

Lesson A5–7

Applying Metal Inert Gas (MIG) Welding Techniques

Unit A. Mechanical Systems and Technology

Problem Area 5. Metal Fabrication

Lesson 7. Applying Metal Inert Gas (MIG) Welding Techniques

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: VIII: Plan, implement, manage, and/or provide support services to facility design and construction; equipment design, manufacture, repair, and service; and agricultural technology.

Benchmark: VIII-B: Follow architectural and mechanical plans to construct building and facilities.

Performance Standard: 1. Identify and select appropriate building materials. 3. Construct with wood and metal.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain the advantages of the metal inert gas (MIG) welding process.
2. Describe the equipment, types of shielding gases, and electrodes used in the MIG welding process.
3. Describe the types of metal transfer patterns used in MIG welding and relate their applications.
4. Describe the correct techniques for starting, controlling, and stopping an MIG bead.
5. Explain how to adjust and maintain the MIG welder.
6. Identify safety practices that should be observed in MIG welding.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Burke, Stanley R., and T.J. Wakeman. *Modern Agricultural Mechanics*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook, Chapter 7)

Minnick, William H. *Gas Metal Arc Welding Handbook*. Tinley Park, Illinois: The Goodheart-Willcox Company, Inc., 1996.

Phipps, Lloyd J., and Carl Reynolds. *Mechanics in Agriculture*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook, Chapter 13)

Other Resources. The following resources will be useful to students and teachers:

Metal Inert Gas (MIG) Welding (VAS 3037). University of Illinois, Urbana, Illinois: ITCS Instructional Materials.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet
MIG welder and welding supplies
Steel pieces

Terms. The following terms are presented in this lesson (shown in bold italics):

Burnback
Ductility
Globular transfer
Inert gas
Short arc transfer
Spray arc transfer
Stickout
Transition current
Travel angle
Whiskers

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Show students welds that have been done with fuel-gas, arc, and MIG welding processes. Do not tell them which process did the welds. Ask them to note any differences between them. Lead a discussion on the advantages and disadvantages of each.

Summary of Content and Teaching Strategies

Objective I: Explain the advantages of the metal inert gas (MIG) welding process.

Anticipated Problem: What are the advantages of the MIG welding process?

- I. Metal inert gas welding (MIG) is a process in which a consumable wire electrode is fed into an arc and weld pool at a steady but adjustable rate, while a continuous envelope of inert gas flows out around the wire and shields the weld from contamination by the atmosphere.

The MIG welding process has several advantages which account for its popularity and increased use in the agricultural and welding industries.

- A. Welding jobs can be performed faster with the MIG process. The continuous wire feed eliminates the need to change electrodes.
- B. Weld cleaning and preparation time is less for MIG welding than for stick electrode welds. Since the gaseous shield protects the molten metal from the atmospheric gases, there is no flux or slag, and spatter is minimal.
- C. Little time is required to teach individuals how to MIG weld.
- D. Because of the fast travel speed at which MIG welding can be done, there is a smaller heat-affected zone than with the shielded metal arc welding process. The smaller heat-affected zone results in less grain growth, less distortion, and less loss of temper in the base metal.
- E. Both thick and thin metals can be welded successfully and economically with the MIG process.
- F. Less time is needed to prepare weld joints since the MIG welds are deep penetrating. Narrow weld joints can be used with MIG welding and still secure sound weldments.
- G. The MIG welding process can be used to join both ferrous and nonferrous metals. The development of electrode wire and the use of spool guns has made the MIG process widely used for aluminum, stainless steel, high-carbon-steel, and alloy-steel fabrication.
- H. The weld visibility is generally good. There is less smoke and fumes so operator environment is improved.

Use TM: A5–7A to illustrate the MIG welding process. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen

student understanding of concepts. Chapter 7 in *Modern Agricultural Mechanics*, Chapter 13 in *Mechanics in Agriculture and Section 1 in Metal Inert Gas (MIG) Welding (VAS 3037)* are recommended.

Objective 2: Describe the equipment, types of shielding gases, and electrodes used in the MIG welding process.

Anticipated Problem: What equipment, types of shielding gases, and electrodes are used in the MIG welding process?

- II. To understand the MIG welding process, you must understand the equipment needed. It consists of a welder, a wire feed system, cable and welding gun assembly, shielding gas supply, and electrode wire.
 - A. Most welders used for MIG welding are direct current machines of the constant voltage type.
 - B. MIG welding machines must be designed to produce a constant voltage. With a constant voltage MIG machine, the output voltage will change very little with large changes in current.
 - C. Welding voltage has an effect on bead width, spatter, undercutting, and penetration.
 - D. The constant voltage welding machines are designed so that when the arc voltage changes, the arc current is automatically adjusted or self-corrected.
 - E. Most MIG welding units have three adjustments which must be in balance to achieve a quality weld. These are voltage control, wire feed speed, and shielding gas flow rate.
 1. The wire feeder continually draws a small diameter electrode wire from the spool and drives it through the cable assembly and gun at a constant rate of speed.
 2. The constant rate of wire feed is necessary to assure a smooth even arc. This must be adjustable to provide for different welding current settings that may be desired.
 3. Wire speed varies with the metal thickness being welded, type of joint, and position of the weld.
 - F. To move the electrode wire from the spool to the MIG welding gun, run the wire through a conduit and system of drive wheels. These drive wheels, depending upon their location in the wire feed unit, are either the push type or the pull type.
 1. The pull-type drive wheels are located relatively close to the MIG gun and exert a pulling action on the wire. Pull-type drive wheels are used on most spool guns.
 2. With the push-type drive wheels, the wire goes through the wheels and is pushed through the electrode lead and out through the MIG gun.
 - G. Correct tension on the wire feed drive wheels is very important.
 1. Too little tension results in drive wheel slippage which causes the wire to be fed into the puddle at an uneven rate, giving a poor-quality weld.
 2. Too much tension on the wire feed wheels results in deformation of the wire shape. This altered wire shape can make it difficult to thread the electrode through the conduit and the contact tip in the MIG gun.

