WELDING

INTRODUCTION

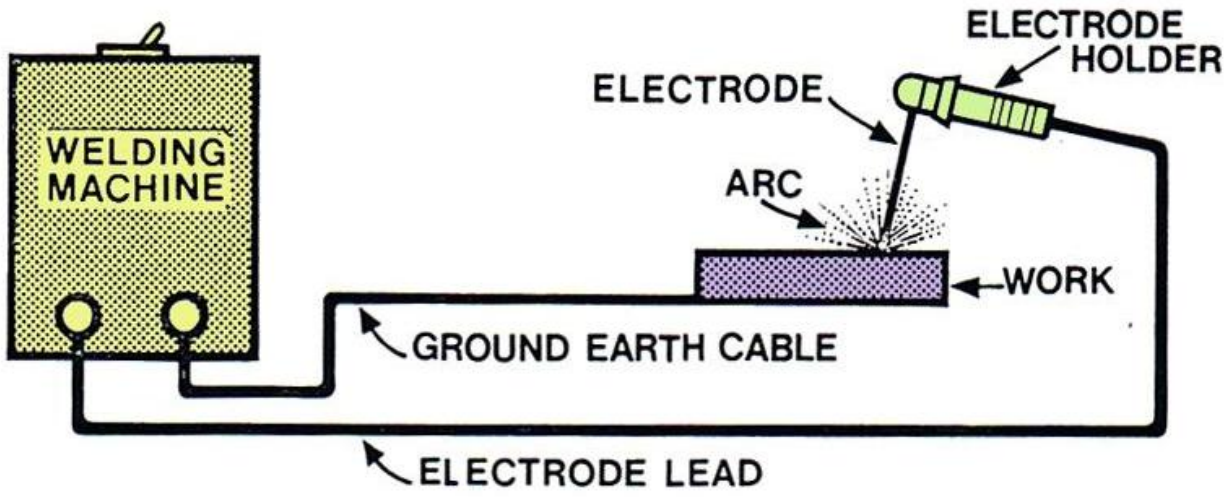
Welding is the process of joining similar metals by the application of heat, with or without application of pressure or filler metal, in such a way that the joint is equivalent in composition and repairing all kinds of worn or damaged parts. Now, it is extensively used in manufacturing industry, construction industry (construction of ships, tanks, locomotives and automobiles) and maintenance work, replacing riveting and bolting, to a greater extent. The various welding processes are:

1. Electric arc welding,
2. Gas welding
3. Thermal welding
4. Electrical Resistance welding and
5. Friction welding

However, only electric arc welding process is discussed in the subject point of view.

ELECTRIC ARC WELDING

Arc welding is the welding process, in which heat is generated by an electric arc struck betweenan 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:

a. Power supply (AC or DC);
b. Welding electrode;
c. Work piece;

d. 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 joint 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. Transformers, motor generators and rectifiers' sets are used as arc welding machines. These machines supply high electric currents at low voltage and an electrode is used to produce the necessary arc. The electrode serves as the filler rod and the arc melts the surface so that, the metals to be joined are actually fixed together.

Sizes of welding machines are rated according to their approximate amperage capacity at 60% duty cycle, such as 150,200,250,300,400,500 and 600 amperes. This amperage is the rated current output at the working terminal.

1 Transformers

The transformers type of welding machine produces A.C current and is considered to be the least expensive. It takes power directly from power supply line and transforms it to the voltage required for welding. Transformers are available in single phase and three phases in the market.

2 Motor generators

These are D.C generators sets, in which electric motor and alternator are mounted on the same shaft to produce D.C power as pert the requirement for welding. These are designed to produce D.C current in either straight or reversed polarity. The polarity selected for welding depends upon the kind of electrode used and the material to be welded.

3 Rectifiers

These are essentially transformers, containing an electrical device which changes A.C into D.C by virtue of which the operator can use both types of power (A.C or D.C, but only one at a time).In addition to the welding machine, certain accessories are needed for carrying out the welding work.

