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R.F. Note #71

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K800 Resonator with Insulators

1/2 Scale Model

Measurements on the 1/2 scale model have been very frustrating, particularly as regards measuring Q, or the power requirements. In general the Q was down by a factor of 5 or so from what it should be, and repeatability of measurements was bad. Finally, by geometrical measurement we determined that the fingers on the outer conductor were making indifferent contact, and also probably not contacting all the way around. So we are modifying the model to remedy this.

However, the frequency vs short position was repeatable, as well as the measured voltage distribution, so we decided that these results could be used to develop a proper computer model. The geometry for the computer model is as in Fig. 1. The dee and dee stem consist of 7 lengths of transmission line each with its own Z(N), R(N) and L(N). We chose to make measurements at only three frequencies: 78 MHz, 55 MHz and 21.5 MHz, and at each of these frequencies we recorded:

1. L(10), the length from median plane to the short.
2. V(0)/V(3), the ratio of extraction to injection voltage
3. V(0)/V(G), " " " to dee center "
4. V(0)/V(8), " " " to a point where the dee ties on to the stem, 5 inches below M/P.

Then we repeatedly ran the program, varying C(10), C(13), C(16), Z(1), Z(2), Z(4), Z(5), Z(7) and Z(9) until the program gave identical results at each of the 3 frequencies for the 4 parameters recorded above. The general technique was to adjust the 3 lumped capacitors to get L(10) right at 21 MHz, then adjust the dee Z's to get the right ratios for 2 and 3 above, then adjust Z(9) to get L(10) right for 78 and 55 MHz. A force fit was finally arrived at and then we rescaled the pgm for the range 9 to 27.5 MHz and ran R. Burleigh's design with the insulator. Fig. 2 shows this design.

The results are very encouraging; at 27.5 MHz the short is 7 inches below the insulator flange and the power is 170 kW, Q = 6200. At 9 MHz, the short is 200 inches below the M/P and the power is 120 kW, Q = 6700. The dee capacity is 500 pf.

Maximum short current is 5100 amps. This is by no means an optimum design--it is a design that will work, however. This resonator will tune to 32 MHz with L(10) = 1".

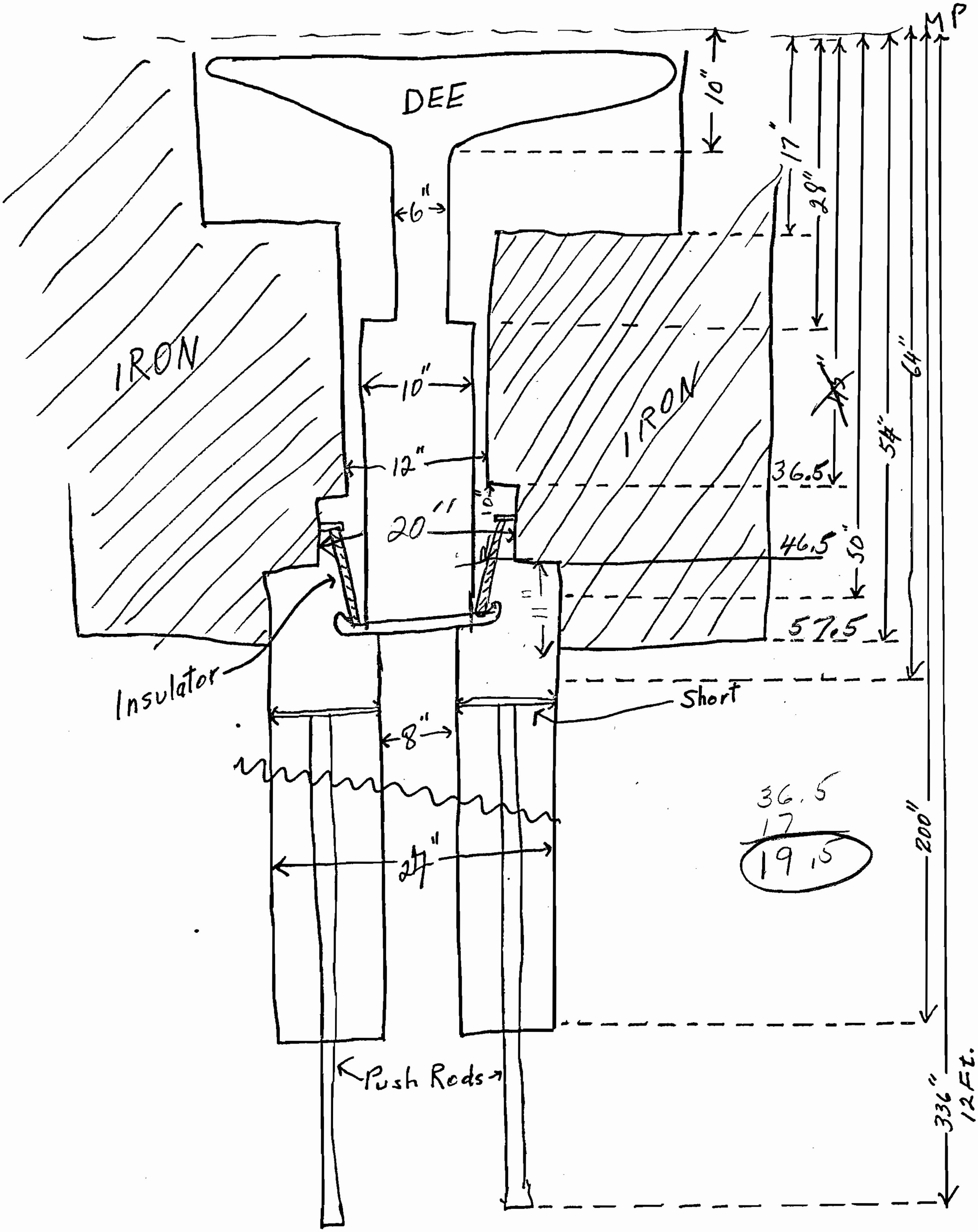
The computer model for this resonator is shown in Fig. 3 and Table I shows the data and results. Obviously we need to experiment (on the computer) with modifying B(9) and B(10) and the ratio L(9)/L(10), and possibly add another section of low Z below the insulator to shorten L(15) at 9 MHz. We choose to wait until the model is reassembled and remeasured before doing this. Right now we have a proof of concept.

