Arc Welding Processes

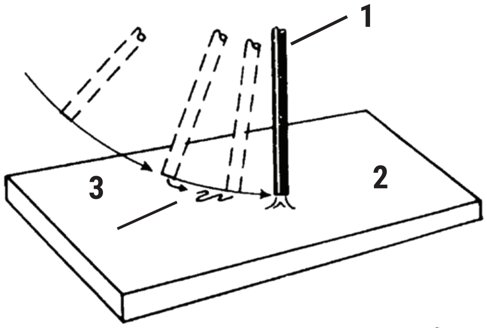
Arc welding processes use a power supply to create and maintain an electric arc between an electrode and the base material to melt metals. They can use direct current (DC) or alternating current (AC), and either consumable or non-consumable electrodes. The welding area is sometimes protected by an external inert or active gas known as a shielding gas. Filler material is commonly used as well. Examples include: Shielded Metal Arc Welding (SMAW or stick), Gas Metal Arc Welding (GMAW or MIG), Gas Tungsten Arc Welding (GTAW or TIG), and Flux-cored Arc Welding (FCAW).

Stick (Shielded Metal Arc Welding — SMAW)

Stick, the most basic of welding processes, offers the easiest option for joining steel and other metals. Stick welding power sources deliver inexpensive options for welding versatility, portability and reliability.

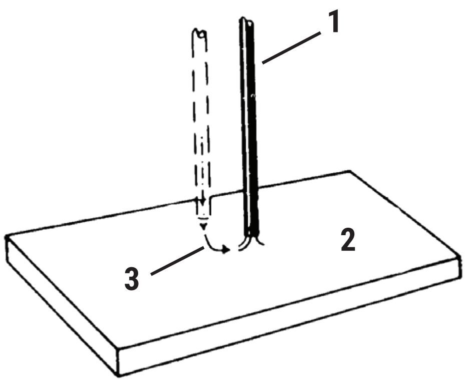
Stick welding joins metals when an arc is struck between the electrode and the work piece, creating a weld pool and depositing a consumable metal electrode into the joint. The electrode's protective coating also acts as a shielding gas, protecting the weld and ensuring its purity and strength.
Best for windy conditions and adverse environments.

There are two general methods of striking the arc: scratching and tapping.



Scratch-Start Technique

Drag the electrode across the work piece like striking a match. Tilt the electrode slightly while touching the work piece. If the arc goes out, the electrode was lifted too high. If the electrode sticks to the work piece, give it a quick twist to free it.



Tapping Technique

Bring the electrode straight down to the work piece, then lift sharply to start the arc. If the arc goes out, the electrode was lifted too high. If the electrode sticks to the work piece, give it a quick twist to free it.

1 Electrode; 2 Workpiece; 3 Arc

AWS Shielded Metal Arc Covered (Stick) Electrode Classification System | Mild Steel

X (X)XX X X

- Electrode — X
- Minimum Tensile Strength in psi — (X)XX
  First two digits of a four digit or
  First three digits of a five digit number
- Position — X
  1 = All Positions
  2 = Flat and Horizontal Fillet
  4 = Vertical Down
- Usability, Type of Coating, Weld Current Type and Polarity — X
  (See interpretation of last digit chart below)

Interpretation of Last Digit in AWS Electr

LAST DIGIT	0	1	2	3	4	5	6	7	8	9
Power Source	(a)	AC or DC electrode positive	AC or DC	AC or DC	AC or DC	DC electrode positive	AC or DC electrode positive	AC or DC	AC or DC electrode positive	AC or DC
Type of Coating	(b)	Organic	Rutile*	Rutile*	Rutile*	Low Hydrogen	Low Hydrogen	Mineral	Low Hydrogen	Rutile*
Type of Arc	Digging	Digging	Medium	Soft	Soft	Medium	Medium	Soft	Medium	Medium
Penetration	(c)	Deep	Medium	Light	Light	Medium	Medium	Medium	Medium	Medium
Iron Powder in Coating	0–10%	None	0–10%	0–10%	30–50%	None	None	50%	30–50%	0–10%

Notes: (a) E6010 is DC electrode; E6020 is AC or DC, (b) E6010 is organic, E6020 is mineral, (c) E6010 is deep penetration; E6020 is medium penetration
*A hard titanium dioxide coating.

When choosing electrodes for mild steel stick welding, keep in mind the amperage ranges you will be working with, as well as the application.

Stick Electrode Chart Selection | Mild Steel

Electrode	Diameter	Amperage	Application
6010/6011	3/32 1/8" 5/32	40–85 75–125 110–165	**6010:** All position electrode only suitable with DC power sources. It delivers deep penetration and has the ability to dig through rust, oil, paint and dirt. This electrode features an extremely tight ar for inexperienced welders. Excellent for penetr **6011:** All position electrode for use with AC and DC power sources. It produces a deep, penetrating arc that cuts through corroded and unclean metals — ideal for maintenance and repair. Excellent for penetration on joints
6013	3/32 1/8" 5/32	40–90 80–130 105–180	All position electrode with a soft arc and minimal spatter, moderate penetration and easily removable slag. Suitable with AC or DC power sources, this electrode is better served on newer and clean materials, thinner materials and wide root openings.
7018	3/32 1/8" 5/32	65–100 110–165 150–220	All position electr on powder content, which makes it one of the easiest electrodes to use. These electrodes produce a smooth, quiet arc with minimal spatter and medium arc penetration. Produces strong welds with high impact properties (even in cold weather) and can be used on carbon steel, high-carbon, low-alloy and high-strength steel base metals. Suitable with AC and DC power sources.

Source: Hobart Brothers

Care for Stick Electrodes

Stick electrodes must be properly stored in order to deposit quality welds. When stick electrodes absorb moisture from the atmosphere, they must be dried in order to restore their ability to deposit quality welds. Electrodes with too much moisture may lead to cracking or porosity. Operational characteristics may be affected as well. If you've experienced unexplained weld cracking problems, or if the stick electrode arc performance has deteriorated, it may be due to your storage methods or re-drying procedures.

Typical Storage and Drying Conditions for Covered Arc Welding Electrodes

AWS	Storage Conditions [a, b]		
A5.1	Ambient Air	Holding Ovens	Drying Conditions [c]
E6010, E6011	Ambient Temperature	Not Recommended	Not Recommended
E6013	80˚F ± 20˚F 50 percent max relative humidity	20˚F to 40˚F above ambient temperature	275˚F ± 25˚F 1 hour at temperature
E7018	Not Recommended	50˚F to 2500˚F above ambient temperature	500˚F ± 800˚F 1 to 2 hours at temperature

Notes:

a. After removal from manufacturer's packaging.

b. Some of these electr absorbing requirements.
This designation does not imply that storage in ambient air is recommended.

