

RESTRICTED

NAVAER 08-5S-78

MANUAL OF TEST EQUIPMENT  
*for*  
AIRBORNE ELECTRICAL  
*and*  
ELECTRONIC EQUIPMENT

NOTE.—THIS MANUAL SUPERSEDES  
CO-NAVAER 08-5S-78 DATED  
1 JANUARY 1945

PUBLISHED BY DIRECTION OF  
THE CHIEF OF THE BUREAU OF AERONAUTICS

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## Section I GENERAL INFORMATION

### INTRODUCTION

This reissue of the "Manual of Test Equipment for Airborne Electrical and Electronic Equipment" has been prepared to provide field maintenance activities with information on equipment in use by the Bureau of Aeronautics, Navy Department. The information given is as complete as possible as of the date of issue. Subsequent revisions and additions will be issued periodically to keep the publication up to date.

### TABLE OF CONTENTS

The table of contents lists all the test equipments of which individual descriptions appear in this manual.

There are twelve major classifications, several of which are broken down into two or more subclassifications. Each major division is preceded by an introduction which gives a general description and the theory of operation of the equipments contained in that section. The introductions to each section are listed in the Table of Contents.

### INDEX

The index lists all of the test equipments which are mentioned in this manual. It includes not only a list of equipments which are individually described but those which are part of, or used with, such equipments and are so described. Cross referencing is as extensive as practicable, and each unit is listed under its nomenclature, its type, and under any other popular names by which it is known.

### INDIVIDUAL DESCRIPTIONS

Each equipment which is individually described includes a statement of primary purpose, a general description, a list of electrical and mechanical characteristics, and a list of accessories supplied with the unit. When available, indexed photographs and stock numbers have been included.

### STOCK NUMBERS

Each major unit of test equipment including all of its component parts has received an ASO stock number. This

number is that of the complete equipment described. When accessories are included, and a stock number for that particular accessory is available, it is indicated below the ASO stock number for the complete equipment. Numbers for the individual accessories are preceded by the index number (1), (2), (3), etc., by which they have been noted in the list of equipment supplied with the major components. A space has been provided for writing in stock numbers which were not available by the date of publication. Major components (signal generators, tube testers, etc.) which are usually indexed as (1) receive no stock number since they are included in the number for the complete equipment. When the major component (1) is available without the accessories, an ASO stock number is assigned. Ordinarily no ASO stock number is to be expected for (1) and the space is left blank for possible future inclusion.

### INSTRUCTION BOOKS

Instruction books for test equipment are generally known as "Handbook of Maintenance Instructions" and are assigned a NAVAER or AN number. Books, when available, are packed one with each test equipment and additional copies are distributed to Carriers, Air Stations, etc. Copies may be ordered from the nearest major publication Supply Point as shown in the Naval Aeronautical Publications Index and monthly supplement thereto, NavAer 00-500. When ordering books list the NAVAER or AN number if available. If not available give a detailed description of the equipment concerned.

Operating instructions are not included in a separate handbook but are included in the "Handbook of Maintenance Instructions." Early models of Test Equipment do not have maintenance handbooks.

### TEST EQUIPMENT LIST

Listed immediately after this introduction is an alphabetical list of basic equipment showing test equipment required for the maintenance of basic equipment. For each basic equipment listed there is presented the test equipment required along with suitable alternates.

## TEST EQUIPMENT SELECTION LIST FOR CURRENT BASIC EQUIPMENT

These Lists of test equipments do not necessarily reflect a need for all items in the performance of maintenance on the basic equipment, rather they are intended to serve as Lists of recommended items for all classes of maintenance. In some cases information contained in the Handbook of Maintenance Instructions concerning test equipment required has been superseded by the recommended equipment contained in these Lists.

**Test Equipment for AM-14/APT, AM-18/APT, AM-33/APT**

Control Box, C-157/AP  
(Items 1, 4 and 5 are used for radiation indications in lieu of TS-131/AP)

Double Packing Tester, TS-92/AP

Frequency Meter, TS-323/UR  
(TS-174/U is a suitable alternate)

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)

Pickup Antenna, AS-168/AP

Test Meter, TS-60/U  
(TS-297/U with 2 circuit phone plug is a suitable alternate)

Voltmeter, AC, IS-185

Voltmeter, Low DC, PX-14 (Westinghouse)

Wattmeter, TS-118/AP

**Test Equipment for AN/AIA-2A**

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/AIC-4**

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/AIC-6**

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/AIC-7**

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APA-5**

Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Hickok 133 are suitable alternates)

Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Oscilloscope, TS-239/UP  
(TS-34/AP or Dumont 241 are suitable alternates)

Range Calibrator, TS-102A/AP

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

Voltmeter, AC, IS-185

**Test Equipment for AN/APA-6A**

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C or 205-AG are suitable alternates)

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Simpson 260 or Weston 790 are suitable alternates)

Oscilloscope, TS-239/U  
(TS-34/AP or Dumont 241 are suitable alternates)

Pulse Generator, Measurement Corp., 79-B

Test Oscillator, TS-47/APR

**Test Equipment for AN/APA-10**

Multimeter, TS-352/U  
(Weston 790, Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)

Signal Generator, TS-382A/U  
(Hewlett-Packard 200-C or 205-AG are suitable alternates)

Signal Generator, TS-413/U  
(Hickok 19X is a suitable alternate)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APA-11**

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C or 205-AG are suitable alternates)

Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260 or Weston 790 are suitable alternates)



Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Oscilloscope, TS-239/U  
(TS-34/AP or Dumont 241 are suitable alternates)

Pulse Generator, Measurements Corp. 79-B  
Test Oscillator, TS-47/APR

#### Test Equipment for AN/APA-16

Multimeter (Bench), TS-352/U  
(Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)

Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Oscilloscope, TS-239/UP  
(TS-34/AP or Dumont 241 are suitable alternates)

Range Calibrator, TS-102A/AP  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltmeter, AC, IS-185

#### Test Equipment for AN/APA-17, -17A

Multimeter, TS-352/U  
(Hickok 133, Navy "OE", Weston 790 or Simpson 260 are suitable alternates)

Signal Generator, TS-382A/U  
(Hewlett-Packard 200-C is a suitable alternate)

Signal Generator, TS-418/U  
(Navy Models LAE or LAF are suitable alternates)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

Test Oscillator, TS-189/U

Voltmeter, AC, IS-185

Voltmeter, Low DC, PX-14 (Westinghouse)

#### Test Equipment for AN/APA-22

Echo Box, TS-61/AP  
(Not required if equipment is equipped with an echo box)

Multimeter, TS-352/U  
(Model "OE", Simpson 260, Hickok 133, or Weston 790 are satisfactory alternates)

Oscilloscope, TS-239/UP  
(Syncroscope TS-34/AP is a suitable alternate)

Power Meter, TS-125/AP

#### Test Equipment for AN/APA-23

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Weston 790, Hickok 133 or Simpson 260 are suitable alternates)

Test Oscillator, TS-47/APR

Tube Tester, I-177-A

(Hickok 540 or 545 are suitable alternates)

#### Test Equipment for AN/APA-24

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)

Test Oscillator, TS-47/APR

#### Test Equipment for AN/APA-26

Echo Box, TS-61/AP  
(Not required if equipment is equipped with echo box)

Multimeter, TS-352/U  
(Navy Model "OE", Simpson 260, Hickok 133 or Weston 790 are satisfactory alternates)

Oscilloscope, TS-239/UP  
(Syncroscope TS-34/AP is a suitable alternate)

Power Meter, TS-125/AP

Tube Tester, I-177-A

(Hickok 540 or 545 are suitable alternates)

#### Test Equipment for AN/APA-30

Multimeter, TS-352/U  
(Navy Model "OE", Simpson 260, Hickok 133 or Weston 790 are suitable alternates)

Oscilloscope, TS-239/UP  
(Syncroscope TS-34/AP is a suitable alternate)

Range Calibrator, TS-102A/AP

Tube Tester, I-177-A

(Hickok 540 or 545 are suitable alternates)

#### Test Equipment for AN/APA-38

Multimeter, TS-352/U  
(Navy Model "OE", Simpson 260, Hickok 133 or Weston 790 may be used as satisfactory alternates)

Signal Generator, TS-382/U  
(Hewlett-Packard 200-C audio oscillator may be used as a satisfactory alternate)

Signal Generator, TS-413/U  
(General Radio 804-CS2 or Measurements Corp. Model "80" signal generator may be used, each as a satisfactory alternate for both the TS-413/U and TS-437/U)

**Signal Generator, TS-437/U**

(General Radio 804-CS2 or Measurements Corp. Model "80" signal generator may be used, each as a satisfactory alternate for both the TS-413/U and TS-437/U)

**Tube Tester, I-177**

(Hickok 540 or 545 may be used as satisfactory alternates)

**Test Equipment for AN/APA-48****Audio Signal Generator, TS-382-A/U**

(Hewlett-Packard 200-C is a suitable alternate)

**Multimeter, TS-297/U**

(Weston 663 or Simpson 443 are suitable alternates)

**Multimeter, TS-352/U**

(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)

**Signal Generator, TS-437/U**

(Measurements Model 80 or G-R 804-CS2 are suitable alternates)

**Vacuum Tube Tester, I-177-A**

(Hickok 540 or 545 are suitable alternates)

**Vacuum Tube Voltmeter, Hewlett-Packard 400-A****Test Equipment for AN/APN-1, -1A****Calibrator, TS-250/APN****Delay Line Test Set, TS-10B/APN****Frequency Meter, TS-127/U****Multimeter, TS-297/U**

(Weston 663 or Simpson 443 are satisfactory alternates)

**Multimeter, TS-352/U**

(Navy "OE" or Weston 790 are suitable alternates)

**Oscilloscope, TS-239/UP**

(Dumont 241 or TS-34/AP are suitable alternates)

**Signal Generator, TS-382/U**

(Hewlett-Packard 200-C is a suitable alternate)

**Signal Generator, TS-418/U**

(Measurements "84" is a suitable alternate)

**Tube Tester, I-177**

(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APN-4****Frequency Meter, LM Series****Multimeter (Bench), TS-352/U**

(Navy "OE", Simpson 260, Weston 790 or Hickok 133 are suitable alternates)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are suitable alternates)

**Oscilloscope, TS-239/UP**

(TS-34/AP is a suitable alternate)

**Test Set, TS-251/UP****Training Equipment, RC-242****Tube Tester, I-177-A**

(Hickok 540 or 545 are suitable alternates)

**Vacuum Tube Voltmeter, TS-375/U**

(Radio City 662 is a suitable alternate)

**Voltmeter, IS-185****Test Equipment for AN/APN-11****Monitor Test Set, TS-416/AP****Multimeter, TS-352/U**

(Navy "OE", Simpson 260, Weston 790 or Hickok 133 are suitable alternates)

**Oscilloscope, TS-239/UP**

(TS-34/UP is a suitable alternate)

**Pressurizing Unit, MK-20/UP****R-F Load, TS-108/AP****Signal Generator, TS-382-A/U**

(Hewlett-Packard 200-C is a suitable alternate)

**Spectrum Analyzer, TS-148/UP****Test Set, TS-120/UP****Voltage Divider, TS-89/AP****Test Equipment for AN/APQ-2A, -2B****Control Box, C-157/AP****Field Strength Meter, TS-509/UR**

(TS-509/UR Field Strength Meter may be used in lieu of AS-168/AP, C-157/AP and TS-60/U for radiation indicator)

**Frequency Meter, TS-175/U****Multimeter, TS-352/U**

(Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)

**Pickup Antenna, AS-168/AP****Test Meter, TS-60/U****Tube Checker, I-177-A**

(Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APQ-15****Matching Network, CU-107/AP****Multitester, TS-297/U****Multitester, TS-352/U**

(For interim use the Navy Model "OE", Simpson 260 or Weston 790)

**Oscilloscope, TS-239/UP**

(Dumont 241 or TS-34/AP can be used as satisfactory alternate)

**Pulse Generator, Measurements Corp. 79-B**

Signal Generator, TS-437/U  
(General Radio 804-CS-2 or Meas. Corp. 80 are satisfactory alternates)  
Test Oscillator, TS-47/APR  
Tube Tester, I-177-A  
(Hickok 540 or 545 may be used for interim use)  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is satisfactory for interim use)

**Test Equipment for AN/APR-1**

Het. Frequency Meter, TS-323/UR  
(TS-175/U is suitable alternate)  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)  
Signal Generator, TS-413/U  
(General Radio 804-CS2 or Meas. Corp. 80 are suitable alternates)  
Signal Generator, TS-437/U  
(G-R 804-CS2 or Meas. Corp. 80 are suitable alternates)  
Signal Generator, TS-418/U  
(Meas. Corp. 84 or Navy LAE are suitable alternates)  
Test Oscillator, TS-47/APR  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)  
Voltmeter, AC, IS-185

**Test Equipment for AN/APR-4**

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C or 205-AG are suitable alternates)  
Het. Frequency Meter, TS-323/UR  
(TS-175/U is a suitable alternate)  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
Signal Generator, TS-413/U  
Signal Generator, TS-437/U  
(General Radio 804-CS2 or Measurements Corp. Model 80 are suitable alternates for the required range of TS-413/U and TS-437/U)

Signal Generator, TS-418/U  
Navy Model LAE or Measurements Corp. Model 84 are suitable alternates)  
Test Oscillator, TS-47/APR  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltmeter, AC, IS-185

**Test Equipment for AN/APR-5A**

Multimeter, TS-352/U  
(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltmeter, AC, IS-185

**Test Equipment for AN/APS-2 through -2G**

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is a suitable alternate)  
Crystal Test Set, TS-268/U  
Fluxmeter, TS-15A/AP  
Milliammeter, TS-11/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or Hickok 133 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)  
Power Meter, TS-125/AP  
Pressurizing Pump, MK-20/UP  
Signal Generator, TS-155C/UP  
Test Set, TS-61/AP  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(Radio City 662 is a suitable alternate)  
Voltage Divider, TS-89/AP  
Voltmeter, AC, IS-185

**Test Equipment for AN/APS-3, -3A**

Echo Box, TS-62/AP  
Fluxmeter, TS-15A/AP  
Milliammeter, TS-11/AP  
Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or Hickok 133 are suitable alternates)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)

Pressurizing Pump, MK-20/UP  
R-F Load, TS-108/AP  
Spectrum Analyzer, TS-148/UP  
Test Set, TS-147/UP  
(TS-146/UP is a suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltage Divider, TS-89/AP

**Test Equipment for AN/APS-4**

Adapter, CV-49519  
Audio Signal Generator, TS-382-A/UP  
(Hewlett-Packard 200-C is suitable alternate)  
Echo Box, TS-62/AP  
Fluxmeter, TS-15A/AP  
Milliammeter, TS-11/AP  
Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or  
Hickok 133 are suitable alternates)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alter-  
nates)  
Neon Lamp Kit, MX-109/U  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)  
Pressurizing Pump, MK-20/UP  
R-F Test Load, TS-108/AP  
Spectrum Analyzer, TS-148/UP  
Test Set, TS-147/UP  
(TS-146/UP is a suitable alternate)  
Test Rack, TS-188/APS-4  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(Radio City 662 are is a suitable alternate)  
Voltage Divider, TS-89/AP  
Voltmeter, AC, IS-185  
Voltmeter, Low DC, PX-14

**Test Equipment for AN/APS-6**

Echo Box, TS-62/AP  
Fluxmeter, TS-15A/AP  
Milliammeter, TS-11/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alter-  
nates)  
Multimeter, TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or  
Hickok 133 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is suitable alternate)  
Power Absorber, MX-580/AP

Pressurizing Pump, MK-20/UP  
R-F Test Load, TS-108/AP  
Spectrum Analyzer, TS-148/UP  
Spinner Balancer, CGJ-10AEH  
Telescope Elbow, M1A1  
Test Set, TS-147/UP  
(TS-146/UP is a suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltage Divider, TS-89/AP  
Voltmeter, AC, IS-185  
Voltmeter, DC Low, PX-14

**Test Equipment for AN/APS-15, -15A, -15B**

Dummy Load, TS-108/AP  
Echo Box, TS-62/AP  
Fluxmeter, TS-15A/AP  
Milliammeter, TS-11/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alter-  
nates)  
Multimeter, TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or  
Hickok 133 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)  
Oscilloscope Calibrator, TS-100/AP  
Pressurizing Pump, MK-20/UP  
Spectrum Analyzer, TS-148/UP  
Test Load Unit, TS-101/AP  
Test Set, TS-147/UP  
(TS-146/UP is a suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Voltage Divider, TS-89/AP  
Voltmeter, AC, IS-185  
Voltmeter, Low DC, PX-14

**Test Equipment for AN/APS-19**

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is suitable alternate)  
Bench Harness, AN/APM-61  
Crystal Checker, TS-268/U  
Echo Box, TS-62/AP  
Milliammeter, TS-11/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alter-  
nates)  
Multimeter, TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or  
Hickok 133 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is suitable alternate)  
Power Absorber, MX-580/AP  
Pressurizing Pump, MK-20/UP

R-F Test Load, TS-108/AP  
Range Calibrator, TS-102-A/AP  
Signal Generator, TS-413/U  
(Navy LP-3 or LP-5 are suitable alternates)  
Signal Generator, TS-437/U  
(Measurements Corp. Model 80 or General Radio  
804-CS2 are suitable alternates)  
Spectrum Analyzer, TS-148/UP  
Spinner Balancer, CGJ-10AEH  
Test Set, TS-147/UP  
(TS-146/UP is suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(Radio City 662 is a suitable alternate)  
Voltmeter, AC, IS-185  
Voltmeter, Low DC, PX-14

#### Test Equipment for AN/APS-20, -20A

A/R Range Scope, Dumont 256-B  
Attenuator, CN-45/UP  
Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is suitable alternate)  
Blower, HD-5/APS-20  
Capacitance Divider, A-5347 (Radiation Lab)  
Crystal Checker, TS-268/U  
Dummy Load, TS-338/UP  
Dummy Mixer, TPS-70CB  
Echo Box, TS-270/UP  
Fluxmeter, TS-15A/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Weston 790 or Simpson 260 are suitable alternates)  
Oscilloscope, TS-34/AP  
Oscilloscope, TS-239/UP  
(Dumont 241 is suitable alternate)  
Power Meter, TS-125/AP  
Pressurizing Pump, MK-20/UP  
Pressurizing Plate, TS-378/U  
Slotted Section & Probe, TS-339/AP  
Sweep Signal Generator, MI-18709B  
Test Load, TS-346/UP  
Test Set, TS-155C/UP  
(Navy LAD is satisfactory alternate)  
Tube Tester, I-177  
(Hickok 540 or 545 are suitable alternates)  
Voltmeter, AC, IS-185  
Voltmeter, Low DC, PX-14  
Voltmeter, V-T (Peak-to-Peak), TS-487/U

#### Test Equipment for AN/APS-31, -33

Audio Signal Generator, TS-382-A/U  
(Hewlett Packard 200-C is acceptable alternate)  
Bench Harness, AN/APM-60  
Crystal Checker, TS-268/U  
Echo Box, TS-62/AP  
Milliammeter, TS-11/AP  
Multimeter (Bench), TS-352/U  
(Alternate for TS-297/U, preferred over Navy  
"OE" or Simpson 260)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is acceptable alternate)  
Pressurizing Unit, MK-20/UP  
R-F Test Load, TS-108/AP  
Spectrum Analyzer, TS-148/UP  
Signal Generator, TS-413/U  
(G-R 804-CS2, Measurements 80 or LP-5 are acceptable alternates)  
Test Set, TS-147/UP  
(TS-146/UP is acceptable alternate)  
Tube Tester, I-177  
(Hickok 540 or 545 are acceptable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(Radio City 662 is acceptable alternate)  
Vee Power Absorber, MX-580/AP  
Voltage Divider, TS-89/AP  
Voltmeter, AC, IS-185  
Voltmeter, Low DC, PX-14 (Westinghouse)

#### Test Equipment for AN/APS-32-34

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is suitable alternate)  
Crystal Checker, TS-268/U  
Fluxmeter, TS-15A/AP  
FM Test Set, TS-223/AP  
Milliammeter, TS-11/AP  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or  
Hickok 133 are suitable alternates)  
Oscilloscope, TS-239/UP  
(TS-34/AP is a suitable alternate)  
Pressurizing Pump, MK-20/UP  
R-F Test Load, TS-253/AP  
Signal Generator, TS-413/U  
(Navy LP-5 or Meas. Corp. Model 80 are suitable alternates)

Spectrum Analyzer, TS-333/AP  
 Standing Wave Indicator, TS-299/UP  
 Test Set, TS-259/AP  
 Tube Tester, I-177-A  
 Vacuum Tube Voltmeter, TS-375/U  
 (Radio City 662 is a suitable alternate)  
 Voltage Divider, TS-89/AP  
 Voltmeter, AC, IS-185  
 Voltmeter, DC, PX-14 (Westinghouse)  
 Wattmeter, TS-254/AP  
 (Power Meter facilities of TS-223/AP may be used as an alternate)

**Test Equipment for AN/APT-5, -5A**

Control Box, C-157/AP  
 (To be used in conjunction with AS-168/AP in lieu of TS-131/AP)  
 Het. Frequency Meter, TS-323/UR  
 (TS-175 is a suitable alternate)  
 Multimeter, TS-352/U  
 (Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
 Pickup Antenna, AS-168/AP  
 (To be used in conjunction with C-157/AP in lieu of TS-131/AP)  
 Test Meter, TS-60/U  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are suitable alternates)  
 Voltmeter, AC, IS-185

**Test Equipment for AN/APX-1, -2 Series**

Bench Test Set, AN/UPM-1  
 (Hazeltine TE-1000-C is suitable alternate)  
 Multimeter, TS-297/U  
 (Weston 663 or Simpson 443 are suitable alternates)  
 Multimeter, TS-352/U  
 (Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)  
 Oscilloscope, TS-239/UP  
 (TS-34/AP is suitable alternate)  
 Test Set, TS-182/UP  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APX-6**

Multimeter, TS-297/U  
 (Weston 663 or Simpson 443 are suitable alternates)  
 Multimeter, TS-352/U  
 (Navy "OE", Simpson 260 or Hickok 133 are suitable alternates)

Signal Generator, TS-437/U  
 (Meas. Corp. Model 80 or G-R 804-CS2 are suitable alternates)  
 Test Meter, TS-11/AP  
 Test Set, AN/UPM-4  
 Test Set, AN/UPM-6  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APX-7**

Multimeter, TS-297/U  
 (Weston 663 or Simpson 443 are suitable alternates)  
 Multimeter, TS-352/U  
 (Navy "OE", Simpson 260 or Hickok 133 are suitable alternates)  
 Signal Generator, TS-437/U  
 (Meas. Corp. Model 80 or G-R 804-CS2 are suitable alternates)  
 Test Meter, TS-11/AP  
 Test Set, AN/UPM-4  
 Test Set, AN/UPM-6  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are suitable alternates)

**Test Equipment for AN/APX-13, -13A**

A/R Range Scope, Dumont 256-B  
 Capacitance Divider, A-5347  
 Multimeter (Bench), TS-352/U  
 (Navy "OE", Simpson 260, Hickok 133 or Weston 790 are suitable alternates)  
 Multimeter (Portable), TS-297/U  
 (Weston 663 or Simpson 443 are satisfactory alternates)  
 Oscilloscope, TS-34/AP  
 Oscilloscope, TS-239/UP  
 (Dumont 241 is suitable alternate)  
 Signal Generator, TGI-3CA  
 Sweep Signal Generator, MI-18709B  
 Test Set, TS-355C/UP  
 Tube Tester, I-177  
 (Hickok 540 or 545 are suitable alternates)  
 Voltmeter, AC, IS-185  
 Voltmeter, DC Low, PX-14 (WSTH)  
 Voltmeter (Peak-to-Peak), TS-487/U

**Test Equipment for AN/ARC-1, -1A**

Field Strength Meter, TS-509/U  
 Output Meter  
 (TS-297/U, Weston 663 and Simpson 443 are satisfactory alternates)  
 Oscilloscope, TS-239/UP  
 (Triumph 830, TS-34/AP and Dumont 241 are suitable alternates)

Power Meter, TS-511/U  
(TS-329/U Transmitter Dummy Antenna may be used in lieu of TS-511/U but does not give indication of power)  
Receiver, Phantom Antenna, TS-79/U  
Signal Generator, TS-510/U  
(TS-437/U, General Radio 804-CS2 or Measurements Corp. 80 are suitable alternates)  
Test Meter, TS-80/U  
Test Set, IE-35A  
Tube Tester, I-177  
(Hickok 540 or 545 are suitable alternates)  
Voltmeter (Low DC), PX-14 (Westinghouse)  
Voltmeter (V-T), TS-375/U  
(RCP-662 is a suitable alternate)

#### Test Equipment for AN/ARC-2

Frequency Meter, LM Series  
Multimeter (Bench), TS-352/U  
(Navy Model "OE", Weston 790 and Simpson 260 are satisfactory alternates)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are satisfactory alternates)  
Signal Generator (Audio), TS-382-A/U  
(Hewlett-Packard 200-C is satisfactory alternate)  
Signal Generator, TS-413/U  
(Navy LP-5 is suitable alternate)  
Tube Tester, I-177  
(Hickok 540 or 545 are satisfactory alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(RCP 662 is a satisfactory alternate)  
Voltmeter (Low DC), PX-14 (Westinghouse)

#### Test Equipment for AN/ARC-5 (LF-MF-HF)

Receiver Testing:  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are satisfactory alternates)  
Output Meter, Weston 687  
Signal Generator, TS-413/U  
(Navy LP-5 is satisfactory alternate)  
Test Set, AN/GRM-1  
(Test Set ARC-7918 is suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are satisfactory alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)  
Voltmeter (Low D.C.), PX-14 (Westinghouse)  
Transmitter Testing:  
Frequency Meter, LM-13 (or equal)  
Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Hickok 133 or Weston 790 are suitable alternates)

Multimeter (Portable), TS-297/U  
(Weston 663 and Simpson 443 are satisfactory alternates)  
Oscilloscope, TS-239/UP  
(Triumph 830 or TS-34/AP are suitable alternates)  
Test Set, AN/GRM-1  
(Test Set ARC-9558 is suitable alternate)  
Voltmeter (Low, D.C.), PX-14 (Westinghouse)

#### Test Equipment for AN/ARC-12

Frequency Meter, TS-323/UR  
(TS-175/U is suitable alternate)  
Oscilloscope, TS-239/UP  
(TS-34/AP, Dumont 241 or Triumph 830 are suitable alternates)  
Output Meter  
(TS-297/U Multimeter, Weston 687 or Simpson 427 are suitable alternates)  
Panoroscope and Companion Receiver for Frequency 112.5 to 175 Mcs.  
Power Meter and Phantom Antenna, TS-511/U  
Receiver Phantom Antenna, TS-79/U  
Signal Generator, TS-413/U  
(Measurements Corp. Model 80 or Navy LP-5 are satisfactory alternates)  
Signal Generator, TS-437/U  
(Measurements Corp. Model 80 or Navy LAF are satisfactory alternates)  
Test Meter, TS-80/U  
Tuning Wand, ASO Stk. No. R16-WE-B41301  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a satisfactory alternate)

#### Test Equipment for AN/ARC-28

Field Strength Meter, TS-509/U  
Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Weston 790 or Hickok 133 are suitable alternates)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Oscilloscope, TS-34/AP  
(Triumph 830 is suitable alternate)  
Power Meter, TS-511/U  
(TS-329/U Transmitter Dummy Antenna may be used in lieu of TS-511/U but does not give indication of power.)  
Receiver Phantom Antenna, TS-79/U  
Signal Generator, TS-437/U  
(General Radio 804-CS2 or Measurements Corp. Model 80 are suitable alternates)  
Signal Generator, TS-510/U

Test Meter, TS-80/U  
 Test Set, IE-35A  
 Tube Tester, I-177  
 (Hickok 540 or 545 are suitable alternates)  
 Voltmeter (V-T), TS-375/U  
 (RCP-662 is a suitable alternate)  
 Voltmeter (Low D-C), PX-14 (Westinghouse)

**Test Equipment for AN/ARN-5, -5A**

Multimeter (Bench), TS-352/U  
 (Navy Model OE, Weston 790 and Simpson 260 are suitable alternates)  
 Multimeter (Portable), TS-297/U  
 (Weston 663 and Simpson 443 are satisfactory alternates)  
 Oscilloscope, TS-239/UP  
 (Triumph 830 or TS-34/AP are satisfactory alternates)  
 Output Meter, GR-583-A  
 (This meter is used only for output measurements during R-F and I-F alignment procedures. The TS-297/U or alternates are satisfactory substitutes if used with a proper shunting resistor to produce a 4000 ohm load at the output test points)  
 Test Oscillator, TS-170/ARN-5  
 Test Set, TS-67/ARN-5  
 Tube Tester, I-177-A  
 (Hickok 540 is satisfactory alternate)  
 Vacuum Tube Voltmeter, TS-375/U  
 (RCP-662 is a satisfactory alternate)

**Test Equipment for AN/ARN-7**

Multimeter (Bench), TS-352/U  
 (Navy Model OE, Weston 790 and Simpson 260 are satisfactory alternates)  
 Multimeter (Portable), TS-297/U  
 (Weston 663 and Simpson 443 are suitable alternates)  
 Signal Generator, TS-382-A/U  
 (Hewlett-Packard 200-C is satisfactory alternate)  
 Signal Generator, TS-413/U  
 (Navy LP-5 is satisfactory alternate)  
 Test Set, I-100-A  
 (This test set is optional for Navy use—nearly all tests provided with this unit can be made with the use of TS-375/U, TS-297/U and TS-352/U)  
 Tube Tester, I-177-A  
 (Hickok 540 is satisfactory alternate)  
 Vacuum Tube Voltmeter, TS-375/U  
 (RCP-662 is a satisfactory alternate)

**Test Equipment for AN/ARN-8**

Multimeter (Bench), TS-352/U  
 (Navy Model "OE", Weston 790, or Simpson 260 are suitable alternates)  
 Multimeter (Portable), TS-297/U  
 (Weston 663 or Simpson 443 are suitable alternates)  
 Signal Generator, TS-382A/U  
 (Hewlett-Packard 200-C is suitable alternate)  
 Signal Generator, TS-437/U  
 (General Radio 804-CS2 or Measurements Corp. Model 80 are satisfactory alternates)  
 Test Oscillator (Portable), 1-76  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are satisfactory alternates)

**Test Equipment for AN/ARR-2 Series**

Frequency Meter, LM (Series)  
 Multimeter (Bench), TS-352/U  
 (Navy "OE", Simpson 260 or Weston 790 are satisfactory alternates)  
 Multimeter (Portable), TS-297/U  
 (Weston 663 or Simpson 443 are satisfactory alternates)  
 Signal Generator, TS-437/U  
 (General Radio 804-CS2 or Measurements Corp. Model 80 are satisfactory alternates)  
 Test Oscillator, TS-24A/ARR-2  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are satisfactory alternates)  
 Vacuum Tube Voltmeter, TS-375/U  
 (RCP-662 is a satisfactory alternate)

**Test Equipment for AN/ARR-3A**

Multimeter (Bench), TS-352/U  
 (Navy "OE", Weston 790 or Simpson 260 are suitable alternates)  
 Signal Generator, TS-382A/U  
 (Hewlett-Packard 200-C is suitable alternate)  
 Signal Generator, TS-413/U  
 (Navy LP-5 is suitable alternate)  
 Signal Generator, TS-437/U  
 (General Radio 804-CS2 or Measurements Corp. Model 80 may be used as alternate for TS-413/U and TS-437/U)  
 Tube Tester, I-177-A  
 (Hickok 540 or 545 are suitable alternates)  
 Vacuum Tube Voltmeter, TS-375/U  
 (RCP-662 is a suitable alternate)  
 Voltage Injector, TS-322/URM-1  
 (Part of AN/URM-1 Test Set)



**Test Equipment for AN/ARR-5**

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Simpson 260 or Hickok 133 are suitable alternates)

Signal Generator, TS-413/U  
(Navy LP-5 is suitable alternate)

Signal Generator, TS-437/U  
(G-R 804-CS2 or Meas. Corp. Model 80 are suitable alternates)

*Note*—For output measurements Items 1 and 2 may be used with proper shunting resistors to match the recommended load.

**Test Equipment for AN/ARR-7**

Multimeter, TS-352/U  
(Navy "OE", Simpson 260 or Hickok 133 are suitable alternates)

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Signal Generator, TS-413/U  
(Navy Model LP-5 is only alternate)

*Note*—for output measurements Items 1 and 2 may be used with proper shunting resistors to match the recommended load.

**Test Equipment for AN/ARR-15**

Multimeter (Bench), TS-352/U  
(Navy "OE", Simpson 260, Hickok 133 or Weston 790 are satisfactory alternates)

Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are satisfactory alternates)

Signal Generator, TS-413/U  
(Navy LP-5 is suitable alternate)

Tube Tester, I-177-A  
(Hickok 540 or 545 are satisfactory alternates)

**Test Equipment for AN/ARR-16B**

Multimeter (Bench), TS-352/U  
(Navy "OE", Weston 790 or Simpson 260 are suitable alternates)

Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is a suitable alternate)

Signal Generator, TS-413/U  
(Navy LP-5 is a suitable alternate)

Signal Generator, TS-437/U  
(Measurements Corp. Model 80 or General Radio 804-CS2 may be used as alternates for both TS-413/U and TS-437/U)

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)  
Voltage Injector, TS-322/YRM-1  
(Part of AN/URM-1 Test Set)

**Test Equipment for AN/ART-13**

Het. Frequency Meter, LM  
(Any one of the LM series may be used)

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Weston 790, Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)

Oscilloscope, TS-239/UP  
(TS-34/AP or Dumont 241 are suitable alternates)

Phantom Antenna, NAF-67816-1  
(A phantom antenna consisting of 3 to 5 ohms in series with 100 MMF capacitance may be used as an alternate)

Tube Checker, I-177-A  
(Hickok 540 or 545 are suitable alternates)

Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)

Voltmeter, Low DC, PX-14 (Westinghouse)

**Test Equipment for AN/ART-22**

A/R Range Scope, Dumont 256-B

Frequency Meter, TS-175/U

Milliammeter, CRV-60058  
(Weston 663 or Simpson 443 are suitable alternates for CRV-60058 or TS-297/U)

Multimeter, TS-297/U

Multimeter (Bench), TS-352/U  
(Navy "OE", Weston 790 or Simpson 260 are suitable alternates)

Oscilloscope, TS-34/AP

Oscilloscope, TS-239/UP  
(Dumont 241 is suitable alternate)

Reflectometer, TS-377/U

R-F Wattmeter, TS-118/AP

Test Set, IE-35A

Tube Tester, I-177  
(Hickok 540 or 545 are suitable alternates)

Video Signal Generator, TS-345/ART-22

Voltmeter, AC, IS-185

Voltmeter, Low DC, PX-14 (Westinghouse)

Voltmeter (Peak-to-Peak), TS-487/U

**Test Equipment for AN/ARW-3**

Audio Signal Generator, TS-382A/U  
(Hewlett-Packard 200-C is a suitable alternate)

**Dummy Load, TS-307/ARW**

(Link 1696-2 as furnished with the 1671 test set is a suitable alternate)

**Multimeter (Bench), TS-352/U**

(Navy "OE" or Weston 790 are satisfactory alternates)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are satisfactory alternates)

**Oscilloscope, TS-239/UP**

(Triumph 830 or TS-34/AP are suitable alternates)

**Signal Generator, TS-413/U**

(General Radio 804-CS2 Navy LP-5 or Meas. 80 are suitable alternates)

**Test Set, TS-306/ARW**

(Link 1671 is suitable as an alternate)

**Test Meter, 1623 (Link)****Tube Tester, I-177-A**

(Hickok 540 or 545 are satisfactory alternates)

**Voltmeter (Low), D-C, PX-14 (Westinghouse)****Test Equipment for AN/ARW-8X****Audio Signal Generator, TS-382A/U**

(Hewlett-Packard 200-C is a satisfactory alternate)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are satisfactory alternates)

**Oscilloscope, TS-239/UP**

(Triumph 830 or TS-34/AP are suitable alternates)

**Tube Tester, I-177-A**

(Hickok 540 or 545 is a suitable alternate)

**Test Equipment for AN/ARW-17****Audio Signal Generator, TS-382A/U**

(Hewlett-Packard 200-C is a suitable alternate)

**Dummy Load, TS-307/ARW**

(Link 1696-2 as furnished with the 1671 test set is a suitable alternate)

**Multimeter (Bench), TS-352/U**

(Navy "OE" or Weston 790 are satisfactory alternates)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are satisfactory alternates)

**Oscilloscope, TS-239/UP**

(Triumph 830 or TS-34/AP are suitable alternates)

**Signal Generator, TS-413/U**

(General Radio 804-CS2, Navy LP-5 or Meas. Corp. 80 are suitable alternates)

**Test Set, TS-306/ARW**

(Link 1671 is suitable as an alternate)

**Test Meter, 1623 (Link)****Tube Tester, I-177-A**

(Hickok 540 or 545 are satisfactory alternates)

**Voltmeter, D-C (low), PX-14 (Westinghouse)****Test Equipment for AN/ARW-19, -20****Audio Signal Generator, TS-382-A/U**

(Hewlett-Packard 200-C is suitable alternate)

**Multimeter, TS-297/U**

(Weston 663 or Simpson 443 are suitable alternates)

**Signal Generator, TS-413/U**

(Measurements Corp. Model 80 or Navy LP-5 are suitable alternates)

**Tube Tester, I-177-A**

(Hickok 540 or 545 are suitable alternates)

**Voltmeter, V-T, TS-375/U**

(RCP-662 is a suitable alternate)

**Test Equipment for AN/ARW-26, -26A, -26Y****Audio Signal Generator, TS-382-A/U**

(Hewlett-Packard 200-C is suitable alternate)

**Multimeter (Bench), TS-352/U**

(Navy "OE", Simpson 260 or Weston 790 are satisfactory alternates)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are suitable alternates)

**R-F Signal Generator, TS-437/U**

(General Radio 804-CS2 or Measurements Corp. Model 80 are satisfactory alternates)

**Test Oscillator, TS-326/U**

(TS-382-A/U and TS-437/U together may be used in lieu of this unit)

**Test Set, TS-257/ARW****Tube Tester, I-177-A**

(Hickok 540 or 545 are satisfactory alternates)

**Test Equipment for AN/ARW, -34, -35****Audio Signal Generator, TS-382-A/U**

(Hewlett-Packard 200-C is suitable alternate)

**Dummy Load, TS-307/ARW**

(Link 1696-2 as furnished with Link 1671 (mod) is a suitable alternate)

**Frequency Meter, TS-323/UR****Multimeter (Bench), TS-352/U**

(Navy "OE", or Weston 790 are satisfactory alternates)

**Multimeter (Portable), TS-297/U**

(Weston 663 or Simpson 443 are suitable alternates)

Oscilloscope, TS-239/UP  
(Dumont 241 or TS-34/AP are suitable alternates)  
Signal Generator, TS-437/U  
(General Radio 804-CS2 or Measurements Corp. Model 80 are suitable alternates)  
Test Meter, 1623 (Link)  
Test Set, TS-306/ARW  
(Link 1671 (modified) is a suitable alternate)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)

#### Test Equipment for AN/ARW-37

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is suitable alternate)  
FM Signal Generator, 150-A or 151-A  
(Note—"I-F" frequency range *only* is satisfactory for use on this equipment)  
Multimeter (Bench), TS-352/U  
(Navy "OE" or Weston 790 are satisfactory alternates)  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Oscilloscope, TS-239/AP  
(TS-34/AP, Dumont 241 or Triumph 830 are suitable alternates)  
Signal Generator, TS-413/U  
(Navy LP-5 or Measurements Corp. Model 80 are suitable alternates)  
Test Set, TS-306/ARW  
(Link 1671 (modified) is a suitable alternate)  
Test Set, TS-307/ARW  
Test Set, 1623 (Link)  
V-T Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)

#### Test Equipment for AN/ASQ, -1, -1A

Magnetic Compensator, TS-7/ASQ-1  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
Oscilloscope, TS-239/UP  
(Dumont 241 or TS-34/AP are suitable alternates)  
Oscilloscope Calibrator, TS-8A/U  
Tube Tester, TS-9A/ASQ-1

Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a suitable alternate)

#### Test Equipment for AN/ASQ-3A

Magnetic Calibrator, TS-85/ASQ-3  
Multimeter (Portable), TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Hickok 133 or Simpson 260 are suitable alternates)  
Oscilloscope, TS-239/UP  
(Dumont 241 or TS-34/AP are suitable alternates)  
Test Bench, TS-83/ASQ-3  
Test Mechanism, TS-84/ASQ-3  
Test Set, TS-86/ASQ-3  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U (Radio City Products Co. 662 is a suitable alternate)

#### Test Equipment for AN/CRC-7

Field Strength Meter, TS-509/UR  
(Army I-106-A is a suitable alternate)  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)

#### Test Equipment for AN/CRT-1A, -1B

Field Strength Meter, TS-509/U  
(TS-153/AP or I-95-A are suitable alternates; a 0-100 milli-ampere R.F. thermocouple type meter will also suffice for relative power output measurements)  
Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)  
Multimeter, TS-352/U  
(Navy "OE", Weston 790, Simpson 260 or Hickok 133 are suitable alternates)  
Tube Tester, I-177-A  
(Hickok 540 or 545 are suitable alternates)  
Vacuum Tube Voltmeter, TS-375/U  
(Radio City 662 is a suitable alternate)

## Test Equipment for AN/CRT-4

Audio Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C or 205-AG are suitable alternates)

Field Strength Meter, TS-153/AP  
(A 0-100 milliampere R-F thermocouple type meter will suffice as relative power output indicator in lieu of this item)

Heterodyne Spectroscope, Navy RBW-2M

Multimeter, TS-297/U  
(Weston 663 or Simpson 443 are suitable alternates)

Multimeter, TS-352/U  
(Navy "OE", Simpson 260 or Hickok 133 are suitable alternates)

Signal Generator, TS-437/U  
(General Radio 804-CS2 or Measurements Corp. Model 80 are suitable alternates)

Test Set, AN/URM-1

## Test Equipment for SCR-269-F, -G

Multimeter (Bench), TS-352/U  
(Navy Model OE, Weston 790 and Simpson 260 are satisfactory alternates)

Multimeter (Portable), TS-297/U  
(Weston 663 and Simpson 443 are satisfactory alternates)

Signal Generator, TS-382-A/U  
(Hewlett-Packard 200-C is satisfactory alternate)

Signal Generator, TS-413/U  
(Navy LP-5 is satisfactory alternate)

Test Set, I-100-A  
(This test set is optional for Navy use—nearly all tests provided with this unit can be made with the use of TS-375/U, TS-297/U and TS-352/U)

Tube Tester, I-177-A  
(Hickok 540 is satisfactory alternate)

Vacuum Tube Voltmeter, TS-375/U  
(RCP-662 is a satisfactory alternate)

## Section II ANTENNAS (PHANTOM)

### FUNCTION

In the testing of transmitter equipment it is necessary to have a means of simulating operating conditions without actually radiating any of the r-f transmitter power into space. To accomplish this the antenna must be replaced by a test unit which will present to the transmitter the same impedance, the same frequency characteristics, and the same power absorbing qualities as the replaced antenna. Due to its qualities of being able to reproduce for the transmitter the identical functions of an antenna which is not actually there, the replacing unit is known as a "phantom antenna" or "dummy load."

### POWER ABSORPTION

Since r-f transmitter power must be dissipated in a form which will not interfere with radio receivers, it is very convenient to transform this r-f power into heat, which is a form of energy that can be readily radiated without causing interference to electronic equipment. This transformation into heat energy solves the problem of dissipating transmitter r-f power and causes no major difficulties in duplicating the frequency response or impedance characteristics of the actual antenna.

The transforming medium may, in practice, take several forms. It may be a shield of absorbing material placed in front of the actual antenna and thus simulating space conditions while converting the r-f power into heat on its surface. For other conditions the absorbing medium may take the form of a coaxial line or waveguide filled with a sand and special carbon (Aquadag) mixture and con-

nected to the transmission line in place of the antenna. Other forms this transforming medium may take are that of a resistor, an incandescent lamp, or a specially constructed resistance wire in some type of envelope.

Some applications of phantom antennas and dummy loads require that not all of the r-f power be dissipated and that a small amount be thus made available to actuate test and auxiliary equipment. In order to meet this requirement several types of load units are so constructed that they may be connected as attenuators which pass only the desired amount of r-f energy and dissipate the remainder.

### IMPEDANCE MATCHING AND FREQUENCY RESPONSE

The phantom antenna or dummy load must employ some method of matching the impedance of the signal source and present the same frequency characteristics as the antenna. This is accomplished in the mechanical and electrical design of the load unit by building into it the proper forms and amounts of resistance, capacitance, and inductance.

Considerations of power dissipation, impedance, and frequency range must be borne in mind when choosing a test load for a particular application. The following pages of this section present a wide variety of equipment designed for general and special application, the characteristics of each are tabulated with the description of each equipment.

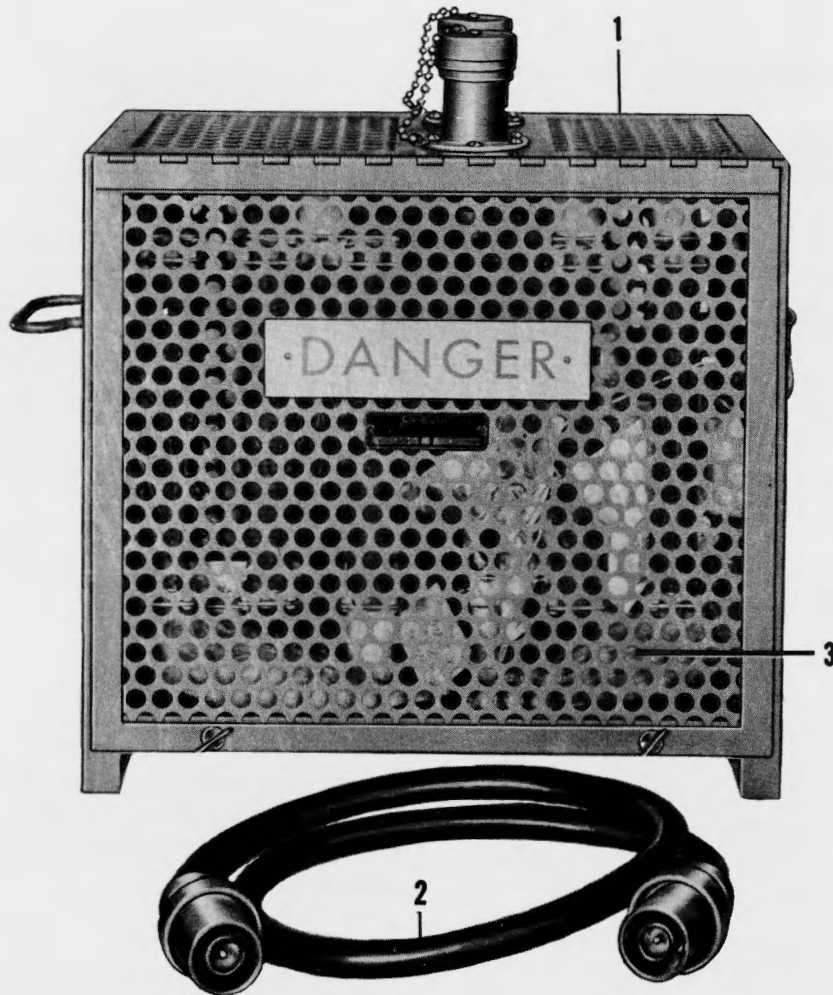


Figure 2-1. Attenuator and Modulator Load—CN-45/UP

## ATTENUATOR AND MODULATOR LOAD CN-45/UP

Primary purpose: To serve as an artificial load for AN/APS-20 modulator. To decrease pulse voltage applied to AN/APS-20 magnetron to permit seasoning of magnetron.

When connected as an artificial load the equipment serves as load for AN/APS-20 modulator. The main resistance elements of the load consist of 10 non-inductive 10 ohm resistors connected in series-parallel to present a resistance of 25 ohms  $\pm$  10% at the input terminals. This load is capable of dissipating an average power of 1500 watts continuously without the use of forced draft ventilation.

When connected as an attenuator the equipment presents between its terminals a resistance of 10 ohms  $\pm$

10% in series with an inductance consisting of 30 turns of #16 AWG enameled wire close wound in a single layer on a  $\frac{3}{4}$ -inch diameter form.

Electrical characteristics:

Power required: None.

Tubes: None.

Batteries: None.

Mechanical characteristics:

Dimensions: 18" x 9 $\frac{1}{2}$ " x 19".

Weight: 31 $\frac{1}{2}$  pounds.

Complete equipment consists of:

- (1) 1 Attenuator CN-45/UP.
- (2) 1 Pulse cable (3 feet).
- (3) 1 Octopus cable (approx. 20 inches over-all).
- (4) 1 Instruction book NAVAER 16-5S-511.

ASO stock No. R16-AN-CN-45/UP.

- (1) .....
- (2) .....
- (3) .....

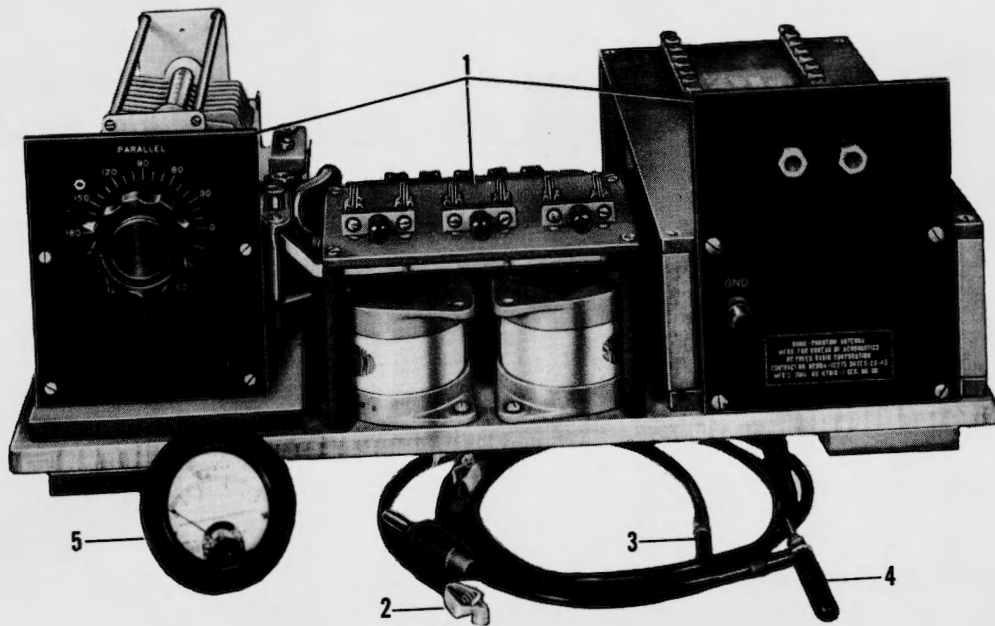


Figure 2-2. Phantom Antenna—NAF-67816-1

**VEE POWER ABSORBER**

**MX-580/AP**

Primary purpose: This equipment is designed to provide an r-f power absorber and pickup antenna for testing of airborne X-band radar equipment.

The absorber consists of a wedge-shaped metal frame that is covered on the inside surface with Harp power absorbing material, MX-410A/AP. A standard horn type antenna, AT-68/UP, is mounted on the inside of the wedge, and the whole unit is demountable for ease of storing and transporting.

**Electrical characteristics:**

- Frequency: 9320 to 9430 mc.
- Power required: None.
- Tubes: None
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 22 x 24 x 16 inches when assembled.
- Weight: 10 pounds.

**Complete equipment consists of:**

- (1) 1 MX-580/AP, Power absorber.
- (2) 1 AT-68/UP Pickup antenna.
- (3) 1 RF cable assembly.
- (4) 1 Instruction book NAVAER 16-35MX580-500.

**ASO stock No. R16-AN-MX-580/U.**

- (1) .....
- (2) R16-AN-AT-68/UP
- (3) .....

**PHANTOM ANTENNA**

**NAF 67816-1**

Primary purpose: Specifically for tuning GO-9 transmitter; may be used for GP series also.

This equipment is similar to the SK-980. However, in this equipment there are two variable condensers and a variable resistor in the circuit. It will also handle much higher power.

**Electrical characteristics:**

- Power rating: approximately 150 watts.
- Tubes: None.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 23 1/2" x 16 1/4" x 8 1/4".
- Weight: Not available.

**Complete equipment consists of:**

- (1) 1 Phantom Antenna, NAF 67816-1.
- (2) 1 Test lead for grounding.
- (3) 1 Test lead with straight probe.
- (4) 1 Test lead with right angle probe.
- (5) 1 Test meter, r-f ammeter.

**ASO stock No. R16-A-4990.**

- (1) ..... (2).....
- (3) ..... (4).....
- (5) .....



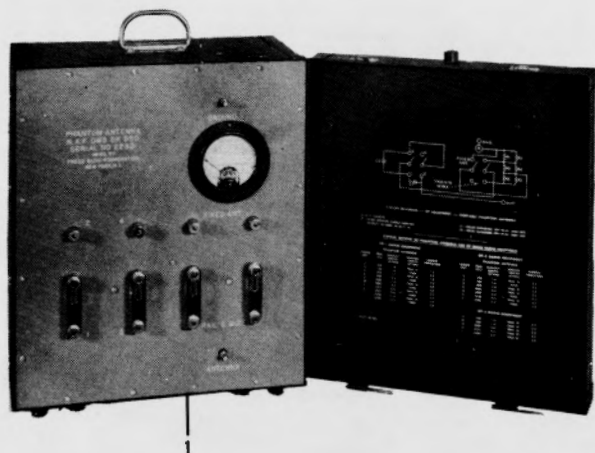


Figure 2-3. Phantom Antenna—SK980

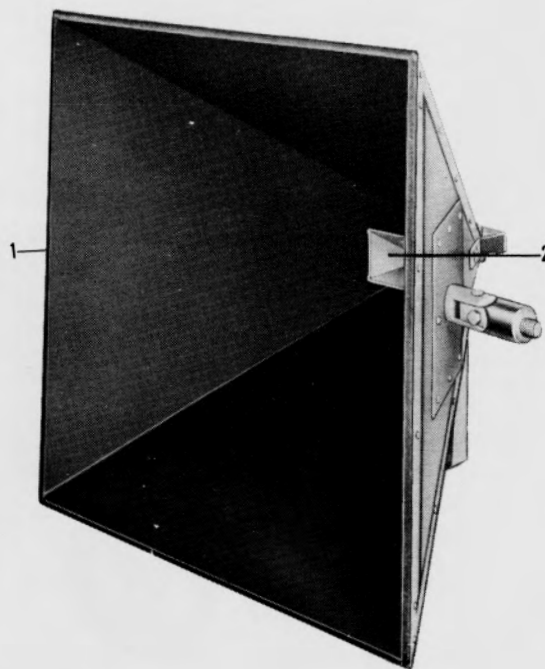


Figure 2-4. Power Absorption Cone—TMX-4DE

### PHANTOM ANTENNA

#### SK-980

Primary purpose: For testing GP transmitting equipment.

This equipment provides a dummy load for testing and tuning the different models of GP transmitting equipment (GP-1 through GP-7). It consists of a self-contained portable unit requiring no power. Within the cabinet are found two fixed capacitors and three plaques of resistors in parallel. There are four rows of three binding posts each on the front panel with a shunting strip to connect the center post to either of the two end posts of each row. By different combinations of the two condensers, the frequency band is adjusted to match the band of the transmitter. By different combinations of resistors there are simulated the different antennas, either fixed or trailing wire, for different GP sets.

**Electrical characteristics:**

Frequency range: 350, 800, 3000, 4525, and 6200 kc.

Power rating: 40 watts.

Resistance load: 18 ohms.

Meter, r-f ammeter: 0-0.9 ampere.

**Mechanical characteristics:**

Dimensions: 12<sup>3</sup>/<sub>8</sub>" x 14<sup>3</sup>/<sub>16</sub>" x 9<sup>3</sup>/<sub>8</sub>".

**Complete equipment consists of:**

(1) 1 Phantom antenna, SK-980.

ASO Stock No. R16-V-4850.

### POWER ABSORPTION CONE

#### TMX-4DE

Primary purpose: To provide an absorbing shield for radar transmitting antennas to prevent radiation; and by absorbing the r-f to prevent reflections from nearby objects which cause erratic operation of the radar.

The apparatus consists of a pick-up horn mounted at the apex of the pyramid. The pyramid is constructed to absorb energy radiated from the system under test. The inner walls of the pyramid are lined with a material that has high absorbing qualities, so that the radiation that does not fall on the horn will be absorbed by this material. Power picked up by the horn may be connected into an echo box or other test devices dependent on the technique being used. The pyramid of <sup>3</sup>/<sub>16</sub> inch plywood, copper foil covered, is light and portable.

**Electrical characteristics:**

Frequency range: 9305 to 9445 mc.

Tubes: None.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 18<sup>1</sup>/<sub>2</sub>" x 18<sup>1</sup>/<sub>2</sub>" x 16".

Weight: 8 pounds.

**Complete equipment consists of:**

(1) 1 Absorbing pyramid.

(2) 1 Pick-up horn AT-48/UP.

(3) 1 Instruction book AN 16-45-71.

ASO stock No. R16-DNE-TMX-4DE.

(1) ..... (2) R16-H-8150.



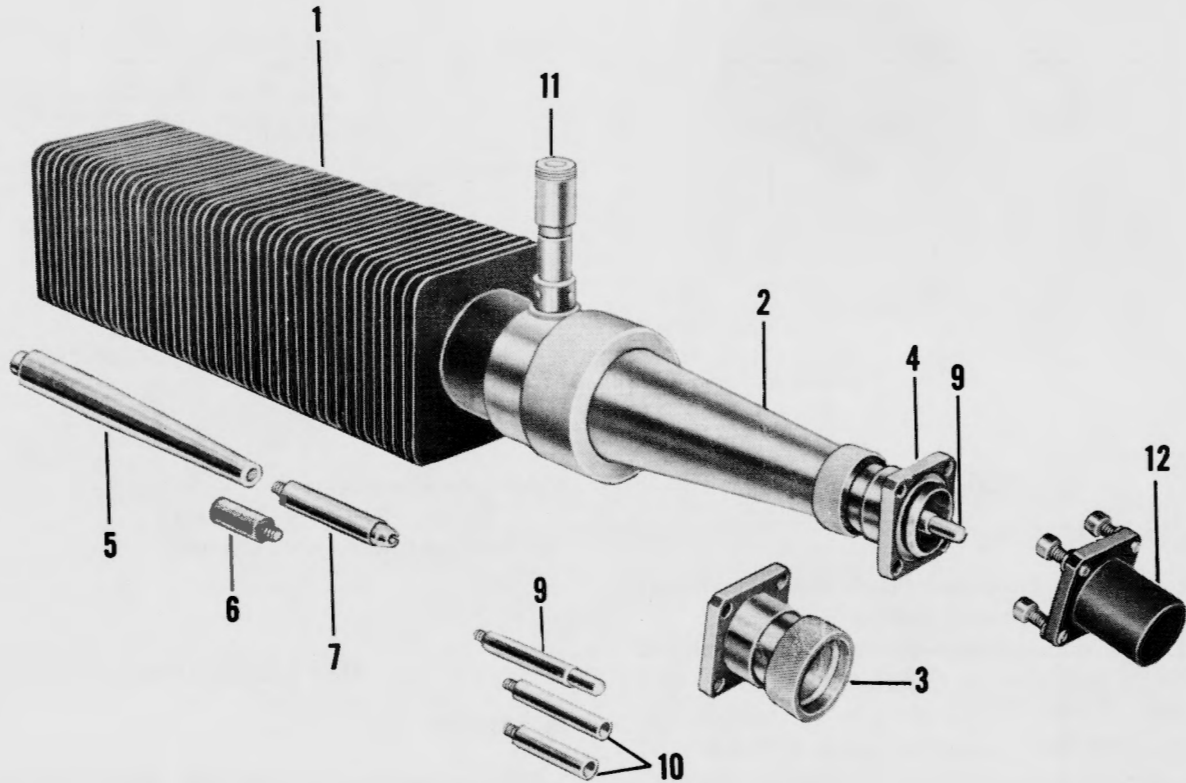


Figure 2-5. Phantom Antenna and Attenuator—TS-74/UPM

### PHANTOM ANTENNA

#### TS-74/UPM

Primary purpose: To provide a power absorbing termination for the r-f transmission line of radar transmitters.

Phantom Antenna and Attenuator TS-74/UPM normally is employed in testing radar sets operating in the airborne "SA" band (3100-3400 mc.) but is capable of functioning over the entire range of 2700-3400 mc. It provides a power absorbing termination for the r-f transmission line into which the radar transmitter can work without radiation into space.

#### Electrical characteristics:

- Frequency range: 2700 to 3400 mc.
- Input impedance: 50 ohms.
- Maximum power: 200 watts average at peak power of 250 kilowatts.
- Standing wave ratio: 1.5 db. (1.19 to 1 volt) or less in 3100-3400 megacycle band.
- Attenuation: 25 to 30 db.

#### Complete equipment consists of:

- (1) 1 Phantom antenna and attenuator TS-74/UPM.
- (2) 1 Tapered outer conductor.
- (3) 1 Female line coupling for outer conductor.
- (4) 1 Male line coupling for outer conductor.
- (5) 1 50-ohm tapered center conductor.
- (6) 1 Male adapter for 50-ohm conductor.
- (7) 1 Female adapter for 50-ohm conductor.
- (8) 1 72-ohm tapered center conductor (Installed in item 2 in photograph).
- (9) 2 Male adapters for 72-ohm conductor.
- (10) 2 Female adapters for 72-ohm conductor.
- (11) 1 Test probe.
- (12) 1 Dust cover.
- (13) 1 Instruction book AN 16-35TS74-2.

ASO stock No. R16-AN-TS-74/UPM.

(1) .....	(2) .....
(3) .....	(4) .....
(5) .....	(6) .....
(7) .....	(8) .....
(9) .....	(10) .....
(11) .....	(12) .....



Figure 2-6. Dummy Antenna—TS-78/U, TS-79/U

### TEST SET

#### TS-78/U, TS-79/U

Primary purpose: Field and bench tests on aircraft VHF radio communication equipment.

TS-78/U is a dummy antenna providing a matched load for the r-f output of the transmitter. It consists of a bank of three 28-volt, 4 watt pilot bulbs connected in parallel, mounted in a housing equipped with a coaxial connector, equivalent to a C-49195 connector. It provides a load of approximately 50 ohms at 12 watts. This unit is equivalent to and interchangeable with the A-85-A dummy antenna provided in the IE-35-A test equipment.

TS-79/U is a dummy antenna providing a 50-ohm matching input for tests on the receiver. It consists of a 50-ohm (5%) resistor mounted in a housing equipped with a coaxial connector, equivalent to a C-49195 connector.

No instruction book is provided for these units. Description and instructions are contained in the instruction book on the AN/ARC-1.

#### Electrical characteristics:

- Impedance: 50 ohms.
- Tubes: None.
- Power required: None.

#### Mechanical characteristics:

- Dimensions:
  - TS-78/U: 1½" x 2½".
  - TS-79/U:
- Weight:
  - TS-78/U: 4 ounces.
  - TS-79/U:

Complete TS-78/U equipment consists of:

- (1) 1 Dummy antenna, TS-78/U.

Complete TS-79/U equipment consists of:

- (2) 1 Dummy antenna, TS-79/U.

ASO stock numbers:

- TS-78/U-R16-AN-TS-78/U.
- TS-79/U-R16-AN-TS-79/U.

### TEST LOAD UNIT

#### TS-101/AP

Primary purpose: To test the range unit in radar equipment.

The test load unit consists of condensers simulating the load of the range units CP-5/APS-15, CP-5A/APS-15, CP-11/APS-15A, CP-11A/APS-15A. Terminals are provided on test load unit TS-101/AP for making connections for viewing the following wave forms while used in conjunction with test oscilloscope TS-100/AP: (1) Range mark, (2) 10:1 count, (3) PPI trigger, (4) modulator trigger, (5) altitude mark.

It is housed in a rectangular shaped metal case with permanently attached cord.

#### Electrical characteristics:

- Power required: None
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: 2¾" x 2¾" x 4¾".
- Weight: 1⅝ pounds.

Complete equipment consists of (see fig. 8-1):

- (1) 1 Test load unit TS-101/AP (fig. 8-1, item 8).
- (2) 1 Cord CX-237/U (fig. 8-1, item 9).
- (3) 1 Instruction book AN 16-35TS101-2.

ASO stock No. R16-AN-TS-101/AP.

- (1) ..... (2) R16-AN-CX-237/U.

Note—TS-101/AP is illustrated with Test Oscilloscope Assembly AN/APM-18. (See fig. 8-1.)

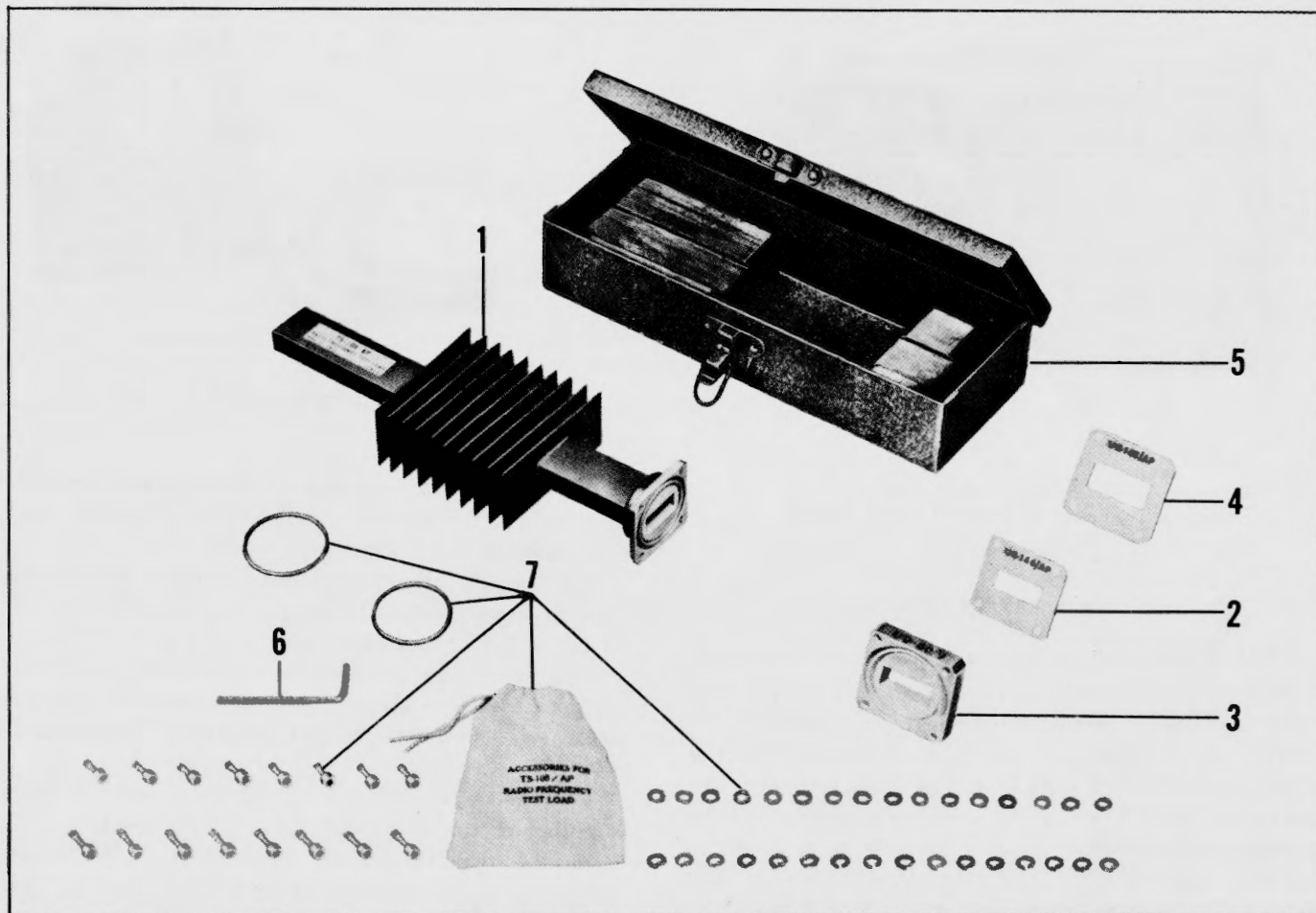


Figure 2-7. RF Test Load—TS-108/AP

### R-F TEST LOAD

#### TS-108/AP

Primary purpose: To simulate the antenna load of a transmitter in bench tests of various radar equipment.

The equipment consists of a section of waveguide, filled with a mixture of 50-50 aquadag-coated sand and uncoated sand, and three adapters. The equipment, including adapters may be used on both flange and choke terminations of  $1/2'' \times 1''$  and  $5/8'' \times 1 1/4''$  waveguide. The section of waveguide used in the dummy load is closed at one end, has a coupling choke on the other, and 10 fins attached to the guide to dissipate heat. A metal carrying case is provided.

#### Electrical characteristics:

Frequency range: 9300 to 9450 mc.

VSWR: 1: 1.1.

Power capacity: Maximum average 150 watts; maximum peak 200 kw.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $9 3/16'' \times 3'' \times 1 5/8''$  over-all.

Weight: 5 pounds total.

#### Complete equipment consists of:

- (1) 1 Dummy load TS-108/AP.
- (2) 1 Adapter: UG-144/AP, converts  $1'' \times 1/2''$  choke flange into flange coupling cover.
- (3) 1 Adapter: UG-80/U provides transitions from  $1 1/4''$  waveguide to  $1'' \times 1/2''$  waveguide.
- (4) 1 Adapter: UG-145/AP, converts  $1 1/4'' \times 5/8''$  choke coupling into flange coupling cover.
- (5) 1 Metal carrying case CY-247/AP.
- (6) 1 Allen wrench.
- (7) 1 Bag accessories.
- (8) 1 Instruction book NAVAER-AN 08-5QS-15

#### ASO stock No. R16-AN-TS-108/AP.

- |                     |                       |
|---------------------|-----------------------|
| (1) .....           | (2) R16-AN-UG-144/AP. |
| (3) R16-AN-UG-80/U. | (4) R16-AN-UG-145/AP. |
| (5) .....           | (6) .....             |
| (7) .....           |                       |

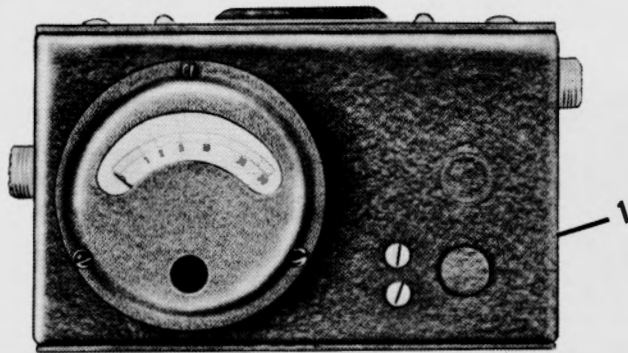


Figure 2-8. Dummy Load—TS-307/ARW

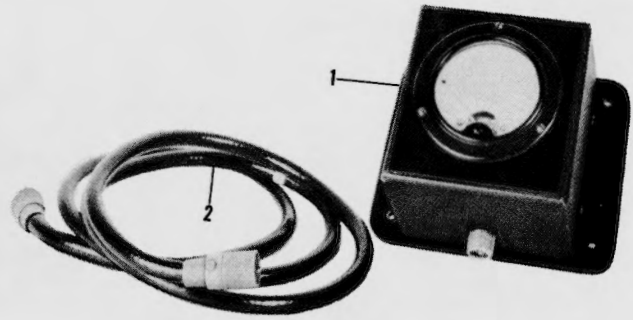


Figure 2-9. Dummy Load—TS-329/U

### DUMMY LOAD

#### TS-307/ARW

Primary purpose: For use in conjunction with TS-306/ARW for testing certain radio control transmitters.

This test set is designed to provide a means of feeding a portion of the r-f output of FM radio control transmitters to the TS-306/ARW with the remainder of the power dissipated in a resistive load. It is designed to operate with the AN/ARW-3, AN/ARW-13, and AN/ARW-34 transmitting equipments. The dummy load contains a directly calibrated meter reading from 0-30 watts.

**Electrical characteristics:**

- Range: 30-75 mc.
- Maximum power: 30 watts.
- Power required: None.
- Tubes: None.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: Not known.
- Weight: Not known.

**Complete equipment consists of:**

- (1) 1 Dummy load TS-307/ARW.
  - (2) 1 Instruction book AN 16-35TS306-3.
- ASO stock No. R16-A-4950.

### DUMMY ANTENNA

#### TS-329/U

(The TS-329/U is identical to the Army type A-68-A dummy antenna.)

Primary purpose: Output measurements of aircraft VHF transmitters.

The TS-329/U consists of a resistor bank in series with a 0-500 r-f milliammeter, mounted in a wooden box. Connector on box is Navy type 49194.

The TS-329/U dummy antenna provides a terminating load having an impedance of approximately 50 ohms up to 160 mc. The maximum power rating is 12.5 watts.

This dummy antenna may be used in any application consistent with its electrical characteristics and is specifically recommended for use in testing AN/ARC-1, AN/ARC-4, and AN/ARC-5 transmitters.

The TS-329/U is identical to dummy antenna A-68-A supplied as part of test equipment AN/GRM-1.

In the maintenance of AN/ARC-1, AN/ARC-4, AN/ARC-5, and other similar equipments, the TS-329/U is recommended in place of the TS-78/U for terminating the transmitter output. The transmitter output is indicated by a lamp load in the TS-78/U whereas the TS-329/U indicates output on a r-f milliammeter, thus enabling more accurate indications of change of output and allowing comparison of power output with other transmitters of similar equipment.

**Electrical characteristics:**

- Frequency range: Up to 160 mc.
- Maximum power: 12.5 watts.
- Power required: None.
- Tubes: None.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 5" x 4" x 3".
- Weight: 2 pounds (approximate).

**Complete equipment consists of:**

- (1) 1 TS-329/U dummy antenna.
  - (2) 1 Cable, 5-foot RG-8/U, each end terminated in 49195 connectors.
  - (3) 2 Instruction sheets.
- ASO stock No. R16-AN-TS-329/U.
- (1) .....
  - (2) .....

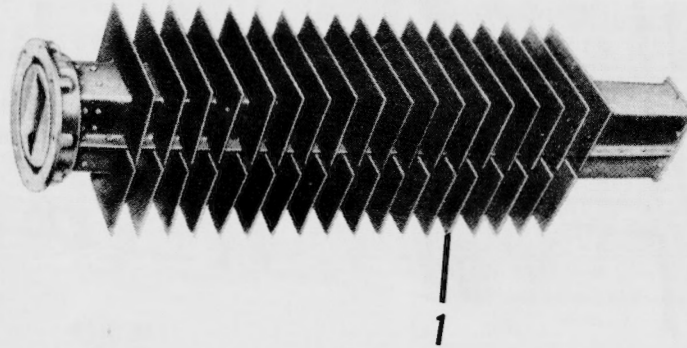


Figure 2-10. Dummy Load—TS-338/UP

**DUMMY LOAD**

**TS-338/UP**

Primary purpose: To properly terminate and load the radar transmitter in bench tests of AN/APS-20, -20A.

The equipment consists of a section of waveguide structure containing a dissipative dielectric to absorb a radio frequency power of 600 watts average and 1 megawatt peak power. VSWR is better than 1.1 to 1 when used to terminate a 1½" x 3" waveguide.

**Electrical characteristics:**

Frequency: 2500 mc. to 3750 mc.

Sensitivity: Will dissipate 600 watts average power or 1 megawatt peak power for 4 hours continuously.

Power required: None.

Tubes: None.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 7½" x 6" x 25" (approximately).

Weight: 35 pounds (approximately).

**Complete equipment consists of:**

- (1) 1 Dummy load, TS-338/UP.
- (2) 1 Metal disc (cover).
- (3) 1 CG-384/U (0' 4") transmission line.

**ASO stock No. R16-AN-TS-338/UP.**

- (1) .....
- (2) .....
- (3) .....



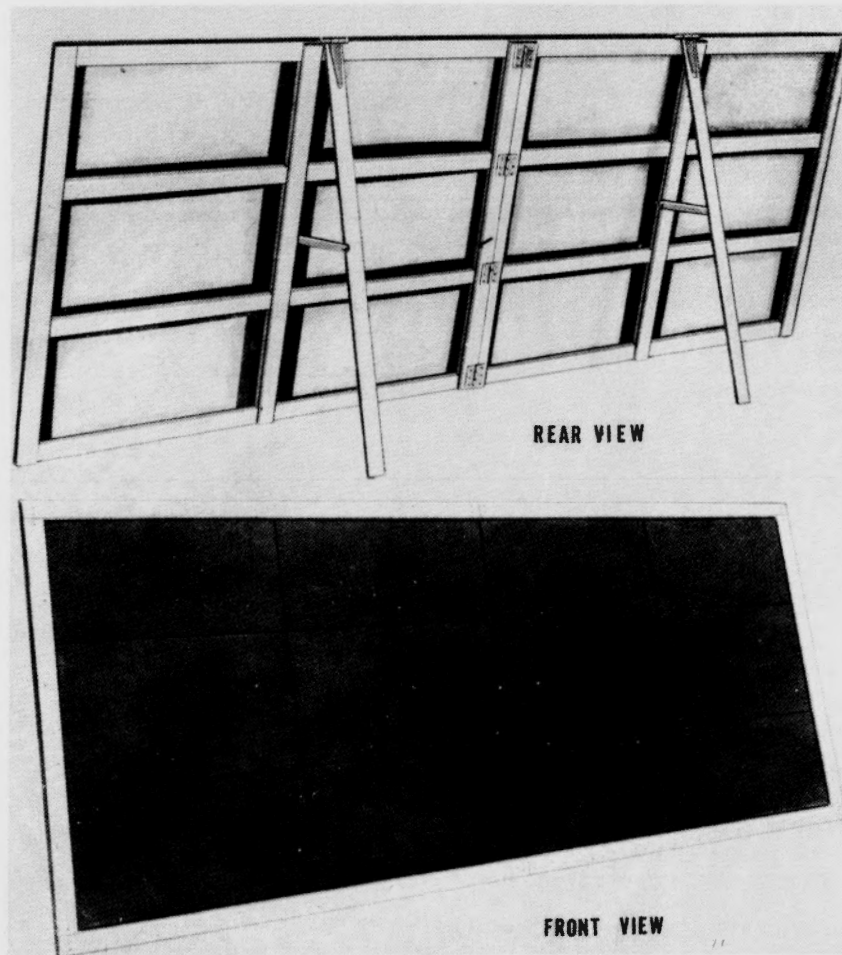


Figure 2-11. Absorbing Screen—TS-346/UP

### ABSORBING SCREEN

#### TS-346/UP

Primary purpose: To absorb the output of a high powered airborne radar transmitter.

The equipment consists of a screen designed to absorb r-f energy. Its purpose is to absorb the output of a high powered airborne radar transmitter when it is desired to operate the radar in an enclosed space. The absorption prevents high power reflections from being returned to the radar system or to other radars.

The screen is composed of 12 identical panels 30" x 16". Each panel consists of a piece of expanded hard rubber. The conducting fabric has a d.c. resistance of about 460

ohms per square.

#### Electrical characteristics:

Frequency: 2700 mc. to 2900 mc.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 10' x 4' x 3".

Weight: 100 pounds.

#### Complete equipment consists of:

(1) 1 Absorbing Screen, TS-346/UP.

(2) 1 Instruction book. NAVAER 16-5S-505.

ASO stock No. R16-AN-TS-346/UP.

## Section III CALIBRATORS

### FUNCTION

Many types of equipment require special calibration before their accurate use is possible. A calibrator may be described as a special instrument which is so designed that it serves as a reliable standard and provides a convenient method for the adjustment of the equipment being tested for accuracy.

In the following section only a few specialized types of calibrators are considered. They are designed for use with special oscilloscopes, ranging units, and altimeters. Due to the fact that the purpose and theory of operation of these instruments is so widely varied, discussion of their individual characteristics is reserved for inclusion in the description of the particular equipments.

### RANGE CALIBRATORS

In the group of range calibrators the purpose is, in general, to furnish accurately spaced marker pulses which

when observed on an oscilloscope indicate the distances from the radar transmitter of the various echoes appearing on the screen. Direct comparison between the marker pulses and the various echoes permits easy and accurate ranging.

The marker pulses are produced by an oscillator which generates a sine wave corresponding in time interval between peaks to a particular radar range or combination of ranges. By means of shaping stages, this sine wave is formed into either positive or negative marker pips (as required by the equipment being tested). These pips are then delivered to the indicator of the system being tested.

Some types of range calibrators also furnish trigger pulses. The sine waves produced by the oscillator are shaped into pips and used to synchronize a multivibrator. By differentiating one of the square waves produced in the multivibrator, the trigger pulse is obtained.

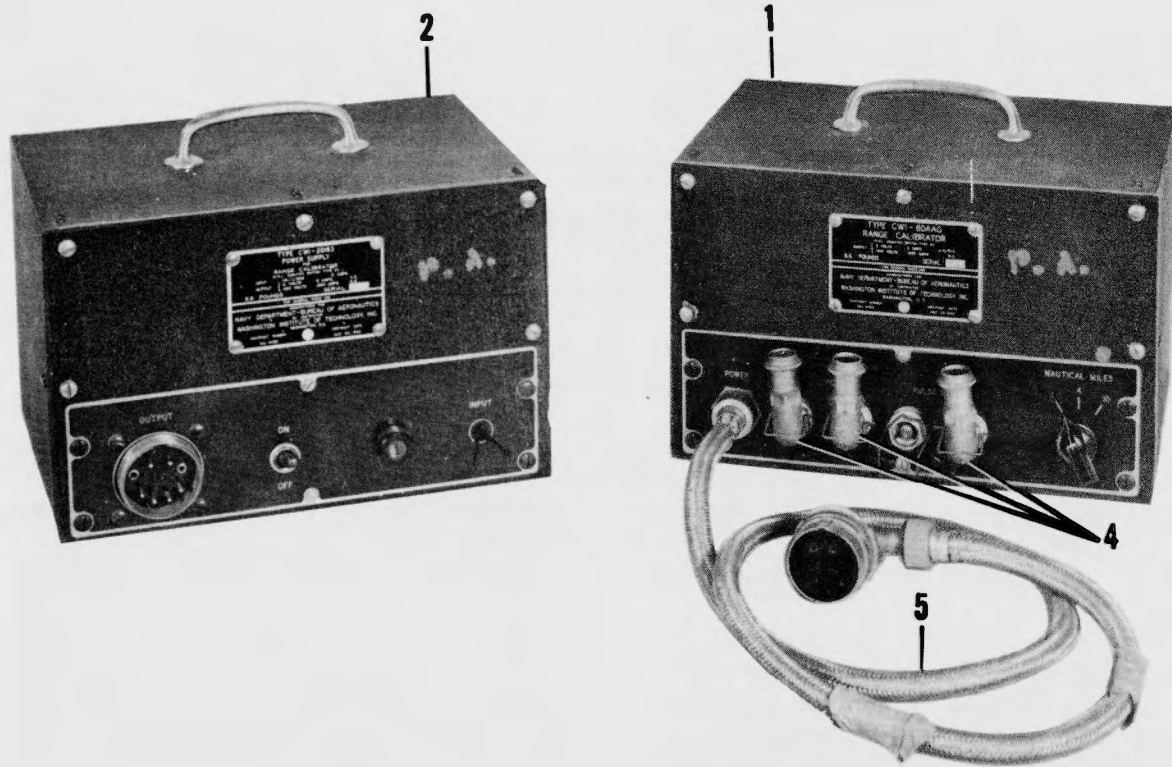


Figure 3-1. Range Calibrator—CWI-60AAG

## RANGE CALIBRATOR

### CWI-60AAG

Primary purpose: For calibrating the range scale ASB, ASE, ASV, and ASVC indicators.

The later models may be used on ASE, ASV, and ASVC in the same manner as earlier models. The plugs on the video cables of the ASE equipment fit the connectors on the calibrator. Adapters are furnished to allow the connection of the ASB video cables.

The circuit employs a CW oscillator followed by successive clipping and amplifying circuits. (For complete description see page 42, ASE instruction book.) Three oscillatory circuits provide calibrating pips spaced 1, 4, and 10 nautical miles, corresponding to oscillator frequencies of 80.9 kc., 20.2 kc., and 8.09 kc., respectively. For checking these frequencies V. is removed from its socket, allowing the oscillator to run free. Either positive or negative polarity is available at the output. The input requires an initiating pulse of positive polarity.

#### Electrical characteristics:

##### Signal:

Input: Initiating pulse (positive).

Output: Positive or negative calibrating pips.

Impedance, output: 50 ohms.

Accuracy: Plus or minus 3%; calibrator is triggered on the end of the pulse.

The markers are  $\frac{1}{16}$  mile late on 1-mile markers,  $\frac{1}{8}$  mile late on 4-mile markers,  $\frac{1}{2}$  mile late on 10-mile markers.

Power required: 115 volts, 800 c. p. c. only.

Tubes: 2 type 6C5GT; 1 type 6SJ7; 1 type 6V6GT;

1 type 6SF5; 1 type 5Y3GT; 1 type 6SK7.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $7\frac{5}{8}$ " x  $9\frac{11}{16}$ " x  $8\frac{7}{8}$ ".

Weight: Calibrator  $8\frac{1}{2}$  pounds; power supply  $9\frac{1}{2}$  pounds.

#### Complete equipment consists of:

- (1) 1 Range calibrator CWI-60AAG.
- (2) 1 Power supply (later models) type CWI-20163.
- (3) 1 Transit box (not illustrated).
- (4) 3 Coaxial plug adapters.
- (5) 1 Power cable with connectors.
- (6) 1 Instruction book NAVAER 16-5QS-503.

#### ASO stock No. R16-C-4100.

- |           |                   |
|-----------|-------------------|
| (1) ..... | (2) R16-NT-20163. |
| (3) ..... | (4) .....         |
| (5) ..... |                   |



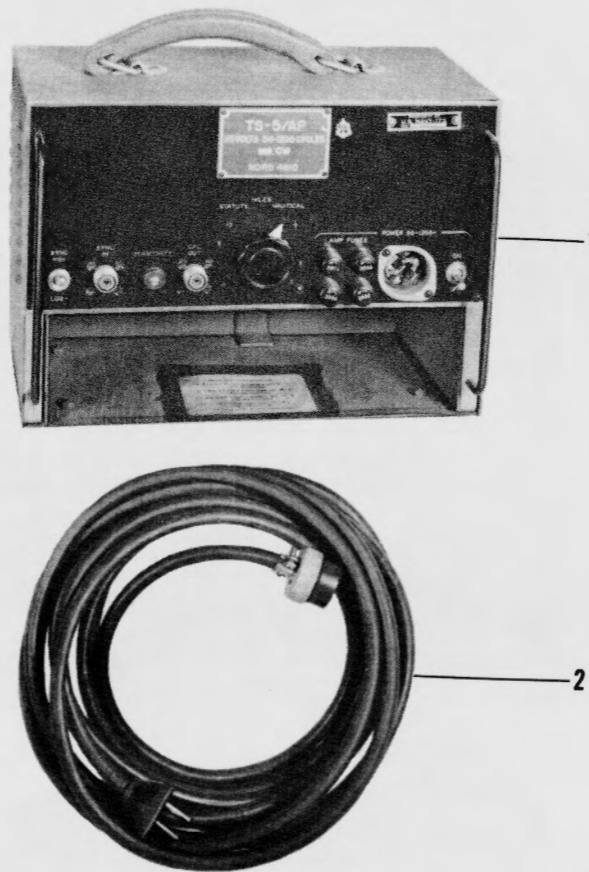


Figure 3-2. Range Calibrator—TS-5/AP

## RANGE CALIBRATOR

### TS-5/AP

Primary purpose: Calibrating, checking, and adjusting type B and PPI indicators.

TS-5/AP is a portable device used to calibrate, check, and adjust type B and PPI indicators. It is primarily for use in planes and depot test equipment.

#### Electrical characteristics:

External trigger: at least 1 volt positive or negative.

Output: Provides marker pips for the intensity grid of the radar indicator cathode tube ray, thus providing a series of bright dots or the trace with known mile spacings.

Output voltages: Will deliver 5 volts of positive calibrating pips into a 72-ohm load, or 50 volts into a 1000-ohm load except on 1/4-mile range. The 1/4-mile pips are 35 volts amplitude into 1000-ohm load.

Accuracy: Pip spacing—plus or minus 3%.

Ranges: 1/4 mile, 1 mile, 5 miles, and 10 miles nautical or statute.

Tubes: 3 type 6SN7GT, 1 type 6AG7, 1 type 6X5GT.  
Batteries: None.

Power required: 105-125 volts, 50-1200 cycles, approximately 50VA.

#### Mechanical characteristics:

Dimensions: 13" x 12" x 9 1/4".

Weight: 28 pounds.

#### Complete equipment consists of:

- (1) 1 Range Calibrator, TS-5/AP.
  - (2) 1 Power cable (20 feet) with connectors AN-3106-22-10P and Hubbell # 7259.
  - (3) 1 Coaxial cable, video (6 feet) with 50-ohm C-49195 plug at each end (not illustrated).
  - (4) 1 72-ohm Jones Adapter (not illustrated).
- ASO stock No. R16-AN-TS-5/AP.
- (1) .....
  - (2) R16-AN-CX-5/AP.
  - (3) R16-AN-CX-4/AP.
  - (4) .....



Figure 3-3. Oscilloscope Calibrator—TS-8/U and TS-8A/U

### OSCILLOSCOPE CALIBRATORS

#### TS-8/U and TS-8A/U

Primary purpose: To calibrate an oscilloscope for use in testing MAD equipment.

Voltage measurements on MAD equipment require the use of an accurately calibrated oscilloscope. For this reason, the scope calibrator is used to compare a known voltage with the deflecting voltage applied to the oscilloscope. An indicating meter is used to balance the two voltages, and the value of the deflecting peak-to-peak voltage is read from two dials, one coarse and one vernier. The TS-8A/U is interchangeable with the TS-8/U. Their sizes and mounting provisions are identical. The range of the model TS-8A/U is extended on its lower end to position X.01 of the multiplier or Range switch, S101, while the lowest range obtainable with the model TS-8/U is at its position X-1.

#### Electrical characteristics:

Peak-to-peak range: 0.01, 0.1, 1.0, 10 or 100 volts.  
Power required: 115 volt, 60 c/s, 35 watts. (Constant supply voltage imperative for accurate calibrating).

Impedance: To operate into not less than 500k ohms.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $9\frac{7}{16}$ " x  $6\frac{13}{16}$ " x  $9\frac{3}{8}$ ".

Weight:  $9\frac{1}{4}$  pounds.

#### Complete equipment consists of:

(1) 1 Oscilloscope calibrator, TS-8/U or TS-8A/U.

(2) 2 Test leads.

(3) 1 Instruction book AN 08-35TS8-2.

ASO stock No. R16-C-4080.

(1) ..... (2) .....

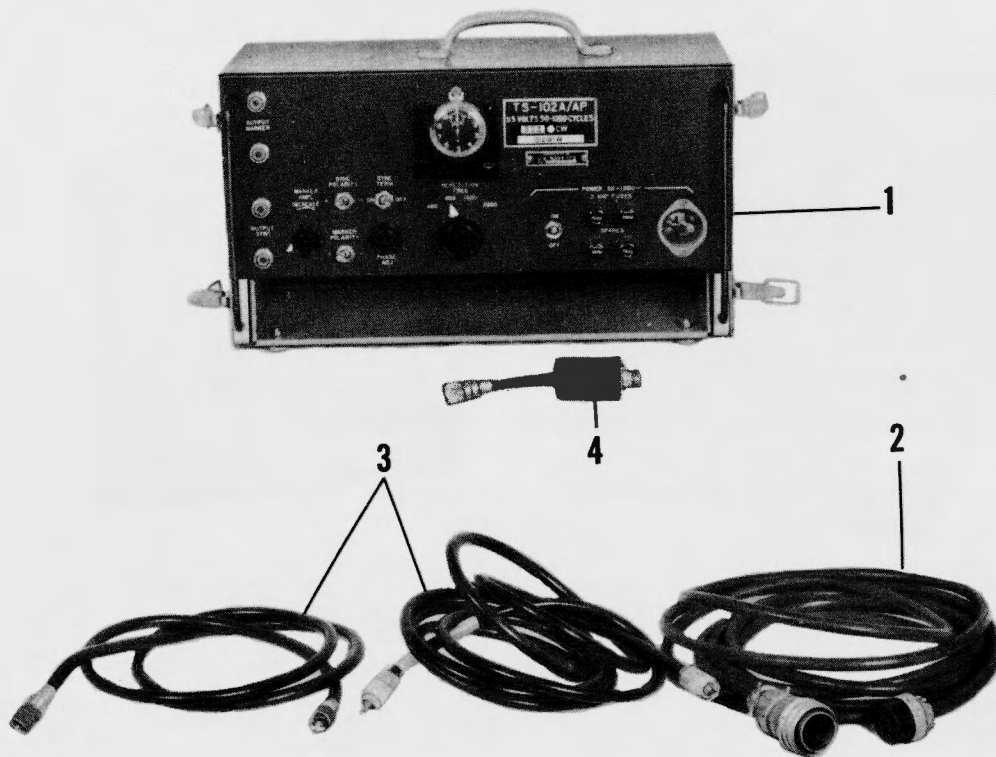


Figure 3-4. Range Calibrator—TS-102A/AP

**RANGE CALIBRATOR**

**TS-102A/AP**

Primary purpose: Calibration of range units of various bombing and gun-laying radars including AN/APG-1, AN/APG-2, AN/APQ-10, AN/APQ-7, AN/APQ-5, AN/APQ-5B, AN/APA-5, AN/APA-10.

Accurately spaced marker pulses required for calibration of the above equipment are produced by a crystal oscillator which generates a sine wave of 327.8 kc., corresponding to a radar range of 500 yards. By means of shaping stages this sine wave is formed into either positive or negative marker pips which are then delivered into the radar indicator. Trigger pulses for the above radar systems are also furnished by the range calibrator. The sine waves produced by the oscillator are shaped into pips and used to synchronize a multivibrator. By differentiation of one of the square waves produced in this multivibrator, the trigger pulse is obtained.

**Electrical characteristics:**

Frequency range: Video.

Trigger pulses: 0.80 microsecond base width, 30-50 volts magnitude, positive or negative.

Pulsing rates: 400, 800, 1,600, 2,000 cycles. Marking pulses (positive or negative): 0.4 microsecond base

width, spaced 500 yards, variable from 0 to 30 volts.

Accuracy: Marker spacing, plus or minus 0.1%.  
Marker stability with respect to trigger pulse, plus or minus 0.02 microsecond.

Temperature: Minus 40° to plus 120° F.

Power supply: 105-120 volts AC, 50-1,200 cycles, 0.6 amps.

Tubes: 2 type 6SN7GT; 5 type 6AC7; 2 type 6AG7; 1 type 5Y3GT.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 17<sup>7</sup>/<sub>8</sub>" x 9<sup>7</sup>/<sub>8</sub>" x 11".

Weight: 38 pounds.

**Complete equipment consists of:**

- (1) 1 Range calibrator, TS-102A/AP.
  - (2) 1 Cord CX-234/AP (Power cord).
  - (3) 4 Cords CG-107/U.
  - (4) 2 Adapter cables CG-177/U.
  - (5) 1 Instruction book AN 16-35TS102-2.
- ASO stock No. R16-AN-TS-102A/AP.

- (1) .....
- (2) R16-AN-CX-234/AP.
- (3) .....
- (4) R16-AN-CG-177/U.

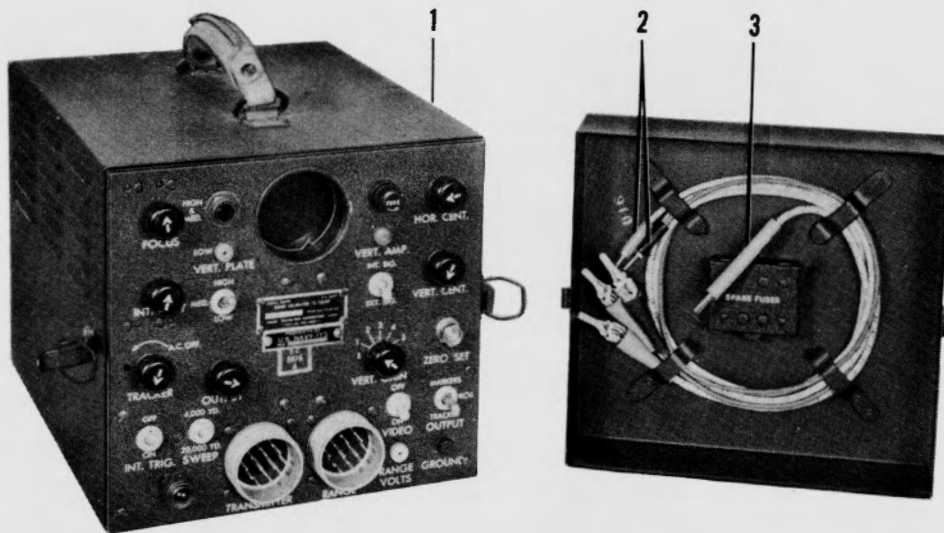


Figure 3-5. Range Calibrator—TS-126/AP

## RANGE CALIBRATOR

### TS-126/AP

Primary purpose: To facilitate the testing, maintenance and adjustment of certain airborne range finding radar systems (AN/APG-5, -14, -15).