Insulator

There are three important reasons for using an insulator:

1. The dees are much more rigidly supported
2. The short is in air, more accessible for repairs, and, by virtue of our K500 experience, of known current handling capability.
3. Because no bellows are necessary for the push rods, the total length at low frequencies is reduced.

With the design presented here the voltages on the ends of the insulator at 27 MHz are 83 and 59 kV. No problem. At 9 MHz Resmini says that 120 kV on the dee is adequate. The insulator should have no problem here either.


MP
DEE
10"
6"
17"
28"
IRON
IRON
10"
12"
36.5
20"
46.5"
50
54"
64"
57.5
11"
Insulator
Short
8"
36.5
17
19.5
24"
200"
Push Rods
336"
12 Ft.

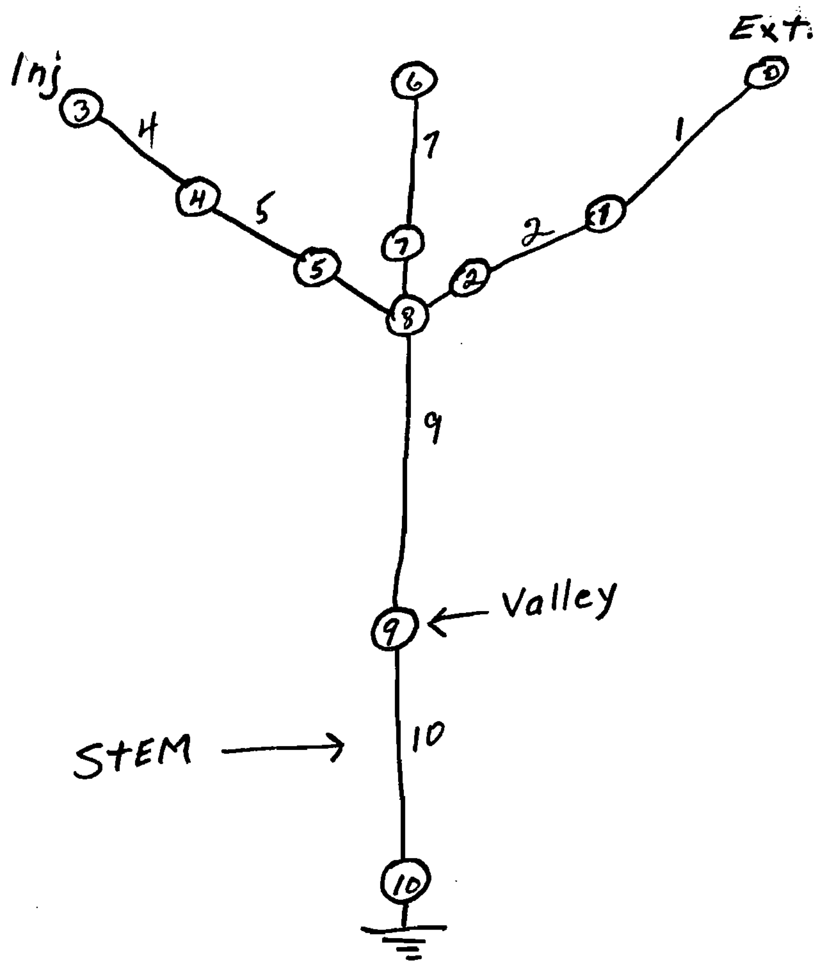

Inj
Ext.
4
5
7
2
1
9
Valley
STEM
10

FIG 1

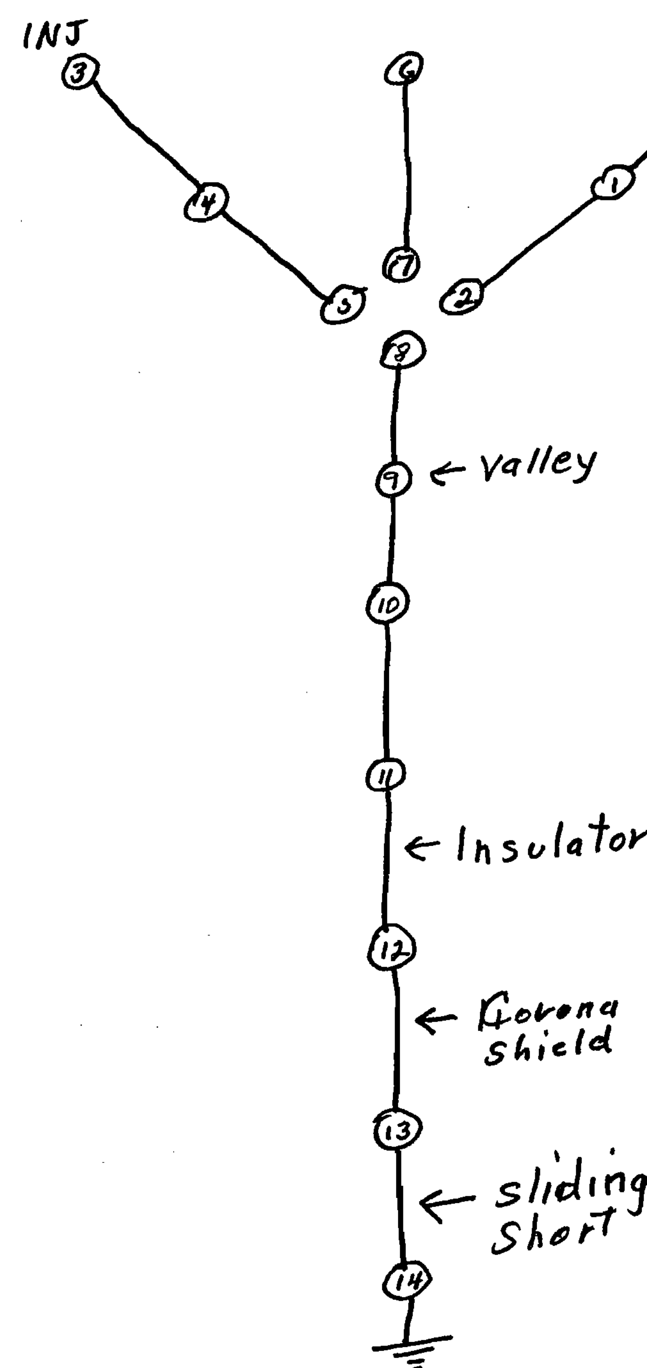

