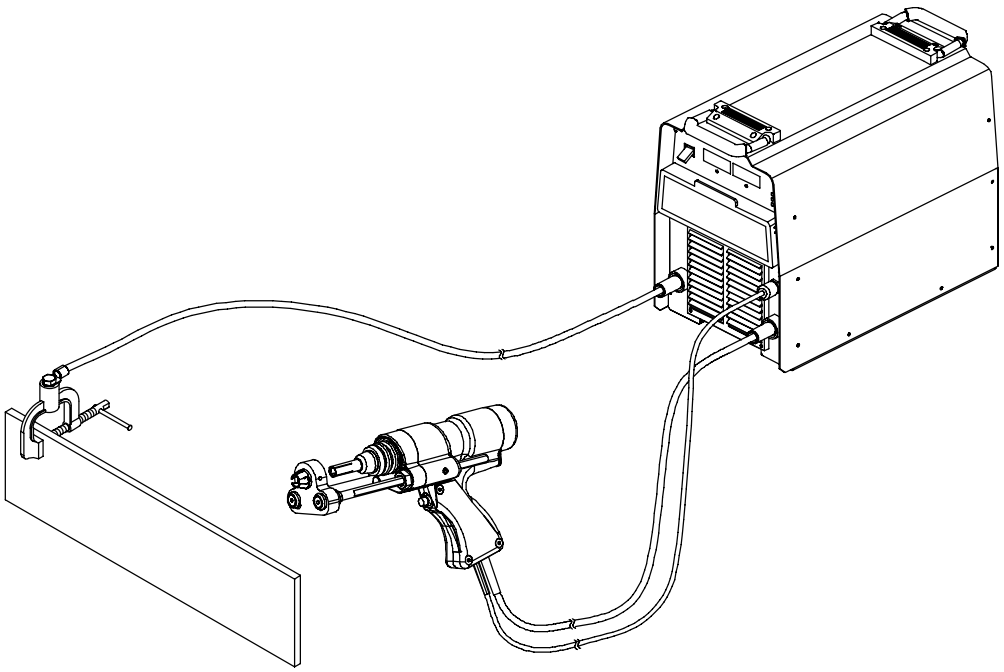
003 338B
July 2005

Arc Stud Welding Fundamentals



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SECTION 1 – SAFETY PRECAUTIONS - READ BEFORE USING

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▲ **Warning: Protect yourself and others from injury — read and follow these precautions.**

1-1. Symbol Usage

Means Warning! Watch Out! There are possible hazards with this procedure! The possible hazards are shown in the adjoining symbols.

▲ **Marks a special safety message.**

☞ *Means "Note"; not safety related.*

This group of symbols means Warning! Watch Out! possible ELECTRIC SHOCK, MOVING PARTS, and HOT PARTS hazards. Consult symbols and related instructions below for necessary actions to avoid the hazards.

1-2. Arc Welding Hazards

▲ **The symbols shown below are used throughout this manual to call attention to and identify possible hazards. When you see the symbol, watch out, and follow the related instructions to avoid the hazard. The safety information given below is only a summary of the more complete safety information found in the Safety Standards listed in Section 1-5. Read and follow all Safety Standards.**

▲ **Only qualified persons should install, operate, maintain, and repair this unit.**

▲ **During operation, keep everybody, especially children, away.**

ELECTRIC SHOCK can kill.

Touching live electrical parts can cause fatal shocks or severe burns. The electrode and work circuit is electrically live whenever the output is on. The input power circuit and machine internal circuits are also live when power is on. In semiautomatic or automatic wire welding, the wire, wire reel, drive roll housing, and all metal parts touching the welding wire are electrically live. Incorrectly installed or improperly grounded equipment is a hazard.

- Do not touch live electrical parts.
- Wear dry, hole-free insulating gloves and body protection.
- Insulate yourself from work and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground.
- Do not use AC output in damp areas, if movement is confined, or if there is a danger of falling.
- Use AC output ONLY if required for the welding process.
- If AC output is required, use remote output control if present on unit.
- Additional safety precautions are required when any of the following electrically hazardous conditions are present: in damp locations or while wearing wet clothing; on metal structures such as floors, gratings, or scaffolds; when in cramped positions such as sitting, kneeling, or lying; or when there is a high risk of unavoidable or accidental contact with the workpiece or ground. For these conditions, use the following equipment in order presented: 1) a semiautomatic DC constant voltage (wire) welder, 2) a DC manual (stick) welder, or 3) an AC welder with reduced open-circuit voltage. In most situations, use of a DC, constant voltage wire welder is recommended. And, do not work alone!
- Disconnect input power or stop engine before installing or servicing this equipment. Lockout/tagout input power according to OSHA 29 CFR 1910.147 (see Safety Standards).
- Properly install and ground this equipment according to its Owner's Manual and national, state, and local codes.
- Always verify the supply ground – check and be sure that input power cord ground wire is properly connected to ground terminal in disconnect box or that cord plug is connected to a properly grounded receptacle outlet.
- When making input connections, attach proper grounding conductor first – double-check connections.
- Frequently inspect input power cord for damage or bare wiring – replace cord immediately if damaged – bare wiring can kill.
- Turn off all equipment when not in use.
- Do not use worn, damaged, undersized, or poorly spliced cables.
- Do not drape cables over your body.
- If earth grounding of the workpiece is required, ground it directly with a separate cable.
- Do not touch electrode if you are in contact with the work, ground, or another electrode from a different machine.
- Do not touch electrode holders connected to two welding machines at the same time since double open-circuit voltage will be present.
- Use only well-maintained equipment. Repair or replace damaged parts at once. Maintain unit according to manual.
- Wear a safety harness if working above floor level.
- Keep all panels and covers securely in place.
- Clamp work cable with good metal-to-metal contact to workpiece or worktable as near the weld as practical.
- Insulate work clamp when not connected to workpiece to prevent contact with any metal object.
- Do not connect more than one electrode or work cable to any single weld output terminal.

SIGNIFICANT DC VOLTAGE exists in inverter-type welding power sources after removal of input power.

- Turn Off inverter, disconnect input power, and discharge input capacitors according to instructions in Maintenance Section before touching any parts.

FUMES AND GASES can be hazardous.

Welding produces fumes and gases. Breathing these fumes and gases can be hazardous to your health.

- Keep your head out of the fumes. Do not breathe the fumes.
- If inside, ventilate the area and/or use local forced ventilation at the arc to remove welding fumes and gases.
- If ventilation is poor, wear an approved air-supplied respirator.
- Read and understand the Material Safety Data Sheets (MSDSs) and the manufacturer's instructions for metals, consumables, coatings, cleaners, and degreasers.
- Work in a confined space only if it is well ventilated, or while wearing an air-supplied respirator. Always have a trained watchperson nearby. Welding fumes and gases can displace air and lower the oxygen level causing injury or death. Be sure the breathing air is safe.
- Do not weld in locations near degreasing, cleaning, or spraying operations. The heat and rays of the arc can react with vapors to form highly toxic and irritating gases.
- Do not weld on coated metals, such as galvanized, lead, or cadmium plated steel, unless the coating is removed from the weld area, the area is well ventilated, and while wearing an air-supplied respirator. The coatings and any metals containing these elements can give off toxic fumes if welded.

ARC RAYS can burn eyes and skin.

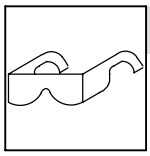
Arc rays from the welding process produce intense visible and invisible (ultraviolet and infrared) rays that can burn eyes and skin. Sparks fly off from the weld.

