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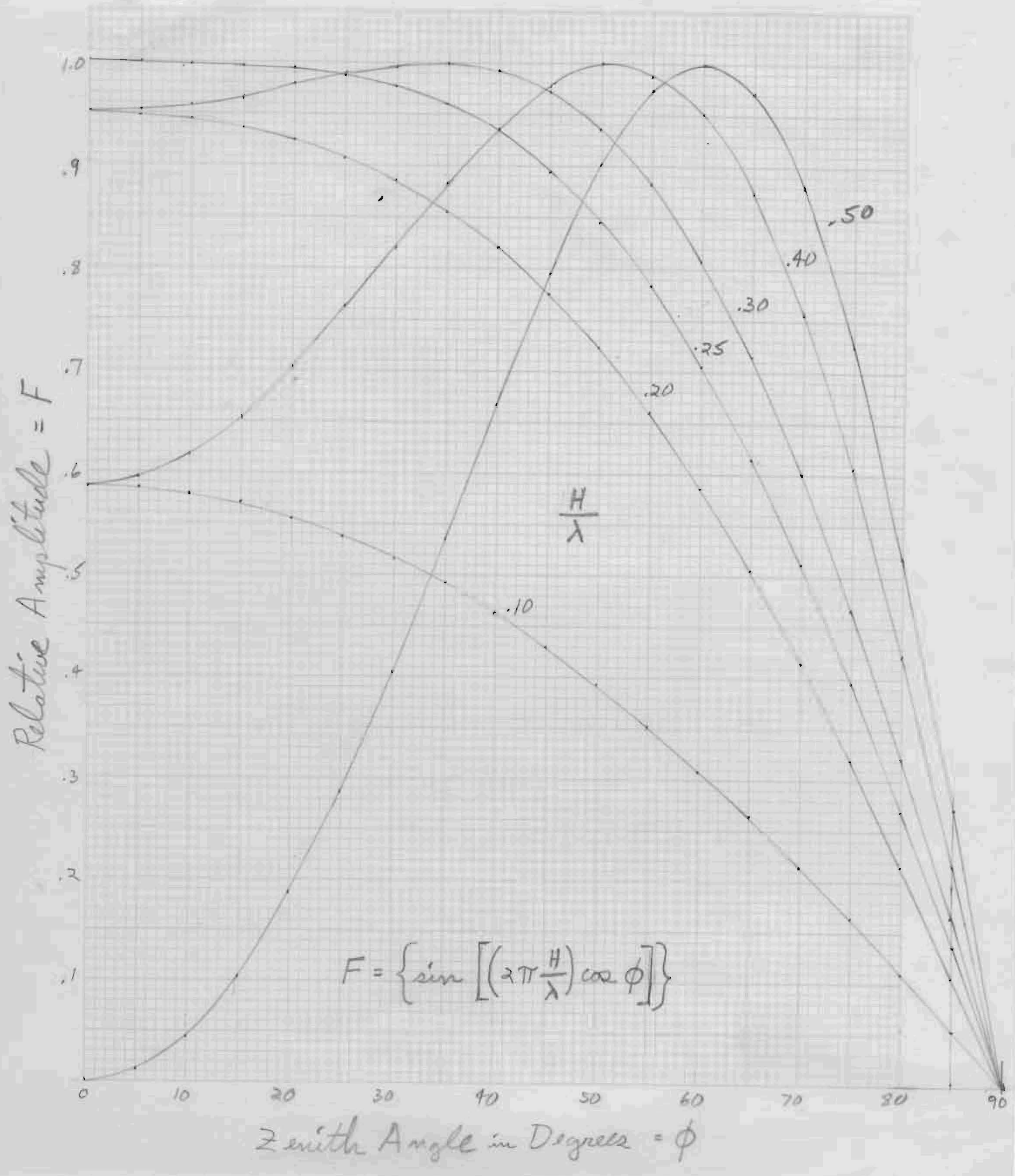
Frequency allocations according to Harry Melling