INJ
Ext.
Valley
Insulator
Corona shield
sliding Short

FIG. 3

FOR 27.50 MHZ THE RESULTS ARE

N	Z	L	A	B	G	H	K	C	C
0	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	10.8
1	67.2	16	6.00	4.00	2.00	6.00	1.53	13.83	0.0
2	73.4	33	10.00	6.00	4.00	3.00	1.24	13.83	0.0
3	0.0	33	0.00	0.00	0.00	0.00	0.00	0.00	10.8
4	80.0	49	10.00	6.00	2.00	6.00	1.34	13.83	0.0
5	85.8	66	11.00	4.00	4.00	3.00	1.25	13.83	0.0
6	0.0	66	0.00	0.00	0.00	0.00	0.00	0.00	9.6
7	76.2	81	8.00	6.00	3.00	3.00	1.24	12.57	0.0
8	0.0	10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	60.0	17	26.00	6.00	0.00	0.00	1.00	6.16	0.0
10	40.7	28	11.63	6.00	0.00	0.00	1.00	8.91	0.0
11	11.1	45	11.63	9.83	0.00	0.00	1.00	14.25	0.0
12	39.2	50	18.90	9.83	0.00	0.00	1.00	4.19	0.0
13	22.0	54	26.00	18.00	0.00	0.00	1.00	3.77	0.0
14	65.8	64	24.00	6.00	0.00	0.00	1.00	7.96	0.0