- Wear an approved welding helmet fitted with a proper shade of filter lenses to protect your face and eyes when welding or watching (see ANSI Z49.1 and Z87.1 listed in Safety Standards).
- Wear approved safety glasses with side shields under your helmet.
- Use protective screens or barriers to protect others from flash, glare and sparks; warn others not to watch the arc.
- Wear protective clothing made from durable, flame-resistant material (leather, heavy cotton, or wool) and foot protection.

WELDING can cause fire or explosion.

Welding on closed containers, such as tanks, drums, or pipes, can cause them to blow up. Sparks can fly off from the welding arc. The flying sparks, hot workpiece, and hot equipment can cause fires and burns. Accidental contact of electrode to metal objects can cause sparks, explosion, overheating, or fire. Check and be sure the area is safe before doing any welding.

- Remove all flammables within 35 ft (10.7 m) of the welding arc. If this is not possible, tightly cover them with approved covers.
- Do not weld where flying sparks can strike flammable material.
- Protect yourself and others from flying sparks and hot metal.
- Be alert that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas.
- Watch for fire, and keep a fire extinguisher nearby.
- Be aware that welding on a ceiling, floor, bulkhead, or partition can cause fire on the hidden side.
- Do not weld on closed containers such as tanks, drums, or pipes, unless they are properly prepared according to AWS F4.1 (see Safety Standards).
- Connect work cable to the work as close to the welding area as practical to prevent welding current from traveling long, possibly unknown paths and causing electric shock, sparks, and fire hazards.
- Do not use welder to thaw frozen pipes.
- Remove stick electrode from holder or cut off welding wire at contact tip when not in use.
- Wear oil-free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes, and a cap.
- Remove any combustibles, such as a butane lighter or matches, from your person before doing any welding.
- Follow requirements in OSHA 1910.252 (a) (2) (iv) and NFPA 51B for hot work and have a fire watcher and extinguisher nearby.



FLYING METAL can injure eyes.

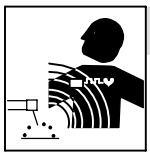
- Welding, chipping, wire brushing, and grinding cause sparks and flying metal. As welds cool, they can throw off slag.
- Wear approved safety glasses with side shields even under your welding helmet.

BUILDUP OF GAS can injure or kill.

- Shut off shielding gas supply when not in use.
- Always ventilate confined spaces or use approved air-supplied respirator.

HOT PARTS can cause severe burns.

- Do not touch hot parts bare handed.
- Allow cooling period before working on gun or torch.
- To handle hot parts, use proper tools and/or wear heavy, insulated welding gloves and clothing to prevent burns.



MAGNETIC FIELDS can affect pacemakers.

- Pacemaker wearers keep away.
- Wearers should consult their doctor before going near arc welding, gouging, or spot welding operations.

NOISE can damage hearing.

Noise from some processes or equipment can damage hearing.

- Wear approved ear protection if noise level is high.

CYLINDERS can explode if damaged.

Shielding gas cylinders contain gas under high pressure. If damaged, a cylinder can explode. Since gas cylinders are normally part of the welding process, be sure to treat them carefully.

- Protect compressed gas cylinders from excessive heat, mechanical shocks, physical damage, slag, open flames, sparks, and arcs.
- Install cylinders in an upright position by securing to a stationary support or cylinder rack to prevent falling or tipping.
- Keep cylinders away from any welding or other electrical circuits.
- Never drape a welding torch over a gas cylinder.
- Never allow a welding electrode to touch any cylinder.
- Never weld on a pressurized cylinder – explosion will result.
- Use only correct shielding gas cylinders, regulators, hoses, and fittings designed for the specific application; maintain them and associated parts in good condition.
- Turn face away from valve outlet when opening cylinder valve.
- Keep protective cap in place over valve except when cylinder is in use or connected for use.
- Use the right equipment, correct procedures, and sufficient number of persons to lift and move cylinders.
- Read and follow instructions on compressed gas cylinders, associated equipment, and Compressed Gas Association (CGA) publication P-1 listed in Safety Standards.

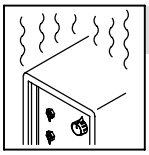
1-3. Additional Symbols For Installation, Operation, And Maintenance

FIRE OR EXPLOSION hazard.

- Do not install or place unit on, over, or near combustible surfaces.
- Do not install unit near flammables.
- Do not overload building wiring – be sure power supply system is properly sized, rated, and protected to handle this unit.

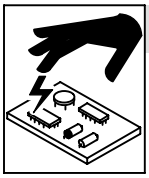
FALLING UNIT can cause injury.

- Use lifting eye to lift unit only, NOT running gear, gas cylinders, or any other accessories.
- Use equipment of adequate capacity to lift and support unit.
- If using lift forks to move unit, be sure forks are long enough to extend beyond opposite side of unit.



OVERUSE can cause OVERHEATING

- Allow cooling period; follow rated duty cycle.
- Reduce current or reduce duty cycle before starting to weld again.
- Do not block or filter airflow to unit.



STATIC (ESD) can damage PC boards.

- Put on grounded wrist strap BEFORE handling boards or parts.
- Use proper static-proof bags and boxes to store, move, or ship PC boards.

MOVING PARTS can cause injury.

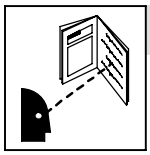
- Keep away from moving parts.
- Keep away from pinch points such as drive rolls.

WELDING WIRE can cause injury.

- Do not press gun trigger until instructed to do so.
- Do not point gun toward any part of the body, other people, or any metal when threading welding wire.

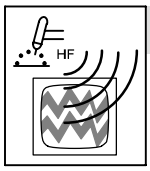
MOVING PARTS can cause injury.

- Keep away from moving parts such as fans.
- Keep all doors, panels, covers, and guards closed and securely in place.
- Have only qualified persons remove doors, panels, covers, or guards for maintenance as necessary.
- Reinstall doors, panels, covers, or guards when maintenance is finished and before re-connecting input power.



READ INSTRUCTIONS.

- Read Owner's Manual before using or servicing unit.
- Use only genuine Miller/Hobart replacement parts.



H.F. RADIATION can cause interference.

- High-frequency (H.F.) can interfere with radio navigation, safety services, computers, and communications equipment.
- Have only qualified persons familiar with electronic equipment perform this installation.
- The user is responsible for having a qualified electrician promptly correct any interference problem resulting from the installation.
- If notified by the FCC about interference, stop using the equipment at once.
- Have the installation regularly checked and maintained.
- Keep high-frequency source doors and panels tightly shut, keep spark gaps at correct setting, and use grounding and shielding to minimize the possibility of interference.

ARC WELDING can cause interference.

- Electromagnetic energy can interfere with sensitive electronic equipment such as computers and computer-driven equipment such as robots.
- Be sure all equipment in the welding area is electromagnetically compatible.
- To reduce possible interference, keep weld cables as short as possible, close together, and down low, such as on the floor.
- Locate welding operation 100 meters from any sensitive electronic equipment.
- Be sure this welding machine is installed and grounded according to this manual.
- If interference still occurs, the user must take extra measures such as moving the welding machine, using shielded cables, using line filters, or shielding the work area.

