MODULE4

WELDING PROCESSES

Welding definition

Welding is process of joining two materials (similar or dissimilar) by the application of heat with or without the application of pressure and addition of filler material. All metals and alloys can be welded. The materials to be joined are held in contact together and the required energy is applied mainly in the form of heat. This heat fuses the material and on cooling the joint solidifies. The joint formed is called welded joint. Heat is the main source of energy, which can be obtained by electricity, gas or chemical reaction or friction. Welding is a fabrication process.

Advantages:

- Any metal/alloy can be welded
- Any shape of component can be generated
- Strength of the joint will be the same as that of the base metal.

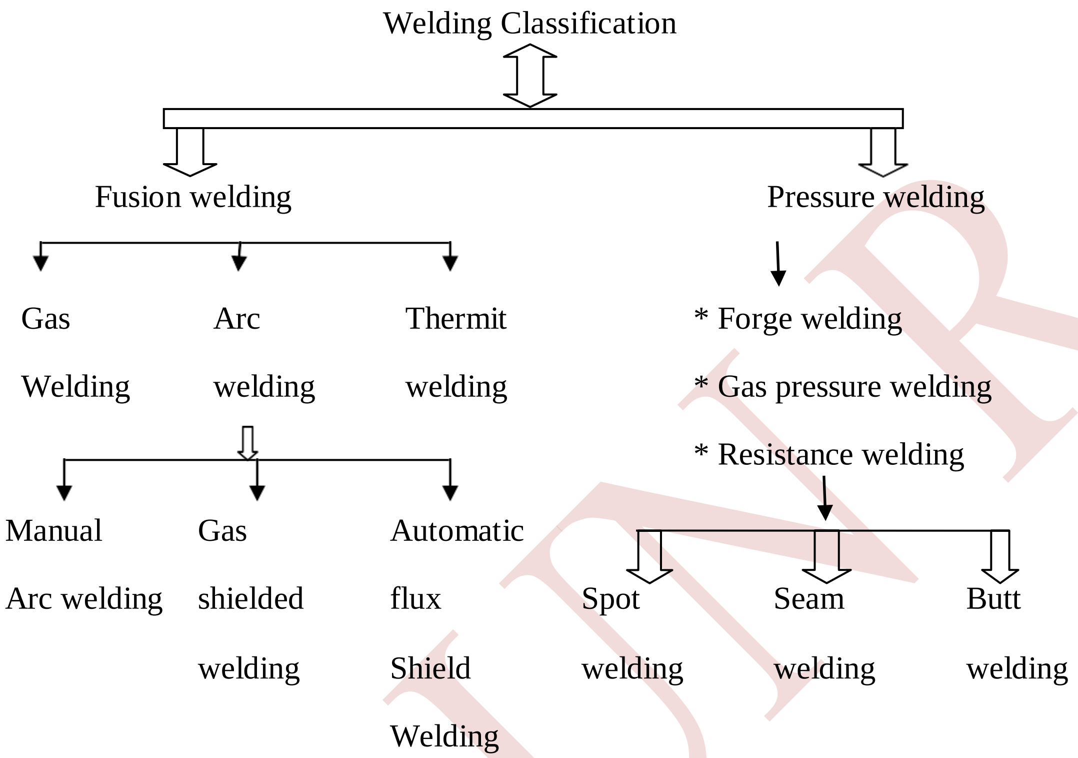
Disadvantages / Limitations:

- Harmful radiation and fumes may be generated during the process
- Residual stresses may be setup in the welded joint
- Skilled operator may be required
- Structure of the weld portion will differ from parent metal.

Application:

Fabrication of aircraft and automobile components, bridges, building structures, ships, pressure vessel, pipes, etc.

Classification of welding



The detailed classification of welding processes are:

Gas welding

* Air acetylene welding
* Oxy hydrogen welding
* Oxy acetylene welding
* Pressure gas welding

Arc Welding

* Carbon arc welding
* Shielded metal arc welding
* Flux cored arc welding
* Submerged arc welding
* Tungsten inert gas welding
* Metal inert gas welding
* Plasma arc welding
* Electro slag welding
* Stud arc welding

Resistance Welding

* Spot welding
* Projection welding
* Flash welding
* High frequency resistance welding

* Resistance butt welding

Solid State welding

* Cold welding
* Explosive welding
* Friction welding
* Roll welding
* Diffusion welding
* Forge welding
* Hot pressure welding
* Ultrasonic welding

Thermo chemical welding

* Thermit welding
* Atomic welding

Radiant Energy welding

* Electronic beam welding
* Laser beam welding

Using consumables electrodes

* Metal arc welding
* Gas shielded metal arc welding
* Submerged arc welding
* Plasma welding

Commonly welded metals

Metals that are welded on a regular basis are classified under two categories:

Ferrous Metals ⟺	**Non Ferrous Metals**
Ex. Wrought iron	Ex. Aluminium alloys
Carbon steel	Copper alloys
Cast steel	
Stainless steel	

ARC WELDING

It is a fusion welding process. Here an electric arc is used as the heat source. An electric arc is a continuous stream of electron flowing between two electrodes into a medium. This gives rise to intense heat generation. This is used to melt the surface and deposit the metal from the electrode resulting in a joint on cooling.

Principle:

The source of heat for arc welding process is an *'electric arc'* generated between two electrically conducting materials. One of the workpiece material called electrode is connected to one pole of the electric circuit, while the other workpiece which forms the second conducting material is connected to the other pole of the circuit.

When an arc is struck between a metal electrode and the work, the arc heats the metal and forms a pool of liquid. The electrode material can be either non-consumable or consumable. The non-consumable electrode made of tungsten, graphite, etc., serve only strike the arc, whereas, the consumable electrode which is made of the same material as that of workpiece strike the arc and gets consumed. The electrode gets consumed as and when the metal is deposited. The liquid pool of metal mix the work and becomes a part of it. On cooling, solid metal of homogeneous bond results. A joint is formed. The distance between the tip of the electrode and the work through which arc is formed is termed as *'arc length'*.

