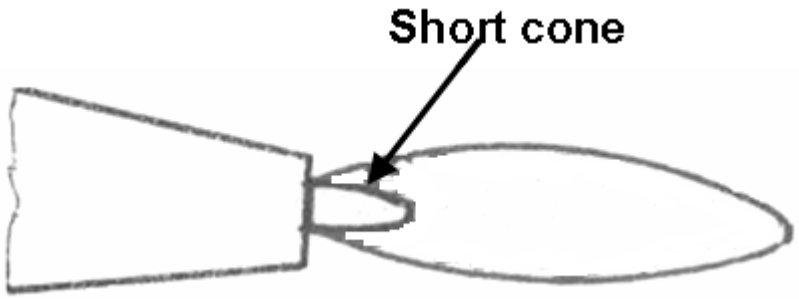
Gas welding flames



i. **Neutral flame**



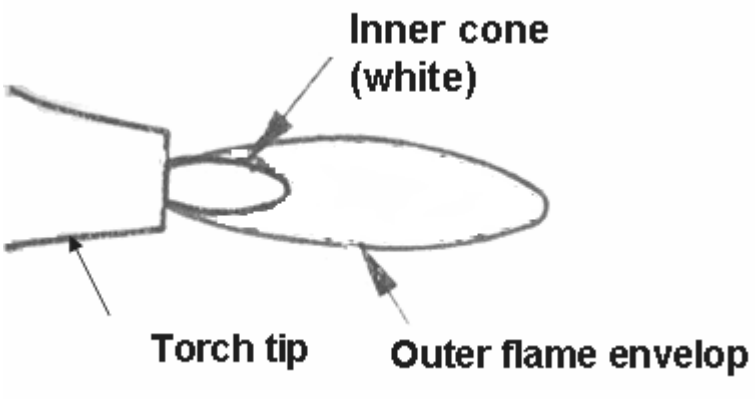
ii. **Carburizing flame**



iii. **Oxidizing flame**

Gas welding flames

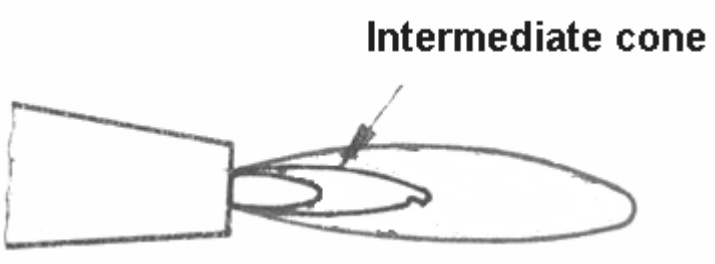
1. Neutral Flame



- Obtained by mixing equal volumes of oxygen and acetylene gases.
- It has an sharp inner cone which is white in colour surrounded by an outer envelope which is bluish in colour.
- The inner cone provides the heat and the outer envelope protects the molten metal from oxidation.
- The neutral flame is widely used for welding steel, alloy steels and cast iron.

Gas welding flames

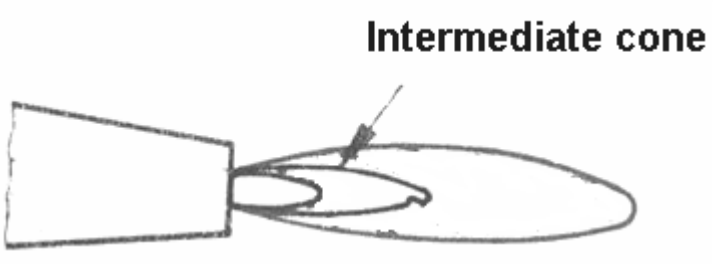
2. Carburizing Flame



- This type of flame is obtained by supplying excess volumes of acetylene gas.
- It is recognized by an intermediate cone known as “intermediate flame feather” between the inner cone and the outer bluish envelope. Its length is an indication of the amount of excess acetylene.
- This flame is used for welding non ferrous metals and high carbon steels.