4 Welding cables

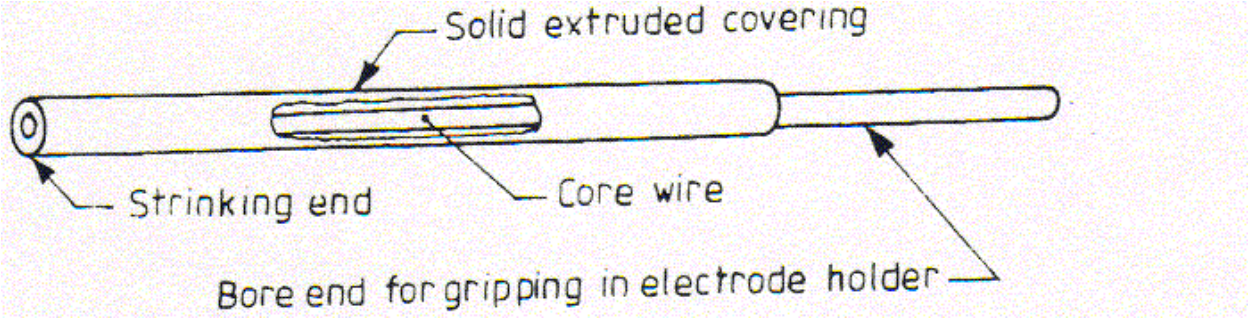
Two welding cables are required, one from machine to the electrode holder and the other, from the machine to the ground clamp. Flexible cables are usually preferred because of the case of using and coiling the cables. Cables are specified by their current carrying capacity, say 300 A, 400 A, etc.

5 Electrodes

Filler rods are used in arc welding are called electrodes. These are made of metallic wire called

core wire, having approximately the same composition as the metal to be welded. These are coated

uniformly with a protective coating called flux. While fluxing an electrode; about 20mm of length is left
at one end for holding it with the electrode holder. It helps in transmitting full current from electrode
holder to the front end of the electrode coating. Flux acts as an insulator of electricity. Figure.4 shows
the various parts of an electrode.



In general, electrodes are classified into five main groups; mild steel, carbon steel, special alloy steel, cast iron and non-ferrous. The greatest range of arc welding is done with electrodes in the mild steel group. Various constituents like titanium oxide, potassium oxide, cellulose, iron or manganese, Ferrosilicates, carbonates, gums, clays, asbestos, etc., are used as coatings on electrodes. While welding, the coating or flux vaporizes and provides a gaseous shield to prevent atmospheric attack. The size of electrode is measured and designated by the diameter of the core wire in SWG and length, apart from the brand and code names; indicating the purpose for which there are most suitable.

Electrodes may be classified on the basis of thickness of the coated flux. As

1. Dust coated or light coated
2. Semi or medium coated and
3. Heavily coated or shielded Electrodes are also classified on the basis of materials, as

1. Metallic and
2. Non-metallic or carbon Metallic arc electrodes are further sub-divided into

1. Ferrous metal arc electrode (mild steel, low/medium/high carbon steel, cast iron, stainless steel, etc)
2. Non-ferrous metal arc electrodes (copper, brass, bronze, aluminum, etc).

In case of non-metallic arc electrodes, mainly carbon and graphite are used to make the electrodes

WELDING TOOLS

1 Electrode holder

The electrode holder is connected to the end of the welding cable and holds the electrode. It should be light, strong and easy to handle and should not become hot while in operation. Figure shows one type of electrode holder. The jaws of the holder are insulated, offering protection from electric shock.

2 Ground clamp

It is connected to the end of the ground cable and is clamped to the work or welding table to complete the electric circuit. It should be strong and durable and give a low resistance connection.

