"Super Tough" Rotary Spark Gap Parts for Experimenters

Modern Resonance (Tesla) Transformers required an efficient system to switch the power off, ie, quench the spark gap, after the primary spark gap has fired and delivered its stored capacitive energy into the secondary coil system where it causes a rapid ring up in 2-3 microseconds. This secondary ring up hits a maximum potential in an average of 2.0 to 2.5 microseconds. Decay period is usually 15-25 microseconds, ie, 10-12 wave train oscillations.

It is imperative that most of the energy is delivered into the secondary system in the first or second notch of quenching, ie, the first or second primary oscillation wave train. If allowed to keep oscillating the stored energy to and fro between the primary and secondary systems in an unchecked manner excessive losses build up thus taking energy away from the secondary coil.

A very efficient method of achieving this desirable first or second notch quenching in classic Tesla oscillators is to employ a rotary spark gap device to assist in the interruption process, ie, opening of the switch. It is important to note that the mechanical process is way too slow to do proper quenching which must occur in the order of microseconds. The benefit of a rotary spark gap lies in high speed cooling and the constant presentation of cool electrode surfaces.

Neon sign powered coil operating at 30 milliAmperes or less does not require a rotary spark gap for efficient switching. Standard 3 inch long x ½ inch dia. copper tubes fitted within a 6 inch ID PVC tube provide good quenching on 30 mA systems. Be sure to use a 125-150 CFM fan to provide cooling through the tube.

NST powered coils operating at 60 mA or 120 mA require a more efficient method of cooling the spark gap to promote good switching and efficient quenching of the spark gap electrodes. Most of these gains are associated with eliminating excessive heat energy from the spark gap by providing a rapid fan-like cooling of the rotating electrodes.

If overdriven to high break rates, ie, very high pulses per second (PPS), NSTs can fail. This paper will present useful information to design NST power supplies and rotary spark gaps that will operate to provide excellent quenching without damaging the NST.

Pole and potential transformers (PTs) can sustain more abuse and operate at high rapid break rates which provide a more continuous "pumping" of the ionized air and plasma channels surrounding the high voltage electrode atop the secondary coil.

Common and very effective break rate design for a pole or PT operated system would be as follows:

10 electrodes @ 3450 RPM on a 17 inch dia. x ½ thick G-10 glass laminate rotor with a 16 inch dia. electrode to electrode center. The rotating electrodes should be ½ inch dia. for power levels of 4-10 kVA and ¾ inch dia. for power levels of 10.5 to 20 kVA, and 1 inch dia. for power levels of 20 to 30 kVA. At 20 to 30 kVA range we use ¾ inch dia. rotor thickness to ensure safety with the large 1 inch dia. electrodes. Above this power level we use special synchronous counter-rotating electrodes however this paper will not address those design criteria.

A standard pole pig (PP) system would run at 3450 RPM, then a ¾ HP, 3450 motor rev/sec x 1sec/60 rev x 10 electrodes/rev = 575 pps break rate.

This provides excellent cooling and pumps a very favorable ion charge cloud and plasma field for long spark discharges. Please don't confuse long spark discharges with a particular potential as these are two completely separate entities once the initial plasma ionization forms.

We use a 17 inch dia rotor on all of our 5 kVA to 25 kVA designs. We just vary the electrode dia. per the specifications listed above. These large rotors provide a high speed electrode ft/sec value which provides efficient quenching action usually promoting first or second notch switching. All of these motors are rated ¾ HP for the ½ and ¾ inch dia. electrodes, and 1.5 HP for the 1 inch dia. electrodes. All pole xmfr operated systems should use G-10 or G-11 glass laminate phenolic plate and NEVER type LE or CE phenolic because these materials could soften at the high peak currents (2,200 plus amperes) and cause a rotor explosion.

Stationary electrodes are one inch dia. for all of the pole and PT operated systems. These are fitted into slotted (machined finned) brass blocks measuring 2 x 2 x 2 inches in dia. to promote heat transfer away from the electrodes and into the ambient air.

PT systems in the 2.5 to 4.0 kVA range can also operate on a 10 inch dia. type CE phenolic rotor with 8 electrodes on the wheel. Any smaller wheel than this will not provide the ft/sec. required for good quenching especially in the 3.0 to 4.0 kVA range.

The alloys we used for all of these "super tough" RSG electrodes are cobalt, tungsten, and vanadium.

NST powered systems are more delicate and must operate at lower break rates. We run most of our 60 mA, 90 mA, and 120 mA NST powered coils with the following rotor design running at a conservative 1725 RPM x ¼ HP 1725 rpm electric motor. Be sure to use a "Terry filter" on all NST designs to protect the transformer from transient RF damage.

Our design for NST powered coil systems employs 6 pcs of ¼ inch dia. electrodes spinning at 1725 RPM, thus:

1725 motor rev/min x 1 sec/60 = 28.75 rotor rev/sec x 6 electrodes = 172.5 pps break rate.

We use a 10 inch dia. rotor with ¼ inch dia. electrodes on 9 inch dia. electrode-electrode centers. This provides a nice ft/sec. rotary speed to provide good electrode cooling thus preventing local "hot spots" and insures good quenching especially in the range above 60 mA.

Small setscrews are used on all rotor design to "capture" the electrode even though the electrodes are very tightly press fitted with a .0005 inch tolerance. The press fit would hold the electrode but, for safety considerations, we employ a 4-40 setscrew at every rotary electrode.

We furnish electrodes for experimenters in the following sizes:

For NST powered coils:

Typical systems operating at 1.0 to 4.5 kVA:

0.250 inch dia. x 1 inch long   p/n RSGNST-250   (set of 6 electrodes)

Stationary electrodes for NST powered coils are 2.000 inches long x 0.500 inch dia. p/n NSTSE-500
(set of 2 electrodes)

for potential transformer (PT) powered coils:

Typical systems operating at 2-4.5 kVA:

0.375 inch dia. x 1.25 inch long (for 10" x .375" thick type CE phenolic rotors) p/n RSGPT-375
(set of 8 electrodes)

Stationary electrodes for PT powered coils are 3.000 inches long x 0.500 inch dia. p/n PTSE-500
(set of 2 electrodes)

for pole pig (PP) operated coils:

0.500 inch dia. x 1.5 inch long (for 17inch x .500" thick G-10 phenolic rotors) p/n RSGPP-500
(set of 10 electrodes)

1.000 inch dia. x 1.75 inch long (for 17 inch x .750 thick G-10 phenolic rotors) p/n RSGPP-1000
(set of 10 electrodes)

Stationary electrodes for above rotor designs 4.000 inches long x 1.000 inch dia. p/n SEPP-1000
Used with most PP operated coils at 7.5 to 20 kVA
(set of 2 electrodes)

For the stationary electrodes in 20-30 kVA coil designs we use 4.000 inches long x 2.000 inch dia.
p/n SEPP-2000 (set of 2 electrodes)

Custom machined brass holder blocks are also available for NST, PT, and PP stationary electrode holders.

Contact us **via telephone** (not internet) for current pricing and more info on these particular parts.
Tel 520.850.7076 winter and 608.356.3647 summer
Best time to call is around 4-5 PM MST (winter) or 3-4 PM CST (summer)

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