# WELDING

**Q1. Describe with the help of neat sketch the principle of spot welding.**

**Ans.** The principle of spot welding is illustrated in fig, where a transformer core is shown having primary and secondary windings *P* and *C* respectively. One end of the secondary windings is connected to the upper electrode $E_1$ carried in the movable copper or bronze arm *A* and the other end to the lower electrode $E_2$ mounted on the fixed arm *B*. In operation the metal sheets $S_1$ and $S_2$ are held and pressed between the electrodes and a strong current at low voltage is switched on. Due to the resistance offered by the sheet metal to the flow of this current the temperature at the contact surfaces rises to fusion point and the weld is completed under the contact pressure of the electrodes.

***Q2. Write shorts on***

**1)Welding rods**

**2)Fluxes**

**3)Gas flames**

**Ans:** ***1)Welding rods:***

Sufficient care should be taken in selecting a suitable *welding rod or filter rod* for welding a particular material. Always the best available quality of the rods should be selected as the cheaper qualities are likely to contain more impurities and they will result is the production of an unsound joint. Welding rods suitable for welding different metals are produced by various standard manufacturers under their own trade names and it is advisable, at least for a beginner, to be guided by the manufacturer's instructions in the selection and use of these rods. However, it is reckoned that a welding rod will posses the same or nearly same composition of its constituents as that of the metal which is to be joined.

***2)Fluxes:***

The chemicals, which deoxidize the metal surface and provide inert atmosphere around the molten, are known as fluxes.

***FUNCTION:***

1)To prevent oxides from the hot surfaces.
2)To reduce the viscosity of molten metal.
3) It maintains a steady arc in case of arc welding

Fluxes are available as liquid, powder, paste and gas. Powder flux is sprinkled on the surfaces to be welded or the filter rod is dipped into the powder. Liquid & paste fluxes are sprayed on the surfaces to be welded. Gas fluxes are used to form inert atmosphere around the joint

to be welded.

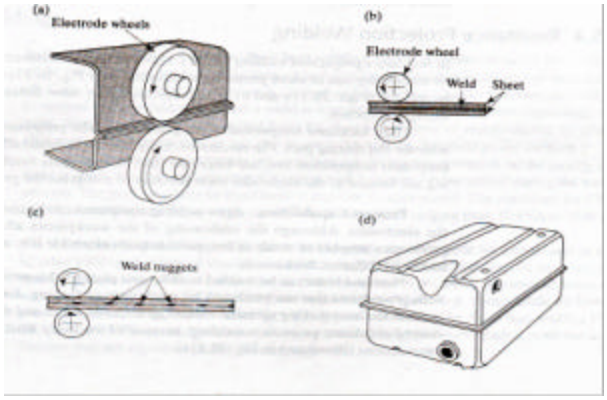
***1) Gas flames***

There are three types of gas flames :

1.Oxidising Flame 2. Carburising Flame 3. Neutral Flame

**Q.3. Briefly explain seams welding and butt welding.**

**Ans.** ***Seam Welding:***




Seam welding is used for making continuous welds between two overlapping pieces of sheet metals. In this process the current is not passed continuously but is regulated by a timer. The work to be welded is placed between the two wheels, which apply sufficient pressure between the sheets and also carry sufficient current or producing continuous welds. The heat is generated due to passing of the current through the resistance in the welding circuit. The heat generated can be controlled by either varying the current or pressure between the sheets, which varies the contact resistance. If the heat rate is high then the speed of rollers in increased thereby reducing the weld time and vice versa. The electrodes are made of copper alloys and are water circulated in order to dissipate heat from them. In high speed seam welding using continuous current, the frequency of the current acts as an interrupter. In seam welding, a series of over-lapping spot welds are formed as shown in Fig and these have sufficient overlap to provide a pressure-tight joint. However the spacing of these spots can be regulated also.

