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AMPLITUDE AND PHASE OF THE LOW- AND VERY- LOW- RADIOFREQUENCY GROUND WAVE

BY J.R. JOHLER, L.C. WALTERS, AND C.M. LILLEY

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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ABSTRACT

Graphs and tables of the low- and very low-radiofrequency ground wave are presented as a function of frequency, 100 c/s to 1000 kc.

PREFACE

Computation techniques for the classical Bremmer-van der Pol theory have been developed[1]. As a result of various theoretical ground wave pulse investigations during the past several years with the aid of electronic computer programs, a considerable volume of calculated data on the ground wave has been accumulated and is

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[1] J. R. Johler, W. J. Kellar, L. C. Walters, "Phase of the Low-Radiofrequency Ground Wave," NBS Circular 573, U. S. Gov. Print. Off., Washington, D. C., (1956). See also, J. R. Johler, L. C. Walters, C. M. Lilley, "Low- and Very Low-Radiofrequency Tables of Ground Wave Parameters for the Spherical Earth Theory: The Roots of Riccati's Differential Equation," NBS Technical Note No. 7, PB 151366, February 1, 1959. An extensive bibliography is presented in the above papers. The following paper is of interest in the LF-VLF spectrum: J. R. Wait and H. H. Howe, "Amplitude and Phase Curves for Ground Wave Propagation in the Band 200 Cycles per Second to 500 Kilocycles," NBS Circular 574, U. S. Gov. Print. Off., Washington, D. C. (1956).

herewith presented in tabular and graphical form[2]. The computer program employed the techniques described in NBS Circular 573, hence, the formulas will not be repeated here. The amplitude, $|E_r|$ volts/meter and the phase arg $E_r = \phi_c$, radians have been tabulated for various frequencies, f, distances, d, conductivities σ, dielectric constants ϵ_2, and vertical lapse of permittivity factors α. The tables employ standard tabular frequencies, f, and Gaussian frequencies, f_m, described in published work on pulse propagation[3]. All fields, $|E_r|$, are normalized to a standard dipole current mount, $I_o \ell = 1$. With the aid of the expression [4],

$$P_r = 1.6\,(10^{-13})\,\omega^2\,(I_o\ell)^2/z_o \quad ,$$

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2 This tabulation was motivated by USAF Ground Electronics Engineering and Installation Agency (GEEIA) requirements of NBS project 8570-40-85472 and the application of the ground wave theory to LF radio navigation systems such as Loran-C (Cyctac) system described in the following publication: W. P. Frantz, W. Dean, R. L. Frank, "A Precision Multipurpose Radio Navigation System," IRE 1957 Convention Record, Part 8, pp. 79-102.

3 See for example, J. R. Johler and L. C. Walters, "Propagation of a Ground Wave Pulse Around a Finitely Conducting Spherical Earth from a Damped Sinusoidal Source Current," IRE Trans. on antennas and propagation, Vol. AP-7, No. 1, January 1959, pp. 1-10.

4 The notion of radiated power, P_r, is apparently due to S. Ballentine, "On the Radiation Resistance of a Simple Vertical Antenna at Wavelengths Below the Fundamental," Proc, IRE Vol. 12, December 1924, pp. 823-839.

where z_o = 377 ohms, the conventional engineering notion of radiated power, P_r, can be introduced. It is only necessary to employ a linear translation of the scale, $|E_r|$ volts/meter for dipole current moments other than unity. These considerations, of course, do not affect the phase.

The phase arg $E_r = \phi_c$ is tabulated in radians. These values can be readily converted to the conventional radio navigation system microseconds, t_c,

$$t_c = 10^6 \phi_c/\omega \quad .$$

The table entries include a number and an associated power of ten (10). The integers to the right of each table entry, if present, indicates the power of the factor ten (10) by which the entry is to be multiplied, thus, for example, 6.4307-1 = 0.64307.

The number of terms (s + 1), s = 0, 1, 2, 3$\cdots$, of the series of residues required for the calculation can be estimated with the aid of Figs. 1, 2, assuming eight significant figure precision. Of course, if less computation precision is required, fewer terms are necessary. Note the large increase in the number of terms required at short distances and low frequencies as a result of the slow convergence of the series of residues.

Boulder, Colorado, June 1, 1960.

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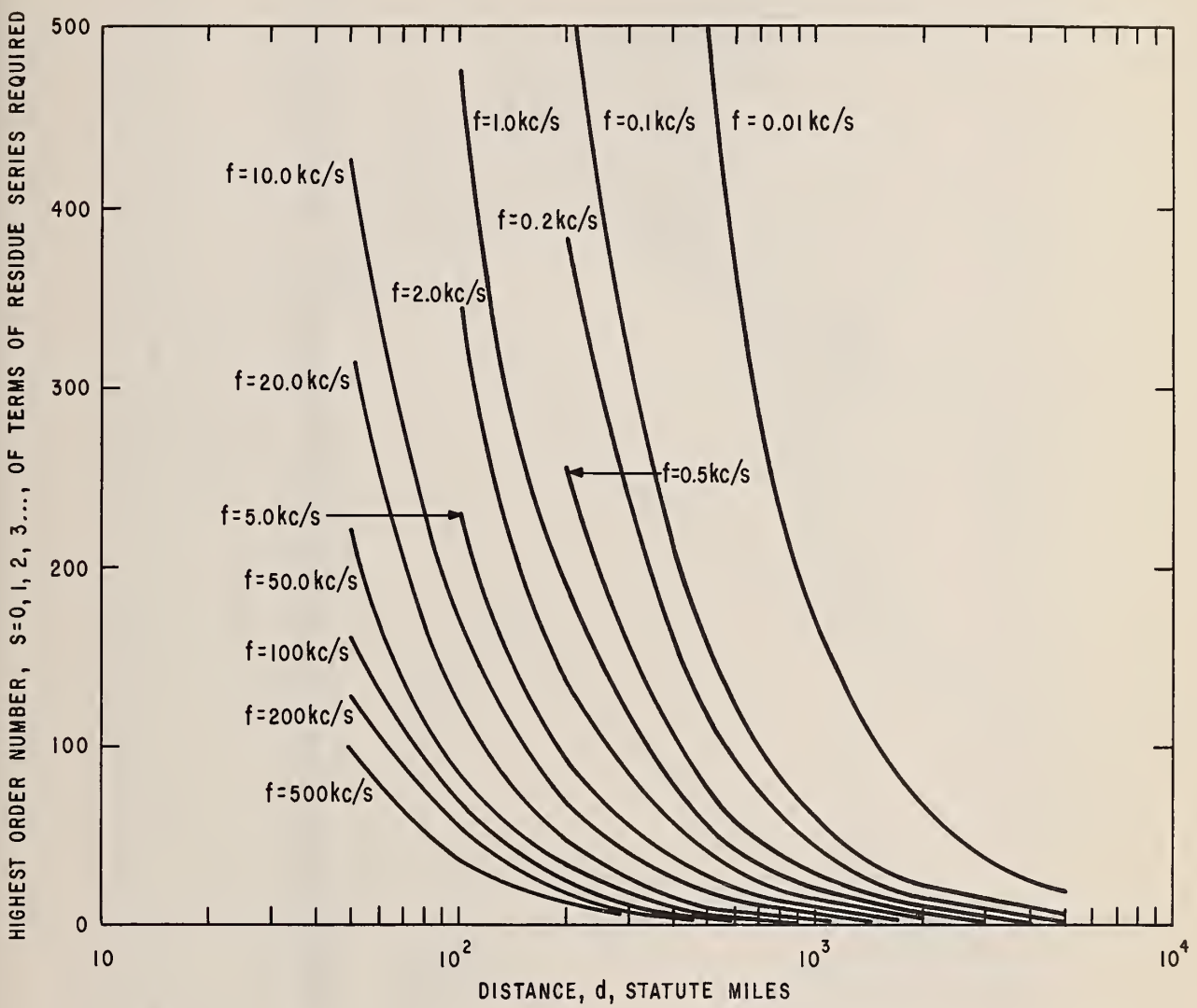


Fig. 1 - Highest order number, s = 0, 1, 2, 3•••, of terms of the series of residues required for eight significant figure computation precision as a function of distance from the source for various frequencies.

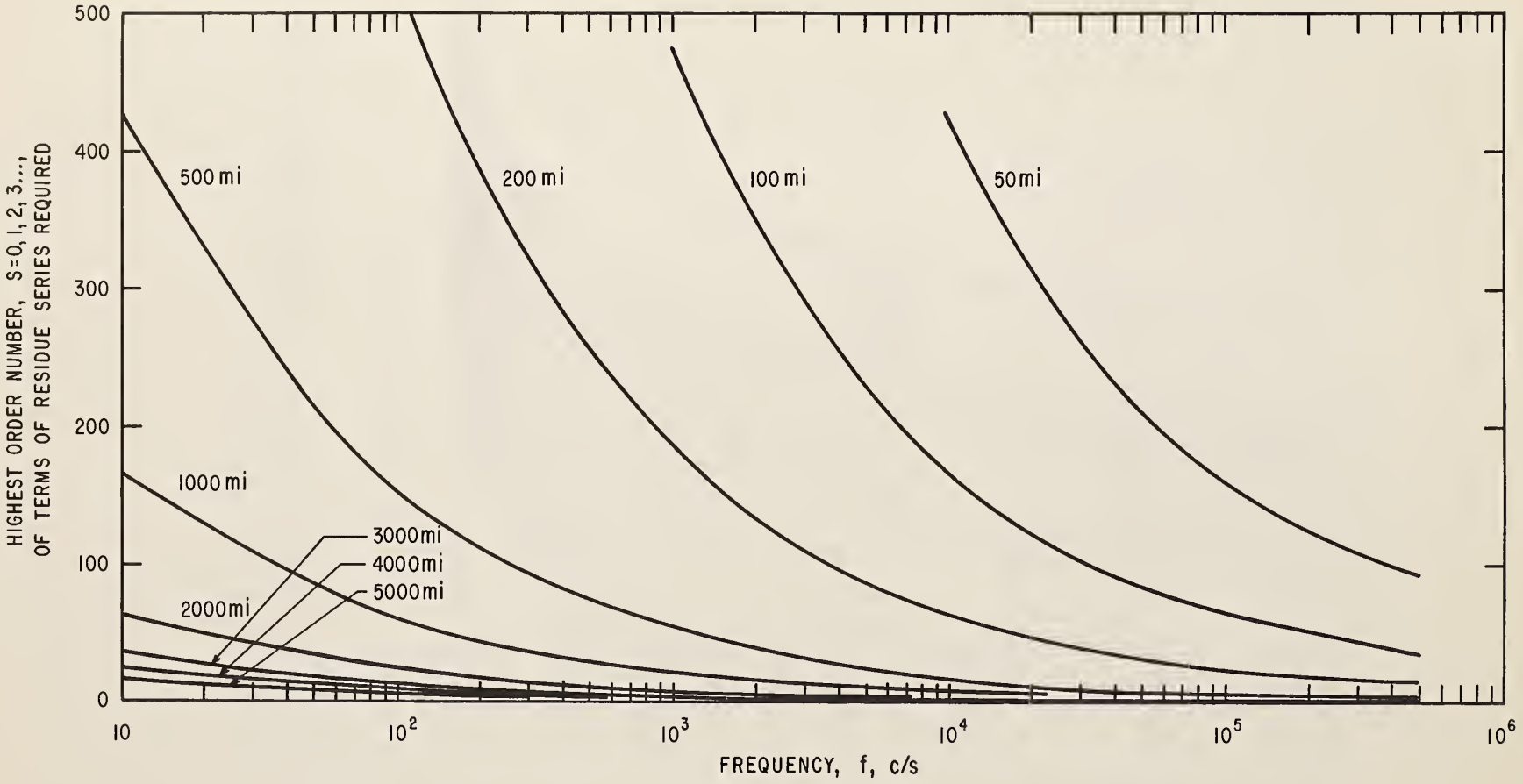


Fig. 2 - Highest order number, s = 0, 1, 2, 3•••, of terms of the series of residues required for eight significant figure computation precision as a function of frequency for various distances.

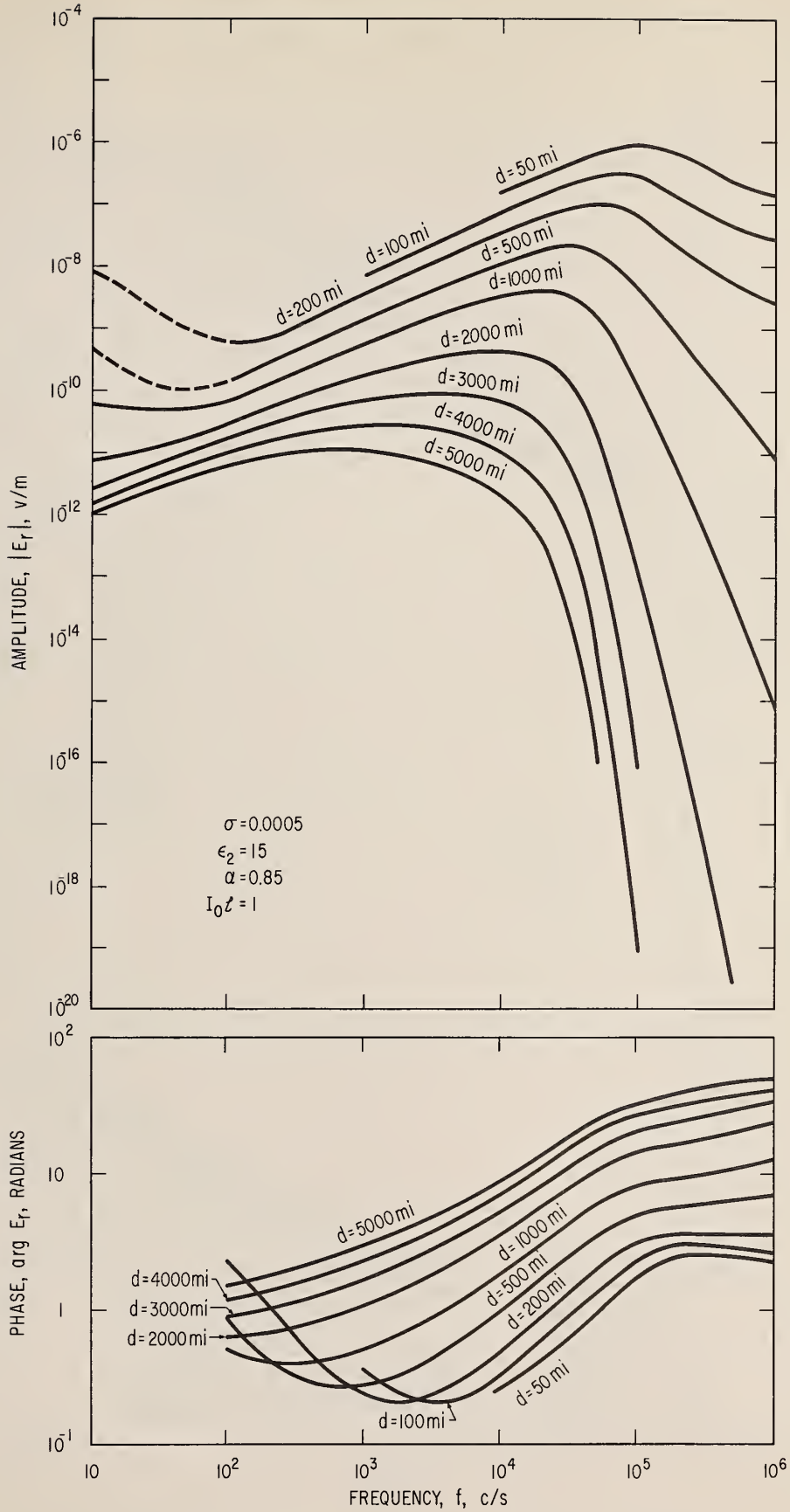


Fig. 3 - Amplitude and phase of the ground wave.

