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NEWSLETTER

How to Minimize Igniter Mis-fires

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How To Minimize Igniter Mis-Fires

By Tim Van Milligan

Dave Donaldson writes: *"I put a lot of love and care into building my rockets, but often times I wind up embarrassed when the engine will not ignite. I think the causes are varied: Sometimes I hear the igniter burn, sometimes I think there is a short... could you provide a checklist to maximize the possibility of a good launch?"*

Don't be embarrassed. I don't know of anyone that has 100% success when lighting black-powder motors.

Is it the igniter that is the problem? Maybe. But how much are you are willing to pay? If you want more reliability and fault tolerance to improper installation, the higher the price you'll have to pay. Just think of how much NASA must pay for igniters on its solid rocket motors!

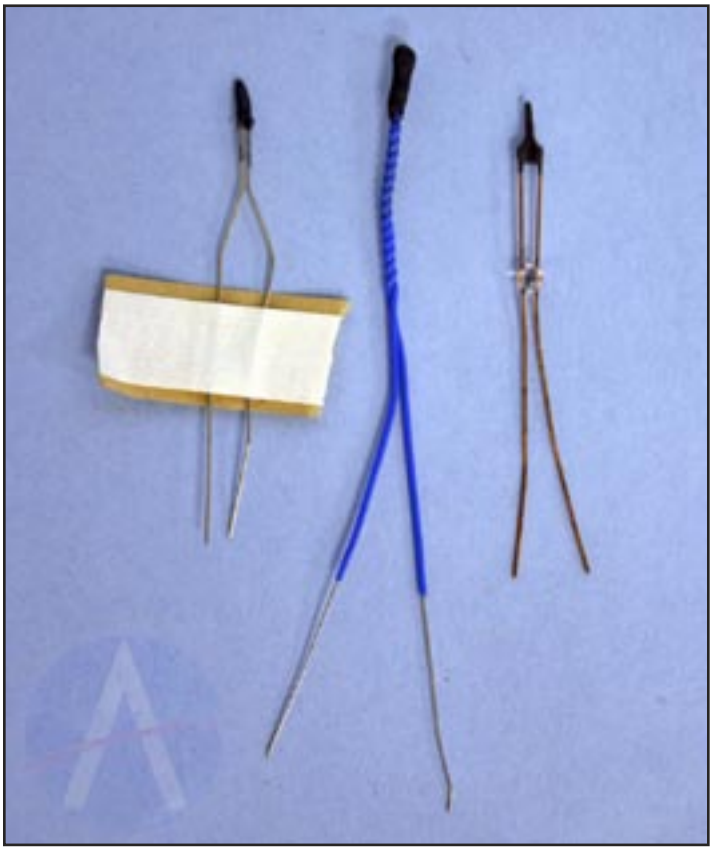

Figure 1: The three types of igniters for black powder motors: Estes Solar igniter, the new Quest Q2G2, and the original Quest Q2 igniter with the glass bead.

Unfortunately, the motor manufacturers like Estes and Quest are under a lot of pressure to keep the price of motors and igniters down to a minimum. So while they would love to give you an igniter that is 100% reliable, they have to make an igniter that is also inexpensive, which is done by using lower cost materials and construction techniques.

The quality of the igniters have come a long way in the last thirty years. Just ask anyone that remembers the bare nichrome wires of the 1960's. Even in the last 10 years, I've seen a number of new igniter designs from Quest that have been improvements on previous designs.

There are currently three different igniters used for igniting black-powder motors. The Estes Solar igniter, the Quest Q2 igniter, and the new Quest "Q2G2" igniter (see Figure 1). "G2" stands for *Generation 2.*

The reason Quest has two igniters is that they recently switched manufacturing plants that make their motors. The new manufacturing plant is located in China, and is supplying the "Q2G2" igniter with the motors they make. I contacted Bill Stine from Quest for this article, and he mentioned that there is no current plans to discontinue the original Q2 igniter (http://www.apogeerockets.com/igniters.asp). In fact, he said that Quest has plans to offer a new version without any pyrogen on the tip. This new bare-wire igniter is designed to fit into the tiny nozzle of the MicroMaxx motors.

