

UNIT-II

Electric Welding

3. Electric welding

Electric Welding is defined as the **process of joining two metal pieces**, in which the **electrical energy** is used to generate **heat** at the point of welding in order to melt the joint.

Advantages Of Welding:

- ✓ Welding is the **most economical** method to permanently join two metal parts.
- ✓ It provides design flexibility.
- ✓ Welding equipment is not so costly.
- ✓ It joins all the **commercial** metals.
- ✓ Both similar and dissimilar metals can be joined by welding.
- ✓ **Portable** welding equipment are available.

Disadvantages Of Welding:

- ✓ Welding gives out **harmful radiations** and fumes.
- ✓ Welding needs internal **inspection**.
- ✓ If welding is not done carefully, it may result in the **distortion** of workpiece.
- ✓ **Skilled** welding is necessary to produce good welding.

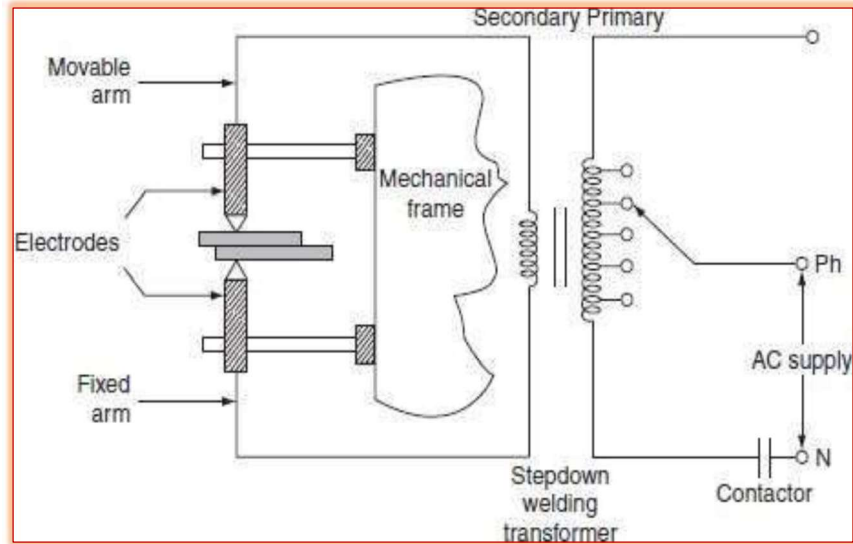
1. Resistance welding.
2. Arc welding.

3.1. Resistance welding:

Resistance welding is the process of joining two metals together by the heat produced due to the resistance offered to the flow of electric current at the junctions of two metals. The heat produced by the resistance to the flow of current is given by:

$$H = I^2 \cdot R \cdot t$$

where I is the current through the electrodes, R is the contact resistance of the interface, and t is the time for which current flows.



Advantages:

- ❑ Welding process is rapid and simple.
- ❑ No need of using **filler metal**. E.g.:(tin, lead, silver, lead- free, cadmium-free, copper, aluminium, nickel, and gold.)
- ❑ Both **similar** and **dissimilar** metals can be welded.
- ❑ Comparatively **lesser skill** is required.
- ❑ It can be employed for **mass production**.

drawbacks:

- ✓ Initial cost is very high.
- ✓ High maintenance cost.
- ✓ The workpiece with **heavier thickness cannot be welded**, since it requires high input current.

Applications:

- ✓ It is used by many industries manufacturing products made up of **thinner gauge metals**.
- ✓ It is used for the manufacturing of tubes and **smaller** structural sections.

