Safety

Objectives: At the end of this lesson you shall be able to
- **state the importance of safety in welding shop**
- **list the general safety precautions to be observed in welding shop.**

Safety

Welding can be dangerous and unhealthy if the proper precautions are not taken. However, using new technology and proper protection greatly reduces risks of injury and death associated with welding. Since many common welding procedures involve an open electric arc or flame, the risk of burns and fire is significant, that is why it is classified as a hot work process.

To prevent injury, welders wear personal protective equipment in the form of heavy leather gloves and protective long-sleeve jackets to avoid exposure to extreme heat and flames. Additionally, the brightness of the weld area leads to a condition called arc eye or flash burns in which ultraviolet light causes inflammation of the cornea and can burn the retinas of the eyes. Goggles and welding helmets with dark UV-filtering face plates are worn to prevent this exposure.

Since the 2000s, some helmets have included a face plate which instantly darkens upon exposure to the intense UV light. To protect bystanders, the welding area is often surrounded with translucent welding curtains. These curtains, made of a polyvinyl chloride plastic film, shield people outside the welding area from the UV light of the electric arc, but can not replace the filter glass used in helmets.

Welders are often exposed to dangerous gases and particulate matter. Processes like flux-cored arc welding and shielded metal arc welding produce smoke containing particles of various types of oxides. The size of the particles in question tends to influence the toxicity of the fumes, with smaller particles presenting a greater danger. This is because smaller particles have the ability to cross the blood brain barrier. Fumes and gases, such as carbon-di-oxide, ozone, and fumes containing heavy metals, can be dangerous to welders lacking proper ventilation and training. Exposure to manganese welding fumes, for example, even at low levels (<0.2 mg/m^3) may lead to neurological problems or to damage to the lungs, liver, kidneys, or central nervous system. Nano particles can become trapped in the alveolar macrophages of the lungs and induce pulmonary fibrosis. The use of compressed gases and flames in many welding processes possess an explosion and fire risk. Some common precautions include limiting the amount of oxygen in the air, and keeping combustible materials away from the workplace.

General safety

- To prevent injury to personnel, extreme caution should be exercised when using any types of welding equipment. Injury can result from fire, explosions, electric shock, or harmful agents. Both the general and specific safety precautions listed below must be strictly observed by workers who weld or cut metals.
- Do not permit unauthorized persons to use welding or cutting equipment.
- Do not weld in a building with wooden floors, unless the floors are protected from hot metal by means of fire resistant fabric, sand, or other fireproof material. Be sure that hot sparks or hot metal will not fall on the operator or on any welding equipment components.
- Remove all flammable material, such as cotton, oil, gasoline, etc., from the vicinity of welding.
- Before welding or cutting, warm those in close proximity who are not protected to wear proper clothing or goggles.
- Remove any assembled parts from the component being welded that may become warped or otherwise damaged by the welding process.
- Do not leave hot rejected electrode stubs, steel scrap, or tools on the floor or around the welding equipment. Accidents and/or fires may occur.
- Keep a suitable fire extinguisher nearby at all times. Ensure the fire extinguisher is in operable condition.
- Mark all hot metal after welding operations are completed. Soapstone is commonly used for this purpose.

Safety precautions in handling gas welding plant

Objectives : At the end of this lesson you shall be able to
- **state the general safety precautions in oxy-acetylene plants.**
- **state the safety rules for handling gas cylinders**
- **state the safety practices for handling gas regulators and hose-pipes.**
- **state the safety precautions related to blowpipe operations.**

To be accident-free, one must know the safety rules first and then practise them as well. As we know can 'accident starts when safety ends'.

Ignorance of rules is no excuse!

In gas welding, the welder must follow the safety precautions in handling gas welding plants and flame-setting to keep himself and others safe.

Safety precautions are always based on good common sense.

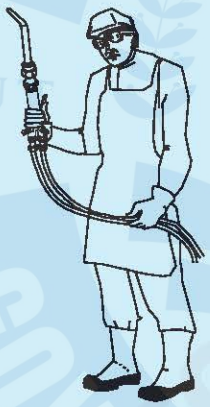
The following precautions are to be observed, to keep a gas welder accident-free.

General safety

Do not use lubricants (oil or grease) in any part or assembly of a gas welding plant. It may cause explosion.

Keep all flammable material away from the welding area. Always wear goggles with filter lens during gas welding. (Fig 1)

Fig 1



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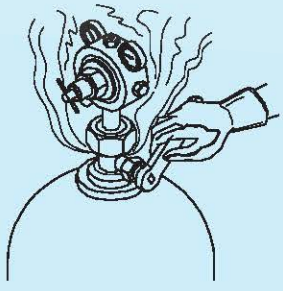
Always wear fire resistant clothes, asbestos gloves and apron.

Never wear nylon, greasy and torn clothes while welding.

Whenever a leakage is noticed rectify it immediately to avoid fire hazards. (Fig 2)

Fig 2



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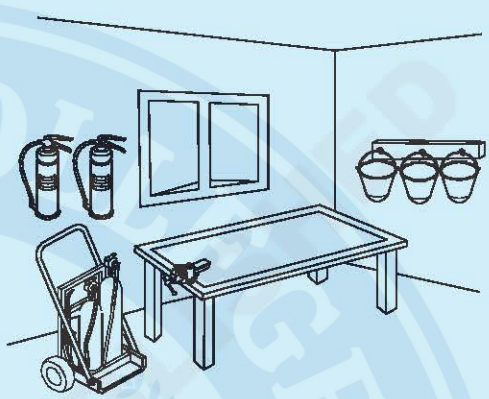
Even a small leakage can cause serious accidents.

Always keep fire-fighting equipment handy and in working order to put out fires. (Fig 3)

Keep the work area free from any form of fire.

Fig 3



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Safety precautions before gas welding

Safety for cylinders.

Do not roll gas cylinders or use them as rollers.

Use a trolley to carry the cylinders.

Close the cylinder valves when not in use or empty.

Keep full and empty cylinders separately.

Always open the cylinder valves slowly, not more than one and a half turn.

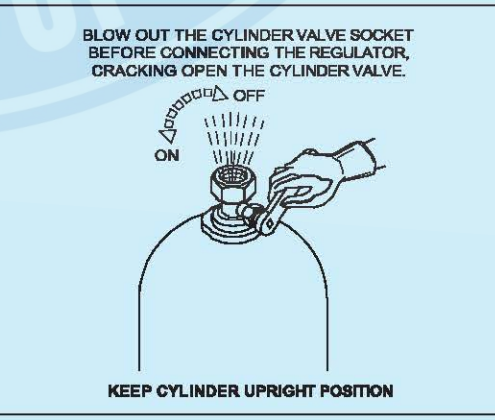
Use the correct cylinder keys to open the cylinders.

Do not remove the cylinder keys from the cylinders while welding. It will help to close the cylinders QUICKLY in the case of a back-fire or flash-back.

Always use the cylinders in an upright position for easy handling and safety.

Always crack the cylinder valves to clean the valve sockets before attaching regulators. (Fig 4)

Fig 4



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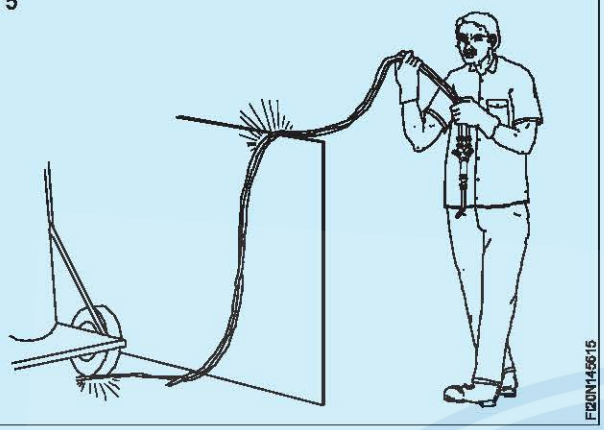
Safety for rubber hose pipes (Fig 5)

Fig 5



Inspect the rubber hose pipes periodically and replace the damaged ones.

Do not use odd bits of hose pipes / tubes.

Do not replace the hose pipes for acetylene with the ones used for oxygen.

Always use a black hose pipes for oxygen and maroon hosepipes for acetylene.

Safety for regulators

Prevent hammer blows to the gas cylinders and ensure that water, dust and oil do not settle on the cylinders.

One right hand threaded connection for oxygen and left hand threaded connection for acetylene.

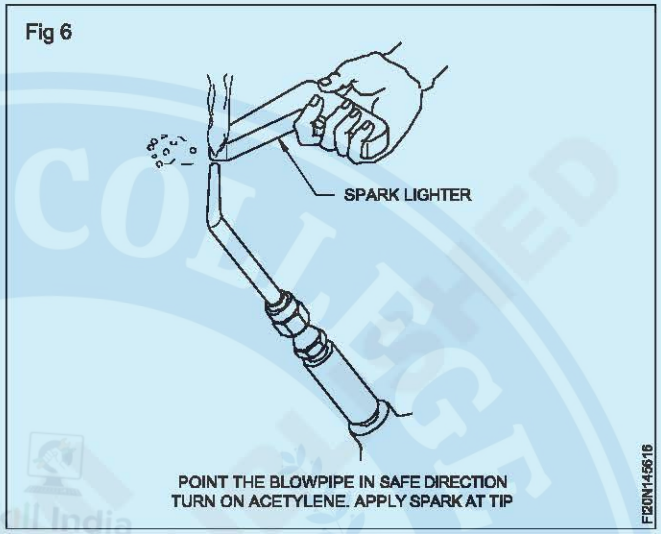
Safety for blowpipes

When a blowpipe is not in use put out the flame and place the blowpipe in a safe place.

When flame snaps out and backfires, quickly shut both the blowpipe valves (oxygen first) and dip in water.

While igniting the flame, point the blowpipe nozzle in a safe direction. (Fig 6)

Fig 6



While extinguishing the flame, shut off the acetylene valve first and then the oxygen valve to avoid a backfire.

Safety precautions before, during, after arc welding

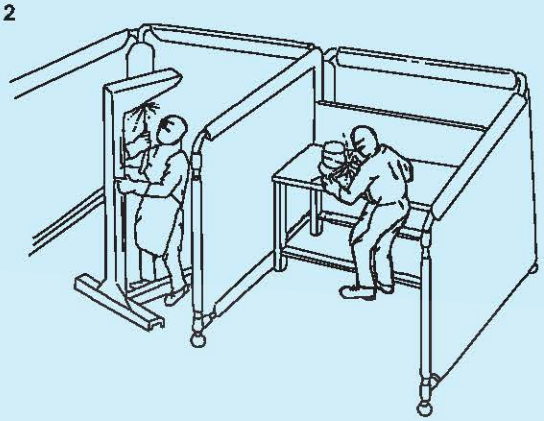
Objective : At the end of this lesson you shall be able to
- **state the precautions necessary in arc-welding.**

Safety precautions

- Never stand on a damp or wet place while arc-welding.
- Always wear all the safety apparels (gloves, apron, sleeves, shoes). (Fig 1)
- Use welding and a chipping screen during welding and chipping respectively, for the protection of the eyes and the face.
- Switch off the machine when not in use.
- Keep the clothes free from oil and grease.
- Use tongs while handling hot metals.
- Do not carry matches or petrol lighters in your pocket during arc-welding.
- Protect the outsiders from radiation and reflection of rays, by using portable screens or welding booths. (Fig 2)
- Keep the welding area free from moisture and flammable material.
- Do not try to rectify electrical faults yourself; call an electrician.

Fig 1

Fig 2



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- Do not throw the electrode stubs on the floor. Put them in a container. (Fig 3)
- Use exhaust fans to remove the arc-welding smoke and fumes. (Fig 4)
- Safety precautions after gas and electric welding after working gas welding and gas cutting bleed the lines to take pressure off regulators, neatly coil the hoses and replace equipment.
- Store hoses, torches, blow pipes regulators safety in proper place.
- Store away the gas cylinders from in flammable and combustible materials.
- After electric welding operations are completed the welder will mark the hot metal or provide some other means of warning other workers.

Fig 3

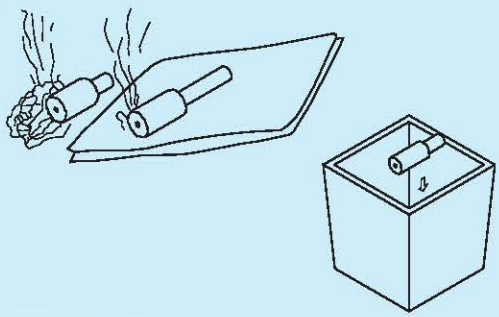

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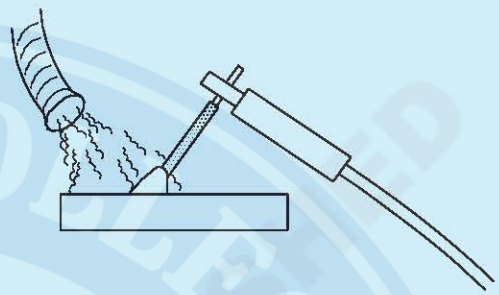
Fig 4



EXHAUST DUCTS CAN CAPTURE FUMES AND GASES

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- Welding machines will be disconnected from the power source.
- Disconnect the welding cables from welding equipment.
- Neatly coil the cable and kept in place safety.
- Place and store electrode holder and other hand tools safely.

Safety equipment and their uses in welding

Objectives : At the end of this lesson you shall be able to

- **Name the safety apparels and accessories used in arc welding**
- **Select the safety apparels and accessories to protect from burns and injuries**
- **learn how to protect yourself and others from the effect of harmful arc rays and toxic fumes**
- **select the shielding glass for eye and face protection.**

Non-fusion welding: This is a method of welding in which similar or dissimilar metals are joined together without melting the edges of the base metal by using a low melting point filler rod but without the application of pressure.

Example: Soldering, Brazing and Bronze welding.

During arc welding the welder is exposed to hazards such injury due to harmful rays (ultra violet and infra red rays)of the arc, burns due to excessive heat from the arc and contact with hot jobs, electric shock, toxic fumes, flying hot spatters and slag particles and objects falling on the feet.

The following safety apparels and accessories are used to protect the welder and other persons working near the welding area from the above mentioned hazards.

1 Safety apparels
   - a Leather apron
   - b Leather gloves
   - c Leather cape with sleeves
   - d Industrial safety shoes

2 a Hand screen
   - b Adjustable helmet
   - C Portable fire proof canvas screens

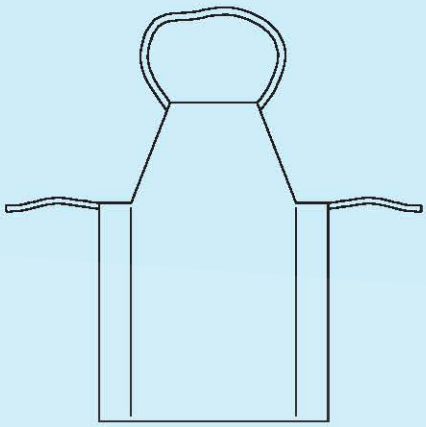
3 Chipping/grinding goggles

4 Respirator and exhaust ducting

The leather apron, glooves, cape with sleeves and leg guard Fig 1,2,3 and 4 are used to protect the body, hands, arms, neck and chest of the welder from the heat radiation and hot spatters from the arc and also from the hot slag particles flying from the weld joint during chipping off the solidified slag.

All the above safety apparels should not be loose while wearing them and suitable size has to be selected by the welder.

Fig 1



APRON

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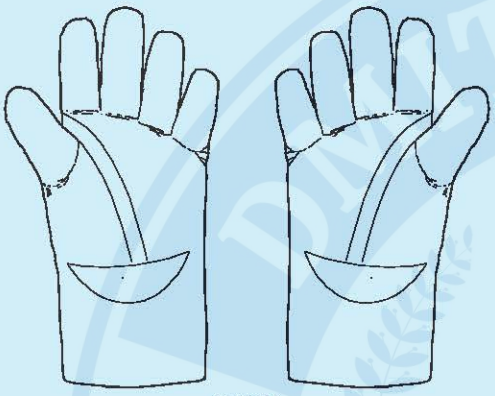
Fig 2



GLOVES

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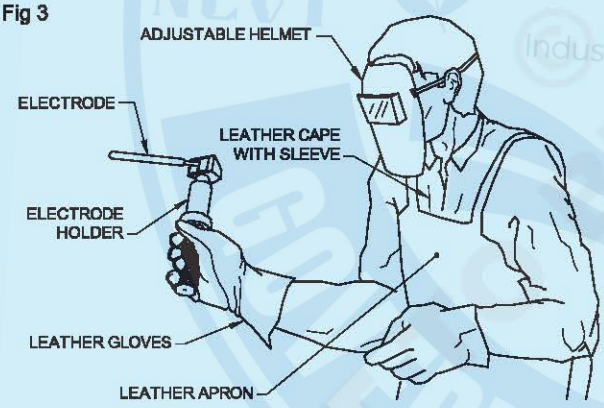
Fig 3



CAPE WITH SLEEVES

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Fig 4

LEG GUARDS

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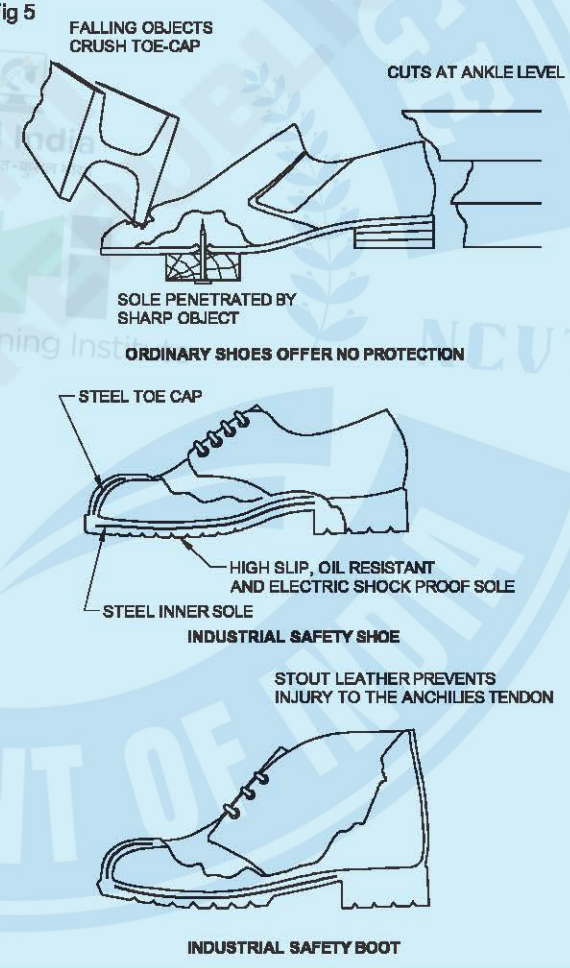
Fig 5



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The industrial safety boot (Fig5)is used to avoid slipping. injury to the toes and ankle of the foot. It also protects the welder from the electric shock as the sole of the shoe is specially made of shock resistant material.