N	Z	L	DEG	DEG	R/M	V	I	P	E
0	0.0	0	0	0	0.0	2.00E+05	2.6E+02	0.0	3.7E+07
1	67.2	16	9	23	2.2E-02	1.86E+05	6.4E+02	2.0E+03	5.2E+07
2	73.4	33	20	34	7.1E-03	1.65E+05	1.1E+03	2.2E+03	5.1E+07
3	0.0	33	0	0	0.0	2.04E+05	2.7E+02	0.0	3.9E+07
4	80.0	49	8	22	1.1E-02	1.91E+05	6.9E+02	1.1E+03	5.9E+07
5	85.8	66	24	38	7.6E-03	1.65E+05	1.0E+03	2.5E+03	4.5E+07
6	0.0	66	0	0	0.0	1.74E+05	2.0E+02	0.0	2.5E+07
7	76.2	81	7	20	7.9E-03	1.65E+05	5.5E+02	4.6E+02	4.2E+07
8	0.0	10	0	0	0.0	1.65E+05	2.7E+03	0.0	0.0
9	60.0	17	54	60	3.5E-03	1.40E+05	2.6E+03	5.0E+03	2.1E+07
10	40.7	28	49	58	4.3E-03	1.13E+05	3.2E+03	1.1E+04	3.1E+07
11	11.1	45	24	38	3.2E-03	9.71E+04	4.9E+03	2.3E+04	1.3E+08
12	39.2	50	70	74	2.7E-03	7.72E+04	5.0E+03	8.2E+03	7.1E+06
13	22.0	54	64	67	1.6E-03	6.68E+04	5.1E+03	4.7E+03	7.8E+06
14	65.8	64	82	90	2.9E-03	1.41E-03	5.2E+03	1.9E+04	1.6E+06

25 W ANNULUS= 12927.1

W/DEE KW	R/DEE MVA	C	R SH	C EQ PF	C COUP 3 DEES
182	1067	5945	109	314	2475

FOR 9.00 MHZ THE RESULTS ARE

N	Z	L	DEG	DEG	R/M	V	I	W	E
0	0.0	0	0	0	0.0	2.00E+05	86.	0.0	1.2E+07
1	67.2	16	3	8	1.3E-02	1.99E+05	2.1E+02	1.3E+02	1.8E+07
2	73.4	33	6	11	4.1E-03	1.96E+05	3.6E+02	1.5E+02	2.1E+07
3	0.0	33	0	0	0.0	2.00E+05	87.	0.0	1.2E+07
4	80.0	49	3	7	6.1E-03	1.99E+05	2.3E+02	66.	2.0E+07
5	85.8	66	8	12	4.4E-03	1.96E+05	3.5E+02	1.6E+02	1.8E+07
6	0.0	66	0	0	0.0	1.97E+05	76.	0.0	1.1E+07
7	76.2	81	2	6	4.5E-03	1.96E+05	2.1E+02	37.	1.8E+07
8	0.0	10	0	0	0.0	1.96E+05	9.3E+02	0.0	0.0
9	60.0	17	22	24	2.0E-03	1.93E+05	1.0E+03	3.5E+02	1.1E+07
10	40.7	28	17	20	2.5E-03	1.90E+05	1.2E+03	8.0E+02	2.3E+07
11	11.1	45	6	10	1.8E-03	1.88E+05	2.2E+03	2.3E+03	1.3E+08
12	39.2	50	32	34	1.5E-03	1.85E+05	2.2E+03	9.4E+02	1.1E+07
13	22.0	54	21	22	9.3E-04	1.83E+05	2.4E+03	5.6E+02	1.7E+07
14	85.8	200	50	90	1.6E-03	1.41E-03	3.1E+03	4.9E+04	6.3E+07

25 W ANNULUS= 2614.27

W/DEE KW	E/DEE MVA	C	R SH	C EQ PF	C COUP 3 DEES
114	771	6740	174	682	5982

TABLE I