

NAVSHIPS 91688



INSTRUCTION BOOK

for

TEST-TOOL SET
AN/USM-3A

RADIO FREQUENCY LABORATORIES, INC.

BOONTON, NEW JERSEY

BUREAU OF SHIPS

NAVY DEPT

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TABLE OF CONTENTS CONT'D

SECTION 4— CONT'D

<i>Paragraph</i>	<i>Page</i>
4. Interference Generator SG-23/U	4-13
a. Limitations	4-13
b. Operation of Interference Generator SG-23/U	4-13
c. Typical Applications	4-13
5. Voltage Indicator-Probe ID-265/U	4-13
a. Limitations	4-13
b. Operation of Voltage Indicator-Probe ID-265/U	4-13
c. Typical Applications	4-13
6. RF Indicator-Probe ID-263/U	4-14
a. Limitations	4-14
b. Operation of RF Indicator-Probe ID-263/U	4-14
c. Typical Applications	4-14
7. Resistance Indicator-Probe ID-264/U	4-15
a. Limitations	4-15
b. Operation of Resistance Indicator- Probe ID-264/U	4-15
c. Typical Applications	4-15
8. Decade Resistor TS-672A/U and Decade Capacitor TS-671/U	4-15
a. Limitations	4-15
b. Operation of Decade Resistor and Decade Capacitor	4-16
c. Typical Applications	4-16

SECTION 5—MAINTENANCE

<i>Paragraph</i>	<i>Page</i>
1. Tube Tester TV-4A/U	5-2
a. Preliminary Tests	5-2
b. Disassembly Procedure	5-2
(1) Tube Tester Case Removal	5-2
(2) Socket Panel Removal	5-4
(3) Chassis Removal From Bakelite Panel	5-4
c. Detailed Checks	5-4
2. Signal Tracer TS-673/U, Trouble Shooting	5-11
3. Interference Generator SG-23/U, Trouble Shooting	5-14
4. Voltage Indicator-Probe ID-265/U, Disassembly	5-15
5. RF Indicator-Probe ID-263/U, Disassembly	5-15
6. Resistance Indicator-Probe ID-264/U, Disassembly and Repair	5-15
7. Repair of Decade Resistor TS-672A/U and Decade Capacitor TS-671/U	5-15

SECTION 6—PARTS LISTS

1. General	6-0
------------------	-----

LIST OF ILLUSTRATIONS

SECTION 1—GENERAL DESCRIPTION			SECTION 4—OPERATION		
<i>Figure</i>	<i>Title</i>	<i>Page</i>	<i>Figure</i>	<i>Title</i>	<i>Page</i>
1-1	Test-Tool Set AN/USM-3A, Identification of Units	1-0	4-1	Curves, Capacity Reading Corrections for Various Power Line Frequencies for Capacity Meter Section of Tube Tester	4-1
1-2	Tube Tester TV-4A/U, Identification of Controls on Control Panel.....	1-1	4-2	Tube Tester in Operating Position.....	4-1
1-3	Signal Tracer TS-673/U, Test Prod MX-933/U, Test Prod MX-934/U, RF Cable Assembly CG-570/U (3'0''), Navy Type CTE-491898 Telephone Receiver, Navy Type CAOR-491901 Headband, and Navy Type CQG-62472 Power Cable Assembly; Identification of Units	1-2	4-3	Resistance Curve for Capacity Meter Section	4-8
1-4	Interference Generator SG-23/U and Navy Type CAOR-491895 Electrical Lead, Identification.....	1-3	4-4	Inductance Curve for 60 Cycles.....	4-8
1-5	Voltage Indicator-Probe ID-265/U and Navy Type CAOR-491899-A Electrical Lead, Identification	1-3	4-5	Inductance Curve for 400 Cycles	4-8
1-6	RF Indicator-Probe ID-263/U, Identification	1-4	4-6	Detecting Signal in IF Stage of Radio Receiver with Signal Tracer and Test Prod MX-934/U	4-10
1-7	Resistance Indicator-Probe ID-264/U, Identification	1-4	4-7	Curves Showing Frequency Response of Signal Tracer TS-673/U and Test Prod MX-933/U	4-11
1-8	Decade Resistor TS-672A/U, Identification	1-4	4-8	Curves Showing Frequency Response of Signal Tracer TS-673/U and Test Prod MX-934/U for Unmodulated Signals	4-11
1-9	Decade Capacitor TS-671/U, Identification	1-5	4-9	Curve Showing Modulated RF, IF Voltage Input to Test Prod MX-934/U vs AC Output Voltage	4-12
SECTION 2—THEORY OF OPERATION			4-10	Using the Interference Generator for Testing an RF Tuned Circuit	4-13
2-1	Simplified Schematic, Tube Test Section of Tube Tester	2-0	4-11	Measuring Line Voltage on Transformer with Voltage Indicator-Probe	4-14
2-2	Simplified Schematic, Capacity Meter Section of Tube Tester	2-2	4-12	Checking RF Output of Radio Transmitter at Antenna with RF Indicator-Probe	4-15
2-3	Simplified Schematic, Signal Tracer ...	2-3	4-13	Checking an Electrolytic Capacitor in a Radio Receiver with Resistance Indicator-Probe	4-15
2-4	Simplified Schematic, Interference Generator	2-4	4-14	Substituting Decade Resistor and Decade Capacitor in an Electronic Circuit	4-16
SECTION 3—INSTALLATION			SECTION 5—MAINTENANCE		
3-1	Resistance Indicator-Probe, Method of Removing Clamping Ring	3-1	5-1	Failure Report, Sample Form	5-1
3-2	Resistance Indicator-Probe, Disassembled	3-1	5-2	Side View of Tube Tester TV-4A/U, Case Removed	5-3
3-3	Interference Generator, Disassembled .	4-0	5-3	Angle View of Tube Tester, Case Removed	5-3
			5-4	Rear View of Socket Panel of Tube Tester TV-4A/U	5-4
			5-5	Front View of Sockets	5-5
			5-6	Schematic Diagram of Tube Tester TV-4A/U	5-6

LIST OF ILLUSTRATIONS, CONT'D

SECTION 5— CONT'D

<i>Figure</i>	<i>Title</i>	<i>Page</i>
5-7	Wiring Diagram of Tube Tester TV-4A/U	5-7
5-8	Rear View Front Panel, Signal Tracer TS-673/U	5-11
5-9	Top View, Signal Tracer Chassis	5-11
5-10	Bottom View, Signal Tracer Chassis ...	5-11
5-11	Schematic Diagram, (1) Signal Tracer TS-673/U, (2) Test Prod MX-933/U, (3) RF Cable Assembly CG-570/U (3'0''), and (4) Test Prod MX-934/U ..	5-12
5-12	Wiring Diagram of Signal Tracer TS-673/U	5-13
5-13	Schematic Diagram, Interference Generator SG-23/U	5-14

SECTION 5—, CONT'D

<i>Figure</i>	<i>Title</i>	<i>Page</i>
5-14	Adjustment of Signal Buzzer.I-301	5-14
5-15	Schematic Diagram, Voltage Indicator-Probe ID-265/U	5-15
5-16	Schematic Diagram, RF Indicator-Probe ID-263/U	5-15
5-17	Schematic Diagram, Resistance Indicator-Probe ID-264/U	5-15
5-18	Schematic Diagram, Decade Resistor TS-672A/U	5-15
5-19	Schematic Diagram, Decade Capacitor TS-671/U	5-16

LIST OF TABLES

SECTION 1—GENERAL DESCRIPTION

1-1	Electron Tube Complement	1-6
1-2	Battery Complement	1-6
1-3	Equipment Supplied	1-7
1-4	Technical Summary	1-8

SECTION 4—OPERATION

4-1	Socket Selection #1	4-5
4-2	Socket Selection #2	4-6
4-3	Toggle Switch and Socket Connections ..	4-6
4-4	Voltage and Current Output from Tube Tester	4-9

SECTION 5—MAINTENANCE

5-1	Resistance Table for Tube Tester	5-8
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SECTION 5—, CONT'D

5-2	Point-to-Point Voltages on Tube Tester for T-101 and LINE SHORT CHECK Circuits	5-9
5-3	Point-to-Point Voltages on Tube Tester for Filament and Socket Wiring	5-10
5-4	Point-to-Point Voltages, Signal Tracer TS-673/U	5-14
5-5	Tube Operating Voltages and Currents .	5-16
5-6	Tube Characteristics	5-16
5-7	Winding Data	5-17

SECTION 6—PARTS LISTS

6-1	List of Major Units	6-0
6-2	Combined Parts and Repair Parts List	6-1
6-3	Cross Reference Parts List	6-28
6-4	Color Codes and Miscellaneous Data ...	6-30
6-5	List of Manufacturers	6-31

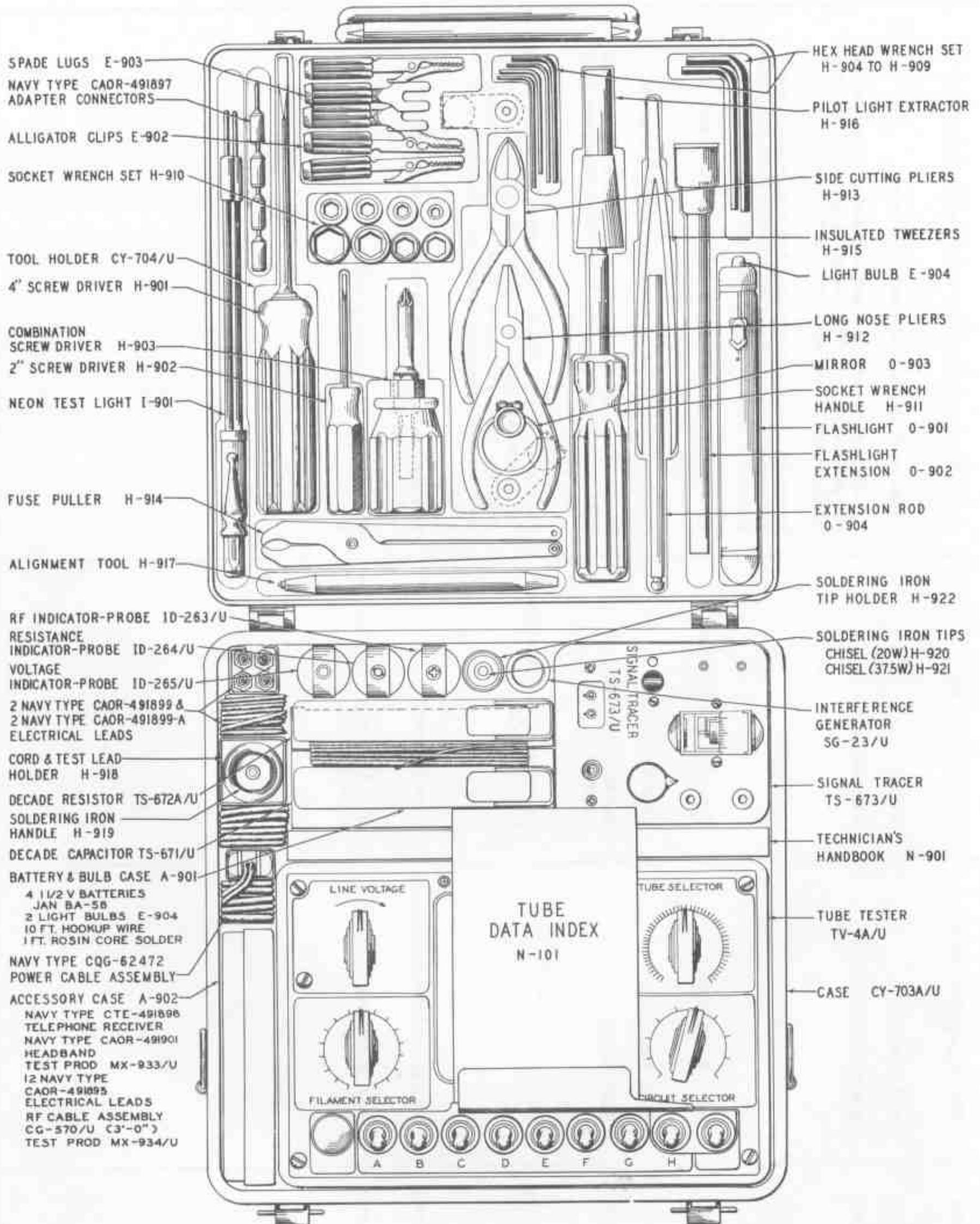


Figure 1-1. Test-Tool Set AN/USM-3A, Identification of Units

SECTION 1 GENERAL DESCRIPTION

1. INSTRUCTION BOOK COVERAGE.

This instruction book covers Test-Tool Set AN/USM-3A as shown in figure 1-1. The units are shown in place in the carrying case.

2. PURPOSE AND BASIC PRINCIPLES.

The Test-Tool Set AN/USM-3A is designed for use as a test and repair set for emergency repair on electronic and electrical equipment. It is intended only for getting equipment back into operation in a situation where more accurate test equipment is either unavail-

able or where all necessary precision test equipment is damaged or cannot be carried. To accomplish this end, a compact, lightweight case is supplied with the items as shown in figure 1-1 fitted into it so that all items are accessible and easily located.

3. DESCRIPTION OF UNITS

a. CASE CY-703A/U. (See figure 1-1.) - The Case consists of two drawn aluminum covers 9-1/2 x 9-1/2 x 3-1/2 inches which are hinged together, forming a box 7 inches deep. Latches, fittings, and a handle are provided.

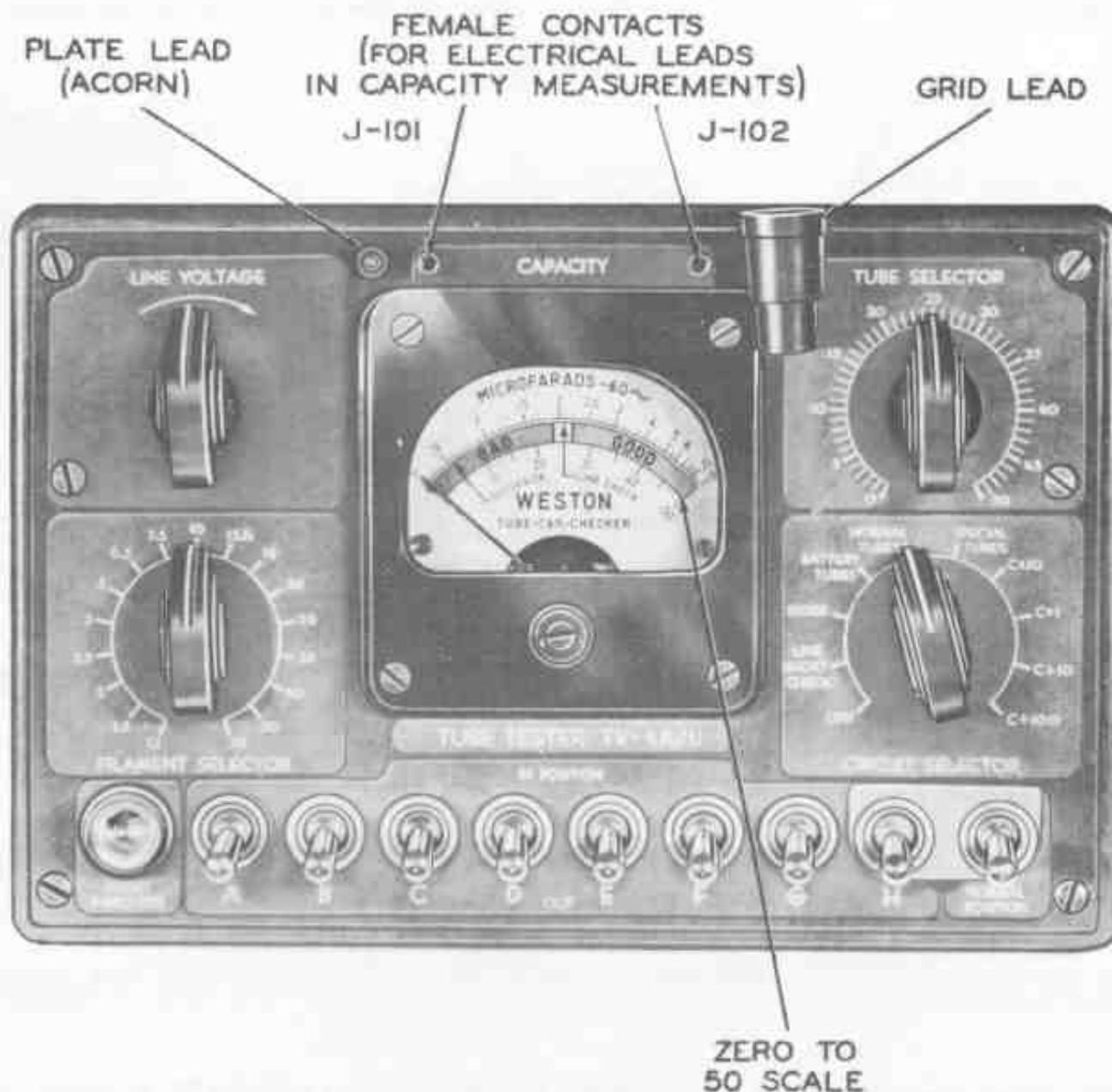


Figure 1-2. Tube Tester TV-4A/U, Identification of Controls on Control Panel

b. TUBE TESTER TV-4A/U. (See figure 1-2.) - This unit consists of a molded bakelite control panel on which are mounted the meter and all of the controls, a socket panel for all of the tube test sockets, and a wrap-around case enclosing the complete unit. Pin jacks are available at the top of the control panel for capacity readings in addition to all of the tube test functions. The complete assembly is mounted in a steel case and is pivoted on a full length hinge so that it can be raised into operating position through an angle of 45 degrees. The hinge is fastened to the front face of the Tube Tester and the front edge of the Case. A supporting arm, hinged at the bottom of the Case, holds the Tube Tester at a 45-degree angle when it is pivoted into position for operation.

Two grid leads are provided and extend from the front panel. One is a captive double-ended connector for contacting the top cap stud on metal and glass vacuum tubes; the other is an acorn connector lead that terminates in a small, split phosphor-bronze connector for attachment to the top pin of acorn tubes.

A 105- to 125-volt AC only, 50- to 1600-cycle single phase power supply source is required. The power demand at 115 volts is approximately 25 watts. From such a power source, tube test filament potentials at power line frequency are available in 17 steps: from 1.1 to 117 volts inclusive.

For the tube test function, two electrode potentials and four load impedances are available for diode, battery type, normal, and special type tubes. One meter reversing toggle switch and eight electrode toggle switches provide the required flexibility for the total emission and individual electrode emission tests on the various tube types listed in the Tube Data Index.

The indicating meter is calibrated with three scale arcs; the top arc for capacity readings, the middle arc for tube indications in three different colors, and the inside, or bottom, arc for comparative readings between different tubes of the same type. This inside arc is linear and is used for several purposes, as outlined in Section 2, paragraph 1(b).

The Tube Data Index is a small booklet attached to the Tube Tester by a panel bracket and is folded over the front face of the Tester when not in use. When the Tube Tester is raised to the operating position, the Tube Data Index can be rotated to the right and swung forward for ready reference.

c. SIGNAL TRACER TS-673/U. (See figure 1-3.) - This equipment consists of a variable gain amplifier and output meter. A Navy Type CQG-62472 Power Cable Assembly is provided for plugging in a 105- to 125-volt, 50- to 1600-cycle AC power source. Navy

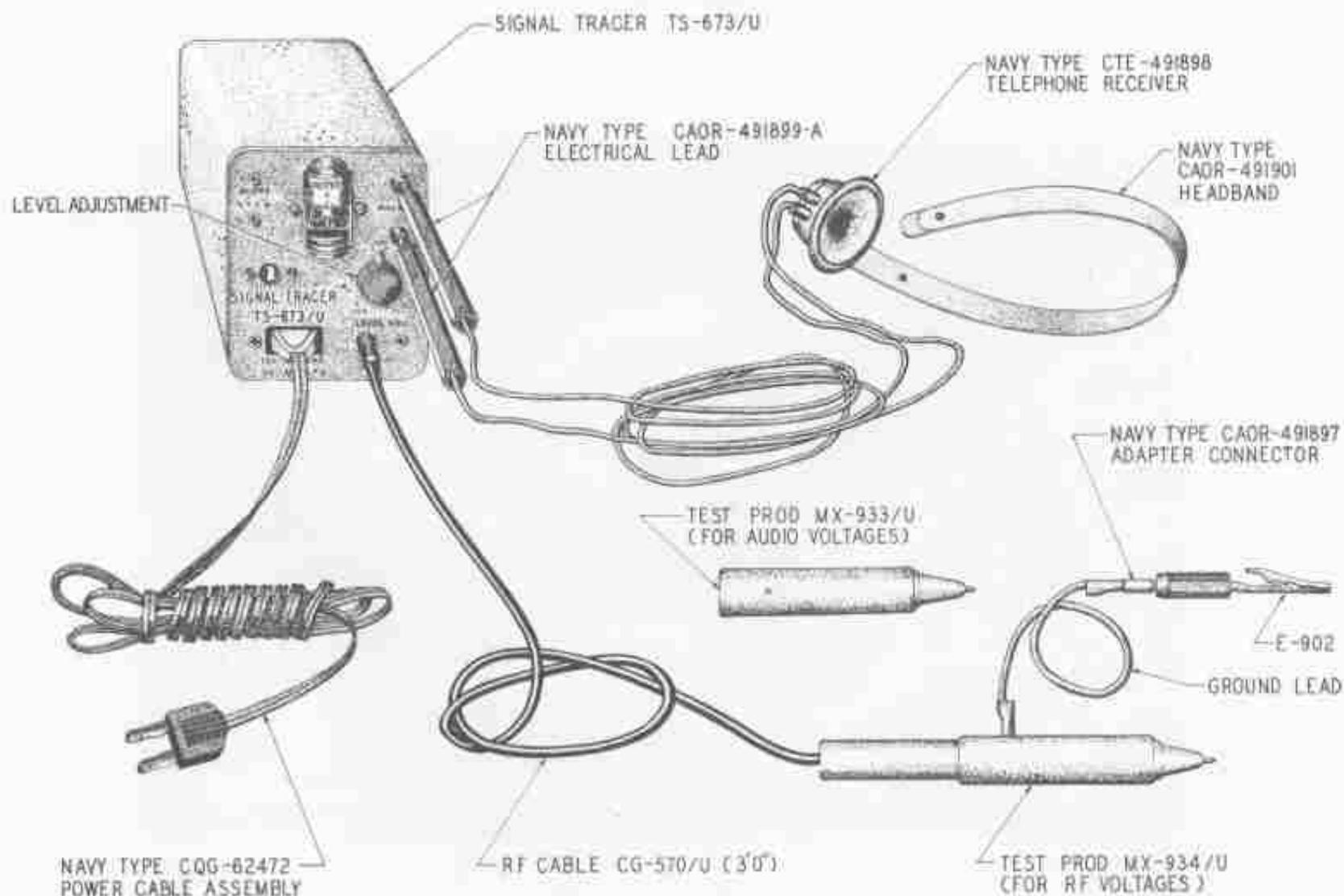


Figure 1-3. Signal Tracer TS-673/U, Test Prod MX-933/U, Test Prod MX-934/U, RF Cable Assembly CG-570/U (3'0"), Navy Type CTE-491898 Telephone Receiver, Navy Type CAOR-491901 Headband, and Navy Type CQG-62472 Power Cable Assembly; Identification of Units

Type CAOR-491897-A Electrical Leads are provided for connecting an oscilloscope, an earphone, or an electronic voltmeter to the output. The RF Cable Assembly CG-570/U (3'0") is used with Test Prod MX-934/U (for RF signals) and Test Prod MX-933/U (for audio signals). The Navy Type CAOR-491895 Electrical Lead with Navy Type CAOR-491897 Adapter Connector and Alligator Clip E-902 are used to ground the prod.

The amplifier is capable of amplifying AC voltages from 47 to 15,000 cycles per second when used with the Test Prod MX-933/U. Audio modulation on voltages having frequencies from 15,000 cycles to 400 megacycles is detected by Test Prod MX-934/U and amplified by the Signal Tracer. The Signal Tracer is located behind the Tube Tester as shown in figure 1-1.

The Telephone Receiver and Headband, RF Cable Assembly, Electrical Leads CAOR-491895, and Test Prods are in the Accessory Case to the left of the Tube Tester (see figure 1-1) and are listed in table 1-3 under Accessories.

d. INTERFERENCE GENERATOR SG-23/U. (See figure 1-4.) - This unit is an aperiodic impulse buzzer type generator housed in a probe case. Pressing the button at the top connects the battery to the buzzer. The white line on the button indicates the position of the attenuator. The buzzer is connected directly to the probe tip in position 1 and through a variable capacitor in positions 2 through 10. The buzzer frequency is approximately 1000 cycles per second with harmonics extending up to approximately 400 megacycles. It is used to generate audio and radio frequency voltages for test purposes. It is used with Navy Type CAOR-491895 Electrical Lead, Navy Type CAOR-491897 Adapter Connector, and Alligator Clip E-902. These items are located in the Accessory Case and in the Tool Holder. (See figure 1-1.)

The Interference Generator is located next to the Signal Tracer in the back of the Case as shown in figure 1-1.

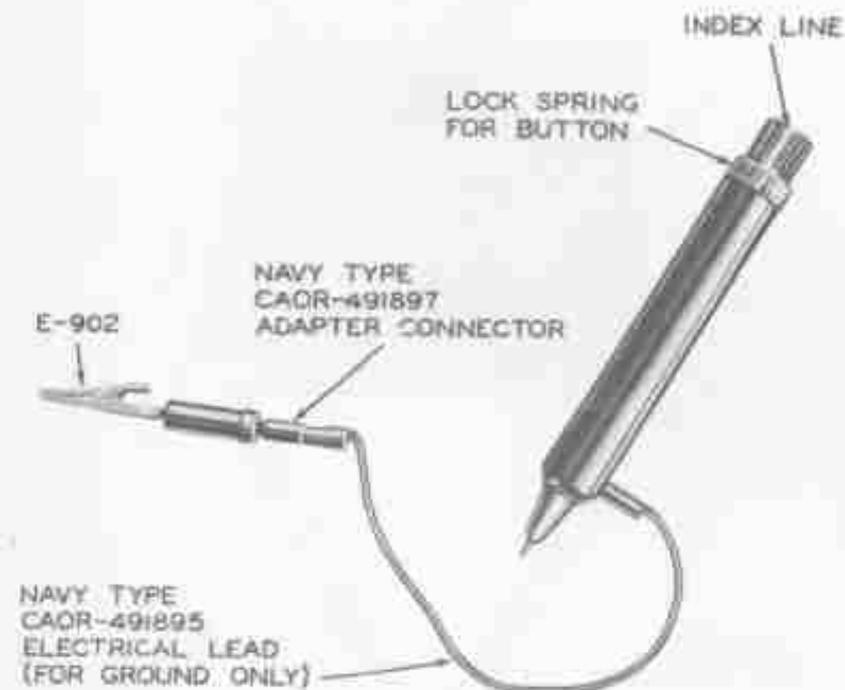


Figure 1-4. Interference Generator SG-23/U and Navy Type CAOR-491895 Electrical Lead, Identification

e. VOLTAGE INDICATOR-PROBE ID-265/U. (See figure 1-5.) - This unit is shown with its lead attached for a complete circuit. It consists of two meter elements so arranged electrically that one, M-401, indicates whether the line is AC or DC. If the line is DC, the polarity of the probe tip is indicated. The second meter movement M-402 indicates the magnitude of the voltage. The scale is marked 0, 55, 110, 220, and 440 volts. The AC voltage measured can be in the frequency range of 10 to 10,000 cycles. The lead used with this probe is Navy Type CAOR-491899-A, which is located on the Cord and Test Lead Holder H-918 behind the Accessory Case.

This Probe is located in the Case behind the Tube Tester. (See figure 1-1.)

NAVY TYPE
CAOR-491899-A
ELECTRICAL LEAD



Figure 1-5. Voltage Indicator-Probe ID-265/U and Navy Type CAOR-491899-A Electrical Lead, Identification

f. RF INDICATOR-PROBE ID-263/U. (See figure 1-6.) - This unit contains a meter movement and a crystal rectifier circuit housed in a plastic body. It is used to indicate the presence of electric RF fields of relatively large magnitude. Its sensitivity is of the order of 25% of full-scale when one volt of RF voltage is applied to the tip of the Probe. The hand capacitance of the operator supplies the return RF connection.

To reach into a deep chassis or into high voltage areas, the Extension Rod O-904 is provided. This rod slips onto the tip of the Probe. When used, it normally increases the sensitivity of the unit. It is stowed in the Tool Holder, and the Probe is located at the rear of the Case as shown in figure 1-1.



Figure 1-6. RF Indicator-Probe ID-263/U, Identification

g. RESISTANCE INDICATOR-PROBE ID-264/U. (See figure 1-7.) - Also of the probe type, this unit consists of a meter movement, a calibrating resistor, and a 1-1/2-volt battery enclosed in a plastic case. The scale is marked from 0 to 10,000 ohms. The electrical connections are at the probe tip and through a test lead plugged into the top of the case. This Probe is used with Electrical Lead CAOR-491899-A, which is located on the Cord and Test Lead Holder. For its location in the Test-Tool Set refer to figure 1-1.

h. DECADE RESISTOR TS-672A/U. (See figure 1-8.) - This unit consists of a molded plastic case housing 28 two-watt resistors, each insulated from the other. The values are arranged in a one, two, three, six series from one ohm to six megohms; thus allowing any value between one ohm and 12 megohms to be obtained in steps of one ohm by connecting the proper resistors in series by means of the Navy Type CAOR-491895 Electrical Leads. Figure 1-1 shows its location in the rear of the Case.



Figure 1-7. Resistance Indicator-Probe ID-264/U, Identification

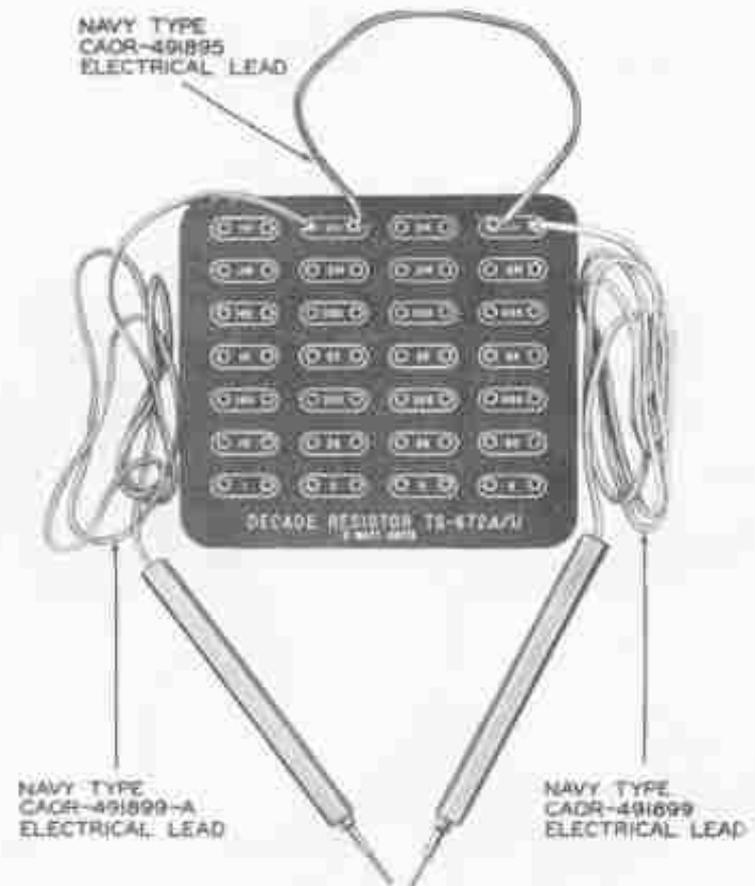


Figure 1-8. Decade Resistor TS-672A/U, Identification

i. **DECADE CAPACITOR TS-671/U.** (See figure 1-9.) - Consisting of a molded case similar to the Decade Resistor, this unit contains a series of capacitors covering a range between 0.0001 microfarad and 48 microfarads. Individual capacitors having values of 0.0001, 0.0003, 0.001, 0.003, 0.01, 0.02, 0.1, and 0.25 microfarads, rated at 600 volts, are placed as indicated by the front panel markings. The two 20/4-microfarad electrolytic capacitors each have a common negative. Other values in the range covered can be obtained by the use of electrical leads. The Decade Capacitor is located in the Case immediately in front of the Probes as shown in figure 1-1.

for the capacity meter function of the Tube Tester. They are stowed in the Tool Holder CY-704/U as shown in figure 1-1. The units adapt a banana plug to a phone tip jack.

m. **NAVY TYPE CAOR-491895 ELECTRICAL LEADS.** - These leads are eight inches long and have a combination banana plug and female connector on each end. They are used as grounding leads for the Test Prods and as patch cords for the Decade Capacitor and Decade Resistor.

n. **TOOL HOLDER CY-704/U.** (See figure 1-1.) - It consists of two pressed, transparent, plastic sheets with recesses provided for stowing each tool. The bottom sheet is fastened to the inside top of Case CY-703A/U. The top sheet holds the tools in their respective compartments and is secured by two snap-slides. The name and standard Navy stock number of each tool appears in the bottom of its individual compartment, and all tools are installed in the top of the Case. The top sheet, or tool cover, is held by a wire to prevent its loss when open.

o. **TECHNICIAN'S HANDBOOK.** (See figure 1-1.) - This book is provided for ready reference on the part of the operator when making emergency repairs and includes sufficient technical data and information necessary to use the Test-Tool Set. It is located in the Case in back of the Tube Tester.

p. **BATTERY AND BULB CASE.** (See figure 1-1.) - Pressed from plastic, this case provides storage space for four 1-1/2-volt flashlight batteries JAN BA-58, two flashlight bulbs, 10 feet of hook-up wire, and one foot of 50/50 rosin core solder.

q. **TOOLS AND MINOR ITEMS.** (See figure 1-1.) - The tools and items listed below are contained in the Tool Holder in the top of the Case, unless otherwise noted.

