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**SUBJECT**

ANTENNAS FOR GUIDED MISSILES COUNTERMEASURES

ON DESTROYER ESCORTS

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6 March 1944

NRL Report No. R-2240

NAVY DEPARTMENT

Report on

ANTENNAS FOR GUIDED MISSILES  
COUNTERMEASURES ON DESTROYER ESCORTS



NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D. C.

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INDEX

Subject	Page
INTRODUCTION . . . . .	1
METHODS . . . . .	2
DATA OBTAINED . . . . .	5
CONCLUSIONS AND RECOMMENDATIONS . . . . .	7

Figures 1 - 39

APPENDIX

- Drawings:  
RA 66F 264B  
RA 66F 266A  
RA 66F 267A

INTRODUCTION

1. The work reported here was carried out under the authorization of NRL Problem No. S444.1R-S, priority AAA.

2. The problem was to determine designs and locations for antennas on board ship for use with countermeasures equipment against guided missiles. The requirements called for separate antennas for transmitting and receiving. The frequency range considered essential was 17-55 Mc/s, with coverage over the band 15-60 Mc/s considered desirable. Operation on both horizontal and vertical polarization was also desired. Separate transmitting and receiving antenna systems were demanded by the nature of the equipment used with the antennas. For the transmitting antenna system the standing-wave-ratio on a 50-ohm transmission line was to be not greater than 2:1, while for the receiving antenna system, a standing-wave-ratio up to 5:1 could be tolerated. For the receiving antenna, moreover, either 50 or 70-ohm line could be used. It was considered that designs would be required for DE's and DD's, and possibly also CL's. Information on the DE was needed immediately.

3. On 23 November 1943, antenna experts made available by NDRC accompanied NRL and BuShips personnel in an inspection at the New York Navy Yard of ships of the DE, DD and CL classes. This inspection was for the purpose of determining what locations were available that were suitable for the installation of wide band antennas.

4. After inspection of the ships and discussion of various possible types of antenna that might be suitable for the wide band requirements, the consensus of opinion was that for the transmitting antenna system the best prospects for immediate trial appeared to be the use of the coaxial sleeve type of antenna. This antenna has been described by P. S. Carter in NDRC Report 895-1. In order to cover the frequency band (15-60 Mc/s) with a standing-wave-ratio not greater than 2:1, it seemed certain that at least two antennas would be required. These antennas should be mounted at 45° to the ship's line as well as at 45° to the vertical, in order to obtain best overall coverage on both horizontal and vertical polarizations. In the case of the DE, it appeared that a single pair of antennas might accomplish the job. For the DD, however, it appeared that it would be necessary to employ a pair of antennas on either side of the lock-out bridges in order to obtain substantially all-around coverage. The situation on the CL visited appeared to be fairly clear-cut, since ample room appeared to be available around the foremast and mainmast.

5. For the receiving antenna system, it was decided to try to use a single fan antenna for the entire frequency range. With the more liberal tolerance of 5:1 standing-wave-ratio, it was thought that it might be possible to attain this in a single antenna design. Sketches showing the locations and approximate relative sizes of the sleeve and fan antennas on the DE are shown in Fig. 1.

6. In order to tackle the immediate problem of determining suitable designs for DE installation, the services of a DE had been requested for a period of one to two weeks at the NRL dock. DE-170 (U.S.S. Booth) was assigned for the purpose and reported on 1 December 1943.

7. Mr. P. S. Carter of RCA Laboratories, Rocky Point, N. Y.; kindly furnished detailed data on the characteristics of the sleeve antenna to serve as a guide in the experimental program to be carried out on the DE. Data on fan antenna characteristics were kindly furnished by Lt. A. S. Meier of ARL, Wright Field. The information obtained from these sources proved very valuable in the early part of the work, and allowed a satisfactory solution to be obtained in a relatively short time.

#### METHODS

8. After an inspection of the superstructure of the DE, it was decided to mount the transmitting antennas on the two forward corners of the flying bridge, one for the low band, and the other for the high band. Because of their relatively high and unobstructed positions, these corners were judged to provide good mounting locations for all-around coverage. Furthermore, the ship's captain agreed that this location would not interfere with visibility or operations.

9. The impedance measurements necessary to arrive at a satisfactory design were made by slotted-line measuring technique. Because of the low frequencies involved, a slotted-line approximately 20 feet long was required. No single slotted-line of this length being available, five 4-foot slotted-lines were connected in tandem by means of short 50-ohm patch cables. Each slotted-line carried an adjustable sliding probe, so that all the probes could be set to give equal coupling to their respective inner conductors, thus providing, in effect, a continuous slotted-line. In order to handle cases where a minimum or maximum occurred in a patch cable, cables of several different lengths were used, permitting a degree of adjustment of the positions of minimum and maximum values along the lines.

10. The signal source was a signal generator with calibrated attenuator, while the detector for the slotted-line probes was a short-wave receiver. For the lower frequencies, a General Radio 605-B signal generator and a Hammarlund HQ-120 receiver were used, while for the higher frequencies the combination was a General Radio 804-B and a Hallicrafter S-27. A sketch of the way in which the slotted lines, signal generators and receivers were set up is given in Fig. 2. The equipment was set up on a table in the Chart House and connected to the antennas through a length of shielded cable running up to the flying bridge through the speaking tube.

11. Standing-wave-ratios were determined in terms of signal generator attenuator settings. With the signal generator set to give maximum output, the slotted line probe was set at the position of the minimum on the slotted-line and the receiver manual gain control adjusted to give a convenient reading on the output meter. Then, without disturbing the receiver gain setting, the probe was moved to the maximum position and the signal generator output adjusted by means of the attenuator to give the same reading on the output meter as before. The ratio of the two settings of the attenuator, at minimum and maximum, then gave the standing-wave-ratio (expressed as a number greater than 1).

12. An essential feature of the sleeve antenna which produces its wide band features is a length of transforming line, which is an integral part of the antenna. If the impedance characteristics of the antenna without its internal transformer are known, it is a relatively simple matter to compute overall impedance characteristics for different impedances and lengths, and thus arrive at the most favorable combination. Accordingly, measurements were made of sleeve antenna impedance directly at the feed point (outer end of sleeve).

13. Since a minimum of antennas to cover the frequency band was desired, the work was aimed at covering the required frequency spread in two bands, a low band between 15 and 30 Mc/s, and a high band between 30 and 60 Mc/s. Measurements were made to determine a number of curves of impedance versus frequency for different combinations of sleeve and rod lengths for each band. From these measurements, a fairly comprehensive idea of the behavior of the sleeve antenna in the locations tried was obtained.

14. From the measured data, transformer sections were computed to determine the overall characteristics of the complete antenna. In designing transformer sections, impedance values were taken from each measured curve and were transformed through sections of various lengths and characteristic impedances. In this way, the combinations giving the best overall characteristics could be determined readily.

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15. After the best combinations of antenna and transformer dimensions were determined in this way, transforming sections were built into the experimental antennas and then the combination measured to determine the standing-wave-ratio on the 50-ohm feed line.

16. For the fan antenna, the lower starboard forestay position on the foremast was used. The forestay was broken up by insulators to provide the desired length of conductor, and four wires were run from this down to the feed point. Measurements were made with two locations for the feed point (with corresponding changes in the lengths of the individual fan wires). The fan location shown in Fig. 1 is the one which gave the better performance.

17. After arriving at satisfactory designs, some measurements of the directional patterns of the antennas were made. This work was done in the Potomac River, just above the Morgantown bridge. The pattern measurements were made by transmitting from the U.S.S. Aquamarine and measuring the voltage received by the antennas on the DE. The DE was anchored at one side of the channel in the Potomac, while the Aquamarine circled slowly around it at a radius of about 1000 yards. Due to the limitations of the channel, only about a semi-circle could be covered at a time. Partial data for the other half circle were obtained after the swing of the tide.

18. Low-band transmissions from the Aquamarine were provided by a General Radio 804-B signal generator feeding into the forward sloping-wire antenna of the Aquamarine. The high-band signals were provided by a TBY, which had a quarter-wave vertical whip antenna. Under the conditions, it is considered that both antennas provided mainly vertical polarization at the receiving antennas.

19. The relative voltages received by the antennas on the DE were determined by a substitution method. The received signals were read on the output meters connected to receivers, and the input signal determined by replacing the antenna connection to the receiver by one from a signal generator, which was then adjusted to give the same output meter reading as obtained from the antenna.

20. The experimental work performed on the DE provided the necessary information from which final designs of production models were produced. A small number of these antennas was then made in the NRL shop.

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DATA OBTAINED

21. Figs. 3-15 show the impedance data measured for several combinations of sleeve and rod lengths. Figs. 16-20 give the resulting standing-wave characteristics for the overall combination of antenna and transformers of various lengths and impedances.

22. On the basis of the measured and computed characteristics, the following combinations were chosen for experimental check:

- a) High-band antenna:
- |                        |                        |
|------------------------|------------------------|
| Sleeve length:         | 3' 8 $\frac{1}{2}$ "   |
| Rod length:            | 3' 8 $\frac{1}{2}$ "   |
| Transformer length:    | $\lambda/4$ at 53 Mc/s |
| Transformer impedance: | 100 ohms.              |
- b) Low-band antenna:
- |                        |                        |
|------------------------|------------------------|
| Sleeve length:         | 6' 10"                 |
| Rod length:            | 6' 10"                 |
| Transformer length:    | $\lambda/4$ at 25 Mc/s |
| Transformer impedance: | 100 ohms.              |

Transforming sections were inserted in the test antennas in accordance with the above values.

23. Measured values on the low-band antenna agreed fairly well with the calculated values. The measured standing-wave ratio did exceed 2:1 slightly at some parts of the band, but this was corrected by shortening both the rod and the sleeve to 6' 6". The resulting standing-wave characteristic is shown in Fig. 21.

24. On the high-band antenna, the agreement between calculated and measured values was poor; the measured standing-wave-ratio was less than 2:1 over only a small part of the frequency band. Only a slight improvement was obtained by changing the dimensions of the antenna and the length of the transformer. Subsequent measurements made on the transformer indicated that electrical discontinuities (presumably due to supporting insulators) were present. The results also suggested that the original impedance data were in error (these had been made at the beginning of the work, when considerable difficulty from pickup of radiation from parts of the ship's structure were experienced. These difficulties were subsequently overcome). Since time limitations did not permit rebuilding the transformer, and the impedance data were in question, the remaining time available was used to collect more reliable impedance data on the antenna without transformer. The data obtained are plotted in Figs. 29-30. From these data, it was found that a satisfactory design could be obtained by the proper combination of dimensions.

25. The directive patterns of the antennas obtained for the various antennas are shown in Figs. 22-28. Measurements on the low-band sleeve were made at 20 and 25 Mc/s; measurements on the high-band sleeve were made at 47.5 and 55.7 Mc/s; measurements on the fan were made at all four of the above frequencies. In making the pattern measurements, it was difficult to keep the Aquamarine at a constant aspect to the DE, so that any directivity imparted by the ship's structure to the transmissions from the Aquamarine affects the pattern measured on the DE antennas. In spite of this possible effect, however, the measurements reveal no serious blind spots in the horizontal patterns.

26. After the experimental work on the DE had been completed, efforts were directed to make production type designs for the antennas. From considerations of mechanical rigidity and water-tightness, it became evident that a strong insulator would be required at the end of the sleeve to support the rod and to seal the inside of the sleeve. An appreciable capacitance would thereby be introduced, which would modify the untransformed antenna impedance, particularly at the high end of the band. It was necessary, therefore, to see whether this capacitance could be accommodated by readjustment of some of the other elements of the antenna.

27. Micalex disc insulators were considered as offering the best combination of mechanical and electrical characteristics and availability. For insulators of requisite strength, the capacitance introduced across the end of the sleeve was calculated to be 5  $\mu\text{f}$  for the low-band sleeve, and 3.5  $\mu\text{f}$  for the high-band sleeve. From an examination of the impedance data and calculations of transformed impedance using various designs of transforming sections, it was found that not only could the effect of the capacitance be overcome, but that the band width obtainable was even somewhat greater than was obtained without the insulator. The computed standing-wave characteristics are shown in Figs. 31-38.

28. On the basis of these data, the following dimensions were chosen for the final sleeve antenna designs:

- a) High-band antenna:
- |                        |  |
|------------------------|--|
| Sleeve length:         | 3'7"                                       |
| Rod length:            | 3'7"                                       |
| Transformer length:    | $\lambda/4$ at 55 Mc (4'5 $\frac{1}{2}$ ") |
| Transformer impedance: | 104 ohms                                   |
- b) Low-band antenna:
- |                        |  |
|------------------------|--|
| Sleeve length:         | 6'6"                                       |
| Rod length:            | 6'6"                                       |
| Transformer length:    | $\lambda/4$ at 30 Mc (8'2 $\frac{1}{2}$ ") |
| Transformer impedance: | 107.5 ohms                                 |

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29. The standing-wave characteristic for the fan antenna is shown in Fig. 39. The performance with 70 ohm feed line is the better, so that RG-12/U cable has been specified.

30. The final designs for the DE application are shown in the following drawings:

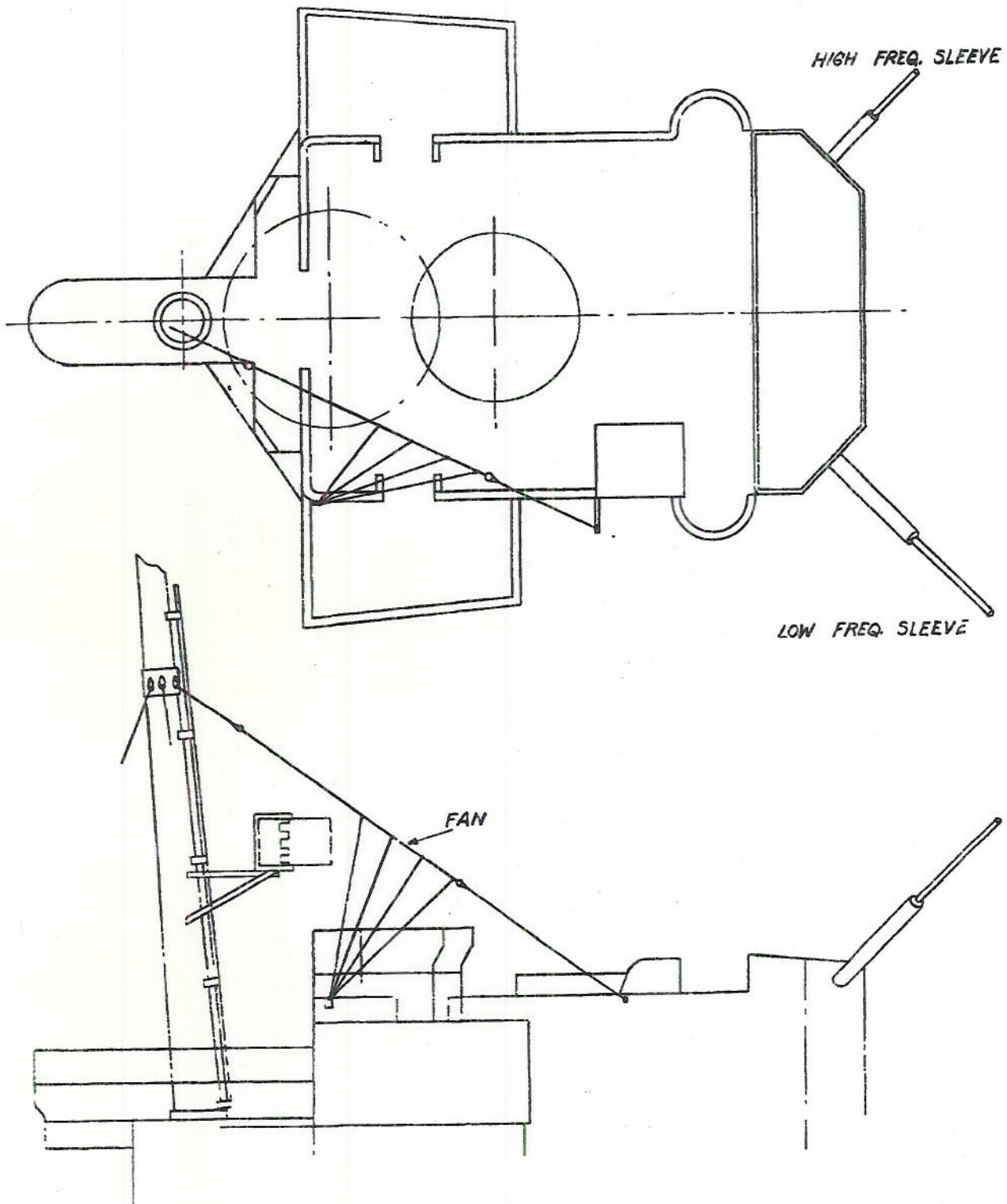
Fan Antenna:	RA 66F 264B
High-Band Sleeve Antenna:	RA 66F 266A
Low-Band Sleeve Antenna:	RA 66F 267A

#### CONCLUSIONS AND RECOMMENDATIONS

31. The general results obtained from the experimental work on the DE were encouraging. It appears that the requirements have been met as well as can be expected under the difficult circumstances encountered aboard ship. Since the completeness of coverage provided for all directions about the ship could not be determined in the test period, it must remain for operational experience to ascertain whether the designs provide adequate protection. If more data are obtained regarding the characteristics of the antenna system used in the enemy guided missiles, it may be possible to settle the question of polarization of the transmissions, and thus simplify the coverage problem.

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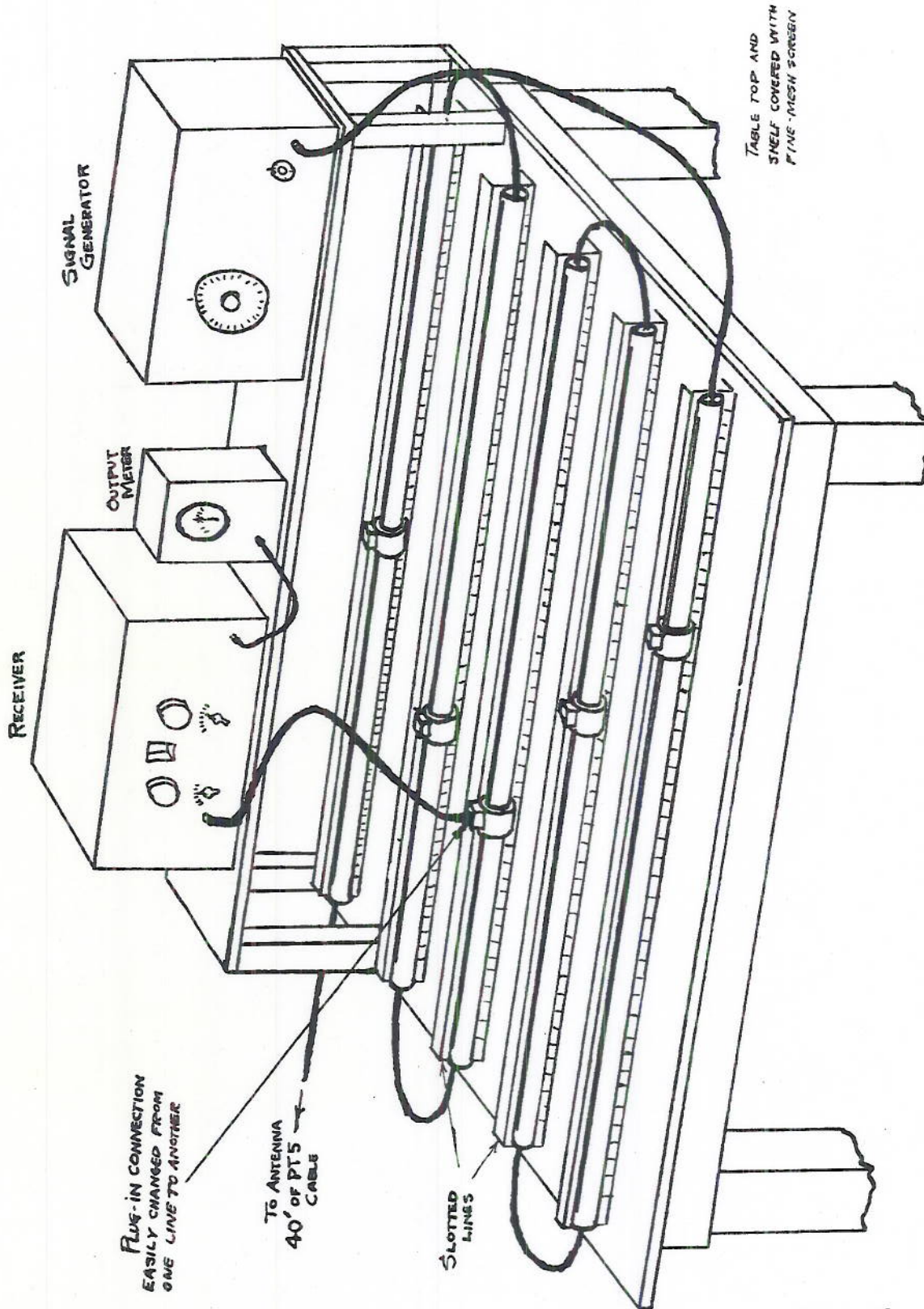
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BROAD BAND ANTENNAS INSTALLED  
ON DE