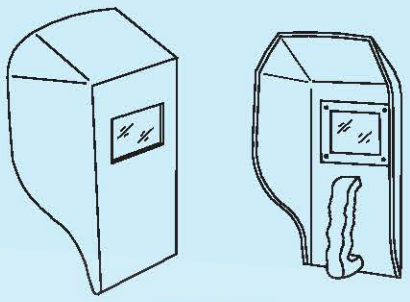
Welding hand screens and helmet: These are used to protect the eyes and face of a welder from arc radiation and sparks during arc welding.

A hand screen is designed to hold in hand (Fig 6)

A helmet screen is designed to wear on the head.(Fig 7)

Clear glasses are fitted on each side of the coloured glass to protect it from weld spatters. (Fig 8)

Fig 6



HAND SCREEN

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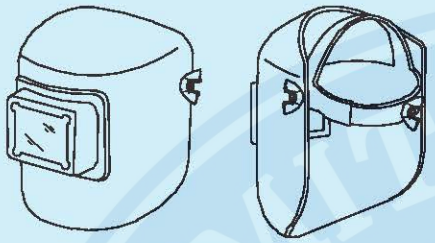
Fig 7



WELDING HELMET

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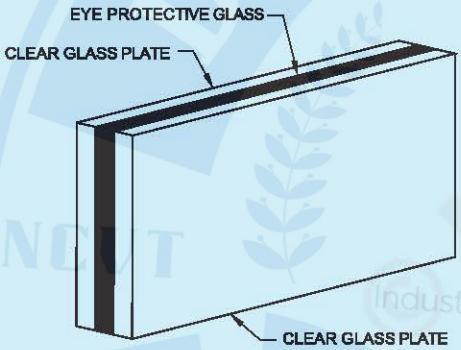
Fig 8



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The helmet screen provides better protection and allows the welder to use his both hands freely.

Coloured (filter) glasses are made in various shades depending on the welding current ranges used. (Table 1)

Table 1

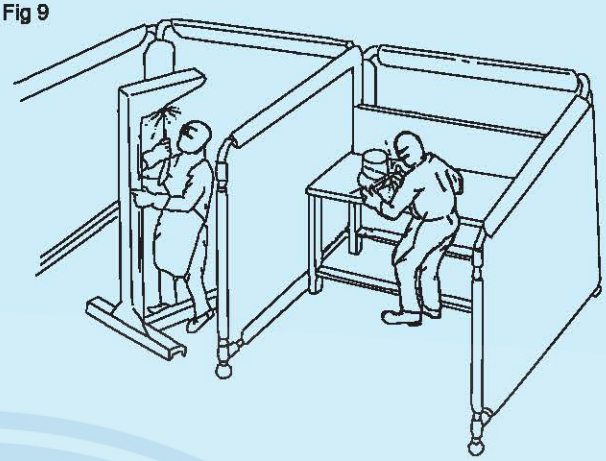
Recommendations of filter glasses for manual metal arc welding

Shade No of coloured glass	Range of welding current current in amperes
8-9	Up to 100
10-11	100 to 300
12-14	Above 300

Portable fire proof canvas screens. Fig 9 are used to protect the persons who work near the welding area from arc flashes

Plain goggles are used to protect the eyes while chipping the slag or grinding the job. Fig 10

Fig 9



PORTABLE FIREPROOF CANVAS SCREENING

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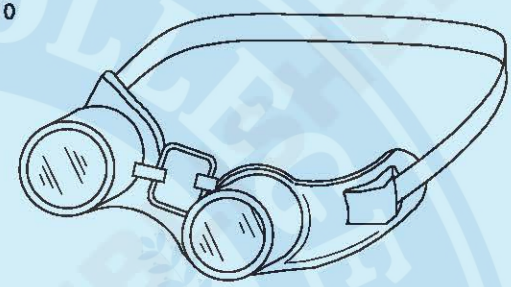
Fig 10



SAFETY GOGGLES

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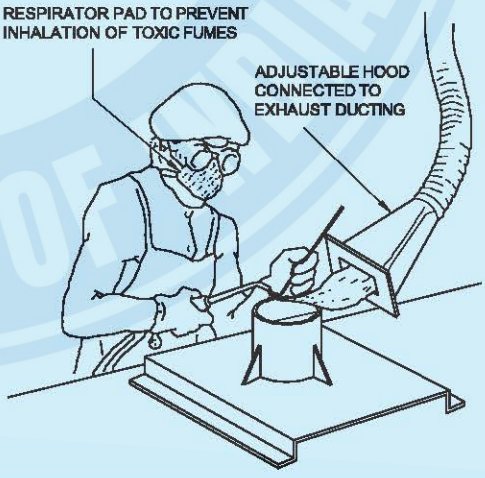
It is made of Bakelite frame fitted with clear glasses and an elastic band to hold it securely on the operator's head.

It is designed for comfortable fit, proper ventilation and full protection from all sides.

Sometimes toxic fumes and heavy smoke may be liberated (given out) from the weld while welding non-ferrous alloys like brass etc. Use a respirator and use exhaust ducts and fans near the weld area to avoid inhaling the toxic fumes and smoke. Fig 11.

Fig 11



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Inhaling toxic fumes will make the welder to become unconscious and fall on the hot welded job/ on the floor. This causes burns or injury.

Gas welding equipment and accessories

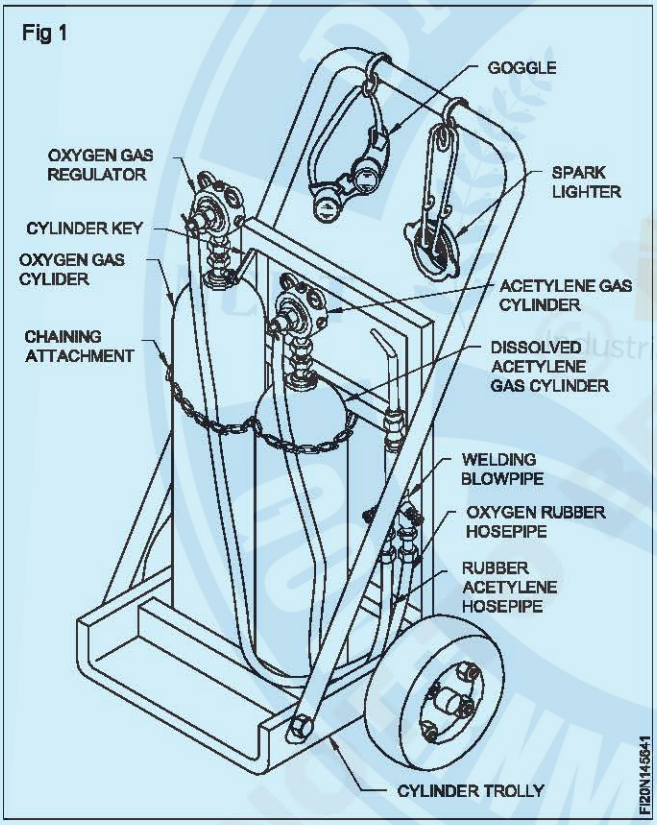
Objectives : At the end of this lesson you shall be able to
- **brief the process of gas welding**
- **list the equipment used in gas welding**
- **state the functions of each equipment used in gas welding.**

Oxy-acetylene welding, popularly known as gas welding is simple, cheap and easy to operate. The heat input can be closely controlled to weld even thin, tiny components. In oxy-acetylene welding process, the metal is heated by an intense flame (3300°C) produced by burning proper quantity of oxygen and acetylene at the tip of welding torch. The flame is directed towards the weld location to melt the metal to be joined and are fused together thus producing weld.

Gas welding equipment

The principle function of the oxy-acetylene welding equipment is to supply the oxy-acetylene gas mixture in the correct ratio to the welding tip at the correct rate of flow and velocity. (Fig 1)

Fig 1

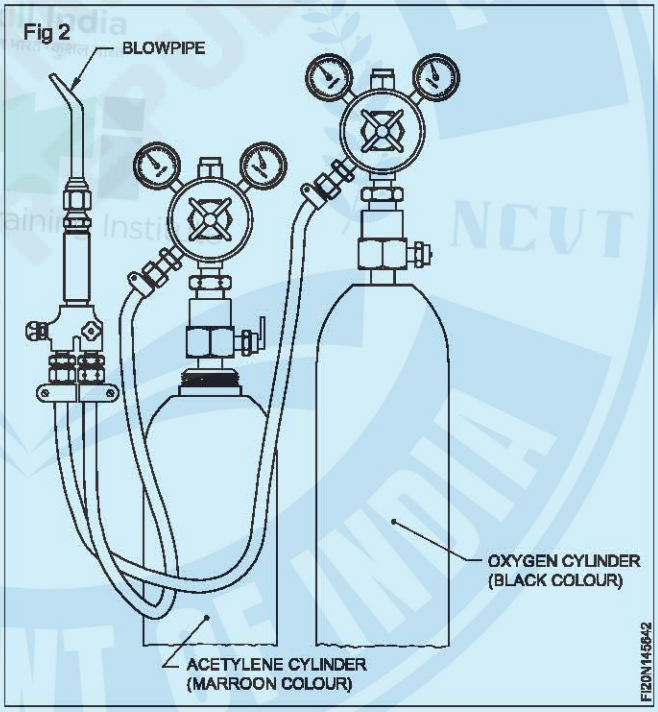


The basic equipment used to carry out gas welding are

- Oxygen gas cylinder
- Acetylene gas cylinder
- Oxygen pressure regular
- Oxygen gas hose (black/green)
- Acetylene gas hose (Maroon)
- Welding torch or blow pipe with a set of nozzles and gas lighter.
- Trolleys for transportation of oxygen and acetylene cylinder.
- A set of keys and spanners
- Filler rod and fluxes
- Protective clothing for welder (Leather apron, gloves, goggles, etc)

Oxygen gas cylinders: The oxygen gas required for gas welding is stored in bottle-shaped cylinders. These cylinders are painted in black colour. (Fig 2) Oxygen cylinders can store gas to a capacity of $7m^3$ with the pressure ranging between 120 to 150 kg/cm^2. Oxygen gas cylinder valves are right hand threaded.

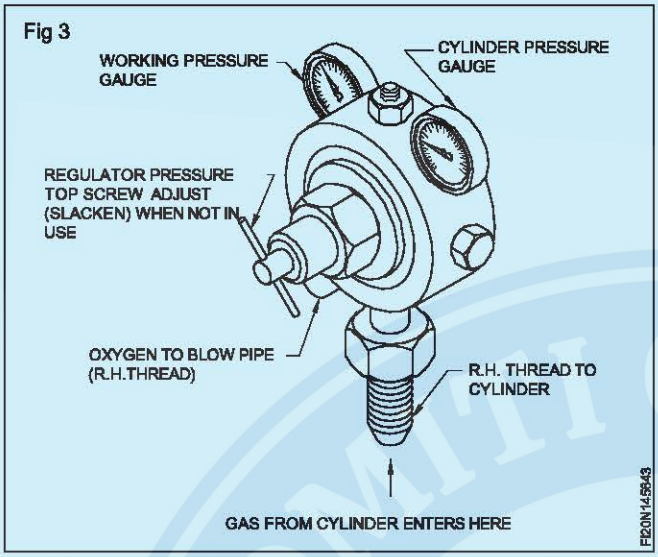
Fig 2



Dissolved acetylene cylinders: The acetylene gas used in gas welding is stored in steel bottles (cylinders) painted in maroon colour. The normal storing capacity of storing acetylene in dissolved state is $6m^3$ with the pressure ranging between 15-16 kg/cm^2.

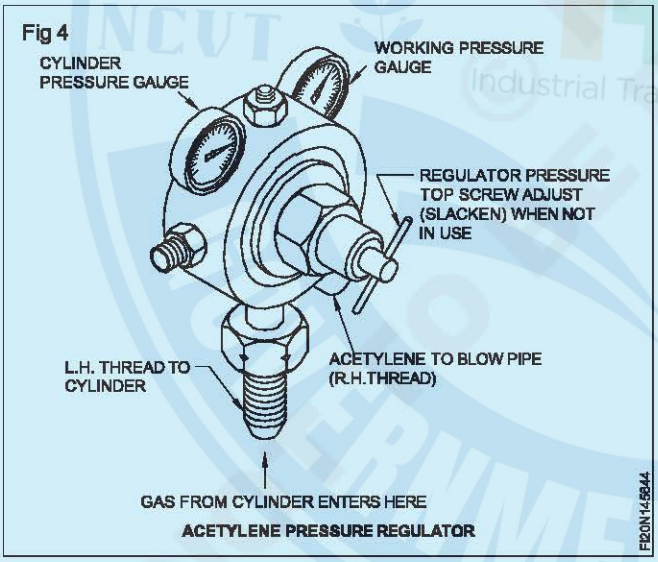
Oxygen pressure regulator: This is used to reduce the oxygen cylinder gas pressure according to the required working pressure and to control the flow of oxygen at a constant rate to the blowpipe. The threaded connections are right hand threaded. (Fig 3)

Fig 3



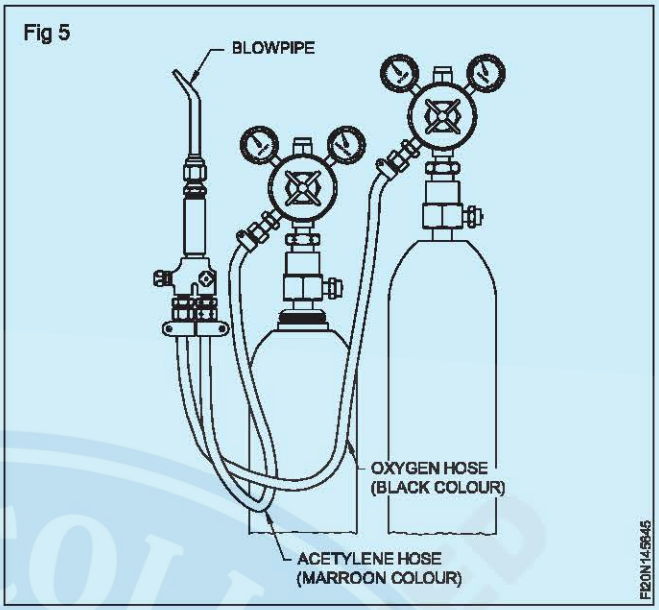
Acetylene regulator: As with the case of oxygen regulator this also is used to reduce the cylinder gas pressure to the required working pressure and to control the flow of acetylene gas at a constant rate to the blowpipe. The threaded connections are left handed. For quickly identifying the acetylene regulator, a groove is cut at the corners of the nut.(Fig 4)

Fig 4



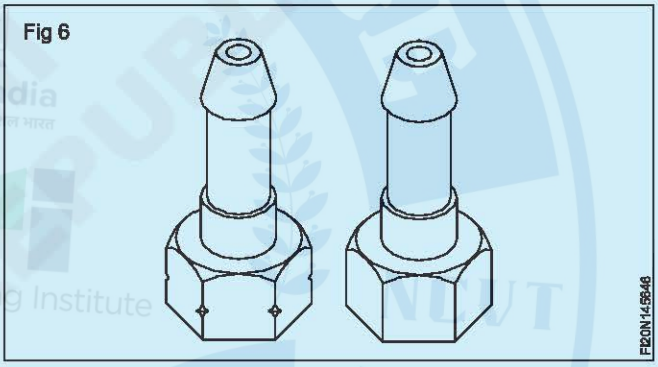
Rubber hose-pipes and connections: These are used to carry gas from the regulator to the blowpipe. These are made of strong canvas rubber having good flexibility. Hose-pipes which carry oxygen are black in colour and the acetylene hoses are of maroon colour. (Fig 5)

Fig 5



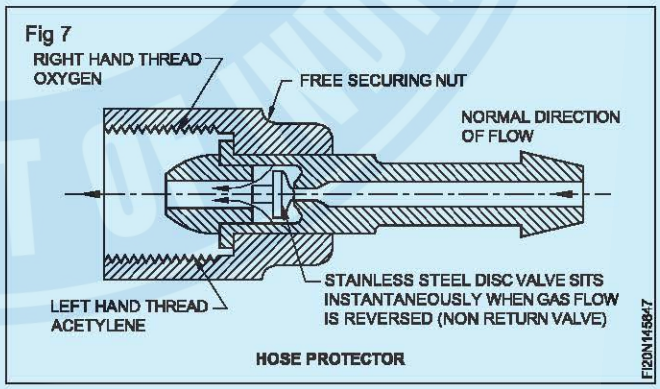
Rubber hoses are connected to regulators with the help of unions. These unions are right hand threaded for oxygen and left hand threaded for acetylene. Acetylene hose unions have a groove cut on the corners. (Fig 6)

Fig 6



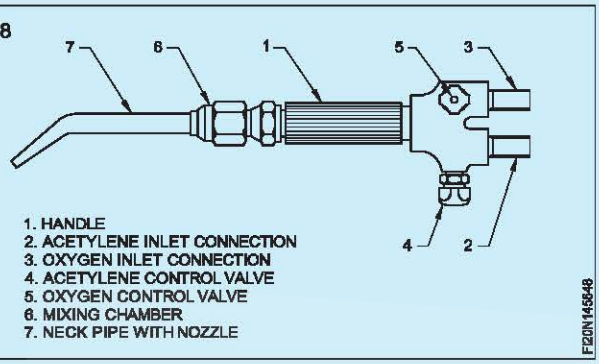
At the blowpipe end of the rubber hoses hose-protectors are fitted. The hose protectors are in the shape of a connecting union and have a non-return disc fitted inside to protect from flashback and backfire during welding. (Fig 7)

Fig 7



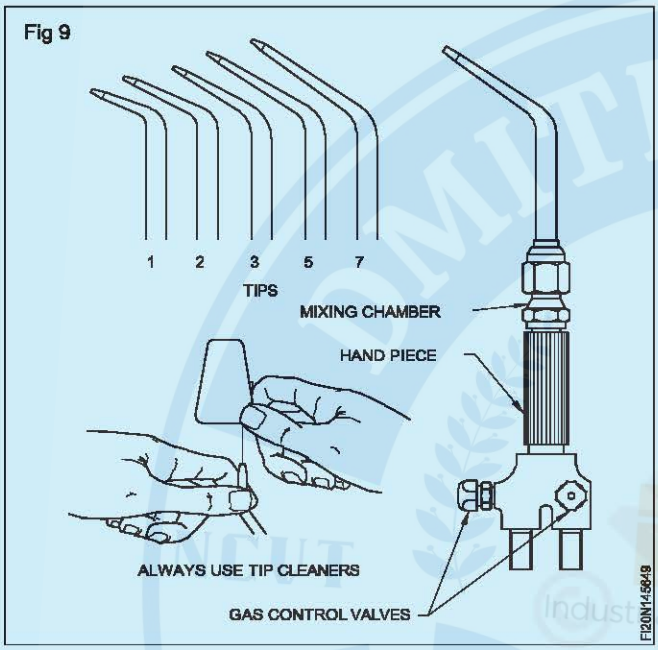
Blowpipe and nozzle: Blowpipes are used to control and mix the oxygen and acetylene gases to the required proportion. (Fig 8)

Fig 8



A set of interchangeable nozzles/tips of different sizes is available to produce smaller or bigger flames. (Fig 9)

Fig 9



The size of the nozzle varies according to the thickness of the plates to be welded. (Table 1)

TABLE 1

Plate thickness (mm)	Nozzle size (Number)
0.8	1
1.2	2
1.6	3
2.4	5
3.0	7
4.0	10
5.0	13
6.0	18
8.0	25
10.0	35
12.0	45
19.0	55
25.0	70
Over 25.0	90

Arc welding machines and accessories

Objectives : At the end of this lesson you shall be able to
- **state the function of arc-welding machines**
- **name the different types of arc-welding machines.**

In the arc-welding process, the source of heat is electricity (high ampere low voltage). This heat is supplied by the arc-welding machine which is the power source.

