FLAME CUTTING HANDBOOK

BUG-O SYSTEMS

BUG-O Systems' Kits are assembled from modular components. Each kit was originally an adaptation to meet an actual problem. The concept is both practical and economical, and is quickly and easily adapted on the job site.

Initially developed to carry cutting torches in a precise work path, the primary aim of the BUG-O System is movement at controlled speed and direction in any position. The secondary function is to provide suitable holding or clamping devices to make BUG-O integral with both the workpiece and the cutting or welding tool.

BUG-O is more than a flame cutting system- it's a revolution in welding procedures. Ingenious customers have developed hundreds of ways to cut time and costs by putting this system to work for them, and most of the these applications have saved the cost of the unit on the first job.

With BUG-O Systems you can double your welding production!

The nucleus of the BUG-O System of modular path and rate control components is the BUG-O. It is a self-propelled multipurpose carriage and rail system with infinitely variable speeds. A steel pinion meshes with a machine-cut steel rack to provide a positive drive. The BUG-O is locked onto a rail, which is mounted on the work.

The BUG-O unit is suitable for use with the most advanced electric welding processes. It is also the practical way to carry any process requiring precision movement; in applications such as gouging, spraying, guiding ultrasonic inspection and others.

PRECISION HOLE BORING, BEVELING AND WELDING

HOB-O cuts, bevels or welds in any position….. any plane or angle. Carry the tool to the work. HOB-O weighs only 30 lbs. (18.6 kg)… can be moved and placed in minutes by one man. Powerful magnets lock it to the workpiece …. exactly where you want it. Easily adjustable, the HOB-O flame bores holes from 1" to 8" (25-200mm) diameter, inside the machine and 14-1/2" to 48" (368-1220mm) diameter, outside. Self-propelled, it has an infinitely variable speed control to suit any application. HOB-O gives you the precision of drilling … the speed of flame boring … and the convenience of a portable tool costing less than one 4" high speed drill bit.

PREFACE

This booklet has been prepared to show how to operate and maintain “Gas Cutting” equipment. Specifically, it shows how to set up, light, set travel speed and position the “Cutting Torch” for a quality cut.

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INTRODUCTION

GAS CUTTING OF FERROUS (CARBON STEEL) METALS

Gas cutting is a process of preheating carbon steel to its combustion temperature, then burning it rapidly by means of a regulated jet of oxygen. A cutting torch is used for this operation.

The process is primarily a chemical one. It is based on the chemical relationship of oxygen to iron metals that have been heated to a temperature of 1400° to 1600° F (760° to 871° C). Only the metal within the direct path of the oxygen jet is affected.

In cutting, a "kerf" is formed. This is a narrow slit having uniformly smooth and parallel walls. A skilled workman using a BUG-O and a machine cutting torch can maintain the following tolerances with respect to squareness and straight alignment of the cut surface: 1/32nd of an inch (.79mm) on plate thickness up to 4 inches (100mm) and 1/16th of an inch (1.58mm) on plate thicknesses from 4 to 12 inches (100 to 300 mm).

In actual gas cutting, the iron or steel removed from the "kerf" is not entirely burned or consumed by the oxygen. About 30 to 40 percent of the metal is washed out of the cut as unconsumed or metallic iron due to the eroding effect of the oxygen jet.

CONTENTS

SAFETY INSTRUCTIONS

EVERY TIME a machine cutting torch is used the following safety and operation precautions MUST BE PRACTICED! Deviation from the following safety and operation instructions can result in fire, explosion, damage to the apparatus or injury to the operator.

1. Inspect the inlet connections, valves, and torch head for dirt, dust, oil, grease, or damaged parts. Dirt or dust can be removed with a clean cloth. **DO NOT USE THE CUTTING TORCH IF OIL OR GREASE IS PRESENT!** Have your manufacturer's repair center clean the torch or repair any damage.
2. Inspect the torch head. The tapered seating surface must be in good condition. If dents, burrs or burned seats are present, the seat must be resurfaced. If the torch is used with poor setting surface, backfire or backflash may occur and damage the equipment.
3. Select the required size and type of cutting tip. Inspect the tip seating surface for damage. **REMEMBER**- these seating surfaces prevent premature mixing of gases that can cause fire and explosions. If the tapered seats on the tip are damaged, **DON'T USE IT!** Inspect the preheat and cutting oxygen holes. Spatter can stick on or in these holes but can be removed with a tip cleaner.
4. Insert the tip in the Cutting Torch head and tighten securely.
5. Adjust the regulator delivery pressures according to the size and type of tip being used.
6. **IMPORTANT:** Always purge out the cutting oxygen passages by opening the cutting oxygen valve (at least five seconds before lighting the torch.) Open the fuel valve approximately one-half turn and ignite the gas with a spark lighter. Adjust the fuel valve until the flame clears the end of the tip about ½ inch (13mm), then reduce slightly to return the flame to the tip.

