BOC

Welding & Cutting Guide

BOC products perform with reliability and the backing of Australia's leading welding supplier

Introduction

This guide provides the basic knowledge required for using the gas welding, cutting and heating equipment supplied in this BOC kit.

BOC has accumulated extensive knowledge in the design and manufacture of gas equipment for over 100 years. Our involvement in the gases industry dates back to 1886.

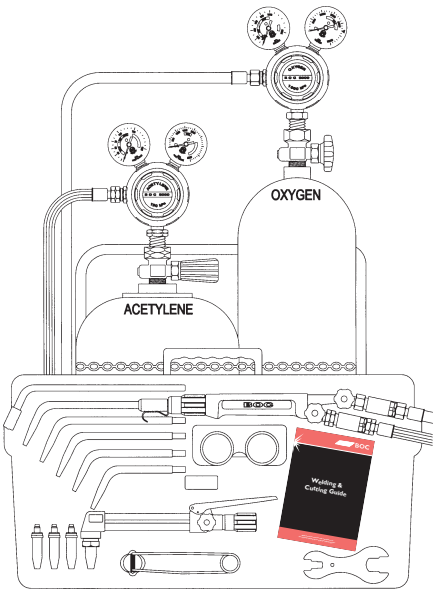
Access to a wealth of experience and technical information, built-up over the years makes the BOC range of gas equipment a world leader.

BOC Gas equipment and technical support is available through our national BOC Customer Service Centre on 131262 and at any of our 70 Gas and Gear Centres.

Contents

Protect yourself and others; read and understand the precautions in this guide.
They are for your personal safety and the safety of people near the equipment

Safety



BOC's ProMaster, Master and MasterStart kits, in conjunction with cylinders of oxygen and acetylene, provide a comprehensive set of metalwork tools.

This plant will provide:

- Sufficient concentrated heat to melt steel and other metals to weld surfaces together.
- A pressurised jet of oxygen to cut steel.
- With special tips and nozzles the versatility to allow heating, brazing, flame cleaning and gouging of surfaces.

Proficiency in the process depends upon the ability of the operator to control movement of the blowpipe and filler rod to produce good-quality welds, and a steady hand for smooth flame cutting.

YOUR RESPONSIBILITY

Your responsibility is to thoroughly read this manual. Do not attempt to operate the gas equipment unless you are familiar with the operating principles and safe practices outlined in this manual. Careless operation and not following the safety precautions may result in fire, explosion, and damage to the equipment and injury to the operator.

COMBUSTION

Combustion requires:

• Fuel • Oxygen • Ignition

Fuel Gases readily ignite in air and in an enclosed vessel could explode if heated.

Oxygen does not burn but supports and accelerates combustion. In the presence of high pressure oxygen most materials, including metals, will burn.

Ignition can occur from obvious sources like open flames and electric sparks. If high-pressure oxygen is suddenly released into a regulator, enough heat can be generated to burn out the regulator valve seat.

Cylinder valves should always be opened slowly to lessen the shock on the regulator valve seat and pressure gauges.

In **BOC** Gas Equipment design, special care is taken to select materials compatible with the gases and with high resistance to ignition.

Oxygen and non-flammable gases have right-hand threaded fittings while fuel gases have left-hand. For ease of identification left-hand threaded fittings have notches in the corners of the hexagon.

BEFORE YOU START:

WORK AREA

- Fire-proof floor – dirt, concrete or wooden covered in sand or wet down is acceptable.
- Protect walls and nearby combustibles from flying hot metal sparks and slag produced by cutting – use metal or cement sheets.
- Oxygen causes oil and grease to burn violently – keep away from all oxygen equipment.
- Have adequate ventilation to dissipate fumes.
- A firebrick top workbench is recommended.
- Cylinders must be secured in a trolley or to a wall.

PERSONAL PROTECTION

- Clothing with long sleeves and a snug fit at wrists, long pants and leather boots should be worn. Woollen clothing is preferred to cotton because it does not readily ignite. Nylon and synthetic clothing and open shoes should not be worn. Leather gloves, apron, spats and welders cap will help protect from sparks and spatter.

EYE PROTECTION

The oxy-acetylene flame produces an intense bright light which causes discomfort and possible injury to the eyes.

In order to comfortably and safely see the flame when welding or cutting, welding goggles must be worn.

Different lenses are recommended for the various processes:

Shade 4

- Oxy-cutting and gouging.
- Flame descaling.
- Braze welding of light copper and steel.
- Silver brazing.

Shade 5

- Fusion welding of steel, cast iron, nickel and copper.
- Braze welding of heavy steel and cast iron.
- Hardfacing.

Shade 6

- Fusion and braze welding of cast iron and steel castings.

FIRE PROTECTION

- Do not work near oil and grease containers, flammable vapours or combustible dust.
- Move all combustibles at least 10 m away from the work site. Otherwise protect with flame proofed covers.
- Have a fire extinguisher or water and sand available.
- After welding/cutting is completed, carefully inspect for sparks and smouldering material before leaving the area.

SPECIAL WARNINGS

Never weld, heat or cut on containers that have held flammable substances until they have been thoroughly steam cleaned. Flammable vapours may explode. Even after cleaning, the containers should be filled with water before welding or cutting. Make sure the space above the water is vented for escape of heated air.

Do not weld or cut painted, plated or coated parts unless special precautions have been taken with ventilation. Toxic fumes may be given off.

Gases Safety

THE GASES USED

Oxygen (black cylinder) is compressed to 17,500 kPa. The pressure in the cylinder is directly related to the quantity of gas stored. If pressure falls to half, then half the contents remains.

- If cylinder pressure rises as a result of fire a bursting disc safety device will fracture before the increased cylinder pressure can rupture the cylinder.
- Oxygen under pressure accelerates combustion.
- Oil, grease and rust will ignite violently in oxygen and must not be permitted to contaminate oxygen connections or equipment.

Acetylene (maroon cylinder) is a highly flammable gas in both air and oxygen. The cylinder is filled with a porous mass and acetone. The acetylene gas is dissolved in the acetone hence the name dissolved acetylene or 'DA'. This allows acetylene to be stored safely up to 1800 kPa.

- Acetylene reacts with copper to form unstable copper acetylides, so pure copper must not be used with acetylene under pressure. Copper welding tips and nozzles are OK because the oxy-acetylene mixture is downstream of the mixer.
- DA cylinders have fusible plugs in the neck ring; these will melt in the event of a fire.
- Acetylene is lighter than air so leaked acetylene will dissipate.
- The oxy-acetylene flame at 3100°C is the hottest flame available for welding mild steel.
- High pressure acetylene gas is unstable. The maximum pressure outside the cylinder is restricted to 150 kPa.
- Tips and nozzles for acetylene are stamped '**A**'.

LP-Gas (Handigas silver cylinder) Liquefied Petroleum Gas is a flammable gas stored as liquid in the cylinder. The pressure is less than 1000 kPa.

- LP-Gas cylinders have a spring loaded safety device that releases gas in the event of the cylinder being overheated or overfilled.
- Heavier than air so LP-Gas leaks flow into low-lying recesses and will remain for a considerable time.
- Accumulated gas can ignite and explode. An odourant is added to give an unpleasant smell as a warning to check for leaks and avoid sources of ignition.
- The oxy-LP-Gas flame is not suitable for welding steel, but is for heating, brazing and cutting of steel.
- Mixer, tips and nozzles for use with LP-Gas are stamped 'P' (Propane) and must not be used with acetylene.