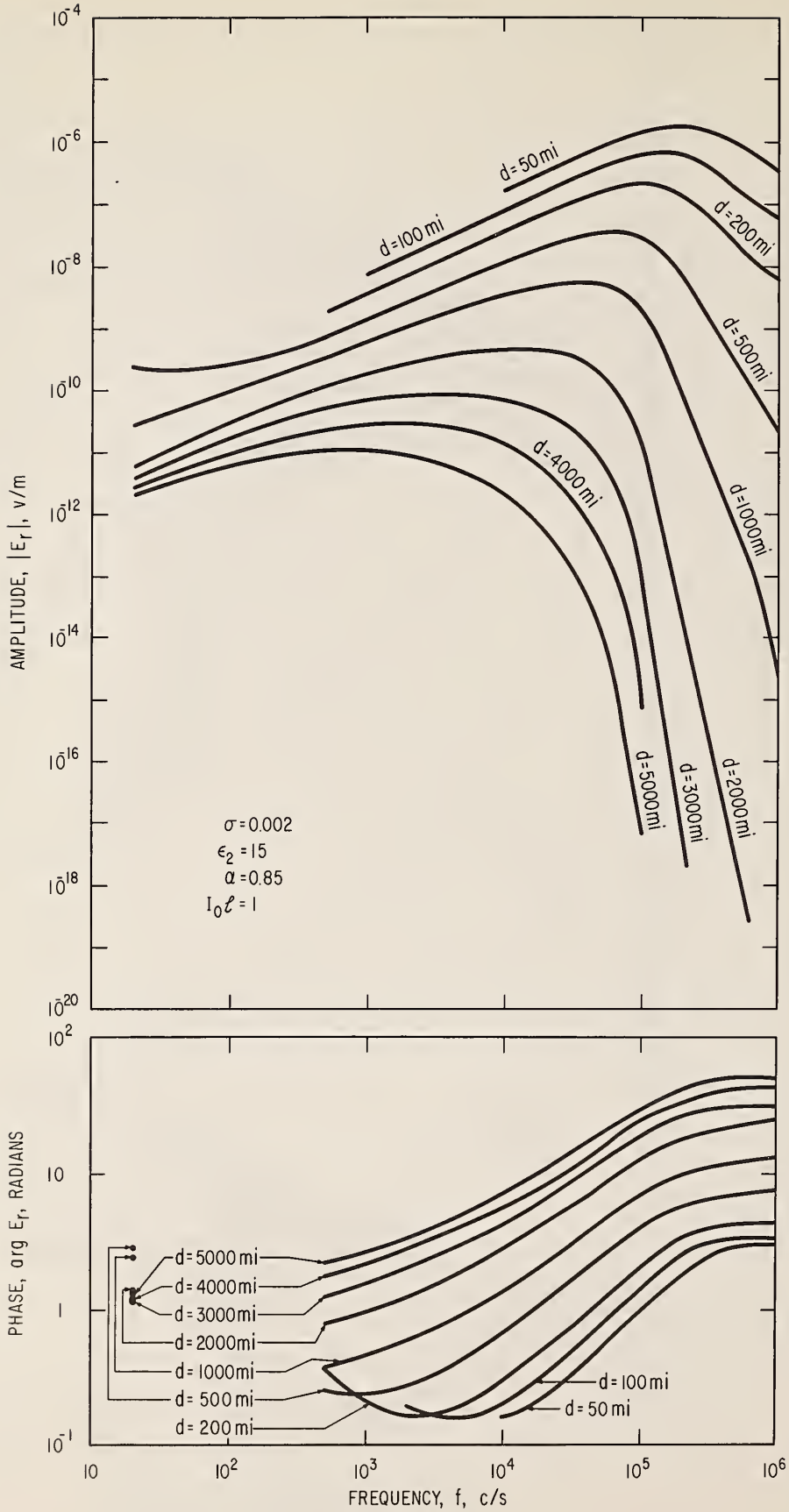
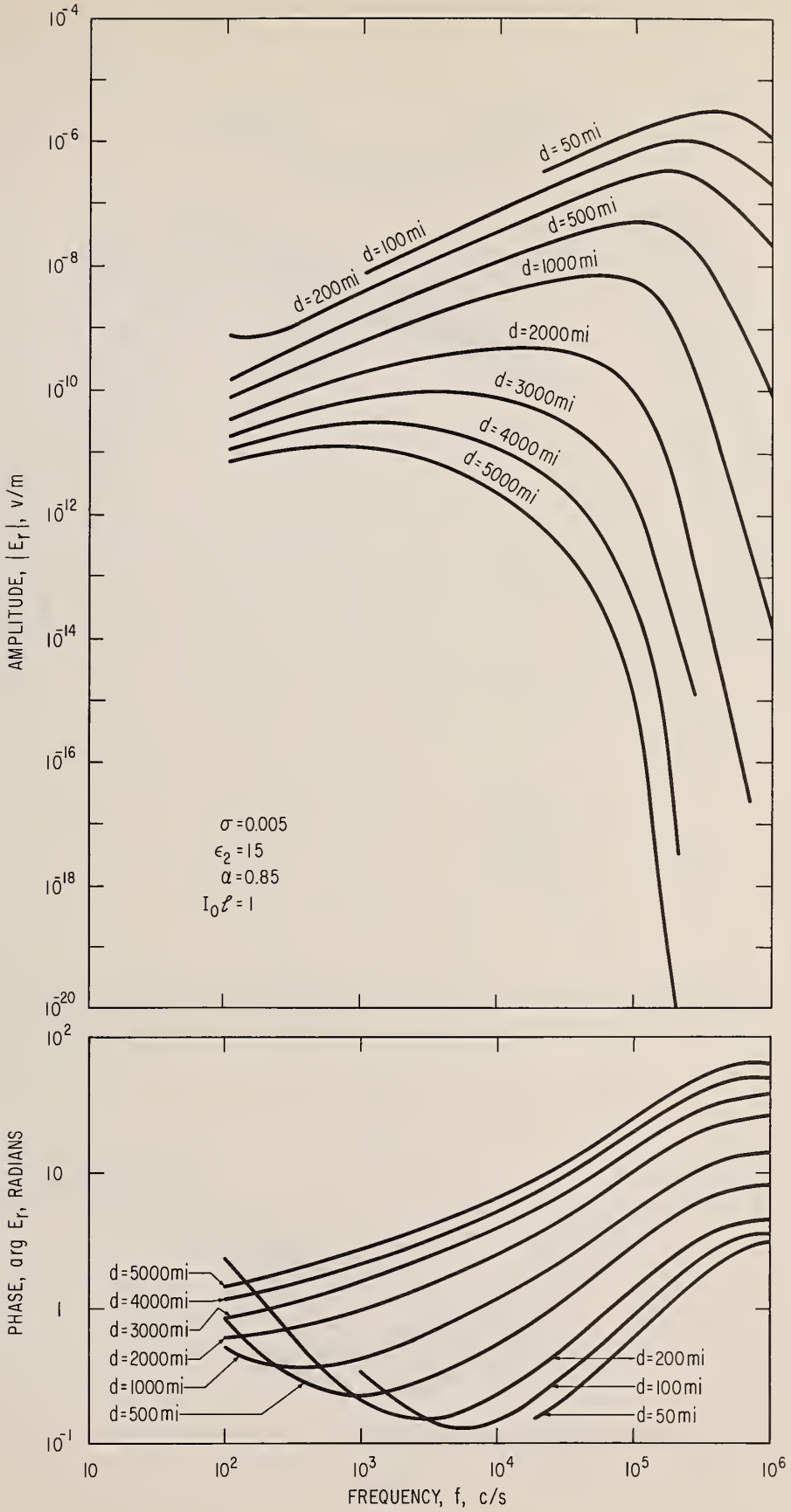


Fig. 4 - Amplitude and phase of the ground wave.



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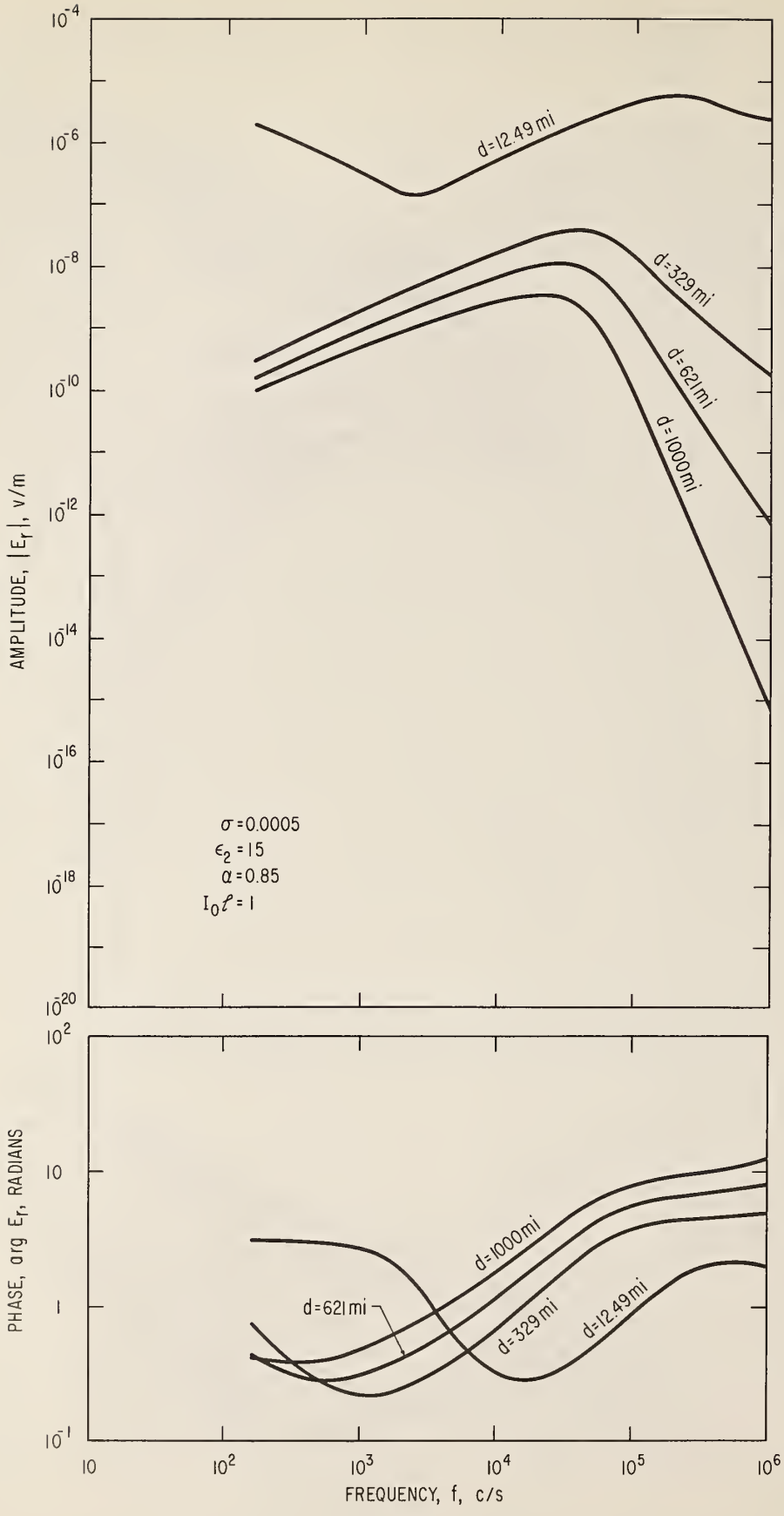

Fig. 6 - Amplitude and phase of the ground wave.

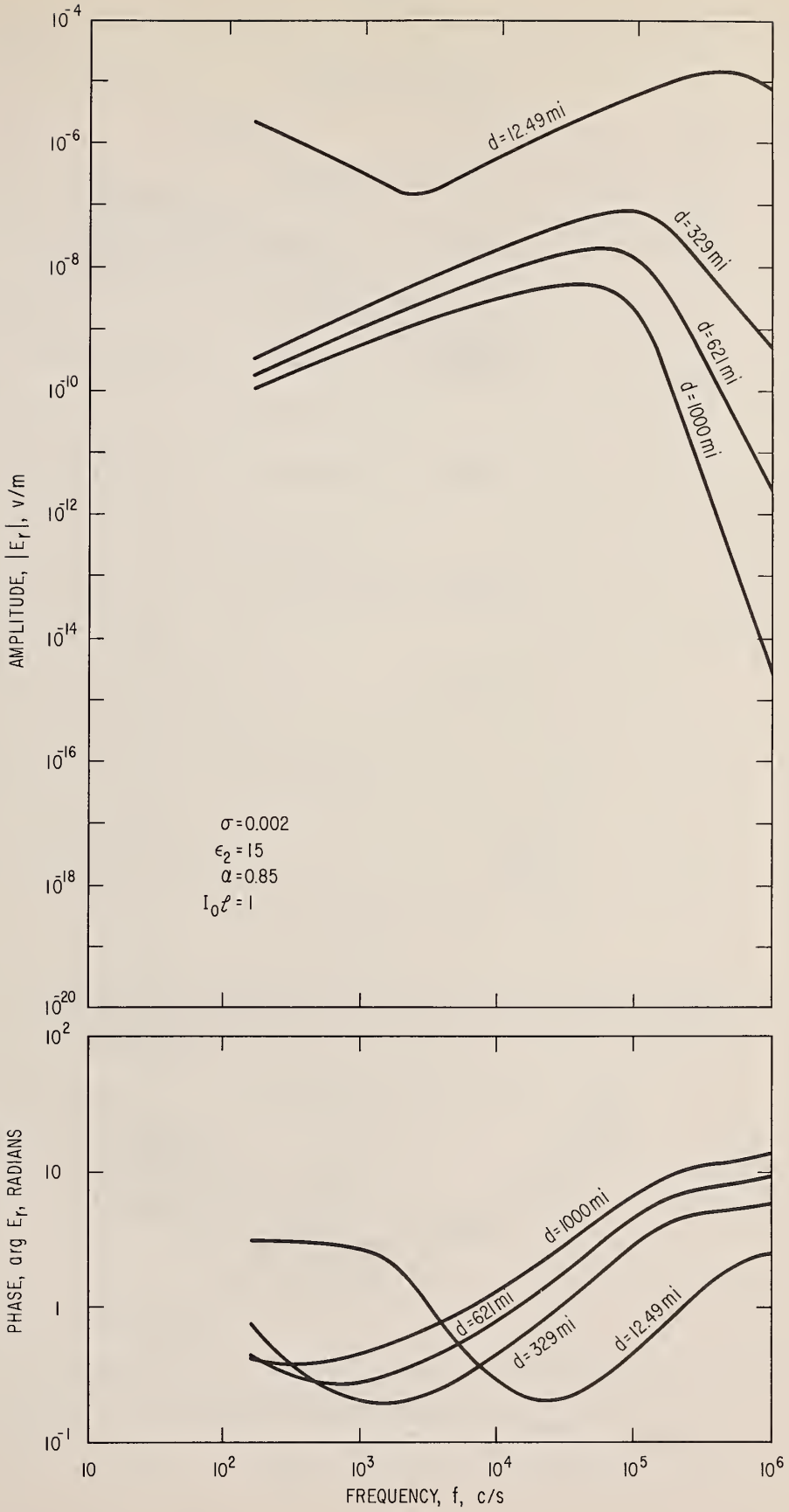

Fig. 7 - Amplitude and phase of the ground wave.

