# Principles of arc welding brief description classification and applications

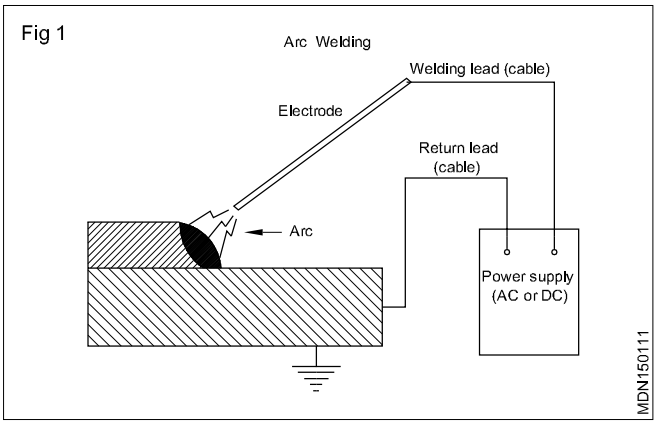
**Objectives:** At the end of this lesson you shall be able to
- **state the principle of arc welding**
- **state the clasification of arc welding**
- **state the application of arc welding**

Arc welding is a 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.

- Power supply (AC or DC)
- Welding electrode
- 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.

Fig 1



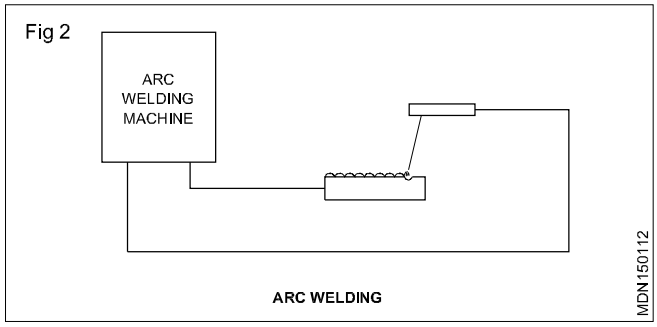

**Classification and applications of Arc welding**

- Shield metal arc welding
- Carbon arc welding
- Tungsten inert gas arc welding
- Gas metal arc welding
- Atomic Hydrogen are welding
- Submerged arc welding
- Electro slag welding
- Plasma arc welding

**Shielded Metal arc welding** (Fig 1,2): This is an arc welding process in which the welding heat is obtained from an arc, formed between a metallic (consumable) electrode and welding job.

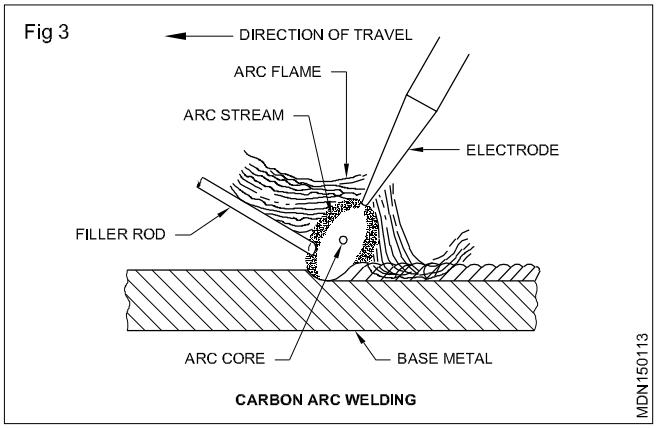
The metal electrode itself melts and acts as a filler metal.