- H. When a blockage or burnback occurs, the MIG gun should be turned off immediately to prevent entanglement. A **burnback** occurs when the electrode wire is fused to the contact tip.
- I. The wire feeders have different sized drive rolls so they can accommodate different sizes and types of wire.
- J. The electrode holder is commonly referred to as the MIG gun. The MIG gun has a trigger switch for activating the welding operation, a gas nozzle for directing the flow of the shielding gas, and a contact tip.
 - 1. The nozzle on the MIG gun directs the shielding gas over the puddle during welding. A nozzle that is too large or too small may result in air from the atmosphere reaching the puddle and contaminating the weld.
 - 2. The nozzle is made of copper alloy to help remove the heat from the welding zone.
- K. When welding outside, where the weld zone is subjected to drafts and wind currents, the flow of shielding gas needs to be strong enough so that drafts do not blow the shielding gas from the weld zone.
- L. The contact tip helps to guide the wire electrode into the puddle as well as transmit the weld current to the electrode wire. The electrode wire actually touches the contact tip as it is fed through the MIG gun. During this contact, the weld current is transmitted to the electrode.
- M. The shielding gas displaces the atmospheric air with a cover of protective gas. The welding arc is then struck under the shielding gas cover and the molten puddle is not contaminated by the elements in the atmosphere.
- N. Inert and non-inert gases are used for shielding in MIG welding. An **inert gas** is one whose atoms are very stable and will not react easily with atoms of other elements.
 - 1. Argon has a low ionization potential and therefore creates a very stable arc when used as a shielding gas. The arc is quiet and smooth sounding and has very little spatter.
 - a. Argon is a good shielding gas for welding sheet metal and thin metal sections. Pure argon is also used for welding aluminum, copper, magnesium, and nickel.
 - b. Pure argon is not recommended for use on carbon steels.
 - 2. Helium gas conducts heat well and is preferred for welding thick metal stock. It is good for welding metals that conduct heat well, such as aluminum, copper, and magnesium.
 - a. Helium requires higher arc voltages than argon.
 - b. Helium-shielded welds are wider, have less penetration and more spatter than argon-shielded welds.
 - 3. Carbon dioxide is the most often used gas in MIG welding because it gives good bead penetration, wide beads, no undercutting and good bead contour and it costs much less than argon or helium.
 - a. The main application of carbon dioxide shielding gas is welding low and medium carbon steels.

- b. When using carbon dioxide shielding gas, the arc is unstable, which causes a lot of spatter.
 - c. Carbon dioxide gas has a tendency to disassociate. At high temperatures encountered in the arc zone, carbon dioxide will partially break up into oxygen and carbon monoxide.
 - d. Good ventilation is essential to remove this deadly gas.
4. When used in a mixture with argon, oxygen helps to stabilize the arc, reduce spatter, eliminate undercutting, and improve weld contour. The mixture is primarily used for welding stainless steel, carbon steels, and low alloy steels.
 5. An argon-helium mixture is used for welding thick non-ferrous metals. This mixture gives the same arc stability as pure argon with very little spatter, and produces a deep penetrating bead.
 6. The argon-carbon dioxide mixture is used mainly for carbon steels, low alloy steels, and some stainless steel. The gas mixture helps to stabilize the arc, reduce spatter, eliminate undercutting and improve metal transfer straight through the arc.
 7. The fabrication of austenitic stainless steel by the MIG process requires a helium, argon, carbon dioxide shielding gas mixture. The mixture allows a weld with very little bead height to be formed. The tank supplying the shielding gas will have a gauge and a gas flowmeter. The volume of gas directed over the weld zone is regulated by the flowmeter.
- O. The selection of the correct electrode wire is an important decision and the success of the welding operation depends on the correct selection. There are factors to consider when selecting the correct electrode.
1. Consider the type of metal to be welded and choose a filler wire to match the base metal in analysis and mechanical properties.
 2. Consider the joint design. Thicker metals and complicated joint designs usually require filler wires that provide high ductility. **Ductility** is the ability to be fashioned into a new form without breaking.
 3. Examine the surface condition of the metal to be welded. If it is rusty or scaly, it will have an effect on the type of wire selected.
 4. Consider the service requirements that the welded product will encounter.
- P. MIG electrode wire is classified by the American Welding Society (AWS). An example is ER70S6. For carbon-steel wire, the “E” identifies it as an electrode, “R” notes that it is a rod, the first two digits relate the tensile strength in 1,000 lbs. psi, the “S” signifies the electrode is a solid bare wire, and any remaining number and symbols relate the chemical composition variations of electrodes.

Again, use TM: A5–7A to illustrate the MIG welding process. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 7 in Modern Agricultural Mechanics, Chapter 13 in Mechanics in Agriculture and Section 2 in Metal Inert Gas (MIG) Welding (VAS 3037) are recommended.

Objective 3: Describe the types of metal transfer patterns used in MIG welding and relate their applications.

Anticipated Problem: What are the types of metal transfer patterns used in MIG welding and when are they used?

III. In MIG welding, the metal from the wire electrode is transferred across the arc plasma to the puddle by globular, short arc, or spray transfer patterns. The type of transfer used for any given weld depends upon the arc voltage, current, kind of shielding gas used, and diameter of the wire electrode.

A. When the molten metal from the wire electrode travels across the arc in large droplets, it is in the **globular transfer** pattern.

1. Globular transfer pattern occurs at low wire feed rates, low current, and low arc voltage settings.
2. The current for globular transfer is below transition current. **Transition current** is the minimum current value at which spray transfer will occur.
3. The molten globules are two to three times larger than the diameter of the electrode. Surface tension holds the globules on the end of the wire electrode. When the globules become too heavy to remain on the electrode, they drop off and move across the arc. The globules do not move across the arc in an even pattern.
4. Welds made with globular transfer have poor penetration and excessive spatter and are used little in MIG welding.