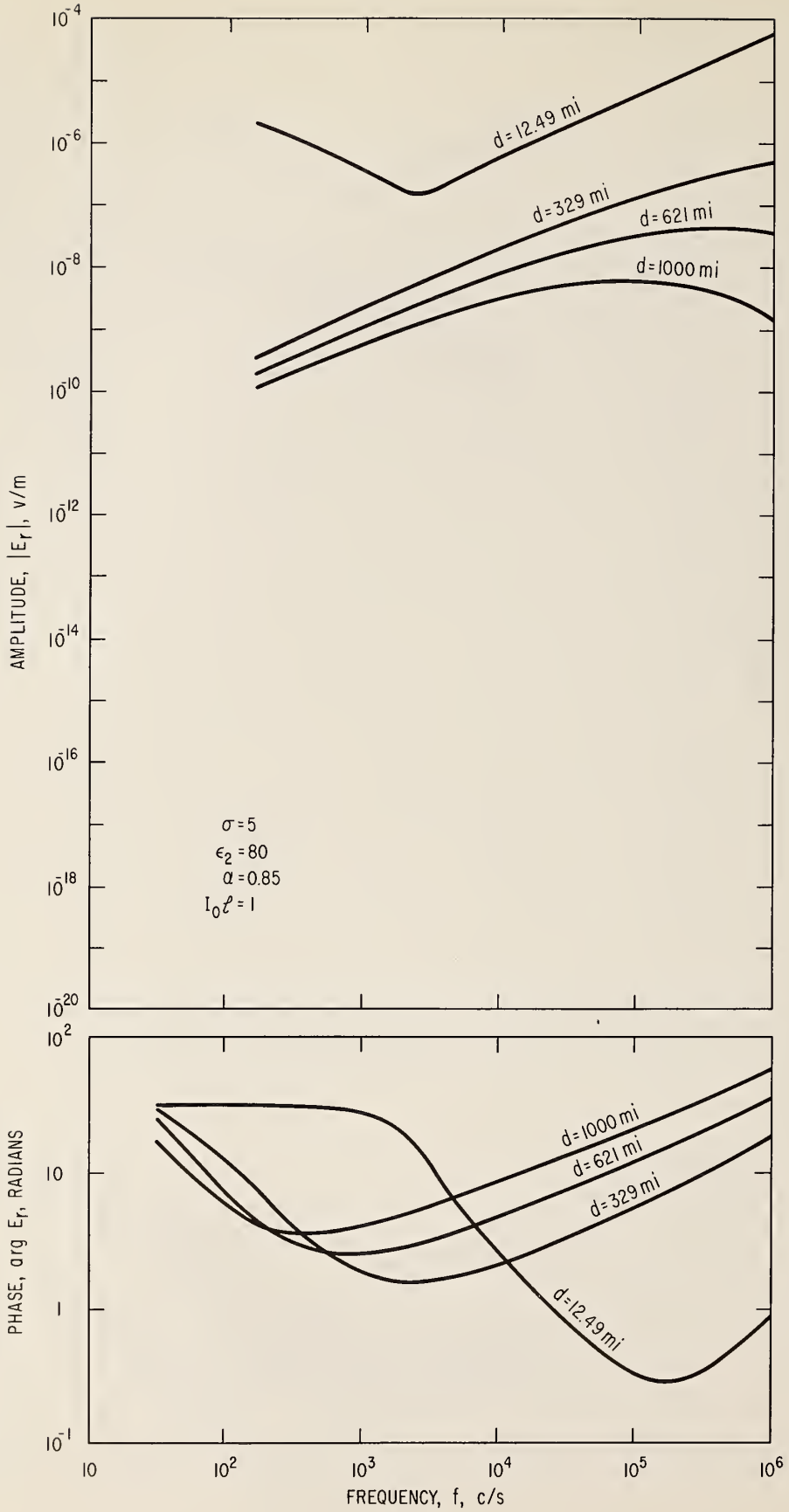

Fig. 8 - Amplitude and phase of the ground wave.

List of Tables

† Tabulated at Gaussian frequencies, f_m.

† Tabulated at Gaussian frequencies, f_m.

Table 1

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85^{\circ}$

f, kc	d = 5000 miles $\lvert E_r \rvert$		arg E_r		d = 4000 miles $\lvert E_r \rvert$		arg E_r	
0.01	1.0990	-12	1.8208		1.4845	-12	1.8787	
0.1	6.6410	-12	1.4586		1.0405	-11	1.1502	
0.2	9.2012	-12	1.7232		1.5876	-11	1.3446	
0.5	1.1632	-11	2.2608		2.3738	-11	1.7663	
1	1.1546	-11	2.8648		2.7736	-11	2.2504	
2	9.4242	-12	3.7484		2.7674	-11	2.9626	
5	4.9181	-12	5.7289		2.0276	-11	4.5636	
10	1.9175	-12	2.1848		1.1144	-11	4.9710	- 1
20	2.8707	-13	7.8935	- 1	2.8306	-12	4.4540	
50	1.0117	-16	5.8818		5.7607	-15	1.1197	
100	1.05	-22	1.41		9.34	-20	1.46	
200	3.74	-29	2.36	- 1	5.95	-25	5.59	
500	1.966	-38	2.904					
1000					3.4618	-39	1.6389	
	d = 3000 miles				d = 2000 miles			
0.01	2.4916	-12	2.1500		7.4449	-12	2.5822	
0.1	1.7081	-11	8.6196	- 1	3.0635	-11	6.1766	- 1
0.2	2.8589	-11	9.7844	- 1	5.5865	-11	6.4262	- 1
0.5	5.0416	-11	1.2768		1.1495	-10	8.0551	- 1
1	6.9359	-11	1.6375		1.8531	-10	1.0347	
2	8.4659	-11	2.1773		2.7646	-10	1.3958	
5	8.7117	-11	3.3985		4.0007	-10	2.2340	
10	6.7498	-11	5.0926		4.3720	-10	3.4052	
20	2.9086	-11	1.8355		3.1967	-10	5.5003	
50	3.4185	-13	2.6409		2.1697	-11	4.1622	
100	8.68	-17	1.51		8.63	-14	1.57	
200	9.87	-21	4.66		1.75	-16	3.72	
500	2.369	-26	3.631		2.839	-20	8.536	- 1
1000	1.9596	-31	3.1178		1.1865	-23	4.5968	
	d = 1000 miles				d = 500 miles			
0.01	6.4543	-11	2.9167		5.3842	-10	3.0340	
0.1	6.8851	-11	5.1809	- 1	1.3314	-10	8.3231	- 1
0.2	1.3706	-10	3.9547	- 1	2.8700	-10	4.2284	- 1
0.5	3.2211	-10	3.9541	- 1	7.2443	-10	2.6929	- 1
1	5.9590	-10	4.8016	- 1	1.4156	- 9	2.6434	- 1
2	1.0671	- 9	6.4934	- 1	2.7228	- 9	3.2905	- 1
5	2.1436	- 9	1.0870		6.2646	- 9	5.5584	- 1
10	3.2960	- 9	1.7262		1.1232	- 8	9.1797	- 1
20	4.0898	- 9	2.8858		1.7982	- 8	1.5980	
50	1.6033	- 9	5.686		1.7020	- 8	3.3191	
100	9.97	-11	1.62		4.13	- 9	4.83	
200	3.62	-12	2.79		6.13	-10	5.48	
500	3.960	-14	4.359		5.56	-11	6.112	
1000	8.3616	-16	6.0759		8.3670	-12	5.3148	- 1

Table 2

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

f, kc	d = 200 miles $\lvert E_r \rvert$		arg E_r		d = 100 miles $\lvert E_r \rvert$		arg E_r	
0.01	8.5397	- 9	3.0982					
0.1	7.3828	-10	2.2830					
0.2	6.7000	-10	1.0639					
0.5	1.8400	- 9	3.7040	- 1				
1	3.7680	- 9	2.3100	- 1	7.4235	- 9	3.5798	- 1
2	7.5175	- 9	1.9968	- 1	1.5254	- 8	2.2213	- 1
5	1.8403	- 8	2.7898	- 1	3.8136	- 8	2.1141	- 1
10	3.5560	- 8	4.6014	- 1	7.5227	- 8	3.1147	- 1
20	6.5480	- 8	8.2889	- 1	1.4457	- 7	5.5008	- 1
50	1.0791	- 7	1.8435		2.9011	- 7	1.2556	
100	6.86	- 8	3.00		2.96	- 7	2.20	
200	2.03	- 8	3.51		1.24	- 7	2.91	
500	5.706	- 9	3.509		4.278	- 8	2.794	
1000	2.6896	- 9	3.5519		2.6861	- 8	2.6223	
	d = 50 miles							
10	1.5356	- 7	2.4640	- 1				
20	3.0137	- 7	3.9173	- 1				
50	6.7009	- 7	8.8005	- 1				
100	9.12	- 7	1.61					
200	6.03	- 7	2.44					
500	2.164	- 7	2.494					
1000	1.480	- 7	2.252					

Table 3

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

f, kc	d = 5000 miles $\lvert E_r \rvert$		arg E_r		d = 4000 miles $\lvert E_r \rvert$		arg E_r	
0.02	2.1044	-12	1.3379		2.8146	-12	1.19878	
0.1	6.6346	-12	1.4488		1.0398	-11	1.1417	
0.2	9.1788	-12	1.7026		1.5850	-11	1.3270	
0.5	1.1542	-11	2.2050		2.3607	-11	1.71933	
1	1.1347	-11	2.7452		2.7385	-11	2.1505	
2	9.0964	-12	3.4898		2.6955	-11	2.7482	
5	4.6117	-12	5.0078		1.9342	-11	3.9705	
10	1.9103	-12	6.2694	- 1	1.1197	-11	5.5048	
20	4.9695	-13	3.8241		4.4562	-12	1.8020	
50	1.4156	-14	5.8833		3.1513	-13	2.2542	
100	7.91	-18	4.73		8.97	-16	5.20	
200	2.86	-25	3.84		1.03	-21	2.14	
500	1.06	-36	6.37		6.54	-31	3.43	
1000	6.78	-47	4.71		2.13	-38	4.26	
	d = 3000 miles				d = 2000 miles			
0.02	3.9322	-12	1.1543		6.1780	-12	1.3967	
0.1	1.7075	-11	8.5485	- 1	3.0629	-11	6.1203	- 1
0.2	2.8560	-11	9.6386	- 1	5.5838	-11	6.3119	- 1
0.5	5.0241	-11	1.2386		1.1476	-10	7.7610	- 1
1	6.8794	-11	1.5573		1.8458	-10	9.7402	- 1
2	8.3212	-11	2.0071		2.7415	-10	1.2696	
5	8.4539	-11	2.9334		3.9494	-10	1.8968	
10	6.8394	-11	4.0996		4.4680	-10	2.6945	
20	4.1642	-11	6.0631		4.1622	-10	4.0412	
50	7.3108	-12	4.9082		1.8141	-10	1.2791	
100	1.06	-13	5.67		1.34	-11	6.14	
200	3.88	-18	4.36	- 1	1.56	-14	5.02	
500	4.19	-25	6.22		2.88	-19	2.72	
1000	9.33	-31	5.24		4.37	-23	6.22	
	d = 1000 miles				d = 500 miles			
0.02	2.9168	-11	2.4068		2.5786	-10	2.8466	
0.1	6.8848	-11	5.1420	- 1	1.3314	-10	8.2959	- 1
0.2	1.3704	-10	3.8765	- 1	2.8699	-10	4.1737	- 1
0.5	3.2199	-10	3.7563	- 1	7.2439	-10	2.5557	- 1
1	5.9541	-10	4.4014	- 1	1.4156	- 9	2.3678	- 1
2	1.0657	- 9	5.6801	- 1	2.7236	- 9	2.7361	- 1
5	2.1474	- 9	8.7765	- 1	6.2927	- 9	4.1580	- 1
10	3.3900	- 9	1.2971		1.1496	- 8	6.3588	- 1
20	4.8356	- 9	2.0220		2.0013	- 8	1.0378	
50	5.2378	- 9	3.9340		3.3925	- 8	2.1323	
100	1.97	- 9	3.22	- 1	2.88	- 8	3.71	
200	7.30	-11	3.32		5.92	- 9	5.63	
500	2.30	-13	5.51		2.44	-10	6.24	- 1
1000	2.38	-15	9.15	- 1	2.09	-11	1.40	

Table 4

$\dot{\sigma} = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

f, kc	d = 200 miles $\lvert E_r \rvert$		arg E_r		d = 100 miles $\lvert E_r \rvert$		arg E_r	
0.5	1.8401	- 9	3.6179	- 1				
0.2	6.6998	-10	1.0605					
1	3.7683	- 9	2.1376	- 1	7.4240	- 9		
2	7.5206	- 9	1.6515	- 1	1.5258	- 8	1.9780	- 1
5	1.8458	- 8	1.9247	- 1	3.8205	- 8	1.5054	- 1
10	3.6019	- 8	2.8710	- 1	7.5789	- 8	1.8984	- 1
20	6.9075	- 8	4.8588	- 1	1.4901	- 7	3.0846	- 1
50	1.5000	- 7	1.0646		3.4859	- 7	6.8634	- 1
100	2.10	- 7	1.95		5.81	- 7	1.29	
200	1.33	- 7	3.30		6.07	- 7	2.35	
500	2.14	- 8	4.16		1.60	- 7	3.31	
1000	6.23	- 9	4.28		6.11	- 8	3.30	
	d = 50 miles							
10	1.5421	- 7	1.6054	- 1				
20	3.0655	- 7	2.2083	- 1				
50	7.4244	- 7	4.6801	- 1				
100	1.35	- 6	8.90	- 1				
200	1.89	- 6	1.68					
500	8.90	- 7	2.88					
1000	3.41	- 7	2.91					

Table 5

$\sigma = 0.005$ $\epsilon_2 = 15$ $\alpha = 0.85$

f, kc	$\lvert E_r \rvert$		arg E_r		$\lvert E_r \rvert$		arg E_r	
	d = 5000 miles				d = 4000 miles			
0.1	6.6322	-12	1.4452		1.0396	-11	1.1386	
0.2	9.1704	-12	1.6951		1.5839	-11	1.3205	
0.5	1.1507	-11	2.1846		2.3556	-11	1.7021	
1	1.1269	-11	2.7013		2.7244	-11	2.1138	
2	8.9575	-12	3.3947		2.6645	-11	2.6694	
5	4.4371	-12	4.7418		1.8783	-11	3.7518	
10	1.7980	-12	4.5550	- 2	1.0697	-11	5.0291	
20	4.8447	-13	2.5605		4.3881	-12	7.7203	- 1
50	2.9901	-14	2.5585		5.7979	-13	5.8348	
100	3.927	-16	5.516		2.097	-14	7.189	- 1
200	5.48	-21	1.27		3.09	-18	6.23	
500	4.02	-34	4.28		9.28	-29	4.89	- 2
1000	1.54	-44	1.11	- 1	3.91	-37	5.08	- 1
	d = 3000 miles				d = 2000 miles			
0.1	1.7072	-11	8.5224	- 1	3.0627	-11	6.0995	- 1
0.2	2.8549	-11	9.5850	- 1	5.5828	-11	6.2698	- 1
0.5	5.0172	-11	1.2245		1.1469	-10	7.6529	- 1
1	6.8563	-11	1.5278		1.8427	-10	9.5173	- 1
2	8.2569	-11	1.9445		2.7304	-10	1.2232	
5	8.2863	-11	2.7619		3.9072	-10	1.7725	
10	6.6318	-11	3.7295		4.3974	-10	2.4301	
20	4.1419	-11	5.2668		4.1816	-10	3.4784	
50	1.1716	-11	2.8280		2.5323	-10	6.1045	
100	1.167	-12	2.205		6.946	-11	3.691	
200	1.82	-15	4.91		1.15	-12	3.59	
500	2.23	-23	2.10		5.74	-18	4.14	
1000	1.03	-29	9.04	- 1	2.92	-22	1.30	
	d = 1000 miles				d = 500 miles			
0.1	6.8847	-11	5.1277	- 1	1.3314	-10	8.2858	- 1
0.2	1.3704	-10	3.8477	- 1	2.8699	-10	4.1536	- 1
0.5	3.2194	-10	3.6837	- 1	7.2436	-10	2.5052	- 1
1	5.9516	-10	4.2544	- 1	1.4154	- 9	2.2665	- 1
2	1.0646	- 9	5.3811	- 1	2.7232	- 9	2.5323	- 1
5	2.1423	- 9	8.0055	- 1	6.2933	- 9	3.6426	- 1
10	3.3840	- 9	1.1379		1.1522	- 8	5.3156	- 1
20	4.9050	- 9	1.6924		2.0309	- 8	8.2657	- 1
50	6.3679	- 9	3.0981		3.8271	- 8	1.6079	
100	4.812	- 9	5.178		4.795	- 8	2.786	
200	8.41	-10	2.27		2.73	- 8	4.75	
500	1.72	-12	6.19		1.11	- 9	9.33	- 1
1000	9.63	-15	1.70		6.58	-11	1.89	