- (1) Fuse Puller H-914 - flat dual size.
- (2) Pilot Light Extractor H-916 - a rubber cup device to aid in the removal of pilot lamps from inaccessible locations.
- (3) Hex Head Wrench Set H-904 to H-909 - 0.050, 1/16, 5/64, 3/32, 1/8, and 5/32.
- (4) Insulated dental type Mirror O-903 - can be attached to Flashlight Extension O-902 to examine areas hidden from direct view.
- (5) Insulated Tweezers H-915 - 6 inches.
- (6) Flashlight O-901 with lucite Flashlight Extension O-902.
- (7) Long Nose Pliers H-912 - 4 inches.
- (8) Side Cutting Pliers H-913 - 4-1/2 inches.
- (9) Socket Wrench Set H-910 - 3/16, 7/32, 1/4, 9/32, 5/16, 11/32, 3/8 and 7/16 with Handle H-911.
- (10) Neon Test Light I-901 - 200,000 ohms impedance, 60-500 v AC, and 90-500 v DC - tests for presence of voltage.
- (11) Combination Screwdriver H-903 with interchangeable 1/4-inch slot drive bit and #2 Phillips drive - stubby size.
- (12) Screwdriver H-901 - 4 inches with 3/16-inch blade.

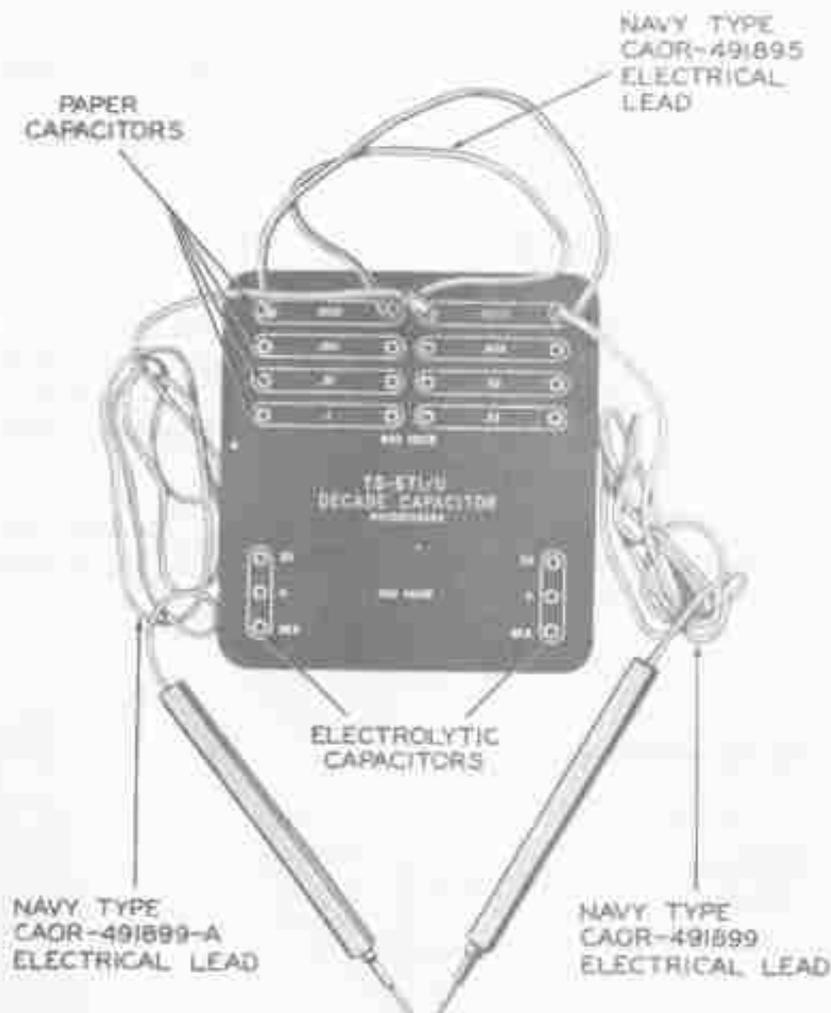


Figure 1-9. Decade Capacitor TS-761/U, Identification

j. **NAVY TYPE CQG-62472 POWER CABLE ASSEMBLY.** - This cable is used with the Tube Tester as a line cord or with the Signal Tracer as required. The cord is two-conductor, #18 AWG, 57 inches long with a male plug on one end and a female plug on the other end.

k. **NAVY TYPE CAOR-491899 AND CAOR-491899-A ELECTRICAL LEADS.** - These consist of two red and two black 30-inch leads with miniature banana plug terminals at one end and phone tip plugs on the other. The Navy Type CAOR-491897 Adaptor Connectors fit the capacity pin jacks directly above the meter of the Tube Tester and adapt the banana plugs of these leads to the pin jacks.

l. **NAVY TYPE CAOR-491897 ADAPTER CONNECTORS.** - Four of these units are provided. Two are used

(13) Screwdriver H-902 - 2 inches with 3/32-inch blade.

(14) Extension Rod O-904 - for use with all Probe units. It has a metal center conductor and plastic exterior. A removeable insulating cover is provided for use with the RF Indicator-Probe ID-263/U and for Test Prod MX-934/U.

(15) Three Alligator Clips E-902 - for test leads.

(16) Two Spade Lugs E-903 - for test leads.

(17) Alignment Tool H-917 - an insulated low capacitance screwdriver for adjusting variable trimmer capacitors.

(18) Pen type Soldering Iron H-919-115 volts, 50 to 1600 cycles. The unit is stored in Cord and Test Lead Holder H-918 as shown in figure 1-1.

(19) Cord and Test Lead Holder H-918 - frame for holding Navy Type CAOR-491899 and CAOR-491899-A Electrical Leads, Navy Type CQG-62472 Power Cable Assembly, and Soldering Iron Handle H-919. This unit is stored in Case as shown in figure 1-1.

(20) Accessory Case A-902 - container for stowing Test Prods MX-933/U and MX-934/U, RF Cable Assembly CG-570/U, Navy Electrical Leads CAOR-491895, Navy Type Telephone Receiver CTE-491898, and Navy Type Headband CAOR-491901. This unit is stored in Case as shown in figure 1-1.

(21) Soldering Iron Tip Holder H-922 - provides positive gripping of Soldering Iron Tips H-920 and H-921 for removal from Soldering Iron Handle H-919 when hot and for storage of same. This unit is stored in Case as shown in figure 1-1.

(22) Soldering Iron Tips H-920 and H-921, chisel type, 20 watts and 37.5 watts respectively. These units are mounted in Soldering Iron Tip Holder H-922.

4. REFERENCE DATA.

a. NOMENCLATURE. - Test-Tool Set AN/USM-3A.

b. CONTRACT. - NObsr-52269, dated 23 May 1951.

c. CONTRACTOR. - Radio Frequency Laboratories, Inc., Boonton, New Jersey.

d. COGNIZANT NAVAL INSPECTOR. - Inspector of Navy Materiel, Newark, New Jersey.

e. PACKAGES PER COMPLETE SHIPMENT. - One.

f. CUBICAL CONTENTS. - 5.9 cu. ft. crated; 0.42 cu. ft. uncrated.

g. TOTAL WEIGHTS. - 53 lbs. crated; 23 lbs. uncrated.

h. POWER SUPPLY. - Signal Tracer TS-673/U and Tube Tester TV-4A/U require 105 to 125 volts at 50 to 1600 cycles. Interference Generator SG-23/U and Resistance Indicator-Probe ID-264/U each require a self-contained 1-1/2-volt battery JAN BA-58.

i. POWER CONSUMPTION. - Signal Tracer TS-673/U consumes 7 watts. Tube Tester TV-4A/U consumes 25 watts at 115 volts, 60 cycles.

TABLE 1-1. ELECTRON TUBE COMPLEMENT

UNIT	SYMBOL DESIG.	TUBE TYPE
Tube Tester TV-4A/U	V-101	3A4
Signal Tracer TS-673/U	V-201	12AX7
	V-202	12AX7
	V-203	6AL5

TABLE 1-2. BATTERY COMPLEMENT

UNIT	JAN TYPE	STANDARD NAVY STOCK NUMBER OF UNIT	VOLT-AGE	MAX SIZE (INCHES)		NO. REQ.
				DIA.	LENGTH	
Flashlight	BA-58		1-1/2	37/64	1-31/32	2
Interference Generator	BA-58	F16-G-59001-1001	1-1/2	37/64	1-31/32	1
Resistance Indicator-Probe	BA-58	F17-P-84841-1831	1-1/2	37/64	1-31/32	1

TABLE 1-3. EQUIPMENT SUPPLIED

QUAN- TITY PER EQUIP- MENT	NAME OF UNIT	NAVY TYPE DESIGNA- TION	OVER-ALL DIMENSIONS (INCHES)			VOL- UME (CU FT)	WEIGHT (LBS)
			HEIGHT	WIDTH	DEPTH		
	MAJOR UNITS:						
1	Case	CY-703A/U	7	9-3/4	10-1/2	0.42	5.0
1	Tool Holder	CY-704/U	3/4	9-1/4	9-1/4	0.037	
1	Tube Tester	TV-4A/U	5-1/2	8-1/4	5-1/2	0.145	9.0
1	Signal Tracer	TS-673/U	3-1/2	3	5-3/4	0.035	2.0
1	Interference Generator	SG-23/U		3/4 diam	5-3/4		
1	Voltage Indicator-Probe	ID-265/U		1 diam	6		
1	RF Indicator-Probe	ID-263/U		1 diam	6		
1	Resistance Indicator-Probe	ID-264/U		1 diam	6		
1	Decade Resistor	TS-672A/U	3/4	4-3/4	4-3/8	0.009	
1	Decade Capacitor	TS-671/U	1-1/4	4-3/8	4-3/4	0.015	
	ACCESSORIES:						
1	Test Prod	MX-933/U					
1	Test Prod	MX-934/U					
1	RF Cable Assembly	CG-570/U (3'0")					
1	Telephone Receiver	CTE-491898					
1	Headband	CAOR-491901					
1	Power Cable Assembly	CQG-62472					
2	Electrical Lead (red)	CAOR-491899					
2	Electrical Lead (black)	CAOR-491899-A					
4	Adapter Connector	CAOR-491897					
12	Electrical Lead	CAOR-491895					
1	Extension Rod						
1	Cord and Test Lead Holder						
1	Battery and Bulb Case (w/2 bulbs, 10' of hook-up wire and 1' of solder)						
1	Accessory Case						
1	Technician's Handbook						
1	Tube Data Index						
	TOOLS:						
3	Alligator Clips						
2	Spade Lugs						
1	Screwdriver (4-inch)						
1	Screwdriver (2-inch)						
1	Combination Screwdriver						
1	Hex Head Wrench Set (0.050, 1/16, 5/64, 3/32, 1/8, 5/32)						
1	Socket Wrench Set						
1	Socket Wrench Handle						
1	Long Nose Pliers						
1	Side Cutting Pliers						
1	Fuse Puller						
1	Insulated Tweezers						
1	Pilot Light Extractor						
1	Alignment Tool						
1	Soldering Iron Handle						
1	Soldering Iron Tip (Chisel) 20 watt						
1	Soldering Iron Tip (Chisel) 37.5 watt						
1	Soldering Iron Tip Holder						
1	Neon Test Light						
1	Flashlight						
1	Flashlight Extension						
1	Mirror						
1	Instruction Book	NAVSHIPS 91688					

TABLE 1-4. TECHNICAL SUMMARY

TUBE TESTER TV-4A/U	Power supply:	105 to 125 volts, 50 to 1600 cycles.
	Power consumption:	25 watts at 115 volts and 60 cycles.
	Measurements:	(1) Tests all tubes listed in Tube Data Index for filament continuity, emission, shorted elements, and open elements. (2) Capacities from 0.001 to 100 microfarads when operated from 60 cycle per second power supply. See figure 4-1.
SIGNAL TRACER TS-673/U	Power supply:	105 to 125 volts, 50 to 1600 cycles.
	Power consumption:	7 watts.
	AF range:	47 to 15,000 cycles per second.
	RF range:	Audio modulated signals 15 kc to 400 megacycles per second.
	Audio sensitivity:	0.002 volt audible in earphone. 0.004 volt for 1/2-scale M-201.
	RF sensitivity:	0.005 volt of 50% modulated RF audible in earphone. 0.05 volt of 50% modulated RF for 1/2-scale M-201.
INTERFERENCE GENERATOR SG-23/U	Power supply:	1-1/2-volt battery JAN BA-58.
	Current:	0.09 amp.
	Frequency:	Audio approx 1000 cycles per second. Harmonics to approx 400 megacycles per second.
VOLTAGE INDICATOR- PROBE ID-265/U	Measurements:	(1) 0 to 440 volts AC or DC. (2) DC polarity.
	Frequency range AC:	10 to 10,000 cycles per second.
	Impedance:	510,000 ohms.
RF INDICATOR- PROBE ID-263/U	Useful frequency range:	100 kc to 400 megacycles per second.
	Sensitivity:	25% full-scale for one volt RF direct connected.
	Sensitivity, approx with extension rod in RF field:	5 volts/meter for 25% full-scale.
	Max RF signal:	10 volts across crystal diode.

TABLE 1-4. TECHNICAL SUMMARY, CONT'D

RESISTANCE INDICATOR- PROBE ID-264/U	Measurements:	0 to 10,000 ohms.
	Power supply:	1-1/2-volt battery JAN BA-58.
DECADE RESISTOR TS-672A/U	Power rating:	Two watts per resistor. 10 watts for unit.
	Tolerance:	±10%.
	Range:	One ohm to 12 megohms in one- ohm steps.
DECADE CAPACITOR TS-671/U	Range:	0.0001 to 48 microfarads.
	Tolerance (paper):	±10%.
	Voltage rating (paper):	500 volts DC.
	Tolerance (electrolytic):	-0% +75%.
	Voltage rating (electrolytic):	450 volts DC.
TEST PROD MX-934/U	Maximum RF signal:	20 volts.
	Voltage rating:	400 volts DC.
TEST PROD MX-933/U	Maximum AF signal:	100 volts.
	Voltage rating:	400 volts DC.
	Input resistance:	One megohm.
	Input capacitance:	0.0001 microfarad.

SECTION 2 THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS.

a. BASIC CIRCUITS OF TUBE TESTER TV-4A/U. (See figure 2-1.) - The major circuit sections of the Tube Tester are shown in the simplified schematic, figure 2-1. Energy for all tube elements is supplied by the power transformer through the FILAMENT SELECTOR switch, CIRCUIT SELECTOR switch, and TUBE SELECTOR control to the socket panel. For purposes of explanation, the unit can be subdivided into the following basic circuit sections.

(1) POWER TRANSFORMER. - The transformer supplies all potentials for the tube test functions as well as for the capacity meter ranges. Basically, this transformer consists of a primary winding and three secondary sections with a total of 29 terminals. All windings are accurately wound so that a single line control of the potentiometric type in the primary circuit can be used to adjust all of the secondary voltages.

(2) FILAMENT SELECTOR. - This consists of a 17-position switch with each contact connected to a transformer tap on the filament winding. Filament voltages can thus be individually selected in steps from 1.1 volts to 117 volts by rotating the switch knob. The operator should realize that it is important to index this switch correctly as the first operation in testing a tube.

NOTE

Excessive filament voltage will, in most cases, burn out the filament or ruin the tube.

(3) CIRCUIT SELECTOR. - The CIRCUIT SELECTOR switch is a 10-position rotary switch and performs the following functions.

(a) On-off switch energizes or disconnects the Tube Tester from the line circuit.

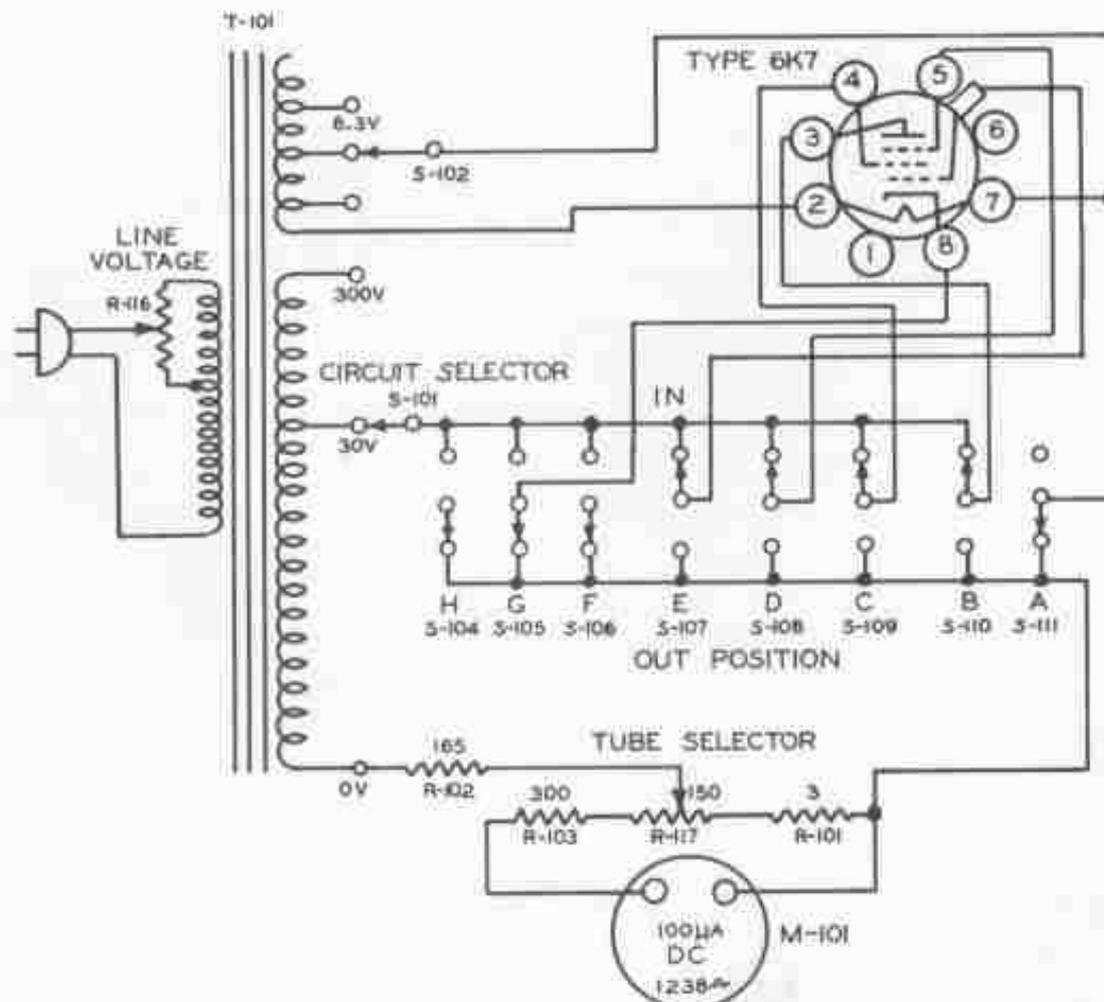


Figure 2-1. Simplified Schematic, Tube Test Section of Tube Tester

(b) Connects the indicating meter into the line check circuit for line voltage reading.

(c) Applies potential to the short test circuit to energize the neon SHORT INDICATOR lamp.

(d) Selects four different load resistances and voltage combinations for diodes, battery types, normal, and special type tubes.

(e) Connects the indicating meter into the capacity meter network, as shown in the simplified schematic, figure 2-2, and is used on four positions to select the required capacity range. The switch is so designed that the Tube Tester transformer will be energized on all switch positions except the first position marked OFF.

(4) TUBE SELECTOR. - This is a wire-wound potentiometer used for controlling the sensitivity of the indicating meter for all tube test emission readings. This control must always be indexed to a definite number in accordance with the Tube Sel. column of the Tube Data Index. A wide range of adjustment is necessary on this sensitivity control due to the large variation in different types of vacuum tubes.

(5) ELECTRODE SWITCHES. - As shown in figure 2-1, these switches connect between the socket panel and the electrode energizing circuits, with the exception of the filament circuit. Filament current is not fed through these switches. The switches are used individually or in groups for both tube tests and short tests. The first electrode switch marked A is used particularly for the cathode leakage test on indirectly heated tubes. It also releases the tapped filament connection on those tubes having three filament connections. Tubes of this type are printed in green in the Tube Data Index. The other electrode switches marked B through H are each connected to a socket terminal and control the energization of that terminal. One switch is used for each active tube element. Table 4-3 shows the socket terminal controlled by each switch. The lower right-hand switch marked NORMAL POSITION in figure 1-2 is the meter reversing switch. As it is only used for tests on three or four particular tubes, it is not shown in figure 2-1.

(6) SOCKET PANEL. - The socket panel is actually a separate subassembly and is wired and tested as a complete unit before assembly in the Tube Tester. All socket terminals are wired directly to a single terminal strip, which in turn connects to the electrode switches, as shown in figure 2-1. The tube test sockets in the socket panel are labeled with one of three letters, A, B, or R, and the proper selection is made by noting the pin arrangement of the tube to be tested and by referring to the Sock. column in the Tube Data Index. Generally speaking, those sockets lettered with an R are used for tubes having regular or normal filament connections. Sockets labeled with an A or B are used to test tubes having filament connections which are not normal. A combination socket near the left-hand edge of the socket panel is used for testing all four-prong, five-prong, and six-prong tubes. The large seven-pin socket, next in line, will accommodate both large and small diameter seven-pin bases. The acorn socket is designed to take five and seven radial pin acorn tubes with or without axial contacts. Octal, loctal, and miniature seven- and nine-pin sockets are also available.

(7) SHORT TEST CIRCUIT. - The short test circuit consists of a transformer winding in series with a rectifier which supplies the DC current required for the SHORT INDICATOR neon lamp and also for the LINE CHECK meter reading. Since the indicating meter is a DC milliammeter, a rectifier is required between the transformer and the meter. This rectifier is a type 3A4 miniature tube V-101 connected as a diode. It is mounted inside the equipment with the other components and supplies DC potential for both short test and line check functions.

(8) LINE VOLTAGE. - This is a power type potentiometer for adjusting all test potentials.

(9) INDICATING METER. - This meter is basically a DC milliammeter operating in conjunction with the electron tube rectifier for the LINE CHECK reading. It functions with a full-wave copper-oxide rectifier for capacity readings and is used directly as a DC milliammeter for tube test readings.

b. METHODS OF MEASUREMENT USING TUBE TESTER TV-4A/U. - Most tube failures are due to one or more of the following defects.

- (1) An inter-electrode short.
- (2) Low cathode to heater resistance, also referred to as cathode leakage.
- (3) Poor electron emission from heater or cathode.
- (4) Open element connection.
- (5) Instability due to loose parts.

Tests for each one of these defects can be made by the Tube Tester TV-4A/U. The neon lamp marked SHORT INDICATOR is used for the determination of the first two. Failure of the types listed under (3), (4), and (5) above can be detected by watching the instrument pointer.

For the inter-electrode short test, each element of the tube is individually isolated by one of the electrode switches, and a DC potential is applied in series with the short indicator. The polarity of this potential is opposite to that required for normal emission current and, in this way, the SHORT INDICATOR will only register leakage resistance or actual short circuit between elements. The tube filament is heated to normal temperature for all short testing.

The cathode leakage test applies only to tubes of the indirectly heated type as marked by a small star after the type number in the Tube Data Index. Here the heater is isolated from the cathode by operation of the electrode switch marked A; a potential is applied through the short indicator circuit; the resultant heater-cathode resistance below 1/2 megohm will cause the SHORT INDICATOR neon lamp to light. The short indicator sensitivity must be limited to this value, since many indirectly heated tubes are manufactured under specifications approaching 1/2 megohm for minimum heater-cathode resistance.

The emission characteristic is indicated on the meter in terms of a three-color scale with segments in red, yellow, and green. Readings in the red section indicate at once that the tube is defective, except for tests on

diodes. Readings in the yellow section indicate a borderline tube very close to the rejection point. Pointer deflections into the green section indicate a good tube or one that has a normal emission characteristic. However, an emission reading that falls off even though in the green section indicates a bad tube. Where comparative emission readings may be useful or data are to be recorded, the 50-line scale arc marked 0 to 50 is available. Meter readings as noted on this 50-line arc provide a means for plotting the fall-off in emission on any tube throughout its normal life.

The basic principle of operation can be readily understood by referring to the simplified schematic, figure 2-1, showing a 6K7 tube under emission test.

All potentials applied to the tube are AC and are delivered by transformer T-101. Resistors R-101 and R-103 and the control R-117 form a network that provides a sensitivity adjustment on the indicating meter. Note that R-117 is the TUBE SELECTOR control. R-102 is the load resistor and serves to limit the maximum current drawn from the tube under test.

Indexing toggle switches S-104 through S-110 to the IN POSITION selects the tube electrodes to be checked. Note that only those toggle switches that connect to a tube element are indexed to the IN POSITION, and when in this position all of these elements are tied together. Any toggle switches corresponding to a heater or cathode connection must be in the OUT position. The toggle switches to be placed to the IN POSITION for any particular tube type are listed in the Tube Data Index under the "IN" Position column.

The energizing potential is produced by the 30-volt winding of T-101. This winding is connected in series with the following series of components: (1) the load resistor R-102, (2) the DC meter including its variable sensitivity network (R-103, R-117, and R-101), (3) the cathode of the tube under test, (4) back through the tube elements (the socket terminals 3, 4, 5, and the tube cap), and (5) back to the 30-volt winding by way of those toggle switches that are in the IN POSITION.

Since the tube under test acts as a half-wave rectifier and there is a closed circuit, the meter will indicate a current which is a function of the cathode emission.

For checking diode or battery type tubes the circuit is the same, except that an additional resistance, R-112 or R-113 respectively, is inserted in series with the 30-volt winding of T-101. For special types, the original circuit is used, except that the 30-volt potential is changed to 300 volts with R-115 inserted in series. See figure 5-6.

Open elements can be detected by connecting or disconnecting each electrode from the indicating and energizing circuit. This operation is performed by operating the individual electrode switches as listed in the Tube Data Index. The change in emission reading is noted on the meter.

Intermittent operation due to loose electrodes, their supports, or faulty connections in the tube under test can often be detected by tapping the tube with a pencil

during both short test and emission test. Faulty operation will be apparent by a lighted SHORT INDICATOR when the CIRCUIT SELECTOR switch is in the LINE SHORT CHECK position or by a fluctuation of the meter reading when the CIRCUIT SELECTOR switch is in the DIODE, BATTERY TUBES, NORMAL TUBES, or SPECIAL TUBES position.

c. CAPACITY METER SECTION OF TUBE TESTER TV-4A/U. (See figure 2-2.) - In this section of the Tube Tester, the circuit on each range consists of an AC potential supplied by one of the transformer windings and applied through a series resistance and an instrument shunt network to the capacity jacks which in turn are connected across the capacitor under test. Effectively, the instrument operates as an AC milliammeter indicating the impedance of the capacitor under fixed applied voltage conditions. A current limiting series resistor is used on each range so that the capacity meter operates very much like a conventional series ohmmeter. By short circuiting the Test leads, the LINE VOLTAGE control R-116 can be rotated, adjusting the applied potential for a full-scale deflection of the milliammeter pointer. This is equivalent to zero external impedance or infinite capacitance. The insertion of capacity between the test leads will then increase the impedance of the circuit causing the meter to deflect a given amount for each capacitance. This capacitance is calibrated directly on the dial for a 60-cycle power supply.

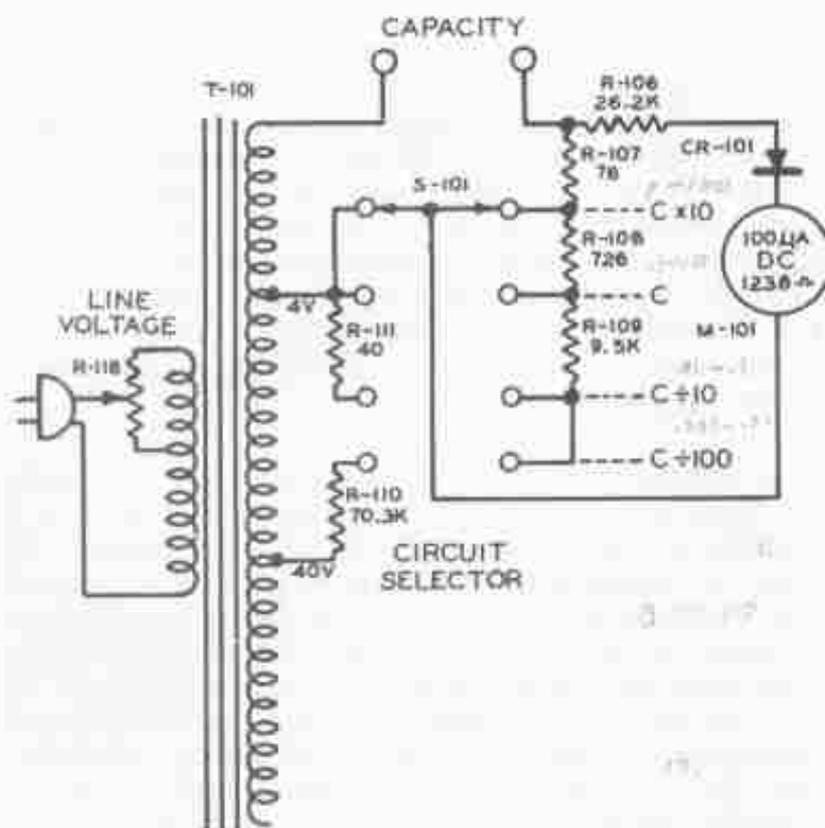


Figure 2-2. Simplified Schematic, Capacity Meter Section of Tube Tester

d. BASIC CIRCUIT OF SIGNAL TRACER TS-673/U. (See figure 2-3.) - This unit comprises a conventional three-stage linear amplifier, the output of which is of the cathode follower type, and a power supply capable of operating on 50- to 1600-cycle source. The power supply is of the full-wave type with capacitor input and resistor-capacitor filter network. The power trans-

former is of special design to cover the power supply frequency range. The following items are accessories.

- (1) Test Prod MX-933/U for audio frequencies from 47 to 15,000 cycles per second.
- (2) Test Prod MX-934/U to detect an audio modulated RF signal within the range from 15,000 cycles to 400 megacycles per second.
- (3) Navy Type CTE-491898 Telephone Receiver, Navy Type CAOR-491901 Headband, and connecting cable RF Cable Assembly CG-570/U (3'0'') for the test prods.