CARE OF CYLINDERS

- Cylinders must be handled carefully as they contain gas compressed at high pressure.
- A pressure-reducing valve or regulator must be used to reduce cylinder pressure to operating pressure.
- Always open cylinder valves slowly, two full turns is sufficient, and tightly close after use.
- Gas pressure increases as temperature rises so cylinders **must be kept away** from sources of heat.
- Cylinders have safety devices to vent pressure build-up in excess of safe operating conditions.
- Cylinders must be stored and used in the upright position – oxygen, DA and LP-Gas.
- If for any reason the cylinder valve or safety device starts to vent, if possible take the cylinder outside and away from ignition sources, where the gas may dissipate. Promptly report the incident to **BOC**.
- If an acetylene cylinder becomes hot, close the cylinder valve and clear all personnel from the area. From a protected position, cool the cylinder with water until the cylinder is cool – revealed by the water not drying-off. Notify the fire brigade and **BOC**.

NOTE: If the acetylene or LP-Gas is burning and no secondary damage is being caused, do not extinguish the flame – this prevents the spread of unburned gas. Use water to cool the cylinder from a safe position.

- A leaking cylinder creates an atmosphere of concentrated gas that will cause a fire hazard unless there is adequate ventilation. A cloud of oxygen will accelerate any fire and a cloud of fuel gas (acetylene or LP- Gas) may explode.

Oxy-Handigas permits brazing, heating, cutting and gouging but **not** welding.

Setting Up

TO COMMENCE WELDING & CUTTING

In addition to the **BOC** kit, the following are required:

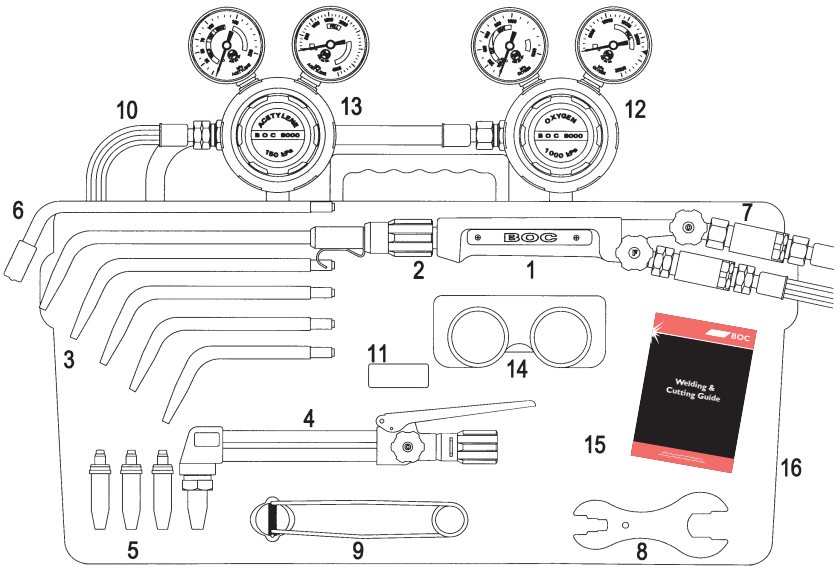
- Oxygen cylinder
- Acetylene cylinder
- Trolley
- Leather gloves
- Welding filler rods
- Welding flux

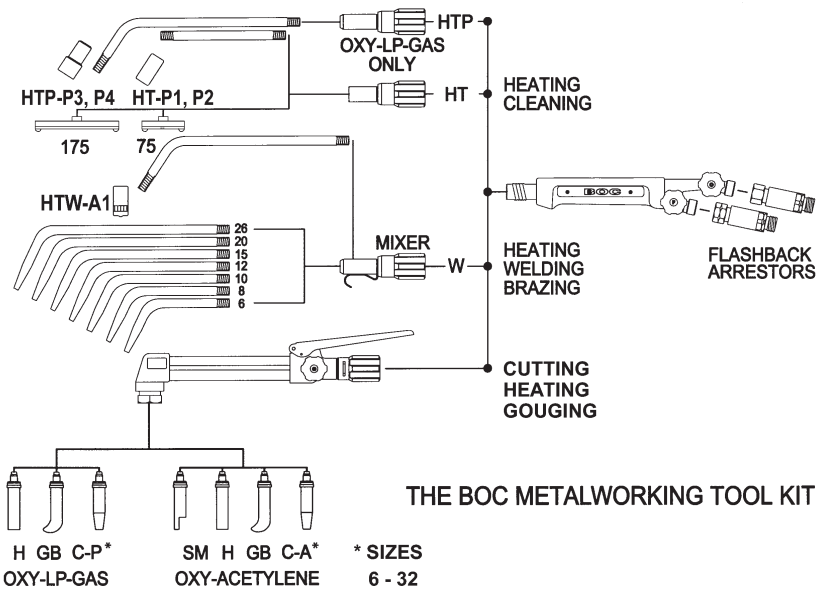
The BOC ProMaster contains:

1. Welding blowpipe handle
2. Welding mixer – W
3. Welding tips – sizes: W(6), 8, 10, 12, 15, 20, (26)
4. Cutting attachment
5. Cutting nozzles – sizes: C-A, 8, 12, 15, 20, (24, 32)
6. Heating tip – size HTW-A1 & barrel
7. Flashback arrestors – oxygen and acetylene to fit blowpipe inlets
8. Combination spanner
9. Flint lighter
10. Twin hose with fittings oxygen (BLUE), acetylene (RED)
11. Tip and nozzle cleaners
12. Oxygen 8000 regulator – 1000 kPa maximum
13. Acetylene 8000 regulator – 150 kPa maximum
14. Welding goggles
15. **BOC** Welding & Cutting manual
16. Toolbox and lift-out tray with snap-in recesses

Sizes ( ) not included in ProMaster – available as extra items see chart below.

The BOC Master and MasterStart outfits contain fewer tips and nozzles but the toolbox tray has spare recesses for the extra items.





THE BOC METALWORKING TOOL KIT

OXY-HANDIGAS

The following items are necessary for cutting and heating with oxy-Handigas.

- LP-Gas regulator – 400 kPa maximum.
- Cutting nozzles – sizes: C-P, 8, 12, 15, 20, 24, 32.
- Tips and mixer – W for brazing.
- Heating mixer – HT or HTP.
- Heating tips – sizes: HT-PI, HT-P2, HTP-P3, HTP-P4.

It is recommended LP-Gas compatible hose be used – colour coded orange.

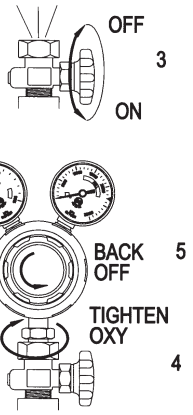
WARNING:

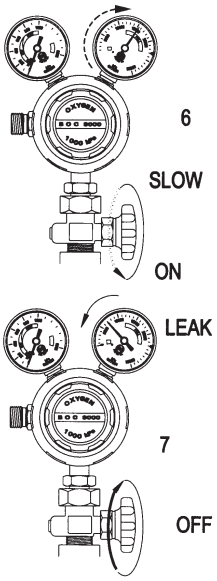
LP-Gas regulator, mixer, tips and nozzles **must not be used with acetylene.**