Table 6

$\sigma = 0.005$ $\epsilon_2 = 15$ $\alpha = 0.85$

f, kc	d = 200 miles $\lvert E_r \rvert$		arg E_r		d = 100 miles $\lvert E_r \rvert$		arg E_r	
0.1	7.3828	-10	2.2806					
0.2	6.6998	-10	1.0592					
0.5	1.8401	- 9	3.5863	- 1				
1	3.7683	- 9	2.0742	- 1	7.4241	- 9	3.4135	- 1
2	7.5209	- 9	1.5246	- 1	1.5259	- 8	1.8886	- 1
5	1.8466	- 8	1.6065	- 1	3.8216	- 8	1.2816	- 1
10	3.6091	- 8	2.2328	- 1	7.5882	- 8	1.4504	- 1
20	6.9687	- 8	3.5800	- 1	1.4978	- 7	2.1886	- 1
50	1.5921	- 7	7.4895	- 1	3.6034	- 7	4.6450	- 1
100	2.670	- 7	1.367		6.622	- 7	8.701	- 1
200	3.14	- 7	2.47		1.01	- 6	1.63	
500	7.66	- 8	4.19		5.67	- 7	3.19	
1000	1.69	- 8	4.60		1.61	- 7	3.57	
	d = 50 miles							
20	3.0742	- 7	1.5765	- 1				
50	7.5600	- 7	3.1110	- 1				
100	1.451	- 6	5.846	- 1				
200	2.53	- 6	1.12					
500	2.67	- 6	2.44					

Table 7

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

	d = 12.49 miles				d = 329 miles			
f,kc †	$\lvert E_r \rvert$		arg E_r		$\lvert E_r \rvert$		arg E_r	
0.030725	1.1456	- 5	3.1289		1.0573	- 9	2.7485	
0.16175	2.1713	- 6	3.0746		3.3338	-10	7.4341	- 1
0.39689	8.7482	- 7	2.9746		8.8931	-10	3.2068	- 1
0.73521	4.5755	- 7	2.8177		1.6570	- 9	2.3618	- 1
1.1753	2.7036	- 7	2.5709		2.6295	- 9	2.2055	- 1
1.7153	1.7778	- 7	2.1692		3.7981	- 9	2.3182	- 1
2.3530	1.4836	- 7	1.6078		5.1511	- 9	2.5746	- 1
3.0857	1.6796	- 7	1.1089		6.6750	- 9	2.9248	- 1
3.9103	2.1409	- 7	7.9887	- 1	8.3551	- 9	3.3452	- 1
4.8233	2.7237	- 7	6.1712	- 1	1.0175	- 8	3.8226	- 1
5.8210	3.3756	- 7	5.0469	- 1	1.2117	- 8	4.3489	- 1
6.8991	4.0786	- 7	4.3115	- 1	1.4162	- 8	4.9183	- 1
8.0532	4.8254	- 7	3.8124	- 1	1.6290	- 8	5.5261	- 1
9.2783	5.6119	- 7	3.4673	- 1	1.8478	- 8	6.1683	- 1
10.569	6.4348	- 7	3.2286	- 1	2.0704	- 8	6.8413	- 1
11.921	7.2911	- 7	3.0665	- 1	2.2945	- 8	7.5415	- 1
13.327	8.1773	- 7	2.9617	- 1	2.5176	- 8	8.2652	- 1
14.783	9.0898	- 7	2.9009	- 1	2.7374	- 8	9.0089	- 1
16.281	1.0025	- 6	2.8744	- 1	2.9514	- 8	9.7690	- 1
17.816	1.0979	- 6	2.8751	- 1	3.1576	- 8	1.0542	
19.381	1.1947	- 6	2.8978	- 1	3.3539	- 8	1.1324	
20.969	1.2925	- 6	2.9381	- 1	3.5384	- 8	1.2111	
22.575	1.3910	- 6	2.9926	- 1	3.7096	- 8	1.2899	
24.190	1.4896	- 6	3.0587	- 1	3.866	- 8	1.369	
25.810	1.5880	- 6	3.1339	- 1	4.007	- 8	1.447	
27.425	1.6856	- 6	3.2163	- 1	4.13	- 8	1.52	
29.031	1.7822	- 6	3.3041	- 1	4.24	- 8	1.60	
30.619	1.8772	- 6	3.3960	- 1	4.33	- 8	1.67	
32.184	1.9703	- 6	3.4905	- 1	4.41	- 8	1.75	
33.719	2.0611	- 6	3.5865	- 1	4.47	- 8	1.82	
35.217	2.1492	- 6	3.6829	- 1	4.52	- 8	1.88	
36.673	2.2343	- 6	3.7788	- 1	4.56	- 8	1.95	
38.079	2.3161	- 6	3.8732	- 1	4.58	- 8	2.01	
39.431	2.3942	- 6	3.9655	- 1	4.59	- 8	2.07	
40.722	2.4684	- 6	4.0548	- 1	4.60	- 8	2.12	
41.947	2.5385	- 6	4.1405	- 1	4.59	- 8	2.18	
43.101	2.6041	- 6	4.2220	- 1	4.59	- 8	2.22	
44.179	2.6650	- 6	4.2987	- 1	4.57	- 8	2.27	
45.177	2.7211	- 6	4.3703	- 1	4.56	- 8	2.31	
46.090	2.7723	- 6	4.4361	- 1	4.54	- 8	2.35	
46.914	2.8182	- 6	4.4958	- 1	4.52	- 8	2.38	
47.647	2.8589	- 6	4.5490	- 1	4.50	- 8	2.41	
48.285	2.8942	- 6	4.5955	- 1	4.48	- 8	2.43	
48.825	2.9240	- 6	4.6350	- 1	4.47	- 8	2.45	
49.265	2.9482	- 6	4.6673	- 1	4.45	- 8	2.47	
49.603	2.9668	- 6	4.6921	- 1	4.44	- 8	2.48	
49.838	2.9797	- 6	4.7094	- 1	4.43	- 8	2.49	
49.969	2.9868	- 6	4.7190	- 1	4.43	- 8	2.50	

† Gaussian frequencies, interval: 0-50 kc.

Table 8

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		arg E_r		d = 329 miles $\lvert E_r \rvert$		arg E_r
50.277	3.0036	- 6	4.7416	- 1	4.42	- 8	2.51
51.456	3.0679	- 6	4.8286	- 1	4.37	- 8	2.55
53.572	3.1820	- 6	4.9855	- 1	4.29	- 8	2.63
56.617	3.3438	- 6	5.2128	- 1	4.14	- 8	2.74
60.578	3.5497	- 6	5.5103	- 1	3.93	- 8	2.87
65.438	3.7949	- 6	5.8772	- 1	3.03	- 8	2.88
71.177	4.0735	- 6	6.3113	- 1	2.82	- 8	3.14
77.771	4.3780	- 6	6.8092	- 1	2.51	- 8	3.34
85.193	4.7001	- 6	7.3665	- 1	2.16	- 8	3.51
93.410	5.0302	- 6	7.9771	- 1	1.82	- 8	3.66
102.39	5.3581	- 6	8.6344	- 1	1.51	- 8	3.78
112.09	5.6734	- 6	9.3303	- 1	1.25	- 8	3.88
122.48	5.9659	- 6	1.0056		1.13	- 8	4.02
133.50	6.2264	- 6	1.0803		9.33	- 9	4.10
145.12	6.4472	- 6	1.1562		7.75	- 9	4.17
157.29	6.6224	- 6	1.2322		6.52	- 9	4.21
169.95	6.7485	- 6	1.3074		5.53	- 9	4.25
183.05	6.8246	- 6	1.3810		4.75	- 9	4.28
196.53	6.8519	- 6	1.4521		4.11	- 9	4.31
210.34	6.8338	- 6	1.5200		3.59	- 9	4.33
224.43	6.7754	- 6	1.5841		3.16	- 9	4.35
238.72	6.6828	- 6	1.6440		2.81	- 9	4.37
253.17	6.5628	- 6	1.6992		2.51	- 9	4.39
267.71	6.4222	- 6	1.7496		2.25	- 9	4.40
282.29	6.2674	- 6	1.7951		2.04	- 9	4.42
296.83	6.1043	- 6	1.8358		1.86	- 9	4.43
311.28	5.9378	- 6	1.8719		1.698	- 9	4.446
325.57	5.7721	- 6	1.9035		1.563	- 9	4.459
339.66	5.6105	- 6	1.9309		1.4453	- 9	4.4704
353.47	5.4552	- 6	1.9546		1.3433	- 9	4.4814
366.95	5.3081	- 6	1.9748		1.2545	- 9	4.4919
380.05	5.1702	- 6	1.9919		1.1769	- 9	4.5017
392.71	5.0422	- 6	2.0063		1.1089	- 9	4.5110
404.88	4.9243	- 6	2.0183		1.0494	- 9	4.5198
416.50	4.8165	- 6	2.0282		9.9725	-10	4.5281
427.52	4.7186	- 6	2.0363		9.5148	-10	4.5359
437.91	4.6303	- 6	2.0430		9.1138	-10	4.5431
447.61	4.5512	- 6	2.0483		8.7632	-10	4.5498
456.59	4.4809	- 6	2.0526		8.4577	-10	4.5560
464.81	4.4188	- 6	2.0560		8.1929	-10	4.5616
472.23	4.3646	- 6	2.0586		7.9650	-10	4.5666
478.82	4.3181	- 6	2.0607		7.7709	-10	4.5711
484.56	4.2786	- 6	2.0623		7.6081	-10	4.5750
489.42	4.2459	- 6	2.0634		7.4745	-10	4.5782
493.38	4.2198	- 6	2.0643		7.3684	-10	4.5809
496.43	4.2001	- 6	2.0649		7.2885	-10	4.5830
498.54	4.1865	- 6	2.0653		7.2337	-10	4.5844
499.72	4.1791	- 6	2.0655		7.2035	-10	4.5852

† Gaussian frequencies, interval: 50-500 kc.

Table 9

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

†	d = 12.49 miles			d = 329 miles		
f, kc	$\lvert E_r \rvert$		arg E_r	$\lvert E_r \rvert$		arg E_r
500.31	4.1754	- 6	2.0656	7.1886	-10	4.5856
501.62	4.1671	- 6	2.0658	7.1554	-10	4.5864
503.97	4.1524	- 6	2.0662	7.0964	-10	4.5880
507.35	4.1315	- 6	2.0667	7.0128	-10	4.5903
511.75	4.1048	- 6	2.0673	6.9064	-10	4.5932
517.15	4.0728	- 6	2.0678	6.7794	-10	4.5968
523.53	4.0359	- 6	2.0683	6.6342	-10	4.6011
530.86	3.9949	- 6	2.0687	6.4734	-10	4.6060
539.10	3.9503	- 6	2.0688	6.2998	-10	4.6115
548.23	3.9031	- 6	2.0688	6.1162	-10	4.6176
558.21	3.8532	- 6	2.0684	5.9251	-10	4.6242
568.99	3.8024	- 6	2.0676	5.7291	-10	4.6314
580.53	3.7500	- 6	2.0664	5.5305	-10	4.6391
592.78	3.6975	- 6	2.0648	5.3315	-10	4.6473
605.69	3.6452	- 6	2.0627	5.1338	-10	4.6559
619.21	3.5931	- 6	2.0604	4.9390	-10	4.6649
633.27	3.5429	- 6	2.0575	4.7485	-10	4.6743
647.83	3.4939	- 6	2.0542	4.5634	-10	4.6840
662.81	3.4461	- 6	2.0506	4.3844	-10	4.6941
678.16	3.3998	- 6	2.0469	4.2123	-10	4.7044
693.81	3.3560	- 6	2.0427	4.0474	-10	4.7149
709.69	3.3154	- 6	2.0388	3.8902	-10	4.7256
725.75	3.2775	- 6	2.0335	3.7408	-10	4.7365
741.90	3.2375	- 6	2.0288	3.5993	-10	4.7474
758.10	3.2004	- 6	2.0250	3.4657	-10	4.7584
774.25	3.1745	- 6	2.0221	3.3399	-10	4.7694
790.31	3.1330	- 6	2.0130	3.2217	-10	4.7803
806.19	3.0999	- 6	2.0087	3.1109	-10	4.7912
821.84	3.0836	- 6	2.0076	3.0074	-10	4.8019
837.19	3.0538	- 6	2.0000	2.9110	-10	4.8124
852.17	3.0371	- 6	1.9978	2.8213	-10	4.8226
866.73	3.0135	- 6	1.9949	2.7381	-10	4.8326
880.79	3.0557	- 6	1.9833	2.6612	-10	4.8423
894.31	2.9261	- 6	1.9763	2.5904	-10	4.8515
907.22	2.9456	- 6	2.0036	2.5253	-10	4.8604
919.47	2.9758	- 6	1.9502	2.4658	-10	4.8688
931.01	2.9678	- 6	1.9663	2.4117	-10	4.8768
941.79	2.8875	- 6	1.9611	2.3627	-10	4.8842
951.77	2.8976	- 6	1.9967	2.3187	-10	4.8911
960.90	2.8472	- 6	1.9869	2.2794	-10	4.8974
969.14	2.9055	- 6	1.9746	2.2449	-10	4.9030
976.47	2.8803	- 6	1.9512	2.2148	-10	4.9081
982.85	2.8839	- 6	1.9691	2.1891	-10	4.9125
988.25	2.7757	- 6	1.9851	2.1677	-10	4.9162
992.65	2.8165	- 6	1.9074	2.1504	-10	4.9192
996.03	2.8653	- 6	1.9649	2.1373	-10	4.9215
998.38	2.9340	- 6	1.9228	2.1283	-10	4.9232
999.69	2.8464	- 6	1.9773	2.1233	-10	4.9241

† Gaussian frequencies, interval: 500-1000 kc.

Table 10

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		arg E_r		d = 1000 miles $\lvert E_r \rvert$		arg E_r	
0.030725	7.9832	-11	2.4046		2.2340	-11	1.6720	
0.16175	1.8504	-10	4.4409	- 1	1.1158	-10	4.1786	- 1
0.39689	4.5575	-10	2.9672	- 1	2.6084	-10	3.8290	- 1
0.73521	8.2308	-10	2.9082	- 1	4.5513	-10	4.3354	- 1
1.1753	1.2781	- 9	3.2295	- 1	6.8479	-10	5.1098	- 1
1.7153	1.8107	- 9	3.7273	- 1	9.4105	-10	6.0287	- 1
2.3530	2.4106	- 9	4.3369	- 1	1.2162	- 9	7.0530	- 1
3.0857	3.0676	- 9	5.0317	- 1	1.5035	- 9	8.1662	- 1
3.9103	3.7715	- 9	5.7983	- 1	1.7967	- 9	9.3602	- 1
4.8233	4.5117	- 9	6.6288	- 1	2.0902	- 9	1.0630	
5.8210	5.2778	- 9	7.5174	- 1	2.3788	- 9	1.1970	
6.8991	6.0589	- 9	8.4594	- 1	2.6576	- 9	1.3378	
8.0532	6.8439	- 9	9.4505	- 1	2.9219	- 9	1.4848	
9.2783	7.6218	- 9	1.0486		3.1673	- 9	1.6375	
10.569	8.3814	- 9	1.1563		3.3898	- 9	1.7955	
11.921	9.1116	- 9	1.2674		3.5857	- 9	1.9582	
13.327	9.8022	- 9	1.3817		3.7520	- 9	2.1248	
14.783	1.0443	- 8	1.4986		3.8864	- 9	2.2948	
16.281	1.1026	- 8	1.6175		3.9873	- 9	2.4673	
17.816	1.1544	- 8	1.7379		4.0538	- 9	2.6417	
19.381	1.1990	- 8	1.8592		4.0862	- 9	2.8171	
20.969	1.2361	- 8	1.9809		4.0855	- 9	2.9926	
22.575	1.2655	- 8	2.1024		4.0537	- 9	3.1676	
24.190	1.287	- 8	2.223		3.993	- 9	3.341	
25.810	1.301	- 8	2.342		3.908	- 9	3.512	
27.425	1.308	- 8	2.460		3.801	- 9	3.680	
29.031	1.308	- 8	2.575		3.677	- 9	3.845	
30.619	1.302	- 8	2.687		3.539	- 9	4.004	
32.184	1.291	- 8	2.796		3.392	- 9	4.159	
33.719	1.275	- 8	2.901		3.240	- 9	4.308	
35.217	1.26	- 8	3.00		3.09	- 9	4.45	
36.673	1.23	- 8	3.10		2.93	- 9	4.59	
38.079	1.21	- 8	3.19		2.78	- 9	4.71	
39.431	1.18	- 8	3.28		2.64	- 9	4.84	
40.722	1.15	- 8	3.36		2.50	- 9	4.95	
41.947	1.13	- 8	3.43		2.37	- 9	5.05	
43.101	1.10	- 8	3.50		2.25	- 9	5.15	
44.179	1.07	- 8	3.57		2.14	- 9	5.24	
45.177	1.05	- 8	3.62		2.04	- 9	5.32	
46.090	1.03	- 8	3.68		1.96	- 9	5.39	
46.914	1.01	- 8	3.72		1.88	- 9	5.46	
47.647	9.88	- 9	3.76		1.81	- 9	5.51	
48.285	9.71	- 9	3.80		1.75	- 9	5.56	
48.825	9.57	- 9	3.83		1.70	- 9	5.60	
49.265	9.46	- 9	3.85		1.67	- 9	5.63	
49.603	9.37	- 9	3.87		1.64	- 9	5.66	
49.838	9.31	- 9	3.88		1.62	- 9	5.67	
49.969	9.28	- 9	3.89		1.61	- 9	5.68	

† Gaussian frequencies, interval: 0-50kc.

