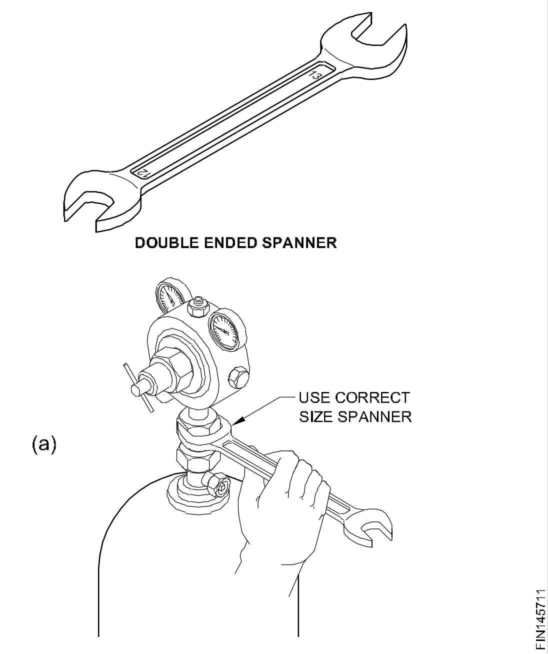
Welding hand tools

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

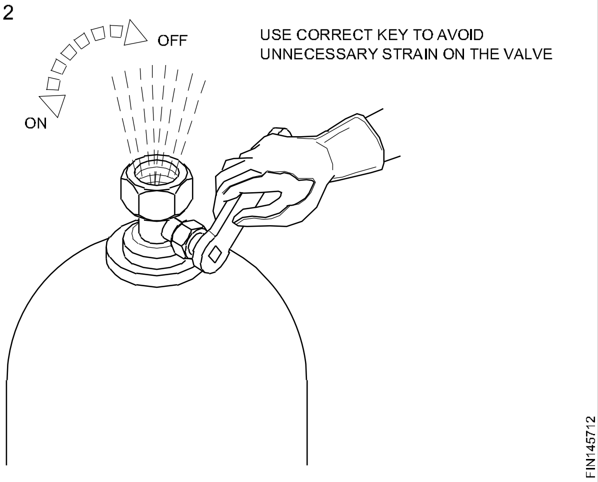


Do not use the spanner as a hammer; use the correct size spanner to avoid damage to the nut/bolt head.

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.

Fig 2

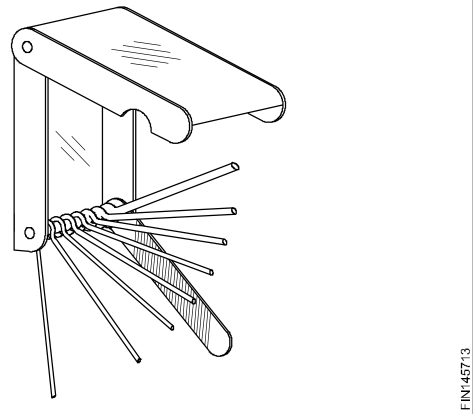


Nozzle or tip cleaner

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.

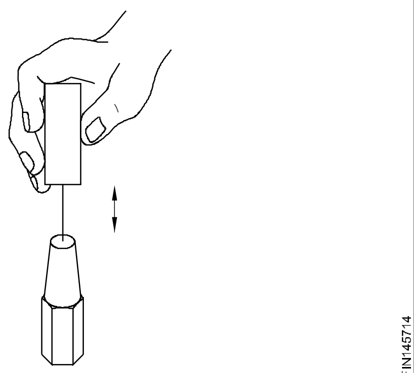
Tip cleaner: A special tip cleaner is supplied with the torch container. For each tip there is a kind of drill and a smooth file Fig.3.

Fig 3



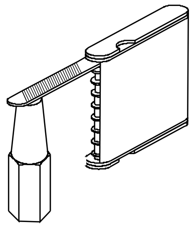
Before cleaning the tip, select the correct drill and move it, without turning, up and down through the hole in the tip Fig.4.

Fig 4



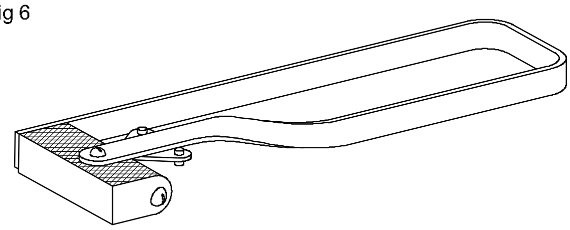
The smooth file is then used to clean the surface of the tip Fig.5. While cleaning, leave the oxygen valve partly open to blow out the dust.

Fig 5



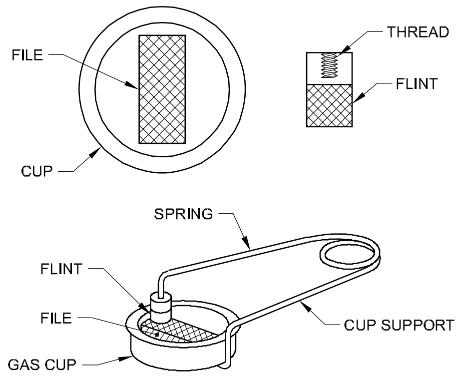
Spark lighter: The spark lighter, as illustrated in Fig.6 & 7 is used for igniting the torch. While welding, form the habit of always employing a spark lighter to light a torch. Never use matches. The use of matches for this purpose is very dangerous because the puff of the flame produced by the ignition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

Fig 6



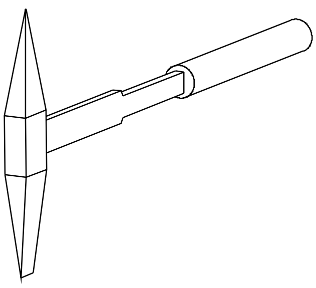
ALWAYS USE A SPARKLIGHTER TO LIGHT A TORCH

Fig 7



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

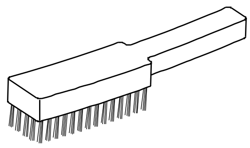


CHIPPING HAMMER

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



WIRE BRUSH

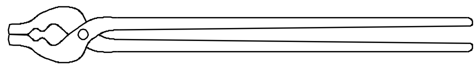
– Cleaning the work surface from rust, oxide and other dirt etc. prior to welding.
– Cleaning the interbead weld deposits after chipping off the slag.
– General cleaning of the weldment.

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.

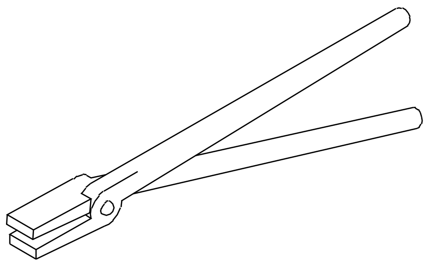
Tongs: Fig.10 and Fig.11 shows a pair of tongs used to hold hot work pieces and to hold the job in position.

Fig 10



TONGS

Fig 11



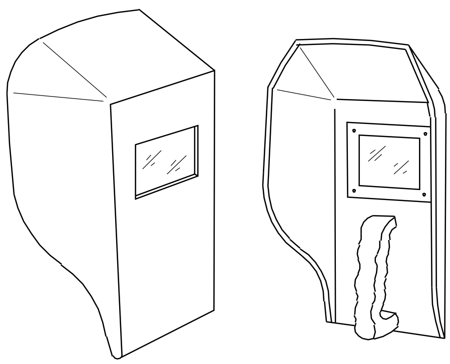
TONGS

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.

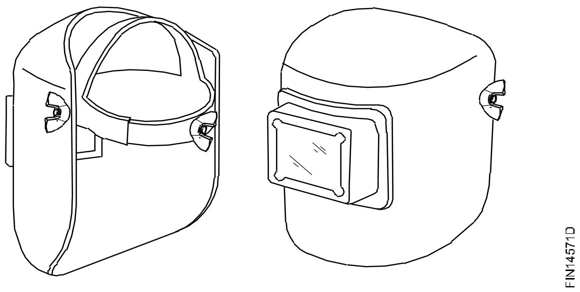
Fig 12



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

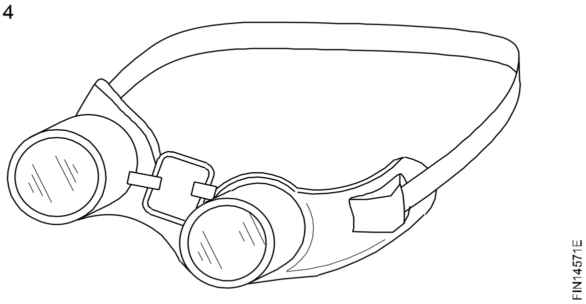


Chipping goggles (Fig 14)

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

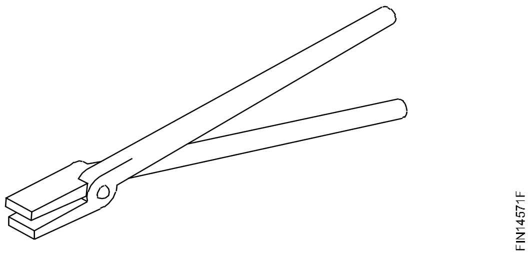


Tong (Fig 15)

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

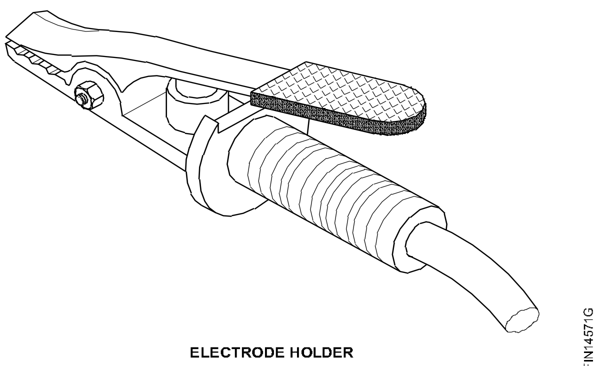
They are also used to hold the metal for hammering.

Fig 15



Electrode holder with cable (Fig 16)

Fig 16

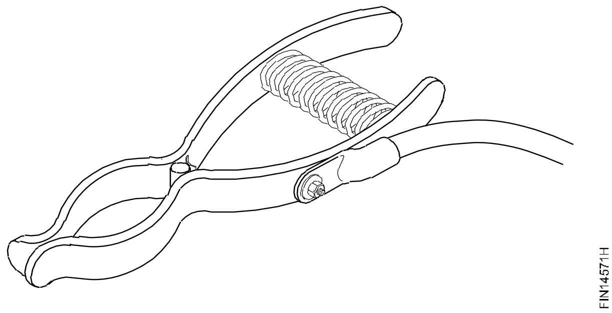


An electrode holder is used to hold and manipulate the electrode.

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



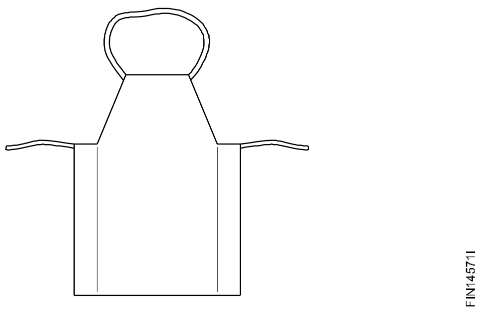
An earth clamp is used to connect the return lead firmly to the job or to the welding table.

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



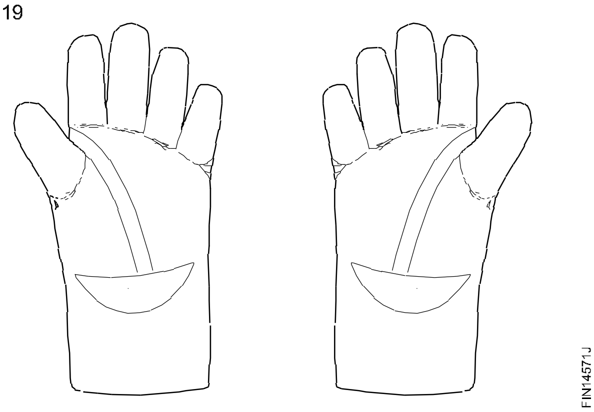
An apron is used to protect the body.

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



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

The gloves are also made of leather.

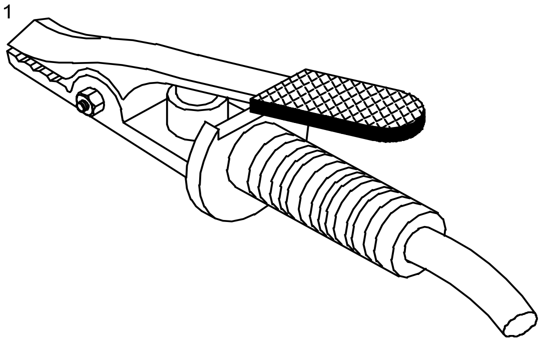
Arc welding accessories

Objectives : At the end of this lesson you shall be able to
- **name the arc welding accessories**
- **explain the function of each accessory.**

Arc welding accessories: Some very important items, used by a welder with an arc welding machine during the welding operation, are called arc welding accessories.