Fig 2




**Carbon arc welding** (Fig 3): Here the arc is formed between a carbon electrode (non-consumable) and the welding job.

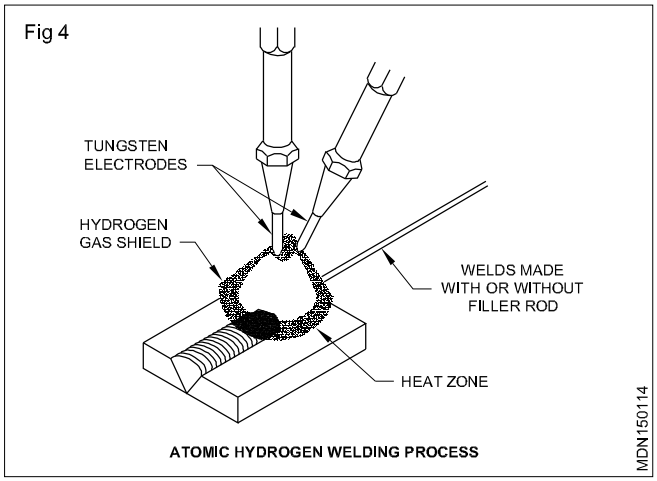
Fig 3




A separate filler rod is used since the carbon electrode is a non-metal and will not melt.

**Atomic hydrogen arc welding** (Fig 4): In this process the arc is formed between two tungsten electrodes in an atmosphere of hydrogen gas.

Fig 4



The welding job remains out of the welding circuit.

A separate filler rod is used to add the filler metal.

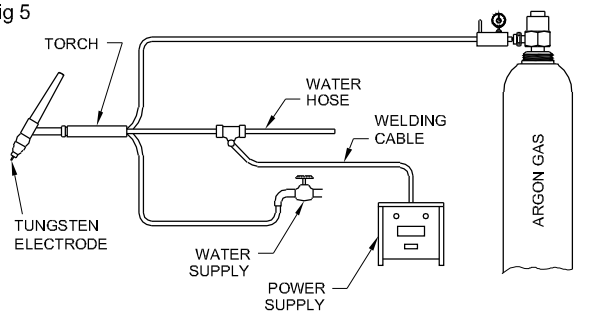
**Tungsten inert gas arc welding** (TIG) (Fig 5): In this case the arc is formed between the tungsten electrodes (non-consumable) and the welding job in an atmosphere of an inert gas (argon or helium).

A separate filler rod is used to add the filler metal.

This process is also called gas tungsten arc welding (GTAW) process.

**Gas metal arc welding (GMAW) or Metal inert gas arc welding** (MIG) (Fig 6): In this process the arc is formed between a continuous, automatically fed, metallic consumable electrode and welding job in an atmosphere of inert gas, and hence this is called metal inert gas arc welding (MIG) process.