***Butt Welding :***

In butt-welding, the two pieces of metal of same cross-section are gripped together and pressed while heat is generated in the contact surface by electrical resistance when the current is passed. As pressure keeps on acting continuously, the joint is upset slightly which has to be rounded up by machining or grinding. It is desirable that both parts are of same resistance in order to have uniform heating at the joint. In order to have good weld, first the pressure must be less and then

increased steadily to the value sufficient to effect weld. In this process there is no flashing or arcing at the joint during the operation. This process is best suited to rods, pipes and many other parts of uniform cross-section. Butt-welding can be sub-divided into two groups, i.e. upset butt-welding and flash butt welding. In the first type, the parts to be welded are clamped edge to edge in clamps of the machine and brought together with light contact while current flows to heat the joint. The pressure applied upsets the joint. Upset butt-welding is used principally for non-ferrous metals.
In the flash butt welding, the parts are brought together in a vary light contact. A high voltage starts a finishing action. The parts keep on moving against each other till forging temperature is reached and then sufficient pressure is applied to effect the weld. In this process it is very important to have proper timing and current for the size and section of parts used. Usually large areas are welded by flash welding process. This process requires less current and is quite rapid. Most of the non-ferrous metals except those containing high percentages of lead, zinc, tin and copper can be welded satisfactorily.

**Q.4. What is resistance welding?**
**Ans.** ***Resistance Welding*** **:**
It is the process of joining metal pieces together by raising the temperature of the pieces to fusion point and applying a mechanical pressure to join them. In this the pieces to be joined are held together and a strong electric current(A.C.) of high amperage and low voltage is passed through them. This current comes across a certain resistance in passing from one piece to the other and it is this resistance offered to the flow of current which results in raising the temperature of the two pieces to fusion of melting point at their junction. The mechanical pressure applied at this movement completes the weld. This method of welding is widely used in modern practice for making welded joints in sheet metal parts and bars and tubes etc.

**Q.5. Write short notes on the following highlighting the principal, application in industries and limitations if any.**
**Ans.** ***Brazing :***
The term brazing implies the use of brass as the filter material but nowadays a number of other alloys are also in use. The filter metal is called, ‘spelter’. In brazing, metal parts are joined by coalescence at temperatures above $560^0$C. However, non-ferrous filter metal is used which has a melting temperature below that of the

base metals. Consequently, the base metals are never melted. The filter metal is distributed in the joint between the base metals by capillary attraction and the coalescence is between the base metals and the filter metal and not between the base metals.

***Application :***

Brazing is used for electrical items, radiators, heat exchangers, pipes & pipe fittings and tool tips.

***Disadvantages :***

1. Low strength.
2. Not applicable for hardened steel and aluminium alloys.

**SOLDERING**

Soldering is a process of joining two metals by using another low temperature metal alloy. The metal used for the joining purpose is called solder. Solders are of two types :

1. Hard Solder
2. Slot Solder

Hard solder is an alloy of copper and zinc where as the soft solder is an alloy of tin and lead.

Process/Procedure :

The surfaces to be joined are cleaned and are placed on each other. A flux s employed to prevent oxidation. Zinc chloride is commonly used for this purpose. The soldering iron(shown in the figure) is heated either electrically or by some external heat. Then the hot end is dipped into the flux and solder is pressed against the surfaces to be joined. A joint is formed by melting the solder.

**Applications :**

Soldering in widely used for sheet metal work and in radio and television work for joining wires.

***Advantages :***

1. Joining cost is low
2. Equipment is very simple and cheap
3. Good sealing in fabrication as compared to other processes like rivet, spot weld and bolts
4. It provides a positive electrical connection.
5. Due to low operating temperature, the properties of base metal are not affected.

***Disadvantage :***

1. Joints formed are weak.

***Riveting :*** It is a permanent fastening process in which the end of the metal pin is pressed over or spread out by hammering operation Riveting can be cold riveting for light work. Wrought iron and steel are used for hot riveting and copper, brass and aluminium are used for cold riveting.