This range calibrator intended for ground use only, is similar to a conventional synchroscope, as it contains a cathode ray tube with high speed horizontal sweep of a start-stop variety. A negative trigger starts each individual sweep cycle, and the spot is swept across the screen in a very small fraction of the total time between trigger repetitions. The spot is normally blanked out after passing across the screen, so that no return is visible. Any synchronized signal may be viewed by impressing it on one of the vertical deflection plates of the CRT, either directly, or through an adjustable high voltage attenuator system, or through a video amplifier having an adjustable low voltage input attenuator. Synchronized signals ranging in amplitude from 1 volt to 8 kilovolts may be viewed, provided they lie within the range of one of the two available sweeps. The unit contains a trigger generator with adjustable p. r. f. This may be used where the circuit under test requires external triggering. It also generates two types of simulated echo signals which may be used in aligning, adjusting, and testing the range-finding gear.

#### Electrical characteristics:

Trigger voltage: (Self-synchronous) 100 volts  $\pm 10\%$ , rise time 0.18 microseconds, duration 1 microsecond, p. r. f. 950 to 1,450 per second; load—minimum of 4,000 ohms.

Tracer pip: Variable 2 to 10 volts; polarity positive;

range variable out to about 4,500 yards; load 220 ohms.

Marker pips: Variable 1 to 10 volts; polarity positive; distance 400 plus or minus 1.3 yards (except between 1st and 2d pips); fixed marker delay 550 yards; variable marker delay—adjustable 600 and 850 yards; load 220 ohms plus or minus 20%.  
External trigger: 100 volts plus or minus 20%; rep. rate—950 to 1,650 per second.

#### Sweep voltage:

4,000-yard setting—4,500 yards across screen.  
20,000-yard setting—21,000 yards across screen.

Power required: 115 v. plus or minus 10%, 400 to 1,600 c. p. s.

Tubes: 5 type 6SN7GT, 2 type 6AC7, 1 type 6SL7GT, 1 type 2X2/879, 1 type 5Y3GT, 1 type 2AP1.

#### Mechanical characteristics:

Dimensions:  $14\frac{3}{16}$ " x  $10\frac{1}{2}$ " x  $10\frac{3}{16}$ ".

Weight: 41 pounds.

#### Complete equipment consists of:

- (1) 1 Range Calibrator, TS-126/AP.
  - (2) 2 Low voltage test leads (3 feet long).
  - (3) 1 High voltage test load (3 feet long).
  - (4) 1 Cord CG-243/AP (9 feet long) (not illustrated).
  - (5) 1 Cord CG-243/AP (3 feet long) (not illustrated).
  - (6) 1 Instruction book AN 16-35TS126-3.
- ASO stock No. R16-AN-TS-126/AP.
- |                       |                       |
|-----------------------|-----------------------|
| (1) .....             | (2) R17-L-8232.       |
| (3) .....             | (4) R16-AN-CG-243/AP. |
| (5) R16-AN-CG-243/AP. |                       |





Figure 3-6. Calibrator-TS-250/APN

**CALIBRATOR**

**TS-250/APN**

Primary purpose: For accurate over-all calibration of FM radio altimeters.

This calibrator is a relatively light-weight equipment providing electronic means of accurate over-all calibration (referred to the frequency of a quartz crystal) of the AN/APN series of FM radio altimeters, and for measurement of their r-f loop sensitivities. A means is also provided for calibration of counter sensitivities and residual altitude, and for eliminating "fixed error" in over-all calibration.

The calibrator is contained in a carrying case which includes a stowage compartment for eight feet of connecting cables, the attenuator for r-f sensitivity checks, and connecting plugs, all of which are supplied with the unit.

**Electrical characteristics:**

Frequency range: AN/APN-1 series on high and low range. 440 mc.  $\pm$  20 mc.

Accuracy:  $\pm$  1%.

Sensitivity checker accuracy:  $\pm$  5% or  $\pm$  5 db.

Crystal frequency: 2 modes, 130 kc. or 1,300 kc.

Tubes: 2 type 955; 2 type 559; 2 type 6AG7; 1 type OD3/VR150; 2 type 12SJ7.

Crystals: 2 type 1N21B.

Power required: 27 volt DC 2.6 amp. (gets power from line supplying altimeter under test through an adapter fitting).

Batteries: None.

**Mechanical characteristics:**

Dimensions: 12" x 12" x 15".

Weight: 20 pounds.

**Complete equipment consists of:**

- (1) 1 Calibrator, TS-250/APN.
- (2) 1 Attenuator assembly.
- (3) 1 Power cable assembly.
- (4) 1 Signal cable assembly.
- (5) 1 Synchronizing cable assembly.
- (6) 1 Instruction book AN 16-35TS250-2.

ASO stock No. R16-AN-TS-250/APN.

- (1) .....
- (2) .....
- (3) .....
- (4) .....
- (5) .....

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## Section IV ECHO BOXES

### FUNCTION

In the operation of radar transmitters and receivers it is often necessary that an overall performance check be made using only simple test equipment. An echo box is such a device; it will allow the operator to maximize transmitter adjustments, to measure relative power and frequency, to detect double moding, and to acquire an indication of signal-to-noise ratio. Proper use of an echo box makes it possible to compare the performance of any given radar set with the maximum performance capabilities of its respective model.

### CONSTRUCTION

Basically, an echo box (or ring box) consists of a resonant cavity, the dimensions of which are determined by the frequency band in which it operates. It is tuned by moving a plunger in and out of the cavity. This plunger is mechanically connected to a calibrated tuning dial. The echo box is connected to the radar set by a cable which is connected to either a pick-up dipole, or coaxial horn placed in the antenna field of the radar set; or it is connected by a cable which is connected to a directional coupler in the transmission line of the radar set. Included as part of the echo box is an output power meter circuit which is made up of a microammeter, a crystal, a filter capacitor, and an attenuator to prevent overloading the meter.

### THEORY OF OPERATION

The echo box ringing cavity is electrically equivalent to a high "Q" (low-loss) resonant circuit consisting of resistance, inductance and capacitance. The echo box picks up r-f energy from a transmitted radar pulse. When the cavity is tuned to the frequency of the pulse, this picked

up r-f energy causes oscillations to build up in the resonant cavity. These oscillations continue after the radar pulse but gradually die out because of internal losses and output meter dissipation and because some of the energy is coupled back to the radar set. The energy which is coupled back to the radar set under test is detected by the receiver and appears as a pattern on the radar scope or indicator. The time from the beginning of the radar pulse to the point where the signal from the echo box fades into the noise level (ring time) can be used as a measure of the over-all performance of the radar set because the time duration of the signal will depend on the amount of power in the transmitted pulse and the sensitivity of the receiver.

### APPLICATION

The output meter circuit is so coupled to the cavity that the meter deflection is approximately proportional to the power introduced into the cavity from the radar transmitter at the frequency to which the echo box is tuned. The meter reading will be proportional to the pulse length as well as to the average power of the pulse. Because of the sharply tuned nature of the resonant cavity and the finely adjustable tuning mechanism, it is possible to change the resonant frequency of the cavity by a few megacycles at a time. The microammeter in the output circuit is sufficiently sensitive to register the small changes in energy caused by changing the size of the cavity.

Double moding, which is an abrupt and irregular jumping from one frequency to another, occurring in microwave equipment, is readily detected by the sharply tuned cavity and output indicator. Aligning receiver and transmitter frequency and checking signal-to-noise ratio can readily be accomplished by following the directions in the instruction book for the particular type of echo box in use.

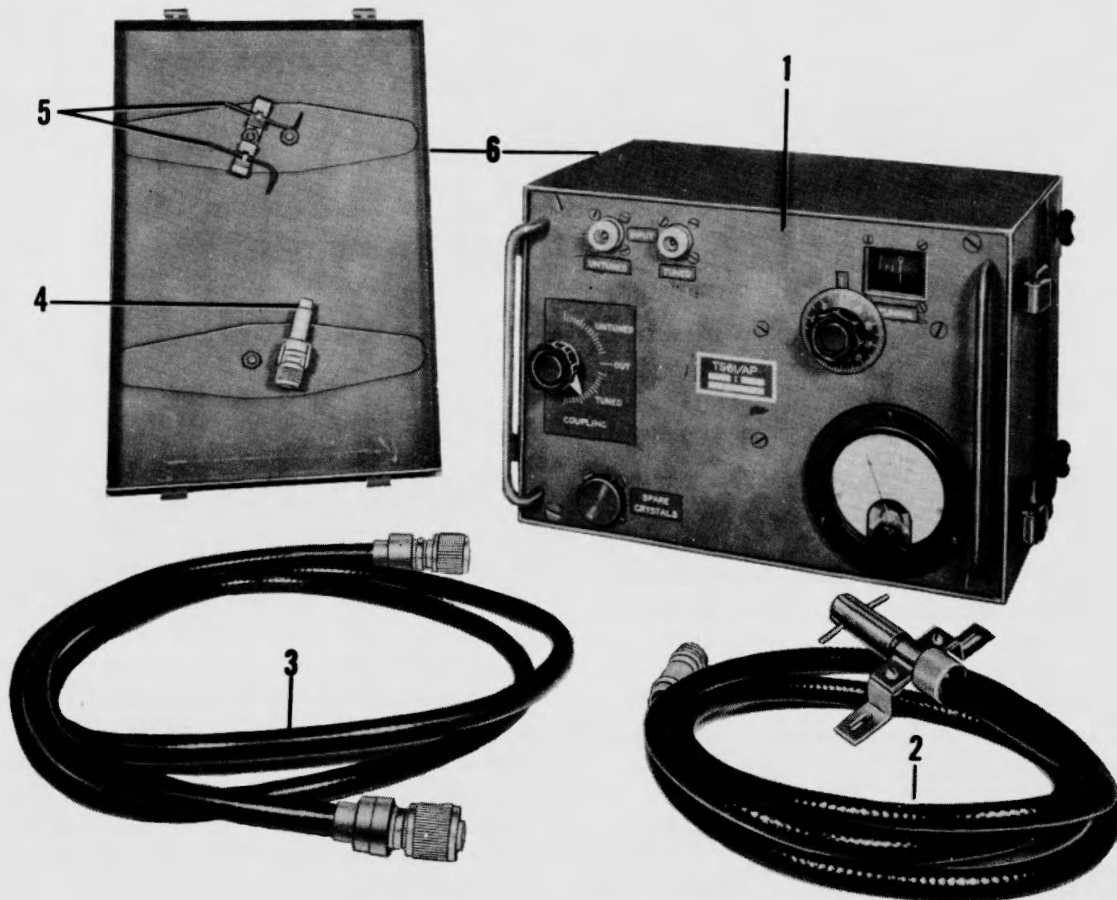


Figure 4-1. Echo Box-TS-61/AP

**ECHO BOX**

**TS-61/AP**

Primary purpose: Making rough analysis of radar transmitters, receivers, and over-all performance when simple test equipment must be used.

A hand-tuned ring box with an associated dipole which picks up the r-f energy from the radar and returns it. The equipment consists of a resonant cavity, an output meter, dipole with coax cable, a patch cord and aluminum carrying case. An instruction book is furnished.

It may be used to check and maximize transmitter adjustments. It will determine relative power output, detect double moding, and give an indication of signal-to-noise ratio.

**Electrical characteristics:**

Frequency range: 3140-3640 mc.

**Accuracy:**

Frequency: plus or minus 5 mc. (approximately).

Relative power: plus or minus 2 db.

Sensitivity: Dipole must be placed to transmitter antenna if a directional coupler is not available.

Operating Q: 35,000.

Decay: 2.3 db per microsecond.

Impedance: 50 ohms.

Power required: None.

Tubes: None.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 12" x 8" x 10<sup>5</sup>/<sub>8</sub>".

Weight: 10 lbs.; with case 24 pounds.

**Complete equipment consists of:**

- (1) 1 Echo box, TS-61/AP.
- (2) 1 Antenna assembly AS-107/AP.
- (3) 1 Connecting Cord CG-92/U.
- (4) 1 Impedance matching adapter.
- (5) 2 Allen wrenches.
- (6) 1 Carrying case.
- (7) 1 Instruction book. AN 16-35TS61-3.

**ASO stock No. R16-AN-TS-61/AP.**

- (1) .....
- (2) R16-AN-TS-107/AP.
- (3) R16-C-3851.
- (4) R16-R-2436-3.
- (5) .....
- (6) .....



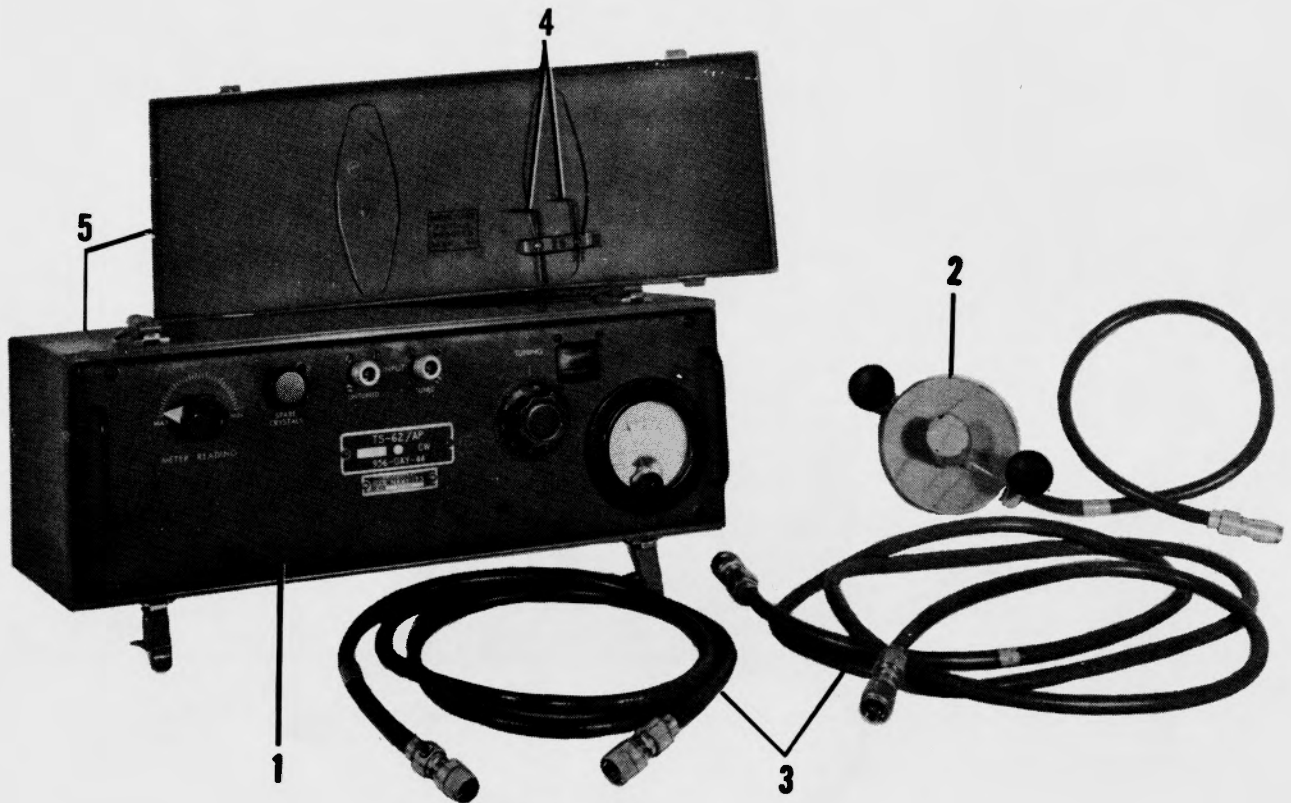


Figure 4-2. Echo Box—TS-62/AP

## ECHO BOX

### TS-62/AP

Primary purpose: Making rough analyses of radar transmitters, receivers, and over-all performance when simple test equipment must be used.

A hand-tuned ring box with an associated dipole which picks up the r-f energy from the radar and returns it. The equipment consists of a resonant cavity, an output meter, a dipole antenna with coax cable, a patch cord and aluminum carrying case.

It is used to maximize transmitter adjustments and to determine relative power output. It will detect double moding and give an indication of signal-to-noise ratio. Frequency is indicated by referring dial settings to a calibrated chart. Resonance and relative power are indicated by meter deflections. An attenuator is provided to prevent overloading the meter.

#### Electrical characteristics:

Frequency range: 9200-9530 mc.

Accuracy: Frequency  $\pm 5$  mc. (at room temperature), relative power  $\pm 2$  db.

Q: 50,000 to 80,000.

Decay: 3 db/microsecond.

Sensitivity: Dipole must be placed close to transmitter antenna unless directional coupler is available (directional coupler coupling recommended).

Impedance: 50 ohms.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 18 $\frac{1}{4}$ " x 6" x 11 $\frac{3}{8}$ ".

Weight: 10 pounds.

#### Complete equipment consists of:

- (1) 1 Echo box, TS-62/AP.
- (2) 1 Antenna assembly, AS-106/AP.
- (3) 2 Cords CG-92/U.
- (4) 2 Allen wrenches.
- (5) 1 Carrying case.
- (6) 1 Instruction book AN 16-35TS62-3.

ASO stock No. R16-AN-TS-62/AP.

- |                 |                       |
|-----------------|-----------------------|
| (1) .....       | (2) R16-AN-AS-106/AP. |
| (3) R16-C-3851. | (4) .....             |
| (5) .....       |                       |

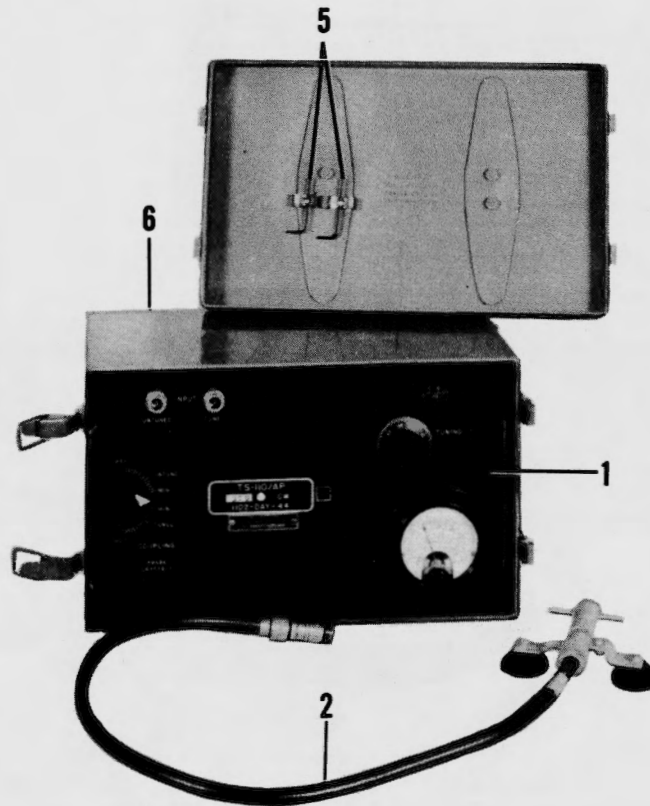


Figure 4-3. Echo Box-TS-110/AP

## ECHO BOX

### TS-110/AP

Primary purpose: Making rough analyses of radar transmitters, receivers, and over-all performance when simple test equipment must be used.

This is a hand-tuned ringing cavity (echo box) designed for a rough, rapid test of radar systems. It is primarily used to maximize transmitter adjustments by indicating relative power output. It will also detect double moding and give indication of signal-to-noise ratios.

#### Electrical characteristics:

Frequency range: 2400-2700 mc.

#### Accuracy:

Frequency: plus or minus 5 mc. (approximately).

Relative power: plus or minus 2 db.

Operating Q: 40,000.

Decay: 2.3 db./microsecond.

Impedance: 50 ohms.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 12" x 10<sup>5</sup>/<sub>8</sub>" x 8".

Weight: 12 pounds; with case 24 pounds.

#### Complete equipment consists of:

- (1) 1 Echo box, TS-110/AP.
- (2) 1 Antenna assembly (including dipole, bracket, coax transmission line): AS-159/AP.
- (3) 1 Connecting cord CG-92/U (not illustrated).
- (4) 1 Impedance matching adapter (not illustrated).
- (5) 2 Wrenches.
- (6) 1 Carrying case.
- (7) 1 Instruction book AN 16-35TS61-3.

#### ASO stock No. R16-AN-TS-110/AP.

- |           |                       |
|-----------|-----------------------|
| (1) ..... | (2) R16-AN-AS-159/AP. |
| (3) ..... | (4) .....             |
| (5) ..... | (6) .....             |

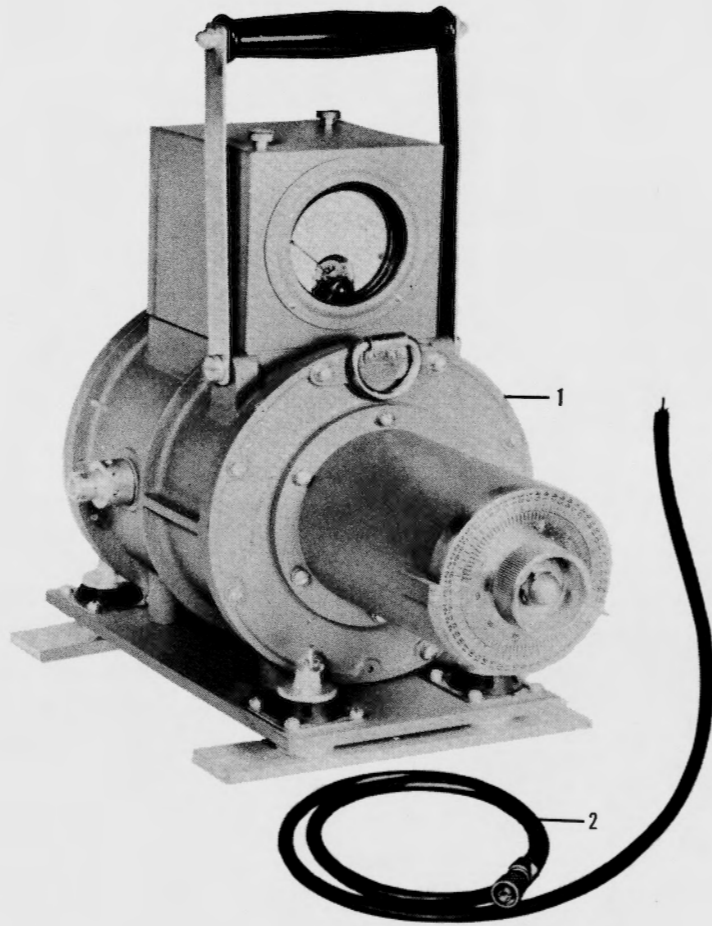


Figure 4-4. Echo Box—TS-270/UP

**ECHO BOX**

**TS-270/UP**

Primary purpose: Making rough analyses of radar transmitters, receivers, and over-all performance when simple test equipment† must be used.

The equipment is a hand-tuned echo box consisting of a high Q cavity which, when properly coupled to the radar system, receives energy from the transmitter and retransmits it to the receiver and radar scope where it shows up as a saturated signal which decays exponentially into the noise indication. Resonance and relative power are indicated by meter deflections.

**Electrical characteristics:**

Frequency: 2700 mc to 2900 mc.

Sensitivity: The sensitivity is such that each loss of approximately 90 yards in ringtime indicates the radar is "down" one decibel in performance.

Power required: None.

Tubes: None.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 14<sup>5</sup>/<sub>8</sub>" x 8" x 12<sup>1</sup>/<sub>4</sub>".

Weight: 25<sup>3</sup>/<sub>4</sub> pounds; 17<sup>1</sup>/<sub>2</sub> pounds total accessories.

**Complete equipment consists of:**

- (1) 1 Echo box TS-270/UP.
- (2) 1 Connecting cable 10-foot RG-8/U.
- (3) 1 Equipment spare parts case (not illustrated).
- (4) 1 Accessory box (not illustrated).
- (5) 1 Carrying strap (not illustrated).
- (6) 1 Socket wrench, 5/8-inch hex (not illustrated).
- (7) 1 Spanner wrench, 1-inch (not illustrated).
- (8) 1 Instruction book AN 08-35TS270-2.

**ASO stock No. R16-AN-TS-270/UP.**

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |
| (5) ..... | (6) ..... |
| (7) ..... |           |

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## Section V FIELD STRENGTH METERS

### FUNCTION

Field strength meters are used for checking transmitter frequency, antenna field strength, and the presence of modulation. Field strength meters included in this manual are either the crystal rectifier type or the uncalibrated vacuum-tube voltmeter type. These instruments are designed to register on a meter the voltages that are induced in the antenna. The antenna is coupled to a tuned circuit, usually comprised of a fixed inductance and a variable tuning capacitor. This circuit will resonate at any frequency within the design limits.

### THEORY OF OPERATION

When the tuned circuit is in resonance with the signal to be measured, an induced voltage is created in the tuned circuit. This voltage is rectified by either a vacuum tube rectifier or a crystal. In vacuum tube type field strength meters this rectified voltage is impressed on the control grid of a tube through a balancing circuit which balances out the normal tube current flow; therefore, the magnitude of the millimeter deflection is proportional to the

impressed voltage due to the strength of the received signal. In the crystal type the rectified current is usually applied directly to the meter. Operation is similar to that of the vacuum tube type field strength meter.

### APPLICATION

When using a field strength meter, objects or persons near either the radiating source or the test meter may cause shadows or reflections which result in erratic meter readings. The antenna of the test meter should always be extended to its full length in order to prevent the antenna from affecting the tuning circuit and the normal meter indications.

Many types of field strength meters are intended for use within approximately 25 feet of the transmitter antenna. This distance will vary with the type of equipment being tested. A satisfactory distance is one which gives a meter scale reading at approximately mid-scale. For operating techniques and interpretation of meter readings, refer to the instruction books of the meter and the equipment being tested.



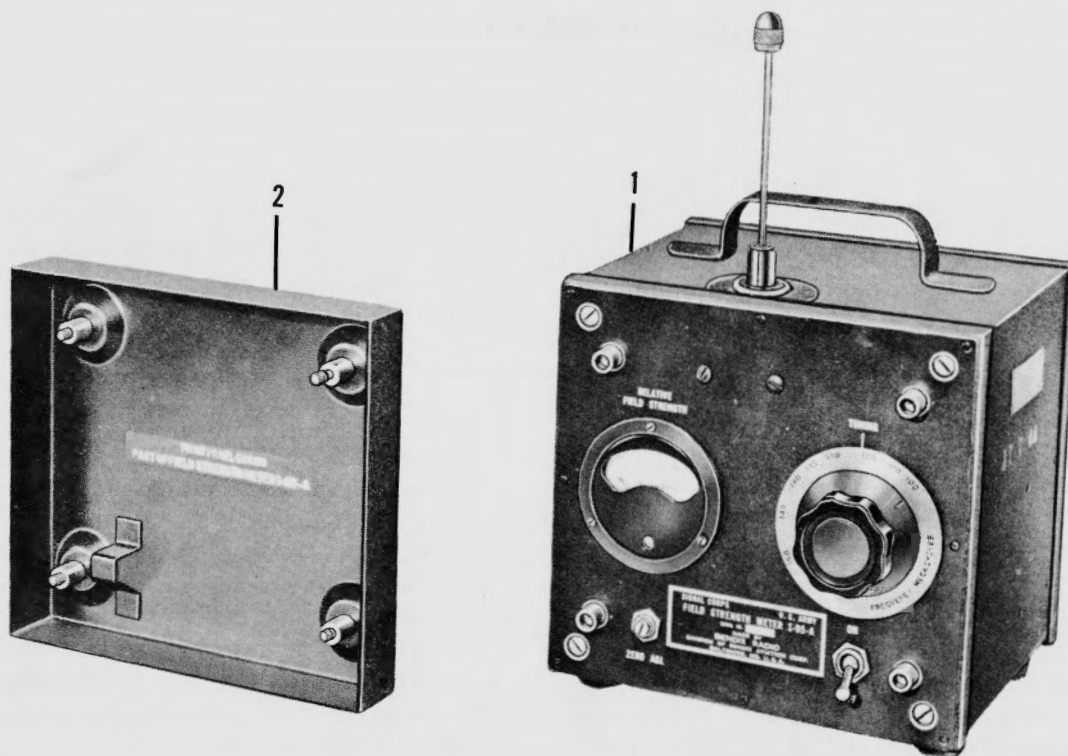


Figure 5-1. Field Intensity Meter-I-95-A

## FIELD INTENSITY METER

### I-95-A

Primary purpose: To measure antenna field strength of VHF transmitters.

The I-95-A is an uncalibrated vacuum-tube voltmeter type field strength meter. The r-f current measured is indicated on a 0-1 milliampere DC meter. In addition to indicating antenna field strength this instrument may be used to check approximate transmitter frequency and indicate the presence of modulation. Self-contained in a metal case, the meter has a removable, protective front cover.

This equipment is part of the IE-12-A and IE-19-A test sets.

### Electrical characteristics:

Frequency range: 100 to 156 mc.

Meter: 0-1 milliampere, dc.

Tubes: 1 type 1S5.

Batteries: 2 type BA-2; 1 type BA-23.

### Mechanical characteristics:

Dimensions: 8 $\frac{1}{2}$ " x 7 $\frac{1}{4}$ " x 7 $\frac{3}{8}$ ".

Weight: 10 $\frac{1}{2}$  pounds.

### Complete equipment consists of:

(1) 1 Field strength meter I-95-A.

(2) Front Panel Guard.

ASO stock No. R16-AYS-I-95A.



Figure 5-2. Indicator-I-106-A

### INDICATOR

#### I-106-A

Primary purpose: To measure relative antenna field strength of VHF transmitters.

The I-106-A is a crystal type resonance indicator designed to indicate relative field strength of antenna fields in the frequency range of the 100-156 mc. It consists of a telescopic antenna coupled to a parallel tuned circuit which is in turn connected to a silicon-crystal rectifier and a d. c. microammeter. The unit may be used for an approximate check of transmitter frequency. Indicator I-106-A is part of and included in the description of Test Set IE-35-A.

#### Electrical characteristics:

Frequency range: 100-156 mc.  
Tubes: None.  
Batteries: None.

#### Mechanical characteristics:

Dimensions:  
Weight:

Complete equipment consists of:

(1) 1 Crystal indicator I-106-A.  
ASO stock No. R16-AYS-I-106A.



Figure 5-3. Crystal Indicator-TS-94/AX

### CRYSTAL INDICATOR

#### TS-94/AX

Primary purpose: Measuring relative field strength of radio frequency fields.

A crystal resonance indicator designed for indicating relative strength of a radio frequency field of frequencies up to 500 megacycles. A retractable steel tape provides control of the amplitude. All component parts including operating spares mount in the front panel which is bolted to a steel case. The case and panel are finished in black wrinkle enamel.

#### Electrical characteristics:

Frequency range: 50 mc. to 500 mc.  
Crystal type: IN21.  
Power required: None.  
Batteries: None.  
Tubes: None.

#### Mechanical characteristics:

Dimensions: 3" x 4" x 5".  
Weight: 3 pounds.

Complete equipment consists of:

(1) 1 Crystal indicator, TS-94/AX.  
ASO stock No. R16-AN-TS-94/AX.

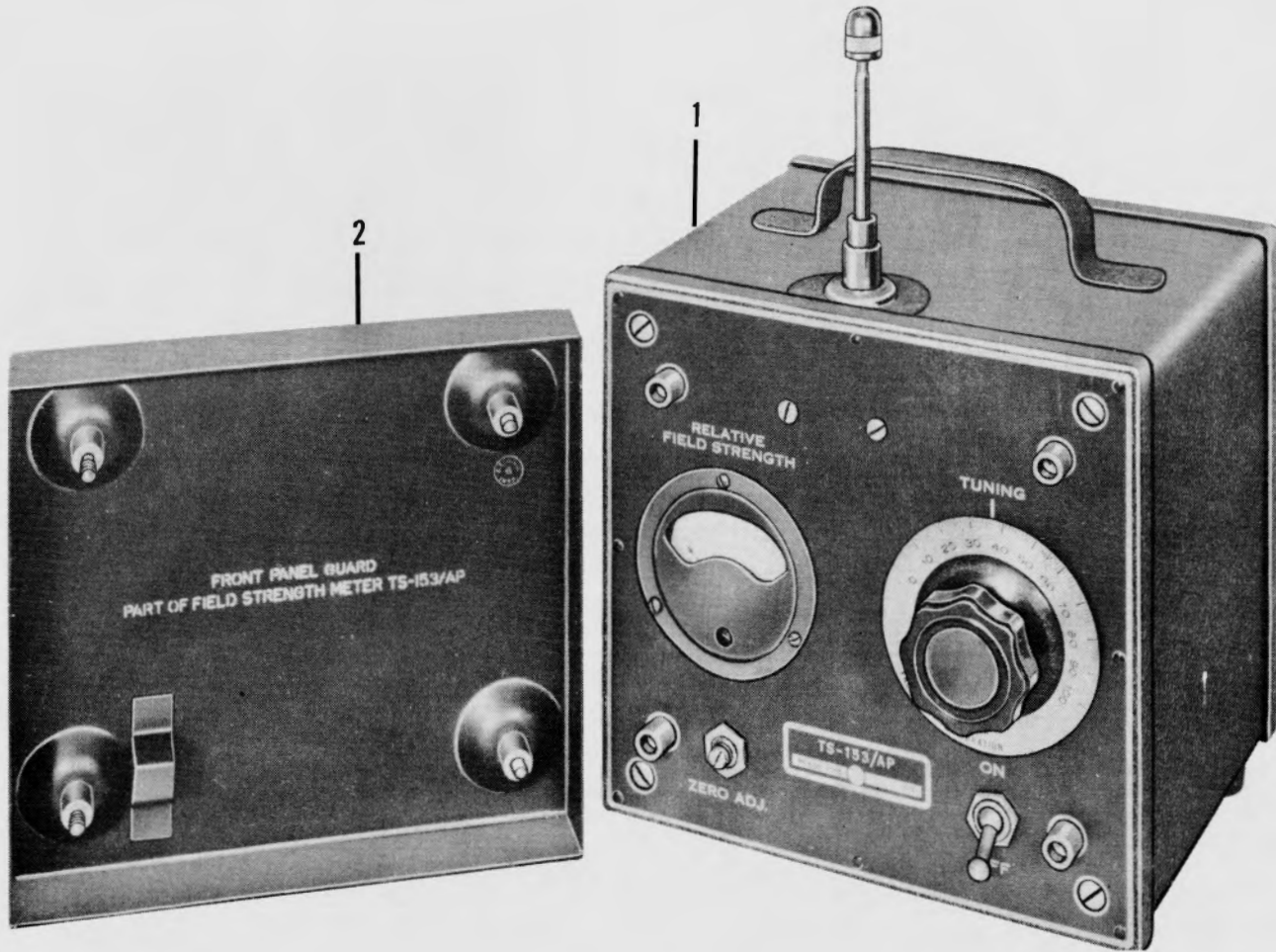


Figure 5-4. Field Strength Meter—TS-153/AP

### FIELD STRENGTH METER

#### TS-153/AP

Primary purpose: To indicate the relative field strength and frequencies of the radiation of a transmitter, particularly for use with AN/ARR-3.

This meter is an uncalibrated instrument to be used to indicate transmitter field strength and frequencies and may be used to indicate modulation of the carrier. It is housed in a metal case on which the front panel and rear cover are mounted. A telescopic antenna is included as an integral part of the equipment.

Electrical characteristics:

Frequency range: 62 to 75 mc.

Power consumption: 0.15 watts.

Power required: Self-contained batteries.

Tubes: 1 type 1S5.

Batteries: 1 type BA-30; 1 type BA-51, not supplied.

Batteries should be requisitioned when ordering this equipment.

Complete equipment consists of:

- (1) 1 Field strength meter, TS-153/AP.
  - (2) Front Panel Guard with spare tube mounted in bracket.
  - (3) 1 Instruction book AN 16-35TS153-3.
- ASO stock No. R16-AN-TS-153/AP.
- (1) ..... (2) .....



## Section VI FREQUENCY METERS

### FUNCTION

A frequency meter is an instrument which is used to provide a simple, accurate, and reliable means for adjusting the emitted or resonant frequency of transmitters, field strength meters, receivers and other tuned detectors or emitters to any desired frequency within its design range. The term "Frequency Meter" is sometimes applied to instruments which measure the frequencies of external signals and have no provision for emitting a signal. This latter type of instrument is more properly called a "Wavemeter."

### WAVEMETER OPERATION

The wavemeter sometimes called an "Absorption Type Frequency Meter," is an instrument which consists of a calibrated tuned line or cavity coupled to a crystal or vacuum tube detector which in turn gives an indication on a meter or oscilloscope. Some types of wavemeters consist of a variable calibrated tuned circuit coupled by an inductive loop across a crystal detector. When the tuned circuit is adjusted to resonance at the frequency of the applied signal, it produces a low impedance across the input to the detector circuit which in turn minimizes the power delivered to the detector—resulting in a dip in the meter reading. The dial reading on the calibrated tuned circuit gives an accurate measurement of the unknown frequency, either directly or in conjunction with a calibration chart. This type of wavemeter is sometimes capable of accuracies in the order of 0.01%.

Crystal calibrated heterodyne frequency meters are capable of an accuracy of 0.01 percent under service conditions of 32° F. (0° C.) to 120° F. (50° C.). An accuracy of 0.005 percent is obtainable under fixed conditions at room temperature.

### FREQUENCY METER OPERATION

In the class of "Frequency Meters" the heterodyne type containing a crystal calibrator is fairly typical. This type

of instrument usually consists of a heterodyne oscillator, r-f harmonic amplifier, crystal controlled oscillator, mixer, modulator, and an a-f output amplifier. Usually furnished with the instrument is a set of calibration charts giving the dial readings for the frequencies listed together with a table of the crystal harmonics thus providing complete and accurate frequency coverage over the designed frequency range.

In operation, the output of the variable heterodyne oscillator is coupled into the r-f harmonic amplifier. When signals are being generated, the output of this harmonic or "distortion" amplifier is coupled to the antenna. When signals are being received, the amplifier output is coupled to the mixer tube.

The crystal controlled oscillator operates at a fixed frequency but is also capable of emitting the various harmonic frequencies of the crystal for use as check points.

When the mixer is switched to the CALIBRATE position, the antenna is disconnected and the heterodyne oscillator output is combined with that of the crystal oscillator permitting the calibration by the "zero beat" method of the variable oscillator on the desired frequency range. When the mixer is not switched in the CALIBRATE position, signals from the antenna are coupled into the mixer along with signals from the heterodyne oscillator.

The audio amplifier has two functions. It may amplify the beat note produced by the mixing of the unknown signal and the calibrated heterodyne oscillator and thus give a "zero beat" in the earphones when the heterodyne oscillator is adjusted to the same frequency as the unknown signal. On the other hand, it may be used to modulate at audio frequency the signal of the heterodyne oscillator when no separate modulator is supplied.

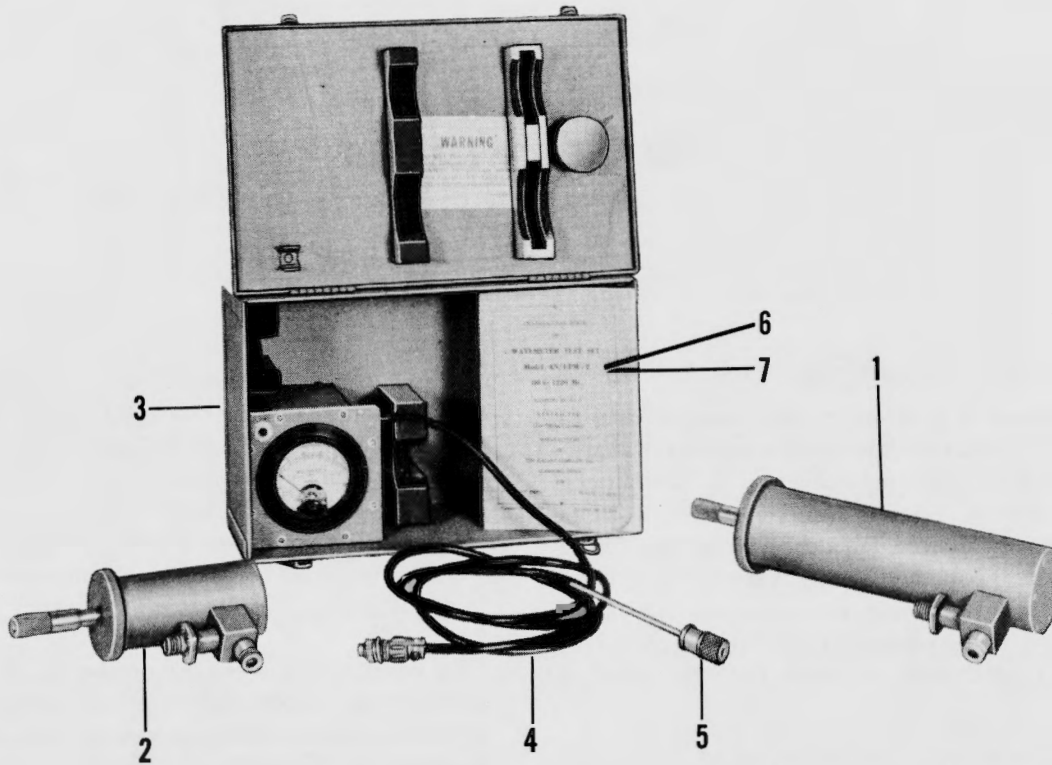


Figure 6-1. Frequency Meter, Absorption-AN/UPM-2

## FREQUENCY METER, ABSORPTION

### AN/UPM-2

Primary purpose: Testing of jamming transmitters operating within its frequency range.

This unit may be used with most radar countermeasure systems operating within its limits. The frequency meters are used to determine the frequency of r-f signal generators, test oscillators and transmitters.

Both TS-211/UPM-2 and TS-212/UPM-2 consist of resonating cavity tunable by a plunger with a micrometer adjustment. Each requires a 0-1 millimeter for resonance indication. This meter is permanently mounted in the carrying case.

#### Electrical characteristics:

##### Frequency range:

TS-211/UPM-2: 80-360 mc.

TS-212/UPM-2: 330-1220 mc.

Sensitivity: 5 mw.

Accuracy:  $\pm 1$  megacycle.

Power required: None.

Tubes: 1 Crystal type 1N21.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $5\frac{5}{8}$ " x  $8\frac{3}{4}$ " x  $13\frac{1}{16}$ ".

Weight:  $17\frac{1}{2}$  pounds, including carrying case.

#### Complete equipment consists of:

- (1) 1 Low frequency absorption type frequency meter: TS-211/UPM-2.
- (2) 1 High frequency absorption type frequency meter: TS-212/UPM-2.
- (3) 1 Metal carrying case: CY-194/UPM-2.
- (4) 1 Cable and connectors: (6 feet).
- (5) 1 Antenna: AT-63/UPM-2.
- (6) 1 Calibration chart.
- (7) 1 Instruction book AN 16-30UPM2-3.

#### ASO stock No. R16-AN/UPM-2.

- (1) R16-AN-TS-211/UPM-2.
- (2) R16-AN-TS-212/UPM-2.
- (3) R16-AN-CY-194/UPM-2.
- (4) .....
- (5) R16-AN-AT-63/UPM-2.
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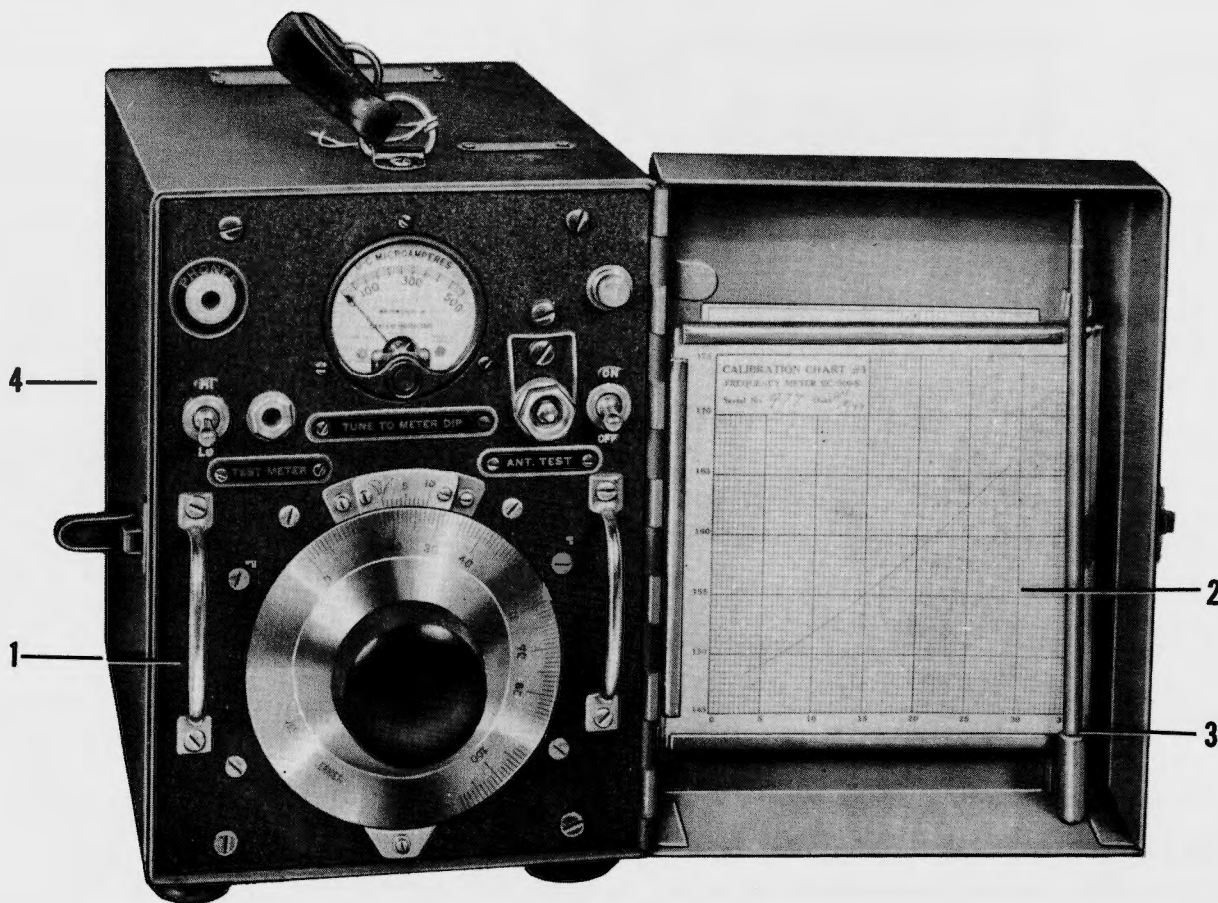


Figure 6-2. Frequency Meter—BC-906 (D and E)

### FREQUENCY METER

#### BC-906 (D and E)

Primary purpose: General frequency meter applications.

This unit is an absorption-type frequency meter powered by self-contained batteries. The instrument is used to determine the frequency of r-f signals and to calibrate radio equipment. It may also be used for checking receiver sensitivity and alignment checks.

The BC-906 determines the actual frequency value indirectly, as the dial reading is referred to a calibration chart. In any case resonance is indicated by maximum deflections of an inherent meter located on the front panel of the test unit. On the BC-906-E the meter may be used independently as a microammeter. The unit is housed in a black wrinkle-finish metal cabinet. The BC-906 is also supplied as part of IE-46 and IE-56 test equipment.

Electrical characteristics:

Frequency range:

BC-906-D: 160 to 220 mc.

BC-906-E: 150 to 234 mc.

Accuracy:  $\pm 0.5$  mc.

Power required: Self-contained batteries.

Tubes: 1 type 1S5.

Batteries: 1 type BA-53, 1 type BA-35 (not supplied). Batteries should be requisitioned when ordering this equipment.

Mechanical characteristics:

Dimensions: BC-906 (D and E),  $6\frac{1}{2}$ " x  $9\frac{1}{4}$ " x  $12\frac{3}{8}$ ".

Weight: BC-906 (D and E), 17.8 pounds (less case and batteries); case 15.2 pounds.

Complete equipment consists of:

- (1) 1 Frequency meter, BC-906 (D, E).
- (2) 1 Calibration chart.
- (3) 1 Antenna extension type  $8\frac{3}{8}$  inches collapsed, 20 inches extended. Stored in the door of the meter.
- (4) 1 Transportation case.
- (5) 1 Instruction book AN 08-40BC906-2.

ASO stock No. R16-W-2121.

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| (1) .....            | (2) ..... |
| (3) R16-PH-358-1667. | (4) ..... |

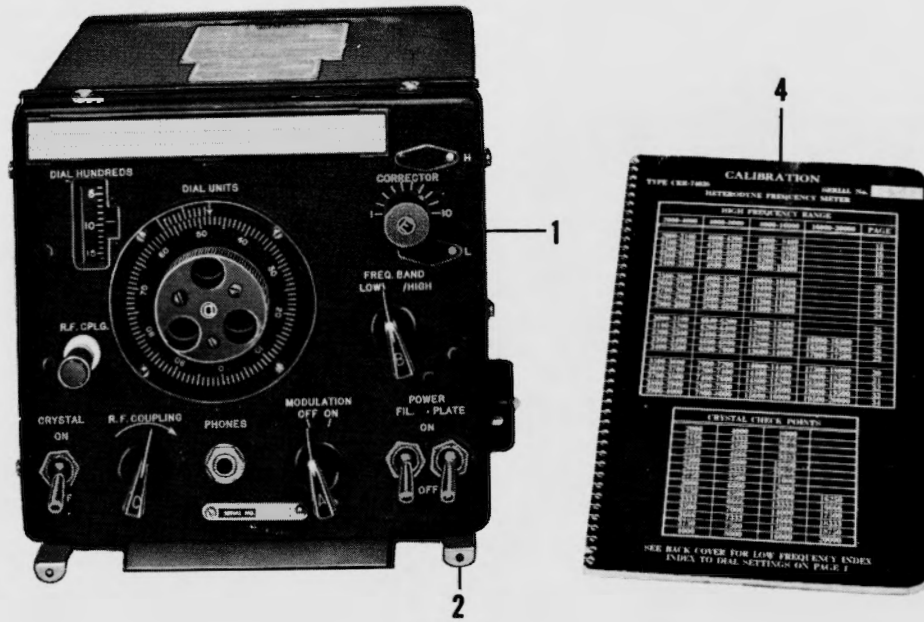


Figure 6-3. Frequency Meter—LM-14

## FREQUENCY METER

### Hewlett-Packard 500-A

Primary purpose: Laboratory measurements of the frequency of an alternating voltage from 5 cycle to 50 kilocycles per second.

The frequency meter consists of a wide-band amplifier with a limiting circuit, an electronic switch, a constant current supply, a frequency discriminating circuit, and an output meter and rectifier.

The reading is practically independent of input voltage wave form. A multiplier switch provides ten scale ranges. Provision is made for checking the calibration against power line frequency. Provision is also made to operate an Esterline-Angus 1 ma. recorder with the model 500-A for a continuous record of frequency.

#### Electrical characteristics:

Frequency range: 0-50-100-200-500-1K-2K-5K-10K-20K-50K cycles per second.

Input required: Minimum of 0.5 volts; maximum of 200 volts.

Input impedance: 50,000 ohms.

Accuracy: 2% of full scale value.

Recorder output: for 1 milliampere, 1400-ohm Esterline-Angus Automatic Recorder.

Power supply: 115 volts 50/60 cycle, 65 watts.

Tubes: 3 type 6SJ7, 2 type 6V6, 1 type 6L6, 1 type 6H6, 1 type 5Z4, 1 type OD3/VR150.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 8 $\frac{3}{4}$ " x 19" x 12".

Weight: 28 pounds.

#### Complete equipment consists of:

(1) 1 Hewlett-Packard Model 500-A.

ASO stock No. R16-HWP-500A.

## FREQUENCY METER

### Model LM—Crystal calibrated frequency indicating equipment.

Primary purpose: General frequency meter applications for operation of airborne radio equipment.

The LM frequency meter has been produced in 19 models, starting with model LM and successive models, affixing numerals in consecutive order. Approved models are: LM-10, -13, -14, -15, and -17.

All units of the series are completely interchangeable electrically and mechanically.

Some models are complete with power supply; others are powered from the communication radio power supply. A telephone headset (600 ohms) used in the operation of the frequency meter is not supplied. All models are similar in mechanical design except for the battery box and lack of shock mounting in LM-13, -17.





Figure 6-4. Frequency Meter-LM-13

**Electrical characteristics:**

Fundamental frequency of heterodyne oscillator:  
125-250 kc., 2-4 mc. (all approved models).

Recommended Usable Frequency Range: 125 kc. to  
20 megacycles.

Frequency measuring unit: CRR-74028 (LM-10,  
-13); CKB-74028 (LM-14, -15, -17).

Modulation: 500 cycles sinewave.

Accuracy of Fundamental Frequencies:

± 0.02% from 125-250 kc.

± 0.01% from 2 mc-4 mc.

Tubes: 1 type 76, 1 type 77, 1 type 6A7, 1 crystal  
type CJL-40023B, and two 1/4-watt, two-element,  
bayonet base, neon tubes equivalent to GE Co.  
T-4-1/2.

**Power required:**

LM-10 and LM-14: 12-14/24-28; 200-260/260-  
475 volts d. c.

LM-13 and LM-17: Self contained batteries.

LM-15; Rectifier power unit CKB-20104 (110 v.,  
60 cycle).

Batteries: (LM-13, LM-17) 4 type BA-59, and 2  
type BA-203/U are required but not supplied in  
the instrument.

**Mechanical characteristics:**

The nominal dimension of the heterodyne frequency  
meter is 8 1/2" x 8 1/8" x 8 7/16" and the weight is 11.5  
pounds. On models having self-contained batteries the  
over-all dimensions are 15 7/16" x 9 5/8" x 9 3/4" and the  
weight is 40 pounds. The rectifier power unit dimensions  
are 8 3/10" x 8 5/8" x 8 3/16" and the weight is 13.5 pounds.

Complete equipment for models LM-10 and -14 con-  
sists of:

- (1) 1 Heterodyne frequency meter.
- (2) 1 Mounting base.
- (3) 1 Shielded power cable.
- (4) 1 Calibration book (typed).
- (5) 1 Waterproof canvas cover CRR-10086 (not  
illustrated).

Complete equipment for models LM-13 and -17 con-  
sists of items 1 and 4 above plus:

- (6) 1 Carrying case with battery compartment:  
CKB-10111.
- (7) 1 Waterproof canvas bag: CMQ-10110.

Complete equipment for model LM-15 consists of  
items 1, 2, 3, 4, above plus:

- (8) 1 Rectifier power unit, CKB-20104.
- (9) 1 Shock mounting for rectifier unit (not illus-  
trated).
- (10) 1 Power cable.

Note—Instruction books: NAVAER 08-5Q-35 (LM-  
10) and NAVAER 08-5Q-38 (LM-13) are available.

ASO stock No.

LM-10-R16-I-2105.

LM-13-R16-I-2108.

LM-14-R16-I-2109.

LM-15-R16-I-2110.

LM-17-R16-I-2112.

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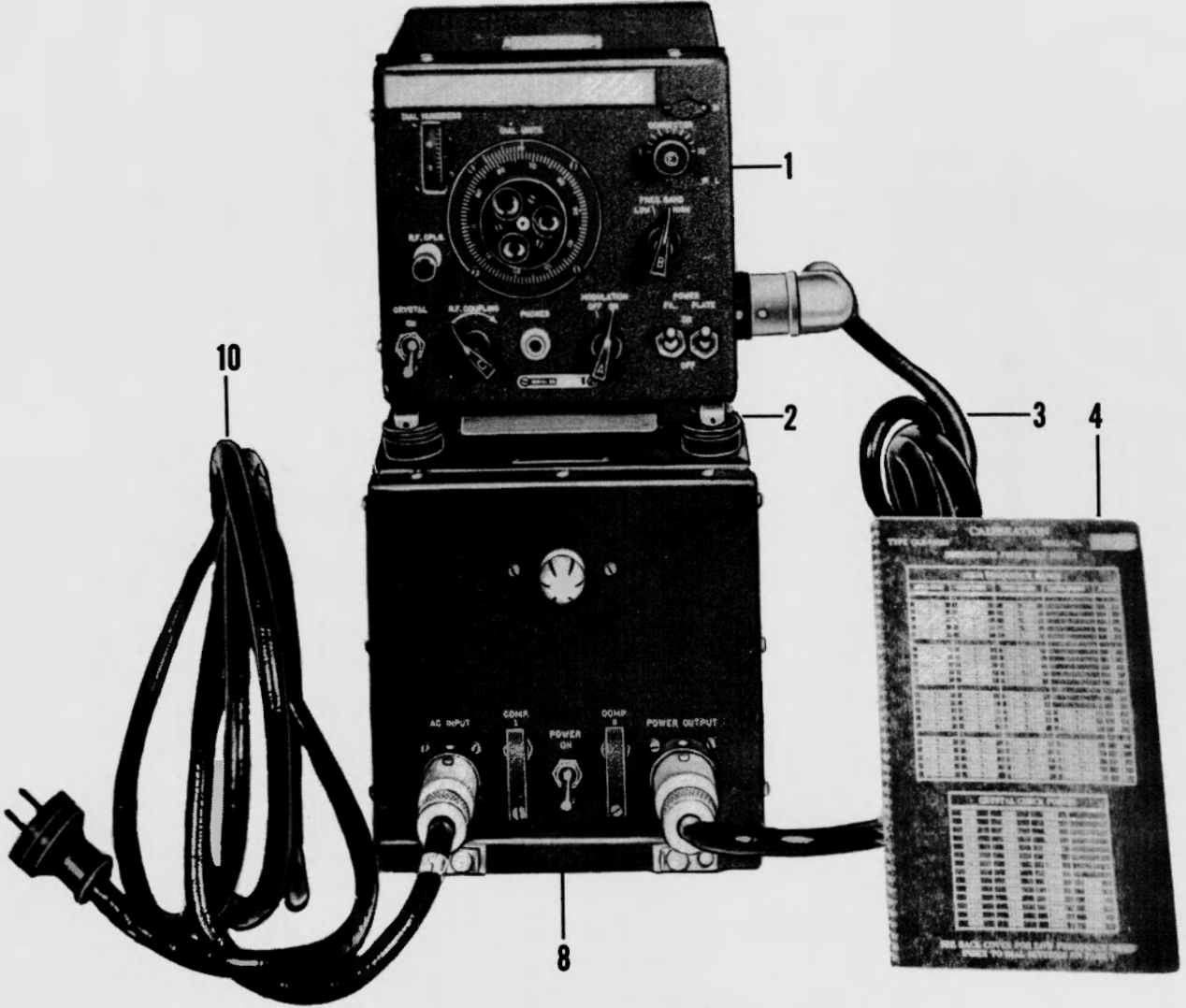


Figure 6-5. Frequency Meter—LM-15

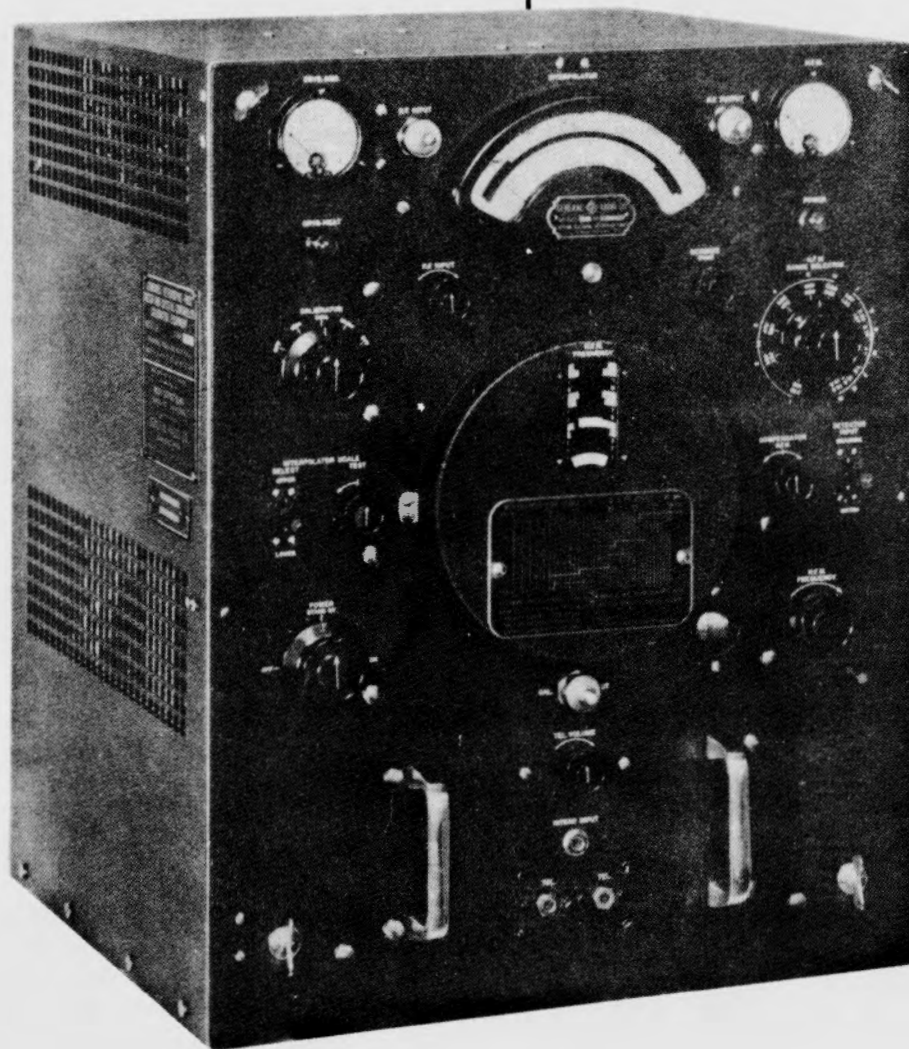


Figure 6-6. Frequency Meter-LR-2

## FREQUENCY METER AND CALIBRATOR

### Model LR-2

Primary purpose: Measuring transmitter frequency and setting receiver frequency in the range 160 kc. to 30 mc.

The LR-2 is a combined heterodyne frequency meter and crystal controlled calibrator working in the range 160 kc. to 30 mc. By harmonic extension, frequencies above 30 mc. may be measured.

The crystal in the calibrator section is of the bar type operating at a frequency of 100 kc.  $\pm$  1 cycle at 50°C. It is contained in a temperature controlled system at 50°C  $\pm$  2.5°C. By use of a multivibrator the various harmonic multiples are used to give numerous frequency check points over the entire band.

### Electrical characteristics:

Frequency range: 160 kc. to 30 mc.

Crystal frequency: 100 kc.  $\pm$  1 cycle at 50°C.

Frequency meter scale: 13 direct reading ranges.

Power required: 110-120 volts, 60 cycle, 160 watts.

Tubes: 2 type 6C6, 9 type 76, 1 type 75, 1 type 6SK7,  
4 type OC3/VR105, 2 type 884, 1 type 84, 1 type  
83.

### Mechanical characteristics:

Dimensions: 18" x 23" x 17½".

Weight: 155 pounds.

### Complete equipment consists of:

- (1) 1 Frequency Meter and Calibrator LR-2.
- (2) 1 Instruction book.

ASO stock No. R16-C-4091.

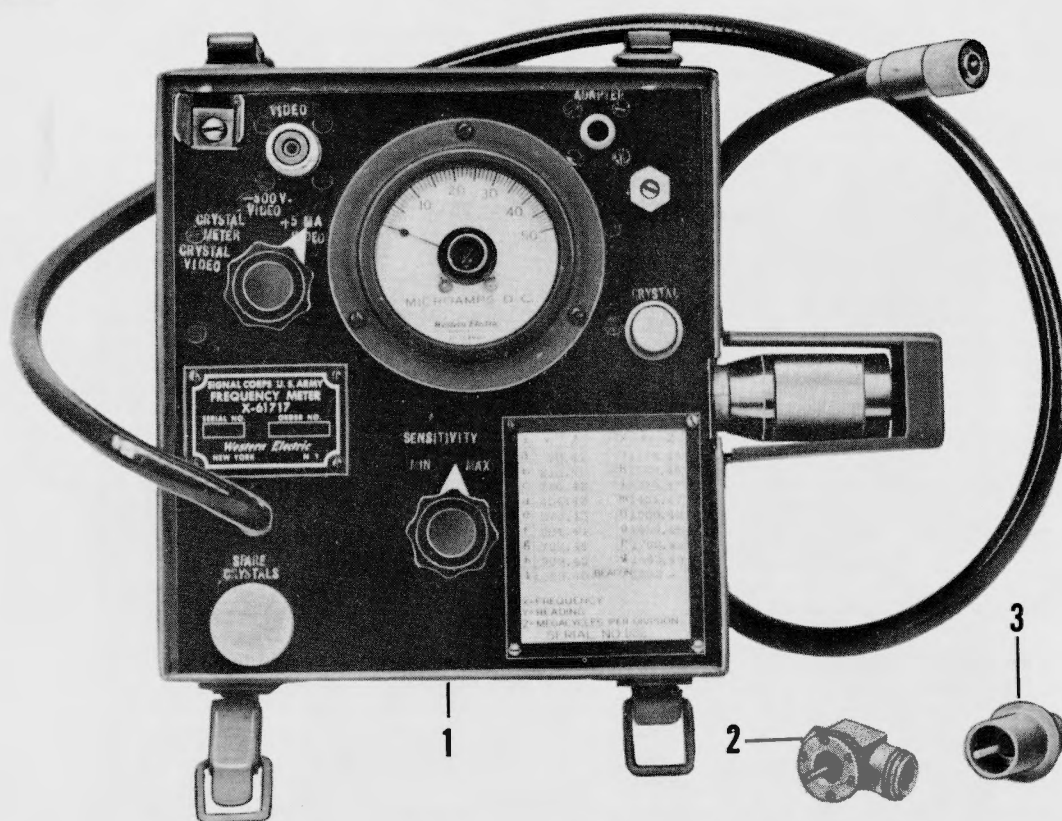


Figure 6-7. Frequency Meter—TS-33/AP

## FREQUENCY METER

### TS-33/AP

Primary purpose: To measure frequencies of various airborne radar equipments.

This unit is used in maintaining radar systems within its range. It will measure either CW or pulsed transmissions.

The equipment contains a variable tuned coaxial cavity, crystal rectifier (1N22), 50 microamp d. c. meter and a 35-db attenuator. The output may be switched from the internal meter to a video output jack for use with an external oscilloscope or synchroscope. A 3-foot coaxial cable is permanently attached at one end to the test set and the other end is fitted with a standard type "N" 50-ohm connector.

#### Electrical characteristics:

Frequency range: 8700 to 9500 mc.

Accuracy: Plus or minus 0.03% except beacon frequencies are plus or minus 0.01%.

Temperature coefficient: 0.03 mc./° C. (approximately).

Sensitivity: CW, 0.2 mw. (min.); pulsed, 2 mw.

Signal input (For a 20 microampere meter):

Min.: CW, 0.2 mw. (minus 7 dbm.).

Pulsed, 150 mw., duty cycle 0.002 sec./sec.

Max.: CW, 2 watts.

Pulsed, 1,000 watts, duty cycle 0.002 sec./sec.

Pulsed, 2,000 watts, duty cycle 0.001 sec./sec.

Pulsed power input for 0.1 volt output:

Min.: 2 mw. peak pulse.

Max.: 20 watts peak pulse.

Frequency determination: Calibration chart for micrometer readings.

Power required: None.

Tubes: None.

Crystal: 1N21 or 1N22.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9" x 10" x 6".

Weight: 8 pounds.

#### Complete equipment consists of:

- (1) 1 Frequency meter, TS-33/AP.
  - (2) 1 Right-angle adapter (mounted in holder provided on panel surface).
  - (3) 1 Straight adapter (held in bracket inside wooden cover).
  - (4) 1 Instruction book CO AN 08-35TS33-2.
- ASO stock No. R16-W-1950.
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Figure 6-8. Frequency Meter—TS-46/AP

## FREQUENCY METER

### TS-46/AP

Primary purpose: For frequency measurement of receiver local oscillator (CW) and transmitter (pulsed) on radar equipment.

This unit alone is not suitable for frequency measurements of pulsed RF since the peak power will burn out the crystal rectifier before the average current through the meter reaches a readable value. For pulsed RF measurements the tuned cavity is connected to an oscilloscope instead of to the meter; two 6-foot coax cables are supplied for the external connections.

This frequency meter consists essentially of a tunable coaxial line coupled by an inductive loop across a crystal detector circuit. When the line is tuned to resonance at the frequency of the applied signal, it produces a low impedance across the input to the detector circuit, which minimizes the power delivered to the detector thereby producing a sharp dip in the meter reading. The tuning adjustments on the coaxial line are made by means of a micrometer screw with its micrometer head extending beyond the box containing the meter. The reading of the micrometer is then translated into the resonating frequency of the coaxial cavity.

#### Electrical characteristics:

Frequency range: 3,267-3,333 mc.

#### Power input:

Max. CW, 2 mw. into 70 ohms; max. peak, 200 mw.

Min. CW, 0.1 mw.; min. pulse, 6 mw.

Impedance: 72 ohms (coaxial cable).

#### Accuracy:

Relative  $\pm 1$  mc.

Absolute  $\pm 3$  mc.

Sensitivity: minimum measurable power—0.1 mw (av.).

Resonance indication: 0-200 microammeter.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $3\frac{3}{4}$ " x  $3\frac{1}{4}$ " x 12".

Weight:  $4\frac{1}{2}$  pounds.

#### Complete equipment consists of:

- (1) 1 Frequency meter, TS-46/AP.
- (2) 2 Six-foot coax cables (not illustrated).
- (3) 1 Six-inch coax cable.
- (4) 1 Instruction book CO AN-08-35TS46-2.

ASO stock No. R16-W-2625.

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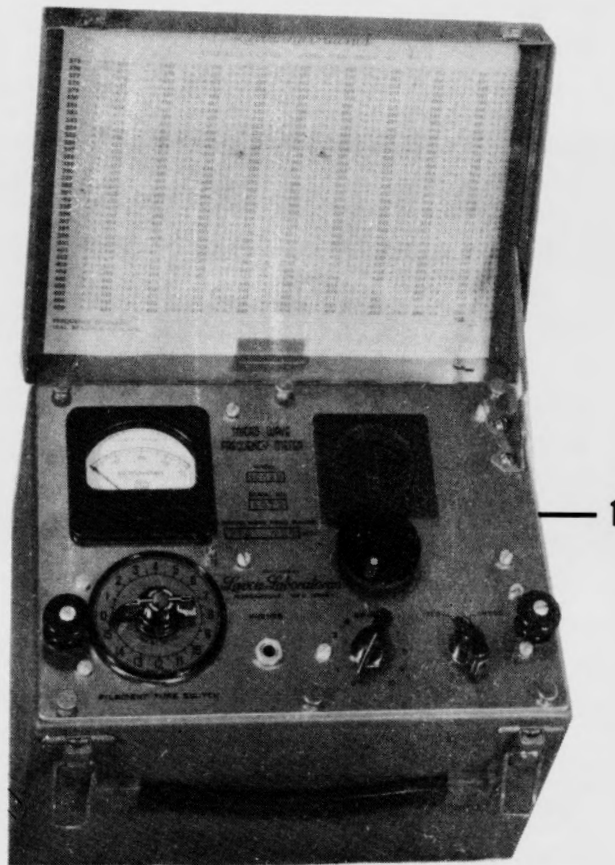


Figure 6-9. Frequency Meter—TS-127/U

## FREQUENCY METER

### TS-127/U

Primary purpose: General field use in measuring the frequency of pulsed or c. w. r-f transmitters and signal generators.

The TS-127/U is an improved model 105-S Lavoie frequency meter. The instrument is encased in a gray wrinkle-finished metal case; a 15-minute automatic time switch is provided; the calibration card is of the index type instead of a curve. The circuit consists of a diode detector and two-stage audio amplifier. Selector switch is provided for modulated or unmodulated signals. A 4-foot length of coax cable is provided for r-f pick-up.

In operating this meter care must be exercised to prevent overcoupling or the meter will show two resonance points. Keep the gain control fairly high and couple the meter just close enough to the r-f source under measurement to cause a deflection on the meter.

#### Electrical characteristics:

Frequency range: 375-725 mc.

Accuracy:  $\pm 1$  mc.

Dial: 5,000 divisions.

Meter: 0-200 microamp.

Tubes: 1 type 957; 1 type 3S4; 1 type 1S5.

Power required: Dry batteries, one 45-volt; one 1 $\frac{1}{2}$ -volt.

Batteries: 1 type BA-59, 1 type BA-35. Supplied only on early shipments. Batteries should be requisitioned when ordering this instrument.

#### Mechanical characteristics:

Dimensions: 9 $\frac{1}{2}$ " x 11 $\frac{1}{4}$ " x 8 $\frac{1}{2}$ ".

Weight: 20 pounds.

#### Complete equipment consists of:

- (1) 1 Frequency meter, TS-127/U.
- (2) 1 Four-foot, single conductor, coaxial pick-up cable with shielded connector plug.
- (3) 1 Four-inch flexible probe.
- (4) 1 Instruction book AN 16-35TS127-2.

ASO stock No. R16-W-2438.

- (1) .....
- (2) R16-AN-CD-1098.
- (3) R16-AN-4988-500.

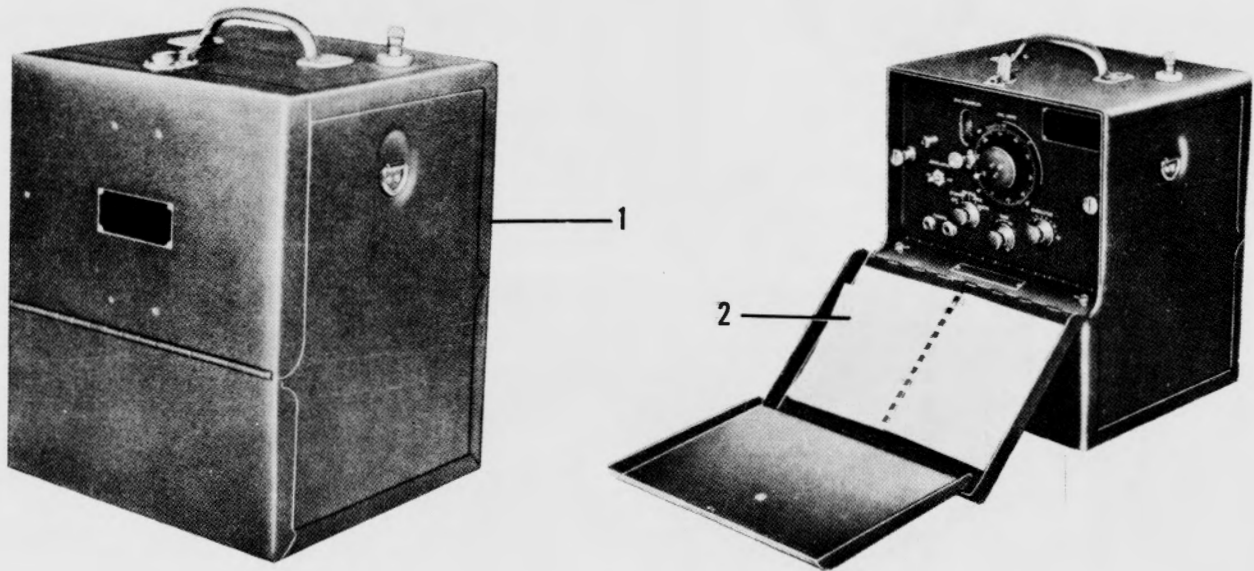


Figure 6-10. Frequency Meter—TS-174/U

## FREQUENCY METER

### TS-174/U

Primary purpose: A crystal controlled heterodyne frequency meter used for testing of radar systems within its frequency range.

This instrument may be used to measure or check the frequencies of transmitters or signal generators. It may also be utilized in the calibration of receivers. It consists of a heterodyne oscillator, crystal oscillator, mixer and an audio amplifier. Two phone jacks for headphones are provided. A vernier dial and associated calibration chart are used in making measurements. Crystal check points are provided at 1 mc. intervals along the oscillator fundamental frequency range. It is contained in a metal case with carrying handle. A calibration book is mounted inside the front protective door.

#### Electrical characteristics:

Frequency range: 20 to 250 mc.

Oscillator fundamental frequency range: 20 to 40 mc.

Accuracy: 0.05% (crystal frequency).

Signal input: 20 millivolts to 2 volts (sensitivity).  
Signal output: 50 microvolts to 20 millivolts modulated at 1000 cycles.

Power required: Self-contained batteries.

Tubes: 1 type 6K8; 1 type 6SJ7; 1 type 6SJ7-Y.

Batteries: 4 type BA-23, 6 type BA-2. Batteries should be requisitioned when ordering this equipment.

#### Mechanical characteristics:

Dimensions: 14" x 10<sup>1</sup>/<sub>4</sub>" x 9<sup>3</sup>/<sub>4</sub>".

Weight: 42 pounds (with batteries).

#### Complete equipment consists of:

- (1) 1 Frequency meter, TS-174/U.
- (2) 1 Calibration book.
- (3) 1 Set spare tubes (not illustrated).
- (4) 1 Crystal unit, DC-9 (Army) (not illustrated).
- (5) 1 Instruction book AN 08-35TS174-2.

#### ASO stock No. R16-AN-TS-174/U.

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Figure 6-11. Frequency Meter—TS-175/U

## FREQUENCY METER

### TS-175/U

Primary purpose: A heterodyne frequency meter used (1) as a signal generator, (2) in calibration of radio transmitters and receivers, and (3) in measuring any frequency within its range.

This is a portable self-contained battery-operated unit enclosed in a two-section cabinet. The top section contains the frequency meter chassis and includes the heterodyne oscillator and a 5,000 kc. crystal for calibration of the oscillator at a number of points. The bottom section accommodates the batteries. A small compartment on the front panel is used to store the cords and antenna used with the test set.

#### Electrical characteristics:

Frequency range: 85-1000 mc.  
Output, r-f: Not less than 500 microvolts.  
Output audio: 1.0 milliwatt.  
Accuracy:  $\pm 0.04$  percent.  
Modulation: 1,000 c. p. c.

Calibration: 5,000 kc. crystal.

Tubes: 1 type 6K8; 1 type 6C8G; 1 type 9002.

Crystal: 1 CR-1A/AR.

Batteries (not supplied): Six 22.5 volt type BA-2; four 1.5 volt type BA-23. Batteries should be requisitioned when ordering this equipment.

#### Mechanical characteristics:

Dimensions: 14" x 9 $\frac{3}{4}$ " x 10 $\frac{3}{16}$ ".

Weight: 18 pounds.

#### Complete equipment consists of:

- (1) 1 Frequency meter TS-175/U—calibration book included.
- (2) 1 Crystal unit, CR-1A/AR (inside freq. meter).
- (3) 1 Antenna, AT-66/U.
- (4) 1 Cord, CG-55/U.
- (5) 1 Cord, CG-56/U.
- (6) 1 Set of spare tubes (inside freq. meter).
- (7) 1 Instruction book AN 16-35TS175-2.

#### ASO stock No. R16-AN-TS-175/U.

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| (1) .....           | (2) R16-C-38594-500. |
| (3) R16-A-4934-34.  | (4) R16-AN-CG-55/U.  |
| (5) R16-AN-CG-56/U. | (6) .....            |



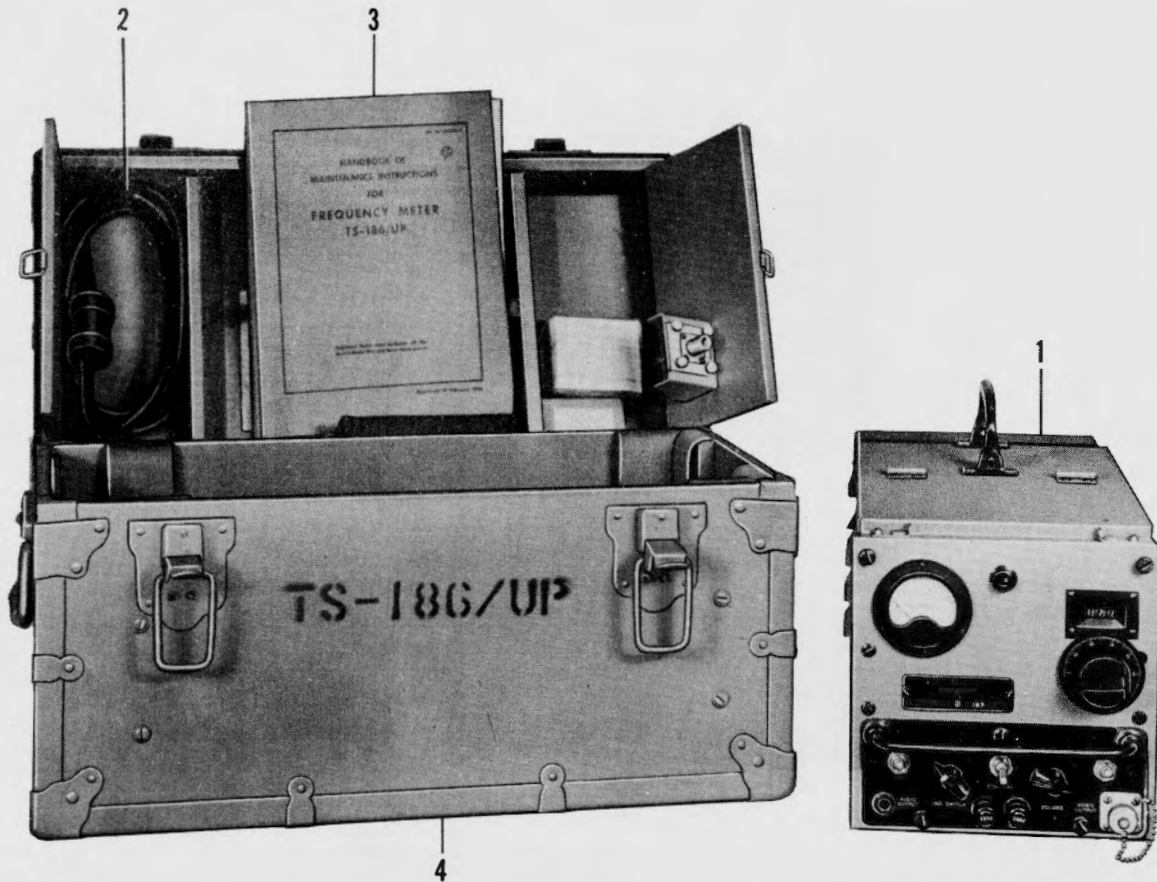


Figure 6-12. Frequency Meter—TS-186/UP

## FREQUENCY METER

### TS-186/UP

Primary purpose: To measure frequencies of transmitters, oscillators or signal generators within its frequency range.

This meter, housed in an all-aluminum case, has all controls mounted on one face. It has a crystal controlled calibrator incorporating a 5 mc., low temperature coefficient quartz plate. The calibrator and frequency multiplier are capable of producing clearly audible check points up to and including 500 mc., when beating with the fundamental and harmonic frequencies of the heterodyne oscillator.

#### Electrical characteristics:

Frequency range: 100-10,000 mc. (fundamental range: 500-1250 mc.).

Accuracy: 0.01% (crystal 0.002%).

Voltages—Input signal: 500 microvolts to 1 volt.

Sensitivity (Output): 1,000 microvolt input signal produces amplifier output of 20 milliwatts; at

10,000 mc.—1 milliwatt of r-f input produces amplifier output of 20 milliwatts.

Audio amplifier range: 10-100,000 c. p. s.

Power required: 115 v., 50-1600 cycles, 60 watts.

Tubes: 5 type 6SJ7; 1 type 955; 1 type 2C40; 2 type OD3/VR-150; 1 type 5Y3GT.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9½" x 8½" x 20".

Weight: Frequency meter, 40 pounds; case 23 pounds.

#### Complete equipment consists of:

- (1) 1 Frequency meter, TS-186/AP.
- (2) 1 Power cable: 7 feet fitted with proper a. c. line plugs.
- (3) 1 Instruction book AN 16-35TS186-3.
- (4) 1 Transit case.

#### ASO stock No. R16-AN-TS-186/UP.

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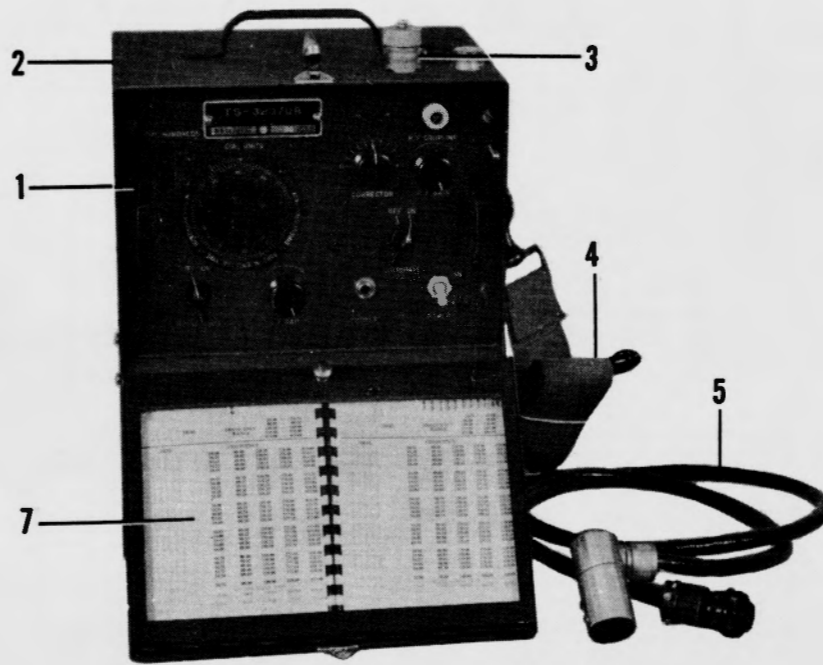


Figure 6-13. Frequency Meter-TS-323/UR

## FREQUENCY METER

### TS-323/UR

Primary purpose: To measure the carrier frequencies of unmodulated CW radio transmitters, oscillators and other r-f generators.

This frequency meter and calibrator unit contains a variable heterodyne oscillator, a calibration oscillator, a mixer, and audio amplifier and an audio frequency modulator. The harmonic output of the calibration oscillator is sufficient to provide 12 usable harmonic check points throughout the frequency range of the heterodyne oscillator. This meter may be used (a) to measure the frequency of unmodulated CW radio transmitters, oscillators or other r-f generators; (b) to adjust to specified frequencies the output of unmodulated CW radio transmitters, etc.; (c) to measure the frequency of oscillating or nonoscillating radio receivers, field strength meters or other tuned detectors of r-f energy. A suitable plug is provided so that an external power source such as the PP-106/U may be utilized.

#### Electrical characteristics:

- Frequency range: 20 to 450 megacycles.
- Accuracy: 0.01% (service conditions).
- R-f output: 50-1,000 microvolts.
- Audio: 20 mw. at check points.
- Modulation: 30% to 90% between 800-1200 cycles.

Sensitivity: 50,000 microvolts signal gives audio beat note output of 10 mw.; range 2500-500,000 microvolts.

Power required: Self-contained batteries.

Tubes: 2 type 6AK5, 1 type 6C4, 1 type 9001, 1 type 9002, 1/4 watt neon.

Batteries: 2 type BA-203/U; 3 type BA-59 (not supplied). Batteries should be requisitioned when ordering equipment.

#### Mechanical characteristics:

Dimensions: 14<sup>5</sup>/<sub>16</sub>" x 11<sup>1</sup>/<sub>8</sub>" x 9<sup>1</sup>/<sub>2</sub>".

Weight: 21 pounds less batteries.

#### Complete equipment consists of:

- (1) 1 Frequency meter TS-323/UR.
- (2) 1 Carrying case, CY-133/UR.
- (3) 1 One rod antenna.
- (4) 1 Carrying strap.
- (5) 1 Power cord.
- (6) 2 Allen wrenches (inside instrument case).
- (7) 1 Calibration book.
- (8) 1 Instruction book AN 08-35TS323-2.

#### ASO stock No. R16-AN-TS-323/UR.

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## Section VII MULTIMETERS

### FUNCTION

In the servicing of electronic equipment there are two generally accepted methods of testing. The "dynamic" method is one in which measurements are made of the actual performance of the equipment. Measurable amounts of r-f or audio signal are injected into the equipment being tested, under simulated operating conditions. Measurements are made of the gain per stage, conversion factor, band width, etc. This method of testing requires extensive signal generating and measuring equipment.

The second or "static" method of testing is one in which measurements are made by electrical indicating instruments which give readings of the voltages, currents, resistances, and capacitances associated with the various circuits under test. This method is based on the assumption that if all the operating voltages and electrical characteristics of the components of the equipment under test are intact and properly adjusted the equipment will function as a whole. This method requires only a multimeter and therefore is suitable for servicing under conditions where extensive test equipment is not available.

### THEORY OF OPERATION

A multimeter may contain any combination or all of the following measuring devices: a. c. voltmeter, d. c. voltmeter, d. c. current meter, capacitance meter, and ohmmeter. Fundamentally a multimeter will consist of a d. c. microammeter which, in combination with a series of resistor multipliers and shunts, is utilized for reading either voltage or current.

A source of d. c. voltage (internal batteries) is provided for the ohmmeter which connects this d. c. voltage in series with the external unknown resistance and translates the current flow through it and the internal multipliers into a direct resistance reading. A rheostat is provided on the front panel in order to correct for variation of battery voltage by giving a "zero ohms" adjustment, which is made with the probes shorted together before measuring external resistances.

A multimeter is enabled to make a. c. voltage readings on a d. c. microammeter by incorporating a copper oxide rectifier and a special resistor multiplier system. This combination reduces the impressed a. c. voltage and rectifies it in terms of d. c. current which can be impressed upon the meter. In many instruments of this type it is necessary to make use of a separate scale on the meter face for reading a. c. voltages. These special scales are usually printed in a different color and are necessary primarily because of the nonlinear characteristics of the rectifier unit.

### CAPACITY MEASUREMENTS

When a multimeter is equipped to make capacity measurements it incorporates a source of a. c. voltage usually derived from the a. c. power line. This power line connection is in most cases only necessary for capacity measurements. This type of measurement is actually a reading of capacitive reactance or impedance and is accomplished by impressing a measured and manually adjusted standard voltage on the meter through a resistance multiplier and the external unknown capacitance. The accuracy of such a reading is dependent on meter accuracy, the accuracy of the line frequency, the absence of internal resistance in the unknown capacitance, and the relationship of the ground side of the capacitance to the ground side of the a. c. line.

### APPLICATION

Field servicing of electronic equipment is greatly assisted by having a chart of the equipment under test showing the actual wiring and the various terminal and tube socket voltages and currents to be expected under proper operating conditions. The absence or incorrect amounts of these voltages and currents can be checked and traced back to the failure of component parts such as wiring, resistors, or capacitors. These components can then be checked individually with the multimeter to verify whether or not they are the cause of the incorrect voltages or currents.



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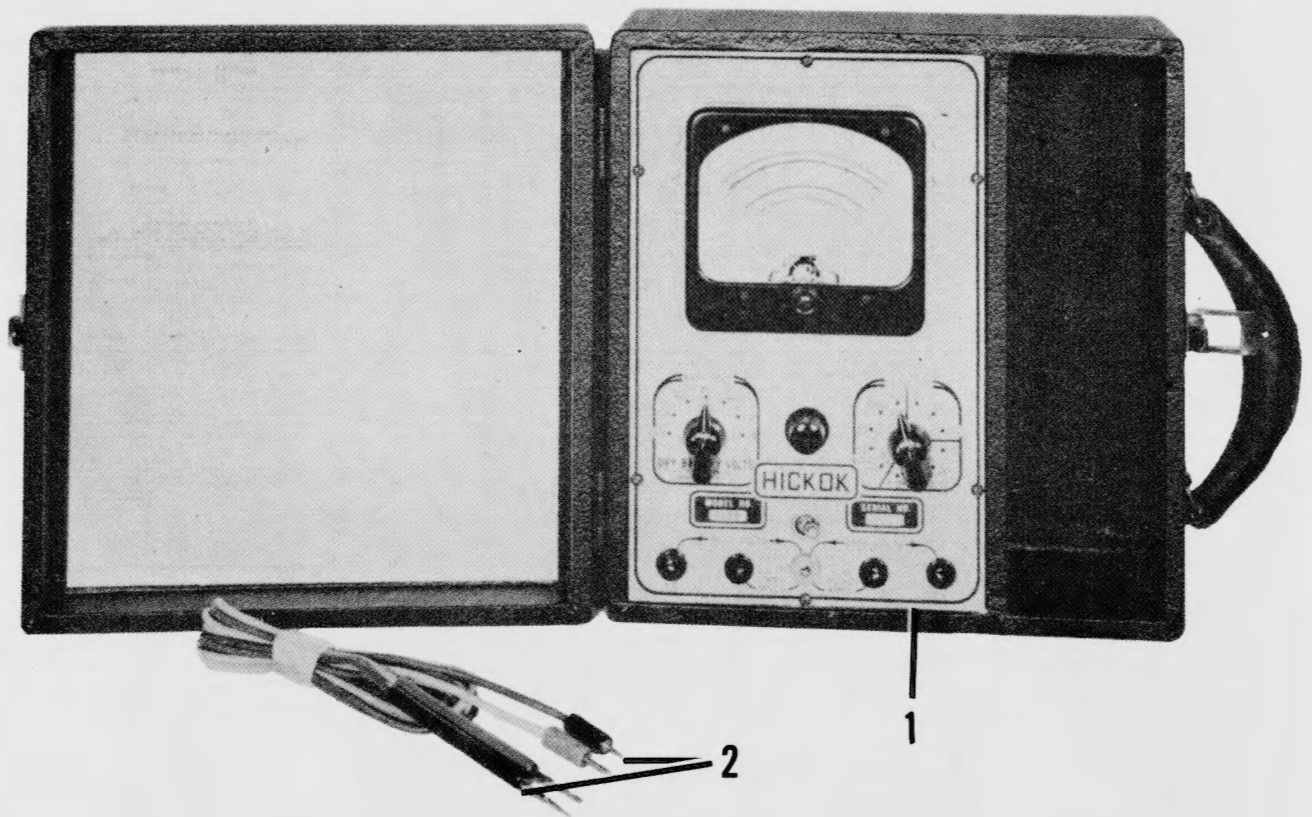


Figure 7-1. Volt-Ohm-Milliammeter—Hickok 133

## VOLT-OHM-MILLIAMMETER

### Hickok 133

Primary purpose: General service testing and maintenance of electronic equipment.

This instrument is a volt-ohm-milliammeter and includes a db scale. It consists of a single unit, one meter instrument built into a carrying case. It may be used as a dry battery tester up to 135 volts. There is provided a zero-set rheostat for the ohms scales.

#### Electrical characteristics:

##### Ranges:

- AC/DC volts: 0-2½-10-50-250-500-2,500.
- DC ma: 0-40-500 microamps, 0-5-50-500 ma.
- AC ma: 0-1 (2.5 volts a. c.).
- Ohms: 0-30-10K-1 meg. -10 meg.
- Db: -20 to + 3, + 15, + 29, + 43.

#### Sensitivity:

DC-25,000 ohms/volt.

AC-1,000 ohms/volt.

Accuracy: 2% of full scale reading.

Power required: Self-contained batteries.

Tubes: None

Batteries: 2 type BA-28, 1 type BA-30 supplied in early equipment. For later issues batteries may be ordered from stock.

#### Mechanical characteristics:

Dimensions: 13" x 11" x 7".

Weight: 9 pounds.

#### Complete equipment consists of:

- (1) 1 Volt-ohm-milliammeter, Hickok 133.
- (2) 2 Test probes.
- (3) 1 Instruction book AN 08-45-34.

ASO stock No. R16-T-1830.

