19/5/64

Phase Reversing Coils

Choose $d = 3.125 + .025 = 3.15$ "

$l = 3.15 - 2.63 = 8.29$ "

$N = 1880/Kdf_1 = 1880/.92 \cdot 3.15 \cdot 6.50 = 1880/1885 = 100$ turns

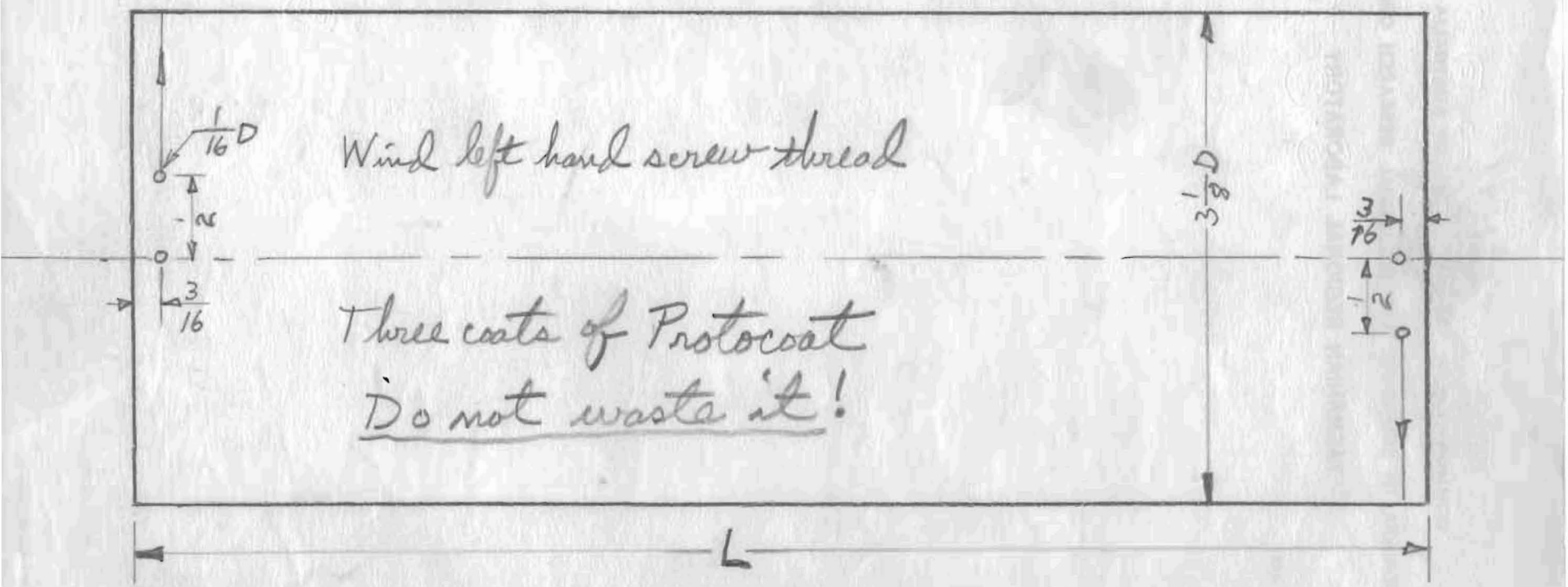
tpi $= 100/8.29 = 12.05$

$w = 1/2 \cdot 12.05 = .0415$" diameter (actual 0.036" dia wire)

		l	form	wire length
Wind coils a few turns too much	120 turns @ 11 tpi =	10.92	$11\frac{1}{2}$	99 ft
	110 turns @ 12 tpi =	9.16	$9\frac{3}{4}$	91 ft
	100 turns @ 13 tpi =	7.69	$8\frac{1}{4}$	83 ft

Phase Reversing Coil

Wanted 5/6/64



f, mc Two each making six coils with 0.036" dia bare aluminium wire

				l	d	l/d
6.22	6.22	L = 8 1/4"	102 turns at 13 tpi	7.75	3.16	2.452
6.06,	6.04	L = 9 3/4"	113 turns at 12 tpi	9.3	3.16	2.941
6.00,	5.97	L = 11 1/2"	121 turns at 11 tpi	10.9"	3.16	3.448