Metal Arc Welding (MAW)

- It is also referred as consumable electrode arc welding.
- Arc is struck between the work and electrode which melts and furnishes the required feed metal.
- Both the rod and the work melt.
- Both AC and DC supply can be used.
- Arc supplies the required heat.
- The temperature and the heat input can be increased or decreased by increasing or decreasing the arc current.
- High arc current and low arc length produces high intense heat.
- The metallic rod is normally coated with a flux.
- The flux coating melts and produces slag which covers the molten metal at the joint.
- The slag formed will also give the arc stability.
- An arc length of 0.6 to 0.8 times the electrode diameter yields high quality weld.

Flux Shielded Metal Arc Welding (FSMAW)

The welding is carried out manually, and then it is referred to as Manual Metal Arc Welding (MMAW).

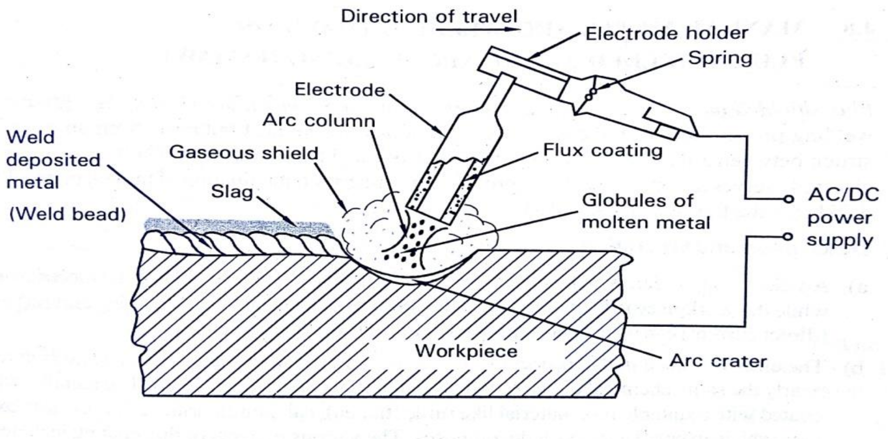


Figure 4.2 Flux shielded metal arc welding

- The surface of the work is cleaned to remove dirt to obtain a sound weld.
- The work pieces are held in position.
- Welding leads are connected to the power source and the work piece.
- Power is switched on and a suitable current is allowed to pass.
- Electrode is gripped by means of a holder and strikes the arc, by moving the electrode near to the workpiece.
- The arc length is adjusted, such that continues stable arc and supply of molten metal.
- During welding, slag is used as a protection to the molten metal.
- Flux acts as a shield to the weld portion.
- This is referred to as Flux Shielded Metal Arc Welding (FSMAW).

Tungsten inert gas welding (TIG)

An arc is struck between the non-consumable tungsten electrode and the workpiece in the presence of an inert gas such as helium or argon, which is passed near the arc thereby creates a shield. This is referred to as Tungsten Inert Gas Welding (TIG). A filler rod is used to supply molten metal to the joint. Fig. 4.3 shows the TIG welding. Pressure of the gas varies between 0.1 to 0.15 N/mm^2. Mainly DC supply is used.

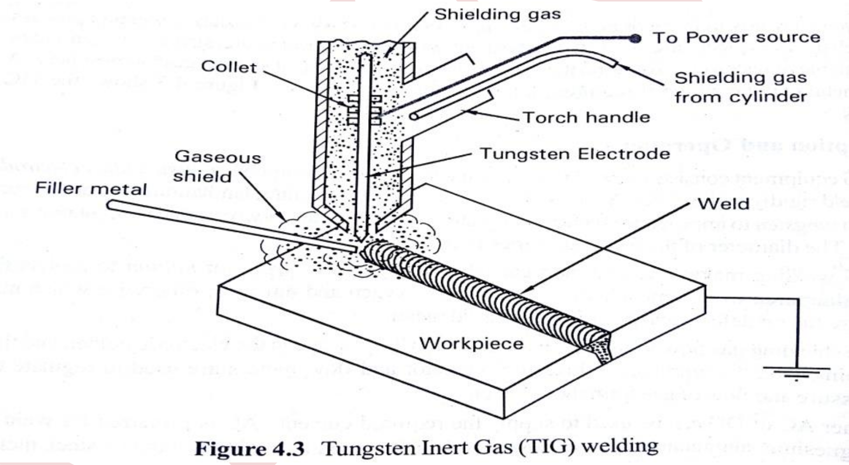


Fig. 4.3 Tungsten inert gas welding (TIG)

Advantages:

- Suitable for thin metals
- Clear visibility of the arc provides the operator to have greater control over the weld.
- Strong and high quality of joints are obtained.
- No flux is used, no slag formation, results in clean weld joint.

Disadvantages:

- TIG is most difficult process compared to all the other welding process.
- Skilled operator is required.
- Process is slower.
- Not suitable for thick metals.

Application:

TIG welding is most commonly used to weld stainless steel and non-ferrous materials such as aluminium and magnesium. Aerospace industry is one of the primary user, refrigerators, air conditioners and chemical plants are other users.

Metal Inert Gas Welding (MIG)

Metal inert gas welding, in which the workpiece is joined by the heat obtained from an electric arc struck between a metal consumable electrode (uncoated) and the workpiece in the presence of an inert gas, which is a mixture of argon & carbon dioxide. The consumable metal electrode itself will supply the required metal. No filler is required. Fig. 4.4 shows the MIG welding.