***Application :***

In engineering practice, there are many items, which are built up of a number of separate pieces rigidly

attached together by means of permanent joints. For example, boilers, water-tanks and various other vessels, which are subjected to internal pressure, are constructed out of separate steel sheets joined together permanently. Further, steel structures, such as cranes, bridges, beams, trusses, etc., are also built up of separate steel sections rigidly fastened together. Riveting is one o the most commonly used methods of producing rigid and permanent joints in all such cases.

**Q.7. Describe the Thermit welding process.**

**Ans.** ***Thermit Welding :-***

Thermit welding is the application of a filler material or the joining of two pieces of metal, usually steel, through the use of heat supplied by a chemical reaction. The chemicals used for the heating process are a mixture of aluminium and iron oxide. The thermit, as the mixture is called, requires an igniter of some type to set of the reaction. The chemical formula for this process is

$8Al + 3Fe_3O_4 = 9Fe + 4Al_2O_3$

The heat released is approximately $3000^0C$, causing the iron, remaining in the charge, to charge and melt.The thermit is mixed in a suitable crucible and the igniter is placed on top. It is then lit with a red hot metal rod. As the igniter burns, temperatures around $1150^0C$ are reached before another reaction begins. At this point the metal begins to melt.

The reaction carries burning throughout the mixture for 25 to 30 seconds. The heat released causes the iron to change from a solid to a liquid. This steel then becomes molten and reaches the desired fusion temperature. It is channeled into a prepared mould. The fracture or two pieces to be joined together, have been preheated to the high temperature of the liquid steel, and thus the parts are welded together.

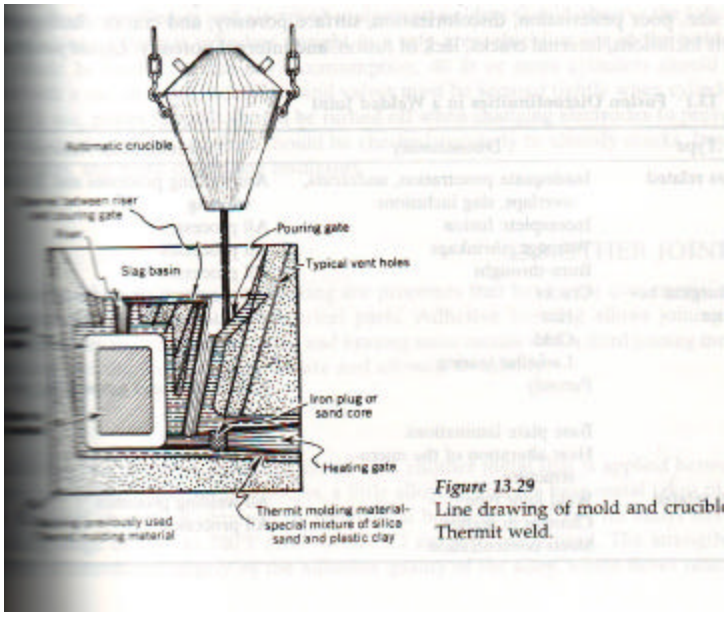



*Figure 13.29*
Line drawing of mold and crucibl
Thermit weld.

**Q.8. What are the advantages of welding over other processes of similar purposes? Why is inspection necessary after welding?**

**Ans.** ***Replacing Casting :***

A wide variety of machine parts, which were manufactured by casting, are now being designed and fabricated as weldments. Machinery base, frames and brackets are made up of standard steel shapes and rolled plates and joined by any one of the welding processes.

***Replacing Riveting and Bolting :***

Welding is gaining importance day by day in the joining of metals as it gives speedy and sound joints and at the same time, the joined structure is lighter in weight.

***Welding as the only means of fabrication :***

Welding is the only solution in cases where the equipment is to be constructed of steel plates, the thickness of which is greater than those joined by means of riveting and caulking.

***Testing and Inspection of Welds :***

It is very important that for satisfactory operation and working, welds are properly tested and inspected as their failure may result into hazards and great losses. The tests can be either of destructive or non-destructive nature. The former type gives the quantitative information and is used in laboratories, whereas the second type gives the idea of quality of weld.

