Electrode Detection of a Gas Flame

Theory of Operation

If you look closely at a finger of burner flame you will see that it is clearly made up of three separate elements:
(see figure 1)
1. Inner fuel rich cone
2. *Ionized blue outer cone with current carrying capabilities
3. Outer air rich mantle.
When gas combined with air; burned energy is released in the form of heat and light. When the gas / air mixture is controlled, the outer blue cone will actually carry electrical current similar to a wire.

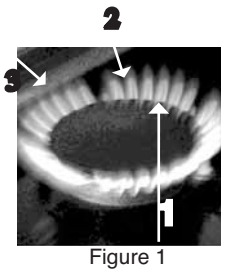


Figure 1

If we place a metal probe into this “Ionized Plume” and apply a voltage between it and the burner, current will flow. An important characteristic of a burner/flame/electrode assembly is its ability to mainly pass current in one direction. It behaves as a one way valve or rectifier.

Flame Rectification systems make use of this directional characteristic when detecting a good flame to distinguish it from leakage currents that can arise due to moisture contamination, soiled igniter tip, poorly grounded burner spreader ring / burner head, cracked igniter insulation or poor house ground.

A voltage of alternating polarity (an AC voltage) is applied to the electrode from the spark module and the resultant current flow which is greater in one direction than the other, is electronically detected. This current is very small, about one microamp (one millionth of an amp).

The Dacor re-igniter has a specified minimum flame current that will be sensed as a flame of 0.5 microamps (1.3uA minimum sensitivity for C664 Series Gas Ignition Systems). The minimum recommended flame current measured under all likely conditions in an installation should be 1.0 microamps for re-igniters (2.0 microamps for C664 Series). When a burner flame is present the Ionized outer cone will be producing a small DC current. This current is known as (Flame Current). The flame current has to be at a certain level to allow voltage from the spark module to flow efficiently.

The accurate placing of the electrode in the flame is important. This igniter tip needs to be perfectly located in the ionized outer blue cone to effectively send and then detect current flow.

To break it down further, the spark module acts as a simple capacitor. It saves voltage like a sponge until it can hold no more. It will save and release this voltage approximately 3 times per second. When the voltage is released it follows the spark wire until reaches the spark electrode tip. The built up voltage wants to leave the tip and move to the point of least resistance. In a healthy situation this will be the burner spreader ring. From the burner spreader ring the voltage flow will pass through the burner head, burner tube, chassis and to ground. An interruption of this current path will cause the spark system to misbehave.

The flame also plays a very important role in this process. Because the flame is conductive, it allows the voltage to pass through its body like a bridge to the burner spreader ring. This {bridge} allows the built up spark voltage to bleed off of the igniter tip and move to ground more easily. The resultant ionized flame bridge has now become the path of least resistance for the spark to take across the gap between the spark electrode and the burner body.

By bleeding off the buildup of voltage we stop the spark from occurring. The spark is, in effect, still there, you just can't see it.

* Ionized / To separate into Ions or to become electrically charged.
In order to successfully detect a flame we first need to;

1. Place the electrode in the correct position under all flame conditions.
2. Ensure the flame is stable and does not "lift off" the burner at the ports adjacent to the electrode and put the flame beyond the electrode. It is very important to have a stable flame especially around the igniter tip.
3. Ensure there is a secure ground path to earth from the burner spreader ring / burner head.
4. Confirm the appliance is properly connected to earth ground.

Current Path
The current path for detection is through the spark electrode, outer plume of flame, burner spreader ring, burner head, burner base, chassis and earth ground. If this path is broken, the current cannot flow and sparking will occur. A proper flame will keep this from happening. In other words, the current will always flow through the path of least resistance and it might not be on top of the cooktop, it might be below the top frame and out of sight. In this case, suspect a defective spark wire or a pinched spark wire.

Do you have a ground prior to the igniter tip?

If there is a current path (leak / ground) prior to spark electrode,there will likely not be a spark pulse between the electrode and the burner spreader ring. This phenomenon is what leads most servicers to believe they have a defective spark module.

The spark module can tolerate a relatively large leakage before going into fault condition and generating a spark. The tolerance to leakage decreases with an increasing amount of flame current therefore it is desirable to obtain a high flame current at the appliance design stage to provide some allowance for increasing leakage with age and use. The better the flame current / ground, the less likely there is to be reignition.

Possible Causes Of Continuous Sparking:
Defective spark wires.
Continuous high heat can cause spark wires to degrade. Use volt/ohm meter to determine continuity of spark wires. Look for obvious cuts/ abrasions or pinch points. A defective wire can allow spark voltage to transfer through insulation to ground prior to reaching spark electrode. Under normal circumstances all igniters fire together and if the burner in question has found an easier ground path the spark will go there. It will not, however, in most cases have found a CONTINUOUS ground path such as what the flame would provide under normal circumstances. This will cause the spark module to re-ignite.

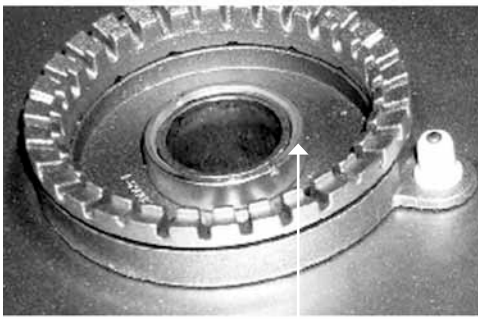
Cracked Ceramic Spark Electrode
It's important to determine whether the spark electrode is faulty. Physical impacts and high heat can cause the ceramic post to fracture or crack. If this occurs the spark can shoot through the ceramic insulation and will normally go to ground on the burner head rather than through the flame /burner spreader ring.

Faulty Burner Grounding
From the spark electrode / burner spreader ring to earth ground it is important that you have a strong connection. This can be interrupted in many different ways.

- Soiled spark electrode
- Soiled burner spreader ring
- Soiled burner head
- Corrosion between the burner head and burner tube.
  Normally this will appear as a brownish stain and can be easily cleaned with a small wire brush.

Any of these conditions can interrupt current flow. We recommend frequent cleaning with a stiff plastic or soft wire bristle brush using pure alcohol or a window cleaning solution that contains alcohol. It is commonly thought that simple igniter cleaning is enough, it is not. You have to clean all three conductive components to ensure good continuity. A small amount of grease or oil can act as an insulator and prevent the spark from flowing properly.

The burner head and burner tube connection has to be tight. The fastening ring that holds them together has to be seated properly in order for the two components to properly pass electrical current.



Burner Fastening Ring

Poor house ground
If you have thoroughly diagnosed the spark system and continue to have erratic sparking do not dismiss the home ground as the culprit. Many older homes that are being remodeled do not have adequate ground systems in place to handle today's demands. A quick diagnostic tool is a 20-foot piece of 16-gauge wire with alligator clips on each end. This can be used a temporary {jumper} to a known ground source. If the problem is eliminated when you connect the {jumper} you have to suspect the home ground as the culprit. When tested, the Neutral and ground should share less than 20 volts.

Erratic Sparking
It is common to find one or a series of burners that will only spark occasionally. As with the previously described scenarios check all possible ground faults. This is the number one cause of erratic sparking, not spark modules as is more commonly thought. If you have made certain that you have a strong flame current / flame placement / solid ground; replace spark module.