B. The **short arc transfer** pattern is actually a series of periodic short circuits that occur as the molten tip of the advancing wire electrode contacts the workpiece and momentarily extinguishes the arc.

1. The droplet forms on the end of the electrode and begins to sag while the arc is ignited. The droplet sags further and touches the molten puddle. When the droplet touches the puddle, the arc is short-circuited and extinguished. The droplet continues to melt and breaks off the end of the wire electrode. At this instant, the arc reignites and a new droplet begins to form.
2. New droplet formation and arc shorting may occur from 20 to 200 times per second.
3. Short arc transfer is also known as short circuiting transfer and dip transfer.
 - a. Short arc transfer is especially good for welding in the horizontal, vertical, and overhead positions where puddle control is usually hard to maintain.
 - b. Short arc welding is most feasible at current levels below 200 amps and with small-diameter electrode wire.

C. The **spray arc transfer** pattern is a spray of very fine droplets.

1. Spray arc transfer is a high-heat method of welding with a rapid deposition of metal. It is used for welding all common metals from $\frac{3}{32}$ inch to over 1 inch in thickness.
2. This transfer occurs only with argon or argon-oxygen mixture of shielding gas.

Use TM: A5–7B, A5–7C and A5–7D to reinforce the various transfer patterns. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 7 in *Modern Agricultural Mechanics*, Chapter 13 in *Mechanics in Agriculture* and Part 1 in *Metal Inert Gas (MIG) Welding (VAS 3037)* are recommended.

Objective 4: Describe the correct techniques for starting, controlling, and stopping an MIG weld.

Anticipated Problem: What is the correct technique for starting, controlling, and stopping an MIG weld?

- IV. Follow proper procedures when starting, controlling, and stopping an MIG weld.
 - A. Preparing to start welding with the MIG welder requires you to make adjustments to the machine.
 1. Be sure the gun and ground cables are properly connected.
 - a. If possible, attach the ground directly to the workpiece and weld away from the ground.
 - b. Long, coiled cables act as reactors and set up stray magnetic fields that affect arc action.
 2. Check that the wire type, wire size, and shielding gas are correct for the metal to be welded.
 3. Set the shielding gas flow rate, proper amperage, and wire speed for the metal being welded.
 4. In MIG welding there are two types of starts that may be employed to get the bead going.
 - a. In the fuse start technique, the end of the wire electrode acts like a fuse. The welding current flows through the wire until it becomes hot and begins to melt.
 - i. When the welding gun trigger is “on”, the wire is moving out of the wire contact tip.
 - ii. The object of a fuse start is to melt the wire fed out of the gun before it touches the base metal.
 - iii. When the arc first occurs, it should take place between the tip of the wire and the base metal. If the arc starts at some other point along the wire, other than the tip, then an unmelted section will reach the base metal. Unmelted electrode wires, stuck in the bead, are called **whiskers**.
 - b. The scratch start requires the electrode wire to touch and move along the base metal as the arc ignites.
 - i. The contact point between the electrode tip and the base metal acts like a fuse.
 - ii. Dragging the wire over the base metal is the preferred method of scratch-ing.

- iii. The lighter the drag pressure, the smaller the amount of current needed and the better the start.
- B. When ready to start the welding process, travel speed, stickout, and gun angle are important considerations.
1. The speed at which the arc is moved across the base metal affects the puddle. Proper control of the puddle provides for good penetration, with correct bead width and bead height, and prevents undercutting.
 - a. Travel speed may also affect arc stability and the metal transfer pattern.
 - b. Travel speeds vary with the size of the electrode wire, current density, metal thickness, weld position, and kind of metal being fabricated.
 2. The tip-to-work distance can affect weld penetration and weld shape, and is known as **stickout**.
 - a. Short stickout distances ($\frac{3}{8}$ inch or less) are desirable on small-wire, low-amperage applications.
 - b. It is desirable to keep this distance as short as possible to get precision wire alignment over the joint and proper placement in the puddle.
 3. Holding the MIG gun at the correct angle is very important since it controls shielding gas distribution, puddle control, and bead formation. Two angles which must be correct to make a quality weld are the travel angle and the work angle.
 - a. **Travel angle** is the angle at which the MIG gun leans toward or away from the direction of movement.
 - i. A travel angle of 10 degrees to 20 degrees is used for most welding.
 - ii. Travel angle is sometimes referred to as drag angle.
 - b. The work angle is perpendicular to the line of travel and varies considerably, depending upon the type of weld being made and the welding position. The work angle for a flat position surfacing weld should be 15 degrees to 25 degrees.
 4. The MIG gun may be held three different ways.
 - a. Perpendicular to the base metal.
 - b. Leaning in the direction of travel, also known as the backhand or pull position.
 - c. Leaning opposite the direction of travel, also known as the forehand or push position.
- C. If the weld current is stopped instantly, the weld puddle freezes, gases become entrapped in the bead, and porosity results.
1. The best stop is achieved by allowing the weld current to taper down.
 2. Stopping the wire feed as quickly as possible after the MIG gun trigger is off is desirable.
 3. Stopping the flow of shielding gas is the last thing to be done when stopping a weld. The shielding gas needs to flow over the puddle until it is fully solidified.

Use TM: A5–7E and A5–7F to illustrate gun angle and position. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to

strengthen student understanding of concepts. Chapter 7 in *Modern Agricultural Mechanics*, Chapter 13 in *Mechanics in Agriculture* and Section 4 in *Metal Inert Gas (MIG) Welding (VAS 3037)* are recommended.

Objective 5: Explain how to adjust and maintain the MIG welder.

Anticipated Problem: How is the MIG welder adjusted and maintained?