**Q.9. Give two applications of the following :-**

**(1) Resistance Welding**

**(2) Oxy-acetylene Welding**

**(3) Atomic Hydrogen Welding**

**(4) Gas cutting**

***Ans:*** **(1) Resistance welding:**

Resistance welding is a group of welding processes where in coalescence is produced by the heat obtained from resistance of the work to the flow of electric current in a circuit of which the work is a part and by the applications of pressure used for

i) Joining sheets, bars, rods and tubes
ii) Welding aircraft and automobile parts.
iii) Making cutting tools
iv) Making fuel tanks of cars, tractors etc.
v) Making wire fabric, grids, grills, mask weld, containers etc.

***2) Oxy-acetylene Welding:***

It is a process in which acetylene is mixed with oxygen in correct proportion in the welding torch. It is a furion welding process. It joins metals using the intense heat of combustion.

***Uses:***

1)For joining thin materials
2)For joining materials in whose case excessively high temperature or rapid heating and coating of the job would produce unwanted or harmful changes in the metals.
3)For joining materials in whose case extremely high temperature would cause certain demerits in the metals to escape into atmosphere.
4)For joining most ferrous and non-ferrous metals. e.g. carbon steels, alloy steel, cast iron, Alluminium, copper, nickel, magnesium and its alloys etc.
5)In automotive and aircraft industries, in sheet metal fabricating plants etc.

***3)Atomic hydrogen Welding:***

It is a welding process where in coalescence (furion) 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.

***Uses:***

1) The process can be used for the welding of most of the metals and alloys like plain carbon steel, alloy steel, stainless steel, Alluminium, copper, nickel and their alloys.
2)For surfacing dies and tools.

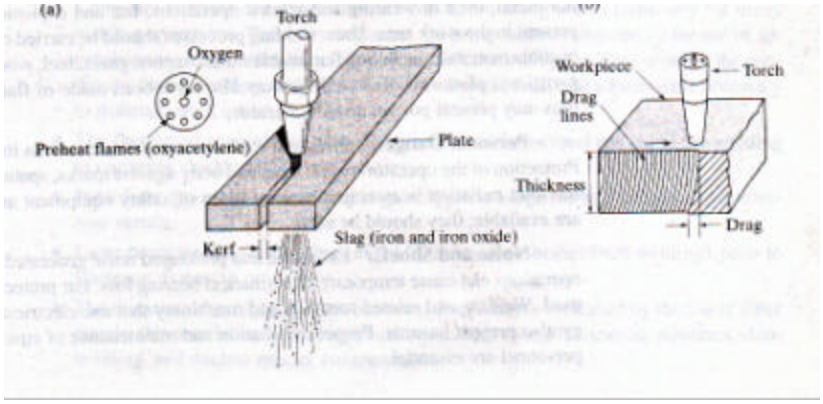
3) ***Gas cutting:-***

Gas cutting is a group of cutting processed where the severing or removing of metals is effected by means of the chemical reaction of oxygen with the base metal at elevated temperatures in the case of oxidation resistant metals, their reaction is facilitates by use of a chemical flux or metal powder.

***Uses:***

1) To prepare edges of plates for bevel and groove weld

joint designs.
2) To cut small sized work-piece from bigger plates for further processing.
3) To cut rivets, gates and risers from castings.
4) To cut many layers of thin sheets at same time(stack cutting) to reduce both time and cost for production work.
5) To pierce holes and slots in steel plates
6) For salvage work.




***Q.10.What is resistance welding? Explain spot welding in detail with the sketch.***

Q.13.State various differences between branzing and soldering.

*Ans.* DIFFERENCE BETWEEN SOLDERING AND BRAZING

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| ***Brazing*** | **Soldering** |
|---|---|
| 1. Filter metal has the melting point above $400^0$C. | Filter metal has the melting point below $400^0$C. |
| 2. More stable joints can be made. | Less stable joints can be made. |
| 3. High pressure & temperature do not affect the joint. | Joints are affected by high temperature & pressure. |
| 4. Equipment cost is more. | Equipment cost is very low. |

***Q.11. What is weldability?***

**Ans.** ***Weldability of Metals :***

It may be defined as the capacity of the metals to be welded into inseparable joints having specified properties such as definite weld strength, proper structure

etc.
This means, if a particular metal has weldability, then it should be readily suitable for welding. If the metal has poor weldability, it can be improved by the use of proper (a) shielding against atmospheric action,(b)flux,(c)filter metal,(d)welding procedure and, in some cases,(e)proper heat-treatment of the metal before and after deposition.

