

INTRODUCTION

Welding is the metal joining method wherein localized coalescence is produced either by heating the metal to suitable temperatures, with or without use of filler metal or by application of pressure.

The filler material has similar composition and melting point temperatures as the base metal. It is used to fill gap between the joint surfaces.

TYPES OF WELDING

The welding processes are divided into two main sub divisions as shown in the following tree diagram.

PLASTIC WELDING

The pieces of metal to be joined are heated to the plastic state and then forced together by external pressure without the filler material.

FORGE WELDING

The work pieces are placed in a forge or other appropriate furnace and heated within the area to be joined to the plastic condition. Then parts are quickly superimposed and worked into a complete union by hand or power hammering or by pressing together.

RESISTANCE WELDING

In resistance welding, a heavy electric current is passed through the metals to be joined over limited area, causing them to be locally heated to plastic state and the welding is completed by the application of pressure for the prescribed period of time.

THERMIT WELDING

Thermit welding is a fusion process in which weld is effected by pouring super heated liquid thermit steel, around the parts to be united with or without the pressure.

GAS WELDING

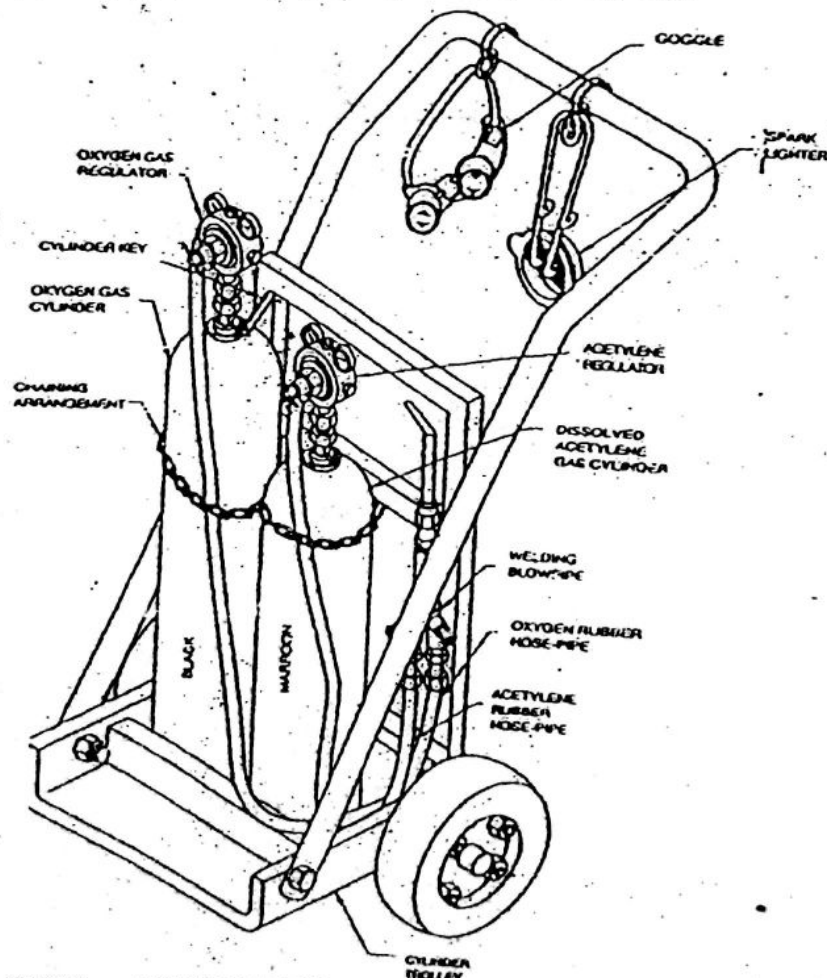
Gas welding is a process in which the required heat to melt the surfaces is supplied by a high temperature flame obtained by a mixture of two gases

Usually the mixture of oxygen and acetylene is used for welding purpose. The following table describes about the various combination of gaseous mixtures and their flame temperature.

