UNDERSTANDING AUTOMOBIL CONTRUCTION

- To accurately estimate the parts, labour, and related materials needed to perform any repair, body shop manager (technician) must fully understand hoe the vehicle is designed & constructed.
- The objective of collision & damage repair is to restore the vehicle to its pre-accident condition

You must be capable of accurately identifying
- All damaged components
- The options available for their repair or replacement
- Must know the materials used in constructing the vehicle & how these materials may affect their repair process.

BODY SHAPES

Various methods of classifying vehicles exist such as:-
- By engine type
- Body /frame construction
- Fuel used
- Body shapes

There are six basic body shapes are use:-

1. Sedan
2. Hard top
3. Convertible top
4. Lift back /batch back
5. Station wagon
6. Sports /multipurpose vehicles

Construction type

In today's care there are two methods of construction
1. conventional body over frame
2. unitized or unibody

Conventional body over frame

The frame (chassis) & body are built as two separate units.
- The body is assembled on to the frame with mounting brackets which have rubber bushed bolts to hold the body to the rigid frame. This means that the car can be dismantled into the two units of body and frame.

The chassis assembly is built-up of engine, wheels spring and transmission

Characteristics of conventional body over frame:-
- Load induced vibrations that are transferred to the body via the frame, thus, resulting in a smooth ride
- Rubber mounting between the body and frame insulate it from vibrations, providing a quiet interior.
- High amount of energy are absorbed during a collision
- Under surfaces of the body are protected over rough roads

- Suspension and power train parts can be quickly assembled on the basic frame
- Heavy frame made of thick sheet metal is approximately 3/64 to 1/8 in.
- The vehicle profile is generally high of the ground

Types of Frame

1. Leader Frame

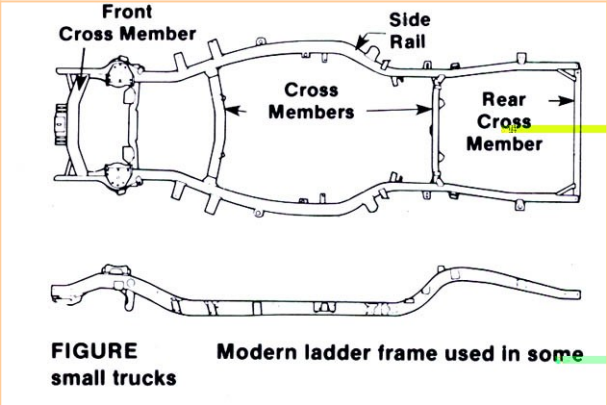


FIGURE Modern ladder frame used in some small trucks

- It consists of two side rails, not necessary parallel
- The two side rails are connected to each other by a series of cross members like a leader

2. The X-frame

- Narrows in the center giving the vehicle a rigid structure that is designed to with stand a high degree of twist
- It is heavy front cross number to support the upper & lower suspension control arms and coil springs.
- At the rear the portion of the frame raised above the center section (to accommodate the war axle assembly & permit flexible of the rear springs).
- The x-frame has not been use since the late *1960s*

3. The Perimeter frame

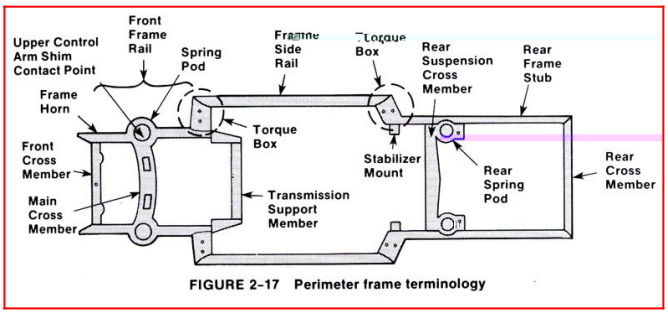


FIGURE 2-17 Perimeter frame terminology

- It is similar in construction to the ladder frame
- *Its side rails*:-
- Support the body at its greatest width
- Provides more protection to the passengers in the case of a side impact to the body
- The areas behind the front wheels and in front of the rear wheels are steeped to form a torque box structure

- In a head on collision, the stepped areas absorb much of the energy & in a side impact collision, since the center frame rail is near the front floor side member, the passenger compartment is protected from collapse.
- Most of the conventional frames used today are of the perimeter design

Unitized/ unibody

- This construction employs the same principles of the aircraft
- The main aim is to strengthen the body with out unnecessary weight
- It has no separate frame like conventional type
- The egg shell is often cited as an example of this type of body structure
- Even when pressing hard on an egg shell, it is comparatively difficult to destroy since all the strength applied by the fingers is not concentrated in one place but is dispersed effectively through the entire shell (this action is called **stressed hall structure**)
- In a car body, there is no complete stressed hull structure.

