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An Approach to Best Welding Practice : Part – VII

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"AN APPROACH TO BEST WELDING PRACTICE, Part – VII." is the Seventh Detail Part of **"AN APPROACH TO BEST WELDING PRACTICE"** which was written as a General and Overall approach to the subject matter.

AN APPROACH TO BEST WELDING PRACTICE, Part – VII is particularly focused on the setting up of the equipment and accessories especially for Gas Metal Arc Welding (GMAW) with special reference to Welding Guns and Torches to obtain the best results in shop floor operation.

All over the world Gas Metal Arc Welding (GMAW) is mostly and widely used welding process in all types of small, medium and large scale fabrication and manufacturing industries covering a wide range of products – inter continent pipe lines, bridges, ships, buildings, rolling stocks, automobiles. Gas Metal Arc Welding (GMAW) has simplified the process of welding in comparison to other welding processes as less skill is required and easiest to learn and perform. The main reason is because the power source does virtually all the work as it adjusts welding parameters to handle differing conditions.

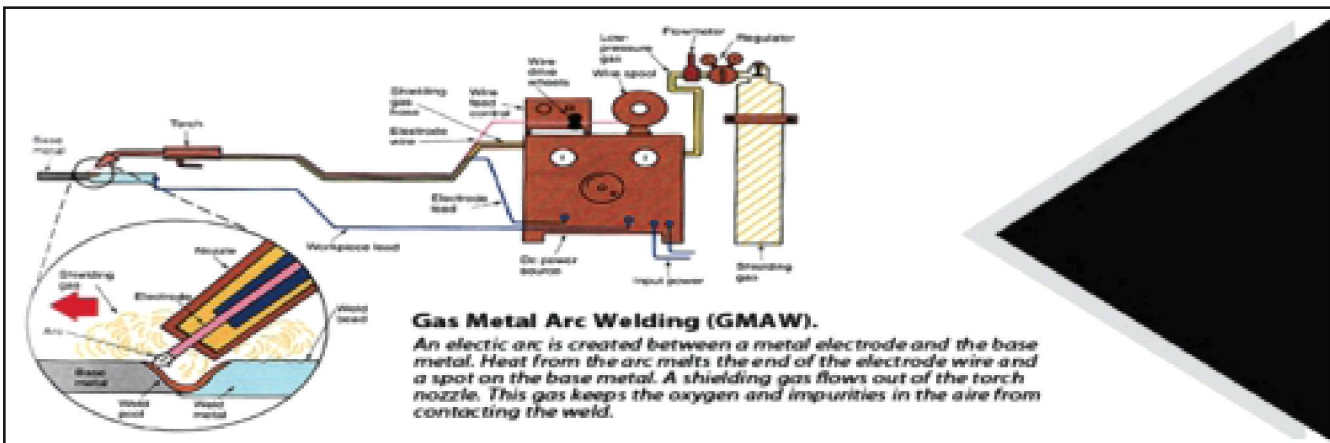
In GMAW the main Equipment used are :

- DC Output Power Source and Welding Control unit
- Wire feed unit
- Welding Torch
- Shielding gas supply.
- Work return welding lead and Cable Connections

In order to get the best out of GMAW process for optimum production and productivity a systematic approach on the setting up of the equipment especially the Power Source, the Wire Feeder Unit and the **Welding Torch** is necessary. It is obvious to look at the essential setting up and maintenance requirement of the Power Source which has been covered in Part – V and the Wire Feeder types, systems of wire feeding and control and operating procedure for optimum results have been covered in Part VI. In this part we will focus on the Welding Guns and Torches to obtain the best results in shop floor operation.

GMAW Torch Or Welding Gun

The GMAW torch provides a conduit for the welding current, the shielding gas, and the electrode to the welding arc. The welding current is picked up at the torch power block located on the wire drive. Current transfers from the welding cable to the electrode through the contact tip. Contact tips are available in a range of sizes designed to accommodate the electrode diameter in use, and they usually attach to the gas diffuser via a threaded connection. The electrode is fed through an internal



Gas Metal Arc Welding (GMAW).
An electic arc is created between a metal electrode and the base metal. Heat from the arc melts the end of the electrode wire and a spot on the base metal. A shielding gas flows out of the torch nozzle. This gas keeps the oxygen and impurities in the aire from contacting the weld.

liner usually located internal to the power cable. The shielding gas connections are located at the welding gun mounting block on the wire drive. They connect to the output side of the gas solenoid. The gas flows to the gas diffuser, which uniformly delivers the gas to the arc. The nozzle size is selected depending on the electrode diameter and the shielding gas rate of flow. Most of the welding with the GMAW process requires a selection of a torch that will meet the anticipated comfort level of the welder and simultaneously meet the wire requirement imposed by the welding operation. The welding current used in the application is primary to the selection, and the durability of the torch under conditions of the arc dictates the appropriate welding.

