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RF Note No. 85

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by J. Riedel

Loop Coupling into the Dee Stem

We are having troubles with our present method of coupling power into the dees. We use capacity coupling through a "window". This window is causing considerable down time due to a combination of sparking on the air side and multipactoring and or glow discharge arcing on the vacuum side.

Initially, loop coupling was considered but was ruled out because the only place in air for such a loop restricted the upper frequency range. However, this range is already limited to 27.5MhZ because of the presence of the neutralizing loops. It is believed that additional loops, identical to the neutralizing loops will provide satisfactory coupling.

Analysis

First, consider the present coupling scheme of Fig. 1. $\vec{Z}2$= A+jB resulting in the equivalent circuit of Fig. 2 where $A=Z_o$ and $\omega L'=1/\omega C_c$ so that B=O at the proper tuning condition.

Fig. 3 shows the loop coupling scheme, Ls is the fixed self inductance of the loop, which is about 8×10^{-8}H. α is the ratio of the flux intercepted by the loop to the entire flux of the resonator and is variable by suitably rotating the loop. Again the Z looking into the loop is A+jB, and it is possible to find an equivalent circuit (Fig. 4) where $A=Z_o$ and B=O. The total stored energy of the equivalent circuit must be the same.

Fig. 5 shows an equivalent circuit where we transform Lo, Co & Ro to the impedance seen by the loop. There is a phase shift across Ls which, at 25 MhZ, is about 10^o. To the extent that tan $\theta=\theta$ for $\theta < 10^{o}$, this phase shift can be compensated for by a length of cable, so that the phase difference between the incident voltage in the line and the stem voltage is the proper criterion for adjusting C (fine tuner). Because the directional coupler measures dv/dt, then these phases should be different by 90^{o}. The amount of flux intercepted by the loop can be varied by rotating the loop to minimize the reflected power in the line while simultaneously adjusting C for tuning. Thus the only difference in the adjustments as between capacitive and inductive coupling is the 90^{o} phase difference in the signals going to the phase detectors. This means that one of the mixer signals will have to come from F+ rather than $\overline{F}$+. To compensate for the additional phase shift, the cable from the ~~dee loop~~ forward voltage should be increased in length by 8 inches. Fig. 6 shows some calculations of the transformed circuit which were made to verify that a correct tuning condition can exist.

<u>Hardware</u>

The loop can be identical to or a little smaller than the existing neutralizing loops. It need not be water cooled, as the maximum dissipation is only 1.5 watts per inch. The 1-1/8 inch outer conductor can make a finger stock wiping connection to the ground hole and fingers on the 5/8" O.D. inner conductor can similarly make a wiping contact onto a transition piece that connects to the 4 1/8" line.

Detailed calculations of the entire transmitter - TR line - dee circuit to study the effects f transmitter and or dee mistuning, and the effect at the transmitter of dee shorts or multipactoring are under way and will be presented in a future report.

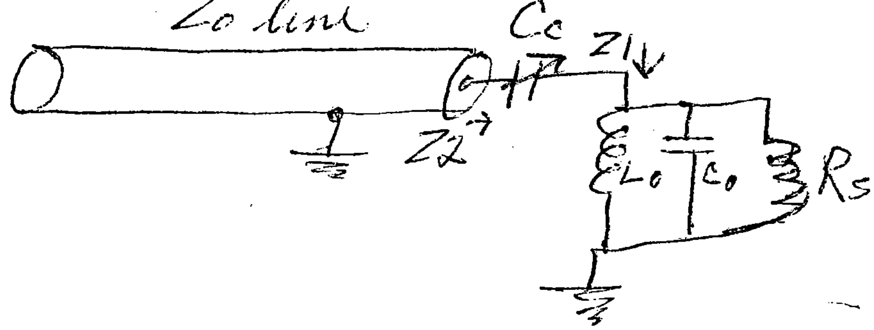


FIG 1.

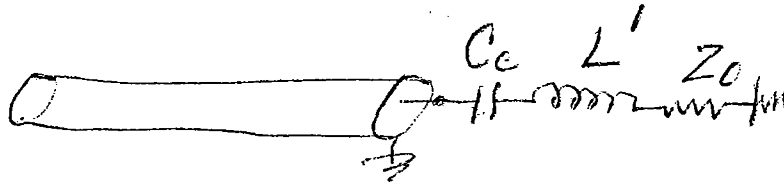


Fig2.