FIG. 1

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IMPEDANCE MEASURING SET-UP IN RADAR CHARTING ROOM

FIG. 2

IMPEDANCE CHARACTERISTICS  
OF HIGH-BAND SLEEVE ANTENNA

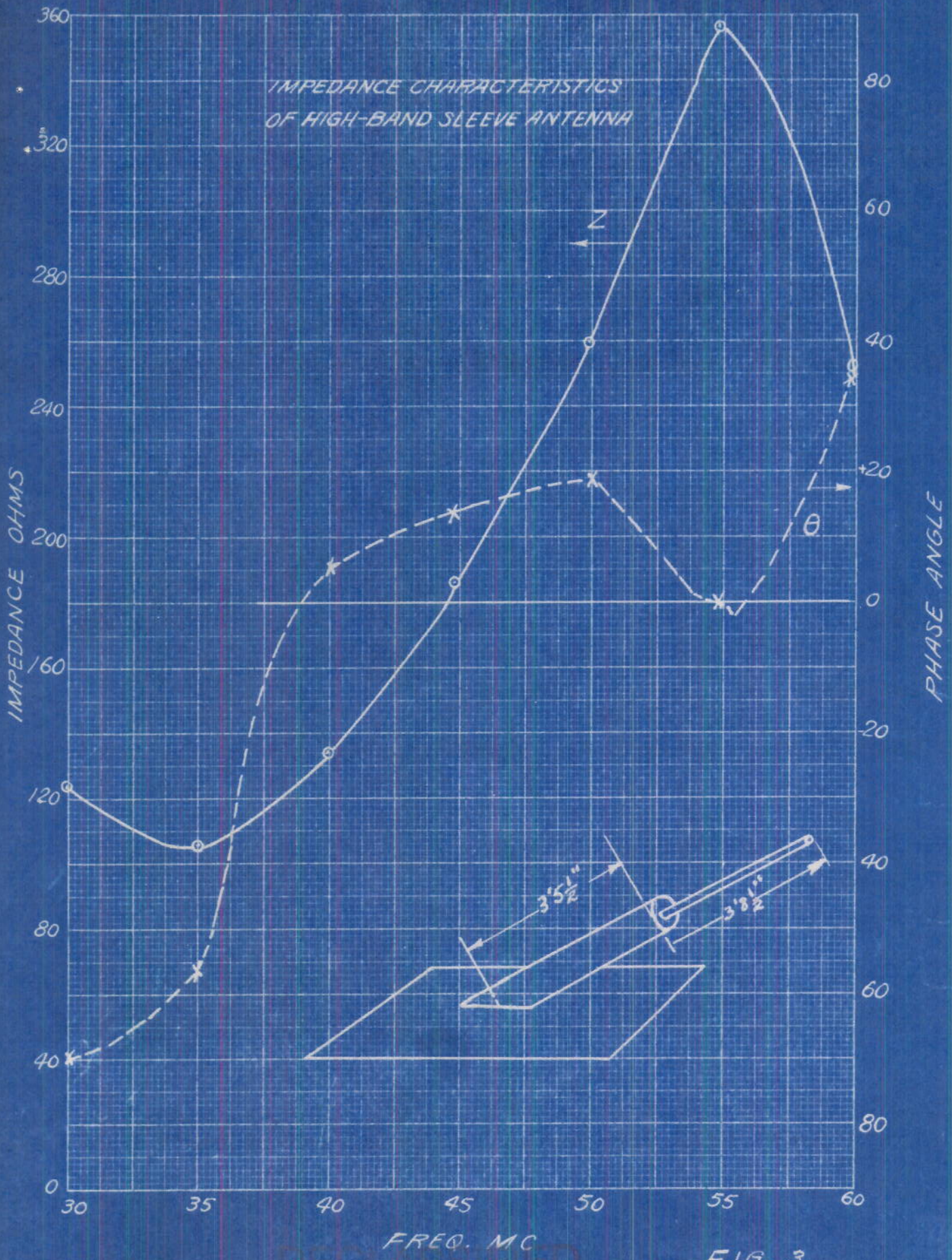
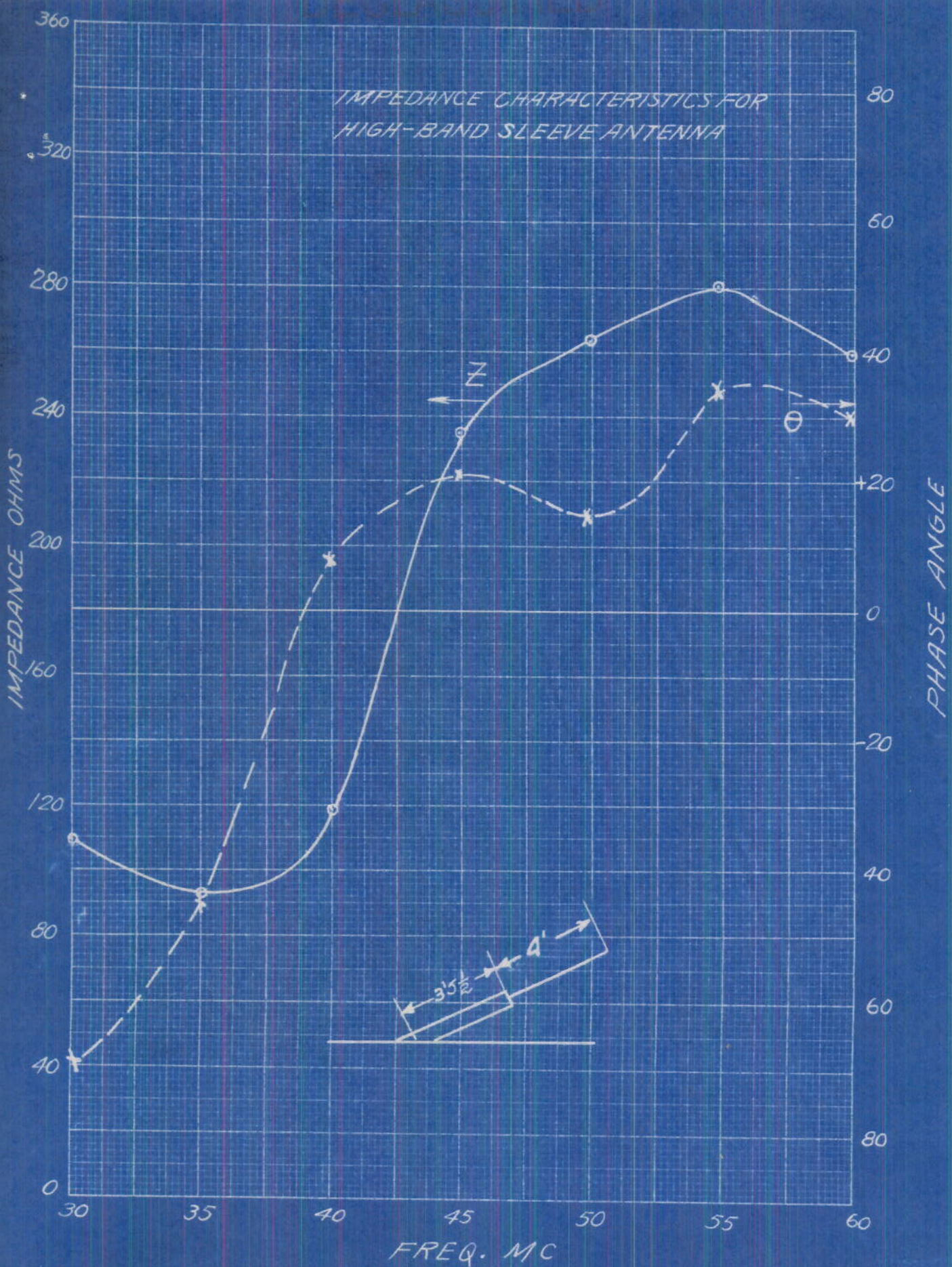


FIG. 3



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FIG. 4

IMPEDANCE CHARACTERISTICS FOR  
HIGH-BAND SLEEVE ANTENNA

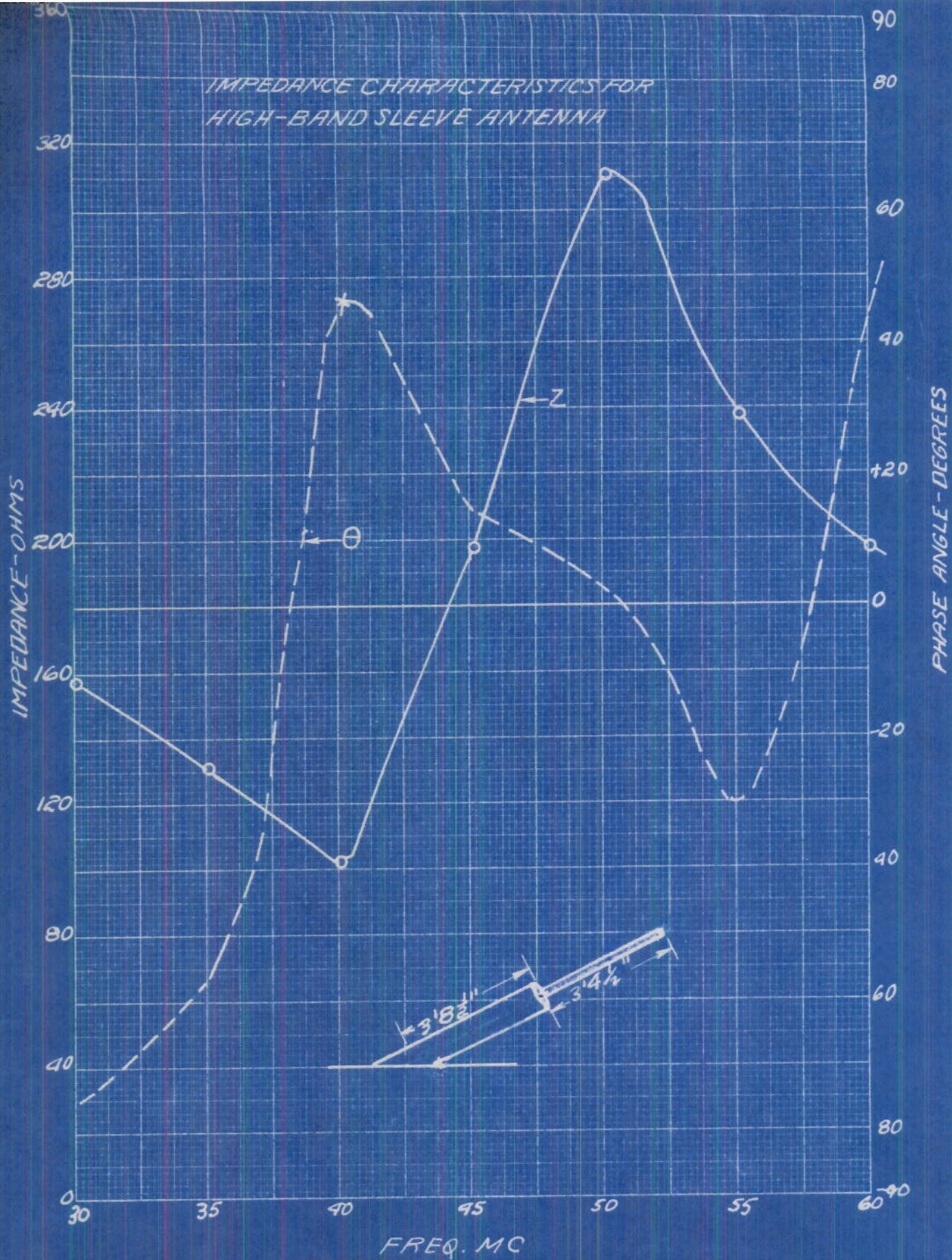


FIG. 5

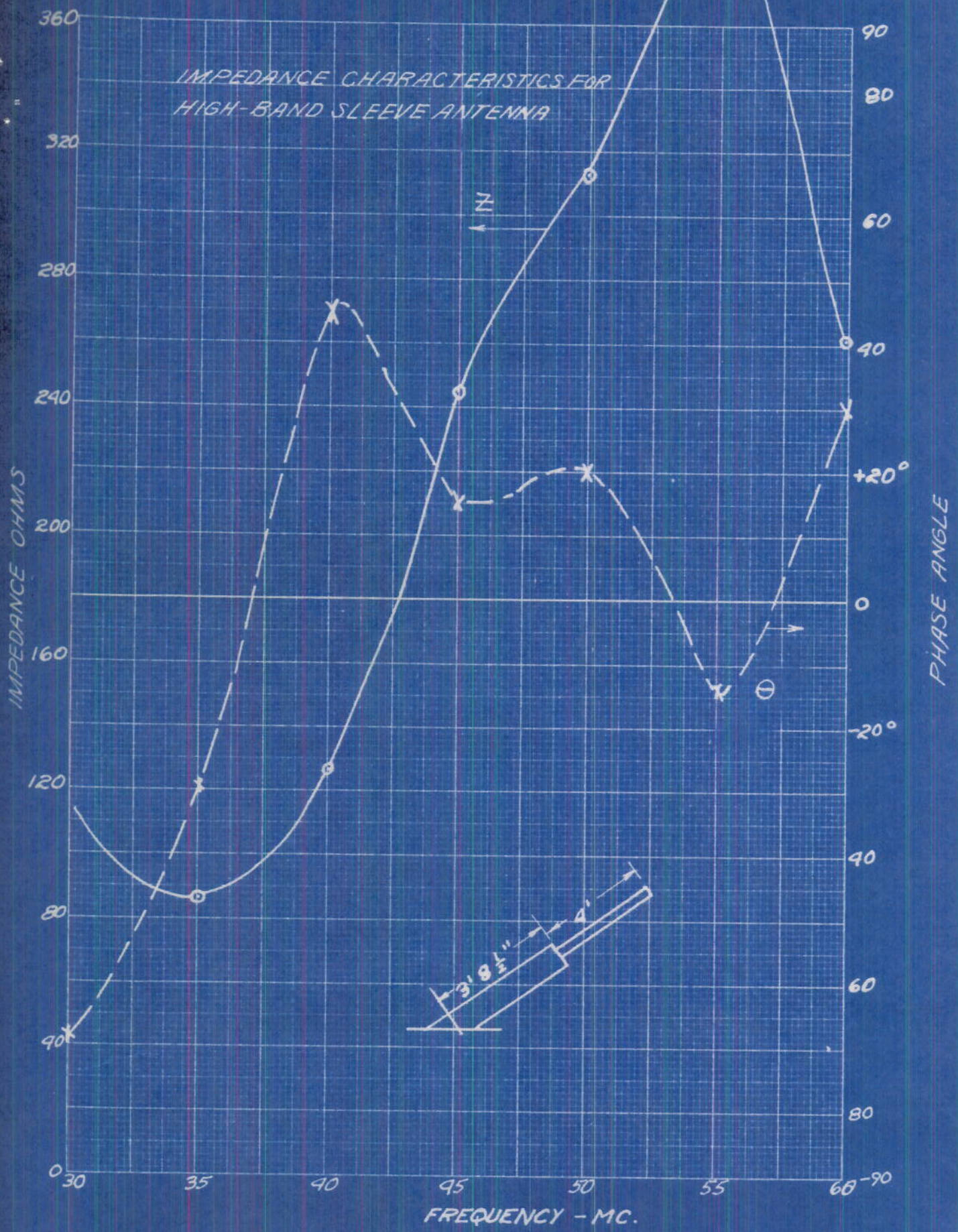
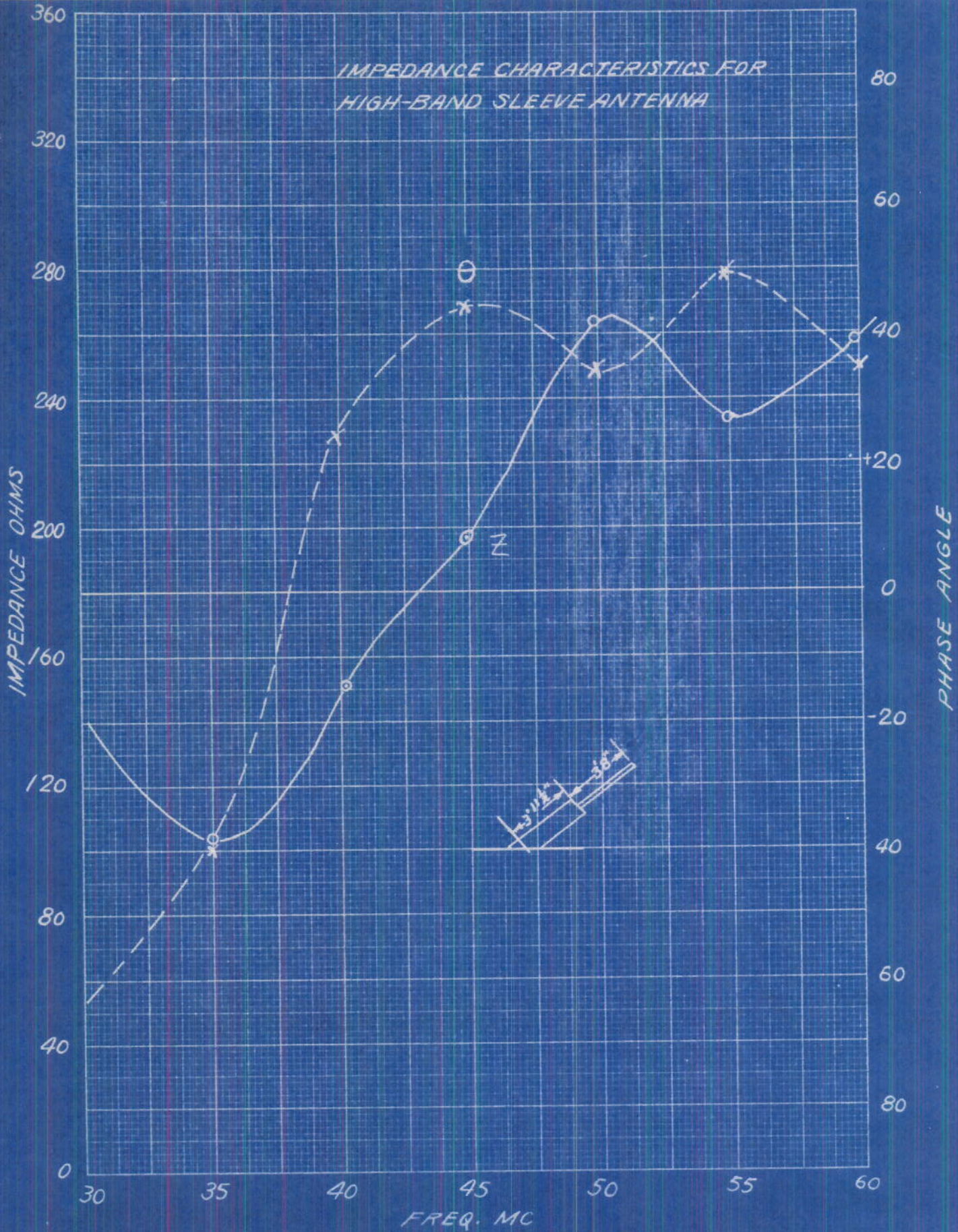


