CHAPTER V

CONCLUSION

The purpose of this thesis is to study and analyse the radiation fields of a hollow cylindrical antenna. The current distribution along the hollow cylindrical antenna is assumed to be sinusoidal. Then the radiation field expressions are developed by approximation approach and are checked by a series of experiments. A thin cylindrical antenna is also designed and constructed to compare its field patterns with those of a hollow cylindrical antenna.

From the experiments, it is found that the field patterns obtained are in good agreement with those obtained from theory. And the field patterns of a thin cylindrical antenna are nearly the same as those of a hollow cylindrical antenna. So, it might be conclude that the radiation field expressions derived are satisfy and its field patterns are independent of the diameter. The results from this thesis is useful for any work that a hollow cylindrical antenna is desired. And the theory developed may serve as a potential guidance for further study.

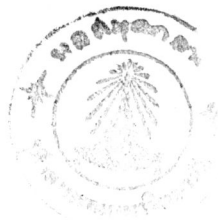
APPENDIX A.

Computer Program for Theoretical Analysis of a Thin Cylindrical Antenna

This program is run by the computer NEAC-SERIES 2200 which was installed at Computer Science Center.

```
FORTRAN     200        SOURCE LISTING AND DIAGNOSTICS                    PROGR

      C      PROGRAM SOLVING THE FIELDS OF A THIN HOLLOW CYLINDRICAL ANT
      C      EAI = FIELD STRENGTH OF THE ANTENNA
      C      Y   = MAXIMUM VALUE OF THE FIELD
      C      XY = NORMALIZE VALUE OF THE FIELD
001           DIMENSION EA1(181),XY(181)
002           ID=1
003         5 WRITE(3,15)
004        15 FORMAT(1H1,10X,6HDEGREE,10X,5HVALUE, 8X,10HNORMALIZE ,/)
005           A=0
006           I=0
007           GO TO (10,20,70),ID
010        10 X=A*3.1416/180.
011           I=I+1
012           AE01=3.1416*COS(X)
013           E02=(1.+COS(AE01))/SIN(X)
014           EA1(I)=E02
015           IF(A.EQ.360.)GO TO 40
016           A=A+2.
017           GO TO 10
020        20 X=A*3.1416/180.
021           I=I+1
022           AE02 = 0.838*3.1416*COS(X)
023           E04 =(0.97235+COS(AE02))/SIN(X)
024           EA1(I)=E04
025           IF(A.EQ.360.)GO TO 40
026           A=A+2.
027           GO TO 20
030        40 Y=EA1(46)
031           NN=0
032           DO45N=1,181
033           XY(N)=EA1(N)/Y
034           WRITE(3,35)   NN,EA1(N),XY(N)
035        35 FORMAT(I14,2F17.6)
036           NN=NN+2
037        45 CONTINUE
040            ID=ID+1
041           GO TO 5
042        70 STOP
043           END
```



1. Field Pattern of the Thin Cylindrical Antenna from Theory at Frequency = 150 MHz.

DEGREE	VALUE	NORMALIZE
0*	.9999999999E+99*	.5000000000E+99
2	.000052	.000026
4	.000419	.000209
6	.001416	.000708
8	.003356	.001678
10	.006556	.003278
12	.011327	.005664
14	.017983	.008991
16	.026831	.013415
18	.038176	.019088
20	.052316	.026158
22	.069540	.034770
24	.090124	.045062
26	.114331	.057165
28	.142400	.071200
30	.174548	.087274
32	.210960	.105480
34	.251789	.125895
36	.297144	.148572
38	.347088	.173544
40	.401630	.200815
42	.460721	.230360
44	.524249	.262124
46	.592031	.296016
48	.663814	.331907
50	.739268	.369634
52	.817986	.408993
54	.899483	.449742
56	.983201	.491600
58	1.068507	.534253
60	1.154702	.577351
62	1.241028	.620514
64	1.326675	.663338
66	1.410794	.705397
68	1.492507	.746253
70	1.570925	.785462
72	1.645159	.822579
74	1.714339	.857169
76	1.777629	.888815
78	1.834245	.917123
80	1.883469	.941735
82	1.924664	.962332
84	1.957289	.978644
86	1.980911	.990455
88	1.995212	.997606
90	2.000000	1.000000
92	1.995210	.997605
94	1.980907	.990453
96	1.957283	.978641
98	1.924656	.962328
100	1.883460	.941730
102	1.834234	.917117
104	1.777617	.888808
106	1.714325	.857162
108	1.645143	.822572
110	1.570908	.785454
112	1.492490	.746245
114	1.410776	.705388
116	1.326658	.663329