While the Q2G2 is still new to me, I believe that it will be my igniter of first choice. The insulated wires solve so many problems with installing and hooking it up that I'm really excited about its potential. And besides being great for clustering motors, it can also be used in composite propellant motors like the Apogee E6 and F10 motors (http://www.apogeerockets.com/composite_motors.asp).

At the moment, I only have them available in the packs that contain rocket motors. But we will be getting 6-packs of Q2G2 igniter in the next week or two. I just found out that they are now available, so I have ordered some for you.

Getting Igniter Reliability

Since we know from experience that we are not going

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to get 100% reliability from any igniter, the next best thing is to do everything we can to improve our own current success rates. I don't know of anyone that tracks their own ignition success, but it isn't a bad idea to start. Once you have data, you can establish procedures to improve your success rate.

Step 1: Inspect the igniter wires where they protrude out of the pyrogen at the tip. They must not touch each other.

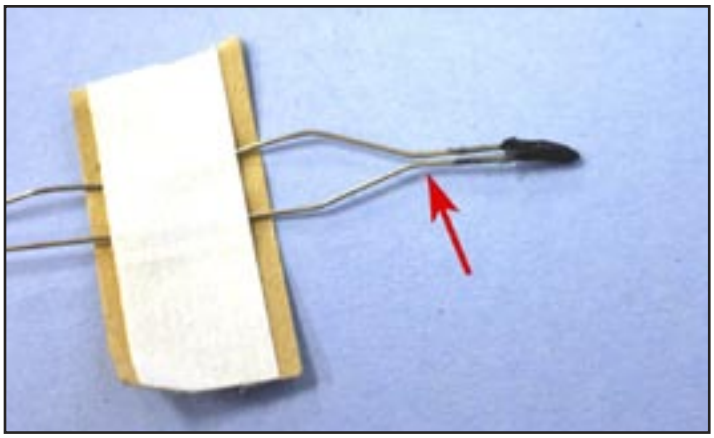

Figure 2: Make sure the wires don't touch each other. But use care when separating them.

If they are touching or are so close that you worry that they might touch, then you must open up the legs.

Between the Estes Solar Igniter and the original Quest Q2 igniter, I prefer the one from Quest. The reason is that little glass bead that holds the two wires apart. When it comes from the factory, that little bead really grips the wires and does an outstanding job of keeping the wires from touching.

The Estes Solar igniter only uses a piece of tape to hold the wires apart (see Figure 2). Unfortunately, the tape doesn't really grip the wires that well, and they can slide closer together near the pyrogen at the tip.

I've watched people playing with the Estes igniter, and I can tell that they too realize that the tape isn't holding well. So they just take the two ends of the wire and spread them apart even further so that they aren't touching. But what they always do is spread the legs too far, and you hear a little "pop," which means that they just broke the pyrogen on the tip.

At that point, you've compromised the structural integrity of the igniter. It may still be a good igniter, but there is no way to know without firing it off.

If you must spread the wires apart on the Estes igniter,

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be sure to pinch the pyrogen tip in your fingers. That way when you spread the wires apart, you won't break the pyrogen on the tip.

The Quest Q2 igniters with the glass bead should be held the same way if you have to spread the wires apart. But because of the little glass bead, it will be harder to do. I like to take a pointy object like a toothpick, and slip it between the wires to pry them apart. But this is pretty rare, since I've found the wires of the Q2 igniter to be very stiff and resistant to being squished together.

The new Quest Q2G2 igniter uses insulated wires, so there is no need to separate them. They are twisted at the tip; and you should leave them that way.

Step 2: Turn the rocket upside down, so the nozzle is pointing up.