The over-all sensitivity of the Signal Tracer is controlled by potentiometer R-202, the moving contact of which is connected to the grid of V-201. The resistor R-203 and capacitor C-205 feed an opposite phase voltage back to the input grid, so lowering the gain of the first stage, and expanding the frequency range of the amplifier. An audio signal that is applied to the input of the Signal Tracer is amplified by tubes V-201 and V-202A and applied to the grid of the cathode follower stage V-202B through coupling capacitor C-207 and voltage divider resistors R-208 and R-209. The PHONES plug and the output meter circuit are connected to the cathode follower output by means of coupling capacitor C-210. The SCOPE V.T.V.M. plug is connected internally to the plate of tube V-202A through capacitor C-207 and should be connected only to equipment having a high impedance input, such as an oscilloscope or vacuum tube voltmeter. The meter circuit consists of dropping resistor R-211, full-wave copper-oxide bridge rectifier CR-202, and 200 ua full-scale DC meter M-201. The circuit rectifies and indicates a portion of the audio energy output of the cathode follower tube, so giving a means of determining relative input voltage magnitudes. As shown in figure 5-11, the Test Prod MX-933/U contains only a 0.1-microfarad 400-volt DC coupling capacitor. The Test Prod MX-934/U contains a conventional crystal diode detector circuit.

e. BASIC CIRCUIT OF INTERFERENCE GENERATOR SG-23/U. (See figure 2-4.) - This is an aperiodic, impulse buzzer type generator and is housed in a probe

case. The simplified schematic is shown in figure 2-4. When the switch is closed by pressing the button at the top of the probe, a modified square wave appears across the energizing coil. The harmonic content of this wave extends into the megacycle region. Varying the position of the inner tip with respect to the outer tip by means of the index at the end varies the coupling capacitance and allows some attenuation. For audio output, the inner and outer probes are placed in contact by setting the attenuator at position 1.

f. BASIC CIRCUIT OF VOLTAGE INDICATOR-PROBE ID-265/U. - A schematic diagram of this device is shown in figure 5-15. This unit indicates voltage by indicating the AC or DC current flowing through a high impedance calibrating resistor R-401. The sensitivity of meter M-401 is 250-0-250 microamperes DC and indicates the polarity of the Probe tip for DC measurements. The meter M-402 has a sensitivity of 0.88 milli-ampere full-scale and, with the aid of the full-wave copper-oxide bridge rectifier CR-401, will indicate the relative magnitudes of either AC or DC. An AC current of a frequency greater than 10 cycles per second will flow through the high resistance calibrating resistor R-401 and not disturb the moving system of meter M-401, but this AC current will be rectified by rectifier CR-401 and the average value of current indicated on DC meter M-402. For a DC current through R-401, the pointer of DC meter M-401 is moved in a direction determined by direction of electron flow in the coil of the moving system, so indicating polarity. A path also exists for DC current flow through the rectifier and meter M-402, which moves and indicates the average value. As the unit is calibrated by means of an RMS AC voltage, a DC voltage of the same magnitude will read about 10% high.

g. CIRCUIT OF RF INDICATOR-PROBE ID-263/U. - The schematic diagram of this Probe is shown in figure 5-16. The circuit is of conventional design with a diode around the instrument network to prevent the coupling capacitors from assuming a DC charge. The sensitivity of the meter M-501 is 200 microamperes full-

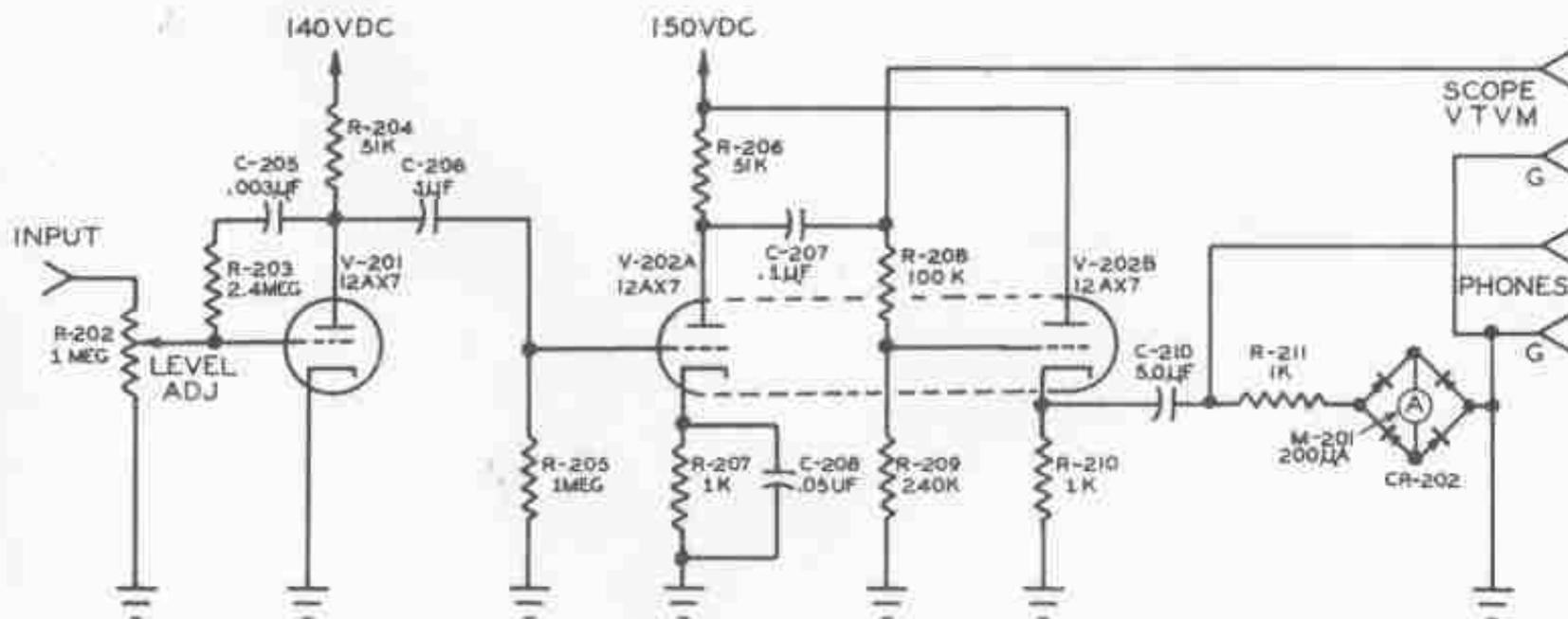


Figure 2-3. Simplified Schematic, Signal Tracer

scale. When the unit is placed in an electric RF field, dielectric or capacity currents flow on to the probe tip and through the coupling capacitor C-501. On the positive half-cycle the capacity current flows through the germanium diode CR-501 to the instrument frame and then through the operator's hand capacity to the operator and back into the field. On the negative half-cycle the current flows through diode CR-502 and DC meter M-501 which indicates the magnitude of this current.

h. CIRCUIT OF RESISTANCE INDICATOR-PROBE ID-264/U. - A schematic diagram of this unit is shown in figure 5-17. The circuit is the conventional series ohmmeter type and consists of a 1000-ohm dropping resistor R-601 and a DC milliammeter. The sensitivity of the meter is approximately 1.48 milliamperes full-scale.

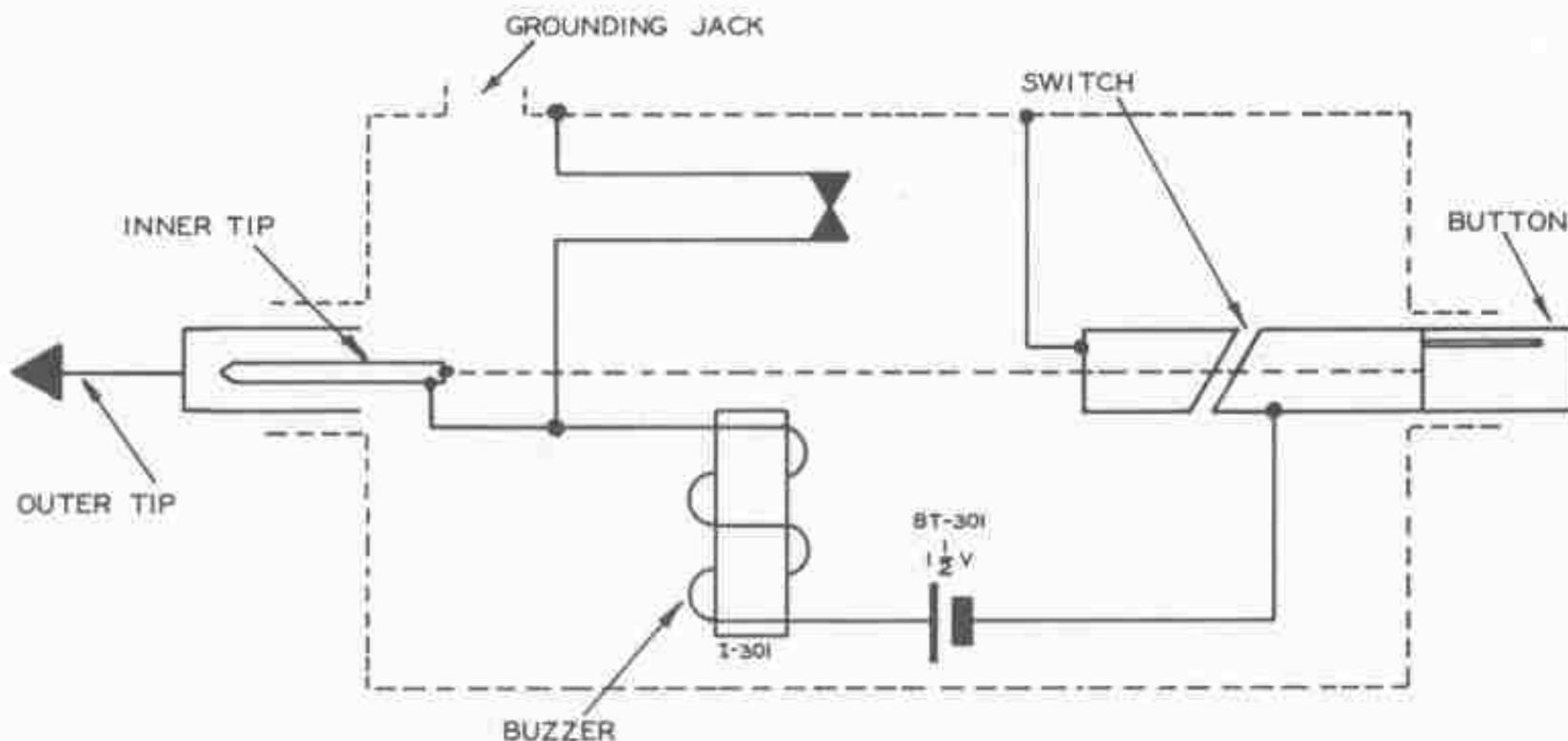


Figure 2-4. Simplified Schematic, Interference Generator

SECTION 3 INSTALLATION

1. UNPACKING INSTRUCTIONS.

Remove the top of the wood packing case and take out the cushioning material above the equipment. Lift out the equipment box. Remove the outer paper wrapping and the inner cushioning wrap from the equipment box.

CAUTION

This equipment incorporates fragile instruments. It has been packed with extreme care and should be unpacked and handled in like manner.

2. PREPARATION FOR USE.

To prepare the Test-Tool Set for use in repairing electrical equipment, unsnap the latches and open the Case. The tools are obtained by releasing the snap-slides and removing the Tool Holder cover in the top of the Case. The cover is held to the Case by a spring wire to prevent loss of this item. If the Tube Tester is to be used, the Technician's Handbook behind it should be removed from the Case, allowing the Tester to be tilted up and forward into operating position. If leads or other accessories are required, they will be found as indicated in figure 1-1.

NOTE

Batteries must be installed in the Resistance Indicator-Probe ID-264/U, Interference Generator SG-23/U, and the Flashlight O-901 before they are put in operation.

Four flashlight batteries JAN BA-58 are required for these three units. Four spare batteries should be kept with the two flashlight bulbs in the Battery and Bulb Case.

The battery can be installed in the Resistance Indicator-Probe by inserting the tip of the 2-inch screwdriver in the slot of the metal clamping ring and gently prying the ring open. (See figure 3-1.) The Probe end may then be slipped off the body, exposing the battery compartment. Since the resistor R-601 is held in place by spring pressure only, it may fall out when the Probe is disassembled. (See figure 3-2.) Therefore, when reassembling the Probe, make sure that this resistor is in place.

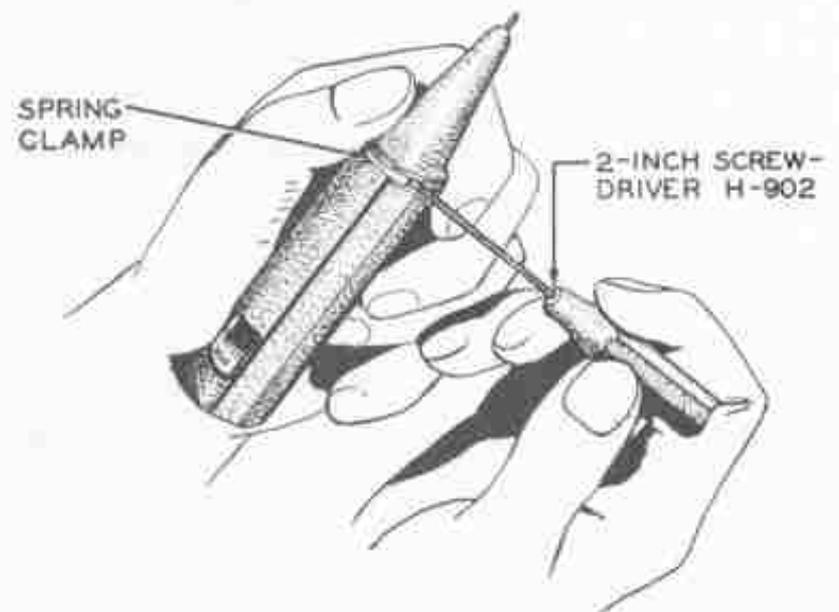


Figure 3-1. Resistance Indicator-Probe, Method of Removing Clamping Ring

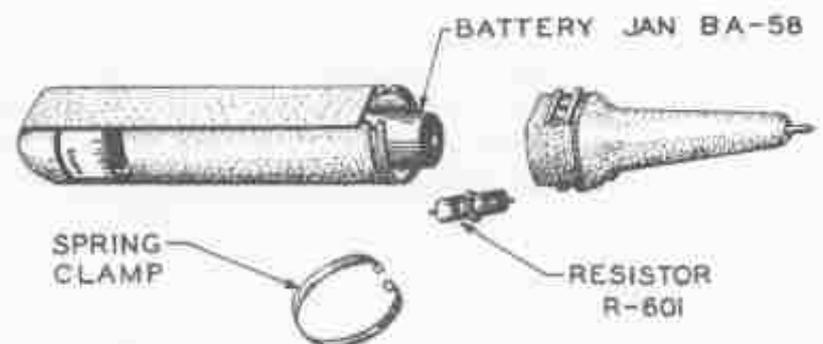


Figure 3-2. Resistance Indicator-Probe, Disassembled

The battery compartment of the Interference Generator is reached by lifting the flared end of the metal index ring and removing the bakelite knob. Figure 3-3 shows the unit disassembled. The battery is inserted with its positive end toward the Probe tip. The half-round screw head in the index button (indicated as battery adj. screw) adjusts for different battery lengths. It may be necessary to turn this screw in or out when a new battery is installed, until the inner tip touches the outer tip only on position 1. Contact between the two tips can be tested by inserting an electrical lead CAOR-491895 in the ground jack and touching the other end to the Probe tip. The buzzer noise will stop if the tips are in contact. When reassembling, the white index line on the knob should be set at a numbered position on the index ring before the knob assembly is reinserted.

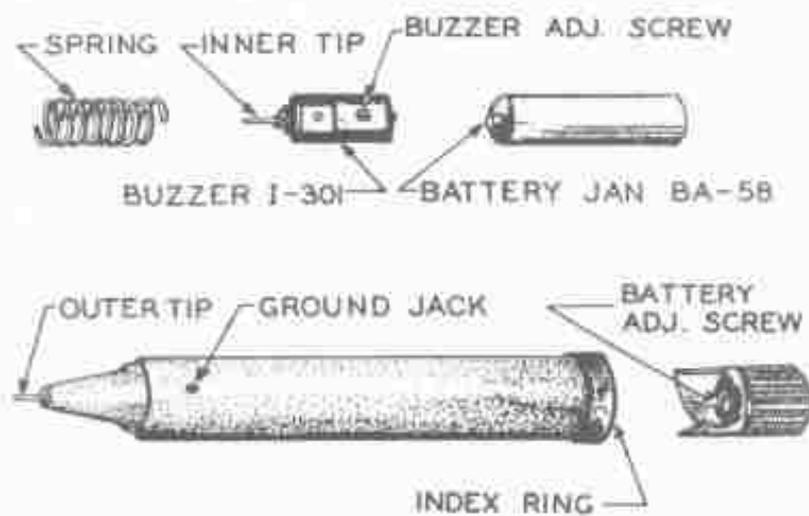


Figure 3-3. Interference Generator, Disassembled

The two JAN BA-58 batteries are placed in the Flashlight with their positive end toward the bulb.

Four spare JAN BA-58 batteries should always be kept in the Battery and Bulb Case.

3. REPLACEMENT OF UNITS IN CASE.

All units must be replaced in their proper location in the Test-Tool Set as shown in figure 1-1. Be sure to engage both snapsides on the Tool Holder before closing the Case.

SECTION 4 OPERATION

1. INTRODUCTION.

The major parts, tools, and accessories contained in this Test-Tool Set are specifically designed for emergency repair of electronic equipment. The units are small in size and incorporate only basic electrical features. An attempt has been made to design each unit to suggest its operation and use. Since the set also includes sensitive meters, it must be handled with reasonable care.

2. Tube Tester TV-4A/U.

a. CAPABILITIES AND LIMITATIONS. - This is an ultra-compact portable unit for checking the performance of receiving type electron tubes only; it is not designed for tests of transmitting tubes. The device is made as flexible as possible to handle the large number of receiving tubes used in Navy as well as commercial equipment. A minimum number of controls are used to test any one tube so that the average operator will find the testing procedure quite simple to understand after study of the operational instructions.

The Tube Tester requires a 105- to 125-volt, 50- to 1600-cycle power source for operation. (Operation must not be attempted on frequencies below 50 cycles per second.) It is designed to test all the tubes listed in the Tube Data Index for emission, shorted, and open elements. The unit will not indicate a gassy condition in a tube, except as it may affect the emission.

The Tube Tester can also measure capacities from 0.001 to 100 microfarads. The capacity values for a

60-cycle supply are obtained directly from the meter scale and the multiplier position. For other frequency power sources, the calibration curves shown in figure 4-1 should be used.

b. PRELIMINARY OPERATION. - To set up the Tube Tester in operating position, unlatch the Test-Tool Set cover by opening the two snapcatches on the front or handle side. Open the cover and remove the Technician's Handbook. Then tilt the Tube Tester forward into position about 45 degrees from the bottom of the case, exposing the socket panel until the locking arm locks into place. (See figure 4-2.)

Unwind the Power Cable Assembly from the Cord and Test Lead Holder H-918 and plug it into the line receptacle on the left-hand side of the Tube Tester. Connect the other end to a power outlet (105 to 125 volts, 50 to 1600 cycles).

Swing the Tube Data Index to the right, exposing the indicating meter. This Index contains type numbers of the various tubes to be tested and is mounted on a special bracket for easy reference.

Rotate the CIRCUIT SELECTOR switch to the LINE SHORT CHECK position. The meter pointer should deflect up-scale near the LINE CHECK arrow. Rotate the LINE VOLTAGE control until the meter pointer rests over the LINE CHECK mark. The Tube Tester is now ready for operation. Thirty seconds is the minimum warm-up time. For a description of the front panel controls and sockets refer to Section 2, paragraph 1a.

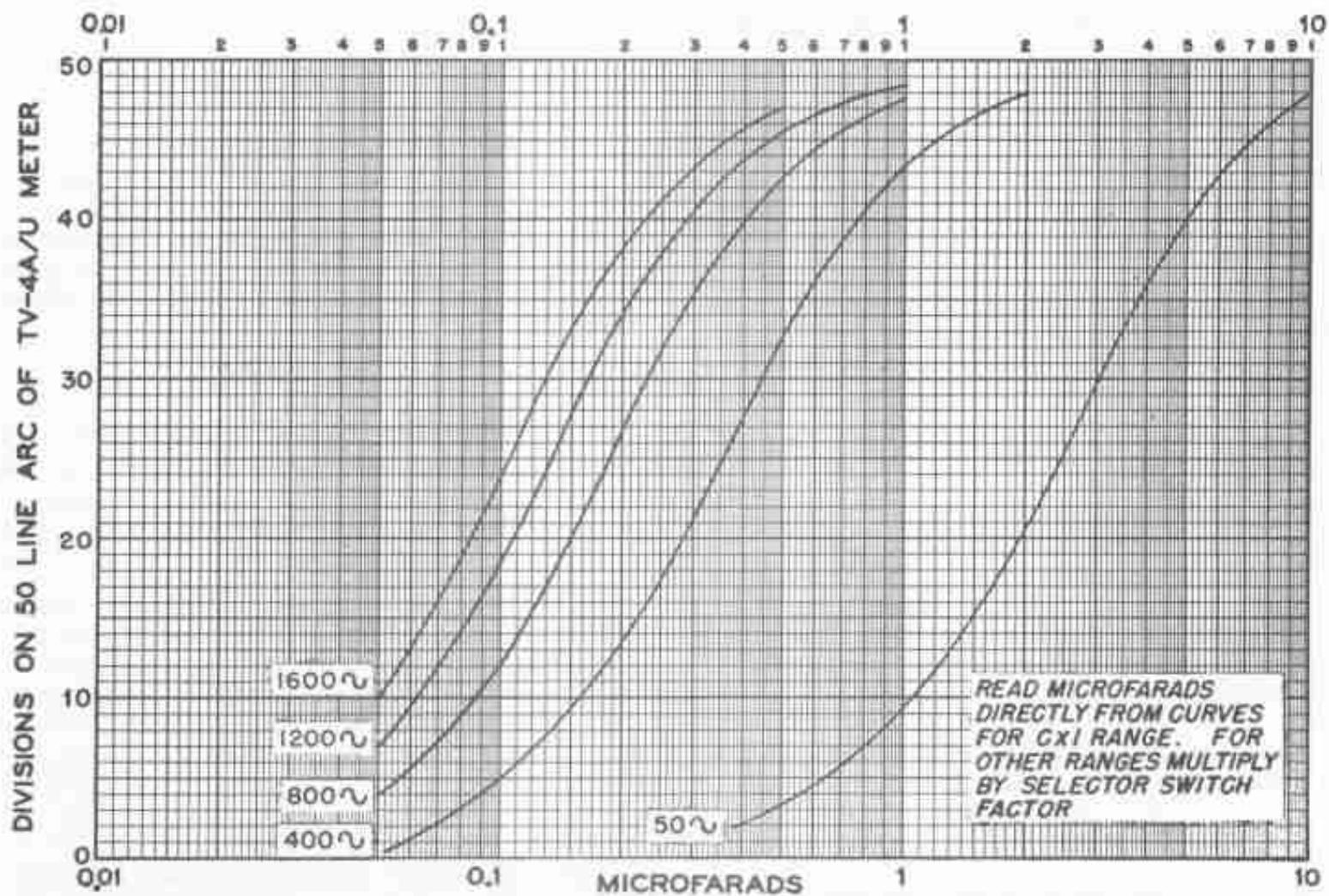


Figure 4-1. Curves, Capacity Reading Corrections for Various Power Line Frequencies for Capacity Meter Section of Tube Tester

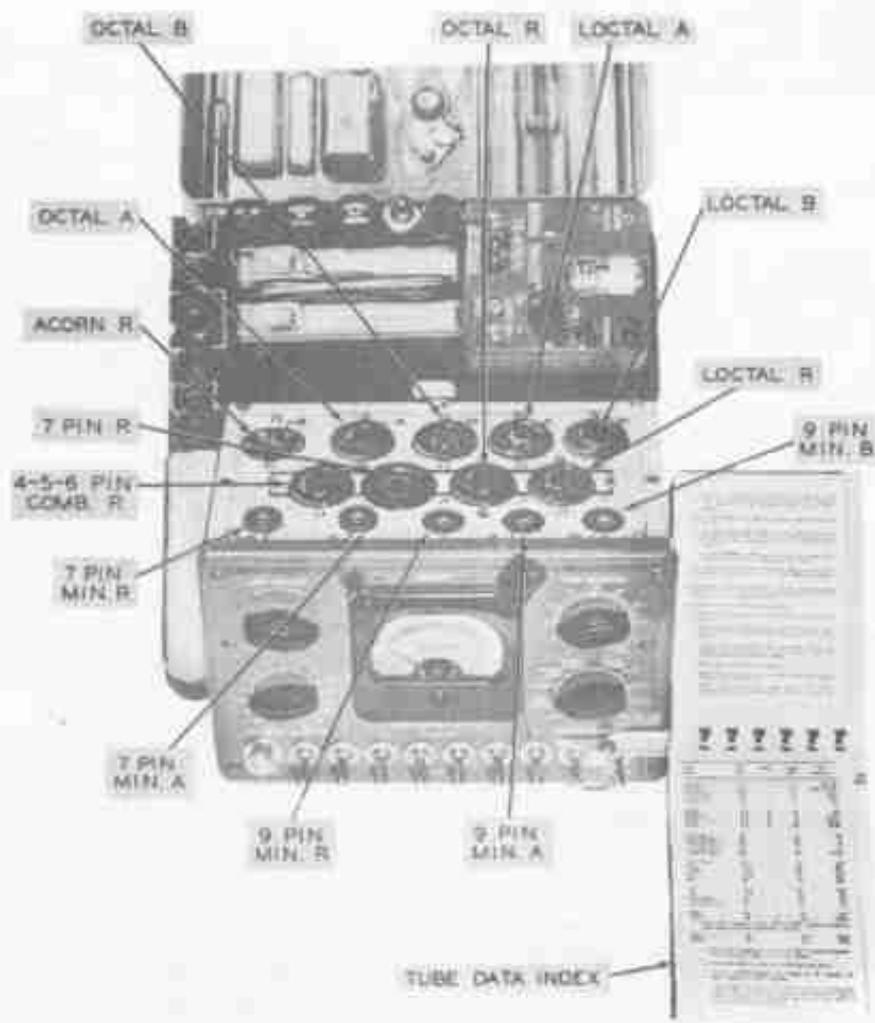


Figure 4-2. Tube Tester in Operating Position

c. STEP-BY-STEP PROCEDURE FOR TESTING TUBES.

WARNING

DO NOT INSERT TUBE UNTIL STEP 1C

(1) GENERAL.

(a) Turn the CIRCUIT SELECTOR switch to the OFF position, place all toggle switches to the OUT position, then plug the Tube Tester into a 50- to 1600-cycle 110- to 120-volt supply.

CAUTION

For tubes printed in green in the Tube Data Index, follow the additional CAUTION steps printed in green in this procedure or the tube will be burned out. These tubes are further identified by a dagger † following the tube type number in the Tube Data Index.

(b) Set the FILAMENT SELECTOR switch to the position listed in the Tube Data Index.

CAUTION

For tubes printed in green, set the A toggle switch to the IN POSITION.

(c) Turn the CIRCUIT SELECTOR switch to the LINE SHORT CHECK position and insert the tube in the socket listed in the Tube Data Index. Note that if the meter reading drops slightly when inserting the tube, that continuity of the filament or heater is indicated.

CAUTION

For tubes printed in green, a lighted SHORT INDICATOR is all right. It indicates continuity of a tapped filament connection.

(d) Allow the tube 1/2 minute to warm up, then adjust the LINE VOLTAGE control until the meter reads at the LINE CHECK mark.

(2) SHORT TEST.

CAUTION

For tubes printed in green, first set the FILAMENT SELECTOR switch to 1.1; then perform the short test rapidly so that the tube remains warm during the test.

(a) Set all toggle switches to the OUT position and the CIRCUIT SELECTOR switch in the LINE SHORT CHECK position.

(b) Index only one of the toggle switches listed in the "IN" Position column of the Tube Data Index to

the IN POSITION. Tap the tube and note if the neon

CAUTION

For tubes printed in green, leave the A toggle switch set to the OUT position.

lamp SHORT INDICATOR lights. Return the toggle switch to the OUT position. Repeat for each toggle switch listed. If the SHORT INDICATOR lights, reject the tube.

NOTE

Bracketed toggle switches should be switched together and treated as one toggle switch. Disregard any momentary flash of light which may occur when switching the toggles.

(c) If a star * follows the tube type number in the Tube Data Index, place the A toggle switch to the IN POSITION, leave all other toggle switches set to the OUT position, tap the tube. If the SHORT INDICATOR lights, reject the tube as having heater-to-cathode leakage. Return the A toggle switch to the OUT position.

CAUTION

For tubes printed in green, first place the A toggle to the IN POSITION, then set FILAMENT SELECTOR switch according to the Tube Data Index.

(3) EMISSION TEST.

(a) Set the TUBE SELECTOR control according to the Tube Data Index.

(b) Rotate the CIRCUIT SELECTOR switch to the position listed in the Tube Data Index.

(c) Place those toggle switches listed in the "IN" Position column of the Tube Data Index to the IN POSITION and note the meter readings, include bracketed toggle switches. The reading depends on the CIRCUIT SELECTOR switch position.

1. Tubes which use DIODE position, should read above the DIODES OK mark.

2. Tubes which use BATTERY TUBES position, should read in the green section.

3. Tubes which use NORMAL TUBES position, should read in the green section.

4. Tubes which use SPECIAL TUBES position, should read steadily in the green, and not drop slowly.

(d) If the reading is low, reject the tube. If the reading is satisfactory, proceed.

NOTE

A test which may indicate probably life of a tube is to reduce the filament voltage one step. If reading stays on green portion then the tube probably has a long life as shown by emission. If indication falls to red portion, the tube may be getting low.

(4) OPEN ELEMENT TEST.

(a) Start with the Tube Tester set for the emission test as step 3c.

(b) Switch only one of the toggle switches already in the IN POSITION to the OUT position, and note a

CAUTION

FOR tubes printed in green, leave the A toggle switch in the IN POSITION.

drop in meter deflection. If a small or large drop occurs, the connection is good. Return the toggle switch back to the IN POSITION.

NOTE

Bracketed toggle switches should be switched together and treated as one toggle switch.

(c) If a drop occurs for each toggle switch tested, the tube is satisfactory, proceed to step 5.

(d) The drop in meter reading may be large or it may be as small as 1/4 division. If no drop is seen, the test is made more sensitive as follows:

1. Switch to OUT position that toggle switch which causes the greatest drop and leave it out.
2. Turn the TUBE SELECTOR control to 0.
3. Repeat the open element test 4b for the toggle switch or bracketed toggle switches which cause no drop.

(e) If no drop occurs even with the sensitive test, then an open circuit exists, reject the tube. If a drop occurs, proceed to step 5.

(5) MULTIPLE SECTION TUBES.

When a tube has several line of data appearing in the Tube Data Index, repeat the test procedure for each line of data.

(6) GOOD TUBES.

A tube which is not rejected in the above tests is probably a good tube. (See par. 2e.) Remove tube from socket. Turn Tube Tester off by rotating CIRCUIT SELECTOR switch to the OFF position.

d. DETAILED EXPLANATION OF STEP-BY-STEP PROCEDURE. - Refer to warning immediately preceding paragraph 2c(1). It is very important that the tube be inserted in the Tube Tester only after certain settings have been made. Failure to observe this command may cause a tube to be burned out.

Step (1)(a) - It is advisable to follow the procedure outlined in paragraph (1)(a), especially if the operator is not completely familiar with the operation of the Tube Tester TV-4A/U. Setting the switches as indicated makes following the Step-by-Step procedure easier. The CAUTION note in paragraph (1)(a) was

introduced at this point to call the operator's attention to the fact that tapped filament tubes require special attention or a burned out filament will result.

Step (1)(b) - Failure to set the FILAMENT SELECTOR switch correctly will cause the tube to burn out or give a sufficiently low emission reading to cause rejection when actually the tube may be good.

The CAUTION note in paragraph (1)(b) is the first command to set the A toggle switch to the IN POSITION. Failure to heed this command at this point will cause a tapped filament tube type to burn out in paragraph (1)(c).