Grote Reber
28/5/64

10/6/64

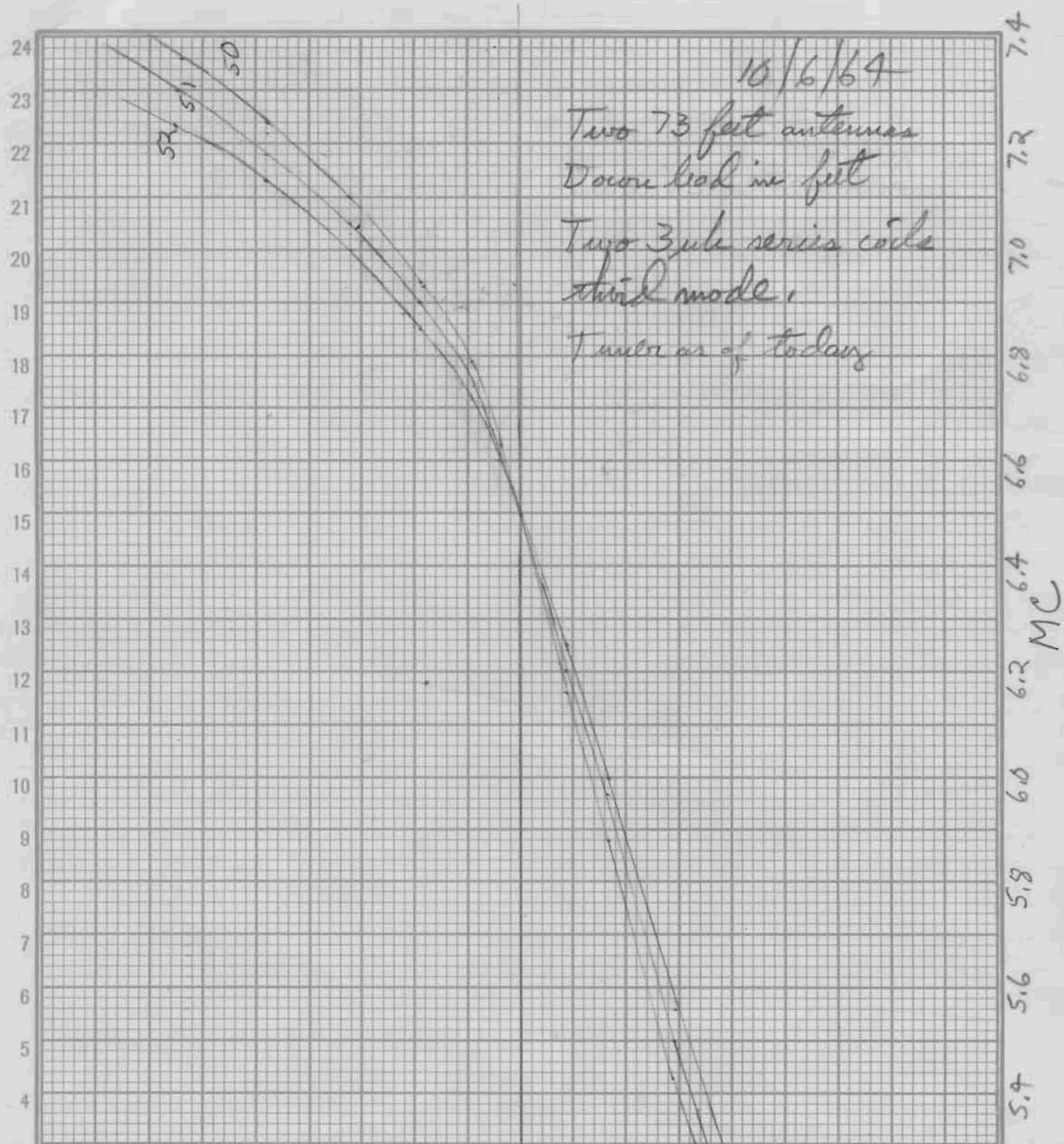
Down leads plus one antenna 73 ft long each side.
2-2.96 μh series coils at bottom to simulate coupler primary.

Down Lead		50 feet		51 feet		52 feet	
		Frequency MC	Reactance ohms.	Frequency MC	Reactance ohms.	Frequency MC	Reactance MC.
Two series capacitors	pf						
	27	7.36	-1600	7.30	-1616	7.23	-1630
	37	7.24	1190	7.18	1200	7.13	1207
	56	7.10	801	7.05	807	7.00	813
	99	6.94	464	6.90	466	6.85	470
	199	6.79	236	6.75	237	6.72	238
	490	6.63	-98.0	6.61	-98.4	6.60	-98.6
	Direct	6.50	0	6.50	0	6.50	0
	Direct	(6.58)	Resonance with traps set for 51 ft.	(6.57)	Resonance with traps set for 52 ft		
One series inductance	μh						
	5.7	6.16	+221	6.20	+222	6.25	+224
	11.0	5.88	406	5.97	412	6.00	414
	21.2	5.43	723	5.50	732	5.56	740
	37.5	4.96	1169	5.00	1178	5.07	1195
	84	4.30	2270	4.38	2310	4.43	2340
	178	3.80	4250	3.95	4410	4.04	4520

Series Traps

	Right	Left	Right	Left	Right	Left.
Condensers	110 pf	111 pf	105 pf	106 pf	100 pf	102 pf
Inductors	16.2 μh	15.8 μh	16.2 μh	15.8 μh	16.2 μh	15.8 μh
Resonance Computed	3.74	3.77 mc	3.82 mc	3.85 mc	3.92 mc	3.93 mc
Resonance Observed	3.60 mc	3.60 mc	3.75 mc	3.75 mc	3.96 mc	3.96 mc

Grid dip meter response is broad 5.5 to 7.0 mc because of large radiation resistance of antennas.


