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# 1 OF 3

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USAEPG-SIG 920-151
REPORT NR 1

FINAL REPORT

# EVALUATION OF THE MULTIPURPOSE JAMMER ECM SYSTEM (U)

TASK NR 33-58-0093

USAEPG

FC





U. S. ARMY ELECTRONIC PROVING GROUND
FORT HUACHUCA, ARIZONA
AUGUST 1959

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Fort Huachuca, Arizona

USAEPG-SIG 920-151, Final Report Task 33-58-0093, "Evaluation of the Multipurpose Jammer ECM System," Report Nr 1: "3/4-Ton Truck Installation" (U), has been prepared by the Electronic Warfare Department and is published for the information of all concerned. Distribution of this publication has been approved under the provisions of Para 7h, AR 310-1, by the Adjutant General acting for the Secretary of the Army, 21 November 1958. Suggestions or comments relative to this report are invited and should be addressed to the Commanding General, U. S. Army Electronic Proving Ground, Fort Huachuca, Arizona, ATTN: SIGPG-DBC.

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ERRATA SHEET

Pg 19 The figure caption was omitted; it is:

Fig. 3. (C) MPJ 3/4-ton truck installation (interior view).

Pg 87 The clear scope presentation at the top of this page is upside down.

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EVALUATION OF THE MULTIPURPOSE JAMMER ECM SYSTEM (U)
REPORT NR 1: 3/4-TON TRUCK INSTALLATION (U)

Task Nr 33-58-0093

AUTHORITY

(U) These tests were performed as part of Task Nr 33-58-0093 of the USAEPG Technical Program. Authorization is contained in CSigO COP FY 59 para 2a(6)(a)6 and SIGCCD 56T4.

OBJECTIVE

(U) The objective of these tests was to evaluate the 3/4-ton, Multipurpose Jammer ECM System as fabricated under Contract Nr DA-36-039 SC-67913. Tests were performed to determine the feasibility of the MPJ concept, basic parameters for the employment of the MPJ ECM System, and to set the standards by which a comparison of the relative effectiveness or variations of MPJ ECM Systems can be accomplished.

APPROVAL

(U) This report has been reviewed and approved.

Harold F. Warren
HAROLD F. WARREN
Lt Col SigC
Chief, Electronic Warfare Department

August 1959
Electronic Warfare Department
U. S. Army Electronic Proving Ground
Fort Huachuca, Arizona



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## FOREWORD (U)

This report on the Multipurpose Jammer (MPJ) ECM System is the first in a series of reports on this system to be prepared by the Electronic Warfare Department (EWD), U. S. Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona. These reports are concerned with engineering, operational, and simulated tactical evaluation of the equipment and system utilized in the implementation of the EW concept outlined in "A Field Army Electronic Warfare System," USAEPG-SIG 920-63, dated January 1957.

This report is concerned with the engineering and operational evaluation of those tests on the 3/4-ton truck installation which has been conducted to date. It is intended to serve as a progress report on the first model and as a guide to personnel engaged in research, development and fabrication of future models as well as a capability analysis for troop users. Subsequent reports will delve into the evaluation of such modifications as may be performed as well as evaluation of the other equipment configurations, i.e., M-59 personnel carrier and U1-A "OTTER" aircraft installations; new antenna systems; or changes in the major components.

## SUMMARY


(C) The results obtained, from the experimental model testing accomplished thus far, indicate that the MPJ concept is sound in principle. It is feasible to fabricate a single vehicle having the capability of rough intercept and direction-finding (DF), signal analysis, and jamming of enemy signals over an extremely broad frequency spectrum.

(S) The MPJ consists of a number of readily available airborne-type components that have been modified for ground utilization. This equipment permits intercept, rough DF, and signal analysis in the frequency range of 30 to 10,750 mcs. The system is also capable of transmitting a jamming signal to any enemy receiver operating in the frequency range of 24 to 10,500 mcs.

(S) The tests which have been completed include:

a. Intercept, DF, and jamming of a mortar-locating radar
b. Intercept and jamming of a VHF close-air-support radio net
c. Intercept and jamming of VHF tactical unenciphered radio communications nets
d. Intercept and jamming of the TACAN navigation system

(S) Tests currently programmed include:

a. Tests against combat surveillance radars
b. Tests against UHF combat surveillance drone control systems

(S) The tests conducted with the mortar-locating radar indicate the MPJ is capable of effective intercept, DF, and jamming at ranges in excess of 30,000 yards provided line-of-sight conditions exist. This range would be reduced, however, when terrain masking or heavily wooded areas exist.

(S) When employed against the VHF, close-air-support radio net the MPJ was capable of completely jamming the airborne radio when the aircraft was approximately 50 miles from the MPJ.

(S) Jamming ranges on the order of 50 miles were common when the MPJ was utilized against the low-power VHF tactical unenciphered communications nets. However, as on the close support tests, trouble with transmitter frequency drift and excessive receiver bandwidth limited the operational capabilities. Modifications are currently being planned to correct these faults.

(S) In the tests against the TACAN navigation system, the MPJ was capable of completely jamming the airborne indicator when the aircraft was 56,000 yards from the jammer. The MPJ was located 20 miles from the beacon for these tests.

(S) The tests against the combat surveillance radars have been delayed due to excessive VSWR and attenuation in the RF transmission system. The system has been redesigned and it is planned to complete these tests prior to the end of 4th quarter FY 1959. It is anticipated that the MPJ will be capable of effectively jamming such radar equipment as the AN/PPS-4, AN/TPS-21, and AN/TPS-25 at ranges of approximately 30,000 yards. This estimate is based on the results obtained from another project utilizing a comparable jammer system.

(C) The tests against a drone control system have been delayed pending delivery of the OA-1186/ALT-6B transmitter group from the Air Force. Present planning indicates that this test should be completed during late FY 1959 or early FY 1960. It is planned to conduct this against the 420-mcs SD-2 drone system.

(U) The above incompleted tests, plus data on the proposed modifications to the MPJ system, will be included in subsequent reports of this series.

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# I. INTRODUCTION

## 1. (U) BACKGROUND

The concept of electronic warfare employment in the Field Army for the 1960 to the 1970 period, as generated by "Preliminary Study, Field Army Electronic Warfare System," USAEPG-SIG 920-63, established the need for an MPJ.

Early efforts in the design and fabrication of an MPJ proved discouraging because the immediately available items of Signal Corps equipment were too large, too heavy, and too bulky.

Investigation of the development of usable items of equipment being constructed for the Air Force disclosed that, within their program of production, there were items of equipment which could be utilized, with modifications, for the field testing of the MPJ concept. Such investigation led to the early 2-1/2-ton version of the MPJ as shown in fig. 1.

The Electronic Warfare Department was able to obtain sufficient quantities of the necessary items of equipment via a Military Interdepartmental Procurement Request and thus proceeded with the MPJ program. The fabrication of such equipment into an MPJ was performed by Motorola Research, Inc., Riverside, California, and initial delivery of this equipment was completed in January of 1958. Exterior and interior views of this equipment are shown in figs. 2 and 3.

## 2. (U) SCOPE

The tests contained in this report are concerned with the engineering and operational evaluation of the MPJ ECM System, 3/4-ton truck installation. Information is presented on the results of the performance measurements of the MPJ as well as the field test results against typical tactical targets. The testing was conducted under controlled conditions which gave an indication of equipment capability only. Future testing under simulated tactical conditions should provide a more realistic measurement of the Electronic Warfare Concept of which the MPJ is a part.

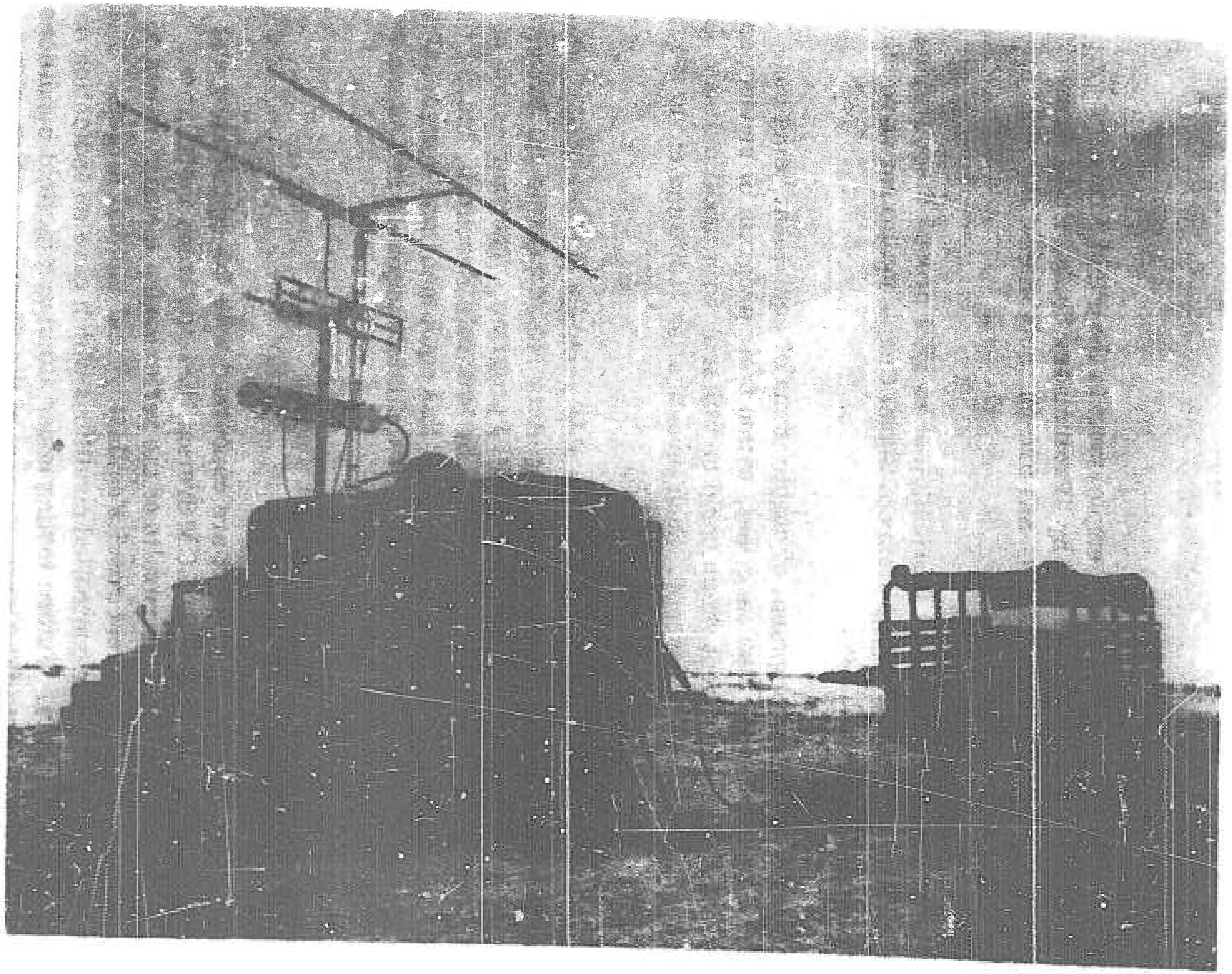

Fig. 1. (U) Early model (phase I, 2-1/2-ton truck version) of the MPJ with attached antenna array and trailer-mounted power unit

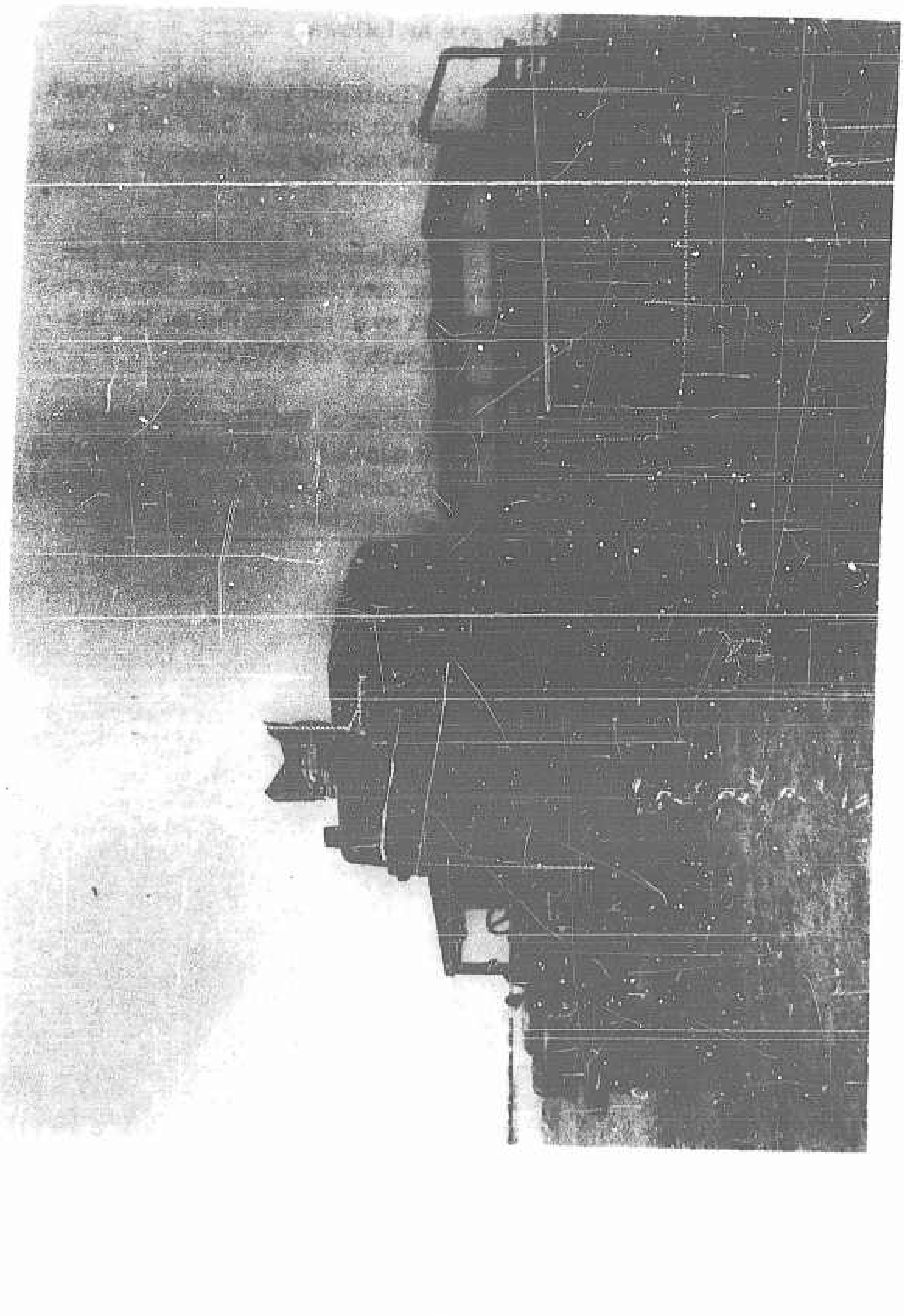

Fig. 2. (U) MPJ 3/4-ton truck installation with trailer

3. (U) TESTING PROGRAM

The immediate program is concerned with the continued testing of the present MPJ system and of the consequent modifications as well as the evaluation of the System under simulated tactical conditions. The anticipated completion dates for the currently programmed tests are as follows.

Testing of the present models of the MPJ as installed in the 3/4-ton truck, the M-59 personnel carrier, and the U1-A aircraft should be finished by the 1st quarter of FY 1960. The U1-A and the M-59 models are shown in figs. 4, 5, and 6.

Testing of the improved antenna system installation for both the 3/4-ton truck and the M-59 personnel carrier should be completed by the 1st quarter of FY 1960; the testing of the improved antenna system installation for the U1-A aircraft should be completed by the 2d quarter of FY 1960.

The prelminary tactical test and field evaluation of the first EW Company (ROCID) is scheduled for completion by the 2d quarter of FY 1960. The evaluation of the U. S. Army Research and Development Laboratories (USASRDL) engineering model is to be completed by the 2d quarter of FY 1961.

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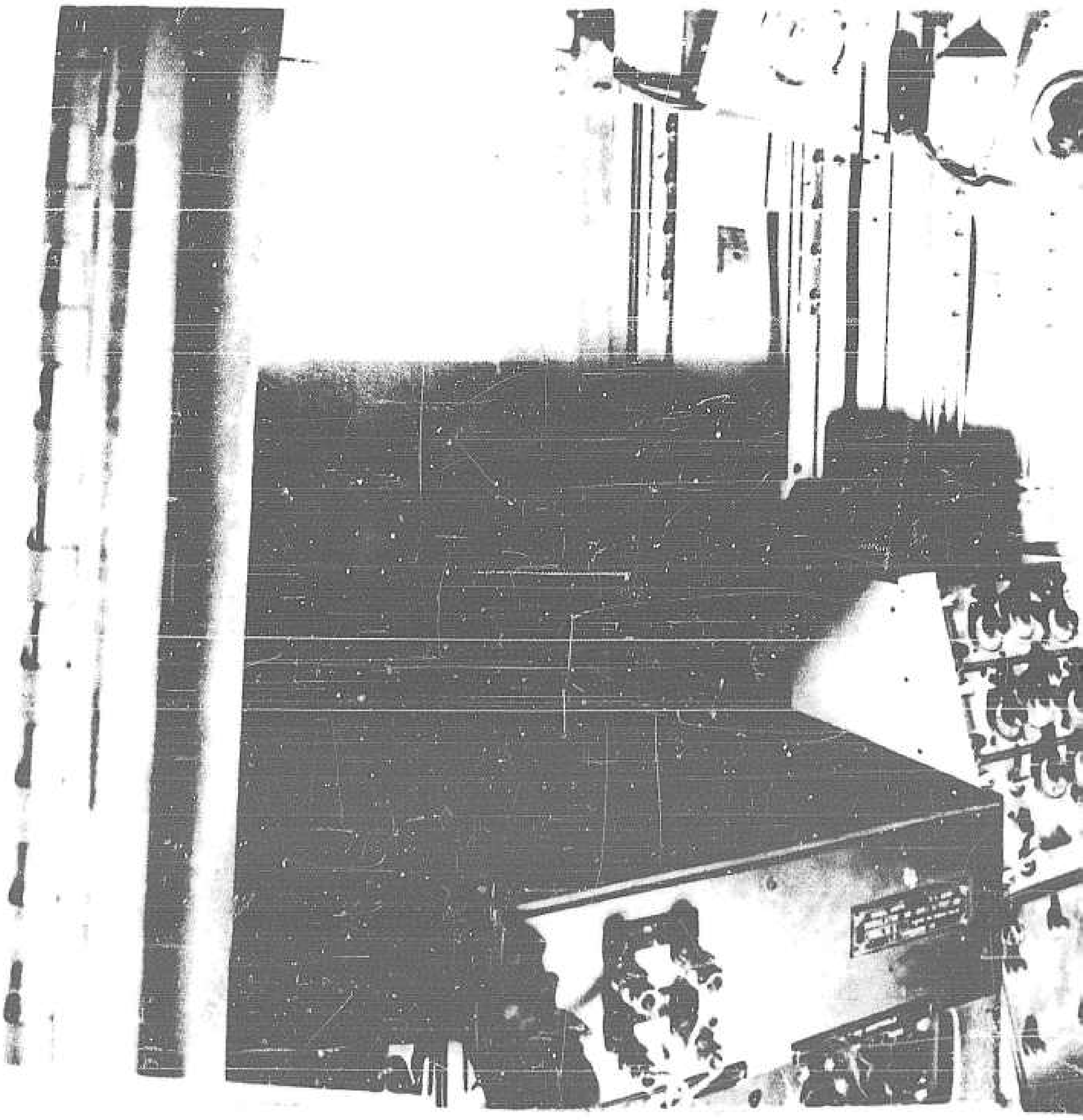

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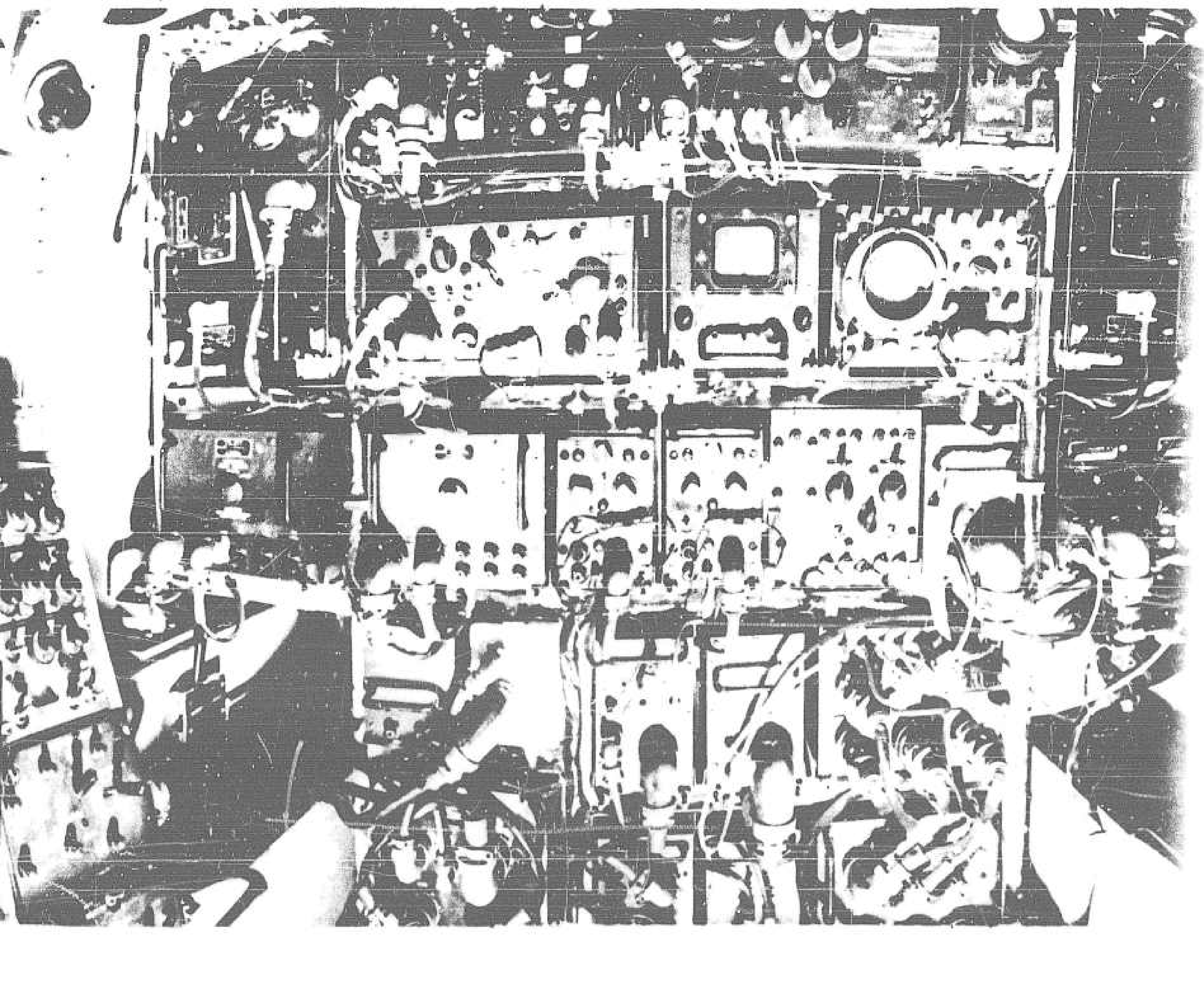

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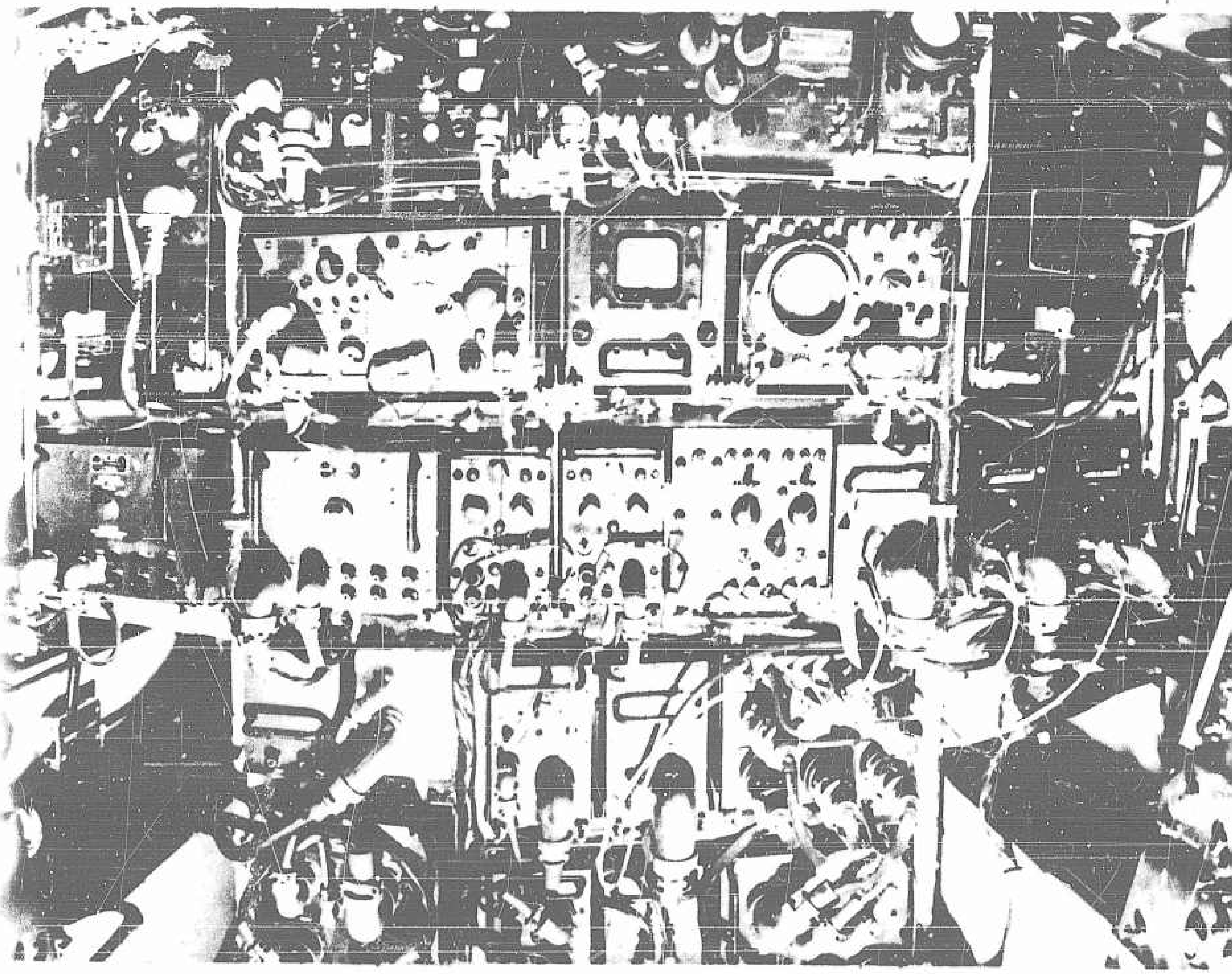

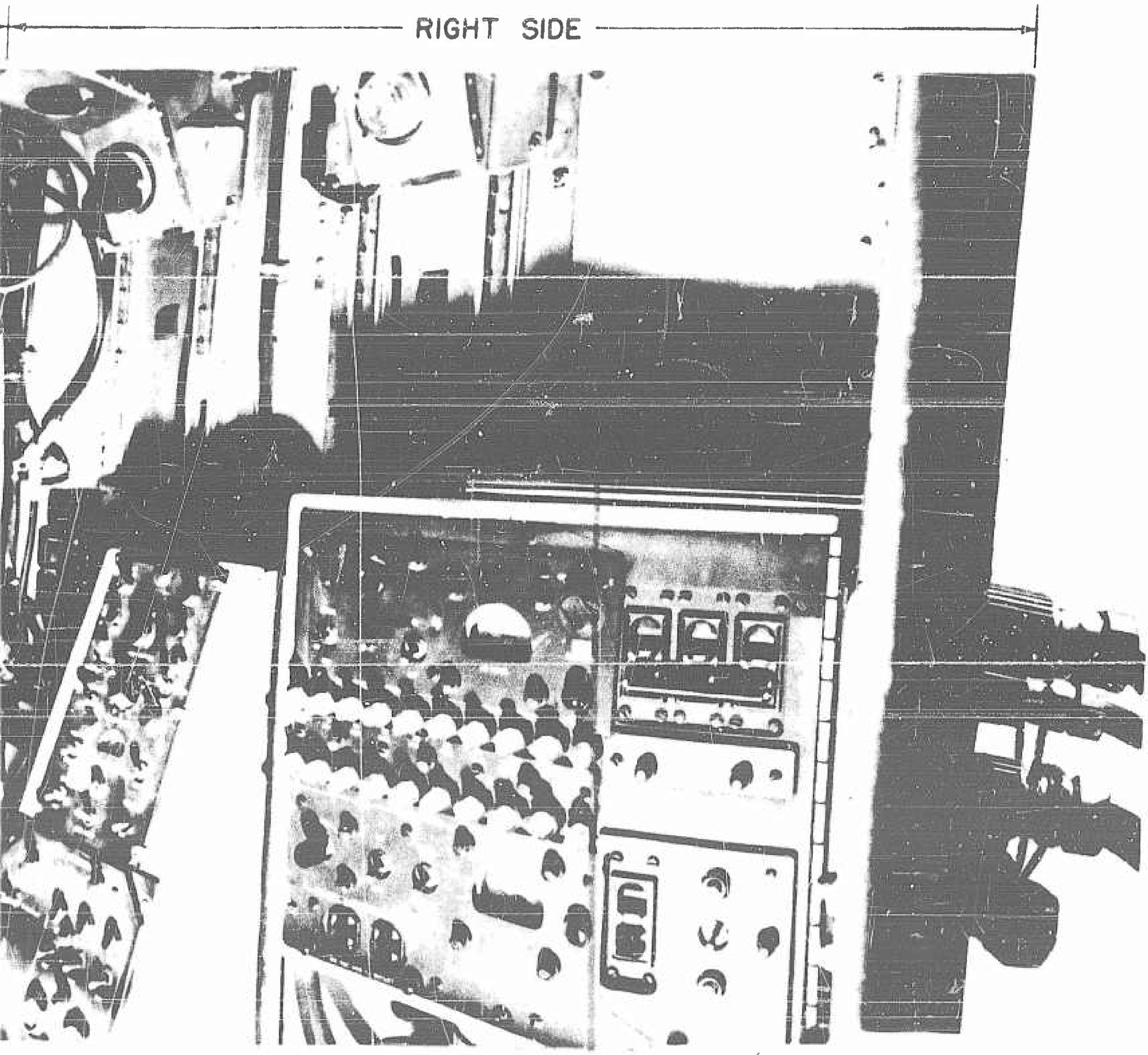


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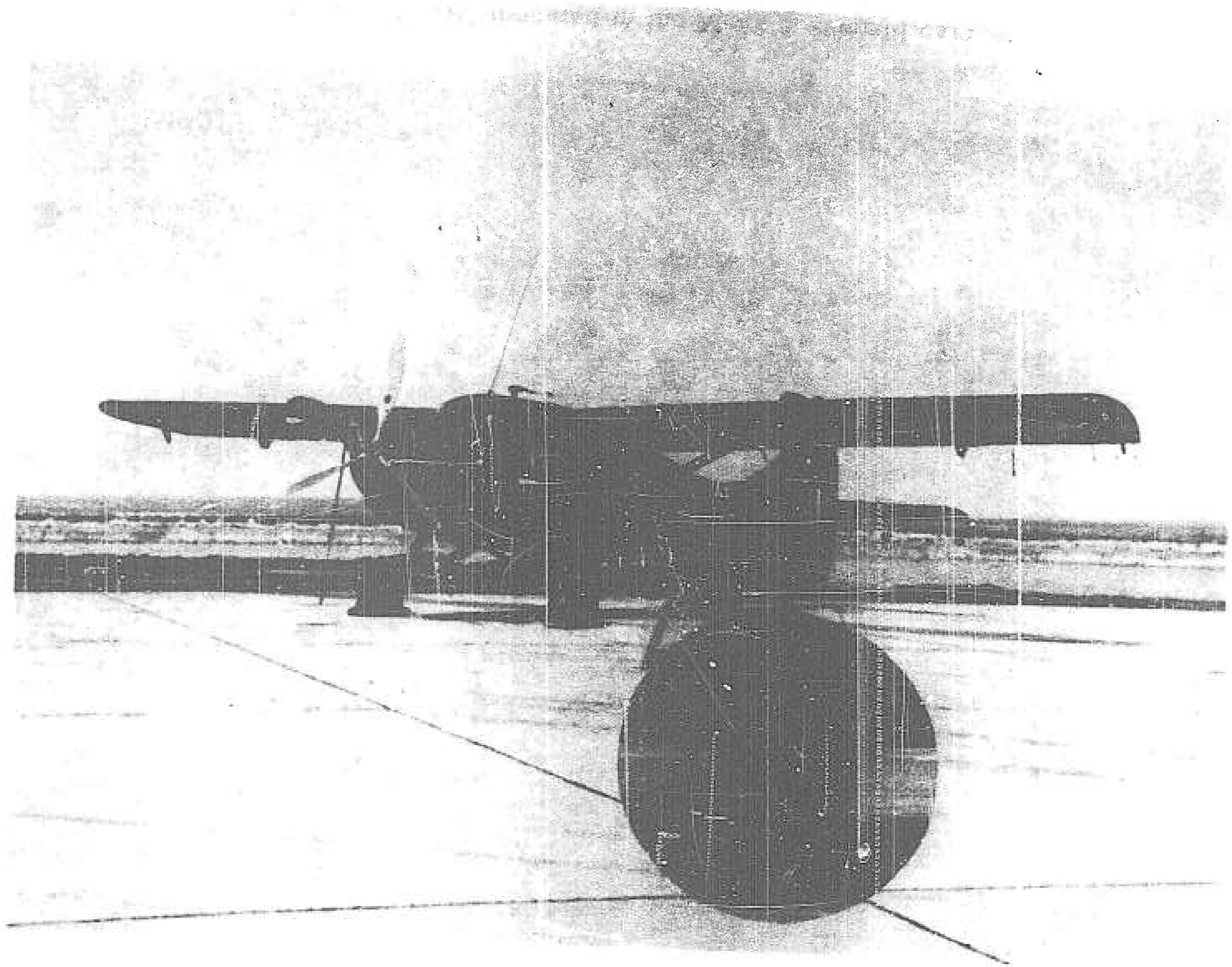

Fig. 4. (U) MPJ mounted in the U1-A "OTTER" aircraft modified with a radome covering for the antennas