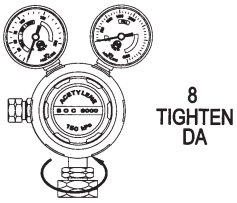
Putting the Equipment into Service

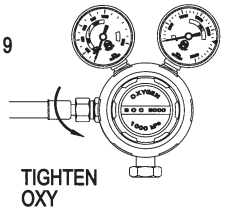
PUTTING THE EQUIPMENT INTO SERVICE

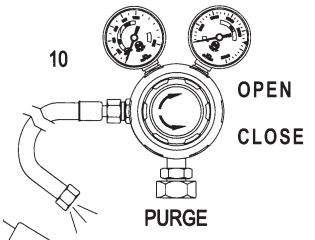
1. Ensure your hands and gloves are free of grease, oil and flammable solvents.
2. Inspect both cylinder valve outlets for damage and freedom from dirt, oil and grease. If required wipe with a clean lint-free cloth.
3. Wearing eye and ear protection, momentarily open and close the oxygen cylinder valve to blow out dust – 'cracking the valve'. Repeat for fuel gas valve – the area must be well ventilated and away from open flames and other ignition sources.
4. Remove the plastic protective cap from the oxygen regulator inlet. Inspect the connection threads and o-rings for damage and freedom from oil and grease. Attach the regulator to cylinder valve by hand, then tighten (right-hand thread) with the spanner.
5. Ensure regulator valve is fully closed by backing off the knob (anti-clock wise) until the screw is loose.
6. Open the cylinder valve slowly, two full turns is sufficient. The inlet pressure gauge (on right-hand side) pointer moves slowly to a maximum reading. Do not stand directly in front of or behind the regulator when opening the cylinder valve.
7. Check for leakage by closing the cylinder valve. If the pressure gauge pointer drops there is a leak at the inlet connection – retighten.
8. Repeat previous steps with the acetylene regulator – left-hand thread.
9. Connect the blue hose to the outlet of the oxygen regulator and the red hose to the outlet of the acetylene regulator. Tighten fittings with spanner.
10. Separately for each gas, purge dust from the hose by screwing the regulator knob in to open the regulator valve. Back off knob to close regulator seat. Ensure no open flames are nearby.
11. If included, connect the flashback arrestors to the **BOC** blowpipe inlets and tighten with spanner.
12. Connect the blue hose to the oxygen flashback arrestor and the red hose to the fuel flashback arrestor and tighten. If flashback arrestors are not included couple the hoses to the O and F blowpipe inlets.
13. With the blowpipe valves closed, turn regulator knob clockwise setting each regulator to about 50 kPa.
14. Check for oxygen leaks by closing the oxygen cylinder valve. If there are no leaks the 50 kPa set will remain steady. If there is a pressure drop search for the leak using a leak-detecting solution applied to all connections. A soft or liquid soap in water applied to the connections will reveal most leaks.
15. Repeat 14 for the fuel gas regulator and connections.
16. Inspect the welding mixer to see that both o-rings are present and they are free from dust and other contaminants. Insert the mixer into the blowpipe by a combination of pushing and twisting. Hand tighten the mixer nut until the mixer teeth lock.
17. Select the welding tip appropriate to the work as specified in **Table 1**. Firmly hand tighten the tip in the mixer. Release the mixer nut to allow the tip to be rotated to the desired position. Retighten the mixer nut.

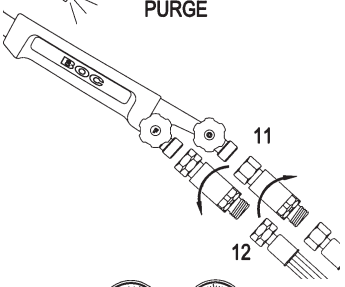


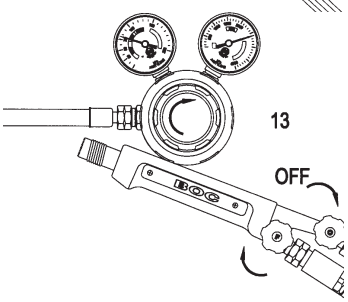


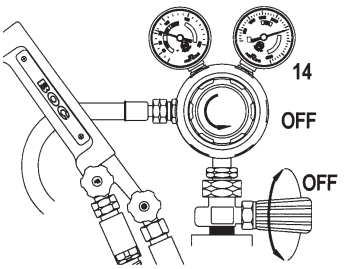


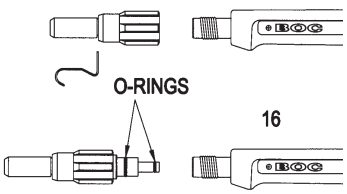


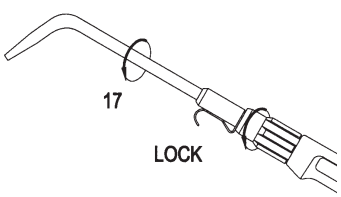












Commencing Welding

TO COMMENCE WELDING

1. Set the specified operating pressure on each regulator (**Table 1**) In the WELD zone (50 – 100 kPa) for oxy-acetylene welding.
2. Purge the blowpipe and hoses of any air by separately opening, for about 10 seconds, and closing each blowpipe valve in turn. Delivery pressures should be maintained while the gas is flowing, if not re-adjust the regulator knob.

LIGHTING UP

With the system now free of leaks:

1. Put on the welding goggles and cap.
2. Open fuel gas blowpipe valve F slightly and light the acetylene flame with the flint lighter (do not use matches or cigarette lighter). Continue to open the valve until the black smoke and soot cease and before the flame leaves tip end.
3. Open valve O until a neutral clear flame is produced with a brightly defined inner cone.
4. A neutral flame is used for most work to avoid oxidising the weld surface. A carburising flame with excess acetylene (shown by a feather on the inner cone), and an oxidising flame with excess oxygen (sharp pointed bluish inner cone) have special applications.

WARNING:

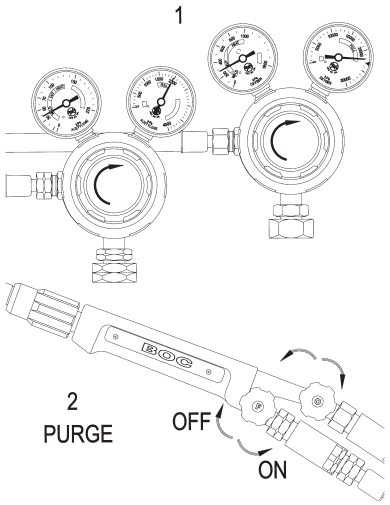
If a **FLASHBACK** occurs and the flame goes out. Shut both valves, check the connections and then relight. It may be the result of flow too low, touching the tip on the job, overheating or the oxygen cylinder being empty.

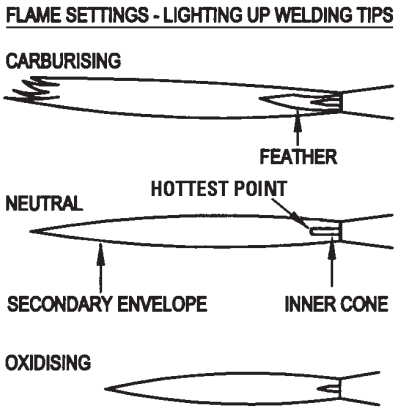
A **BACKFIRE OR SUSTAINED BACKFIRE** (squealing or hissing) occurs when the flame continues burning back inside the tip or blowpipe. Immediately close the oxygen valve to stop internal burning, then close off the fuel valve.

IF A BACKFIRE OR SUSTAINED BACKFIRE OCCURS

- Let the equipment cool for at least 1 minute.
- Inspect the mixer o-rings for damage.
- Check the regulator settings.
- Purge the oxygen and acetylene separately before attempting to relight.

The use of **FLASHBACK ARRESTORS** is recommended to limit the damage that may result if a flashback occurs. If not stopped, a flashback will melt the equipment close

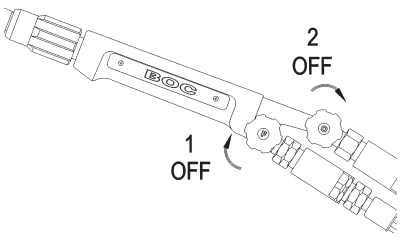




to the mixer and may travel back to the cylinder. Flashback arrestors have a very sensitive non-return valve that stops the gas flow and a fine sintered metal filter that quenches the flame.