Step (1)(c) - Setting the CIRCUIT SELECTOR switch to LINE SHORT CHECK position is convenient at this time as the operator will soon discover that in all tubes, except BATTERY TUBE types, the LINE SHORT CHECK indication on the instrument will drop upon inserting a tube in a test socket. If no drop is noticed, the tube filament is open and no further checks need to be made.

The CAUTION note concerning tapped filament types is inserted at this point as a lighted neon lamp, indicating continuity of the third filament connection, might worry the technician using this device.

Step (1)(d) - Allow one-half minute to warm up the tube. Failure to heed this may allow a tube having a short to pass the short test satisfactorily.

Step (2) - The CAUTION note is required at this time for tubes printed in green in the Tube Data Index. Failure to perform this step will cause these tube types to burn out.

Step (2)(a) - Tapped filament types may be rejected for a short when none exists if this step is not performed. Furthermore, the short test circuit will not function unless all toggle switches except the one corresponding to the tube element being short checked, are in the OUT position.

Step (2)(b) - It is important that only one toggle switch be placed to the IN POSITION at a time.

For tubes printed in green the CAUTION note is required to keep the operator from putting the A toggle switch to the IN POSITION.

An explanation of how to handle bracketed toggle switches is necessary at this time. Some tubes have a given element connected to more than one pin. These internal connections within the tubes are indicated by the bracketed () toggle switches in the "IN" Position column of the Tube Data Index.

Because shorts will be indicated in the short tests, it becomes necessary to treat the bracketed toggles as one switch.

Step (2)(c) - This step is self-explanatory with the possible exception of the last sentence, "Return the A toggle switch to the OUT position". Following this command will leave the tube tester properly set for the emission test.

In the case of tapped filament types, the CAUTION note following paragraph (2)(c) must be followed or the emission readings obtained under paragraph (3) will be in error.

Step (3)(a) - The TUBE SELECTOR control is a variable sensitivity adjustment on the meter. Accurate settings of the control are required for accurate tube testing.

Step (3)(b) - The CIRCUIT SELECTOR switch selects the proper load resistance and element voltage for the type of tube to be tested. Advancing this control clockwise beyond the setting called for in the Tube Data Index may damage the tube. This is only true if the test procedure is not followed in the sequence given.

Step (3)(c) - Placing the correct toggle switches to the IN POSITION is an absolute must. All other toggle switches must be in the OUT position. The toggle switches to be placed in the IN POSITION are listed in the 'IN' Position column of the Tube Data Index. The operator of this device must understand that the elements in the tube are connected in the test circuit by means of these switches.

Step (3)(c) - 1, 2, 3, & 4 - All tubes, if good, should read in the green section except diode types which should read above the DIODES OK line on the meter scale. On tubes requiring the CIRCUIT SELECTOR switch to be set in the SPECIAL TUBES position a further requirement is that the meter reading, even if in the green section, must not drop slowly.

Step (3)(d) - If the tube reading is low at this point, make no further checks unless the technician wishes to know why the tube is being rejected.

Step (4)(a) - To make open element tests, the Tube Tester must first be set as for the emission test. If the Step-by-Step procedure ahead of paragraph 4 were followed exactly, Step (4)(a) would not be necessary.

Step (4)(b) - In an emission checker, the element which is farthest from the cathode will handle the smallest current.

This means, for instance, that if the suppressor or plate of any pentode were open, the meter deflection would be in the green section and yet the tube should be rejected.

It then becomes necessary to make an open element check to locate an open plate, suppressor, or screen.

Switching one of the toggle switches already in the IN POSITION to the OUT position disconnects the corresponding tube element from the test circuit. Therefore, the meter indication should drop.

The CAUTION note is required at this point for tubes printed in green only because the A toggle switch must not be put in the OUT position or the tube will be burned out.

The NOTE on bracketed toggle switches is a further reminder that such switches must be treated as one switch.

Step (4)(c) - If this be the case, the tube has satisfactorily passed the open element test.

Step (4)(d) - If no visible drop in meter deflection occurs for any one of the toggle switches used in the open element test, perform steps in paragraph (4)(d) 1, 2, & 3. In some pentode tubes the drop in meter deflection on the open element test is too small to be noticed on the suppressor or plate element. Paragraph

(4)(d) 1, 2, & 3 represent a procedure whereby the open element test can be made more sensitive.

Step (5) - Multiple section tubes, whether of the twin type or multi-purpose type, have the data for each section listed on a separate line in the Tube Data Index. Do not fail to check each section.

Step (6) - Tubes which have passed the above tests are to be considered good.

e. PROPER USE OF THE TUBE TESTER. - When the above test procedure is mastered, the average time required to check a tube after warm-up is about 30 seconds. Continue to use the step-by-step procedure until at least 30 tubes have been checked. By means of this repetition the exact procedure will be learned.

Tubes should be checked intelligently. This means that the symptoms of the defective equipment should be made known to the person checking the tubes. For instance, if a set is completely dead, one should be looking for a shorted element or a tube that has absolutely no emission. Do not expect a tube that has a slightly low emission reading to be the cause of the fault.

On the other hand, a piece of electronic gear may be working but exhibit low sensitivity. In this case, the accent should be on locating all tubes that may have low emission readings.

If a single hum bar appears in television sets or on radar scopes, particular attention should be given to cathode leakage tests. In some cases the operator may wish to advance the LINE VOLTAGE control to the most clockwise position to raise the filament voltage slightly above normal to increase the sensitivity of this test. This procedure will not damage a tube that is normally good, but it should never be used except for cathode leakage tests.

Some pieces of electronic equipment will fail consistently after five or ten minutes of operation. In such cases, it may be necessary to allow the tubes to remain in the Tube Tester for an equivalent length of time before defects will appear.

If distortion increases rapidly from a power stage after several minutes of operation, the fault may be due to a gassy power tube. Such a fault will not be detected in the Tube Tester, except as it may affect the emission. In such cases, always try a new tube in the equipment.

Always keep in mind that a tube tester will not detect all defective tubes. This presents a serious problem. If a tube checks as bad, it is bad; but if the tube checks as good, there is still a possibility that it may be bad. Therefore, if resistors, voltages, and tubes all check as good in a piece of electronic equipment, replace with all new tubes. If the equipment operates satisfactorily, proceed to replace the new tubes with the old tubes until the defective tube is found. Recheck this tube carefully to determine its defect. It may be that the application of the tube in its circuit is sufficiently severe to require an earlier rejection. If this is so, determine a new setting for the TUBE SELECTOR control which will reject the tube for this application.

f. METHOD OF ESTABLISHING TUBE DATA. - Sometimes it is necessary to set up tube data for tubes not listed in the Tube Data Index.

Developing tube data in accordance with the procedure outlined below produces satisfactory results when a tube is used in a normal manner and within its ratings. If the application of a tube to a circuit is severe, the TUBE SELECTOR control should be set to reject those tubes which fail to operate properly.

In developing tube data, first determine whether there is another tube in the Tube Data Index which has the same base connection diagram. If so, the information in the Sock., Tube Type, and "IN" Position columns can be copied directly. There is one exception. Power rectifiers and RF diodes may have the same base connections but require a different setting of the CIRCUIT SELECTOR switch. Check power rectifiers in the SPECIAL TUBES position and RF diodes in the DIODE position.

Determine the proper test socket to be used if no tube in the Tube Data Index has the same base connections. This may be accomplished by first noting the pin arrangement and deciding whether a 4-, 5-, 6-, 7-, pin octal, loctal, 7- or 9- pin miniature socket is to be employed. When the tube to be tested has an octal, loctal, 7- pin miniature, or 9- pin miniature base, table 4-1 indicates whether an R, A, or B socket is to be used when the NORMAL POSITION toggle switch is in the OUT position.

NOTE

In tables 4-1 and 4-2, and in the description which follows, "ACTIVE TUBE ELEMENTS" is defined as meaning any tube elements except heaters or cathodes. The words filament and heater

are to have the same meaning. On tapped filament tubes, FILAMENT CONNECTIONS under CONDITION #1, in tables 4-1 and 4-2, refers to those pins which include the complete filament. In table 4-1 use the socket listed in the left-hand column if either CONDITION #1 or CONDITION #2 can be met.

Proceed to table 4-2 to select a socket only if CONDITIONS #1 or #2 can not be satisfied in table 4-1. When using the second SOCKET SELECTION table, the NORMAL POSITION toggle switch must be placed in the IN POSITION.

Enter table 4-3 in the column for the socket selected choosing the numbers which correspond to the "ACTIVE TUBE ELEMENTS" and note the toggle switches in the left-hand column which will be used for the "IN" Position column in the Tube Data Index.

For example on a 6K7 tube: from a base diagram of this tube it is noted that the tube has an octal base with filaments on pins 2 and 7 and other elements on pins 3, 4, 5, and cap. (Disregard the cathode on pin 8 as it is not an "ACTIVE TUBE ELEMENT".) Table 4-1 lists three octal sockets. A comparison of the 6K7 filament pin numbers with those listed shows that octal R socket should be used because CONDITION #1 in the table is satisfied. From table 4-3 the column of figures under the octal R socket indicates that toggle switch B is connected to pin 3, C to pin 4, D to pin 5, and E to the grid cap.

NOTE

Table 4-3 is always used to determine the IN POSITION toggle switches even though the socket selection was made on the basis of either table 4-1 or 4-2.

TABLE 4-1. SOCKET SELECTION ✕1

SOCKET TO BE USED	CONDITION #1	CONDITION #2		
	FILAMENT CONNECTIONS ON	1st FILAMENT CONNECTION ON	2nd FILAMENT CONNECTION ON	"ACTIVE TUBE ELEMENTS" MAY NOT FALL ON
OCTAL R	2 & 7	2	Any Pin	7
OCTAL A	7 & 8	7	Any Pin	8
OCTAL B	6 & 2	6	Any Pin	2
LOCTAL R	1 & 8	1	Any Pin	8
LOCTAL A	2 & 8	2	Any Pin	8
LOCTAL B	2 & 7	2	Any Pin	7
7 PIN MIN. R	7 & 1	7	Any Pin	1
7 PIN MIN. A	4 & 3	4	Any Pin	3
9 PIN MIN. R	4 & 5	4	Any Pin	5
9 PIN MIN. A	9 & 5	9	Any Pin	5
9 PIN MIN. B	2 or 3 & 9	2 or 3	1, 4, 6, or 9	* 5, 7, 8, or 9

* On 9-pin miniature B socket the cathode must not fall on pin Nos. 5, 7, or 8.

NOTE: Place NORMAL POSITION toggle switch in the OUT position if a socket is selected from table 4-1.

TABLE 4-2. SOCKET SELECTION ≅2

SOCKET TO BE USED	CONDITION ≅1		CONDITION ≅2	
	FILAMENT CONNECTIONS ON	1st FILAMENT CONNECTION ON	2nd FILAMENT CONNECTION ON	"ACTIVE TUBE ELEMENTS" MAY NOT FALL ON
OCTAL R	7 & 2	7	Any Pin	2
OCTAL A	8 & 7	8	Any Pin	7
OCTAL B	2 & 6	2	Any Pin	6
LOCTAL R	8 & 1	8	Any Pin	1
LOCTAL A	8 & 2	8	Any Pin	2
LOCTAL B	7 & 2	7	Any Pin	2
7 PIN MIN. R	1 & 7	1	Any Pin	7
7 PIN MIN. A	3 & 4	3	Any Pin	4
9 PIN MIN. R	5 & 4	5	Any Pin	4
9 PIN MIN. A	5 & 9	5	Any Pin	9
9 PIN MIN. B	9 & 2 or 3	9	1, 2, 3, 4, or 6	* 2, 3, 5, 7, or 8

* On 9-pin miniature B socket the cathode must not fall on pin Nos. 5, 7, or 8.

NOTE: #1. Do not use table 4-2 if a socket selection can be made from table 4-1.
#2. Place NORMAL POSITION toggle switch in the IN POSITION if a socket is selected from table 4-2.

TABLE 4-3. TOGGLE SWITCH AND SOCKET CONNECTIONS

TOGGLE SWITCH	ACORN	4 PRONG	5 PRONG	6 PRONG	7 PIN MINIATURE R	7 PIN MINIATURE A	7 PRONG LARGE & SMALL	LOCTAL R	LOCTAL A	LOCTAL B	OCTAL R	OCTAL A	OCTAL B	9 PIN MINIATURE R	9 PIN MINIATURE A	9 PIN MINIATURE B
	2nd Fil. A	6	1	1	1	1	3	1	8	8	7	7	6	2	5	5	9
B	3	2	2	2	3	1	2	2	1	3	3	3	3	1	3	1
C	4	3	3	3	4	7	3	3	3	4	4	4	4	2	4	4
D	2	..	..	..	5	5	4	4	4	5	5	5	5	3	1	6
E	Cap	Cap	Cap	Cap	Cap	Cap	Cap	5	Cap	Cap	Cap	Cap	Cap	9	7	Cap
F	8	..	..	4	6	6	5	6	6	6	6	6	7	6	6	..
G	7	..	4	5	2	2	6	7	7	8	8	1	1	7	8	..
H	5	..	..	..	..	..	..	..	5	1	1	2	8	8	2	..
1st Fil.	1	4	5	6	7	4	7	1	2	2	2	7	6	4	9	2 & 3

NOTE

The A toggle switch is used primarily for heater to cathode leakage tests but serves a useful purpose when testing tubes having tapped filaments.

CAUTION

Any tube having a tapped filament should have the A toggle switch indexed to the IN POSITION before inserting a tube in the socket. Use the FILAMENT SELECTOR switch position corresponding to the rated filament voltages, i.e., both sections of the filament, listed in the tube manufacturer's specifications or the nearest value available.

Determine the CIRCUIT SELECTOR switch by taking into account the type of tube that is to be tested. The diode position is used for RF diode types and for those battery types on which the load on the tube is too great. Whether the load is too great or not can be determined by placing the tube in its proper socket and indexing the CIRCUIT SELECTOR switch to the BATTERY TUBES position. If the meter pointer deflects up-scale to a reasonable deflection and then tends to deflect slowly down-scale toward the zero mark, the load placed upon the tube is too great and the DIODE position should be used instead.

The BATTERY TUBES position will be used for those tubes having more than two elements and having filament voltages corresponding to the 1.4- or 2.0-volt types. Center tapped filament tubes with ratings of 2.8 and 4 volts fall under this same classification. The SPECIAL TUBES position should be used only on tubes of the rectifier type, such as the 0Z4, 5U4-G, etc. All other types should have the CIRCUIT SELECTOR switch indexed to the NORMAL TUBES position during test.

After determining the CIRCUIT SELECTOR switch and FILAMENT SELECTOR switch positions and the toggle switches to be used, it is then necessary to rotate the TUBE SELECTOR control until the meter indicates approximately 36 on the 50-line DC scale for tubes known to be good. Several good tubes should be used for determining this TUBE SELECTOR control position. All diode types should have the TUBE SELECTOR control set at zero. This procedure will give reasonably accurate tube test data.

g. OPERATION OF CAPACITY METER SECTION OF TUBE TESTER TV-4A/U. - Aside from the tube test functions, a four-range capacity meter is available in the Tube Tester. The CIRCUIT SELECTOR switch is used on the last four positions for capacity meter range selection. These four switch positions are marked $C \times 10$, $C \times 1$, $C \div 10$, and $C \div 100$. The meter scale reads directly in microfarads from 0.1 to 10 on the $C \times 1$ range. Other ranges are: $C \times 10$ from one to 100 microfarads, $C \div 10$ from 0.01 to one microfarad, $C \div 100$ from 0.001 to 0.1 microfarad.

The Tube Tester transformer supplies all potentials for the capacity ranges at power line frequency. The

meter scale is calibrated for a frequency of 60 cycles. If capacity readings are taken when the Tube Tester is energized from 50, 400, 800, 1200, or 1600 cycle power sources, a correction factor must be applied. Refer to figure 4-1 for capacity readings on any of these power line frequencies. These corrections are necessary since the meter actually measures impedance; therefore, the pointer deflection is a function of both capacitance and frequency.

To determine the value of a capacitor, connect the Tube Tester to a 105- to 125-bolt AC power line of known frequency. Rotate the CIRCUIT SELECTOR switch to one of the C positions. Insert two test leads CAOR-491195 with the ADAPTER CONNECTORS CAOR-491897 in the two pin jacks directly above the meter marked CAPACITY. Short the test leads and rotate the LINE VOLTAGE control until the meter pointer shows full-scale deflection at the infinity mark. For best accuracy, select the capacity range that gives a reading nearest to the center of the scale and read the capacity in microfarads on the top arc. Multiply or divide by the switch position marking as required. Correct for line frequencies different from 60 cycles.

If power line frequencies other than 60 cycles are used, the initial reading is taken of the 0 to 50 scale. Figure 4-1 is then entered and the corrected capacity obtained.

NOTE

Be sure the capacitor under test is not energized by potentials in the circuit where it is connected. No shunt impedances, such as coils, chokes, or resistors should be in parallel with the capacitor. To obtain a true reading disconnect one terminal of the capacitor from the circuit before testing.

h. TYPICAL APPLICATIONS. - Beyond the normal function of measuring capacity, the capacity meter section can be used to indicate the AC value of resistance, inductance, and impedance. The Tube Tester can also be used as an AC voltage source.

(1) RESISTANCE. - When measuring resistance connect the unknown resistor to the jacks of the capacity meter section of the Tube Tester and set the CIRCUIT SELECTOR switch at $C \times 10$, $C \times 1$, $C \div 10$, or $C \div 100$, whichever position gives a reading on the scale. Read the zero to 50 scale and refer to figure 4-3 to determine the resistance value.

To find the value of resistance R, locate the reading on the zero to 50 scale on the horizontal axis and read up to a point on the curve. From the point on the curve read left to determine value for A which, when multiplied by switch position factor, gives resistance in ohms. Example: for a reading of 24.5 on the zero to 50 scale of the meter with the CIRCUIT SELECTOR switch set to the $C \div 10$ position, the value A is 68. The resistance $R = A \times 100$ or 6,800 ohms. The meter may be used for values of resistances from approximately 2 ohms to 1 megohm.

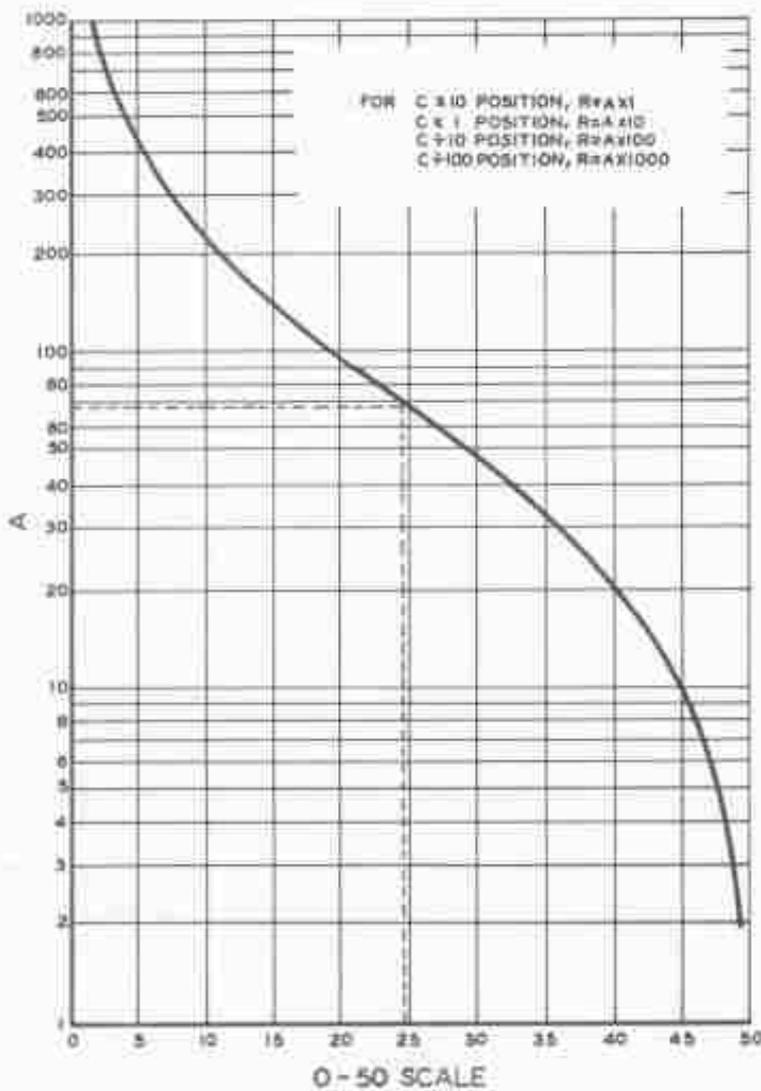


Figure 4-3. Resistance Curve for Capacity Meter Section

(2) PURE INDUCTANCE. - The value of pure inductances can be measured on the capacity meter section of the Tube Tester. The inductance L is measured in the same manner as a capacitor, and the value is calculated from the meter reading using the following formula:

$$L = \frac{10^6}{(2\pi f)^2 C} \text{ henries}$$

Where: f is the power source frequency and C is the value in microfarads as read on the meter scale, multiplied or divided by the CIRCUIT SELECTOR switch position. (The value of C must be corrected for any line frequency other than 60 cycles. See figure 4-1.)

The curves of figure 4-4 and figure 4-5 show the relation between L and C for 60 and 400 cycles.

After a value of C is obtained for an unknown inductance, refer to figure 4-4 for the value of L . For example, if C were 10 microfarads, the inductance L would be 0.7 henry as shown by the dotted lines.

(3) IMPEDANCE. - True impedance cannot be measured by means of the capacity meter section of the Tube Tester. However, impedances can be approxi-

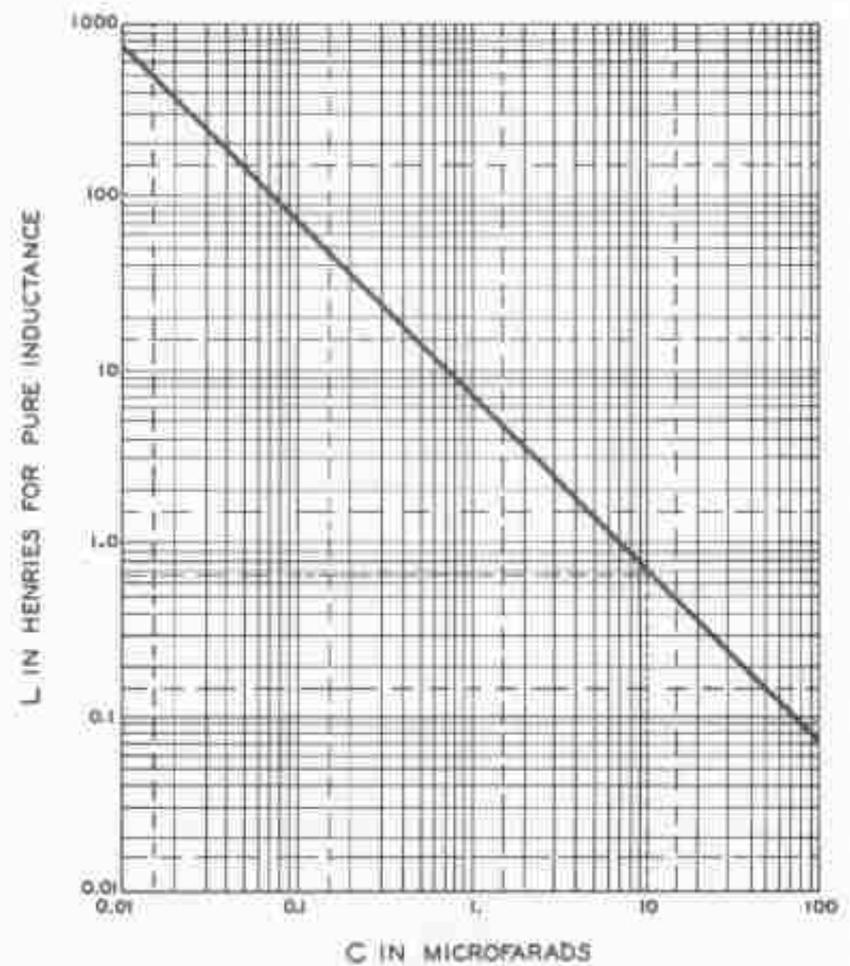


Figure 4-4. Inductance Curve for 60 Cycles

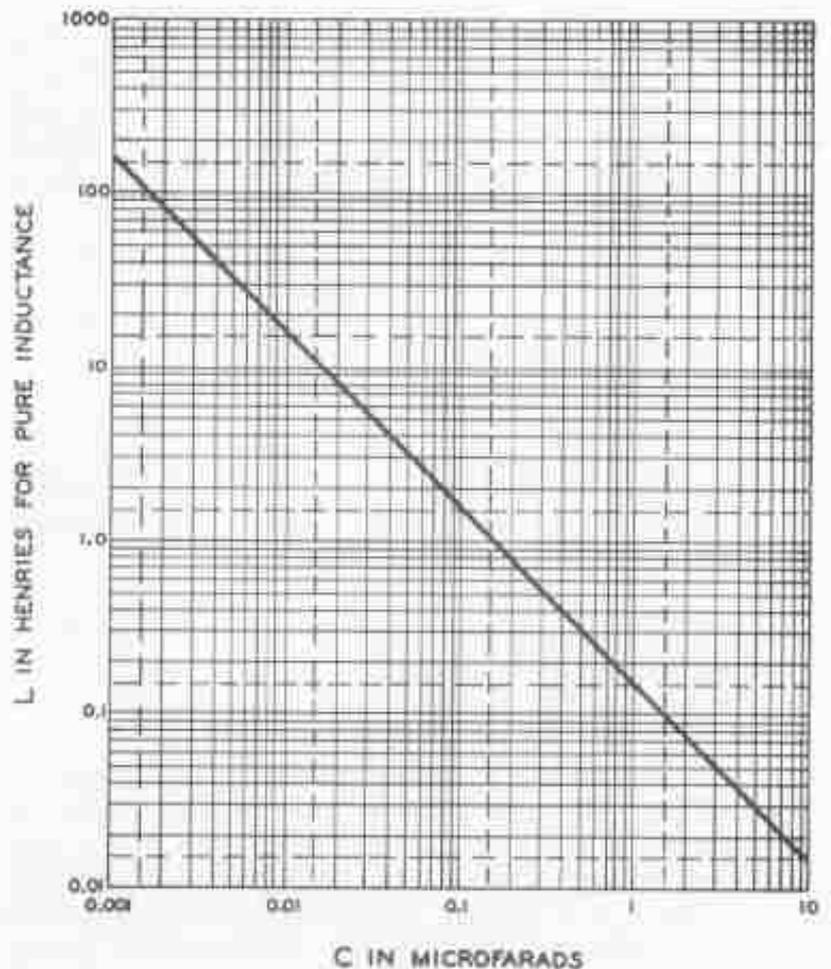


Figure 4-5. Inductance Curve for 400 Cycles

mately determined by considering the unknown impedance to be a pure capacitive or inductive reactance. The value of capacitance in microfarads or the inductance in henries is found as explained in the preceding paragraphs. This value is then converted to reactance in ohms at the circuit frequency. This reactance is the approximate value of the impedance at the circuit frequency.

The above information applies to inductances with a Q between 1 and 10 at the power source frequency and to capacitors with a power factor from 0.1 to 1. Inductances with a Q greater than 10 at power source frequency can be termed pure inductances, and the values obtained will be correct to $\pm 20\%$.

Most power transformers and inter-stage audio coupling transformers have Q 's in the order of 1 to 3 at audio frequencies. For a Q less than 1, measure the component as a resistor, using the resistance curves of figure 4-3.

(4) VOLTAGE SOURCE. - The Tube Tester can be used as a source of variable AC voltage. This is done by plugging Electrical Leads 491899 and 491899-A into pins 2 and 7 of the regular octal socket and turning on the power. The position of the FILAMENT SELECTOR switch then determines the magnitude of voltage between the electrical leads. To check a pilot lamp with this voltage, place the FILAMENT SELECTOR switch at the lamp's rated voltage, or nearest value, before touching the lamp contacts with the leads. The voltage and current outputs available for each position of the FILAMENT SELECTOR switch are given in table 4-4.

TABLE 4-4. VOLTAGE AND CURRENT OUTPUT FROM TUBE TESTER

FILAMENT SELECTOR POSITION	VOLTAGE OUTPUT (V)	MAX. LOAD CURRENT (A)
1.1	1.1	3
1.5	1.5	3
2	2.0	3
2.5	2.5	3
3	3.0	3
5	5.0	3
6.3	6.3	2
7.5	7.5	2
10	10.0	.6
12.6	12.6	.6
19	19.0	.3
25	25.0	.3
28	28.0	.3
35	35.0	.3
50	50.0	.150
70	70.0	.150
117	117.0	.150

3. SIGNAL TRACER TS-673/U.

a. LIMITATIONS. - This unit requires a 105 to 125-volt, 50 to 1600-cycle power source. In conjunction with

the Test Prod MX-933/U and RF Cable Assembly, it can be used as an amplifier for AF voltages from 47 to 15,000 cycles, with its output fed to an oscilloscope, an electronic voltmeter, or a telephone receiver, as indicated by the markings on its front panel (see figure 1-3.) The meter M-201 indicates the magnitude of the output voltage. A typical application is the tracing, stage-by-stage, of an audio signal through an audio amplifier.

This unit, in combination with Test Prod MX-934/U, can also be used as a detector and amplifier for modulated RF voltages. Its over-all sensitivity when used as a detector-amplifier is such that a 0.005-volt RF signal modulated 50% will give an audible output in the telephone receiver. Refer to table 1-4 for additional data on the meter sensitivity.

CAUTION

Do not apply more than 20 RF volts to the Test Prod MX-934/U.

b. OPERATION OF SIGNAL TRACER TS-673/U. - The Power Cable Assembly, stowed in the Cord and Test Lead Holder, is connected to the Signal Tracer as shown in figure 1-3 and plugged into a 105-to 125-volt, 50 to 1600-cycle power source. Accessory parts, which include the RF Cable Assembly CG-570/U (3'0"), Navy Type CTE-491898 Telephone Receiver, Navy Type CAOR-491901 Headband, Test Prod MX-934/U, and Test Prod MX-933/U are contained in the Accessory Case and are shown assembled in figure 1-3.

The Test Prods are assembled to the RF Cable Assembly by turning the prods into the bakelite covered connector on the cable. The other end of the cable is attached to the input contact of the Signal Tracer. Provision is made for directly plugging a grounding lead into both Prods and also in the front panel of the Signal Tracer. When working with RF signals, the ground is made at the Prod. The equipment being tested should also be grounded. The output of the Signal Tracer is indicated by the arbitrary scale meter M-201 on the front panel of the Signal Tracer. The output of the Signal Tracer can also be applied to an oscilloscope or electronic tube voltmeter by connecting electrical leads to the jacks marked SCOPE V.T. V.M. The lower terminals marked G on the front panel are chassis ground. If an audible indication of AC voltage is desired, the Telephone Receiver can be connected with two electrical leads to the jacks marked PHONES. The magnitude of the output is adjusted by the control marked LEVEL ADJ. Turning this control clockwise increases the over-all gain of the amplifying circuit.

To trace a signal through an audio amplifier that does not operate, Test Prod MX-933/U is connected to the RF Cable Assembly and Signal Tracer. The faulty amplifier is plugged into its proper power source and its chassis grounded to earth. The Signal Tracer is grounded to the amplifier chassis and plugged into its power source. Both units are allowed to warm up. The test signal can be obtained by using the Interference

Generator or any audio oscillator. If the Interference Generator is used, its tip is applied directly to the probe tip of the Signal Tracer and the LEVEL ADJ. control turned so that the output indicates on the meter M-201 scale. The Interference Generator is excited and its tip applied to the input of the amplifier; at the same time, the probe tip of the Signal Tracer is touched to the plate of the first tube. A greater indication on meter M-201 shows that the tube is operating. The LEVEL ADJ. control is then turned counter-clockwise, until the meter is back on scale. The next stage is tested by placing the Signal Tracer probe tip on the plate of the second tube and again exciting the input. An increase in output indicates operation of the circuits between the input and the plate of the second stage. This procedure is continued until a stage is found not operating, and the same step-by-step method is applied to determine the faulty component of that stage, whether it is a tube, capacitor, resistor, etc.

c. TYPICAL APPLICATIONS. - A few applications of the Signal Tracer and accessories are listed below.