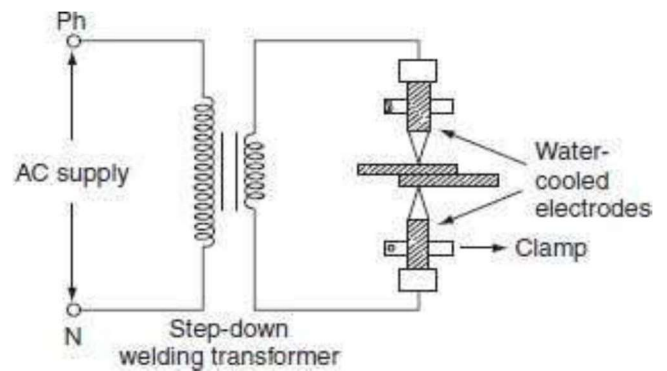
Types of Resistance Welding

Depending upon the **method of weld obtained** and the type of **electrodes used**, the resistance welding is classified as:

- 3.1.** Spot welding.
- 3.2.** Seam welding.
- 3.3** Projection welding.
- 3.4.** Butt welding.

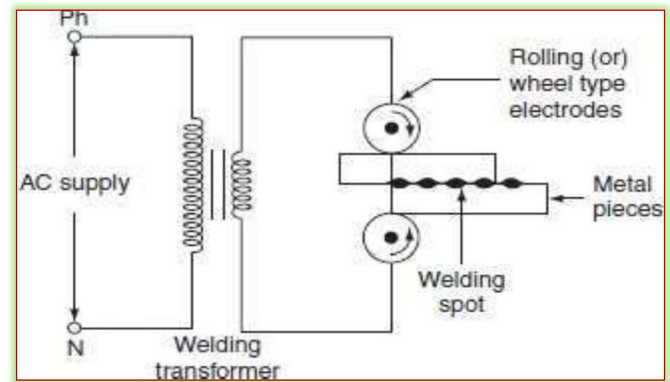
1. Spot welding:

- ✓ Spot welding means the joining of two metal sheets and **fusing(blend)** them together between copper electrode tips at suitably spaced intervals by means of **heavy electric current passed through the electrodes** as shown in Figure.
- ✓ The electrodes are made up of **copper or copper alloy** and are **water cooled**. The welding current varies widely depending upon the thickness and composition of the plates. It varies from **1,000 to 10,000 A**, and **voltage between the electrodes is usually less than 2 V**.
- ✓ A **step-down transformer** is used to reduce a high-voltage and low-current supply to low-voltage and high-current supply required. Since the heat developed being proportional to the product of welding time and square of the current. **Good weld can be obtained by low currents for longer duration and high currents for shorter duration.**



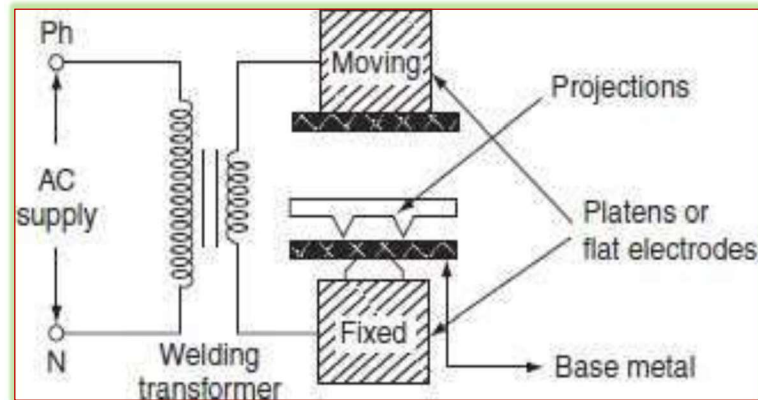
3.2. Seam welding:

- Seam welding is nothing but the **series of continuous spot welding**. If number spots obtained by spot welding are placed very closely that they can overlap, it gives rise to seam welding. In this welding, continuous spot welds can be formed by **using wheel type or roller electrodes instead of tipped electrodes as shown in Figure**. In this welding, the **contact area of electrodes should be small, which will localize the current pressure to the welding point**. After forming weld at one point, the weld so obtained can be **cooled by splashing water over the job by using cooling jets**.