Gaseous mixture	Flame Temp in °C
Acetylene - Oxygen	3200 - 3300°C
Acetylene - Air	1750 - 1850°C
Propane - Hydrogen	2450 - 2775°C
Propylene - Hydrogen	2500 - 2850°C
Coal gas - Oxygen	2000 - 2100°C

OXY-ACETYLENE WELDING

In oxy-acetylene welding Oxygen and Acetylene are the two gases used for producing flame. The oxygen is mainly used for supporting the combustion intensity. A typical oxy-acetylene gas welding setup is shown in fig.



OXY - ACETYLENE WELDING EQUIPMENT

CA

The oxygen and acetylene is obtained under high pressure in cylinders which are fitted with pressure regulators. Each cylinder is connected to the blowpipe by flexible hoses. The oxygen cylinders are painted black and acetylene cylinders are painted maroon.

When acetylene is mixed with oxygen in correct proportions in the welding torch, ignition is taking place. The flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal. The flame temperature is about 3200°C . The filler metal rod is generally added to the molten metal pool to build up the seam for greater strength.

Types of flames

1. Neutral Flame (Oxygen, Acetylene in equal proportions)
2. Oxidising Flame (excess of Oxygen)
3. Reducing Flame (excess of Acetylene)



Neutral Flame



Oxidising Flame



Reducing Flame

Neutral Flame

- A neutral flame is produced when approximately equal volumes of oxygen and acetylene are mixed in the welding torch and burnt at the torch tip.
- The temperature of the neutral flame is of the order of about 3260°C .
- The flame has inner cone which is light blue in colour.
- The neutral flame is used for the welding of mild steel, copper, aluminium, cast iron, etc.

Oxidising Flame

- If the volume of the oxygen supplied to the neutral flame is increased, then resulting flame will be oxidising flame (i.e. rich in oxygen).
- The temperature of oxidising flame is of the order of about 3482°C .
- Normally the outer flame envelope is much shorter. It has very small white inner cone.
- This flame is used to weld copper - base metals, zinc-base metals.

Reducing Flame [Carburising Flame]

- If the volume of the oxygen supplied to the neutral flame is reduced, the resulting flame will be a carburising or reducing flame (i.e. rich in acetylene).
- In this case, flame is recognised by acetylene feather which exists between the inner cone and outer envelope. The outer flame envelope is longer than that of the neutral flame and is usually much brighter in colour.
- It has an appropriate temperature of 3038°C .
- In this type, flames are used to weld the high-carbon steel, non-ferrous alloys, zinc-bearing alloys.

Welding Techniques

There are two techniques in gas welding depending upon the ways in which the welding rod and the welding torch are used.

- i) Leftward technique or Forehand welding method
- ii) Rightward technique or Backhand welding method

i) Leftward Technique

- Welding is done in a right to left direction.
- In this process, the welding flame is directed away from the finished weld (i.e) the flame follows the completed bead and the filler rod.
- Suitable for upto 3mm thick sheets and for other general purpose applications.

Advantages

- (i) The flame is pointed in the direction of welding and it preheats the edges of joint.
- (ii) Good control and a neat appearance are characteristics are ensured in the leftward technique.

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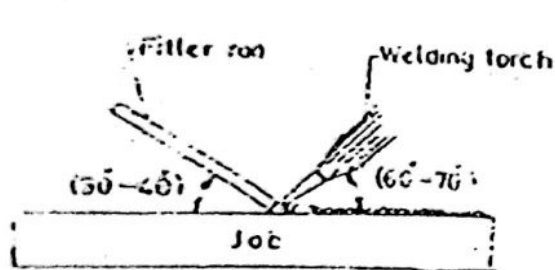
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2. Rightward Technique

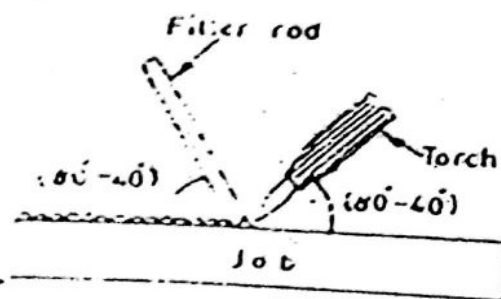
- In this welding process, the welding is done in a left to right direction.
- The filler rod follows the welding torch and the flame.
- Suitable for large size jobs.

Advantages

- (i) As the flame is always directed towards the solidified weld, it results in annealing effect and better mechanical properties are obtained.
- (ii) Very little agitation is produced because torch moves in a straight line. (Agitation leads to excessive oxidation within the molten weld pool).