Function (Fig 1)

The equipment is used to

- provide A.C. or D.C. supply for arc welding
- change the high voltage of main supply (A.C.) to low voltage, heavy current (A.C. or D.C.) suitable for arc welding
- control and adjust the required supply of current during arc welding

Types (Fig 2)

Basically the power sources are

- alternating current (A.C.) welding machine
- direct current (D.C.) welding machine.

Fig 1

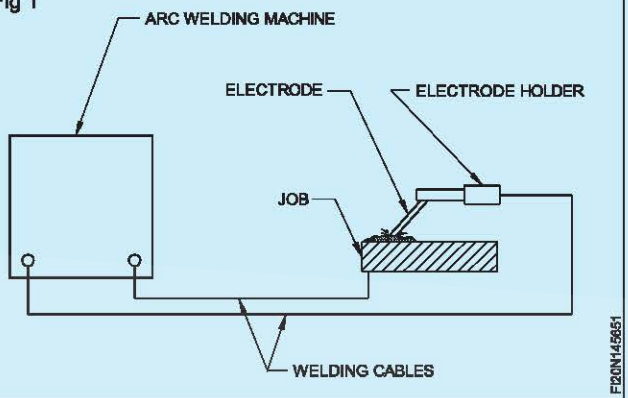
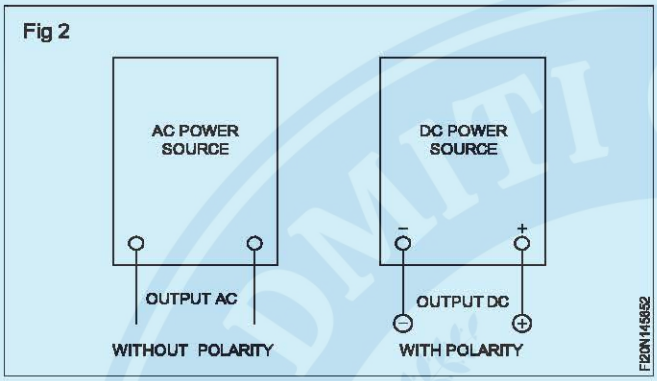


Fig 2



These may be further classified as

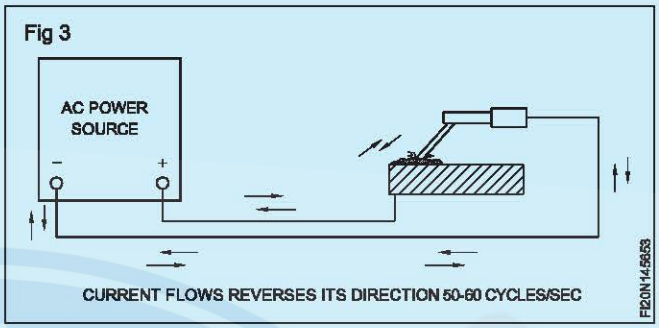
- D.C.Machines
- motor generator set
- engine generator set
- rectifier sets.

A.C. Machines

- Transformer sets

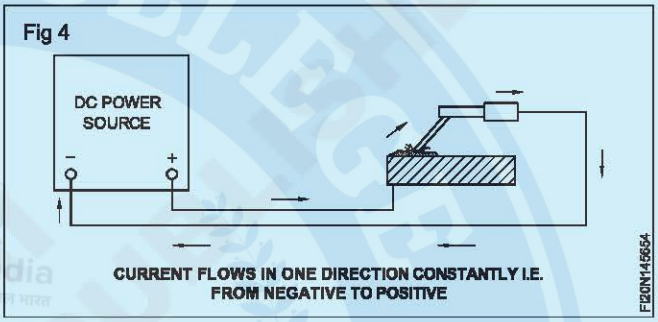
A.C. means Alternating Current. It changes or reverses its direction of flow 50-60 cycles per second. (Fig 3)

Fig 3



D.C. means Direct Current. It flows steadily and constantly in one direction. (Fig 4)

Fig 4



A.C. welding transformer and welding generator

Objectives : At the end of this lesson you shall be able to

- **state the features of A.C. welding transformers**
- **state the advantages and disadvantages of A.C. welding machines.**

A.C. welding transformer

An A.C. welding transformer is a type of A.C. welding machine which converts the A.C. main supply into an A.C. welding supply. (Figs 1 and 2)

The A.C. main supply has high voltage - low ampere.

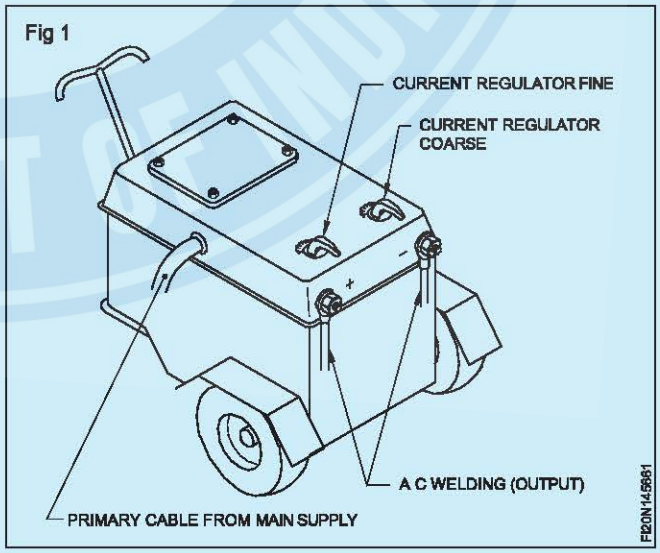
The A.C. welding supply has high ampere - low voltage.

It is a STEP-DOWN transformer which reduces the main supply voltage (220 or 440 volts) to the welding supply open circuit voltage (O.C.V.), between 40 and 100 volts.

It increases the main supply low current to the required output welding current in a hundred or thousand amperes.

The A.C. welding machine cannot be operated without the A.C. main supply.

Fig 1



Advantages

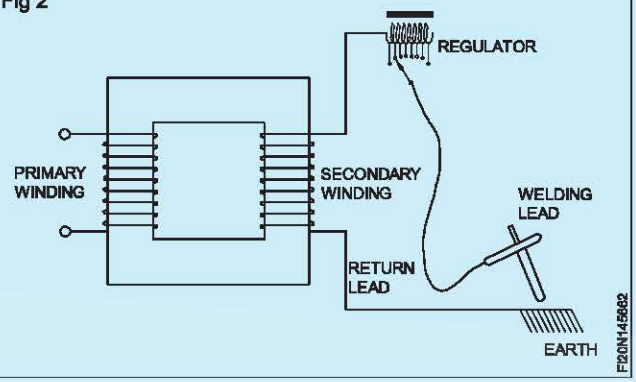
- Less initial cost
- Less maintenance cost
- Freedom from arc blow.

Magnetic effect which disturbs the arc is called the arc blow.

Disadvantages

- Not suitable for the welding of non-ferrous metals, light coated and special electrodes.
- The A.C. cannot be used without special safety precautions.

Fig 2



D.C. Arc-welding machines

Objectives : At the end of this lesson you shall be able to
- **state the features of a D.C. welding machine**
- **state its advantages and disadvantages.**

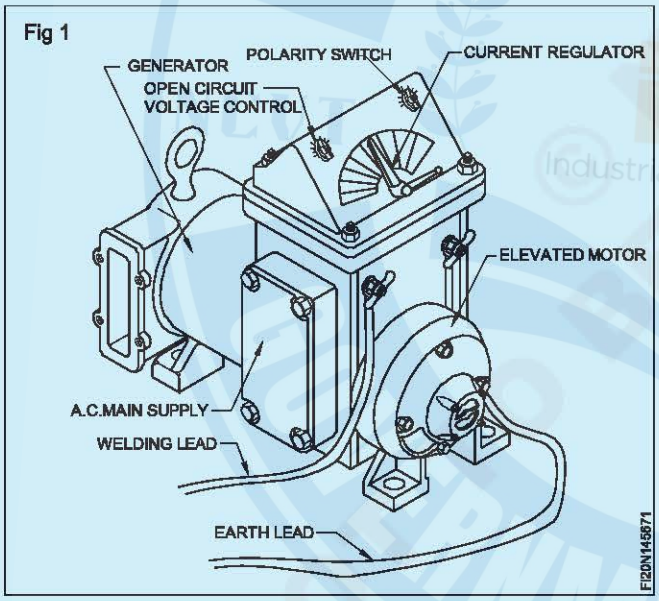
Motor generator set (Fig 1)

It is used to generate D.C. for arc-welding.

The generator is driven by an A.C. or D.C. motor.

Main supply is a must to run the machine.

Fig 1



Engine generator set (Fig 2)

Equipment is similar to the motor generator set except that the generator is driven by a petrol or diesel engine.

Its running and maintenance charges are higher.

It can be used anywhere in field work, away from electric lines.

Rectifier set (Fig 3)

It is used to convert A.C. into D.C. welding supply.

Basically it is an A.C. welding transformer. The output of the transformer is connected with a rectifier to change the A.C. into D.C.

Fig 2

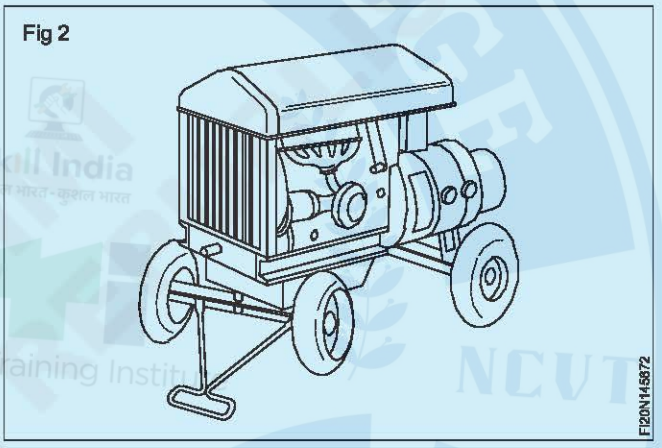
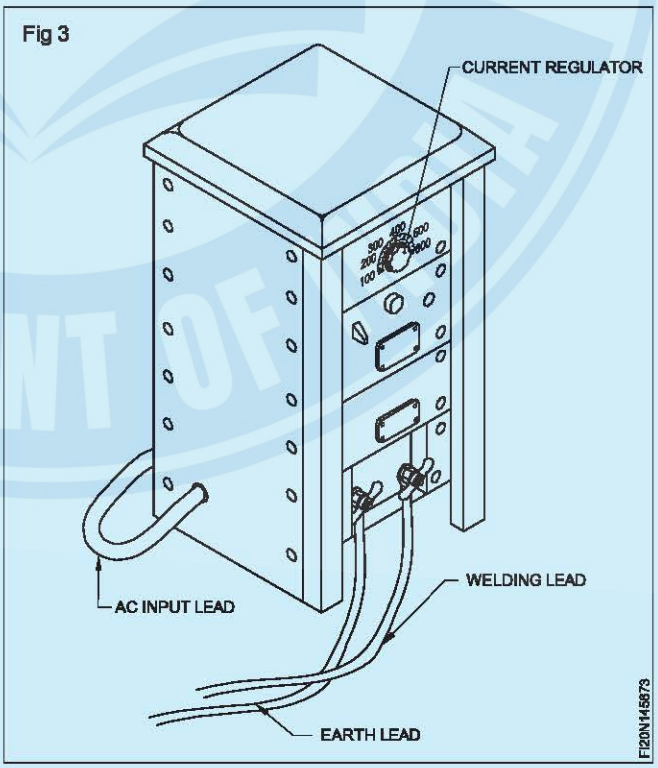


Fig 3



It may be designed to supply both A.C. and D.C. currents for welding (called A.C.-D.C. rectifier set).

Advantages

Suitable for welding all ferrous and non-ferrous metals using all types of electrodes

- Better heat distribution in the electrode and job due to polarity in the welding current supplies constant main load and accurate current setting.

It ensures safe working.

Disadvantages

- Initial cost is higher
- Maintenance cost is more
- Arc-blow trouble faced at certain times.

Polarity in arc welding

Objectives : At the end of this lesson you shall be able to
- **state what is polarity in arc welding**
- **state the types of polarity.**

Polarity in D.C. power source

The polarity of a machine refers to the direction of the current flow.

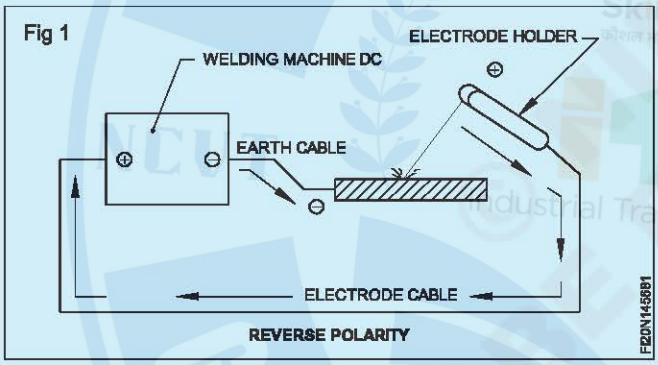
The polarity can be obtained only in D.C.

Polarity may be straight or reverse.

Reverse polarity (Fig 1)

When the electrode cable is connected to the positive terminal, it is called positive polarity or reverse polarity.

Fig 1



Straight polarity (Fig 2)

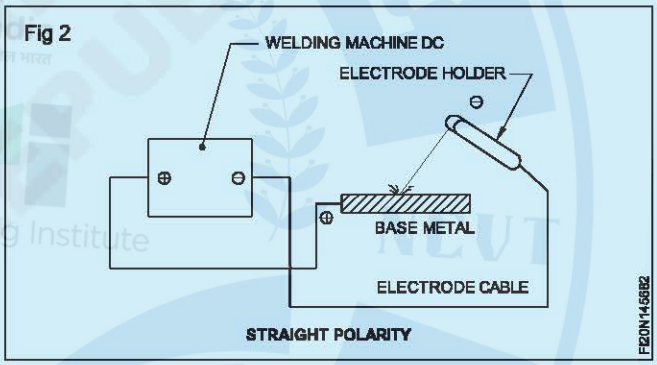
When the electrode cable is connected to the negative terminal as it is called negative polarity or straight polarity.

Remember

A.C. has no polarity

The total heat produced in D.C. arc consists of 2/3 heat from the POSITIVE Terminal (66%) and 1/3 heat from the NEGATIVE Terminal (33%).

Fig 2



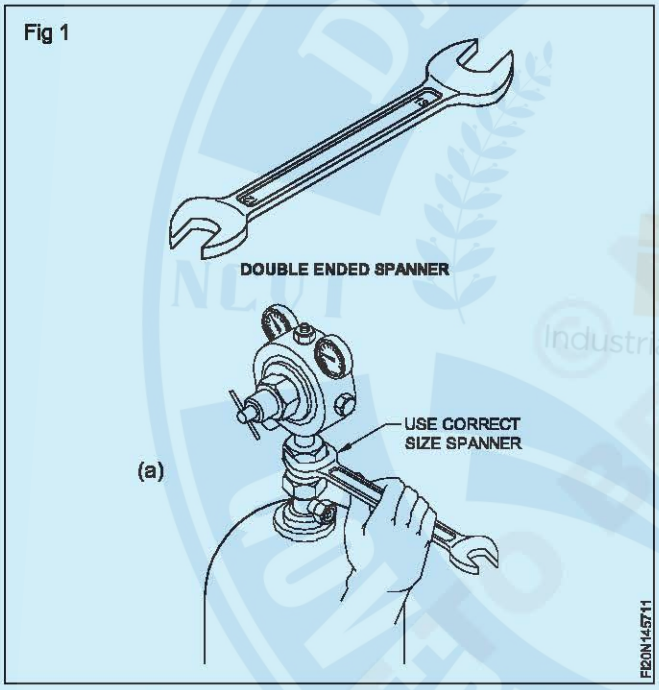
Welding hand tools

Objectives: At the end of this lesson you shall be able to
- **name the hand tools used by a welder**
- **state their uses**
- **state the care and maintenance to keep the hand tools in good working condition.**

The following are the details of different hand tools used by a welder.

Double ended spanner: A double ended spanner is shown in Fig.1 and 1a. It is made of forged chrome vanadium steel. It is used to loosen or tighten nuts, bolts with hexagonal or square heads. The size of the spanner is marked on it as shown in Fig.1. In welding practice the spanners are used to fix the regulator onto the gas cylinder valves, hose connector and protector to the regulator and blow pipe, fix the cable lugs to the arc welding machine output terminals, etc.

Fig 1



Do not use the spanner as a hammer; use the correct size spanner to avoid damage to the nut/bolt head.

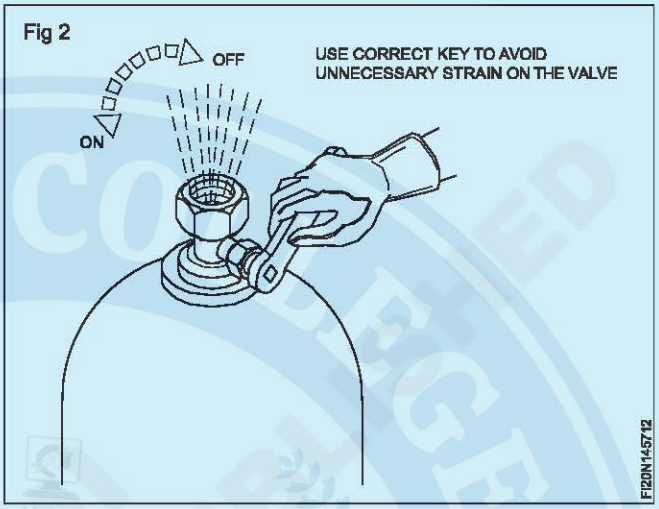
Cylinder key: A cylinder key is shown in Fig.2. It is used to open or close the gas cylinder valve socket to permit or stop the gas flow from the cylinder to the gas regulator.