Types of GMAW Torch

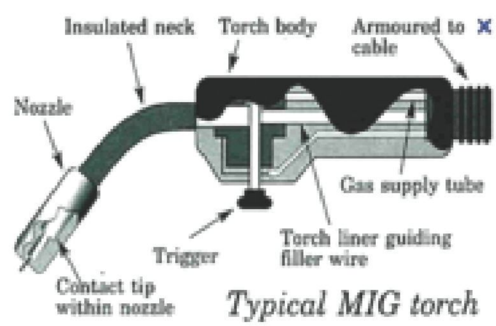
Normally three styles of MIG Guns are in use.

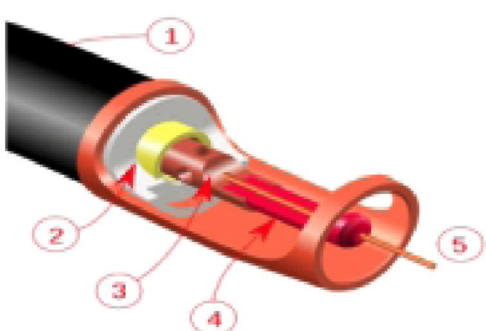
- The most common electrode holder is a semiautomatic air-cooled holder. Compressed air circulates through it to maintain moderate temperature. It is used with lower current levels for welding lap or butt joints.
- The second most common electrode holder is semi-automatic water-cooled type, where the only difference is that water takes the place of air. It uses higher current levels for welding T or corner joints.
- The third typical holder type is a water cooled automatic electrode holder—which is typically used with automated equipment.

The welding gun used in GMAW has a number of key parts —

1. a control switch, the control switch, or trigger, when pressed by the operator, initiates the wire feed, electric power, and the shielding gas flow, causing an electric arc to be struck
2. a contact tip, the contact tip is normally made of copper and sometimes chemically treated to reduce spatter
3. a power cable, connects the torch to the welding power source and transmits the electrical energy to the electrode while directing it to the weld area.
4. a gas nozzle, the gas nozzle directs the shielding gas evenly into the welding zone. Larger nozzles provide greater shielding gas flow, which is useful for high current welding operations that develop a larger molten weld pool. A gas

PARTS OF A GMAW TORCH





GMAW torch nozzle cutaway image.

(1) Torch handle,

(2) Molded phenolic dielectric (shown in white) and threaded metal nut insert (yellow),

(3) Shielding gas diffuser,

(4) Contact tip,

(5) Nozzle output face

hose from the tanks of shielding gas supplies the gas to the nozzle

5. an electrode conduit and liner On the way to the contact tip, the wire is protected and guided by the electrode conduit and liner, which help prevent buckling and maintain an uninterrupted wire feed.
6. a gas hose, sometimes, a water hose is also built into the welding gun, cooling the gun in high heat operations.

Selection Of GMAW Torches

The selection of the proper GMAW torch, commonly called a MIG gun, depends upon the following factors:

- Type of welding: semiautomatic, hard automation or robotic automation.
- Level of current (Amps) required by the welding application and capacity of the torch.
- Shielding gas selected CO_2, Argon, Helium, Mixtures of these gases
- Duty cycle of the torch.
- Preference of an air-cooled or water-cooled torch.

Torch for Semiautomatic GMAW Welding

A duty cycle rating for all GMAW torches for semi-automatic welding is specified for which the heat generated and transferred to the torch handle needs to be considered. The duty cycle of the GMAW torch selected relates to the shielding gas and the maximum current that is specific to the welding application. A 60% duty cycle is specified for most of the air-cooled torches rated for a specific current, and their operation is based upon the use of 100% CO_2 shielding. If argon based blends are indicated, then the torch duty cycle should be reduced by 50%.

Most GMAW torches with electrode conduit and liner come in lengths of 10 - 25 ft. (3 – 8 m) and the length selected should provide no compromise for delivery of the shielding gas and the electrode to the arc.

