MANUAL

Operating Theory

GENERAL:

The Flame Generators utilize a flow of DC current through an electrolytic cell to dissociate ordinary distilled water into its two components hydrogen and oxygen, in the gaseous state. The gases thus produced are in the ideal ratio for combustion (2 parts hydrogen, I part oxygen) and are used in a wide variety of applications requiring a continuous source of heat.

Gas Generating System

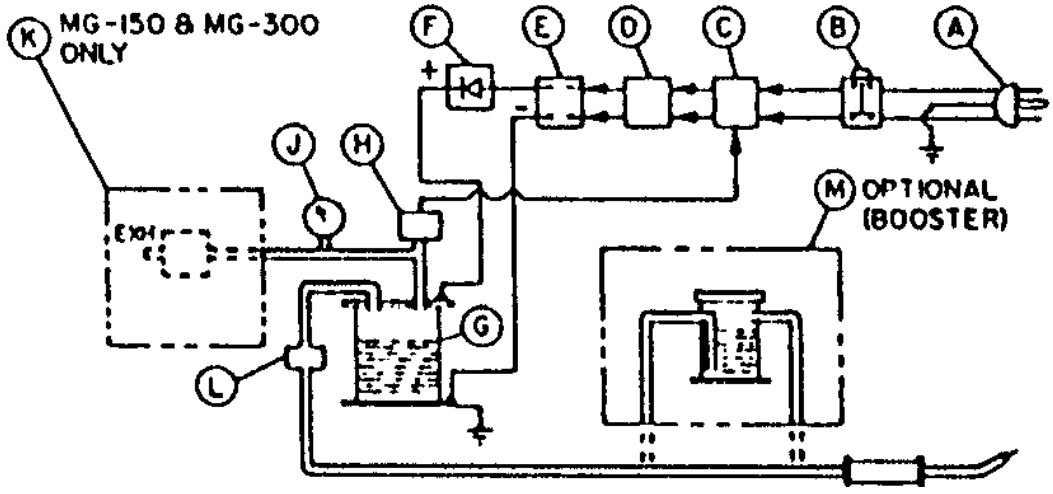


Figure 1

Figure 1 is a simplified drawing of a Flame Generator, showing all primary components utilized to generate mixed hydrogen and oxygen gas. It is recommended to become familiar with all components and procedures prior to utilizing this instrument.

The three wire, grounded line cord "A" maybe plugged into any convenient grounded receptacle with adequate capacity to provide the required source of alternating electrical current. (See specifications sections for power requirements of your particular model. 120 VAC, single phase, 60 cycle is standard. Other voltages and frequency options available on special order).

Note: A three wire, grounded line cord is essential for safe operation of the mixed gas generator. Removal of the ground lug or improper use of an adapter to by-pass the grounding lug will void the warranty on your unit.

The flow of electrical power is controlled and regulated to the electrolytic cell, "G", by means of a power switch "B", relay "C", voltage regulator "D", step-down transformer "E", and an "AC" to "DC" converter "F".

The flow of "AC" current to the step-down transformer "E" is interrupted by the pressure switch "H" any time the system gas pressure exceeds the factory pre-set pressure (approximately 25-oz/in).

The pressure gauge "J" provides a continuous indication of system gas pressure.

The electrolytic cell consists of a head plate with one or more attached anodes and a tank welded to a base plate with one or more attached cathodes. The head plate is insulated from the tank and is directly connected to the positive side of the DC power. The base plate is grounded to the chassis, which serves as reference ground for the complete electrical system.

The cell is partially filled with a mixture of distilled water and an electrolyte to increase the electrical conductivity and allow flow of current through the fluid from anode to cathode. This current flow dissociates the distilled water into oxygen and hydrogen at the anodes and cathodes respectively.

The gases thus generated, collect and mix in the tank head space and flow through the filter "L" to the gas outlet tube at the front of the housing. The torch handpiece "N" can be directly connected to the outlet, or gas flow may be directed first through an optional booster "M" and then to the torch handpiece.
The function of the optional booster will be explained in the "operating instruction" section of this manual.

Pre-Operational Procedure

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure 2

Legend

1. Power Switch
2. Generator Chassis
3. Electrolyte
4. Float
5. Torch Handpiece
6. Funnel
7. Torch Tips
8. Booster Body
9. Booster Cap
10. Generator Outlet tube
11. Filter Cap
12. Filler Cap

RECEIVING AND HANDLING

1. Inspect carefully for damage that may have been caused by shipping. Any claims for loss or damage that may have occurred in transit must be filed by the buyer with the carrier. Copy of bill of lading will be furnished on request if occasion to file claim arises.

Particular care should be used in unpacking the instrument because it is easy to throw away important components with the packing material. The glass float is completely hidden inside a cardboard wrapped to protect it from breakage in transit, and the torch tips, hoses, handpieces and filler cap are in small plastic sacks which can be overlooked. Each generator package is inspected for presence of all the necessary components and accessories before it leaves the factory. If the instrument must be returned for service, a return authorization number must be assigned.

2. Remove the filler tube cap from the top of your gas generator tank.

3. Your new gas generator will be shipped with the proper amount of electrolyte solution required for the initial charge. Using the plastic funnel provided, carefully pour the entire contents of the electrolyte bottle (or bottles) into the gas generator through the open filler tube. Since the electrolyte is premixed with the proper amount of distilled water, it is not necessary to add additional distilled water for this initial charge.

CAUTION: Electrolyte fluid contains a strong caustic chemical, and must be handled with care to avoid contact with the body. Use of rubber gloves, safety glasses/face shield and a rubber apron is recommended.

4. Gently lower the glass float, large diameter end down, into the gas generator through the filler tube spout. This float indicates proper liquid level and should be left permanently in the tank. Proper liquid level is approximately 6" down from the lip of the filler tube. This will be indicated when the top of the glass float rests from even with to 1/2" above the filler tube lid.

5. Screw the filler tube cap firmly into position so that it seals the filler tube.

6. Turn the power control knob to "zero" position.

7. Plug the power cord into a three wire grounded receptacle of sufficient capacity for your unit.

8. Turn on power by pushing the on-off power switch. Observe the pilot light in the switch body to see that the power is on.

Should the switch fail to hold on after several attempts, or if the circuit breaker opens, electrical shorting is indicated. Call Technical Services Department for further instructions

9. With power on, hold one finger over open end of gas outlet tube and slowly turn up power adjustment to maximum while observing gas pressure gauge. After a few minutes of operation, pressure should build up to the maximum pressure switch setting, at which point, power to transformer will be interrupted. (Pilot light will remain "on" and fan will continue to run.)

If pressure fails to build after a few minutes, immediately turn off power and recheck steps (1) through (8) above to make certain all steps have been performed. If all is in order and unit will still not build pressure, internal gas leaks or an electrical fault is indicated. Immediately turn off power, unplug line cord, and call Technical Service Department for further instructions.

If unit is performing normally, proceed to step 9a or 9b

9a. If optional booster will not be used, connect the torch handpiece directly to the gas outlet tube at the front of the unit, using the 3 feet of rubber hose provided.