**Q.12.Describe resistance seam welding. Also mention its limitations.**

**Ans.** ***Limitations*** **:**It cannot be applied to those portions when abrupt change in contour occurs along the path of electrode wheels, such as on sharp corners.

1) In longitudinal seam welding machines the maximum length of the seam joint that can be made equals the throat depth of the machine.

2) It is necessary to avoid obstructions in the path of electrode wheel or else a corresponding recess should be provided on the wheel periphery to accommodate these.

3) It is necessary that the weld should proceed along a straight line or a uniform curve.

4) Stock thickness above 3 mm cannot be welded with normal case.

5) For successful welding and production of defect free welds it is essential that the work surfaces should be perfectly clean and free from grease, paint, oil, rust and scale.

**Q.13. Explain Tungsten Inert gas arc welding with its specific application.**

**Ans.** This process has popularly been called TIG since it is based on a tungsten electrode working in the presence of inert gas. This process consists of a torch with a tungsten electrode. The use of filler material depends on the material composition, thickness, etc. and is fed either with hand (for manual operations) or by means of a feeding mechanism (for semi-automatic and fully automatic). Details have been shown in Figure.

The tungsten electrode may range in diameter from 0.15mm to 9.25 mm and may be made of pure tungsten, Thoriated tungsten or Zirconiated tungsten. The oxides of Thorium/Zirconium held in easy electron emission and easy starting. Very little tungsten is lost, during welding process, since its boiling point is very high ($5860^0$C). If the electrode touches the base metal, some tungsten may be deposited on the weldment.

While welding stainless steels and other steels, electrode of 0.35mm to 0.75mm diameter and A.C. high frequency current are used to help stablise the arc and to ease starting. G.T.A. process is conventionally useful on stainless steels, nickel-cobalt alloys, aluminium and

copper alloys, and titanium or highly alloyed metals where weld purity is essential. There is hardly any need to finish the weld. The welds are hard.

