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NRL REPORT NO. R-2251

DATE 10 March 1944

SUBJECT

Antennas for Guided Missiles Countermeasures
Installed on DD-425 and DD-427

by

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NAVY DEPARTMENT

Report on

ANTENNAS FOR GUIDED MISSILES COUNTERMEASURES
INSTALLED ON DD-425 AND DD-427.



NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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INDEX

Subject	Page
INTRODUCTION	1
METHODS	1
DATA OBTAINED	2
CONCLUSIONS AND RECOMMENDATIONS	3
FIGURES 1 - 17	

APPENDIX

Drawings:
RA 66F 269A

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INTRODUCTION

1. The work reported here was carried out under the authorization of NRL Problem S444.1R-S, priority AAA.

2. The problem was to determine the most suitable locations aboard DD's for the sleeve and fan antennas which had been developed for DE application in connection with guided missiles countermeasures. These antennas have been described, and constructional drawings given in NRL Report R-2240. Installations of antennas and equipment were to be made on two destroyers at New York Navy Yard within approximately a week's time. The two destroyers were DD-425 and DD-427.

METHODS

3. As pointed out in Report R-2240, it was considered that two sets of antennas would be required for DD's to obtain adequate 360° coverage. From the experience gained in the DE work, the best positions on the DD's were judged to be along the top edge of the pilot house, the high-band sleeve antennas at the front and the low-band sleeves at the rear, in locations which would orient them at 45° to the ship's head and to the vertical. Such an arrangement would have the high-band antennas pointing toward the forward quarters and the low-band antennas pointing toward the aft quarters.

4. The design engineers of the Navy Yard would not agree to cutting into the pilot house structure on an experimental basis, and suggested that the antennas be mounted out from the pilot house on brackets, so that it would not be necessary to cut into the pilot house structure. Although it appeared doubtful that this would yield the proper impedance characteristics, it was agreed to make a trial installation and determine the characteristics by measuring the standing-wave-ratios.

5. Alternate locations were also chosen for investigation. For the high-band sleeves, positions on the forward part of the splinter shield of the pilot house bridge were chosen which allowed the antennas to protrude at the desired 45° angles. For the low-band sleeves, the alternate positions were over the side at the aft end of the pilot house bridge slightly below the coaming. These positions turned out to be the ones which had to be used.

6. Measurements of standing-wave-ratio were made in the same way as described in Report R-2240. Measurements were made for all four locations (two for each antenna band).

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7. For the low-band antenna locations described in paragraph 5, the antennas protruded out beyond the docking line, and it was necessary, therefore, to incorporate a hinge in the mounting so that the low-band antennas could be swung in to a vertical position when docking. This was arranged by welding a flat plate to the ship, and hinging the antenna mounting plate to it at the top. Four dogs along the sides were used to provide contact pressure. Since the mounting plates were steel, bronze rings about ten inches in diameter were brazed on the two contacting surfaces to provide good electrical contact.

8. A fan antenna substantially of the dimensions determined for the DE was installed from the foremast to an outrigger on the starboard side of the pilot house. The hub of the fan was located on the back of the Mark 37 director.

9. Receiving equipment considerations had made it desirable to have two fan antennas available, in order to reduce crosstalk between low and high-band receivers. Accordingly, a second fan was installed on the port side, in the same way as the starboard fan, but with dimensions approximately 25% longer.

10. After the installations were completed, patterns were taken on the antennas of DD-425, using DD-427 as transmitting ship. A vertical whip antenna mounted at the top rear of the Mark 37 director was used as radiator. DD-427 lay at anchor, while DD-425 pivoted around in a circle.

DATA OBTAINED

11. The measured standing-wave-ratios for the locations described in paragraph 3 are plotted in Figs. 1-2. The results were very poor. Attempts were made to improve performance by installing fairing plates from the mounting brackets to the side of the pilot house, to give a greater surface for the base currents. However, the measurements still showed unsatisfactory performance.

12. The measurements of standing-wave-ratios for the positions described in paragraph 5 are plotted in Figs. 3-4. The standing-wave-ratio of the low-band sleeve is below 2:1 from 18.5 to 30.3 Mc/s. From 16 to 32.5 Mc/s the standing-wave-ratio does not exceed 2.6:1. The high-band sleeve has better than a 2:1 standing-wave-ratio from 34 to 54 Mc/s, and better than 3:1 from 31 to 59 Mc/s. Thus, the combination provides a fair overlap to give coverage over the entire band.

13. The results of the measurements on the fan antennas are shown in Fig. 5. It is seen that the longer fan, on the port side, covers the entire range from 15 to 60 Mc/s, exceeding 5:1 standing-wave-ratio slightly only between 25 and 26 Mc/s. The

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starboard fan, however, gives poorer results, exceeding 5:1 between 24 and 33 Mc/s and at 16 Mc/s. Time did not permit making any alterations for improving the performance, however.

14. Patterns were taken at 55 Mc/s for the two fans and the two high-band sleeves on DD-425. The data obtained are plotted in Figs.6-7. Other pattern measurements were attempted at other frequencies, as well as on the low-band sleeves, but due to difficulties which were encountered during the maneuvers, only partial data could be obtained in the time available.

15. From the patterns taken at 55 Mc/s, it is seen that the combination of two antennas for each band provides adequate 360° coverage. Copies of the data obtained were left with the ship for guidance of the operating personnel.

16. For purposes of comparison, Fig.8 shows the standing-wave-ratio obtained with the low frequency sleeve antenna previously tested on DE-170. Fig.9 shows the location of the sleeve and fan antennas on DE's.

17. After work on the DD installations had been completed, a new simplified design for the fan antenna feed connection for DD's was made. This is given on Drawing No. RA 66F 269A.

18. Photographs

Fig.10 shows the 30-55 Mc sleeve antenna mounted in its final position. Fig.11 is a close-up of the cable connection to the impedance matching transformer at the base of the 30-55 Mc sleeve antenna. Fig.12 shows the 15-30 Mc antenna in its final form. Fig.13 shows the hinged mounting of this antenna in the secured position, while Fig.14 shows the mounting in its operating position. Figs.15, 16 and 17 show details of the 15-60 Mc fan receiving antenna.

CONCLUSIONS AND RECOMMENDATIONS

19. The antennas installed on the DD's give adequate coverage of the necessary frequency range. Considering that the antennas were designed on the basis of measurements made on a DE, it is a matter of good luck that the performance on the DD turned out as well as it did.

20. The locations finally chosen for the DD installations cannot be considered as entirely satisfactory. The high-band antennas, which are mounted forward, come within the range of fire of the 20 mm guns on the lower deck when these are directed aft at high angles. The installation of the low-band antennas involves a great deal of difficult work. For installation on a wide scale, further investigation aimed at simplifying the installational design should be made.

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21. Both of the objections mentioned in paragraph 20 would have been avoided if the locations described in paragraph 3 had proved satisfactory. It is still considered that these locations are the logical ones from an antenna point of view, and it is believed that the results obtained would be satisfactory if the mountings were made as originally suggested. If an appreciable number of DD's are to be fitted with these installations, further work on these positions would be warranted.

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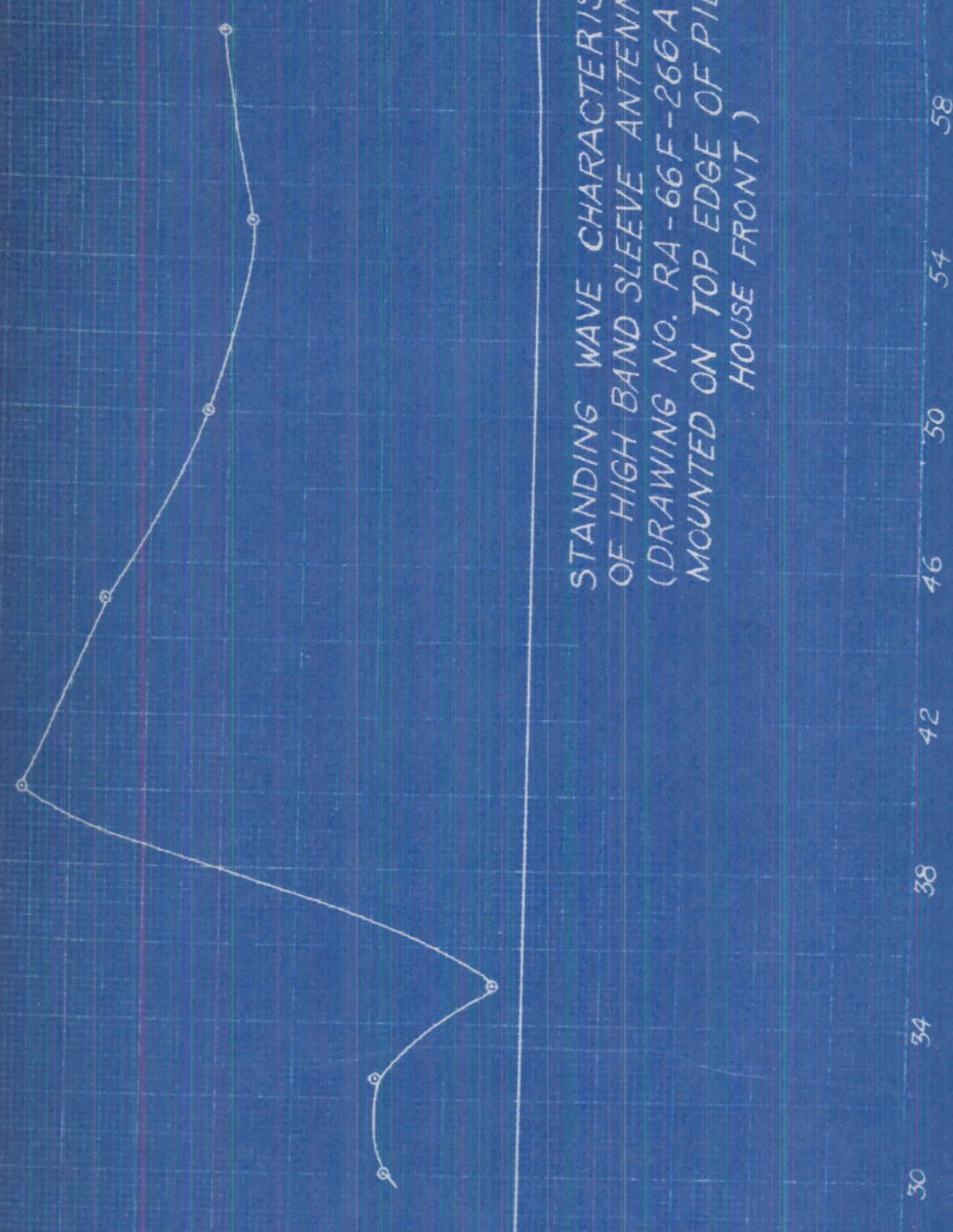
STANDING WAVE RATIO (52- Ω LINE)