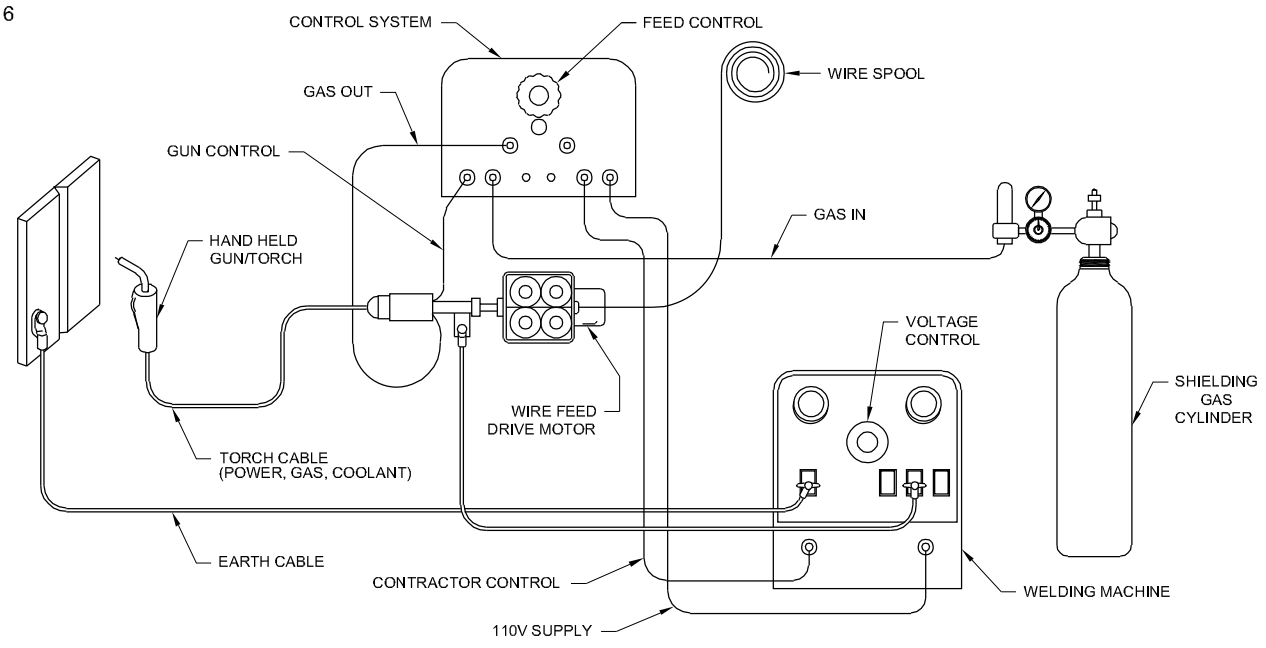
Fig 5




When the inert gas is replaced by carbon dioxide then it is called $CO_2$ arc welding or metal active gas (MAG) arc welding.

The common name for this process is gas metal arc welding (GMAW).

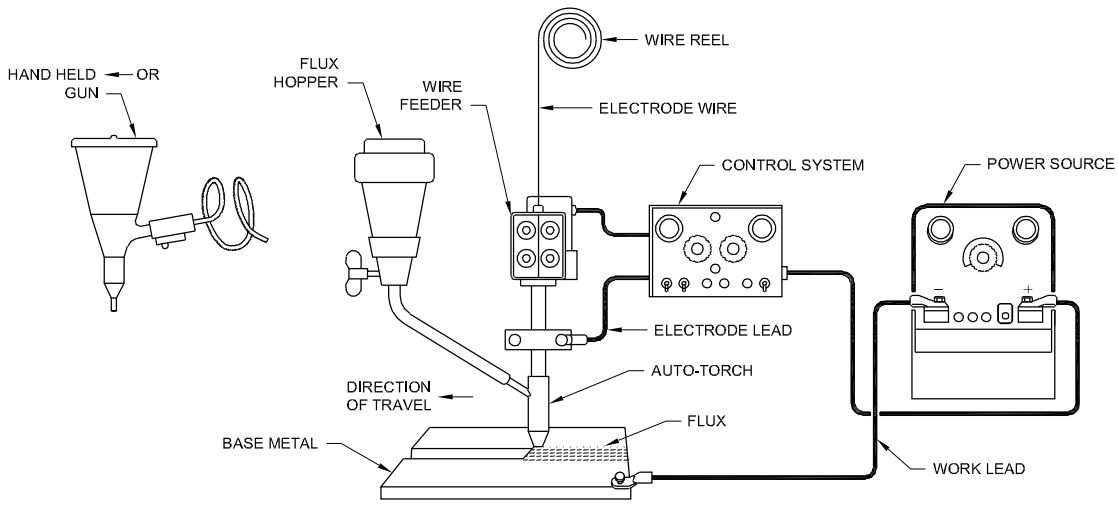
Fig 6




BLOCK DIAGRAM (GMAW/MIG)

**Submerged arc welding** (Fig 7): Here the arc is formed between a continuous, automatically fed, metallic consumable electrode and the welding job under a heap of powdered/granulated flux.

Fig 7




SUBMERGED ARC WELDING

The arc is totally submerged in the flux (invisible).