- V. The MIG welder must be set correctly in order to do the best job. Machine adjustment and maintenance are important.
 - A. Most MIG machines have a voltage adjustment in addition to the wire feed control.
 - 1. Determine what the voltage should be for the kind and thickness of metal and the shielding gas being used.
 - 2. Fine adjustments may then need to be made so welding occurs with the right sound, bead penetration, shape, and contour.
 - B. Check specifications to see what the correct gas volume should be for the weld.
 - 1. Stand to one side of the regulator, open the tank valve completely.
 - 2. Adjust the flowmeter to the predetermined gas volume.
 - 3. Hold the MIG gun “on” to set to the correct operating volume.
 - C. Some machines have a self-contained coolant system, while others must be connected to a water source. If it is water cooled, be sure the water is turned on.
 - D. The nozzle should be kept clean and free of spatter in order to properly direct the flow of shielding gases over the puddle.
 - 1. If filled with spatter, the nozzle may be cleaned with a nozzle reamer or a round file. Be careful not to deform the tip while cleaning.
 - 2. Anti-spatter dip or spray may be put on the nozzle to help prevent spatter build-up and to make cleaning easier.
 - E. Contact tips need to be sized to fit the diameter of electrode wire being used.
 - 1. The current is transmitted to the wire electrode in the contact tip.
 - 2. Tips are usually threaded into the MIG gun so that good electrical contact is made.

Use text material to strengthen student understanding of concepts. Chapter 7 in *Modern Agricultural Mechanics*, Chapter 13 in *Mechanics in Agriculture* and Section 6 in *Metal Inert Gas (MIG) Welding (VAS 3037)* are recommended.

Objective 6: Identify safety practices that should be observed in MIG welding.

Anticipated Problem: What are the safety practices that are observed in MIG welding?

- VI. The following are suggested practices and tips that will help to eliminate shop accidents when MIG welding.

- A. Make sure that all welding cables and their connections are in good repair. Do not use cables that are cracked or cut or have damaged insulation. Electrical connections on each cable should be tight and not have frayed ends or bare wires exposed.
- B. Wear welding gloves, helmet, leather apron, welding chaps, leather shoes, and other personal protective equipment to help prevent weld burns.
- C. When operating a MIG welder, never touch an electrical connection, a bare wire, or a machine part which may cause electrical shock. Never weld in damp locations because of the shock hazard.
- D. Never weld with flammables (matches, butane lighters, fuel stick, etc.) in your pockets.
- E. Use pliers or tongs to handle hot metal from the MIG welding process. Never leave hot metal where others may touch it and be burned.
- F. Select the correct shaded lens for the electrode size being used. Shades 10 and 12 are recommended.
- G. Perform all welds in a well-ventilated area. Welding fumes should be ventilated away from the weldor, not across the weldor's face. Remember that shielding gases are asphyxiants, and welding fumes are harmful. Work in well-ventilated areas to prevent suffocation or fume sickness.
- H. Store inert gas cylinders in a cool, dry storage area. Do not drop or abuse gas cylinders in any way. Do not move cylinders unless the valve protection cap is in place and tight. Check all connections with soapy water to detect leaks.
- I. Hang the welding gun on a hook when it is not in use. Do not hang it on the flow meter, regulator, or cylinder valve. Do not lay the gun on the work or worktable.
- J. Protect other workers by using a welding screen to enclose your area. Warn persons standing nearby, by saying "cover", to cover their eyes when you are ready to strike an arc.
- K. Before starting to weld, clear the surrounding area of possible fire hazards. Remove straw, shavings, rags, paper, and other combustible materials.
- L. Be alert for fires at all times. Because the operator's helmet is lowered, clothing may catch fire without being noticed. Depend on your senses of touch, smell, and hearing to indicate that something is wrong. In case of a clothing fire, strip off the article if possible. Do not run, as running fans the flames. Wrap yourself in a fire blanket, or improvise with a coat or piece of canvas. If there is nothing at hand to wrap in, drop to the floor and roll slowly.
- M. Protect hoses and welding cables from being stepped on or run over by vehicles. Do not allow them to become tangled or kinked. Position them so they are not a tripping hazard. Protect them from flying sparks, hot metal, or open flame, and from oil and grease which will cause rubber to deteriorate.
- N. Always unplug the welder and put all equipment away when you have finished welding for the day.

Use text material to strengthen student understanding of concepts. Chapter 7 in *Modern Agricultural Mechanics*, Chapter 13 in *Mechanics in Agriculture and Section 6 in Safety in the Shop (VAS 3022a)* are recommended.

Review/Summary. Focus the review and summary of the lesson around the student learning objectives. Call on the students to explain the content associated with each objective. Use their responses as the basis for determining any areas that need re-teaching. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary. Use the lab activities in reviewing and reinforcing student learning.

Application. Application can involve the following student activity using the attached lab sheet. It is understood that before attempting the lab activities, proper safety precautions in the agriculture mechanics shop must be covered thoroughly.

LS: A5-7A—MIG Welding Exercises

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance, on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1 = d, 2 = f, 3 = i, 4 = a, 5 = e, 6 = b, 7 = h, 8 = j, 9 = g, 10 = c

Part Two: Completion

1. Inert gas
2. voltage, wire speed, gas flow rate
3. flux, slag, spatter
4. globular, short arc, spray transfer

Part Three: Short Answer

1. E is electrode, R is rod, 70 is 70,000 psi, S is solid bare wire.
2. Welding is faster, cleaning and preparation time is less, easy to learn, less distortion, weld thin and thick metals, less time needed to prepare joints, can join both ferrous and non-ferrous metals, visibility is good.
3. Too little tension results in drive wheel slippage which cause uneven feeding rate which results in poor quality welds. Too much tension results in deformation of the wire shape which makes it hard to thread through the unit.

