

A) INTRODUCTION

The Power Arc Ignitor is a non-fouling, inextinguishable, high energy electric ignitor for all common oil and gaseous fuels.

Essentially the ignitor consists of a controlled capacitor discharge that produces a high temperature arc. This Arc is generated at various arc rates, depending on model, from 2 to 15 pulses per second. It ignites fossil fuels more efficiently than a gas or oil torch.

In schematic form, the ignitor works this way: A high voltage DC source supplies a D.C. current to a capacitor. When the capacitor is charged to a preset level, it discharges through a gas filled 'Spark Gap' to the semi-conductor arc tip, where the electric energy is dispersed in the form of a high temperature arc, which lights the fuel. When discharged, the ignitor automatically recharges it's capacitor. This charging/discharging occurs in well under a second's time, so an ignitor left on for say 15 seconds will deliver 15 times the pulse rate of high temperature/ high current arcs for a particular light off.

The ignitors energy output is rated in joules. A joule is the unit of energy that refers to the energy stored and discharged in each capacitive discharged pulse. A simply calculated example: $E = \frac{1}{2}CV^2$: 12 joules = $\frac{1}{2} \times (6 \text{ uf } \{\text{capacitor}\}) \times (2,000 \text{ VDC } \{\text{voltage of stored charge}\})^2$ squared.

The term PowerArc comes from the original models of the early 1960's. Some of our models are still produced today but we also make a line of newer units. Today they belong to a genre called CD (capacitor discharge) ignitors. They are also referred to as "direct energy ignitors" -meaning the electric energy supplied to the units light main burners directly.

Ignitors are supplied with two basic segments: a lance assembly with an "Arc Probe" that is the actual part of the ignitor that touches the fuel and provides the high temperature arc and a "Power Pack" that is the power supply that provides the pulsating energy. Both units are designed to work together and therefore an evaluation of either one necessitates an understanding of the circuit as a whole. In particular the pulsating aspect of the Power Pack only becomes apparent when connected to the Arc Probe.

Differences between ignitors reflect diverse styles of "Arc Probes", different energies of Power Packs, and an assortment of interconnecting hardware. This manual focuses on applications and general trouble shooting criteria. Therefore for specific understanding of your equipment one should review the equipment itself or its' drawings.

B) ** WARNING **

The Power Arc Ignitor System deals with:

- Stored Energy in a Large Capacitor,
- Sizable Electric Currents,
- High Voltage,
- and a Bright, High Temperature Welding Type Arc.

PLEASE TAKE PRECAUTION: Extreme maturity and professional knowledge must be used when dealing with and evaluating these ignitors. They can be lethal, or at the very least cause pain, if not dealt with in a sensible manner.

C) THEORY OF OPERATION

GENERAL:

The Arc of the ignitor is not like a normal 10,000 volt AC spark that one might have experienced in the past. Rather it is a high current DC Arc at a relatively low voltage that is initiated so many times per second.

The energy output of the Power Arc is rated in joules and refers to the energy of each pulse. Larger energies are needed for heavier fuels to burn through viscousness and contaminates. Energy ratings are usually either 2, 4, 12 and 20 Joules. The pulse rate too is a variable between models. So many 'x' joule pulses per second. The higher the pulse rate the higher the rate of ignition "attempts."

A joule is equal to one watt second, that is, disbursing one watt in one second. When a unit is rated at 12 joules it means that each arc of the ignitor is delivering 12 joules of energy. Since the discharge duration of each arc is approximately 6 micro seconds, the calculated power output amounts to 2,000,000 watts per arc. Or, in other words, a 12 Joule Power Arc System delivers Ten 2 Megawatt pulses for each second it is on.

It is this high current Arc, accomplished by taking the energy stored in a capacitor and discharging it over a short time duration, that accounts for it's ability to ignite any fuel and "burn" through all sorts of dirt and contamination on the Arc Probe.

IMPORTANT ASPECT:

The actual arc of the Arc Probe occurs directly on the end surface of the Probe. The spark that one might see, if actually looking at it, is the incidental aura of this surface arc - not the arc itself. As a result, the Arc Probe that is delivering the pulsed energy must actually be in the fuel stream such that the fuel spray is touching the surface of the tip of the Arc Probe.

The spark of the Arc Probe, in almost all cases, reliably lights the small bit of fuel that it touches. This can usually be observed by yellow-white flames coming from the blue-white spark. However, this small amount of combusted fuel is only a portion of the total fuel spray. Complete ignition of the burner happens, therefore, by propagation of this small amount of heat to the balance of the fuel pattern. This aspect is more fully explained in some of the following paragraphs.

