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1. K800 Transmitter Modifications

2. K500 upgrade

3. K800 wood and copper resonator model

4. Of this and that

1. K800 Anode Circuit Modifications

It has been decided to return to the design presented in RF Note # 80 for the K800 transmitter anode circuit. Table I lists six options for doing this. These particular options (many others were considered but they involved more expensive changes to the present structure) were chosen to minimize alterations. The purpose in making a modification is to minimize parasitic modes.

My personal preferences either #1 or #5, although any of them would work well. The mechanical engineers should make the final choice. J. Vincent can provide the detailed geometry.

Although the bicycle chain drives for the K500 Xmitter work fine, for some reason I don't know, push rods seem to be preferred. So we will use push rods (I am tired of fighting). The finger contacts on the moving short will be graphite-silver .1 inch by 1/16" diameter tips on the end of about 1" long silver plated Be Cu springs. I will insist that the drive for the push rods be a dc motor or a 2 phase motor capable of linear analog control. After initial position adjustment the servo will be locked out, and friction will insure that the shorts will not move during long runs. But during initial tuning we will have a knob or a phase servo to adjust the position, not a button! I have a paranoidal hate for "up" "down" "left" "right" buttons or switches. Imagine having to steer a car that way!

K500 Upgrade

At the present time I see that there are only three problems with the rf system of the K500 cyclotron.

1. Dee sparking at V dee > 70KV is excessive even though sometimes we can achieve 100 KV. Some future genius will solve this problem. At present, apparently, extraction electrode sparking is more limiting than dee sparking.

2. Dee coupling capacitor insulators fail due to persistent arcs developing on the air side resulting in vacuum leaks. Some 10 to 20 of these have occurred in the last two years. Why? The answer is obvious. Due to a dee to coupler spark an air arc develops at the air side of the "window" and the impedance of this arc is sufficiently high such that the -dv/dt monitor is sufficiently low such that the rf is not turned off. The arc lives and destroys the insulator.

How to solve this problem? We are designing alternate insulators; but in my opinion this is not the proper solution. Instead I believe we can solve the problem by electronic control.

We can adjust the neutralizing loops and the coupler positions to attain a ratio of reflected V- to forward V+ of better than 10 to 1, meaning a reflected power os less than 1%. If a coupler insulator arc develops the most sensitive measure of this event is that V-/V+ will increase by at least a factor of 5.

The reason we didn't initially use this feature to protect the insulators was that first we were confused by the excessive V-signal before we installed the neutralized loops, and after that by the large harmonic content in the V-signal at certain frequencies. And then, after the neutralizing loops did their jobs on the fundamental (resulting in our ability to achieve .01 ratios of V-/V+ on the fundamental, but still having only .1 ratios of V-/V+ on the harmonics at certain frequencies we hit on the solution.

We are again fortunate to have an F+ signal, always 2MH2 above the F signal. Se we used our spare phase detector module, the F minus F+ mixer boards plus 2MH mixer boards and filters to render a true F- and F+ signal minus all harmonics. Unfortunately the outputs of the filters was too low to achieve linearity of the outputs, so we had to attenuate the V+ and V- signals, then mix and filter, then amplify and finally peak detect. Then we take the logarithm of each, subtract, amplify and finally have a true V-/V+ signal. This is fed to a comparator which can turn the rf off incase of excessive V-/V+.

On 1/19/84 we tested this circuit, as follows: we removed the 1/2" dia. spark gap from the box just under the coupler on "A" station and while running at 60 KV delicately inserted a sharpened wooden pencil in the spark gap hole and as it neared the center conductor of the transmission line drew a high impedance arc, quite visible.

The V-/V+ signal immediately turned the rf off and extinguished the arc! This proved that we were protected from living arcs on "A" station. Within a week we will have these circuits on "B" & "C" stations and I assert; we will then have no further coupler failures!

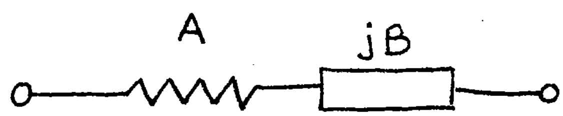
When initially turning on at a new frequency the tuning and coupler setting may not be sufficiently correct to prevent us being able to turn on because of the V-/V+ protection circuits. We will supply a button that can be pushed to disable the V-/V+ protection circuit while things are adjusted (at a low dee voltage). When ones finger is removed from this button the protection is restored. We could, instead, and later will certainly do so, arrange it such that the V-/V+ protection is disabled for dee voltages less than 20 KV, although this is dangerous because we can also have coupler failures due to multifactoring on the vacuum side especially at voltages less than 20 KV. This multifactoring may be such a high impedance as to not significantly increase V-/V+.