4750 - 5060	Broadcasting
5060 - 5480	Mobile
5480 - 5730	Aeronautical
5730 - 5950	Point to Point
5950 - 6200	Broadcasting
6200 - 6525	Marine
6525 - 6765	Aeronautical
6765 - 7000	Point to Point
7000 - 7100	Amateurs
7100 - 7300	Broadcasting

Broadcasting has very high power of 50 to 500 kilowatts and continuous carrier operation.
Point to point has high power of 5 to 50 kilowatts and high speed code equivalent to continuous carrier.
Marine has medium power of .5 to 5 kilowatts and intermittent operation.
Mobile and Aeronautical are low power .05 to .5 kilowatts and intermittent operation.

Apparently the bands 5060 to 5730 and 6200 to 6765 are best.
5395 center 6483 center



1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
80
90
Relative Amplitude = F
Zenith Angle in Degrees = φ
.50
.40
.30
.25
.20
.10
H/λ
F = {sin [(2π H/λ) cos φ]}

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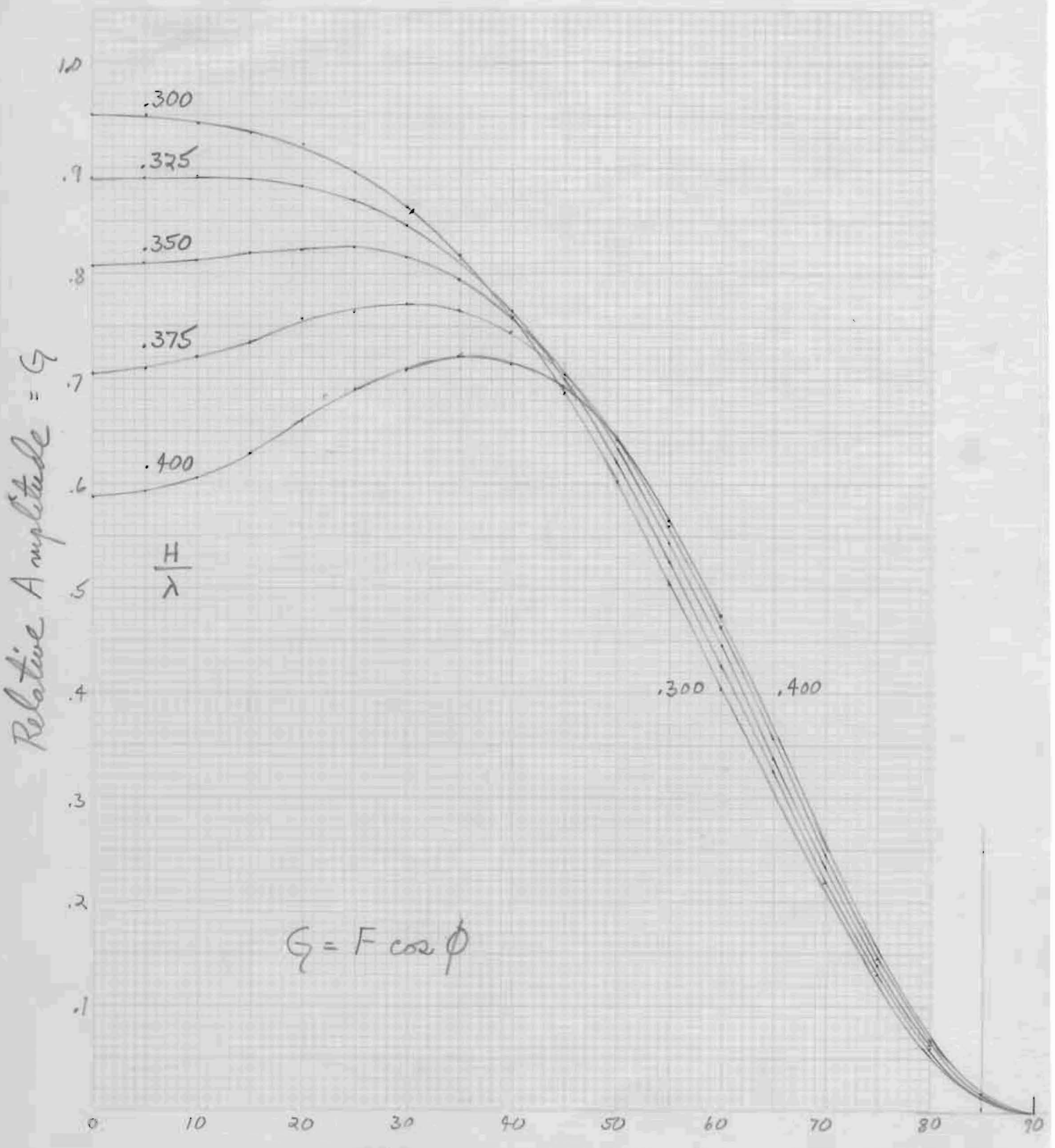
Polar diagram versus height H of horizontal dipole, from Terman page 790

