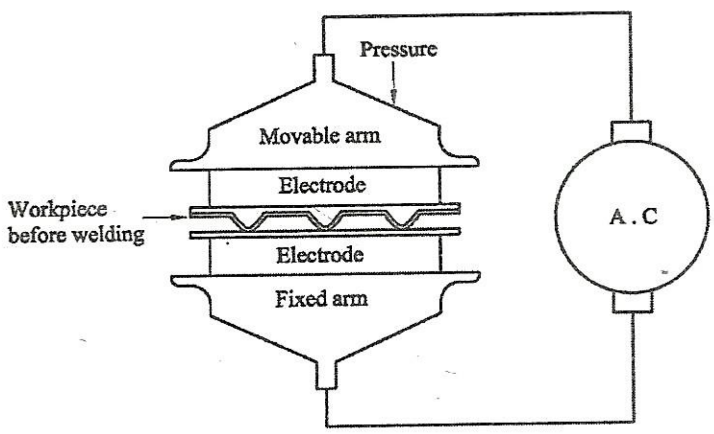

Figure 2.26 Projection welding

The heat is produced at the contact point of the base metal because of electrical resistance. Now, the work pieces are pressed together by bringing down the upper electrode. The projections are made into flat under pressure and the two pieces are joined together by a strong weld at all points of contact. The surface at the projection must be cleaned. There should not by any scale on the surface. An un-cleaned surface will reduce the resistance to the current flow. So the joint will be weaker.

Projection welding is used for joining thin sheet metals of thickness upto to 3 mm. It is used in automobile industries. A wire or rod may be easily welded on its length of a flat surface. This welding process is used in mass production.

2.14 Plasma Arc Welding

Conventional methods are not suitable for machining metals such as cast alloy, wasp alloy, carbides having promising applications in various industries also machining these materials in conventional methods causing increased machining cost. So, these types of materials in special welding methods are preferred. It will increase the productivity, number of rejected components are reduced and achieving the close tolerance.

Principle

Plasma is high temperature ionized gas. It is a mixture of neutral atoms, positively charged atoms and free elements. When this high temperature plasma is passed through the orifice, the proportion of the ionized gas increases and plasma arc welding is formed.

Working

When the high heat content plasma gas is forced through the torch, orifice is surrounded by negative tungsten electrode in the form of jet. The plasma cutting force imposes a swirl on the orifice gas flow. The arc is initiated in the beginning by supplying electrical energy between nozzle and tungsten electrode. This will release high energy and heat. This heat is normally in between 10000°C to 30000°C. This high amount of heat energy is used to weld the metal they are two types plasma are welding used practically, They are

1. Transfer type, and
2. Non-transferred type

Transferred type

In transferred type, the tungsten electrode is connected to the negative terminal and the work piece is connected to the positive terminal. An electric are in maintained between the electrode and the work piece heats a so-axial flowing gas and maintains it in a plasma state. It is difficult to initiate the arc first between the work piece and the electrode. For that, the pilot are is struck between the nozzle and the electrode.

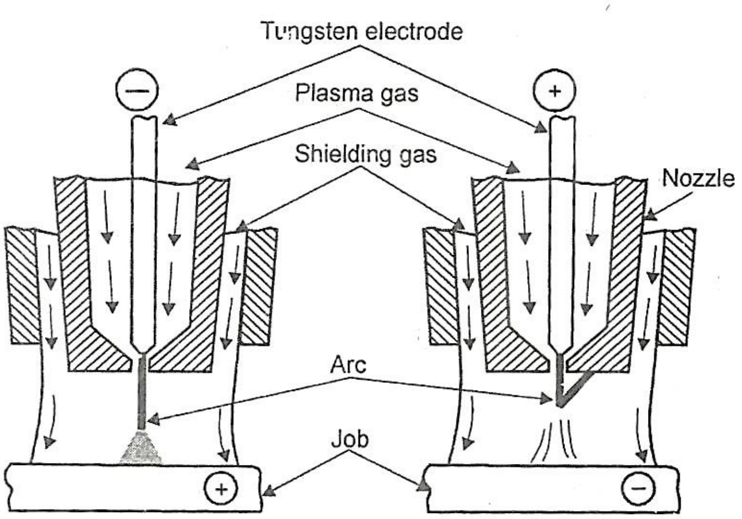

Figure 2.27 Plasma Arc Welding

Non-transferred type

In this type, power is directly connected with the electrode and the torch of nozzle. The electrode carries the same current. Thus, the ionizing is at high velocity gas that is strewing towards the work piece. The main advantage of this type is that the spot moves inside the wall and heat the incoming gas and outer layer remains cool. This type plasma has low thermal efficiency.