10/6/64
Two 73 feet antennas
Down lead in feet
Two 3 μh series coils
third mode.
Tuner as of today
50
51
52
MC
Reactance Ohms
2000
1000
0
1000
2000
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4

13/6/64 — 17/6/64

Antennas 146 ft long with loading coils at center 3 1/8" Diameter

12 TPI. Turns	F1 MC	F3 MC	Capacity Pf	Performance with 26 turn loading coils: Low Mode Frequency MC	Low Mode Reactance Ohms	High Mode Frequency MC	High Mode Reactance Ohms.
113	1,64	6.42					
111	"	6·45					
109	1,65	6·47	27	3·25	-3630	7·60	-1550
107	"	" "	39	3·11	2760	7·50	1147
104	1,66	6·48	56	2·92	1950	7·33	776
99	1,67		99	2·70	1191	7·05?	457
90	1,68		199	2·45	654	6·75	237
80	1,72		490	2·26	-288	6·60	-98
70	1,75		∞	2.14	0	6.50	0
60	1,80						
50	1·86	6·50					
40	1·95	6·52					
30	2·08	6·50	Inductance µh				
27	2·12	6·45					
26	2·14	6·50	5·7	2·11	+76	6.25	+274
			11·0	2·09	144	5·98	413
			21·2	2·03	270	5·50	732
			37·5	1·98	467	5·03	1185
			84·0	1·88	992	4·47	2360
			178·0	1·79	2000	4·22	4720

26 turn coils.
0,036" dia aluminium wire

MC	pf	Q	ohms
1,1	435	230	1,43
2,2	106	255	2,46

$C_0 = 3.7$ pf, $L_0 = 47.6$ µh
$R = 299\,MC/Q$ ohms.
$l = 2.08"$, $d = 3.16"$, $l/d = 0.658$
$L/d = 1.55$, $L = 49.0$ µh

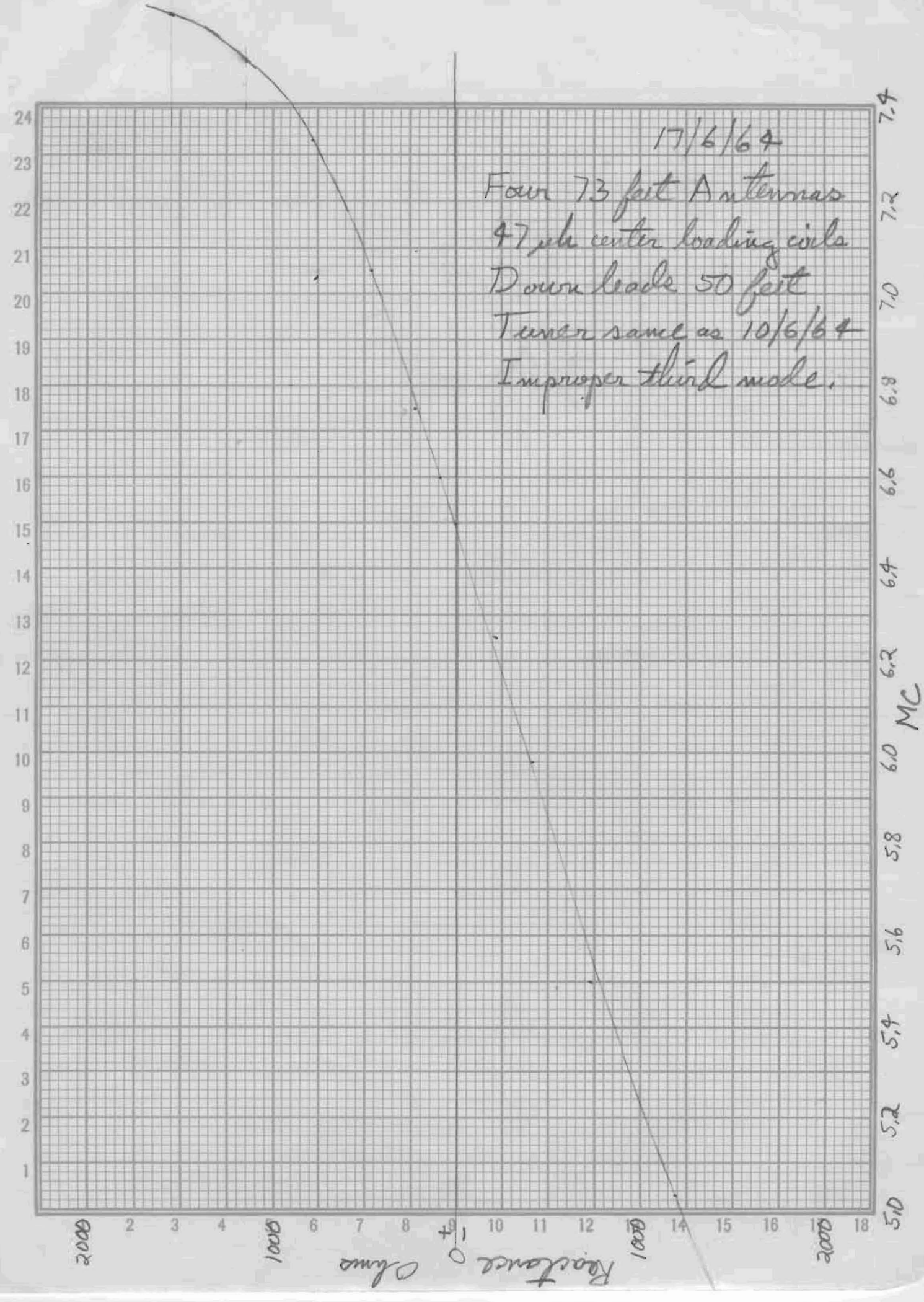
Down leads 50 feet long.
Tuner at bottom same as 10/6/64