$$F = \left\{ \sin\left[\left(2\pi\frac{H}{\lambda}\right)\sin\theta\right]\right\}$$ where θ = angle from horizontal

H/λ		0.10		0.20		0.25		0.30		0.40		0.50	
$(2\pi H/\lambda)^\circ$		36°		72°		90°		108°		144°		180°	
θ	$\sin\theta$	$()\sin\theta$	sin[ ]	$()\sin\theta$	sin[ ]	$()\sin\theta$	sin[ ]	$()\sin\theta$	sin[ ]	$()\sin\theta$	sin[ ]	$()\sin\theta$	sin[ ]
0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	.0872	3.14	.055	6.28	.109	7.94	.138	9.42	.164	12.56	.218	15.88	.273
10	.1746	6.26	.110	12.52	.217	15.65	.270	18.80	.322	25.04	.423	31.30	.520
15	.2589	9.32	.164	18.64	.320	23.30	.396	27.97	.469	37.28	.606	46.60	.727
20	.3420	12.31	.213	24.62	.417	30.80	.512	36.93	.601	49.24	.758	61.60	.880
25	.4228	15.22	.263	30.44	.507	38.07	.616	45.70	.716	60.88	.874	76.14	.971
30	.5000	18.00	.309	36.00	.588	45.00	.707	54.00	.809	72.00	.951	90.00	1.000
35	.5735	20.64	.352	41.28	.660	51.60	.784	61.92	.882	81.56	.989	103.20	.974
40	.6428	23.15	.393	46.30	.723	57.85	.847	69.42	.936	92.60	.999	115.70	.901
45	.7071	25.46	.430	50.92	.777	63.61	.896	76.39	.972	101.84	.979	127.22	.796
50	.7661	27.60	.463	55.20	.821	69.00	.934	82.80	.992	110.40	.937	138.00	.669
55	.8191	29.48	.492	58.96	.857	73.75	.960	88.50	1.000	117.92	.884	147.50	.538
60	.8666	31.20	.518	62.40	.886	78.00	.978	93.60	.998	124.80	.821	156.00	.407
65	.9063	32.60	.539	65.20	.908	81.60	.989	97.93	.990	130.40	.762	163.20	.289
70	.9398	33.81	.557	67.62	.925	84.60	.995	101.50	.980	135.24	.704	169.20	.187
75	.9660	34.80	.571	69.60	.937	87.00	.998	104.45	.968	139.20	.653	174.00	.105
80	.9848	35.43	.580	70.86	.945	88.62	.999	106.40	.959	141.72	.619	176.24	.046
85	.9962	35.85	.586	71.70	.949	89.70	1.000	107.55	.954	143.40	.596	179.90	.011
90	1.0000	36.00	.588	72.00	.951	90.00	1.000	108.00	.951	144.00	.588	180.00	.000

Zenith angle $\phi = 90^\circ - \theta$


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.300
.325
.350
.375
.400
H / λ
.300
.400
G = F cos φ
Relative Amplitude = G
0
10
20
30
40
50
60
70
80
90
Zenith Angle in Degrees = φ

