214-0076-01-01_00

8 - CAA-B-E

RF [illegible]

RF Note 75

July 1, 1981
J. Riedel

K800 RF SYSTEM NO 3

Contents

1. Dee stem insulator and vicinity design

Fig. 1 shows our new design for the insulator. This insulator is identical to the K500 insulator, but will have to dissipate 50% more power. The resistance paper technique was used to find the equipotentials. The maximum gradient in the insulator occurs near the grounded end, and is 19.6KV/inch for 100KV resulting in a worse case dissipation of 1.13 watts/sq in of the air surface.

Because of the negative temperature coefficient of Q, it is desireable to transfer this heat to air with a surface temperature rise of no more than 100°C. At this temperature the power is up by 17%. To guarantee a uniform high velocity of air flow at the surface, we propose to use a 10 mil polystyrene cylinder coaxial with the insulator. This is a technique that was successfully used 30 years ago. One drawback is that a spark can ignite it and it would burn up possibly causing damage to the insulator. Therefore we might consider using a thin mica cylinder instead, or polypropylene.

F. Marti has done some calculations of air flow. His conclusions are that we need about 200 cu ft/min of air flowing in a 1/4" space between the insulator and the polystyrene, resulting in a maximum insulator temperature of 80°C. To achieve this, we need 150 - 1/8 inch holes at the insulator flange with a head in the plenum of .5PSI.

2. Insulator to stem end design

Fig. 2 shows the cross section view of the stem, the milieu of the moving short. The moving short is visualized as being identical to the K500 short except that it is larger. The inner conductor of the stem is 6 inches in diameter and has the same current density as the K500 short. The outer conductor, again hexagonal, is to be made of 1/4 in thick x 16 inch wide panels 12 feet long, water cooled at least in the corners. We presume that these may be flat plates clamped in the corners as in Fig. 2A, although we may use bent pieces as in the K500 design. We are investigating the feasibility of using copper plated aluminum castings with built in water cooling, as used in Wakefield heat sinks, for these panels.

3. Insulator to dee design

Table I shows the parameters used in the computer calculations. The positions 0 through 8 represent the dee. Note that the stem from the dee to the beginning of the magnet hole is 5" in diam. The insulator is between N=13 to 18. The L's are the individual lengths of the sections. Table II shows the calculated results for 27 and 9 MHz. Here, from N=9 on, the L's are the distance from the median plane.

4. Test Stand

We have new ideas for the test stand. First, perhaps since we couldn't find any place for a permenant stand, all the space having been preempted for cryogenics and power supplies, H.B. has decreed that a temporary test stand will suffice; that all r.f. problems will be solved by mid 1982! This is good news, as it will save a lot of time and effort in continually trying to improve the r.f. system. Fig. 4 shows a vertical section of the test stand, executed by R. Burleigh on his last visit. Fig. 5 shows where it is to be located in the K800 vault.

This test stand is conceived to serve two purposes: to test the ability to achieve 200 KV peak across one inch spacing with edge radii of 1/2 inch, and to determine whether or not the insulator will or will not survive the power dissipated in it. If the K500 stem short functions satisfactorily, so will the K800 short, as the linear current density is about the same, and both are in air.

This test stand is capable of being tuned over the range 9 to 28 MHz, requiring 117KW at 27 MHz. There will be no fine tuner; we will fine tune the frequency to maintain resonance during testing, as we did for the K500 test stand.

Table I shows the parameters and results for 27 MHz. At 9 MHz the short is 119 inches above the position for 27 MHz and the power for 100 KV is only 10 KW.

5. Coupler for Test Stand

Fig. 4 shows the coupler at the bottom of the resonator, the high voltage point. However, this was an undesirable location beacuse it covered up most of the area making visual monitoring of a spark difficult, and it compromised the voltage holding capability. So now it is at position 10 which is 37 inches from the high voltage end. The voltage is 138KV at 27MHz and 96.4KV at 9MHz. The shunt impedance of the resonator referred to this point is 81KΩ and 465KΩ for the high and low frequency limits and the required coupling capacity is 2.93 pf and 3.66 pf. Thus there is a great advantage in locating the coupler at this location, as it only need be changed by 20% over our range.

We choose a minimum spacing of 1 in. and thus need about 18 sq in of area. A simple way to accomplish this is shown in Fig. 6. The positioning method, insulator and TR line coupler will be the same as for the K500 coupler.

6. Test Stand Transmitter

The transmitter could be as delineated in RF Note 73. The anode circuit is a copy of the K500 transmitter except for being only 12 ft. long. Since the transmitter will be built before the test stand, there may be merit in making the transmitter anode circuit using the same panels as for the dees, thus debugging the technique. A decision on this should be made very soon as we are ready to build the transmitter.

7. Driver for RCA 4648 Final Tube

Four circuit configurations for driving the final tube have been investigated. Until we have tested the tube and learn better, we assume that we will need up to 200 volts rms on the final grid. The 1200 pf of grid capacity results in a requirement of 40 amperes at 27 MHz. The circuit of Fig. 1A, the same as is used in the K500, is eliminated because of the difficulty of building the variable inductor. The circuit of Fig. 1B has the same virtue as 1A in that there is only one variable element involved, but the only sure way of building this inductor is with a transmission line 1/2 inch inner conductor in a 6 inch pipe and a moving short spanning 12 feet. This length is objectionable. The circuit of Fig. 1D, described in detail in RF Note 69, although it requires two variable inductors, has the virtue that L1 is purchasable (the same as used in theK500 driver) and L2 is a TR line only 4 ft long. The transformer almost works and we are continuing to try and make it really work.. The only problem is manufacturing good 200Ω cable.