I rarely see new modelers turn their rockets over so the nozzle is up. So I am beginning to think that this is a big reason why they have a lower ignition reliability than I do. Why is this important? Continue reading in step 3.

Figure 3: Turn motor so nozzle is pointing up before inserting the igniter.

Step 3: Drop the igniter into the nozzle.

The pyrogen on the tip of the igniter must be touching the propellant inside the motor. If it doesn't, there is a good chance that there will not be enough heat transfer from the igniter to the propellant to start the combustion process. That is why you need to "drop" the igniter into the nozzle. Gravity will automatically pull it down to the bottom of the hole so the tip is touching the propellant. If you have the rocket sideways, then gravity doesn't help you when putting the igniter in.

Step 4: Insert the igniter plug/holder into the nozzle to hold the igniter in place.

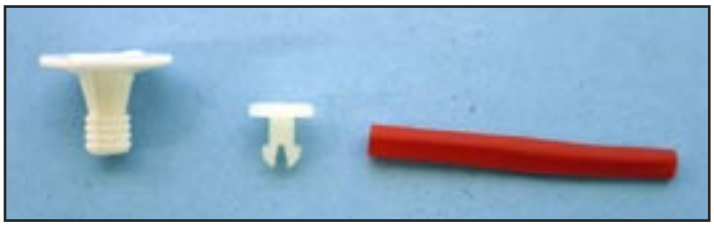

Figure 4: Igniter plugs. L to R: Estes, Quest Tiger Tac, and plastic straw for the Quest Q2G2 igniter.

Each igniter comes with its own plug/holder. The Estes igniter plugs are the best, because they are molded and give the proper amount of snugness when they are inserted into the motor.

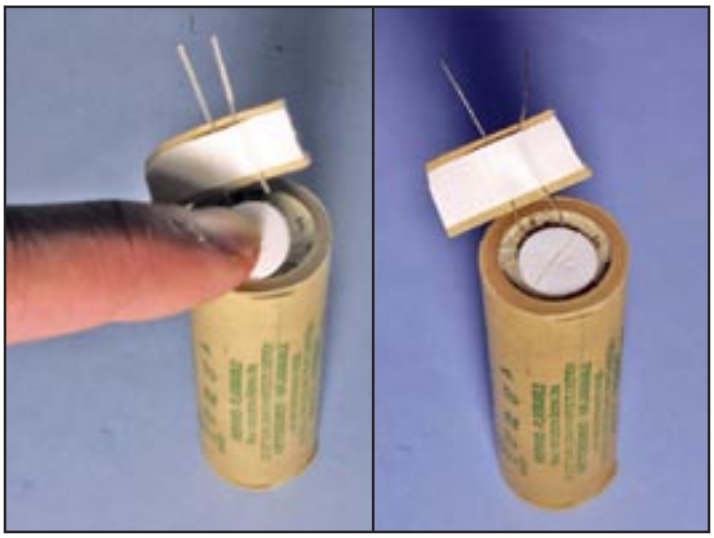

Figure 5: Push down HARD when installing the Estes igniter plug into the motor.

If you notice, the plugs from Estes are color-coded to the engine that they fit into. They are not interchangeable between the different motors. For example a plastic plug for the C6 motor is not the same size as the one for the D12. So make sure you have the correct one. The little flag that is on the tip of the row of plugs will tell you what engine the plug fits into.

To use the Estes plastic plug, just use your thumb to press firmly on the plug until it is all the way into the nozzle.

As nice as the Estes plastic plugs are, there are three ways to screw them up. The first way is to leave the little plastic separator on the tip. This is the little do-dad on the tip that is a remnant of the molding process (see Figure 6). This little do-dad must be removed, otherwise the plug can't be inserted far enough into the nozzle to get a good grip and hold the igniter in place.

Figure 6: Remove the scrap piece, or it won't fit in the nozzle.

