TECHNIQUE FOR POWERING
CW MAGNETRONS

by

J. C. Sprott

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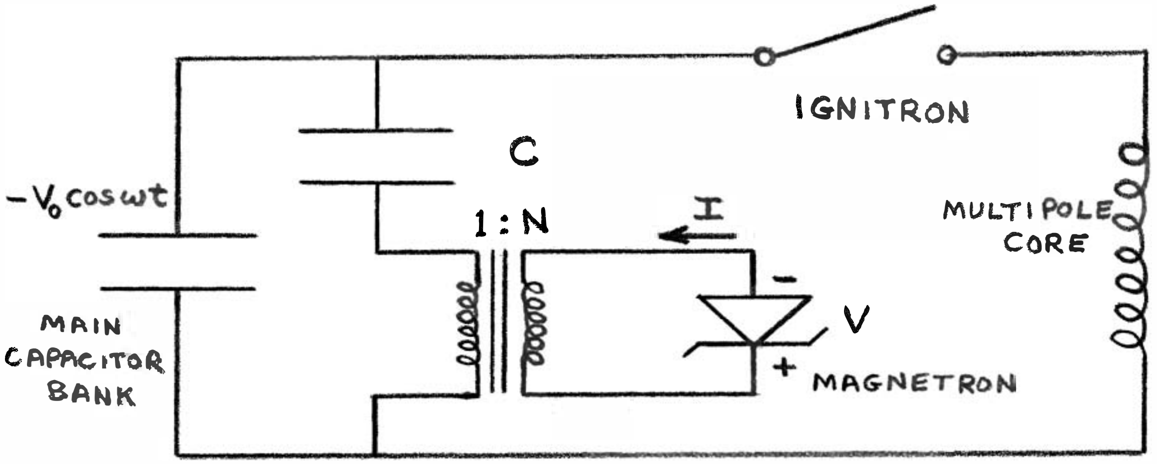
As we contemplate adding higher, long pulse microwave power to the toroidal octupoles, the cost of the dc power supply, switching, and timing circuits escalates rapidly. An appealing technique for powering these magnetrons involves using some of the energy stored in the capacitor bank that drives the main magnetic field. A circuit suitable for this application is shown below:



An extra capacitor (C) is added across the main bank in series with a transformer of turns ratio 1:N. Alternately, one of the existing capacitors could be used. The magnetron is represented by a zener diode of voltage V with current I. We ask how I varies with time for the usual bank voltage waveform, $-V_o \cos \omega t$.

Kirchoff gives

$$V_o \cos \omega t = \frac{N}{C} \int I \, dt - \frac{V}{N}.$$

Solving for I,

$$I = \frac{V_o \omega C}{N} \sin \omega t - I_o,$$

where I is given by the initial condition

$$I(t_o) = 0 \text{ for } V_o \cos \omega t_o = V_o - \frac{V}{N},$$

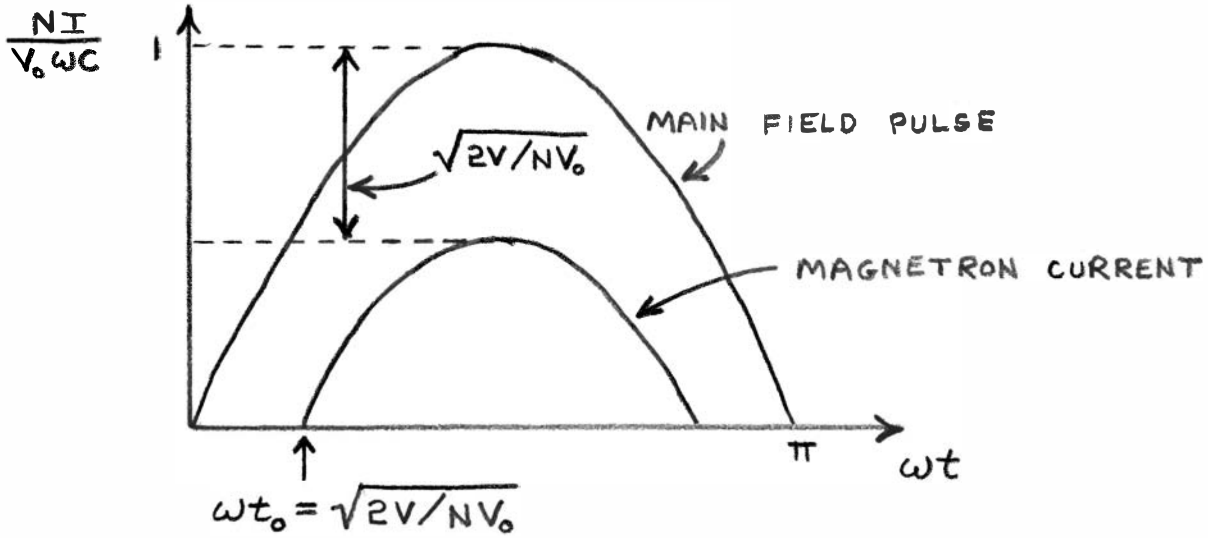
or

$$\omega t_o \cong \sqrt{2V/NV_o}.$$

Therefore, the magnetron current is

$$I = \frac{V_o \omega C}{N} \left(\sin \omega t - \sqrt{\frac{2V}{NV_o}}\right).$$

The microwave power is proportional to this current. The current waveform is sketched below:



In practice, we usually want $\omega t_o \lesssim \frac{1}{2}$, and so the turns ratio must be at least

$$N \gtrsim \frac{8V}{V_o}.$$

Finally, the capacitance is chosen from the desired magnetron current:

$$C \cong \frac{NI}{\omega V_o}$$

Such a system has been successfully operating on the small supported octupole, at the Barn.