So, finally we may have to settle on the circuit of Fig. 1C. C5 is added so that the inductor has to be only 4 ft long. Although we have two variable elements, in practice the inductor would simply be set from a look up table and only C5 would be servoed. The danger here is that the lead inductance between C5 and C3 will resonate on a low harmonic of the fundamental. However, we can always vary L and C5 to avoid this condition. One thing is clear: in order to minimize this inductance, everything gets tightly packed.

There is a fifth way, namely to use the circuit of Fig. 1B, but make the L with biasable ferrite cores. We are not making any decision as to which scheme to adopt until we have done a bit more investiagtion, but the circuit of Fig. 1C will most likely be our choice, because no development work is involved. All the components have been ordered to build this configuration.

8. Aydin P.S.

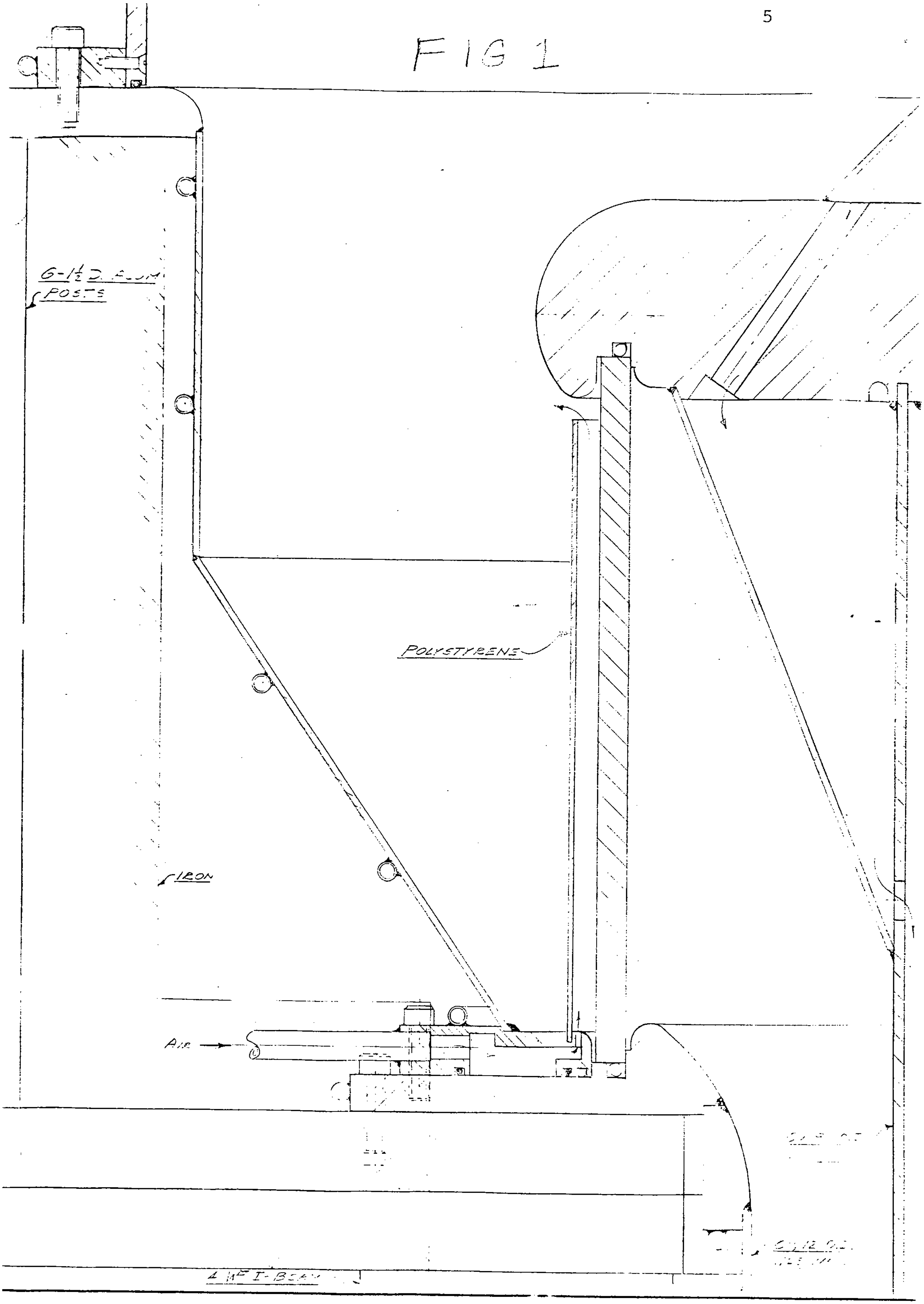
The 1.2 MW final anode power supply is due to arrive in October and we will have three months to acceptance test it. This will be inconvenient. In order to test it at full load by January 1, 1982, we would have to make water loads (approx 20K$) and when testing it would have to shut down the K500 as we would need all the available water. By April 1982 we will have occupancy of the K800 room and could use its water. If we can wait until April or May of 1982 to test the P.S. then we could be prepared to test it if we arrange to have all three K800 transmitters assembled. 3 transmitters + 1 - 300KW water load gives us 1050KW of load and our existing 300 KW of load does the rest.

9. Schedule

Within a few weeks we should be able to arrive at the final design for the grid circuit of the 4648 tube. Then we can, and should, immediately detail the transmitters and build three. The goal should be to have the first one finished by 1/1/82 and the other two by April. Therefore we should order tubes, blockers and vacuum condensers soon.

Meanwhile, a final layout of the test stand is underway. The goal would be to have a completed test stand by April 1, 1982.