FIG. 7

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IMPEDANCE CHARACTERISTICS FOR  
HIGH-BAND SLEEVE ANTENNA



DECLASSIFIED

FIG. 8

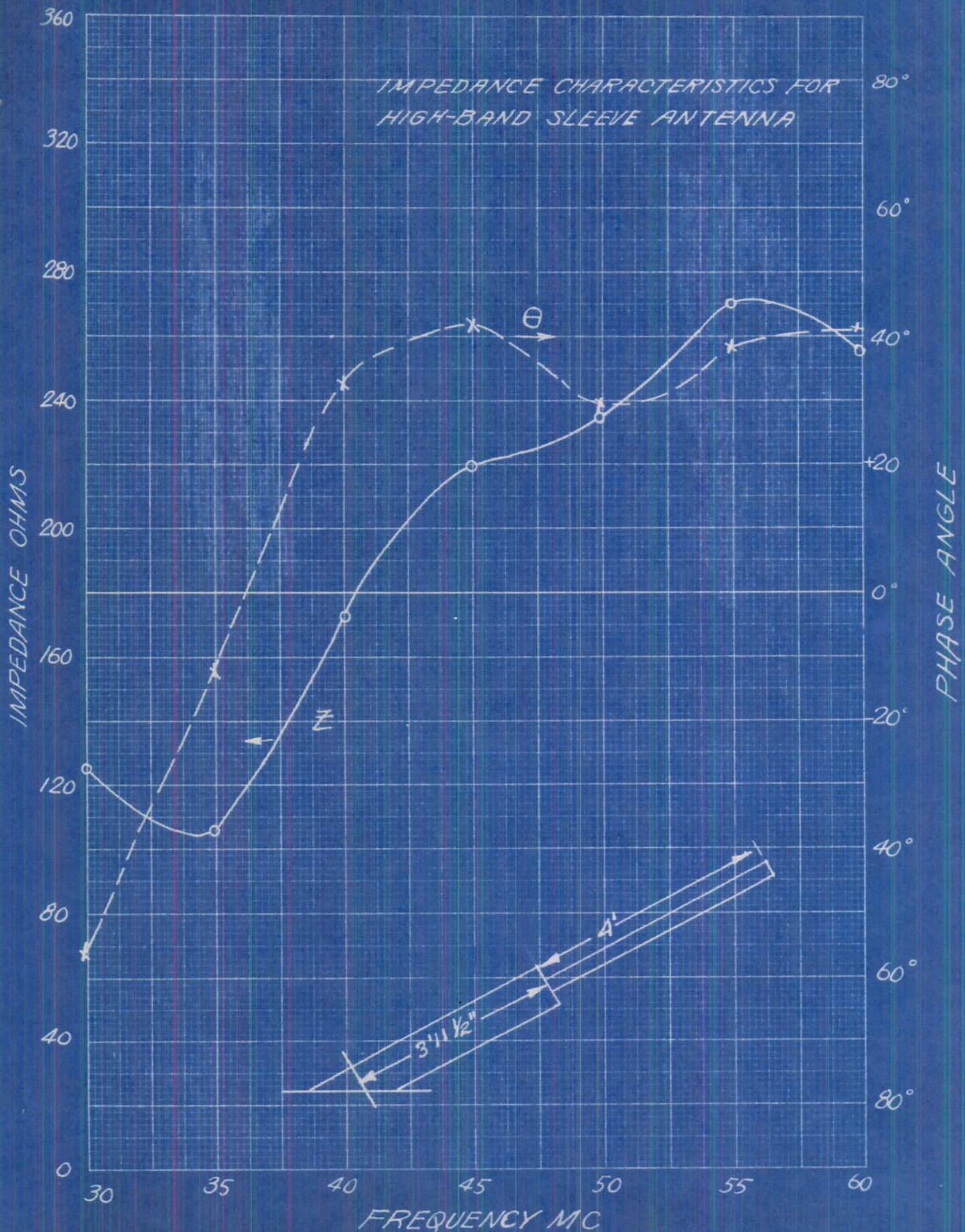


FIG. 9

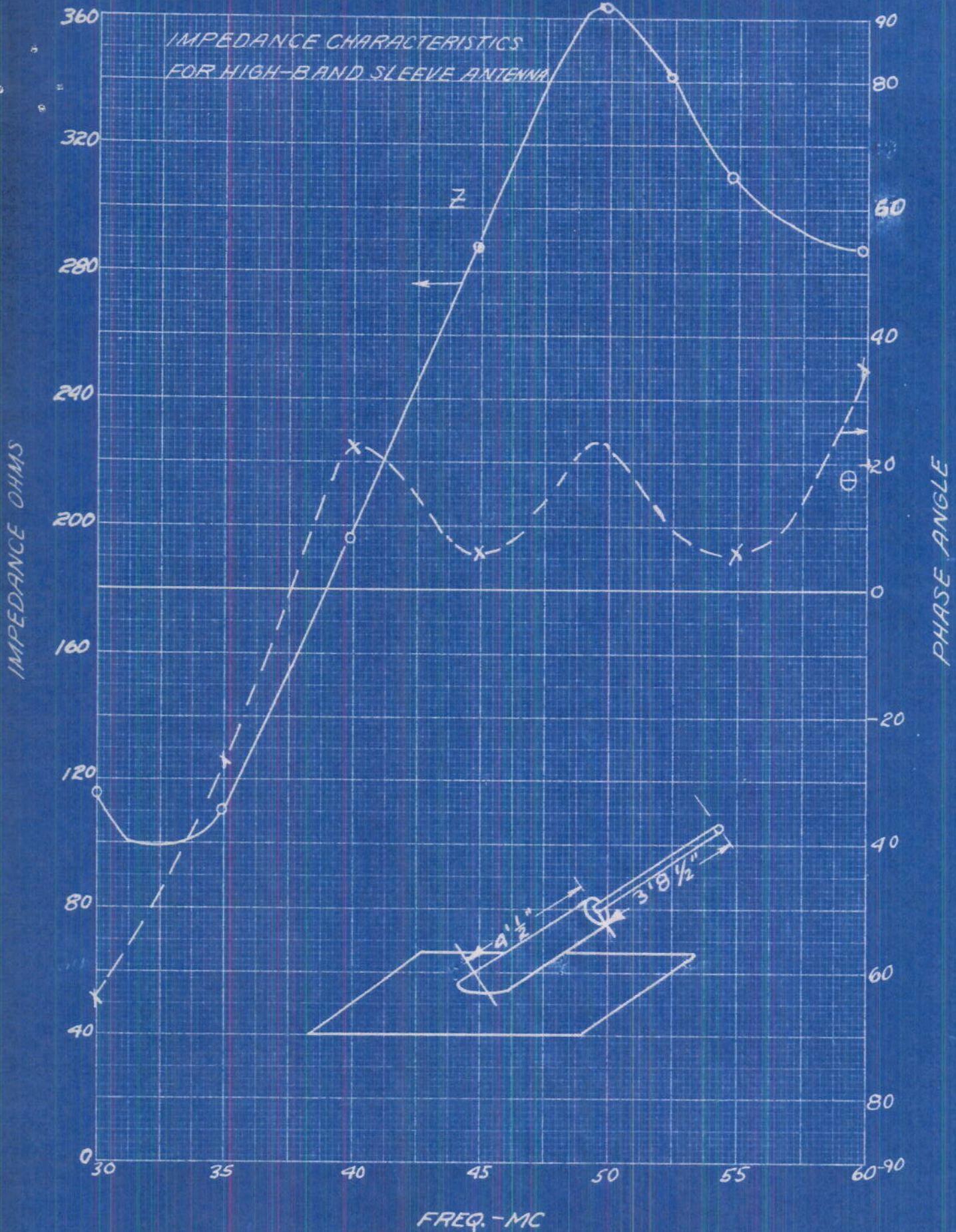


FIG. 10

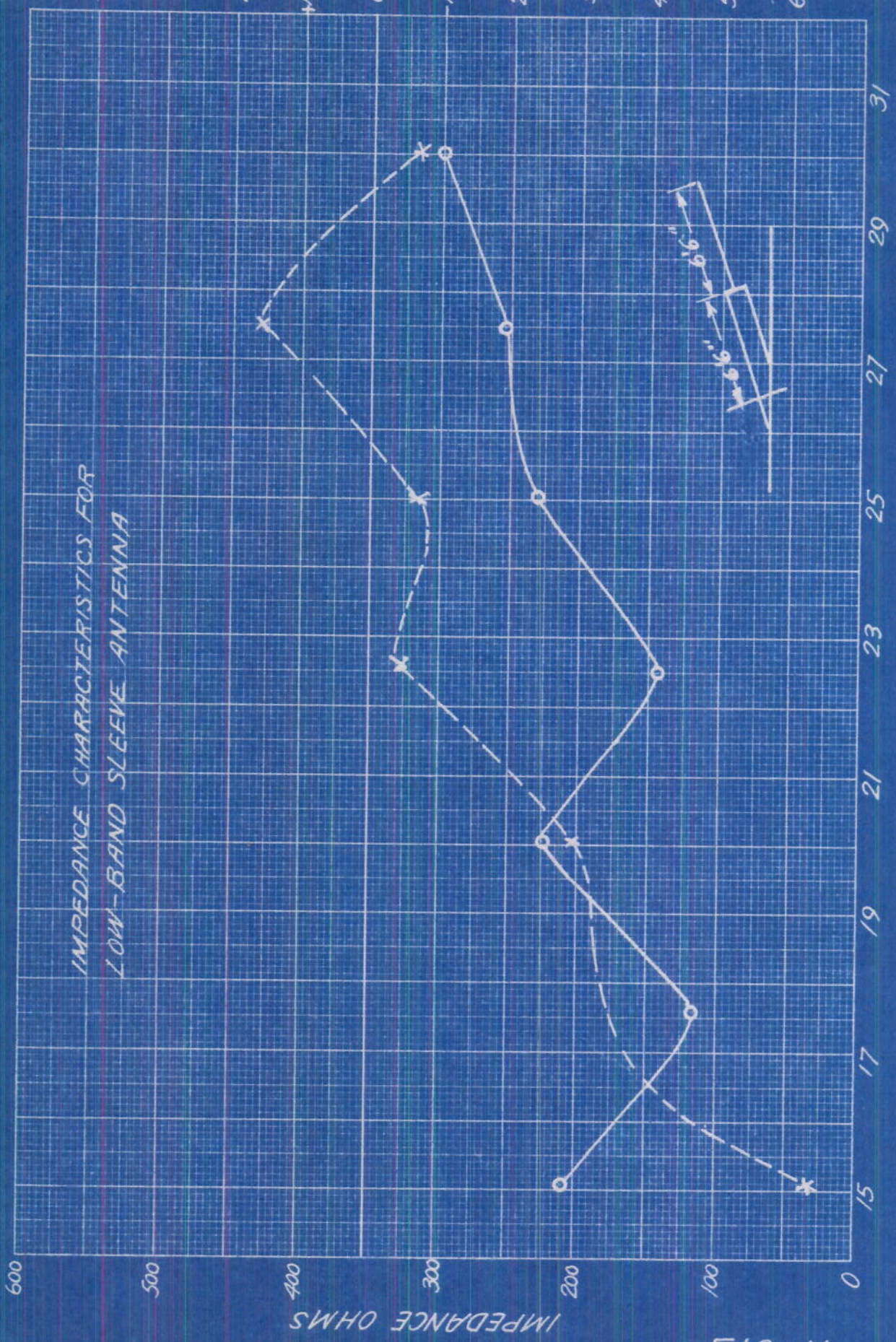
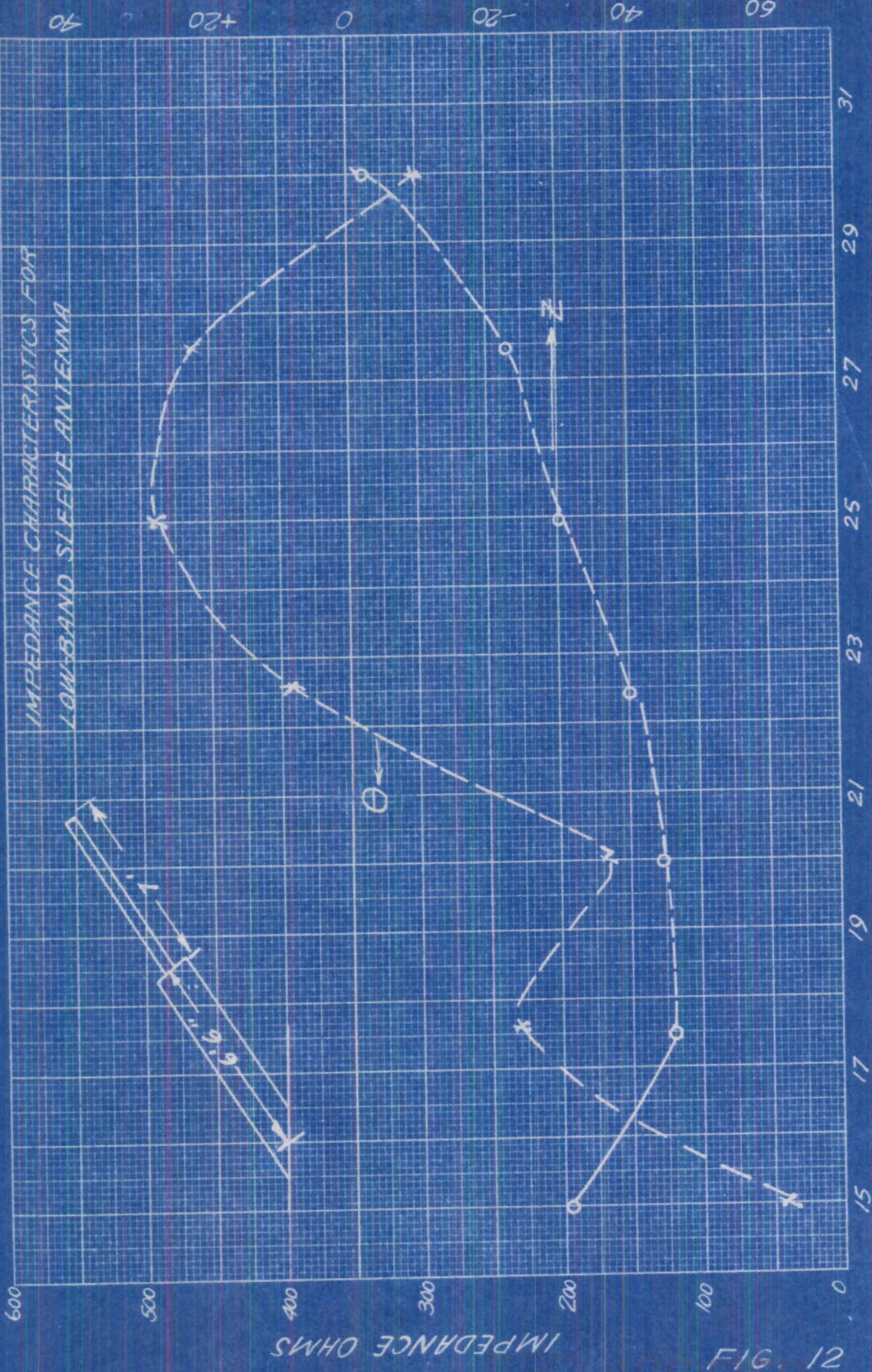


FIG. 11

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FREQ. - MC

21 916

60  
40  
-20  
0  
+20  
40

IMPEDANCE CHARACTERISTICS FOR  
LOW-BAND SLEEVE ANTENNA

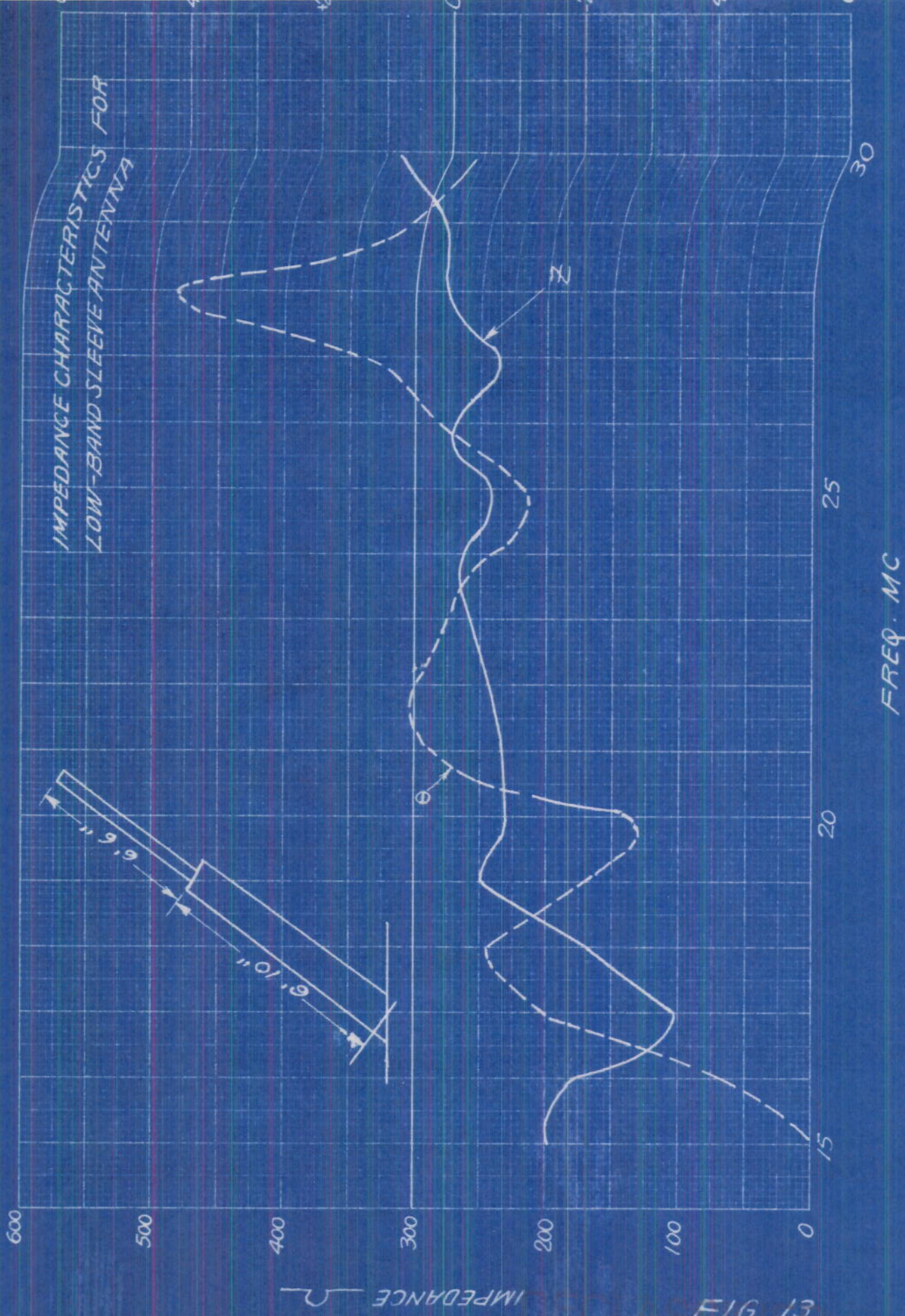
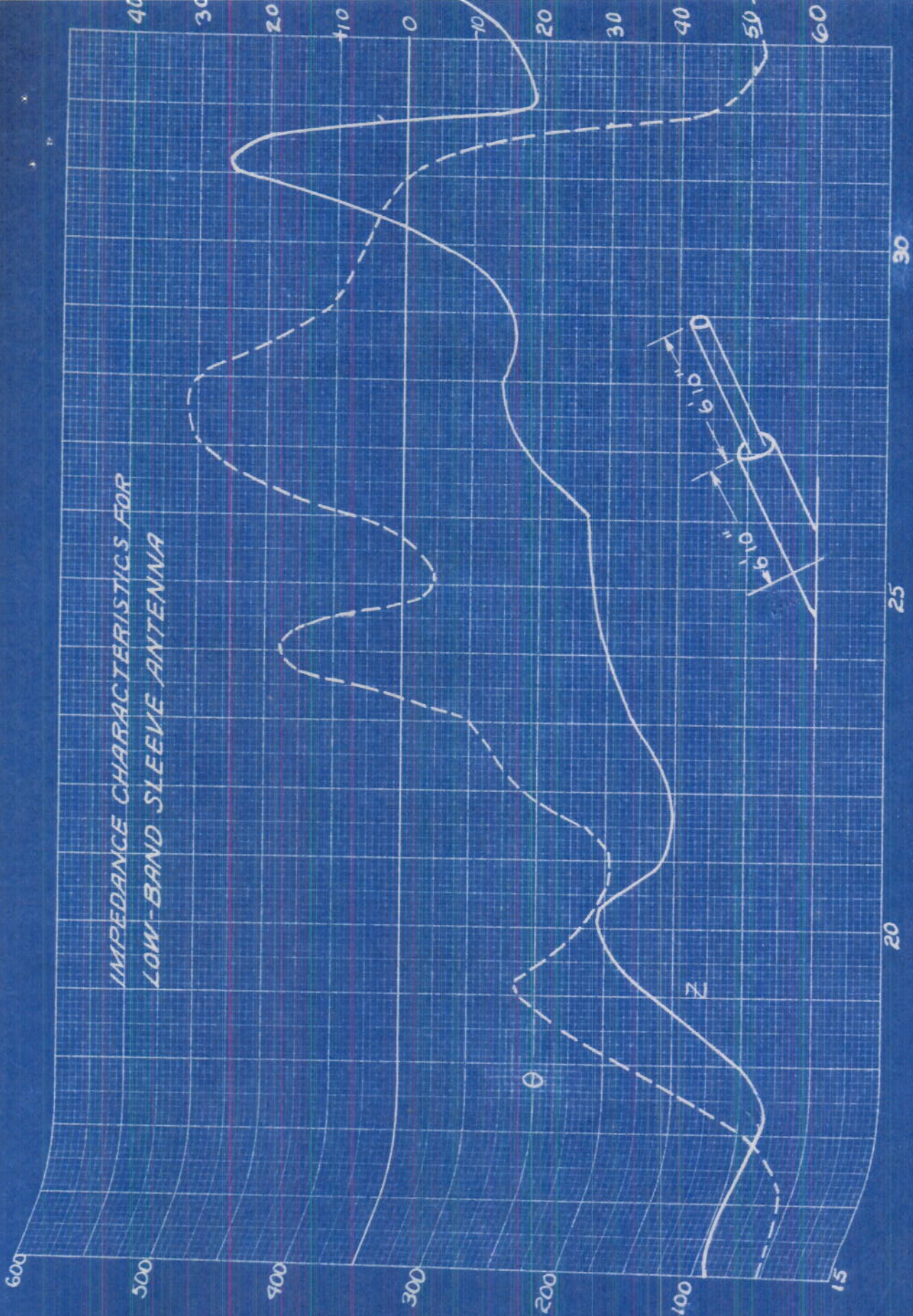


FIG. 13

IMPEDANCE CHARACTERISTICS FOR  
LOW-BAND SLEEVE ANTENNA



IMPEDANCE CHARACTERISTICS FOR  
LOW-BAND SLEEVE ANTENNA

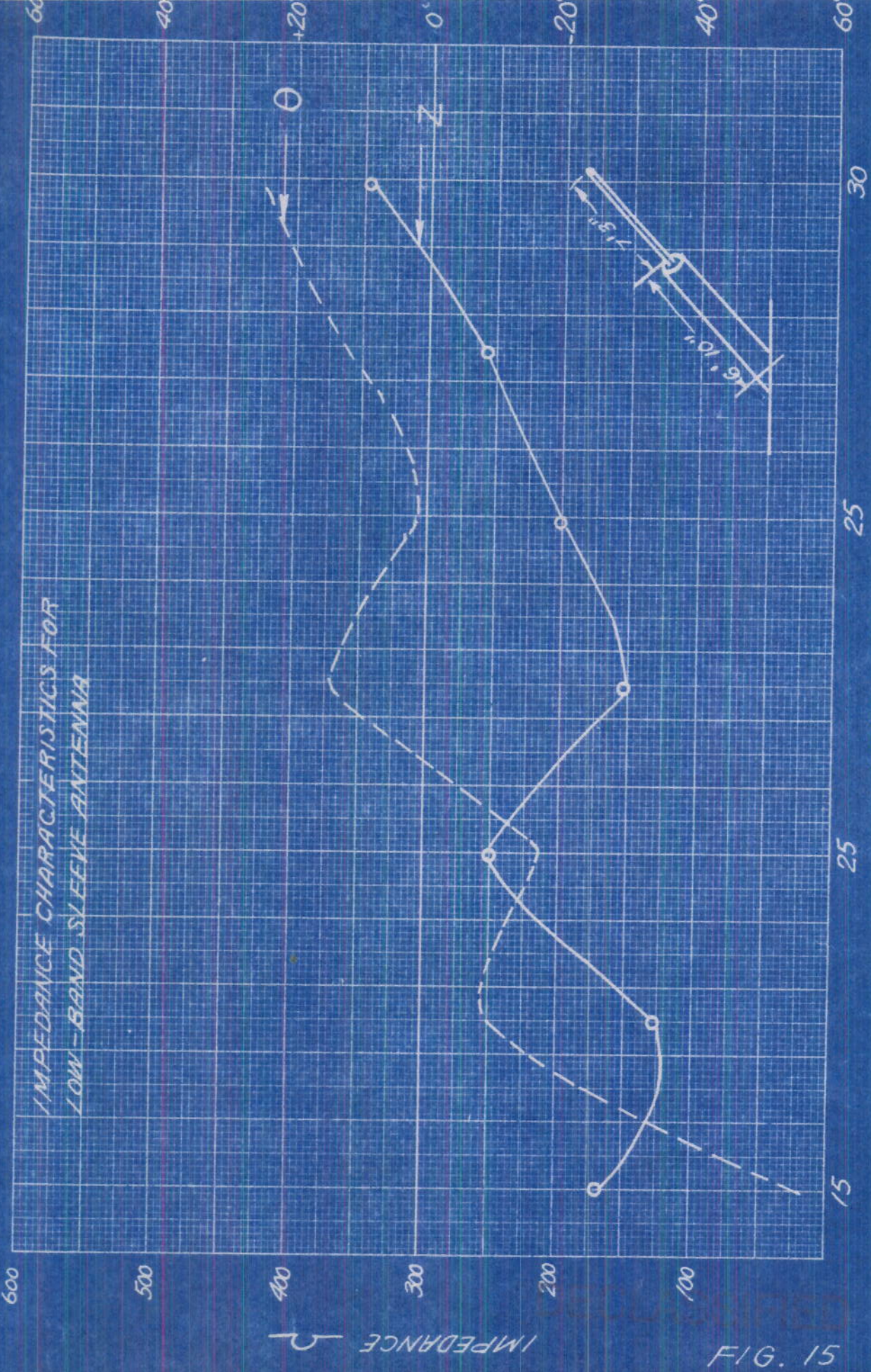


FIG. 15

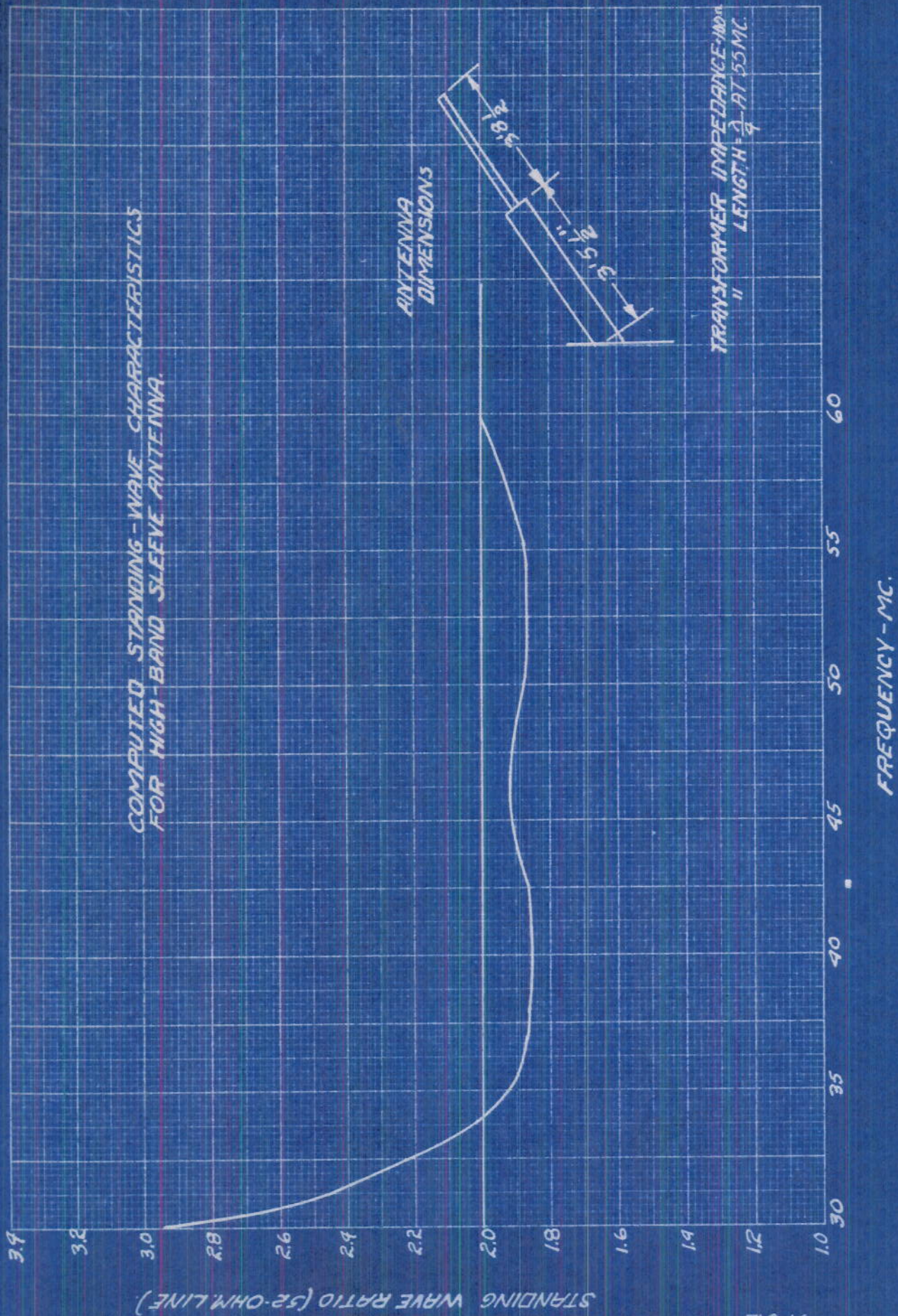


FIG. 16

COMPUTED STANDING-WAVE CHARACTERISTICS  
FOR HIGH-BAND SLEEVE ANTENNA.

