formed and molten slag remains between the electrode and the work. The temperature of this slag remains between 1600 to 1900° C inside surface. So, this high amount of heat energy is enough for melting the work piece and the electrode. Thus, the weld is formed.

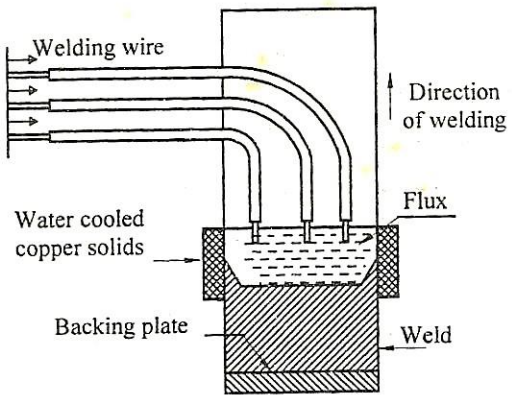

Figure 2.19 Electro Slag Welding process

The electric current passes from the electrode to the work piece through the slag pool. The welding flux used in electro slag welding should be cleared from impurities and oxidation.

Applications

1. It is used for welding carbon steels alloys steels and nickel alloys.
2. Forgings and castings are welded.
3. Heavy plates can be welded.

Advantages

1. Heavy thickness metals can be welded economically.
2. Low stress formation.
3. Preparation of joints is easier.
4. High deposition during the weld.
5. Low distortion.

Disadvantages

1. It is difficult to weld cylindrical objects.
2. Hot cracking may occur.
3. Grain size becomes larger.
4. The cost is high.

2.13 RESISTANCE WELDING

In resistance welding, the parts to be joined are heated to plastic state by their resistance to the flow of electric current and mechanical pressure is applied to complete the weld. In this process, there are two copper electrodes in a circuit of low resistance. The metal parts to be welded are placed between the electrodes. When the current is passed through the electrodes, the electrical resistance at the metal joints becomes very high. So, the metals are brought to red-hot

plastic condition. Now, the mechanical pressure is applied to complete the weld. Therefore, the heat developed by the current is proportional to the electric resistance of the weld.

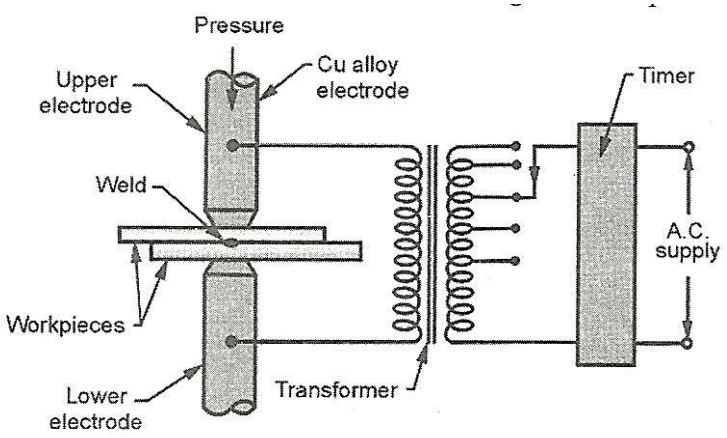

Figure 2.20 Resistance Welding

The heat generated in the weld may be expressed by

Q = RT

Where, Q

I Current in amps

R

T

A.C. with a suitable transformer is used for the power supply. Usually, 4 to 12 volt is used dependent on the composition, area and thickness of the metal to be welded. The power supply ranges from 6 top 18kW per area used.

Resistance welding is used in mass production for welding sheet metal, wire and tubes. It is also used in welding bars, boxes, cans, rods pipes and frames metals of medium and high resistance such as steel, stainless steel, monel metal and silicon bronze which are easy to weld.

The various types of resistance welding are:

1. Spot-welding
2. Seam welding
3. Butt-welding
4. Projection welding
5. Percussion Butt-welding

2.13.1 Spot welding

It is one type of electrical resistance welding process. Spot welding is used for making lap joints. By using this method, the metal sheets from 0.025 mm to 1.25 mm thickness can be easily welded. The metal pieces are assembled and placed between two copper electrodes and

then current is passed. The parts are heated at their area of contact by electrical resistance. Then the electrodes are pressed against the metal pieces by mechanical or hydraulic pressure.

The electrodes must possess high electrical and thermal conductivity and retain the strength at high temperature. So, they are made of pure copper for a limited amount of service and of alloys of copper or tungsten. The electrode pressure can be in the range of up to 2kN. They are made of cold rolled electrolytic copper – transfer or molybdenum alloys. Electrodes are cooled with water during the operation to prevent overheating.