Test

Lesson A5–7: Applying Metal Inert Gas (MIG) Welding Techniques

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|----------------------|--------------|-----------------|
| a. burnback | e. short arc | h. travel angle |
| b. ductility | f. spray arc | i. whiskers |
| c. globular transfer | g. stick out | j. wire speed |
| d. MIG gun | | |

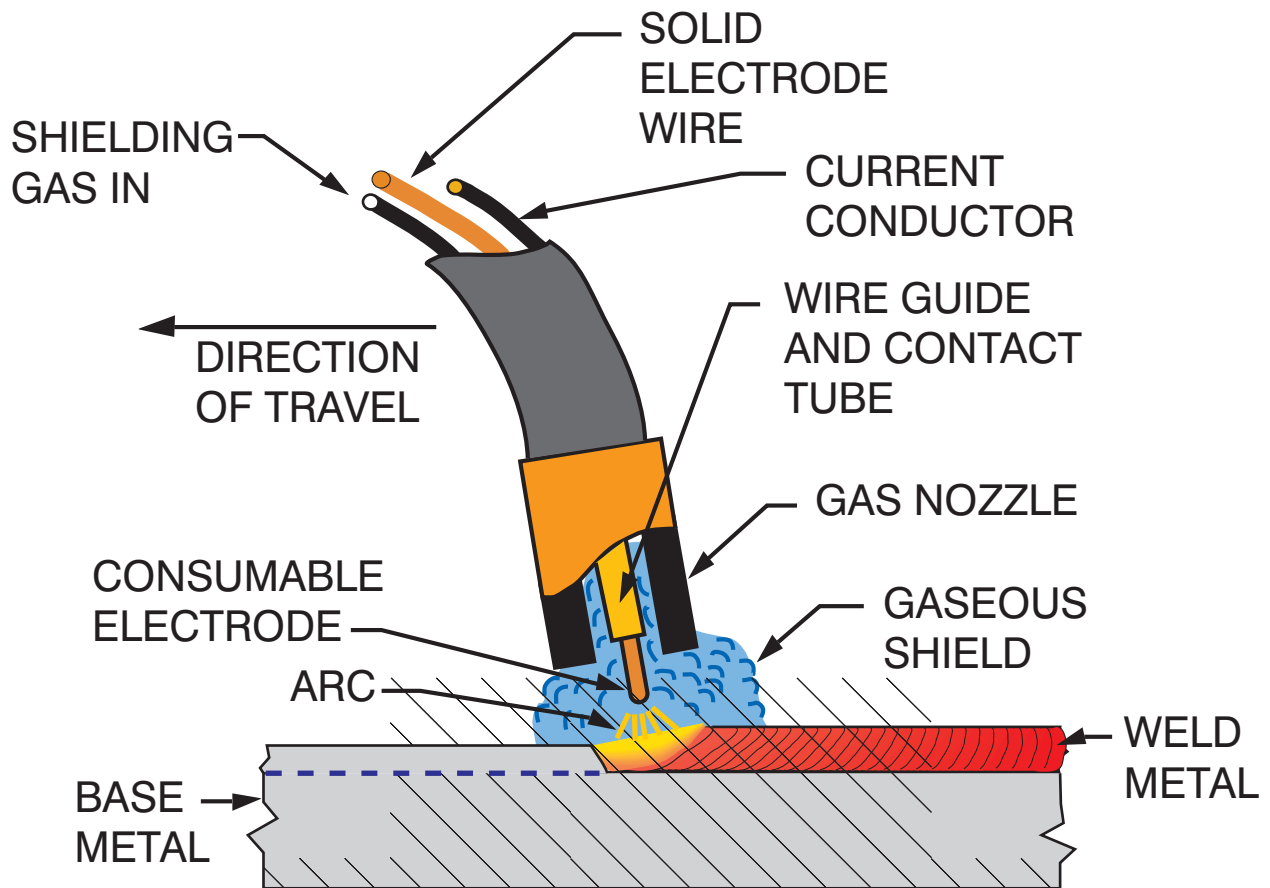
- _____ 1. Electrode holder.
- _____ 2. Spray of very fine droplets.
- _____ 3. Unmelted electrode wires, stuck in the bead.
- _____ 4. Electrode wire is fused to the contact tip.
- _____ 5. Series of periodic short circuits that occur as the molten tip of the advancing wire electrode contacts the work piece and momentarily extinguishes the arc.
- _____ 6. Capability of being fashioned into a new form without breaking.
- _____ 7. Angle at which MIG gun leans toward or away from the direction of movement.
- _____ 8. Varies with metal thickness, type of joint and welding position.
- _____ 9. Tip-to-work distance that affects weld penetration and shape.
- _____ 10. Molten metal from wire electrode travels across the arc in large droplets.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

