ADI 1275-Q

CONCOA®

PRECISION GAS CONTROLS

Certified ISO 9000

OXY-FUEL WELDING, HEATING AND CUTTING

PROCESS MANUAL
INSTALLATION AND OPERATION INSTRUCTIONS

Before Installing or Operating, Read and Comply with These Instructions

Controls Corporation of America
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To Order Call 1-800-225-0473 or 757-422-8330 • Fax 757-422-3125
www.concoa.com

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USER RESPONSIBILITY

This equipment will perfom in conformity with the description thereof contained in this manual and accompanying labes and/or inserts when installed, operated, maintained and repaired in accordance with the instructions provided. This equipment must be checked periodically. Defective equipment should not be used. Parts that are broken, missing, plainly worn, distorted or contaminated, should be replaced immediately. Should such repair or replacement become necessary, it is recommended that a telephonic or written request for service advice be made to the Authorized Distributor from whom the equipment was purchased.

This equipment or any of its parts should not be altered without the prior written approval of Controls Corporation of America, Inc. (CONCOA). The user of this equipment shall have the sole responsibility for any malfunctions which results from improper use, faulty maintenance, damage, improper repair, or alteration by anyone other than Controls Corporation of America, Inc. (CONCOA) or a service facility designated by Controls Corporation of America, Inc. (CONCOA).

Protect yourself and others. Read and understand these instructions:

FUMES AND GASES can be dangerous to your health. HEAT RAYS (INFRARED RADIATION from flame or hot metal) can injure eyes.

- Read and understand the manufacturer's instructions and your employer's safety practices.
- Keep your head out of fumes.
- Use enough ventilation, exhaust to the flame, or both, to keep fumes and gases from your breathing zone, and the general area.
- Wear correct eye, ear and body protection.
- See American National Standard Z49.1 "Safety in Welding and Cutting," published by the American Welding Society, Box 351040, Miami, FL 33135; OSHA Safety and Health Standards, 29 CFR 1910, available from U.S. Government Printing Office, Washington, D.C., 20402

Oxy-Fuel Gas Cutting and Welding

Operation of oxy-fuel torches involves oxygen and flammable gases under pressure, open flames, flying slag and hot metal, meatl fumes and combustion products.

Follow the precautions in this SAFETY section and those throughout this manual for your personal safety and the safety of people near the equipment.

Safety In The Use of Welding Hose

1. Hose for use with fuel gas (including acetylene): Grade T. This Grade replaces the former Grade M. Hose for use with acetylene only: Grade R & Grade RM.

2. Never use hose other than for specified use. Working pressure limits for welding hose is 200 PSIG maximum. General hose identification rule is red for fuel gas (see paragraph 1) green for oxygen, and black for inert gases.

3. Avoid long runs, kinks or tangles. Do not allow hose to come in contact with oil or grease. Protect hose from open flames, sparks or other hot objects.

4. Examine hose regularly for leaks, worn areas, loose or damaged fittings. Immerse pressurized hose in water: bubbles indicate leaks. Never use a flame to check for leaks. Defective hose must be repaired or replaced immediately.

5. Use ferrules or clamps designed for hose as a binding to connect fitting to the hose. Makeshift repairs are not permissible.

6. Repair leaks or worn hose by cutting out the damaged area and using only brass hose splicers, ferrules or clamps (as in 5 above). **DO NOT USE TAPE FOR REPAIRS.**

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I. SAFETY

1.1 Workplace

1. A dirt or concrete floor is recommended, however, a wood floor covered with sand or wet down is permissible.
2. Protect any nearby combustibles (walls, floors, etc.) from slag and flying hot metal with approved fireboard such as 518" gypsum.
3. Work in a well ventilated area. DO NOT ventilate with oxygen from tanks.
4. Fireproof any surface used as a worktable. Fire brick is recommended because it is inexpensive, easy to find, and long-lasting.
5. Secure fuel and oxygen cylinders by chaining to wall or bench, or use cylinder cart. DO NOT lay cylinder down on floor.

1.2 Personal Protection

1. Wear heavy flame resistent work clothing with long sleeves to protect arms. Make sure sleeves are secured around wrist.
2. Wear eye protection safety goggles with filter lens and other protective equipment when welding and cutting. Select filter lens based on the following guide from the American Welding Society:

OPERATION	METAL THICKNESS	SHADE NUMBER
Gas Welding		
Light	under 1/8" (3.2mm)	4 or 5
Medium	1/8" to ½" (3.2 to 12.7 mm)	5 or 6
Heavy	over 10 ½" (12.7 mm)	6 or 8
Gas Welding		
Light	under 1/8" (3.2mm)	3 or 4
Medium	1/8" to 10½" (3.2 to 12.7 mm)	4 or 5
Heavy	over 10 ½" (12.7 mm)	5 or 6

1.3 Fire Protection

1. Do not use oxy-fuel equipment near oil or grease containers.
2. Keep oil, grease and combustible dust away from all oxygen equipment.
3. Where practicable, relocate all combustibles at least 35 feet horizontally from the work site. Where relocation is impractible, protect combustibles with flame-proofed covers or other wise shield with metal or flame resistant guards or curtains.
4. Maintain nearby a means of extinguishing any fire: a fire extinguisher, water, and sand.
5. Prior to leaving work area after welding is completed, carefully inspect for sparks or smoldering material.

1.4 Other References

Also refer to the latest revisions of the following sources of safe practices in welding and cutting:

A. National Fire Protection Association Standard 51B, CUTTING AND WELDING PROCESSES, obtainable from the NFPA, Batterymarch Park, Quincy, MA 06269.
B. NFPA Standard 51, OXYGEN-FUEL GAS SYSTEMS FOR WELDING AND CUTTING, obtainable sames as item A.
C. American Welding Society publication C4.2-78, OPERATOR'S MANUAL FOR OXY-FUEL GAS CUTTING, obtainable from AWS, Box 351040, Miami, FL 33135.
D. CONCOA publication ADE 872, SAFE PRACTICES IN WELDING AND CUTTING.

FOR MAXIMUM SAFETY USE FLASHBACK ARRESTORS

Regulator Mounted	Regulator Mounted	Torch Mounted
Model-78 Resettable	Model-53	Model 460
801 0786 "B" Size for Oxygen	801 0536 "B" Size for Oxygen	801 1466 "B" Size for Oxygen
801 0789 "B" Size for Fuel Gas	801 0539 "B" Size for Fuel Gas	801 1469 "B" Size for Fuel Gas

UL LISTED - MEETS OSHA REQUIREMENTS - COMPLY WITH ISO 5175

II. SETTING UP

2.1 Contents of Typical Outfit

2.1.1 Fuel Gas Regulator
A pressure regulator is provided for fuel in each outfit to reduce high cylinder pressures to safe working pressures.

2.1.2 Oxygen Regulator
A pressure regulator is provided for oxygen in each outfit to reduce high cylinder pressures to safe working pressure.

2.1.3 Hose
Standard hose fittings are provided with the outfit and have standard threads (right-hand for oxygen, left-hand for fuel) for connection to the regulators and the torch. Use RMA-CGA Grade T hose for fuel gas (including Acetylene) to prevent hose failure. Grade R and RM are for Acetylene only.

2.1.4. Welding Torch/Tips
The torch is equipped with hose connections, valve for gas control, a handle for holding the torch, and a head to which the mixer is attached. Any one of various-sized interchangeable tips provided connects to the mixer.

2.1.5. Cutting Attachment/Tips
The cutting attachment is fastened to the welding torch in place of the welding tip and mixer to permit cutting. A cutting tip provided with the outfit connects to the attachment.

2.1.6. Goggles
Goggles with filter lens shade (see SAFETY section, paragraph 1.2) should always be worn whenever torch is lit.

2.1.7. Sparklighter
The Sparklighter is provided to ignite the oxygen and fuel mixture.

2.2 Personal Protection

1. Remove protective cap from cylinder valve.
2. Make sure regulator matches gas in service.
3. Make sure valve connections are clean and free of particles and dirt. Crack cylinder valve to blow out dirt. Wipe with a lint-free cloth. Be sure that regulator adjusting screw is not engaged.
4. Screw on connecting nut and wrench-tighten.

2.3 Mount Oxygen Regulator

1. Remove protective cap from cylinder.
2. Make sure valve connections are clean and free of particles and dirt. Crack cylinder valve to blow out dirt. Wipe with a lint-free cloth. Be sure that regulator adjusting screw is not engaged.
3. Screw on connecting nut and wrench-tighten.

2.4 Hoses

1. Make sure connections are clean.
2. The green hose carries oxygen and the red hose carries fuel from the respective pressure regulators on the torch. Fuel hose nuts are grooved around the middle for further identification. Screw on hose nuts to respective regulators and wrench-tighten.

2.5 Connect Hose to Torch

1. Attach red hose to connection marked “F” or “Fuel.”
2. Attach green hose to connection marked “O” or “Oxygen.”
3. Wrench-tighten.

2.6 Connect Either Cutting Attachment or Welding Tip

1. Cutting Attachment
   - a) Screw onto torch hand-tight
   - b)remove tip nut from attachement
   - c)insert tip supplied with outfit
   - e)screw on and wrench-tighten nut

OR

2. Welding Tip
   - a) Challenger model only: install mixer hand-tight, then screw on tip to mixer, also hand-tight.
   - b)Other models: install tip/mixer assembly hand-tight.

2.7 Testing Assembly for Leaks

1. Make sure all torch valves are closed - fully clockwise.
2. Apply a thin film of leak test solution* and vigorously brush onto all connections - cylinders, regulators, torch. (*must be compatible with oxygen)
3. Slowly open oxygen cylinder valve all the way. Fully turn valve counterclockwise to ensure that upper seal in valve is fully seated to prevent leakage around ste.
4. Check for bubbles around valves and threaded connections.
5. Screw in regulator adjustment screw to obtain pressure in regulator and check for bubbles around hose connections at regulator and torch. If any appear, tighten.
6. Repeat for fuel gas, except crack valve only ¼ turn, leave wrench on cylinder for quick shut-off.

2.8 Purge
Purge oxygen and fuel lines individually before lighting torch by briefly opening and closing each valve in turn, including the oxygen lever.

CAUTION

Do not purge in the presence of flame, lit cigarettes or other ignition sources. Never purge towards people, clothing, or combustibles.

III. SAFETY CHECKLIST

1. Is the area well ventilated?
2. Have you tested all connections for leaks?
3. Are all combustibles away from work area or protected from sparks?
4. If in use, have you checked properly the functioning of the flashback arrestors and or check valves? (See applicable manual.)
5. Have you purged the gas hoses and regulators of residual gas?
6. Remember to open gas cylinder valves slowly.
7. Never use oxygen to ventilate area or clean off clothing.
8. Have you removed all oil, grease, and combustibles from oxygen equipment?
9. Be sure you are properly protected: Are you goggles in good condition? Do the goggles have the appropriate filter lens? Are you wearing long sleeves secured at the wrists?
10. Is your equipment clean and in good operating condition?

IV. OPERATION

4.1 Selecting Tip

Choose tip and set regulator pressures as recommended in Table 1: Welding Tips or Table 2: Cutting Tips

4.2 Lighting Torch

1. Open fuel valve about 1/8 of a turn. Without delay, ignite gas with a sparklighter or pilot light. DO NOT USE MATCHES. (Figure 4.1).

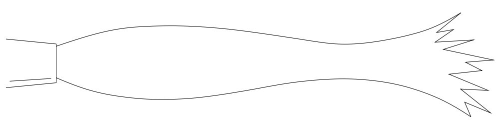


Figure 4.1. Pure Acetylene Flame

2. Slowly open torch oxygen valve. Flame will be carburizing (Figure 4.2).

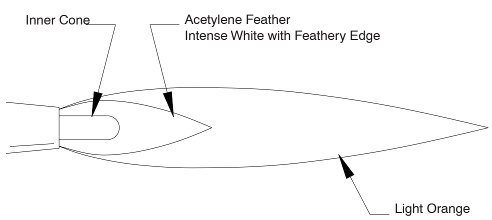


Figure 4.2. Carburizing Flame

3. Continue to turn oxygen valve to geta neutral flame (Figure 4.3).

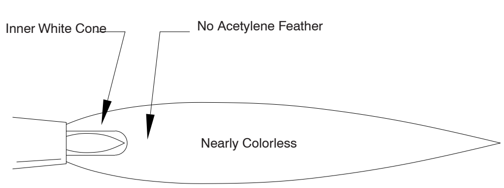


Figure 4.3. Neutral Flame

4. Too much oxygen produces an undesirable oxidizing flame (Figure 4.4).

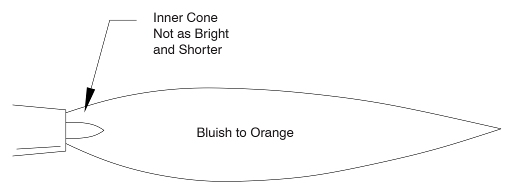


Figure 4.2. Carburizing Flame

TABLE 1. Welding Tip Guide for Outfits

Tip Size	Pressure (PSIG)*		Acetylene** Consumption	Metal Thickness
	Oxygen	Acetylene		
00	1	1	0.5	1/64
0	1	1	1	1/32
1	1	2	2	1/16
2	2	2	5	3/32
3	3	3	9	1/8
4	4	4	16	3/16
5	5	5	25	¼
6	6	6	30	5/16
7	7	7	40	3/8
8	8	8	60	½
9	9	9	70	5/8
10	9	9	90	3/4 up

*Gas pressure are for 5/16 inch hose lengths up to 25 feet. Increase pressure for smaller, longer, or restricted hose.
** Oxygen consumptions are 1.05 times acetylene consumptions. SCFH - standard cubic feet per hour (apprx.)