Electrode-holder(Fig 1): It is a clamping device used to grip and manipulate the electrod eduring arc welding. It is made of copper/copper alloy for better electrical conductivity.

Fig 1



ELECTRODE HOLDER

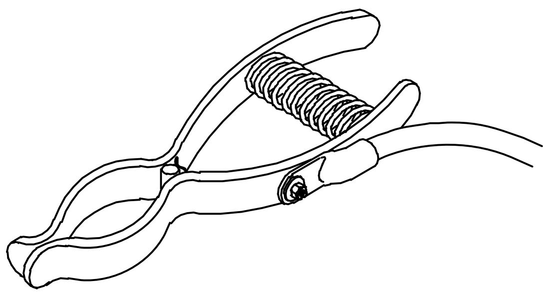
FIN145781

Partially or fully insulated holders are made in various sizes i.e 200-300-500 amps

The electrode-holder is connected to the welding machine by a welding cable.

Earth clamp(Fig 2): It is used to connect the earth cable firmly to the job or welding table. It is also made of copper/copper alloys.

Fig 2



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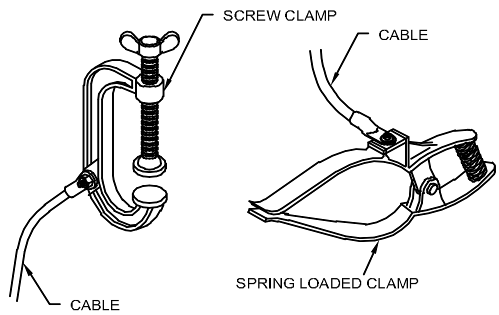
Screw or spring-loaded earth clamps are made in various sizes i.e. 200-300-500 amps. (Fig 3)

Fig 3



WORK CABLE ATTACHMENTS

FIN145783

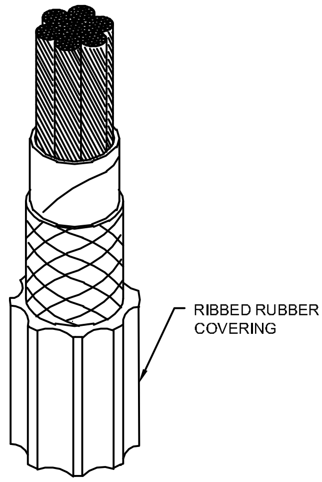
Welding cables/leads: These are used to carry the welding current from the welding machine to the work and back.

The lead from the welding machine to the electrode-holder is called electrode cable.

The lead from the work or job through the earth clamp to the welding machine is called earth(ground)cable.

Cables are made of super flexible rubber insulation,having fine copper wires and woven fabric reinforcing layers. (Fig 4)

Fig 4



WELDING CABLE WITH HEAVY RIBBED OUTER RUBBER COVERING

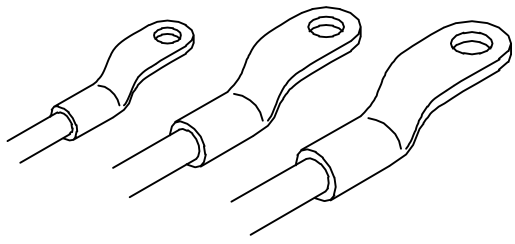
FIN145784

Welding cables are made in various sizes (cross-sections) i.e.300, 400,600 amps etc.

The same size welding cables must be used for the electrode and the job.

The cable connection must be made with suitable cable attachments (lugs) (Fig 5).

Fig 5



LUGS FOR WELDING LEADS

THE THREE SIZES WILL FIT CABLES FROM NO 6 TO 4/0. THEY MAY BE CONNECTED TO THE LEAD BY SOLDERING OR MECHANICAL CRIMPING

FIN145785

Loose joints or bad contacts cause overheating of the cables.

The length of the cable has considerable effect on the size to be used. (See Table 1).

Voltage drop app. 4 volts with all connections clean and tight.

Table 1

Recommendations of copper cable for arc weld-

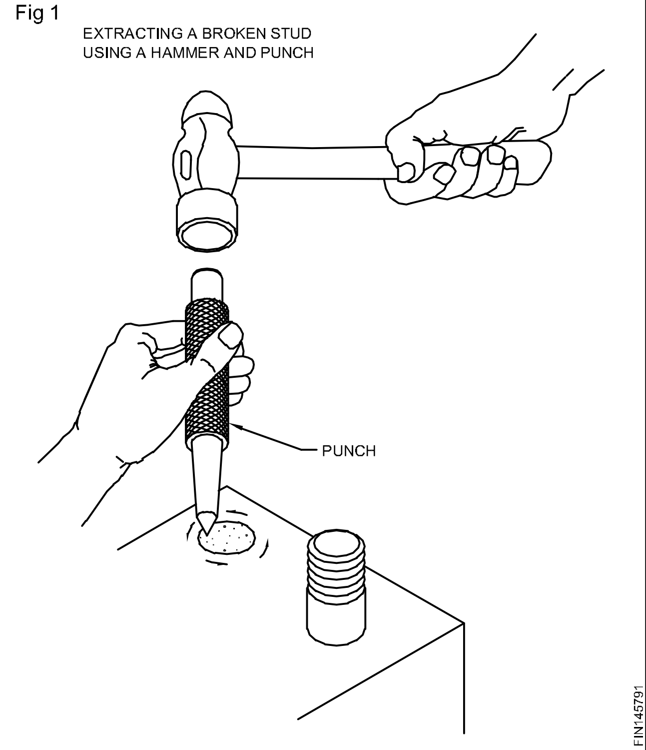
Cable dia. (mm)	Length of cable in metres Current capacity in am-		
	0 - 15	15 - 30	30 - 75
24.0	600	600	400
21.0	500	400	300
19.0	400	350	300
18.0	300	300	200
16.5	250	200	175
15.0	200	195	150
14.5	150	150	100
13.5	125	100	75

Hammer

Objectives : At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **name the parts of an engineer's hammer and state their functions**
- **name the types of engineer's hammers**
- **specify the engineer's hammer.**

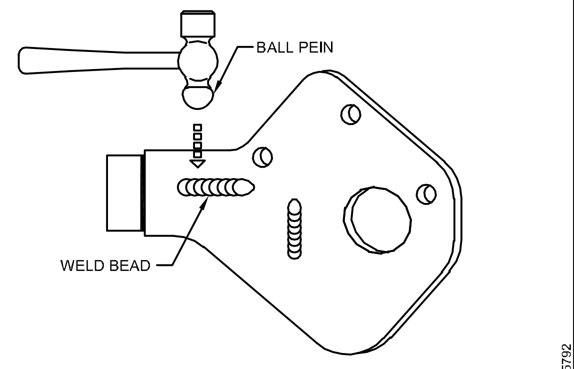
An engineer's hammer is a hand tool used for striking purposes while

Fig 1



- Punching (Fig.1)
- Bending
- Straightening
- Chipping
- Peening(Fig.2)
- forging
- riveting

Fig 2



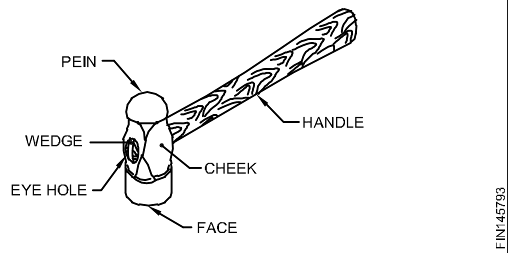
PEEN THE WELD BEAD WHILE IT IS COOLING

Major parts of a hammer: The major parts of a hammer are a head and a handle.

The head is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

The parts of a hammer-head are the face, pein, cheek, eye hole(Fig 3)

Fig 3



Face: The face is the striking portion, Slight convexity is given to it to avoid digging of the edge into the job.

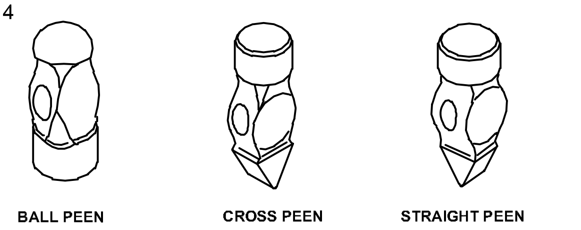
Peen or Pein: The pein is the other end of the head. It is used for shaping and forming work like riveting. Peening and bending. The pein is of different shapes(Fig.4) like the

Ball pein

Cross pein

straight pein

Fig 4



The face and the pein are hardened.

A welder uses the ball pein hammer for punching,chiseling, peening, removing bends and for straightening of sheets.

Cheek: The cheek is the middle portion of the hammer head.The weight of the hammer is stamped here.

This portion of the hammer-head is left soft.

Eye hole: An eye hole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eye hole. (See Figs 5 and 6)

Fig 5

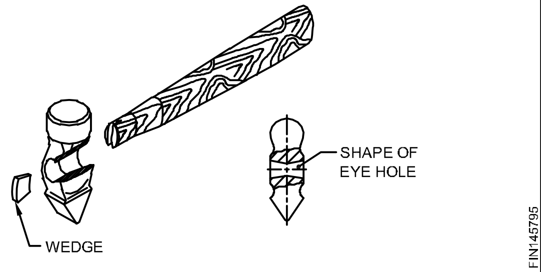
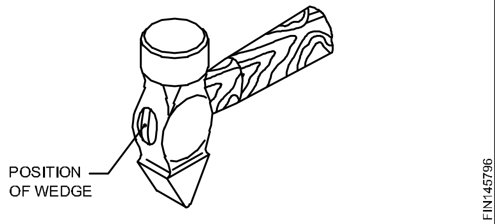


Fig 6



Specification: An engineer's hammer is specified by their wegiht and the shape of the pein. Their weight varies from 125g to 1500 g.

The weight of an engineer's hammer, used by a welder is 1000 g and for making purposes, is 500g.

The ball pein hammers are used for general work in a workshop.

Before using a hammer

- **Make sure the handle is properly fitted.**
- **Select a hammer with the correct weight suitable for the job.**
- **Check the head and handle for any cracks.**
- **Ensure the face of the hammer is free from oil or grease.**
- **Always the handle is to be held at its extreme end while hammering.**

Types and uses of welding processes

Objectives : At the end of this lesson you shall be able to
- **state the classify the electric welding processes**
- **state the classify the gas welding processes**
- **name and classify the other welding processes**
- **state the applications of various welding processes.**

According to the sources of heat, welding processes can be broadly classified as:

- Electric welding processes(heat source is electricity)
- Gas welding processes (heat source is gas flame)
- Other welding processes (heat source is neither electricity nor gas flame)

Electric welding processes can be classified as:-

- Electric arc welding
- Electric resistance welding
- Laser welding
- Electron beam welding
- Induction welding

Electric arc welding can be further classified as:

- Shielded Metal Arc Welding/Manual Metal Arc Welding
- Carbon arc welding
- Atomic hydrogen arc welding
- Gas Tungsten Arc Welding / TIG Welding
- Gas Metal Arc Welding / MIG/MAG Welding
- Flux cored arc welding
- Submerged arc welding
- Electro-slag welding
- Plasma arc welding.

Electric resistance welding can be further classified as:

- Spot welding
- Seam welding
- Butt welding
- Blash butt welding

Projection welding

Gas welding processes can be classified as:

- Oxy-acetylene gas welding
- Oxy-hydrogen gas welding

The other welding processes are:

- Thermit welding
- Forge welding
- Friction welding
- Ultrasonic welding
- Explosive welding
- Cold pressure welding
- Plastic welding

Code	**Welding process**
AAW	Air Acetylene
AHW	Atomic Hydrogen
BMAW	Bare Metal Arc
CAW	Carbon Arc
EBW	Electron Beam
ESW	Electro Gas
ESW	Electroslag
FCAW	Flux cored Arc
FW	Flash
FLOW	FLOW
GCAW	Gas Carbon Arc
GMAW	Gas Metal Arc
GTAW	Gas Tungsten Arc
IW	Induction
LBW	Laser Beam
OAW	Oxy-Acetylene
OHW	Oxy-Hydrogen
PAW	Plasma Arc
PGW	Pressure Gas
RPW	Resistance Projection
RSEW	Resistance Seam
SAW	Submerged Arc
SMAW	Shielded Metal Arc
SCAW	Shielded Carbon Arc
SW	Stud Arc
TW	Thermit
UW	Ulrosonic

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 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.

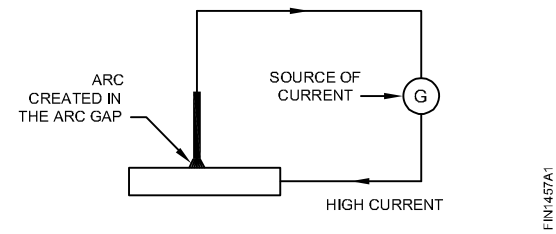
Flash butt welding is used to join heavy sections of rods/ blocks similar to butt welding except that arc flashes are produced at the joining ends to melt them before applying heavy pressure to join them.