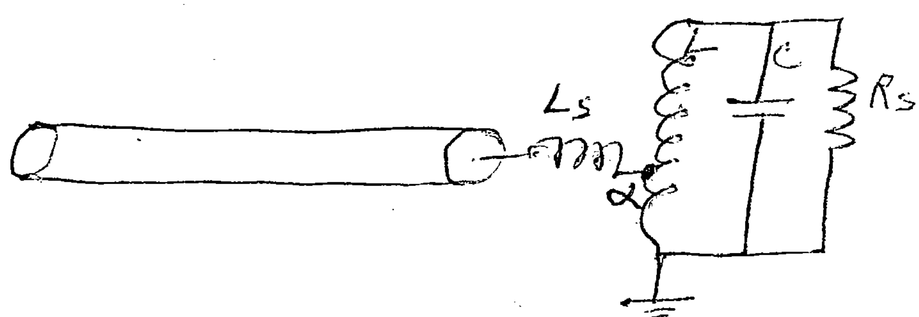


Fig 3

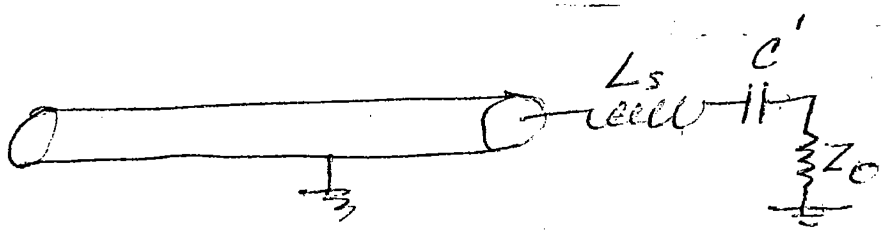


Fig 4

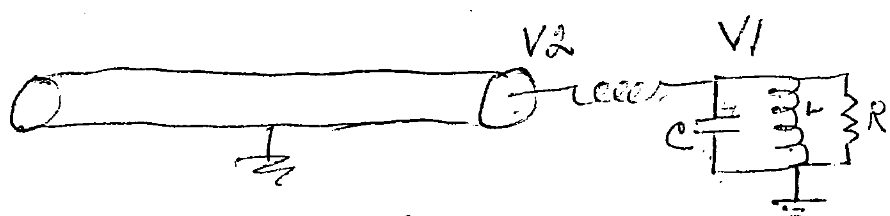


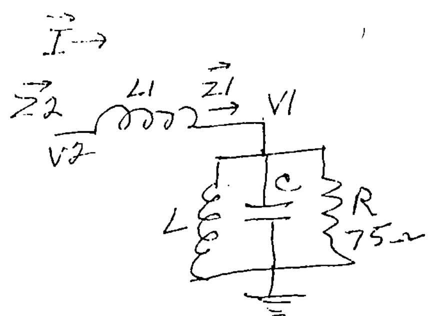
FIG.5

RUN
1613 JUL 14 VESUB...

F = 2.5 Mhz.

ΔC	A1	B1	R1	X1	A2	B2	R2	X2	V1/V2	∠φ
0.00	75.0	-1.25E-10	75.0	-4.48E+13	75.0	12.6	77.1	460.	.986	-9.51
1.93E-12	75.0	-1.70	75.0	-3.30E+03	75.0	10.9	76.5	528.	.990	-9.55
3.86E-12	74.8	-3.40	75.0	-1.65E+03	74.8	9.16	76.0	621.	.994	-9.58
5.79E-12	74.7	-5.09	75.0	-1.10E+03	74.7	7.47	75.4	753.	.997	-9.62
7.72E-12	74.4	-6.77	75.0	-825.	74.4	5.80	74.8	960.	1.00	-9.66
9.65E-12	74.0	-8.42	75.0	-660.	74.0	4.15	74.3	1.33E+03	1.00	-9.69
1.16E-11	73.6	-10.0	75.0	-550.	73.6	2.52	73.7	2.15E+03	1.01	-9.73
1.35E-11	73.1	-11.6	75.0	-471.	73.1	.924	73.2	5.79E+03	1.01	-9.77
1.54E-11	72.6	-13.2	75.0	-412.	72.6	-.639	72.6	-8.25E+03	1.02	-9.80
1.74E-11	72.0	-14.7	75.0	-367.	72.0	-2.16	72.1	-2.40E+03	1.02	-9.84
1.93E-11	71.3	-16.2	75.0	-330.	71.3	-3.65	71.5	-1.40E+03	1.02	-9.88
2.12E-11	70.6	-17.7	75.0	-300.	70.6	-5.09	71.0	-984.	1.03	-9.92
2.32E-11	69.8	-19.0	75.0	-275.	69.8	-6.48	70.4	-758.	1.03	-9.96
2.51E-11	69.0	-20.4	75.0	-254.	69.0	-7.82	69.9	-616.	1.04	-10.0
2.70E-11	68.1	-21.7	75.0	-236.	68.1	-9.11	69.3	-518.	1.04	-10.0
2.89E-11	67.2	-22.9	75.0	-220.	67.2	-10.3	68.8	-447.	1.04	-10.1
3.09E-11	66.2	-24.1	75.0	-206.	66.2	-11.5	68.2	-392.	1.05	-10.1
3.28E-11	65.3	-25.2	75.0	-194.	65.3	-12.7	67.7	-349.	1.05	-10.2
3.47E-11	64.2	-26.3	75.0	-183.	64.2	-13.7	67.2	-314.	1.06	-10.2
3.67E-11	63.2	-27.3	75.0	-174.	63.2	-14.7	66.6	-286.	1.06	-10.2
3.86E-11	62.1	-28.3	75.0	-165.	62.1	-15.7	66.1	-262.	1.07	-10.3

50000 HALT



when Z2 is real, V2 leads V1 by 9.5° and I is in phase with V2
when Z1 is real V2 leads V1 by 9.5°, I is in phase with V1

$L = 1.05 \times 10^{-10}$
$C = 3.8 \times 10^{-7}$
$L1 = 8 \times 10^{-9}$

if loop is shorted, Fφ changes by .05%

$Z1 = A1 + jB1$
$Z2 = A2 + jB2$

R1, X1 } eq. parallel ckt.
R2, X2 }

to achieve a decent termination requires that C be correct to within 100PPM

Transformed to the dec

$L = 1.1 \times 10^{-7}$
$C = 360 pf$
$R = .8E4$

FIG. 6