K800 wood and copper model

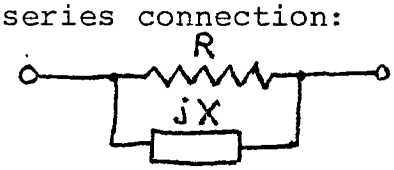
More effort is going to be put into this project with the aim of completing it by mid February.

About This And That

1. Here is an exercise in complex arithmetic manipulation. Although it is simple, I don't find it in any textbooks, yet there are many times when an engineer needs to have recourse to the following equivalencies, and they are tricky to derive.



series connection: $Z = A + jB$



parallel connection: $Z = \frac{RX^2}{R^2 + X^2} + j \frac{R^2 X}{R^2 + X^2}$

The equivalent expressions are:

$$A = \frac{R X^2}{R^2 + X^2} \quad , \quad B = \frac{R^2 X}{R^2 + X^2}$$

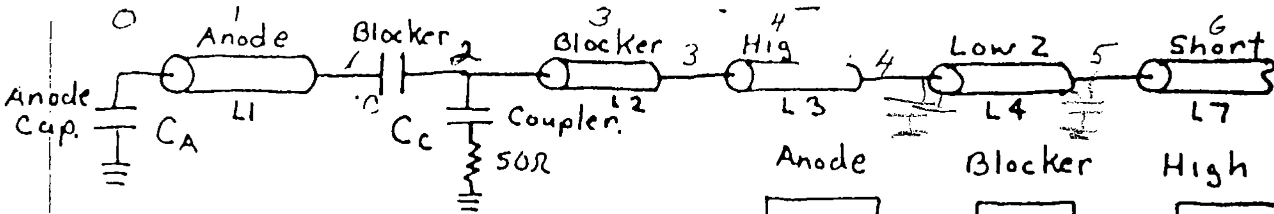
$$R = \frac{B^2 + A^2}{A} \quad , \quad X = \frac{B^2 + A^2}{B}$$

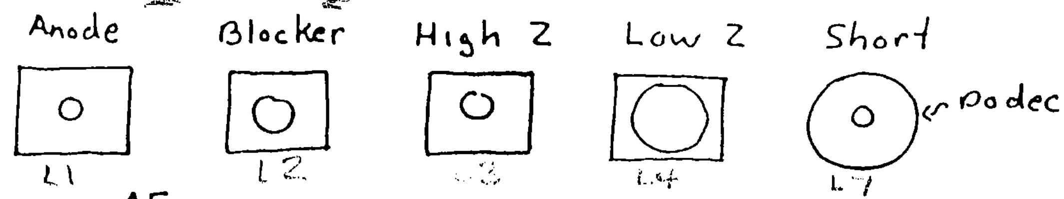
and the quality factor

$$Q = \frac{B}{A} = \frac{R}{X}$$

I write these down for future reference to myself. It is interesting to note that the phase angle between the voltage and current is $\theta = \text{atn } Q$.

J. VI 'ENT
JAN., 84





Option	Imax	Wan	WTOT	Cc	Ceq	Q	$\frac{\Delta F}{F \cdot \Delta L7}$	L1	L2	L3	L4	L7
1	510 A.	217 W 48	611 W 498	29 P.F. 25	154 P.F 353 P.F.	6201 7018	.038 .085	5"/4"	15"/14"	13"/9"	33"/26"	4" 69"
2	650 A.	373 62	962 587	29 25	215 410	5470 6956	.038 .010	5/4	15/14	5/9	41/26	4 62.
3	620 A.	345 61	901 582	29 25	262 407	5490 6955	.038 .010	5/4	15/14	5/6	41/26	4 62
4	500 A.	225 51	632 519	29 25	156 366	6051 7021	.047 .009	5/4	15/14	13/9	35/26	4" 67"
5	580 A	303 72	779 637	29 25	173 442	5445 6909	.054 .011	5/4	15/14	13/9	35/27	3.5" 56."
6	710 A.	451 114	1040 836	29 25	200 564	4721 6713	.075 .015	5/4	15/14	13/9	35/28	3.2" 44.4"

FOR L1, L2, L3, L4, THE TOP NUMBER IS THE LENGTH AND THE BOTTOM NUMBER IS THE INNER CONDUCTOR DIAMETER. FOR L7 THE TOP NUMBER IS THE SHORT LENGTH AT 27 MHZ AND THE BOTTOM NUMBER IS THE SHORT LENGTH AT 9 MHZ.