H/λ	.375			.350			.325			.300	.400
$(2\pi H/\lambda)^\circ$	135°			126°			117°			108°	144°
θ	( ) sin θ	sin [ ]	sin θ { }	( ) sin θ	sin [ ]	sin θ { }	( ) sin θ	sin [ ]	sin θ { }	sin θ { }	sin θ { }
0	0	0	0	0	0	0	0	0	0		
5	11.77	.204	.018	10.99	.191	.017	10.20	.178	.016		
10	23.50	.399	.069	21.92	.374	.065	20.38	.348	.061		
15	34.91	.572	.148	32.60	.539	.140	30.30	.505	.131		
20	46.17	.721	.246	43.10	.683	.234	40.00	.643	.220		
25	57.09	.839	.359	53.25	.801	.339	49.50	.761	.326		
30	67.50	.924	.462	63.00	.891	.446	58.50	.853	.427	.405	.476
35	77.40	.976	.560	72.25	.952	.545	67.10	.921	.528	.506	.567
40	86.80	.998	.642	81.00	.988	.635	75.25	.967	.621	.602	.642
45	95.50	.995	.704	89.18	1.000	.707	82.80	.992	.701	.688	.694
50	103.5	.972	.745	96.60	.993	.760	89.70	1.000	.766	.760	.718
55	110.5	.937	.767	103.3	.973	.796	95.85	.995	.814	.819	.724
60	117.0	.891	.771	109.1	.945	.818	101.4	.980	.848	.864	.710
65	122.5	.844	.764	114.3	.912	.827	106.1	.961	.870	.898	.691
70	126.1	.808	.759	118.5	.879	.826	109.9	.940	.884	.922	.661
75	130.5	.761	.735	121.8	.850	.821	113.0	.921	.890	.935	.630
80	133.0	.732	.721	124.1	.828	.815	115.2	.905	.892	.944	.608
85	134.5	.713	.710	125.5	.814	.811	116.5	.895	.891	.950	.594
90	135.0	.707	.707	126.0	.809	.809	117.0	.891	.891	.951	.588

$G = F \cos\phi$

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Array Design

Every third line operates at 2.15 and 6.50 mc.
In between lines operate at 6.50 mc only.
Duplex lines at edges of array.
M = number of duplex lines
N = total number of lines

$N = 3M - 2$

Choose M even numbers to keep line off center of Array.

$S = N - M = 2(M-1)$ = number of simple lines

Make array elliptical with long axis North/South.

Ellipse $= \frac{X^2}{a} + \frac{Y^2}{b} = 1$ or $y = b\left(1 - \frac{x^2}{a^2}\right)^{1/2}$

where a and b are semimajor and semiminor axis.

Array to operate from 0 to 45° zenith angle. a kind of astigmatism will cause beam to broaden out in N/S direction when off zenith. It is due to shortened projected width of array. Maximum is $1/\cos 45° = 1.414$ to 1. This may be divided evenly as $(1.414)^{1/2} = 1.190$ elongation E/W when beam at 0° and 1.190 elongation N/S when beam at 45°. Beam will be circular at $\theta = \cos^{-1}(1/1.190) = \cos^{-1} .84 = 32.8°$ from zenith $= 2° \times 2°$. at 0° beam 2° E/W × 1.68° N/S. at 45° beam 2° E/W × 2.38° N/S.

Thus $a = 1.190\, b$, where: a + b are semi N/S and semi E/W axis.