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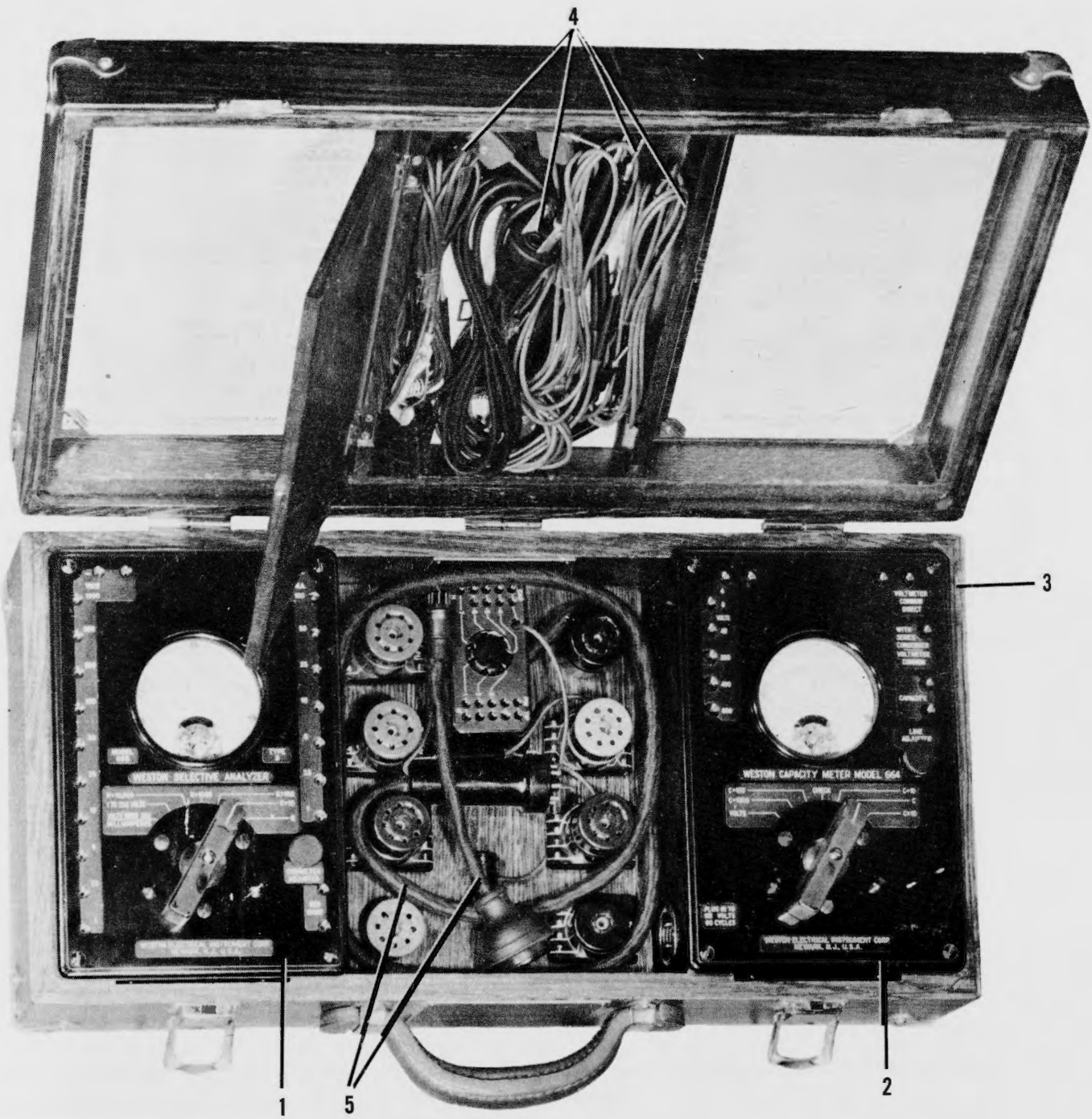


Figure 7-2. Volt-Ohm-Milliammeter—Navy Model OE

### VOLT-OHM-MILLIAMMETER

#### Navy Model OE

Primary purpose: General service testing and maintenance of electronic equipment.

Navy Model OE consists of three separate units encased in an oak carrying case which also provides for stowage of accessories. The units are: d. c. volt-ohm-milliammeter; a. c. volt capacity meter; circuit analyzer assembly. The model OE has all the instruments necessary for the measurement of d. c. voltages up to 1,000, d. c. currents up to 100 milliamperes, a. c. voltages up to 1,000, capacitances up to 20 microfarads, and resistances up to 10 megohms, as well as accessories necessary to permit the rapid and easy electrical insertion of the instruments into any part of the various circuits.

#### Electrical characteristics:

DC: 0-1-2½-5-10-25-50-100-250-500-1,000.

AC: 0-4-8-40-200-400-800-1,000.

#### Sensitivity:

DC: 25,000 ohms/volt up to 250 volts.

1,000 ohms/volt up to 1,000 volts.

AC: 1,000 ohms/volt.

Milliampere ranges: 0-1-2½-10-25-50-100.

Capacity ranges: 0.0001-0.02; 0.001-0.2; 0.01-2; 0.1-20; 1-200.

Resistance ranges: 0-1000; 10,000; 100,000; 1 megohm; 10 megohms.

#### Accuracy:

DC 2% of full scale reading.

AC 5% of full scale reading.

Tubes: None.

Power required: 115 v. a. c., 60 cycle; single phase (for operation of capacity meter only).

Batteries: 2 type BA-34 (Supplied).

#### Mechanical characteristics:

Dimensions: Case. 18⅝" x 11⅜" x 5⅞".

Weight: 19¼ pounds.

#### Complete equipment consists of:

- (1) 1 d. c. meter.
- (2) 1 a. c. meter.
- (3) 1 Oak carrying case.
- (4) Various test leads and a. c. line cords, cables, tube socket selectors, and adapters.
- (5) Various cables, tube sockets, and adapters.
- (6) 1 Instruction book AN 08-5Q-74.

#### ASO stock No. R16-A-4317.

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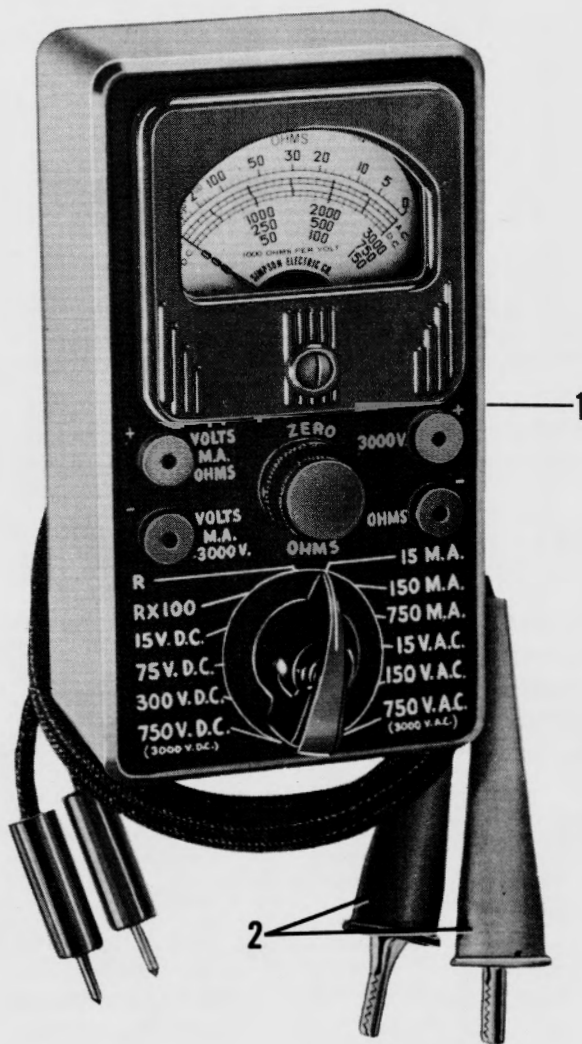


Figure 7-3. Volt-Ohm-Milliammeter—Simpson 240

## VOLT-OHM-MILLIAMMETER

### Simpson 240

Primary purpose: General service testing and maintenance of electronic equipment.

This instrument is a self-contained unit such that no external multipliers are necessary. Voltage measurements up to 3,000 volts a. c. or d. c. may be obtained. It incorporates a copper oxide rectifier for a. c. voltage ranges. Self-contained batteries are provided for both ohmmeter ranges.

#### Electrical characteristics:

##### Range:

- Volts, a. c.: 0-15-150-750-3,000.
- d. c.: 0-15-75-300-750-3,000.
- DC Milliamperes: 0-15-150-750.
- Ohms: 0-3,000-300K.

Sensitivity: a. c. and d. c.—1,000 ohms/volt.

Accuracy: d. c. plus or minus 2%; a. c. plus or minus 5%.

Power required: 1-1.5-volt d. c. battery.

Tubes: None.

Batteries: 1 type BA-58. Supplied in early equipment. For later issues batteries must be ordered from stock.

#### Mechanical characteristics:

Dimensions: 2 $\frac{7}{8}$ " x  $\frac{5}{4}$ " 1 $\frac{3}{4}$ ".

Weight: 2 pounds.

#### Complete equipment consists of:

- (1) 1 Volt-ohm-milliammeter, Simpson 240.
  - (2) 2 Test probes.
  - (3) 1 Instruction book NAVAER 08-5QS-17.
- ASO stock No. R16-V-4899-100.
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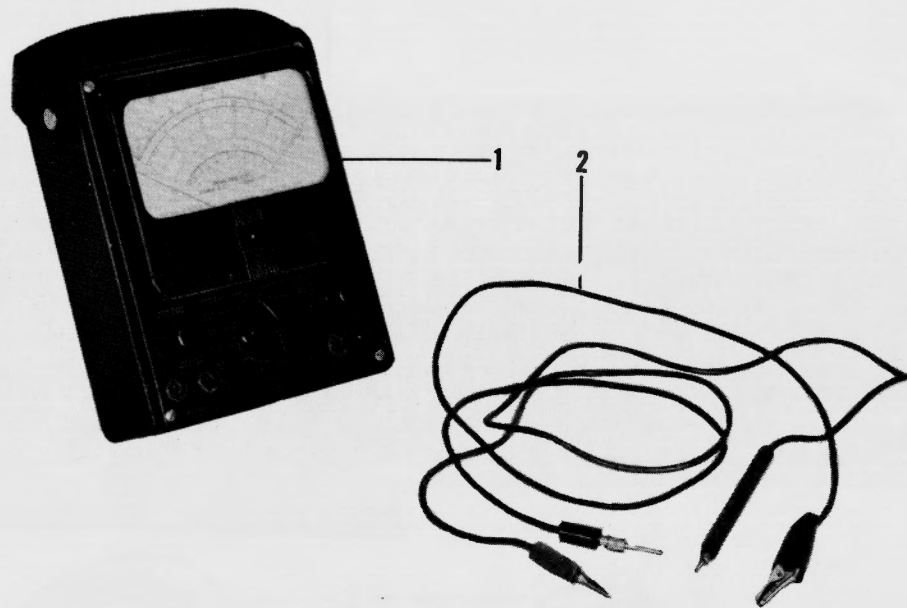


Figure 7-4. Volt-Ohm-Milliammeter—Simpson 260

### VOLT-OHM-MILLIAMMETER

#### Simpson Model 260 (Army Type IS-189)

Primary purpose: General service testing and maintenance of electronic equipment.

This instrument is a highly sensitive volt-ohm-milliammeter used for general purpose testing of electronic equipment. It will measure d. c. or a. c. volts, d. c. microamps, d. c. milliamps, decibels, and resistances.

#### Electrical characteristics:

##### Ranges:

Volts, a. c. and d. c.: 0-2.5-10-50-250-1,000-5,000.

Milliamperes d. c.: 0-10-100-500.

Microamperes d. c.: 0-100.

Decibels: (5 ranges), 0 to plus 52.

Ohms: 0-1,000, 100K, 10 megohms.

Sensitivity: d. c.—20,000 ohms/volt: a. c.—1,000 ohms/volt.

Accuracy: d. c. plus or minus 2%; a. c. plus or minus 5%.

Power required: 1-1.5 volt and 2-3 volt batteries.

Tubes: None.

Batteries: 1 type BA-42, 2 type BA-208/U. Supplied in early equipment. For later issues, batteries must be ordered from stock.

#### Mechanical characteristics:

Dimensions: 5½" x 7" x 3".

Weight: 3 pounds.

#### Complete equipment consists of:

(1) 1 Volt-ohm-milliammeter, Simpson 260.

(2) 2 Test leads.

(3) 1 Instruction book NAVAER 08-5QS-16.

ASO stock No. R16-V-4899-125.

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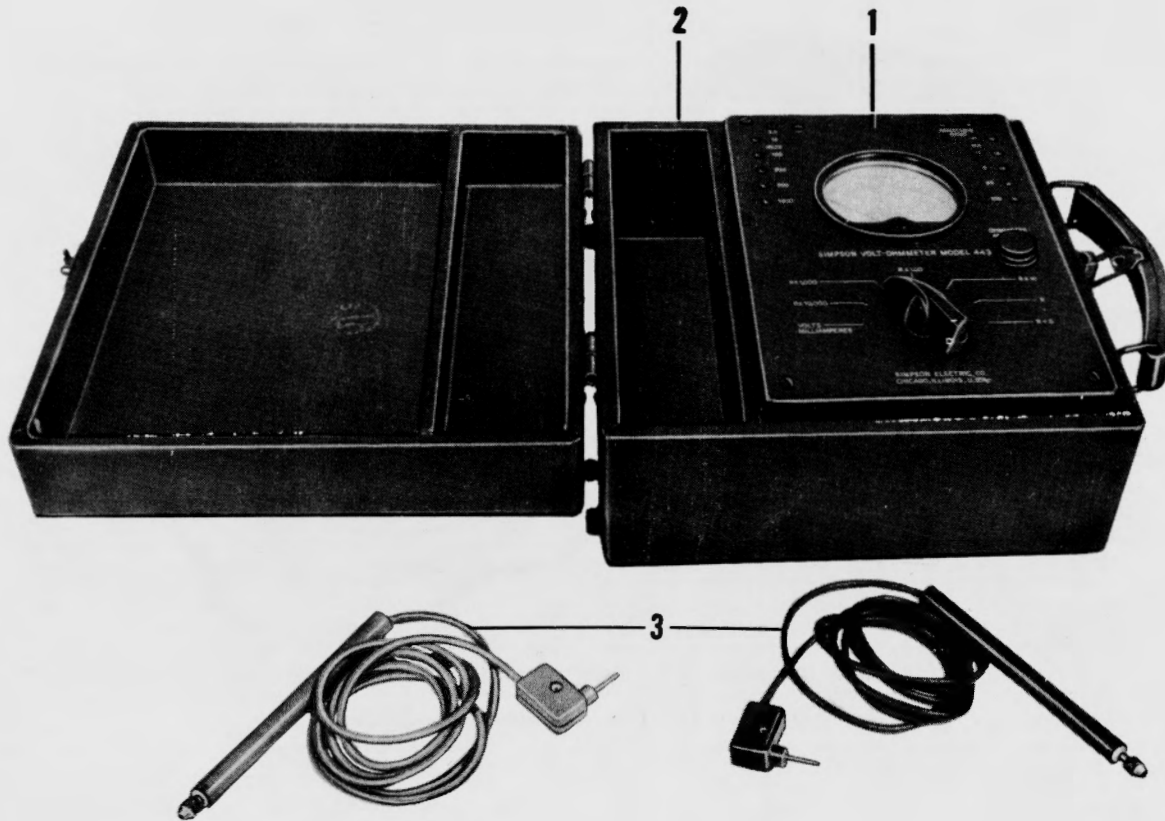


Figure 7-5. Volt-Ohm-Milliammeter—Simpson 443

### VOLT-OHM-MILLIAMMETER

#### Simpson 443

Primary purpose: General service testing and maintenance of electronic equipment.

Characteristics: Same as Weston Model 663 except for battery complement.

Batteries included are: 1 type BA-30 and 3 type BA-31.

Complete equipment consists of:

- (1) 1 Volt-ohm-milliammeter, Simpson 443.
- (2) 1 Carrying Case.
- (3) 2 Test leads.

ASO stock No. R16-V-4850.

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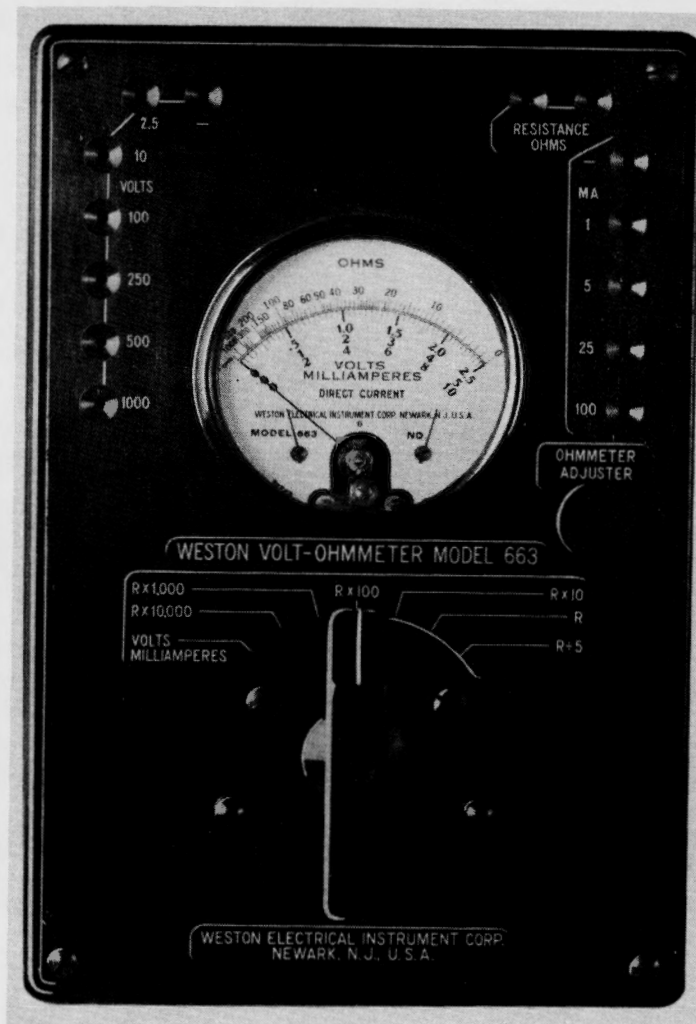


Figure 7-6. Volt-Ohm-Milliammeter—Weston 663

## VOLT-OHM-MILLIAMMETER

### Weston 663

Primary purpose: General service testing and maintenance of electronic equipment.

This light, compact meter is a single unit, one meter instrument having a separate carrying case. It does not have an a. c. scale.

#### Electrical characteristics:

##### Range:

D. c. volts: 0-2 $\frac{1}{2}$ -10-100-250-1,000.

D. c. ma: 0-1-5-25-100.

Ohms: 0-200-1K-10K-100K-1 meg. -10 meg.

Sensitivity: 1,000 ohms/volt.

Accuracy: plus or minus 2% of full scale reading.

Power required: 10-1.5 volt batteries.

Tubes: None.

Batteries: 10 type BA-30. Supplied on early equipment. For later issues batteries must be ordered from stock.

#### Mechanical characteristics:

Dimensions: 8 $\frac{1}{4}$ " x 5 $\frac{1}{2}$ " x 3 $\frac{7}{8}$ ".

Weight: 4 $\frac{1}{2}$  pounds.

#### Complete equipment consists of:

- (1) 1 Volt-ohm-milliammeter, Weston 663.
- (2) 1 Carrying Case (not illustrated).
- (3) 2 Test leads (not illustrated).

ASO stock No. R16-V-4850.

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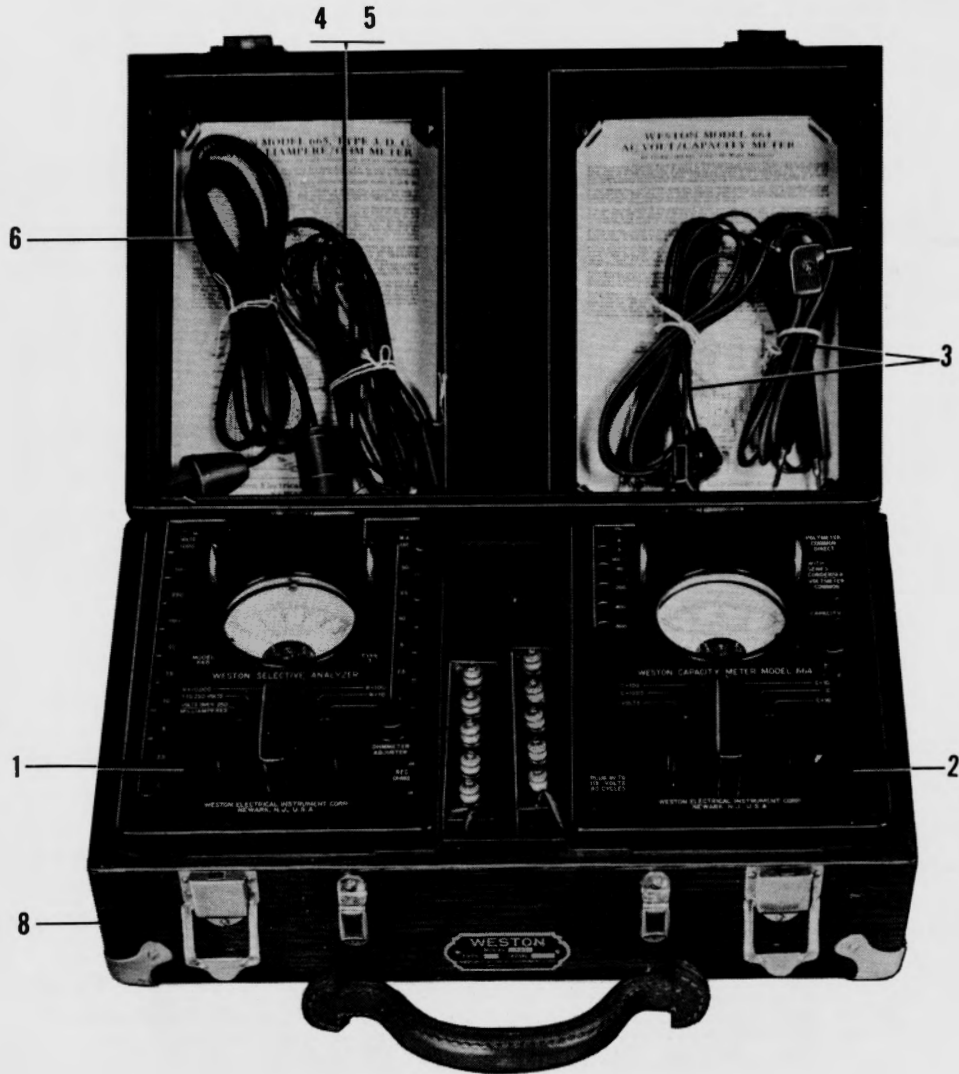


Figure 7-7. Volt-Ohm-Milliammeter—Weston 790

**VOLT-OHM-MILLIAMMETER**

**Weston 790**

Primary purpose: General service testing and maintenance of electronic equipment.

This instrument consists of two multirange meters equipped with moulded bakelite panels and metal cases. The meters and leads (listed below) are all enclosed in a heavy oak carrying case provided with a leather carrying handle. See figure for the arrangement of the equipment. This instrument differs from the Navy OE in one respect: the third unit, analyzer and adapters, is omitted and the space is used for storage of leads, etc.

**Electrical characteristics:**

Same as for Navy Model OE.

Batteries: 2 type BA-34. Supplied.

**Mechanical characteristics:**

Dimensions: Case 14<sup>3</sup>/<sub>8</sub>" x 11<sup>3</sup>/<sub>8</sub>" x 5<sup>3</sup>/<sub>8</sub>"

Weight: 13<sup>1</sup>/<sub>2</sub> pounds.

**Complete equipment consists of:**

- (1) 1 d. c. volt-ohm-milliammeter unit.
- (2) 1 a. c. volt/capacity meter unit.
- (3) 2 Test leads.
- (4) 1 Ground lead with connector plug.
- (5) 1 Output connector lead.
- (6) 1 a. c. line attachment cord with plug.
- (7) 1 Instruction book AN 08-45-28.
- (8) 1 Carrying case.

**ASO stock No. R16-A-4329.**

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## Section VIII OSCILLOSCOPES

### FUNCTION

An oscilloscope is an instrument which displays a visible plot of the time variation of a voltage wave. These instruments also provide for self-contained or external means of measuring the duration and instantaneous magnitude of the impressed voltage. Oscilloscopes are primarily intended for use in bench testing all types of electronic equipment in the radar and communications field.

### CATHODE RAY TUBE

The cathode ray tube is the basic component of an oscilloscope. Essentially it consists of a highly evacuated glass envelope containing an electron "gun" which directs a beam of electrons at a fluorescent screen which covers the inside surface of the large end of the envelope or tube. The electron emitter also contains a pair of deflecting plates which set up an electric field to control the up and down motion of the electron beam by means of the amplified voltage of the wave being observed. Another pair of deflection plates sets up an electric field which controls the side to side or horizontal movement of the electron beam by making use of the amplified voltage of an internal or external time base circuit. The synchronous combination of these two motions results in a luminous picture of the variation of signal voltage with time, or what may be referred to as an image of the signal.

Due to the fact that the electron beam has an extremely small mass and inertia and is easily controlled by the electric fields between the pairs of deflection plates, the cathode ray tube may be used to make visible the characteristics of very rapid electrical events. However these electrical events must recur frequently enough to allow the screen and visual persistence to give the illusion of a continuous pattern of light.

### ASSOCIATED CIRCUITS

A simple oscilloscope contains, in addition to the cathode ray tube:

(1) A calibrated amplifier which controls the vertical action of the electron beam. This amplifier increases to the desired amount the signal under observation and places this amplified voltage on the vertical deflecting plates.

(2) A calibrated horizontal or sweep amplifier which directs the horizontal movement of the electron beam. This amplifier controls the magnitude of the internal or external signal which is used to move the beam horizontally through the action of the horizontal deflecting plates.

(3) A sawtooth voltage or sweep generator which, when connected through the horizontal amplifier, sweeps the electron beam from left to right across the screen in any desired time and then snaps it back to its starting position at the left; this action repeats continuously. The frequency relationship between this sawtooth wave and the signal being observed determines how many images of the observed voltage will be seen on the screen. If the sweep frequency is one-quarter the frequency of the vertical signal, four images of the signal will be seen. If the sweep frequency is equal to the observed signal frequency, one image of the signal will be seen.

(4) A synchronizing circuit which permits a steady image to be seen in spite of minor frequency variations of the signal being observed. This circuit amplifies a small part of the signal frequency and uses it to control the sweep, in effect locking the two together.

(5) Focusing, brightness, and position controls which adjust the appearance and position of the image on the screen. These adjustments act upon the electric fields in the electron gun and thus enable the operator to adjust the focus, intensity, and position of the image on the fluorescent screen to those suitable for best observation.

(6) A power supply which furnishes the high voltages required by the electron gun in addition to the voltages required by the amplifiers, sweep, and control circuits.

### SPECIAL CIRCUITS

To render an oscilloscope adaptable for observation and measurement of signal pulses varying widely in magnitude, duration, and rate of recurrence and for use in circuits of widely varying impedances, it is necessary to include a number of auxiliary circuits. These include additional (and sometimes highly specialized) amplifying, delaying, attenuating, pulse generating, circular sweeping, rectifying, and switching circuits. The number and type of these circuits is determined by the particular specialized application for which the oscilloscope is designed.

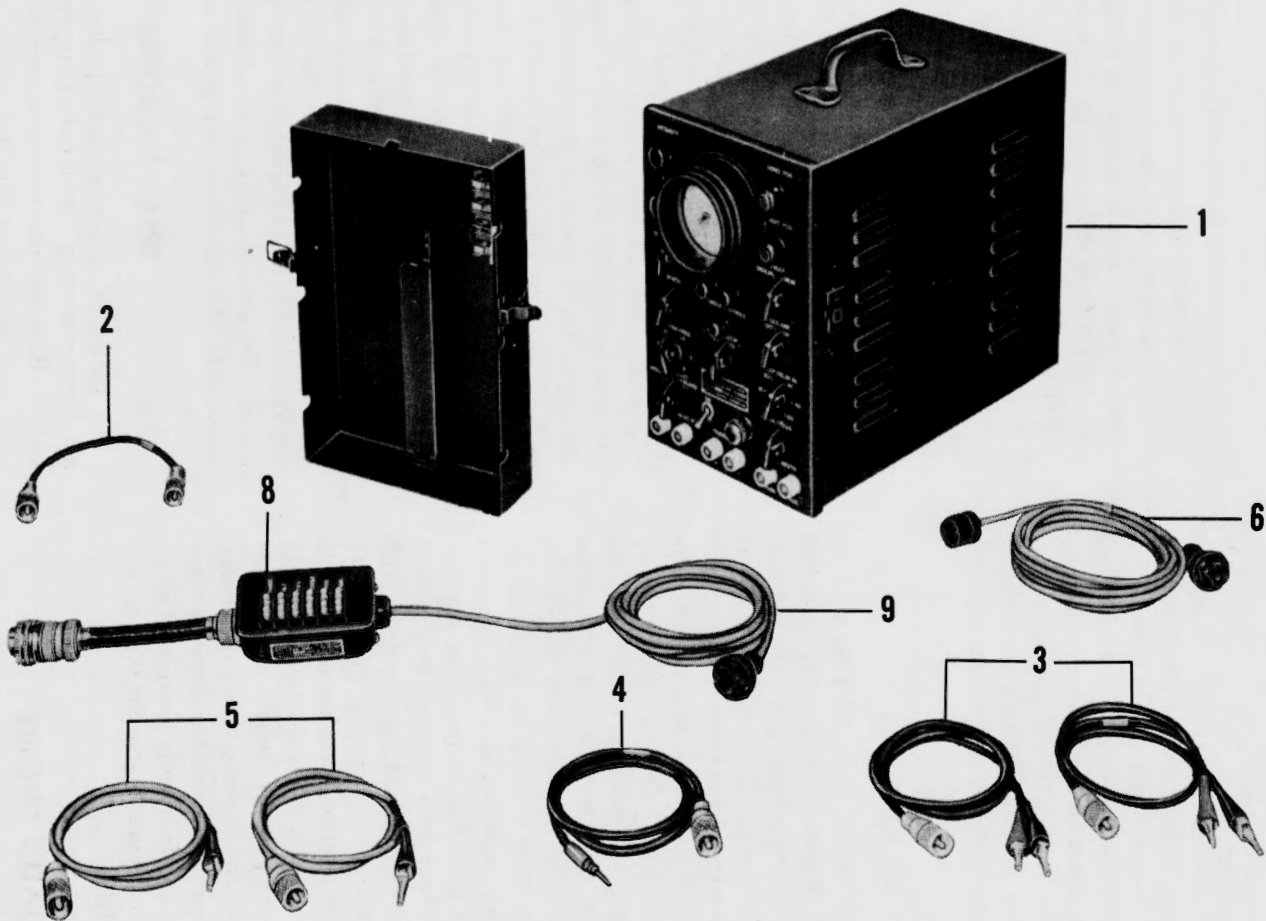


Figure 8-1. Test Oscilloscope Assembly—AN/APM-18



## TEST OSCILLOSCOPE ASSEMBLY

### AN/APM-18 (TS-100/AP and TS-101/AP)

Primary purpose: To calibrate the range of various airborne radar equipments.

TS-100/AP may be used as a general test scope or calibrator. It incorporates a type J crystal-controlled internal sweep and 3 type A sweeps. An amplifier is provided when an external source is used for the J sweep. The type J, or circular, sweep frequency has been chosen so as to make the circumference of the circle one nautical mile. A gated or ungated circle may be chosen via selector switch. This instrument is portable, being housed in a metal case provided with a detachable cover. Controls, scope, and cable connections are available on the front panel as shown in the illustration.

TS-101/AP is a test load unit used with but not part of TS-100/AP. This test load unit is completely described in the Phantom Antenna section of this book. Although the oscilloscope and the test load are available separately, they are available together as AN/APM-18.

The Electrical and Mechanical characteristics included below are for the Test Oscilloscope TS-100/AP only. A complete description of the test load unit will be found in the Phantom Antenna section.

#### Electrical characteristics:

Frequency range: Video up to 3 mc.

#### Sweeps—Characteristics:

J (circular sweep)—2,000 yards ungated or with 1 mile, 30-mile or 350-mile gated.

X—J sweep delayed 0.5 to 50 nautical miles.

A (linear sweep)—1–30 and 350 nautical miles.

R—A sweep delayed 0.5 to 50 miles.

Delay: Linear to 1% with 10-mile points marked on dial.

Range: 0–50 miles.

Trigger output: Plus 100 and minus 70 volts; 1.25 microsecond max. duration, frequency 300 to 1500 c. p. s.

Output impedance: 300 ohms.

Input impedance: High on all positions.

Trigger input:

Plus or minus 15 to 150 volts; at 100 volts/microsecond rise time in repetition rates of 0/4000 c. p. s.

With circular sweep: An 80.86 or 81.94 kc. sine wave of 35 volts and locked in phase with trigger signal must be supplied to the unit.

Accuracy: Circular sweep with 360° rotation: one mile  $\pm$  1 yard.

Power required: 115 or 230 volts, 50 to 1200 cycles, 110 watts.

Tubes: 7 type 6SN7; 1 type 6AG7; 1 type 5Y3GT; 1 type 2X2; 1 type 3DP1 (CRT).

Batteries: None.

#### Mechanical characteristics:

Dimensions: 14" x 10" x 18" (with cover).

Weight: 45 pounds.

#### Complete equipment consists of:

- (1) 1 Test Oscilloscope TS-100/AP.
- (2) 1 Cord CG-128/AP (12-inch).
- (3) 2 Cords CG-129/AP (36-inch).
- (4) 1 Cord CG-130/AP (36-inch).
- (5) 2 Cords CX-242/AP (36-inch).
- (6) 1 Cord CX-237/U (120-inch).
- (7) 1 Instruction Book AN 16-35TS100-2.
- (8) 1 Test Load TS-101/AP.
- (9) 1 Test Load Cord CX-237/U.
- (10) 1 Test Load Instruction Book AN 16-35TS101-2.

Note—Items 1 to 7 are supplied separately as TS-100/AP. Items 8 to 10 are supplied separately as TS-101/AP.

ASO stock No. R16-AN/APM-18.

- (1) R16-AN-TS-100/AP. (2) R16-AN-CG-128/AP.
- (3) R16-AN-CG-129/AP. (4) R16-AN-CG-130/AP.
- (5) R16-AN-CX-242/AP. (6) R16-AN-CX-237/U.
- (8) R16-AN-TS-101/AP. (9) R16-AN-CX-237/U.



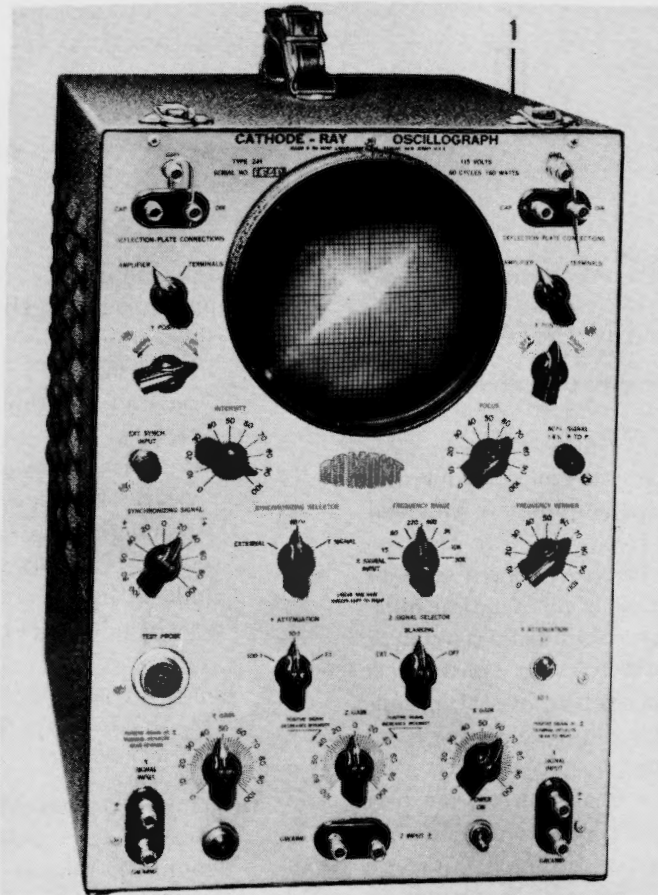


Figure 8-2. Oscilloscope—Dumont 241

## OSCILLOSCOPE

### Dumont 241

Primary purpose: General service testing and maintenance of radio, radar, and electronic equipment.

Semiportable, housed in metal case with removable front cover, this equipment has all its controls and connections on the front panel. X, Y, and Z axes are available. Input to X and Y axes may be direct, through a series condenser, or through an amplifier. Z axis provides beam intensity modulation for timing or blanking. A test probe consists of a compensated 10:1 attenuator mounted in an insulated probe and a 3-foot low-capacitance coaxial cable (connects to Y amplifier input). Sync may be internal or external. The screen diameter is 5 inches.

#### Electrical characteristics:

##### Amplifier Frequency Response:

- X axis: 5 cycles to 100 kc.
- Y axis: 20 cycles to 2 mc.
- Z axis: 30 cycles to 2 mc.

##### Input Impedance:

- Y axis: 2 meg. and 40 uuf.; with probe 1 meg. and 10 uuf.

X axis: 2 meg. and 40 uuf.

Z axis: 1 meg. and 20 uuf.

Frequency range of Sweep: 15 to 30,000 c. p. s.

Amplifier gain:

- Y axis, 250 times.
- X axis, 100 times.
- Z axis, 10 times.

Power required: 115 volts, 60 cycles, 160 watts.

Tubes: Cathode ray tube 5JP1 (5 inch); 3 type 6SN7GT; 2 type 6AG7; 2 type 6AC7; 2 type 6SG7; 1 type 5Z3; 1 type CD-2005 CL (neon); 1 type 6J5; 1 type 6Q5G; 1 type 6SJ7; 1 type 6V6 GT; 1 type 80.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 17½" x 10¾" x 21".

Weight: 65 pounds.

#### Complete equipment consists of:

- (1) 1 Oscilloscope, Dumont 241.
- (2) 1 Test probe (held inside cover by clips).
- (3) 1 Instruction book NAVAER 08-5S-127.

ASO stock No. R16-0-1850.

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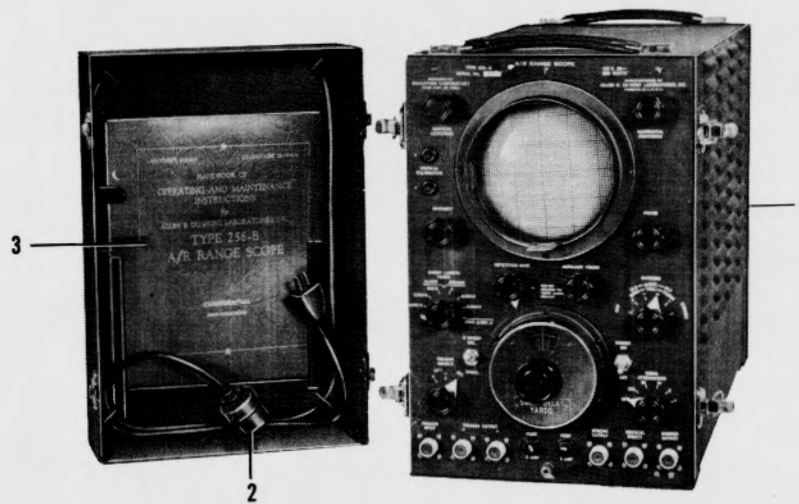


Figure 8-3. A/R Range Oscilloscope—Dumont 256-B

### A/R RANGE OSCILLOSCOPE

#### Dumont 256-B

Primary purpose: A ranging unit and test oscilloscope for radar systems.

An auxiliary ranging unit and test oscilloscope used with existing radar systems to increase their accuracy in ranging, extend their range scale, provide accurate crystal controlled markers, provide expanded delayed and undelayed sweeps, act as precision test scope and calibrator. An "A" scope indicates range only with distance measured from the left edge of the trace. An "R" sweep is an expanded portion of an "A" sweep.

#### Electrical characteristics:

CRT-5CP1 operating with total of 4,000 volts accelerating potential.

"A" Sweep—2 0,000, 20,000, 4,000, 2,000; 800 yards; in addition 4,500 microsecond sweep for observing the entire duty cycle at repetition rates of 300 per second.

"R" Sweeps and Ranging—4,000, 2,000, 800 yards which may be delayed to cover any portion of the 20,000 yard "A" sweep; 4,000 and 2,000 yards which may be delayed to cover any portion of the 200,000-yard "A" sweep. The delay is read directly on a dial with an accuracy of 0.1% of full scale in 500-20,000-yard or 1,000-200,000-yard regions.

#### Internally Triggered Operation:

Trigger output, 100 volts peak negative or positive polarity.

Trigger rise, 0.3 microseconds.

Trigger duration, 1.0 microseconds.

Trigger rep. rate, 80 to 400 on 20,000 yards and

4,500 microsecond range; 80-2000 on 20,000 yard range.

Crystal controlled range marks each 2,000 and 10,000 yards (first 10,000-yard marker at 8,000 yards).

Range mark rise, 0.25 microsecond.

Range mark duration, 1.0 microsecond.

Range mark accuracy, 0.02%.

Externally triggered operation—Trigger input 15 volts minimum at 100 volt per microsecond rise for accurate ranging.

Rep. rate, 2,000 maximum on 20,000-yard scale; 400 maximum on 200,000-yard scale.

No range marks available.

Vertical deflection—Direct: 79 d. c. volts per inch.

#### Video amplifier:

Attenuator 1:1, 3:1, 10:1, 30:1, 100:1.

Input impedance, 1 megohm with 20 mmf shunt cap.

Gain 125, down 3 db at 7 mc., 6 db at 10 mc.

Deflection 0.2 volt with full gain gives 3/4-inch deflection.

Power required: 220 watts, 115 volt 60 c. p. s.

Tubes: 9 type 6SN7GT, 2 type 6H6, 1 type 5U4G, 2 type 2X2A, 1 type 5CP1, 1 type 6AC7, 1 type 6AG7, 1 type 807.

Batteries: None.

#### Complete equipment consists of:

(1) 1 Type 256B A/R Range Scope.

(2) 1 Line Cord.

(3) 1 Instruction book CO-NAVAER 16-5S-504.

ASO stock No. 16-DUM-256-B.

(1) ..... (2) .....

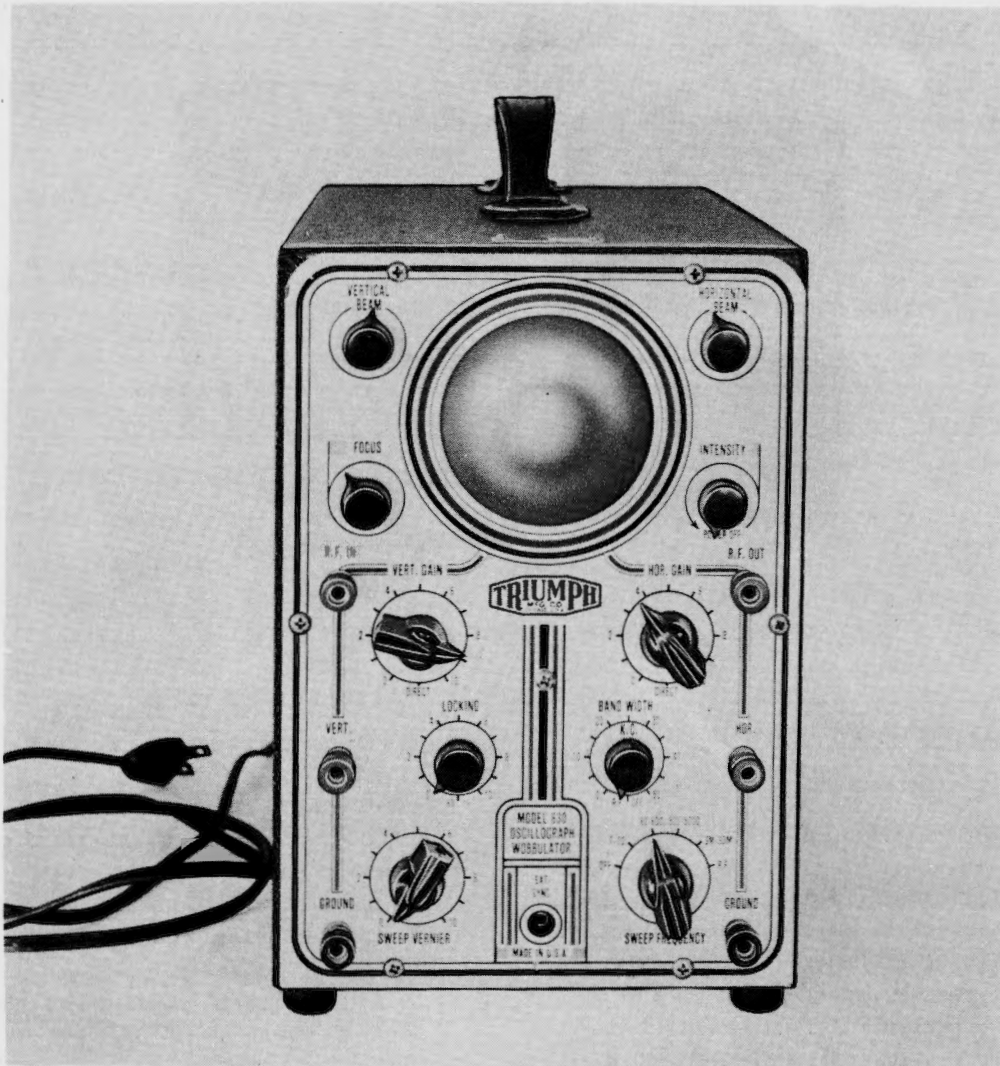


Figure 8-4. Oscilloscope-Wobbulator-Triumph 830

## OSCILLOSCOPE—WOBBULATOR

### Triumph 830

Primary purpose: General service testing and maintenance of radio, radar, and electronic equipment.

Portable, housed in a metal case; 3-inch scope; all controls and connections are on the front panel. X and Y axes input may be through a series condenser or through an amplifier. Internal or external sync. Built-in sweep frequency modulator (Wobbulator), mid frequency 1000 kc. and variable sweep from 0-50 kc.

Electrical characteristics consist of:

- Y axis response: 10 c. p. s. to 100 kc./sec.
- X axis response: 10 c. p. s. to 100 kc./sec.
- Y axis deflection: 0.45 r. m. s. per inch (through amplifier).

Y axis maximum signal input: 400 volts d. c.

Y axis input impedance: 1 megohm at 1,000 cycles.

X axis input impedance: 0.7 megohm.

Sweep frequency: 7 to 30,000 cycles (overlapping in 5 bands).

Power required: 115 volts; 50-60 cycles.

Tubes: 1 type 3AP1; 2 type 6SJ7GT; 1 type 1-V; 1 type 6K8GT; 1 type 884; 1 type 6J5; 1 type 6X5GT.

Batteries: None.

Mechanical characteristics:

Dimensions: 10 $\frac{3}{4}$ " x 7 $\frac{1}{8}$ " x 14".

Weight: 22 pounds.

Complete equipment consists of:

- (1) 1 Oscilloscope, Triumph 830.
  - (2) 1 Instruction book NAVAER 08-5Q-255.
- ASO stock No. R16-0-1865.

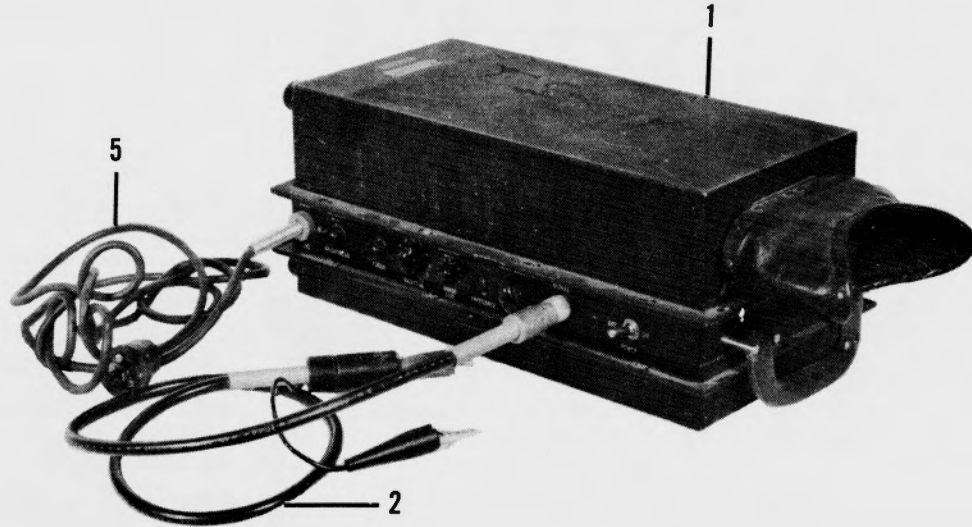


Figure 8-5. Oscilloscope—TS-34/AP

## OSCILLOSCOPE

### TS-34/AP

Primary purpose: General service testing and maintenance of radio, radar and electronic equipment in flight or in the field or laboratory.

A small, portable instrument in a metal case provided with a fiber-carrying container. It employs a light-protected 2-inch cathode ray tube of medium persistence with the screen magnified to 3 inches.

An auxiliary probe lead is furnished for high impedance wave form checking. The oscilloscope is insensitive to interference from microwave fields. Direct connection can be made to both sets of plates.

Timing pulses may be applied to the Z axis (no amplification available).

#### Electrical characteristics:

Range:  $\frac{1}{4}$  microsecond to 30,000 microsecond positive or negative pulses; 30 to 1,000,000 c. p. s. sine waves.

#### Input impedance:

Oscilloscope alone—low 62 ohms; high 430K—shunted by 30 micromicrofarads.

Oscilloscope with probe—4 megohms shunted by 12 micromicrofarads.

#### Input voltage:

Oscilloscope alone—low impedance input 0.1 to 1 volt.

Oscilloscope alone—high impedance input 0.1–1–10–100 volt.

Oscilloscope with probe—1 to 450 volt.

Oscilloscope with probe and TS-89/AP—200 to 20 Kv.

#### Synchronization:

Internal—synchronized by observed signal.

External—0.5 to 75 volts.

Input impedance—1,000 to 2,000 ohms.

#### Sweeps:

Start-stop; 50–50–250 microseconds.

Sawtooth, Frequency:

50K to 5K c. p. s. (20 to 200 microseconds).

5,000 to 250 c. p. s. (200 to 4,000 microseconds).

250 to 10 c. p. s. (4,000 to 100,000 microseconds).

Power required: 115 plus or minus 10 volts, 50–1,200 cycles. 90 watts.

Tubes: 4 type 6AK5; 2 type 6AG7; 2 type 6SL7GT; 1 type 6SN7GT; 1 type 5Y3GT; 1 type 6X5GT; 1 type 2AP1.

Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

Oscilloscope, 6" x 8" x 15".

Carrying case, 29" x 9 $\frac{3}{4}$ " x 10".

##### Weight:

Oscilloscope, 26 pounds.

Carrying case, 15 $\frac{3}{4}$  pounds.

#### Complete equipment consists of:

- (1) 1 Oscilloscope, TS-34/AP.
  - (2) 1 Probe assembly MX-50/AP (50 inches long).
  - (3) 2 Coaxial patching cords (10 feet long). CG-72/U.
  - (4) 2 Adapters (1 foot long). CX-152/U.
  - (5) 1 Power extension cord (15 feet long). CX-150/U.
  - (6) 1 Carrying case CY-110/U.
  - (7) 1 Instruction book AN 08-35TS34-3.
- ASO stock No. R16-0-1885.
- (1) .....
  - (2) R16-AN-MX-50/AP.
  - (3) R16-AN-CG-72/U.
  - (4) R16-AN-CX-152/U.
  - (5) R16-AN-CX-150/U.
  - (6) R16-AN-CY-110/U.



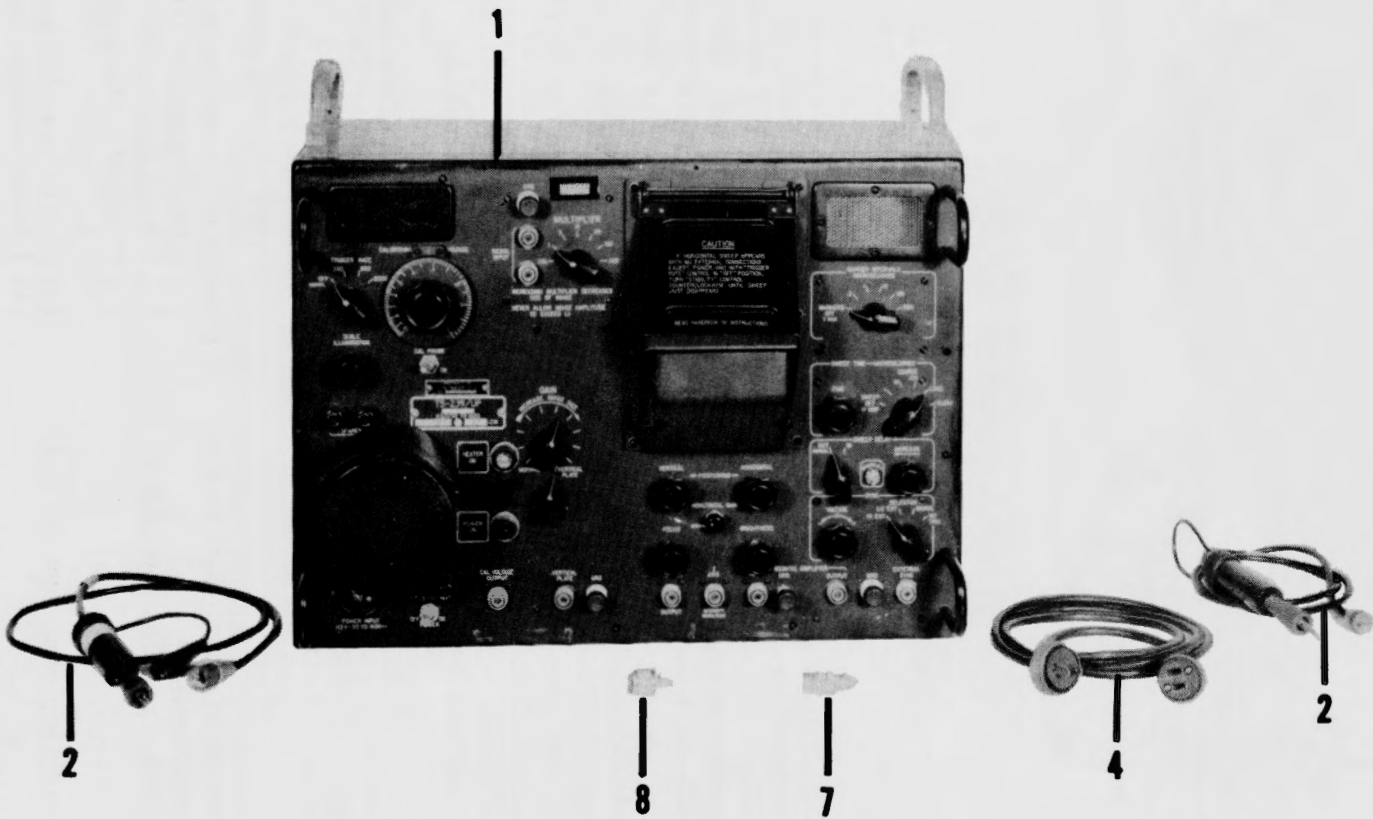


Figure 8-6. Oscilloscope—TS-239/UP

### OSCILLOSCOPE

#### TS-239/UP

Primary purpose: Maintenance of airborne electronic equipment.

Bench type oscilloscope for general maintenance use. Completely shielded 3-inch cathode ray tube. Instrument contains internal calibrating circuit, pulse generator, timing markers and broad band video amplifiers for vertical and horizontal deflection use. An instrument meeting service specifications and eventually should replace all bench type oscilloscopes.

#### Electrical characteristics:

Transients observable: Rise time, 0.08 microseconds (10% to 90% full amplitude); max. sq. pulse duration, 5,000 microseconds; positive or negative.

Sine waves observable: 10 cycles to 5 mc. per second.

Signal input voltage and sensitivity: Nominal for image of standard amplitude, 0.6 inch: .01 to 100 volts peak. With probe: 10 times oscilloscope alone with max. of 450 volts.

Calibrating voltage: Square wave, 150 c. p. s., adjustable from 0.1 to 1 volt peak-to-peak applied internally; 75 volt peak-to-peak square wave available.

Synchronization: Leading or lagging of pulse:

Internal: Signal observed or trigger generator.

External: Without probe  $\pm 0.5$  to  $\pm 150$  volts; with probe  $\pm 5$  to  $\pm 450$  volts.

Input impedance: 300 K ohms paralleled by 30 mmf; with probe, 3 megohms paralleled by 12 mmf.

Sweeps: Start-stop circuit, 0.5 to 50,000 microseconds per inch continuously adjustable.

Timing markers: 0.2, 1, 10, 100, or 500 microseconds.

Trigger pulse output: 25 volts, 4 microseconds at 300, 800 or 2000 pps with 0.5 microsecond rise time.

Sawtooth output: 150 volts.

Power required: 115 volts  $\pm 10\%$ , 50-1600 c. p. s.

Tubes: 3 type 6AK5; 2 type 6AG7; 2 type 6C4; 8 type 7F8; 1 type 6AL5; 2 type 6SN7; 1 type OC3/VR105; 1 type 3JP1; 2 type 6X5GT; 1 type 5R4GY.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 21 $\frac{1}{2}$ " x 16 $\frac{1}{2}$ " x 13 $\frac{1}{2}$ ".

Weight: 63 pounds, 90 pounds with case and accessories.

#### Complete equipment consists of:

- (1) 1 Oscilloscope, TS-239/UP.
- (2) 2 Probes, MX-607/AP.
- (3) 2 Cords, CG-332/U (8 feet) (not illustrated).
- (4) 1 Power cord, CX-337/U (6 feet).
- (5) 1 Adapter, M358 (Navy type 49199) (not illustrated).
- (6) 4 Adapters, binding post (Navy type 491429) (not illustrated).
- (7) 3 Adapters UG-255/U.
- (8) 3 Adapters, UG-273/U.
- (9) 1 Transit case, CY-537/UP (not illustrated).
- (10) 1 Instruction book, AN 16-35TS239-3.

#### ASO stock No. R16-AN-TS-239/UP.

- |                      |                       |
|----------------------|-----------------------|
| (1) .....            | (2) R16-AN-MX-607/AP. |
| (3) R16-AN-CG-332/U. | (4) R16-AN-CX-337/U.  |
| (5) .....            | (6) .....             |
| (7) .....            | (8) .....             |
| (9) .....            |                       |



**RESTRICTED**

**RESTRICTED**

## Section IX POWER METERS

### FUNCTION

Radio frequency power meters (or wattmeters) are instruments designed to measure r-f power for the purpose of maintaining and adjusting transmitters within their designed power and frequency limits.

### THEORY OF OPERATION

The power coupled into the impedance matching circuit is fed to a special circuit which may be a thermocouple, a thermistor circuit, or a specially constructed resistor. This circuit contains a meter which gives either an absolute or a relative power indication, depending upon the test conditions.

A thermistor may be defined as (a) A constant current resistor, (b) A special resistor having a high, negative, temperature coefficient, (c) A sensitive resistor bridge whose resistance varies significantly with temperature and, therefore, with the power applied.

A thermocouple may be defined as a circuit made up of two different metals in which one junction is at a higher temperature than the other. In such a circuit there is generated an electromotive force which causes an electric current. This electromotive force varies in a non-linear but predictable manner with the temperature of the junctions and thus can be calibrated in terms of r-f power converted to heat.

A resistor load which is properly matched to the transmitter impedance will convert the r-f power directly into heat which can be measured by a calorimeter device or by a measurement of either the voltage across, or the current through, the known value of resistance.

### IMPEDANCE MATCHING

For comprehensive measurements r-f wattmeters employ some method of matching the impedance of the wattmeter and the transmitter. Maximum transfer of power is accomplished only when this matching of the impedance of the transmitter output to the impedance of the wattmeter input is completely adjusted, and only then can proper and accurate readings be made. This coupling is accomplished by directional couplers, pick-up horns, tuned lines or direct resistor matching.

In order to properly match impedances it is necessary to understand the standing wave condition in the transmission lines being used. A standing wave is a distribution of current and voltage on a transmission line formed by two sets of waves travelling in opposite directions. It is characterized by the presence of points of successive maximums and minimums in the distribution curves. Since the presence of standing waves indicate reduced power output they are kept to a minimum. For further information see introduction to the section on "Standing Wave Indicators."

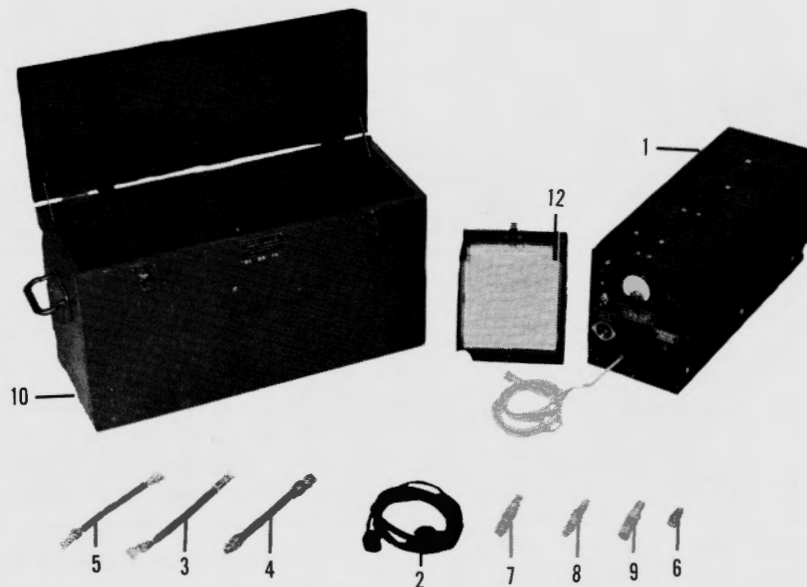


Figure 9-1. Wattmeter-TS-118/AP

## WATTMETER

### TS-118/AP

Primary purpose: For maintenance and adjustment of radar and countermeasures transmitters.

This meter measures the r-f output from 5 to 500 watts within specified frequency limits. Power to be measured is coupled into the wattmeter through a thermocouple selected for the correct power to be measured. The output from the thermocouple feeds through a high loss line and load resistor. The measured r-f power is indicated on 0-1 ma DC meter. Power readings are interpreted from a calibration chart. The thermocouples are supplied in different ranges, low, medium, and high for respective power measurements.

The rectangular metal case with controls on front panel includes a compartment in the base of the instrument for storing cords, adaptors, and thermocouples. A wood-carrying case is provided for storage and handling.

#### Electrical characteristics:

Frequency range: 20 to 1400 mc.

Power range: 5 to 500 watts; accuracy 10%.

Input impedance: 50 ohms.

Power required: 115 volts a. c. (25-60 c. p. s.) or d. c., approximately 22 watts.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 24 $\frac{1}{2}$ " x 11" x 8 $\frac{1}{2}$ ".

Weight: 26 pounds, case 22 pounds.

#### Complete equipment consists of:

- (1) 1 Radio frequency wattmeter, TS-118/AP.
- (2) 1 Cord CX-237/U (10 feet), 120 inches.
- (3) 1 Cord CG-122/U, 9 inches.
- (4) 1 Cord CG-123/U, 8 inches.
- (5) 1 Cord CG-56/U, 9 inches.
- (6) 2 Radio frequency adapter UG-108/U.
- (6) 2 Radio frequency adapters UG-108/U.
- (7) 3 Thermocouples MX-205/AP, 4 inches.
- (8) 3 Thermocouples MX-206/AP, 4 inches.
- (9) 3 Thermocouples MX-207/AP, 4 inches.
- (10) 1 Case CY-174/AP.
- (11) 1 Tuning stub TN-87/AP (not illustrated).
- (12) 1 Calibration chart (low-medium power).
- (13) 1 Calibration chart (high power range) (not illustrated).
- (14) 5 Fuses (2 amperes) (not illustrated).
- (15) 1 Set screw wrench (not illustrated).
- (16) 1 Instruction book. AN 16-35TS118-2.

#### ASO stock No. R16-AN-TS-118/AP.

- |                       |                        |
|-----------------------|------------------------|
| (1) .....             | (2) R16-AN-CX-237/U.   |
| (3) R16-AN-CG-122/U.  | (4) R16-AN-CG-123/U.   |
| (5) R16-AN-CG-56/U.   | (6) R16-A-564.         |
| (7) R16-AN-MX-205/AP. | (8) R16-AN-MX-206/AP.  |
| (9) R16-AN-MX-207/AP. | (10) R16-AN-CY-174/AP. |
| (11) R16-AN-TN-87/AP. | (12) .....             |
| (13) .....            | (14) .....             |
| (15) .....            | .....                  |

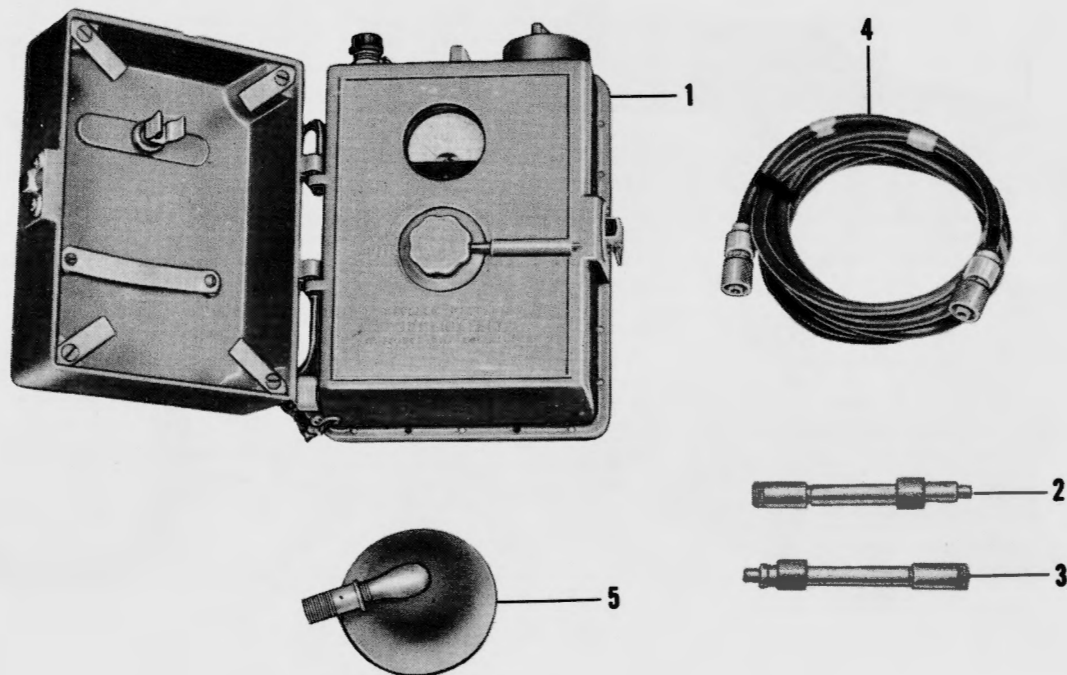


Figure 9-2. Power Meter-TS-125/AP

## POWER METER

### TS-125/AP

Primary purpose: Measuring RF power.

This unit is a compact, light-weight battery-operated wattmeter encased in a cast aluminum box. If the space attenuation is known or a directional coupler is used it will give absolute power measurements, otherwise the power will be relative. The box contains a thermistor mount with sensitivity and zero compensating discs, mounted on its sides, 250-ohm bridge circuit, meter, balancing potentiometer, and batteries.

Electrically this power meter consists of a wheatstone bridge circuit employing a thermistor bead element, and r-f matching transformer, and a DC indicating meter. In order to facilitate zero setting the meter, a balancing potentiometer is provided. TS-125/AP may be used for making average power measurements. Peak power may be computed by knowing the pulse length and the pulse repetition frequency (PRF) of the system being tested.

#### Electrical characteristics:

Frequency range: 2400 mc. to 3335 mc.

Sensitivity: 2 milliwatts full scale, 4 watts maximum with attenuators.

Calibration: Dbm. and milliwatts.

Tubes: None.

Power required: 3-1.5 volt batteries type BA-30 (not supplied). Current drain 30 ma. (Batteries must be requisitioned when ordering this equip.)

Accuracy: When used with the same radar, same dipole, same position relative to the radar, same cables and attenuators, day to day accuracy can be read to 1/2 db.

#### Mechanical characteristics:

Dimensions: 10" x 7 7/8" x 5 5/16" over-all.

Weight: 12 pounds.

#### Complete equipment consists of:

- (1) 1 Power Meter, TS-125/AP.
- (2) 1 Attenuator (5 inches long) 10 db.
- (3) 1 Attenuator (5 inches long) 20 db.
- (4) 1 RF cable with plugs CG-171/AP.
- (5) 1 Pickup dipole AT-67/AP.
- (6) 1 Instruction book AN 08-35TS125-3.

ASO stock No. R16-AN-TS-125/AP.

- |           |                 |
|-----------|-----------------|
| (1) ..... | (2) .....       |
| (3) ..... | (4) R16-A-4934. |
| (5) ..... |                 |

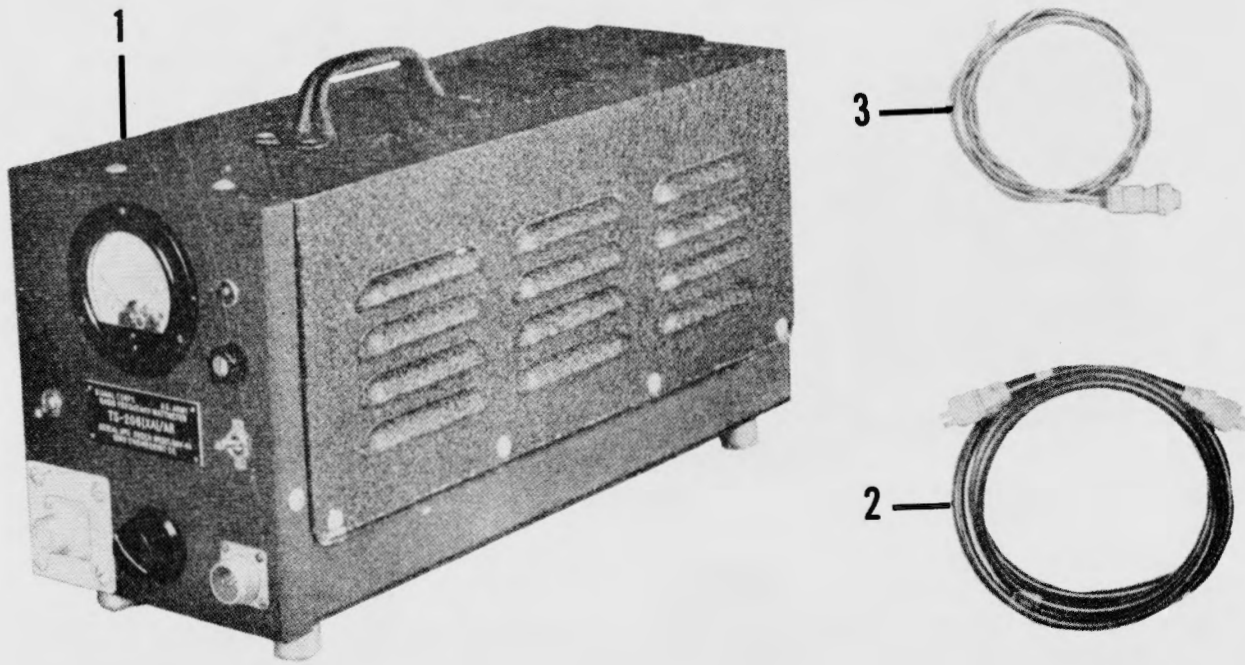


Figure 9-3. Wattmeter-TS-206/AR

## WATTMETER

### TS-206/AR

Primary purpose: A radio frequency wattmeter designed for testing of high power radar transmitters not exceeding 1 kw.

An r-f wattmeter in which the external r-f power is dissipated into a specially constructed 50-ohm resistor encased in a hydrogen-filled atmosphere. Power indications are obtained by the functions of an airflow calorimeter. A blower fan provides a source of air for the calorimeter and for cooling the resistor. Power measurements are read from a 0-1 ma. d. c. meter in conjunction with calibration charts.

It is self-contained in a metal case with accessory carrying handle. Louvres are provided for air circulation. An r-f cable and power cord are supplied. A wooden carrying case is supplied for storage when the wattmeter is not in use.

#### Electrical characteristics:

- Frequency range: 20 to 60 mc.
- Power range: 50 to 1,000 watts (average).
- Accuracy:  $\pm 10\%$ .
- Input impedance: 50 ohms.
- Power required: 28 V. d. c.
- Tubes: None.

#### Mechanical characteristics:

- Dimensions:  $16\frac{1}{8}'' \times 7\frac{3}{4}'' \times 8\frac{1}{4}''$ .
- Weight: 32 pounds; 50 pounds with case.

#### Complete equipment consists of:

- (1) 1 Radio frequency wattmeter, TS-206/AR.
- (2) 1 Cord CG-123/U, 7 feet.
- (3) 1 Cord CX-356/U, 10 feet.
- (4) 1 Case CY-185/AR (not illustrated).

#### ASO stock No. R16-AN-TS-206/AR.

- (1) ..... (2) R16-AN-CG-123/U.
- (3) ..... (4) R16-AN-CY-185/AR.



## Section X SIGNAL GENERATORS

### FUNCTION

The purpose of a signal generator is to produce a signal of desired frequency and modulation characteristics and to produce this signal at the required amplitude.

### TYPES

There are numerous types of signal generators included in the following pages, some of them having highly specialized application. However, it is possible to classify them roughly as audio and video, RF, FM, and special signal generators. The equipments in this section are divided into these groups.

### AUDIO AND VIDEO GENERATORS

In addition to the simple buzzer type, audio and video generators fall into two groups, both of which contain a power supply, an oscillator section, an amplifier, and an output control.

(A) Beat frequency oscillators—in which the audio or video frequency is produced by mixing the signals of 2 r-f oscillators one of which is fixed in frequency and the other variable. The difference in frequency between these r-f oscillators is equal to the desired audio frequency. For instance, if the fixed and variable oscillator both had a frequency of 400 kc., the resultant output frequency would be zero cycles. When the variable oscillator is changed to 401 kc., the resultant output would be 1 kc. By this action any desired frequency may be produced.

(B) RC oscillators in which the audio frequency is directly produced by a resistance-capacitance oscillator. In order to vary frequency either R or C may be varied. However, in practice, C is chosen as the variable since the variation of a tuning capacitor is much more readily controlled than that of a variable resistor. The change of frequency which can be produced by this method is limited, therefore it is often necessary to cover the desired frequency range in several steps. This is accomplished by switching either or both the resistance and capacitance values.

### R-F GENERATORS

An r-f signal generator contains, in addition to the necessary power supply, three main sections: oscillator circuit, modulator circuit, and output circuit.

(A) The oscillator has as its function the emission of a signal the frequency of which can be accurately set to any point on the designed frequency range. The type of oscillator used depends on the range of frequencies required. It may have as its resonating circuit a simple coil and condenser (LC oscillator), a tuned line, a tuned cavity, or any of the various specialized types designed for microwave frequencies.

(B) The modulating circuit functions to superimpose upon the r-f signal an audio or video frequency which varies the r-f output in accordance with the successive instantaneous voltage values of the superimposed audio or video signal. The result is an r-f output with a superimposed "modulation envelope." The modulating signal may be provided from a source contained within the signal generator (internal modulation), or it may be provided by the operator from an outside source (external modulation). Either or both of these methods may be provided on a particular instrument. A meter is often included to indicate and permit control of the percentage modulation.

The form the modulating signal may take depends upon the application of the particular signal generator. It may consist of a sine wave, square wave, or pulse. Some instruments have special provision for pulse modulation which permits the r-f signal to be pulsed over a wide range of pulse repetition frequencies (p. r. f.) and at various pulse widths. An external synchronizing pulse may be used to initiate a signal generator pulse which may be sometimes delayed as long as 300 microseconds after being initiated.

(C) The output circuit contains a calibrated attenuator and often an output level meter. The output level meter gives an indication of, and permits control of, the output of the oscillator by indicating arbitrary values of output in tenths through the value of one. The attenuator "picks up" the amount of this output that is required and is usually calibrated in terms of microvolts. When the output level meter is adjusted to unity (1), the attenuator gives a direct reading in microvolts. If the output cannot be brought to, or is not desired at 1 the decimal value is multiplied by the attenuator reading to give the micro-volt output.



### FM GENERATORS

A frequency modulated signal is one in which the frequency varies above and below a "center frequency." The overall frequency variation is sometimes known as the "frequency swing," and the rate at which this swing recurs is controllable at any audio or video frequency rate for which the generator has been designed. The change of frequency of the output may be accomplished by the mechanical variation of either the capacitance or inductance of the oscillator circuit. However, this controlled variation may be accomplished by the incorporation of a reactance tube in the oscillator circuit. Changes of the voltage impressed on the grid of the reactance tube change the reactance introduced into the oscillator tuned circuit and consequently cause its frequency to change. The frequency of the signal on the grid of the reactance tube thereby controls the rate of frequency swing, and the amplitude of this grid signal voltage controls the amplitude of the frequency swing.

### SIGNAL GENERATORS

The last portion of the signal generator section contains instruments which are designed for the testing of special equipment. These signal generators, in general, perform many more functions than those listed previously, some of them highly specialized. Some of these

generators have provision for measuring frequency by means of built-in frequency meters. Power measurements may be made in some cases through the employment of self-contained power meters. Other generators will measure repetition rates and delay time of transpondors and some are intended for special testing of IFF equipment. Because of the varied purposes of the signal generators included in this section, further discussion is reserved for inclusion in the individual descriptions.

### FREQUENCY SPECTRUM

Due to the fact that the various ranges in the frequency spectrum are sometimes very loosely used, a table of the proper nomenclature is presented.

<i>Range</i>	<i>Noun</i>
10 kc.-30 kc.	Very-low frequency
30 kc.-300 kc.	Low frequency (LF)
300 kc.-3000 kc.	Medium frequency
3 mc.-30 mc.	High frequency (HF)
30 mc.-300 mc.	Very-high frequency (VHF)
300 mc.-3000 mc.	Ultra-high frequency (UHF)
3000 mc.-30,000 mc.	Super-high frequency (SHF)
30,000 mc.-300,000 mc.	Super-super-high frequency (SSHF)

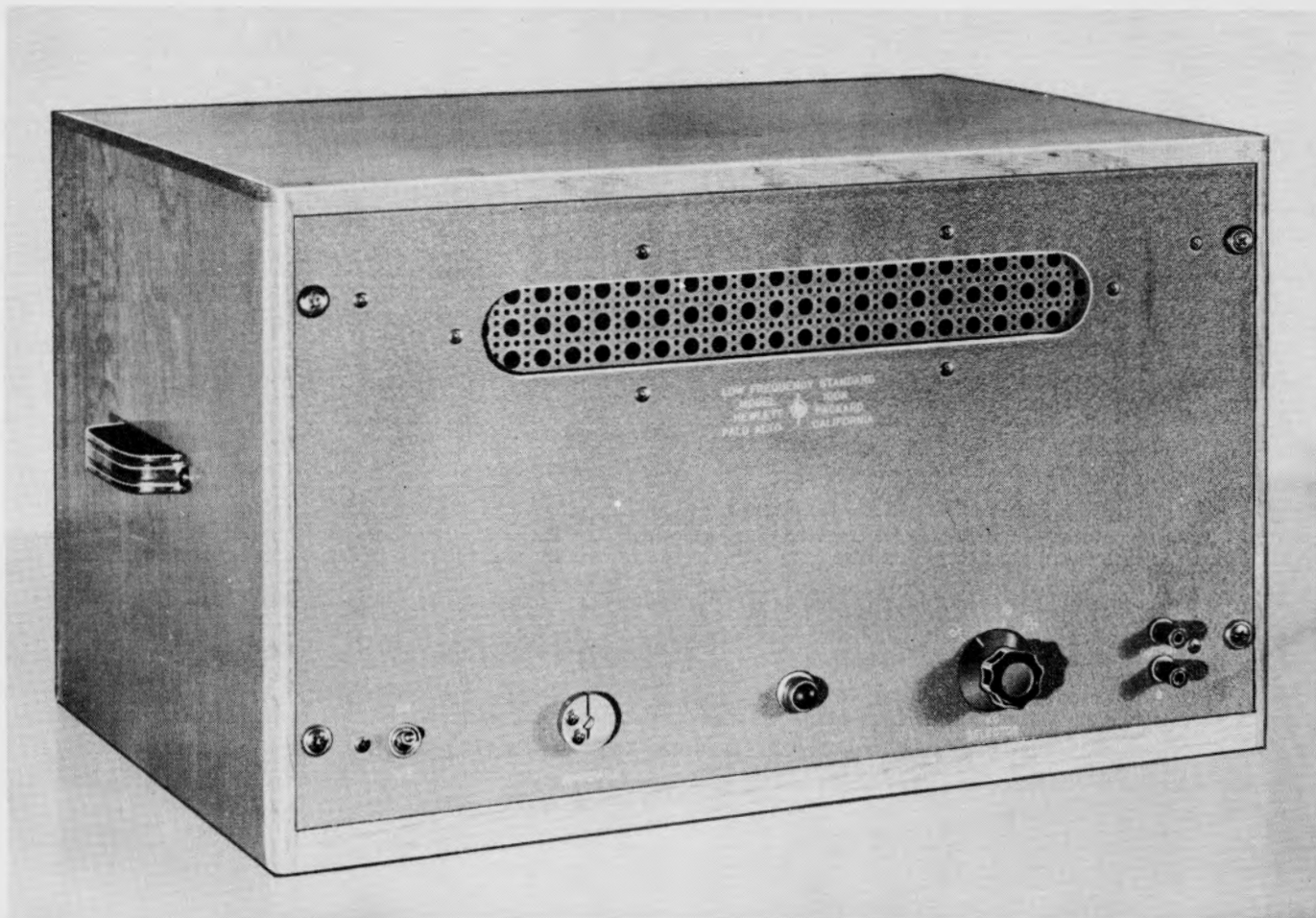


Figure 10-1. Low Frequency Standard—Hewlett-Packard 100-A

## LOW FREQUENCY STANDARD

### Hewlett-Packard 100-A

Primary purpose: To provide crystal-controlled frequency standards of 100, 1000, 10,000, and 100,000 cycles.

The Model 100-A Low Frequency Standard consists of a 100 kc. crystal-controlled oscillator, and a series of three 10 to 1 regenerative modulator type frequency dividers providing frequencies of 10 kc., 1 kc., and 100 c. p. s. Output from each frequency is brought to separate terminals at the rear of the chassis through buffer stages having a low impedance output. Two output terminals are also provided on the front panel, together with a switch to select any one of the output frequencies desired. Output on all frequencies is essentially sinusoidal.

Electrical characteristics:

Frequency: 100, 1000, 10,000, and 100,000 cycles.

Accuracy:  $\pm .01\%$ , temperature variation  $\pm 33^\circ$  C.

Output: 5 volts.

Output Impedance: 200 ohms.

Power Supply: 115 volts, 60 cycles, 105 watts.

Tubes: 1 type 6SJ7, 4 type 6AC7, 6 type 6L7, 1 type 5Z4, 2 type 6L6G, 1 type 6SF5.

Mechanical characteristics:

Dimensions: 19" x 10 $\frac{1}{2}$ " x 12".

Weight: 53 pounds.

Complete equipment consists of:

- (1) 1 Model 100-A Low Frequency Standard.
- (2) 1 Power Cable (not illustrated).
- (3) 1 Instruction book NAVAER 16-5Q-500.

ASO stock No. R16-HWP-100-A.

- (1) .....
- (2) .....



Figure 10-2. Audio Oscillator—Hewlett-Packard 200-C

## AUDIO OSCILLATOR

### Hewlett-Packard 200-C

Primary purpose: A source of low-power variable audio frequency for modulating signal generators and radio transmitters, and for testing audio band widths of filters, radio receivers, and audio amplifiers.

Audio and intermediate frequencies are covered in four continuously variable ranges from 20 cycles to 200,000 cycles. The output to all frequencies is continuously variable from 0 to maximum output and the output 1 db. for frequencies between 20 cycles and 150,000 cycles. Distortion is less than 1% below 20 kc. and the hum level at all frequencies less than 0.01%. The frequency stability is plus or minus 0.2% at 1 kc. for line voltage changes of  $\pm 20\%$ .

#### Electrical characteristics:

Frequency range: 20 to 200,000 cycles.

Stability:  $\pm 0.2\%$ .

Output: Maximum, 10 volts r. m. s. into 1,000-ohm load.

Power: 115 volts, 60 cycles, 70 watts.

Batteries: None.

Tubes: 2 type 6J7; 1 type 6F6; 1 type 6V6; 1 type 5Z4 or 5Y3/GT.

Lamp: One 3-watt 120-volt Mazda.

Fuses: 1 3AG (1 amp).

#### Mechanical characteristics:

Dimensions:  $15\frac{3}{4}$ " x  $10\frac{5}{8}$ " x 7".

Weight: 30 pounds.

#### Complete equipment consists of:

(1) 1 Audio oscillator, H-P 200-C.

(2) 1 Instruction book NAVAER 08-5QS-2.

ASO stock No. R16-0-1784.

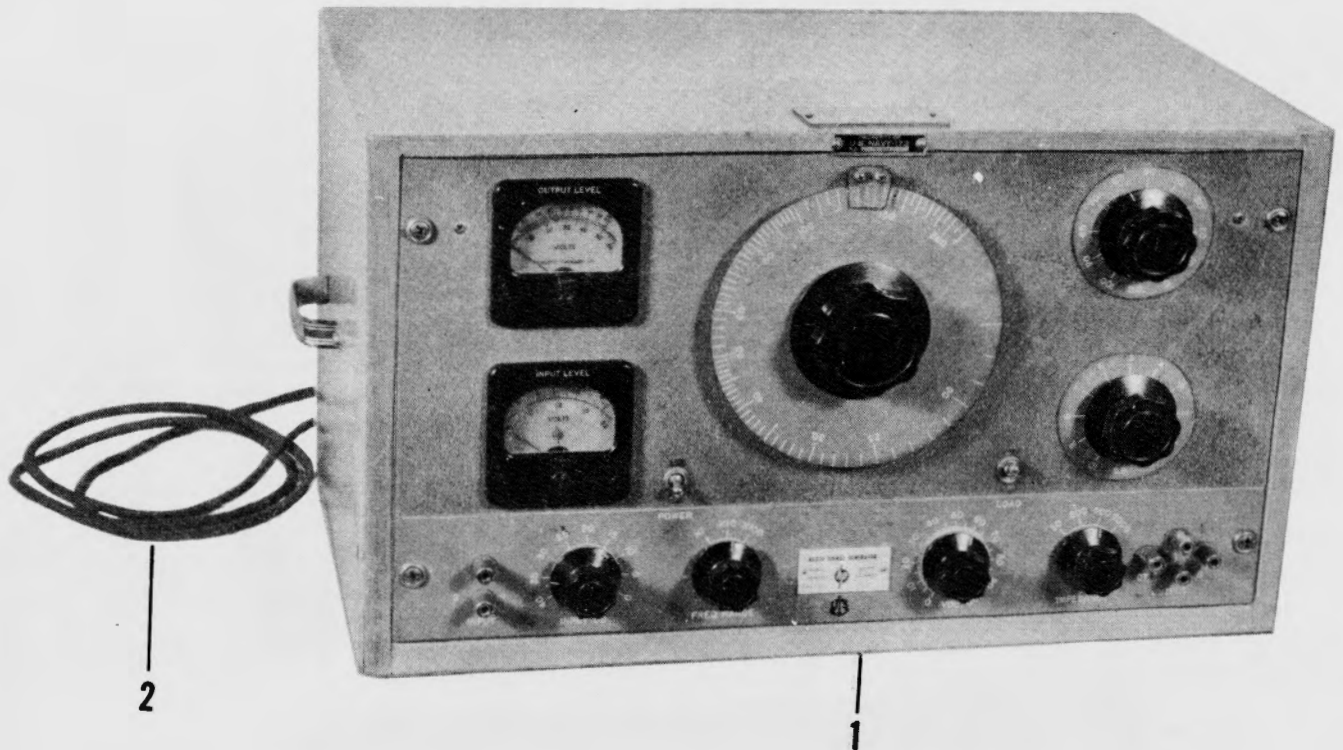


Figure 10-3. Audio Signal Generator—Hewlett-Packard 205-AG

## AUDIO SIGNAL GENERATOR

### Hewlett-Packard 205-AG

Primary purpose: General audio applications where high degree of accuracy is desired.

This instrument consists of a resistance-tuned oscillator in combination with an output meter, attenuator, and an impedance matching system. The input meter is of the average reading type calibrated to read the r. m. s. value of a sine wave. It consists of a two-stage resistance coupled amplifier with a full wave diode voltmeter in its output circuit. Negative feedback is employed in the amplifier circuit to stabilize its gain and improve the linearity of the scale. An "input" meter is provided for measuring the output of the equipment under test.

#### Electrical characteristics:

Frequency range: 20-20,000 cycles (3 ranges).

Frequency indicator: Dial is calibrated 0-200 cycles; range switch indicates multiplying factor.

Input meter range: 60 volts full scale from 500-ohm output.

Output impedance: 12½, 50, 125, 200, 500, 1,250 and 5,000 ohms.

Output Voltage: -80 dbm to + 37 dbm.

Attenuators (two): 100 db in 10 db steps and 10 db in 1 db steps.

Output meter: 2 volts full scale with 5,000-ohm output impedance.

Input multiplier: 0-40 db in 5 db steps.

Accuracy: Less than 2 percent drift with normal temperatures.

Lamp: One 3-watt, Mazda 47.

Tubes: 2 type 6SF5; 2 type 6H6; 1 type 6F8G; 2 type 6L6G; 1 type 6F6; 1 type 5T4; 1 type 6J7.

Power input: 115 volts, 60-cycle, single phase, 125 watts.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 11½" x 22½" x 13¾".

Weight: 67 pounds.

#### Complete equipment consists of:

(1) 1 Signal generator, H-P 205-AG.

(2) 1 Power cord.

(3) 1 Instruction book NAVAER 08-5QS-1.

ASO stock No. R16-0-1785-25.

(1) ..... (2) .....



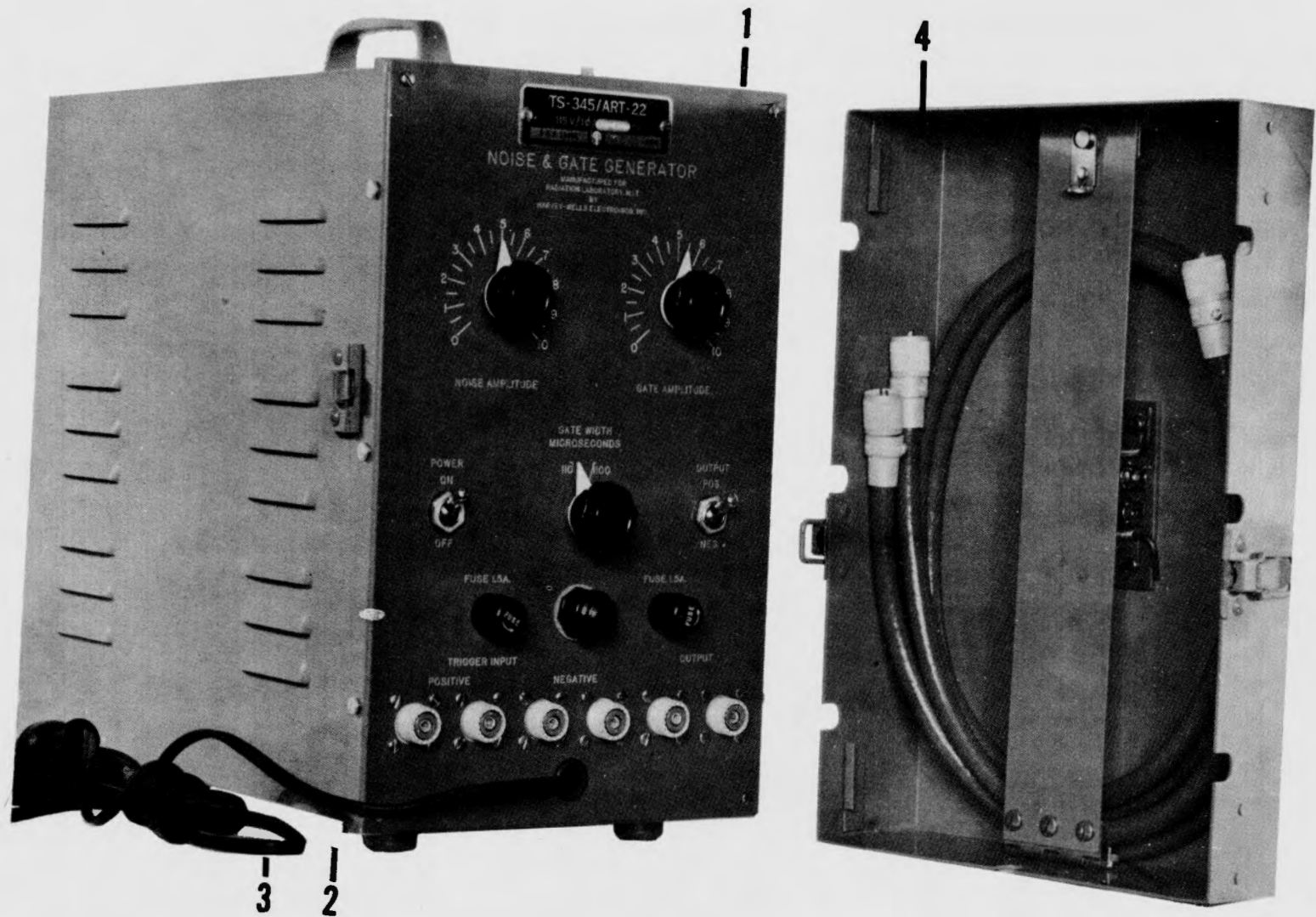


Figure 10-4. Artificial Video Generator—TS-345/ART-22



### ARTIFICIAL VIDEO GENERATOR

#### TS-345/ART-22

Primary purpose: To modulate transmitter T-123/ART-22 directly or in combination with the SN-22/APS-20 synchronizer.

The equipment will furnish artificial video consisting of continuous artificial noise interrupted only by a gate of 120 microseconds or 1110 microseconds length and which occurs 500 microseconds after an external trigger of from 35 to 200 volts of either polarity as applied. The gate will completely blank out the noise during the interval that the gate occurs. The gate and noise are adjustable in amplitude independently and can be switched in polarity together. The equipment simulates the output of a radar receiver with the gain turned up to show noise and with a long continuous block of signals.

Electrical characteristics:

Frequency: Video.

Tubes: 4 type 6SN7, 2 type 6SL7, 1 type 6D4, 1 type 5R4GY, 1 type 6X5GT, 2 type OD3/VR-150, 1 type OC3/VR-105.

Batteries: None.

Power required: 115-volt, 50-1600 cycles, 100 watts.

Mechanical characteristics:

Dimensions: 16" x 8" x 13" (case).

Weight: 35 pounds.

Complete equipment consists of:

- (1) 1 Test set, TS-345/ART-22.
- (2) 1 Trigger cable (4 feet) RG-9/U with 49195 connectors.
- (3) 1 Output cable (4 feet) RG-9/U with 49195 connectors.
- (4) 1 Cover.
- (5) 1 Instruction book CO-NAVAER 16-5Q-503.

ASO stock No. R16-AN-TS-345/ART-22.

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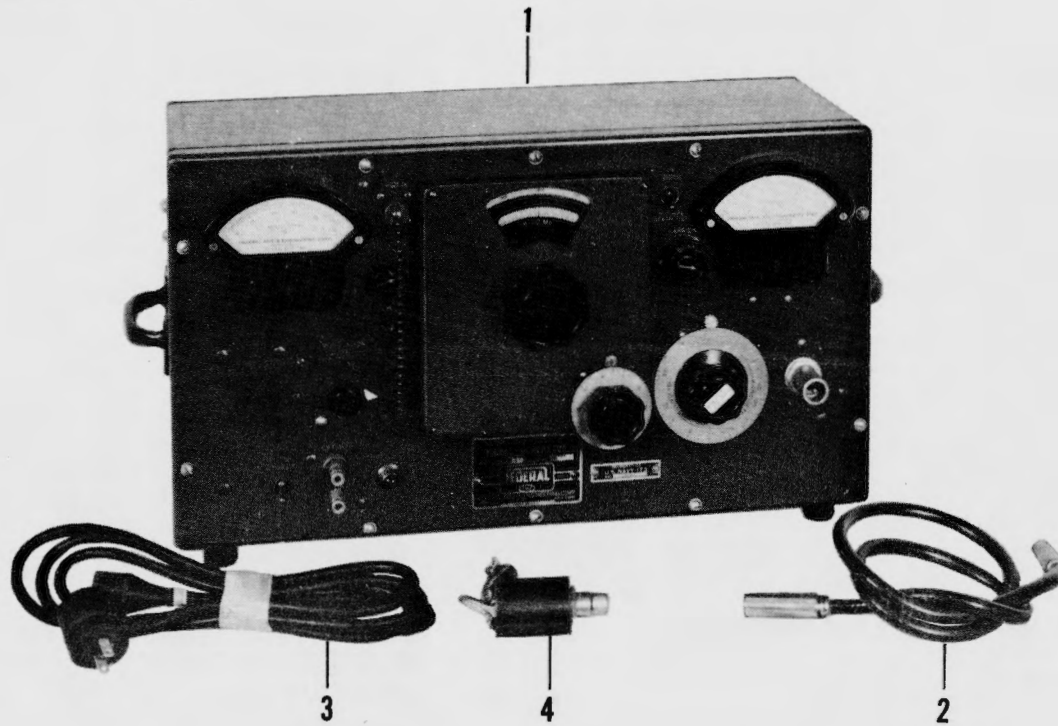


Figure 10-5. Signal Generator-GR-805-CS2

## SIGNAL GENERATOR

### GR-804-CS2

Primary purpose: For general signal generator applications in the UHF band.

This signal generator is designed to measure and check receiver alignment and sensitivity. The frequency range is covered in five steps and is read directly from the frequency dial. The internal modulation is variable and is indicated by a percentage modulation meter. A calibrated dial and attenuator indicates the output power.

Model 804-C series differs from Model 804-B only in that it has an internal modulation frequency of 1000 c. p. s. and has been electrically altered to accept pulse modulation. The Navy code for model GR 804-C is Model LX.