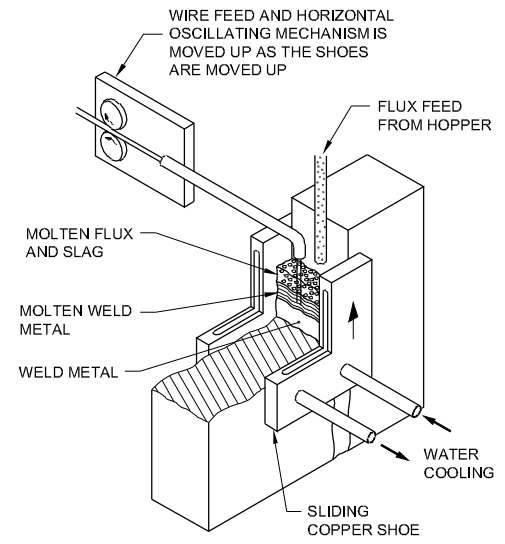
**Electro-slag welding** (Fig 8): The arc is formed between a continuous, automatically fed, metallic consumable electrode and the welding job under a thick pool of molten flux (slag).

This automatic process requires special equipment and is used only in vertical position for the welding of heavy thick plates.

**Plasma arc welding**: In this process the arc is formed between a tungsten electrode and the welding job in an atmosphere of plasma-forming gas-nitrogen, hydrogen and argon.

A separate filler rod is used to add the filler metal in the joint, if necessary. But normally no filler rod is used.

Fig 8




## Arc-Welding machines

**Objectives :** At the end of this lesson you shall be able to
- **state the function of arc-welding machines**
- **name the different types of arc-welding machines.**

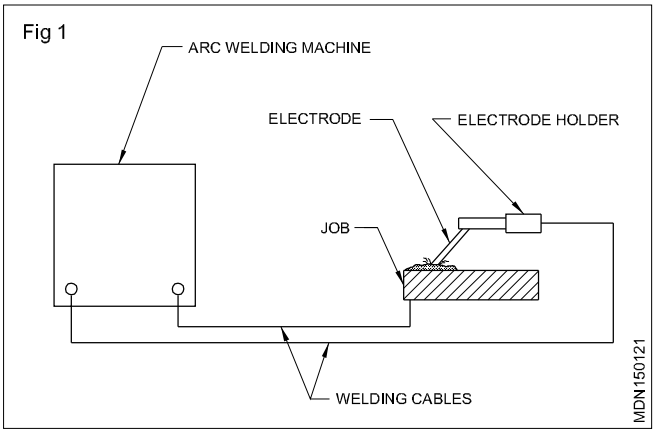
In the arc-welding process, the source of heat is electricity (high ampere low voltage). This heat is supplied by the arc-welding machine which is the power source.

**Function (Fig 1)**

The equipment is used to

- Provide A.C. or D.C. supply for arc welding
- Change the high voltage of main supply (A.C.) to low voltage, heavy current (A.C. or D.C.) suitable for arc welding
- Control and adjust the required supply of current during arc welding

Fig 1




**Power sources (Fig 2)**

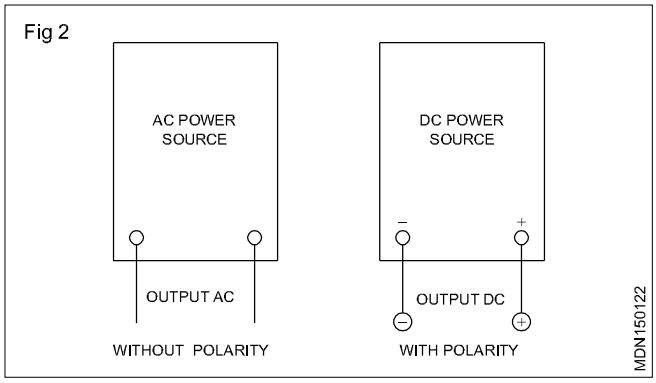
Basically the power sources are
- Alternating current (A.C.) welding machine
- Direct current (D.C.) welding machine.