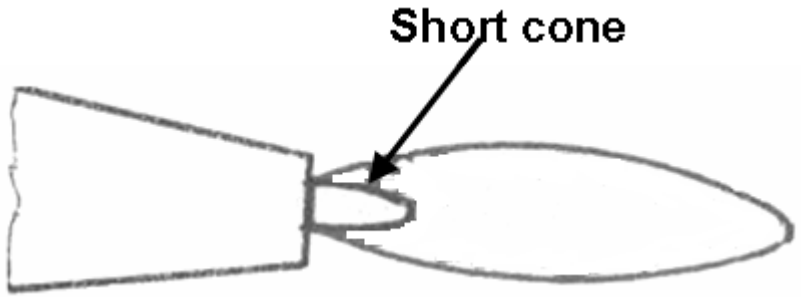
Gas welding flames

2. Carburizing Flame



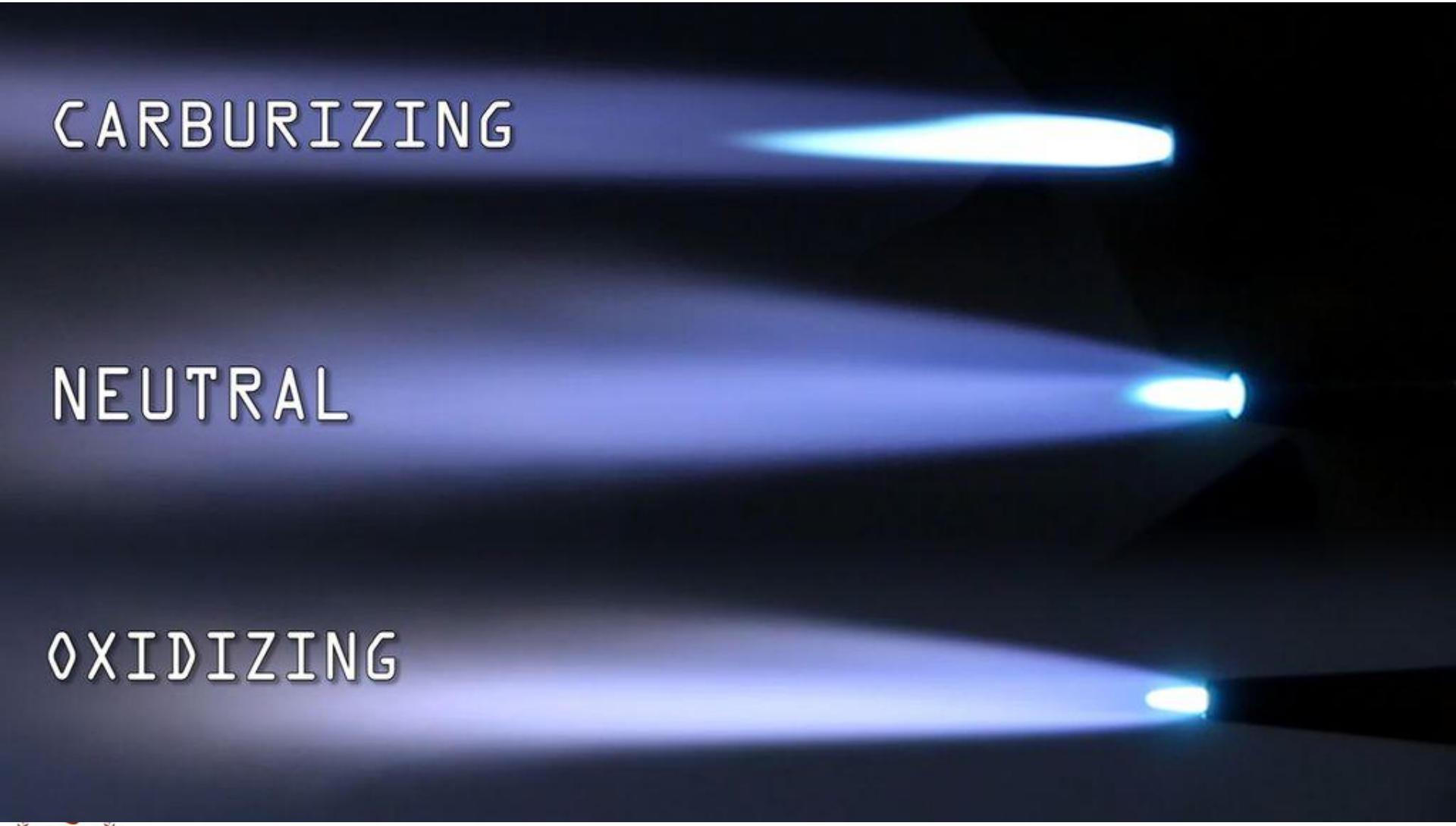
Gas welding flames

3. Oxidizing flame



- This type of flame is obtained by supplying excess oxygen.
- It is similar to the neutral flame except that the inner white cone is shorter in length.
- It is not suitable for welding since the weld metal gets oxidized.
- It is used in oxy acetylene gas cutting

Gas welding flames



SOLDERING & BRAZING

SOLDERING

- Soldering is a process of joining thin pieces of metal using a fusible alloy called the solder and by the application of heat.
- Soldering is extensively used in sheet metal work and in joining electrical and electronic circuits.
- The solder used is an alloy of lead and tin. Higher the percentage of tin lower will be the melting temperature of the solder.

SOLDERING

- The parts to be soldered are first thoroughly cleaned to make them free from dust, oil, scales etc. and are placed in position.
- Then the joining surfaces are coated with a flux usually zinc chloride.
- The soldering iron is then heated to the desired temperature electrically.
- After heating the soldering iron it is rubbed on the solder. The solder melts and spreads over the hot surface of the bit and forms a coating over it.
- This enables the bit to pick up the molten solder and deposit it as required on the joint surface. The joint is then allowed to cool so that the molten solder solidifies.

SOLDERING

Soft solder

- Alloy of lead and tin
- Melting temperature, 150 – 350^{0}C
- Used for lighter joints

Hard solder

- Alloy of copper , tin and silver
- Soldering temperature, 600 – 900^{0}C
- Used for stronger joints

BRAZING