Leftward technique



Rightward technique

Flame Adjustment

Neutral Flame

- To get the Neutral flame, add sufficient oxygen to make the white cone clear and round.
- During neutral flame, the gas mixture from the blow pipe consists of oxygen and acetylene in the ratio of 1:1.

Oxidising Flame

- To get the oxidising flame add more oxygen.
- The white cone will become short and sharp.
- The flame will produce a hissing sound and will have a short length.

Carburising Flame

- To get the carburising flame add more acetylene to the neutral flame.
- The white cone will become long surrounded by a feather-like portion. Flame will burn quietly and have more length.

- No flux is used in the gas welding of steel
- The most commonly used flux material are boric acid, soda ash, and sodium chloride.

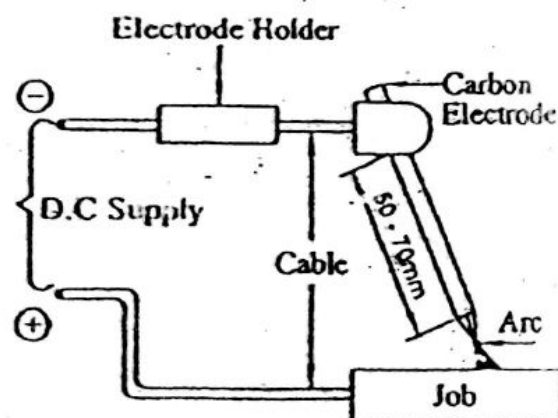
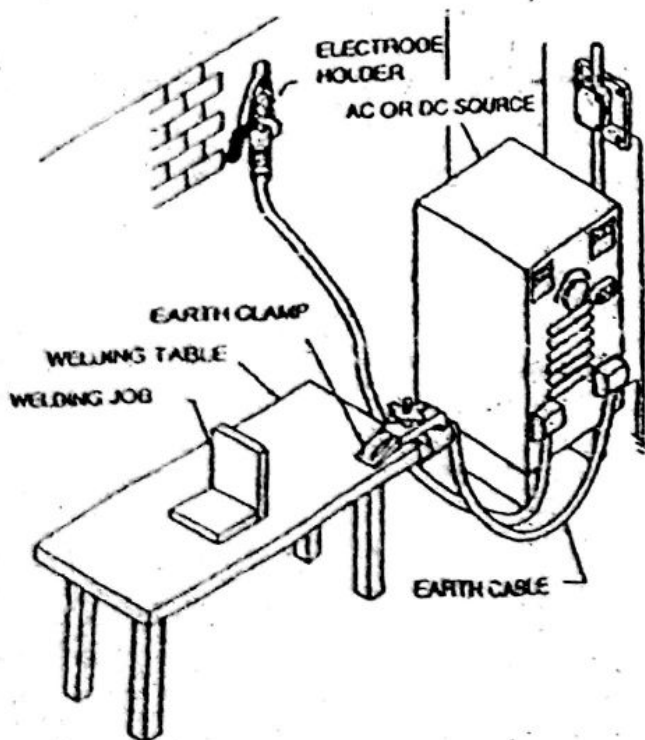
Advantages of Gas Welding

- It can be applied to a wide variety of manufacturing and maintenance situations.
- The rate of heating and cooling is relatively slow.
- Since the sources of heat and of filler metal are separate, the welder has control over filler-metal deposition rates.

Disadvantages of Gas welding

- Heavy sections cannot be joined economically.
- Flame temperature is less than the temperature of the arc welding.
- Fluxes used in certain welding and brazing operations produce fumes that are irritating to the eyes, nose, throat and lungs.

ARC WELDING



Arc Welding

White cone appears clear and round



Sufficient Oxygen for
Neutral Flame

White cone short & pointed



More Oxygen for
Oxidising Flame

Acetylene Feather



More Acetylene for Carburising Flame

Shutting off the Plant

At the end of the work, shut off the plant as mentioned below.

- Step 1: Close the acetylene cylinder valve.
- Step 2: Open the blow pipe acetylene valve and release all pressure.
- Step 3: Release the acetylene regulator pressure by adjusting screw.
- Step 4: Close the blow-pipe acetylene valve.
- Step 5: Repeat the above four steps for shutting off oxygen cylinder also.