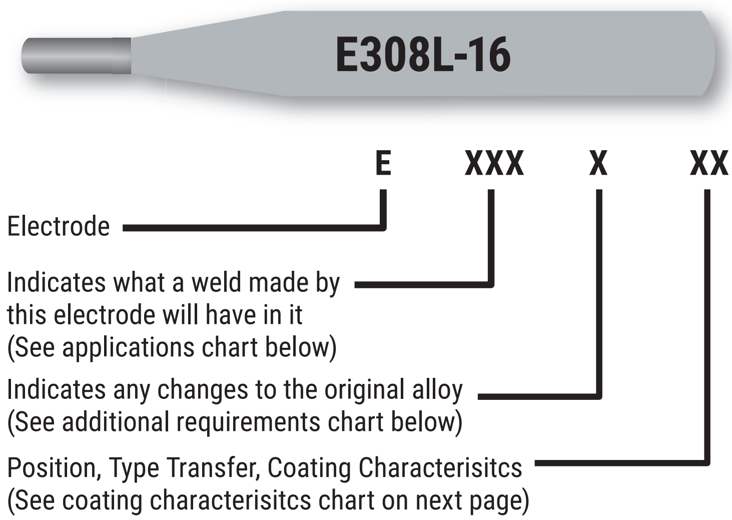
c. Because of inherent differences in covering composition, the manufacturers should be consulted for the exact drying conditions.

Source: AWS A5.1/A5.1M:2004

Average Pieces per Pound of Arc Welding Electrodes

Type	Diameter		
	3/32"	1/8"	5/32"
6010	30	17	12
6011	25	15	11
6013	25	15	10
7018	32	15	10

AWS Shielded Metal Arc Covered (Stick) Electrode Classification System | Stainless Steel



Stainless Steel Applications Chart

Type	Class	Brief Description
A	E308	Used for welding many dissimilar 300 series stainless steels
A	E309	Used for welding many dissimilar metals — mild steel to stainless steel
A	E310	Used to join similar alloys — some dissimilar metals
A	E312	Excellent for welding dissimilar metals
A	E316	Molybdenum (Mo) added to help prevent pitting and increase creep resistance
A	E317	Even more Mo added than E316
A	E330	For heat and scale resistance above 1800˚ F on similar base metal
A	E347	Columbium (Cb) added to prevent corrosion just outside of the weld bead
M	E410	For welding martensitic stainless steels and used for surfacing carbon steels
D	E2209	For welding similar duplex stainless steels

A – Austenitic M – Martensitic D – Duplex

Stainless Steel Additional Requirements Chart

	Additional Requirements
L	Has a lower carbon content
H	Limited to the upper range on carbon content
Mo	Molybdenum added — pitting resistance, creep strength, ferrite increased
Ni	Nickel added — high temperature strength, corrosion resistance, added toughness

Stainless Steel Coating Characteristics Chart

Coating	Dash Number	Out of Position	Bead Ripple	Slag Removal	Spatter Level	Crack Resistance	Operating Current	Bead Pr
AC-DC	-15	1	3	3	3	1	DCEP	Convex
AC-DC	-16	2	2	2	2	2	AC/DCEP	Flat
AC-DC	-17	3	1	1	1	3	AC/DCEP	Concave

Ratings: 1 (the Best) to 3 (the Least)

Maintenance and Repair Applications for Stick Welding

Stick welding processes are used in many maintenance and repair applications due to some of its advantages over other welding processes. For example, stick welding electrodes are self-shielding, meaning there isn't a need to have a cylinder of shielding gas, which cuts down on the amount of equipment involved and therefore is more portable. Also, it provides good protection of the weld bead in outdoor applications where wind may interfere with shielding gas effectiveness.

Choosing the correct replacement, or , material is very important. It should meet or exceed the strength of the work pieces. The correct choice ensures weld quality and longevity, as well as protects against premature failure of the weld.

Guidelines for Cast Iron Repair and Welding

Given the brittle nature of most cast iron, repairing and welding cast iron can be dif oper steps are taken. First and foremost, don't rush. Taking your time to weld cast iron right the o ensure a successful weld repair that will prolong the life of the welded part.

- Preparing the base metal is most important. If not prepared correctly, cracking and weld failure might occur.
- **Cleaning —** grinding is best.
- **Weld preparation —** unlike common carbon steel where a "V" groove is commonly used, cast iron requires a "U" type groove with no sharp edges — any sharp corners or edges could result in cracking, usually along the weld.
  - If the base metal is over 3⁄4"thick, the "U" type weld prep should be only 2⁄3"of the thickness deep — if the base metal is less than 3⁄4", make your weld prep 50% of the wall thickness of the base metal.
- **Preheating —** it is best to preheat cast iron when possible — a soaked preheat with a minimum of 500°F is required, with slow cooling after welding.
- **Welding —** unlike carbon steel, cast ir oove — cast iron requires using:
  - Buttering — passes from the bottom to the top of the weld.
  - Peening — required on every pass. **Do not use** an automatic peening gun as this tends to cool the weld too quickly — use a ball peen hammer
  - Weld using a low current, to minimize admixture and residual stresses.
  - In some cases, it may be necessary to restrict the welds to small, approximately 1" long segments to prevent the build-up of residual stresses that can lead to cracking.
  - Peening of weld beads can be helpful as well.

While there are a variety of types of cast iron, the most common is known as "gray" cast iron, meaning that it contains more than 1.75% of carbon – the greater part of which is present in the structure in the form of graphite. The guidelines below are directed towards this type of cast iron. Be aware that another type of cast iron, "white" or "chilled," is gener ve the distinctive gray color of most cast iron.

TIG (Gas Tungsten Arc Welding – GTAW)

Gas Tungsten Arc Welding (GTAW), also known as Tungsten Inert Gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a

GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys. The operator has greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and dif o master, and furthermore, it is signi than most other welding techniques.

Operating Modes

The mode used is largely dependent on the parent material being welded.

DC Electrode Negative (DCEN)

In this mode the tungsten electrode is the negative pole in the welding circuit, the workpiece being the positive pole. DCEN is the most common mode of operation and is widely used for welding all carbon, alloy and stainless steels, as well as nickel and titanium alloys. Copper alloys, with the exception of those containing aluminum in signi

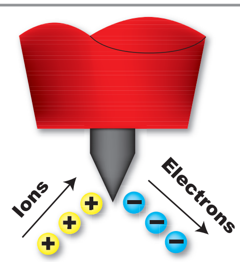
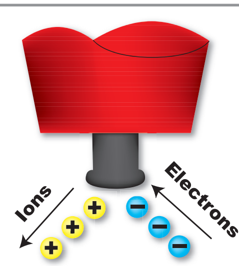
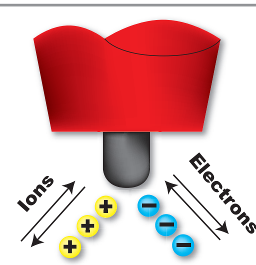
DC Electrode Positive (DCEP)

In this mode the tungsten electrode is the positive pole in the welding circuit, the workpiece being the negative pole. DCEP is used for aluminum alloys when welding, with pure helium as the shielding gas, since this polarity has a strong cathode cleaning effect capable of removing the tenacious aluminum o om the surface. It may also be used for TIG welding magnesium alloys.