10a. Select a torch tip and install it on the torch handpiece by twisting it firmly onto the tapered torch outlet tube. It is important that the tip be firmly seated. If air leaks into the tip, it will not burn properly, and flashbacks into the torch body may occur.

11a. Your unit is now ready for operation. It is highly recommended that you read the balance of the operating instructions" before proceeding.

Optional Booster

9b. Remove the booster cap and fill one-third to one-half full of the "super booster" provided with your unit. Replace cap firmly for a gas tight seal to booster body.

10. Attach 1-foot rubber hose from gas outlet tube on front of gas generator to inlet tube on booster body.

Note: Inlet tube curves up from booster body at an angle of approximately 15 degrees. Outlet tube is horizontal. If booster is connected in reverse, gas pressure will force liquid alcohol out through the torch.

11. Connect the 2-foot hose between the booster outlet and the torch handpiece inlet tube.

12. Select a torch tip and install it on the torch handpiece by twisting it firmly onto the tapered torch outlet tube. It is important that the tip be firmly seated. If air leaks into the tip, it will not burn properly, and flashbacks into the torch body may occur.

13. Your unit is now ready for operation. It is highly recommended that you read the balance of the operating instructions" before proceeding.

Operating Instructions

General

In order to successfully and safely operate the flame gas generator for soldering, welding, or other heat dependent processes, it is necessary to have some understanding of proper gas pressure setting in relation to torch tip size.

The Gas Generator is equipped with automatic pressure switches and pressure gauges that read in ounces/square inch from 0 to 60. Optimum operational pressures can be established for each size torch tip by adjusting gas output (with the power dial or with an adjustment of the setting on the automatic pressure switch) to give a steady pressure reading on the gauge before lighting the torch. It has been determined by experience that optimum pressure levels for the various sized tips are approximately as follows:

Note: When operating with the Booster, Pressure in ounces at the gauge should be equal to one half (1/2) the tip size number.

Tip pressures can vary over a fairly wide range particularly when running with the booster and still provide trouble free performance. However, when the flame blows out or refuses to stay lighted, the pressure is too high and when the torch tip begins to turn red hot or to melt, the pressure is too low.

Too low pressures are the most serious problem because they permit the flame to burn back inside the tip which sometimes results in a burned up tip, an overheated torch handpiece, or a back fire into the gas hose with a loud "pop."

The normal MAXIMUM tip size for the CLEAN FLAME 150 is the No. 17 tip. MINIMUM tip size for the CLEAN FLAME 150 is the No. 30, which requires very little electrical power in order to sustain proper operating pressure. When trying to adjust input power for a given tip without the use of a pressure switch or a pressure gauge one must feel the force of the stream of gas coming out of the tip before lighting the flame. If a strong flowing stream is evident, it is probably sufficient to support a flame that will not burn back into the torch tip and can be lighted. Once the flame has been lighted, one must by visual observation determine that the flame does not tend to:

1. Burn back into tip turning tip red hot (TOO LOW PRESSURE); or

2. Blow out (TOO HIGH PRESSURE).

Careful adjustment of input power is necessary to assure proper tip pressure because slight changes in the power setting cause significant changes in gas output. A low pressure setting for the generator could reasonably be considered as 80-85% of full power setting on the power dial. The automatic pressure switch takes care of power adjustment by cycling power on" and "off" to the gas generator to automatically limit power input and gas output.

The number of users or torches permitted on a machine is a function of tip size. The following table lists the number of manifold torch tips that can theoretically be supported by the Flame Generator.

MODEL 150

Gauge # (Tip Size)	Qty with Booster (Maximum Output)
17, 18	**1**
19	**2**
20	**3**
21	**4**
22	**5**
23	**7**
24	**10**
25,26 *	**15**
27	**20**
23,29, 30	**25**

***Note:** No. 25 and No. 26 tips have the same orifice diameters.

Extinguishing Torch Flame

The best method of extinguishing the torch flame is to blow it out. This works well for the smaller flames up to approximately No. 21 tip size. Sometimes the larger flames are so strong they cannot be blown out. These flames are then extinguished by pinching the hose shut tight next to the torch handpiece with a firm, rapid pinch.

It is important that the torch be lighted last in the steps preparatory to use and it is equally as important that the torch be extinguished first in the steps leading to shut down after use. This is because the chances for accidental fire, injury, burned up tips and back flashes are reduced dramatically when there is no flame on the torch. This is an important safety procedure always to be remembered.

When the flame is extinguished by pinching the hose, there is always a chance for a flashback into the hose, especially with the pencil type torch handpieces which do not have an expanded body containing a filter element, which tends to block back flashes. The reason for the flashback is because when the hose is pinched, the remaining gas in the hose and handpiece between the pinch point and the tip must release its pressure through the torch tip (and the flame); as the pressure is released, it progressively decreases; as pressure decreases, a corresponding decrease in gas velocity occurs at the torch tip; when gas velocity falls below flame velocity, the flame will sometimes burn back into the tip, the torch handpiece, and (with the pencil handpieces) into the hose with a sharp " pop." Most often, the flame just goes out when the hose is pinched shut.

If the gas generator should happen to be turned off while the torch flame is still burning, or if a torch tip or connecting hose should happen to be removed while the torch flame is

still burning, there will almost certainly be a flashback with possible damage to the torch tip.

Remember that the first step in shut down is always extinguishing of the torch flame.

Workpiece Sizes

The small pencil like flame of the Flame Generator torch produces temperatures of up to 6,000 °F, when the booster is not used and up to 4,700° F when the booster is used. The flame, when directed on small workpieces, will rapidly increase their temperature to 4,700°F or 6000° F. Larger workpieces conduct heat (BTU) away from the point where the torch is directed at a rapid rate and thereby prevent high work-piece temperatures from being achieved.

When the booster is placed in gas communicating series between the gas generator and torch handpiece, a larger, lower temperature flame is produced which has a slower combustion rate than the regular flame. Although flame temperature is reduced, BTU content is very substantially increased by reason of added heat of combustion of entrained alcohol vapor. Where temperatures of 4,700 °F or less are required, the booster flame will handle larger workplaces because of its greater BTU content.

For small exotic metal welding operations, the booster flame is superior because of its reducing character. Entrained alcohol vapor in the gas mixture absorbs atmospheric oxygen during combustion and thereby prevents an excess of free oxygen from penetrating the flame envelope and reaching the workpiece at the point where the flame is impinging upon the workpiece.

Where extremely small flames are required (below 0.010" orifice diameter), the straight oxy/hydrogen flame (without booster) is better adapted because of its higher combustion rate and self-sustaining combustion characteristics. In as much as the straight oxy/hydrogen gas mixture is combustible without additional oxygen support from the atmosphere, it is not easily extinguished accidentally even though it is extremely small. It will also burn in inert atmospheres or vacuum.

By way of example, it can be said that the largest flame from the largest Flame Generator instrument can just barely butt weld together the ends of two pieces of 1/4" diameter mild steel bar under optimum conditions.

Reduced Power Settings

The gas generator should be run on less than maximum power setting whenever possible. It does not damage the generator to run at full power 100%of the time, but the gas generator will run hotter and tend to spit out water and electrolyte along with the oxy/hydrogen gas. This then tends to plug up filter elements and contaminate the booster fuel at shorter intervals and it also tends to make torch tips plug up faster.