Characteristics of unibody

- It is made by combining pieces of thin sheet metal processed to from panels of various shapes and joined into an integrated structure by spot welding. This light structure is highly rigid to bending or twisting.
- The bulk taken by the frame can be used to make the car more compact
- Vibration and noise from the drive train & suspension enter the floor pan & are amplified by the body, which acts an acoustic chamber making it necessary to add extra components to the body to suppress vibration & noise
- Once deformed, special procedures which do not cause additional damage are needed to restore it to its original shape
- With the thin sheet metal body close to the road surface, adequate measure must be to prevent the deterioration in strength from corrosion, This is particularly important when dealing with rein forcing materials that make up the under body.

Crash safety principles

- Every car should be designed with the following crash safety principles in mind

1. The impact from a collision is absorbed gradually by controlled deformation of the outer parts of the car body
2. The passenger area is kept intact (untouched) as long as possible
3. The interior is designed to reduce the risk of injury

In a vehicle there are two type of safety: -

1. **Active Safety**

Refers to the feature designed into the vehicle, which reduce the possibility of **an accident**. This includes

- Dual circuit braking systems
- High aerodynamic stability
- Efficient bad weather equipment
- Make the drivers environment safer, such as
    - Efficient through ventilation
    - Easy to read instruments

2. **Passive safety**

These safety features are intended to protect the occupants in the event of an accident

There are engineering features such as impact energy absorbing steering columns, head restrains, bumpers & burst proof locks

Body shells are now designed to withstand major collision and rollover impacts while absorbing shock by controlled deformation of structure in the front & rear of the vehicle.

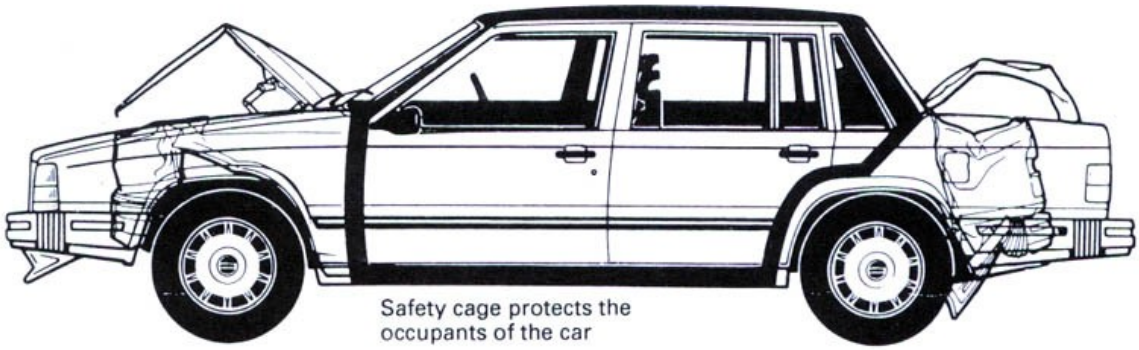
Energy is absorbed by work done on the vehicle materials by elastic deformation.

The pail assemblies used for energy absorbing purpose should have a lower stiffness than the control section or passenger compartment of the vehicle.

The crumple zones are designed to help decelerate the car by absorbing the forces of collision at a controlled rate, there by cushioning the passengers & reducing the risk of injury

The safety cage (safety coil) is the control section of the car body, which acts as the passenger compartment. To ensure passenger safety, all body apertures around the passenger area should be rain forced by box type profiles, seats should be secured rigidly to the floor; and heavy interior padding should be used around the bush road areas.

A strengthened roof construction, together with an anti roll bar, affords additional protection in case of over turning.



Safety cage protects the occupants of the car

GAS WELDING

Oxy –Acetylene

The first successful oxy-acetylene welding equipment was developed in France at the turn of the century (1901-3)

Gas welding processes are so called because the welding heat is provided by a flame produced by the combustion of a mixture of gasses. A variety of gasses are used commercially but an Oxy-acetylene mixture is the most common because of its high flame temperature and because the gases are convenient to handle.