D) INSTALLATION

General & Oil Fired:

When used to light oil, the Ignitor should be installed according to the burner manufacturers recommendation. Generally speaking the inserted Arc Tip should just reach the oil spray approximately 3" - 6" from the burner tip, more or less perpendicular, and within 1/2 inch of the solid part of the fuel spray. In most applications after ignition, the Ignitor Probe must be withdrawn to keep from burning up.

The general idea is that one wants the oil to actually touch the center of the end of the Arc Probe (where the actual spark originates) and then remove the Probe from the resulting flame as soon as possible.

In retraction, one is aiming to withdraw the Ignitor Tip to behind the diffuser, where it is much cooler, as soon as the fire is stable. Under no circumstances should the ignitor be left in the fire if it is not arcing and no longer than its duty cycle. How to accomplish this is determined by the logic of the burner management control system which is the result of Application Engineering. Therefore questions on this aspect must be directed to those responsible for actually applying the Ignitor and not to this manual.

The driving energy for the Arc Probe comes from the Power Pack. Since the Power Pack is delivering high pulsating currents (see the "Theory of Operation" section for review of this aspect), the distance between the Power Pack and the Ignitor Tip can be critical. Line losses can reduce the amount of energy delivered. Generally the cable between the Power Pack and Ignitor should be as short as possible, usually no more than about 20 feet. However, if an application allows for less than full energy, a longer cable run can be used. For instance, a 12 Joule PowerPack might be used with a 140 ft. long cable run if a 4 joule PowerPack would have sufficient energy for the particular situation using a "shorter" cable. In other words, the cable loss can be made up with a larger PowerPack.

Physical clearances are also a consideration. Since the Ignitor will be moving in and out during normal operation, one should insure that the Ignitor will not hit any physical obstructions such as the burner's diffuser on insert or over head obstructions on retraction. Also one should anticipate outside clearance for removing the Ignitor Probe as well as the thermal expansion of the boiler with respect to the foundation.

For Natural & Lp Gas Firing:

Generally the same criteria that apply to oil firing also apply to gas fired situations with two additional considerations:

1) When one immerses an Arc Probe in an oil stream the spark of the ignitor lights the oil because there is adjacent oxygen for oil to combust with. However, gaseous fuels, unlike oil, tends to displace surrounding air. Therefore it is possible that the spark of the Ignitor might be positioned such that it is in a cloud fuel with no oxygen and thus, although sparking correctly, does not light the gas.

In applying the Power Arc system one must therefore be careful to position the arc probe in an area of the burner that has a mixture of both air and gas. Often this can be found in the outside zone of the gaseous spray pattern. But if not, then some other region of turbulence must be established; the Ignitor Tip must be see both gas and air to work.

2) Unlike an oil fired system, the Ignitor Tip may sometimes be left in a flame pattern, without retraction, if careful attention is paid to the exact placement of the ignitor tip. Basically it involves insuring that the ignitor tip is not seeing too much heat.

In both the above cases, choosing the described position involves subtle design criteria. It is the responsibility of application engineering, and is therefore beyond the scope of this writing.

E) EQUIPMENT STORAGE

For long term storage, it is advisable to store the Ignitor in a heated facility to minimize condensation build up. Normal temperature extremes (-20 degrees F to +180 degrees F) will not affect the unit. However, if it is suspected that the unit has been exposed to excess water or temperatures, it is advisable to trouble-shoot the system as outlined under the "No Spark" subsection, or at least thoroughly pre-test the ignitor as outlined below in the "Initial Check Out" section.

F) INITIAL CHECK OUT

It is best to operate the Ignitor and its control system before a light off is actually tried. This can often be accomplished by manually shutting off the fuel valve and then by-passing various interlocks.

However this should only be attempted with the knowledge and consent of the burner's operator (s).

For initial start-up, check all physical, electrical and pneumatic connections. Disconnect the voltage input wire to the Power Pack, insuring that the Ignitor itself is not turned on, and stroke the Ignitor in and out to insure it is moving into the anticipated position. Reconnect the voltage input wire and check that the Ignitor is arcing.

CAUTION:

Since the Ignitor is delivering the spark into a combustion area, one must be sure the furnace is free from combustion vapors.

Any difficulty at this point should be evaluated as described later in this manual. If the Ignitor is inserting and arcing, one is now ready to try a light-off. Read the "Principles of Operation" section of this manual and "Combustion Setting" subsection (in the "Trouble Shooting" area) to understand how the Ignitor lights a burner to anticipate light-off problems.