The selection of a water-cooled torch for GMAW has several advantages :

1. They are rated 100% duty cycle for their given capacity.
2. They increase the life of the consumable components of the torch by approximately 50%.
3. Water–cooled torches have operator appeal because they reduce the heat transferred to the GMAW torch handle.

The downside of a water-cooled torch is that they tend to require more maintenance.

Additionally, the use of a water-cooled torch requires the purchase of a water cooler. Implementation of a water-cooled GMAW torch depends largely upon the size of the electrode used, the amount of time a welder spends at the arc, and the projected cost of welding torch consumables.

GMAW Torches for Automation and High Productivity

Automation requires the torches meet the demands of high productivity. The choice of water-cooled torches versus an air-cooled torch depends on the same criteria applied to the selection of a torch for automatic and semiautomatic welding. Most automation systems incorporate a system design that provides the need for a torch with electrode and liner no longer than 3 ft. (1 m). This aids in smooth and uninterrupted feeding, and reduces maintenance time and cost.

Torch liners, torch barrels, diffusers, nozzles, and contact tips, require replacement and a ready store is essential to maintain weld productivity and quality.

Air-Cooled Torch Ratings			
Torch designate	Range Ampere	Diameter Range	Duty Cycle
200	200	0.025 - 0.045(0.6 - 1.1)	60
300	300	0.035 - 5/64(0.9 - 2.0)	60
400	400	0.035 - 5/64 60(0.9 - 2.0)	60
550	550	035 - 1/8	60

Torches for Robotic Automation

GMAW torches employed for robotic applications follow the same criteria and pattern for selecting as used for both semiautomatic and hard automation. The torch must be of a physical size to move between tooling, holding clamps. It must also be flexible enough to access hard to reach locations. To meet the demanding needs of robotic applications, a number of torch configurations are available that incorporate long torch barrels, Nozzles with small diameter, and torch exchange systems. A collision sensor and a breakaway mounting to the end of the robot arm are standard for all robotic applications. Each of these two components is designed to limit damage to a system.

Special Wire Feeding System

Aluminum fillers are characterized as softer than steel electrodes and they have lower stiffness strength. The smaller the diameter of aluminum electrode, 0.030 - 0.047" (0.8 – 1.2 mm), the more difficult it is to feed. Spool guns are designed to provide a means for delivering aluminum, and other small 1 and 2 lb. (0.45 and 0.90 kg) packages of electrode to the arc. The spool gun incorporates a wire drive motor, a wire feed speed control, and an electrode enclosure in a comfortable lightweight design. A spool gun only has to push the electrode 8" - 10" (200 - 250 mm) to the arc.

A push-pull system is designed with the same principle in mind. In either case, these systems feed aluminum filler metals more reliably than a standard hand held GMAW gun. Both robotic and hard automation applications benefit from push-pull systems.

TORCH MAINTENANCE

Cleaning Torches, Gas Nozzles, & Contact Tips

It is obvious that the torch being used for welding must be well maintained for its longevity, productivity and for quality welds. Regular Inspection of MIG Equipment the gun liner, gun contact tips, gas nozzles, the water/out & power cable, water-in hose & gas hose, gas diffuser/spatter disc, insulation tubes, require regular care and attention. As illustrated earlier a torch is made up of parts which are interchangeable and a store of these items in a controlled way is necessary. Regular cleaning and maintenance require a minimum effort but the results are outstanding.

It should be noted to always unplug the machine before performing any maintenance tasks.

1. Cleaning the Torch

After the shift work, the torch body must be cleaned from metal dust, spatters, dirt, oily materials and other sticking materials with a clean rough cloth. Soft brushes can be used before and after the cleaning by cloth.

2. Contact Tips in MIG Welding

After shift's work inspection of every gun at work must be made to make sure that

a. The gun tip isn't worn out or that weld spatter is not on the tip near the exit hole.

b. The contact tip in the gun should be perfectly round and just a few thousandths inch larger than the wire itself. Worn tips are typically oval and can cause an erratic arc from the random electrical connection and physical movement of the wire inside the worn tip.

c. Contact tips precisely made from a wear-resistant copper alloy will ensure superior welding performance.