To obtain the oxygen in a state that makes it usable for welding, it is necessary to separate it from the other gasses. Oxygen is produced commercial either by the electrolyte process or by a separation method known as the liquid air process.

Unlike Oxygen acetylene is not a natural but a manmade gas. It is a hydrocarbon gas produced by the action of water on calcium carbide. Acetylene a colourless gas with a very distinctive nauseating odour, It is highly combustible when mixed with air or oxygen. It burns in ordinary air with a luminous smoking flame, but in pure oxygen it burns with an intensely hot non-luminous flame. Although it is stable under law pressure, it be comes very unstable & dangerous it compressed to any great pressure. Hence acetylene for welding purposes is dissolved in a liquid chemical known as acetones, which is capable of absorbing up to 25 times its own volume with out changing the nature of the gas itself, and then stored in steel cylinder.

Oxy- Acetylene Welding Equipment

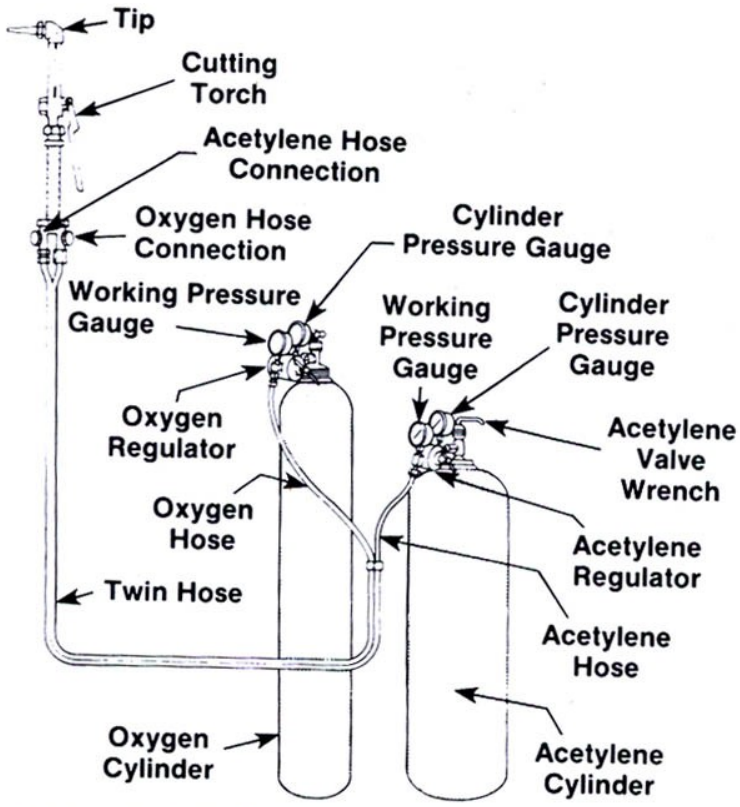


FIGURE 6–111 Typical oxyacetylene welding and cutting outfit

- Oxy-acetylene welding equipment comprises
  1. Cylinder of dissolved acetylene
  2. Cylinder of Oxygen
  3. High pressure welding torch with separated oxygen control and acetylene control, and various sized tips for different thickness
  4. Acetylene regulator with gauges
  5. Oxygen regulator with gauges
  6. Two high pressure rubber concaves hose with clips and fitted with hose check valves /red for acetylene & blue for oxygen/
  7. Acetylene flashback arrester & oxygen flashback arrester
  8. Keys to fit cylinders & spanners for gland nuts, and for fixing the regulators to the cylinders
  9. Pair of welding goggles
  10. Cylinder trolley

Acetylene supply

The acetylene is supplied in steel cylinders painted *maroon (brownish red*) and continuing between $0.57m^3$ & $8.73m^3$ when fully charged. The cylinder contain a porous filling usually kapok or charcoal, which acts as an absorbent for the acetone. To prevent the interchange of fittings between cylinders, the *acetylene* cylinder valve in to which the regulator is fitted has a *left hand thread*, while the *oxygen cylinder* valve has a *right hand thread*.

The actual cylinder valves all opened anti-clock wise & closed clockwise in the usual way.

Oxygen Supply

The oxygen supply in the high-pressure system comes in seamless steel cylinders containing between $0.68m^2$ &$9.66m^3$ of oxygen and painted *black.* As this is a non-combustible gas, the cylinder has a right *threaded valve* outlet, oxygen is supplied at a maximum pressure of 137 bar at 15^0c.