Power Controller

A variable transformer is provided on all models of Flame Generator instruments. It is especially designed to work with a pressure switch to handle the electrical load of the gas generator.

A variable transformer varies voltage into the primary winding of the power step-down transformer. The step down transformer is connected via its secondary winding to the gas generator tank. This controls power input to the gas generator tank, and in turn, gas output of the generator tank. Since all the gas produced in the gas generator tank must pass out of the system through the torch tip, Voltage input to the gas generator tank ultimately determines gas pressure at the torch tip. The variable transformer is hooked up in all Flame Generator instruments to work through a power relay switch that is actuated by a pressure switch. The pressure switch simply closes and opens the electrical circuit to the power relay coil that actuates the relay switch open or closed.

The variable transformer dial is mounted on the front panel of the gas generator chassis and has a scale marked off in numbers from 0 to 100 to approximately indicate percentage of power being fed into the gas generator tank.

Variable transformers are subject to burnout from spurious line voltage spikes caused by such phenomena as RF feedback into the line by other equipment such as high frequency apparatus. Such failures are quite rare.

Example: Assume for instance, that the pressure switch is set for 20 ounces pressure with a dead band of 4 ounces, allowing pressure to drop not below 16 ounces. This means the pressure switch remains closed and does not do anything after the welder is turned on until pressure reaches 20 ounces. At 20 ounces, the pressure switch opens and shuts OFF all electricity going into the generator tank until pressure drops to 16 ounces.

At 16 ounces, the pressure switch closes again and turns ON the electricity into the generator tank again. The pressure switch controls gas output (and pressure) only when the variable transformer setting is higher than necessary to produce the maximum pressure at the torch tip as called for by the setting on the pressure switch. The variable transformer has exclusive control of gas output below the pressure switch setting.

To operate torch tips and establish their pressure exclusively by variable transformer setting, the pressure switch should be set at a high level such as 35 ounces, which is higher than any torch tip would normally be operated.

The most ideal setting for the variable transformer when it is operating in cooperative conjunction with the pressure switch, is at a level only slightly higher than necessary to produce the torch tip pressure as set on the pressure switch. This keeps on"/"off" electrical cycling to a minimum.

Pressure Gauge

The pressure switch protects the gauge from accidental over pressure damage during normal operation that might be caused by a torch tip that becomes plugged or partially plugged during use.

When running without a pressure switch, operating procedure requires that the desired size torch tip should be mounted onto the torch handpiece and before lighting, the control dial should be rotated (clockwise to increase pressure or counter clockwise to reduce pressure) to produce a proper, steady holding pressure on the pressure gauge. After the pressure has been so adjusted, the torch tip may be lighted for use.

The pressure gauge takes the guesswork out of pressure switch settings and voltage control dial settings and also indicates when a "too large" tip cannot be operated because of insufficient pressure. This indication provides information to prevent a "too large" tip from being lighted and then burning up because of low pressure.

A highly sensitive pressure gauge is provided on all models of Flame Generators. This gauge can be permanently damaged if subjected to as much as 10 % pressure over its maximum reading. The gauge reads from 0 to 60 ounces per sq. in. Because of their delicate nature, they can be blown out in a few seconds by operator error when starting up or running a welder. Simple common sense use of the gauge as outlined above will permit its continued operation for many years. If the pressure gauge should become blown and leaking, it should immediately be replaced. Replacement gauges are available from the factory, normally as a shelf stock item.

Chapter 5 • Safety Precautions

As with most types of industrial equipment, there are some safety hazards associated with the operation and use of Flame Generators. However, an awareness of these hazards and strict adherence to a few simple safety rules will result in complete safe operation of your unit at all times.

The sources of possible safety hazards and the precautions that must be observed with each are as follows:

Electrical Hazards

The CLEAN FLAME 150 Generator uses electrical energy to dissociate distilled water into mixed hydrogen and oxygen gases. All generators operate on 120 or 220 volt, alternating current, so the danger of electrical shocks or burns exist as with any other electrical equipment.

In order to avoid possible injury, the following precautions must be observed:

1. Avoid electrical overloads on your plant electrical system by making certain the selected outlet has sufficient capacity for your unit.

Consult the specification section of this manual to determine the power requirement of your unit.

2. Always use a three wire, grounded receptacle.

3. Inspect the line cord at regular intervals and replace if worn or damaged.

4. Always turn off power and unplug power cord before removing back cover for repairs or adjustments.

5. Keep your unit clean and in good working order.

Fuel Cell Electrolyte

The fuel cell in CLEAN FLAME 150 Generator is similar to an automotive battery in that it consists of a solution of electrolyte and water to allow current flow in the cell. The electrolyte used by the CLEAN FLAME 150 is a concentrated solution of distilled water, potassium hydroxide, and other proprietary buffer compounds to minimize cell decomposition. This electrolyte solution is a strong caustic and the following precautions are recommended when handling to avoid possible injury:

1. Always wear protective clothing, including a rubber apron, rubber gauntlet gloves, and face and eye protection.

2. First aid procedure for accidental exposure is as follows:

A. Wash exposed areas thoroughly with clean, flowing water.

B. Neutralize with mild vinegar.

C. Rinse with isopropyl alcohol.

D. Wash again with clean soap and water.

E. Consult a physician.

3. If ingested, take mild vinegar as an antidote, and obtain medical assistance immediately.

4. Electrolyte is very corrosive to most metals, including copper, brass, zinc and aluminum and will react violently with acids. Use only chemically resistant polypropylene funnel for filling fuel cell.

If electrolyte is spilled on metal parts or in work area, wash thoroughly with water and neutralize with mild vinegar.

5. Follow EPA rules for hazardous materials when disposing of used electrolyte solution.

Booster Fluid (Methanol Alcohol)

Booster fluid is methyl alcohol, together with harmless additives to provide a green color that turns colorless or light red when the fuel becomes too contaminated for further use. Methyl alcohol has an area cup flashpoint of 60 °F and is explosively flammable. In addition, breathing concentrated alcohol vapors can be dangerous. In order to avoid these hazards, the following precautions should be observed:

1. Always add booster fluid to booster tank in an open area with adequate ventilation.

2. Keep open alcohol containers away from open flames, cigarettes, sparks or other glowing materials.

3. Avoid placing face directly over open containers of alcohol.

4. Keep a dry chemical or carbon dioxide fire extinguisher handy in the work area. Do not attempt to extinguish alcohol flames with water.

5. In the event of accidental breathing of booster fuel vapor, consult a physician immediately.

6. If methyl alcohol is ingested, keep patient warm and obtain immediate medical aid.

7. For eye or skin exposure, wash immediately with clean, flowing water.

8. Store booster fluid in tightly closed, approved containers, and in a cool, dry environment.

9. Follow EPA guidelines for disposing of used booster fuel.

Oxy/Hydrogen Gas Flame

The CLEAN FLAME 150 Generator produces a mixture of hydrogen and oxygen gases which is explosively flammable and burns at a temperature of up to 4,500°F. Under normal operating conditions, the amount of oxy/hydrogen present in the generator is very small and gas pressure is less than 60 oz/in, so the danger of a catastrophic explosion is practically nonexistent.