1-4. California Proposition 65 Warnings

▲ **Welding or cutting equipment produces fumes or gases which contain chemicals known to the State of California to cause birth defects and, in some cases, cancer. (California Health & Safety Code Section 25249.5 et seq.)**

▲ **Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling.**

For Gasoline Engines:

▲ **Engine exhaust contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.**

For Diesel Engines:

▲ **Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.**

1-5. Principal Safety Standards

Safety in Welding, Cutting, and Allied Processes, ANSI Standard Z49.1, from Global Engineering Documents (phone: 1-877-413-5184, website: www.global.ihs.com).

Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping, American Welding Society Standard AWS F4.1 from Global Engineering Documents (phone: 1-877-413-5184, website: www.global.ihs.com).

National Electrical Code, NFPA Standard 70, from National Fire Protection Association, P.O. Box 9101, 1 Battery March Park, Quincy, MA 02269–9101 (phone: 617–770–3000, website: www.nfpa.org).

Safe Handling of Compressed Gases in Cylinders, CGA Pamphlet P-1, from Compressed Gas Association, 1735 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202–4102 (phone: 703–412–0900, website: www.cganet.com).

Code for Safety in Welding and Cutting, CSA Standard W117.2, from Canadian Standards Association, Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3 (phone: 800–463–6727 or in Toronto 416–747–4044, website: www.csa–international.org).

Practice For Occupational And Educational Eye And Face Protection, ANSI Standard Z87.1, from American National Standards Institute, 11 West 42nd Street, New York, NY 10036–8002 (phone: 212–642–4900, website: www.ansi.org).

Standard for Fire Prevention During Welding, Cutting, and Other Hot Work, NFPA Standard 51B, from National Fire Protection Association, P.O. Box 9101, 1 Battery March Park, Quincy, MA 02269–9101 (phone: 617–770–3000, website: www.nfpa.org).

OSHA, Occupational Safety and Health Standards for General Industry, Title 29, Code of Federal Regulations (CFR), Part 1910, Subpart Q, and Part 1926, Subpart J, from U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250 (there are 10 Regional Offices––phone for Region 5, Chicago, is 312–353–2220, website: www.osha.gov).

1-6. EMF Information

Considerations About Welding And The Effects Of Low Frequency Electric And Magnetic Fields

Welding current, as it flows through welding cables, will cause electromagnetic fields. There has been and still is some concern about such fields. However, after examining more than 500 studies spanning 17 years of research, a special blue ribbon committee of the National Research Council concluded that: "The body of evidence, in the committee's judgment, has not demonstrated that exposure to power-frequency electric and magnetic fields is a human-health hazard." However, studies are still going forth and evidence continues to be examined. Until the final conclusions of the research are reached, you may wish to minimize your exposure to electromagnetic fields when welding or cutting.

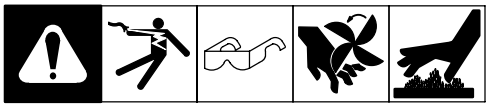
To reduce magnetic fields in the workplace, use the following procedures:

1. Keep cables close together by twisting or taping them.
2. Arrange cables to one side and away from the operator.
3. Do not coil or drape cables around your body.
4. Keep welding power source and cables as far away from operator as practical.
5. Connect work clamp to workpiece as close to the weld as possible.

About Pacemakers:

Pacemaker wearers consult your doctor before welding or going near welding operations. If cleared by your doctor, then following the above procedures is recommended.

SECTION 2 – ARC STUD WELDING (SW) GUIDELINES



2-1. Process Description

Arc stud welding (SW) is a welding process in which a metal fastener (weld stud) is joined to a workpiece. This process is generally referred to as stud welding. The metal fastener is joined under pressure once sufficiently heated with an electric arc.

The fastener or weld stud is positioned for welding through the use of a stud gun. When the operator activates the stud gun trigger, the fastener (electrode) is welded to the workpiece without the use of filler metal. The welding duration of SW is typically one second or less.

One end of a SW fastener is prepared for welding. A ceramic ferrule surrounding the weld end of the fastener provides partial shielding of the weld. The ferrule also dams the molten metal to form a fillet type weld. Shielding gases or flux may or may not be used to protect the weld.

2-2. Typical Uses Of The Arc Stud Welding Process

The arc stud welding process lends itself to a wide range of applications such as automotive, ship building, appliance, aero-dynamics, boilers, light or heavy construction, preassembled fabrication designs and fit-up parts design.

The process may be utilized on a range of material thickness from about .060 in to several inches.

The stud welding process is advantageous for the following reasons:

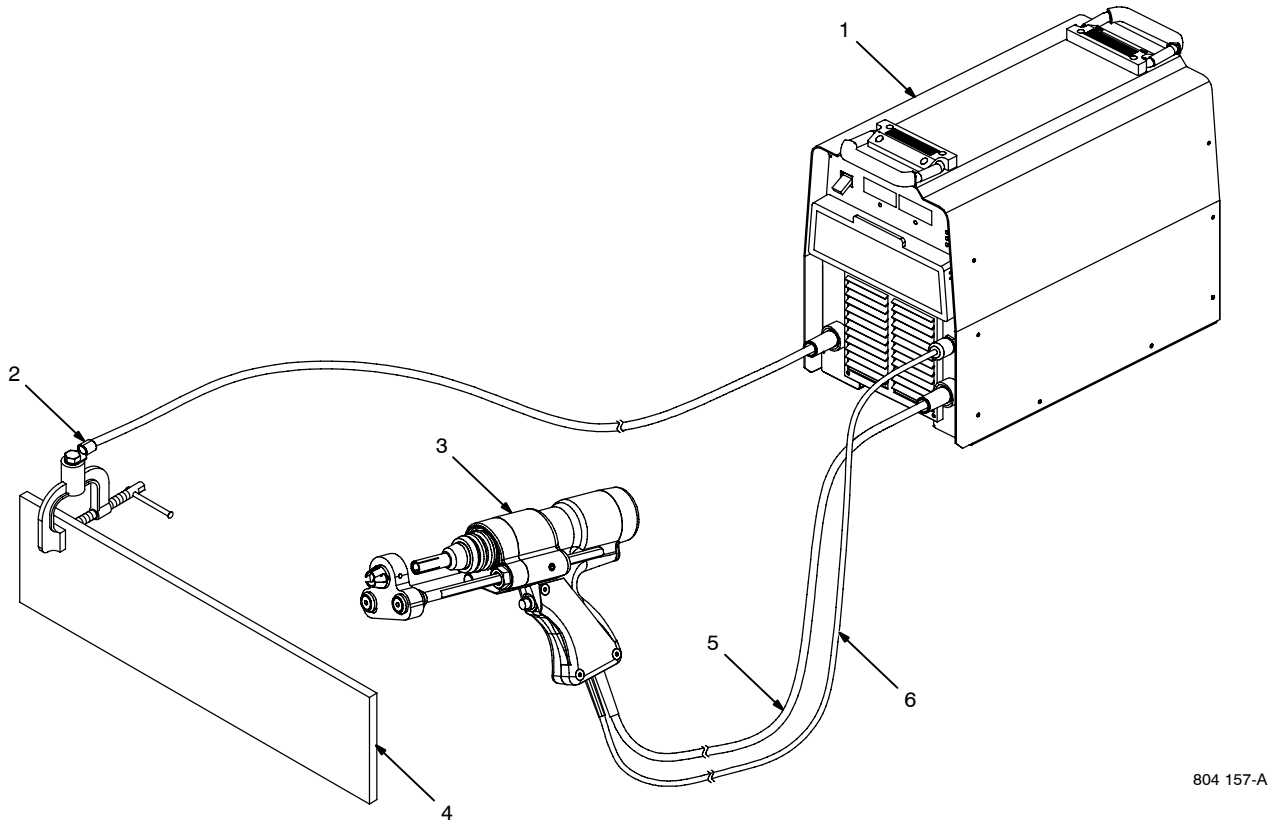
- Major design specifications may be readily adapted to the process, such as material types, metallurgical aspects, special thread designs, fit-up tolerances, etc.
- Capable of producing a full cross section weldment with a minimum of base metal distortion or surface disruption.
- Can be used in locations which do not permit use of other fastening methods.
- Process lends itself to the automated concept or high production shops.
- Capable of producing welds which are less costly per unit than other methods.
- Process may be effectively utilized with a minimum of time spent in personnel training.
- Process may be effectively used in maintaining weld quality with a minimum inspection time.