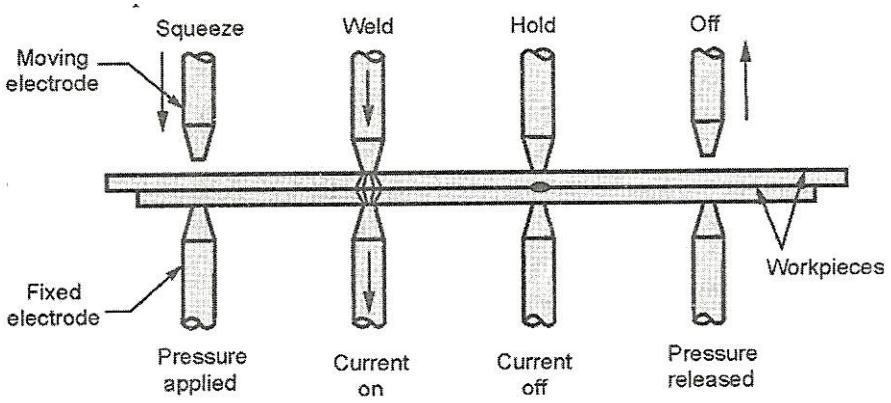

Fig. 2.21 : Stages in making a spot welding

Spot welding can be done on metal strips up to 12mm thick. All combination of ductile metals and alloys can be spot-welded. It is used for fabricating all types of sheet metal structure where the mechanical strength rather than water or air tightness is required.

2.13.2 Butt Welding

This is one kind of resistance welding. There are two types of butt-welding, namely

1. Upset butt welding
2. Flash butt welding.

1. Upset butt-welding

For making upset welding, the edges of the work piece should be cleaned perfectly and flatten the parts to be welded are clamped in copper jaws, as shown in figure. The jaws act as electrodes. Both the work pieces of edges are prepared and butted together.

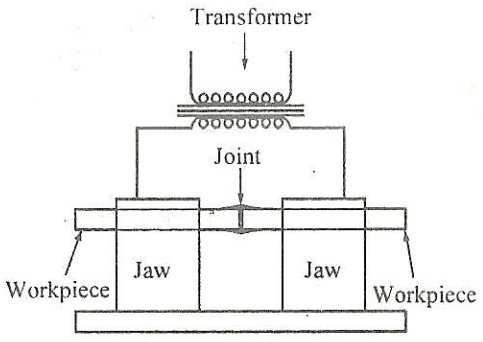

Figure 2.22 Upset butt-welding

There may be some gap between the parts, but it should be such that no arcing takes place. Then the jaws are brought together in a solid contact when the current flaws through the point of contact of jaws to form a locality of high electric resistance. At this point, the applied pressure upsets or forges the parts together. This process is mainly used for welding nonferrous materials of smaller cross section such as bars, rods, wire, tube etc.,

2. Flash butt welding

In this process, the parts to be welded are clamped in copper jaws of the welding machine. They act as electrodes. The jaws are water-cooled. They are connected to the heavy current electric power supply. The work pieces are brought together in a slight contact when the current flows through the work pieces, an electric arc or flash is produced. The ends reach fusing temperature and power is switched off. Now, the ends are forced together by applying mechanical force to complete the weld. In this welding, a small projection is produced around the weld. That projection is finished by grinding. This process is used for the part having larger cross section. This process is suitable for welding steel and ferrous alloy other than cast iron.

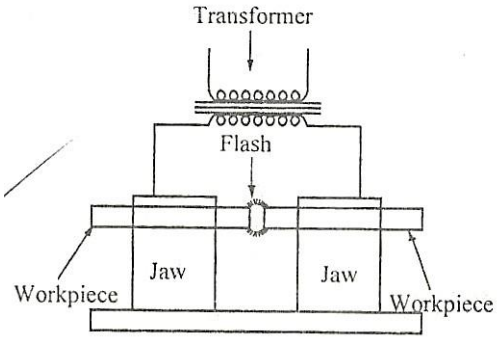

Figure 2.23 Flash butt welding

A major advantage of flash butt welding is that many dissimilar metals with different melting temperature can be flash welded. Butt welding is used in automobile construction of the body, axles. Wheels frames etc., The non ferrous alloys such as lead, tin, zinc, antimony, bismuth and their alloys cannot be welded by this method.