FIG 1



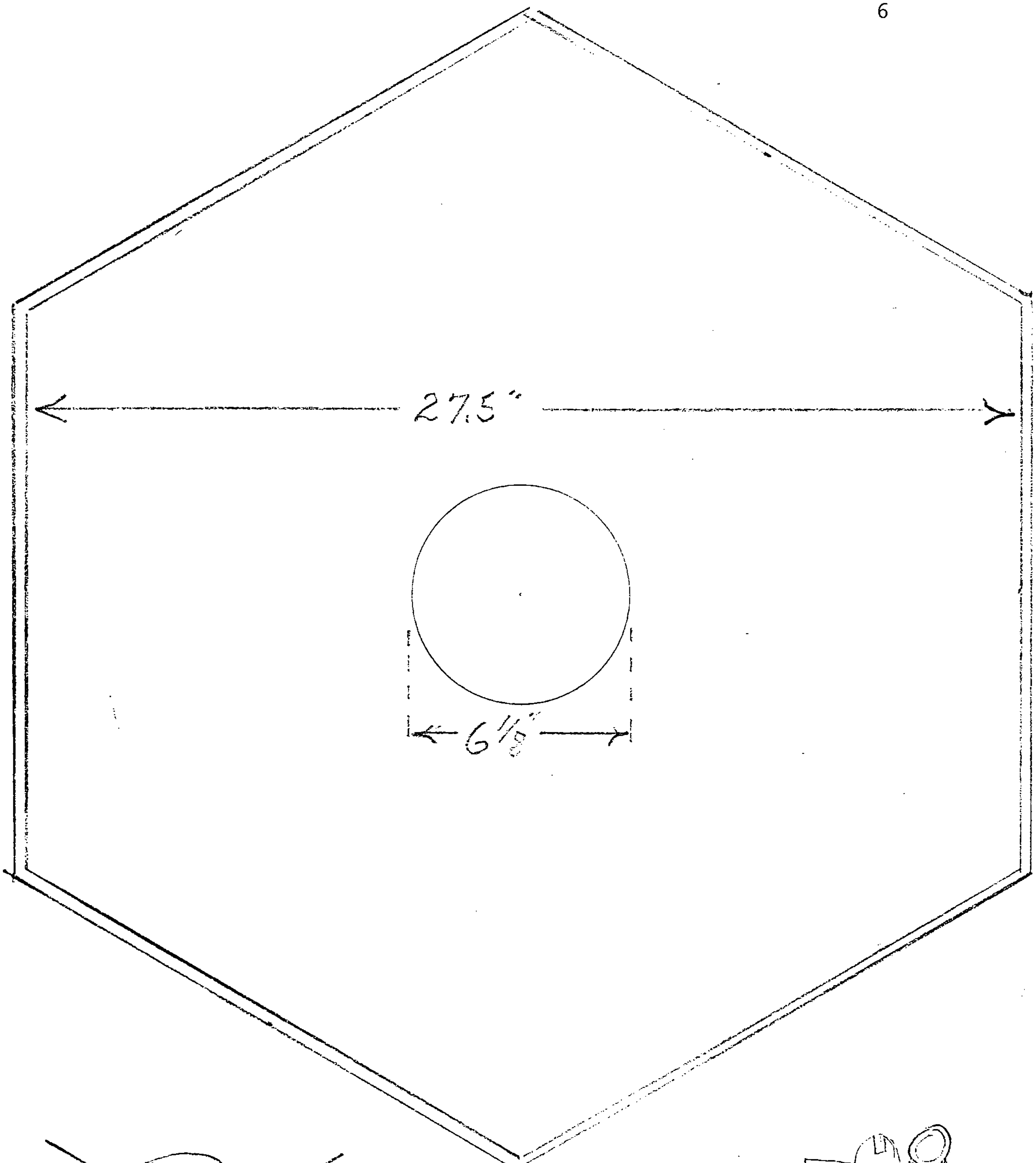


FIG 2

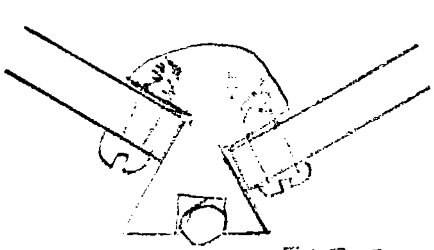
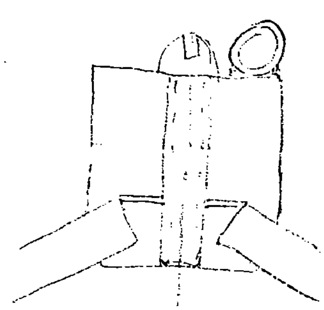