Modification kits to convert the model 804-B and 804-C to a model 804-CS2 have been distributed.

#### Electrical characteristics:

Frequency range: 7.6 to 330 mc.

Range switch: 5 steps for full coverage.

Internal modulation: 1,000 cycles 0 to 60% (400 cycles for Model 804-B).

Provision for external modulation.

Output: 1 microvolt to 20 millivolts up to 100 mc./

sec.; 1 microvolt to 10 millivolts from 100 to 330 mc./sec.

Output impedance: 75 ohms.

Accuracy: Plus or minus 2%.

Attenuator: Variable capacity voltage divider 1 to 20,000 microvolts.

T-pad attenuator: Provided for additional external attenuation (Coaxial insertion unit).

Tubes: 1 type 955; 1 type 6X5GT; 1 type 6G6G; 1 type OD3/VR-150.

Power input: 115/230 volts, 25 watts, 40/60 cycles, single phase.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9" x 19½" x 11⅝".

Weight: 36 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator, GR-804-CS-2.
- (2) 1 Output cable.
- (3) 1 AC line cord assembly.
- (4) 1 10:1 attenuator CFD-631210.
- (5) 1 Terminal unit CFD-49182 (not illustrated).
- (6) 1 Instruction book NAVAER 08-5QS-14.

ASO stock No. R16-G-3120.

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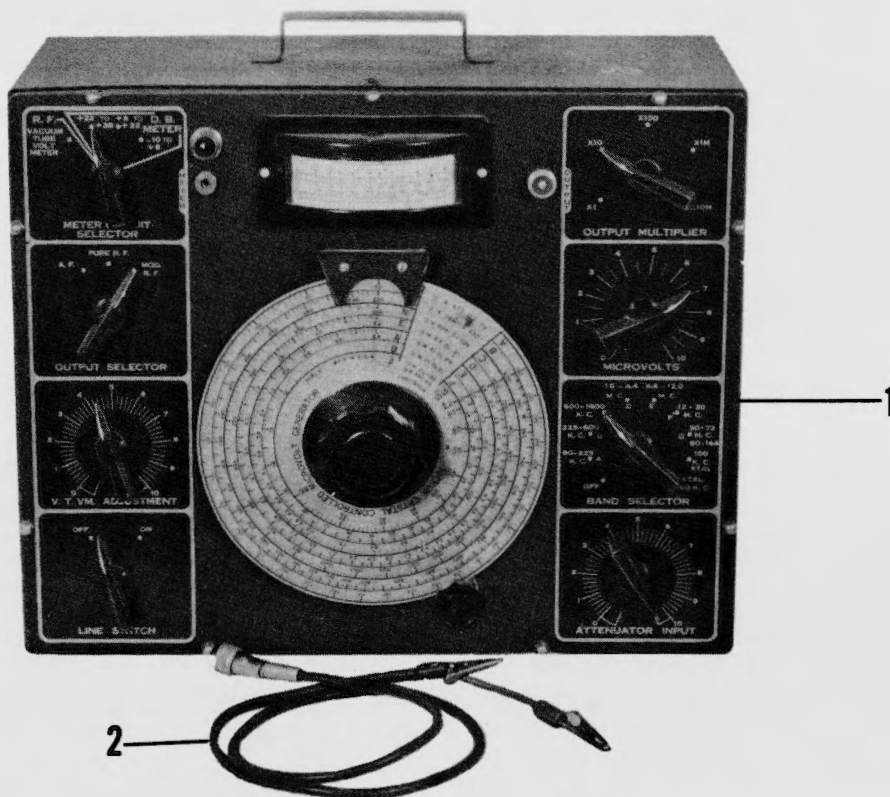


Figure 10-6. Signal Generator—Hickok 19-X

## SIGNAL GENERATOR

### Hickok 19-X

Primary purpose: General signal generator applications for radio maintenance.

A crystal controlled microvolt signal generator, covers in 6 ranges from 100 kc. to 30 mc. on fundamentals. Frequencies up to 144 mc. are obtainable by harmonics on one additional step. Crystal outputs at 100 kc. and 1,000 kc. are available in 2 additional steps. A built-in crystal oscillator provides crystal check points every 100 kc. up to 15 mc. and every 1,000 kc. up to 120 mc. The dial is calibrated directly in frequency.

A 400-cycle modulator may be used to provide approximately 30 percent modulation to the signal generator output. The output of the modulator may also be switched to the attenuator so that a calibrated audio output of 1.0 volt is available.

Also supplied is a calibrated attenuator and db. vacuum tube voltmeter used in conjunction with each other for accurate calibration of the output.

### Electrical characteristics:

Frequency range: 100 kc. to 144 mc.  
Modulation: 400 cycle; 30 percent.  
Accuracy:  $\pm 1.0$  percent.  
Crystal controlled output accuracy:  $\pm 0.01\%$ .  
Output: R-F, 0.5 microvolt to 100,000 all ranges;  
AF, 0 to 1.0 volt.

Output control: Calibrated attenuator in conjunction with a vacuum tube voltmeter.  
Tubes: 1 type 6SN7; 1 type 6X5GT; 2 type 6J5.  
Power required: 115 v., 60 cycles.  
Batteries: None.

### Mechanical characteristics:

Dimensions: 13" x 16" x 7".  
Weight: 20 pounds.

### Complete equipment consists of:

- (1) 1 Signal generator, Hickok 19-X.
- (2) 1 Shielded output cable.
- (3) 1 Meter connector lead (not illustrated).
- (4) 1 Instruction book NAVAER 08-5Q-260.

### ASO stock No. R16-G-3150.

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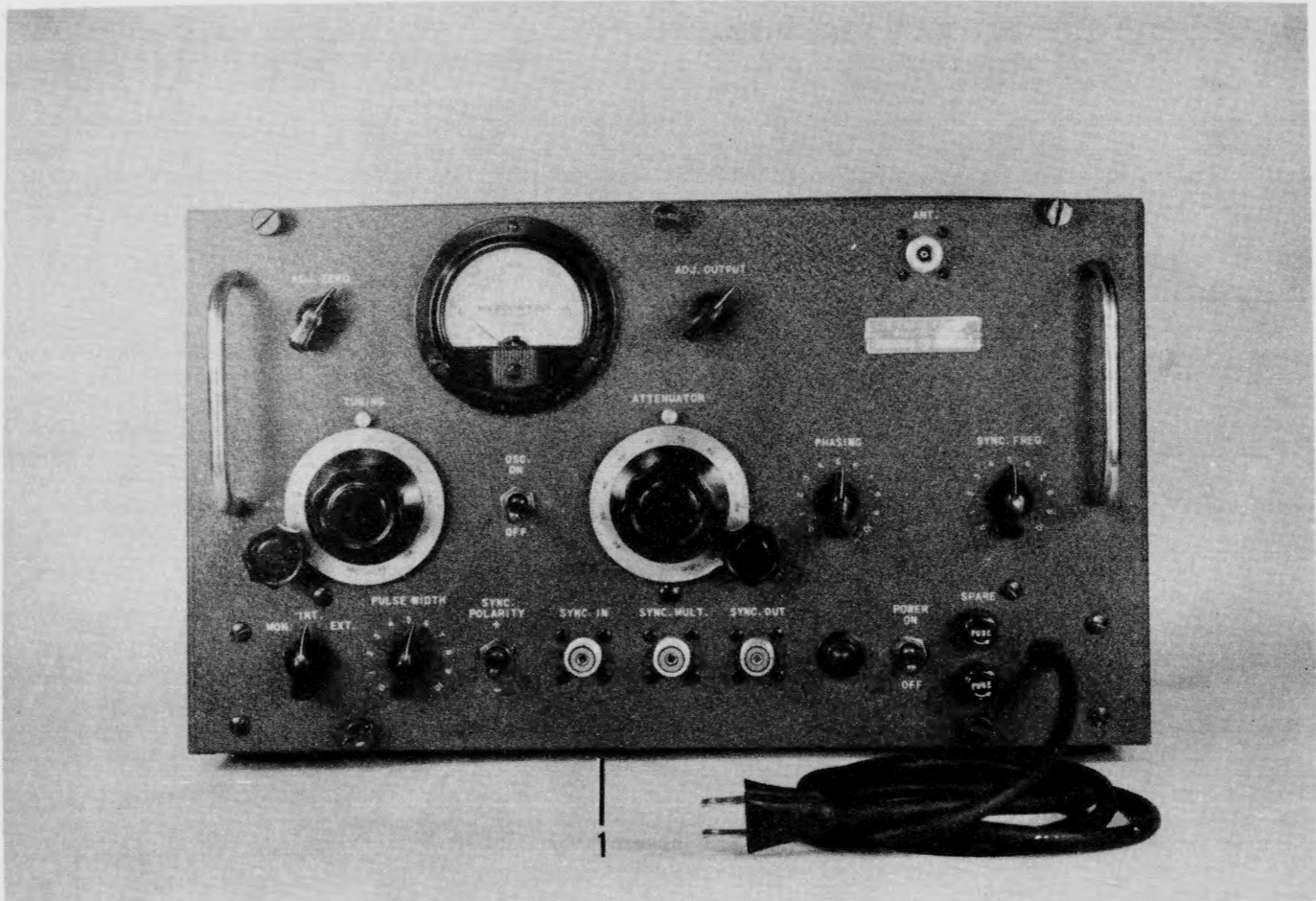


Figure 10-7. RF Test Set—Navy Model LAD

## RF TEST SET

### Navy Model LAD

Primary purpose: Bench and field testing of radars.

This portable test set is a generator of calibrated r-f signals. Provision is made so that it can be pulsed internally and externally. This instrument can be used to check receiver sensitivity, measure transmitter power output, and as a transfer frequency meter (uncalibrated) to align the transmitter and receiver to a common frequency. A thermistor is provided to measure transmitter power and to monitor the signal generator.

#### Electrical characteristics:

- Frequency: 2700 mc. to 2900 mc.
- Power input: 20-200 milliwatts to 1.5 db.
- Power output: Minus 20 dbm to minus 100 dbm.
- Pulse width: 1 to 2.8 microseconds.

Phasing: 10 to 200 microseconds after trigger (at 1000 p. r. f.).

Internal sync: Width fixed at 2 microseconds.

Power required: 115 volts  $\pm$  10%, 50-800 c. p. s.  
80 watts.

Batteries: None.

Tubes: 2 type 6SN7, 1 type 6AC7, 1 type 446B,  
1 type OC3/VR-105, 1 type 5Y3GT.

#### Mechanical characteristics:

Dimensions: 16 $\frac{3}{4}$ " x 9 $\frac{3}{4}$ " x 11 $\frac{1}{4}$ ".

Weight: 40 pounds.

#### Complete equipment consists of:

- (1) 1 RF Test Set, LAD.
- (2) 1 Sync cable (6 feet) (not illustrated).
- (3) 1 Antenna cable (6 feet) (not illustrated).
- (4) 3 Allen wrenches (6-8-10) (not illustrated).
- (5) 1 Instruction book CO-NAVAER 16-5Q-507.

#### ASO stock No. R16-NAV-LAD.

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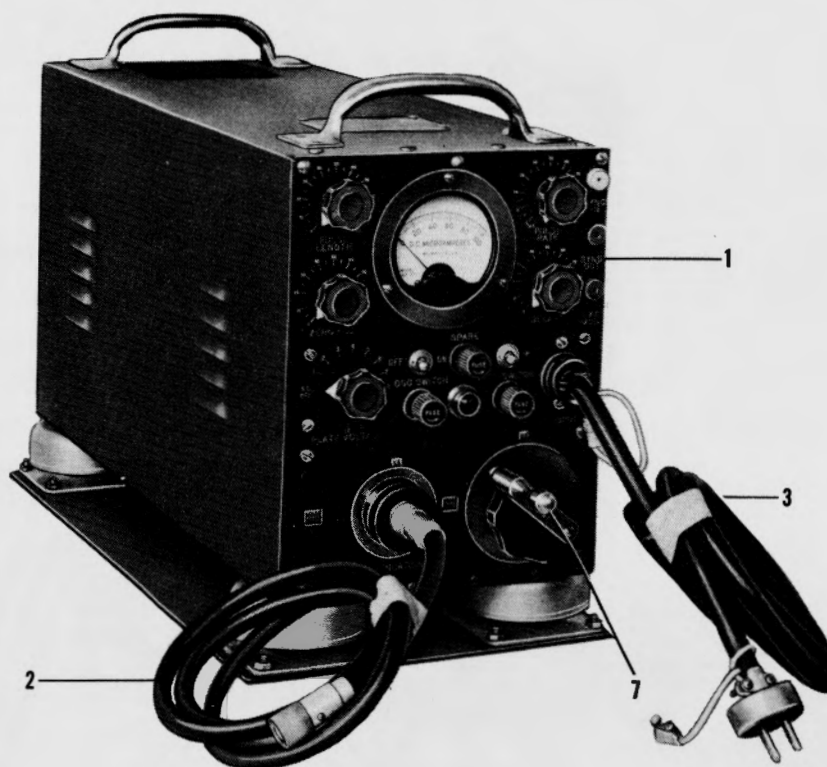


Figure 10-8. RF Test Set—Navy Model LAE

## SIGNAL GENERATOR, UHF

### Navy Model LAE Series

Primary purpose: For aligning UHF receivers and for measurement work when an accurate, adjustable, and known r-f voltage is required, unmodulated, modulated, or pulsed.

The model LAE equipment consists of four major units; Variable frequency cavity oscillator, pulser, power supply, and power level monitor. All are housed in a single steel cabinet.

Pulse operation is instantly available, with the pulse rate variable from 60 to 2,500 c. p. s. and the pulse length variable between 2 and 30 microseconds. A pulse delay circuit is provided which allows delaying the final pulse relative to the synchronizing pulse by an interval adjustable from 3 to 300 microseconds. Provision is made for internal synchronization, external synchronization, and external modulation. No internal sine wave modulation is provided.

The frequency is varied by changing the length of the cavities in the oscillator by means of a dial control. Output voltage, controlled by an attenuator dial, is taken across a 50-ohm concentric line permanently attached to an attenuator.

#### Electrical characteristics:

Frequency range: 520 mc. to 1300 mc.

Accuracy:  $\pm 1\%$ .

Output voltage: 0 to 100,000 microvolts.

Output impedance: 50 ohms.

Pulse rate: 60 to 2500 c. p. s.

Pulse length: Variable 2 to 30 microseconds.

Pulse delay: Final relative to synchronizing pulse variable 3 to 300 microseconds.

Batteries: None.

Tubes: 1 type 6J5; 2 type 6AC7; 1 type 884; 1 type 5Z4; 1 type 6SN7; 2 type OD3/VR-150; 1 type 6AG7; 1 type 446A.

#### Mechanical characteristics:

Dimensions:  $11\frac{7}{8}$ " x 8" x  $21\frac{1}{2}$ ".

Weight: 68 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator, LAE.
- (2) 1 Output coaxial cable 4 feet.
- (3) 1 Power supply cable  $6\frac{1}{2}$  feet.
- (4) 3 Connector cables, 4 feet each (not illustrated).
- (5) 1 Set calibration charts.
- (6) 1 Set of operating spare parts (in paper carton) (not illustrated).
- (7) 1 Handle, Crank.
- (8) 1 Instruction book AN 08-45-7.

#### ASO stock No. R16-G-3112.

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| (1) .....            | (2) R16-ADO-AS-1220. |
| (3) R16-ADO-AS-1235. | (4) R16-ADO-AS-1219. |
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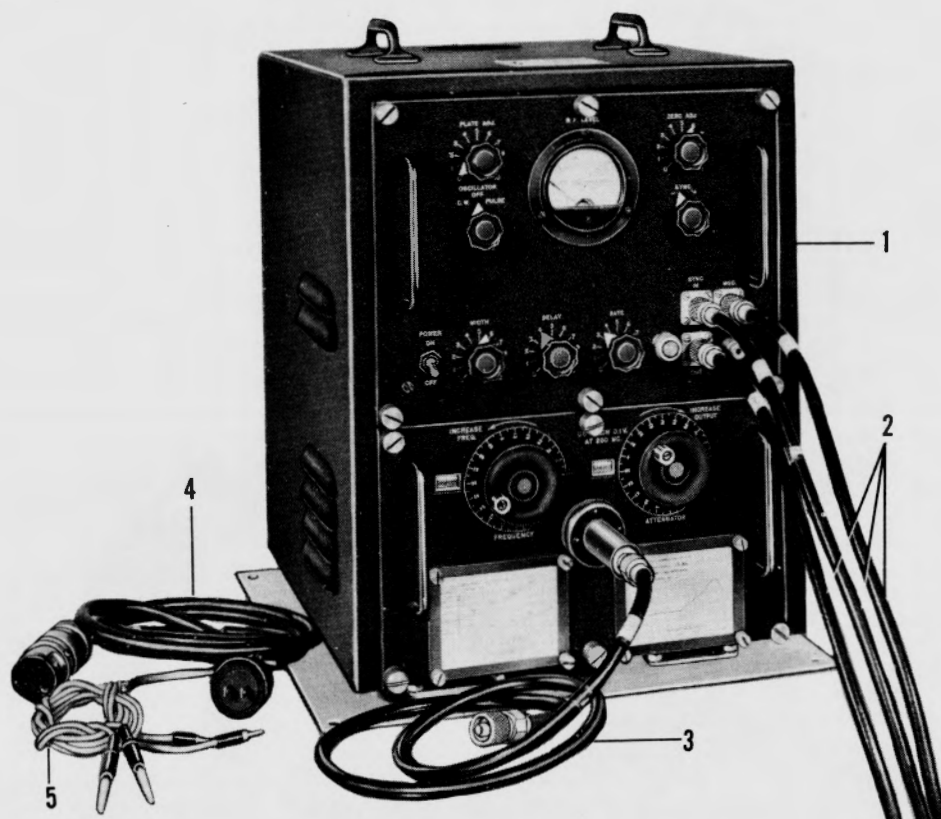


Figure 10-9. Signal Generator—Navy Model LAF

## SIGNAL GENERATOR, VHF

### Navy Model LAF Series

Primary purpose: For aligning radio receivers and in measurement work where an accurate, adjustable and known r-f voltage is required.

The LAF equipment includes an oscillator unit, pulser unit, power supply, and set of output and frequency calibration curve charts. It is contained in one metal cabinet with a carrying handle. A blower provides ventilation.

A switch permits selection of either CW or pulsed r-f output, and the oscillator unit is designed to permit use of either a self-contained modulation system or externally applied modulation. Internal modulation is of the pulsed type and produces square waves variable from 2-30 microseconds long at a rate ranging from 60-2,500 per second and a pulse delay from 3 to 300 microseconds.

#### Electrical characteristics:

Frequency range: 90 mc. to 600 mc.

Modulation: Internal, pulse type; also provision for external modulation.

Accuracy:  $\pm 1\%$ .

Output voltage: 0-100,000 microvolts.

Output impedance: 50 ohms.

Power requirements: 105-125 volts, 50-60 cycle, single phase, a. c.

Batteries: None.

Tubes: 1 type 6J5, 1 type 884, 1 type 6SN7, 1 type 6AG7, 2 type 6AC7, 1 type 5Z4 (or 5Y3GT), 1 type OD3/VR-150, 1 type 2C40.

Weight: 93 pounds.

Complete equipment consists of:

- (1) 1 Signal generator, LAF.
- (2) 3 Coaxial cables, 4 feet long, 49195 connectors on each end.
- (3) 1 R-f cable with type "N" connectors on each end.
- (4) 1 AC power cable, 6 feet long.
- (5) 2 Test leads 4 feet long with alligator clips on one end and insulated phone tips on the other end.
- (6) 5 Calibration charts.
- (7) 1 Set spare parts (attached to power supply chassis).
- (8) 1 Instruction book AN 08-45-32.

ASO stock No. R16-NAV-LAF.

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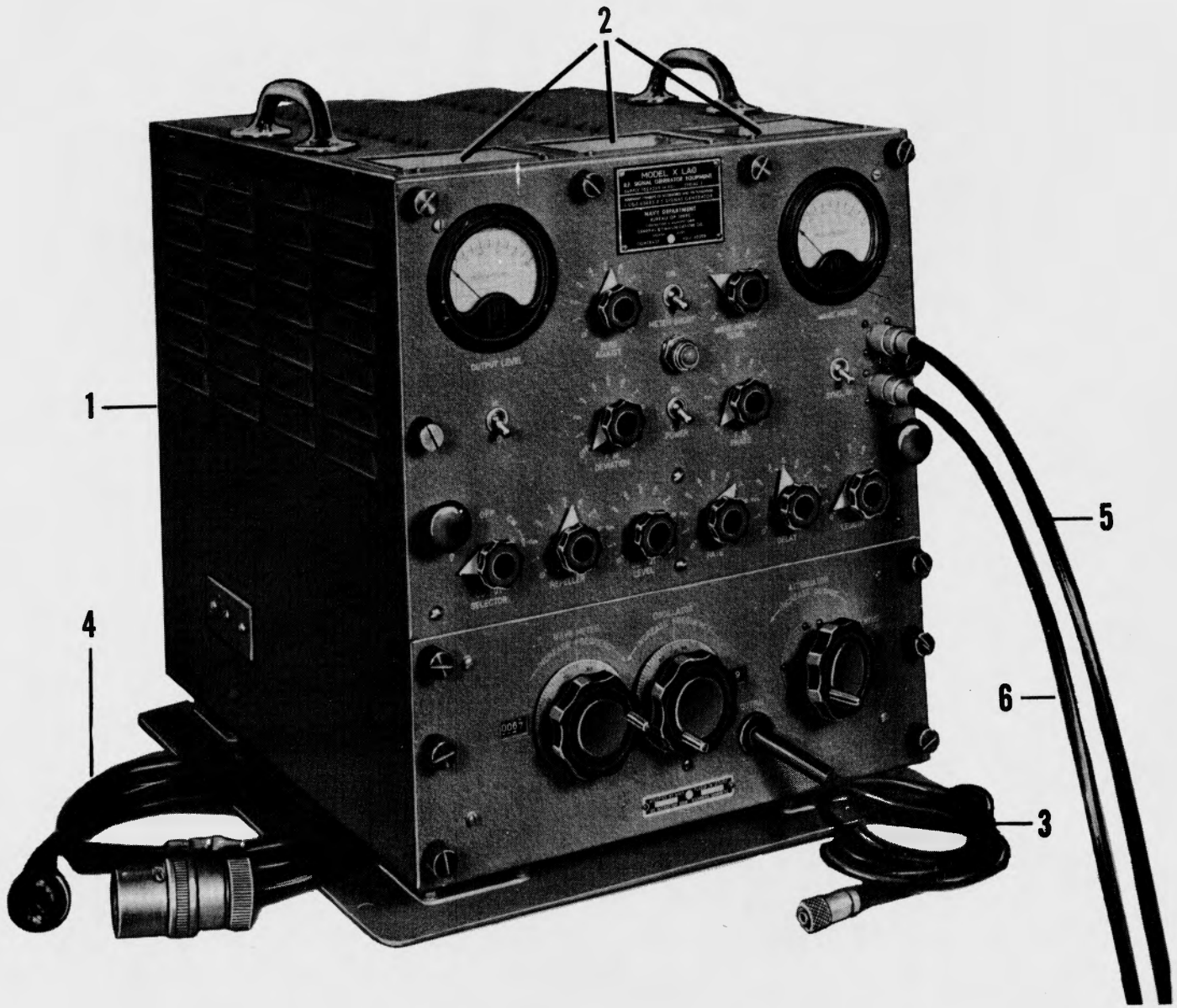


Figure 10-10. Signal Generator—Navy Model LAG

### SIGNAL GENERATOR

#### Navy Model LAG Series

Primary purpose: For aligning radio receivers—and in measurement work when an accurate, adjustable and known r-f voltage is required.

This equipment includes an r-f oscillator, an attenuator for the r-f output, a thermistor bridge for measuring the r-f input level to the attenuator, a video pulse generator to pulse modulate the r-f output and furnish an externally available synchronizing pulse, and a variable delay circuit to delay the r-f pulse relative to the initiating video pulse. It is contained in one metal cabinet with a carrying handle. A blower provides ventilation.

A switch permits selection of either CW or pulsed r-f. The oscillator is so designed as to permit the use of either self-contained modulation or externally applied modulation. The internal modulation is of the pulsed type with the produced pulses being essentially square shaped, of variable length, and of variable repetition rate; 60 cycle frequency modulation is available.

The CW output level is indicated on the attenuator calibrated directly in decibels.

#### Electrical characteristics:

Frequency range: 1,200 to 4,000 megacycles.

Output: CW, 0-100,000 microvolts (approximate).

#### Modulation:

Internal: Pulsed type, unmodulated, FM.

External: Available.

Output impedance: 50 ohms (resistive).

Input impedance: 10,000 ohms shunted by 30 mmf.

External synchronization: Positive or negative.

Delay: R-f pulse relative to initiating video pulse—variable 3 to 300 microseconds.

Accuracy:  $\pm 1\%$ .

Power required: 105 v., 50-60 cycles.

Tubes: 1 type 707B; 1 type 6J5; 1 type 884; 1 type 6SN7; 1 type 6AG7; 4 type 6AC7; 3 type 5U4G, 1 type 6Y6G; 5 type OD3/VR-150.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 20 $\frac{11}{16}$ " x 16 $\frac{3}{16}$ " x 19" overall.

Weight: 130 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator unit.
- (2) 1 Set of output and frequency calibration curve charts.
- (3) 1 Output cable, 50-ohm flexible, permanently installed, RG-38/U.
- (4) 1 Power cable, 7 feet 5 inches long.
- (5) 1 Sync in Cable, RG-8/U.
- (6) 1 Sync out Cable, RG-8/U.
- (7) 2 Allen wrenches (not illustrated).
- (8) 2 Spare fuses (not illustrated).
- (9) 1 Instruction book, CO-NAVAER 16-5Q-518.
- (10) 1 Complete set of tubes (not illustrated).

#### ASO stock No. R16-NAV-LAG.

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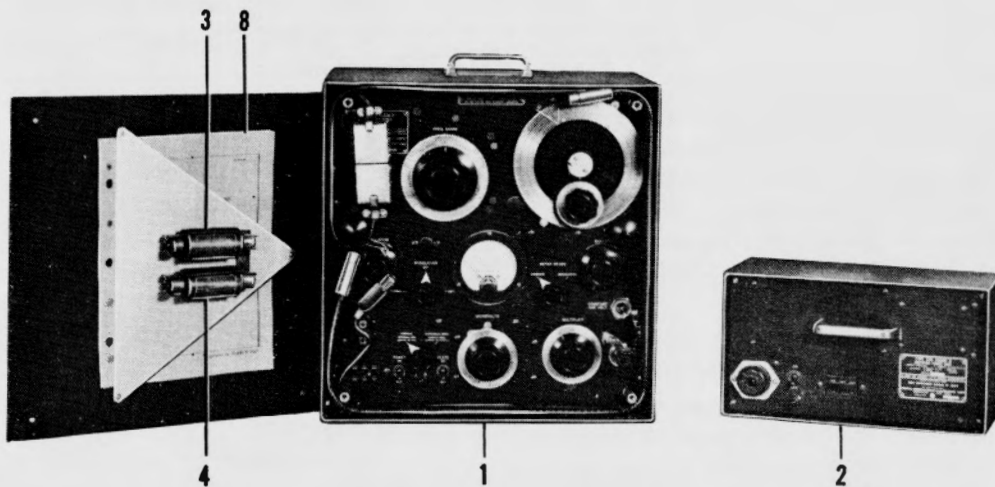


Figure 10-11. Signal Generator—Navy Model LP-5, LP-3

## SIGNAL GENERATOR

### Navy Models LP-5, LP-3.

Primary purpose: General signal generator applications for maintenance and testing of radio equipment.

The model LP signal generator equipment consists of four units: signal generator oscillator, rectifier power unit, dummy antenna, and attenuator.

The frequency is read directly from the main tuning dial; total coverage is accomplished in seven steps of the band change switch.

The rectifier power unit employs a flux regulated transformer to compensate for line voltage variations. For this reason the frequency of the power mains must be 60 cycles plus or minus 2 cycles.

The rectified power supply may be replaced by: 200 volts, 40 milliamperes—"B" supply; 6 volts, 1.7 amperes—"A" supply.

The dummy antenna and "plug-in" 10:1 attenuator are contained in a small cylindrical aluminum casting with plug and jack terminals. At frequencies above 2.5 mc. the antenna simulates a resistance of from 220 ohms to 400 ohms.

The LP-5 is equivalent to LP-3 but is more accurate and has less leakage. The LP-3 is equivalent to General Radio Co. model 605A.

#### Electrical characteristics:

Frequency range: 9.5 kc. to 50 mc.

Accuracy: 1% up to 30 mc. 5% from 30 to 50 mc.

Output: Variable from 0.5 microvolt to 0.1 volt.

#### Output impedance:

50 ohms (attenuator multiplier in last position).

10 ohms (in all other positions of the attenuator).

Modulation: Internal 1000 cycles, up to 50 percent; also external modulation or none.

Tubes: 2 type 84/6Z4; 1 type 89; 2 type 76; 1 type 955.

Power input: 115 volts, 55 watts, 60 cycles.

Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

Signal generator, 17" x 15" x 11½".

Power unit, 7" x 12" x 6".

##### Weight:

Signal generator, 55 pounds.

Power unit, 20 pounds.

#### Complete equipments consists of:

- (1) 1 Signal generator unit.
- (2) 1 Rectifier power unit.
- (3) 1 Dummy antenna.
- (4) 1 Attenuator unit.
- (5) 1 Interconnecting cable 10½ feet long—6 terminal shielded cable (not illustrated).
- (6) 1 Output cable 20 inches long (not illustrated).
- (7) 1 Power cable (not illustrated).
- (8) 1 Instruction book AN 08-45-41.

#### ASO stock No.

LP 3-R16-G-3175-7.

LP 5-R16-NAV-LP-5.

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| (1) .....       | (2) R17-P-7135-510. |
| (3) R16-A-4952. | (4) R16-A-6530.     |
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TEST SET, RF

Navy Model LZ

Primary purpose: To test power output, transmitter and local oscillator frequency, receiver sensitivity, signal-to-noise ratio and T-R box leakage of S-band radars. Signal generator and scope may also be used for standard tests.

The model LZ test set consists of a signal generator, oscilloscope, power meter (LZ calibrator), antenna unit, and cables.

1. *Signal generator.*—This includes a McNally oscillator, crystal detector circuit, mutual-inductance attenuator, and resonant-cavity wavemeter. The unit is capable of a CW or pulsed output of 6 milliwatts across 72 ohms. It may be internally pulsed about 500 times per second at either 1 or 10 microsecond pulse widths, or externally pulsed giving 0.5 to 50 microsecond pulses. The detector circuit is used for metering purposes and to allow viewing the signal on the scope.

2. *Oscilloscope.*—Three-inch tube, 72 ohm input. Set includes a one-half microsecond delay network. Used to view video pulses of 0.25 to 100 microsecond duration which recur 100 or more times per second or sine wave of 3 kc. to 1 mc. frequency. Includes a blanking circuit and 3-18 and 50-250 microsecond start-stop sweeps.

3. *Power meter (LZ calibrator) CW-60ABU.*—This is a thermistor bridge in which the compensation and measurements are obtained by balancing the thermistor circuit against 100-ohm resistor. Used to calibrate signal generator.

4. *Antenna unit and cables.*—The antenna is a half-wave dipole with a 9-inch parabolic reflector and plexiglass cover and is supported by a 12-foot collapsible tripod.

5. *Probe Amplifier CW-50 ADB.*—This is a device by means of which oscilloscope CW-60AAY may be used with high-impedance circuits. It obtains its power from the associated oscilloscope. The input impedance is approximately 2 megohms paralleled by 12 mmf. It includes a single vacuum tube, the output of which is connected to the oscilloscope. Pulses of 2 to 200 peak volts can be observed and measured by the use of this probe in conjunction with the oscilloscope and a source of calibrating pulses.

Electrical characteristics:

Frequency: 2700-3400 mc.

Signal generator: Wavemeter accuracy  $\pm 1$  mc.

Tubes: 4 type 6AC7; 1 type 6L7; 1 type 1622; 1 type 5T4; 1 type 6ZY5-G; 2 type 6Y6-G; 2 type 6SF5; 4 type OD3/VR150; 1 type OC3/VR105; 1 type 707A.

Input: 105-125 volt, 50-800 c. p. s. 250 v. a.

Oscilloscope:

Input 105-125 volt, 50-1200 c. p. s., 150 v. a.

Tubes: 1 type 3BP1; 5 type 6AC7 (1 in probe amplifier); 1 type 6H6; 2 type 6SN7GT; 1 type 6SJ7; 1 type 6AG7; 1 type 5T4; 1 type 2X2/879.

Power meter:

Range: 0.5 to 12 milliwatts.

Input impedance: 72 ohms.

Requires (2) type BA-30.

Mechanical characteristics:

Dimensions:

Signal generator 14 $\frac{7}{8}$ " x 18 $\frac{1}{16}$ " x 11 $\frac{1}{8}$ ".

Oscilloscope: 14 $\frac{9}{16}$ " x 10 $\frac{9}{16}$ " x 14 $\frac{5}{8}$ "; probe amplifier, 3 $\frac{9}{16}$ " x 3" x 3 $\frac{1}{16}$ " (excluding cables).

Tripod: 80 inches folded.

Carrying case—15" x 21 $\frac{7}{8}$ " x 17 $\frac{5}{8}$ ".

Power meter—9 $\frac{3}{4}$ " x 6 $\frac{3}{8}$ " x 7 $\frac{1}{16}$ ".

Weight:

Signal generator 72 pounds, carrying case weighs 44 pounds more.

Oscilloscope, 60 pounds; probe amplifier, 3 pounds; carrying case weighs 36 pounds more.

Tripod—34 pounds. Carrying case and contents, 76 pounds.

Total: 322 pounds.

Complete equipment consists of:

- (1) 1 Signal generator, CW-60AAX.
- (2) 1 Case (not illustrated).
- (3) 1 Oscilloscope, CW-50AAY.
- (4) 1 Case (not illustrated).
- (5) 1 Power meter CW-60ABU (not illustrated).
- (6) 1 Case (not illustrated).
- (7) 1 Probe amplifier CW-50 ADB (not illustrated).
- (8) 1 Adapter cable (10-inch) 3 conductors (not illustrated).
- (9) 1 Antenna assembly CW-66ACX (not illustrated).
- (10) 1 Tripod, CW-10AAY (not illustrated).
- (11) 1 Antenna cable, 40-feet, 10 db (not illustrated).
- (12) 1 Double-ended power cable, 35-feet (not illustrated).
- (13) 2 Patch cables, 35-feet (not illustrated).
- (14) 1 Patch cable, 5-feet (not illustrated).
- (15) 1 Low loss coax cable, 10-feet (not illustrated).
- (16) 1 Cable 25-30 db (not illustrated).
- (17) 1 Instruction book AN 16-45-65.

ASO stock No. R16-T-1820.

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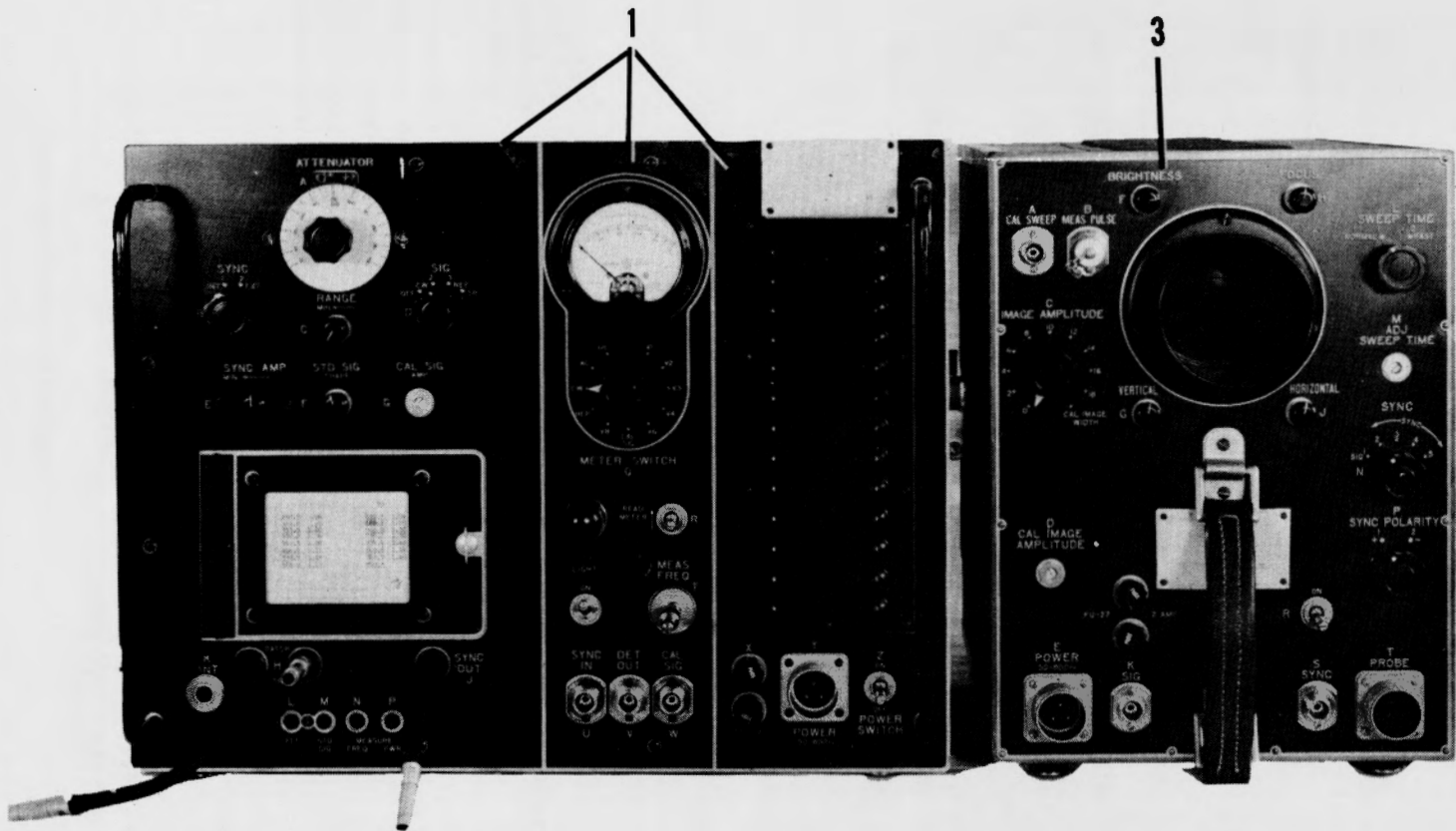


Figure 10-12. RF Test Set—Navy Model LZ

10-17

RESTRICTED  
NavAer 08-55-78

Section X  
Signal Generators



Figure 10-13. Pulse Generator—Measurements 79-B

## PULSE GENERATOR

### Measurements Corp. Model 79-B

Primary purpose: Service testing and maintenance of radar and IFF systems.

Multivibrator oscillator, differentiating circuit, amplifier, and cathode follower output for pulse generating; the other side of the multivibrator is fed to a fixed differentiating circuit and amplifier and provides a time delay sync voltage. Provision is also made for external sync. A circuit is provided for pulse modulating RF, the output being pulses of the applied RF voltage.

Late models have Navy standard C-49194 connectors on synchronizing input, synchronizing output, and pulse output.

#### Electrical characteristics:

Pulse frequency: 60 to 100,000 cycles in 3 steps.

Pulse width: 0.5 to 40 microseconds.

Pulse output: 150 volts positive polarity.

Output impedance: less than 1,000 ohms.

Sync: Internal and external.

Sync output: 40 volts positive polarity.

Sync output impedance: 2,500 ohms (approximate).

Tubes: 3 type 6C5; 1 type 6Y6G; 2 type 5V4G; 2 type 6AG7; 1 type 6SA7; 1 type OD3/VR-150.

Power input: 117 volt, 60-cycle, single phase, 125 watts.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 13 $\frac{3}{4}$ " x 10" x 10 $\frac{1}{2}$ ".

Weight: 32 pounds.

#### Complete equipment consists of:

(1) Pulse generator, Meas. Corp. 79-B.

(2) Instruction book NAVAER 08-5S-126.

ASO stock No. R16-G-3105.

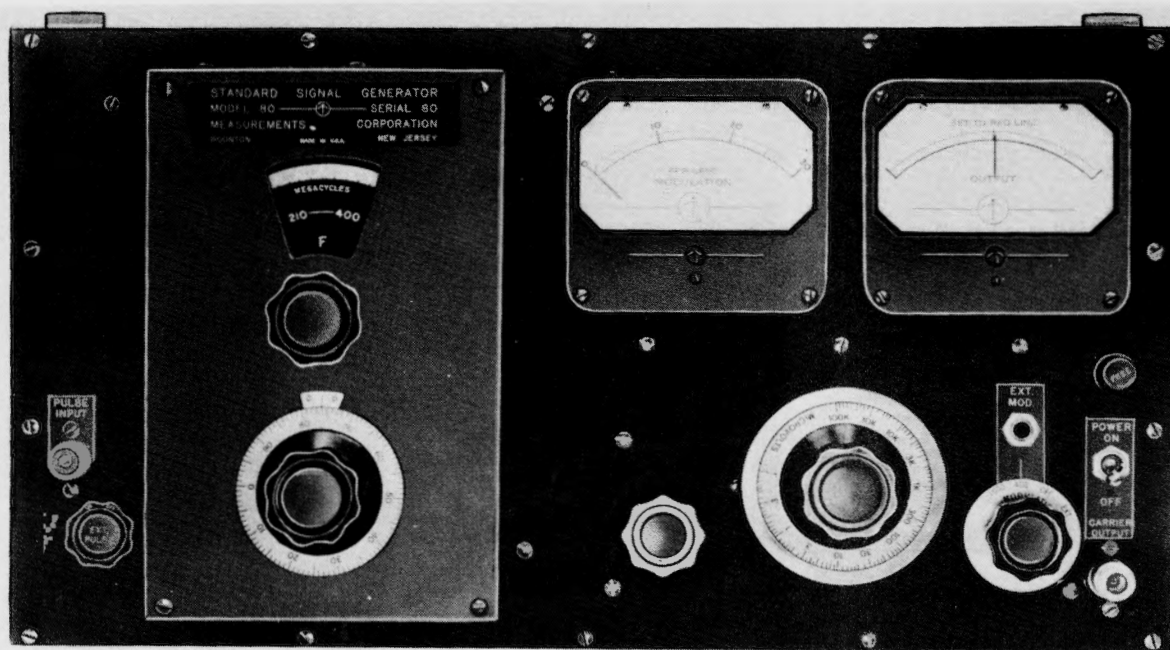


Figure 10-14. Signal Generator—Measurements 80

## SIGNAL GENERATOR, VHF

### Measurements Corp., Model 80

**Primary purpose:** Used as a source of calibrated voltage at radio frequencies for checking radio receivers and other electronic equipment, and for general testing.

This instrument has internal means for modulating the radio frequency output at audio frequencies and will accept a pulse or square wave external source of modulation and thereby produce a pulsed or square wave modulated radio frequency signal.

Frequency range is covered in 6 overlapping bands and scale is direct reading in megacycles. Internal modulation of 400 and 1,000 cycles (sine wave) and external modulation may be square wave or pulses of 1 microsecond or longer. Radio frequency output is variable from 0.1 to 100,000 microvolts adjustable by a direct-reading attenuator and monitored by an internal vacuum tube voltmeter circuit. Leakage from the instrument is less than 0.1 microvolt.

#### Electrical characteristics:

Frequency range: 2 to 400 mc.  $\pm 0.5\%$ .

Output voltage: 1 microvolt to 0.1 volt across 50 ohms.

Output impedance: 50 ohms (approximately).

Modulation: Internal; 400 or 1000 cycles; external; 50 to 10,000 cycles. Provision made for external pulse modulation.

Power required: 117 volts, 50 to 60 cycles, 65 watts.  
Batteries: None.

Tubes: 1 type 955; 1 type 5Y3GT; 2 type 6V6GT; type 6SJ7GT; 2 type 6SN7GT; 1 type OC3/VR-105; 1 type OA3/VR-75; 1 type 6SL7GT.

Fuse: 1 3AG-2.

#### Mechanical characteristics:

Dimensions: 19" x 10 $\frac{3}{4}$ " x 9 $\frac{1}{2}$ ".

Weight: 53 pounds.

#### Complete equipment consists of:

(1) 1 Signal generator, Meas. Corp. 80.

(2) 1 Instruction book AN 08-45-33.

ASO stock No. R16-G-3165.

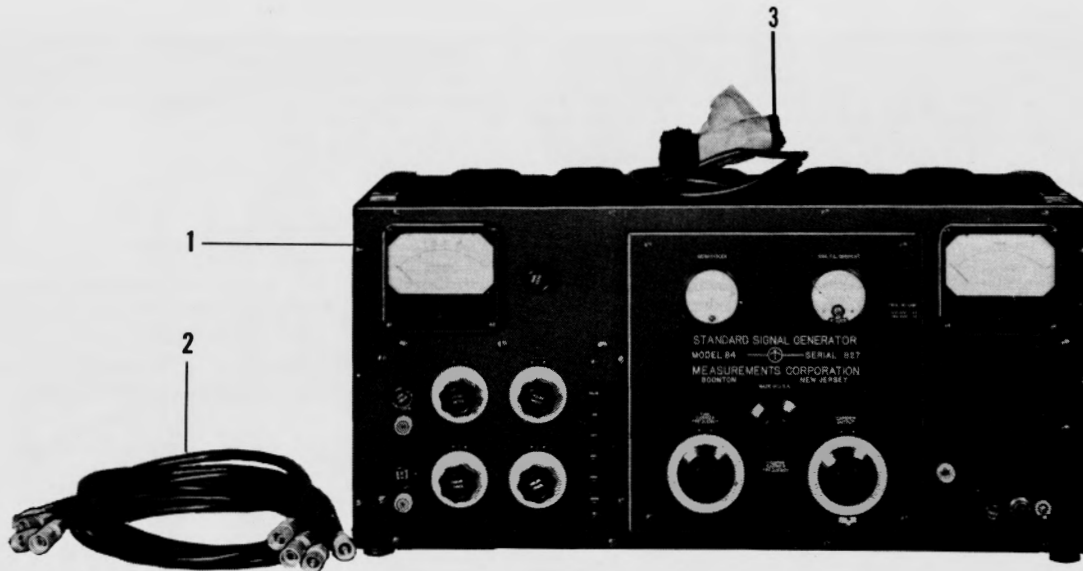


Figure 10-15. Signal Generator—UHF—Measurements 84

## SIGNAL GENERATOR, UHF

### Measurements Corp., Model 84

Primary purpose: General signal generator applications in the UHF band.

A general purpose UHF signal generator. The frequency range is covered in one band and the output may be unmodulated, sine wave or pulse modulated by internal means without auxiliary equipment. Synchronization may be obtained from an external source of voltage. When desired a sync voltage can be obtained from the instrument that is advanced up to a maximum of 50 microseconds in time phase with respect to the r-f output.

#### Electrical characteristics:

Frequency range: 300 to 1,000 mc.

Accuracy:  $\pm 0.5\%$  for frequency;  $\pm 10\%$  for voltage output.

Output voltage: 0.1 microvolt to 0.1 volt.

Output impedance: 50 ohms.

Modulation characteristics: (a) Sine wave of 400, 1,000, or 2,500 cycles (0-30%). (b) Pulse (either internal or external synchronization): 200 mc., min. 8 microseconds, max. 50 microseconds; 500 mc. 5 microseconds, max. 50 microseconds; 1,000 mc., min. 2 microseconds, max. 50 microseconds;

at repetition rates of 50 to 100,000 times per second but not more than 40 percent duty cycle; pulse repetition frequency (PRF): 60 cycles to 100 kc. Power required: 117 volts, 60 cycles, 230 watts (with line voltage regulator).

Batteries: None.

Fuses: 1 type 3AG (3 amp.).

Tubes: 1 type 368-AS (or 703A); 1 type 6SJ7; 2 type 6J5; 2 type 6V6; 1 type 6L6; 1 type OC3/VR105; 1 type OD3/VR150; 1 type 6H6; 4 type 6SN7; 2 type 6AG7; 2 type 5Y3GT; 1 type 5R4GY.

Note—The type 368-AS tube is a select 703A. Spares are not expected to be available.

#### Mechanical characteristics:

Dimensions: 26" x 12" x 10".

Weight: 110 pounds, voltage regulator 26 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator, Meas. Corp. 84.
- (2) 4 Patch cables (48-inch).
- (3) 1 Line voltage regulator.
- (4) 1 Instruction book NAVAER 08-5QS-11.

ASO stock No. R16-G-3168.

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- (3) .....

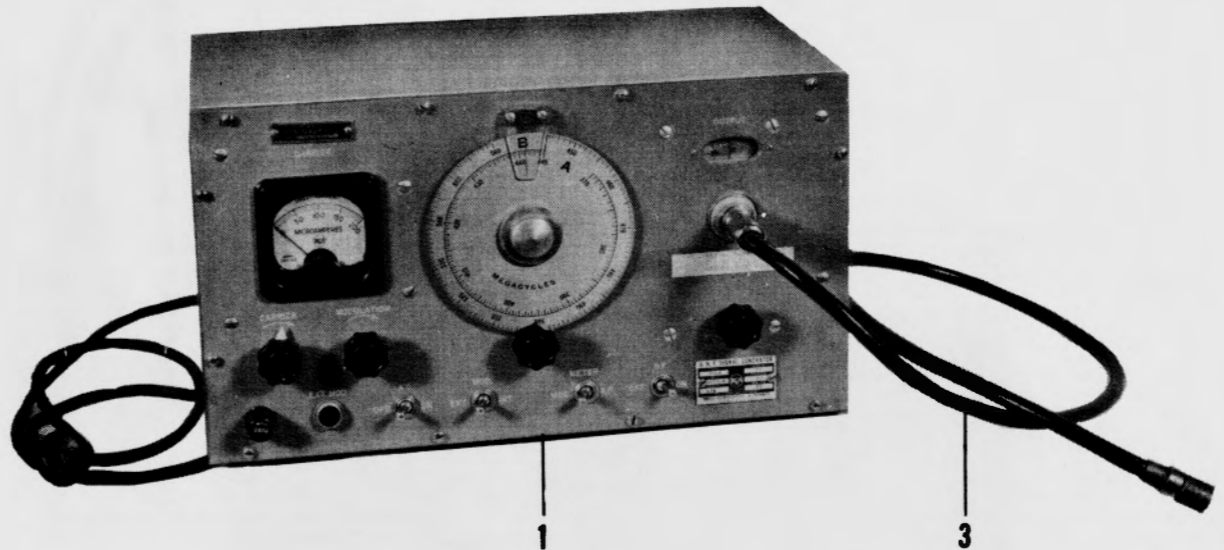


Figure 10-16. Signal Generator—RCA 18710-A

**SIGNAL GENERATOR, UHF**

**Model RCA 18710-A**

Primary purpose: General signal generator applications in the UHF band. This equipment is intended for bench maintenance of radio altimeters until Measurements Model 84 or Navy Model LAG is available.

The MI-18710-A equipment includes a high frequency oscillator and attenuator, an audio modulating oscillator, and a power supply in one case, which is fitted with a carrying handle and removable lid. It will operate with the carrier modulated: amplitude modulated to a high degree by an internal oscillator, externally pulse modulated or externally high-frequency modulated. Output of the high-frequency oscillator is continuously variable by means of a small variable capacitance linked to the direct-reading dial on the panel. The necessary shielded output cable is furnished.

**Electrical characteristics:**

Frequency range: 360 to 540 mc.

Output: 10 microvolts to 0.1 volt.

Accuracy: Frequency to  $\pm 1.0\%$ . Attenuator calibration,  $\pm 1.5$  db.

Amplitude modulation available: 400 cycles  $\pm 10\%$ .

Power supply: 105-115 volts, 50-60 cycles, 50 watts.

Tubes: 1 type 6SN7GT; 1 type 955; 1 type 6X5GT;

2 type OD3/VR-150.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 16" x 9" x 13".

Weight: 30 pounds.

**Complete equipment consists of:**

- (1) 1 Signal generator, RCA 18710-A.
- (2) 1 Input cable, coaxial, 72 ohm, 36 inches long (not illustrated).
- (3) 1 Output cable, r-f low loss, 50 ohm, 30 inches long.
- (4) 1 Envelope of calibration and deviation charts.

ASO stock No. R16-G-3207.

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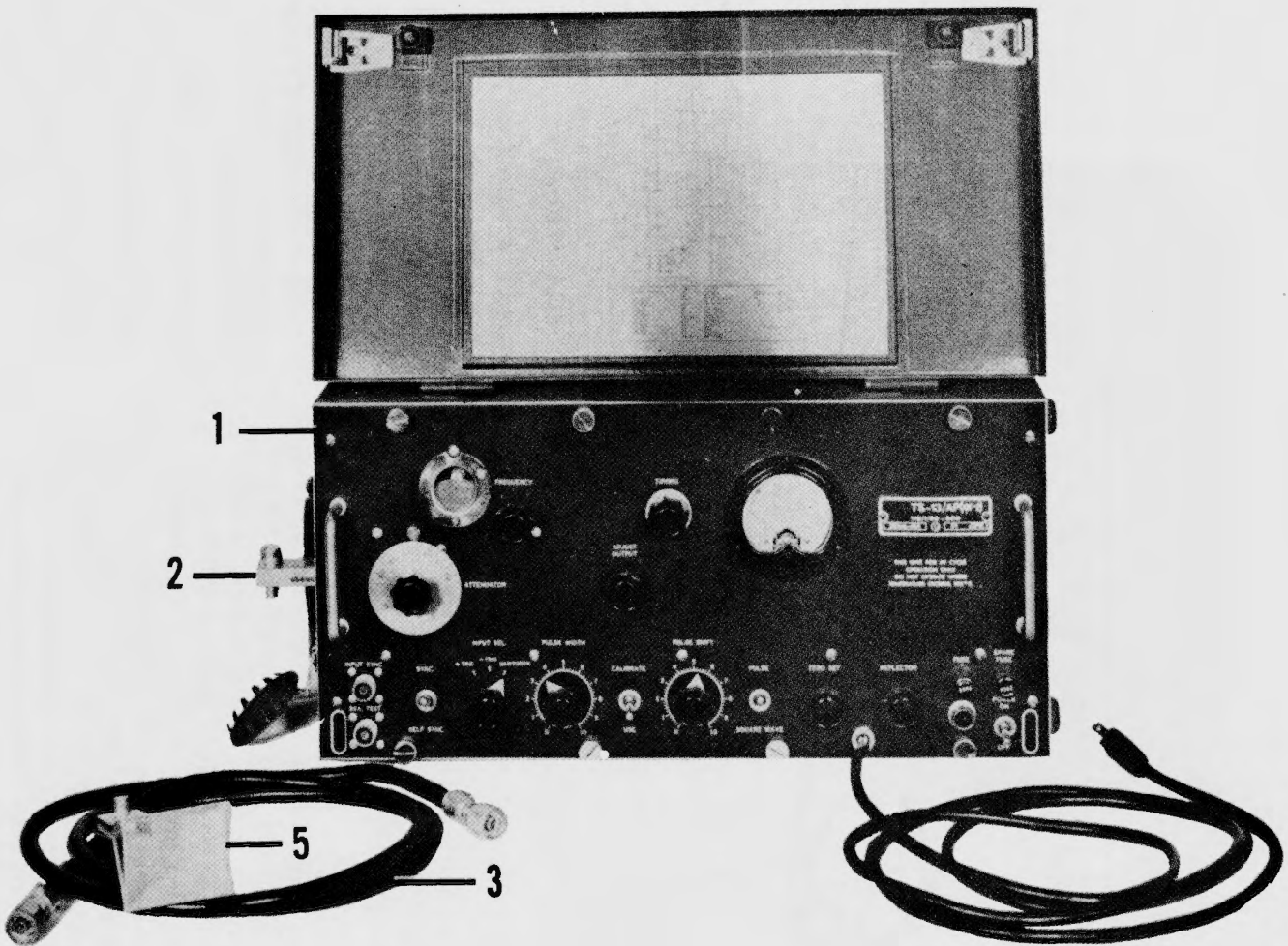


Figure 10-17. RF Test Set—TS-13/AP

### TEST SET

#### TS-13/AP

Primary purpose: Bench and field testing of X-band radars. It tests power output, transmitter frequency, signal-to-noise ratio, IF bandpass, and provides a signal for receiver tuning. Further, it may be used for standard signal-generator tests.

This unit consists of a signal generator with calibrated attenuator, a wavemeter, and a thermistor power-measuring circuit. It is used as the source of r-f power for the TS-12/AP when making SWR measurements.

The signal generator output is either pulsed or CW. The width of the Square wave output is variable and phaseable. The CW output can be frequency modulated by a sawtooth input from an external source (TS-34/AP oscilloscope will provide this).

#### Electrical characteristics:

Frequency range: 9305-9445 mc.

Signal output: 0 to 50 microwatts (cw. at PRF of 1,000 c. p. s.); 250 microwatts-peak power.

Pulse width: 1 to 2 microseconds.

Pulse phasing: 6 to 200 microseconds.

Calibrated attenuator: 13 to 65 dbm.

#### Accuracy:

Frequency  $\pm 2$  mc./sec.

Power monitor  $\pm 1$  db.

Signal input: Positive trigger pulses not less than 15 volts and 1 to 20 microseconds long. Negative trigger pulses not less than 50 volts.

Sensitivity: Power meter, 50 milliwatts for half scale meter deflection.

Internal synchronization: 1000 c. p. s.

Power required: 105-120 volts, 60-800 c. p. s., 150 watts.

Tubes: 3 type 6SN7; 2 type 6AC7; 1 type 5Y3GT; 1 type 6Y6; 1 type 5U4G; 3 type OC3/VR-105; 1 type 723-AB (2K25).

Batteries: None.

#### Mechanical characteristics:

Dimensions: 21" x 10 $\frac{1}{2}$ " x 11 $\frac{1}{2}$ ".

Weight: 73 pounds.

#### Complete equipment consists of:

- (1) 1 RF test set, TS-13/AP.
- (2) 1 Waveguide to coax adapter, UG-81/U.
- (3) 1 RF cable (6 feet of RG-9/U with type UG-24/U connectors).
- (4) 1 Sync cable (6 feet of RG-11/U with type 49195 connectors) (not illustrated).
- (5) 1 Pickup Horn, AT-48/UP.
- (6) 1 Spare parts box (not illustrated).
- (7) 1 Instruction book AN 16-35TS13-3.

#### ASO stock No. R16-T-1873.

- |                     |                |
|---------------------|----------------|
| (1) .....           | (2) R16-A-407. |
| (3) R16-AN-CG-92/U. | (4) .....      |
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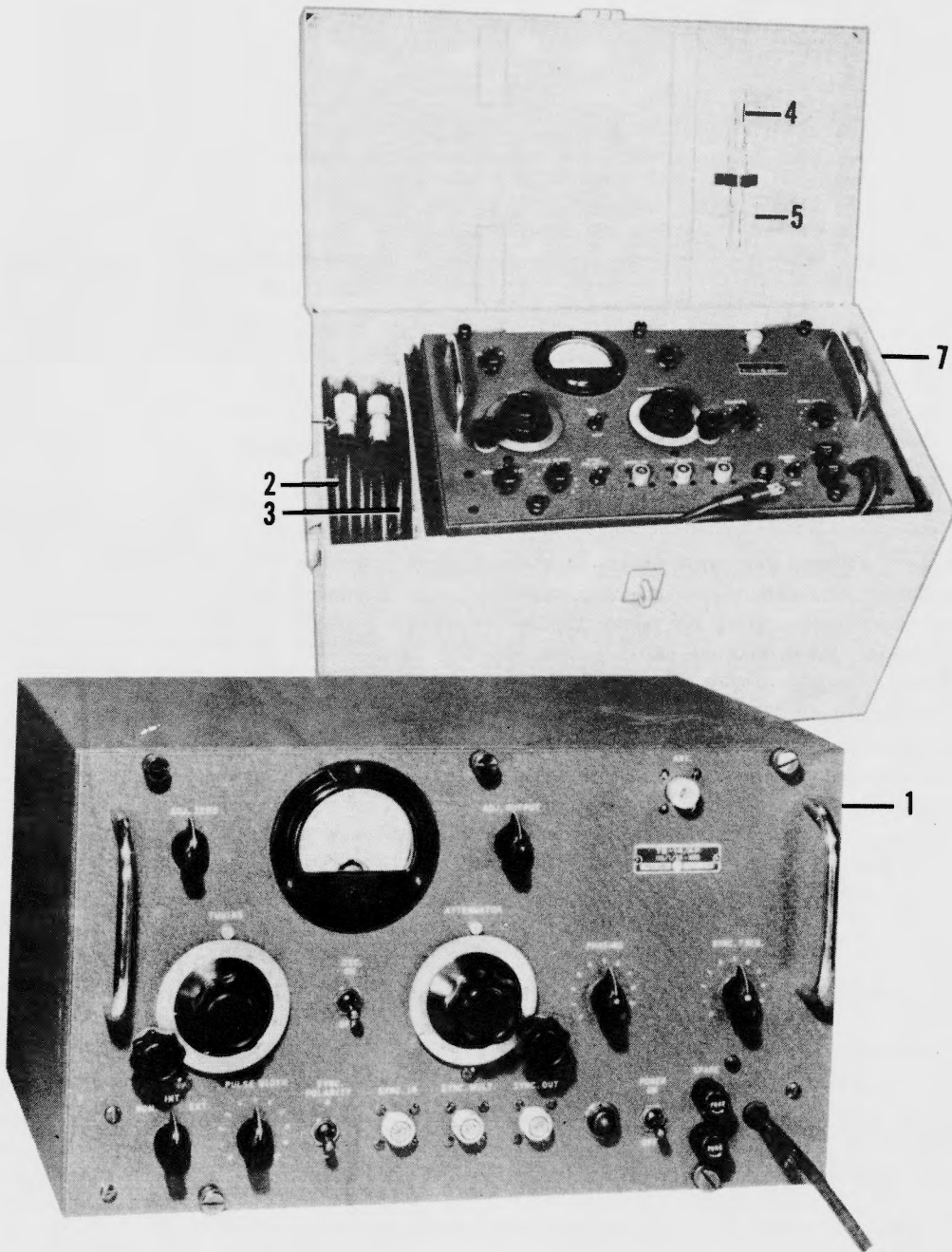


Figure 10-18. RF Test Set—TS-14/AP

### RF TEST SET

#### TS-14/AP

Primary purpose: Bench and field testing of various radars.

This portable metal-encased test set is a generator of calibrated r-f signals. Provision is made so that it may be pulsed internally or externally. This instrument can be used to (a) check receiver sensitivity, (b) measure transmitter power output, (c) be a transfer frequency meter (uncalibrated) to align the transmitter and receiver closely to a common frequency. A thermistor is provided to measure transmitter power and to monitor the signal generator.

#### Electrical characteristics:

Frequency range: 3200-3370 mc.

Power input: With attenuator set to the reference mark the meter reads directly the average r-f power input between 20 and 200 milliwatts. Accuracy plus or minus 1.5 db at full scale.

Power output: At settings of 20 and above, the attenuator dial reads peak power at the antenna jack in db below 1 milliwatt (-dbm.).

Pulse width: 1.0 to 2.8 microseconds (at 1,000 c. p. s.).

Phasing: 10 to 200 microseconds after the trigger (at p. r. f. approximately 1,000).

Internal synchronization: Width fixed 2 microseconds; 300 to 2,500 c. p. s. greater than 100 volts.

External synchronization: Width 0.5 to 20 microseconds; 300 to 2,500 c. p. s.; 20 to 180 volts.

Attenuator: Dial is direct reading in decibels below one milliwatt from minus 20 dbm to minus 100 dbm.

Tubes: 4 type 6SN7; 1 type 6AC7; 1 type 446B, 1 type OC3/VR-105; 1 type 5Y3GT.

Power required: 115 v, 50-800 cycles, 80 watts.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 16<sup>3</sup>/<sub>4</sub>" x 9<sup>3</sup>/<sub>4</sub>" x 11<sup>1</sup>/<sub>4</sub>".

Weight: 40 pounds, case 25 pounds.

#### Complete equipment consists of:

- (1) TS-14/AP test set.
- (2) Sync. Cable, type CG-107/U (15) 15 feet long.
- (3) Antenna cable, length 6 feet, CG-92/U.
- (4) Adapter, type UG-110/U.
- (5) Dipole antenna, type AS-23/AP.
- (6) 3 Allen set screw wrenches (#6-8-10) (in the instrument).
- (7) Carrying case CY-177/U.
- (8) Instruction book AN 08-35TS14-3.

#### ASO stock No. R16-T-1874.

- |                      |                      |
|----------------------|----------------------|
| (1) .....            | (2) .....            |
| (3) .....            | (4) R16-AN-UG-110/U. |
| (5) R16-AN-AS-23/AP. | (6) .....            |
| (7) R16-AN-CY-177/U. | (8) .....            |

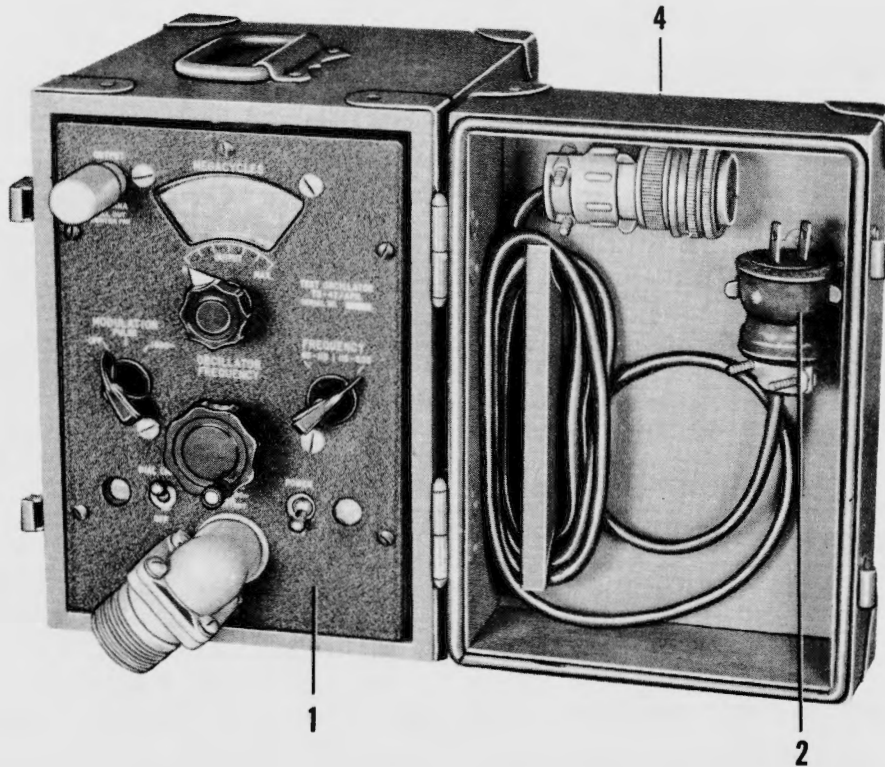


Figure 10-19. Test Oscillator—TS-47/APR

## TEST OSCILLATOR

### TS-47/APR

Primary purpose: Testing various RCM receivers.

It provides a calibrated high frequency signal source for testing receivers in the field. It consists of a triode oscillator employing a butterfly tuning circuit and an internal audio oscillator to plate modulate the triode oscillator or a blocking type oscillator for pulse modulation. The power output is coupled through a pick-up loop into a 50-ohm line connected to an output connector which of itself also serves as an adjustable antenna.

It is shock mounted in a tropicallized wood combination carrying case with the power cord mounted inside the cover when not in use.

#### Electrical characteristics:

Fundamental frequency range: 40-500 megacycles in two ranges; 40 to 115 mc. and 115 to 500 mc.

Useful range harmonics: Up to 3,000 mc.

Accuracy of dial: Plus or minus 1% of indicated frequency.

Output voltage: Adjustable, approximate. 3 milliwatts maximum up to 400 mc. (uncalibrated).

Modulation: Sine wave—1,000 cycles at 50%. Pulsed: 500 cycles at 70 microseconds width.

Output impedance: 50 ohms.

Power required: 80, 115 or 230 volts at 50-3,600 cycles per second, or 200 volts d. c. and 6.3 volts d. c.

Tubes: 2 type 9002, 1 type 6X5GT.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 6 $\frac{1}{2}$ " x 9 $\frac{1}{2}$ " x 11 $\frac{1}{2}$ ".

Weight: 15 pounds, including case.

#### Complete equipment consists of:

- (1) 1 Test Oscillator, TS-47/APR.
- (2) 1 Power cord CX-153/U (6 feet).
- (3) 1 Instruction book AN 16-35TS47-2.
- (4) 1 Carrying case.
- (5) Special equipment required for battery operation: 1 resistor, 2000 ohm, 1 watt; 5 dry batteries, 45V 0.020 amp. and 4 dry batteries 1.5V 0.55 amp., 1 cord made up (not illustrated).

ASO stock No. R16-AN-TS-47/APR.

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Figure 10-20. Signal Generator—TS-155 C/UP

**SIGNAL GENERATOR**

**TS-155C/UP**

Primary purpose: General purpose signal generator.

This signal generator may be used to check the over-all system performance, receiver sensitivity, and power output of transmitters. The unit also supplies trigger pulses for synchronization. There are provisions for external double pulsing and variable delay, also contained is an r-f wattmeter (thermistor bridge).

**Electrical characteristics:**

- Frequency: 2700-3400 mcs. in 3 bands.
- Output Trigger Repetition Rate: 80 to 2600 c. p. s.
- Output Trigger Amplitude: + 50 to + 100 v.
- R-F Attenuator: -20 to -100 dbm.
- Tubes: 1 type 5Y3GT, 1 type OD3/VR-150, 1 type OC3/VR-105, 4 type 6SN7, 1 type 6AG7, 1 type 2C40.
- Internally synchronized pulse width: 0.75 to 5.75 microsecond.
- Power required: 115 volts  $\pm$  10%, 50-1600 c. p. s., 100 watts. Provisions for 230 volt operation.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions:**
  - Generator: 9" x 16 $\frac{3}{4}$ " x 12 $\frac{3}{4}$ ".
  - Case: 15 $\frac{1}{4}$ " x 21" x 10 $\frac{3}{8}$ ".
- Weight:**
  - Generator: 41 pounds.
  - Case: 30 pounds.

**Complete equipment consists of:**

- (1) 1 Signal Generator TS-155C/UP.
- (2) 1 Grid Cylinder MS-678/UP 2900-3100 mc. (not illustrated).
- (3) 1 Grid Cylinder MX-679/UP 3100-3400 mc. (not illustrated).
- (4) 1 Grid Cylinder MX-680/UP 2700-2900 mc. (not illustrated).
- (5) 2 Cord CG-92/UP (RF) 96" (not illustrated).
- (6) 2 Cord CG-409/U (Trigger) 96 inches (not illustrated).
- (7) 1 Cord CX-337/U (Power) 72 inches (not illustrated).
- (8) 1 RF Adapter UG-28/U (not illustrated).
- (9) 1 RF Adapter UG-57/U.
- (10) 1 RF Adapter UG-29/U.
- (11) 1 Crystal Adapter UG-119/UP.
- (12) 2 Adapters UG-255/U.
- (13) 2 Adapters UG-273/U.
- (14) 1 Adapter UG-131/U.
- (15) 1 Crystal 1N21B (not illustrated).
- (16) 1 Horn Antenna AT-67/AP.
- (17) 4 Allen Wrenches #4, 6, 8, 10 (not illustrated).
- (18) 1 Transit Case.
- (19) 1 Instruction book, TM 11-2657C.
- (20) 1 Set spare tubes (not illustrated).

**ASO stock No. R16-AN-TS-155C/UP.**

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| (1) .....              | (2) .....      |
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| (5) .....              | (6) .....      |
| (7) .....              | (8) R16-A-565. |
| (9) .....              | (10) .....     |
| (11) R16-AN-UG-119/UP. | (12) .....     |
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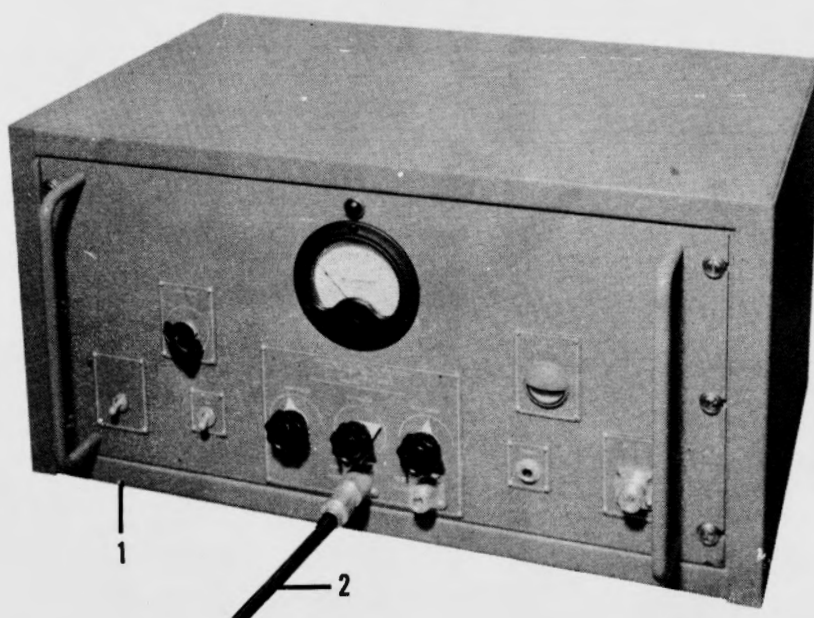


Figure 10-21. Signal Generator, Harmonic-TS-202/U

## HARMONIC SIGNAL GENERATOR

### TS-202/U

Primary purpose: A dependable portable secondary standard of frequency for calibrating test equipment.

This generator makes available modulated or unmodulated HF signals of prescribed frequencies with a high degree of frequency accuracy and stability. It may be used for identification of output or incoming signals and permits accurate calibration of relatively insensitive frequency meters.

The equipment includes a main unit, contained in a metal case, and frequency identifiers. A crystal oscillator furnishes a signal of high stability, and a switch permits choice of harmonics in multiples of 10 and 40 mc. Output is available through a concentric cable or from a cavity of the main unit by means of a probe.

The equipment will operate in temperature ranging from  $-65^{\circ}$  C. to  $+85^{\circ}$  C. ( $-85^{\circ}$  F. to  $+185^{\circ}$  F.), in humidity as high as 95 percent and at altitude up to 50,000 feet.

All controls are on the front panel, as is a phone jack which permits aural monitoring of the audio modulation generator.

A high Q tuned circuit or "identifier" to accentuate one frequency is used.

#### Electrical characteristics:

Frequency range: 100 mc. to 1,500 mc. in 10 mc. and 40 mc. steps.

Identifiers: 200-500-1,000 mc.

Accuracy:  $\pm 0.02\%$ .

Output voltage: 100 microvolts.

Modulation: 1000 c. p. s., variable percentage.

Output impedance: 50 ohms.

Power required: 115 v., 250 watts (approximate), 50-800 cycles, single phase, 1.5 amperes.

Tubes: 2 type 6L6, 2 type 6AG7, 2 type 6J6, 1 type 9002, 1 type 6AC7, 1 type 6E5, 1 type 6SN7, 1 type 6V6, 1 type 5U4G.

Crystal: 5 mc.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $10\frac{1}{2}$ " x  $14\frac{5}{8}$ " x 21".

Weight: 60 pounds.

#### Complete equipment consists of:

- (1) 1 Harmonic Signal Generator, TS-202/U.
- (2) 1 Output cable, RG-8/U (30 inches).
- (3) 1 Frequency Identifier: 200 mc. (not illustrated).
- (4) 1 Frequency Identifier: 500 mc. (not illustrated).
- (5) 1 Frequency Identifier: 1000 mc. (not illustrated).
- (6) 1 Instruction book NAVAER 16-5S-528.

ASO stock No. R16-AN-TS-202/U.

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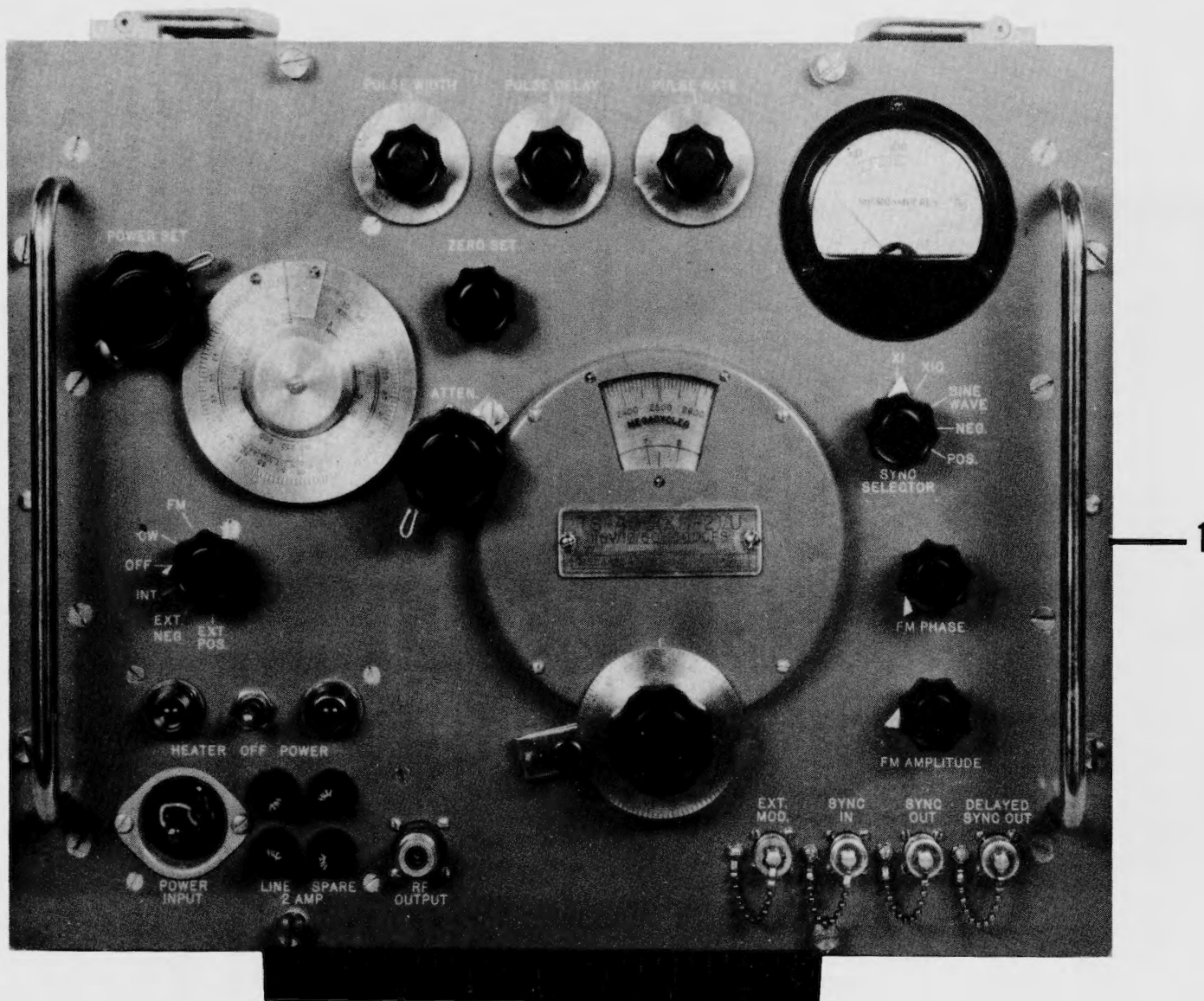


Figure 10-... Signal Generator—TS-403/U

### SIGNAL GENERATOR

#### TS-403/U

Primary purpose: To provide accurate pulse, frequency modulated, and continuous wave radio frequency signals in the band of frequencies between 1800 and 4000 megacycles per second for use in testing and maintaining aircraft radio and radar receivers and other electronic devices which require less than 0.20 milliwatts of measured power.

Description: A semi-portable signal generator for general application. The frequency of the output signal is continuously variable from 1800-4000 mc in one band and is directly indicated by means of a single front panel control. The output signal power level is continuously variable between 0.1 volt and 0.1 microvolt and is directly indicated by means of a single front panel control. The instrument provides pulsed and CW RF signals together with both delayed and undelayed trigger pulses for external application.

#### Electrical characteristics:

Frequency range:

1800-4000 mc/s in a single band.

Frequency accuracy:

Directly indicated to within plus or minus 1%.

Output power:

Minus 7 dbm through minus 120 dbm. (100 millivolts through 0.16 microvolts into 50-ohm load.)

Output impedance:

50 ohms

Type of output:

Modulated (FM or pulse) or unmodulated (CW).

Modulation:

Internal Pulse Modulation:

P.R.F.—40 cps. to 4000 pps.

Pulse width—adjustable from 0.5 to 10 microseconds.

External synchronization—positive or negative pulses or sine wave.

Timing: undelayed or delayable from 3 to 300 microseconds from external synchronizing signal or internal pulse.

Internal FM modulation:

Phase: variable by approximately 180°.

Deviation: variable control.

External modulation: Pulse or square wave of positive or negative polarity and of 40 volts maximum amplitude.

Repetition rate of 40 to 4,000 p. r. f.

The equipment also provides variable delay or undelayed video triggers for external applications.

Power Source Required: 105-125 volts, 50-1600 cycles.

Tubes: 1 type 6SL7GT, 3 type 6J6, 4 type 6C4, 2 type 6Y6G, 1 type 2K28, 1 type 5R4GY, 2 type 6X5GT, 3 type OA2/VR75.

Batteries: None.

Mechanical characteristics:

Dimensions: height 14½", width 17" and depth 12½".

Weight: 64 pounds.

Complete equipment consists of:

- (1) 1 Signal Generator, TS-403/U.
- (2) 1 R-F cable, CG-92/U (6 feet) (not illustrated).
- (3) 2 Video cables (each 8 feet of RG-58/U with a UG-88/U plug at each end) (not illustrated).
- (4) 3 UG-273/U adapters, each with a 49195 plug and a UG-89/U jack (not illustrated).
- (5) 5 Spare fuses (not illustrated).
- (6) 3 Spare pilot lamps (not illustrated).
- (7) 1 Thermistor mount (not illustrated).
- (8) 1 Transit case (not illustrated).
- (9) 1 Handbook of Maintenance Instructions for TS-403/U Signal Generator.

ASO stock No. ....

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| (3) ..... | (4) ..... |





Figure 10-23. Test Oscillator—TS-406/UP

## TEST OSCILLATOR

### TS-406/UP

**Primary purpose:** General test oscillator application.

This is a field type test oscillator designed to provide a low power test signal for receivers within its frequency range. The tunable concentric line cavity resonator is excited by a battery-operated buzzer. The output amplitude can be controlled by the attenuator whose dial is calibrated to show relative attenuation in db.

#### Electrical characteristics:

Frequency: 1000-3500 mc.

Pulse frequency: 1500 to 2000 c. p. s.

Output Impedance: 50 ohms.

Power Output: Over 10 microvolts on 50 ohm load.

Sensitivity: Relative attenuation (0 to 60 db).

Tubes: None.

Batteries: 1-BA-205/U (not supplied).

#### Mechanical characteristics:

Dimensions: 10" x 12" x 5", including cover.

Weight: 14 pounds complete.

#### Complete equipment consists of:

- (1) 1 Test Oscillator, TS-406/UP.
- (2) 1 RG-9/U coax cable (6 feet) terminated in UG-24/U fittings.
- (3) 2 Setscrew wrenches (not illustrated).
- (4) 1 Spare buzzer (not illustrated).
- (5) 1 Instruction book AN 16-35TS406-3.

ASO stock No. R16-AN-TS-406/UP.

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### SIGNAL GENERATOR

TS-418/U

Primary purpose: To provide accurate pulse, frequency modulated, and continuous wave radio frequency signals in the band of frequencies between 400 and 1000 megacycles per second for use in testing and maintaining aircraft radio and radar receivers and other electronic devices which require less than 0.20 milliwatts of measured power.

Description: A semiportable signal generator for general application. The frequency of the output signal is continuously variable from 400-1000 mc. in one band and is directly indicated by means of a single front panel control. The output signal power level is continuously variable between 0.1 volt and 0.1 microvolt and is directly indicated by means of a single front panel control. The instrument provides pulsed and CW RF signals together with both delayed and undelayed trigger pulses for external application.

Electrical characteristics:

Frequency range:

400-1000 mc/s in a single band.

Accuracy:

Frequency directly indicated to within plus or minus 1%.

Output power:

Minus 7 dbm through minus 120 dbm (100 millivolts through 0.16 microvolts into a 50-ohm load)

Output impedance:

50 ohms.

Type of output:

Unmodulated (CW) modulated (pulse or external sine wave).

Modulation:

Internal pulse modulation:

PRF: 40-4,000 pps.

Pulse Width: adjustable from 0.5 to 10.0 microseconds.

External Synchronization: From positive or negative pulses or sine waves.

Timing: Undelayed or delayable from 3 to 300 microseconds from external synchronizing signal or external pulse.

External Pulse Modulation: From pulses having a width from 0.5 to 10 microseconds, positive or negative polarity, amplitude of 40-70 volts, and a pulse repetition between 40 and 4,000 pps.

External Sine Wave Modulation: 30% or more from sine waves having a minimum amplitude of 3 volts and a frequency between 100 cycles and 100 kilocycles per second.

Equipment also provides delayed and undelayed video trigger for external application.

Power Source Required: 105 to 125 volts a. c., 50-1600 c. p. s., 130 watts.

Batteries: None required.

Tubes: Not established at this date.

Mechanical characteristics:

Dimensions: 13 1/2" long by 17 5/8" by 14 1/2".

Weight: Test Set Alone-60 pounds. Test Set plus transit case, accessories and handbook, 75 pounds.

Complete equipment consists of:

- (1) 1 Signal generator TS-418/U.
- (2) 1 Transit case.
- (3) 1 Power cord CX-337/U (6 feet).
- (4) 3 Adapters UG-201/U.
- (5) 3 Adapters UG-255/U.
- (6) 3 Adapters UG-273/U.
- (7) 3 Indicator lamps.
- (8) 5 Fuses.
- (9) 1 Handbook of Operating and Maintenance Instructions.
- (10) 3 R-F Cables (each 8 feet of RG-58/U cable with UG-88/U plugs on both ends).

ASO stock No. ....

- (1) ..... (2) .....
- (3) ..... (4) .....
- (5) ..... (6) .....

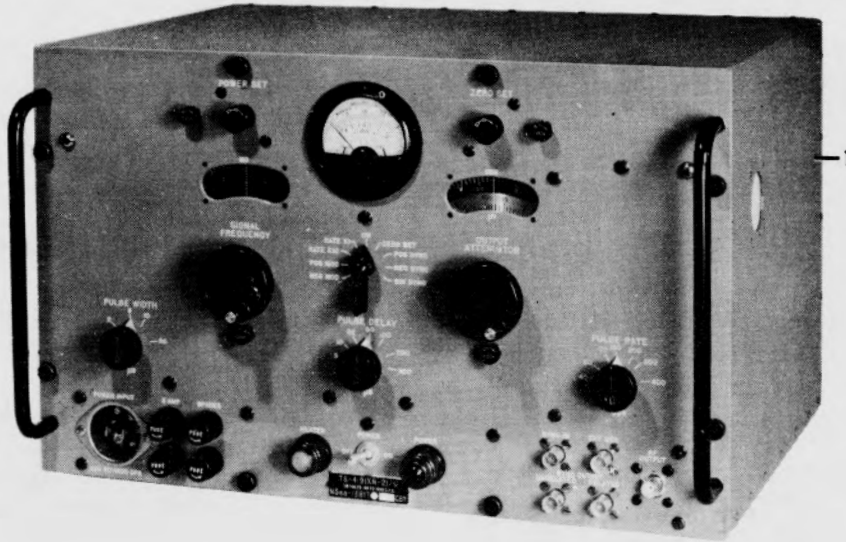


Figure 10-24. Signal Generator—TS-419/U

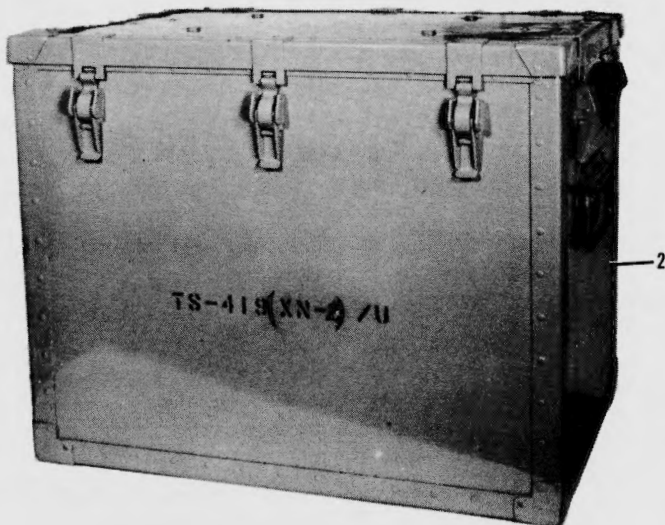


Figure 10-24. Signal Generator—TS-419/U

## SIGNAL GENERATOR

### TS-419/U

Primary purpose: To provide accurate pulse, frequency modulated, and continuous wave radio frequency signals in the band of frequencies between 900 and 2100 megacycles per second for use in testing and maintaining aircraft radio and radar receivers and other electronic devices which require less than 0.20 milliwatts of measured power.

Description: A semiportable signal generator for general application. The frequency of the output signal is continuously variable from 900–2100 mc in one band and is directly indicated by means of a single front panel control. The output signal power level is continuously variable between 0.1 volt and 0.1 microvolt and is directly indicated by means of a single front panel control. The instrument provides pulsed and CW RF signals together with both delayed and undelayed trigger pulses for external application.

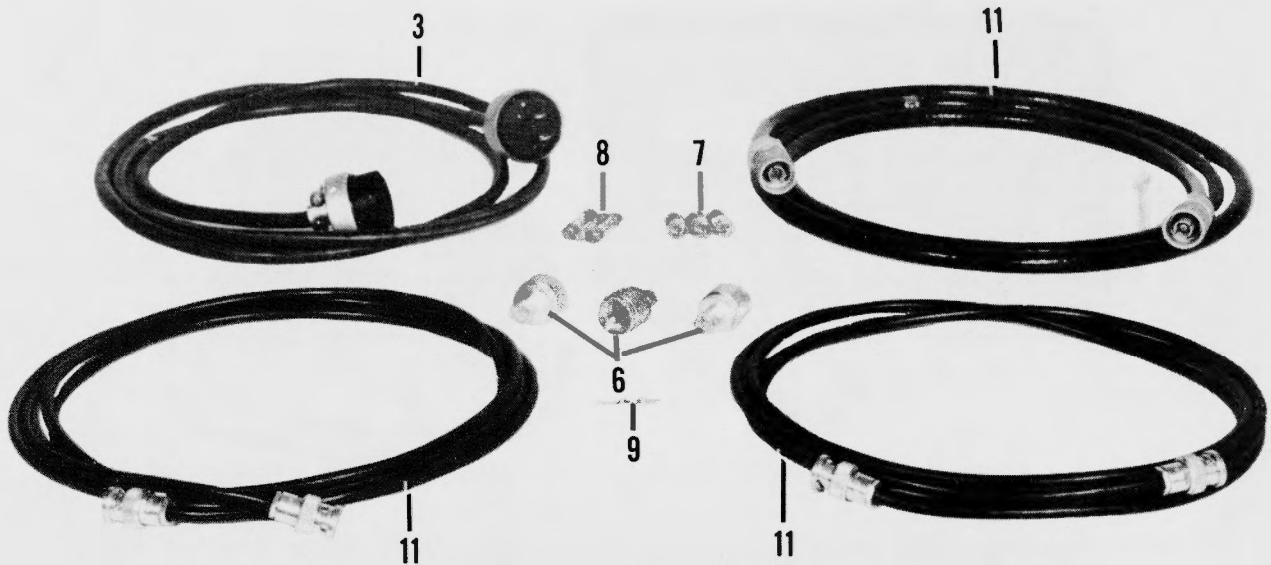


Figure 10-24. Signal Generator—TS-419/U

**Electrical characteristics:**

Frequency range: 900-2100 mc/s in a single band.  
Accuracy: Frequency directly indicated to within plus or minus 1%.

**Output power:**

Minus 7 dbm through minus 120 dbm (100 millivolts through 0.16 microvolts into 50 ohms load).

Output impedance: 50 ohms.

**Type of output:**

Unmodulated (CW) or modulated (pulse).

**Modulation:**

**Internal pulse modulation:**

PRF: 40-4,000 pps.

Pulse Width: adjustable from 0.5 to 10.0 microseconds.

External Synchronization: From positive or negative pulses or sine waves.

Timing: Undelayed or delayable from 3 to 300 microseconds from external synchronizing signal or external pulse.

External Pulse Modulation: From pulses having a width from 0.5 to 10 microseconds, positive or negative polarity, amplitude of 40-70 volts, and a pulse repetition between 40 and 4,000 pps.

Equipment also provides delayed and undelayed video triggers for external application.

Power Source Required: 105 to 125 volts a. c.,  
50 to 1600 c. p. s. 200 watts.

Batteries: None required.

Tubes: Not established at this date.

**Mechanical characteristics:**

Dimensions: 11" x 12" x 17".

Weight: Test Set alone—45 pounds. Test Set plus transit case, accessories, and handbook, 65 pounds.

**Complete equipment consists of:**

- (1) 1 Signal generator, TS-419/U.
- (2) 1 Transit case.
- (3) 1 Power cord CX-337/U (6 feet).
- (4) 3 Adapters UG-201/U (not illustrated).
- (5) 3 Adapters UG-255/U (not illustrated).
- (6) 3 Adapters UG-273/U.
- (7) 3 Indicator lamps.
- (8) 5 Fuses.
- (9) 1 Thermistor bead.
- (10) 1 Handbook of Operating and Maintenance Instructions.
- (11) 3 R-F cables (each 8 feet of RG-58/U cable with a UG-88/U plug at each end).

ASO stock No. ....

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |
| (5) ..... | (6) ..... |

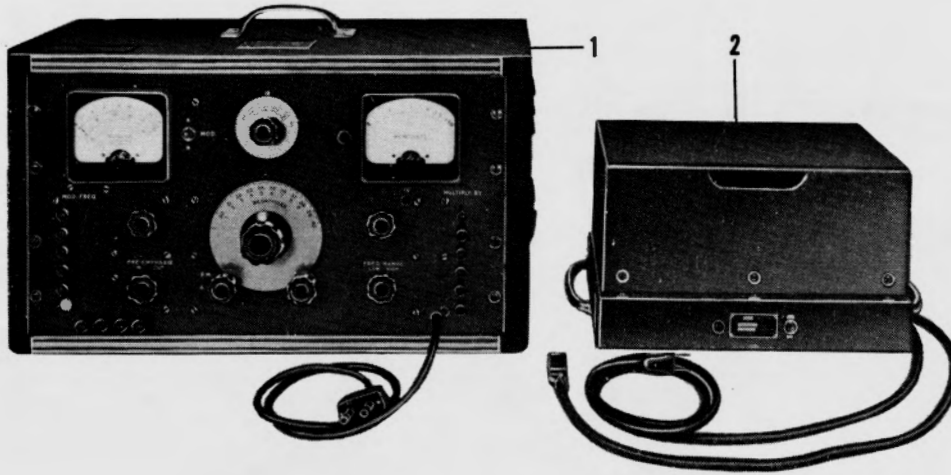


Figure 10-25. Signal Generator—Boonton Model 150-A, 151-A

## SIGNAL GENERATOR

### Boonton Model 150-A, 151-A

Primary purpose: Special purpose FM generator for testing and maintenance of certain P/A FM electronic equipment.

These FM generators supply a signal voltage at the output terminals in two frequency ranges. Boonton Models 150-A and 151-A differ only in frequency range as noted below. The fixed r-f oscillator is frequency modulated by an a-f oscillator through a reactance tube, thus providing FM which is independent of variations of the output signal mean frequency. The modulation meter is calibrated in kc. deviation. External terminal posts permit the introduction of modulation voltage from an external oscillator. The output voltage of the internal a-f oscillator is available for visual alignment purposes and for general laboratory work.

#### Electrical characteristics:

##### Frequency range:

Model 150-A Carrier frequency: 41-50 mc.

Model 151-A Carrier frequency: 30-40 mc.

Model 150-A Intermediate frequency: 1-10 mc.

Model 151-A Intermediate frequency: 1-7 mc.

Vernier control: Variation of the mean frequency of from zero to 300 kc. may be obtained on each frequency range.

Internal fixed audio frequencies: 100, 400, 1K, 4K, and 10K cycles.

FM (deviation) range: From zero to 225 kc. meter calibrated in 2-ranges 0-75 kc., 0-225 kc. and also calibration for 30% amplitude modulation.

Output voltage range: Continuously variable from 0.1 microvolt to 0.1 volt at terminal unit, and 0.1 volt to 1.0 volts at one volt tap.

#### Distortion:

± 5% (FM with deviation of 75 kc. using internal 400 c. p. s. modulation).

± 3% (using external a-f oscillator with pure wave form).

Output impedance: 55 ohms.