118	1.241010	.620505
120	1.154684	.577342
122	1.068489	.534244
124	.983183	.491592
126	.899466	.449733
128	.817969	.408984
130	.739252	.369626
132	.663799	.331899
134	.592017	.296008
136	.524235	.262117
138	.460708	.230354
140	.401618	.200809
142	.347077	.173538
144	.297134	.148567
146	.251780	.125890
148	.210952	.105476
150	.174540	.087270
152	.142394	.071197
154	.114325	.057163
156	.090120	.045060
158	.069536	.034768
160	.052312	.026156
162	.038173	.019086
164	.026828	.013414
166	.017981	.008991
168	.011326	.005663
170	.006555	.003278
172	.003356	.001678
174	.001415	.000708
176	.000419	.000209
178	.000052	.000026
180	-.000004	-.000002
182	-.000052	-.000026
184	-.000419	-.000210
186	-.001416	-.000708
188	-.003357	-.001678
190	-.006557	-.003278
192	-.011329	-.005664
194	-.017984	-.008992
196	-.026833	-.013416
198	-.038178	-.019089
200	-.052319	-.026159
202	-.069544	-.034772
204	-.090129	-.045065
206	-.114336	-.057168
208	-.142406	-.071203
210	-.174555	-.087277
212	-.210969	-.105484
214	-.251798	-.125899
216	-.297154	-.148577
218	-.347099	-.173549
220	-.401642	-.200821
222	-.460734	-.230367
224	-.524263	-.262131
226	-.592046	-.296023
228	-.663830	-.331915
230	-.739284	-.369642
232	-.818003	-.409001
234	-.899501	-.449750
236	-.983219	-.491609
238	-1.068525	-.534263

240	-1.154721	-.577360
242	-1.241047	-.620523
244	-1.326693	-.663347
246	-1.410811	-.705406
248	-1.492524	-.746262
250	-1.570941	-.785470
252	-1.645174	-.822587
254	-1.714353	-.857176
256	-1.777642	-.888821
258	-1.834257	-.917128
260	-1.883479	-.941739
262	-1.924672	-.962336
264	-1.957295	-.978647
266	-1.980915	-.990457
268	-1.995214	-.997607
270	-2.000000	-1.000000
272	-1.995208	-.997604
274	-1.980903	-.990451
276	-1.957277	-.978639
278	-1.924648	-.962324
280	-1.883450	-.941725
282	-1.834223	-.917112
284	-1.777604	-.888802
286	-1.714311	-.857155
288	-1.645128	-.822564
290	-1.570892	-.785446
292	-1.492473	-.746237
294	-1.410759	-.705379
296	-1.326640	-.663320
298	-1.240992	-.620496
300	-1.154666	-.577333
302	-1.068471	-.534235
304	-.983165	-.491583
306	-.899448	-.449724
308	-.817952	-.408976
310	-.739236	-.369618
312	-.663783	-.331892
314	-.592002	-.296001
316	-.524221	-.262111
318	-.460695	-.230348
320	-.401606	-.200803
322	-.347066	-.173533
324	-.297124	-.148562
326	-.251771	-.125886
328	-.210944	-.105472
330	-.174533	-.087267
332	-.142387	-.071194
334	-.114320	-.057160
336	-.090115	-.045057
338	-.069532	-.034766
340	-.052309	-.026154
342	-.038170	-.019085
344	-.026826	-.013413
346	-.017979	-.008990
348	-.011325	-.005663
350	-.006554	-.003277
352	-.003355	-.001678
354	-.001415	-.000707
356	-.000419	-.000209
358	-.000052	-.000026
360	.000002	.000001