Alternating Current (AC)

In this mode the polarity of the tungsten electrode and the workpiece alternate between negative and positive at the frequency of the applied welding current. AC polarity is used most commonly when welding aluminum and its alloys with pure argon or argon-helium mixtures to take advantage of the combination of the cyclic heating and cleaning action. It is also suitable for welding magnesium alloys and aluminum bronze.

TIG Welding Current and Polarity

Current Type	DCEN	DCEP	AC (Balanced)
Electrode Polarity	Negative	Positive	Negative/Positive
Electron and Ion Flow			
Oxide Cleaning Action	No	Yes	Yes – Once Every Half Cycle
Heat Balance In The Arc (Approx.)	70% At Work End 30% At Electrode End	30% At Work End 70% At Electrode End	50% At Work End 50% At Electrode End
Electrode Capacity	Excellent 1/8" 400 A	Poor 1/4" 120 A	Good 1/8" 225 A

TIG Filler Metal Rod Options

AWS TIG (GTAW) Electrode/Rod Classification Systems | Carbon Steel | ER70S-2

ER XX X X

- Electrode or Rod — ER
- Tensile Strength psi — XX
- Solid — X
- Chemical Composition and Shielding Gas — X

Carbon Steel | Direct Current | Straight Polarity (DCEN) | Argon Shielding Gas

Work Thickness	Welding Current (Amps)			Tungsten Diameter	Size		Gas Flow Cu Ft/Hr
	Flat	Vertical	Overhead		Filler Rod	Cup	
1/16	85–115	75–105	75–105	1/16	1/16	1/4", 5/16, 3/8"	11
3/32	105–135	95–125	95–125	1/16	3/32	1/4", 5/16, 3/8"	11
1/8"	125–155	115–140	110–145	1/16, 3/32	3/32	1/4",5/16,3/8"	11
3/16	205–280	155–230	155–230	3/32, 1/8"	1/8"	3/8", 7/16, 1/2"	13

AWS TIG (GTAW) Electr | Aluminum | ER4043

ER X X XX

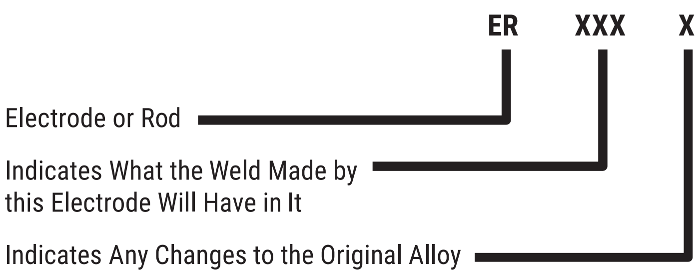
- Electrode or Rod — ER
- Indicates the Principle Alloying Element or Elements — X
- If Different from Zero, Denotes a Modification to the Original Alloy — X
- The Number Used to Identify the Specific Alloy — XX

Designation System for Aluminum Alloys

Alloy Series	Principle Alloying Element
4XXX	Silicon
5XXX	Magnesium

Aluminum | Alternating Current | Stabilized (AC) | Argon Shielding Gas

Work Thickness	Welding Current (Amps)			Tungsten Diameter	Size		Gas Flow Cu Ft/Hr
	Flat	Vertical	Overhead		Filler Rod	Cup	
1/16	60–90	60–90	60–90	1/16	1/16	1/4", 5/16, 3/8"	15
1/8"	125–160	115–135	120–160	3/32	3/32	3/8", 7/16	17
3/16	150–240	190–220	180–210	1/8"	1/8"	7/16, 1/2"	21



AWS TIG (GTAW) Electrode/Rod Classification Systems | Stainless Steel | ER308L

Designation System for Stainless Steel

	Additional Requirements
L	Has a lower carbon content
LSi	Lower carbon content, Higher silicon

Stainless Steel | Direct Current | Straight Polarity (DCEN) | Argon Gas

Work Thickness	Welding Current (Amps)			Tungsten Diameter	Size		Gas Flow Cu Ft/Hr
	Flat	Vertical	Overhead		Filler Rod	Cup	
1/16	80–110	70–100	70–100	1/16	1/16	1/4", 5/16, 3/8"	11
3/32	100–130	90–120	90–120	1/16	3/32	1/4", 5/16, 3/8"	11
1/8"	120–150	110–135	105–140	1/16, 3/32	3/32	1/4",5/16, 3/8"	11
3/16	200–275	150–225	150–225	3/32, 1/8"	1/8"	3/8", 7/16, 1/2"	13

AWS TIG (GTAW) Electr onze | ERCuSi-A

Silicon Bronze | Direct Current | Straight Polarity (DCEN) | Argon Gas

Work Thickness	Welding Current (Amps)			Tungsten Diameter	Size		Gas Flow Cu Ft/Hr
	Flat	Vertical	Overhead		Filler Rod	Cup	
1/16	100–130	90–120	90–120	1/16	1/16	1/4", 5/16, 3/8"	13
1/8"	130–160	120–150	120–150	1/16, 3/32	3/32	3/8", 7/16, 1/2"	15
3/16	150–225	–	–	3/32	1/8"	3/8", 7/16, 1/2"	17

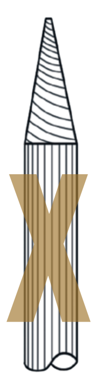
Preparing Tungsten Electrodes for TIG Welding

Get the Right Point

welding requires a balled end.

Correct Grind

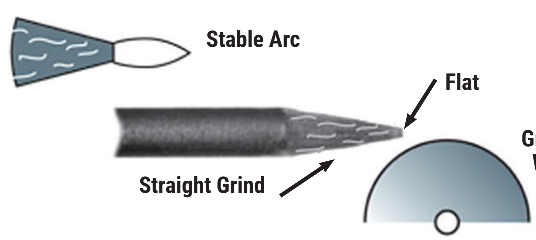
Properly ground and cut electrodes improve arc stability and all around welder productivity. Grind with the grain along the length of the electrode.