The second way to mess things up is to twist the igniter wires during the plug insertion process. If the wires are touching, they will cause a

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short and electricity will not reach the tip to start the pyrogen burning. What will happen is the wires will melt at the point they touch and you'll get a mis-fire. When you pull the plastic plug out, you'll see that the pyrogen on the tip is still good. But at that point, you will still have to replace it.

The third way I've seen people mess up the plug insertion is to not push hard enough on the base of the plug. Again, the igniter will not be held in place tight enough. As soon as they flip the rocket over and hook up the igniter clips, the weight of those clips will tug down just enough to pull the tip away from the propellant. If they are lucky, the whole igniter will fall out and they'll get a second chance at putting it in properly. If they are un-lucky, then the igniter will fire, but the motor will not ignite, a common mis-fire.

Figure 7: You should be able to lift the motor by the igniter without it pulling out the plug.

When I'm working with younger children, I'll have them remove the motor completely from the rocket and put the igniter in first. Why do this?

First, it is harder to twist up the wires this way. I usually see them fumbling as they try to maneuver their thumb around the metal motor clip that holds the motor in the rocket. It is that fumbling that causes the wires to get twisted. So without the clip in the way, they can get a good straight shot at the hole as they are pressing down to put the plug into the nozzle.

The second thing that having the motor out of the kit

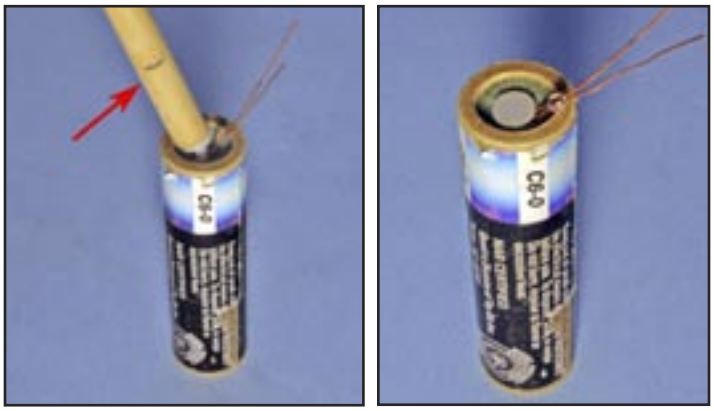

Figure 8: Use a wood dowel to push down hard when installing the Quest "Tiger Tac" plug.

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Figure 9: Use the plastic straw with the "Q2G2" igniters.

does is that it allows them to check on the grip of the plug in the motor. You should be able to hold the motor by the free ends of the igniter wires without the motor falling (see Figure 7). This works even on heavy "D" size rocket engines. If the plug pulls out, then you didn't push hard enough to hold it in properly.

The original Quest Q2 igniter uses a one-size-fits-all plastic plug called the "tiger tac." Unfortunately, it doesn't fit really well, and it is a bear to put in. The reason is that Quest was forced to use an off-the-shelf item to get around the patent that Estes has on its igniter plug. That plastic plug was created for another purpose, which I think was a rivet to hold sheet-metal parts together.

It does work though, but you have to push it really, really hard into the nozzle. I use the flat end of a wood dowel to push it into the nozzle.

The new Quest Q2G2 igniter uses a thin plastic straw to hold the igniter into the nozzle. To use it, take the straw and flatten one end and fold it in half. Then you can shove it into the nozzle after you drop in the igniter.

The plastic straw serves another purpose too. The straw is slipped over the pyrogen to protect it from being smashed during transport. So don't throw it away after you remove the igniter from the package.

Step 5: Hook up the igniter clips

As you already know, you want to make sure the two clips don't touch each other, and neither touching the metal blast deflector. If they do, they'll short out and the igniter will not fire. I like the idea that our local rocket club does to prevent the clips from shorting out on the blast deflector. They slip an old CD-ROM on top of the metal blast deflector to provide some insulation. The disk gets pretty warped from the heat at launch, but it would probably have been discarded anyway.