STANDING WAVE CHARACTERISTICS
OF HIGH BAND SLEEVE ANTENNA
(DRAWING NO. RA-66F-266A
MOUNTED ON TOP EDGE OF PILOT
HOUSE FRONT)

3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0

34 38 42 46 50 54 58 62
FREQUENCY - MC

FIG. 1



STANDING WAVE CHARACTERISTICS
 LOW BAND SLEEVE ANTENNA
 (DRAWING NO. RA - 66F - 267A
 MOUNTED ON TOP EDGE OF PILOT
 HOUSE AFT)

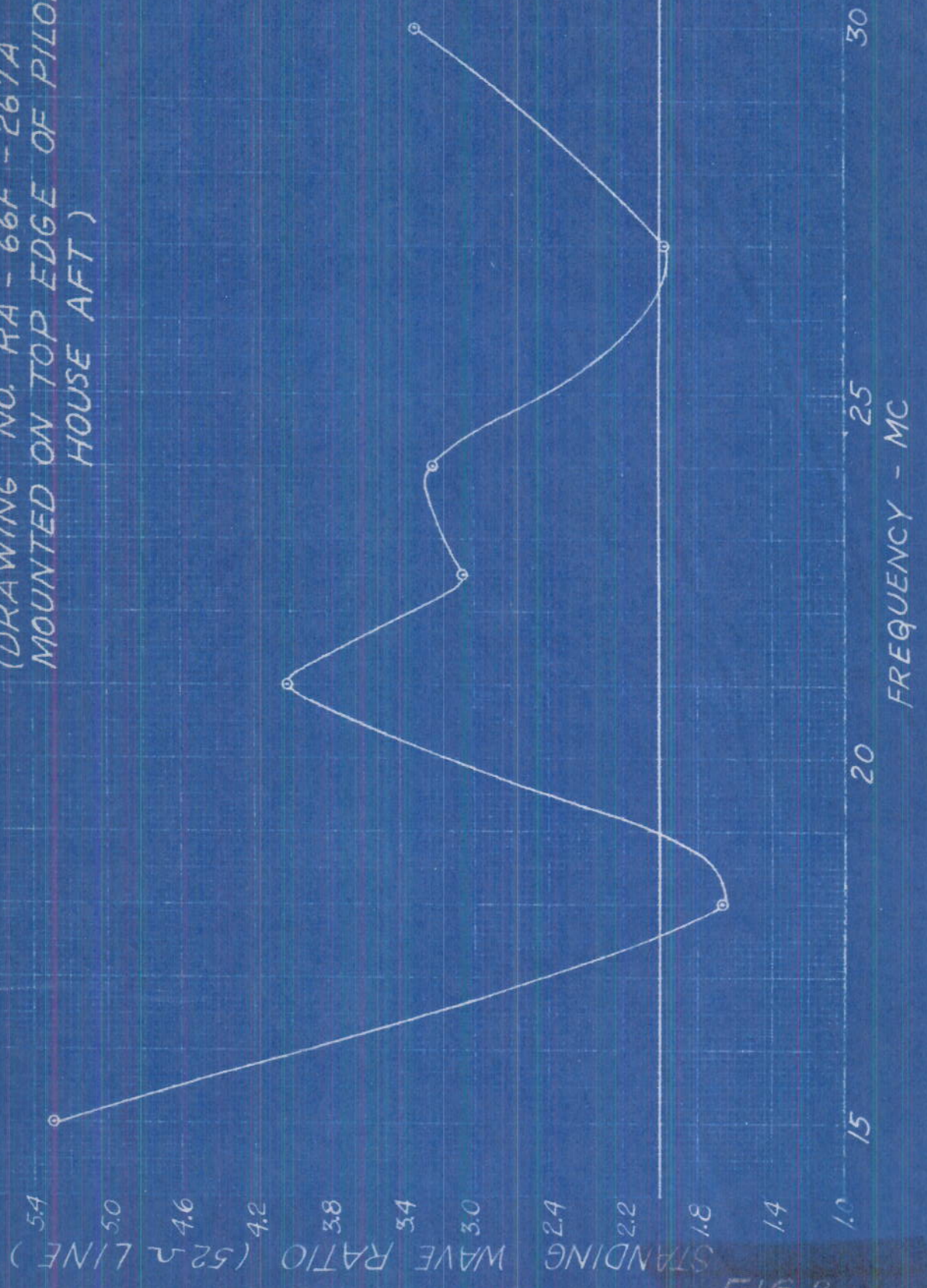
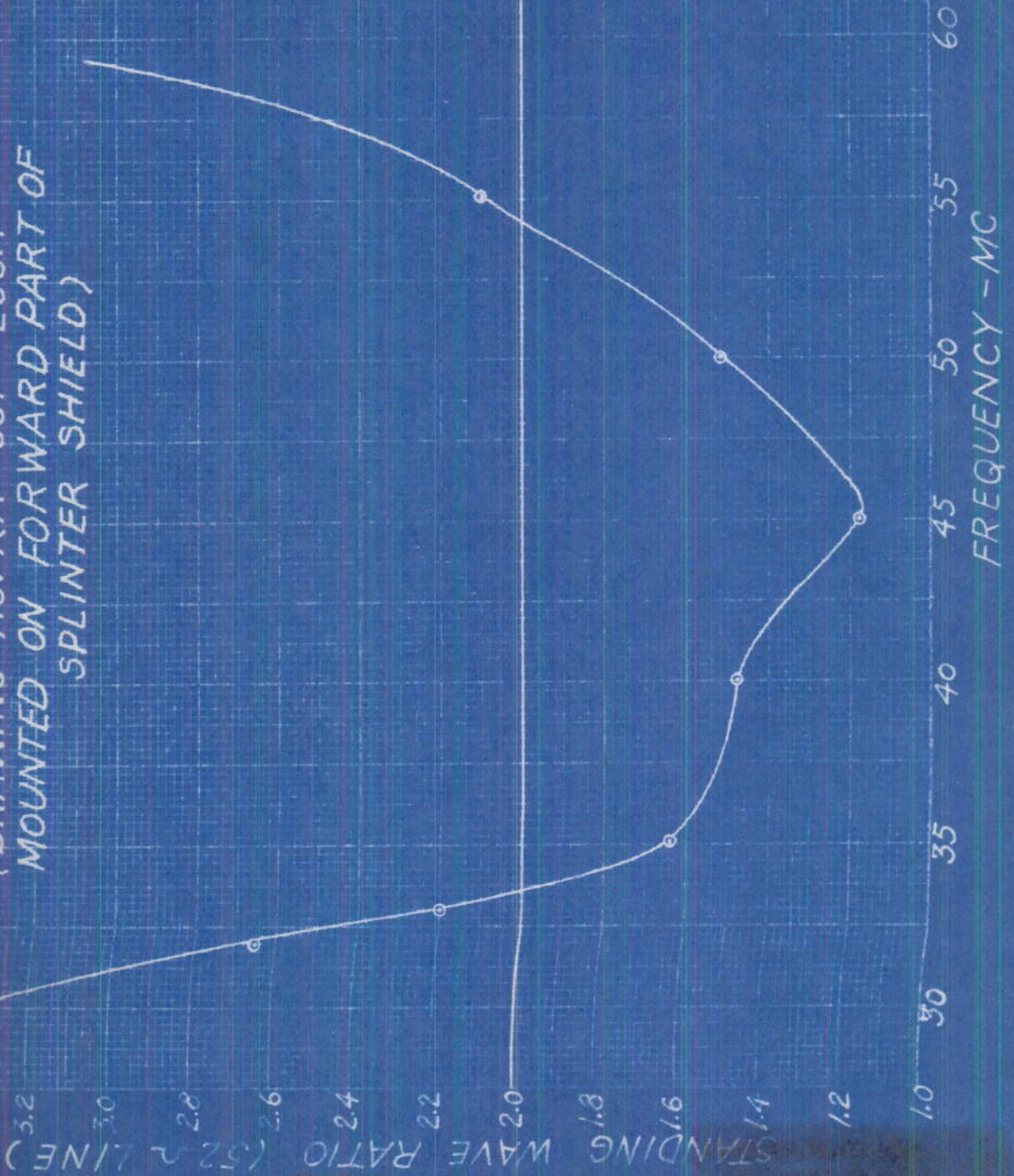