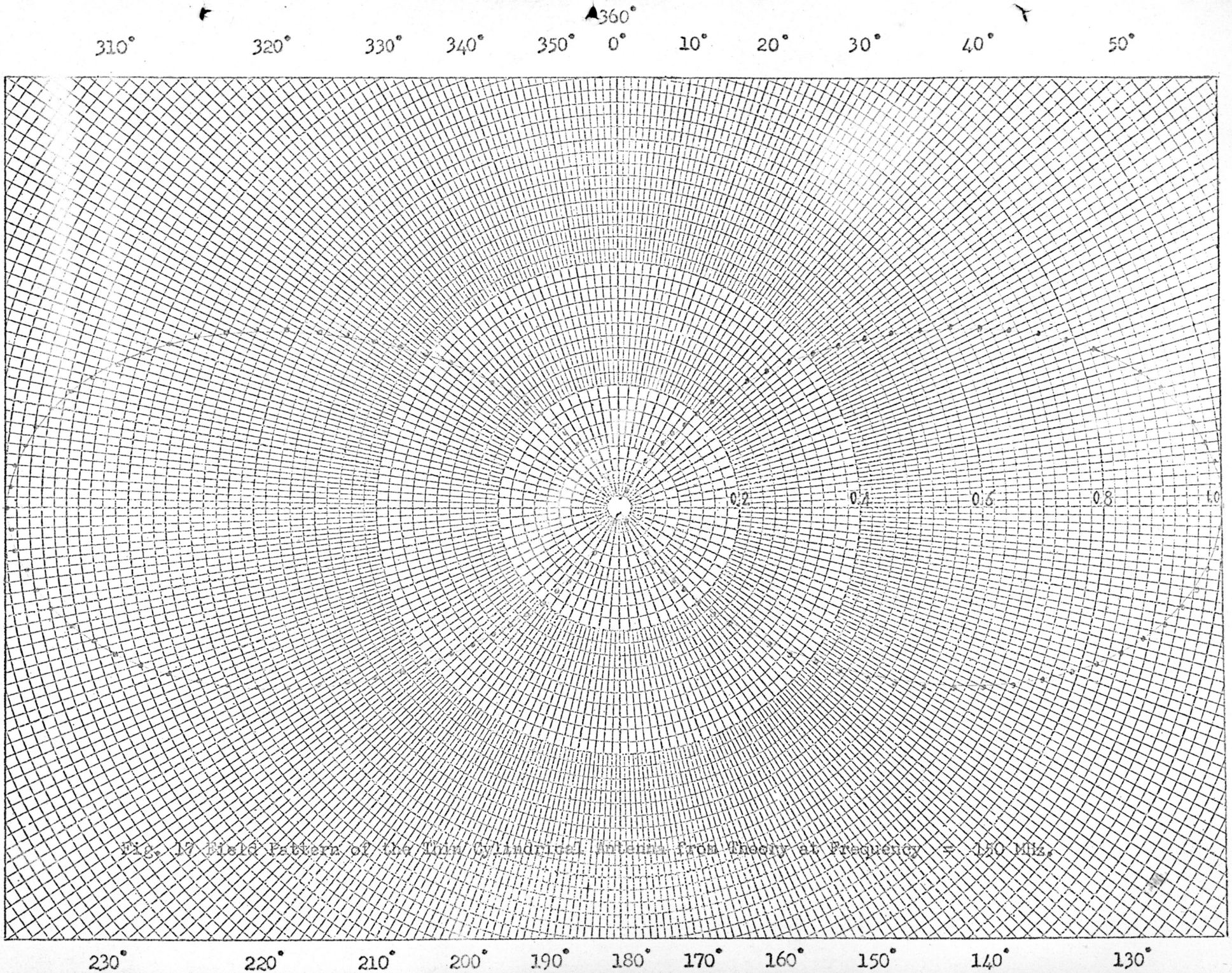


Fig. 17 Field Pattern of the Thin Cylindrical Antenna from Theory at Frequency = 150 MHz.

2. Field Pattern of the Thin Cylindrical Antenna from Theory at Frequency = 126 MHz.

DEGREE	VALUE	NORMALIZE
0*	.9999999999E+99*	.5070094050E+99
2	2.861556	1.450836
4	1.465484	.743014
6	1.016010	.515127
8	.803699	.407483
10	.686822	.348225
12	.618266	.313467
14	.577945	.293024
16	.555902	.281848
18	.546677	.277170
20	.547051	.277360
22	.555023	.281402
24	.569290	.288636
26	.588976	.298616
28	.613467	.311034
30	.642316	.325660
32	.675182	.342324
34	.711788	.360883
36	.751894	.381217
38	.795278	.403213
40	.841719	.426759
42	.890990	.451740
44	.942847	.478032
46	.997027	.505502
48	1.053241	.534003
50	1.111170	.563374
52	1.170469	.593439
54	1.230763	.624008
56	1.291648	.654878
58	1.352694	.685829
60	1.413448	.716632
62	1.473439	.747047
64	1.532177	.776828
66	1.589167	.805723
68	1.643910	.833478
70	1.695908	.859841
72	1.744677	.884567
74	1.789747	.907419
76	1.830676	.928170
78	1.867054	.946614
80	1.898506	.962561
82	1.924708	.975845
84	1.945383	.986327
86	1.960311	.993896
88	1.969332	.998470
90	1.972350	1.000000
92	1.969331	.998469
94	1.960308	.993895
96	1.945379	.986326
98	1.924703	.975843
100	1.898500	.962558
102	1.867046	.946610
104	1.830668	.928166
106	1.789738	.907414
108	1.744667	.884562
110	1.695898	.859836
112	1.643899	.833472
114	1.589156	.805717
116	1.532165	.776822