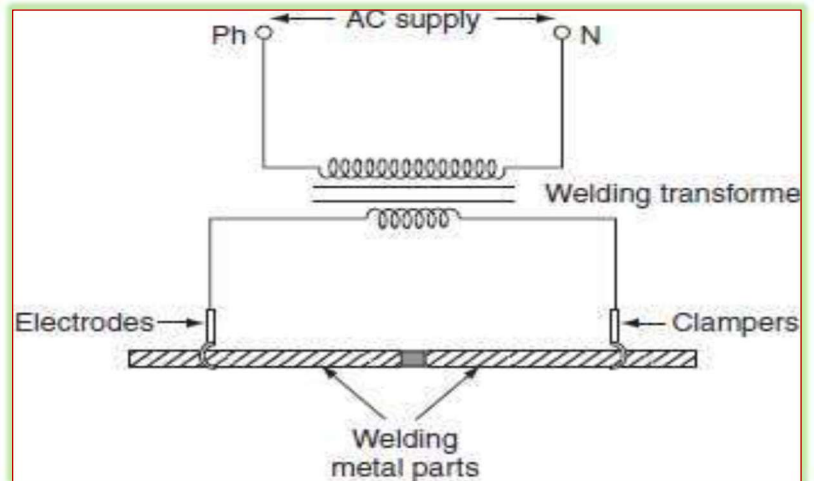
3.3. Projection welding:

- ✓It is a **modified form of the spot welding**. In the projection welding, **both current and pressure are localized** to the welding points as in the spot welding. But the **only difference** in the projection welding is the **high mechanical pressure applied** on the metal pieces to be welded, after the formation of weld.
- ✓The **electrodes** used for such welding are **flat metal plates** known as **platens**. The two pieces of **base metals** to be weld are held together in **between the two platens**, one is **movable** and the **other is fixed**, as shown in Figure.



4. Butt welding:

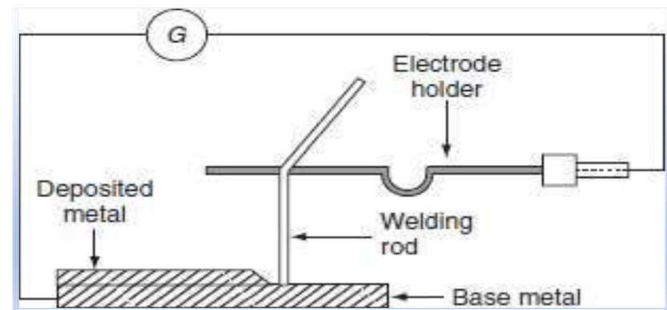
Butt welding is similar to the spot welding; however, the only difference is, in butt welding, instead of electrodes the metal parts that are to be joined or butted together are connected to the supply.



3.2. Electric Arc welding:

Electric arc welding is the process of joining two metallic pieces or melting of metal is obtained due to the heat developed by an arc struck between an electrode and the metal to be welded or between the two electrodes as shown in Figure. The heat so developed is utilized to melt the part of workpiece and filler metal and thus forms the weld. In this method of welding, no mechanical pressure is employed; therefore, this type of welding is also known as “Non-Pressure welding”.

For the arc welding, the temperature of the arc should be $3,500^{\circ}\text{C}$. At this temperature, mechanical pressure for melting is not required. Both AC and DC can be used in the arc welding. Usually 70–100 V on AC supply and 50–60 V on DC supply system is sufficient to struck the arc in the air gap between the electrodes. Once the arc is struck, 20–30 V is only required to maintain it.