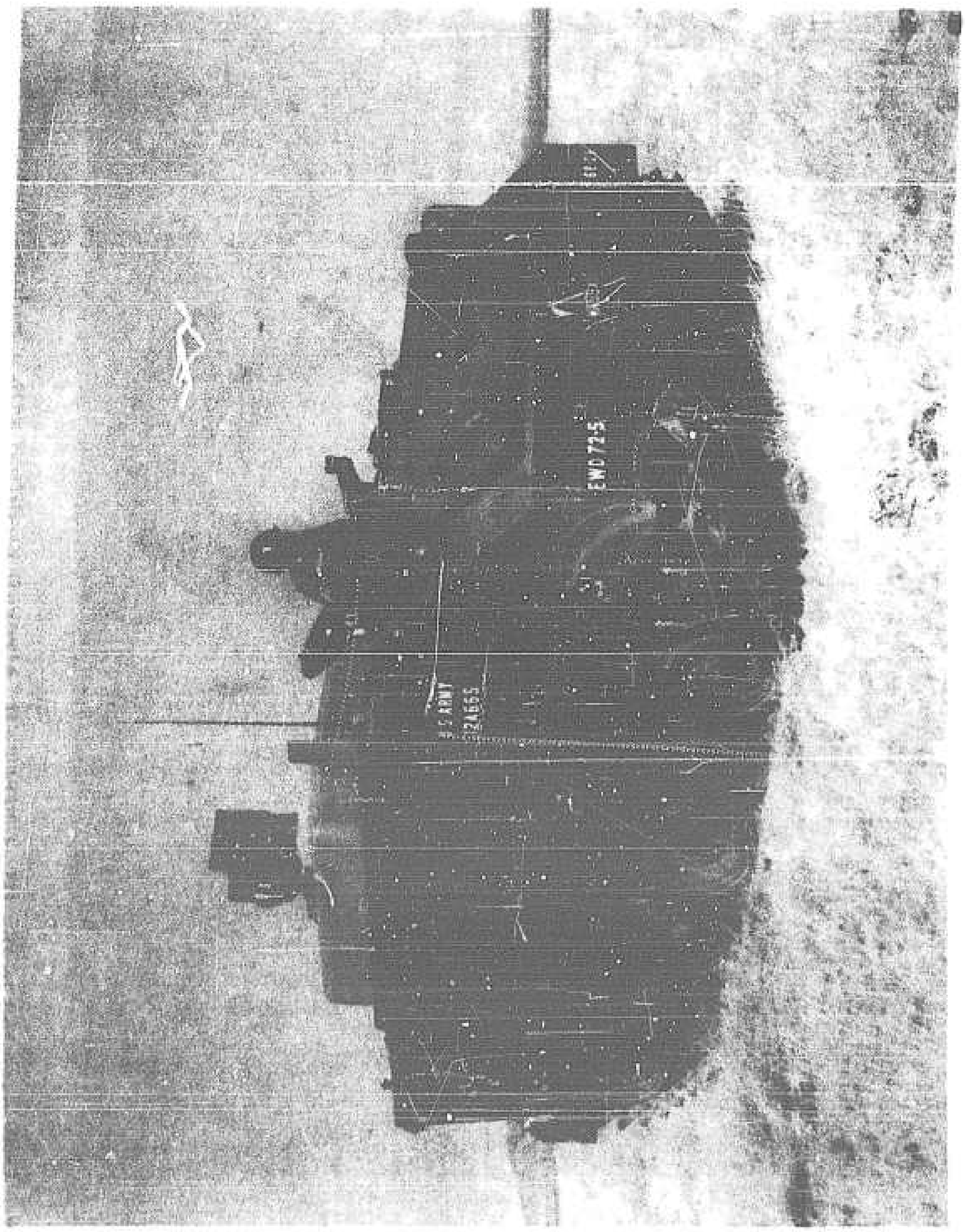

Fig. 5. (U) MPJ mounted in the M-59 personnel carrier

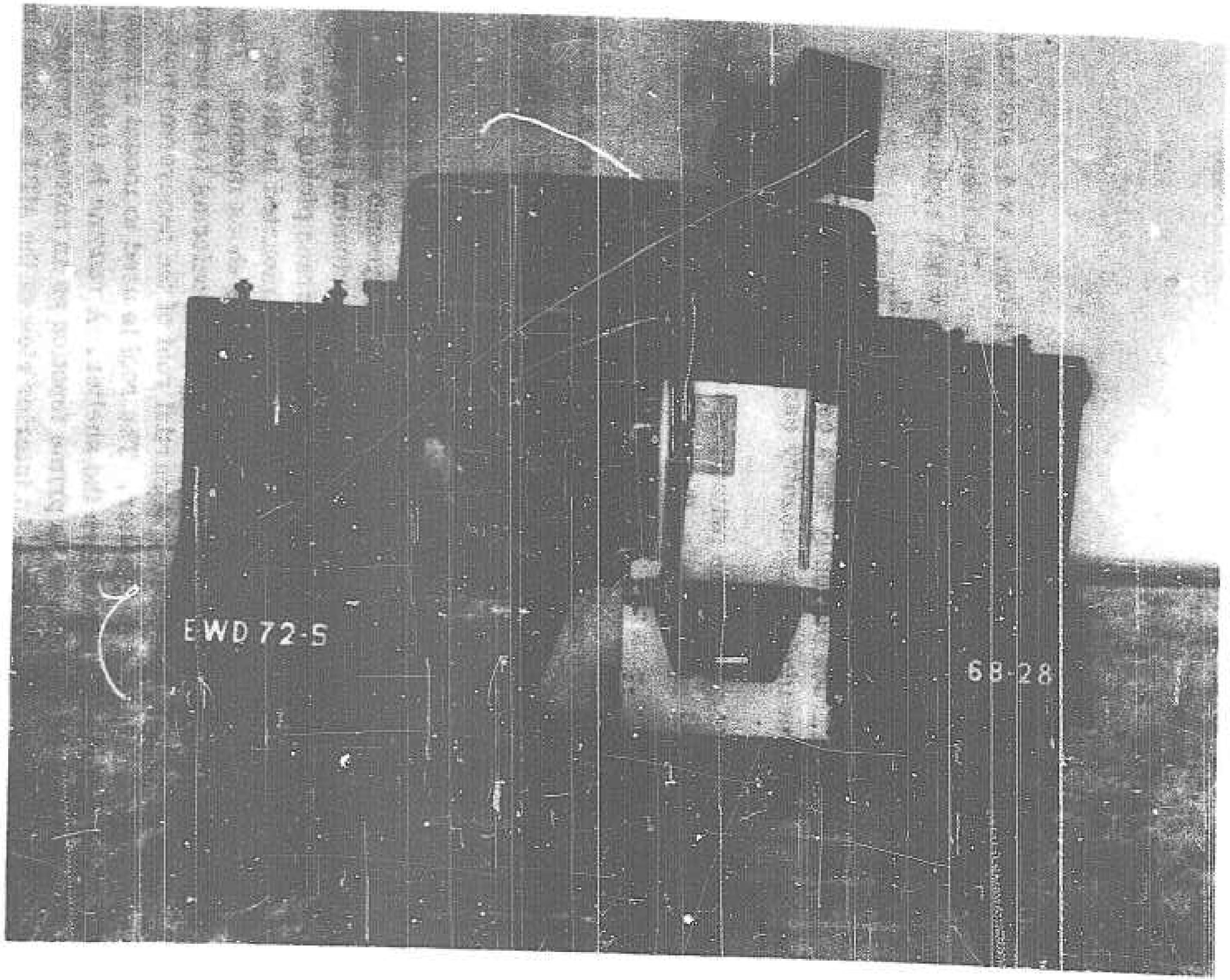

Fig. 6. (U) MPJ mounted in the M-59 personnel carrier (interior view)

## II. DESCRIPTION OF EQUIPMENT

### 4. (S) INSTALLATION

#### a. Vehicle

The MPJ equipment is mobilized by an M-37, 3/4-ton, 4 x 4, standard Army cargo truck, and a standard M-101, 3/4-ton trailer. The majority of the active equipment is installed in the equipment shelter which replaces the cargo compartment of the 3/4-ton truck as shown in fig. 2.

The 3/4-ton cargo truck normally has a cargo capacity of 160 cubic feet and carries a recommended cross-country cargo of 1,500 pounds.

The 3/4-ton trailer carries the prime power source, the communications equipment, additional tuning heads, the horn antennas, and an air conditioner.

The trailer has a cargo capacity of 175 cubic feet and carries a recommended cross-country cargo of 1,500 pounds.

#### b. Equipment Shelter

The electronic equipment, some antennas, and the operator are housed in a lightweight, aluminum-skinned shelter made of a honeycomb material. This shelter is sturdy enough to withstand the strain of equipment loading during cross-country driving and to withstand the stress of crane pickup even though loaded with equipment. The equipment racks are mounted in the forward portion of the shelter and are equipped with suitable shock mounts. The shelter provides a maximum of internal volume and yet conforms to the normal or the near-normal vehicle silhouette. A partial roof of the honeycomb material covers the forward half of the shelter. The roof is used to mount a transmitting mast assembly and to strengthen the shelter. A radome is fitted over the entire shelter and, in addition to its prime function as an antenna protector, serves as a roof for the shelter. An interior view of the MPJ is shown in fig. 3.

The dimensions of the shelter are approximately 69 inches wide, 74 inches long, and 56 inches high with the radome cover adding another 15 inches of height. The equipment occupies the forward bulkhead of the shelter from top to bottom and from side to side to a depth of 26 inches. The roof area that is available for antenna mounting consists of approximately 30 square feet. The total weight of the equipment and shelter is approximately 2,100 pounds which is about 600 pounds in excess of the vehicle limitations. A breakdown of weights allows 800 pounds for electronic equipment with 1,300 pounds allowed for the shelter, racks, cables, and ventilating equipment.

The equipment mounted in the shelter includes (1) transmitting equipment, (2) receiving equipment, (3) modulation and lookthrough equipment, (4) analysis equipment, (5) receiving antennas, and (6) programming equipment.

c. Antennas

The receiving antennas mounted on the shelter consist of five antennas covering the following frequency bands from 30 to 210 mcs with a fixed whip mounted on the exterior of the shelter and a range of 65 to 10,750 mcs with four AN/ALA-6 antennas mounted on the vertical sidewalls of the shelter; the antennas slide up to be placed into operating position as shown in fig. 7.

The transmitting antennas mounted on the exterior of the shelter consist of five antennas covering frequencies from 100 to 350 mcs with the broad-band stub; 350 to 2,400 mcs with the AT-428( )/U; 2,350 to 5,000 mcs with the AT-551( )/U; 4,950 to 8,800 mcs with the AT-552( )/U; and 8,750 to 10,500 mcs with the AT-553( )/U. This antenna assembly is shown in fig. 8.

d. Transmitting Equipment

The major functional groups of the AN/ALT-6B transmitting equipment consist of the C-1965/ALT-6B control indicator; the PP-1533/ALT-6B power supply; the T-608/ALT-6B low-frequency transmitter; the T-608/ALT-6B high frequency transmitter; and OA-1186/ALT-6B through OA-1195/ALT-6B oscillators with the allied tuning controls and adapters.

The major functional groups of the AN/ALT-7 transmitting equipment consist of the T-464/ALT-7 transmitter with the PP-506/APT-6 power supply and the T-465/ALT-7 transmitter with the PP-506/APM-6 power supply. The 0- to 10,000-mcs dummy load is utilized with all transmitters.

The Countermeasures Transmitting Set AN/ALT-6B is a cw, noise and frequency modulated, remote controlled, airborne jamming system designed to jam defensive-search, tracking, gunlaying radar, and similar victim equipment.

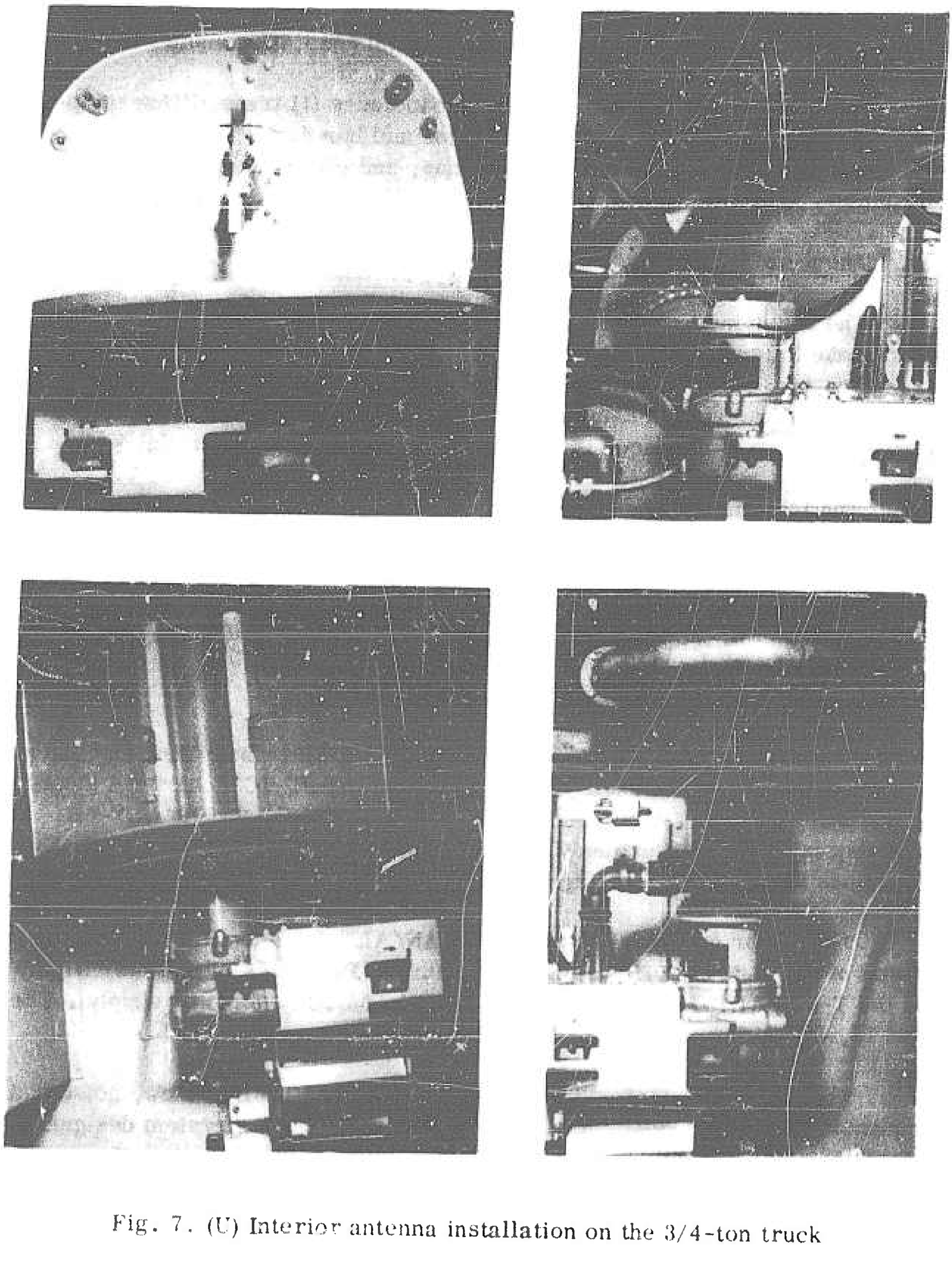

Fig. 7. (U) Interior antenna installation on the 3/4-ton truck

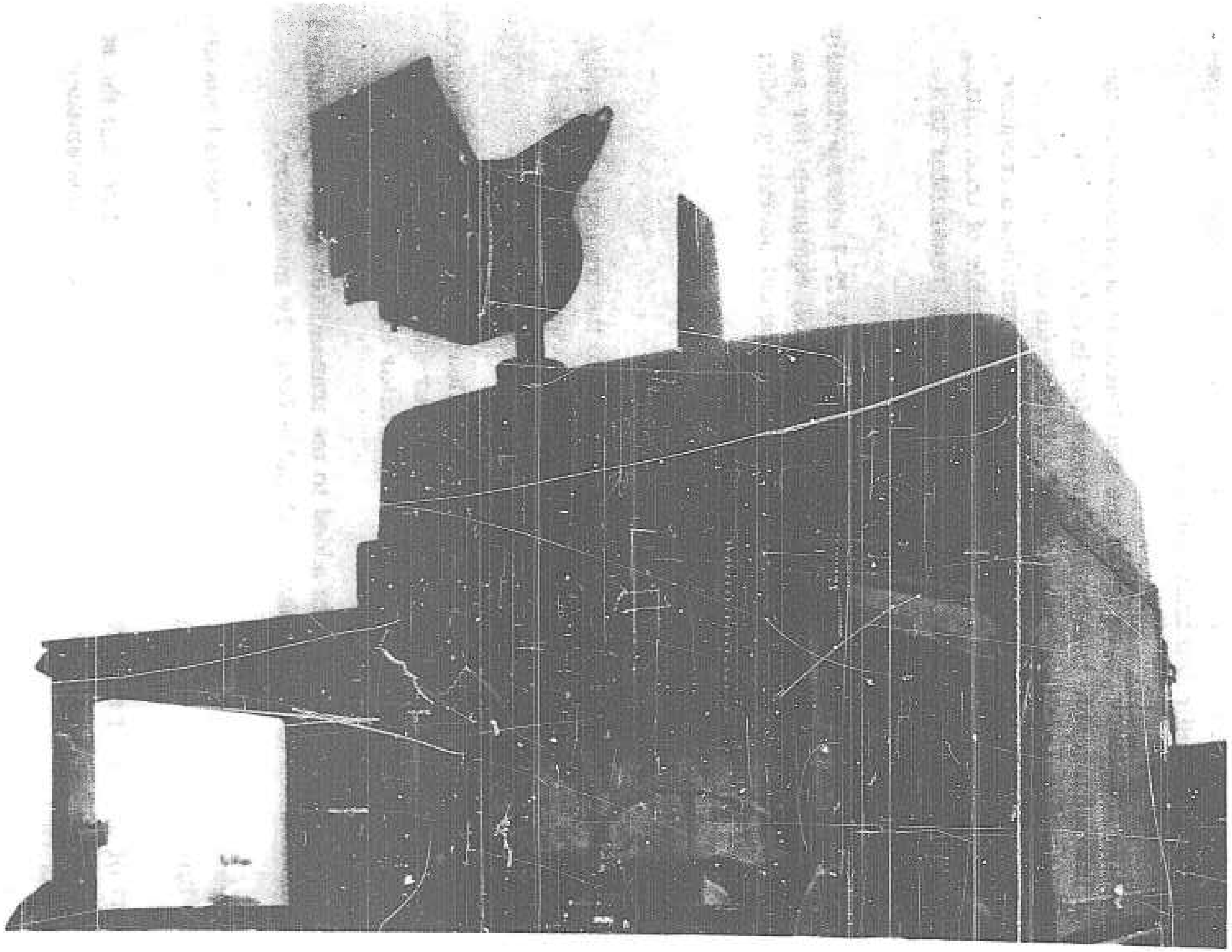

Fig. 8. (U) Exterior antenna installation on the 3/4-ton truck

Victim electronic equipment is jammed by tuning the transmitting set, either manually or automatically, to or through the transmitting frequency of the sets of equipment to be jammed. The energy transmitted from the transmitting set will, if tuned to the proper frequency, enter a receiver and cause the receiver output to be unintelligible. The transmitter contains two seperate, automatically tuned radio transmitters.

Effective frequency coverage of the equipment is determined by the selection of interchangeable transmitter groups for installation in the transmitting set. Each transmitter group of the AN/ALT-6B covers a specific frequency range within 350 to 10,500 mcs; each group includes a frequency control indicator and a tunable magnetron oscillator capable of transmitting and jamming a different range of frequencies. Only one transmitter in a given transmitting set can be operated at any one time.

Radio transmitters T-464/ALT-6B and T-465/ALT-7 are specifically designed as airborne electronic countermeasures (ECM) equipment for jamming enemy radar facilities. Enemy am. or fm equipment operating within the range of 100 to 352 mcs can also be jammed.

e. Transmitter Modifications

A number of modifications have been made to the transmitting equipment of the MPJ to increase the applicability of the equipment to the MPJ system.

On the AN/ALT-6B, lookthrough is provided by enabling the lookthrough pulse from a modulator to gate-off the transmitter during signal reception. The lookthrough pulse is fed from a pulse generator to a modulator.

A jack receptacle has been added to the transmitter to accept external amplitude modulation and the lookthrough pulse from the modulator.

A selector switch on the modulator selects either the external modulation or the internal noise modulation.

Part of the top of the AN/ALT-6B case has been hinged so that the rf plug-in heads can be changed without completely removing the transmitter case from the rack.

On the AN/ALT-7, a jack has been provided to accept external am. and the lookthrough pulse from the modulator. The modulation bandwidth switch was removed and a relay was added to disable the noise modulation circuit. Due to the lack of a suitable antenna, the T-464/ALT-7 transmitter has been modified to prevent it from transmitting below 100 mcs.

f. Receiving Equipment

The major functional item of the AN/APR-14 is the R-484/APR-14 receiver equipment.

The major functional groups of the AN/APR-9 receiving equipment are the ID-226/APR-9 panoramic indicator; the TN-128/APR-9, TN-129/APR-9, TN-130/APR-9, and the TN-131/APR-9 rf tuners; CV-43/APR-9 mixer amplifier; C-654/APR-9 remote control; PP-336/APR-9, and the PP-337/APR-9 power supplies.

The radar receiver R-484/APR-14 receives am. or fm signals in the frequency range of 30 to 1,000 mcs, and presents a visible indication of these signals on a panoramic display tube. The radar receiver is used in conjunction with ECM equipment to provide a lookthrough operation.

Radar Set AN/APR-9 is an airborne intercept receiver intended to receive radio and radar transmissions in the frequency range of 1,000 to 10,750 mcs. For analysis purposes, the signals are presented aurally by means of a headset and visually by means of a panoramic oscilloscope. Provisions have been made for remote operation.

g. Receiver Modifications

On the AN/APR-14, provisions have been made for operating the Antenna Switch in conjunction with the Receiver Band Switch.

On the AN/APR-9, synchronous pulses are derived from the horizontal sweep of the panoramic display so as to operate the pulse generator during synchronous lookthrough.

h. Modulation and Lookthrough Equipment Modifications

This equipment consists of an MD-156/TRT-2B modulator and two O-207/ALA-7 lookthrough pulse generators.

The modification to the modulator consisted of the following outputs for the AN/ALA-7 transmitter (1) a low-tone square wave that is adjustable from 17 to 600 cps; (2) a high-tone square wave that is adjustable from 275 to 6,000 cps; (3) bagpipes that consist of five sequential square waves of different frequencies; and (4) control voltages to allow cw or noise modulation to be selected in the transmitter.

The modulator modification also allows for the following outputs on the AN/ALT-6B transmitter (1) a low-tone square wave that is adjustable from

17 to 600 cps; (2) a high-tone square wave that is adjustable from 275 to 6,000 cps; and (3) control voltages to allow cw or noise modulation to be selected in the transmitter.

The pulse generators are specifically designed to work in conjunction with ECM equipment so as to provide an additional feature known as "look-through" operation. They generate either a positive or negative square wave at either a regular or random rate. The prf of the square wave is variable from 1 pulse in 5 seconds to a rate of 30 pps. The pulse delay is adjustable from 1 to 40 ms with the pw being adjustable from 1 to 15 ms in length.

i. Analysis Equipment

The AN/ALA-3 analyzer consists of an IP-264/ALA-3 indicator and a PP-1051/ALA-3 power supply. The AN/ALA-3 is a piece of equipment for airborne use in analyzing video signals received from a radar-intercept receiver. For MPJ use, the signals are observed as oscillographic traces on the face of a three-gun cathode-ray tube (CRT). The pw and the prf of the received pulses are obtained directly from an engraved calibrated scale overlayed on the face of the CRT. The readable pw and prf ranges are from 00.1 to 20.0 usec and from 20 cps to 2 mcs, respectively.

j. Programing Equipment

The programing equipment consists of a power control panel, a receiver switching unit, a receiver antenna control unit, and an E-1798-1 power and if. switching unit for the AN/APR-9 receiver.

k. Prime Power Source

The prime power source of power comes from one PU-346/G as shown in fig. 9; this generator set is a 120-volt, 3-phase, 400-cycle unit. It is capable of supplying 8 kw of power at an 80-percent power factor. The generator, complete with integral 5-1/2-gallon fuel tank, weighs approximately 700 pounds. An air-cooled diesel engine with a 4,000-hour service life is used as the prime mover and will operate for 5-1/2 hours on each tank of fuel. The unit has both a manual and an electrical starting system.

The 28-volt, dc power supply has 6 silicon diode rectifiers connected in a double 3-phase, halfwave (double wye) rectifier circuit. This unit is mounted in the PU-346/G, in the 3/4-ton trailer, and is capable of supplying 2.5 kw of power. A voltmeter and ammeter are provided for metering the 28-volt, dc supply.

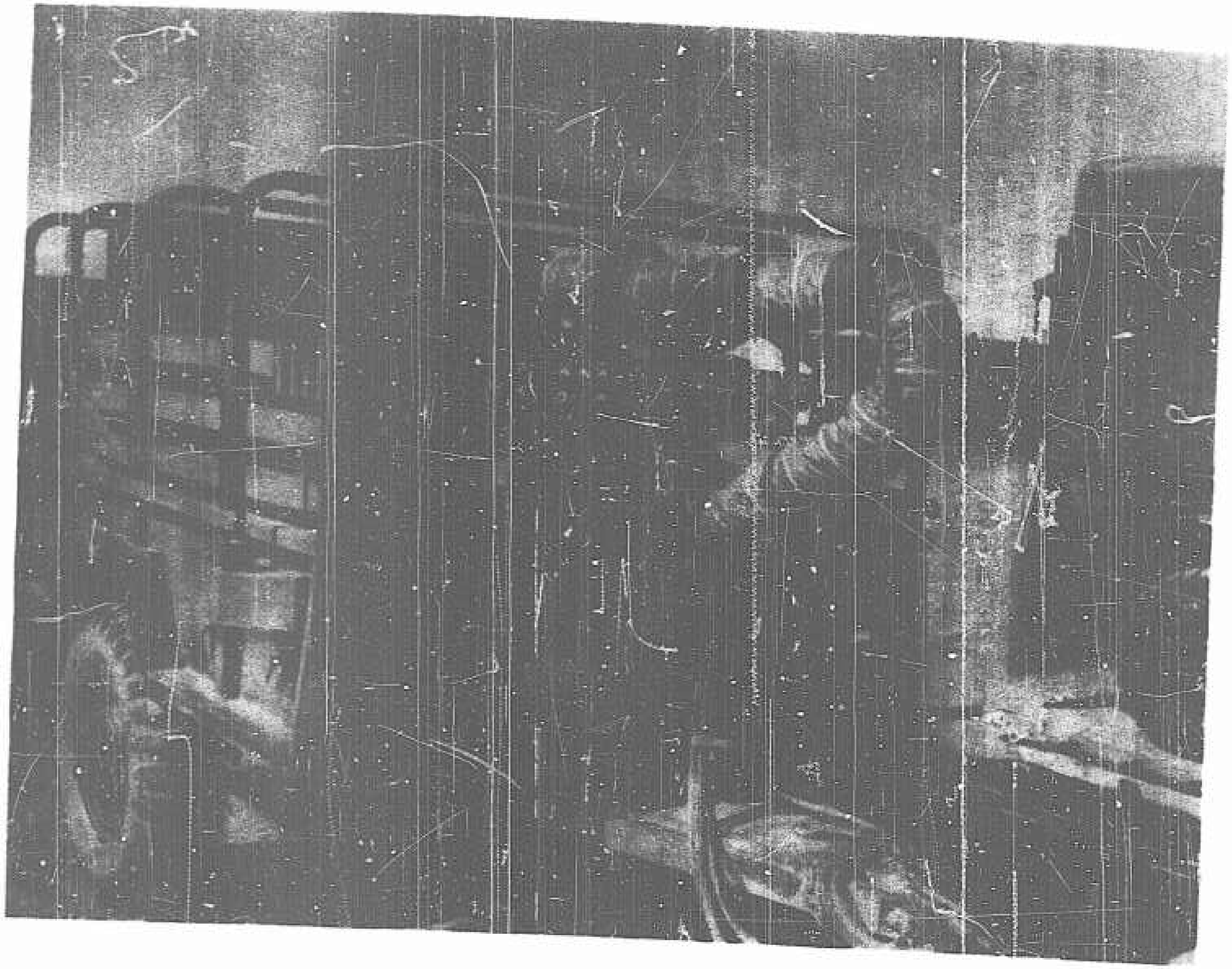

Fig. 9. (U) MPJ power source mounted in 3/4-ton trailer

l. Communications Equipment

The AN/VRC-17 radio set is an fm radio-telephone transceiver with a frequency range of 27 to 39 mcs. The set is designed for short-range operation (between 10 and 15 miles) and can be installed in nearly any type of vehicle.

m. Receiving Antennas

The antenna array consists of an omnidirectional whip antenna operating from 30 to 210 mcs; an AS-654/ALA-6 horizontally polarized loop antenna operating from 65 to 210 mcs; an AS-655/ALA-6 horizontally and vertically polarized antenna operating from 210 to 1,000 mcs; an AS-656/ALA-6 horizontally and vertically polarized antenna operating from 1,000 to 5,000 mcs; and an AS-657/ALA-6 circularly polarized antenna operating from 5,000 to 10,750 mcs.

n. Transmitting Antennas

The antenna array consists of an omnidirectional broadband stub antenna operating from 100 to 350 mcs; an AT-428( )/U linearly polarized horn antenna operating from 950 to 2,400 mcs; an AT-551( )/U linearly polarized horn antenna operating from 2,350 to 5,000 mcs; an AT-552( )/U linearly polarized horn antenna operating from 4,950 to 8,800 mcs; and an AT-553( )/U linearly polarized horn antenna operating from 8,750 to 10,500 mcs.

o. Direction-Finding Equipment

Direction-finding group AN/ALA-6 displays radar (or radio) signals on a cathode-ray screen having a degree-calibrated scale from which the relative bearing of the received signal can be read. The equipment consists of an IP-243/ALA-6 indicator; a PP-974/ALA-6 power supply; a C-1246/ALA-6 antenna control; a CU-397/ALA-6 coupler; four TG-23/ALA-6 antenna drives; and three CU-398/ALA-6 couplers.

The Antenna Drives, TG-23/ALA-6, have been modified so that the direction of rotation can be reversed and the speed of rotation varied.

5. (S) MPJ OPERATIONAL CAPABILITY: RECEIVING

a. Frequency Range

The receiving equipment of the MPJ is capable of continuous coverage from 30 to 10,750 mcs. The AN/APR-14 receiving component covers the range of 30 to 1,000 mcs in the following three bands: 30 to 210 mcs; 210 to 400 mcs; and 400 to 1,000 mcs. The AN/APR-9 receiving component (using the four tuning heads available) covers from 1,000 to 10,750 mcs in the following four bands: 1,000 to 2,600 mcs; 2,300 to 4,400 mcs; 4,300 to 7,300 mcs; and 7,000 to 10,750 mcs. Both components are capable of manual or automatic sector tuning with adjustable limits within each band.

b. Antennas

The five receiving antennas will provide a frequency coverage from 30 to 10,750 mcs. Four AN/ALA-6 antennas (two on each sidewall) are mounted on vertical slides of the shelter. The slides permit each antenna to be raised into operating position when required with only two of these antennas raised into operating position at any one time so as to minimize sector blocking of one antenna by another. Photographs of the antennas are shown in fig. 7.

Two of the AN/ALA-6 antennas cover from 65 to 210 mcs and from 210 to 1,000 mcs and are connected to the AN/APR-14 receiver. A whip antenna, which covers from 30 to 210 mcs, is mounted to cover the low-frequency end of the AN/APR-14 receiver. The remaining two AN/ALA-6 antennas cover from 1,000 to 5,000 mcs and from 5,000 to 10,750 mcs and are connected to the AN/APR-9 receiver. The four rotatable AN/ALA-6 antennas are covered by a radome which also serves as a roof for the shelter.

Antenna polarization varies over the frequency range of the MPJ: from 30 to 210 mcs, the antenna is vertically polarized; from 65 to 210 mcs, the antenna is horizontally polarized; from 210 to 5,000 mcs, the antenna is either horizontally or vertically polarized; and from 5,000 to 10,750 mcs, the antenna is circularly polarized.

c. Direction Finding

The MPJ has a DF capability from 65 to 10,750 mcs. From 250 to 10,750 mcs, the antennas have unidirectional beams of 5 to 15 degrees of beamwidth in both the horizontal and the vertical direction. Since the band is narrow, caution is required in leveling the truck so as to prevent a misdirection of antenna orientation and coverage. From 65 to 210 mcs, the antenna has a bidirectional (figure eight) pattern approximately 60 to 90 degrees wide; this results in a 180-degree ambiguity. In order to use this bidirectional antenna, it is necessary to know in advance which direction or sector contains the victim signal.

Reception of signals in the 65- to 210-mcs range usually will be improved by using the omnidirectional whip antenna in place of the bidirectional AS-654/ALA-6 antenna; however, the limited DF capabilities in this frequency range will be lost. The whip antenna can be switched into position by switching the DF - SEARCH switch on the AN/ALA-6 to the SEARCH position. Because of antenna space limitations, the MPJ has no DF capability below 65 mcs.

The single DF indicator on the AN/ALA-6 is capable of displaying the video output of only one receiver at any one time. Antenna rotation speed and position adjustment controls are available for both the AN/APR-9 and the AN/APR-14 receivers. The speed control is variable and provides for optimum display when using either the AN/ALA-6 indicator for initial intercept and DF, or when using the receiver panoramic display for subsequent monitoring while jamming. During initial intercept and while using the AN/ALA-6 indicator, a high antenna rotation speed (approximately 300 rpm) is desirable so as to increase the probability of intercept from concurrent frequency searching. However, once jamming has commenced and energy is transmitted, the AN/ALA-6 indicator will be useless on the victim signal frequency because of the strong reception of its own jamming transmission. The panoramic display of both receivers has synchronous lookthrough for monitoring the signal. When in this monitoring mode of operation, the receiving antenna must be trained on target or synchronized with the panoramic sweep display.

d. Analysis

The AN/ALA-3 pulse analyzer is switched from one receiver output to another in conjunction with the AN/ALA-6 indicator. This analysis equipment is capable of determining the prf (over a range of 20 to 2,000,000 pps) and the pw (from 0.1 to 20 usec) of an intercepted signal. The AN/ALA-6 indicator presentation, during initial intercept, will be capable of visually presenting some signal characteristics such as antenna polarization and rotation, relative prf, lobe switching, and modulation. A trained person, by observing the AN/ALA-3 and AN/ALA-6 indicators simultaneously, may determine accurately the signal characteristics without stopping the antenna rotation and directing the antenna to the signal source. Should there by more than one signal on the same frequency, the AN/ALA-3 presentation may be erroneous unless each signal is examined separately by positioning the antenna.

e. Programing

(1) Prime Power Programing. During normal MPJ operation, all of the receiving, analysis, and DF equipment is in simultaneous operation and is ready for instant use over the entire frequency band. In addition to being available for instant use, it is also desirable to keep all of the previously mentioned equipment turned on for phase balancing of the 3-phase prime power supply; this is done to prevent excessive harmonic currents in the power supply and to maintain power balance. No master power programing switch is provided; individual units of the receiving system should be turned off (by means of the power switches on each unit) for maintenance or removal.

(2) RF Programing. The rf programing for the receiving system automatically connects the proper receiving input to the appropriate antenna

and transmission line. The rf programing for the AN/APR-14 receiver is actuated from the Receiver Band Selector switch and also from the Low Band Antenna switch circuitry (30 to 210 mcs) within the receiver. The low-band input (from 30 to 210 mcs) is fed from either the omnidirectional whip antenna (30 to 210 mcs) or from the AS-654/ALA-6 antenna (65 to 210 mcs). The middle-band input (210 to 400 mcs) is fed from the AS-655/ALA-6 antenna.

The AN/APR-9 receiving component is fed from the AS-656/ALA-6 antenna (1,000 to 5,000 mcs) or the AS-657/ALA-6 antenna (5,000 to 10,750 mcs). The transmission line is automatically connected to the selected tuning head by the Receiver Band Selector switch through a coaxial relay operated from the receiver antenna switching unit.

(3) Video Programing. The video programing allows the operator to select, for display on the AN/ALA-6 indicator, either the AN/APR-9 video and the corresponding antenna-position-resolver (APR) output, or the AN/APR-14 video and the corresponding APR output. The video input to the AN/ALA-3 indicator is paralleled with the input of the AN/ALA-6 indicator and, simultaneously, both units display the video selected. In addition, a switch is provided to control the output of the AN/ALT-6B transmitting APR for display of the transmitting antenna orientation on the AN/ALA-6 indicator.

(4) Programing Simultaneous Reception. With the available receiving antenna configuration, it is possible to monitor simultaneously two separate frequencies (one on each receiver): the AN/APR-9 receiver is capable of operating in either the band from 1,000 to 5,000 mcs or the band from 5,000 to 10,750 mcs. Concurrent operation of the AN/APR-14 receiver is available on any one of the three bands: 30 to 210 mcs, 210 to 400 mcs, or 400 to 1,000 mcs.

Since the transmitting equipment is capable of operating on two different frequency bands below the 1,000-mcs range, the MPJ receiver may be called upon to monitor two frequencies below 1,000 mcs. Since only one receiver is provided to cover the range below 1,000 mcs, any monitoring must be done in sequence or on a time-sharing basis.

For frequencies above the 1,000-mcs range, there is only one receiver and one transmitter capable of operating at any given time.