The base metals welded by plasma arc welding are:

1. Stainless steels
2. Titanium alloys
3. Carbon and low alloy steels
4. Copper alloys
5. Aluminum alloys

The types of joint which are made by plasma arc welding are:

1. Filler welds
2. T-welds
3. Grooves (Single groove (or) „V‟ groove)
4. Square groove

Applications

1. It is used in aerospace applications.
2. It is used for melting high melting point metals.
3. It is used for welding titanium plates.
4. It is used in welding nickel alloys.
5. It is used for tube mill applications.

Advantages

1. Penetration is uniform
2. Arc stability is good
3. Fully penetrated keyholes can be obtained
4. High accuracy weld can be produced
5. High speed weld can be obtained

Disadvantages

1. Huge noise occurs during welding.
2. Chances of electric hazards may occur during welding.
3. It is limited to high thickness applications.
4. Ultraviolet radiations can affect human body.
5. Gas consumption is high.

2.15 Thermit welding

Thermit welding comprises a group of welding processes wherein coalescence is produced by heating with superheated liquid metal and slag resulting from chemical reaction between and metal oxide and aluminum, with or without the application of pressure. The liquid metal acts as filler metal too.

Procedure of thermit welding

The various steps involved in the non-pressure fusion thermit welding of metal parts are given below. The mold is non-repetitive in nature and is used for repair welds.

Clean the joint

An oxyacetylene torch may be used to clean the metal surfaces by heating. During cleaning, all dirt, grease, loose oxides, scale, etc., must be removed.

Allow for contraction

After cleaning, the part to be welded are to be linked up with a space of about 1.5 to 6mm between the ends, depending upon the size of the parts to be joined.

This space makes up for

1. The contraction of the thermit steel in cooling
2. The shrinkage of the base metal which has been heated during the welding Operation.

Construct the mold

After the parts have been cleaned and spaced properly, the next stage is the making of the wax pattern from which the mould will be formed and which must in shape constitude a replica of the eventual weld.

The molding material should be about 100mm thick between the wax pattern and the molding box at all points.

The mold should provided with the necessary number of pouring gates, heating gates and risers depending on the size of the weld.

Preheating the mold

The mold prepared as above is then preheated in order to:

1. Melt away and remove the wax thereby leaving a mold cavity in the exact shape of the Weld.
2. Dry the mold thoroughly otherwise the superheated molten metal will form steam within the mold and cause porous weld.

Crucible and its charging

Thermit mixture is charged in the container knows as crucible or reaction vessel. The vessel is of conical shape and is lined with management tar-lining.

The outside shell of this vessel is made up of sheet steel. Located at the bottom of the vessel is a magnesia stone and magnesia thimble through which the tapping pin is suspended.

The thimble is plugged by suspending the tapping pin through the thimble and placing a metal disc above the pin. This disc is then covered with refractory sand.

After drying the crucible, small quantity of the thermit power is first introduced, the object being to avoid damage to the refractory sand layer and to cushion off the plugging material in the bottom of the crucible from the impact of the full weight of the thermit charge.

Igniting the thermit mixture

A low ignition point thermit in the form of a powder is placed on the top of the thermit in the crucible.To ignition the reaction, the low ignition-temperature thermit is contacted with a hot rod. This ignition immediately starts the reaction in the main thermit charge.