The gas generating cell is designed to contain an accidental internal explosion if gas pressure is 15 psi or less. A pressure relief valve in the filler cap will automatically vent gas to atmosphere if internal pressure exceeds 15 psi.

As with any other welding equipment utilizing stored or generated gas for fuel, there are precautions that must be followed to insure safe operation:

1. Always extinguish torch flame by blowing out or pinching off rubber hose near torch inlet before:

A. Turning off power to flame generator.

B. Remove or changing torch tip.

C. Removing or changing hose.

D. Removing gas generator cap or booster cap.

E. Laying down torch.

2. Check fluid level in generator before starting unit in the Morning. Add only distilled water as necessary.

Additional, electrolyte should never be added after the initial charge, unless electrolyte is depleted. See maintenance section.

3. Do not remove generator cap until power has been turned off at least one hour. Even a static electrical spark can ignite gas in the tank if it is opened too soon.

4. Do not point burning torch toward your body or that of another person.

Hydrogen and oxygen burn at temperatures up to 4,500 °F and high temperatures exist at a considerable distance directly ahead of the torch tip.
The flame from a small tip may be practically invisible, particularly in a brightly lighted area.

5. Check safety relief valve weekly in accordance with instructions in maintenance section.

6. Keep work area clean and free of paper, cloth or other flammable material at all times.

Maintenance

General

Extensive testing of Flame Generator instruments coupled with user experience has indicated users can achieve trouble free performance by observing certain maintenance procedures as follows:

1. Add distilled water to generator tank before starting up.

2. Add booster fuel to booster daily before start up.

3. Exercise filler cap riser piston before start up.

4. Clean booster out weekly.

5. Clean or change filter element monthly.

6. Lubricate filler cap riser piston cylinder walls monthly with a very thin film of silicone grease. This will also lubricate the 0-ring.

7. Change filter gaskets, filler cap gasket and booster cap gasket semiannually.

8. Send equipment to the factory for safety inspection, cleanout, hose and gasket replacement and test running every 18 months or 2,000 hours use, whichever shall first occur, or sooner if an operational problem should develop.

Water Addition -Gas Generator

The gas generator liquid level should be checked by removing the generator cap and observing the position of the glass float. The unit is full when the top of the float is even with to 1/2" above the lid of the fill tube. Distilled water should be added to maintain proper liquid level in the gas generator. Water consumption is as set forth in the specifications in this instruction manual and water need not be added more often than once each 8 hours of running time.

The electrolyte at initial charging contains the initial charge of distilled water. When the gas generator is charged for the first time, the electrolyte liquid contained in the bottles provided is the only liquid which should be put into the gas generator. Addition of distilled water at this time will cause the generator to be overfilled. How to properly handle an overfilled condition is discussed elsewhere in this manual.

Fuel Addition - Booster

The booster alcohol level should be checked every eight hours running time when the gas generator is not running and electricity has been off for one hour or longer. Remove the

booster cap and observe the amount of alcohol in the booster body. Proper level is from 1/2 to 2/3 full.

Do not place face or eye directly y above booster when checking its fuel level - look in from the side.

Filter Assembly

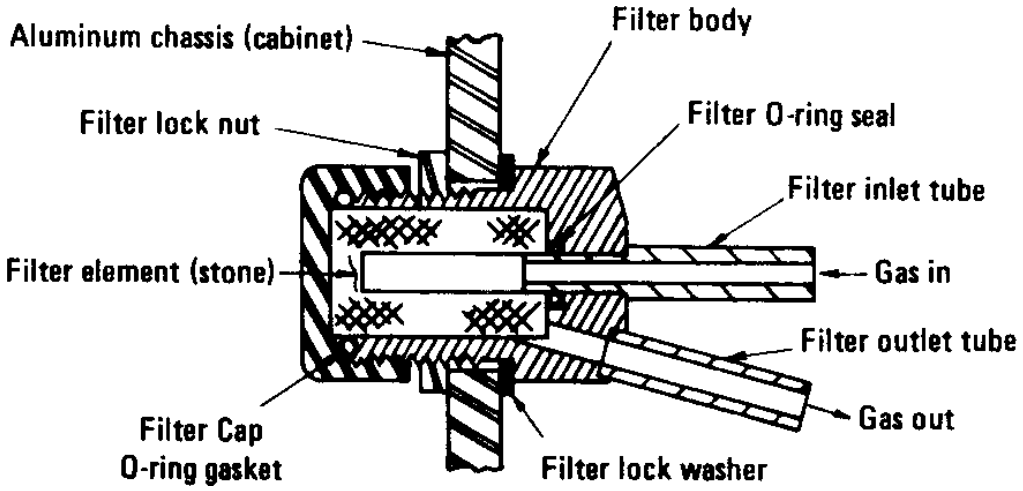


Figure 3 • Filter Assembly

Figure 3 above illustrates the heavy-duty filter assembly incorporated into the flame generators. This assembly contains one replaceable filter element which must be thoroughly cleaned and dried or changed every month or 200 operating hours. The element is very simply removed from the outside of the gas generator chassis as follows:

1. While wearing rubber gloves, a safety face mask and a rubber apron, carefully unscrew the knurled stainless steel filter cap which is approximately 1" in diameter and 1/2" long by turning same counterclockwise when viewed from the rear of the gas generator chassis. This cap is located high on the outside of the chassis at the front thereof, up near the cover.

2. Be careful not to permit moisture or liquid contained in the filter assembly to drip or run onto anything as it is powerfully caustic and very harmful to human tissue, clothing, furniture finishes, paint, some plastics, certain metals such as aluminum and copper.

3. Carefully twist and pull out the filter stone and discard it into a chemical waste container for caustic items. Next, remove and discard the filter cap 0-ring gasket and filter 0-ringseal in the same manner as for the filter element.

As an alternative to discarding the filter stone and 0-rings, they may be cleaned in an ultrasonic bath of clear water, thoroughly dried and reused if they appear to be in sound mechanical condition.

4. In sequence, replace the filter 0-ring seal, filter 0-ring gasket, filter element (stone) and filter cap. Tighten the filter cap snuggly so oxy/hydrogen gas cannot leak or escape from it when the gas generator is operating.

Make certain the 0-rings go back properly and the assembly fits together snuggly If the 0-rings and filter stone are NOT in proper arrangement, loud and frightening flashbacks into the gas generator tank can possible occur during the operation of the generator.

5.All items that have come into contact with the internal filter assembly component should now be washed thoroughly with soap and water, rinsed thoroughly with clear water and then dried.

6.Filter stone and 0-ring replacement kits are available from the factory and consist of:

a. Filter element (stone),
b. 0-ring,
c. 0-ring,

Pressure Relief Filler Cap

Figure 4

The pressure relief filler cap assembly is specially designed to:

1. Visually warn when excessive gas pressure is generated within the generator tank (as illustrated in Figure 4) because of a plug up of a gas line.