Principle and method of operating of arc welding

Objectives : At the end of this lesson you shall be able to
- **state the methods of operating the ARC welding.**

When high current passes through an air gap from one conductor to another, it produces very intense and concentrated heat in the form of a spark. The temperature of this spark(or arc) is app. 3600°C, which can melt and fuse the metal very quickly to produce a homogeneous weld (Fig 1)

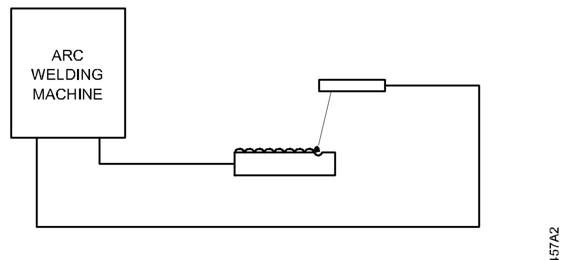
Fig 1



Shielded Metal Arc welding (Fig 2): This is an arc welding process in which the welding heat is obtained from an arc, formed between a metallic (consumable) electrode and welding job.

The metal electrode itself melts and acts as a filler metal.

Fig 2

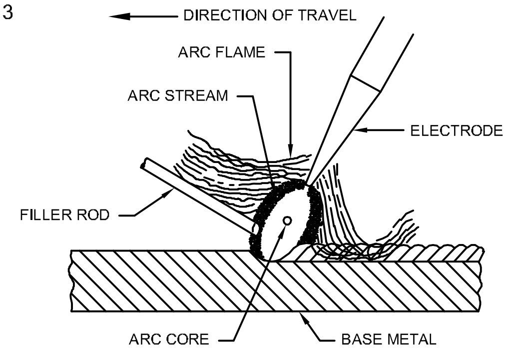


ARC WELDING

Carbon arc welding (Fig 3): Here the arc is formed between a carbon electrode (non-consumable)and the welding job.

A separate filler rod is used since the carbon electrode is a non-metal and will not melt.

Fig 3



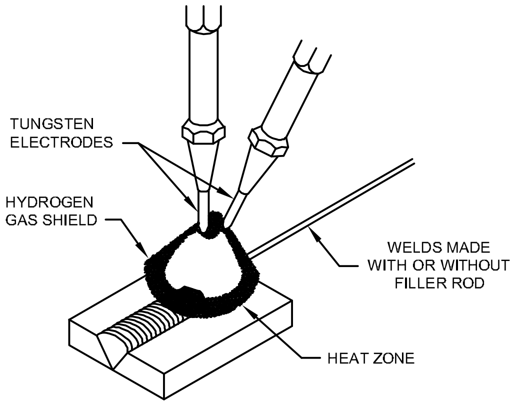
CARBON ARC WELDING

Atomic hydrogen arc welding (Fig4): In this process the arc is formed between two tungsten electrodes in an atmosphere of hydrogen gas.

The welding job remains out of the welding circuit.

A separate filler rod is used to add the filler metal.

Fig 4



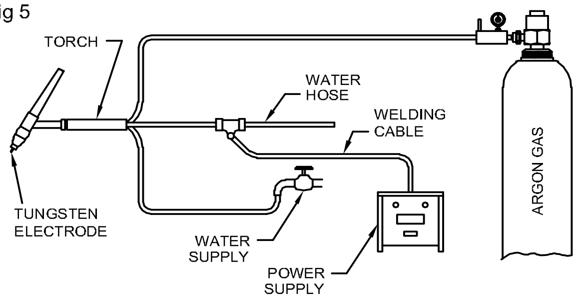
ATOMIC HYDROGEN WELDING PROCESS

Tungsten inert gas arc welding(TIG) (Fig 5): In this case the arc is formed between the tungsten electrodes (non-consumable) and the welding job in an atmosphere of an inert gas (argon or helium)

A separate filler rod is used to add the filler metal

This process is also called gas tungsten arc welding (GTAW)process.

Fig 5



Gas metal arc welding (GMAW) or Metal inert gas arc welding (MIG) (Fig 6): In this process the arc is formed between a continous, automatically fed, metallic consumable electrode and welding job in an atmosphere of inert gas, and hence this is called metal inert gas arc welding (MIG) process.

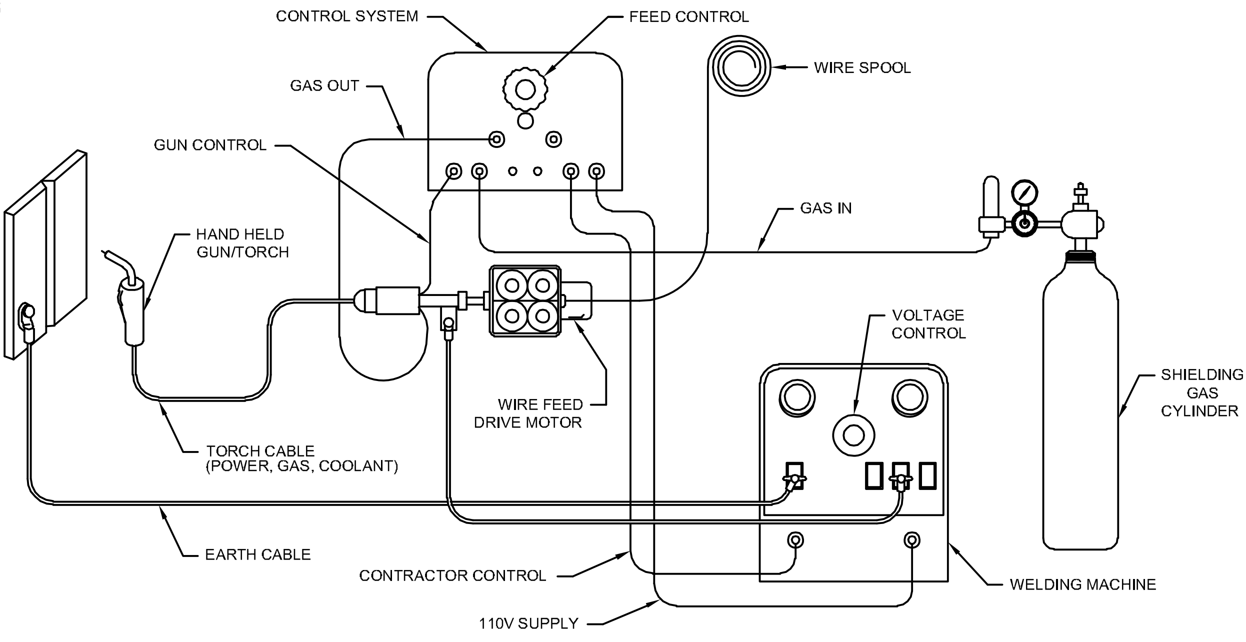
When the inert gas is replaced by carbon dioxide then it is called CO arc welding or metal active gas (MAG) arc welding.

The common name for this process is gas metal arc welding(GMAW)

Submerged arc welding (Fig7): Here the arc is formed between a continous, automatically fed, metallic consumable electrode and the welding job under a heap of powdered/granulated flux.

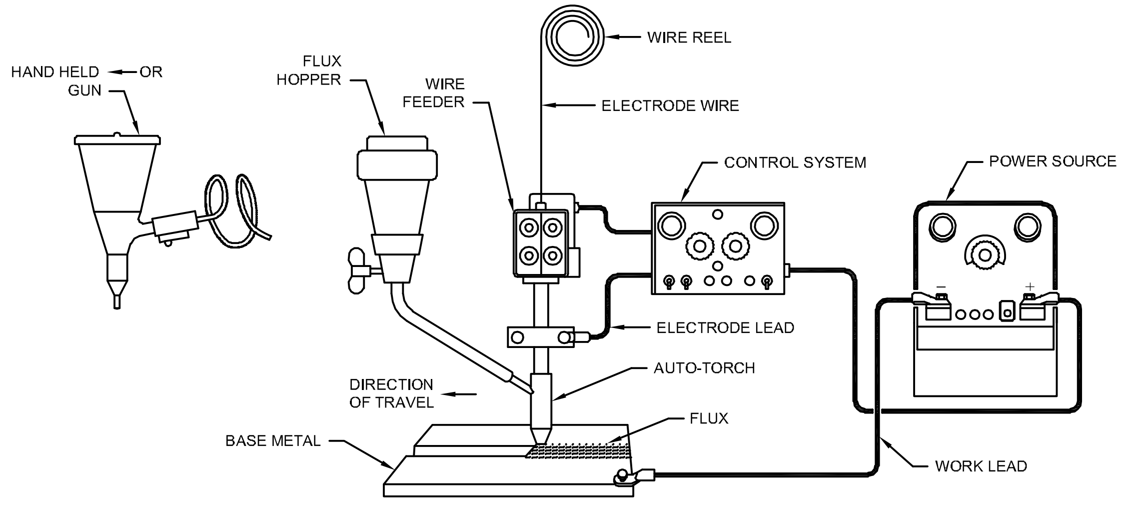
The arc is totally submerged in the flux (invisible)

Fig 6



BLOCK DIAGRAM (GMAW/MIG)

Fig 7



SUBMERGED ARC WELDING

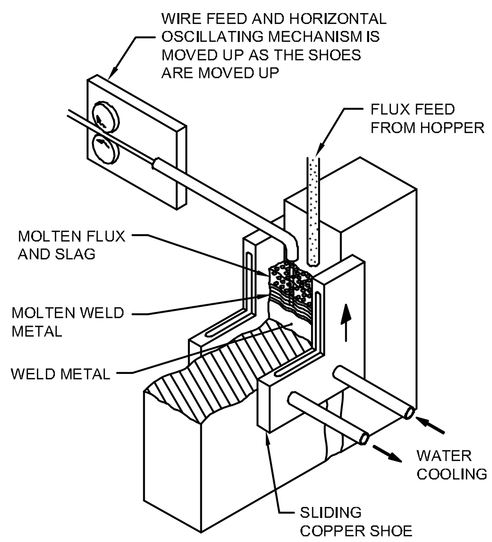
Electro-slag welding (Fig 8): The arc is formed between a continous, automatically fed, metallic consumable electrode and the welding job under a thick pool of molten flux (slag).

This automatic process requires special equipment and is used only in vertical position for the welding of heavy thick plates.

Plasma arc welding(Fig 9): In this process the arc is formed between a tungsten electrode and the welding job in an atmosphere of plasma-forming gas-nitrogen, hydrogen and argon.

A separate filler rod is used to add the filler metal in the joint. if necessary. But normally no filler rod is used.

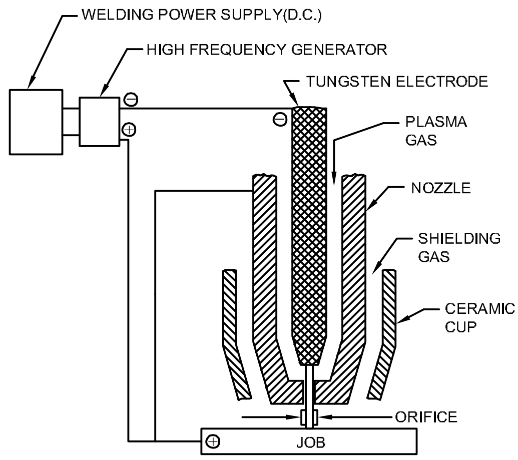
Fig 8



The process is similar to TIG welding.

Plasma cutting is used to cut non-ferrous metals and alloys successfully and quickly.

Fig 9



PLASMA ARC WELDING SYSTEM

Material preparation method

Objectives : At the end of this lesson you shall be able to
- **State the necessity of preparing the materials to be welded**
- **State different methods used to cut mild steel sheets and plates to the required size before welding**
- **Name different tools and equipments used to prepare the mild steel sheets and plates.**

Necessity of materials prepartion for welding: While fabricating(producing or making)different components/parts by welding, different sizes of plates, sheets, pipes, angles, channels with different dimensions are joined together to get the final objects. For example, a railway compartment, an aeroplane, an oil or water pipe line, a gate, a window grill, a stainless steel milk tank, etc. So these objects can be made to the required dimensions only by cutting them from the larger size sheets, plates, pipes etc. which are available in standard sizes, thickness, diameters and lengths in the market. Hence cutting and preparing the base metal to the required dimensions from the original material available in many store is necessary before welding them.

Also the base metals before cutting them to size will have impurities like dirt, oil, paint, water and surface oxides, due to long storage.

These impurities will affect the welding and will create some defects in the welded joint. These defects will make the joint weak and it is possible that the welded joint will break, if the weld defects are present in the welded joints.

So in order to get a strong welded joint, it is necessary to clean the surfaces to be joined and remove the dirt, oil paint, water, surface oxide etc. from the joining surfaces before welding.

Different methods used to cut metals

1 By chiselling the sheets

2 By hacksawing

3 By shearing using hand lever shear

4 By using guillotine shear

5 By gas cutting

For thin sheets the first 4 methods are used. For thick materials method 2,4 and 5 are used.

Tools and equipments used to cut metals

1 Cold chisel

2 Hacksaw blade with frame

3 Hand lever shear

4 Guillotine shear

5 Oxy-acetylene cutting torch

The cut edges of the sheet or plate are to be filed to remove burrs and to make the edges to be square(at 90°angle)with each other. For ferrous metal plates,which are more than 3mm thick, the edges can be prepared by grinding them on a bench/pedestal grinding machine.