TABLE 2. Cutting Tip Guide for Outfits

*For additional information, refer to CONCOA Cutting Guide: ADI 1744 for Tip Style 144 & 164.
**Gas pressures are for 5/16 inch ID hose up to 25 feet long. Increase pressure for smaller, longer or restricted hose. Scfh- Standard Cubic Feet per Hour.

Acetylene (Tip Style 144)*						
Stock Number 854 -	Metal Thickness (inches)	Cutting Tip Size	Pressure (PSIG)**		Consumption (SCFH)	
			Oxygen	Acet.	Oxygen	Acet.
4499	1/8	00	30	1½	33	11
4400	1/4	0	30	3	57	18
4401	3/8	1+	30	3	84	20
	1/2	1+	40	3	100	20
4402	3/4	2	40	3	134	22
	1	2	50	3	154	22
4403	1½	3	45	3	190	23
4404	2	4	50	3	263	25
4405	3	5	45	4	313	31
	4	5	60	4	383	31
	5	6	50	5	457	43
4406	6	6	55	5	492	43

MAPP-Propylene STINGER STYLE 245						
Stock Number 813	Material Thickness (In.)	Tip Size No.	Gas Consumption			
			Oxygen		Fuel	
			Press. PSIG	Flow (CFH)	Press. PSIG	Flow (CFH)
2499	3/16	00-72	55	40-45	2-3	6-8
2450	1/4	0-68	40	55-65	2-3	6-8
	3/8	0-68	45	55-65	3-4	7-10
2451	1/2	1-62	50	80-90	3-4	7-10
	5/8	1-62	55	85-95	3-4	7-10
2452	3/4	2-56	50	110-120	3-4	7-10
	1	2-56	55	115-120	4-5	10-14
2453	1¼	3-54	50	155-170	4-5	10-14
	1½	3-54	55	165-180	4-5	10-14
2454	2	4-52	50	215-230	4-5	10-14
	2½	4-52	55	230-245	5-6	14-18
2455	3	5-49	50	285-300	5-6	14-18
	4	5-49	55	300-315	6-7	14-18
2456	6	6-39	60	670-685	6-7	14-18
	8	6-39	65	715-730	6-7	14-18
2457	10	7-30	65	935-945	7-8	18-20
	12	7-30	70	985-1000	7-8	18-20
2458	14	8-18	70	1075-1090	7-8	18-20

Acetylene (Tip Style 164)*						
Stock Number 854 -	Metal Thickness (inches)	Cutting Tip Size	Pressure (PSIG)**		Consumption (SCFH)	
			Oxygen	Acet.	Oxygen	Acet.
6499	1/8	00	25	1½	33	13
6400	5/16	0	30	2	60	17
6401	1/2	1	40	3	105	25
6402	1	2	50	3	160	27
6403	1-3/4	3	50	3	210	29
6404	2½	4	50	3	275	31
6405	4	5	60	4	400	45
6406	6	6	55	5	505	52
6407	8	7	60	6	680	70
6408	10	8	55	6	760	70
6410	12	10	55	6	950	78

Natural Gas/Propane STINGER STYLE 275								
Stock Number 813	Material Thickness (In.)	Tip Size No.	Gas Pressures and Consumption					
			Oxygen		Natural Gas		Propane	
			Press. PSIG	Flow (CFH)	Press. PSIG	Flow (CFH)	Press. PSIG	Flow (CFH)
2799	3/16	00-72	25	45-65	2-4	18-28	2-3	8-12
2750	1/4	0-68	35	68-85	2-4	18-28	2-3	8-12
	3/8	0-68	40	80-95	3-5	25-33	3-4	11-14
2751	1/2	1-62	45	110-125	3-5	28-35	3-4	12-16
	5/8	1-62	55	120-135	3-5	28-35	3-4	12-16
2752	3/4	2-56	50	140-155	3-5	28-35	3-4	12-16
	1	2-56	55	150-165	3-5	28-35	3-4	12-16
2753	1¼	3-54	50	180-200	4-7	30-40	4-5	14-18
	1½	3-54	52	190-210	4-7	30-40	4-5	14-18
2754	2	4-52	50	250-280	4-7	30-40	4-5	14-18
	2½	4-52	55	280-300	4-7	30-40	4-5	14-18
2755	3	5-49	50	305-325	5-8	35-45	5-6	16-20
	4	5-49	55	325-345	5-8	35-45	5-6	16-20
2756	6	6-39	60	550-570	5-8	35-45	5-6	16-20
	8	6-39	65	585-605	5-8	35-40	5-6	16-20
2757	10	7-30	65	810-830	5-8	50-60	6-8	18-22
	12	7-30	70	840-860	5-8	50-60	6-8	18-22
2758	14	8-18	70	1065-1085	5-8	50-60	6-8	18-22

V. WELDING

NOTE

See your Distributor for the complete selection of tips and tip guides.

5.1 Oxy-Fuel Welding Principles

Basically, oxy-fuel welding consists of joining metal together by the heat of the flame. The edges of the metal to be joined are first prepared as will be explained later, then heated to the melting point, with the torch. After reaching the melting point, a puddle of molten welde metal is formed. The molten metal flows together and, when cooled, forms a solid, seamless joint. In effect, the edges to be joined have been melted and completely fused together so the original edge no longer exist and the two pieces of metal become on; a jointless joint.

5.2 Tip Selection

Choose a welding tip that will provide you with the easiest control on the character (thickness, heat conductivity, melting point) of the material being welded, the type of joint, and the position in which the weld is being made. Select the tip size and the recommended pressure according to metal thickness; from acetylene or MAPP® Gas column in Section IV, Table 1. The resulting flame should be adequate yet soft enough to avoid blowing away molten metal.

5.3 Flame Adjustment

Before lighting torch, purge both gas systems as described in Subsection 2.8.

Open the oxygen valve a crack, open the fuel valve, and without delay ignite the gas with a sparklighter. Adjust the fuel valve to obtain full flow at the recommended pressure. Open the oxygen valve slowly, adjusting until the carburizing tail of the inner cone just disappears (Figure 4.3). This is a neutral flame used for most operations.

5.4 Base Metal Preparation

In preparing the base metal for welding, clean the edges and remove all traces of dirt, oil, grease, and other foreign matter. Also clean the surface of the metal around the edges to be joined.

Figure 5.1 shows some of the more common methods of

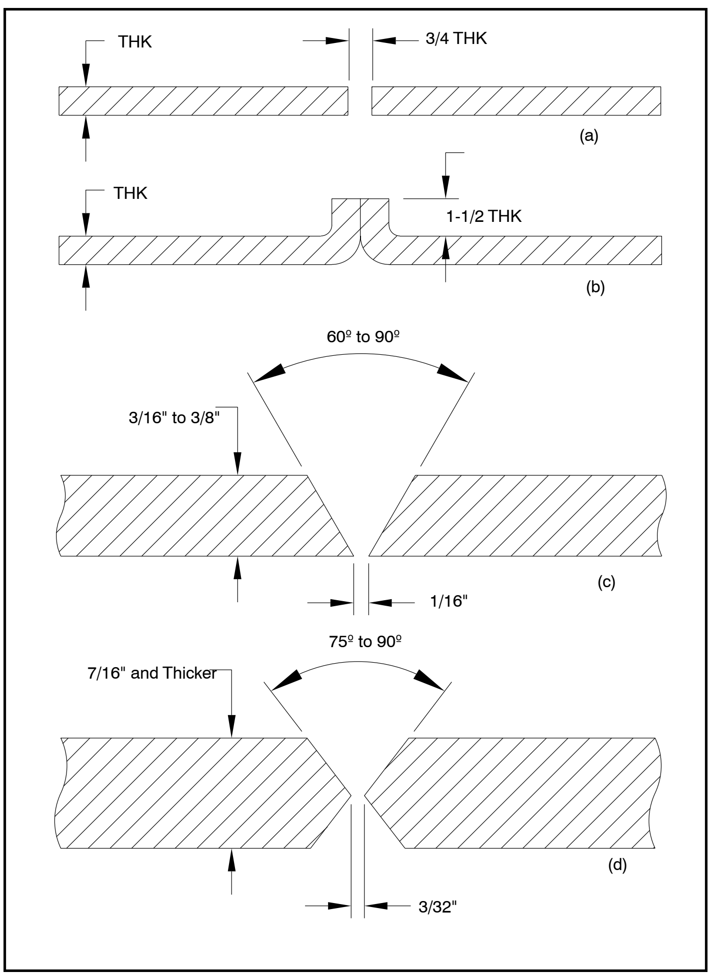


Figure 5.1. Joint Preparation for Groove Welds

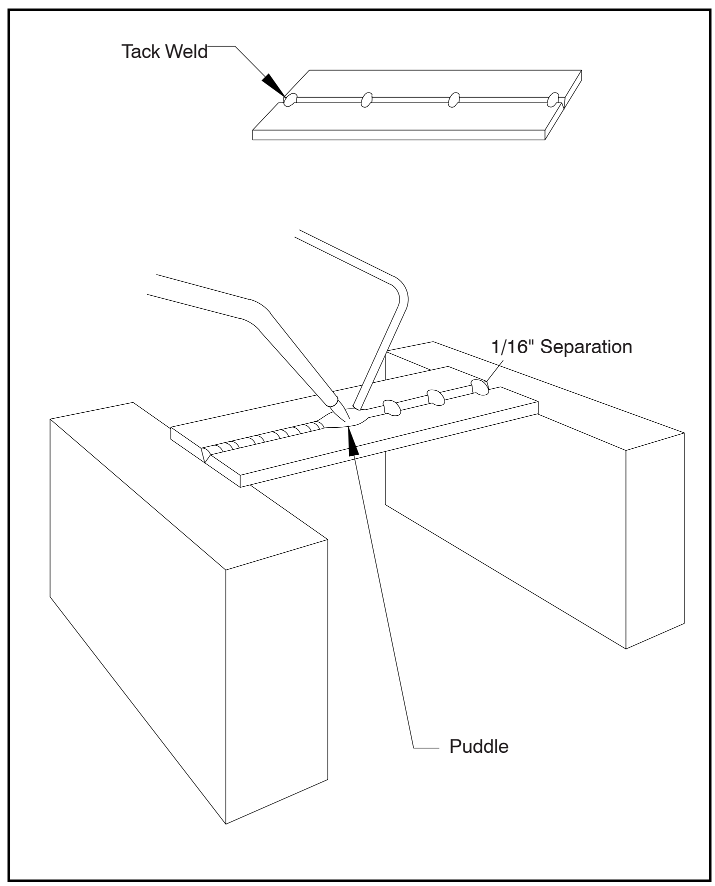


Figure 5.2. Welding Plates with Welding Rods.

paring joints for welding. View (a) show a square-edge butt joint. This type of joint is used where the thickness of the metal does not exceed 1/8-inch.

View (b) shows a flanged-edge joint used where the metal is not over 1/32-inch thick. The upturned edges of the joint prevent warping caused by the heat of the flame, and become filler metal in the joint.

In view (c), a single-vee groove joint is shown. This type of joint is used where the metal is over 3/16 inch thick. With this plate thickness, it is desirable when welding from one side, to bevel the edges of the joint and allow melting to extend all the way into the area to be welded. The weld is built from the bottom up by melting a rod of simliar (filler) metal in the puddle. The beveled edges permit the joint to be fused all the way through.

View (d) shows a double-vee groove joint which is used where the metal is over 7/16-inch thick. Here the metal is too thick for one vee to pe practical. In this case, the double-vee, welded from both sides, reduces the amout of welding and is better balanced that a single-vee joint.

The use of the welding rod as filler metal for joints described in views (c) and (d) is explained later in this section.