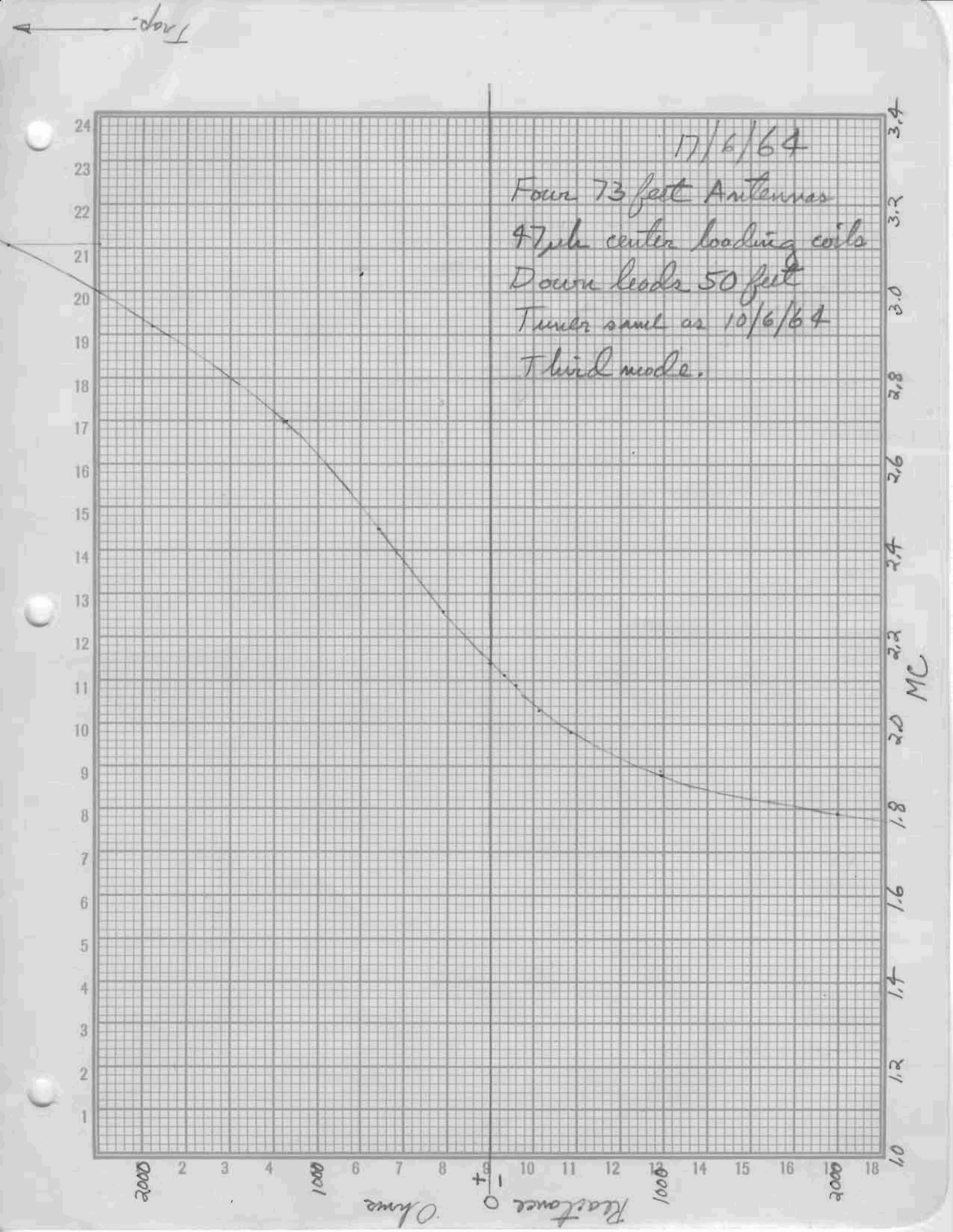
The loading coils work as expected at F1. Decreasing inductance raises the resonant frequency. System has much greater rate of change of reactance than down leads only on 30/5/64.

Loading coils merely act as chokes at F3. They isolate

(over)

for half of wire and effectively open circuit. Thus antenna acts as a three half wave system similar to 10/6/64. Phase reversing coils cannot be short and fat. This agrees with experience of C.A. Shain. He found they must be long and slender about 1956.


17/6/64
Four 73 foot Antennas
47 μh center loading coils
Down leads 50 foot
Tuner same as 10/6/64
Improper third mode.
MC
Resistance Ohms
2000
1000
0
1000
2000


17/6/64
Four 73 feet Antennas
47 µh center loading coils
Down leads 50 feet
Tuner same as 10/6/64
Third mode.
MC
Ohms
Reactance
0
+
-

24/6/64

Antennas 146 feet long with loading coils of 19/6/64 at centre.
Down leads 50 feet long. Tuner at bottom same as 10/6/64

Turns	F1	F3
168	1·99	6·41
169	2·01	6·41
150	2·06	6·41
140	2·10	6·41
130	2·13	6·41
124	2·15	6·41

Turns removed from centre of coil

124 turn coils characteristics

MC	pf	Q	ohms
1.1	490	157	2.05
2.2	102	172	3.75

C_0 = 10.7 L_0 = 46.6

R = 293 MC/Q

Most of C_0 is in measuring setup. True C_0 probably 1 pf.