2-3. Equipment

Necessary equipment for stud welding:

- Constant Current (CC) Power Source
- Stud Welding Gun
- Weld Cable With Stud Gun Control Card
- Work/Ground Cable With “C” Clamp Type Connector

2-4. Arc Stud Welding System



▲ **Turn off power before connecting to weld output terminals.**

6 Power Source

Constant Current (CC)

7 Ground Cable and Clamp

8 Stud Gun (Negative)

9 Workpiece (Positive)

10 Weld Cable to Gun

11 Control Cable

2-5. Power Source

The typical power source for stud welding should have the following characteristics:

- Constant Current (CC)
- Open circuit voltage range of 70-100 VDC
- Rapid current rise time
- High current output for relatively short time periods

Arc stud welding is a very fast weld done at high amperage. The weld requires the rise to peak current within milliseconds. However, because the weld time is very short typical duty cycles are very low.

☞ *Some non-current stud welding power sources may use an external device for setting amperage and time requirements.*

2-6. Stud Welding Controls

The control circuit of an arc stud welding system regulates arc duration through the welding cycle and provides adjustable controls for various stud diameters.

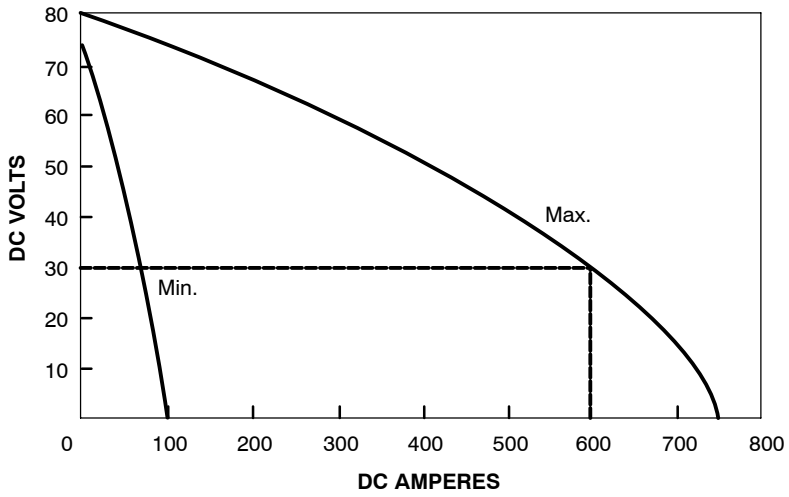
A control circuit consists of a contactor, timing device, and current control. The weld time is a percentage of seconds or milliseconds, the current is typically depicted as amperage.

Weld time is determined by stud diameter.

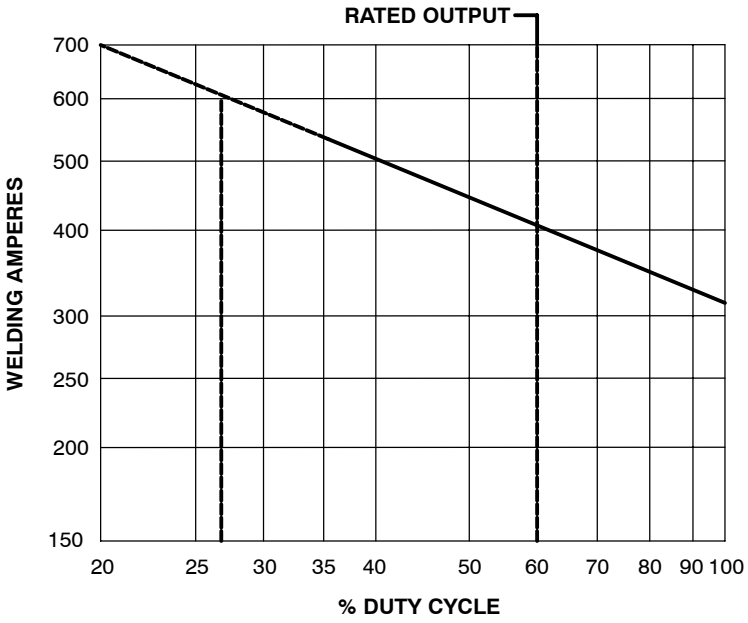
NOTE ☞

The charts in (Sections2-7 and 2-8) show the voltage/amperage output and duty cycle of a stud welding power source that uses an external device for setting amperage and time.

2-7. Volt/Ampere Curve - Constant Current (CC) Power Source



2-8. Duty Cycle - Power Source For Constant Current (CC) Welding



Explanation of charts:

A nominal voltage for stud welding is 30 volts dc.

To determine the duty cycle of stud welding while using a constant current (CC) power source:

- A horizontal dotted line is extended from 30 volts in section 2-7.
- The 600 amps shown in section 2-7 is then used in section 2-8 to determine the duty cycle.
- The result is 26% duty cycle.

2-9. Arc Stud Welding Guns

There are two basic arc stud welding guns available:

- Portable, pistol grip configuration, which is used for hand-held or manual operation.
- Fixed, production gun, which is usually mounted on a positioning device and is usually incorporated with an automatic fastener loading system.

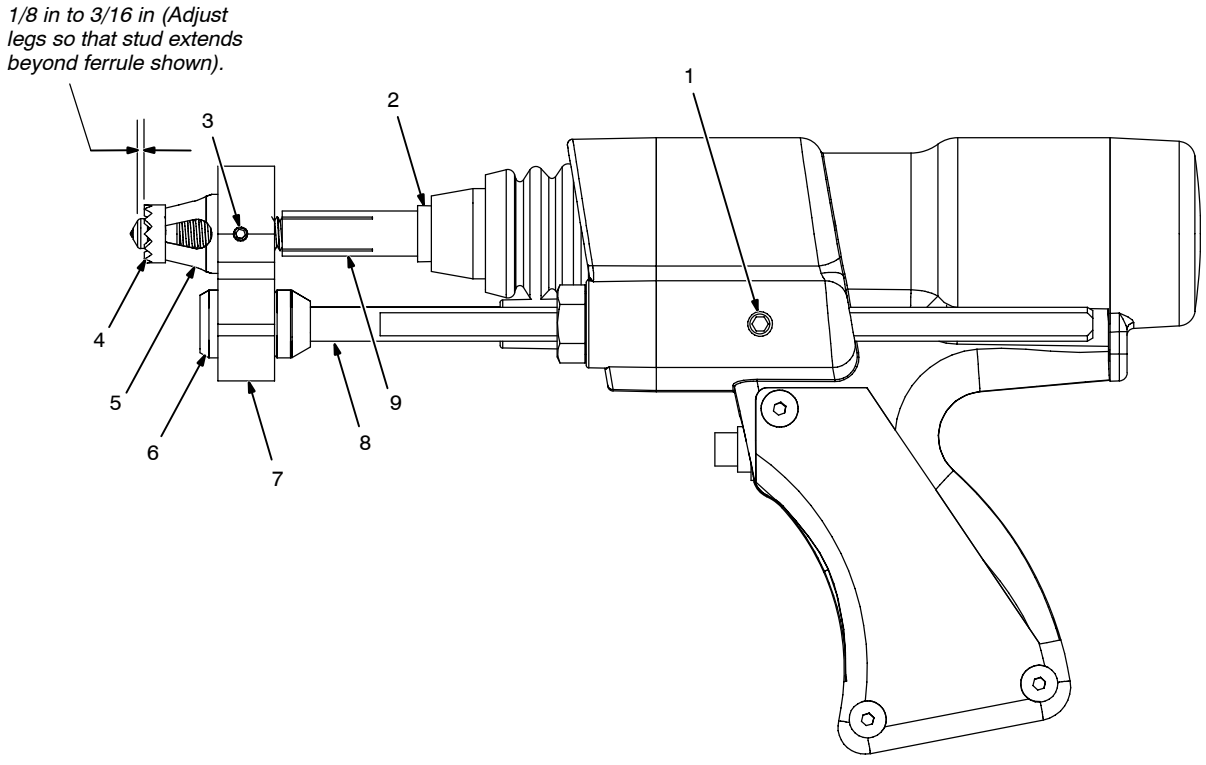
The portable, pistol grip design is offered in three capacities:

- Light Duty (Stud diameters 1/8 in (3.2 mm) to 3/8 in (9.5 mm)
- Standard Duty (Stud diameters 1/8 in (3.2 mm) to 5/8 in (15.9 mm)
- Heavy Duty (Stud diameters 1/8 in (3.2 mm) to 1-1/4 in (31.8 mm)

Portable stud guns normally weigh between 4.5 lb (2 kg) to 9 lb (4 kg) with the body being constructed of high impact plastic.

The stud gun consists of a body, trigger and lift mechanism. Stud gun accessories consist of a chuck or fastener holder, and an adjustable support (leg) for the ferrule holder (grip). Chucks and ferrule holders are easily changed to permit various diameters of studs and ferrules to be used. An adjustment for the lift of the fastener is provided on the stud gun. Some manufacturers use a permanent ferrule rather than individuals ferrules.

2-10. Pistol Grip Stud Gun Components



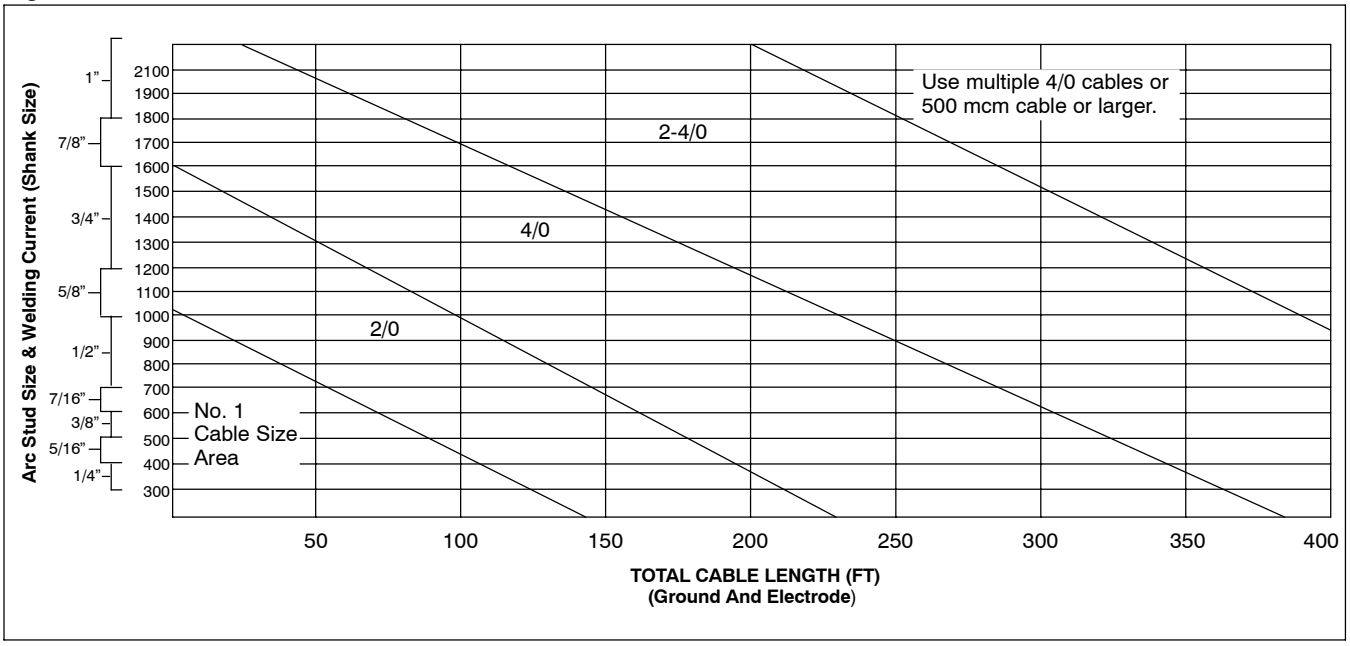
1	Leg Screw	4	Ferrule (Center Stud in Ferrule)	7	Foot
2	Chuck Adapter	5	Ferrule Grip	8	Legs
3	Set Screw	6	Foot Screws	9	Chuck

2-11. Selecting Cable Length and Size

Weld cable length and size are very important. A power source is often penalized by the use of too small a cable or too long a cable system. The following chart will serve as a guide to selecting cable size and lengths in relation to the stud diameter and approximate amperage.

A voltage drop will occur between the power source terminals and the stud gun due to cable resistance. Cables must be of sufficient size to allow the necessary voltage to be available at the stud gun. Avoid more than a 5 volts drop in the cables.

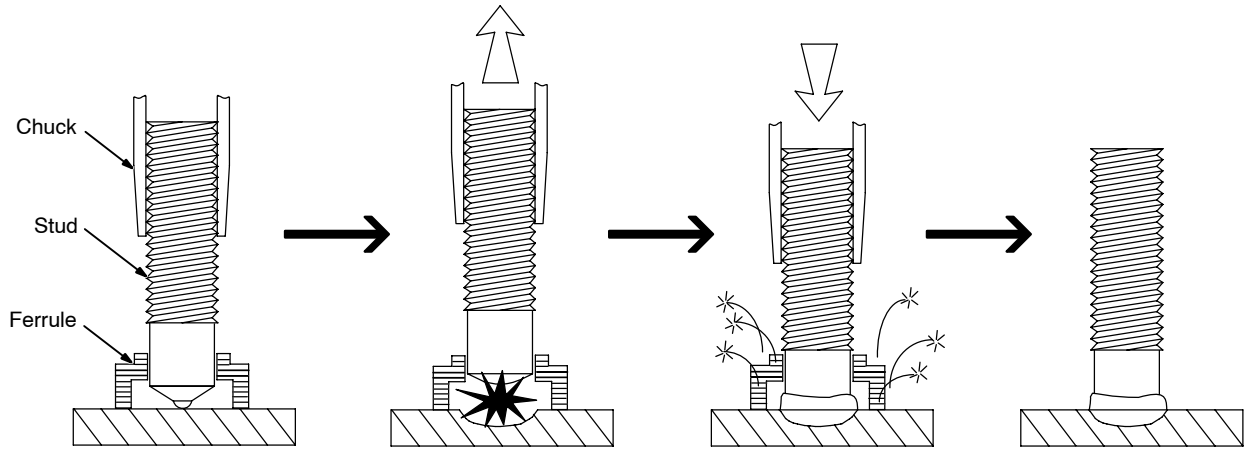
Cable connections and splices are another area to consider. Make the best possible electrical and mechanical connections. Use commercially available welding cable connectors, making certain the right size is used for cable size being used. Since the time cycle is so short, any arcing in a poor connection will prevent satisfactory stud welding.