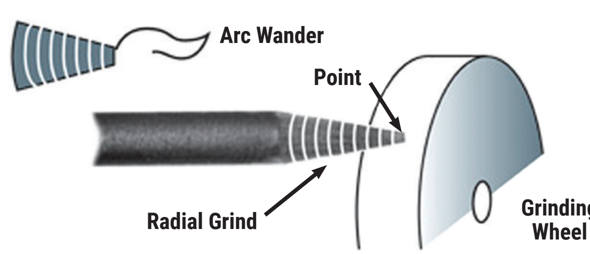
Incorrect Grind

Improperly prepared electrodes can lead to arc wander, splitting, shedding and inconsistencies or expensive mistakes.

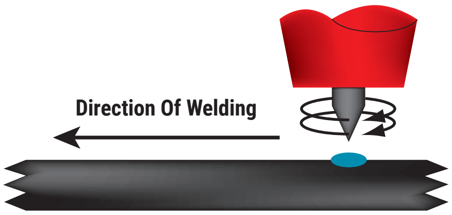
Ideal Tungsten Peparation | Stable Arc



Wrong Tungsten Peparation | Wandering Arc

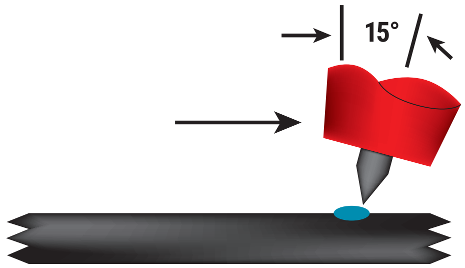


Technique for Manual TIG Welding



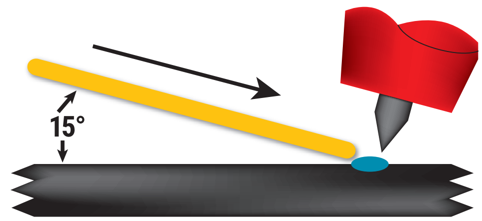
A. Develop the pool with circular or side-to-side motion.

Establishing and maintaining a suitable weld pool is important and welding must not proceed ahead of the puddle.



B. Move electrode to trailing edge of pool.

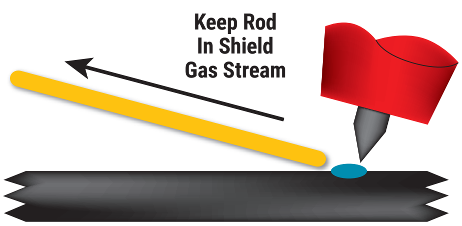
This reduces the chance that you contaminate the tungsten when the



C. o center of leading edge of pool.

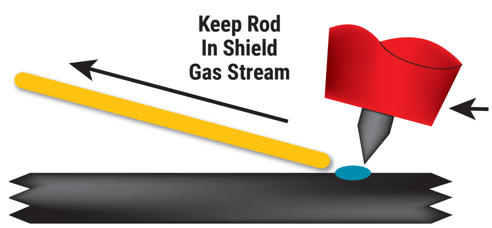
Th

about 15 degrees to the work surface and slowly fed into the molten pool.



D. Withdrawal rod.

During welding, the hot end of the welding rod must not be removed from the shield gas stream in order to pre



E. Move electrode to leading edge of pool.

Th orch must be moved progressively and smoothly so the weld pool, hot welding rod end, and

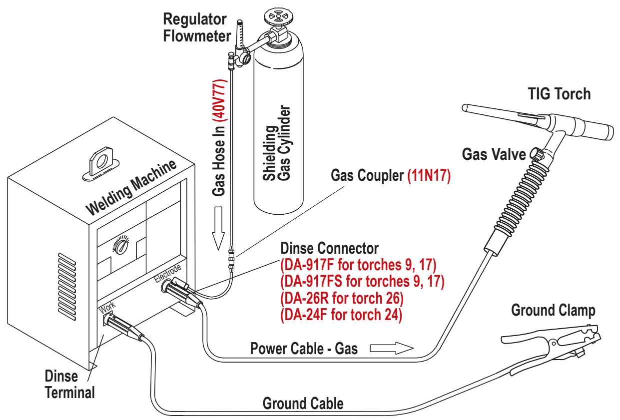
o

air that will contaminate the weld metal area or heat-affected zone.

Common TIG Welding Configurations | Gas-Cooled Torch

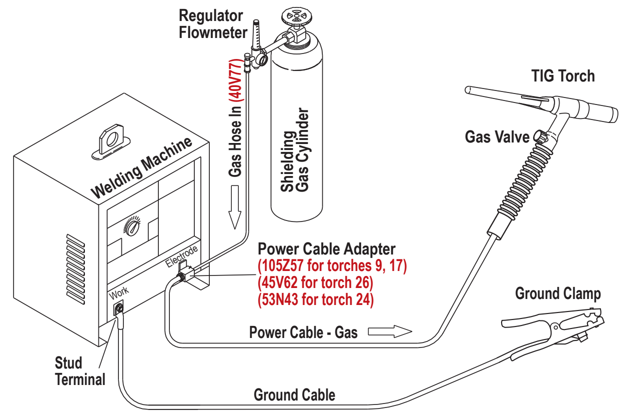
Gas-Cooled with Valve | One-Piece Power Cable | Dinse

For machines without gas solenoid using Dinse connectors



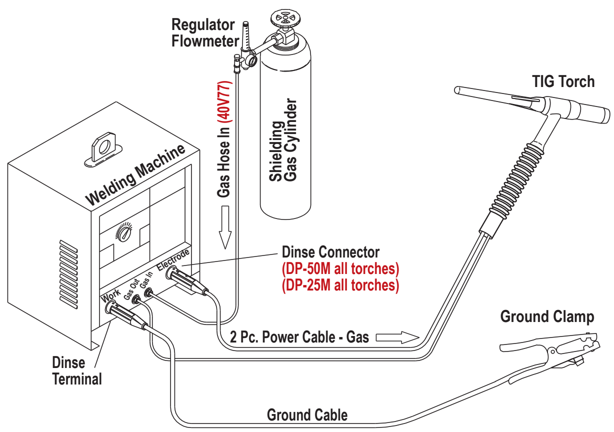
Gas-Cooled with Valve | One-Piece Power Cable | Stud

For machines without gas solenoid using stud terminals and power cable adapter



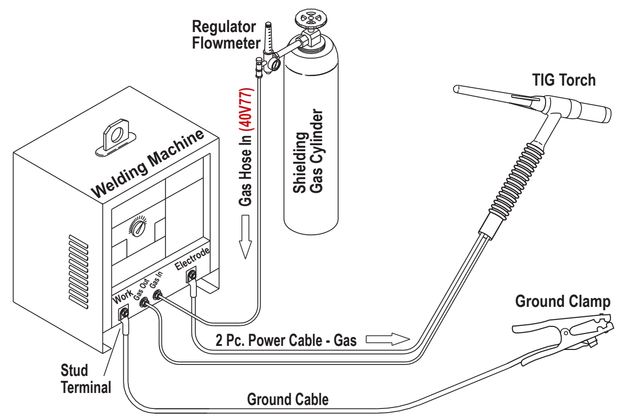
Gas-Cooled without Valve | Two-Piece Power Cable | Dinse

