214-0039-01-01_00

RF Note #38

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January 16, 1979

1. Power Supplies

The first of three final filament supplies has been received and tested. Although it was not built in accordance with the specifications, it will perform satisfactorily, so we will use it and accept the others after a few small modifications.

The other supplies necessary are:

Name	Quantity	V	I	W	Reg.	Ripple		Crowbar
Final Screen	4	+750 to 1500	1 A	1500	6%	1V	ptop	Yes
Final grid	4	-200 to -350	.2	70	.1%	.01V	"	Yes
driver B+	4	+3000	2	6000	5%	1V	"	Yes
driver Sc	4	+350	.2	75	.1%	.01	"	Yes
driver grid	4	-30 to -80	.1	8	.01%	.001	"	Yes

It is hoped that the 3Kv 15 amp DA-2 supply acquired from PPA can be resuscitated , as it will meet the requirements for the driver B+ as well as, with some additions, the final screen P.S.'s.

It is proposed that circuitry as in Figure 1 be added to this supply. Parts have been ordered to test the resistor+ Zener diode string idea. It will all, no doubt, work fine.

A "DA-2 Fast Trip" box will have to be designed and built. The 8 outputs from the CT's will go to this box where discriminators will turn off DA-2 if any current becomes excessive and will remember which one did so. In addition a fast dI/dT monitor on each output will fire the crowbar, again displaying which output was guilty.

The final grid, driver grid and screen supplies are to be purchased from industry on a low bid basis. They will have internal bleeders of .1 amps not read on the current meters. The output current meters will be zero center so as to be able to read negative output current. And they will be crowbarable, i.e., short circuit proof. We will add SCR crowbars to them. It is hoped that W. Johnson will undertake the procurement of these supplies.

DEE-TRANSMISSION LINE-XMITTER CKT

A program (TRED 3) exists which calculates everything about the above titled circuit using the model of Figure 2 for 20 MHz.

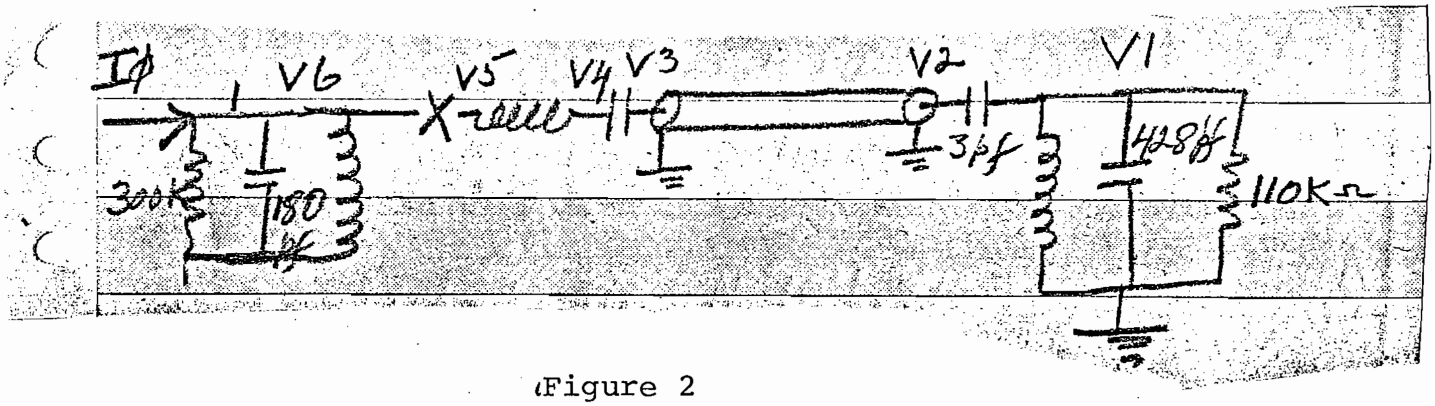

Figure 2

$I\phi$ = tube current = 8 amps
V6 = anode rf voltage = 14kV nominal
V1 = dee voltage = 100 kV nominal

Naturally, the calculated results at resonance were as expected, but the purpose of the calculations was to see what happens off resonance, and to see whether there exist good criteria for accomplishing the various tuning adjustments. Rather than present the copious computer printouts I will summarize them and present my conclusions.