FIG. 2

STANDING WAVE CHARACTERISTICS
OF HIGH BAND SLEEVE ANTENNA
(DRAWING NO. RA-66F-266A
MOUNTED ON FORWARD PART OF
SPLINTER SHIELD)



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FIG. 3

STANDING WAVE CHARACTERISTICS
LOW BAND SLEEVE ANTENNA
(DRAWING NO. RA-66F-267A
MOUNTED ON AFT END OF PILOT
HOUSE BRIDGE)

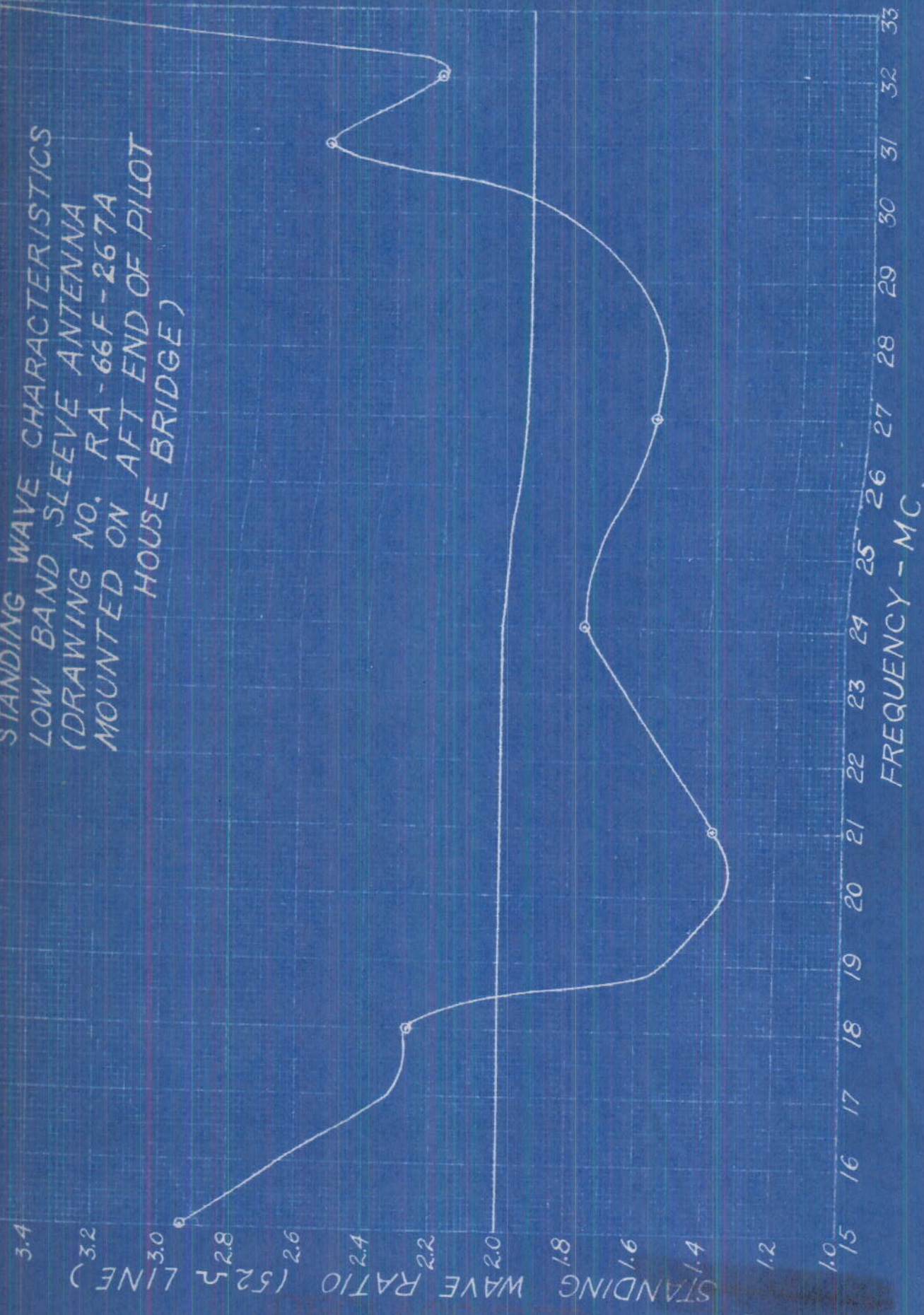
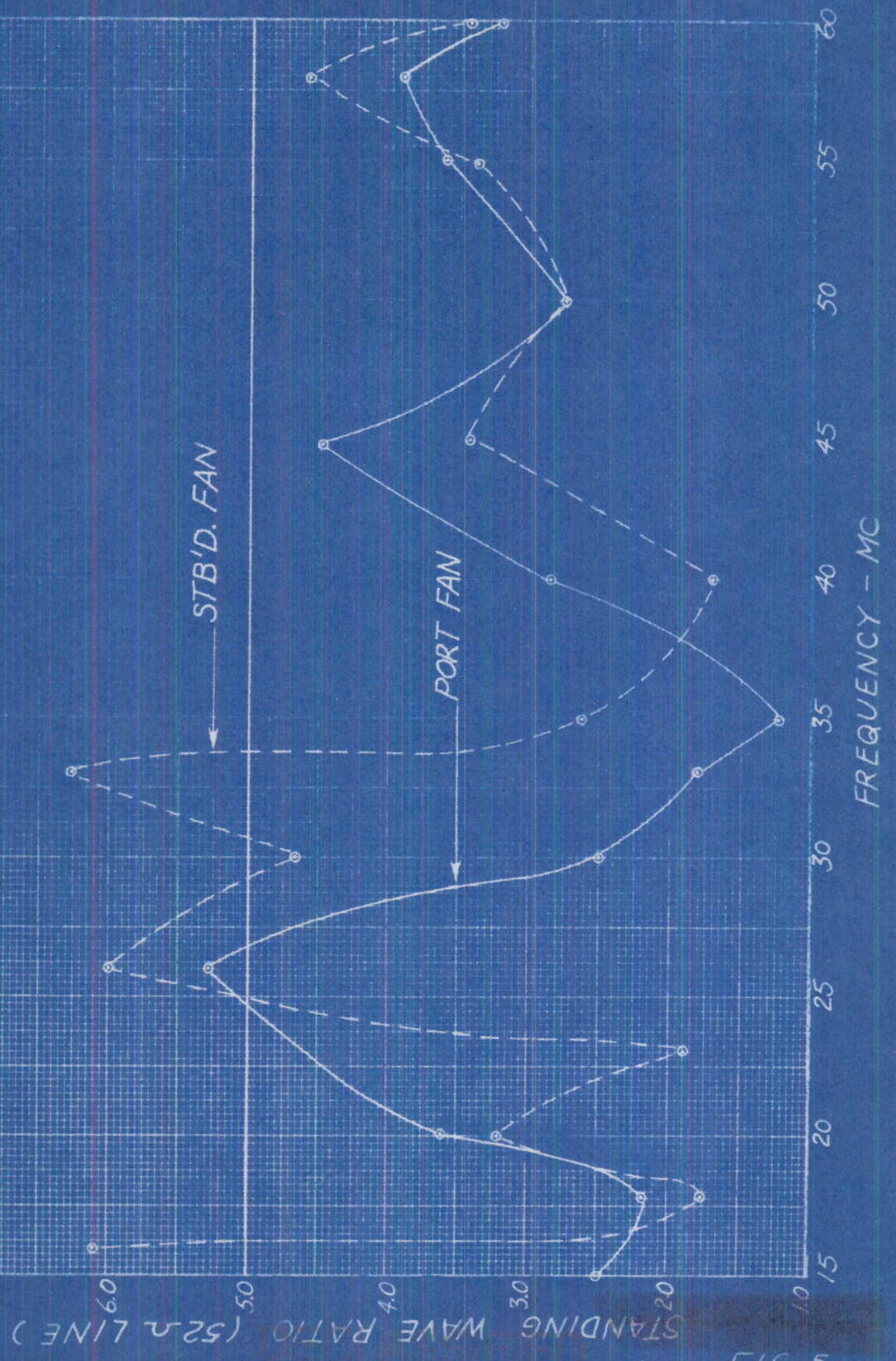


