Safety in GMAW

Objective: At the end of this lesson you shall be able to
- **safety precaution to be followed in the process.**

Safety in GMA welding/CO_2 welding

The general safety precautions for arc welding (SMAW) are also applicable to GMAW.

Ultra violet light

During MIG welding Ultra Violet Light production is at the higher end of the scale and suitable eye protection must be used.

Adequate eye protection should always be worn. If welding for long periods, flash goggles with A#12 lens shade should be worn under the arc helmet. A#11 lens is recommended for nonferrous GMAW and A#12 for ferrous GMAW. All welding should be done in booths or in areas protected by curtains. This is done to protect others in the weld area from arc flashes.

Heat

Welding in any form produces heat which can cause burns and the possibility of fire.

Suitable clothing must be worn. This is done to protect all parts of the body from radiation or hot metal burns. Leather clothing offers the best protection from burns.

Fumes

Fumes from the MIG welding process are produced by the burning of contaminants on the surface of the material being heated.

The MIG welding of galvanised metal is extremely dangerous to the operator because of zinc poisoning unless suitable protection is used.

Ventilation should be provided. This ventilation and/or filtering equipment is necessary to keep the atmosphere around the welder clean. Carbon monoxide is generated when doing GMAW and using CO_2 as a shielding gas. It is suggested that all welding be done in well ventilated areas.

Ozone is also produced when doing GMAW and ozone is a highly toxic gas. Metals still covered with chlorinated hydrocarbon solvents will form poisonous, toxic phosgene gas when welded.

Protect arc cables from damage. Do not touch uninsulated electrode holders with bare skin or wet gloves. A fatal shock could result. Welding in wet or damp areas is not recommended.

Shielding gas cylinders must be handled with caution.

Welding environment safety rules

– keep the welding area clean

– keep combustibles out of the weld area

– maintain good ventilation in the weld area

– repair or replace damaged power cables

– make sure the part to be welded is securely grounded/ earthed

– welding helmets should have no light leaks. Should not have scratches or cracks

– use the proper colored lens with correct shade number in the helmet

– wear safety glasses when grinding

– do not see the arc with bare eyes

– use safety screens or shields to protect your area

– wear proper clothing. Your entire body should be covered to protect you from arc radiation

GTAW safety

Objective: At the end of this lesson you shall be able to
- **state the safety precautions to be followed in TIG welding process.**

GTAW/TIG welding is a skill which may be performed safely with a minimum of risk if the welder used good common sense and safety rules. It is recommended that you establish good safety habits as you work in this industrial area. Check your equipment regularly and be sure that your environment is safe. Safety in TIG welding covers the following major areas and includes

Electrical current: Primary current to the electrical powered welding machine is usually 220V A/C or more, and this amount of voltage can cause extreme shock to the body and possible death. For this reason

– never install fuses higher than specified

– always ground/earth the welding machine properly

– install electrical components as per the codes given by the electricity boards

– ensure electrical connections are tight

– never open a welding machine when it is operating

– lock primary voltage switches, open and remove fuses when working on electrical components inside the machine

– welding current supplied by the power supply has a maximum of 80 open circuit volts. At this low voltage, the possibility of lethal shock is very small. However, it will still produce a good shock. To reduce the possibility of this occurrence.

– keep the welding power supply dry

– keep the power cable, ground cable and torch dry

– do not weld in damp area. If you must, wear rubber boots and gloves

– make sure the ground clamp is securely attached to the power supply and the work piece

– High frequency components in some GTAW machines produce a spark for starting the initial arc or maintenance of the arc during the alternating current welding. The high frequency voltage is very high, however the amperage is very low. Since the amperage is so low, the high frequency voltage will not usually travel through the body and is therefore not as dangerous as other currents.

Inert gases: Inert gases used in GTAW are produced and distributed to the user in two forms: high pressure gas and liquid. All storage vessels used for inert gases are approved by the department of transportation and are so stamped on the vessel name plate or the cylinder wall.

Most of the gases used in GTAW are inert, colourless and tasteless. Therefore special precautions must be taken when using them. Nitrogen, argon,and helium are non toxic. However they can cause asphyxiation (suffocation) in a confined or closed area that does not have adequate ventilation. Any atmoshphere that does not contain at least 18 % oxygen can cause dizziness, unconsciousness or even death. The gases cannot be detected by the human senses and will be inhaled like air. So ensure the welding area is well ventilated with good air circulation.

