KF ...

RF Note #50

J. Riedel
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Test 3

Test 3 started out inauspiciously. Both stems were now on. One bright thing was that the top frequency was 31 MHz and the fine tuners could achieve a range of 3% there. Figure 1 and 2 show the stem position (from the minimum) vs follow pot voltage, and Fig. 3 shows the correct follow potentiometer settings for the two stems and the coupling capacitor vs frequency. The stems need only be positioned to an accuracy of .2 inches.

Then on June 2 we tried to come on at 30.6 MHz. We thumped away for an hour or so and then were inundated with water coming from a separated soft solder joint that connects the inner conductor to the top of the top insulator flange via a spinning. This separated due to the forces put on it because of the flimsy mechanical mounting of the test stand, and when people working on top of the top stem moved violently the structures swayed excessively. It was resoldered , unsuccessfully, and then holes were drilled and tapped and many round head brass screws added to achieve mechanical strength, and then it was resoldered. After this it only oozed water out of a few leaks.

Meanwhile, the vacuum was not in good shape. Besides the expected seepage of air through the RTV seals, there was probably also a leak, and in addition the valve or fitting to the mechanical pump leaked so that it had to be always on.

By the time we finally were able to try to come on again after all these fixes (naturally it was Friday, the 29th of June, my ostensibly last day here this trip) the best vacuum was 2×10^{-5} Torr. So we thumped away and had difficulty breaking through multipactoring. Then it was noted that some recent "improvements" to the amplitude regulator (which determines the turn on rate) had increased the turn on time to 10μs. After a bit of experimenting it was found that turn on could only be achieved by detuning the resonator on the high side by 50 KHz.

However, we finally got on and soon found that various sparks emanated from volts attaching the lower outer stem to the insulator spinning. These were tightened, and then a little later we observed a bolt getting red hot. Mon Dieu!

So D. Lawton and crew took things apart and verified his suspicions: in the process of soldering additional water cooling tubes to the spinning , the corrosive flux used had driffed down on the crack connecting the aluminum plate to the spinning and there was a powdery 10 mil film separating the two supposedly well connecting surfaces. Things were scrubbed up and everything reconnected and at 2 PM we came on again. The loop was calibrated via the Xray technique of P. Miller at 65 KV = 2V rms on the loop.

Meanwhile, the amplitude regulator was modified to permit it to turn on in 3μs, and now one need not detune to turn on.

Historical detail has become wearisome so I will merely sum up results. We were able to operate stably at 65 KV, i.e. for minutes at a time between sparks. We achieved a maximum voltage of 85 KV for a few seconds and H. Blosser reports that he achieved 87 KV transiently. The only indication of anything wrong with the resonator was that we had a few (maybe 5) first event signals from S. Francis light monitors that there may have been sparks at the upper short. In my opinion, there was excessive vacuum sparking, presumably at the coupler capacitor, and I suspect that it is malcentered.

Then the poor vacuum and poor pumping speed caused problems. But the problem that caused us to terminate TEST 3 was the final power supply. It simply doesn't meet Riedel's specifications for an anode power supply!, and something has to be done about it before TEST 4. It is bad in two regards: When we turn on a current suddenly, the voltage dips, and when we turn a large current off the voltage surges. Now all power supplies do this, but within limits. Specifically, the front panel meter shows that the voltage falls from 15KV to 10 KV on turn on, and on turn off surges from 15 to 23 KV, which results in the late up over voltage meter relay turning the supply off and someone has to trot over to it and manually reset it. Well, one could say that we could live with that by posting someone there!

But I say no! First, we have no oscilloscope monitor of what the voltage is actually doing; and very probably the excursions are transiently greater than observed on the galvanometer. The reduction in voltage at turn on causes excessive screen current, and the excess voltage at turn off causes overvoltages which may disastrously harm the transmitter. The transmitter is the one unit of our rf system which so far has not caused trouble and I hate to see it subject to damage. So here we finish talking about TEST 3 and talk about what to do before TEST 4.