6. (S) MPJ OPERATIONAL CAPABILITY: TRANSMITTING

a. Frequency Range

The continuous frequency coverage of the AN/ALT-6B and the AN/ALT-7 transmitting equipment is from 100 to 10,500 mcs. This capability requires four transmitters with each having a specific coverage of the entire frequency range: the T-464/ALT-7 can be operated within a band of 100 to 170 mcs and the T-465/ALT-7 can be operated within a band of 168 to 352 mcs. With the use of different oscillators, the two T-608/ALT-6B transmitters cover the range from 350 to 10,500 mcs. One transmitter covers the band from 350 to 5,000 mcs with the use of six oscillators operating from 350 to 585 mcs; 565 to 975 mcs; 950 to 1,525 mcs; 1,475 to 2,400 mcs; 2,350 to 3,600 mcs; and 3,500 to 5,000 mcs. The second transmitter covers the band from 4,950 to 10,500 mcs with four oscillators operating from 4,950 to 6,200 mcs; 6,150 to 7,300 mcs; 7,250 to 8,800 mcs; and 8,750 to 10,500 mcs. The second T-608/ALT-6B transmitter system rf cable is designed so that it is important that the oscillators with frequencies above 5,000 mcs be used with this set so as to prevent an excessively high VSWR and consequent damage to the magnetron.

b. Antennas

The transmitting antenna installations provide a frequency coverage from 100 to 350 mcs and from 1,000 to 12,000 mcs. The low frequencies (from 100 to 350 mcs) fall within the capabilities of the stub antenna which is mounted permanently on the outer front portion of the shelter. There is no antenna transmitting capability from 350 to 1,000 mcs.

The second antenna consists of a group of four horns that are mounted on a single mast which can be rotated by a motor-driven pedestal; the group covers a band from 1,000 to 10,500 mcs. A remotely controlled coaxial switch is mounted on the mast to select the proper antenna or to connect the output line to a dummy load. The entire assembly is removable from the pedestal socket and is adequately safeguarded against weather.

Blocking of one antenna by another is minimized by staggering the antenna heights to obtain beam clearance. The 100- to 350-mcs stub antenna is vertically polarized. The horn antenna assembly can be set manually to vertical, 45-degree, or horizontal detent positions.

c. Direction Finding

The antenna pedestal, which receives the mast and directional horn antennas, is capable of being rotated through an arc of approximately 350 degrees. The pedestal drives a video resolver of the type used in the AN/ALA-6 antenna drive unit. The antenna horns are directional with beamwidths on the order of 40 degrees (both horizontal and vertical) and thus minimize the possibility of jamming friendly equipment.

The video resolver input is obtained from the fluxgate compass circuits of the AN/ALA-6 indicator and presents the transmitting antenna position on the AN/ALA-6 indicator simultaneously with the received signal bearing in the form of a narrow strobe line. Thus an immediate DF position can be obtained by superimposing the transmitting antenna strobe line upon the pattern of the received signal.

d. Frequency Matching

There are two methods used for frequency matching: one method is when both the victim signal and the jammer signal must be presented simultaneously on the panoramic display of the receiver. The second method is when the victim signal and the jammer signal are monitored aurally. The dial settings of the transmitting equipment are not accurate enough for ideal frequency matching.

The transmitted signal coupling is reduced to a suitable level for relatively accurate frequency matching by using coaxial cable with a shielded outer conductor and operating the transmitter output from the antenna to the dummy load. Rapid switching of the transmitter output from the antenna to the dummy load is provided by coaxial relays, and is controlled by the operator.

Since both transmitters employ self-exciting oscillators to generate the carrier frequency, the exact operating frequency will depend somewhat on the load impedance. Thus, if the dummy load differs considerably from the antenna load impedance, the frequency will vary from the matched conditions whenever the transmitter is switched to the antenna. The frequency pulling is kept to a minimum by keeping the antenna VSWR low and by using a well-designed dummy load.

When using the panoramic display of either receiver, the display resolution will allow frequency matching within $\pm 0.25$ mcs. In the event that the jammer output is to be swept in frequency or operated against a wide bandwidth receiver of a microwave radar, this degree of frequency matching is adequate. However, for critical frequency matching for the spot jamming of narrow-band communications (or similar equipment) the operator may have to employ the aural zero-beat method.

e. Modulation and Lookthrough

The MPJ transmitting equipment is capable of being modulated in the following manner:

(1) The am. noise mode of operation, that is normally provided for in the AN/ALT-7 and the AN/ALT-6B transmitters, is preserved. This method of modulation is most often used because of its multipurpose nature.

(2) The fm provided for in the AN/ALT-7 transmitter has a frequency deviation of ±3.5 to 5 percent; it also has an adjustable sweep speed of 8 to 400 sweeps per second. The fm provided for in the AN/ALT-6B transmitter is capable of a slow sweep (2 to 120 sweeps per minute) over the range of 0 to 1,200 mcs and a fast sweep (2 to 20 sweeps per second) over the range of 0 to 350 mcs or the simultaneous use of both modes.

(3) The MD-156/TRT-2B modulator provides several types of modulation for the AN/ALT-7 transmitter (a) a low-tone square wave that is adjustable from 17 to 600 cps; (b) a high-tone square wave that is adjustable from 275 to 6,000 cps; (c) bagpipes, consisting of five sequential square waves of different frequencies; and (d) control voltages to allow cw or noise modulation to be selected in the transmitter.

All types of modulation (mentioned in the previous paragraph) except bagpipes are available from the MD-156/TRT-2B modulator for the AN/ALT-6B transmitters.

While in the jamming mode, synchronous lookthrough may be used with either or both transmitters so as to monitor the received victim signal. In order to keep the transmitter off-time to a minimum and on-time to a maximum, the lookthrough gate is synchronized with the panoramic sweep indicator of the receiver in use. (By delaying the synchronous lookthrough gate and adjusting its width until it just "brackets" the received signal on the panoramic indicator, minimum transmitter off-time can be achieved.) The O-207/ALA-7 pulse generator is capable of supplying a lookthrough gate for each synchronous pulse, or it can be adjusted to a random-rate countdown by means of a noise coincidence circuit. The gate width is variable from 1 to 20 ms and the gate delay is variable from 1 to 40 ms.

Two O-207/ALA-7 pulse generators are incorporated because of the difference in sweep speeds of the two panoramic receivers. The lookthrough generator, operated with the AN/ALT-6B transmitter, is synchronized with either the AN/APR-9 or the AN/APR-14 receiver, depending on which receiver covers the desired operating frequency. The lookthrough generator, employed with the AN/ALT-7 transmitter, is synchronized with the AN/APR-14.

f. Programing

(1) Prime Power Programing. Both transmitters of the AN/ALT-7 and the AN/ALT-6B are on standby condition (with heater voltage applied) at all times. This allows rapid change from one transmitter to the other, of each pair, without waiting for time delays to cycle. With transmission equipment on standby operation, each transmitter becomes operable in a minimum

amount of time and minimizes frequency drift that occurs upon initial operation. With this prime power applied at all times, the only power programing needed is the switch that selects the desired transmitter from each pair. The unit power switches are available for emergency use or maintenance.

(2) RF Programing. To minimize the time and procedure necessary in changing the frequency of operation in the performance of frequency matching or in changing transmitters, an automatic rf programer is incorporated wherever possible. The active transmitter, when selected, will be connected automatically, in each case, to the proper antenna transmission line.

The two T-608/ALT-6B transmitters designated for use between 350 and 10,500 mcs automatically select the proper antenna on the mast; this automatic antenna selection operates with the tuning head in use. With the exception of the 350- to 1,000-mcs range, the MPJ antennas cover the range of 100 to 10,500 mcs.

A manual switch provides for the termination of any of the active transmissions into a dummy load (for frequency matching) or the termination into an antenna (for jamming transmission). All rf switching works in conjunction with the transmitter interlocks which prevent switching with any rf power present.

(3) Simultaneous Transmitting. With the transmitting antenna configurations available, it is possible to radiate simultaneously two signals at different frequencies: one will be from the AN/ALT-7 on a frequency range of 100 to 352 mcs, and the other will be from the AN/ALT-6B on a frequency range of 1,000 to 10,500 mcs.

The two transmitters in the AN/ALT-7 group utilize the broadband stub antenna and have separate power supplies; whereas, the two transmitters in the AN/ALT-6B group utilize the horn antennas and share a common power supply.

## III. PRELIMINARY TESTS

(U) System performance measurements were conducted for the purpose of insuring that the System was operating according to the individual equipment specifications and to aid in establishing a performance standard by which future modifications and repaired items could be judged. These tests, although conducted on a major component basis, were designed to measure the operational parameters of the System, and determine the effect of related subsystems on each other, e.g., the effect of the rf system on the transmitter or lookthrough scheme suitability.

(U) The tests which were conducted and the method of measurement are described in the test and the results depicted in graph form. The graphs depict average values taken from data received on eight different systems and should not be considered as representative or as absolute.

### 7. (C) TEST 1, POWER OUTPUT AS A FUNCTION OF FREQUENCY FOR THE AN/ALT-6B

a. (U) Purpose

The purpose of this test was to determine the power output as a function of frequency for the AN/ALT-6B transmitter component of the MPJ.

b. (U) Procedure

The AN/ALT-6B transmitter was adjusted according to the procedure outlined in the "Handbook of Field Maintenance Instruction, AF TO 12P3-2 ALT6-42." The rf output was then connected through a 2-foot length of coaxial cable or waveguide, as applicable, to a Calorimetric Wattmeter as illustrated in fig. 10.

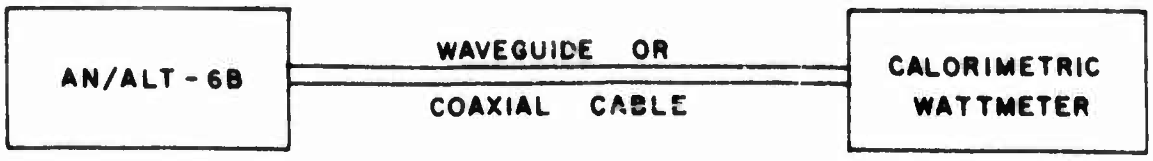


Fig. 10. (C) Equipment setup for test 1

Each of the available oscillators were connected, in turn, to the transmitter and at least three power output measurements were made for each oscillator. The average readings were taken (eight oscillator units at each frequency) and plotted.

c. (U) Results

The AN/ALT-6B transmitter was adjusted, at optimum, for the O-444/ALT-6B oscillator only. The areas which contain no measurements are for the O-441/ALT-6B and the O-442/ALT-6B oscillators which were unavailable at the time of the test. The results of the rf power output are shown in graphic form in fig. 11.

8. (C) TEST 2, POWER OUTPUT AS A FUNCTION OF FREQUENCY FOR THE AN/ALT-7

a. (U) Purpose

The purpose of this test was to determine the power output as a function of frequency of the AN/ALT-7 transmitter.

b. (C) Procedure

The AN/ALT-7 transmitter was adjusted in accordance with the procedure outlined in the "Handbook of Service Instruction, AF TO 12P3-2 ALT-2." A Bird Termaline Wattmeter was connected to the transmitter "Antenna" terminal. Then the rf power output was measured across the frequency band of both the T-464/ALT-7 and the T-465/ALT-7 for each type of external modulation available to the AN/ALT-7. The external modulations utilized, from a modified MD-156/TRT-2B modulator, included cw, noise (internal), bagpipes (random square wave), and both low (17 cps square wave) and high (6,000 cps square wave) tones.

c. (U) Results

The power output as a function of frequency for each modulation is shown in graphic form in figs. 12 and 13.

9. (C) TEST 3, DETERMINATION OF RF SYSTEM VSWR AND ATTENUATION MEASUREMENTS OF THE AN/ALT-6B

a. (U) Purpose

The purpose of this test was to determine the VSWR and attenuation measurements of the rf system of the AN/ALT-6B transmitter.

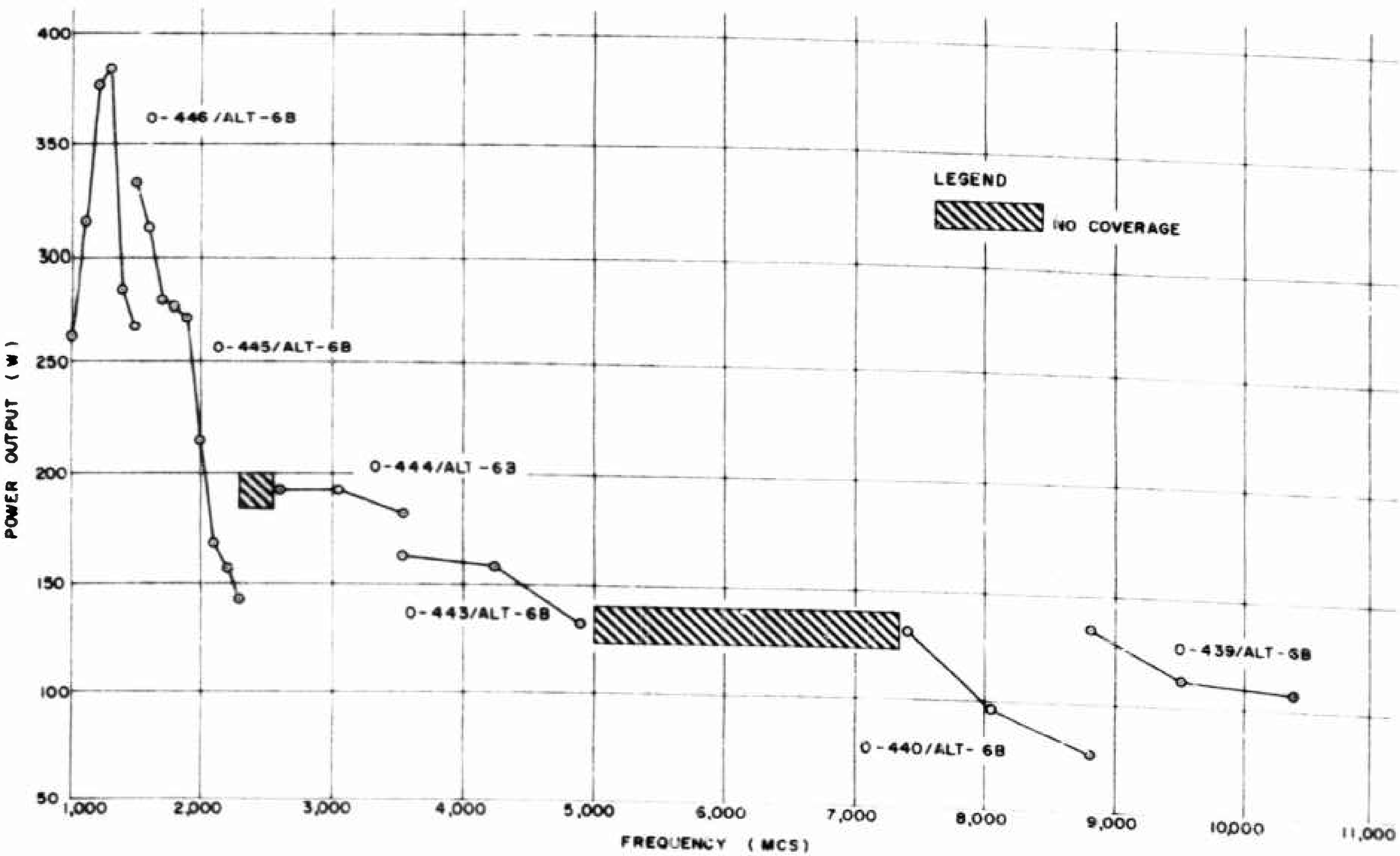


Fig. 11. (C) Power output as a function of frequency for the AN/ALT-6B transmitter

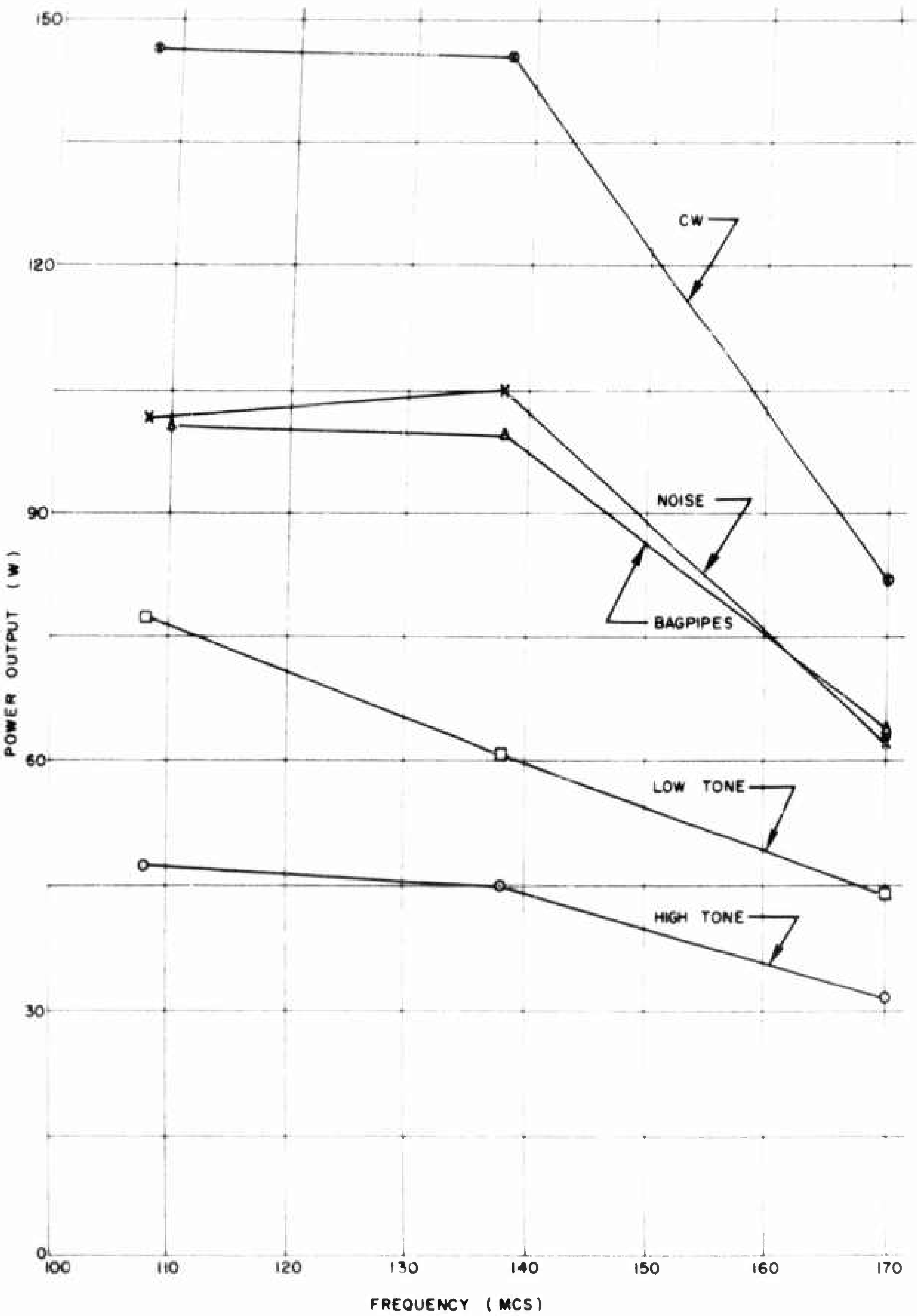


Fig. 12. (S) Power output as a function of frequency for the T-464/ALT-7 transmitter

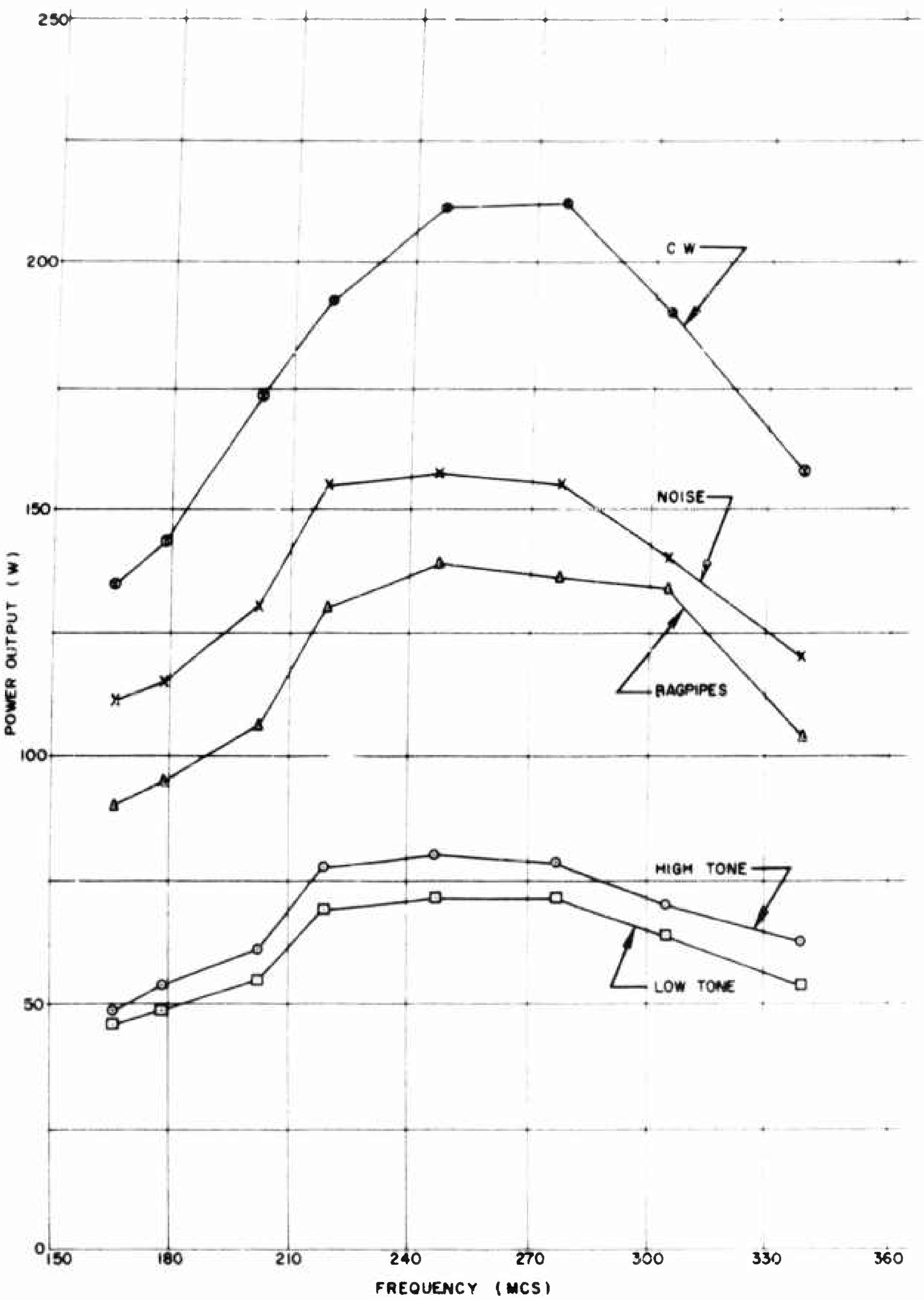


Fig. 13. (S) Power output as a function of frequency for the T-465/ALT-7 transmitter

b. (C) Procedure

The rf system VSWR and attenuation measurements for the AN/ALT-6B were conducted with the equipment setup as shown in figs. 14 and 15. The signal source was a series of signal generators that covered the required frequency range. The rf output of the generator was applied to a slotted line and probe measuring device. The slotted line was connected in series with the rf transmission system of the MPJ. This test was performed utilizing six different oscillators (1,000 to 10,500 mcs) for each of the two (both high and low frequency) transmitters of seven different MPJ's. A record was kept of the readings from all MPJ's and then averaged.

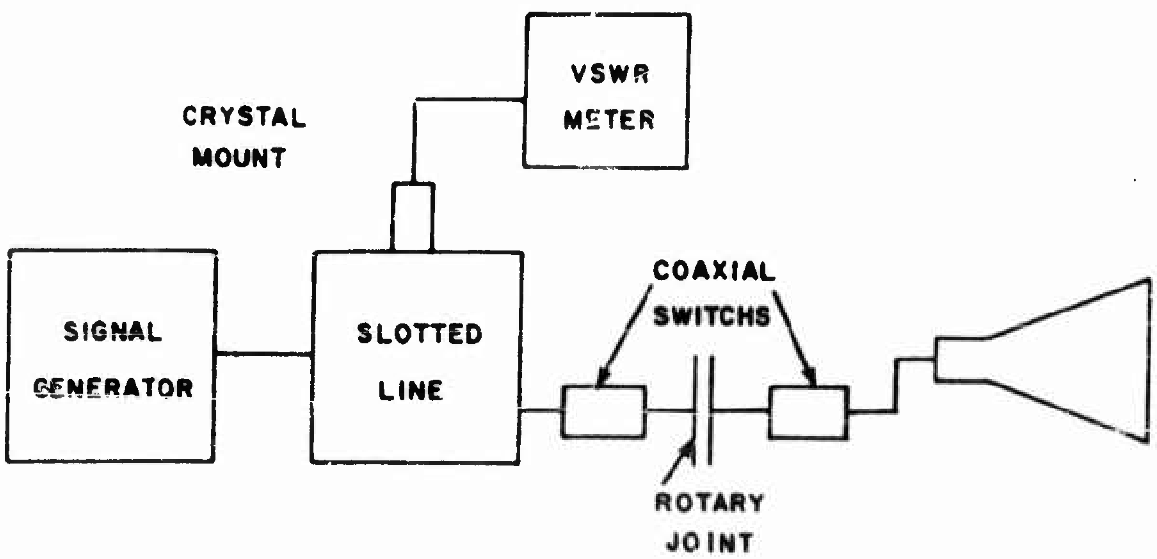


Fig. 14. (U) VSWR test setup

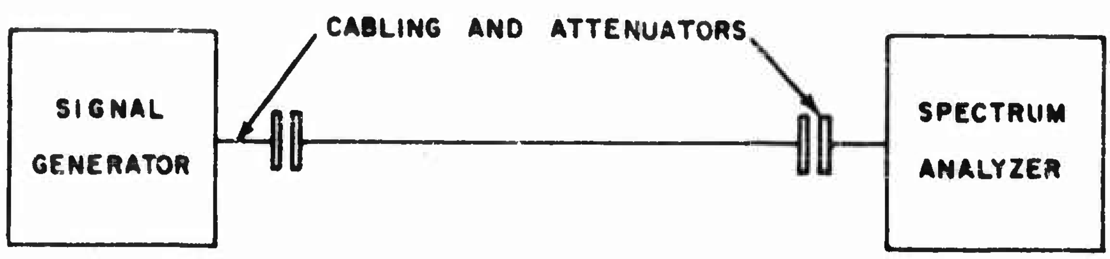


Fig. 15. (U) Attenuation test setup

With the setup for the attenuation and VSWR test, the rf system attenuation measurements were taken in the range of 1,000 to 10,400 mcs. Spot checks were also taken at frequencies below 1,000 mcs.

To perform the tests, the output from a series of signal generators was fed into a calibrated section of coaxial cable and then to a spectrum analyzer and the relative indicated signal was measured. Then the rf system was connected in series with the calibrated cable and the signal amplitude readjusted to the previous indication. The difference in the attenuator control settings for the two readings was recorded. The readings thus obtained were plotted as a function of frequency and are shown with VSWR results.

c. (C) Results

The results of the VSWR portion of the test are shown in figs. 16 and 17. The readings shown are the average values received from the seven different MPJ's. The VSWR readings of 3:1 to 3.5:1 were recorded at certain spot frequencies in the region of 10,000 mcs. The VSWR readings of 2:1 were recorded in the region of 1,000 mcs on four of the seven MPJ's. Apparently, the variations were caused by the varied lengths of cables used in the MPJ equipment.

Spot checks below 1,000 mcs showed that the system attenuation was only a few tenths of a decibel and thus were considered satisfactory.

As a result of the excessive VSWR and attenuation encountered, the rf system is being redesigned for the frequency range of 5,000 to 11,000 mcs. The new system will employ ridged waveguide. In addition, load isolators are being installed for the entire AN/ALT-6B frequency range (from 350 to 11,000 mcs) to prevent magnetron damage due to excessive VSWR's at some frequencies. It is expected that these corrections will provide an acceptable system.

10. (C) TEST 4, DETERMINATION OF RF SYSTEM VSWR AND ATTENUATION MEASUREMENTS OF THE AN/ALT-7

a. (U) Purpose

The purpose of this test was to determine the VSWR and attenuation measurements of the rf system of the AN/ALT-7 transmitter.

b. (C) Procedure

The rf system VSWR and attenuation measurements for the AN/ALT-7 were conducted with the equipment setup as shown in fig. 18. The signal source was a signal generator; the output was connected to the slotted line and the system was measured for the frequency band of 100 to 350 mcs. Readings were not taken below 100 mcs because the blade antenna exhibited excessive VSWR at low frequencies. The rf system attenuation and VSWR were measured in the same manner as specified in test 3.

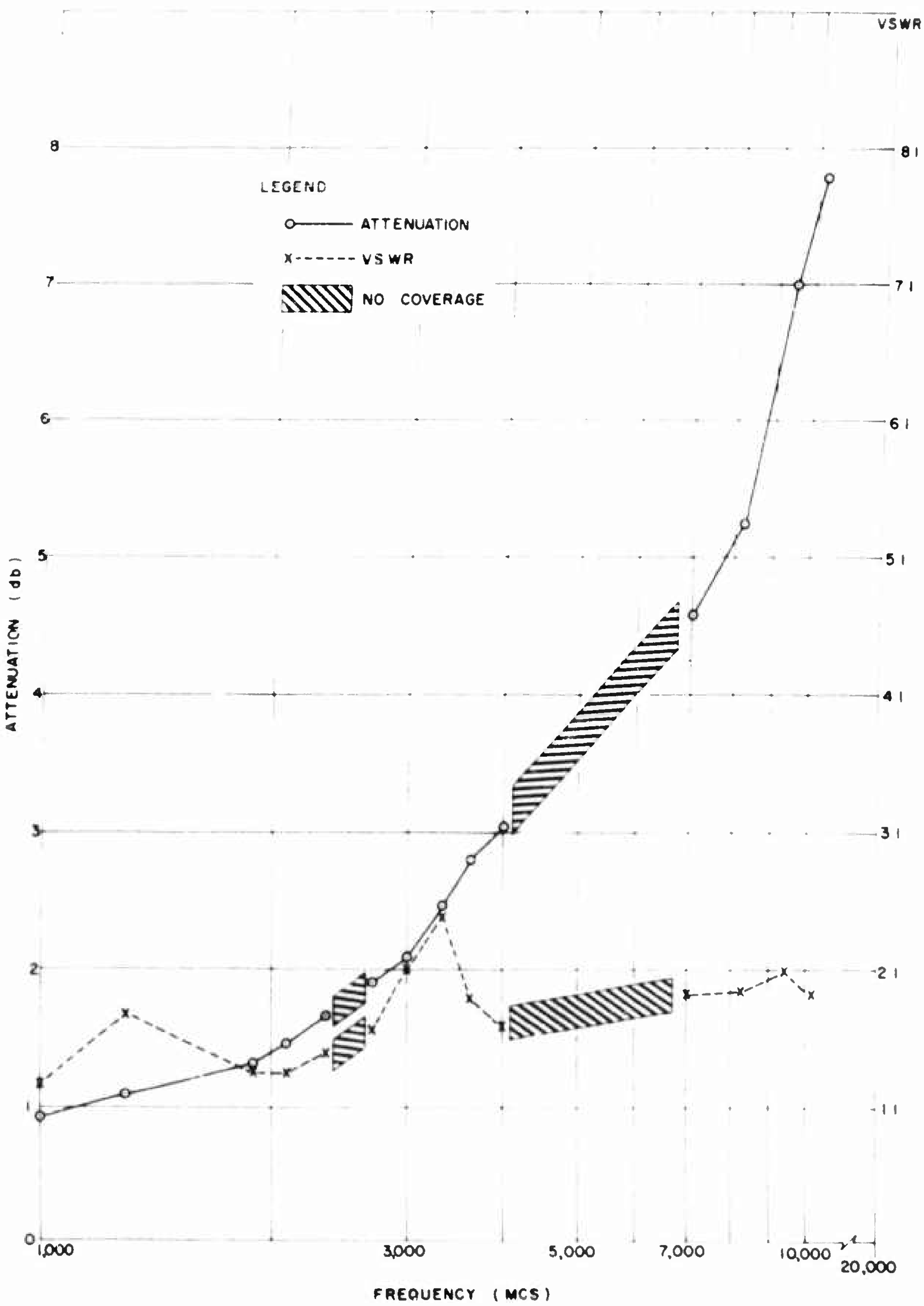


Fig. 16. (C) RF attenuation and VSWR as a function of frequency for the six oscillators used on the LF AN/ALT-6B transmitters

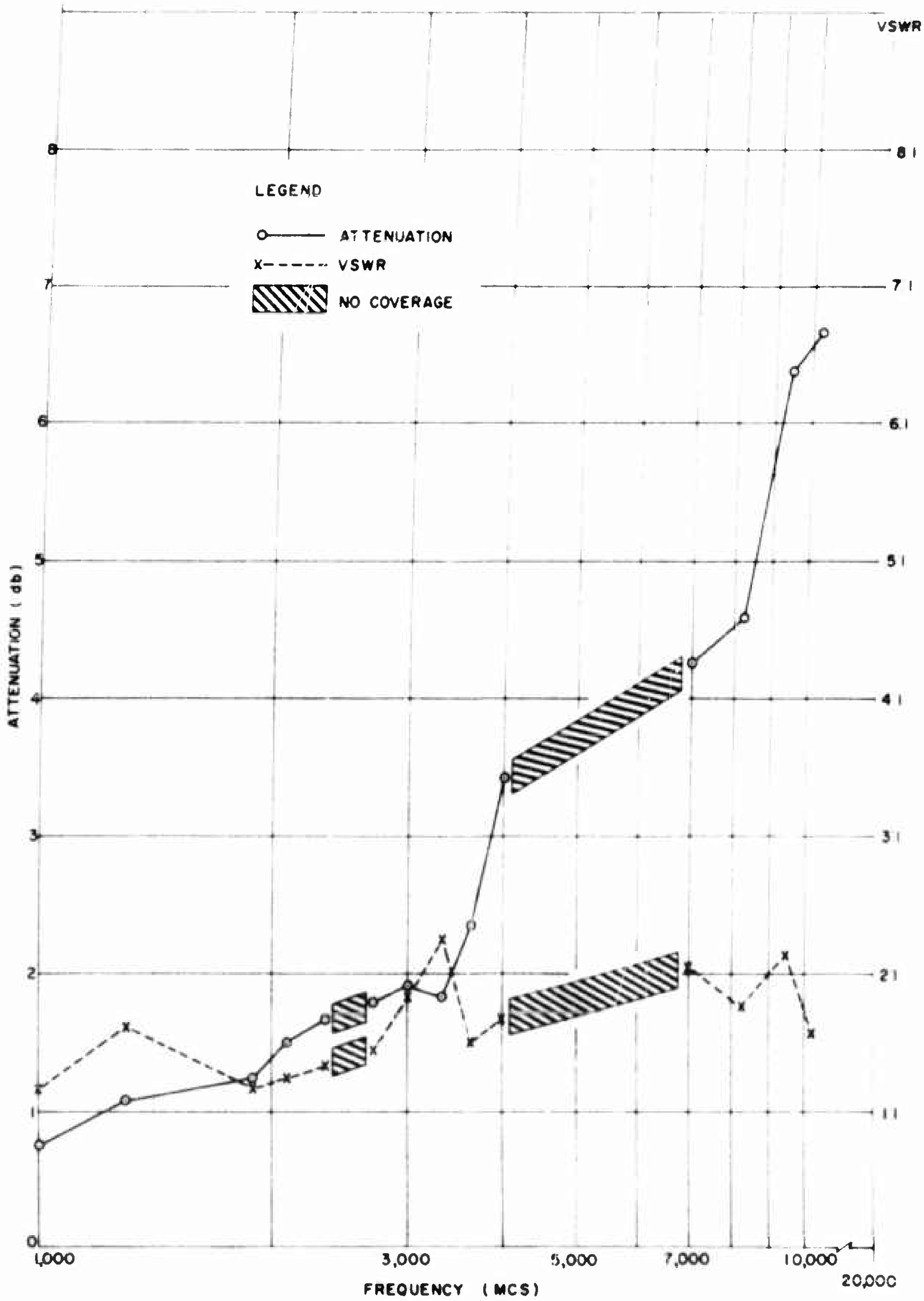


Fig. 17. (C) RF attenuation and VSWR as a function of frequency for the six oscillators used in the HF AN/ALT-6B transmitters

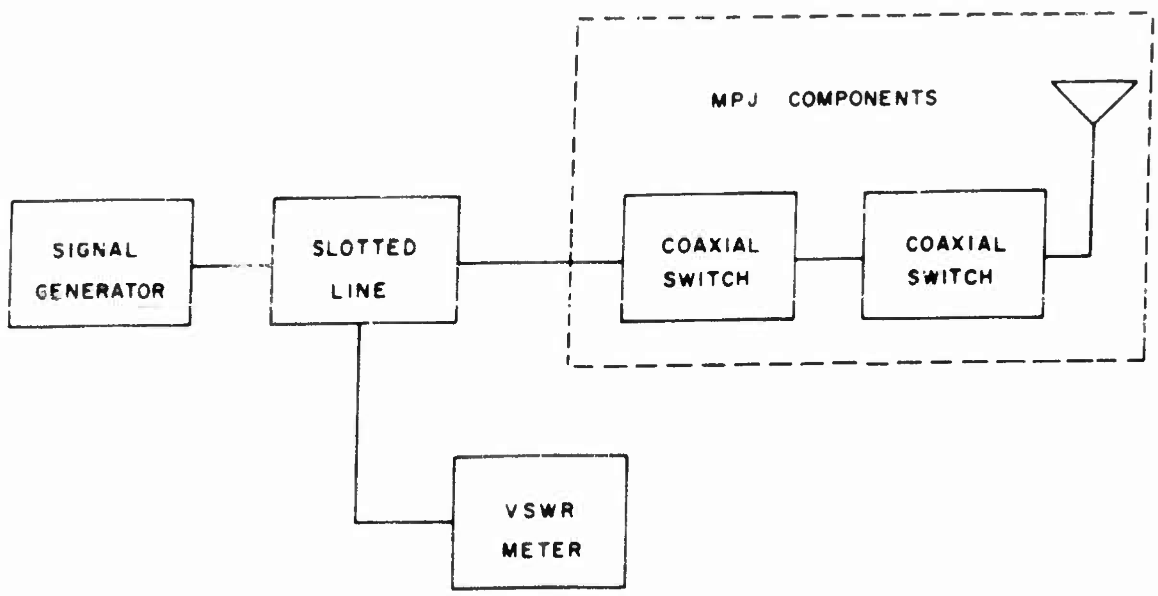


Fig. 18. (C) Attenuation and VSWR test setup

c. (C) Results

The attenuation and VSWR results are shown as average readings from seven MPJ's and are graphically presented in fig. 19.