While hooking up clips seems easy, I've seen some small things people do that can cause problems. The biggest mistake is not checking the clips to see if they are clean. The slag build-up on the clips will insulate the metal, and you won't get a good electrical connection when you attach the clips on the igniter wires. Alligator clips with "teeth" on the jaws are notorious for collecting a build-up of residue at the notch in the "V" of the teeth. And unfortunately, that is right where the clip touches the wire of the igniter. I think a lot of people are like me and prefer flat-jaw clips for small rockets because of this problem, and because the flat-jaw clips are easier to clean.

The other problem I see a lot, especially with kids, is that when attaching the alligator clip to the igniter, they place the igniter wire too far into the jaw. When the wire is too close to the pivot point of the clip, it is in an area that has a big gap. Therefore the wire is not being grabbed tight enough by the clip and it won't make good electrical contact. Make sure the get the wire on the flat area of the alligator clip, as close to the tip as possible.

The problem with flat-jaw clips is that often times the tip area is bent upward and you can't get good grip on the wire at that area (see bottom image in Figure 10). The solution is to inspect the clips beforehand, and bend the tips downward before you hook up the wires. It will bend pretty easily. Don't be afraid to adjust the clips so that they grip better.

Another thing that I see newbies do is to attach the clips to the very end of the igniter wires, and sometimes

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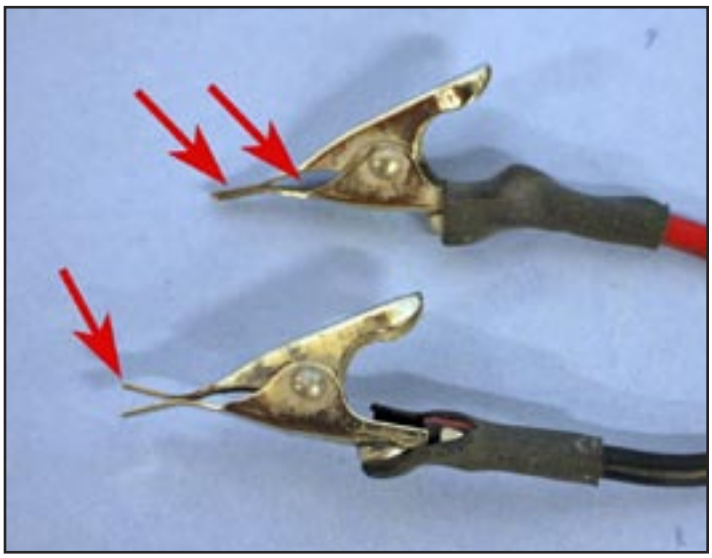

Figure 10: Attach to wire on the flat section of the clip, not in the gap near the pivot point (top). Bend the jaws flat if they are curved upward at the tip (bottom)

even parallel to the wire instead of perpendicular to the jaw. I suppose they do that because it gives more separation distance between the two clips. But that causes more problems than it solves. When the clip is at the very end of the wire, it is much easier for the clip to drop off the wire completely when the wind jostles the rocket. That is just as frustrating as a misfire, because you have to make another walk toward the pad to make the fix by reattaching it.

Ideally, you want the clip as close to the pyrogen as possible. This reduces the resistance in the circuit so it requires less power to fire off the igniter. When I hook up an igniter, I'll either pre-bend the wires on the igniter to a "U" shape and attach to that, or I'll wrap the excess bare wire around the clip of the jaw. Both these allow the clip to be attached closer to the tip, and they keep the excess wire from accidentally touching the other clip (see Figure 11).