FIG 3



ALT FIG 3

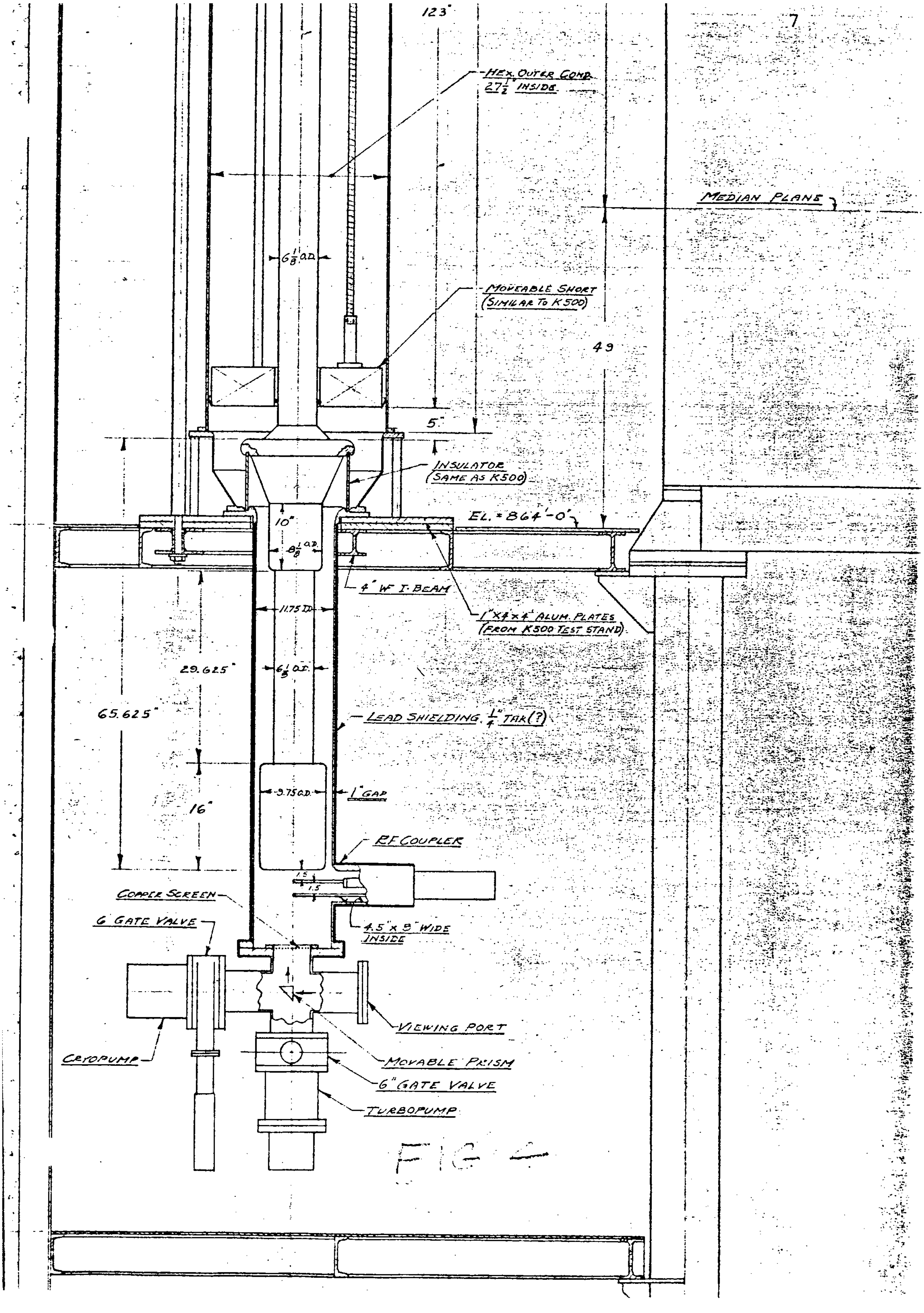

123"
HEX. OUTER COND. 27½" INSIDE
MEDIAN PLANE
6⅛" O.D.
MOVEABLE SHORT (SIMILAR TO K500)
49
5"
INSULATOR (SAME AS K500)
10"
8⅛" O.D.
EL. = 864'-0"
4" WF I-BEAM
1"×4"×4" ALUM. PLATES (FROM K500 TEST STAND)
11.75 I.D.
6⅛" O.D.
29.625"
65.625"
LEAD SHIELDING ¼" THK(?)
16"
9.75 O.D.
1" GAP
RF COUPLER
1.5
1.5
COPPER SCREEN
6" GATE VALVE
4.5" x 9" WIDE INSIDE
VIEWING PORT
CRYOPUMP
MOVABLE PRISM
6" GATE VALVE
TURBOPUMP