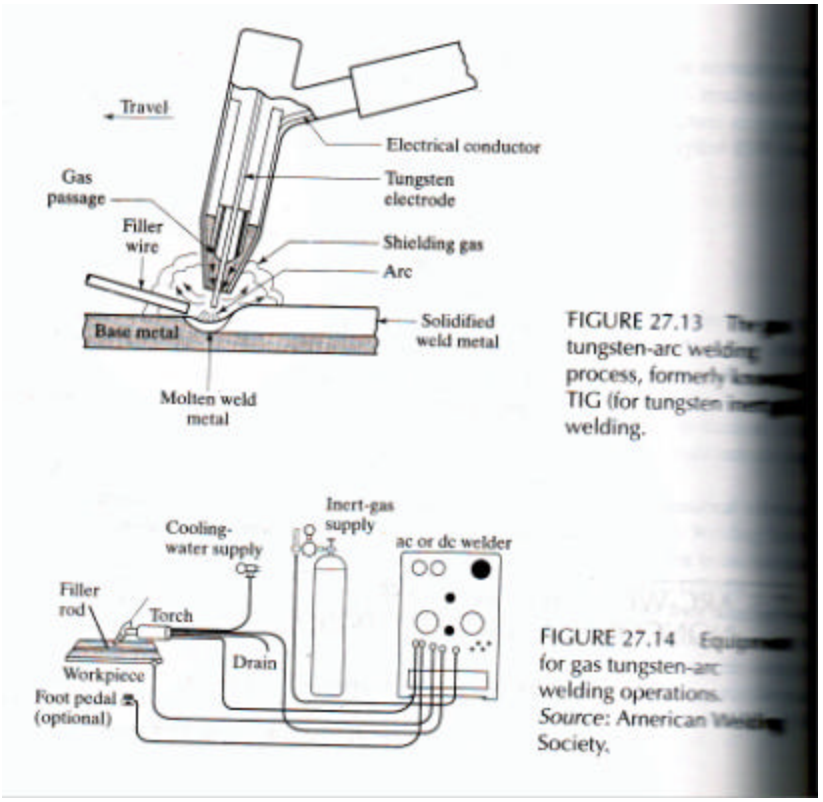



FIGURE 27.13 Th... tungsten-arc welding process, formerly k... TIG (for tungsten ... welding.

FIGURE 27.14 Equip... for gas tungsten-arc welding operations. *Source*: American Welding Society.

***Advantages*** – Useful for welding those metals which tend to oxidise rapidly (primarily for non-ferrous metals).
***Disadvantages*** – The process is relatively slow in operation.

**Q.14. Describe MIG type of welding with its specific application.**

**Ans.** In this reference, Metal Inert Gas(MIG) shielded arc welding is very common. Wire, acting as consumable bare electrode, is fed through the welding head with the help of wire feed rolls. Inert gases are used for welding the jobs. Electric arc is developed between a continuously fed consumable electrode and the work piece. Metal is transferred through protected arc column to the work. A fixed relationship exists between the rate of wire burn-off and the welding current such that the stabilised arc is maintained. Current depends on the electrode wire diameter, speed of melting the wire, composition of parent metal, and its thickness.

In case of using high amperage, the gun or welding torch may either be air cooled or water cooled. During welding, the welding area is flooded with inert gas which does not react with metal and the rate of flow of inert gas is kept enough to keep oxygen of air away from the hot molten pool

and hot area.
For welding non-ferrous (A1-alloys; Cu-alloys, high nickel alloys) argon or argon-helium gas mixture may be used. Titanium needs only argon gas shielding. No flux is needed. It gives high welding speed. This process can be easily made automatic.

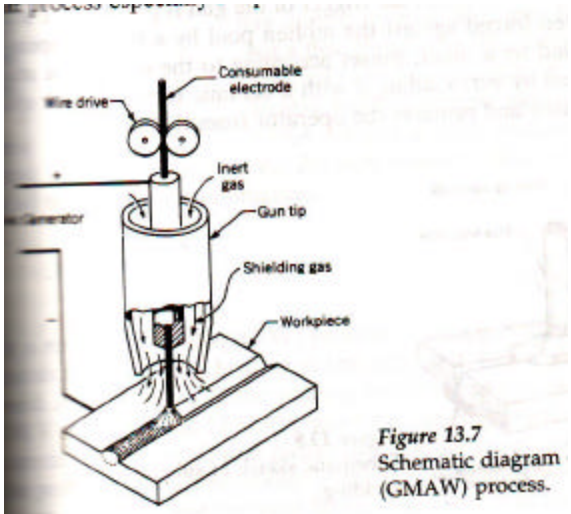
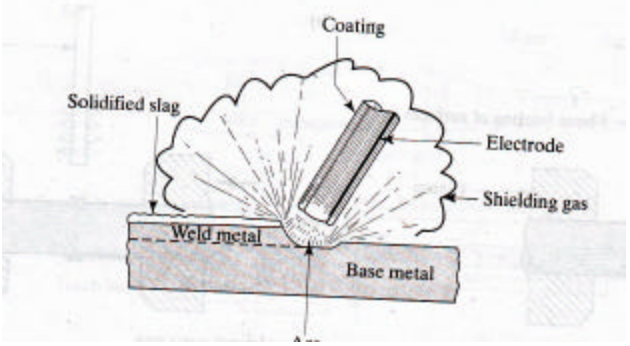



*Figure 13.7* Schematic diagram (GMAW) process.