CLOSING DOWN

1. Close fuel gas blowpipe valve F.
2. Close oxy blowpipe valve O.



IF LEAVING EQUIPMENT UNATTENDED:

3. Close acetylene cylinder valve.
4. Close oxygen cylinder valve.
5. Open fuel gas blowpipe valve F (valve O closed) drain the line until both pressure gauges read zero. Release the acetylene regulator knob until loose, then close the blowpipe valve F.

Table 1: Welding - W Mixer

Plate mm	Tip Size	DA kPa	Oxy kPa
0.8	6	50	50
1	8	50	50
1.6	10	50	50
2.5	12	50	50
3.5	15	50	50
5	20	50	50
8	26	50	50

6. Open oxygen blowpipe valve O (valve F closed) drain the line. Release the oxygen regulator knob until loose, and then close the oxygen blowpipe valve O.

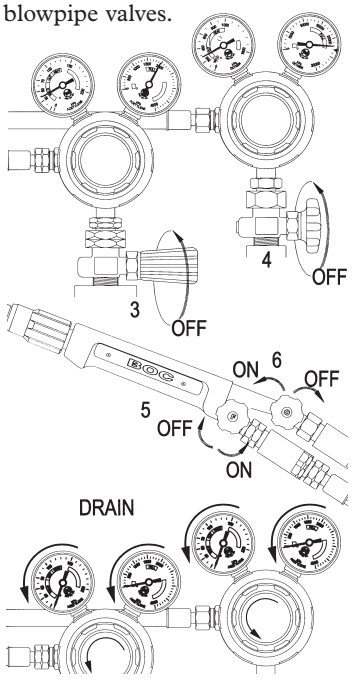
Always close the cylinder valves when not in use.

DISMANTLING THE SYSTEM

1. Undo the hose connections at regulator outlets and blowpipe inlets.
2. Unscrew welding tip from the mixer.
3. Replace tips (cold), blowpipe and flashback arrestors (if fitted) in the recesses in the tray.
4. The regulators may be either left in position on the cylinders or removed and placed in the toolbox.

REMEMBER

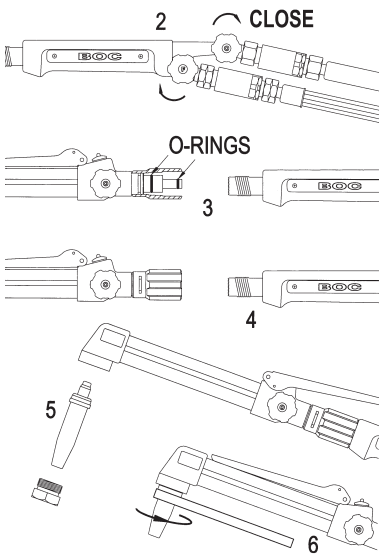
1. Check for leaks.
2. Purge both lines separately.
3. Lighting up – first fuel then adjust oxygen to produce a neutral flame.
4. Closing down – close fuel first then oxygen.
5. Close cylinder valve and drain system.
6. Release regulator knobs and close blowpipe valves.

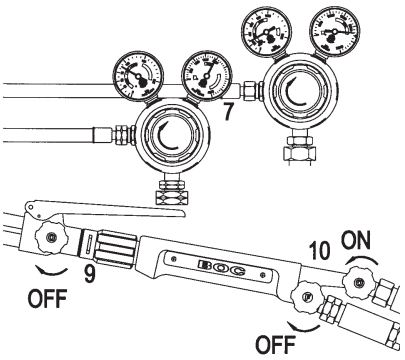


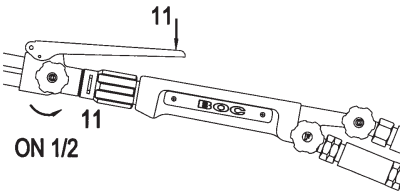
Using the Cutting Attachment

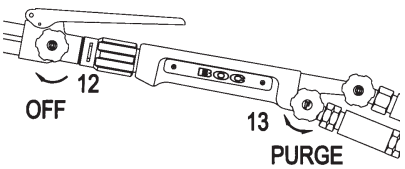
USING THE CUTTING ATTACHMENT

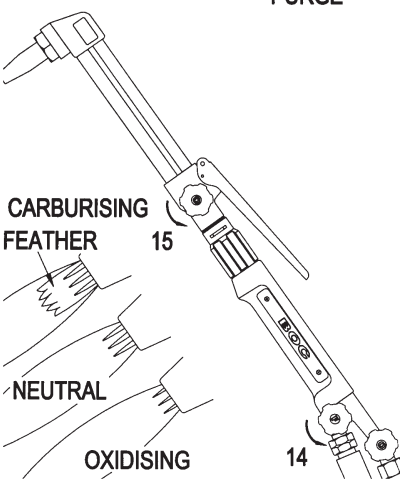
1. Follow the set-up instruction for connecting the welding blowpipe.
2. Close the oxygen O and fuel gas F blowpipe valves.
3. Inspect the cutting attachment to see both o-rings are present.
4. Insert the cutting attachment into the welding handle and hand tighten (teeth locked), cutting head/nozzle perpendicular to the handle.
5. Inspect the nozzle seat in the torch head. The seat surface must be free of dirt, dents and scratches.
6. Select the cutting nozzles to suit the metal thickness to be cut (**Table 2**). Tighten nozzle securely with spanner.
7. Set regulator pressure (**Table 2**) acetylene & oxygen in the CUT zone.
8. Put on goggles, gloves & welder's cap.
9. Close PH valve O on side of cutting attachment.
10. Fully open the rear oxygen blowpipe valve O. The cutting attachment valve O is used to control the preheat flame (PH).
11. Open PH valve O half a turn and depress the cutting oxygen (CO) lever. Adjust oxygen regulator to CO pressure in **Table 2** while oxygen is flowing. This purges the oxygen line.
12. Release CO lever and close PH valve.
13. Open fuel valve F for 10 seconds then close. This purges the fuel gas line. Do not do this near open flames.
14. Open valve F slowly and ignite preheat flames at the nozzle with the flint lighter. Continue to open until all smoke and soot cease. Do not use matches or cigarette lighters.
15. Adjust to a neutral flame by opening the oxygen PH valve until cones are sharp and clearly defined.
16. Depress the CO lever (the preheat will change slightly) readjust preheats to neutral by opening PH valve.

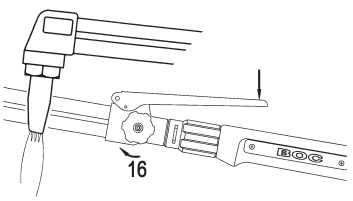












CLOSING DOWN CUTTING ATTACHMENT

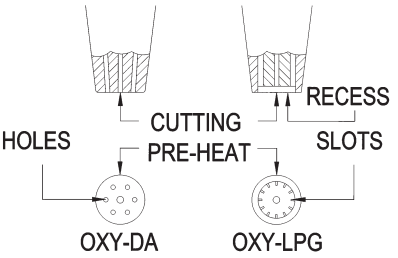
1. Close blowpipe valve F.
2. Close oxygen PH valve.

If leaving equipment unattended:

3. Close blowpipe valve O.
4. Close both cylinder valves.
5. Open blowpipe valve F (valve O closed) drain the DA line until both gauges read zero. Release the DA regulator knob then close blowpipe valve F.

Table 2: Cutting

Plate mm	Tip Size	DA kPa	Oxy kPa
0.8	6	50	50
1.0	8	50	50
1.6	10	50	50
2.5	12	50	50
3.5	15	50	50
5.0	20	50	50
8.0	26	50	50



CUTTING NOZZLES

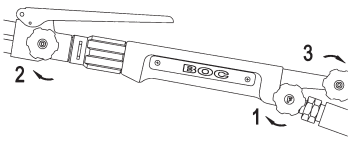
6. Open the PH valve and the blowpipe valve O (valve F closed) drain the line, release oxygen regulator knob, then close the PH valve and blowpipe valve O.

