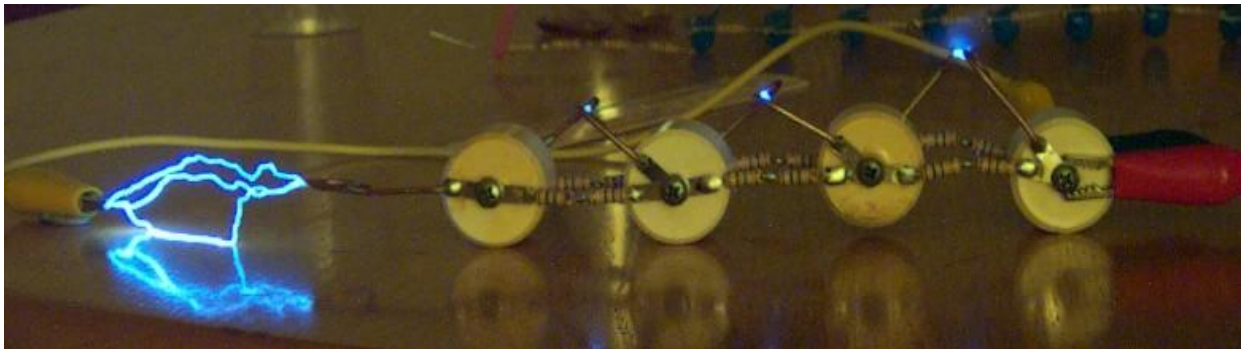
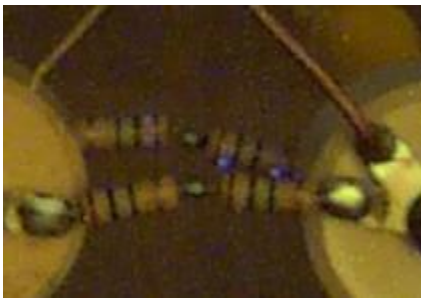
More Marx Generators

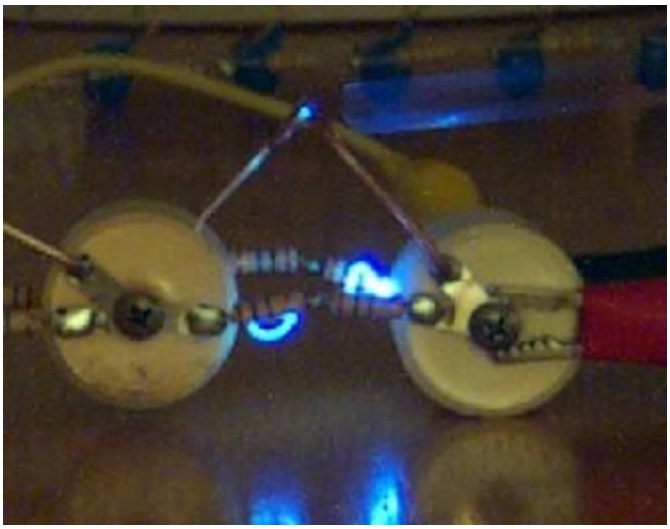
Two new prototypes for the New Year! With new capacitors and different construction techniques.



The first is made with doorknob capacitors I found laying around in a box. 470p, 30kV capacitors designed for pulse discharge and RF service. Note how one discharge has followed the desk surface, interesting. The charging resistors are two series connected 10M 1W units, on each side of each stage. This once again was a bad choice. Corona has come back to haunt me:



As these capacitors are good for 30kV I tried to space everything such that I could get the full voltage performance if I wanted to. These 1W resistors just aren't up to it. The have small, but very sharp points on the end-cap to resistance film soldering, the molding compound doesn't cover these well and they punch through in moments. The solder tags also suck, never use them in HV work! I should have known better, they are too thin and spray off the edges. They are also quite painful to work with mechanically. The end result is losses and more than occasional misfires when running at only 17.4kV:



The blury blue thing near the first gap is the soda straw I used to trigger it. As in my previous discovery, I can fire the gap manually by approaching it carefully with a dielectric. This proved quite handy for making these pictures, you'll see it in all the ones I took this evening. I simply set the gaps to (just) not automatically fire, turn off the lights, trigger the camera shutter and start waving the straw near the first gap.