118	1.473426	.747041
120	1.413436	.716625
122	1.352681	.685822
124	1.291635	.654871
126	1.230750	.624002
128	1.170456	.593432
130	1.111158	.563367
132	1.053229	.533997
134	.997016	.505496
136	.942836	.478027
138	.890979	.451735
140	.841709	.426754
142	.795268	.403208
144	.751885	.381213
146	.711780	.360879
148	.675174	.342320
150	.642309	.325657
152	.613461	.311031
154	.588972	.298614
156	.569287	.288634
158	.555021	.281401
160	.547051	.277360
162	.546678	.277171
164	.555905	.281849
166	.577952	.293027
168	.618277	.313472
170	.686841	.348235
172	.803731	.407499
174	1.016071	.515158
176	1.465628	.743087
178	2.862148	1.451136
180	-13487.518296	-6838.298626
182	-2.860963	-1.450535
184	-1.465339	-.742941
186	-1.015948	-.515095
188	-.803666	-.407466
190	-.686804	-.348216
192	-.618255	-.313461
194	-.577939	-.293020
196	-.555899	-.281846
198	-.546676	-.277170
200	-.547052	-.277361
202	-.555025	-.281403
204	-.569294	-.288637
206	-.588981	-.298619
208	-.613473	-.311036
210	-.642322	-.325664
212	-.675189	-.342327
214	-.711796	-.360887
216	-.751903	-.381222
218	-.795287	-.403218
220	-.841729	-.426764
222	-.891000	-.451746
224	-.942858	-.478038
226	-.997039	-.505508
228	-1.053253	-.534009
230	-1.111182	-.563380
232	-1.170482	-.593445
234	-1.230776	-.624015
236	-1.291661	-.654884
238	-1.352707	-.685835

240	-1.413461	-.716638
242	-1.473451	-.747054
244	-1.532189	-.776834
246	-1.589179	-.805729
248	-1.643921	-.833483
250	-1.695919	-.859847
252	-1.744687	-.884573
254	-1.789756	-.907423
256	-1.830685	-.928174
258	-1.867061	-.946617
260	-1.898512	-.962564
262	-1.924713	-.975848
264	-1.945387	-.986329
266	-1.960314	-.993897
268	-1.969334	-.998471
270	-1.972350	-1.000000
272	-1.969330	-.998469
274	-1.960306	-.993894
276	-1.945375	-.986324
278	-1.924698	-.975840
280	-1.898494	-.962554
282	-1.867039	-.946606
284	-1.830660	-.928162
286	-1.789729	-.907409
288	-1.744657	-.884557
290	-1.695887	-.859831
292	-1.643887	-.833466
294	-1.589144	-.805711
296	-1.532153	-.776816
298	-1.473413	-.747034
300	-1.413423	-.716619
302	-1.352668	-.685816
304	-1.291622	-.654865
306	-1.230737	-.623995
308	-1.170444	-.593426
310	-1.111145	-.563361
312	-1.053217	-.533991
314	-.997004	-.505490
316	-.942825	-.478021
318	-.890968	-.451729
320	-.841699	-.426749
322	-.795259	-.403204
324	-.751876	-.381208
326	-.711772	-.360875
328	-.675167	-.342316
330	-.642303	-.325654
332	-.613456	-.311028
334	-.588967	-.298612
336	-.569283	-.288632
338	-.555018	-.281399
340	-.547050	-.277359
342	-.546679	-.277171
344	-.555908	-.281851
346	-.577958	-.293030
348	-.618288	-.313478
350	-.686859	-.348244
352	-.803763	-.407515
354	-1.016133	-.515189
356	-1.465773	-.743160
358	-2.862741	-1.451437
360	6743.776458	3419.158090