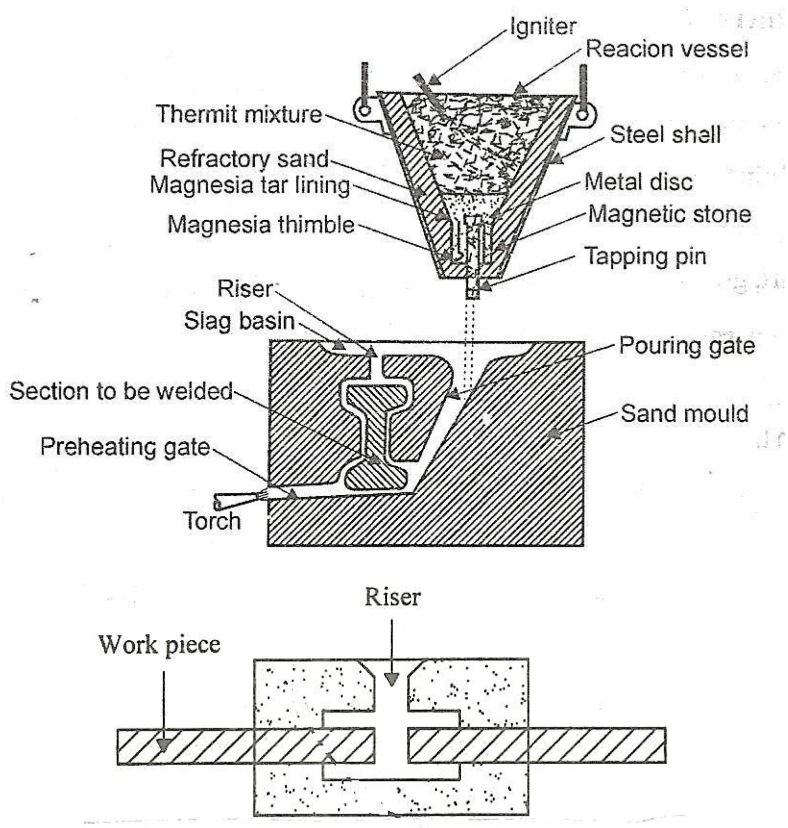

Figure 2.28 Thermit welding

Opening the mold

The actual period for which the mold is left unopened depends upon the dimensions of the weld, being shorter (two or three hours) for small sections and longer (about four hours) for heavy sections. The longer the mould can be left unopened, the better it is.

Finishing the weld

After removing the mold, the risers and gates are cut away with a cutting torch. In case of shafts or parts requiring specific finished contour the same can be given by either machine or grinding.

Advantage

The heat necessary for welding is obtained from a chemical reaction and thus no costly power-supply is required. Therefore broken parts (rails etc) can be welded on the site itself.

Limitations

Thermit welding is applicable only to ferrous metal parts of heavy sections, i.e., mill housing and heavy rail sections.

The process is uneconomical if used to weld cheap metal of light parts.

2.16 Electron Beam Welding (EBM)

Principle

Beam of electron is used for producing high temperatures and melting the work piece to be welded.

Working

When tungsten filament is electrically heated in vacuum, it will emit the electrons. This electrons carrying the negative charge which is passed through the anode hole. The electron beam is focused by the focusing lens. When the focused electron beam strikes the work piece, the kinetic energy of this electron beam is converted into heat energy. This heat energy is used to weld the metals. The operation is carried out in vacuum. So, it is possible to weld holes. The beam are focused about 0.25 to 1mm diameter and the power density of 10kW/mm2. Aluminium material has focusing length of about 40mm and steel about 30mm.

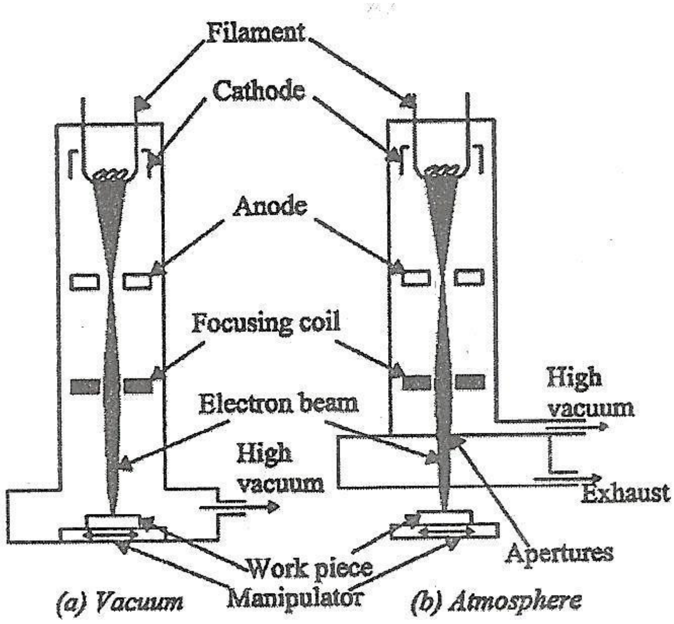

Figure 2.29 Electron Beam Welding

The variables which are controlled in the electron beam welding are:

1. Voltage
2. Speed
3. Distance between beam gun to work piece.

Advantages

1. High quality weld is produced.
2. Deep welding is possible.
3. Clean and bright weld can be obtained.
4. High speed operation can be achieved.
5. Dimensional accuracy is good.
6. Energy loss is very less.

7. Very small part can be welded.
8. There is no need of using electrodes.

Disadvantages

1. The cost is high.
2. Skilled persons are required.
3. It is limited to small size welding.
4. Welding should be carried out in vacuum seal only.
5. It is a time consuming process.

Applications

1. Dissimilar metals can be welded.
2. Refractory and reaching metals can be welded.
3. It is used in aircrafts.
4. It is suitable for large scale.
5. It is used in cams.

2.17 Friction welding

Principle

It is a solid state welding process wherein coalescence is formed by the heat which is obtained from mechanically induced sliding motion between rubbing surfaces.

Working

Initially, the components to be welded are held under pressure. One part is rotated at high speed and other part is held stationary. In this welding, the movable clamp is moved and contacted with the rotating component. The heat is produced between contact surfaces. This heat is used to weld the components under pressure. The pressure during welding may be about to few Mpa.

During this period, the metal is slowly extruded from the weld region to form on upset. For stopping the relative motion, the brake system is applied.

The parameters which are considered in friction welds are:

1. Friction Pressure
2. Speed
3. Burn off.

The materials that can be welded are listed below.

1. Brass of Bronze
2. Nickel
3. Titanium alloys
4. Stainless steel
5. Aluminium and aluminium alloys

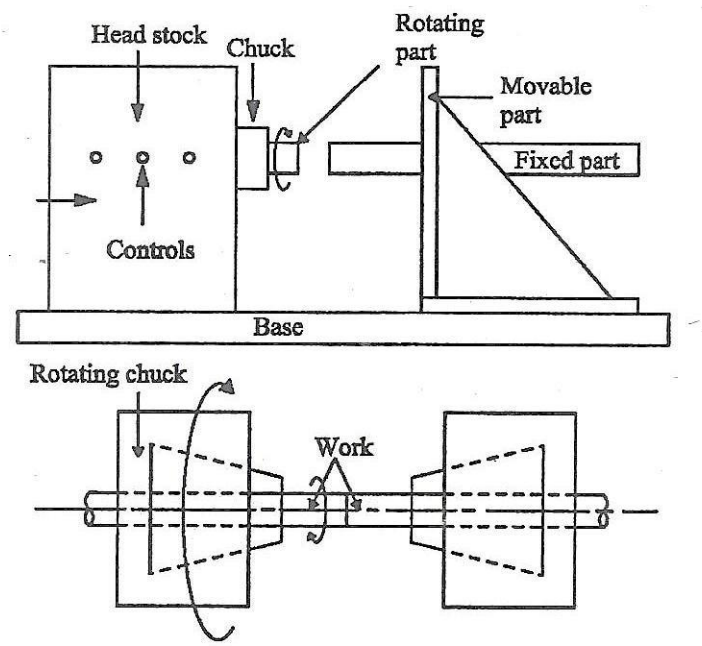

Figure 2.30 Friction welding

The basic joints are made by friction welding as follows:

1. Bar-belt Joint
2. Bar-Ball Joint
3. Tee-Butt Joint.

Applications

1. It is used in super alloys.
2. It is used in produce axle shafts, valves and gears.
3. It is used in production cutting tools such as tapers reamers drills.
4. It is used in refrigeration.
5. It is used for making simple forgings.
6. It is used for manufacturing of all steel alloys.