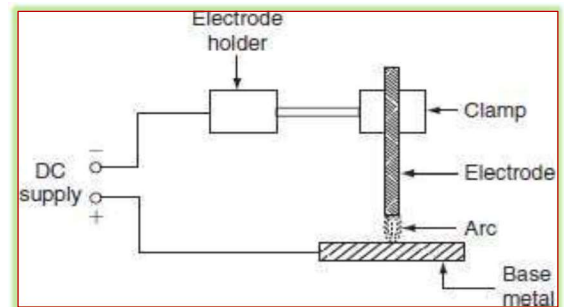
Various types of electric arc welding are:

1. Carbon arc welding.
2. Metal arc welding.
3. Atomic hydrogen arc welding.
4. Inert gas metal arc welding.
5. Submerged arc welding.

3.2.1. Carbon arc welding:

It is one of the processes of arc welding in which **arc is struck between two carbon electrodes or the carbon electrode and the base metal**. The simple arrangement of the carbon arc welding is shown in Figure.

In this process of welding, the electrodes are placed in an **electrode holder used as negative electrode** and the **base metal being welded as positive**. DC is preferred for carbon arc welding since there is no fixed polarity maintained in case of AC.

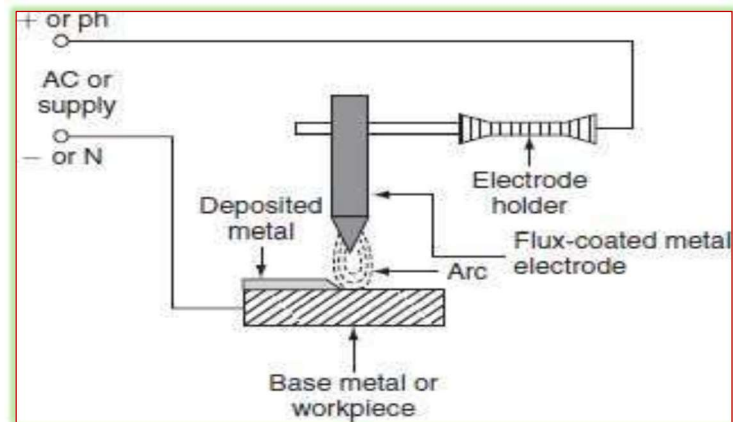


3.2.2. Metal arc welding:

In metal arc welding, the electrodes used must be of the same metal (Flux coated with chemical) as that of the work-piece to be welded. The electrode itself forms the filler metal. An electric arc is struck by bringing the electrode connected to a suitable source of electric current, momentarily in contact with the workpieces to be welded and withdrawn apart. The circuit diagram for the metal arc welding is shown in Figure. The arc produced between the workpiece and the electrode results in high temperature of the order of about $2,400^{\circ}\text{C}$ at negative metal electrode and $2,600^{\circ}\text{C}$ at positive base metal or workpiece.

This high temperature of the arc melts the metal as well as the tip of the electrode, then the electrode melts and is deposited over the surface of the workpiece, forming a complete weld.

Both AC and DC can be used for the metal arc welding. The voltage required for the DC metal arc welding is about $50\text{--}60\text{ V}$ and for the AC metal arc welding is about $80\text{--}90\text{ V}$.



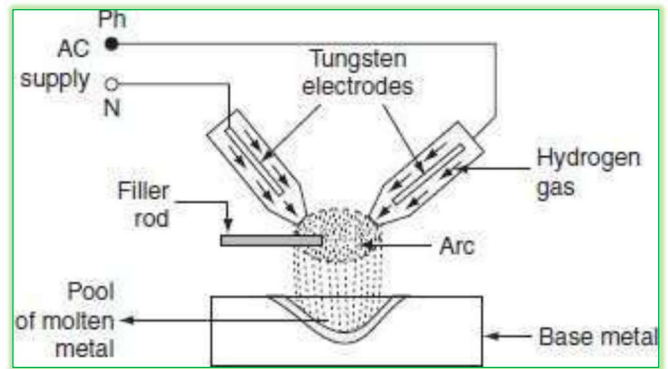
3.2.3. Atomic hydrogen arc welding:

In atomic hydrogen arc welding, shown in Figure, the heat for the welding process is produced from an electric arc struck between two tungsten electrodes in an atmosphere of hydrogen.