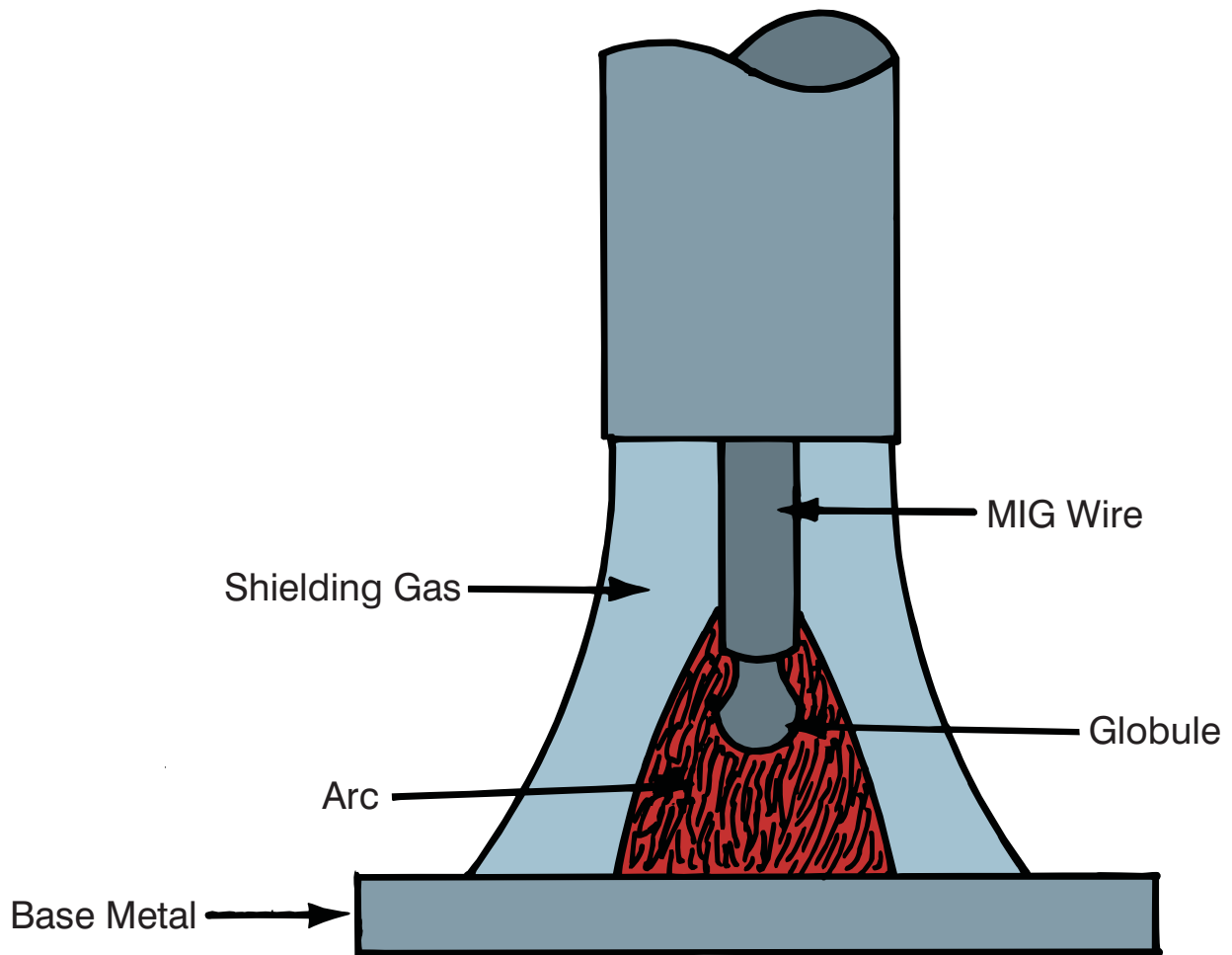
1. _____ is a gas whose atoms are very stable and will not react easily with atoms of other elements.
2. The three adjustments which must be in balance to achieve a quality weld with MIG welding are _____, _____ and _____.
3. In MIG welding, the gaseous shield protects the molten metal from the atmosphere, there is no _____ or _____ and _____ is minimal.

MIG WELDING PROCESS



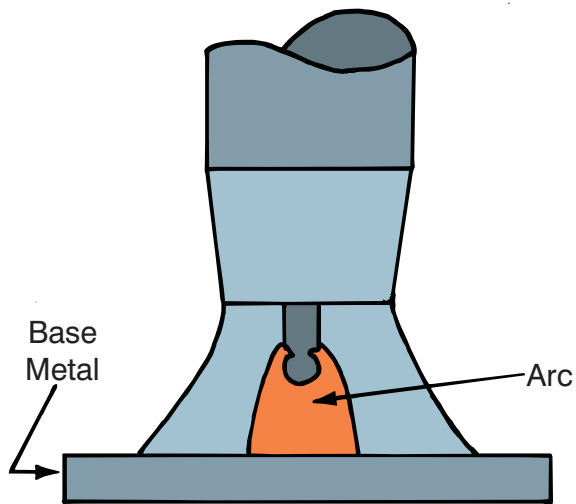
(Courtesy, Interstate Publishers, Inc.)

GLOBULAR TRANSFER

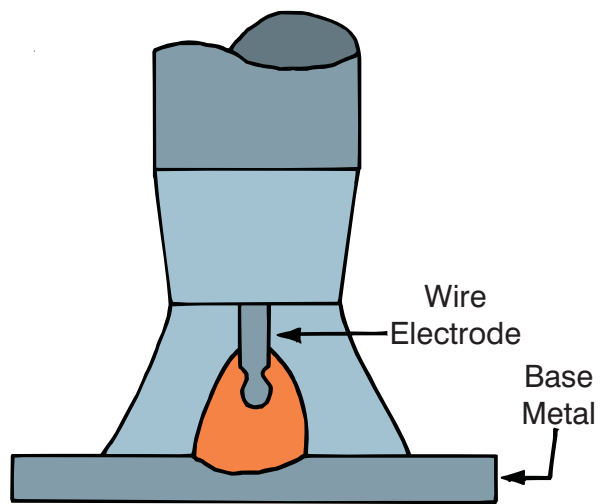


(Courtesy, Interstate Publishers, Inc.)