2.13.3 Seam Welding

In previous, spot welding is not continuous one where as seam welding is used to produce continuous joint between two overlapping pieces of sheet metal. The work pieces are placed between two rotating wheel electrodes when electric current is passed through the electrodes. High heat is produced on the work pieces between wheels. At the same time, the pressure is applied to complete the weld. The work piece is continuously moved in between the wheels. Thus, the leak proof continuous seam is achieved by supplying coolant to the electrodes. Finally, it speeds up the welding process.

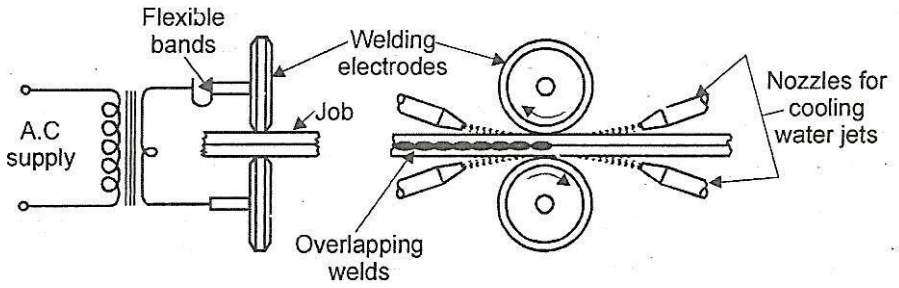

Figure 2.24 Seam Welding

Applications

Seam welding is used to make leak proof tanks, drums, radiators, household utensils, automobile bodies etc. It is also used for welding thin sheets.

2.13.4 Percussion Welding

It is one type of resistance butt-welding process. The parts to be welded are clamped in copper jaws of the welding machine. In which one clamp is fixed and other one is movable. The movable clamp is backed up against the pressure from a heavy spring. The jaws act as electrodes. Heavy electric current is connected to the work pieces. Now, the movable clamp is released rapidly and it moves forward at high velocity. When the two parts are approximately 1.6 mm apart, a sudden discharge of electrical energy is released, causing an intense are between two surfaces. The arc is extinguished by the percussion blow of the two parts coming together with sufficient force to complete in 0.1 second. No upset or flash occurs at the weld. This method is primarily employed to join dissimilar metals. The method is also used to weld pins, studs, bolts and so on. This method is limited to small areas of about 150 to 300 mm^2.

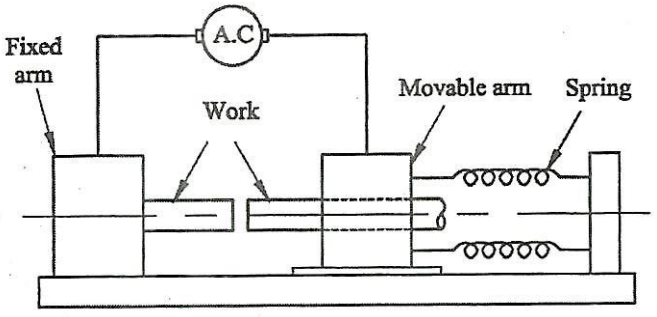

Figure 2.25 Percussion Welding

2.13.5 Projection welding

Projection welding is one kind of resistance welding which is developed from spot welding. In this, a series of spots are welded at a time. The metal pieces to be welded are placed between two metal arms which act as electrodes. One of the work pieces has projections on its surface. The work pieces are clamped between the arms. When A.C. is supplied, the welding current will be passed through these projections.

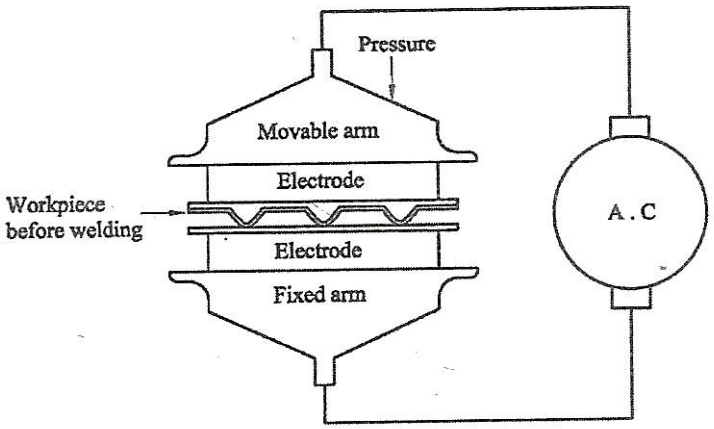

Figure 2.26 Projection welding

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