First, all the circuit elements were set to give perfect results at resonance, and then the frequency was stepped in increments of 10 PPM and a printout given whenever any phase difference from the time a previous printout was made was greater than $\pi/20$. Thus the frequency spectrum from $F\phi$-200 KHz to $F\phi$ + 200 KHz was carefully scanned and, on the average about 60 frequencies for printout occurred. The results depended very dramatically on the length of the transmission line. This was equivalent to keeping the length constant and scanning the entire frequency range from 9 to 32 MHz. Over this grand range the line at specific frequencies will be $\lambda/2$ and $3\lambda/4$ long. So it was sufficient to select three line lengths to investigate the extremes and an intermediate condition.

When the line is near $3\lambda/4$ long things are well behaved. At the anode one sees three modes, a mode being identified as a frequency where the current and voltage are in phase, and the impedance is real. At - 84 KHz the impedance is 1 ohm and below that, capacitive. At $F\phi$ the impedance is 1800 Ω and at +64 KHz the impedance is 1.47 ohms and above that it is inductive. So there is no problem at the anode if we are mistuned. The maximum voltage in the line due to the high standing wave ratio off resonance never exceeds 4 kV. And the dee voltage peaks at $F\phi$ where the phase difference between V1 and V2 is 90 degrees.

When the line is $\lambda/2$ long things are bad. Again there are three modes at the anode: at -5 KHz $R=2 \times 10^4$, at $F\phi$ things are O.K., and at $F\phi$+60 KHz $R=3 \times 10^5$.

The consequence of these high impedances off resonance is that, with constant rf drive current, the anode would saturate and excessive screen current would shut us off. So it is obvious that we will have to have the amplitude servo shift over and regulate on screen current rather than dee voltage whenever the screen current exceeds a certain value.

At intermediate lengths of transmission there are only two nearby modes, but again the wrong mode is a very high impedance one and the same problem as above exists. It is obvious that ideally we would like to set the line length for each frequency, but we are going to try to live with a fixed line length.

One comforting result is that at any line length the criterion for tuning the dee is fine. To tune the transmitter I suspect that when we select a new frequency we either tune it via a look-up table, or first disconnect the line, replacing it by a resistor and tune the transmitter, then not touch the transmitter adjustments again after reconnecting the line. This can be done with a SPDT switch at the transmitter output which can connect it to a 50 KW dummy load.

Transmitter into dummy load

At first, low level measurements on the transmitter coupled into a 75 Ω dummy load were very confusing. Obviously the computer model wasn't correct. The trouble was that if the leakage inductance resonating condenser wasn't set right, there were two modes at the anode and neither seemed right. Many of the causes of confusion were finally traced to measuring technique, and finally when high impedance probes to the vector volt meter were used everything fell into place.

If the condenser is misadjusted there are two modes (frequencies where the anode voltage peaks for a constant current drive)--one has the voltage phase leading the current phase by about 90°, the other results in a lag. Neither mode is right. As the condenser is adjusted (the moving short has to also be moved to compensate for reactance changes), the two modes sort of degenerate into low Q modes and finally the correct operating condition is achieved at a frequency midway between them. This frequency results in 0° phase difference between the current, the anode voltage and the output voltage. Furthermore, on this correct frequency, the voltage ratio between anode and output is correct. Furthermore, the frequency and ratio is independent of the load, so that it is equally correct for 50 and 75 Ω. Let us hope that high power tests will substantiate these conclusions.

The correct capacity is about 75 pf and the variable 5 to 100 pf capacitor on loan from ORIC will do fine.

High Power Transmitter Tests

On 1/19/79, for the first time, we fired up the transmitter using the cyclotron B+ supply. At 10 KV B+ we delivered 40 KW into the 50 Ω dummy load and everything seemed normal. At this output we were limited by excessive screen current, meaning the V Min must have been about 1 KV, resulting in 9 KV peak rf in the anode box. The drive was 300 volts peak and the screen voltage 560 volts.

When we endeavored to raise the plate voltage we got quite a few crowbars and discovered that one of the temporary blockers was scrogged. So we terminated the tests, because just then the final blockers arrived and rather than replace the defunct blocker we decided to schedule to install the final blocker next week.

So during the next two weeks we will do a variety of things including making more high level tests (but at only 12 KV DC) and get everything ready to do final transmitter testing the week of February 5.