2. Automatically relieve excessive gas pressure inside the generator tank if the operator fails to notice the stem of the riser piston has extended (Figure 3) and fails to shut off the electricity to the gas generator.

3. Vent over pressure gases to atmosphere without danger of burn back of said venting gases into the generator tank if said venting gases are accidentally ignited.

4. Be manually exercised at least twice weekly (during down time periods) by pressing the riser piston (Figure 4) at least three times with a blunt pencil or wooden dowel pin to cause a 3/8" movement thereof and allowing it to return under its built in spring bias.

5. Be easily disassembled (Figure 4) for lubrication of 0-ring or replacement of 0-ring or gasket.

The pressure relief filler cap assembly is designed to minimize the potential hazard of operating a generator with a plugged gas line. Such plugging may be the result of a soaked or blocked filter element, which can easily be corrected by removing the filter element and installing a new element. The generator need not be returned to the factory for such replacement.

The stem of the riser piston begins to rise when a pressure of 6 psig is developed in the generator tank and releases gas initially at 15-16 psig, then backs off to 12-13 psig and releases gas continuously at this pressure until the electricity is turned off. The generator should never be left running unattended**,** and should be shut off and repaired whenever the riser piston raises even a small amount, before it rises to its fully extended position and releases gas. it is unnecessary to ever operate a generator with tank pressures more than 100 percent higher than maximum torch tip operating pressures (over 2 psig or thereabout), such excess tank operating pressures (over 4 psig) being only the result of a plugged generator which requires servicing. The riser piston should be exercised. After each exercise, the operator should quickly wash his hands to remove any minute particles of caustic electrolyte which might have been transferred from the inside of the filler cap to his hands during exercise. If the riser piston does not move freely during exercise, the filler cap assembly can be disassembled (Figure 4) and cleaned and the 0-ring lubricated with silicone grease. In reassembly, the screw should be installed with loctite or epoxy to assure it does not easily come loose.

Electrolyte Maintenance

In theory, the electrolyte solution should not work out in use, and electrolyte should never be added or changed unless it becomes badly contaminated.
However, there are conditions where the electrolyte may become diluted and it may be necessary to add a small amount of concentrated electrolyte or replace the initial charge in order to maintain rated gas output.

When the flame generator is operated for long periods of time at full maximum output, the generator tank will heat up to 130° - 140° F. Under this condition, the generator will produce steam and may spit out small quantities of liquid electrolyte. This will be trapped in the filter, carried out into the torch hose as liquid or be trapped in the booster. (or in an optional drying tower if one is used).
Under these operating conditions, electrolyte density should be checked weekly, using a hydrometer that can be purchased from your local auto parts store.

Electrolyte density is checked when electrolyte is at the full level, and after the generator has been operating with the electrolyte at the full level so that the electrolyte is well mixed and uniform in density throughout the system.

Electrolyte density is checked by drawing electrolyte into the hydrometer through the filler tube of the generator. This operation is performed in a similar manner as is done in

checking the electrolyte density of an automobile battery. Similar precautions should also be taken as the electrolyte is Very corrosive in nature. The electrolyte is alkaline (caustic).

Electrolyte density checked at "FULL" level and with electrolyte well circulated and mixed, should normally be between 1180 and 1220.

When electrolyte density falls below 1105, 1/2 pint of electrolyte (Electrolyte comes in 1 quart bottles, so only 1/4 bottle would be added at one time) should be added along with the distilled water the next time liquid is needed. Successive electrolyte density checks and additions of electrolyte to maintain density will give the operator a feel as to how often and how much new electrolyte must be added based on a given mode of operation. Each time a density check is made, it is important for safety's sake to rinse out the hydrometer with clear water and clean the hydrometer before putting it away, Remembering that electrolyte is powerfully alkaline (and corrosive) in nature.

Electrolyte Change

The electrolyte is a highly concentrated alkali and should not be allowed to splash onto skin, clothing and/or other surfaces. However, if this occurs, the electrolyte should be diluted with large quantities or water. An immediate and generous flushing of clothing, skin or other surface with fresh water will minimize
damage by chemical action from electrolyte.

Check the specifications section of this manual to determine capacity of your particular model.

1. Wear rubber gloves and safety glasses. Disconnect electricity from the gas generator.

2. Remove filler cap and flush thoroughly with clean water. Use care not to drip electrolyte onto anything. The electrolyte contains powerful caustic chemicals that can injure materials subject to caustic attack.

3. Move the gas generator near source of clean water. Secure a small lift pump with a plastic or stainless steel pumping mechanism and all plastic or stainless steel connections and tubing. (An electrically driven centrifugal laboratory pump works well). Insert the end of the intake tube of the pump into the gas generator tank through the filler tube and push the intake tube down to the very bottom of the gas generator tank. Place the discharge end of the out-
let tube for the pump into a container approved for disposal of caustic waste. A second person should now turn on the pump while holding the intake tube down at the bottom of the gas generator tank (using rubber gloves). (A pump with small pumping volume MUST be used so as to minimize the chances of splashing electrolyte out the discharge end.

Splashing could result in the unwanted wetting of objects by electrolyte).
A dark muddy looking substance will be observed in the electrolyte being pumped out, this is normal.

4. Refill the gas generator tank with distilled water to within one inch from the lip of the filler tube and pump it dry again, using the same pumping procedure as outlined in the preceding paragraph.

5. Repeat the flushing operation as outlined in the preceding paragraph several times.

6. Withdraw the pump intake tube from the gas generator tank (being careful not to drip liquid from it onto anything) and wash it thoroughly with clean water. Run clear water through the pump for a minute or two to remove electrolyte from its tube and moving parts.

7. Place the discharge end of a plastic funnel into the open end of the gas generator filler tube.

8. Very carefully, pour new electrolyte into the gas generator tank through the funnel using only the specified quantity for the model involved.

9. Replace the stainless steel pressure relief filler cap on the filler tube and tighten snugly in place. The gas generator is now ready to operate again.

10. Wash hands, face and other exposed skin areas thoroughly with soap and water.

Headplate Gasket

The headplate gaskets are made of a special rubber compound designed to resist chemical attack, exhibit high dielectric strength and maintain resilience for a long period of time. The gasket does deteriorate with age and it is a good idea to have it changed at the factory at least every 18 months.

It is recommended that the gas generator tanks never be opened except at the factory**.** Opening a generator tank in the field is a hazardous and potentially dangerous procedure. Headplate gasket replacement requires such opening and should therefore be done at the factory. It is recognized that some owners may open their generator tanks to change headplate gaskets even though it is not recommended; hence, the steps for changing are as follows:

1. Wear rubber gauntlet gloves, a full-length rubber apron, and a full plastic face mask and rubber apron that fully covers the head and shields the ears.

2. Remove the gas generator cover from the chassis.

3. Disconnect gas discharge tube (or tubes).

4. Carefully remove electrolyte from the generator tanks as outlined in the

section Electrolyte Change. This electrolyte may be discarded or saved for reuse by pumping it into a large plastic or chemical resistant container. It is powerfully caustic and should be handled with extreme care and caution.