FIG. 4

STANDING WAVE CHARACTERISTICS OF FAN ANTENNAS



5.91F

DIRECTIVE PATTERN FOR
HIGH BAND SLEEVE ANTENNA
AT 55 MC

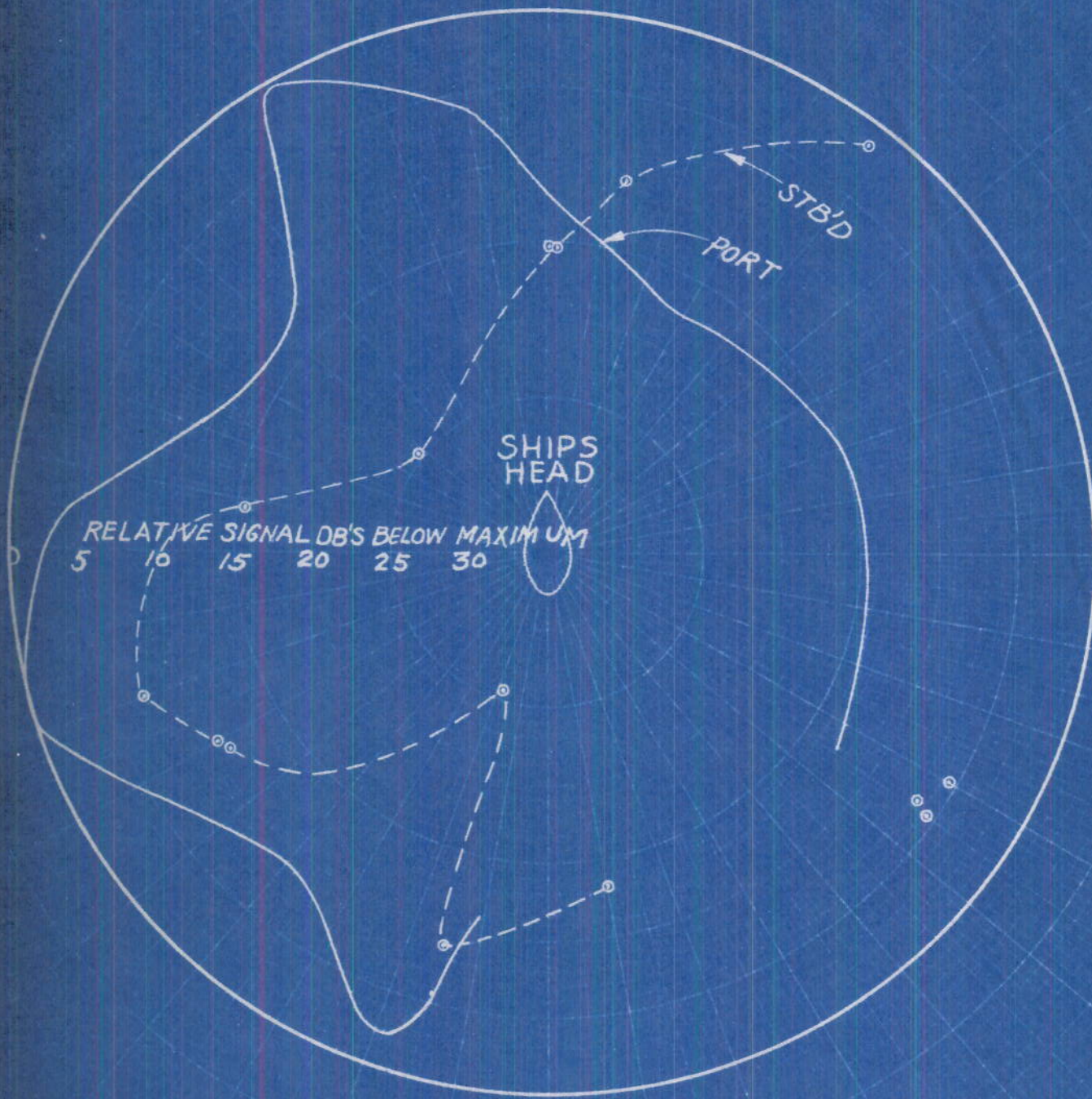


FIG. 6

DIRECTIVE PATTERNS FOR FAN ANTENNAS AT 55 M³/S

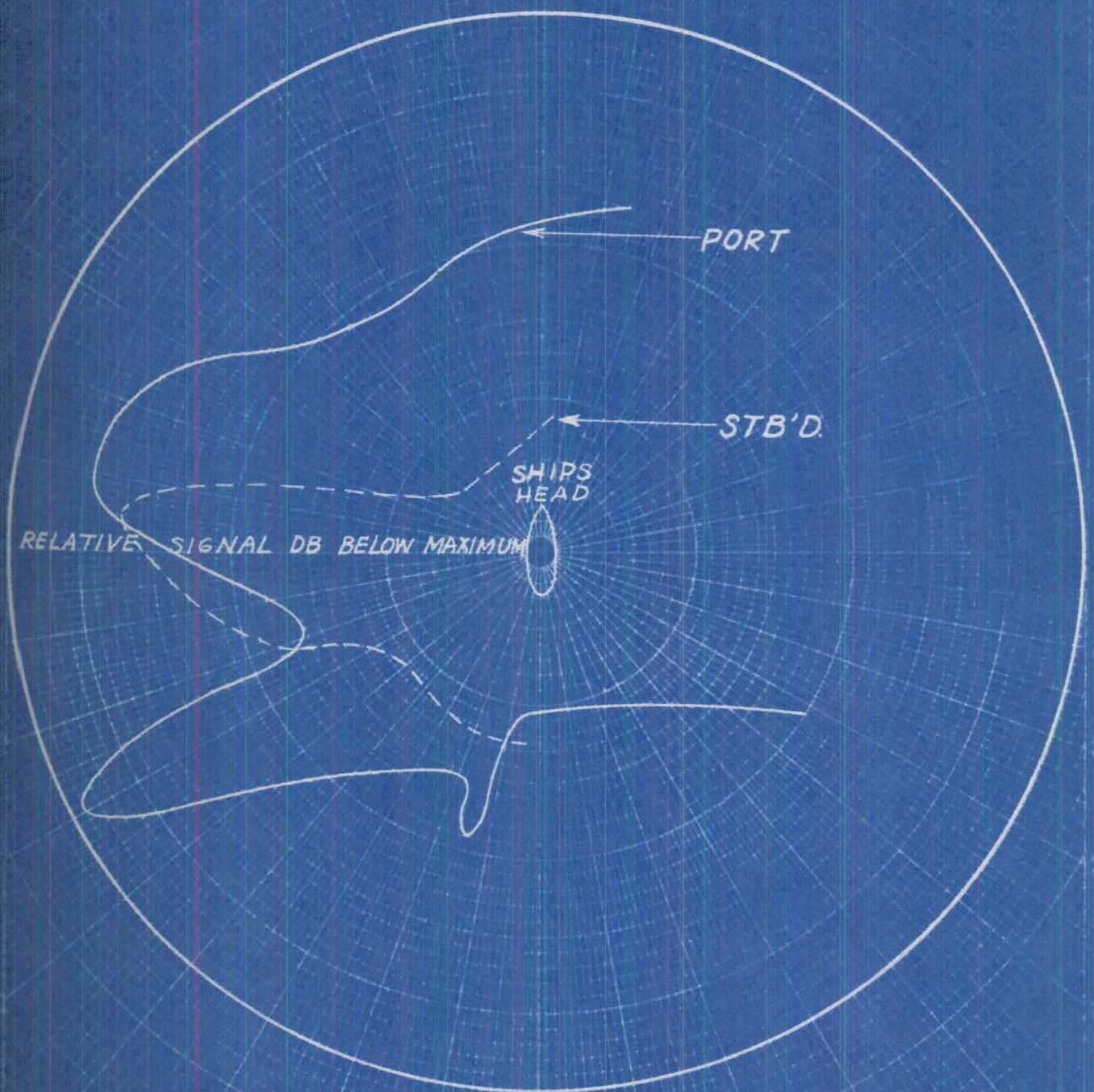
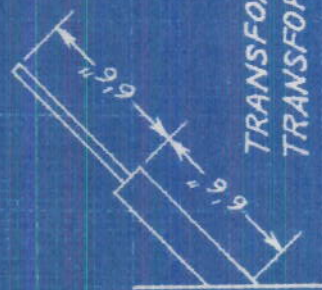