These may be further classified as

**D.C.Machines**
- Motor generator set
- Engine generator set
- Rectifier sets.

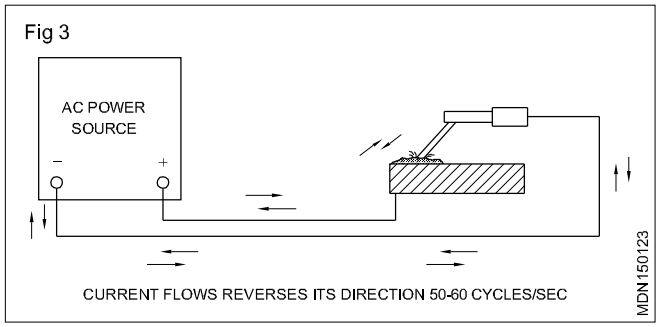
**A.C.Machines**
- Transformer sets

Fig 2

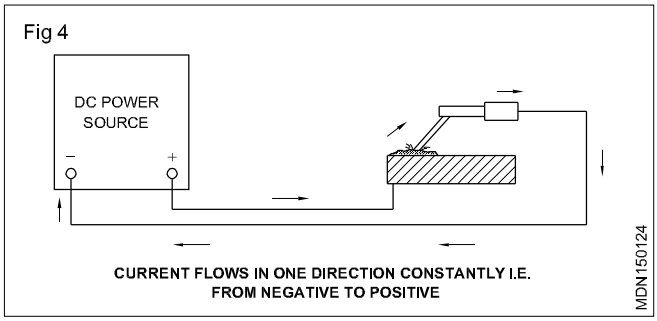



A.C. means Alternating Current. It changes or reverses its direction of flow 50-60 cycles per second. (Fig 3)

Fig 3




D.C. means Direct Current. It flows steadily and constantly in one direction. (Fig 4)

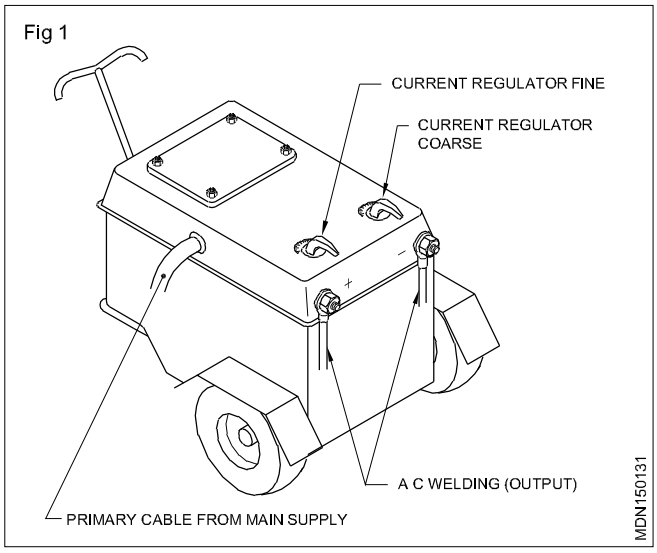



## A.C. Arc welding machine

**Objectives :** At the end of this lesson you shall be able to
- **state the features of A.C. welding transformers**
- **state the advantages and disadvantages of A.C. welding machines.**

### A.C. welding transformer

An A.C.welding transformer is a type of A.C. welding machine which converts the A.C. main supply into an A.C. welding supply. (Figs 1 and 2)

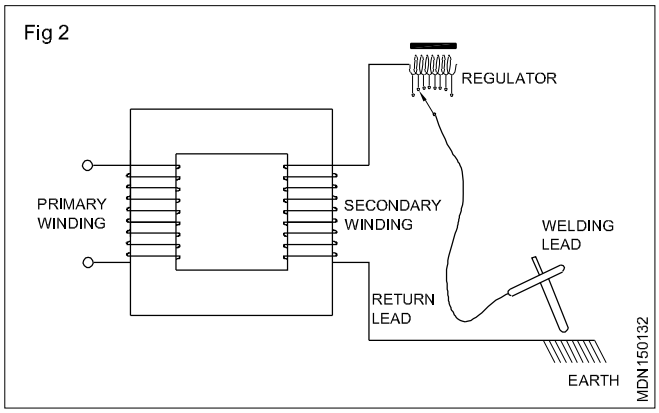



The A.C. main supply has high voltage - low ampere.