Filler Metal

It is the material that is added to the weld pool to assist in filling the gap. Filler metal forms an integral part of the weld. The filler metal is usually available in rod form. These rods are called filler rods.

Fluxes

During the welding, if the metal is heated in air, oxygen in the air combines with the metal to form oxides which result in poor quality, low strength welds or in some cases may even make welding impossible. In order to avoid this problems, a flux is added during the welding. This flux prevents oxidation by preventing oxygen from contacting the weld zone.

In arc welding process, the source of heat is electricity. In arc welding process, coalescence is produced by heating the workpiece with an electric arc struck between an electrode and the workpiece. Welding may be carried out in air or in an inert atmosphere. Filler material may or may not be used. The temperature of the arc is of the order of 3600°C .

Principle of Arc Welding

Principle of operation

The heat required for joining the metals is obtained from an electric arc. The electric motor generator or transformer sets are used to supply high electric current and the electrodes are used to produce the necessary arc. The electrode serves as the filler rod and arc melts the surfaces so that the metals to be joined are fused together.

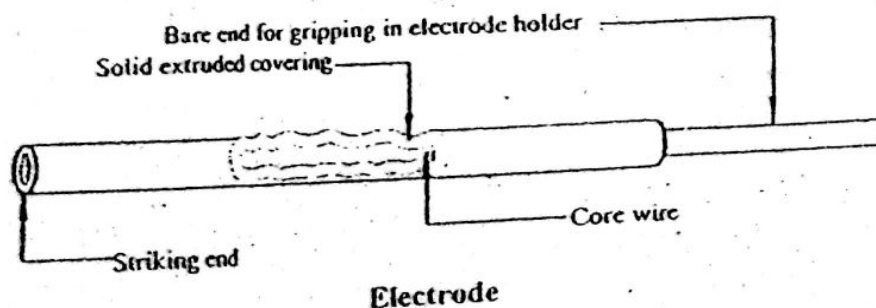
The transformer type welding machine produces A.C current. It takes power directly from power supply and to produce high current and low voltage for the welding. It is least expensive.

Motor generator type welding machine produces DC current to welding machine. This current is having straight or reversed polarity. The polarity selected for welding depends on the electrode arc used in the welding.

NOTE : A high current arc with a smaller arc length produces a very intense heat.

Electrodes

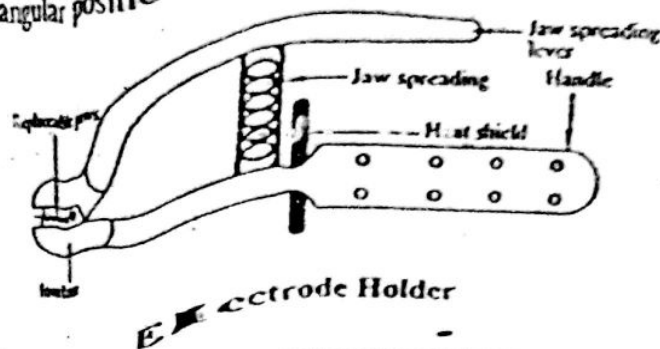
Filler rods used in arc welding are called as electrodes. The Electrodes are made of metallic wire called core wire. It is coated uniformly with a protective coating called flux while fluxing an electrode about 20 mm of length is left bare at one end for holding it using electric holder. It is used to transmit full current from electrode holder to the front end of the electrode coating.



The size or diameter of the core wire will depend upon the amount of weld metal to be deposited and on the type of joint.

Electrode Holder

- It is a device used for mechanically holding the electrode and conducting current to it.
- Electrode holder should be light, to minimize fatigue incurred by the welder.
- Jaws are made to hold the bare end of the electrode in either a vertical or an angular position.



Welding Cables

- Two cables are needed for welding purpose. One is used to connect the power source to the electrode another cable is connected to ground.
- The cables are well isolated with rubber.

Accessories

Welding Bead Cleaning

(a) Chipping hammer

A chipping hammer is chisel-shaped one and it is used to remove the slag from the weld bead.

(b) Wire Brush

A wire brush made up of stiff steel wire, embedded in wood, removes small particles of slag from the weld bead after the chipping hammer has done its job.