Power required: (Separate power supply unit type 150-R. Power unit requires 105-125 volts, 60 c. p. s.).

Tubes: 150-A and 151-A; 1 type 6H6; 2 type 6F6; 2 type 6V6; 2 type 6J5; 2 type 6AC7; 2 type S-6-120V-6W lamps.

Tubes: 150-R; 1 type 5V4G; 1 Mazda 47.

Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

150-A and 151-A: 21½" x 10" x 13½".

150-R: 15½" x 7½" x 8".

Weight: 38 pounds. (150-R: 29 pounds).

#### Complete equipment consists of:

(1) 1 FM signal generator, Boonton 150-A or 151-A.

(2) 1 Power Supply, 150-R.

(3) 1 Instruction Book NAVAER 08-5Q-288.

ASO stock Nos.

Boonton Model 150-A-R16-BTN-150A.

Boonton Model 151-A-R16-BTN-151A.

(1) ..... (2) R16-BTN-150R.



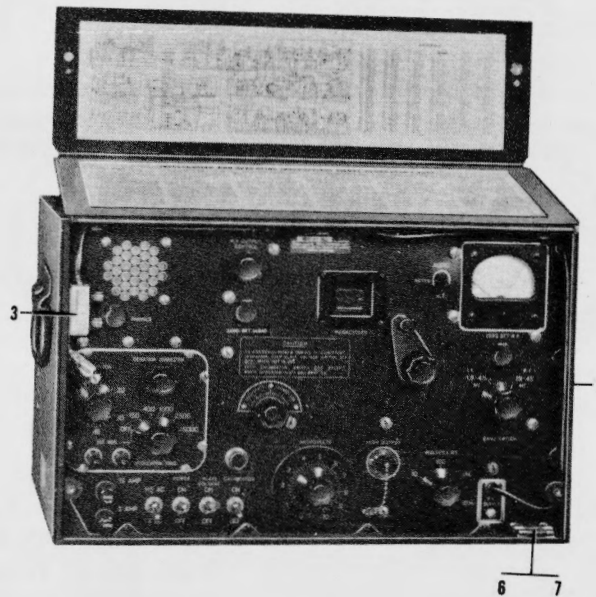


Figure 10-26. Signal Generator-I-208

## SIGNAL GENERATOR

### I-208

Primary purpose: Signal Generator I-208 is a crystal controlled frequency and voltage standard for testing frequency modulated radio equipment. It is used in the calibration, alignment, and determination of sensitivity of frequency modulated radio receivers. The major circuit units are an audio oscillator, a radio frequency source, a calibrator, a power supply, and a dynamotor assembly.

The signal generator may be installed on mounting FT-237 for use in mobile units or for field use.

#### Electrical characteristics:

Range: 1.9 to 4.5 mc., 19 to 45 mc.

Frequency Deviation: 0 to 5 kc. each side of center frequency on low band. 0 to 50 kc. deviation each side of center frequency on high band.

Modulation: Internal, 150, 400, 1,000, 2,500 and 5,000 c. p. s. Provisions for external modulation.

Output: 100,000 microvolts on 30-ohm line.

Accuracy: Frequency  $\pm .03\%$  from 0°-60° C.

Power: 11 to 14 volts d. c., 105 to 130 volts a.c.

#### Tube complement:

##### R-F Unit:

- 1 type 65Q7GT; 2 type 12SA7GT;
- 1 type 12A6GT; 3 type 12SH7;

1 type 6AG7; 1 type 955.

##### Audio Osc. Unit:

- 1 type 12SN7GT.

##### Calibrator Unit:

- 1 type 12SN7GT; 1 type 12SA7GT;
- 1 type 12A6GT; 1 type 12SH7.

##### Power Supply and Dynamotor Unit:

- 1 type 5U4G; 1 type OD3/UR150;
- 1 Amperite type 1H-20 ballast resistor.

#### Complete equipment consists of:

- (1) 1 Signal Generator, I-208.
- (2) 1 Power Cord CD-778 (8 feet) (not illustrated).
- (3) 1 Output cord CD-749 (40 feet).
- (4) 1 Extension cord CD-984 (36 inches) (not illustrated).
- (5) 1 Crystal Unit DC-23A (spare) (not illustrated).
- (6) 1 Fuse FU-53 (9 spare).
- (7) 1 Fuse FU-54 (9 spare).
- (8) 1 Lamp LM-27 (6 spare) (not illustrated).
- (9) 1 Dial Film (2 oz. spare) (not illustrated).

#### ASO stock No. R16-AYS-I-208.

- |                     |                     |
|---------------------|---------------------|
| (1) .....           | (2) R16-AYS-CD-778. |
| (3) R16-AYS-CD-749. | (4) R16-AYS-CD-984. |
| (5) .....           | (6) .....           |
| (7) .....           | (8) .....           |
| (9) .....           |                     |

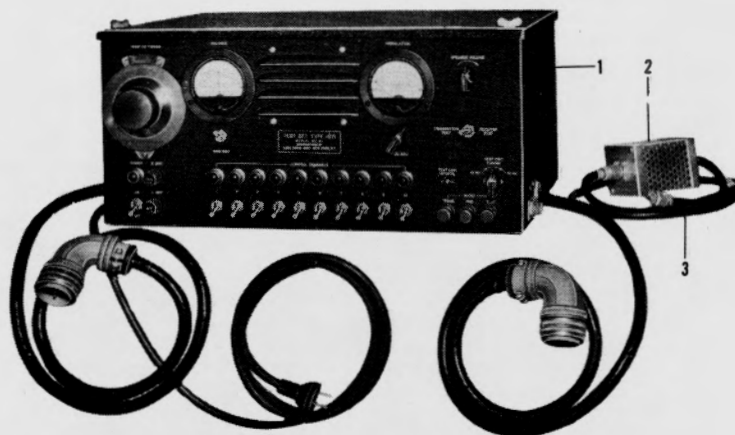


Figure 10-27. Radio Control FM Test Set—Link 1671

## RADIO CONTROL FM TEST SET

### Link 1671

**Primary purpose:** The test set is designed to provide a means of aligning the tone oscillator circuits of Transmitter T-24/ARW-3 and adjusting the tone controlled circuits of radio receivers, R-32/ARW-2 and R-33/ARW-2X.

It consists of transmitter and receiver units built into a test set and used as a standard for testing AN/ARW-2 and AN/ARW-3.

It contains the following functional circuits:

1. Frequency modulation (FM) monitor receiver to permit adjustments of the level and frequency of the modulating tones of T-24/ARW-3; includes a decibel meter to indicate modulation level and loud speaker for aural monitoring of the transmitter.

2. Ten audio oscillators that may be used as frequency standards for the tone oscillators of transmitter T-24/ARW-3, and which may be used to modulate the test oscillator for adjusting the circuits of radio receivers R-32/ARW-2 and R-33/ARW-2X.

3. A crystal-controlled FM test oscillator and modulator to supply a signal to radio receivers R-32/ARW-2 and 2X for adjusting the RF and tone-controlled circuits of the receivers.

4. A voltage regulated power supply to provide power for the operation of the test set.

5. Switching circuits indicating lights and inter-connecting cables to operate the tone circuits of radio transmitter T-24/ARW-3 and to indicate operation of the tone-controlled relays in receivers AN/ARW-2 and 2-X.

#### Electrical characteristics:

Frequency range: 30-42 mc.

Type modulation: FM, plus or minus 15 kc. maximum deviation.

Power supply: self-contained.

Power input: 75 watts, 115 volts, 50-60 cycles a.c.

Tone channel frequency: 300, 420, 590, 830, 1155, 1620, 2270, 3180, 4450, 6230 c. p. s.

Monitor sensitivity: 250 microvolts.

Test oscillator output: 300 microvolts.

Tubes: 1 type 6SJ7; 12 type 6SH7; 1 type 6AC7; 1 type 6H6; 1 type 6SN7; 1 type 6J5GT; 2 type 6SLGT; 1 type 6X5GT; 2 type OC3/VR-105.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9½" x 23" x 13½".

Weight: 50 pounds.

#### Complete equipment consists of:

- (1) 1 Test meter 1671.
- (2) 1 Dummy Load.
- (3) 1 RF cable RG-8/U (40 inches).
- (4) 1 Instruction book AN 16-45-67.

ASO stock No. R16-M-2051.

- (1) .....
- (2) R16-LNK-1696-2.
- (3) .....

## RADIO CONTROL FM TEST SET

### Link 1671 (Modified)

**Primary purpose:** To provide a means of aligning the tone oscillator circuits of transmitter T-125/ARW-34 and adjusting the tone controlled circuits of radio receiver R-146/ARW-35.

Same as Link 1671 except modified to frequency range of 50 to 70 mc.

ASO stock No. ....

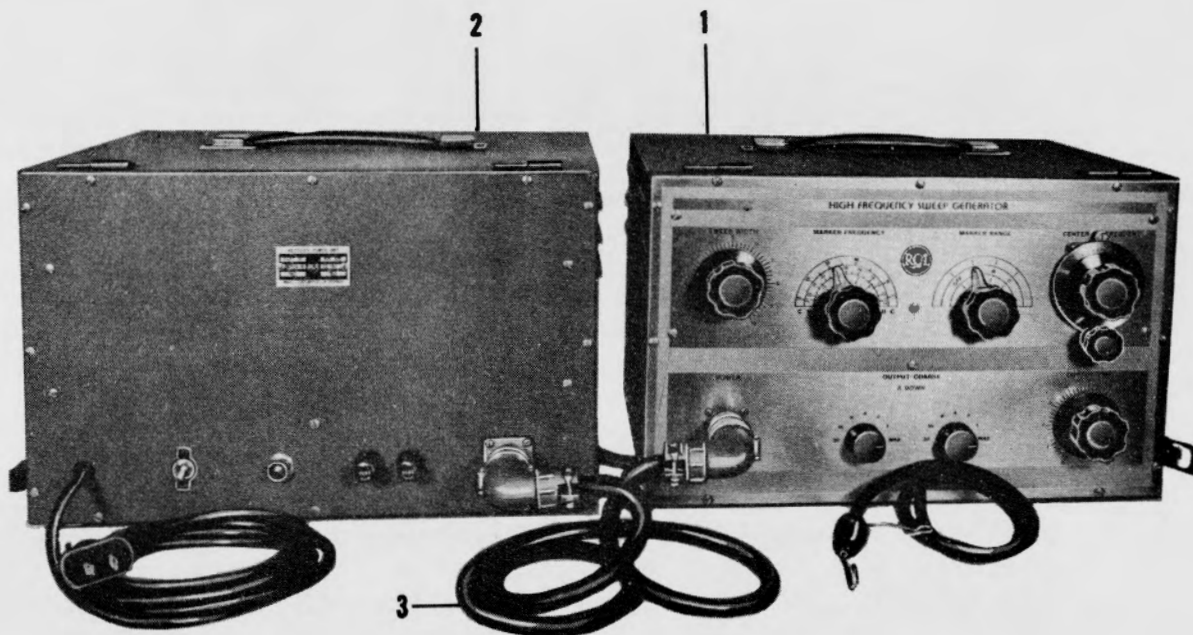


Figure 10-28. Sweep Generator—RCA MI-18709-B

## SWEEP GENERATOR

### RCA MI-18709-B

Primary purpose: General sweep generator applications, specifically intended for IF alignment.

Two units, signal generator and power supply. The power supply is electronically regulated to maintain 270 volts d. c. output with input variations between 105 and 125 volts a.c. The signal generator output is a heterodyne of two VHF oscillators mixed in a balanced detector. One oscillator is frequency modulated, its midfrequency constant. The other oscillator frequency is variable, producing a variable heterodyne.

Although the specified upper frequency limit is 65 mcs., most of these signal generators will function satisfactorily up to about 75 mcs. The dial scale is marked in red on some instruments from 65 mcs. to 75 mcs.

The difference between MI-18709A and the MI-18709-B is that the MI-18709-B has a marker oscillator for identifying any frequency in the range of the sweep generator by viewing the oscilloscope pattern.

#### Electrical characteristics:

Center frequency: 5 to 65 mc.  
Frequency excursion: 0.2 to 20 mc.

Modulation frequency: Supply frequency.  
Marker frequency: 5 to 70 mc.  
Output voltage: 0.5 to 0.001 volts.  
Output lead: Terminated 75 ohm cable.  
Power supply: 105-125 volts, 50-60 cycles can be converted to 210-230 volts, 50-60 cycles.  
Power consumption: 150 watts.  
Tube Sweep Generator: 4 type 955, 3 type 6AC7, 1 type 6J5.  
Power supply: 1 type 5U4G, 1 type OC3/VR105, 2 type 6L6G, 1 type 6SJ7.

#### Mechanical characteristics:

##### Dimensions:

Sweep Generator: 10" x 17" x 12".  
Power Supply: 10" x 17" x 12".

##### Weight:

Sweep Generator: 36 pounds.  
Power Supply: 43 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator.
- (2) 1 Power supply.
- (3) 1 Interconnecting power cable.

ASO stock No. R16-G-3025.

- (1) .....
- (2) .....
- (3) .....

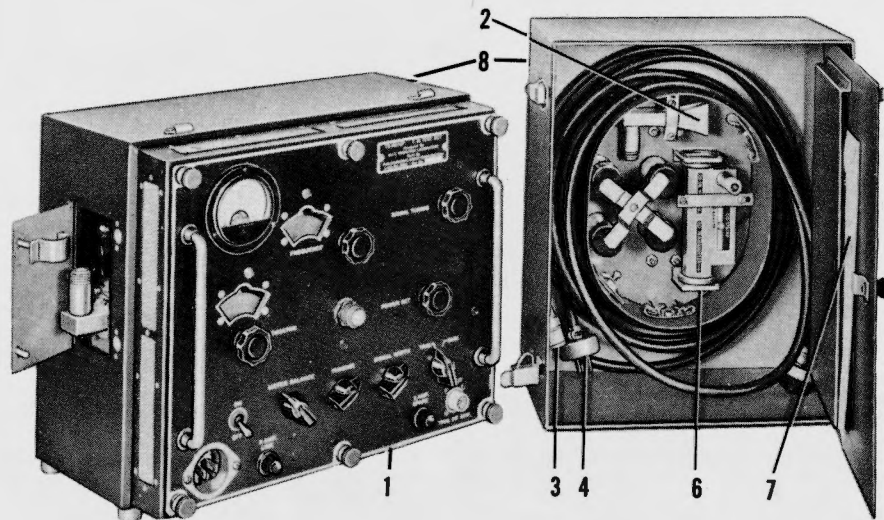


Figure 10-29. FM Test Set—TS-146/UP

## FM TEST SET

### TS-146/UP

Primary purpose: To measure the transmitted power and frequency of radar sets and to provide an artificial echo to check the receiver sensitivity of the radar.

Average power levels, in reference to 1 milliwatt, are measurable over the aircraft X-band when fed to the test set through either a wave guide or coaxial line.

Receiver sensitivity measurements are made by using a signal derived from this test as the equivalent of an echo and reducing the signal level by means of the calibrated test set attenuator to determine the weakest signal that the radar will show on the radar cathode ray tube screen.

This test set received its name from the fact that the output signal is variable in frequency over the aircraft band as follows: The rate of change of frequency is variable and the center frequency about which the signal output varies is adjustable. These variations are accomplished by using the internal sawtooth voltage or from an external source (preferably a TS-34/AP oscilloscope sweep). The radar system under test must provide the initiating video pulse to synchronize the FM test set signal for the required receiver test to determine radar receiver sensitivity.

Radar receiver over-all band width and midband frequency can be checked with this equipment as well as TR recovery time and locking of the AFC circuit.

#### Electrical characteristics:

Frequency range: 9285-9465 mc.

Power output: -5 to -75 dbm (calibrated -40 to 75 dbm).

Power input: Max. av. 1 watt; peak power, 8 to 500 watts.

Trigger for signal generator; sawtooth 100 to 200 volts into impedance greater than 100 kilohms; pulse 10-to-100 volts into impedance greater than 25,000 ohms.

Input impedance: Horn to type "N" connector 50 ohms (directional coupler also provided).

Accuracy: Wattmeter  $\pm 2$  db; signal generator output  $\pm 1.5$  db; frequency  $\pm 2$  mc.

Power required: 109 to 121 volts, 50 to 1,200 c. p. s., 60 watts.

Tubes: 3 type OD3/VR150; 1 type 5R4G; 1 type 723A/B (2K25); 1 type 884.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9 $\frac{1}{2}$ " x 13 $\frac{1}{2}$ " x 12".

Weight: 35 pounds.

#### Complete equipment consists of:

- (1) 1 FM test set, TS-146/UP.
- (2) 1 Pick-up horn, AT-68/UP.
- (3) 1 R-f coaxial cable CG-92/U, 8 feet long.
- (4) 1 Power cable, CX-337/U, 10 feet long.
- (5) 1 Video cable, CG-91/U, 6 feet long (not illustrated).
- (6) 1 Directional coupler, CG-176/UP.
- (7) 1 Instruction book AN 16-35TS146-3.
- (8) 1 Carrying case.

#### ASO stock No. R16-AN-TS-146/UP.

- |                 |                       |
|-----------------|-----------------------|
| (1) .....       | (2) R16-AN-AT-68/UP.  |
| (3) R16-C-3851. | (4) R16-AN-CX-337/U.  |
| (5) R16-C-3856. | (6) R16-AN-CG-176/UP. |
| (8) .....       |                       |



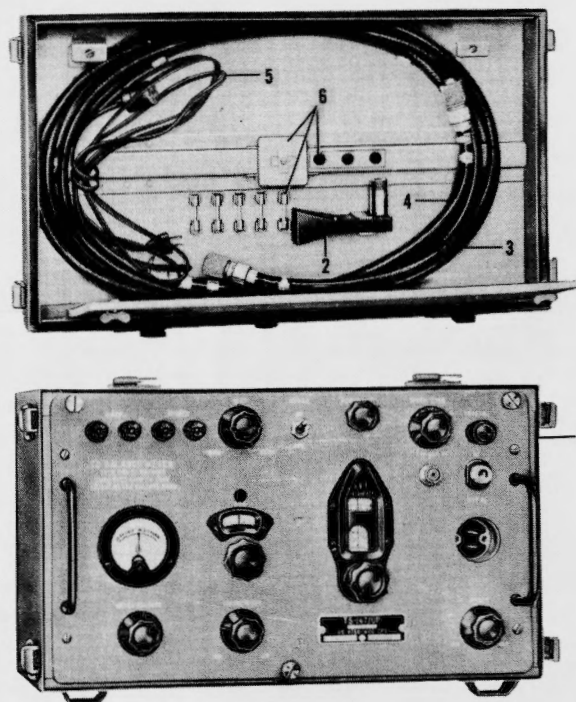


Figure 10-30. FM Test Set—TS-147/UP

## FM TEST SET

### TS-147/UP

Primary purpose: To measure transmitted power, frequency, and receiver sensitivity of radar sets.

The TS-147/UP is built to service specifications and will replace TS-146/UP as the standard FM test set. In general the operation and applications of this equipment are the same as TS-146/UP except as follows.

A direct reading frequency meter is built into the equipment. It may be triggered by the r-f pulse from the radar set under test thus eliminating the necessity for a video synchronizing pulse connection to the test set. The test set also contains a power meter (thermistor bridge type).

#### Electrical characteristics:

Frequency range: 8500-9600 mcs.  $\pm 2.5$  mc.

Frequency excursion of sweep: 0 to 60 mc.

Power output range: -5 to -83 dbm; calibration from -42 to -83.

Power meter range (reads average): -42 to -83 dbm. (from generator), 7 to 30 dbm. (from outside source).

Input connection: Type N.

Accuracy: Frequency measurement—plus or minus 1 to 5 mc.

Power output calibration: Plus or minus 2 db (normal temperature and humidity plus or minus 0.5 db).

Power meter: Plus or minus 2 db (normal temperature and humidity plus or minus 0.5 db).

Power required: 105 to 125 volts, 50 to 1,600 cycles, 125 watts maximum at 60 cycles.

Tubes: 1 type 5R4GY; 1 type 6Y6, 1 type 6SH7; 2 type OC3/VR105; 1 type 723A/B (2K25); 2 type 6SL7.

Batteries: None.

Mechanical characteristics:

Dimensions: 11" x 18 $\frac{3}{4}$ " x 12 $\frac{1}{4}$ ".

Weight: 35 pounds.

Complete equipment consists of:

- (1) 1 Test set, TS-147/UP.
  - (2) 1 Pickup horn, AT-68/UP.
  - (3) 1 R-f cable assembly, CG-92/U.
  - (4) 1 Video cable assembly, CG-91/U.
  - (5) 1 Power cord, CX-337/U.
  - (6) 1 Set spare fuses, crystals, gaskets.
  - (7) 1 Instruction book AN 08-35TS147-3.
- ASO stock No. R16-AN-TS-147/UP.
- |                      |                      |
|----------------------|----------------------|
| (1) .....            | (2) R16-AN-AT-68/UP. |
| (3) R16-C-3851.      | (4) R16-C-3856.      |
| (5) R16-AN-CG-337/U. | (6) .....            |



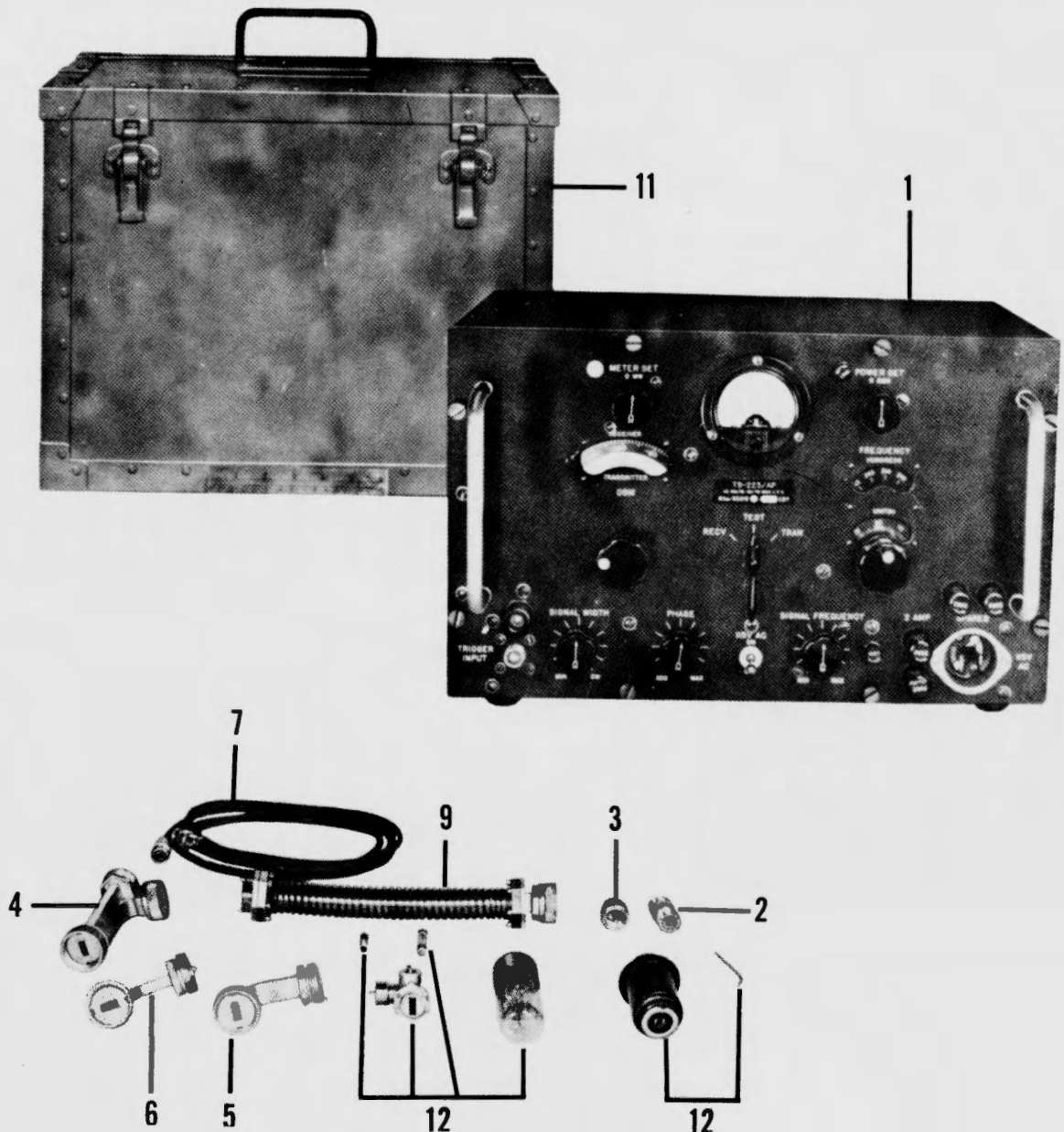


Figure 10-31. FM Test Set—TS-223/AP

### FM TEST SET

#### TS-223/AP

Primary purposes: To measure transmitted power, frequency and receiver sensitivity of radar sets.

This test set indicates average power levels in reference to 1 milliwatt when fed to the test set. Receiver sensitivity measurements are made by using a signal derived from this test set as the equivalent of an echo and reducing the signal level by means of a calibrated attenuator to determine the lowest test set signal that will show on the radar cathode ray tube screen. Radar receiver overall band width and midband frequency can be checked as well as TR recovery time and locking of the AFC circuit. A thermistor bridge type power meter is included.

#### Electrical characteristics:

Frequency: 23,500 mc. to 24,500 mc.  
Transmitter output: 10 dbm to 30 dbm (av.).  
Receiver sensitivity: -37 to -90 dbm.  
Power required: 100 volt amperes-115 volts  $\pm 10\%$ ,  
50 to 1600 c. p. s.  
Frequency Meter Accuracy:  $\pm 0.1\%$ .  
Tubes: 1 type 2K50 (or 1462); 2 type 6SL7GT; 1  
type 5R4GY; 1 type 1478 (or 2A21); 1 type 6Y6;  
1 type 6SH7, 1 type OD3/VR150.  
Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

Test Set: 15" x 9 $\frac{3}{8}$ " x 10 $\frac{1}{4}$ ".  
Case: 18 $\frac{3}{4}$ " x 13" x 12 $\frac{3}{4}$ ".

##### Weight:

Test Set: 24 pounds.  
Case: 14 pounds.

#### Complete equipment consists of:

- (1) 1 FM test set, TS-223/AP.
- (2) 2 UG-255/U adapters.
- (3) 2 UG-273/U adapters.
- (4) 1 CU-127/UP coupler.
- (5) 1 CG-345/U transmission line (waveguide).
- (6) 1 CG-346/U transmission line (waveguide).
- (7) 1 CG-409/U (6 feet) cable.
- (8) 1 CX-337/U (6 feet) cable (not illustrated).
- (9) 2 UG-344/U (8-inch) transmission line (waveguide).
- (10) 1 Instruction book.
- (11) 1 Carrying case CY-438/AP (not illustrated).
- (12) 1 Set operating spares.

#### ASO stock No. R16-AN-TS-223/AP.

- |                      |                        |
|----------------------|------------------------|
| (1) .....            | (2) R16-A-507.         |
| (3) R16-A-478.       | (4) R16-AN-CU-127/UP.  |
| (5) R16-AN-CG-345/U. | (6) R16-AN-CG-346/U.   |
| (7) R16-C-3761.      | (8) R16-AN-CX-337/U.   |
| (9) R16-AN-UG-344/U. | (11) R16-AN-CY-438/AP. |
| (12) .....           |                        |

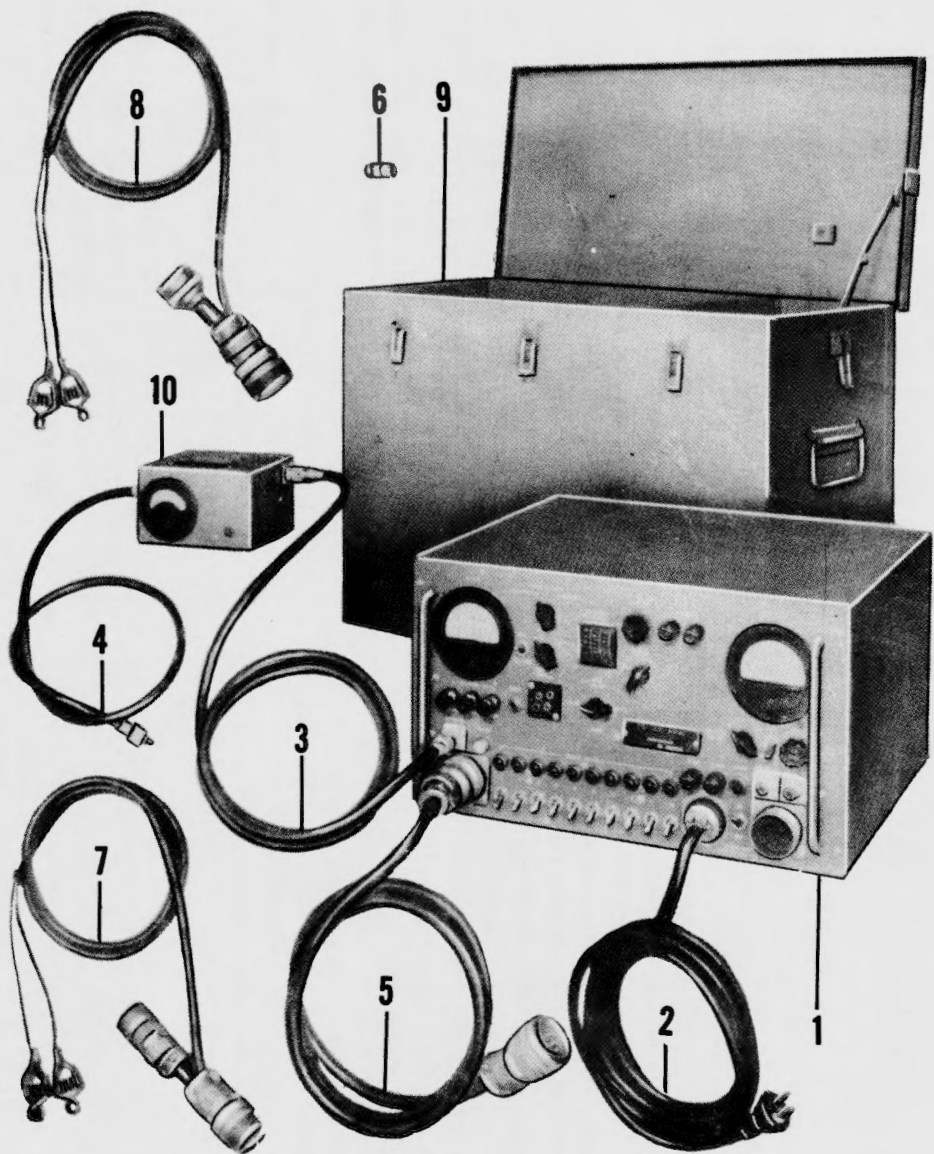


Figure 10-32. FM Radio Control Test Set—TS-306/ARW

### FM RADIO CONTROL TEST SET

#### TS-306/ARW

Primary purpose: To test certain radio control transmitters and receivers.

The test set is designed to provide a means of aligning the tone oscillator circuits of transmitters AN/ARW-3, -13, -34, and adjusting the tone controlled circuits of receivers AN/ARW-2, -14, -17, -35, -37. It consists of transmitter and receiver unit built into a test set and used as a standard for testing the above equipments.

An FM receiver is included to permit adjustment of the level and frequency of transmitter modulating tones. It includes a modulation level indicator and a jack for ear-phones.

Also included is a crystal controlled FM test oscillator and modulator for use as a signal source and 10 audio oscillators for use as tone oscillator frequency standards or for modulating the FM test oscillator. Various switching circuits, indicating lights and connecting cables operate and indicate the functioning of tone circuits and relays in transmitters and receivers.

#### Electrical characteristics:

Frequency: Monitor receiver 30-75 mc; test oscillator 30-75 and 132-140 mc.

Type Modulation: FM of test oscillator, maximum deviation  $\pm 15$  kc. in 30-75 mc. range and maximum deviation of  $\pm 45$  kc. in 132-140 mc. range.

Tone channel frequencies: 300, 420, 590, 830, 1155, 1620, 2270, 3180, 4450, and 6230 c. p. s.

Test oscillator output: 20-5000 microvolts variable but uncalibrated.

Power required: 90 watts, 115 volts  $\pm 10\%$ ; 50-1600 c. p. s.

Tubes: 23 Type 6AK5, 1 type 6C4, 1 type 6J6, 1 type 6AL5, 1 type 5U4G, 1 type OD3/VR-150.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 17 $\frac{1}{8}$ " x 16 $\frac{1}{8}$ " x 9 $\frac{3}{4}$ ".

Weight: 70 pounds, including case.

#### Complete equipment consists of:

- (1) 1 TS-306/ARW.
- (2) 1 Power cord CX-337/U (6 feet).
- (3) 1 RF cable CG-91/U (6 feet).
- (4) 1 RF cable CG-91/U (3 feet).
- (5) 1 Control cable (6 feet).
- (6) 1 Adapter UG-255/U.
- (7) 1 Adapter Control Cable AN/ARW-37.
- (8) 1 Adapter Control Cable AN/ARW-17.
- (9) 1 Case CY-582/ARW.
- (10) 1 Dummy Load TS-307/ARW.
- (11) 1 Instruction book AN 16-35TS306-3.

ASO stock No. R16-AN-TS-306/ARW.

- |           |            |
|-----------|------------|
| (1) ..... | (2) .....  |
| (3) ..... | (4) .....  |
| (5) ..... | (6) .....  |
| (7) ..... | (8) .....  |
| (9) ..... | (10) ..... |

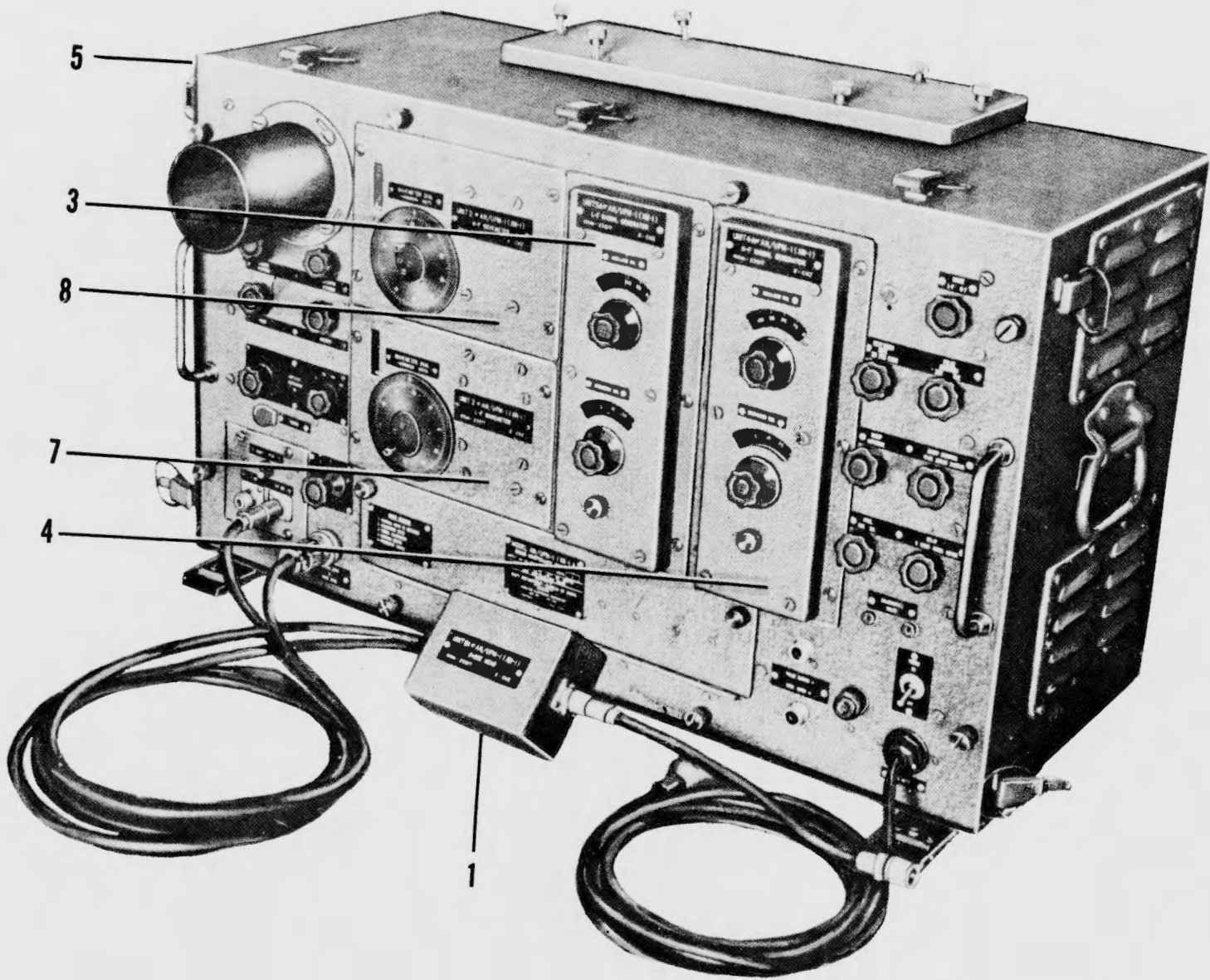


Figure 10-33. Bench Test Set—AN/UPM-1



## BENCH TEST SET

### AN/UPM-1

Primary purpose: Bench testing of radar and IFF equipment.

A ground portable beacon monitor and test set used to test and monitor radar beacons and test IFF equipment.

This equipment will measure IFF beacon and radar systems for (a) pulse transmitter frequency, (b) pulse transmitter output, (c) pulse width and shape, (d) receiver sensitivity, (e) receiver band width, (f) repetition rates and delay time of transponders or beacons, (g) gain and distortion of video amplifiers, (h) and permit the monitoring of beacons.

The aforementioned test may be performed only on IFF, radar, and beacons which operate in the frequency ranges of ABK, ABF and AN/APX (MK III), ABD and ABE (MK II), ABA (MK IV), IFF, Rebecca, Eureka, YH and YJ beacons. Numerous other radar systems pertaining to the Navy and Army may be checked such as Shoran, SC, SCR-527, 627, 588, 602, 521, 268. Additional attenuators would be required to make some of these tests as the latter equipments are in the high power class. The Console Rack MT-189/UPM-1 contains a scope, rectifier power unit, and circuits for coordinating the functions of associated units.

Two wavemeters are included: Wavemeter TS-134/UPM-1 (460-570 mc.) and wavemeter TS-133/UPM-1 (155-235 mc.). Each wavemeter is equipped with a diode detector and is accurate to within 0.25 of one percent and is resettable to within 0.1 of one percent.

#### Electrical characteristics:

Frequency range: 155 to 235 mc. and 460 to 570 mc.

Power required: 80 to 115 volts or 230 volts, 50 to 1,000 c/s, 140 to 210 watts dependent upon power source frequency and voltage.

#### Vacuum tube complement:

MT-189/UPM-1:

9 type 6SN7GT; 1 type 3BP1;  
2 type 6SH7; 1 type 6AG7;  
1 type OD3/VR150; 1 type 5U4G;  
1 type 2X2/879.

TS-134/UPM-1: 1 type 9006.

TS-133/UPM-1: 1 type 9006.

O-13/UPM-1: 1 type 6J6; 1 type 6C4.

O-12/UPM-1: 1 type 6J6; 1 type 6C4.

CV-11/UPM-1: 1 type 9005; 1 type 6C4.

J-94/UPM-1: 2 type 9005.

Batteries: None.

#### Mechanical characteristics:

Weight: 135 pounds (includes all major components and accessories).

#### Complete equipment consists of:

- (1) 1 CV-11/UPM-1, diode head.
- (2) 1 CW-24/UPM-1, dust cover (not illustrated).
- (3) 1 O-12/UPM-1, oscillator.
- (4) 1 O-13/UPM-1, oscillator.
- (5) 1 MT-189/UPM-1, console rack.
- (6) 1 MT-190/UPM-1, mounting base (not illustrated).
- (7) 1 TS-133/UPM-1, wavemeter.
- (8) 1 TS-134/UPM-1, wavemeter.
- (9) Connecting cables (not illustrated).
- (10) 1 Instruction book, AN 16-30UPM1-3.

ASO stock No. R16-T-1775.

- (1) R16-AN-CV-11/UPM-1.
- (2) R16-AN-CW-24/UPM-1.
- (3) R16-AN-O-12/UPM-1.
- (4) R16-AN-O-13/UPM-1.
- (5) R16-AN-MT-189/UPM-1.
- (6) R16-AN-MT-190/UPM-1.
- (7) R16-AN-TS-133/UPM-1.
- (8) R16-AN-TS-134/UPM-1.

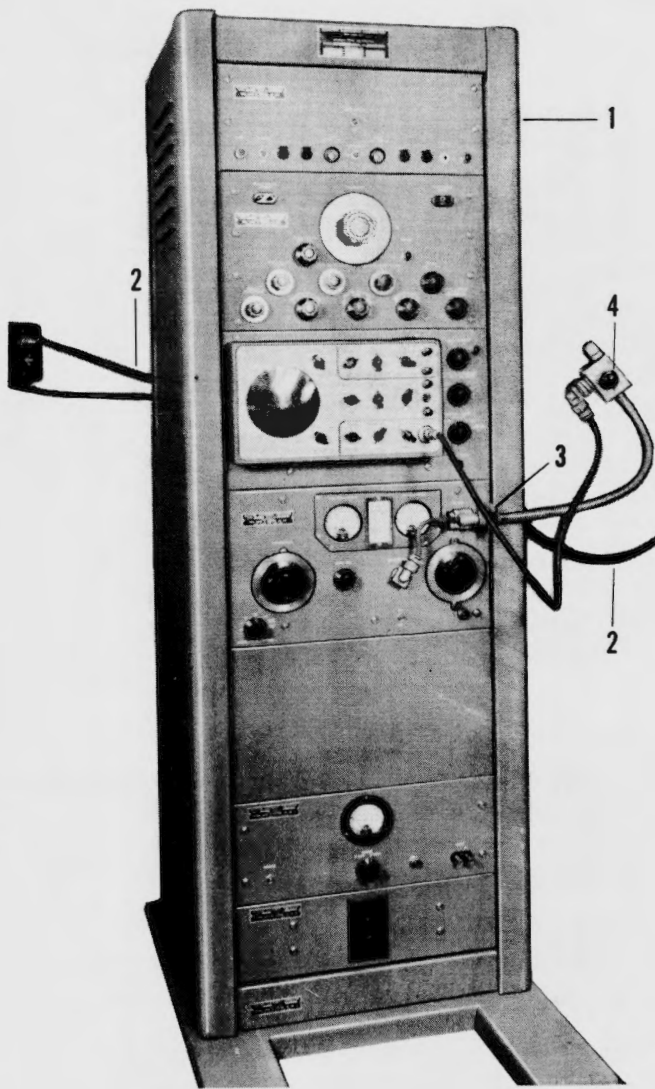


Figure 10-34. Test Rack—Hazeltine TE-1000-C

### TEST RACK

#### Hazeltine TE-1000-C

Primary purpose: For bench checking and alignment of IFF equipment.

This equipment is similar to the model TE-1000-B but has certain refinements and additions to provide adequate tests for AN/APX-1 and AN/APX-2 as well as ABK.

A new-type pulse and sweep generator is used, having a built-in audio oscillator and variable pulse width control. Two RF signal generators are used. It is intended for use only at large air stations. Other activities will be supplied with the AN/UPM-1. See description appearing in this book.

At the top of the rack is a transmitter frequency range checker, model 1020A, which is a four channel crystal controlled superheterodyne receiver equipped with signal

indicators in the form of two double "electric eyes" used in checking the frequency coverage of certain receiver-transmitter equipments.

Immediately below is a pulse and sweep generator, model 1021A, which includes an audio frequency generator; an oscilloscope, model 1002A; an r-f signal generator, model 1001C; a pulse counter, model 1028; and a power panel, model 1005A.

#### Electrical characteristics:

Over-all frequency coverage of equipment: 150-235 megacycles.

Audio frequency output: 20 to 20,000 c. p. s., 40 volts peak-to-peak.

Square wave output: fixed at 75 volts.

Sweep durations: 5, 25, 100, 500, or 2000 microseconds.

Oscilloscope calibrating voltages: .05, 1, 20, 100 volts.

Pulse counting: P. r. f. 20 to 1,000 pulses per sec.

Pulse counter input: 5 volts min., 2 to 50 microseconds pulse width.

#### Tubes:

Range checker 1020A: 9 type 6SH7; 1 type 6J5; 2 type 6AK5; 4 type 2050; 2 type 6H6; 2 type 6AF6G, 1 type 5U4G.

Pulse and sweep generator: 2 type 6SJ7; 1 type 6K6GT; 8 type 6SN7GT; 3 type 6J6; 1 type 2A3; 1 type OA3/VR75; 1 type 5U4G; 1 type 6H6; 4 type 6AG7.

Pulse Counter 1028: 1 type 6J5GT; 1 type 6SH7; 1 type 2050; 1 type OC3/VR105; 1 type 6X5GT.

Oscilloscope: 1 type 5LP1; 1 type 5Y3GT; 1 type 6J5GT; 1 type OC3/VR-105; 1 type 6C6; 1 type 6SJ7; 1 type 6AC7/1852; 1 type 884; 1 type 2X2/879.

Model 1001C RF generator; 1 type 6Y6G; 2 type 6C4; 1 type 6X5GT/G; 1 type 5Y3GT/G; 1 type 6H6.

Total Power Required: 115 volts, 60 cycles, 820 watts.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 24" x 33 $\frac{1}{2}$ " x 73 $\frac{7}{16}$ "

Weight: 521 pounds.

#### Complete equipment consists of:

- (1) 1 Test rack, TE-1000-C.
- (2) Interconnecting and power supply cables.
- (3) 1 Model 1039 Ten Decibel Attenuator.
- (4) 1 Diode head, 1017-2.
- (5) 1 Instruction book, CO-NAVAER 08-5S-82.

ASO stock No. R16-T-1730.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |

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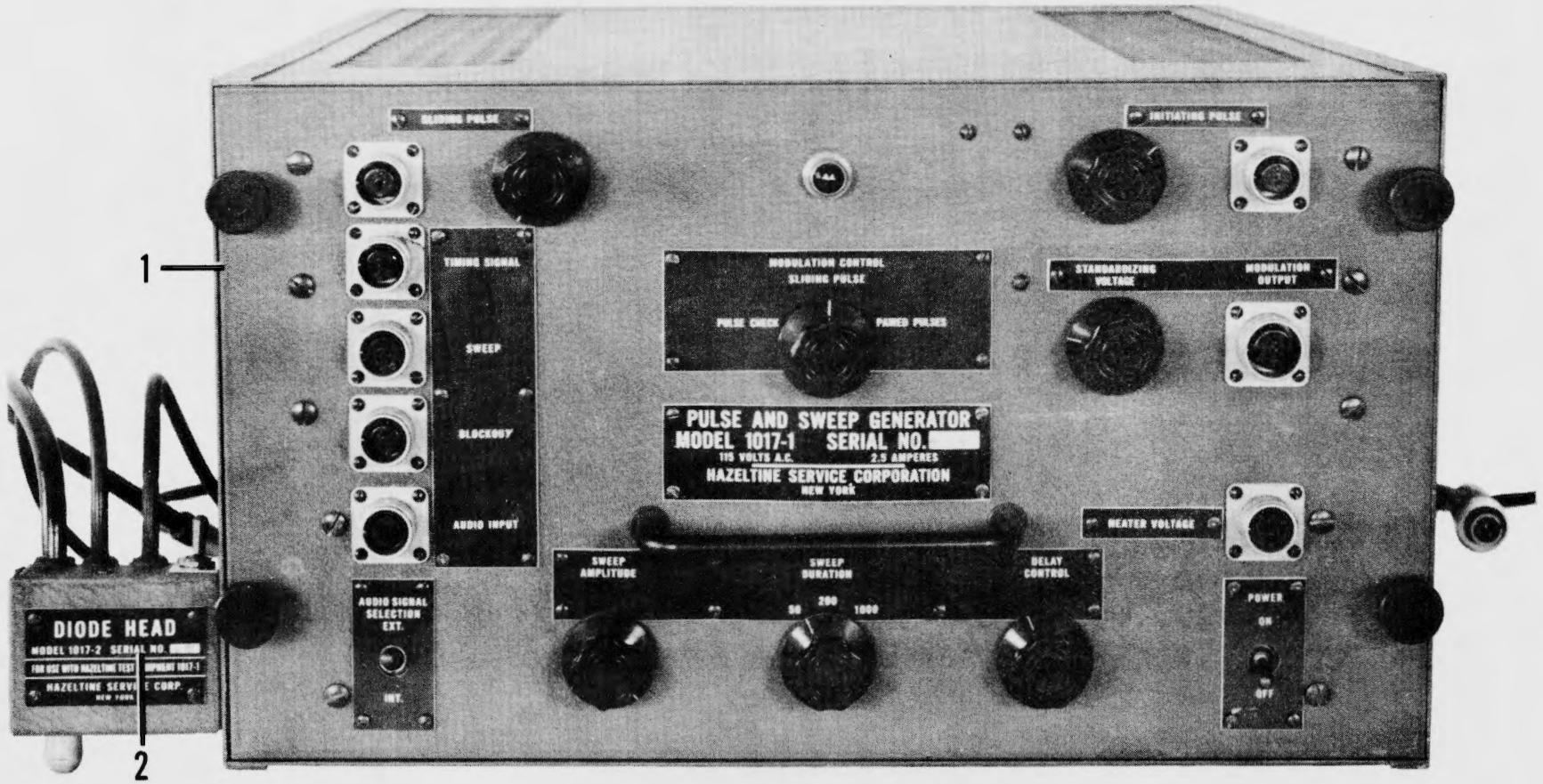


Figure 10-35. Sliding Pulse Generator—Hazeltine 1017

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NavAer 08-55-78

Section X  
Signal Generators

## SLIDING PULSE GENERATOR

### Hazeltine Model 1017

Primary purpose: Specifically intended for use in IFF testing.

May also be used in general pulse generator application for radio, radar, and other electronic equipment maintenance.

Hazeltine Model 1017-1 Pulse and Sweep Generator and a Model 1017-2 Diode Head. For IFF testing it is used with a G. R. Model 804-CS2 signal generator, a Dumont type 241 oscilloscope and either a Hewlett-Packard Model 205-AG, a Jackson Model 652, or Hewlett-Packard Model 200-C Audio Oscillator. This combination performs the same functions as the Hazeltine Test Rack Model TE-1000-B or the AN/UPM-1.

The audio oscillator controls the recurrence frequency of the 1017. The diode head serves as a coupling unit with the proper impedance terminations between the signal generator and the IFF and between the IFF and the oscilloscope.

The 1017-1 includes several control and pulse shaping circuits which supply the following signals and control voltages to its various output terminals.

The 1017-1 Pulse and Sweep generator supplies an oscilloscope return trace block-out voltage, a linear sweep voltage of variable sweep duration, a d. c. "initiating pulse," a "sliding pulse," and a timing signal for horizontal sweep calibration.

The "initiating pulse" has a duration of 10 microseconds and its pulse rate is determined by the audio oscillator. All other pulses of the unit are synchronized with it.

The sliding pulse is of approximately rectangular wave form and may be delayed over a wide range with respect to the initiating pulse.

A modulation output control of the unit permits either the sliding pulse only or both the initiating pulse and the sliding pulses to be obtained at the modulation output terminal. When both pulses are supplied, the output is

called a "paired pulse" output. The modulation output is to be delivered to the r-f signal generator to cause it to supply pulse modulated r-f signals.

#### Electrical characteristics:

Pulse frequency: Initiating and sliding pulses—external, audio oscillator range; internal, power supply frequency.

Pulse width: Initiating and sliding pulses, 10 microseconds.

Pulse amplitude: Initiating and sliding pulses, + 150 volts.

Sliding Pulse delay: Variable over full trace length. Sweep duration: 50, 200, and 1000 microseconds.

Tubes: 16 type 6SJ7; 3 type 6AG7; 3 type 6L6; 2 type 6J5GT; 2 type 6SN7GT; 1 type 5U4-G; 1 type 6SK7; 1 type 6Y6G; 1 type 991; 1 type 9002.

Power input: 110-125 volts, 60-cycle, single phase. Batteries: None.

#### Mechanical characteristics:

Dimensions: 13 $\frac{1}{2}$ " x 20 $\frac{1}{2}$ " x 23".

Weight: 85 pounds.

#### Complete equipment consists of:

- (1) 1 Pulse generator, Model 1017.
- (2) 1 Diode head, Model 1017-2.
- (3) 1 Cable, SA-1481.
- (4) 2 Cable, SA-1482.
- (5) 1 Cable, SA-1483.
- (6) 1 Cable, SA-1484.
- (7) 1 Cable, SA-1485.
- (8) 1 Cable, SA-1486.
- (9) 1 Cable, SA-1487.
- (10) 1 Cable, SA-2876.
- (11) 1 Instruction book—NAVAER 08-5Q-236.

#### ASO stock No. R16-G-3110.

- |                      |                       |
|----------------------|-----------------------|
| (1) .....            | (2) R16-HZL-1017-2.   |
| (3) R16-HZL-SA-1481. | (4) R16-HZL-SA-1482.  |
| (5) R16-HZL-SA-1483. | (6) R16-HZL-SA-1484.  |
| (7) R16-HZL-SA-1485. | (8) R16-HZL-SA-1486.  |
| (9) R16-HZL-SA-1487. | (10) R16-HZL-SA-2876. |



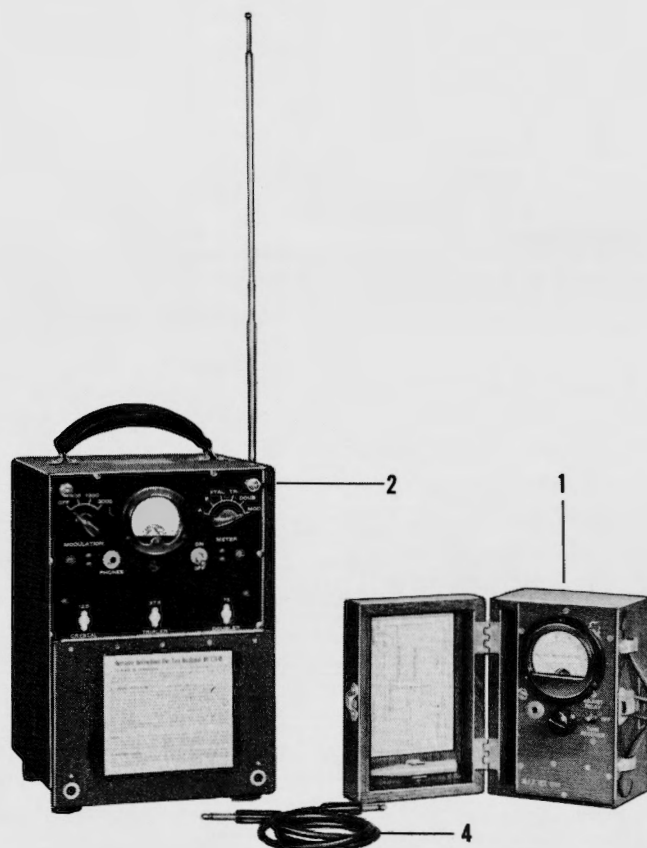


Figure 10-36. Oscillator-I-76

## OSCILLATOR

I-76

Primary purpose: Testing of marker beacon receivers and transmitters.

A portable set used to check and fix frequencies on marker beacon receivers and transmitters. A crystal test oscillator, BC-376-A, provides a 75 mc. modulated signal for the alignment of marker beacon receivers and also serves as a 75-mc. frequency meter for tuning marker beacon projector A-1 and radio transmitter BC-302 (marker beacon). The crystal oscillator has connections to permit earphone attachment so the operator may listen to the beat note. A test indicator or output meter is supplied for tuning marker and beacon frequencies.

### Electrical characteristics:

Frequency: 75 mc. modulated.

Modulation: 400, 1,300, or 3,000 c/s.

Accuracy: frequency 2%.

Power required: Self-contained batteries, supplied.

For oscillator, 2 type BA-36 or BA-19; 1-BA-35.

For indicator, 2 type BA-31.

Filament, 1.5 volts, 0.27 amps.

Plate and screen, 90 volts, 28 ma.

Tubes: 3 type 1A5G., 1 type 1C5GT.

### Mechanical characteristics:

#### Dimensions:

Test indicator:  $7\frac{13}{16}$ " x  $5\frac{1}{4}$ " x  $4\frac{13}{16}$ ".

Test oscillator:  $9\frac{3}{16}$ " x  $12\frac{3}{16}$ " x  $7\frac{3}{4}$ ".

Weight: 27 pounds.

### Complete equipment consists of:

- (1) 1 Test indicator, BE-67, output meter for tuning marker beacon receivers.
- (2) 1 Test oscillator, BC-376-A, equipped with telescoping antenna.
- (3) 1 Headset, HS-23 (not illustrated).
- (4) 1 Cord, CD-316, 3 feet long.
- (5) 1 Cord, CD-307, 4 feet long (not illustrated).
- (6) 1 Instruction book-A. T. O. 08-10-95.

ASO stock No. R16-T-1695.

- |                    |                   |
|--------------------|-------------------|
| (1) R16-I-1910.    | (2) R16-O-1800.   |
| (3) R16-H-3864-20. | (4) R-16-C-35862. |
| (5) R16-C-34841.   |                   |





Figure 10-37. Test Set-I-173-A

## TEST SET

### I-173-A.

Primary purpose: For preflight checking of localizer receivers.

A spark gap oscillator provides a carrier which is modulated by 100-cycle and 150-cycle vibrators. This modulated signal radiated by test set I-173-A is picked up by localizer receiver under test, indication of operation being shown by right or left movement of the vertical needle in indicator I-101 which is a component of the localizer receiver installation.

Test Set I-173-A is mounted within a wooden combination carrying case. Space for batteries is provided. A two-way single pole momentary switch is mounted on the case and is used to turn the test set on and to control the frequency of modulation.

### Electrical characteristics:

Frequency range: Random frequency characteristics of a spark gap.

Output: R-f carrier is uncalibrated and modulated at 100 or 150 cycles. (Switch is marked 90-150 cycles.)

Power required: Self-contained batteries.

Tubes: None.

Batteries: 2 type BA-35. Supplied.

### Mechanical characteristics:

Dimensions: 11 $\frac{1}{2}$ " x 3 $\frac{3}{4}$ " x 7".

Weight: 8 $\frac{1}{2}$  pounds.

### Complete equipment consists of:

(1) 1 Test set, I-173-A.

(2) 1 Instruction book AN 08-10-169.

ASO stock No. R16-AYS-I-173-A.



Figure 10-38. Test Set-1E-12-A

Note—Figure 10-38 lacks I-96 Signal Generator illustrated on figure 10-40 and major units of SCR-522-A.

## TEST SET

### IE-12-A

Primary purpose: Testing of airborne V. H. F. communication equipment at a base or depot. Particularly for use with SCR-522.

Equipment which simulates a complete set of radio equipment operates on batteries but I-96-A may be used on a. c. I-96-A is a signal generator with a range of 100 to 156 mc. and contains a 6,000 kc. crystal oscillator. I-95-A is a battery-operated field strength meter which uses a diode rectifier tube, and field intensity is read on a meter.

#### Electrical characteristics:

Frequency range: Signal generator, 100-156 mc.

Sensitivity: Receiver—3 to 4 microvolts for 10 db signal-to-noise ratio.

Power required: Self-contained batteries or 110-115 volts, 50-60 c/s.

#### Tubes:

Signal generator: 2 type 9002; 4 type 9003; 1 type OD3/VR150; 1 type 5Y3GT/G.

Field strength meter: 1 type 1S5.

Radio transmitter: 2 type 832, 3 type 12A6, 1 type 6G6G, 2 type 6SS7.

Radio receiver: 1 type 12J5GT, 1 type 12C8, 1 type 9002, 3 type 9003, 1 type 12AH7GT, 3 type 12SG7.

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**NavAer 08-5S-78**

Batteries: 5 type BA-23, 8 type BA-2 (not supplied).  
Batteries should be requisitioned when ordering this equipment.

**Mechanical characteristics:**

**Dimensions:**

Signal generator, 26 $\frac{1}{2}$ " x 19" x 9 $\frac{1}{2}$ ".

Case, 16 $\frac{1}{8}$ " x 12 $\frac{1}{2}$ " x 10 $\frac{3}{4}$ ".

Weight: 130 pounds total (approximately).

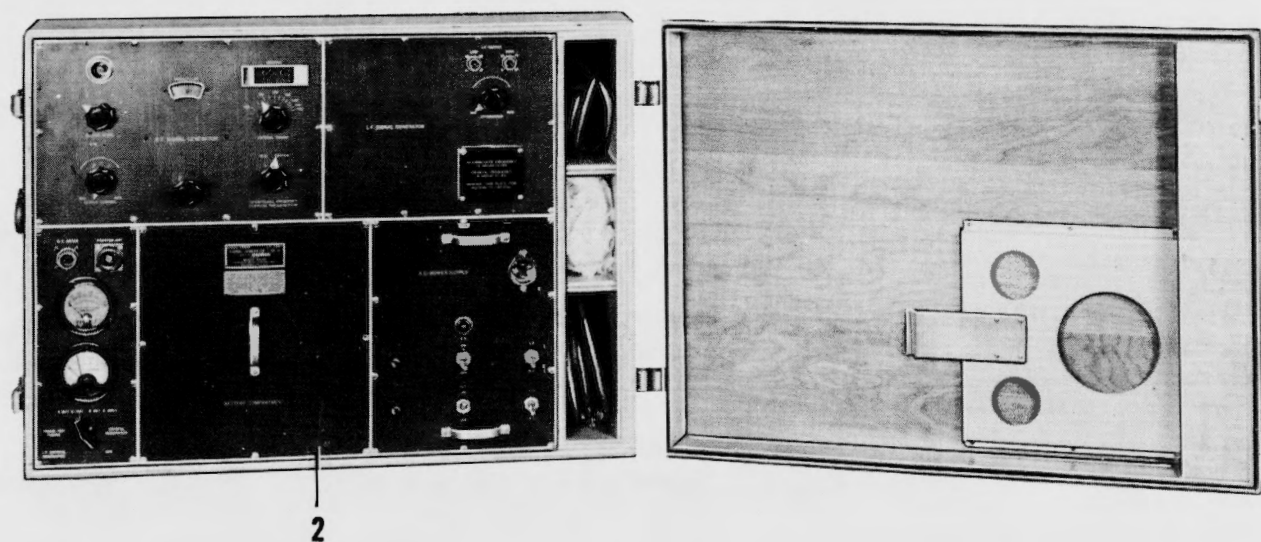
**Complete equipment consists of:**

- (1) 1 Transmitter-receiver assembly, Model SCR-522-A (not illustrated).
- (2) 1 I-96-A signal generator (not illustrated).
- (3) 1 I-95-A meter (not illustrated).
- (4) 1 BC-602-A control box (not illustrated).

- (5) 1 JB-29-A junction box (not illustrated).
- (6) 1 BC-629A jack box (not illustrated).
- (7) 1 BC-630A jack box (not illustrated).
- (8) 1 PE-94-A dynamotor 28 volt (not illustrated).
- (9) 1 Crystal unit DC-11-A (not illustrated).
- (10) 1 Case CS-80-A (not illustrated).
- (11) 1 Instruction book AN 16 16-40IE 12-3.
- (12) Miscellaneous tools, parts, and cables.

ASO stock No. R16-T-1822.

- (1) ..... (2) R16-AYS-I-96A.
- (3) R16-AYS-I-96-AM. (4) R16-AYS-BC-602B.
- (5) R16-B-10216-115. (6) R16-AYS-BC-629A.
- (7) R16-AYS-BC-630A. (8) R16-D-5795.
- (9) ..... (10) R16-C-15879-100.



*Figure 10-39. Test Set-I-96-A Part of IE-12-A*

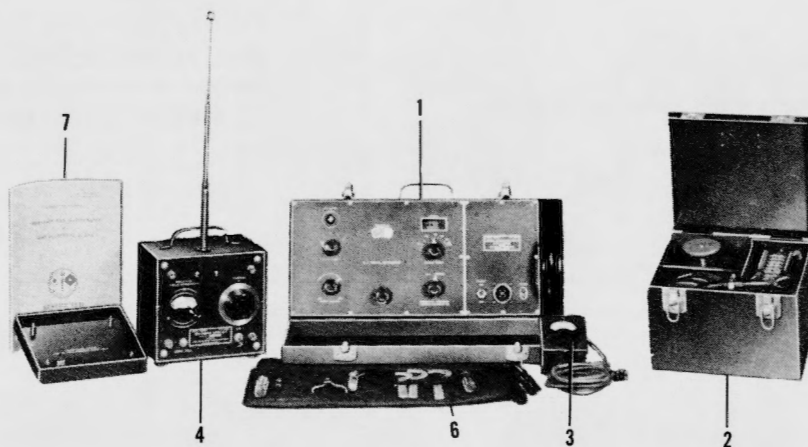


Figure 10-40. Test Set-IE-19-A

### TEST SET

#### IE-19-A

Primary purpose: Bench and field testing of airborne communication equipment.

Equipment especially designed for the SCR-522 and SCR-542 and used to align and test the transmitter and receiver units. It is operated with batteries and contained in a wooden chest.

The Signal Generator I-30-A, is used in tuning the Radio Transmitter BC-625-A and Receiver BC-624-A and produces tone-modulated signals in its frequency range.

The I-139-A 0-1 milliammeter is used to test various circuits in the transmitter, receiver, and signal generator. Various readings are taken in current and voltage by plugging the meter into the circuits.

The I-95-A field strength meter is designed to indicate relative field intensity from the transmitting antenna. The circuit is a diode rectifier type, operated from batteries.

#### Electrical characteristics:

Frequency range: Signal generator, 100-156 mc.

Modulation: 1,000 cycles.

Output: Variable from nearly zero to 5,000 microvolts.

Scales: Field strength meter, 0-1 ma.

Power required: Self-contained batteries.

#### Tubes:

Signal generator, 2 type 9002, 3 type 9003.  
Field strength meter, 1 type IS5.

#### Batteries:

5 type BA-23, 8 type BA-2 (Not supplied). Batteries should be requisitioned when ordering this equipment.

#### Mechanical characteristics:

Dimensions: 11" x 19 $\frac{1}{2}$ " x 22 $\frac{3}{4}$ " (size of chest).

#### Weight:

Signal generator, 27 pounds.

Battery box, 9.5 pounds (without batteries).

Field strength meter, 11 pounds (without batteries).

Chest 48 $\frac{1}{2}$  pounds (loaded).

#### Complete equipment consists of:

- (1) 1 Signal generator I-130-A; includes 1 cord CD-477, 1 set of vacuum tubes.
- (2) 1 Battery box BX-33-A.
- (3) 1 Test set I-139-A.
- (4) 1 Field strength meter I-95-A.
- (5) 1 Chest CH-93-A (not illustrated).
- (6) 1 Set of special tools.
- (7) 1 Instruction book ATO 08-10-111 (Army).

ASO stock No. R16-T-1825.

- (1) R16-AYS-I-130-A. (2) R16-AYS-BX-33-A.
- (3) ..... (4) R16-AYS-I-95-AM.
- (5) R16-AYS-CH-93A. (6) R16-K-2835-610.



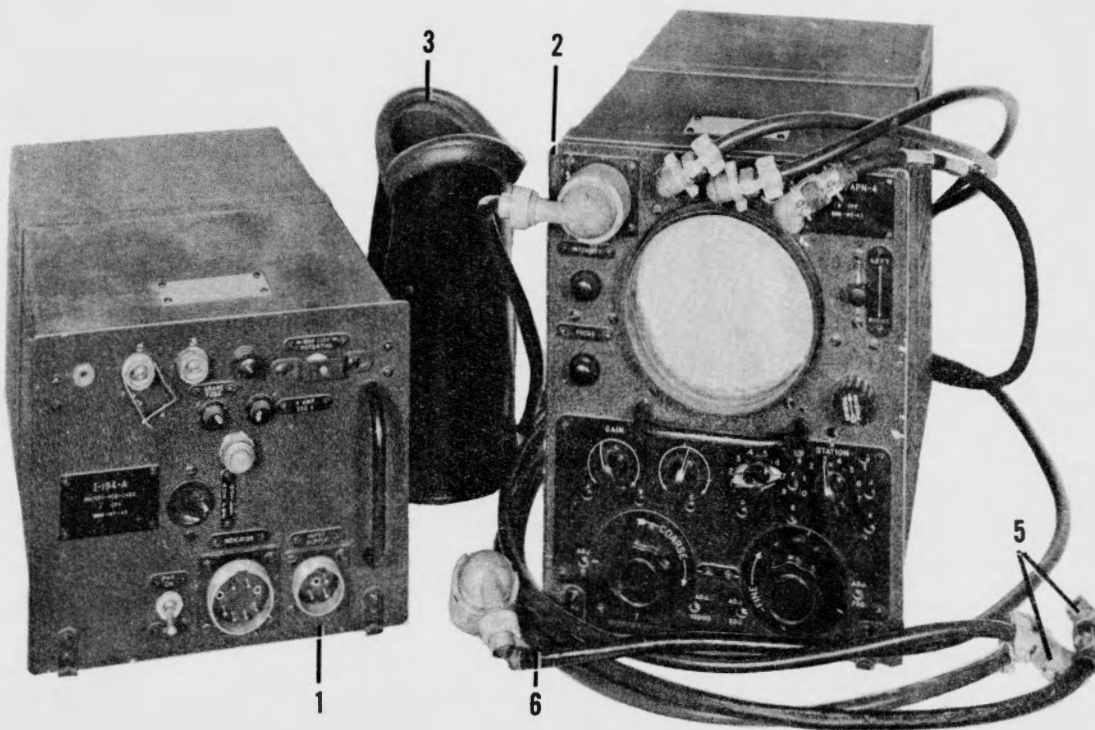


Figure 10-41. Loran Training Equipment—RC-242-A

### LORAN TRAINING EQUIPMENT

#### RC-242-A

Primary purpose: To train personnel in the operation of Radio Set AN/APN-4. May also be used for maintenance.

This equipment simulates the transmission of signals from one pair of LORAN ground stations. It consists of two major assemblies, signal generator and indicator. The indicator "triggers" the generator so that pulses radiated from the antenna simulate in frequency and p. r. f. one pair of Loran stations.

#### Electrical characteristics:

Frequency range: 1,800 kc. to 2,000 kc., preset frequency 1,950 kc.

Tubes: 2 type 6SJ7; 1 type 6SL7; 3 type 6SK7; 1 type 6V6G; 3 type 6B4G; 1 type OC3/VR105; 1 type 6SN7; 1 type 5U4G; 2 type 2X2.

Power required: 80 or 115 v. at 400-2,400 c/s; 2.4 amps. at 80 v. 400 c/s.

Batteries: None.

#### Indicator:

See handbook on AN/APN-4.

Tubes: 14 type 6SN7; 8 type 6H6; 3 type 6SL7; 1 type 5CPL; 1 type 6SJ7.

#### Mechanical characteristics:

##### Dimensions:

Signal generator, 19½" x 9" x 7⅞".

Indicator, 19½" x 9" x 11¾".

##### Weight:

Signal generator, 24 pounds.

Indicator, 35 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator I-194-A.
  - (2) 1 Indicator ID-6/APN-4 (same as used in AN/APN-4).
  - (3) 1 Indicator visor.
  - (4) 1 Power cable (not illustrated).
  - (5) 2 Six-foot cables, WC-547-A.
  - (6) 1 Cable, CD-239-A with plug PL-Q171 at each end.
  - (7) 1 Insulated wire #18—telephone connector tips ends (not illustrated).
  - (8) 1 Instruction book CO-AN 08-40RC242-2-X. ASO stock No. R16-T-1826-40.
- |                      |                 |
|----------------------|-----------------|
| (1) R16-AYS-I-194-A. | (2) R16-I-2251. |
| (3) R16-PH-358-4316. | (4) .....       |
| (5) .....            | (6) .....       |
| (7) .....            | (7) .....       |



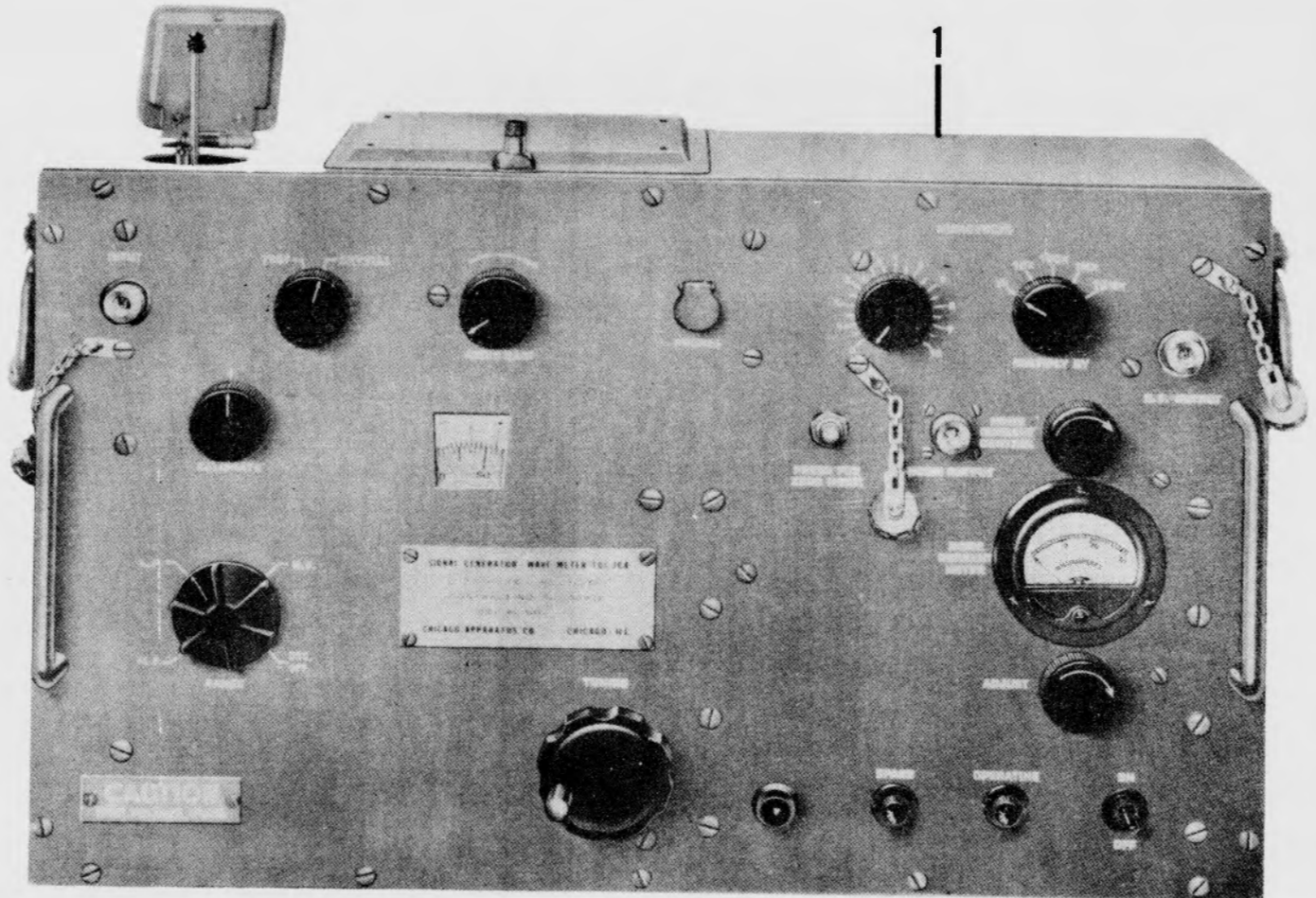


Figure 10-42. Signal Generator, Frequency Meter—TGI-3CA

## SIGNAL GENERATOR—FREQUENCY METER

### TGI-3CA

Primary purpose: To provide a method of checking the frequency of radio transmitters, tuning and aligning receivers and measuring the sensitivity of superheterodyne receivers.

The equipment consists of a combination signal generator, heterodyne type frequency meter and receiver sensitivity measuring device. It consists of a 5 megacycle crystal controlled oscillator used as a frequency standard calibrator, a variable 3-range oscillator, an untuned detector with two stages of audio amplification, a noise diode, a sliding-rod quarter-wave antenna, a pi type attenuator, and a power supply.

#### Electrical characteristics:

Frequency: 8-15 mc., 20-40 mc., 135-230 mc.  
Power required: 55 watts, 117.5 volts, 60 c. p. s.  
Tubes: 1 type 6J5, 2 type 6SJ7; 1 type 5Y3GT/G;  
1 type 9002; 1 type 9006; 1 type 6X5GT; 1 type 15E.

#### Mechanical characteristics:

Dimensions: 19 $\frac{1}{2}$ " x 12" x 7 $\frac{1}{2}$ ".  
Weight: 64 pounds.

#### Complete equipment consists of:

- (1) 1 Signal generator frequency meter, TGI-3CA.
  - (2) 1 Output cable (5 feet).
  - (3) 1 Power cable (8 feet).
  - (4) 1 Instruction book: NAVAER 16-5S-508.
- ASO stock No. R16-NAV-TGI-3CA.
- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... |           |



Figure 10-43. Test Oscillator—TS-24/ARR-2

## TEST OSCILLATOR

### TS-24/ARR-2

Primary purpose: To provide a test signal for tuning AN/ARR-1 and AN/ARR-2 equipments.

This oscillator is a self-powered portable unit that provides a test signal for both the high and low frequency circuits of the radio receiver. The high frequency portion generates a stable signal at 246 mc. and produces sufficient output to permit the alignment of the high frequency receiver circuits when the unit is placed approximately 25 feet from the receiver antenna.

The low frequency circuits used to modulate the high frequency oscillator can be turned over a range of 540 to 830 kc. Six individual channels are available and each may be tuned over the above mentioned frequency range. A selector switch connects any one of the six channels into the circuit. Energy from the low frequency circuits may be coupled into the test point of the receiver directly to facilitate the alignment of the modulation frequency circuits in the receiver.

### Electrical characteristics:

#### Frequency:

Carrier-stable at 246 mc.

Modulation-tunable 540 kc. to 830 kc.

Power Out: (10 feet from AN/ARR-2 antenna)  
more than 100 mw.

Accuracy: Carrier—less than plus or minus 1% of  
246 mc. Mod. frequency plus or minus 800 c. p. s.

Tubes: 2 type 955.

Power required: 90 volts "B"; 6 volts "A".

Batteries: 2 type BA-59, 2 type BA-203/U.

### Mechanical characteristics:

Dimensions: 6<sup>3</sup>/<sub>4</sub>" x 7<sup>1</sup>/<sub>8</sub>" x 11<sup>1</sup>/<sub>8</sub>".

Weight: 20 pounds.

### Complete equipment consists of:

- (1) 1 TS-24/ARR-2 unit.
- (2) 1 Calibration chart (not illustrated).
- (3) 1 Detachable "fish pole" antenna.
- (4) 1 Instruction book AN 16-30ARR2-2.
- (5) 1 Canvas case (not illustrated).

ASO stock No. R16-AN-TS-24/ARR-2.

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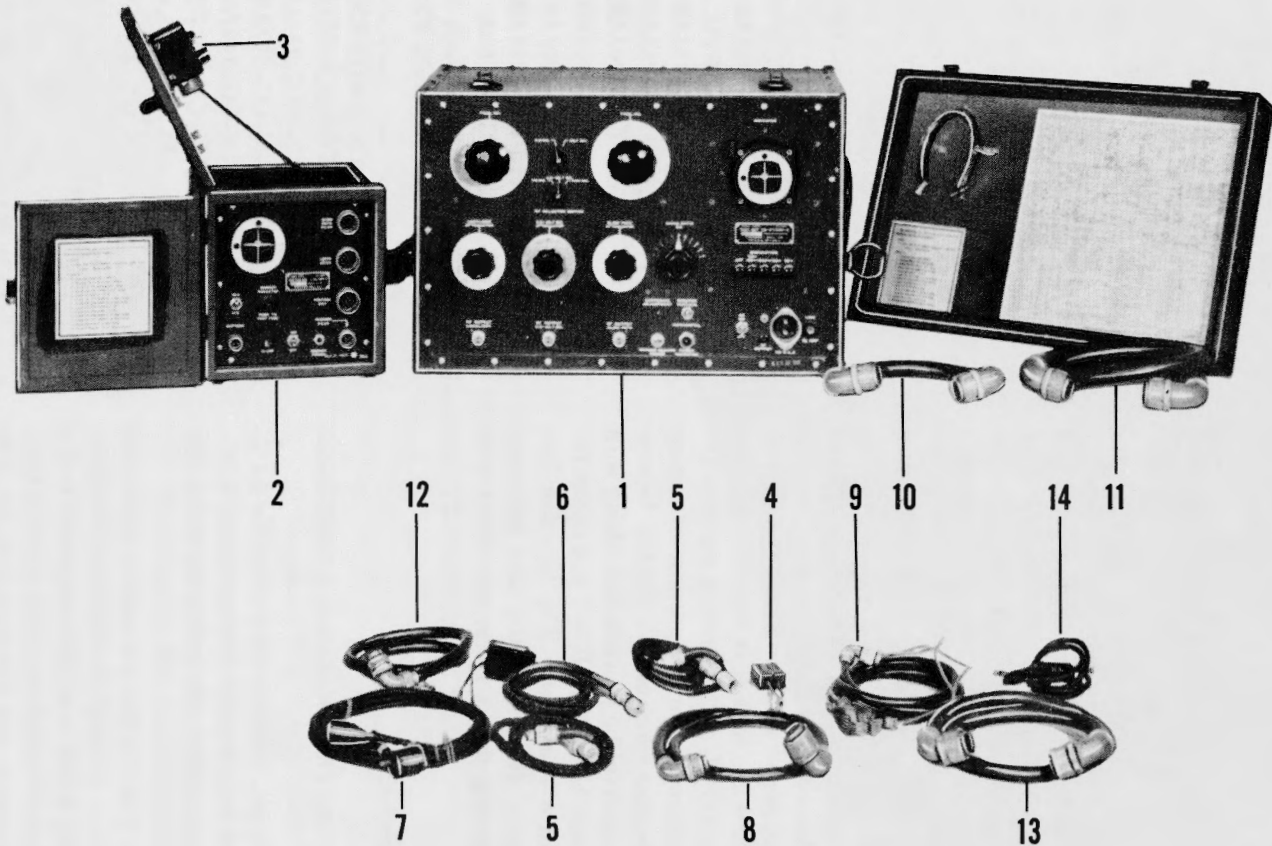


Figure 10-44. Test Set—TS-67/ARN-5

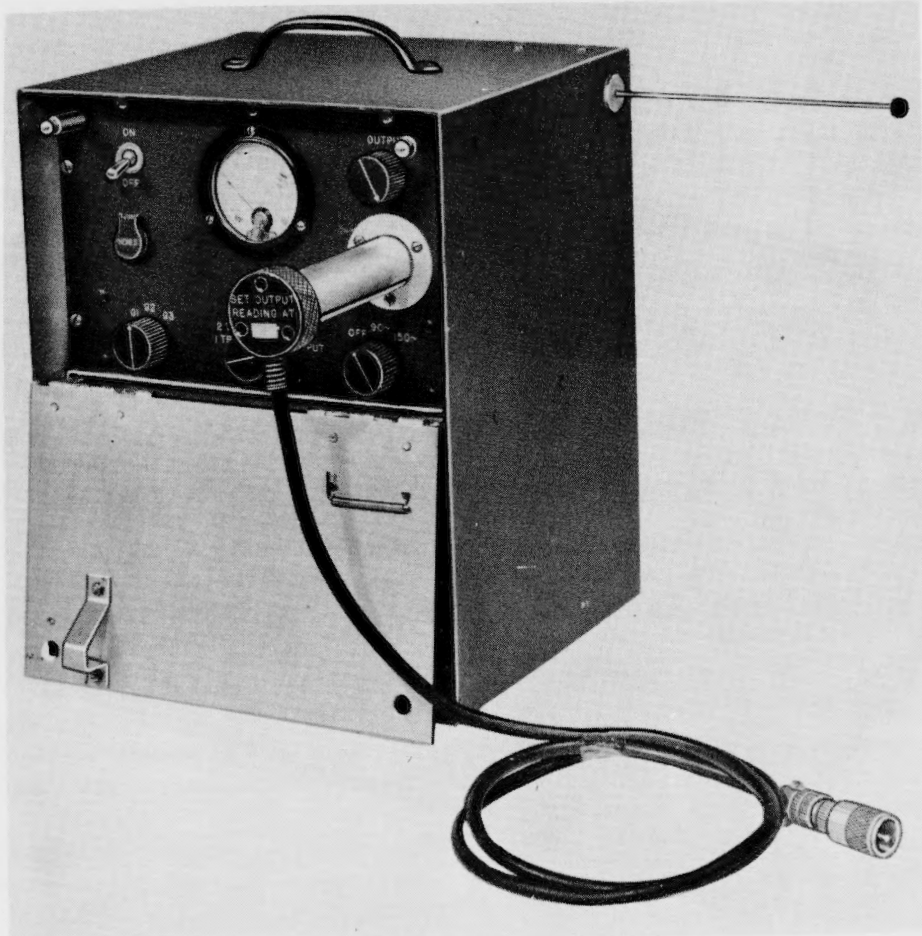


Figure 10-46. Test Oscillator—TS-170/ARN-5

## TEST OSCILLATOR

### TS-170/ARN-5

Primary purpose: For pre-flight checking of radio receiving equipment AN/ARN-5 and AN/ARN-5A.

This special test oscillator is used to check receiver sensitivity and to check the audio channels. It is a portable high frequency crystal controlled test oscillator in a metal case. The controls and attenuator are located on the front panel which is protected by a cover when not in use. A collapsible antenna is mounted on the side of the test set.

It has three frequencies, capable of being modulated with either 90 cycles or 150 cycles, which are crystal controlled. Modulation is provided by self-contained audio oscillator. The output available at the end of the transmission line can be attenuated approximately within the limits of 10 microvolts to 1,000 microvolts.

#### Electrical characteristics:

Frequency range: 332.6 mc., 333.8 mc., 335.0 mc.

Frequency accuracy: 0.02%.

#### Output:

Voltage: 10 to 1000 microvolts.

Impedance: Approx. 50 ohms.

Audio modulation: 90 and 150 cycles.

#### Temperature ranges:

Operating: Minus 10° C. to plus 60° C.

Nonoperating: Minus 55° C. to plus 71° C.

Power required: Self-contained batteries.

Tubes: 1 type 959; 4 type 3Q4.

Crystals: 1 type IN21A.

Batteries: 2 type BA-35; 1 type BA-36. Supplied.

#### Mechanical characteristics:

Dimensions: 11" x 9" x 9".

Weight: 21 pounds.

#### Complete equipment consists of:

(1) Test oscillator, TS-170/ARN-5.

(2) 1 Instruction book.

ASO stock No. R16-AN-TS-170/ARN-5.



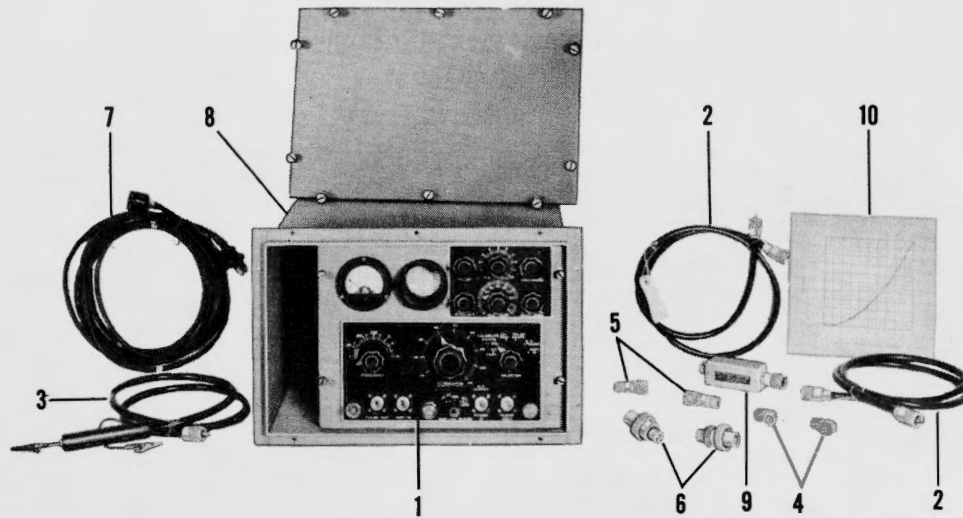


Figure 10-47. IFF Test Set—TS-182/UP

IFF TEST SET

TS-182/UP

Primary purpose: To test Mark III and Mark IV IFF systems.

TS-182/UP is a portable test equipment capable of rapidly determining the performance characteristics of interrogator-respondors, transpondors, and transponder beacons for Mark III and Mark IV IFF systems.

A metal cabinet is provided to house the test set and accessory cables and adapters.

The test set will perform the following checks on IFF: Power output, receiver sensitivity, pulse shapes, coding, and recovery time. The equipment consists of a pulsed r-f oscillator with calibrated frequency dial and attenuator dial, built-in pulser, diode head, and power supply. The unit contains a built-in cathode ray oscilloscope. The r-f oscillator is a plug-in type—separate units being furnished for the Mark III and Mark IV bands. The equipment is designed for portable use and is intended for checking the IFF at the airplane.

Electrical characteristics:

Frequency Range: 150-240 mc.

Input Impedance: 50 ohms.

Attenuator: 30-110 db below 1 volt, accuracy  $\pm 2$  db.

Power Measurement: 40 pulse watts maximum on low 3,000-pulse watts maximum on high.

Video Pulses Observable: 2-200 microseconds.

Tubes: 3 type 6SN7GT; 1 type 6J5; 1 type 6AC7; 1 type 6AG7; 1 type 2AP1; 1 type 6X5GT; 1 type

5R4GY; 1 type 955; 1 type 6AL5.

Power Supply: 105 to 125 volts, 50 to 1200 cycles a. c. 72 watts.

Mechanical characteristics:

Dimensions:

TS-182/UP: 16" x 9 $\frac{1}{4}$ " x 12".

Case: 16" x 17" x 11 $\frac{1}{2}$ ".

Weight:

TS-182/UP: 43 pounds.

Case: 15 pounds.

Complete equipment consists of:

- (1) 1 IFF Test Set, TS-182/UP.
- (2) 2 Cables (4 feet), 49195 connectors.
- (3) 1 Cable (4 feet), 49195 connector and high impedance probe.
- (4) 2 Adapters, 49149 receptacle to British 10H/701 plug.
- (5) 2 Adapters, 49194 receptacle to British 110H/584 plug.
- (6) 2 Adapters, 49194 receptacle to type N plug.
- (7) 1 a. c. Line Cord (15 feet).
- (8) 1 Case, CY-278/UP.
- (9) 1 Power Adapter (100:1) CN-46/U.
- (10) 1 Calibration Chart.
- (11) 1 Instruction book AN 08-35TS182-2.

ASO stock No. R16-AN-TS-182/UP.

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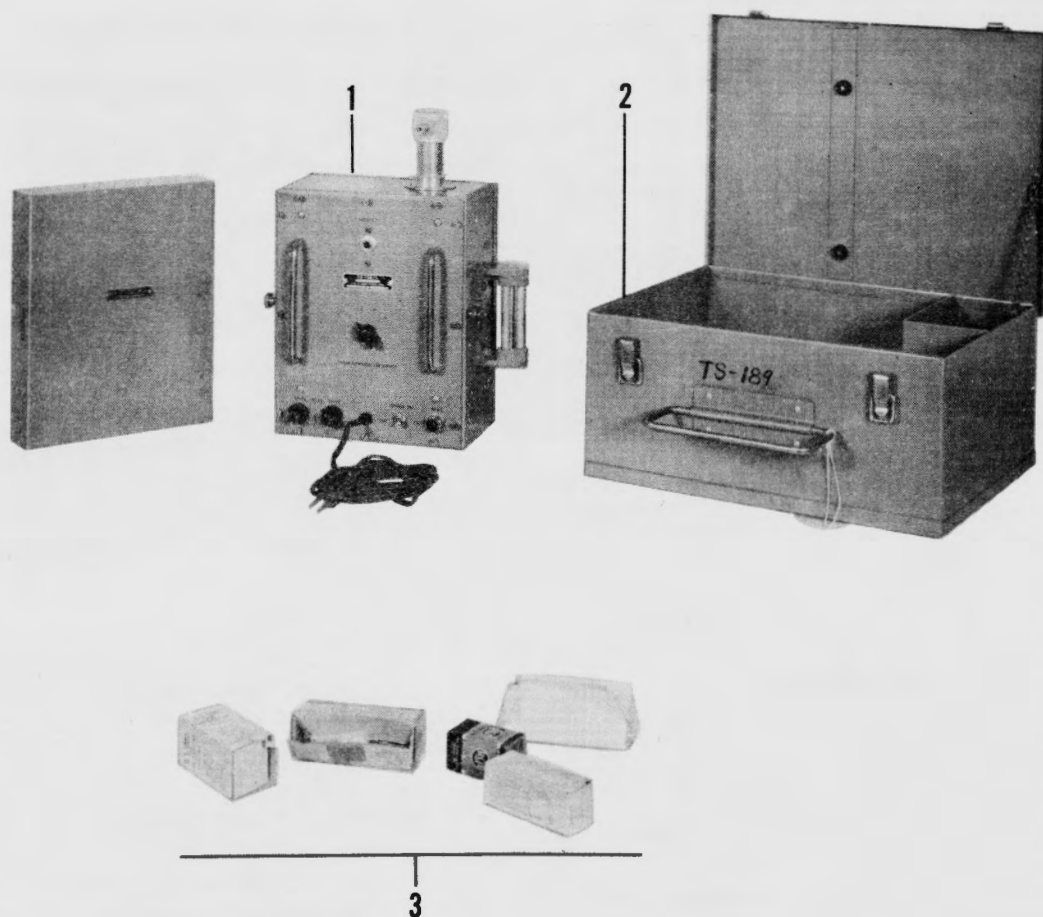


Figure 10-48. Test Oscillator-TS-189/U

## TEST OSCILLATOR

### TS-189/U

**Primary purpose:** Designed primarily for testing the AN/APA-17, but it can be used for testing similar systems. This is a portable pulsed oscillator, which provides, in addition, a demodulated r-f signal at a front panel jack.

The unit is contained in a metal cabinet with removable lid which protects the front panel controls. The arms of the dipole antenna unscrew, when not in use, and are inserted in brackets on one side of the cabinet to provide a carrying handle.

**Electrical characteristics:**

R-f frequency: Fundamental 270 mc.; 2nd Harmonic

540 mc.

P.R.F.: 450, 1875, 2750, and 3750 c. p. s.

Modulation: Pulse — 2½ microseconds approximately.

Peak output power: 2 watts.

Tubes: 1 type 6SN7GT; 1 type 955; 1 type 6H6; 1 type 1N21 (Crystal).

Power required: 115 v, 400 to 2,600 cycles, 10 watts.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 6" x 8" x 10".

Weight: 13 pounds (approximate)

**Complete equipment consists of:**

- (1) 1 Test oscillator, TS-189/U.
- (2) 1 Transit case.
- (3) 1 Set spare parts.
- (4) 1 Instruction book AN 16-35TS189-2.

**ASO stock No. R16-AN-TS-189/U.**

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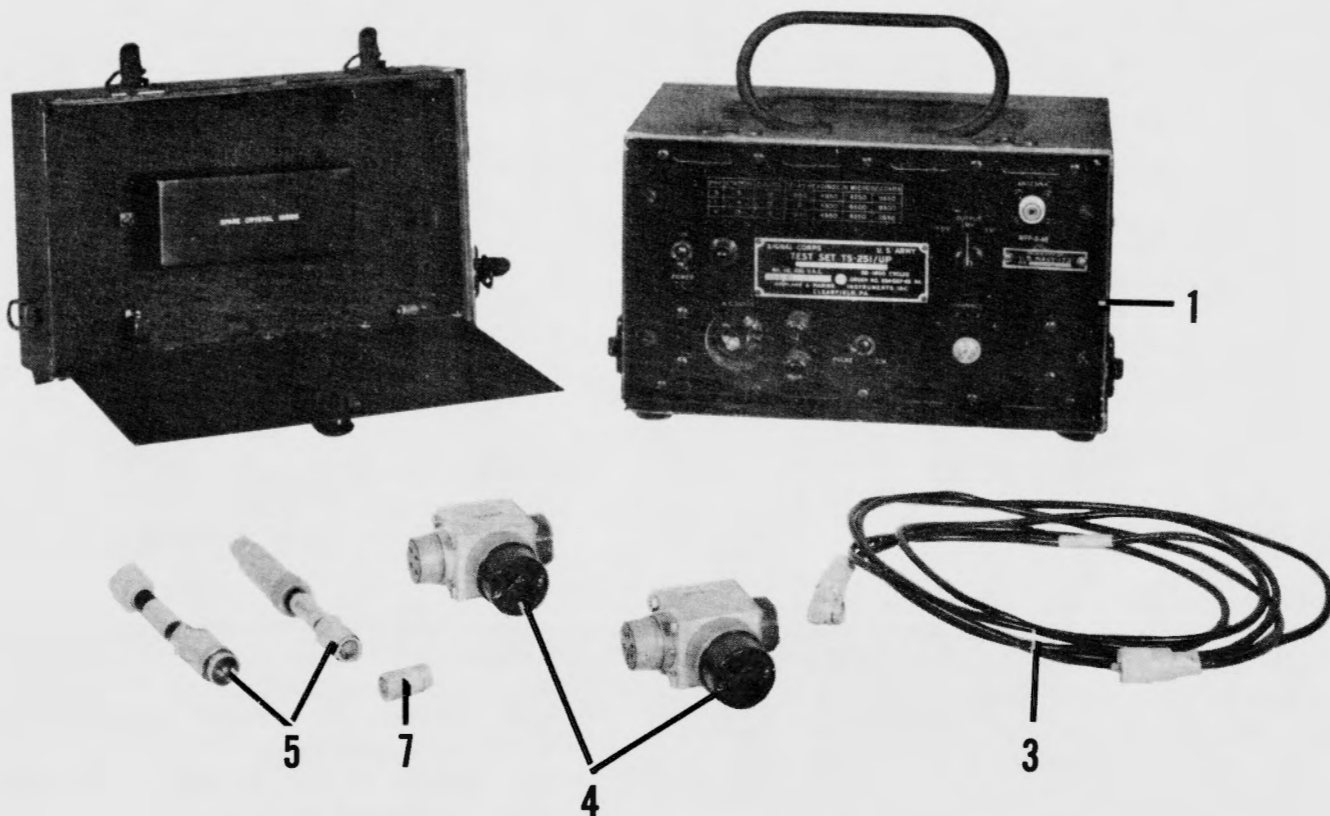


Figure 10-49. Loran Test Set—TS-251/UP

LORAN TEST SET

TS-251/UP

Primary purpose: This unit is a small portable signal generator for use in preflight checking of Loran receivers.