Welding Torches

The welding torch comprises two needle valves/ one for regulating the oxygen and the other for the acetylene /, a mixing chamber and an interchangeable welding nozzle all incorporated in a shank. The torch, sometimes known as the blowpipe, mikes acetylene and oxygen in the correct proportion and permits the mixture to flow to the end of the welding tip or nozzle, where it is burned. The acetylene and oxygen are fed independently to the mixing chamber, and then flow through the tip on the rear end of the torch there are two female unions for connecting the relevant hoses, the oxygen union has a right hand thread and the acetylene union a left hand thread.

To make possible the welding of different thickness of metal welding torches are equipped with an assortment of different size heads or nozzles. The size of the nozzles is governed by the diameter of the opening at the welding end. The most common size system uses numbers which are marked on the

nozzle and the larger the number, the greater is the diameter of the opening in the nozzle; no 1-35 are for use with thickness up to 10mm & no 35-90 are for 10-25mm.

Regulators:-

There are two types of regulator, the two stages and the single stage gauge. The oxygen and acetylene pressure regulators perform two functions. They reduce the cylinder pressure to the required working pressure, and they produce a steady flow of gas under verying cylinder pressures. With the two stage regulator the gas flows from the cylinder in to a first chamber where a predetermined high pressure is maintained by a means of a spring and diaphragm from the high pressure chamber the gas passes in to a second reducing chamber where the pressure is governed by an adjusting screw. The principal advantage of the two stages regulator is that the working pressure remains constant until the gas in the cylinder is exhausted, and little adjustment of gas flow is needed.

In the single stage regulator there is only one low pressure chamber; the gas from the cylinder flows into the regulator and is controlled entirely by the adjusting screw.

Both type of regulator have two gauges one indicating the pressure in the cylinder and the other showing the actual working pressure or line pressure at the torch. The content gauge on the oxygen regulator is calibrated up to 300 bar, from 0 to 6 bar. The content gauge on the acetylene regulator is calibrated from 0 to 2.5 bar. It is most important to remember to release (turn out) the adjusting screw on the regulator before opening the cylinder valve otherwise the tremendous pressure of the gas in the cylinder is forced in to the working pressure gauge & this could result in gauge damage.

Gas hose

Gas hose are of a special non-porous rubber reinforced with canvas. They are designed to with stand the working pressure which transmit gas from the regulator to the welding torch hoses are available internal diameters of 5-20mm and are coloured *red for acetylene* and *blue for oxygen* to prevent the risk of hose interchange. The nut on the acetylene hose is distinguished from the nut on the oxygen hose by a groove that runs around its centre, indicating that it has a left hand thread. A ferrule (clips) is used to squeeze the hose around the union shank to prevent it from working loose. The life of the hose may be prolonged by reasonable care in use, eg by keeping it away from heat, sparks, oil and grease and by preventing it from being crashed.

Hose check valve

This is a safety device in the form of a non-returnable valve, which is fitted behind the welding torch and connected to the hose. There are check valves for both oxygen and acetylene connections. If the pressure or gas flow tires to reverse, the hose check valve immediately seals of the torch from the main

supply, thus eliminating the possibility of flashback and backfiring of the welding torch through the hose to the regulator & cylinder.

Cylinder Key

This key is an essential part of the equipment & is used for turning the valves on the gas cylinders on & off. It should be always attached to the welding equipment or plant so that it is readily available in case of emergency.

OXYACETYLENE WELDING

It is a type of fusion welding. Acetylene & oxygen are mixed in a chamber ignited at the tip, & used as a high temperature heat source /approximately 3200C^0/to melt & join the welding rod and base metal together.

It is difficult to concentrate the heat in one area, the heat affects the strength surrounding areas and reduces the strength of the steel panels due to this reason is not recommended for in repairs of damaged vehicles.