(1) With Test Prod MX-933/U the Signal Tracer can be used as an audio amplifier to increase the sensitivity of oscilloscopes and electronic voltmeters.

(2) With Test Prod MX-933/U and the Telephone Receiver, the Signal Tracer can be used to trace audio or pulse signals, Stage-by-stage, through an amplifier. The Interference Generator can be used to excite the input of an amplifier. A rough gain check can be obtained during the signal tracing process. This is accomplished (signal source on) by setting the LEVEL ADJ. control of the Signal Tracer (Prod at input of the amplifying stage) for a meter reading of 1/2-scale of M-201. Take LEVEL ADJ. control reading. Move Prod to output of stage. Take LEVEL ADJ. control reading again for 1/2-scale on M-201. To determine voltage gain of stage, divide the second reading by the first. Figure 4-7 shows the response of the Test Prod MX-933/U and Signal Tracer TS-673/U for audio signals.

(3) With the Test Prod MX-934/U and Telephone Receiver, the Signal Tracer can be used to detect audio modulated RF fields and to trace audio modulated IF and RF signals in IF and RF amplifiers. When the Test Prod MX-934/U tip is extended with the Extension Rod, the equipment can be used as a radio receiver near transmitter antennas. The Prod tip is placed about five feet from (or closer but never touching) the antenna. Audio modulated signals will be heard in the earphone. Only the key clicks will be received on CW operation.

NOTE

As shown by figure 4-8 the Test Prod MX-934/U has a low frequency response to unmodulated audio signals. Care should be taken in the testing of circuits with audio signals present in the RF or IF voltages that the indications of the Signal Tracer TS-673/U are not misinterpreted.

WARNING

The maximum safe rating on Test Prods MX-933/U and MX-934/U is 400 volts. The equipment must not be used to test circuits using voltages above 400 volts.

(4) When used with Test Prod MX-934/U, Interference Generator SG-23/U, and the Telephone Receiver, the Signal Tracer can test RF amplifiers. A signal is generated with the Interference Generator and traced with the Signal Tracer from stage-to-stage. Normally, an increase in gain is expected from the input of a stage to the output. This may not be true in the following cases:

(a) A decrease in output may occur due to the step-down ratio of the output transformer.

(b) When using the Interference Generator, a gain may not be realized in tuned stages, due to reduced band width.

(c) A mixing or converter stage may not give an increase in gain, depending on design.

(5) When connected to the Test Prod MX-933/U, the Signal Tracer can be used as a null voltage indicator. The sensitivity of AC impedance bridges can be increased by connecting the bridge output into the input of the Signal Tracer. Care should be taken that both the Signal Tracer and the ground side of the bridge are externally grounded at the same point.

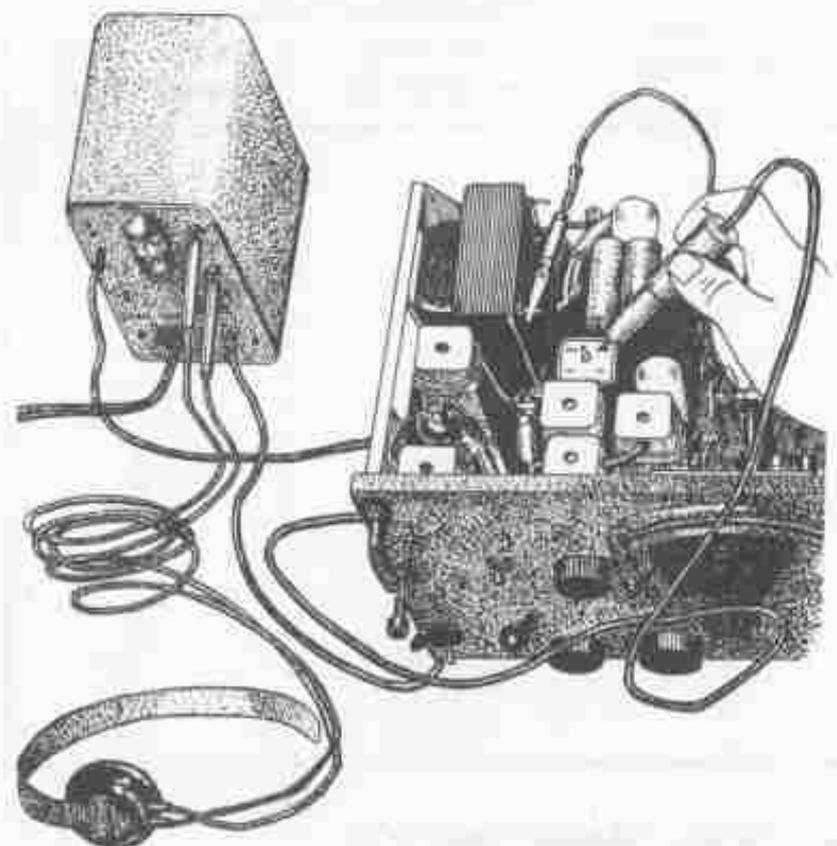
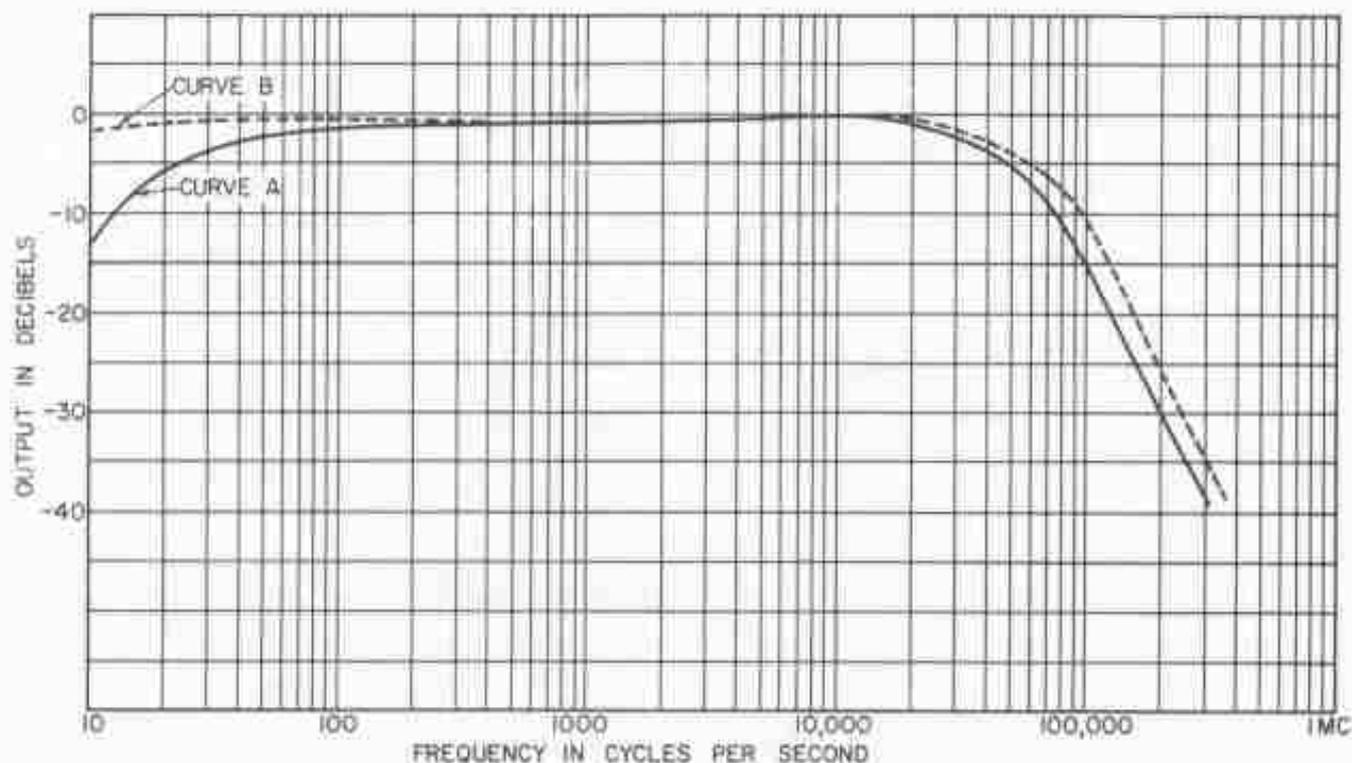


Figure 4-6. Detecting Signal in IF Stage of Radio Receiver with Signal Tracer and Test Prod MX-934/U

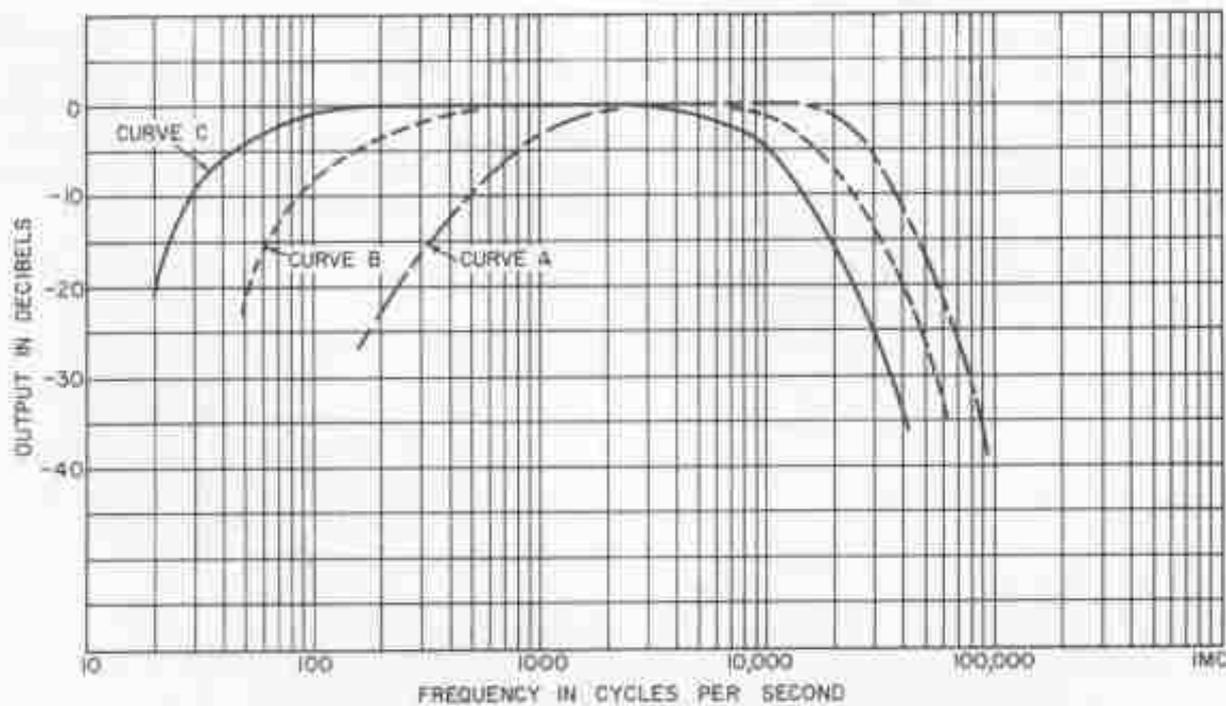


NOTES:

1. CURVE A: LEVEL ADJ. (R-202) SET AT 1. ZERO DB IS FULL SCALE OF M-201 AT CENTER BAND WITH .0025 VOLTS INPUT AND 3 VOLTS ON THE SCOPE TERMINALS.

CURVE B: LEVEL ADJ. (R-202) SET AT 100. ZERO DB IS FULL SCALE OF M-201 AT CENTER BAND WITH .15 VOLTS INPUT AND 3 VOLTS ON THE SCOPE TERMINALS.

Figure 4-7. Curves Showing the Frequency Response of Signal Tracer TS-673/U and Test Prod MX-933/U.



NOTES:

1. CURVE A: LEVEL ADJ. (R-202) SET AT 1. ZERO DB IS FULL SCALE OF M-201 AT CENTER BAND WITH .006 VOLTS INPUT AND 3 VOLTS AT SCOPE TERMINALS.
CURVE B: LEVEL ADJ. (R-202) SET AT 10. ZERO DB IS FULL SCALE OF M-201 AT CENTER BAND WITH .040 VOLTS INPUT AND 3 VOLTS AT SCOPE TERMINALS.

CURVE C: LEVEL ADJ. (R-202) SET AT 100. ZERO DB IS FULL SCALE OF M-201 AT CENTER BAND WITH .15 VOLTS INPUT AND 3 VOLTS AT SCOPE TERMINALS.
2. CURVES ARE APPROXIMATE AND CAN BE APPLIED TO EITHER THE VOLTAGE OUTPUT AT SCOPE TERMINALS OR THE READING OF M-201.

Figure 4-8. Curves Showing the Frequency Response of Signal Tracer TS-673/U and Test Prod MX-934/U for Unmodulated Signals.

(6) When used with Test Prod MX-934/U and Extension Rod, the Signal Tracer is a radio interference locator. A common source of radio interference is the arcing at the brushes of electric motors. With the aid of the Telephone Receiver as a detector, the Prod is moved into the vicinity of the suspected motors. Once the interference can be heard in the earphone, the Prod is moved in the direction of loudest signal to the arcing brushes.

(7) The Test Prod MX-934/U and Signal Tracer can be used to check the approximate gain of RF and IF amplifier stages. (See Section 4, paragraph 3c(2).) (A sine wave generator must be used for these gain tests, as the generated signals from the Interference Generator are attenuated rapidly by tuned circuits, and this unit can only be used for audio gain checks.)

(8) With Test Prod MX-934/U the Signal Tracer can be used for servicing low level RF lines. To check a line for center conductor continuity, open the line at a jack and place the Prod near the center conductor. Audio modulation of the RF voltage is detected through the earphone. An RF line carrying its maximum power should not be opened. A mis-match may occur with arcing of the line.

(9) The RF Test Prod MX-934/U can be used as a demodulator for an oscilloscope or an electronic voltmeter. Figure 4-9 shows the relation between 50% modulated IF or RF voltage input and modulation voltage output of the Prod.

(10) For connecting an electronic voltmeter, telephone receiver, or oscilloscope to the Test Prod MX-934/U, a simple adapter for the RF Cable Assembly can be constructed. An input jack assembly J-203 from the spare parts of the Test-Tool Set can be obtained and short lengths of wire soldered to its output terminals. The wires can then be stripped and attached to any electronic voltmeter or oscilloscope.

(11) The Telephone Receiver can be used with the 0.25-mfd capacitor of the Decade Capacitor TS-671/U to trace audic signals when amplification is not required.

(12) Open circuits in wires can be detected by tracing a signal along the path of the wire. This signal can be generated by the Interference Generator and detected with Test Prod MX-934/U connected to the Signal Tracer.

(13) The Test Prod MX-934/U with adapter mentioned in paragraph (10) above can be connected to an AC electronic voltmeter to indicate modulated RF voltages of weak oscillators.

(14) In applications on radar sets, the Telephone Receiver can be used to check the existence of trigger pulses from the modulator unit to the indicator unit of less than 600 volts peak. This is done by disconnecting the cable at the indicator unit panel and connecting the earphone in series with a 0.25-mfd capacitor of the Decade Capacitor across the cable terminals. A loud tone will indicate that the pulses from the modulator unit are reaching the indicator unit panel.

(15) Pulses at IF frequencies in radar sets can be detected by use of the Test Prod MX-934/U and amplified by the Signal Tracer. Pulses can be detected on the output of the Signal Tracer by means of the Telephone Receiver or an oscilloscope. Pulse shapes observed on the oscilloscope will generally be distorted due to the limited band width of the Signal Tracer.

(16) Video pulses can be traced with the audio Test Prod MX-933/U and the Signal Tracer with Telephone Receiver. In cases where the signal is of a high level and some distortion is allowable, the Telephone Receiver in series with a 0.25-mfd capacitor can sometimes be used directly.

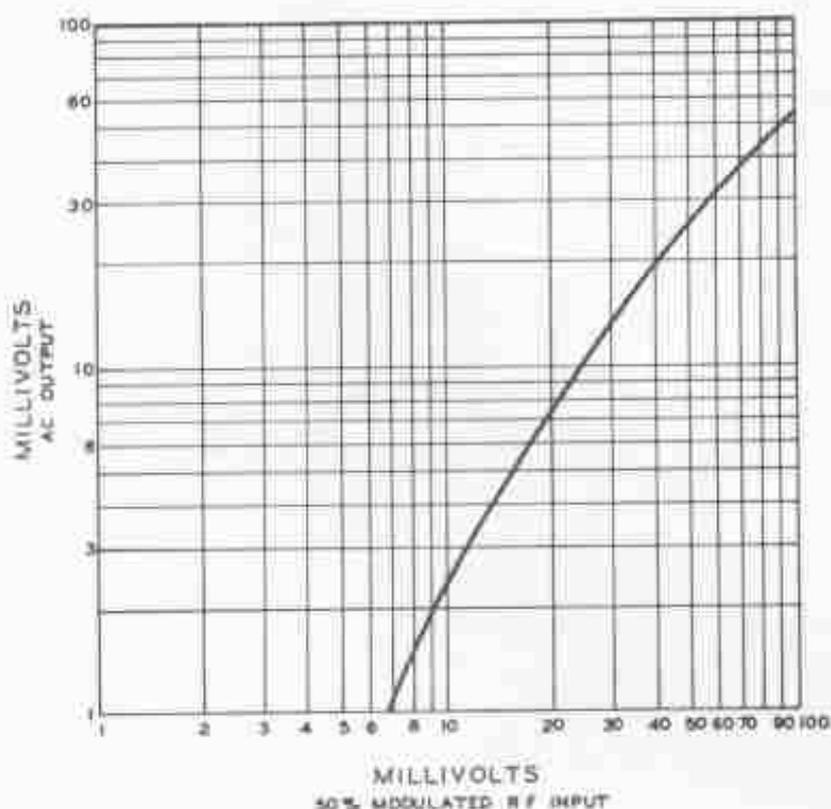


Figure 4-9. Curve Showing Modulated RF, IF Voltage Input to Test Prod MX-934/U vs AC Output Voltage

CAUTION

Many video signals exceed the voltage rating of Test Prod MX-934/U, since the germanium diode will only withstand 50 volts maximum peak inverse. Random probing must not be done due to the high voltages which are likely to be encountered.

In signal tracing, a loss of gain is usually experienced in stages containing output or matching transformers. The voltage ratio of a transformer is related to the matching impedances by the following formula:

$$\text{Voltage Ratio} = \left(\frac{E_{in}}{E_{out}} \right) = \sqrt{\frac{\text{Impedance in } (Z_{pri})}{\text{Impedance out } (Z_{sec})}}$$

For example: Some typical output tubes, impedances of transformers usually used with these tubes, and the voltage ratios of these transformers are tabulated below:

Single Tube	Pri Impedance (ohms)	Output Impedance (ohms)	Voltage Ratio
6L6, 25L6, 35L6, and 50L6	2500	4 500	25:1 2.2:1
Push-Pull Tubes			
Two 6V6's or two 45's	7000 (plate to plate)	4 500	42:1 3.8:1

4. INTERFERENCE GENERATOR SG-23/U.

a. **LIMITATIONS.** - This device has a fundamental audio output of about 1000 cycles. The harmonics generated by the buzzer contacts and the sharp wave fronts extend into the radio frequency range.

In general, this unit is used to supply an input signal to electronic amplifying circuits, while observing the effect on the output voltage.

b. **OPERATION OF INTERFERENCE GENERATOR SG-23/U.** - Pressing the button at the top of the unit places the buzzer in operation. Touching the probe tip to the grid or plate terminal will excite the circuit. If audio output is desired, place index at position 1. For higher frequencies, place index between 2 and 10. Greatest attenuation of output occurs at position 10. The unit can be grounded by plugging a Navy Type CAOR-491895 lead into the small hole in back of the tip as shown in figure 1-4. Usually, this ground is not required.

This device may be used with Test Prod MX-933/U and Signal Tracer to feed audio circuits if its index is set to position 1, as described in Section 4, paragraph 3b. It may also be used with Test Prod MX-934/U and Signal Tracer combination, with its index set on positions 2 through 10, to excite RF circuits. The Extension Rod O-904 can be attached to the tip of the Interference Generator to provide a means for reaching into a deep chassis, especially if high voltage exists on exposed contacts which the technician might accidentally touch while using this unit.

c. **TYPICAL APPLICATIONS.** - The following list indicates some of the uses of the Interference Generator.

(1) It can be used to energize audio circuits for signal tracing purposes.

(2) It can also be used to generate a signal in RF and AF tuned circuits for signal tracing purposes.

(3) The Interference Generator can be used with the Telephone Receiver to "ring" out cables and check continuity of wiring. Care must be taken that an operation of this type does not interfere with needed services. The Resistance Indicator-Probe is probably more desirable to use in these cases.

(4) With the Signal Tracer, the Interference Generator can be used to measure audio amplifier gain. Refer to Section 4, paragraph 3c(2) to see how this is done.

(5) The Interference Generator can be used as a triggering device for multi-vibrator circuits.

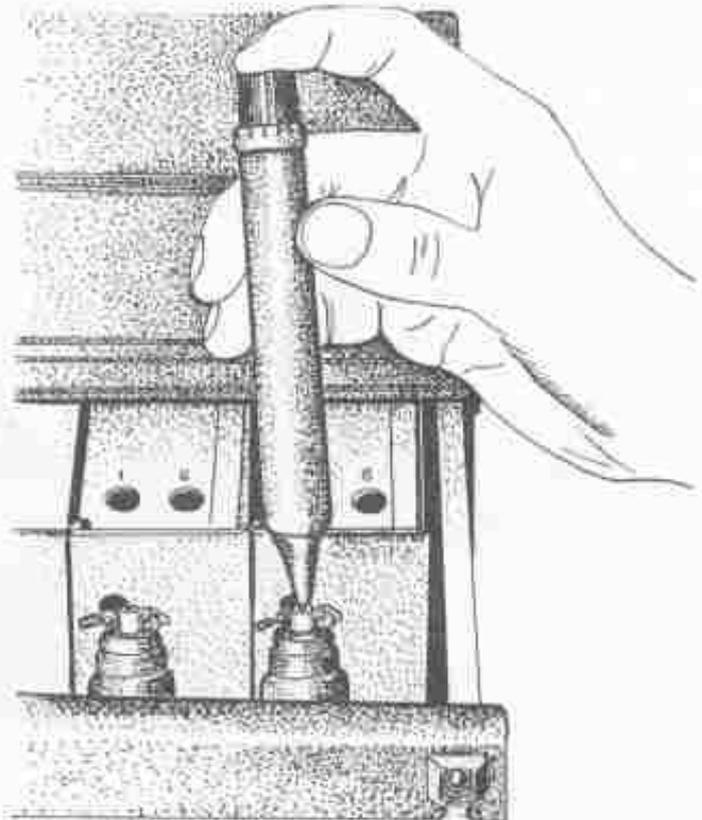


Figure 4-10. Using the Interference Generator for Testing an RF Tuned Circuit

5. VOLTAGE INDICATOR-PROBE ID-265/U.

a. **LIMITATIONS.** - While measuring voltage magnitudes from zero to 440 volts AC or DC, this instrument also indicates whether the source is AC or DC, and the polarity of the source if DC; the tip is positive (+) when the Polarity Indicator M-401 moves toward the + side. The AC voltage frequency range is 10 to 10,000 cycles. The total internal resistance of the circuit is 510,000 ohms. A typical use of this unit is to determine the presence of line voltage. It is not a precision instrument, and no attempt should be made to read exact voltages.

b. **OPERATION OF VOLTAGE INDICATOR-PROBE ID-265/U.** - An electrical lead with banana plug end is plugged into the top of the Probe to complete the circuit. The meter indicates the approximate voltage magnitude across these terminals. (See figure 1-5.)

If a DC supply voltage is being measured, the return lead is usually clipped to the chassis of the equipment under test and the probe tip touched to the voltage point of interest. The polarity of the tip is indicated by the instrument marked POLARITY. A deflection toward (+) means the probe tip is positive. The instrument marked VOLTS moves up-scale for either polarity of applied voltage. The Extension Rod O-904 without its plastic tip can be attached to the end of the unit to increase the prod length when used near high voltages.

c. **TYPICAL APPLICATIONS.** - The paragraphs below show some of the uses for this unit.

(1) The presence and magnitude of line voltage at junction boxes and power transformers can be indicated. Figure 4-11 shows the Probe in use indicating the presence of AC voltage at a power supply transformer.

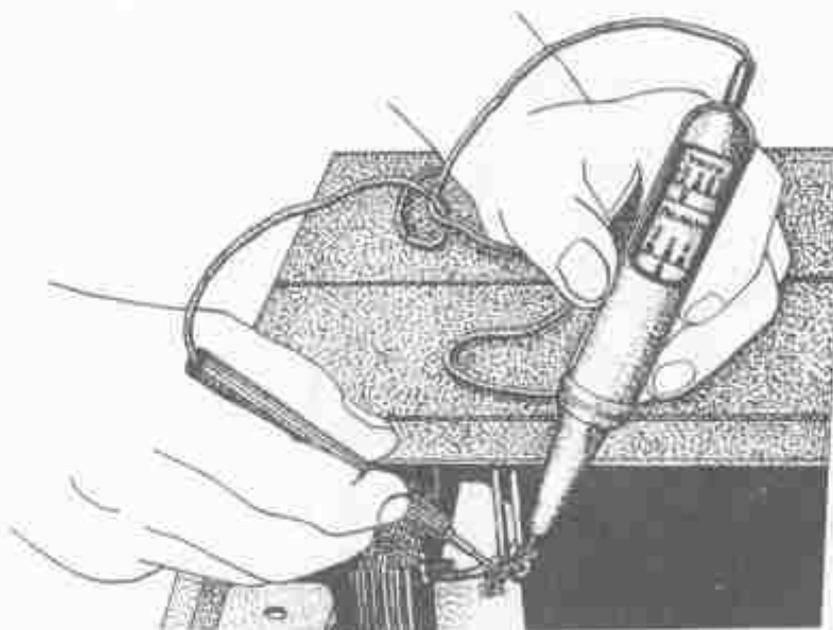


Figure 4-11. Measuring Line Voltage on Transformer with Voltage Indicator-Probe

(2) The magnitude of DC plate voltages in amplifiers and other electronic equipment can also be indicated up to 400 volts.

(3) The Voltage Indicator-Probe can indicate audio signals on transformer secondaries.

(4) Audio voltage in the presence of DC can be indicated by connecting the 0.1-mfd capacitor of the Decade Capacitor in series with the Probe.

(5) The Voltage Indicator-Probe can be used on audio tuned circuits as a peaking meter. Also, the IF circuits of a radio receiver can be aligned approximately by using this Probe as a peaking meter to indicate audio output while adjusting the trimmer capacitors of IF coils with Alignment Tool H-917.

(6) The Alignment Tool consists of a bakelite rod with a brass slug in one end and a steel slug in the other. The steel slug is also shaped like a screwdriver bit for adjusting trimmer capacitors. Placing the brass slug into a coil lowers its inductance; placing the steel slug in the coil raises its inductance. This effect is used in the tuning of IF and RF tuned circuits. If the output of a tuned amplifier is decreased by inserting either end of the tool into a tuned coil, that coil is aligned with the other tuned circuits. If inserting the brass slug increases the output, reduce the tuning capacity by means of the screwdriver bit. If inserting the steel slug increases the output, increase the tuning capacity. A sine wave signal generator, audio, IF, or RF, should be used as a voltage source for aligning and tuning such circuits instead of the Interference Generator SG-23/U.

(7) The Voltage Indicator-Probe can be used to indicate high resistance by placing the unknown resis-

tance in series with the Probe and an approximate 300-volt DC source E. The resistance R in kilohms is then calculated by the formula:

$$R = 500 \left(\frac{E}{\text{Reading in Volts}} - 1 \right) \text{ Kilohms}$$

(8) It can also be used to measure, for test purposes, the voltages available at the pins of tube sockets with the tube removed. Adapters in the Navy Type-49992 Adapter Kit will make these measurements possible from the top of the socket with the tube in the circuit.

6. RF INDICATOR-PROBE ID-263/U.

a. LIMITATIONS. - This Probe will indicate the presence of electric RF fields near oscillators and power amplifiers. The sensitivity is approximately 25% of full-scale for 1 volt of RF energy applied to the tip at 1.0 megacycle, and is used to determine the presence of intense electric radio frequency fields such as exist around transmitters and other RF oscillators. The direct connected sensitivity of the unit as given in table 1-4 was obtained by actually connecting a 1-volt source of 1.0 megacycle to the tip; the return path being provided by a metal shield over the top of the probe. The sensitivity with Extension Rod O-904 is a calculated value at a high frequency and, at best, is only approximate.

b. OPERATION OF RF INDICATOR-PROBE ID-263/U. - The probe is held in the operator's hand with the tip pointing in the direction of greatest RF electric field. The manner in which the Probe is held may change the sensitivity slightly. The smaller the capacitive impedance between the operator's hand and the meter frame (inside and at the top), the greater will be the sensitivity. If the Probe is not held in hand but is isolated, the sensitivity is lower. If the field is strong, no contact with the probe tip is required. For smaller fields the point is touched to the source. For hard-to-reach places or near high voltage terminals, plug the Extension Rod O-904 onto the tip of the Probe.

CAUTION

Approach the source slowly, watching the instrument. Do not let the pointer go off-scale, especially when making a direct connection to the tip. Near high voltage, use the Extension Rod to remove the hand as far as possible from the danger area.

When the Extension Rod is used without the plastic cover, a direct connection exists between the tip of the Extension Rod and the probe tip. This is used for small fields to touch the actual source of radiation.

c. TYPICAL APPLICATIONS. - Some of the uses to which this Probe can be put are listed below.

(1) The RF Indicator-Probe will indicate the presence of intense radiation from antennas or RF transmitters. Figure 4-12 shows the method of use of this Probe near an antenna. This is a direct test for radi-

ation and will show if the over-all transmitter and antenna are operating. The Probe indicates the electric field and will give maximum indication near the ends of the dipole antenna. A test of operation for a transmitter would be to move the Probe into the vicinity of the output tubes and coils. An intense source of radiation, such as in this example, should be approached cautiously with the Probe, so as not to overload the internal germanium diodes and meter.

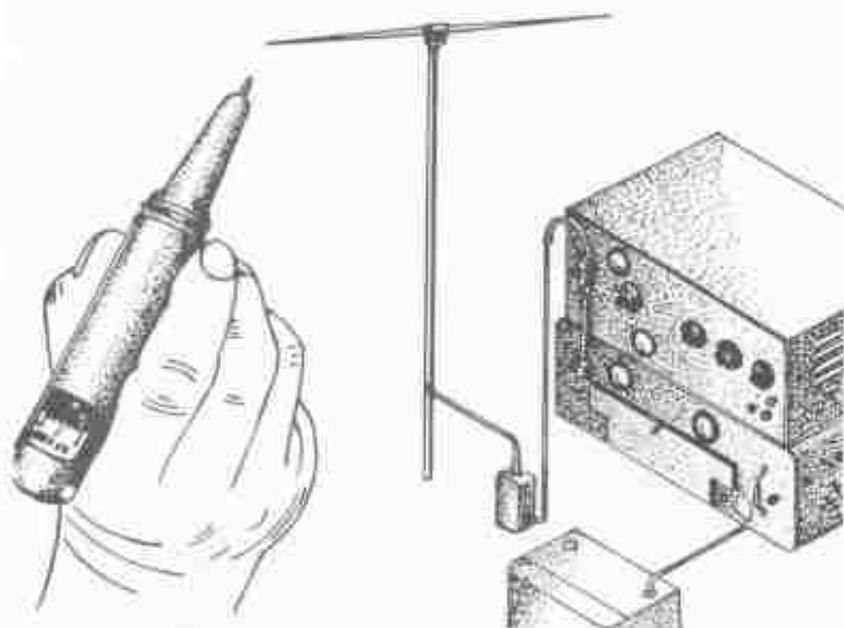


Figure 4-12. Checking RF Output of Radio Transmitter at Antenna with RF Indicator-Probe

(2) This Probe will indicate the presence of electric RF fields near local oscillator coils in radio receivers.

(3) It can be used to detect nulls and maximums along whip and dipole antennas and open transmission lines.

(4) Transmitter antennas can be adjusted as to length and tuned to a particular frequency by placing the RF Indicator-Probe near the energized antenna and observing the meter deflection. The antenna is adjusted for maximum meter deflection.