5.5 Tack Welding

Where long pieces of metal plate have to be joined together as in Figure 5.2, it is best to tack weld the plates together at two or more places. Tack welding consists of fusing a small weld deposit between the two edges of the joint to make sure they stay in alignment during the welding operation. Figure 5.2 also shows the proper method of supporting the plates.

5.6 Welding Steel

Most types of steel and steel alloys can be welded by the oxy-fuel method. Different welding rods are available from your authorized distributor as filler metal for the various types of steel welds desired. Each type of steel may require a different procedure and welding setup. Only the basic procedures for welding steel are covered in this manual.

One of the most important facts about steel welding is that molten steel solidifies almost as soon as the flame is removed. Because of this, steel can be welded in vertical and overhead positions as well as in the flat position.

5.6.1 Effect of Oxy-Fuel Flame

When the neutral or slightly carburizing flame (Figures 4.2 or 4.3) is directed against a steel surface, the molten puddle of metal remains initially clean and calm. There is no foaming, boiling, or appreciable sparking. This flame protects the molten steel from oxidation and gives the toughest, most effective welds.

A strong carburizing flame (Figure 4.2) usually adds carbon to the molten steel and may cause brittleness.

An oxidizing flame (Figure 4.4) makes the molten steel puddle foam and spark, indicating the excess oxygen is forming iron oxide which will cause a porous weld.

5.6.2 Welding Techniques

There are several different methods of oxy-fuel steel welding which produce good results. These methods also apply generally to welding of other metals. The most suitable method to use depends largely on the type of work.

The various methods or techniques, however, are all based on the same general principles. The most important welding principles are:

a. Maintain a calm puddle of molten metal. Move this puddle evenly along the joint as the weld is made.
b. Melt the end of the welding rod (is used) by holding it in the puddle. Do not hold the rod in the flame above the puddle where it may melt and drip into the puddle. Use the rod to deposit additional weld metal in the joint.
c. Avoid contact of the inner flame cone with the molten base metal, welding rod, or the molten metal of the puddle.
d. The flame should bring the edges of the joint to the fusion point ahead of the puddle as it advances along the seam.
e. The penetration (fusion to the base metal) of the molten metal should be all the way down to the bottom surface of the joint, but molten metal should not be allowed to drip in beads from the bottom of the weld.
f. Always make allowances for expansion of the metal when it is heated and for contraction when it is cooled.

5.6.3 Forehand Welding

In the forehand method of welding (Figure 5.3) also known as puddle or ripple welding, the welding rod is moved ahead of the torch tip in the direction in which the weld is being made. The flame is also pointed in this direction and is directed downward at an angle so it will preheat the edges of the joint as it is moved along. The torch tip and the welding rod are manipulated to give opposite back-and-forth movements in semicircular paths. This motion provides uniform distribution of both the heat of the flame and the molten metal along the path of the weld.

Forehand welding has certain disadvantages. If the metal to be welded is thick, the beveled edges of the ve have to be deeply melted to provide good fusion of the base metal and the added weld metal from the welding rod. A wide vee of as much as 90 degrees is required when welding thicker metals with this method.

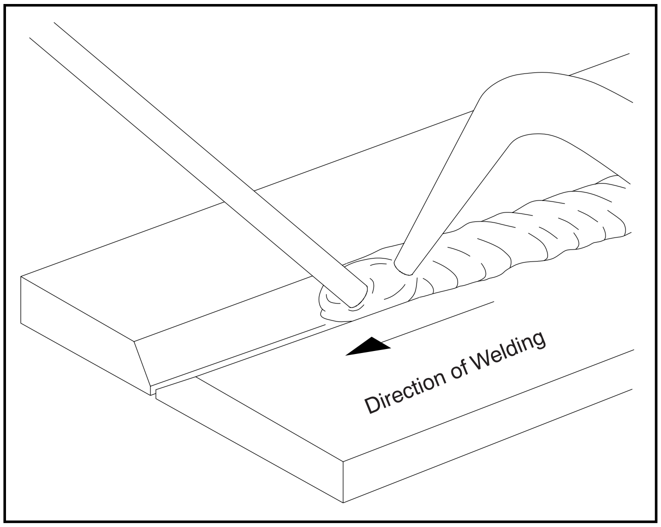


Figure 5.3, Forehand Welding

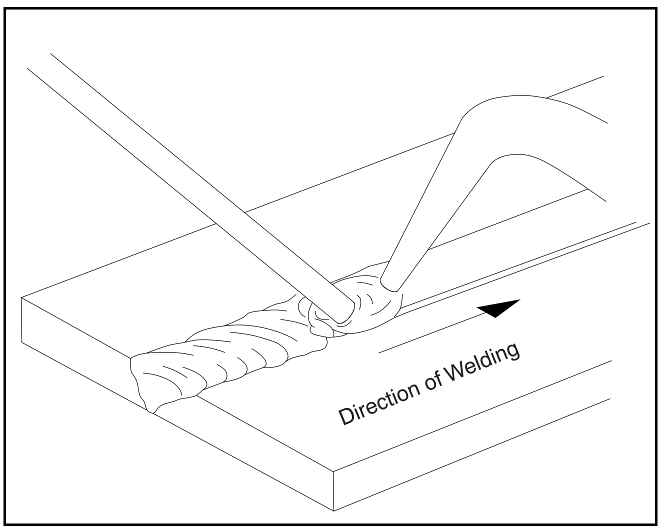


Figure 5.4, Backhand Welding

5.6.4 Backhand Welding

Backhand welding (Figure 5.4) does not have the disadvantages of forehand welding because the torch tip is moved ahead of the welding rod in the direction in which the weld is being made. The torch flame is pointed back at the molten puddle and the portion of the weld that has already been completed. The end of the welding rod is kept in the flame between the torch tip and the weld.

Using these positions of the torch tip and welding rod, the motion of the welding rod may be an oscillating one with the end of the rod moving from side to side in the puddle. In this case the rod is held straight. If desired, the rod may be held bent at an angle and moved back and forth across the puddle, made to move in full circles within the puddle, or in semi-circles partway around the puddle and back again.

To get a better weld when using MAPP Gas, do NOT stir the puddle with the rod.

The torch is usually held so the flame is moved back and forth across the weld to flow the molten metal onto and up each side wall.

Backhand welding permits the use of narrow vees; 60 degrees is often sufficient. This results in less puddling of the weld. Thus, there is considerable saving in welding rods, in amounts of oxygen and fuel used, and in welding time.

5.6.5 Finished Weld

The completed weld (Figure 5.5) should be thoroughly fused to the base metal throughout the groove area. The weld metal should pentrate to the root of the joint with a small amount extending below the surface to assure a full section weld. At the face of the weld, there is usually a build-up known as reinforcement. This reinforcement should be slight, blending smoothly with the base metal surfaces. It is especially important to avoid undercutting or overlapping at the juncture of the weld and base metal.

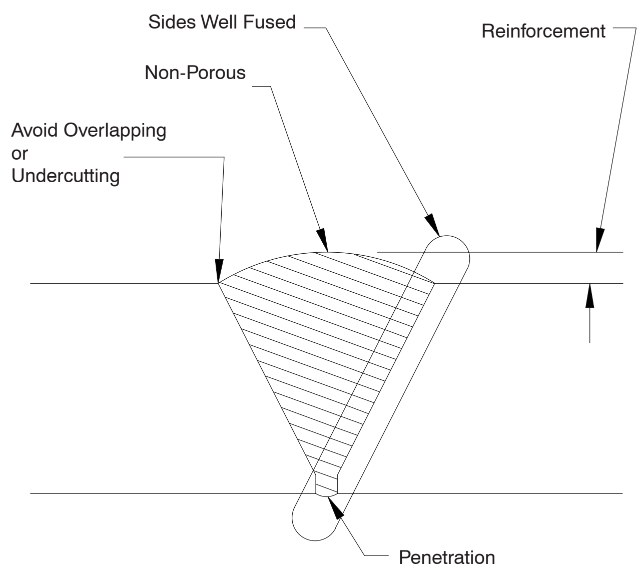


Figure 5.5, Finished Weld

5.7 Welding Cast Iron

In welding cast iron, a slightly carburizing flame (Figure 4.2) must be used; an oxidizing flame will burn out a considerable portion of the carbon in the cast iron leaving a hard weld.

Gray cast iron such as used for machinery frames, gears, and journal boxes has mechanically held free carbon in it. White cast iron has chemically combined carbon and by heat treatment is used to make maleable iron castings where high ductility is required. Alloy cast iron had additional elements for greater hardness, ductility, and other properties.

Use cast iron rods for welding gray iron castings; use moly-nickel cast iron rods for alloy iron castings. It is essential to use CONCOA ATLAS@ cast iron welding flux in all cast iron welding. Both rods, when deposited with ATLAS flux on preheated castings, can produce sound, nonporous, machinable welds on cast iron.

The following procedures are applicable to both gray iron and alloy castings.

5.7.1 Preparation for Welding

In preparing gray cast iron for welding, first clean all grease, dirt, paint, and other foreign matter from the parts to be joined. Next, match the broken parts to make sure that none are missing. Finally, chip, grind, or cut bevels along the lines of fracture to make vees of about 90 degrees. If possible, make double vees for heavy sections.

5.7.2. Preheating

Gray cast iron must be preheated before welding to avoid breakage caused by unequal temperatures of the metal during welding or cooling operations. In addition, preheating is necessary to retard cooling of the casting to avoid hard spots and assist in machining after welding.

The usual procedure is to place the prepared casting on a firebrick platform that has been raised to convenient height. Be sure that the parts to be welded are in proper alignment and are firmly supported by the firebrick to prevent sagging. Small parts can be preheated with the welding torch, while larger parts require a firebrick furnace. Preheat the entire casting gradually and uniformly to a dull red, 900 degrees to 1100 degrees F. Supplementary torch flames or charcoal fires will be required for preheating large castings in furnaces.

5.7.3 Welding

Heat the end of the cast iron welding rod, dip it into the ATLAS flux, and tack weld the edges to be joined. (Then,-using the proper welding rod and ATLAS flux-begin to weld the cast iron.) Use the forehand welding technique and a slightly carburizing flame (Figure 4.2) making sure that the forward end of the puddle is kept molten as welding progresses. This will result in a ripple weld similar to one in steel, except that the ripples will not be as clearly defined.

REPLACEMENT PARTS

The following illustrations of the equipment identify each resplacement part by items number as tabulated in the related parts list. The list identifies each part by stock number, description, and quantity uesd.

Attaching hardware items are listed, deeply indented, below the part they attach. They may not be shown. Order them separately.

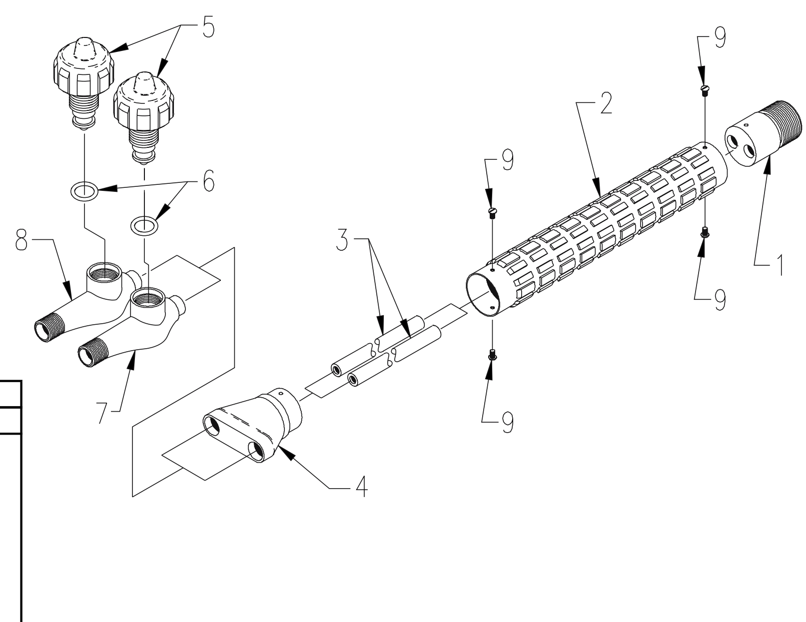
ORDERING

To assure proper operation, it is recommended that only genuine CONCOA parts and products be used with this equipment. To order replacement parts:

a. Give stock number, description, and quantity of each part required.

b. Give stock number, and description of equipment on which parts are to be used.