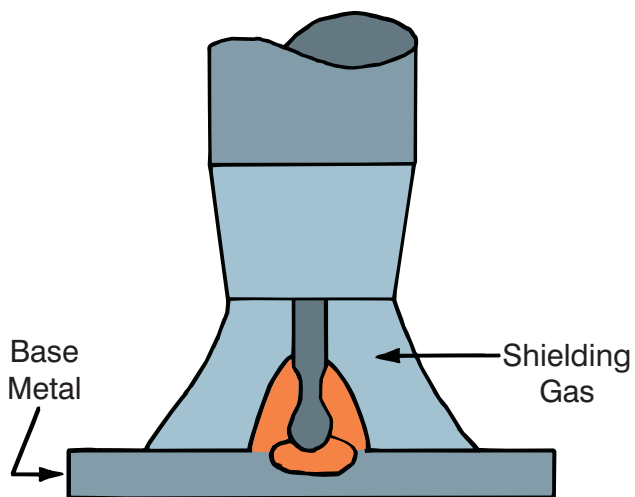
SHORT ARC TRANSFER



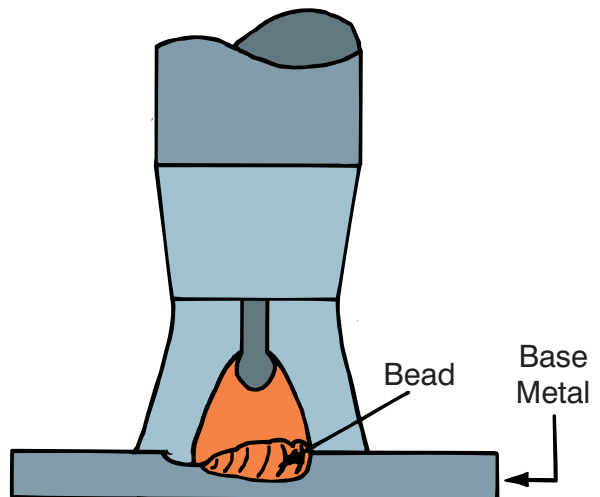
Beginning of the short arc cycle.



Molten electrode elongates.



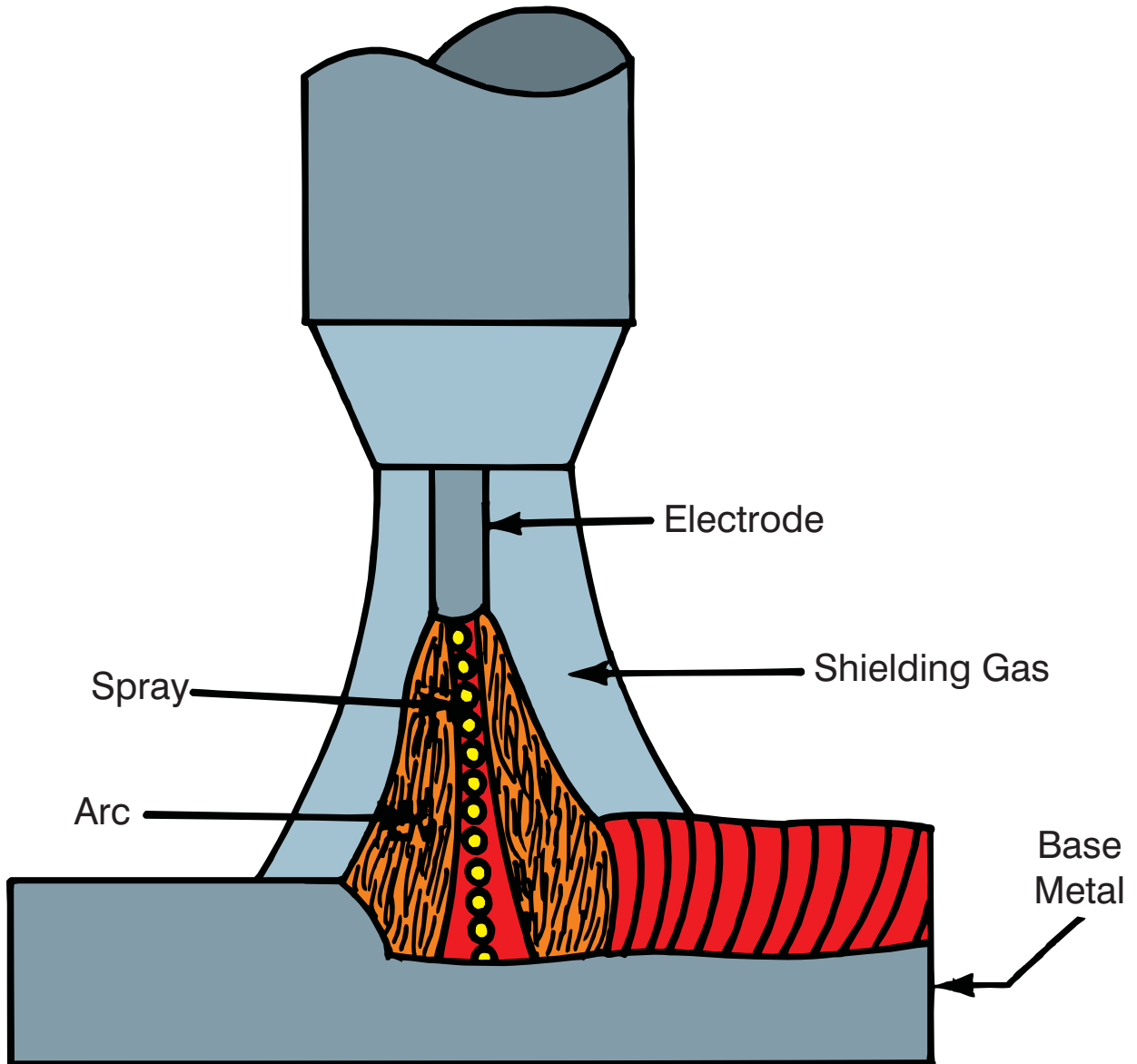
Molten electrode touches puddle and short circuits.



Molten drop separates from electrode and the arc is reignited.