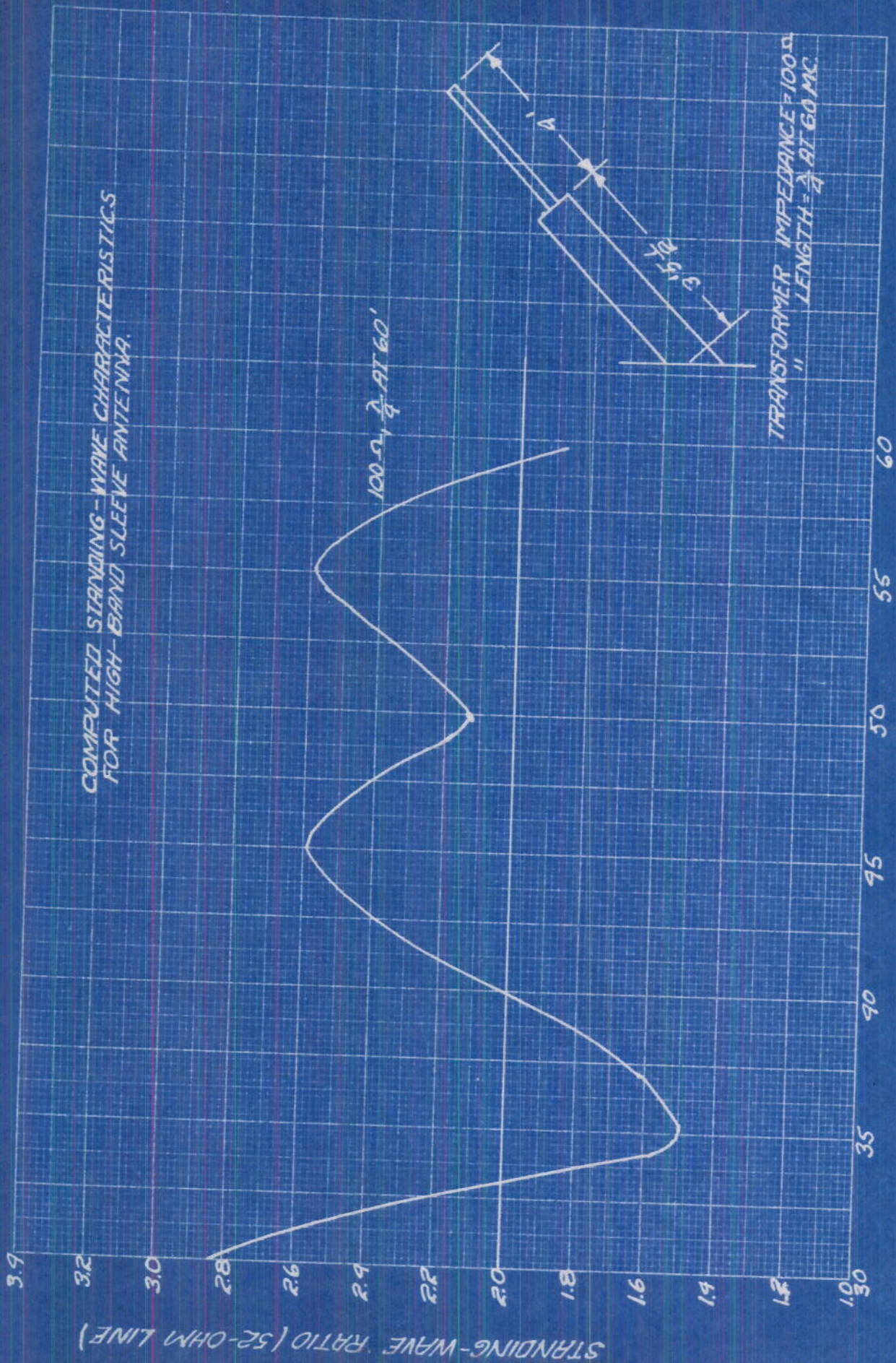
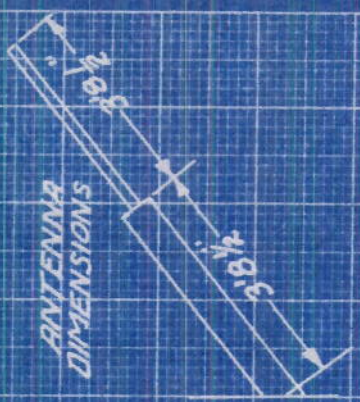
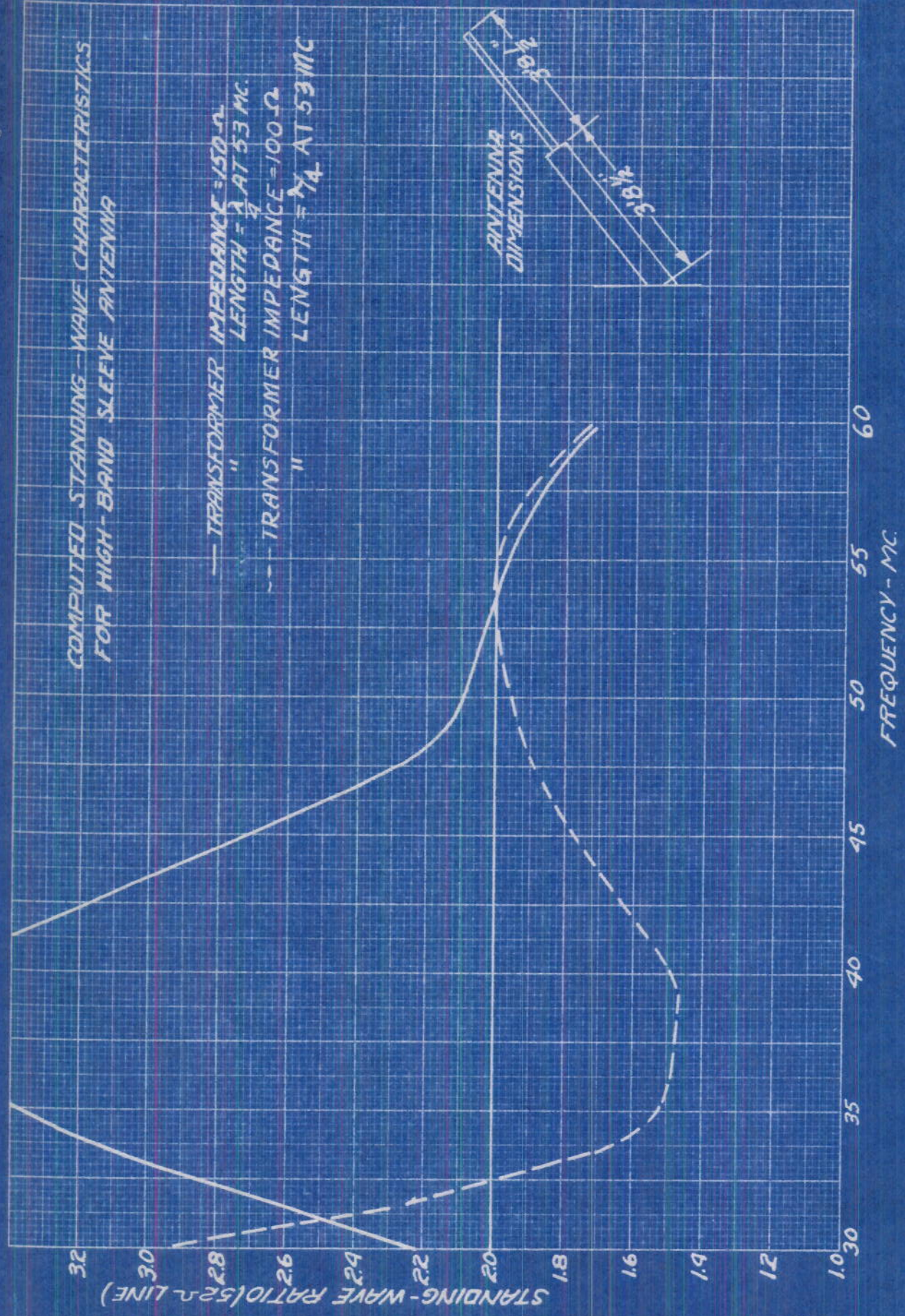


FIG. 17

COMPUTED STANDING-WAVE CHARACTERISTICS  
FOR HIGH-BAND SLEEVE ANTENNA

- TRANSFORMER IMPEDANCE = 150  $\Omega$
- "                    LENGTH =  $\frac{\lambda}{4}$  AT 53 MC.
- - - TRANSFORMER IMPEDANCE = 100  $\Omega$
- "                    LENGTH =  $\frac{\lambda}{4}$  AT 53 MC



81.91F

COMPUTED STANDING-WAVE CHARACTERISTICS  
FOR HIGH-BAND SLEEVE ANTENNA

--- TRANSFORMER IMPEDANCE = 100  $\Omega$   
 " LENGTH =  $\frac{1}{4}$ " AT 53 MC.  
 --- TRANSFORMER IMPEDANCE = 100  $\Omega$   
 " LENGTH =  $\frac{1}{4}$ " AT 48.5 MC.

STANDING-WAVE RATIO (S.W. LINE)

3.2  
3.0  
2.8  
2.6  
2.4  
2.2  
2.0  
1.8  
1.6  
1.4  
1.2  
1.0

30 35 40 45 50 55 60

FREQUENCY - MC.

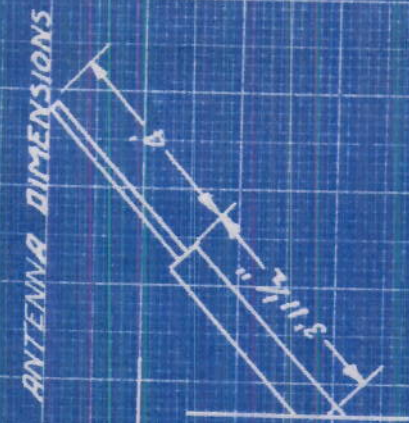


FIG. 19



STANDING-WAVE CHARACTERISTICS  
FOR LOW-BAND SLEEVE ANTENNA  
AND TRANSFORMER

TRANSFORMER IMPEDANCE =  $100 \Omega$   
TRANSFORMER LENGTH =  $\frac{\lambda}{4}$  AT 25 MC

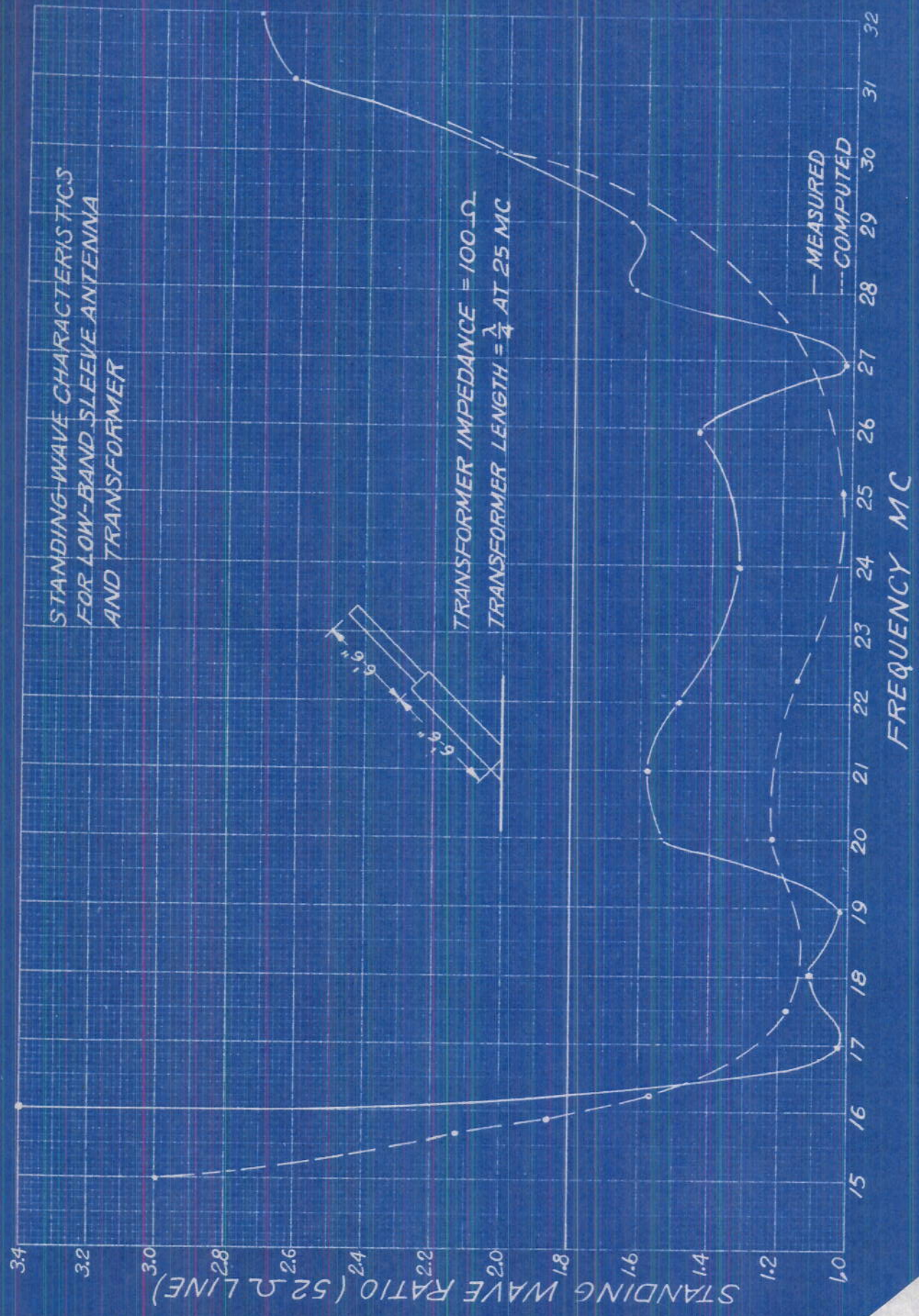


FIG. 21

LOW-BAND SLEEVE  
ANTENNA  
FIELD PATTERN  
AT 20 MC.

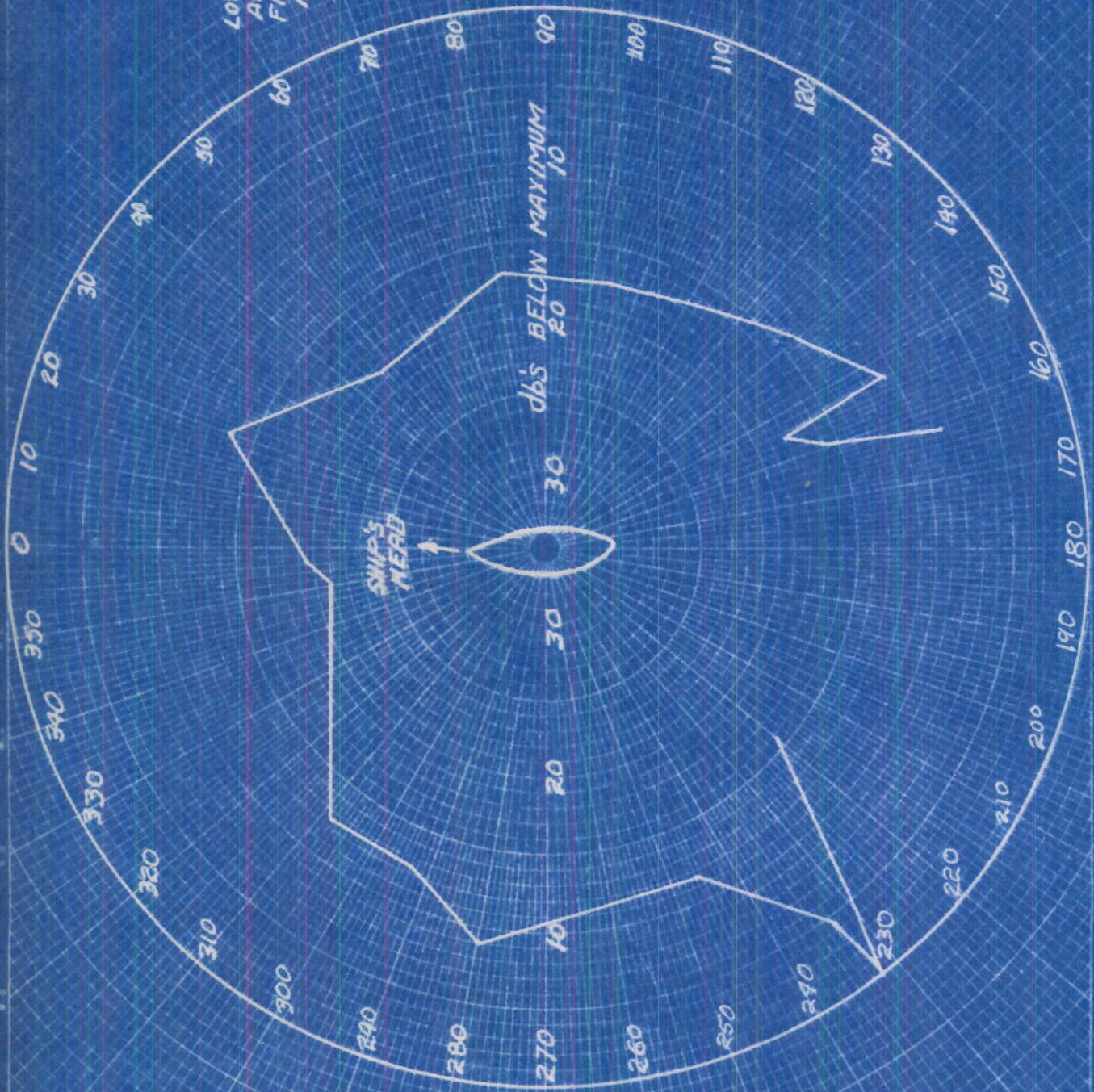


FIG. 22

LOW-BAND SLEEVE  
ANTENNA  
FIELD PATTERN  
AT 25 MC



FIG. 23

FAN ANTENNA  
FIELD PATTERN  
AT 47.5 MC.

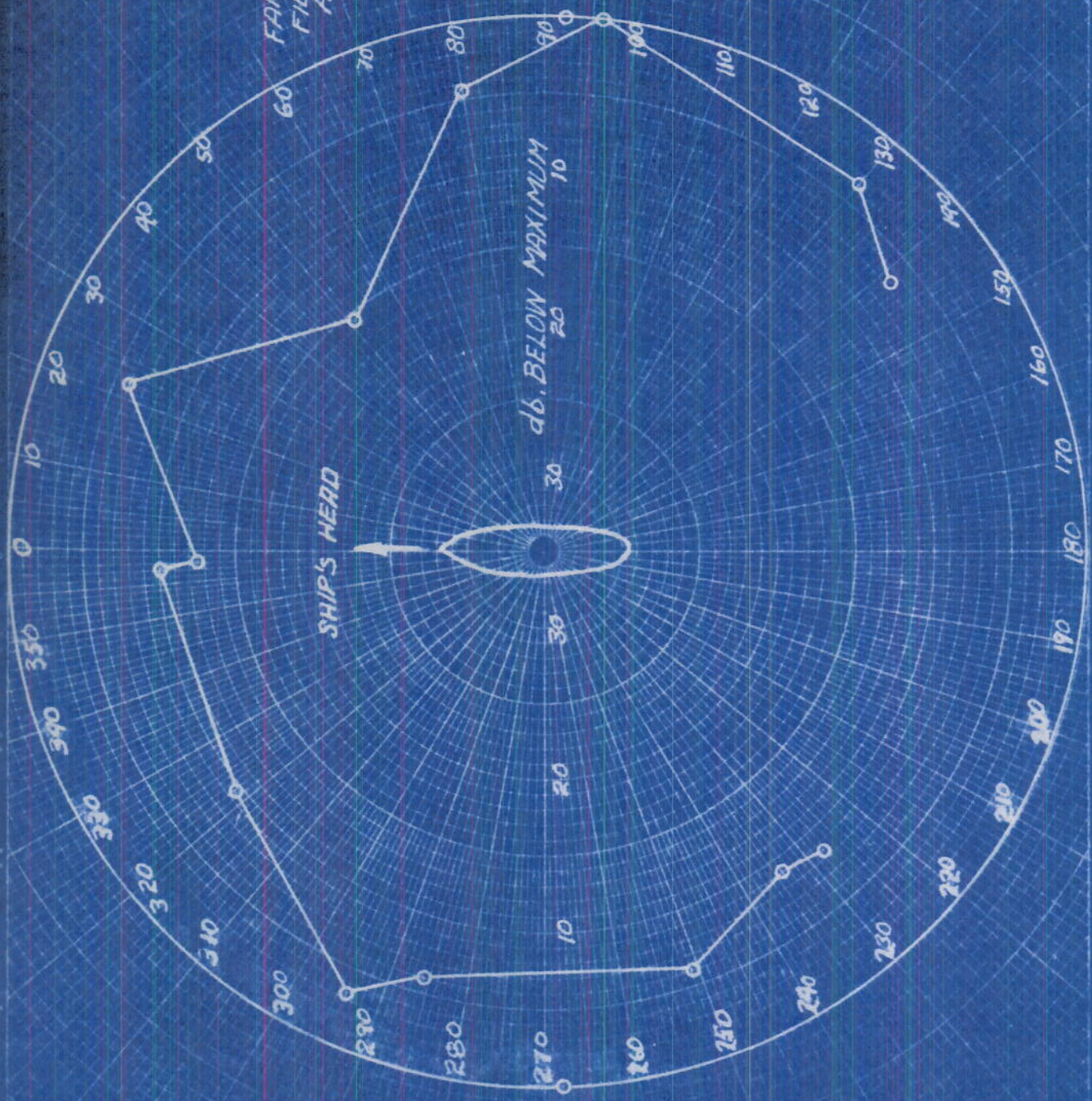


FIG. 24

HIGH BAND SLEEVE  
ANTENNA  
AT 55.7 MC.