For machines with gas solenoid using Dinse connectors



Gas-Cooled without Valve | Two-Piece Power Cable | Stud

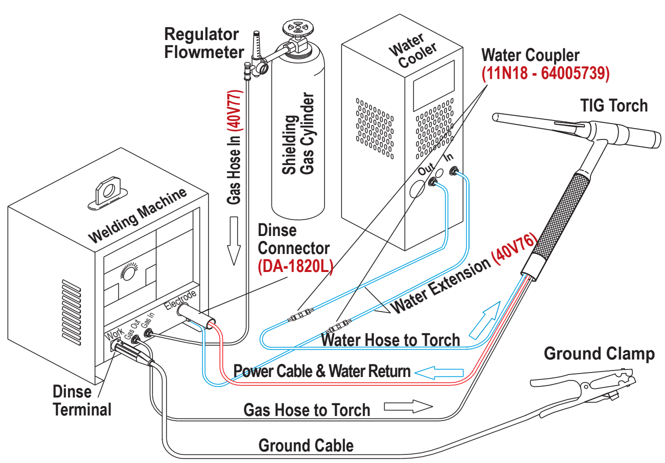
For machines with gas solenoid using stud terminals



Common ations | Water-Cooled Torch

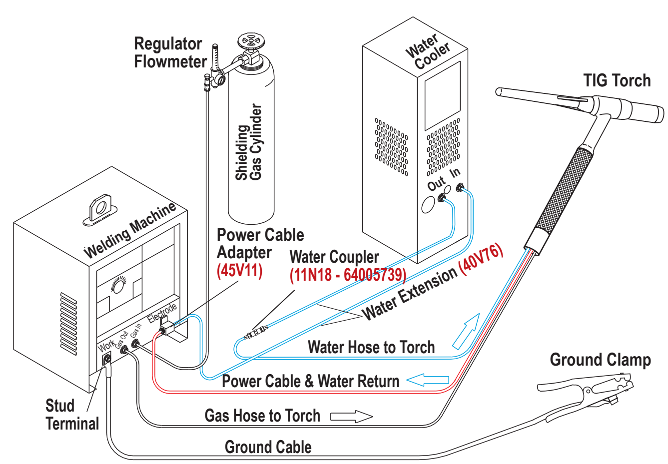
Water-Cooled without Valve | Water Cooler | Dinse

For machines with gas solenoid using Dinse connector



Water-Cooled without Valve | Water Cooler | Stud

For machines with gas solenoid using stud terminals and power cable adapter



Frequently Asked TIG Questions

When should a gas valve torch be used?

Torches with valves are generally used with scratch-start DC welding machines that are NOT equipped with built-in gas solenoids to control . The most common application for this style tor construction. (Operator contr alve.)

Should I use an air-cooled (inert gas) or water-cooled (coolant-cooled) torch?

In general, if you are welding below 200 amps @ 60% duty, an air-cooled torch could be used. If you are welding above this amp range, you should be using a water-cooled torch.

What is the difference between PVC and braided rubber hoses and cables?

For power cables, and water and gas hoses, PVC is considered the economy-grade hose. Braided rubber is the professional grade. For water-cooled torches, braided rubber is recommended.

orch?

Flex torches are the most popular style of air-cooled torches. They allow the welder t orch head to improve the work angle, like around tubing. They also can reduce operat orch for a better work angle, which produces better welds.

Is there any special way t TIG Torch?

or

orch head has

o the desired position.

In air-cooled torches, why do you offer both one-piece and two-piece power cables?

Welders may prefer one cable over the other, but the one-piece is neatly assembled with the conductor inside the hose. The two-piece cable has an external gas hose along with the power cable which can easily be extended to accommodate longer distances from your power source.

Should I tape my power cable and hoses together to keep them neat and organized?

We do NOT recommend taping torch leads together as this will concentrate heat at these points and eventually cause your cables to leak. We recommend the use of a zippered cable cover to protect and organize your leads.

Can a torch longer than 25 feet be purchased or special ordered?

To extend your torch, it is recommended to use an extension kit found on page 112. This will avoid a special-ordered product and allow an off-the-shelf purchase. However, torch packages up to 50' can be ordered.

Can a water-cooled torch be set up to turn on the water circulator when striking an arc?

be turned on PRIOR to welding. The water circulator must be on when the machine is turned on. This will ensure that the tor o striking an ARC. o the cable and torch within seconds.

What is the difference between a scratch start and a high-frequency start?

A scratch start for DC welding is when the tungsten makes contact with the base metal to start an arc. High-frequency start uses high-frequency current to start the arc without the tungsten having to make contact with the base metal.

What work angle position should the TIG torch be during the welding process?

The best case scenario is for the torch angle to be 10–15 degrees or less. Tor
ultimately melt the rod before you get it into the weld puddle.

How far should the tungsten extend beyond the end of the cup?

In general, the tungsten should not stick out any more than 2 1⁄2 times the diameter of the electrode. Example: 1⁄8" electrode x 2.5 = 5⁄16 beyond the cup for standard consumables.

However, if you use a gas lens, your electrode may stick out up to 1 1⁄4" beyond the cup.

How do I know what diameter and type of tungsten electrode to use?

The electrode type and size depends on the welding application, thickness, type of joint and material type being welded. See electrode reference chart on page 146.

Why use a gas lens collet body instead of a standard collet body?

The gas lens allows for a very concentric stream of shielding gas that better shields the weld puddle from the surrounding atmosphere. It also allows the tungsten electrode to be extended beyond the end of the nozzle, in some cases up to 1 1⁄4". Gas lenses also help scrub away excess heat from the torch head.

Why are there different lengths of back caps available?

Smaller back caps are mostly used for weld joint accessibility. Longer back caps are preferable so that longer tungsten can be used which means you don't have to cut your tungsten. Longer tungsten and longer back caps also help to dissipate heat from the torch head.

What is the difference between lava and alumina?

Alumina nozzles are the most common. They have excellent electrical insulating properties, high impact resistance and good thermal conductivity. Lava nozzles are more fragile but perform

into the nozzle.

What do the numbers printed on alumina gas nozzles indicate?

The number printed on the nozzle indicates, in 1⁄16 increments, the inside diameter of the nozzle. Sometimes nozzles are referred to as cups. A number 4 cup/nozzle would be four units of 16, therefore, a number 4 cup is 1⁄4" ID, a number 5 cup is 5⁄16 ID, and a number 6 cup is six units of 16 of an inch or 3⁄8" ID.