Performance with 124 turn loading coils

Capacity pf	Low Frequency MC	Low Mode Reactance Ohms	High Frequency MC	High Mode Reactance Ohms.
27	3·23	-3650	7·61	-1550
37	3·12	2760	7·55	1141
56	2·95	1930	7·40	769
99	2·71	1187	6·80?	473
199	2·46	652	6·68	240
490	2·28	-285	6·53	-99
∞	2·15	0	6·41	0

Inductance μh.

5·1	2·13	+76	6·19	+222
11·0	2·10	145	5·98	413
21·2	2·05	273	5·50	732
37·5	1·99	469	5·05	1185
84	1·89	996	4·48	2360
178	1·80	1990	4·21	4700

These results are nearly identical to 17/6/64, At 2.15 mc a long slender coil is identical to short fat coil. At 6.5 mc both act merely as chokes which disconnect the outside half of antenna wire. Experiment is a failure. Try a quarter wave line next.

(over)

19/6/64

These special loading coils

$\ell = 36"$, $d = 1.625"$, $\ell/d = 22.2$, $n = 170$ uniform winding.

$L = 47\,\mu h$, wire 72 feet.

Distance	2"	3"	.7"	12"	7"	3"	2"	Total 36"
tpi	1	2	4	8	4	2	1	
turns	2	6	28	96	28	6	2	168 turns

Coils resonate on grid dip meter at 4.7 mc using small coil,
also at 5.6 on large coil D = 5.02 mc.

27/6/64.

Antenna 146 feet long with stub lines at centre.
Down leads 50 ft long. Tuner at bottom same as 10/6/64

Length of Stubs 38 ft.

Stub	F1	F3	Capacity	Low Mode		High Mode	
feet	MC	MC.	Pf	Frequency	Reactance	Frequency	Reactance
				MC	Ohms	MC	Ohms.
42	2.28	6.22.					
40	2.30	6.37					
38	2.31	648	27	3.25	-3630	7.35	-1605
36	2.32	6.58	37	3.13	2750	7.15	1205
34	2.33	6.70	56	2.98	1910	6.95	818
32	2.35	6.81	99	2.77	1160	6.80	473
30	2.36	6.96	199	2.57	623	6.65	241
			490	2.40	-271	6.55	-99
			5	2.31	0	6.48	0

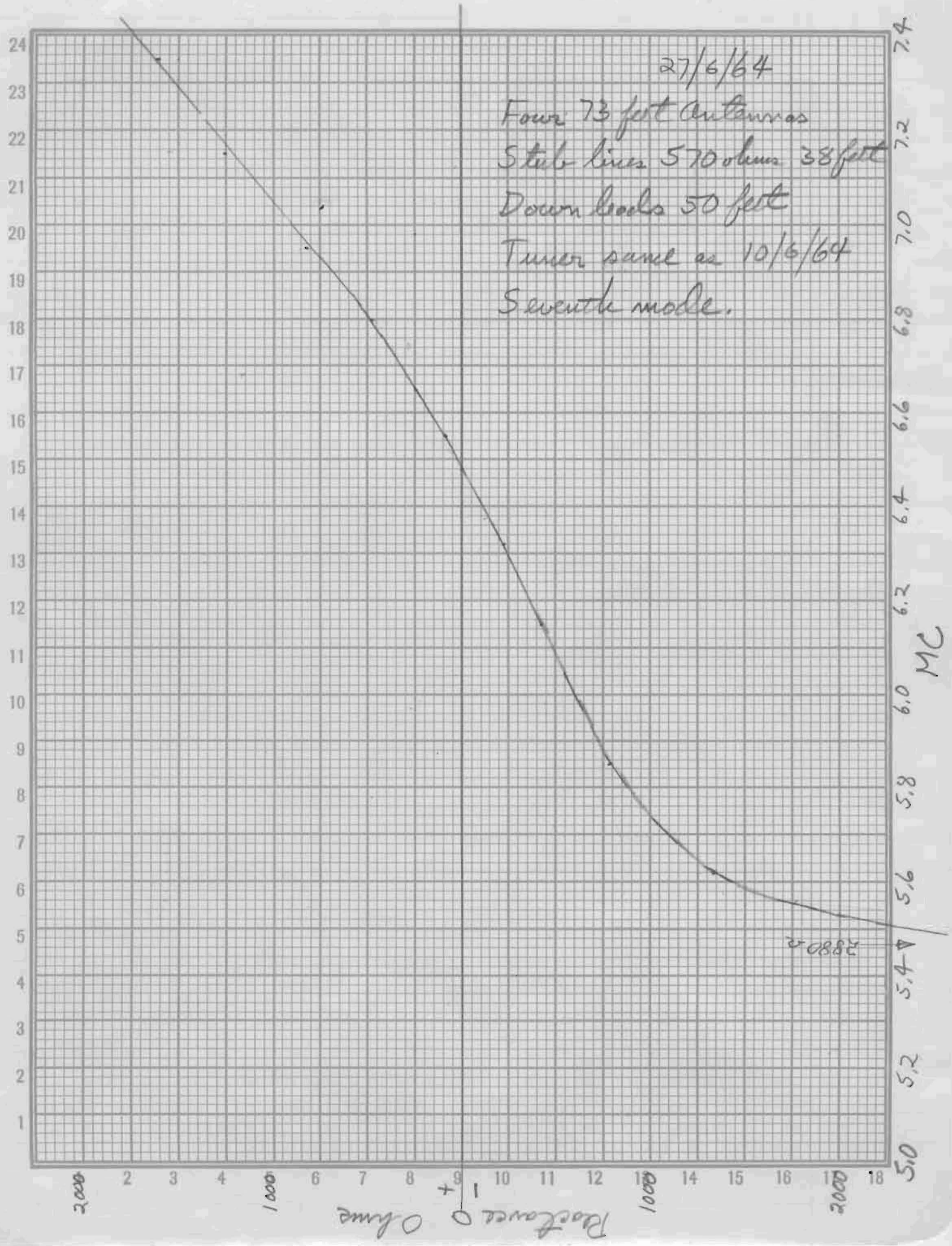
Line 7/.036 = .108" dia
Spacing 6.25", $\frac{D}{r} = 116$
$Z = 276 \log 116 = 570$ ohms.