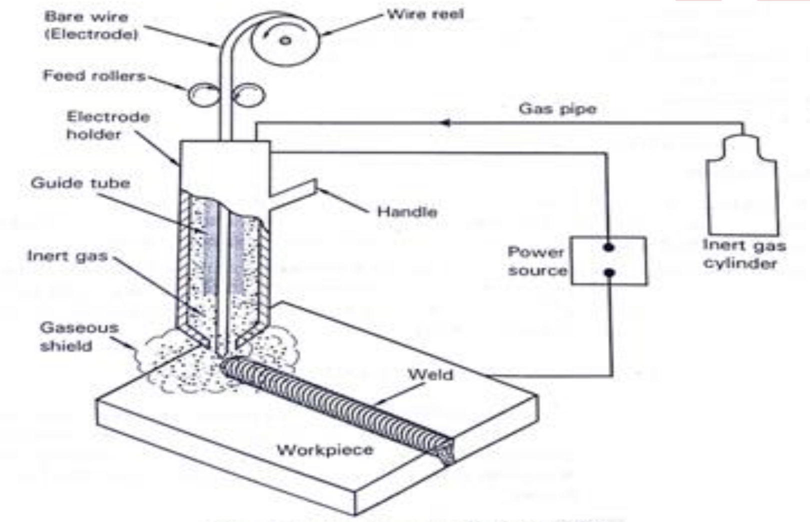


Figure 4.4 Metal Inert Gas (MIG) welding

Fig. 4.4. Metal Inert Gas Welding (MIG)

Advantages:

- MIG welding is fast and economical.
- Weld deposition rate is high due to continuous wire feed.
- No flux is used, no slag formation, clean weld is obtained.
- Process can be automated.

Disadvantages:

- Equipment is costlier.
- Dross & porosity are the most prevalent quality problem.

Application:

It is used extensively in sheet metal & automobile industry.

Submerge Arc Welding (SAW)

An arc is struck between a consumable electrode and the parent metal, buried under a granular flux such as TiO_2, SiO_2. Granular flux is allowed to drop through the hopper near the arc. Flux melts and forms a liquid. The rod supplies the molten metal for welding. Liquid flux covers the molten metal with an impermeable slag and protects the weld until it cools. Fig. 4.5 shows the SAW.

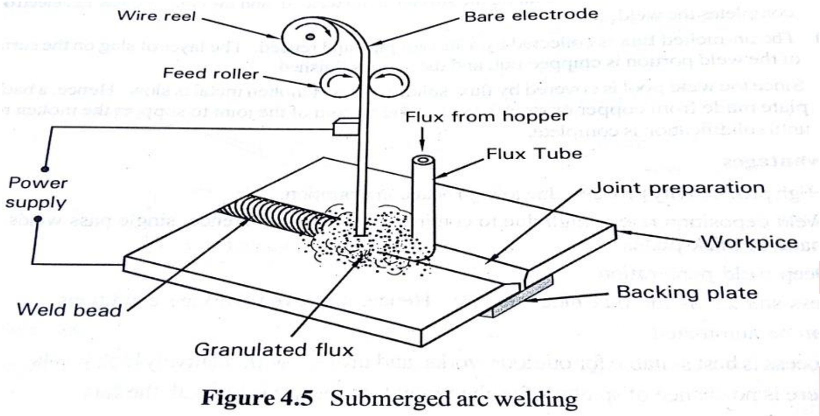


Fig. 4.5 Submerge Arc Welding (SAW)

Advantages:

- Weld deposition rate is high due to continuous wire feed.
- High productivity process due to high heat generation.
- Deep weld penetration.
- Can be automated.
- Less smoke, as the flux hides the arc.

Disadvantages:

- Use of powdered flux restricts the process to be carried only on a flat position.
- Need for extensive flux handling.
- Slow cooling rate may lead to hot cracking defects.

Applications:

Used especially for large products in the fabrication of pressure vessels, penstocks, boilers, etc.

Atomic Hydrogen Welding (AHW)

It is a welding process wherein fusion is produced by heating the job with an electric arc maintained between two tungsten electrodes in an atmosphere of hydrogen, which also acts as a shielding gas. Filler rod and pressure may or may not be applied depending upon the condition.

Principle:

- It possesses the features of both arc and flame welding processes.
- The job does not form a part of the electric circuit.
- Combined energy of the arc and a chemical reaction is utilized for welding.
- Electric arc is struck between two tungsten electrodes.
- This arc supplies energy for a chemical reaction.

Chemical reaction:

The molecular hydrogen passes through the electric arc and it dissolves into atomic hydrogen by absorbing the energy supplied by the electric arc.

$H_2 \rightleftharpoons H + H - 100700 \text{ cal}$

The atomic hydrogen thus formed is unstable and has a tendency to revert back to molecular state. This recombination takes place as the atomic hydrogen touches a relatively cold work piece to be welded. The recombination is an exothermic reaction which liberates large amount of heat (app., 3730^{o}C). This heat combined with that of the arc is utilized for welding process. Because of very high heat conductivity of hydrogen at elevated temperatures, the heat is delivered to work piece at very fast rates.

Equipment

1. Welding torch with tungsten electrodes and cable.
2. Hydrogen gas supply.
3. AC power source (a transformer with an open circuit voltage of about 300 volts). Fig. 4.6 shows the detail.

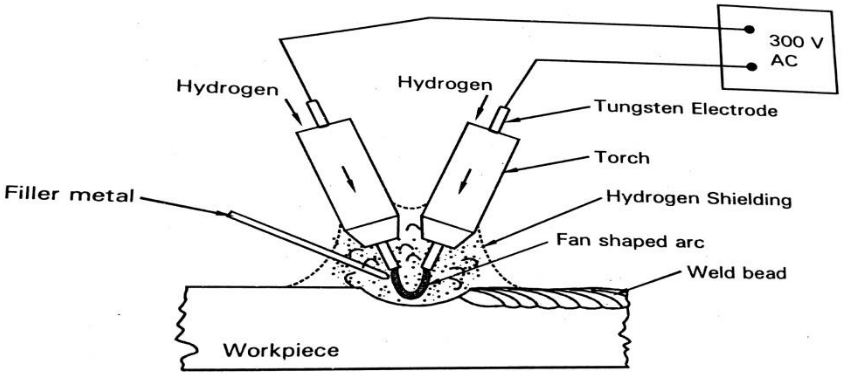


Figure 4.6 Atomic hydrogen welding

Operation:

- Hydrogen gas supply is made and current is switched on.
- The arc is struck by bringing the two tungsten electrodes in touch with each other momentarily and then separating them by a pre-determined distance (say 1.5 mm).
- Depending upon the thickness of the job to be welded a current value can be set.
- The atomic hydrogen welding arc is held over the job till a molten pool forms.
- The welding torch is carried along the surface to be welded with the arc edge touching the surface.
- Hydrogen creates a reducing atmosphere and avoids weld metal contamination.
- Depending upon job thickness filler metal may or may not be added.
- For welding a mild steel plate of 10mm thickness, about 60 amps of arc current is required.