The Oxy acetylene is have some uses in repair of auto body such as:-

- Heat shrinking operation
- Surface cleaning
- Cutting of non-structural parts

Oxyacetylene should not be used cut structural parts of any vehicle unless special care is taken

TYPES OF FLAME AND ADJUSTMENT

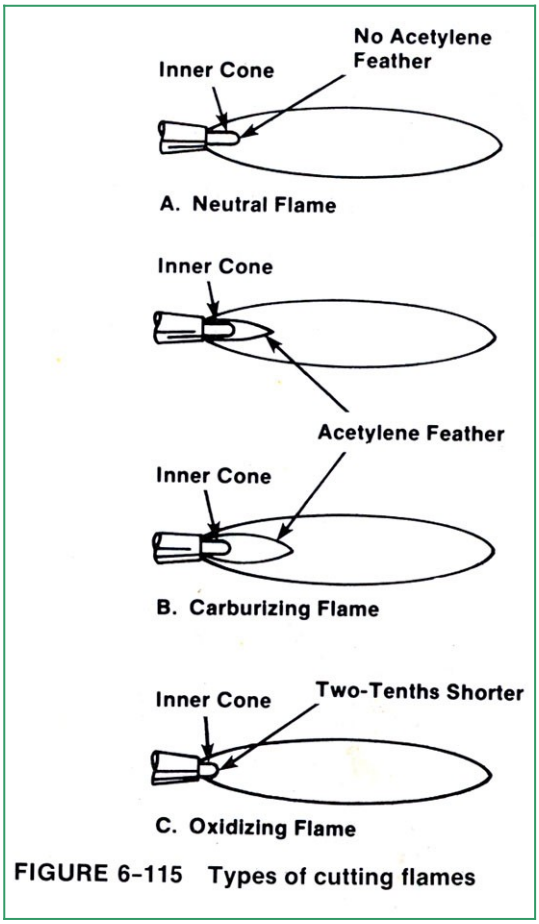


FIGURE 6–115 Types of cutting flames

When acetylene & oxygen are mixed & burned in the air, the condition of the flame varies depending on the volume of oxygen & acetylene.

Neutral Flame:- The standard flame is said to be a natural flame acetylene & oxygen mixed is a 1 to 1 ration by volume produces a neutral flame.

This flame has a brilliant white cone surrounded by a clear blue outer flame

Carburizing flame

This flame sometimes called a surplus or reduction flame is obtained by mixing slightly more acetylene than oxygen in the carburizing flame there are three different parts. The cone and the outer flames are the same as the neutral flame but between them there is an intermediate light coloured acetylene cone enveloping the cone.

The length of the acetylene cone varies according to the amount of surplus acetylene in the gas mixture

A carburizing flame is used for welding aluminium, nickel & other alloys

Oxidizing flame

This flame is obtained by mixing slightly more oxygen than acetylene. The oxidizing flame resembles the neutral flame in appearance but the acetylene cone is shorter & its colour is a little more violet compared to the neutral flame the outer flame is shorter & fully at the end.

It is used in the welding of brass & bronze

Assembly & operation of Oxy acetylene welding equipment

The cylinders must be kept upright and all metal joining surfaces should be free from oil or greases. Before fitting the regulators blow out the cylinder valves to remove any dirt or obstruction. To ensure gas tight connections between cylinder valves & regulators, first screw down the hexagon or ring nuts by hand, then give the regulators a twist to bed them down on their seats, & finally thighbone the nuts properly, but with out the use of excessive force. New hoses in use for the first time should be blown through to remove any girt that may be present. Attach the appropriate hoses to the regulators and welding torch and fit the latter with a suitable welding tip. Next slacken off the pressure regulating screws open the regulator out let valves the pressure regulating screws, open the regulator out let valves and turn on the gasses with the cylinder key, this must be done slowly to avoid damage to the regulators. The cylinder valves must be opened at least two full turns to ensure that the flow of gases to the regulators to the required pressure, open the acetylene control valve on the welding torch, check working pressure when pure acetylene is coming out of the end of the nozzle and then light the gas. Reduce or increase the acetylene supply by the welding torch valve until the flame just ceases to smoke then turn on the oxygen by the welding torch control valve until the white inner cone is sharply defined, & check working pressures again. The welding torch is now ready and is burning with a neutral flame which is used on must welding operations.

On completion of the welding operation the following procedure must be carried out to render the equipment safe. Turn off the acetylene first by the welding torch control valves. Open the welding torch valves one at a time to release the pressure in the hose; Open
the oxygen valve and shut it. Unscrew the pressure regulating screws on the oxygen and acetylene regulators.

PRINCIPLES OF MIG WELDING

The welding method uses a welding wire that is fed automatically at a constant speed as an electrode. It has a DC electrical source (an electrical power supply). A short arc is generated between the base metal & the wire and the resulting heat from the arc melts the welding wire & join the base metals together. During the welding process either inert or active gas shields the weld from the atmospheric & prevents oxidation of the base metal.

The type of inert or active gas used depends on the base material to be welded.