Table 11

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		arg E_r		d = 1000 miles $\lvert E_r \rvert$		arg E_r	
50.277	9.20	- 9	3.91		1.58	- 9	5.71	
51.456	8.89	- 9	3.97		1.48	- 9	5.79	
53.572	8.34	- 9	4.07		1.32	- 9	5.93	
56.617	7.58	- 9	4.22		1.11	- 9	6.12	
60.578	6.63	- 9	4.39		8.83	-10	5.78	- 2
65.438	4.52	- 9	4.35		4.64	-10	6.28	
71.177	4.09	- 9	4.71		4.07	-10	5.00	- 1
77.771	3.38	- 9	5.00		3.05	-10	8.88	- 1
85.193	2.64	- 9	5.23		2.10	-10	1.20	
					1.38	-10	1.46	
102.39	1.50	- 9	5.58		8.92	-11	1.67	
112.09	1.12	- 9	5.72		5.77	-11	1.86	
122.48	8.31	-10	5.85		3.75	-11	2.02	
133.50	6.27	-10	5.95		2.48	-11	2.17	
145.12	4.79	-10	6.04		1.66	-11	2.30	
157.29	3.70	-10	6.12		1.13	-11	2.43	
169.95	2.89	-10	6.20		7.84	-12	2.55	
183.05	2.29	-10	6.26		5.51	-12	2.66	
196.53	1.83	-10	4.48	- 2	3.93	-12	2.77	
210.34	1.48	-10	1.05	- 1	2.84	-12	2.87	
224.43	1.20	-10	1.62	- 1	2.09	-12	2.97	
238.72	9.92	-11	2.16	- 1	1.55	-12	3.06	
253.17	8.24	-11	2.68	- 1	1.17	-12	3.15	
267.71	6.92	-11	3.17	- 1	8.96	-13	3.24	
282.29	5.85	-11	3.65	- 1	6.93	-13	3.33	
296.83	4.99	-11	4.10	- 1	5.43	-13	3.41	
311.28	4.298	-11	4.529	- 1	4.307	-13	3.486	
325.57	3.729	-11	4.941	- 1	3.456	-13	3.561	
339.66	3.2601	-11	5.3352	- 1	2.8048	-13	3.6336	
353.47	2.8721	-11	5.7106	- 1	2.3025	-13	3.7029	
366.95	2.5493	-11	6.0679	- 1	1.9113	-13	3.7690	
380.05	2.2793	-11	6.4069	- 1	1.6042	-13	3.8318	
392.71	2.0525	-11	6.7278	- 1	1.3611	-13	3.8914	
404.88	1.8613	-11	7.0304	- 1	1.1672	-13	3.9476	
416.50	1.6996	-11	7.3145	- 1	1.0116	-13	4.0005	
427.52	1.5626	-11	7.5801	- 1	8.8597	-14	4.0499	
437.91	1.4462	-11	7.8268	- 1	7.8402	-14	4.0958	
447.61	1.3474	-11	8.0545	- 1	7.0096	-14	4.1382	
456.59	1.2636	-11	8.2630	- 1	6.3312	-14	4.1769	
464.81	1.1926	-11	8.4519	- 1	5.7767	-14	4.2121	
472.23	1.1329	-11	8.6210	- 1	5.3239	-14	4.2435	
478.82	1.0830	-11	8.7703	- 1	4.9561	-14	4.2713	
484.56	1.0418	-11	8.8993	- 1	4.6598	-14	4.2953	
489.42	1.0085	-11	9.0080	- 1	4.4249	-14	4.3155	
493.38	9.8238	-12	9.0962	- 1	4.2436	-14	4.3319	
496.43	9.6287	-12	9.1638	- 1	4.1101	-14	4.3444	
498.54	9.4960	-12	9.2107	- 1	4.0202	-14	4.3531	
499.72	9.4231	-12	9.2367	- 1	3.9711	-14	4.3580	

† Gaussian frequencies, interval: 50-500 kc.

Table 12

$\sigma = 0.0005$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		d = 621 miles arg E_r		d = 1000 miles $\lvert E_r \rvert$		d = 1000 miles arg E_r
500.31	9.3873	-12	9.2496	- 1	3.9470	-14	4.3604
501.62	9.3075	-12	9.2786	- 1	3.8937	-14	4.3657
503.97	9.1665	-12	9.3304	- 1	3.8000	-14	4.3753
507.35	8.9683	-12	9.4047	- 1	3.6697	-14	4.3891
511.75	8.7186	-12	9.5011	- 1	3.5080	-14	4.4070
517.15	8.4243	-12	9.6188	- 1	3.3206	-14	4.4289
523.53	8.0928	-12	9.7571	- 1	3.1142	-14	4.4545
530.86	7.7322	-12	9.9151	- 1	2.8951	-14	4.4838
539.10	7.3504	-12	1.0092		2.6696	-14	4.5165
548.23	6.9553	-12	1.0286		2.4433	-14	4.5524
558.21	6.5538	-12	1.0497		2.2209	-14	4.5913
568.99	6.1525	-12	1.0722		2.0064	-14	4.6330
580.53	5.7568	-12	1.0962		1.8029	-14	4.6773
592.78	5.3714	-12	1.1215		1.6125	-14	4.7238
605.69	4.9998	-12	1.1478		1.4364	-14	4.7723
619.21	4.6450	-12	1.1752		1.2753	-14	4.8225
633.27	4.3087	-12	1.2034		1.1294	-14	4.8743
647.83	3.9924	-12	1.2324		9.9821	-15	4.9273
662.81	3.6967	-12	1.2620		8.8109	-15	4.9813
678.16	3.4217	-12	1.2920		7.7715	-15	5.0360
693.81	3.1671	-12	1.3223		6.8537	-15	5.0912
709.69	2.9325	-12	1.3529		6.0466	-15	5.1467
725.75	2.7170	-12	1.3835		5.3394	-15	5.2022
741.90	2.5197	-12	1.4140		4.7214	-15	5.2574
758.10	2.3396	-12	1.4444		4.1826	-15	5.3123
774.25	2.1755	-12	1.4745		3.7136	-15	5.3665
790.31	2.0263	-12	1.5042		3.3060	-15	5.4198
806.19	1.8910	-12	1.5333		2.9519	-15	5.4721
821.84	1.7684	-12	1.5618		2.6446	-15	5.5232
837.19	1.6575	-12	1.5896		2.3781	-15	5.5729
852.17	1.5575	-12	1.6165		2.1468	-15	5.6209
866.73	1.4673	-12	1.6425		1.9463	-15	5.6673
880.79	1.3861	-12	1.6675		1.7724	-15	5.7117
894.31	1.3133	-12	1.6914		1.6217	-15	5.7541
907.22	1.2480	-12	1.7140		1.4911	-15	5.7943
919.47	1.1897	-12	1.7354		1.3781	-15	5.8322
931.01	1.1378	-12	1.7555		1.2803	-15	5.8677
941.79	1.0918	-12	1.7742		1.1961	-15	5.9007
951.77	1.0512	-12	1.7914		1.1236	-15	5.9311
960.90	1.0157	-12	1.8070		1.0616	-15	5.9587
969.14	9.8483	-13	1.8212		1.0089	-15	5.9836
976.47	9.5837	-13	1.8337		9.6450	-16	6.0056
982.85	9.3604	-13	1.8445		9.2766	-16	6.0248
988.25	9.1762	-13	1.8537		8.9769	-16	6.0409
992.65	9.0294	-13	1.8612		8.7408	-16	6.0540
996.03	8.9184	-13	1.8669		8.5639	-16	6.0641
998.38	8.8423	-13	1.8709		8.4434	-16	6.0711
999.69	8.8002	-13	1.8731		8.3771	-16	6.0749

† Gaussian frequencies, interval: 500-1000 kc.

Table 13

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\|E_r\|$		arg E_r		d = 329 miles $\|E_r\|$		arg E_r	
0.030725	1.1456	- 5	3.1288		5.8965	-10	2.8187	
0.16175	2.1713	- 6	3.0739		3.3338	-10	7.3983	- 1
0.39689	8.7482	- 7	2.9729		8.8931	-10	3.1190	- 1
0.73521	4.5756	- 7	2.8146		1.6570	- 9	2.1988	- 1
1.1753	2.7037	- 7	2.5658		2.6297	- 9	1.9444	- 1
1.7153	1.7778	- 7	2.1619		3.7992	- 9	1.9364	- 1
2.3530	1.4837	- 7	1.5977		5.1546	- 9	2.0501	- 1
3.0857	1.6799	- 7	1.0956		6.6838	- 9	2.2359	- 1
3.9103	2.1413	- 7	7.8208	- 1	8.3741	- 9	2.4710	- 1
4.8233	2.7246	- 7	5.9642	- 1	1.0212	- 8	2.7430	- 1
5.8210	3.3772	- 7	4.7971	- 1	1.2185	- 8	3.0446	- 1
6.8991	4.0813	- 7	4.0155	- 1	1.4278	- 8	3.3711	- 1
8.0532	4.8298	- 7	3.4669	- 1	1.6477	- 8	3.7191	- 1
9.2783	5.6187	- 7	3.0694	- 1	1.8767	- 8	4.0859	- 1
10.569	6.4451	- 7	2.7753	- 1	2.1134	- 8	4.4692	- 1
11.921	7.3059	- 7	2.5554	- 1	2.3563	- 8	4.8670	- 1
13.327	8.1980	- 7	2.3905	- 1	2.6038	- 8	5.2774	- 1
14.783	9.1181	- 7	2.2674	- 1	2.8545	- 8	5.6986	- 1
16.281	1.0063	- 6	2.1770	- 1	3.1070	- 8	6.1288	- 1
17.816	1.1028	- 6	2.1124	- 1	3.3597	- 8	6.5663	- 1
19.381	1.2011	- 6	2.0684	- 1	3.6113	- 8	7.0092	- 1
20.969	1.3006	- 6	2.0412	- 1	3.8603	- 8	7.4560	- 1
22.575	1.4011	- 6	2.0276	- 1	4.1056	- 8	7.9047	- 1
24.190	1.5020	- 6	2.0252	- 1	4.3459	- 8	8.3537	- 1
25.810	1.6030	- 6	2.0320	- 1	4.5801	- 8	8.8012	- 1
27.425	1.7037	- 6	2.0462	- 1	4.8072	- 8	9.2454	- 1
29.031	1.8036	- 6	2.0665	- 1	5.0262	- 8	9.6847	- 1
30.619	1.9023	- 6	2.0917	- 1	5.2364	- 8	1.0117	
32.184	1.9994	- 6	2.1206	- 1	5.4371	- 8	1.0542	
33.719	2.0945	- 6	2.1524	- 1	5.6278	- 8	1.0956	
35.217	2.1873	- 6	2.1864	- 1	5.8079	- 8	1.1359	
36.673	2.2772	- 6	2.2217	- 1	5.9773	- 8	1.1749	
38.079	2.3641	- 6	2.2579	- 1	6.1356	- 8	1.2124	
39.431	2.4474	- 6	2.2942	- 1	6.2829	- 8	1.2483	
40.722	2.5269	- 6	2.3302	- 1	6.4190	- 8	1.2825	
41.947	2.6023	- 6	2.3655	- 1	6.5440	- 8	1.3149	
43.101	2.6732	- 6	2.3997	- 1	6.6581	- 8	1.3453	
44.179	2.7393	- 6	2.4323	- 1	6.7615	- 8	1.3736	
45.177	2.8005	- 6	2.4630	- 1	6.8543	- 8	1.3997	
46.090	2.8564	- 6	2.4916	- 1	6.9370	- 8	1.4235	
46.914	2.9069	- 6	2.5177	- 1	7.0097	- 8	1.4450	
47.647	2.9517	- 6	2.5413	- 1	7.0728	- 8	1.4641	
48.285	2.9907	- 6	2.5619	- 1	7.1265	- 8	1.4806	
48.825	3.0237	- 6	2.5795	- 1	7.1712	- 8	1.4946	
49.265	3.0505	- 6	2.5940	- 1	7.2070	- 8	1.5060	
49.603	3.0712	- 6	2.6051	- 1	7.2341	- 8	1.5148	
49.838	3.0855	- 6	2.6129	- 1	7.2528	- 8	1.5209	
49.969	3.0935	- 6	2.6172	- 1	7.2632	- 8	1.5243	

† Gaussian frequencies, interval: 0-50 kc.

Table 14

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		d = 12.49 miles arg E_r		d = 329 miles $\lvert E_r \rvert$		d = 329 miles arg E_r
50.277	3.1122	- 6	2.6275	- 1	7.2873	- 8	1.5322
51.456	3.1841	- 6	2.6670	- 1	7.3775	- 8	1.5626
53.572	3.3127	- 6	2.7391	- 1	7.5300	- 8	1.6169
56.617	3.4973	- 6	2.8451	- 1	7.729	- 8	1.694
60.578	3.7364	- 6	2.9866	- 1	7.950	- 8	1.794
65.438	4.0281	- 6	3.1645	- 1	8.167	- 8	1.915
71.177	4.3699	- 6	3.3795	- 1	8.347	- 8	2.056
77.771	4.7590	- 6	3.6313	- 1	8.458	- 8	2.214
85.193	5.1919	- 6	3.9194	- 1	8.469	- 8	2.388
93.410	5.6643	- 6	4.2424	- 1	8.35	- 8	2.57
102.39	6.1717	- 6	4.5988	- 1	8.10	- 8	2.77
112.09	6.7088	- 6	4.9865	- 1	7.71	- 8	2.97
122.48	7.2697	- 6	5.4032	- 1	7.19	- 8	3.17
133.50	7.8483	- 6	5.8463	- 1	6.56	- 8	3.37
145.12	8.4380	- 6	6.3132	- 1	1.09	- 7	3.42
157.29	9.0319	- 6	6.8011	- 1	5.00	- 8	3.65
169.95	9.6231	- 6	7.3068	- 1	4.41	- 8	3.91
183.05	1.0205	- 5	7.8274	- 1	3.79	- 8	4.11
196.53	1.0770	- 5	8.3598	- 1	3.21	- 8	4.28
210.34	1.1313	- 5	8.9007	- 1	2.78	- 8	4.39
224.43	1.1828	- 5	9.4470	- 1	2.33	- 8	4.51
238.72	1.2310	- 5	9.9956	- 1	1.98	- 8	4.67
253.17	1.2755	- 5	1.0543		1.68	- 8	4.69
267.71	1.3160	- 5	1.1087		1.44	- 8	4.76
282.29	1.3522	- 5	1.1625		1.25	- 8	4.82
296.83	1.3841	- 5	1.2153		1.09	- 8	4.87
311.28	1.4116	- 5	1.2669		9.60	- 9	4.92
325.57	1.4349	- 5	1.3171		8.53	- 9	4.95
339.66	1.4539	- 5	1.3657		7.64	- 9	4.99
353.47	1.4691	- 5	1.4124		6.89	- 9	5.02
366.95	1.4806	- 5	1.4572		6.26	- 9	5.05
380.05	1.4888	- 5	1.4998		5.72	- 9	5.07
392.71	1.4941	- 5	1.5402		5.26	- 9	5.10
404.88	1.4968	- 5	1.5782		4.87	- 9	5.12
416.50	1.4973	- 5	1.6139		4.53	- 9	5.14
427.52	1.4960	- 5	1.6470		4.25	- 9	5.16
437.91	1.4934	- 5	1.6776		4.00	- 9	5.17
447.61	1.4896	- 5	1.7057		3.78	- 9	5.19
456.59	1.4851	- 5	1.7312		3.60	- 9	5.20
464.81	1.4802	- 5	1.7541		3.44	- 9	5.21
472.23	1.4751	- 5	1.7745		3.31	- 9	5.22
478.82	1.4701	- 5	1.7924		3.20	- 9	5.23
484.56	1.4654	- 5	1.8077		3.10	- 9	5.24
489.42	1.4612	- 5	1.8206		3.03	- 9	5.25
493.38	1.4576	- 5	1.8309		2.97	- 9	5.25
496.43	1.4547	- 5	1.8389		2.92	- 9	5.26
498.54	1.4527	- 5	1.8443		2.89	- 9	5.26
499.72	1.4515	- 5	1.8474		2.87	- 9	5.26

† Gaussian frequencies, interval: 50-500 kc.