Advantages:

- ✓ No flux or separate shielding gas is used; hydrogen itself acts a shielding gas and avoids metal oxidation.
- ✓ The job does not form a part of the electrical circuit.
- ✓ The arc remains between two tungsten electrodes and can be moved to other places easily without getting extinguished.
- ✓ Welding of thin materials is also possible which otherwise may not be successfully carried out by metallic arc welding.
- ✓ Due to high concentration of heat, welding can be carried out at fast rates and with less distortion of work piece.

Disadvantages:

- ✓ The process cannot be used for depositing large quantities of metals.
- ✓ Welding speed is less as compared to that of metallic arc or MIG welding.
- ✓ The process becomes uneconomical for certain applications because of higher operating cost as compared to that of other welding processes.

Application:

The process can be used for the welding of most of the metals and alloys like plain carbon steel, alloy steel, stainless steel, aluminium, copper, nickel and their alloys.

<u>SPECIAL TYPE OF WELDING</u>

RESISTANCE WELDING

Whenever a heavy electric current is passed through a material, the material will offer resistance to the flow of current. This results in local heating of the material. This principle is used to generate the required heat at the joint for welding. The quantity of heat generated in the material due to the current flow is given by Joules law : $\mathbf{Q \; \alpha \; I^2 R \;\; t}$

$$\mathbf{Q = 0.24 \times I^2 R \; t}$$

Where,

Q= Heat generated in calories
0.24= Constant of proportionally
I^2= Current in the Circuit in amperes
R= Resistance in the circuit in Ohms
t= Time of flow of current in seconds

- Heat generated is very rapid as very high currents of 300-10^5 amps with a voltage upto 25 volts is used.
- A transformer is used for the purpose.
- AC source is used.
- The parts to be joined are heated to plastic state and high pressure is applied.

- This results in joint, after cooling.
- Current consumed depends on the area of contact and time.
- Pressure applied is approximately around 25-55 N/mm^2.
- No filler metal is required for the purpose.
- Copper electrode is used to carry the current to the joint.
- Resistance welding can be used for all metals except tin, lead & zinc, as they pose several problems.

Advantages of Resistance Welding

- No filler rod required
- Fast rate of welding is possible
- Semi skilled workers can be employed
- Both similar and dissimilar metals can be welded
- Very high reliability and reproducibility obtained in the welds
- Semi automatic equipments can be used

Disadvantages of resistance welding

- Initial cost of equipments is high
- Needs good control and maintenance of equipments
- Higher thickness of metal cannot be welded
- Process is simple and the operation is very rapid. Used for mass production.

Application of resistance welding

- Used for joining sheets, bars, rods and tubes.
- Used for welding aircraft automobile parts.
- Used for general engineering fabrication purposes like grills, containers, tanks, etc.,

Types of Resistance Welding

1. Butt welding
2. Spot welding
3. Seam welding
4. Projection welding

1. BUTT WELDING

- Two metal pieces of the same cross section are held together by clamps and pressed.
- A current is now applied through the secondary coil of the transformer.
- Heat is generated at the contact surface and a joint result.
- The weld joint will be bulging and round.
- It has to be machined.
- Fig 4.7 shows resistance butt welding.

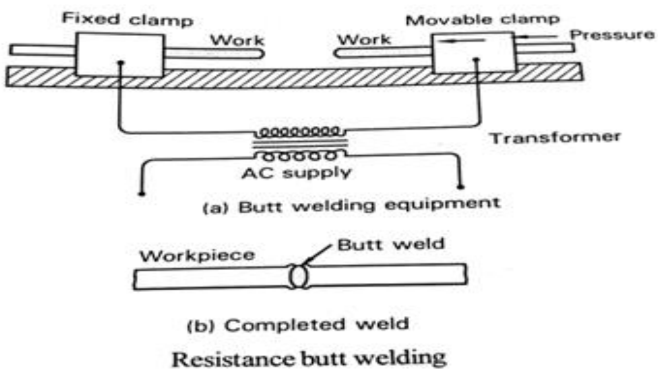


Fig. 4.7 Resistance Butt Welding

Advantages

- Joint obtained is clean, as filler metal is not used in this process.
- Produces defect free joint.
- Oxides, scales and other impurities are thrown out of the weld joint due to high pressure applied at elevated temperatures.

Disadvantages

- The process is suitable for parts with similar cross-sectional area.
- Joint preparation is a must for proper heating of workpiece.

Applications

- Used for producing joints in long tubes and pipes.

2. SPOT WELDING

- It is the simplest form of resistance welding.
- Used for welding sheet metal, both ferrous and non-ferrous metals of 8 mm thick and less.
- Consists of two electrodes (water cooled), one is fixed and other is movable.
- The sheets are cleaned first and are placed between the electrodes.
- Bottom electrode is fixed and the top electrode is movable.
- By operating a foot lever the movable electrode is brought in contact with the sheet and a pressure of 22-25 N/mm^2 is applied.
- A low voltage of 30-40V and high current of 120-300 amps is passed between the electrodes.
- This results in intense heat and the sheet gets welded within 10-15 sec.
- Soon after the current is switched off with pressure on.
- After the weld cools, pressure is released.
- Materials having higher thermal conductivity can be easily welded.
- Fig. 4.8 shows the details.