Welding environment safety rules

– keep the welding area clean

– keep combustibles out of the weld area

– maintain good ventilation in the weld area

– repair or replace damaged power cables

– make sure the part to be welded is securely grounded/ earthed

– welding helmets should have no light leaks. Should not have scratches or cracks

– use the proper colored lens with correct shade number in the helmet

– wear safety glasses when grinding

– do not see the arc with bare eyes

– use safety screens or shields to protect your area

– wear proper clothing. Your entire body should be covered to protect you from arc radiation

– when welding on cadmium coated steels, copper or beryllium copper use special ventilation to remove fumes from the weld area.

Introduction to GMAW

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)

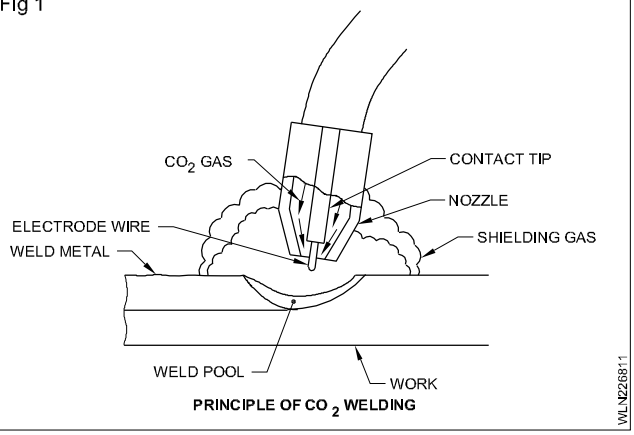
If an inert gas is used to protect the arc produced by a consumable metal electrode, this process is called Metal Inert Gas Welding (MIG).

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.

Other names

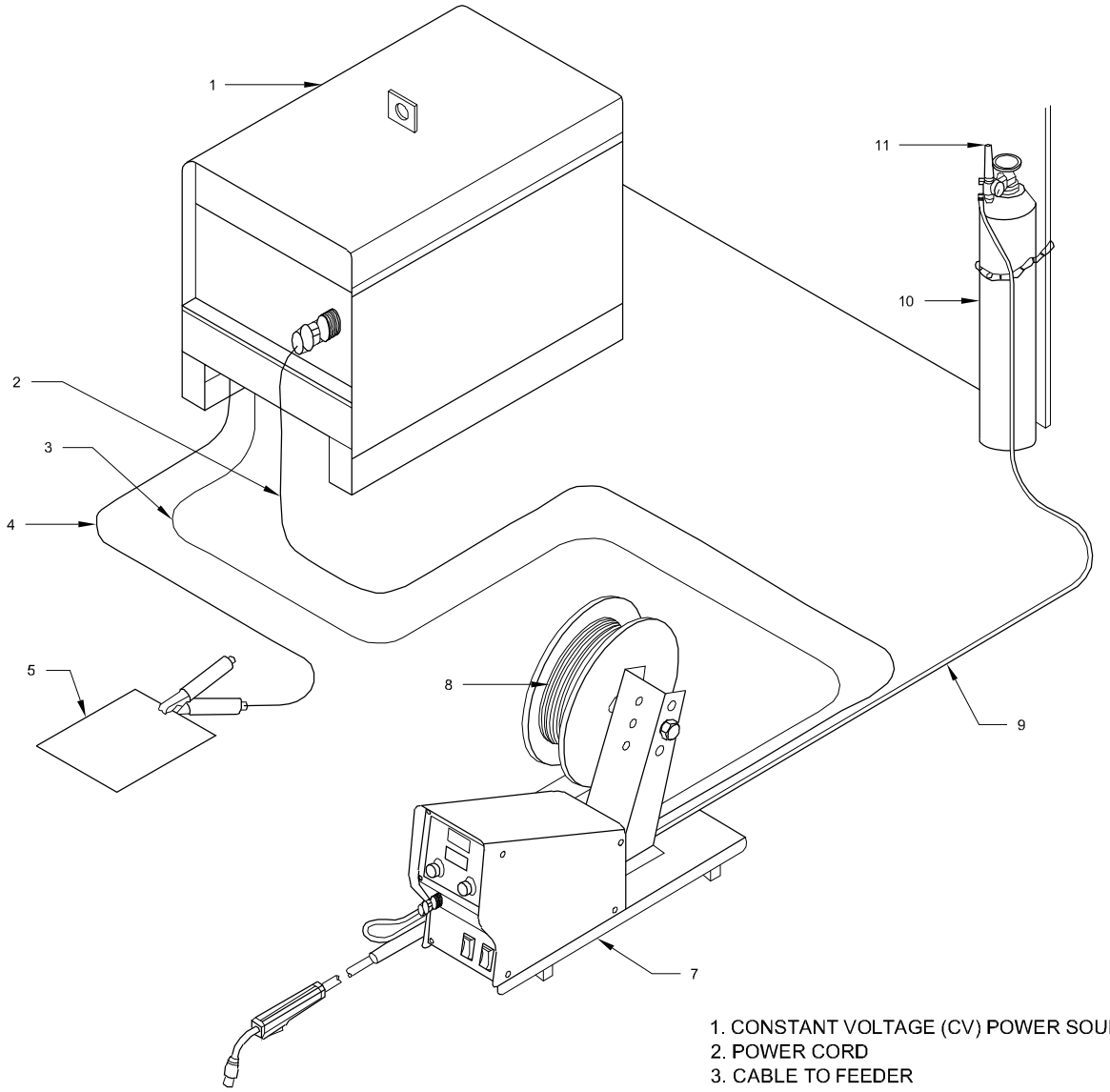
- MIG (Metal Insert Gas) welding,
- MAG (Metal Active Gas)/CO_2 Welding
- GMAW (Gas Metal Arc Welding)