Here, hydrogen serves mainly two functions;

- Firstly, acts as a protective screen for the arc and
- Secondly, it acts as a cooling agent for the glowing tungsten electrode tips.

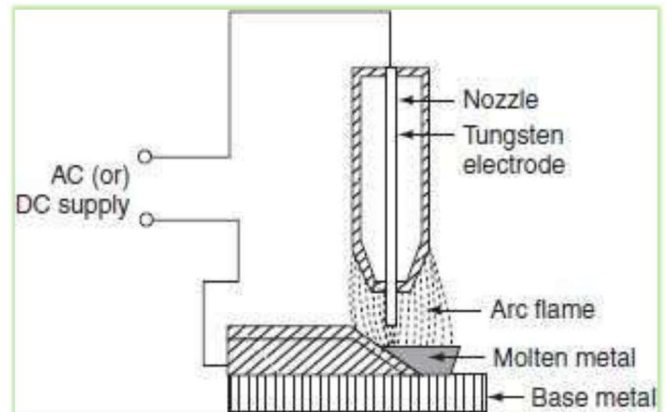
As the hydrogen gas passes through the arc, the hydrogen molecules are broken up into atoms, absorbs heat from the glowing tungsten electrodes so that these are cooled.



3.2.4. Inert gas metal arc welding:

It is a **gas-shielded metal arc welding**, in which an electric **arc is struck between tungsten electrode and workpiece** to be welded. A **welding gun**, which carries a **nozzle**, through this nozzle, **inert gas such as beryllium or argon** is blown around the arc and onto the weld, as shown in Figure.

As both beryllium and argon are **chemically inert**, so the **molten metal is protected from taking part in to chemical reaction**. As **molten metal** has an affinity for oxygen and nitrogen, if exposed to the atmosphere, thereby forming their **oxides and nitrides**, which makes **weld leaky and brittle**.



3.2.5. Submerged arc welding:

In Submerged Arc Welding, the **arc** is established **between above metal electrode and the workpiece**. Electric arc and molten pool are **shielded by blanket of granular flux** on the workpiece. The flux may be made of silica, metal oxides, and other compounds fused together and then crushed to proper size.

Initially to start an arc, short circuit path is provided by introducing **steel wool(?)** between the welding electrode and the workpiece. This is due to the coated flux material, when cold it is non-conductor of the electricity but in molten state, it is highly conductive.

Welding zone is shielded by a blanket of flux, so that the **arc is not visible**. Hence, it is known as '**submerged arc welding**'. As the arc in progress, the melted electrode metal forms globules and mix up with the molten base metal, **so that the weld is completed**.

4. Comparison between Resistance and Arc Welding:

Resistance welding	Arc welding
1. The source of supply is AC only.	The source of supply is either AC (1- ϕ or 3- ϕ) or DC.
2. The heat developed is mainly due to the flow of contact Resistance.	The heat developed is mainly due to the striking of arc between electrodes or an electrode and the workpiece.
3. The temperature attained by the workpiece is not so high.	The temperature of the arc is so high, so proper care should be taken during the welding.
4. External pressure is required.	No external pressure is required hence the welding equipment is simpler and easier to control.
5. Filler metal is not required to join two metal pieces.	Suitable filler electrodes are necessary to get proper welding strength.
6. It cannot be used for repair work; it is suitable for mass production.	It is not suitable for mass production. It is most suitable for repair works and where more metal is to be deposited.

5. Comparison between A.C. and D.C. Welding:

AC welding	DC welding
1. Motor -Generator set or Rectifier is required in case of the availability of AC supply.	Only Transformer is required.(For momentarily Transient current).
2. The cost of the equipment is high.	The cost of the equipment is cheap.
3. Arc stability is more.	Arc stability is less.
4. The heat produced is uniform.	The heat produced is not uniform.
5. Both bare and coated electrodes can be used.	Only coated electrodes should be used.

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