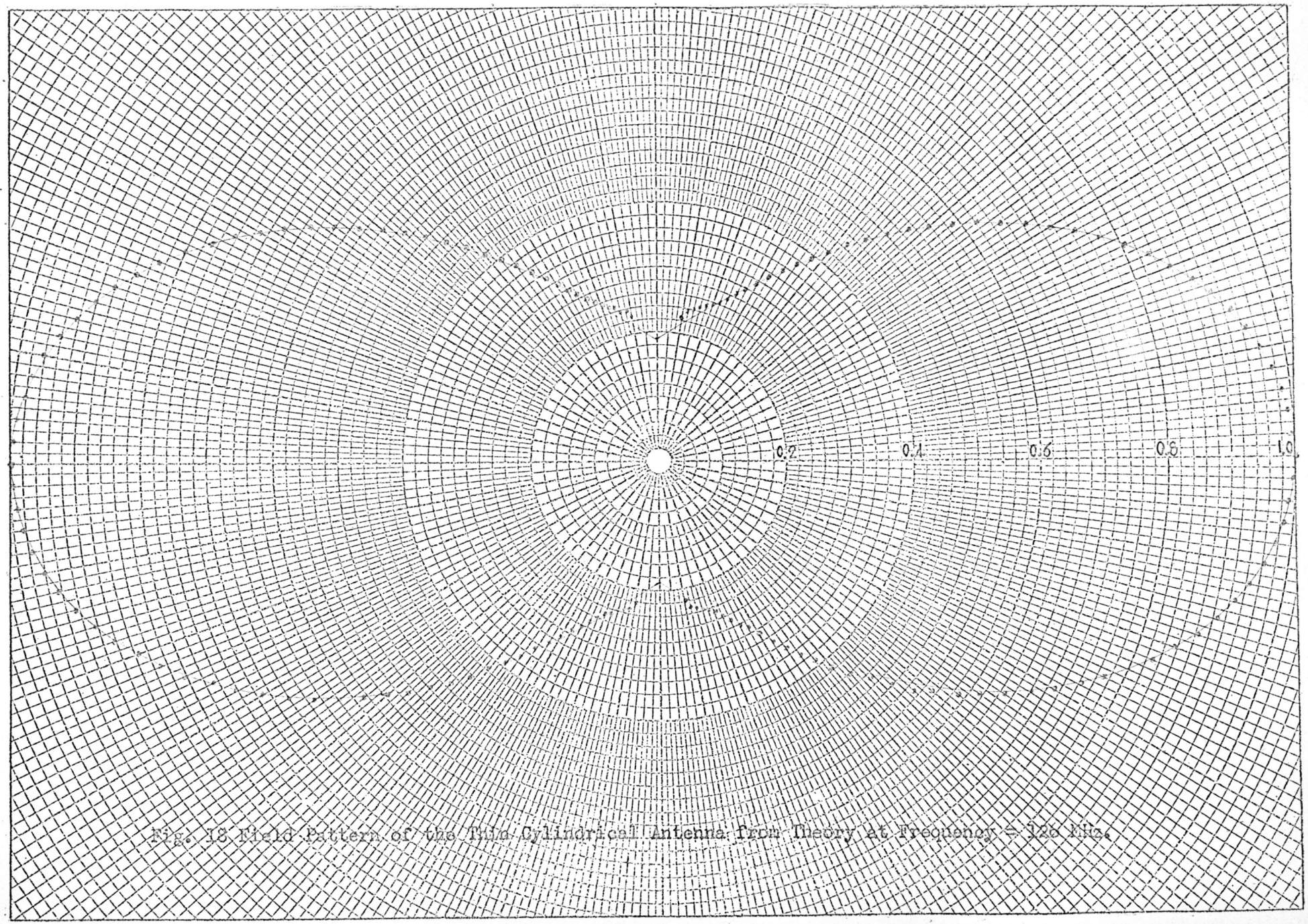


Fig. 18 Field Pattern of the Thin Cylindrical Antenna from Theory at Frequency = 126 Mhz.

APPENDIX B.

Field Pattern Measurements of a Thin Cylindrical Antenna

The thin cylindrical antenna used is made of brass with its length = 100 centimeters and 1.3 centimeters in diameter. The experiment set up is the same as those when the field patterns of the hollow cylindrical antenna are measured. And it is measured at the same surrounding as when the hollow cylindrical antenna field patterns are measured. The results are recorded in the following tables.

1. Field Pattern of the Thin Cylindrical Antenna from Experiments at Frequency = 150 MHz.

FREQUENCY = 150 MHZ

SENDING POWER = 0.85 WATTS

REFLECTION = 0.10 WATTS

DEGREES	FIELD STRENGTH (μV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
0	21	24	25	23	0.17
5	21	25	23	23	0.17
10	23	28	28	26	0.19
15	25	28	30	28	0.21
20	27	30	30	29	0.21
25	30	35	35	33	0.24
30	35	40	45	40	0.29
35	45	50	52	49	0.36
40	54	58	60	57	0.42
45	60	72	72	68	0.50
50	78	85	80	81	0.60
55	85	98	90	91	0.67
60	100	110	105	105	0.77
65	115	118	114	116	0.85
70	120	125	120	122	0.90
75	130	130	130	130	0.96
80	130	136	131	132	0.97
85	133	137	133	134	0.99
90	135	139	134	136	1.00
95	130	138	130	133	0.98

FREQUENCY = 150 MHZ.