GMAW can be done in three different ways:

- **Semiautomatic welding** - equipment controls only the electrode wire feeding. Movement of welding gun is controlled by hand. This may be called hand-held welding.
- **Machine welding -** uses a gun that is connected to a manipulator of some kind (not hand-held). An operator has to constantly set and adjust controls that move the manipulator.
- **Automatic welding -** uses equipment which welds without the constant adjusting of controls by a welder or operator.

  On some equipment, automatic sensing devices control the correct gun alignment in a weld joint.

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

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Introduction to GMAW equipment and accessories

Objective: At the end of this lesson you shall be able to
- **state the power sources for GMAW**

MIG welding power sources have come a long way from the basic transformer type power source to the highly electronic and sophisticated types we see around today.

Even though the technology of MIG welding has changed, the principles of the MIG power source have, in most cases, not. The MIG power sources use mains power and converts that mains power into CV (constant voltage), DC (direct current) power suitable for the MIG welding process.

MIG welding power sources control voltage – this is done by either voltage stepped switches, wind handles, or electronically. The amperage that the power source produces is controlled by the cross sectional area of the wire electrode and the wire speed, ie the higher the wire speed for each wire size, the higher the amperage the power source will produce.

Because the output of the MIG power source is DC (direct current) the terminals on the front will have + positive and negative on the output side. The principles of electric circuits states that 70% of the heat is always on the positive side.

This means that the lead that is connected to the positive side of the welder, will carry 70% of the total energy (heat) output.

The characteristics volt, ampere curves (A & B) are shown in Fig.1.

Curve A (For SMAW): On the output slope or voltampere curve A, a change from 20 volts to 25 volts will result in a decrease in amperage from 135 amps to 126 amps. With a change of 25 percent in voltage, only a 6.7 percent change occurs in the welding current in curve A. Thus if the welder varies the length of the arc, causing a change in voltage, there will be very little change in the current and the weld quality will be maintained. The current in this machine, even though it varies slightly is considered constant.

This is called drooping characteristic power source. Also called constant current (CC)power source.

This type of power source is used in SMAW & GTAW process.

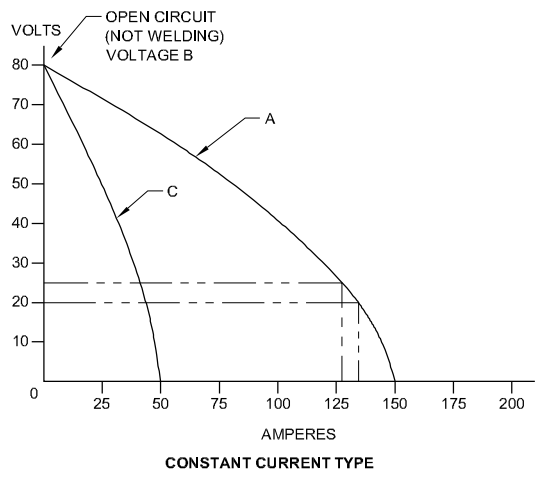
Curve B (For GMAW): The open circuit voltage curve for a setting of 50 volts on the machine is shown as curve B in the Fig.1. The same 20 volt to 25 volt (25 percent) change in the welding voltage will result in a drop in current from 142 amps to 124 amps or 13.3 percent. This slower sloping volt ampere curve output causes a large change in amperage with the same small change in voltage. A welder may wish to have this slower sloping (flatter) volt-ampere output curve.