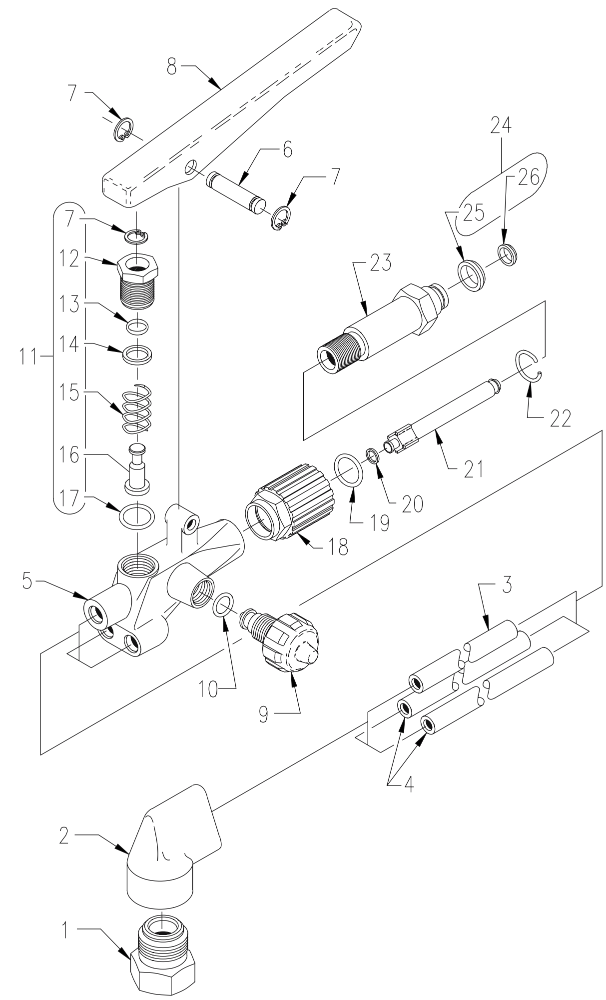
c. Indicate any special shipping instructions.



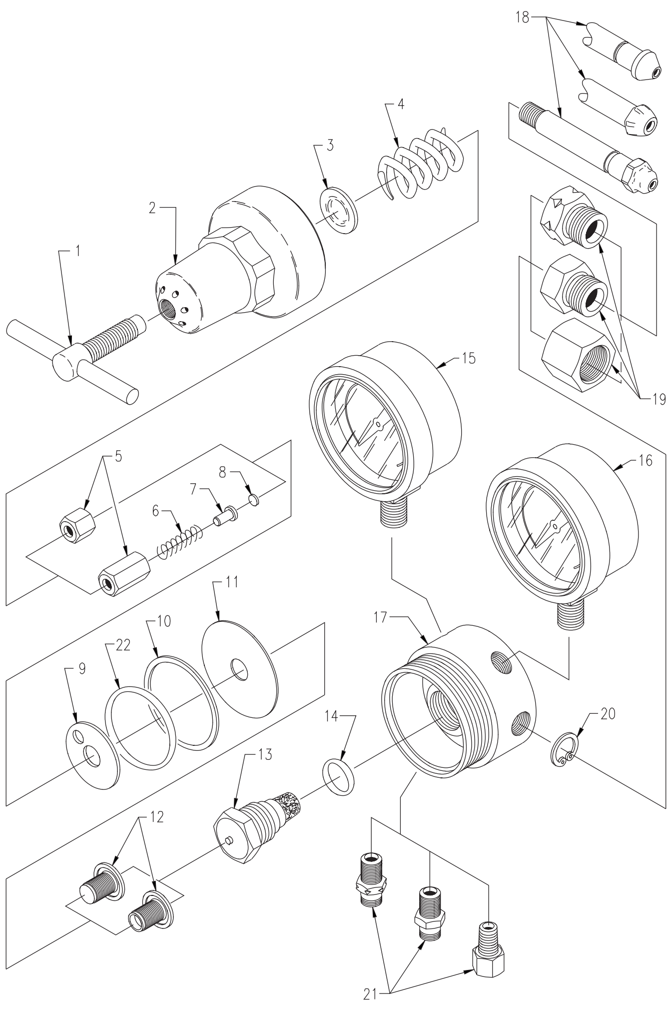
818 0750		
Item No.	**Description**	**Part No.**
1	Torch Head	831 1335
2	Torch Handle	831 2674
3	Gas Tubes (2)	831 1336
4	Rear End	831 2618
5	Valve Stem Assembly (2)	831 7722
6	O Ring, Valve Stem Seal (incl. W/Valve Stem Ass'y)	831 2896
7	Oxygen Valve Body	831 4466
8	Fuel Valve Body	831 4465
9	"Taptite" Panhead Screws, #4-40 x 3/16 (4)	9204 3223

Style 750 Welding Torch

822 5790		
Item No.	**Description**	**Part No.**
1	Tip Nut	831 2259
2	Torch Head	831 2319
3	Cutting Oxygen Tube	831 2261
4	Preheat Tube (2)	831 5721
5	Body	831 5722
6	Pin	831 1951
7	Retaining Ring (3)	9226 0058
8	Lever	831 1762
9	Valve Stem Assembly	831 4449
10	O Ring, Valve Steam Seal (included w/valve stem ass'y)	831 4075
11	Cutting Oxygen Valve Kit (items 12 thru 17 + 7)	831 4159
12	Oxygen Valve Retainer	831 2780
13	O Ring, Oxygen Valve, Inner	831 2781
14	Oxygen Valve Washer	831 2783
15	Oxygen Valve Spring	831 2782
16	Oxygen Valve Pin	831 4157
17	O Ring, Oxygen Valve, Outer	831 2859
18	Connecting Nut	831 2890
19	O Ring, Adapter Seal, Large	831 2896
20	O Ring, Adapter Seal, Small	831 2895
21	Adapter Insert	831 2887
22	Lock Ring	810 2004
23	Adapter	831 2888
24	Sealing Ring Set (6 each of items 25 & 26)	810 0450
25	Large Sealing Ring	810 0412
26	Small Sealing Ring	810 0411

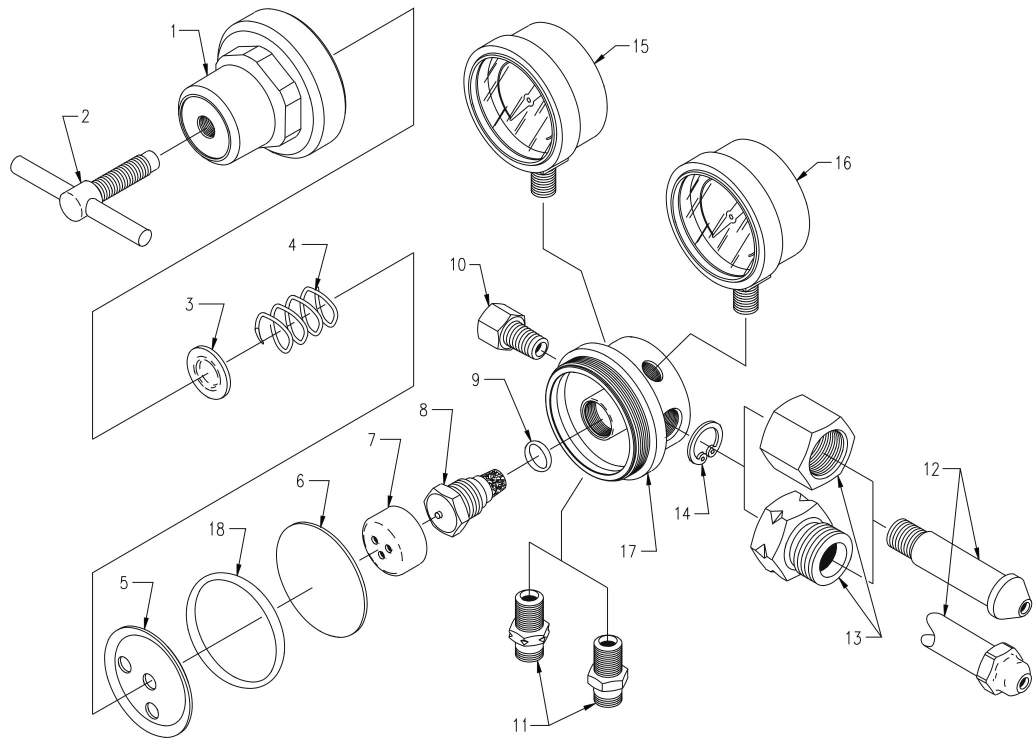


Cutting Attachment, Style 5700



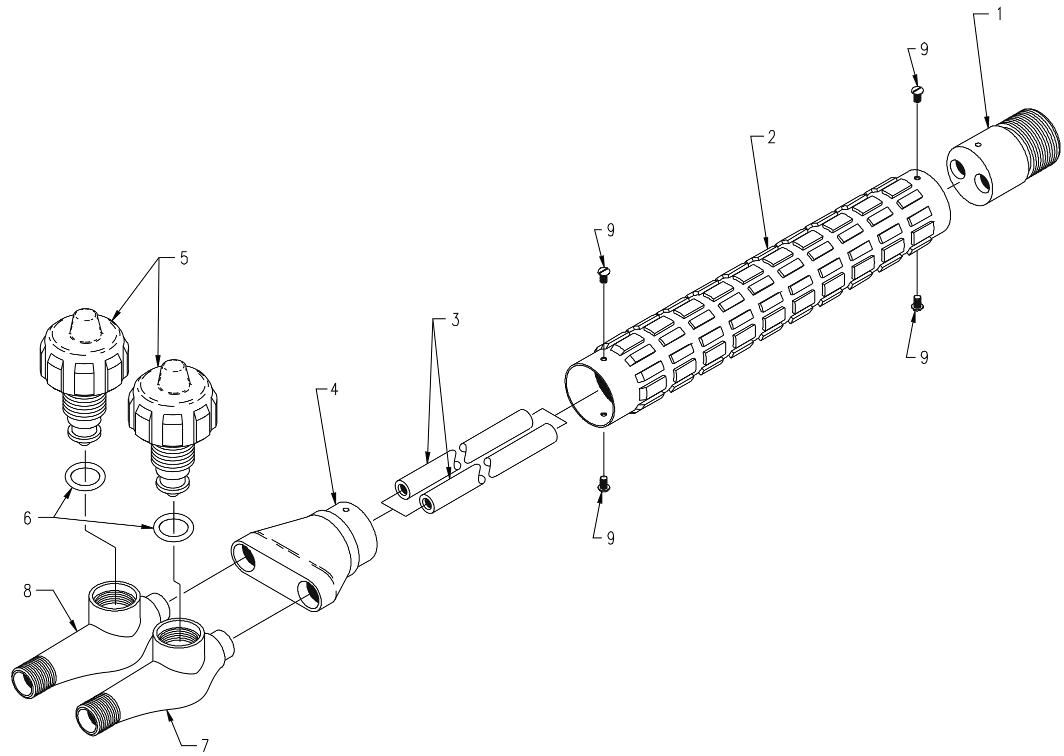
5500 Series Regulator

5500 Series Regulator				
Item No.	**Description**	**Acetylene CGA-300 (15 PSIG) 806 5502**	**Oxygen CGA-540 (125 PSIG) 806 5506**	**Fuel Gas CGA-510 (15 PSIG) 806 5509**
1	Adjusting Screw	830 5745	830 5745	830 5745
2	Spring Case	830 4894	830 4894	830 4894
3	Spring Button	830 0088	830 0088	830 0088
4	Adjusting Spring	830 4912	830 4911	830 4912
5	Cap, Top	830 4917	830 4909	830 4917
6	Spring	———	830 0095	———
7	Seat Holder	———	830 5051	———
8	Seat, Relief	———	830 5053	———
9	Diaphragm Plate	830 4926	830 4926	830 4926
10	Slip Ring	830 1685	830 1685	830 1685
11	Diaphragm	830 4910	830 4910	830 4910
12	Cap, Bottom	830 4916	830 5052	830 4916
13	Capsule	830 4839	830 4839	830 4839
14	O Ring, Capsule Seal	830 4840	830 4840	830 4840
15	Outlet Gauge	841 0221	841 0219	841 0221
16	Inlet Gauge	841 0222	841 0218	841 0222
17	Body	830 4883	830 4883	830 4883
18	Inlet Gland	830 4920	830 4102	830 3274
19	Inlet Nut	830 0143	830 3322	839 5581
20	Retaining Ring	9226 0057	9226 0057	———
21	Outlet Fitting	803 0007	803 0006	803 0007
22	O Ring, Vibration Damper	———	830 2675	———