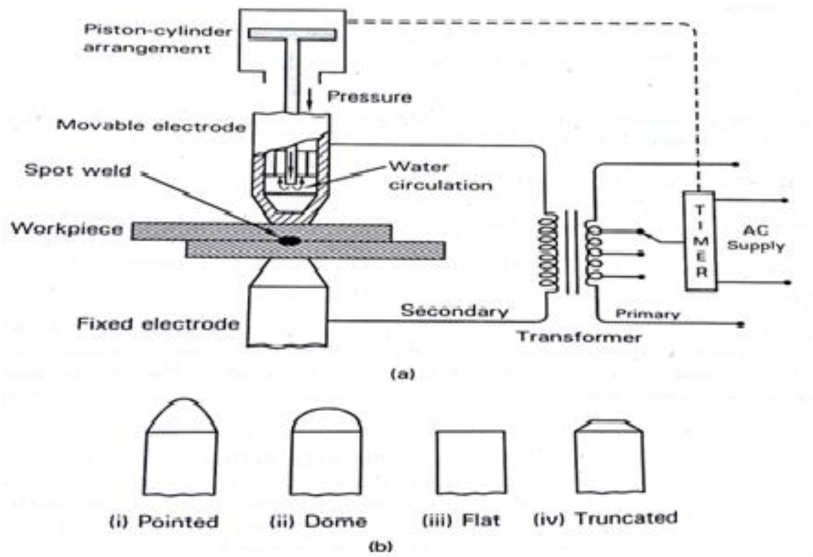


Fig. 4.8 Spot Welding

Spot welding cycle

During one welding cycle there will be 4 different timings involved.

Squeeze time: It is the time (0-1) between the initial application of pressure on the work through the electrode and the initial application of current for making the weld. Full electrode pressure is obtained during the period. Upper electrode comes in contact with it and full pressure is realized. Slowly the pressure is increased and maintained as welding current is applied.

Weld time: Period 1-2, weld current is applied through the electrodes for a known time.

Hold time: The pressure is maintained after welding at full pressure for some time then cooled at point 3.

Off time: It is the time interval from the end of the hold time to the starting of squeeze time for the next cycle.

3. SEAM WELDING

Here two copper wheels act as electrode through which current is passed and pressure is applied.

- Work pieces are kept between the electrodes and current is passed through the electrodes and pressure is applied.
- A weld is formed. Continuous weld is formed as the work is moved between the electrodes.
- Heat is generated due to the flow of current and the work offers resistance to this.
- Either current or pressure can be varied to control the heat generated.
- This changes the contact resistance.
- A series of overlapping welds are formed and the spacing can be controlled by

controlling the movement of the work.

- Used for making continuous welds between two overlapping sheets of metal for producing water tight joint.
- Fig. 4.9 shows the details.

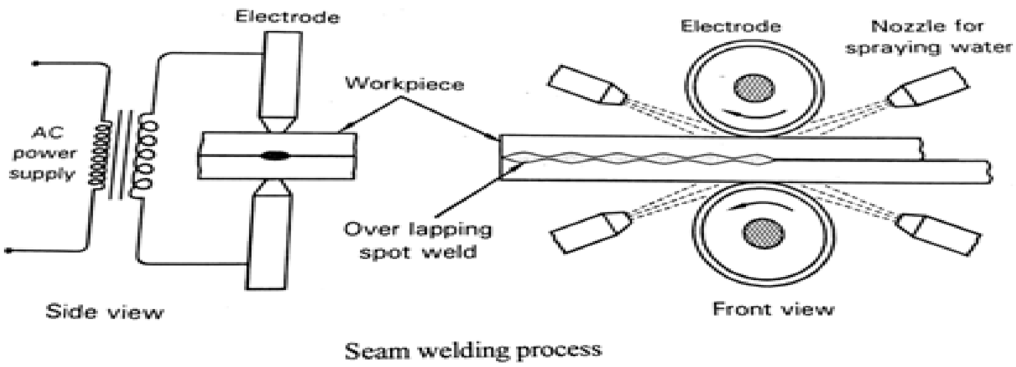


Fig. 4.9 Seam Welding

PROJECTION WELDING

- It is similar to Spot Welding.
- Copper platens are held in the arms.
- The work pieces are held in position in the arms.
- One piece has projections and the other is flat.
- Current is passed and pressure is applied.
- The projections flatten and the two pieces get welded.
- Large number of welds can be done at various points by having projections.
- Any metal or alloy can be welded.
- Fig 4.10 shows the details.

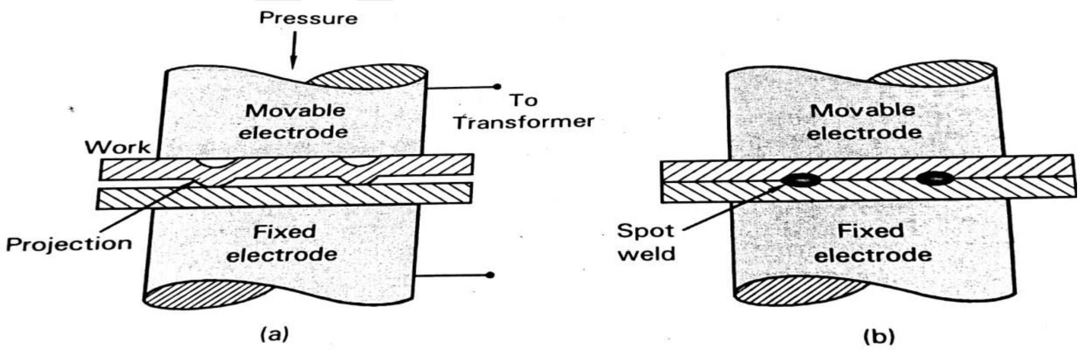


Figure 4.10 Resistance projection welding

FRICTION WELDING

- Heat produced due to friction is utilized and by applying pressure a joint is formed.
- The heat is enough to fuse the work pieces.
- One of the work pieces is held stationary and the other work piece is pressed against it and kept rotating at high speed, a very high pressure is applied and the rotation is stopped.

- Perfect joint results.
- No preparation of the surface required. The surfaces to be welded must be flat. Process is well suited to non ferrous alloys.
- Pipes, tubes, bars of carbon steel, stainless steel. Al, Ti alloy, steels can be welded with ease.
- Dissimilar metal can be joined.
- Initial pressure, heating time and final upsetting pressure can be varied to suit the requirement.

Fig. 4.11 shows the details of friction welding.