(c) Hand Screen

It is a protective device used in arc welding. A hand shield is held in the hand of the welder and is fitted with a suitable filter lens.

(d) **Helmet**

It is used for shielding and protecting the face and neck of the welder and it is fitted with a suitable filter lens.

(f) **Tongs**

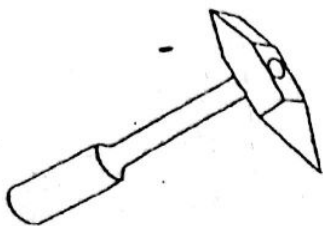
Tongs are used to handle the hot metal-welding job while cleaning, they are also used to hold the metal for hammering.

(g) **Goggles**

Chipping goggle are used to protect the eyes while chipping the slag. They are fitted with a plain glass to see the area to be cleaned.

(h) **Hand gloves**

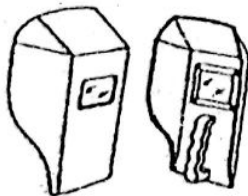
Hand gloves are used to protect the hands from electrical shock, arc radiation and hot spatters.



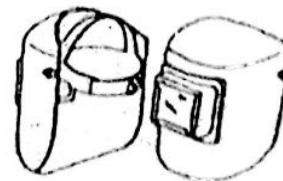
Chipping Hammer



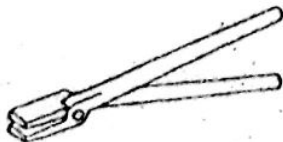
Wire Brush



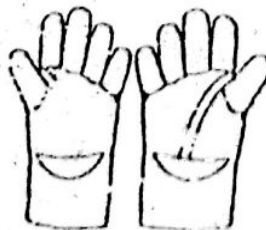
Hand Screen



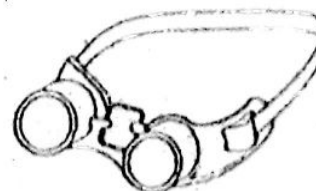
Helmet



Tong



Hand Gloves



Goggles

Points to be considered before welding

Before going to welding following points to be considered

- Check whether the welding cables are connected to proper power sources.
- Set the welding current as per the diameter of the electrode to be used.
- Select the electrode as per true thickness of the metal to be welded.

Plate Thickness in mm	Electrode Current	
	Size mm	Range (amperes)
1.6	1.6	40 - 60
2.5	2.5	50 - 80
4.0	3.2	90 - 130
6.0	4.0	120 - 170
8.0	5.0	180 - 270
25.0	6.0	300 - 400

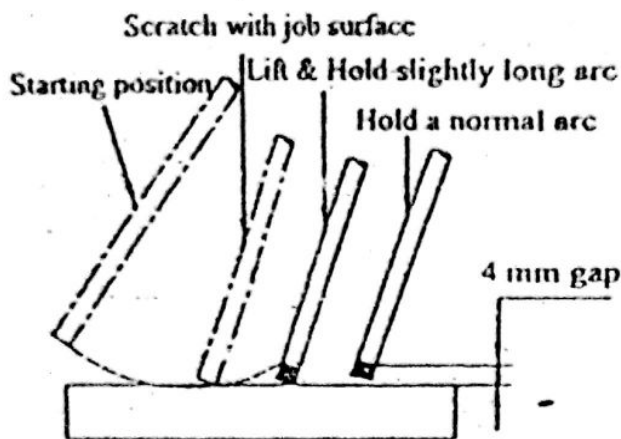
- Before going for welding, the material must be prepared well.
- Hold the electrode about 25 mm above the job-piece at one end, perpendicular to the surface and then, bring the welding screen in front of your eyes.
- Strike the arc by dragging the electrode quickly and softly across the welding job.
- Withdraw the electrode 6 mm from the surface of the welding material far from and then lower it to 4 mm distance to the material.
- Hold the electrode at an angle of 70° - 80° with the weld line and 90° with the adjoining plate surface.

