
SIGNAL
GENERATOR
TS-465/U



WARNING

HIGH VOLTAGE
exists in this equipment.

DEATH ON CONTACT
may result if personnel
fail to observe safety precautions.

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CHAPTER I

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for the installation, operation, theory, maintenance, and repair of Signal Generator TS-465(*)/U (fig. 1). In addition to these instructions, there are two appendixes covering a list of references and an identification table of parts.

b. Official nomenclature followed by (*) is used to denote all models of the item of equipment included in this manual. Thus, Signal Generator TS-465(*)/U represents Signal Generators TS 465/U, TS-465A/U, and TS-465B/U. Throughout this manual, text material and illustrations are based mainly on one model, Signal Generator TS-465B/U. Where differences exist between models, they are specifically mentioned under each applicable paragraph. The basic differences between models are noted in paragraph 9.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment.

a. DD Form 6 (Report of Damaged or Improper

Shipment) will be filled out and forwarded as prescribed in SR 745-45-5 (Army), Navy Shipping Guide Article 1850-4, and AFR 71-4 (Air Force).

b. DA Form 468 (Unsatisfactory Equipment Report) will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. AF Form 54 (Unsatisfactory Report) will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA AGO Form 11-238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) will be prepared in accordance with instructions on the back of the form (fig. 9).

e. DA AGO Form 11-239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) will be prepared in accordance with instructions on the back of the form (fig. 10).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Signal Generator TS-465(*)/U (fig. 1) is a portable test set which consists of an r-f (radio-frequency) oscillator with facilities for producing unmodulated, a-m (amplitude-modulated), f-m (frequency-modulated), and audio beat-frequency outputs, and a 400-cycle audio signal. The signal generator is used as a signal source for trouble shooting, maintenance, and repair of a-m and f-m equipment and audio amplifiers.

b. The following outputs can be obtained from the signal generator:

(1) An f-m signal, variable with respect to bandwidth, frequency, and output level, to be used for test and alinement of a-m and f-m receivers. Sweep widths are

available up to 30 kc (kilocycles) on the low range (100 kc to 110 mc (megacycles)) and to 150 kc on the high range (1 mc to 160 mc). In Signal Generator TS-465/U, the sweep width is fixed at 30 kc on the low range and 150 kc or 750 kc on the high range. In Signal Generator TS-465A/U, a variable sweep width, 0 to 450 kc, is available on the high range in addition to the variable 150 kc. F-m signals range from 100 kc to 160 mc (100 kc to 133 mc in Signal Generator TS-465/U) and are covered in overlapping bands.

(2) An a-m signal, variable with respect to frequency and output level, for test and alinement of a-m receivers and other

electronic devices requiring a wide-range a-m signal. A-m signals range from 100 kc to 110 mc and are covered in overlapping bands.

- (3) An a-f (audio-frequency) signal, variable with respect to frequency and output level, over a frequency range from 0 to 15 kc, and a fixed 400-cycle signal. These signals are used for testing audio equipment. (In Signal Generator TS-465/U, the a-f signal is variable over a frequency range of 0 to 10 kc.)
- (4) An accurate, crystal-controlled signal at 100 kc or 1,000 kc, or useful harmonics of these frequencies up to approximately 30 mc, unmodulated or amplitude-modulated.
- (5) An unmodulated r-f signal variable from 100 kc to 110 mc.

c. The signal generator also contains an output meter for measuring a-f voltages from 0 to 140 volts and db (decibel) power levels from -10 to +38 db in three ranges.

4. Technical Characteristics

a. *Input.* 105-125 volts ac (alternating current), 55-65 cycles.

b. *Output.*

(1) Radio-frequency ranges.

Band	Signal Generator TS-465B/U	Signal Generators TS-465/U and TS-465A/U
A	100 kc to 165 kc.....	100 kc to 300 kc.
B	170 kc to 330 kc.....	300 kc to 850 kc.
C	320 kc to 800 kc.....	850 kc to 2200 kc.
D	790 kc to 2100 kc.....	2.2 mc to 6.5 mc.
E	2.0 mc to 5.7 mc.....	6.5 mc to 20 mc.
F	5.6 mc to 16.5 mc.....	20 mc to 50 mc.
G	16.1 mc to 51.2 mc.....	50 mc to 110 mc.
H	52 mc to 110 mc.....	-----

(2) Frequency-modulated ranges.

- Signal Generator TS-465/U. Narrow band (30-kc fixed) 100 kc to 110 mc in 7 bands.
Wide band (150-kc fixed and 750-kc fixed) 1 mc to 133 mc in 7 bands.
- Signal Generator TS-465A/U. Narrow band (0-30 kc variable) 100 kc to 110 mc in 7 bands.
Wide band (0-150 kc variable and 0-450 kc variable) 1 mc to 160 mc in 7 bands.
- Signal Generator TS-465B/U. Narrow band (0-30 kc variable) 100 kc to 110 mc in 8 bands.
Wide band (0-150 kc variable) 1 mc to 160 mc in 8 bands.

(3) Audio-frequency ranges.

400 cycles ($\pm 10\%$)

0- to 15-kc variable. (0- to 10-kc variable in Signal Generator TS-465/U).

(4) Crystal-controlled output.

100 kc, unmodulated.

100 kc, 400-cycle internal amplitude modulated.

1,000 kc unmodulated.

1,000 kc, 400-cycle internal amplitude modulated.

Harmonics up to 30 mc.

(5) Synchronized sweep voltage output.

67 volts, 60 cycles, for synchronizing external equipment.

c. Characteristics.

(1) Internal modulation.

Amplitude modulation. Up to 30 percent at 400 cycles.

Frequency modulation. Signal Generator TS-465B/U. 50-mc r-f, 400-cycle modulating frequency, 0-150 kc variable sweep. (± 25 percent at full-scale setting.) 1 mc r-f, 60-cycle modulating frequency, 0-30 kc variable sweep.

Signal Generator TS-465A/U. 50-mc r-f, 60- and 400-cycle modulating frequencies, 0-450 kc and 0-150 kc variable sweeps. 1 mc r-f, 60 cycle modulating frequency, 0-30 kc variable sweep.

Signal Generator TS-465/U. 23-mc r-f, 750 kc fixed sweep, 60-cycle modulating frequency, and 150-kc fixed sweep, 400-cycle modulating frequency. 1-mc r-f, 30-kc fixed sweep, 60-cycle modulating frequency.

(2) Output level.

R-f.....Continuously variable from zero (max leakage) to maximum.*

Maximum r-f output level on each band (Signal Generator TS-465B/U) is as follows:

Band	Frequency	Output (v)
A to F	100 kc to 16.5 mc	.3 to 6
G, H	16.1 mc to 110 mc	.4 to 1.0

A-f.....Continuously variable from zero to maximum.

Maximum a-f output levels (Signal Generator TS-465B/U) are as follows:

Frequency	Output (v)
400 cycles	.3
0-15 kc	.2

* In Signal Generator TS-465B/U, at frequencies below 10 mc, the r-f leakage is below 400 uv (microvolts); between 10 mc and 100 mc, the r-f leakage varies between 400 and 8,000 uv; and between 100 mc and 160 mc, the leakage varies between .005 and .01 volt.

(3) Output impedance. Approximate output impedances at the various attenuator settings are as follows.

Output multiplier	Output impedance (ohms)
R. F. X1	50
R. F. X100	55
R. F. X1000	60

(4) Accuracy of FREQUENCY ADJUSTMENT.

dial reading..... $\pm 1\%$ up to 52.5 mc. $\pm 1\frac{1}{2}\%$
from 52 to 110 mc.

(5) DECIBEL METER.

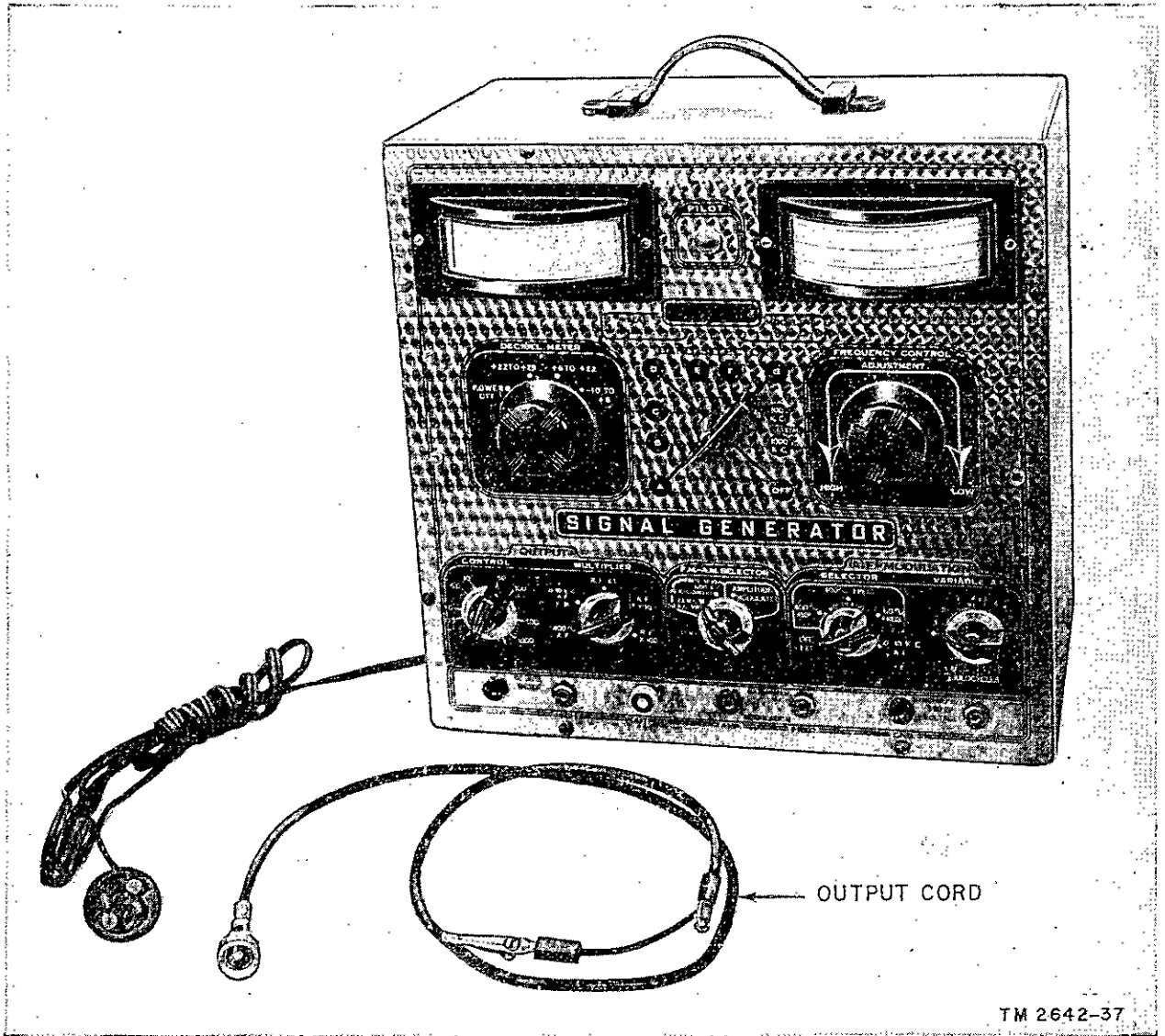
ranges.....-10 to +6 db, +6 to +22 db,
and +22 to +38 db. (0 db.=
.006 watts across 500 ohms.)

Voltmeter ranges...0-3.5 volts, 0-20 volts, 0-140
volts ac.

(6) Number of tubes.....6

5. Packaging Data

When packed for export shipment, Signal Generator TS-465(*)/U is inclosed in moistureproof-vaporproof containers, and packed in a wooden export crate. A cutaway view of a typical unit packed for export shipment is shown in figure 5.



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Figure 2. Signal Generator TS-465/U.

6. Table of Components

Component	Re-quired No.	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Signal Generator TS-465/U.	1	13¼	8¾ ₁₆	13¼	1.0	33.0
Signal Generator TS-465A/U.	1	13¼	8¾ ₁₆	16¼	1.2	38.0
Signal Generator TS-465B/U.	1	14¼	8¾ ₈	14½	1.1	38.5
Output cable ^a	1	-----	-----	36.0 ^b	-----	.85
Test lead (red)	1	-----	-----	36.0 ^b	-----	.25
Test lead (black)	1	-----	-----	36.0 ^b	-----	.25
Technical Manual TM 11-2642.	2	-----	-----	-----	-----	-----

^a The output cable is permanently attached to Signal Generator TS-465B/U.

^b Length excluding terminations.

Note: The list above is for general information only. See appropriate supply manual for information pertaining to requisitioning of spare parts.

7. Description

a. Signal Generator TS-465(*)/U consists of a single unit, self-contained in a metal carrying case containing a folding handle. The unit proper is

fastened to the case by means of eight screws through the front panel. The power cord is permanently attached to the unit in the rear of the case. Two leads, color-coded red and black, are provided for use with the decibel and a-c voltmeter. A shielded OUTPUT cable is provided for use with Signal Generators TS-465/U and TS-465A/U. Signal Generator TS-465B/U has a shielded OUTPUT cable permanently attached to the chassis at the front panel.

b. Location of the front panel instruments and controls in each of the models of the signal generator is indicated in figures 2, 3, and 4.

8. Running Spares

No running spares are furnished with Signal Generator TS-465(*)/U.

9. Differences in Models

The differences in models are described below. When these differences affect installation, operation, theory, or maintenance of the equipment,

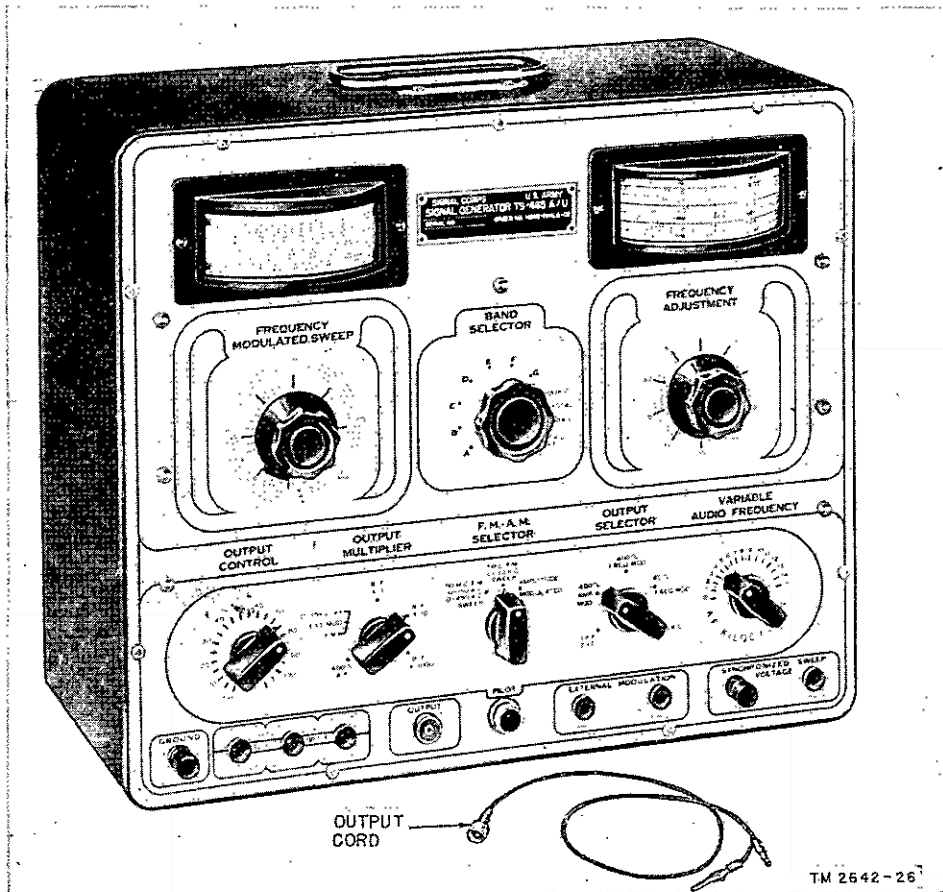


Figure 3. Signal Generator TS-465A/U.

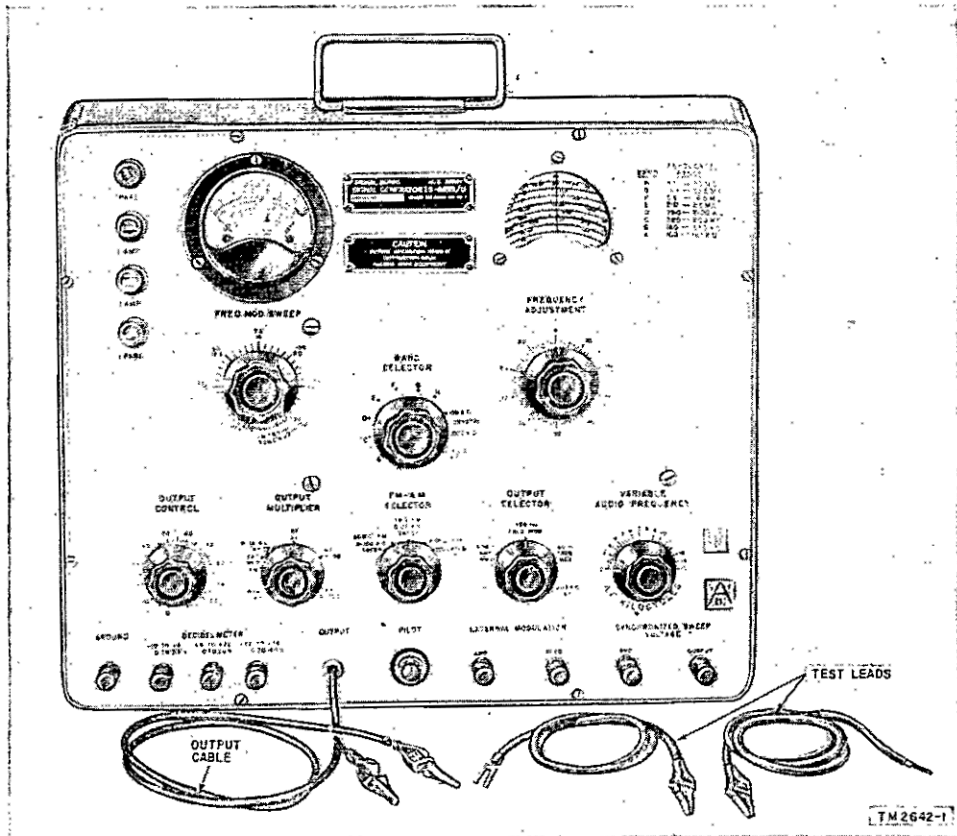


Figure 4. Signal Generator TS-465B/U.

they are re-emphasized in appropriate sections of the manual.

a. *External Appearance.* Figures 2, 3, and 4 illustrate the differences in external appearance of the test sets. Signal Generators TS-465/U and TS-465A/U contain drum-type frequency adjustment and meter dials. In addition, Signal Generator TS-465B/U has two fuseholders and two spare fuseholders on the front panel. Signal Generator TS-465/U has two jacks for the DECIBEL

METER connections and a DECIBEL METER switch in place of the variable FREQ. MOD. SWEEP control. The panel layout, over-all dimensions, labels, and knob styles differ somewhat among the models.

b. *Internal Circuits.*

(1) The following table lists the differences in tube types, and function of the circuits for each of the models.

Circuit	Model	Tube type	Function
Main R-f oscillator	Signal Generator TS-465/U	7N7 duo-triode	Colpitts-type oscillator and cathode-follower.
	Signal Generator TS-465A/U	6C4 triode	Colpitts-type oscillator.
	Signal Generator TS-465B/U	6J6 duo-triode	Two-terminal positive grid oscillator.
Crystal oscillator	Signal Generator TS-465/U	6J5 triode	Tuned-plate, -tuned-grid oscillator.
	Signal Generator TS-465A/U	½ 6SN7 duo-triode	
	Signal Generator TS-465B/U	½ 12AU7 duo-triode	

Circuit	Model	Tube type	Function
Frequency-modulated oscillator.	Signal Generator TS-465/U..	Triode section of 6K8 triode-hexode.	Modified Hartley oscillator (1 mc and 23 mc).
	Signal Generator TS-465A/U..	½ 6SN7 duo-triode.....	Modified Hartley oscillator (1 mc and 50 mc).
	Signal Generator TS-465B/U..		
Reactance modulator.....	Signal Generator TS-465/U..	6AB7 pentode.....	Shunt reactance across f-m oscillator.
	Signal Generator TS-465A/U..		
	Signal Generator TS-465B/U..	6SG7 pentode.....	
Mixer.....	Signal Generator TS-465/U..	Hexode section of 6K8 triode-hexode.	Hexode converter.
	Signal Generator TS-465A/U..	½ 6SN7 duo-triode.....	Triode employing grid-cathode mixing.
	Signal Generator TS-465B/U..		
Cathode-follower.....	Signal Generator TS-465/U..	½ 7N7 duo-triode.....	Cathode-follower for r-f output.
	Signal Generator TS-465A/U..	½ 6SN7 duo-triode.....	
	Signal Generator TS-465B/U..	½ 12AU7 duo-triode.....	
Power supply.....	Signal Generator TS-465/U..	6X5-G and OD3/VR-150.	Full-wave rectifier and voltage regulator.
	Signal Renerator TS-465A/U..		Full-wave rectifier.
	Signal Generator TS-465B/U..	6X5-GT.....	
400 ~ or b-f oscillator.....	Signal Generator TS-465(*)/U.	6SJ7.....	Transitron (negative-resistance oscillator).

- (2) In Signal Generator TS-465B/U, the decibel meter and its series resistors are hermetically sealed. Four terminals are provided on the meter case for the three ranges and ground. In Signal Generator TS-465A/U, the resistors are external to the meter. In Signal Generator TS-465/U, the connections from the meter are brought out to a four-position DECIBEL METER switch and to two jacks on the front panel.

- (3) Figures 31 through 43 show the differences in the chassis layout, wiring, parts, and placement of parts among the three models.

c. Frequency Ranges.

- (1) *R-f ranges.* In Signal Generators TS-465/U and TS-465A/U, the frequency range is covered in seven bands (A to G). In Signal Generator TS-465B/U the frequency range is covered in eight bands (A to H).
- (2) *A-f ranges.* In Signal Generator TS-465/U, the a-f range is from 0 to 10 kc.

In Signal Generators TS-465A/U and TS-465B/U, the a-f range is from 0 to 15 kc.

- (3) *F-m ranges.* In Signal Generator TS-465/U, a high-band carrier frequency of 23 mc is modulated at 60 cycles for a fixed sweep of 750 kc, or at 400 cycles for a fixed sweep of 150 kc. On the low band, a 1-mc signal is modulated at 60 cycles for a fixed 30-kc sweep signal. In Signal Generator TS-465A/U, the carrier frequency is 50 mc on the high band. This may be modulated at 60 cycles for a variable 0- to 150-kc sweep voltage; or it may be modulated at 400 cycles for a variable 0- to 450-kc sweep voltage. On the low band, a 1-mc signal is modulated at 60 cycles for a variable sweep of 0 to 30 kc. In Signal Generator TS-465B/U, a 50-mc signal on the high band is modulated at 400 cycles for a variable sweep signal of 0 to 150 kc. The low band signal is the same as that in Signal Generator TS-465A/U.

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF SIGNAL GENERATOR TS-465(*)/U

10. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 12.

a. General. Signal Generator TS-465(*)/U may be shipped in oversea packing cases or domestic packing cases. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and, if possible, where it may be installed permanently.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. Avoid thrusting tools into the center of the packing container. If the equipment is damaged, a complete overhaul might be required or the equipment might be rendered completely useless.

b. Uncrating and Unpacking Equipment (fig. 5).

- (1) Place the packing case in a convenient location near the operating position, where it may be opened easily.
- (2) Cut the metal straps with a suitable cutting device or twist them with pliers until the straps crystallize and break.
- (3) Remove nails from the top of the shipping container with a nail puller.
- (4) Cut the tape and seals of the case liner so that the waterproof liner will be damaged as little as possible.
- (5) Lift out the packaged signal generator, and carefully remove the waterproof wrap.
- (6) Cut the tape that seals the top flaps of the carton in a way that will leave the carton undamaged. Open the carton and remove the moisture-vaporproofed package.
- (7) Cut away the moisture-vaporproof barrier. Remove the inner corrugated carton.
- (8) Be careful when cutting the tape which seals the top flaps of the inner carton, so that the carton will not be damaged.
- (9) Open the inner carton and remove the top cushioning cells and desiccant. Lift out the signal generator.
- (10) Inspect the equipment for possible damage incurred during shipment or unpacking.

(11) Check the contents of the package against the master packing slip.

(12) Return all interior cushioning materials, except the desiccants, to the inner carton for use in repackaging the equipment.

11. Installation

Signal Generator TS-465(*)/U is a portable test set, with crystal and all tubes installed. Before putting the set in operation proceed as follows:

a. Place the equipment on a firm base not more than 3 feet from a 115-volt, a-c outlet 55 to 65 cps (cycles per second) and away from stray magnetic fields.

b. Check to make sure that the FREQ. MOD. SWEEP control (DECIBEL METER switch in Signal Generator TS-465/U) is in POWER OFF position.

c. Plug the unit into the a-c outlet by means of the male power plug and cord located in the rear of the case.

Caution: Signal Generator TS-465(*)/U has been moistureproofed and fungiproofed. Avoid removing any of this protective covering.

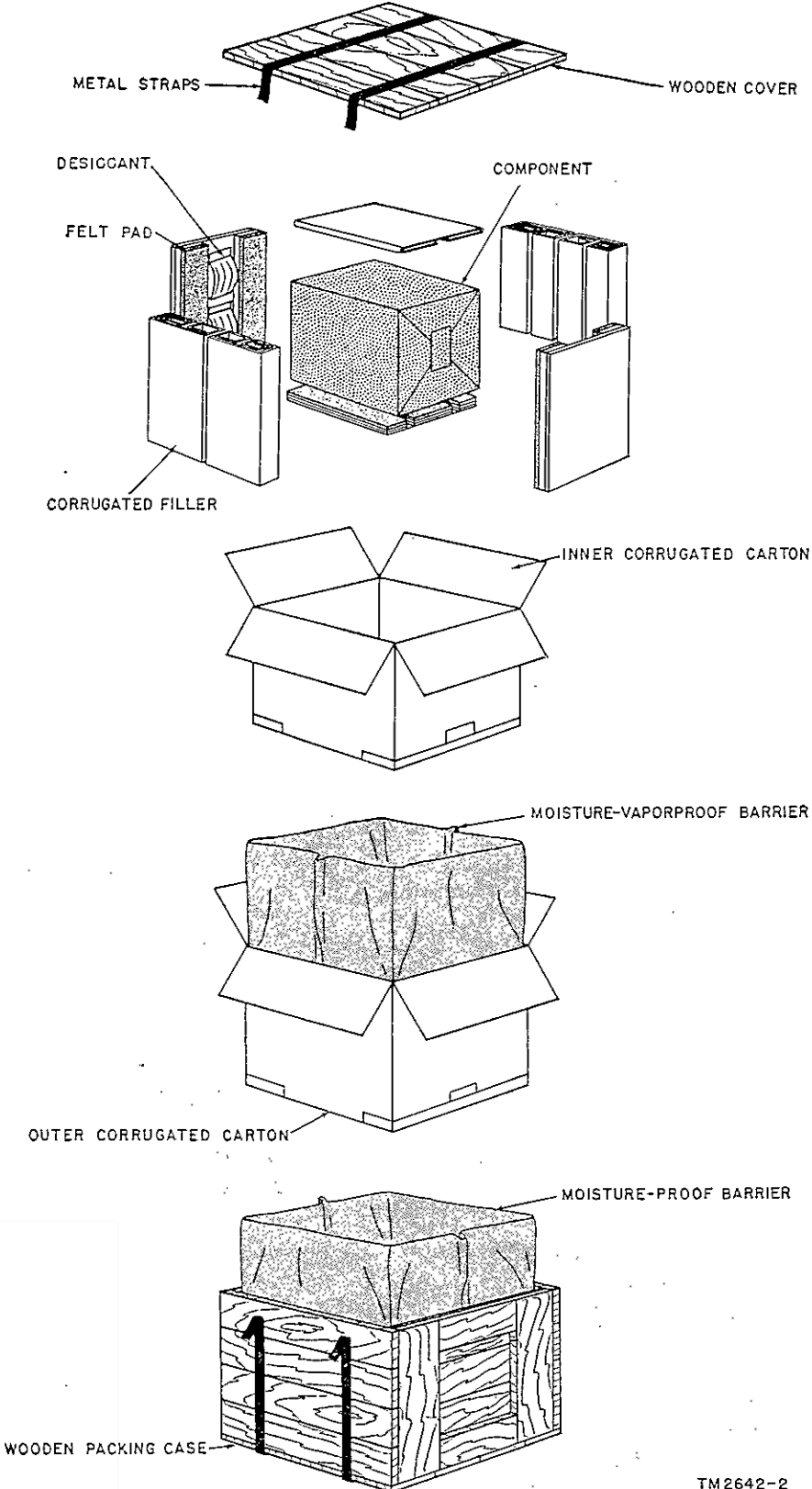
12. Service upon Receipt of Used or Reconditioned Equipment

a. Follow instructions in paragraph 10 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes in this manual preferably on the schematic diagrams (figs. 48, 49, or 50).

c. Check the operating controls for ease of rotation.

d. Perform the installation and connection procedures in paragraph 11.



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Figure 5. Signal Generator TS-465(*)/U, packed for export shipment.

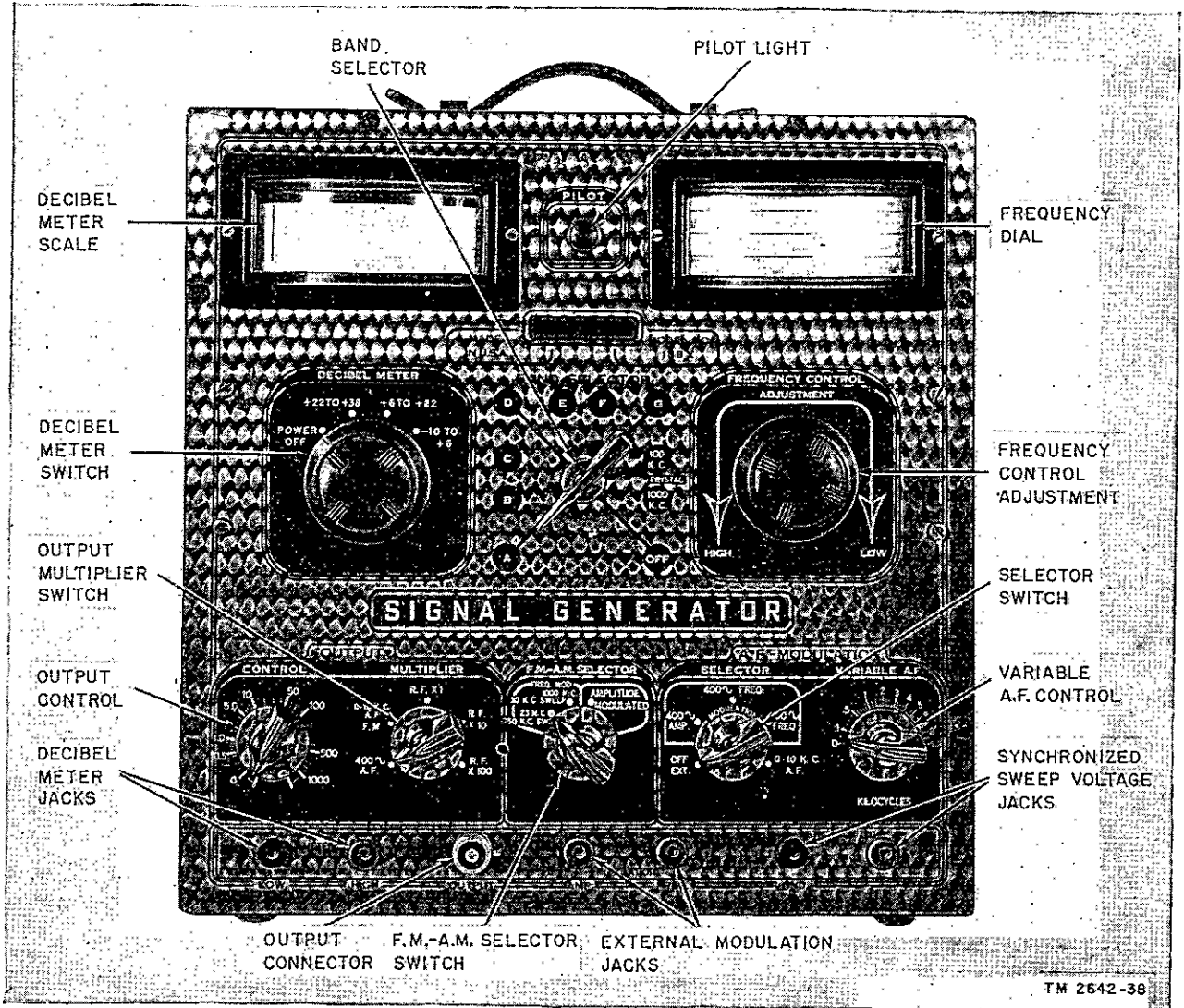


Figure 6. Signal Generator TS-465/U, front panel controls.

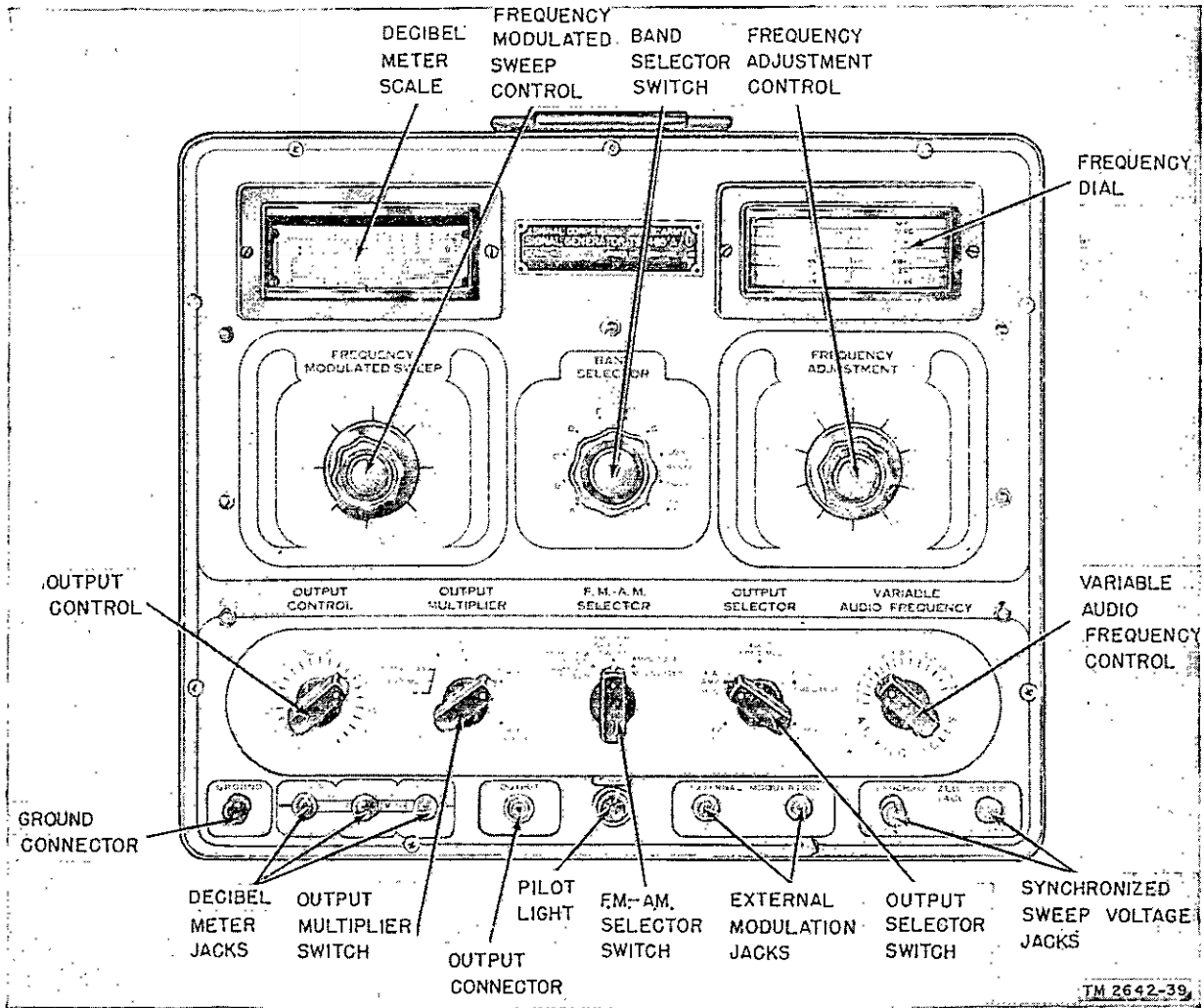


Figure 7. Signal Generator TS-465A/U, front panel controls.

Section II. CONTROLS AND INSTRUMENTS

13. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason, it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 15 through 17.

14. Controls

(figs. 6, 7, and 8)

The following table lists the operating controls of Signal Generator TS-465(*)/U and indicates their functions. Controls for Signal Generators TS-465/U, TS-465A/U, and TS-465B/U are the same except where noted.