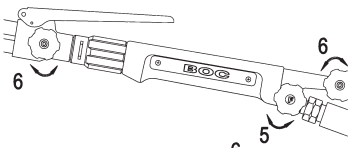
If you experience a **BACKFIRE** or a **FLASHBACK** immediately close the PH valve and then close valve F.

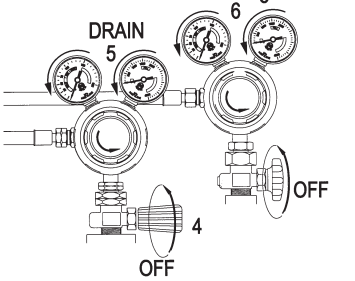
- Allow the cutting attachment to cool.
- Tighten the nozzle.
- Check the regulator pressures.
- **Purge** before attempting to relight.

Causes of Flashback:

- Dirty nozzle seating.
- Not purging gas lines.
- Incorrect pressures.
- Flow of oxygen or DA too low.
- Nozzle too close to work.
- Nozzle overheating.







Welding

WELDING OF STEEL

The oxy-acetylene flame has sufficient temperature and intensity to melt steel and weld edges together forming a joint as strong as the parent metal.

1. Choose the welding tip suitable for the metal thickness from **Table 1**.
2. Clean the edges of the steel & prepare the joint for welding see **Table 3**.
3. Light the acetylene and set a neutral flame.

Welding without using a filler rod

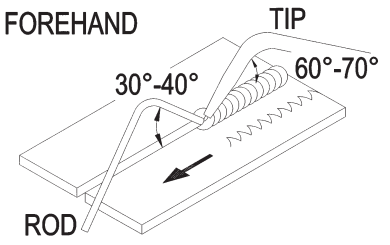
4. Rotate the flame in a small circle until molten metal puddle forms.
5. Oscillate the tip across the joint in a circular motion. The tip of the inner cone should be 2-3 mm above the puddle as the tip is moved forward.

Welding with a filler rod
increases the strength of the weld.

1. Dip the end of the filler rod into the puddle. The heat of the puddle will melt the rod.
2. Hold the rod 2-3 mm above the puddle and 10 mm from the flame. Oscillate the tip across the joint at the same time moving the rod and tip forward in the direction of welding.
3. Dip the filler rod into the puddle to add metal to the weld. The rod must not be held continuously in the puddle, but just above it in the secondary cone of the flame to avoid oxides forming.
4. For best results on steel 3 mm or thicker grind a bevel of 30° on each plate edge.

There are two techniques of welding.

1. Forehand – where the rod is moved ahead of the tip in the direction of welding, for thickness under 5 mm.



2. Backhand – where the rod is moved behind the tip in the direction of welding, used for thickness over 5 mm.

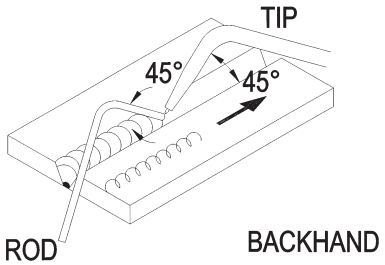


Table 3: Welding Joints - Tip Sizes

mm	JOINT	GAP	ROD	WELDING TIPS		
FOREHAND				MILD STEEL	ALUMINIUM	COPPER
0.5 - 0.8		-	-	6 - 8A	6A	10A
1.0 - 1.6		-	-	6 - 8A	6 - 8A	12 - 15A
1.0 - 1.6		0.8	1.6	8 - 10A	6 - 8A	15A
1.6 - 2.5		1.0	1.6	10 - 12A	8A	15A
2.5 - 3.0		1.2	2.4	12 - 15A	8A	15 - 20A
3 - 4	60°-90°	1.5	2.4	12 - 15A	10 - 12A	20 - 26A
4 - 5		2.5	3.2	15 - 20A	12 - 15A	20 - 26A
6 - 6.5		3.0	5.0	15 - 20A	15A	-
BACKHAND				MILD STEEL		
5 - 6		3.0	3.2	20 - 26A	-	-
6 - 8		3.0	5.0	20 - 26A	-	-
6 - 10	60°	3.0	5.0	26A	-	-
USE W MIXER WITH ALL TIPS SET REGULATORS IN WELD ZONE - 50 kPa BOTH O & DA						

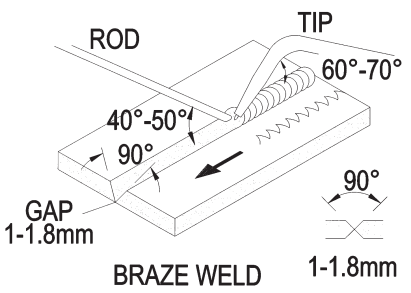
BRAZE WELDING

The advantage of braze welding over fusion welding is that different metals can be joined without melting the parent metal. Repairs can be made on cast iron.

1. Before braze welding the surfaces should be clean and have a good fit up.
2. The metals to be joined are preheated above the melting point of the rod.
3. Clean flux is applied on the joint surfaces to reduce oxidation and float oxides.
4. Heat the rod and dip it into the flux, which sticks to the rod.
5. Heat the joint until both pieces are dull red then insert the rod into the joint allowing it to melt and flow into and around the joint.

A neutral flame may be used but a slightly oxidising flame will reduce the flux required.

Avoid breathing the fumes.



BRAZING

Brazing and braze welding have similar techniques. A closer fit up is required for brazed joints as the molten filler metal is drawn into the joint by capillary attraction.

The surfaces **must** be clean. Most metals can be brazed. The common brazing filler metals are:

- silver base alloys
- copper phosphorus alloys
- aluminium.

The joint clearance (other than aluminium) should be 0.05 to 0.15 mm, and for aluminium 0.15 to 0.25 mm. Lap joints produce the most reliable results.

SILVER BRAZING

Silver brazing is faster than bronze brazing because silver has a lower melting point than bronze.

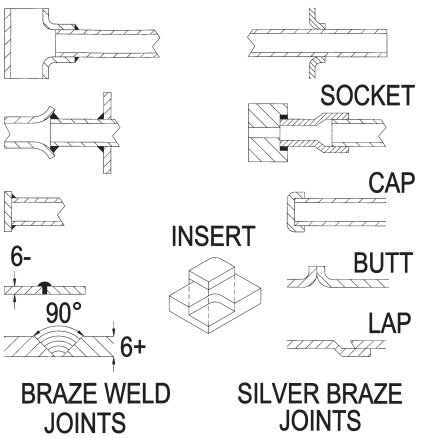
Silver will not bridge a gap as well as bronze so tight fit up of joints is important.

Silver brazing is one of the most reliable methods to join parts with a strong leak proof joint and neat finish.

Thorough pre-cleaning of the parts is one of the secrets of successful brazing.

1. Apply flux directly to joint.
2. Use a 'soft' neutral flame.
3. Heat the parts uniformly and gradually – avoid overheating.
4. When heat has dehydrated the flux it will melt and becomes water clear.
5. Remove the flame and apply the silver alloy to the joint, by capillary action the silver alloy will follow the heat. When the silver has visibly flowed all around the joint remove flame.

Do not breathe the fumes.



Heating & Cutting

HEATING WITH OXY-ACETYLENE

Use a suitable size heating tip. Too small takes excessive heating time, too large wastes gas.

The ProMaster kit has 5 single hole welding/heating tips and a multi-hole heating tip HTW-A1 that will all operate with the standard W mixer. Acetylene cylinders are restricted in draw-off flow, to a maximum of ⅐th of the contents per hour of operation. Excess draw off can result in acetone withdrawal that shows as 'spitting' and a green flame. This lowers the pressure in the cylinder and the temperature of the flame.