FIG. 7

STANDING WAVE CHARACTERISTICS
FOR LOW BAND SLEEVE ANTENNA
AND TRANSFORMER



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

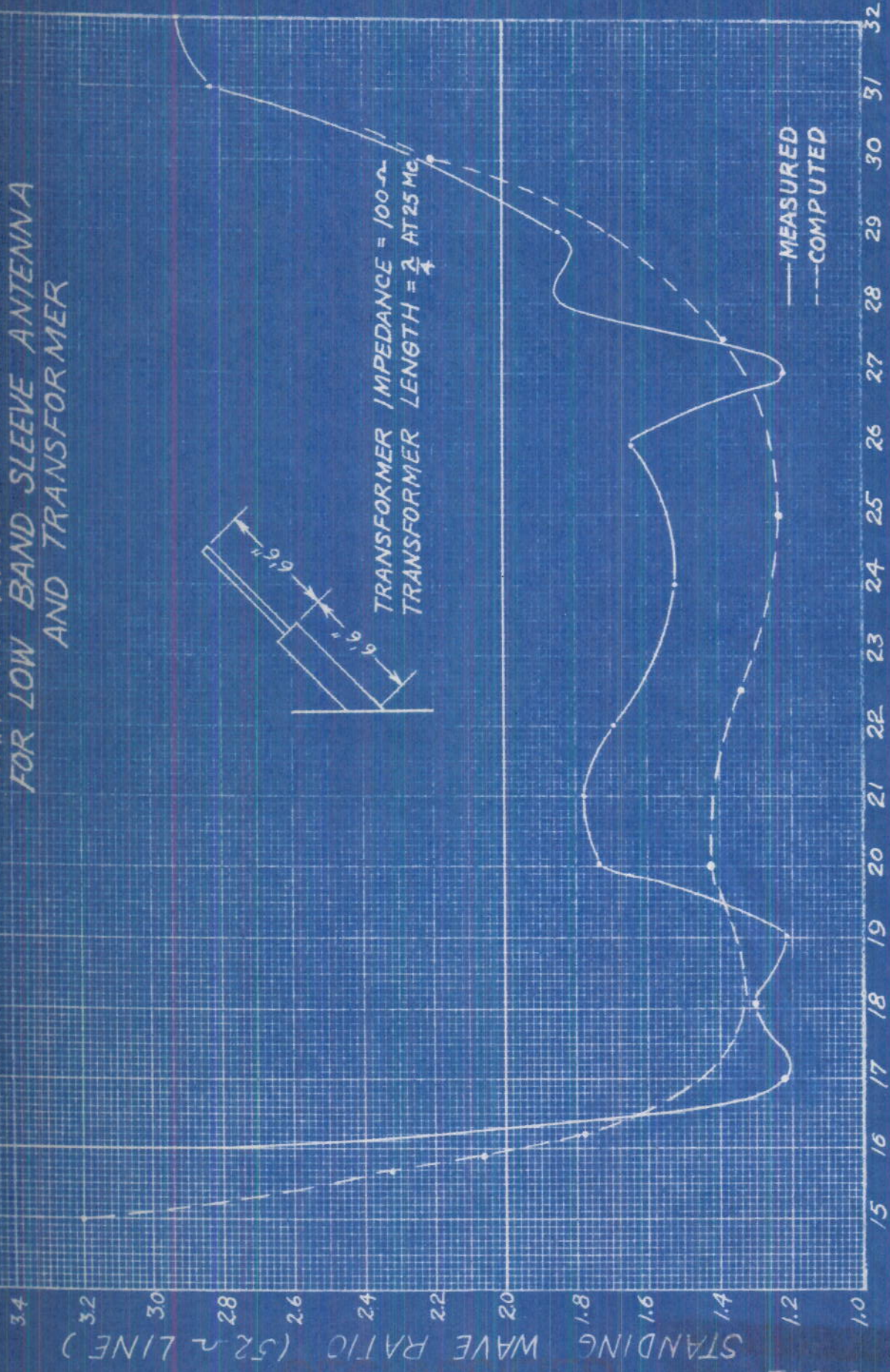
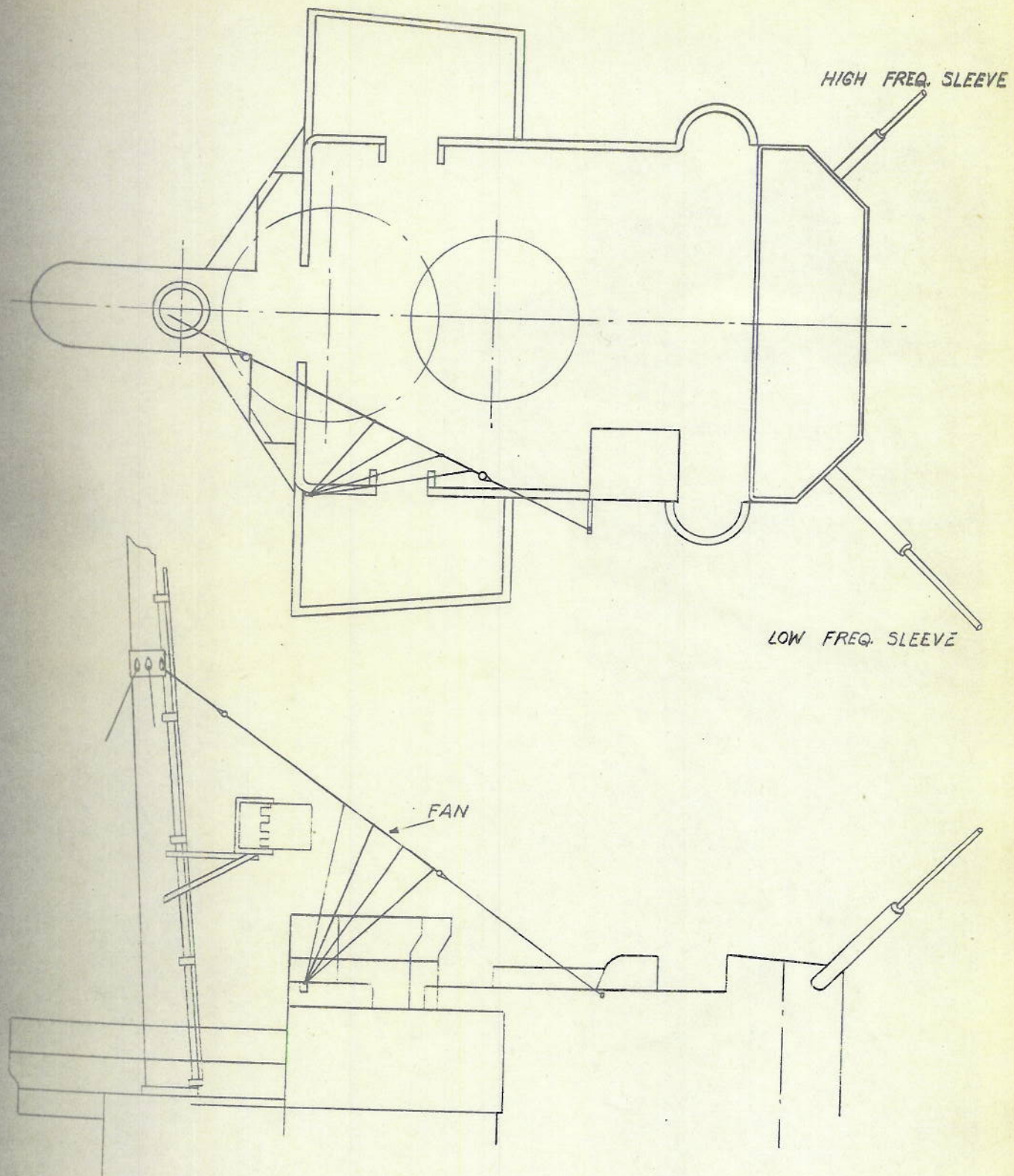


