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A POSSIBLE METHOD FOR REDUCING THE GAP VOLTAGE FALL TIME OF THE ACOL BUNCH ROTATING CAVITIES

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The main technical problem involved in the ACOL bunch rotating cavities (assuming they are not plagued by multipactoring) is the very rapid voltage drop required after bunch rotation.

It has been shown[1] that using the simplest possible scheme, an oversize tube directly at the cavity or $n\lambda/2$ away from it, a fall time of $\sim$ 30 μs can be expected, which is regarded as adequate.

It may be interesting to note that by using the same components in a slightly different manner, a further reduction of the fall time by a factor of $\sim$ 2 could in principle be obtained.

To see how this might be achieved we consider the power handling limits of a triode, used either as an RF generator or as a load.

For a low duty cycle system the limits are essentially the maximum instantaneous voltage on the anode $\hat{V}$ (limited by breakdown) and the maximum cathode emission $\hat{I}$. Then for an applied DC anode voltage V and a peak RF anode voltage $\tilde{V}$ we have for a class B generator

$$\hat{V} = V + \tilde{V}$$

$$\tilde{V} \simeq \tfrac{1}{2} \hat{V}$$

$$\tilde{I} \simeq \tfrac{1}{2} \hat{I}$$

and the maximum power that can be generated is

$$P_G \simeq \frac{\hat{V}\hat{I}}{8} .$$

It is easily seen that if the tube is used to absorb power, the limits are much the same, so long as the DC anode voltage is applied. However, if it is suppressed for power absorption, then we can have

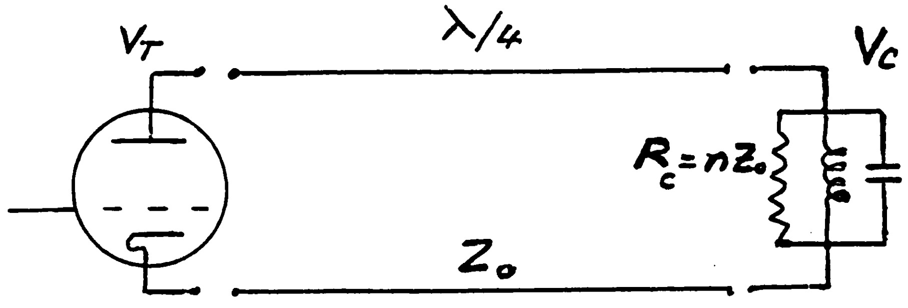
$$\tilde{V} = \hat{V}$$

and as $\tilde{I}$ remains the same the maximum power that can be absorbed is

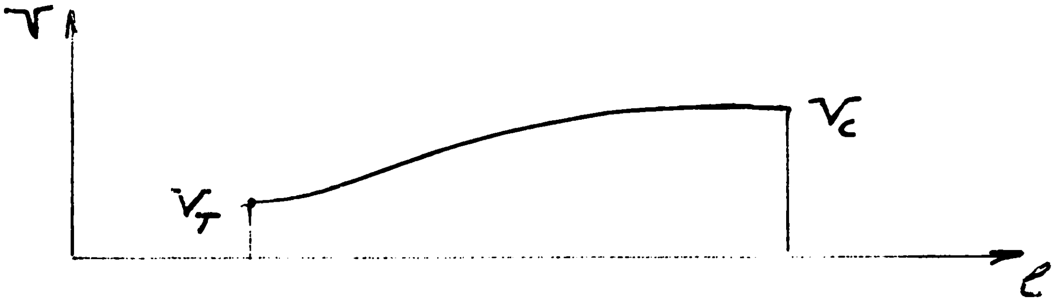
$$P_A \simeq 2\, P_G .$$

In order to take advantage of this possibility, a method must be found for changing the voltage transformation ratio from cavity to tube anode, depending on whether the tube is acting as a generator or a load.

This can be achieved without any switching, simply by placing the tube $\sim \frac{1}{4}\,\lambda$ away from the cavity and overcoupling the cavity to the feed line, as shown.

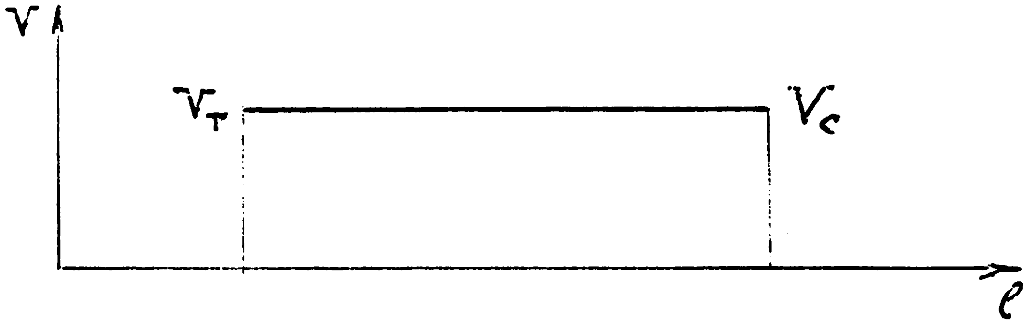


Then for a forward power flow, with the tube acting as a generator, we have at the end of the voltage build up in the cavity



where $V_T = \frac{V_C}{n}$.

After V_C has reached its maximum value we suppress the DC anode voltage and adjust the grid drive so that the impedance presented by the tube to the power flowing back from the cavity is Z_o. Then



$V_T = V_C$

and the power absorbed is initially n times the forward power, for a given $\tilde{I}$.

In our application the power required to reach V_C (estimated by Superfish) is $\sim$ 1 MW. The tube, which is oversize, can supply $\sim$ 5 MW as a generator for $\tilde{I}$ = 300 A, $\tilde{V}$ = 35 kV. With anode voltage suppressed we have $P_A \simeq$ 10 MW, so n $\simeq$ 10.

Obviously, with this type of arrangement, the modulator need only supply the relatively modest power required for the build-up of the cavity.

In addition, the impedance presented by the tube to the modulator is very much reduced as, when it is operating as a generator, it draws high current but generates only a relatively low RF voltage at its anode, and therefore a lower DC voltage can be used.

Finally, we must remember that the ¼ λ separation between valve and cavity is normally avoided (in Linacs for example) as the coupling loop presents a short circuit before the cavity voltage has built up, and this is reflected as an open circuit at the tube anode.

How far this is really dangerous if proper precautions are taken would need to be tested.

REFERENCES

1. P. Marchand, ACOL Bunch Rotator, PS/RF/Note 85-8.