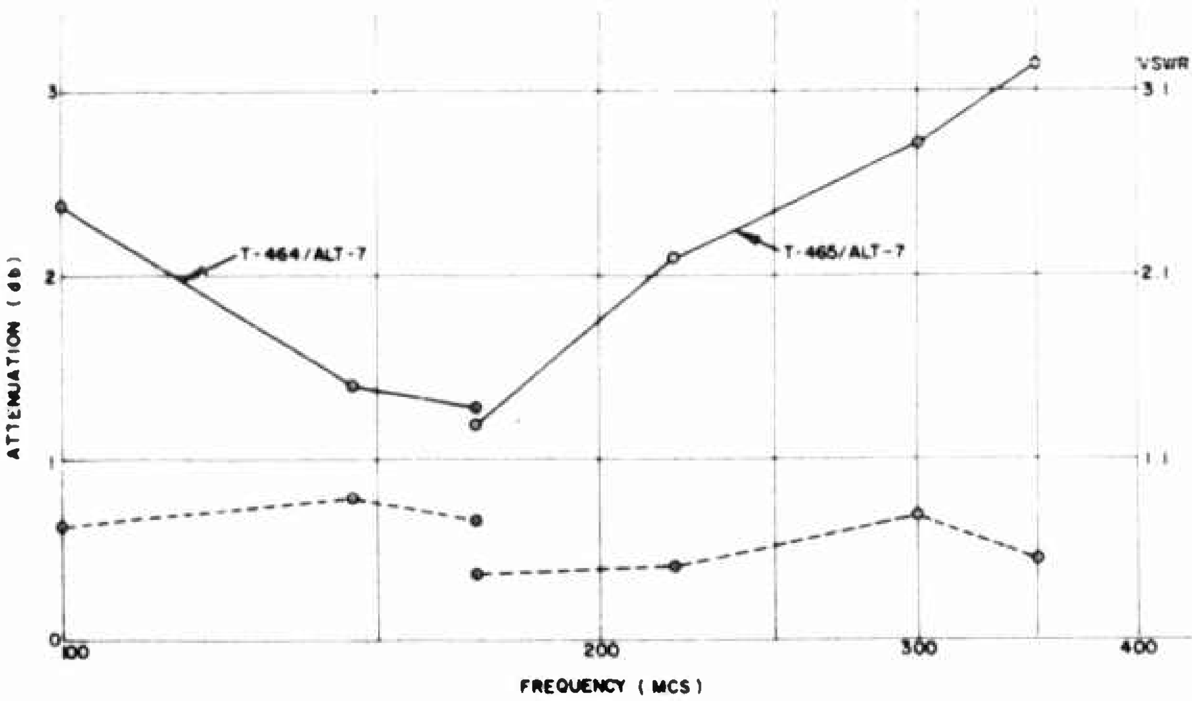


Fig. 19. (C) Attenuation and VSWR as a function of frequency

## 11. (C) TEST 5, DETERMINATION OF TRANSMITTING ANTENNA PATTERNS (1,000 TO 11,150 MCS)

a. (U) Purpose

The purpose of this test was to determine the antenna patterns of the horn antenna assembly.

b. (U) Procedure

The radiation patterns of the transmitting antennas AS-428/U, AS-551/U, AS-552/U and AS-553/U were measured when they were (1) oriented directly toward the front, and (2) when the antenna was 90 degrees to one side; the antennas were measured for both horizontal and vertical polarization.

c. (C) Results

The results of the antenna pattern measurements are shown graphically in figs. 20 through 33.

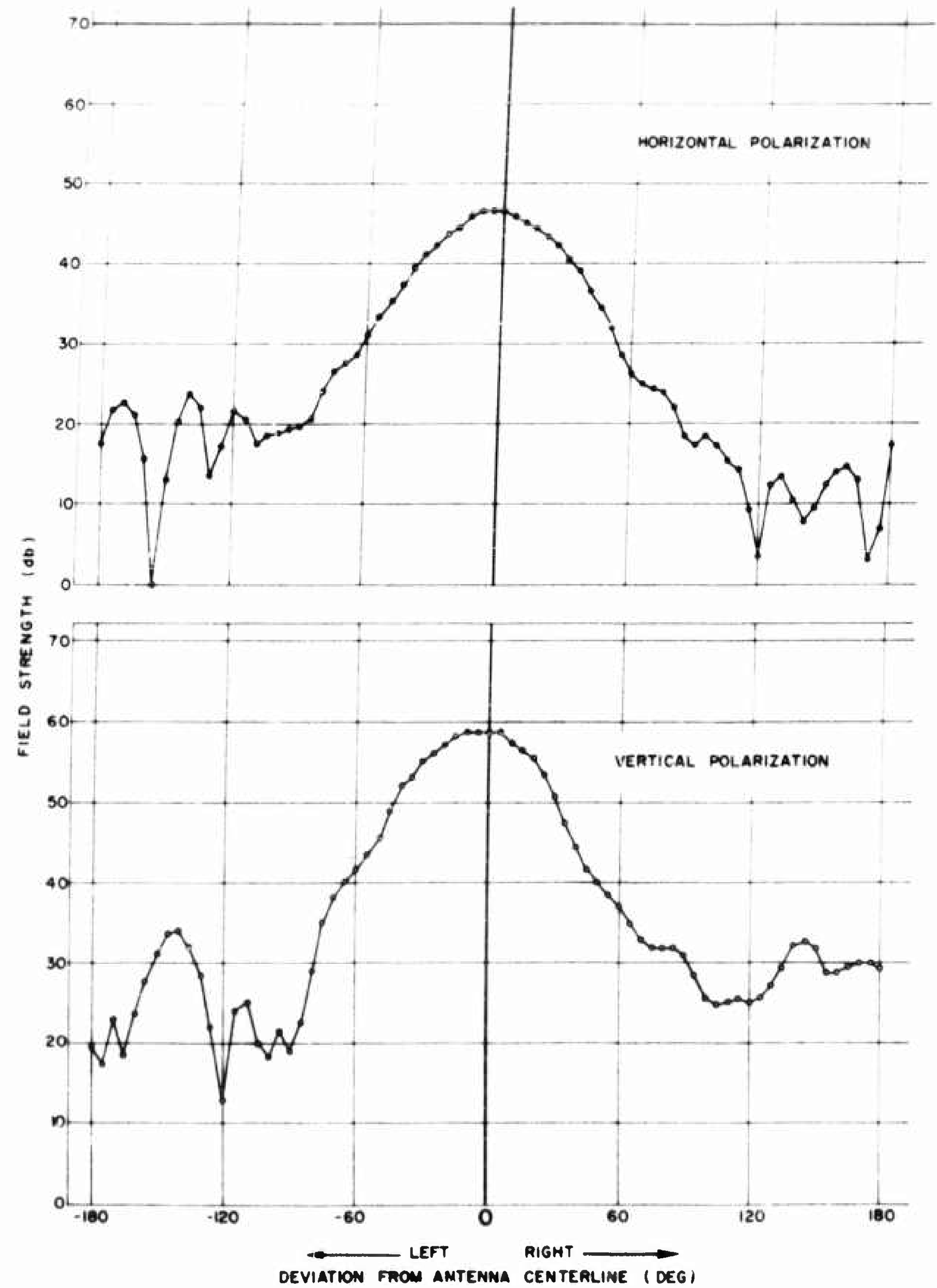


Fig. 20. (C) Antenna pattern, 1,000 mcs

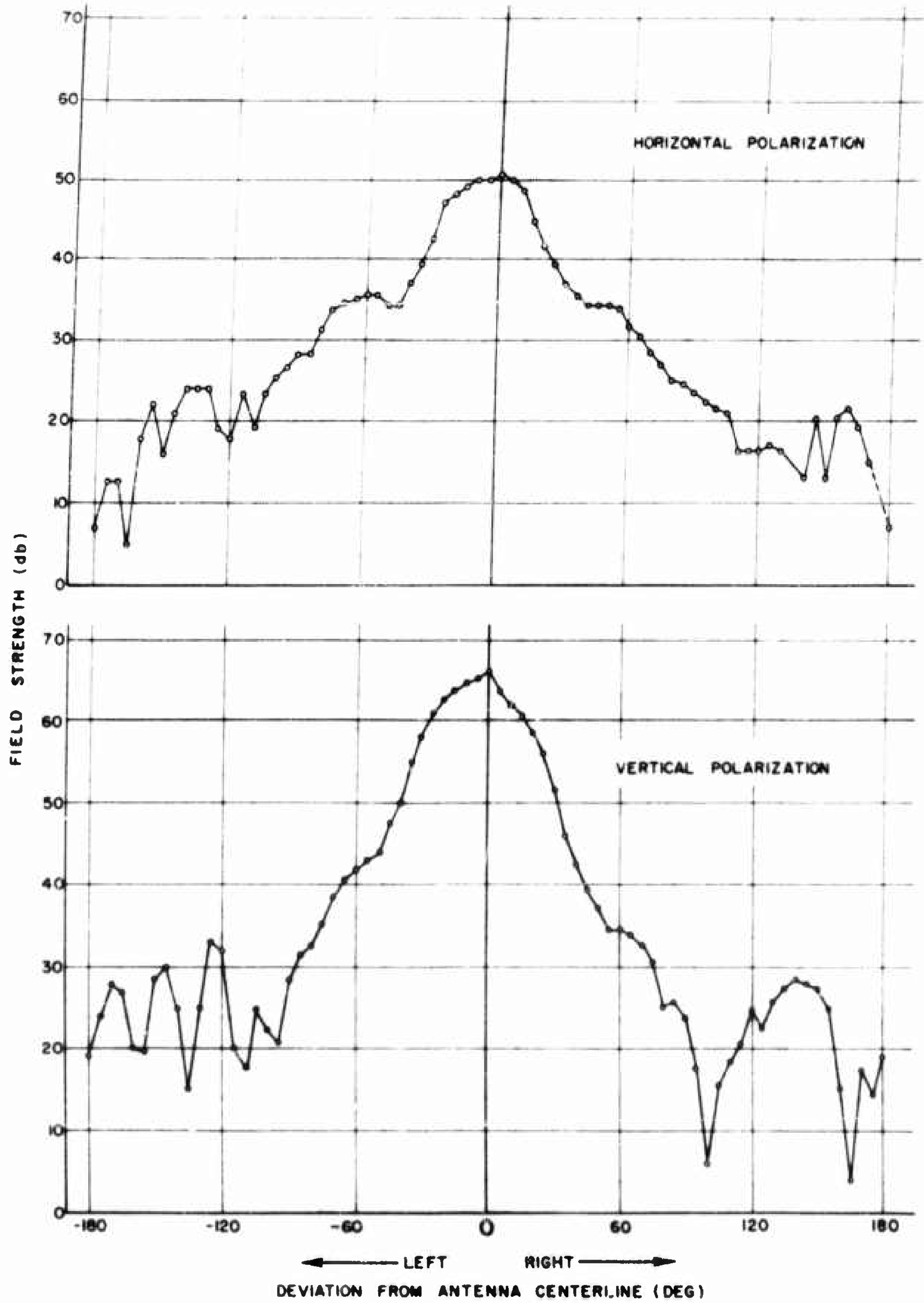


Fig. 21. (C) Antenna pattern, 1,500 mcs

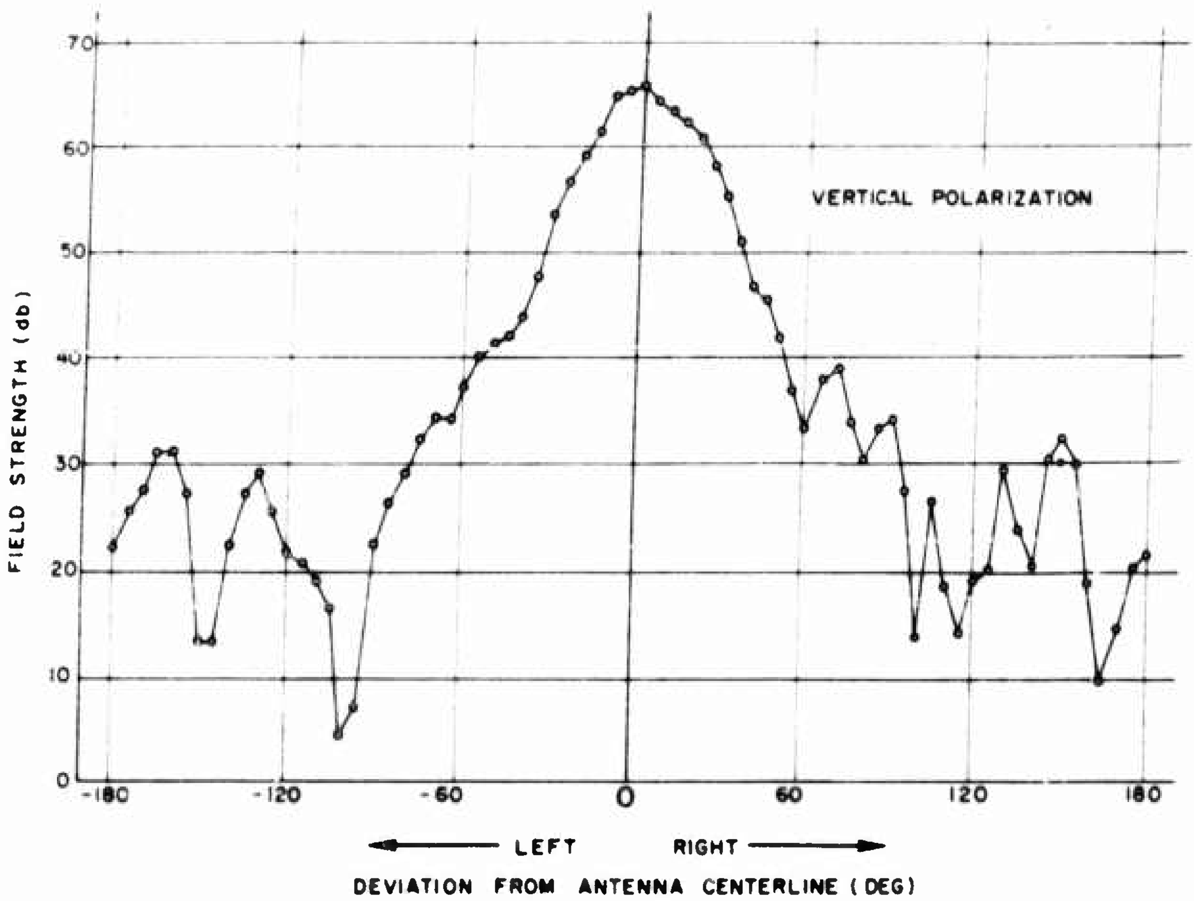


Fig. 22. (C) Antenna pattern, 1,500 mcs, truck rotated to 90-degree aspect

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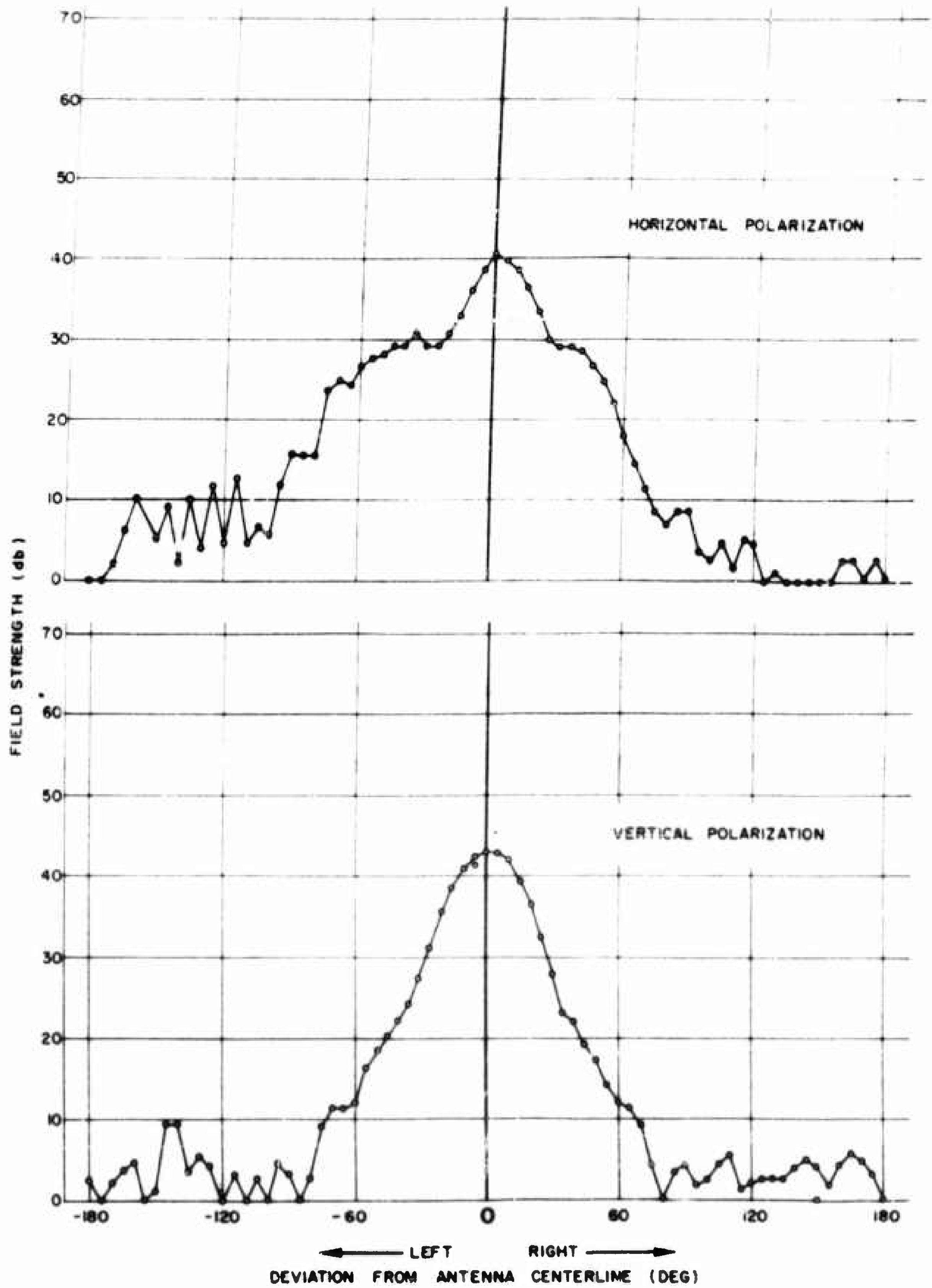


Fig. 23. (C) Antenna pattern, 2,000 mcs



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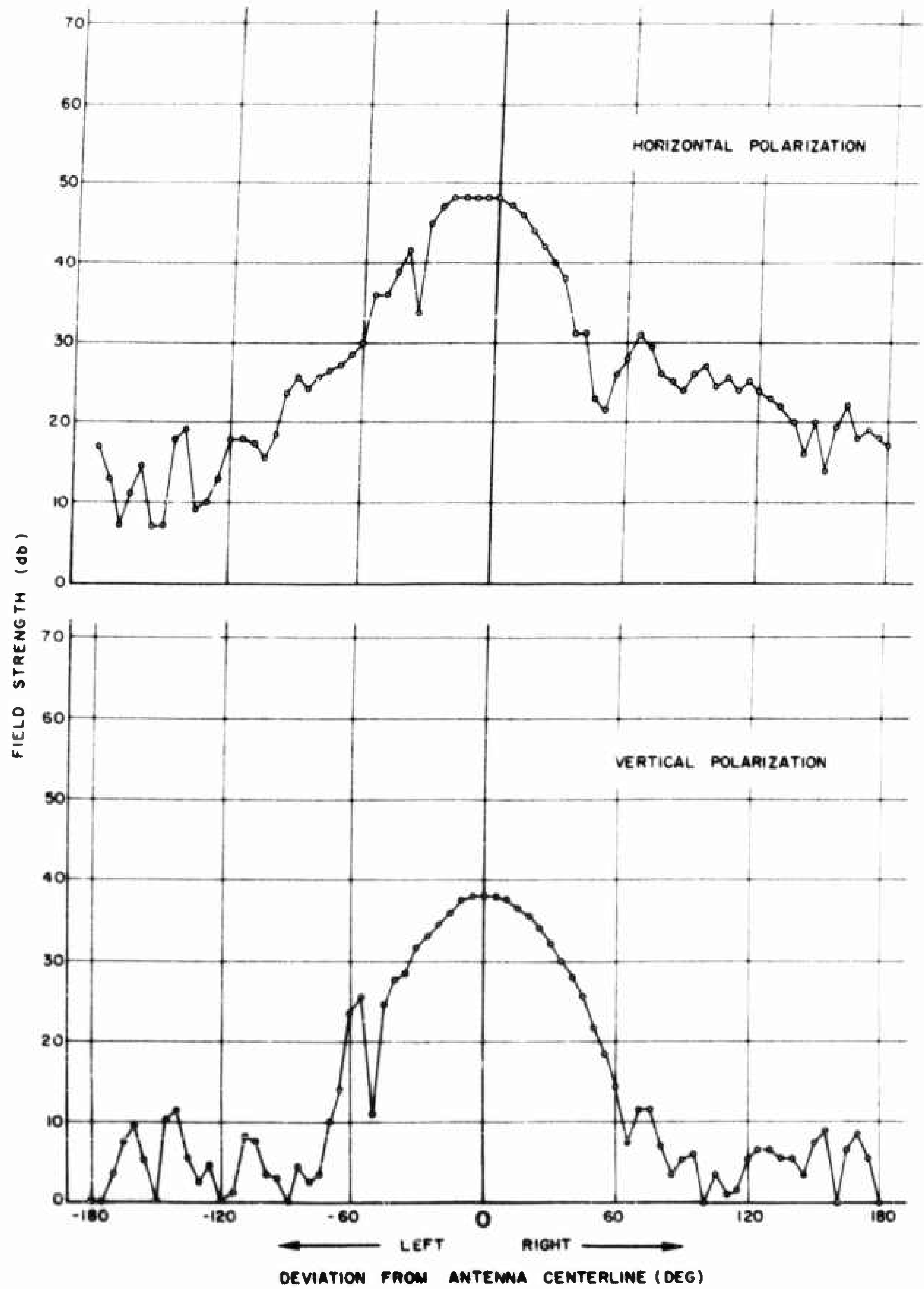


Fig. 24. (C) Antenna pattern, 2,200 mcs

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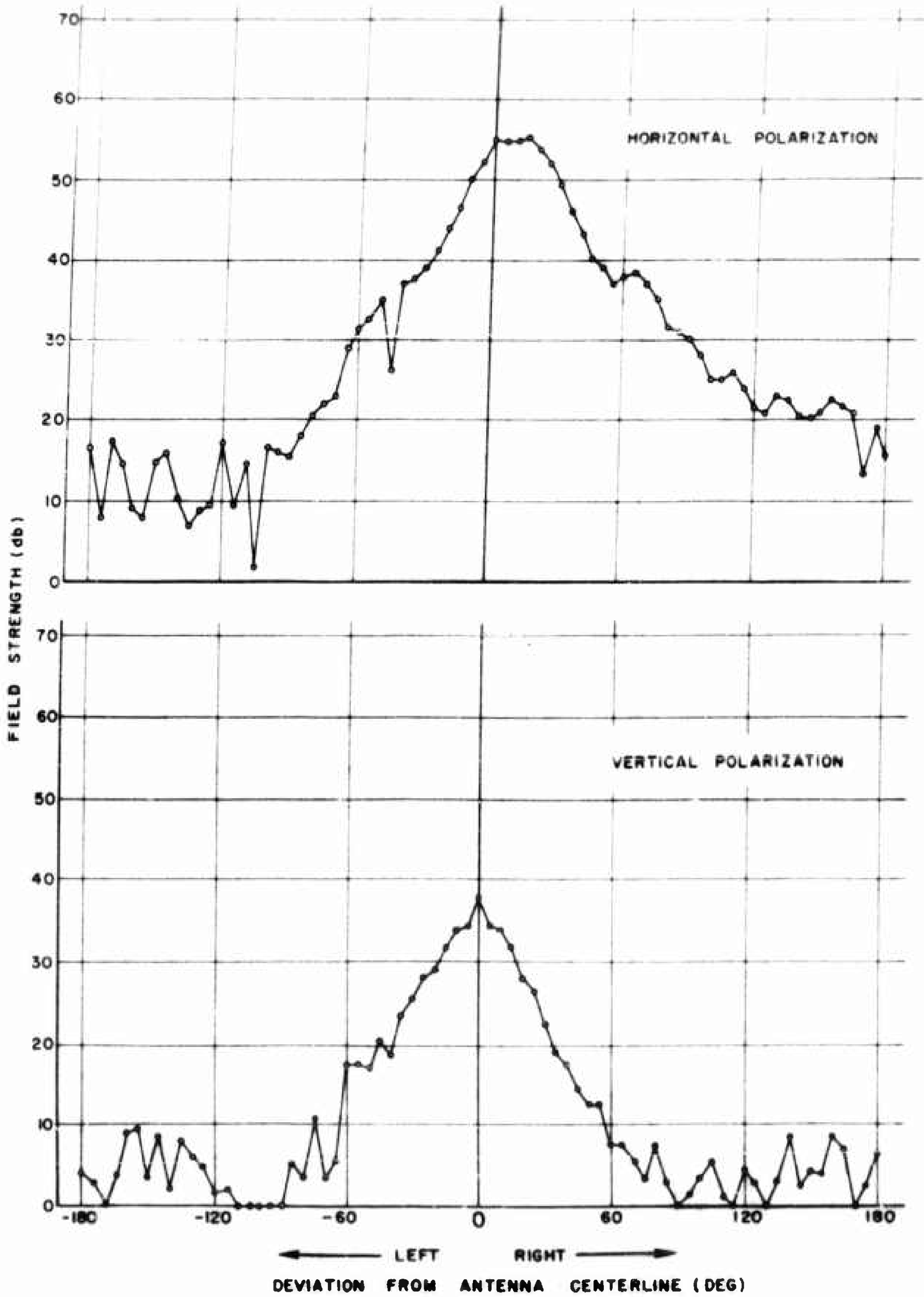


Fig. 25. (C) Antenna pattern, 3,200 mcs



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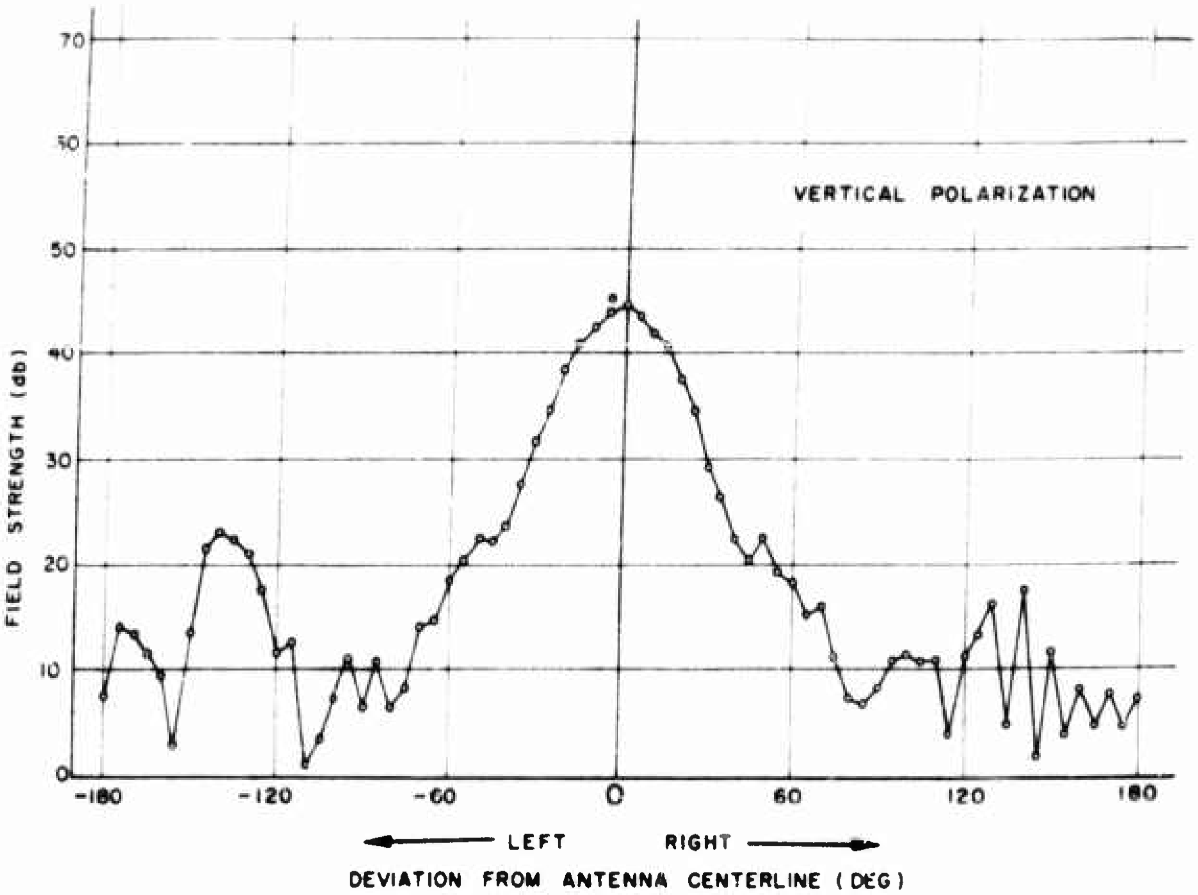


Fig. 26. (C) Antenna pattern, 3,200 mcs, truck rotated to 90-degree aspect



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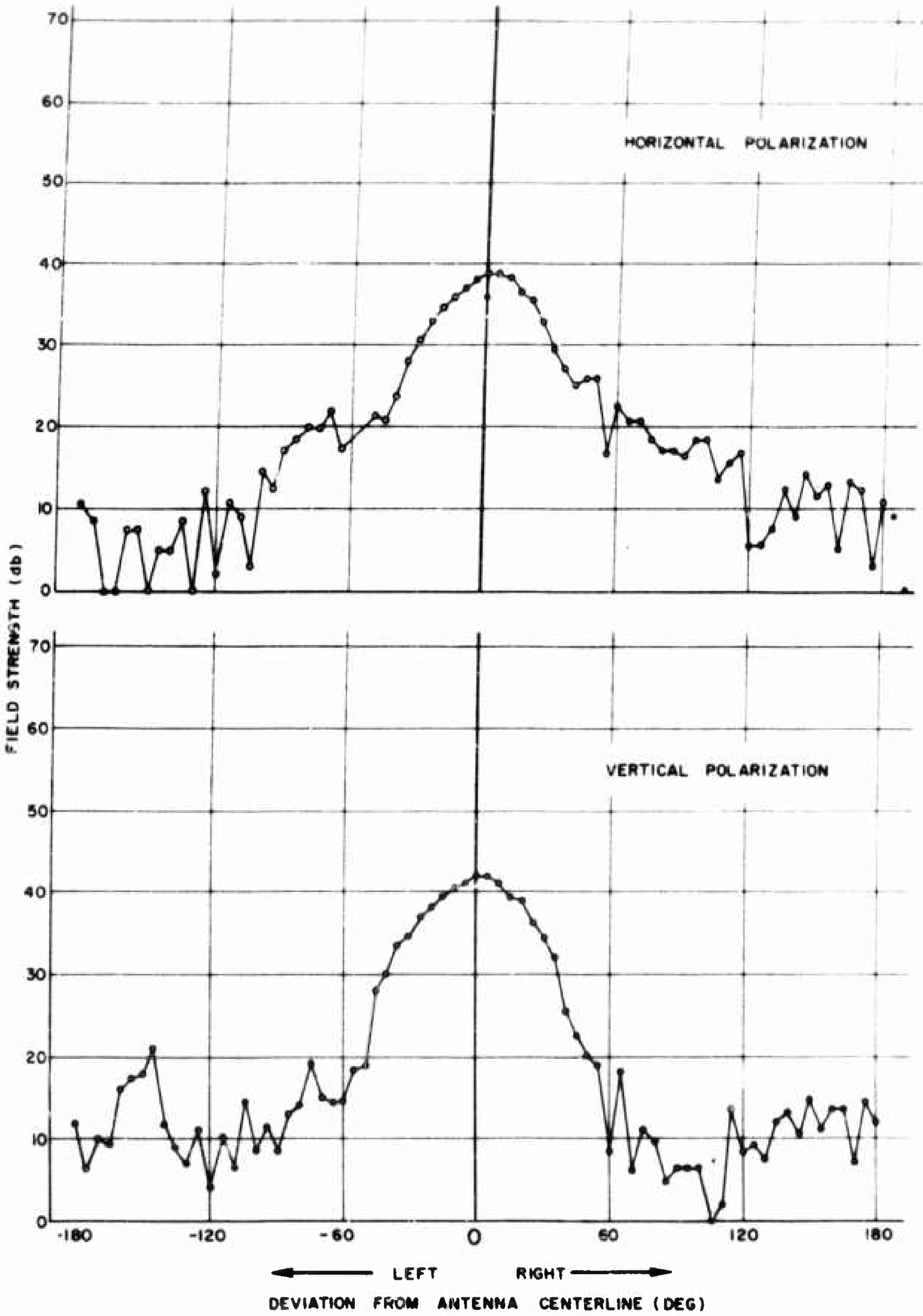