7. Slowly open the preheat oxygen valve until a neutral flame is established (a sharp inner cone). **SPECIAL NOTE FOR TWO HOSE MACHINE TORCHES ONLY:** After the neutral flame has been established as described, open the cutting oxygen valve. Note that the preheat flames change slightly from neutral to a carburizing flame with a feather. With the cutting oxygen flowing, adjust the preheat oxygen valve until the preheat flames are again neutral.
8. If you experience a backfire or backflash (a hissing sound when the flame is burning inside the cutting torch) IMMEDIATELY turn off the preheat oxygen valve, then shut off the torch fuel valve. Allow the cutting torch to cool before attempting to re-use it. If trouble persists, call your manufacturer's repair center.
9. **WHEN YOU FINISH YOUR CUTTING OPERATION:**
    - **a.** First shut off the oxygen preheat valve, then shut off the torch fuel valve. If this procedure is reversed, a "pop" may occur. The "pop" throws carbon soot back into the torch and may in time partially plug it.
    - **b.** Close both cylinder valves.
    - **c.** Open the torch oxygen preheat valve, and release the pressure in the hose and regulator. Close the torch valve.
    - **d.** Turn the adjusting screw on the oxygen regulator counter-clockwise until the adjusting spring pressure is released.
    - **e.** Open the torch fuel valve and release the pressure in the hose.
    - **f.** Repeat **"d"** using fuel regulator.
    - **g.** Close all valves on torch handle and the cutting attachment.

NOTE: The use of Reverse Flow Check Valves is strongly recommended to reduce the possibility of mixing gases in the hoses and regulator. Mixed gases will rapidly burn once the torch is lighted. These combustible gases can explode in the hoses, regulators or cylinders, resulting in serious injury to the operator.

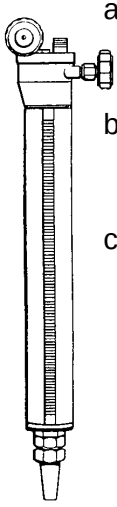
INSTRUCTIONS AND PRECAUTIONS FOR GAS CUTTING

A. SAFETY

1. Before handling or using any flame cutting equipment, understand and apply at all times the safe-practice instructions in this manual.
   a. Be sure work areas are free of flammable and combustible or explosive materials.
   b. Always wear protective personal equipment.
      (1) A close-fitting hat with hair tucked in.
      (2) Flame retardant clothing. *Shirt*- collar buttoned close around neck; pockets with flaps buttoned; full length sleeves, fastened at the wrist. *Trousers*- must cover top of shoes- no cuffs!
      (3) Hightop work shoes.
      (4) Approved eye protection.
      (5) Leather work gloves.

B. BURNING EQUIPMENT

1. Torches



a. A 2- or 3-hose machine torch 8 to 15 inches (203 to 381 mm) long is generally used on BUG-O machines.

b. 3-hose torches are recommended for heavy cutting on steel thicknesses up to 36 inches (914mm).

c. Torch valves, bodies and racks should be in good condition and have no gas leaks.

(If a torch is damaged in any way, it should be sent to the supplier for repair.)

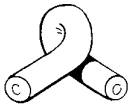
2. HOSES

CIR - 1010

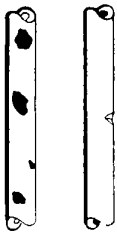
a. Use ¼ inch (6.4mm) twin and single hose (red for gas and green for oxygen) with "B" size fittings. The (notched) fitting is for gas and the smooth fitting is for oxygen.

MUG - 1119

b. Fitting should be clamped tightly so there will be no gas or oxygen leakage. However, avoid stripping the threads of the clamps and fittings.



c. Hoses with kinks, burned spots or small cuts are *very dangerous*, and will affect the quality of the cut.



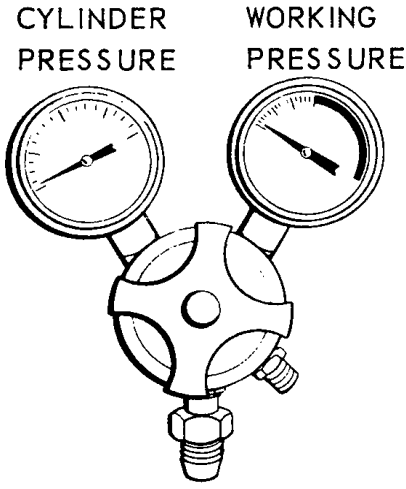
d. If hose is damaged, should be spliced or scrapped. *NEVER USE TAPE TO STOP A LEAK.* It is dangerous, and could cause a fire or explosion which could seriously injure the operator or others.

e. For a three-hose torch, the oxygen hose has a 3/8 (10mm) to ½" (13mm) inside diameter to allow a greater volume of oxygen flow for cutting.

f. The 50-foot (15.2m) standard length of hose should be used. Additional lengths of 25 feet (7.6m) can be added. It is important for the operator to know the exact total length of hose connected to the torch so the regulator gage can be set with the correct pressure. Increase oxygen pressure 5 pounds (3515 Kg/M²) and gas pressure 1 pound (703 Kg/M²) for each additional 25 feet (7.6m) of hose.