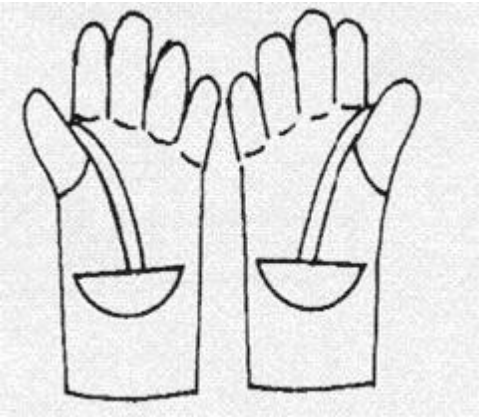
Ground clamp

3 Wire brush and chipping hammer

A wire brush is used for cleaning and preparing the work for welding. A chipping hammer is used for removing slag formation on welds. One end of the head is sharpened like a cold chisel and the other, to a blunt, round point. It is generally made of tool steel. Molten metal dispersed around the welding heads, in the form of small drops, is known as spatter. When a flux coated electrode is used in welding process, then a layer of flux material is formed over the welding bead which contains the impurities of weld material. This layer is known as slag. Removing the spatter and slag formed on and around the welding beads on the metal surface is known as chipping.

Hand gloves

These are used to protect the hands from electric shocks and hot spatters



TECHNIQUES OF WELDING

1 Preparation of work

Before welding, the work pieces must be thoroughly cleaned of rust, scale and other foreign material. The piece for metal generally welded without beveling the edges, however, thick work piece should be beveled or veed out to ensure adequate penetration and fusion of all parts of the weld. But, in either case, the parts to be welded must be separated slightly to allow better penetration of the weld. Before commencing the welding process, the following must be considered

a) Ensure that the welding cables are connected to proper power source.

b) Set the electrode, as per the thickness of the plate to be welded.

c) Set the welding current, as per the size of the electrode to be used.

Table 3.1 Electrode current Vs electrode size Vs plate thickness.

Plate thickness, mm	Electrode size, mm	Electrode current range, amp

NOTE: While making butt welds in thin metal, it is a better practice to tack-weld the pieces intervals to hold them properly while welding.

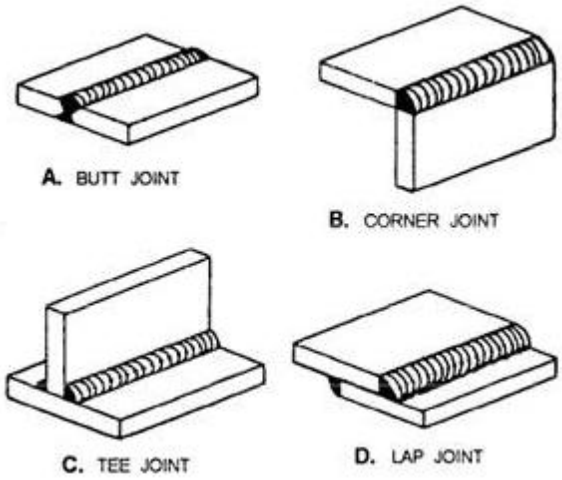
TYPES OF JOINTS

Welds are made at the junction of the various pieces that make up the weldment. The junctions of parts, or joints, are defined as the location where two or more numbers are to be joined. Parts being joined to produce the weldment may be in the form of rolled plate, sheet, pipes, castings, forgings, or billets. The five basic types of joints are listed below.

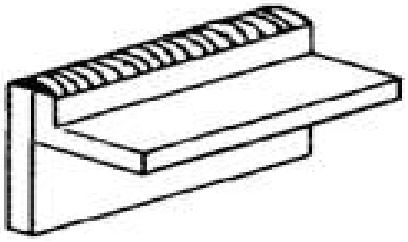
A butt joint is used to join two members aligned in the same plane (fig. 3.10, view A). This joint is frequently used in plate, sheet metal, and pipe work. A joint of this type may be either square or grooved.

Corner and tee joints are used to join two members located at right angles to each other (fig. 3.10, views B and C). In cross section, the corner joint forms an L-shape, and the tee joint has the shape of the letter T. Various joint designs of both types have uses in many types of metal structures.

A lap joint, as the name implies, is made by lapping one piece of metal over another (fig. 3.10, view D). This is one of the strongest types of joints available; however, for maximum joint efficiency, you should overlap the metals a minimum of three times the thickness of the thinnest member you are joining. Lap joints are commonly used with torch brazing and spot welding applications.