Fig. 27. (C) Antenna pattern, 5,000 mcs

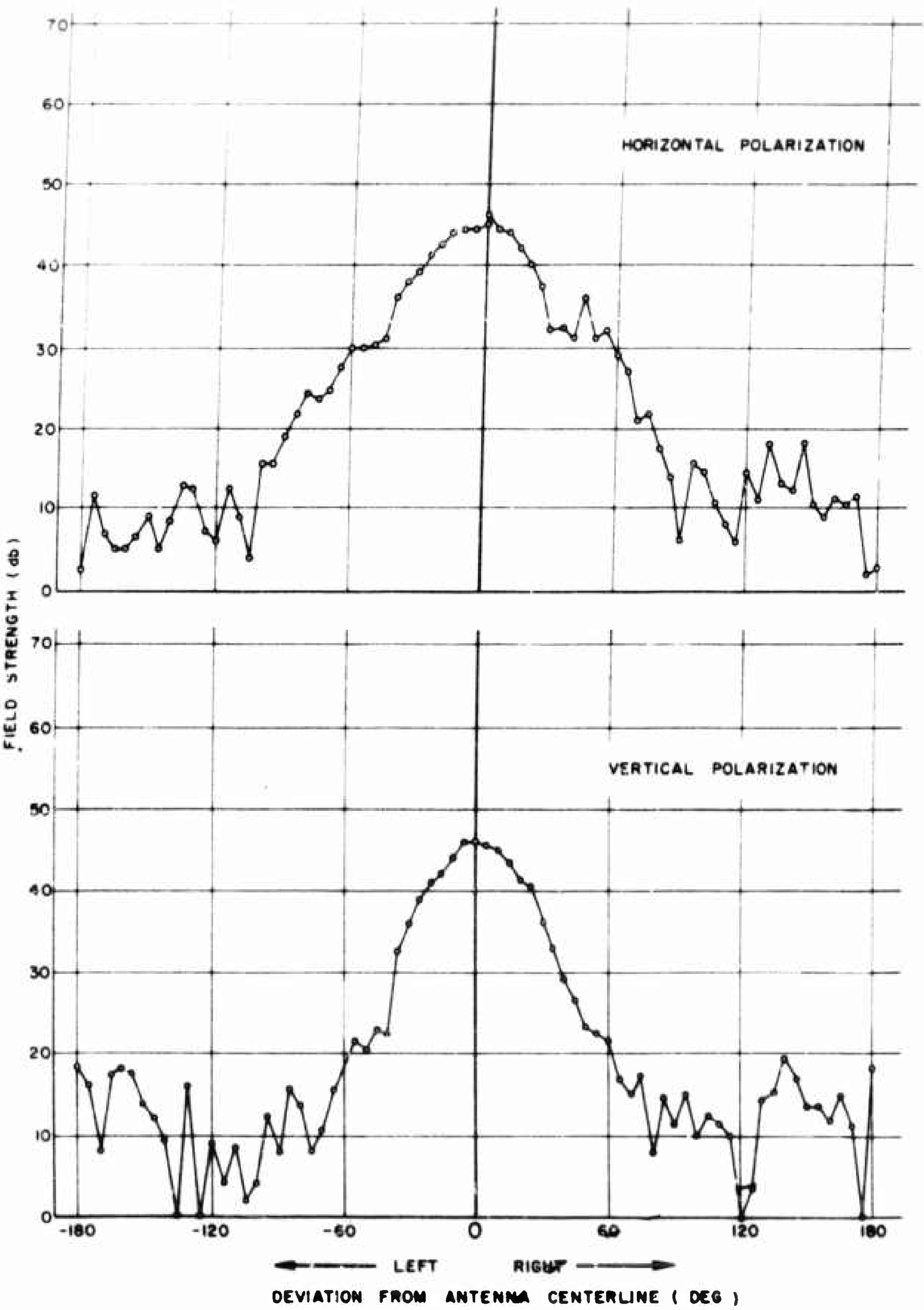


Fig. 28. (C) Antenna pattern, 6,500 mcs

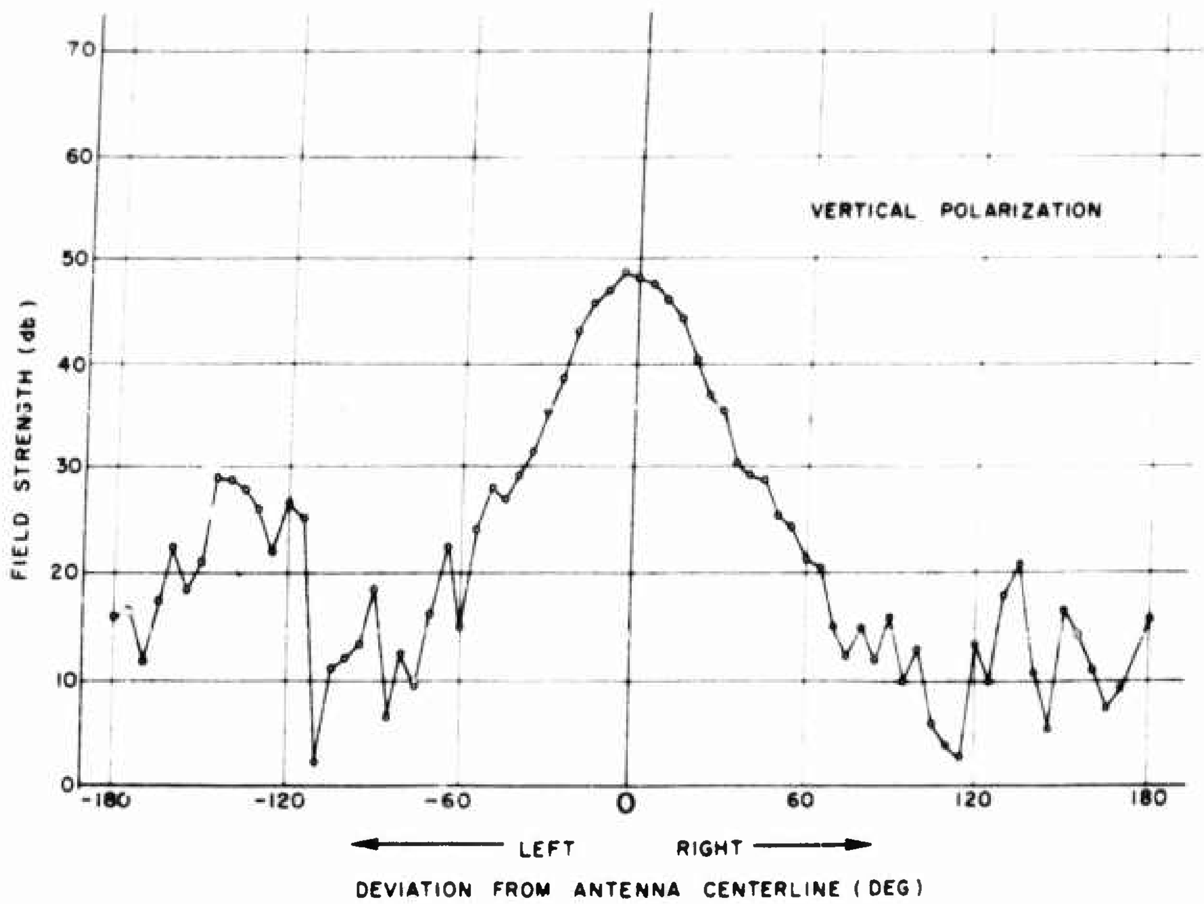


Fig. 29. (C) Antenna pattern, 6,500 mcs, truck rotated to 90-degree aspect

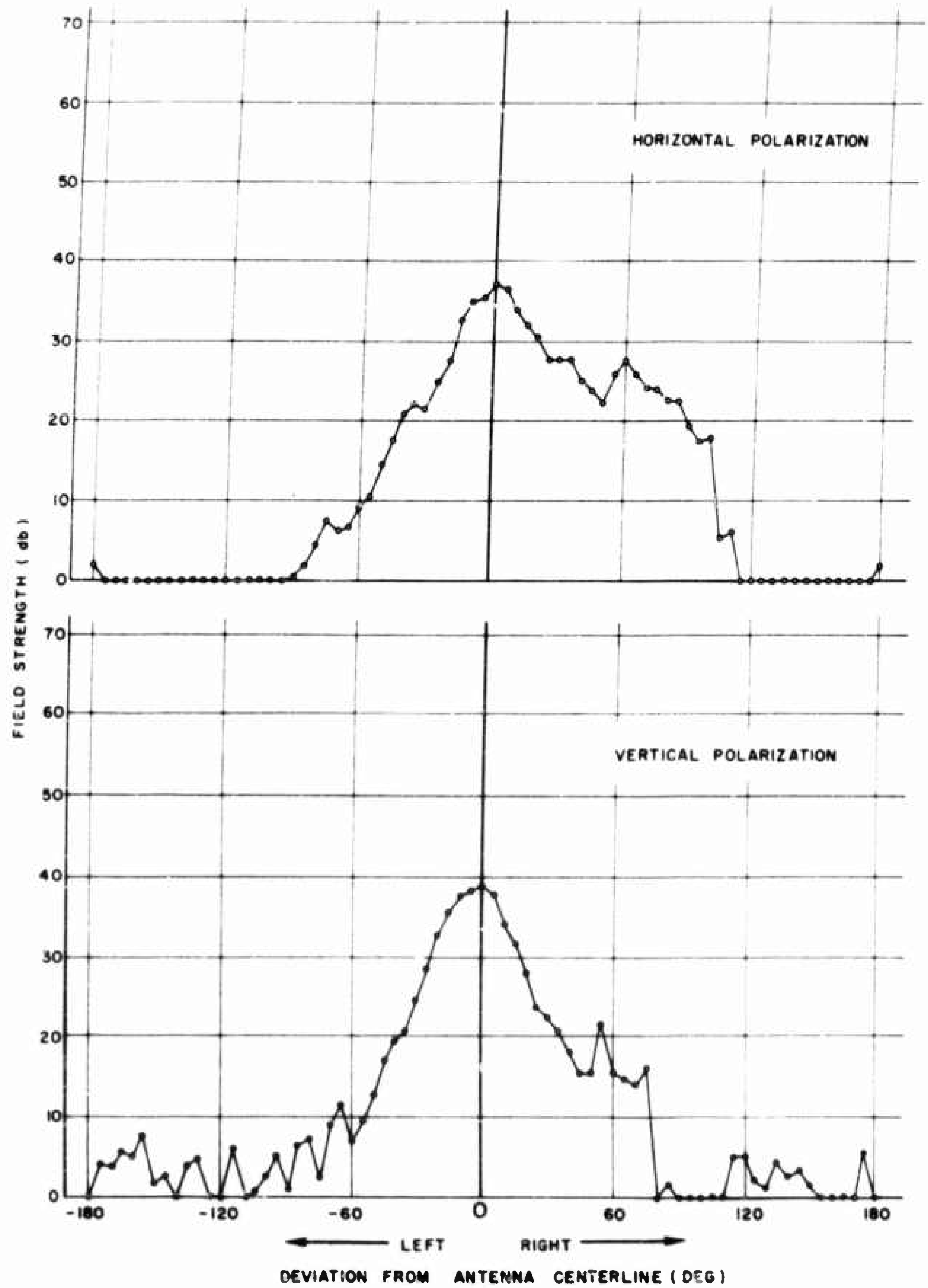


Fig. 30. (C) Antenna pattern, 8,000 mcs

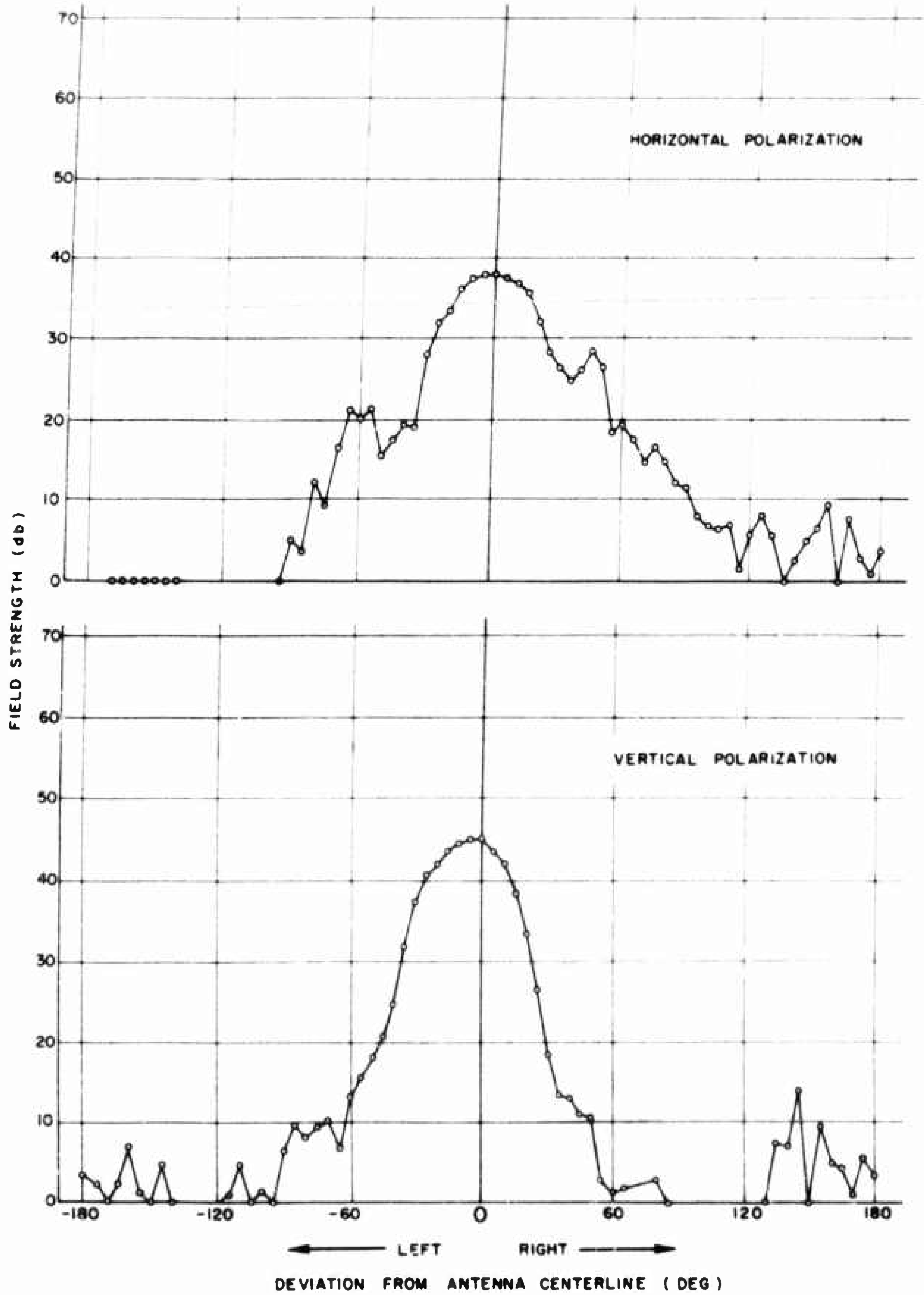


Fig. 31. (C) Antenna pattern, 10,500 mcs

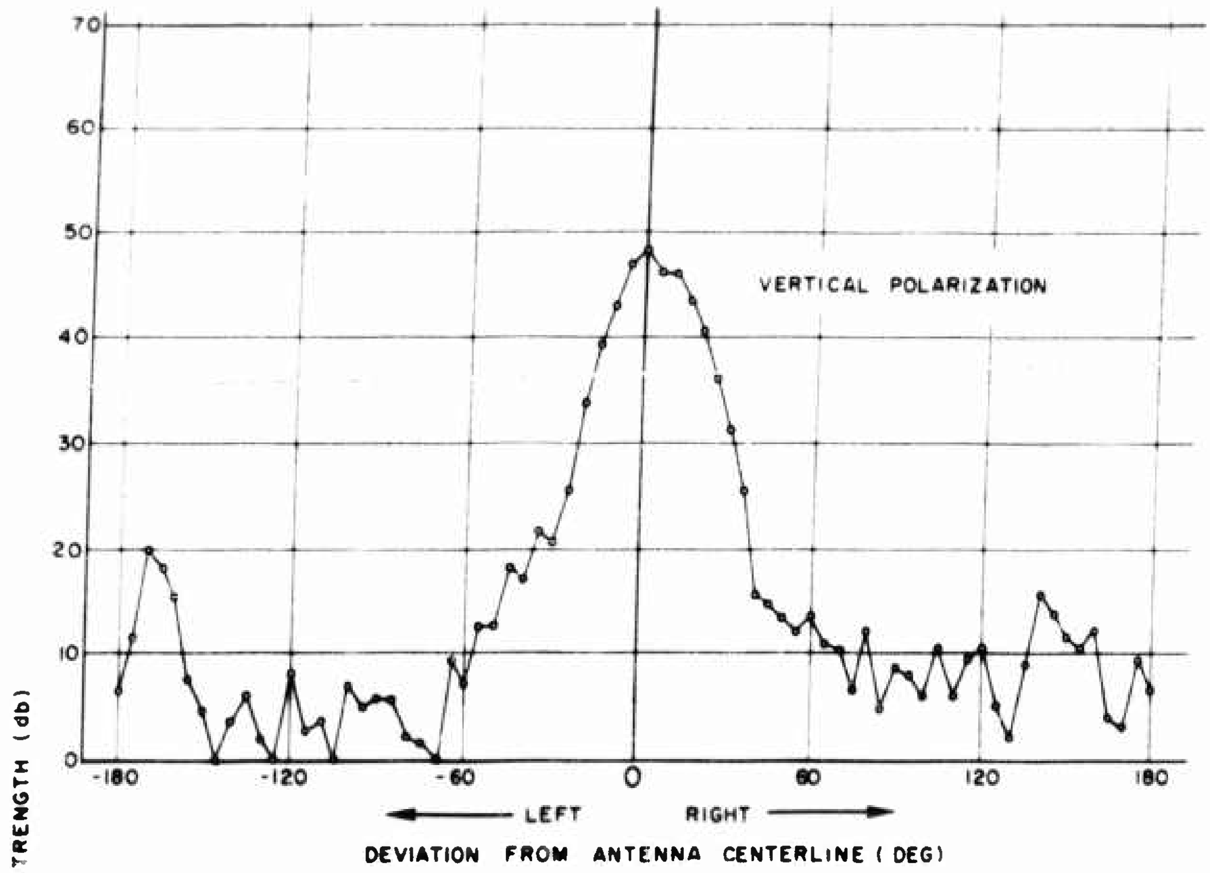


Fig. 32. (C) Antenna pattern, 10,500 mcs, truck rotated to 90-degree aspect

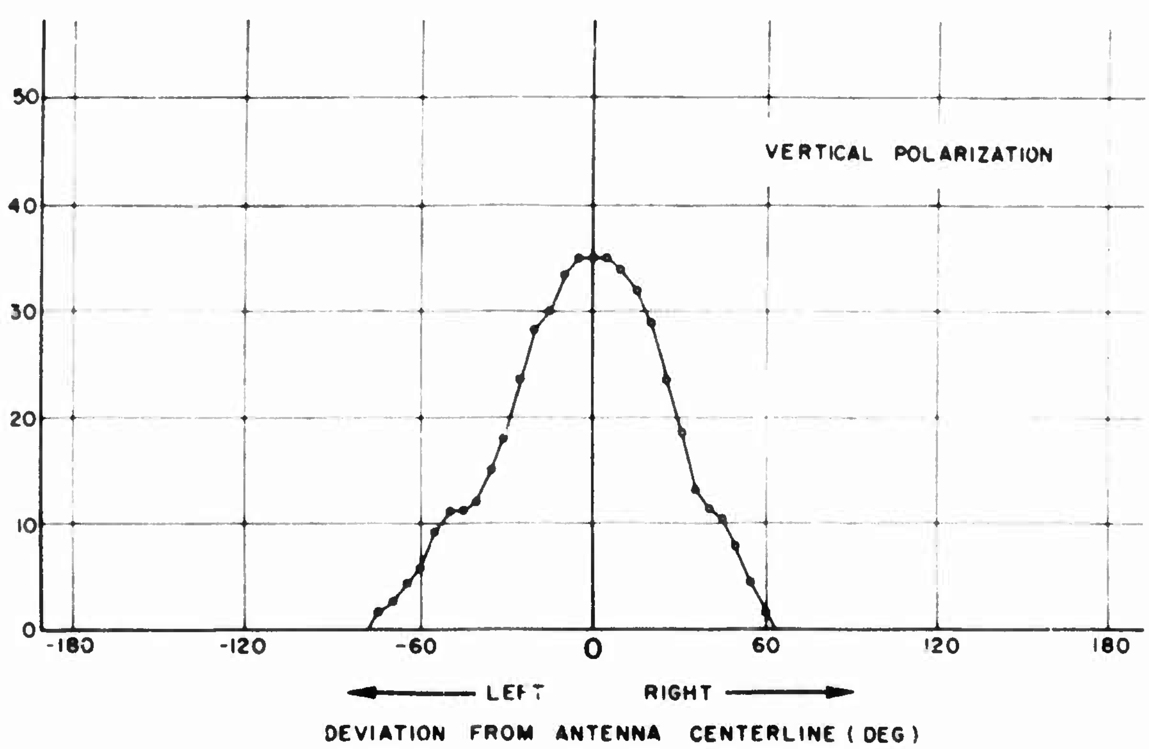


Fig. 33. (C) Antenna pattern, 11,150 mcs

12. (C) TEST 6, DETERMINATION OF TRANSMITTING ANTENNA BEAMWIDTHS

a. (U) Purpose

The purpose of this test was to obtain a comparison between the theoretical free-space beamwidth and the actual beamwidth when the antennas were installed on the MPJ.

b. (U) Procedure

The testing was run concurrently with previous antenna tests and the results were recorded.

c. (C) Results

The results of this test are shown in two illustrations comparing published beamwidths with actual beamwidths. Both horizontal and vertical beamwidths are shown in figs. 34 and 35.

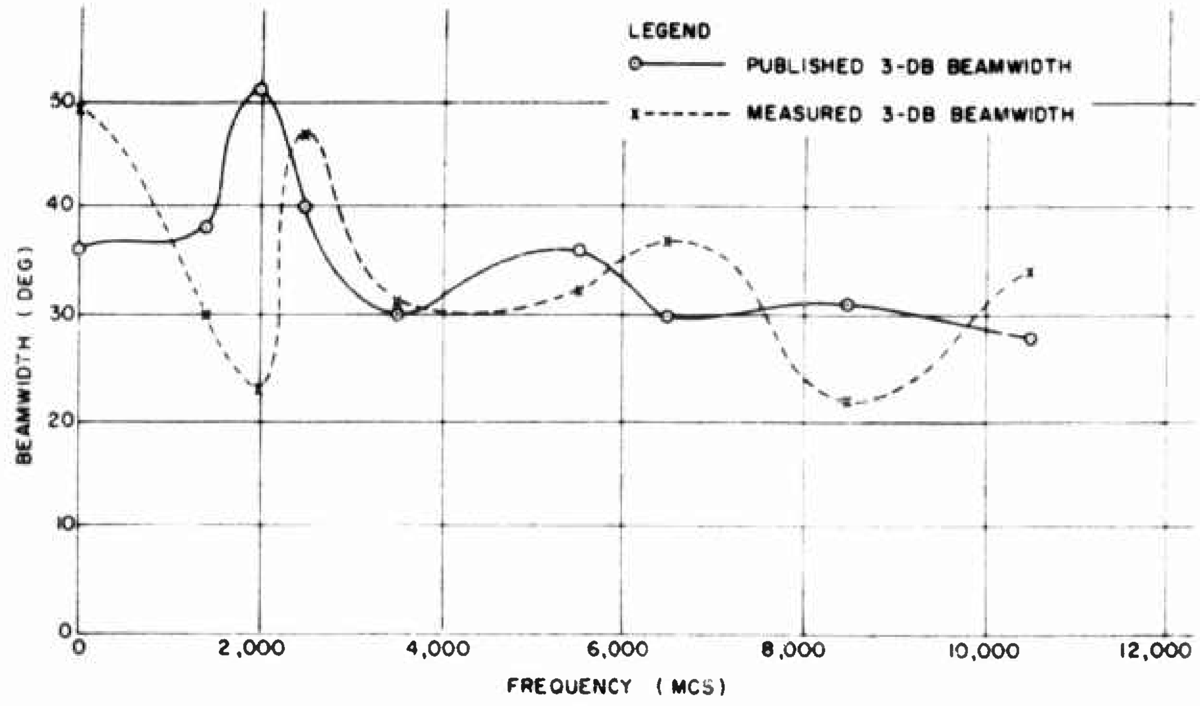


Fig. 34. (C) Antenna beamwidth comparison, vertically polarized

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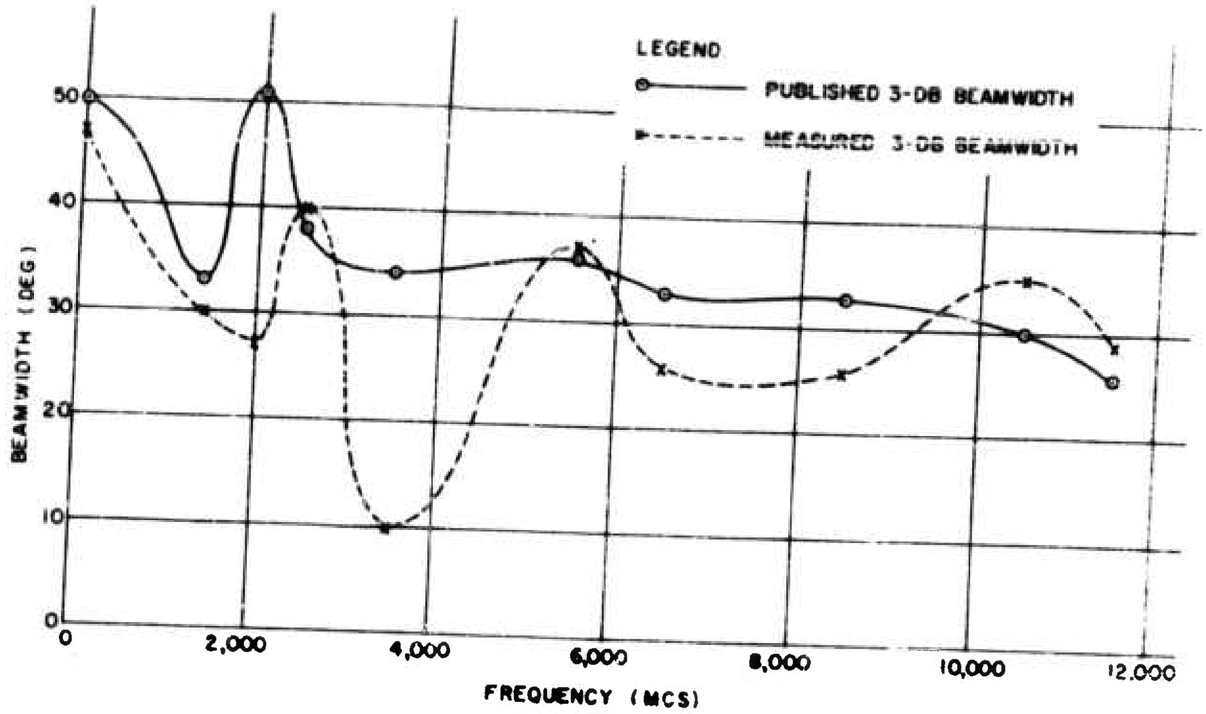


Fig. 35. (C) Antenna beamwidth comparison, horizontally polarized



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## IV. MPJ EQUIPMENT TESTS NOT PERFORMED

### 13. (S) EQUIPMENT CAPABILITY AGAINST COMBAT-AREA SURVEILLANCE RADARS

The tests in this section were designed to determine the capability of the AN/ALT-6B transmitting component of the MPJ to jam the combat surveillance radars AN/PPS-4, AN/TPS-21, and/or AN/TPS-25.

Due to the difficulty experienced during the engineering test phase of the program, these tests were held in abeyance pending redesign of the rf transmission system in the frequency ranges of 5,000 to 11,000 mcs. The trouble, as previously outlined, was excessive VSWR and attenuation. Since the VSWR exceeded the maximum ratio permissible (1.5) for the magnetron, excessive magnetron failure (holes in the windows) was anticipated and the testing was halted.

A proposed transmission system, utilizing ridged waveguide (DR-19) and load isolators, is expected to alleviate the current problems (see fig. 36).

### 14. (C) EQUIPMENT CAPABILITY AGAINST COMBAT SURVEILLANCE DRONE SYSTEMS

When the test plan for the MPJ, 3/4-ton truck installation, was prepared, it was planned to test it against the 70-mcs drone (RP-71C). Meanwhile, the 70-mcs drone system was abandoned; the newer system operates at 420 mcs. The MPJ was not able to operate at this frequency since the appropriate transmitter group (OA-1186/ALT-6B) was not in production. It is anticipated that the group will be received by EWD during the 1st quarter of FY 1960 and the testing can be reinstated at that time.

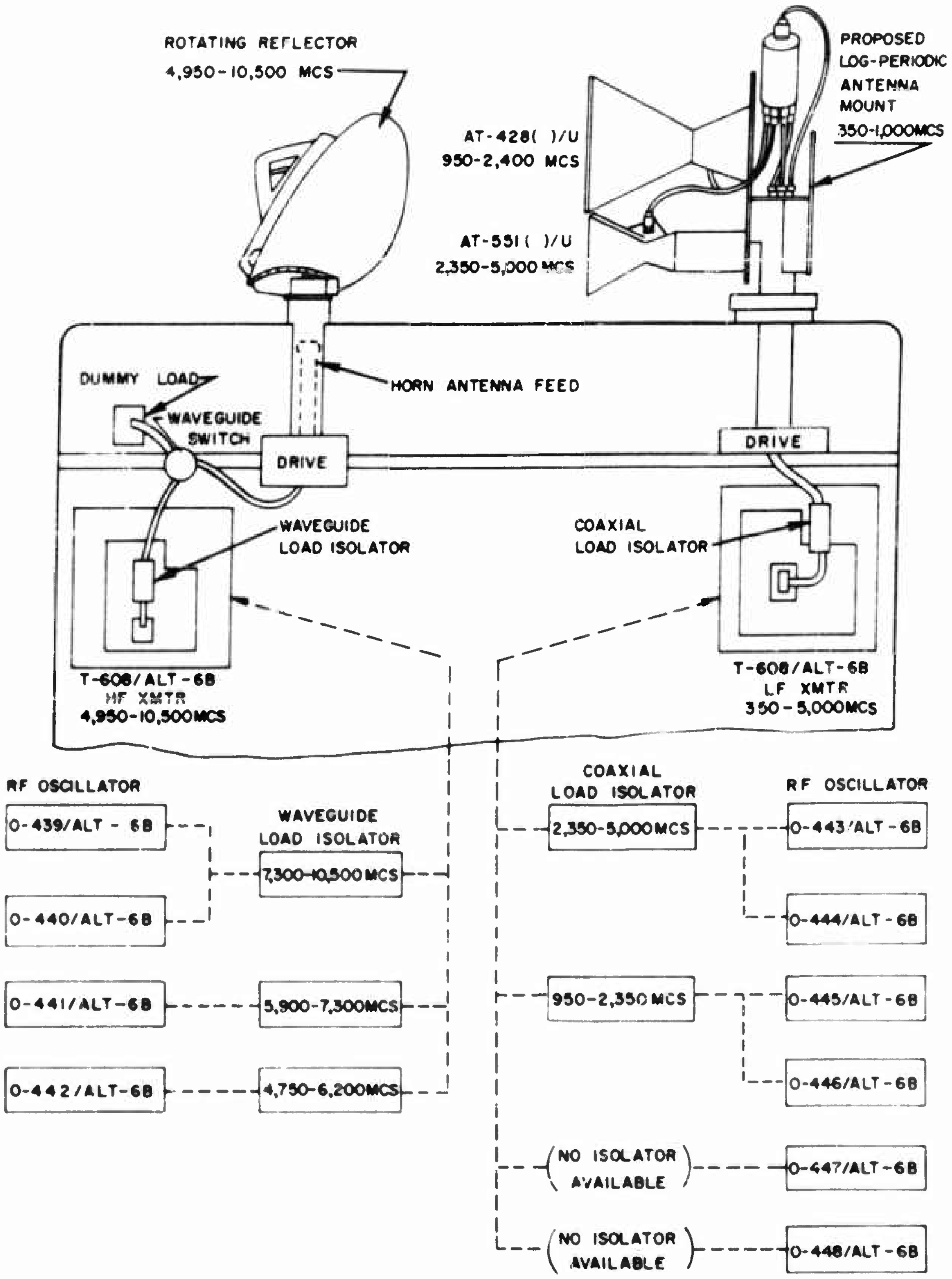



Fig. 36. (S) Proposed transmission system utilizing ridged waveguide and load isolators

## V. EQUIPMENT CAPABILITY AGAINST COUNTER MORTAR-LOCATING RADARS

(C) The tests in this section were designed to determine the suitability and compatibility of the AN/ALT-6B when employed against counter mortar-locating radars of the AN/MPQ-10A type. The results obtained from these tests not only indicate the capability and suitability of the AN/ALT-6B transmitter, but will serve as a standard for comparison of future versions of the MPJ.

### 15. (S) TEST 7, INSTRUMENTATION

a. (U) Purpose

This test was added to the test plan so as to obtain data which could more readily be utilized as a standard for future comparison.

b. (S) Procedure

In order to provide a realistic target for the radar set, a 12-inch styrofoam ball was fabricated and covered with aluminum foil; this was attached to standard weather balloon and during times of high winds (+10 knots) it was attached to a kytoon (see figs. 37 and 38). The captured balloon was guyed for stability and allowed to rise to an altitude of from 1,000 to 1,500 feet. The AN/MPQ-10A radar was located approximately 3,000 yards from the balloon launch site as shown in fig. 39.

By experimentation, for this location, it was determined that a radar antenna elevation angle of greater than 100 mils was required before the balloon-borne target was clearly removed from the ground clutter seen on the radar indicators.

The amplitude of the return echo from the ball-target was measured when the radar antenna was manually oriented at the target; the receiver gain circuit of the radar set was operated manually and the AJ switch was in the OFF position. The radar transmitter was then turned OFF and a signal from a signal generator (TS-155C) was applied through the directional coupler to the receiver. This signal was adjusted until it was equal to a previously measured target signal.