Table 15

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		d = 12.49 miles arg E_r	d = 329 miles $\lvert E_r \rvert$		d = 329 miles arg E_r
500.31	1.4509	- 5	1.8489	2.87	- 9	5.26
501.62	1.4496	- 5	1.8522	2.85	- 9	5.26
503.97	1.4472	- 5	1.8582	2.82	- 9	5.27
507.35	1.4437	- 5	1.8668	2.77	- 9	5.27
511.75	1.4390	- 5	1.8779	2.71	- 9	5.28
517.15	1.4331	- 5	1.8913	2.64	- 9	5.28
523.53	1.4257	- 5	1.9069	2.56	- 9	5.29
530.86	1.4170	- 5	1.9246	2.47	- 9	5.30
539.10	1.4066	- 5	1.9441	2.38	- 9	5.31
548.23	1.3947	- 5	1.9652	2.28	- 9	5.32
558.21	1.3812	- 5	1.9878	2.18	- 9	5.33
568.99	1.3660	- 5	2.0115	2.08	- 9	5.34
580.53	1.3491	- 5	2.0361	1.98	- 9	5.36
592.78	1.3307	- 5	2.0614	1.88	- 9	5.37
605.69	1.3107	- 5	2.0871	1.78	- 9	5.38
619.21	1.2893	- 5	2.1129	1.69	- 9	5.40
633.27	1.2667	- 5	2.1387	1.597	- 9	5.413
647.83	1.2430	- 5	2.1642	1.510	- 9	5.428
662.81	1.2183	- 5	2.1892	1.426	- 9	5.442
678.16	1.1930	- 5	2.2135	1.347	- 9	5.457
693.81	1.1673	- 5	2.2370	1.273	- 9	5.472
709.69	1.1412	- 5	2.2595	1.203	- 9	5.486
725.75	1.1152	- 5	2.2808	1.1379	- 9	5.5006
741.90	1.0893	- 5	2.3010	1.0771	- 9	5.5148
758.10	1.0637	- 5	2.3199	1.0205	- 9	5.5288
774.25	1.0388	- 5	2.3374	9.6808	-10	5.5424
790.31	1.0145	- 5	2.3537	9.1959	-10	5.5558
806.19	9.9101	- 6	2.3686	8.7485	-10	5.5687
821.84	9.6849	- 6	2.3823	8.3364	-10	5.5813
837.19	9.4700	- 6	2.3946	7.9578	-10	5.5934
852.17	9.2661	- 6	2.4058	7.6106	-10	5.6051
866.73	9.0737	- 6	2.4158	7.2929	-10	5.6163
880.79	8.8932	- 6	2.4247	7.0029	-10	5.6269
894.31	8.7247	- 6	2.4326	6.7389	-10	5.6370
907.22	8.5682	- 6	2.4396	6.4993	-10	5.6465
919.47	8.4240	- 6	2.4457	6.2826	-10	5.6555
931.01	8.2917	- 6	2.4510	6.0874	-10	5.6638
941.79	8.1712	- 6	2.4556	5.9125	-10	5.6715
951.77	8.0624	- 6	2.4596	5.7567	-10	5.6786
960.90	7.9651	- 6	2.4630	5.6190	-10	5.6850
969.14	7.8792	- 6	2.4658	5.4984	-10	5.6908
976.47	7.8038	- 6	2.4682	5.3943	-10	5.6959
982.85	7.7396	- 6	2.4702	5.3058	-10	5.7003
988.25	7.6863	- 6	2.4718	5.2324	-10	5.7040
992.65	7.6428	- 6	2.4730	5.1736	-10	5.7070
996.03	7.6104	- 6	2.4740	5.1290	-10	5.7093
998.38	7.5875	- 6	2.4746	5.0984	-10	5.7109
999.69	7.5748	- 6	2.4750	5.0814	-10	5.7118

† Gaussian frequencies, interval: 500-1000 kc.

Table 16

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		arg E_r		d = 1000 miles $\lvert E_r \rvert$		arg E_r	
0.030725	7.9832	-11	2.4037		2.2340	-11	1.6708	
0.16175	1.8503	-10	4.3915	- 1	1.1157	-10	4.1154	- 1
0.39689	4.5571	-10	2.8455	- 1	2.6077	-10	3.6725	- 1
0.73521	8.2296	-10	2.6818	- 1	4.5486	-10	4.0429	- 1
1.1753	1.2779	- 9	2.8658	- 1	6.8413	-10	4.6379	- 1
1.7153	1.8106	- 9	3.1942	- 1	9.3983	-10	5.3340	- 1
2.3530	2.4112	- 9	3.6026	- 1	1.2145	- 9	6.0917	- 1
3.0857	3.0705	- 9	4.0648	- 1	1.5017	- 9	6.8952	- 1
3.9103	3.7793	- 9	4.5683	- 1	1.7960	- 9	7.7370	- 1
4.8233	4.5294	- 9	5.1060	- 1	2.0930	- 9	8.6126	- 1
5.8210	5.3126	- 9	5.6736	- 1	2.3888	- 9	9.5192	- 1
6.8991	6.1212	- 9	6.2678	- 1	2.6803	- 9	1.0455	
8.0532	6.9481	- 9	6.8859	- 1	2.9646	- 9	1.1417	
9.2783	7.7863	- 9	7.5256	- 1	3.2395	- 9	1.2403	
10.569	8.6291	- 9	8.1847	- 1	3.5031	- 9	1.3412	
11.921	9.4704	- 9	8.8610	- 1	3.7538	- 9	1.4441	
13.327	1.0304	- 8	9.5523	- 1	3.9902	- 9	1.5488	
14.783	1.1125	- 8	1.0256		4.2111	- 9	1.6549	
16.281	1.1928	- 8	1.0971		4.4158	- 9	1.7623	
17.816	1.2708	- 8	1.1694		4.6035	- 9	1.8705	
19.381	1.3461	- 8	1.2422		4.7738	- 9	1.9793	
20.969	1.4182	- 8	1.3153		4.9264	- 9	2.0884	
22.575	1.4870	- 8	1.3886		5.0613	- 9	2.1974	
24.190	1.5520	- 8	1.4616		5.1788	- 9	2.3059	
25.810	1.6132	- 8	1.5342		5.2791	- 9	2.4136	
27.425	1.6702	- 8	1.6060		5.3629	- 9	2.5202	
29.031	1.7231	- 8	1.6770		5.4308	- 9	2.6252	
30.619	1.7717	- 8	1.7467		5.4838	- 9	2.7283	
32.184	1.8161	- 8	1.8149		5.5228	- 9	2.8291	
33.719	1.8563	- 8	1.8814		5.5491	- 9	2.9274	
35.217	1.8924	- 8	1.9460		5.5638	- 9	3.0227	
36.673	1.9246	- 8	2.0084		5.5683	- 9	3.1147	
38.079	1.9530	- 8	2.0683		5.5639	- 9	3.2032	
39.431	1.9780	- 8	2.1257		5.5519	- 9	3.2877	
40.722	1.9996	- 8	2.1802		5.5338	- 9	3.3680	
41.947	2.0182	- 8	2.2318		5.5109	- 9	3.4439	
43.101	2.0340	- 8	2.2801		5.4843	- 9	3.5150	
44.179	2.0473	- 8	2.3251		5.4554	- 9	3.5812	
45.177	2.0584	- 8	2.3666		5.4252	- 9	3.6422	
46.090	2.0675	- 8	2.4045		5.3949	- 9	3.6979	
46.914	2.0749	- 8	2.4386		5.3653	- 9	3.7479	
47.647	2.0809	- 8	2.4688		5.3374	- 9	3.7923	
48.285	2.0855	- 8	2.4950		5.3119	- 9	3.8308	
48.825	2.0891	- 8	2.5171		5.2894	- 9	3.8634	
49.265	2.0918	- 8	2.5352		5.2705	- 9	3.8899	
49.603	2.0937	- 8	2.5490		5.2557	- 9	3.9102	
49.838	2.0950	- 8	2.5586		5.2452	- 9	3.9243	
49.969	2.0957	- 8	2.5640		5.2392	- 9	3.9321	

† Gaussian frequencies, interval: 0-50 kc.

Table 17

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		arg E_r		d = 1000 miles $\lvert E_r \rvert$		arg E_r	
50.277	2.0972	- 8	2.5765		5.2252	- 9	3.9505	
51.456	2.1021	- 8	2.6245		5.1692	- 9	4.0210	
53.572	2.1073	- 8	2.7102		5.0608	- 9	4.1466	
56.617	2.107	- 8	2.832		4.889	- 9	4.326	
60.578	2.093	- 8	2.989		4.643	- 9	4.555	
65.438	2.059	- 8	3.179		4.314	- 9	4.831	
71.177	1.995	- 8	3.397		3.905	- 9	5.150	
77.771	1.898	- 8	3.642		3.425	- 9	5.505	
85.193	1.766	- 8	3.908		2.900	- 9	5.890	
93.410	1.60	- 8	4.19		2.36	- 9	1.30	- 2
102.39	1.41	- 8	4.48		1.84	- 9	4.30	- 1
112.09	1.20	- 8	4.78		1.37	- 9	8.47	- 1
122.48	9.98	- 9	5.07		9.78	-10	1.25	
133.50	8.01	- 9	5.34		6.69	-10	1.62	
145.12	4.89	- 9	5.11		2.79	-10	1.20	
157.29	4.42	- 9	5.65		2.46	-10	2.00	
169.95	3.60	- 9	6.03		1.81	-10	2.54	
183.05	2.80	- 9	2.99	- 2	1.23	-10	2.94	
196.53	2.13	- 9	2.51	- 1	8.11	-11	3.25	
210.34	1.63	- 9	4.35	- 1	5.34	-11	3.50	
224.43	1.24	- 9	5.85	- 1	3.55	-11	3.71	
238.72	9.56	-10	7.12	- 1	2.40	-11	3.89	
253.17	7.49	-10	8.25	- 1	1.65	-11	4.04	
267.71	5.91	-10	9.23	- 1	1.16	-11	4.18	
282.29	4.73	-10	1.01		8.26	-12	4.30	
296.83	3.83	-10	1.09		6.02	-12	4.41	
311.28	3.14	-10	1.16		4.46	-12	4.52	
325.57	2.60	-10	1.23		3.36	-12	4.61	
339.66	2.18	-10	1.29		2.58	-12	4.70	
353.47	1.85	-10	1.34		2.01	-12	4.79	
366.95	1.58	-10	1.39		1.59	-12	4.86	
380.05	1.37	-10	1.44		1.28	-12	4.94	
392.71	1.20	-10	1.49		1.04	-12	5.00	
404.88	1.06	-10	1.53		8.61	-13	5.07	
416.50	9.39	-11	1.56		7.22	-13	5.13	
427.52	8.43	-11	1.60		6.13	-13	5.18	
437.91	7.64	-11	1.63		5.28	-13	5.23	
447.61	6.98	-11	1.66		4.60	-13	5.28	
456.59	6.43	-11	1.69		4.06	-13	5.32	
464.81	5.97	-11	1.71		3.63	-13	5.36	
472.23	5.59	-11	1.73		3.29	-13	5.39	
478.82	5.28	-11	1.75		3.02	-13	5.42	
484.56	5.03	-11	1.76		2.80	-13	5.45	
489.42	4.82	-11	1.78		2.63	-13	5.47	
493.38	4.66	-11	1.79		2.50	-13	5.48	
496.43	4.55	-11	1.80		2.40	-13	5.50	
498.54	4.47	-11	1.80		2.34	-13	5.51	
499.72	4.42	-11	1.81		2.30	-13	5.51	

† Gaussian frequencies, interval: 50-500 kc.

Table 18

$\sigma = 0.002$ $\epsilon_2 = 15$ $\alpha = 0.85$

† f, kc	d = 621 miles $\|E_r\|$		arg E_r	d = 1000 miles $\|E_r\|$		arg E_r	
500.31	4.40	-11	1.81	2.29	-13	5.51	
501.62	4.36	-11	1.81	2.25	-13	5.52	
503.97	4.27	-11	1.82	2.18	-13	5.53	
507.35	4.16	-11	1.83	2.09	-13	5.54	
511.75	4.01	-11	1.84	1.98	-13	5.56	
517.15	3.84	-11	1.85	1.86	-13	5.59	
523.53	3.65	-11	1.87	1.72	-13	5.61	
530.86	3.44	-11	1.89	1.57	-13	5.64	
539.10	3.23	-11	1.91	1.43	-13	5.68	
548.23	3.01	-11	1.93	1.28	-13	5.71	
558.21	2.79	-11	1.95	1.14	-13	5.75	
568.99	2.58	-11	1.98	1.01	-13	5.80	
580.53	2.37	-11	2.01	8.90	-14	5.84	
592.78	2.17	-11	2.04	7.78	-14	5.89	
605.69	1.98	-11	2.07	6.78	-14	5.94	
619.21	1.81	-11	2.10	5.88	-14	5.99	
633.27	1.646	-11	2.128	5.087	-14	6.041	
647.83	1.495	-11	2.160	4.390	-14	6.094	
662.81	1.357	-11	2.192	3.784	-14	6.148	
678.16	1.232	-11	2.224	3.260	-14	6.202	
693.81	1.118	-11	2.256	2.808	-14	6.257	
709.69	1.015	-11	2.289	2.420	-14	2.829	- 2
725.75	9.2218	-12	2.3210	2.0887	-14	8.2694	- 2
741.90	8.3909	-12	2.3529	1.8059	-14	1.3668	- 1
758.10	7.6471	-12	2.3843	1.5650	-14	1.9005	- 1
774.25	6.9824	-12	2.4152	1.3602	-14	2.4260	- 1
790.31	6.3895	-12	2.4455	1.1860	-14	2.9414	- 1
806.19	5.8614	-12	2.4750	1.0380	-14	3.4450	- 1
821.84	5.3915	-12	2.5037	9.1215	-15	3.9351	- 1
837.19	4.9738	-12	2.5315	8.0516	-15	4.4103	- 1
852.17	4.6029	-12	2.5583	7.1412	-15	4.8689	- 1
866.73	4.2739	-12	2.5840	6.3661	-15	5.3097	- 1
880.79	3.9823	-12	2.6085	5.7056	-15	5.7314	- 1
894.31	3.7243	-12	2.6319	5.1425	-15	6.1327	- 1
907.22	3.4962	-12	2.6540	4.6622	-15	6.5126	- 1
919.47	3.2950	-12	2.6747	4.2524	-15	6.8700	- 1
931.01	3.1181	-12	2.6941	3.9029	-15	7.2040	- 1
941.79	2.9629	-12	2.7121	3.6052	-15	7.5138	- 1
951.77	2.8274	-12	2.7286	3.3523	-15	7.7985	- 1
960.90	2.7099	-12	2.7436	3.1380	-15	8.0575	- 1
969.14	2.6087	-12	2.7570	2.9576	-15	8.2901	- 1
976.47	2.5225	-12	2.7689	2.8070	-15	8.4958	- 1
982.85	2.4503	-12	2.7793	2.6829	-15	8.6740	- 1
988.25	2.3910	-12	2.7879	2.5826	-15	8.8244	- 1
992.65	2.3440	-12	2.7950	2.5039	-15	8.9466	- 1
996.03	2.3085	-12	2.8004	2.4452	-15	9.0403	- 1
998.38	2.2843	-12	2.8042	2.4054	-15	9.1053	- 1
999.69	2.2709	-12	2.8063	2.3835	-15	9.1415	- 1

† Gaussian frequencies, interval: 500-1000 kc.