Control	Function
BAND SELECT-OR switch.	In position A, selects 100- to 165-kc signal (100- to 300-kc signal in Signal Generators TS-465/U and TS-465A/U). In position B, selects 170- to 330-kc signal (300- to 850-kc signal in Signal Generators TS-465/U and TS-465A/U). In position C, selects 320- to 800-kc signal (850- to 2200-kc signal in Signal Generators TS-465/U and TS-465A/U). In position D, selects 790- to 2100-kc signal (2200- to 6500-kc signal in Signal Generators TS-465/U and TS-465A/U). In position E, selects 2.0- to 5.7-mc signal (6.5- to 20-mc signal in Signal Generators TS-465/U and TS-465A/U). In position F, selects 5.6- to 16.5-mc signal (20- to 50-mc signal in Signal Generators TS-465/U and TS-465A/U). In position G, selects 16.1- to 52.5-mc signal (50- to 110-mc signal in Signal Generators TS-465/U and TS-465A/U). In position H, selects 52- to 110-mc signal. In 100 K. C. CRYSTAL position, selects 100-kc crystal-controlled signal. In 1000 K. C. CRYSTAL position, selects 1000-kc crystal-controlled signal. In 0-15 K. C. A. F. position, connects r-f oscillators for a 0- to 15-kc beat-frequency output. (This position is not used in Signal Generator TS-465/U.)

Control	Function
OUTPUT MULTIPLIER switch.	In 400 ~ A. F. position, connects a 400-cycle audio output to output control circuit. In 0-15 K. C. A. F. EXT. MOD. F. M. position, connects a 0- to 15-kc signal, an externally modulated r-f signal, or an f-m signal, from the mixer tube to the output control circuit. (In Signal Generator TS-465/U, this position is marked 0-10 K. C. A. F. F.M. and connects a 0- to 10-kc signal, an externally modulated r-f signal, or an f-m signal, from the mixer tube to the output control circuit.) In R. F. X1 position, attenuates the r-f output to 1/1000 of value of available output. In R. F. X10 position (Signal Generators TS-465/U and TS-465A/U only), attenuates r-f output to 1/100 of available output. In R. F. X100 position (Signal Generators TS-465/U and TS-465B/U only), attenuates r-f output to 1/10 of value of available output. In R. F. X1000 position (Signal Generators TS-465A/U and TS-465B/U only), provides full r-f output.
F. M.-A. M. SELECTOR switch.	Signal Generator TS-465B/U. In 50 M. C. F. M. 0-150 K. C. SWEEP position, selects 50-mc, f-m, 0- to 150-kc sweep signal. In 1 M. C. F. M. 0-30 K. C. SWEEP position, selects 1-mc, f-m, 0- to 30-kc sweep signal. Signal Generator TS-465A/U: In 50 M. C. 0-150 K. C. 0-450 K. C. SWEEP position, selects 50-mc, f-m, 0- to 450-kc or 0- to 150-kc sweep signal. In 1 M. C. F. M. 0-30 K. C. SWEEP position, selects 1-mc, f-m, 0- to 30-kc sweep signal. Signal Generator TS-465/U. In 1000 K. C. 30 K. C. SWEEP position, selects 1-mc, f-m, 30-kc fixed sweep signal. In 23 M. C. 750 K. C. SWEEP position, selects 23-mc, f-m, 150-kc or 750-kc fixed sweep signals.
IN AMPLITUDE MODULATED	position, provides a-m output for all r-f signals except f-m output signals.

Control	Function
OUTPUT SELECTOR switch.	In OFF EXT. position, selects unmodulated r-f output and either f-m or a-m input signals from external source. In 400 ~ AMP. MOD. position, selects either a 400-cycle signal for a-m output or a 400-cycle signal for a-f output. In 400 ~ FREQ. MOD. position, selects a 400-cycle signal for modulating the 50-mc, 0- to 150-kc sweep output. In 60 ~ FREQ. MOD. position, selects a 60-cycle signal for modulating either the 1-mc signal (0- to 30-kc sweep) or the 50-mc signal (0- to 150-kc sweep) (0- to 450-kc sweep in Signal Generator TS-465A/U.) In 0-15 K. C. A. F. position, selects a 0- to 15-kc a-f signal. (In Signal Generator TS-465/U, the 0-10 K. C. A. F. position selects a 0- to 10-kc a-f signal.)
FREQ. MOD. SWEEP control (Not used in Signal Generator TS-465/U).	In POWER OFF position, turns a-c power off. Potentiometer controls width of variable f-m output.

Control	Function
FREQUENCY ADJUSTMENT control.	Selects a frequency in the band selected by operating the BAND SELECTOR switch. Dial reading indicates frequency selected.
VARIABLE AUDIO FREQUENCY control.	Selects a-f output signal between limits of 0- to 15-kc (0- to 10-kc in Signal Generator TS-465/U).
Decibel Meter-----	Measures db power or a-c voltage in 3 ranges. In Signal Generators TS-465A/U and TS-465B/U, ranges are selected by connecting leads between GROUND and terminals marked -10 TO +6 0 TO 3.5V, +6 TO +22 0 TO 20V, or +22 TO +38 0 TO 140V. In Signal Generator TS-465/U, ranges are selected by the DECIBEL METER switch and leads are connected to terminals marked HIGH and LOW.
DECIBEL METER switch (Signal Generator TS-465/U only).	Selects db-meter ranges and in POWER OFF position turns a-c power off.
OUTPUT CONTROL.	Sets level of output voltage between zero and maximum value within range set by OUTPUT MULTIPLIER switch.

Section III. OPERATION UNDER USUAL CONDITIONS

15. General

Signal Generator TS-465(*)/U is a portable unit that may be used for alining and testing a-m and f-m communication equipments and audio amplifiers. The following operational procedures are based on Signal Generator TS-465B/U. Differences between this model and prior models are indicated where such differences are important for proper operation.

16. Types of Operation

Turn the FREQ. MOD. SWEEP control in a clockwise direction until the red pilot light flashes on. (In Signal Generator TS-465/U turn the DECIBEL METER control clockwise until the red pilot light flashes on.) Allow the tubes of the signal generator to warm up for 20 minutes before placing the equipment in operation.

a. Variable R-F Signal Generator.

- (1) Turn the BAND SELECTOR switch to the desired frequency band. The exact value of the frequency desired, within the

band selected, can be tuned by means of the FREQUENCY ADJUSTMENT control. This frequency is read from the appropriate scale located directly above the FREQUENCY ADJUSTMENT control.

- (2) Turn the F. M.-A. M. SELECTOR switch to the AMPLITUDE MODULATED position.
- (3) Set the OUTPUT MULTIPLIER to one of the three attenuation ranges, depending on the level of output signal desired. The OUTPUT CONTROL varies the amplitude level from a minimum to a maximum value, within the range selected.
- (4) Turn the OUTPUT SELECTOR switch to the OFF EXT. position. The unmodulated r-f output is obtained at a two-terminal OUTPUT cable extending from the front panel. (In Signal Generators TS-465/U and TS-465A/U, an output cable is supplied with alligator clips on one end and a connector on the other end for connection to the OUTPUT connector.)

b. Variable R-F Signal Generator (Internal Amplitude Modulation).

- (1) Repeat the steps in *a*(1) through *a*(3) above.
- (2) Switch the OUTPUT SELECTOR to the 400 ~ AMP MOD. position. The modulated output is obtained at the OUTPUT cable.

c. Variable R-F Signal Generator (External Amplitude Modulation).

- (1) Repeat the steps in *a*(1) and (2) above.
- (2) Turn the OUTPUT SELECTOR switch to the OFF EXT. position; turn the OUTPUT MULTIPLIER to the EXT. MOD. position. (In Signal Generator TS-465/U turn the OUTPUT MULTIPLIER to the desired r-f multiplying factor.) Use the OUTPUT CONTROL to vary the amplitude level of the modulated output from a minimum to a maximum value.
- (3) Connect the external modulating signal output between the front panel binding posts labeled EXTERNAL MODULATION AMP and GROUND. The externally modulated r-f output then is obtained at the OUTPUT cable.

d. Variable F-M Signal Generator.

- (1) Set the BAND SELECTOR switch to the desired f-m range. The desired output frequency is tuned by the FREQUENCY ADJUSTMENT control. This frequency will be equal to the sum or difference of the f-m oscillator output and the main r-f oscillator output.
- (2) Set the FREQUENCY ADJUSTMENT control to a dial reading that is the sum or difference of the 1-mc or 50-mc signal (1-mc or 23-mc signal in Signal Generator TS-465/U) and the r-f signal. Thus, for a narrow-band f-m output of 5.25 mc, set the F. M.-A. M. SELECTOR switch to 1 M. C. F. M. 0-30 K. C. SWEEP position and set the BAND SELECTOR and FREQUENCY ADJUSTMENT controls for a dial reading of 4.25 mc or 6.25 mc.
- (3) Set the OUTPUT SELECTOR switch to either the 400 ~ FREQ. MOD., 60 ~ FREQ. MOD., or OFF EXT. position for fm by 400 cycles, 60 cycles, or by an external source, respectively. An external signal, when used, is inserted in the f-m circuit between the front panel binding posts labeled EXTERNAL MODULATION FREQ. and GROUND.

- (4) Set the OUTPUT MULTIPLIER switch to the F. M. position. Vary the OUTPUT CONTROL to adjust the amplitude level of the full output from a minimum to a maximum value. The modulated output is obtained at the OUTPUT cable.

e. Variable A-F Signal Generator.

- (1) Set the BAND SELECTOR switch to the 0-15 K. C. A. F. position. (In Signal Generator TS-465/U, set the BAND SELECTOR switch to the A band and set the FREQUENCY CONTROL ADJUSTMENT to a calibrated dial marking between 240 and 250 kc.) The exact frequency within this range is tuned by the VARIABLE AUDIO FREQUENCY control, and its value is read from the calibrated dial around the control (par. S9).
- (2) Turn the OUTPUT MULTIPLIER switch to the 0-15 K. C. A. F. position (0-10 K. C. A. F. position in Signal Generator TS-465/U). Set the F. M.-A. M. SELECTOR switch to the AMPLITUDE MODULATED position. The amplitude level of the audio output signal is varied by the OUTPUT CONTROL.
- (3) Set the OUTPUT SELECTOR to the 0-15 K. C. A. F. position (0-10 K. C. A. F. position in Signal Generator TS-465/U); the a-f output signal is obtained at the OUTPUT cable.

f. Fixed 400-Cycle Signal Generator. Set the OUTPUT MULTIPLIER switch to the 400 ~ A. F. position and the OUTPUT SELECTOR switch to the 400 ~ AMP. MOD. position. The OUTPUT CONTROL varies the output level of the 400-cycle signal; the output signal is taken from the OUTPUT cable.

g. Crystal-Controlled R-F Oscillator.

- (1) Set the BAND SELECTOR switch to either the 100 K. C. CRYSTAL or the 1000 K. C. CRYSTAL position.
- (2) Set the OUTPUT MULTIPLIER switch to the desired r-f multiplying factor. Within each range, the OUTPUT CONTROL varies the amplitude level of the output signal from a minimum to a maximum.
- (3) Turn the F. M.-A. M. SELECTOR switch to the AMPLITUDE MODULATED position.

- (4) If 400-cycle amplitude modulation of the oscillator is desired, set the OUTPUT SELECTOR to the 400 ~ AMP. MOD. position. For A. M. from an external source, switch the OUTPUT SELECTOR to the OFF EXT. position.
- (5) The unmodulated or modulated output signal from the crystal-controlled oscillator is obtained at the OUTPUT cable.

17. Operations Chart

The following table lists the positions of the panel controls of Signal Generator TS-465(*)/U for all of the possible output signals. The indicated control nomenclature and panel markings are for Signal Generator TS-465B/U only. For equivalent control nomenclature and panel markings in Signal Generators TS-465/U and TS-465A/U, see the schematic diagrams (figs. 48, 49, and 50), and the front panel controls (figs. 6, 7, and 8).

Controls ¹								
Signal output	FREQ MOD SWEEP ²	OUTPUT SELECTOR	BAND SELECTOR	FREQUENCY ADJUSTMENT	F. M.-A. M. SELECTOR	VARIABLE AUDIO FREQUENCY	OUTPUT MULTIPLIER	OUTPUT CONTROL
1. Unmodulated r-f (100 kc to 110 mc).	Power on ³ .	OFF EXT.	Desired frequency band.	Desired frequency.	AMPLITUDE MODULATED.	-----	Desired r-f multiplying factor.	Desired level of output.
2. Amplitude - modulated r-f (100 kc to 110 mc). a. 400 ~ internal mod.-----	Power on.	400 ~ AMP MOD.	Desired frequency band.	Desired frequency.	AMPLITUDE MODULATED.	-----	Desired r-f multiplying factor.	
		OFF EXT.					EXT. MOD. ⁴	
3. Frequency-modulated r-f ⁵ . a. 100 kc to 110 mc; 0- to 30-kc sweep.	Power on 0-30 kc.	60 ~ FREQ MOD.	Desired frequency band ⁶ .	Desired frequency ⁶ .	1 M. C. F. M. 0-30 K. C. SWEEP.	-----	F. M.	
b. 150 kc to 160 mc; 0- to 150-kc sweep.	Power on 0-150 kc.	400 ~ FREQ MOD.	Desired frequency band. ⁷	Desired frequency. ⁷	50 M. C. F. M. 0-150 K. C. SWEEP.	-----	F. M.	
c. 100 kc to 110 mc; externally modulated 0- to 30-kc sweep. ⁸	Power on 0-30 kc.	OFF EXT.	Desired frequency band.	Desired frequency.	1 M. C. F. M. 0-30 K. C. SWEEP.	-----	F. M.	
d. 150 kc to 160 mc; externally modulated 0- to 150-kc sweep. ⁹	Power on 0-150 kc.	OFF EXT.	Desired frequency band.	Desired frequency.	50 M. C. F. M. 0-150 K. C. SWEEP.	-----	F. M.	

Controls :

Signal output	FREQ MOD SWEEP ²	OUTPUT SELECTOR	BAND SELECTOR	FREQUENCY ADJUSTMENT	F. M.-A. M. SELECTOR	VARIABLE AUDIO FREQUENCY	OUTPUT MULTIPLIER	OUTPUT CONTROL
4. Audio frequency 0- to 15-kc. ¹⁰	Power on.	0-15 K. C. A. F.	0-15 K. C. A. F. ¹¹	Mark on dial. ¹² (0-15 K. C. A. F.)	AMPLITUDE MODULATED.	0 to 15 kc (desired frequency).	0-15 K. C. A. F.	Desired level of output.
5. Audio frequency, 400 ~ fixed.	Power on.	400 ~ AMP. MOD.	-----	-----	AMPLITUDE MODULATED.	-----	400 ~ A. F.	
6. Frequency - modulated a-f signal.		60 ~ FREQ. MOD.	D	985 or 1015 kc.	1 M. C. F. M. 0-30 K. C. SWEEP.	-----	F. M.	
7. Crystal-controlled frequency. a. 100 kc unmodulated-----		OFF EXT.	100 K. C. CRYSTAL.	-----	AMPLITUDE MODULATED.	-----	Desired r-f multiplying factor.	
b. 1000 kc unmodulated-----			1000 K. C. CRYSTAL.					
c. 100 kc modulated-----	400 ~ AMP. MOD. or OFF EXT.	100 K. C.						
d. 1000 kc modulated-----		1000 K. C.						

¹ In Signal Generator TS-465/U, a four-position DECIBEL METER switch is provided for switching meter ranges.

² The FREQ. MOD. SWEEP control is eliminated in Signal Generator TS-465/U. All f-m sweeps are fixed.

³ The power on-off switch in Signal Generator TS-465/U is part of the DECIBEL METER switch.

⁴ In Signal Generator TS-465/U, set OUTPUT MULTIPLIER to the desired r-f multiplying factor.

⁵ Signal Generator TS-465/U has only fixed sweep outputs: 1 mc at 30 kc, and 23 mc at 150 kc and 750 kc. Signal Generator TS-465A/U has an additional sweep output on the high range: 50 mc at 0 to 450 kc.

⁶ This frequency will be the frequency which is either the sum or difference of 1 mc and the desired frequency. Thus, for 456 kc i-f alignment, this frequency is either 1456 kc or 544 kc.

⁷ This frequency will be the frequency which is either the sum or difference of 50 mc and the desired frequency. Thus, for 10.7 mc i-f alignment, this frequency is either 39.3 mc or 60.7 mc.

⁸ In Signal Generator TS-465B/U, the external voltage must be 6.3 volts rms (root mean square) (sine voltage) to obtain a calibrated sweep.

⁹ In Signal Generator TS-465B/U, the external voltage must be 11.7 volts rms (sine voltage) to obtain a calibrated sweep.

¹⁰ In Signal Generator TS-465/U, the audio frequency range is 0 to 10 kc.

¹¹ In Signal Generator TS-465/U, set the BAND SELECTOR switch to the A band.

¹² In Signal Generator TS-465/U, the frequency adjustment is at some frequency between 240 to 250 kc on the A band.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

18. General

The operation of Signal Generator TS-465(*)/U may be difficult in regions where extreme cold, heat, humidity, and moisture, sand conditions, etc., prevail. Instructions on procedures for minimizing the effect of these unusual operating conditions are given in paragraphs 19 through 21.

19. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

- a. Handle the equipment carefully.
- b. Keep the equipment warm and dry. If the signal generator is not in a heated inclosure, construct an insulated box for it. Keep resistor heaters (if supplied) turned on, or keep the filaments of vacuum tubes lighted constantly, unless these measures overtax the power supply.
- c. Locate the equipment within a heated inclosure where there is no danger of a cold draft striking the glass tubes when a door is opened. A sudden draft of cold air often is sufficient to shatter the glass envelope of a heated tube. If the inclosure is constructed so that this precaution is impossible, place a blanket or barrier between the source of the draft and the equipment.
- d. When equipment which has been exposed to the cold is brought into a warm room, it may sweat until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly. This condition may arise also when equipment warms up during the day after exposure during a cold night.

20. Operation in Tropical Climates

When operated in tropical climates, the generator may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground, and when it is set up in swampy areas, moisture conditions are more acute than normal in the Tropics. Ventilation usually is very poor, and the high relative humidity causes condensation of moisture on the equipment whenever its temperature becomes lower than the ambient air. To minimize this condition, place lighted electric bulbs under the equipment.

21. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand or dust and dirt which may enter moving parts of the signal generator. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

d. Take care to keep the equipment as free from dust as possible. Make frequent preventive maintenance checks.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

22. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that break-downs and needless interruptions in service are held to a minimum. Preventive maintenance differs from trouble shooting and repair, since its object is to anticipate and eliminate troubles before they occur. See AR 750-5.

23. Tools and Materials Required

Tools and materials required for organizational maintenance of this equipment are listed in *a* and *b* below. The tools and materials contained in Tool Equipment TE-41 are listed in Department of the Army Supply Manual SIG 6 TE-41.

a. Tools.

Tool Equipment TE-41 (6R38041)
Tube Puller TL-201

b. Materials.

Orange stick (6Z7360)
Cheesecloth, bleached, lint-free (6Z1989)*
Carbon tetrachloride (6G184.1)*
Paper, sand, flint No. 000 (6Z7500-000)
Solvent, Dry Cleaning (SD) (Fed. spec No. P-S-661a) (6G1914)

24. General Preventive Maintenance Techniques

a. Use crocus cloth or No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

- (1) If necessary (except for electrical contacts), moisten the cloth or brush with solvent (SD); then wipe the parts dry with a cloth.
- (2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged

breathing of the fumes is dangerous. Make sure that adequate ventilation is provided.

c. If available, use dry compressed air at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places. Be careful not to damage light components with the air blast.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

25. Use of Preventive Maintenance Forms (figs. 9 and 10)

a. The decision as to which items on DA AGO Forms 11-238 and 11-239 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second or third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 9 and 10 are partially or totally applicable to Signal Generator TS-465/U. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

26. Performing Preventive Maintenance

a. Performing Exterior Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

- (1) Check for completeness and general condition of the signal generator. The components are listed in paragraph 6 and illustrated in figures 2, 3, and 4.
- (2) Check suitability of location and installation for normal operation. (par. 11).
- (3) Clean dirt and moisture from panels, jacks, plugs, etc.
- (4) Inspect seating of readily accessible *pluck-out* items such as tubes, crystals, fuses, etc. (figs. 31 through 43).

* Part of Tool Equipment TE-41.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT									
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR									
INSTRUCTIONS: See other side									
EQUIPMENT NOMENCLATURE					EQUIPMENT SERIAL NO.				
LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ⊗ Defect corrected. NOTE: Strike out items not applicable.									
DAILY									
NO	ITEM	CONDITION							
		S	M	T	W	T	F	S	S
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories). PAR. 260 (1)								
②	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 260 (2)								
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 260 (3)								
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 260 (4)								
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 260 (5)								
⑥	CHECK FOR NORMAL OPERATION. PAR. 260 (6)								
WEEKLY									
NO.	ITEM	COND - TION	NO.	ITEM	COND - TION				
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 260 (7)		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.					
⑧	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 260 (8)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 260 (11)					
⑨	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 260 (9)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 260 (12)					
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.					
11	INSPECT CANYAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.					
⑩	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWER-STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 260 (10)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.					
19	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.								

DA AGO FORM 11-238
1 MAY 51

REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2642-50

Figure 9. DA AGO Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT			
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR			
INSTRUCTIONS: See other side			
EQUIPMENT NOMENCLATURE		EQUIPMENT SERIAL NO.	
LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; I Adjustment, repair or replacement required; ① Defect corrected; NOTE: Strike out items not applicable.			
NO.	ITEM	NO.	ITEM
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories). PAR. 26 a (1)	19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 26 d (1)
②	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 26 d (2)	20	INSPECT FIRM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 26 d (3)	21	INSPECT FIXED CAPACITORS FOR LEAKS, BUBBLES, AND DISCOLORATION. PAR. 26 b (2)
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 26 d (4)	22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, FITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 26 d (5)	23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 26 b (3)
⑥	CHECK FOR NORMAL OPERATION. PAR. 26 d (6)	24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 26 b (4)
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 26 d (7)	25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 26 b (5)
⑧	INSPECT CASES, MOUNTINGS, ANTENNAS, YAGERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 26 d (8)	26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 26 b (6)
⑨	INSPECT CORDS, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 26 d (9)	27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	28	CHECK SETTINGS OF ADJUSTABLE RELAYS.
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR WIDERS, TEARS, AND FRAYING.	29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POTENTIOMETERS, RELAYS, SELFSYS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 26 d (10)	30	INSPECT GENERATORS, AMPLIFIERS, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CROKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 26 b (7)
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 26 d (11)	32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 26 b (8)
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 26 d (12)	33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.
		37	MOISTURE AND FUNGIPROOF.
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.		

DA AGO FORM 11-239
1 MAY 51

REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

16-46207-1

TM 2642-51

Figure 10. DA AGO Form 11-239.

- (5) Inspect controls for binding, scraping, excessive looseness, worn or chipped gears, misalignment (figs. 6, 7, and 8).
- (6) Check for normal operation (pars. 15, 16, and 17).
- (7) Clean and tighten exterior of component.
- (8) Inspect case and exposed metal surfaces for rust, corrosion, and moisture.
- (9) Inspect cord and wire for cuts, breaks, fraying, deterioration, kinks, and strain.
- (10) Inspect for looseness of accessible items: switches, knobs, jacks, connectors, transformers, capacitors, and pilot light assembly.
- (11) Clean nameplates, dial and meter windows, jewel assemblies (figs. 6, 7, and 8).
- (12) Inspect meters for damaged glass and cases (figs. 6, 7, and 8).

b. Performing Interior Preventive Maintenance (figs. 31 through 43).

Caution: Disconnect all power before performing the operations listed in (1) through (8) below. Upon completion, reconnect power and check for satisfactory operation.

- (1) Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket spring tension; clean dust and dirt from tubes; check emission of receiver type tubes.
- (2) Inspect fixed capacitors for leaks, bulges, and discoloration.
- (3) Inspect variable capacitors for dirt, moisture, misalignment of plates, and loose mountings.
- (4) Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.
- (5) Inspect terminals of large fixed capacitors and resistors for corrosion, dirt and loose contacts.
- (6) Clean and tighten switches, terminal boards, and interior of chassis not readily accessible.
- (7) Clean and tighten connections and mountings for transformers, chokes, potentiometers, and rheostats.
- (8) Inspect transformers, chokes, potentiometers and rheostats for overheating and oil-leakage.

Section II. WEATHERPROOFING AND PAINTING

27. Weatherproofing

a. General. Signal Corps equipment requires special treatment and maintenance when operated under the severe climatic conditions prevailing in tropical, arctic, or desert regions. Insects, dust, corrosion, fungus growth, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moisture-proofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against insects, corrosion, fungus, salt spray, and excessive moisture. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions

necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

28. Rustproofing and Painting

a. When the finish on the cabinet or panel has been badly scarred or damaged, rust and corrosion can be prevented by touching up the bared surface. Use No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright, smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the cabinet by cleaning corroded metal with solvent (SD). In severe cases, use solvent (SD) to soften the rust, and sandpaper to complete the preparation for painting. Paint used must be authorized and consistent with existing regulations.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

29. General

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) necessarily is limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and use of the senses in determining such troubles as burned-out tubes, cracked insulators, etc.

b. The following paragraphs in this section will help in determining which stage is at fault and which component in that stage is defective.

30. Visual Inspection

a. Failure of this equipment to operate properly may be caused by one or more of the following visible faults:

- (1) Improper connection to a-c power line.
- (2) Broken or disconnected cords or plugs, and lead wires.
- (3) Burned-out fuses and switch contacts.
- (4) Defective resistors or capacitors.
- (5) Defective or damaged tubes.
- (6) Incorrect setting of controls.

b. When failure is encountered and the cause is not apparent immediately, check as many of these items as practicable before starting a detailed examination of the component parts of the system.

31. Trouble Shooting by Using Equipment Performance Checklist

a. *General.* The equipment performance checklist (par. 32) aids in determining whether the instrument is functioning properly. The checklist gives the item number, the action or condition under which the item is checked, the normal indication, and the corrective measures.

Note. This checklist describes items that may be corrected by the operator. More detailed trouble-shooting and repair procedures are covered in chapter 5 and should be performed only by qualified repair personnel.

b. *Action or Condition.* This column indicates an operation to be performed on a control or part of the equipment.

c. *Normal Indications.* The normal indications listed include the visible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. *Corrective Measures.* The corrective measures listed are those that the operator can make without turning in the equipment for repairs. If the recommended corrective measures do not yield results, the equipment should be turned over to an experienced repairman for trouble shooting. If the equipment is not completely inoperative, and if the tactical situation demands continued operation, the operator must maintain the unit in operation for as long as possible.

32. Equipment Performance Checklist

	Item No.	Action or condition	Normal indications	Corrective measures
P R E P A R A T O R Y	1	Connect power plug to 105- to 125-volt, 50- to 70-cps power line.		

	Item No.	Action or condition	Normal indications	Corrective measures
E Q U I P M E N T P E R F O R M A N C E	2	Turn FREQ. MOD. SWEEP control clockwise until on-off switch clicks on. (In Signal Generator TS-465/U, turn DECIBEL METER control until on-off switch clicks on.)	Pilot lamp lights.	Check fuses (F101, F102) in a-c input circuit. Check line cord and plug. Check on-off switch. Check pilot lamp.
	3	Connect OUTPUT cable to antenna terminals of standard a-m receiver. Set controls for a 400-cycle a-m output (par. 17). Tune signal generator and receiver through frequency range.	400-cycle note in headset or speaker at matched frequencies.	Check V106, V101, V103, and V104.
	4	Set OUTPUT MULTIPLIER to each of r-f multiplying positions in turn (below 10 mc).	Volume of receiver output changes.	Check S103.
	5	Rotate OUTPUT CONTROL.	Volume of receiver output changes.	Check R110.
	6	Set controls for a modulated crystal-controlled output (par. 17). Set receiver frequency for a multiple of 100 kc or 1,000 kc.	400-cycle note in receiver headset or loudspeaker.	Check V102, V103, and V104.
	7	Connect OUTPUT cable to antenna of standard f-m receiver. Set controls for 60-cycle f-m (par. 17). Tune signal generator and receiver through each band in turn.	60-cycle note in receiver headset or speaker.	Check V104, V105.
	8	Connect the SYNCHRONIZED SWEEP VOLTAGE OUTPUT and GROUND terminals to the DECIBEL METER +22 to +38 0 TO 140 V and GROUND terminals respectively.	DECIBEL METER M101 reads 67 volts approximately.	Check M101.
	9	Connect the OUTPUT terminals to the DECIBEL METER GROUND and -10 to +6 0 to 3.5 V terminals. Set the control for an audio frequency output (par. 17).	Decibel meter reads to .2 volt approximately.	Check V101, V103, and V104.
	10	Set controls for a 400-cycle output (par 17).	Decibel meter reads to .3 volt approximately.	Check V103.
	S T O P	11	Turn FREQ. MOD. SWEEP control to POWER OFF position. (In Signal Generator TS-465/U, turn DECIBEL METER control to POWER OFF position.)	Pilot lamp goes off.

CHAPTER 4 :

THEORY

Section I. GENERAL THEORY OF OPERATION

33. Introduction

This section explains the general theory of operation of Signal Generator TS-465(*)/U. The circuits and reference symbols are based on Signal Generator TS-465B/U. Differences in circuit operation between this model and Signal Generators TS-465/U and TS-465A/U are described where applicable. The circuits are explained on the basis of the outputs obtainable from the unit. For a more detailed discussion of the theory, see paragraphs 42 through 65. The block diagram (fig. 11) shows the source and routing of each signal through the circuits of the signal generator. In order to simplify the discussion, no switching is shown.

34. Main R-F Oscillator Stage

Main r-f oscillator stage V101 generates an r-f signal continuously variable from 100 kc to 110 mc in eight bands.

a. The variable r-f signal is fed through cathode-follower tube V102A, OUTPUT CONTROL R110, and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The signal output is an unmodulated r-f voltage, variable from 100 kc to 110 mc.

b. The main r-f oscillator is plate-modulated by a 400-cycle signal from 400-cycle oscillator tube V103. The resulting a-m signal is fed through cathode-follower tube V102A, OUTPUT CONTROL R110, and OUTPUT MULTIPLIER switch

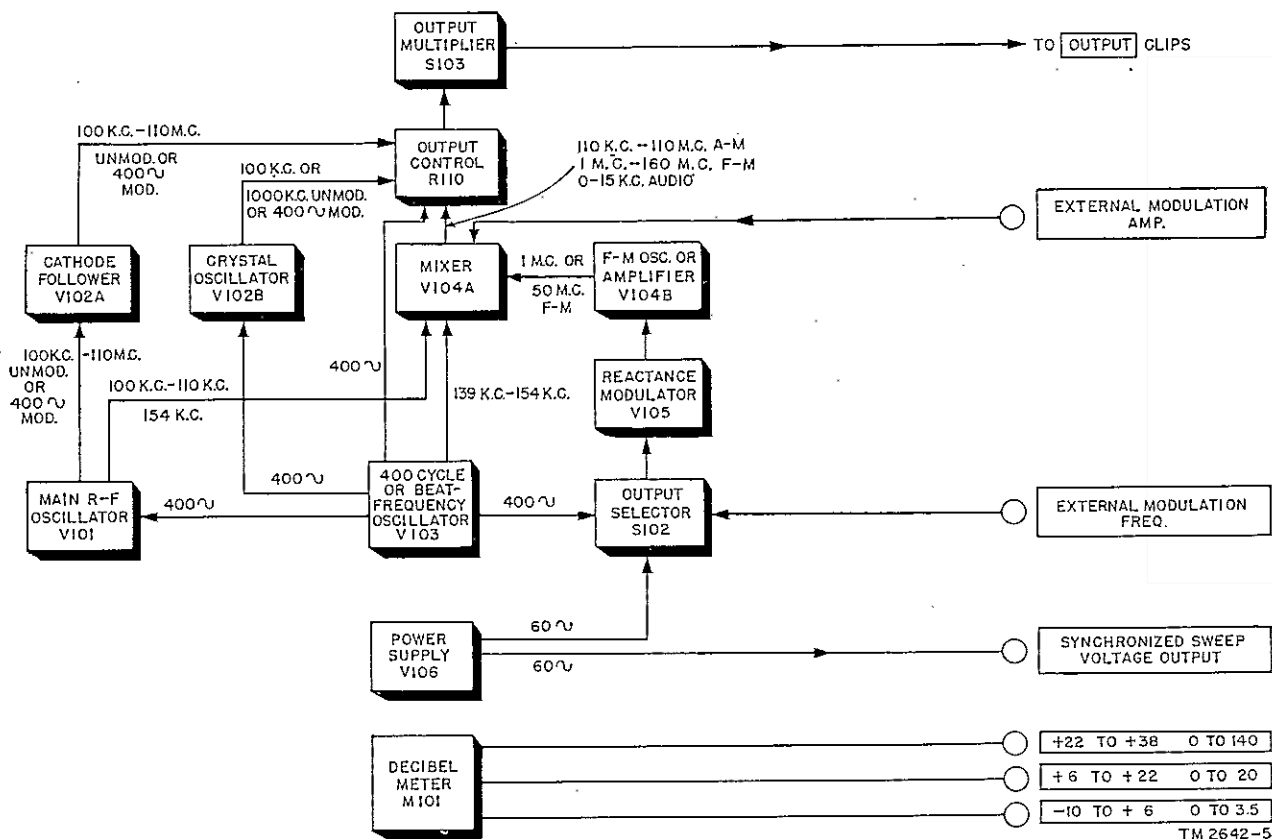


Figure 11. Signal Generator TS-465B/U, over-all block diagram.

S103 to the OUTPUT cable. The signal output is an r-f voltage, amplitude-modulated by 400 cycles and variable from 100 kc to 110 mc.

c. The variable r-f signal is fed to mixer tube V104A, where it can be amplitude-modulated by an external audio signal fed to the mixer stage from EXTERNAL MODULATION AMP. connector E107. The output of the mixer is fed through OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The signal output is an r-f voltage, variable from 100 kc to 110 mc, and amplitude-modulated at the frequency of the external signal.

d. The variable r-f signal is fed to mixer tube V104A, where it can be heterodyned against a frequency-modulated 1- or 50-mc signal from oscillator tube V104B. (In Signal Generator TS-465/U, the f-m signal is at 1 or 23 mc.) The output of the mixer is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The signal output is an f-m signal, variable from 100 kc to 160 mc. (In Signal Generator TS-465/U, the output is an f-m signal, variable from 100 kc to 133 mc.)

e. The variable r-f signal is fed to mixer tube V104A. An external signal fed into reactance modulator tube V105 from EXTERNAL MODULATION FREQ. connector E103 is used to frequency-modulate oscillator tube V104B. The resulting f-m signal is fed into the mixer where it is heterodyned with the variable r-f signal from main r-f oscillator tube V101. The output of the mixer is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The signal output is an r-f voltage variable from 100 kc to 160 mc, frequency-modulated at the frequency of the external signal. (In Signal Generator TS-465/U, the frequency range of the output signal is 100 kc to 133 mc.)

f. A 154-kc r-f signal is fed to mixer tube V104A, where it can be heterodyned with an r-f signal, variable from 139 kc to 154 kc, from bfo (beat-frequency oscillator) tube V103. (In Signal Generator TS-465/U, the r-f signal is at 240 to 250 kc.) (In Signal Generator TS-465A/U, the r-f signal is at 160 kc.) The output of the mixer is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The signal output is an audio voltage continuously variable from 0 to 15 kc. (In Signal Generator TS-465/U, the audio output is variable from 0 to 10 kc.)

35. Crystal Oscillator Stage

Crystal oscillator stage V102B produces a crystal-controlled r-f signal at either 100 kc or 1,000 kc. This signal is routed in the following ways:

a. The signal is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The output is an unmodulated 100- or 1,000-kc signal.

b. Crystal oscillator tube V102B is amplitude-modulated by the output of 400-cycle oscillator tube V103. The resulting signal is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The output is then a 400-cycle, a-m, 100- or 1,000-kc signal.

36. 400-Cycle and Beat-Frequency Oscillator Stage

The 400-cycle and bfo stage, V103, produces either a 400-cycle audio signal or an r-f signal continuously variable from 139 kc to 154 kc. (In Signal Generator TS-465/U, the r-f signal is continuously variable from 240 to 250 kc; in Signal Generator TS-465A/U, the r-f signal is continuously variable from 145 to 160 kc.) These signals are routed as follows:

a. The 400-cycle signal is fed to main r-f oscillator tube V101 when that stage is amplitude-modulated by a 400-cycle signal, as described in paragraph 34b.

b. The 400-cycle signal is fed to crystal oscillator tube V102B when that stage is amplitude-modulated by a 400-cycle signal, as described in paragraph 35b.

c. The 400-cycle signal is fed through OUTPUT SELECTOR switch S102 to reactance modulator tube V105 when that stage is used to frequency-modulate oscillator tube V104B, as described in paragraph 37.

d. The 400-cycle signal is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The output is then a 400-cycle signal.

e. The 139- to 154-kc signal (145- to 160-kc signal in Signal Generator TS-465A/U and 240- to 250-kc signal in Signal Generator TS-465/U) is fed to mixer tube V104A, where it is heterodyned with the 154-kc output (160-kc output in Signal Generator TS-465A/U, 250-kc output in Signal Generator TS-465/U) from main r-f oscillator tube V101, as described in paragraph 34f.

37. Reactance Modulator Stage

Reactance modulator stage V105 is used to modulate f-m oscillator tube V104B. Two fixed modulating frequencies, 60 cycles from the power supply or 400 cycles from 400-cycle oscillator tube V103, are selected by OUTPUT SELECTOR switch S102. An external modulating voltage also is fed through OUTPUT SELECTOR switch S102 into the reactance modulator from EXTERNAL MODULATION FREQ. connector E103. FREQ. MOD. SWEEP control R130 controls the amplitude of the modulating signal applied to the reactance modulator and thus the sweep width of the output of f-m oscillator tube V104B. (In Signal Generator TS-465/U, this control is eliminated; all sweep voltages are fixed in amplitude to give fixed sweep widths.)

