http://www.somis.org/SB220ci.html

Silicon Rectifier "Protection"

In the early 1960s, silicon-rectifier manufacturing technology was hit and miss. There was considerable variation between individual rectifiers of the same type. The variation between rectifiers led designers to use resistor-capacitor equalizer circuits in parallel with series rectifiers.

Today, silicon-rectifier manufacturing technology has improved, so that same-type rectifiers are very uniform in their parameters. Modern silicon rectifiers do not need to be equalized. Unfortunately, old habits die a slow death and many hams are still clinging onto 1960s design techniques.

Much has been written about adding "equalizing" resistor-capacitor protection networks across the rectifiers in the SB-220's HV power supply. Unfortunately, these "protection" circuits not only do not perform as advertised, they can lead to premature rectifier failure.

Here's why: The 1/2W resistors that are typically used are rated at 250V maximum. How can a 250V resistor be trusted across a 600V or a 1000V rectifier? If anything breaks down in a series-rectifier circuit, it is like dominoes falling. One resistor failure can wipe out the remaining good parts in the circuit.

The most frequent failure mode for HV power supply rectifiers is too much reverse-current. This problem can be eliminated if the total PIV capability of the series connected rectifiers substantially exceeds the peak voltage in the circuit.

In any series circuit, the current in all of the elements is exactly equal. The rectifiers are all in series. So, the reverse-current burden is exactly the same for each rectifier unit. How is it that something which is already exactly equal needs to be "equalized"?

During the half-cycle application of reverse-voltage, it is important that all of the rectifiers in a series leg have similar junction capacitances. If they don't, then the reverse-voltage across the lower capacitance rectifiers will be excessive. Here's why: in a series circuit, smaller capacitors charge-up faster, and to a higher voltage, than larger capacitors.

Approximately 10nF [0.01µF or 10,000pF] of bypass capacitance across each rectifier is probably a good idea if, for example, 1A rectifiers are placed in series with 6A rectifiers. This is the case because of the wide difference in junction capacitance between 6A and 1A rectifiers.

If all of the rectifiers in a series leg are similar, they will all have similar junction capacitances, so no external capacitors, or resistors, are needed.

Long ago, before they knew better, some commercial high-voltage silicon rectifier-stack manufacturers used "equalizer" R/C networks. These manufacturers stopped using "equalizers" for the same reasons that were previously outlined above. I don't know of any commercial HV-rectifier manufacturer who has not abandoned the malpractice.