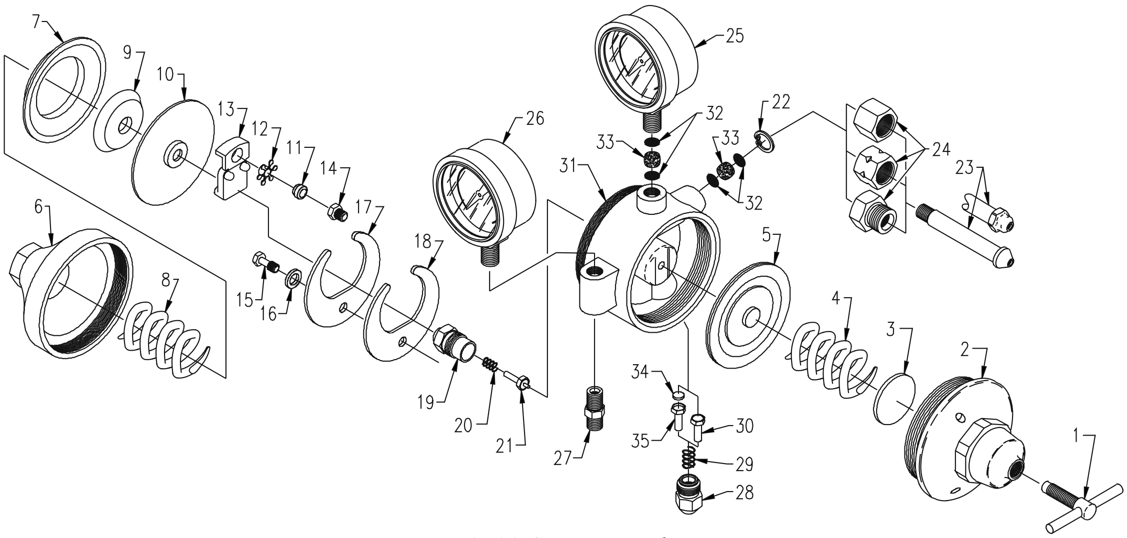
6500 Series Regulator

6500 Series Regulator				
		Regulator Stock Number		
Item No.	**Description**	**Acetylene CGA-300 (15 PSIG) 806 6512**	**Oxygen CGA-540 (120 PSIG) 806 6516**	**Fuel Gas CGA-510 (15 PSIG) 806 6519**
1	Bonnet	830 5568	830 5568	830 5568
2	Tee Screw	830 5629	830 5629	830 5629
3	Pivot	830 5575	830 5575	830 5575
4	Adjusting Spring	830 5571	830 5573	830 5571
5	Diaphragm Plate	830 5570	830 5570	830 5570
6	Diaphragm	830 5569	830 5569	830 5569
7	Cap	830 5513	830 5513	830 5513
8	Capsule Assembly	830 5539	830 5539	830 5539
9	O Ring, Capsule Seal	830 5830	830 5830	830 5830
10	Relief Valve	--------	830 5529	--------
11	Outlet Fitting	803 0007	803 0006	803 0007
12	Inlet Gland	830 5609	830 5636	830 3274
13	Inlet Nut	830 0143	830 3322	839 5581
14	Retaining Ring	9226 0057	9226 0057	--------
15	Outlet Gauge	841 0003	841 0005	841 0003
16	Inlet Gauge	841 0007	841 0102	841 0007
17	Regulator Body	830 5614	830 5557	830 5614
18	O Ring, Vibration Damper	--------	830 5743	--------



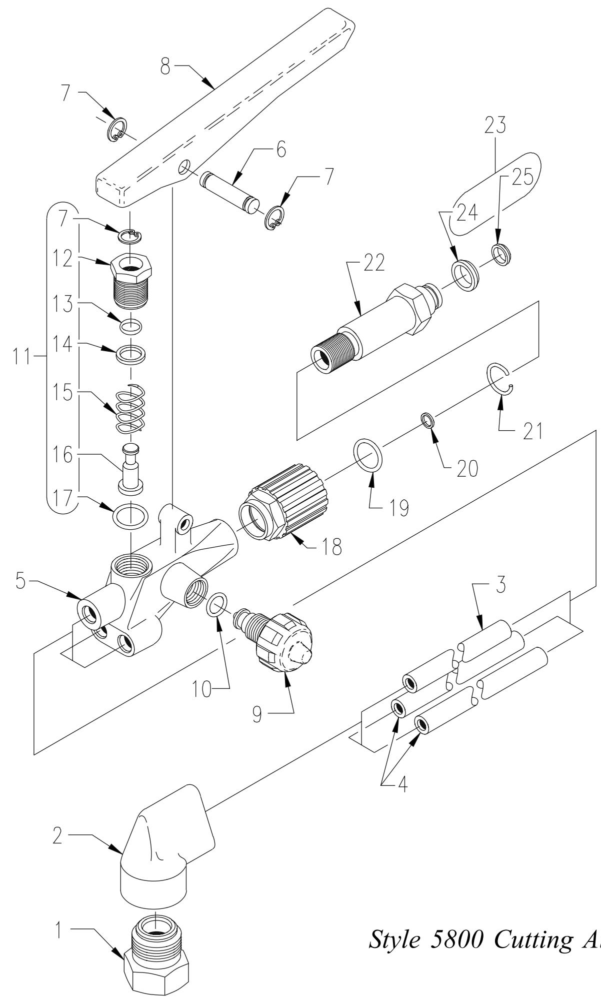
Style 800 Welding Torch

819 0800		
Item No.	**Description**	
1	Torch Head	831 2945
2	Torch Handle	831 2997
3	Gas Tubes (2)	831 2943
4	Rear End	831 2944
5	Valve Stem Assembly (2)	831 7730
6	O Ring, Valve Stem Seal (incl. W/Valve Stem Ass'y	831 7737
7	Oxygen Valve Body	831 5502
8	Fuel Valve Body	831 5503
9	"Taptite" Panhead Screws, #4-40 x 3/16 (4)	9204 3223



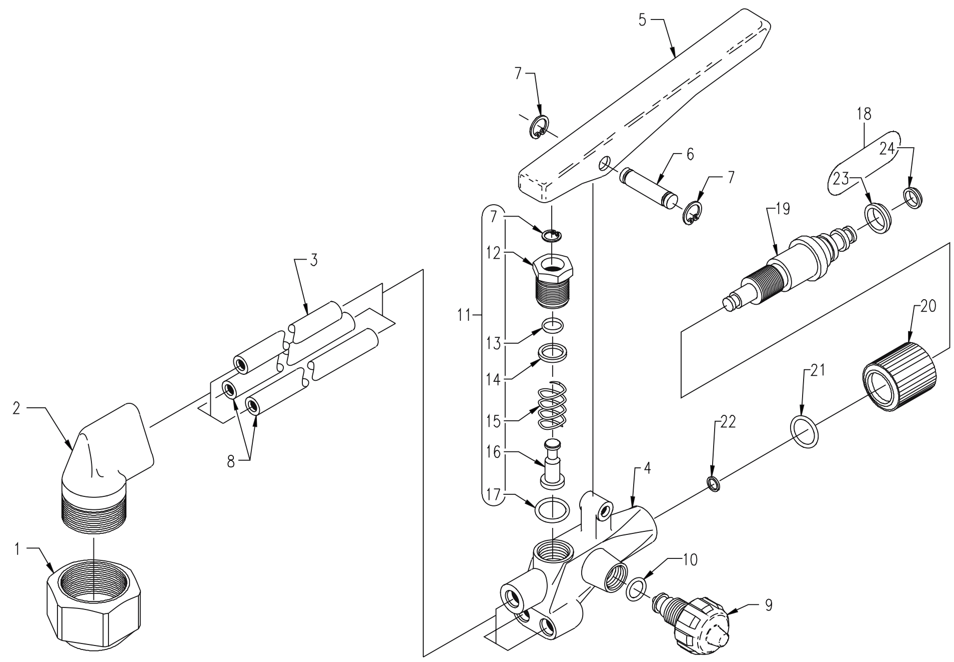
8400 Series Regulators

8400 Series Regulator				
Item No.	**Description**	**Oxygen CGA-540 (100 PSIG) 806 8456**	**Acetylene CGA-300 (15 PSIG) 806 8402**	**Acetylene CGA-5100 (15 PSIG) 806 8409**
1	Adjusting Screw	830 0381	830 0092	830 0092
2	Bonnet	830 0079	830 0079	830 0079
3	Spring Button, 2nd Stage	830 0088	830 0088	830 0088
4	Adjusting Spring, 2nd Stage	830 0239	830 0137	830 0137
5	Diaphragm Assembly, 2nd Stage	830 0255	830 0255	830 0255
6	Back Cap	830 0379	830 0084	830 0084
7	Back Cap Plate	830 0614	------	------
8	Spring, 1st Stage	830 0242	830 0137	830 0137
9	Diaphragm Plate	830 0098	830 0098	830 0098
10	Diaphragm Assembly, 1st Stage	830 0377	830 0240	830 0240
11	Seat, High Pressure	830 0075	830 0075	830 0075
12	Seat Retainer	830 0048	830 0048	830 0048
13	Lever	830 0072	830 0072	830 0072
14	Nozzle	830 0127	830 0127	830 0127
15	Retaining Screw	830 0914	830 0914	830 0914
16	Bearing Plate	------	830 0091	830 0091
17	Compensating Spring #1	830 0074	830 0074	830 0074
18	Compensating Spring #2	830 0074	------	------
19	Guide Thimble	830 0081	830 0081	830 0081
20	Marginal Spring	830 0295	830 0295	830 0295
21	Seat Assembly, Low Pressure	830 0102	830 0102	830 0102
22	Retaining Ring	9226 0057	9226 0057	------
23	Inlet Gland	830 4050	830 3282	830 4123
24	Inlet Nut	830 3322	830 0143	839 5581
25	Inlet Gauge	841 0102	841 0007	841 0007
26	Outlet Gauge	841 0005	841 0003	841 0003
27	Outlet Fitting	803 0006	803 0007	803 0007
28	Relief Valve Cap	830 0882	830 0882	830 0882
29	Relief Valve Spring	830 0757	830 0095	830 0095
30	Relief Valve Seat & Holder Ass'y	830 0917	830 0917	------
31	Body	830 0884	830 0884	830 0884
32	Screen (4)	830 4052	830 4052	830 4052
33	Filter (2)	830 4060	830 4060	830 4060
34	Relief Valve Seat	------	------	830 4260
35	Relief Valve Seat Holder	------	------	830 4261



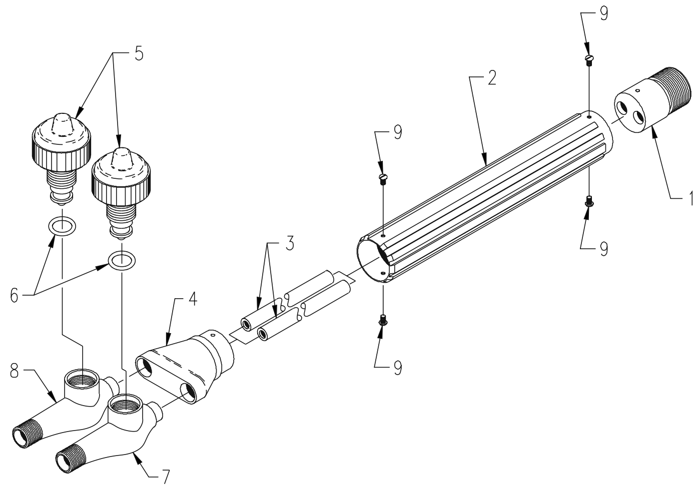
Style 5800 Cutting Attachment

822 5890		
Item No.	**Description**	**Part No.**
1	Tip Nut	831 2259
2	Torch Head	831 2319
3	Cutting Oxygen Tube	831 2261
4	Preheat Tube (2)	831 5721
5	Body	831 5722
6	Pin	831 1951
7	Retaining Ring	9226 0058
8	Lever	831 1762
9	Valve Stem Assembly	831 4449
10	O Ring, Valve Steam Seal (included w/valve stem ass'y)	831 4075
11	Cutting Oxygen Valve Kit (items 12 thru 17 + 7)	831 4159
12	Oxygen Valve Retainer	831 2780
13	O Ring, Oxygen Valve, Inner	831 2781
14	Oxygen Valve Washer	831 2783
15	Oxygen Valve Spring	831 2782
16	Oxygen Valve Pin	831 4157
17	O Ring, Oxygen Valve, Outer	831 2859
18	Connecting Nut	831 2891
19	O Ring, Adapter Seal, Large	831 2896
20	O Ring, Adapter Seal, Small	831 2895
21	Lock Ring	810 2005
22	Adapter	831 2984
23	Sealing Ring Set (6 each of items 25 & 26)	811 1132
24	Large Sealing Ring	811 0896
25	Small Sealing Ring	811 0897