SENDING POWER = 0.85 WATTS

REFLECTION = 0.10 WATTS

DEGREES	FIELD STRENGTH(μV)				NORMALIZED VALUE
	1	2	3	AVERAGE	
100	135	135	130	133	0.98
105	130	132	125	129	0.95
110	120	130	120	123	0.90
115	110	120	118	116	0.85
120	108	110	110	109	0.80
125	100	105	102	102	0.75
130	95	100	100	98	0.72
135	85	80	80	82	0.60
140	72	75	70	72	0.53
145	67	70	67	68	0.50
150	60	65	58	61	0.45
155	50	60	51	54	0.40
160	40	50	45	45	0.33
165	35	40	38	38	0.28
170	27	30	30	29	0.21
175	25	25	28	26	0.19
180	24	25	25	25	0.18
185	25	27	26	26	0.19
190	30	32	30	31	0.23
195	40	45	35	40	0.29

FREQUENCY = 150 MHZ.

SENDING POWER = 0.85 WATTS

REFLECTION = 0.10 WATTS

DEGREES	FIELD STRENGTH(μV)				NORMALIZED VALUE
	1	2	3	AVERAGE	
200	48	55	45	49	0.36
205	60	60	54	58	0.43
210	65	65	62	64	0.47
215	70	70	70	70	0.51
220	77	80	77	78	0.57
225	85	88	84	86	0.63
230	95	95	90	93	0.68
235	100	100	98	99	0.73
240	105	110	105	107	0.79
245	115	115	112	114	0.84
250	122	125	119	122	0.90
255	125	128	125	126	0.93
260	130	130	128	129	0.95
265	130	135	130	132	0.97
270	133	137	135	135	0.99
275	133	136	132	134	0.99
280	130	130	129	130	0.96
285	126	125	126	126	0.93
290	125	124	124	124	0.91
295	120	120	120	120	0.88

FREQUENCY = 150 MHZ.

SENDING POWER = 0.85 WATTS

REFLECTION = 0.10 WATTS

DEGREES	FIELD STRENGTH (μV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
300	110	115	108	111	0.82
305	100	108	105	104	0.76
310	95	95	98	96	0.71
315	82	80	75	79	0.58
320	75	70	68	71	0.52
325	65	55	62	61	0.45
330	54	50	55	53	0.39
335	46	48	48	47	0.35
340	45	48	40	44	0.32
345	40	40	36	39	0.29
350	30	35	35	33	0.24
355	28	30	32	30	0.22
360	25	28	30	28	0.21