ARC-producing Methods

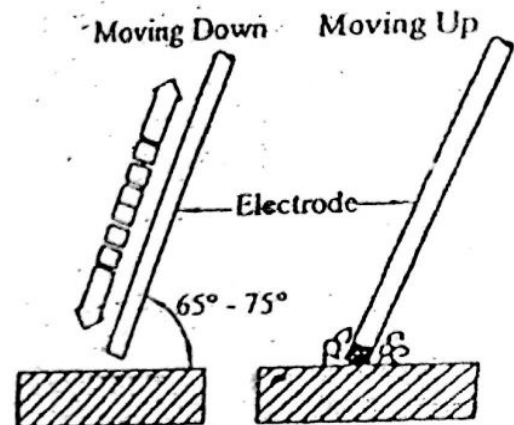
- (i) Scratching method
- (ii) Tapping method

Scratching Method

Strike the arc by moving the electrode down to touch the job surface lightly.



Scratching Method



Tapping Method

ii. Tapping Method

- In this method, the arc is produced by moving the electrode slowly by approximately 6 mm for a few seconds and then lower it to approximately 4 mm from the surface
- This method is generally recommended because it does not produce pit marks on the job surface.

Preparation of workpieces and Electrodes

- Before welding, edges of the workpieces are suitably prepared. The edges and the area adjoining them is cleared from all the scale, rust, dust, paint, grease or any other foreign matter by using brush or grinding wheel etc.
- The work pieces to be welded are positioned and spaced with respect to each other and held in a fixture or tack welded to maintain correct root gap during welding.

- Welding leads are properly connected to the power source and the work piece.
- The power source is switched on and suitable welding currents are set.

Advantages of arc welding

- Flux shielded manual metal arc welding is the simplest of all the arc welding processes.
- The equipment can be portable and the cost is fairly low.
- This process finds innumerable applications, because of the availability of a wide variety of electrodes.
- A big range of metals and their alloys can be welded.

Disadvantages of arc welding




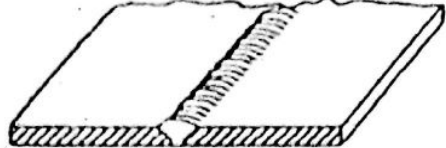

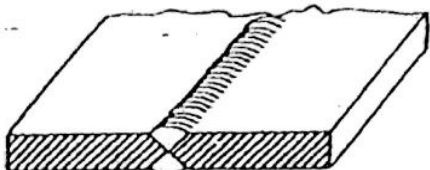

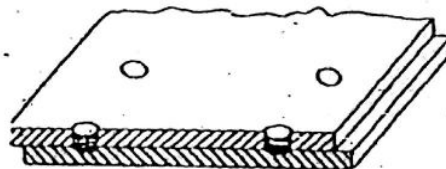

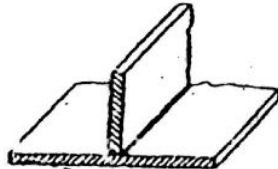

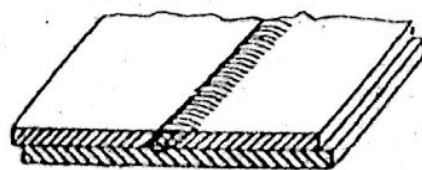

- Because of the limited length of each electrode and brittle flux coating on it, mechanization is difficult.
- In welding long joints (e.g. in pressure vessels), as one electrode finishes, the weld is to be progressed with the next electrode. Unless properly cared, a defect (like slag inclusion or insufficient penetration) may occur at the place where welding is restarted with the new electrode.

Applications of Arc welding

- Today, almost all the commonly employed metals and their alloys can be welded by the arc welding process.
- Shielded metal arc welding is used both as a fabrication process and for maintenance and repair jobs.
- The process finds application in
 - air receiver, tank, boiler and pressure vessel fabrications.
 - Ship building
- Arc welding is used in building and bridge construction.

WELDING SYMBOLS

The welding symbols are used to convey the information required for welding from the designer to the operator. These symbols provide necessary indications regarding the specific weld to be carried out.

S.No.	Types	Figure	Symbol
3.	 -butt Weld		
4.	Single V-butt with root face		
5.	Double V-butt		
6.	Spot weld		
7.	T-Joint (fillet weld)		
8.	Seam weld		

1. ~~SINGLE V-BUTT JOINT~~ - BUTT JOINT

Ex.No. :

DATE . :

Aim:

To make a single v-butt joint using arc welding on the given workpieces.

Material supplied:

Mild steel plate of size 100×50×6 mm - 2 Nos.