(5) RF bypass capacitors in circuits in which the RF can be indicated directly by the probe can be checked by touching the tip of the Probe to the RF side of the capacitor. No, or a very small, meter deflection should be observed on a good capacitor.

7. Resistance Indicator-Probe ID-264/U.

a. LIMITATIONS. - This Probe can indicate circuit continuity and resistance values between zero and 10,000 ohms. The instrument should be shorted and zero checked before using. This is not a precision instrument and cannot be used to measure critical values of resistance.

b. OPERATION OF RESISTANCE INDICATOR-PROBE ID-264/U. - This unit is first checked for zero resistance by shorting the test lead to the metal probe tip. The meter pointer should move up-scale and on past the 500-ohm mark when terminals are shorted. If the pointer does not reach the 500-ohm mark, the battery should be replaced (see figure 3-1). Approximate

values of resistance in ohms are indicated directly on the scale. The accuracy can be increased by proportionally correcting for the amount off on the zero resistance test.

c. TYPICAL APPLICATIONS. - A few of the uses for the Resistance Indicator-Probe are listed in the following paragraphs.

(1) This unit will measure approximate resistance values in the range from 0 to 10,000 ohms.

(2) It will indicate continuity of wiring.

(3) The forward and reverse resistances of crystal rectifiers and small copper-oxide rectifiers can be indicated. The tip of the Probe is positive.

(4) Electrolytic capacitors can be tested for shorts by placing the tip of the Probe to the positive side of the capacitor and return lead to the negative side with one end of the capacitor disconnected. Figure 4-13 shows the Probe being used to test an electrolytic capacitor.

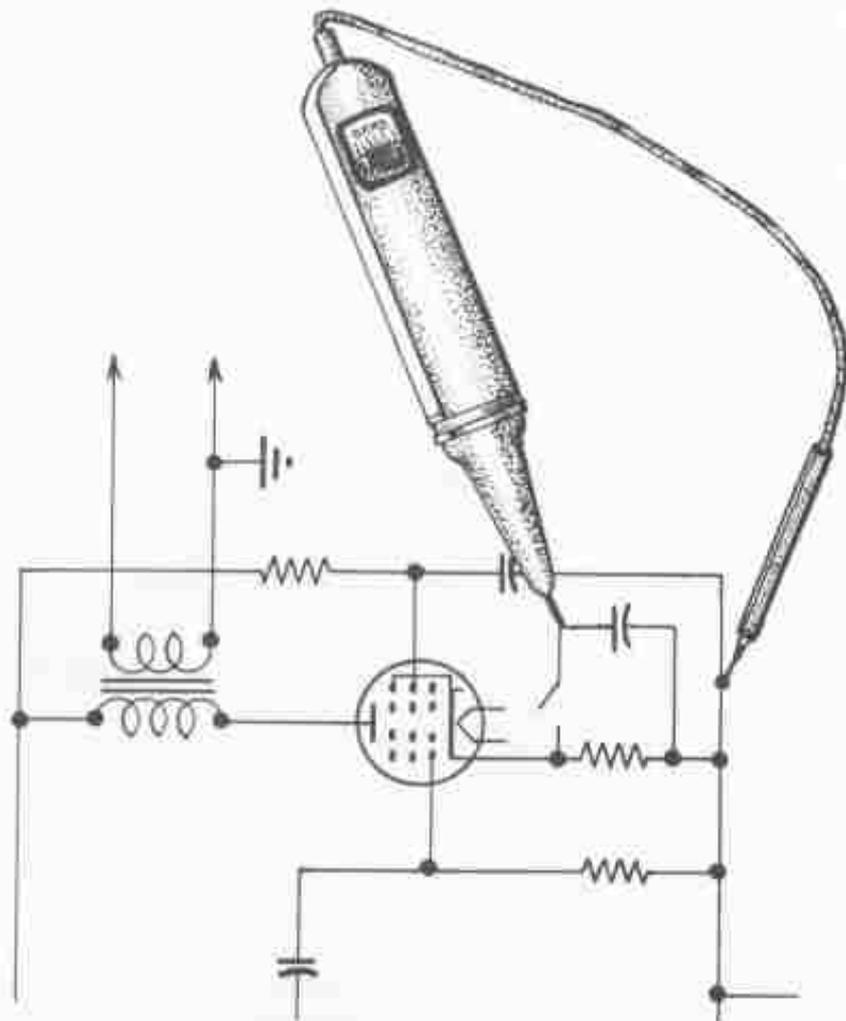


Figure 4-13. Checking an Electrolytic Capacitor in a Radio Receiver with Resistance Indicator-Probe

8. Decade Resistor T5-672A/U and Decade Capacitor T5-671/U.

These units are designed for use as substitution and test resistors and capacitors having the full range of values required for test, temporary repair, or troubleshooting of electronic equipment.

a. LIMITATIONS. - The Decade Resistor unit can be used to obtain values of resistance from one ohm to

12 megohms. Each resistor in the case is rated at two watts dissipation, and care should be taken when using this decade to make sure that the energy dissipation per resistor does not exceed this value. The accuracy is $\pm 10\%$. The total dissipation inside the decade case should not be permitted to exceed 10 watts.

The Decade Capacitor can be used to obtain values of capacitance between 0.0001 and 48 microfarads. The capacitors in the range of 0.0001 microfarad to 0.25 microfarad have a DC working voltage rating of 600 volts. The electrolytic 20/4-mfd capacitors are rated at 450 v DC. Polarity of electrolytic capacitors must be observed. The accuracy is $\pm 10\%$ for the paper capacitors and $-0\% + 75\%$ for the electrolytic capacitors.

b. OPERATION OF DECADE RESISTOR AND DECADE CAPACITOR. - The resistors in this unit can be placed in series by means of Navy Type CAOR-491895 Electrical Leads as shown in figure 1-8 in which the decade resistor is connected so that 8 megohms are between the probe tips.

The capacitors in Decade Capacitor may be hooked up in parallel by electrical leads as shown in figure 1-9. These capacitors have values normally required for test and substitution in electronic equipment. Their DC voltage ratings should not be exceeded. If large AC currents and voltages are involved in the use of paper capacitors, care must be exercised that the peak AC voltage does not exceed the DC working voltage rating. A safe value of AC current through the mica and paper capacitors for frequencies up to 30 megacycles is 0.1 ampere.

CAUTION

Polarity of electrolytic capacitors must be observed. Never allow the positive terminal to become negative with respect to the common (NEG) terminal.

When using the electrolytic capacitors in alternating current circuits (where no DC voltages or currents are involved), the two NEG terminals are connected together and the substitution capacity taken as that between the positive terminals of equal value. The total value of capacitance is approximately one-half of that of one capacitor. This is the only way that the electrolytic capacitors can be used on straight AC; in all other cases the electrolytic capacitors must be biased positively with a DC voltage that is 20% greater than the peak AC voltage, but less than 450 volts DC.

c. TYPICAL APPLICATIONS. - Both units may be used independently or in combination as shown below.

(1) The Decade Resistor and Decade Capacitor can be used individually for substitution tests in any electrical circuit, provided the ratings as given in table 1-4 are not exceeded. To check a capacitor by the substitution method, one lead or connection of the suspected component must be unsoldered and the proper value from the Decade Capacitor connected into the same position in the circuit by means of electrical leads. If one side of a component is at ground voltage level, only the high side should be unsoldered. This will lower stray capacitances. The stray capacities created by the addition of leads and Decade boxes may interfere with the operation of critical circuits. To check a resistor by the substitution method, the value of resistance from the box should be selected and inserted across the resistor. Figure 4-14 shows the method of substituting both units.

(2) Both units can be connected in series and used as an RC time constant or phase shift network.

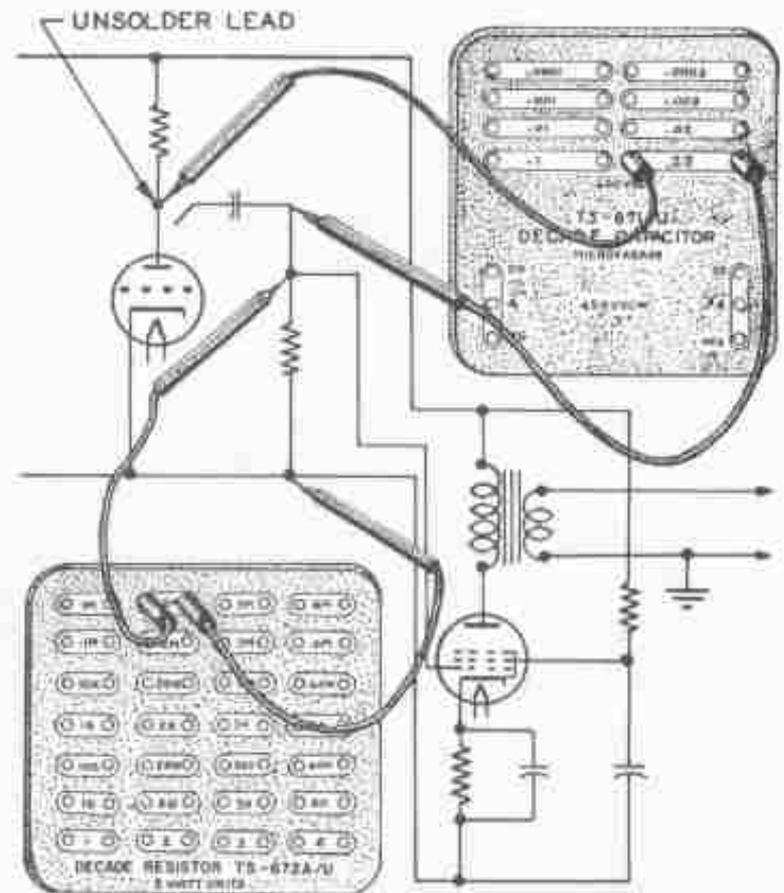


Figure 4-14. Substituting Decade Resistor and Decade Capacitor in an Electronic Circuit

WARNING

ELECTRONIC EQUIPMENT OPERATES AT DANGEROUS VOLTAGES

STOP ! LOOK ! THINK !

Men have been killed by very low voltage circuits. As little as 30 volts may be fatal under the proper combination of circumstances.

Haste, heedlessness, attempts to work where there are distracting noises, and attempts to carry on a conversation while servicing lead to materiel and personnel casualties.

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause

of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from any Electronics Officer.

ELECTRONIC EQUIPMENT FAILURE REPORT (SIG)		NOTICE—Read notes on cover prior to preparing this form.		* REPORT NO. _____	
NAVSHIPS (NBS) 383 (REV. 11-60)				DATE _____	
ORGANIZATION PERFORMING MAINTENANCE _____			NAME AND RANK OF OFFICER ACCOUNTABLE FOR MAINTENANCE _____		
EQUIPMENT INVOLVED					
<input type="checkbox"/> Navy	<input type="checkbox"/> Army	<input type="checkbox"/> USMC	<input type="checkbox"/> JAG	<input type="checkbox"/> Commercial	<input type="checkbox"/> Other _____ (Specify)
<input type="checkbox"/> Radio	<input type="checkbox"/> Radar	<input type="checkbox"/> Sonar	<input type="checkbox"/> Misc	<input type="checkbox"/> Test	<input type="checkbox"/> Test
<input type="checkbox"/> Power	<input type="checkbox"/> Speed	<input type="checkbox"/> Other _____ (Specify)			
EQUIPMENT MODEL DESIGNATION _____		SERIAL NUMBER OF EQUIPMENT _____		NAME OF CONTRACTOR _____	
TYPE NUMBER AND NAME OF NAVAL UNIT INVOLVED _____		SERIAL NUMBER OF UNIT _____		CONTRACT OR NO DATA OF UNIT _____	
				DATE EQUIPMENT RECEIVED _____	
ITEM WHICH FAILED					
THIS SIDE FOR TUBES			THIS SIDE FOR PARTS (NOTE 1)		
TUBE TYPE (INCLUDING PREFIX LETTERS) _____		SERIAL NO. (NOTE 2) _____		NAME OF PART _____	
TUBE MANUFACTURER _____		CONTRACT NO. (NOTE 2) _____		SERIAL NO. _____	
				* CONTRACT DATA _____	
FAILURE OCCURRED IN		GUARANTEED HOURS (NOTE 2) _____		* CHECK-OFF ON TAG DATA (NOTE 2) _____	
<input type="checkbox"/> Storage	<input type="checkbox"/> Operation	ACTUAL HOURS _____		* MANUFACTURER'S DATA (NOTE 2) _____	
<input type="checkbox"/> Handling	<input type="checkbox"/> Other (Specify in Remarks)	DATE OF ACCEPTANCE (NOTE 2) _____		CIRCUIT SYMBOL (e.g. P-31) _____	
<input type="checkbox"/> Installation		DATE OF FAILURE _____		NAVY TYPE NO. _____	
		TYPE OF FAILURE (NOTE 2) _____		* PARTS STOCK NO. _____	
		TUBE CIRCUIT SYMBOL _____		BRIEF DESCRIPTION AND CAUSE OF FAILURE, INCLUDING APPROXIMATE LIFE (CONTINUE ON BACK)	
NATURE OF FAILURE AND REMARKS (NOTE 2) (CONTINUE ON BACK) _____					
CONCLUSION					
<input type="checkbox"/> Replaced equipment	<input type="checkbox"/> Storage	<input type="checkbox"/> Reinstallation	<input type="checkbox"/> Failure	<input type="checkbox"/> Transcription markings	<input type="checkbox"/> Other _____ (Specify)
*NOT REQUIRED FOR REPORTS SUBMITTED BY NAVAL ACTIVITIES.					

Figure 5-1. Failure Report, Sample Form

SECTION 5 MAINTENANCE

1. Tube Tester TV-4A/U.

In case of trouble with the Tube Tester, the following procedure should be followed before attempting to repair the unit.

Connect the Tube Tester with the line cord to a 115-volt AC power line. Index the CIRCUIT SELECTOR switch to the LINE SHORT CHECK position. The Tube Tester meter should show a reading near the center of the scale. Rotate the LINE VOLTAGE control to set the meter pointer to the LINE CHECK mark. Obtain a directly heated or filament type tube for test purposes. Locate the tube type number in the Tube Data Index; set the FILAMENT SELECTOR switch to the required voltage and insert the tube in the correct socket. With the CIRCUIT SELECTOR switch in the LINE SHORT CHECK position, and all the electrode switches in the OUT position, move the A switch to the IN POSITION. The SHORT INDICATOR lamp should glow, indicating that the neon lamp is functioning correctly. Complete the tests on the tube to be sure that the device is operating normally.

Remove the tube, and index the CIRCUIT SELECTOR switch to one of the capacity ranges. Plug a pair of test leads in the capacity jacks, and short circuit the test prods. Rotate the LINE VOLTAGE control for full-scale pointer deflection on each capacity range. In general, the capacity ranges will function normally if this full-scale setting can be made on each range assuming that the power line potential is within ± 10 volts of the nominal 115-volt amplitude.

CAUTION

Do not attempt to open case before reading instructions under Section 5, paragraph 1b.

a. PRELIMINARY TESTS. - If the Tube Test section or capacity meter section are not operating properly, the following performance checks should be carried out.

In servicing the Tube Tester TV-4A/U perform only those repairs necessary to make the device function properly. Remember that most of the resistors are precision adjusted. Unless the component indicates a direct short or open circuit, the method of test must involve the standardization of the equipment being used to make these tests. Since most faults will be opens, shorts, or a mechanical failure, ordinary test equipment can be used to repair most of the difficulties.

Therefore, before attempting to check the individual components, check the fuse and line cord and then try to localize the failure into one or more of the first six categories listed below:

(1) Completely dead unit.

(2) Neon lamp lights all the time or when one of toggle switches is indexed to the IN POSITION. No tube should be placed in a test socket while making this check.

(3) Low or no LINE CHECK indication.

(4) Indication too high on total emission checks.

(5) Inability to make top mark on capacity meter ranges.

(6) Capacity meter in error.

(7) Defective components.

(8) After classifying the fault as above, disassemble the unit and proceed as outlined under Section 5, paragraph 1c, where detail checks are given for each fault above. The line cord and fuse are to be checked immediately if the unit is apparently dead.

b. DISASSEMBLY PROCEDURE. - The Tube Tester in addition to its outer case has three main assemblies: the socket panel, chassis, and bakelite panel. These three sections should never be separated at one time, unless the repair personnel is absolutely certain that such procedure is the only course, or that the ensuing instrument readings indicate that it is necessary.

(1) TUBE TESTER CASE REMOVAL. - The case is removed from the instrument as follows:

(a) Remove the three screws that fasten the top side of the hinge to the Tube Tester TV-4A/U.

(b) Lift the Tube Tester out of the Test Kit.

(c) Place the Tube Tester on the bench with the socket panel face up.

(d) Remove the line cord.

(e) Remove the five binder-head screws around the three edges of the socket panel.

CAUTION

DO NOT REMOVE ANY OF THE FRONT
PANEL SCREWS

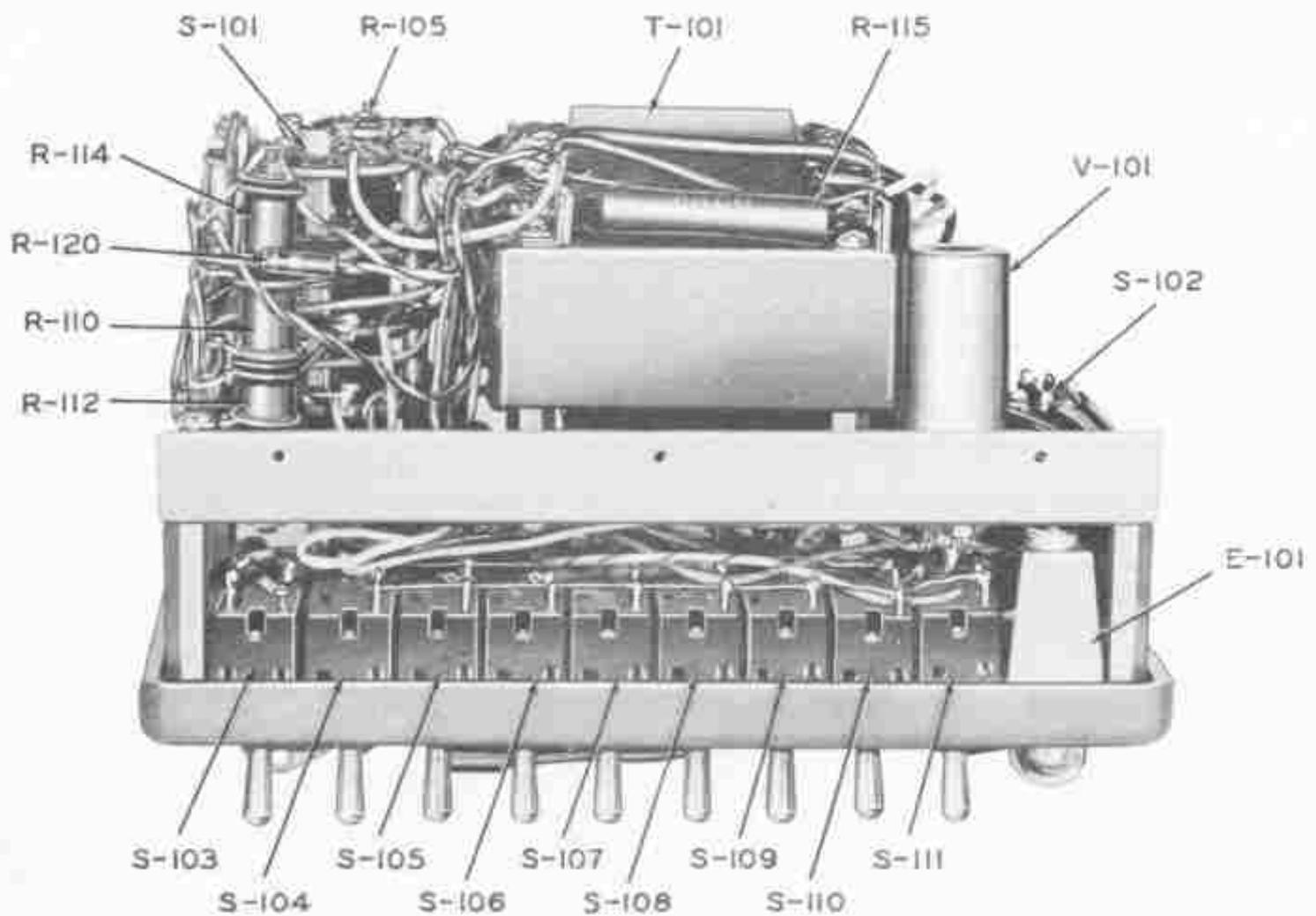


Figure 5-2. Side View of Tube Tester TV-4A/U, Case Removed

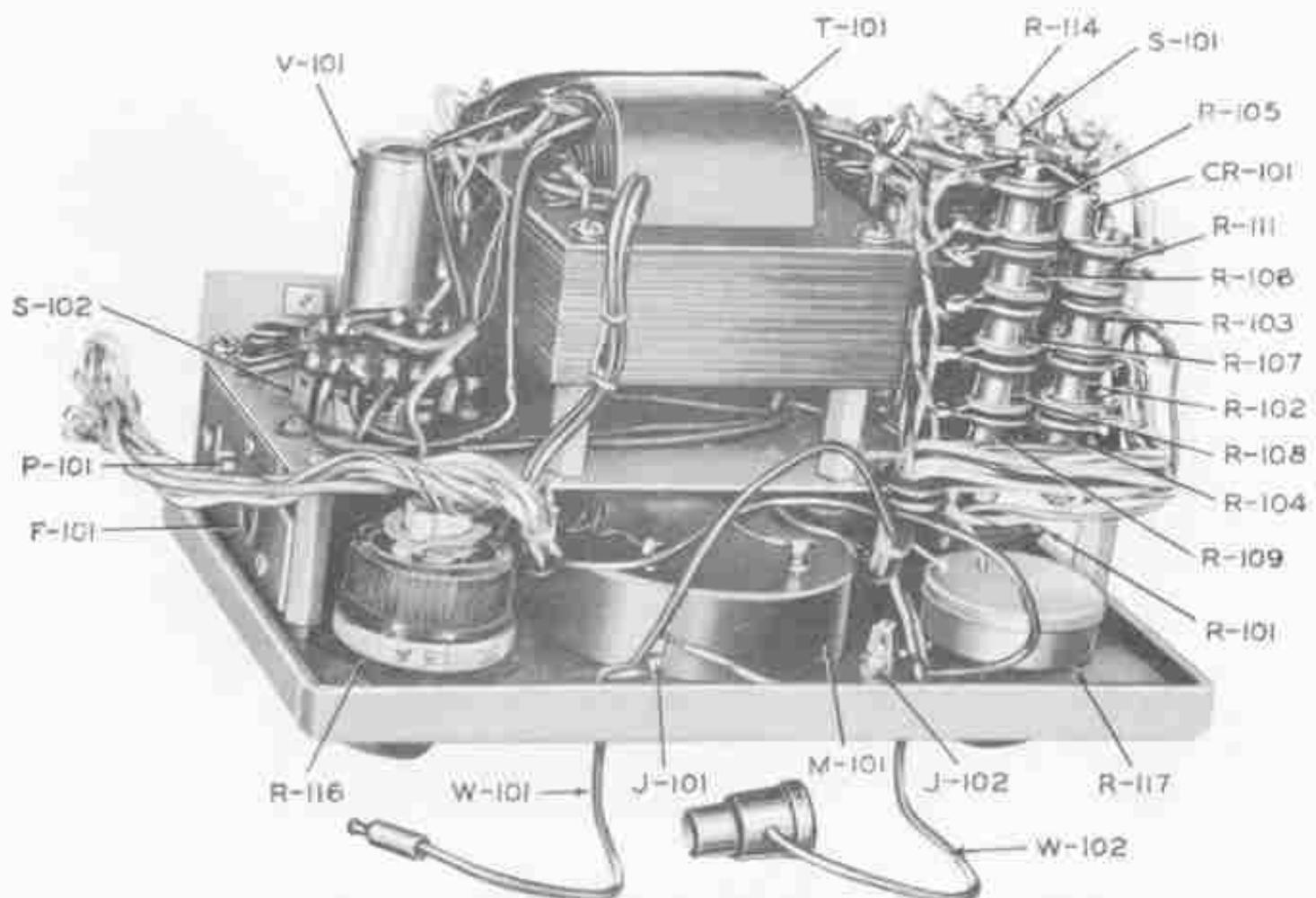


Figure 5-3. Angle View of Tube Tester, Case Removed

(f) Pull the bottom of the case away from the bakelite panel. The socket panel will stay affixed to the bakelite panel, but the case which forms the bottom, ends, and opposite side of the device will come off.

(2) SOCKET PANEL REMOVAL.

(a) Remove outer case as described in previous paragraph.

(b) Remove the two corner screws at the top of the bakelite panel nearest the socket panel.

(c) Carefully lift socket panel away from the bakelite panel and then pull away from the chassis.

(d) Unsolder only those leads from the terminal board that go either to the chassis or bakelite panel. Many repairs can be made by just pulling the socket panel away from the Tube Tester without unsoldering any wires to the terminal plate, since the cable is quite long.

(3) CHASSIS REMOVAL FROM BAKELITE PANEL.

(a) Remove outer case as described in previous paragraphs.

(b) Remove socket panel as per previous paragraph.

(c) Remove the knobs from the FILAMENT SELECTOR and the CIRCUIT SELECTOR switches.

(d) Remove the four panel screws fastening the four chassis posts to the panel.

(e) Lift the chassis away from the panel and lay it to one side. The leads in the cable are sufficiently long so that connections need not be unsoldered.

c. DETAILED CHECKS. - The following checks are given for each of the faults listed in paragraph 1a above.

(1) A completely dead unit can be caused by an open primary in T-101, burned out LINE VOLTAGE control R-116, bad fuse or line cord, or an open meter.

(a) The line control is a 350-ohm, 25 watt unit and can be readily checked by the Resistance Indicator-Probe. Unsolder the leads to the outside terminals before testing. If the component is defective, remove the chassis assembly from the bakelite panel. See Section 5, paragraph 1b(3).

(b) See point-to-point resistance measurements for determining defective transformer or meter.

(2) A lighted neon lamp with no tube in the test sockets indicates a short in the socket panel wiring, at the terminal strip mounted on the socket panel, in the wiring to S-101, or a short at the terminals on the transformer T-101. Check for the shorts as follows:

(a) Start with all toggle switches in the OUT position and index the CIRCUIT SELECTOR switch through

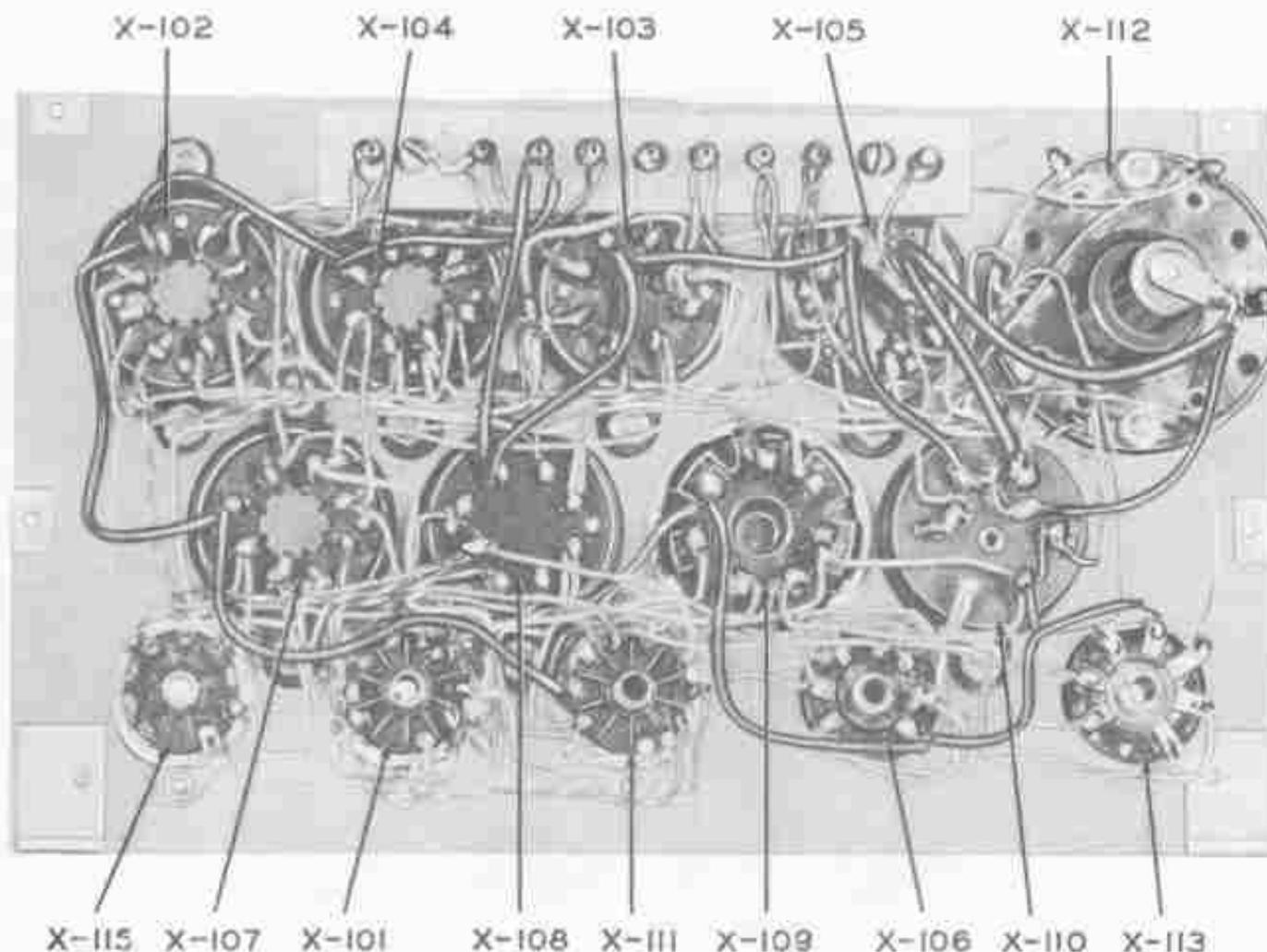


Figure 5-4. Rear View of Socket Panel of Tube Tester TV-4A/U.

all positions including the capacity meter ranges. A lighted neon lamp indicates a short in the wiring to the CIRCUIT SELECTOR switch, incorrect wiring on those units where a replacement of the CIRCUIT SELECTOR switch has been made, or a short at the transformer terminals.

1. Mechanically inspect lead dress at S-101 and T-101.

2. Repeat above checks.

(b) With CIRCUIT SELECTOR switch in LINE SHORT CHECK position index each of the toggle switches separately to the IN POSITION and then return to the OUT position. A lighted neon lamp indicates a short in the socket panel or at the terminal strip on the socket panel.

1. Unsolder the wires that run from the chassis and bakelite panel to the socket panel at the terminal strip.

2. Fan out these unsoldered leads and repeat the check. If no short is indicated, the socket panel is faulty.

3. Using an ohmmeter that gives a good indication on two megohms, check between each connection on the terminal strip to locate the shorted leads. An indication of two megohms, or lower, will cause trouble.

NOTE

Do not use solder paste or acid core solder, as it will cause such high leakage currents that the short check will become completely inoperative, requiring that all components on the socket panel be discarded. Use only rosin mixed in alcohol as a flux or a good grade of rosin core solder.

(3) Low or no LINE CHECK indication involves only two components, V-101 and R-114 the line check resistor.

(a) A burned out V-101 or an open R-114 will cause the LINE CHECK indication to be zero.

(b) If V-101 has low emission, the LINE CHECK indication will be low.

NOTE

A low LINE CHECK indication will cause the LINE SHORT CHECK sensitivity to be low or zero.

(4) Tubes reading too high as indicated by a number of tubes giving off-scale readings is caused by incorrect adjustment of the line check resistor R-114, TUBE SELECTOR control, or both.