38. F-M Oscillator or Amplifier Stage

F-m oscillator or amplifier stage V104B can function as an oscillator at 1 mc or 50 mc (23 mc in Signal Generator TS-465/U), or it can function as an amplifier.

a. When the stage functions as an oscillator, it is frequency-modulated by reactance modulator tube V105, as described in paragraph 37. F. M.-A. M. SELECTOR switch S104 is set for either a 1- or 50-mc center frequency (1- or 23-mc center frequency in Signal Generator TS-465/U). The f-m output is fed to mixer tube V104A.

b. When F. M.-A. M. SELECTOR switch S104 is set to the AMPLITUDE MODULATED position, the stage functions as an amplifier for either the 139- to 154-kc output of bfo tube V103, or the audio voltage fed in through EXTERNAL MODULATION AMP. connector E107. The output of the amplifier is applied to mixer tube V104A for mixing with or modulating the r-f signal input to the mixer.

39. Mixer Stage

Mixer stage V104A functions as a modulating or mixing stage. The output of the mixer is fed

through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The mixer performs the following functions:

a. When fed with a 154-kc signal from main r-f oscillator tube V101 (160-kc signal in Signal Generator TS-465A/U; 250-kc signal in Signal Generator TS-465/U) and a variable signal from bfo tube V103, the mixer will produce a continuously variable 0- to 15-kc signal (0- to 10-kc in Signal Generator TS-465/U).

b. When fed a continuously variable 100-kc to 110-mc signal from main r-f oscillator tube V101 and a 1- or 50-mc f-m signal (23 mc in Signal Generator TS-465/U) from f-m oscillator tube V104B, the mixer will produce an f-m signal continuously variable from 100 kc to 111 mc (with the 1-mc f-m signal) and 1 mc to 160 mc (with the 50-mc f-m signal) (1 mc to 133 mc with the 23-mc signal in Signal Generator TS-465/U).

c. When fed a continuously variable 100-kc to 100-mc signal from main r-f oscillator tube V101 and an external modulating signal from EXTERNAL MODULATION AMP. connector E107, the mixer will produce an a-m signal continuously variable from 100 kc to 110 mc and modulated at the frequency of the external signal.

40. Power Supply Stage

Power supply stage V106 is the source of power for the other stages in the signal generator. It also furnishes a 60-cycle signal for f-m oscillator tube V104B and a 60-cycle signal to SYNCHRONIZED SWEEP VOLTAGE OUTPUT connector E108.

41. Decibel Meter

A decibel meter, M101, is available for measuring power levels in three ranges (-10 to +6, +6 to +22, and +22 to +38 db) or voltage in three ranges (0 to 3.5 volts, 0 to 20 volts, and 0 to 140 volts). The decibel level is based on a 0-db level of 6 mw (milliwatts) across 500 ohms. See figure 44 for the db-correction factor to be applied when using loads other than 500 ohms.

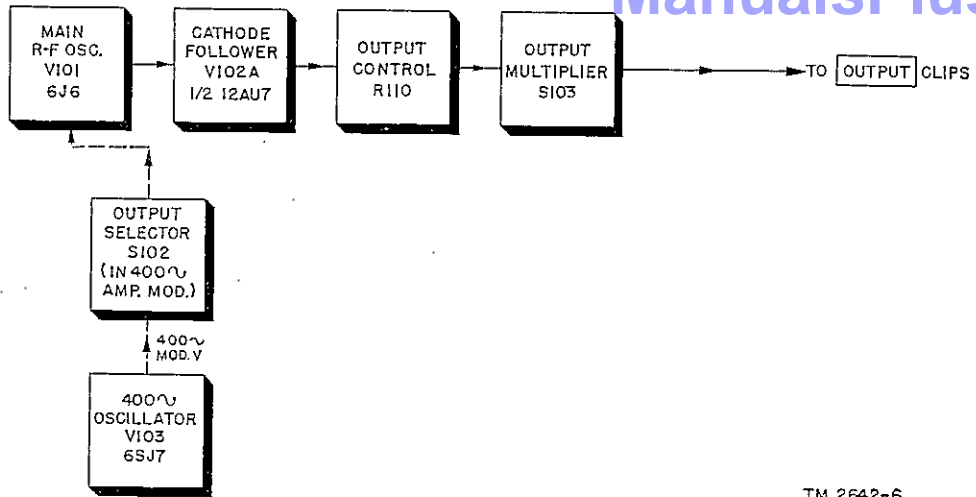
Section II. VARIABLE R-F SIGNAL GENERATOR

42. Block Diagram (Internal Amplitude Modulation)

(fig. 12)

a. The variable r-f signal generator produces an r-f signal continuously variable from 100 kc to 110 mc. The signal output may be either unmodulated or 400-cycle amplitude-modulated.

b. Main r-f oscillator tube V101 generates the r-f signal which is fed through cathode-follower tube V102A, OUTPUT CONTROL R110, and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The main r-f oscillator output may be amplitude-modulated by a 400-cycle signal from 400-cycle oscillator tube V103.



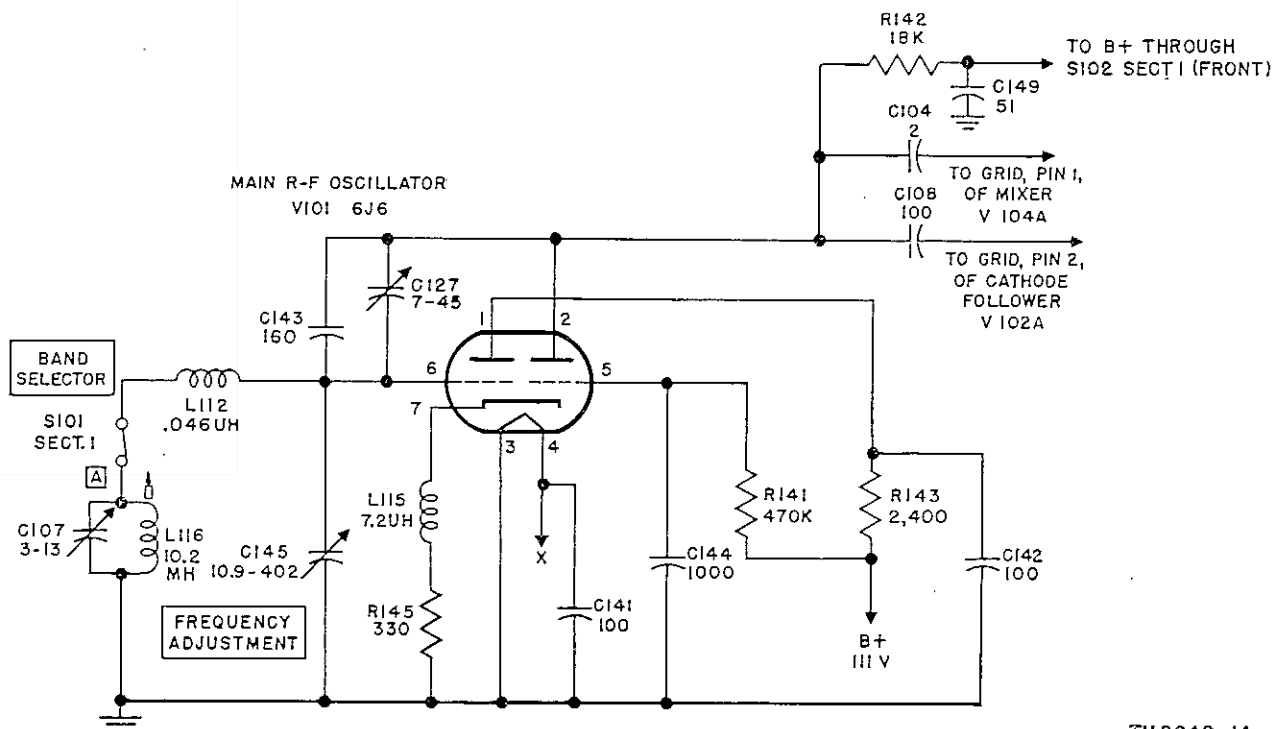
TM 2642-6

Figure 12. Variable r-f signal generator (internal amplitude modulation), block diagram.

43. Main R-F Oscillator Stage (fig 13)

a. Main r-f oscillator tube V101 is a two-terminal positive-grid oscillator used for generating radio frequencies in eight overlapping ranges, covering all frequencies from 100 kc to 110 mc. (Signal Generators TS-465/U and TS-465A/U use a Colpitts type oscillator.) Oscillation is maintained by feeding back part of the voltage on the plate (pin 2) of

one section of tube V101 through capacitor C143 to the grid (pin 6) of the other section of tube V101. The two-terminal oscillator used in Signal Generator TS-465B/U permits considerable simplification of the band-switching circuit over the shunted Colpitts type used in Signal Generators TS-465/U and TS-465A/U, since no tap is necessary on the oscillator inductance.



TM 2642-14

Figure 13. Main r-f oscillator, functional schematic.

b. The circuit used in Signal Generator TS-465B/U and shown in figure 13 has been simplified for clarity. Actually, main r-f oscillator tube V101 is connected through section 1 of BAND SELECTOR switch S101 to any one of eight separate tank circuits. FREQUENCY ADJUSTMENT capacitor C145, coil L112, and one of the circuits selected by switch S101 form the grid tank circuit.

(1) Coil L112 can be used by itself or in series with the tank circuits (L101 and C105, L103 and C110, L104 and C114, L105 and C118, L106 and C123, L116 and C107, or L107 and C130). Capacitors C107, C105, C110, C114, C118, C123, and C130 are 3- to 13- μf (micromicrofarad) trimmers connected in parallel with their respective coils. Each of the coils has a movable iron core which may be used to vary the inductance and thus facilitate alinement of the respective tank circuit.

(2) The r-f ranges of the tank circuits in positions A through H of the BAND SELECTOR switch for each of the models of the signal generator are listed in paragraph 4.

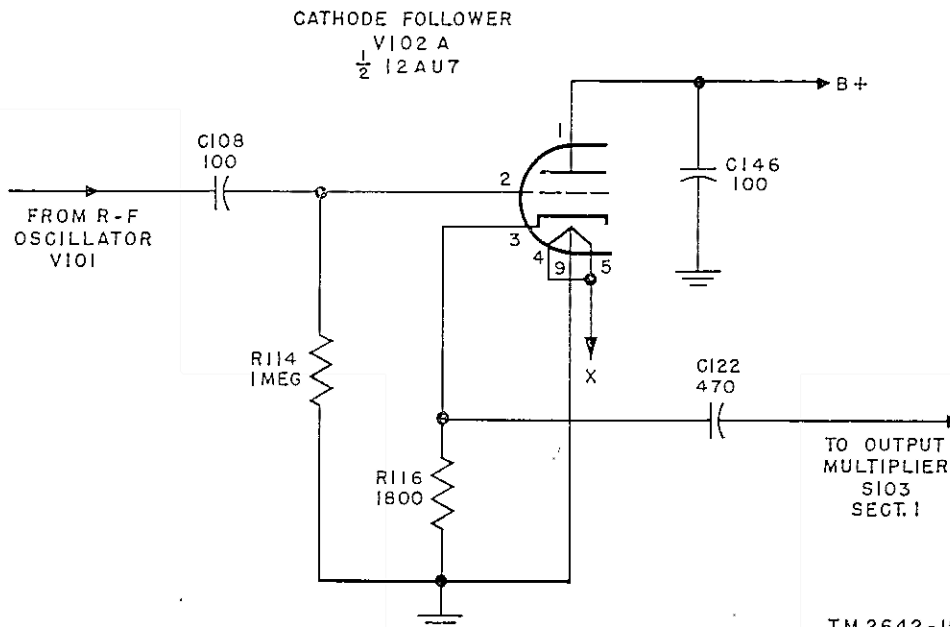
c. Resistor R145 is a cathode-bias resistor. Inductance coil L115 is placed in the common cathode circuit to raise the cathode impedance at higher radio frequencies, thus improving higher frequency oscillations. Capacitor C141 provides a low-

impedance path to ground for any r-f energy on the filament lines. Dropping resistor R141 provides a low positive voltage (with respect to ground) for the grid (pin 5) of tube V101, and capacitor C144 maintains the grid at r-f ground potential.

d. Tube V101 actually functions as a two-stage oscillator-amplifier, with the output of the second stage (pin 2) fed back through capacitor C143 to the input (pin 6) of the first stage. The common cathode circuit couples the first stage to the second stage and provides degenerative feedback, improving stability and waveform. As the plate current through the first stage (oscillator section) increases, because of a positive-going grid voltage, the common cathode circuit decreases the current through the second stage (amplifier section). The resulting positive-going voltage from the plate circuit of the amplifier section is fed back to the grid (pin 6) of the oscillator section, through coupling capacitor C143, to sustain oscillations.

e. Resistor R142 is the load resistor in the amplifier plate circuit. Resistor R143 acts as a load resistor and stabilizes the output of the oscillator stage. Capacitor C149 is a bypass capacitor used to keep r-f out of the B + supply.

f. The output of the main r-f oscillator stage is fed through capacitor C104 to the grid of Mixer tube V104A and through capacitor C108 to the grid of cathode-follower tube V102A.



TM 2642-15

Figure 14. Cathode-follower, functional schematic.

44. Cathode-Follower Stage

a. Cathode-follower stage V102A differs from a conventional amplifier in two ways; the output is taken from the cathode circuit instead of from the plate circuit, and the gain of the stage is less than unity. An important advantage of the cathode-coupled stage is that it can operate as an impedance-matching or isolating device for coupling a high-impedance source to a low-impedance load. Thus, cathode-follower tube V102A isolates main r-f oscillator tube V101 from the low-impedance load of the output circuit.

b. The r-f output of the main r-f oscillator stage is coupled to the control grid of tube V102A through capacitor C108. Cathode resistor R116 sets the grid bias and serves as a load for the output signal which appears across the resistor. Resistor R114 maintains a constant load on the grid input circuit and helps to stabilize the grid bias.

c. The output of the cathode-follower is coupled to the output circuit through capacitor C122. Capacitor C146 improves the h-f (high-frequency) bypass action of capacitor C132. Together, they prevent rf from entering the power circuits through the B + supply line.

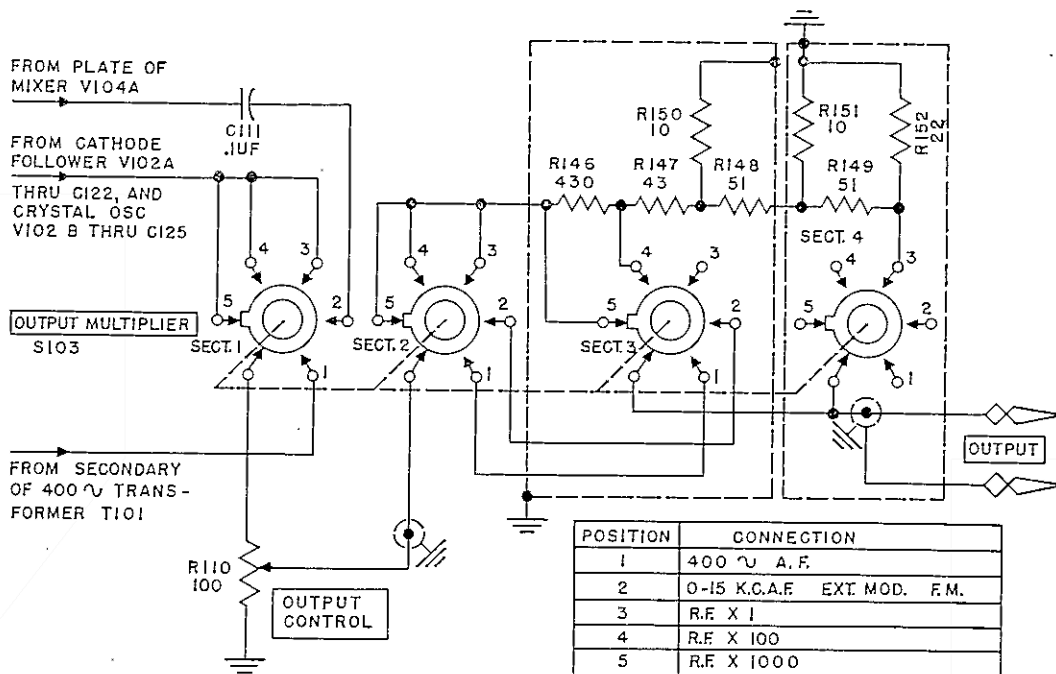
45. Output Circuit

(fig. 15)

a. The output circuit selects and attenuates signals going to the OUTPUT cable. The circuit consists of a four-gang OUTPUT MULTIPLIER switch S103, a potentiometer, OUTPUT CONTROL R110, and a resistor attenuating network. (Signal Generators TS-465/U and TS-465A/U use a two-gang switch.)

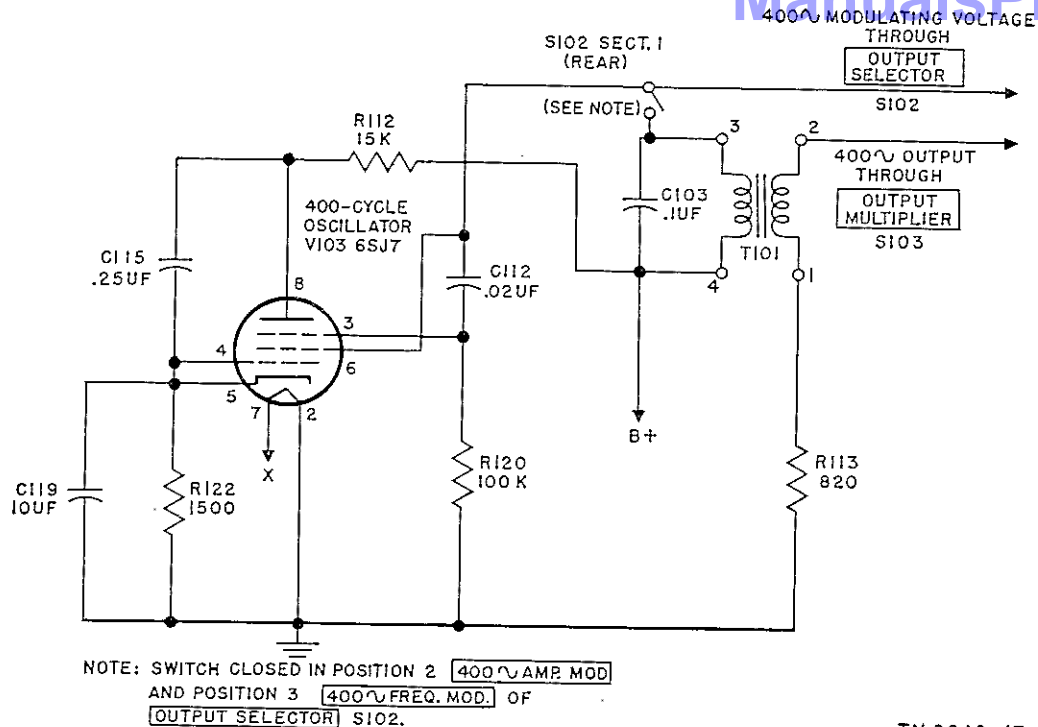
b. The output of cathode-follower tube V102A is fed through section 1 of switch S103 to OUTPUT CONTROL R110 when switch S103 is set to R. F. X1, R. F. X100, or R. F. X1000 (positions 3, 4, and 5, respectively). OUTPUT CONTROL R110 can set the signal amplitude at any value from zero to maximum. (In Signal Generator TS-465/U, the OUTPUT MULTIPLIER switch has an R. F. X1, R. F. X10, and an R. F. X100 position. In Signal Generator TS-465A/U, the OUTPUT MULTIPLIER switch has an R. F. X1, R. F. X10, and an R. F. X1000 position.)

c. The signal on the movable arm of OUTPUT CONTROL R110 is fed through section 2 of switch S103 (in position 3, 4, or 5) to the input of the attenuator circuit consisting of resistors R146 through R152 and sections 3 and 4 of switch S103. The resistor network is a step-type or ladder attenuator.



TM 2642-13

Figure 15. Output circuit, functional schematic.



TM 2642-17

Figure 16. 400-cycle oscillator, functional schematic.

d. In position 3 of switch S103, the signal passes from the attenuator network through section 4 of switch S103 to the OUTPUT cable. In positions 4 and 5, the signal passes from the attenuator through section 3 of switch S103 to the OUTPUT cable.

46. Internal Amplitude Modulation

When the required output is an a-m r-f signal, the main r-f oscillator tube V101 is plate-modulated by the output of 400-cycle oscillator tube V103. With OUTPUT SELECTOR switch S102 in the 400 ~ AMP. MOD. position, the plate circuit of the main r-f oscillator stage is disconnected from the B+ line and connected to terminal 3 of transformer T101. Transformer T101 primary forms a tuned circuit for the 400-cycle oscillator (fig. 16). It also varies the plate voltage for the main r-f oscillator stage for 400-cycle amplitude modulation. Thus, the output of the main r-f oscillator stage will be amplitude-modulated by the 400-cycle voltage developed across transformer T101.

47. 400-Cycle Oscillator Stage (fig. 16)

a. The 400-cycle oscillator stage, V103, is a modi-

fied negative-resistance or transitron oscillator which uses a sharp cutoff pentode tube with the cathode and control grid connected together. The tank circuit (primary of transformer T101 and capacitor C103) is located in the screen circuit, and the screen grid is connected to the suppressor grid through capacitor C112, which acts as a low-impedance feedback pass.

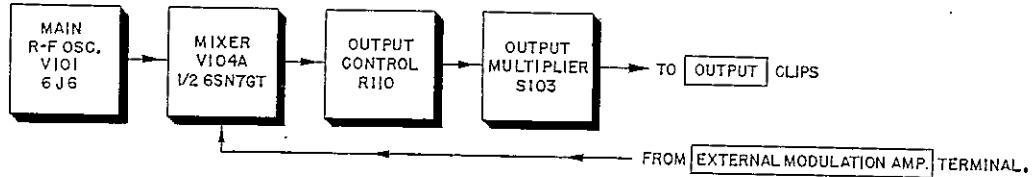
b. On the negative half of the oscillating cycle (negative voltage swing on screen), most of the tube current will flow through the screen grid. This is because of the negative voltage placed on the suppressor grid through resistor R120, which causes a decrease in the flow of plate current. As screen current flows, the voltage across the tank circuit increases positively, decreasing the negative voltage on the suppressor grid. As the suppressor grid becomes less negative, the plate current increases, and the screen current decreases. As the screen current decreases, the charge on capacitor C112 also decreases and the voltage on the suppressor grid returns to normal. This, in turn, reduces the plate current and starts a new cycle. This negative-resistance effect causes sustained oscillations in the I-C (inductance-capacitance) circuit connected to the screen grid. Oscillations

occur at the frequency determined by the inductance of the primary of transformer T101 and the capacitance of capacitor C103. The 400-cycle output signal is obtained from the secondary winding of transformer T101.

c. Resistor R122 is the cathode-bias resistor, bypassed by capacitor C115. Capacitor C115 bypasses the a-f component on the plate of tube V103 and keeps the plate voltage effectively at a-c ground potential.

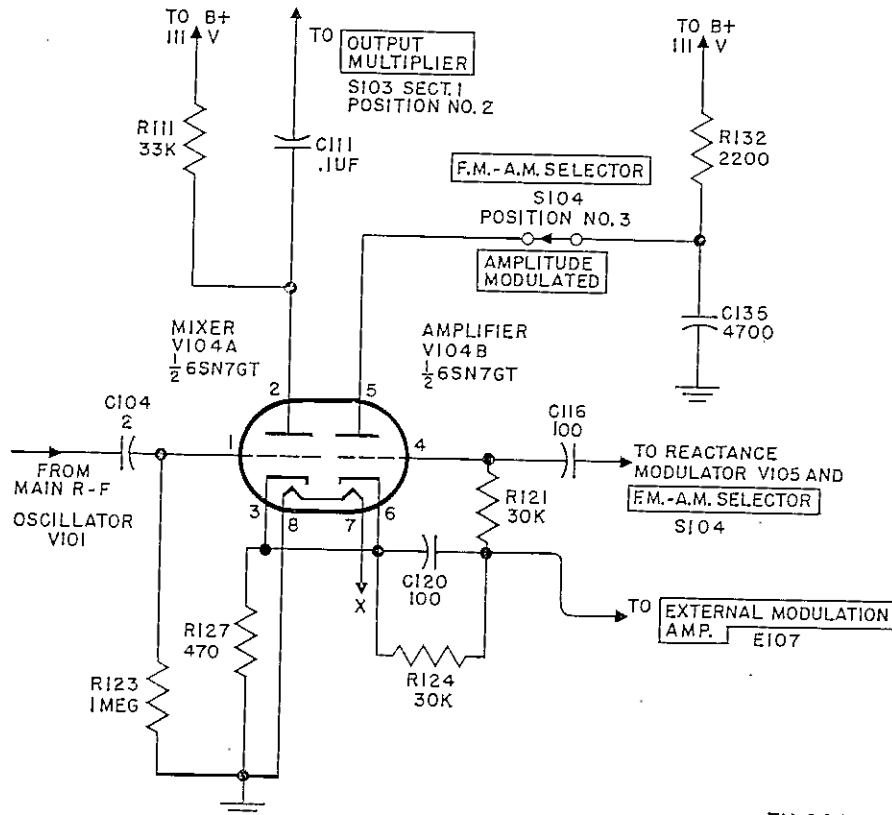
48. External Amplitude Modulation (fig. 17)

When the output of the main r-f oscillator stage is to be amplitude-modulated by an external signal, the r-f output is fed to the grid of mixer tube V104A through capacitor C104. The external signal is fed to the mixer through amplifier tube V104B, where it modulates the r-f signal. The output of the mixer stage is fed to the output circuits through capacitor C111.



TM 2642-7

Figure 17. External amplitude modulation, block diagram.



TM 2642-11

Figure 18. Mixer and amplifier, functional schematic.

49. Amplifier Stage (fig. 18)

a. Amplifier stage V104B is an isolating and impedance-matching stage. It couples signals from high-impedance circuits to the low-impedance cathode circuit of the mixer and prevents feedback of signals from the mixer cathode circuit to other external circuits. (This stage is not used in Signal Generator TS-465/U.)

b. The amplifier circuit functions as follows: The external signal connected to EXTERNAL MODULATION AMP. connector E107 is fed to the grid (pin 4) through resistor R121. This resistor limits the signal fed to the grid, prevents the grid from going positive, and acts as a grid leak for the f-m oscillator. Capacitor C120 is an h-f bypass which does not affect the operation of the amplifier at the audio frequencies used for amplitude modulation.

c. The output of the amplifier appears across the common cathode resistor and thus is coupled into the mixer circuit. Resistor R132 and capacitor C135 form a decoupling network in the B + supply to the plate of tube V104B.

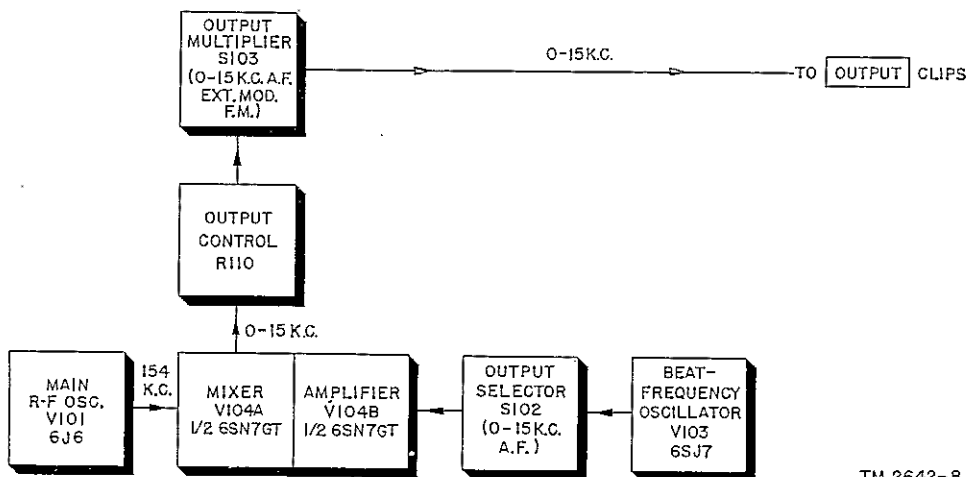
50. Mixer Stage (fig. 18)

a. Signals fed to the grid (pin 1) of mixer stage V104A through capacitor C104 are amplitude-modulated by the audio voltage appearing across common cathode resistor R127. Resistor R127 in the cathode circuit furnishes grid bias for the stage. Resistor R123 provides a d-c grid return to ground.

b. The resulting a-m signal is fed to the output circuit through capacitor C111. Resistor R111 is the plate load for the mixer stage.

c. When external amplitude modulation is used, OUTPUT MULTIPLIER switch S103 is set to the EXT. MOD. position. The output of the mixer passes through section 1 of switch S103 to OUTPUT CONTROL R110, which controls the level of the output signal. The signal then passes through sections 2 and 3 of switch S103 to the OUTPUT cable.

d. The mixer stage in Signal Generator TS-468/U uses the hexode section of a type 6K8 hexode-triode tube. R-f signals are fed to the grid (pin 3) and frequency-modulated, r-f and amplitude-modulated signals are fed to the grid (pin 1). Output from the plate of the mixer is coupled to the 0-10 K. C. A. F. F. M. position of the OUTPUT MULTIPLIER switch and to the OUTPUT cable.



TM 2642-8

Figure 19. Variable a-f signal generator, block diagram.

Section III. VARIABLE A-F SIGNAL GENERATOR

51. Block Diagram (fig. 19)

The variable a-f signal generator produces a signal continuously variable from 0 to 15 kc (0 to 10

kc in Signal Generator TS-465/U). The main r-f oscillator tube, V101, feeds a 154-kc signal to mixer tube V104A. Bfo tube V103 feeds a continuously variable 139- to 154-kc signal through OUTPUT

SELECTOR switch S102 and amplifier tube V104B to the mixer stage. The two signals are heterodyned in the mixer and the resulting signal is fed to the output circuits.

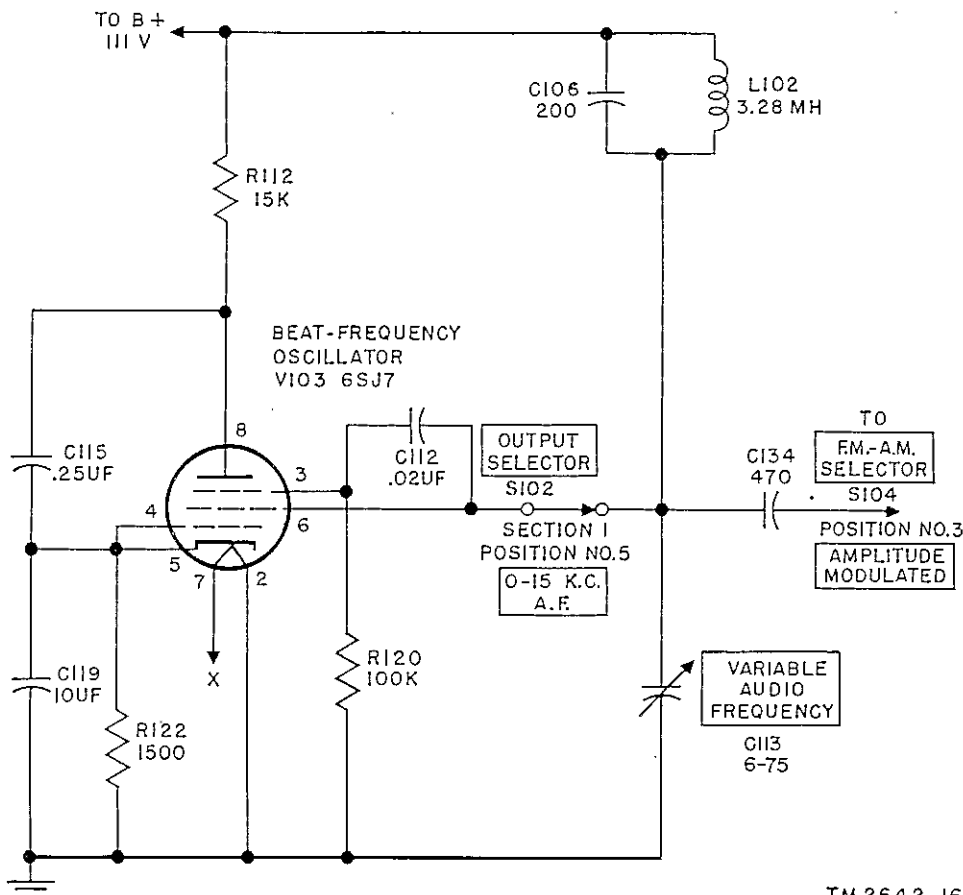
Note. In Signal Generator TS-465/U, a 250- to 260-kc signal from the main r-f oscillator tube is beat against a variable bfo signal to give a 0- to 10-kc difference frequency. In Signal Generator TS-465A/U, a 160-kc signal is heterodyned against a variable bfo signal to a 0- to 15-kc difference frequency.

52. Beat-Frequency Oscillator Stage

(fig. 20)

a. The bfo circuit of tube V103 is the same as that described in paragraph 47, except for the tank circuit and the output connections.

b. For 139- to 154-kc operation, coil L102 and capacitors C106 and C113 form the tank circuit in place of transformer T101 and capacitor C103 which are used for 400-cycle operation. The 0-15 K. C. A. F. position of OUTPUT SELECTOR switch S102, section 1, selects the tank circuit.



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Figure 20. Beat-frequency oscillator; functional schematic.

VARIABLE AUDIO FREQUENCY control C113 is effectively across L102 for r-f signals and thus controls the frequency of the oscillator output by varying the capacity in the parallel resonant tank circuit, and thus the frequency of the audio output.

c. The output signal is fed to amplifier tube V104B through capacitor C134 when F. M.-A. M. SELECTOR switch S104 is set to the AMPLITUDE MODULATED position.

53. Amplifier Stage

(fig. 18)

a. The amplifier circuit of tube V104B is the same as that described in paragraph 49, except for the input circuit.

b. The signal from the bfo is coupled through capacitor C116 directly to the grid of mixer tube V104B. Resistor R121 functions as part of the grid load.

c. The output of the amplifier is coupled into the mixer circuit through the common cathode resistor in the manner described in paragraph 49.

54. Mixer Stage
(fig. 18)

a. Mixer stage V104A heterodynes the two signals: one from the main r-f oscillator injected into the grid circuit, and the other from the bfo injected into the cathode circuit, to produce a continuously variable 0- to 15-kc output signal. (In Signal Gen-

erator TS-465/U, the output of the mixer stage is a 0- to 10-kc signal.)

b. This signal is fed to the output circuit through capacitor C111. OUTPUT MULTIPLIER switch S103, set to 0-15 K. C. A. F. position, feeds the signal through OUTPUT CONTROL R110 to the OUTPUT cable.

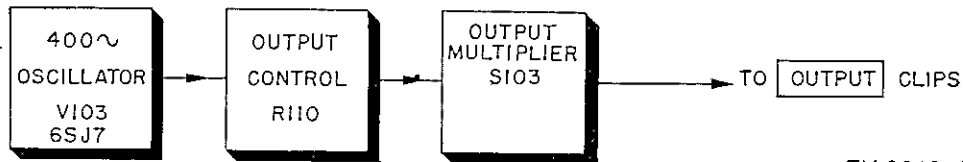
Section IV. FIXED 400-CYCLE SIGNAL GENERATOR

55. Block Diagram
(fig. 21)

The fixed 400-cycle signal generator furnishes a 400-cycle voltage, variable in amplitude. This signal is generated by 400-cycle oscillator tube V103 and is fed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable.

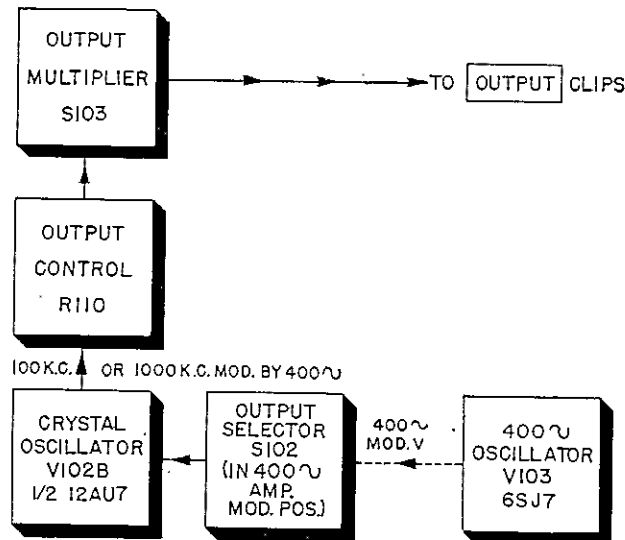
56. 400-Cycle Oscillator Stage
(fig. 16)

The operation of 400-cycle oscillator V103 is described in paragraph 47. The only difference in its use here is in the output connections. An output signal is taken from the secondary of transformer T101 at terminal 2 and fed to the output circuit. Resistor R113 prevents the load on the secondary of T101 from falling below 820 ohms, regardless of the load imposed by the external circuit under test. With OUTPUT MULTIPLIER switch S103 in the 400 ~ A. F. position, the signal is fed through OUTPUT CONTROL R110 to the OUTPUT cable.



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Figure 21. Fixed 400-cycle signal generator, block diagram.



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Figure 22. Crystal-controlled r-f signal generator, block diagram.