G) TROUBLE SHOOTING

If a fuel ignition problem is experienced, first determine if the ignitor is sparking at the Tip. If it is, then an Ignition problem must either be caused by a combustion setting or an incorrect positioning situation.

Combustion Setting:

If the ignitor is arcing and touching the oil spray, it will light the fuel that it encounters. However, the propagation of this small flame to the balance of the oil spray (that is, a successful burner light-off) can be retarded. Too high a wind velocity or too much oil spray can quench the initial ignition effort.

Generally, one has selected a light-off position or conditions that have or have created a stagnation area to allow more time for the initial oil flame to propagate. As an example, the sequence of operation might have the air dampers deliberately being closed at light off to facilitate this. Or too, the fuel or air pressure settings might be specifically selected downward for the light off situation.

The following are potential criteria that could negatively affect ignition of the complete burner: Low oil temperature, short duration of oil spray, a different spray angle, wet atomizing steam, cold air temperature, clogged oil nozzle, fuel or air pressures that are different than the designed start-up settings.

Some burners are more affected by the above criteria than others and, therefore, an acquaintance with the normal light-off conditions is helpful in trouble shooting a combustion situation.

Retract Models: Not In Position-

If the Ignitor is sparking but not in position:

1) If the Ignitor is not inserting, check the power and air supply to the solenoid valve. Check the solenoid valve to make sure air supply is changing from retract to insert ports. Check the cylinder for leaking gaskets and/or piston rings. There are kits available to re-build both the retract cylinder and solenoid.

2) If the Ignitor is inserting nut not in the edge of the fuel spray, check the guide pipe and retract assemblies, make sure they are correctly installed and tight. To reposition the ignitor, loosen it's jam nut and move it.

No Spark-

If no spark is observed during the Ignitor cycle, check the following:

(CAUTION: This is a high voltage unit. Trouble shooting this equipment should be done by trained personnel only.)

1. Check supply power to the Power Pack, make sure there is proper voltage to the correct terminals. Check that the proper jumpers are installed as per Power Pack drawing.
2. Turn off power. Make a visual check of Ignitor cables, electrical connectors and arc tip. Insure that the ignitor cable is not damaged, that connectors are seated properly and Arc tip Arc tip is not eroded (Carbon buildup will not affect spark). Check that all wires are made properly to their termination points.
3. With the cable disconnected, check continuity.

4. If the Power Pack has an external resistor, check it's continuity.
5. Check the resistance of the Arc Probe Tip by putting a meter across the two terminals in the probe housing.

The Tip is a semi-conductor device and can have a resistance between a few ohms and 10 meg ohms, but it should not be much above that - and definitely not infinity. Carbon build-up will not effect the spark, but it will effect the resistance readings. To replace the tip, hold the tip nut and loosen the socket nut. To remove, pull the tip straight out.

6. Check for shorting in the single conductor wire. Since the Arc Probe is neither an open circuit nor a pure conductor, one must remove the Arc Probe and then measure continuity. With the Arc Probe removed, there should be NO RESISTANCE between the central conducting wire and ground. If there is, this is an indication of a shorted pathway for the pulsating voltage and might be causing "No Spark" being delivered to Arc Probe Tip when the Tip is otherwise installed.

7. On newer models, the Spark Gap is designed to be easily replaced. If this is case, this item could be defective in preventing a spark from leaving the unit. One quick check is that immediately after an ignition attempt, using an insulated plastic handled shrew driver, short the "shorting" side of the spark gap. If a spark occurs the unit is at least partially working. Try this a few times if a week spark seems to be occurring; one might have perchance stopped the unit in a lower voltage period.

8. Try the Ignitor with a Power Pack, known to be good. If ignitor sparks, replace Power Pack. A defective Power Pack cannot be field repaired; return it to a factory repair facility. Before removing make sure power is off and short each terminal to ground, to make sure all voltage bleed off.

Sparking along Cable or in ground areas-

If the ignitor is sparking in places other than the electrode end.

Because the ignitor's pulses are very large current spikes, on the order of 500 to 1,000 amps in each arc, earth grounds (such as is used in simple high voltage spark plugs) are not used in these circuits. There is provided a separate ground wire of equal or larger gage. Make sure the provided ground connections are as solidly connected as the High voltage side, otherwise an electric sparks and shocks could follow on the earthen side of these systems.

1. Turn off power. Make a visual check of ignitor cables and electrical connectors. Assure that cables are not damaged, connectors are seated properly and all wires are made properly to their termination points.
2. Check cable connectors and make sure both ends of cable braid is well grounded, if armored cable.