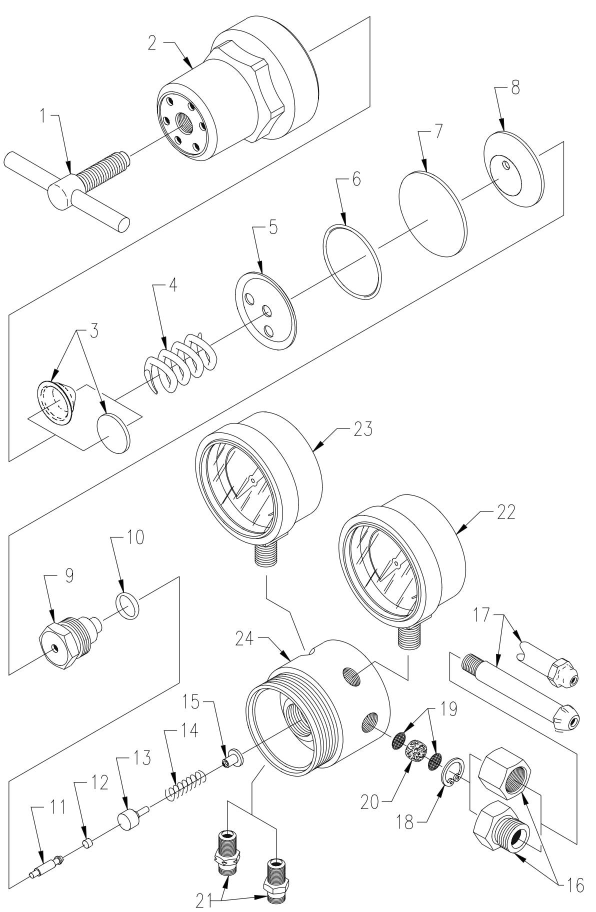
Style 3590 Cutting Attachment

822 3590		
Item No.	**Description**	**Part No.**
1	Tip Nut	831 4478
2	Torch Head	831 4471
3	Cutting Oxygen Tube	831 4469
4	Body	831 4475
5	Lever	831 2092
6	Pin	831 1951
7	Retaining Ring (3)	9226 0058
8	Preheat Tube (2)	831 2262
9	Valve Stem Assembly	831 4480
10	O Ring, Valve Steam Seal (included w/valve stem ass'y)	831 4075
11	Cutting Oxygen Valve Kit (items 12 thru 17 + 7)	831 4159
12	Oxygen Valve Retainer	831 2780
13	O Ring, Oxygen Valve, Inner	831 2781
14	Oxygen Valve Washer	831 2783
15	Oxygen Valve Spring	831 2782
16	Oxygen Valve Pin	831 4157
17	O Ring, Oxygen Valve, Outer	831 2859
18	Sealing Ring Set (6 each of items 24 & 25)	810 0450
19	Adapter	831 4474
20	Connecting Nut	831 4477
21	O Ring, Adapter Seal, Large	831 2896
22	O Ring, Adapter Seal, Small	831 2895
23	Large Sealing Ring	810 0412
24	Small Sealing Ring	810 0411



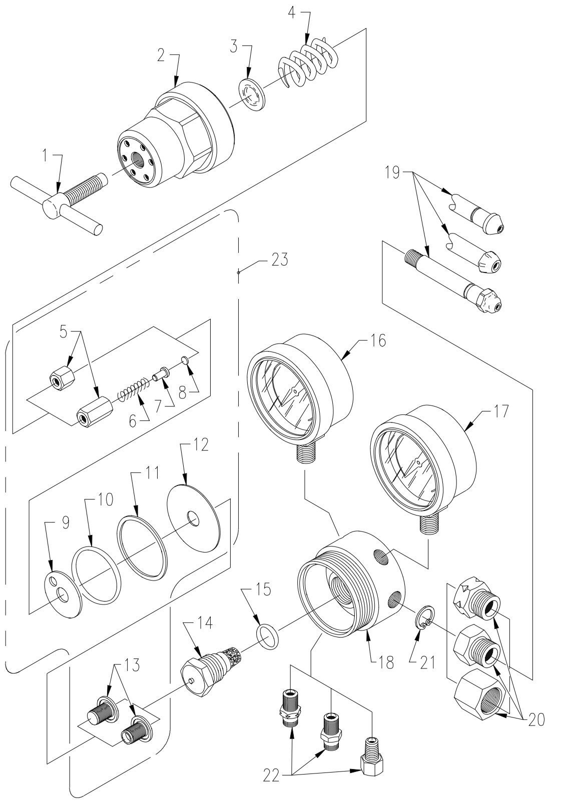
818 0550		
Item No.	Description	Part No.
1	Torch Head	831 4483
2	Torch Handle	831 4490
3	Gas Tubes (2)	831 1336
4	Rear End	831 2618
5	Valve Stem Assembly (2)	831 4488
6	O Ring, Valve Stem Seal (incl. W/Valve Stem Ass'y)	831 2896
7	Oxygen Valve Body	831 4466
8	Fuel Valve Body	831 4465
9	"Taptite" Panhead Screws, #4-40 x 3/16 (4)	9204 3223

550 Style Torch



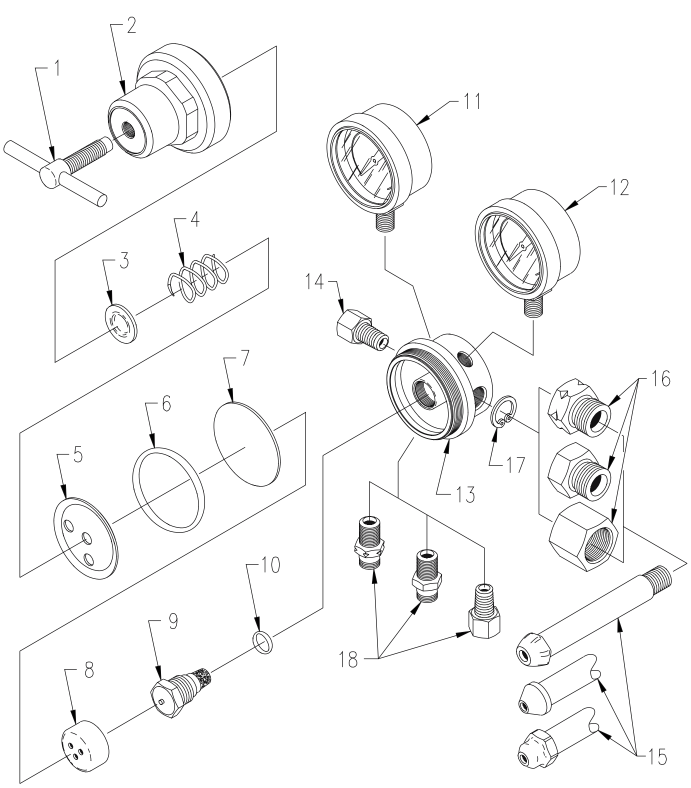
4700 Series Regulator				
Item No.	Description	Acetylene CGA-300 806 4702	Oxygen CGA-540 806 4706	Fuel CGA-510 806 4709
1	Adjusting Screw	830 4022	830 4022	830 4022
2	Bonnet	830 6013	830 6013	830 6013
3	Button, Spring	830 1687	830 3203	830 1687
4	Spring, Adjusting	830 6015	830 0094	830 6015
5	Plate, Diaphragm	830 4587	830 4587	830 4587
6	Damper Ring	--------	830 5742	--------
7	Diaphragm	830 5517	830 5517	830 5517
8	Plate, Thrust	830 6125	830 6125	830 6125
9	Retainer	830 4540	830 4540	830 4540
10	O Ring	830 3907	830 3907	830 3907
11	Pin	830 4541	830 4541	830 4541
12	Seat	830 4542	830 4542	830 4542
13	Holder, Seat	830 4236	830 4236	830 4236
14	Spring, Marginal	830 4550	830 4550	830 4550
15	Guide, Spring	830 4054	830 4054	830 4054
16	Nut, Inlet	830 0143	830 3322	839 5581
17	Gland, Inlet	830 3282	830 4102	830 3274
18	Ring, Truarc #5133-62MD	9226 0057	9226 0057	--------
19	Screen (2)	830 4052	830 4052	830 4052
20	Filter	830 4060	830 4060	830 4060
21	Outlet Fitting	803 0007	803 0006	803 0007
22	Inlet Gauge	841 0222	841 0218	841 0222
23	Outlet Gauge	841 0221	841 0219	841 0221
24	Body	830 4586	830 4586	830 4586

4700 Series Regulator



5600 Series Regulator					
Item No.	**Description**	**Acetylene CGA-300 (15 PSIG) 806 5602**	**Oxygen CGA-540 (125 PSIG) 806 5606**	**Fuel Gas CGA-510 (15 PSIG) 806 5609**	**Fuel Gas CGA-510 (40 PSIG) 806 5632**
1	Adjusting Screw	830 5192	830 5192	830 5192	830 5192
2	Spring Case	830 4963	830 4963	830 4963	830 4963
3	Spring Button	830 0088	830 0088	830 0088	830 0088
4	Adjusting Spring	830 4912	830 4911	830 4912	830 4913
5	Cap, Top	830 4917	830 4909	830 4917	830 4917
6	Spring, Internal Rel. Valve	--------	830 0095	--------	--------
7	Seat Holder	--------	830 5051	--------	--------
8	Internal R.V. Seat	--------	830 5053	--------	--------
9	Diaphragm Plate	830 4926	830 4926	830 4926	830 4926
10	O Ring Vibration Damper	--------	830 2675	--------	--------
11	Slip Ring	830 1685	830 1685	830 1685	830 1685
12	Diaphragm	830 4910	830 4910	830 4910	830 4910
13	Cap, Bottom	830 4916	830 5052	830 4916	830 4916
14	Capsule	830 4839	830 4839	830 4839	830 4839
15	Teflon O Ring	830 4840	830 4840	830 4840	830 4840
16	Delivery Gauge	841 0057	841 0134	841 0057	841 0076
17	Inlet Gauge	841 0056	841 0093	841 0056	841 0056
18	Body	830 4883	830 4883	830 4883	830 4883
19	Inlet Gland	830 4920	830 4102	830 3274	830 3274
20	Inlet Nut	830 0143	830 3322	839 5581	839 5581
21	Retaining Ring	9226 0057	9226 0057	--------	--------
22	Outlet Fitting	803 0007	803 0006	803 0007	803 0007
23	Diaphragm Assembly	830 6330	830 6331	830 6330	830 6330

5600 Series Regulator



6600 Series Regulator					
Item No.	**Description**	**Acetylene CGA-300 (15 PSIG) 806 6602**	**Oxygen CGA-540 (120 PSIG) 806 6606**	**Fuel Gas CGA-510 (15 PSIG) 806 6609**	**Fuel Gas CGA-510 (40 PSIG) 806 6632**
1	Adjusting Screw	830 5215	830 5215	830 5215	830 5198
2	Spring Case	830 4965	830 4965	830 4965	830 4965
3	Spring Button	830 5575	830 5575	830 5575	830 5575
4	Adjusting Spring	830 5571	830 5574	830 5571	830 5572
5	Diaphragm Plate	830 5570	830 5570	830 5570	830 5570
6	O Ring, Vibration Damper	------	830 5743	------	830 5743
7	Diaphragm	830 5569	830 5569	830 5569	830 5569
8	Cap	830 5513	830 5513	830 5513	830 5513
9	Capsule Assembly	830 5539	830 5539	830 5539	830 5539
10	O Ring, Capsule Seal	830 5830	830 5830	830 5830	830 5830
11	Outlet Gauge	841 0003	841 0005	841 0003	841 0077
12	Inlet Gauge	841 0007	841 0102	841 0007	841 0007
13	Body	830 5614	830 5557	830 5614	830 5614
14	Relief Valve	------	830 5529	------	------
15	Inlet Gland	830 5609	830 5636	830 3274	830 3274
16	Inlet Nut	830 0143	830 3322	839 5581	839 5581
17	Retaining Ring	9226 0057	9226 0057	------	------
18	Outlet Fitting	803 0007	803 0006	803 0007	803 0007

6600 Series Regulator

Puddling slightle with the cast iron welding rod will help oxides and foreign matter out of the weld. Blowholes can be prevented by holding the torch flame over the weld puddle without overheating or excessive puddling, to keep oxygen in the surrounding air from coming into contact with the molten metal. Hard spots in welds in thin cast iron can sometimes be caused by not heating the end of the welding rod before inserting it in the puddle.

Where conditions permit, try to complete the weld without stopping. If it is necessary to stop, be sure to do it at a point where it is unlikely to cause internal stresses in the casting.

Cast iron melts between 1950 degress and 2300 degrees F, depending upon its composition. This temperature range is below the melting points of iron oxides. Therefore, it is essential to use a good flux when welding. Flux floats dirt and oxides to the surface of the molten pool.