Section V. CRYSTAL-CONTROLLED R-F SIGNAL GENERATOR

57. Block Diagram

(fig. 22)

The crystal-controlled r-f signal generator functions to produce stable 100- or 1,000-kc signals and their harmonics. The crystal-controlled signal generated by crystal oscillator tube V102B is routed through OUTPUT CONTROL R110 and OUTPUT MULTIPLIER switch S103 to the OUTPUT cable. The output of the crystal oscillator may be amplitude-modulated by a 400-cycle signal from 400-cycle oscillator tube V103.

58. Crystal Oscillator Stage

(fig. 23)

a. One section of tube V102 (V102B) is used as a crystal oscillator. This circuit is similar to a tuned-plate tuned-grid oscillator, oscillations being sustained by energy fed back from the tuned plate circuit to the tuned grid circuit, through the inter-electrode capacitance of the tube. A crystal has been substituted for the tuned grid circuit to provide greater frequency stability.

b. Crystal Y101 has two fundamental outputs or modes: 100 kc and 1,000 kc. The plate tank circuit (L114 and C139) is resonant at 100 kc. The oscillator output is 100 kc or 1,000 kc, depending on the number of turns of coil L114 placed in the plate circuit by the BAND SELECTOR switch. When all of coil L114 is between the B+ lead and the

plate of tube V102B, the leading on the tube is such that the amplitude and phase of voltage fed back to the grid circuit causes the crystal to operate in the 100-kc mode. In the 1,000 K. C. CRYSTAL position of the BAND SELECTOR switch, coil L114 is tapped down, placing only a portion of the coil turns in the plate circuit. This changes the plate loading and thus the excitation on the crystal, allowing it to oscillate in the 1,000-kc mode.

c. Since there is no bypass capacitor across cathode resistor R138, the r-f output appears across this resistor, and is taken off through capacitor C125 and fed to the output circuit. This type of cathode coupling insures minimum loading of the oscillator stage, isolating the resonant elements from the output load.

d. For operation of the output circuit, see paragraph 45.

59. Internal Amplitude Modulation

a. When the output of the crystal oscillator is to be amplitude-modulated by a 400-cycle signal, OUTPUT SELECTOR switch S102 is set to the 400 ~ AMP. MOD. position. This connects the plate circuit of the crystal oscillator to B+ through transformer T101.

b. The 400-cycle voltage generated across transformer T101 plate-modulates the output of the crystal oscillator. For a description of this type of operation, see paragraph 46.

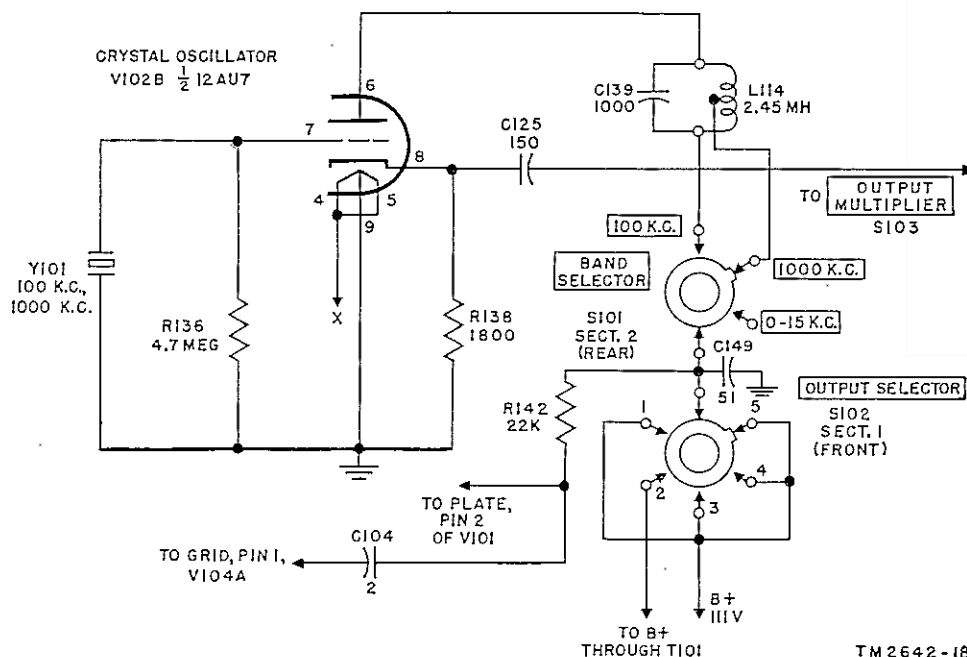


Figure 23. Crystal oscillator, functional schematic.

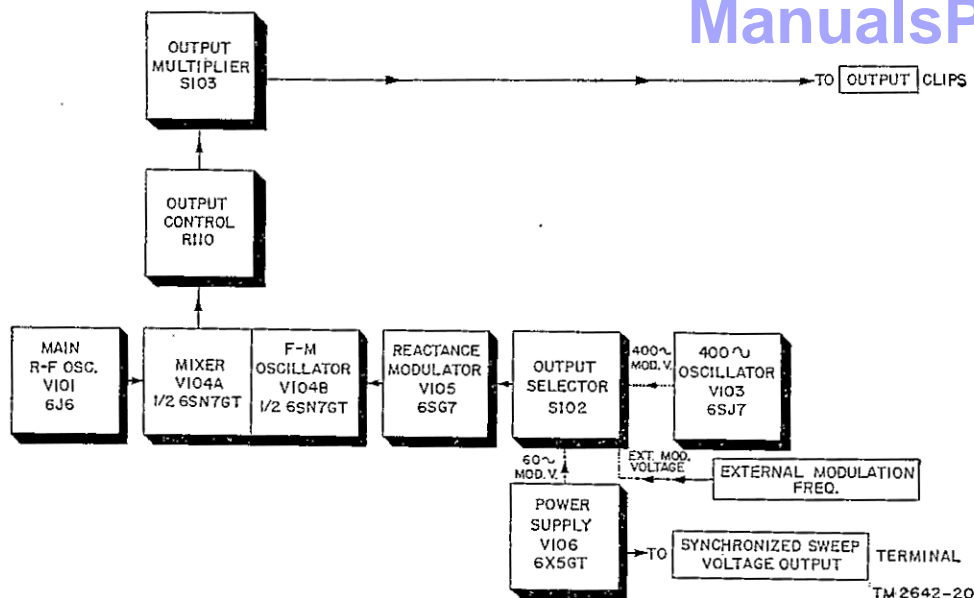


Figure 24. Variable f-m signal generator, block diagram.

Section VI. VARIABLE F-M SIGNAL GENERATOR

60. Block Diagram (fig. 24)

a. Variable f-m carrier frequencies from 100 kc through 160 mc (100 kc through 133 mc in Signal Generator TS-465/U) can be generated by the equipment when it is used as a variable f-m signal generator. Sweep widths from 0 to 150 kc are available. (Signal Generator TS-465A/U has a 0- to 450-kc sweep width and Signal Generator TS-465/U has a 750-kc fixed sweep signal.)

b. F-m oscillator tube V104B generates a carrier frequency of either 1 mc, with a maximum sweep width of 30 kc, or 50 mc, with a maximum sweep width of 150 kc. The output of the oscillator is frequency-modulated by reactance modulator tube V105. The reactance modulator tube receives either a 60-cycle signal from the power supply, a 400-cycle signal from 400-cycle oscillator V103, or an external audio signal from EXTERNAL MODULATION FREQ. connector E103.

c. The output of the f-m oscillator is fed into mixer tube V104A. The output of main r-f oscillator tube V101 is fed to the mixer stage and heterodyned with the fixed f-m signal, providing a continuously variable f-m signal which is fed to the output circuits.

61. Frequency-Modulation Circuit (fig. 25)

a. The f-m circuit uses reactance modulator tube V105, f-m oscillator tube V104B, and mixer tube

V104A. The modulating voltage is selected by OUTPUT SELECTOR switch S102, section 2. In the OFF EXT. position, a signal from EXTERNAL MODULATION FREQ. connector E103 is fed to the reactance modulator tube. In the 400 ~ FREQ. MOD. position, the output of the 400-cycle oscillator stage is fed to the reactance modulator tube. In the 60 ~ FREQ. MOD. position, a 60-cycle signal from power transformer T102 is fed to the reactance modulator tube.

b. F-m oscillator tube V104B uses a Hartley circuit with inductive feedback. The tank circuit consists of either L108 or L111, and the grid-to-plate capacitance of tube V104B. The coils are slug-tuned for alinement. A-c voltage is generated in the plate circuit of tube V104B. By inductive coupling in the coil in the circuit (L108 or L111), part of which is in the plate circuit and part in the grid circuit, some of this energy is fed back into the grid circuit through coupling capacitor C116, thus sustaining oscillations.

c. Resistors R121 and 124 in series form the grid-leak resistance. Capacitor C120 is connected across resistor R124 to reduce the impedance in the grid circuit for r-f signals. Capacitor C115 functions as a grid leak, and coupling capacitor.

d. Reactance modulator tube V105 is connected in parallel with the grid-circuit section of the tuned tank circuit. A small portion of the current induced in the tank coil (either L108 or L111) is fed into a phase-shifting network consisting of capaci-

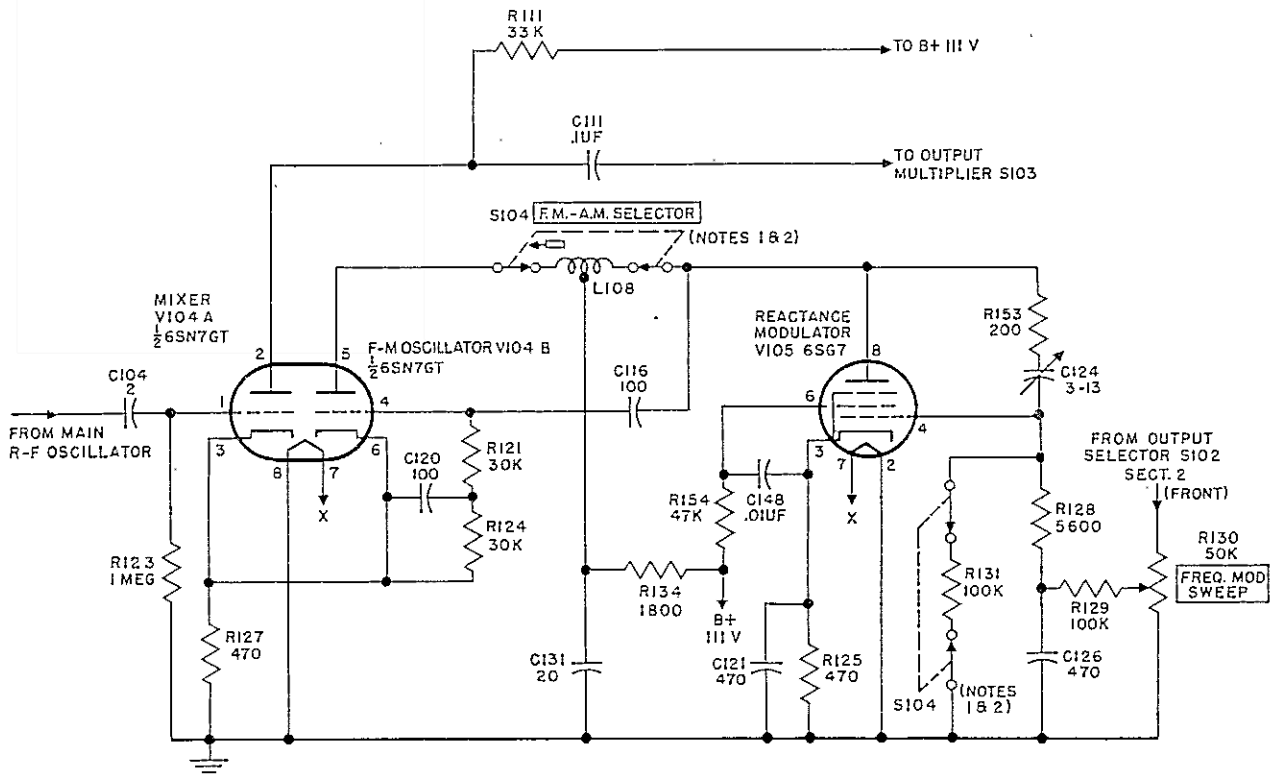
tor C124 and resistor R131 (or R139). The network introduces a phase shift, with the current leading the voltage. The leading voltage across R131 (or R139) is applied to the control grid, pin 4, of tube V105, and appears as a leading current or capacitive reactance in the plate circuit. Since the plate circuit of tube V105 is connected in parallel with part of the f-m oscillator tank circuit, this capacitive reactance appears as part of the reactance in the tank circuit.

e. The modulating signal selected by OUTPUT SELECTOR switch S102 is fed through FREQ. MOD. SWEEP control R130, which controls the amplitude of the signal. The modulating voltage is fed through a voltage-dropping and isolating network consisting of resistors R129, R128, and R131 (or R129), to the control grid of tube V105. The signal is amplified by the tube and appears as an a-c current in the plate circuit. This a-c current acts as a leading current across L108 and thus varies the frequency of f-m oscillator tube V104B.

f. Either resistor R131 or R139 may be switched

into the grid circuit of tube V105 as a grid leak and phase shifter. Resistors R131 and R139 are interchanged by F. M.-A. M. SELECTOR switch S104. Capacitor C126 lowers the grid impedance for r-f signals and prevents feedback of these signals through FREQ. MOD. SWEEP control R130. Resistors R134 and R154 are the plate- and screen-load resistors, respectively, for tube V105. Capacitor C148 bypasses rf from the screen-load resistor. Capacitor C131 provides a low-impedance r-f path from the coil tap in the plate circuit of the reactance modulator to ground. Resistor R125 is the cathode-bias resistor, and capacitor C121 is the cathode r-f bypass.

g. The output of f-m oscillator tube V104B is coupled into the mixer circuit by the common cathode resistor, R127. The f-m signal is heterodyned in the mixer with an r-f signal from main r-f oscillator tube V101, and the output signal is fed to the output circuits. For a discussion of the operation of the mixer and output circuits under these conditions, see paragraph 54.



NOTES:

1. SWITCH S104 IN POSITION 1: 50 M.C. F.M. 0-150 K.C. SWEEP
2. SWITCH S104 IN POSITION 2: 1 M.C. F.M. 0-30 K.C. SWEEP, L111 REPLACES L108, R139 (220K) REPLACES R131

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Figure 25. Frequency-modulation circuit, functional schematic.

62. General

Decibel meter M101 is used to measure the level of a-c signals in the audio range. The meter is a conventional a-c hermetically sealed meter. It has a self-contained, copper-oxide rectifier and built-in resistors for the three range settings.

63. Decibel Meter

(fig. 50)

a. The following ranges can be measured to ground:

- (1) From E104: -10 to +6 db; 0 to 3.5 volts.
- (2) From E105: +6 to +22 db; 0 to 20 volts.

- (3) From E106: +22 to +38 db; 0 to 140 volts.

Note. In Signal Generator TS-465/U, the three ranges are selected by means of a DECIBEL METER switch.

b. Capacitor C117 is in series with the ground connection to the meter. Capacitor C117 serves as a d-c blocking capacitor so that the meter may be used to measure a-c voltage or power in circuits containing both ac and dc.

c. Decibel readings are based on a 0-db level of .006 watt (6 mw) across 500 ohms. For other than 500-ohm terminations, refer to the db correction chart (fig. 44) for the correct reading.

Section VIII. POWER SUPPLY**64. General**

This stage supplies the voltages and currents needed for normal operation of the test instrument. The power supply is a conventional full-wave transformer-type unit which operates from 105- to 125-volt, 50- to 70-cycle power-supply line.

65. Power Supply

(fig. 26)

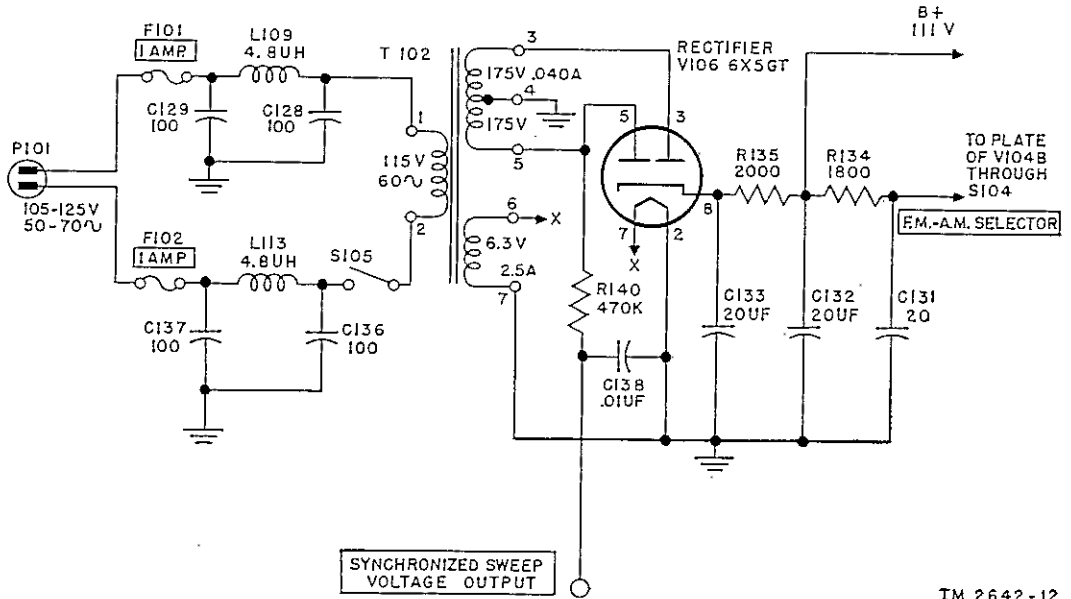
a. Line cord plug P101 is a nonpolarized male plug. Two 1-ampere, 250-volt, 3AG-type fuses, F101 and F102, are in series with the a-c power input. Pi-type filters C129, L109, and C128, and C137, L113, and C136, in series with each side of the line, bypass r-f signals from the power line. A single-pole, single-throw switch, S105, controls the power to the primary circuit. This switch is mounted on the rear of the **FREQ. MOD. SWEEP** control, R130. (In Signal Generator TS-465/U, this switch is mounted on the rear of the **DECIBEL METER** control.)

b. The secondary h-v (high-voltage) winding of the transformer supplies 350 volts. The filament winding supplies 6.3 volts. The 350-volt winding is center-tapped to ground, delivering 175 volts at 40 ma (milliamperes) to each plate of the 6X5GT rectifier tube, V106.

c. A synchronized sweep voltage of approximately 68 volts is obtained from one of the 175-volt points through an a-c voltage divider consisting of resistor R140 and capacitor C138. The signal is fed to the **SYNCHRONIZED SWEEP VOLTAGE OUTPUT** connector, E108, where it is available for use as a synchronizing voltage for external oscilloscopes or other equipment.

d. The rectified 175 volts is filtered through a pi-type filter, consisting of capacitors C133 and C132 and resistor R135. The output voltage is approximately 111 volts, depending on the condition of the rectifier tube, capacitors C133 and C132, and the line voltage. (In Signal Generator TS-465/U, the B + voltage is 225 volts.) R134 is a dropping resistor, and C131 is a decoupling capacitor. The output obtained through the dropping resistor is approximately 55 volts, and it is used for the plate voltage of tube V104B. (In Signal Generator TS-465/U, voltage regulator tube V7 (OD-3/VR-150) is used to keep the voltage on the plates of V4, V8, and V1 at 150 volts.)

e. The filament winding supplies 6.3 volts at 2.5 amperes. One side of the winding is grounded. The other side supplies a 60-cycle modulating frequency input and heater currents for all tubes, including the rectifier tube, V106.



TM 2642-12

Figure 26. Power supply, functional schematic.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing the signal generator, be extremely careful of any exposed high voltages. In making static checks such as resistance measurements, be sure to remove the power plug from the power source and to discharge power supply capacitors before testing. Potentials as high as 500 volts are present in some of the models. With the power on, use one hand when measuring socket voltages with the probe. After turning off the equipment, short all parts to ground before touching them.

66. Trouble-Shooting Procedures

a. General. The first step in servicing a defective signal generator is to sectionalize the fault. Sectionalization means tracking the fault to the *major component or circuit* responsible for abnormal operation. The second step is to localize the fault. Localization means tracing the fault to the *defective part* responsible for the abnormal condition. Burned-out resistors, arcing, and shorted transformers often can be located by sight, smell, and hearing. The majority of faults, however, must be localized by *checking voltage and resistance* (figs. 27 through 30).

b. Component Sectionalization and Localization. The tests listed in (1), (2), and (4) below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that servicing procedures should cause no additional damage to the signal generator. All trouble should be localized to a single stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

- (1) *Visual inspection.* The purpose of this inspection is to locate any visible trouble. By this inspection alone, the repairman may discover the trouble or determine the stage in which trouble exists. This inspection is valuable in avoiding additional damage to the signal generator or

to replacement parts that might occur through improper servicing methods, and in avoiding future failures.

- (2) *Input resistance measurements.* These measurements (par. 71) prevent further damage to the signal generator from possible short circuits. Since this test gives an indication of the condition of the input filter circuits and power transformer, its function is more than preventive.
- (3) *Trouble-shooting chart* (par. 72). The trouble-shooting chart will aid considerably in localizing trouble.
- (4) *Intermittents.* In all these tests the possibility of intermittents should not be overlooked. If present, this type of trouble can be evidenced by tapping or jarring the unit. It is possible that the trouble does not exist in the signal generator, but is in the equipment being tested. The trouble also may result from trouble in the power source external to the instrument.

67. Trouble-Shooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following trouble-shooting data:

Fig. or par. No.	Description
Fig. 27	Signal Generator TS-465/U, voltage and resistance measurements.
Fig. 28	Signal Generator TS-465A/U, voltage measurements.
Fig. 29	Signal Generator TS-465A/U, resistance measurements.
Fig. 30	Signal Generator TS-465B/U, voltage and resistance measurements.
Fig. 31	Signal Generator TS-465/U, rear view of chassis.
Fig. 32	Signal Generator TS-465/U, r-f subchassis, right rear view.
Fig. 33	Signal Generator TS-465/U, r-f subchassis, left rear view.

Fig. or par. No.	Description
Fig. 34	Signal Generator TS-465/U, bottom rear view of chassis.
Fig. 35	Signal Generator TS-465A/U, top rear view of chassis.
Fig. 36	Signal Generator TS-465A/U, bottom rear view of chassis.
Fig. 37	Signal Generator TS-465A/U, r-f subchassis, rear view.
Fig. 38	Signal Generator TS-465A/U, r-f chassis tuning capacitor.
Fig. 39	Signal Generator TS-465A/U, rear view detail.
Fig. 40	Signal Generator TS-465B/U, top rear view of chassis.
Fig. 41	Signal Generator TS-465B/U, bottom rear view of chassis.
Fig. 42	Signal Generator TS-465B/U, bottom rear view of chassis, flexible coupling.
Fig. 43	Signal Generator TS-465B/U, r-f subchassis, rear view.
Fig. 46	Resistor color code.
Fig. 47	Capacitor color code.
Fig. 48	Signal Generator TS-465/U, schematic diagram.
Fig. 49	Signal Generator TS-465A/U, schematic diagram.
Fig. 50	Signal Generator TS-465B/U, schematic diagram.
Par. 68	D-c resistances of transformers and coils.

68. D-C Resistances of Transformers and Coils

The d-c resistances of the transformer windings and coils in each model of the signal generator are listed *a* through *c* below.

a. Signal Generator TS-465/U.

Transformer or coil	Terminal	Ohms
T1	Primary.	26
	Secondary #1.	600
	Secondary #2.	.8
T2	Primary.	120
	Secondary.	9
A band		70
B band		20
C band		3
D band		.5
E band		Less than .1
F band		Less than .1
G band		Less than .1
L1	Entire winding	40
	1-mc section.	3
L4		43

b. Signal Generator TS-465A/U.

Transformer or coil	Terminal	Ohms	
T102	Primary.	16.5	
	Secondary #1.	600	
T101	Secondary #2.	.8	
	Primary.	22	
L101	Secondary.	108	
	L101	70	
	L103	20	
	L104	3	
	L105	.5	
	L106	Less than .1	
	L107	Less than .1	
	L112	Less than .1	
	L111	3	
	L108	.5	
	L114	Entire winding	40
		1-mc section.	3
	L109	Less than .1	
	L113	Less than .1	
L102		40	

c. Signal Generator TS-465B/U.

Transformer or coil	Terminal	Ohms
T102	1-2	16.5
	3-4	300
	4-5	300
	6-7	.8
T101	1-2	22
	3-4	108
L101		41
L102		43
L103		12
L104		4.3
L105		.4
L106		Less than .1
L107		Less than .1
L108		Less than .1
L109		Less than .1
L111		10
L112		Less than .1
L113		Less than .1
L114	Entire winding	40
	1-mc section.	3
L115		Less than .1
L116		85

69. Test Equipment Required for Trouble Shooting

Test Equipment required for trouble-shooting Signal Generator TS-465(*)/U is listed below.

Test equipment	Technical manual
Tube Tester TV-2(*)/U	
Multimeter TS-352/U	TM 11-5527
Oscilloscope OS-8/U	NAV SHIPS 91272

Test equipment	Technical manual
Electronic Multimeter TS-505/U....	TM 11-5511
Frequency Meter Set SCR-211-(*)..	TM 11-300
Frequency Meter TS-174B/U.....	TM 11-5044
Audio Oscillator TS-382A/U.....	TM 11-2684A
Panoramic Adaptors BC-1031-A, -B, -C, BC-1032-A and BC- 1032-B.	TM 11-446
Hewlett-Packard Noise and Distortion Analyzer 330D.	
Radio Receiver (AM) 100 kc to 110 mc.	
Auto-Transformer (110 volts, 1 ampere).	
Signal Generator TS-497A/URR....	TM 11-5030

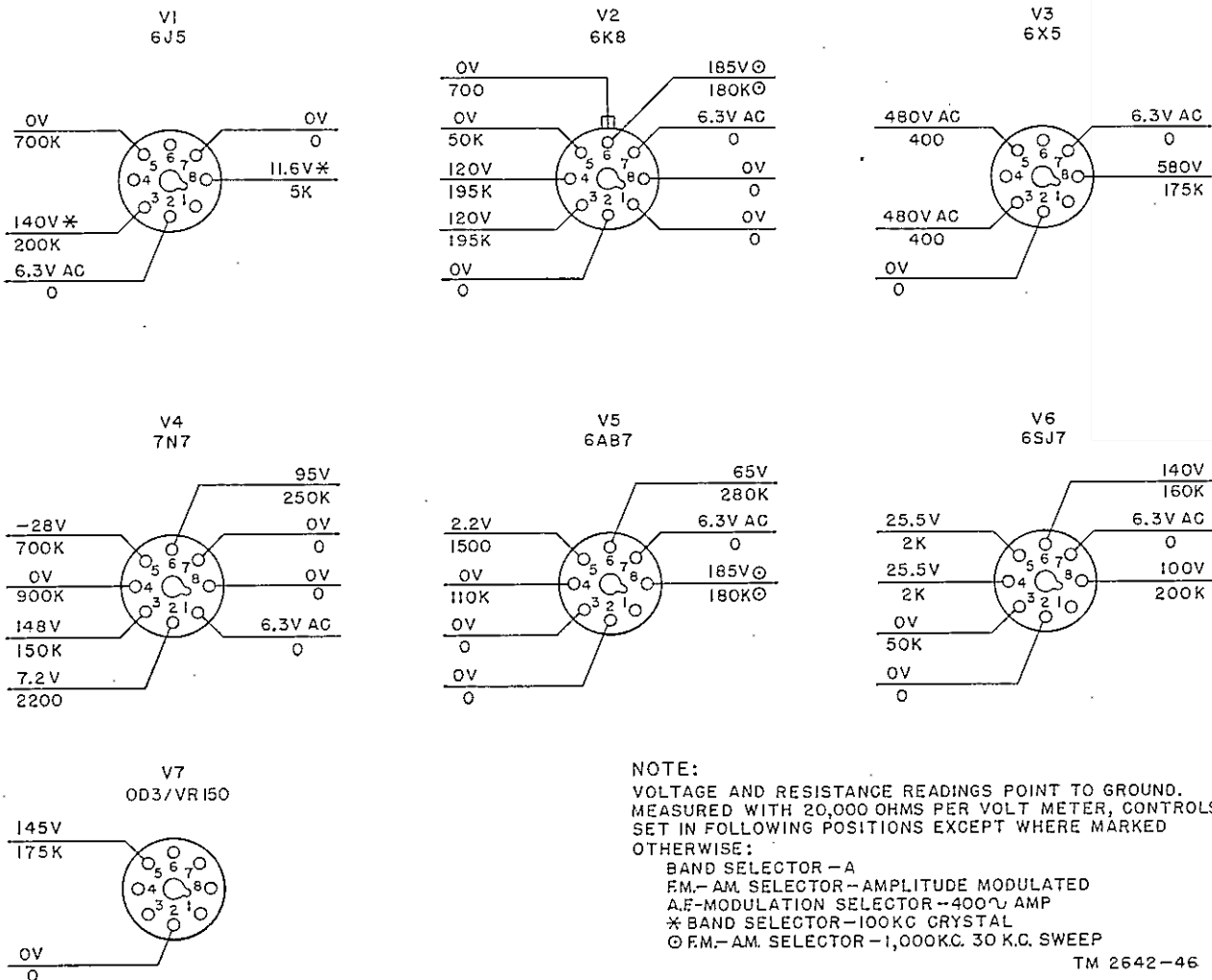
70. General Precautions

When servicing Signal Generator TS-465(*)/U, take the following precautions:

a. Be careful when the unit is removed from its case; dangerous high voltages are exposed.

b. Careless replacement of parts often makes additional faults inevitable. Note the following points:

- (1) Before a part is unsoldered, tag the position of the leads. If a part, such as a transformer, has a number of leads, tag each carefully to correspond with its component.
- (2) Be careful not to damage other leads by pulling or pushing them out of the way.
- (3) Do not allow drops of solder to fall into the set; they may cause short circuits.
- (4) A carelessly soldered connection may cause a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.
- (5) When a part is replaced in r-f circuits, it must be replaced exactly in the same position. A part that has the same electrical



NOTE:
 VOLTAGE AND RESISTANCE READINGS POINT TO GROUND.
 MEASURED WITH 20,000 OHMS PER VOLT METER, CONTROLS
 SET IN FOLLOWING POSITIONS EXCEPT WHERE MARKED
 OTHERWISE:
 BAND SELECTOR - A
 F.M.-AM SELECTOR - AMPLITUDE MODULATED
 A.F.-MODULATION SELECTOR - 400 \sim AMP
 * BAND SELECTOR - 100KC CRYSTAL
 ⊙ F.M.-AM. SELECTOR - 1,000KC. 30 K.C. SWEEP

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Figure 27. Signal Generator TS-465/U, voltage and resistance measurements.

71. Checking Key Circuits

Trouble within the signal generator often may be detected by checking the resistance of the h-v circuits before applying power to the equipment, thereby preventing damage to the power supply. Make the following checks before attempting to put the signal generator into operation:

- a. Check the resistance between pin 8 of tube V106 and ground. The resistance should check with the value given in the resistance chart (par. 68).
- b. If the reading is higher than normal, check the B+ circuit.
- c. If the resistance value is lower than normal, remove the B+ lead and check through the power supply for shorts.

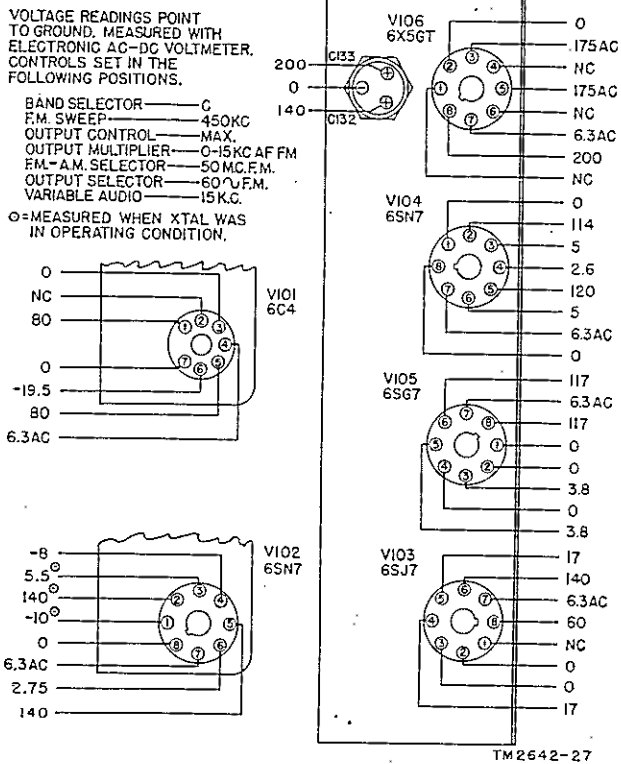


Figure 28. Signal Generator TS-465A/U, voltage measurements.

value, but different physical size, may cause trouble in h-f circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in decreased gain or in oscillation of the circuit.

(6) Do not disturb the settings of capacitors C107, C105, C110, C114, C118, C123, and C130 or the associated inductor core settings. Failure to observe these precautions may result in decreased gain, non-oscillation, or off-frequency operation of the circuit.

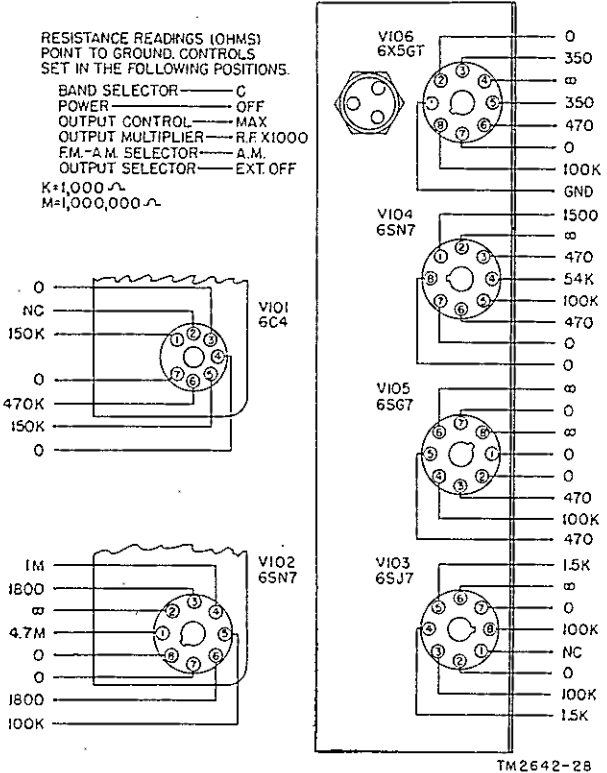


Figure 29. Signal Generator TS-465A/U, resistance measurements.

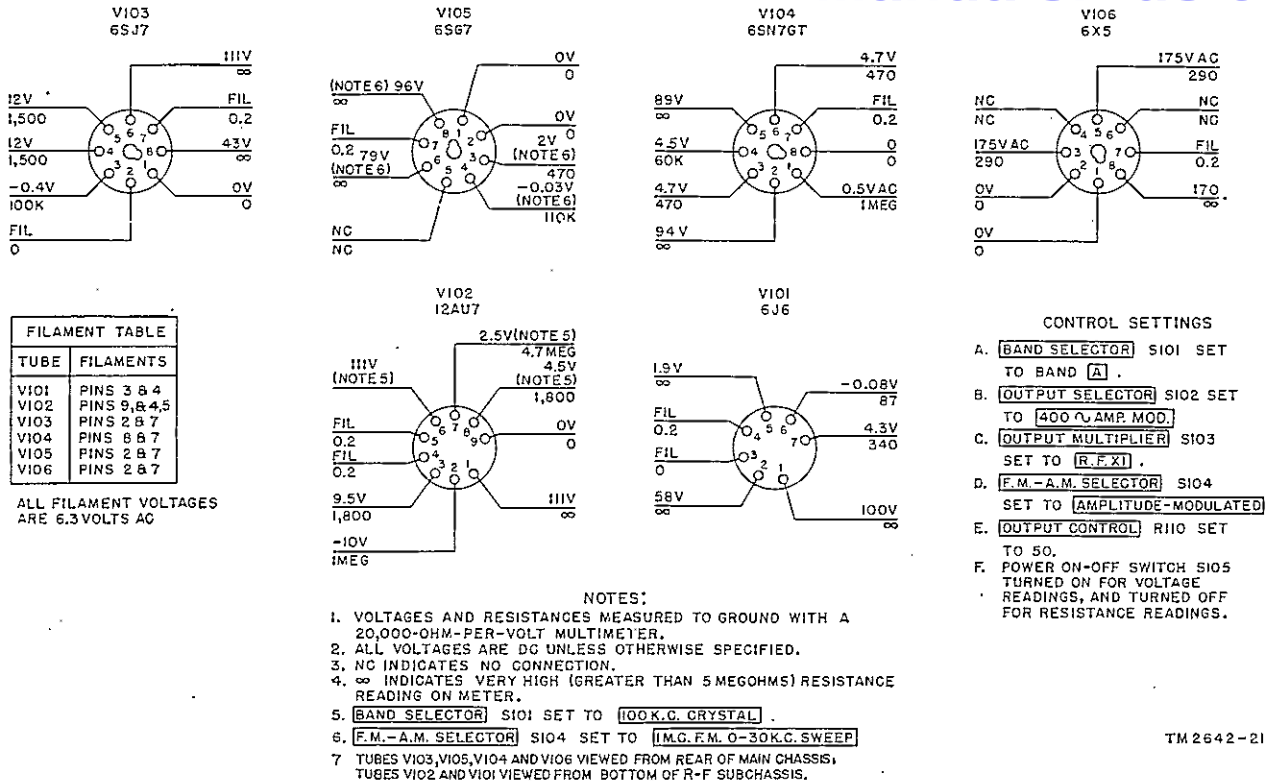


Figure 30. Signal Generator TS-465B/U, voltage and resistance measurements.