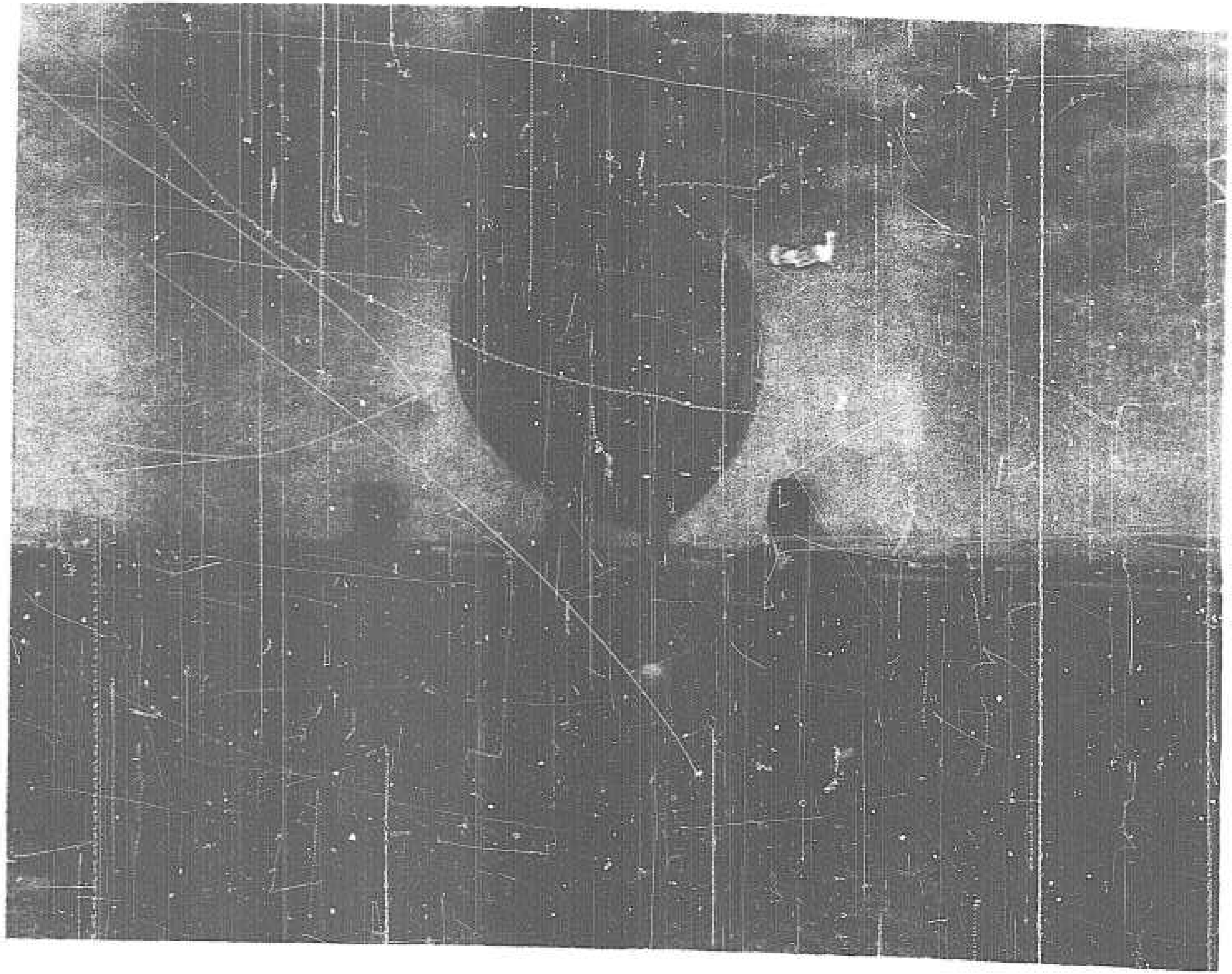


Fig. 37. (U) Simulated target (shell) attached to regular weather balloon for test use

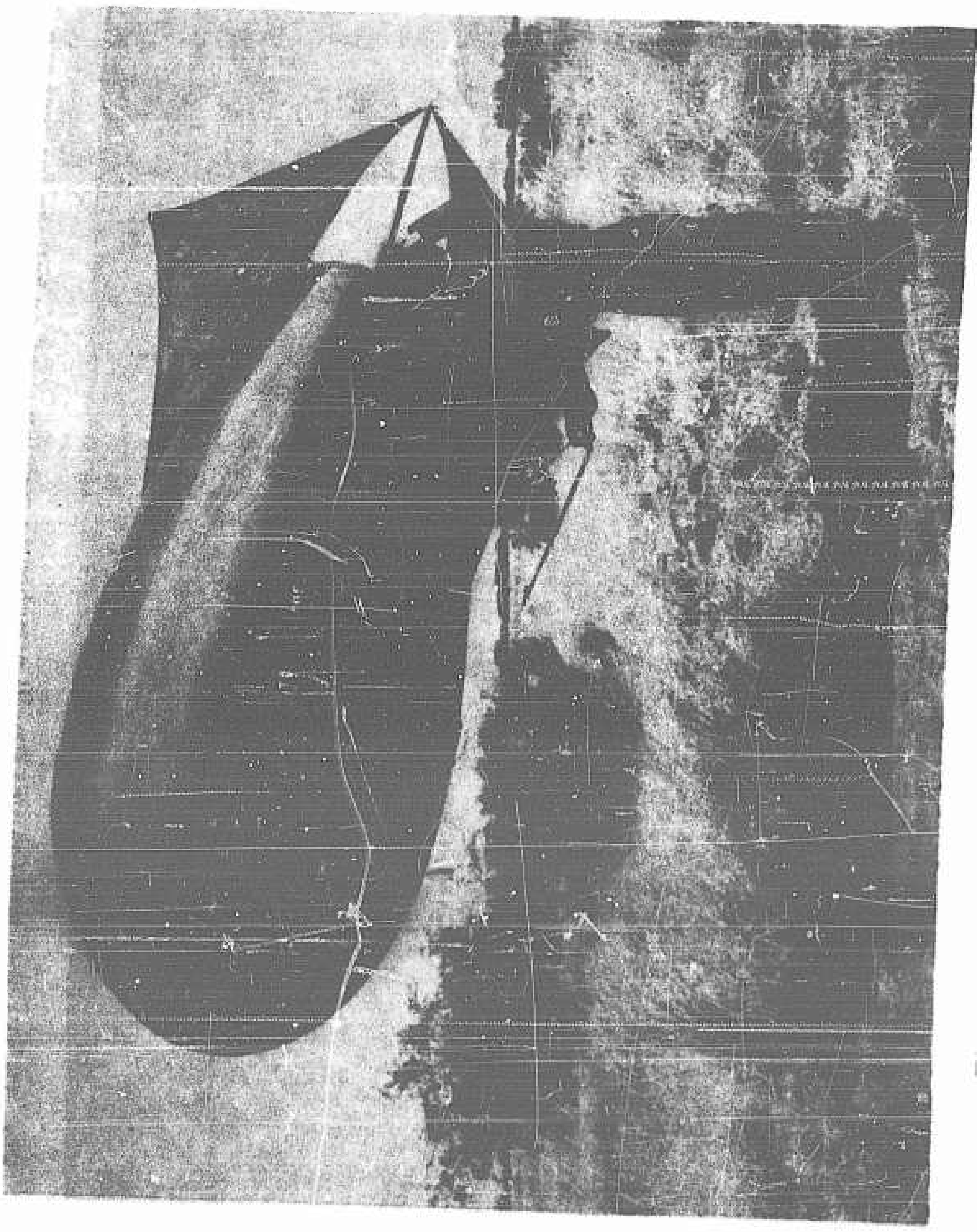


Fig. 38. (U) Simulated target (shell) attached to Kytoon for test use

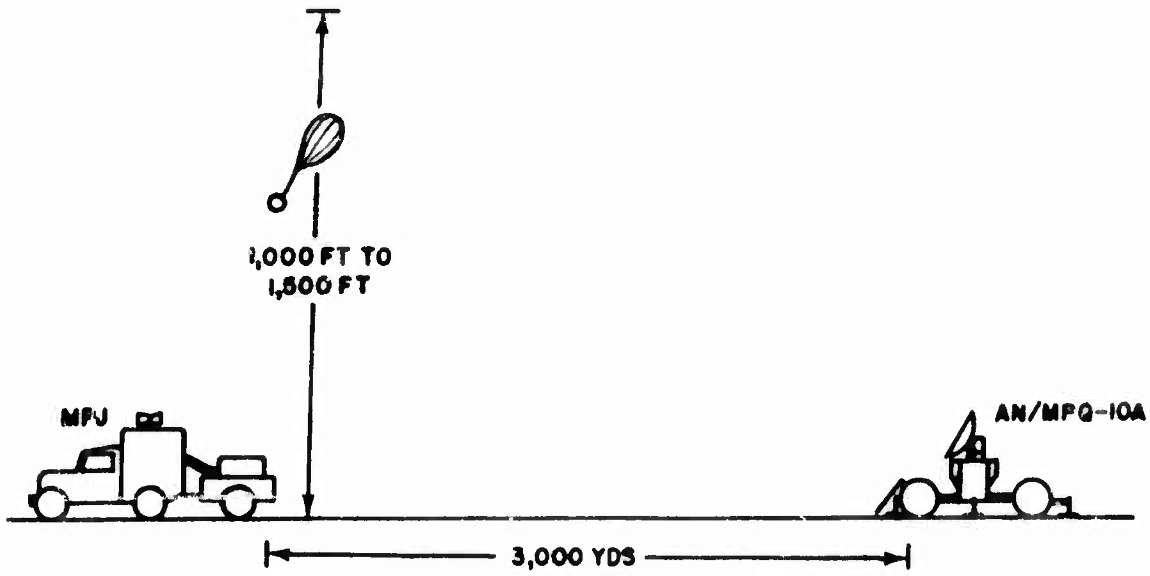



Fig. 39. (S) Siting arrangement for the determination of optimum jamming mode

The strength of this simulated signal was measured as -70 dbm and is considered to be a close approximation to the strength of the signal returned from the balloon-borne target. The use of the balloon-borne target allowed the radar set to automatically track a target with a return echo similar to that of a mortar shell without the actual firing of a mortar shell.

In addition, a method was devised for measuring the jamming signal strength applied to the radar; this was to allow a measurable comparison between jamming and target signal strength. This method entailed the removal of a section of the coaxial transmission line from the radar set; it was replaced with a length of RG-9/U cable (via a 7/8-inch to a type-N coaxial transition). The incoming jamming signal was then coupled from the radar antenna through the fabricated cable system to a calibrated, Polarad, Model R, receiver from which the strength was recorded.

Since the aspect between the jammer and the radar antennas would constantly be changing as the radar tracked a projectile, the jamming signal strength at the radar was measured as a function of radar angle. For this portion of the test, the jammer was located at the balloon launching site and the jammer antenna was oriented directly at the radar antenna. The field strength readings (dbm) are shown plotted as a function of the radar antenna azimuth for the various radar antenna elevations.

c. (S) Results

The results are shown in figs. 40 through 45.

To simplify the task of measuring the jammer's signal field strength for each jammer site used in the test, the Model R receiver was employed with an AT-551/U antenna. Comparison of the main-lobe signal strength readings between the AT-551/U and the AN/MPQ-10A antennas indicated that the readings obtained with the AT-551/U were 12 db lower than those obtained with the radar antenna. It is believed that the reading (-41 dbm) obtained with the AT-551/U antenna is fairly accurate since the calculated signal strength was -38.3 dbm. The formula for the calculation is as follows:

$$S_J = \frac{P_J G_{RJ} G_J \lambda^2}{(4\pi)^2 R^2}$$

where:

$S_J$ = Jammer signal strength at the radar receiver

$P_J$ = Jammer power output (156 watts)

$G_{RJ}$ = Gain of the receiver antenna (oriented in the direction of the jammer) (12 db)

$G_J$ = Jammer antenna gain (12 db)

$\lambda$ = Wavelength (0.07 meters)

R = Range (3,000 yards)

therefore:

$$S_J = \frac{156 \times 16 \times 16 \times (0.07)^2}{1.58 \times 10^2 \times 9 \times 10^6}$$

$$= 14.8 \times 10^{-8} \text{ watts}$$

$$= -38.3 \text{ dbm}$$

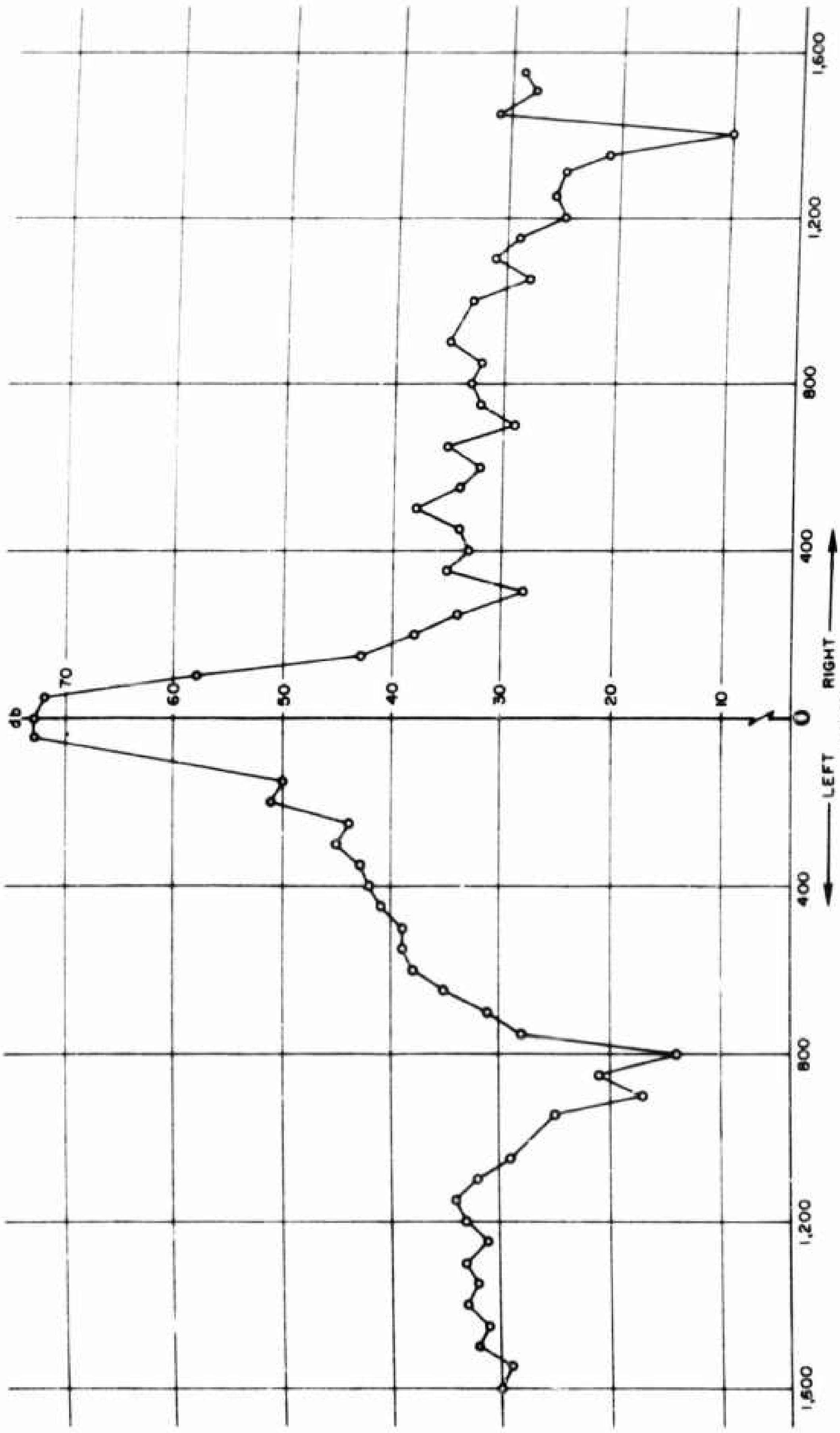



Fig. 40. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 0-mil elevation

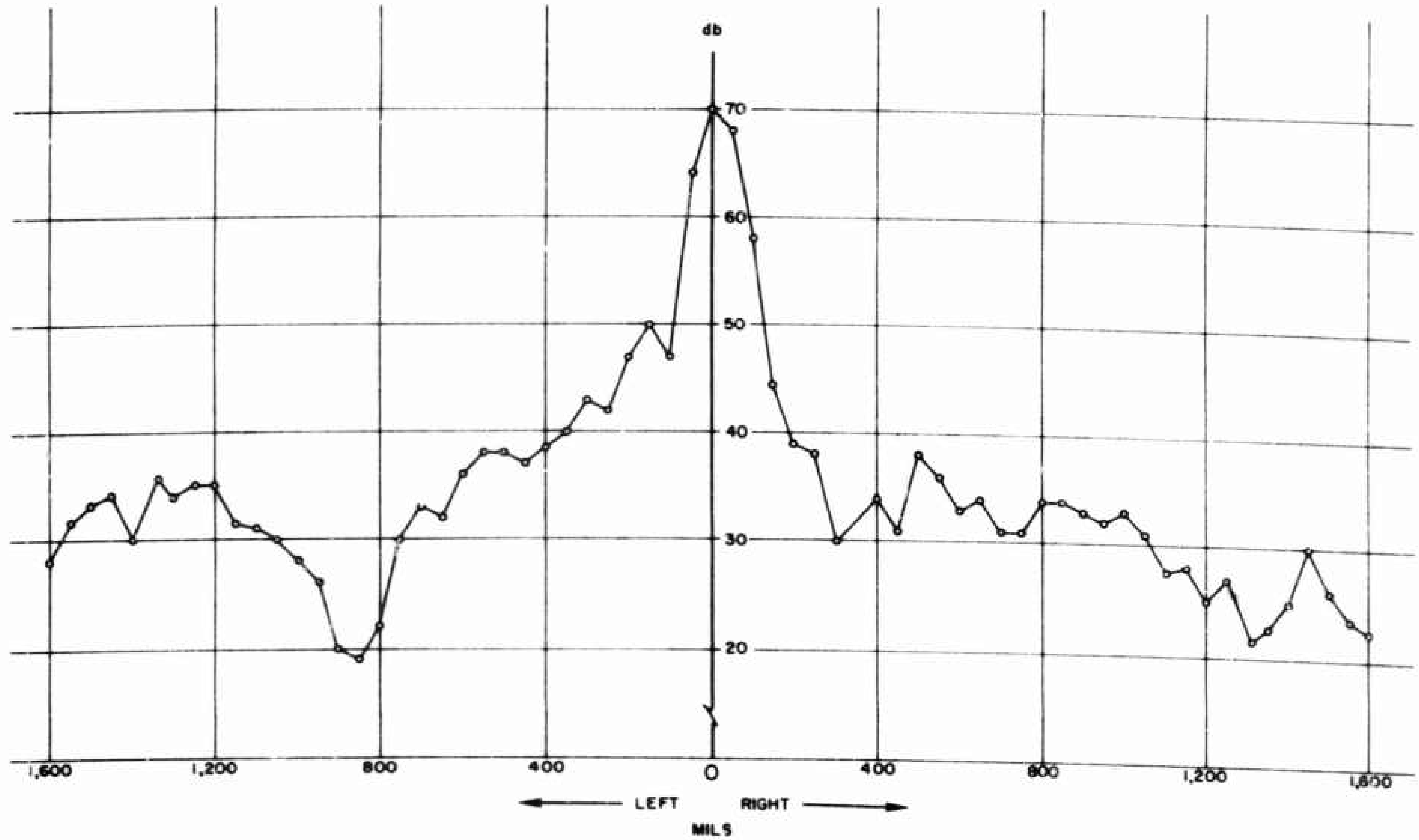



Fig. 41. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 50-mil elevation

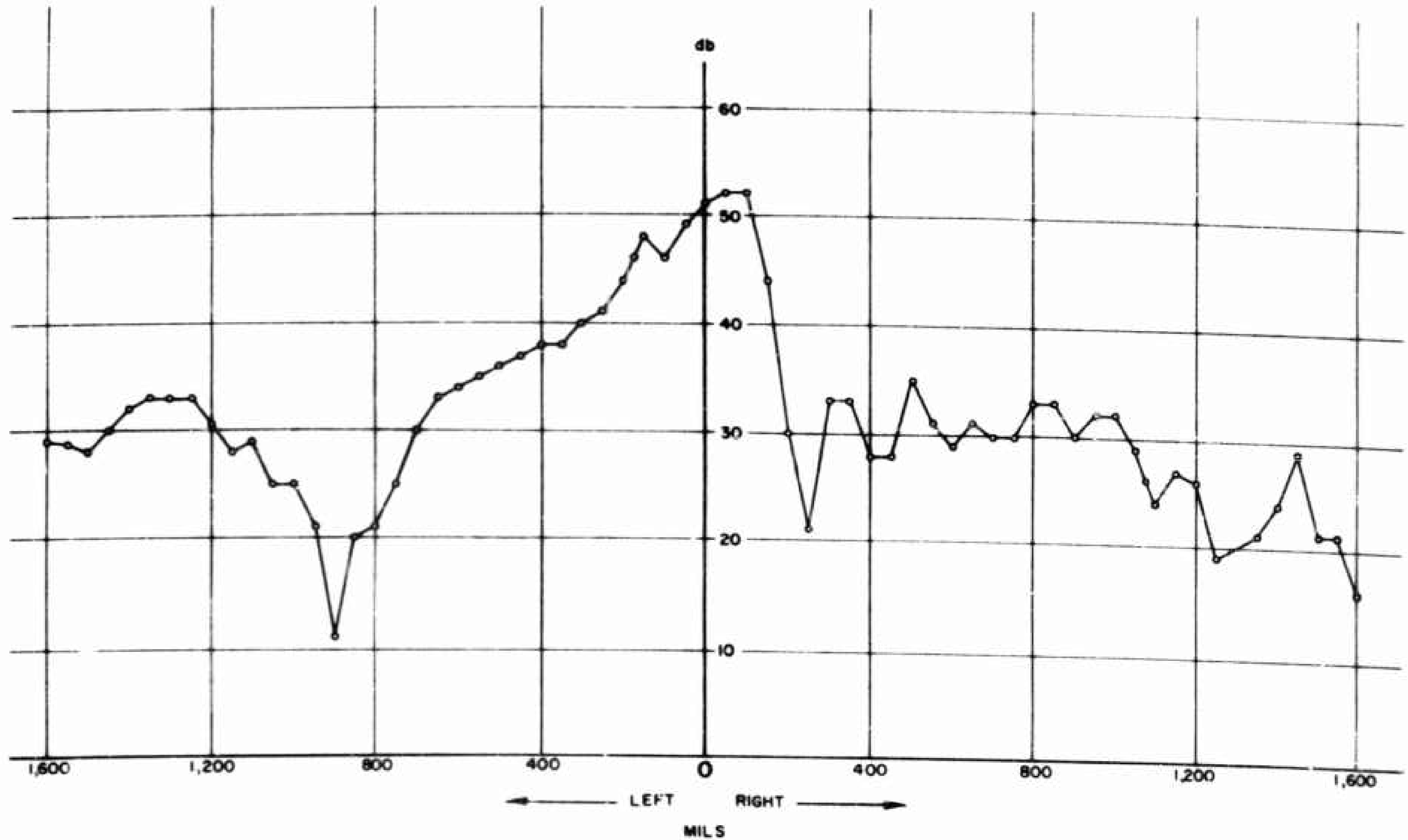



Fig. 42. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 100-mil elevation.

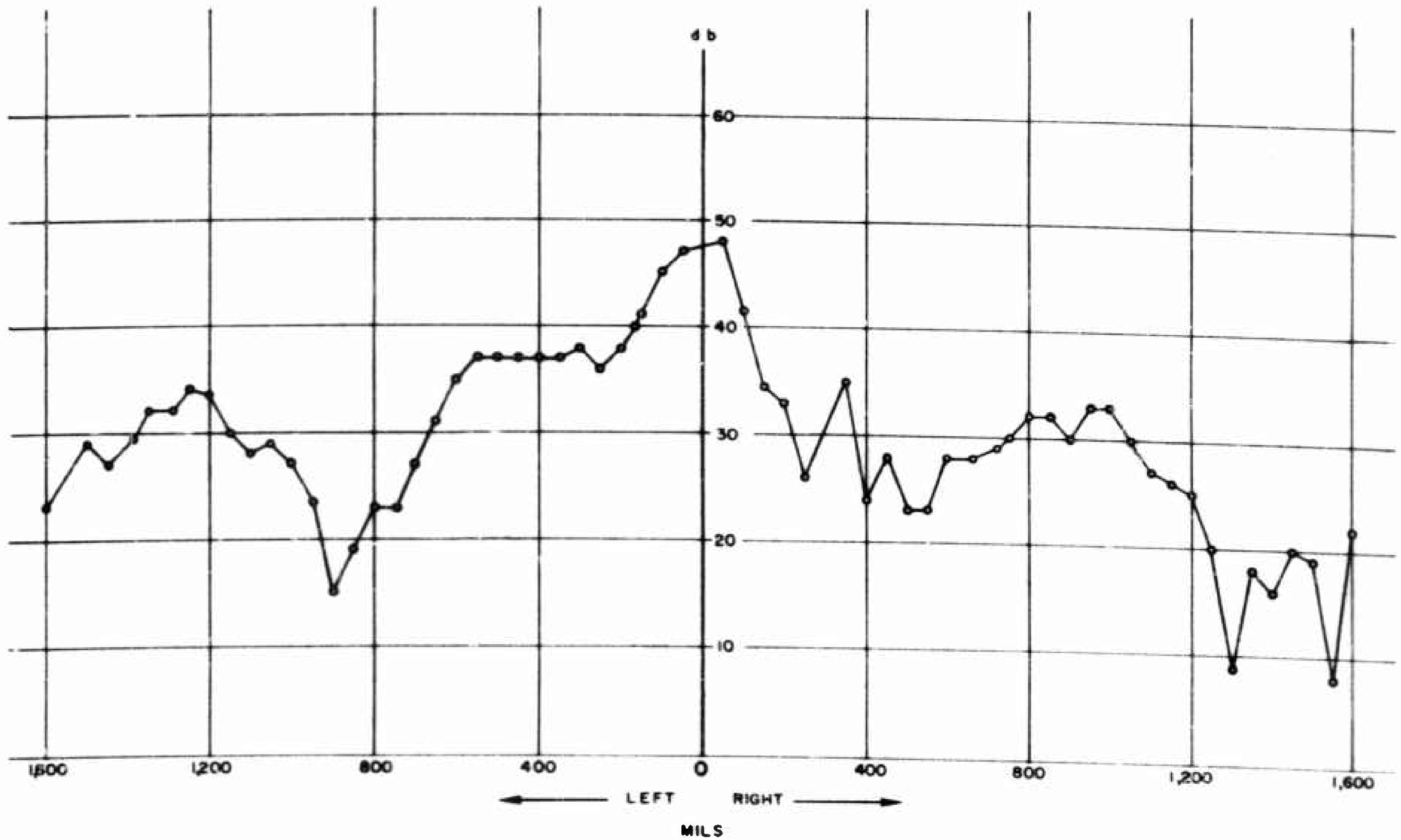



Fig. 43. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 150-mil elevation

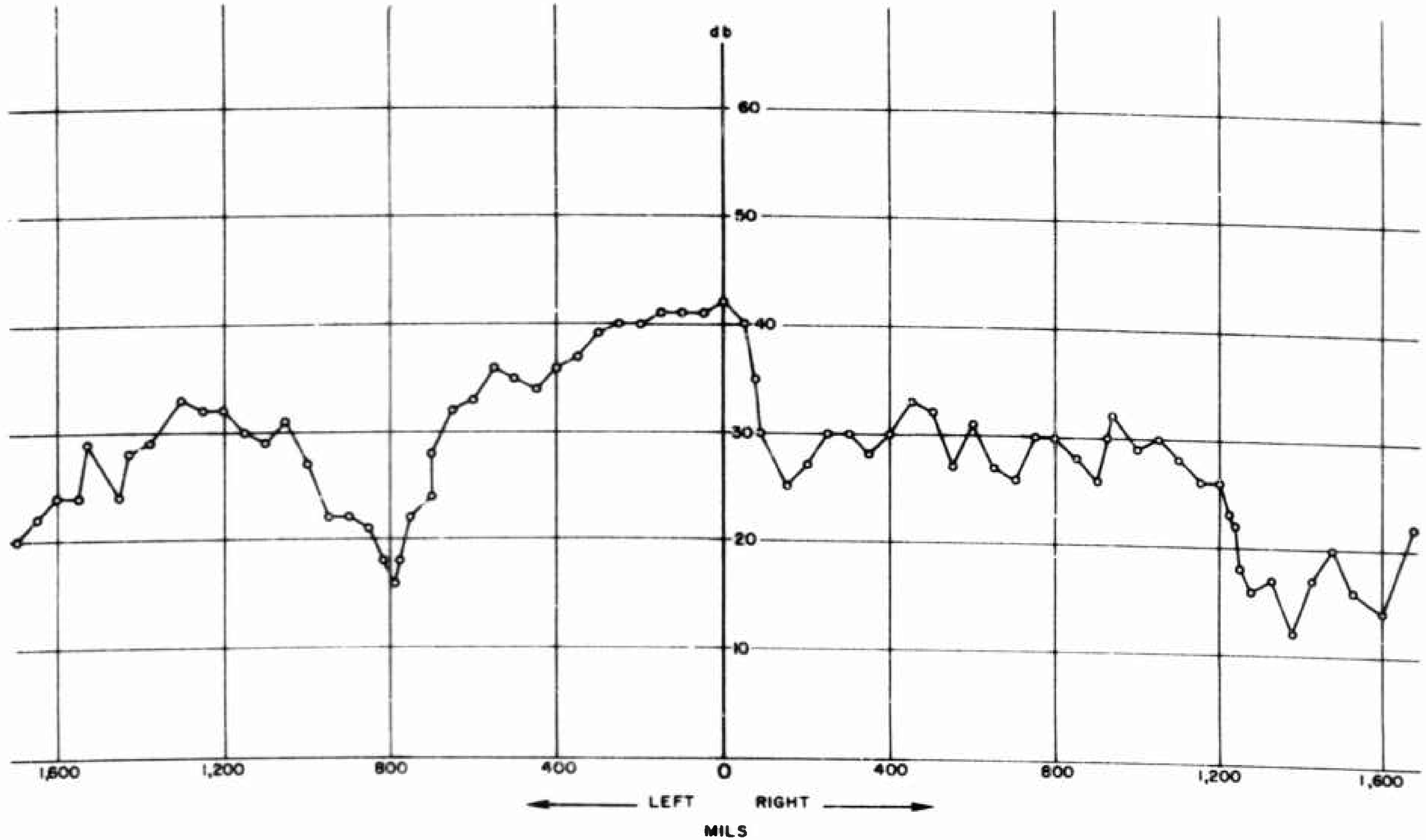



Fig. 44. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 200-mil elevation

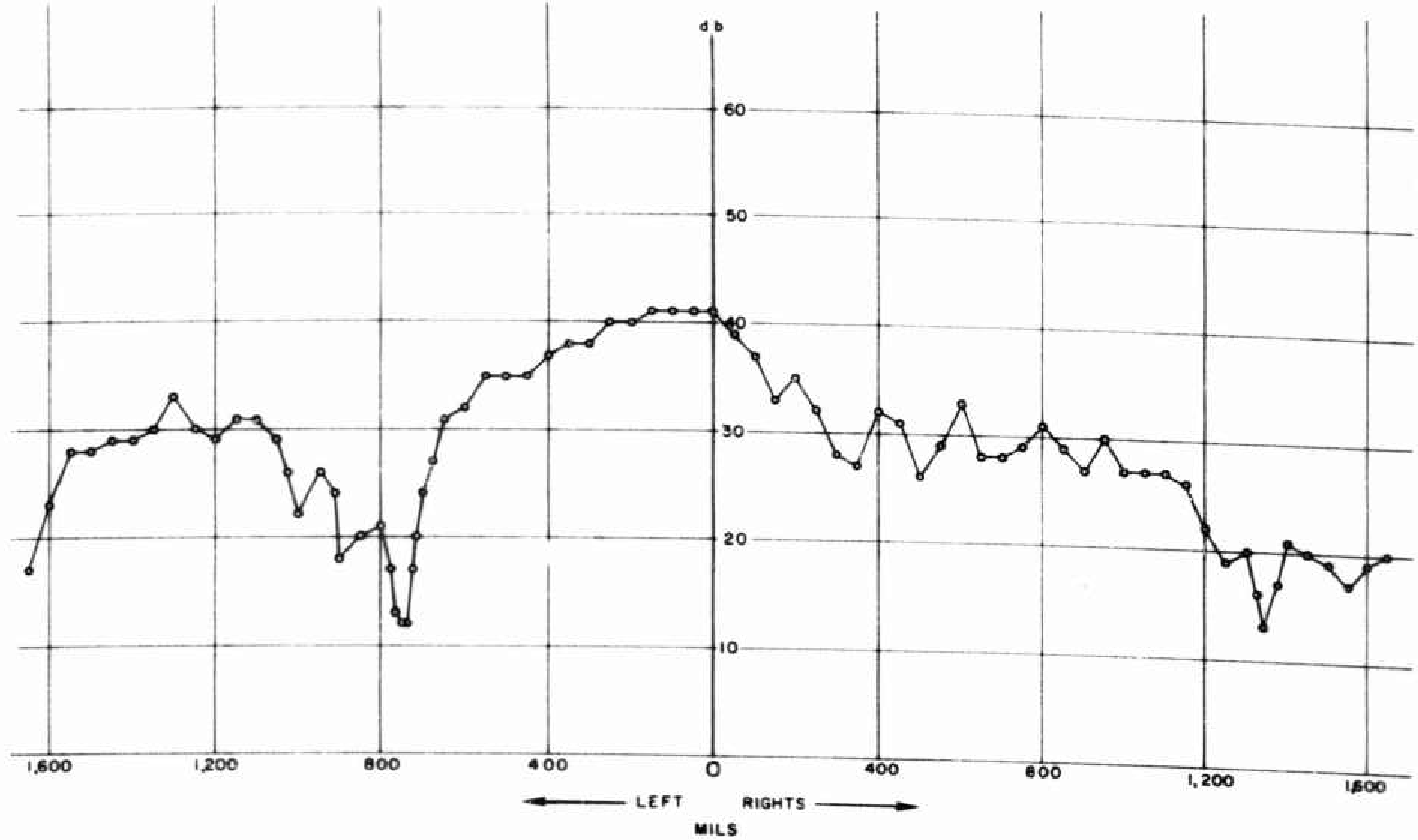



Fig. 45. (S) Jamming signal strength as a function of the AN/MPQ-10A antenna orientation at 250-mil elevation

16. (S) TEST 8, MPJ CAPABILITY TO INTERCEPT AND IDENTIFY THE AN/MPQ-10A RADAR SET

a. (C) Purpose

The purpose of this test was to determine the capability of the MPJ to intercept and display, for analysis purposes, the signal from an AN/MPQ-10A radar when the radar was used for mortar locating.

b. (C) Procedure

A simulated tactical setup was used in which the AN/MPQ-10A was used as a mortar-locating radar. The MPJ was used to intercept and identify; afterwards, the MPJ utilized its capability and jammed the mortar-locating radar.

The AN/APR-9 receiver and the AN/ALA-3 analyzer were used to determine frequency, pw, and prf.

c. (S) Results

Results showed that the MPJ will have the sensitivity and ability to intercept, to identify, and to jam a mortar-locating radar, of the AN/MPQ-10A type, in a tactical situation.

With line-of-sight conditions, the MPJ successfully intercepted and identified the AN/MPQ-10A radar to a distance of over 30 miles; no maximum ranges were determined for line-of-sight conditions.

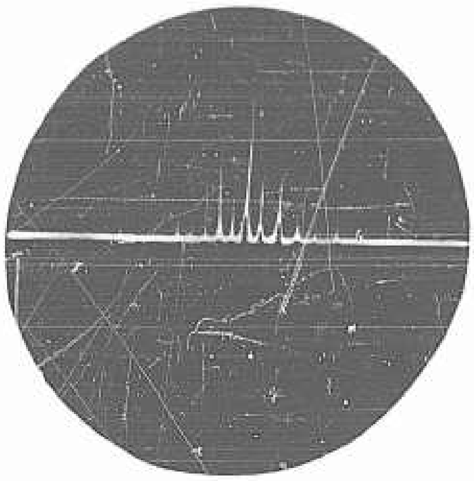
The MPJ lookthrough capability, although slightly troublesome to adjust, performs satisfactorily for the frequency matching and jamming of target signals of this type. The target signal pw and prf can be determined from the AN/ALA-3 indicator. Pulse width errors of 0.1 to 0.2 ms and prf errors of less than 50 cps are normal for AN/MPQ-10A signals. Such errors appeared on all sets even though trained operators were used.

Sample presentations of the AN/APR-9 and the AN/ALA-3 indicators are shown in fig. 46.

17. (S) TEST 9, MPJ CAPABILITY TO LOCATE THE AN/MPQ-10A RADAR SET BY DF

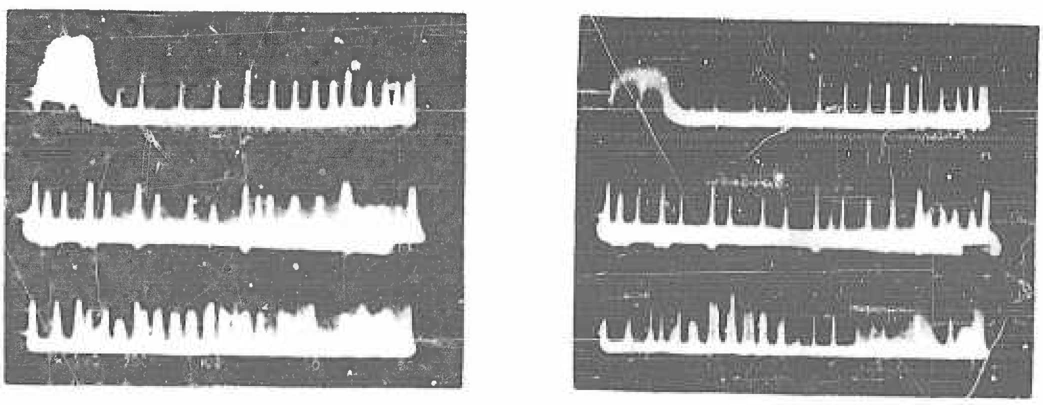
a. (C) Purpose

The purpose of this test was to determine the capability of the AN/ALA-6 to DF the signals from an AN/MPQ-10A radar set.