~~base~~ Omit it
for now

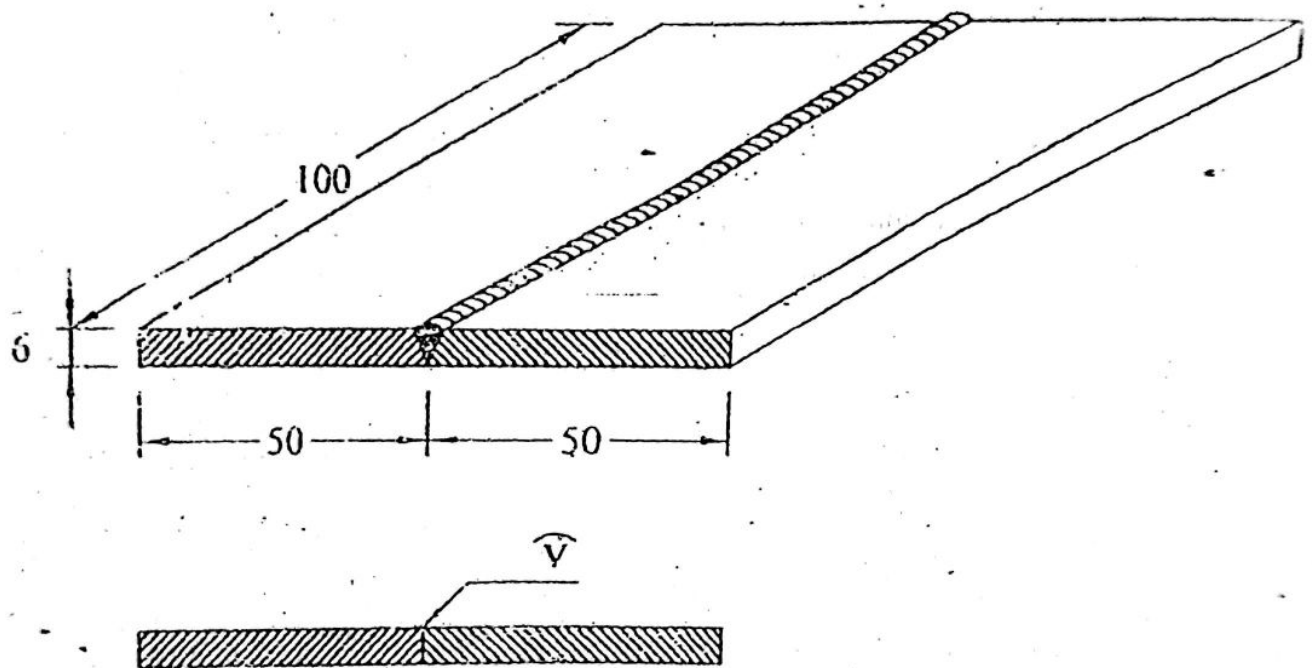
Tools required:

1. Power supply (AC or DC)
2. Welding Torch
3. Electrodes
4. Tongs
5. Chipping hammer
6. Wire brush
7. Gloves
8. Apron
9. Shield
10. Safety goggles
11. Earthing clamps

Sequence of operations:

1. Edge preparation (Removal of rust, scale etc.)
2. Tacking
3. Welding
4. Cooling
5. Chipping
6. Cleaning

Do not Label --- For Now



Welded Joint Representation

Working steps:

1. First of all, the work pieces must be thoroughly cleaned to remove rust, scale and other foreign materials.
2. Then the given workpieces are placed on the table in such a way that two workpieces are brought close to each other so that it forms a 'V-shape' when the plates butt each other.
3. Appropriate power supply should be given to the electrode and the workpieces.
4. Now the welding current output may be adjusted.
5. When current is passed, arc is produced between the electrode and workpieces.
6. Now set the two workpieces in correct position and maintain the gap 3mm and tack at both ends of the workpieces as shown in figure.
7. Then the welding is carried out throughout the length.
8. As soon as the welding process is finished, switch off the current supply and drop the workpiece into water for cooling using tongs.
9. Slags are removed by chipping process with the help of chipping hammer.
10. Finally using wire brush, welded portions are cleaned.

Result:

Thus the desired single V-butt joint is obtained using arc welding.