SECTION 3 – STUD WELDING PROCESS

3-1. Stud Welding Sequence

Welding sequence of control unit and process is broken down into four steps as shown below.



Gun is properely positioned and main gun spring is partially compressed.

Step 1

Trigger is pressed and the stud lifts off the work. An arc is created and melts the stud and parent material.

Step 2

After arcing is complete, the main spring plunges the stud into the molten pool of metal.

Step 3

Gun is withdrawn from the welded stud. The ferrule is broken away and discarded.

Step 4

3-2. Recommended Procedures And Techniques

After the part has been designed for stud welding and a particular type and size of stud has been selected, follow these guidelines when stud welding:

1. Have sufficient weld power available for the diameter of stud to be welded. Stainless steel studs require 10% more power than an equivalent sized carbon steel stud.
2. Have weld cables of sufficient size, reasonable length, and tight connections.
3. Secondary hook-up should be DC straight polarity for steel and stainless steel, and reverse polarity for aluminum and magnesium.
4. A good ground is essential. Use a “C” clamp type connector and clean contact area of paint and heavy surface scale.
5. Setup stud gun in accordance with manufacturer’s recommendations. Adjust gun leg(s) so that stud extension beyond ferrule is as recommended.
6. Select positions of stud placement by layout or suitable templates.
7. Clean area where stud is to be placed. Grind or scrape area to remove any surface contaminants.
8. Stud gun should be positioned perpendicular to the work surface, and depressed until the ferrule is firmly seated against the work. The ferrule should remain firmly seated until the trigger is actuated.
9. The trigger should be actuated once and released. Do NOT move the gun during welding. Do NOT actuate the trigger a second time if the stud is attached to the plate. (Damage (arcing) could result to the chuck.)
10. At the completion of the weld time, the gun should be held in position momentarily to allow solidification of molten metal. Remove the gun, ferrule and inspect weld.

3-3. The Welding Stud

Welding grade studs are made of most commercially used metals, and normally range in diameters from 1/8 in (3.2 mm) to 1-1/4 in (31.8 mm) with lengths as required. In addition to straight threaded or unthreaded studs, it is possible to obtain a wide variety of shapes and sizes.

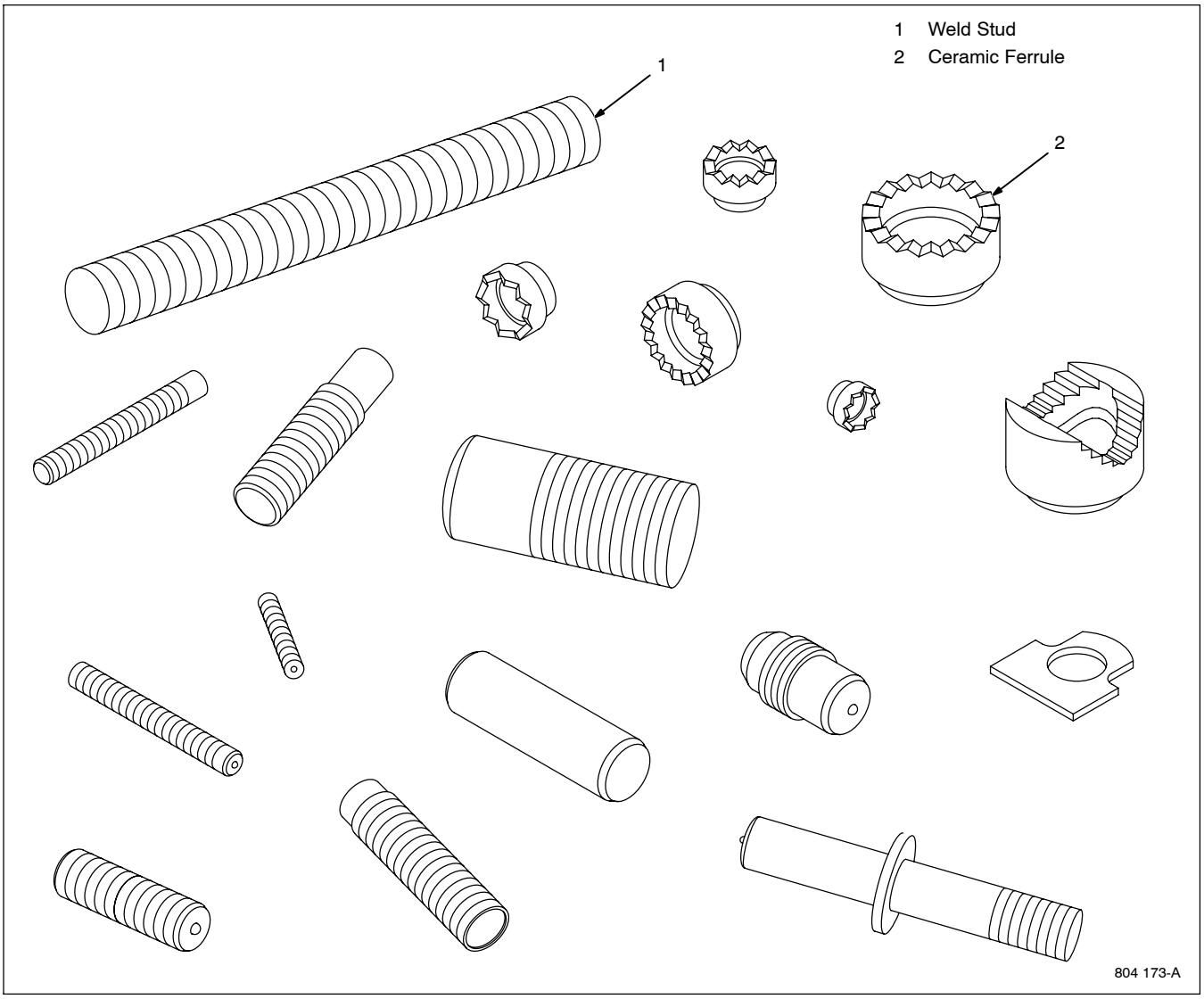
3-4. Arc Shields (Ferrules)

The ceramic ferrule performs several important functions and is required to do each weld. Some equipment is available with a permanent shield attached directly to the stud gun. The ferrule:

- Concentrates the arc heat to the immediate weld area.
- Protects the molten weld pool from atmospheric contamination.
- Confines the molten metal to the weld zone, to form a fillet.
- Prevents charring and disruption of surrounding base metal surfaces.
- Reduces the possibility of open arc flash; therefore, the operator and surrounding personnel need only wear suitable flash type safety glasses.