3. REGULATORS

a. Regulators are reducing valves used to reduce the high supply pressure to that which is desired. The gage on the regulator indicates the pressure at which gas is supplied to the torch.



Single-Stage Regulator

b. The Regulators should be handled with care. Damaged regulators will give inaccurate pressure readings which will affect the quality of the cut. The needle should read 0 before pressure is applied.

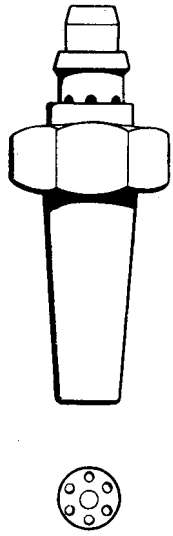
c. Grease or oil should never be used on regulator fittings because they can cause burning or explosion of lines.

d. Gas and oxygen outlets should be blown out to remove grit or dust, before attaching to the regulator.

e. If needle on gage appears to be stuck when pressure is applied, tap lightly with your finger. If this does not cause the needle to move, the gage should be sent to the repair department.

4. TIPS

a. The proper care of a tip will allow many feet of burning before it wears out.



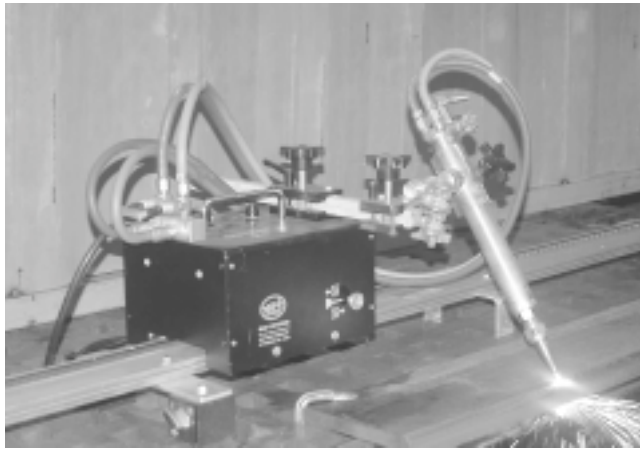
b. Tip cleaners should be used periodically to insure that holes are not plugged and that there are no burrs to deflect the gas.

c. The seat of the tip should be smooth to make a tight seal. If the seat is damaged, it will have a nick or nicks. This allows gas to escape and produces a flame around the top of the tip.

d. Tips should *never be thrown* in a tool box. They should be kept in their boxes or placed in special holding racks.

5. BUG-O SYSTEM (PORTABLE)

a. The BUG-O should be in good condition so it will travel smoothly and at a steady speed.

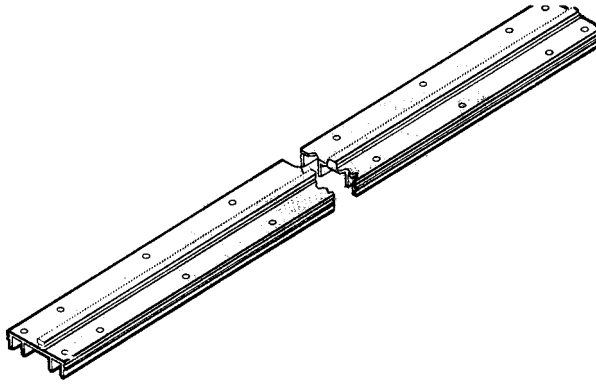


(1) Check the wheels to make sure there are no burrs or spatter stuck to them. They should be smooth and clean and rotate freely.

(2) The speed adjustment knob should turn smoothly to allow speed-up or slow-down from one setting to the other.

(3) The track ways or “grooves” should be periodically brushed clean. This removes particles that could obstruct the wheels and ruin the cut. The track should be straight with no burrs or nicks in the grooves.

(4) If the BUG-O or track is damaged or does not work well, have it repaired.



(5) The gears in the machine may eventually become worn, permitting excessive backlash. With the machine on the track, and the clutch engaged the BUG-O should not move more than 1/8 inch (3mm) back and forth when hand pressure is applied in these directions.