5. Remove strap connecting tank, or tanks, to the heatsink and bend the wires out of the way.

6. Remove cap screws, washers and insulating grommets, which hold the headplate onto the generator tank.

7. Remove headplate by raising straight up, being careful not to drip electrolyte liquid onto any electrical components.

8. Gently rest headplate electrode assembly upside down after rinsing copiously with clean distilled water.

It is important that the electrodes not be bent. If an electrode is bent, a new headplate assembly should be acquired from the factory, discarding the damaged assembly.

9. Remove and discard old gaskets in a suitable caustic waste receptacle

10. Install new gaskets into place and install headplate-electrode assemblies in reverse order of disassembly.

11. Torque retaining cap screws of headplates to 14-16 inch pounds.

12. Visually inspect installation to insure

a. gaskets not unusually deformed
b. uniform seal all around
c. no metal to metal contact around tank

13. Reconnect gas discharge tube or tubes.

NOTE: Electrical connections must be tight. Loose connections may cause damage to the electrical system rendering the instrument useless.

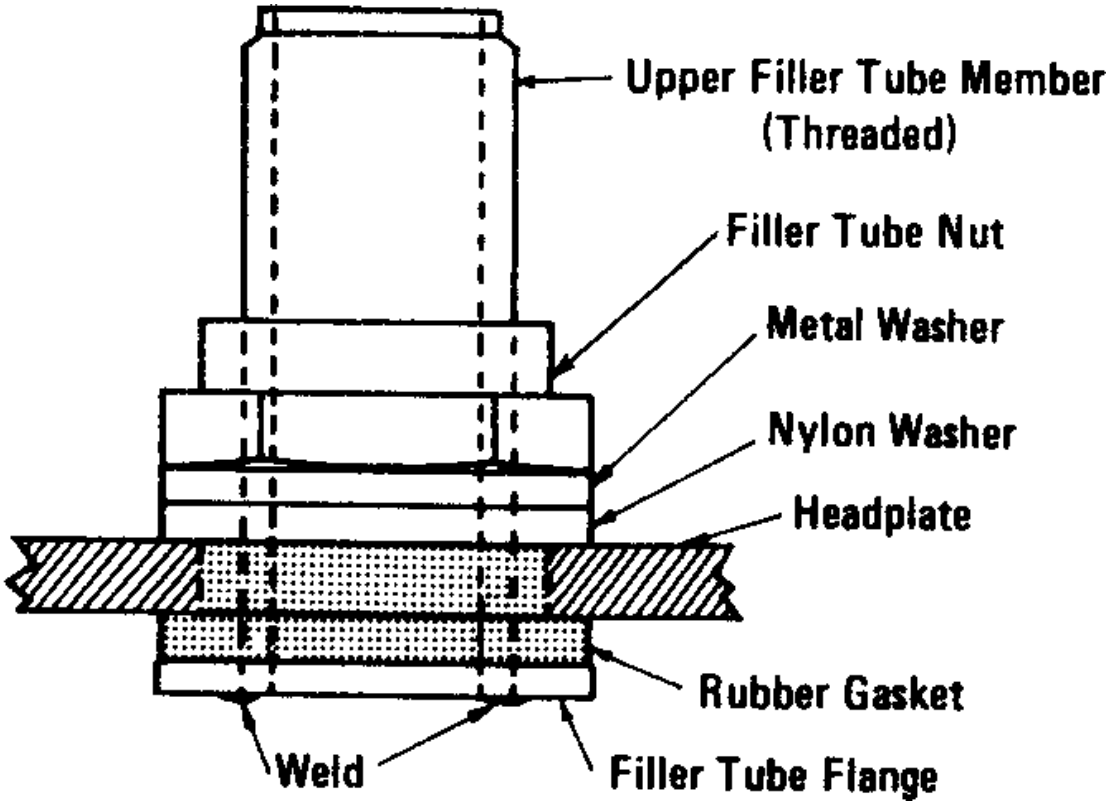
NOTE: THE CAP SCREWS AT THE TOP OF THE HEADPLATE SHOULD BE INSTALLED AND F TIGHTENED CAREFULLY AND EVENLY WITH A PRECISION TORQUE WRENCH, USING EXACTLY 15 INCH POUNDS OF TORQUE ON F EACH.

These cap screws should first be tightened slightly (finger snug) all around, then tightened all around with 5 inch pounds of torque, then all around with 10 inch pounds of torque, then all around with 12 inch pounds of torque, then all around with 14 inch pounds of torque and finally, all around with 15 inch pounds of torque OBSERVING the gasket at all times to detect any irregularity such as bulging at any point during tightening. Upon

completion of headplate installation, the generator tank should be subjected to pressure test by pumping air into the tank through its gas outlet tube in the generator headplate (with filler cap in place) at 12 to 15 psig, and the tank must hold this pressure for 15 minutes without any loss thereof over the 15 minute period.

The generator can become dangerous to use if the headplate gasket re-placement procedure is not followed exactly. Explosions can occur from gas leaks or electrical shorts between the headplate and the generator tank.

Filler Tube



The drawing above shows the proper assembled relationship of various parts, which make up a filler tube assembly.

All metal parts of the assembly are made on non-magnetic stainless steel including:

1. Upper Filler Tube Member
2. Filler Tube Nut
3. Metal Washer
4. Filler Tube Flange

These parts are electrically isolated from the Headplate to which they are mechanically mounted by:

1. Nylon Washer

2. Rubber Gasket

Since the Headplate is an anodic current carrying member, it is important that its electrical isolation from the filler tube be maintained.
The rubber gasket is made of a special compound having long life in the environment provided inside the generator tank. The gasket does deteriorate with age and it is a good idea to have it changed at the factory at least every 18 months.

If there should ever be a suspicion this gasket is leaking, it can be checked by removing the cover from the gas generator chassis; painting over the filler tube nut, metal washer and nylon washer with a soap/water solution; plugging in the electric cord of the gas generator and turning on the electricity to create a pressure of about 20 ounces; and observing whether soap bubbles form in the film of soap/ water solution around the filler tube elements listed above. if bubbles do form, there is probably a leak and the gas generator should be returned to the factory for repair.

Trouble

Overfilling Gas Generator

If the gas generator should accidentally be overfilled with distilled water, it is best to run the gas generator on a low power setting to minimize overheating which will occur until the excess water has been consumed. The gas generator may have to be turned off intermittently during this procedure to cool off.

Under no circumstances should excess liquid ever be removed or siphoned from the gas generator tank as this would upset the chemical balance of the powerful caustic electrolyte contained within the tank.

Burning up Tips

Torch tips will burn up when gas velocity through the torch tip orifice falls below flame velocity of the burning flame, thus permitting the flame to burn backward into the tip to melt it.

If a manifold torch system is in use, removal of the tip from any one torch will cause pressure loss in the entire system - possibly resulting in burned tips because of the gas velocity loss that attends a pressure loss.

If the booster runs low on fuel and straight oxy/hydrogen gas goes through the tips, pressure (and gas velocity) must be nearly double in order to prevent burn back because of the very fast flame velocity of the pure oxy/hydrogen flame.