Line 38 feet at 2.15 mc = 29.9°
$X_L = 570 \tan 29.9° = 328$ ohms.

By experiments of 10 & 17/6/64 about 47 μh is required.
$X_L = \omega L = 634$ ohms.
Required $Z = \frac{634}{328} 570 = 1100$ ohms
$\log \frac{D}{r} = \frac{1100}{276} = 4.0$, $\frac{D}{r} = 10{,}000$
if $r = 0.005"$, $D = 50"$. Not practical.

Inductance μh				
5.7	2.28	+82	6.32	+226
11.0	2.26	156	6.15	425
21.2	2.21	294	5.85	778
37.5	2.16	508	5.62	1325
84	2.05	1080	5.47	2880
178	1.94	1990	too faint	—

By observation of today, about 42 μh at centre of system is needed to resonate at 2.15 mc. This amounts to 21 μh or $X_L = 283$ ohms in each down lead. 283 + 328 = 611 ohms which is a reasonable agreement to 634 ohms. The effective inductance of coil in trap is a bit larger than 16 μh.


27/6/64
Four 73 foot Antennas
Stub lines 570 ohms 38 feet
Down leads 50 feet
Tuner same as 10/6/64
Seventh mode.
MC
Ohms
Reactance

1/7/64

Antenna 146 feet long, 38 ft stub lines at centre, 570 ohms. Down leads 50 feet long. Tuner like 10/6/64 except:

Trap coils 20 turns, 13 tpi

Trap Coils 13 TPI Turns.	FI MC	Trap MC	Capacity pf.	Low Mode Frequency MC	Low Mode Reactance Ohms	High Mode Frequency MC	High Mode Reactance Ohms.
29	1.95	2,36					
27	1.97	2,49	27	2.75	-4280		
23	2,05	2,77	37	2.66	3240		
21	2.10	2,93	56	2.57	2215		
20	2.14	3,05	99	2.40	1340		
			199	2.29	699		
			490	2.20	-295		
			∞	2.14	0	6.45	0

Trap coil performance

MC	pf	Q	ohms.
2,2	220	222	1.48
4.4	54	261	7.51

C_o = 1.3 pf L_o = 23.7 uh

$R = 149 \frac{MC}{Q}$ ohms.

Coil form grooves 0.020" deep.