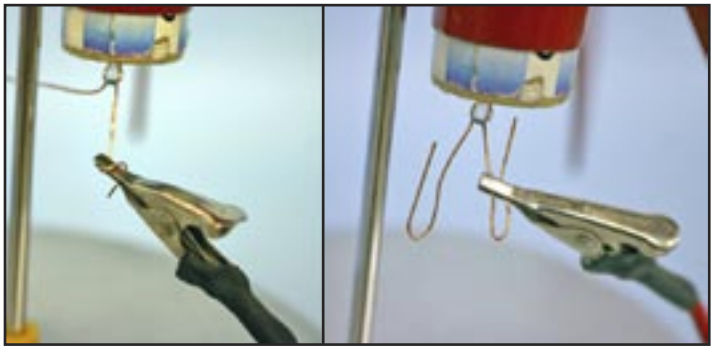

Figure 11: To get a better electrical connection, wrap the excess igniter wire around the clip (left), or curve the wires in a "U" shape and attach the clip across the leads (right).

Using the New Quest Q2G2 Igniter

Hooking up the clips to the Q2G2 igniter is similar to any other igniter. But I'd wrap the excess bare wire around the clip as shown on the left side in Figure 11. And because the wires are longer, the clips may want to sag toward each other and short out. Just make sure they stay apart from each other after you've hooked them up.

There is one concern you have to watch out for when using the new Quest Q2G2 igniter. It uses a very tiny bridge wire, and therefore has a very low all-fire current (150 ma). It is designed for use with the Quest 9V launch controller and the Sky and Estes 6V one. Many 12V systems or older launch systems with an incandescent continuity bulb will fire the igniter when the safety key is inserted. Quest is recomending that the consumer perform a safety/continuity test with an igniter by itself (with the igniter out of the motor).

This low current igniter would also make a good igniter when firing off motors using the staging timer (http://www.apogeerockets.com/Staging_Timer.asp). Just be sure to ground test the device first to confirm it works fine.

Other Things That Can Cause a Problems

Even if you have everything hooked up properly, there are still other things that can go wrong and prevent ignition. By far the biggest issue is dying or dead batteries in the launch controller. This happens all the time, even at large launches when the host club provides the launch system. So if nothing happens when you push the launch button, and you've verified that the clips are hooked up and not shorted out at the pad, then the first thing you should check are the batteries. Rare, but still possible is that the launch system might have a problem. This usually happens with club launch systems that have some fairly sophisticated circuits in them.

Some Causes of Mis-Fires

If you push the button and the igniter goes off, but the motor fails to ignite, this is commonly called a mis-fire.

In my opinion, mis-fires are almost always caused by the igniter not being in good contact with the propellant. That is why I always hold the rocket motor upside down when installing the igniter.

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It is possible for a little bit of dust residue to accumulate inside the nozzle and insulate the propellant surface from the igniter. This might happen if you drop the motor onto bare ground (dry), or if the motor has been sitting loose in a box with other black-powder motors for a long time. Whatever the cause, you can probably get it out by blowing air into the nozzle to get the dust out.

One last thing that I've seen is the wires melting off and falling out of the nozzle when the launch button is pressed. This is caused by a short in the igniter wires inside the nozzle of the motor. What this means is that you did not do a good job of making sure the igniter leads weren't close together or twisted when inserted into the nozzle. Seems to me that this is more of a problem with the Estes Solar igniter than the Quest Q2 igniter where the glass bead does a better job at preventing the wires from shifting.

Conclusion

I know how frustrating it is to push the button to launch the rocket and either nothing happens or you get a mis-fire. No one is perfect at installing the igniter, and occasionally, the igniter will fail. My suggestion is to laugh it off. Rocketry is fun after all, so just go with the flow.

At NARAM this past summer, I was watching a group of friends (all very experienced modelers) that went to the launch pad at the same time. I could tell that they were having a good time when they began singing out “”Lookie, Lookie, There's a Rookie!” when one of them would suffer a mis-fire. Sooner or later, every one of them in the group had earned the chant. What goes around, comes around...

About The Author:

Tim Van Milligan (a.k.a. “Mr. Rocket”) is a real rocket scientist who likes helping out other rocketeers. Before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *“Model Rocket Design and Construction,” “69 Simple Science Fair Projects with Model Rockets: Aeronautics”* and publisher of a FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with “SUBSCRIBE” as the subject line of the message.