R-f pulses produced by the signal generator permit the technician to test any Loran receivers under simulated operating conditions. It can be used to check receiver alignment, sensitivity, CRT indicator sweep frequency markers, crystal phasing control action, and accuracy of the crystal. The generator has four band-switching operating frequencies.

Electrical characteristics:

Frequency, 4 channels:

Operable	Factory set on—
1890 kc.—2010 kc.....	1950 kc.
1790 kc.—1910 kc.....	1850 kc.
1840 kc.—1960 kc.....	1900 kc.
1700 kc.—1850 kc.....	1750 kc.

Output voltage: Selector switch off: (a) 15 microvolts; (b) 1 mv.; (c) 1 v.

Accuracy: R-f frequency drift less than plus or minus 10 kc. from -65° C. to + 85° C.

Pulse rate: Crystal controlled 3,300 microseconds (303.03 c/s).

Crystal oscillator frequency: 1,817.44 c. p. s. plus or minus 0.3 c. p. s.

Tubes: 1 type 6SJ7; 1 type 6J5; 1 type 6SN7GT; 1 type 6SL7; 1 type 6SK7; 1 type 6X5GT.

Power required: 80, 115, or 230V, 50-1600 cycles, approx. 22 watts.

Mechanical characteristics:

Dimensions:

TS-251/UP: 10<sup>5</sup>/<sub>8</sub>" x 7" x 6<sup>1</sup>/<sub>4</sub>".

Case: 11<sup>3</sup>/<sub>4</sub>" x 10<sup>1</sup>/<sub>2</sub>" x 7<sup>3</sup>/<sub>4</sub>".

Weight:

TS-251/UP: 10.6 pounds.

Case: 7.5 pounds.

Complete equipment consists of:

- (1) 1 TS-251/UP unit.
- (2) 1 Power cable, a. c. (10 feet).
- (3) 1 Antenna lead (10 feet).
- (4) 2 T's for power cable.
- (5) 2 6" extensions for r-f cables.
- (6) 1 Junction plug (not illustrated).
- (7) 1 Navy adapter No. 49544.
- (8) 1 Instruction book AN 16-35TS251-2.

ASO stock No. R16-AN-TS-251/UP.

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IFF TEST SET

TS-355/UP

Primary purpose: The equipment is used to measure receiver sensitivity, transmitter power output and for rough frequency measurements. It contains a built-in cathode-ray oscilloscope which can be used to examine pulse shape of r-f pulses from 2 to 150 microseconds long.

The equipment is similar to TS-182/AP except for design changes to adapt it for use with AN/APX-13, -13A. It may also be used on a general test scope.

Electrical characteristics:

Frequency: 150 to 240 mc.

Output: 50 ohms.

Attenuator: 30 to 110 db below 1 volt.

Pulse Delay: 0 and 40 microseconds.

R-F Pulse Power Measurements:

Max. 3,000 pulse watts on 50-ohm load.

Power required: 105-125 volts, 50-1200 cycles per second.

Tubes: 4 type 6SN7GT, 1 type 6AG7, 1 type 2AP1, 1 type 6X5GT, 1 type 5R4GY, 2 type 955, 1 type 6AL5, 1 type 6SL7.

Mechanical characteristics:

Dimensions: 16" x 9 1/4" x 12".

Weight: 43 pounds, case 15 pounds.

Complete equipment consists of:

- (1) 1 TS-355/UP.
- (2) 1 A-C Line Cord (15 feet).
- (3) 2 Cables (4-feet) RG-8/U with 49190 connectors on each end.
- (4) 1 Cable (4 feet) RG-8/U with 49190 connector and test prod.
- (5) 2 Adapters: 49190 to UG-58/U.
- (6) 2 Adapters: 49190 to British Type 110H/585.
- (7) 2 Adapters: 49190 to British Type 10H/528.
- (8) 1 Power Adapter 100:1-CN-46/U.
- (9) 1 Pad 1:5.
- (10) 1 Transport case-CY-278/UP.
- (11) 1 Instruction book CO-NAVAER 16-5S-507.

ASO stock No. R16-AN-TS-355/UP.

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| (7) ..... | (8) .....  |
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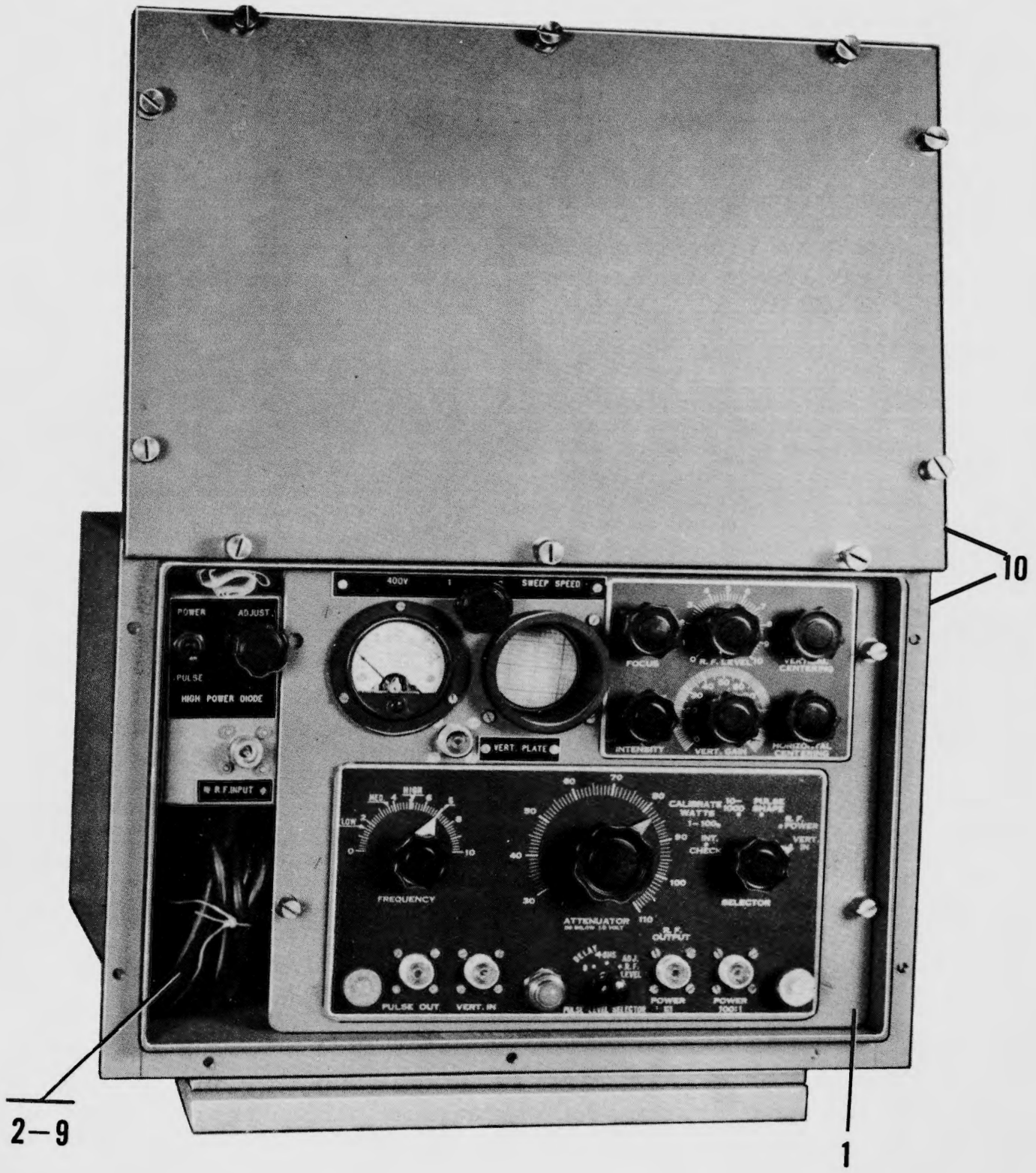


Figure 10-50. IFF Test Set—TS-355/UP



**RESTRICTED**

**RESTRICTED**



## Section XI STANDING WAVE INDICATORS

### FUNCTION

Standing wave indicators are used in checking or determining the voltage standing wave ratio (VSWR) and relative output power in the r-f transmission line between a transmitter or signal source and its antenna or load. By making this check it gives information suitable for determining how well matched are the transmission line and antenna.

### COMPONENTS

A standing wave indicator usually consists of a coupling or section which fits between sections of r-f plumbing, a probe assembly, a rectifier amplifier or detector, an indicator meter, and various adapters. Any signal source having the proper power output and frequency range can be tested, although some standing wave indicators are designed for use with specific equipment.

The coupling portion may consist of a slotted section and uni- or bi-directional couplers to which a pick-up probe is connected in some manner. During the test these elements become a part of the transmission line between the signal source or radio transmitter and the antenna or load. The rectifier, amplifier or detector links the probe and the microammeter which is calibrated in terms of standing wave ratio. A mechanical arrangement is provided so that the probe can be changed in position and/or directivity.

### THEORY OF OPERATION

The method by which a standing wave indicator operates is by making readings of both the voltage of the wave sent by the power source down the line towards the load and the reflected wave. The forward wave voltage is denoted by  $V_f$ . Generally the load will not accept all the power delivered to it by the line, and the power not absorbed by the load is reflected back towards the source in the form of another traveling wave whose voltage is denoted by  $V_b$ . When both of these waves are present in a line they produce an interference pattern which causes the average line voltage to vary from point to point along the line. At certain points the interference is constructive and the forward and backward wave add to produce a voltage  $V_{max} = V_f + V_b$ . A quarter of a wavelength distant on each side of the maximum voltage the forward and reflected waves interfere in a destructive manner and result in a voltage  $V_{min} = V_f - V_b$ . The ratio of  $V_{max}/V_{min}$  is called the "voltage standing wave ratio."

Any line joining a power source to a load will have standing waves unless there is no power reflected from the load (i. e., the load is completely matched to the source) in which case the VSWR is equal to one (1).

A standing wave indicator may operate either by measuring  $V_f$  and  $V_b$  or by comparing  $V_{max}$  and  $V_{min}$ . In some types of indicators the gain of the detector or rectifier amplifier may be adjusted to read  $V_f$  or  $V_{max}$  full scale on the meter. The reading for  $V_b$  or  $V_{min}$  will then directly indicate VSWR on the meter. This comparison is made by adjusting the probe to read first  $V_f$  or  $V_{max}$  and then rotating or sliding the probe to read  $V_b$  or  $V_{min}$ .

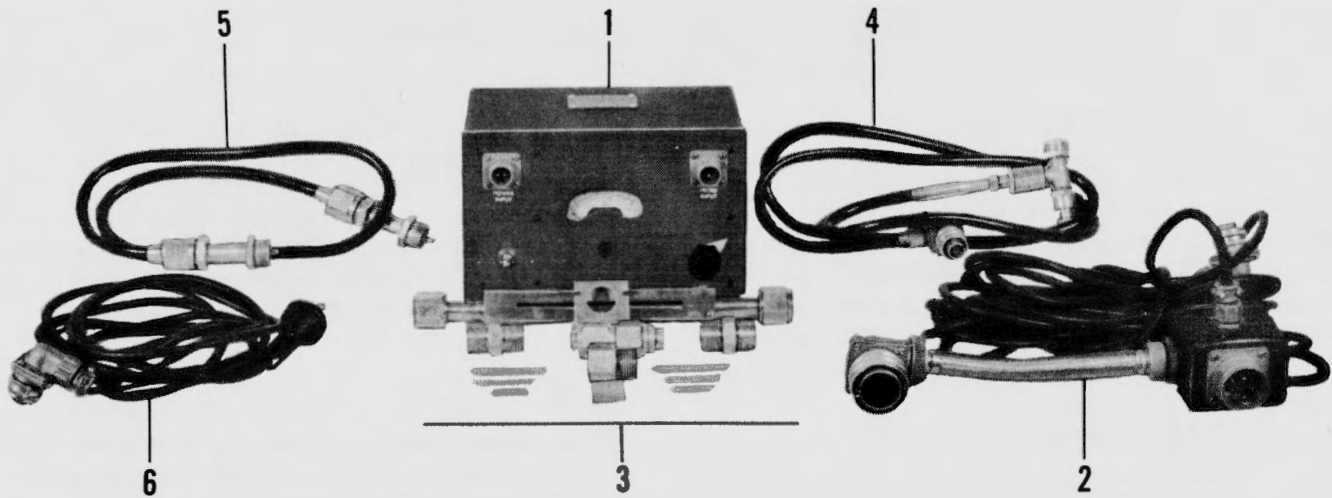


Figure 11-1 Standing Wave Indicator—Navy Model OAK

## STANDING WAVE INDICATOR

### Navy Model OAK

Primary purpose: To measure standing wave ratios in coaxial lines.

The model OAK standing wave indicator consists of a slotted section which fits between pieces of plumbing, a probe assembly which fits over this section, an amplifier (with indicator) to which the probe pick-up is fed, and adapters and fittings so that it may be used on a variety of  $\frac{5}{8}$ -inch r-f lines. The same probe and amplifier may be used without the slide to measure SWR on systems using  $\frac{7}{8}$ -inch plumbing.

#### Electrical characteristics:

Frequency range: 3100-3400 mcs.

Impedance: Slotted section—45 ohms.

Power required: 115 volts, 60 cycle.

Tubes: 1 type 6SJ7GT; 1 type 6SL7GT; 1 type 6H6GT; 1 type 6X5GT.

Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

Amplifier— $5\frac{1}{8}$ " x  $8\frac{1}{4}$ " x  $5\frac{3}{4}$ "

Carrying case—13" x 11" x 12".

Weight:

Amplifier—9 pounds.

Carrying case and fittings—20 pounds.

Complete equipment consists of:

- (1) 1 Rectifier-amplifier, CPR-50ABY.
- (2) 1 Junction box (having two cables permanently attached, one 6 inches long, one power cable assembly 25 feet long, CPR-62074).
- (3) 1 Slotted transmission line, CPR-62ABD, and accessories.
- (4) 1 Probe and transmission line (cable is 5 feet long) CPR-14AAO.
- (5) 1 Flexible r-f cable 3 feet long.
- (6) 1 Power cable 10 feet long.
- (7) 1 Carrying case CPR-10158 (not illustrated).
- (8) 1 Instruction book NAVAER 08-5R-1.

ASO stock No. R16-I-2310.

- |                   |                      |
|-------------------|----------------------|
| (1) R16-NT-50ABY. | (2) R16-B-10216-55.  |
| (3) R16-NT-62ABD. | (4) R16-NT-14AAO.    |
| (5) .....         | (6) R16-PH-358-2964. |
| (7) R16-NT-10158. |                      |

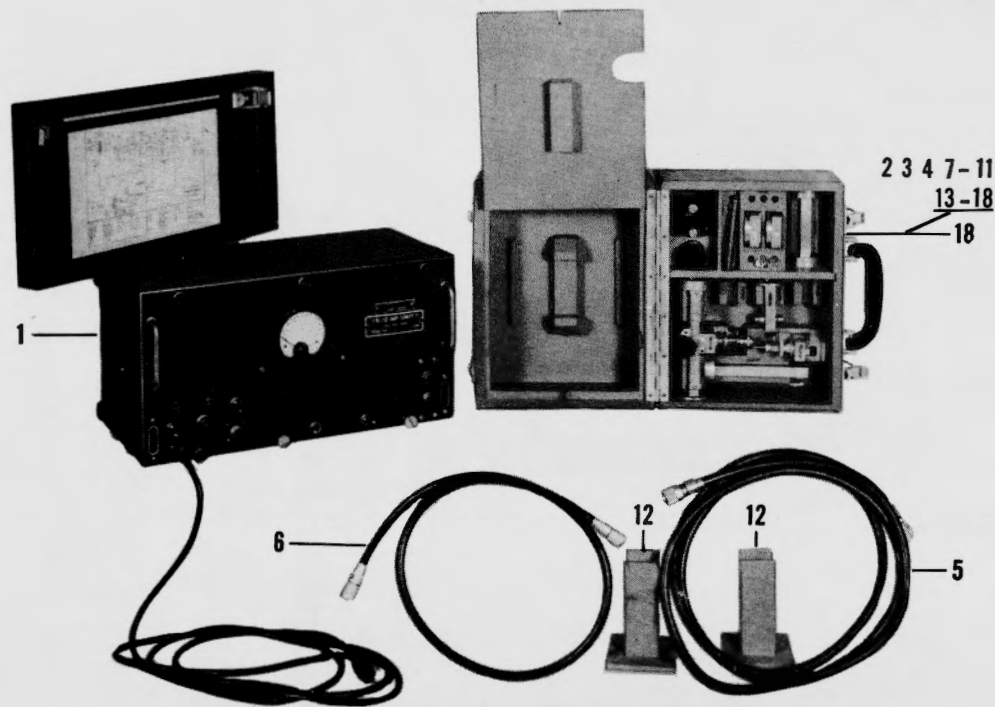


Figure 11-2. Standing Wave Indicator—TS-12/AP

### STANDING WAVE INDICATOR

#### TS-12/AP

Primary purpose: To be used with TS-13/AP for standing wave measurements on various airborne equipments.

This set consists of a slotted section, pickup probe, high-gain amplifier with indicator and fittings to allow connection to the various equipments. The TS-13/AP signal generator is used for the source of r-f power. This equipment comes in two cases, one for the amplifier, the other for the plumbing and accessories.

The amplifier unit is a 3-stage high gain linear amplifier. The amplifier takes its input from the crystal rectifier in the gear-driven probe assembly. The measurements are made with an output meter directly calibrated in voltage standing wave ratio (VSWR) when used with a square-law pickup probe.

#### Electrical characteristics:

Frequency range: 9305-9445 mc.

Accuracy:  $\pm 3\%$ .

Sensitivity: 15 microvolts min.; PRF 400 to 3500 c. p. s.

Input impedance: Square-law pick-up to 50 ohms.

Power required: 115 volts. 60-800 c. p. s., 35 watts.

Tubes: 2 type 6SJ7; 1 type 6V6GT; 1 type 6H6; 1 type 6X5GT.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 16 $\frac{5}{8}$ " x 9" x 8 $\frac{7}{8}$ ".

Weight: 60 pounds (total).

Complete equipment consists of:

- (1) 1 Standing wave indicator, TS-12/AP.
- (2) 2 Waveguide-coax adapter UG-81/U.
- (3) 1 Waveguide to waveguide CG-90/U (Adapter).
- (4) 1 R-f cable CG-92/U.
- (5) 1 Sync. cable CG-91/U.
- (6) 1 Sync. cable 3 feet 6 inches CG-89/U.
- (7) 1 Waveguide to coax adapter UG-79/U.
- (8) 1 Slotted section CG-87/U.
- (9) 1 Probe assembly MX-158/U.
- (10) 1 Terminating section CG-88/U.
- (11) 2 Large-to-small waveguide adapters UG-80/U.
- (12) 2 Support blocks.
- (13) 6 Spare type 1N21 crystals.
- (14) 2 Screwdrivers.
- (15) 4 Clamps.
- (16) 2 Spare probe conductors.
- (17) 1 Box operating spares.
- (18) 1 Carrying case.
- (19) 1 Instruction book AN 08-35TS12-3.

ASO stock No. R16-I-2300.

- |                      |                      |
|----------------------|----------------------|
| (1) .....            | (2) R16-A-407.       |
| (3) R16-AN-CG-90/U.  | (4) R16-AN-CG-92/U.  |
| (5) R16-AN-CG-91/U.  | (6) R16-AN-CG-89/U.  |
| (7) R16-AN-UG-79/U.  | (8) .....            |
| (9) R16-AN-MX-158/U. | (10) R16-AN-CG-88/U. |
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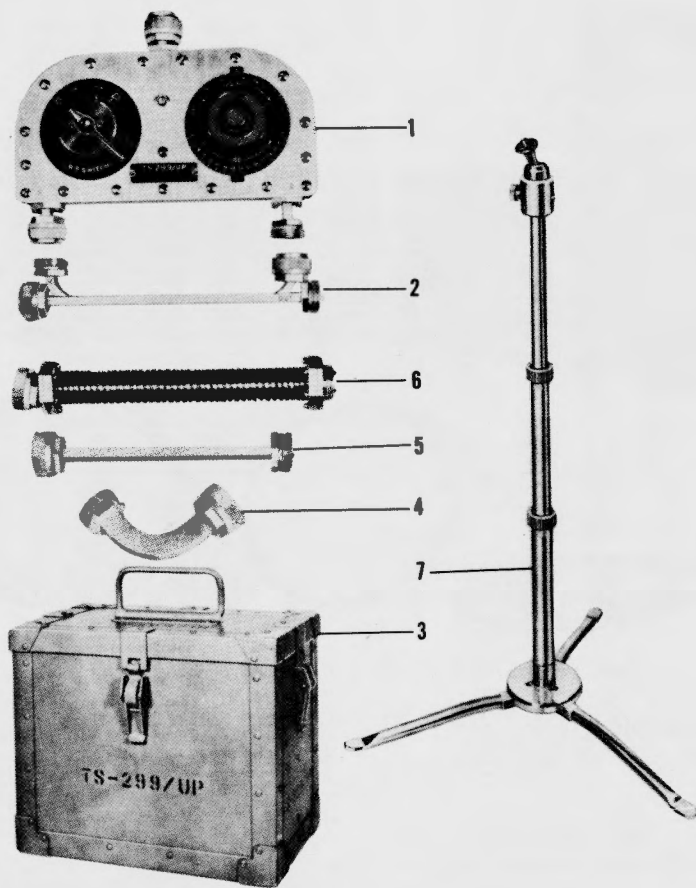


Figure 11-3. Standing Wave Indicator—TS-299/UP

**STANDING WAVE INDICATOR**

**TS-299/UP**

Primary purpose: To measure voltage standing wave ratio of the transmission line of radars when used in conjunction with TS-254/AP power meter.

This VSWR Indicator consists of two unidirectional couplers which are coupled to the main transmission line in such a way that one measures direct power and the other measures reflected power. The coupling of the direct power unidirectional coupler is nominally 20 db and the directivity is 20 db. The coupling of the reflected power unidirectional coupler is 20 db and the directivity is 32 db.

**Electrical characteristics:**

Frequency: 23,500 mc. to 24,500 mc.

**Sensitivity:**

Coupling—Direct power 20 db; reflected power 20 db.

Directivity—Direct power 20 db; reflected power 32 db.

Attenuator—Direct power 6 to 21 db VSWR—1.2 to 3.0.

Signal Power required: 10 watts to 100 kw: peak.  
Power required: None.  
Tubes: None.  
Batteries: None.

**Mechanical characteristics:**

Dimensions: 8<sup>3</sup>/<sub>4</sub>" x 2<sup>1</sup>/<sub>2</sub>" x 8<sup>1</sup>/<sub>2</sub>".

Weight: 3.7 pounds; case and accessories 12 pounds.

**Complete equipment consists of:**

- (1) 1 Microwave network (A.R.C. # 10016).
- (2) 1 Bi-directional coupler CU-136/UP.
- (3) 1 Case CY-581/UP.
- (4) 3 Transmission lines, CG-346/U.
- (5) 2 Transmission lines, CG-470/U.
- (6) 1 Transmission line, CG-344/U.
- (7) 1 Stand, MT-545/U.
- (8) 1 Instruction book, AN 16-35TS299-3.

ASO stock No. R16-AN-TS-299/UP.

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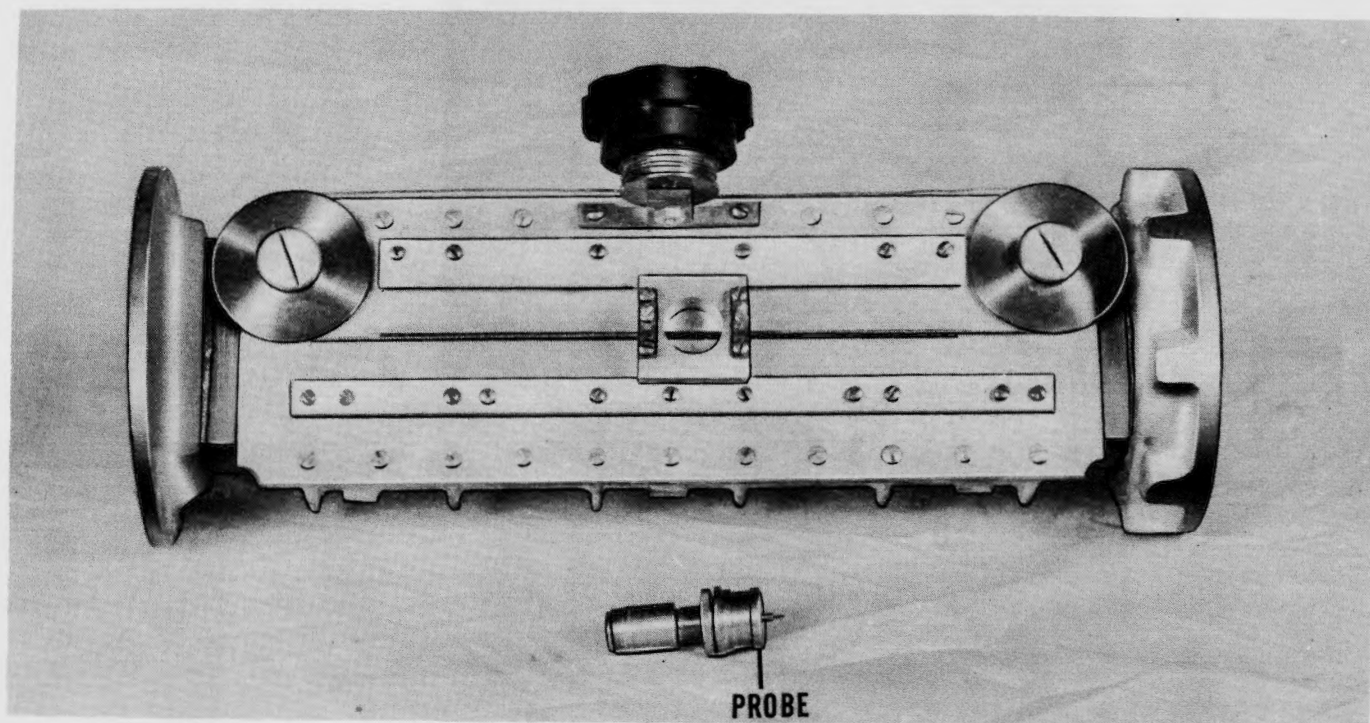


Figure 11-4. Slotted Section and Probe—TS-339/UP

### SLOTTED SECTION AND PROBE

#### TS-339/UP

Measuring the VSWR of high power radar equipment when the TS-125/AP power meter is used as an indicator. TS-339/UP is designed primarily for use with AEW systems.

The equipment consists of a slotted section and probe. The slotted section of  $1\frac{1}{2}$ " x 3" waveguide terminates on one end in a choke flange coupling and on the other end in a plain flange coupling. The probe is movable along the slot.

#### Electrical characteristics:

Frequency: 2770 mc. to 2900 mc.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 6" x 6" x 12" (approximate).

Weight: 26 pounds (approximate).

#### Complete equipment consists of:

- (1) 1 Slotted section and probe, TS-339/UP.
- ASO stock No. R16-AN-TS-339/AP.



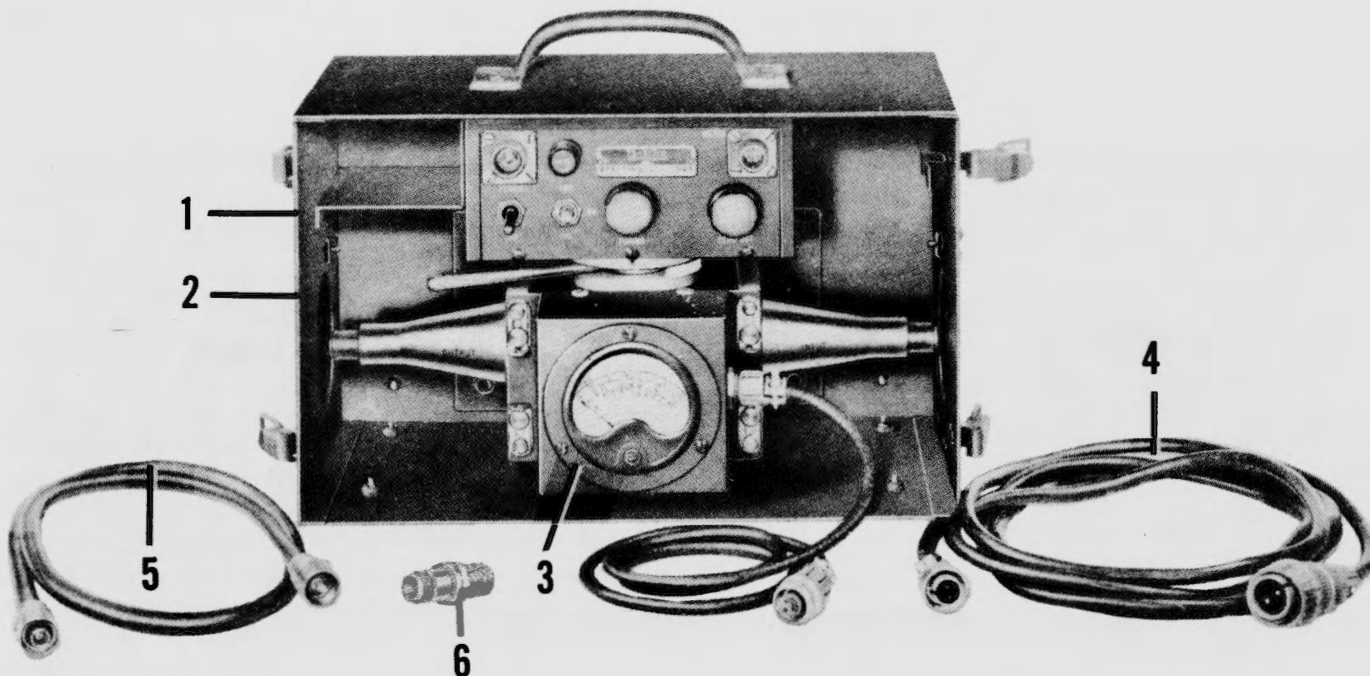


Figure 11-5. Reflectometer-TS-377/U

**REFLECTOMETER**

**TS-377/U**

**Primary purpose:** The reflectometer measures the voltage standing wave ratio and relative output power in r-f transmission lines between the transmitter or signal source and its antenna or load.

The equipment consists of a bi-directional coupler, a detector assembly with power cable, and a meter cable. The equipment is suitable for permanent mounting. The equipment performs a check suitable in determining how well the transmission line and antenna are matched. Although any signal source having the proper power output frequency range can be tested, the equipment was designed specifically to test T-123/ART-22.

**Electrical characteristics:**

Frequency: 275 mc. to 330 mc.

Power: Above 5 watts average required for meter indications.

Power required: 24 volts to 30 volts d. c., 0.16 amperes.

Tubes: Two type 9002.

Batteries: None supplied.

**Mechanical characteristics:**

Dimensions: 14<sup>1</sup>/<sub>4</sub>" x 7<sup>5</sup>/<sub>8</sub>" x 8<sup>3</sup>/<sub>8</sub>" (case).

Weight: 28 pounds total.

**Complete equipment consists of:**

- (1) 1 Reflectometer, TS-377/U.
- (2) 1 Carrying case.
- (3) 1 Meter assembly with meter cable.
- (4) 1 Power cable (10 feet).
- (5) 1 RF cable RG-9/U (4 feet).
- (6) 1 Bi-female junction connector UG-29/U.
- (7) 1 Instruction book NAVAER 16-5S-512.

ASO stock No. R16-AN-TS-377/U.

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## Section XII VOLTMETERS

### FUNCTION AND TYPES

The purpose of a voltmeter is to give an accurate indication of the voltage difference existing between any pair of test points. The voltmeters considered in this section are of two types—voltmeters (conventional type) and vacuum tube voltmeters.

### VOLTMETERS

Conventional type voltmeters consist essentially of a d. c. microammeter which is used in combination with a set of resistor multipliers. By measuring the current flow through a known resistance, an indication of voltage is given. If the meter is to make a. c. voltage measurements, a copper oxide rectifier and associated resistor multipliers are included to allow the a.c. voltage to be rectified into a d.c. current which can be indicated on the meter. For further explanation and applications see Multimeter section.

### VACUUM TUBE VOLTMETERS

A vacuum tube voltmeter measures either d. c. or a.c. voltages by making use of either the amplifier characteristic or the rectifier characteristic of a tube, or both. The input impedance is very high, often over 10 megohms, and the current used to actuate the meter is not taken from the circuit being measured. When compared with the 20,000 ohms per volt resistance of a good conventional type voltmeter, it is seen that this type of instrument will draw an infinitesimal amount of current from the circuit under test, thereby leaving the characteristics of the tested circuit unchanged.

Many vacuum tube voltmeters make use of a voltage regulator type tube to stabilize the operating voltages of the voltage measuring tube, so that they will remain constant and produce accurate readings regardless of line voltage variations. Because of this regulation and also because of the low plate and filament potentials usually employed in the design, this type of instrument is very stable in operation and requires no readjustment of the "zero" point when changing ranges.

### VTVM CIRCUITS

The voltage measuring circuit consists of a multiplier composed of very high value resistors. This multiplier is connected to the grid circuit of the voltmeter tube. The types of vacuum tube voltmeter circuits are legion, but basically either plate or cathode current is registered by the indicating meter. This current is proportional to the external voltage being measured. The indicating meter may simply measure an adjusted amount of the plate or cathode current or there may be a balancing circuit which is adjusted to eliminate indicator zero voltage change, line voltage change, or varying characteristics caused by the changes within the vacuum tube. One common method of eliminating vacuum tube variations due to heating, aging, and fluctuation of operating voltages is accomplished by the use of two identical vacuum tubes in a bridge circuit. This circuit balances out these changes which are for all practical purposes identical in the two tubes.

A. c. voltage measurements are accomplished by the use of a resistor multiplier and a vacuum tube rectifier which allows the resulting d. c. voltage to be impressed upon the d. c. meter section. In such cases a separate a. c. voltage scale is not always necessary.

When a. c. voltage measurements are made the meter will give direct readings of effective or RMS values of voltage. Any distorted wave form will be read on the meter as a deviation from the effective sine wave value directly proportional to the degree of harmonics that are present.

When an ohmmeter circuit is included, the unknown resistance is connected in series with an internal battery and the ohmmeter multiplier resistors. The electronic d. c. voltmeter is then internally connected so as to measure the voltage drop across the unknown resistor and indicate it on the meter in terms of ohms.

Each time a vacuum tube voltmeter is put into operation it is necessary to allow the instrument to warm up for at least several minutes and calibrate the zero voltage point on the indicating meter. This is done by use of the "zero adjust" rheostat located on the front panel. A. c. and d. c. calibration adjustments are not usually available on the front panel. They are fixed at the factory and recalibration is usually unnecessary except when changing the tubes in the voltmeter.

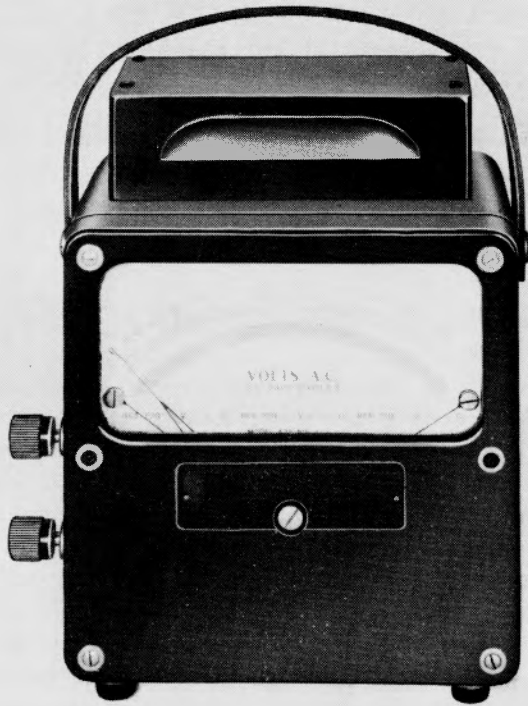


Figure 12-1. Voltmeter, AC-IS-185

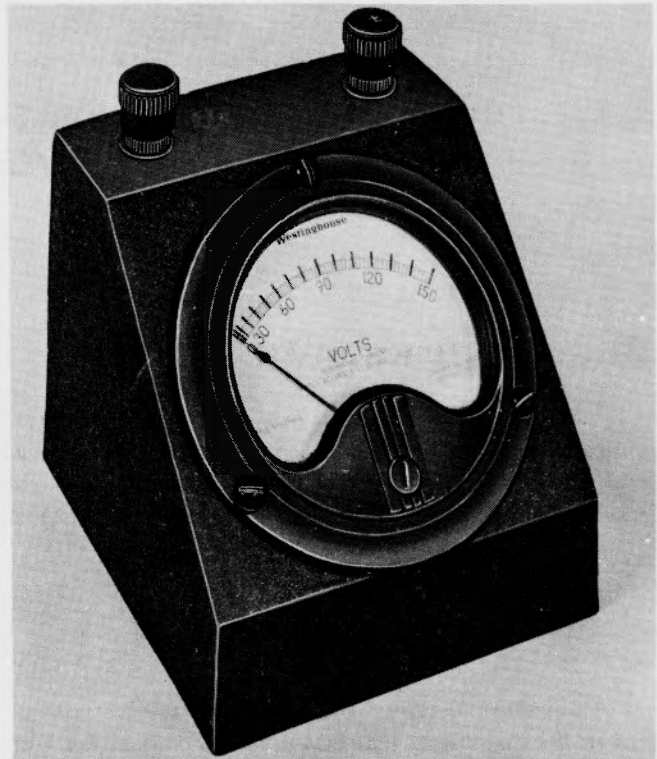


Figure 12-2. Voltmeter, DC—Westinghouse NA-35

### VOLTMETER, AC

#### IS-185

Primary purpose: Variable frequency a. c. voltage measurements.

This IS-185 is a modified Weston type 433, having a compensator to provide for greater accuracy over the wide frequency range specified. The meter may be left in circuit continuously without overheating. It is magnetically shielded and contained in a molded bakelite case with carrying strap. A 4-inch scale provides good visibility of hand calibrated mirror scales.

#### Electrical characteristics:

- Range: 0-150 volts.
- Frequency range: 60-2,400 cycles.
- Accuracy:  $\pm 1.25\%$ .
- Power consumption: 2.5 watts at 115 volts.
- Input impedance: 5,300 ohms.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: 7" x 3 $\frac{1}{2}$ " x 5 $\frac{3}{4}$ ".
- Weight: 2 $\frac{1}{2}$  pounds.

Complete equipment consists of:

- (1) 1 Voltmeter, Army type IS-185.
- ASO stock No. R16-V-1955.

### VOLTMETER, AC

#### Westinghouse, NA-35 Type

Primary purpose: To measure variable frequency a. c. voltages.

The type NA-35 is an a. c. voltmeter for use in measuring voltages of various frequencies in the range 0-150 volts. Its particular application is in measuring the output of aircraft-type generators where the frequency may vary and in the setting of a. c. voltage regulators. The meter is encased in a small metal box with sloping front panel and is equivalent to the unmounted type RA-35 which is used in radio-radar maintenance trucks.

#### Electrical characteristics:

- Range: a. c. volts 0-150.
- Frequency range: 25-1600 cycles.
- Accuracy: Plus or minus 2% of full scale reading.
- Power required: None.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: 3 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ ".
- Weight: 20 ounces.

Complete equipment consists of:

- (1) 1 Voltmeter, Westinghouse NA-35 type.
- ASO stock No. R16-V-1965.

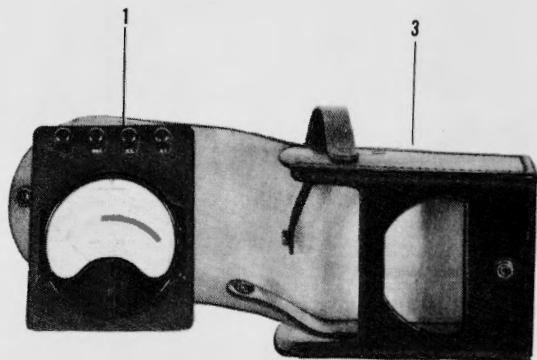


Figure 12-3. Voltmeter, DC—Westinghouse PX-14

### VOLTMETER, DC

#### Westinghouse, PX-14 Type

Primary purpose: Accurate adjustment of aircraft type voltage regulators.

The PX-14 is an accurate d. c. voltmeter, permanent-magnet moving-coil type, mounted in a bakelite case and provided with a leather carrying case with strap. Two 50-inch test leads, with test prods on one end and spade terminals on the other, are supplied. This meter can also be used as an ammeter by using standard aircraft 50-milli-volt shunts. Two separate scales are provided on the meter face. A mirror behind the pointer prevents parallax. The meter is shielded both electrically and statically and is treated for tropical and low temperature service.

#### Electrical characteristics:

##### Range (full scale) accuracy.

0-50 mv: 2 percent at all points.

0-15 volts:

1/2 percent from 13.5 to 14.5 volts, inclusive.

1 percent from 12 volts to full scale.

2 1/2 percent at all other points.

0-30 volts:

1/2 percent from 27-29 volts, inclusive.

1 percent from 24 volts to full scale.

2 1/2 percent at all other points.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 5 1/4" x 4 1/4" x 1 3/4".

Weight: 2 pounds (less case).

Complete equipment consists of:

(1) 1 Voltmeter, Westinghouse, PX-14 type.

(2) 2 Test leads (not illustrated).

(3) 1 Carrying case.

ASO stock No. R17-V-802.

(1) ..... (2) .....

(3) .....

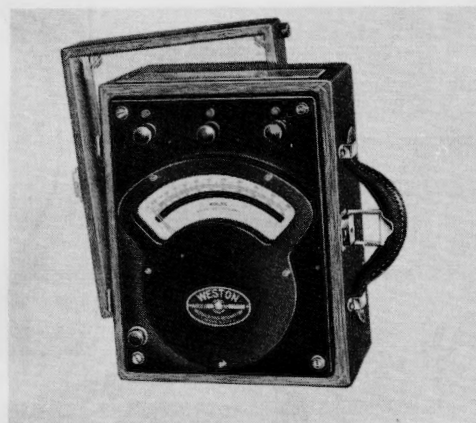


Figure 12-4. Voltmeter, AC and DC—Weston 341

### VOLTMETER, AC and DC

#### Weston 341

Primary purpose: To provide an accurate measurement of a.c. voltage of aircraft generators where non-uniform and distorted wave forms are involved.

This instrument is an electro-dynamometer type shielded from external magnetic effects. It is contained in a wooden carrying case.

#### Electrical characteristics:

Models are available in any of the following voltage ranges: 0-30 volts a. c./d. c., 0-150 volts a. c./d. c.

Frequency range: 25-1000 cycles.

Accuracy: 0.25% of full scale reading.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 8" x 10 1/4" x 5 3/4".

Weight: 11 pounds.

Complete equipment consists of:

(1) 1 Voltmeter, Weston 341, 0-30V.

ASO stock No. R17-V-850.

(2) 1 Voltmeter, Weston 341, 0-150V.

ASO stock No. R17-V-859-20.





Figure 12-5. Output Meter—Simpson 427

### OUTPUT METER

Weston 687 and Simpson 427.

Primary purpose: To measure audio output.

This is a rectifier type a. c. voltmeter. It can be used to measure a. c. voltages but is not recommended for d. c. measurements. Sensitivity is 1000 ohms/volt.

Electrical characteristics:

Range: Volts a. c., 0-2-10-50.

Power required: None

Tubes: None.

Batteries: None.

Mechanical characteristics:

Dimensions: 5" x 2<sup>7</sup>/<sub>8</sub>" x 1<sup>7</sup>/<sub>8</sub>".

Weight: 1<sup>1</sup>/<sub>4</sub> pounds.

Complete equipment consists of:

- (1) 1 Output meter, Weston 687, or Simpson 427.
- (2) Test leads.

Note—The Simpson Model 427 has characteristics identical to the Weston 687. Both have the same ASO stock number.

ASO stock No. R16-M-2000.

- (1) ..... (2) .....



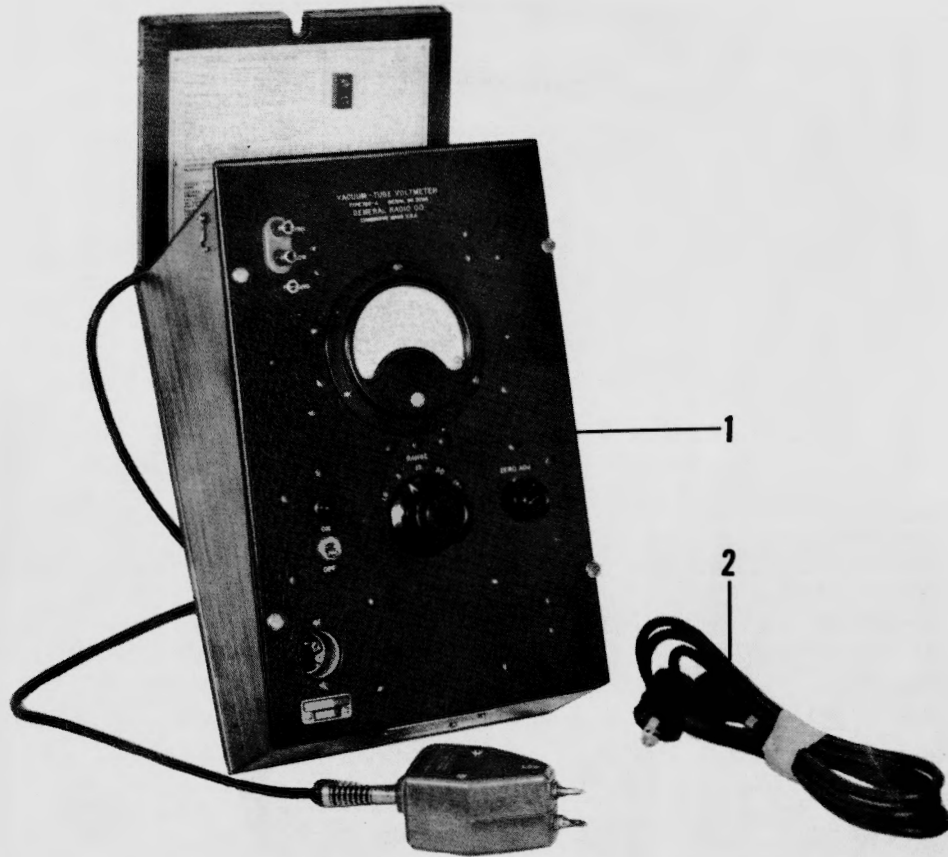


Figure 12-6. Vacuum Tube Voltmeter—General Radio 726-A

## VACUUM TUBE VOLTMETER

### General Radio Type 726-A

Primary purpose: To provide vacuum tube voltmeter measurements both at audio and radio frequencies.

The 726-A vacuum tube voltmeter can be used at both audio and radio frequencies. In addition it can be used as a radio frequency ammeter when used with capacitive shunts. When used this way it has application in the measurement of antenna current for the determination of antenna power input.

The circuit components included regulated power supply, a one tube degenerative d. c. amplifier and an acorn tube diode-condenser rectifier built into a small probe. The scale is essentially linear except on the lowest scale.

#### Electrical characteristics:

A. c. Range: 1-1.5-5-15-50-150 volts full scale.

Accuracy:  $\pm 2\%$  of full scale on all five ranges for sinusoidal voltages.

Input impedance: 6 megohms in parallel with 6.6 mmf. correction chart for high frequencies.

Power supply: 100-130 volts a. c., 50, 60 or 42 cycles or 200-260 volts, 50 cycles.

Power input: 30 watts.

Tubes: 1 type 995, 1 type 6Q7-G, 1 type 1-V.

#### Mechanical characteristics:

Dimensions: 9 1/2" x 14" x 8 1/2" over-all.

Weight: 17 1/2 pounds.

#### Complete equipment consists of:

- (1) 1 GR type 726-A with attached probe.
- (2) 1 Line cord.
- (3) 1 Frequency error correction chart (not illustrated).

ASO stock No. R16-V-3470.

- (1) .....
- (2) .....
- (3) .....



Figure 12-7. Vacuum Tube Voltmeter—Hewlett-Packard 400-A

## VACUUM TUBE VOLTMETER

### Hewlett-Packard 400-A

Primary purpose: Measurement of a. c. voltages. The input binding posts, the range selector, the power switch, the pilot light, and the indicating meter are located on the front panel.

#### Electrical characteristics:

Range: A. c. volts 0 to 0.03, 0.1, 0.3, 1.0, 3, 10, 30, 100, 300.

Frequency range: 10 cycles to 1 megacycle.

Input impedance: 16 *mmf.* Parallel resistance: 1

megohm (.03–30 volts); 3 megohm (100 volts); 2.4 megohm (300 volts).

#### Accuracy:

± 3% 10 c. p. s. to 100 kc.

± 5% 100 kc. to 1 mc.

Power required: 115 volts, 50–60 cycles, 35 watts.

Tubes: 1 type 6J5; 2 type 6AC7; 1 type 6H6; 1 type 6V6; 1 type 6SF5; 1 type 5Y3GT; 1 Neon 1/4 watt.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 7½" x 8" x 9".

Weight: 20 pounds.

#### Complete equipment consists of:

(1) 1 Vacuum tube voltmeter, H.P. 400A.

(2) 1 Instruction book NAVAER 08-5S-125.

ASO stock No. R16-V-3480.

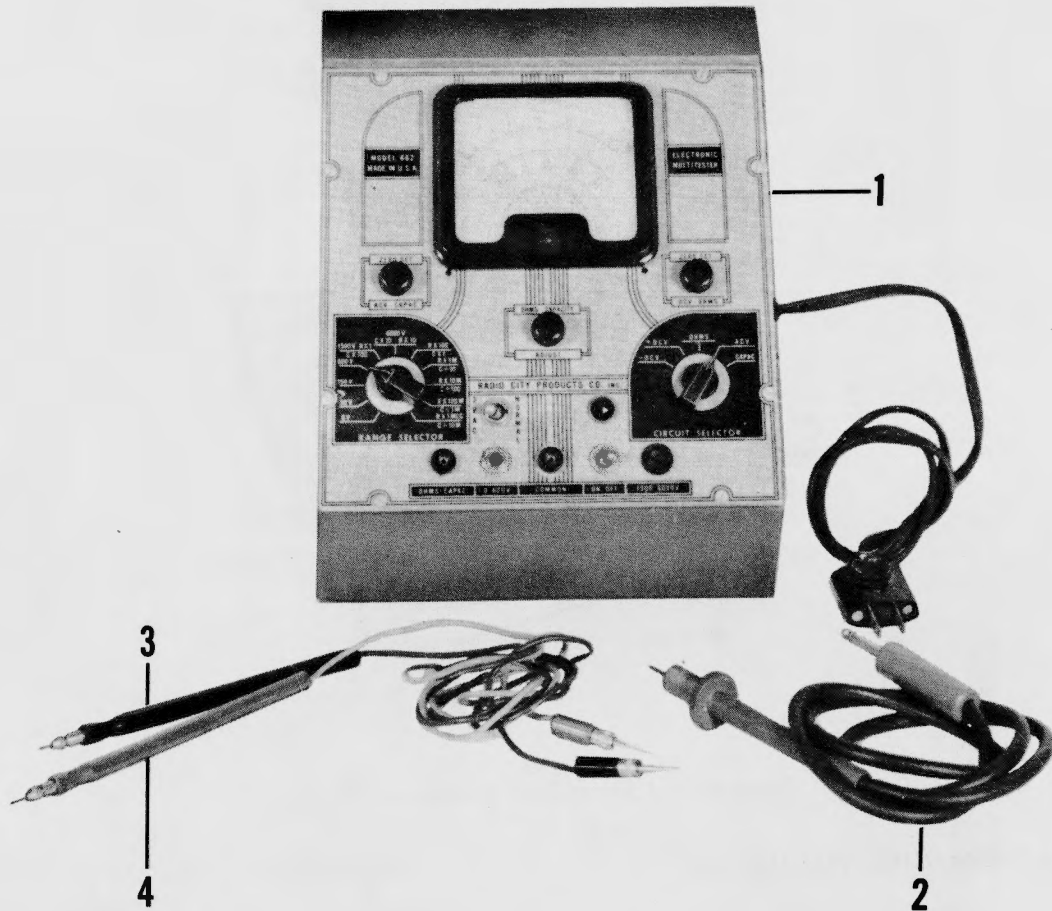


Figure 12-8. Vacuum Tube Voltmeter—Radio City 662

## VACUUM TUBE VOLTMETER

### Radio City 662

Primary purpose: General vacuum tube voltmeter applications in service testing and maintenance of electronic equipment.

This instrument is a vacuum tube voltmeter on both a. c. and d. c. It does not incorporate a copper oxide rectifier. It is an electronic ohmmeter and capacity meter. It permits voltage measurements without affecting circuit constants. This metal encased instrument uses a 4½-inch square meter, mounted on a sloping front panel.

#### Electrical characteristics:

##### Range:

- DC volts: 0-6-30-150-600-1,500-6,000.
- AC volts: 0-3-6-30-150-600-1,500-6,000.
- Ohms: 0-1K-10K-100K -1 meg. -10 meg. -100 meg.-1,000 meg.
- Mfd. (capacity): 0-0.002-0.02-0.2-2-20-200-2,000.

Accuracy: Plus or minus 3% of full scale on d. c.:  
5% on a. c.

Input resistance (a. c. and d.c.): High ranges, 160 meg.; low ranges, 16 meg.; 50 micro-microfarads shunt capacity at terminals of instrument on both ranges.

Power required: 105-130 volts, 60 cycles, 10 watts.

Tubes: 1 type 6K6GT; 1 type 6X5GT; 1 type OC3/VR-105.

Batteries: 1 type BA-205/U. Supplied only in early equipment. Batteries should be requisitioned when ordering this equipment.

#### Mechanical characteristics:

Dimensions: 7½" x 9⅞" x 9¼".

Weight: 10½ pounds.

#### Complete equipment consists of:

- (1) 1 Vacuum tube voltmeter, Radio City 662.
- (2) 1 Lead, shielded, 4 feet long, a.c.
- (3) 1 Lead, black, 4 feet long, high voltage.
- (4) 1 Lead, red, 4 feet long, high voltage.
- (5) 1 Instruction book AN 08-45-6.

ASO stock No. R16-T-1696.

- |                 |                     |
|-----------------|---------------------|
| (1) .....       | (2) R16-L-4872.     |
| (3) R16-L-4875. | (4) R16-L-4875-500. |

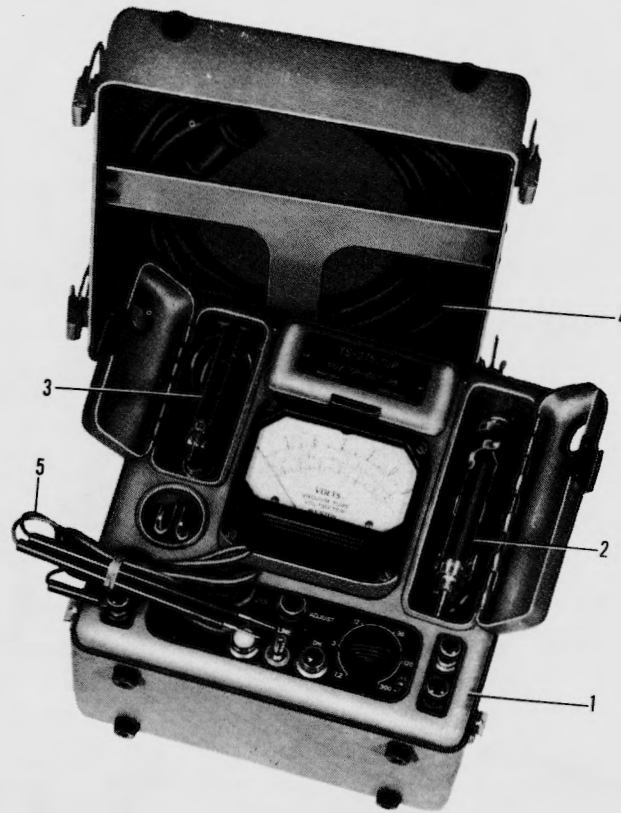


Figure 12-9. Vacuum Tube Voltmeter—TS-375/U

## VACUUM TUBE VOLTMETER

### TS-375/U

**Primary purpose:** General purpose VTVM applications.

This is a vacuum tube voltmeter which measures both a. c. and d. c. and is designed to meet service field conditions.

The meter is housed in a waterproof case, and the range scales appear on a conveniently read 4½" sealed meter.

The voltmeter measures both a. c. and d. c. voltages within the range specified below either through connectors on the front panel or through use of the high impedance probes.

#### Electrical characteristics:

Frequency range: 40 cycles to 50 kc. using panel terminals; 10 kc. to 150 mc. using probe; up to 300 mc. with correction curve.

#### Input impedance:

AC probe input capacitance: 8 mmf.

AC probe input resistance: 5 megohms.

DC probe resistance: 5 megohms.

Full scale range: a. c./d. c.—1.2, 3.0, 12.0, 30.0, and 120 volts with 300-volt scale for d. c. only.

#### Accuracy:

DC — ± 3% of full scale range.

AC—10 c. p. s. ± 5%; 50 c. p. s. to 50 mc. ± 4%;  
50 to 150 mc. ± 6% without calibrating curve,  
or ± 3% with calibrating curve; 150 to 300mc.  
± 8%, with calibrating curve.

Power required: 115 volts ± 10%, 50–1600 cycles,  
28 watts.

Tubes: 2 type 6SJ7, 1 type 5Y3GT, 1 type 6SN7,  
2 type 991 neon tubes, 2 type CK-606.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 10½" x 10½" x 6¾".

Weight: 18½ pounds.

#### Complete equipment consists of:

- (1) 1 VTVM, TS-375/U.
- (2) 1 A-C Probe (48 inches) MX-661/U.
- (3) 1 D-C Probe (48 inches) MX-660/U.
- (4) 1 Line Cord (96 inches) CX-337/U.
- (5) 2 Test Leads (36 inches) CX-529/U.
- (6) 1 Ground Prod. (not illustrated).
- (7) 2 Alligator Clips (not illustrated).
- (8) 1 Box spare parts (not illustrated).

#### ASO stock No. R16-AN-TS-375/U.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |
| (5) ..... | (6) ..... |
| (7) ..... | (8) ..... |



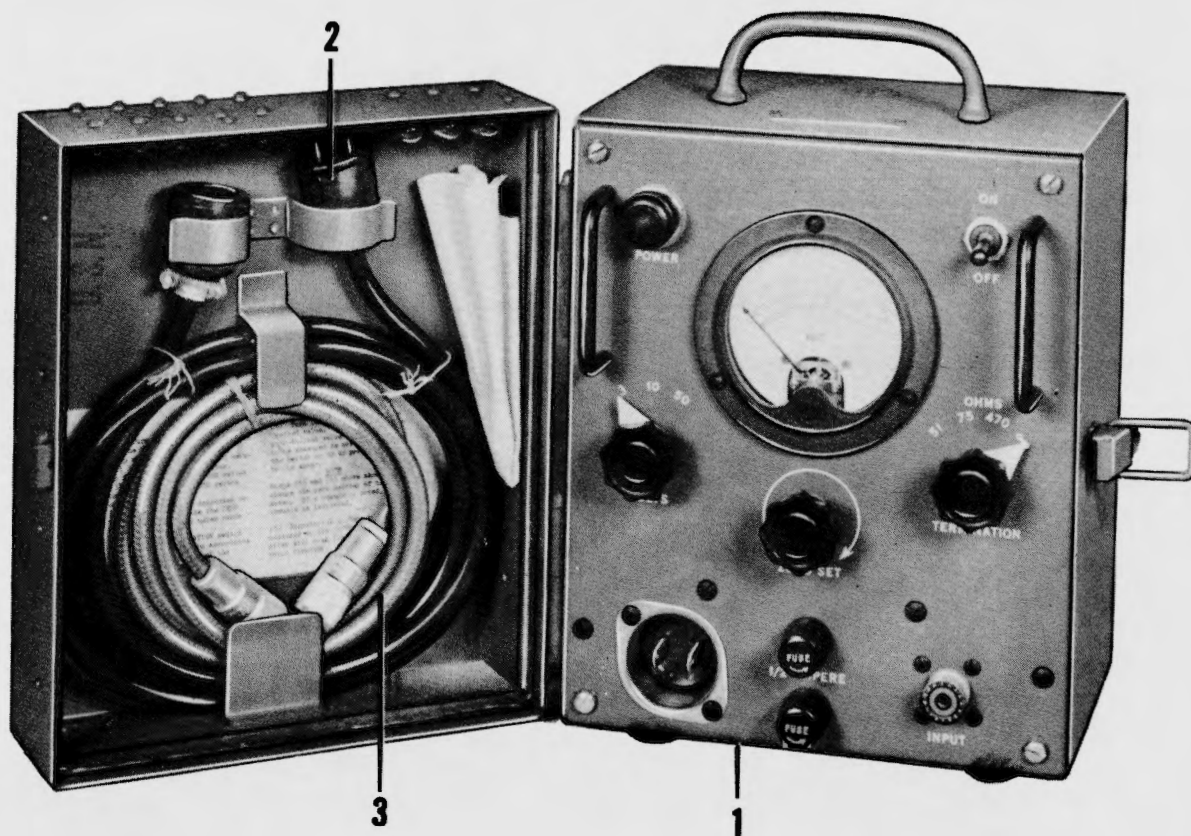


Figure 12-10. Vacuum Tube Voltmeter—TS-487/U

## VACUUM TUBE VOLTMETER

TS-487/U

Primary purpose: To measure the peak-to-peak voltage excursion of video type signals.

This equipment measures the peak-to-peak voltage excursion of video type signals. The instrument provides resistance terminations of 51, 75, 470, and infinite ohms, and the full scale voltage readings can be switched to 3, 10, or 50 volts on a 3½-inch round meter.

### Electrical characteristics:

Frequency: Video.

Range: 0-3, 0-10, and 0-50 volts.

Accuracy: ± 5% of full scale on duty cycles greater than 0.01.

Power required: 30 watts, 115 volts, 50 to 1600 cycles per second.

Tubes: 1 type 6H6, 3 type 6SN7.

### Mechanical characteristics:

Dimensions: 8½" x 7¾" x 11".

Weight: 19 pounds.

### Complete equipment consists of:

- (1) 1 Voltmeter TS-487/U.
  - (2) 1 Power cord 6 feet long.
  - (3) 1 Video cable RG-39/U 4 feet long with 49195 connectors.
  - (4) 1 Instruction book NAVAER 16-35TS487-505.
- ASO stock No. R16-AN-TS-487/U.
- (1) ..... (2) .....  
(3) .....



**RESTRICTED**

**RESTRICTED**

## Section XIII MISCELLANEOUS EQUIPMENT

Miscellaneous Equipment included in this manual is divided into four main groups which are:

### 1. HARNESS ASSEMBLIES

The Harness Assembly group consists of cable assemblies, benches, mounting racks, etc.

### 2. TUBE TESTERS

The Tube Tester group consists of both emission type and mutual conductance type tube checkers.

### 3. MISCELLANEOUS TEST SETS

The Miscellaneous Test Set group consists of test sets, frequency meters, test meters, etc.

### 4. SPECIAL UNITS AND ACCESSORIES

Special Units and Accessories consist of adapters, elbows, junction boxes, valves, etc.

Due to the fact that these equipments fall into many categories, no attempt is made here to describe the general theory of their operation. Such description is reserved for inclusion, when deemed necessary, with the general description of the individual equipment.



Figure 13-1. Bench Harness Test Set—AN/APM-39

**BENCH HARNESS TEST KIT  
AN/APM-39**

Primary purpose: For bench testing AN/APS-15 radar systems.

This maintenance set is comprised of the following AN cables which are designated alphabetically in the instruction book on the AN/APS-15 radar.

Complete equipment consists of:

- A 1 CX-199/U—6 feet long.
- AA 1 CX-200/U—4 feet long.
- AB 1 CX-201/APM-39—4 feet long.
- AC 1 CX-202/APM-39—6 feet long.
- AD 1 CX-203/U—4 feet long.
- AE 1 CX-308/APM-39—6 feet long.
- AF 1 CX-309/APM-39—6 feet long.
- AG 1 CX-204/U—6 feet long.
- AH 1 CX-205/U—4 feet long.
- AJ 1 CX-206/U—6 feet long.
- AK 1 CX-310/APM-39—4 feet long.
- AM 1 CX-207/U—6 feet long.
- AN 1 CX-311/APM-39—4 feet long.
- AO 1 CX-312/APM-39—10 feet long.
- AP 1 CX-208/U—4 feet long.
- AR 1 CX-209/U—14 feet long.
- B 1 CX-210/U—6 feet long.
- C 1 CX-211/U—6 feet long.
- G 1 CX-212/U—6 feet long.
- H 1 CX-213/U—14 feet long.
- (I) 1 CG-182/U Flex Waveguide—1½ feet long.

ASO stock No. R16-AN-AN/APM-39.

- (A) R16-AN-CX-199/U.
- (AB) R16-AN-CX-201/APM-39.
- (AD) R16-AN-CX-203/U.
- (AF) R16-AN-CX-309/APM-39.
- (AH) R16-AN-CX-205/U.
- (AK) R16-AN-CX-310/APM-39.
- (AN) R16-AN-CX-311/APM-39.
- (AP) R16-AN-CX-208/U.
- (B) R16-AN-CX-210/U.
- (G) R16-AN-CX-212/U.
- (AA) R16-AN-CX-200/U.
- (AC) R16-AN-CX-202/APM-39.
- (AE) R16-AN-CX-308/APM-39.
- (AG) R16-AN-CX-204/U.
- (AJ) R16-AN-CX-206/U.
- (AM) R16-AN-CX-207/U.
- (AO) R16-AN-CX-312/APM-39.
- (AR) R16-AN-CX-209/U.
- (C) R16-AN-CX-211/U.
- (H) R16-AN-CX-213/U.
- (I) .....

### BENCH HARNESS TEST KIT

#### AN/APM-40

Primary purpose: For bench testing AN/APS-6 and AN/APS-6A radar systems.

This maintenance kit is composed of the following AN cables which are designated in numerical sequence starting with number 1 when referenced in the handbook on maintenance for the APS-6 and -6A.

#### Complete equipment consists of:

- (1) 1 CX-313/APM-40-10 feet long.
- (2) 1 CX-314/APM-40-10 feet long.
- (3) 1 CX-315/APM-40-6 feet long.
- (4) 1 CX-317/APM-40-6 feet long.
- (5) 1 CX-318/APM-40-4 feet long.
- (6) 1 CX-319/APM-40-6 feet long.
- (8) 1 CX-320/APM-40-6 feet long.
- (9) 1 CX-321/APM-40-8 feet long.
- (10) 1 CX-322/APM-40-6 feet long.
- (11) 1 CX-323/APM-40-6 feet long.
- (12) 1 CX-324/APM-40-6 feet long.
- (13) 1 CX-325/APM-40-6 feet long.
- (14) 1 CX-326/APM-40-6 feet long.
- (15) 1 CG-185/APM-40-6 feet long.
- (16) 1 CX-327/APM-40-7 feet long.
- (17) 1 CX-328/APM-40-6 feet long.
- (18) 1 CX-329/APM-40-6 feet long.
- (19) 1 CG-182/APM-40-1½ feet long.
- (20) 1 CG-181/APM-40-1½ feet long.
- (21) 1 CG-141/U-6 feet long.

#### The following are also included:

- (22) 1 ID-32/APS-6, indicator.
- (23) 1 J-24/APS-6, junction box.
- (24) 1 J-42/APS-6A, junction box.
- (25) 1 C-46/APS-6, control unit.
- (26) 1 C-47/APS-6, auxiliary control unit.
- (27) 1 AS-103/APM-40, antenna.

#### ASO stock No. R16-AN-AN/APM-40.

- (1) R16-AN-CX-313/APM-40.
- (2) R16-AN-CX-314/APM-40.
- (3) R16-AN-CX-315/APM-40.
- (4) R16-AN-CX-317/APM-40.
- (5) R16-AN-CX-318/APM-40.
- (6) R16-AN-CX-319/APM-40.
- (8) R16-AN-CX-320/APM-40.
- (9) R16-AN-CX-321/APM-40.
- (10) R16-AN-CX-322/APM-40.
- (11) R16-AN-CX-323/APM-40.
- (12) R16-AN-CX-324/APM-40.
- (13) R16-AN-CX-325/APM-40.
- (14) R16-AN-CX-326/APM-40.
- (15) R16-AN-CG-185/APM-40.
- (16) R16-AN-CX-327/APM-40.
- (17) R16-AN-CX-328/APM-40.
- (18) R16-AN-CX-329/APM-40.
- (19) R16-AN-CG-182/APM-40.
- (20) R16-AN-CG-181/APM-40.
- (21) R16-AN-CG-141/U.
- (22) R16-AN-ID-32/APS-6.
- (23) R16-AN-J-24/APS-6.
- (24) R16-AN-J-42/APS-6A.
- (25) R16-AN-C-46/APS-6.
- (26) R16-AN-C-47/APS-6.
- (27) R-16-A-4932-505.





Figure 13-2. Bench Harness—AN/APM-46

**BENCH HARNESS**

**AN/APM-46**

Primary purpose: For bench testing AN/APS-3 and AN/APS-3A radar systems.

This maintenance kit is comprised of the following AN cables and designated alphabetically in the instruction book for the AN/APS-3 and -3A radar. The cables are completely assembled with connectors and provide for interconnection of units of AN/APS-3 and AN/APS-3A for bench testing of the radar equipment.

Complete Equipment consists of:

- C 1 CX-330/APM-46—4 feet long.
- D 1 CX-331/APM-46—6 feet long.
- E 1 CG-91/U—6 feet long.

- G 1 CX-332/APM-46—6 feet long.
- H 1 CX-333/APM-46—4 feet long.
- J 1 CX-334/APM-46—4 feet long.
- M 1 CX-335/APM-46—14 feet long.
- N 1 CX-336/APM-46—4 feet long.
- P 1 CG-141/U—6 feet long.

ASO stock No. R16-AN-AN/APM-46.

- (C) R16-AN-CX-330/APM-46.
- (E) R16-AN-CG-91/U (6 feet).
- (H) R16-AN-CX-333/APM-46.
- (M) R16-AN-CX-335/APM-46.
- (P) R16-AN-CG-141/U.
- (D) R16-AN-CX-331/APM-46.
- (G) R16-AN-CX-332/APM-46.
- (J) R16-AN-CX-334/APM-46.
- (N) R16-AN-CX-336/APM-46.





Figure 13-3. Bench Harness Test Kit—AN/APM-47

### BENCH HARNESS TEST KIT

#### AN/APM-47

Primary purpose: For bench testing AN/APS-6 and AN/APS-6A radar systems.

This maintenance kit is comprised of a set of cables similar to those furnished with AN/APM-40 and two junction boxes. The kit is made up to take advantage of using a spare radar system.

Complete equipment consists of the following cables numbered as designated in the instruction book.

- (1) 1 CX-313/APM-40—10 feet long.
- (2) 1 CX-314/APM-40—10 feet long.
- (3) 1 CX-315/APM-40—6 feet long.
- (4) 1 CX-317/APM-40—6 feet long.
- (5) 1 CX-318/APM-40—4 feet long.
- (6) 1 CX-319/APM-40—6 feet long.
- (8) 1 CX-320/APM-40—6 feet long.
- (9) 1 CX-321/APM-40—8 feet long.
- (10) 1 CX-322/APM-40—6 feet long.
- (11) 1 CX-323/APM-40—6 feet long.
- (12) 1 CX-324/APM-40—6 feet long.
- (13) 1 CX-325/APM-40—6 feet long.
- (14) 1 CX-326/APM-40—6 feet long.
- (15) 1 CG-185/APM-40—6 feet long.
- (16) 1 CX-327/APM-40—7 feet long.
- (17) 1 CX-328/APM-40—6 feet long.

- (18) 1 CX-329/APM-40—6 feet long.
- (19) 1 CG-182/APM-40—11½ feet long.
- (20) 1 CG-181/APM-40—11½ feet long.
- (21) 1 CG-141/U—6 feet long.
- (22) 1 J-24/APS-6 Junction Box, not designated as (22).
- (23) 1 J-42/APS-6A Junction Box, not designated as (23).

ASO stock No. R16-AN-AN/APM-47.

- (1) R16-AN-CX-313/APM-40.
- (2) R16-AN-CX-314/APM-40.
- (3) R16-AN-CX-315/APM-40.
- (4) R16-AN-CX-317/APM-40.
- (5) R16-AN-CX-318/APM-40.
- (6) R16-AN-CX-319/APM-40.
- (8) R16-AN-CX-320/APM-40.
- (9) R16-AN-CX-321/APM-40.
- (10) R16-AN-CX-322/APM-40.
- (11) R16-AN-CX-323/APM-40.
- (12) R16-AN-CX-324/APM-40.
- (13) R16-AN-CX-325/APM-40.
- (14) R16-AN-CX-326/APM-40.
- (15) R16-AN-CG-185/APM-40.
- (16) R16-AN-CX-327/APM-40.
- (17) R16-AN-CX-328/APM-40.
- (18) R16-AN-CX-329/APM-40.
- (19) R16-AN-CG-182/APM-40.
- (20) R16-AN-CG-181/APM-40.
- (21) R16-AN-CG-141/U.
- (22) R16-AN-J-24/APS-6.
- (23) R16-AN-J-42/APS-6A.



Figure 13-4. Harness—AN/APM-59

**HARNESS**

**AN/APM-59**

Primary purpose: Bench testing AN/APA-5 radar equipment.

The AN/APM-59 Harness comprises 21 separate cable assemblies and an indicator (ID-183/APM-59) for bench testing AN/APA-5 radar equipment. Cable numbers refer to AN/APA-5 instruction book designations.

Complete equipment consists of—

- (1) 1 CG-393/U, 60 feet, cable # 110.
- (2) 2 CG-395/U, 30 feet, cable # 111, # 129.
- (3) 1 CX-909/U, 10 feet, cable # 112.
- (4) 1 CX-894/U, 6 feet, cable # 113.
- (5) 1 CX-903/U, 10 feet, cable # 114.
- (6) 1 CX-901/U, 60 feet, cable # 115.
- (7) 3 CG-394/U, 8 feet, cable # 116, # 117, # 118.

- (8) 1 CX-905/U, 15 feet, cable # 119.
- (9) 1 CX-897/U, 5 feet, cable # 121.
- (10) 1 CX-898/U, 5 feet, cable # 122.
- (11) 1 CX-899/U, 10 feet, cable # 123.
- (12) 1 CX-900/U, 10 feet, cable # 124.
- (13) 1 CX-904/U, 6 feet, cable # 127.
- (14) 1 CX-906/U, 12 feet, cable # 131.
- (15) 1 CX-912/U, 30 feet, cable # 133.
- (16) 1 CX-896/U, 30 feet, cable # 134.

ASO stock No. R16-AN/APM-59.

- (1) R16-AN-CG-393/U. (2) R16-AN-CG-395/U.
- (3) ..... (4) .....
- (5) ..... (6) R16-AN-CX-901/U.
- (7) R16-AN-CG-394/U. (8) R16-AN-CX-905/U.
- (9) R16-AN-CX-897/U. (10) R16-AN-CX-898/U.
- (11) R16-AN-CX-899/U. (12) R16-AN-CX-900/U.
- (13) R16-AN-CX-904/U. (14) R16-AN-CX-906/U.
- (15) R16-AN-CX-912/U. (16) R16-AN-CX-896/U.

HARNESS

AN/APM-60

Primary purpose: Shop maintenance of AN/APS-31, 32, 33, 34 radar equipments.

The AN/APM-60 consists of work benches, mounting racks and cables required in shop maintenance of the AN/APS-31, 32, 33, 34 radar equipments.

Complete equipment consists of:

- (1) 1 Antenna cradle.
- (2) 1 Synchro mounting.
- (3) 1 Modulator mounting.
- (4) 1 Interconnecting cable.

Plus one of each of the following cables designated alphabetically (not illustrated).

<i>Cable</i>	<i>Length</i>	<i>Connection</i>
(A)	48 in.	Control Unit to Synchronizer.
(B)	130 in.	Control Unit to Transmitter-Receiver.
(C)	130 in.	Control Unit to Scanner.
(D)	60 in.	Synchronizer to Modulator.
(E)	35 in.	Synchronizer to Indicator Connector Box.
(F)	35 in.	Synchronizer to Indicator Connector Box.
(G)	60 in.	Modulator to Synchronizer.
(H)	144 in.	Scanner to Synchronizer.
(J)	70 in.	Synchronizer to Relay Box.
(K)	132 in.	Transmitter-Receiver to Relay Box.
(L)	72 in.	Modulator to Indicator Connector Box.
(M)	72 in.	Modulator to Indicator Connector Box.
(N)	144 in.	Modulator to Transmitter-Receiver.
(P)	28 in.	Indicator Connector Box to Indicator Connector Box.

<i>Cable</i>	<i>Length</i>	<i>Connection</i>
(Q)	140 in.	Junction Box to Scanner.
(R)	24 in.	Junction Box to Indicator Connector Box.
(S)	24 in.	Junction Box to Indicator Connector Box.
(T)	102 in.	Scanner to Gyro.
(U)	120 in.	True Bearing Amp. to Scanner.
(V)	105 in.	True Bearing Amp. to Selwyn.
(W)	48 in.	True Bearing Amp. to Control Unit.
(Y)	48 in.	Synchronizer to Auto Transformer.
(Z)	48 in.	Relay Box to Inverter.
(AA)	40 in.	Indicator Connector Box to Synchronizer.
(BB)	40 in.	Indicator Connector Box to Synchronizer.
(CC)	20 ft.	Power Source to Synchronizer.
(DD)	100 in.	True Bearing Amp. to 400-cycle inverter.

ASO stock No. R16-AN/APM-60.

(1) .....	(2) .....
(3) .....	(4) .....
(A) .....	(B) .....
(C) .....	(D) .....
(E) .....	(F) .....
(G) .....	(H) .....
(J) .....	(K) .....
(L) .....	(M) .....
(N) .....	(P) .....
(Q) .....	(R) .....
(S) .....	(T) .....
(U) .....	(V) .....
(W) .....	(Y) .....
(Z) .....	(AA) .....
(BB) .....	(CC) .....
(DD) .....	



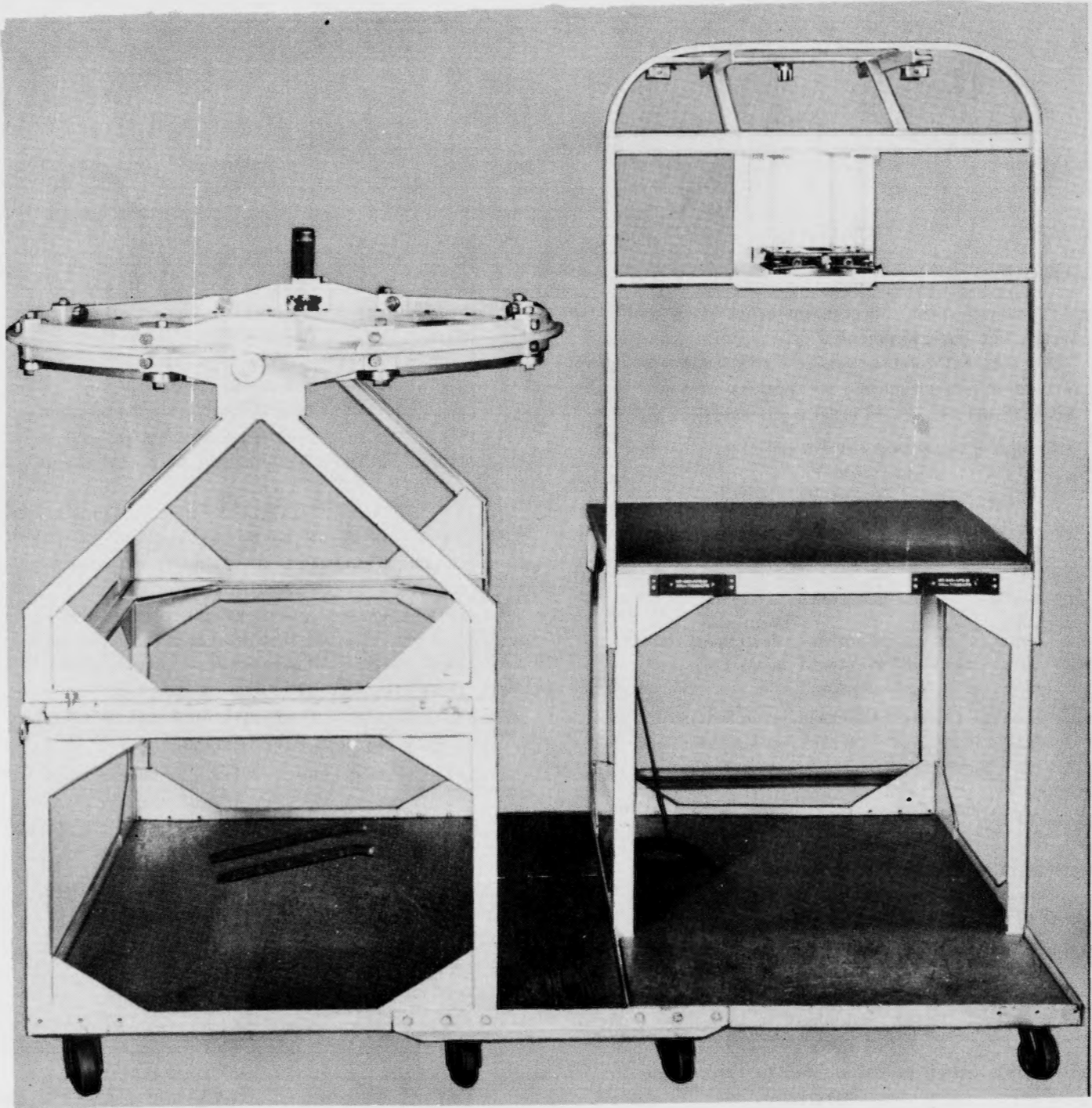


Figure 13-5. Harness—AN/APM-60

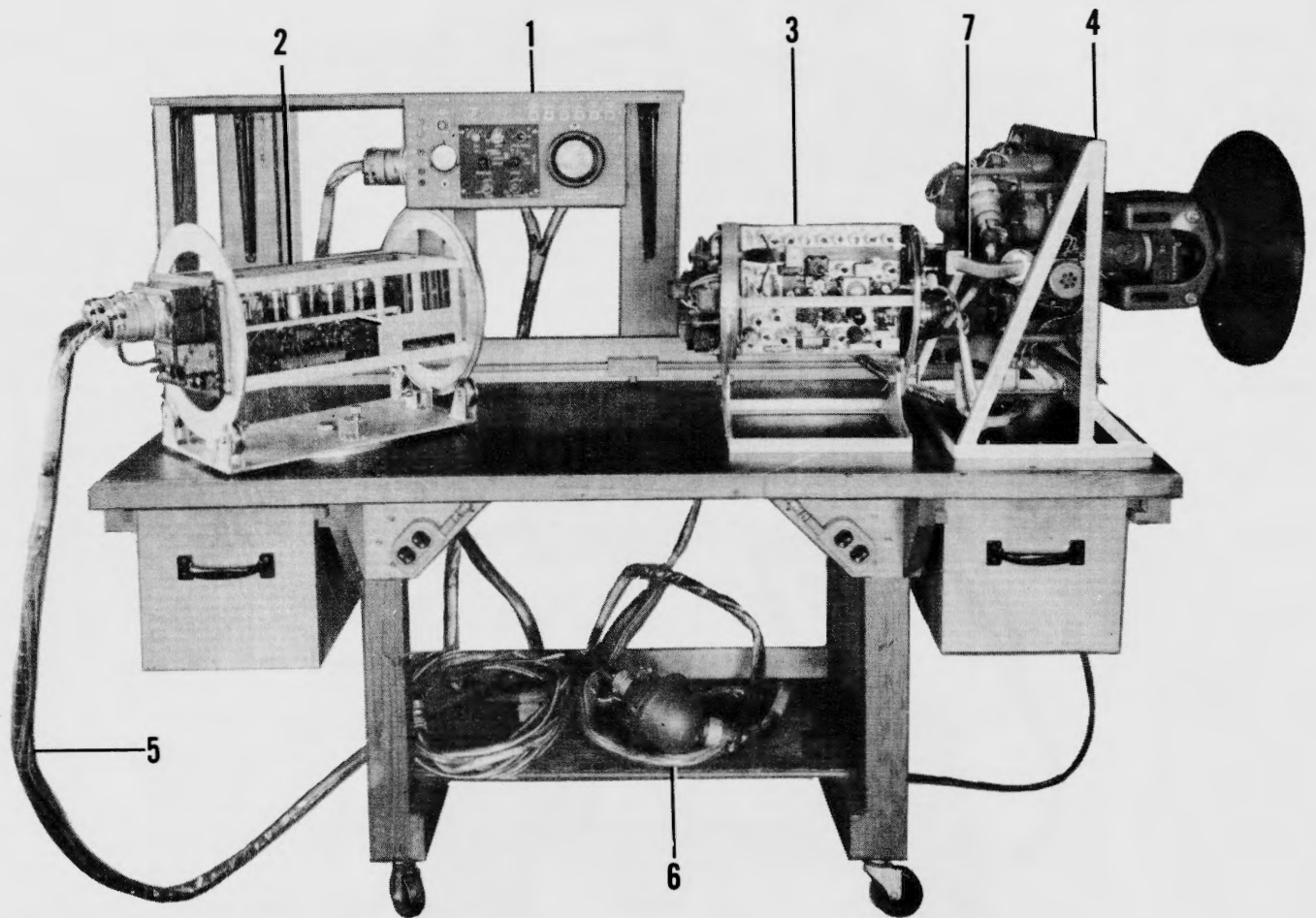


Figure 13-6. Harness—AN/APM-61

**HARNESS**

**AN/APM-61**

Primary purpose: Bench testing of AN/APS-19 Radar Equipment.

This harness equipment is for use in the test of a complete AN/APS-19 Aircraft Search Radar Equipment, or individual units thereof.

Complete equipment consists of:  
(1) 1 Test panel assembly.

- (2) 1 Power-synchronizer rack assembly.
  - (3) 1 Transmitter-receiver rack assembly.
  - (4) 1 Antenna rack assembly.
  - (5) 1 No. 1 Cable assembly.
  - (6) 1 No. 2 Cable assembly.
  - (7) 1 Flexible waveguide assembly.
- ASO stock No. R16-AN/APM-61.

(1) .....	(2) .....
(3) .....	(4) .....
(5) .....	(6) .....
(7) .....	



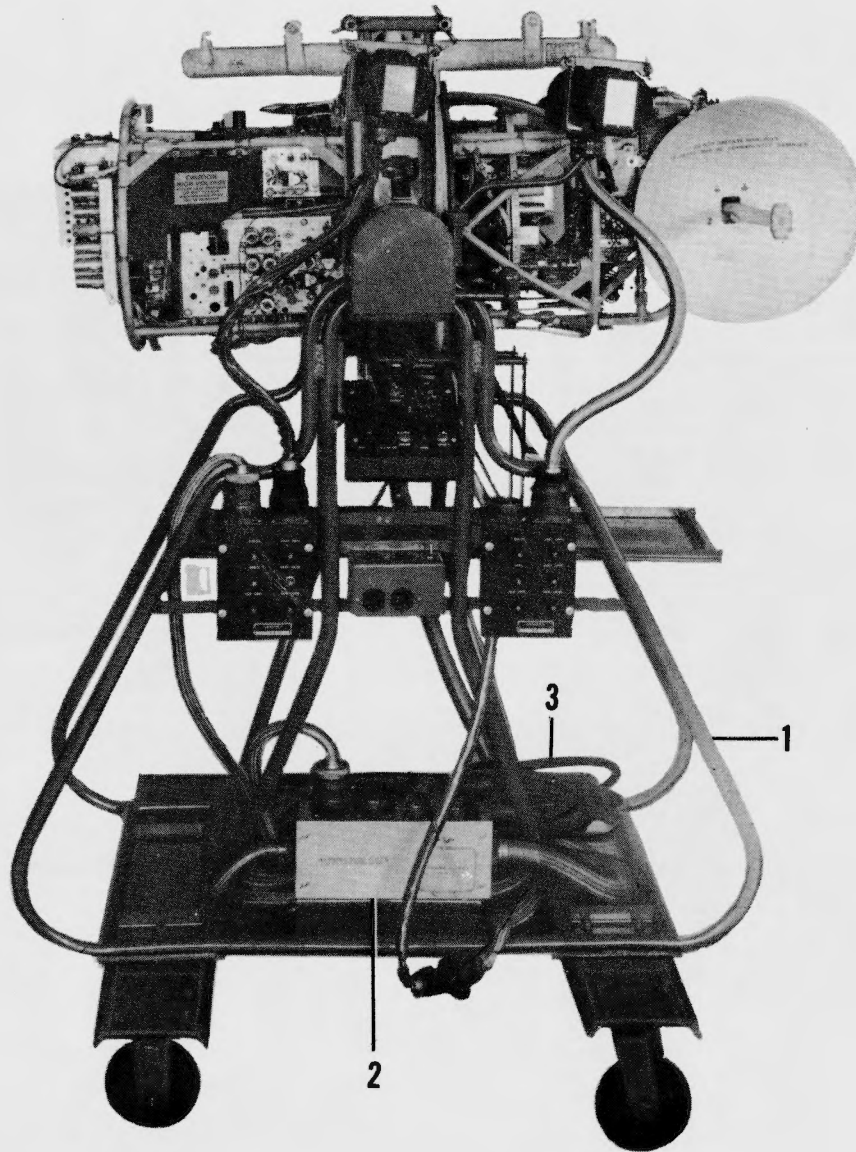


Figure 13-7. Test Bench for AN/APS-4, TS-188/APS-4

**TEST BENCH FOR AN/APS-4**

**TS-188/APS-4**

Primary purpose: To hold the AN/APS-4 to facilitate the servicing of this radar.

This service rack is furnished with a fixed junction box and a set of interconnecting cables which are similar to those used in a regular plane installation. There is provision for mounting the indicators, the indicator-amplifier and the control box, which are to be tested or serviced. The radar may be fastened in the cradle by means of two clamps which are hooked together with a bolt and thumb

screw. A crank provides a means of tilting the gear to any desired position.

**Mechanical characteristics:**

Dimensions: 42" x 60" x 36" (approximate) over-all.

**Complete equipment consists of:**

- (1) 1 Test bench, TS-188/APS-4.
- (2) 1 Junction box.
- (3) 1 Set of interconnecting cables (similar to cables for plane installation).

ASO stock No. R16-AN-TS-188/APS-4.

- (1) .....
- (2) .....
- (3) .....

## TUBE CHECKER

### General Electric TC-3P

Primary purpose: To provide emission checking of all standard tubes.

The TC-3P emission type tube checker has sockets for all American tube types with two spare positions for new sockets. A series of 18 individually operated lever switches permit placing the proper voltages on the proper pin of a tube. Shorts, line, and output are all checked by one control knob. Opposed grid and plate voltages produce a meter reading affected simultaneously by ability of the grid to control the plate current and the ability of the cathode to furnish the necessary current.

A d. c. Voltmeter is provided for battery testing.

#### Electrical characteristics:

- Will test all standard tubes.
- Good—Green scale.
- Bad—Red scale.
- Meter accuracy:  $\pm 2\%$ .
- Short test sensitivity: 2 meg.
- Voltmeter range: 0-10-100-1000 volts d. c.
- Tubes: 1 type 80.

#### Mechanical characteristics:

- Dimensions:  $14\frac{1}{2}'' \times 14'' \times 7\frac{1}{2}''$ .
- Weight: 13 pounds.

#### Complete equipment consists of:

- (1) 1 Tube checker TC-3P.
  - (2) 1 Tube chart.
- ASO stock No. R16-A-4992.
- (1) .....
  - (2) .....

## TUBE TESTER, RECEIVER TYPE

### Hickok 540

Primary purpose: For testing all standard radio receiver tubes as well as some others similar in characteristics.

The Hickok Model 540 tube tester measures the dynamic mutual conductance directly in micro-ohms on a meter. Three ranges are available; 0-3,000, 6,000, and 15,000 micro-ohms. The tester has sockets to fit all types

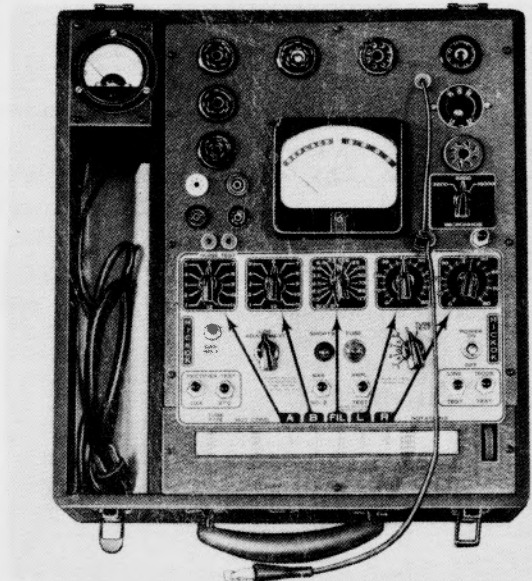


Figure 13-8. Tube Checker Hickok 540

of bases in use on receiver tubes at the present time, including acorn tubes. Filament voltages from 1.1 to 117 volts are available. A roller type index chart is built in the instrument and contains complete testing data for receiver tubes. Tubes under test are modulated 100 percent while measuring the mutual conductance. Noise, gas, shorts, and leakage may also be detected.

#### Electrical characteristics:

- Micro-ohms: 0 to 3,000, 6,000 and 15,000.
- Tube bases: Test octals, loktals, ballast, miniature and acorn tubes plus 4-, 5-, 6-, and 7-prong standard.
- Filament range: 1.5 to 117 volts in steps.
- Meter scale calibration: 0 to 3,000 micro-ohms.
- Short test: Neon lamp.
- Tubes: 1 type 5W4; 1 type 83.
- Power required: 117 volts; 60 cycles.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions:  $14'' \times 16'' \times 6''$ .
- Weight: 17 pounds.

#### Complete equipment consists of:

- (1) 1 Tube tester, Hickok 540.
  - (2) 1 Instruction book.
- ASO stock No. R16-T-1720.

### TUBE TESTER

#### I-177-A (Hickok 545)

Primary purpose: For testing receiving types of vacuum tubes by mutual conductance measurements.

The I-177-A is essentially the same tube tester as the Hickok 540, except that the I-177-A is constructed to meet Army specifications, is contained in a metal case, is treated for protection against moisture and fungus (tropicalized) and has a rearranged lay-out of the panel controls.

**Electrical characteristics:**

- Same as Hickok 540.
- Power required: 115 ± 10% volts, 60 cycles.
- Tubes: 1 type JAN 5Y3GT; 1 type JAN 83.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 5<sup>3</sup>/<sub>4</sub>" x 15<sup>1</sup>/<sub>2</sub>" x 8<sup>1</sup>/<sub>2</sub>".
- Weight: 15<sup>3</sup>/<sub>4</sub> pounds.

**Complete equipment consists of :**

- (1) 1 Tube tester I-177-A.
  - (2) 1 Instruction book.
- ASO stock No. R16-AYS-I-177-A.



Figure 13-9. MAD Tube Tester—TS-9A/ASQ

The TS-9/ASQ was specifically designed for the maintenance of MK IV B2 equipments; while TS-9A/ASQ is designed to test the tubes of MK IV B2 and AN/ASQ equipment. Their size, weight, and mounting are identical. 6Q7-G tubes can be tested by the TS-9A/ASQ but not by TS-9/ASQ. Both sets will also test type 12SL7GT used in AN/ASQ and MK IV B2 and Type 6K5G used in MK IV B2.