- The method of joining two similar or dissimilar metals using a special fusible alloy called spelter having a melting point of greater than 450ºC but lower than the melting point of the parts to be joined is called Brazing.
- The materials used in brazing are copper base and silver base alloys.
- Brazing is used in many applications such as pipe fittings, carbide tips of tools, radiators, heat exchangers etc.

BRAZING

- The parts to be joined are first cleaned to remove dirt, oxides, grease and other impurities.

- Flux is then applied along the line of the joint. Usually Borax or Boric acid is used as flux in brazing

- After the flux is applied the joint is heated to the required brazing temperature using an oxy-acetylene welding torch.

- The solid filler metal then placed on the joint melts and flows by capillary action into the joint space and sticks to the surface by adhesion which on cooling produces a strong joint.

Comparison of Fusion and Pressure Welding

S.No	Fusion Welding	Pressure Welding
1	Parts to be joined are heated above melting point of the work	Parts to be joined are heated to plastic state.
2	External pressure is not required	External pressure is required to complete the weld.
3	Filler metal can be used	Filler metal is not used.
4	Portion of the work is affected due to heating above the melting point	Base metal is not affected
5	It produces stronger joint	Joint is weak compared to fusion welding.

Comparison between Brazing and Soldering

Brazing	Soldering
Melting point of the filler material is above 450^0C	Melting point of the filler material is below 450^0C
Similar/Dissimilar metals can be joined	Only similar metals can be joined
Good surface finish	Poor surface finish.
Stronger joints	Weaker joints