What type of shielding gas is most common in TIG welding?

Argon is the most common gas used in TIG welding. Argon/helium mix can also be used.

MIG (Gas Metal Arc Welding — GMAW)

MIG welding is an arc welding process in which a continuous solid wire electrode is fed through a welding gun and into the weld pool, joining the two base materials together. A shielding gas is also sent through the welding gun and protects the weld pool from contamination.

MIG Welding Considerations

Safety First

Before tackling any welding project, you need to make sure you have the pr
removed from the welding area. Basic welding safety apparel includes

and long-sleeve jacket, leather gloves, a welding helmet, safety glasses and a bandana or skull cap to protect the top of your head from sparks and spatter.

Metal Preparation

odes, which have higher amounts of special additives, the solid MIG wire does not combat rust, dirt, oil or other contaminants very well. Use a metal brush or grinder and clean down to bare metal before striking an arc. Make sure your work clamp connects to clean metal, too. Any electrical impedance will affect wire feeding performance.

Equipment Preparation

- Check your cables. Before striking an arc, check your welding equipment t
and free of fraying or other damage.
- Select electrode polarity. MIG welding requires DC electrode positive, or reverse polarity. The polarity connections are usually found on the inside of the machine.
- . T ate to 20 to 25 cubic feet per hour. If you suspect leaks in your gas hose, apply a soapy water solution and look for bubbles. If you spot a leak, discard the hose and install a new one.
- Check tension. Too much or too little tension on either the drive rolls or the wire spool hub can lead to poor wire feeding performance. Adjust according to your owner's manual.
- Inspect consumables. Remove excess spatter from contact tubes, replace worn contact tips and liners and discard the wire if it appears rusty.

Wire Selection

For steel, there are two common wire types. Use an AWS classi
ER70S-3 for all-purpose welding. Use ER70S-6 wire when more deoxidizers are needed for welding on dirty or rusty steel. As for wire diameter, 0.030" diameter makes a good all-around choice for welding a wide range of metal thicknesses in home and motorsports applications.

Gas Selection

Gas selection depends upon each welding application and different mixtures are optimized for each transfer mode and material being welded. See pages 173–174 for more information about our ARCAL™ line of shielding gases.

Electrical Stick-Out (ESO)

Stick-out is the length of unmelted electrode extending from the tip of the contact tube and it does not include arc length. Generally, maintain a stick-out of 3/8". If the arc sounds irregular, one culprit could be that your stick-out is incorrect.

Travel Angle

Tra o the gun in a perpendicular position. Normal welding conditions in all positions call for a travel angle of 5 to 15 degrees. Travel angles beyond 20 to 25 degrees can lead to more spatter, less penetration and general arc instability.

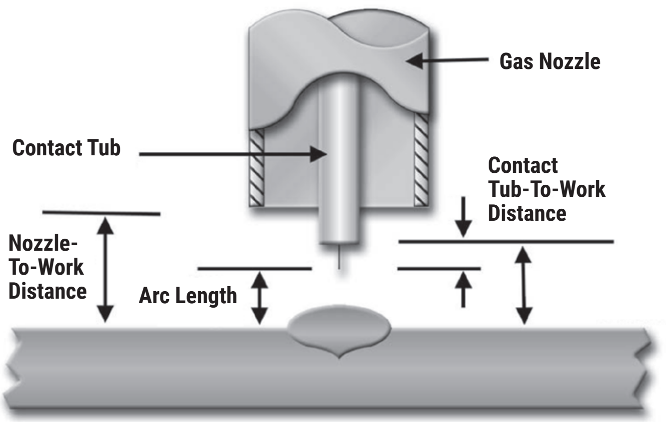
Practice, Practice, Practice!

Note that travel speed — the rate at which you move the gun along the joint — in o a signi
degree. Many experienced MIG welders determine the correct travel speed by judging the weld puddle size in relation to the joint thickness. Knowing that a weld bead needs to be no larger than the thinnest section of metal being welded, they adjust their travel speed accordingly. They also keep the arc on the leading edge of the puddle and don't let the molten metal get ahead of them.

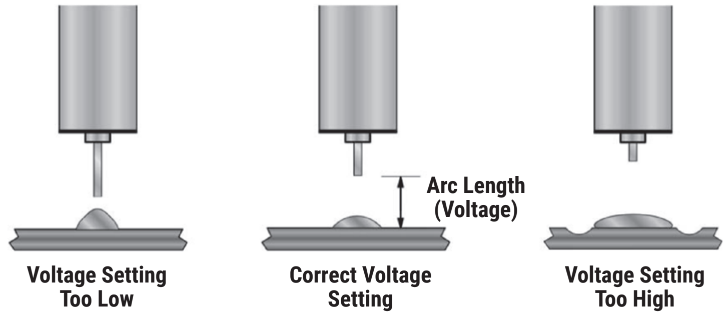
Most people can create good looking, high quality MIG welds with a combination of practice and following the techniques discussed.

Source: Miller®

MIG Gun and Weld Area



MIG (GMAW) Voltage - Bead Changes

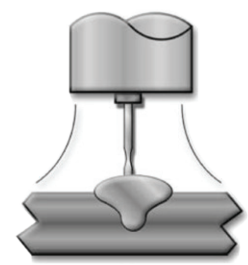


Modes of MIG (GMAW) Transfer

The term modes of transfer is used to describe the process by which the wire electrode is melted and deposited into the puddle. The most common way to classify metal transfer is according to the size, frequency, and characteristics of the metal drops being transferred.

The stability of the welding arc and the metallurgical changes in the electrode wire are dependent on the mode of transfer. Welding procedures are categorized according to the mode of transfer. There are three modes of metal transfer.

Short Circuit Transfer (SCMT)



Short circuit transfer gets its name from the welding wire actually "short circuiting" (touching) the base metal many times per second. When the welding gun trigger is pressed, the electrode wire feeds continuously from the wire feeder, through the gun, and to the arc area, short circuiting to the base metal, exploding and establishing an arc. While welding, this cycle can repeat itself between 20 and as much as 250 times per second.

Globular Transfer

A globular transfer for GMAW is often referred to as the state of transfer between short-circuiting and spray arc transfer. Large "globs" of weld metal transfer across the arc in a gravity transfer. The droplets are usually larger than the electrode wire. Although the electrode wire is pinched off at the arc, globular transfer does not achieve a true spray transfer. Globular is a more unstable transfer, with a less smooth weld bead appearance.

Globular transfer can, in many cases, yield more spatter. Since spatter is waste, it is not a desirable side effect of globular transfer. Globular transfer can also cause cold lapping or incomplete fusion due to the large metal droplets splashing metal out of the puddle.