Welding description (fusion, non-fusion and pressure)

Objectives : At the end of this lesson you shall be able to
- **distinguish between fusion and non-fusion welding**
- **state the method of pressure welding.**

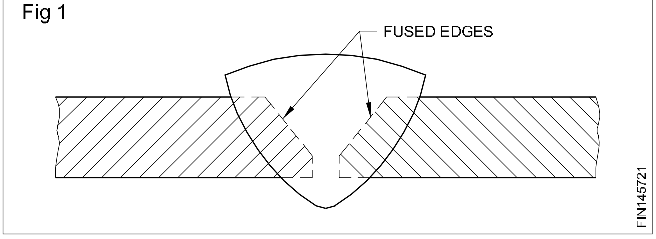
Welding is a method of joining metals permanently.

The method used in ancient days was forge welding.

Types of welding

Fusion welding (Fig 1)

Fig 1



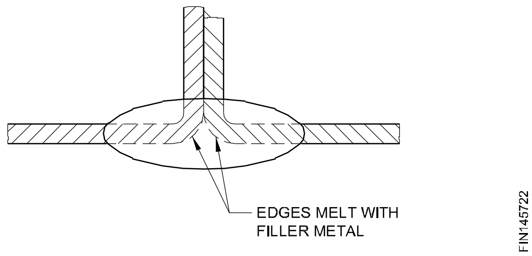
A method of welding in which similar metals are joined together by melting and fusing their joining edges with or without the addition of filler metal but without the application of any kind of pressure is known as fusion welding. The joint made is permanent. The common heating sources are arc welding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

The heat source may be arc or gas welding as in fusion welding.

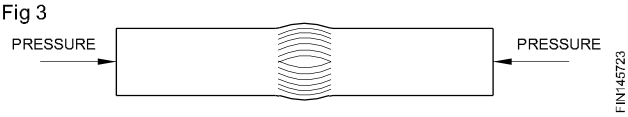
Fig 2



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

Pressure welding (Fig 3)

Fig 3



Pressure welding is a method of welding in which similar metals are joined together by heating them to a 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).

Welding processes

Objectives : At the end of this lesson you shall be able to
- **list the different welding process**
- **describe the welding process of SMAW, GMAW & GTAW**
- **select the welding process depending up on the requirements.**

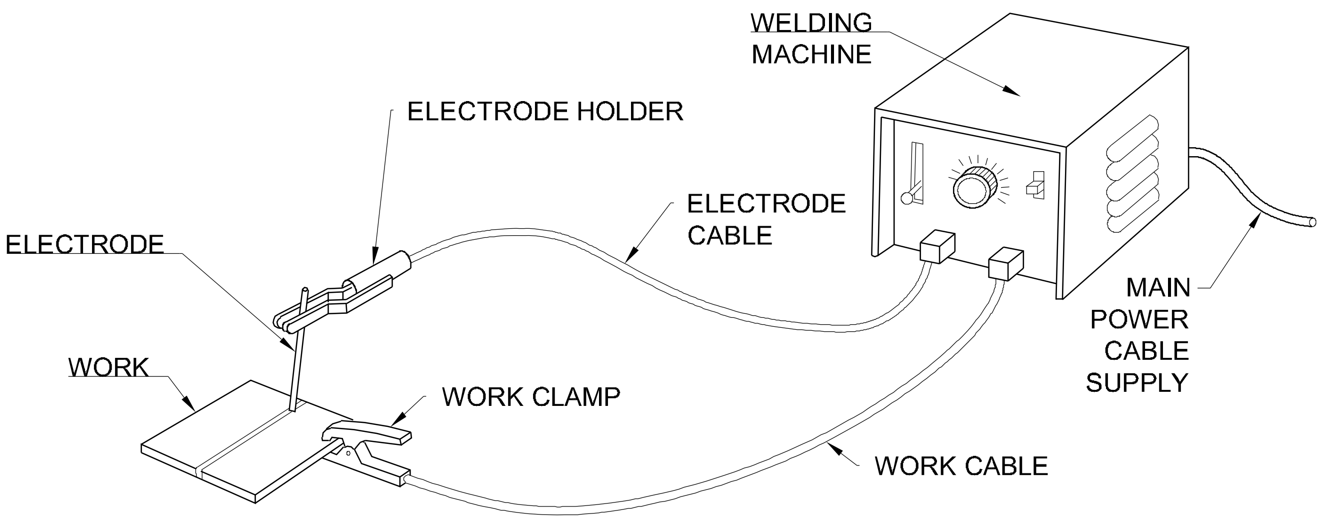
Welding Processes

- The number of different welding processes has grown in recent years. These processes differ greatly in the manner in which heat and pressure (when used) are applied, and in the type of equipment used. There are currently over 50 different types of welding processes; we'll focus on 3 examples of electric arc welding, which is the most common form of welding.
- The most popular processes are shielded metal arc welding (SMAW), gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW).
- All of these methods employ an electric power supply to create an arc which melts the base metal(s) to form a molten pool. The filler wire is then either added automatically (GMAW) or manually (SMAW & GTAW) and the molten pool is allowed to cool.
- Finally, all of these methods use some type of flux or gas to create an inert environment in which the molten pool can solidify without oxidizing.

Shielded Metal Arc Welding (SMAW) (Fig 1)

SMAW is a welding process that uses a flux covered metal electrode to carry an electrical current. The current forms an arc that jumps a gap from the end of the electrode to the work. The electric arc creates enough heat to melt both the electrode and the base materials. Molten metal

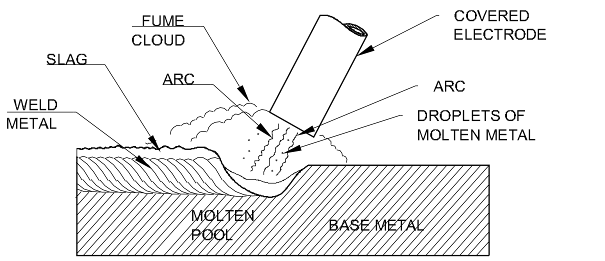
Fig 1



SHIELDED METAL ARC WELDING

from the electrode travels across the arc to the molten pool of base metal where they mix together. As the arc moves away, the mixture of molten metals solidifies and becomes one piece. The molten pool of metal is surrounded and protected by a fume cloud and a covering of slag produced as the coating of the electrode burns or vaporizes (Fig 2). Due to the appearance of the electrodes, SMAW is commonly known as 'stick' welding.

Fig 2



SHIELDED METAL ARC WELDING

SMAW is one of the oldest and most popular methods of joining metal. Moderate quality welds can be made at low speed with good uniformity. SMAW is used primarily because of its low cost, flexibility, portability and versatility. Both the equipment and electrodes are low in cost and very simple. SMAW is very flexible in terms of the material thicknesses that can be welded (materials from 1.5mm thick to several millimeter thick can be welded with the same machine and different settings). It is a very portable process because all that's required is a portable power supply (i.e. generator). Finally, it's quite versatile because it can weld many different types of metals, including cast iron, steel, nickel & aluminum.

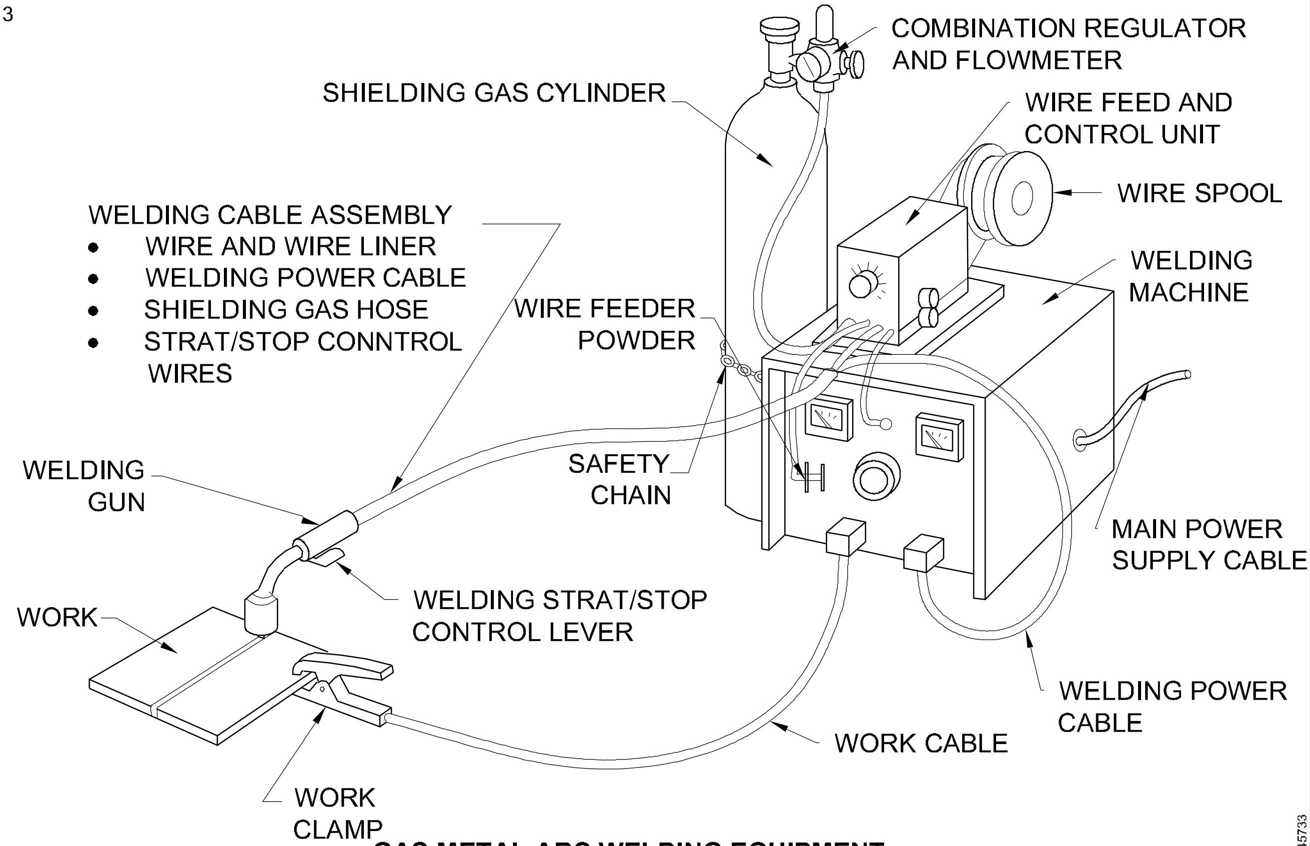
Some of the biggest drawbacks to SMAW are (1) that it produces a lot of smoke & sparks, (2) there is a lot of post-weld cleanup needed if the welded areas are to look presentable, (3) it is a fairly slow welding process and (4) it requires a lot of operator skill to produce consistent quality welds.

Gas Metal Arc Welding (GMAW) (Fig.3)

In the GMAW process, an arc is established between a continuous wire electrode (which is always being consumed) and the base metal. Under the correct conditions, the wire is fed at a constant rate to the arc, matching the rate at which the arc melts it. The filler metal is the thin wire that's fed automatically into the pool where it melts. Since molten metal is sensitive to oxygen in the air, good shielding with oxygen-free gases is required. This shielding gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, GMAW is commonly known as MIG (*metal inert gas*) welding. Since fluxes are not used (like SMAW), the welds produced are sound, free of contaminants, and as corrosion-resistant as the parent metal. The filler material is usually the same composition (or alloy) as the base metal. (Fig.4)

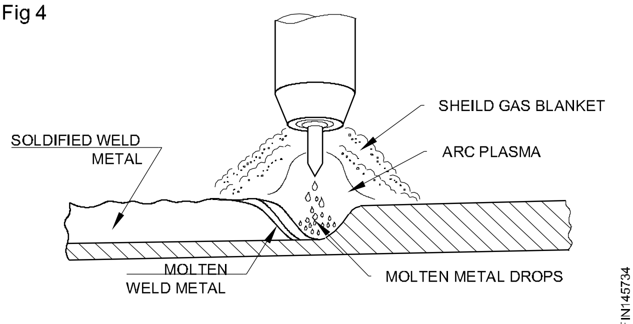
GMAW is extremely fast and economical. This process is easily used for welding on thin-gauge metal as well as on heavy plate. It is most commonly performed on steel (and its alloys), aluminum and magnesium, but can be used with other metals as well. It also requires a lower level of operator skill than the other two methods of electric arc welding discussed in these notes. The high welding rate and reduced post-weld cleanup are making GMAW *the* fastest growing welding process.