Table 19

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		arg E_r		d = 329 miles $\lvert E_r \rvert$		arg E_r	
0.030725	1.1456	- 5	3.1286		5.8965	-10	2.8181	
0.16175	2.1713	- 6	3.0732		3.3337	-10	7.3633	- 1
0.39689	8.7482	- 7	2.9712		8.8928	-10	3.0328	- 1
0.73521	4.5756	- 7	2.8115		8.8928	-10	3.0328	- 1
1.1753	2.7037	- 7	2.5609		2.6294	- 9	1.6884	- 1
1.7153	1.7779	- 7	2.1547		3.7986	- 9	1.5623	- 1
2.3530	1.4837	- 7	1.5879		5.1536	- 9	1.5359	- 1
3.0857	1.6799	- 7	1.0826		6.6823	- 9	1.5605	- 1
3.9103	2.1414	- 7	7.6563	- 1	8.3726	- 9	1.6136	- 1
4.8233	2.7248	- 7	5.7613	- 1	1.0254	- 8	1.7408	- 1
5.8210	3.3776	- 7	4.5522	- 1	1.2226	- 8	1.8190	- 1
6.8991	4.0820	- 7	3.7253	- 1	1.4319	- 8	1.9031	- 1
8.0532	4.8309	- 7	3.1282	- 1	1.6521	- 8	1.9910	- 1
9.2783	5.6204	- 7	2.6791	- 1	1.8820	- 8	2.0810	- 1
10.569	6.4476	- 7	2.3307	- 1	2.1202	- 8	2.1723	- 1
11.921	7.3095	- 7	2.0540	- 1	2.3656	- 8	2.2640	- 1
13.327	8.2030	- 7	1.8299	- 1	2.6169	- 8	2.3557	- 1
14.783	9.1250	- 7	1.6457	- 1	2.8732	- 8	2.4146	- 1
16.281	1.0072	- 6	1.4922	- 1	3.1334	- 8	2.5079	- 1
17.816	1.1041	- 6	1.3630	- 1	3.3959	- 8	2.5998	- 1
19.381	1.2027	- 6	1.2533	- 1	3.6597	- 8	2.6901	- 1
20.969	1.3026	- 6	1.1593	- 1	3.9236	- 8	2.7786	- 1
22.575	1.4036	- 6	1.0783	- 1	4.1866	- 8	2.8651	- 1
24.190	1.5051	- 6	1.0080	- 1	4.4477	- 8	2.9495	- 1
25.810	1.6068	- 6	9.4675	- 2	4.7059	- 8	3.0315	- 1
27.425	1.7082	- 6	8.9311	- 2	4.9603	- 8	3.1110	- 1
29.031	1.8089	- 6	8.4596	- 2	5.2099	- 8	3.1880	- 1
30.619	1.9085	- 6	8.0438	- 2	5.4539	- 8	3.2622	- 1
32.184	2.0066	- 6	7.6761	- 2	5.6916	- 8	3.3336	- 1
33.719	2.1028	- 6	7.3502	- 2	5.9222	- 8	3.4021	- 1
35.217	2.1967	- 6	7.0608	- 2	6.1449	- 8	3.4676	- 1
36.673	2.2879	- 6	6.8035	- 2	6.3590	- 8	3.5299	- 1
38.079	2.3760	- 6	6.5747	- 2	6.5640	- 8	3.5891	- 1
39.431	2.4606	- 6	6.3711	- 2	6.7592	- 8	3.6450	- 1
40.722	2.5415	- 6	6.1900	- 2	6.9441	- 8	3.6976	- 1
41.947	2.6182	- 6	6.0292	- 2	7.1181	- 8	3.7468	- 1
43.101	2.6905	- 6	5.8867	- 2	7.2809	- 8	3.7925	- 1
44.179	2.7580	- 6	5.7608	- 2	7.4319	- 8	3.8347	- 1
45.177	2.8204	- 6	5.6501	- 2	7.5707	- 8	3.8733	- 1
46.090	2.8776	- 6	5.5533	- 2	7.6970	- 8	3.9083	- 1
46.914	2.9292	- 6	5.4694	- 2	7.8105	- 8	3.9396	- 1
47.647	2.9750	- 6	5.3975	- 2	7.9109	- 8	3.9672	- 1
48.285	3.0150	- 6	5.3369	- 2	7.9979	- 8	3.9911	- 1
48.825	3.0488	- 6	5.2869	- 2	8.0713	- 8	4.0112	- 1
49.265	3.0763	- 6	5.2471	- 2	8.1310	- 8	4.0275	- 1
49.603	3.0975	- 6	5.2170	- 2	8.1768	- 8	4.0400	- 1
49.838	3.1122	- 6	5.1963	- 2	8.2086	- 8	4.0486	- 1
49.969	3.1204	- 6	5.1849	- 2	8.2262	- 8	4.0535	- 1

† Gaussian frequencies, interval: 0-50 kc.

Table 20

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		arg E_r		d = 329 miles $\lvert E_r \rvert$		arg E_r	
50.277	3.1396	- 6	5.1584	- 2	8.2676	- 8	4.0647	- 1
51.456	3.2134	- 6	5.0599	- 2	8.4259	- 8	4.1077	- 1
53.572	3.3459	- 6	4.8952	- 2	8.7072	- 8	4.1836	- 1
56.617	3.5364	- 6	4.6822	- 2	9.1063	- 8	4.2903	- 1
60.578	3.7842	- 6	4.4412	- 2	9.6157	- 8	4.4253	- 1
65.438	4.0883	- 6	4.1912	- 2	1.0227	- 7	4.5853	- 1
71.177	4.4473	- 6	3.9474	- 2	1.0929	- 7	4.7672	- 1
77.771	4.8597	- 6	3.7207	- 2	1.1713	- 7	4.9679	- 1
85.193	5.3239	- 6	3.5182	- 2	1.2566	- 7	5.1845	- 1
93.410	5.8378	- 6	3.3434	- 2	1.3479	- 7	5.4143	- 1
102.39	6.3993	- 6	3.1974	- 2	1.4442	- 7	5.6549	- 1
112.09	7.0060	- 6	3.0799	- 2	1.5443	- 7	5.9042	- 1
122.48	7.6554	- 6	2.9894	- 2	1.6475	- 7	6.1603	- 1
133.50	8.3448	- 6	2.9239	- 2	1.7527	- 7	6.4216	- 1
145.12	9.0713	- 6	2.8813	- 2	1.8593	- 7	6.6867	- 1
157.29	9.8318	- 6	2.8592	- 2	1.9664	- 7	6.9541	- 1
169.95	1.0623	- 5	2.8554	- 2	2.0735	- 7	7.2228	- 1
183.05	1.1442	- 5	2.8679	- 2	2.1799	- 7	7.4918	- 1
196.53	1.2285	- 5	2.8947	- 2	2.2851	- 7	7.7600	- 1
210.34	1.3149	- 5	2.9340	- 2	2.3886	- 7	8.0267	- 1
224.43	1.4029	- 5	2.9841	- 2	2.4902	- 7	8.2910	- 1
238.72	1.4923	- 5	3.0435	- 2	2.5893	- 7	8.5522	- 1
253.17	1.5826	- 5	3.1108	- 2	2.6857	- 7	8.8097	- 1
267.71	1.6735	- 5	3.1847	- 2	2.7791	- 7	9.0627	- 1
282.29	1.7646	- 5	3.2640	- 2	2.8694	- 7	9.3107	- 1
296.83	1.8554	- 5	3.3477	- 2	2.9564	- 7	9.5530	- 1
311.28	1.9457	- 5	3.4346	- 2	3.0398	- 7	9.7891	- 1
325.57	2.0351	- 5	3.5239	- 2	3.1197	- 7	1.0019	
339.66	2.1231	- 5	3.6146	- 2	3.1958	- 7	1.0241	
353.47	2.2094	- 5	3.7058	- 2	3.2682	- 7	1.0455	
366.95	2.2937	- 5	3.7969	- 2	3.3367	- 7	1.0661	
380.05	2.3756	- 5	3.8871	- 2	3.4015	- 7	1.0859	
392.71	2.4547	- 5	3.9756	- 2	3.4623	- 7	1.1048	
404.88	2.5307	- 5	4.0619	- 2	3.5193	- 7	1.1227	
416.50	2.6033	- 5	4.1453	- 2	2.9404		5.0635	
427.52	2.6722	- 5	4.2252	- 2	3.6216	- 7	1.1555	
437.91	2.7371	- 5	4.3012	- 2	3.6670	- 7	1.1703	
447.61	2.7977	- 5	4.3728	- 2	3.7085	- 7	1.1841	
456.59	2.8538	- 5	4.4394	- 2	3.7463	- 7	1.1967	
464.81	2.9051	- 5	4.5008	- 2	3.7803	- 7	1.2082	
472.23	2.9515	- 5	4.5565	- 2	3.8105	- 7	1.2185	
478.82	2.9927	- 5	4.6062	- 2	3.8370	- 7	1.2276	
484.56	3.0286	- 5	4.6496	- 2	3.8597	- 7	1.2355	
489.42	3.0589	- 5	4.6864	- 2	3.8788	- 7	1.2421	
493.38	3.0837	- 5	4.7165	- 2	3.8943	- 7	1.2475	
496.43	3.1027	- 5	4.7397	- 2	3.9061	- 7	1.2517	
498.54	3.1159	- 5	4.7558	- 2	3.9142	- 7	1.2546	
499.72	3.1233	- 5	4.7648	- 2	3.9187	- 7	1.2562	

† Gaussian frequencies, interval: 50-500 kc.

Table 21

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

† f, kc	d = 12.49 miles $\lvert E_r \rvert$		d = 12.49 miles arg E_r		d = 329 miles $\lvert E_r \rvert$		d = 329 miles arg E_r
500.31	3.1269	- 5	4.7693	- 2	3.9210	- 7	1.2570
501.62	3.1351	- 5	4.7793	- 2	3.9260	- 7	1.2587
503.97	3.1498	- 5	4.7973	- 2	3.9350	- 7	1.2619
507.35	3.1709	- 5	4.8232	- 2	3.9478	- 7	1.2665
511.75	3.1984	- 5	4.8570	- 2	3.9644	- 7	1.2724
517.15	3.2321	- 5	4.8985	- 2	3.9845	- 7	1.2797
523.53	3.2720	- 5	4.9476	- 2	4.0080	- 7	1.2882
530.86	3.3177	- 5	5.0043	- 2	4.0347	- 7	1.2980
539.10	3.3692	- 5	5.0682	- 2	4.0644	- 7	1.3089
548.23	3.4263	- 5	5.1392	- 2	4.0966	- 7	1.3210
558.21	3.4886	- 5	5.2171	- 2	4.1313	- 7	1.3340
568.99	3.5559	- 5	5.3016	- 2	4.1681	- 7	1.3481
580.53	3.6280	- 5	5.3924	- 2	4.2066	- 7	1.3630
592.78	3.7045	- 5	5.4891	- 2	4.2467	- 7	1.3788
605.69	3.7851	- 5	5.5914	- 2	4.2881	- 7	1.3953
619.21	3.8695	- 5	5.6989	- 2	4.3303	- 7	1.4124
633.27	3.9573	- 5	5.8111	- 2	4.3733	- 7	1.4301
647.83	4.0482	- 5	5.9276	- 2	4.4166	- 7	1.4483
662.81	4.1418	- 5	6.0479	- 2	4.4602	- 7	1.4669
678.16	4.2376	- 5	6.1716	- 2	4.5036	- 7	1.4858
693.81	4.3353	- 5	6.2980	- 2	4.5468	- 7	1.5050
709.69	4.4344	- 5	6.4267	- 2	4.5895	- 7	1.5243
725.75	4.5346	- 5	6.5571	- 2	4.6315	- 7	1.5437
741.90	4.6355	- 5	6.6887	- 2	4.6726	- 7	1.5630
758.10	4.7365	- 5	6.8208	- 2	4.7128	- 7	1.5823
774.25	4.8373	- 5	6.9529	- 2	4.7518	- 7	1.6014
790.31	4.9375	- 5	7.0845	- 2	4.7896	- 7	1.6203
806.19	5.0366	- 5	7.2149	- 2	4.8260	- 7	1.6389
821.84	5.1342	- 5	7.3436	- 2	4.8610	- 7	1.6571
837.19	5.2300	- 5	7.4701	- 2	4.8944	- 7	1.6749
852.17	5.3235	- 5	7.5937	- 2	4.9263	- 7	1.6921
866.73	5.4142	- 5	7.7139	- 2	4.9566	- 7	1.7088
880.79	5.5019	- 5	7.8303	- 2	4.9852	- 7	1.7248
894.31	5.5862	- 5	7.9422	- 2	5.0120	- 7	1.7402
907.22	5.6667	- 5	8.0492	- 2	5.0372	- 7	1.7548
919.47	5.7431	- 5	8.1509	- 2	5.0605	- 7	1.7686
931.01	5.8151	- 5	8.2467	- 2	5.0821	- 7	1.7815
941.79	5.8823	- 5	8.3363	- 2	5.1020	- 7	1.7936
951.77	5.9445	- 5	8.4193	- 2	5.1200	- 7	1.8047
960.90	6.0014	- 5	8.4953	- 2	5.1363	- 7	1.8149
969.14	6.0528	- 5	8.5640	- 2	5.1508	- 7	1.8241
976.47	6.0985	- 5	8.6250	- 2	5.1635	- 7	1.8322
982.85	6.1382	- 5	8.6782	- 2	5.1745	- 7	1.8392
988.25	6.1719	- 5	8.7232	- 2	5.1837	- 7	1.8452
992.65	6.1993	- 5	8.7599	- 2	5.1911	- 7	1.8501
996.03	6.2204	- 5	8.7881	- 2	5.1968	- 7	1.8538
998.38	6.2351	- 5	8.8077	- 2	5.2007	- 7	1.8564
999.69	6.2432	- 5	8.8187	- 2	5.2029	- 7	1.8578

† Gaussian frequencies, interval: 500-1000 kc.