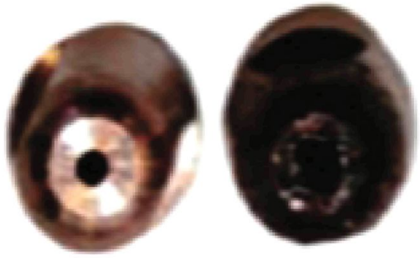
d. If the contact tip comes in touch with the molten weld pool, it should be immediately replaced.

e. In production welding under heavy/ extreme conditions with duty cycles such as 4-hour arc time, it is recommended that the tip is changed after every 100 lbs. of wire is used in welding.

f. To provide an uninterrupted smooth flow of wire, a smooth flow of welding current and to prevent resistance heating through the tip checks to be made at intervals that the contact tip is threaded completely into the adapter or torch body and tightened prior to welding.

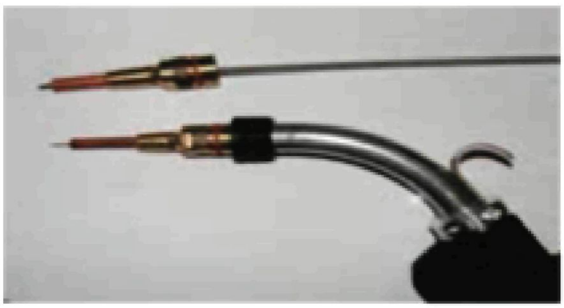
3. Gas Nozzles

The gas nozzle must always be kept clean an important measure for several reasons. A gas nozzle with threads blocked from spatter buildup or oxidization will allow for significantly decreased metal to metal (copper to copper) contact when the gas nozzle is threaded back into the torch. This reduced contact with the copper at the front of the water-cooled nozzle will decrease the amount of cooling on the gas nozzle. More importantly the lack of contact will cause resistance heating. Without a clean connection, the electrical current that passes through the gap between the threads of the gas nozzle and water-cooled nozzle will turn into heat, causing the front of the

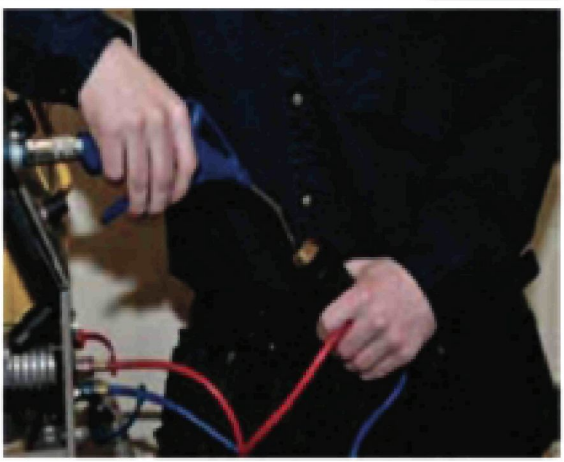


Contact tips and gas nozzle
Remove spatter and replace

Grind the end of the liner conically for optimal fitting of the contact tip.



Contact tip size, liner size and wire diameter
Ensure that the contact tip is the correct size and fits tightly. Ensure the gas nozzle is free from spatter.



Liner
Spiral steel liners are recommended.
Ensure that the liner has the correct inner diameter for the wire size being used.
Check liners regularly for kinks and excessive wear and replace when needed
Clean liners regularly using compressed air.
Note: Remove contact tip prior to cleaning.

torch to be preheated and as copper starts to break down once its temperature exceeds 200 degrees. Further, a torch can be overheated by not threading a copper gas nozzle all the way up so that the copper gas nozzle is not seated on the water-cooled nozzle's copper front; resistance heating will also occur if the gas nozzle is not seated and snug tight. Resistance heating is a great threat to the life of the torch, causing consumables to be used up prematurely, and even causing damage to the torch itself.

Contact tip and gas nozzle

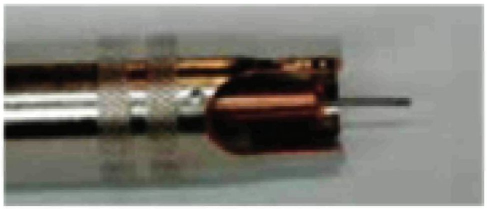
It is essential to fit the gas nozzle and contact tip at the right distance relative to each other. The ideal distance of the contact tip is 5/64 in (2mm) recessed. A longer distance will force the welder to use too long of a stick-out, resulting in poor weldability. This may lead to lack of fusion and slag entrapment, particularly in narrow joints.

Contact tips protruding beyond the gas nozzle can result in insufficient gas shielding.