For a typical 7m^3 DA cylinder the maximum draw off is 1m^3 per hour (17 L/min).

Higher flows will require a number of DA cylinders manifolded together. Use only manifolds from a gas equipment supplier. This limitation of DA is one of the reasons why heating is often done with LP-Gas.

HEATING – OXY/LP-Gas

High output LP-Gas heating tips HT-PI and HT-P2 (300 & 400 mJ/h) are available with a heavy duty HT mixer for the BOC welding blowpipe. For higher output there is an HTP injector for the HTP-P3 and HTP-P4 (800 & 1000 mJ/h) tips.

High flows of LP-Gas will require cylinders to be manifolded to avoid freezing as a result of the high draw off. See your BOC supplier.

CUTTING STEEL

Oxy-fuel gas cutting is a thermochemical reaction in steel where the surface is first preheated to an ignition temperature of 800°C (cherry red). Then a jet of pure oxygen is directed through the flame, rapidly burning the steel and removing the molten oxide. This produces a narrow cut or kerf as the nozzle is moved forward.

The cutting attachment and nozzles for the BOC blowpipe are able to cut steel thickness from 2 to 200 mm. See **Table 2**.

Cutting blowpipes are also available from BOC that will cut to 300 mm.

To Cut Steel

Place the steel to be cut where flammable materials can not be ignited by sparks and molten metal. Sparks can fly up to 10 m. Be sure hoses are clear of molten metal and sparks. Use a metal tray or sand trough to confine the molten slag.

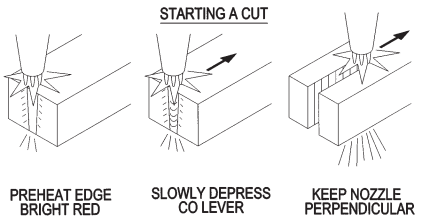
Before starting, the plate should be cleaned of dirt, paint, oil, scale and rust. Mill scale can be removed by moving the preheat flame over the line of cut.

TO START A CUT

1. Select the cutting nozzle appropriate to the metal thickness. Set the oxygen and fuel gas pressures according to **Table 2** – CUT zone on the gauge.
2. A neutral oxy-fuel flame is used for preheating as described for operating the cutting attachment.
3. To start, hold the inner cones of the preheat flame just above the edge of the plate until it becomes cherry red.
4. Slowly depress the cutting lever (CO) to commence flow of oxygen and begin cutting. Move the torch uniformly along the line of cut while maintaining the preheat cones 5 mm above the metal. The sound of sputtering and a steady stream of molten metal indicate a good cut.
5. To stop the cut, release the CO lever. Close the blowpipe valve F, close PH oxygen valve.

If use of the cutting attachment is to be discontinued, close the blowpipe valve O at the rear.

The quality and speed of freehand cutting depends upon the steadiness of the operator.



Flame Settings

For acetylene, set preheat flames to neutral.

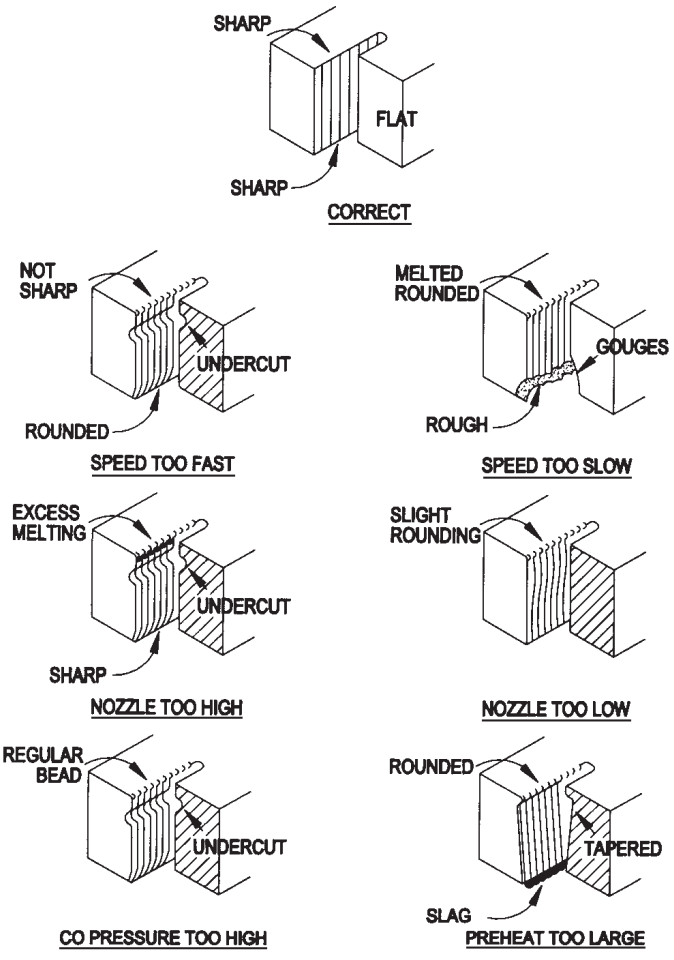
For LP-Gas, set preheat neutral by progressively increasing both LP-Gas and oxygen until the preheat cones cease to shorten.

CUTTING ACCESSORIES

A roller guide attached to the cutting nozzle will assist the operator to maintain a constant distance from the plate.

A circle cutting attachment fitted to a radius bar & roller guide provides a simple means to produce clean circular cuts.

Experience will soon show the optimum flame setting, nozzle height and speed of movement to produce a smooth surface.



Cutting, Cleaning & Hardening

GENERAL CUTTING

Thin Steel (6 mm or less)

Use the smallest nozzle 6C or a special sheet metal nozzle with single preheat 6SM.

Thick Steel

If the cut cannot be started easily the operator may try to start by angling the nozzle. As the corner is cut, move the nozzle to a vertical position until the total thickness is cut.

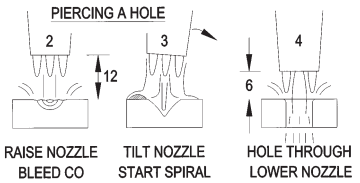
Painted or Galvanised Steel

Clean the surfaces as much as possible before starting. This will minimise toxic zinc-oxide fumes. If the nozzle is held at a slight angle it will help to undercut paint and scale.

A respirator should be worn.

PIERCING HOLES IN STEEL

1. Set neutral flame.
2. Hold nozzle just above plate and heat a spot to bright red.
3. Slowly depress the CO lever and raise the nozzle to about 12 mm above the plate so that slag will not blow back into the nozzle. The nozzle is then moved slightly to one side and tilted to start a small spiral motion.
4. When a hole has burnt through, lower the nozzle to normal height, 6mm above the plate and proceed with the cut.



FLAME GOUGING

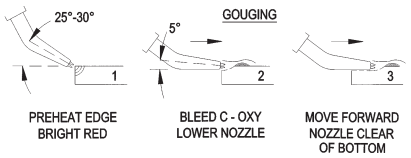
Flame gouging provides a means for cutting U-shaped grooves for the removal of defects and welds.

Special gouging nozzles can be used with standard cutting equipment. These nozzles deliver a large jet of oxygen at low velocity. If the nozzle is properly manipulated a smooth groove can be gouged out of the plate surface. Various size nozzles are available for gouging grooves of different widths. Various grooves can be produced by varying the speed of travel, oxygen pressure and the nozzle angle, see **Table 4**.

1. To start, set a neutral flame. Hold the nozzle at approximately. 20-30° to the surface, pointing along the line of cut.
2. The preheat flames cause the starting spot to become bright red.
3. Gradually depress the CO lever, as the cut progresses reduce the angle of the nozzle to about 5°. If the angle is too low, the groove will become too shallow. If too high the slag will flow backwards, or the groove may be too deep.
4. Hold the nozzle above the surface with the preheat cones 5 to 10 mm behind the spot where cutting is occurring. The nozzle should be held so that it does not ride on the bottom of the groove. Bent gouging nozzles (GB) allow easier control.