FIG 4

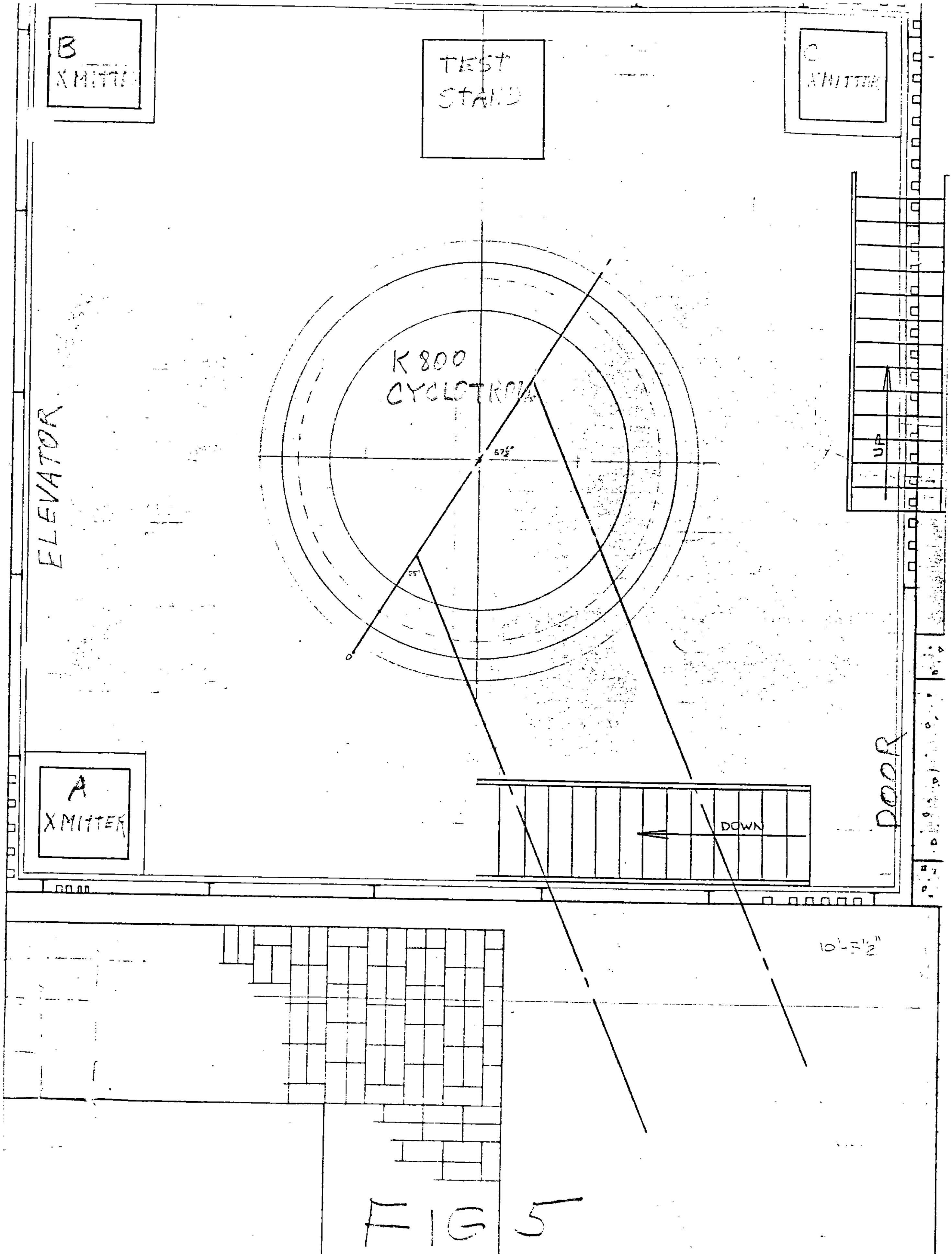
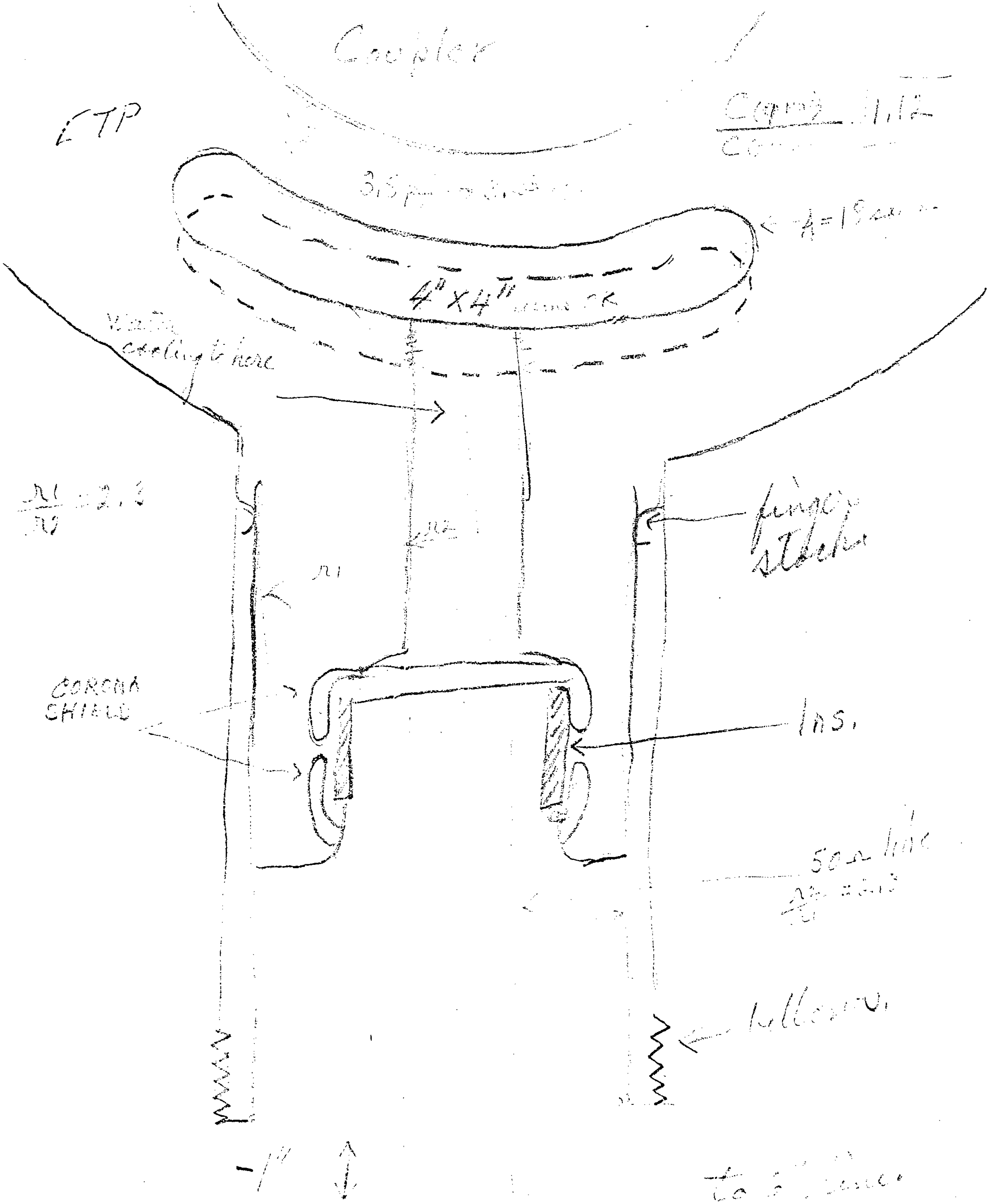

B
XMITTER
TEST
STAND
C
XMITTER
K 800
CYCLOTRON
57½°
35°
ELEVATOR
UP
A
XMITTER
DOWN
DOOR
10'-5½"