<u>50 MeV Final P.S.</u>

I am tempted to write a treatise on what is wrong with the design concept of the Levinthal P.S. used as the final for the 50 MeV RF system, but I successfully resist. Ain't that noble of me? So we concern ourselves with how to modify things so it can be used for the 500 MeV rf system until our new supply is received. There are three ways, as I see it.

1. First, test the 150KW test load we have constructed as one of three to test the Transrex power supply we are purchasing for the 500 MeV machine. This should be done by connecting a third cable leading from the Levinthal to the waterload (ahead of the current transductor). If the water load works, then leaving it in parallel with the 500 MeV transmitter should solve the undershoot and overshoot problems of the power supply.

2. Use the 50 MeV transmitter tube as a voltage regulator while we are making TEST 4. It would be connected in parallel and by varying grid drive it could keep the current from the PS constant, which it wants to do.

3. Add about 10μf of 20 KV capacity to the Leventhal. However this is not advised as I distrust the capability of the Leventhal crowbar to handle this.

But in any case we must have an oscilloscope compatible voltage monitor to see what is going on. I suggest that W. Johnson build the monitor specified in the Transrex purchase and install it in the supply.

Mechanical

The fact that we were incapable of burning up or otherwise destroying the fingers is encouraging! I would say that if the inner and outer conductors are silver plated we have an excellent chance of being able to live with our present finger design. Of course when they are inspected we may deem otherwise.

The problem of assuring that there is proper centering and concentricity of the coupling capacitor in its dee shell needs consideration. D. Lawton assures me that he can devise a means of assuring this, although I fail to see any provision for adjustment. In any case we can always, and should, make a test to determine whether or not it is centered an aligned properly. In air we turn on at a low frequency and determine at what voltage it sparks. If centered it will support 28 KV, if it only supports 20 KV something must be done.

So this is a rule that we should adhere to: always make this check in air after mechanical changes, before acquiring a vacuum and trying to come on.

Soft Soldering: Although almost everyone feels he is an expert at soft soldering I feel that I am really the only expert for electrical usages. Use eutectic solder and water washable Lindseys flux only! But I know I speak to deaf ears so will say no more on this.

But this doesn't mean I have nothing to say on other subjects.

Dee Spark Monitor

It would be desirable to have an unambiguous indication of a dee spark, as now the only indication is a small increase in the pressure. The dV/dt monitor works, but coincident with a vacuum spark, at high voltage, we get a spark at the transmitter end of the transmission line. This latter is expected (see RF note #32).

We propose, therefore, that at a convenient time (when the bottom plate of the vacuum tank is removed for some reason) that a 1/4" diam polystyrene rod, to act as a light pipe, be installed alongside the coupler entrance in such a way that it can look at the coupler capacitor, and a photosensitive transistor then can send a signal to a discriminator etc.

Suggested Program

On July 5, have S.F. turn on in air to measure at what voltage the coupler sparks. Care must be taken to turn off immediately after a spark, as a lingering spark will soon destroy the coupler.

Then, if the spark down voltage thus measured is less than 25KV, retract the coupler and measure the alignment. If it is bad, it must be aligned. My specification is that the centering error should be less than 1/16".

Remove upper panel or panels and carefully inspect fingers for evidence of sparking.

Fix vacuum leak!

If there is no evidence of finger damage then put everything back together for TEST 4.

Meanwhile W. Johnson and Company will solve the 50 MeV final power supply problem. My recommendation is to use method 2 above and send gates to the grid power supply to keep the power supply current constant. When this is done and we are ready for TEST 4 call J. Riedel.

Meanwhile, also, the bang bang servoes need to be looked at and possibly modified. In any case the valve for the lower stem should be replaced.

Also, even if the water load is not to be used to help stabilize the final P.S., W. Johnson and S. Francis can test it, but not before we get at least 15 GPM through it. It is all right to use process water.