The A.C. welding supply has high ampere - low voltage.

It is a STEP-DOWN transformer which reduces the main supply voltage (220 or 440 volts) to the welding supply open circuit voltage (O.C.V.), between 40 and 100 volts.

It increases the main supply low current to the required output welding current in a hundred or thousand amperes.




The A.C. welding machine cannot be operated without the A.C. main supply.

**Advantages**

- Less initial cost
- Less maintenance cost
- Freedom from arc blow.

Magnetic effect which disturbs the arc is called the arc blow.

**Disadvantages**

- Not suitable for the welding of non-ferrous metals, light coated and special electrodes.
- The A.C. cannot be used without special safety precautions.

# D.C. Arc-welding machines

**Objectives :** At the end of this lesson you shall be able to
- **state the features of a D.C. welding machine**
- **state its advantages and disadvantages.**

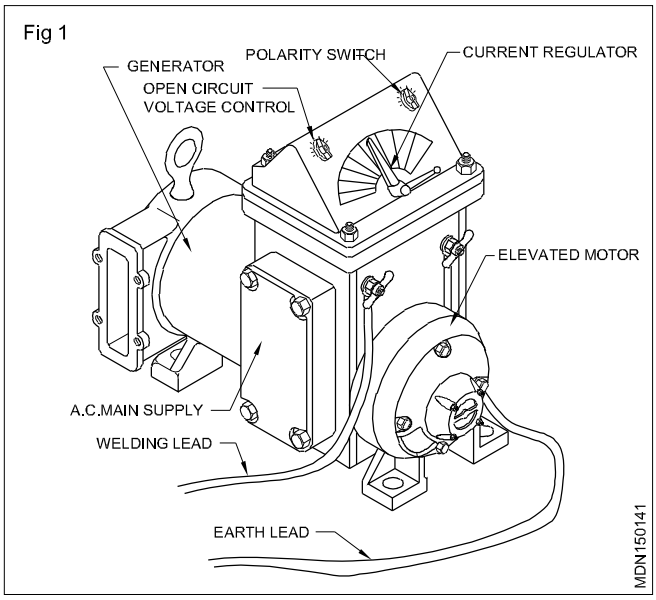
### Motor generator set (Fig 1)

It is used to generate D.C. for arc-welding.

The generator is driven by an A.C. or D.C. motor.

Main supply is a must to run the machine.

Fig 1



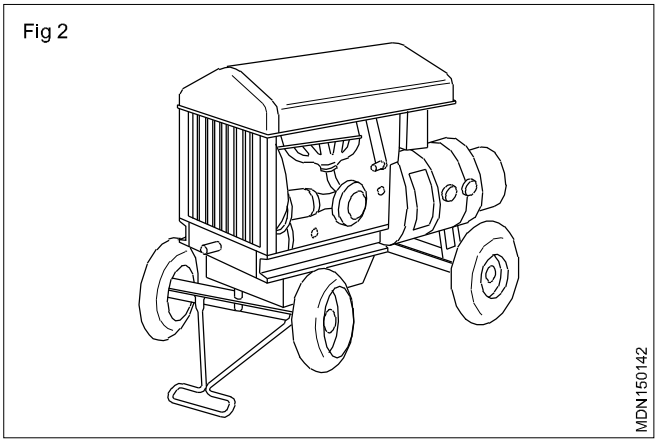

### Engine generator set (Fig 2)

Equipment is similar to the motor generator set except that the generator is driven by a pertrol or diesel engine.

Its running and maintenance charges are higher.

It can be used anywhere in field work, away from electric lines.