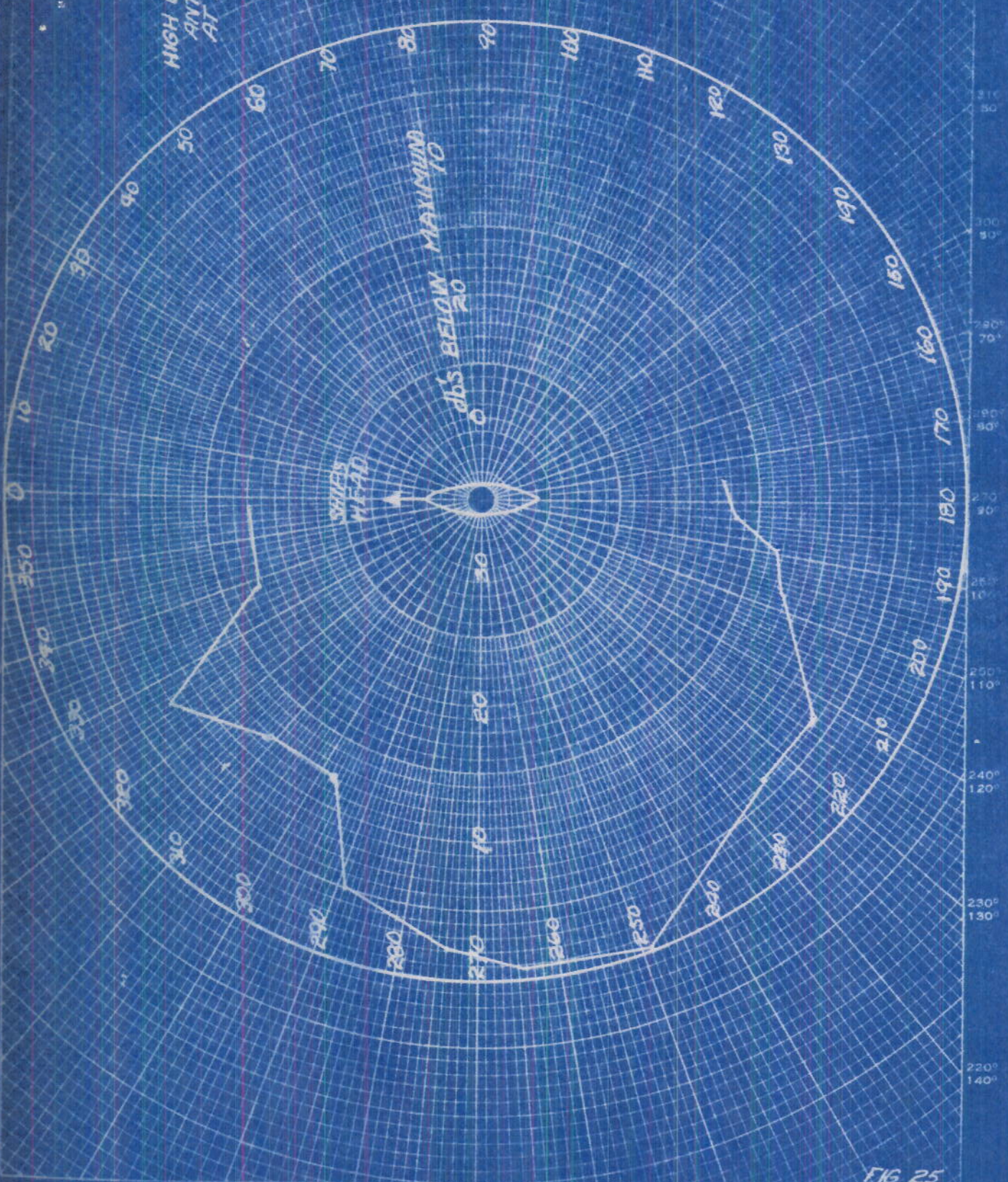


FIG. 25

150° 210° 160° 200° 170° 190° 180° 180° 190° 200° 210° 160° 170° 180°

FAN ANTENNA  
FIELD PATTERN AT 20 MC.

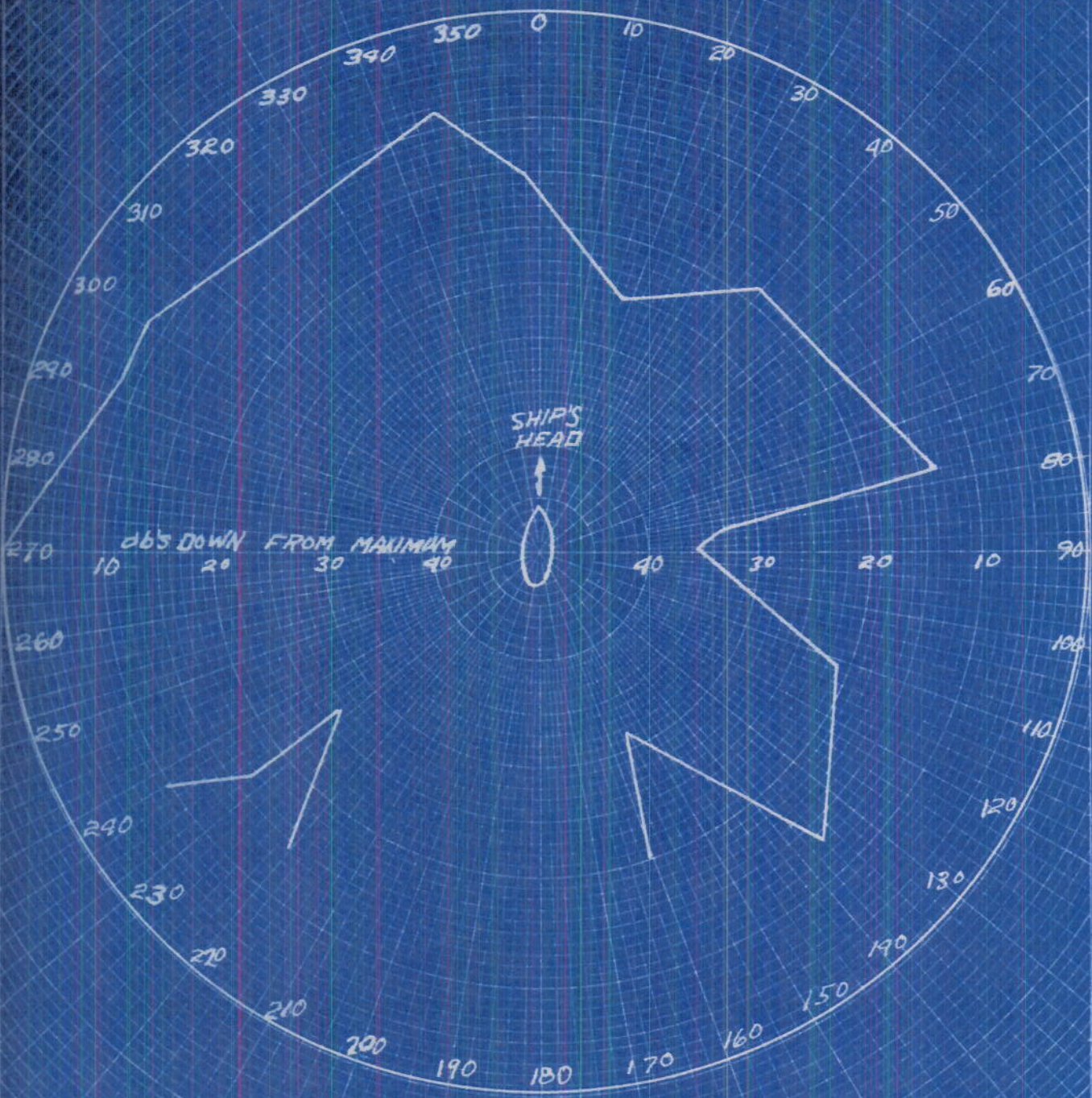


FIG. 26

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FAN ANTENNA  
FIELD PATTERN AT  
25MC