72. Trouble-Shooting Chart

The following chart is supplied as an aid in locating trouble in Signal Generator TS-465B/U. The chart lists the abnormal indications which the repairman may observe either visually or audibly while making a few simple tests. It also indicates

how to localize trouble quickly to the various stages of the equipment. Once the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements within the circuit ordinarily should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figures 27 through 30.

Symptom	Probable trouble	Correction
1. FREQ. MOD. SWEEP control turned on. Generator fails to operate and PILOT lamp does not light.	Open fuse F101 or F102 on front panel.	Replace fuses. If fuses blow again, check for shorts; check capacitors C131, C132, and C133. Check V106 and its socket for shorts. Check C128, C129, C136, and C137.
	Connecting leads to fuseholders or power switch broken.	Repair leads or connections.
	Break in line cord	Replace line cord.
2. A-c voltmeter does not read on any scale.	Open inductor L109 or L113	Replace L109 or L113.
	Capacitor C117 is open	Replace C117.
3. A-c voltmeter does not read on all scales.	Connecting leads to meter are open	Repair leads.
	Meter defective	Replace meter.
4. A-c voltmeter reads incorrectly	Connecting leads to meter are broken	Repair leads.
	Multiplier resistors inside meter are open	Replace meter.
	Meter defective	Replace meter.
	Capacitor C117 defective	Replace C117.

Symptom	Probable trouble	Correction
5. Generator is inoperative on all outputs, but tube filaments and PILOT lamp light.	Failure of B+ supply.....	Compare voltage between pin 1 of tube V102B and ground with value shown in figure 30. If no voltage is present, check power-supply tube V106. If voltage is low, check filters C132 and C133.
	Defective OUTPUT cable.....	Check continuity of OUTPUT cable and, if faulty, repair or replace.
6. OUTPUT CONTROL has no effect on output.	Resistor R110 defective.....	Check resistance of R110 and replace if defective.
	Connections to R110 open.....	Repair connections.
7. OUTPUT MULTIPLIER does not vary output when setting is changed.	R-f leakage.....	See note at end of chart.
	Short or open in output attenuator circuit, resistors R146, R147, R148, R149, R150, and R151.	Make resistance check of circuit.
8. Output obtained only in particular setting of OUTPUT MULTIPLIER.	R-f leakage.....	See note at end of chart.
	Open or shorted resistors R146, R147, R148, R149, R150, and R151.	Make resistance check and replace defective resistor.
9. Objectionable hum in all outputs...	Shorted or open filter capacitors C132 and C133.	Repair leads.
		Check each capacitor by disconnecting positive lead, charging, and then discharging by shorting to chassis with insulated screw driver or shorting stick. Capacitors which do not retain sufficient charge, as indicated by the size of the discharge spark, may be faulty.
10. Intermittent output.....		Check both types of capacitors by connecting new equivalent capacitors for comparison.
	Defective tube, resistor, coil, poor switch contact, or poorly soldered joint.	With an insulated probe, gently tap and move all tubes, resistors, capacitors, coils, switches, sockets, and all soldered connections to locate loose elements or loose connections to any component.
11. No modulation on 100-kc or 1,000-kc crystal operation.	Faulty 400-cycle oscillator stage V103....	Test V103 and its tube socket resistances and voltages (fig. 30). Check C103 for open.
	Defective transformer T101.....	Check resistance, using value given in paragraph 6S.
12. No 100-kc or 1,000-kc crystal output.	Defective crystal Y101.....	Replace Y101.
	Faulty crystal stage V102B.....	Test V102B and its tube socket resistances and voltages (fig. 30).
13. No 400-cycle output.....	Faulty 400-cycle oscillator stage V103....	Test V103 and its tube socket resistances and voltages (fig. 30).
14. No 400-cycle modulation on 400 ~AMP. MOD. output.	See 13 above.....	See 13 above.
	Faulty transformer T101.....	Replace T101.
15. 400-cycle modulation on am, but no external am.	Faulty capacitor C103.....	Replace C103.
	Faulty mixer stage V104A.....	Test V104A and its tube socket resistances and voltages (fig. 30).
16. No a-m r-f output, modulated or unmodulated, but af or fm available.	Broken lead from E107.....	Repair lead.
	Faulty cathode-follower stage V102A....	Test V102A and its tube socket resistances and voltages (fig. 30).
17. No a-m rf, f-m rf, or 0- to 15-kc af..	Faulty main oscillator stage V101.....	Test V101 and its tube socket resistances and voltages (fig. 30).
18. No f-m rf, f-m af, or external-modulation a-m rf, but 400-cycle a-m rf.	Faulty mixer stage V104A.....	Test V104A and its tube socket resistances and voltages (fig. 30).
19. No external am, but 400-cycles am and fm.	Broken connection from E107.....	Repair connection.
	Faulty stage V104B.....	Test V104B and its tube socket resistances and voltages (fig. 30).
20. No f-m rf or f-m af, but 0- to 15-kc af and 400-cycle output.		
	Faulty reactance modulator stage V105..	Test V105 and its tube socket resistances and voltages (fig. 30).

Symptom	Probable trouble	Correction
21. 0- to 30-kc sweep fm but no 0- to 150-kc sweep.	Faulty 400-cycle oscillator stage V103....	Test V103 and its tube socket resistances and voltages (fig. 30).
22. 0- to 150-kc sweep fm but no 0- to 30-kc sweep fm.	Defective resistor R141	Replace R141.
	Defective resistor R108	Replace R108.
23. No external f-m 0- to 30-kc sweep..	Broken wire to 6.3-volt line.....	Check voltage to chassis.
	Defective resistor R139	Replace R139.
24. No synchronized sweep voltage output at terminal E10S.	Broken connection from E103.....	Repair connection.
	Open resistor R140	Replace R140.
25. VARIABLE AUDIO FREQUENCY control is ineffective.	Shorted capacitor C138	Replace C138.
	Broken lead from E10S.....	Repair lead.
26. R-f output only on certain bands..	Open connection at capacitor C113	Repair connection.
	BAND SELECTOR switch defective....	Repair or replace switch.
	Defective coil in band.....	Replace coil.
	Defective capacitor in that band.....	Replace capacitor.

Note. At high frequencies (40 mc and higher), the r-f leakage across the OUTPUT CONTROL and through the generator may be of such magnitude that the OUTPUT CONTROL has little or no effect (par. 4).

Section II. REPAIRS

73. Replacement of Parts (figs. 31 through 43)

a. General. Most of the parts in Signal Generator TS-465(*)/U are readily accessible and can be replaced easily if found to be defective. If a switch, transformer, or meter requires replacement, carefully tag the wires connected to the component to prevent wrong connections when the new part is installed. Follow this identification practice whenever replacement requires the temporary removal of wires.

b. Signal Generator TS-465B/U (figs. 40, 41, 42, and 43).

- (1) To remove the front panel and chassis, remove the eight screws that hold the front panel to the case. The chassis cannot be completely separated from the case because of the plug on the line cord.
- (2) To remove the upper shield, use a screw driver with a 6-inch blade. The two screws holding the shield to the chassis may be reached through the holes located in each side of the right-angle support brackets. The support brackets are welded to the chassis and panel.
- (3) To remove the lower shield, remove the four screws that hold the shield to the chassis. When this shield has been removed, an inner shield located over the a-c power-line filter circuit will be accessible. This inner shield is held by four screws, and can be removed if necessary.

- (4) To service the r-f section or to replace a coil, first remove the upper shield ((2) above). Loosen the two slotted-head set-screws which hold the shaft of the FREQUENCY ADJUSTMENT control (C145) to the friction drive until the calibrated dial rotates freely. Unsolder and tag the wires connected to the six terminal board lugs located in the rear of the miniature tube socket. Remove the three screws located on the front panel. These screws hold the r-f subassembly to the panel. The r-f section may now be lifted out for servicing.
- (5) To remove the coil deck and the variable capacitor from the box, remove the four screws that support the variable capacitor, and the four screws that support the coil deck (fig. 43). To separate the variable capacitor from the coil deck, remove the copper tubing jumpers which are soldered from the variable capacitor to the coil deck. When this is done, all coils are readily accessible for replacement.
- (6) To replace the variable capacitor, first remove the r-f section ((4) and (5) above). Then remove the two screws that hold the subchassis and the crystal to the capacitor, and unsolder all connections to the capacitor.
- (7) To remove the coils located on the BAND SELECTOR switch, remove the coil deck

- from the chassis (5) above). Remove the screw from the rear of the coil mounting plate and remove the locknut on the core adjustment end. The coil may now be removed.
- (8) To remove the r-f attenuator box, remove the OUTPUT MULTIPLIER switch knob from the front panel and remove the hexagon nut which holds the switch to the front panel. Unsolder the switch connections to the attenuator box and tag them. The box may be lifted out after tube V104 has been removed.
- (9) To remove the dial drive, first remove the r-f section (4) above) without disturbing the wiring or components of the r-f section. The calibrated dial may now be removed.

- (10) In some equipments, switches S102 and S104 have shafts $4\frac{1}{16}$ inches long, and $4\frac{7}{8}$ inches long beyond the bushing, respectively (fig. 41). These sets bear the following serial numbers: 18, 34, 36, 39, 41, 56, 64, 65, 74, 76, 88, 90, 101, 109, 113, 129, 136, 137, 144, 153, 156, 162, 165, 168, 180, 181, 183, 185, 187, 188, 192, 197, 202, 205, 209, 212, 216, 219, 220, 229, 231, 234, 238, 241, 242, 247, 256, 265, 277, 282, 283, 285, 289, 304, 310, 322, 324, 335, 340, 342, 343, 364. In all other sets, switches S102 and S104 have shafts three-fourths of an inch long beyond the bushing, and are assembled, respectively, to flexible coupling O118 and shaft O120 and to flexible coupling O119 and shaft O121 (fig. 42).

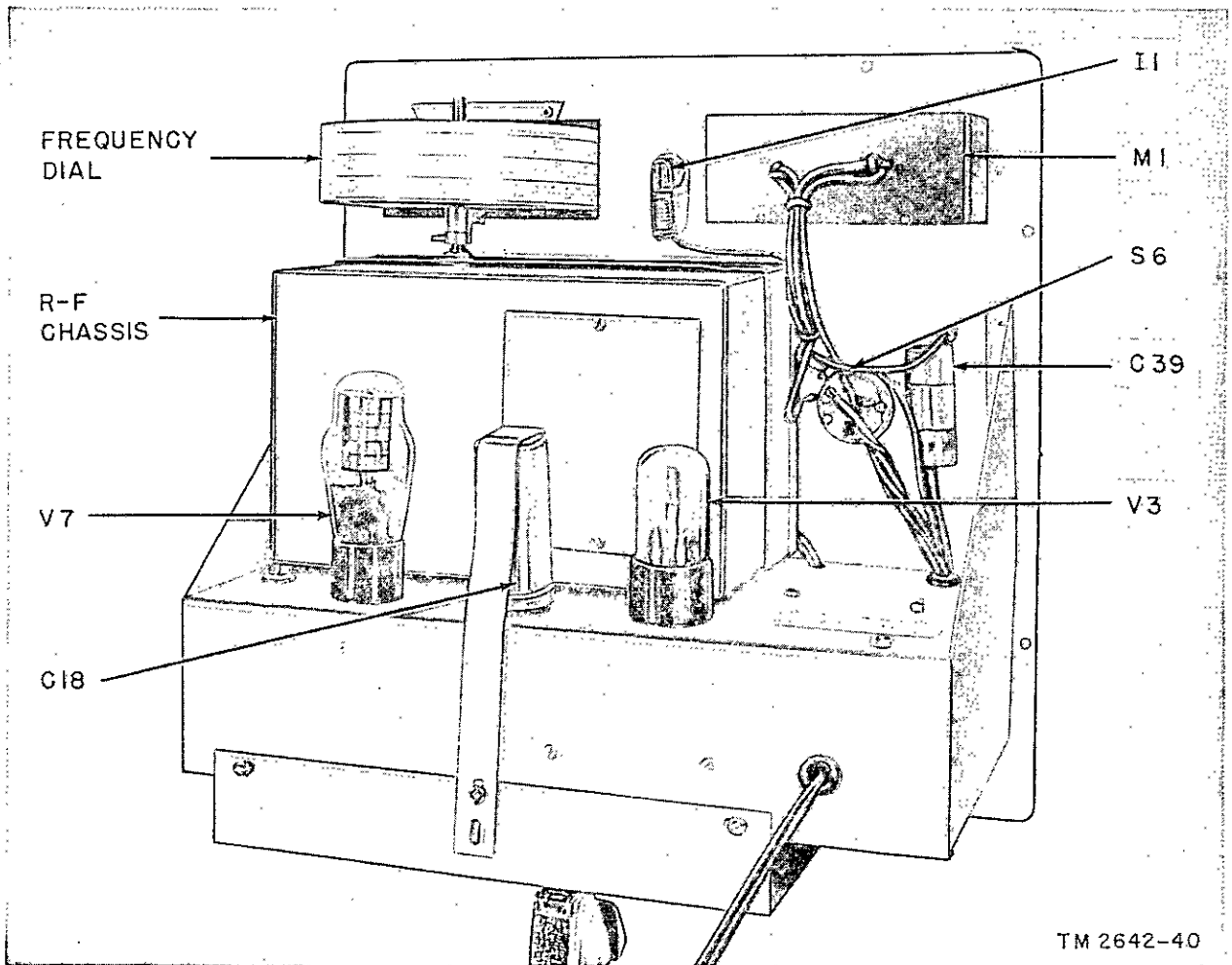


Figure 81. Signal Generator TS-465/U, rear view of chassis.

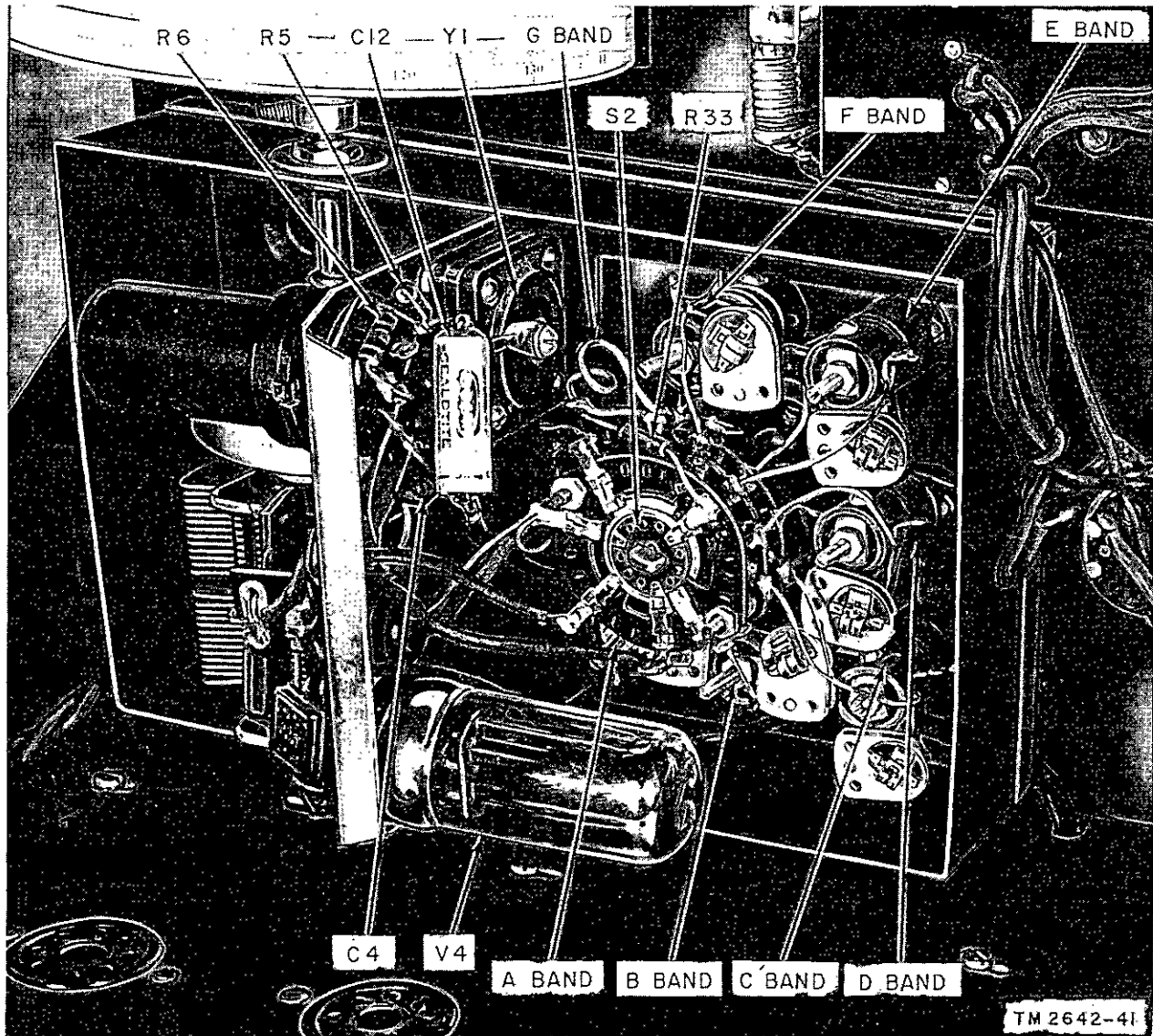


Figure 32. Signal Generator TS-465/U, r-f subchassis, right rear view.

(a) To replace switch S104 (long shaft), with an assembly which consists of switch S104 (short shaft), flexible coupling O119, and shaft O121, proceed as follows: Remove coils L108 and L111, the T-bracket to which these coils are mounted, knob H150 from the front panel, and switch S104. Tag the leads before removal. Mount switch S104 (short shaft) on the rear panel, with a nut and a washer. Resolder all leads to the switch and mount flexible coupling O119 on the shaft of the switch with two setscrews. Mount shaft O121

on the flexible coupling with two setscrews. Mount knob H150 on shaft O121. Replace the T-bracket and coils L108 and L111 in the same position and resolder all leads to the coils.

(b) To replace switch S102 (long shaft), with an assembly which consists of switch S102 (short shaft), flexible coupling O118 and shaft O120, proceed as follows: Remove knob H151 from the front panel and switch S102 from the rear panel. Tag all the leads before removal. Mount switch S102 (short shaft), on the rear panel, with a nut

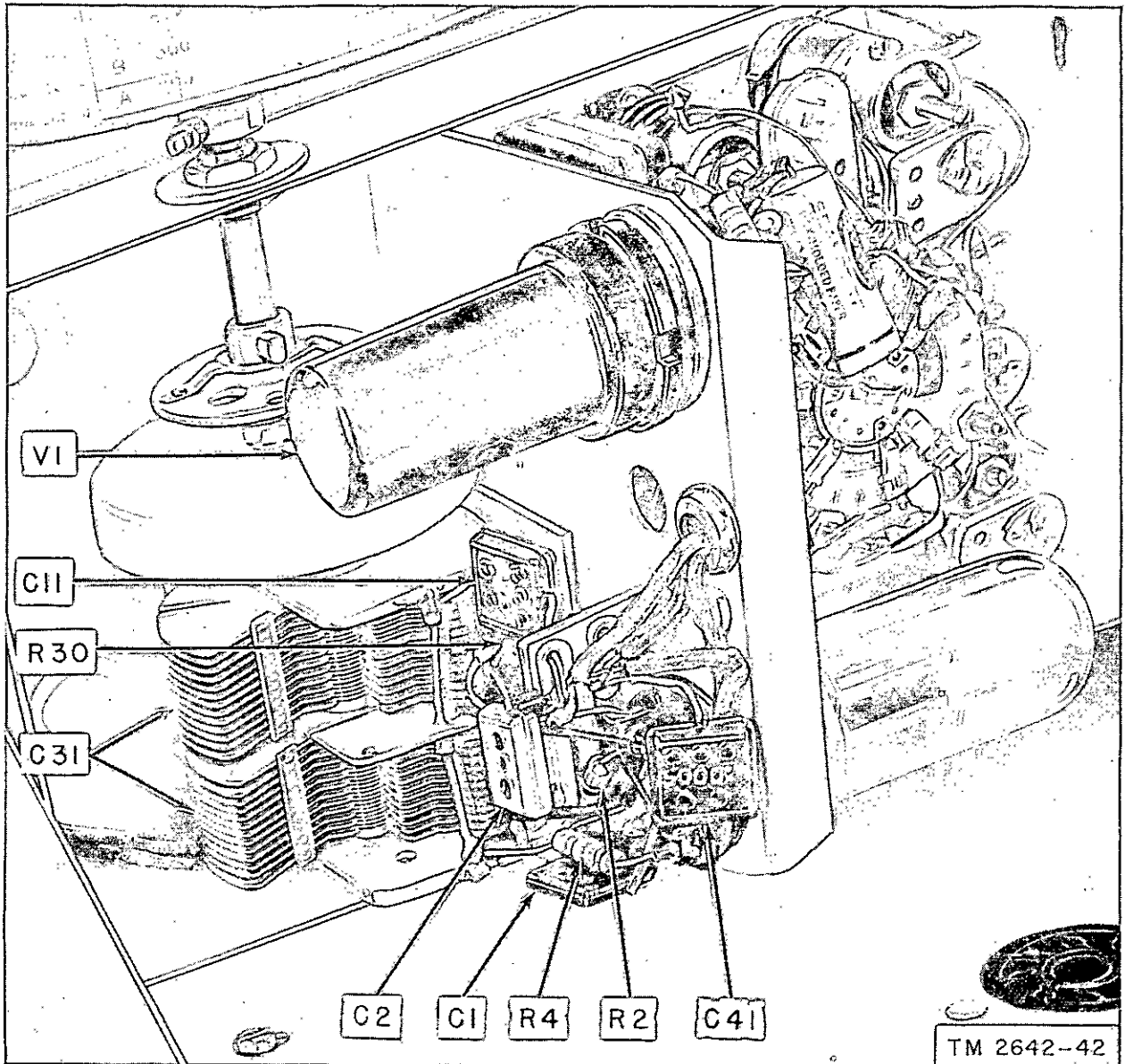


Figure 33. Signal Generator TS-465/U, r-f subchassis, left rear view.

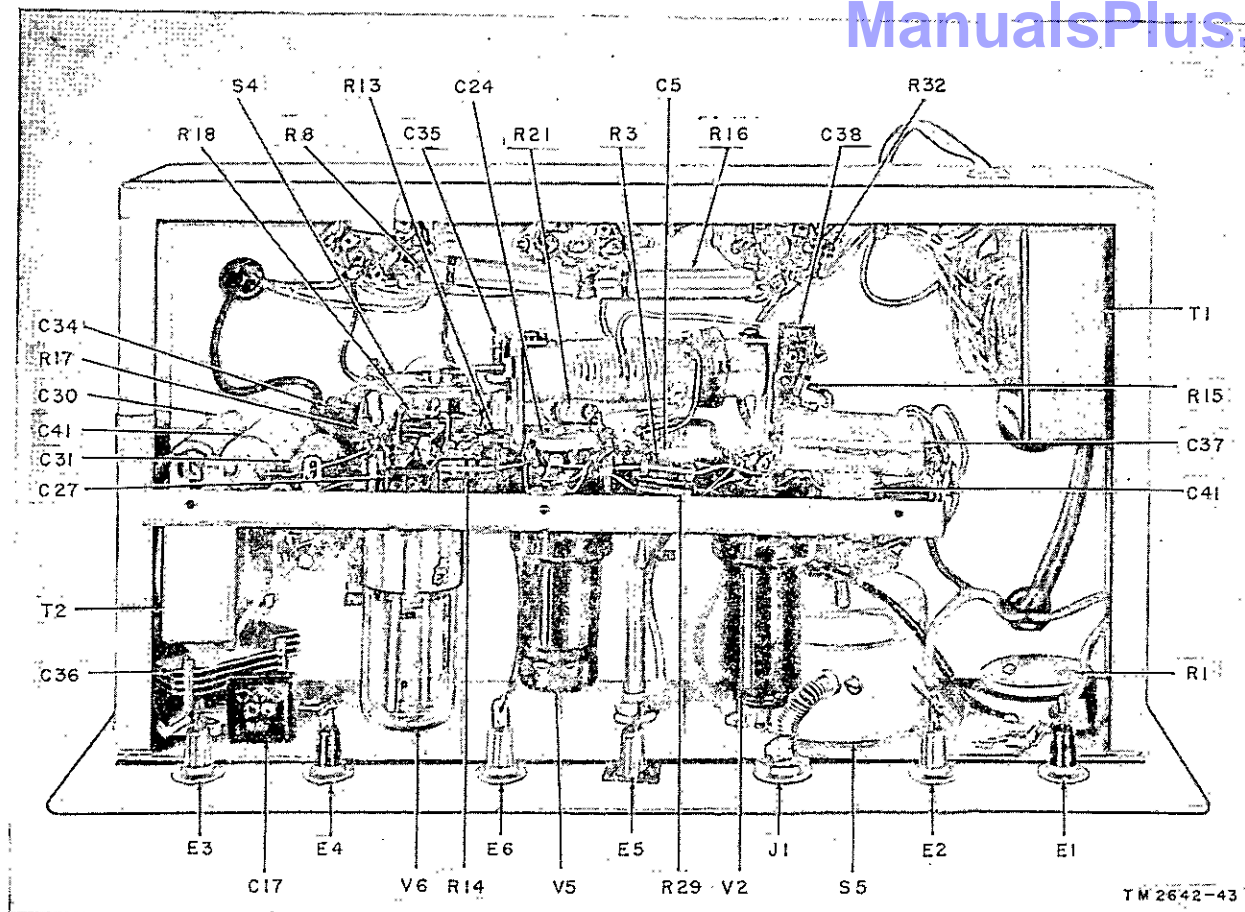


Figure 34. Signal Generator TS-465/U, bottom rear view of chassis.

and a washer. Resolder all leads to the switch and mount flexible coupling O118 on the shaft of the switch; use two setscrews. Mount shaft O120 on the flexible coupling; use two setscrews. Mount knob O151 on shaft O120.

c. Signal Generators TS-465A/U and TS-465/U.

These models differ from the B model chiefly in the presence of drum-type indicator dials for the DECIBEL METER scale and FREQUENCY ADJUSTMENT control. The tuning capacitor is mounted vertically, and may be removed along with the drum-type dial and r-f section by removing the two screws that hold the shield to the rear of the front panel.

74. Adjustment of Frequency Dial and Friction Drive

a. Friction Drive. In Signal Generator TS-465B/U, the dial drive is operated through a fric-

tion drive located on an eccentric bushing which is mounted on the rear of the front panel. The friction drive consists of two disks which tightly squeeze the inside rim of the dial drive. If the dial rotates too tightly or too freely, obtain a smooth drive by positioning the eccentric bushing adjusted by the hexagonal nut on the front panel. Signal Generators TS-465/U and TS-465A/U employ drum-type friction drives and a spring-loaded belt to the tuning capacitors, which are mounted vertically.

b. Zero Adjustment of Dial Frequency. A reference mark on the calibrated dial is used as an electrical zero reference. A mechanical stop on the calibrated dial is used as a mechanical zero reference. Align the variable capacitor with the reference mark in either the fully meshed or unmeshed position, depending on which frequency end of the dial is used. The fully meshed position is used for the l-f (low-frequency) end; the unmeshed position for the h-f end of the dial.

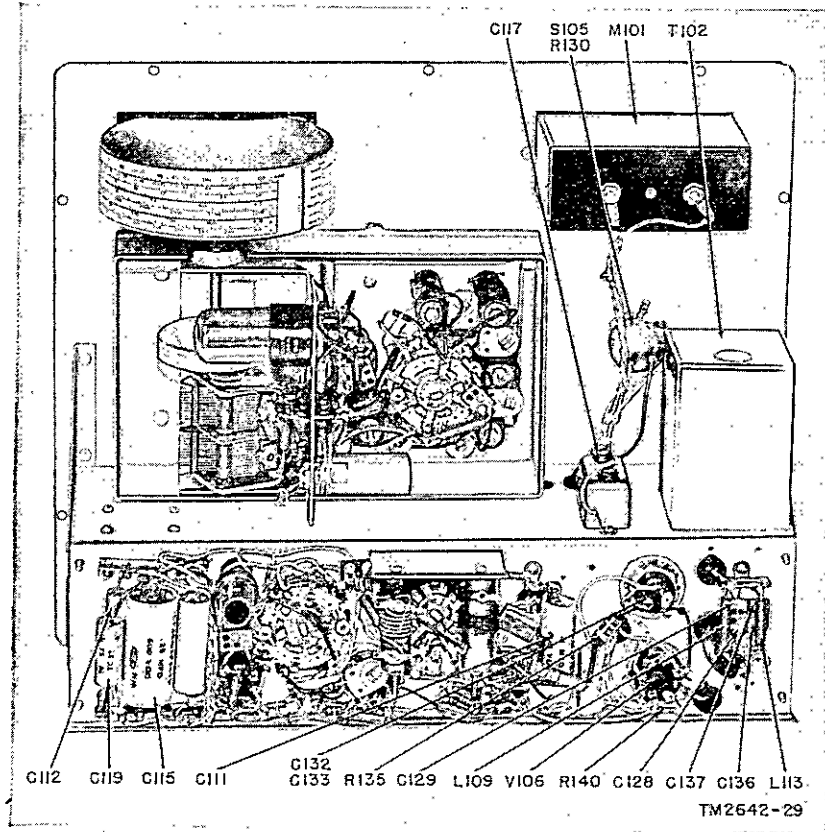


Figure 35. Signal Generator TS-465A/U, top rear view of chassis.

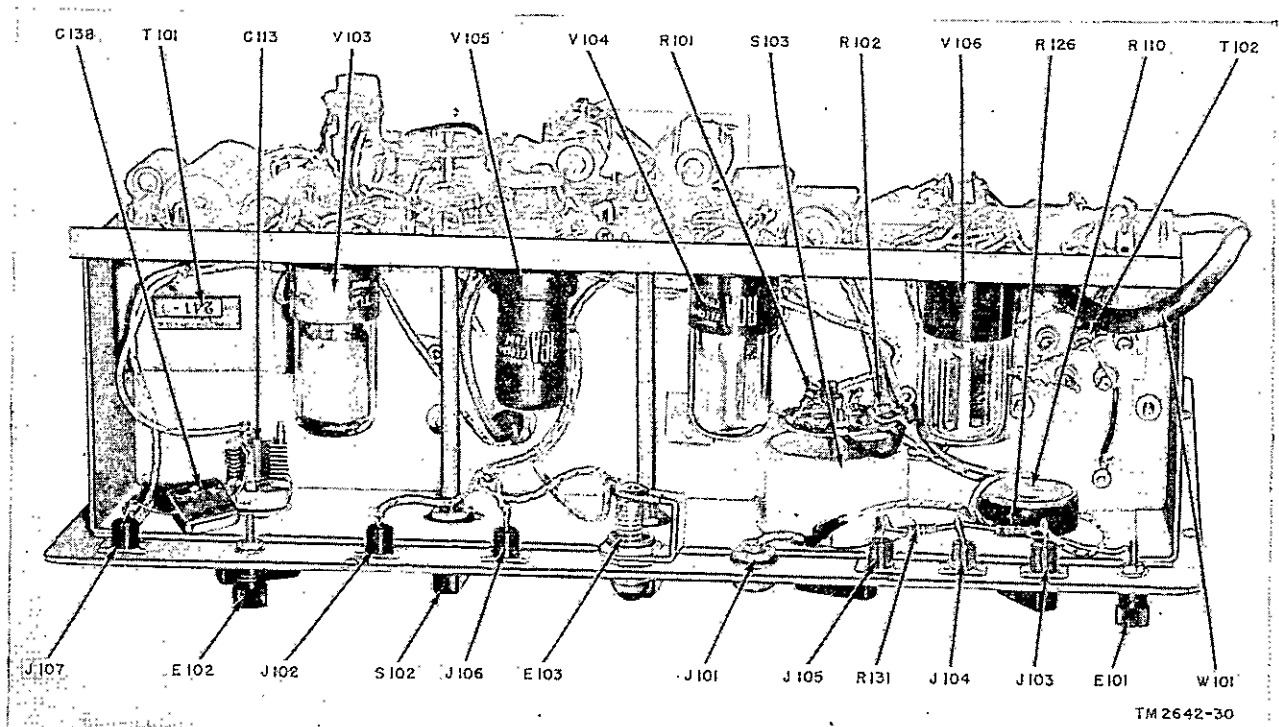


Figure 36. Signal Generator TS-465A/U, bottom rear view of chassis.

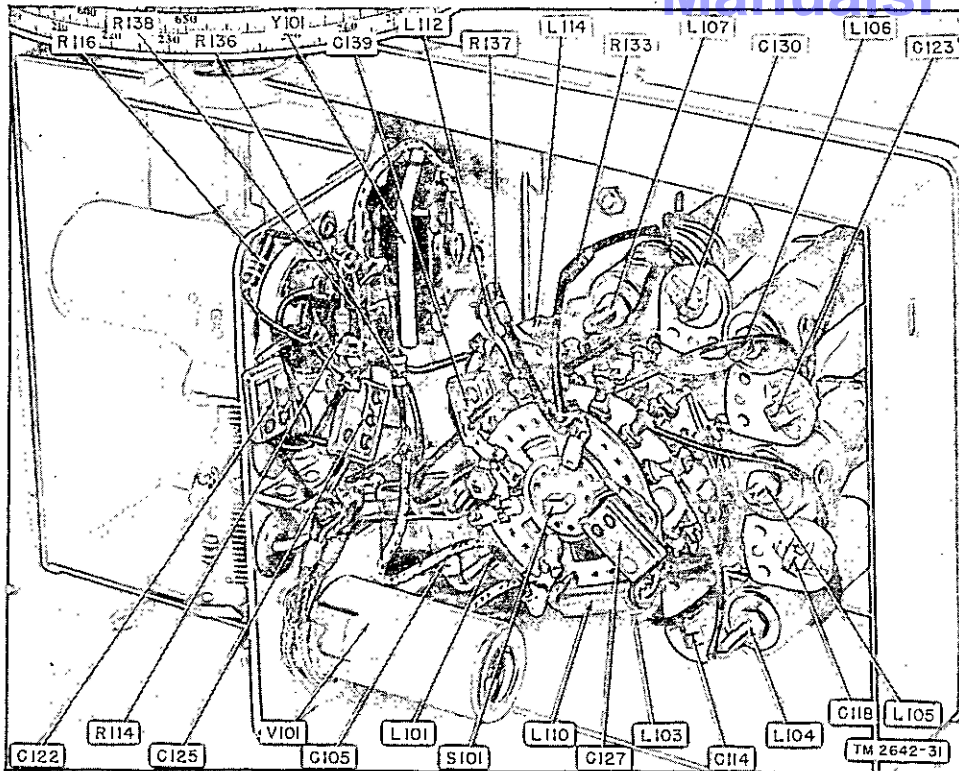


Figure 37. Signal Generator TS-465A/U, r-f subchassis, rear view.

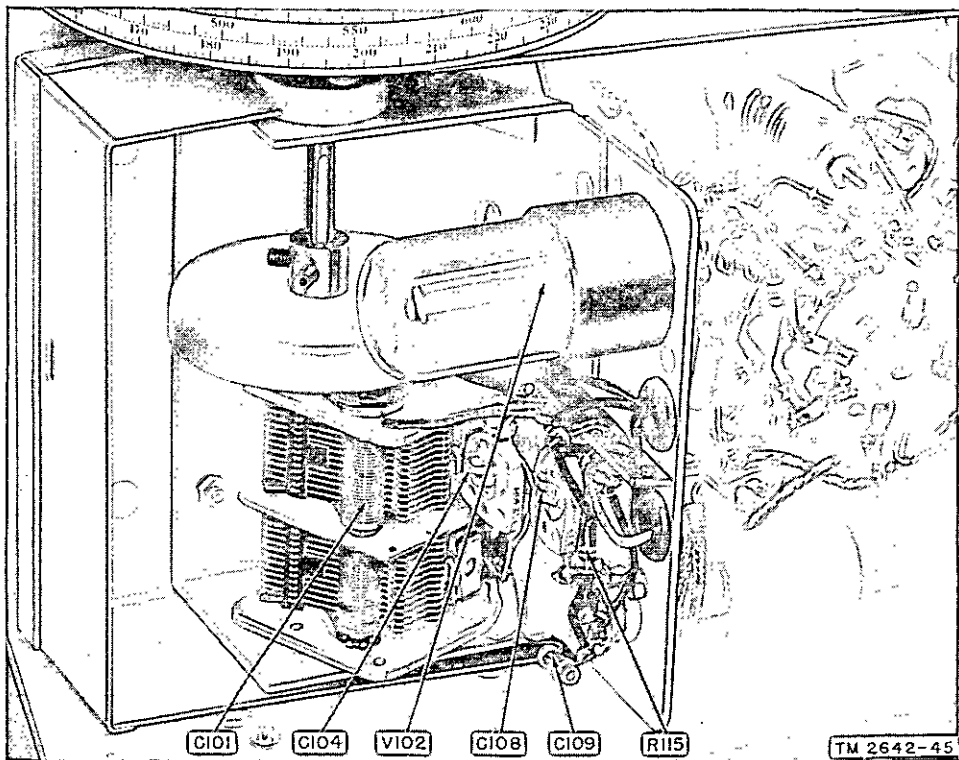


Figure 38. Signal Generator TS-465A/U, r-f chassis tuning capacitor.