C. START UP PROCEDURE

1. HOOKING UP

a. Secure cylinders in upright position. Blow out gas and oxygen supply station outlets to remove any dust and grit particles.

b. Attach regulators to outlet. Finger tighten connections. Use a wrench to make snug. Be careful not to strip the threads.

c. Attach hoses to regulators. Finger tighten connections. Use a wrench to make snug. Be careful not to strip the threads.

d. Place BUG-O in approximate position to make cut.

e. Insert torch into holder on the BUG-O.

f. Attach hoses to the torch. Finger tighten connections. Use a wrench to make snug. Be careful not to strip the threads.

g. (1) Valves on torch should be closed.

(2) Turn valve on regulators counterclockwise until it moves freely so no pressure will register.

(3) Open acetylene cylinder valve ½ turn. Open oxygen cylinder valve all the way.

(4) Slowly open gas and oxygen valves on torch and turn wide open.

(5) Slowly turn in regulator valve until desired pressure is reached on gas and oxygen. (See torch manufacturer's tables for recommended oxygen and gas pressures.)

(6) Close valves on torch.

2. BURNING TIPS

a. Select tip (see torch manufacturer's table for recommended tip sizes).

b. Inspect tip.

c. Use tip cleaners to insure holes are clean and square on used tips.

3. BUG-O

a. Brush off dust/dirt form track grooves, work surfaces and magnet plates.

b. Place rail on work parallel to cut-line. Position torch over cut-line.

c. Adjust speed to approximate burning speed.

(1) Set indicator on 20, 30 or 40 on dial.

(2) Place torch tip ¼ inch (6.4mm) above plate and mark with soap stone. This is the starting point.

(3) Using the second hand on a watch, start the travel machine when the second hand is on 12.. Let the machine travel for one minute, then stop by throwing the switch.

(4) Using a soap stone, mark the spot where the tip stopped. Measure the distance between the two marks-*"This is inches (mm) per minute travel."*

(5) Repeat a different dial positions to establish correct speed settings.

(6) See tables for recommended travel speed settings.

4. LIGHTING THE TORCH AND SETTING THE PREHEAT FLAME

a. Adjust cutting goggles over eyes.

b. Put on gloves.

c. Open gas valve ¼ turn.

d. Open preheat oxygen valve 1/8 turn.

e. Put striker at tip end and light torch.

f. Adjust preheat flame to neutral by turning oxygen and gas valves one at a time and watching the blue flame cones for sharpness.

5. ADJUSTING THE PREHEAT FLAME FOR MAKING A SQUARE EDGE CUT

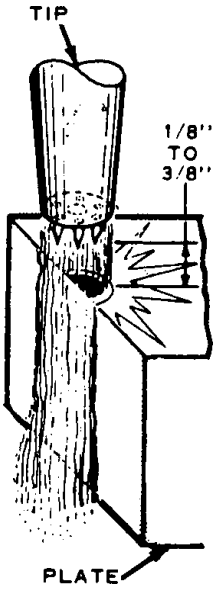
a. A simple rule to follow when a square edge is desired is to have the preheat flame come out as a whisper or a shoooosh rather than having a rush of gas and oxygen come out with such a force that the preheat flame has a shrill whistling sound. The whispering preheat flame has just enough heat to keep the leading edge and sides of the cut barely melting. Little sparkles will be present around the top surface of the hole which indicates that a correct preheat flame is used to give a square edge to the top of the cut. The whistling preheat flame has too much heat that keeps the leading edge and sides melting and will cause a rolled edge to the top of the cut.

b. Place tip half over the edge of plate.

c. Plate edge should start to get red.

1) If the plate edge does not start to melt (making fluid puddle), preheat flame is too cold.

2) If edge starts to melt too much (a fluid puddle the same diameter as the tip end), the preheat flame is too hot.



c) To adjust the too hot preheat flame (so that just enough heat is put into the plate to have a square edge on top of cut):

(1) Both the oxygen and gas valves must be slowly closed to reduce the preheat flame. First, close the oxygen valve slightly until the blue flame gets longer. Then close the gas valve until the blue flame shortens to the correct original length.

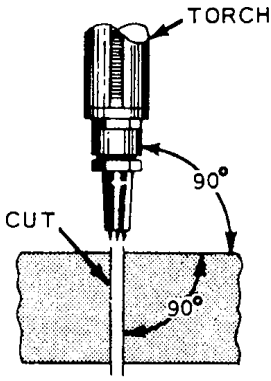
(2) Watch plate edge until fluid puddle is approximately ½ the size of the torch tip.

d. It is better to start with a cold preheat flame and slowly increase the oxygen and gas flow until a small molten fluid puddle appears on the starting edge of the plate.