(over)

$2b = 32$ wavelengths or $b = 16$

$2a = 1.190 \times 32 = 38$ wavelengths or $a = 19$

2 lines per wavelength = 76 lines

Feed point every 3λ wavelengths on each line. Lines $\lambda/2$ apart

$N = 76$, $M = 26$

d = duplex lines

x	$(x/a)^2$	$[1-(\frac{x}{a})^2]$	$[-]^{1/2}$	$y = b[-]^{1/2}$
0	0	1.000	1.000	16.0
1	.003	.997	.999	16.0
2	.011	.989	.994	15.9
3	.025	.975	.988	15.8
4	.044	.956	.978	15.6
5	.069	.931	.966	15.4
6	.100	.900	.949	15.2
7	.136	.864	.930	14.9
8	.177	.823	.907	14.5
9	.224	.776	.882	14.1
10	.277	.723	.850	13.6
11	.336	.664	.814	13.0
12	.398	.602	.776	12.4
13	.469	.531	.730	11.7
14	.543	.457	.676	10.8
15	.624	.376	.613	9.8
16	.710	.290	.538	8.6
17	.800	.200	.447	7.2
18	.897	.103	.321	5.1
19	1.000	0	0	0

Feed Points

8
8 d
8
8
8 d
8
8
8 d
8
8
8 d
8
8
7 d
7
7
7 d
7
7
7 d
7
7
6 d
6
6
6 d
6
5
5 d
5
5
4 d
4
4
3 d
3
2
1 d

Feed Point Sums

13x8 = 104
9x7 = 63
5x6 = 30
4x5 = 20
3x4 = 12
2x3 = 6
1x2 = 2
1x1 = 1
38 lines, 238 points

4x8 = 32
3x7 = 21
2x6 = 12
1x5 = 5
1x4 = 4
1x3 = 3
1x1 = 1
13 d lines, 78 d points

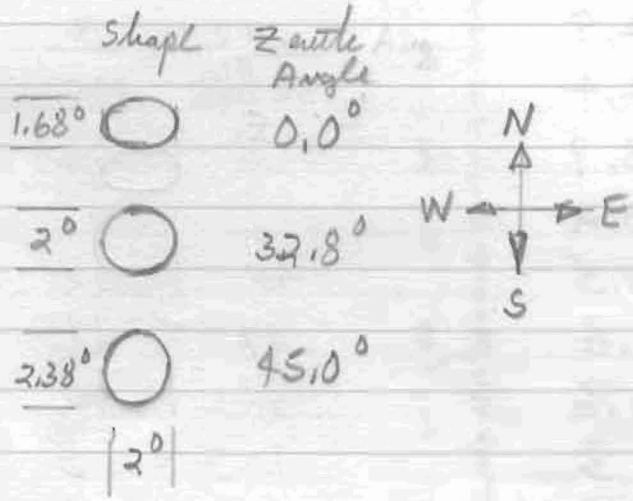
	One quarter Array	Entire Array
Simple	25 lines, 160 points	50 lines 640 points
Duplex	13 lines 78 points	26 lines 312 points
Total	38 lines 238 points	76 lines 952 points

The elliptical array compared to circular array:

$\frac{76}{64}$ = 1,186 times as many lines

$\frac{952}{812}$ = 1,172 times as many feed points.

The array can be made elliptical by less than 20 percent increase of complexity and cost.