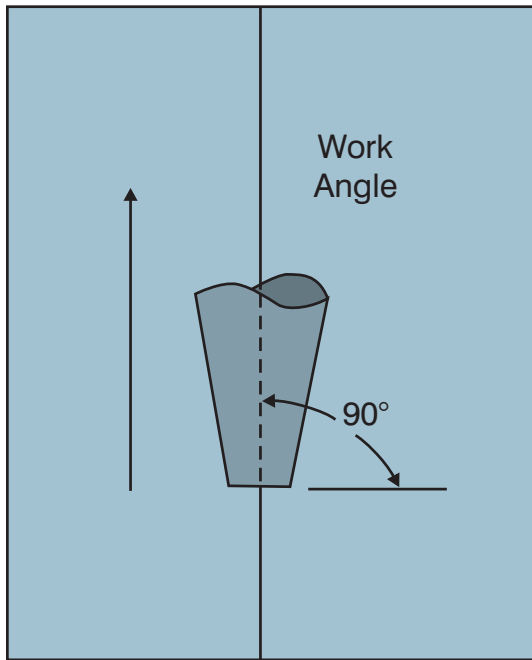
(Courtesy, Interstate Publishers, Inc.)

SPRAY TRANSFER

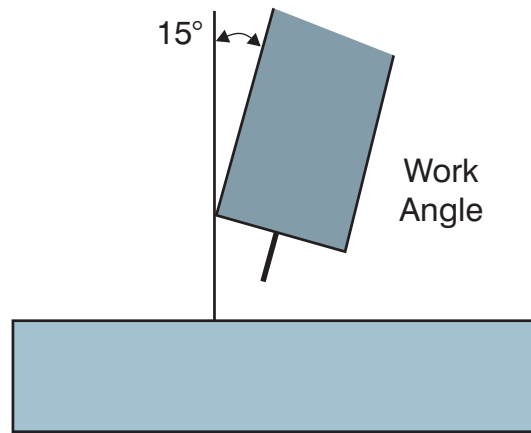


(Courtesy, Interstate Publishers, Inc.)

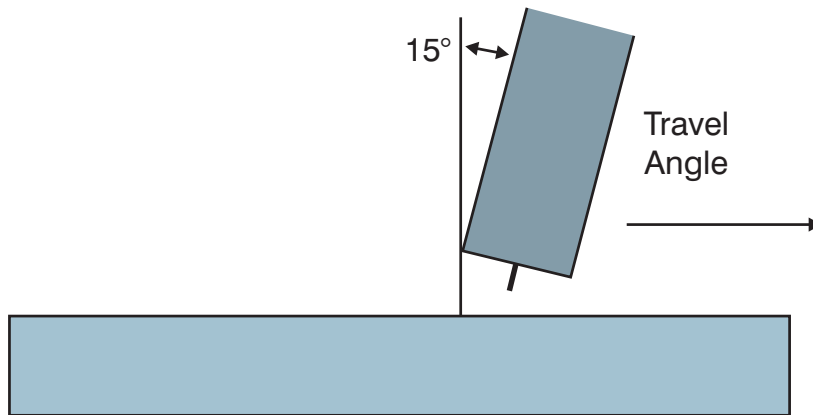
GUN ANGLE



Top View—90° work angle



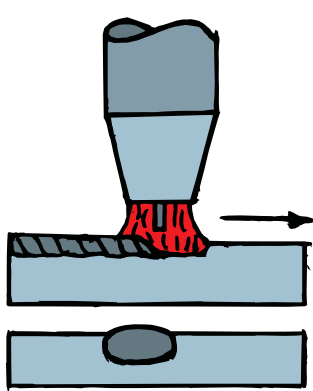
End View—15° work angle



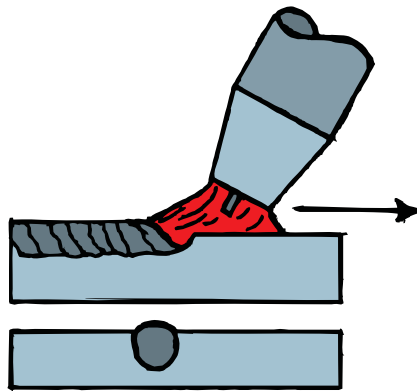
Side View—15° travel angle

(Courtesy, Interstate Publishers, Inc.)

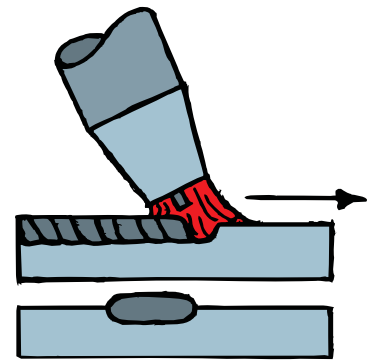
GUN POSITIONS— PERPENDICULAR, BACKHAND, AND FOREHAND



**Perpendicular—
medium band width
and penetration.**



**Backhand—
narrow bead width and
deep penetration.**



**Forehand—
wide bead width and
low penetration.**

(Courtesy, Interstate Publishers, Inc.)

Lab Sheet

MIG Welding Exercises

Each student is to complete the following lab exercises in the order shown. A lab sheet should accompany each exercise. Before moving to the next exercise, gain instructor approval and directions.

- #1 Bead
- #2 Butt Weld
- #3 Lap Weld
- #4 Tee (Fillet) Weld

1. Lab exercise no. and type of weld: _____
2. Welding position: _____
3. Type and size of rod used: _____
4. Type and thickness of base metal: _____
5. Current setting: _____ Wire speed setting: _____ Flowmeter setting: _____

6. SCORECARD:

a. General appearance (smooth, uniform, ripples)	5	4	3	2	1	0
b. Width (uniform)	5	4	3	2	1	0
c. Height (uniform)	5	4	3	2	1	0
d. Penetration	5	4	3	2	1	0
e. Starting	5	4	3	2	1	0
f. Stopping	5	4	3	2	1	0
g. Safety procedures followed	5	4	3	2	1	0
h. Other	5	4	3	2	1	0

i. TOTAL POINTS EARNED _____

7. Comments: _____

8. Grading scale	36-40	A- to A+
	32-35	B- to B+
	28-31	C- to C+
	24-27	D- to D+
	1-23	F
	0	0