This is called flat characteristic power source. Also called constant Voltage(CV)power source.

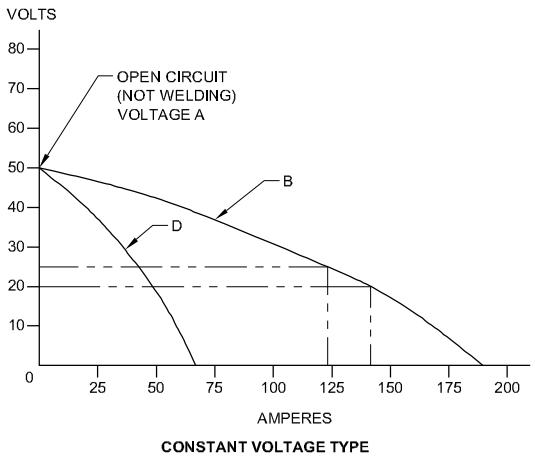
This type of power source is used in **GMAW & SAW** process.

With a flatter output slope the welder can control the molten pool and electrode melt rate by making small changes in the arc length. Control of the molten pool and electrode melt rate are most important when welding in the horizontal, vertical and overhead positions.

Fig 1



CONSTANT CURRENT TYPE



CONSTANT VOLTAGE TYPE

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GMAW (MIG/MAG) torches

Objective: At the end of this lesson you shall be able to
- **state the types and functions of torches.**

MIG/MAG torch connection

The torch connection is the system in which the MIG torch is connected to the wire feeder. There are various types of MIG torch connections. Different manufacturers can use any one of many systems to connect their torch to the wire feeder.

When ordering a new Torch tell the supplier

a the type of torch you need, including amperage rating

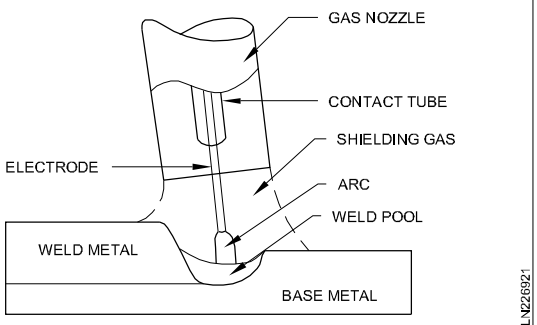
b the type of connection on the feeder so the torch can be supplied to match the connection

The Torch connection is also the area where the wire electrode, welding current and welding gases are passed onto the welding torch. This means these components should be checked for damage or leaky seals etc, so the connection will do its job correctly.

MIG/MAG torches

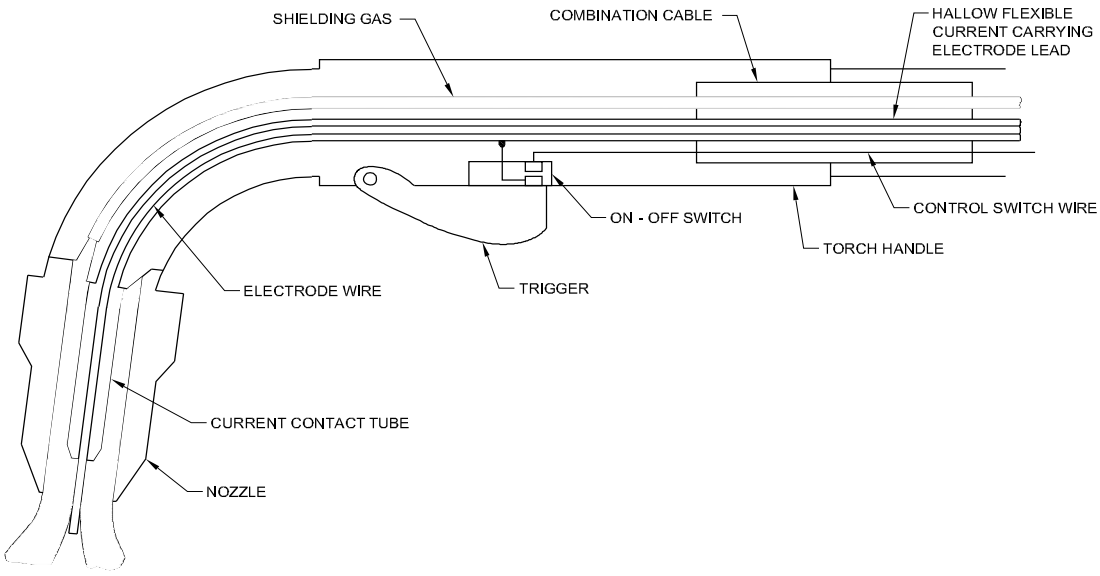
The MIG Torch is connected to the wire feeder, and its job is to deliver the wire electrode, shielding gas and the electrical welding current to the welding area. There are a lot of different shapes and styles of MIG Torch out in the marketplace but they all have things in common. (Fig. 1 & 3).