FIG. 8



BROAD BAND ANTENNAS INSTALLED
ON DE

FIG. 9

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F644C5498

NAVY YARD, NEW YORK

JANUARY 14, 1944

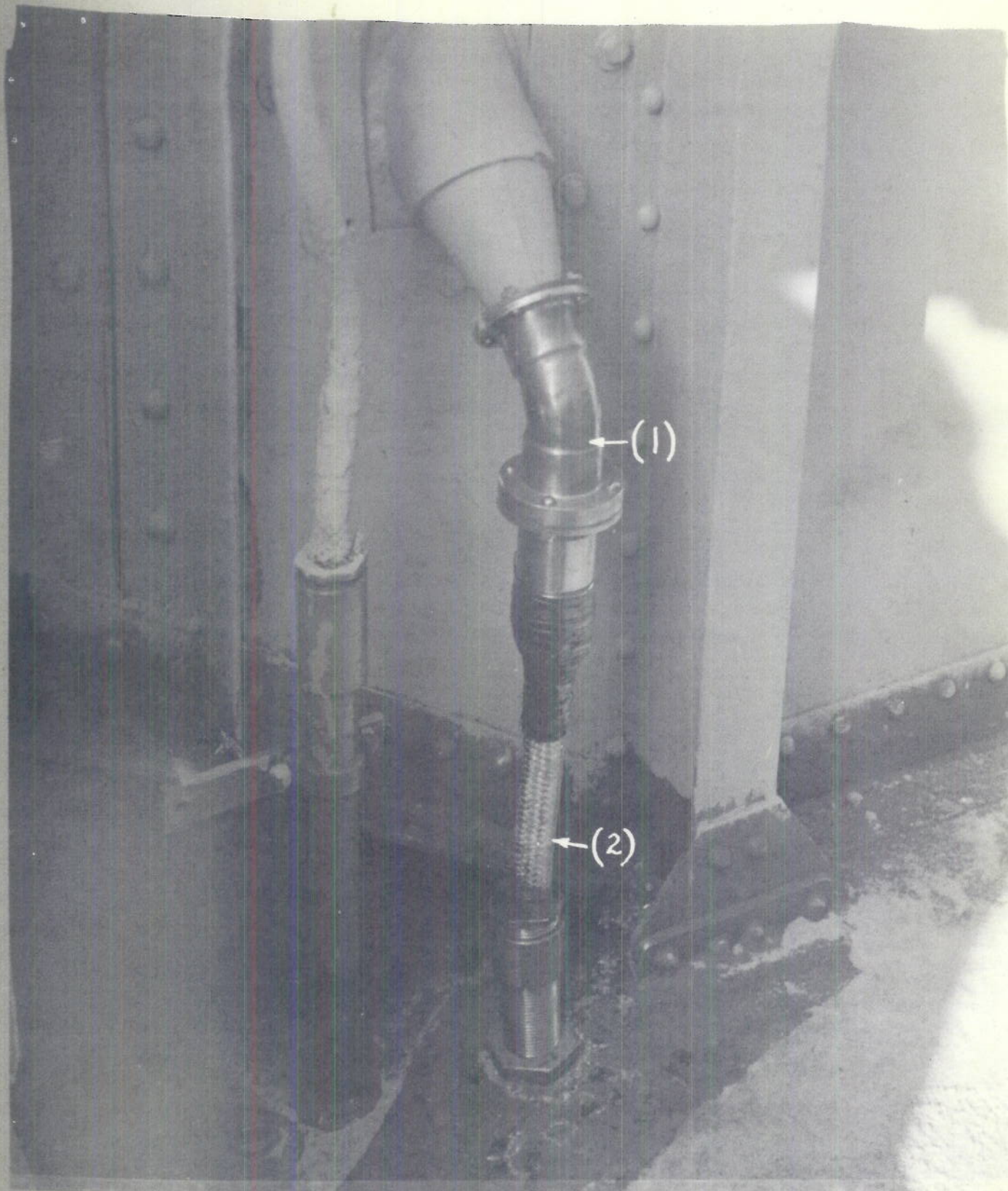
U.S.S. DD 425.

(1) SLEEVE TYPE (HIGH FREQUENCY) TRANSMITTING ANTENNA.



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FIG. 10



F644C5504
U.S.S. DD 425.

NAVY YARD, NEW YORK

JANUARY 14, 1944

- (1) TRANSMITTING ANTENNA CONNECTION.
- (2) RG 18/U.

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FIG. 11



F644C5499
U.S.S. DD 425.

NAVY YARD, NEW YORK

JANUARY 14, 1944

(1) SLEEVE TYPE (LOW FREQUENCY) TRANSMITTING ANTENNA.

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FIG. 12



F644C5502

NAVY YARD, NEW YORK

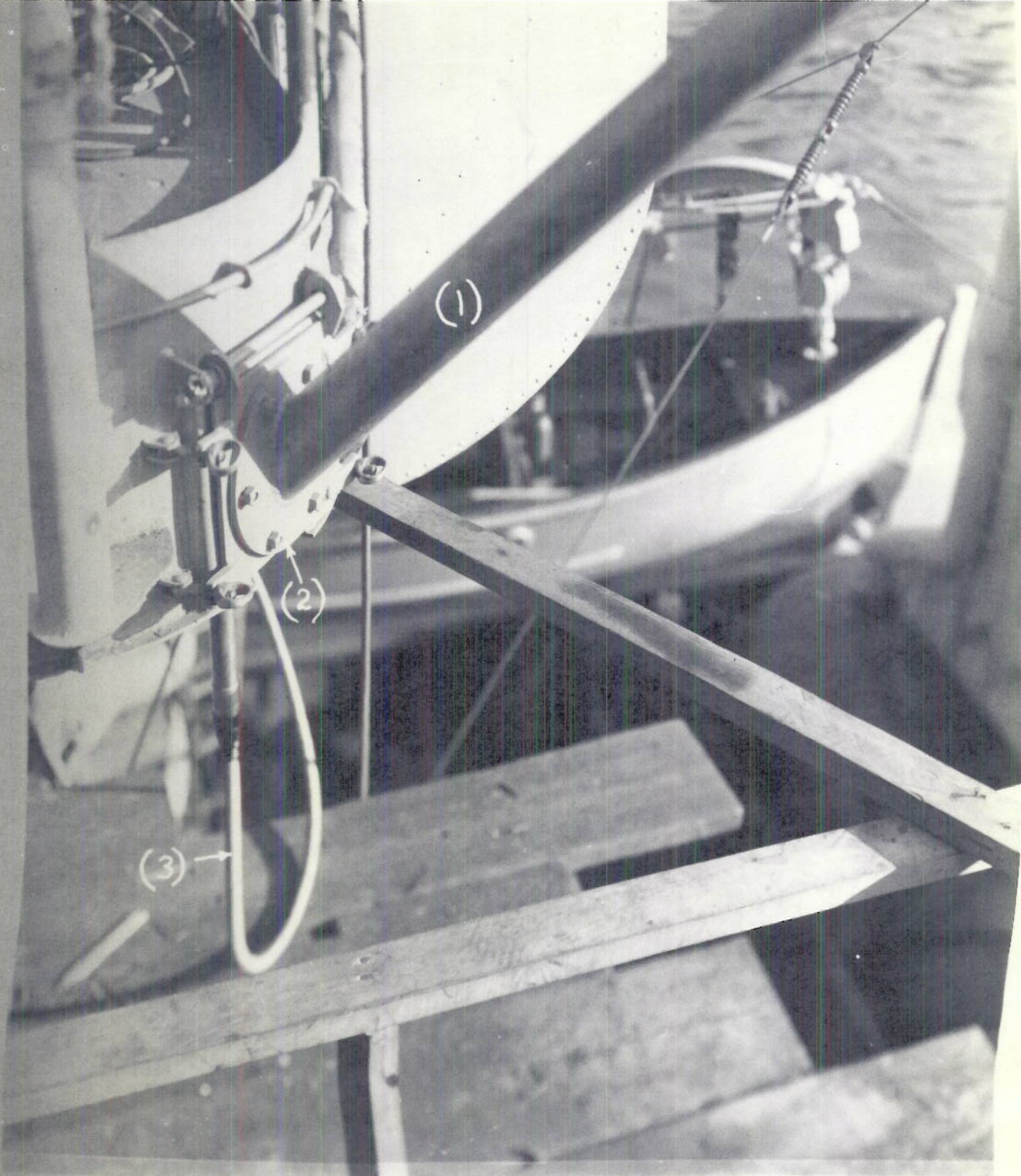
JANUARY 14, 1944

U.S.S. DD 425.

- (1) SLEEVE TYPE TRANSMITTING ANTENNA (LOW FREQUENCY).
- (2) HINGED SUPPORT FOR TRANSMITTING ANTENNA.
- (3) RG 18/U CABLE.