Always use correct size key to avoid damage to the square rod used to operate the valve. The key must always be left on the valve socket itself so that the gas flow can be stopped immediately in case of flash back/back fire.

Nozzle or tip cleaner

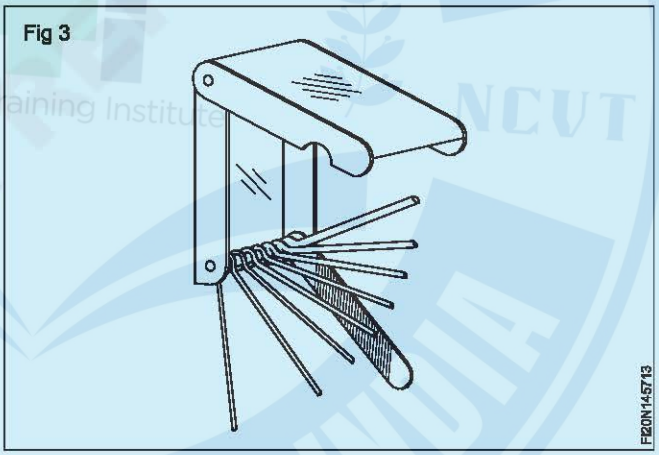
Cleaning the tip: All welding torch tips are made of copper. They can be damaged by the slightest rough handling-dropping, tapping or chopping with the tip on the work may damage the tip beyond repair.

Fig 2



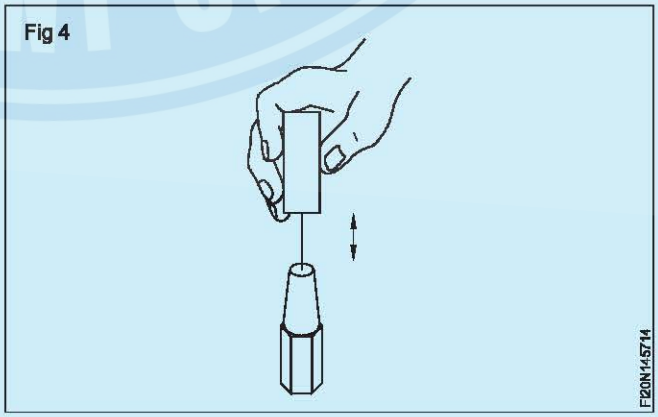
Tip cleaner: A special tip cleaner is supplied with the torch container. For each tip there is a kind of drill and a smooth file Fig.3.

Fig 3



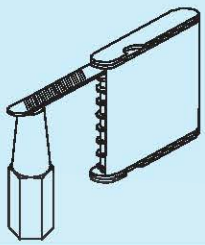
Before cleaning the tip, select the correct drill and move it, without turning, up and down through the hole in the tip Fig.4.

Fig 4



The smooth file is then used to clean the surface of the tip Fig.5. While cleaning, leave the oxygen valve partly open to blow out the dust.

Fig 5



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Spark lighter: The spark lighter, as illustrated in Fig.6 & 7 is used for igniting the torch. While welding, form the habit of always employing a spark lighter to light a torch. Never use matches. The use of matches for this purpose is very dangerous because the puff of the flame produced by the ignition of the acetylene flowing from the tip is likely to burn your hand.

Fig 6

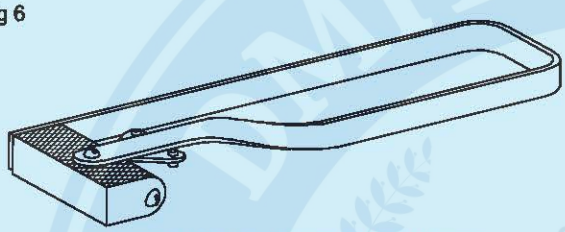

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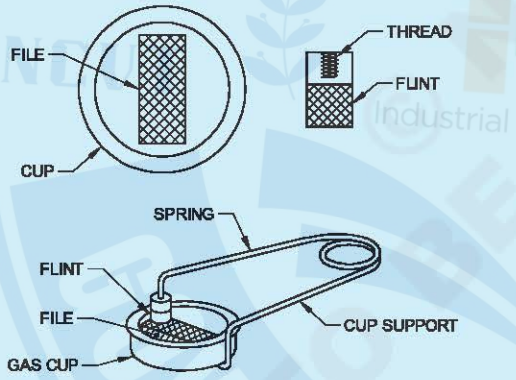
Fig 7



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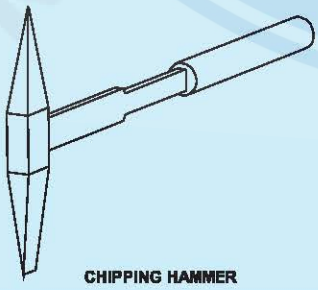
Chipping hammer: The chipping hammer (Fig.8) is used to remove the slag which covers the deposited weld bead. It is made of medium carbon steel with a mild steel handle. It is provided with a chisel edge on one end and a point on the other end for chipping off slag in any position.

Fig 8



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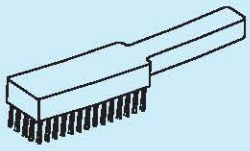
Care should be taken to maintain the sharp chisel edge and the point for effective chipping of slag.

Carbon steel wire brush: A carbon steel wire brush is shown in Fig.9. It is used for

Fig 9



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- Cleaning the work surface from rust, oxide and other dirt etc. prior to welding.
- Cleaning the interbreed weld deposits after chipping off the slag.
- General cleaning of the weldment.

A stainless steel wire brush is used for cleaning a non ferrous and stainless steel welded joint.

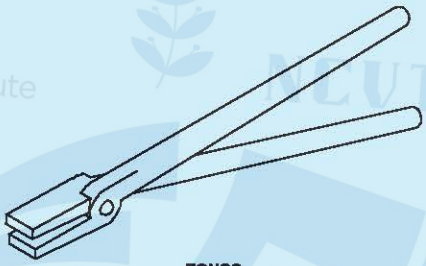
It is made of bunch of steel wires fitted in three to five rows on a wooden piece with handle. The wires are hardened and tempered for long life and to ensure good cleaning action.

Tongs: Fig.10 and Fig.11 shows a pair of tongs used to hold hot work pieces and to hold the job in position.

Fig 10

FI20N145718A

Fig 11



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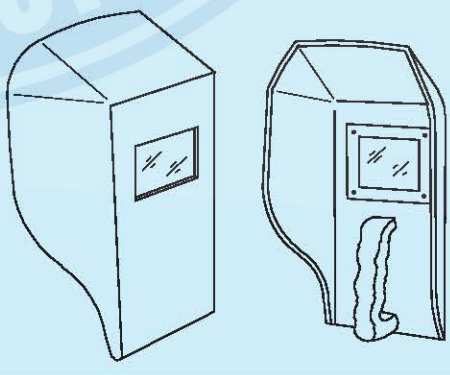
Welding hand screen (Fig 12)

A welding hand screen is used to shield and protect the face and the eyes from the arc radiation.

It is fitted with a filter lens, and plain glass to protect the lens.

Fig 12



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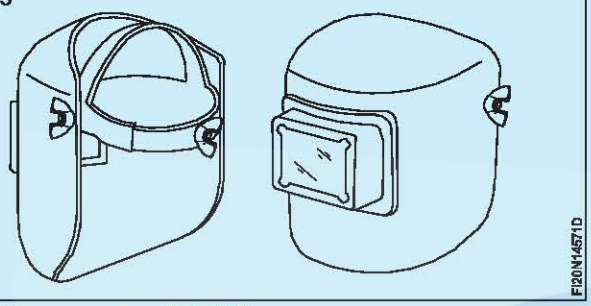
Welding helmet screen (Fig 13)

It is used as a hand screen but it can be worn on the head of the welder to enable him to use both his hands .

Fig 13



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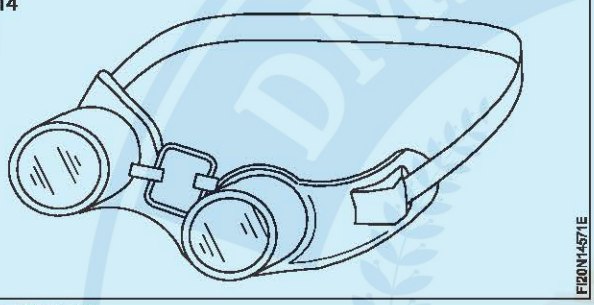
Chipping goggles (Fig 14)

Chipping goggles are used to protect the eyes while chipping the slag.

They are fitted with a plain glass to see the area to be cleaned.

Fig 14



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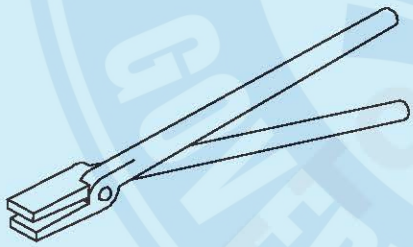
Tong (Fig 15)

Tongs are used to handle the hot metal-welding job while cleaning.

They are also used to hold the metal for hammering.

Fig 15



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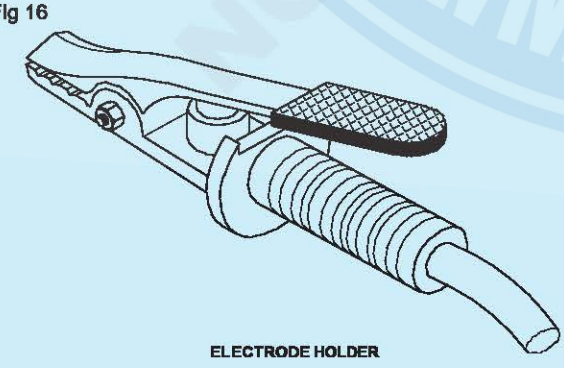
Electrode holder with cable (Fig 16)

Fig 16



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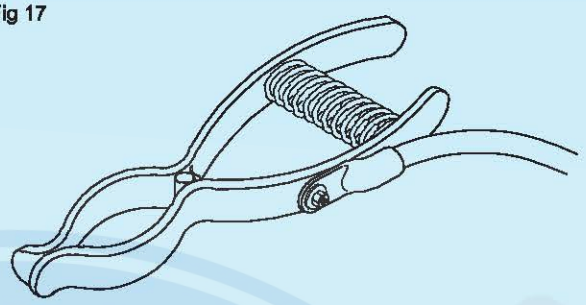
An electrode holder is used to hold and manipulate the electrode.

The cable is insulated with a good quality flexible rubber, and copper core wires, to carry the high current from the welding machines.

Earth clamp with cable (Fig 17)

Fig 17



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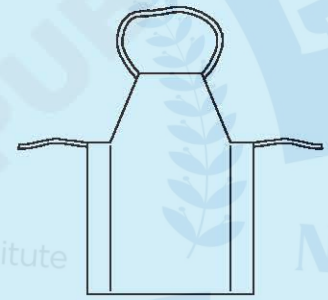
An earth clamp is used to connect the return lead firmly to the job or to the welding table.

Welding table

The welding table is used to keep the jobs and assemble the pieces during welding. The top of the table is made of metal.

Apron (Fig 18)

Fig 18



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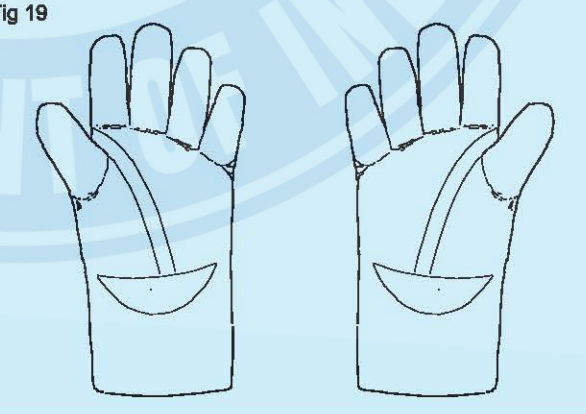
An apron is used to protect the body.

It should be made of leather and worn.

It must be worn for protection from the radiation of the heat rays and hot spatters.

Hand gloves (Fig 19)

Fig 19



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Hand gloves are used to protect the hands from electrical shock, arc radiation, heat, and hot spatters.

The gloves are also made of leather.

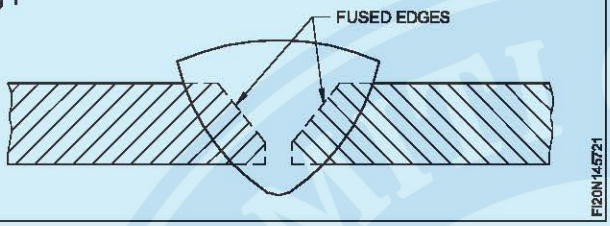
Welding description types and uses

Objectives : At the end of this lesson you shall be able to
- **state what is welding**
- **list the different types of welding and its uses.**

Fusion welding. (Fig 1)

Welding is a fabrication process where by two or more parts are fused together by means of heat pressure or both forming a join as the parts cool. Welding is usually used on metals and thermoplastics but can also be used on wood. The completed welded joint may be referred to as a weldment welding process.

Fig 1

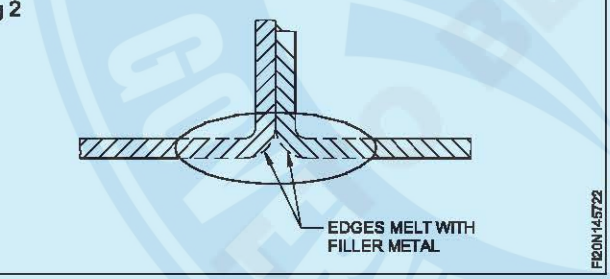


A method of welding in which similar metals are joined together by melting and fusing their joining edges with or without the addition of filler metal but without the application of any kind of pressure is known as fusion welding. The joint made is permanent .The common heating sources are arc welding and gas welding.

Non fusion welding

A method of welding in which similar or dissimilar metals are joined together without melting the edges is known as non - fusion welding. A low melting point filler rod is fused between the joints without the application of pressure (Fig 2) the joint made is temporary

Fig 2



The heat source may be arc, gas welding.

Examples of non - fusion welding are silver soldering, brazing etc.

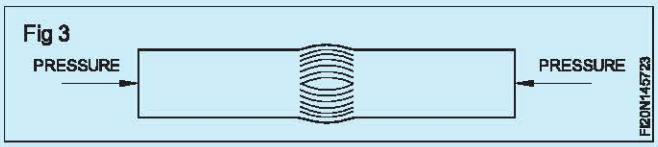
Pressure welding (Fig 3)

Pressure welding is a method of welding in which similar metals are joined together by heating them to plastic or molten state and are then joined by pressing or hammering without the use of the filler metal.

The joint made is permanent

The heat source may be a blacksmith forge (forge welding) or electric resistance (resistance welding).

Fig 3



Types of welding

There are many type welding the process differs greatly in the manner in which heat and pressure are applied and the type of equipment used.

They are

- Forge welding
- Shield metal ARC welding
- Carbon ARC welding
- Submerged ARC welding b
- Co_2 welding (gas metal ARC welding)
- TIG welding (gas tungsten ARC welding
- Atomic hydrogen welding
- Electro slag welding
- Plasma ARC welding
- Spot welding
- Seam welding
- Projection welding
- Butt welding
- Electron bean welding
- Laser welding
- MIG welding (Metal insert gas welding).

Applications of various welding processes

Forge welding : It is used in olden days for joining metals as a lap and butt joint.

Shielded Metal arc welding is used for welding all ferrous and non-ferrous metals using consumable stick electrodes.

Carbon arc welding is used for welding all ferrous and non-ferrous metals using carbon electrodes and separate filler metal. But this is a slow welding process and so not used now-a-days.

Submerged arc welding is used for welding ferrous metals, thicker plates and for more production.

Co_2 welding (Gas Metal Arc Welding) is used for welding ferrous metals using continuously fed filler wire and shielding the weld metal and the arc by carbon-di-oxide gas.

TIG welding (Gas Tungsten Arc Welding) is used for welding ferrous metals, stainless steel, aluminium and thin sheet metal welding.

Atomic hydrogen welding is used for welding all ferrous and non-ferrous metals and the arc has a higher temperature than other arc welding processes.

Electroslag welding is used for welding very thick steel plates in one pass using the resistance property of the flux material.

Plasma arc welding: The arc has a very deep pentrating ability into the metals welded and also the fusion is taking place in a very narrow zone of the joint.

Spot welding is used for welding thin sheet metal as a lap joint in small spots by using the resistance property of the metals being welded.

Seam welding is used for welding thin sheets similar to spot welding. But the adjacent weld spots will be overlapping each other to get a continuous weld seam.

Projection welding is used to weld two plates one over the other on their surfaces instead of the edges by making projection on one plate and pressing it over the other flat surface. Each projection acts as a spot weld during welding.

Butt welding is used to join the ends of two heavy section rods/blocks together to lengthen it using the resistance property of the rods under contact.

Flash butt welding is used to join heavy sections of rods/ blocks similar to butt welding except that arc flashes are produced at the joining ends to melt them before applying heavy pressure to join them.

Electron beam welding used aerospace, nuclear power and automotive industry

Laser beam welding used in automotive industry.

MIG welding is suitable for both thick and then sheets.

Co_2 welding equipment and process

Objectives: At the end of this lesson you shall be able to
- **state the main difference between shielded metal arc welding and co_2 welding**
- **state the principle of co_2 welding.**

Introduction to Co_2 welding: Fusion welding of metal plates and sheets is the best method of joining metals because in this process the welded joint will possess the same properties and strength as the base metal.

Without a perfectly shielded arc and molten puddle, the atmospheric oxygen and nitrogen will get absorbed by the molten metal. This will result in weak and porous welds.

In shielded metal arc welding (SMAW) the arc and molten metal are protected/shielded by the gases produced by the burning of the flux coated on the electrode.

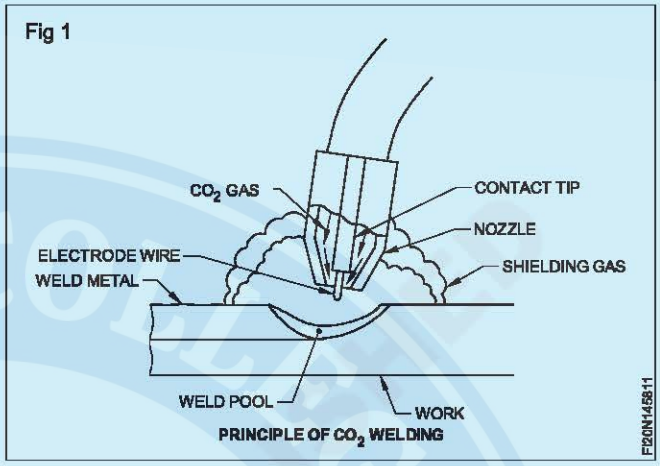
The above mentioned shielding action can be done by passing an inert gas such as argon, helium, carbon-di-oxide through the welding torch/gun. The arc is produced between the base metal and a bare wire consumable electrode fed continuously through the torch.