Fig 1



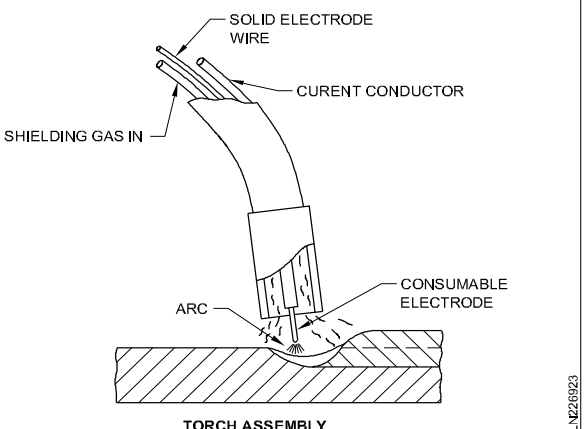
1 Aircooled (less than 200 Amps) or watercooled (above 200 Amps) (Fig 2)

Fig 2



A SCHEMATIC CROSS SECTION OF AN AIR COOLED GAS METAL ARC WELDING TORCH

Fig 3



TORCH ASSEMBLY

2 Current rating. The operator must select the correct size Torch. Using a torch that is not sufficiently rated for the machine may result in the Torch overheating. This may result in a poor weld and damage to the torch. A Torch with an excessive rating will be larger and heavier than the smaller Torch, which could result in discomfort for the operator.

3 They all have parts that will wear out (consumables eg liners, tips, diffuser, nozzle, etc.)

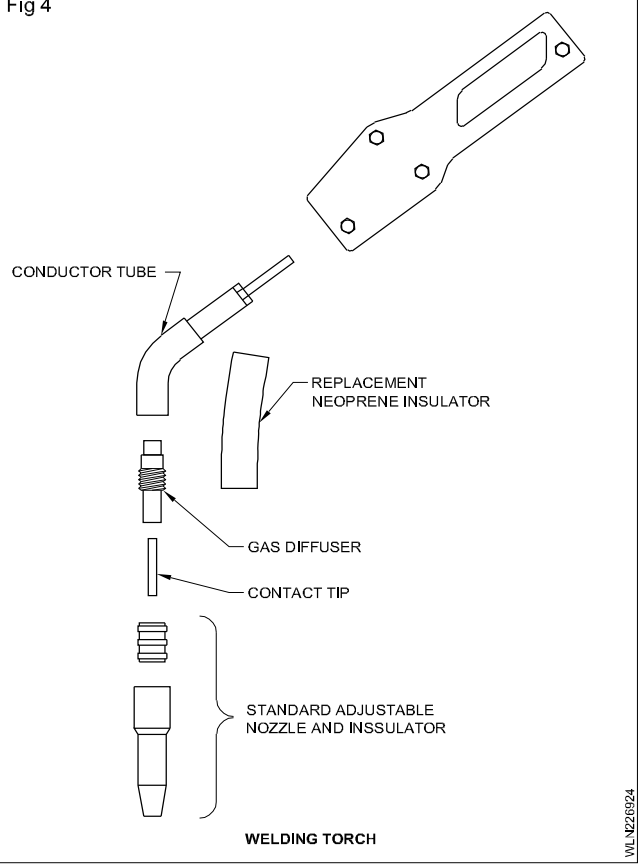
Let's take a look at each part (Fig 4)

Liner: The liner causes the most problems. First, they have a life span that is approximately one to four rolls of MIG wire depending on the quality of the liner and wire.

The life of the liner will also be increased if the operator removes and cleans it by soaking in non-corrosive and a non-toxic solvent. Each wire size needs to have the correct wire size liner. Be aware some liners may fit more than one size of wire.

There are also different materials for different types of wire electrode, eg **steel or stainless liners for solid wires and Teflon liner for aluminium.**

Fig 4



WELDING TORCH

The liner length is most important. In the field it is very common to find even newly fitted liners that have been cut too short. This results in the wire being able to move around behind the welding tip and leading to bad wire feeding. The liner has to be fitted correctly and different MIG Torch will often have a different way of ending up with a liner that is the correct length.