Fig 2



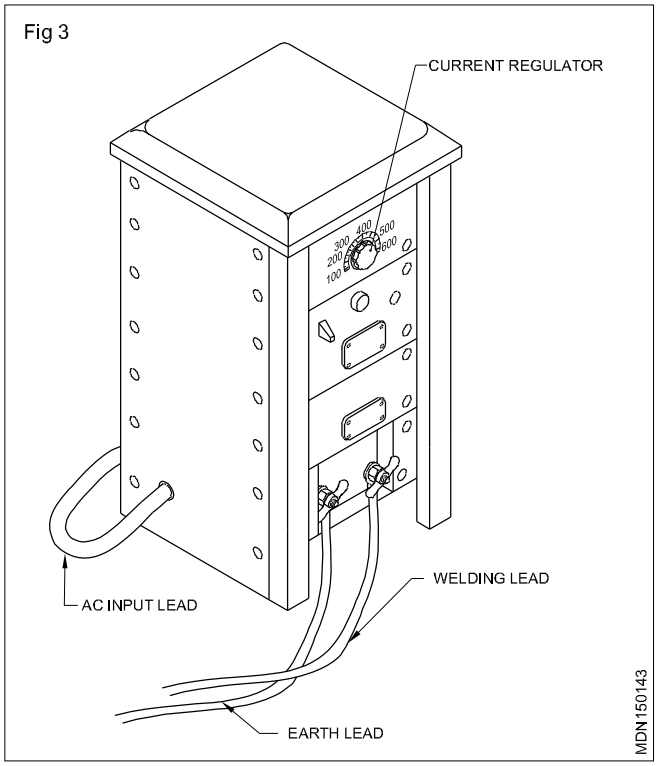

### Rectifier set (Fig 3)

It is used to convert A.C. into D.C. welding supply.

Basically it is an A.C. welding transformer. The output of the transformer is connected with a rectifier to change the A.C. into D.C.

It may be designed to supply both A.C. and D.C. currents for welding (called A.C.-D.C. rectifier set).

Fig 3




### Advantages

Suitable for welding all ferrous and non-ferrous metals using all types of electrodes

- Better heat distribution in the electrode and job due to polarity in the welding current supplies constant main load and accurate current setting.

It ensures safe working.

### Disadvantages

- Initial cost is higher
- Maintenance cost is more
- Arc-blow trouble faced at certain times.

# Edge preparation

**Objectives:** At the end of this lesson you shall be able to
- **state the necessity of edge preparation**
- **describe the edge preparation for butt and fillet welds.**

**Necessity of edge preparation:** Joints are prepared to weld metals. The preparation of edges are also necessary prior to welding in order to obtain the required strength to the joint. The following factors are to be taken into consideration for the edge preparation.

– The welding process like SMAW, oxy-acetylene welds, $Co_2$, electro-slag etc.

– The type of metal to be jointed, (i.e.) mild steel, stainless steel, aluminium, cast iron etc.

– The thickness of metal to be joined.

– The type of weld (groove and fillet weld)

– Economic factors

The square butt weld is the most economical to use, since this weld requires no chamferring, provided satisfactory strength is attained. The joints have to be bevelled when the parts to be welded are thick so that the root of the joints have to be made accessible for welding in order to obtain the required strength.

In the interest of economy, bevel butt welds should be selected with minimum root opening and groove angles such that the amount of weld metal to be deposited is the smallest. "J" and "U" butt joints may be used to further minimise weld metal when the savings are sufficient to justify the more difficult and costly chamferring operations. The "J" joint is usually used in fillet welds.

A root gap is recommended since the spacing allows the shrinking weld to draw the plates freely together in the butt joint. Thus, it is possible to reduce weld cracking and minimise distortion and increase penetration, by providing a root gap for some welded joints.

**Method of edge preparation:** The joining edges may be prepared for welding by any one of the methods mentioned below.

– Flame cutting

– Machine tool cutting

– Machine grinding or hand grinding

– Filing, chipping

TYPES OF EDGE PREPARATION AND SETUP

Different edge preparations generally used in arc welding are shown in (Fig 1).

Fig 1