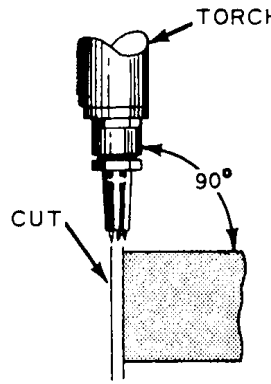
6. START CUTTING (See para. C for detailed procedure for making a starting hole.)

a. With acetylene, natural of propane gas the tip end should be placed about 1 to 3 times the length of the blue flame cones away from the plate surface (about 1/8 or 3/8" [3 or 10 mm] high). For MAPP gas the tip should be maintained from ¼ to 3/4" (6 to 19mm) from the plate.

b. The torch should be *square with the plate. Do not tilt torch.*



FRONT VIEW



SIDE VIEW

c. The top of the plate should be preheated for a distance of 1-1/2" to 2" (38 to 50mm) by moving the torch slowly back and forth over the area.

d. Bring torch to edge of plate so ½ of the preheat flame is touching the plate.

e. Hold at this position until a molten puddle starts to form (a little extra preheat oxygen sometimes is necessary to start this action and should be reduced after the cut is started).

f. Open cutting oxygen valve and start to cut.

g. Throw the travel machine switch to start travel along plate and immediately open the cutting oxygen valve to start cut.

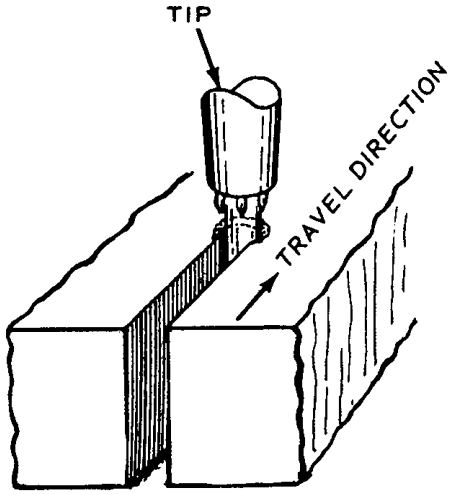
h. If travel is not started immediately, the bottom 1/3 of the cut will pocket and gouge due to the expanding oxygen gas and the molten slag, the same as too slow a travel speed would make. The top of the cut should always lead the bottom of the cut even if it's only 1/16 (1.6mm) on an inch. This prevents the opening or kerf from being clogged with slag.

It is better that the cut be made a little on the fast side, which would give a rippled wave appearance, rather than on the slow side which would require repairing or reburning.

7. OBSERVING THE CUT

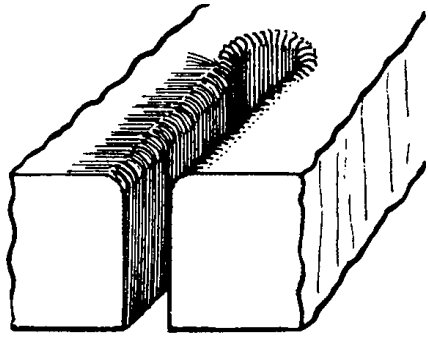
a. Minor adjustments may have to be made to insure good smooth cut.

(1) The "high quality" cut is shown in Sketch #1. Top edge is square, face smooth, side scale pulls away from the sides, bottom slag comes off clean with a little tap, torch tip height and travel speed is correct.



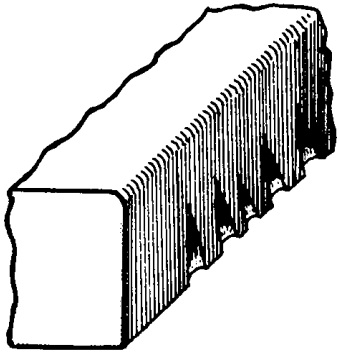
SKETCH NO. 1

(2) In sketch #2 the top edge has a roll. Too hot a preheat flame has melted away the edge and rounded the corners. To avoid this, the preheat flame must be reduced by slightly closing the preheat oxygen valve and the gas valve. Keep repeating this procedure until edge cut is square.



SKETCH NO. 2

(3) Gouges or pockets have formed at the bottom ½ or 1/3 of cut shown in Sketch #3. This was caused by using too high a pressure on the cutting oxygen or too slow travel. Pressure should be reduced or travel speed increased. Excess oxygen will expand and gouge the hot area of burn towards the bottom of the cut.



SKETCH NO. 3

D. PROCEDURES FOR MAKING A STARTING HOLE WITH A MACHINE BURNING TORCH

a. A 2- or 3- hose torch can be used with a 3/8" (10mm) dia. oxygen hose, for volume, with a regulator setting of 80 to 85 PSI (KG/M²).

b. The pre heat flame should be set a little hotter than for the normal cut to get the surface heated and melting faster.

c. The tip of the torch should be no less than 5/8" (16mm) from the surface.

d. As soon as the surface area starts to form a molten puddle from the preheat flame, the cutting oxygen valve is opened and the torch raised to 1-1/2 to 2" (38 to 50mm) above the surface to prevent the molten metal from clogging the cutting nozzle or tip.