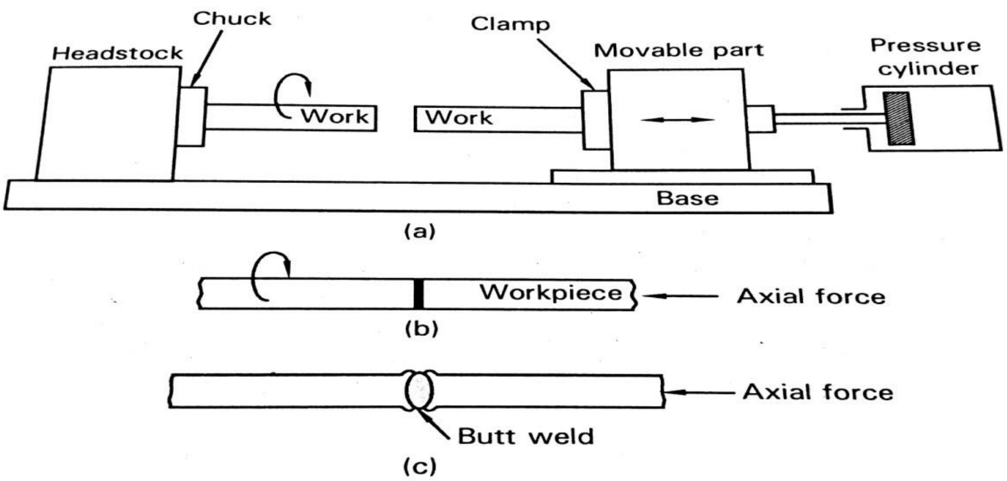


Figure 4.11 Friction welding

EXPLOSIVE WELDING

- Explosive forces generated by the ignition of explosive materials will travel at very high velocities.
- These forces are used to cause ripples in the base metal and lock them together.
- The base metal parts are placed at an angle to each other.
- The parts are covered with flexible rubber and it explosive material is covered.
- The whole arrangement is kept in a special chamber.
- A detonator is used to detonate the explosive material.
- The force of detonation results in ripples in the parts and the shock waves will lock the parts together.
- Like and unlike metals can be joined.
- Normally big items are welded.
- Fig. 4.12 shows the details.

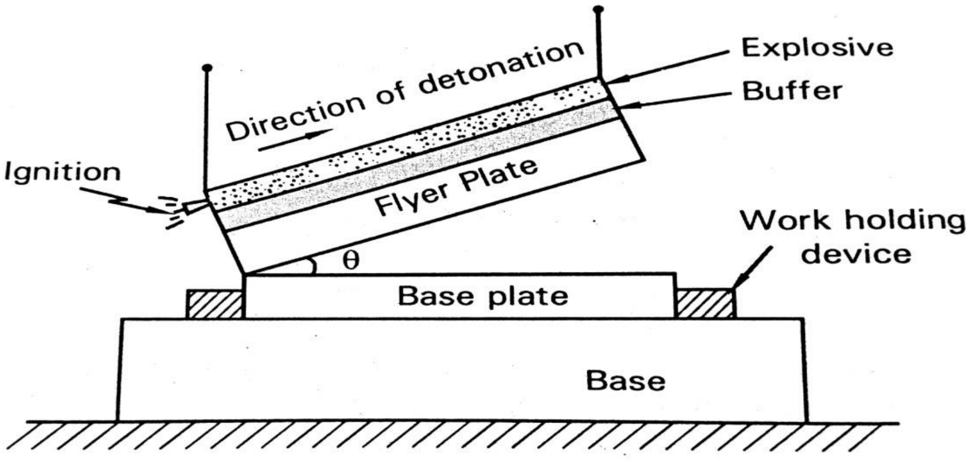


Figure 4.12 Explosive welding

THERMIT WELDING

Thermit welding is primarily a fusion welding process in which the weld if effected by pouring superheated liquid thermit steel around the parts to be welded.

The high temperature obtained from the reaction of finely divided metallic oxide (usually iron oxide) and aluminium is employed to rise the temperature of the parts to be welded to above their fusion point. The liquid metal acts as filler.

- Thermit welding is based on casting & foundry practice.
- It essentially consists of providing, by means of a chemical (thermit) reaction a volume of molten metal which is poured into the joint to be welded. Certain metals are preferentially welded by this method.

Chemical Reaction

1. $3\ Fe_3\ O_4 + 8\ Al \longrightarrow 9\ Fe + 4\ Al_2O_3$ + 7193 Kcal of heat
2. $3\ CuO + 2\ Al \longrightarrow 3\ Cu + Al_2O_3$ + 275.3 Kcal of heat

- The chemical affinity of aluminium for oxygen is the basic for the thermit process.
- Thermit reaction is an exothermic one.
- Thermitical temperature from reaction (1) is 3088^{o}C, but due to radiant heat losses and losses to reaction vessel, this temperature is reduced to 2538^{o}C.
- The thermit mixture is ignited with the help of a special ignition powder consisting largely of barium peroxide.
- This in turn is ignited by a burning magnesium ribbon or by a spark.
- Fig. 4.13 shows, Thermit welding process.

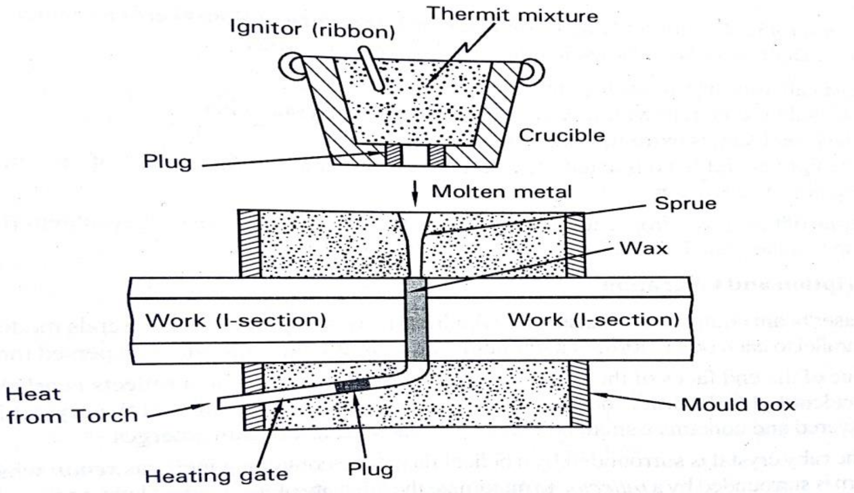


Figure 4.13 Thermit welding

Application of thermit welding:

- Joining of heavy sections.
- Welding of pipe joints.
- Repair field as repair of shafts, machinery frames, etc.
- Welding of railway rails.