Don't just take out the old liner and cut the new one to the same length. It could end up with an incorrect result. Please refer to MIG Torch manual.

All MIG Torch should be laid out straight ont he floor before trimming the liner, to prevent the new liner being cut too short. Do not cut the liner if the torch lead is coiled up.

Gas diffusers The gas diffuser's job is to make sure that the shielding gas is delivered to the shielding nozzle correctly. It is designed to make the gas come out as straight as possible and equally supplied around inside the gas shield nozzle. Diffusers can be made of different materials, eg copper, brass or fibre. Some diffusers will also be the tip holder.

Contact tip holder This is the item which holds the welding tip in place. Again, tip holders can be very different in design and are very often unique to that brand of MIG torch.

Contact tips The Contact tip/tube is the key to good welding. First of all, it is the way that welding amperage is delivered to the welding wire electrode, often with a very high amperage.

Most contact tips are made of copper alloy, the better the alloy the better the tip will pass current to the wire electrode and the less wear the MIG tip will have; also the less the tip will oxidize.

The size is important. The right size contact tip must be selected contact. If the selected tip size is too large the wire electrode will not make a good contact, leading to poor welding performance.

If a contact tip selected is too small, the wire electrode will feed poorly and may even jam in the contact tip.

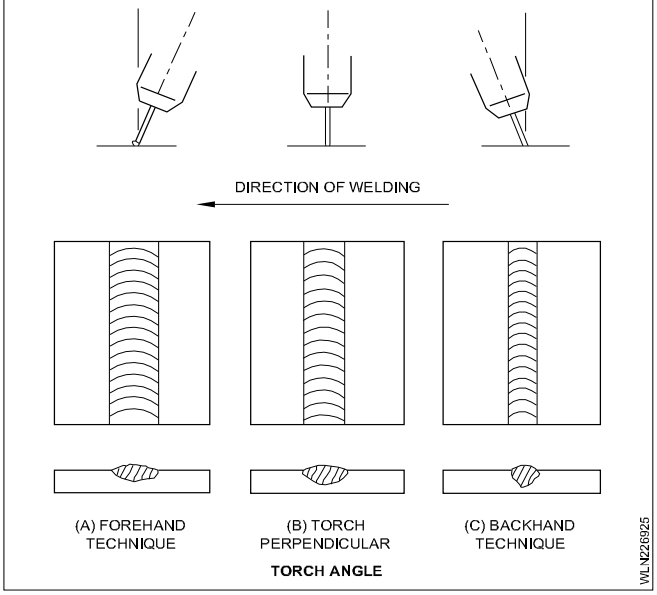
Nozzle: Guns are available with a straight or curved nozzle. The curved nozzle provides easy access to intricate joints and difficult-to-weld.

Torch angle

The position of gun and electrode with respect to the joint affects the weld bead shape and penetration rather than arc voltage or travel speed. The gun is usually maintained within 10 - 20º on either side of the vertical. Depending on which way the gun is incline, the technique is referred to as forehead and backhand. The various electrode positions and techniques and their effects are shown in Fig 5. It is observed that as the electrode is changed from perpendicular to the forehand technique, the weld bead becomes shallower and wider and has less penetration.

Backhand technique gives a more stable arc, less spatter and a narrower, more convex weld bead with deep penetration. Perpendicular technique is used more in automatic welding and avoided in semi-automatic mode because the end of the gas nozzle restricts the operator's view of the weld pool.

Fig 5



TORCH ANGLE

Synergic Control

The complexity of setting welding parameters in conventional DC and pulsed GMAW promoted the development of equipment with 'Single-knob' controls known as Synergic Control. These systems relied on selection of combinations of present welding (e.g. Wire feed speed/mean current and voltage) by means of a single control.

This is possible now because of development of electronic power regulation and micro processor control and programmable equipment which can supply a large number of predetermined welding conditions as well as allowing users to record and retrieve their own customerised parameters.

Although in the pulsed GMAW process the optimum welding parameters can be accurately predetermined, if a change in mean current is required the control settings must be recalculated and a number of the welding parameters reset. This could impose significant practical problems including the possibility of error and resultant deterioration in operating performance. Fortunately it is possible to store both the predetermined parameters and the control equations in the equipment and automatically adjust the output in response to a single input signal. This system is known as Synergic Control (Fig. 6).

Fig 6