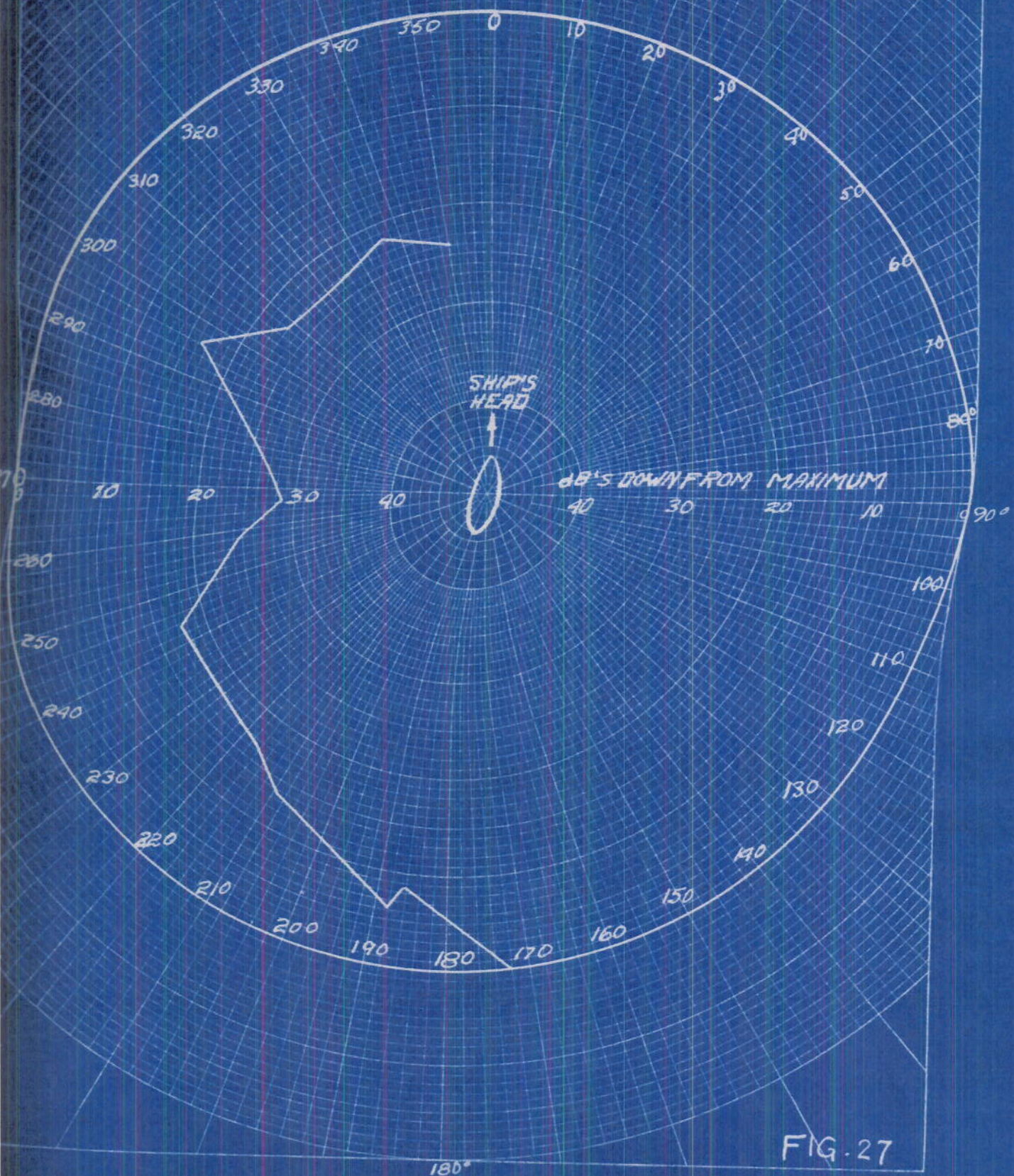


FIG. 27

HIGH-BAND SLEEVE  
ANTENNA  
FIELD PATTERN  
AT 475 MC

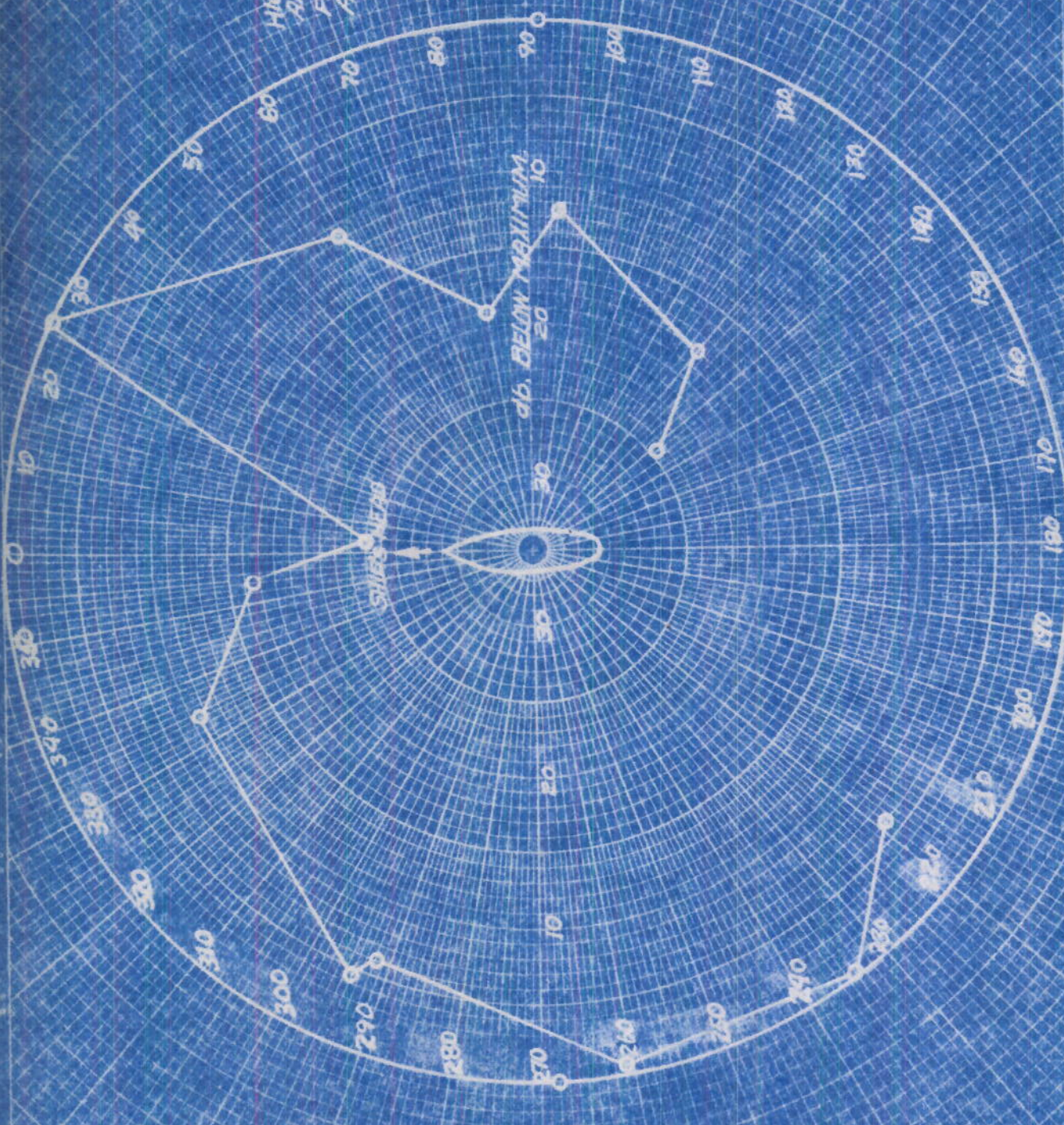


FIG. 28

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IMPEDANCE CHARACTERISTIC  
FOR HIGH-BAND SLEEVE ANTENNA

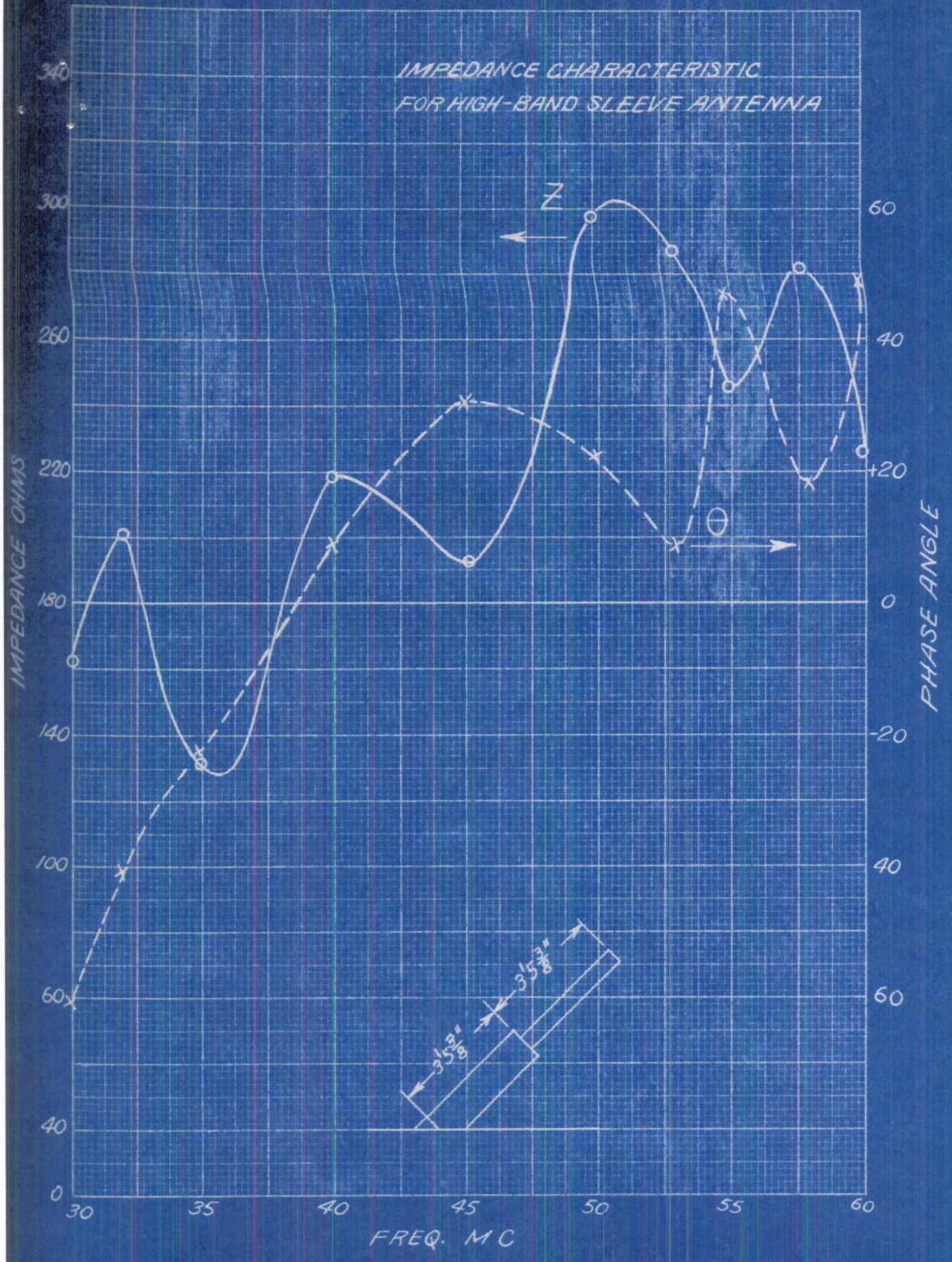


FIG. 29

IMPEDANCE CHARACTERISTIC  
FOR HIGH-BAND SLEEVE ANTENNA

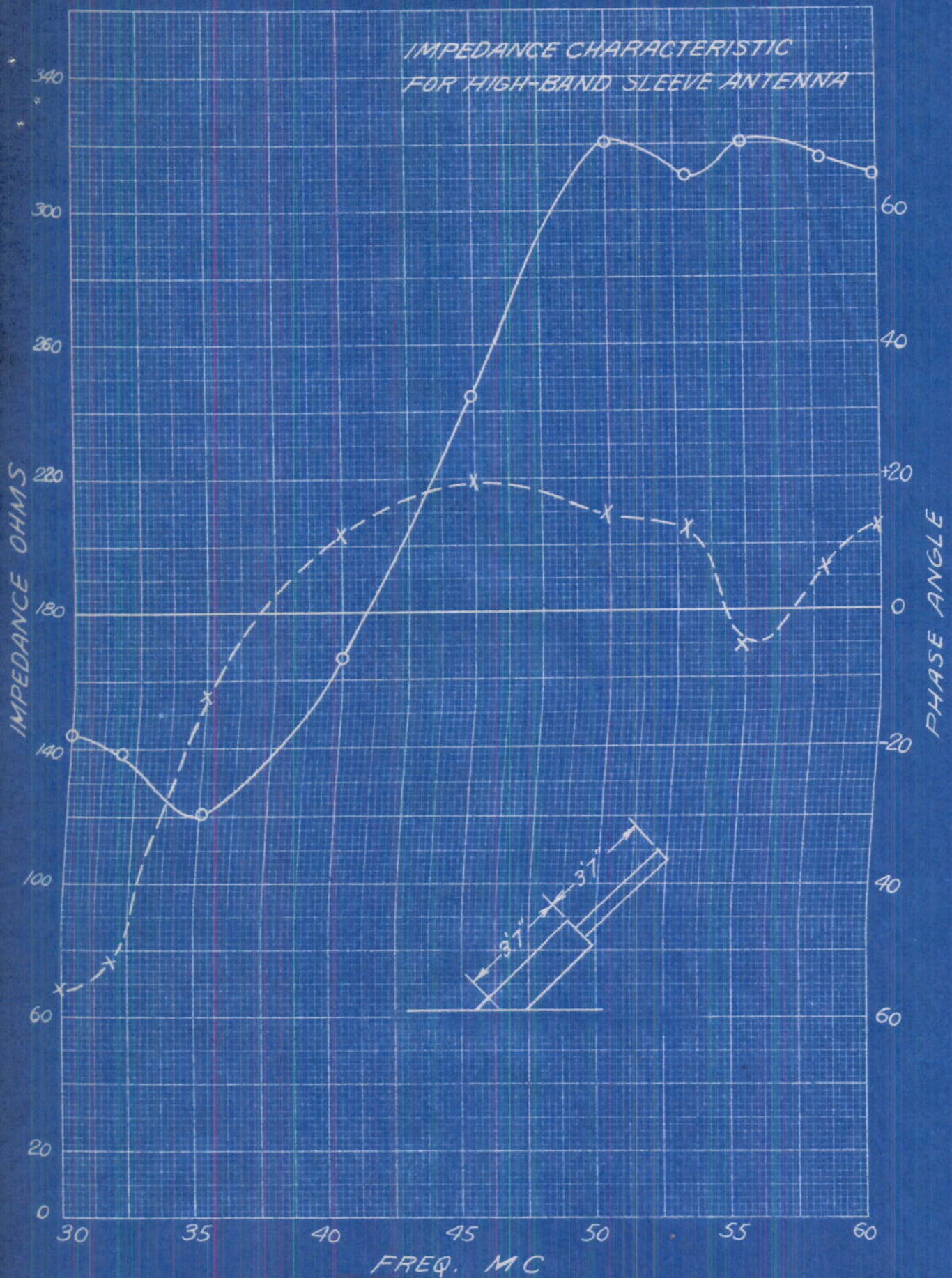


FIG. 30

COMPUTED STANDING-WAVE CHARACTERISTIC  
FOR HIGH-BAND SLEEVE ANTENNA WITH  
100  $\Omega$  TRANSFORMER SECTION

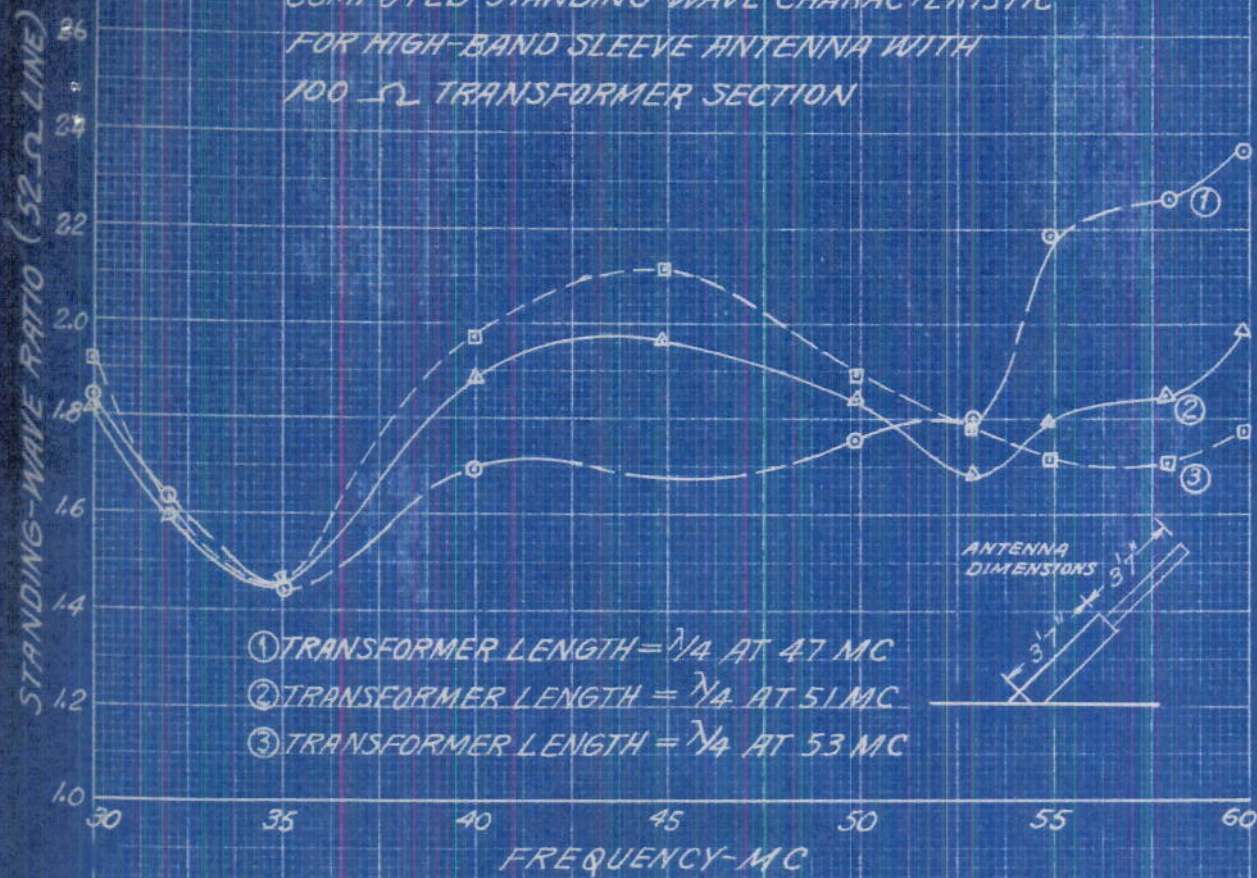


FIG. 31

COMPUTED STANDING-WAVE CHARACTERISTIC  
FOR HIGH-BAND SLEEVE ANTENNA WITH  
110  $\Omega$  TRANSFORMER SECTION

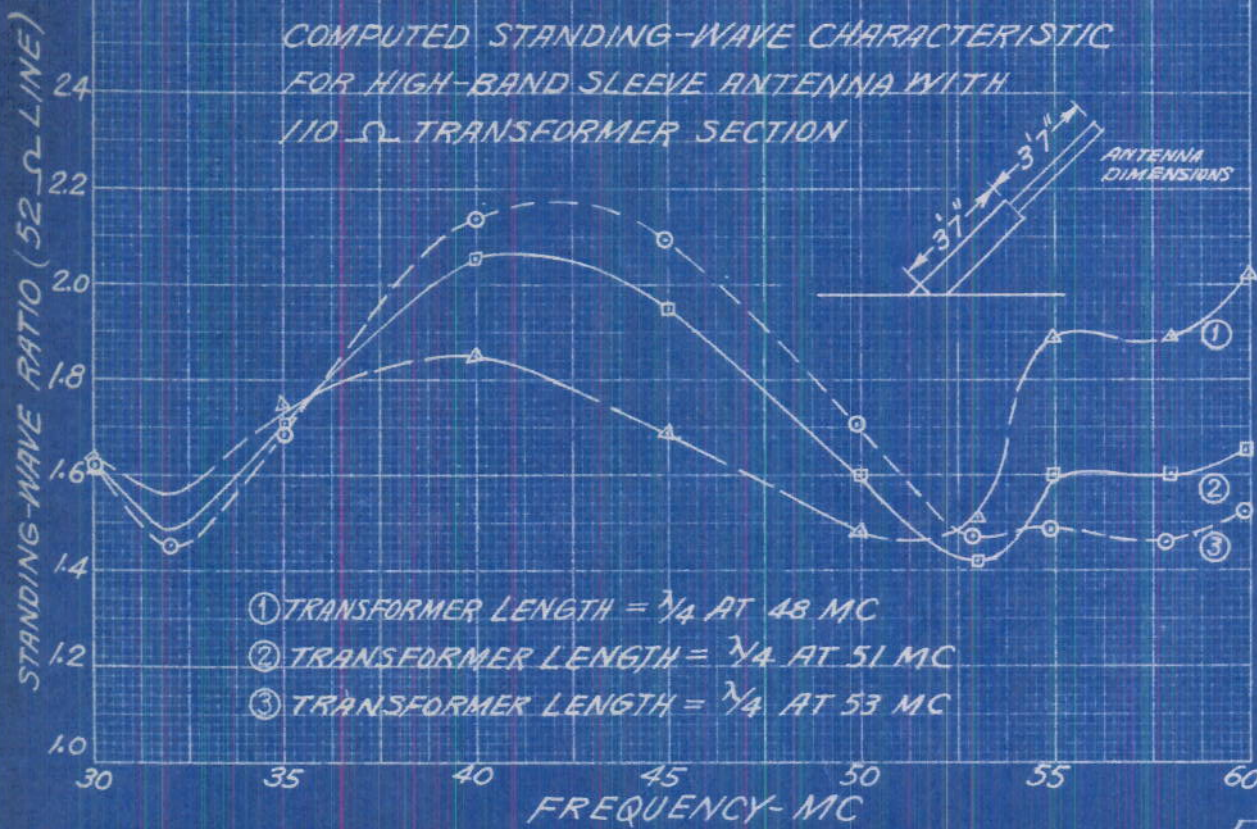


FIG. 32

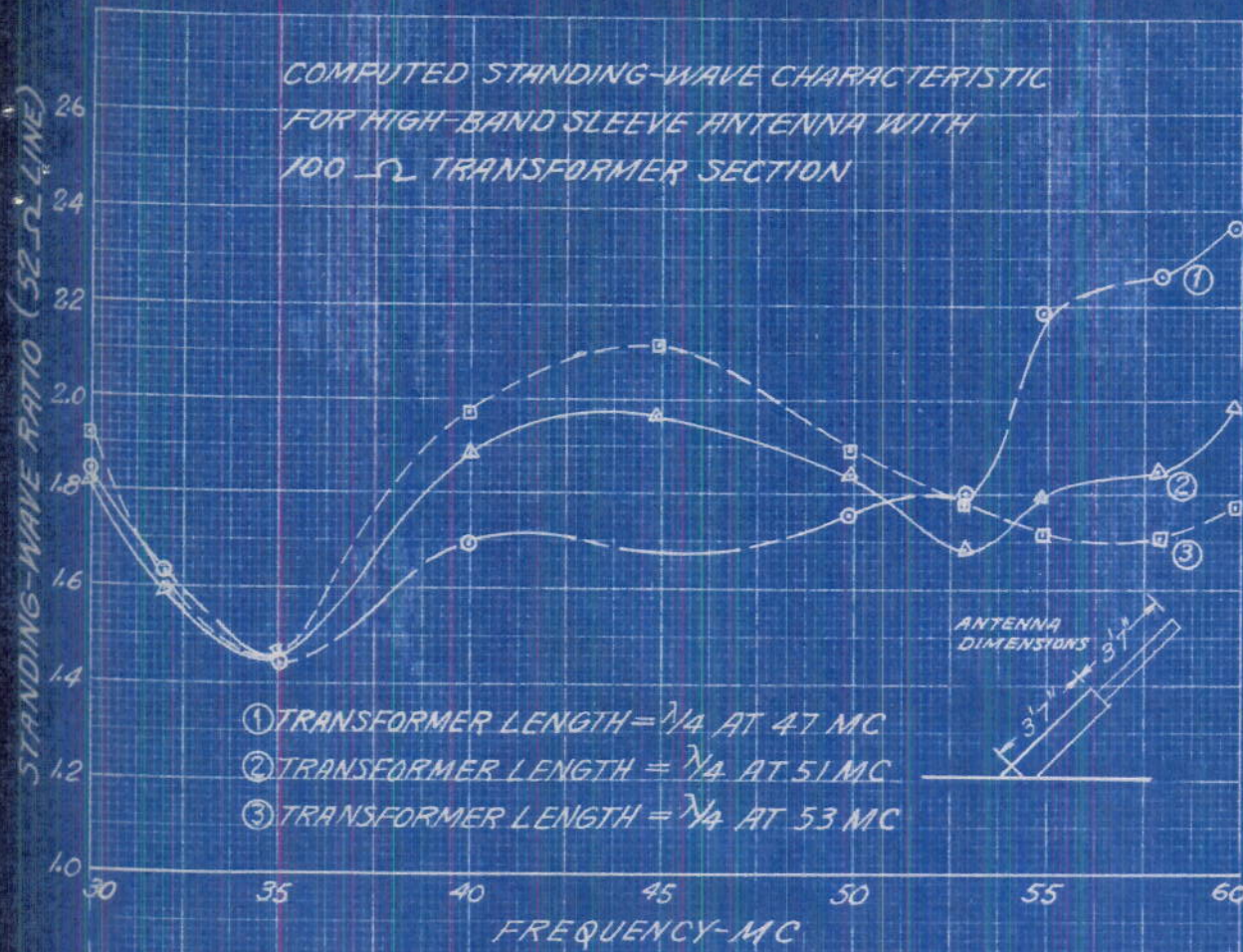


FIG. 31

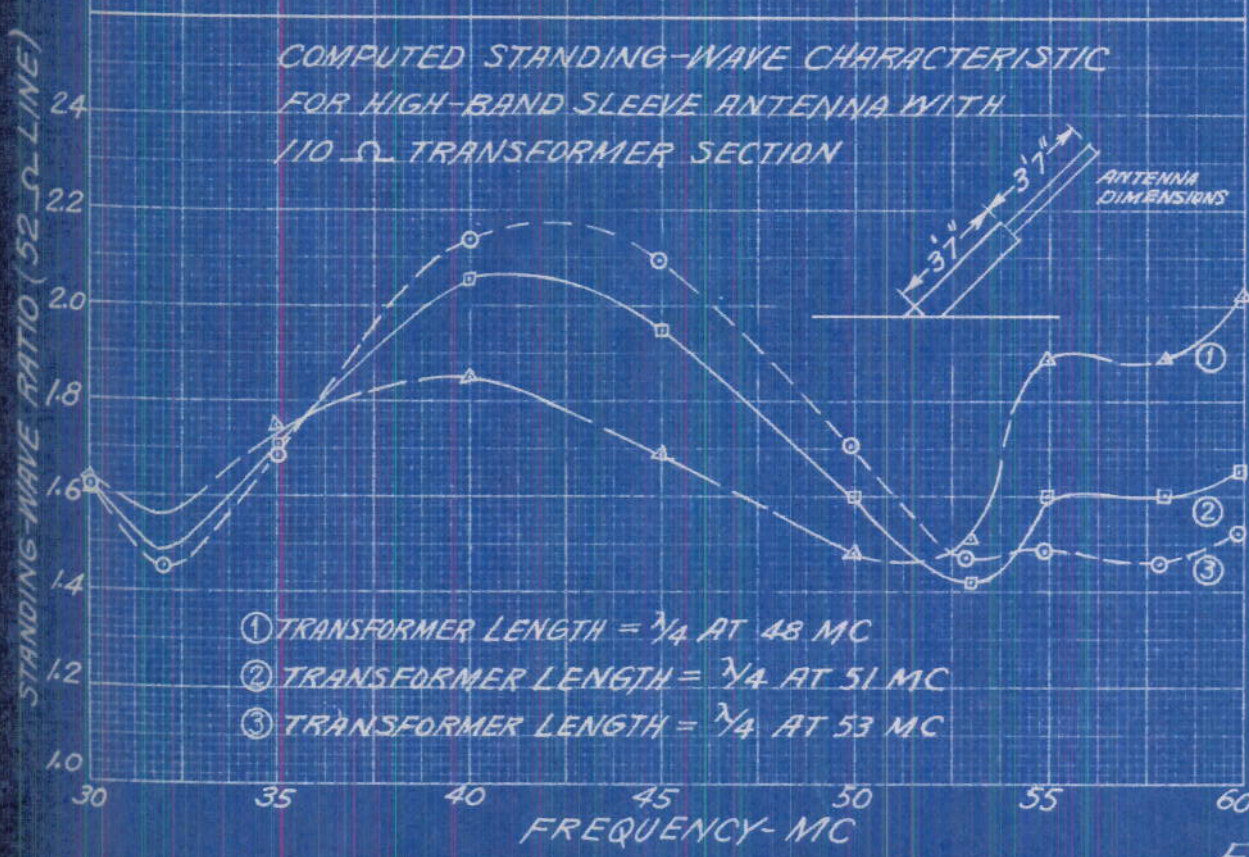


FIG. 32

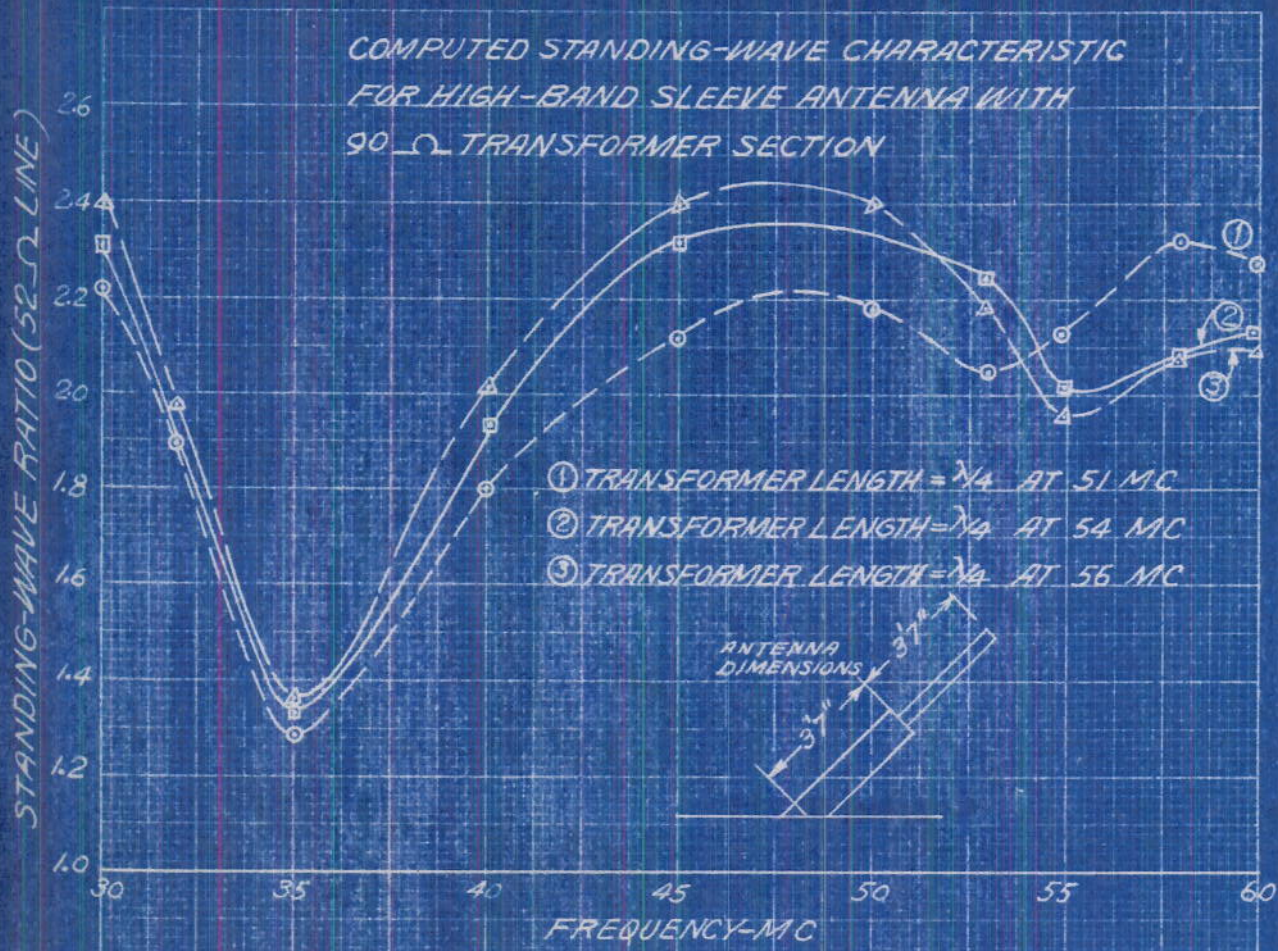


FIG. 33

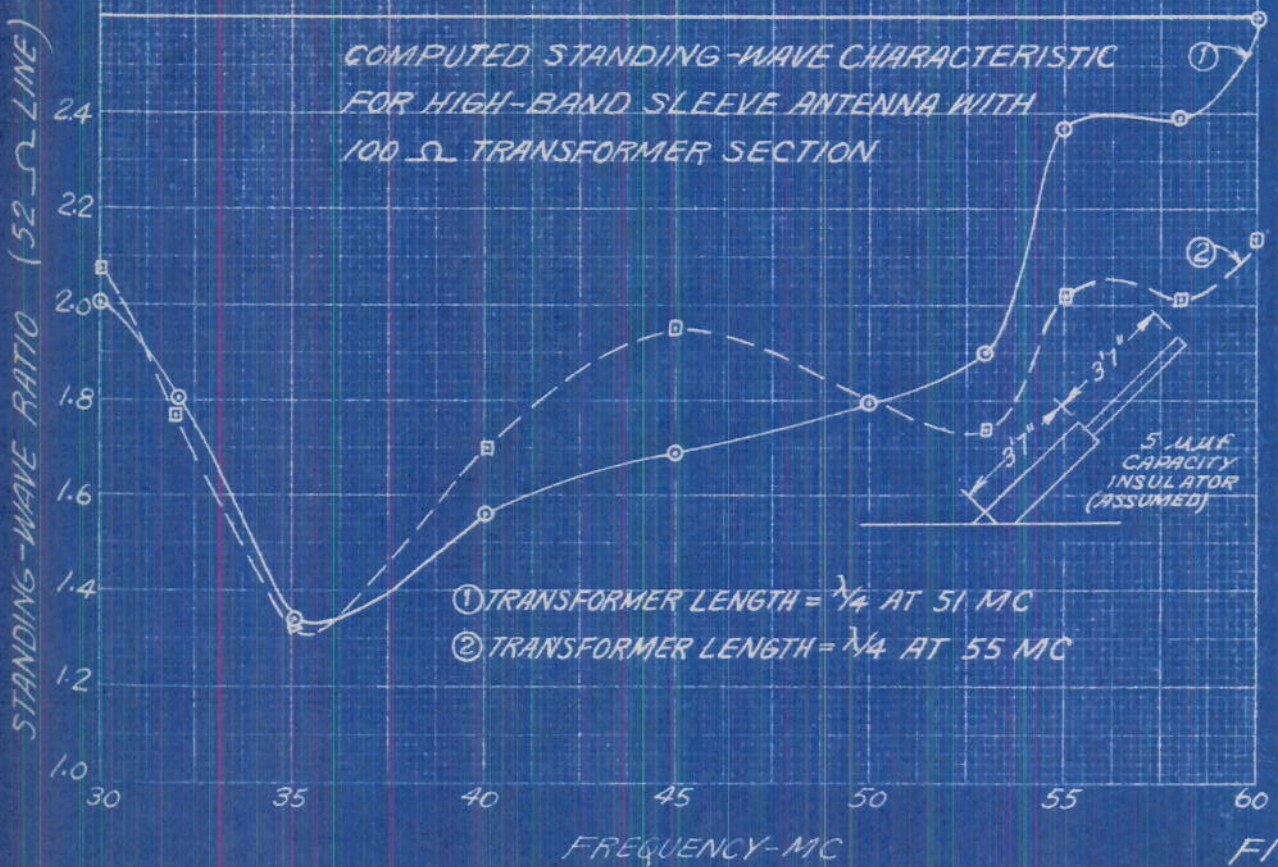


FIG. 34

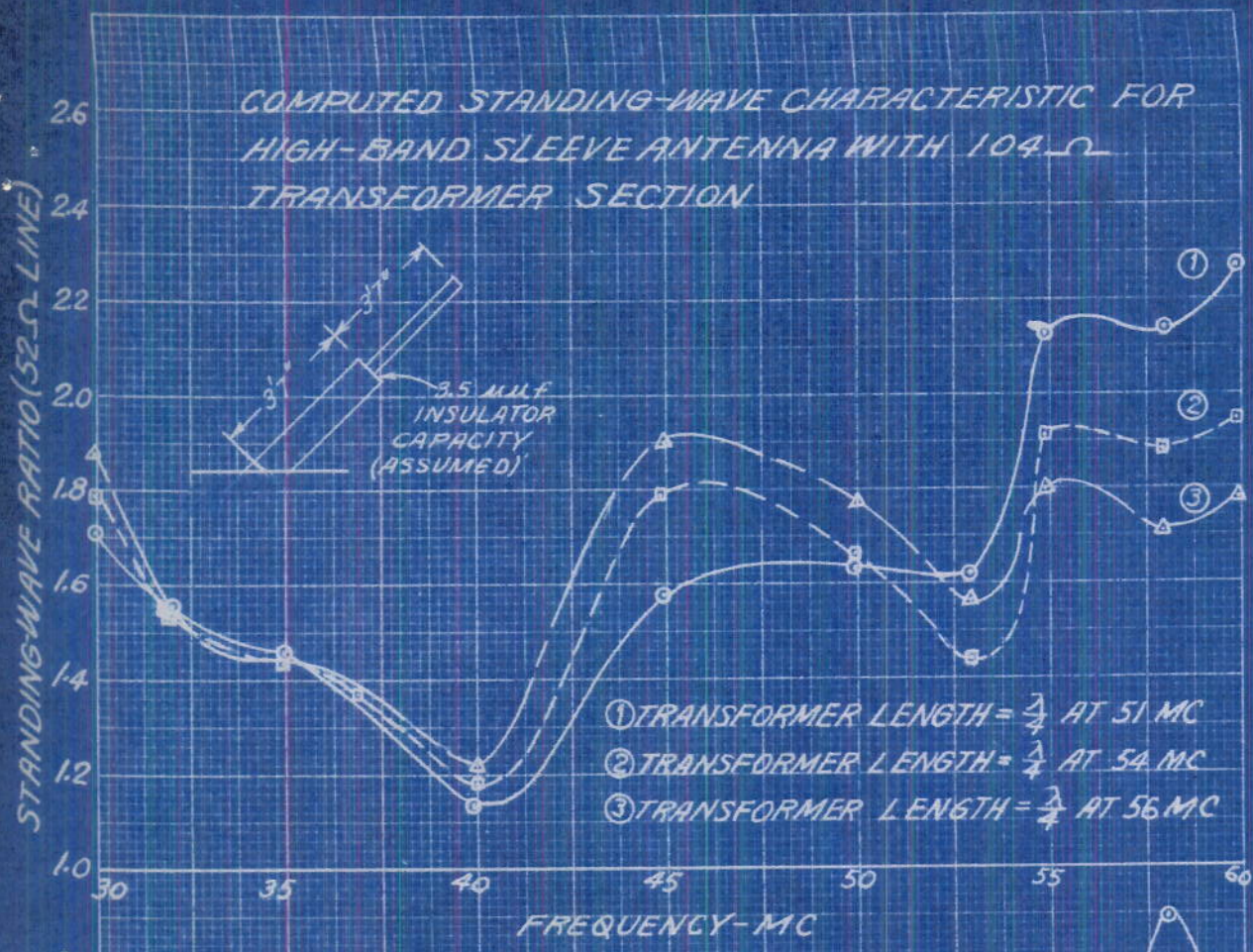


FIG. 35

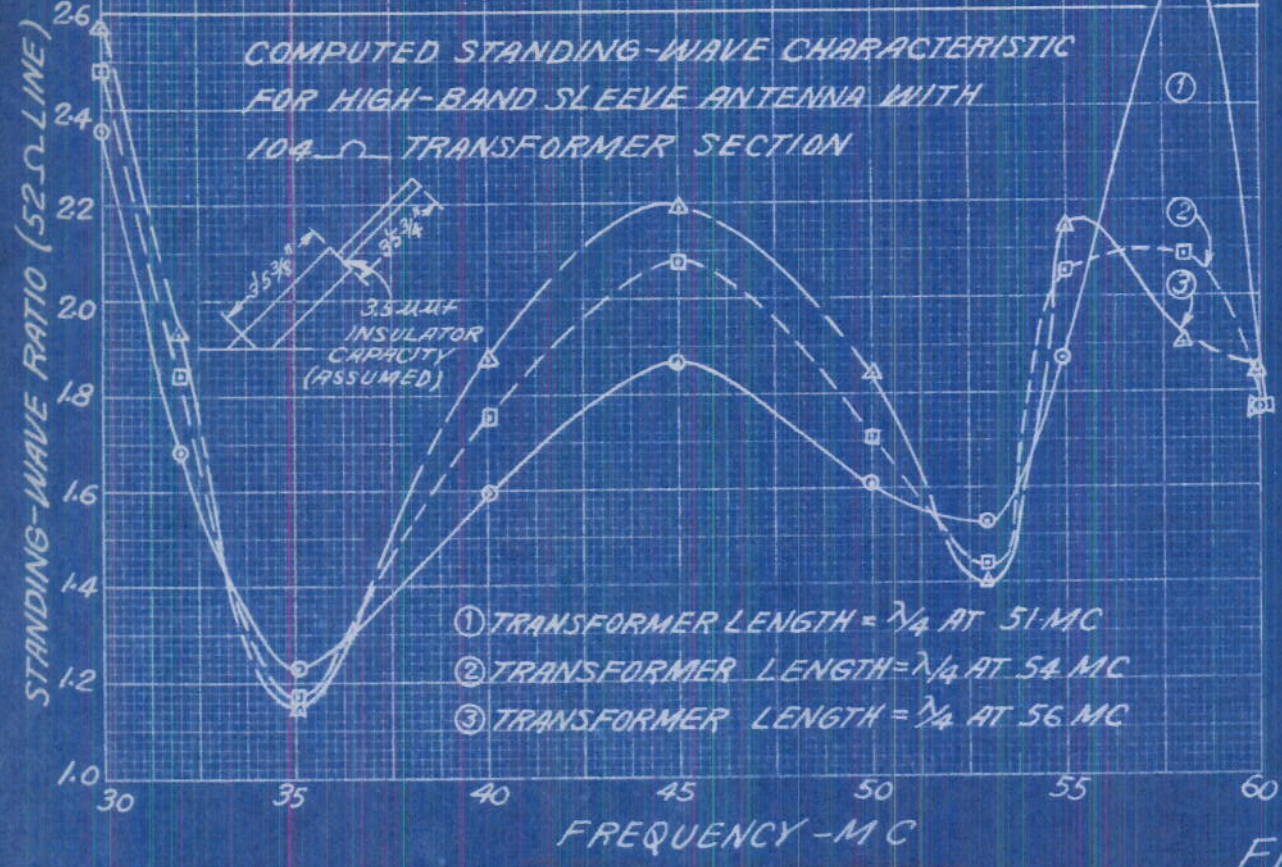


FIG. 36

COMPUTED STANDING-WAVE CHARACTERISTIC FOR LOW-BAND SLEEVE ANTENNA WITH 104 Ω TRANSFORMER SECTION

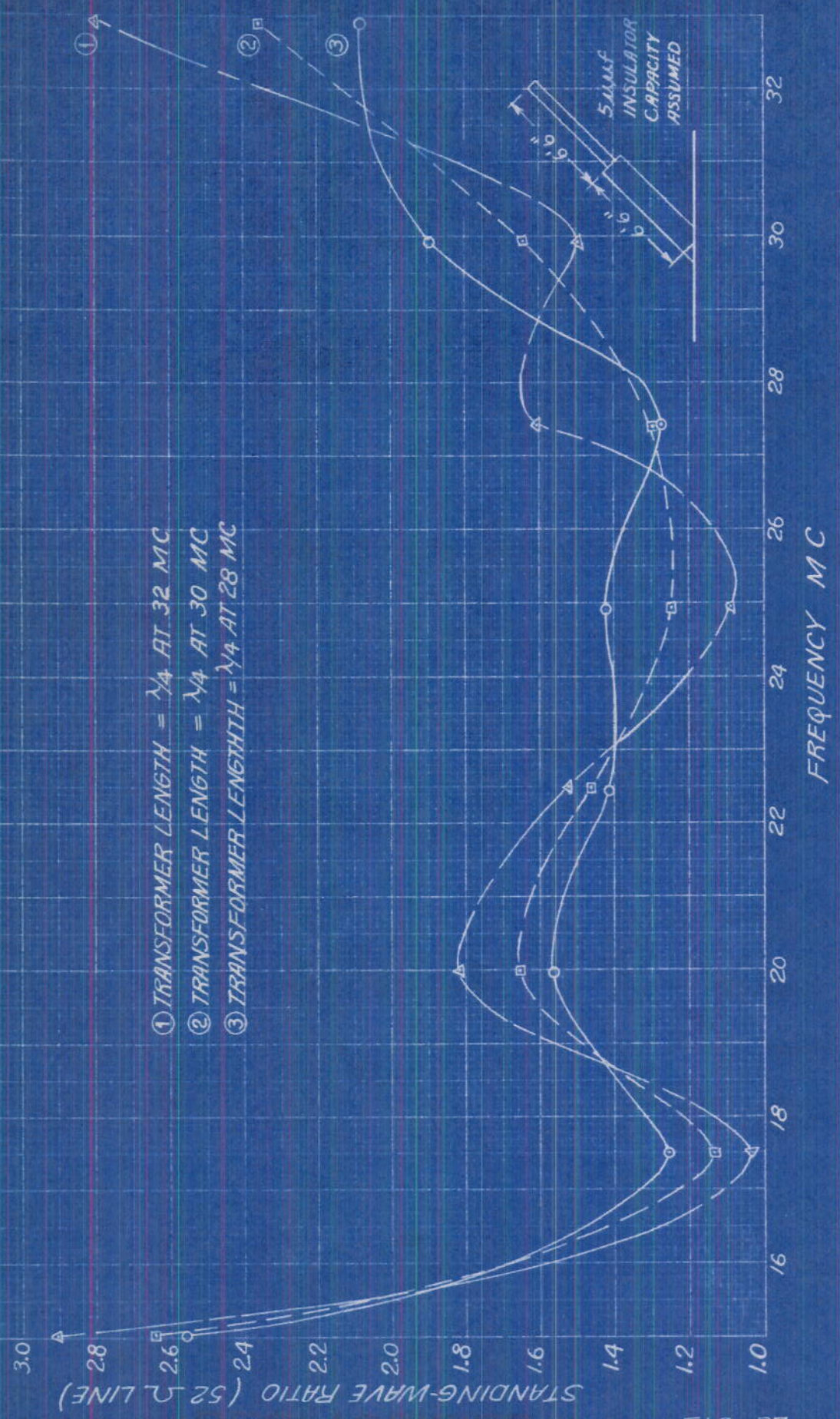


FIG. 37

COMPUTED STANDING-WAVE CHARACTERISTIC FOR LOW-BAND SLEEVE ANTENNA WITH 107.5 Ω TRANSFORMER SECTION

- ① TRANSFORMER LENGTH =  $\lambda/4$  AT 32 MC