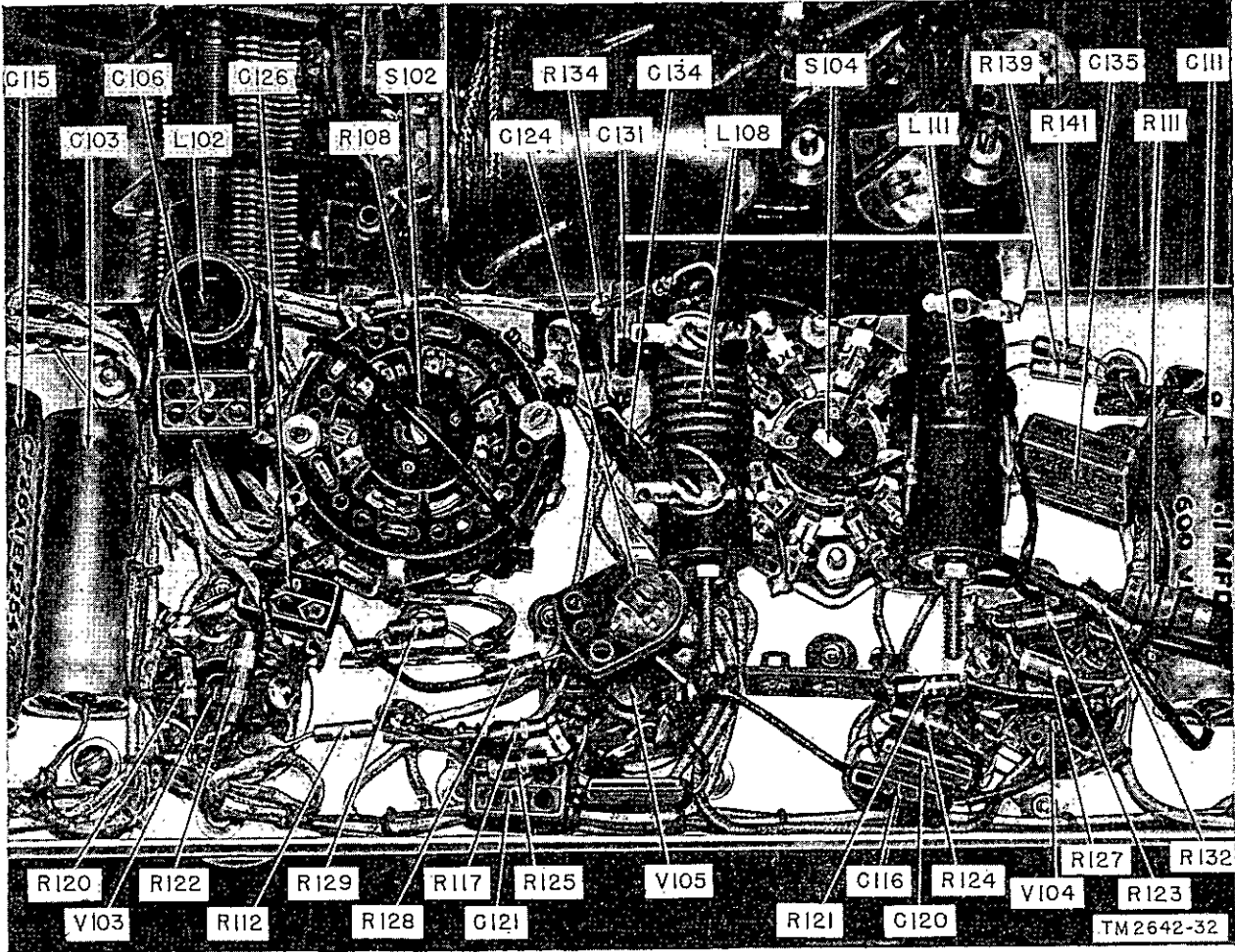


Figure 39. Signal Generator TS-465A/U, rear view detail.

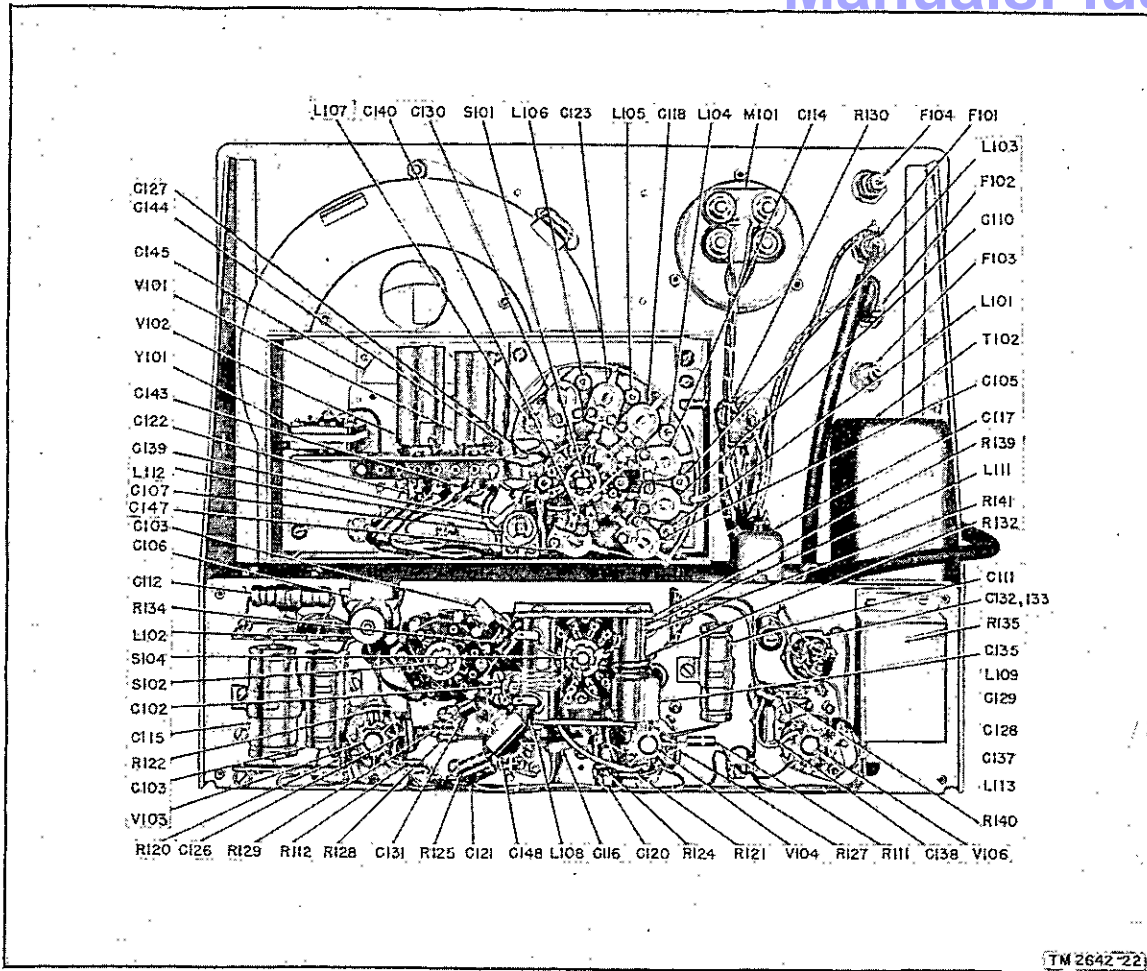


Figure 40. Signal Generator TS-465B/U, top rear view of chassis.

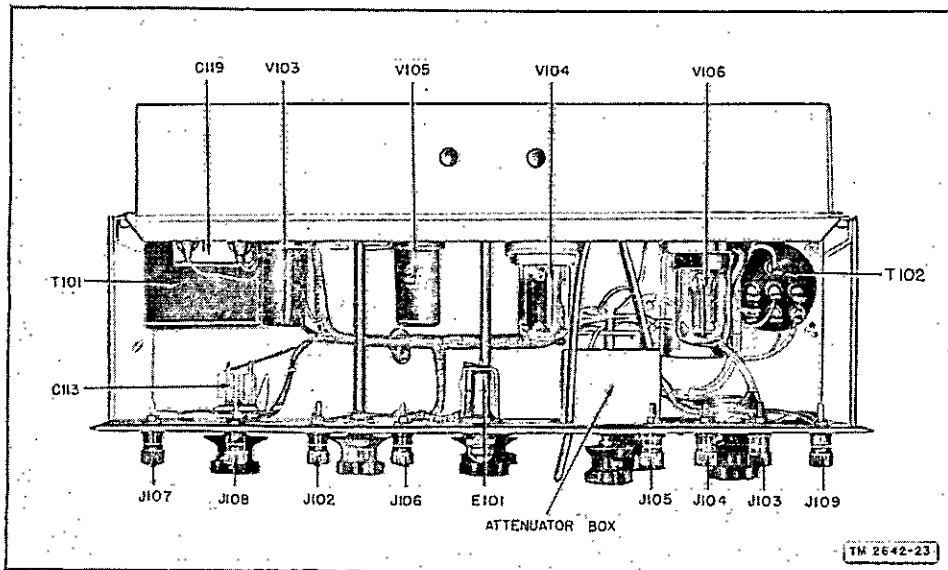
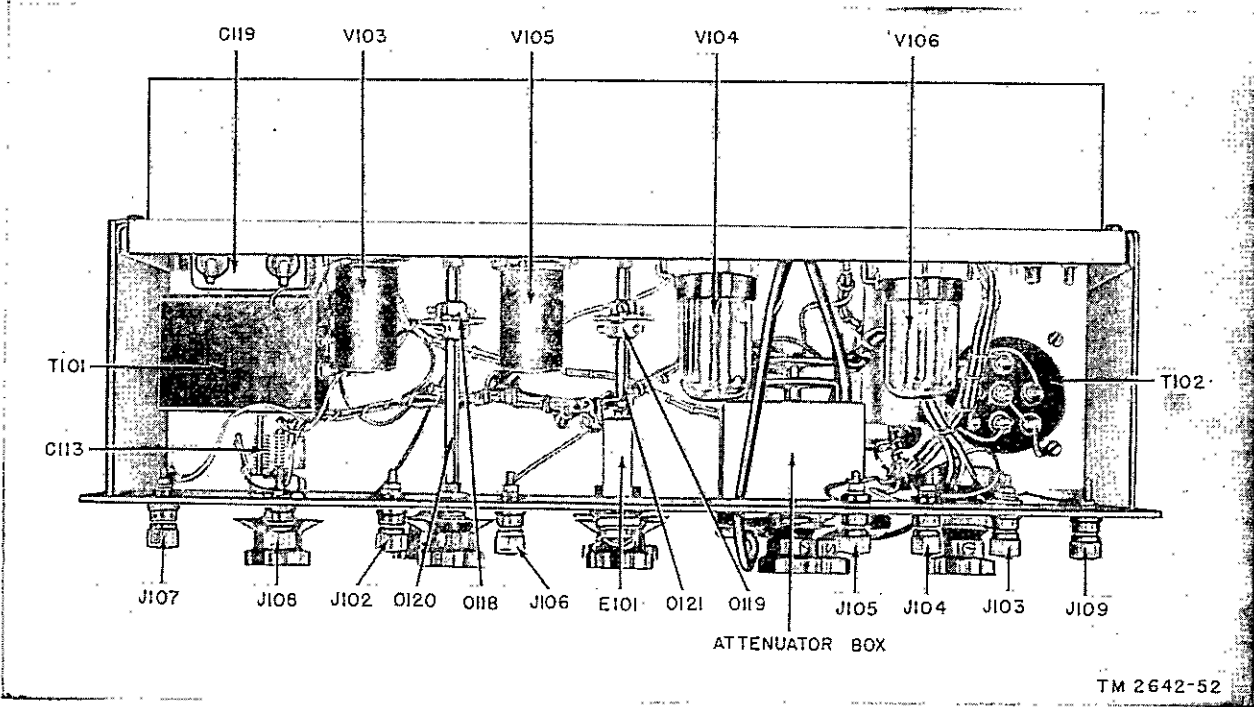
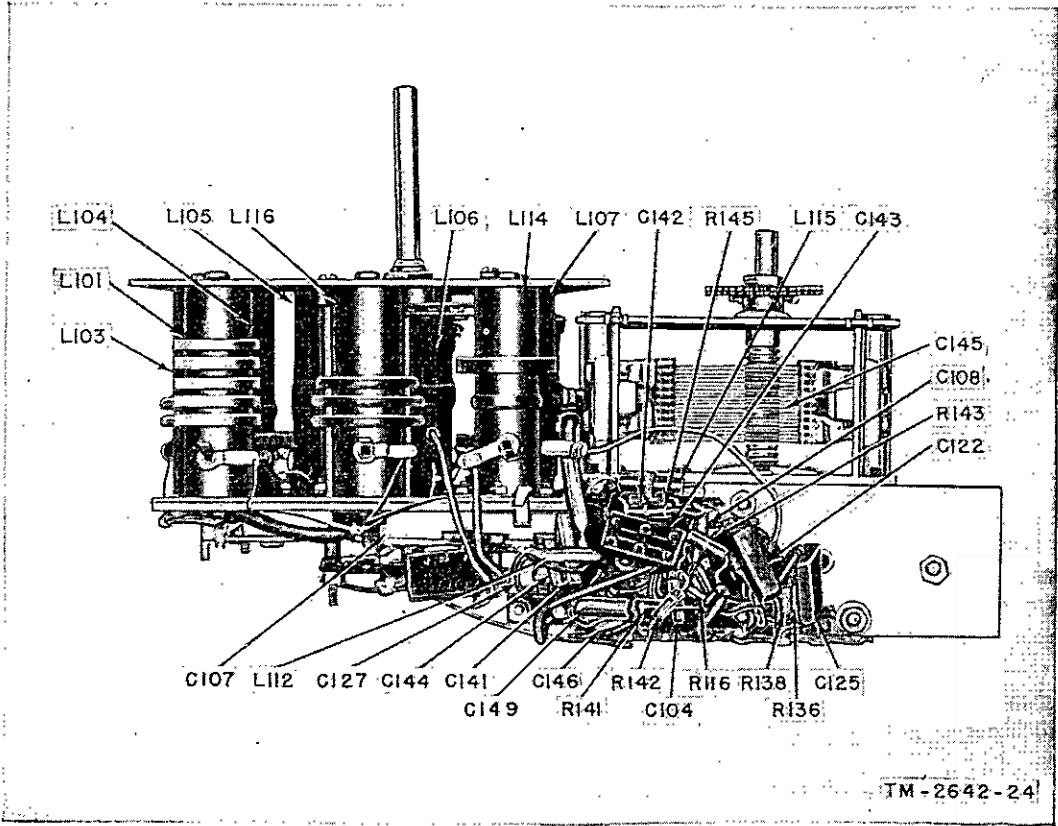


Figure 41. Signal Generator TS-465B/U, bottom rear view of chassis.



TM 2642-52

Figure 42. Signal Generator TS-465B/U, r-f subchassis, rear view, flexible coupling.



TM-2642-24

Figure 48. Signal Generator TS-465B/U, r-f subchassis, rear view.

Section III. ALINEMENT PROCEDURES

75. General

In making the adjustments in this section, set all controls for the particular output required, as shown in the operation chart (par. 17). Refer to paragraph 69 for a complete list of test instruments required to aline Signal Generator TS-465(*)/U.

76. Calibration of Main R-F Oscillator

Accurate calibration of the main r-f oscillator requires the use of a frequency meter. Use Frequency Meter Set SCR-211-(*) for all fundamental frequencies below 20 mc, and use FREQUENCY Meter TS-174(*)/U for all fundamental frequencies above 20 mc. Proceed as follows:

a. Turn on the signal generator and the frequency meter, and allow them to warm up for at least 20 minutes.

b. Calibrate the frequency meter according to the instructions furnished with the meter. Set the frequency meter to the frequency at which the signal generator is to be calibrated. This is determined from the frequency markings on the dial for the particular band being adjusted.

c. Set the BAND SELECTOR switch to the A band and set the FREQUENCY ADJUSTMENT control to the l-f end of the A band (100 kc).

d. Adjust L116 for zero beat in the headset connection to the frequency meter. Partially tighten the hexagonal nut.

e. Set the FREQUENCY ADJUSTMENT control to the h-f end of the A band. Set the frequency meter to the exact frequency at which the signal generator is to be calibrated, and adjust capacitor C107 for zero beat in the headset connected to the frequency meter.

f. Repeat the l-f alinement (steps c and d above) and the h-f alinement (step e above) until no further change in the setting is necessary. Tighten the hexagonal nut on coil L116.

g. Repeat the above procedure for each of the bands (B through G). Band H cannot be alined in this manner, because the inductance of the coil is set by the physical dimension of the tubing, and the capacitance is due to stray and self capacities of the associated circuit.

77. Alinement of Beat-Frequency Oscillator

Set the controls of the signal generator for an audio output (par. 17). Connect the OUTPUT

clips to the horizontal input terminals of Oscilloscope OS-8(*)/U. Connect Audio Oscillator TS-382(*)/U output terminals to the vertical input terminals of the oscilloscope. Proceed as follows:

Note. The setting of the controls of Signal Generator TS-465/U will differ from the settings for Signal Generators TS-465A/U and TS-465B/U. See the footnotes in paragraph 17.

a. Set Audio Oscillator TS-382(*)/U for a frequency output of 1 kc.

b. Set the VARIABLE AUDIO FREQUENCY control to 1 kc. A circular Lissajous pattern will appear on the screen of the oscilloscope if the frequency setting of the VARIABLE AUDIO FREQUENCY control is correct. If a stable circular pattern does not appear, adjust capacitor C147 until this pattern appears. In Signal Generator TS-465A/U, turn the FREQUENCY ADJUSTMENT control until a stable pattern appears and note the setting for future use. In Signal Generator TS-465/U, turn the FREQUENCY CONTROL ADJUSTMENT until a stable pattern appears and note the setting for future use.

78. Alinement of 1-Mc and 50-Mc F-M Oscillator Coils

The 1-mc circuit uses inductor L111 and the 50-mc circuit uses inductor L108. Proceed as follows:

a. Remove the main r-f oscillator tube, V101. This action will permit either the 1-mc or the 50-mc signal (23-mc signal in Signal Generator TS-465/U) to feed directly through the mixer tube to the OUTPUT where the signal may be measured by Frequency Meter Set SCR-211-(*) or Frequency Meter TS-174(*)/U in the same manner as described in paragraph 75.

b. Set the F. M.-A. M. SELECTOR switch to the 1 M. C. F. M. position, set the OUTPUT MULTIPLIER switch to the F. M. position, and set the OUTPUT SELECTOR switch to the OFF EXT. position.

c. Adjust coil L111 until the frequency is set at 1 mc as measured by the zero beat note in the headset connected to the frequency meter.

d. Set the F. M.-A. M. SELECTOR switch to the 50 M. C. F. M. position (23 M. C. position in Signal Generator TS-465/U).

e. Adjust coil L108 until the frequency is set at 50 mc (23 mc in Signal Generator TS-465/U) as measured by zero beat in the headset connected to the frequency meter.

f. Tighten the hexagonal nuts on each of these coils after the adjustment has been made. The cores are accessible through the small panel located on the lower r-f shield.

79. Adjustment of Sweep Width

Note. This adjustment can be made only in Signal Generators TS-465A/U and TS-465B/U. Signal Generator TS-465/U has fixed sweep widths.

This adjustment is made by setting variable capacitor C124. Use Panoramic Adaptor BC-1031-(*) in conjunction with a companion superheterodyne receiver to measure the sweep width. This method depends on the fact that, with a constant modulating frequency, the center frequency (f_0) of an f-m wave disappears at certain definite values of deviation. Proceed as follows:

a. Connect a standard companion superheterodyne receiver (capable of receiving a 50-mc signal) to Panoramic Adaptor BC-1031-(*), as described in TM 11-446.

b. Connect the OUTPUT cable of the signal generator to the antenna terminals of the receiver. Connect the output of Audio Oscillator TS-382(*)/U between the EXTERNAL MODULATION FREQ. connector and GROUND of the signal generator.

c. Set the controls of the signal generator for an externally modulated f-m signal output of 50 mc (par. 17). Remove the main r-f oscillator tube, V101, to permit the 50-mc signal to feed directly through to the OUTPUT cable. Set the FREQ. MOD. SWEEP control to 0. Turn on the test sets and signal generator.

d. Tune in the 50-mc signal on the receiver. A pulse should appear on the scope of the panoramic adaptor. Adjust the controls until a steady, large pulse appears in the center of the scope. Set Audio Oscillator TS-382(*)/U for an output of 13,400 cycles at an output level of 11.7 volts. Slowly vary the FREQ. MOD. SWEEP control in the signal generator in a clockwise direction from 0. Side currents should appear on the screen of the panoramic adaptor. Adjust the sweep control in the panoramic adaptor until the side currents can be seen clearly; as the side currents appear, the center

pulse should grow smaller. Continue rotating the FREQ. MOD. SWEEP control to the completely clockwise position, counting the number of times that the center pulse (center frequency) reduces to zero amplitude. This figure provides a modulation index as follows:

Number of times carrier amplitude drops to zero	Modulation index
1	2.40
2	5.52
3	8.65
4	11.79
5	14.93
6	18.07

e. The frequency deviation (F) is the product of the modulation index and the modulating frequency, or:

$$f = (\text{modulation index}) \times f (\text{modulating frequency}).$$

Since the frequency deviation is one-half the sweep width, for a sweep width of 150 kc, the frequency deviation is 75 kc. This means that for a modulating frequency of 13,400 cycles, the carrier amplitude should drop to 0 twice while rotating the FREQ. MOD. SWEEP control from 0 to 150 kc or:

$$75,000 \text{ cycles} = 5.52 \times 13,400 \text{ cycles}$$

Note. For accurate calibration of the sweep width, the external audio voltage fed into the EXTERNAL MODULATION FREQ. connector must be of the same magnitude as the 60- or 400-cycle voltages generated in the signal generator (see footnote 8, par. 17).

f. If the adjustment for the 150-kc limit is off, as shown by the number of times the carrier-amplitude drops to zero for a complete rotation of the FREQ. MOD. SWEEP control, the limit can be reset by adjusting capacitor C124 in the following manner:

- (1) Adjust capacitor C124 in any direction. Repeat the procedure for determining the number of times the carrier amplitude drops to 0. Notice whether the limit is made smaller or larger, i. e., less than two carrier-amplitude drops to zero, or more than two carrier-amplitude drops to zero. Set capacitor C124 for the required deviation.
- (2) Recheck the frequency of the 50-mc oscillator as described in paragraph 78.
- (3) Repeat (1) and (2) until the settings do not require change.

80. General

This section is intended as a guide to be used in determining the quality of a repaired Signal Generator TS-465(*)/U. The minimum test requirements outlined in the following paragraphs may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

81. Test Equipment Required for Final Testing

The equipment required for testing the repaired instrument is listed in paragraph 69. Equivalent items of test equipment may be used at the discretion of the maintenance personnel. For proper use of these items of test equipment see the manuals provided with the units.

82. R-F Output Voltage

a. Connect the OUTPUT cable to the probe of Electronic Multimeter TS-505(*)/U or an equivalent VTVM (vacuum-tube voltmeter) having an h-f response (with probe) up to 160 mc, and an l-v (low-voltage) range of 1 volt.

b. Set the controls for an unmodulated r-f signal output (maximum level), as described in the operation chart (par. 17).

c. The r-f output should be as follows:

Frequency	Output (v)	
	Signal Generator TS-465B/U	Signal Generators TS-465/U and TS-465A/U
100 kc to 5.7 mc.....	.3 to .6	.4 to 1.5
5.6 mc to 16.5 mc.....	.4 to .6	.2 to .5
16.1 mc to 110 mc.....	.4 to 1.0	.1 to .2

83. Unmodulated Crystal-Controlled Output

a. Connect the OUTPUT cable of the signal generator to the probe of Electronic Multimeter TS-505(*)/U.

b. Set the controls of the signal generator for an unmodulated, maximum crystal-controlled r-f output (100 kc and 1,000 kc) (par.17). The output voltage should be as follows:

Frequency	Output (v)
100 kc	.05
1,000 kc	.1

84. Modulated Crystal-Controlled Output

a. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to the antenna terminals of a standard a-m receiver. Set the controls for modulated crystal-controlled output (par. 17). Set the frequency of the receiver to a multiple of 100 kc or 1,000 kc. Listen to the loudspeaker for indication of 400-cycle modulation.

b. The frequency of the 400-cycle modulating voltage may be determined by means of Lissajous patterns. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to the horizontal input terminals of an oscilloscope. Set the oscilloscope for external sweep. Connect Audio Oscillator TS-382(*)/U output to the vertical input terminals of the scope. Set the audio oscillator to produce a 1:1 Lissajous figure. The frequency determined from the setting of the a-f oscillator should check to within 10 percent of the 400-cycle nominal frequency.

Note. The 60-cycle modulation frequency is dependent on the power line frequency.

85. Audio-Frequency and 400-Cycle Output Voltage

The amplitude of the a-f and 400-cycle output voltages may be measured by connecting the OUTPUT cable of Signal Generator TS-465(*)/U to the input of Electronic Multimeter TS-505(*)/U. Set the controls for an a-f output or 400-cycle maximum output (par. 17). The following approximate readings should be obtained:

Frequency	Output voltage
400 cycles	.3 volt (aprx)
0 to 15 kc	.2 volt (aprx)

86. Accuracy of Frequency Dial Calibration

To check the accuracy of the frequency dial calibration, proceed as follows:

a. Use Frequency Meter Set SCR-211-(*) or Frequency Meter TS-174(*)/U, depending on the range being checked. Turn on the test set and Signal Generator TS-465(*)/U and allow at least 20 minutes warm-up time before making the measurements.

b. Connect the OUTPUT cable of the signal generator to the input antenna terminals of the frequency meter and determine the frequency of the signal generator according to the directions in the

manual supplied with the frequency meter. The dial markings of Signal Generator TS-465(*)/U should correspond with the frequency meter reading to within 1 percent.

87. 400-Cycle Amplitude Modulation

Check for the presence of 400-cycle internal amplitude modulation as follows:

a. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to the antenna terminals of a standard a-m receiver. Set the controls in the signal generator for a 400-cycle a-m output (par. 17).

b. Adjust the dial setting of the receiver to the same frequency as the signal generator. If the receiver is set in phone position, a 400-cycle note will be heard in the loudspeaker.

88. Internal Frequency Modulation

a. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to an f-m receiver and panoramic adaptor as described in paragraph 79. Adjust the frequency output of the signal generator and the f-m receiver to correspond.

b. Set the controls of Signal Generator TS-465(*)/U for 60-cycle internal frequency modulation (par. 17).

c. Observe the pattern on the scope of the panoramic adaptor for presence of modulation. The modulation may also be heard in the speaker of an f-m receiver which is set to the output of the signal generator.

89. Audio Output Dial Calibration

a. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to the vertical input terminals of Oscilloscope OS-8(*)/U. Connect the output of Audio Oscillator TS-382(*)/U to the horizontal input terminals of the oscilloscope.

b. Set the controls of Signal Generator TS-465(*)/U for an audio output (par. 17). Check the dial calibration at selected positions by means of Lissajous figures.

Note. Output frequency may not correspond with the dial reading.

90. R-F Leakage

a. Connect the OUTPUT cable of Signal Generator TS-465(*)/U to the antenna terminals of a standard a-m receiver. Connect a VTVM such as Electronic Multimeter TS-505(*)/U to the second detector load resistor of the receiver. Disable the avc (automatic volume control). Turn the signal

generator OUTPUT MULTIPLIER control to R. F. X1 and turn the OUTPUT CONTROL to 0.

b. Measure the d-c voltage on the VTVM while varying the signal generator and receiver frequency settings over the range from 100 kc to 110 mc. At frequencies above 10 mc, vary the OUTPUT CONTROL between zero and maximum and note whether the VTVM readings vary. At frequencies for which the r-f leakage is great, the attenuator settings will have little or no effect on the VTVM readings. (Leakage at .5 mc is approximately 40 uv; at 108 mc, approximately 10,000 uv.)

91. Stray R-F Field

a. Connect a loop of copper tubing, approximately 3 inches in diameter, to the antenna terminals of a standard a-m receiver. Place Signal Generator TS-465(*)/U about 2 feet from the loop.

b. Connect a VTVM as described in paragraph 90a. Disable the avc. Turn the signal generator OUTPUT CONTROL to 0 and turn the OUTPUT MULTIPLIER to R. F. X1.

c. Measure the d-c voltage on the VTVM while varying the signal generator and receiver frequency settings over the range from 100 kc to 110 mc. Repeat the measurements with Signal Generator TS-497A/URR connected to the antenna terminals of the receiver. A comparison of the readings when the test generator output is known, will give an indication of the amount of stray r-f field. The reading obtained may indicate as much as 3000 uv at some point in the frequency range.

92. R-F Attenuator Setting

a. Connect a VTVM to a standard a-m receiver as indicated in paragraph 90a. Connect Signal Generator TS-465(*)/U OUTPUT cable to the receiver antenna terminals. Set the controls on the signal generator for an unmodulated r-f output of 10 mc (par. 17).

b. Read the VTVM with the signal generator OUTPUT MULTIPLIER in each of the r-f attenuation positions.

c. Connect Signal Generator TS-497A/URR to the receiver antenna terminals and set the controls for an r-f output of 10 mc. Compare the readings obtained with this standard signal generator to the readings obtained with Signal Generator TS-465(*)/U. The accuracy of the OUTPUT MULTIPLIER should be plus or minus 2 db (converting the d-c voltage readings to decibels).

Note. Above 10 mc, the r-f leakage increases, making the attenuator settings unreliable (pars. 4 and 72).

93. Hum and Noise in Output

Hum and noise in the output of the signal generator may be measured by use of Hewlett-Packard Noise and Distortion Analyzer 330D. Connect the OUTPUT cable of the signal generator to the input of the analyzer. The noise reading may be obtained directly from the test set.

94. A-C Voltmeter

Compare the readings of the a-c voltmeter with another Signal Generator TS-465(*)/U meter. A variable transformer may be used to obtain the voltages for each of the three ranges. Multimeter TS-352(*)/U may be used to check the voltage readings. If a variable transformer is not available, the 400-cycle voltage from the signal generator or the 60-cycle synchronized sweep voltage from the power supply may be used to check the meter readings.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT
ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

95. General

The circumstances involved in shipment and storage vary and, therefore, no definite procedure can be given that applies in all situations. The following instructions are intended as a guide for preparing the instrument for shipment and storage.

96. Repacking for Shipment or Limited Storage

a. The exact procedure in repacking for shipment or limited storage depends on the material available

and the conditions under which the equipment is to be shipped or stored. Refer to paragraph 10 and reverse the instructions given therein.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the chest. Protect the chests with a waterproof paper barrier. Seal the seams of the paper barrier with waterproofing sealing compound or tape. Pack the protected chest in a padded wooden case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case so that the instrument cannot move about within the container. Seal the case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

97. General

The demolition procedures outlined in paragraph 98 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

98. Methods of Destruction

a. Smash. Smash the crystal, controls, tubes, coils, switches, capacitors, transformers, and meter, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut internal and external wiring and cabling, using axes, handaxes, knives, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panel and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

g. Other. Destroy Everything.

REFERENCES

Note. For availability of items listed, check SR 310-20-3 and SR 310-20-4. Check Department of the Army Supply Manual SIG 1 for Signal Corps supply manuals.

1. Army Regulations

- AR 380-5 Military Security—Safeguarding Security Information.
- AR 750-5 Maintenance of Supplies and Equipment—Maintenance Responsibilities and Shop Operation.

2. Supply Publications

- SIG 1 Introduction and Index.
- SIG 3 List of Items for Troop Issue.
- SIG 5 Stock List of All Items.
- SIG 6 Sets of Equipment.
- SIG 7 & 8 Organizational Maintenance Allowances and Field and Depot Maintenance Stockage Guide.

3. Publications on Auxiliary Equipment and Test Equipment

- TM 11-5044 Frequency Meter TS-174B/U.
- NAVSHIPS 91272 Oscilloscope OS-8(*)/U.
- TM 11-300 Frequency Meter Sets SCR-211-A, B, C, D, E, F, J, K, L, M, N, O, P, Q, R, T, AA, AC, AE, AF, AG, AH, AJ, AK, AL, and AN.
- TM 11-446 Panoramic Adaptors BC-1031-A, -B, -C, BC-1032-A, and BC-1032-B.
- TM 11-5030 Signal Generator TS-497A/URR.
- TM 11-5511 Electronic Multimeter TS-505/U.
- TM 11-5527 Multimeter TS-352/U.
- TM 11-2684A Audio Oscillator TS-382A/U.

4. Painting, Preserving, and Lubrication

- TB SIG 13 Moistureproofing and Fungiproofing Signal Corps Equipment.

TB SIG 69

Lubrication of Ground Signal Equipment.

TM 9-2851

Painting Instructions for Field Use.

5. Camouflage

FM 5-20

Camouflage, Basic Principles.

6. Decontamination

TM 3-220

Decontamination.

7. Demolition

FM 5-25

Explosives and Demolitions.

8. Other Publications

SR 310-20-3

Index of Training Publications.

SR 310-20-4

Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders and Modification Work Orders.

SR 310-20-7

Index of Tables of Organization and Equipment, Reduction Tables, Tables of Organization, Tables of Equipment, Type Tables of Distribution, and Tables of Allowances.

SR 700-45-5

Unsatisfactory Equipment Report (Reports Control Symbol CSGLD-247).

SR 725-405-5

Issue of Supplies and Equipment—Transportation Corps Sources of Supply.

SR 745-45-5
NAVY SHIP-
PING
GUIDE
ARTICLE

Shipment of Supplies and Equipment, Report of Damaged or Improper Shipment.

1850-4
AFR 71-4

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|------------|---|------------|---|
| TB SIG 66 | Winter Maintenance of Signal Equipment. | TM 11-455 | Radio Fundamentals. |
| TB SIG 72 | Tropical Maintenance of Ground Signal Equipment. | TM 11-496 | Training Text and Applicative Exercises for Amplitude-Modulated Radio Sets. |
| TB SIG 75 | Desert Maintenance of Ground Signal Equipment. | TM 11-660 | Introduction to Electronics. |
| TB SIG 123 | Preventive Maintenance Practices for Ground Signal Equipment. | TM 11-661 | Electrical Fundamentals (Direct Current). |
| TB SIG 178 | Preventive Maintenance Guide for Radio Communication Equipment. | TM 11-681 | Electrical Fundamentals (Alternating Current). |
| TB SIG 219 | Operation of Signal Equipment at Low Temperatures. | TM 11-4000 | Trouble Shooting and Repair of Radio Equipment. |

IDENTIFICATION TABLE OF PARTS

I. Requisitioning Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as a specific T/O&E, T/A, SIG 7 & 8, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Manual applicable to the equipment covered in this manual is SIG 7 & 8 TS-465/U. For an index of available supply manuals in the Signal portion of the Department of the Army Supply Manual, see SIG 1.