Molten cast iron will become liquid very fast if heated to a high enough temperature. It will run freely without warning if the heat of the torch is not withdrawn momentarily to allow the molten metal to cool a smaller, more controllable puddle. Remove the torch from time to time so that control of the molten weld metal can be retained.

5.7.4 Cooling

Cast iron must cool slowly. When welding is completed, cover the casting with abestos paper, using several thickness of paper on heavy sections or use lime. Protect the casting from: cold air and drafts and allow it to cool uniformly and slowly. If the casting cools to rapidly, the weld may crack or be too hard for proper machining afterwards.

5.8 Welding Aluminum and Its Alloys

Aluminum is a comparatively soft metal, about 1/3 the weight of steel. Pure aluminum melts at about 1195 to 1215 degrees F. Aluminum alloys, depending upon composition, have a melting range of 890 to 1200 degrees F.

Aluminum may be gas welded with a slightly carburizing flame (Figure 4.2) which is cooler, to avoid oxidizing and maintain better control of the puddle.

Aluminum oxidizes readily at room or welding temperatures. Since aluminum oxiedes has a high melting point, it presence can prevent proper fusion of the molten base and filler metals. Fluxes specifically designed for gas welding of aluminum must be used.

CAUTION

All flux residues must be removed from the weldment to prevent serious corrosion. Adequate ventilation must be provided to draw off flux fumes when welding. Ventilation requirements for use with these flouride bearing fluxes are given in ANSI Standard Z49.1, and covered in the Safety section, paragraph 3 at front of book. See flux caution in Section IV, paragraph 10.

Apply CONCOA Formula No. 42 NAPOLITAN® aluminum welding flux dry to the joint area and to the welding rod end by dipping the heated rod end into the flux container. Better flux distribution will be obtained by mixing with water or alcohol and painting the slurry on the joint and rods. Dry the flux applications before welding.

Preheating to about 800 degrees F may be necessary with heavy metal thickness (above 3/8 inch) and is generally required for castings. Frequently however, the welding torch flame will suffice for the preheating function.

Aluminum welding rod types are shown in Table 3.

Aluminum has high thermal conductivity, making it necessary to use a welding tip size somewhat larger than would be used with steel.

TABLE 3. Aluminum Welding Rods

AWS Class #	Type	Use on Base Metal, AWS No.:
1100	Commercially Pure, Drawn	1100, 3003
4043	5% Silicon, Drawn	4043,6061,6063
5154	3½ Mag.	5052, 5154, 6061, 6063
5356	5% Mag.	5052, 5356

Aluminum up to 1/8 inch thick does not require beveling; a square groove is quite satisfactory. Use the flanged edge joint for metal up to 1/16 inch thick. The flange height should be about twice the thickness of the sheets. For heavier sections, use the single-vee groove or double-vee groove butt joints, depending upon thickness and accessibility for welding.

Aluminum also has a high coefficient of expansion, necessitating allowance for expansion movement when setting-up material for welding. As far as practical, avoid welds in large, flat areas. Welds in such areas create distortion of the workpiece. Corner joints will minimize this condition. Distortion can also be minimized by the use of many small tack welds if a large flat area must be welded. On thin sheet metal, tacks should be about one inch apart for thicker metal, spacing should range from three to five inches.

5.9 Braze Welding

Braze welding is a gas welding technique in which groove or fillet welds are deposited with a non-ferrous filler metal that melts below the melting point of the base metals but above 800 degrees F. This is sometimes incorrectly called brazing. The joint types and methods of distributing filler metal in the joints differ significantly in the two process. Brazing (capillary brazing) is discussed in paragraph 5.10.

The commonly used brass filler metals melt in the range of 1620 to 1850 degrees F., the range for most braze welding. Because of these low temperatures, this technique is widely used when it is necessary to control the heat input such as braze welding cast iron and sheet steel. A flux designed for use in braze welding is essential to success in this operation. (Table 4).

Table 4. Braze Welding Fluxes

Formula No.	Name	Type	Use
36	HI-BOND®	Dry Powder	All operations, especially free graphite condition
162	MARVEL®	Dry Powder	All operations (designed for copper and copper alloy welding)
16	HI-TEST®*	Liquid Paste	All operations, also brass (not copper) welding

*HI-TEST liquid flux is also capable of controlling the volatilization of the zinc content of brass rods, greatly reducing zinc fumes. Further, this flux may be painted on galvanized surfaces which are to be braze welded to protect the galvanized coating from burning off.

In preparing parts for braze welding it is necessary to clean thoroughly, removing all grease, paint, oxide scale, and other foreign material. The presence of such contamination will prevent the flow of molten filler metal over the joint surfaces. This flow is known as tinning. Under proper conditions of cleanliness and fluxing it will occur a short distance ahead of the advancing puddle of molten braze-welding filler metal; it is a good index of satisfactory braze-welding conditions.

Cast iron fractured surfaces may present difficult conditions for tinning, especially if the fracture exposes areas of graphite. If the condition is mild it may be corrected by searing the surface, using a strongly oxidizing flame (Figure 4.4). However, the best method for overcoming the free graphite condition is by the use of flux designed to react with graphtie (Table 2).

Flux is available as powder, past or rod coating. Flux powder is sprikled over the slightly preheated joint area. The brass rod is similarly preheated and dipped into the flux to pick up additional flux. As braze welding progresses, the hot rod end is dipped into the flux to maintain continuous flux coverage.

Table 5. Braze Welding Rods (Bronze)

Type	Composition Additives	
	Amount	Purpose
Tin	0.75%	Hardener; increase density and tensile strength
Nickle plus minor additions	10% (40% zinc 50% copper)	White metal (to match cast iron or steel); melting point around 1850ºF
Manganese, Nicklel plus Silicon	Small	Increase density and tensile strength; silicon suppresses zinc fumes
Manganese, plus Silicon	Small	Strength; fume suppression

Paint flux paste on the joint surfaces, including the bottom side of the joint root. Dip the braze welding rod in the flux. The welding flame heat will dry out the moisture from the paste, leaving a continuous coating of flux.

Braze welding rods are composed essentially of 60% copper and 40% zinc and are generally referred to as bronze rods.

Additions are made to this basic composition to achieve improved properties. (Table 5)

Since flux is essential to all braze-welding operations, braze welding rods are available with a factory applied extruded or dipped flux coating. The coating usually has the same characteristics as liquid flux. It is recommended that a separate application of liquid flux be made along the joint when using dipped or extruded rods.

When performing the braze welding operation, it is possible to heat the molten metal excessively,oxidizing some of the zinc in these rods. Such a condition is immediately visible in the form of dense, white fumes. Take the following corrective measures:

a. Avoid overheating, particularly the base metal.

b. Make sure that the flame is neutral or only slightly oxidizing. (Figures 4.3, 4.4).

c. Use additional flux which controls fuming.

Avoid breathing these zinc fumes. They are recognizable by a "sweetish" taste in the mouth. Work out-of-doors is possible. See Safety section 1.1.3 in front of book for proper ventilation precautions.

CAUTION

Exposure to zinc-oxide fumes results in a condition which welders call "galvo" since it can also come from welding on galvanized steel. Actually, it is a metal fume fever. If the fumes are breathed for a long period, a feeling of nausea will be experienced. Accompanying this will be profuse perspiring and weakness. If one has been exposed to a large amount of zinc fumes it is best to consult a doctor and follow his advice. Be sure to explain the conditions under which the exposure occurred. Generally, under medical care, zinc fume fever clears up with about a day of rest and does not cause permanent injury.

Adjustment of the oxy-fuel flame for braze welding is somewhat different than for other welding processes. A neutral flame may be used provided there is adequate flux coverage. However a slightly oxidizing flame which may lessen flux requirements is recommended. When an oxidizing flame is used, a thin film of oxide will form over the molten pool and protect the molten metal from further oxidation.

As in any braze welding, it is necessary only to heat the local joint area above the melting point of the filler metal.

5.10 Brazing

Brazing encompasses a group of welding processes taking place above 800° F in which a non-ferrous filler metal with a melt-

TABLE 6. Brazing Filler Metals			
AWS Designation	Brazing Temperature (°F)	Flux	Usable with These Metals
BAg-3	1270-1500		
BAg-2	1295-1550		Ferrous and non-ferrous metals, except
BAg-1	1145-1400	Nos. 12 or 18	aluminum, magnesium, zinc, lead
BAg-1a	1175-1400		
BAg-7	1205-1400		
BCuP-3	1300-1350		
BCuP-5	1300-1350	None or	Copper and copper base alloys
BCuP-3	1350-1550	No. 12	
BALSi-1	1150-1185	Alum. Brazing Flux	Aluminum and aluminum base alloys only.
BALSi-4	1090-1120	Nos. 60 or 44	
RBCuZn-A	1670-1750		
RBCuZn-D	1720-1800		Ferrous and non-ferrous metals, except
RCuZn-B	1670-1750	HI-TEST	aluminum, magnesium, zinc, lead
RCuZn-B	1670-1750	No. 16	

ing point below that of the base metal as in braze welding, is used to join two pieces.

However, the similarity ends there. In brazing, the members of the joint are closely fitted together within thousandths of an inch, and the molten filler metal is distributed in the joint by capillary attraction.

Most metals may be brazed using suitable filler metals and fluxes. In addition, many combinations of dissimilar metals may be readily joined by brazing. In general, the more commonly available brazing filler metals are: silver base alloys; copper-phosphorus alloys; aluminum alloys; and copper-zinc (brass) alloys. The joint American Welding Society-American Society for Testing Materials specification, *Brazing Filler Metals, AWS A5.8, ASTM B260*, establishes the requirements for these filler metals and their classifications. Table 6 lists brazing filler metals in four groups, their classifications and their fields of use.

From the above definition it will be noted that the joints are closely fitted. For most brazing applications other than aluminum, this joint clearance should be in the range of 0.002 to 0.006 inch. For aluminum brazing alloys, joint clearance should range form 0.006 to 0.010 inch for lap lengths less than ¼ inch; and 0.010 to 0.025 inch for lap lengths over ¼ inch. Generally, the lap joint will produce the most reliable results and can be proportioned to give joints strengths equaling the strength of the base metal. For optimum joint strength, a good general rule is to make the length of lap three times the thickness of the thinner memeber joined. Figure 5.6 illustrates the basic joint types used in brazing. Figure 5.7 provides a summary of good and poor brazed joint designs.

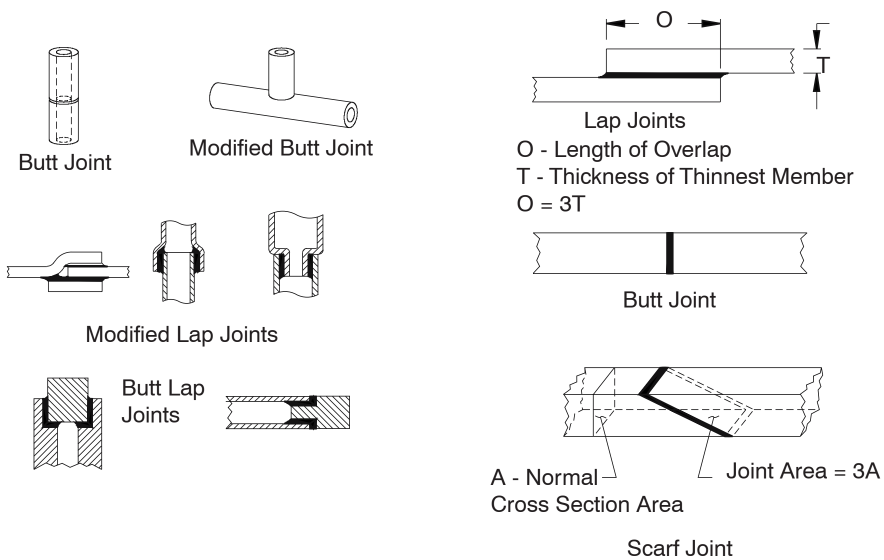


Figure 5.6 Basic Types of Brazed Joints

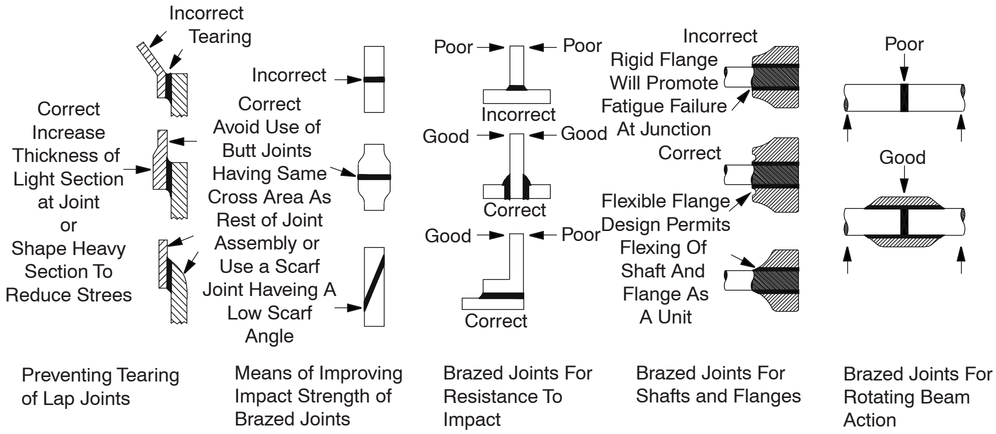


Figure 5.6 Basic Types of Brazed Joints

In the course of heating the joint, the base metals will tend to oxidize. The function of the flux is to protect the metal in the joint area from this oxidation and thus let the molten brazing filler metal flow on clean metal surfaces.