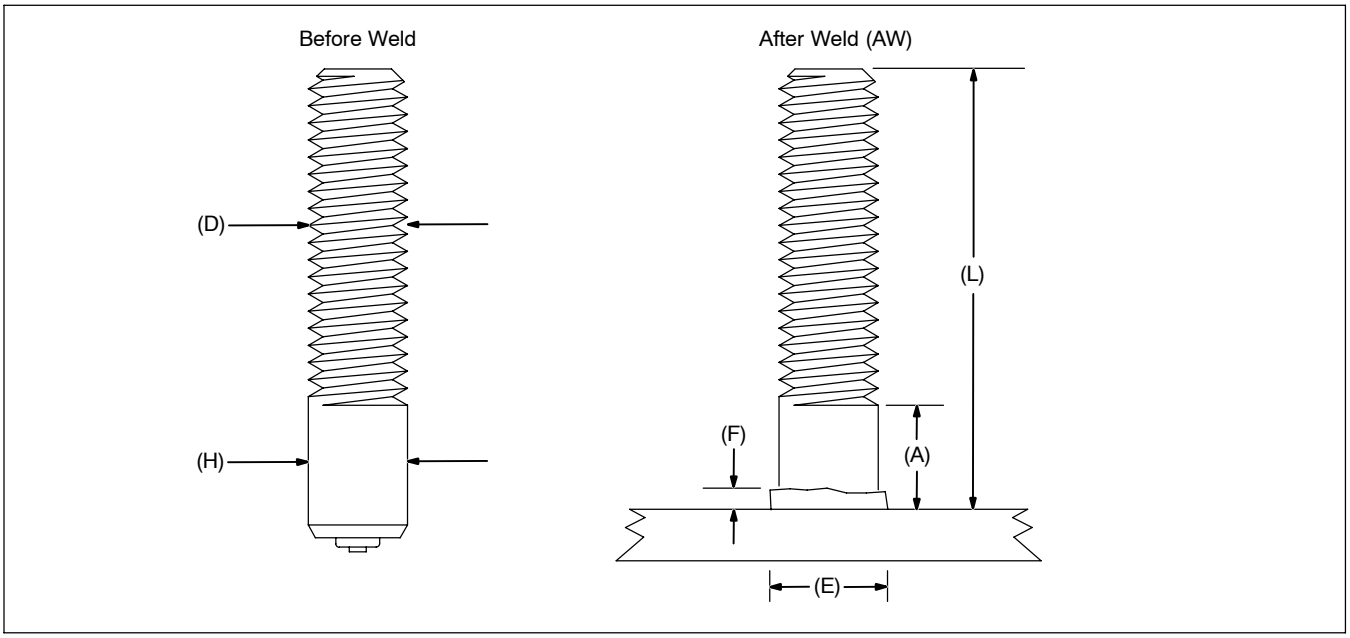
Upon completion of the weld, the protective ceramic shield can be easily removed by chipping it away or lifting it off with a suitable tool.

3-5. Different Types of Weld Studs And Ceramic Ferrules



3-6. Stud Specification Chart

The stud manufacturer's catalogs will list the characteristics and dimensions of the various studs available. When setting up the welding parameters, the diameter (where contact is made to work) should be used as the determining factor for amperage and time setting. On threaded fasteners, the diameter may be less than the threaded diameter.



SPECIFICATION TABLE					
Diameter and Thread (D)	Minimum (AW) Length (A)	(H)	Minimum (AW) Length (L)	Weld Bead Dimensions (E)	(F)
1/4 - 20 5/16 - 18 3/8 - 16	1/4 1/4 1/4	.217 .275 .312	5/8 5/8 5/8	5/16 13/32 7/16	3/32 7/64 7/64
7/16 - 14 1/2 - 13 5/8 - 11	1/4 5/16 5/16	.375 .437 .500	3/4 3/4 7/8	1/2 19/32 11/16	1/8 9/64 5/32
3/4 - 10 7/8 - 9 1 - 8	1/2 1/2 5/16	.625 .750 .875	1 - 1/8 1 - 3/8 1 - 7/8	7/8 1 1 - 1/8	3/16 3/16 3/16

The stud gun should be set up in accordance with the manufacturer's recommendation. The timing device on control circuit and power source should be adjusted to approximate settings shown in stud welding table (see Section 3-7).

3-7. Recommended Settings For Stud Welding Of Steel

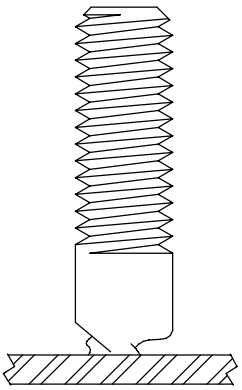
STANDARD TABLE			METRIC TABLE		
Stud Size	**Current**	**Time**	**Stud Size**	**Current**	**Time**
1/4 Inch	300 Amps	.220 Seconds	6 mm	350 Amps	.250 Seconds
5/16 Inch	410 Amps	.300 Seconds	8 mm	420 Amps	.310 Seconds
3/8 Inch	520 Amps	.360 Seconds	10 mm	580 Amps	.430 Seconds
1/2 Inch	750 Amps	.450 Seconds	12 mm	720 Amps	.500 Seconds
5/8 Inch	980 Amps	.730 Seconds	14 mm	880 Amps	.590 Seconds
3/4 Inch	1325 Amps	.750 Seconds	16 mm	1040 Amps	.660 Seconds
7/8 Inch	1680 Amps	.830 Seconds	20 mm	1440 Amps	.780 Seconds
1 Inch	2000 Amps	.870 Seconds	24 mm	1900 Amps	.850 Seconds

Amperage values shown are actual metered readings and not necessarily the dial settings on the power source. The amperage and time values shown are approximately the mid-point of the operating range. Similar results can be obtained with a lower amperage setting and more time, or with higher amperage setting and less time. Consideration should be given to cable sizes, lengths, condition of material, type of stud, etc., when comparing settings from charts to actual conditions.

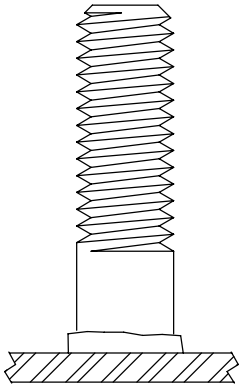
SECTION 4 – WELD INSPECTION/TROUBLESHOOTING

4-1. Inspecting Welded Studs

Inspect studs visually or by mechanical testing.



Poor Weld

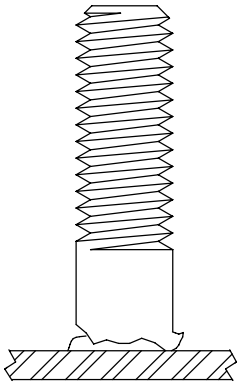


Good Weld

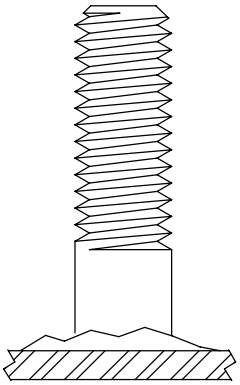
Problem - Poor weld

Plunge of stud too short or high amperage.

Remedy - Ensure that stud extends 3/32 in to 3/16 in beyond the ferrule. Make sure gun action works smoothly and stud is centered inside of the ferrule. Foot and leg adaptors may need adjusting or gun needs cleaning. Power source may be set to high.



Not Enough Amperage



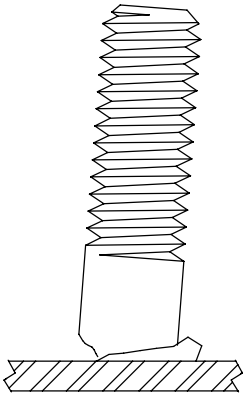
Too Much Amperage

Problem - Not enough amperage

Remedy - Check cable connections and the ground. If satisfactory, turn amperage up slightly on power source, or increase weld time setting.