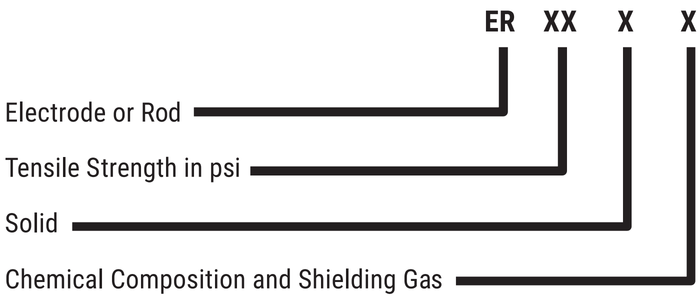
Spray Transfer

A spray transfer "sprays" a stream of tiny molten droplets across the arc, from the electrode wire to the base metal. These molten droplets are usually smaller than the diameter of the unmelted electrode wire. The arc is said to be "on" all of the time, once an arc is established.

The spray transfer uses relatively high voltage (24 volts or higher depending upon the type of shielding gas), wire feed speed and amperage values, compared to short circuit transfer. Because of the high voltage, wire feed speed and amperage, there is a resulting high current density. The high current density produces high metal deposition rates. The high degree of heat in the spray ar
puddle for short circuit transfer. Because of this heat and the size of the weld puddle, spray transfer is somewhat limited in welding positions. The heat and size of the weld puddle also limits spray transfer to material 1/8" or thicker.

MIG Filler Metal Rod Options

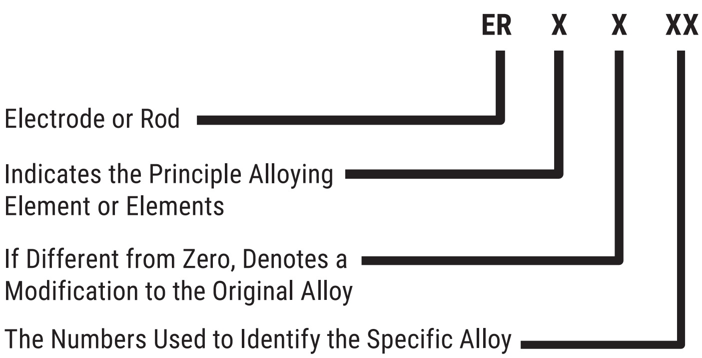
AWS MIG (GMAW) Electrode/Rod Classification Systems | Carbon Steel | ER70S-6



Chemical Composition of Solid Wire Deposited

AWS Class	Chemical Composition					
	C	Mn	Si	P	S	Cu
ER70S-3	0.06–0.15	0.90–1.40	0.45–0.70	0.025	0.035	0.50
ER70S-6	0.07–0.15	1.40–1.85	0.80–1.15	0.025	0.035	0.50

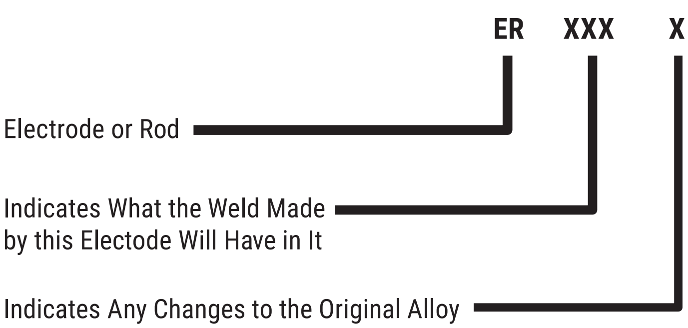
AWS MIG (GMAW) Electrode/Rod Classification Systems | Aluminum | ER4043



Designation System for Aluminum Alloys

Alloy Series	Principle Alloying Element
4XXX	Silicon
5XXX	Magnesium

AWS MIG (GMAW) Electrode/Rod Classification Systems | Stainless Steel | ER308L



Designation System for Stainless Steel

	Additional Requirements
L	Has a Lower Carbon Content
LSi	Lower carbon content, Higher silicon

How to Calculate Filler Metal Consumption

Vtf!uif!ubcmft!cfmpx!up!ftujnbuf!uif!rvboujuz!pg!gjmmfs!nfubm!sfrvjsfe!gps!ipsj{poubm!gjmmfu!xfmet-! trvbsf!hsppwf-!boe!W.hsppwf!cvuu!kpjout/!Jo!dbtft!xifsf!kpjou!jogpsnbujpo!ejggfst!gspn!uif!ubcmft-! tjnqmz!tvctujuvuf!zpvs!ovncfst!jo!uif!gpsnvmb;!! X!>! E0)2.M*

Up!efufsnjof!E-!dbmdvmbuf!uif!bsfb!pg!uif!hsppwf!nvmujqmjfe!cz!uif!mfohui<!uifo!nvmujqmz!uif!sftvmu! cz!1/394-!uif!wpmvnf.up.xfjhiu!dpowfstjpo!gbdups!gps!tuffm/!Jg!xfme!sfjogpsdfnfou!jt!jowpmwfe-!cf! tvsf!up!bee!uijt!up!zpvs!dbmdvmbujpo-!f/h/-!E!>!\)Bsfb!pg!hsppwf!y!Mfohui!pg!hsppwf!y!1/394*!,! Sfjogpsdfnfou!)jg!bqqmjdbcmf*^/

Where –

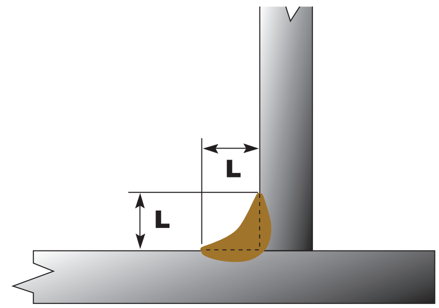
W is the weight of the wire!
!!!!consumed
D is the weight of the steel!
!!!!deposited*
L is the total amount of wire!
!!!!losses

* Table data for square and V-groove joints are based on the efficiency of stick electrodes. To calculate for flux-cored wires, divide D by 0.80; for solid wire, divide D by 0.90.