AN/APR-9 indicator showing signal from the AN/MPQ-10A radar

AN/APR-9 indicator showing noise-modulated jamming signal from AN/ALT-6B



AN/ALA-3 indicator showing pw and prf of the AN/MPQ-10A radar

Fig. 46. (C) Sample presentations of the AN/APR-9 and the AN/ALA-3 indicators

b. (U) Procedure

Testing was run concurrently with other tests; a number of DF cuts were taken at each of the jamming sites.

c. (S) Results

The results showed that the AN/ALA-6 is quite capable of providing an excellent DF reading with errors of only ±2 degrees; jamming signal (field strength) readings indicated that DF errors never exceeded 2 degrees.

For accurate determinations of the DF cuts, an aiming circle and compass were used to double check the MPJ bearing. It was estimated that a trained operator would have a maximum of 3-degree error since testing resulted in an average of 1.7 degrees for eleven readings and less than 1 degree for five readings.

Any errors found could not be attributed to distance, but were attributed to the skill of the operator since the errors were almost the same at various distances.

Figure 47 shows the AN/ALA-6 azimuth indicator display giving azimuth and amplitude of the received signal.

18. (S) TEST 10, RELATIVE EFFECTIVENESS OF VARIOUS JAMMING MODES OF THE MPJ

a. (C) Purpose

The purpose of this test was to determine the relative effectiveness of the various jamming modes available from the modified AN/ALT-6B when employed against the AN/MPQ-10A radar set.

b. (C) Procedure

The AN/MPQ-10A radar set and the MPJ were sited 3,000 yards apart on the south range of Fort Huachuca. The balloon-borne target (shown in figs. 37, 38, and 39) was positioned near the MPJ and raised to such a height so as to allow a radar antenna elevation angle of approximately 100 mils. The signal strength of the echo return from the target was -70 dbm and the cw jamming signal strength at the radar set, as measured with the Model R receiver, was 41 dbm.

The radar was operated in two modes (1) the sector-scan mode, and (2) the automatic-tracking mode. During both modes of radar operation, the

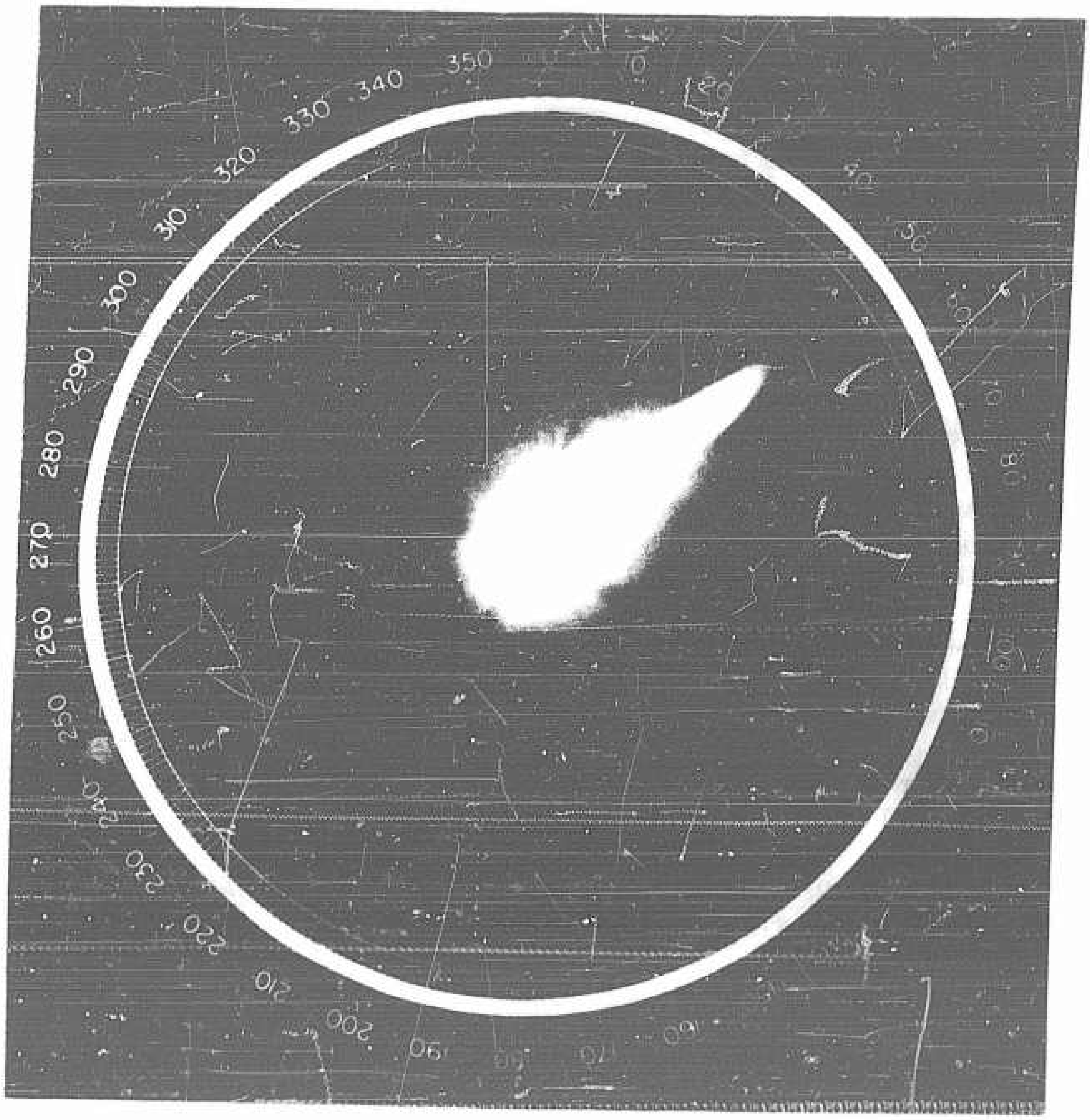



Fig. 47. (S) Sample presentation of the AN/ALA-6 indicator

jamming modulation parameters of the AN/ALT-6B were varied and the results on the AN/MPQ-10A radar were recorded. The sector-scan mode of jamming was recorded from the B-scope and the automatic-tracking mode of jamming was recorded on the J-scope.

c. (S) Results

The results of the test are given with the specific jamming modulations employed.

(1) Sector-Scan Operation

(a) Spot-Frequency Noise. The AN/ALT-6B was operated in the spot-frequency, noise mode of operation and manually tuned to the radar frequency.

This spot-frequency, noise mode of operation was the most effective jamming modulation of all those used against the AN/MPQ-10A radar set. When jammer and radar frequencies were matched, the radar receiver was nearly saturated. A slight detuning (±1 mcs) of the jammer prevented all targets, except heavy ground clutter, from showing through the jamming. The scope photographs, in fig. 48, illustrate the results.

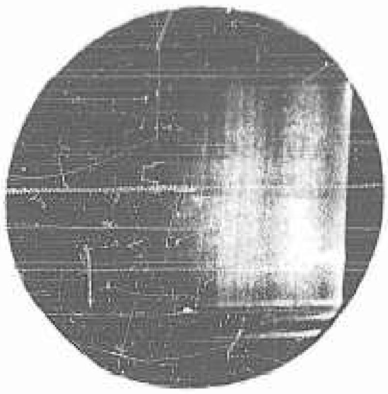
(b) Fast-Sweep Noise. The AN/ALT-6B was operated in the fast-sweep, noise mode of operation with the SWEEP WIDTH control varied from 50 to 350 mcs, and the SWEEP RATE control varied from 2 to 20 cps for each SWEEP WIDTH control setting.

The fast-sweep, noise mode of operation of the AN/ALT-6B is the same type of signal as spot-frequency noise modulation except that the carrier frequency is swept over a variable frequency band at a variable rate as determined by SWEEP WIDTH and SWEEP RATE controls. This type of jamming caused strobe lines to appear as shown in the scope photographs of fig. 49. Although each strobe was of sufficient strength to prevent the appearance of targets, the sweeping mode of operation caused the target to be jammed for only a portion of the time necessary and consequently allowed the target to be presented for a major portion of time; thus, this jamming mode was considerably ineffective.

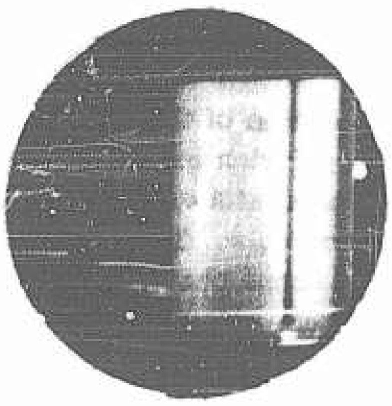
(c) Slow-Sweep Noise. The AN/ALT-6B was operated in the slow-sweep, noise mode of operation with the SWEEP WIDTH control varied from 250 to 1,200 mcs, and the SWEEP RATE control varied from 2 to 120 cpm for each SWEEP WIDTH control setting.

The slow-sweep, noise mode of operation is essentially the same as the fast-sweep, noise mode of operation except that the frequency bandwidth is greater (1,200 mcs) and the sweep rate is slower (2 cps maximum). This type of jamming was completely ineffective against the AN/MPQ-10A radar since the time that the jammer is on frequency is very short as compared to the time that it is off frequency. As a result, the B-scope indicator was completely free of jamming for the major portion of time as shown in fig. 50.

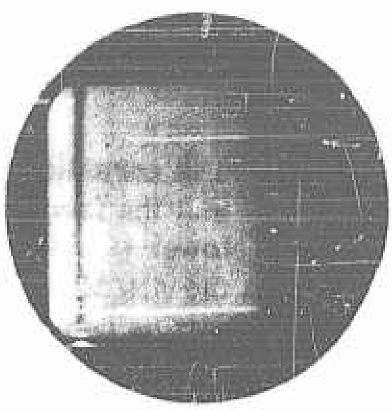
(d) CW. The AN/ALT-6B was operated in the cw mode of operation and manually tuned to the radar frequency.



Jamming on frequency

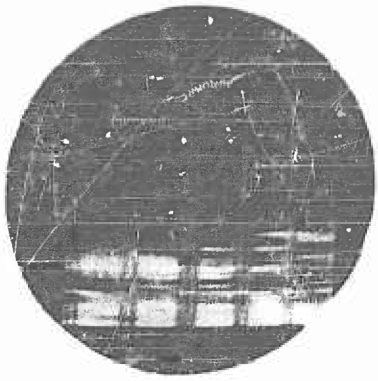


Jamming with ±1 mcs detuning

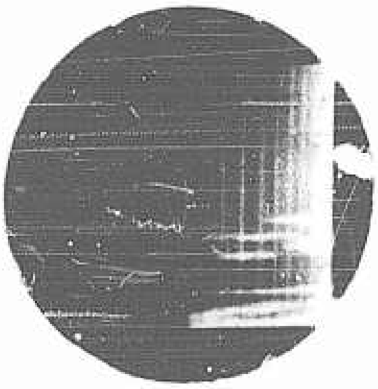


Jamming with -1 mcs detuning

Fig. 18. (S) Effectiveness of spot-frequency, noise modulation, and slight detuning



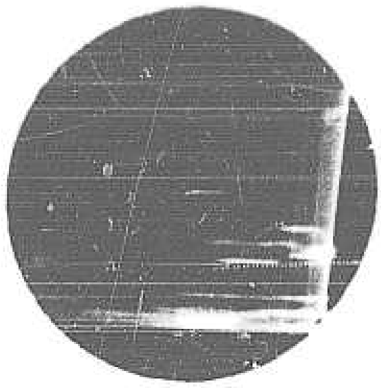
Sweep width 50 mcs
Sweep rate 2 cps



Sweep width 150 mcs
Sweep rate 10 cps

Sweep width 200 mcs
Sweep rate 15 cps

Fig. 49. (S) Effectiveness of fast-sweep noise modulation with variations in sweep width and sweep rate



Sweep width 350 mcs
Sweep rate 20 cps

Fig. 50. (S) Ineffectiveness of slow-sweep, noise-modulated jamming

The cw mode of jamming caused extreme interference to the radar indicator; however, the radar was able to acquire a target during a major portion of the time because of the critical tuning required and the inherent frequency drift of the jamming transmission.

(e) Single Tones. The AN/ALT-6B was operated in the cw mode of operation and activated by a square-wave modulation from the MD-156/TRT-2B modulator at a rate from 20 to 6,000 cps.

Single tones caused light interference on the B-scope indicator during preliminary testing; it was not pursued in detail since the antijamming circuitry reduced the interference to zero.

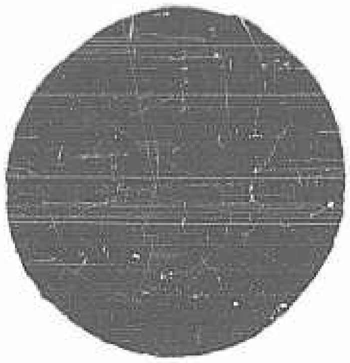
(2) Automatic-Tracking Operation

(a) Spot-Frequency Noise. The AN/ALT-6B was operated in the spot-frequency, noise mode of operation and manually tuned to the radar frequency.

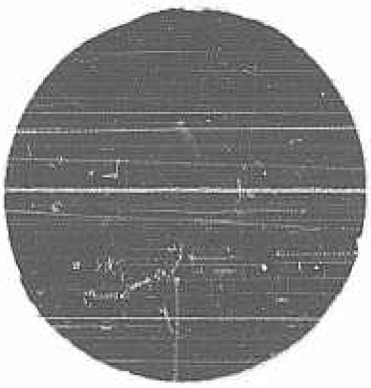
The spot-frequency, noise mode of jamming caused the AN/MPQ-10A to break track on the balloon-borne target the instant the jammer was turned on. Although the antijamming (AJ) circuits were in operation, the radar was still unable to track and the J-scope was completely saturated as shown in fig. 51.

(b) Fast-Sweep Noise. The AN/ALT-6B was operated in the fast-sweep, noise mode of operation with the SWEEP WIDTH control varied from 50 to 350 mcs, and the SWEEP RATE control varied from 2 to 20 cps for each SWEEP WIDTH control setting.

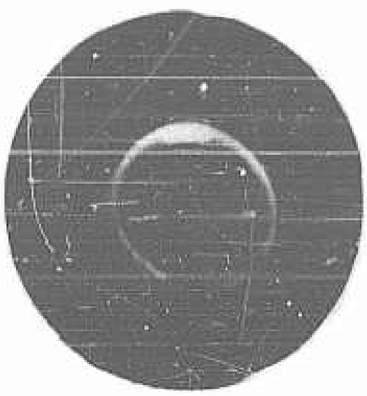
The fast-sweep, noise mode of operation of the AN/ALT-6B caused interference to the J-scope, however, it was never intense enough to



Clear scope



Scope with target in range gate



Target saturated (AJ in operation)

Fig. 51. (S) J-scope presentations indicating clear scope, target, and the effects of spot-frequency, noise-modulated jamming

cause the radar to break track or to obscure the target. As might be expected, the most serious interference was caused from utilizing a small sweep width.

(c) Slow-Sweep Noise. The AN/ALT-6B was operated in the slow-sweep, noise mode of operation with the SWEEP WIDTH control varied from 250 to 1,200 mcs, and the SWEEP RATE control varied from 2 to 120 cpm for each SWEEP WIDTH control setting.

Because of the broad frequency distribution of the jamming power output, (primarily due to the broad sweep width and the low sweep rates) the slow-sweep, noise mode of operation was relatively ineffective against the AN/MPQ-10A. The jamming effort did not prevent the radar from tracking the target, nor did it cause degradation of the operator's ability to acquire a target.

(d) CW. The AN/ALT-6B was operated in the cw mode of operation and manually tuned to the radar frequency.

The cw mode of operation produced jamming results comparable to those obtained with the spot-noise mode (as soon as the jammer was in operation, the AN/MPQ-10A lost track of the target). However, this jamming mode is not acceptable for tactical use because (1) it is not as effective as spot noise, and (2) it is not as accurate in maintaining frequency (since any detuning on the order of $\pm 0.5$ mcs will allow the radar to remain locked on the target).

(e) Single Tones. The AN/ALT-6B was operated in the cw mode of operation and activated by a square wave modulation from the MD-156/TRT-2B modulator at a rate from 20 to 6,000 cps. The procedure was repeated with the AJ circuitry used in an off-and-on switching cycle.

The single tones caused interference to the J-scope but they were not capable of causing the radar to lose track of the target. With the AJ circuitry in operation, no interference to the radar was recorded.

d. (S) Summary

It was determined, from the results of this test, that the most effective modulation available from the MPJ for use against the AN/MPQ-10A radar is the spot-frequency, noise modulation. Consequently this modulation was used in the remainder of the tests where the MPJ was used against the AN/MPQ-10A.

19. (S) TEST 11, MAXIMUM LINE-OF-SIGHT JAMMING RANGE OF THE MPJ

a. (U) Purpose

The purpose of this test was to determine the maximum line-of-sight jamming range of the AN/ALT-6B.

b. (S) Procedure

The tests were conducted on desert terrain that had a 10- to 15-foot brush cover. Although the test sites were chosen for line-of-sight conditions between the radar and the jammer, a slight terrain masking was apparent.

The siting arrangement for the test is shown in fig. 52. Ten balloon launching sites were selected and staked; each site was 3,000 yards from the AN/MPQ-10A and located in the 270- to 360-degree quadrant. Sites were numbered from 1 at 360 degrees to 10 at 270 degrees.

The jammer was initially sited at Balloon Site Nr 1 and operated in the spot-frequency, noise mode. The balloon was launched successively at all sites from 1 through 10.

At each balloon site utilized, the radar was permitted to lock-on the target in azimuth, elevation, and range prior to the initiation of jamming. The jamming effectiveness was then evaluated by observing the ability of the radar to remain locked-on to the target and still show a target presentation.

From the 3,000-yard position of Balloon Site Nr 1, the jammer moved successively to ranges of 8,000, 9,000, 21,000, 25,000, 27,000 and 42,000 yards. Maximum jammer range as a function of radar azimuth was determined for each of the ranges.

c. (S) Results

(1) Jammer-to-Radar Range of 3,000 Yards

With the jammer located at Balloon Site Nr 1, jamming caused the radar to break track on all 10 balloon sites; even at Balloon Site Nr 10, where the radar antenna was at 90-degree aspect to the jammer, the scope of the AN/MPQ-10A was saturated by the jamming signal.

The following table shows the jammer signal strength measured on the Polarad, Model R, Receiver from the AT-551 (MPJ) antenna and the AN/MPQ-10A radar antenna. In addition, the effectiveness of the jamming is also shown so that it may be correlated with the measured signal.

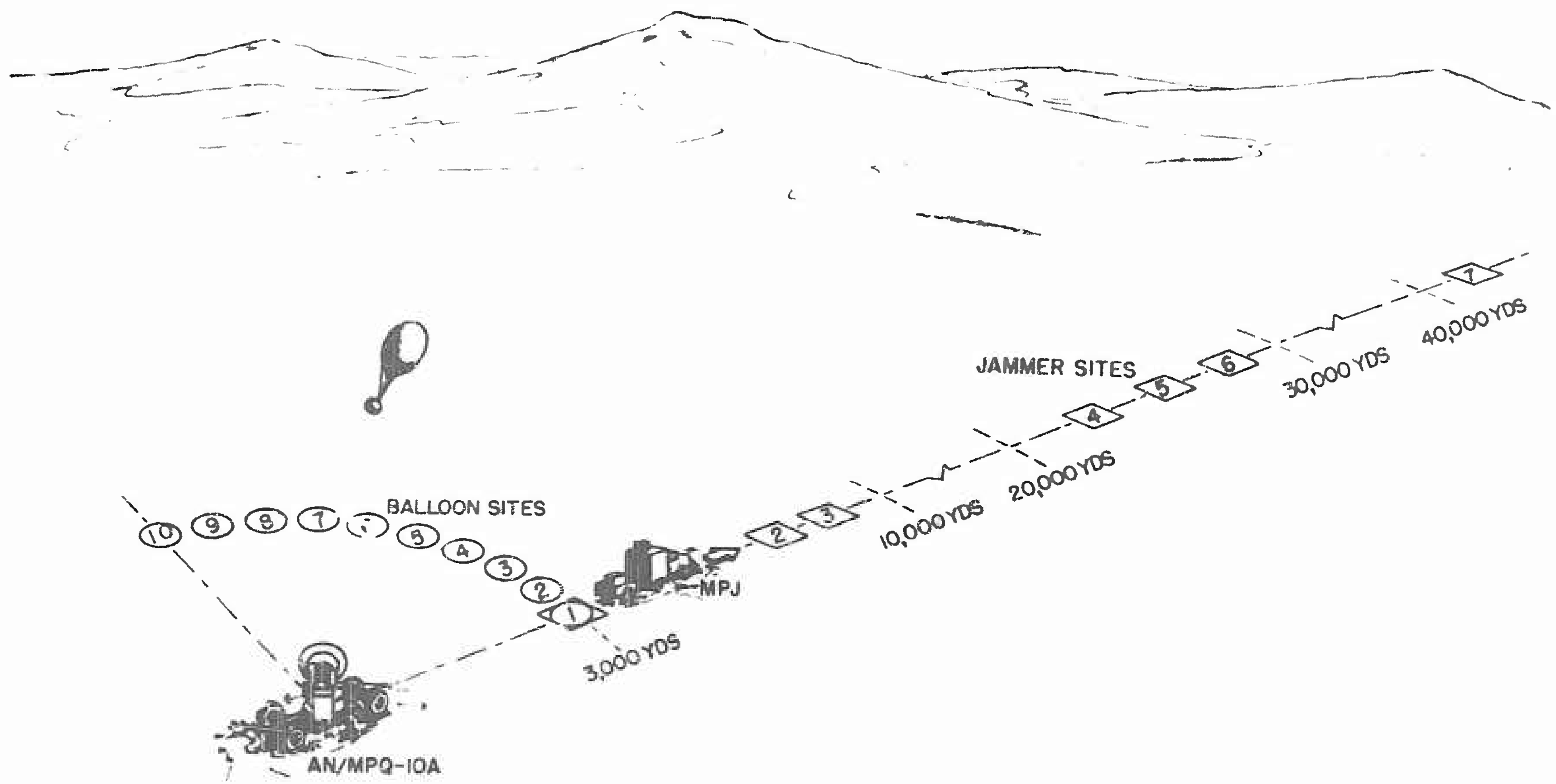



Fig. 52. (S) Siting arrangement for test 11

Table I. (S) Signal Strength as Measured on Polarad Model R

| Balloon site nr | Signal from AT-551 antenna (dbm) | Signal from AN/MPQ-10A antenna (dbm) | Condition of jamming | Radar track broken | Radar ant. gain, relative to AT-551 at $0^{o}$ (db) |
|---|---|---|---|---|---|
| 1 | -41.5 | -31.5 | Intense | Yes | +12 |
| 2 | -41.5 | -53 | Intense | Yes | -14 |
| 3 | -41.5 | -60 | Intense | Yes | -22 |
| 4 | -41.5 | -62 | Intense | Yes | -25 |
| 5 | -41.5 | -67 | Intense | Yes | -30 |
| 10 | -41.5 | -68 | Intense | Yes | -31 |

The AT-551 antenna was constantly oriented in the direction of the jammer while the radar antenna was oriented at the balloon site in azimuth and at an elevation of 100 mils. The J-scope indicator registered intense jamming with no targets visible. For all orientations of the radar antenna, the radar ceased to track the -70 dbm target as soon as the jammer became active.

(2) Jammer-to-Radar Range of 9,000 Yards

With the jammer sited at 9,000 yards from the AN/MPQ-10A radar, the jamming signal was capable of causing the AN/MPQ-10A radar to break lock on the balloon-borne target at Balloon Site Nrs 8, 9, and 10 (70-, 80-, and 90-degree aspects); since such aspects were the most adverse conditions available, such sites were selected as marginal jamming conditions.

In addition, a jammer-to-radar range of 8,000 yards was also utilized in which a line-of-sight condition did not exist. The jamming from this site caused the AN/MPQ-10A to lose track. The results achieved from the two sites are shown in table II.

Under medium jamming, the targets could be seen when the radar was "on-track" but the acquisition of the targets was impossible.

The "signal from AN/MPQ-10A antenna," shown in the previous table, is a computed value derived from the data obtained with the AT-551 antenna (MPJ) and the radar antenna patterns.

Table II. (S) Jamming Results at 8,000 and 9,000 Yards

| Balloon site nr | Signal from AT-551 antenna (dbm) | Signal from AN/MPQ-10A antenna (dbm) | Condition of jamming | Jammer to radar range (yds) | Radar ant. gain, relative to AT-551 at $0^{o}$ (db) |
|---|---|---|---|---|---|
| 10 | -57.5 | -85 | Medium | 8,000 | -31 |
| 8 | -50.5 | -74 | Medium | 9,000 | -27 |
| 9 | -50.5 | -74.5 | Medium | 9,000 | -28 |
| 10 | -50.5 | -77.5 | Medium | 9,000 | -31 |

(3) Jammer-to-Radar Range of 27,000 Yards

The jammer was successively sited at jammer-to-radar ranges of 21,000, 25,000, and 27,000 yards. The results obtained from these sites are as follows: the 21,000- and 25,000-yard sites did not offer line-of-sight conditions and thus the results obtained were not as positive as those from previous sites since the jamming only caused the radar to break track about half the time.

At the 27,000-yard site and under line-of-sight conditions, jamming was 100-percent effective although the balloon-borne target was launched from Balloon Site Nr 9 (80-degree aspect). However, when Balloon Site Nr 10 was used (90-degree aspect), the jammer was ineffective, at any time, causing the radar to break track. The results are shown in table III.

Table III. (S) Jamming Results at 21,000, 25,000, and 27,000 Yards

| Balloon site nr | Signal from AT-551 antenna (dbm) | Signal from AN/MPQ-10A antenna (dbm) | Condition of jamming | Jammer to radar range (yds) | Radar ant. gain, relative to AT-551 at $0^{o}$ (db) |
|---|---|---|---|---|---|
| 9 | -59 | -83.5 | Medium | 21,000 | -28 |
| 10 | -55 | -82.5 | Medium | 25,000 | -31 |
| 9 | -54 | -78 | Medium | 27,000 | -28 |
| 10 | -54 | -81 | Medium | 27,000 | -31 |

(4) Jammer-to-Radar Range of 42,000 Yards

The results obtained from the jammer-to-radar range of 42,000 yards appeared to be consistent although uncorrelated; they are included in this report as unsupported results that might be of interest.

The jamming signal strength appearing on the radar indicators was comparable to that obtained from the jammer-to-radar range of 27,000 yards. The jamming caused the AN/MPQ-10A radar tracking circuits to "jitter" considerably but would not cause the radar to break track. The results are shown in table IV.

Table IV. (S) Jamming Results at 42,000 Yards

| Signal from AT-551 antenna (dbm) | Signal from AN/MPQ-10A antenna (dbm) | Radar to jammer antenna angle (deg) | Condition of jamming | Radar track broken | Radar ant. gain, relative to AT-551 at $0^{o}$ (db) |
|---|---|---|---|---|---|
| -61 | -78 | 16.2 | Medium | No | -19 |
| -61 | -73.5 | 5 | Medium | No | -14 |

The discrepancy in the results appears to be in the "signal from AN/MPQ-10A antenna." This computed value depends on the accurate measurement of the "radar-to-jammer antenna angle."

It was felt that further investigation of this range was unwarranted since the jammer was slightly beyond its maximum effective line-of-sight range.

The exact maximum line-of-sight range could not be determined because of the inaccessible area between the 30,000- and 40,000-yard positions. However, it is believed, for a target at Balloon Site Nr 1, the maximum range should be 40,000 yards; such an interpretation is based on the results obtained from the jammer-to-radar range of 42,000 yards.

An important point to consider, when analyzing the maximum ranges, is that the testing was done under good line-of-sight conditions. Poorer conditions or terrain covered by heavy vegetation (causing terrain masking) would cause a considerable reduction of the ranges achieved.

## 20. (S) TEST 12, LIMITING CONDITIONS FOR NON-LINE-OF-SIGHT JAMMING WITH AN MPJ

### a. (C) Purpose

The purpose of this test was to determine the maximum main-lobe and side-lobe jamming ranges against the AN/MPQ-10A radar when there was a terrain shielding condition present.

### b. (S) Procedure

There was only limited testing done with the MPJ and the AN/MPQ-10A radar; prior to initiation of the field test, a similar test was conducted utilizing the AN/ALQ-3(XA-1). The data obtained agreed with the theoretical results: a ground-based jammer in a 50-mil defilade, at a range of 1,000 yards or more, will not interfere with the operation of an AN/MPQ-10A radar.

In view of the theoretical and actual results of non-line-of-sight conditions, limited testing was performed.

### c. (S) Results

With the antennas oriented directly at each other at a range of 2,000 yards and with the radar in a 50-mil defilade, only condition 2 jamming was recorded. At other antenna aspects, jamming was reduced. No further effort was expended on this test.

## VI. EQUIPMENT CAPABILITY AGAINST RADIO COMMUNICATIONS NETS IN A COMBAT GROUP AREA

### 21. (U) CHARACTERISTICS OF TARGET RADIOS

The MPJ was tested against three ground communication sets: Radio Sets AN/PRC-6, AN/PRC-10, and AN/VRC-17. It was also tested against the Aircraft Radio Corporation VHF Portable Communicator, Type 12, which is a ground-to-air communication equipment. The characteristics of the equipment are shown in table V.

Table V. (C) Characteristics of Communication Sets

| Comm set (type) | Frequency (mcs) | Power output (w) | Rated range (mi) |
|---|---|---|---|
| AN/PRC-6 | 47 to 55.4 | 0.25 | 1 |
| AN/PRC-10 | 38 to 54.9 | 0.9 | 3 to 12 |
| AN/VRC-17 | 27 to 38.9 | 9 to 16 | 10 |
| ARC Type 12 | 116 to 148 | 1.2 | line-of-sight |

### 22. (U) CONDITIONS OF JAMMING

The conditions of communication jamming as they are designated in this report are as follows:

Condition 0: Operator is unaware of jamming.
Condition 1: All transmissions received with minor background annoyance.
Condition 2: Almost all messages understood but occasional words and phrases lost.
Condition 3: Some words and phrases understood, but continuity destroyed.
Condition 4: Operator is aware that transmission is being attempted but cannot receive message.
Condition 5: Operator unaware that a transmission is being made.

23. (S) TEST 13, MPJ MAXIMUM LINE-OF-SIGHT INTERCEPT AND JAMMING RANGES

a. (C) Purpose

The purpose of this test was to determine the maximum line-of-sight intercept and jamming ranges of the MPJ against low-power, tactical communications facilities of 0.25 to 15 watts.

b. (C) Procedure

The AN/ALT-7 transmitter and the AN/APR-14 receiver components of the MPJ were used for this test. They were tested against the AN/GRC-7 (using the RT-68), the AN/PRC-6, and the AN/PRC-10 radio sets operating as communication nets.

After each pair of radio sets had been established as a radio communications net, the MPJ components went into search and intercept operation. Upon intercept, the victim radio transmitted in clear text and the MPJ attempted to interfere with the use of noise modulation.

c. (S) Results

Utilizing the 1.5 meter whip antenna, the intercept capabilities of the AN/APR-14 receiver are listed in table VI. The results are with unskilled operators. *

Table VI. (S) Intercept Results

| Communication set | Power output (w) | Intercept freq (mcs) | Victim-to-MPJ distance (mi) |
|---|---|---|---|
| AN/PRC-6 | 0.2 | 51.0 | 1.6 |
| AN/PRC-10 | 0.6 | 49.1 | 3.0 |
| AN/GRC-7 (RT-68) | 15.0 | 49.1 | 12.5 |

*The minimum interceptable signal for an unskilled operator was considered to be twice the height of the "grass" on the scope of the AN/APR-14.

It was found that condition 5 jamming existed for the AN/GRC-7 and the AN/PRC-10 at the maximum intercept distances. Additional work was performed to determine the maximum jamming capability. Condition 5 jamming existed to a range of 48 miles which was the maximum line-of-sight distance available.

The jamming range test for the AN/PRC-6 was not performed because of a lack of the crystals at the necessary frequency.

There was great difficulty in setting the AN/ALT-7 transmission on the victim radio frequency; several of the causes are as follows:

(1) The lookthrough on the panoramic indicator did not perform satisfactorily.

(2) The minimum bandwidth for the AN/APR-14 receiver is 600 kcs with the audio channel receiving and amplifying any signal and noise with this bandwidth. The frequency deviation of low-power, fm, military sets is ±20 kcs.

(3) The tuning dials on the AN/APR-14 and AN/ALT-7 are calibrated in mcs with the frequency settings of approximately 50 kcs being necessary.

(4) Considerable backlash was present in the tuning mechanism of the AN/ALT-7 transmitter.

A variety of methods was used by the MPJ operators to tune the AN/ALT-7 to the victim radio frequency; of these methods, none were accurate and all allowed errors. The methods of tuning are as follows:

(1) The jamming transmitter was tuned to the same dial setting as the intercept receiver.

(2) The receiver was tuned to a maximum audio signal and then the transmitter was switched on and tuned for a maximum audio signal in the receiver earphone.

(3) The victim signal was centered under the vertical hairline on the panoramic indicator. The transmitter was then turned on; the higher signal level caused deflection off the scope and rendered it useless. Attenuation was added to the signal until it was entirely on the scope; the transmitter was then tuned so the transmitter signal appeared centered on the vertical hairline. The results were inaccurate since the horizontal axis of the scope represented a 6-mcs bandwidth and the victim signal was 40 kcs.

(4) The final method was to use any or a composite of the above methods to determine the victim frequency. Once the jammer started operation, the victim radio searched for the jamming signal frequency and noted the error. The victim radio was then tuned to the proper frequency and the jammer was "talked" on to the frequency of the communication net.

24. (S) TEST 14, LIMITING CONDITIONS FOR NON-LINE-OF-SIGHT JAMMING

a. (C) Purpose

The purpose of this test was to determine the intercept and jamming capability of the MPJ against low-power, tactical radio communications equipment (0.25 to 15.0 watts) under non-line-of-sight conditions.

b. (S) Procedure

Geographic conditions made a change in the testing procedure necessary. The most suitable location was a wide river valley approximately 15 miles from the victim radio sites. Since this range exceeded the intercept capability of the AN/APR-14, only the jamming portion of the test was conducted.

The MPJ was sited at various roadside locations in the same propagation path and jamming was attempted. As shown in fig. 53, the terrain did not permit the measurements between no jamming and complete saturation.

c. (S) Results

The results indicate that defraction of the radio energy at 49.1 mcs is unreliable. Figure 53 is a profile of the propagation path. The shaded area is non-line-of-sight from the victim radio receiver.