Problem - Too much amperage

Remedy - Reduce the power source setting, or the timer setting.



Poor Alignment

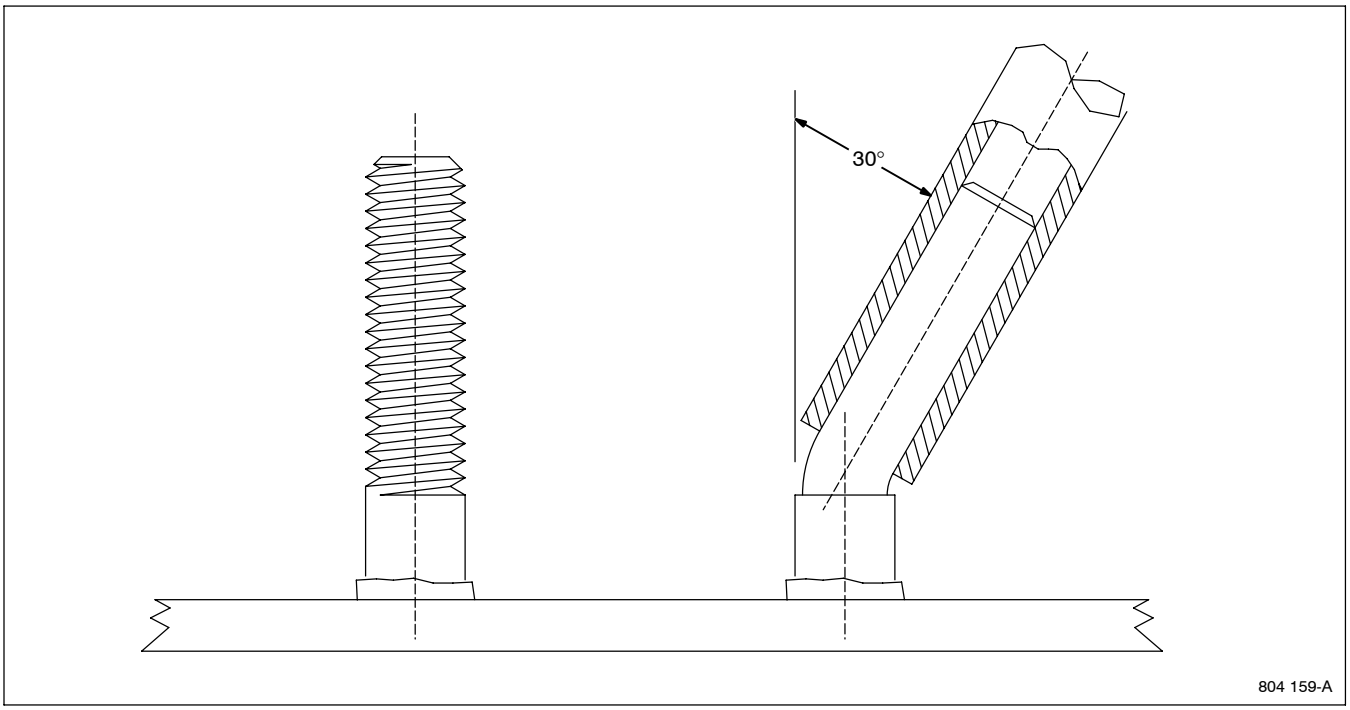
Problem - Poor alignment

Remedy - The stud and ferrule must be held square or perpendicular to the work. Otherwise you will get an uneven fillet and a poorly aligned stud.

804 161-A

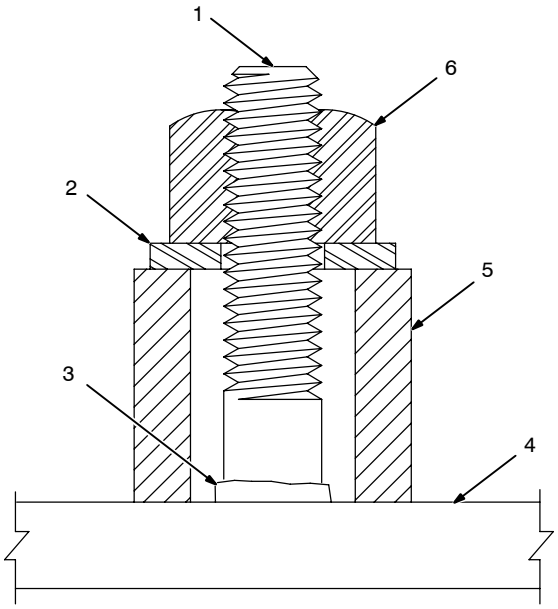
4-2. Performing AWS Bend Test

Mechanical testing can be done to determine the strength of the welding area. This test should be performed when setting up parameters to assure a sound weld is being made.



The AWS Structural Welding Code D1.1-72 states: “Each welding unit before use in production shall be used to weld two stud or shear connectors to separate material in the same general position (flat, vertical, overhead, sloping) and of similar thickness. After being allowed to cool each stud shall be bent to an angle of 30 degrees from its original position by striking with a hammer. If failure occurs in the weld zone of either stud the procedure shall be corrected and two successive studs welded and tested.”

4-3. Performing AWS Torque Test



Studs that are torqued to destruction without failure in the weld are considered qualified.

1 Stud
2 Washer
3 Weld Area
4 Member
5 Sleeve
6 Steel Nut

804 160-A

NOTE ☞ *Dimensions are appropriate to the size of the stud. Threads of the stud shall be clean and free of lubricant other than for the residue of cutting oil.*

REQUIRED TORQUE FOR TESTING THREADED STUDS		
Normal Diameter Of Studs, Inches (mm)	Threads Per Inch And Series Designated	Testing Torque Foot-Pounds
1/4 in (6.3 mm)	28 UNF	5.0
1/4 in (6.3 mm)	20 UNC	4.2
5/16 in (8 mm)	24 UNF	9.5
5/16 in (8 mm)	18 UNC	8.6
3/8 in (9.5 mm)	24 UNF	17.
3/8 in (9.5 mm)	16 UNC	15.
7/16 in (11.1 mm)	20 UNF	27.
7/16 in (11.1 mm)	14 UNC	24.
1/2 in (13 mm)	20 UNF	42.
1/2 in (13 mm)	13 UNC	37.
9/16 in (14.2 mm)	18 UNF	60.
9/16 in (14.2 mm)	12 UNC	54.
5/8 in (15.9 mm)	18 UNF	84.
5/8 in (15.9 mm)	11 UNC	74.
3/4 in (19 mm)	16 UNF	147.
3/4 in (19 mm)	10 UNC	132.
7/8 in (22.2 mm)	14 UNF	234.
7/8 in (22.2 mm)	9 UNC	212.
1 in (25.4 mm)	12 UNF	348.
1 in (25.4 mm)	8 UNC	318.

Notes

Notes

MATERIAL THICKNESS REFERENCE CHART

24 Gauge (.025 in)

22 Gauge (.031 in)

20 Gauge (.037 in)

18 Gauge (.050 in)

16 Gauge (.063 in)

14 Gauge (.078 in)

1/8 in (.125 in)

3/16 in (.188 in)

1/4 in (.25 in)

5/16 in (.313 in)

3/8 in (.375 in)

1/2 in (.5 in)

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