Principle of GMA welding: In this welding process, an arc is struck between a continuously fed consumable bare wire electrode and the base metal. The heated base metal, the molten filler metal and the arc are shielded by the flow of inert/noninert gas passing through the welding torch/ gun. (Fig.1)

If an inert gas is used to protect the arc produced by a consumable metal electrode, this process is called Metal Inert Gas Welding (MIG).

When carbon-dioxide is used for shielding purposes, it is not fully inert and it partly becomes an active gas. So Co_2 welding is also called as Metal Active Gas (MAG) welding.

Fig 1



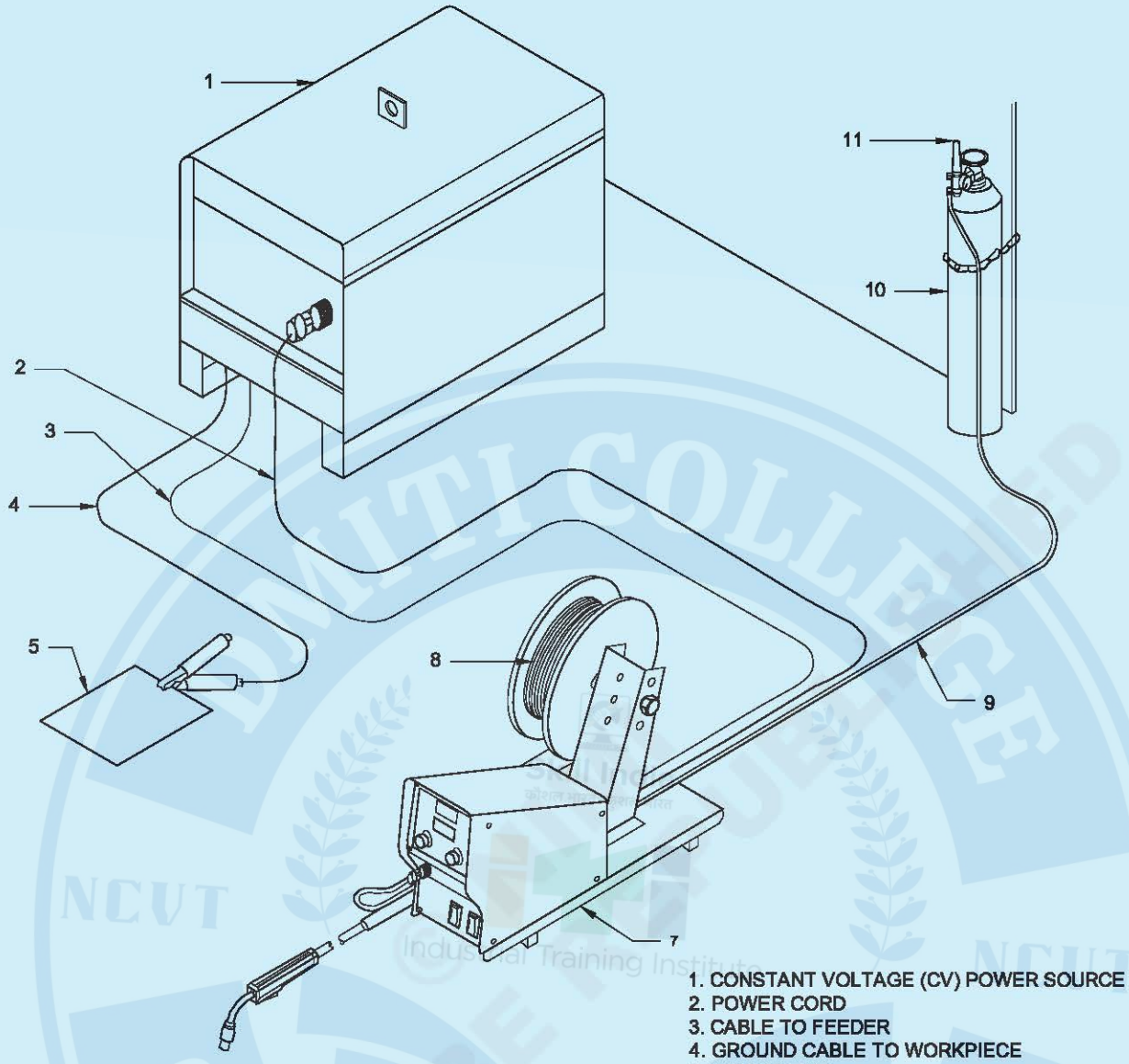
MIG/MAG welding is a name with respect to gas used for shields purpose

On the other hand Gas Metal Arc Welding is the common name.

Basic equipment for a typical GMAW semiautomatic setup (Fig 2)

- Welding Power Source - provides welding power.
- Wire Feeders - controls supply of wire to welding gun.
- Supply of Electrode Wire.
- Welding Gun - delivers electrode wire and shielding gas to the weld puddle.
- Shielding Gas Cylinder - provides a supply of shielding gas to the arc.

Fig 2



HP & LP welding equipment description, principle and method of operating

Objectives : At the end of this lesson you shall be able to

- **Explain the low pressure and the high pressure systems of oxy-acetylene plants and systems**
- **distinguish between low pressure and high pressure blowpipes**
- **State the advantages and disadvantages of both systems.**

Oxy-acetylene plants: An oxy-acetylene plant can be classified into:

high pressure plant

low pressure plant

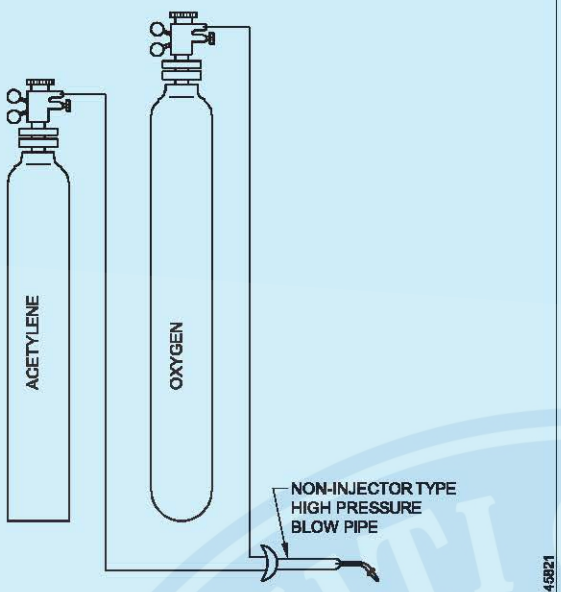
A high pressure plant utilises acetylene under high pressure (15 kg/cm) (Fig1)

Dissolved acetylene (acetylene in cylinder) is the commonly used source

Acetylene generated from a high pressure generator is not commonly used.

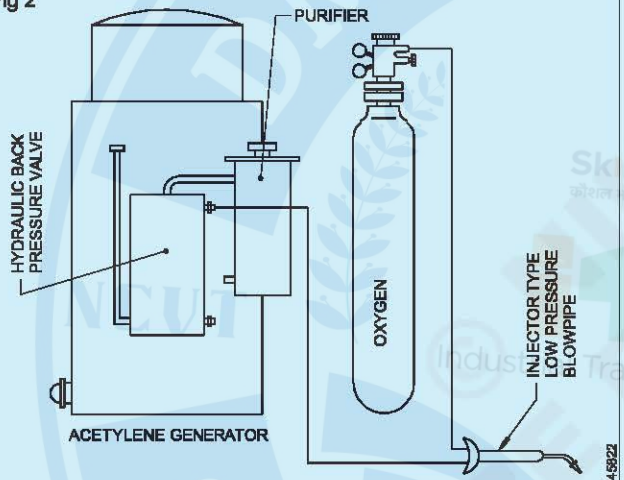
A low pressure plant utilizes acetylene under low pressure(0.017 kg/cm)produced by the acetylene generator only.(Fig 2)

Fig 1



HIGH PRESSURE OXY-ACETYLENE PLANT

Fig 2



LOW PRESSURE OXY-ACETYLENE PLANT

High pressure and low pressure plants utilize oxygen gas kept in compressed high pressure cylinders only at 120 to 150 kg/cm pressure.

Oxy-acetylene systems: A high pressure oxy-acetylene plant is also called a high pressure system.

A low pressure acetylene plant with a low pressure acetylene generator and a high pressure oxygen cylinder is called a low pressure system.

The terms low pressure and high pressure systems used in oxy-acetylene welding refer only to acetylene pressure, high or low.

Types of blowpipes: For the low pressure system, a specially designed injector type blowpipe is required, which may be used for high pressure system also.

In the high pressure system, a mixer type high pressure blowpipe is used which is not suitable for the low pressure system.

To avoid the danger of high pressure oxygen entering into the acetylene pipeline an injector is used in a low pressure blowpipe. In addition a non-return valve is also used in the blowpipe connection on the acetylene hose. As a further precaution to prevent the acetylene generator from exploding, a hydraulic back pressure valve is used between the acetylene generator and the blowpipe.

Advantages of high pressure system: Safe working and less chances of accidents. The pressure adjustment of gases in this system is easy and accurate, hence working efficiency is more. The gases being in cylinder are perfectly under control. The D.A cylinder is portable and can be taken easily from one place to another place.

The D.A cylinder can be fitted with a regulator quickly and easily, thus saving time. Both injector and non-injector type blowpipes can be used. No license is required for keep the D.A cylinder.

Sequence of steps

Slowly open the cylinder valve.

Open the shut-off valve or pressure reducing valve

Open the valve on torch.

Slowly screw in the adjusting screw. (The locking bolt opens.)

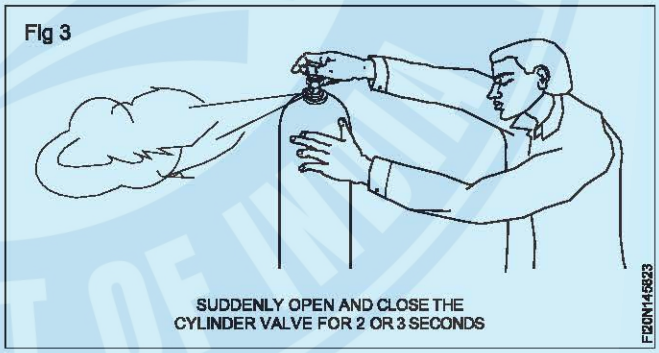
Watch the working pressure gauge.

Turn the adjusting screw until the desired pressure is reached. There is an equilibrium between the bottom adjusting spring and the pressure of the gas on the membrane, which is amplified by the spring of the locking pin.

Care and maintenance of regulators

Check the cylinder connection and crack the cylinder before fixing the regulator. (Fig 3)

Fig 3



Open the cylinder valve slowly and allow the gas to pass to the regulator (cylinder) content gauge.

Loosen the pressure screw.

Do not use oil in regular connections. (Fig 4)

Do not fix the oxygen and acetylene regulators close together (Fig 5)

Do not wind the hose on the regulators (Fig 6)

Fig 4

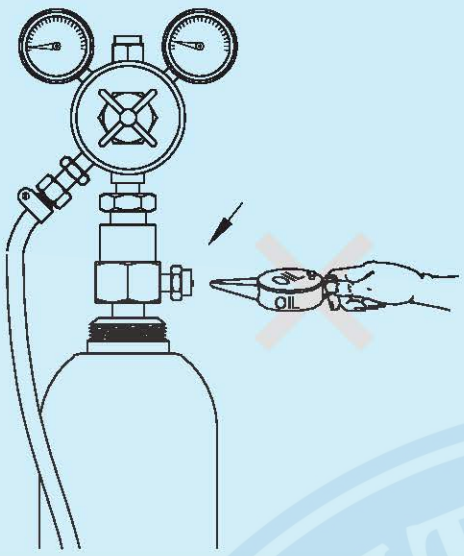


Fig 5

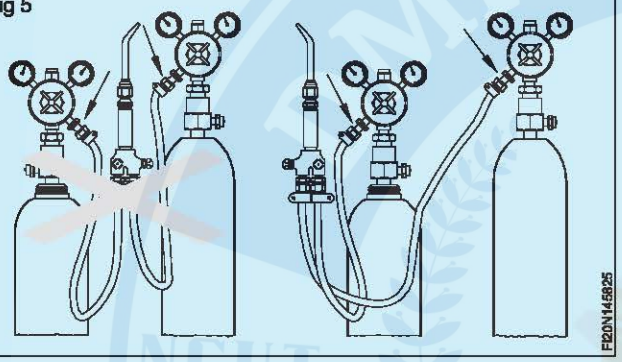
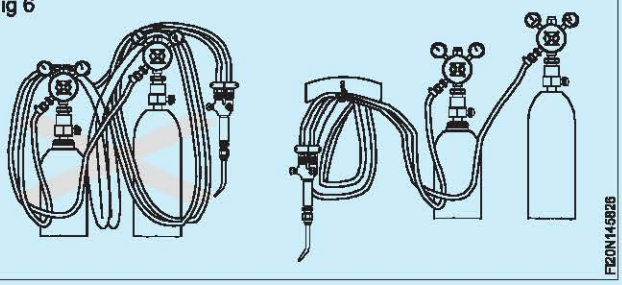


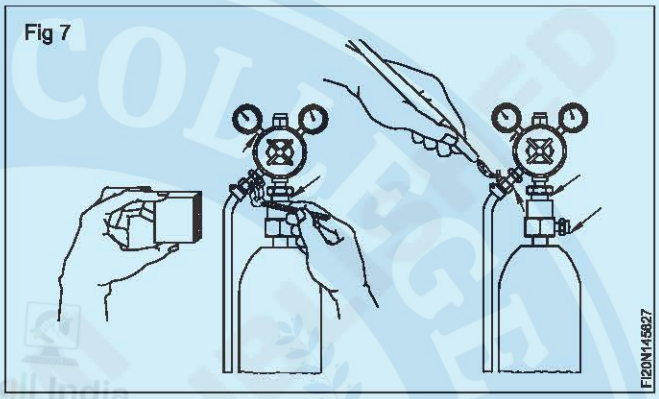
Fig 6



Use hose-clips before connecting to the regulator.

Use soap water to check the leakage in the acetylene regulator connections and plain water on the oxygen relator connections. Fig7

Fig 7



Gas welding torch its type and construction

Objectives : At the end of this lesson you shall be able to

- **State the uses of the different types of blowpipes**
- **describe the working principle of each type of blowpipe**
- **explain its care and maintenance.**

Types

There are two types of blowpipes.

High pressure blowpipe or non-injector by blowpipe

Low pressure blowpipe or injector type blowpipe.

Uses of blow pipes: Each type consists of a variety of designs depending on the work for which the blowpipe is required. i.e gas welding, brazing, very thin sheet welding, heating before and after welding, gas cutting.

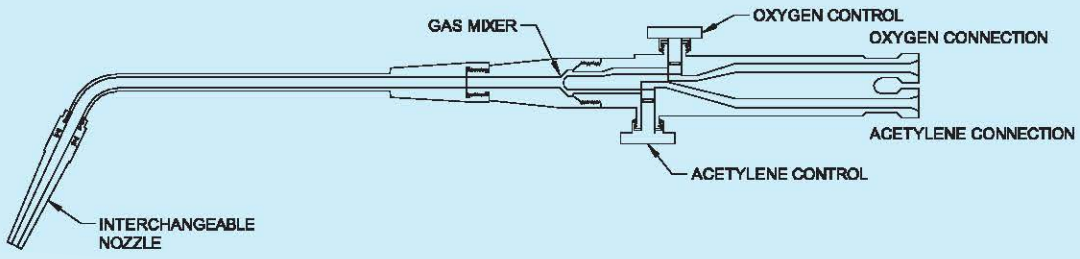
Equal or High pressure blowpipe (Fig 1): The H.P. blowpipe is simply a mixing device to supply approximately equal volume of oxygen and acetylene to the tip, and is fitted with valves to control the flow of the gases as required. i.e the blow pipes/ gas welding torches are used for welding of ferrous and non-ferrous metals, joining thin sheets by fusing the edges, preheating and post heating of jobs, brazing, for removing the dents formed by distortion and for gas cutting using a cutting blow pipe.

The equal pressure blow pipe (Fig.1) consists of two inlet connections for acetylene and oxygen gases kept in high pressure cylinders. Two control valves to control the quantity of flow of the gases and a body inside which the gases are mixed in the mixing chamber (Fig 2). The mixed gases flow through a neck pipe to the nozzle and then get ignited at the tip of the nozzle. Since the pressure of the oxygen and acetylene gases are set at the same pressure of 0.15 kg/cm^2 they mix together at the mixing chamber and flows through the blow pipe to the nozzle tip on its own. This equal pressure blow pipe/torch is also called as high pressure blow pipe/torch because this is used in the high pressure system of gas welding.

A set of nozzles is supplied with each blowpipe, the nozzles having holes varying in diameters, and thus giving various sized flames. The nozzles are numbered with their consumption of gas in litres per hour.

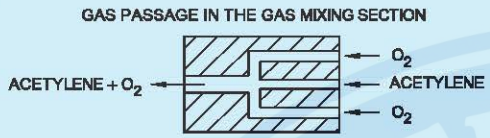
Important caution: A high pressure blowpipe should not be used on a low pressure system.

Fig 1



EQUAL OR HIGH PRESSURE BLOWPIPE

Fig 2



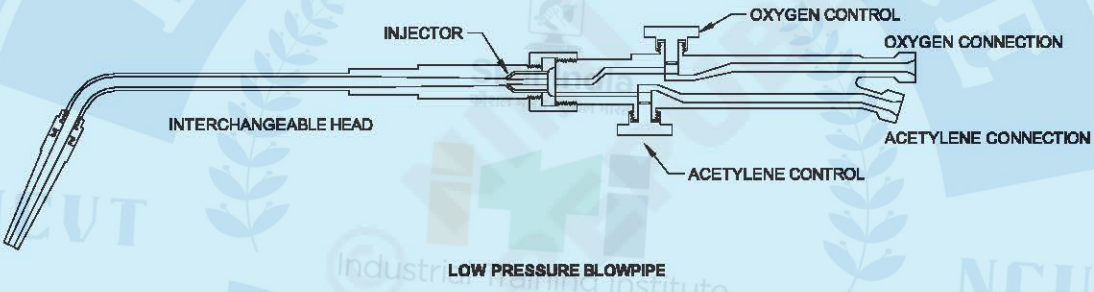
EQUAL PRESSURE TYPE TORCH

Low pressure blowpipe (Fig 3)

This blowpipe has an injector (Fig 3) inside its body through which the high pressure oxygen passes. This oxygen draws the low pressure acetylene from an acetylene generator into a mixing chamber and gives it the necessary velocity to get a steady flame and the injector also helps to prevent backfiring.