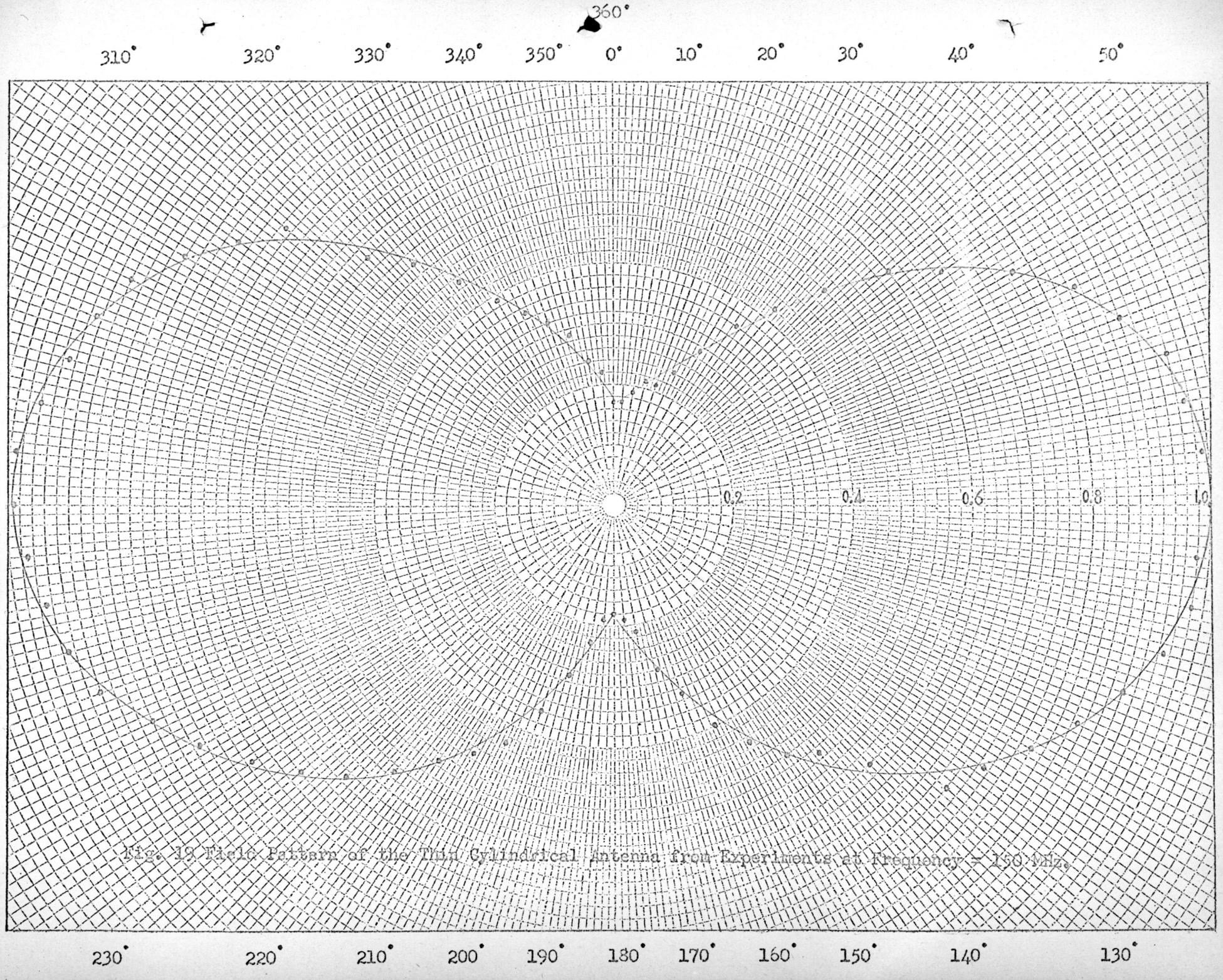


Fig. 19 Field Pattern of the Thin Cylindrical Antenna from Experiments at Frequency = 150 MHz.

2. Field Pattern of a Thin Cylindrical Antenna from Expriments at Frequency = 126 MHz.

FREQUENCY = 126 MHZ

SENDING POWER = 0.78 WATTS

REFLECTION = 0.13 WATTS

DEGREES	FIELD STRENGTH(μV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
0	15	14	15	15	0.25
5	17	15	16	16	0.26
10	19	20	16	18	0.30
15	20	20	18	19	0.31
20	22	22	20	21	0.34
25	25	24	25	25	0.41
30	25	26	26	26	0.43
35	28	30	28	29	0.48
40	31	34	35	33	0.54
45	35	36	36	36	0.59
50	40	40	42	41	0.67
55	46	42	45	44	0.72
60	50	50	46	49	0.80
65	55	55	50	53	0.87
70	57	55	55	56	0.92
75	60	57	57	58	0.95
80	62	58	58	59	0.97
85	62	59	59	60	0.98
90	63	59	60	61	1.00
95	60	58	57	58	0.95

FREQUENCY = 126 MHZ.

SENDING POWER = 0.78 WATTS

REFLECTION = 0.13 WATTS

DEGREES	FIELD STRENGTH(mV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
100	60	58	57	58	0.95
105	59	55	56	57	0.93
110	56	55	55	55	0.90
115	52	50	50	51	0.84
120	48	45	45	46	0.75
125	45	42	42	43	0.70
130	40	39	40	40	0.66
135	38	36	35	36	0.59
140	35	33	33	34	0.56
145	33	30	30	31	0.51
150	28	27	25	27	0.44
155	24	24	24	24	0.39
160	22	22	22	22	0.36
165	19	19	18	19	0.31
170	19	18	17	18	0.30
175	18	17	17	17	0.28
180	17	16	15	16	0.26
185	18	17	16	17	0.28
190	18	19	19	19	0.31
195	20	20	20	20	0.33

FREQUENCY = 126 MHZ.

SENDING POWER = 0.78 WATTS

REFLECTION = 0.13 WATTS

DEGREES	FIELD STRENGTH(μV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
200	22	23	25	23	0.38
205	26	26	26	26	0.43
210	30	28	28	29	0.48
215	34	31	30	32	0.52
220	36	34	35	35	0.57
225	40	37	37	38	0.62
230	42	41	40	41	0.67
235	45	44	45	45	0.74
240	48	46	46	47	0.77
245	50	49	49	49	0.80
250	54	52	52	53	0.87
255	55	54	54	54	0.89
260	57	54	57	56	0.92
265	57	57	58	57	0.93
270	58	58	60	59	0.97
275	58	57	59	58	0.95
280	56	56	58	57	0.93
285	55	55	56	55	0.90
290	54	53	55	54	0.89
295	52	50	59	54	0.89

FREQUENCY = 126 MHZ.