Gouging may be done using either oxy-acetylene or oxy-LP-Gas with appropriate nozzles.

Only use LP-Gas nozzles marked P with torches fitted with propane '**P**' mixers. **These must not be used with acetylene.** Severe flashbacks will result.



Note: Purging before lighting is important because cutting torch passages usually retain mixed gas. There is also more likelihood of blocking the end of the nozzle when cutting in confined spaces, which will cause a flashback. Flashback arrestors are recommended. Assembly, setting up and lighting follow the same steps as given for the cutting attachment.

Table 4: Gouging

Nozzle Size	Fuel kPa	Oxy kPa
32GS	100	500
32GB	100	500
48GB	100	600
64GB	100	650

Groove Size (mm)
32 8 wide x 4 deep
48 10 wide x 6 deep
64 13 wide x 8 deep

FLAME CLEANING

Special tips with high temperature and high velocity oxy-acetylene flames are used to remove rust, scale and paint. At the same time moisture is removed and the warm surface aids the application of protective paint. The normal welding blowpipe is used with the heavy duty HT mixer. The rust and scale is removed by dragging and scrubbing the flame over the surface. Paint is best removed by pushing the flame across the surface.

A highly oxidising flame is used with a to and fro scraping motion of the tip to remove heavy scale and rust. Protective clothing and goggles are necessary to guard against hot flying particles.

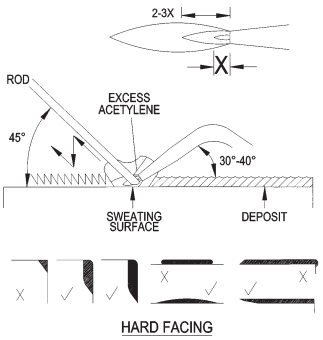
FLAME SPALLING

The high temperature 'Flame Cleaning' tips may be used to roughen concrete. The flame is moved over the surface causing fragments to expand and fly leaving small craters. Protective equipment is essential to guard against flying heated particles. A highly oxidising flame is best, with flow rates of oxygen and acetylene increased until the flame is burning just off the nozzle orifices.

HARD FACING

This process is the addition of an alloy coating to new or worn parts that provides increased resistance to wear and corrosion.

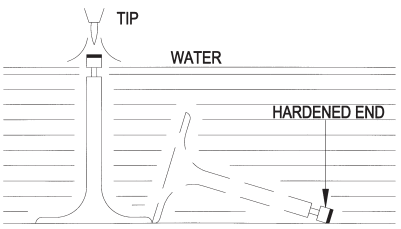
1. Correct preparation is important. The surfaces must be clean (preferably by grinding) with corners grooved, not chamfered and avoiding sharp internal corners.



2. Use a carburising oxy-acetylene flame with the acetylene feather 2 or 3 times the length of the inner cone. The inner cone of the flame is held about 3 mm from the surface until the surface 'sweats'.
3. The alloy rod (preheated in the flame) is deposited in the 'sweat' keeping the inner cone almost touching the rod.
4. The deposit may be reheated to cause it to flow to a smooth finish.

FLAME HARDENING

A simple process for local hardening of low carbon steels. The surface is first heated and then quickly cooled by quenching in water. The oxy-acetylene flame rapidly heats a thin layer of the steel to above the critical temperature & then quenching hardens the surface layer.



Care & Maintenance

CARE & MAINTENANCE OF WELDING TIPS & CUTTING NOZZLES

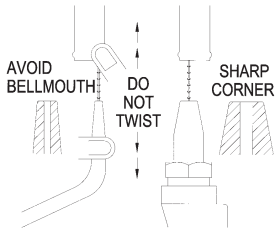
The efficiency of welding and cutting flames depends upon the condition of the nozzle orifices.

Welding tips should have a uniform symmetrical straight flame without distortion of the inner cone and outer envelope. Cutting nozzles should have uniform preheat flames with equal inner cones, and the CO jet should be straight and symmetrical.

If the holes become obstructed by small particles of carbon or hot metal the flame will be distorted. Using the nozzle cleaner supplied can rectify this.

- The cleaner should be selected on the basis of the size that will enter the hole and remove the obstruction. If the next larger will then fit, it should be used to hone the bore.
- Cleaners should only be worked up and down and not twisted. Be careful not to bell-mouth the outlet of the orifice.
- The orifice must be round with square edges and no burs. To restore the edge, rub the end on fine emery cloth on a flat surface (such as glass), while holding the nozzle perpendicular to the flat surface.
- If the preheat still appears short it is probable there are still obstructions in the gas passage – repeat cleaning.
- If the flame goes out with a snap when the valves are closed it is probable that the orifices are still bell-mouthed.

Do not interfere with the taper seat surface on either the nozzle or the cutting head. **Nozzles and tips should not be thrown into a box so that they strike one another.** The BOC Toolbox has snap-in recesses that permit each item to be identified and protected.

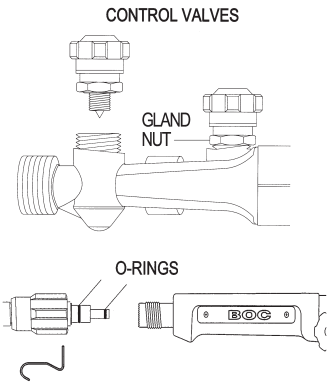


MAINTENANCE OF THE OUTFIT

You have an obligation and responsibility to maintain your equipment in a safe condition. Equipment should be regularly checked and if necessary repaired by an authorised BOC repairer using genuine spare parts.

Blowpipe

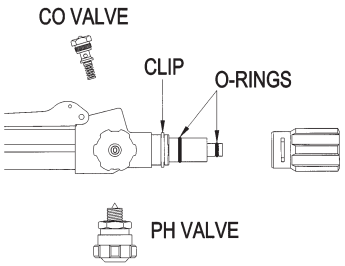
1. If the valves develop leakage around the valve spindle tighten the packing gland nut. To alter the turning resistance tighten the gland nut.



2. Check the condition of both o-rings on the mixer by removing the hook and sliding the nut to expose the o-rings. If they are chipped or worn remove the o-rings with a clean narrow blunt tool that will not damage the metal grooves. Roll in new replacement o-rings and twist to seat in the groove.
3. If the blowpipe valves continue to leak even after removing and wiping the nose with a clean cloth, the valve should be replaced by a new assembly.
4. If the metal seating in the valve body has been damaged have an Approved Repairer reseat the body.

Cutting Attachment

1. If the preheat valve develops leakage around the spindle tighten the packing gland nut.
2. If the valve will not close off, remove the assembly and wipe the seating nose and replace. If this does not stop the leak replace the valve assembly.
3. Check the condition of the o-rings by depressing the locking clip and slide the nut off to expose the o-rings. If they are chipped or worn remove the o-rings with a clean narrow blunt tool that will not damage the metal grooves. Roll in new o-rings and twist to seat.



4. If the cutting oxygen valve will not snap closed or is leaking fold back the lever, undo the hexagon retainer and fit a replacement capsule.

If there is more extensive damage or leakage have an Approved Repairer service it with genuine spare parts.