Duplex Receiver Input System

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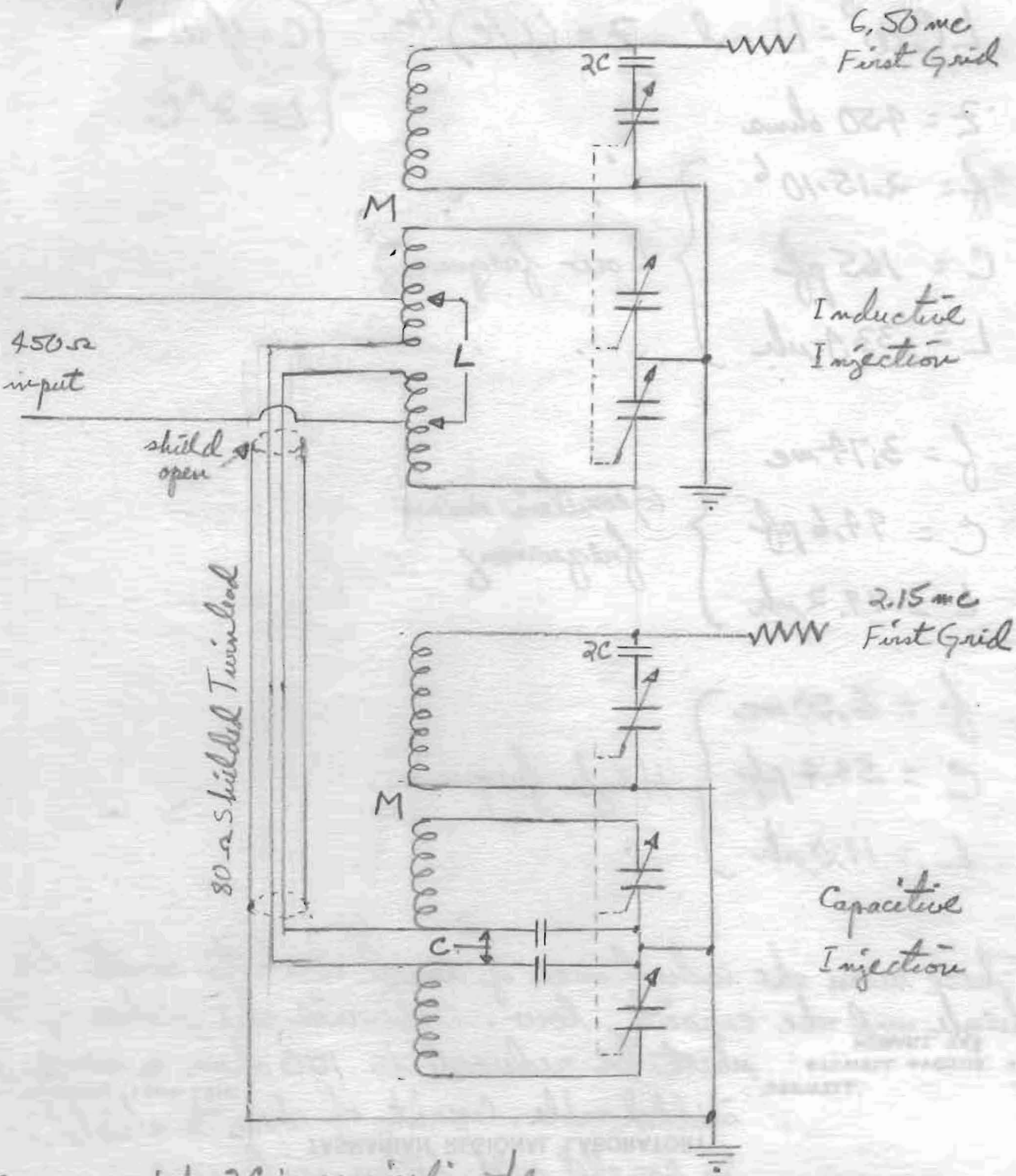

Series capacity 2C is required in the secondary to make it track the primary.

Twin lead must be short and low impedance so that its inductance is very small part of L.

(over)

Injection Constants

$LC\omega^2 = 1$ and $Z = (L/C)^{1/2}$ $\begin{cases} C = 1/\omega Z \\ L = Z^2 C \end{cases}$

$Z = 450$ ohms

$f = 2.15 \cdot 10^6$
$C = 165$ pf
$L = 33.4$ μh
} Low frequency

$f = 3.74$ mc
$C = 94.6$ pf
$L = 19.2$ μh
} Geometric mean frequency

$f = 6.50$ mc
$C = 54.4$ pf
$L = 11.0$ μh
} High frequency

These mean the inductance of tuned circuits must be high and the capacity low. Otherwise the value of Z must be reduced to 100 ohms or so to fit shielded cable. Capacity of wires to shield is in parallel with bottom condensers.