FIG 5

FIG. 6


Coupler
ETP
4" x 4"
cooling to here
CORONA SHIELD
Ins.
finger stock
50Ω line
bellows
~1"

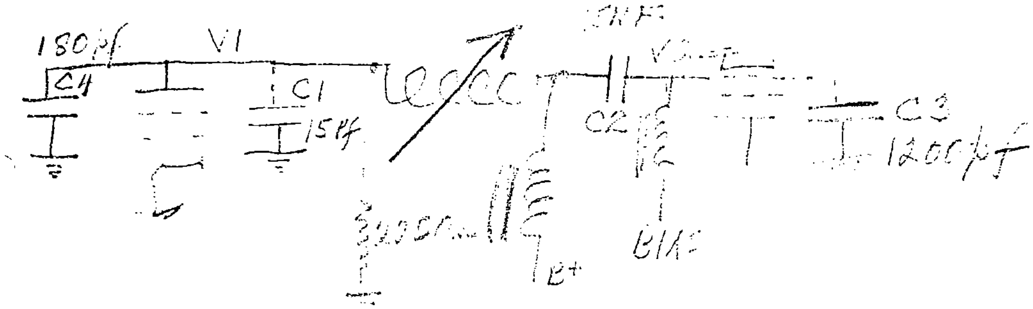


FIG 1A

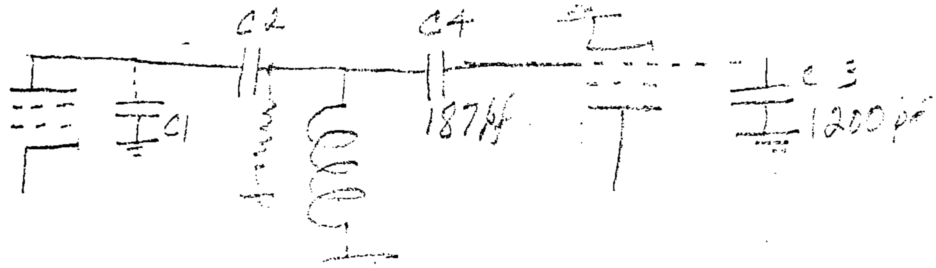


FIG 1B

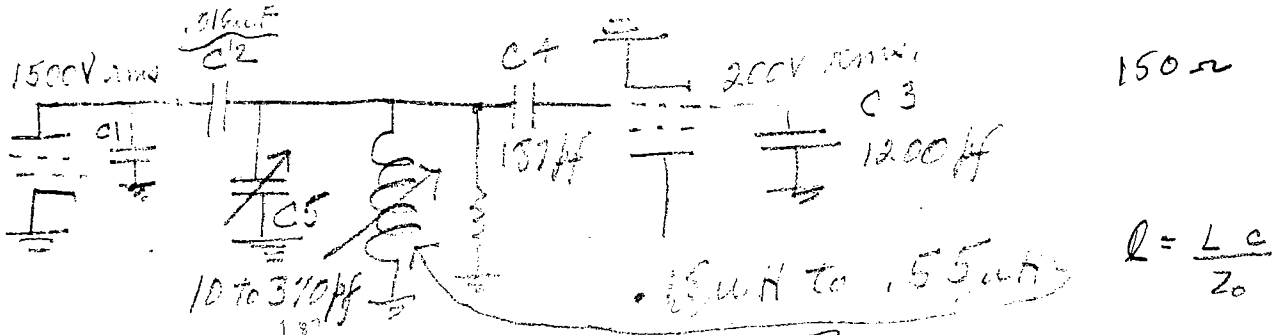


FIG 1C

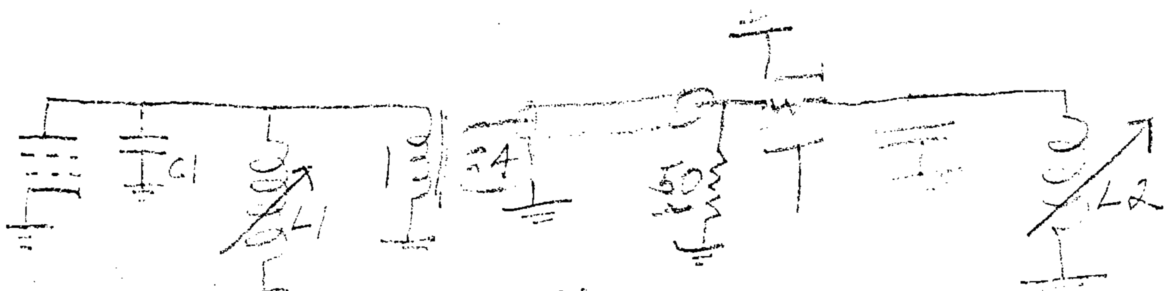


FIG 1D

FOR 27.00 MHZ THE RESULTS ARE

N	Z	L	A	B	G	H	K	Q	C
0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	12.3
1	87.2	16.5	6.00	4.00	2.00	6.00	1.53	13.58	0.0
2	58.7	16.5	10.00	6.00	4.00	3.00	1.24	13.58	0.0
3	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	10.8
4	80.0	16.5	10.00	6.00	2.00	6.00	1.34	13.58	0.0
5	85.8	16.5	11.00	4.00	4.00	3.00	1.25	13.58	0.0
6	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	9.6
7	76.2	15.0	8.00	6.00	3.00	3.00	1.24	12.34	0.0
8	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	60.0	7.3	26.00	8.12	0.00	0.00	1.50	6.05	0.0
10	51.2	10.6	11.75	5.00	0.00	0.00	1.00	8.74	0.0
11	39.0	9.0	11.75	6.12	0.00	0.00	1.00	7.41	0.0
12	22.1	8.2	11.75	8.12	0.00	0.00	1.00	6.72	0.0
13	28.2	1.4	13.00	8.12	0.00	0.00	1.00	1.13	0.0
14	50.9	1.5	19.00	8.12	0.00	0.00	1.00	1.23	0.0
15	48.2	1.5	21.00	9.40	0.00	0.00	1.00	1.23	0.0
16	44.3	1.5	22.00	10.50	0.00	0.00	1.00	1.23	0.0
17	45.3	1.5	25.00	11.75	0.00	0.00	1.00	1.23	0.0
18	33.0	2.2	26.00	15.00	0.00	0.00	1.00	1.85	0.0
19	23.7	2.5	26.00	17.50	0.00	0.00	1.00	2.06	0.0
20	94.0	4.8	29.39	6.12	0.00	0.00	1.00	3.92	0.0