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FIG. 13



F644C5500

NAVY YARD, NEW YORK

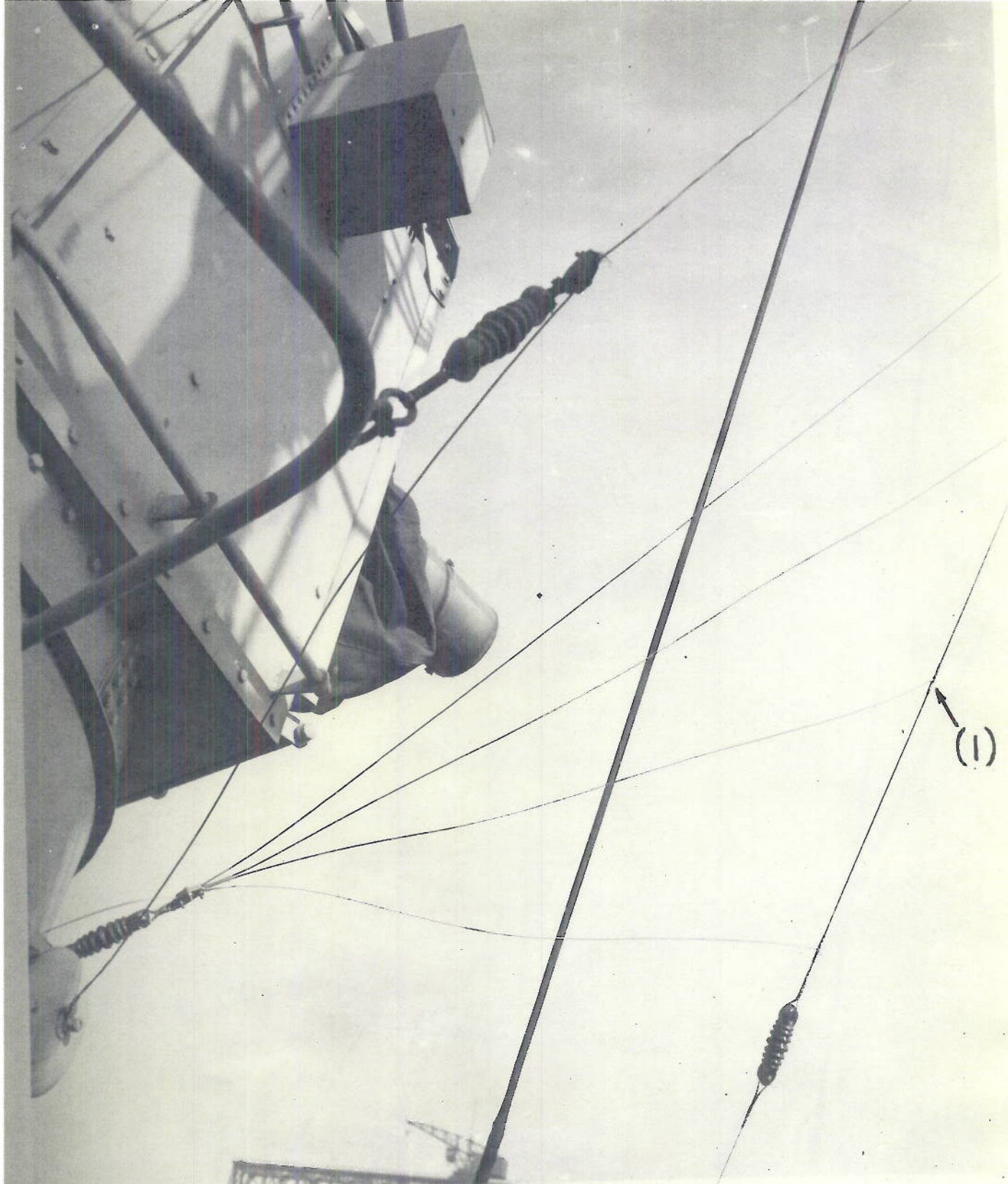
JANUARY 14, 1944

U.S.S. DD 425.

- (1) TRANSMITTING ANTENNA.
- (2) HINGED SUPPORT FOR (LOW FREQUENCY) TRANSMITTING ANTENNA.
- (3) RG 18/U CABLE.

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FIG. 14



F644C5503
U.S.S. DD 425.
(1) FAN TYPE

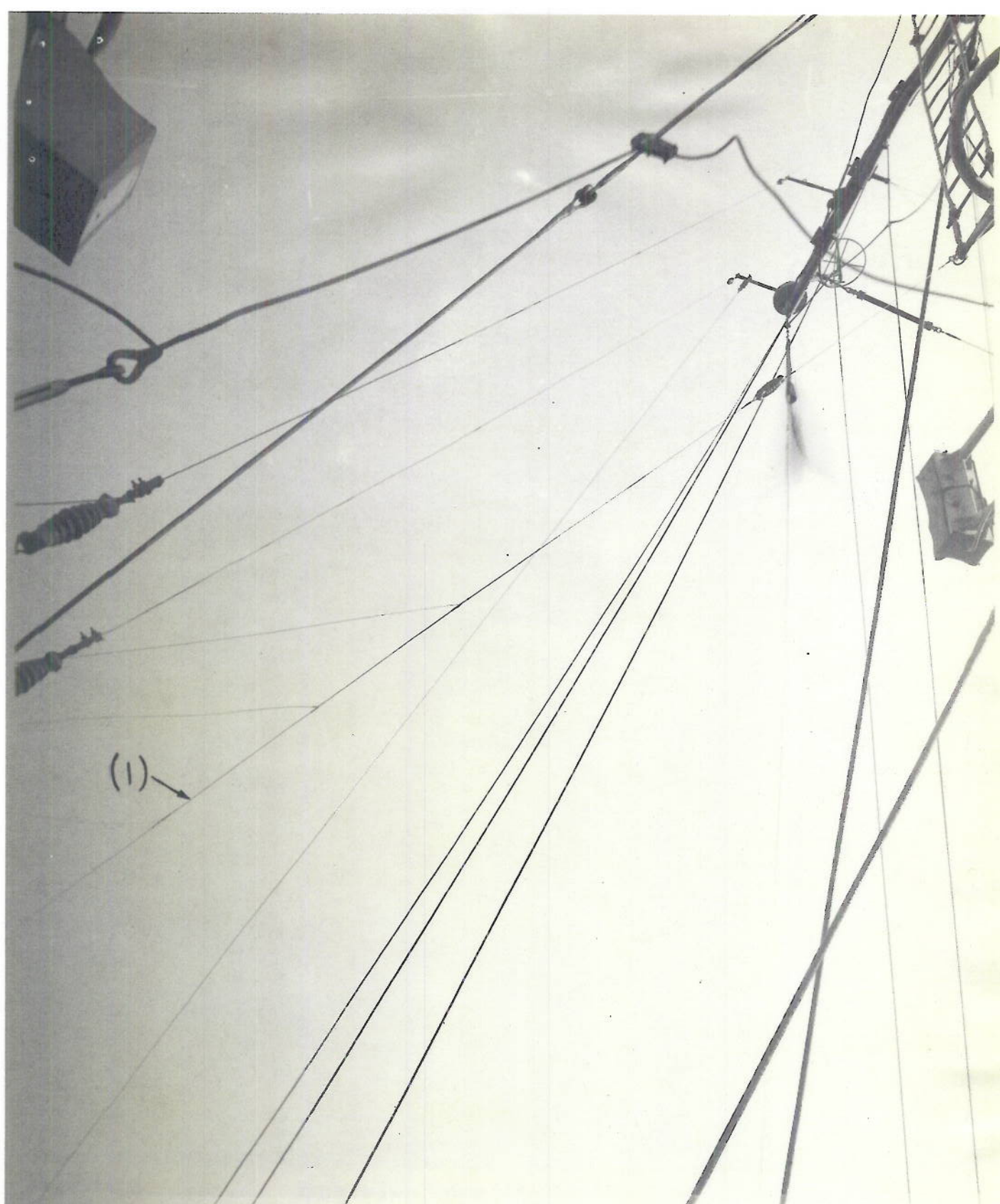
NAVY YARD, NEW YORK
RECEIVING ANTENNA.

JANUARY 14, 1944

SECRET

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FIG. 15



F644C5501

NAVY YARD, NEW YORK

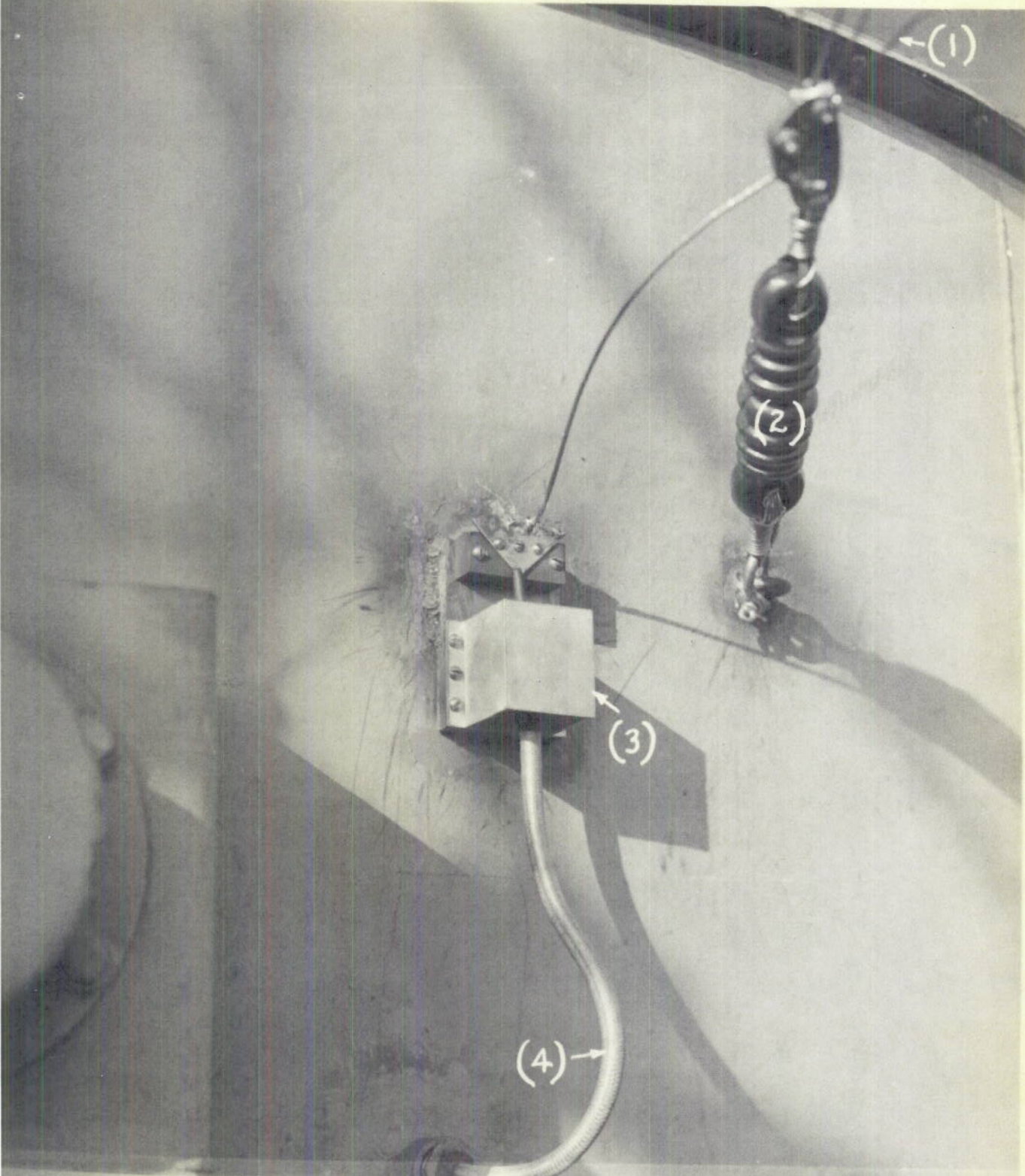
JANUARY 14, 1944

U.S.S. DD 425.