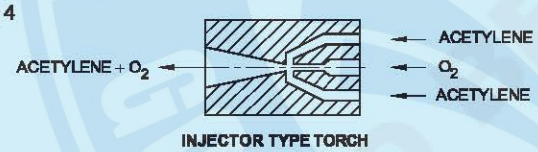
The low pressure blow pipe is similar to the equal pressure blow pipe except that inside its body an injector with a very small (narrow) hole in its centre through which high pressure oxygen is passed. This high pressure oxygen while coming out of the injector creates a vaccuum in the mixing chamber and sucks the low pressure acetylene from the gas generator (Fig. 4)

Fig 3



LOW PRESSURE BLOWPIPE

Fig 4



INJECTOR TYPE TORCH

It is usual for the whole head to be interchangeable in this type, the head containing both the nozzle and injector. This is necessary, since there is a corresponding injector size for each nozzle.

The L.P. blowpipe is more expensive than the H.P. blowpipe but it can be used on a high pressure system, if required.

Care and maintenance

Welding tips made of copper may be damaged by careless handling.

Nozzles should never be dropped or used for moving or holding the work.

The nozzle seat and threads should be absolutely free from foreign matter in order to prevent any scoring/scratch on the fitting surfaces when tightening on assembly.

The nozzle orifice should only be cleaned with a tip cleaner specially designed for this purpose. (Fig 5, 6 & 7)

At frequent intervals the nozzle tip should be filed to remove any damage to the tip due to the excessive heat of the flame and the molten metal.

The inlet for acetylene has left hand thread and that for oxygen has right hand thread. Take care to fit the correct hose pipe with the blow pipe inlet. At frequent intervals, put off the flame and dip the blow pipe in cold water.

Fig 5

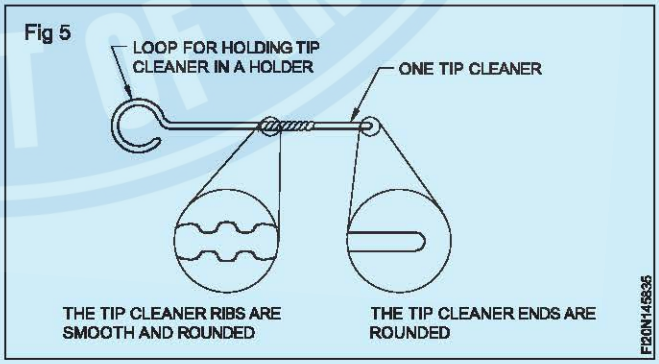
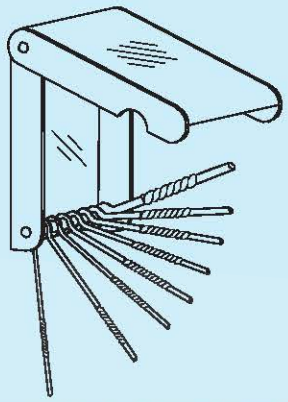


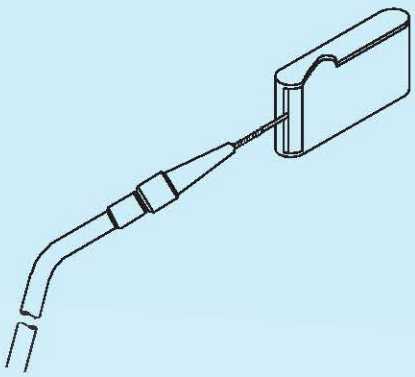
Fig 6



SET OF DIFFERENT SIZE TIP CLEANERS IN A HOLDER

FI20N145838

Fig 7



METHOD OF TIP CLEANING

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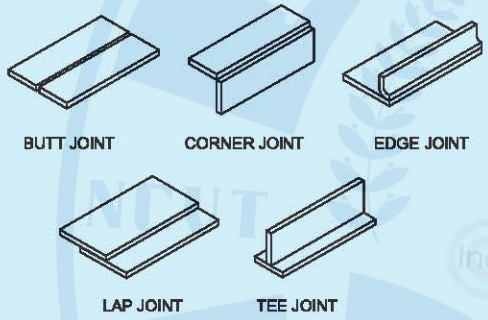
Types of welding joints (butt and fillet)

Objectives: At the end of this lesson you shall be able to
- **illustrate and name the basic welding joints**
- **explain the nomenclature of butt and fillet welds.**

Basic welding joints (Fig 1)

The various basic welding joints are shown in Fig 1.

Fig 1



FUNDAMENTAL TYPE OF JOINTS

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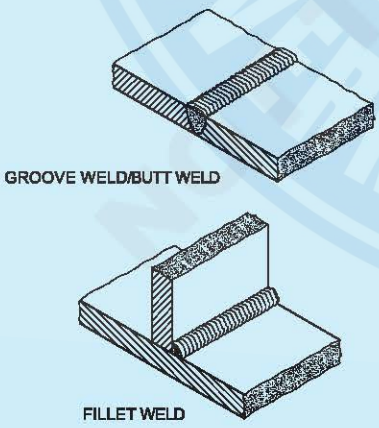
The above types mean the shape of the joint, that is, how the joining edges of the parts are placed together.

Types of weld: There are two types of weld. (Fig 2)

Fig 2



TYPE OF WELD

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– Groove weld/butt weld

– Fillet weld

Nomenclature of butt and fillet weld (Figs 3 and 4)

Root gap: It is the distance between the parts to be joined. (Fig 3)

Fig 3

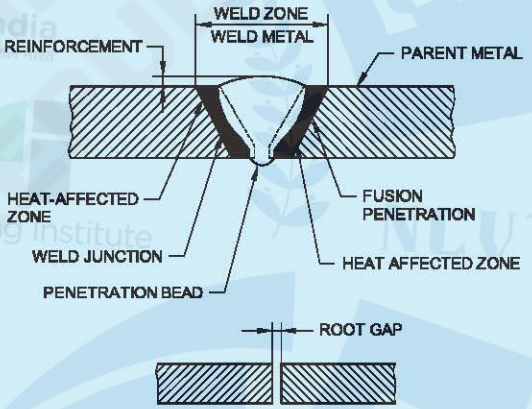

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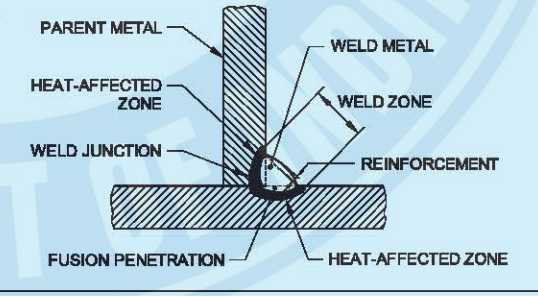
Fig 4



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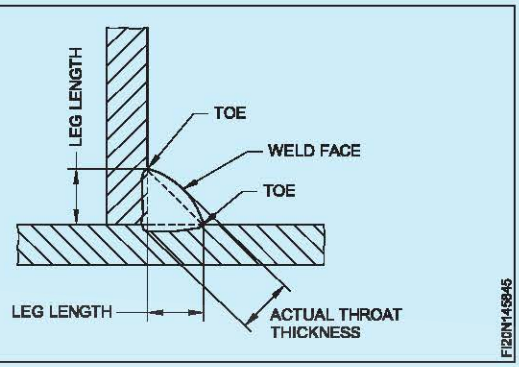
Heat affected zone: Metallurgical properties have been changed by the welding heat adjacent to weld.

Leg length: The distance between the junction of the metals and the point where the weld metal touches the base metal ' toe'. (Fig 5)

Parent metal: The material or the part to be welded.

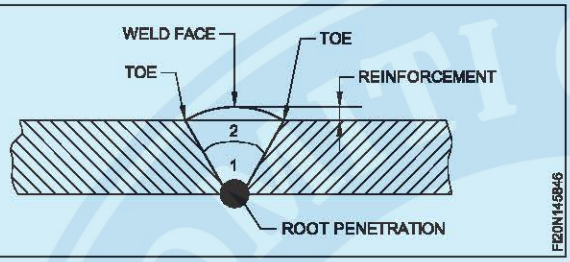
Fusion Penetration: The depth of fusion zone in the parent metal. (Fig.3 and 4)

Fig 5



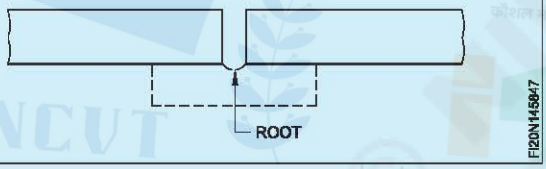
Reinforcement: Metal deposited on the surface of the parent metal or the excess metal over the line joining the two toes. (Fig 6)

Fig 6



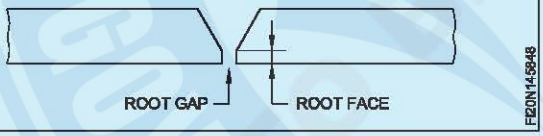
Root: The parts to be joined that are nearest together. (Fig 7)

Fig 7



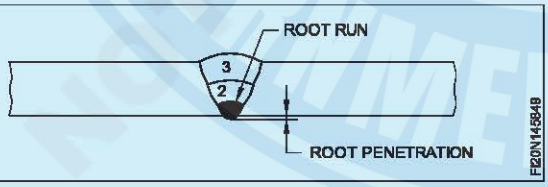
Root face: The surface formed by squaring off the root edge of the fusion face to avoid a sharp edge at the root. (Fig 8)

Fig 8



Root run: The first run deposited in the root of a joint. (Fig 9)

Fig 9



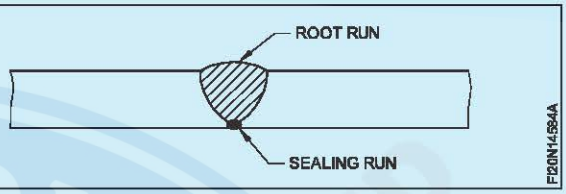
Root penetration: It is the projection of the root run at the bottom of the joint (Fig.6 and 9)

Run: The metal deposited during one pass. Fig.9.

The second run is marked as 2 which is deposited over the root run. The third run is marked as 3 which is deposited over the second run.

Sealing run: A small weld deposited on the root side of a butt or corner joint (after completion of the weld joint). (Fig 10)

Fig 10



Backing run: A small weld deposited on the root side of the butt or corner joint (before welding the joint). Fig.6

Throat thickness: The distance between the junction of the metals and the midpoint on the line joining the two toes. (Fig 5)

Toe of weld: The point where the weld face joins the parent metal. (Fig 5 & 6)

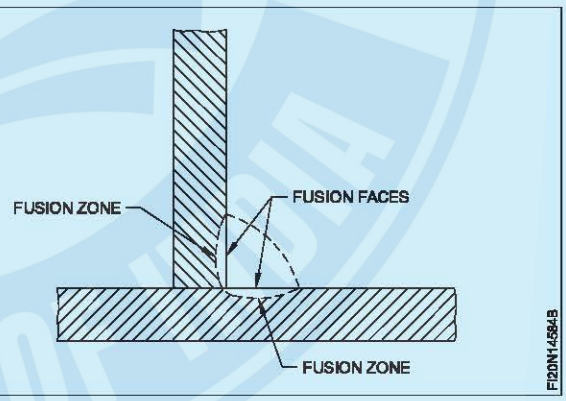
Weld face: The surface of a weld seen from the side from which the weld was made. (Fig 5 & 6)

Weld junction: The boundary between the fusion zone and the heat affected zone. (Fig.3 & 4)

Fusion face: The portion of a surface which is to be fused on making the weld. (Fig 11)

Fusion zone: The depth to which the parent metal has been fused. (Fig 11)

Fig 11



Gases and gas cylinders description, kinds, main difference and uses

Objectives: At the end of this lesson you shall be able to

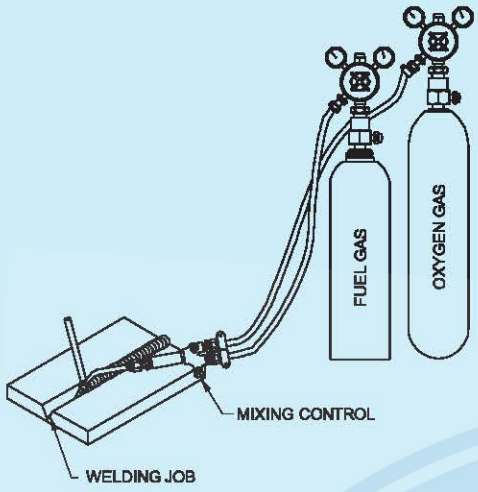
- **name the different types of gases used in gas welding**
- **state the different types of gas flame combinations**
- **state the temperatures and uses of the different gas flame combinations.**

In the different gas welding processes, the welding heat is obtained from the combustion of the fuel gases.

All the fuel gases require oxygen to support combustion.

As a result of the combustion of the fuel gases and oxygen, a flame is obtained. This is used to heat the metals for welding. (Fig 1)

Fig 1



Fuel gases used in welding

The following are the gases used as fuel for welding.

- Acetylene gas
- Hydrogen gas
- Coal gas
- Liquid petroleum gas (LPG)

Supporter of combustion gas

All gases burn with the help of oxygen. Hence it is known as the supporter of combustion.

Different gas flame combinations

Oxygen + Acetylene = Oxy - Acetylene gas flame

Oxygen + Hydrogen = Oxy - Hydrogen gas flame

Oxygen + Coal = Oxy - coal gas flame

Oxygen + LPG = Oxy - LP gas flame

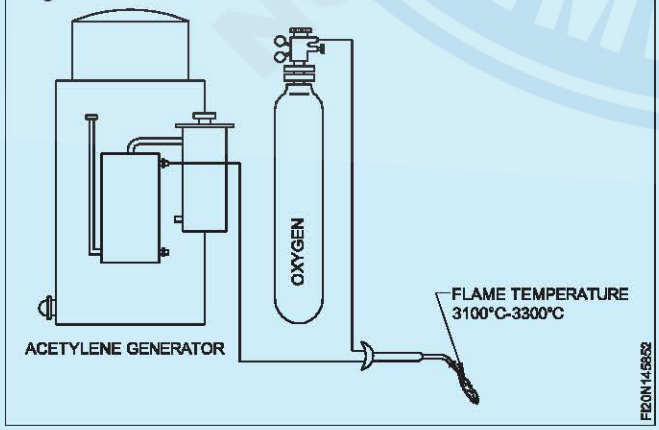
Temperature and uses of gas flame combinations

Oxy-acetylene gas flame (Fig 2)

Flame temperature : 3100° C to 3300° C

The Oxy - Acetylene gas flame is used for welding all ferrous and non-ferrous metals and their alloys, gas cutting, gouging, steel brazing, bronze welding, metal spraying and powder spraying.

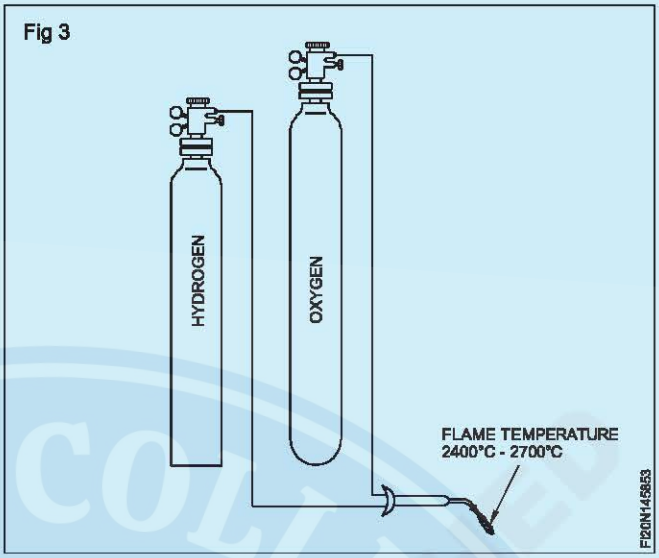
Fig 2



Oxy - Hydrogen gas flame (Fig 3)

Flame temperature : 2400°C to 2700°C

Fig 3



It has carbon and moisture effect in the flame. It is used only for brazing, silver soldering and underwater gas cutting of steel.

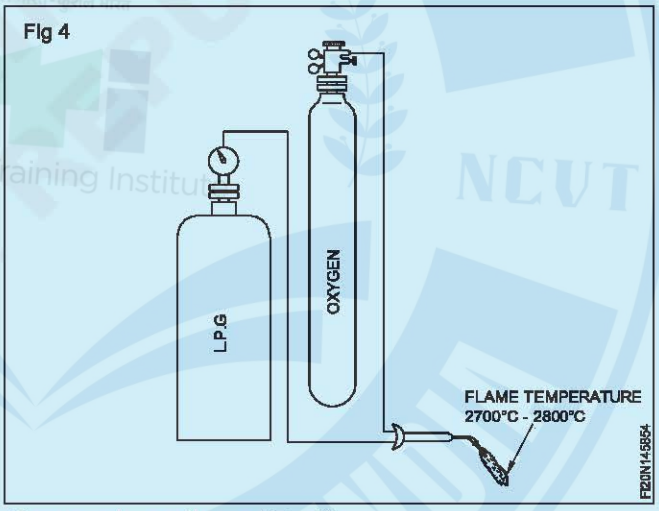
Oxy-liquid petroleum gas flame (Fig 4)

Flame temperature : 2700°C to 2800°C

This flame has carbon and moisture effect.

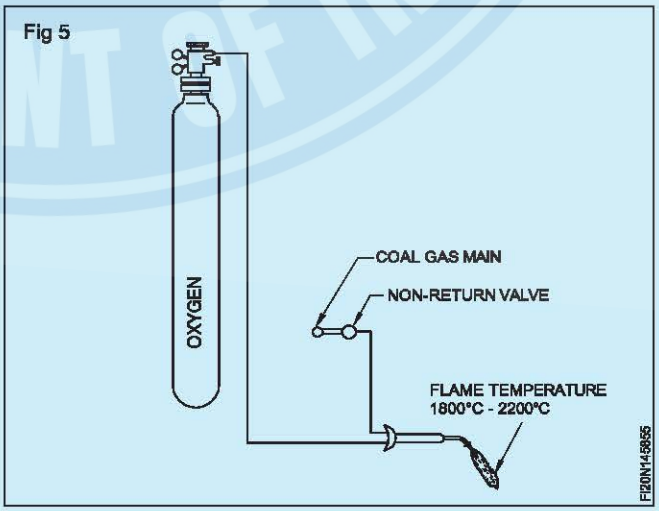
It is only used for gas cutting of steel, and for heating.

Fig 4



Oxy-coal gas flame (Fig 5)

Fig 5



Flame temperature : 1800°C to 2200°C

This flame has carbon effect in the flame and is used for silver soldering and brazing.

The most commonly used gas flame combination is OXY - ACETYLENE.