Base material	Shield gas
Steel Aluminium Stainless steel	Carbon dioxide (Co_2) Argon (mixture of Argon & Helium) Argon with a little oxygen (b/n 4&5%)

MIG welding uses the short circuit arc method that is a unique method of depositing molten drops of metal on to the base metal.

The short circuit arc method uses very thin welding rods

- A low current & voltage

By using this technique the amount of heat introduced in to the panels is kept to a minimum & penetration of the base metal is quite shallow.

MIG WELDING (Metal inert gas welding)

MIG : become popular in body repair work after the car manufacturers began using thin gauge high strength low alloy steels (HSLA)

MIG welding provided clean fast welds all applications

Example:- Welding a rear quarter panel with an oxyacetylene welder averages about 4 hours. A MIG welder can do the same job in about 40 minutes.

The advantages of MIG welding

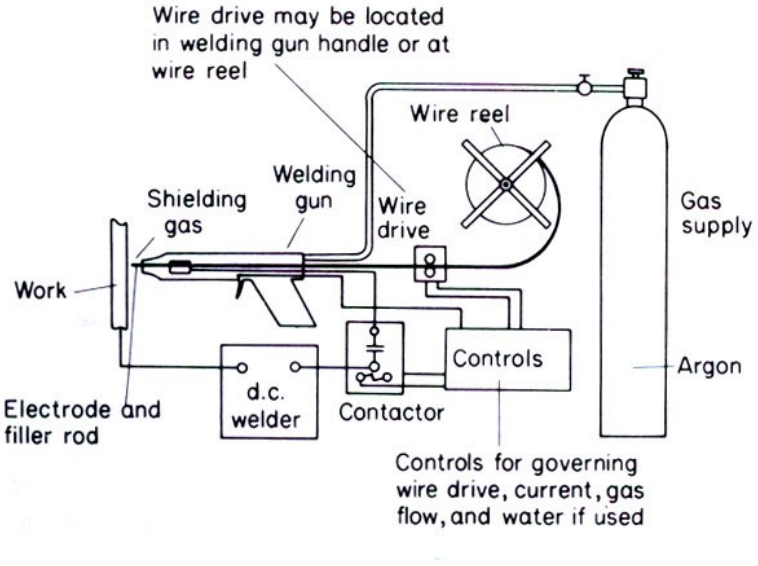
- Easy to learn to use
- It provides 100% fusion in the parent metals
- Low current can be used for thin metal
- The arc is smooth/ the weld peddle small, it is easy to control)
- Big gaps of two joint can be welded by filling the gap
- All steel can be welded with one common type of weld wire
- It is easy to control the temperature & time
- In this welding process the small area to be welded is heated for a short period of time.

MIG WELDING EQUIPMENT

Regardless of the type of MIG equipment used, it will comprise the following basic components.

- Supply of shielding gas with a flow regulator to protect the molten weld pool from contamination
- Wire/feed control to feed the wire at the required speed

- Spool of electrode wire of a specified type & diameter
- Welding machine connected to an electrical power supply
- Work cable & clamp assembly
- Welding gun & cable assembly that the welder holds to direct the wire to the weld area



The shield gas most commonly used for collision repair welding is

- carbon dioxide

- mixture of Argon & carbon dioxide (C-25 gas) it mean 75% carbon dioxide & 25% argon

MIG OPERATION METHODS

- Match the welding power unit in the machine to the available in put voltage
- Adjust the shield gas pressure (gas flow rate) this is approximately 1-3/8 to 1-1/2 cubic inches per minute
- Attached the clamp to clean metal near the weld site it completes the welding circuit from the machine to the work & back to the machine
- Adjust the wire feed rate of the machine have
- Adjustment of welding current, this affects the base metal penetration depth, the speed at which the wire is melted, arc stability, & the amount of weld spatter.
- As the electrical current is increased the penetration depth excess metal height & bead width also increases