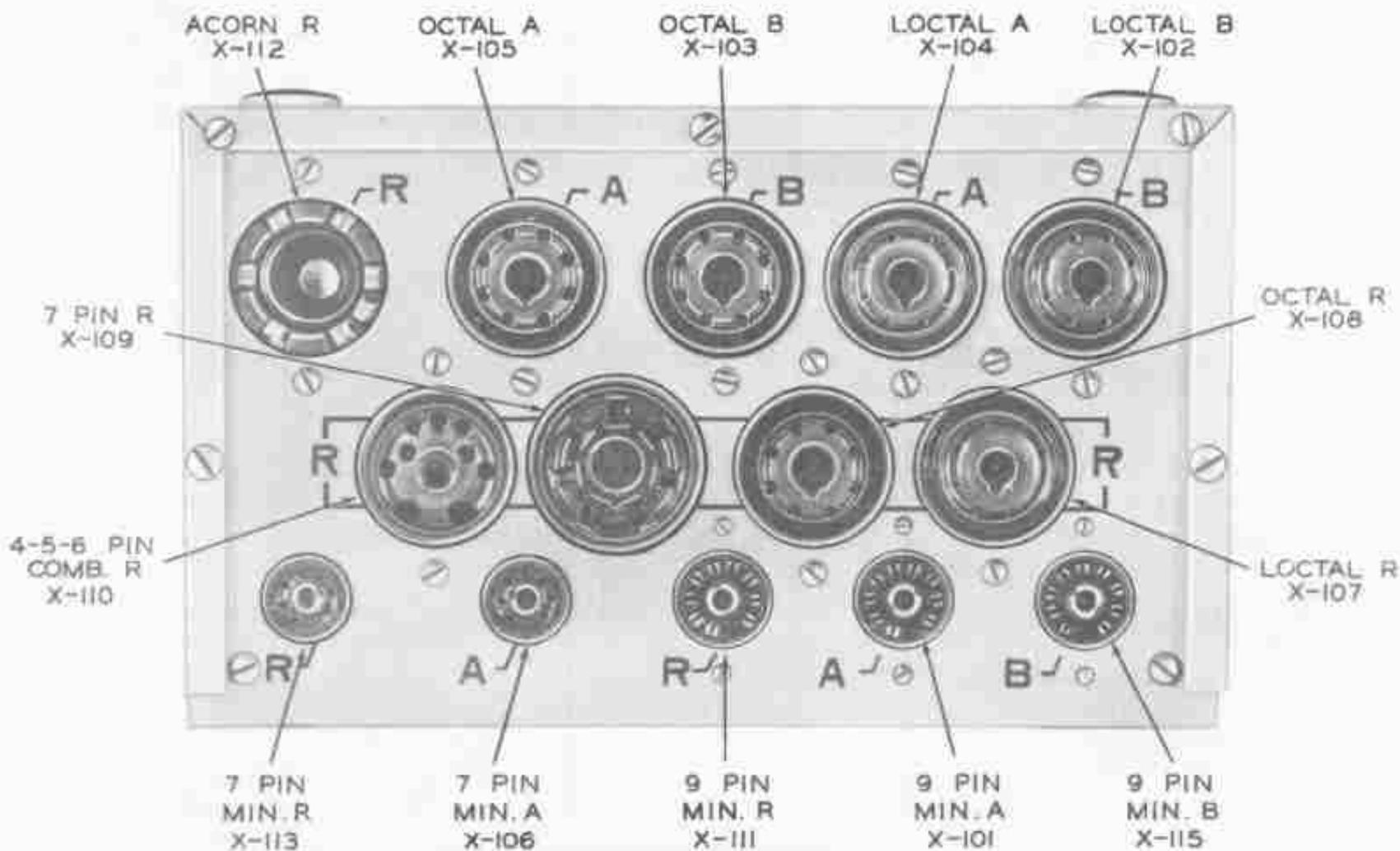


Figure 5-5. Front View of Sockets

R-101	3
R-102	165
R-103	300
R-104	88.36
R-105	1328
R-106	26,224
R-107	78
R-108	728
R-109	8500
R-110	70,300
R-111	40
R-112	4700
R-113	785
R-114	83,000
R-115	2,000
R-116	350
R-117	130
R-118	200,000
R-119	510,000
R-120	VALUE DETERMINED BY LINE CHECK ADJ. JAN 344
V-101	

NOTE:
ALL RESISTANCE VALUES ARE IN OHMS

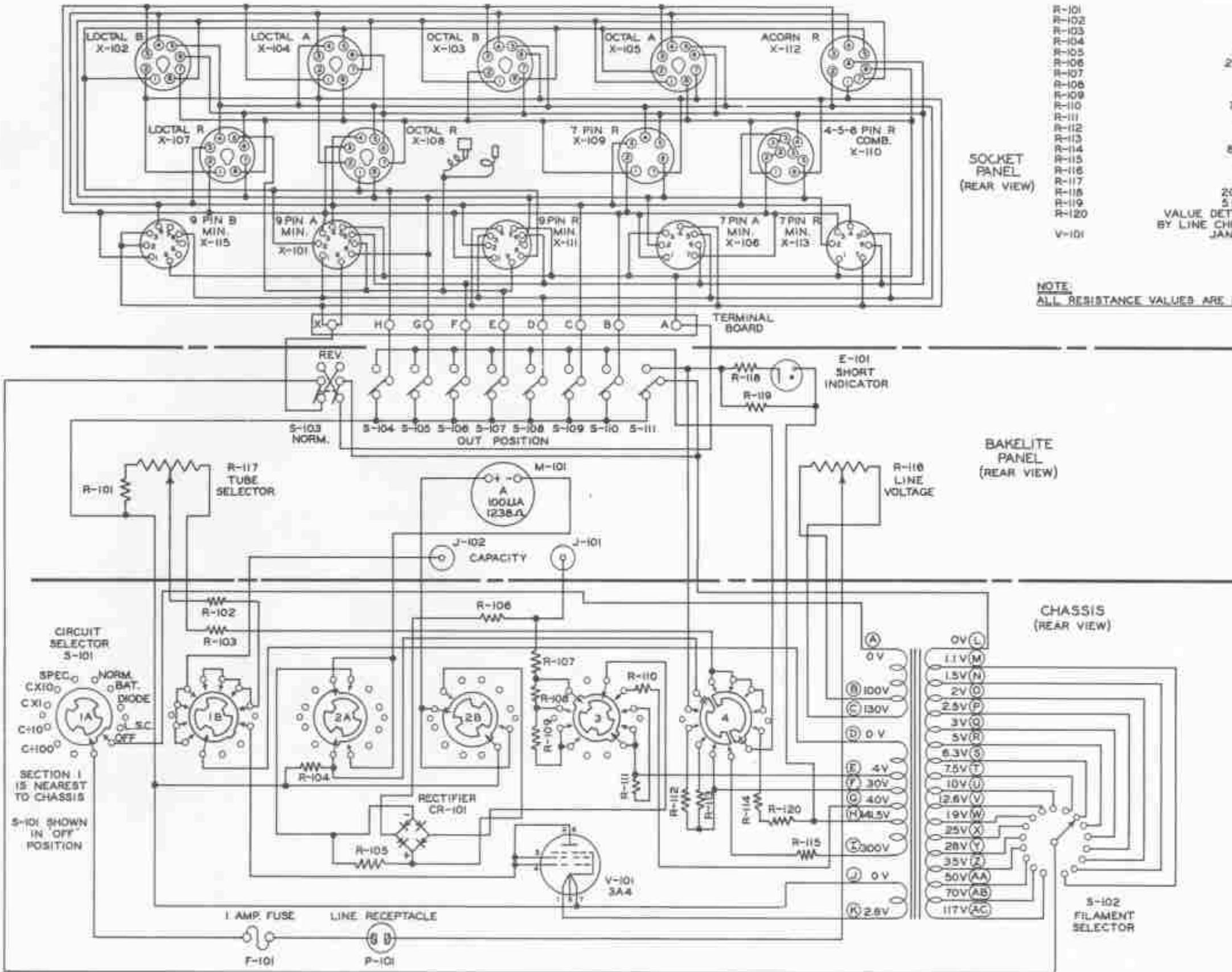


Figure 5-6. Schematic Diagram of Tube Tester TV-4A/U

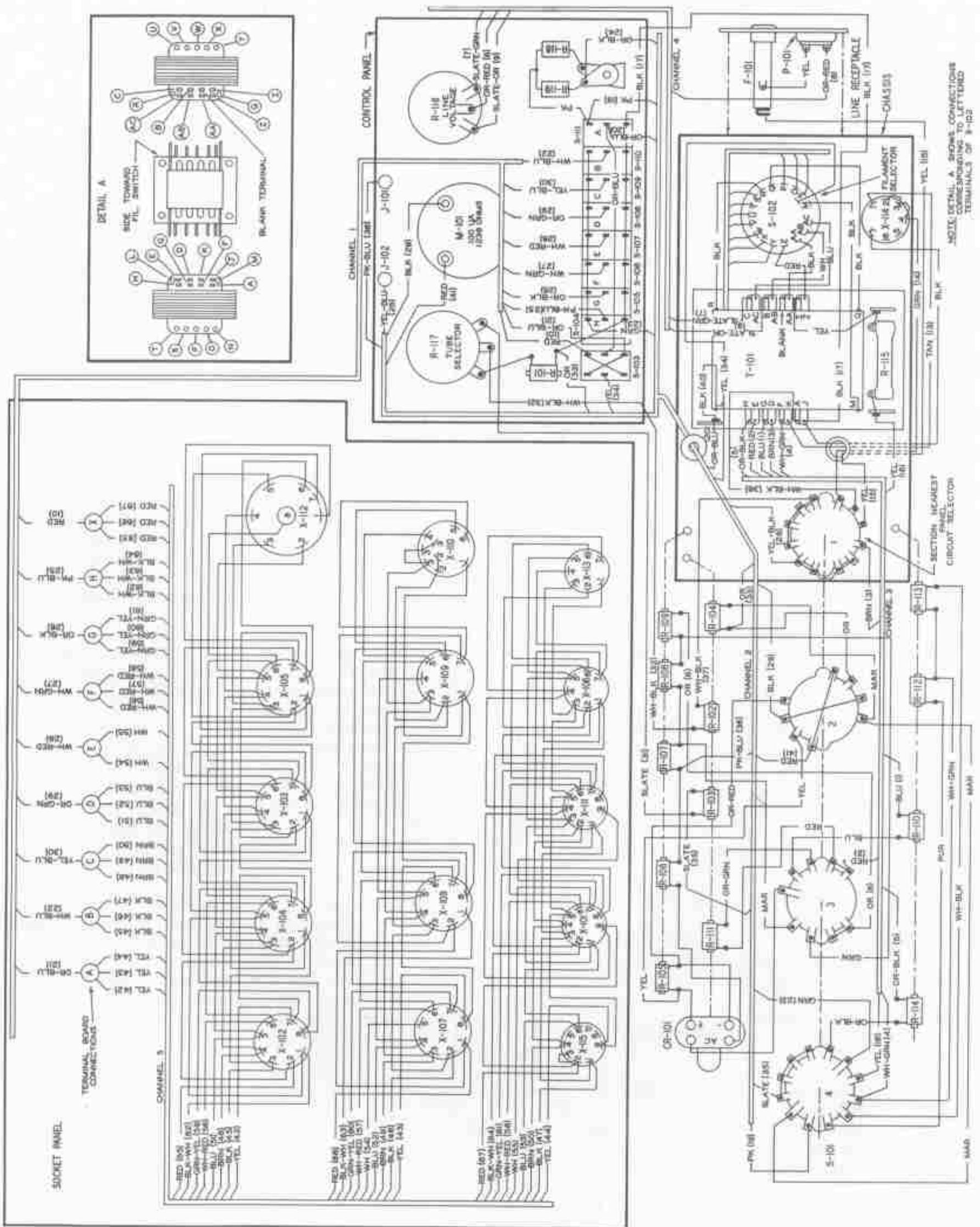


Figure 5-7. Wiring Diagram of Tube Tester TV-4A/U

TABLE 5-1. RESISTANCE TABLE FOR TUBE TESTER

COMPONENT TO BE CHECKED	TEST LEADS ACROSS	RESISTANCE VALUE (OHMS)	TUBE SELECTOR POSITION	CIRCUIT SELECTOR SWITCH POSITION	REMARKS
R-101	R-101	3 ±1/2%	-	C X 10	<p>Unsolder leads from one side of spool.</p> <p>Remove socket panel from bakelite panel. Do not unsolder any leads.</p> <p>Same as R-107.</p> <p>Same as R-107.</p> <p>Remove the four panel screws holding the chassis. Lift chassis away from panel. Unsolder leads to outside terminals of control. To replace control remove socket panel completely and lift chassis away from panel. If adjustment is required see section 5, paragraph 1c(2). Note this measurement must be accurate.</p> <p>Do not check unless short test operates improperly. To test or replace, loosen chassis from bakelite panel and unsolder the leads to this resistor only.</p> <p>See remarks for R-118.</p> <p>Set LINE VOLTAGE control to counter-clockwise position. If resistance is infinity, check F-101 and check section 1A of S-101 for continuity. If satisfactory, T-101 has an open primary. To replace T-101 remove socket panel completely and remove chassis from bakelite panel. Replace S-102 at the same time.</p> <p>Remove four screws from front of meter, remove from panel, and unsolder one of the leads. All toggle switches in OUT position except B. All checks on S-101 assume that all resistor components are good. Incorrect readings indicate faulty switch, incorrect wiring, or a short or open in the wiring to the switch.</p>
R-102	R-102	165 ±1/2%	-	OFF	
R-103	R-103	300 ±1/2%	-	C X 10	
R-104	R-104	88.36 ±1/2%	-	C X 10	
R-105	R-105	7328 ±1/2%	-	-	
R-106	R-106	26,224 ±1/2%	-	NORMAL	
R-107	R-107	76 ±1/2%	-	NORMAL	
R-108	R-108	726 ±1/2%	-	NORMAL	
R-109	R-109	9500 ±1/2%	-	NORMAL	
R-110	R-110	70,300 ±1/2%	-	NORMAL	
R-111	R-111	40 ±1/2%	-	NORMAL	
R-112	R-112	4700 ±1/2%	-	OFF	
R-113	R-113	765 ±1/2%	-	OFF	
R-114	R-114	83,000 ±1/2%	-	OFF	
R-115	R-115	2,000 ±10%	-	OFF	
R-116	R-116	350 ±10%	-	-	
R-117	R-117	150 ±10%	-	C X 10	
Adjustment of R-117	Junction of R-117-R-101 and the center terminal	27 ±1/2%	40	C X 10	
R-118	R-118	200,000 ±10%	-	OFF	
R-119	R-119	510,000 ±10%	-	OFF	
Primary of T-101 and F-101	P-101	19 ±20%	-	LINE SHORT CHECK	
M-101	Meter Studs	1238 ±1%	-	-	
S-101	Pin 1 of 4-5-6-prong socket and pin 3 of R octal socket	Infinity	-	OFF	
	Same as above	510,000 ±10%	-	LINE SHORT CHECK	
	Same as above	4870 ±10%	48	DIODE	
	Same as above	930 ±10%	48	BATTERY TUBES	
	Same as above	175 ±10%	48	NORMAL TUBES	
	Same as above	2300 ±10%	48	SPECIAL	
	Capacity jacks	75 ±10%	-	C X 10	

TABLE 5-1. RESISTANCE TABLE FOR TUBE TESTER CONT'D

COMPONENT TO BE CHECKED	TEST LEADS ACROSS	RESISTANCE VALUE (OHMS)	TUBE SELEC-TOR POSI-TION	CIRCUIT SELEC-TOR SWITCH POSITION	REMARKS
	Capacity jacks	785 ±10%	-	C X 1	
	Capacity jacks	7,850 ±10%	-	C + 10	
	Capacity jacks	79,000 ±10%	-	C + 100	

TABLE 5-2. POINT-TO-POINT VOLTAGES ON TUBE TESTER FOR T-101 AND LINE SHORT CHECK CIRCUITS

COMPONENT OR CIRCUIT TO BE CHECKED	TEST LEADS ACROSS	VOLT-AGE A-C	CIRCUIT SELEC-TOR SWITCH POSITION	TOGGLE SWITCH TO IN POSITION (ALL OTHERS TO OUT POSITION)	FILAMENT SELEC-TOR SWITCH POSITION	REMARKS	
T-101	Filament pins (#2&7) on Octal R socket	115	LINE SHORT CHECK	-	117	All voltage checks on T-101 are made with LINE VOLT-AGE control rotated so that potential on 117-volt position of FILAMENT SELEC-TOR switch is 115 volts. (Test Leads across filament pins (#2&7) on Octal R socket). Voltages shown are nominal and correction for any error in the test meter should be made. Use a 1,000-ohm/volt AC instrument. All voltages should be within ±3%.	
	Same as above	68.8	Same as above	-	70		
	Same as above	48.5	Same as above	-	50		
	Same as above	33.6	Same as above	-	35		
	Same as above	28.0	Same as above	-	28		
	Same as above	25.1	Same as above	-	25		
	Same as above	18.9	Same as above	-	19		
	Same as above	12.7	Same as above	-	12.6		
	Same as above	10.36	Same as above	-	10		
	Same as above	7.53	Same as above	-	7.5		
	Same as above	6.3	Same as above	-	6.3		
	Same as above	5.0	Same as above	-	5		
	Same as above	3.1	Same as above	-	3		
	Same as above	2.5	Same as above	-	2.5		
	Same as above	2.02	Same as above	-	2		
	Same as above	1.55	Same as above	-	1.5		
	Same as above	1.19	Same as above	-	1.1		
	Terminals			NORMAL	-		-
	A&B on T-101	97.6		NORMAL	-		-
	Terminals	127.0		NORMAL	-		-
A&C on T-101	4.15		NORMAL	-	-		
Terminals			NORMAL	-	-		
D&E on T-101	29.5		NORMAL	-	-		
Terminals			NORMAL	-	-		
D&F on T-101	40.7		NORMAL	-	-		
Terminals			NORMAL	-	-		
D&G on T-101	141.5		NORMAL	-	-		
Terminals	303.0		NORMAL	-	-		
D&H on T-101	2.68		NORMAL	-	-		
D&I on T-101			NORMAL	-	-		
J&K on T-101			NORMAL	-	-		
Line Short Check Circuit	A&B on socket panel terminal strip	-	LINE SHORT CHECK	B	1.1	Set to LINE CHECK mark by rotating LINE VOLTAGE control. Use 20,000-ohm/volt DC instrument, 250-volt range. Positive of meter to A terminal reads 54 v DC.	

TABLE 5-3. POINT-TO-POINT VOLTAGES ON TUBE TESTER FOR FILAMENT AND SOCKET WIRING

CIRCUIT TO BE CHECKED	VOLTAGE A-C	TOGGLE SWITCH TO IN POSITION (ALL OTHERS TO OUT POSITION)	TEST LEADS ACROSS PIN NUMBER													REMARKS	
			7 PIN MINIATURE A	OCTAL A	LOCTAL A	OCTAL B	LOCTAL B	9 PIN MINIATURE A	9 PIN MINIATURE B	4-5-6 COMB.	7 PRONG LARGE & SMALL	OCTAL R	LOCTAL R	7 PIN MINIATURE R	ACORN R		9 PIN MINIATURE R
Fil. Socket Wiring	5	-	3-4	8-7	8-2	2-6	7-2	5-9	5-2,3	1-6	1-7	7-2	8-1	1-7	6-1	5-4	FILAMENT SELECTOR switch at 5. Use 1,000-ohm/volt AC instrument. FILAMENT SELECTOR switch at 5. TUBE SELECTOR control at 49. CIRCUIT SELECTOR switch at NORMAL TUBES. If voltage is 24, the filament leads to the socket are reversed. If voltage is 0 the socket wiring or wiring from toggle switches to the socket terminal board is incorrect. For all tests in this table, the NORMAL POSITION toggle switch must be in the OUT position. Furthermore, the pin numbers in the columns refer to those shown on the wiring diagram, figure 5-7.
	29	B	3-1	8-3	8-1	2-3	7-3	9-3	9-1	1-2	1-2	7-3	8-2	1-3	6-3	5-1	
	29	C	3-7	8-4	8-3	2-4	7-4	9-4	9-4	1-3	1-3	7-4	8-3	1-4	6-4	5-2	
	29	D	3-5	8-5	8-4	2-5	7-5	9-1	9-6	-	1-4	7-5	8-4	1-5	6-2	5-3	
	29	E	-	-	-	-	-	9-7	-	1 & Grid Caps	-	-	8-5	-	-	5-9	
	29	F	3-6	8-6	8-6	2-7	7-6	9-6	-	1-4	1-5	7-6	8-6	1-6	6-8	5-6	
	29	G	3-2	8-1	8-7	2-1	7-8	9-8	-	1-5	1-6	7-8	8-7	1-2	6-7	5-7	
	29	H	-	8-2	8-5	2-8	7-1	9-2	-	-	-	7-1	-	-	6-5	5-8	

(a) To adjust line check resistor R-114, proceed as follows:

1. Connect by means of Electrical Leads a 30-volt AC meter of known accuracy to D & F on T-101.
2. Index FILAMENT SELECTOR switch to 1.1 volts, rotate CIRCUIT SELECTOR switch to LINE SHORT CHECK position.
3. Solder a shorting lead across resistor R-120.
4. Rotate LINE VOLTAGE control until the meter of known accuracy indicates 29 volts.
5. The indication on the Tube Tester meter should be at the LINE CHECK mark or higher. If not, replace V-101 with a new type 3A4 tube.
6. Insert sufficient resistance R-120 in series with R-114 to bring the meter indicator to the LINE CHECK mark on the Tube Tester meter scale. The resistance to be inserted may run between 1,000 and 20,000 ohms. Any 1/4- or 1/2-watt resistor will be satisfactory.

(b) To adjust TUBE SELECTOR control R-117 proceed as follows:

1. Index CIRCUIT SELECTOR switch to any one of the capacity ranges.
2. Set the TUBE SELECTOR control to 40 and measure the resistance between the center terminal and the outside terminal to which the resistance spool

R-101 is soldered. The reading should be 27 ohms $\pm 1/2\%$. (This measurement should be made on a bridge or on a series ohmmeter that has been standardized against an accurate 27-ohm resistor.)

3. The position of the TUBE SELECTOR control has been carefully adjusted at the factory for correct tracking in resistance with the 0 to 50 panel marking. Before tampering with the location of this potentiometer, the operator should be certain that it requires re-positioning on the panel by following the procedure outlined in the preceding paragraph using an accurate resistance measuring device.

(5) Inability to make a top mark adjustment on all of the capacity meter ranges and yet be able to obtain a correct LINE CHECK indication when using the Tube Tester, indicates that the small instrument rectifier mounted on top of one of the spool pins is damaged, that the 26,224-ohm resistor R-106 or the 7,328-ohm resistor R-105 are either opened or partially shorted.

(a) Index CIRCUIT SELECTOR switch to NORMAL TUBES position and check R-106 and R-105. In checking R-105, unsolder the leads from one side of the spool.

(b) If R-105 and R-106 are satisfactory, the instrument rectifier is defective.

(6) Error in the capacity meter indication can be caused by defective resistors R-106, R-107, R-108, R-109, R-110, or R-111, or rectifier CR-101. If the

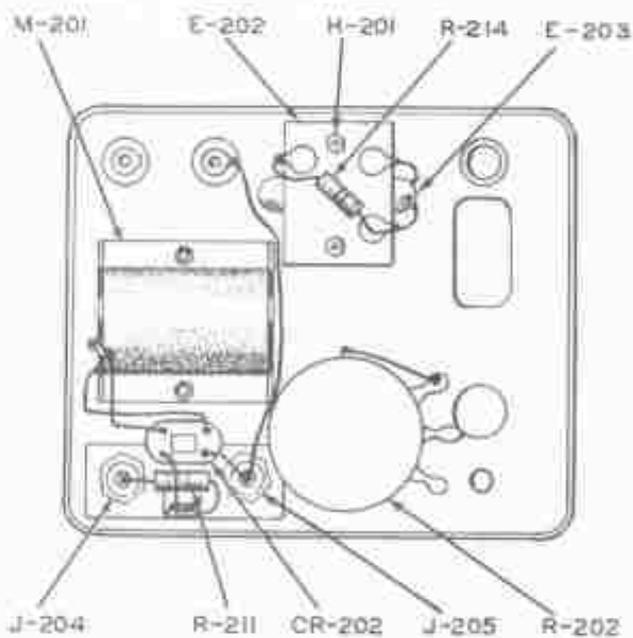


Figure 5-8. Rear View Front Panel, Signal Tracer TS-673/U

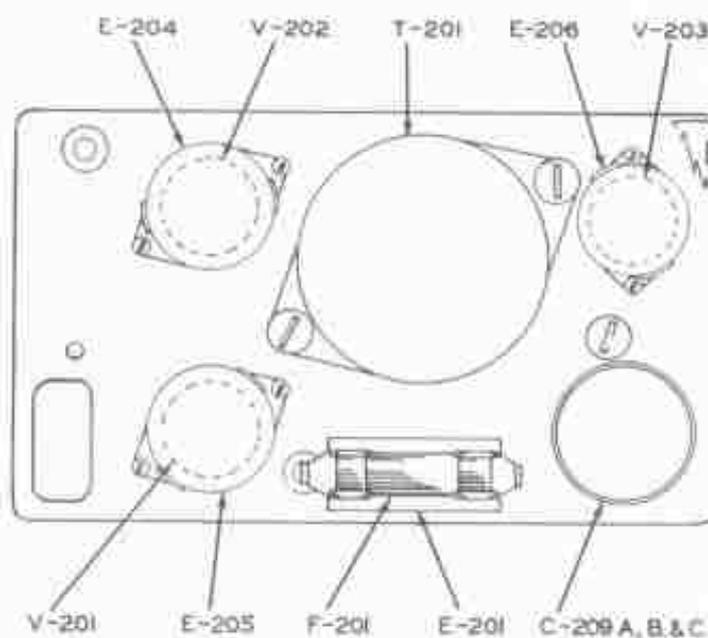


Figure 5-9. Top View, Signal Tracer Chassis

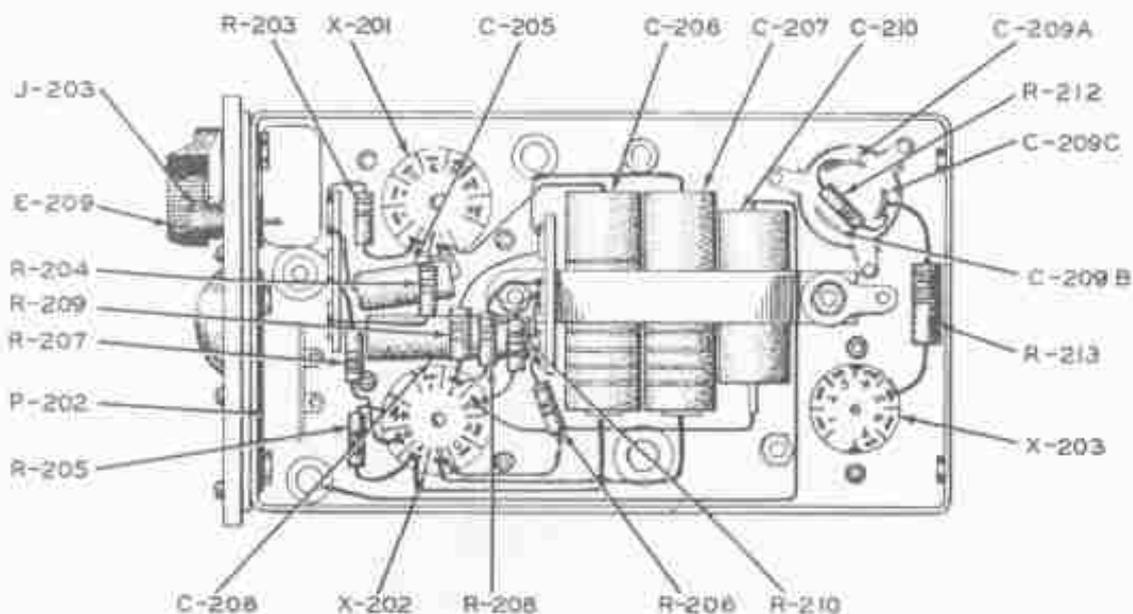


Figure 5-10. Bottom View, Signal Tracer Chassis

resistors mentioned are satisfactory, replace the instrument rectifier.

(7) To locate defective components, proceed through the tables above. The checks listed in the previous paragraphs should be made first, then necessary repairs made and rechecked to determine if satisfactory operation can be obtained. Note that all resistors except R-115, R-118, and R-119 must be measured to within 1/2 of 1%. Controls R-116 and R-117 have a tolerance of $\pm 10\%$. Failure to heed the accuracy limits may result in unsatisfactory performance of the Tube Tester or capacity meter.

(a) In tables 5-1 and 5-2 a dash (-) in a given column indicates that the position of the control or switch is of no consequence.

(b) In table 5-3 a dash (-) with no other figures under the column head indicates that a voltage measurement is not to be made on that particular socket or that the toggle switch position is of no consequence. Pin numbers in the columns refer to standard RMA notation except for the 4-5-6 combination and acorn

sockets. All pin numbers as viewed from the top of panel are given in figure 5-5.

(c) If when making the resistance and voltage measurements shown in tables 5-1, 5-2, and 5-3, a discrepancy is noted from the given value, refer to the schematic diagram of the Tube Tester TV-4A/U, figure 5-6, and note the components involved. These components should be individually checked for a defect. Figure 5-7, wiring diagram of Tube Tester TV-4A/U, will aid in the location of components and connecting wires.

2. SIGNAL TRACER TS-673/U, TROUBLE SHOOTING.

Test the fuse F-201 and line cord for continuity with the Resistance Indicator-Probe before attempting to locate trouble in the chassis. To remove the case from the Signal Tracer, unscrew the two screws at the rear of the unit (these are the bottom screws which hold the legs in place). **DO NOT REMOVE THE SCREWS ON THE FRONT PANEL.**

All replaceable components are easily reached and can be located as shown in figures 5-8, 5-9, and 5-10.