(1) FAN TYPE RECEIVING ANTENNA.

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FIG. 16



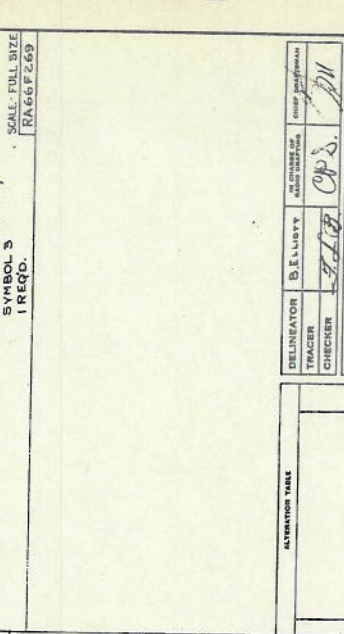
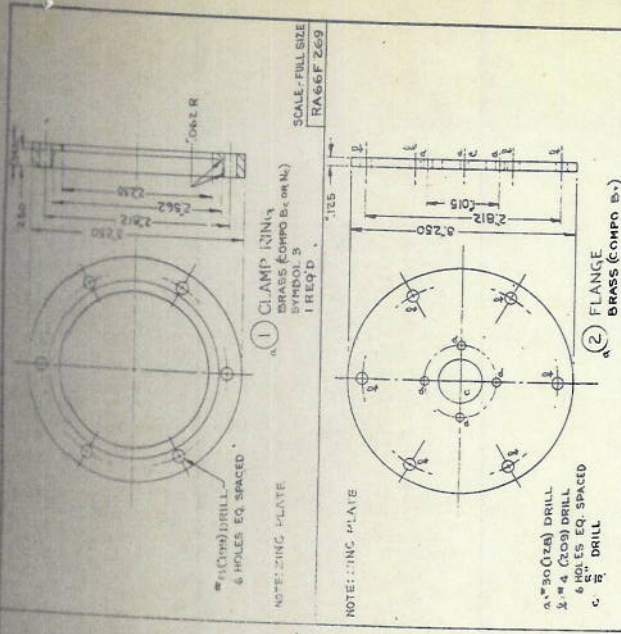
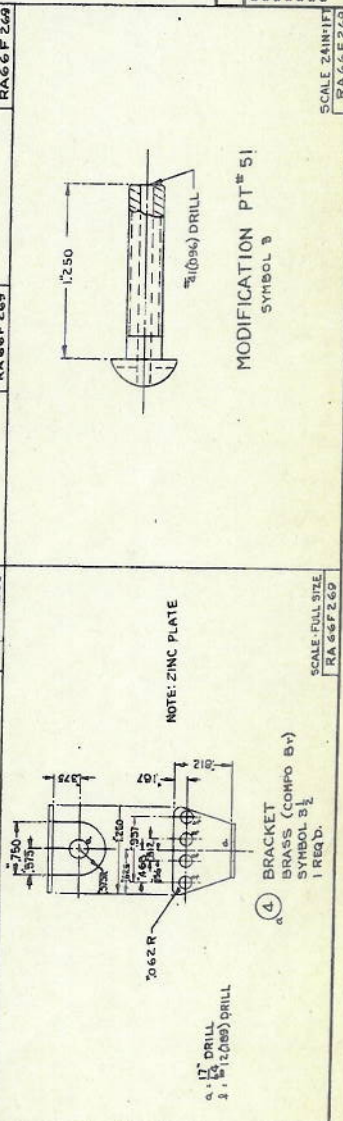
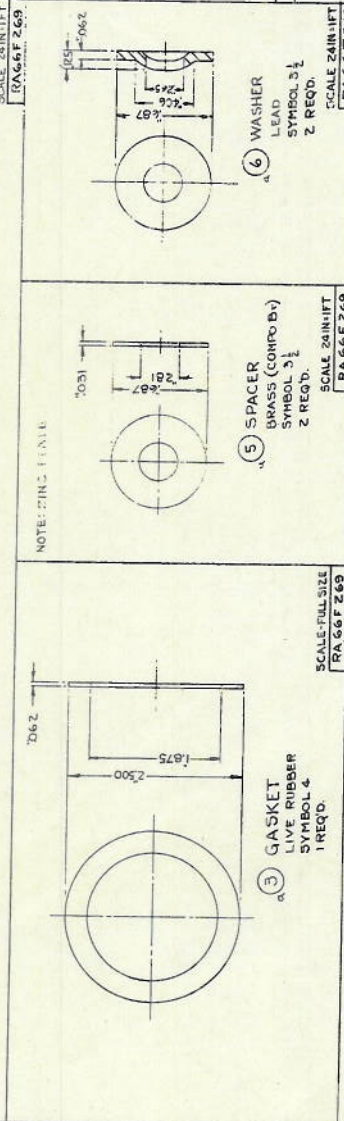
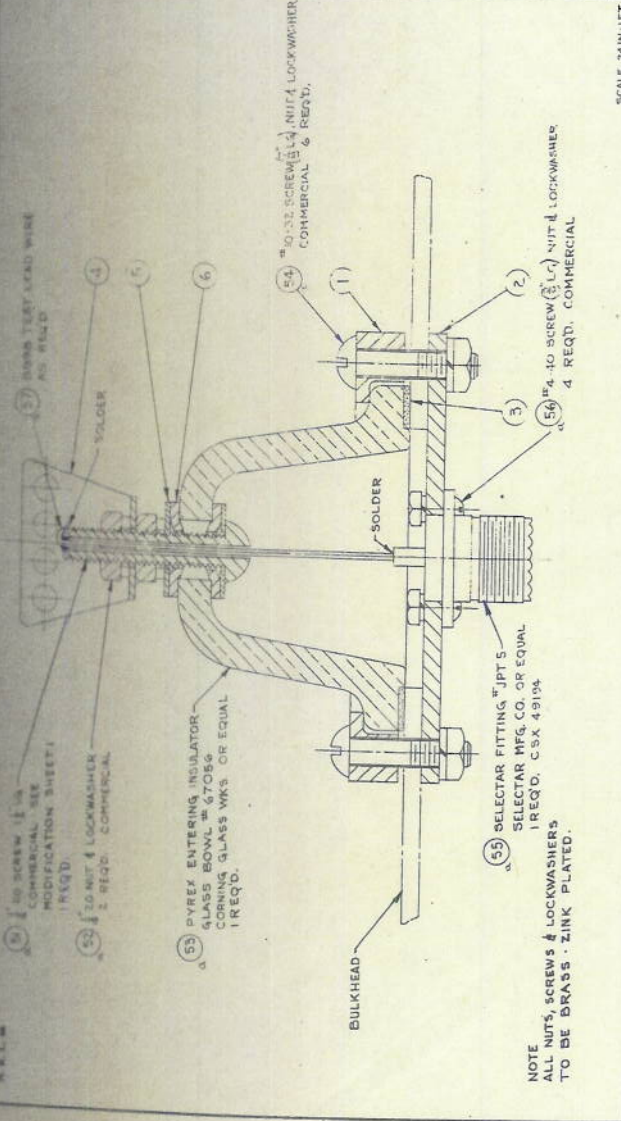
64405505

NAVY YARD, NEW YORK

JANUARY 14, 1944

U.S.S. DD 425.

- (1) FAN TYPE RECEIVING ANTENNA.
- (2) STRENGTH INSULATOR.
- (3) ANTENNA CONNECTION BOX.
- (4) RG - 12/U.



U.S. NAVAL RESEARCH LABORATORY
 "BELLEVUE", ANACOSTIA, D. C.
FAN ANTENNA
 FOR DD INSTALLATION
 ASSEMBLY & DETAILS
 DATE JAN 31, 44
 SCALE: RA 66F 269A

SYMBOLS AND THEIR BASIC DIMENSIONS (UNLESS OTHERWISE NOTED)
 SYMBOL 1: 0.0000
 SYMBOL 2: 0.0010
 SYMBOL 3: 0.0030
 SYMBOL 4: 0.0100
 SYMBOL 5: 0.0200