Advantages:

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

Disadvantages:

- Thermit welding is applicable only to ferrous metal parts of heavy reaction i.e., mill housings and railway reactions.
- The process is uneconomical if used to weld cheap metals or light parts.

LASER WELDING *(Laser Beam Welding)*

Lasers are devices which are capable of generating a very intense beam of optical radiation. The word **laser** is an acronym of ***L***ight ***A***mplification by the ***S***timulated ***E***mission of ***R***adiation.

Laser welding is a process wherein a coalescence beam is produced by the heat obtained from the application of a concentrated light beam impinging upon the surface to be joined.

Principle & Theory of Operation :

- Ruby is Aluminium Oxide (Al_2O_3) with Chromium dispersed throughout, constituting about 1/2000 of the crystal.
- The ends of crystal are silvered to form mirrors internally.
- Around the outside of the crystal are placed flash tubes containing xenon.

- This flash tube converts electrical energy into light.
- Capacitor bank stores electrical energy.
- It energizes the flash tube by an appropriate triggering system.
- When subjected to electrical discharge, xenon transforms electrical energy into white light.
- As the ruby is exposed to the intense light flashes, the chromium atoms are exited and pumped to a high energy level.
- The atoms drop immediately to an intermediate energy level with the evolution of heat and eventually back to their original states with the evolution of red fluorescent light.
- As the red light emitted by one excited atom hits another excited atom, the second atom gives off red light which is in phase with the colliding red light wave.
- This becomes a chain reaction and finally a narrow laser beam comes out of the ruby crystal.
- This beam is focused by an optical focusing lens to produce a small intense spot of laser on the job, thereby heating up and melting it to facilitate the welding operation.
  Fig. 4,14 shows the details.

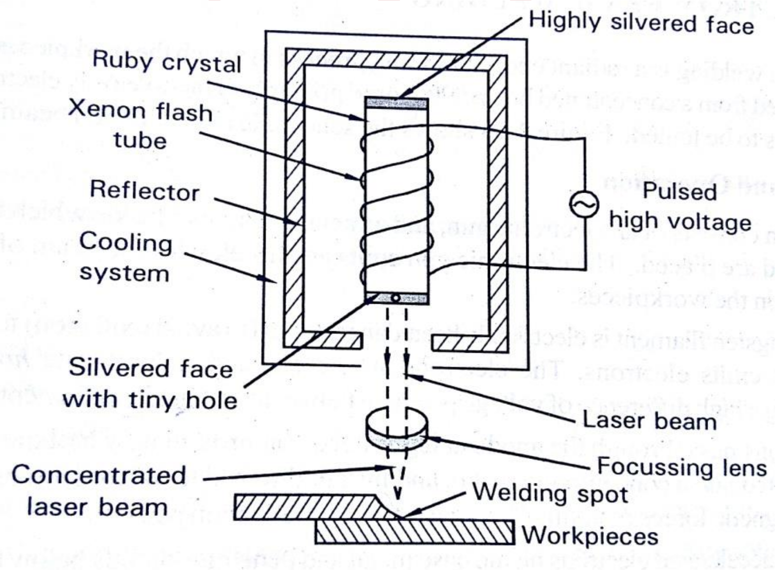


Figure 4.14 Laser welding

Advantages :

- ✓ Welds can be made inside transparent glass or plastic housings.
- ✓ A wide variety of materials can be welded.
- ✓ It permits welding of small, closely spaced components with welds as small as a few microns in diameter.
- ✓ Laser beam being highly concentrated produces narrow size of HAZ.
- ✓ Heat-treated alloy can be welded without affecting their heat treated condition.

- ✓ As no electrode is used, electrode contamination is eliminated.
- ✓ Since it is light, it can be focused to microscopic dimensions and directed with great accuracy.
- ✓ The laser beam concentrated energy can be precisely controlled.
- ✓ Areas not readily accessible can be welded.
- ✓ No protection is needed against atom contamination.

Disadvantages :

- The major drawback is the slow welding speeds (25 to 250 mm/min) resulting from the pulse rate and puddle sizes at the fusion point.
- It is limited to depths of approximately 1.5 mm and additional energy only tends to create gas voids and undercuts in the weld.
- Materials such as Mg tend to vaporize and produce severe surface voids.

Applications :

- Laser is a high energy light beam that can both welded and cut the metals.
- For connecting leads on small electronic components and in integrated circuitry in the electronic industry.
- To weld lead wires having polyurethane insulation without removing the insulation.
- To join hard high melting polyurethane metal alloys.
- In space and aircraft industry for welding light gauge materials.
- It can join dissimilar metals and other difficult metals to weld such as Cu, Ni, Al, Ti, stainless steel, zirconium, tantalum, etc.
- Laser can weld wire-to-wire, sheet-to-sheet, wire-to-sheet, tube-to-sheet and small diameter stud welds.
- Laser beam is used for micro welding purposes.
- It's particularly suitable for the welding of miniature and micro-miniature size components.

(The operation is similar to that, when the sun rays are made to concentrate on a single spot on a paper, which is placed below a magnifying lens, the paper burns. The laser energy source is a refinement of this process)

ELECTRON BEAM WELDING (EBM)

Principle & Theory of Operation :

- Heat is generated by focusing a stream of highly accelerated electrons on the work piece.
- The temperature realized is sufficient to melt.
- Welding can be easily carried out. Electron beam welding is a fusion welding process.
- High velocity electrons are made to strike the metal.