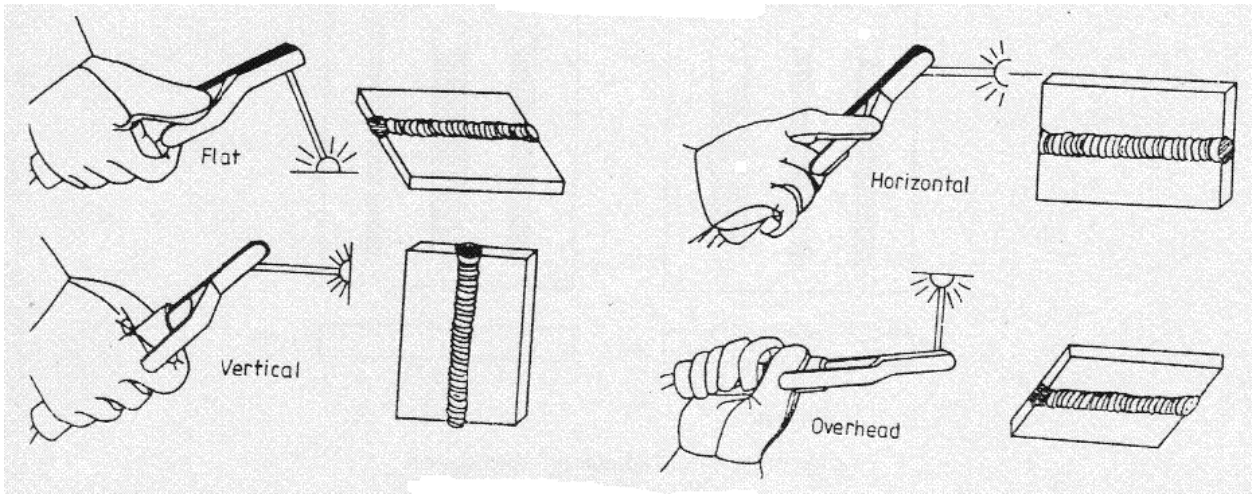
An edge joint is used to join the edges of two or more members lying in the same plane. In most cases, one of the members is flanged, as shown in figure 3.10, view E. While this type of joint has some applications in plate work, it is more frequently used in sheet metal work. An edge joint should only be used for joining metals 1/4 inch or less in thickness that are not subjected to heavy loads.



E. EDGE

WELDING POSITIONS

Depending upon the location of the welding joints, appropriate position of the electrode and hand movement is selected. The figure shows different welding positions.



1 Flat position welding

In this position, the welding is performed from the upper side of the joint, and the face of the weld is approximately horizontal. Flat welding is the preferred term; however, the same position is sometimes called down hand.

2 Horizontal position welding

In this position, welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface.

3 Vertical position welding

In this position, the axis of the weld is approximately vertical as shown in figure.

4 Overhead position welding

In this welding position, the welding is performed from the underside of a joint.

Advantages

1. Welding process is simple.
2. Equipment is portable and the cost is fairly low.
3. All the engineering metals can be welded because of the availability of a wide variety of electrodes.

Disadvantages

1. Mechanized welding is not possible because of limited length of the electrode.
2. Number of electrodes may have to be used while welding long joints.
3. A defect (slag inclusion or insufficient penetration) may occur at the place where welding is restarted with a fresh electrode.

SAFE PRACTICE

Always weld in a well ventilated place. Fumes given off from welding are unpleasant and in some
cases may be injurious, particularly from galvanized or zinc coated parts.

1. Do not weld around combustible or inflammable materials, where sparks may cause a fire.
2. Never weld containers, which have been used for storing gasoline, oil or similar materials, without first having them thoroughly cleaned.
3. Check the welding machine to make sure that it is properly grounded and that all leads properly insulated.
4. Never look at the arc with the naked eye. The arc can burn your eyes severely. Always use a face shield while welding.
5. Prevent welding cables from coming in contact with hot metal, water, oil, or grease. Avoid dragging the cables around sharp corners.
6. Ensure proper insulation of the cables and check for openings.
7. Always wear the safety hand gloves, apron and leather shoes.
8. Always turn off the machine when leaving the work.
9. Apply eye drops after welding is over for the day, to relieve the strain on the eyes.
10. While welding, stand on dry footing and keep the body insulated from the electrode, any other parts of the electrode holder and the work.