Table 22

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

† f, kc	d = 621 miles $\lvert E_r \rvert$		arg E_r		d = 1000 miles $\lvert E_r \rvert$		arg E_r	
0.030725	7.9832	-11	2.4028		2.2340	-11	1.6697	
0.16175	1.8503	-10	4.3432	- 1	1.1156	-10	4.0535	- 1
0.39689	4.5565	-10	2.7263	- 1	2.6068	-10	3.5192	- 1
0.73521	8.2271	-10	2.4599	- 1	4.5449	-10	3.7562	- 1
1.1753	1.2772	- 9	2.5095	- 1	6.8306	-10	4.1755	- 1
1.7153	1.8089	- 9	2.6718	- 1	9.3739	-10	4.6530	- 1
2.3530	2.4080	- 9	2.8827	- 1	1.2097	- 9	5.1494	- 1
3.0857	3.0649	- 9	3.1166	- 1	1.4934	- 9	5.6489	- 1
3.9103	3.7705	- 9	3.3616	- 1	1.7829	- 9	6.1443	- 1
4.8233	4.5126	- 9	3.6220	- 1	2.0735	- 9	6.6311	- 1
5.8210	5.2907	- 9	3.8692	- 1	2.3617	- 9	7.1093	- 1
6.8991	6.0945	- 9	4.1166	- 1	2.6444	- 9	7.5766	- 1
8.0532	6.9170	- 9	4.3623	- 1	2.9191	- 9	8.0325	- 1
9.2783	7.7522	- 9	4.6054	- 1	3.1840	- 9	8.4766	- 1
10.569	8.5944	- 9	4.8450	- 1	3.4377	- 9	8.9086	- 1
11.921	9.4385	- 9	5.0804	- 1	3.6794	- 9	9.3284	- 1
13.327	1.0280	- 8	5.3111	- 1	3.9083	- 9	9.7361	- 1
14.783	1.1117	- 8	5.5375	- 1	4.1241	- 9	1.0132	
16.281	1.1941	- 8	5.7578	- 1	4.3268	- 9	1.0515	
17.816	1.2751	- 8	5.9725	- 1	4.5163	- 9	1.0886	
19.381	1.3545	- 8	6.1812	- 1	4.6930	- 9	1.1244	
20.969	1.4320	- 8	6.3839	- 1	4.8570	- 9	1.1591	
22.575	1.5074	- 8	6.5804	- 1	5.0089	- 9	1.1925	
24.190	1.5806	- 8	6.7704	- 1	5.1491	- 9	1.2247	
25.810	1.6512	- 8	6.9540	- 1	5.2782	- 9	1.2557	
27.425	1.7194	- 8	7.1309	- 1	5.3967	- 9	1.2854	
29.031	1.7848	- 8	7.3011	- 1	5.5052	- 9	1.3140	
30.619	1.8474	- 8	7.4643	- 1	5.6042	- 9	1.3413	
32.184	1.9072	- 8	7.6207	- 1	5.6945	- 9	1.3673	
33.719	1.9641	- 8	7.7699	- 1	5.7764	- 9	1.3921	
35.217	2.0181	- 8	7.9120	- 1	5.8507	- 9	1.4157	
36.673	2.0691	- 8	8.0468	- 1	5.9178	- 9	1.4380	
38.079	2.1171	- 8	8.1742	- 1	5.9783	- 9	1.4591	
39.431	2.1621	- 8	8.2942	- 1	6.0326	- 9	1.4789	
40.722	2.2041	- 8	8.4068	- 1	6.0812	- 9	1.4974	
41.947	2.2430	- 8	8.5117	- 1	6.1246	- 9	1.5147	
43.101	2.2790	- 8	8.6090	- 1	6.1632	- 9	1.5306	
44.179	2.3119	- 8	8.6986	- 1	6.1972	- 9	1.5453	
45.177	2.3419	- 8	8.7804	- 1	6.2272	- 9	1.5588	
46.090	2.3688	- 8	8.8544	- 1	6.2533	- 9	1.5709	
46.914	2.3929	- 8	8.9205	- 1	6.2758	- 9	1.5817	
47.647	2.4139	- 8	8.9787	- 1	6.2951	- 9	1.5912	
48.285	2.4321	- 8	9.0290	- 1	6.3113	- 9	1.5994	
48.825	2.4473	- 8	9.0713	- 1	6.3246	- 9	1.6063	
49.265	2.4596	- 8	9.1055	- 1	6.3352	- 9	1.6119	
49.603	2.4690	- 8	9.1318	- 1	6.3432	- 9	1.6162	
49.838	2.4755	- 8	9.1499	- 1	6.3486	- 9	1.6192	
49.969	2.4791	- 8	9.1600	- 1	6.3516	- 9	1.6208	

† Gaussian frequencies, interval: 0-50 kc.

Table 23

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

	d = 621 miles				d = 1000 miles			
f, kc †	$\lvert E_r \rvert$		arg E_r		$\lvert E_r \rvert$		arg E_r	
50.277	2.4875	- 8	9.1836	- 1	6.3586	- 9	1.6247	
51.456	2.5195	- 8	9.2736	- 1	6.3844	- 9	1.6393	
53.572	2.5755	- 8	9.4321	- 1	6.4267	- 9	1.6652	
56.617	2.6529	- 8	9.6543	- 1	6.4796	- 9	1.7013	
60.578	2.7483	- 8	9.9335	- 1	6.5357	- 9	1.7466	
65.438	2.8580	- 8	1.0263		6.5877	- 9	1.7998	
71.177	2.9782	- 8	1.0634		6.6291	- 9	1.8598	
77.771	3.1050	- 8	1.1041		6.6547	- 9	1.9254	
85.193	3.2350	- 8	1.1477		6.6610	- 9	1.9954	
93.410	3.3652	- 8	1.1936		6.6462	- 9	2.0690	
102.39	3.4930	- 8	1.2413		6.6098	- 9	2.1454	
112.09	3.6163	- 8	1.2904		6.5525	- 9	2.2239	
122.48	3.7336	- 8	1.3405		6.4758	- 9	2.3038	
133.50	3.8437	- 8	1.3913		6.3820	- 9	2.3848	
145.12	3.9459	- 8	1.4425		6.2734	- 9	2.4663	
157.29	4.0396	- 8	1.4939		6.1526	- 9	2.5480	
169.95	4.1247	- 8	1.5453		6.0220	- 9	2.6296	
183.05	4.2012	- 8	1.5964		5.8843	- 9	2.7108	
196.53	4.2692	- 8	1.6472		5.7414	- 9	2.7915	
210.34	4.3291	- 8	1.6975		5.5956	- 9	2.8712	
224.43	4.3813	- 8	1.7472		5.4486	- 9	2.9500	
238.72	4.4263	- 8	1.7961		5.3018	- 9	3.0275	
253.17	4.4645	- 8	1.8442		5.1567	- 9	3.1037	
267.71	4.4964	- 8	1.8913		5.0142	- 9	3.1783	
282.29	4.5227	- 8	1.9373		4.8754	- 9	3.2512	
296.83	4.5439	- 8	1.9822		4.7410	- 9	3.3223	
311.28	4.5605	- 8	2.0258		4.6115	- 9	3.3914	
325.57	4.5730	- 8	2.0682		4.4874	- 9	3.4583	
339.66	4.5819	- 8	2.1091		4.3690	- 9	3.5231	
353.47	4.5878	- 8	2.1485		4.2566	- 9	3.5855	
366.95	4.5909	- 8	2.1864		4.1503	- 9	3.6454	
380.05	4.5918	- 8	2.2227		4.0502	- 9	3.7027	
392.71	4.5908	- 8	2.2572		3.9564	- 9	3.7573	
404.88	4.5882	- 8	2.2900		3.8689	- 9	3.8091	
416.50	4.5845	- 8	2.3209		3.7876	- 9	3.8580	
427.52	4.5798	- 8	2.3500		3.7126	- 9	3.9039	
437.91	4.5745	- 8	2.3770		3.6436	- 9	3.9467	
447.61	4.5689	- 8	2.4021		3.5807	- 9	3.9863	
456.59	4.5630	- 8	2.4251		3.5238	- 9	4.0227	
464.81	4.5572	- 8	2.4461		3.4728	- 9	4.0557	
472.23	4.5516	- 8	2.4648		3.4275	- 9	4.0854	
478.82	4.5463	- 8	2.4814		3.3879	- 9	4.1116	
484.56	4.5415	- 8	2.4958		3.3540	- 9	4.1342	
489.42	4.5373	- 8	2.5079		3.3256	- 9	4.1534	
493.38	4.5338	- 8	2.5177		3.3027	- 9	4.1689	
496.43	4.5311	- 8	2.5253		3.2853	- 9	4.1808	
498.54	4.5291	- 8	2.5305		3.2732	- 9	4.1891	
499.72	4.5280	- 8	2.5334		3.2665	- 9	4.1937	

† Gaussian frequencies, interval: 50-500 kc.

Table 24

$\sigma = 5$ $\epsilon_2 = 80$ $\alpha = 0.85$

f,† kc	d = 621 miles $\lvert E_r \rvert$		d = 621 miles arg E_r	d = 1000 miles $\lvert E_r \rvert$		d = 1000 miles arg E_r
500.31	4.5275	- 8	2.5349	3.2632	- 9	4.1960
501.62	4.5262	- 8	2.5381	3.2558	- 9	4.2011
503.97	4.5240	- 8	2.5439	3.2425	- 9	4.2102
507.35	4.5208	- 8	2.5522	3.2236	- 9	4.2233
511.75	4.5165	- 8	2.5630	3.1992	- 9	4.2404
517.15	4.5111	- 8	2.5762	3.1696	- 9	4.2612
523.53	4.5045	- 8	2.5917	3.1352	- 9	4.2857
530.86	4.4968	- 8	2.6094	3.0962	- 9	4.3137
539.10	4.4879	- 8	2.6293	3.0530	- 9	4.3450
548.23	4.4776	- 8	2.6511	3.0062	- 9	4.3795
558.21	4.4661	- 8	2.6748	2.9562	- 9	4.4170
568.99	4.4533	- 8	2.7003	2.9033	- 9	4.4572
580.53	4.4392	- 8	2.7274	2.8482	- 9	4.5000
592.78	4.4238	- 8	2.7560	2.7911	- 9	4.5450
605.69	4.4072	- 8	2.7858	2.7327	- 9	4.5922
619.21	4.3893	- 8	2.8168	2.6732	- 9	4.6411
633.27	4.3703	- 8	2.8489	2.6132	- 9	4.6917
647.83	4.3502	- 8	2.8818	2.5529	- 9	4.7436
662.81	4.3291	- 8	2.9154	2.4929	- 9	4.7967
678.16	4.3072	- 8	2.9496	2.4333	- 9	4.8506
693.81	4.2844	- 8	2.9842	2.3744	- 9	4.9052
709.69	4.2610	- 8	3.0191	2.3166	- 9	4.9602
725.75	4.2371	- 8	3.0541	2.2601	- 9	5.0154
741.90	4.2128	- 8	3.0890	2.2051	- 9	5.0705
758.10	4.1882	- 8	3.1238	2.1517	- 9	5.1254
774.25	4.1635	- 8	3.1583	2.1001	- 9	5.1798
790.31	4.1387	- 8	3.1924	2.0505	- 9	5.2335
806.19	4.1141	- 8	3.2259	2.0029	- 9	5.2863
821.84	4.0898	- 8	3.2587	1.9575	- 9	5.3381
837.19	4.0658	- 8	3.2907	1.9142	- 9	5.3885
852.17	4.0424	- 8	3.3218	1.8732	- 9	5.4375
866.73	4.0196	- 8	3.3518	1.8344	- 9	5.4849
880.79	3.9975	- 8	3.3807	1.7979	- 9	5.5304
894.31	3.9762	- 8	3.4084	1.7638	- 9	5.5740
907.22	3.9560	- 8	3.4347	1.7319	- 9	5.6154
919.47	3.9367	- 8	3.4595	1.7024	- 9	5.6546
931.01	3.9186	- 8	3.4828	1.6752	- 9	5.6913
941.79	3.9016	- 8	3.5046	1.6503	- 9	5.7256
951.77	3.8860	- 8	3.5246	1.6277	- 9	5.7572
960.90	3.8717	- 8	3.5429	1.6073	- 9	5.7860
969.14	3.8587	- 8	3.5594	1.5892	- 9	5.8119
976.47	3.8473	- 8	3.5740	1.5734	- 9	5.8350
982.85	3.8373	- 8	3.5867	1.5597	- 9	5.8549
988.25	3.8288	- 8	3.5974	1.5483	- 9	5.8719
992.65	3.8220	- 8	3.6061	1.5391	- 9	5.8856
996.03	3.8167	- 8	3.6128	1.5320	- 9	5.8962
998.38	3.8130	- 8	3.6175	1.5271	- 9	5.9035
999.69	3.8110	- 8	3.6201	1.5244	- 9	5.9076

Table 25

f = 153.5 kc

d, miles	σ = 0.001, ϵ_2 = 15, α^2 = 0.75 $\lvert E_r \rvert$		arg E_r		σ = 0.002, ϵ_2 = 15, α^2 = 0.75 $\lvert E_r \rvert$		arg E_r	
50	1.33	- 6	1.75		1.80	- 6	1.32	
60	1.00	- 6	1.90		1.41	- 6	1.45	
70	7.77	- 7	2.04		1.15	- 6	1.56	
80	6.17	- 7	2.17		9.48	- 7	1.67	
100	4.08	- 7	2.39		6.77	- 7	1.86	
200	8.68	- 8	3.22		1.91	- 7	2.66	
300	2.77	- 8	3.87		7.23	- 8	3.34	
400	1.06	- 8	4.49		3.09	- 8	3.98	
500	4.44	- 9	5.12		1.42	- 8	4.61	
600	1.94	- 9	5.77		6.74	- 9	5.24	
	σ = 0.003, ϵ_2 = 15, α^2 = 0.75				σ = 0.004, ϵ_2 = 15, α^2 = 0.75			
50	1.96	- 6	1.10		2.04	- 6	9.62	- 1
60	1.56	- 6	1.21		1.65	- 6	1.06	
70	1.29	- 6	1.31		1.36	- 6	1.15	
80	1.08	- 6	1.40		1.15	- 6	1.24	
100	7.93	- 6	1.58		8.60	- 7	1.40	
200	2.57	- 7	2.34		2.99	- 7	2.11	
300	1.10	- 7	3.02		1.36	- 7	2.75	
400	5.23	- 8	3.67		6.84	- 8	3.38	
500	2.63	- 8	4.32		3.63	- 8	4.01	
600	1.37	- 8	4.97		1.98	- 8	4.63	
	σ = 0.005, ϵ_2 = 15, α^2 = 0.75				σ = 0.006, ϵ_2 = 15, α^2 = 0.75			
50	2.10	- 6	8.68	- 1	2.133	- 6	7.983	- 1
60	1.70	- 6	9.57	- 1	1.732	- 6	8.810	- 1
70	1.41	- 6	1.04		1.447	- 6	9.591	- 1
80	1.20	- 6	1.12		1.233	- 6	1.034	
100	9.04	- 7	1.27		9.338	- 7	1.175	
200	3.27	- 7	1.94		3.479	- 7	1.806	
300	1.55	- 7	2.55		1.684	- 7	2.393	
400	8.06	- 8	3.15		8.987	- 8	2.971	
500	4.42	- 8	3.75		5.033	- 8	3.548	
600	2.49	- 8	4.35		2.896	- 8	4.127	

Table 26

f = 153.5 kc

d, miles	$\sigma = 0.007$, $\epsilon_2 = 15$, $\alpha^2 = 0.75$ $\lvert E_r \rvert$	$\arg E_r$	$\sigma = 0.01$, $\epsilon_2 = 15$, $\alpha^2 = 0.75$ $\lvert E_r \rvert$	$\arg E_r$
50	2.159 - 6	7.436 - 1	2.208 - 6	6.310 - 1
60	1.758 - 6	8.213 - 1	1.805 - 6	6.983 - 1
70	1.471 - 6	8.948 - 1	1.517 - 6	7.623 - 1
80	1.257 - 6	9.652 - 1	1.300 - 6	8.238 - 1
100	9.559 - 7	1.099	9.968 - 7	9.415 - 1
200	3.634 - 7	1.701	3.925 - 7	1.480
300	1.790 - 7	2.265	1.995 - 7	1.995
400	9.711 - 8	2.823	1.114 - 7	2.507
500	5.522 - 8	3.381	6.507 - 8	3.021
600	3.224 - 8	3.941	3.899 - 8	3.538
	$\sigma = 0.02$, $\epsilon_2 = 15$, $\alpha^2 = 0.75$		$\sigma = 5$, $\epsilon_2 = 80$, $\alpha^2 = 0.75$	
50	2.2647 - 6	4.5998 - 1	2.3175995 - 6	6.8680500 - 2
60	1.8599 - 6	5.1114 - 1	1.9110039 - 6	8.2034550 - 2
70	1.5699 - 6	5.6030 - 1	1.6192783 - 6	9.6247370 - 2
80	1.3518 - 6	6.0798 - 1	1.3994859 - 6	1.1121350 - 1
100	1.0453 - 6	7.0025 - 1	1.0897548 - 6	1.4312537 - 1
200	4.2808 - 7	1.1372	4.5842073 - 7	3.3207809 - 1
300	2.2518 - 7	1.5678	2.4498846 - 7	5.5295098 - 1
400	1.2960 - 7	2.0028	1.4212180 - 7	7.9135687 - 1
500	7.7860 - 8	2.4423	8.5620686 - 8	1.0387779
600	4.7913 - 8	2.8847	5.2676120 - 8	1.2903433
	$\sigma = 0.005$, $\epsilon_2 = 15$, $\alpha^2 = 0.85$			
50	2.09 - 6	8.74 - 1		
60	1.69 - 6	9.65 - 1		
70	1.40 - 6	1.05		
80	1.19 - 6	1.13		
100	8.94 - 7	1.29		
200	3.18 - 7	1.98		
300	1.47 - 7	2.63		
400	7.47 - 8	3.27		
500	3.98 - 8	3.92		
600	2.18 - 8	4.56		

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer. Concreting Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

• Office of Basic Instrumentation.

• Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Research. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation Obstacles Engineering. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Ultra High Frequency and Super High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.


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