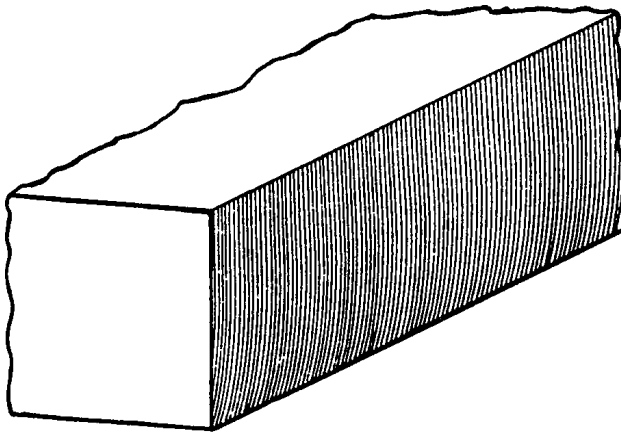
e. CAUTION: The torch holder should be firm without play, so that the torch will not vibrate during the raising motion.

f. As soon as the material is pierced, lower torch to cutting position (3/8" to ½" 10mm-13mm) and start carriage travel.

E. OBSERVE THE CUT BEING MADE

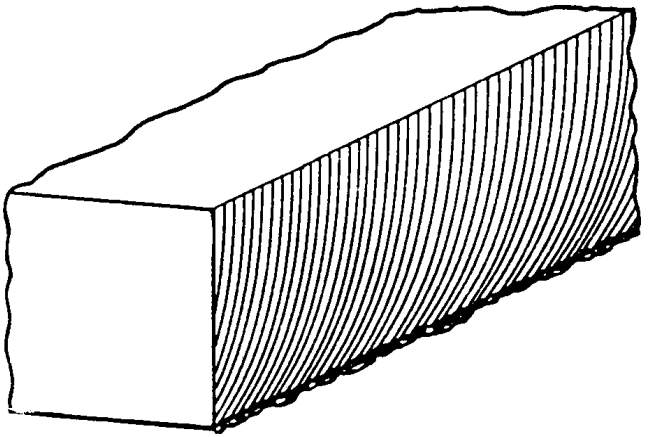
In this series for sketches, a correct cut as well as undesirable cuts and their causes are illustrated.

1. This sketch shows the result of using *correct cutting techniques*. The face of the cut is flat and regular, and the draglines are smooth, uniform and practically vertical. This is an excellent surface which can be welded without machining.



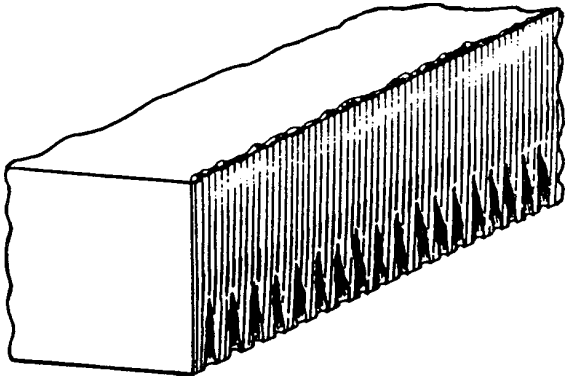
SKETCH NO. 1

2. The *travel speed was a little too fast* in this cut. This is shown by the angle (or rake) of the dragline. The surface of such a cut is rippled but reasonably smooth. It required a *minimum* of grinding to be welded without machining.



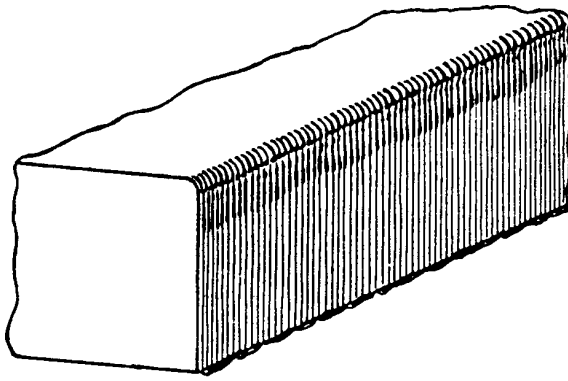
SKETCH NO. 2

3. In this cut, the *travel speed was a little too slow*. This caused an accumulation and sticking of molten slag which resulted in the irregular surface. Gouging and pockets such as these will have to be built back by welding. They must then be machined or hand ground before the cut surface can be used as a proper weld joint.