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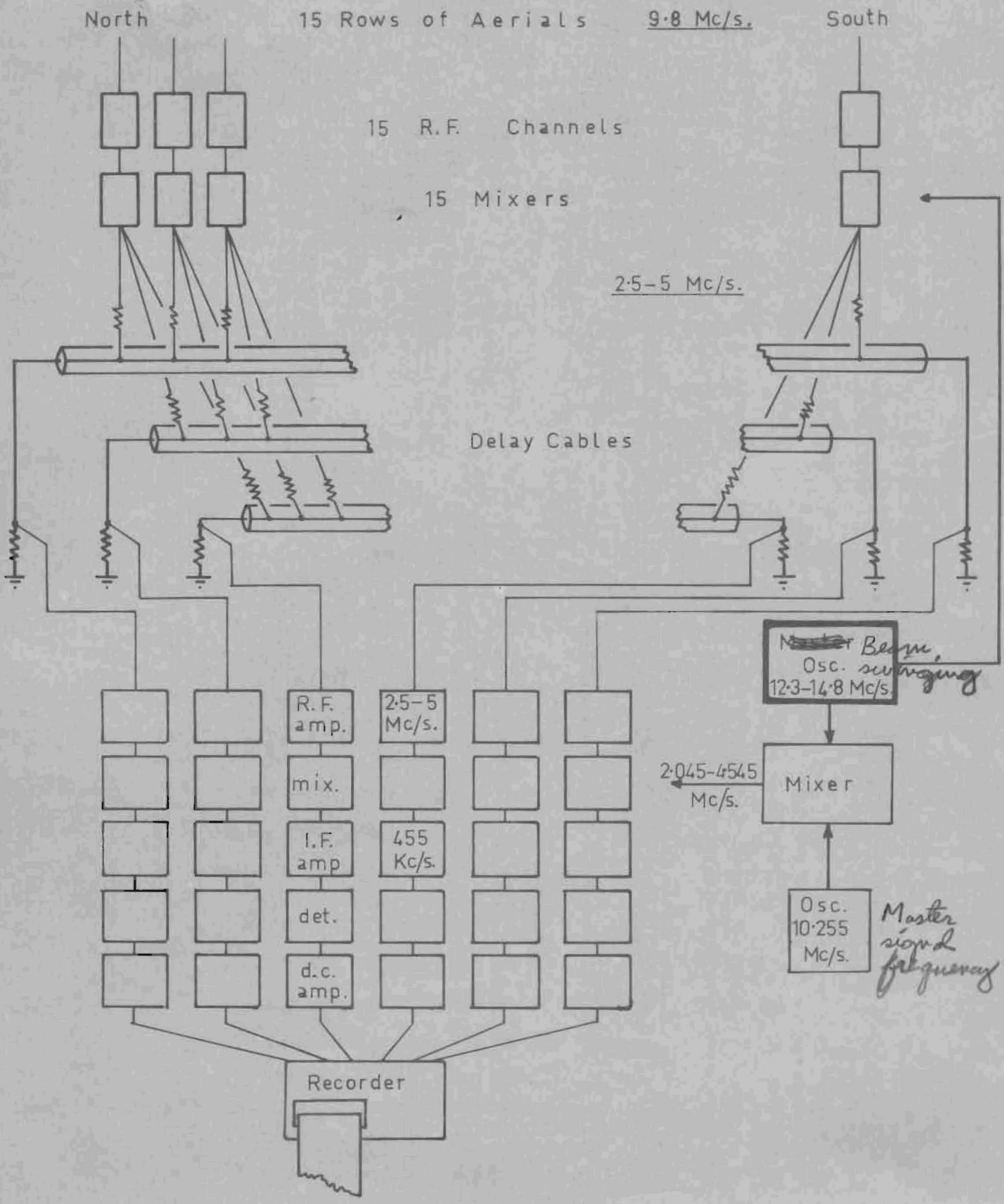