***Q.15. What do you understand by gas welding?***
**Ans.** Gas welding process consists of joining the metals with the help f high temperature flame and filler rod. High temperature flame is generated by combusting a mixture of two gases (Oxygen + Acetylene) and the flame is used to heat the work pieces and filler rod fills the gap. The filler rod melts along with the parent metal and fills the parent metal cavity.
The mixture of these two gases (oxygen and acetylene) is commonly used for gas welding purpose. However, the mixture of other combustible gases can also be used. The production of gases in this reference is very important.

***Welding :-***
This is the oldest of all the methods of weldingprocesses. Generally this process is used in the blacksmith shop. In it, the work pieces are placed in a forge or other appropriate furnace and heated within the area to be joined, to the condition of plastic ity, on the surface.
**Q.16. Explain, what is an electric arc welding.**
**Ans.** Metal are welding process is the most extensively employed method of joining metal parts. The source of heat is an electric arc. When two conductors of an electrical circuit (AC or DC) are brought together and separated by a small air-gap (2 to 4 mm) such that the current continues

to flow through the gaseous medium, an electric arc is produced. Electrical energy at the arc is converted into heat energy producing a temperature of about 3700$_o$C at the centre of the arc. The intense heat given out by the arc raises the temperature of the parent metal, which forms a pool of molten metal. The metal at the end of metal electrode is melted and transferred into the pool in the shape of globules. The added molten metal fills the gap between the parts of the parent metal and forms a permanent joint.




**Q.17. Describe the following methods and their applications.**
**(1) Tig welding**
**(2) MIG Welding**
**Q.27. Describe in brief the equipment required for oral acetylene welding.**
**Ans.** Oxy-acetylene gas welding equipment comprises of the following :
1. ***Oxygen cylinder :*** It is used to store the compressed oxygen gas. It is black in colour and is made of steel.
2. ***Acetylene cylinder :*** It is used to store acetylene gas. It is maroon in colour and is made of steel.
3. ***Blow-pipe :*** It is used to mix oxygen and acetylene gases and then to supply the gas mixture to a nozzle connected to its end. The blow-pipe (also sometimes known as welding torch) has two controlling devices, one for controlling the flow of acetylene and the other for oxygen entering a chamber, called mixing chamber.
**4. *Nozzle :*** It is a device screwed to the end of the blowpipe. It is used to permit the flow of oxy-acetylene gas mixture from the mixing chamber of the blow-pipe to the tip of the nozzle to facilitate burning. The nozzles are interchangeable, as it is the size of the nozzle outlet, which determines the gas consumption, and so the size of the gas flame. A nozzle having small-bore diameter is used for fast melting.
**5. *Pressure-reducing valve :*** Pressure-reducing valve is located on the top of the gas cylinder. Its function is to reduce the pressure of the gas inside the cylinder to a pressure suitable for welding. The regulator located on

the top of the oxygen cylinder is called oxygen pressurereducing valve and the one located on the top of the acetylene cylinder is called acetylene pressure-reducing valve.

**6.** ***Pressure gauges*** *:* Each gas cylinder is provided with two pressure gauges, one for registering the pressure of the gas inside the cylinder and the other for indicating the pressure of the gas supplied to the blow-pipe.

**7.** ***Hose and hose-fittings*** *:* The hose, connecting the outlet of the pressure-reducing valve and the blowpipe, should be strong, durable, flexible, non-porous and light. The hose for the supply of oxygen is green in colour and that for the supply of acetylene is red in colour. The hoses are made of piles of rubber covered with fabric. Hose-fittings are provided at the ends of the hoses for attachment to the blowpipe and the outlet of the pressure-reducing valves.