- ② TRANSFORMER LENGTH =  $\lambda/4$  AT 30 MC
- ③ TRANSFORMER LENGTH =  $\lambda/4$  AT 28 MC

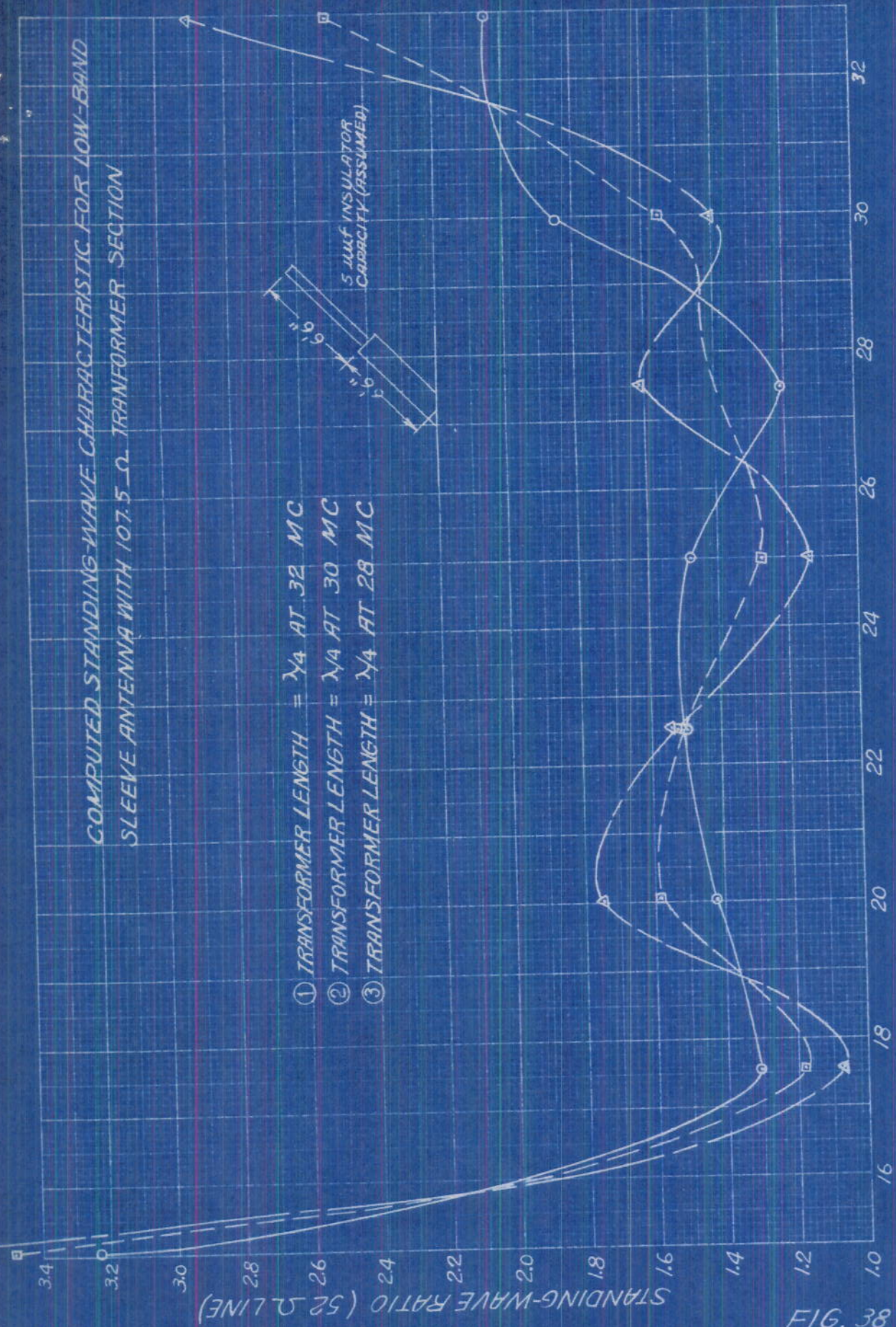
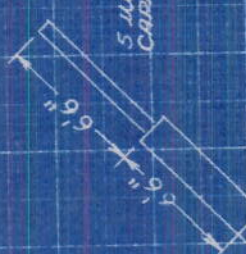


FIG. 38

STANDING-WAVE CHARACTERISTIC  
FOR FAN ANTENNA

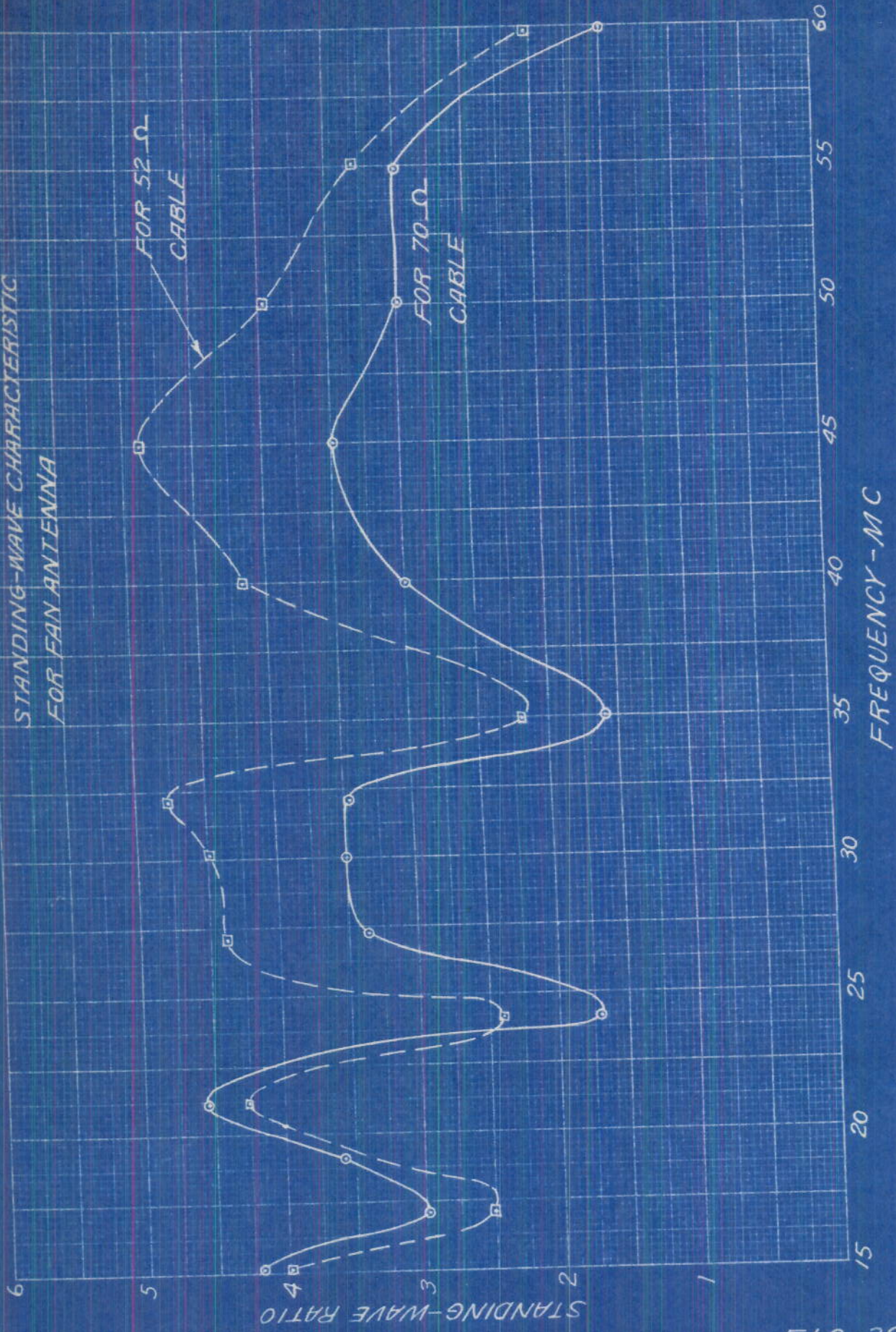
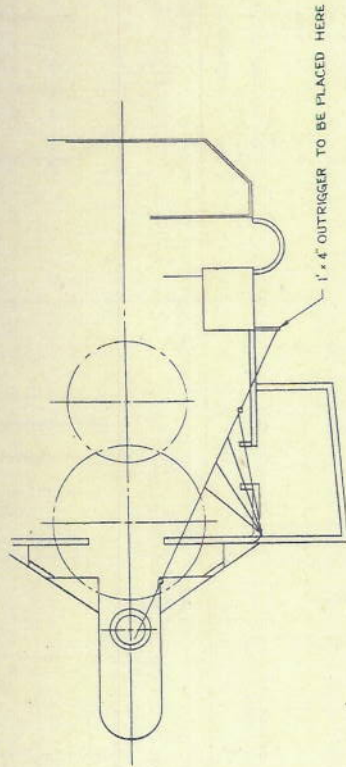
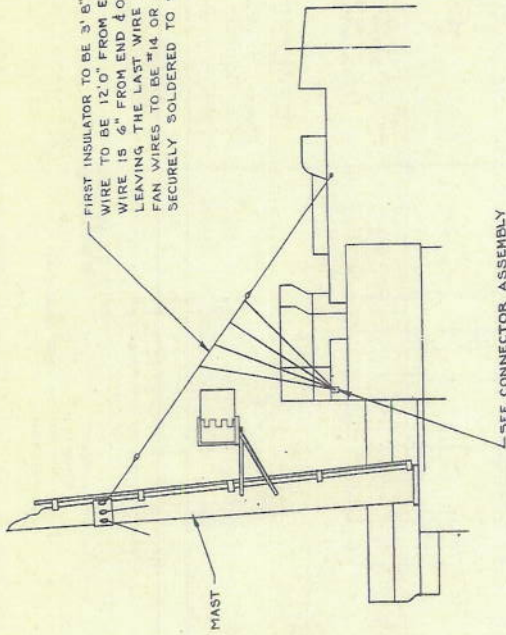


FIG. 39



1.4" OUTRIGGER TO BE PLACED HERE

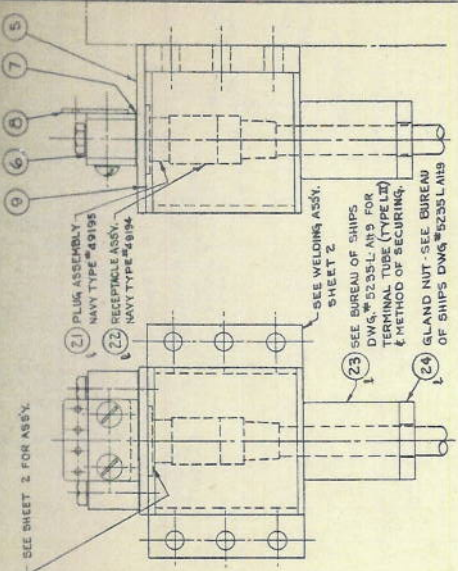


FIRST INSULATOR TO BE 3' 6" FROM MAST. CENTER WIRE TO BE 12.0" FROM END TO END. FIRST FAN WIRE IS 6" FROM END & OTHER 3 ARE SPACED 2' 1" LEAVING THE LAST WIRE 5' 3" FROM THE OTHER END. FAN WIRES TO BE #14 OR LARGER, STRANDED COPPER, SECURELY SOLDERED TO STAY.

LOWER FORESTAY ON STARBOARD SIDE SHOULD BE MOVED TO A NEW POSITION AS SHOWN & ATTACHED AT THE BOTTOM TO AN OUTRIGGER FROM ONE FOOT TO A FOOT & A HALF LONG & BROKEN WITH INSULATORS AS SHOWN

ANTENNA INSTALLATION DATA

SCALE 1/4" = 1'-0"  
RA 66F 264



CONNECTOR ASSEMBLY

NOTE:  
PART 1 OF CONNECTOR ASSEMBLY SHOULD BE WELDED OR SCREWED TO BRIDGE IN POSITION SHOWN  
SCALE-FULL SIZE  
RA 66F 264

DELINEATOR	B. ELLIOTT	DATE	10/1/44
TRACER	ORL	APPROVAL	W. H. Kelly
CHECKER		SUPPLY OF RADIO DIVISION	
FOR DIRECTOR			
BUREAU OF SHIPS			
REFERENCE			

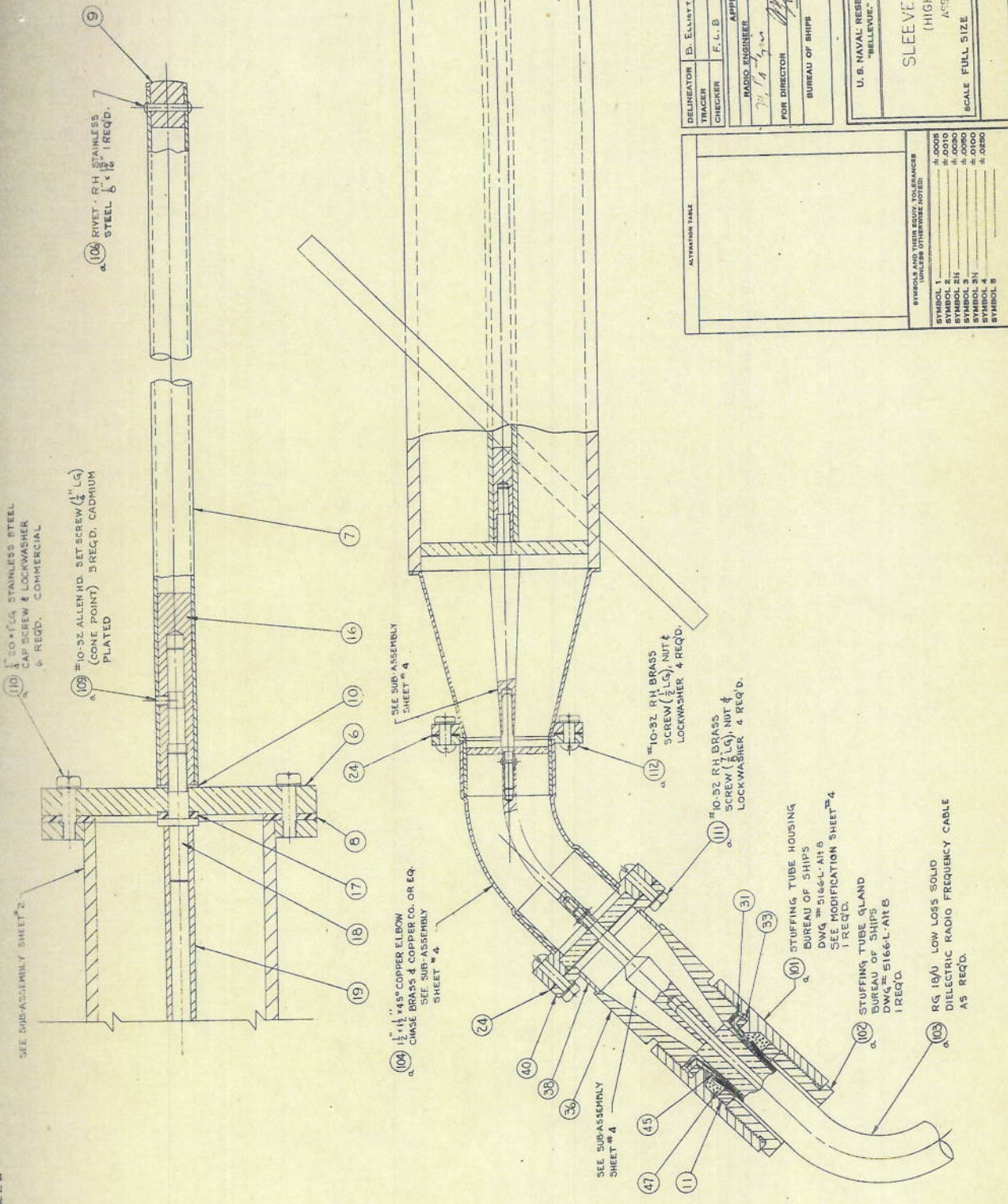
U. S. NAVAL RESEARCH LABORATORY  
"BELLEVUE" ANACOSTIA, D. C.