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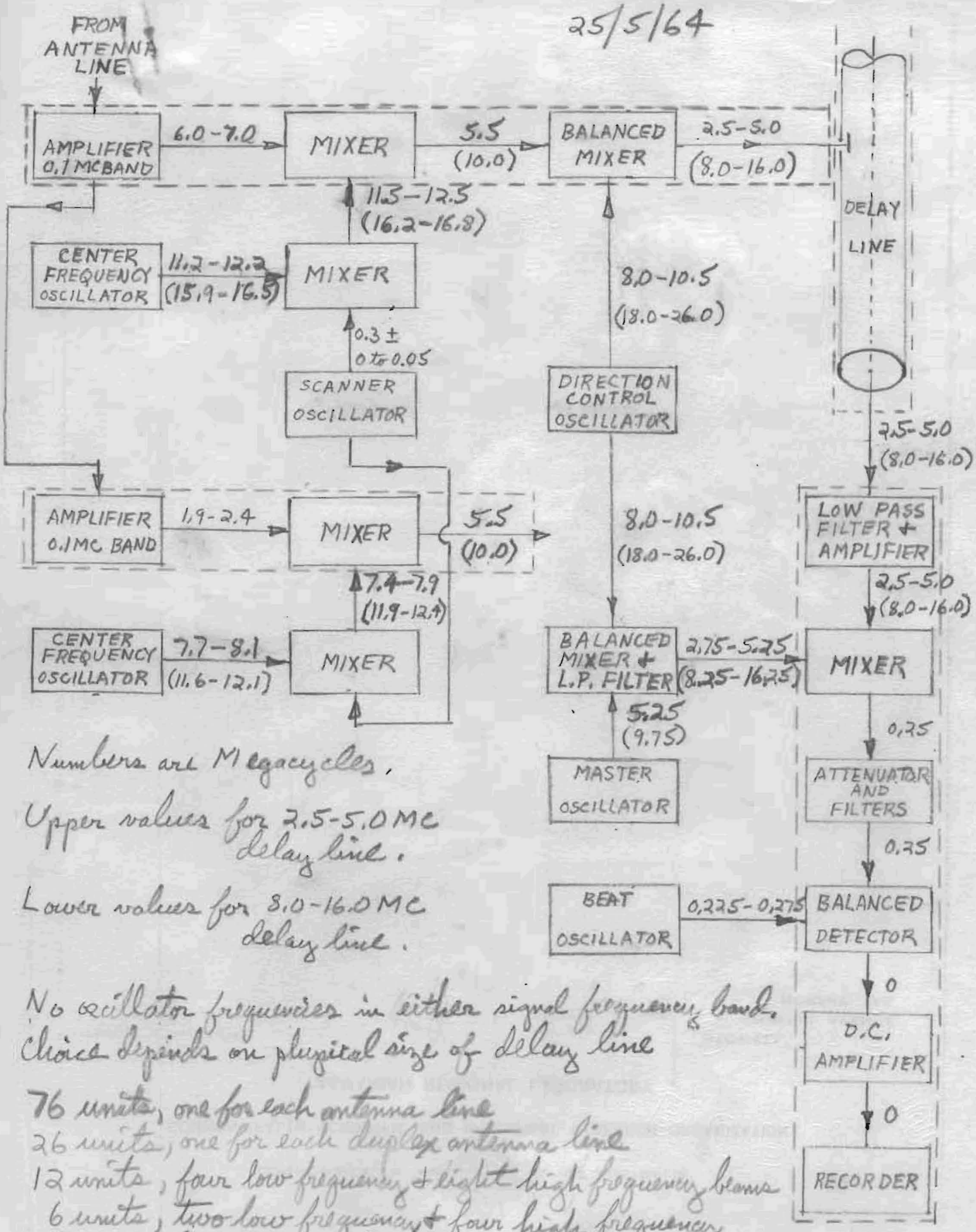

Numbers are Megacycles.

Upper values for 2.5-5.0 MC delay line.

Lower values for 8.0-16.0 MC delay line.

No oscillator frequencies in either signal frequency band.
Choice depends on physical size of delay line

76 units, one for each antenna line
26 units, one for each duplex antenna line
12 units, four low frequency + eight high frequency beams
6 units, two low frequency + four high frequency
Remainder are single units.