**8.** ***Welding goggles*** *:* Goggles with tinted glasses is used during welding to protect the eyes from injury.

**9.** ***Welding gloves*** *:* It is used to protect the hands from the heat and metal splashes.

**10.** ***Spark lighter*** *:* It is used to provide a convenient and instant means for lighting the blowpipe.

**11.** ***Chipping hammer*** *:* It is made of steel and is used to remove metal oxides from welded bead.

**12.** ***Wire-brush*** *:* Its function is to clean surfaces of a joint before and after welding.

**Q.28. How are the different parts prepared before riveting and how is riveting done to join those parts?**

**Ans.** In preparing the joint the primary requirement is the correct drilling of holes in the plates. Of course in thin plates they may be punched. If the holes are punched their edges get hardened and may result in cracks all round the periphery. The safer practice is therefore, to punch the holes slightly smaller in size than required and then enlarge them to the correct size by means of drilling and reaming. Drilling of holes is preferably carried out, as for as possible, by holding the plates together in position. For this a fairly high degree of skill is required of the marker, as the correct drilling of holes will be possible only when the holes will be accurately set out and marked. A common practice, therefore, is to first mark and drills all the holes in one plate and one hole in the other plate. The two plates are then secured either by riveting or bolting in this common hole and the other end is suitably clamped. The plate containing the holes is kept on the top and the other one under it. Holes in the lower plate are then drilled through these holes which act as guides for correct location and drilling of holes in the lower plate. If countersunk rivets are to be used, the holes should be provided with proper chamber to accommodate the counter-sunk head. The operation is known as *countersinking.*

After the above operation is over the rivets are heated up, passed into the drilled holes and the head formed at the free end. Care should be taken in selecting the correct length of the rivet as too large a rivet will bend during hammering and if it is too short in length the head formed will be undersize. The rivets should be heated sufficiently so that they attain the forging heat and then the operation performed quickly. During riveting a snap should be used to support the rivet by accommodating its head inside the cavity at its end and then a similar tool should be used on the other side of the rivet to form the head. However, if a counter-sunk head rivet is being used it should be performed at the other end.

**Q.29. Describe with the help of neat sketch the principal of spot welding.**

**Q.30. Describe fully the method of oxy acetylene cutting?**

**Ans.** It is a chemical process in the sense that the metal, at the portion where it is to be cut, is actually made to oxidise under the action of the flame. All ferrous metals can be cut by means of an oxy-acetylene flame. The metal to be cut is heated up to red heat by means of the flame and then a sharp stream of oxygen is made to this electrode and the work-piece and shielding is provided by the gas evolved during combustion of flux plus the $CO_2$ gas fed around the arc for this purpose.

While welding with flux coated electrode a magnetized granular flux is fed into the arc through the gun nozzle, and there it attaches itself to the electrode. The coating so provided protects the electrode against the atmospheric contamination by the shield of $CO_2$ gas. The method of feeding the electrode wire into the arc is again similar to that in standard MIG welding process described in Art.22.37.above. Thus, it will be observed that the $CO_2$ MIG welding process is exactly similar to the *standard* MIG *welding* process except the electrode wire uses either magnetized flux of as its core.

Main advantages of $CO_2$ MIG welding process are :

1.It is a fast welding process.

2.The deposition rate is quite high.

3.Penetration of the arc is deep.

4.Minimum edge preparation is required, particularly in butt joints.

**Q.31. Explain the process of soldering and brazing.**

**Ans.** ***Soldering :-***

***Brazing*** *:-* The process of joining two metal surfaces by heating and adding a non-ferrous alloy with melting point above $400^0$C is known as brazing.

Process :- The surfaces to be joined are cleaned from all oil, dirt or oxides. Then both the surfaces are placed in joining position. Flux is sprinkled or placed on it. The

heat is given to the surface and the filler metal. The molten filler metal flows to the surfaces to be joined. On cooling brazing joint is formed. The filler metals used are copper, copper alloy, silver alloy and aluminium alloys. In brazing the filler metal melts but the surfaces to be joined remain un-melted. The various methods used to melt the filler metal and flux are

***(i) Gas torch brazing :*** It is a commonly used process in which oxy-acetylene torch is used.

***(ii) Furnace brazing :*** The surfaces to be joined are placed in a furnace already hot.

***(iii) Dip Brazing :*** The surfaces to be joined are dipped in molten filler metal.

***(iv) Electrical brazing :*** In electric brazing heat is produced by resistance or induction method.

**Applications:**

Brazing is used for electrical items, radiators, heat exchangers, pipes & pipe fittings and tool tips.