2. Identification Table of Parts for Signal Generator TS-465(*)/U

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
				SIGNAL GENERATORS TS-465/U, TS-465A/U, TS-465B/U: am. and fm; am. 100 kc-110 mc; fm narrow band 0-30 kc sweep, 100 kc-110 mc; wide band fm 0-150-450 kc sweep, 1-160 mc; xtal controlled rf or am. at 100 kc & 1000 kc; operates from 105-125 v, 50-60 cyc ac.		3F3868
W101			(*)	CABLE ASSEMBLY, special purpose: Radio Frequency Cable RG-58A/U; 3' S' lg excluding terminations; Espey part/dwg L13.144.	OUTPUT cable.....	3E7350-1.44.2
	(*)	(*)		CABLE WS-17/U: ins, Buna S, 1000 v rms; single cond, 65 #36 AWG.	Power cable.....	1B818.152
			(*)	CABLE, power: Cordage CO-130; 2 #18 AWG stranded cond.	Power cable.....	3E2130
			(*)	CABLE, RF: Radio Frequency Cable RG-62A/U; coax; 93 ohms.	OUTPUT cable.....	1F425-62A
C104			(*)	CAPACITOR, fixed: ceramic; 2 $\mu\text{f} \pm \frac{1}{2} \mu\text{f}$; 500 vdew; JAN type CC21CK020D.	Couples mixer grid to output of main r-f oscillator.	3D9002-30
C2	(*)			CAPACITOR, FIXED: mica; 5 $\mu\text{f} \pm 20\%$; 500 vdew; JAN type CM20B050M.	Coupling capacitor in main r-f oscillator V4.	3K2005024
C33, C35	(*)			CAPACITOR, fixed: ceramic; 10 $\mu\text{f} \pm 1 \mu\text{f}$; 500 vdew; JAN type CC21CJ100F.	C33: Couples bfo output to mixer grid V2. C35: Couples 400~ to reactance modulator V5	3D9010-92
C131			(*)	CAPACITOR, fixed: mica; 20 $\mu\text{f} \pm 5\%$; 500 vdew; JAN type CM20B200J.	R-f decoupling in power supply filter.	3K2020022
C134	(*)			CAPACITOR, fixed: mica; 47 $\mu\text{f} \pm 10\%$; 500 vdew; JAN type CM20B470K.	Coupling capacitor for V103.	3K2047021
C109	(*)			CAPACITOR, fixed: ceramic; 51 $\mu\text{f} \pm 1\%$; 500 vdew; JAN type CC32CK510F.	Grid coupling capacitor V101.	3D9051-56
C143	(*)			CAPACITOR, fixed: mica; 160 $\mu\text{f} \pm 5\%$; 500 vdew; JAN type CM20C161J.	Negative feedback for V101.	3K2016132
C134	(*)			CAPACITOR, fixed: mica; 51 $\mu\text{f} \pm 5\%$; 500 vdew; JAN type CM20C510J.	Coupling capacitor in bfo output.	3K2051032
C116, C120, C128, C129, C136, C137	(*)			CAPACITOR, fixed: mica; 100 $\mu\text{f} \pm 5\%$; 500 vdew; JAN type CM20C101J.	C116; Grid coupling for V104B. C120; Cathode bias for V104B. C128, C129, C136, C137: Part of line filter.	3K2010132

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
C4, C5, C6, C7, C116, C120, C125, C128, C129, C131, C136, C137, C139, C140	(*)		(*)	CAPACITOR, fixed: mica; 100 $\mu\mu\text{f}$ $\pm 10\%$; 500 vdcw; JAN type CM20B101K.	C4: Part of crystal oscillator tank. C5: Couples plate V5 to grid V2. C6: R-f bypass in EXTERNAL MODULATION network. C7: Couples output of V1. C116: Couples reactance modulator plate V105 grid V104B. C120: R-f bypass in EXTERNAL MODULATION AMP. C125: Crystal oscillator output coupling capacitor V102B. C128, C129: R-f by-pass in line cord. C131: Part of tuned circuit in f-m oscillator V104B. C136, C137: R-f by-pass in line cord. C139: Part of tuned circuit in crystal oscillator V102B. C140: Couples A band to V101 for audio output.	3K2010121
C108, C125, C141, C142, C146		(*)	(*)	CAPACITOR, fixed: ceramic; 100 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CC26UJ101J.	C108: Couples main r-f oscillator to cathode-follower V102A. C125: Cathode bypass for V102B. C141: Filament bypass for V101. C142: Decouples plate No. 1 of V101. C146: Decouples plate V102A.	3D9100-207
C140		(*)	(*)	CAPACITOR, fixed: mica; 24 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CM20C240J.	Tunes main r-f osc to 154 kc.	3K2024032
C125		(*)	(*)	CAPACITOR, fixed: ceramic; 150 $\mu\mu\text{f}$ $\pm 10\%$; 500 vdcw; JAN type CC26UJ151K.	Output coupling capacitor for V102B.	
C106		(*)	(*)	CAPACITOR, fixed: mica; 200 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CM20C201J.	Part of bfo tank circuit.	3K2020132
C106		(*)	(*)	CAPACITOR, fixed: mica; 300 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CM20B301J.	Part of a-f oscillator V103 tank circuit.	3K2030122
C121, C122, C126		(*)	(*)	CAPACITOR, fixed: mica; 470 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CM20D471J.	C121: Cathode bypass for V105. C122: Couples V102A cathode to OUTPUT CONTROL. C126: Phase-shifting capacitor in Freq. MOD. SWEEP input.	3K2047142

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
C102, C107, C121, C122, C126, C127		(*)		CAPACITOR, fixed: mica; 470 μf $\pm 10\%$; 500 vdew; JAN type CM20B471K.	C102: Part of OUTPUT SELECTOR switch circuit. C107: Couples OUTPUT CONTROL to OUTPUT MULTIPLIER switch. C121: Cathode bypass for V105. C122: Output coupling capacitor for cathode-follower V102A. C126: Phase-shifting capacitor in FREQUENCY MODULATED SWEEP input. C127: R-f bypass plate of cathode - follower V102A.	3K2047121
C1, C10, C11, C21, C25, C27, C28, C34, C38, C40	(*)			CAPACITOR, fixed: mica; 510 μf $\pm 5\%$; 500 vdew; JAN type CM20B511J.	C1: A-f coupling in grid V4. C10: Cathode output in V4. C11: R-f bypass plate circuit V4. C21: Cathode bypass V5. C25: Screen bypass V5. C27: R-f bypass in grid V5. C28: Part of MULTIPLIER network. C34: In bfo tuned circuit. C38: R-f ground in reactance tube V2. C40: R-f bypass in suppressor grid V2.	3K2051122
C139		(*)		CAPACITOR, fixed: mica; 1,000 μf $\pm 2\%$; 500 vdew; JAN type CM30D102G.	Plate tank capacitor for V102B.	3K3010243
C17, C138, C144	(*)	(*)	(*)	CAPACITOR, fixed: mica; 1,000 μf $\pm 10\%$; 500 vdew; JAN type CM30B102K.	C17, C138: Part of SYNCHRONIZED SWEEP VOLTAGE OUTPUT voltage divider. C144: Bypass for V101.	3K3010221
C135		(*)		CAPACITOR, fixed: mica; 4700 μf $\pm 10\%$; 500 vdew; JAN type CM35D472K.	Plate decoupling for V104B.	3K3547241
C135		(*)		CAPACITOR, fixed: mica; 4700 μf $\pm 10\%$; 500 vdew; JAN type CM35B472K.	R-f bypass for plate V104B in AMPLITUDE MODULATED position S104.	3K3547221
C102, C138, C148		(*)		CAPACITOR, fixed: mica; 10,000 μf $\pm 10\%$; 300 vdew; JAN type CM35C103K.	C102: Coupling 400 \sim output to V105. C138: Part of a-c voltage divider for SYNC SWEEP. C148: Screen bypass for V105.	3K3510331

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
C12	(*)			CAPACITOR, fixed: paper; 10,000 $\mu\mu\text{f}$ $\pm 20\%$; 600 vdcw; JAN type CP26A1DF103M.	Cathode bypass in crystal oscillator V1.	3DA10-394
C112		(*)	(*)	CAPACITOR, fixed: paper; 20,000 $\mu\mu\text{f}$ $\pm 20\%$; 600 vdcw; JAN type CP26A1EF203M.	Feedback capacitor in screen of V103.	3DA20-171
C31	(*)			CAPACITOR, fixed: paper; 25,000 $\mu\mu\text{f}$ $-10\% + 20\%$; 600 vdcw; Aerovox type #684.	Feedback capacitor in screen of V6.	3DA25-12
C15, C16	(*)			CAPACITOR, fixed: paper; 50,000 $\mu\mu\text{f}$ $\pm 10\%$; 600 vdcw; JAN type CP26A1EF503K.	Bypass capacitors in power input circuit.	3DA50-224
C32, C37	(*)			CAPACITOR, fixed: paper; 100,000 $\mu\mu\text{f}$ $\pm 5\%$; 400 vdcw; Aerovox #484.	C32: Part of 400 \sim tank circuit. C37: Couples a-f and f-m signals to output circuit.	3DA100-16
C103, C111		(*)	(*)	CAPACITOR, fixed: paper; 100,000 $\mu\mu\text{f}$ $\pm 10\%$; 600 vdcw; JAN type CP26A1EF104K.	C103: 400-cycle oscillator tuning. C111: Coupling capacitor for mixer output.	3DA100-730
C115	(*)	(*)		CAPACITOR, fixed: paper; 250,000 $\mu\mu\text{f}$ $\pm 20\%$; 600 vdcw; JAN type CP26A1EF254M.	Provides for feedback for oscillator V103.	3DA250-326
C117	(*)	(*)		CAPACITOR, fixed: paper; 500,000 $\mu\mu\text{f}$ $\pm 10\%$; 600 vdcw; JAN type CP54B1EF504K.	Protects meter M1	3DA500-560
C39	(*)			CAPACITOR, fixed: paper; 500,000 $\mu\mu\text{f}$ $\pm 10\%$; 200 vdcw; JAN type CP26A1DC504K.	Coupling capacitor in DECIBEL METER output.	3DA500-642
C119	(*)			CAPACITOR, fixed: electrolytic; 10 μf ; 25 vdcw; Mallory #TC22.	Cathode bypass for V103.	3DB10-238
C119		(*)		CAPACITOR, fixed: electrolytic; 10 μf ; 300 vdcw; JAN type CE63C100N.	Cathode bypass for V103.	3DB10-190
C30	(*)			CAPACITOR, fixed: electrolytic; 10 μf ; 25 vdcw; Aerovox type PRS-EP-25.	Cathode bypass for V6	3DB10-30
C18	(*)			CAPACITOR, fixed: electrolytic; 3 sect.; 16 μf ea sect.; 350 vdcw; JAN type CE53C160P.	Filter capacitors in B+ line.	3DB16-52
C132, C133		(*)		CAPACITOR, fixed: electrolytic; 2 sect.; 20 μf ea sect.; 450 vdcw; JAN type CE42F200R.	B+ filter capacitors in cathode V106.	3DB20-113
C149		(*)		CAPACITOR, fixed: ceramic; 51 $\mu\mu\text{f}$ $\pm 5\%$; 500 vdcw; JAN type CC21UJ510J.	B+ bypass	
C24, C104, C105, C108, C110, C114, C118, C123, C124, C130	(*)	(*)		CAPACITOR, variable: ceramic; 3-12 $\mu\mu\text{f}$; Hickok part OS-1707.	C24: Coupling capacitor in grid of V5. C104: Couples V101 plate to f-m oscillator tube V104A. C105: Tunes A band. C108: Couples r-f oscillator output to cathode-follower V102A. C110: Tunes B band. C114: Tunes C band. C118: Tunes D band. C123: Tunes E band. C124: F-m sweep tuning. C130: Tunes F band.	3D9012V-13
C107, C105, C110, C114, C118,		(*)		CAPACITOR, variable: ceramic; 3.0-13 $\mu\mu\text{f}$; 500 vdcw; JAN type CV11B130.	C107: Tunes A band. C105: Tunes B band. C110: Tunes C band. C114: Tunes D band. C118: Tunes E band.	3D9013V-10

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-405/U	TS-406A/U	TS-406B/U			
C123, C124, C130 C145			(*)	CAPACITOR, variable: air; plate meshing; RCC series 17 type C modified.	C123: Tunes F band. C124: F-m sweep tuning. C130: Tunes G band. FREQUENCY ADJUSTMENT control.	3D9402V-8
C113			(*)	CAPACITOR, variable: air; plate meshing type, 1 sect.; Sarkes #0-57F.	VARIABLE AUDIO FREQUENCY control.	3D9057V-1
C147			(*)	CAPACITOR, variable: ceramic; rotary type; 1 sect.; 7 μ f-45 μ f; 500 vdew; JAN type CV11D450.	Adjusts frequency of main r-f oscillator to 154 kc.	3D9045V-22
C101			(*)	CAPACITOR, variable: air; plate meshing type, 2 sect.; Amer Steel Pack #ASP-H-1383.	FREQUENCY ADJUSTMENT control.	3D9420V-3
C3			(*)	CAPACITOR, variable: air; plate meshing type, 2 sect.; SC-C-4236.	FREQUENCY ADJUSTMENT control.	3D9415V
C113			(*)	CAPACITOR, variable: air; plate meshing type, 1 sect.; Hammarlund #APC-75 modified.	A-f tuning capacitor.....	3D9075V-46
C36			(*)	CAPACITOR, variable: air; plate meshing type, 1 sect.; Amer Steel Pack #F-57.	Variable a-f capacitor..	3D9058V-1
C127			(*)	CAPACITOR, variable: ceramic; 7 μ f-45 μ f; 500 vdew; JAN type CV11C450.	Variable feedback capacitor of main r-f oscillator.	3D9045V.15
H146, H147 H144, H145			(*)	CLAMP: mts tube; tube base 1.281" dia; Birtcher #929-1.	Used to mount tubes V105 and V106.	2Z2642.90
			(*)	CLAMP: tube; for tube w/octal base 1 $\frac{3}{8}$ " d; Birtcher #926B-5.	Used to mount tubes V104 and V106.	2Z2635.85
			(*)	CLIP: alligator; bakelite ins, red, $\frac{3}{8}$ " max jaw opening; Mueller Elec #60HS.	Output clip for OUTPUT cord.	3Z1087-8
O115, O116			(*) (*) (*)	CLIP: alligator; black bakelite; $\frac{1}{2}$ " jaw opening; Mueller Elec #60HS.	O115: Output clip for OUTPUT cord. O116: Grounded shield connection for OUTPUT cord.	3Z1087-S.1
L101			(*)	COIL, RF: osc; unshielded; Espey part/dwg #2.592B.	B band tuning.....	3C1081-31L
L102			(*)	COIL, RF: osc; unshielded; Espey part/dwg #2.593C.	154-kc tuning V103.....	3C1081-31M
L102			(*)	COIL, RF: beat osc; unshielded; Hickok part/dwg #X-3320-38.	A-f oscillator coil.....	3C1081-45F
L103			(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.590-E.	C band tuning.....	3C1081-31K
L104			(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.589-E.	D band tuning.....	3C1081-31J
L104			(*)	COIL, RF: osc; unshielded; Hickok part/dwg #X-3320-32.	C band tuning.....	3C1081-45A
L105			(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.588-E.	E band tuning.....	3C1081-31H
L105			(*)	COIL, RF: osc; unshielded; Hickok part/dwg #X-3320-33.	D band tuning.....	3C1081-45B
L106			(*)	COIL, RF: osc; unshielded; Hickok part/dwg #X-3320-34.	E band tuning.....	3C1081-45C
L107			(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.598-C.	G band tuning.....	3C1081-31F
L107			(*)	COIL, RF: osc; unshielded; Hickok part/dwg #X-3320-35.	F band tuning.....	3C1081-45D
L106			(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.581-E.	F band tuning.....	3C1081-31G
L108			(*)	COIL, RF: osc; unshielded; Espey part/dwg #2-594-C.	F-m oscillator V104B tuning for 50 mc.	3C1081-31N
L108			(*)	COIL, RF: hf; unshielded; Hickok part/dwg #X-3320-21.	50-mc f-m oscillator coil..	3C1084Z75

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-466A/U	TS-466B/U			
L109, L113, L110		(*)		COIL, RF: choke; unshielded; Hickok part/dwg #X-3350-17.	L109, L113: R-f filter choke in power cord. L110: R-f filter choke in r-f oscillator tuning circuit.	3C323-200D
L111		(*)	(*)	COIL, RF: hf input choke; unshielded; Espey part/dwg #2-595B.	Provides 1-mc tuning for oscillator V104B.	3C321-40
L109, L113		(*)	(*)	COIL, RF: rf choke coil; unshielded; Espey part/dwg #2-596E.	Power line feedback chokes.	3C321-41
L112		(*)	(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.685-A.	Provides tuning for H band.	3C1081-31P
L114		(*)	(*)	COIL, RF: osc; unshielded; Espey part/dwg #2-599.	Provides plate tuning for V102B on 100 K. C. and 1000 K. C.	3C1081-31Q
L116		(*)	(*)	COIL, RF: osc; unshielded; Espey part/dwg #A2.592-E.	Tunes A band.	
A		(*)		COIL, RF: osc (A band); unshielded; Hickok part #OS-2064.	Tunes A band.....	3F3868-1.1/C5
B		(*)		COIL, RF: osc (B band); unshielded; Hickok part #OS-2065.	Tunes B band.....	3F3868-1.1/C4
C		(*)		COIL, RF: osc (C band); unshielded; Hickok part #OS-2066.	Tunes C band.....	3F3868-1.1/C3
D		(*)		COIL, RF: osc (D band); unshielded; Hickok part #OS-2067.	Tunes D band.....	3F3868-1.1/C6
E		(*)		COIL, RF: osc (E band); unshielded; Hickok part #OS-2068.	Tunes E band.....	3F3868-1.1/C7
F		(*)		COIL, RF: osc (F band); unshielded; Hickok part #OS-2069.	Tunes F band.....	3F3868-1.1/C8
L4		(*)		COIL, RF: beat osc; unshielded; Hickok part #OS-2071.	Bfo oscillator coil.....	3F3868-1.1/C10
L1		(*)		COIL, RF: xtal osc; unshielded; Hickok part #OS-2070.	Crystal oscillator coil....	3F3868-1.1/C9
L114		(*)		COIL, RF: xtal osc; unshielded; Hickok part #X-3320-37.	Crystal oscillator coil....	3C1081-45E
L115		(*)	(*)	COIL RF: osc cathode choke; unshielded; Espey part/dwg #2-597E.	R-f choke coil in cathode V101.	3C321-42
P101		(*)	(*)	CONNECTOR, plug: 2 parallel blade cont, male; straight type; Hubbell #7057.	Plug of line cord.....	6Z1727
J1		(*)		CONNECTOR, receptacle: 1 rd female cont; straight type; Amphenol #78-1P.	OUTPUT connector.....	2Z5581-12
		(*)		CONNECTOR, plug: 1 pressure bead cont; straight type; Amphenol type #75-MC1F.		2Z8671.23
		(*)		CONNECTOR, plug: 1 rd male cont; straight type; Amphenol #71-1S.		2Z7111.23.1
J102, J103, J104, J105, J106, J107		(*)		CONNECTOR, receptacle: 1 female cont; straight type; Amphenol #78-1S.	J102: EXTERNAL MODULATION FREQ. connector. J103, J104, J105: DECIBEL METER connectors. J106: EXTERNAL MODULATION A M P. connector. J107: SYNCHRONIZED SWEEP VOLTAGE OUTPUT connector.	2Z3062-16

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
J101		(*)		CONNECTOR, receptacle: 1 rd male cont; straight type; Amphenol #75-PC1M.	OUTPUT CONNecTOR.	2Z7111-28
Y1	(*)			COUPLING, flexible: 1/4" ID; Bud Rad #FC-S55----		2Z3273-32
Y101	(*)			CRYSTAL UNIT, quartz: 1 plate; dual freq, 100 kc, 1000 kc; Biley Elec #SMC-100.	Provide fixed 100-and and 1000-kc outputs with harmonics.	2X100-100
O117	(*)			DIAL ASSEMBLY: drive type-----	Main tuning dial-----	2Z3714-30
	(*)			DIAL: disk type; Espey part/dwg #3.217-A-----	Main tuning dial-----	3F30995-3
	(*)			DRIVE, tuning: friction type used for dial and tuning capacitor; 1" lg x 1/4" dia. shaft discs 5/8" dia; Hickok part/dwg #19100-6.		3F3868-1.1/D1
F101, F102, F103, F104 E136 thru E139		(*)		FUSE FU-26: 1 amp; Espey part/dwg #32.060-----	F101, F102: Line fuses-- F103, F104: Spare fuses--	3Z1926
		(*)		HOLDER, fuse: extractor post type; 250 v, 1 amp; Buss AGC-1 fuse.	Monut fuses-----	3Z3275
	(*)			JACK: red for std .080" phone tip; Amphenol #78-1P--		2Z5581-11
	(*)			KNOB: bar; black bakelite; for 1/4" shaft; 1 end pointed; Cambridge part/dwg #13803.		2Z5786.47
	(*)			KNOB: bar; black phenolic plastic; for 1/4" shaft; white indicator line; Hickok part #OS-1825.		2Z5822-3
	(*)			KNOB: rd; black phenolic; for 1/4" shaft; white index line on skirt; GR type 637-J.		2Z5835
H153, H154, H155		(*)		KNOB: rd; black bakelite; for 1/4" dia shaft; single white indicator line; Kurtz-Kasch type #S-381-64-BB-L.	H153: FREQUENCY MODULATED SWEEP knob. H154: BAND SELECTOR knob. H155: FREQUENCY ADJUSTMENT knob.	2Z5840-16
H148, H149, H150, H151, H152		(*)		KNOB: rd; black bakelite; for 1/4" dia shaft; 1 cup point slotted #10-32 setscrew; single white indicator line; Kurtz-Kasch type S-380-64-BB-L.	H148: OUTPUT CONTROL knob. H149: OUTPUT MULTIPLIER knob. H150: F. M.-A. M. SELECTOR knob. H151: OUTPUT SELECTOR knob. H152: VARIABLE AUDIO FREQUENCY knob.	2Z5322-65
		(*)		KNOB: bar; black phenolic; 1/4" dia shaft; Kurtz-Kasch type S-246-3L.		2Z5840-18
		(*)		KNOB: rd; black bakelite; 1/4" dia shaft; Kurtz-Kasch type S-481-1.		2Z5822-368
		(*)		KNOB: rd; black bakelite; 1/4" dia shaft; Kurtz-Kasch type S-48-61-6061.		2Z5822-369
I101 E1 E103	(*)		(*)	LAMP LM-52: 6-8 v, .15 amp; SC miniature bayonet.	Pilot light-----	2Z5952
	(*)		(*)	LAMP LM-25: 6-8 v, .15 amp; miniature screw base.	Pilot light-----	2Z5925
		(*)		LEAD SET, test: 2 leads, ea lead #18 AWG, 1600 cir mils, ea lead 3' lg excluding terminations; Espey part/dwg #13.132.	Test leads-----	3E8001-36.3

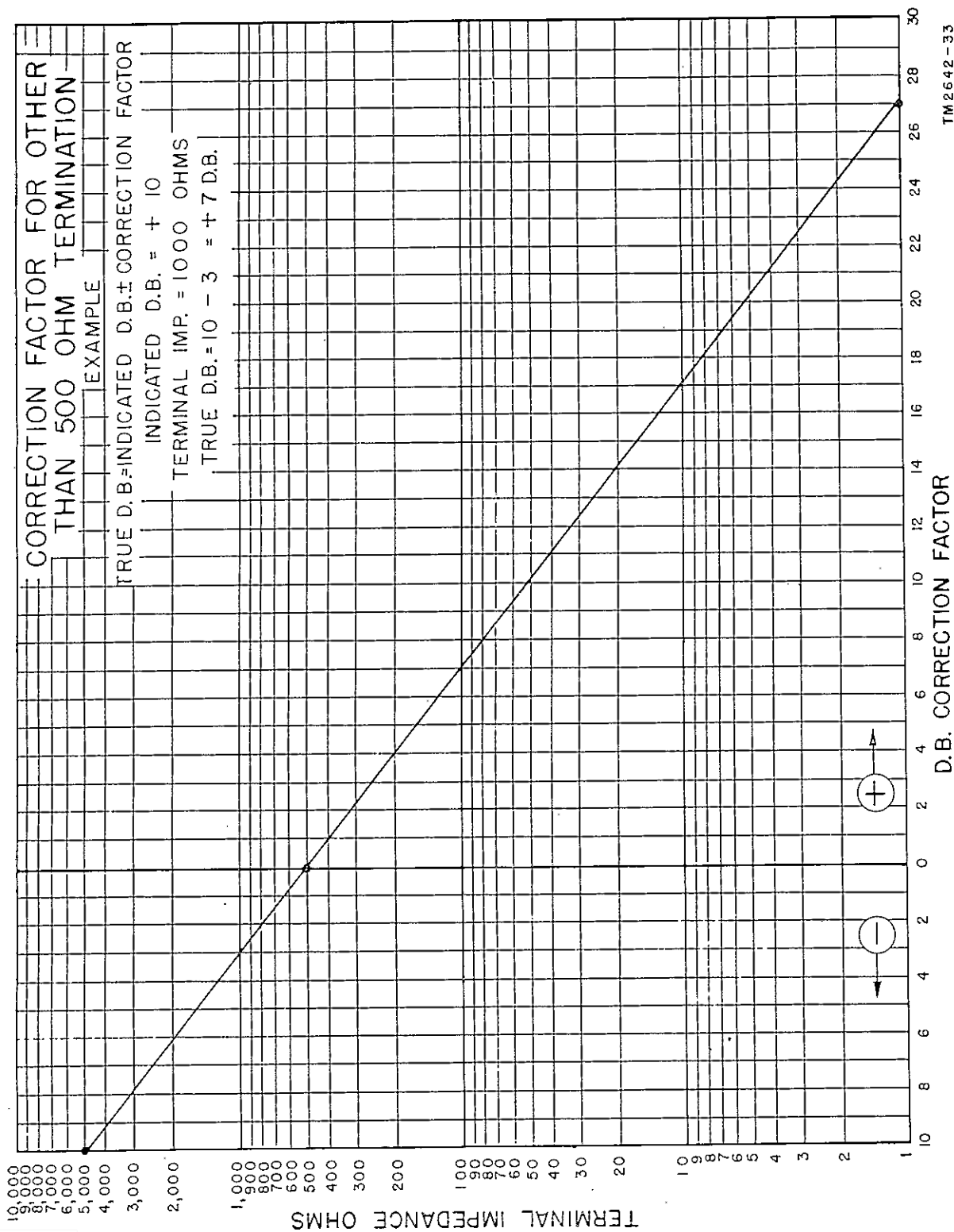
Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
E101			(*)	LIGHT indicator: w/lens; miniature bayonet T3- $\frac{1}{4}$ tubular or G3- $\frac{1}{2}$ globular lamp; Drake Mfg #50-SFA-Red.	Indicates power is on----	2Z5991-229
I1	(*)			LIGHT, indicator: w/lens; miniature screw base; Sig Ind type 510-F.	Indicates power is on----	2Z5999
I101		(*)		LIGHT, indicator: w/lens; miniature screw base, T3- $\frac{1}{4}$ bulb; Drake Mfg #30S.	Indicates power is on----	2Z5883-28
M1	(*)			METER, audio level: ac rect type; 0 to +6 db, +6 to +22 db, +22 to +38 db; Hickok part #510-037.	DECIBEL METER----	3F3307.2-1
M101		(*)		METER, audio level: ac rect type; -10 to +6 db, +6 to +22 db, +22 to +38 db; 0-3.5 v, 0-20 v, 0-140 v; Q. V. S. Inc, model 350, type 323.	DECIBEL METER----	3F3307.15-2
M101		(*)		METER, audio level: ac rect type; -10 to +38 db, 0-3.5 v, 0-140 v ac; Hickok part #510-065.	DECIBEL METER----	3F3307.2-3
E102 thru E109		(*)		POST, binding: Sig C Binding Post TM-152; screw type.		3Z252
E102, E103, E104, E105, E106, E107, E108, E109		(*)		POST, binding: screw type; Hugh B Eby Inc. model #38.	E102: GROUND terminal. E103: EXTERNAL MODULATION FREQ. terminal. E104: -10 to +6 db terminal. E105: +6 to +22 db terminal. E106: +22 to +38 db terminal. E107: EXTERNAL MODULATION AMP. terminal. E108: SYNCHRONIZE SWEEP VOLTAGE OUTPUT terminal. E109: GND terminal.	3Z737-13.3
R150, R151, R147		(*)		RESISTOR, fixed: comp; 10 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF100J.	Part of attenuator network.	3RC20BF100J
R101, R104, R105		(*)		RESISTOR, fixed: comp; 43 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF430J.	Part of attenuator network.	3RC20BF430J
R24, R25, R148, R149		(*)		RESISTOR, fixed: comp; 47 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF470K.	Part of attenuator network.	3RC20BF470K
R29		(*)		RESISTOR, fixed: comp; 51 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF510J.	Part of attenuator network.	3RC20BF510J
R128		(*)		RESISTOR, fixed: comp; 62 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF620J.	Part of attenuator network.	3RC20BF620J
R109		(*)		RESISTOR, fixed: comp; 68 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF680K.	Part of FREQUENCY MODULATED SWEEP circuit.	3RC20BF680K
R153		(*)		RESISTOR, fixed: comp; 100 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF101K.	Part of OUTPUT CONTROL attenuator.	3RC20BF101K
R145		(*)		RESISTOR, fixed: comp; 200 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF201J.	Part of phase-shifting network for f-m sweep circuit.	3RC20BF201J
		(*)		RESISTOR, fixed: comp; 330 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF331J.	Cathode-biasing resistor for V101.	3RC20BF331J

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
R146			(*)	RESISTOR, fixed: comp; 430 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF431J.	Part of attenuator network.	3RC20BF431J
R102, R106, R125, R127			(*)	RESISTOR, fixed: comp; 470 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF471K.	R102, R106: Part of attenuator network. R125: Cathode bias for V105. R127: Cathode bias for V104A.	3RC20BF471K
R22, R23			(*)	RESISTOR, fixed: comp; 510 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF511J.	Part of attenuator network.	3RC20BF511J
R152			(*)	RESISTOR, fixed: comp; 22 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF220J.	Part of attenuator network.	3RC20BF220J
R14			(*)	RESISTOR, fixed: comp; 75 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF750J.	Part of grid input circuit V5.	3RC20BF750J
R113			(*) (*)	RESISTOR, fixed: comp; 820 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF821J.	Loading resistor in secondary of a-f transformer T101.	3RC20BF821J
R20			(*)	RESISTOR, fixed: comp; 820 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF821K.	Load resistor in 400 ~ oscillator circuit.	3RC20BF821K
R143			(*)	RESISTOR, fixed: comp; 2400 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF242J.	Plate No. 1 decoupling resistor for V101.	3RC20BF242J
R13, R122, R123			(*) (*) (*)	RESISTOR, fixed: comp; 1500 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF152K.	R13: Cathode resistor V5. R122: Cathode-biasing resistor V103. R123: Grid-biasing resistor V104A.	3RC20BF152K
R116, R134, R138			(*) (*)	RESISTOR, fixed: comp; 1800 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF182K.	R116: Cathode-biasing resistor for V102A. R134: Part of filter network for V106. R138: Cathode-biasing resistor for V102B.	3RC20BF182K
R135			(*)	RESISTOR, fixed: comp; 1800 ohms $\pm 10\%$; 2 w; JAN type 42BE182K.	Filter resistor for B+ supply.	3RC42BE182K
R135			(*)	RESISTOR, fixed: WW; 2000 ohms $\pm 5\%$; 10 w; JAN type RW31G202.	Filter resistor for B+ supply.	3RW26108
R4, R15			(*)	RESISTOR, fixed: comp; 2000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF202J.	R4: Cathode resistor V4. R15: Cathode resistor V6.	3RC20BF202J
R8, R16			(*)	RESISTOR, fixed: comp; 2000 ohms $\pm 5\%$; 2 w; JAN type RC41BF202J.	R8: Part of plate load in cathode-follower V4. R16: Filter resistor in B+ supply.	3RC41BF202J
R132			(*) (*)	RESISTOR, fixed: comp; 2200 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF222K.	R132: Plate coupling resistor for V104B.	3RC20BF222K
R105			(*)	RESISTOR, fixed: comp; 4700 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF472K.	Part of attenuator network.	3RC20BF472K
R5, R33			(*)	RESISTOR, fixed: comp; 5100 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF512J.	R5: Cathode resistor for V1. R33: Resistor in BAND SELECTOR switch.	3RC20BF512J
R128			(*)	RESISTOR, fixed: comp; 5600 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF562K.	Part of f-m phase-shifting network.	3RC20BF562K
R26			(*)	RESISTOR, fixed: comp; 8250 ohms $\pm 2\%$; $\frac{1}{2}$ w; Concarbon NF- $\frac{1}{2}$.	Part of meter resistor network.	3Z65S2E5
R17, R112			(*) (*)	RESISTOR, fixed: comp; 15,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF153K.	R17: Plate load resistor V6.	3RC20BF153K

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-46S/U	TS-46SA/U	TS-46AB/U			
R108, R142		(*)	(*)	RESISTOR, fixed: comp; 22,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF223K.	R112: Plate dropping resistor for V103, 400-cycle oscillator. R108: Dropping resistor for 60 ~ f-m signal. R142: Plate No. 2 dropping resistor for V101.	3RC20BF223K
R11, R12		(*)		RESISTOR, fixed: comp; 24,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF243J.	Part of EXTERNAL MODULATION input circuit.	3RC20BF243J
R121, R124		(*)		RESISTOR, fixed: comp; 27,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF273K.	R121: Grid return V104B. R124: Cathode bias V104B.	3RC20BF273K
R27		(*)		RESISTOR, fixed: comp; 26,500 ohms $\pm 2\%$; $\frac{1}{2}$ w; Concarbon NF- $\frac{1}{2}$.	Part of meter resistor network.	3Z6626E5
R3, R9, R121, R124, R126		(*)	(*)	RESISTOR, fixed: comp; 30,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF303J.	R3: Plate load V2..... R9: Screen resistor V2. R121: Grid return V104B. R124: Cathode bias V104B. R126: DECIBEL METER dropping resistor.	3RC20BF303J
R111		(*)	(*)	RESISTOR, fixed: comp; 3300 ohms $\pm 10\%$; 1 w; JAN type RC30BF333K.	Plate dropping resistor for V104B.	3RC30BF333K
R107 R154		(*)	(*)	RESISTOR, fixed: comp; 47,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF473K.	R107: Part of plate load V101. R154: Dropping resistor for screen grid of V105.	3RC20BF473K
R18		(*)		RESISTOR, fixed: comp; 51,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF513J.	Screen resistor in V6.....	3RC20BF513J
R19, R21, R117, R120, R129, R131		(*)	(*)	RESISTOR, fixed: comp; 100,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF104K.	R19: Decoupling resistor in grid V5. R21: Screen resistor V5. R117: Voltage dropping resistor for cathode bias. R120: Suppressor grid-biasing resistor of 400-cycle oscillator V103. R129: Isolating resistor for f-m sweep. R131: Grid return for V105.	3RC20BF104K
R28		(*)		RESISTOR, fixed: comp; 168,600 ohms $\pm 2\%$; $\frac{1}{2}$ w; Concarbon X- $\frac{1}{2}$.	Part of meter resistor network.	3Z6716E8
R131		(*)		RESISTOR, fixed: comp; 200,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF204J.	Series resistor in db OUTPUT meter circuit.	3RC20BF204J
R139		(*)	(*)	RESISTOR, fixed: comp; 220,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF224J.	Grid-biasing resistor for V105.	2RC20BF224J
R115, R140, R141		(*)	(*)	RESISTOR, fixed: comp; 470,000 ohms $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF474K.	R115: Grid-biasing resistor for V101. R140: Part of a-c voltage divider for SYNCHRONIZED SWEEP VOLTAGE OUTPUT. R141: Grid No. 5 bias dropping resistor for V101.	3RC20BF474K

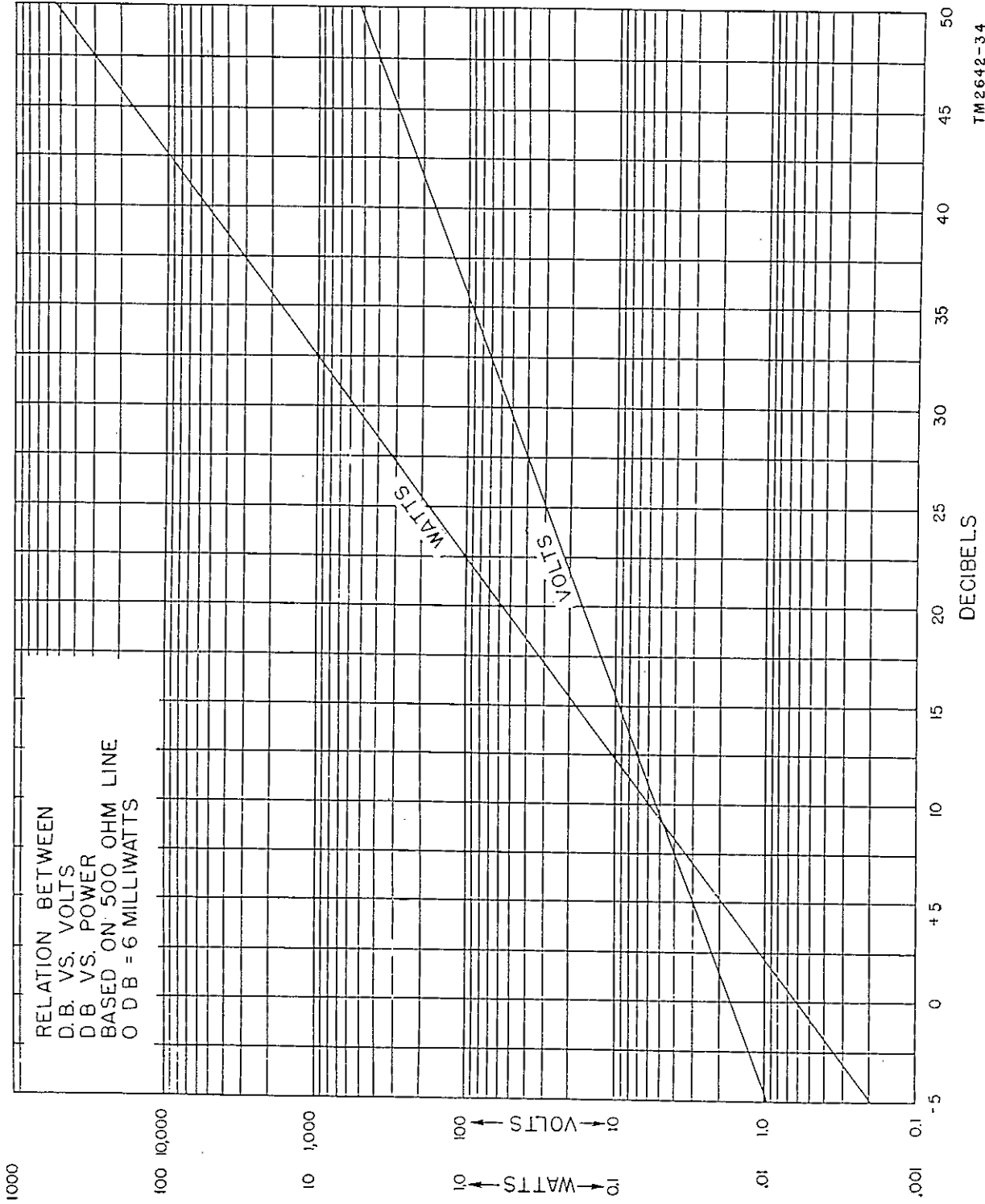
Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-65/U	TS-65A/U	TS-65B/U			
R7,R32	(*)			RESISTOR, fixed: comp; 510,000 ohms $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF514J.	R7: Grid biasing resistor for V4. R32: SYNCHRONIZED SWEEP VOLTAGE output voltage divider.	3RC20BF514J
R2, R31	(*)			RESISTOR, fixed: comp; 1 meg $\pm 5\%$; $\frac{1}{2}$ w; JAN type RC20BF105J.	R2: Grid-biasing resistor V4. R31: Grid-biasing resistor V5.	3RC20BF105J
R114, R123	(*)	(*)	(*)	RESISTOR, fixed: comp; 1 meg $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF105K.	R114: Grid-biasing resistor for V102A. R123: Grid-biasing resistor for V104A.	3RC20BF105K
R6 R136	(*)	(*)	(*)	RESISTOR, fixed: comp; 4.7 meg $\pm 10\%$; $\frac{1}{2}$ w; JAN type RC20BF475K.	R6: Grid-biasing resistor in V1. R136: Grid-biasing resistor V102B.	3RC20BF475K
R1	(*)			RESISTOR, variable: comp; 10,000 ohms $\pm 20\%$; $\frac{1}{2}$ w; JAN type RV3AUFK103B.	OUTPUT CONTROL...	3RV41011
R110		(*)		RESISTOR, variable: comp; 10,000 ohms $\pm 10\%$; 2 w; JAN type RV4APSD103A.	OUTPUT CONTROL...	3RV41017
R130		(*)		RESISTOR, variable: comp; 50,000 ohms $\pm 10\%$; 2 w; JAN type RV4BPSD503A.	FREQUENCY MODULATED SWEEP control.	3RV45027
R30 R130	(*)		(*)	RESISTOR, variable: comp; 50,000 ohms $\pm 10\%$, 2 w; SPST; JAN type RV4BNFK503A.	R30: Plate load resistor V4. R130: Varies input to f-m phase-shifting network.	3RU45039
R110		(*)		RESISTOR, variable: comp; 100 ohms $\pm 10\%$; 2 w; JAN type RV4AWFK101A.	OUTPUT CONTROL...	3RU21009
E113		(*)		SHIELD, electron tube: bayonet type mtg; .930" wd x $1\frac{3}{4}$ " h o/a; JAN type TS102U02.	Shield for tube.....	2ZS304.276
E114		(*)		SHIELD, electron tube: spring mtg; $1\frac{13}{16}$ " lg x .950 ID min, 1.065 ID max; JAN type TS103U02.	Shield for tube.....	2ZS304.275
		(*)		SOCKET, tube: octal; saddle mtg below chassis; Amphenol #SS-SX.		2ZS678.33
X101		(*)	(*)	SOCKET, tube: 7 cont, miniature; 1 piece saddle mtg; JAN type TS102C01.	Mounts tube V101.....	2ZS677.99
X102		(*)	(*)	SOCKET, tube: 9 cont, miniature; 1 piece saddle mtg; JAN type TS103P01.	Mounts tube V102.....	2ZS679.30
X102 X103 thru X106 S1,S6	(*)	(*)	(*)	SOCKET, tube: 8 cont octal; 1 piece saddle mtg; JAN type TS101P01.	Mount tubes V102 through V106.	2ZS670.33
	(*)			SWITCH, rotary: SPST; 1 sect.; AH&H type #1561-KC.	S1: POWER OFF switch. S6: DECIBEL METER switch.	3ZS902
S3	(*)			SWITCH, rotary: 2 pole, 3 position; 1 sect.; Oak part #24190-OH.	F. M.-A. M SELECTOR switch.	3Z9825-62.127
S5	(*)			SWITCH, rotary: 2 pole, 5 position; normally open; 2 sect.; Oak part #35743-H2.	OUTPUT MULTIPLIER switch.	3Z9825-62.428
S103		(*)		SWITCH, rotary: 3 pole, 3 position; normally open; 1 sect.; Oak part #35745-CH.	F. M.-A. M. SELECTOR switch.	3Z9825-62.429
S104		(*)	(*)	SWITCH, rotary: 3 pole, 5 position; 2 sect.; Oak type "H."	OUTPUT SELECTOR switch.	3Z9825-62.624