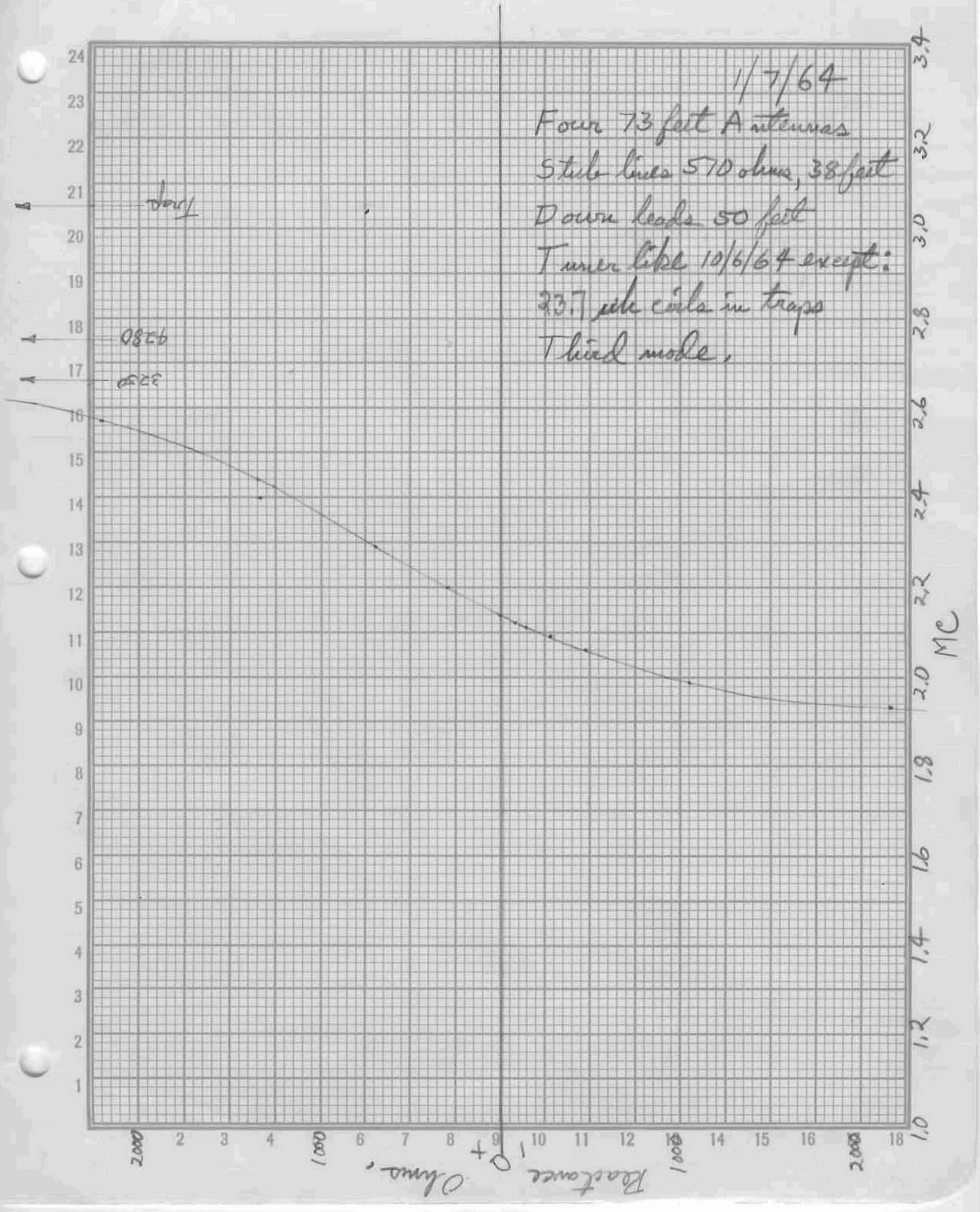
Apparent inductance of trap coils 21+16 = 37 uh.

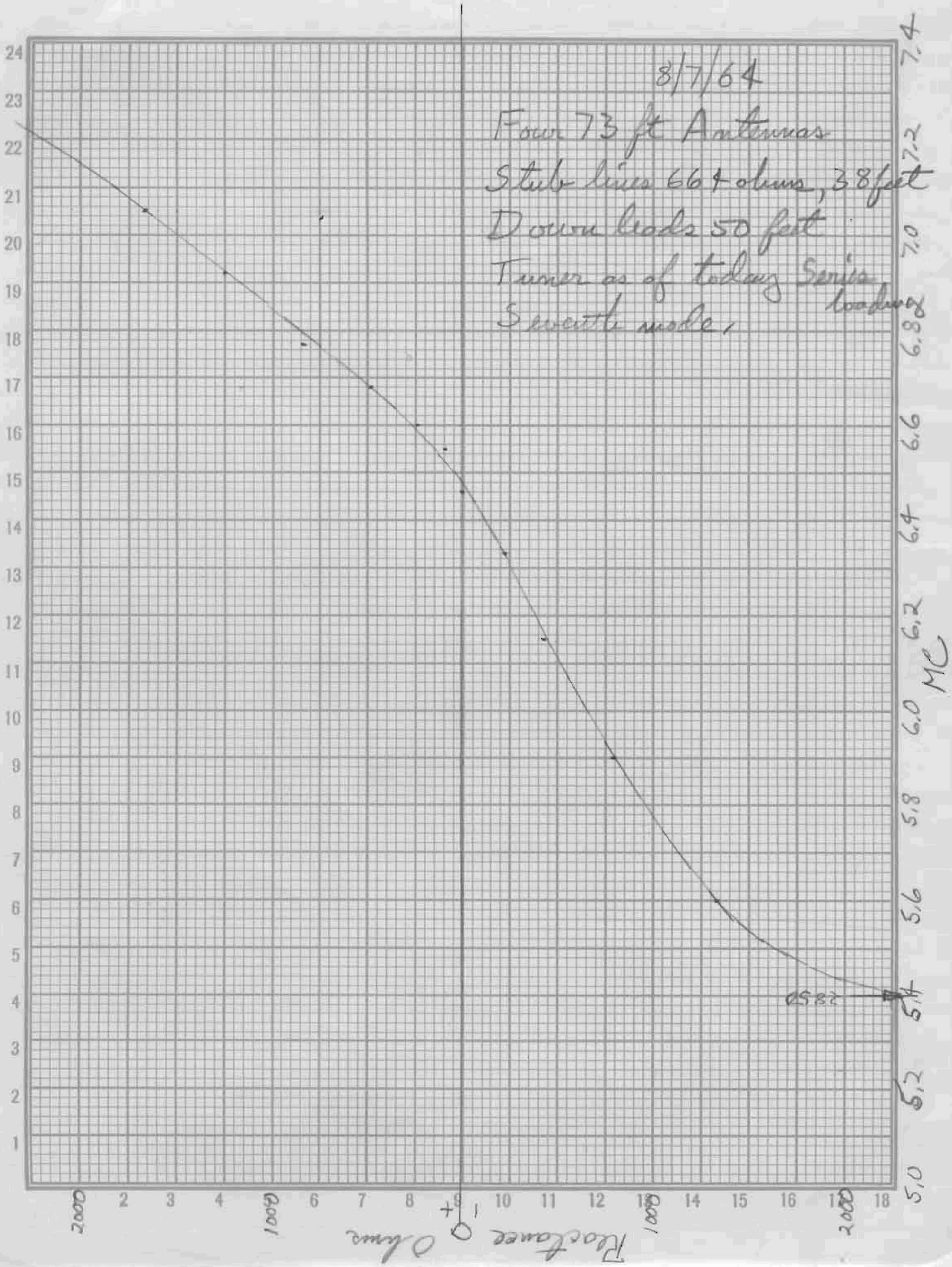
37/23.7 = 1.56 increase of inductance due to close resonance of trap.