- The kinetic energy of the electrons gives almost completely into heat.
  This heat melts and fuses the metal.
- An electromagnet is used to focus the beam of electron accurately.
- A heated filament is used as a source of electrons which are made to flow through a circular ring shaped anode.
- An electromagnetic coil is used to focus the electron beam and is made to fall on the workpiece to be welded.
- The workpiece itself is placed in a vacuum chamber. Provision is made to move the workpiece.
- A tungsten filament which serves as a cathode emits a mass of electron that are accelerated and focused to a 0.25 to 1 mm diameter beam of high energy density upto 0.5 to 10kW/mm^2.
- The heat generated is about 2500^{o}C.
- This is sufficient to melt and vaporize the workpiece material and thus fills a narrow weld gap even without a filler rod.

Construction:

- Electron Beam Welding set up consists of electron emitting and accelerating unit beam focusing unit, a vacuum chamber to hold the workpiece.
- A vacuum of 10^{-4} to 10^{-2} mm of Hg is used.
- The penetrating power of electron beam depends on the speed of electron which in turn is controlled by the accelerating unit (15-30 KV DC).
- Electron beam welds are very narrow and the energy density is nearly 5x10^8 W/mm^2.
- Fig. 4.15 shows the details of Electron Beam Welding

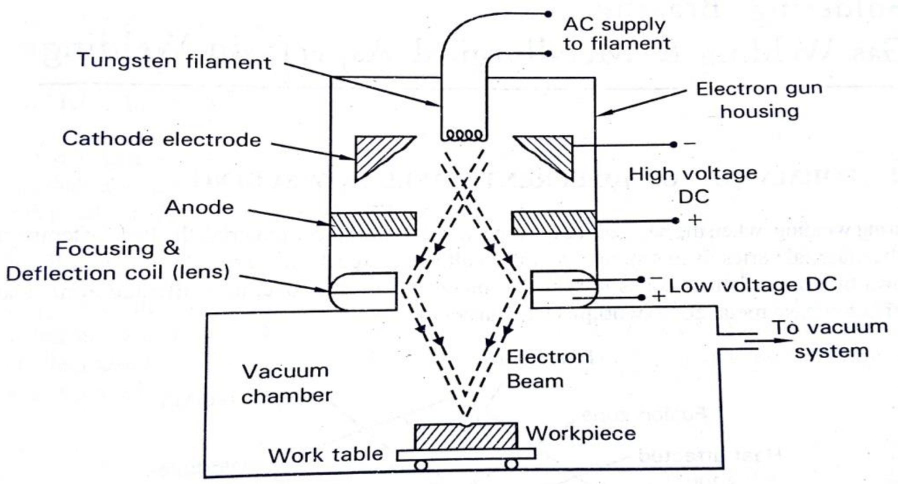


Figure 4.15 Electron beam welding

Working:

- Joint preparation of workpiece is very important to get a sound weld.
- The edges are to be cleaned thoroughly, free of oxide, dust, grease, etc.

- The work pieces are demagnetized before welding.
- They should be free from residual magnetism or else the electron beam gets deflected.
- The residual magnetism can be removed by placing the work piece in an inductive field of 50 cycles frequency.

Merits :

- Heavy sections upto 100 mm thick stainless steel can be welded easily.
- Very thin sections of 0.025 mm can be welded.
- Control of welding is easy.
- Narrow welding can be done.
- Neat welding can be done.

Demerits :

✓ Size of workpiece is limited. Initial cost of equipment is high.
✓ Skilled operators are required.
✓ The workpiece should be electrically conductive in nature.

Application :

- Used for welding super alloys, refractory metals, reactive metals and stainless steels.
- Titanium, beryllium, molybdenum and zirconium components are welded.
- Used in aircraft, automobile industry, farm equipments, electronics, missile industry.
- Used for welding gears, cams, etc.

EDGE PREPARATION

Before starting the welding process, the edges of the two workpieces to be welded should be prepared well to obtain a sound weld. This process is called edge preparation and involves two operations:

(a) Preparation of joint and
(b) Cleaning of joint.

(a) Joint preparation

Joint preparation involves cutting or beveling the edges of the two workpieces to suitable shapes so that heat would be able to penetrate to the entire depth of the workpiece. Figure 4.1 shows the different shapes that can be prepared based on the application.

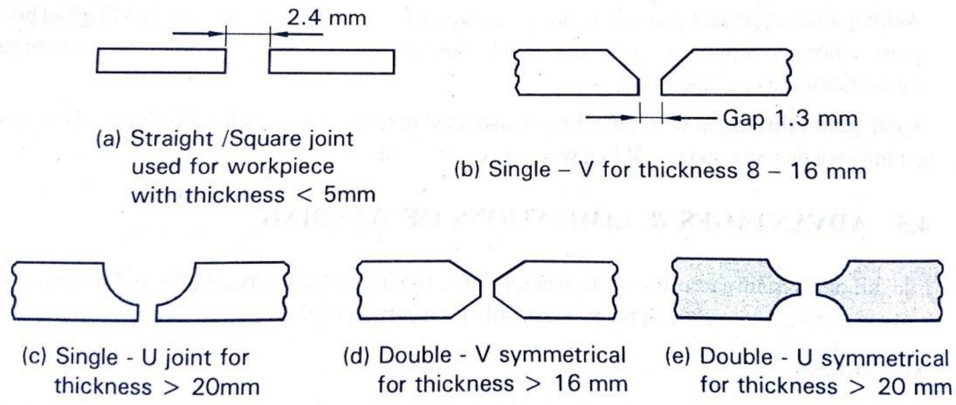


Figure 4.1 Edge preparation

Figure 4.1(a) shows a square or straight joint suitable for workpieces with thickness less than 5 mm. Some workpieces are beveled only on one side, as in single-V or single-U joints, but for very thick plates, beveling is required on both sides as shown in figure 4.1 (d) and (e).

(b) Cleaning of joint

Workpiece surfaces are often chemically contaminated by dirt, grease, oxides etc. Most metals are very reactive, and in air, they become coated with an oxide layer or with adsorbed gas. This layer prevents intimate contact from being made between the two metal surfaces. Hence, the edges of the workpieces and the area adjoining them should be cleaned thoroughly to remove the contaminants.

Cleaning is done either chemically by using acetone or carbon tetrachloride solution or mechanically by using wire brush, hand files or grinding process.