SENDING POWER = 0.78 WATTS

REFLECTION = 0.13 WATTS

DEGREES	FIELD STRENGTH(μV)				NORMALIZED
	1	2	3	AVERAGE	VALUE
300	50	48	48	49	0.80
305	48	45	45	46	0.75
310	45	41	40	42	0.69
315	40	38	38	39	0.64
320	35	35	35	35	0.57
325	32	32	30	31	0.51
330	30	29	29	29	0.48
335	25	25	25	25	0.41
340	23	23	23	23	0.38
345	20	21	20	20	0.33
350	19	19	19	19	0.31
355	18	17	19	18	0.30
360	16	16	17	16	0.26

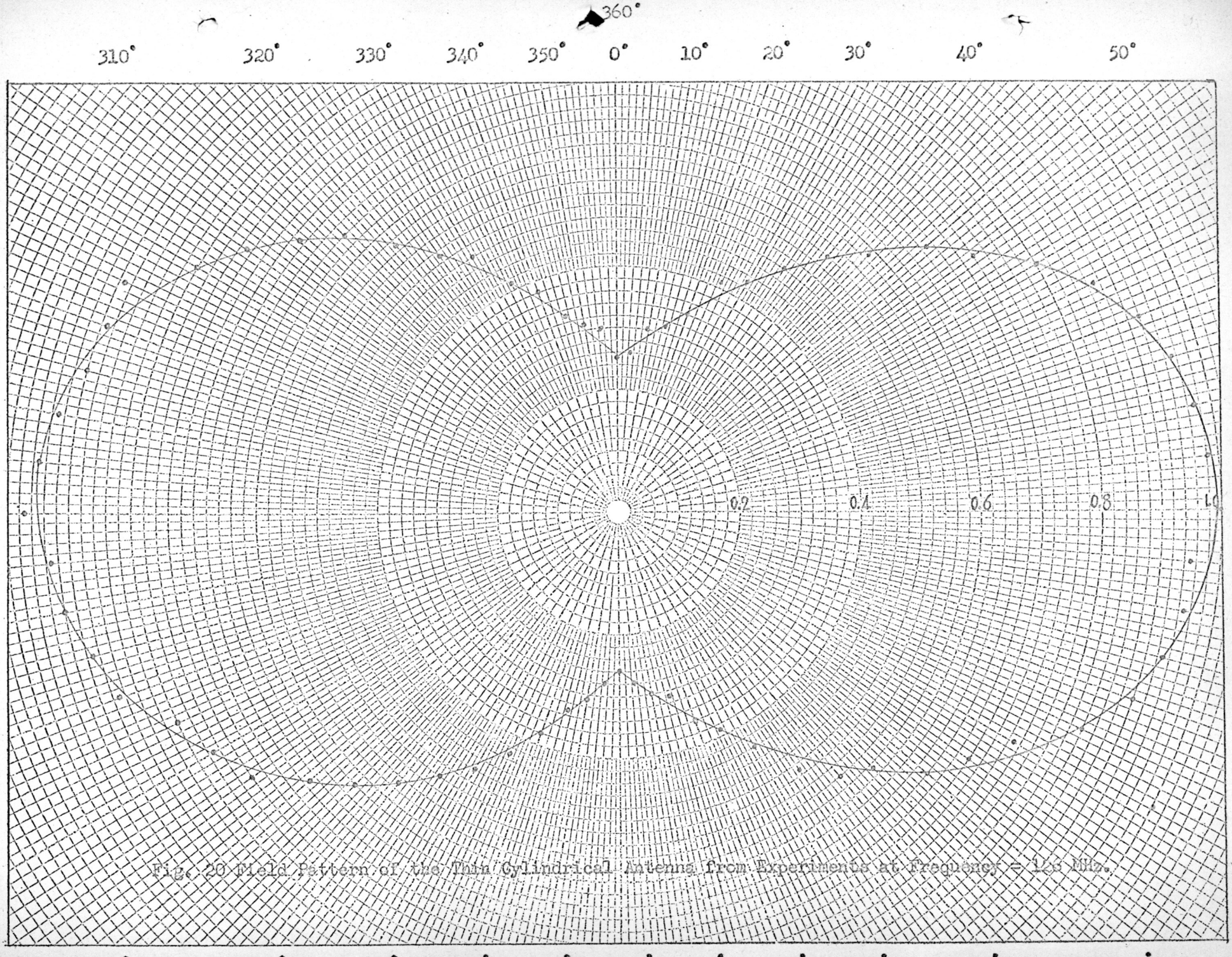


Fig. 20 Field Pattern of the Thin Cylindrical Antenna from Experiments at Frequency = 1.6 Mhz.