Fig 3



GAS METAL ARC WELDING EQUIPMENT

Fig 4



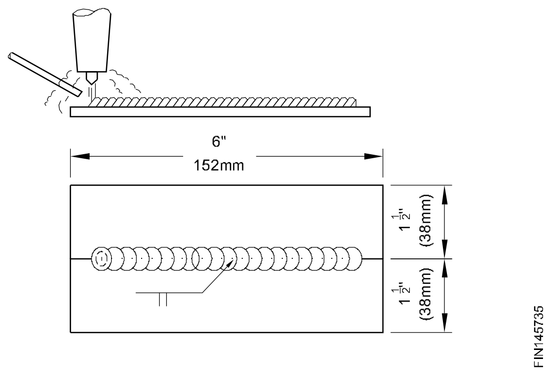
Gas Tungsten Arc Welding (GTAW) (Fig. 5)

In the GTAW process, an arc is established between a tungsten electrode and the base metal. Under the correct conditions, the electrode does not melt, although the work does at the point where the arc contacts and produces a weld pool. The filler metal is thin wire that's fed manually into the pool where it melts. Since tungsten is sensitive to oxygen in the air, good shielding with oxygen-free gas is required. The same inert gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, GTAW is commonly known as TIG (tungsten inert gas) welding. Because fluxes are not used (like SMAW), the welds produced are sound, free of contaminants and slags, and as corrosion-resistant as the parent metal.

Tungsten's extremely high melting temperature and good electrical conductivity make it the best choice for a non-consumable electrode. The arc temperature is typically around 11,000° F. Typical shielding gasses are Argon (Ar), Helium (He), Nitrogen (N) or a mixture of the two. As with GMAW, the filler material usually is the same composition as the base metal.

GTAW is easily performed on a variety of materials, from steel and its alloys to aluminum, magnesium, copper, brass, nickel, titanium, etc. Virtually any metal that is conductive lends itself to being welded using GTAW. Its clean, high-quality welds often require little or no post-weld finishing. This method produces the finest, strongest welds out of all the welding processes. However, it's also one of the slower methods of arc welding.

Fig 5



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 continously 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)

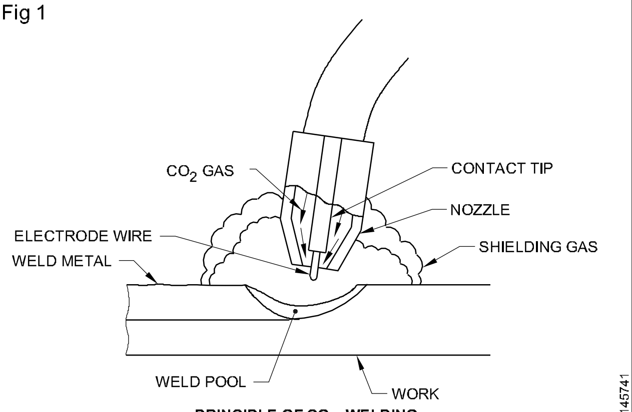
If an inert gas is used to protect the arc produced by a consumable metal electrode, this process is called Metal Inert Gas Welding (MIG).

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.

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.

Fig 1



PRINCIPLE OF CO_2 WELDING

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.

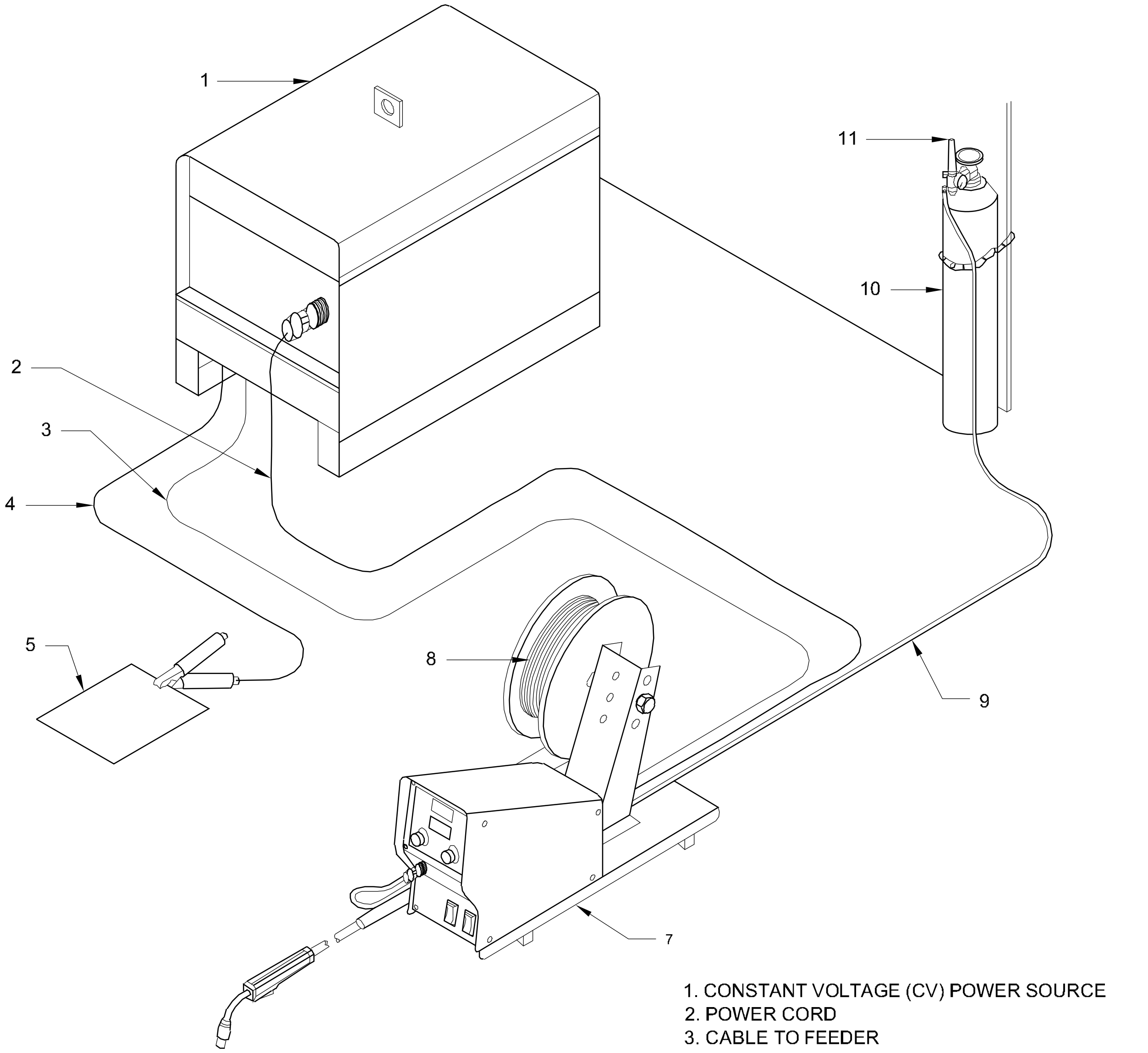


Fig 2

1. CONSTANT VOLTAGE (CV) POWER SOURCE
2. POWER CORD
3. CABLE TO FEEDER
4. GROUND CABLE TO WORKPIECE
5. WORKPIECE
6. WELDING TORCH
7. CONSTANT SPEED WIRE FEEDER
8. ELECTRODE WIRE
9. GAS HOSE
10. SHIELDING GAS CYLINDER
11. GAS REGULATOR WITH FLOW METER

Selection of the welding process

Objectives: At the end of this lesson you shall be able to
- **list the factors considered for selecting welding process**
- **state the advantages and disadvantages of welding process.**

Selection of the welding process

The selection of the joining process for a particular job depends upon many factors. There is no one specific rule governing the type of welding process to be selected for a certain job. A few of the factors that must be considered when choosing a welding process are

- Availability of equipment
- Respectiveness of the operation
- Quality requirements(base metal penetration, consistency, etc)
- Location of work
- Materials to be joined
- Appearance of the finished product
- Size of the parts to be joined
- Time available for work
- Skill experience of workers
- Cost of materials
- Code or specification requirements

General guidelines for selecting one process over another

When selecting one process over the others, it is often useful to examine the principal of each type of welding covered in this lesson.

Welding process	Advantages	Disadvantages
SMAW	Cheap	Major post-weld cleaning
	Portable (no gas required)	Relatively 'dirty' method of welding (sparks/fumes)
	Versatile (can weld various metals & thicknesses)	Requires moderate skill
GMAW	Fastest of all 3 processes	Requires shielding gas
	Versatile (can weld various metals & thicknesses)	Minor post-weld cleaning
GTAW	Highest quality welds	Requires shielding gas
	No post-weld cleaning Versatile (can weld various metals & thicknesses)	Slowest of all 3 processes Requires high degree of operator skill

HP & LP welding equipments 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.**

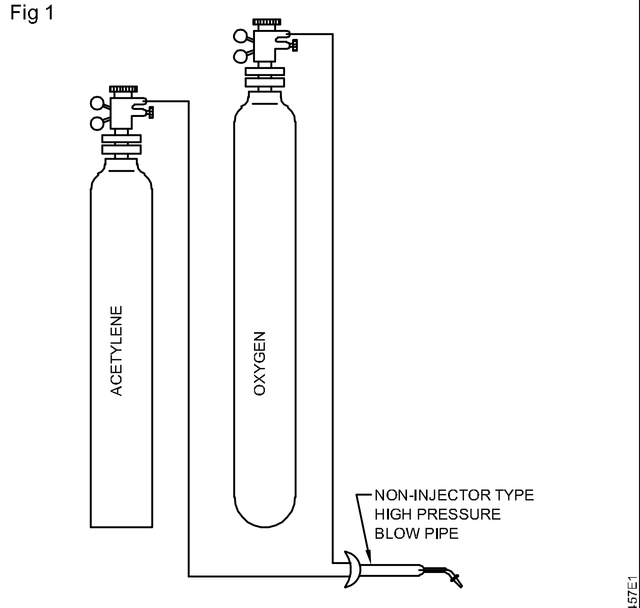
Oxy-acetylene plants: An oxy-acetylene plant can be classified into:

high pressure plant

low pressure plant

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

Fig 1



HIGH PRESSURE OXY-ACETYLENE PLANT

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

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

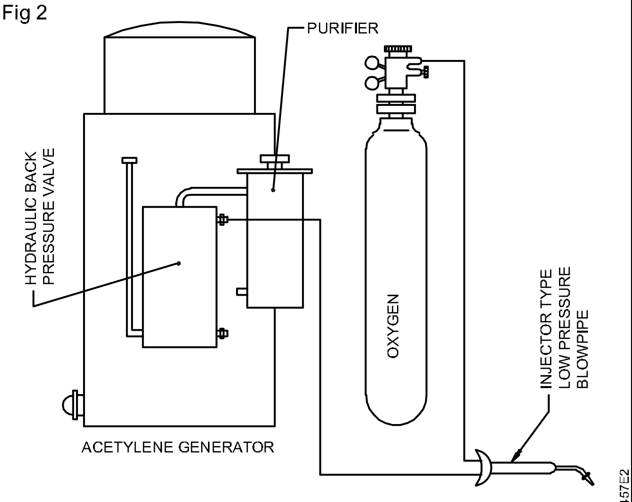
A low pressure plant utilizes acetylene under low pressure(0.017 kg/cm)produced by the acetylene generator only.(Fig 2)

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.

Fig 2



LOW PRESSURE OXY-ACETYLENE PLANT

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.)

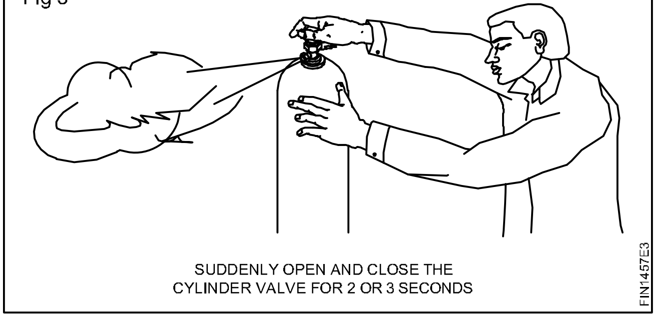
Watch the working pressure gauge.

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

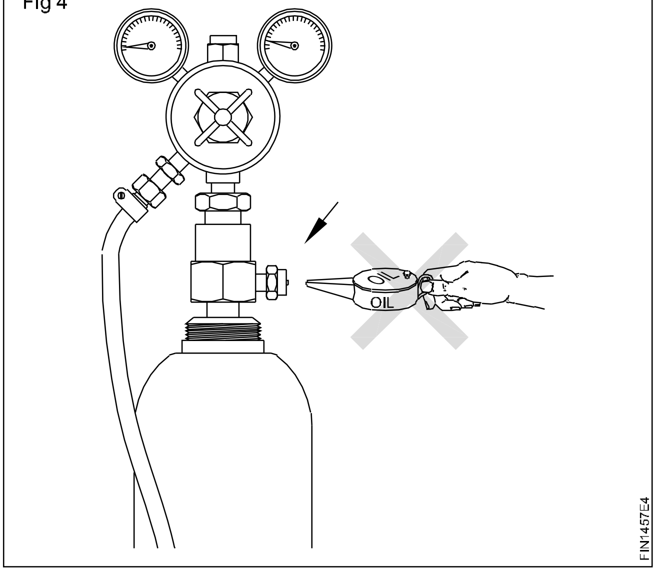


Open the cylinder valve slowly and allow the gas to pass to the regulator (cylinder) content gauge.

