4.5" Tesla Coil System

Some interesting observations:

60Hz resonance: The MMC capacitor described below has a measured capacitance of .01066uF. The measurement was done using high-dollar govt. equipment, so it's there. Using a 15kV 60mA transformer, the impedance matching formula 1 / (2 * pi * F * C) calls to use a .0106uF capacitor...so this is the value I have used. Even though this might not be the optimum capacitance to use for this xfmr, but It's really cool because of the 60Hz resonant charging of the capacitor - I've never heard a sound quite like it. When slowly turning up the variac, my spark gap fires at about 5 - 10% of the 120VAC input voltage...not even enough to register on my voltmeter. At full power (and only at full power), the transformer screams a 120Hz whine - even heard above the output spark noise and spark gap.

Long component lifetime: My MMC cap is rated at 6kVAC. I have it in series with my primary coil, and this in series with my 15kV neon sign transformer and spark gap. Total runtime on the capacitor is 2.5 hours so far. I have NEVER used a safety gap, and I have NEVER used a filter network of any kind on this coil. Being reasonable, It's safe to say that my capacitor is seeing 20kV spikes regularly, along with a solid continuous 15kV from the xfmr. So why has my 6kVAC capacitor lasted so long?? Beats me. Sure - there are 15 or so individual capacitors that are split open, but the sucker still measures right on .01uF, and my coil still runs exactly the same. So far, I have replaced only 2 little blue caps because of internal arcing. I have not touched the others. Anyway I ran the numbers using the MMC lifetime expectancy formula and it came out to be one hour if my math was correct. I find it strange that I've somehow measled my way out of capacitor and transformer failure. The 15kV 30mA NST has never been touched (It's a jefferson by the way). No safety gap, no chokes, and an extremely underrated capacitor...yet it still performs flawlessly after 200% of its (calculated, theorized) lifetime is used up. OH - and the spark gap spacing has been set at .4" for the past hour of coil operation. I believe that my capacitor and/or transformer should've been toast a loooong time ago. So why hasn't it been?? I have no clue. Do you? Fill me in...please! The email is pyrotrons@aol.com

THE SYSTEM AS A WHOLE:

- Transformer
- Capacitor
- Spark Gap
- Pri and Sec coils
- Toroids
- No safety gap, no chokes, nothing for protection



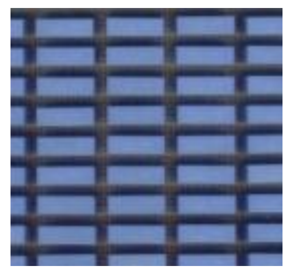

POWER TRANSFORMER:

- Neon Sign Transformer
- 110VAC 60Hz input
- 15kV 60mA output
- 250kohm secondary winding impedance @ 60Hz.
- 900W power output

SECONDARY COIL:

- winding is 21" on 4.5" O.D. PVC form 22" long
- 14.26" circumference
- 960 turns #24 nylon insulated magnet wire @ 47.2 TPI
- Fr - abt. 370kHz unloaded
- Fr - 200kHz w/ 23pF topload
- 20.4 mH inductance
- Self C - 8.5pF (calculated w/ Medhurst formula)
- sealed w/ 4 coats of 2-part epoxy

CAPACITOR:

- MMC Design
- Uses the Philips KP/MMKP polypropylene cap's
- Each capacitor rated 6.2nF @ 2kVDC, 600VAC
- 17 strings in parallel, 10 capacitors in each string
- One string C = .6272nF (.0006272uF)
- Total C of 17 strings = measured .010663uF
- Dissipation Factor = measured .00031
- Max rated VDC = 20kV
- Max rated VAC = only 6kV
- *** Small Note: After putting several hours of runtime on the cap with this system, I counted 20 capacitors that were split open due to internal heating. (there are 170 caps total). But - the thing continues to run on just fine! ***AS OF 10:45pm CST on JAN 20: After about a one-minute run, i started noticing a funny smell. Something caught my eye, and i immediately slammed the off switch down when i saw one of the little blue capacitors of my MMC on fire. It's kind of interesting...the coil's output showed no signs of a problem while the MMC was burning. No big deal, it wont take me 5 minutes to replace the cheap little blue cap :)

FLAT PRIMARY COIL:

This coil was designed to run with a 6" secondary coil, but i'm using it for my 4.5" secondary. There is a huge space (oh...2.5") between the two coils. Im sure this isn't the best coil for the job, but it works SO much better than the aluminum primary that i was using before. With the Al primary, maximum sparklength never exceeded 2.5 feet. Now with the new flat copper primary, I'm easily getting 3 foot arcs. I'm wondering what will happen if i go ahead and solder another turn or two inside the coil. (I just did...several inches of sparklength gained, also a noticeable increase in arc channel current)

- 15 turns of 1/4" O.D. copper tube, 1/4" between turns.
- Tubing is mounted in notches on Lexan standoffs, each standoff being 1" tall.
- Lexan standoffs are epoxied onto square plexiglass base
- Haven't measured the inductance yet - i just know it works!
- 6.5" I.D
- Don't know the O.D.

SPARK GAP:

- RQ design
- 10 copper tubes, each 7/8" O.D. 3" long
- all tubes bolted to inside of 6" PVC pipe section
- Gap spacing is completely adjustable from 0" to 5/8"
- 63 CFM fan mounted on end opposite electrodes
- gap gets warm after a 1 minute, full power run
- Max sparklength @ .35" gap spacing - 36".

TOPLOAD CAPACITANCE:

- Two Al dryer duct toroids sitting on top of each other.
- Both toroid cross-sections = 3.5"
- Top toroid O.D. = 20"
- Bottom toroid O.D. = 14"
- Estimated 20 - 25pF capacitance
- Mounting technique...sits on a pie pan :)

Matching a topload to a secondary coil:

The topload needs to be matched to the secondary coil for best performance. To do this, follow the instructions below, using the two equations provided.

$$X_L = (2 * pi * Fr * L)$$

$$C = \frac{\frac{1}{Xc}}{(2 * pi * Fr)}$$

In the first equation, plug in the coil's UNLOADED resonant frequency in Hertz (Hz) and its inductance in Henries (H). Do the multiplication, and your answer will be coil's inductive reactance in ohms. Next, set Xl = Xc in the second equation. Plug in the same resonant frequency value, then do the math. Take the inverse of Xc, and divide this by the product of 2, pi, and F. Your answer will be the necessary topload capacitance value in Farad's. Multiply this by 10^-12 to get the answer in picofarads (pF). Now all you have to do is design your topload (sphere or toroid...doesnt matter) for this value. Matching a toroid to a secondary coil is very important for good performance...it will insure that the coil's energy will be efficiently transferred into the topload.

Dont operate your coil near sensitive electronics!!

What does a Tesla Coil Sound like??

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