Remove all dirt, grease, and oxide before brazing. Solvents and chemical cleaners are useful, particularly with aluminum, for the removal of oil and grease. Mechanically abrading the joint areas with steel wool or emery cloth is also effective. The flux used in brazing should not be used for cleaning as this impairs its effectiveness as a flux. Resulting flux residues loaded with contamination are difficult to remove. Thorough precleaning of the parts and the filler metals is one of the secrets of successful brazing.

Generally, a brazing flux suitable for use with both the base and filler metals is necessary. However, certain alloys containing phosphorus may be used without flux when used on copper-to-copper joints. In this instance, the phosphorus serves as a flux. Even in these conditions, flux can be helpful.

HI-TEST fluxes come in paste form and should be painted onthe joint areas and the filler metal. Aluminum brazing flux comes as a dry powder which must first be mixed with clean water or alcohol to make a paste. Mix ONLY enough to handle the job since the paste loses activity if permitted to stand for a day or more.

The silver brazing fluxes and aluminum brazing fluxes contain fluorides. These chemical compounds are necessary to produce a low melting point flux with the necessary cleaning action at brazing temperature. The flux labels carry the following caution notice:

CAUTION
Contains Fluorides
This flux, when heated, gives off fumes which may irritate eyes, nose and throat.

1. Avoid fumes - use only in well ventilated spaces.
2. Avoid contact of flux with eyes or skin.
3. Do not take internally.

See Safety Section, paragraph 1.1.3 at front of book for ventilation requirements.

In heating assemblies for brazing, adjust the flame to a slightly excess fuel or neutral condition (Figure 4.3). Avoid an oxidizing flame (Figure 4.4). Heat the parts uniformly and gradually. Thicker parts of the joint, such as flanges require more heating than pipes, for example. Continue heating until the flux liquefies. With initial heating, the flux will dry out as water is evaporated leaving a dry flux crust. With further heating, this dry flux crust will melt and liquefy, becoming "water clear."

When this stage is reached, the heat in the parts should be sufficient to melt the filler metal. Use the heat of the parts, not the torch flame, to melt the filler metal which will then flow thoroughout the joint almost instantaneously. When the filler metal has visibly flowed to the extremities of the joint, discontinue heating. Do not overheat the joint.

After brazing is completed, remove all flux residue from the completed assembly by scrubbing with hot water. Flux residues can pick up moisture from the air and cause serious corrosion of the assembly. If the flux has had to handle gross contamination on the parts, the residue may be a glass-like compound. If this occurs, hand-chipping or chemical cleaning may be required.

If it is necessary to braze plated metals, determine the nature of the plating. Cadmium plating is widely used on steel. Heating such plating for brazing will almost surely produce cadmium-oxide fumes.

CAUTION

DO NOT breathe these fumes. Use adquate ventilation such as fume collectors, exhaust ventilators, or air-supplied

respirators. If chest pain, cough, or fever develops when heating cadmium-plated steel, call physician immediately.

5.11 Surfacing By Oxy-Fuel Welding

Surfacing by oxy-fuel welding is a procedure by which weld metal is deposited on a metal surface to produce certain desired properties or to restore dimensions. It may be performed on new parts to restore them to usable condition. The overlay may be for corrosion resistance, wear resistance, toughness, or to provide anti-friction properties. When the purpose of the overlay is to provide resistance to abrasion, it is referred to as hardfacing, although hardness as such is not always desired. Nevertheless, the term hardfacing is widely used to denote all the operations.

The list of metallic parts which may be surfaced is almost endless; if metal wears in service, there is a Cobalar® hardfacing product available to reclaim the part. Among the most widely hard-surfaced implements are plowshares, grader blades, drill bits for well digging, and automotive engine valves.

Oxy-fuel welding is well suited to surfacing operations. It permits smooth, precise, and very high quality deposits of surfacing metals. Small areas, grooves, and recesses may be accurately filled. Very thin layers of filler metal may be applied smoothly. The inherent heat of the oxyfuel flame provides preheating and develops slow cooling, thereby minimizing cracking. By **sweating** with a slightly carburizing flame, there is a minimum dilution of the weld deposits with the base metals, thus preserving the properties of the surfacing deposit.

Grease and dirt should be removed with suitable cleaners before welding. Oxide and scale may require grinding. Contamination will impede the flow of molten filler metal over the area to be surfaced.

For surfacing operations, use a slightly-carburizing flame (Figure 4.2). For ordinary carbon steel welding, excess fuel is measured by the feather of unburned fuel and the end of the inner cone; this should be 1½ times the length of the inner cone. With a flame adjusted in this manner, it is possible to carburize or inject carbon into the surface condition and the metal appears to **sweat,** hence the description of **sweating** on. While the base metal is beign prepared, hold the surfacing filler metal in the outer envelope of the flame; this serves to preheat the end of the rod. When the required area of the base metal is in the sweating condition, introduce the preheated welding rod end into the hottest part of the area. A small portion will be melted on the base metal. It should wet the base metal and spread smoothly over the heated area. The typical weaving motion of oxyfuel welding is used to control the heating of the base and filler metals and distribute the molten filler metal.

The rods used in surfacing are:

COBALT 1B - Formualted to resist corrosion and abrasion, this cobalt-based tungsten alloy rod can be applied to metals in multiple layers, and is used for such hardfacing applications as hot trimming dies, diesel valves and seats, screw conveyors, and mill guides. It withstands temperature upwards of 1800° F, resists moderate impact, and is machine grindable.
TUBECRAFT™ 40WB - Formulated with large sized tungsten carbide particles, this rod will resist corrosion, very severe abrasion and moderate impact. It will also provide thicker overlays, so it should be used when hardfacing heavier wear surfaces such as mixer plows and blades, pelletizing rolls, post hole augers, rock drilling bits andplow shares.
TUBECRAFT™ 120WB - This rod provides the same resistance to corrsion, abrasion and impact as the Tubecraft 40WB, but because it is made of finer tungsten carbide particles, there is thinner buildup, which provides for thinner overlays. This rod should be used to hardface thinner, sharper surfaces such as pugmill knives, cane knives, dredge pump cutters, churn drills, coal cutter bits and conveyor screws.

VI. HEATING

6.1 Proper Tip Size

Use proper size tip: too small takes excessive time to reach the desired temperature; too large won't cut heating time proportionately, and there will be a large waste of fuel and oxygen. Make trial heats with different tips, comparing fuel consumption (cfh X elapsed time) to determine most economical tip.

6.2 Recommended Flow Rates (Table 7)

Use flow rate recommended in this guide: this rate gives the most efficient flame velocity - a most important factor in transferring heat to the work. If heat is too small or too great, DO NOT CHANGE THE FLOWRATE, CHANGE TO A LARGER OR SMALLER TIP.

NOTE

Acetylene Withdrawal. CGA 5.3.3.13 or G-1 call for a withdrawal rate "not to exceed 1/10 (one-tenth) of the capacity of the cylinder per hour during intermittent use. For full withdrawal of the contents of the cylinder on a continuous basis, the flow rate should be no more than 1/15 (one-fifteenth) of the capacity of the cylinder per hour."

Never discharge fuel gas near any flame, arc spark or other sorce of ignition

TABLE 7. Heating Guides

SIZE NO. 7 Style 760 & 860

Maximum Fuel Flows						
Fuel	Oxygen to Fuel Ratio	PSI at Torch Entry		Primary Cone Lengths (Inch)	Fuel Flow Rate (CFH)	Continuous Operation
		Fuel	Oxygen			Number of Cylinders
Acetylene	1.1:1	7.5	8	1/2	50	1
MAPP (MPS) Gas	2.5:1	6	7	9/16	25	1
Propane	4:1	7	10	1/2	15	1
Natural Gas	2:1	2	2	1/4	15	Pipeline

SIZE NO. 8 Style 760 & 860

Maximum Fuel Flows						
Fuel	Oxygen to Fuel Ratio	PSI at Torch Entry		Primary Cone Lengths (Inch)	Fuel Flow Rate (CFH)	Continuous Operation
		Fuel	Oxygen			Number of Cylinders
Acetylene	1.1:1	10	10	1/2	70	2
MAPP (MPS) Gas	2.5:1	8	9	9/16	35	1
Propane	4:1	8	10	1/2	25	2
Natural Gas	2:1	3.5	4.5	1/2	30	Pipeline

VII. CUTTING

7.1 Oxy-Fuel Cutting Principles

When iron or steel is heated to a temperature of 1600° F, it will burn if brought into contact with oxygen. If the oxygen comes only from the surrounding air, combustion occurs only on the surface of the metal. However, if a jet of pure oxygen is directed at the hot metal, the metal will burn through a narrow zone, called a kerf.

In oxy-fuel cutting, the metal is first preheated with the oxy-fuel flame to the ignition temperature. When the required temperature is reached, the cutting oxygen is turned on, and the stream of pure oxygen is directed against the heated metal. This ignites the iron or steel and starts the cut.

By moving the flame and oxygen jet (torch tip) progressively forward, fresh metal and oxygen are brought together forming iron oxide or slag in molten form and expelling it from the bottom of the kerf. A balance must be achieved among speed of movement, oxygen jet size, and intensity of flame to achieve a continuous operation. See Figure 7.1 for a typical cutting operation.

A typical cutting attachment on a welding torch is shown in Figure 7.2. The preheat oxygen and fuel are first mixed, and the mixture ignites as it issues from the outer ring of orifices as preheating flames. The flow of fuel is controlled by the torch fuel valve and the flow of preheat oxygen is governed by the valve on the side of the cutting attachment. The cutting-oxygen jet is conrtolled by pressure on the lever mounted on top of the attachment. Oxygen to both the preheat oxgyen valve and the cutting oxygen lever valve is supplied through the torch oxygen valve which is opened wide during cutting operations.

7.2 Tip Selection

Interchangeable cutting tips, available with the torch, are selected according to material thickness (Table 2, Section IV). Gas pressures vary accordingly.

7.3 Cutting Steel

In cutting steel, a neutral oxy-fuel flame (Figure 4), is used for preheating. When possible the cut is started at the edge of the workpiece (Figure 7.2). Hold the cutting torch lightly but steadily, so that the ends of the preheating flame cones are about 1/8 inch above the surface of the metal.

Right-hand operators should hold the torch by the asbestos-gloved left hand a few inches back of the head of the attachment and hold the handle in position to operate the cutting-oxygen valve lever with the right hand.

When a spot of metal at the top edge has been heated to a cherry red, press down on the cutting oxygen lever and begin cutting.

With protective goggles, look down into the cut as the cutting progresses and make sure that the flow of slag is clear and not blocked. Move the torch in a straight line to keep a straight cut, and move the torch at a uniform speed at which the flame is cutting through the metal.

Chalk line guides may be drawn on the cutting surfaces to mark the cut. For greater accuracy, use straight edges, shaped guide bars, or templates to steady the hand and guide the cut. The torch may also be clamped to circle guides or wheeled carriages.

NOTE

Acetylene pressures are for tips with light preheating flames for use on clean plate. On rusty, scaly, or painted surfaces, use larger preheat flame which will require higher acetylene pressures than shown. Oxygen pressures remain the same.

7.4 Piercing Steel

When starting a cut in steel away from the edge, pierce a hole through the metal to start the cut (Figure 7.3). To do this, heat a spot to cherry red, raise the torch ½-inch or more above the normal position for cutting to prevent slag from being blown against and fouling the tip, and slowly press the cutting-oxygen lever.

CAUTION

To prevent the blowing of molten slag back into the operator's face, take the following precautions: Start the cut with low cutting oxygen flow. As is Figure 7.3, view 3, eith tilt the tip at a slight angle, or move the tip sideways and rotate around the edge of the cut, blowing the slag away from the face. Use full head and shoulder protection until experienced in hole piercing.

As soon as the hole is burned all the way through the metal, lower torch to the normal height above the work and proceed with the cut.

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