Loosen the pressure screw.

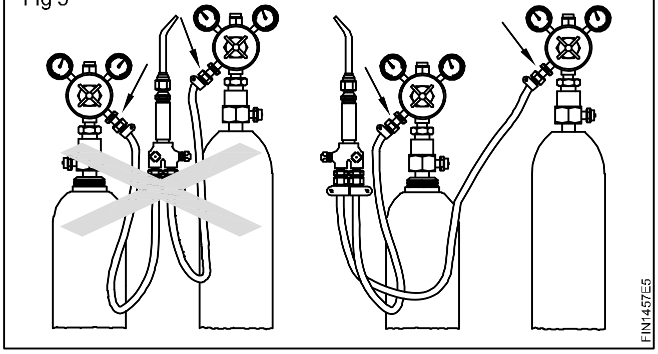
Do not use oil in regular connections. (Fig 4)

Fig 4



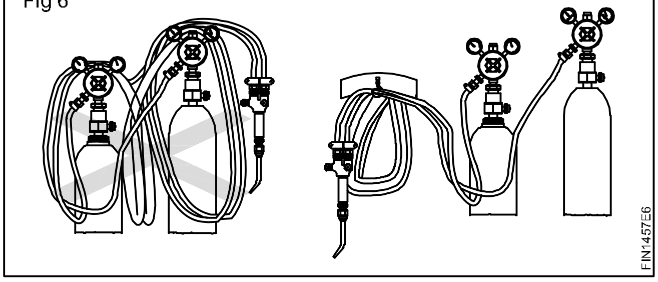
Do not fix the oxygen and acetylene regulators close together (Fig 5)

Fig 5



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

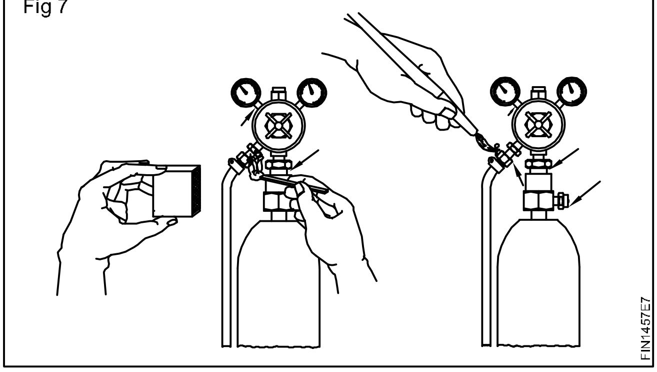
Fig 6



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.

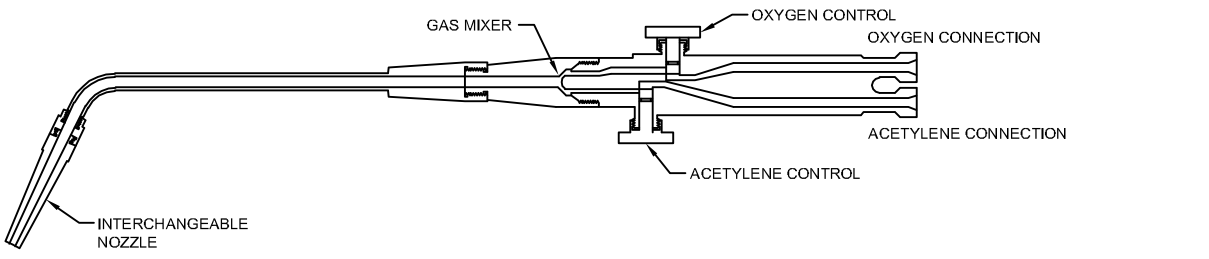
High pressure blowpipe or non-injector bype blowpipe

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.

Fig 1

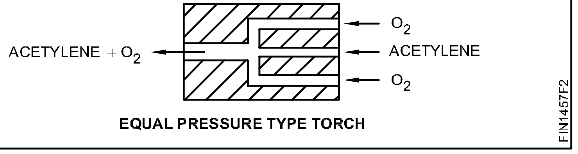


EQUAL OR HIGH PRESSURE BLOWPIPE

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.

Fig 2

GAS PASSAGE IN THE GAS MIXING SECTION



EQUAL PRESSURE TYPE TORCH

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.

Low pressure blowpipe (Fig 3)

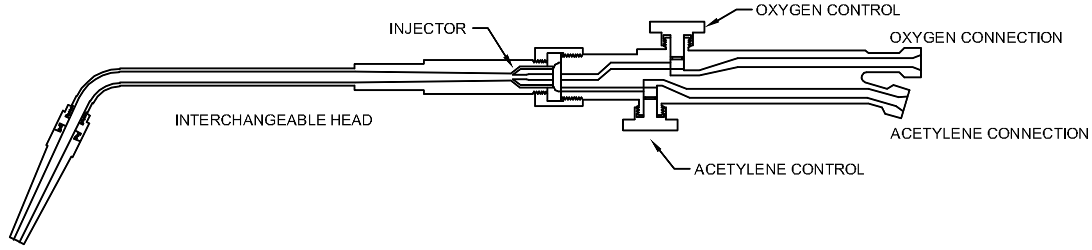
This blowpipe has an injector (Fig 3) inside its body through which the high pressure oxygen passes. This oxygen draws the low pressure acetylene from an acetylene generator into a mixing chamber and gives it the necessary velocity to get a steady flame and the injector also helps to prevent backfiring.

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)

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.

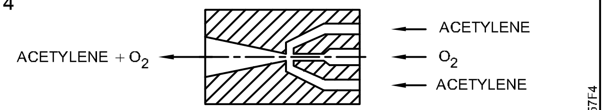
The L.P. blowpipe is more expensive than the H.P. blowpipe but it can be used on a high pressure system, if required.

Fig 3



LOW PRESSURE BLOWPIPE

Fig 4



INJECTOR TYPE TORCH

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 tighening on assembly.

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

Fig 5

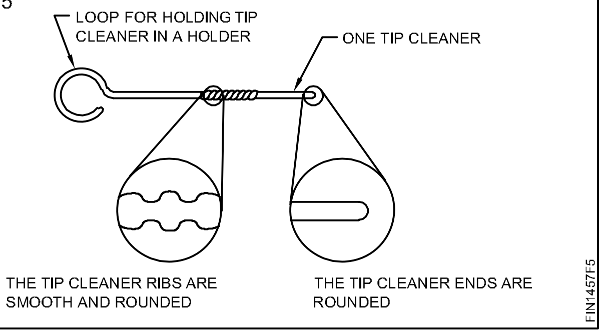
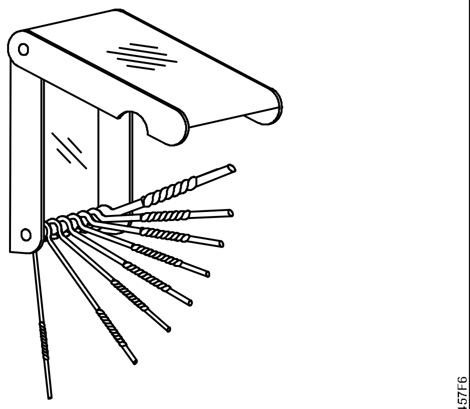
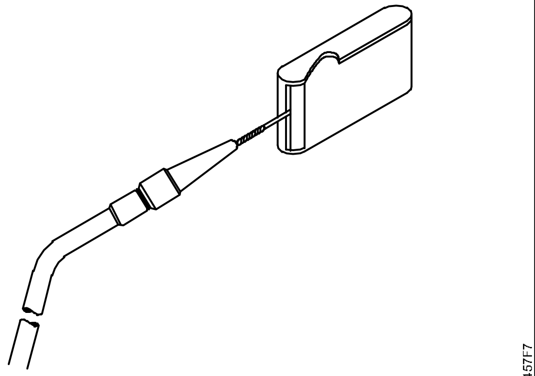


Fig 6



SET OF DIFFERENT SIZE TIP CLEANERS IN A HOLDER

Fig 7



METHOD OF TIP CLEANING

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.

Types of welding joints (butt and fillet)

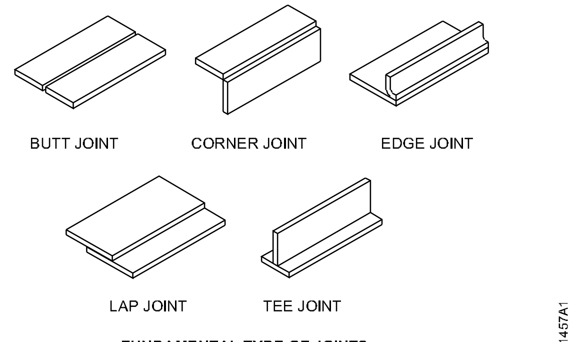
Objectives: At the end of this lesson you shall be able to
- **illustrate and name the basic welding joints**
- **explain the nomenclature of butt and fillet welds.**

Basic welding joints (Fig 1)

The various basic welding joints are shown in Fig 1.

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

Fig 1



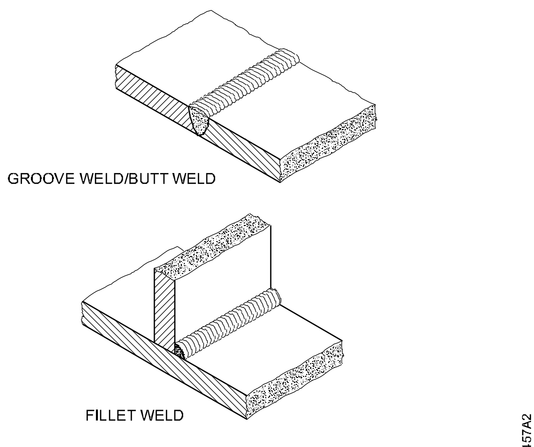
FUNDAMENTAL TYPE OF JOINTS

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

– Groove weld/butt weld

– Fillet weld

Fig 2



TYPE OF 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)

Heat affected zone: Metallurgical properties have been changed by the welding heat adjecent 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 3

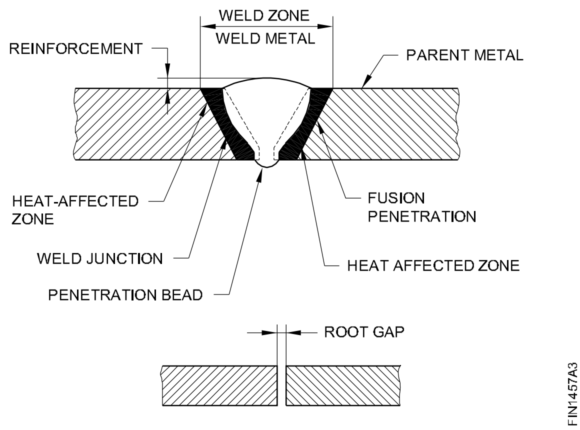


Fig 4

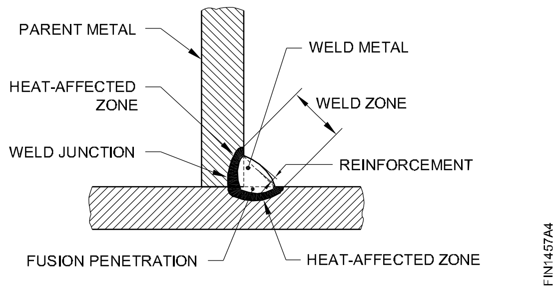
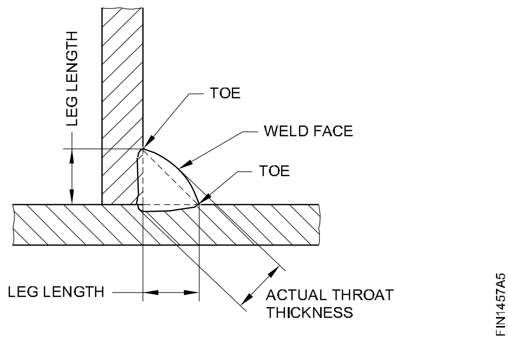
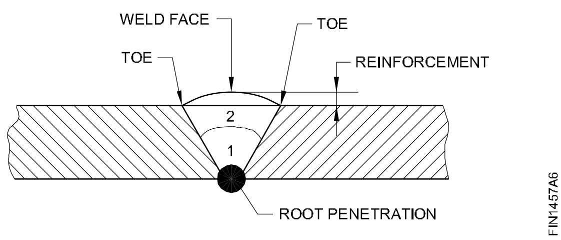


Fig 5



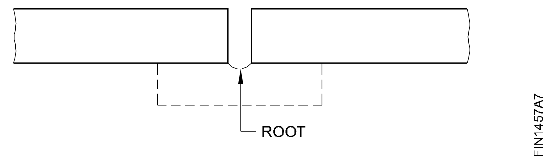
Reinforcement: Metal deposited on the surface of the parent metal or the excess metal over the line joining the two toes. (Fig 6)

Fig 6



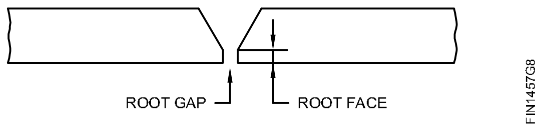
Root: The parts to be joined that are nearest together. (Fig 7)