TABLE I

27 MHZ

N	Z	L	DEG	DEG	R/M	V	I	W	E
0	0.0	0.0	0	0	0.0	2.00E+05	2.9E+02	0.0	4.2E+07
1	87.2	16.5	10	24	2.2E-02	1.86E+05	6.7E+02	2.2E+03	5.1E+07
2	58.7	33.0	17	30	7.0E-03	1.68E+05	1.2E+03	2.6E+03	6.4E+07
3	0.0	33.0	0	0	0.0	2.05E+05	2.7E+02	0.0	3.9E+07
4	80.0	49.5	8	22	1.1E-02	1.93E+05	6.8E+02	1.1E+03	5.9E+07
5	85.8	66.0	23	37	7.6E-03	1.68E+05	1.0E+03	2.4E+03	4.5E+07
6	0.0	66.0	0	0	0.0	1.76E+05	2.0E+02	0.0	2.5E+07
7	76.2	81.0	7	19	7.9E-03	1.68E+05	5.5E+02	4.6E+02	4.2E+07
8	0.0	10.0	0	0	0.0	1.68E+05	2.8E+03	0.0	0.0
9	60.0	17.3	54	60	6.2E-03	1.42E+05	3.0E+03	9.5E+03	2.1E+07
10	51.2	28.0	56	65	4.9E-03	1.08E+05	3.2E+03	1.3E+04	2.4E+07
11	39.0	37.0	59	66	4.3E-03	8.41E+04	3.4E+03	1.1E+04	1.5E+07
12	22.1	45.1	52	59	3.6E-03	7.09E+04	3.7E+03	9.5E+03	1.6E+07
13	28.2	46.5	64	66	3.4E-03	6.80E+04	3.8E+03	1.7E+03	1.7E+06
14	50.9	48.0	76	77	3.0E-03	6.21E+04	3.8E+03	1.6E+03	9.0E+05
15	48.2	49.5	76	78	2.6E-03	5.66E+04	3.8E+03	1.4E+03	7.9E+05
16	44.3	51.0	77	78	2.4E-03	5.14E+04	3.8E+03	1.3E+03	7.1E+05
17	45.3	52.5	78	79	2.1E-03	4.61E+04	3.8E+03	1.2E+03	5.7E+05
18	33.0	54.8	76	77	1.8E-03	4.03E+04	3.9E+03	1.5E+03	9.2E+05
19	23.7	57.3	73	75	1.6E-03	3.56E+04	3.9E+03	1.6E+03	1.1E+06
20	94.0	62.0	86	90	3.4E-03	1.41E-03	3.9E+03	6.3E+03	1.5E+05

31 W ANNULUS= 10486.4

32 W INS FLANGE= 6994.93

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP NPF
170	900	5271	117	265	2435

OR 9.00 MHZ THE RESULTS ARE

N	Z	L	DEG	DEG	R/M	V	I	W	E
0	0.0	0.0	0	0	0.0	1.00E+05	58.	0.0	4.1E+06
1	87.2	16.5	4	9	1.3E-02	9.91E+04	1.2E+02	45.	4.5E+06
2	58.7	33.0	6	10	4.1E-03	9.80E+04	2.2E+02	50.	6.5E+06
3	0.0	33.0	0	0	0.0	1.00E+05	43.	0.0	3.1E+06
4	80.0	49.5	3	7	6.1E-03	9.94E+04	1.1E+02	17.	4.9E+06
5	85.8	66.0	8	12	4.4E-03	9.80E+04	1.8E+02	39.	4.5E+06
6	0.0	66.0	0	0	0.0	9.86E+04	38.	0.0	2.6E+06
7	76.2	81.0	2	6	4.5E-03	9.80E+04	1.0E+02	9.2	4.6E+06
8	0.0	10.0	0	0	0.0	9.80E+04	5.0E+02	0.0	0.0
9	60.0	17.3	23	25	3.6E-03	9.65E+04	5.4E+02	1.8E+02	2.8E+06
10	51.2	28.0	22	25	2.8E-03	9.44E+04	6.0E+02	2.5E+02	4.5E+06
11	39.0	37.0	19	22	2.5E-03	9.28E+04	6.8E+02	2.3E+02	4.8E+06
12	22.1	45.1	13	15	2.1E-03	9.19E+04	7.9E+02	2.3E+02	7.5E+06
13	28.2	46.5	19	19	2.0E-03	9.17E+04	8.1E+02	44.	9.9E+05
14	50.9	48.0	32	33	1.7E-03	9.13E+04	8.2E+02	44.	5.9E+05
15	48.2	49.5	31	32	1.5E-03	9.09E+04	8.3E+02	39.	6.2E+05
16	44.3	51.0	30	30	1.4E-03	9.05E+04	8.4E+02	37.	6.7E+05
17	45.3	52.5	31	31	1.2E-03	9.02E+04	8.5E+02	33.	6.5E+05
18	33.0	54.8	24	24	1.0E-03	8.97E+04	8.7E+02	44.	1.3E+06
19	23.7	57.3	18	19	9.5E-04	8.94E+04	9.0E+02	47.	2.0E+06
20	94.0	191.3	53	90	2.0E-03	1.41E-03	1.1E+03	7.3E+03	9.4E+06