The torch tips are simple stainless steel tubes attached to nickel plated adapter hubs that fit onto torch handpieces. There is really no significant difference in quality from tip to tip - the difference in tip life however is a function of operator care. When tips are immersed in molten metal or other material, this can change the tip orifice characteristics enough to cause them to burn up under production operating conditions.

Plugging Up Tips

Torch tips should be extinguished, removed and cleaned frequently by running a cleaning wire through them. Whenever flame geometry seems to be changed at all, the torch tip should be cleaned - for tips number 23 and smaller, cleaning may be required even more frequently than once every hour.

A method sometimes used to keep torch tips running clean longer is as follows:

In the morning before start up, a tightly packed wad of clean surgical cotton the size of a navy bean is pushed 1/2" deep into the torch hose at the end where the torch hose connects to the torch handpiece. The torch hose is then connected to the torch handpiece and the torch is run all day with the cotton in the hose.

Each succeeding morning, the cotton from the previous day is removed with tweezers and discarded and a new cotton wad of the same size is inserted into the torch hose in the same manner as on the previous day. The cotton wads act as final gas filters for the torch tip and seem to do a very effective job of minimizing torch tip plugging.

Squirting Booster Fuel

The booster can be connected in series between the gas generator and the torch in only one way and that is with the bent (angled upwardly) booster tube connected to the gas generator and the straight (horizontal) booster tube connected to the torch. If the connections are reversed, booster fuel can be squirted out through the torch tip in pure liquid form when the gas generator is turned on. This is extremely dangerous because booster fuel is volatile and flammable and if it is squirted around a room, any small spark can start an immediate and violent fire with explosive force.

Booster fuel can also squirt from the torch when the booster is overfilled with fuel. It should never be more than 2/3 full and any level between 1/2 and 2/3 full is sufficient for a full 8 hour run. The booster must always be standing vertically upright on a horizontal surface. If it is severely tilted, this can cause booster fuel to run into the gas outlet hose and squirt out the torch during operation.

Line Voltage

Where commercial line voltage exceeds that for which the gas generator is rated, the gas generator may severely overheat with prolonged operation on the maximum power position. Under such circumstances, the gas generator should be run at a reduced power setting.

Overheating will cause water vapor to be emitted from the gas generator along with the oxy/hydrogen gas and this water vapor can be emitted from the torch tip during operation. The water vapor will carry small amounts of electrolyte with it and will have a soapy, slippery feel. It can eat holes in clothing and in human
tissue so anything which becomes wetted with this liquid should be
immediately and generously flushed with fresh clean water.

Electrical

In a few isolated instances, instruments have sustained burned out transformers or rectifiers. This can be caused by a power line transient that surges past the breaker (without actuating it) with a very high, short duration voltage spike. To check for a burned out transformer, one should check its open circuit secondary AC voltage, which should be between 5.0 and 7.5 volts at rated maximum voltage across the primary. The rectifiers can be checked by removing them from the circuit and checking the forward and reverse resistances with an ohmmeter.

Another electrical problem can result from "shorts", such as between:

1. The hold down studs and the generator headplate.

2. The generator tank headplate and the chassis or chassis cover or back cover.

3.A transformer secondary lead or choke lead and any surrounding structure.

4. Crossed hook-up wires.

Corroded or oxidized electrical connections, particularly in the circuitry the transformer secondary winding, can restrict current flow to the generator tank and resulting overheating of the gas generator and reduced gas production. Connections that should be particularly checked and kept clean are:

1. Heatsink to tank headplate

2. Diodes to transformer

Loss of Pressure

WARNING - If the electricity to any gas generator instrument with a proper water level and at an ambient temperature of 50°F or greater is turned on a maximum output and the instrument fails to produce gas flow at the torch tip within two (2) minutes, there could be:

1. A **plugged gas line** which is blocking gas flow; or

2. A **bad gas leak** in a tube, seal of connection that is bleeding off the combustible oxy/hydrogen mixture before it reaches the tip.

EITHER OF THESE CONDITIONS IS SERIOUS AND MUST BE CORRECTED AT ONCE BEFORE TRYING TO OPERATE THE GENERATOR ANY FURTHER.

The gases are not visible and must therefore be carefully controlled.
The gases are highly combustible and it is not safe practice to generate such gases to any greater pressure than necessary or to permit such gases to escape randomly via leaks where they might become accidentally ignited.

The generator should be returned to the factory for servicing or repairs if the foregoing condition develops.

In order of their prominence as possible leaking members, the following components should be checked to assure they are gas tight.

1. **Filter Assembly:** All units are equipped with a filter assembly which has a replaceable fused ceramic filter element approximately 0.600" diameter by 1.030" long. It should be cleaned or replaced every month or 200 operating hours. The filter assembly contains two 0-ring gaskets that act as seals and should be replaced about once a year. The filter assembly has been described earlier in this manual under the subtitle "Filter Assembly." **Figure 3** shows how it is sealed with 0-ring gaskets.

2. **Plastic Hose:** The hoses inside the gas generator chassis and their connections at the filter assembly, generator tank outlet tube, pressure gauge and generator chassis outlet tube should be checked for pressure tightness. A leaking hose should be replaced with a new hose and new hose clamps. Hose connections can be checked by brushing over them with a water/soap solution that will bubble up when the instrument is in operation if there is a leak.

3. **Generator Gasket:** A special composition, resilient gasket between the generator tank and the headplate serves as an electrical insulator, a seal and a high-pressure relief means. After long use**,** this gasket may develop a sufficient
set to permit a low pressure leak which can sometimes be stopped by turning down the headplate nuts evenly and equally with extreme care with up to 15 inch pounds of torque. Excessive torque is not recommended and if 15 INCH POUNDS does not stop the leak, the gasket should be replaced. This gasket can be checked for leaks in the same manner as the plastic hoses. If possible, the gas generator should be returned to the factory for replacement of the generator gasket.

4. **Filler cap and booster cap gaskets:** These gaskets are made of special composition rubber that can become cut or take a permanent set and develop a leak. Visual inspection should be sufficient to determine whether replacement is necessary.

5. **Rubber torch hose and booster hose:** These hoses should be visually inspected each time the instrument is used. After a year or two, these hoses can lose their resilience and crack and should then be replaced. These hoses are best inspected under 1Ox magnification with a bright light. When the hose is bent abruptly back upon itself at 1800, cracks will show up at the outside curve of the bend.

6. **Torch Handpieces:** The enlarged torch handpiece (with expanded body section) should be serviced periodically to prevent clogging as described later in this manual.

All torch handpieces can develop leaks at the tapered end where the torch tip slips on if the tapered portion becomes damaged in any manner which destroys the precision taper lock fit between the torch tip and the handpiece. This taper should be carefully checked each time the instrument is used and should be very closely inspected if the torch handpiece is dropped or otherwise struck in a manner which could cause damage.

7. **Filler Cap O-Seal:** The 0-ring should be lubricated whenever necessary. The 0-ring should be replaced about once every 18 months or 2,000 hours use, whichever s all first occur.

The filler cap 0-ring seal can be checked for leakage by painting a water/soap solution around the riser piston screw head during operation of the gas generator. If a soap bubble develops around the riser piston screw head, this means there is leakage past the filler cap 0-ring and it should be lubricated and/or replaced and then rechecked again for pressure tightness. The filler cap can be returned to the factory for servicing if desired.