Oxygen gas cylinder

Objectives: At the end of this lesson you shall be able to

- **name different gas cylinders**
- **explain the constructional features of oxygen gas cylinder and the method of charging.**

Definition of a gas cylinder: It is a steel container, used to store different gases at high pressure safely and in large quantity for welding or other industrial uses.

Types and identifications of gas cylinders: Gas cylinders are called by names of the gas they are holding. (Table 1)

Table 1

Identification of gas cylinders

Name of gas cylinder	Colour coding	Valve threads
Oxygen	Black	Right hand
Acetylene	Maroon	Left hand
Coal	Red (with name coal gas)	Left hand
Hydrogen	Red	Left hand
Nitrogen	Grey (with black neck)	Right hand
Air	Grey	Right hand
Propane	Red (with larger diameter and name propane)	Left hand
Argon	Blue	Right hand
Carbon-di-oxide	Black (with white neck)	Right hand

Gas cylinders are identified by their body colour marks and valve threads. (Table 1)

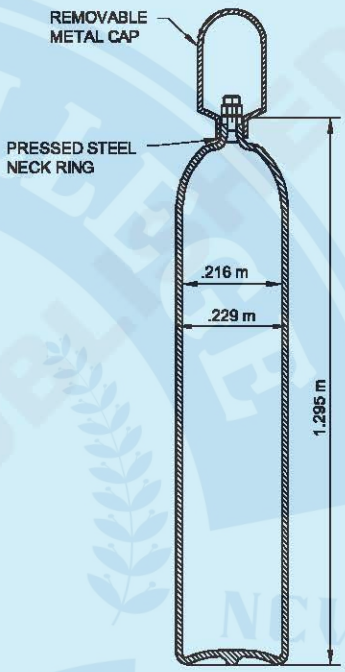
Oxygen gas cylinder: It is a seamless steel container used to store oxygen gas safely and in large quantity under a maximum pressure of 150 kg/cm^2, for use in gas welding and cutting.

Constructional features of oxygen gas cylinder (Fig 1)

It is made from seamless solid drawn steel and tested with a water pressure of 225kg/cm^2. The cylinder top is fitted with a high pressure valve made from high quality forged bronze. (Fig 2)

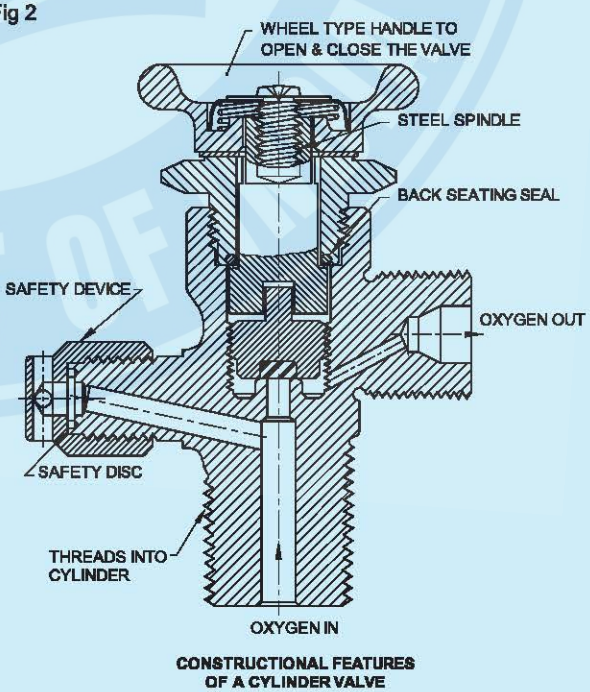
The cylinder valve has a pressure safety device, which consists of a pressure disc, which will burst before the inside cylinder pressure becomes high enough to break the cylinder body. The cylinder valve outlet socket fitting has standard right hand threads, to which all pressure regulators may be attached. The cylinder valve is also fitted with a steel spindle to operate the valve for opening and closing. A steel cap is screwed over the valve to protect it from damage during transportation. (Fig 1)

Fig 1



CONSTRUCTIONAL FEATURE OF OXYGEN GAS CYLINDER

Fig 2



CONSTRUCTIONAL FEATURES OF A CYLINDER VALVE

The cylinder body is painted black.

The capacity of the cylinder may be 3.5m^3– 8.5m^3.

Oxygen cylinders of 7m^3 capacity are commonly used.

Charging of gas in oxygen cylinder: The oxygen cylinders are filled with oxygen gas under a pressure of 120-150 kg/cm^2. The cylinders are tested regularly and periodically. They are annealed to relieve stresses caused during 'on the job' handling. They are periodically cleaned using caustic solution.

Dissolved acetylene gas cylinder

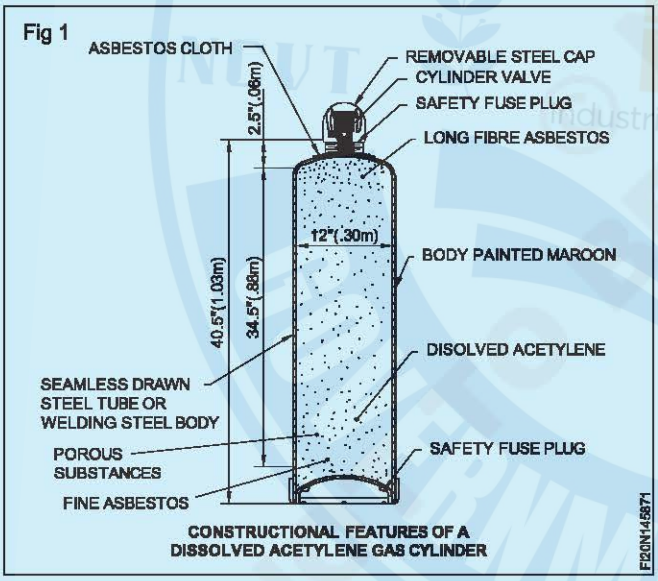
Objectives: At the end of this lesson you shall be able to

- **describe the constructional features of the DA gas cylinder and the method of charging**
- **state the safety rules for handling gas cylinders**
- **explain the safe procedure to be followed in handling an internally fired DA cylinder.**

Definition: It is a steel container used to store high pressure acetylene gas safely in dissolved state for gas welding or cutting purpose.

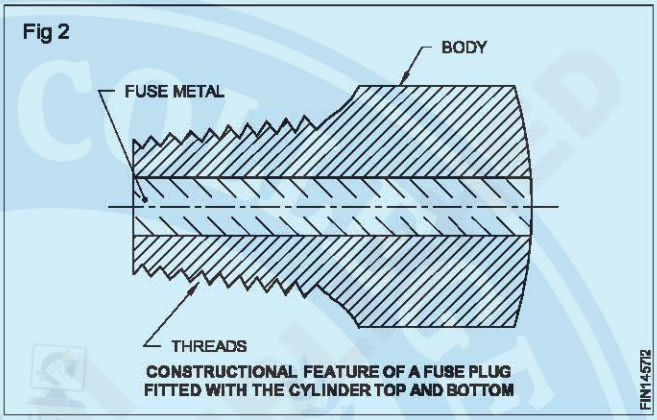
Constructional features (Fig 1): The acetylene gas cylinder is made from seamless drawn steel tube or welded steel container and tested with a water pressure of 100kg/cm^2 The cylinder top is fitted with a pressure valve made from high quality forged bronze. The cylinder valve outlet socket has standard left hand threads to which acetylene regulators of all makes may be attached. The cylinder valve is also fitted with a steel spindle to operate the valve for opening and closing. A steel cap is screwed over the valve to protect it from damage during transportation. The body of the cylinder is painted maroon. The capacity of the D A cylinder may be 3.5m^3–8.5m^3.

Fig 1



The base of the D A cylinder (curved inside) is fitted with fuse plugs which will melt at a temperature of app. 100°C. (Fig 2) In case the cylinder is subjected to high temperature, the fuse plugs will melt and allow the gas to escape, before the pressure increases enough to harm or rupture the cylinder. Fuse plugs are also fitted on the top of the cylinder.

Fig 2



Method of charging D A gas cylinder: The storage of acetylene gas in its gaseous form under pressure above 1kg/cm^2 is not safe. A special method is used to store acetylene safely in cylinders as given below.

The cylinders are filled with porous substances such as:

- pith from corn stalk
- fullers earth
- lime silica
- specially prepared charcoal
- fibre asbestos.

The hydrocarbon liquid named acetone is then charged in the cylinder, which fills the porous substances (1/3rd of total volume of the cylinder).

Acetylene gas is then charged in the cylinder, under a pressure of app.15 kg/cm^2.

The liquid acetone dissolves the acetylene gas in large quantity as safe storage medium; hence, it is called dissolved acetylene. One volume of liquid acetone can dissolve 25 volumes of acetylene gas under normal atmospheric pressure and temperature. During the gas charging operation one volume of liquid acetone dissolves 25x15=375 volumes of acetylene gas under 15kg/cm^2 pressure at normal temperature. While charging cold water will be sprayed over the cylinder so that the temperature inside the cylinder does not cross certain limit.

Safety rules for gas cylinders

Oxy-acetylene equipment is safe if it is properly handled, but it may become a great destructive power if handled carelessly. It is important that the operator be familiar with all the safety rules before handling gas cylinders.

Keep the cylinders free of oil, grease or any type of lubrication.

Check leakage before use.

Open cylinder valves slowly.

Never fall or trip over gas cylinders.

A valve broken in the oxygen cylinder will cause it to become a rocket with tremendous force.

Keep the gas cylinders away from exposure to high temperature.

Remember the pressure in the gas cylinders increases with the temperature.

Store full and empty gas cylinders separately in a well ventilated place.

Mark the empty cylinders (MT/EMPTY) with chalk .

If a cylinder leaks due to defective valve or safety plug, do not try to repair it yourself, but move it to a safe area with a tag to indicate the fault and then inform the supplier to pick it up.

When the cylinders are not in use or they are being moved, put on the valve protection caps.

Cylinders should always be kept in upright position and properly chained when in use.

Close the cylinder valves both when they are full or empty.

Never remove the valve protection cap while lifting cylinders.

Avoid exposing the cylinders to furnace heat, open fire or sparks from the torch.

Never move a cylinder by dragging, sliding or rolling it on its sides.

Never apply undue force to open or close a cylinder valve.

Avoid the use of hammer or wrench.

Always use a proper cylinder (or spindle) key to open or close the cylinder valves.

Do not remove the cylinder key from the cylinder valve when it is in use. It may be needed immediately to close the gas in case of emergency.

Smoking or naked lights should be strictly prohibited near gas cylinders.

Never strike an arc or direct gas flame on a gas cylinder.

Safety procedure for handling an internally fired dissolved acetylene (D A) cylinder

In the case of severe backfire or flashback the D A cylinder may catch fire.

Close the blowpipe valve immediately (oxygen first).

No damage will occur to the cylinder if the backfire is arrested at the blowpipe.

The signs of severe backfire or flashback are:

- a squealing or hissing noise in the blowpipe
- a heavy black smoke and sparks coming out of the nozzle
- overheating of the blowpipe handle.

To control this:

- close the cylinder valves
- disconnect the regulator from the cylinder valve
- check the hosepipes and blowpipe before re-use.

If the cylinder catches fire externally due to the leakage of gas at the connection:

- close the cylinder valve immediately (wearing asbestos gloves as a safety measure)
- use carbon dioxide fire extinguisher to extinguish the fire
- rectify the leakage thoroughly before putting into further use.

If the cylinder becomes overheated due to internal or external fire:

- close the cylinder valve
- detach the regulator from the cylinder
- remove the cylinder to an open space, away from smoking or naked light
- cool the cylinder by spraying with water
- inform the gas cylinder supplier immediately.

Never keep such defective cylinders with the other cylinders.

Setting up parameter for arc welding machine

Objective: At the end of this lesson you shall be able to
- **select and set the electrode and current according to the plate thickness.**

Electrode size and AMPS used

The following will serve as a basic guide of the amp range that can be used for different size electrodes. Note that these ratings can be different between various electrode manufactures for the same size rod. Also the type coating on the eletrode could effect the amperage range. When possible, check the manufactures info of the electrode you wil be using for their recommended amperage settings.

Electrode Table

Electrode	AMP	Plate
1/16"	20 - 40	Up to 3/16"
3/32"	40 - 125	Up to 1/4"
1/8	75 - 185	Over 1/8"
5/32"	105 - 250	Over 1/4"
3/16"	140 - 305	Over 3/8"
1/4"	210 - 430	Over 3/8"
5/16"	275 - 450	Over 1/2"

Note : The thicker the material to be welded, the higher the current needed and the larger the electrode needed.

Selection and storage of electrodes

Objectives: At the end of this lesson you shall be able to
- **select a suitable electrode to weld a particular job**
- **state the necessity of baking a coated electrode**
- **store and handle the electrode properly for better weld quality.**

Selection/choice of electrodes: Selection of an electrode is very important in order to get a joint welded with the required strength.

Selection factors

Properties of base metal: Top quality weld should be as strong as the base metal.

Select an electrode that is recommended as per the properties of the base metal. (Fig 1)

Fig 1

BASE METAL	ELECTRODE SELECTED
MILD STEEL	MEDIUM COATED RUTILE M.S. ELECTRODE
MEDIUM CARBON STEEL	HEAVY COATED LOW HYDROGEN M.S. ELECTRODE
STAINLESS STEEL	COLUMBIAM BASED STABILISED STAINLESS STEEL ELECTRODE
COPPER	HEAVY COATED BRONZE ELECTRODE

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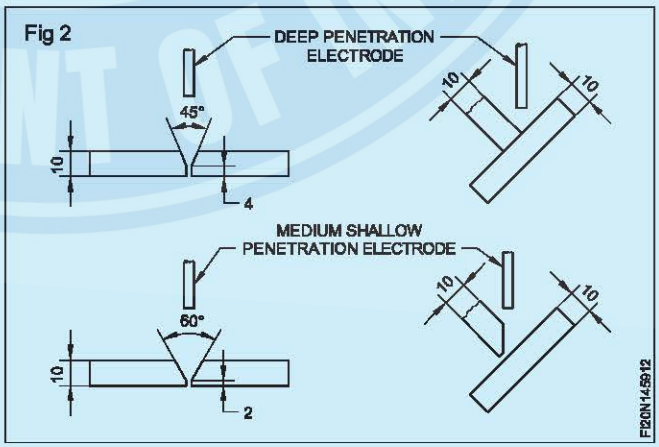
The size of the electrode depends on:
- thickness of metal to be welded
- edge preparation of joints
- root run, intermediate or covering run
- welding position
- welder's skill.

Never use a larger dia. electrode than the thickness of base metal.

Joint design and fit up

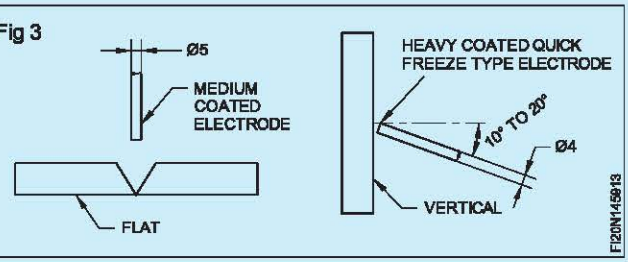
Select:
- deep penetration electrodes for insufficiently bevelled joints
- medium penetration electrodes for open and sufficiently bevelled joints. (Fig 2)

Welding position: Electrodes are manufactured for different positions, to produce better welds.



Select an electrode as per the welding position. (Fig 3)

Fig 3



Welding current: Electrodes are available for use with:

- AC or DC (straight or reverse polarity)
- AC and DC (both).

Select as per the availability of the welding machine.

Production efficiency: The deposition rate of electrode is important in production work. So select an iron powder electrode for production work.

Faster the weld, lower the cost.

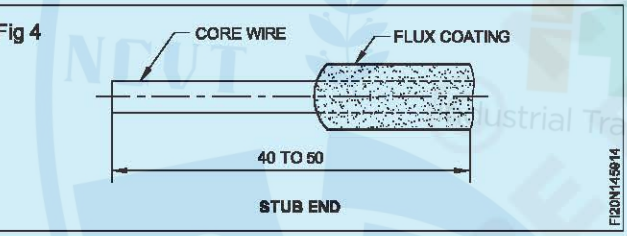
Select the electrode, which is designed for the particular production work.

Usage and storage of electrodes

Electrodes are costly, therefore, use and consume every bit of them.

Do not discard STUB ENDS more than 40-50 mm length. (Fig 4)

Fig 4

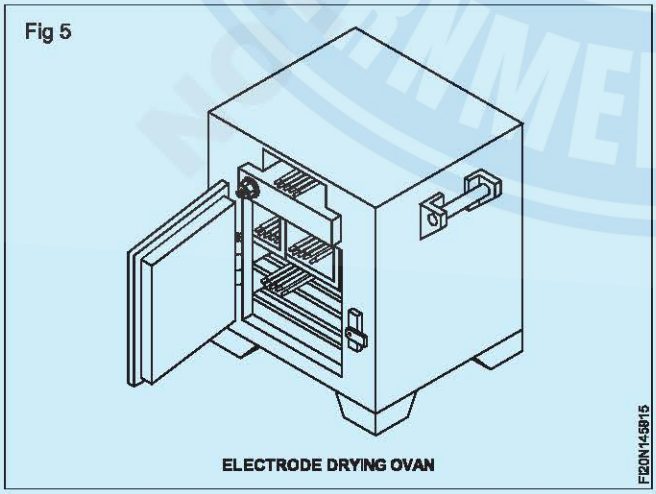


Electrode coating can pick up moisture if exposed to atmosphere.

Store and keep the electrodes (air tight) in a dry place.

Heat the moisture affected/prone electrodes in an electrode drying oven at 110 - 150° C for one hour before using. (Fig 5)

Fig 5



Remember a moisture-affected electrode:

- has rusty stub end
- has white powder appearance in coating
- produces porous weld.

Always pick up the right electrode that will provide:

- good arc stability
- smooth weld bead
- fast deposition
- minimum spatters
- maximum weld strength
- easy slag removal.

Storage of electrodes: The efficiency of an electrode is affected if the covering becomes damp.

- Keep electrodes in unopened packets in a dry store.
- Place packages on a duckboard or pallet, not directly on the floor.
- Store so that air can circulate around and through the stack.
- Do not allow packages to be in contact with walls or other wet surfaces.
- The temperature of the store should be about 5^0C higher than the outside shade temperature to prevent condensation of moisture.
- Free air circulation in the store is as important as heating. Avoid wide fluctuations in the store temperature.
- Where electrodes cannot be stored in ideal conditions place a moisture-absorbent material (e.g silica-gel) inside each storage container.

Drying electrodes: Water in electrode covering is a potential source of hydrogen in the deposited metal and thus may cause:

- Porosity in the weld
- Cracking in the weld.