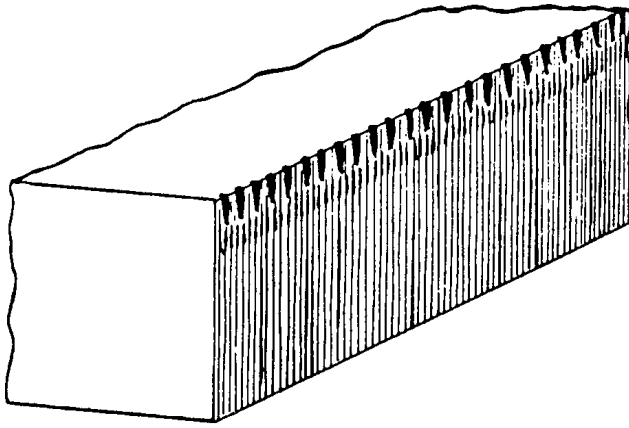
SKETCH NO. 3

4. The *torch was too far from the work* in this cut. It produced excessive melting at the top edge of the cut. A thin layer of scale will stick approximately 1/3 to 1/2 the depth of the cut. Slag will also stick to the bottom edge of the cut. The scale and slag must be vibrated or chipped to make the surface suitable for welding.



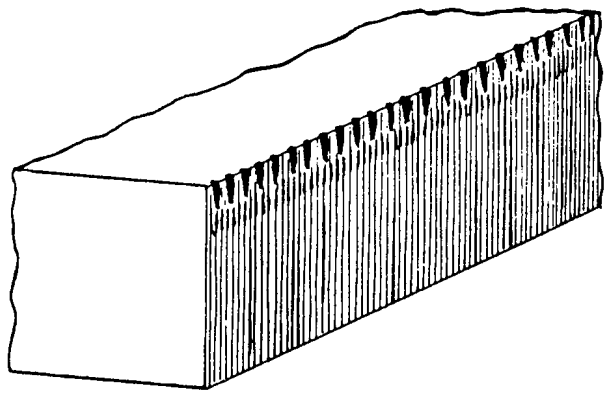
SKETCH NO. 4

5. Here *the torch top was too close to the work.* It caused a portion of the inner cone of the preheat flame to burn inside the top portion of the cut. This produced an unstable cutting action and resulted in the rough (small pockets or gouges) edges at the top quarter of the cut. Areas such as these must be machined or ground to make them suitable for welding.



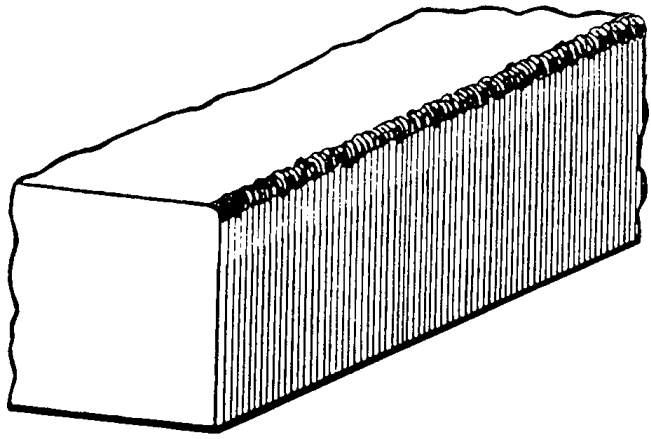
SKETCH NO. 5

6. *Too much pressure on the cutting oxygen produces* a cut of this type. The combustion and melting of the steel always follows the pattern of the oxygen jet. Excessive or high oxygen pressure causes undue expansion of the gas as it leaves the torch tip. This results in excessive turbulence which gives the distorted and unsightly cut shown. Scale is thick and sticks to the surface. Top portion of cut is undercut. Slag is stuck to the bottom of the cut. A cut such as this also must be machined or ground to make it suitable for welding.



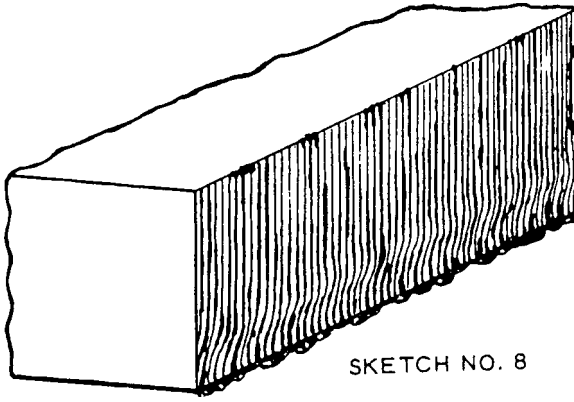
SKETCH NO. 5

7. *High preheat flame was used in this cut.* The top surface is melted and rolls over the edge as small globs of metal. This cut must be machined of ground to make it suitable for welding.