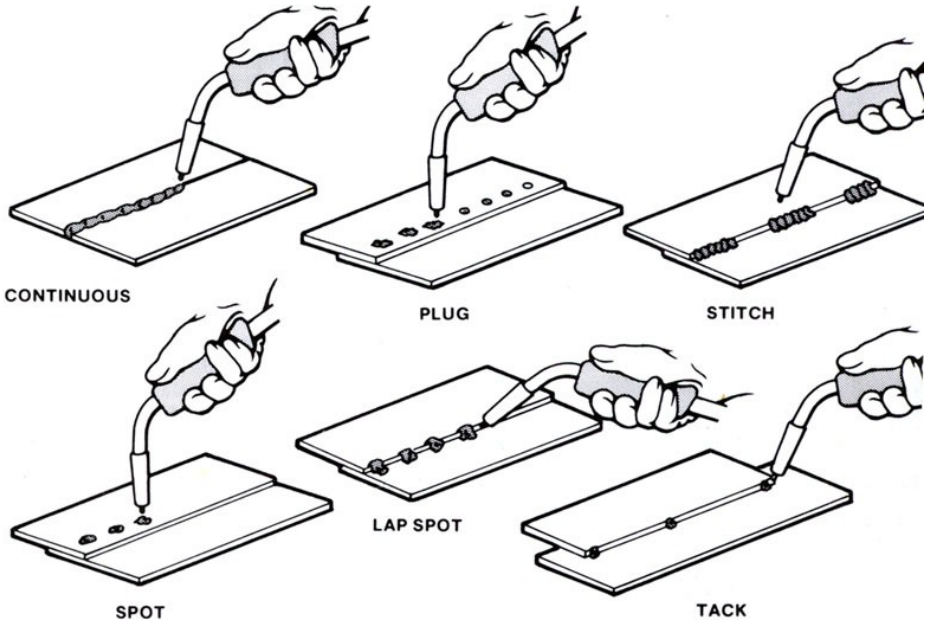
  - Arc voltage adjustment good welding results depend on a proper arc length. The length of the arc is determined by the arc voltage
  - When the arc voltage is high, the arc length increases the penetration is shallow, & the bed is wide & flat

- When the arc voltage is low, the arc length decreases penetration is deep, and the bead is narrow & dome shaped.
- The tip to base distance is an important factor in obtaining good welding results
- The standard distance is approximately 6.35mm –15.87mm (1/4-5/8inc)

If the tip of base metal distance is too long the length of wire protruding from the end of the gun increases & becomes preheated which increases the melting speed of the wire. Also the shield gas effect will be reduced if the tip to base metal distance is too long.

If the tip to base metal distance is too short, it becomes difficult to see the progress of the weld because it will be hidden the tip of the gun.

BASIC WELDING TERCHNIQUES



Basic welding techniques

- **Tack weld**

  It is a temperature welding method to keep the alignment (like clamp or sheet metal screw)

  The distance between each tack welding is determined by the length & thickness of a panel

- **Continuous Welding**

In this method by keeping proper tip-base metal distance & correct gun angle welding up to the end of the panel

- **Plug Weld**

To do this weld first a hole is drilled through the outside piece (pieces), then the arc is directed through the hole to penetrate the inside piece & hole is filled with molten metal.

Spot Weld

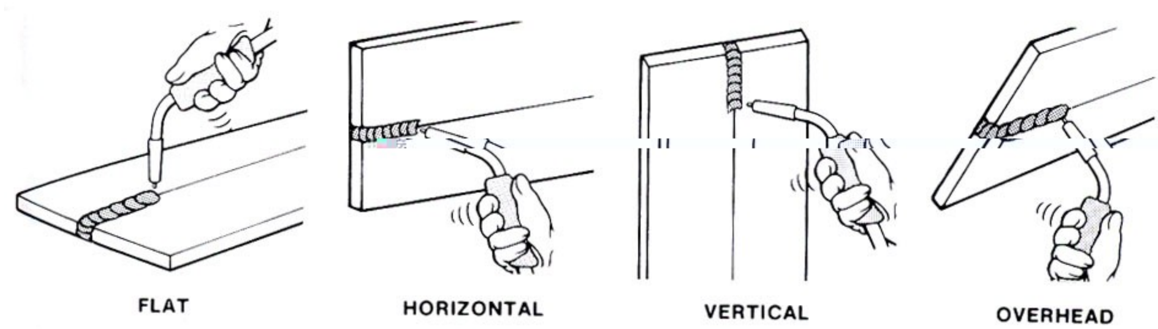
Example:- In a MIG weld the arc is directed through the hole to penetrate both pieces of metal while triggering a timed impulse wire feed.

Stich Weld
It is similar to continuous weld but not the whole work pieces, rather there is an interruption.

Welding Position

In collision repair the welding position is usually indicated by the location of the weld in the structure

- Flat
- Horizontal
- Vertical
- Overhead



Typical welding positions