**Electrical characteristics:**

- Frequency range: Up to 15,000 c/s.
- Input: Meter DC—22 megohms resistance.
- Input: Meter AC—2.75 megohms impedance.
- Scales: Meter—0-10-100-1,000 volts.
- Power required: 110 volts, 60 cycle, AC, 75 watts.
- Tubes: 1 type 6J5; 2 type 6V6GT; 2 type 6X5GT; 1 type 6H-16 (Amprorite input ballast tube).
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 6<sup>3</sup>/<sub>4</sub>" x 9<sup>3</sup>/<sub>4</sub>" x 17<sup>1</sup>/<sub>2</sub>".
- Weight: 15.3 pounds.

**Complete equipment consists of:**

- (1) 1 Tube tester, TS-9/ASQ or TS-9A/ASQ.
  - (2) 2 Test leads.
  - (3) 1 Instruction book, AN 08-35TS9-2.
- ASO stock No. R16-AN-TS-9A/ASQ.
- (1) .....
  - (2) .....

### MAD TUBE TESTER

#### TS-9A/ASQ

Primary purpose: Testing certain tubes for use in MAD equipment.

This tube tester is designed to test certain tubes for mutual conductance, microphonics, and cathode resistance, the last being a very important characteristic in MAD. Provision is made to check six tubes at a time.

Constructed as part of the tube tester is a Vacuum Tube Voltmeter. This Vacuum Tube Voltmeter section, although used as a part of the tube testing operation, may also be used for the measurement of external voltages, both a. c. and d. c. within the range for which it was designed.

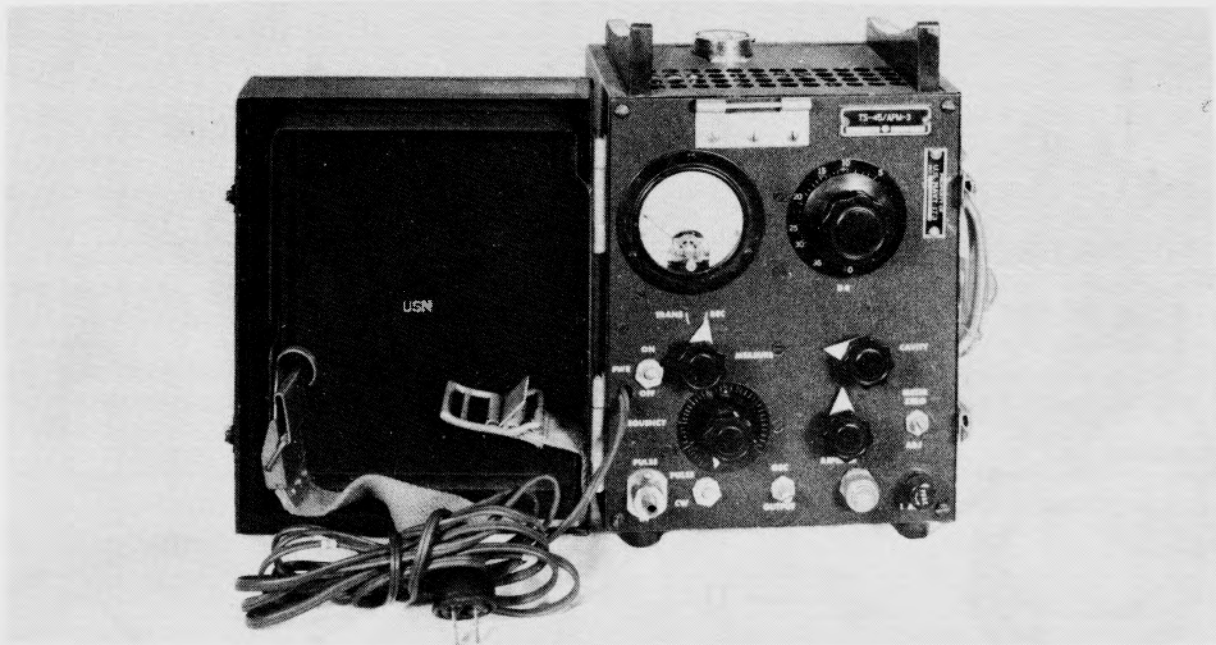


Figure 13-10. Test Set—AN/APM-3A

### TEST SET

#### AN/APM-3A (TS-45A/APM-3 and TS-76A/APM-3)

Primary purpose: Measuring relative output power and transmitted frequency of radars and adjusting receivers.

The radar test set TS-45A/APM-3 and auxiliary test kit TS-76A/APM-3 together form the portable test set AN/APM-3A. The earlier design was known as AN/APM-3.

Components of the set are a thermistor-type power meter, a coaxial line-type frequency meter, a 2K25 oscillator, attenuator, and a choke coupling. The set is designed for continuous wave operation but a jack is provided by means of which an external pulser can be used for pulse operation.

#### Electrical characteristics:

Frequency range: 9,300-9,450 mcs.

#### Accuracy:

Frequency meter:  $\pm 5$  mc.

Power meter:  $\pm 1.5$  db for settings below 16 db.

Power meter:  $\pm 2.5$  db for settings above 16 db.

Signal input: r-f power -10 to +37 dbm.

Signal output: c. w. av. power 10 mw. (+10 dbm).

Attenuator: Calibrated, adjustable 0-30 db loss.

Power required: 107-127 volts, 60-2400 cycles, 55 watts.

Tubes: 1 type 2K25; 1 type 6V6GT; 2 type 6X5GT;  
1 type 6SL7GT; 2 type OC3/VR105.

Batteries: None.

#### Mechanical characteristics:

#### Dimensions:

TS-45/APM:  $11\frac{1}{4}'' \times 8\frac{1}{2}'' \times 10\frac{3}{4}''$ .

TS-76/APM:  $10\frac{1}{4}'' \times 7\frac{1}{16}'' \times 7\frac{13}{16}''$ .

#### Weight:

TS-45/APM: 22 pounds.

TS-76/APM:  $7\frac{1}{2}$  pounds.

#### Complete equipment consists of:

- (1) 1 Test set, TS-45A/APM-3, (including carrying strap).
- (2) 1 Auxiliary test kit, TS-76A/APM-3, containing:
  - (3) 1 Horn antenna AT-65/UP.
  - (4) 1 R-f coupling UG-120/U.
  - (5) 1 R-f coupling UG-121/U.
  - (6) 1 R-f coupling UG-122/U.
  - (7) 1 Test meter TS-75A/U.
  - (8) 2 Plugs and cord assembly CG-150/U (one operating spare).
  - (9) 1 Adapter UG-129/U.
  - (10) 1 Adapter UG-130/U.
  - (11) 1 Adapter UG-128/U.
  - (12) 1 Crystal (operating spare) for meter (mounted in holder on TS-75A/U).
  - (13) 1 Attenuator card (operating spare).
  - (14) 1 Fuse (operating spare).
  - (15) 1 Carrying case.
  - (16) 1 Instruction book AN 16-30APM3-2.



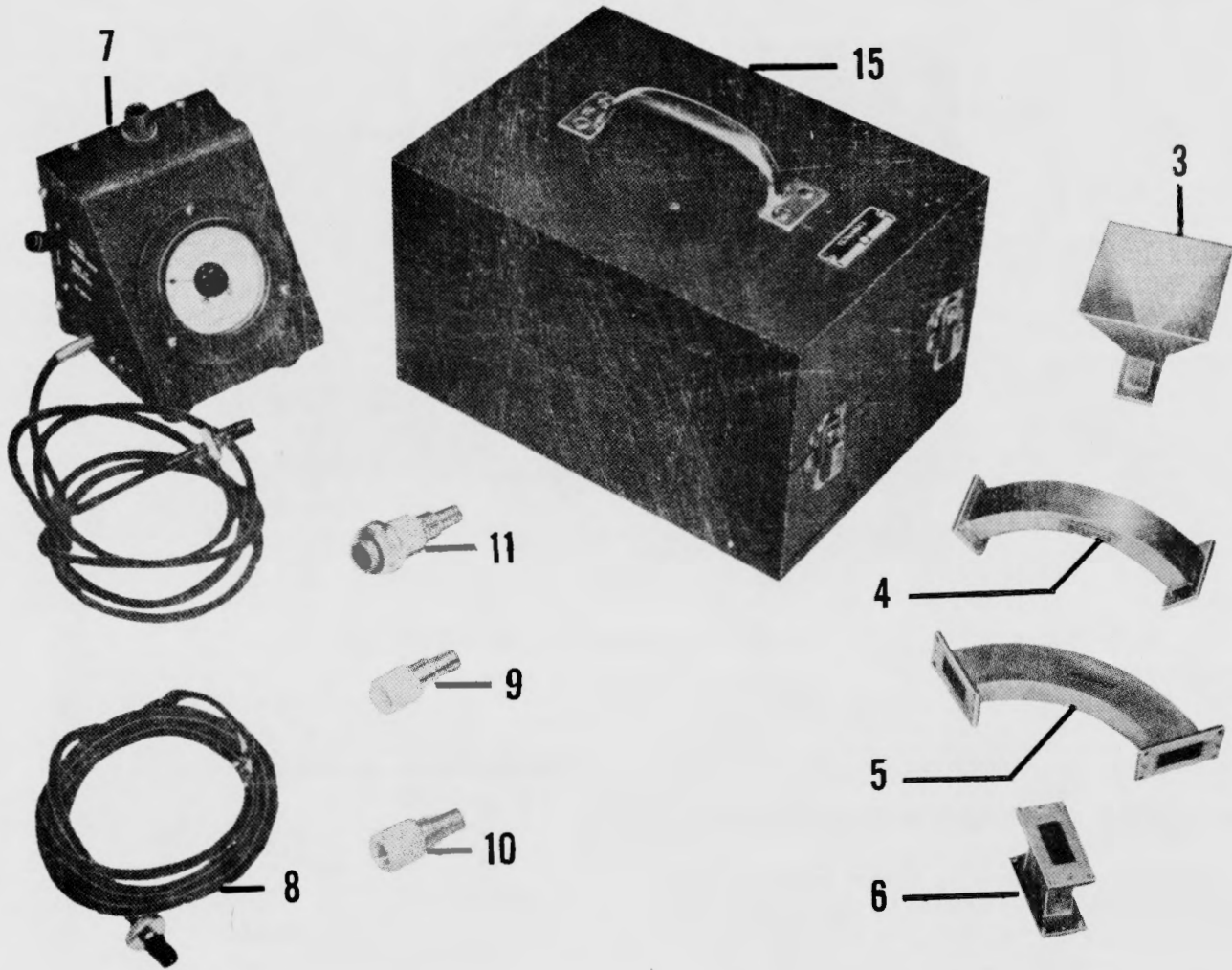


Figure 13-10. Test Set-AN/APM-3A

ASO stock No. R16-T-1750.

- (1) R16-AN-TS-45A/APM-3.
- (2) R16-AN-TS-76A/APM-3.
- (3) .....
- (4) R16-AN-UG-120/U.
- (5) R16-AN-UG-121/U.
- (6) R16-AN-UG-122/U.
- (7) R16-AN-TS-75A/U.

- (8) R16-AN-CG-150/U.
- (9) .....
- (10) .....
- (11) .....
- (12) .....
- (13) .....
- (14) .....
- (15) .....



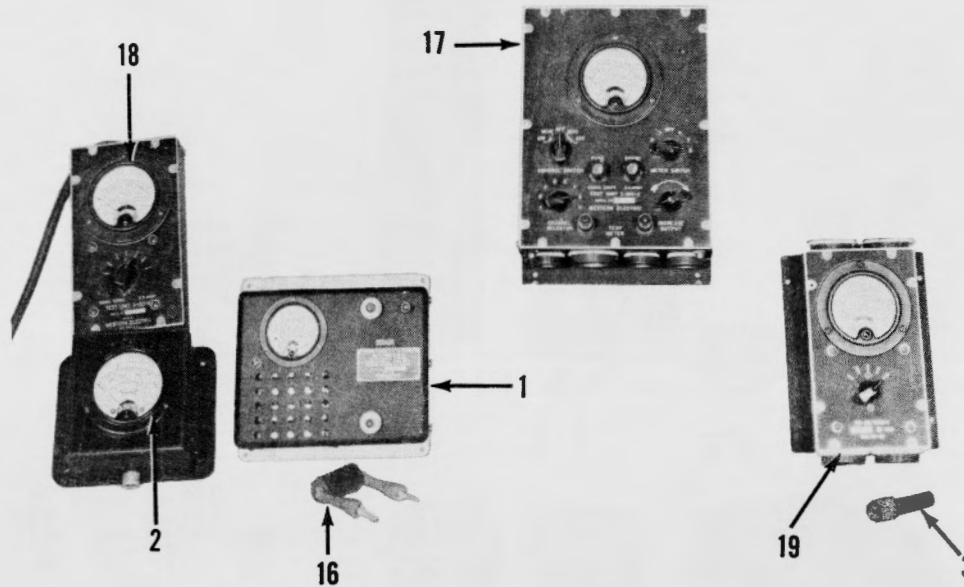


Figure 13-11. Test Set-AN/GRM-1A

TEST SET  
AN/GRM-1A

Primary purpose: Bench testing of airborne radio communication equipment.

Miscellaneous tools are included in the test equipment in addition to the components listed. Equipment not furnished but necessary to make test: Cord (headset extension cord), microphone, 600-ohm headset.

Index No.	Quantity	Designation	Army No.	AN No.	Description
(1)	1	Antenna	A-61-A		Phantom Ant. (LF, MF, HF).
(2)	1	Antenna	A-68-A	TS-329/U	Artificial Ant. (T-23/ARC-5).
(3)	1	Antenna	A-69-A	TS-79/U	Antenna adapter (R-28/ARC-5).
(4)	2	Cord		CX-31/GRM-1	12-conductor (not illustrated).
(5)	1	Cord		CX-32/GRM-1	18-conductor (not illustrated).
(6)	1	Cord		CX-33/GRM-1	Trans. rack adapter (not illustrated).
(7)	1	Cord		CX-34/GRM-1	Channel selection (not illustrated).
(8)	6	Diagram			Instructions (not illustrated).
(9)	2	Shunt. unit			I-F alignment.
(10)	1	Test unit	I-104-A		Test unit Rec.
(11)	1	Test unit	I-155-A		Test unit for T-23/ARC-5.
(12)	1	Test unit	TS-58/GRM-1		Test unit for radio trans.

ASO stock No.

(1) .....	(2) .....	(3) .....	(4) .....
(5) .....	(6) .....	(7) .....	(8) .....
(9) .....	(10) .....	(11) .....	(12) .....

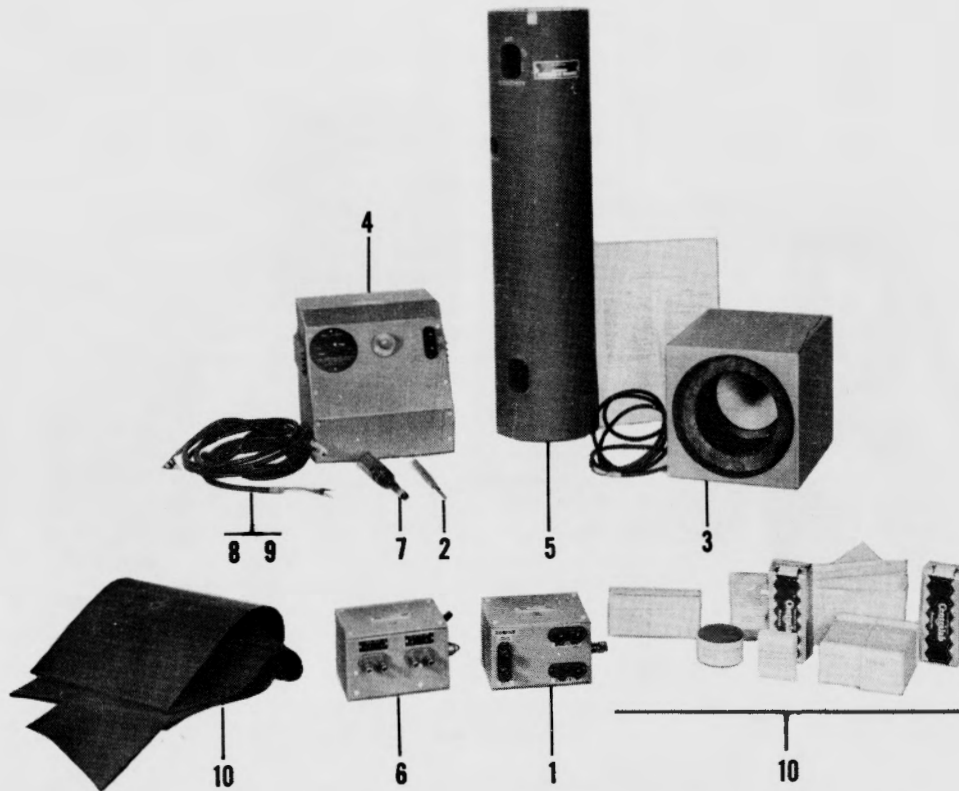


Figure 13-12. Radio Test Set-AN/URM-1

### RADIO TEST SET

#### AN/URM-1

Primary purpose: Maintenance of AN/ARR-16 and AN/CRT-4.

This radio test set consists of several units which have been designed especially for aiding in the maintenance of Radio Transmitting Equipment, AN/CRT-4 and FM Receiving Equipment AN/ARR-16. The Sound Test Box, TS-319/URM-1 provides an audio-frequency signal source for testing the hydrophone of the AN/CRT-4; the Hydrophone Magnetizer, TS-320/URM-1, is for use in remagnetizing the magneto-striction hydrophone of the AN/CRT-4; the Tuning Test Case, TS-321/URM-1, provides a case housing with entry for tuning tools in order that the transmitter can be adjusted under operating conditions; the Voltage Injector, TS-322/URM-1, provides a method for testing the vacuum tube voltmeter circuit of the AN/ARR-16 series receivers; and the Impedance Matching Network, CU-102/U, provides a method of effectively coupling a signal generator to the AN/CRT-4 transmitter for certain tests.

#### Electrical characteristics:

Tubes: None.

Batteries: TS-320/URM-1; 3 type BA-51; TS-322/URM-1; 1 type BA-30 (not supplied).

#### Mechanical characteristics:

Dimensions: 10" x 10" x 26".

Weight: 30 pounds total.

#### Complete equipment consists of:

- (1) 1 CU-102/U, Impedance Matching Network.
- (2) 1 TL-315/U, Tuning Tool.
- (3) 1 TS-319/URM-1, Sound Test Box.
- (4) 1 TS-320/URM-1, Hydrophone Magnetizer.
- (5) 1 TS-321/URM-1, Tuning Test Case.
- (6) 1 TS-322/URM-1, Voltage Injector.
- (7) 1  $\frac{3}{8}$ " Spintite Wrench.
- (8) 1 Transmitter Cable (6 feet).
- (9) 1 Hydrophone Cable (6 feet).
- (10) Spare parts.
- (11) 1 Instruction book AN16-30URM1-3.

#### ASO stock No. R16-AN/URM-1.

- (1) R16-AN-CU-102/U.
- (2) R16-AN-TL-315/U.
- (3) R16-AN-S-319/URM-1.
- (4) R16-AN-TS-320/URM-1.
- (5) R16-AN-TS-321/URM-1.
- (6) R16-AN-TS-322/URM-1.
- (7) .....
- (8) .....
- (9) .....
- (10) .....

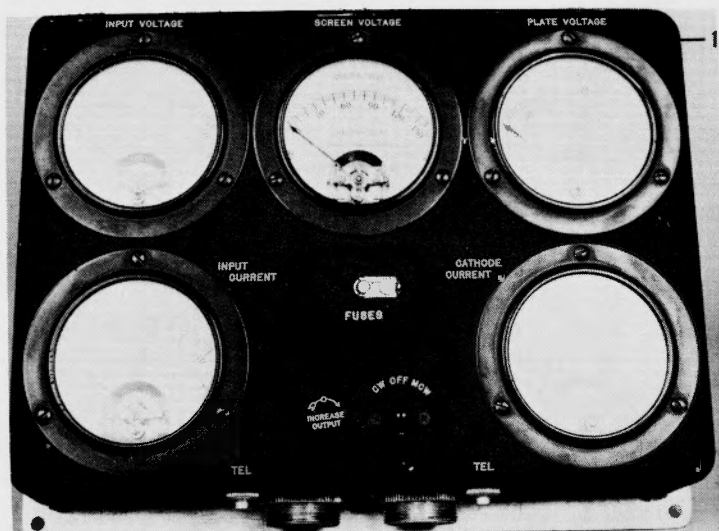


Figure 13-13. Test Set—ARC 7918-7919

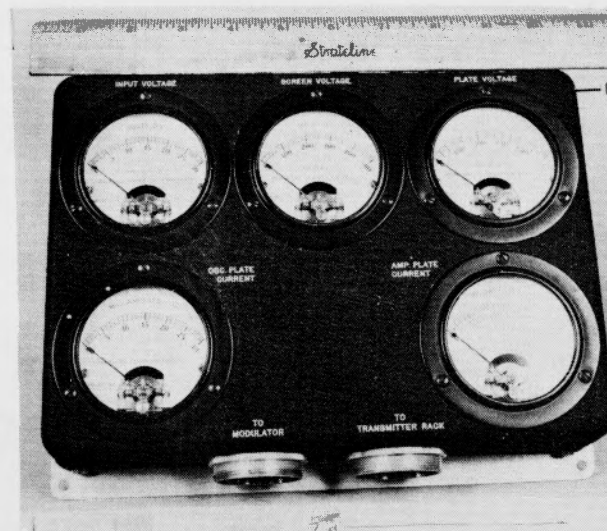


Figure 13-13. Test Set—ARC 7918-7919

**TEST SET**

**ARC 7918-7919**

Primary purpose: Bench testing of airborne radio communication equipment.

This equipment is specifically designed to test radio equipment ATA/ARA. It may also be used on SCR-274-N. Test unit 7918 is used to test the receiver in the above equipments. Test unit 7919 may be used to test only the screen modulated transmitter units in the above equipments. The above test units have 5 meters each for reading currents and voltages in various circuits. Cables and mounting racks are included. The circuits are electrical only; no electronic circuits are included and no power is required to operate the test units. Test unit 7919 includes a phantom antenna.

Complete 7918 equipment consists of:

- (1) 1 Receiver Test Unit, 7369.

- (2) 1 Receiver Test Rack, 7509 (not illustrated).
- (3) 1 Mounting Rack, 7059 (not illustrated).
- (4) 1 Cable Assembly, 7382 (not illustrated).
- (5) 1 Local Tuner, 6743 (not illustrated).

Complete 7919 equipment consists of:

- (6) 1 Transmitter test unit; 7544.
- (7) 1 Transmitter test rack; 7507 (not illustrated).
- (8) 1 Mounting, 7061 (not illustrated).
- (9) 1 Phantom antenna, 7777 (not illustrated).
- (10) 1 Cable assembly, 7843 (not illustrated).

ASO stock Nos.: 7918: R16-T-1880, 7919: R16-T-1920.

- |                  |                     |
|------------------|---------------------|
| (1) R16-T-1704.  | (2) R16-R-1057.     |
| (3) R16-M-5125.  | (4) R16-C-3735.     |
| (5) R16-T-16945. | (6) R16-T-1709.     |
| (7) R16-R-1061.  | (8) R16-M-5127.     |
| (3) .....        | (10) R16-C-3735-65. |



Figure 13-14. Test Meter—CRV- 60058 (I-206-A)

### TEST METER

#### Navy Type CRV-60058 (Army Type I-206-A)

Primary purpose: Aid in tuning of ATJ aircraft radio transmitting equipment.

This meter is used to indicate a current maximum to aid in proper tuning of ATJ transmitters. Three binding posts are on the case. There is a moving coil and 40-ohm plus or minus 2% resistor between post 1 and 2; and 900-ohm plus or minus 2% series resistor between post 2 and 3. Identical to Army Type I-206-A.

#### Electrical characteristics:

Scales: 0-15 ma. and 0-150 ma.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions:  $3\frac{5}{8}$ " x  $5\frac{7}{16}$ " x  $1\frac{7}{8}$ ".

Weight: 2 pounds.

#### Complete equipment consists of:

- (1) 1 Test meter, CRV-60058 with 2 cond. cord 6 feet long with phone plug.

ASO stock No. R16-M-2039.

- (1) .....
- (2) .....





Figure 13-15. Test Set—IE-35-A

TEST SET

IE-35A

Primary purpose: Field testing and maintenance of V. H. F. radio communication equipment.

A portable, universal test set useful for checking radio transmitters and receivers in the 100-156 mc. frequency range and some MF equipments without removing them from aircraft. A buzzer provides a quick check of receivers, and indicators are provided for tuning transmitters.

Complete equipment consists of:

- (1) 1 Antenna A-85-A, consisting of three lamps connected in parallel to provide a load of approximately 50 ohms at 12 watts (A-85-A is same as TS-78/U).
- (2) 1 Lamp Kit, consisting of 6 spare lamps for A-85-A.
- (3) 1 R-f noise generator, which can be used for receivers AN/ARC-1, AN/ARC-4, and AN/ARC-5 (HF) as well as SCR-274-N. It is a buzzer mounted in a tubular flashlight case

with two unit cells, battery BA-30 or equivalent, which are not provided with the set.

- (4) 1 Indicator I-106-A, a field test meter to detect radiation from a V. H. F. antenna and serve as an approximate frequency meter in the range of 100-156 mc. It consists of a telescopic antenna, parallel tuned circuit, silicon rectifier, and d. c. microammeter.
  - (5) 1 Test unit I-155-A, which can be used with the AN/ARC-5 as well as SCR-274-N. It includes a 0-100 scale DC meter (1.0 milli-ampere for full scale deflection), a seven-position rotary switch, 6 resistors, and a cord and plug.
  - (6) 1 Tool kit, consisting of an extractor for receiving tubes, receiver and transmitter tuning wrenches, Phillips screw driver, Allen and Bristo wrenches.
  - (7) 1 Instruction book, NAVAER 08-5Q-282. ASO stock No. R16-T-1826-20.
- (1) R16-AYS-A-85A. (2) .....  
 (3) ..... (4) R16-AYS-I-106-A.  
 (5) R16-AYS-I-155-A. (6) .....





Figure 13-16. Test Set-IE-36-A

**TEST SET**

**IE-36-A**

Primary purpose: Bench testing of airborne V. H. F. radio communications equipment. Particularly SCR-522-A and SCR-542-A.

A test set of several units contained in one wooden case. It reproduces operating functions of the control boxes and jack boxes of SCR-522-A and 542-A by providing headphone and microphone connections, thereby eliminating control boxes and jack boxes as necessary for trouble shooting-tests. The units not supplied but necessary are: Meter 1-139-A, microphones T-17, T-44, 1-headset.

**Electrical characteristics:**

Frequency range: Used with SCR-522-A and 542-A.

**Mechanical characteristics:**

Dimensions: 10" x 9<sup>7</sup>/<sub>8</sub>" x 4" over-all.

Weight: 6.65 pounds (case and parts).

Complete equipment consists of:

- (1) 1 Chest CH-234; wooden chest containing all components of IE-36.
- (2) 1 Control unit BC-1303.
- (3) 1 Phantom Antenna A-29 (12 resistors, 820 ohms each, in parallel with lamp No. 202).
- (4) 1 Cord CD-1169 (adapter connecting jack and plugs).
- (5) 1 Cord CD-1170 (antenna connection).
- (6) 1 Wrench, spanner type 471.
- (7) 1 Lamp extractor.
- (8) 1 Instruction book, NAVAER 08-5Q-289.

ASO stock No. R16-T-1826-22.

- |                      |                      |
|----------------------|----------------------|
| (1) R16-AYS-CH-234.  | (2) R16-AYS-BC-1303. |
| (3) R16-A-4935.      | (4) R16-AYS-CD-1169. |
| (5) R16-AYS-CD-1170. | (6) .....            |
| (7) .....            |                      |

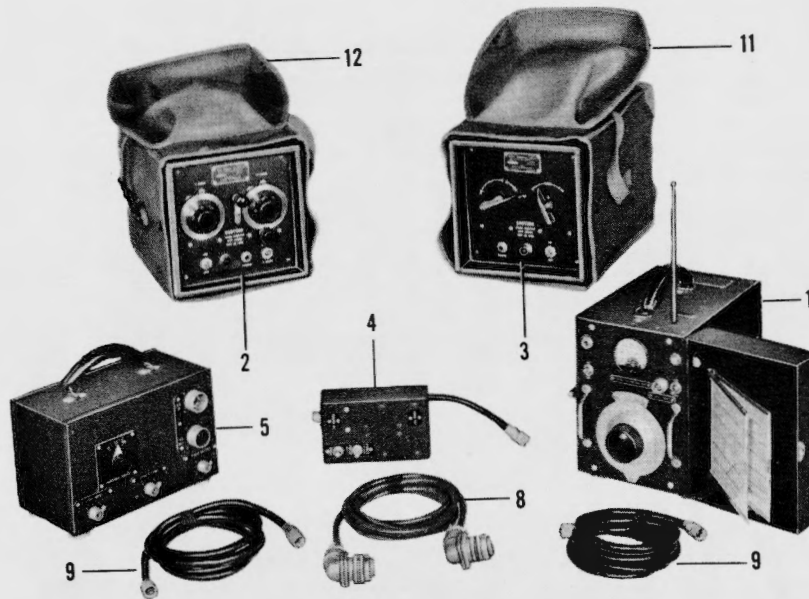


Figure 13-17. Test Set-IE-56-A

**TEST SET**

**IE-56-A and IE-56-B**

Primary purpose: Testing of certain IFF equipments, particularly Radio Sets SCR-729-A and SCR-729-AZ.

This set is a squadron, field test set designed to service airborne IFF and homing-navigational radar systems. It is used to check frequency, range calibration, receiver alignment and sensitivity, and overall system performance.

Range calibrator BC-949-A is used to produce a pulse wave of known frequency which can be used to calibrate an indicator such as BC-929-A, part of SCR-729-A and AN/APN-2. This test equipment is used to calibrate the sweep time of indicator units for its different ranges of 10, 50, and 100 nautical miles.

The 10-mile range produces a 12-microsecond pulse (81 kc.), the 50-mile range produces a 60 microsecond pulse (16.2 kc.), and the 100 mile range produces a 120 microsecond pulse (8.1 kc.).

**Electrical characteristics:**

Frequency range: Will test SCR-720-A, 729, 729-A, ABK, AN/APX-1, and AN/APX-2.

Power required: Self-contained batteries.

**Tubes:**

- I-196-B-1 type 957.
- BC-1066-B-1 type 1D8GT and 2 type 957.
- BC-906-D-1 type 1S5.
- BC-936-A-1 type 957.
- BC-949-A-1 type 6SL7GT and 1 type 6H6GT.

Batteries: 5 Type BA-35, 9 Type BA-53, 2 Type BA-30, supplied in early equipments. Batteries must be requisitioned when ordering this equipment.

**Mechanical characteristics:**

Weight: IE-56-A: 90 pounds (total of all units, cables, etc.).

**Complete IE-56-A equipment consists of:**

- (1) 1 Frequency meter, BC-906-D.
- (2) 1 Radio receiver, BC-1066-B.
- (3) 1 Signal generator, I-196-B.
- (4) 1 Indicator, BC-936-A.
- (5) 1 Range calibrator, BC-949-A.
- (6) 1 Set spare tubes for BC-949-A (not illustrated).
- (7) 1 Set spare tubes for BC-936-A (not illustrated).
- (8) 1 Cord, CD-799.
- (9) 2 Cords, CD-800.
- (10) 1 Canvas carrying case for BC-1066-B (not illustrated).
- (11) 1 Canvas carrying case for I-196-B.
- (12) Miscellaneous charts, cables, hardware.

**Complete IE-56-B equipment consists of:**

Items (4), (5), (6), (7), (8), (10), and (12) listed above, plus:

- (13) 1 Cable assembly, CG-107/U.
- (14) 1 Adapter, AN-3057-10.

ASO stock No. IE-56-A-R16-T-1827,  
IE-56-B-R16-T-1828-5.

- |                       |                       |
|-----------------------|-----------------------|
| (1) .....             | (2) .....             |
| (3) .....             | (4) R16-AYS-BC-936-A. |
| (5) R16-AYS-BC-949-A. | (6) .....             |
| (7) .....             | (8) R16-AYS-CD-799.   |
| (9) .....             | (10) .....            |
| (11) .....            | (12) .....            |
| (13) R16-AN-CG-107/U. | (14) R17-A-2299.      |

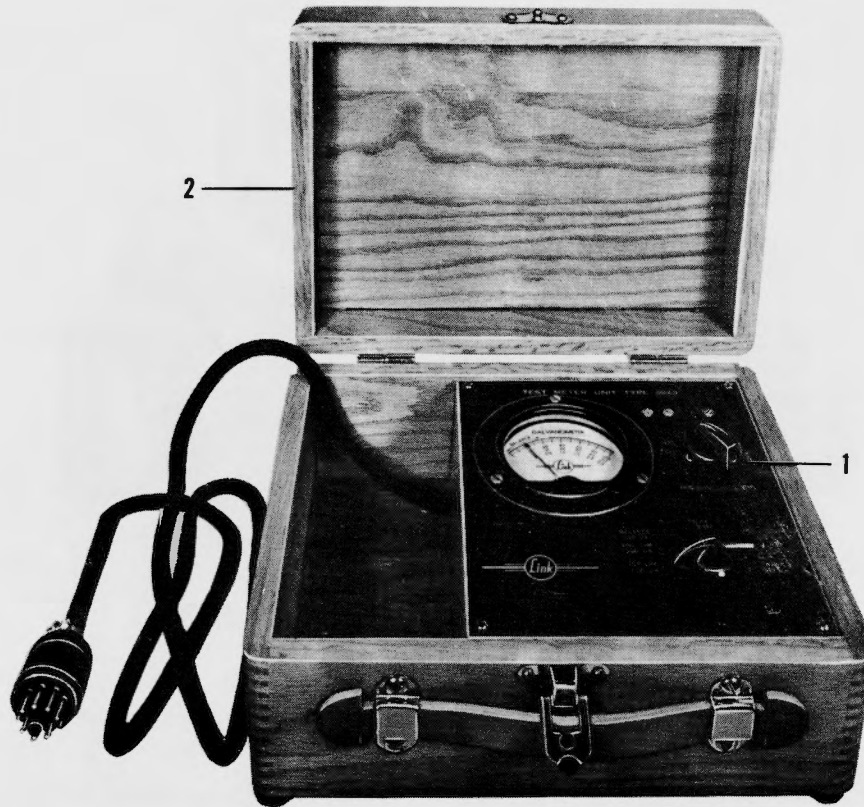


Figure 13-18. Test Meter—Link 1623

**TEST METER**

**Link 1623**

Primary purpose: Receiver test meter for tuning AN/ARW-2 or -2X receiver. Can also be used with transmitter AN/ARW-3 to determine channel frequency.

The test meter utilizes a seven-position switch to check:

- (1) First limiter scale 0-500 microampere full scale.
- (2) Second limiter scale 0-500 microampere full scale.
- (3) Receiver balance scale 0-100 microampere full scale.
- (4) Receiver relay scale 0-50 microampere full scale.
- (5) Battery voltage scale 0-50 volts full scale.
- (6) Plate voltage scale 0-500 volts full scale.
- (7) Absorption type freq. meter (rough check of transmitter channel frequency).

The meter is housed in a wooden case providing space for enclosing the connecting cable which is permanently attached to the meter.

**Electrical characteristics:**

- Frequency range: 30-42 mc.
- Scales graduated: 0 to 2.5; 0 to 50; 0 to 100.

Accuracy: plus or minus 2% of full scale.

Power required: None.

Batteries: None.

Tubes: None.

**Mechanical characteristics:**

Dimensions: 6" x 6<sup>3</sup>/<sub>4</sub>" x 2".

Weight: 8 pounds.

**Complete equipment consists of:**

- (1) 1 Test meter, Link 1623.
  - (2) 1 Carrying Case.
- ASO stock No. R16-M-2046.
- (1) ..... (2) .....

**TEST METER**

**Link 1623 Modified**

Link 1623 Modified is identical to Link 1623 except that the wavemeter frequency range has been changed to 50 to 70 mc. in order to permit use with AN/ARW-35 receiver or AN/ARW-34 transmitter.

ASO stock No. ....



Figure 13-19. Headset and Microphone Tester—NAF-67073-1

### HEADSET AND MICROPHONE TESTER

NAF-67073-1

Primary purpose: To test microphones and headsets of communication equipment.

This equipment is self-contained and portable. When the controlling switch is turned to microphone test, it throws a variable resistor into the plate power supply circuit of the oscillator. This enables the tester to check for sensitivity at low power and distortion at full power. A switch in the cathode circuit provides means for checking the button on the microphone. In testing headsets the tube furnishes constant output and indication is provided by a Weston power level indicator 6-mw. at 500 ohm load. Another tube is the rectifier that provides the plate voltage.

#### Electrical characteristics:

Power required: 110-volt, 60-cycle, and two 1.5-volt dry cells.

Tubes: 2 type 38.

Batteries: 2 type BA-35. Supplied in early equipment. Batteries should be requisitioned when ordering this equipment.

#### Mechanical characteristics:

Dimensions: 9 1/2" x 12" x 6".

Weight: 21.5 pounds.

#### Complete equipment consists of:

- (1) 1 Headset and microphone tester, NAF-67073-1.
- (2) 1 Power cable 10 feet long (not illustrated). ASO stock No. R16-T-1697.
- (1) ..... (2) .....



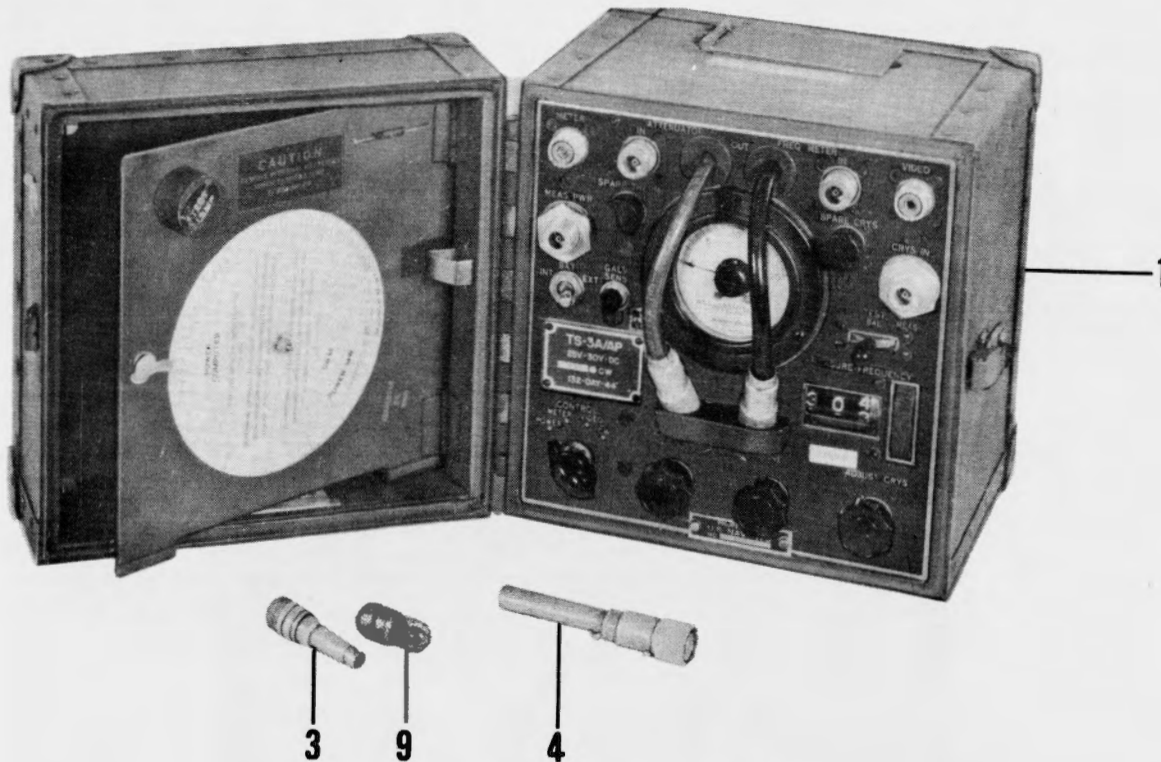


Figure 13-20. Test Set—TS-3A/AP

TEST SET

TS-3A/AP

Primary purpose: Maintaining radar systems in the range of 2400 to 3400 megacycles.

TS-3A/AP comprises a single unit which may be used for the maintenance of radar systems in the range of 2400 to 3400 megacycles. This test set is equivalent to TS-3/AP except that the frequency range of the TS-3/AP model is 2700 to 3400 mc.

Output power of radar transmitters, beat oscillator output of radar receivers, and power output of signal generators may be measured. In addition TS-3A/AP may be used to measure frequency of a signal generator, converter crystal current, and receiver sensitivity. Sensitivity measurements are made in conjunction with a signal generator and a separate i-f amplifier.

Electrical characteristics:

Frequency Range:

TS-3/AP—2700 to 3400 mc.

TS-3A/AP—2400 to 3400 mc.

Input Power Range: 0.5 to 12.5 milliwatts.

RF Impedance: 50 ohms.

D. c. Meter Range: 0-2 milliamperes.

Accuracy:

Power— ± 0.5 db.

Frequency— ± 1 mc.

Tubes: None.

Batteries: 3 type BA-30 (not supplied in equipment—must be requisitioned).

Mechanical characteristics:

Dimensions:

TS-3/AP: 9<sup>1</sup>/<sub>4</sub>" x 8<sup>3</sup>/<sub>4</sub>" x 10<sup>3</sup>/<sub>8</sub>".

TS-3A/AP: 9<sup>1</sup>/<sub>4</sub>" x 8<sup>3</sup>/<sub>4</sub>" x 10<sup>3</sup>/<sub>8</sub>".

Weight: 22 pounds total.

Complete equipment consists of:

- (1) 1 Test set—TS-3A/AP.
- (2) 1 Cord (directional tap) (5 feet)—CG-24/AP (not illustrated).
- (3) 1 Adapter (50 ohm jack, 72 ohm plug) UG-8/AP.
- (4) 1 Adapter (72 ohm jack, 50 ohm plug) UG-7/AP.
- (5) 1 Case (canvas)—CY-45/AP (not illustrated).
- (6) 1 Cord (10 feet)—CX-68/AP (not illustrated).
- (7) 1 Cord (13 feet)—CG-23/AP (not illustrated).
- (8) 1 Cord (5 feet)—CG-381/U (not illustrated).
- (9) 1 Neon Lamp RCA 991.
- (10) 1 Power computer (not illustrated).
- (11) 1 Instruction book AN 16-35TS3-3.

ASO stock No. R16-AN-TS-3A/AP.

- |                      |                      |
|----------------------|----------------------|
| (1) .....            | (2) R16-AN-CG-24/AP. |
| (3) R16-A-406.       | (4) .....            |
| (5) R16-C-15879-40.  | (6) R16-AN-CX-68/AP. |
| (7) R16-AN-CG-23/AP. | (8) R16-AN-CG-381/U. |
| (9) .....            | (10) .....           |





Figure 13-21. Magnetic Compensator-TS-7/ASQ

## MAGNETIC COMPENSATOR

### TS-7/ASQ

**Primary purpose:** To determine the number and strength of compensating magnets necessary for proper installation of MAD gear.

This equipment is designed especially to compensate for the permanent magnetic field present in the ferro-magnetic members of an aircraft. This compensation reduces the spurious indications recorded during aircraft maneuvers by AN/ASQ and 4B2 installations which are caused by the presence of this permanent magnetic field.

Permanent magnets enclosed in solenoids are mounted in suitable locations in the airplane's structure and power from the airplane's source of supply is connected to these solenoids through the control units and junction boxes of the Compensator System. Compensation is accomplished by controlling the strength and direction of the magnetic field of each of these permanent magnets.

#### Electrical characteristics:

Meter: 0-3 amps d. c.

Power required: 24 volts d. c., 70 watts.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: Control unit, 11<sup>3</sup>/<sub>8</sub>" x 9<sup>3</sup>/<sub>8</sub>" x 4<sup>7</sup>/<sub>8</sub>".

Weight: 17.5 pounds (control unit plus 6 coils).

#### Complete equipment consists of:

- (1) 1 Control unit, TS-7/ASQ.
  - (2) 1 Connecting cable, 6 feet.
  - (3) 1 Starboard junction box assembly.
  - (4) 1 Port junction box assembly.
  - (5) 3 Starboard compensating coils .  
(CN-14/ASQ).
  - (6) 3 Port compensating coils (CN-14/ASQ).
  - (7) 1 Bulk length of 2 conductor rubber covered, shielded cable, 50 feet long.
  - (8) 1 Bulk length of 4 conductor rubber covered shielded cable, 150 feet long.
  - (9) 1 Set of operating spare parts per equipment (not illustrated).
  - (10) 1 Instruction book AN 16-35TS7-7.  
ASO stock No. R16-C-29600.
- |                      |                       |
|----------------------|-----------------------|
| (1) .....            | (2) R82-GR-16336.     |
| (3) R82-GR-16336.    | (4) R16-AN-CN-14/ASQ. |
| (5) R16-AN-CN-14/ASQ | (6) .....             |
| (7) .....            | (8) .....             |
| (9) .....            | .....                 |

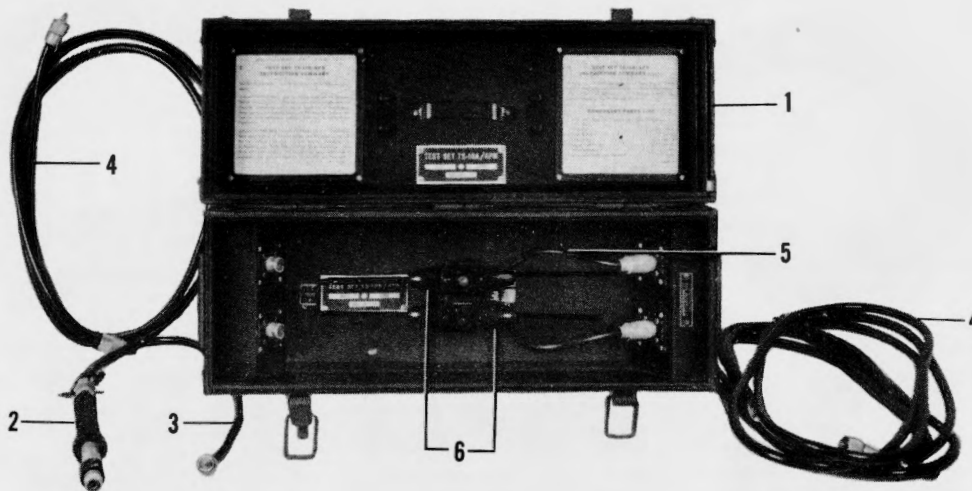


Figure 13-22. Delay Line Test Set—TS-10A/APN

### DELAY LINE TEST SET

TS-10/APN (Army I-184-A), TS-10A/APN, TS-10B/APN

Primary purpose: To test accuracy and range of altimeter equipment.

The TS-10/APN test set consists of a delay line, variable attenuator and a pair of test dipoles. The entire equipment is contained in a strong plywood carrying case, with reinforced corners. A chart outlining the procedure for use of the test set is mounted inside the lid. The equipment is suitable for use at temperatures between  $-54^{\circ}$  C. to  $+50^{\circ}$  C.

The delay line consists of two coils of coaxial cable, the ends terminated in a Navy standard C-49194 connector. The two coils may be connected in series to give a delay of about 350 feet or one coil may be used giving a delay of about 65 feet. Two 8-foot coaxial cables are provided for connection of the test set to the altimeter equipment. These cables are fitted with Navy standard C-49195 connectors.

The attenuator is a calibrated low-loss inductive type and provides an attenuation variable from approximately 25 db to 60 db. The ends are fitted with a Navy standard C-49194 connector.

The dipole antennas are equipped with an indicator lamp to indicate r-f and have hangers which allow them to be clipped onto the altimeter antennas. Spare lamps are provided in the carrying case.

The TS-10A/APN differs from TS-10/APN in that TS-10/APN coils are fabricated from r-f cable RG-30/U, and TS-10A/APN is fabricated from r-f cable RG-54/U.

TS-10B/APN is similar to TS-10A/APN except that indicator ID-98 replaces indicator I-101 and the cord assembly CA-103 replaces CA-102.

#### Electrical characteristics:

Frequency range: 410-470 mc. (approximate).

Impedance: 50 ohms (coaxial adapters 50-72 ohms are supplied).

Accuracy:  $\pm 0.5\%$ . (in delay periods).

Delay periods: Corresponding to altitude 65, 297, and 350 feet.

Power required: None.

Tubes: None.

Batteries: 1-BA-30 for ID-98/APN.

#### Mechanical characteristics:

Dimensions: 20" x 16 $\frac{1}{2}$ " x 7 $\frac{1}{2}$ ".

Weight: 42 pounds total.

#### Complete TS-10/APN equipment consists of:

- (1) 1 Delay unit, TS-10/APN.
- (2) 1 Attenuator L-101 or L-101-A.
- (3) 1 Cord assembly CA-103; joined to attenuator by a small chair.
- (4) 2 Cord CD-800 (8 feet) CA-102 or CA-103.
- (5) 1 Cord CD-800 (12 inches) CA-101 or CA-103.
- (6) 2 Output indicators I-101 or ID-98/APN.
- (7) 2 Spare lamps (special for indicators) I-102 (not illustrated).
- (8) 1 Instruction book, AN 16-35TS10-3.

ASO stock No. R16-T-1868.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |
| (5) ..... | (6) ..... |
| (7) ..... |           |

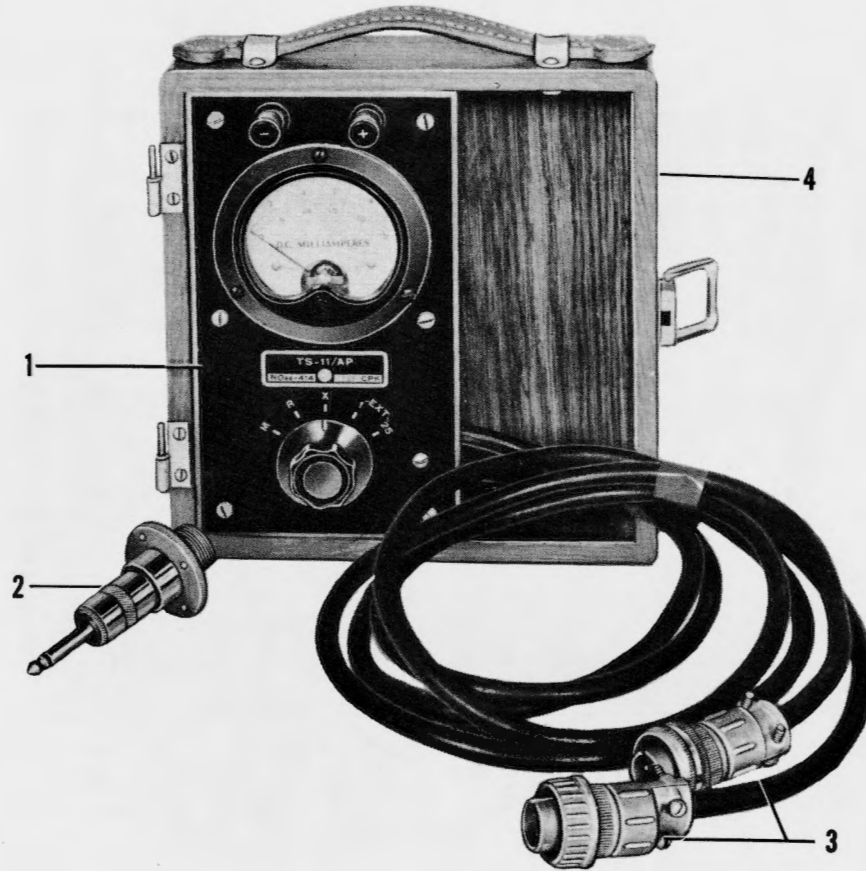


Figure 13-23. Milliammeter Box—TS-11/AP

## MILLIAMMETER BOX

### TS-11/AP

Primary purpose: Radar testing and maintenance.

This unit may also be used as a general purpose milliammeter. It consists of a two-scale milliammeter, a three-position switch and cables terminated in connectors which plug into several radar equipments. The purpose of the meter is to provide a means of checking oscillator, rectifier, and crystal currents in radar transmitters. When the switch is in the position for checking oscillator and rectifier currents, a shunt is switched across the meter making the full-scale deflection 25 ma.; when switched to the crystal position the shunt is removed and the full scale is 1 ma. Binding posts provide access to both scales of the meter, thereby allowing its use as a general purpose milliammeter. Operating instructions are included in the lid.

#### Electrical characteristics:

Frequency range: d. c.

#### Scales:

- 0 to 1 ma. (in xtal check position).
- 0 to 25 ma. (in oscillator and rectifier position).

#### Accuracy:

- On 1 ma. scale: 3% of full scale reading.
- On 25 ma. scale: 5% of full scale reading.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 8" x 3 1/2" x 8".

Weight: 10 pounds.

#### Complete equipment consists of:

- (1) 1 Milliammeter box, TS-11/AP.
- (2) 1 Adapter to permit connection of the AN-3106-14S-1P plug to a phone jack, terminated in a Utah PG-22-7 plug.
- (3) 2 4-foot cables, rubber covered, shielded, terminated AN-3106-14S-2P and AN-3106-14S-1P plugs.
- (4) 1 Instruction Card (in lid).
- (5) 1 Carrying Case.

ASO stock No. R16-M-3675.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (5) ..... |

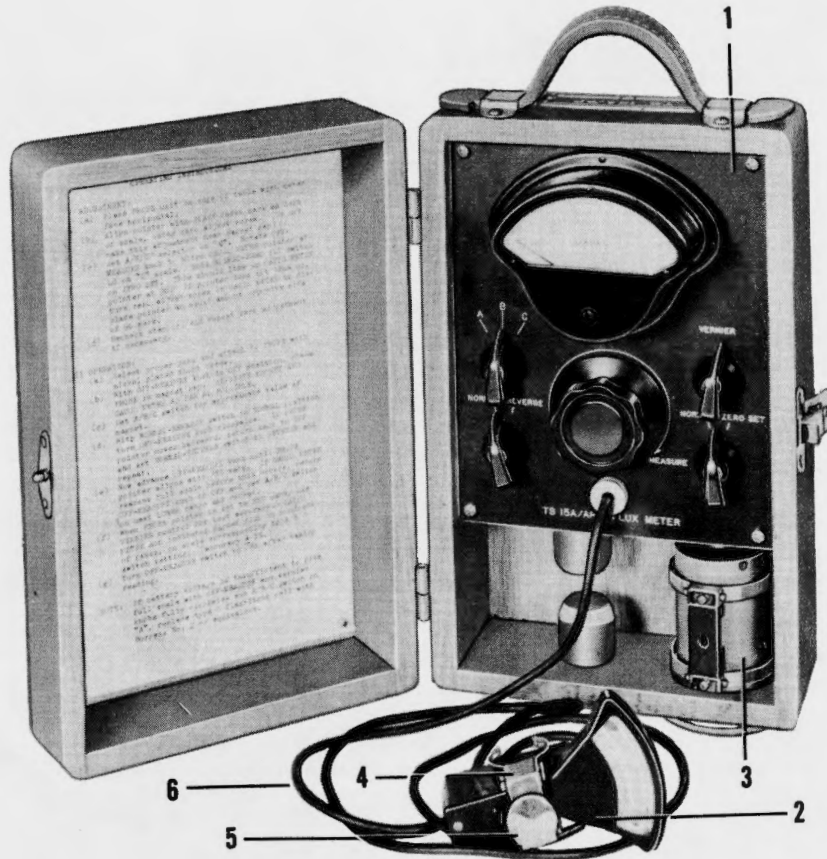


Figure 13-24. Fluxmeter-TS-15A/AP

**FLUXMETER**

**TS-15A/AP**

Primary purpose: To measure the flux density between the pole faces of magnets.

The fluxmeter consists basically of two milliammeters in series, one of which has a self-contained calibrated magnet as a source of flux. The other meter or "probe" derives its power from the magnet under test. The gauss meter is an accurately calibrated milliammeter which measures the current flowing through the probe. The deflection of the probe is a product of the current passing through it, and the strength of the field or flux, in which it is immersed. With a known field strength, the current required to set the probe to the red mark can be measured; conversely, the current required to set the probe to the red mark is a measure of the field strength of the magnet in gauss. As the meter that is placed between the poles of the magnet is set to standard deflection (red mark) the other reads directly in gauss.

**Electrical characteristics:**

Gaps: 1.3 to 1.5 inches; 0.6 to 0.7 inches.

Pole face diameters: 1.5 to 2 inches;  $\frac{7}{8}$  to  $1\frac{1}{8}$  inches.  
Range: 1,200-9,600 gauss in 3 scales: 1,200-2,400, 2,400-4,800, 4,800-9,600.

Accuracy: Plus or minus 2%.

Power required: One BA-30 battery is packed with equipment but not installed in the unit.

Calibration: Directly in gauss.

Complete equipment consists of:

- (1) 1 Gauss meter: 4-inch meter TS-15A/AP.
- (2) 1 Probe unit.
- (3) 1 Yoke for measurements on magnets with gaps from 1.3 to 1.5 inches and pole face diameters from 1.5 to 2 inches.
- (4) 1 Yoke for measurements on magnets with gaps from 0.6 to 0.7 inches and pole face diameters from  $\frac{7}{8}$  to  $1\frac{1}{8}$  inches.
- (5) 1 Yoke holder.
- (6) 1 Cable to probe unit  $4\frac{1}{2}$  feet in length.
- (7) 1 Instruction book AN 16-35TS15-3.

ASO stock No. R16-AN-TS-15A/AP.

- (1) .....
- (2) .....
- (3) .....
- (4) .....
- (5) .....
- (6) R15-C-1600.



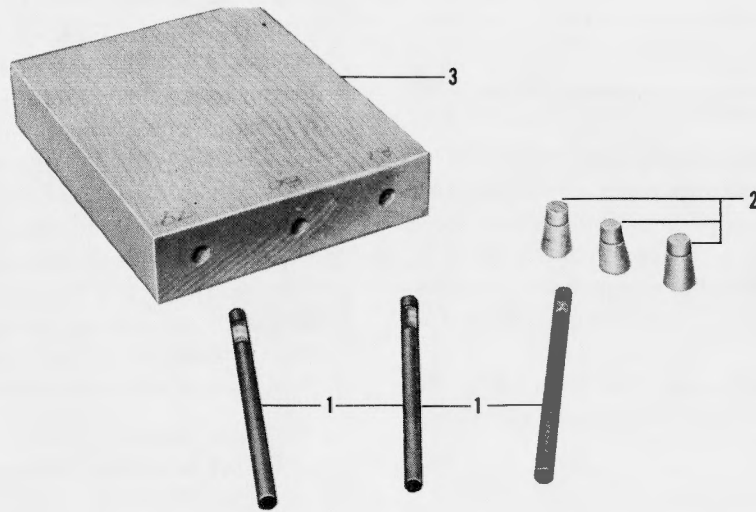


Figure 13-25. Calibrated Magnets—TS-17/ASQ

### CALIBRATED MAGNETS

#### TS-17/ASQ

Primary purpose: Maintenance of AN/ASQ equipment.

The TS-17/ASQ consists of three calibrated Alnico Magnets 1/4-inch diameter by 4 inches long, 1,000 c. g. s. units strength. They are carried in a wooden block drilled for their clearance and kept enclosed by corks.

Complete equipment consists of:

- (1) 3 Magnets TS-17/ASQ.
- (2) 3 Corks.
- (3) 1 Wood block, drilled.

ASO stock No. R16-AN-TS-17/ASQ.

- (1) .....
- (2) .....
- (3) .....

### TEST METER

#### TS-60/U or I-139-A

Primary purpose: Test meter for use with communication radio and RCM equipment.

The TS-60/U and the Army Type I-139-A are equivalent and identical instruments. Consists of a Weston type 501, 0-1 ma, 2 1/2-inch meter, mounted in a rectangular metal box. A 49-ohm 5-watt wire wound resistor is wired in series with the meter, the combined resistance of meter and resistor is 75 ohms. A two wire cord is permanently wired into the meter box and its other end is terminated in a special Bendix 2-contact plug (AC-58220-1). This plug fits receptacles on SCR-522, AN/APT-1, -2, -3, AN/UPT-T1, IE-12-A, IE-19-A, and IE-36-A.

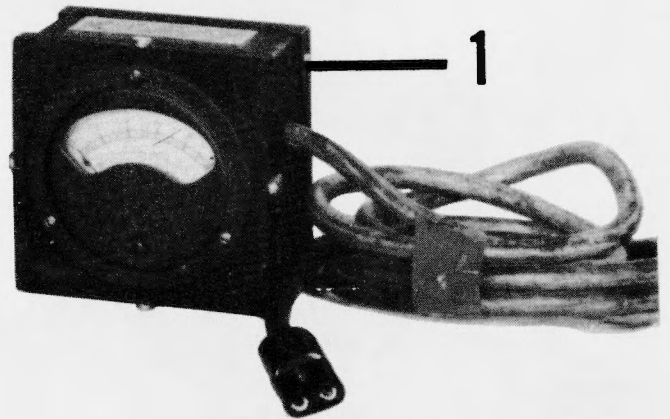


Figure 13-26. Test Meter—TS-60/U

Electrical characteristics:

- Input range: 0 to 200 milliamperes.
- Input impedance: low.
- Accuracy:  $\pm 3\%$  (approximate).
- Sensitivity: 0-200 ma. full scale deflection.
- Internal resistance: 75 ohms; with cord-93 ohms.
- Power required: None.
- Tubes: None.
- Batteries: None.

Mechanical characteristics:

- Dimensions: 4" x 4" x 3".
- Weight: 1 pound (approximate).

Complete equipment consists of:

- (1) 1 Test meter, TS-60/U.
  - (2) Instruction book—A.T.O. 16-10-111.
- ASO stock No. R16-AN-TS-60/U.
- (1) .....



### TEST SET

#### TS-80/U

Primary purpose: To provide a test meter of 0-1 milli-ampere range.

TS-80/U is a 0-1 ma. meter mounted in a closed metal box and provided with a flexible cable terminated in a phone plug. The TS-80/U is plugged into the test meter jack on the front of panel of the AN/ARC-1 or AN/ARC-4. Also provided with this equipment is an insulated aligning tool with hexagonal metal tips, one-quarter inch across flats.

No instruction book is provided for these units. Description and instructions are contained in the instruction book on the AN/ARC-1.

Complete equipment consists of:

- (1) 1 Milliammeter, TS-80/U.
- ASO stock No. R16-AN-TS-80/U.

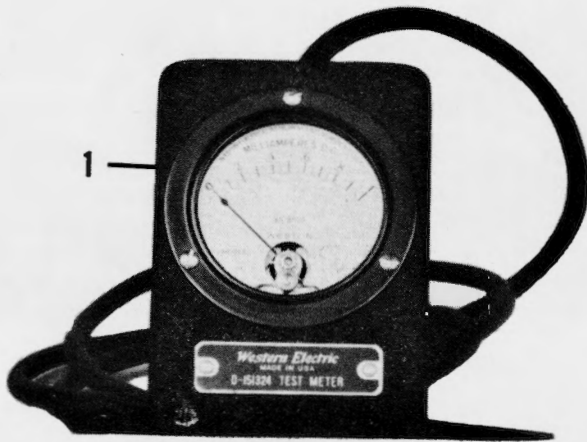


Figure 13-27. Test Set—TS-80/U

### AN/ASQ-3 TEST SET

TS-83/ASQ-3, TS-84/ASQ-3, TS-85/ASQ-3, TS-86/ASQ-3

Primary purpose: Testing of AN/ASQ-3 and AN/ASQ-3A equipment.

TS-83/ASQ-3 is a test bench primarily intended for use as a test fixture for the D-163928 Fluxgate Mounting of the D-163925 AN/ASQ-3 equipment.

TS-84/ASQ-3 is a test mechanism providing necessary rotation to the flux gate for balancing the detector head. The unit is complete with no accessories.

TS-85/ASQ-3 is a calibrator for AN/ASQ-3 equipment comprising a revolving permanent magnet which produces indications in equipment being tested. It is a complete unit with no accessories.

TS-86/ASQ-3 is a test set which shields the flux gate mounting from external magnetic disturbances and provides switches, meters, etc. for adjusting voltages. It is a complete unit with no accessories.

Electrical characteristics:

Power required: Self-contained batteries.

Tubes: None.

Batteries: TS-86/ASQ-3—5 type BA-23 (supplied only in early equipment—must now be requisitioned).

ASO stock numbers:

- (1) TS-83/ASQ-3-R16-T-AN-TS-83/ASQ-3.
- (2) TS-84/ASQ-3-R16-T-AN-TS-84/ASQ-3.
- (3) TS-85/ASQ-3-R16-C-AN-TS-85/ASQ-3.
- (4) TS-86/ASQ-3-R16-T-AN-TS-86/ASQ-3.

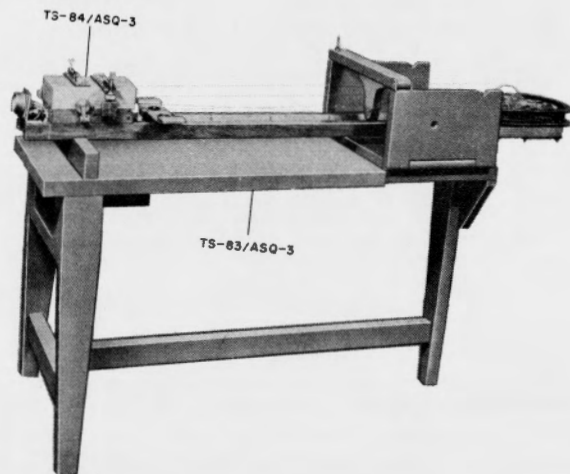


Figure 13-28. Test Bench—TS-83/ASQ-3

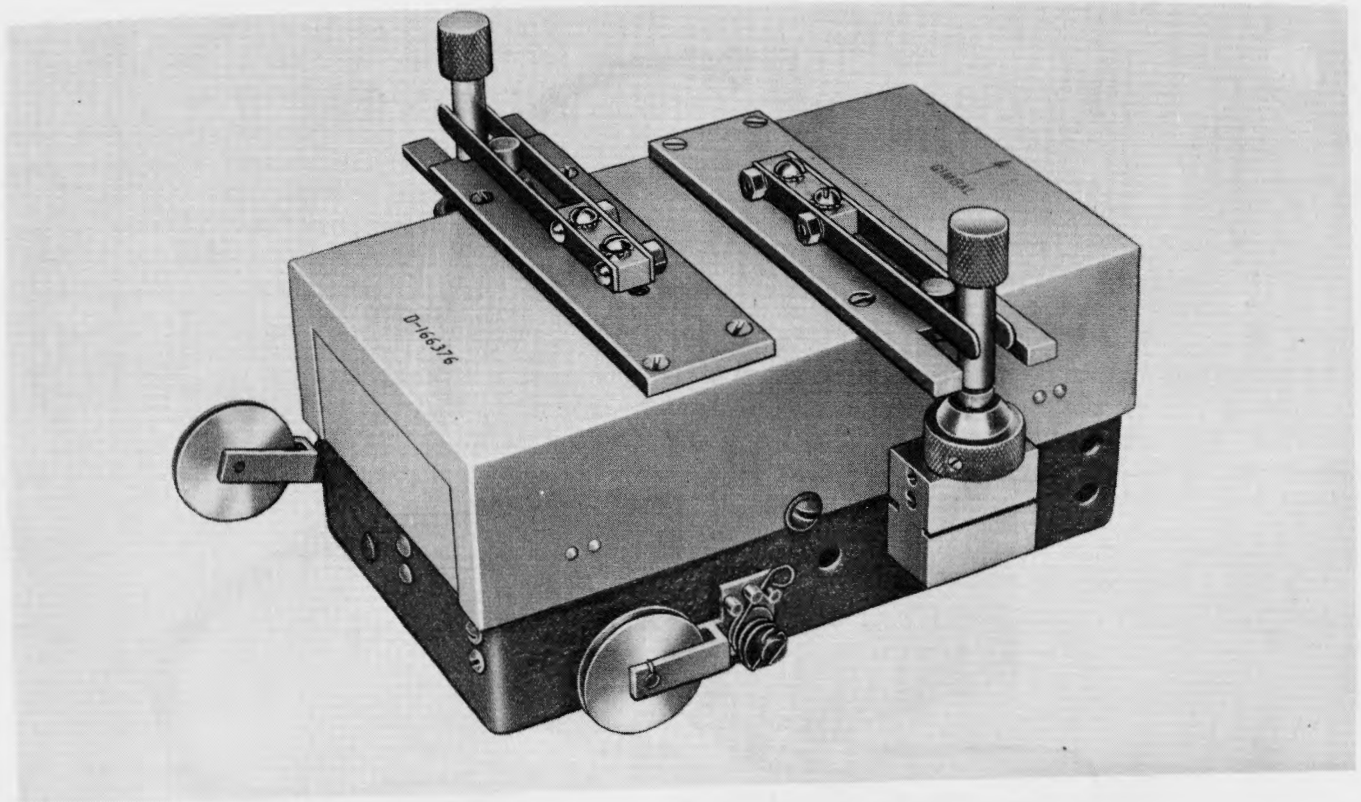


Figure 13-29. Test Mechanism—TS-84/ASQ-3



Figure 13-30. Calibrator—TS-85/ASQ-3



Figure 13-31. Test Set—TS-86/ASQ-3

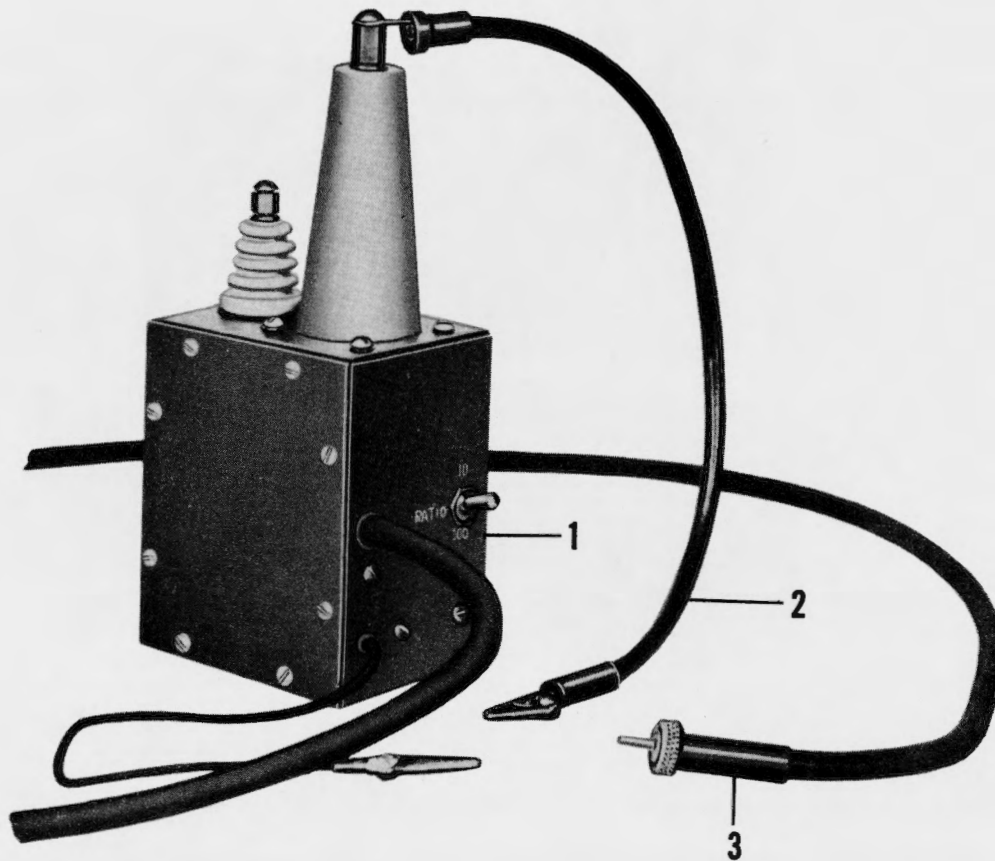


Figure 13-32. Pulse Voltage Divider—TS-89/AP

### PULSE VOLTAGE DIVIDER

#### TS-89/AP

Primary purpose: To divide voltages so that they may be viewed on an oscilloscope.

A device by means of which various oscilloscopes may be used to measure video pulses in excess of 200 volts in high-impedance circuits. It has two input circuits of different capacitances in series which provide two ratios and voltage ranges. The capacitance from each terminal to ground is only about 10 micromicrofarads. The equipment is contained in a steel box and cables are permanently attached.

#### Electrical characteristics:

Frequency range: Video.

Voltage ratio:

100:1 For 2,000 to 20,000 volts.

10:1 For 200 to 2,000 volts.

Voltage limit: 20 kv.

Input impedance: Approximately 2,000 ohms in series with 10 *mmf.*

Output impedance: Designed to work into load of approximately 4 megs. shunted by 20 *mmf.*

Accuracy: Ratios within plus or minus 15% designated values. Transmission-flat within 2 db. from 150 cycles to 5 mc.

Temperature range: Minus 40° F. to plus 120° F.

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 5" x 4" x 10" over-all.

Weight: 4 pounds.

#### Complete equipment consists of:

- (1) 1 Pulse voltage divider, TS-89/AP.
- (2) 1 High voltage input cable, 19 inches long, terminated with an alligator clip.
- (3) 1 Pulse measuring cable (to oscilloscope).
- (4) 1 Instruction book AN 16-35TS89-3.

ASO stock No. R16-AN-TS-89/AP.

- (1) .....
- (2) .....
- (3) .....

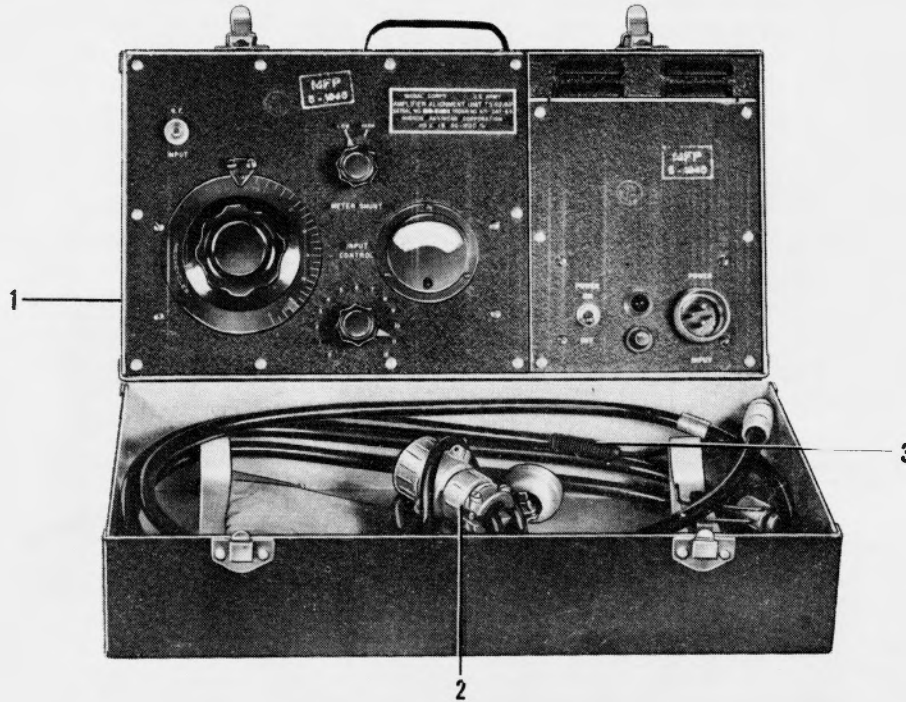


Figure 13-33. Double Peaking Tester—TS-92/AP

## DOUBLE PEAKING TESTER

### TS-92/AP

**Primary purpose:** A special test for alignment and adjustment of the amplifier stages of special jamming radar transmitters.

Amplifier Alignment Unit TS-92/AP is a special super-heterodyne receiver consisting of an untuned crystal mixer, a low pass filter, vacuum tube mixer, IF stages and a diode peak detector. The output is fed into an output indicator meter, which is 0-1 ma d. c. meter. The band width adjustment range is 0.5 to 7 mc. The selectivity is at least 3 db. down at 50 kc. from resonance. In operation, the jamming band width desired is selected by a band width adjustment dial calibrated from 0.5 to 7 mc. The transmitter power amplifier being tested, is then tuned and adjusted for maximum deflection of the output meter.

This unit will measure and align the band width of the broad band amplifier stages of various jamming transmitters. It is self-contained in a metal case with accessory carrying handle. A removable front protective cover, containing space for accessory cordage, is also provided.

#### Electrical characteristics:

Frequency range input: 15 to 500 mc.

Accuracy of dial calibration: 0.125 mc.

Signal input: 100 millivolts to 2 volts. In excess of this value will damage crystal.

Sensitivity: 100 millivolts unmodulated signal will give one-half scale deflection of output meter.

Temperature range: 40° C. to 55° C.

Input impedance: 150 ohms.

Power required: 115 v., 50 to 1200 cycles a. c.

Tubes: 1 type 6SA7; 1 type 6H6; 1 type 6J5; 1 type 5Y3GT/G; 1 type 1N21B (crystal); 2 type 6AC7.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 16 $\frac{1}{8}$ " x 7 $\frac{3}{4}$ " x 8 $\frac{1}{4}$ ".

Weight: 32 pounds.

#### Complete equipment consists of:

- (1) 1 Amplifier alignment unit TS-92/AP.
- (2) 1 Cord CG-153/U, 6 feet.
- (3) 1 Probe antenna AS-122/AP, 6 feet.
- (4) 1 Loop probe AS-142/AP (6 feet) (not illustrated).
- (5) 1 Cable Adapter AN-3057-12 (not illustrated).
- (6) 2 Allen Wrenches, #6 and #8 (not illustrated).
- (7) 1 Instruction book AN 16-35TS92-2.

#### ASO stock No. R16-AN-TS-92/AP.

- |                 |                      |
|-----------------|----------------------|
| (1) .....       | (2) R16-AN-CX-153/U. |
| (3) R16-A-5038. | (4) R16-A-4988-500.  |
| (5) .....       | (6) .....            |



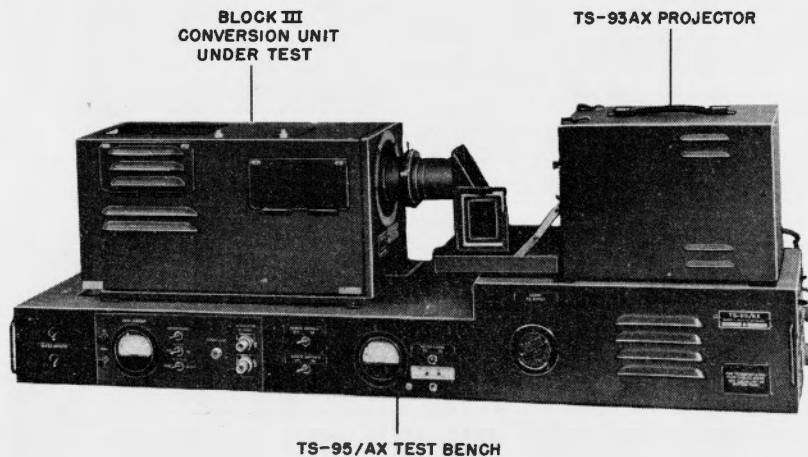


Figure 13-34. Projector-TS-93/AX and Alignment Test Bench-TS-95/AX

## ALIGNMENT TEST BENCH

### Model TS-95/AX

Primary purpose: Alignment of and testing of block I and block III equipments. Used with TS-93/AX.

The alignment test bench incorporates in a single unit the facilities for testing block I and block III equipments. It is designed to accommodate these equipments in a desirable test position, while maintaining optical alignment with the projector. All components are mounted in the steel cabinet which comprises the bench. It is finished in a black wrinkle enamel with the top finished to resist abrasion.

#### Electrical characteristics:

Tubes: None.

#### Dummy Load:

Maximum RF dissipation—25 watts average.

Impedance: 50 ohms 380–250 mc., approaches 72 ohms, 250–100 mc.

Standing Wave Ratio—75% minimum. 100–380 mc.

Power required: 115 v., 50–60 cycles.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 7½" x 12" x 52".

Weight: 40 pounds.

#### Complete equipment consists of:

- (1) 1 Alignment test bench, TS-95/AX, including dummy load.

ASO stock No. R16-AN-TS-95/AX.

## PROJECTOR

### TS-93/AX

Primary purpose: Alignment and testing of block I and block III equipments. Used with TS-95/AX.

A projector which provides an image of selected test slides of adequate illumination and desirable spectral distribution for testing block I and block III equipments. The focus is fixed for infinity projection. The complete unit is enclosed in a steel case finished in black wrinkle enamel and fitted with a handle.

#### Electrical characteristics:

Power required: 115 volts, 50–60 cycles, 60 watts.

Tubes: 2 Mazda FT-5 fluorescent daylight lamp 6 W.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 9¾" x 9½" x 14".

Weight: 10 pounds.

#### Complete equipment consists of:

- (1) Projector, TS-93/AX.
- (2) Set of slides (one each of 2, 4, and 8 to 1 contrast, typical scene, and resolution chart).

ASO stock No. R16-AN-TS-93/AX,

- (1) .....
- (2) .....



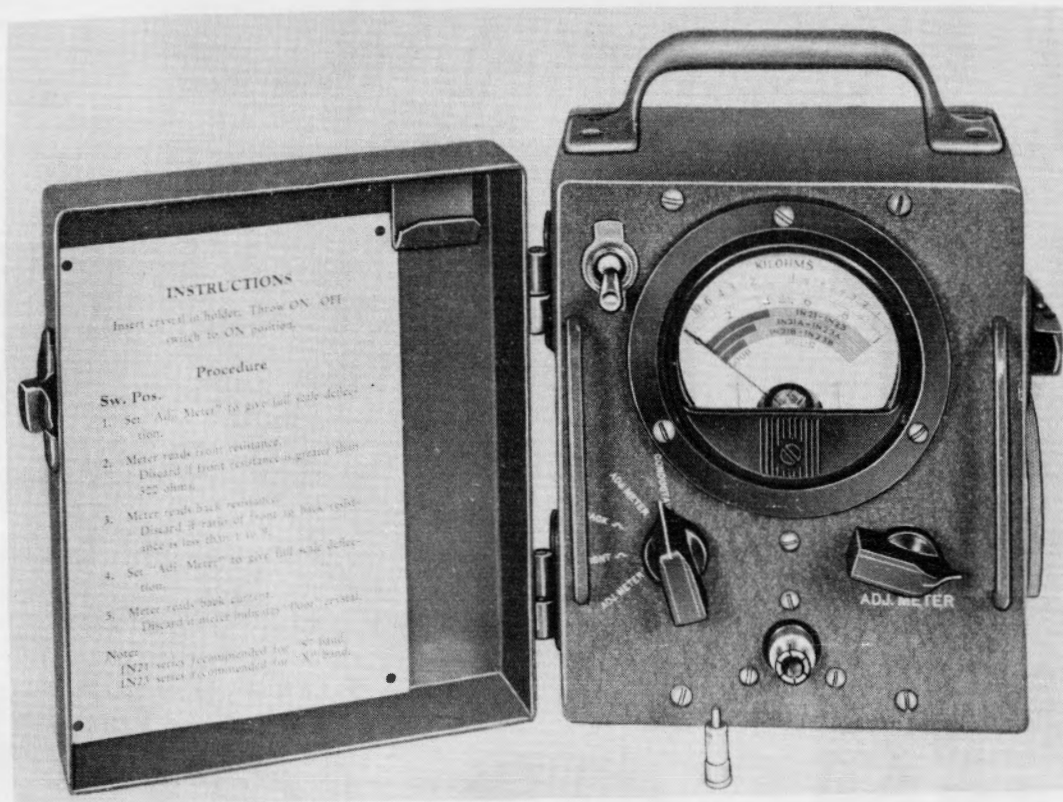


Figure 13-35. Crystal Checker—TS-268/U

### CRYSTAL CHECKER

TS-268/U

Primary purpose: To test crystal rectifiers.

This light, portable, self-contained unit provides these tests for crystals: Forward and backward resistance giving forward to backward ratio; back current at a constant voltage.

Electrical characteristics:

Range: 1N21 series; 1N23 series crystals.

Tubes: None.

Power required: 1.5 v. d. c.

Batteries: 1 Type BA-30, Supplied.

Mechanical characteristics:

Dimensions: 3" x 6" x 7".

Weight: 3 pounds.

Complete equipment consists of:

(1) 1 Crystal checker TS-268/U.

(2) 1 Instruction book AN 16-35TS268-2.

ASO stock No. R16-AN-TS-268/U.

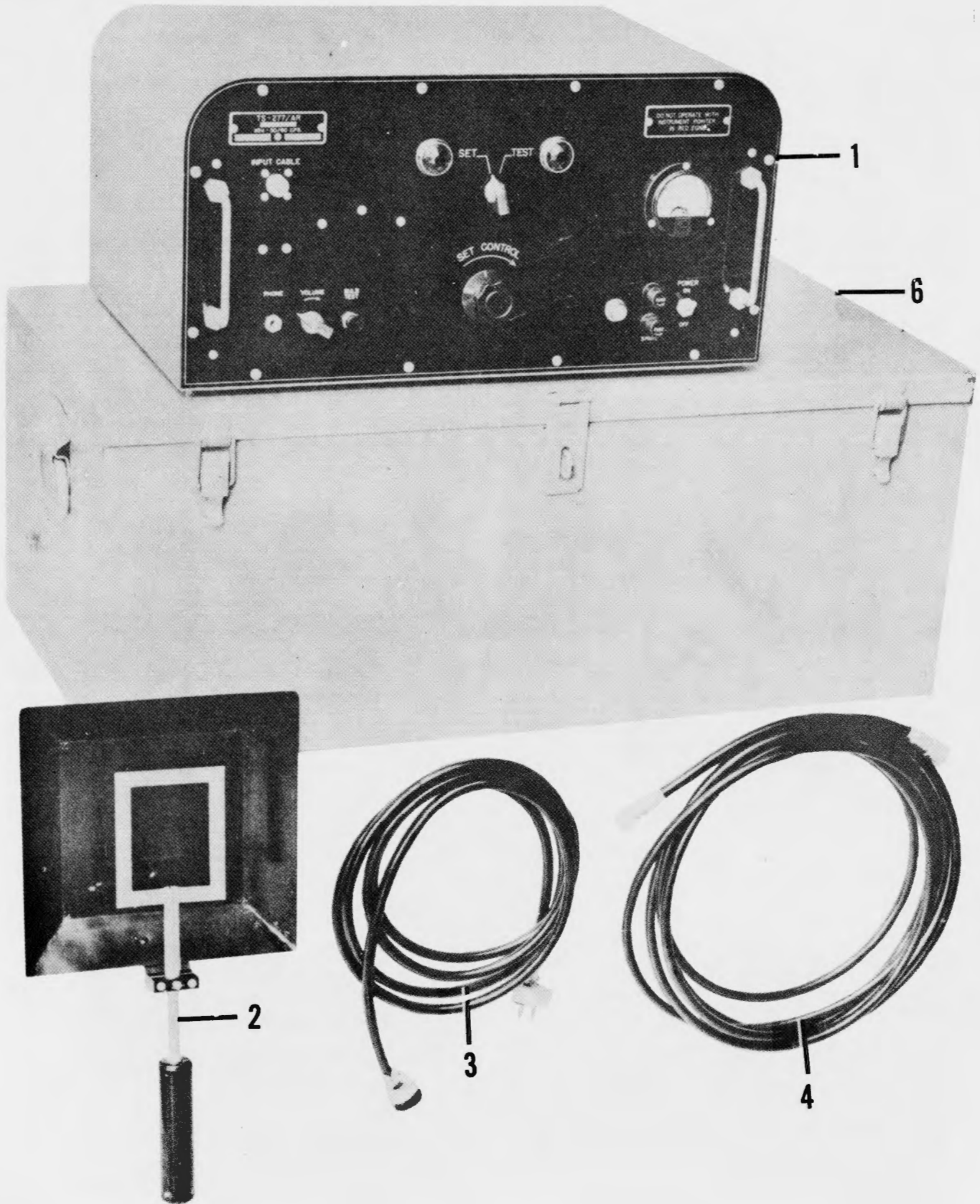


Figure 13-36. Radio Interference Tester—TS-277/AR

### RADIO INTERFERENCE TESTER

#### TS-277/AR

Primary purpose: Isolating electrical interference on airplane engines.

The Radio Interference Tester TS-277/AR is designed for the purpose of detecting, with a view toward eliminating objectionable electrical interferences occurring at the radio frequencies between 950 and 1150 megacycles, produced by various devices. It is further the purpose of the instrument to provide indications of the level of the R.F. interference in excess of the current local or ambient interference level. Primarily the equipment is intended for seeking the presence of objectionable R.F. interference emanating from aircraft engines.

Electrical characteristics:

- Frequency: 950 to 1150 mc.
- Input Impedance: 50 ohms.
- Intermediate Frequency: 30 mc.
- I.F. and Video Gain: 100 db over-all.

I.F. band width: 3.3 mc.

Tubes: 1 type 2C46, 6 type 6AC7, 2 type 6AG7, 1 type 6SN7-GT, 1 type 2050, 1 type 5T4, 1 type 5W4, 2 type 6L6, 1 type OD3/VR-150, 1 type 6SJ7.

Crystal Type: IN28 (detector and mixer).

Power required: 115 volts, 60 cycles, 250 watts: can be converted to 230V, 60 cycles.

Mechanical characteristics:

Dimensions: 30 1/2" x 15 1/2" x 12" (case).

Weight: 95 pounds total.

Complete equipment consists of:

- (1) 1 Radio Interference Tester TS-277/AR.
- (2) 1 Antenna Assembly AS-325/AR.
- (3) 1 Power Cord (10 feet) CX-337/U.
- (4) 1 Antenna Cable (16 feet) CG-401/U.
- (5) 1 Set of operating spare parts.
- (6) 1 Transit case.

ASO stock No. R16-AN-TS-277/AR.

- (1) .....
- (2) .....
- (3) .....
- (4) .....
- (5) .....
- (6) .....

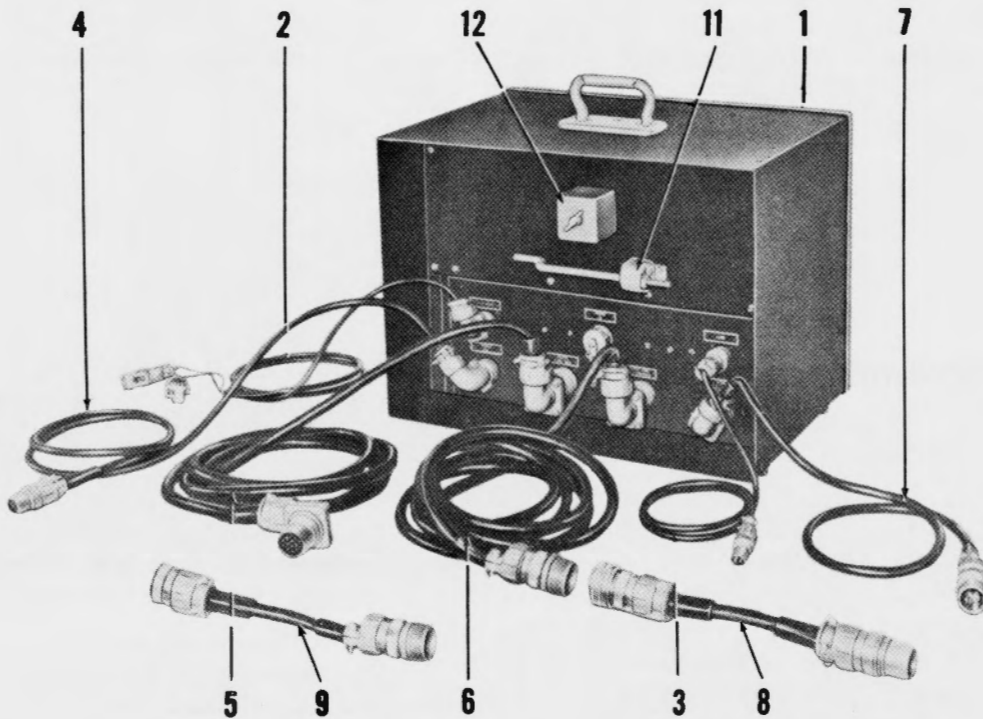


Figure 13-37. Test Set for AN/ASG-10, TS-362/ASG-10

**TEST SET FOR AN/ASG-10**

**TS-362/ASG-10**

Primary purpose: To check the performance of the AN/ASG-10 equipment.

The test set is designed to give time ratio by means of clock readings, to indicate proper circuit operation by means of pilot lamps, to measure grid-cathode leakage of thyratrons, and to measure grid control voltage at which thyratrons fire.

**Electrical characteristics:**

**Clock calibration:**

Seconds (inside hand).

Hundredths of a second (outside hand).

Frequency: For AN/ASG-10 equipment.

Sensitivity: Accuracy of time ratios  $\pm 1\%$ ; As megohmmeter  $\pm 25\%$ .

Power required: 24-29 volts d. c.

Tubes: 1 type 6X5GT; 1 type 6SN7/GT; 1 type OD3/VR150.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 14" x 17" x 12".

Weight: 34 pounds.

Complete equipment consists of:

Note—Cable numbers are instruction book designations.

- (1) 1 Test Set, TS-362/ASG-10.
- (2) 1 Cable, W101 (not illustrated).
- (3) 1 Cable, W103 (not illustrated).
- (4) 1 Cable, W104 (not illustrated).
- (5) 1 Cable, W105 (not illustrated).
- (6) 1 Cable, W106 (not illustrated).
- (7) 1 Cable, W107 (not illustrated).
- (8) 1 Adapter W108 (not illustrated).
- (9) 1 Adapter W109 (not illustrated).
- (10) 1 Power cord (not illustrated).
- (11) 1 Test weight 1.3G (not illustrated).
- (12) 1 Test weight 4.75G (not illustrated).
- (13) 1 Spare vibrator (mounted inside test set).
- (14) 1 Instruction book CO-AN 16-35TS362-3.

ASO stock No. R16-AN-TS-362/ASG-10.

(1) .....	(2) .....
(3) .....	(4) .....
(5) .....	(6) .....
(7) .....	(8) .....
(9) .....	(10) .....
(11) .....	(12) .....
(13) .....	



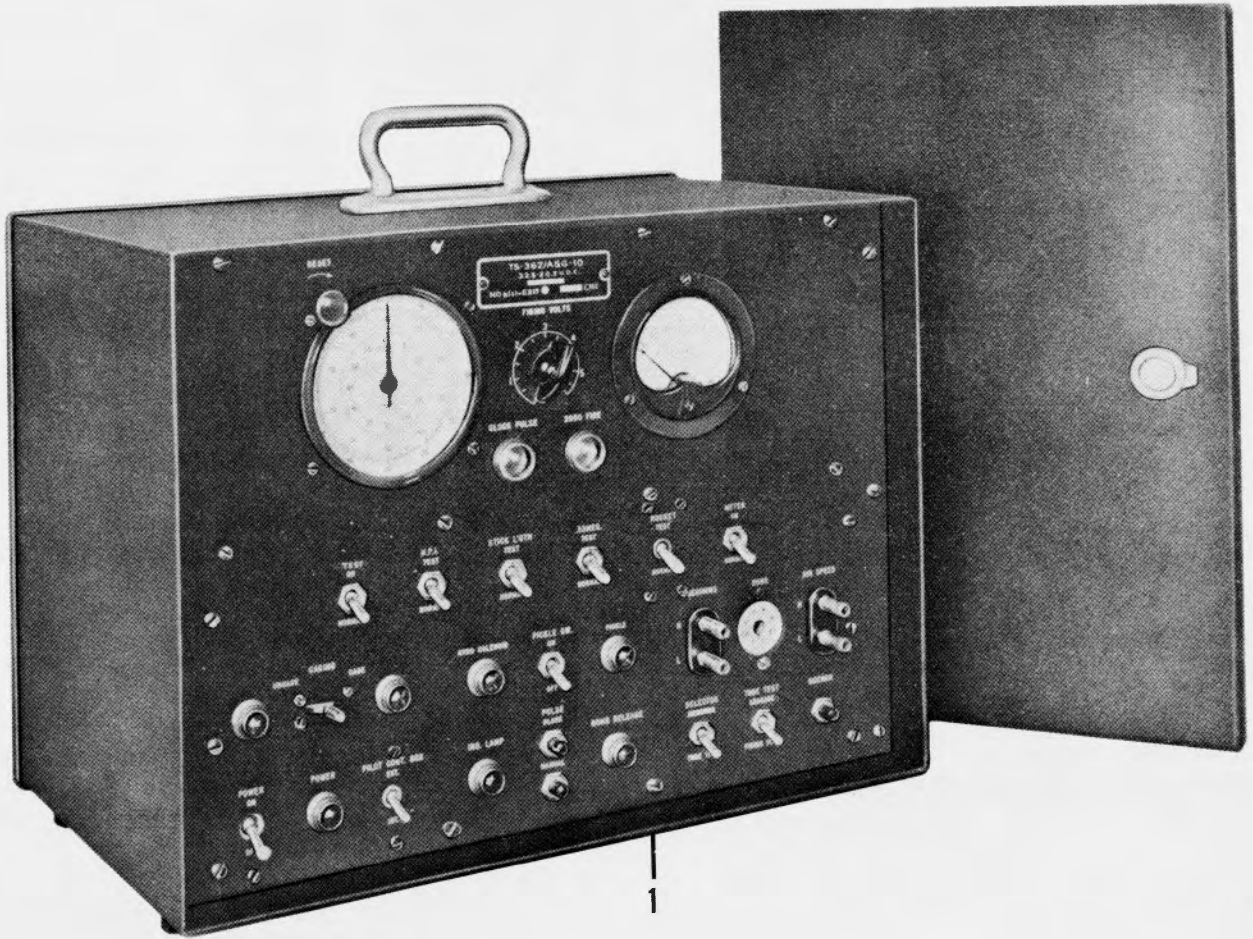


Figure 13-38. Test Set for AN/ASG-10, TS-362/ASG-10



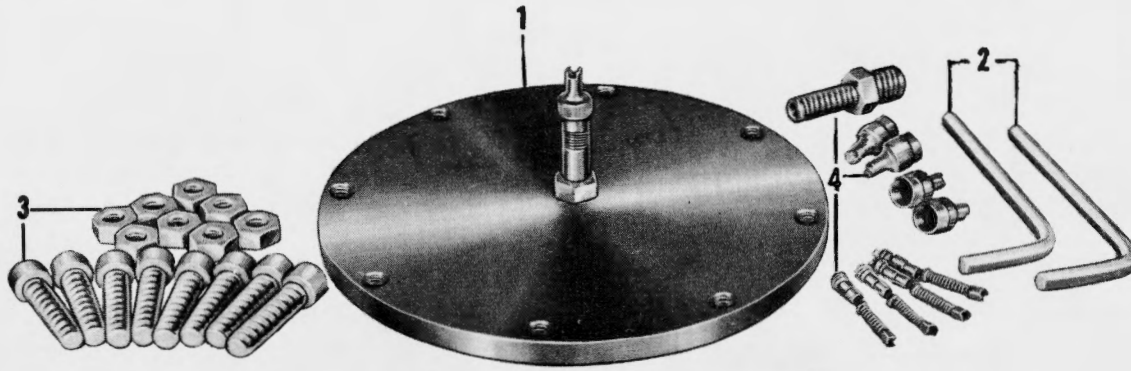


Figure 13-39. Pressurizing Plate-TS-378/U

### PRESSURIZING PLATE

TS-378/UP

Primary purpose: To test waveguides for air leaks.