Indications of electrodes affected by moisture are:

- White layer on covering.
- Swelling of covering during welding.
- Disintegration of covering during welding.
- Excessive spatter.
- Excessive rusting of the core wire.

Electrodes affected by moisture may be dried before use by putting them in a controlled drying oven for approximately one hour at a temperature around 110 - 150^{0}C. This should not be done without reference to the conditions laid down by the manufacturer. It is important that hydrogen controlled electrodes are stored in dry, heated conditions at all times.

Warning: Special drying procedures apply to hydrogen controlled electrodes. Follow the manufacturer's instructions.

Oxy-acetylene cutting equipment

Objectives: At the end of this lesson you shall be able to
- **explain the features of the oxy-acetylene cutting equipment, its parts and cutting torch**
- **describe the oxy-acetylene cutting procedure**
- **differentiate between cutting and welding blowpipes.**

Cutting equipment: The oxy-acetylene cutting equipment is similar to the welding equipment, except that instead of using a welding blowpipe, a cutting blowpipe is used. The cutting equipment consists of the following.

– Acetylene gas cylinder

– Oxygen gas cylinder

– Acetylene gas regulator

– Oxygen gas regulator (Heavy cutting requires higher pressure oxygen regulator.)

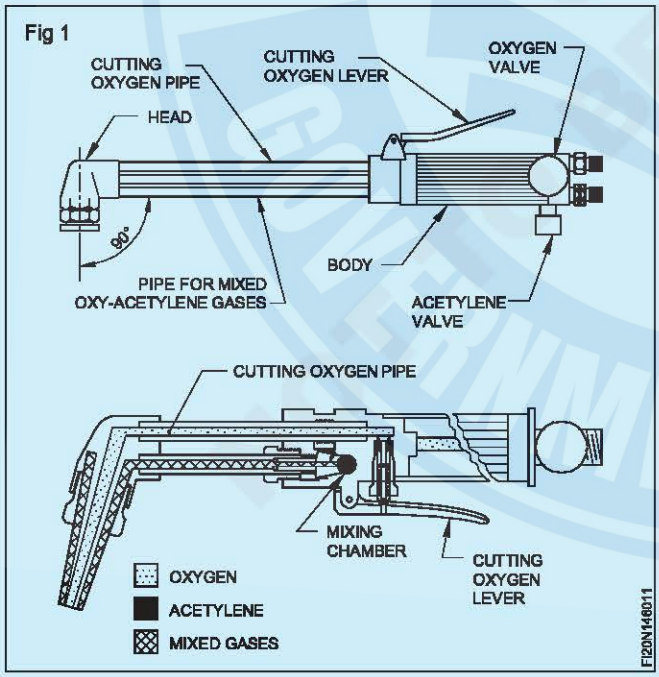
– Rubber hose-pipes for acetylene and oxygen

– Cutting blowpipe

(Cutting accessories i.e. cylinder key, spark lighter, cylinder trolley and other safety appliances are the same as are used for gas welding.)

The cutting torch (Fig 1): The cutting torch differs from the regular welding blowpipe in most cases; it has an additional lever for the control of the cutting oxygen used to cut the metal. The torch has the oxygen and acetylene control valves to control the oxygen and acetylene gases while preheating the metal.

Fig 1



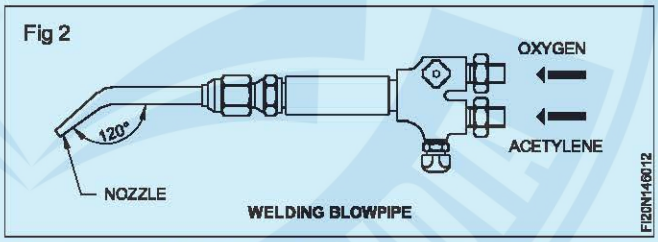
The cutting tip is made with an ORIFICE in the centre surrounded by five smaller holes. The centre opening permits the flow of the cutting oxygen and the smaller holes are for the preheating flame. Usually different tip sizes are provided for cutting metals of different thicknesses.

Oxy-acetylene cutting procedure: Fix a suitable size cutting nozzle in the cutting blowpipe. Ignite the cutting torch the same way as was done in the case of the welding blowpipe. Set the neutral flame for preheating. To start the cut, hold the cutting nozzle at angle 90° with the plate surface, and the inner cone of the heating flame 3 mm above the metal. Preheat the metal to bright red before pressing the cutting oxygen lever. If the cut is proceeding correctly, a shower of sparks will be seen to fall from the underside of the plate. Move the torch steadily on the punched line. If the edge of the cut appears to be too ragged, the torch is being moved too slowly. For a bevel cut, hold the cutting torch at the desired angle and proceed as is done in making a straight line cut. At the end of the cut, release the cutting oxygen lever and close the control valves of the oxygen and acetylene. Clean the cut and inspect.

Difference between cutting blowpipe and welding blowpipe: A cutting blowpipe has two control valves (oxygen and acetylene) to control the preheating flame and one lever type control valve to control the high pressure pure oxygen for making the cut.

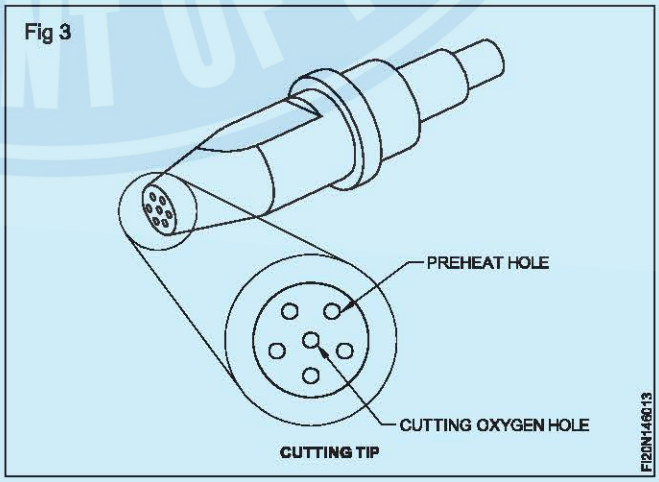
A welding blowpipe has only two control valves to control the heating flame. (Fig 2)

Fig 2



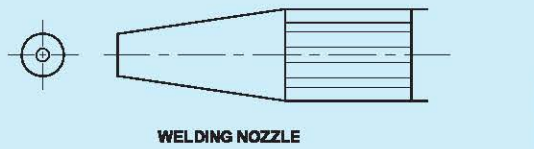
The nozzle of the cutting blowpipe has one hole in the centre for cutting oxygen and a number of holes around the circle for the preheating flame. (Fig 3)

Fig 3



The nozzle of the welding blowpipe has only one hole in the centre for the heating flame. (Fig 4)

Fig 4



WELDING NOZZLE

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The angle of the cutting nozzle with the body is 90°.

The angle of the welding nozzle with the neck is 120°.

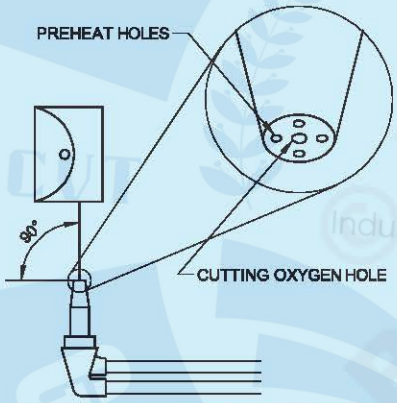
The cutting nozzle size is given by the diameter of the cutting oxygen orifice in mm.

The welding nozzle size is given by the volume of oxy-acetylene mixed gases coming out of the nozzle in cubic meter per hour.

Operating data for cutting mild steel

Cutting nozzle size - mm	Thickness of plate (mm)	Cutting oxygen pressure Kgf/cm^2
0.8	3 - 6	1.0 - 1.4
1.2	6 - 19	1.4 - 2.1
1.6	19 - 100	2.1 - 4.2
2.0	100 - 150	4.2 - 4.6
2.4	150 - 200	4.6 - 4.9
2.8	200 - 250	4.9 - 5.5
3.2	250 - 300	5.5 - 5.6

Fig 5



CLEANING THE HOLES OF CUTTING NOZZLE

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Care and maintenance: The high pressure cutting oxygen lever should be operated only for gas cutting purposes.

Care should be taken while fitting the nozzle with the torch to avoid wrong thread. Dip the torch after each cutting operation in water to cool the nozzle.

To remove any slag particles or dirt from the nozzle orifice use the correct size nozzle cleaner Fig.5. Use an emery paper if the nozzle tip is damaged to make it sharp and to be at 90^0 with the nozzle axis.

Method of handling cutting torch-description, parts, function and uses

Objectives: At the end of this lesson you shall be able to
- **explain the principle of gas cutting**
- **describe the cutting operation and its application.**

Introduction to gas cutting : The most common method of cutting mild steel is by an oxy-acetylene cutting process. With an oxy-acetylene cutting torch, the cutting (oxidation) can be confined to a narrow strip and with little effect of heat on the adjoining metal. The cut appears like a saw-cut on a wooden plank. The method can be successfully used to cut ferrous metals i.e. mild steel.

Non-ferrous metals and their alloys cannot be cut by this process.

Principle of gas cutting: When a ferrous metal is heated to red hot condition and then exposed to pure oxygen, a chemical reaction takes place between the heated metal and oxygen. Due to this oxidation reaction, a large amount of heat is produced and cutting action takes place.

When a piece of wire with a red hot tip is placed in a container of pure oxygen, it bursts into flame immediately and is completely consumed. Fig 1 illustrates this reaction. Similarly in oxy-acetylene cutting the combination of red hot metal and pure oxygen causes rapid burning and iron is changed into iron oxide (oxidation).

By this continuous process of oxidation the metal can be cut through very rapidly.

The iron oxide is less in weight than the base metal.

Also the iron oxide is in molten condition called slag. So the jet of oxygen coming from the cutting torch will blow the molten slag away from the metal making a gap called 'Kerf'. Fig.2

Cutting operation (Fig 2): There are two operations in oxy-acetylene gas cutting. A preheating flame is directed on the metal to be cut and raises it to bright red hot or ignition point (900°C app.). Then a stream of high pressure pure oxygen is directed on to the hot metal which oxidises and cuts the metal.

Fig 1

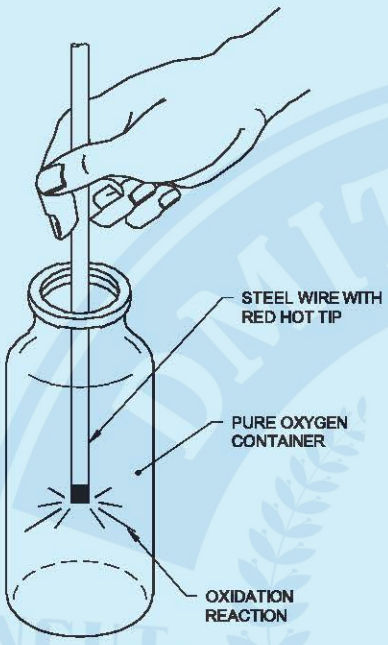
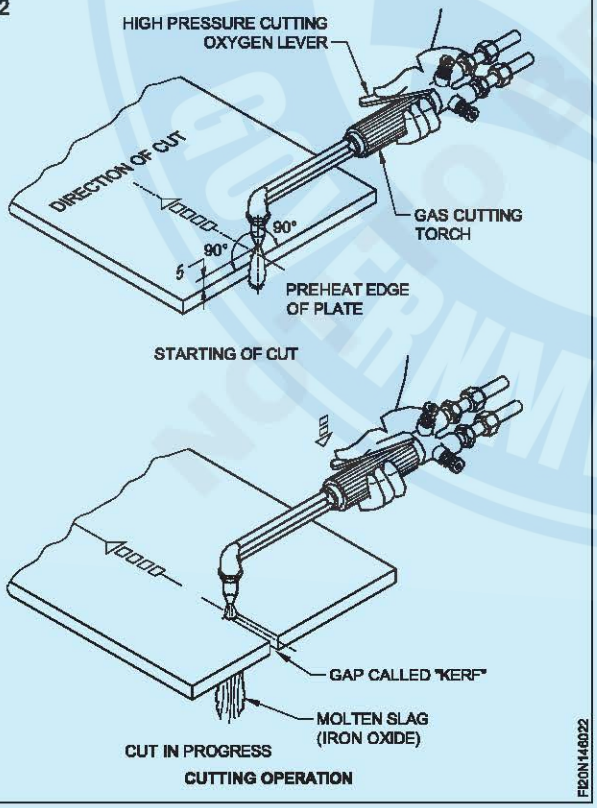


Fig 2



The two operations are done simultaneously with a single torch.

The torch is moved at a proper travel speed to produce a smooth cut. The removal of oxide particles from the line of cut is automatic by means of the force of oxygen jet during the progress of cut.

300 litres of oxygen are required to oxidize one kilogram of iron completely. The ignition temperature of steel for gas cutting is 875°C to 900°C.

Application of cutting torch: Oxy-acetylene cutting torch is used to cut mild steel plates above 4mm thickness. The M.S plate can be cut to its full length in straight line either parallel to the edge or at any angle to the edge of the plate. Bevelling the edges of a plate to any required angle can also be done by tilting the torch. Circles and any other curved profile can also be cut using the cutting torch by using a suitable guide or template.

Fig.3 to Fig.7 shows the guides used to cut straight lines, bevel and small circles.

Fig 3

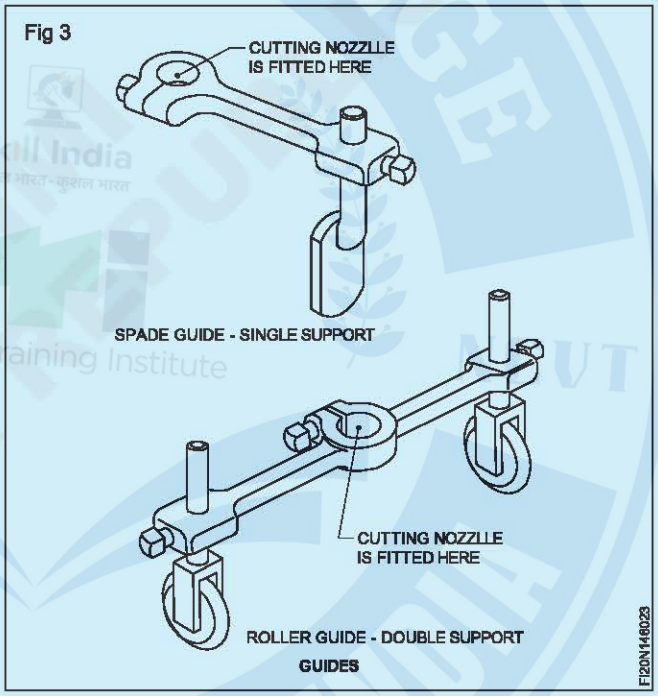
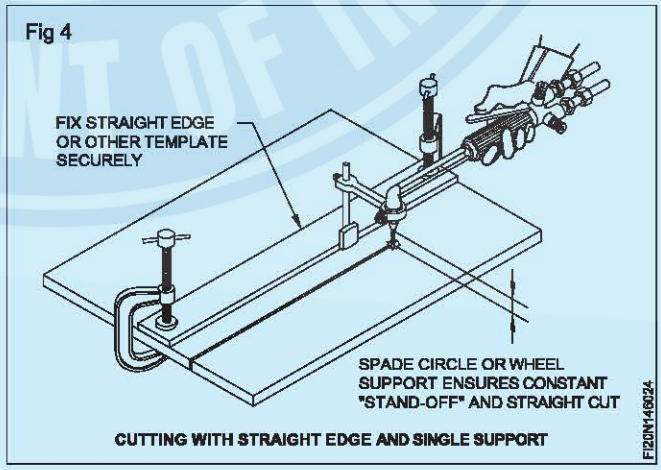


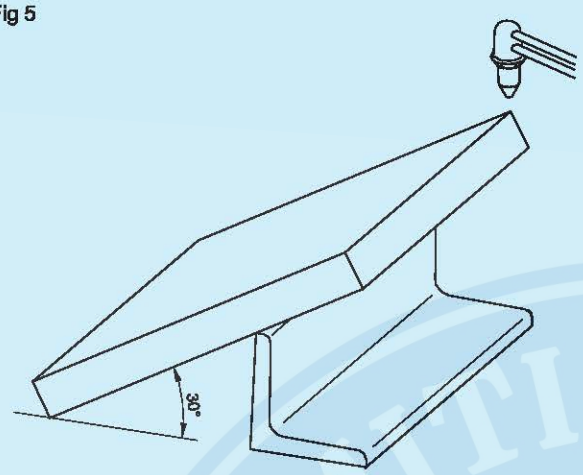
Fig 4



Cutting torch guides: Guides are sometimes used during oxy acetylene cutting.

They can be either a roller guide, double support or spade guide with single support.

Fig 5



ALTERNATIVE METHOD OF CUTTING BEVELLED EDGE ON INCLINE

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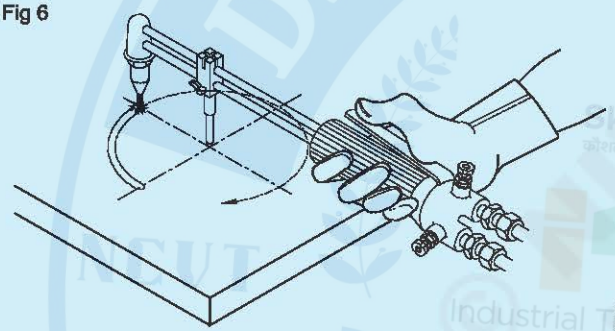
Fig 6



SMALL CIRCLE CUTTING

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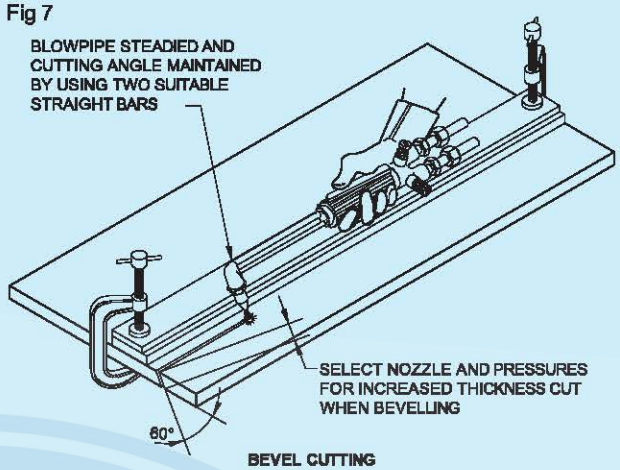
Fig 7



BEVEL CUTTING

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Cutting guides are held onto the nozzle of the cutting torch by tightening a clamp bolt. The clamps, where they are fitted, are adjusted so the inner cones of the preheat flames are approximately 2-3mm above the surface of the metal to be cut. The tip of the cutting nozzle is held at distance of 5-6mm above surface of the plate being cut.