Advantages

1. Power consumption is low.
2. The operation is easy.
3. Parameters are easily determined.
4. It is smooth and clean process.
5. Heat is quickly dissipated.
6. It is an automation process.
7. There is no filler metal flux

Disadvantages

1. Heavy components are not used for weld.
2. There is a possibility of heavy flash out.
3. Heavy rigid machines are required.
4. It is not suitable for flat and angular welds.

Difference between friction welding and Inertia welding:

Friction Welding	Inertia Welding
1. Power from electric motor.	1. Power from flywheel.
2. Size of the motor limits the power.	2. Power is independent of the size of the motor.
3. Heat is produced by sliding motion	3. Heat is produced by intermolecular bonding.
4. Friction speed is very important.	4. Speed of the flywheel is very important.

2.18 Friction stir welding

Friction stair welding (FSW) is a solid state welding process in which a rotating tool is fed along the joint line between two work pieces. During welding, heat is generated due to friction and the metal is mechanically stirring to form the weld seam. FSW differs from normal friction welding in such a way by generating friction heat by a separate wear-resistant tool instead of the parts between them.

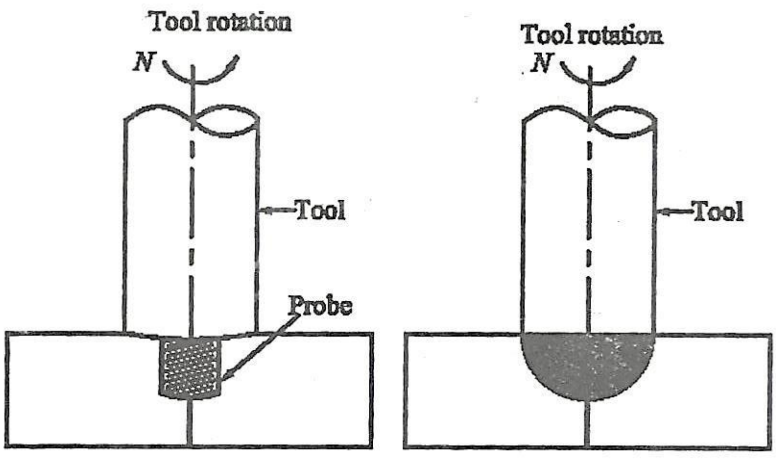

Figure 2.31 Friction stir welding

In friction stir welding process, the rotating tool consists of a cylindrical shoulder rubs against the top surfaces of the two parts thereby developing friction heat and the probe simultaneously generates additional heat by mechanical mixing of the metal along the butt surfaces. At the same time, the probe has been designed in order to perform the mixing perfectly. The heat is produced by the combination of friction and mixing but the metal will not melt but it softens. The softening of metal takes place up to a highly plastic condition. When the tool moves forward along the joint, the leading surface of the rotating probe is forcing the metal around it. Then the developed force forges the metal into a weld flowing around the probe.

FSW process is used in: aerospace, automotive, railway, and shipbuilding industries. The main applications are butt joints on large aluminium parts. Sometimes, steel, copper, and titanium, as well as polymers and composites are also jointed by using FSW.

Advantages

1. It ensures the good mechanical properties of the weld joint.
2. It avoids toxic fumes, warping, shielding issues, and other problems associated with are welding.
3. It permits less distortion or shrinkage on joints.
4. It provides good weld appearance.

Disadvantages

1. An exit hole remains the same after the tool is withdrawn from the work.
2. Heavy-duty clamping of the parts is required.

2.19 Soldering, Brazing and Braze Welding

2.19.1 Soldering

Soldering is a common process for joining steel, copper and other materials at low temperature.

It is defined as a group of joining processes where coalescence is produced by heating to a suitable temperature and by using a filler metal having a liquidus not exceeding 427°C and below the solidus of base metals.

The filler metal (solder) is generally distributed between the properly fitted surfaces of the joint by capillary action.

Soldering is divided into two types i.e.

- Soft solder
- Hard Solder

Soft soldering is used in sheet metal work for joining parts that are not exposed to the high temperature action and not subjected to excessive loads and forces.

Soft soldering is also used for joining wires and small parts.

A suitable flux is always used in soft soldering.

Zinc chloride is a common flux used in this process.