Fig 7



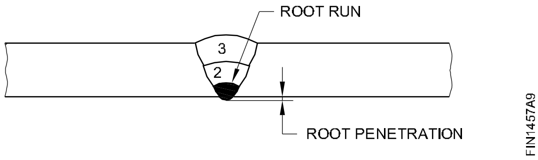
Root face: The surface formed by squaring off the root edge of the fusion face to avoid a sharp edge at the root. (Fig 8)

Fig 8



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

Fig 9



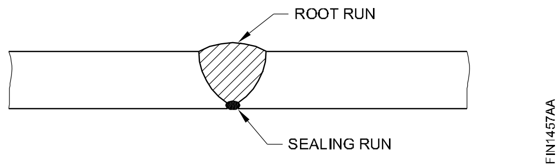
Root penetration: It is the projection of the root run at the bottom of the joint (Fig.6 and 9)

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)

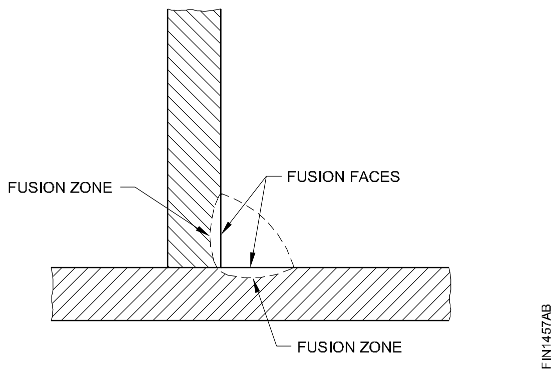
Weld face: The surface of a weld seen from the side from which the weld was made.(Fig 5 & 6)

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



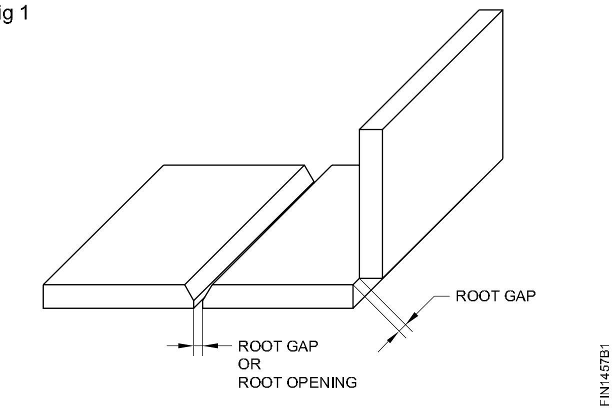
Purpose of root gap, tacking and key hole in the weld joint during welding

Objectives: At the end of this lesson you shall be able to
- **explain the purpose of the root gap kept in the joint before welding**
- **state the purpose of tacking the job pieces before welding and state the importance of key hole during welding.**

Gap: root gap or root opening in welding joints

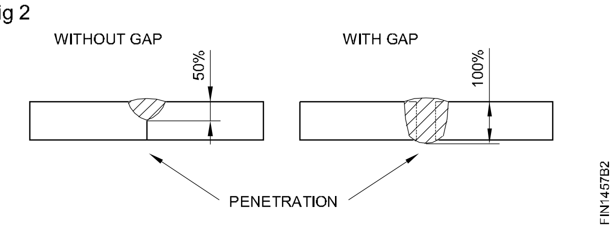
Before welding, the joining parts of the assembly are kept apart for some specific distance. (Fig 1) This distance is called root gap or root opening.

Fig 1



Purpose: The purpose is to obtain the required depth of fusion or complete penetration to the entire depth of the joint during welding. (Fig 2)

Fig 2



The arc has a limitation. It melts only to a certain depth in the base metal. This limit is equal to or less than the diameter of the electrode used. So if root gap is not given the base metal may not be fused till the bottom of the joint. So root gap is essential while welding.

Tack welds: A tack weld is a short weld used to help assembly and to maintain the position of parts during welding.

Tack welds should be between three and four times the plate thickness, upto a maximum length of 35mm at the ends of the joint. (Fig 3 and 4)

Fig 3

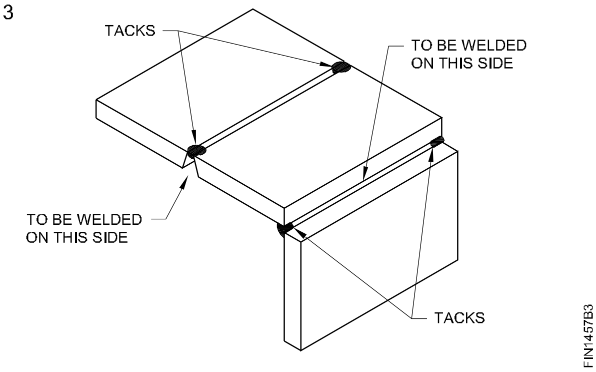
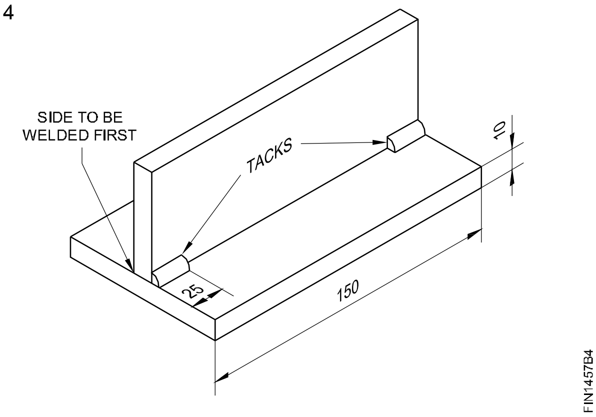


Fig 4



For intermediate tack welds the length should be between two and three times the plate thickness, up to a maximum length of 35mm.

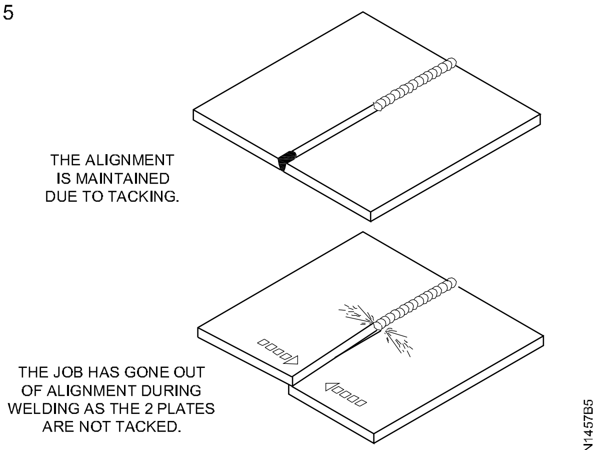
Pitch of tack welds: For mild steel plates of 3mm thickness, the pitch (i.e. distance between centres) of tack welds in butt joints should be 150mm. The pitch should be increased by about 15mm for each 1mm increase in plate thickness, upto maximum of 600mm for thicknesses of 33mm and above.

For lengths less than twice the normal pitch distance, end tack welds only are required. The above pitch distances should be doubled for fillet-welded T-joints.

Tack welds are done on the rear side of the joint and not on the welding side. (Fig.3 and 4)

Purpose: To maintain the root gap and alignment of the assembly parts and for controlling of distortion during welding, tacking is necessary. (Fig 5)

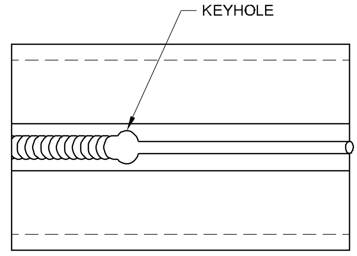
Fig 5



Importance of keyhole during welding: Keyhole is one of the product of welding technique while welding single run weld (corner & butt) or root run in corner and Vee groove welds.

It is a little hole (like a keyhole) at the leading edge of the crater right under the tip of the electrode.(Fig.6)

Fig 6



KEYHOLE TECHNIQUE

It is created to obtain complete penetration without excessive melt through.

A key-hole can be produced by the correct combination of welding current, electrode angles, arc travel speed, electrode motions and arc length. The diameter of the key hole can be slightly (i.e 1mm) more than the root gap. An enlarged key hole will cause a burn through defect.

Edge preparation

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

- **explain the necessity of edge preparation**
- **describe the edge preparation for butt and fillet welds.**

Necessity of edge preparation: Joints are prepared to weld metals at less cost. The preparation of edges are also necessary prior to welding in order to obtain the required strength to the joint. The following factors are to be taken into consideration for the edge preparation.

– The welding process like SMAW, oxy-acetylene welds, Co_2, electro-slag etc.

– The type of metal to be jointed, (i.e.) mild steel, stainless steel, aluminium, cast iron etc.

– The thickness of metal to be joined.

– The type of weld (groove and fillet weld)

– Economic factors

The square butt weld is the most economical to use, since this weld requires no chamferring, provided satisfactory strength is attained. The joints have to be bevelled when the parts to be welded are thick so that the root of the joints have to be made accessible for welding in order to obtain the required strength.

In the interest of economy, bevel butt welds should be selected with minimum root opening and groove angles such that the amount of weld metal to be deposited is the smallest. "J" and "U" butt joints may be used to further minimise weld metal when the savings are sufficient to justify the more difficult and costly chamferring operations. The "J" joint is usually used in fillet welds.

A root gap is recommended since the spacing allows the shrinking weld to draw the plates freely together in the butt joint. Thus, it is possible to reduce weld cracking and minimise distortion and increase penetration, by providing a root gap for some welded joints.

Method of edge preparation: The joining edges may be prepared for welding by any one of the methods mentioned below.

– Flame cutting

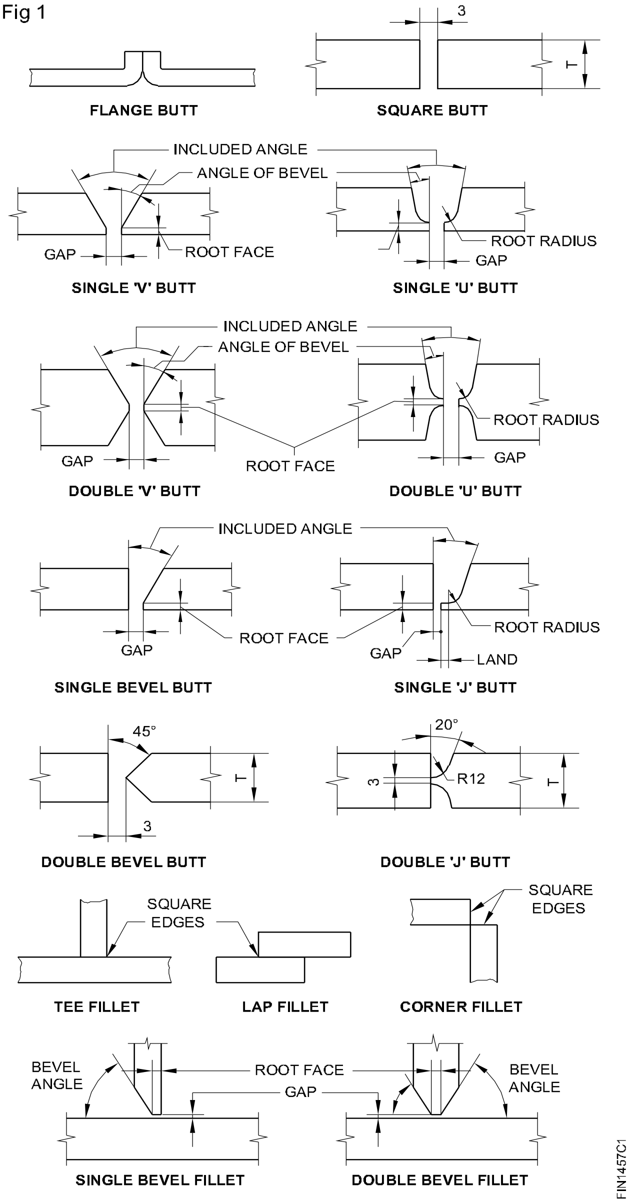
– Machine tool cutting

- Machine grinding or hand grinding
- Filing, chipping

Types of edge preparation and setup

Different edge preparations generally used in arc welding are shown in Fig 1 below.

Fig 1



Basic welding joints and position

Objectives : At the end of this lesson you shall be able to
- **name the basic welding joints from drawings**
- **state the basic welding positions from drawings.**

Basic welding joints (Fig 1)

The following are the basic welding joints.

- Butt joint
- Lap joint
- Tee joint
- Corner joint
- Edge joint

The above types indicate the shape of the joints and how the joining edges of parts are placed together. (Joint designs are very important in fabrication work).

Basic welding positions (Fig 2)

The following are the important basic welding positions

- Flat or downhand position
- Horizontal position
- Vertical position
- Overhead position

Welding action takes place in the molten pool,formed in the welding joint or the welding line.