FAN ANTENNA  
FOR DE INSTALLATION  
ASSEMBLY

DATE FEB 11, 44

SCALE RA 66F 264B





DESIGNATOR	D. ELLIOTT	DATE	CRS.	BY	5/11
TRACER	F. L. B.				
APPROVAL					
SUPV. OF RADIO DIVISION					
RADIO ENGINEER					
FOR DIRECTOR					
BUREAU OF SHIPS					
U. S. NAVAL RESEARCH LABORATORY					
"BELLEVUE", ANACOSTIA, D. C.					
SLEEVE ANTENNA					
(HIGH BAND)					
ASSEMBLY					
SCALE FULL SIZE					
DATE FEB. 1, 44					
RA 66F 266A					

ATTENTION TABLE

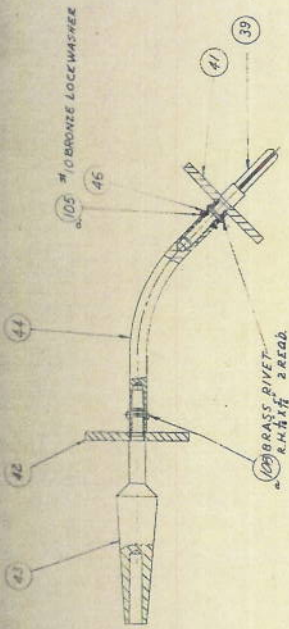
SYMBOLS AND THEIR EQUIV. TOLERANCES UNLESS OTHERWISE NOTED	
SYMBOL 1	± .0008
SYMBOL 2	± .0010
SYMBOL 3	± .0015
SYMBOL 3H	± .0020
SYMBOL 4	± .0100
SYMBOL 5	± .0250

DECLASSIFIED



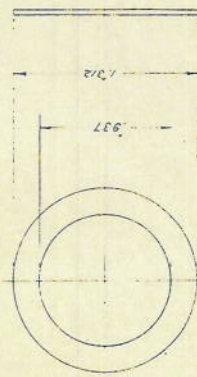


DECLASSIFIED



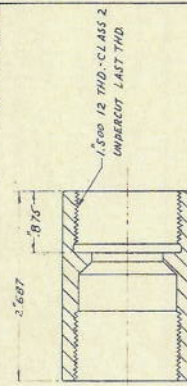
SUB ASSEMBLY  
LOWER INNER CONDUCTOR

SCALE: FULL SIZE  
RA 66F 266



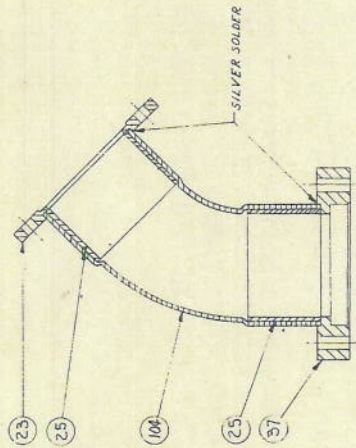
31 GASKET  
NEOPRENE 1/32 THK.  
SYMBOL 3 1  
1 RECD.

SCALE: 2 1/4 IN 1 IN  
RA 66F 266

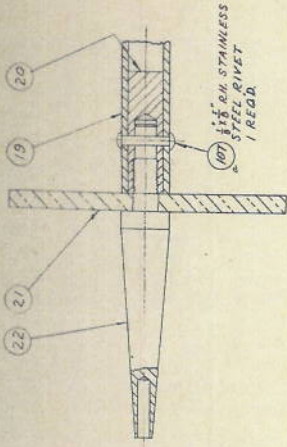


MODIFICATION PT #101  
SYMBOL 3

SCALE: FULL SIZE  
RA 66F 266

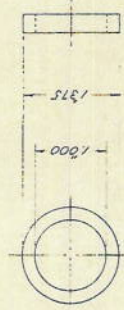


ELBOW SUB ASSEMBLY



SUB ASSEMBLY  
UPPER INNER CONDUCTOR

SCALE: FULL SIZE  
RA 66F 266



33 SPACER  
BRASS COMP. B-N 1/2 THK.  
SYMBOL 3  
1 RECD.

SCALE: FULL SIZE  
RA 66F 266

DELINEATOR	L. B. M/S	APPROVAL	SUPT. OF RADIO DIVISION
CHECKER	F. L. B.	C.R.S.	
RADIO ENGINEER		FOR DIRECTOR	
BUREAU OF SHIPS		REFERENCE	
U.S. NAVAL RESEARCH LABORATORY		"BELLEVUE", ANACOSTIA, D. C.	

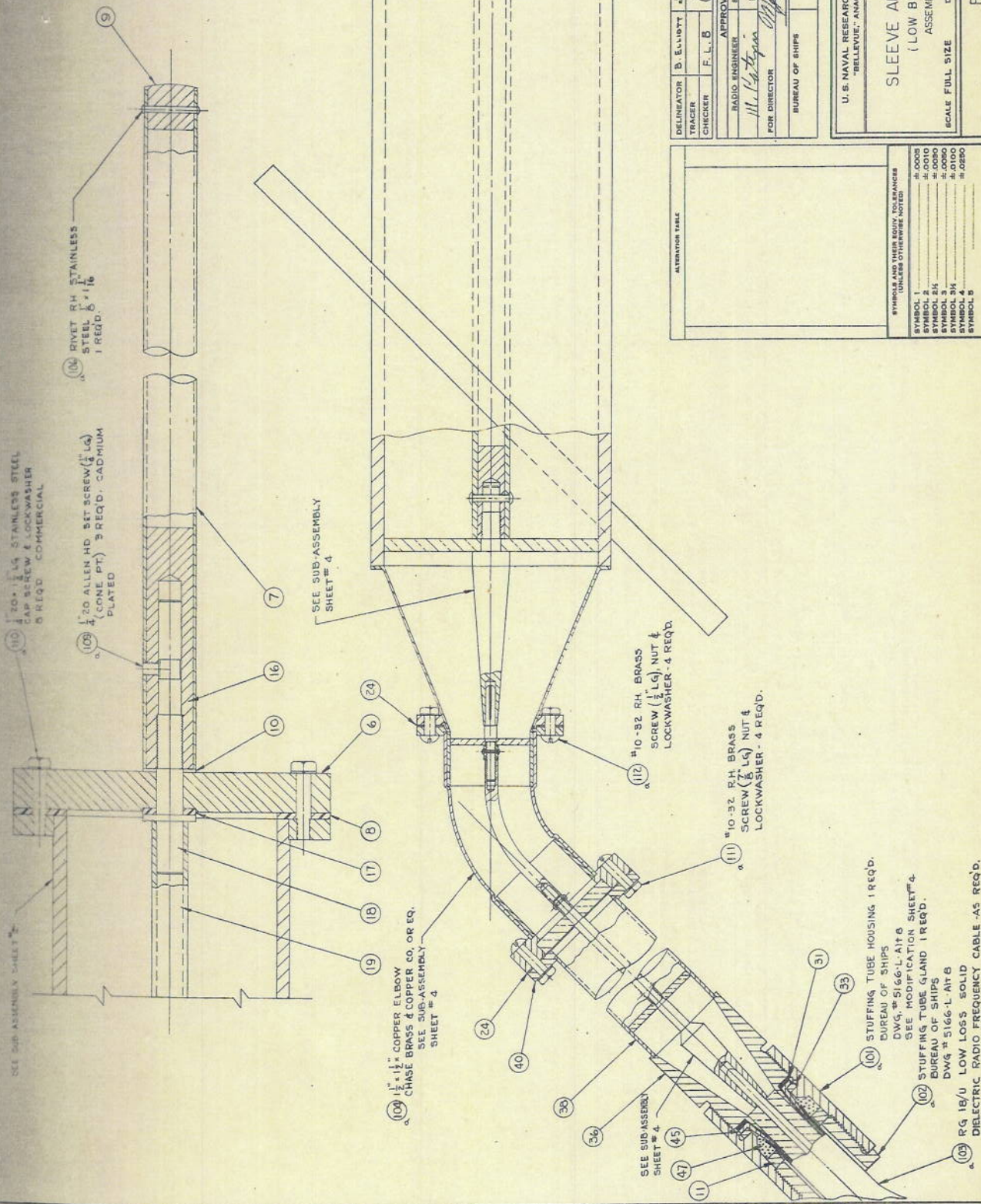
SLEEVE ANTENNA  
(HIGH BAND)  
SUB ASSEMBLY B DETAILS  
DATE FEB. 1, 1944  
SCALE  
RA 66F 266

SYMBOLS AND THEIR EQUIV. TOLERANCES  
(UNLESS OTHERWISE NOTED)

SYMBOL 1	± .0005
SYMBOL 2	± .0010
SYMBOL 2H	± .0020
SYMBOL 3K	± .0100
SYMBOL 4	± .0200
SYMBOL 5	± .0300



DECLASSIFIED



DELINEATOR	B. E. V. D. T.	APPROVAL	CHIEF ENGINEER
CHECKER	F. L. B.	RADIO ENGINEER	BUFT. OF RADIO DIVISION
		FOR DIRECTOR	U. S. NAVAL RESEARCH LABORATORY
		BUREAU OF SHIPS	BELEFUEVE, ANACOSTIA, D. C.
		REFERENCE	

U. S. NAVAL RESEARCH LABORATORY  
BELEFUEVE, ANACOSTIA, D. C.

SLEEVE ANTENNA  
(LOW BAND)  
ASSEMBLY

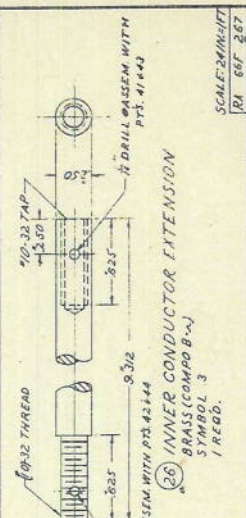
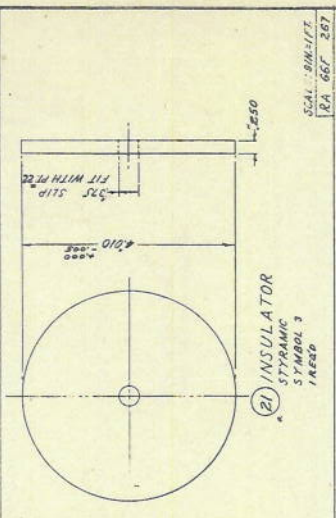
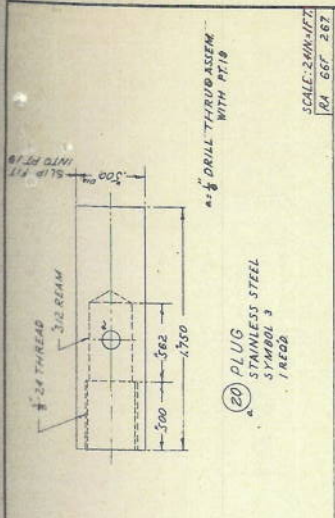
SCALE FULL SIZE DATE FEB. 1, 44

RA 66F 267A

5 SHEETS SHEET 1

SYMBOLS AND THEIR MEANINGS (UNLESS OTHERWISE NOTED)	
SYMBOL 1	± .0008
SYMBOL 2	± .0010
SYMBOL 3	± .0030
SYMBOL 4	± .0100
SYMBOL 5	± .0200





DELIMITATOR	F. B. Mc	APPROVAL	RADIO ENGINEER
TRACER	F. L. B.	FOR DIRECTOR	BUREAU OF SHIPS
CHECKER		COMDR U.S.N.	REFERENCE

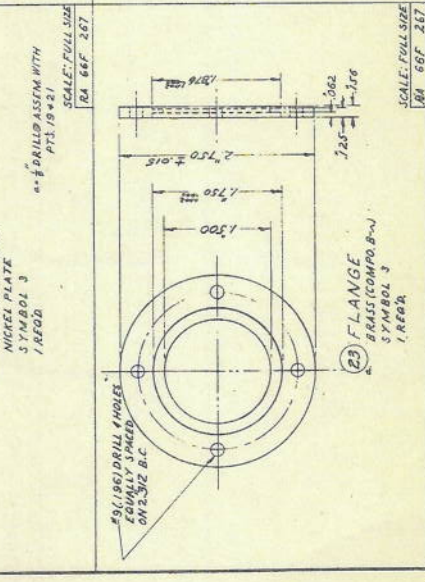
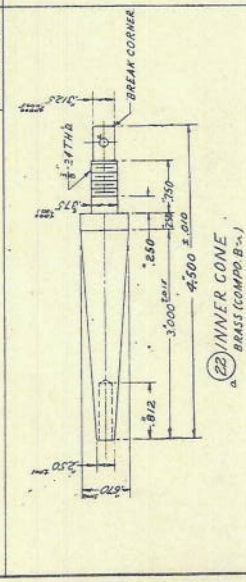
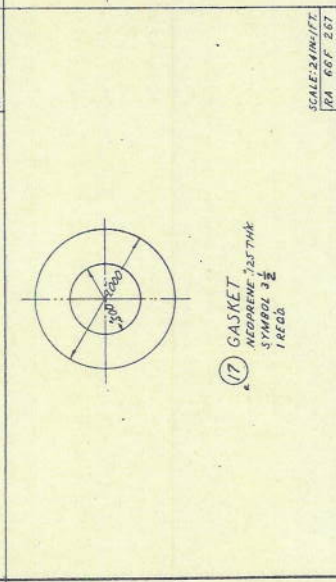
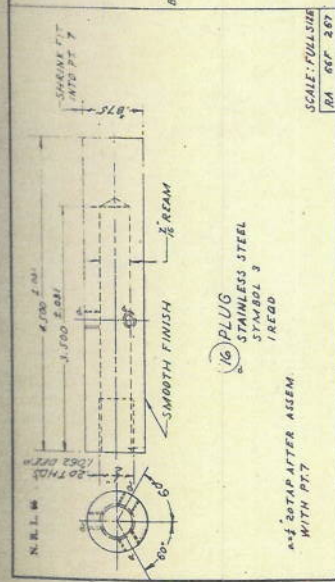
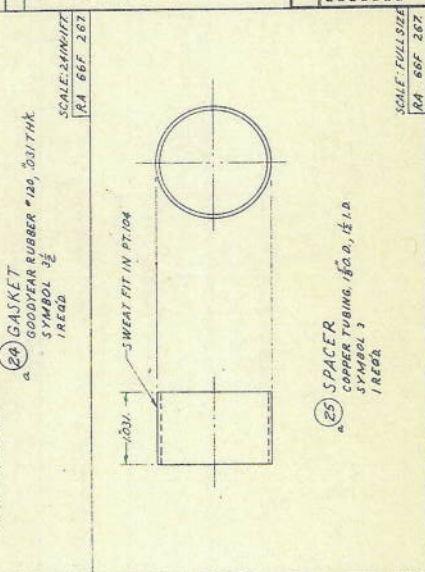
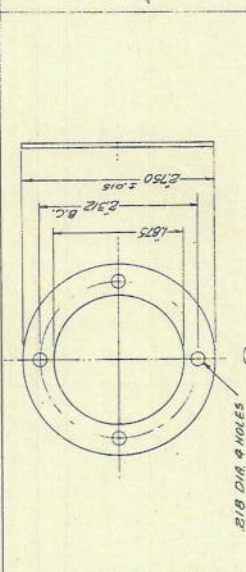
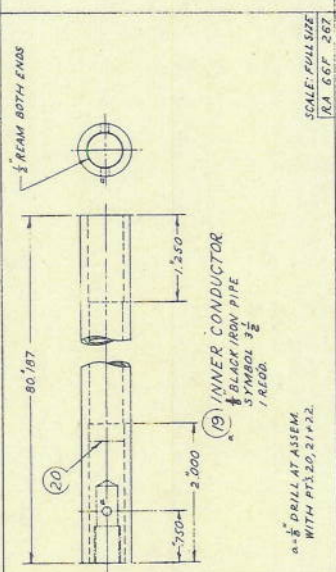
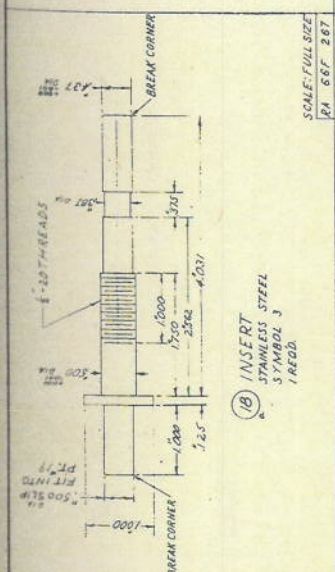
U.S. NAVAL RESEARCH LABORATORY  
"BELLEVUE", ANACOSTIA, D. C.

SLEEVE ANTENNA  
(LOW BAND)  
DETAILS

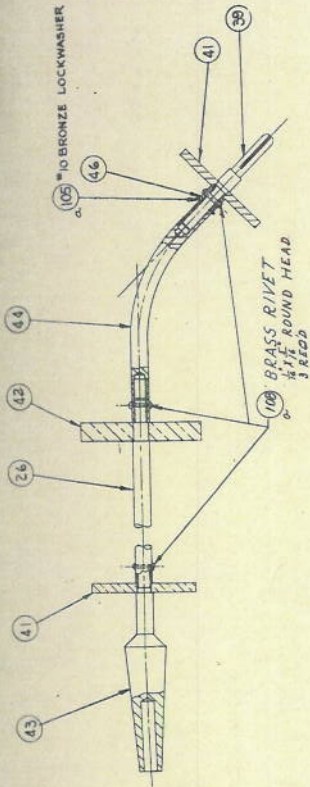
DATE FEB. 1, 1944

SCALE RA 66F 267

SHEET 34

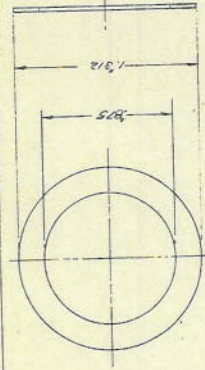


DECLASSIFIED



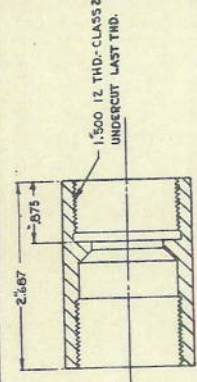
SUB ASSEMBLY LOWER INNER CONDUCTOR

SCALE: FULL SIZE RA 66F 267



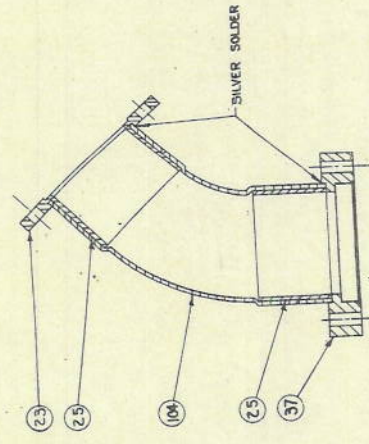
51 GASKET NEOPRENE 1/25 THK SYMBOL 34 1 REQD

SCALE: 2X/1X RA 66F 267

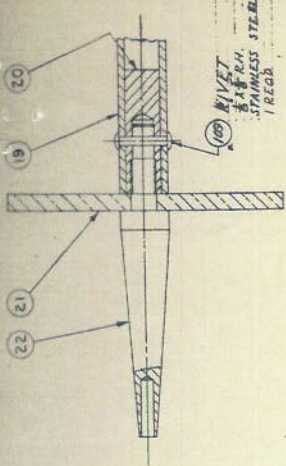


MODIFICATION PT 101 SYMBOL 3

SCALE: FULL SIZE RA 66F 267

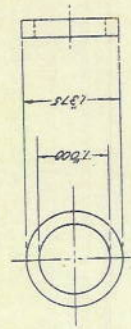


ELBOW SUB ASSEMBLY



SUB ASSEMBLY UPPER INNER CONDUCTOR

SCALE: FULL SIZE RA 66F 267



93 SPACER BRASS (COMPO. 80% Cu, 20% Zn) SYMBOL 3 1 REQD

SCALE: FULL SIZE RA 66F 267

DESIGNATOR	ARC	APPROVAL
TRACER	F. L. D.	CRS.
CHECKER		
RADIO ENGINEER	SUPT. OF BUREAU ELECTRICAL	
FOR DIRECTOR		
BUREAU OF RHPS		
GENERAL M.A.N.		
REFERENCE		

U. S. NAVAL RESEARCH LABORATORY  
"BELLVUE", ANACOSTIA, D. C.

SLEEVE ANTENNA  
(LOW BAND)  
SUB-ASSEMBLY B. DETAILS  
DATE: FEB. 1, 1944

SCALE: FULL SIZE  
RA 66F 267

SYMBOLS AND THEIR EQUIV. TOLERANCES (UNLESS OTHERWISE NOTED)

SYMBOL 1	± .0008
SYMBOL 2	± .0010
SYMBOL 3	± .0012
SYMBOL 3H	± .0008
SYMBOL 3H	± .0008
SYMBOL 4	± .0100
SYMBOL 5	± .0200