8. **Defective Pressure Relief Solenoid:** A leak in the solenoid valve seat can be detected by placing the index finger over the gas discharge port on the bottom of the solenoid and feeling for a pressure buildup. The valve should open and remain open only when the instrument is de-energized. Carefully check the inlet and outlet tubes.

Orange Flame

An orange flame develops generally from one or more of five causes:

1. Insufficient gas pressure at the torch tip permitting flame to burn backward into torch tip and burn up tip. Causes are:

a. Gas leaks
b. Plugged gas line
c. Dirty filter element (stone)
d. Low water level in gas generator tank
e. Low line voltage
f. Deformed torch tip
g. Too large torch tip being used
h. Corroded electrical connections
i. Electrical failure

2. Booster low on fuel or out of fuel.

3. Dust particles ' in air, which contain sodium, are being burned up in flame.

4. Torch tip dirty.

5. Gas generator is overheated and is delivering water vapor through torch tip.

Corrective measures for each of the foregoing causes are described elsewhere in this manual under appropriate headings. A close and thorough study of the instruction manual should be made to learn about and understand each of the causes and the respective corrective measure for each cause.

Spitting / Overheating

Spitting of liquid from a torch tip during operation is often, but not always, associated with overheating of the gas generator. Possible causes of such over heating are:

1. Gas generator tank overfilled with distilled water.

2. Too high line voltage.

3. Contaminated electrolyte.

4. Corroded electrical connections inside gas generator chassis.

5. High resistance short circuit inside gas generator chassis.

6. Operating environment too hot.

7. Fan failure.

8. Gas generator excessively dirty.

9. Power setting too high.

Corrective measures for each of the foregoing causes are described elsewhere in this manual under appropriate headings. A close and thorough study of the instruction manual should be made to learn about and understand each of the causes and the respective corrective measure for each cause.

The gas generator will generally run hot, and a temperature of 140 ° F on the generator tank surface is not unusual. This temperature can be achieved when the gas generator runs continuously at or near full load conditions. At this temperature, the gas generator can be expected to deliver some water vapor into the gas lines along with the oxy/hydrogen gas. However, the booster will tend to trap out the water vapor before it reaches the torch tip. The green colored booster fuel supplied by the factory will change in color from green to pink when the booster has trapped out significant amounts of water vapor. This change in color indicates the booster fuel has become excessively contaminated and the booster should be cleaned out and replenished with new clean booster fuel.

When electrolyte in the gas generator becomes even slightly contaminated, especially with booster fuel, significant quantities of liquid and water vapor will be emitted from the gas generator at eve B lower tank temperatures than 140 P and the booster will require more frequent cleaning in order to serve effectively as a contaminant trap. Under certain conditions of electrolyte contamination, the tank temperature can also rise above 140 °F giving a doubly severe boiling type condition inside the gas generator tank and the gas generator should then have its electrolyte changed or be returned to the factory for servicing and generator tank clean out.

In super critical applications where an absolutely dry oxy/hydrogen gas must be delivered to the torch tip, use of a gas purification and drying tower is recommended. Such a tower is available from the factory and is described later in the manual.

After spitting once occurs, all gas lines and filter elements become wetted and will continue to emit liquid through the system until they run themselves dry or until they are

dried out by being removed and cleaned. Such removal and cleaning is only a temporary corrective measure unless the cause of vapor emission from the generator tank is also eliminated.

Trouble Shooting Guide

Problem

Blowing Circuit Breaker

Cause

1.Short between headplate and top cover or rear cover.
2. Shorted power transformer.
3. Shorted control circuit wiring.
4.Shorted rectifier.

Problem

Torch Hard to light

Cause

1. Contaminated booster fluid.
2. Condensate liquid has formed in hose.
3. Torch tip is partially plugged.
4. Excessive pressure at torch tip.

Problem

Flame has shrunk in size

Cause

1. Gas generator low on water.
2. Booster low on booster fuel.
3. Contaminated booster fuel.
4. Gas leak in system: Refer to Chapter 7, "Loss of Pressure"
4a. Filler cap gasket and seals Booster cap gasket
4b. Filter cap seal
4c. Loose torch tip
4d.Cracked or broken rubber hose
4e.Leaky plumbing inside generator
4f. Blown pressure gauge
4g. Faulty tank seal
5. Electrode dissipated inside tank.
6. Gas generator too cold.

Problem

Flame size has excessively increased.

Cause

1. Line voltage too high.
2. Overfilled gas generator.

Problem

Flame has a feathery appearance with insufficient heat.

Cause

1. Contaminants (oil, alcohol, and tap water) have most likely been introduced into gas generator or booster assembly.

Problem

Push-button switch does not light.

Cause

1. Circuit breaker has tripped on gas generator.
2. Line circuit breaker has tripped.
3. Indicator light has burned out.
4. Electrical short in circuitry.

Problem

Generator seems to be overheating (Tank temperature over 160°F)

Cause

1. Fan burned out.
2. Ambient temperature too high.
3. Line voltage too high.
4. Water level in generator is excessive.
5. Contaminants have been introduced into generator tank.

Problem

Burning up torch tips.

Cause

1. Too large torch tips being used.
2. Too many torch tips manifold on same generator.
3. Gas production too low.

Problem

Flame backfires into hose.

Cause

1. Torch handpiece or benchpiece is without a torch tip.
2. Torch Tip is too big (try smaller)
3. Pressure to low

Problem

Flame is orange.

Cause

1. Too low gas pressure.
2. Low voltage on power line.
3. Low water level.
4. Contaminated generator tank.
5. Plugged filter assembly.
6. Low booster.
7. Dirty torch tip.
8. Heavy dust conditions.

Shipping

Call 1- 800-40 FLAME to obtain a Return Authorization number along with our shipping procedure form. The most practical and safest way to ship a gas generator instrument is by motor freight (truck). UPS will deliver but take extreme caution to package and insure your equipment.

ALWAYS REMOVE ALL LIQUIDS from the gas generator before packaging for shipment. Do not ship the Booster tank. The gas generator gas outlet tube on the front panel of the chassis **MUST** be sealed off with appropriate cork or plug to prevent any residual traces of electrolyte whatever from leaking out. Using a small section of black rubber hose with a knot on one end is acceptable. The filler cap **MUST** be snug on the filler tube for shipping. The electrolyte, which is powerfully caustic, will corrode and mutilate the instrument badly if it leaks out in transit.

ALWAYS use the original DOT approved box the unit was originally shipped in to prevent damage. Please call if you need a new Box. Insure the unit for $2,800

Equipment returned to the factory should be shipped "freight prepaid".
If equipment is returned for repair or servicing, cost for the work required will be quoted by the factory for acceptance in advance by the customer. Normally, any repair can be completed at the factory within one week from receipt of a customer's authorization to proceed. All parts are returned for your inspection.
U. S. Department of Transportation regulations covering hazardous materials place the burden or responsibility for safe packaging upon the shipper. These regulations also require that the package be properly labeled to identify any hazardous material contained inside.