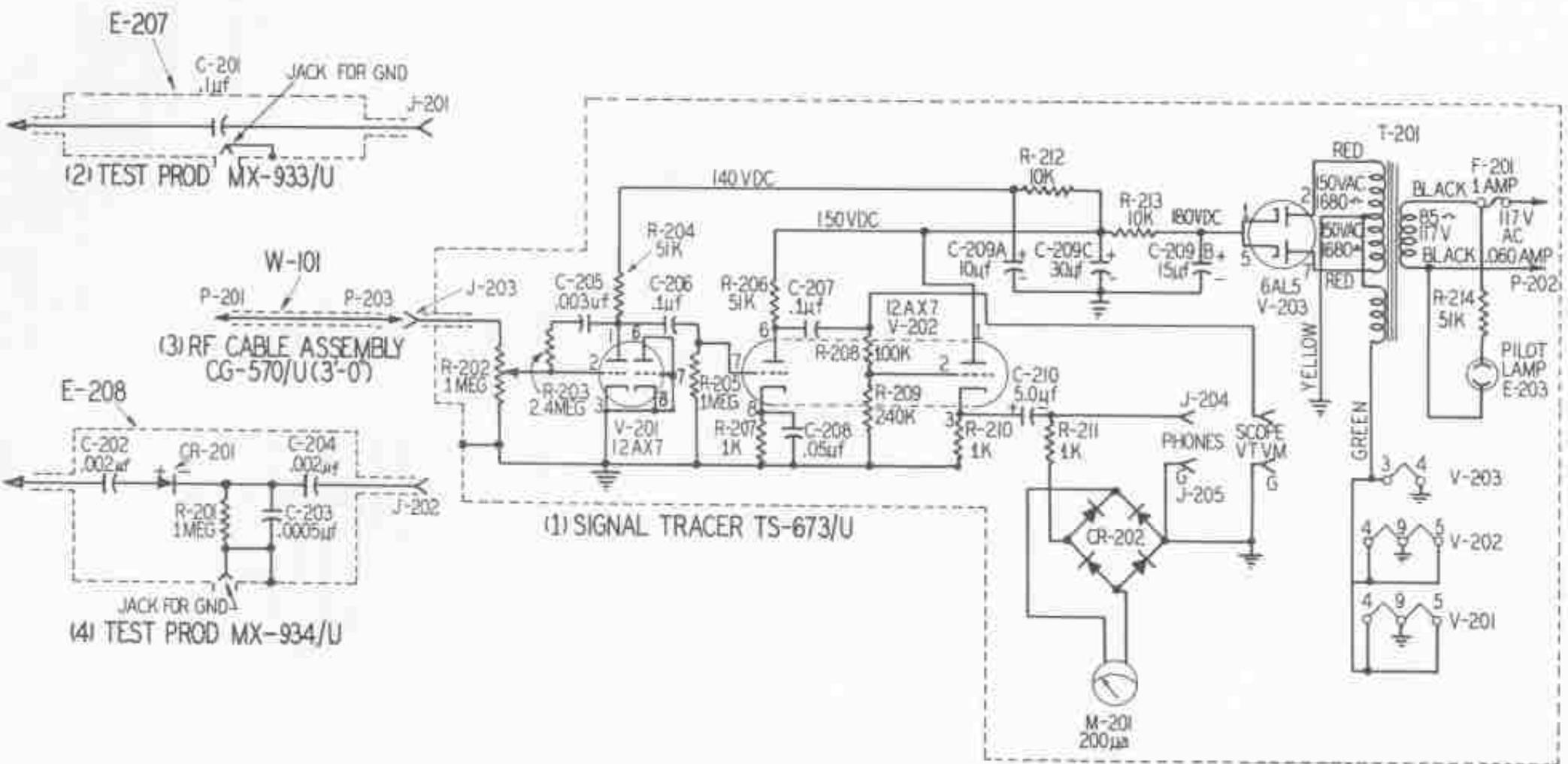


Figure 5-11. Schematic Diagram, (1) Signal Tracer TS-673/U, (2) Test Prod MX-933/U, (3) RF Cable Assembly CG-570/U (3'0") and (4) Test Prod MX-934/U

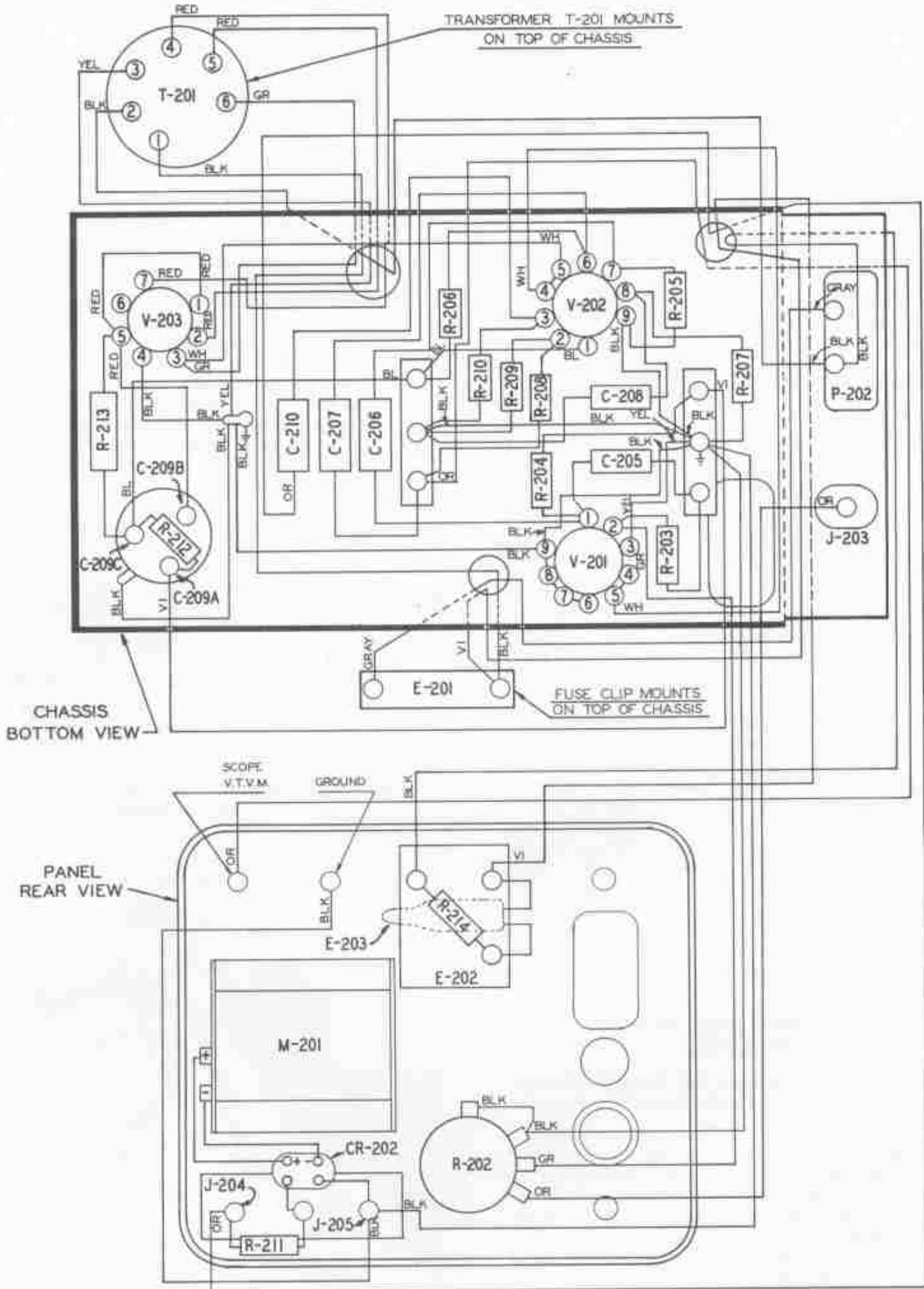


Figure 5-12. Wiring Diagram of Signal Tracer TS-673/U

The pilot light E-203 on the front panel (shown in figure 5-8) can be replaced by unsoldering its leads. The fuse F-201 is mounted in a clip on top of the chassis as shown in figure 5-9. The point-to-point voltages listed in table 5-4 are helpful in trouble shooting on the Signal Tracer and are used in conjunction with the schematic diagram, figure 5-11, and figures 5-8, 5-9, and 5-10. These voltages were measured with an electronic voltmeter such as the Navy Model OBQ Series or equivalent. For an indication of the presence and approximate magnitude of AC or DC voltage greater than 55 volts, the Voltage Indicator-Probe may be used. GND is the chassis. The wiring diagram of Signal Tracer TS-873/U, figure 5-12, is used to locate the test points.

TABLE 5-4. POINT-TO-POINT VOLTAGES, SIGNAL TRACER TS-673/U

COMPONENT	TERMINALS	OPERATING VOLTAGE	NORMAL VOLTAGE TO GROUND
V-201	1-GND	80	v DC
V-201	4 or 5-GND	6.3	v AC
V-202	1-GND	150	v DC
V-202	3-GND	0.8	v DC
V-202	4 or 5-GND	6.3	v AC
V-202	6-GND	110	v DC
V-202	8-GND	0.5	v DC
V-203	1 or 5-GND	180	v DC
V-203	3-GND	8.3	v AC
V-203	7-GND	150	v AC
V-203	2-GND	150	v AC

The indicating meter M-201 can be replaced by (1) removing the two binder-head screws at the rear of the Signal Tracer case and slipping off the cover, (2) unsoldering one wire and removing the screw and wire lug of the other wire at the top of the instrument, (3) removing the round-head screws on each side of the meter, (4) removing the tube shields E-204 and E-205, (5) removing the instrument from the rear, (6) removing the two round-head screws that hold the metal frame to the new instrument and replacing with the fillister-head screws, and (7) reversing the procedure outlined above by replacing the instrument and screws in the front panel and connecting the two wires to the instrument.

3. INTERFERENCE GENERATOR SG-23/U, TROUBLE SHOOTING.

The 1-1/2-volt battery in this unit should be changed at regular intervals or as indicated by erratic behavior of buzzer.

The unit may be taken apart by lifting the flared end of the index ring (see figure 3-3) and dropping out the components. The binder-head screw in the base of the index button (battery adj. screw in figure 3-3) adjusts for a change in battery length. When a new battery is installed, it may be necessary to turn this screw in or out until the inner tip of the buzzer touches the outer tip of the probe head (see figure 2-4) when the index ring and line indicate position 1 (see figure 3-3). Contact between the two tips can be tested by making a

connection with Electrical Lead CAOR-491895 between the ground jack and the outer tip. Making this connection will stop the buzzer when the button is depressed if the tips are in contact. The sound generated by the buzzer is audible. If the buzzer fails to operate, change the position of the buzzer adj. screw shown in figure 3-3.

Interference Generator SG-23/U will not function when its Signal Buzzer I-301 is out of adjustment. Re-adjustment of the buzzer can easily be made with Test Set equipment. Figure 5-14 shows the equipment used and a convenient method for making the adjustment. With this method, the buzzer is energized through the screwdriver and battery terminal and will buzz when the adjusting screw is turned to the correct setting.

CAUTION

Pressure against the adjusting screw with the screwdriver bit will cause the buzzer to buzz at a false setting. Use a very light touch with the screwdriver.

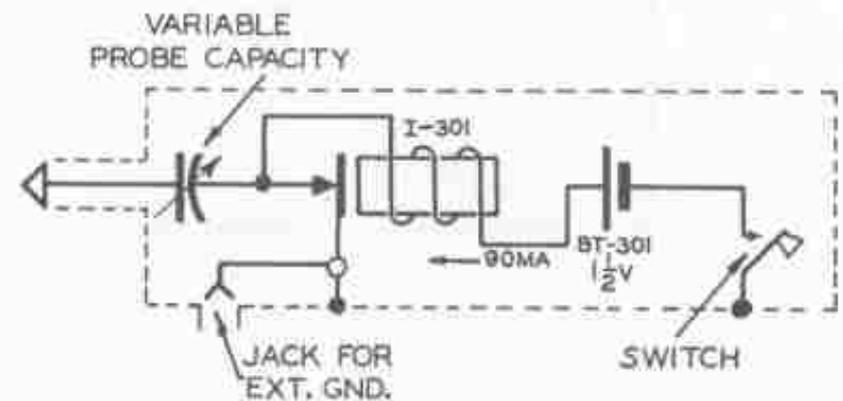


Figure 5-13. Schematic Diagram, Interference Generator SG-23/U

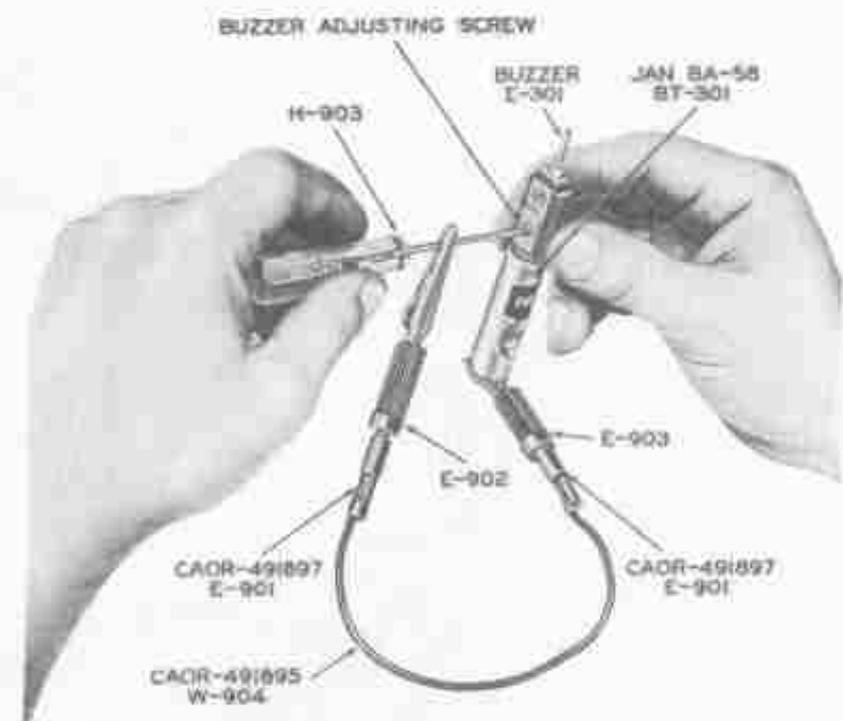


Figure 5-14. Adjustment of Signal Buzzer I-301

4. VOLTAGE INDICATOR-PROBE ID-265/U, DISASSEMBLY.

To disassemble the probe remove the spring clamp by means of the small screwdriver H-902. Figure 3-1 illustrates the operation. Insert screwdriver as shown and lift end of spring clamps gently. The cover can then be slipped off. The resistor R-401 can be reached by removing the two screws which hold the probe tip to the brass studs. The resistor can then be dropped out of the probe tip. A schematic diagram of this unit is shown in figure 5-15.

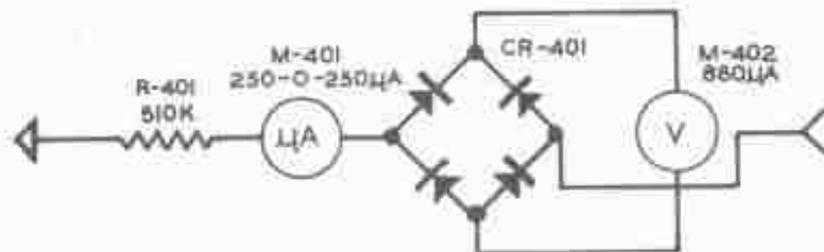


Figure 5-15. Schematic Diagram, Voltage Indicator-Probe ID-265/U

5. RF INDICATOR-PROBE ID-263/U, DISASSEMBLY.

This unit is disassembled by removing the spring clamp with a small screwdriver gently, as indicated in figure 3-1. Care should be taken that the capacitor C-501 and the spring contact in the probe tip are not lost in this operation. The instrument M-501 and crystal rectifiers CR-501 and CR-502 can be taken from the cover after removing the Phillips machine screw at the top of the probe.

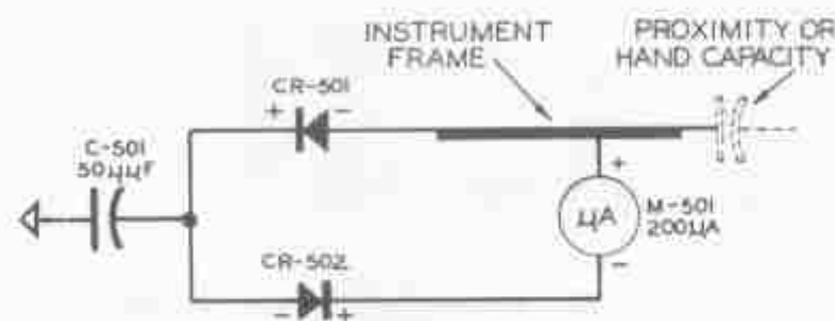


Figure 5-16. Schematic Diagram, RF Indicator-Probe ID-263/U

6. RESISTANCE INDICATOR-PROBE ID-264/U, DISASSEMBLY AND REPAIR.

This probe is checked before use for zero position by touching the tip with the electrical lead plugged in the top as shown in figure 1-7. If the pointer does not fall below 500 ohms on the scale, the battery should be changed. The probe is taken apart by removing the spring clamp as shown in figure 3-1. Care should be taken that resistor R-601 is not dislodged in this operation. The battery is placed in the probe with the positive end toward the tip. The meter M-601 can be taken from the case after removing the threaded ring nut at

the top. A schematic diagram is illustrated in figure 5-17. The return lead of the Resistance Indicator-Probe should not touch the tip while the probe is not in use. Keeping the instrument on short for long periods of time will dissipate the battery.

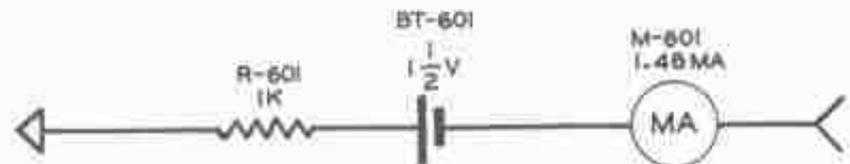


Figure 5-17. Schematic Diagram, Resistance Indicator-Probe ID-264/U

7. Repair of Decade Resistor TS-672A/U and Decade Capacitor TS-671/U.

These units can be repaired after removing the rear cover of each case. Care should be taken that the terminal leads of components being replaced in these cases are not over-heated in the soldering process. Schematic diagrams of both units are shown in figures 5-18 and 5-19.

NOTE

The Indicator-Probes, the Interference Generator, the Test Prods, and the RF Cable Assembly are not to be disassembled for repair except as covered above. These items will be in stock as complete assemblies for spares.

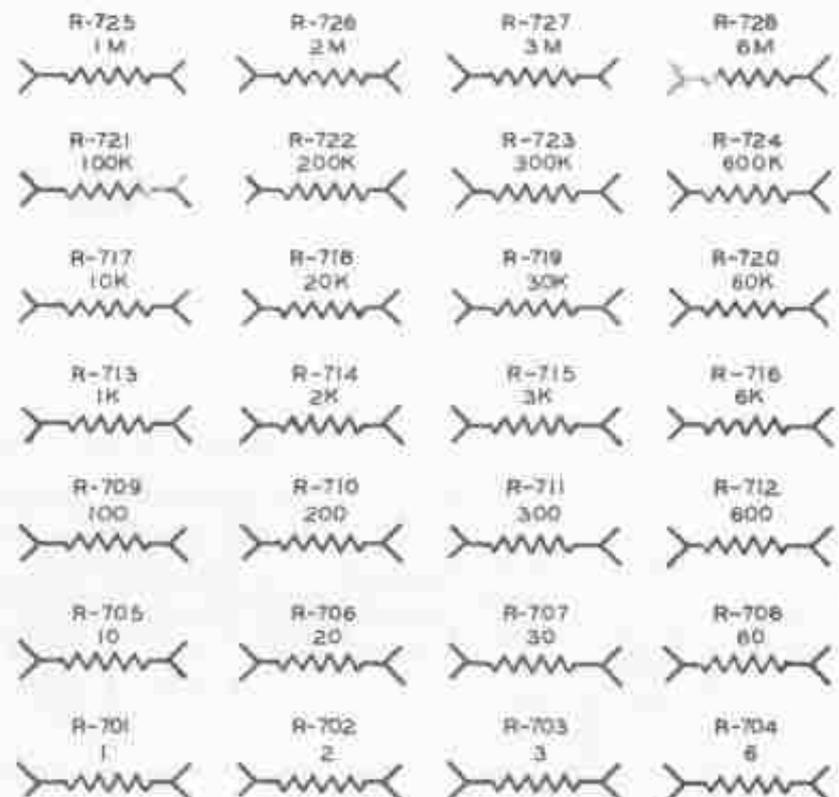


Figure 5-18. Schematic Diagram, Decade Resistor TS-672A/U

TABLE 5-5. TUBE OPERATING VOLTAGES AND CURRENTS

TUBE TYPE	FUNCTION	SECTION	PLATE (E)	PLATE (MA)	CATH. (E)	GRID (E)	HEATER (E) A-C
3A4	Rectifier						
12AX7	Amplifier	(1)	80	1.0	0	0	6.3
12AX7	Cathode Follower Amplifier	(1)	150	0.8	0.8	0	6.3
		(2)	110	0.55	0.55	0	
6AL5	Rectifier			3.2			

CAUTION

This equipment contains sensitive instruments. Precautions must be taken in handling, transportation, and use to prevent damage.

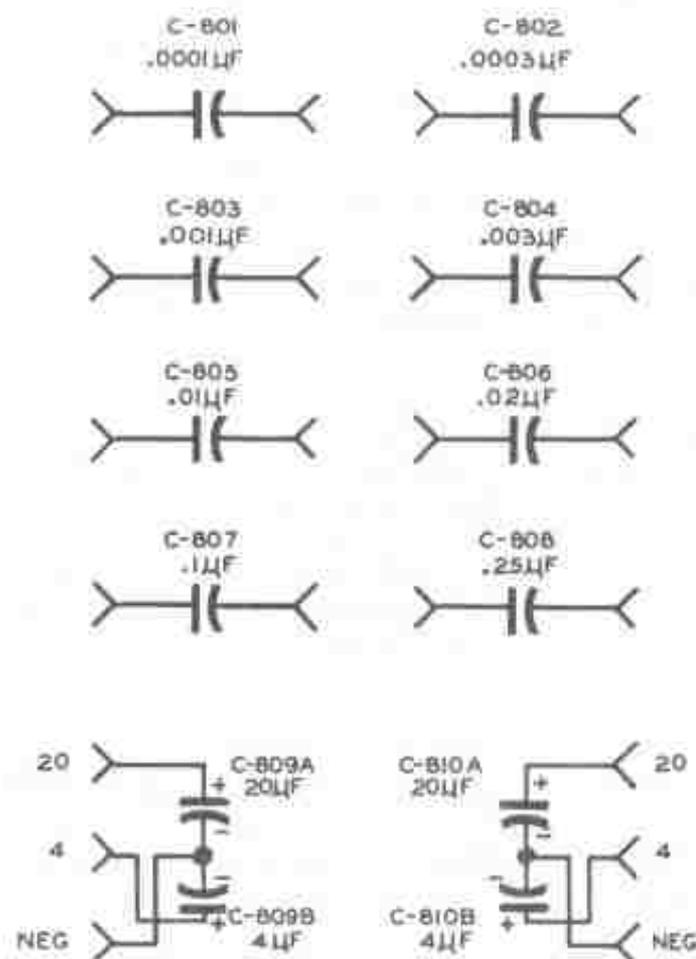


Figure 5-19. Schematic Diagram, Decade Capacitor TS-671/U

TABLE 5-6. TUBE CHARACTERISTICS

TUBE TYPE	FILA-MENT VOLT-AGE (V)	FILA-MENT CUR-RENT (A)	PLATE VOLT-AGE (V)	GRID BIAS (V)	SCREEN VOLT-AGE (V)	PLATE CUR-RENT (MA)	SCREEN CUR-RENT (MA)	A-C PLATE RESIST-ANCE (OHMS)	VOLT-AGE AMPLI-FICATION FAC-TOR (MU)	TRANSCON-DUCTANCE (MICROMHOS)		EMISSION	
										NOR-MAL	MINI-MUM	15 (MA)	TEST VOLT
3A4	2.8	0.1	135	-7.5	90	14.8	2.6	90,000		1900	1400		
12AX7	6.3	0.3	100	-1.0		0.5		80,000	100	1250	900		
6AL5	6.3	0.3	150 VAC			9.0						9.0	2

TABLE 5-7. WINDING DATA

DESIGNATION SYMBOL	R. F. L. PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	D. C. RESISTANCE IN OHMS	REMARKS
T-101	HA-5081		1 A-B 1 A-C 2 E-F 2 E-G 2 E-H 2 E-I 3 D-E 4 Z-AA 4 Z-AB 4 Z-AC 5 J-K 6 T-U 6 T-V 6 T-W 6 T-X 6 T-Y 6 T-Z 7 L-M 7 L-N 7 L-O 7 L-P 7 L-Q 7 L-R 7 L-S 7 L-T	No. 27 No. 27 No. 34 No. 34 No. 34 No. 34 No. 22 No. 28 No. 28 No. 28 No. 26 No. 24 No. 24 No. 24 No. 24 No. 24 No. 24 No. 20 No. 20 No. 20 No. 20 No. 20 No. 20 No. 20 No. 20	410 533 107 154 579 1289 17 63 147 342 12 12 22 48 74 86 109.5 5 6.5 8.5 10.5 13 21 26.5 31.5	10. 12. 14.4 21.4 82. 180. 0.15 2.3 5.4 12.7 0.32 0.21 0.39 0.82 1.22 1.51 2.0 0.035 0.06 0.09 0.11 0.14 0.21 0.26 0.30	1000 v AC Hipot Test
I-301	H-2516			No. 33	200	3.9	
T-201	H-2199		Pri. Sec. C.T. Fil.	No. 32 No. 44 No. 25	1364 3770 86	85 2370 1	Core Material - Allegheny Audio Grade Silicon Steel. 750 v AC Hipot Test

INDEX

SUBJECT	TABLE	FIGURE	PAGE
A			
Accessories—list of.....	1-3	.....	1-7
Adapter connectors—use of.....	.....	.....	1-5
Adjustments—			
interference generator buzzer contact.....	.....	5-14	5-14
screws.....	.....	3-3	4-0
signal tracer level adjust.....	.....	.....	4-9
Amplifier—signal tracer.....	.....	.....	1-2
Application, typical—			
decade capacitor.....	.....	.....	4-16
decade resistor.....	.....	.....	4-16
interference generator.....	.....	.....	4-13
resistance indicator-probe.....	.....	.....	4-15
RF indicator-probe.....	.....	.....	4-14
signal tracer.....	.....	.....	4-10
tube tester.....	.....	.....	4-7
voltage indicator-probe.....	.....	.....	4-13
B			
Batteries—			
table of, complement.....	1-2	.....	1-6
installation of.....	.....	3-1, 3-2, 3-3	3-1
Buzzer—winding data.....	5-7	.....	5-17
C			
Capabilities and limitations of—			
decade capacitor.....	.....	.....	4-15
decade resistor.....	.....	.....	4-15
interference generator.....	.....	.....	4-13
resistance indicator-probe.....	.....	.....	4-15
RF indicator-probe.....	.....	.....	4-14
signal tracer.....	.....	.....	4-9
tube tester.....	.....	.....	4-0
voltage indicator-probe.....	.....	.....	4-13
Capacity meter section of tube tester.....	.....	.....	2-2
Circuit description of—			
interference generator.....	.....	.....	2-3
resistance indicator-probe.....	.....	.....	2-4
RF indicator-probe.....	.....	.....	2-3
signal tracer.....	.....	.....	2-2
tube tester—			
basic circuit.....	.....	.....	2-0
capacity meter section.....	.....	.....	2-2
short test circuit.....	.....	.....	2-1
voltage indicator-probe.....	.....	.....	2-3
Cognizant naval inspector.....	.....	.....	1-6
Color codes.....	6-4	.....	6-30
Controls, tube tester.....	.....	.....	2-0
Correction page.....	.....	.....	C
Cubical contents.....	1-3	.....	1-7
Curves—			

SUBJECT	TABLE	FIGURE	PAGE
ac output voltage vs voltage input - Test Prod MX-934/U.	4-9	4-12
capacity reading corrections for various power line frequencies	4-1	4-1
frequency response of Signal Tracer TS-873/U & Test Prod MX-933/U	4-7	4-11
frequency response of Signal Tracer TS-873/U & Test Prod MX-934/U	4-8	4-11
inductance curve for sixty cycles	4-4	4-8
inductance curve for four hundred cycles	4-5	4-8
resistance curve for capacity meter section	4-3	4-8
D			
Data, reference	1-6
Description of—			
adapter connectors	1-5
battery and bulb case	1-5
case	1-1
decade capacitor	1-5
decade resistor	1-4
electrical leads	1-5
interference generator	1-3
power cable assembly	1-5
RF indicator-probe	1-3
resistance indicator-probe	1-4
signal tracer	1-2
technician's handbook	1-5
tool holder	1-5
tools and minor items	1-5
tube data index	4-0
tube tester	1-2
voltage indicator-probe	1-3
Diagrams—			
simplified of—			
capacity meter section of tube tester	2-2	2-2
interference generator	2-4	2-4
signal tracer	2-3	2-3
tube test section of tube tester	2-1	2-0
schematic of—			
decade capacitor	5-19	5-16
decade resistor	5-18	5-15
interference generator	5-13	5-14
resistance indicator-probe	5-17	5-15
RF cable assembly	5-11	5-12
RF indicator-probe	5-16	5-15
signal tracer	5-11	5-12
test prod MX-933/U	5-11	5-12
test prod MX-934/U	5-11	5-12
tube tester	5-6	5-6
voltage indicator-probe	5-15	5-15
wiring diagram of			
signal tracer	5-12	5-13
tube tester	5-7	5-7
Differentiating characteristics between AN/USM-3 & AN/USM-3A Test-Tool Set	viii
Dimensions of units	1-3	.....	1-7
E			
Effective pages—list of	A
Electrical leads	1-5

SUBJECT	TABLE	FIGURE	PAGE
Electrode switches—description of.....	2-1
Equipment—			
location of.....	1-1	1-0
purpose and basic principles.....	1-1
supplied, table of.....	1-3	.....	1-7
Expendable units.....	5-15
Extension rod—use of.....	1-4
F			
Failure report.....	vi
Frequencies—			
interference generator.....	1-3
signal tracer.....	1-2
tube tester.....	1-2
voltage indicator probe.....	1-3
G			
Guarantee.....	v
General description—see Description			
I			
Identification of—			
decade capacitor.....	1-9	1-5
decade resistor.....	1-8	1-4
headband.....	1-3	1-2
interference generator.....	1-4	1-3
power cable assembly.....	1-3	1-2
resistance indicator-probe.....	1-7	1-4
RF cable assembly.....	1-3	1-2
RF indicator-probe.....	1-6	1-4
signal tracer.....	1-3	1-2
telephone receiver.....	1-3	1-2
test prod MX-933/U.....	1-3	1-2
test prod MX-934/U.....	1-3	1-2
tube tester controls.....	1-2	1-1
tube tester sockets.....	5-5	5-5
units in case.....	1-1	1-0
voltage indicator-probe.....	1-5	1-3
Impedance—telephone receiver.....	6-2	.....	6-25
Indicating instrument—tube tester.....	2-2
Installation record.....	v
M			
Maintenance—			
decade capacitor.....	5-15
decade resistor.....	5-15
interference generator.....	5-14
resistance indicator-probe.....	5-15
RF indicator-probe.....	5-15
signal tracer.....	5-11
tube tester			
detailed checks.....	5-4
disassembly procedure.....	5-2
line check.....	5-10
preliminary tests.....	5-2

SUBJECT	TABLE	FIGURE	PAGE
voltage indicator-probe .....	.....	.....	5-15
Major units— list of	6-1	.....	6-0
Manufacturers — list of	6-5	.....	6-31
O			
Operation of —			
decade capacitor .....	.....	.....	4-16
decade resistor .....	.....	.....	4-16
interference generator .....	.....	.....	4-13
resistance indicator-probe .....	.....	.....	4-15
RF indicator-probe .....	.....	.....	4-14
signal tracer .....	.....	.....	4-9
tube tester			
capacity meter section .....	.....	.....	4-7
controls .....	.....	.....	2-0
detailed explanation of step-by-step procedure .....	.....	.....	4-3
establishing tube data .....	.....	.....	4-5
preliminary operation .....	.....	.....	4-0
proper use .....	.....	.....	4-4
step-by-step procedure for testing tubes .....	.....	.....	4-2
voltage indicator-probe .....	.....	.....	4-13
Ordering parts — instructions for .....	.....	.....	vi
P			
Parts —			
cross reference list	6-3	.....	6-28
list	6-2	.....	6-1
ordering instructions .....	.....	.....	vi
Power cable assembly — use of .....	.....	.....	1-5
Power consumption	1-4	.....	1-6
Power supplies required .....	.....	.....	1-6
Power transformer of tube tester			
description of .....	.....	.....	2-0
point-to-point voltages	5-2	.....	5-9
position of terminals .....	.....	5-7	5-7
winding data	5-7	.....	5-17
Preparation for use .....	.....	.....	3-1
Promulgating letter .....	.....	.....	B
R			
Reference data .....	.....	.....	1-6
Repair of units-see maintenance .....	.....	.....
Replacement of units in case .....	.....	.....	4-0
Resistance table, tube tester	5-1	.....	5-8
Resuscitation notice .....	.....	.....	vii
S			
Safety notice .....	.....	.....	vii
Socket panel, description of .....	.....	.....	2-1
Socket panel, removal of .....	.....	.....	5-4
Sockets — tube, relative location —			
signal tracer .....	.....	5-9	5-11
tube tester .....	.....	5-5	5-5
Symbols, tube data chart .....	.....	.....	4-2
T			
Technical summary	1-4	.....	1-8
Tools — list of	1-3	.....	1-7

SUBJECT	TABLE	FIGURE	PAGE
U			
Unpacking — instructions for .....	.....	.....	3-1
V			
Vacuum tubes —			
cause of failure .....	.....	.....	2-1
characteristics	5-6	.....	5-16
data, method of establishing .....	.....	.....	4-5
operating voltages and currents	5-5	.....	5-16
table of, complement	1-1	.....	1-6
testing —			
for cathode leakage .....	.....	.....	2-1
for emission .....	.....	.....	4-2
for inter-electrode short .....	.....	.....	4-2
for intermittent operation .....	.....	.....	2-2
for open element .....	.....	.....	4-3
general .....	.....	.....	4-2
good tubes .....	.....	.....	4-3
multiple section tubes .....	.....	.....	4-3
step-by-step procedure .....	.....	.....	4-2
Voltages — signal tracer	5-4	.....	5-14
W			
Weights of —			
individual units	1-3	.....	1-7
total equipment .....	.....	.....	1-6