Inductance uh.		
5.7	2.12	+76
11.0	2.11	146
21.2	2.09	278
37.5	2.06	485
84.0	1.99	1050
178.0	1.93	2160

The stub lines should be made higher impedance and the down leads longer. This will put more inductance into system and allow traps to tune to higher frequency. The rate of change of reactance will then be similar to 17/6/64.

(over)


1/7/64
Four 73 foot Antennas
Stub lines 570 ohms, 38 feet
Down leads 50 feet
Tuner like 10/6/64 except:
23.7 mh coils in traps
Third mode,
Trap
4280
3230
MC
Ohms
Reactance
+
-

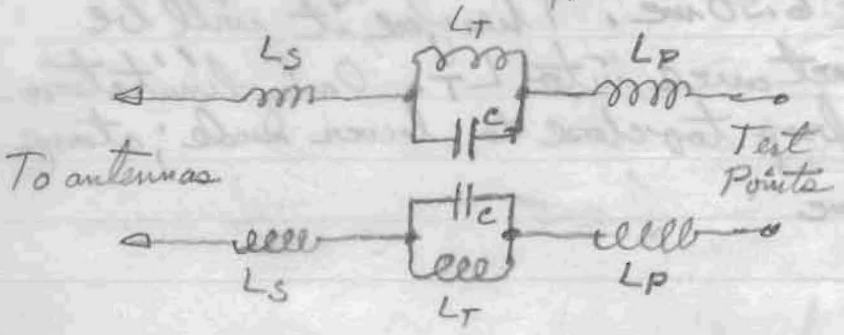


8/7/64
Four 73 ft Antennas
Stub lines 664 ohms, 38 feet
Down leads 50 feet
Tuner as of today Series loading
Seventh mode.
2850
MC
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
2000
1000
0
1000
2000
+
-
Reactance Ohms

8/7/64

Antenna testing

Four 73 ft antennas. Down leads 50 ft.
Stub lines 7/.029 spaced 11", Z = 664 ohms; 38 feet long.



L_S = 13 tpi, L_T = 11 tpi
L_P = 3 μh.

L_S		L_T		C	F_T	F_1	F_3
Turns	μh	Turns	μh	pf	MC	MC	MC
20	23.7	20	21.7	82	3.71	2.04	4.85 / 5.70
17					observed	2.06	4.99 / 5.80
14					3.77	2.09	5.08 / 6.00
12					computed	2.11	5.13 / 6.12
10						2.13	5.18 / 6.26
8						2.14	5.20 / 6.40
7	3.84					2.15	5.20 / 6.46
Stub feet	L_S = 7 turns						
42						2.12	6.28
40						2.13	6.38
38						2.15	6.46
36						2.17	6.59
34						2.19	6.70

Trap coils 20t, 11 tpi
C_o = 1.7 pf
L_o = 21.7 μh

Q machine observations

MC	pf	Q	R
2.1	263	254	
4.2	64.5	>250	

Trap Condensers 80.3 pf.

Series Coils 7t, 13 tpi
C_o = 4.0 pf
L_o = 3.84 μh.

(over)

L_S has reactance of 51,8 ohms at 2.15 mc
156,8 ohms at 6.50 mc,
This can be absorbed into system by lengthening stub lines and/or down leads. While necessary at 2.15 mc it is undesirable at 6.50 mc. Therefore it will be better to put this reactance into L_T. Only limitation is that F_T does not drop too close to lower mode; stays preferably above 3.30 mc

8/7/64

Antenna Testing

Antennas 146 feet long with 664Ω stub 38 ft long at center.
Tuner L_S = 7t, 13 tpi, 3,84 μh. L_T = 20t, 11 tpc, 21,7 μh.
Down leads 50 feet. C = 82 pf. F_T = 3,71 mc
3 μh inductance as dummy primary.

Capacity Pf.	Low Frequency MC	Mode Reactance Ohms	High Frequency MC	Mode Reactance Ohms.
27	3.13	-3770	7.05	-1675
37	2.98	2890	6.92	1250
56	2.81	2050	6.77	840
99	2.58	1240	6.68	482
199	2.36	678	6.60	243
490	2.23	-291	6.55	-99
∞	2.15	0	6.46	0
Inductance μh.				
5.7	2.14	+77	6.33	+227
11.0	2.12	146	6.15	425
21.2	2.10	280	5.90	786
37.5	2.06	485	5.60	1320
84.0	1.97	1040	5.40	2850
178.0	1.90	2120	Too faint.	—