31 W ANNULUS= 496.672

2 W INS FLANGE= 213.534

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP NPF
18	141	7579	267	501	4839

TABLE II

10000 HALT

>

FOR 27.00 MHZ THE RESULTS ARE

	Z	I	A	B	G	H	K	Q	C
	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	5.0
8	11.2	16.0	11.75	9.75	0.00	0.00	1.00	13.17	0.0
9	39.0	10.0	11.75	6.12	0.00	0.00	1.00	8.23	0.0
10	39.0	16.1	11.75	6.12	0.00	0.00	1.00	13.27	3.4
11	39.0	3.5	11.75	6.12	0.00	0.00	1.00	2.88	0.0
12	22.1	9.0	11.75	8.12	0.00	0.00	1.00	7.41	0.0
13	50.9	1.9	19.00	8.12	0.00	0.00	1.00	1.56	0.0
14	48.8	1.5	21.00	9.30	0.00	0.00	1.00	1.23	0.0
15	47.0	1.5	23.00	10.50	0.00	0.00	1.00	1.23	0.0
16	45.5	1.5	25.00	11.70	0.00	0.00	1.00	1.23	0.0
17	41.5	2.0	26.00	13.00	0.00	0.00	1.00	1.65	0.0
18	23.7	2.6	26.00	17.50	0.00	0.00	1.00	2.14	0.0
19	63.6	1.3	26.00	9.00	0.00	0.00	1.00	1.07	0.0
20	94.0	4.2	29.39	6.12	0.00	0.00	1.00	3.47	0.0

N	Z	L	DEG	DEG	R/M	V	I	W	E
7	0.0	0.0	0	0	0.0	2.00E+05	1.2E+02	0.0	1.7E+07
8	11.2	16.0	1	14	3.2E-03	1.94E+05	3.0E+03	4.1E+03	4.0E+08
9	39.0	26.0	40	49	4.3E-03	1.69E+05	3.5E+03	1.1E+04	6.1E+07
10	39.0	42.1	49	62	4.3E-03	1.20E+05	4.1E+03	2.5E+04	6.3E+07
11	39.0	45.6	62	65	4.3E-03	1.09E+05	4.2E+03	6.6E+03	8.4E+06
12	22.1	54.6	51	58	3.6E-03	9.06E+04	4.6E+03	1.6E+04	2.9E+07
13	50.9	56.5	75	76	3.0E-03	8.14E+04	4.7E+03	3.2E+03	2.0E+06
14	48.8	58.0	76	77	2.7E-03	7.44E+04	4.7E+03	2.2E+03	1.3E+06
15	47.0	59.5	77	78	2.4E-03	6.77E+04	4.7E+03	2.0E+03	1.2E+06
16	45.5	61.0	77	79	2.1E-03	6.11E+04	4.7E+03	1.8E+03	9.8E+05
17	41.5	63.0	78	79	2.0E-03	5.31E+04	4.8E+03	2.3E+03	1.1E+06
18	23.7	65.6	72	74	1.6E-03	4.71E+04	4.8E+03	2.5E+03	2.0E+06
19	63.6	66.9	84	85	2.6E-03	3.90E+04	4.8E+03	2.0E+03	2.7E+05
20	94.0	71.1	87	90	3.4E-03	1.41E-03	4.8E+03	8.5E+03	1.6E+05

31 W ANNULUS= 16023.5

32 W INS FLANGE= 6752.12

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP MPF	R SH @ 10	C COUP 10
110	590	5342	180	173	1959	65	3262

FOR 9.00 MHZ THE RESULTS ARE

N	Z	L	DEG	DEG	R/M	V	I	W	E
7	0.0	0.0	0	0	0.0	1.00E+05	20.	0.0	1.4E+06
8	11.2	16.0	0	5	1.9E-03	9.97E+04	5.0E+02	67.	3.4E+07
9	39.0	26.0	16	18	2.5E-03	9.82E+04	5.9E+02	1.9E+02	6.0E+06
10	39.0	42.1	18	23	2.5E-03	9.54E+04	7.4E+02	4.4E+02	9.3E+06
11	39.0	45.6	23	24	2.5E-03	9.47E+04	7.7E+02	1.2E+02	1.9E+06
12	22.1	54.6	14	17	2.1E-03	9.36E+04	9.0E+02	3.3E+02	8.6E+06
13	50.9	56.5	35	35	1.7E-03	9.30E+04	9.1E+02	69.	7.8E+05
14	48.8	58.0	34	34	1.5E-03	9.26E+04	9.2E+02	49.	6.3E+05
15	47.0	59.5	33	34	1.4E-03	9.21E+04	9.3E+02	45.	6.5E+05
16	45.5	61.0	33	33	1.2E-03	9.17E+04	9.4E+02	41.	6.7E+05
17	41.5	63.0	31	32	1.1E-03	9.12E+04	9.5E+02	52.	9.6E+05
18	23.7	65.6	19	20	9.5E-04	9.08E+04	9.9E+02	59.	2.2E+06
19	63.6	66.9	44	45	1.5E-03	9.02E+04	9.9E+02	48.	4.0E+05
20	94.0	192.0	56	90	2.0E-03	1.41E-03	1.2E+03	8.0E+03	9.1E+06

31 W ANNULUS= 571.150

32 W INS FLANGE= 163.387

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP MPF	R SH @ 10	C COUP 10
10	76	7511	489	271	3576	445	3747

TABLE III