Horizontal Fillet Weld

Size of Fillet "L"	Steel Deposited per Linear Foot of Weld (lb)	Approximate Pounds of Wires Required Per Linear Foot of Weld: Stick* (SMAW)	Flux-Cored (FCAW)	Solid (GMAW)
1/8"	0.027	0.049	0.034	0.03
3/16"	0.063	0.114	0.079	0.07
1/4"	0.106	0.193	0.133	0.118
5/16"	0.166	0.302	0.208	0.184
3/8"	0.239	0.434	0.298	0.265
1/2"	0.425	0.773	0.531	0.472
5/8"	0.663	1.205	0.829	0.737
3/4"	0.955	1.736	1.194	1.061
1	1.698	3.087	2.123	1.890

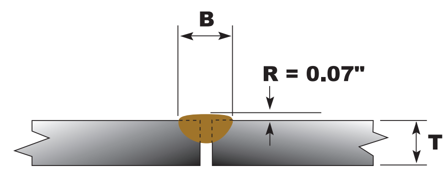
Horizontal Fillet Weld



Square Groove Butt Joint

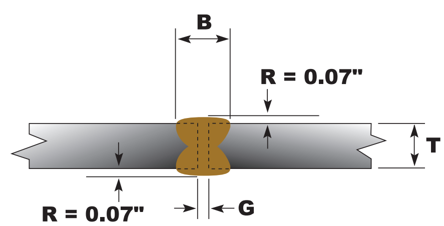
Joint Dimensions: Metal Thickness T	Bead Width B	Root Open G	Steel Deposited Per Linear Foot of Weld (lb): Without Reinforcement	With Reinforcement (R**=0.08")	Approximate Pounds of Wire Required Per Linear Foot of Weld: Without Reinforcement	With Reinforcement (R**=0.08")
3/16"	3/8"	0	–	0.088	–	0.16
–	–	1/16"	0.020	0.109	0.04	0.20
1/4"	7/16"	1/16"	0.027	0.129	0.05	0.23
–	–	3/32"	0.039	0.143	0.07	0.26
5/16"	1/2"	1/16"	0.033	0.153	0.06	0.27
–	–	3/32"	0.050	0.170	0.09	0.30
1/8"	1/4"	0	–	0.119	–	0.21
–	–	1/32"	0.013	0.132	0.03	0.24
3/16"	3/8"	1/32"	0.020	0.199	0.04	0.36
–	–	1/16"	0.040	0.218	0.07	0.39
1/4"	7/16"	1/16"	0.053	0.261	0.10	0.47
–	–	3/32"	0.080	0.288	0.14	0.53

Square Grove Butt Joint Welded on One Side



Square Grove Butt Joint Welded on Two Sides

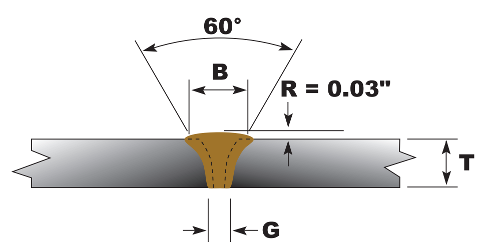
If root of t
and welded, add 0.07 lb. to steel deposited
(equivalent to approximately 0.13 lb of wires).



"V" Groove Butt Joint

Joint Dimensions: Metal Thickness T	Bead Width B	Root Open G	Steel Deposited Per Linear Foot of Weld (lb): Without Reinforcement	With Reinforcement (R**=0.08")	Approximate Pounds of Wire Required per Linear Foot of Weld: Without Reinforcement	With Reinforcement (R**=0.08")
1/4"	0.207	1/16"	0.085	0.143	0.15	0.25
5/16"	0.311	3/32"	0.173	0.258	0.31	0.46
3/8"	0.414	1/8"	0.282	0.394	0.50	0.70
1/2"	0.588	1/8"	0.489	0.641	0.87	1.15
3/8"	0.702	1/8"	0.753	0.942	1.35	1.68
3/4"	0.847	1/8"	1.088	1.320	1.94	2.35
1	1.138	1/8"	1.930	2.240	3.45	4.00

"V" Groove Butt Joint



* Includes scrap end and spatter Loss ** R=Height of reinforcement

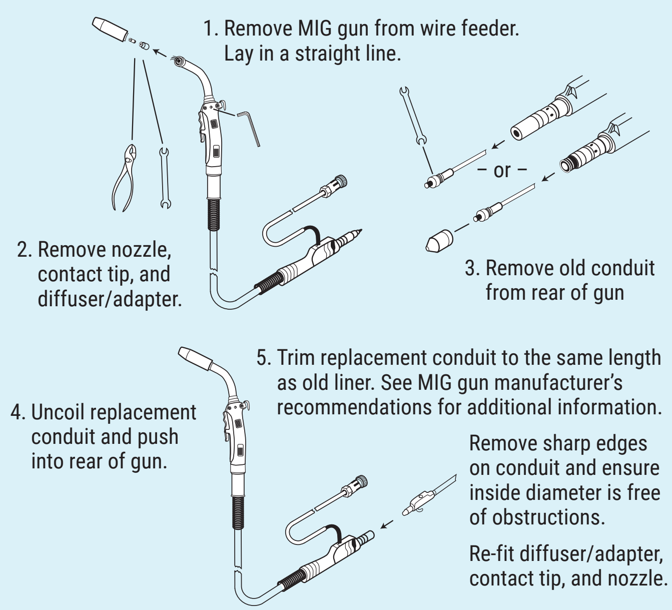
MIG Gun Conduit/Liner

Feeding problems are marked by erratic wire feeding, wire burn back and, in some cases, bird nesting. Causes are typically the result of worn or incorrect drive rolls, clogged liners, wrong tip size, and incorrect installation of wire liner, among others. One of the most overlooked causes is the use of incorrect wire liners. The MIG gun liner is often thought of as the simplest component in the MIG gun assembly but can often prove to be the most important and has a dramatic effect on welding fabrication downtime.

A MIG gun liner is either a tube or helically wound wire which acts as a conduit to guide the welding wire through the MIG gun to the contact tip. It is important to match the type and size of the MIG gun liner to the type and size of the welding wire consumed. In other words, identifying and supplying the right tool for the job.

Source: Abicor Binzel

Changing the Wire Conduit (Liner)



Flux-Cored Arc Welding (FCAW)

Flux-cored arc welding (FCAW or FCA) is a semi-automatic or automatic arc welding process. FCAW requires a continuously-fed consumable tubular electrode containing a flux and a constant-voltage or, less commonly, a constant-current welding power supply. An externally supplied shielding gas is sometimes used, but often the flux itself is relied upon to generate the necessary protection from the atmosphere, producing both gaseous protection and liquid slag protecting the weld. The process is widely used in construction because of its high welding speed and portability.

Advantages of FCAW Welding

- FCAW may be an "all-position" pr
- No shielding gas needed with some wires making it suitable for outdoor welding and/or windy conditions
- A high-deposition rate pr
  applied) in the 1G/1F/2F
- Some "high-speed" (e.g., automotive) applications
- As compared to SMAW and GTAW, there is less skill required for operators
- Less precleaning of metal required
- Porosity chances very low
- Less equipment required, easier to move around

FCAW Filler Metal Welding Wire Options

RADNOR®
welding wire options to choose from. See pages 171–172 for our FCAW wire products.

AWS FCAW Electr
Tubular Wire | E71T-11