Fig 1

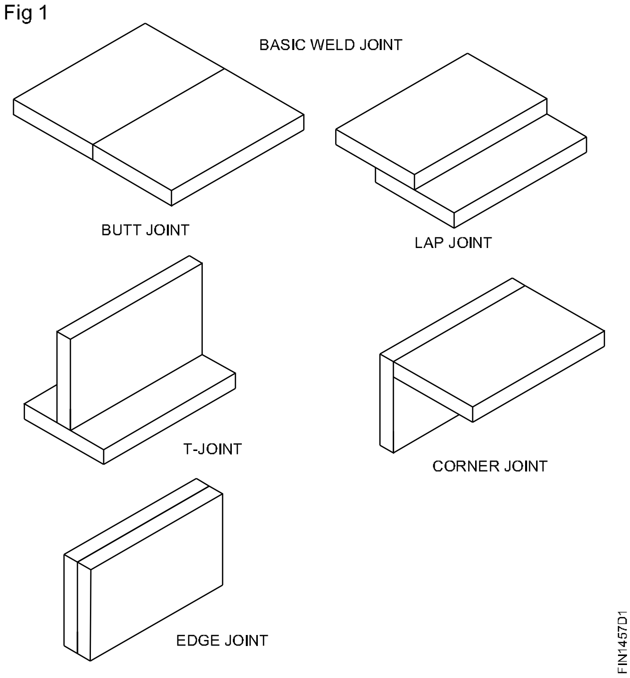
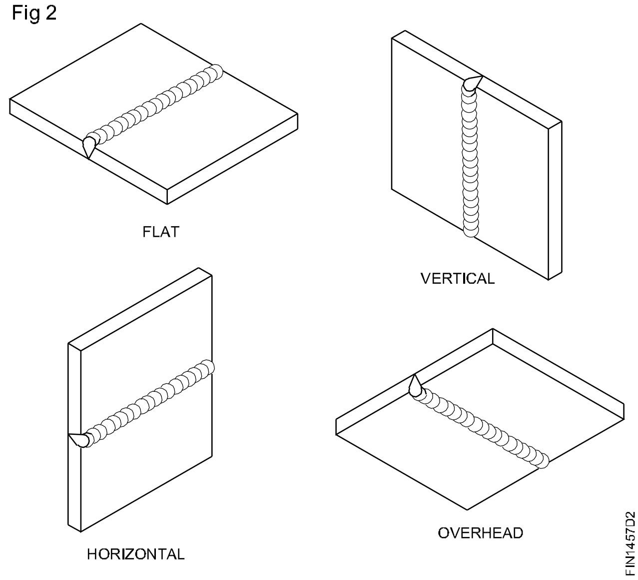


Fig 2



The position of the welding joint line in respect of the ground axis indicates the welding position.

All joints can be welded in all positions.

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

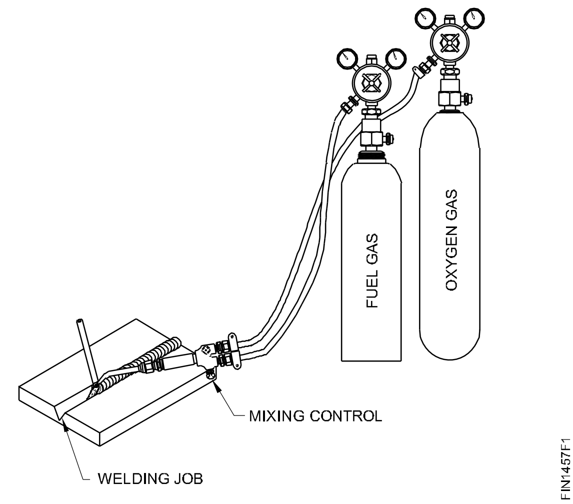
Objectives: At the end of this lesson you shall be able to
- **name the different types of gases used in gas welding**
- **state the different types of gas flame combinations**
- **state the temperatures and uses of the different gas flame combinations.**

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

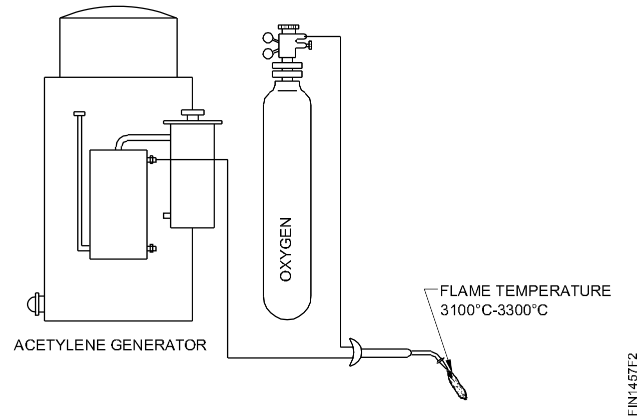
Temperature and uses of gas flame combinations

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.

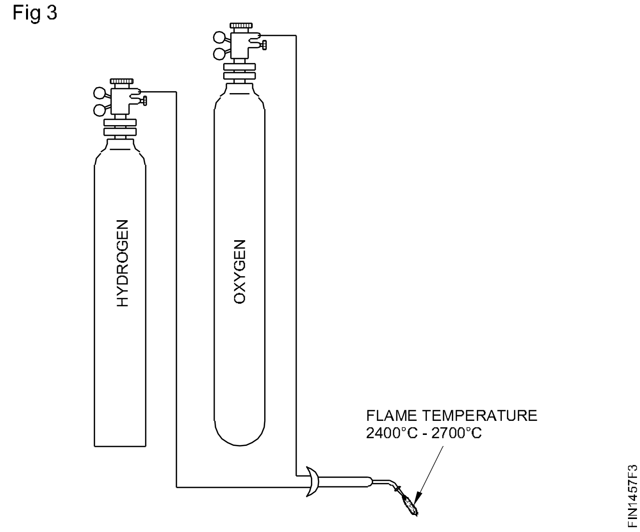
Fig 2



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.

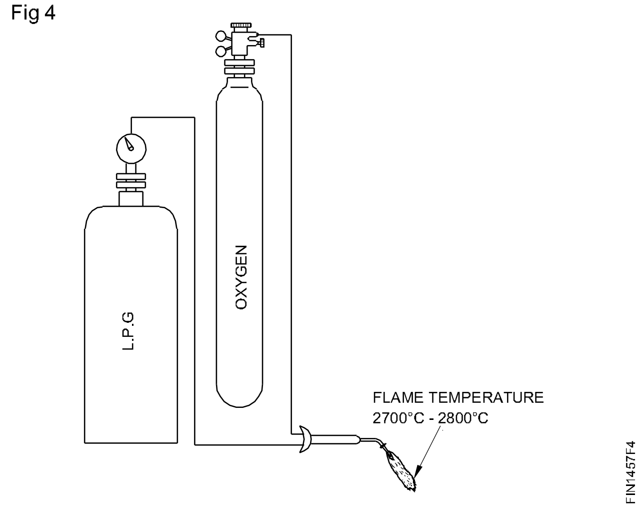
Oxy-liquid petroleum gas flame (Fig 4)

Flame temperature : 2700°C to 2800°C

This flame has carbon and moisture effect.

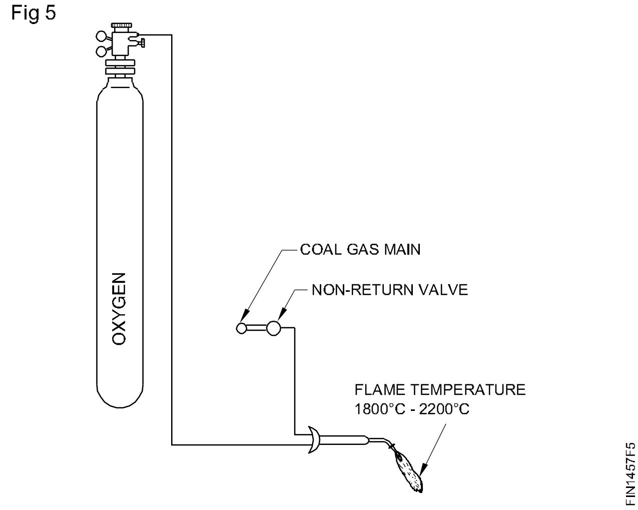
It is only used for gas cutting of steel, and for heating.

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

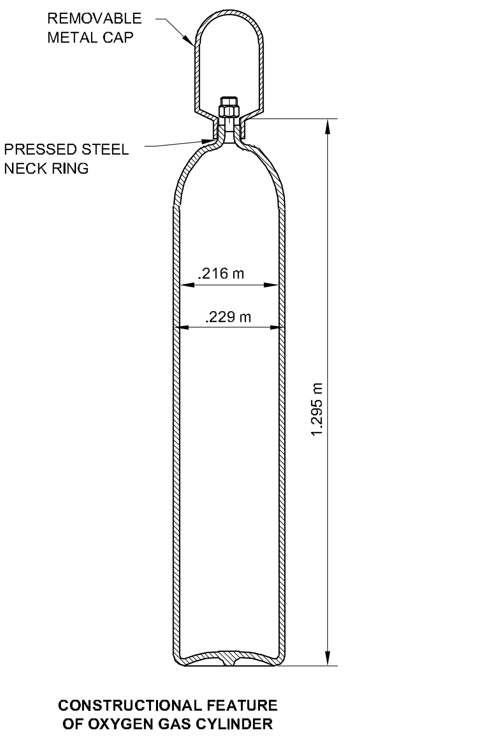
Name of gas cylinder	Colour coding	Valve threads
Oxygen	Black	Right hand
Acetylene	Maroon	Left hand
Coal	Red (with name coal gas)	Left hand
Hydrogen	Red	Left hand
Nitrogen	Grey (with black neck)	Right hand
Air	Grey	Right hand
Propane	Red (with larger diameter and name propane)	Left hand
Argon	Blue	Right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

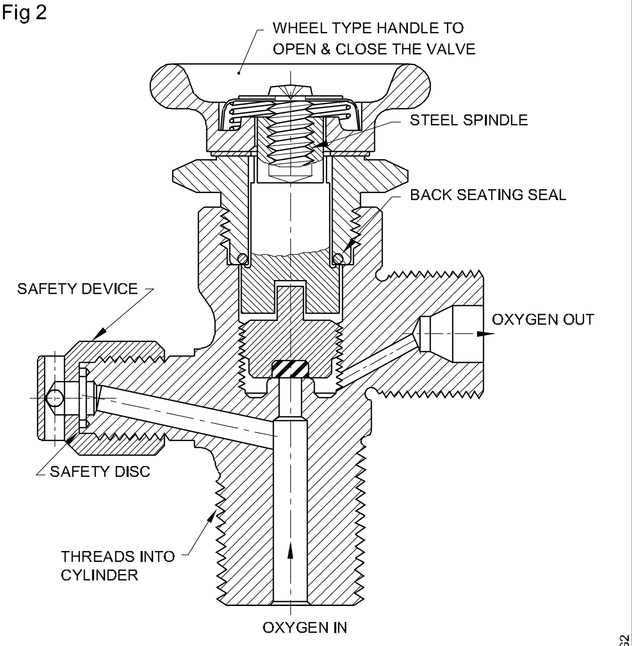
Fig 1



CONSTRUCTIONAL FEATURE OF OXYGEN GAS CYLINDER

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)

Fig 2



CONSTRUCTIONAL FEATURES OF A CYLINDER VALVE

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)

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.

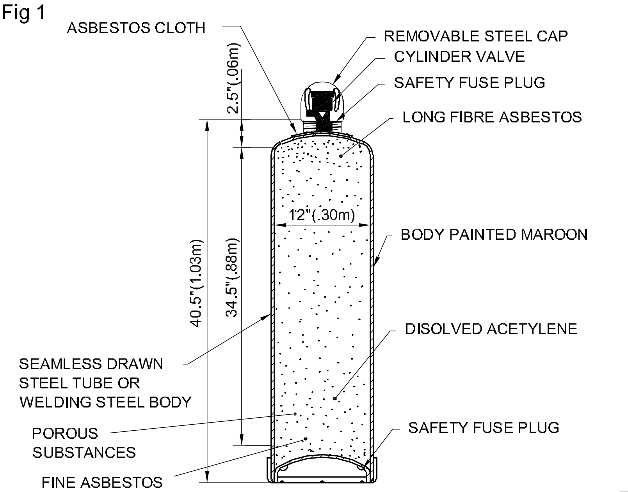
Dissolved acetylene gas cylinder

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.

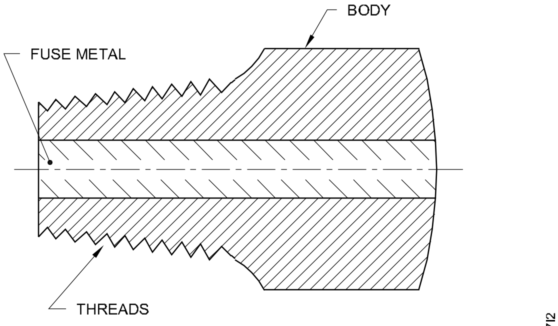
Fig 1



CONSTRUCTIONAL FEATURES OF A DISSOLVED ACETYLENE GAS CYLINDER

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



CONSTRUCTIONAL FEATURE OF A FUSE PLUG FITTED WITH THE CYLINDER TOP AND BOTTOM

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.