25. (S) TEST 15, MPJ EFFECTIVENESS AGAINST A CLOSE-AIR SUPPORT, VHF COMMUNICATION NETWORK

a. (C) Purpose

The purpose of this test was to determine the effectiveness of the MPJ when used against a close-air support equipped with a VHF air communication network.

| COMMUNICATION SET | SITE 1 | SITE 2 | SITE 3 | SITE 4 |
|---|---|---|---|---|
| | JAMMING CONDITIONS | | | |
| AN/GRC-7 (RT-68) | 1 | 0 | 0 | 5 |
| AN/PRC-10 | 1 | 1 | 0 | 5 |

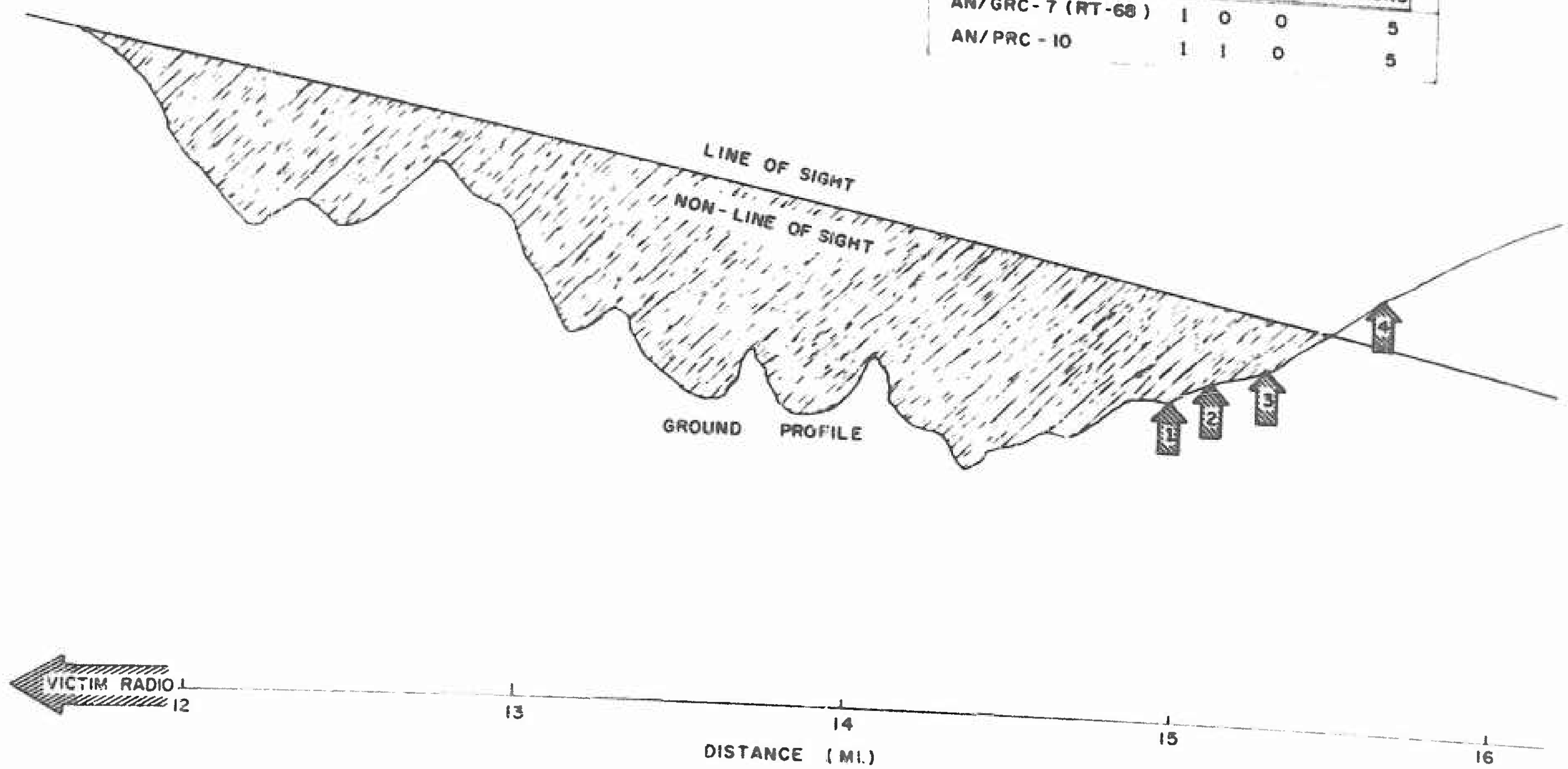



Fig. 53. (S) Site arrangement and jamming conditions received from variations of line-of-sight

b. (S) Procedure

The MPJ 3/4-ton truck was located on the west range and the radio net control established at 6,000 yards in range. The second portion of the ARC Type 12 radio net was airborne and varied in range from 0 to 55 miles.

The L-20 aircraft, containing the second ARC Type 12, made a series of flights to simulate the type of passes that might be expected from a close-air support mission. Figure 54 illustrates the three types of flights that were made.

On each flight, the simulated Air Control Team, located at the M-33 radar site, transmitted a one-time-no-repeat message to the aircraft. The MPJ operators intercepted the test message and attempted to jam the airborne receiver.

c. (S) Results

Sweep-frequency, noise-modulated jamming proved ineffective due to the frequency drift of the AN/ALT-7 and the relatively short dwell time of the jamming within the passband of the radio receiver.

Spot-frequency, noise-modulated jamming proved to be successful to a range of 55 miles; however, the instability of the AN/ALT-7 oscillator caused continual retuning so as to remain within the victim radio 6-db passband of 100 kcs.

In addition, the lookthrough feature proved unsatisfactory for this type of victim signal and the necessary retuning of the oscillator could be achieved only by coaching from the radio receiver.

It can be concluded, from the results of this test, that the 140-watt power output of the AN/ALT-7 is sufficient for tactical use in jamming tactical communications of the ARC Type 12. Needless to say, the frequency instability and the tuning difficulty make the AN/ALT-7 an unsatisfactory countermeasure against this type of crystal-controlled radio communication.

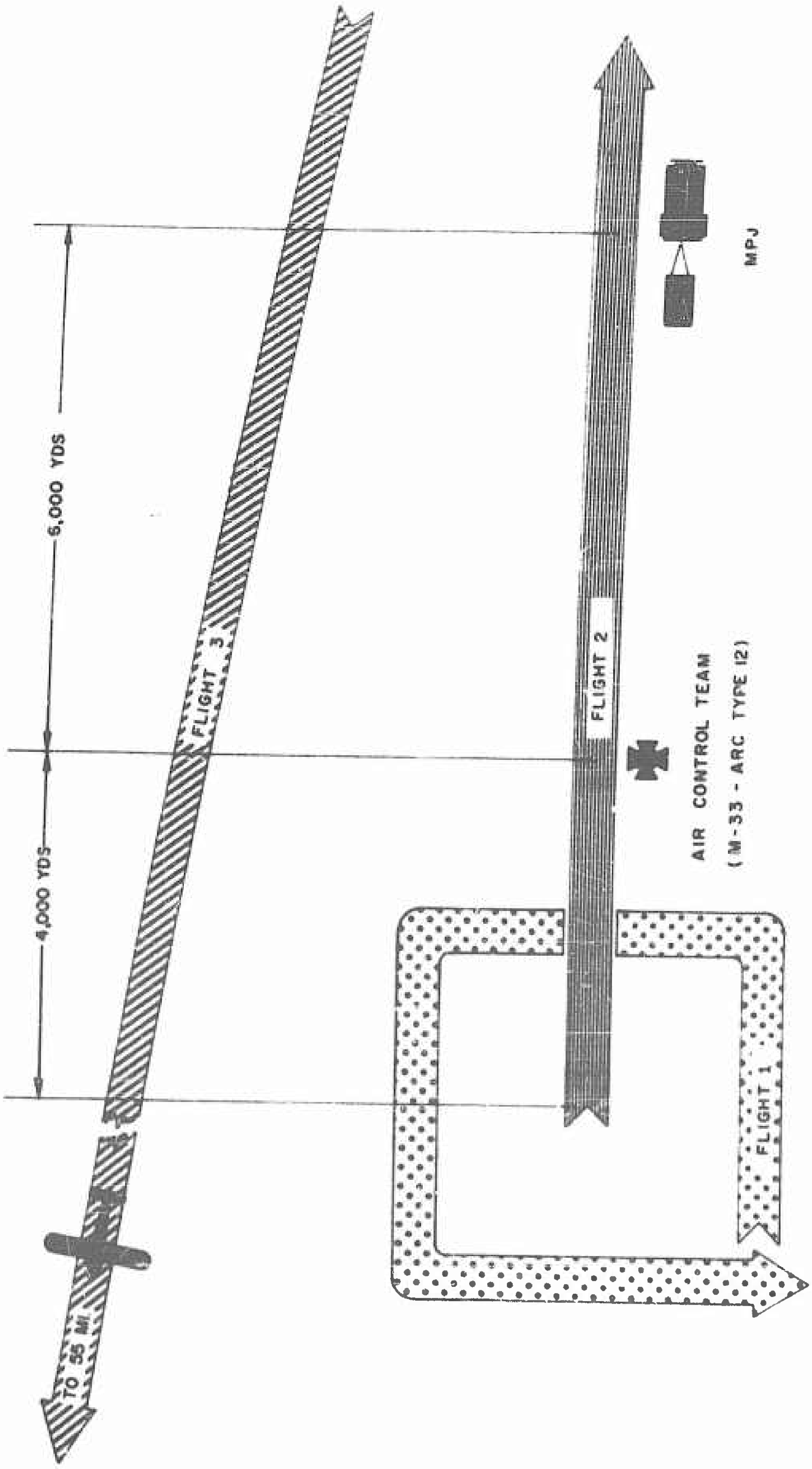



Fig. 54. (S) Flights simulating close-air support

## VII. EQUIPMENT CAPABILITIES AGAINST TACAN

(C) The results in this section give the effectiveness of various jamming modes against the TACAN AN/ARN-21 receiver with results on range, effectiveness, and intercept and DF.

(S) In the jamming mode tests, the setup was similar in that the output of the AN/ALT-6B was attenuated by deflecting the main lobe of the jammer radiation 20 degrees to the right of the target AN/ARN-21 and placing the MPJ in defilade.

### 26. (S) TEST 16, EFFECTIVENESS OF THE SPOT-JAMMING MODE AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine the effects of the MPJ spot-jamming mode against the AN/ARN-21 navigation receiver.

b. (C) Procedure

Using the general test setup, the AN/ALT-6B was operated in the spot-jamming mode using a cw unmodulated signal. The jammer frequency was adjusted to the AN/ARN-21 receiver frequency by using a spectrum analyzer.

The AN/ALT-6B attenuator was adjusted until jamming caused the AN/ARN-21 to go into search. The jammer output was reduced until the AN/ARN-21 returned to the tracking mode. The procedure was repeated twice.

c. (S) Results

The results of the test showed that the spot-jamming mode, using a cw unmodulated signal, was effective in jamming the AN/ARN-21 navigation receiver. This jamming completely negated the navigational capability of the AN/ARN-21.

27. (S) TEST 17, EFFECTIVENESS OF THE SPOT-JAMMING MODE, NOISE MODULATED, AGAINST TACAN NAVIGATIONAL AID

a. (C) Purpose

The purpose of this test was to determine the effects of the MPJ spot-jamming mode, noise modulated, against the AN/ARN-21 navigation receiver.

b. (C) Procedure

Using the general test setup, the AN/ALT-6B was operated in the spot-jamming mode with a noise-modulated signal. The jammer frequency was adjusted to the AN/ARN-21 receiver frequency by using a spectrum analyzer.

The AN/ALT-6B attenuator was adjusted until jamming caused the AN/ARN-21 to go into search. The jamming output was reduced until the AN/ARN-21 returned to the tracking mode. The procedure was repeated twice.

c. (S) Results

The results of the test showed that the spot-jamming mode, using a noise-modulated signal, was effective in jamming the AN/ARN-21 navigation receiver. This jamming capability negated the navigational capability of the AN/ARN-21.

28. (S) TEST 18, EFFECTIVENESS OF THE SLOW-SWEEP JAMMING MODE AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine the effects of the MPJ slow-sweep jamming mode against the AN/ARN-21 navigation receiver.

b. (C) Procedure

Using the general test setup, the AN/ALT-6B was operated in the slow-sweep jamming mode using a cw unmodulated signal. The jammer frequency was adjusted to the AN/ARN-21 receiver frequency by using a spectrum analyzer.

The AN/ALT-6B attenuation was adjusted to a predetermined power output value (determined from previous results in test 16) so as to cause the TACAN to break track and go into search operation.

c. (S) Results

The results of the test showed that the slow-sweep jamming mode using a cw unmodulated signal did not jam or affect the operation of the AN/ARN-21 navigation receiver.

29. (S) TEST 19, EFFECTIVENESS OF THE SLOW-SWEEP JAMMING MODE, NOISE MODULATED, AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine the effects of the MPJ slow-sweep jamming mode using a noise-modulated signal.

b. (C) Procedure

Using the general test setup and the power output determined from previous results in test 16, the jammer frequency was adjusted to the AN/ARN-21 receiver frequency by using a spectrum analyzer. The SLOW WIDTH control was set at 100 mcs. The SLOW SWEEP rate was varied slowly from minimum to maximum over a period of 1 minute. When an effective sweep rate was found it was recorded and checked; upon positive results the power output attenuation was reduced to find the minimum output necessary for the AN/ARN-21 to break track and go into search operation.

c. (S) Results

The results of the test showed that the slow-sweep jamming mode using a noise-modulated signal did not jam or affect the operation of the AN/ARN-21; the variations in attenuation and sweep rate did not improve the MPJ effectiveness in any way.

30. (S) TEST 20, EFFECTIVENESS OF THE FAST-SWEEP JAMMING MODE, NOISE MODULATED, AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine the effects of the MPJ fast-sweep jamming mode using a noise-modulated signal.

b. (C) Procedure

Using the general test setup and the power output determined from previous results in test 16, the jammer frequency was adjusted to the AN/ARN-21 receiver frequency by using a spectrum analyzer. The SLOW WIDTH control was set at 10 mcs. The FAST SWEEP rate was varied slowly from minimum to maximum over a period of 1 minute. When an effective sweep rate was found, it was recorded and checked; upon positive results the power output attenuation was reduced to find the minimum output necessary for the AN/ARN-21 to break track and go into search operation.

c. (S) Results

The results of the test showed that the fast-sweep jamming mode using a noise-modulated signal did not jam or affect the operation of the AN/ARN-21; the variations in attenuation and sweep rate did not improve the MPJ effectiveness in any way.

31. (S) TEST 21, OPERATIONAL EFFECTS OF THE AN/ALT-6B AGAINST THE AN/ARN-21 AND AN/URN-3

a. (C) Purpose

The purpose of this test was to determine the operational effects of the AN/ALT-6B against the AN/ARN-21 receiver and the AN/URN-3 beacon.

b. (C) Procedure

A TACAN equipped aircraft with the necessary ground beacon and communications equipment was used for this test. Only TACAN equipment was used for navigation with Instrument Flight Rules applying and the pilot being required to navigate from a blacked-out compartment (a co-pilot was aboard as a safety measure).

An M-33 tracking radar was sited 8 miles east and 1/2 mile south of Benson, Arizona; this site is about 4,000 feet above sea level (SL). The aircraft flew at 10,000 feet above SL; thus the aircraft was actually 6,000 feet above terrain.

Six flights were made: two from west to east, two from east to west, and two from south to north.

c. (S) Results

(1) West-to-East Flights

With the use of an unmodulated spot-jamming mode, effective jamming of the AN/ARN-21 receiver in both the range and bearing indicators occurred at approximately 6,000 yards west of the Benson site to a point 20,000 yards east of the site; this was a total of 26,000 yards. The jammer-to-aircraft range varied from 30,000 yards at the west point to 36,000 yards at the eastern termination point.

With the use of a modulated spot-jamming mode on the second flight, similar jamming occurred at approximately 8,000 yards west of the Benson site to a point 18,000 yards east of the site. Again the total was 26,000 yards with the jammer-to-aircraft range varying from 30,000 yards at the west point to 34,000 yards at the eastern termination point.

(2) East-to-West Flights

With the use of an unmodulated spot-jamming mode, effective jamming of the AN/ARN-21 receiver in both range and bearing indicators occurred at approximately 25,000 yards east of the Benson site to a point 6,000 yards west of the site; this was a total of 31,000 yards. After 5,000 yards, the jammer saturated the receiver for an additional 10,000 yards. The jammer-to-aircraft range varied from 39,000 yards at the east point to 36,000 yards at the western termination point.

With the use of a modulated spot-jamming mode on the second flight, similar jamming occurred at approximately 28,000 yards east of the Benson site to a point 8,000 yards west of the site. In this flight the total was 36,000 yards with the jammer-to-aircraft range varying from 40,000 yards at the east point to 29,000 yards at the western termination point.

(3) South-to-North Flights

With the use of an unmodulated spot-jamming mode, effective jamming of the AN/ARN-21 receiver in both range and bearing indicators occurred at approximately 26,000 yards south of the Benson site to a point 28,000 yards north of the site; this was a total of 54,000 yards. The jammer-to-aircraft range varied from 7,000 yards at the south point to 58,000 yards at the northern termination point.

With the use of a modulated spot-jamming mode on the second flight, similar jamming ranges occurred at approximately 28,000 yards south of the Benson site to a point 46,000 yards north of the site. For this flight, the total was 64,000 yards with the jammer-to-aircraft range varying from 4,000 yards at the south point to 76,000 yards at the northern termination point.

The differences of effective jamming ranges between the east, west, and north flights were primarily caused by the advantageous conditions presented during the south-to-north flights. The east and west flights passed directly in front of the jammer and thus presented a relatively fast moving target for tracking, whereas the south-to-north flights were more directly into and away from the MPJ. Since the south-to-north flights had minimum tracking difficulty coupled with optimum tracking capability, maximum antenna propagation was directed at the target with a consequently high jamming capability achieved, for example, 76,000 yards.

From the foregoing test results, it can be concluded that if some tracking facility had been available, there would have been equal jamming capability on all flights.

In addition, whenever the MPJ is located between the TACAN beacon and the TACAN receiver, the 350-watt power output at 1,164 mcs will completely block the TACAN receiver with brute-force jamming.

32. (S) TEST 22, MAXIMUM EFFECTIVE RANGE OF THE MPJ AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine the effective range of the MPJ when utilized against an airborne AN/ARN-21.

b. (C) Procedure

The airborne TACAN was flown on a prescribed course back and forth in front of the MPJ; after each pass by the aircraft, the range from jammer-to-aircraft would be extended another 10 miles. Since the antenna was highly directional, the antenna orientation was directed to cover an optimum portion of the flight plan.

Jamming of the TACAN receiver was to be achieved by superimposing the spot-jamming signal on the beacon frequency.

c. (S) Results

Since there is no tracking capability in the MPJ and since the transmitting antenna pattern is highly directional, jamming was poor and only effective when the aircraft flew into the highly directional radiation beam. In some cases, jamming was intermittent or only partially effective on either the range or bearing indicators. Poor jamming effectiveness (although the maximum range achieved was 80,000 yards) can also be attributed to the inability of the MPJ to get on and to stay on the target frequency.

TACAN jamming requires accuracy and stability in jamming and a certain capability to track a moving object.

In trying to jam the TACAN receiver, several problems arose. Of these, one was the problem of continually monitoring the beacon signal so as to remain in the vicinity of the beacon frequency. In addition, since it is not possible to intercept both target and ground beacon frequencies simultaneously, (the MPJ has only one receiver available for this purpose) the use of time sharing of intercepted frequencies had to be used; this was done with little success. Upon finding the lookthrough capability unusable, a spectrum analyzer was installed in the aircraft to determine the waywardness of the MPJ transmitter. It was found that the MPJ was ±1 mcs off-frequency.

Although the antenna mount of the MPJ can be moved in azimuth, there is no automatic means to move the antenna in elevation. Thus any change in elevation is impossible.

33. (S) TEST 23, INTERCEPT AND DF CAPABILITIES AGAINST THE AN/ARN-21

a. (C) Purpose

The purpose of this test was to determine intercept and DF capabilities against the AN/ARN-21 in an area defense.

b. (C) Procedure

An aircraft, equipped with TACAN and communications to the ground site, flew a triangular course from Libby Field at an altitude of 5,000 feet above terrain.

The MPJ, with intercept and DF equipment, was located at the junction of Arizona highways 80 and 92. The TACAN ground beacon was located at Libby Field.

With the aircraft flying the proposed course illustrated in fig. 55, the MPJ was to intercept and DF the airborne TACAN receiver.

c. (S) Results

The MPJ was successful in intercepting and DF the AN/ARN-21 receiver at any point of the flight.

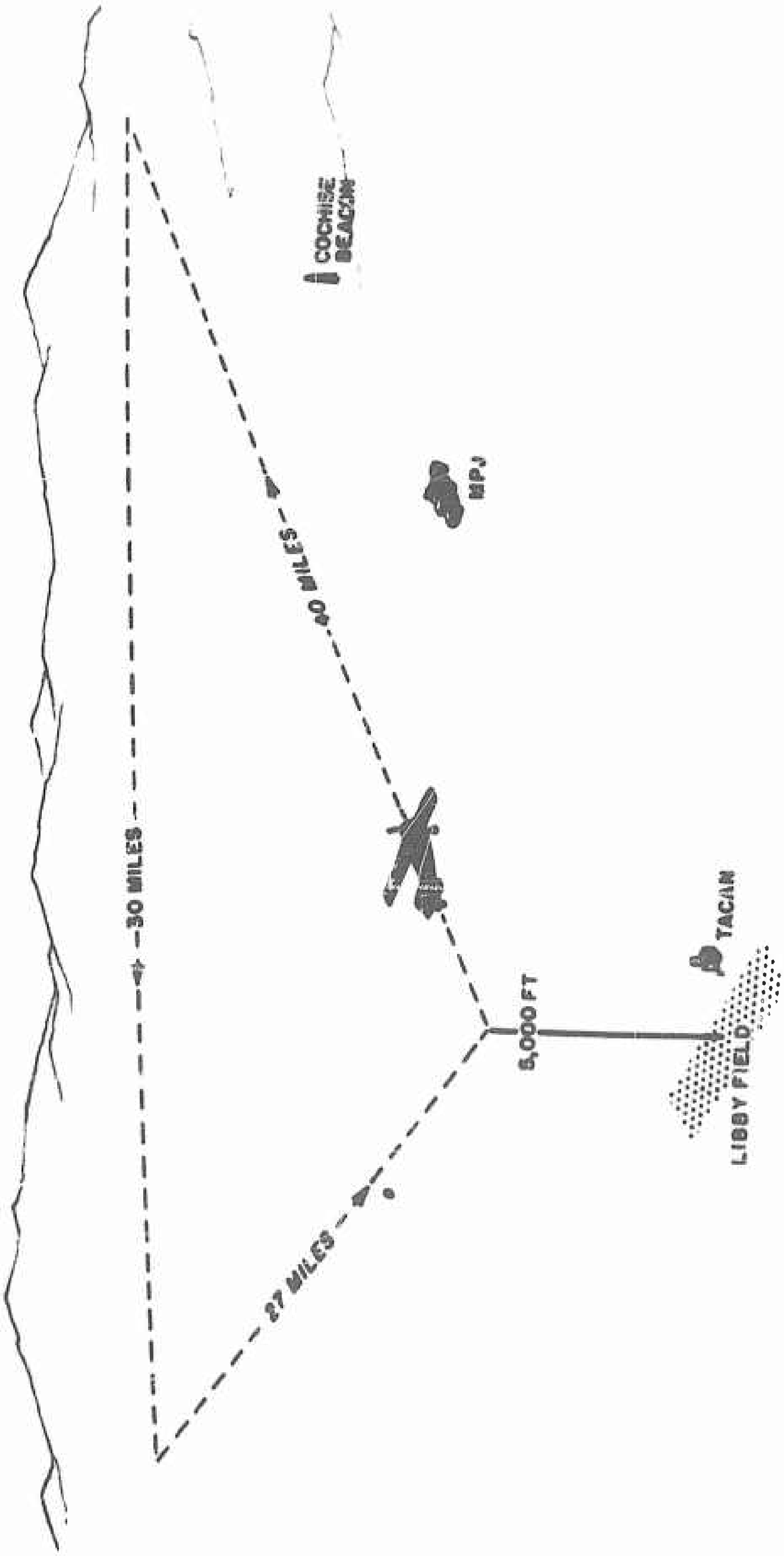



Fig. 55. (C) Flight plan for intercept and DF test

## VIII. FACILITY OF OPERATION

### 34. (C) TEST 24, MAN-MACHINE EVALUATION

a. (U) Purpose

The purpose of this test was to evaluate the man-machine relationship of the layout and the general operating environment of the MPJ 3/4-ton truck installation.

b. (U) Procedure

Human engineering personnel conducted observations of the layout of the MPJ 3/4-ton truck installation and interviewed operators as a means of evaluating the man-machine relationships. Consideration of the general operating environment was the object of this evaluation.

c. (C) Results

It was found that the lighting within the shelter, with the door closed, is such that the operator's work area is covered by his own shadow.

The AN/APR-14 and the AN/APR-9 receivers, in the upper tier of equipment, are too high for comfortable operation at a sitting position. In general, cables run in front of the equipment panels and interfere with the operation of the MPJ.

In summary, a reduction of cable clutter, component rearrangement for eye-level scope arrangement, and improved lighting of the operator's work area would improve the man-machine environment.

## IX. MAJOR PROBLEM AREAS

(U) While testing, certain "problem areas" were encountered. Many of these problems were a direct result of fabricating the system from available off-the-shelf items of Air Force and Navy hardware instead of initially designing equipment that would perform the MPJ mission. The problems due to operational and engineering deficiencies are inherent when utilizing specialized equipment for purposes other than what it was intended. It must be realized however, that although many deficiencies do exist, the equipment was the only type available within the time frame which approaches the desired operation, the size, and the weight of the MPJ concept.

(U) The information contained in the following "major problem areas" are presented for the purpose of serving as a guide to personnel involved in the research, the development, and the fabrication of future models or modifications.

(U) For general orientation of the following problem areas, a general interior view of the 3/4-ton truck installation is shown in fig. 3.

35. (C) TRANSMITTING, 350 TO 10,500 MCS (AN/ALT-6B)

The major problems with the AN/ALT-6B were caused by modifications performed for the purpose of operating the equipment under conditions other than those for which the equipment was originally designed. This alteration of purpose and design was as follows: in the original concept of the MPJ it was intended that the operator could change frequency bands by simply operating a switch. However, since available equipment did not permit such a simple switching operation, it was decided to utilize the AN/ALT-6B and have the operator manually change each oscillator unit when a different frequency band was desired. A correlation of information available at the time of this decision indicated that such manual operation was possible without realigning the AN/ALT-6B for each oscillator.

Results of this decision were as follows: when the complete set of oscillators were delivered and checked for optimum operation, it was found that the modulation voltage and magnetron filament voltage must be readjusted for each magnetron so as to meet manufacturers specifications and thus prevent injury to or failure of the magnetron.

This manual mode of operation prevents the original concept of MPJ operation. Such manual adjustments are intended to be a maintenance function rather than the duties of an ECM operator who is unqualified in proper maintenance. However, there are two possible solutions to this manual readjustment problem: one solution is to use a separate transmitter for each frequency band of the OA transmitter group; this solution is negated by the additional weight and space problems to the already overladen MPJ transporting vehicle. The second solution, which has proved to be feasible after considerable investigation, is to relocate the magnetron filament control to the front panel. This allows the operator to readjust the filament voltage to a simple meter reading for each magnetron. Further investigation has resulted in a common modulation voltage for all magnetrons operating above 5 kmcs and a common modulation voltage for the magnetron operating between 1 and 5 kmcs. These voltages, although not optimum, provide an acceptable jamming signal on all bands and partially restore the original operational concept of the MPJ.

Additional problems, associated with the AN/ALT-6B, are those of (1) adverse VSWR effects on the magnetron operation, and (2) transmission line losses on System efficiency: excessive VSWR's (greater than 1.5:1) were measured throughout the frequency band and as a result, a number of tube failures (holes in the magnetron window) have been experienced during this test phase. The MPJ excessive transmission line losses, as high as 15 db, occurred in the same areas above 5,000 mcs.

To prevent further tube failures, the RF system of the MPJ is currently undergoing modifications. The modifications consist of (1) a waveguide system installed for frequencies above 5,000 mcs (with fig. 36 illustrating this new system) and, (2) coaxial and waveguide load isolator installations for complete frequency band coverage.

The preceding two modifications should result in a moderately efficient transmission system and thus reduce tube failures to a normal level.

36. (C) TRANSMITTING, 24 TO 352 MCS (AN/ALT-7)

The major deficiency of the AN/ALT-7 transmitting system is the inherent frequency drift of the transmitter. Constant monitoring of the tuning dial is required to keep the transmitter tuned to the specific frequency desired. Additional difficulty is encountered by the backlash of the tuning control when trying to jam a receiver with a bandwidth on the order of 15 kcs. Such deficiences, however, are caused by attempting to operate an airborne sweep-frequency jammer for spot-frequency jamming; the problem ceases to exist during sweep operation of the jammer.

37. (C) RECEIVING, 30 TO 1,000 MCS (AN/APR-14)

The primary difficulty in the AN/APR-14 receiving system is the inability of the receiver to audibly present voice-type signals in high signal density areas. The carrier of the target signal is adequately presented on the receiver indicator but no audio signal is presented even at extremely close ranges. Examination of this problem indicates that this lack of audio signal is caused by the wide (600 kcs) bandwidth of the receiver. Such a bandwidth permits any signal within ±300 kcs of the target signal to be amplified equally well and consequently causes a large amount of clutter during am. operation and causes the "capture" effect during fm operation.

To determine if decreasing the receiver bandwidth would increase the audio-intercept capability, the arrangement of fig. 56 was attempted. An

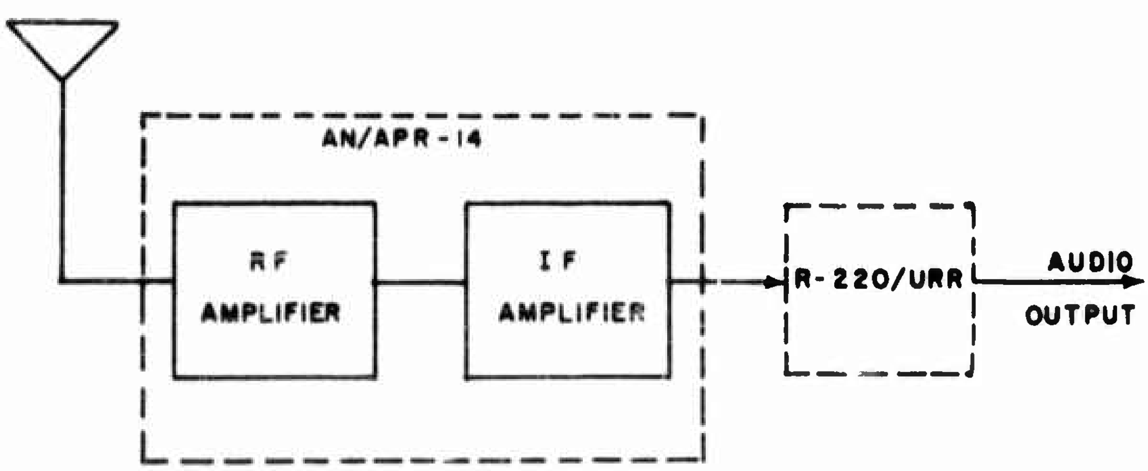



Fig. 56. (C) Testing arrangement for audio intercept

R-220/URR receiver was connected to the output of the AN/APR-14 if. strip and the R-220/URR receiver was tuned to the if. of the AN/APR-14. This arrangement increased the audio intercept range of the system by a conservative factor of 6. It is believed that this increase in range was caused by the decrease in bandwidth (reduced to 200, 50, or 10 kcs from the original 600 kcs) rather than by the additional gain of the R-220/URR since the noise level is established in the if. and the rf stages of the AN/APR-14.

As a result of the previous examination, a narrow band crystal filter has been ordered for one MPJ and should this prove as beneficial as anticipated, they will be added to the remainder of the MPJ systems. With such modifications, it will be possible to switch the filter IN and OUT of the receiver as required and thus return the wideband feature required for many applications of the MPJ.

38. (C) SUMMARY OF PROPOSED MODIFICATIONS

To provide the 72d Signal Battalion (EW) with the best possible capability, the following MPJ modifications are currently being programed. These modifications will eliminate the need for a major retro-fit program and still keep within the time frame of 1959-61.

a. An antenna system which will provide full frequency coverage from 24 to 10,500 mcs for both transmitting and receiving.

b. An rf transmission line system utilizing ridged waveguide above 5 kmcs and load isolators where VSWR exceeds 1.5:1 for the transmitting system.

c. Narrow band crystal filters for the AN/APR-14 receiver which will permit reception of communications signals within a high signal density area.

d. The AN/ALT-6B magnetron filament voltage control to be relocated to the front panel. This will allow the operator to adjust the voltage for each magnetron to a predetermined simple voltmeter indication.

## X. CONCLUSIONS AND RECOMMENDATIONS

### 39. (S) CONCLUSIONS

From an analysis of the results obtained from testing the MPJ it is concluded that:

a. The concept of providing the Field Army with a single vehicle having the capability of intercept, rough DF, and jamming of enemy electronic equipment operating in the frequency range of 24 to 10,500 mcs is basically sound.

b. The equipment incorporated within the interim MPJ provides this capability within the limitations imposed by utilization of equipment which was designed for airborne application.

c. A relatively low-cost modification program will result in an item of equipment with an improved operational capability which can be utilized in support of maneuvers and field exercises until the production items are available.

### 40. (C) RECOMMENDATIONS

It is recommended that:

a. The Electronic Warfare Department accomplish the following modifications as expeditiously as possible so that the best operational capability possible, within the time frame of 1959 - 1961, will be available to the 72d Signal Battalion (EW).

(1) An antenna system for the full frequency range of 24 to 10,500 mcs.

(2) An rf transmission system utilizing ridged waveguide and load isolators.

(3) Narrow band crystal filters for the AN/APR-14 receiver.

(4) Relocation of the AN/ALT-6B magnetron filament control.

b. The USASRDL consider the engineering and operational limitations of the current equipment during the preparation and planning of the production items.

c. Close liaison between the user U. S. Continental Army Command and developing agencies USASRDL and USAEPG be maintained during the accomplishment of the MPJ program.

Annex A. (C) Components of 3/4-Ton Mtd MPJ

| Type of equipment | Description | Quantity |
|---|---|---|
| Transmitting* | AN/ALT-6B transmitter (power output) | |
| | C-1956/ALT-6B control indicator | 1 |
| | PP-1533/ALT-6B power supply | 1 |
| | T-608/ALT-6B transmitter | 2 |
| | OA-1186/ALT-6B through OA-1195/ALT-6B transmitter groups without antennas | 1 each |
| | AN/ALT-7 transmitter (power output) | |
| | T-464/ALT-7 transmitter | 1 |
| | T-465/ALT-7 transmitter | 1 |
| | PP-506/APT-6 power supply | 2 |
| | 0-1 kmcs dummy load | 1 |
| | 1-11 kmcs dummy load | 1 |
| | Transmitting antennas | |
| | To cover the frequency range of 24 to 10,500 mcs | As required |
| Receiving** | AN/APR-14 receiver | 1 |
| | AN/APR-9 receiver | |
| | ID-226/APR-9 panoramic indicator | 1 |
| | TN-128/APR-9 rf tuner | 1 |
| | TN-129/APR-9 rf tuner | 1 |
| | TN-130/APR-9 rf tuner | 1 |
| | TN-131/APR-9 rf tuner | 1 |
| | CU-43/APR-9 mixer amplifier | 1 |
| | C-654/APR-9 remote control | 1 |
| | PP-336/APR-9 power supply | 1 |
| | PP-337/APR-9 power supply | 1 |

Annex A. (C) Components of 3/4-Ton Mtd MPJ (Cont)

| Type of equipment | Description | Quantity |
|---|---|---|
| Modulation and look-through | MD-156/TRT-2B modulator | 1 |
| | AN/ALA-7 lookthrough pulse generator | 2 |
| Analysis | AN/ALA-3 pulse analyzer | |
| | IP-246/ALA-3 indicator | 1 |
| | PP-1051/ALA-3 power supply | 1 |
| Programing | Power control panel | 1 |
| | Receiver antenna and video switch unit | 1 each |
| | Transmitter antenna and modulation switching unit | 1 each |
| | E-1798-1 power and if. switching unit for AN/APR-9 | 1 each |
| Prime power source (mounted in trailer) | PU-346/G generator set | 1 |
| | 2 kw, 28 v dc rectifier unit | 1 |
| Communications | AN/VRC-17 radio set complete with AN/GRA-6 control group | 1 each |
| | C-433/GRC remote control | 1 |
| Direction finding | IP-243/ALA-6 indicator | 1 |
| | PP-974/ALA-6 power supply | 1 |
| | TG-23/ALA-6 antenna drive | 4 |
| | C-1246/ALA-6 antenna control | 1 |
| | CU-397/ALA-6 coupler | 1 |
| | CU-398/ALA-6 coupler | 3 |

*The frequency coverage of the transmitting equipment will be continuous from 40 to 10,500 mcs when all frequency heads for the AN/ALT-6B are available. At present, the AN/ALT-7 is being used in place of the AN/ALT-6B in the frequency range of 24 to 350 mcs.

**The receiving equipment is capable of continuous coverage from 30 to 10,750 mcs. The AN/APR-14 receiver covers the range of 30 to 1,000 mcs in three bands, and the AN/APR-9 covers the range of 1,000 to 10,750 mcs in four heads.

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