SKETCH NO. 7

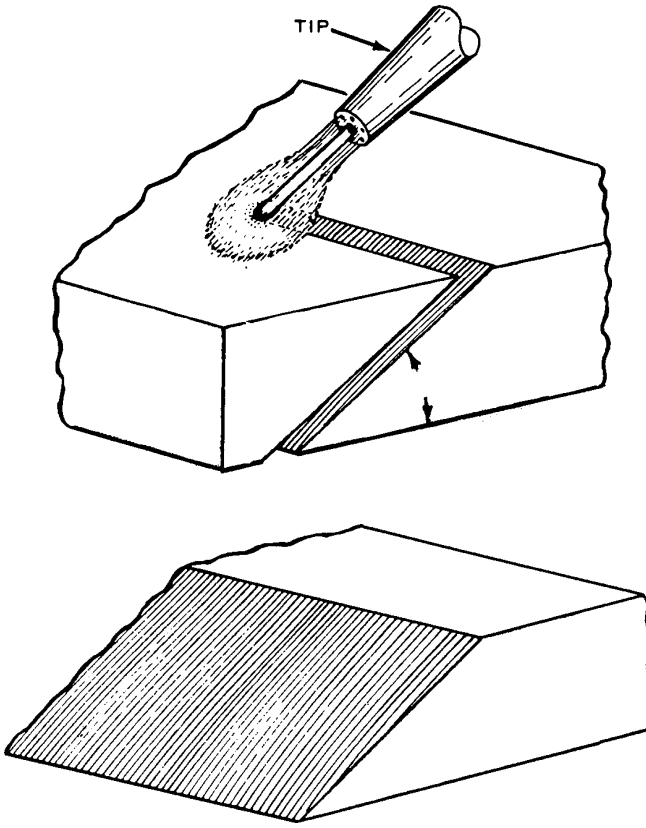
8. *A dirty or slag-clogged tip was used in this cut.* It caused the oxygen stream to lose its parallel form. As a result, the surface of the cut is no longer clear and regular. This surface will require machining or grinding to make it suitable for welding.



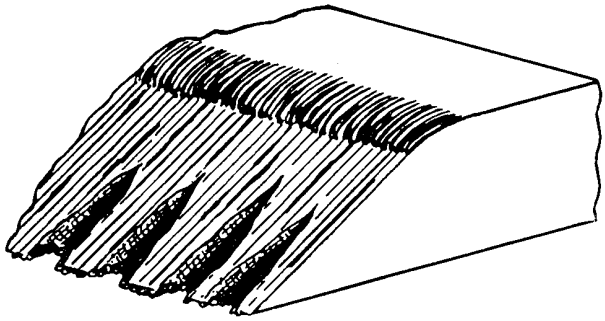
F. BEVEL CUTTING

In this series of sketches a 3-inch (76.2mm) carbon steel plate was beveled to show what can happen when proper and improper techniques are used in Bevel Cutting. *More preheat is required for beveling than for vertical cutting.* That's because the angle of the tip to the plate surface causes the heat to *bounce off.* When selecting a tip for Bevel Cutting, the depth of the cut rather than just the plate thickness should be considered.

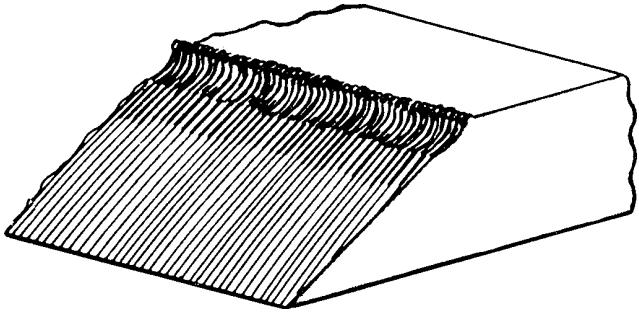
The PAN-1000 Panograph Torch Floater is recommended for bevel cutting on both "flat" and "wavy" material. The Panograph Torch Floater maintains constant nozzle-to-work distance which assures a uniform bevel!



1. This section is uniformly smooth on edges and surface and represents a quality cut.



2. This section is very bad. (a) *Very high preheat* has melted and rolled the top edge. (b) *Travel speed was too slow* causing gouges and slag sticks to the bottom of the cut.



3. This section is slightly cupped just below the top edge because of excess oxygen pressure. The slight beading along the top edge indicated that a little too much preheat was used.

CUTTING NOTES:

MACHINE CUTTING TIP CHART

(Fill in figures from torch manufacturer's literature.)

PLATE THICKNESS		TIP SIZE	CUTTING O_2 PRESSURE	FUEL GAS PRESSURE	KERF WIDTH	CUTTING SPEED
IN.	MM.					
1/16	2					
1/8	3					
1/4	6					
3/8	10					
1/2	13					
3/4	19					
1	25					
1-1/4	32					
1-1/2	38					
2	51					
2-1/2	64					
3	76					
4	102					
5	127					
6	152					
7	178					
8	203					
9	229					
10	254					
11	279					
12	305					