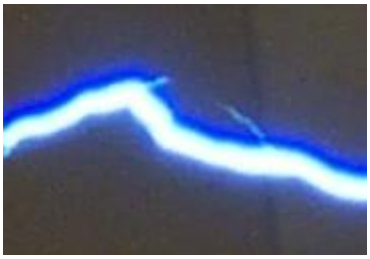
With an erected capacitance of only 117pF and charged a mear to 17.4kV the report is deafening. There is over 280mJ of energy stored in these caps at that voltage. This device is moderately dangerous. I haven't been shocked by it yet, and I don't want to be, it could be very nasty if it got you good.

As with my last device, if a striking ground is not offered, or is too far away, pale purple sparks jump all the gaps with a very soft cracking sound. The higher voltages involved in this unit though offer no doubt erection is happening properly. The hairs on my arm stand on end from the huge electric field generated at the top. Invisible streamers nip your fingers gently, if you are the closest object to the output terminal. It isn't painful, more surprising, but a few tens of millimetres closer and it might be a very different story.

With some corona dope I may be able to rescue this device, otherwise I'll have to junk the resistors (and the rest of the 500 on the tape, damn!) and use the 1/2W devices that were so much better in the previous unit. Still, it works as-is, with 60mm long, very loud and fat, sparks.

The next unit is made with eBay win capacitors. 2n2 10kV Russian military surplus capacitors. I am still waiting on a few other capacitor types to arrive, but most are of the same make as these devices, just different voltage and capacitance ratings.

That little leader branching out and back into the main spark is rather interesting, I thought.



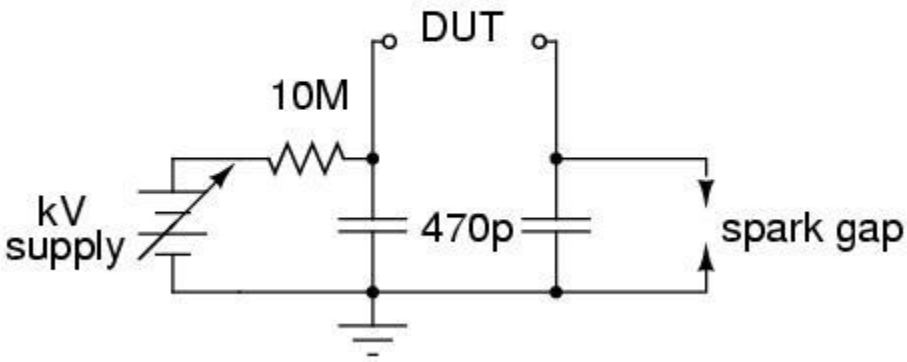
I am not proud of the construction, I tried very hard to keep it all neat and tidy. Then I hung it up to test it, and it all went wonky. The gaps alternate each side of the stack, which was necessary because of the lead length, unless I wanted to make a lot of gaps out of extra wire. I think next time I will make the effort, their leads are quite thin, about 0.71mm and make barely sufficient gaps.

This is probably the best Marx Generator I've built so far. While it has a slight leakage problem (I can hear some, but not find it), and the gap staggering makes it a little more temperamental to tune, it delivers deafening sparks over 100mm long with ease. It has an erected capacitance of 220p, charged to 7.4 kV from the -ve rail of the coronatron PSU, it has a stored energy of about 600mJ. I could raise that to 1.1J if I could find the extra 2.6kV safely. I am cautious about over-stressing these caps, they don't really look like they were built for pulse service. I have not done a destructive test either, I purchased only 20 of them and they are a little too pricy to just blow up.

Thoughts for the Next Round

I really need to get some corona dope and seal all the charging network. I'll fall back to 1/2W resistors, they are better at the HV, and are fine dissipation wise. I've worked out how to test the charging network components under the sharp rise time transients they'll experience:

Charging Element Tester



The principle of operation is simple enough, the first cap is charged through the 10M resistor, the second through the device under test. The spark gap breaks down, pulling one end of the device under test to ground very fast. The entire stored energy in the first cap flows through the device under test as fast as it allows.

I've been considering moving to choke charging networks. The actual inductance required isn't that big. The rise time of the discharge is fantastically fast, so even a few turns of wire would be a much larger impedance than the spark gaps.

I also have to implement an electrical trigger system. It is becoming a safety issue, as well as a performance one. One thing I did consider was using a small Marx generator to trigger a larger one. Perhaps triggering all gaps at once with equal length phasing lines to each gap. That should supply the ultimate in rise-time and jitter performance if properly implemented. I'd need some serious test gear to optimize that, but I can't really afford it right now.

Source: http://www.vk2zay.net/article/56