Pressurizing plate used to seal a section of waveguide in order to test for air leaks. Consists of a 1/4-inch circular brass plate 5 1/8-inch in diameter, drilled to fit 1 1/2" x 3" waveguide flange bolt circle and provided with a Schrader air valve to permit pressurizing.

Electrical characteristics:

- Power required: None.
- Tubes: None.
- Batteries: None.

Mechanical characteristics:

- Dimensions: 5 1/8 inches diameter, 1/4-inch thick.
- Weight: 1 1/2 pounds.

Complete equipment consists of:

- (1) 1 Pressurizing Plate, TS-378/UP.
- (2) 2 Allen wrenches.
- (3) 8 Attaching bolts and nuts.
- (4) Assorted valve parts and fittings.

ASO stock No. R16-AN-TS-378/UP.

- (1) ..... (2) .....
- (3) ..... (4) .....

### HEADSET, MICROPHONE AND FLYING SUIT TESTER

TS-387/U

Primary purpose: To check headsets, microphones and flying suit heater units. Primarily for preflight use in ready room.

It provides an audio means of testing headsets by listening to an audio oscillator. It provides an output meter for checking microphones. An ammeter is provided for checking the current drain of flying suit heater units.

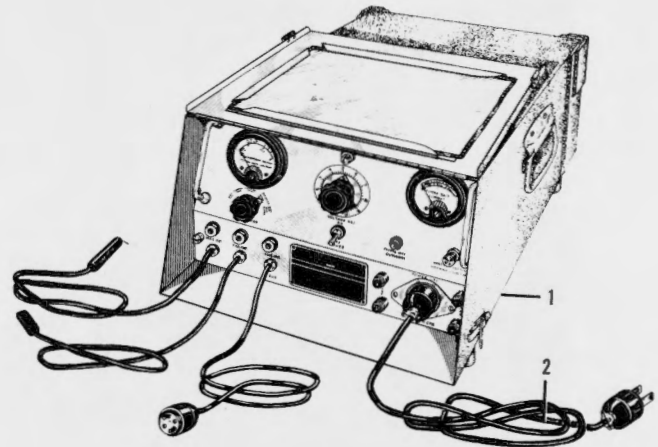


Figure 13-40. Headset, Microphone and Flying Suit Tester-TS-387/U

Electrical characteristics:

- Output: 0.3 mw and 110 mw at 1000 ± 20% c. p. s.
- Output impedance: 600 ohms.
- Ammeter Range: 0-3, -9 amperes.
- Voltmeter accuracy: ± 5% full scale.
- Power required: 115 volts ± 10% at 50-1600 c. p. s.
- Tubes: 1 type 6N7; 2 type 6SJ7; 1 type 6V6GT; 1 type 6X5/GT.
- Batteries: None.

Mechanical characteristics:

- Dimensions: 13 5/8" x 10 1/8" x 18" over-all.
- Weight: Approximately 55 pounds.

Complete equipment consists of:

- (1) 1 Test set TS-387/U.
- (2) 1 Power Cord.
- (3) 2 Allen wrenches (not illustrated).
- (4) 2 Spare fuses (not illustrated).
- (5) 1 Instruction sheet.

ASO stock No. R16-AN-TS-387/U.

- (1) ..... (2) .....
- (3) ..... (4) .....

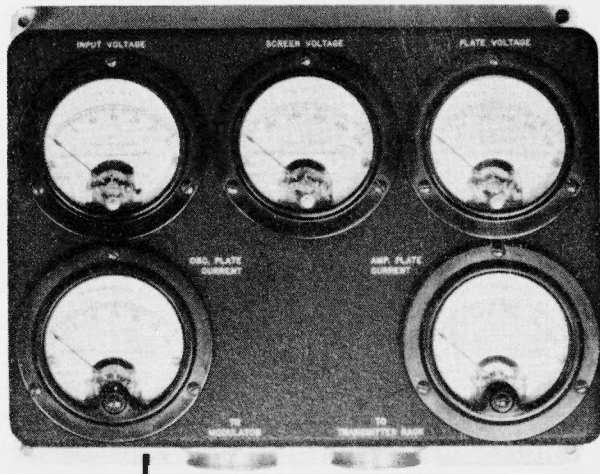


Figure 13-41. Test Set—W. E. Co. 9558

**TEST SET**

**Western Electric Co. 9558**

Primary purpose: Testing transmitter units of AN/ARC-5 (LF, MF, HF).

Test unit 9558 measures on 5 meters various voltages and currents in the AN/ARC-5 (LF, MF, HF) transmitter equipment. In volts d. c. it measures input voltage, screen voltage, and plate voltage. In milliamperes d. c. it measures oscillator plate current and amplifier plate current. A phantom antenna is included.

Complete equipment consists of:

- (1) 1 Rack, MT-69/ARC-5.
- (2) 1 Base, MT-68/ARC-5.
- (3) 1 Phantom antenna, ARC-7777.
- (4) 1 Cable, ARC-9557.
- (5) 1 Set crystals, ARC-7785 3; 4; 5.3; 7; and 9.1 mc.

ASO stock No. R16-T-1928.

- (1) .....
- (2) .....
- (3) .....
- (4) .....
- (5) .....

**INTERROGATOR—RESPONDER**

**AN/GPX-2**

Primary purpose: To provide a visual check on the operation of IFF equipment.

AN/GPX-2 Interrogator-Responder provides a visual check on the operation of IFF equipment installed in airplanes arriving at and taking off from air bases. So used, it provides a positive dynamic test of the airplane's IFF equipment under actual flight conditions. In operation the equipment is identical with standard interrogator-responder equipment.

Electrical characteristics:

- Frequency Range: 160 to 186 mc.
- Antenna Impedance: 50 ohms.
- Transmitter Output Power: 500 watts maximum (peak pulse).
- Pulse Frequency: 215 to 260 pulses per second.
- Power Required: 115 volts, a. c.; 60 cycles 300 watts.
- Indicator Range: 0-10-50-100 miles (10 miles normal).

Tubes:

- Receiver R-151/GPX-2: 3 type 956; 1 type 955; 7 type 6AC7; 1 type 6H6GT; 1 type 6V6GT, 2 type 6SL7GT.

- Transmitter T-129/GPX-2: 2 type 2X2; 1 type 5U4G; 3 type 6SN7; 1 type 2C26; 2 type 6H6GTG; 1 type 6G6G; 1 type 6X5GT; 1 type 3BP1.

Mechanical characteristics:

Dimensions:

- Receiver Transmitter Case: 21" x 19 1/2" x 14 3/4".
- Indicator: 19" x 12 1/4" x 14 3/8".

Weight:

- Receiver Transmitter: 101 pounds.
- Indicator: 41 pounds.

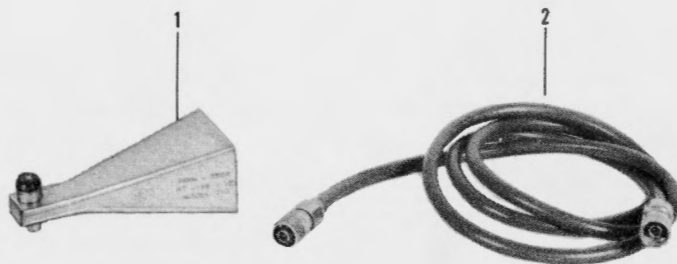


Figure 13-42. Horn Antenna-AT-48/UP

Complete equipment consists of:

- (1) 1 Receiver R-151/GPX-2.
- (2) 1 Transmitter T-129/GPX-2.
- (3) 1 Indicator-Control ID-139/GPX-2.
- (4) 1 Receiver-Transmitter Cabinet CY-389/GPX-2.
- (5) 2 Receiving Antenna Assembly AS-257/GPX-2.
- (6) 1 Transmitting Antenna AN/147A.
- (7) 1 Visor for Indicator.
- (8) 1 Connector Plug AN-3108-22-17S.
- (9) 1 Connector Plug AN-3108-22-17P.
- (10) 10 Elbow Connector M-359.
- (11) 15 Plugs PI-259.
- (12) 1 Plug AN-3108-18-3P.
- (13) 2 Plugs AN-3108-18-3S.
- (14) 1 50 Ft. 8 Conductor shielded cable NAF47024-803.
- (15) 1 300 Ft. Coaxial cable RG8/U.
- (16) 2 Cable Clamps AN-3057-12.
- (17) 3 Cable Clamps AN-3057-10.
- (18) 1 Cable Clamp M297.
- (19) 1 T-Connector M358.
- (20) 1 British Elbow Connector 10H701.
- (21) 1 Instruction Book AN 16-30GPX2-3.

ASO stock No. R16-AN/GPX-2.

- (1) R16-AN-R-151/GPX-2.
- (2) R16-AN-T-129/GPX-2.
- (3) R16-AN-ID-139/GPX-2.
- (4) R16-AN-CY-389/GPX-2.
- (5) R16-AN-AS-257/GPX-2.
- (6) R16-AYS-AN-147A.
- (7) .....
- (8) R17-P-4430-900-50.
- (9) R17-P-4430-900-45.
- (10) R16-P-3660.
- (11) R16-P-5005.
- (12) R17-P-4430-625.
- (13) R17-P-4430-630.
- (14) .....
- (15) .....
- (16) R17-A-2301.
- (17) R17-A-2299.

(18) R16-C-19545.

(19) R16-C-36028.

(20) R16-C-36045.

### HORN ANTENNA

#### AT-48/UP

Primary purpose: To provide a means for receiving and emitting r-f energy in the X-band.

If a directional coupler (CG-176/AP) is not available on the basic equipment then this unit having a type N connector is a means of coupling test sets (such as TS-13/AP), etc., to various X-band radars.

Mechanical characteristics:

Dimensions: Opening 2 1/2" x 2"; length 5 1/2".

Weight: 1/2 pound.

Complete equipment consists of:

(1) 1 Horn Antenna, AT-48/UP.

(2) 1 Extension Cord, CG-92/U.

ASO stock No. R16-H-8150.

(1) ..... (2) R16-P-3726.

### HORN ANTENNA

#### AT-68/UP

Primary purpose: To provide a means for receiving and emitting r-f energy in the band of 8500 to 9600 mc.

The pick-up horn is a small directive antenna assembly which can be used both for receiving external r-f energy to be measured by a test set and for transmitting the r-f test signal generated in a test set. The horn consists of a tapered section of wave guide which is terminated by a probe coupling to a coaxial fitting. The horn is generally connected to the test set by means of the r-f cable assembly CG-92U.

Mechanical characteristics:

Dimensions: 4 1/2" x 2 1/2"; 6 3/4" long.

Weight: 0.14 pound.

Complete equipment consists of:

(1) 1 Horn Antenna, AT-68/UP.

ASO stock No. R16-AN-AT-68/UP.

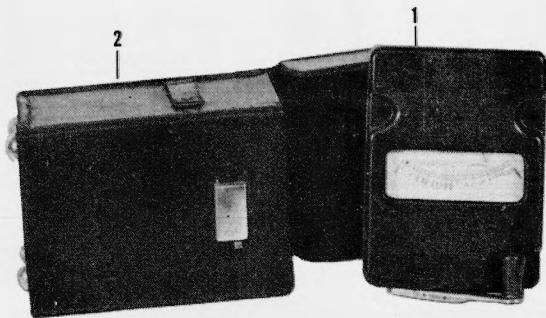


Figure 13-43. Insulation Tester—Biddle 705

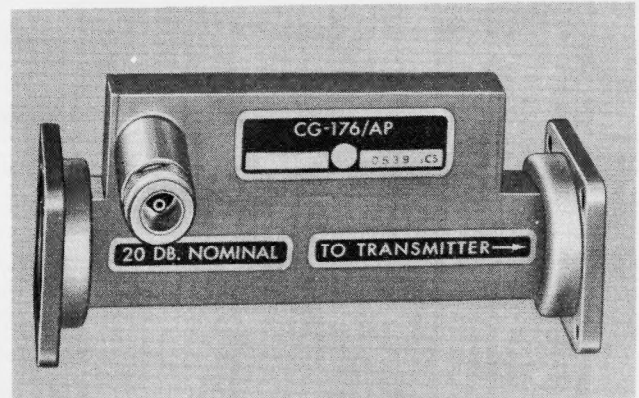


Figure 13-44. Directional Coupler—CG-176/AP

### INSULATION TESTERS

#### Biddle Midget Megger No. 705 and 7705.

Primary purpose: To test insulation resistance.

This lightweight portable insulation tester checks the insulation of wiring in radio, radar and electronic equipment. It may also be utilized in checking the insulation wiring in motors, generators, transformers, and other electrical equipment used in connection with them. It is operated by a hand crank.

The Model 7705 is the American model of the British-made Model 705.

#### Electrical characteristics:

- Range: 0-50 megohms.
- Generator voltage: 500 volts d. c. variable pressure.
- Power required: None.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: 5<sup>3</sup>/<sub>4</sub>" x 4" x 2<sup>3</sup>/<sub>8</sub>".
- Weight: 4<sup>1</sup>/<sub>8</sub> pounds with case; 3 pounds without case.

#### Complete equipment consists of:

- (1) 1 Insulation tester, Midget Megger 705 or 7705.
  - (2) 1 Carrying case.
- ASO stock Nos. 705-R17-T-5605, 7705-R17-T-5606.
- (1) .....
  - (2) .....

### DIRECTIONAL COUPLER

#### CG-176/AP

Primary purpose: To provide an accurate means of coupling test equipment to radar systems.

This 5-inch X-band piece of waveguide provides a means of getting 1% coupling with the transmitted energy of a radar system. It is terminated at both ends in square choke joints so that it may be reversed in the line. Two adapters are provided to fit any combination of joints. It fits directly into the waveguide of the system. A convenient type N connector is provided for attaching a coax line from the coupler to the test equipment. The directional coupler is part of Test Set, TS-147/UP.

#### Electrical characteristics:

- Waveguide, RG-52.
- Connector, Type N which mates with UG-21/U.
- Choke joint, UG-40/U (mates with UG-39/U).
- Coupling, 20 db.

#### Mechanical characteristics:

- Dimensions: 5 inches long.
- Weight: 1<sup>1</sup>/<sub>2</sub> pounds.

#### Complete equipment consists of:

- (1) 1 Directional coupler CG-176/AP.
  - (2) 2 Type UG-144/AP adapters.
- ASO stock No. R16-AN-CG-176/AP.
- (1) .....
  - (2) R16-AN-UG-144/AP.



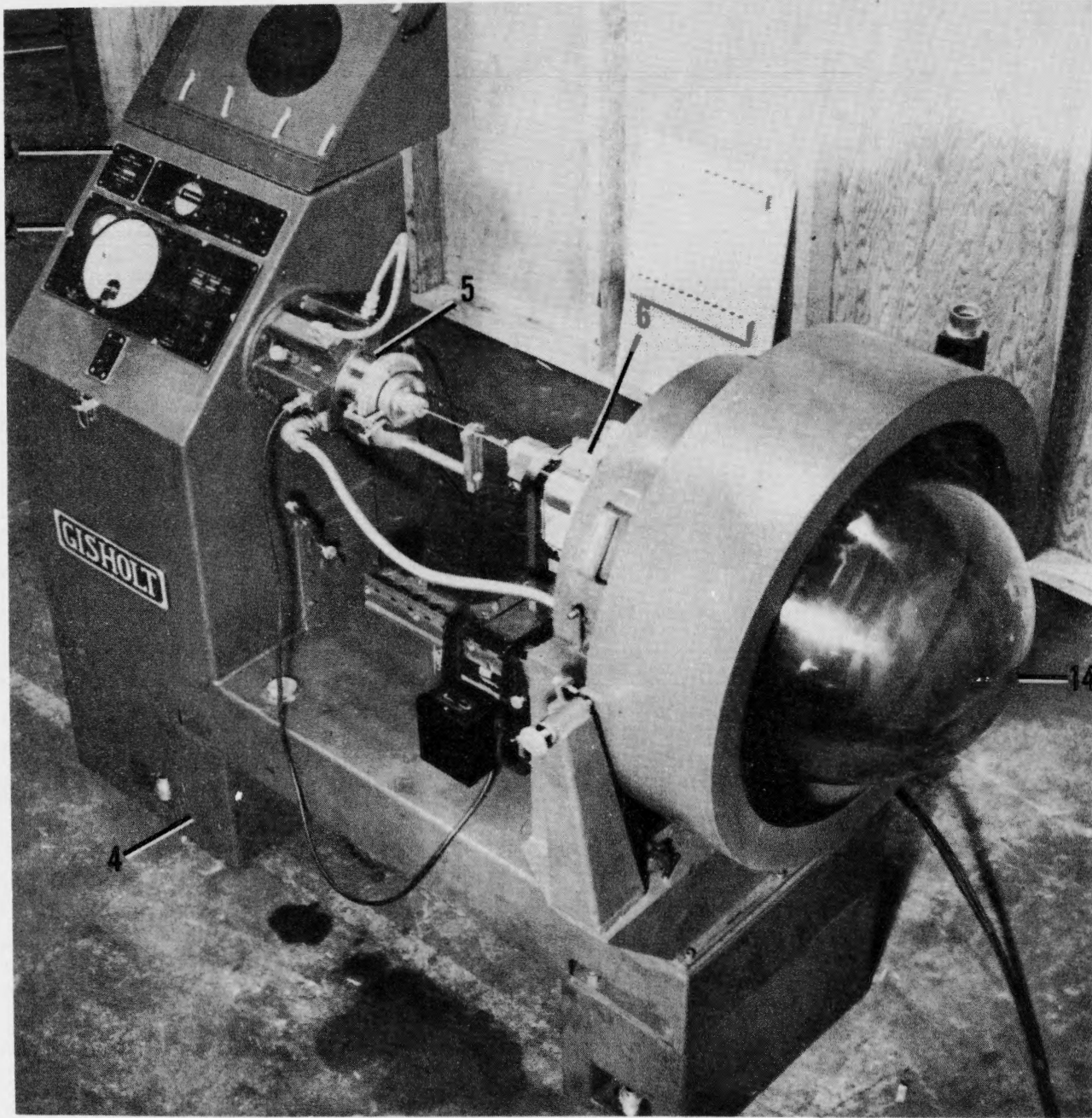


Figure 13-45. Antenna Balancing Machine CGJ-10 AEH

### ANTENNA BALANCING MACHINE CGJ-10AEH

Primary purpose: To facilitate adjusting the AIA antenna assembly.

The balancing machine provides a suitable support for both the antenna and the measuring equipment necessary for balancing. The antenna assembly to be balanced is

held rigidly in a flexibly mounted vibration cradle by means of a mounting or holding fixture. This machine measures and analyzes vibration in terms of amount and location of weight to be added to procure satisfactory operation. The units used are (a) a vibration pickup which translates the vibration into a corresponding alternating voltage, (b) a two-phase generator which generates two alternating currents which are  $90^\circ$  out of phase with each other, (c) a wattmeter which indicates the



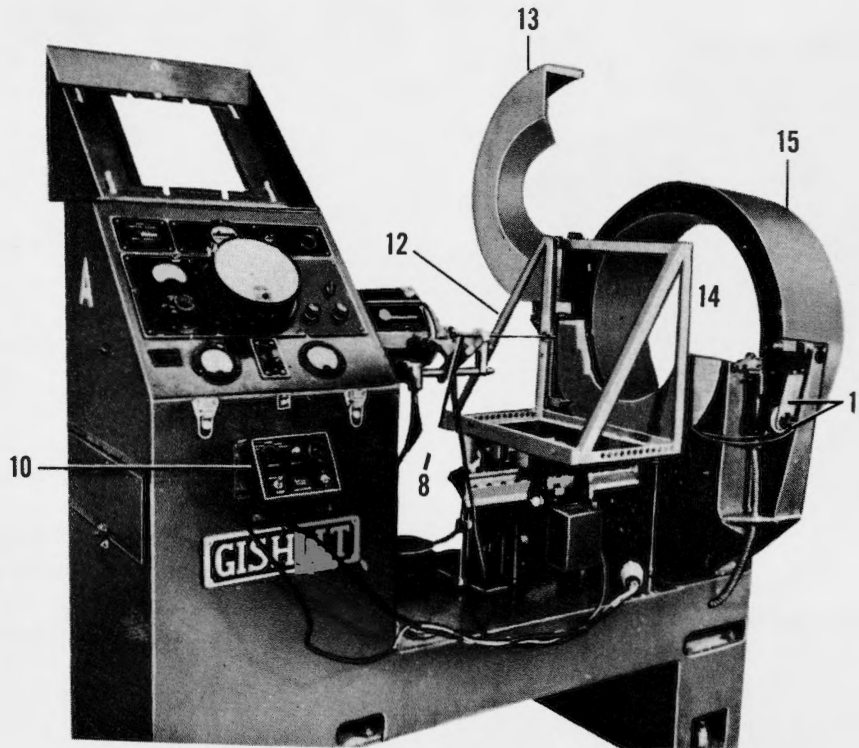


Figure 13-45. Antenna Balancing Machine CGJ-10 AEH

product of the in-phase components of the current and voltage developed by the first two units which in turn indicates the components of unbalance in each plane for which the pickups have been positioned.

**Electrical characteristics:**

Power required: 27 volts d. c., 20 amps. running current, starting current 100 to 200 amps.

Batteries: Not supplied (use d. c. generator for above power when possible).

**Mechanical characteristics:**

Dimensions: 5' x 3' x 4 1/2'.

Weight: 1 ton.

**Complete equipment consists of:**

- (1) 1 Antenna balancing machine assembly (#34V-9531) (not illustrated).
- (2) 1 Control panel assembly.
- (3) 1 Meter unit assembly (#34Z-5301).
- (4) 1 Battery case assembly.
- (5) 1 Two-phase generator and housing assembly (#34V-9515).
- (6) 1 Vibration pick-up and bracket assembly.
- (7) Miscellaneous machine parts (not illustrated).

ASO stock No. R16-B-1275.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... | (4) ..... |
| (5) ..... | (6) ..... |
| (7) ..... |           |

**MODIFICATION KIT FOR CGU-10AEH**

In order to modify the standard AIA Balance Machine for use with the AS-238/APS-19 Antenna Assembly it is necessary to replace several parts on the standard AIA Balance Machine.

AS-238/APS-19 Modification Kit contains the necessary replacement parts.

**Complete equipment consists of:**

- (8) 1 Arbor (drive for 20-cycle generator).
- (9) 1 Flexible Coupling Assembly.
- (10) 1 Antenna Control Box complete with mounting bracket cable and plugs.
- (11) 1 Auxiliary Control Box.
- (12) 1 Antenna Mounting Fixture.
- (13) 1 Shroud (metal battle).
- (14) 1 Plastic Dome.
- (15) 1 Plastic Dome Mounting Ring.

ASO stock No. ....

- |            |            |
|------------|------------|
| (8) .....  | (9) .....  |
| (10) ..... | (11) ..... |
| (12) ..... | (13) ..... |
| (14) ..... | (15) ..... |

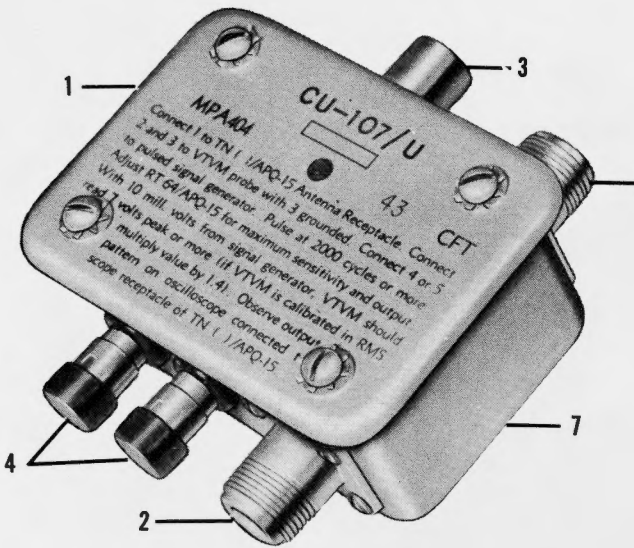


Figure 13-46. Matching Network-CU-107/U

### MATCHING NETWORK

#### CU-107/U

Primary purpose: To test and maintain AN/APQ-15.

This matching network properly terminates Radar Set AN/APQ-15 in 50 ohms while being triggered by a signal generator and provides terminals by which the AN/APQ-15 output can be simultaneously measured with a standard vacuum tube voltmeter.

#### Electrical characteristics:

- Power required: None.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: 2" x 2" x 2" over-all.
- Weight: 1/4 pound.

#### Complete equipment consists of:

- (1) 1 Matching network-CU-107/U.
- (2) 2 R-f jack UG-22/U.
- (3) 1 General Radio coaxial jack.
- (4) 2 Pin jacks.
- (5) 1 40 ohm 1/4-watt resistor (contained in case).
- (6) 1 40 ohm 1/4-watt resistor (contained in case).
- (7) 1 Case (not illustrated).
- (8) 1 Cable (3 feet), r-f, RG-8/U terminated in r-f jack UG-21/U at each end (not illustrated).

ASO stock No. R16-AN-CU-107/U.

- |           |                 |
|-----------|-----------------|
| (1) ..... | (2) R16-P-5010. |
| (3) ..... | (4) .....       |
| (5) ..... | (6) .....       |
| (7) ..... | (8) .....       |

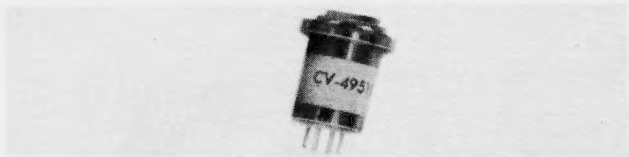


Figure 13-47. Tube Socket Adapter-CV-49519

### TUBE SOCKET ADAPTER

#### CV-49519

Primary purpose: To facilitate maintenance of electronic equipment employing miniature tubes.

The adapter consists of a cylindrical barrel of bakelite tubing, having a base similar to a 7-prong miniature tube, which will plug into a miniature tube socket. The top of the barrel is fitted with a miniature tube socket with metal tabs extending from the socket connections. When servicing compact electronic equipment it is sometimes impossible to reach the tube socket connections for taking voltage and resistance readings. By means of this adapter the tube socket connections are made available at the top of the socket.

#### Electrical characteristics:

- Power required: None.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

- Dimensions: Over-all: 1 inch diameter by 1 1/2-inch length.
- Weight: 2 ounces (each).

#### Complete equipment consists of:

- (1) 5 Tube adapters CV-49519 per package.
- ASO stock No. R16-A-600.

### MODULATOR BLOWER

#### HD-5/APS-20

Primary purpose: To furnish cooling air to modulator of AN/APS-20.

The equipment consists of a 1/8-hp. motor, #3 blower, and metal adapter spout to fit the airscoop on the plane to furnish cooling air when plane is on deck.

#### Electrical characteristics:

- Power required: 27 volts d. c., 8 amps. Motor rating: 1/8-horsepower, 5,600 r. p. m.
- Blower Output: 66 cubic feet air per minute against 2-inch head.

#### Mechanical characteristics:

- Dimensions: 12" x 7" x 15".
- Weight: 7 pounds.

#### Complete equipment consists of:

- (1) 1 Modulator blower, HD-5/APS-20.
- (2) 1 Hose.
- (3) 1 Instruction book NAVAER 16-5S-506.

ASO stock No. R16-AN-HD-5/APS-20.

- (1) .....
- (2) .....

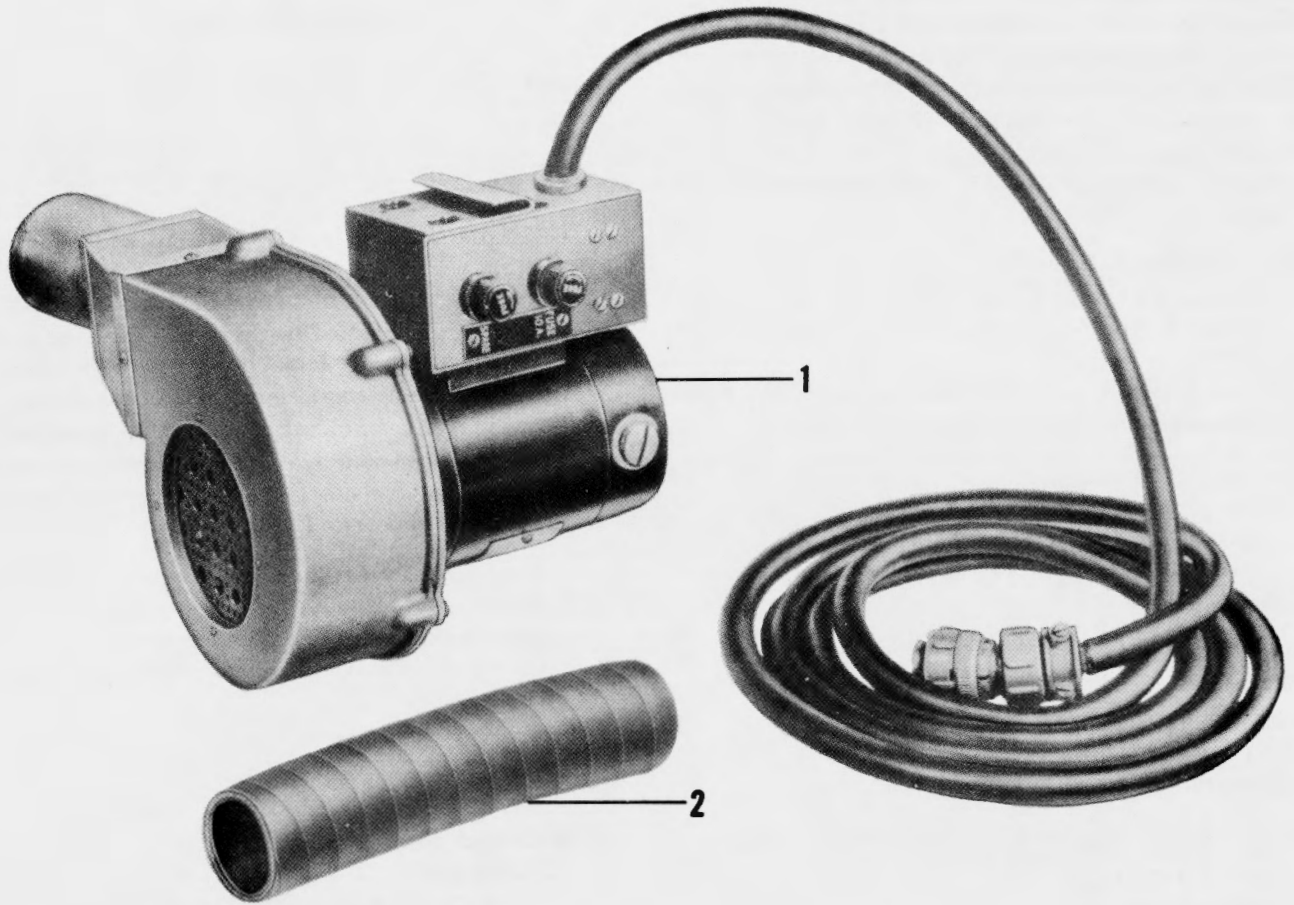


Figure 13-48. Modulation Blower—HD-5/APS-20

TEST SET

I-100-A

Primary purpose: To provide a rapid means of checking, loop-orienting circuits of Radio Compasses.

Though intended for use in a shielded room in conjunction with radio compass test set-ups the test set may be used for testing radio compasses in aircraft. It is particularly intended for use with BC-433-G, R-5/ARN-7, SCR-269-G, and AN/ARN-7. The I-100-A will check the loop motor, loop autosyn, loop compensator and indicators.

Electrical characteristics:

Tubes: 2 type 5Z4; 1 type 6B8; 1 type 6F6; 1 type 6H6; 1 type 6J5; 2 type OD3/VR-150; 2 type 2051.

Power required: 115 volts, 400 cycle only, 115 watts maximum.

Mechanical characteristics:

Dimensions:

BC-713-A:  $12\frac{3}{4}$ " x  $12\frac{3}{8}$ " x  $13\frac{7}{8}$ ".  
BC-714-A:  $12\frac{5}{8}$ " x  $5\frac{7}{8}$ " x  $10\frac{3}{16}$ "

Weight:

BC-713-A: 21 pounds, approximate.  
BC-714-A: 19 pounds, approximate.

Complete equipment consists of:

- (1) 1 Test Unit-BC-714-A.
- (2) 1 Test Unit-BC-713-A.
- (3) 1 Cover.
- (4) 2 Bristol Wrench #6.
- (5) 1 Line Cord.
- (6) 1 Set of test leads.
- (7) 1 Cord CD-548-A (adapter) 10-foot.
- (8) 1 Cord CD-549-A (adapter) 10-foot.
- (9) 1 Cord CD-550-A (adapter) 10-foot.
- (10) 1 Cord CD-551-A (adapter) 3-foot.
- (11) 1 Cord CD-552-A (adapter) 3-foot.
- (12) 1 Adjustable Strap ST-19-A.
- (13) 1 Package of maintenance parts.
- (14) 1 Set Test Prods.
- (15) 1 Instruction book AN 16-40I100-3.

ASO stock No. ....

- |                      |                      |
|----------------------|----------------------|
| (1) .....            | (2) .....            |
| (3) .....            | (4) .....            |
| (5) .....            | (6) .....            |
| (7) R16-C-3318.      | (8) R16-C-3319-200.  |
| (9) R16-C-3319-100.  | (10) R16-C-3319-500. |
| (11) R16-C-3319-700. | (12) R16-S-9135.     |
| (13) .....           | (14) .....           |

INSULATION TESTER

Interstate Type "G" (formerly M-1000)

Primary purpose: To test insulation resistances.

This portable insulation resistance test set was designed for testing electrical resistance up to 1000 megohms. It consists of a high range ohmmeter of special design (cross coil ratio type) mounted in the same case with a hand operated d. c. generator. It may be used to check insulation resistance: between conductors of multiple cables; between windings and windings to ground in transformers; between windings and windings to frame in rotating equipment; and for other equipment where insulation resistance is an important factor.

Electrical characteristics:

Resistance range: 0 to 1,000 megohms.  
Voltage output: Approximately 500 v. d. c. 10 ma.  
Tubes: None.  
Power required: None.  
Batteries: None.

Mechanical characteristics:

Dimensions:

Type "G" test set:  $7\frac{3}{4}$ " x 6" x  $7\frac{3}{4}$ ".  
Case:  $6\frac{1}{2}$ " x  $9\frac{3}{4}$ " x  $8\frac{1}{2}$ ".

Weight:

Type "G" test set:  $10\frac{3}{4}$  pounds.  
Case:  $2\frac{3}{4}$  pounds.

Complete equipment consists of:

- (1) 1 Insulation resistance test set.
- (2) 2 ten-foot test leads (equipped with terminals for connection to test set and insulated battery clamps for test connections).
- (3) 1 Carrying case of wood.
- (4) 1 Canvas strap.
- (5) 1 Instruction book AN 08-45-24.

ASO stock No. R17-T-5588-50.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... |           |

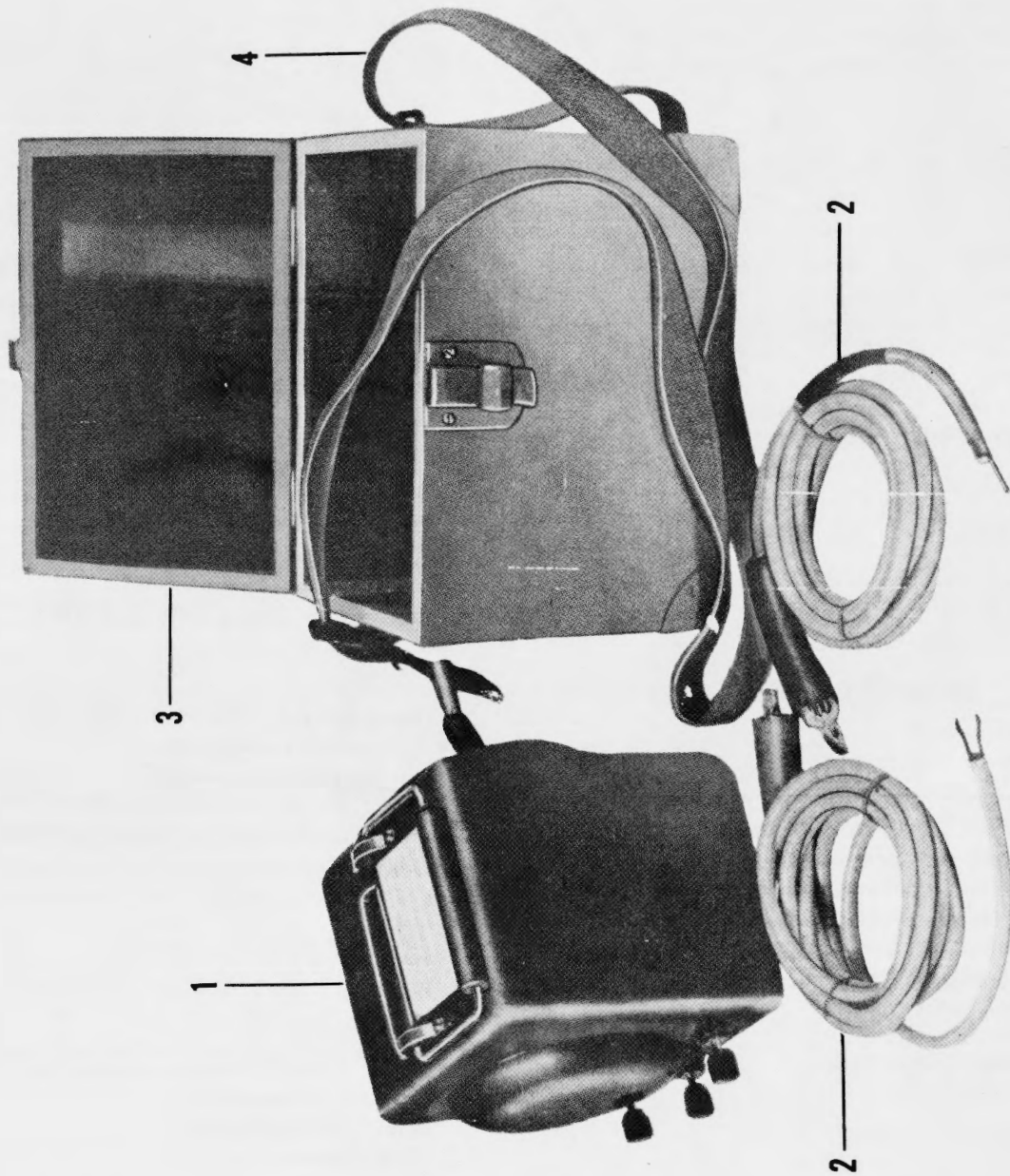


Figure 13-49. Insulation Tester—Interstate Type G



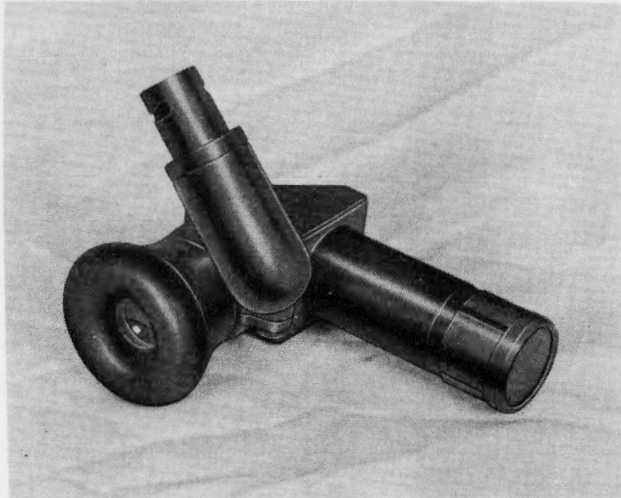


Figure 13-50. Telescope Elbow-M1A1

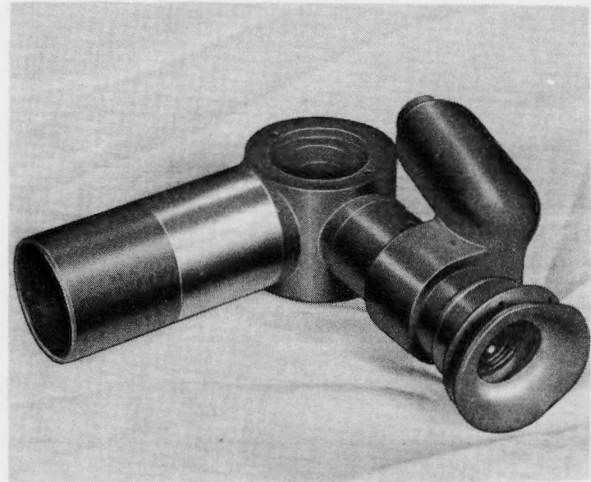


Figure 13-51. Telescope Elbow-M2A1

### TELESCOPE ELBOW

#### M1A1

Primary purpose: To facilitate boresighting AIA, AN/APS-6, and AN/APS-6A equipment.

This right-angle telescope clamps on the -X side of the spinner bracket such that the telescope is lined up with the waveguide feed to the dish. It is equipped with filter and internal lighting. A convenient cross-hair scale is provided in the middle of the lens. As the dish is rotated a reading is taken every 90° as an adjustment procedure.

#### Electrical characteristics:

Connection provided for internal lighting.

#### Mechanical characteristics:

##### Dimensions:

Eyepiece 1 $\frac{3}{4}$  inches diameter.

Eyepiece to elbow 2 $\frac{3}{4}$  inches.

Elbow to tip 3 $\frac{1}{2}$  inches.

Weight: 1 pound.

Complete equipment consists of:

(1) 1 Telescope elbow, M1A1.

ASO stock No. R16-S-7920.

### TELESCOPE ELBOW

#### M2A1

Primary purpose: Aid in boresighting of AN/APS-6 and AN/APS-6A equipment.

This telescope is mounted by a specially designed bracket to the antenna waveguide feed. When the dish is locked in "dead center" by the adjustable blocking bar, the telescope provides a means of aligning the waveguide feed of the radar with the firing conversion point of the plane's guns.

The mounting bracket slides end-on over the antenna feed. The telescope is mounted on the end of this bracket. Cross hairs numerically scaled on the glass provide a means of adjusting proper balance and centering.

#### Electrical characteristics:

Power required: None.

Tubes: None.

Batteries: None.

#### Mechanical characteristics:

Dimensions: Main barrel diameter  $\frac{3}{4}$ -inch, length 24 inches.

Complete equipment consists of:

(1) 1 Telescope elbow, M2A1.

ASO stock No. R16-S-7920.

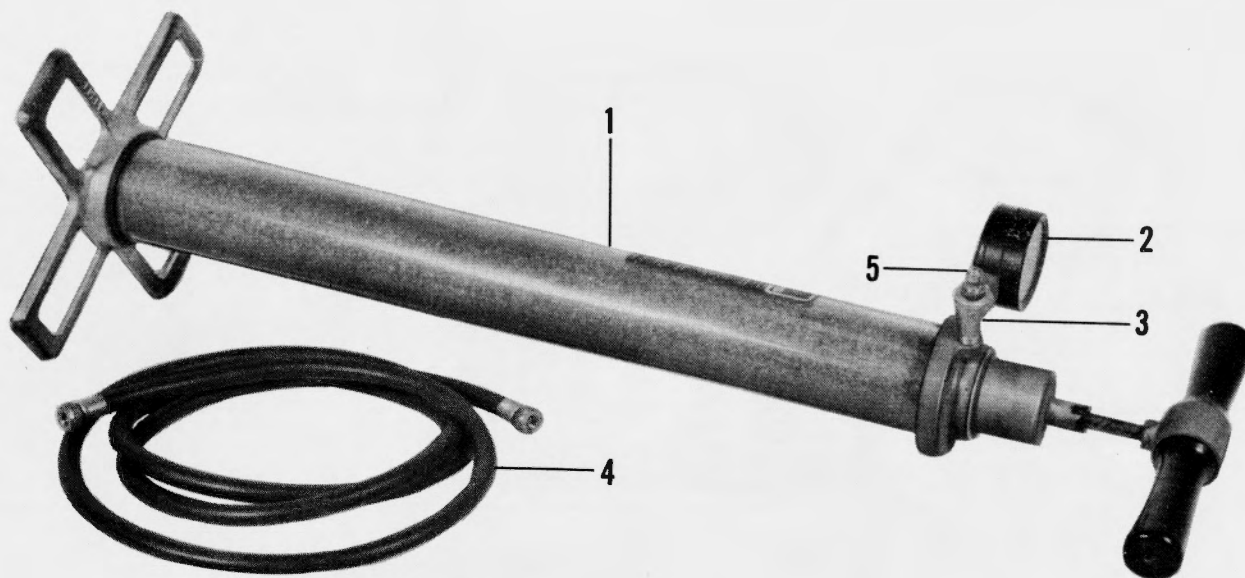


Figure 13-52. Pressurizing Unit—MK-20A/UP

### PRESSURIZING UNIT

#### MK-20/UP and MK-20A/UP

Primary purpose: Pressurizing certain radar waveguide systems.

The MK-20/UP is manufactured by the Victor Andrew Co., and is equivalent to their model 870.

The unit consists of an automobile-type hand pump, a cylinder containing the silica gel drying agent, a 0-30 pound pressure gauge and a 7-foot rubber hose. The hose terminations fit standard automobile-type valve stems. Each stroke of the pump produces 26 cubic inches of air. No instruction book is supplied with the equipment since sufficient information is contained on the label.

A limited quantity of a similar pump, type 876, was distributed to maintenance activities. This pump was slightly different in appearance but basically equivalent.

The barrel of the MK-20/UP is transparent lucite and on the MK-20A/UP the barrel is aluminum with a small

lucite window for examination of the condition of the silica gel. Later models of MK-20A/UP are provided with an additional 7-foot length of hose for use as an extension.

#### Mechanical characteristics:

Dimensions: 25 inches high, 9 inches over-all at base.  
Weight: 8½ pounds.

#### Complete equipment consists of:

- (1) 1 Pressurizing Unit MK-20/UP or MK-20A/UP.
- (2) 1 Gauge, 3024.
- (3) 1 Tee, 3022.
- (4) 1 Hose, 876-228.
- (5) 1 Valve Cap, 876-231.

ASO stock Nos. MK-20/UP-R16-D-1165, MK-20A/UP-R16-D-1160.

- (1) ..... (2) R16-ANV-3024.
- (3) R16-ANV-3022. (4) R16-ANV-876-228.
- (5) R16-ANV-876-231.

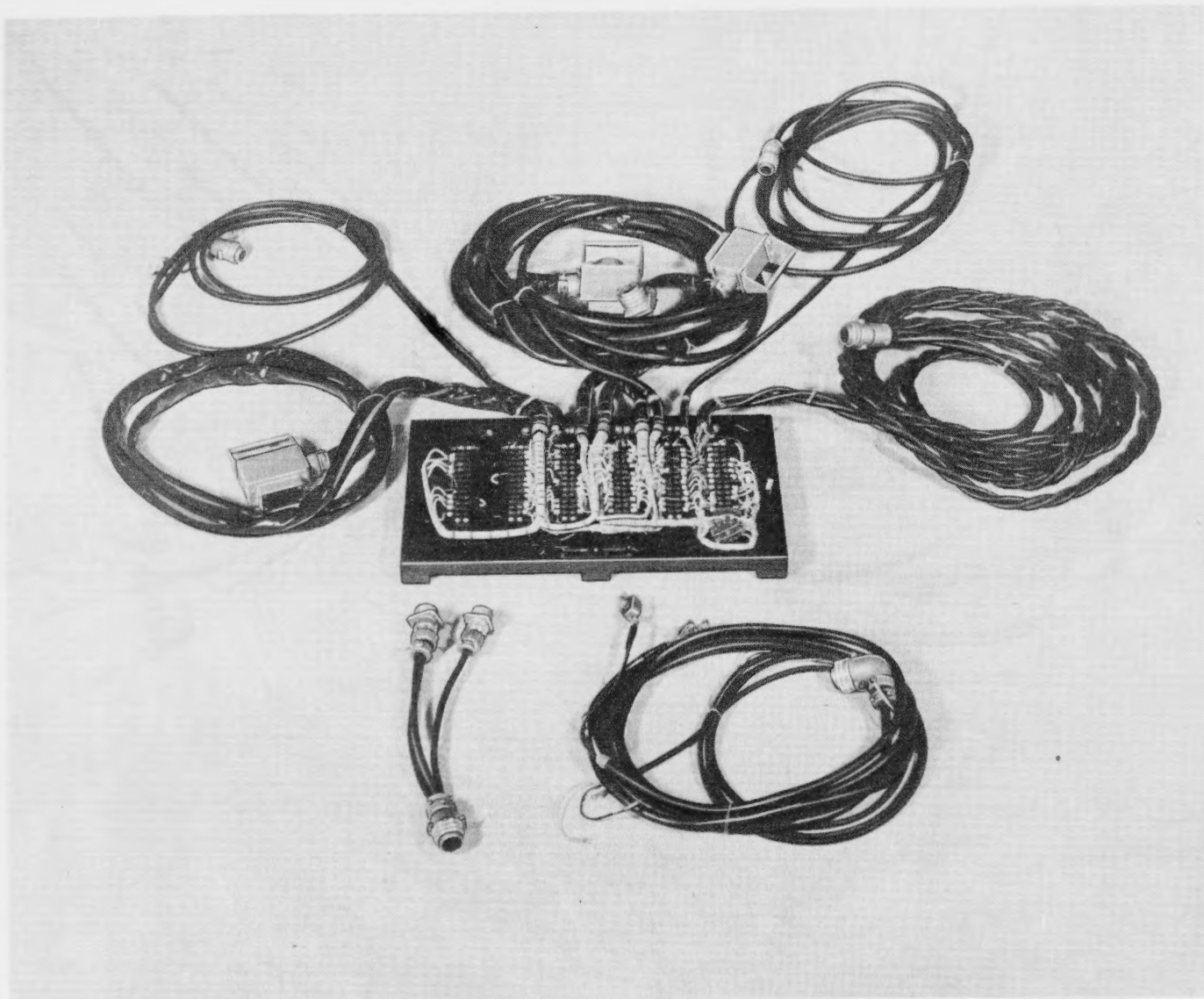


Figure 13-53. Test Junction Box—MK-25/ASQ-1

### TEST JUNCTION BOX

#### MK-25/ASQ-1

Primary purpose: To facilitate bench testing of AN/ASQ-1, 1A, 2, and 2A equipment.

This unit is a duplicate of the J-27/ASQ-1 junction

box supplied with the basic gear. This unit is used to make readily accessible for test purposes all points available in the system junction box, and is supplied complete with no attaching parts.

Mechanical characteristics:

Dimensions:  $16\frac{29}{32}$ " x  $9\frac{13}{32}$ " x  $9\frac{1}{4}$ ".

ASO stock No. R16-AN-MK-25/ASQ-1.

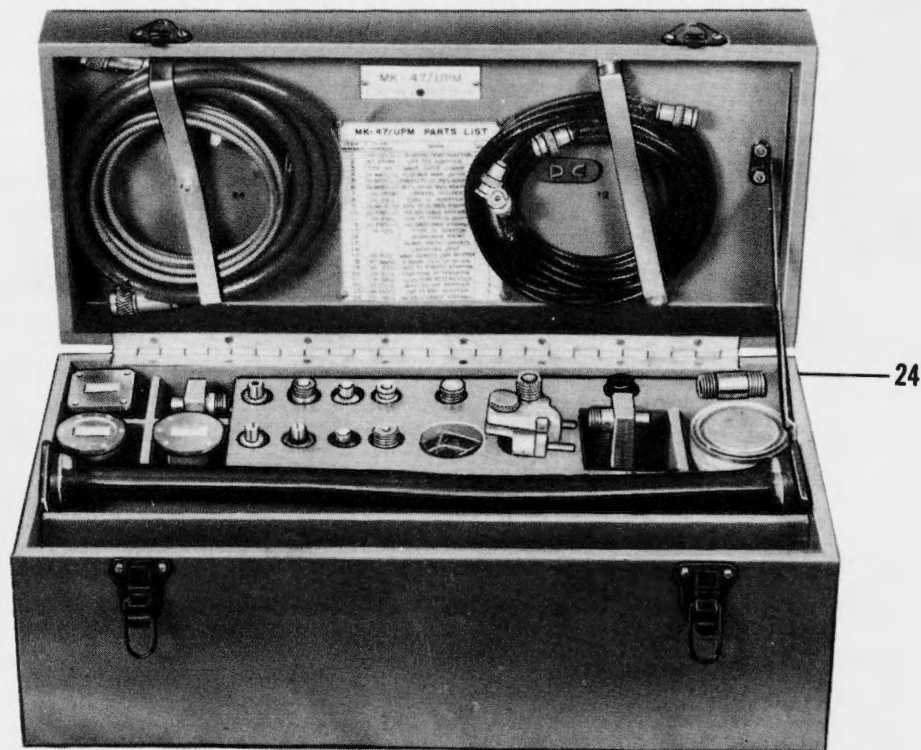


Figure 13-54. Maintenance Kit—MK-47/UPM

## MAINTENANCE KIT

### MK-47/UPM

Primary purpose: Maintenance of X-band radar system.

A kit of adapters and miscellaneous accessories which will facilitate the use of X-band test equipments with various X-band airborne radar systems that have non-standard test point connections.

Complete equipment consists of:

- (1) 1 Adapter, UG-332/U.
- (2) 1 Video "T" connection, 49199.
- (3) 1 Waveguide clamp for RG-52/U guide, TPX-39.
- (4) 2 Flexible piece of RG-52/U waveguide with choke and flange connectors, CG-164/U.
- (5) 1 Waveguide to coax adapter (RG-52/U type to UG-21/U), UG-81/U.
- (6) 1 X-band pick-up horn, AT-48/UP.
- (7) 1 BTL to Presto type flange to flange adapter, UG-163/U.
- (8) 1 Presto to UG-39/U type flange to flange adapter, CG-442/U.
- (9) 1 BTL to UG-39/U type flange to flange adapter, CG-443/U.
- (10) 1 Crystal Detector, UG-199/UP. (Input connection: 49195. Output connection: 49194).
- (11) 1 Connector, UG-29/U.
- (12) 1 TPX-PB/U (10)—10 db X-band coax attenuator, CN-57/U.
- (13) 1 TPX-PB/U (20)—20 db X-band coax attenuator, CN-58/U.
- (14) 1 AN/APS-3A type flange to UG-39/U adapter, CG-441/U.
- (15) 1 Cable assembly, CG-92A/U (consisting of 6 feet RG-9/U cable, 2 UG-21B/U connectors).
- (16) 2 Adapter, UG-255/U (49195 plug to UG-89/U).
- (17) 2 Adapter, UG-273/U (49194 to UG-88/U).
- (18) 1 Adapter, UG-83/U UG-21/U to 49194).
- (18) 1 Adaptor, UG-83/U (UG-21/U to 49194). 8 feet RG-58/U cable, 2 UG-88/U connectors).
- (20) 1 Adapter, UG-57/U.
- (21) 1 Bottle of aluminum paint.
- (22) 10 Pressed Monel Metal Gaskets, type #0045F38.
- (23) 1 Cable assembly, CG-150/U.
- (24) 1 Carrying case.



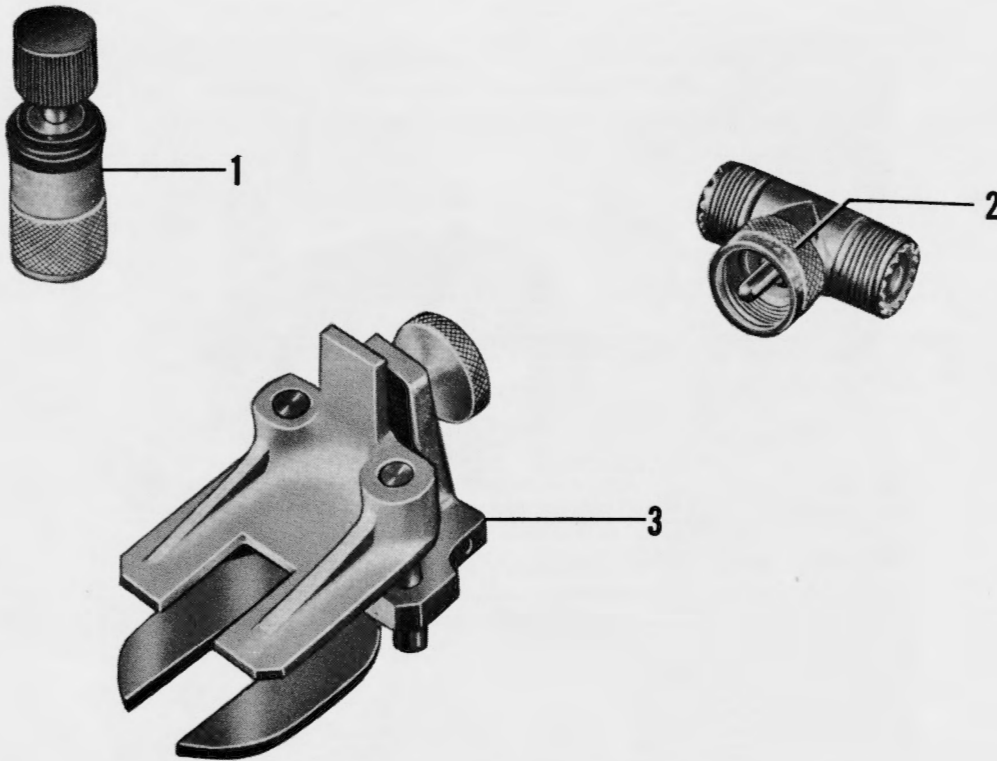


Figure 13-55. Parts of Maintenance Kit-MK-47/UPM

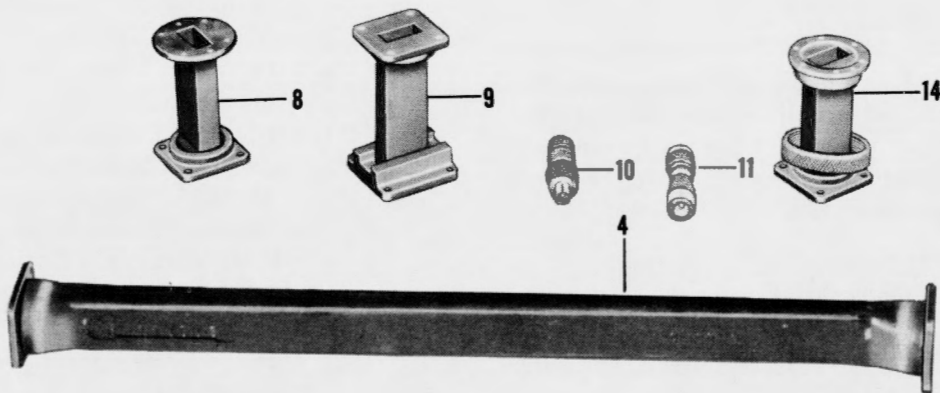


Figure 13-56. Parts of Maintenance Kit-MK-47/UPM

ASO stock No. R16-AN-MK-47/UPM.

(1) .....	(2) R16-C-36028.	(13) R16-AN-CN-58/U.	(14) .....
(3) .....	(4) .....	(15) .....	(16) R16-A-507.
(5) R16-A-407.	(6) R16-H-8150.	(17) R16-A-478.	(18) .....
(7) R16-P-2700-100.	(8) .....	(19) .....	(20) R16-A-567.
(9) .....	(10) .....	(21) .....	(22) .....
(11) .....	(12) R16-AN-CN-57/U.	(23) R16-AN-CG-150/U.	(24) .....



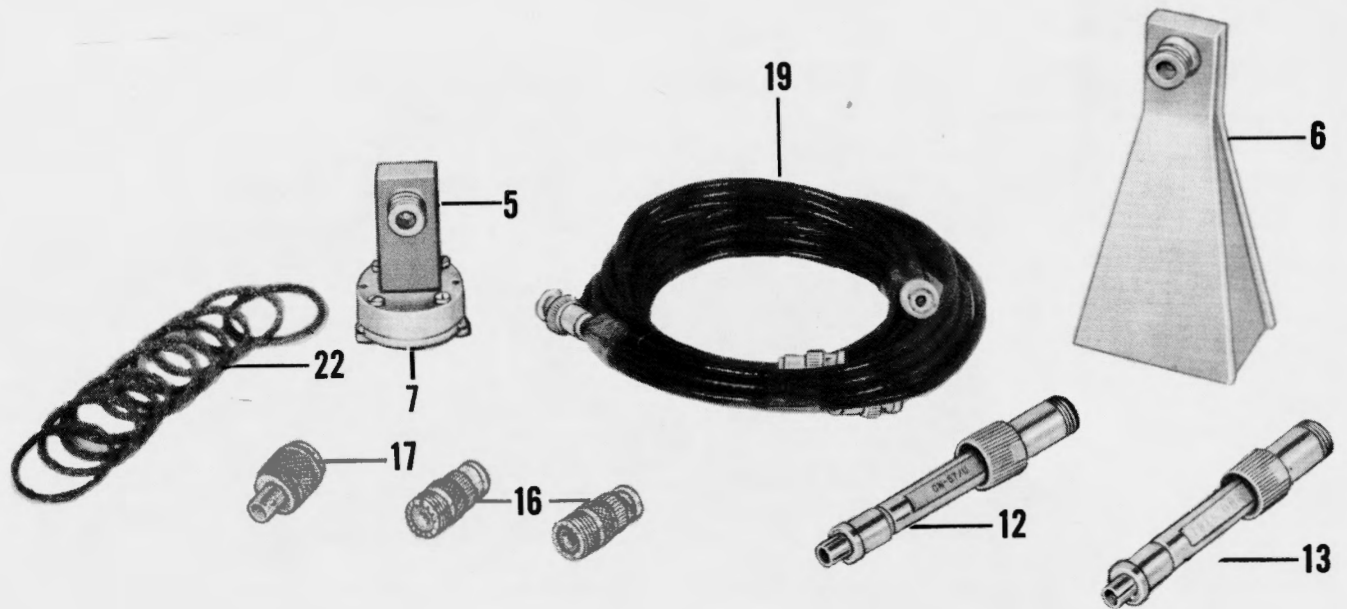


Figure 13-57. Parts of Maintenance Kit-MK-47/UPM

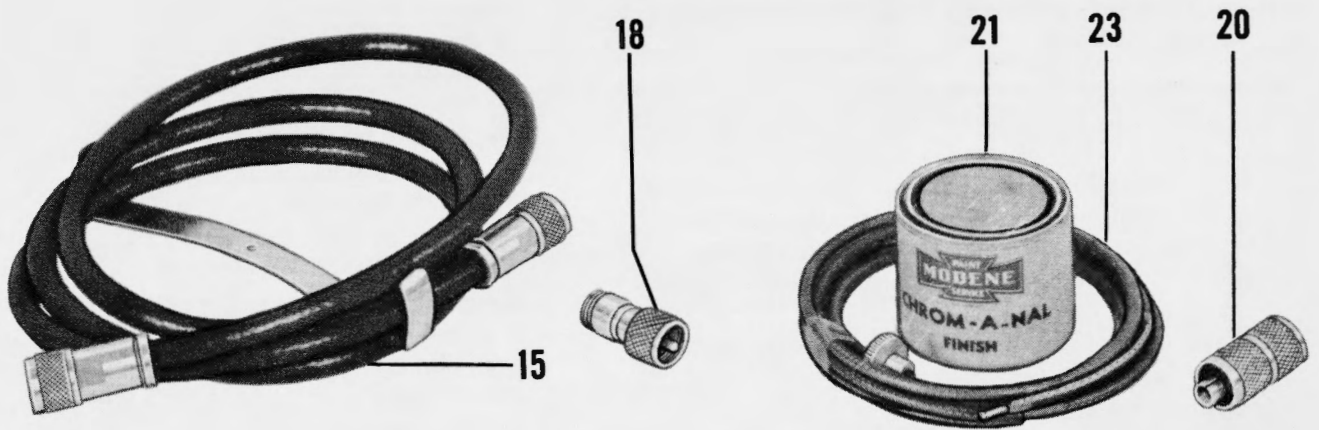


Figure 13-58. Parts of Maintenance Kit-MK-47/UPM

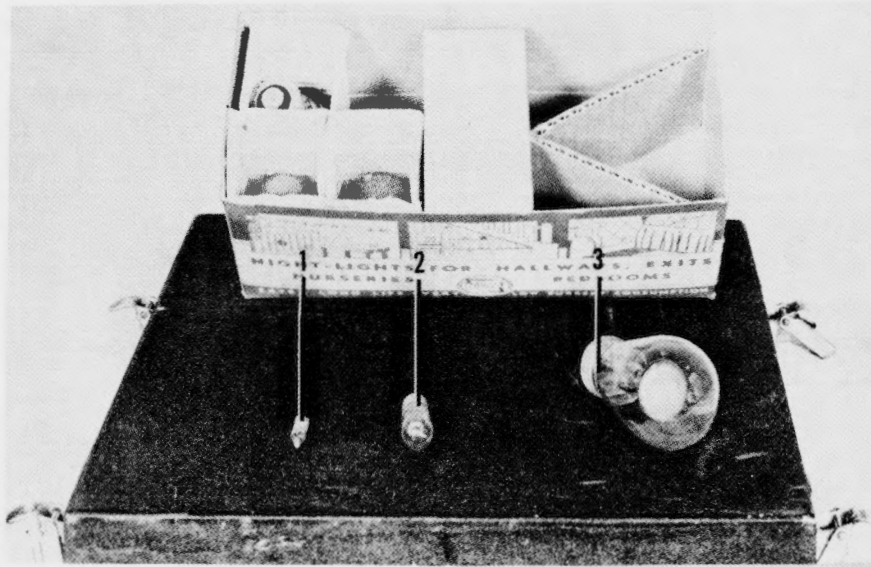


Figure 13-59. Neon Lamp Kit—MX-109/U

### NEON LAMP KIT

#### MX-109/U

Primary purpose: For RF indication in radio and radar testing.

The General Electric neon lamp kit consists of a package of assorted neon lamps.

A rod of insulating material with a neon bulb secured to one end provides a handy RF probe for servicing radio and radar transmitters.

Complete equipment consists of:

- (1) 10 Type Neon Lamps NE-2, 1/25-watt, 105-125-volt. Very small lamps having no bases, 2 stiff wires provide for connection. Similar to lamp used in FG communication equipment control box to indicate transmitter keying.
- (2) 6 Type T-41 $\frac{1}{2}$ , 1/4-watt, 105-125-volt. Candelabra size screw base.
- (3) 4 Type S-14, 3-watt, 105-125-volt. Medium size screw base.

ASO stock No. R17-K-470.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... |           |

### INTERFERENCE LOCATING EQUIPMENT

#### OF-2

Primary purpose: Locating interference in the 0.15 to 0.35 mc. and 0.54 to 20 mc. ranges.

The OF-2 equipment is a voltmeter capable of measuring r-f microvoltages. It is self-contained with the exception of the external battery supply.

It consists of a 2 band superheterodyne radio receiver which amplifies the input to the desired amplitude level for measurement by standard indicating instruments. A shot noise diode calibrator which must be initially compared with a signal generator is included.

Electrical characteristics:

Frequency Range:

0.15 to 0.35 mc.

0.54 to 20 mc.

Accuracy:  $\pm 10\%$ .

Sensitivity as Microvoltmeter:

10 to 100,000 microvolts.

2.5 to 25 microvolts (not direct reading).

Sensitivity as field strength meter: 10 to 100,000 microvolts.

Batteries: 2 type BA-58 (Penlite cells), 2 type 1.5 volts, (BA-35), 3 type 45 v., (BA-59), 4 type 4.5 v., (BA-31).

Tubes: 2 type 1T4; 2 type 1LE3; 1 type 1LC6; 1 type 1S5; 1 type 3A5.

Mechanical characteristics:

Dimensions: 14 $\frac{1}{8}$ " x 16 $\frac{3}{4}$ " x 9 $\frac{5}{32}$ ".

Weight: 34 pounds.

Complete equipment consists of:

- (1) 1 OF-2 Interference Locating Equipment.
- (2) 1 Section Collapsible Antenna 73" extended.

ASO stock No. R16-NAV-OF-2.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
|-----------|-----------|

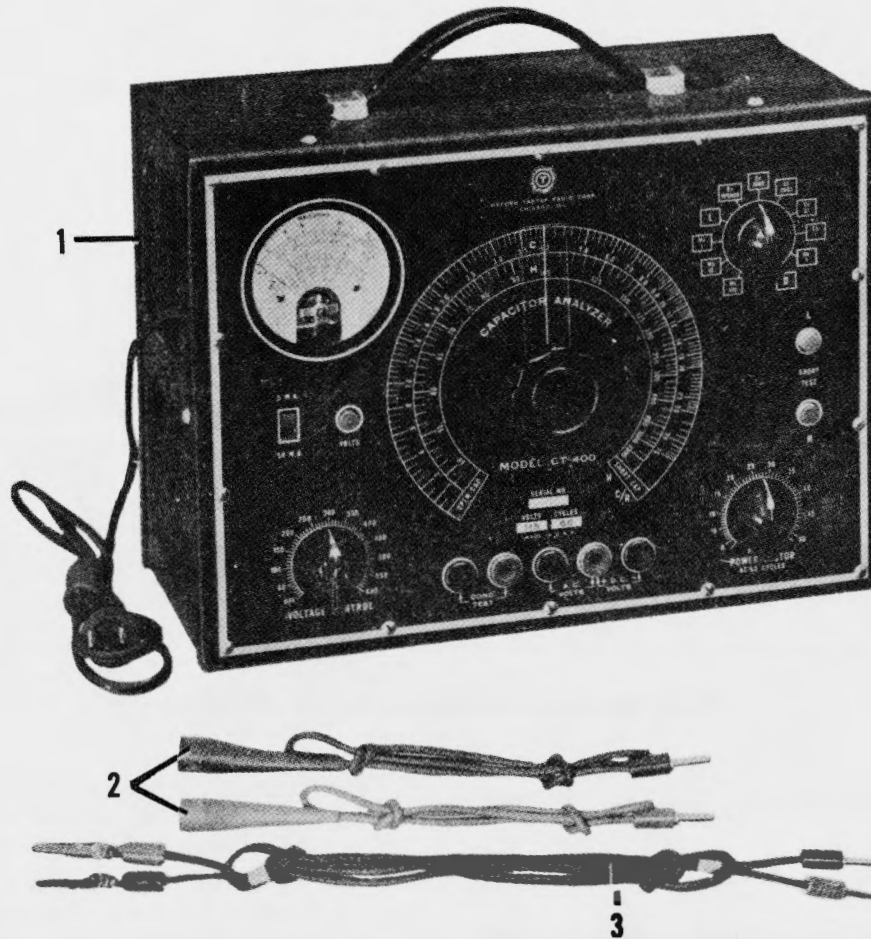


Figure 13-60. Condenser Tester—Oxford Tartac CT-400

## CONDENSER TESTER

### Oxford-Tartac CT-400

Primary purpose: Condenser testing and measuring, may also be used as a vacuum tube voltmeter, output meter, continuity tester, and insulation tester and ohmmeter.

The circuit consists of a balanced r-f oscillator to which the condenser under test is connected, a milliammeter indicator, a vacuum tube voltmeter, and power supply.

The tester will show open or shorted condensers and defective electrolytics without removing them from the equipment and with the equipment operating or "dead."

A continuously variable d. c. voltage from 0 to 550 volts is provided for measuring leakage. The power factor of electrolytic capacitors can be read directly from a scale calibrated from 0 to 50 percent. The vacuum tube voltmeter will measure d. c. voltages up to 550 volts and may also be used in r-f measurements and as an output indicator.

#### Electrical characteristics:

D. c. Voltmeter Range: 0-14-50-550 volts.

A. c. Voltmeter Range: 10-50 volts.

Capacity measuring range: 0.00001 to 2,000 mfd. in 4 ranges.

Resistance measuring range: 50 ohms to 10,000 megohms.

Power required: 110-volt, 60-cycle, 25 watts.

Tubes: 2 type 6J5; 1 type 6L6.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 11 $\frac{5}{8}$ " x 8 $\frac{3}{4}$ " x 6 $\frac{1}{2}$ ".

Weight: 12 pounds.

#### Complete equipment consists of:

- (1) 1 Condenser tester, Oxford-Tartac CT-400.
- (2) 2 Test leads terminated in pin plugs and insulated clips.
- (3) 2 Test leads terminated in pin plugs and alligator clips.
- (4) 1 Instruction book AN 08-45-40.

ASO stock No. R16-A-4368.

- |           |           |
|-----------|-----------|
| (1) ..... | (2) ..... |
| (3) ..... |           |



Figure 13-61. Electronic Power Supply—PP-106/U

## ELECTRONIC POWER SUPPLY

### PP-106/U

Primary purpose: General purpose voltage regulated power supply.

The PP-106/U is a power supply which can be used to provide power to various test equipments for bench use. It is particularly applicable to test equipments which are battery operated when it is desired to use them for extended periods on the bench. The LM-13 frequency meters and TS-24/ARR-2 oscillators are examples of battery operated equipment which can be used with the PP-106/U.

The unit provides a continuously variable, regulated d. c. output of 90 to 300 volts. This voltage is indicated on a 0-500 voltmeter on the front panel. A choice of 3 a. c. voltage outputs are also available (cannot use simultaneously) for filaments. An instruction sheet and circuit diagram is attached to the inside of the case.

#### Electrical characteristics:

##### Filament power output:

- 6.3 ± 0.3 volts at 5 amps.
- 12.6 ± 0.6 volts at 2.5 amps.
- 28.0 ± 1.0 volts at 2.5 amps.

##### Plate power output:

- 90 volts to 270 volts at 0.010 to 0.080 amperes, and 270 to 300 volts at 0.01 to 0.06 amps.

##### Accuracy, meter:

- ± 2% of full scale between 20°-25° C. at 30% humidity.

- ± 3% of normal reading between -30° to + 60° C. at relative humidities up to 95%.

#### Accuracy, output:

- Filament— ± 10% when supply voltage is varied ± 10% from 115 volts.

- Plate— ± 2% of d. c. output voltage at rated current.

Maximum Ripple: Less than 1.0 volts peak-to-peak.

Noise: Less than 5,000 microvolts between 200 kc. and 600 mc.

Power required: 115 volts ± 10%; 50 to 1,200 c/s, 1.6 amperes max.

Tubes: 1 type 6SJ7; 1 type 6X5GT/G; 2 type 1625; 1 type 5R4GY; 1 type OC3/VR-105; 1 Mazda lamp.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 14" x 7<sup>3</sup>/<sub>4</sub>" x 10<sup>9</sup>/<sub>16</sub>".

Weight: 44 pounds.

#### Complete equipment consists of:

- (1) 1 Electronic power supply, PP-106/U.
- (2) 1 Power cable, 10 feet long, CC-101.
- (3) 2 Cables, 4 feet long.
- (4) 1 Instruction book AN 08-35PP106-2.

ASO stock No. R16-P-7080.

- (1) .....
- (2) .....
- (3) .....

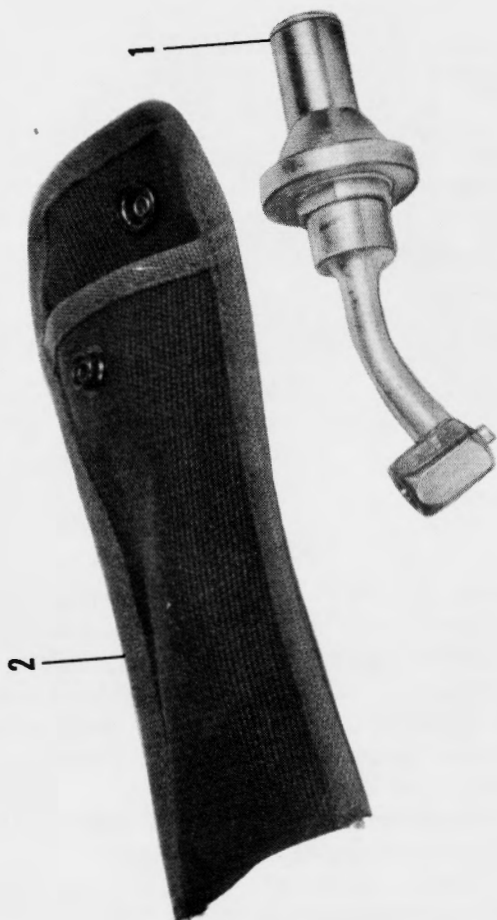


Figure 13-62. Pressure Indicator Valve—Schrader 3715

### PRESSURE INDICATOR GAUGE

Schrader #3715

Primary purpose: For taking pressure readings on pressurized units of aircraft electronic equipment.

Consists of an all metal pipe having an automobile type valve stem connector on one end and a plunger type indicator on the other end.

**Electrical characteristics:**

- Power required: None.
- Tubes: None.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: Over-all: 5<sup>3</sup>/<sub>8</sub>-inch length; 1<sup>1</sup>/<sub>2</sub>-inch diameter.
- Weight: 9 ounces.

Complete equipment consists of:

- (1) 1 Pressure gauge, Schrader #3715.
- (2) 1 Canvas envelope.

ASO stock No. R16-G-2637.

- (1) .....
- (2) .....

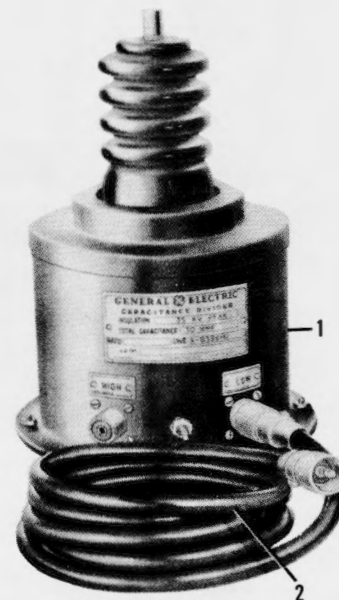


Figure 13-63. Pulse Voltage Divider—RL A45437  
G. E. Cat. 8317379 G-7

### PULSE VOLTAGE DIVIDER

RL #A5347, GE Cat. 8317379 G-7

Primary purpose: To faithfully reproduce at low-voltage levels, a high voltage, high frequency, pulse type waveform.

The pulse voltage divider designed for use with AEW systems provides a means of reducing high voltage pulses to a voltage which is within the limits of an oscilloscope, so that the pulse shape may be viewed on the scope. Fundamentally the circuit consists of two condensers in series and a voltage applied across the series will divide in a ratio proportional to the ratio of the condenser values.

**Electrical characteristics:**

- Frequency: Video.
- Insulation: 35 Kv. peak.
- Total capacitance of porcelain bushing: 30 micro-microfarads.
- Ratio: 200:1, 50:1.
- Power required: None.
- Tubes: None.
- Batteries: None.

**Mechanical characteristics:**

- Dimensions: 6<sup>1</sup>/<sub>4</sub>" x 5<sup>3</sup>/<sub>8</sub>" x 9<sup>1</sup>/<sub>8</sub>".
- Weight: 6 pounds, 5 ounces.

Complete equipment consists of:

- (1) 1 Capacitance voltage divider RL #A5347.
- (2) 2 Output cables, RG-11/U terminating in Navy type No. 49190 connectors.

ASO stock No. R16-MIT-A-5347.

- (1) .....
- (2) .....



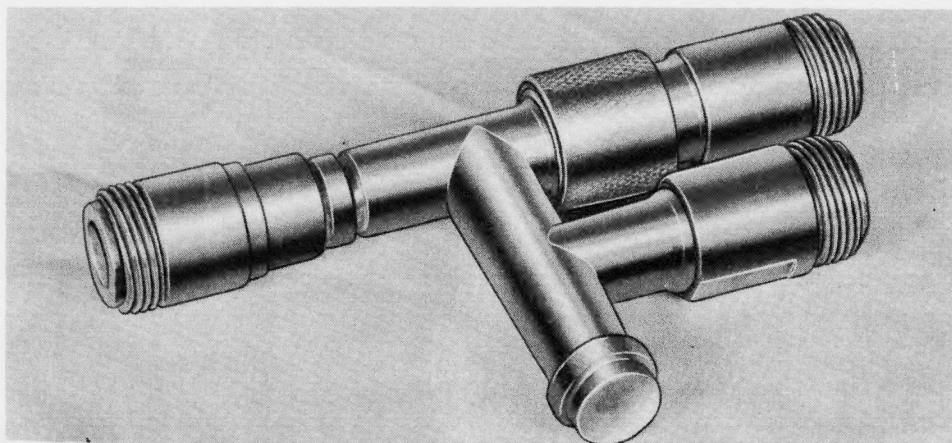


Figure 13-64. Dummy Mixer—TPS-70 CB

### DUMMY MIXER

#### TPS-70 CB

Primary purpose: For use as a dummy mixer with AN/APS-20.

This is a rectifier crystal holder with two connectors into which two different frequencies can be fed via suitable connectors and the difference frequency taken off a third connector. This method enables one to test the receiver without use of the system plumbing.

By substituting a fixed resistor in place of the crystal rectifier, a suitable match between a signal generator and IF strip will result, facilitating IF alignment.

**Electrical characteristics:**

Frequency: RF or video.

Power required: None.

Tubes: None.

Batteries: None.

**Mechanical characteristics:**

Dimensions: 2" x 3/4" x 5" (approximate).

Weight: 3/4 pound (approximate).

**Complete equipment consists of:**

- (1) 1 Dummy mixer TPS-70 CB.

ASO stock No. R16-NAV-TPS-70CB.

### TEST SET

#### TS-23/APN

Primary purpose: To test transmitter frequency, power, and pulse wave shape.

Test Set TS-23/APN is a portable equipment designed for depot testing of radio sets SCR-718-A, AM, B, and C. This test set is used to test the transmitter frequency, to check the transmitter power output, and to observe the

transmitter pulse wave shape. The test equipment is connected between the radio receiver-transmitter and indicator, and by use of a switching arrangement in the test set the signal can be made to pass through the desired test circuit. A diode rectifier, a resonant circuit wavemeter, and a 0-200 microammeter are included in the measuring circuits.

Three connecting cords CA-101, CA-102, and CA-103 are permanently attached to the test set.

**Electrical characteristics:**

Power supply test: Permits B + adjustment to 320 v. d. c.

Pulse shape test: Permits examination of 440 mc. pulsed corner signal.

Power test: Indicates a value between average and peak power. Sufficient for desired tests.

Frequency meter: Accurately fixed at 440 mc.

Tubes required: 1 type 9004.

Batteries: None.

Power required: 115 volts, 400-2400 cycles, 10 milliamperes.

**Mechanical characteristics:**

Dimensions: 11" x 6" x 4".

Weight: 6.9 pounds; case, 7.2 pounds.

**Complete equipment consists of:**

- (1) 1 Test Set, TS-23/APN.
- (2) 1 Case.
- (3) 2 Spare tubes type 9004.
- (4) 1 Allen wrench.
- (5) 1 Cord CD-800.
- (6) 1 Instruction book AN 16-35TS23-3.

ASO stock No. R16-AN-TS-23/APN.

- (1) .....
- (2) .....
- (3) .....
- (4) .....
- (5) .....

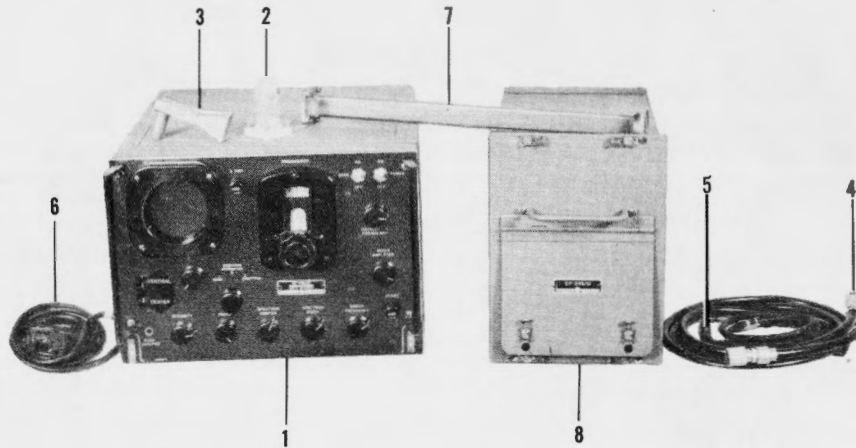


Figure 13-65. Spectrum Analyzer-TS-148/UP

## SPECTRUM ANALYZER

### TS-148/UP

Primary purpose: To test radar transmitters operating in the range 8470-9630 mcs.

This spectrum analyzer provides a visual indication of radio frequency oscillators which operate in the specified band. The test set includes a direct reading frequency meter which has a very open scale. Visual alignment of plumbing such as resonant chambers, mixer chambers, RT and TR boxes which will assure that all components are set to the same desired frequency may be accomplished by this test set. The equipment is shock mounted in a water-tight carrying case which also contains the accessories listed below.

#### Electrical characteristics:

Frequency Meter Range: 8470 to 9630 mc.

Sweep frequencies: 10 to 30 c. p. s.

Attenuation (spectrum amplitude): 3 to 70 db.

Frequency swing of R-F oscillator: 40 to 50 mc.

I-F band width: 50 kc.

#### Sensitivity to CW:

Spectrum Amplified: 80 db. below 1 watt.

Spectrum: 55 db. below 1 watt.

Maximum dispersion of spectra: 1.5 mc. per inch.

Power Output: 1 milliwatt.

Power Required: 105-125 volts, 50-1200 cycles, 125 watts.

Tubes: 2 type 6SJ7; 1 type 6SA7; 3 type 6SN7GT; 1 type 6Y6; 1 type 5R4GY; 1 type 2X2; 1 type 3BP1; 1 type 884; 1 type 2K25 or 723A/B; 4 type 991; 1 type 1N23A crystal detector.

Batteries: None.

#### Mechanical characteristics:

Dimensions: 25" x 19" x 13".

Weight: 45 pounds.

#### Complete equipment consists of:

- (1) 1 Spectrum Analyzer-TS-148/UP.
- (2) 1 Waveguide to Coaxial Adapter: UG-183/U.
- (3) 1 Antenna Horn-AT-68/UP.
- (4) 1 Antenna Horn Cable (6 feet)-CG-92/U.
- (5) 1 Mixer Cable (4 feet) CX-464/UP with PL-55 plugs.
- (6) 1 Power Cable (6 feet) CX-337/U.
- (7) 1 Flexible Waveguide-CG-182/APM-40-15.
- (8) 1 Spare parts box-CY-245/U.
- (9) 1 Carriage-MT-325/U (not illustrated).
- (10) 1 Case-CY-246/U (not illustrated).
- (11) 1 Choke-to-choke adapter-UG-144/AP (not illustrated).
- (12) 3 Allen wrenches #4, #6, #8 (not illustrated).
- (13) 1 Tuning wrench (not illustrated).
- (14) 1 Directional coupler-CG-176/AP (not illustrated).
- (15) 1 Instruction book-AN 16-35TS148-5.

#### ASO stock No. R16-A-AN-TS-148/UP.

- (1) .....
- (2) R16-WX-7415323-G1.
- (3) R16-AN-AT-68/UP.
- (4) R16-AN-CG-92/U.
- (5) R16-WX-7415326-G1.
- (6) R16-AN-CX-337/U.
- (7) R16-WX-7415324-G1.
- (8) .....
- (9) R16-AN-MT-325/U.
- (10) R16-AN-CY-246/U.
- (11) R16-AN-UG-144/AP.
- (12) .....
- (13) .....
- (14) .....

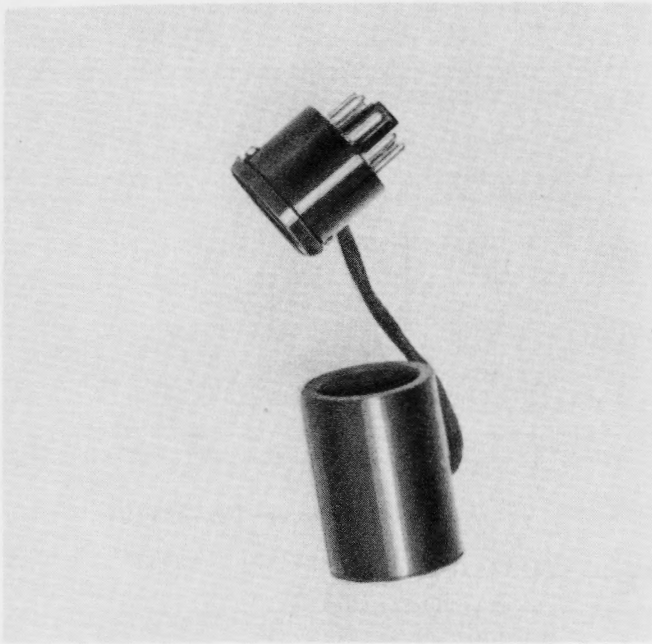


Figure 13-66. Tube Socket Adapter-U-48/U

### TUBE SOCKET ADAPTER

#### U-48/U

Primary purpose: To allow testing of type 446 tubes in the Hickok 540 and I-177 tube testers.

Two piece construction: socket adapter and cap connector; with 6-inch two-wire cable connecting the two. Consists of an octal tube socket mounted in a metal cylinder; the base of the cylinder is fitted with pins which will plug into an octal tube socket. All pins on the base are wired through to the corresponding plugs on the socket except for the grid and plate leads. A pair of wires connect to the grid (pin 5) and the plate (pin 3) in the base; the other ends of these wires connect to contactors in the cap connector.

#### Electrical characteristics:

- Power required: None.
- Tubes: None.
- Batteries: None.

#### Mechanical characteristics:

##### Dimensions:

- Socket adapter: 2½-inch length; 2-inch diameter.
- Cap connector: 1¼-inch length; 1½-inch diameter.

Weight: 5 ounces.

#### Complete equipment consists of:

- (1) 1 Tube adapter, U-48/U.
- (2) 1 Instruction sheet.

ASO stock No. R16-A-605.

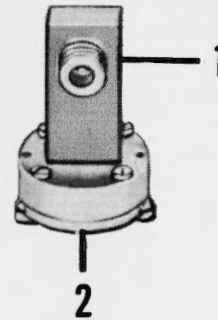


Figure 13-67. Adapter-UG-81/U and Adapter Plate-UG-163/U

### ADAPTER

#### UG-81/U.

Primary purpose: To provide a waveguide to coax adapter.

UG-81/U is a coaxial waveguide adapter used to adapt Radio Frequency Plug UG-24/U to Radio Frequency Line RG-52/U. On one end is a choke joint and on the other is a Radio Frequency Jack UG-25/U, or equivalent connector. The UG-81/U is part of Standing Wave Indicator TS-12/AP and Radio Frequency Test Set TS-13/AP.

#### Mechanical characteristics:

Weight: 7 ounces.

#### Complete equipment consists of:

- (1) 1 Adapter-UG-81/U.
- ASO stock No. R16-A-407.

### ADAPTER PLATE

#### UG-163/U

Primary purpose: To provide a means of adapting type BTL Connector to Presto type flange adapter for waveguides.

UG-163/U is an adapter plate consisting of a plain flange and BTL Special flange brazed together. It is used for connecting an adapter UG-81/U to coaxial line adapter attached to the transmission line of Radar Test Set AN/APM-3, -3A. It is also part of MK-47/UPM, Adapter Kit.

#### Complete equipment consists of:

- (1) 1 Adapter Plate UG-163/U. (See fig. 13-67, item 2.)

ASO stock No. R16-P-2700-100.

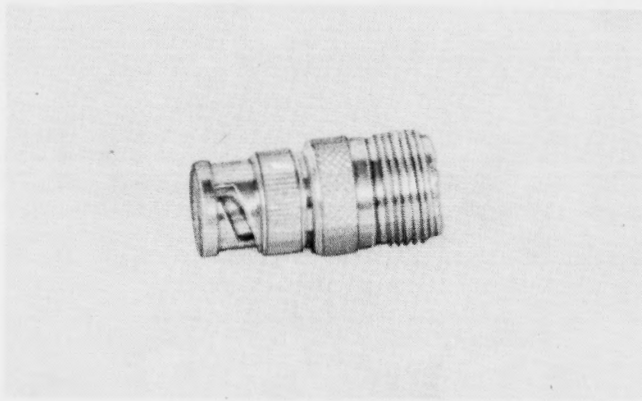


Figure 13-68. Adapter-UG-255/U

### ADAPTER

#### UG-255/U

Primary purpose: To provide a coupling between Navy type 49190 or 49195 plug to a Radio Frequency Jack UG-89/U, UG-90/U or Receptacle UG-185/U.

UG-255/U is an R.F. coaxial adapter assembly. At one end it has a receptacle similar to Navy type 49194 and the other end is similar to Radio Frequency Plug UG-88/U. Adapter UG-255/U is part of TS-239/UP and MK-47/UPM.

Mechanical characteristics:

Dimensions:

$\frac{5}{8}$ -inch outside diameter.

$1\frac{3}{8}$ -inch long.

Weight: 3 ounces.

Complete equipment consists of:

(1) 1 Adapter, UG-255/U.

ASO stock No. R16-A-507.

### ADAPTER

#### UG-273/U

Primary purpose: To provide a coaxial adapter to connect a type BNC receptacle to a UHF receptacle.

The UG-273/U Adapter consists of a brass silver-plated assembly which at one end is like plug Navy Type 49190 and S.C. Type plug PL-259. The other end is like Radio Frequency Jack UG-89/U. It is used to couple Radio Frequency plug UG-88/U to Navy Type 49194 receptacle (S.C. type socket SO-239). Adapter UG-273/U is part of TS-239/UP and MK-47/UPM.

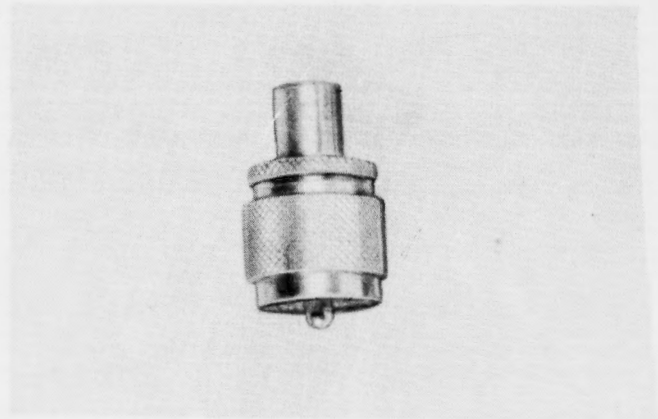


Figure 13-69. Adapter-UG-273/U

Mechanical characteristics:

Dimensions:

$\frac{3}{4}$ -inch outside diameter.

$1\frac{3}{8}$ -inch long.

Weight: 3 ounces.

Complete equipment consists of:

(1) 1 Adapter UG-273/U.

ASO stock No. R16-A-478.

### TEST ANTENNA ADAPTER

#### UG-302/U

Primary purpose: To provide an adapter which makes contact with a  $\frac{1}{4}$ -wave antenna and terminates in a Navy type connector 49194.

The UG-302/U Test Antenna Adapter provides a means for testing entire equipment installations while shielding the antenna from external radiation. It connects a  $\frac{1}{4}$ -wave antenna to a cable leading to test equipment; cable connection may be a Navy type 49195 or equivalent. Capable of handling up to 1000 pulse watts it is used with Test Set TS-182/UP and other equipment.

Mechanical characteristics:

Dimensions:

$2\frac{1}{2}$  inches diameter, 19 inches long.

Complete equipment consists of:

(1) 1 Test Antenna Adapter UG-302/U.

ASO stock No. R16-A-440.



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