Regulators

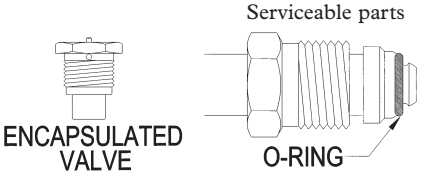
1. If the bullnose o-ring has been chipped or worn roll out the old one with clean fingers and fit a genuine replacement. Note: The bullnose will still seat if the o-ring is missing.
2. If the delivery pressure gauge pointer continues to rise (creep) beyond the initial reading (into the Red band) when the blowpipe valves are closed a new seat capsule is required. A rise of 50 kPa is considered excessive.
3. If leakage occurs around the bonnet, the pressure gauge stems, the outlet, the pressure relief valve, and the bullnose connection have an Approved Repairer service the regulator with genuine spare parts.
4. Always protect the oxygen regulator from contamination by oil and grease. If this occurs return it to your Approved Repairer for cleaning.

Regulator repairs require specialised equipment.
Repairs should not be attempted without proper service instructions and genuine spare parts.

Hoses

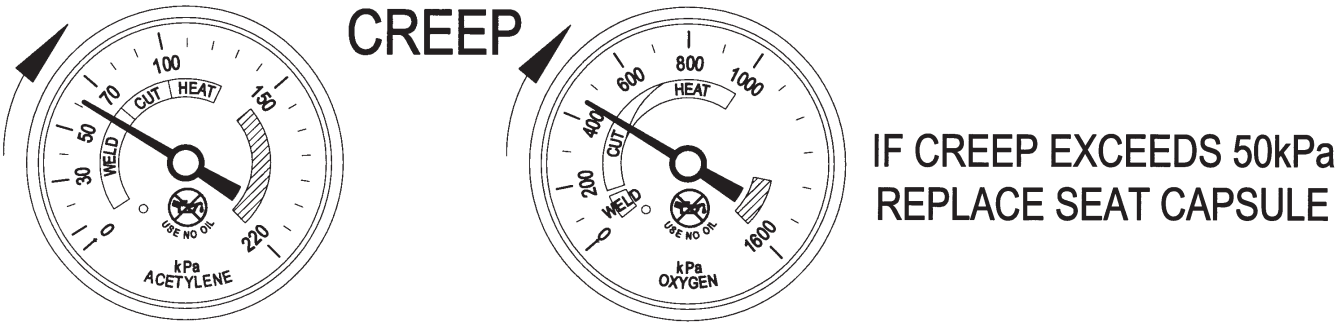
1. Regularly check hoses for leakage. The simplest method is immersion in a water bath.
2. Factory hose assemblies with crimped hose ferrules are recommended.
3. If hoses are cut do not repair either acetylene or oxygen hoses with make-shift tubing, twisted wire & tape. The end pull on hoses may cause a leak. Use proper joiners or replace whole assembly.
4. Keep hoses away from oil and grease & never use with oil lubricated air tools.
5. Use only blue hose with right-hand threaded fittings for oxygen, red hose with left-hand fittings for acetylene and orange hose for LP-Gas. If hoses are burned in a flashback, discard the hose.

Repair kits are available with instructions from BOC for competent users to change faulty components. More extensive repairs should be carried out by BOC Repairers.



Cutting Tables

Unacceptable Lock-Up



Comprehensive Cutting Tables

Table 5: Cutting Mild Steel Oxy-Acetylene (DA)

Plate mm	Nozzle Size	DA kPa	Oxy kPa	Speed mm/min	DA L/min	Oxy L/min
1-5	6	100	180	450	2	11
6-10	8	100	200	400	3	20
12-20	12	100	220	350	4	40
25-40	15	100	250	300	6	60
50-80	15	100	350	220	7	80
100-125	20	100	400	150	10	150
150-200	24	100	500	120	13	260

Table 6: Cutting Mild Steel Oxy-LP-Gas (LPG)

Plate mm	Nozzle Size	DA kPa	Oxy kPa	Speed mm/min	DA L/min	Oxy L/min
2-5	6	100	180	450	1.5	17
6-10	8	100	200	400	3.0	30
12-20	12	100	220	350	4.0	50
25-40	15	100	250	300	5.0	75
50-80	15	100	350	220	5.0	85
100-125	20	100	400	150	6.0	160
150-200	24	100	500	120	9.0	300

Gas consumption and speeds apply to normal workshop conditions. Since these do not always exist in practice variations can be expected. Experienced operators will find they may achieve satisfactory results with lower gas pressures and lower consumption of gases.

Table 7: Gouging Oxy-Fuel Gas (DA & LPG)

Plate mm	Nozzle Size	DA kPa	Oxy kPa	Speed mm/min	DA L/min	Oxy L/min
32GS	100	500	15	60	12	95
32GB	100	500	15	60	12	95
48GB	100	600	18	85	12	120
64GB	100	650	20	110	15	150

Groove Size (mm)
32 8 wide x 4 deep
48 10 wide x 6 deep
64 13 wide x 8 deep

Table 8a: Welding - W Mixer

Plate mm	Tip Size	DA kPa	Oxy kPa
0.8	6	50	50
1.0	8	50	50
1.6	10	50	50
2.5	12	50	50
3.5	15	50	50
5.0	20	50	50
6.5	26	50	50

Table 8b: Cutting

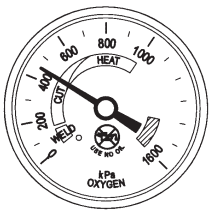


Plate mm	Tip Size	DA kPa	Oxy kPa
3	6	100	180
6	8	100	200
12	12	100	220
25	15	100	250
50	15	100	350
100	20	100	400
200	24	100	500

- Crack cylinder valves before connecting regulators.
- Open cylinder valves slowly to pressurise regulators.
- Check no leaks are present before ignition.
- Purge each hose before lighting up.

Table 9: Welding & Heating Oxy-Acetylene (DA)

Plate mm	Tip Size	DA kPa	Oxy kPa	DA L/min	Oxy L/min
0.5-0.8	6	50	50	1.5	1.5
0.8-1.0	6	50	50	2.0	2.0
1.0-1.5	10	50	50	3.0	3.0
1.6-2.4	10	50	50	4.0	4.0
1.6-2.4	12	50	50	7.0	7.0
2.5-3.5	15	50	50	12.0	12.0
4.0-6.5	20	50	50	22.0*	22.0*
HEAT	HTW-A	150	100	50.0*	50.0

W Mixer is used with all tips listed:
- To prevent withdrawal of acetone from DA cylinders for 7 m^3 (G) cylinder max. draw off 17 L/min - 3.2 m^3 (E) cylinder max. draw off 8 L/min.
- If flame becomes green, flows exceed rates for a single cylinder-manifold 2 or more DA cylinders.

Filler Rod & Flux Reference Table

Table 10: Ready Reference – Filler Rod & Flux Selection

MATERIAL	FLAME	FILLER ROD	FLUX
Fusion Welding			
Iron	N	Mild Steel	-
Mild Steel	N	Mild Steel	-
Medium Carbon Steel	SC	Triple Deoxidised Steel	-
Cast Steel	N	Steel	-
Cast Iron	N	Cast Iron	Cast Iron
Stainless Steel	N	347 Stainless steel	Stainless
Copper, Bronze, Brass	SO	Tobin Bronze	Copper & Brass
Aluminium	N	Pure Aluminium	Aluminium
Die Casting	Option	Die Cast	-
Braze Welding			
Steel	SO	Manganese Bronze	Copper & Brass
Cast Iron	SO	Manganese Bronze	Bronze
Malleable Iron	SO	Manganese Bronze	Bronze
Aluminium	N	Pure Aluminium	Aluminium
Everdur	N-SO	Tobin Bronze	Copper & Brass
Silver Brazing			
Copper, Bronze, Brass	N	Prosilver 2, 5, 15 & 45	SBA Flux
Steel	N	Prosilver 35 & 45	GP Flux
Stainless	N	Prosilver 503 & 402	Stainless Steel Flux

Flame N - Neutral
SO - Slightly oxidising
SC - Slightly carburising
GP - General purpose