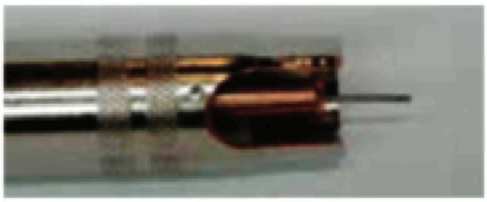
Correct stick-out length

The stick-out is the distance between the contact tip and workpiece and must be kept between 1/2 to 3/4 in (15 to 20mm) for .045 and .052 in diameters (ø1.2 and 1.4mm). Excessive stickout results in too short of an arc length, larger droplets, unstable arc, and splatter which causes poor weldability.

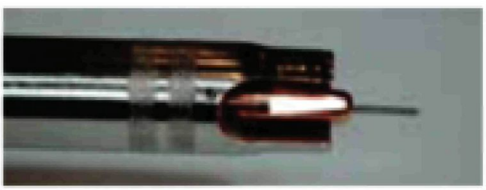
Ideal stick-out for wire diameters .045 and .052 in (1.2 and 1.4mm) 3/4 - 1 in for ø 1/16 in (20-25mmfor ø 1.6mm).



Correct positioning of the contact tip



Incorrect contact tip too recessed



Incorrect Contact Tip protruding beyond gas nozzle

4. **Preventing Spatter Buildup in the Gas Nozzle.**

The Gas Nozzle often becomes filled with spatter while welding. It is important to keep the nozzle clean and free from spatters in order to avoid inhibiting the flow of gas and preventing the ability to weld.

Using a nozzle dip or anti-spatter will help keep the nozzle clean. The nozzle must be dipped in the product every once in a while during welding to reduce the buildup of spatter.

5. **Cleaning Spatter and Reconditioning Nozzles**

When nozzles end up collecting spatter in them, the gas nozzle is to be removed for inspection first. A spatter-full or damaged nozzle can then be wire brushed with a hand drill or lathe with a wire wheel brush. Brushing the outside and inside flat surfaces, brushing the edges, and brushing out the threads would result thorough cleaning. Once cleaned, a gas nozzle should be free of surface inconsistencies, and the threads should be clean enough to allow the copper nozzle to be threaded back on to the chrome water-cooled nozzle by hand. If the threads are damaged, a thread chaser Tap can be used. It is important to remember that after cleaning out the nozzle, air blow to be done to remove any metallic or foreign particles that might prevent a clean thread connection.

6. **Gas Diffuser/Spatter Disc Cleaning and Maintenance**

Just like on a gas nozzle the buildup of spatter, on the gas diffuser/spatter disc will also inhibit the flow of gas. The gas diffuser/spatter disc is held into the front of the torch by the by the support tube which is held in place by the collet nut or by the threaded contact tip. This gas diffuser/spatter disc disperses the shielding gas required for MIG or gas-shielded flux-cored welding. On a regular basis it has to be cleaned by removing the gas cup, tip (collet), and support tube to check the diffuser to ensure that it's not clogged. If there is spatter in the diffuser, a razor blade may be used to clean the surface, a small wire used to clean holes or a rag used just to wipe it clean.

7. **Torch Position & Other Precautions**

The positioning of the torch during welding is an important factor to consider for minimizing torch maintenance. To ensure that the GMAW Gun contact tip stays in the best shape, touching the tip to the work piece must be avoided. Every time an unwanted electrical connection between the tip and the work piece is made, the tip is damaged. It is often possible to burn the tip enough to modify the path of the wire through the tip, thus affecting weld quality also.

For best performance during welding the torch must always be above the work piece at the correct height with the correct gas coverage. It has to be ensured that the tip is clean and seated in the torch all the way down for copper touching copper. If the tip is not bottomed out and snugged tight it will also get resistance heating similar to that occurring with improperly seated gas nozzles. It must be made sure that the tip is hand tight or snug tight. These precautions will improve torch life and weld quality, but despite a welder's best efforts, gun contact tips do eventually need to be replaced.

CONCLUSION.

In any system or process, if the parts are made to function effectively and efficiently the system productivity automatically increases. Mathematically, if there are Five parts in a system and even if their individual efficiencies are 90 % each, then the System Efficiency will be = 0.9 x 0.9 x 0.9 x 0.9 x 0.9 = 0.59, that is only Fifty Nine Percent !

It is therefore intended that we should try to acieve 100% efficiency and effectiveness in each of the parts of the System or Process.