Ref symbol	Models			Name of part and description	Function of part	Signal Corps stock No.
	TS-465/U	TS-465A/U	TS-465B/U			
S4 S103 S101	(*)		(*)	SWITCH, rotary: 4 pole, 5 position; 2 sect.; Oak part #24153-H2.	OUTPUT SELECTOR switch.	3Z9825-62.128
			(*)	SWITCH, rotary: 4 pole, 11 position; 2 sect.; Oak type "H."	BAND SELECTOR switch.	3Z9825-62.623
S2 S101 T101	(*)		(*)	SWITCH, rotary: 4 pole, 10 position; normally open; 3 sect.; Oak part #40469-H32.	BAND SELECTOR switch.	3Z9825-62.422
			(*)	TRANSFORMER, AF: plate coupling type; HS metal case; Chi Trans part #20800-87.	A-f transformer for 400-cycle output.	2Z9632.654
T2	(*)			TRANSFORMER, AF: plate coupling type; pri 4000 ohms, sec'd 5 ohms; open frame; Hickok part #OS-1671.	A-f transformer for 400-cycle output.	2Z9638-86
T101		(*)		TRANSFORMER, AF: plate coupling type; pri 10,000 ohms; sec'd 275 ohms; 6.5 max pri cur., HS metal case Allegheny dynamo steel; Chi Trans #14657.	A-f transformer for 400-cycle output.	2Z9632.530
T1	(*)			TRANSFORMER, power: fil and plate type; 110-220 v, 60 cyc pri input; sec'd #1, 550 v, 50 ma ct; sec'd #2, 6.3 v, 2.5 amp; Hickok part #OS-1672.	Main power transformer.	2Z9613.271
T102			(*)	TRANSFORMER, power: fil and plate type; 115 v ac, 60 cyc single ph input; sec'd #1, 175 v, 40 ma dc w/ct; sec'd #2, 6.3 v, 2.5 amp; HS metal case; Chi Trans #20800-86.	Main power transformer.	2Z9613.720
T102		(*)		TRANSFORMER, power: fil and plate type; 115 v, 60 cyc single ph; sec'd #1, 6.3 v 2.5 amp; sec'd #2, 350 v, 40 ma; HS metal case; Chi Trans #14655.	Main power transformer.	2Z9619-240
L111		(*)		TRANSFORMER, RF: lf; unshielded; Hickok part/dwg #3320-12.	l-mc f-m oscillator coil.	2Z9629-213
L103		(*)		TRANSFORMER, RF: osc; unshielded; Hickok part/dwg #3320-31.	B band tuning.	2Z9629-212
L101		(*)		TRANSFORMER, RF: osc; unshielded; RCA part #P-71476.	A band tuning.	2Z9629-21
V101 V1	(*)			TUBE, electron: type 6C4.	Main r-f oscillator.	2J6C4
V101			(*)	TUBE, electron: type 6J5.	Crystal oscillator.	2J6J5
V2	(*)			TUBE, electron: type 6J6.	Main r-f oscillator.	2J6J6
V105		(*)	(*)	TUBE, electron: type 6KS.	F-m oscillator and mixer.	2J6KS
V6	(*)			TUBE, electron: type 6SG7Y.	Reactance modulator.	2J6SG7Y
V103 V104		(*)	(*)	TUBE, electron: type 6SJ7.	400-cycle and bfo.	2J6SJ7
V3	(*)			TUBE, electron: type 6SN7WGT.	Mixer, oscillator, and amplifier.	2J6SN7WGT
V106		(*)	(*)	TUBE, electron: type 6X5WGT.	Rectifier.	2J6X5WGT
V4	(*)			TUBE, electron: type 7N7.	Main r-f oscillator.	2J7N7
V5	(*)			TUBE, electron: type 7V7.	Reactance modulator.	2J7V7
V102			(*)	TUBE, electron: type 12AU7.	Cathode-follower and crystal oscillator.	2J12AU7
V7	(*)			TUBE, electron: type OD3/VR-150.	Voltage regulator.	2JOD3/VR150



TM 2642-33

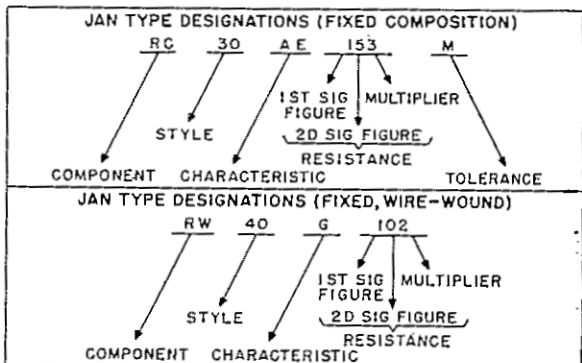
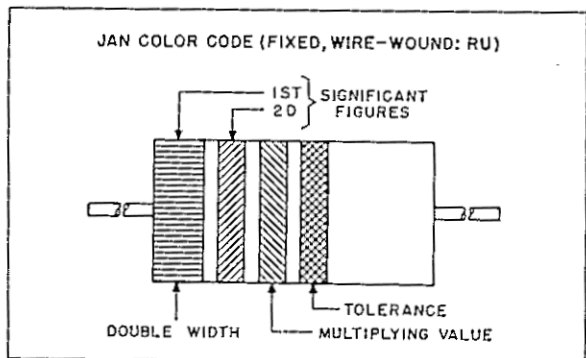
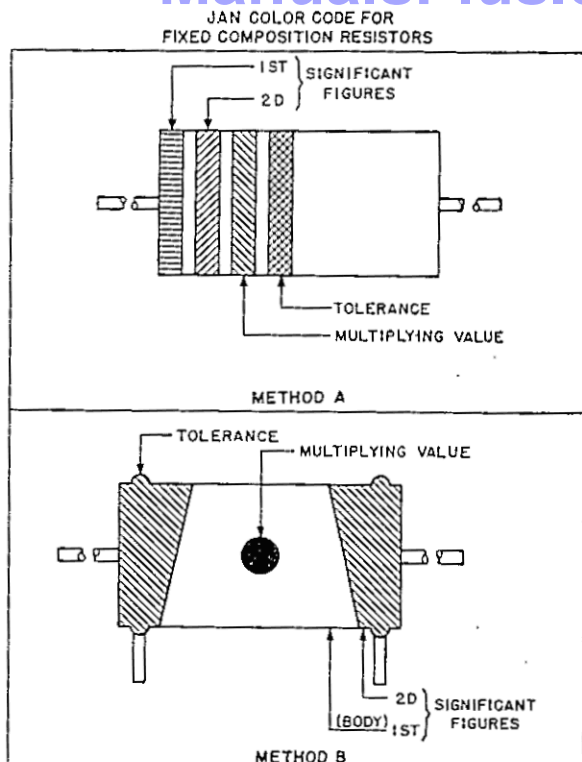
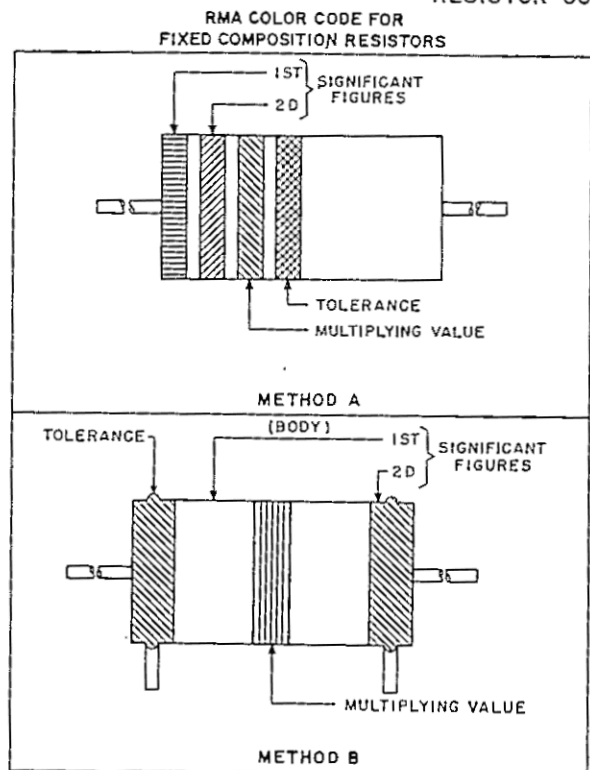
Figure 44. Signal Generator TS-165(*)/U, db correction factor.



TM 2642-34

Figure 45. Decibel-voltage chart.

RESISTOR COLOR AND LETTER CODE



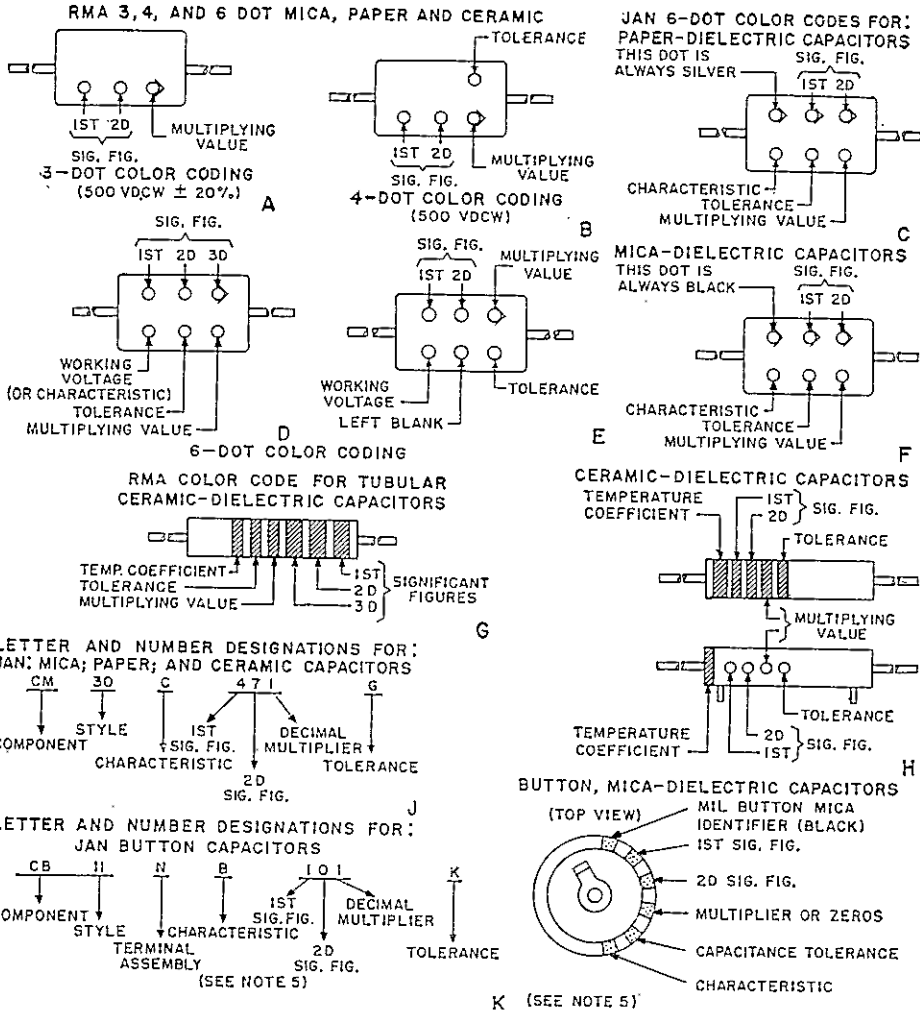
STANDARDS				
COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	--	--
BROWN	1	10	± 1	F
RED	2	100	± 2	G
ORANGE	3	1,000	± 3	--
YELLOW	4	10,000	± 4	--
GREEN	5	100,000	± 5	--
BLUE	6	1,000,000	± 6	--
VIOLET	7	10,000,000	± 7	--
GRAY	8	100,000,000	± 8	--
WHITE	9	1,000,000,000	± 9	--
GOLD	--	0.1	± 5	J
SILVER	--	0.01	± 10	K
NO COLOR	--	--	± 20	M

- NOTES:**
- RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
 - RMA: RADIO MANUFACTURERS ASSOCIATION.
 - JAN: JOINT ARMY - NAVY.
 - THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
 - RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
 - WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TMRC

Figure 46. Resistor color codes.

CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CW		JAN CERAMIC-CC					
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	YDCW	LETTER TOL.	CHARACTERISTIC	LETTER TOL.	CHARACTERISTIC	DEC. MULT.	% CAP. TOL. FOR MORE THAN 10 UUF	LETTER DESIGNATION	UUF	LETTER DESIGNATION	CHARACTERISTIC
BLACK	0	1	±20	500	M	A	M	.A	1	±20	M	±2.0	G	C
BROWN	1	10	±1	100	-	B	-	*E	10	±1	F	-	-	H
RED	2	100	±2	200	G	C	-	H	100	±2	G	-	-	L
ORANGE	3	1,000	±3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	±4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	±5	500	-	F	-	R	-	±5	J	±0.5	D	S
BLUE	6	1,000,000	±6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	±7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	±8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	±9	900	-	-	-	-	0.1	±10	K	±1.0	F	SL
GOLD	-	0.1	±5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	-	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-

* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±2%
NOTES

- JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION
- THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
 - THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
 - CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
 - BUTTON CAPACITORS ARE GENERALLY 300 VDCW
 - READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
 - CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
 - THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
CP MICA BUTTON; CC CERAMIC; CM MICA MOULDED; CW PAPER MOULDED

TM CC

Figure 47. Capacitor color codes.

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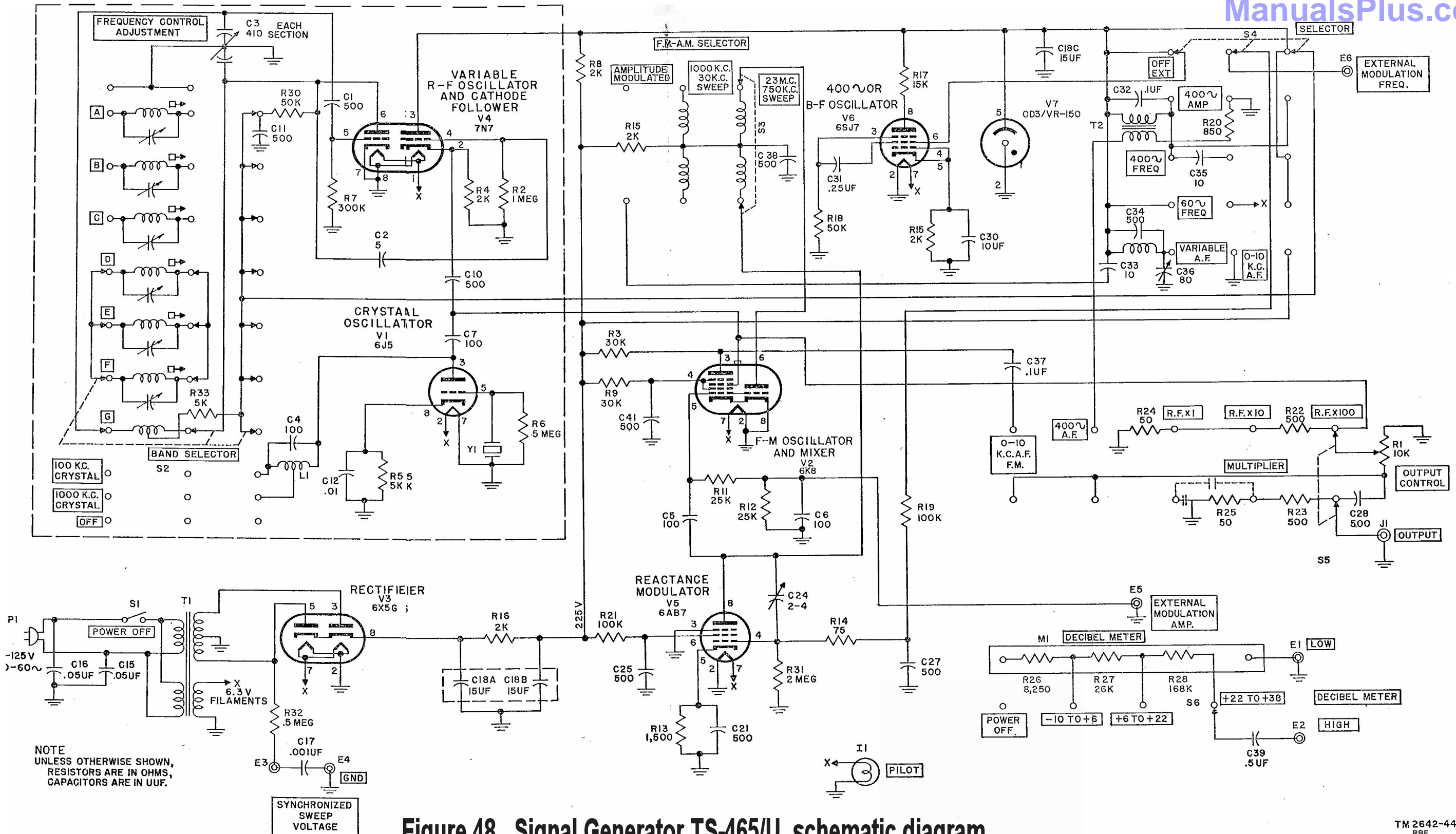
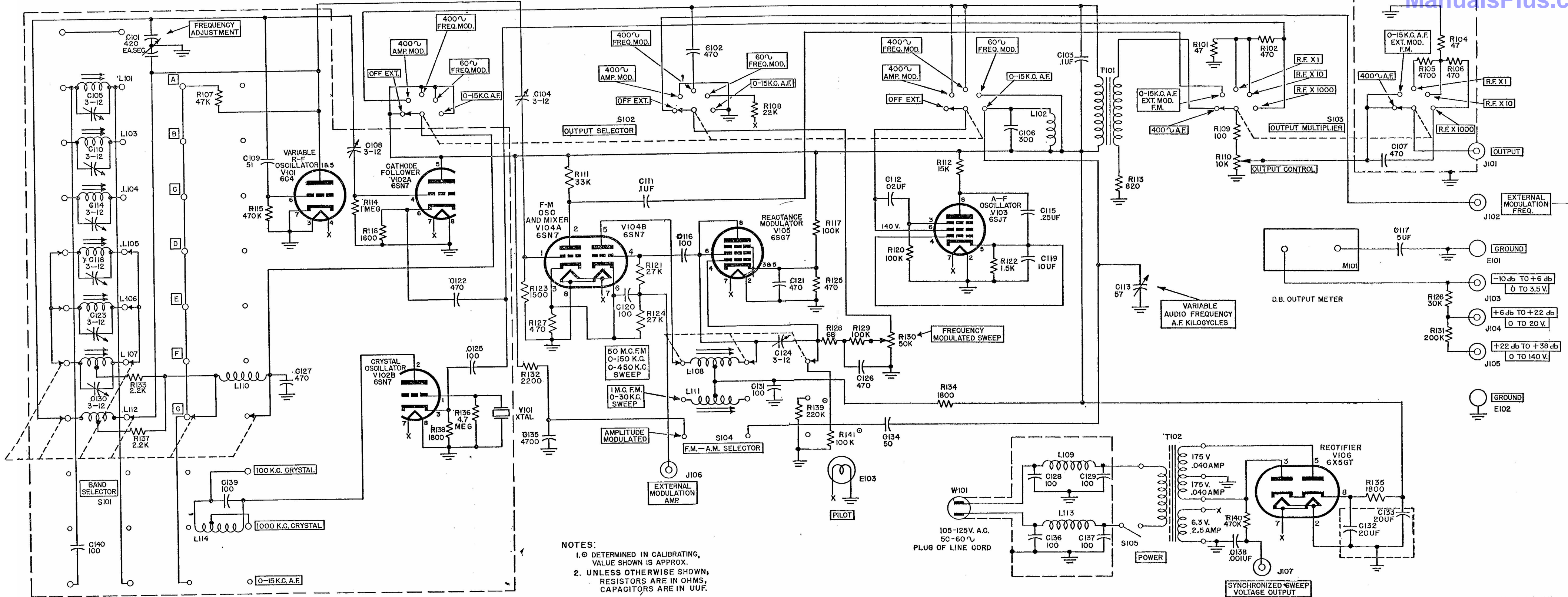
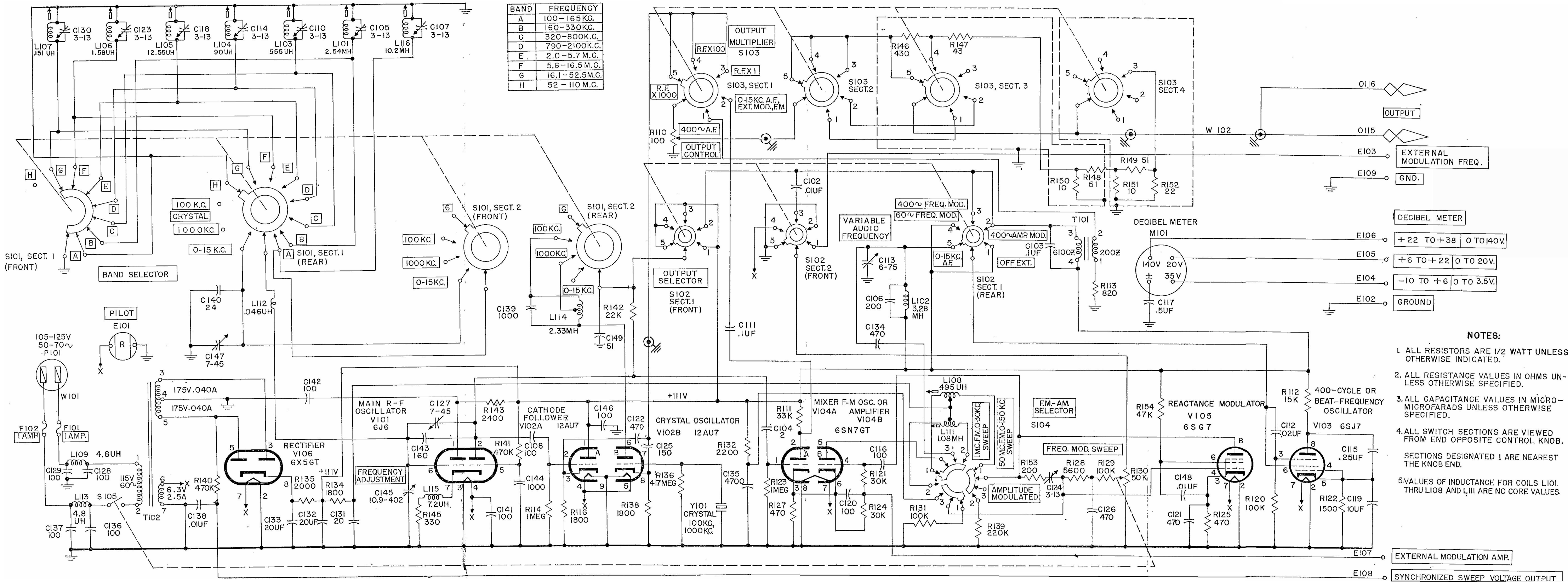


Figure 48. Signal Generator TS-465/U, schematic diagram



NOTES:
 1. Ⓞ DETERMINED IN CALIBRATING, VALUE SHOWN IS APPROX.
 2. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.

Figure 49. Signal Generator TS-465A/U, schematic diagram



- NOTES:**
1. ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE INDICATED.
 2. ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
 3. ALL CAPACITANCE VALUES IN MICRO-MICROFARADS UNLESS OTHERWISE SPECIFIED.
 4. ALL SWITCH SECTIONS ARE VIEWED FROM END OPPOSITE CONTROL KNOB. SECTIONS DESIGNATED 1 ARE NEAREST THE KNOB END.
 5. VALUES OF INDUCTANCE FOR COILS L101, THRU L108 AND L111 ARE NO CORE VALUES.

Figure 50. Signal Generator TS-465B/U, schematic diagram

SIGNAL GENERATORS TS-465/U, TS-465A/U, TS-465B/U, and TS-465C/U

TM 11-2642 }
TO 33A1-3-70-1 }
CHANGES No. 1 }

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON 25, D. C., 2 December 1958

TM 11-2642/TO 33A1-3-70-1, 10 June 1953, is changed as follows:

Change the title of the manual to: SIGNAL GENERATORS TS-465/U, TS-465A/U, TS-465B/U, and TS-465C/U.

Page 1, chapter 1. Add the following note below the title of chapter 1.

Note. Signal Generator TS-465C/U is similar to Signal Generator TS-465A/U in operation and electrical circuitry. The two equipments differ only with regard to interchangeability of component parts. Information in this manual applies to both signal generators unless otherwise specified.

Page 1, paragraph 1b, line 5. Delete "and TS-465B/U" and substitute: TS-465B/U and TS-465C/U.

Delete paragraph 2 and substitute:

2. Forms and Records

a. Unsatisfactory Equipment Reports.

- (1) Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to the Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700-38.
- (2) Fill out and forward AF TO Form 29 (Unsatisfactory Report) to the Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00-35D-54.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army) and AFR 71-4 (Air Force).

c. DA Form 11-238. Prepare DA Form 11-238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)), in accordance with instructions on the back of the form (fig. 9).

d. DA Form 11-239. Prepare DA Form 11-239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)), in

accordance with instructions on the back of the form (fig. 10).

e. Comments on Manual. Forward all comments on this publication direct to the Commanding Officer, U. S. Army Signal Publications Agency, Fort Monmouth, N. J.

Page 5, paragraph 9a, line 1. After "3," add: 3.1.

Page 6, paragraph 9b(2), line 6. After "resistors" add: (R126 and R131).

Paragraph 9b(3), line 3. Change "three" to: four.

Page 41, paragraph 67, table, "Fig. or par. No." and "Description" columns. Make the following changes:

After "Fig. 35," add: Fig. 35.1 Signal Generator TS-465C/U, top rear view of chassis.

After "Fig. 36," add: Fig. 36.1 Signal Generator TS-465C/U, bottom rear view of chassis.

Paragraph 69. Delete the chart and substitute:

Test equipment	Technical manual
Signal Generator TS-497A/U.....	TM 11-5030
Frequency Meter AN/URM-79.....	TM 11-5094
Frequency Meter AN/URM-80.....	TM 11-5095
Audio Oscillator TS-382A/U.....	TM 11-2684A
Panoramic Indicator IP-173A/U.....	TM 11-5086
Tube Tester TV-2/U.....	TM 11-2661
Radio Receiver R-220/URR.....	TM 11-882
Radio Receiver R-390/URR.....	TM 11-856
Multimeter TS-352/U.....	TM 11-5527
Electronic Multimeter TS-505/U.....	TM 11-5511
Radio Receiver R-389/URR.....	TM 11-855
Transformer, variable power CN-16/U..	
Oscilloscope OS-8C/U.....	TM 11-1214A
Voltmeter ME-30/U.....	TM 11-5132

Page 43, paragraph 70. Delete (6) and substitute:

- (6) Do not disturb the settings of capacitors C105, C110, C114, C118, C123, and C130

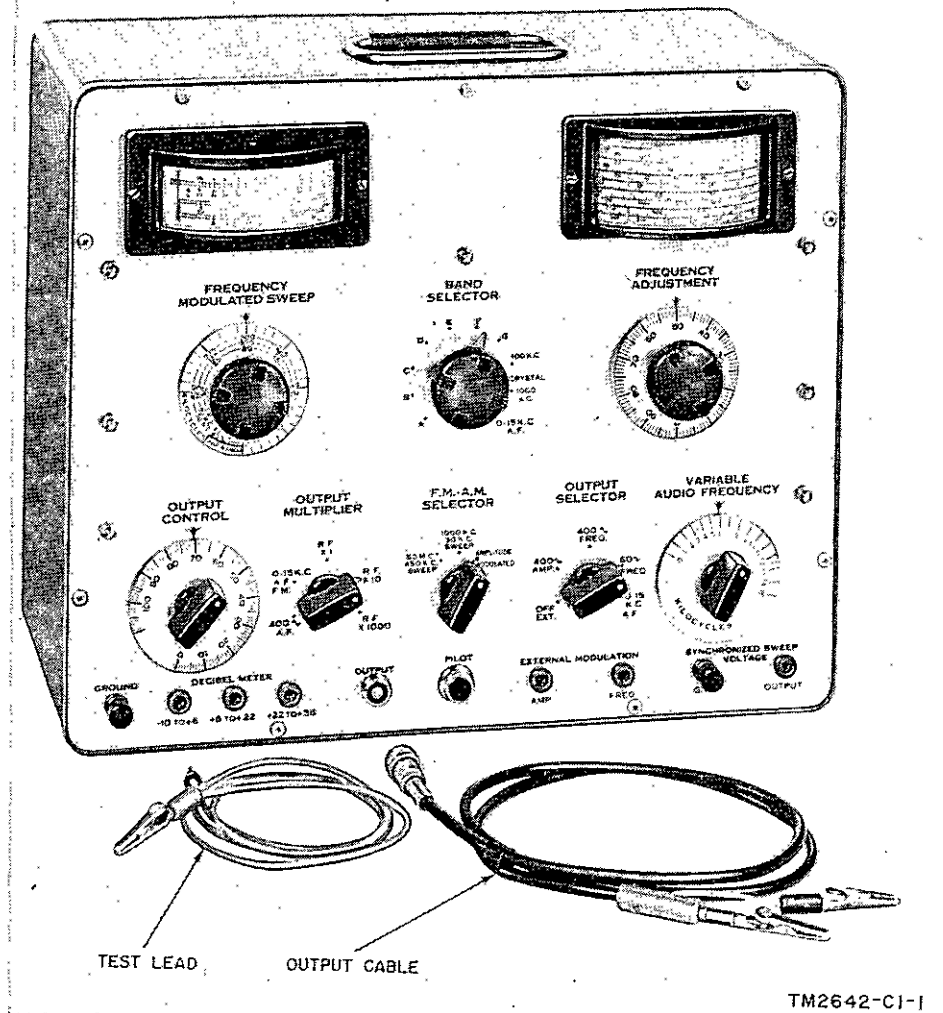


Figure 3.1. (Added) Signal Generator TS-465C/U.

in TS-465A/U or TS-465C/U. Do not disturb the settings of capacitors C105, C107, C110, C114, C118, C123, and C130 in TS-465B/U. Capacitors in the TS-465/U which correspond to capacitors C105, C110, C114, C118, C123, and C130 in TS-465A/U and TS-465C/U should not be disturbed. Failure to observe these precautions may result in decreased gain, nonoscillation, or off-frequency operation of the circuit.

Paragraph 71a, line 3. Delete "(par. 68)". Add the following: (On model TS-465/U, check from pin 8 of V3 to ground.)

Page 44, paragraph 72, troubleshooting chart. Make the following changes:

Item 1, Probable trouble column. Add the

following at the end of the sentence: (in TS-465B/U only).

Item 1, Correction column, line 6. Add the following at the end of "connections": or replace switch.

Item 3, Probable trouble column. Add the following item: In TS-465A/U or TS-465B/U, multiplier resistors R126 or R131 are open or have poor connections.

Item 3, Correction column. Add the following: Replace R126 or R131 or repair connection.

Page 45, paragraph 72, troubleshooting chart. Make the following changes:

Item 5, Correction column. Delete the first sentence and substitute: Compare the voltage between pin 1 of tube V102A and

ground with value shown in figure 30. (In TS-465A/U and TS-465C/U, compare voltage between pin 5 of tube V102A and ground with value shown in figure 28.)

Item 8, Probable trouble column. Add the following at the end of the sentence: (R101, R102, R104, R105, and R106 in TS-465A/U and TS-465C/U).

Items 11, 12, 13, 15, 16, 17, 18, 19, 20 and 21. In the Correction column, add "(figs. 28 and 29 in TS-465A/U and TS-465C/U)" after "(fig. 30)".

Item 19, Probable trouble column. After "E 107," add: (J106 in TS-465A/U and TS-465C/U).

Page 46, paragraph 72, troubleshooting chart. Make the following changes:

Item 23, Probable trouble column. After "E 103" add: (J102 in TS-465A/U and TS-465C/U).

Item 24, Symptom and Probable trouble columns. After "E 108," add: (J107 in TS-465A/U and TS-465C/U).

Paragraph 73. Make the following changes: Subparagraph *b*. Change the title to: Replacement Procedures (figs. 35-43).

Subparagraph *b*(3), line 2. After "four screws" add: or nuts.

(4.1) (Added) To service the RF section or replace a coil in models TS-465A/U or TS-465C/U, first remove the upper shield ((2) above). Unsolder and tag the four wires which enter the IF section through the grommets hole in the bottom of the RF section. Loosen the two setscrews that hold the FREQUENCY ADJUST control knob in place, and remove the knob. Loosen the set screw that holds the BAND SELECTOR knob in place, and remove the knob. Remove the two $\frac{3}{8}$ -inch by 32 hexagonal nuts which are then exposed. The RF section may now be removed for servicing.

(5.1) (Added) To remove the coil mounting plate in TS-465A/U or TS-465C/U for servicing, unsolder and tag the four leads that connect the coils to the oscillator subchassis. Remove the $\frac{3}{8}$ -inch by 32 hexagonal nut from the BANK SELECTOR bushing and remove V101 from its socket. The coil subchassis may

now be removed from the RF section for servicing.

(6.1) (Added) To remove the variable capacitor (in TS-465A/U or TS-465C/U), loosen the two setscrews in the upper end of the insulating coupling and remove the dial drum and shaft assembly. Loosen the two setscrews in the lower end of the insulating coupling and the two setscrews that hold the drive drum in place on the shaft. Slide the coupling and drive drum up on the shaft so as to disengage the edge of the drive drum from the drive assembly. Unsolder and tag the four leads, capacitor C108, and the grounding strap of the variable capacitor. The variable capacitor may now be removed from the RF section by pulling the snap-in mounting pins from the snap-in retainers.

Page 47, paragraph 73*b*.

(7.1) (Added) To remove the coil located on the BAND SELECTOR switch (in TS-465A/U or TS-465C/U), remove the coil mounting plate from the RF section ((5) above). Unsolder and tag the leads of the coil. Remove the screw from the rear of the coil mounting plate. The coil may now be removed.

(9.1) (Added) To remove the friction drive shaft assembly (in TS-465A/U or TS-465C/U), first remove the RF section and the variable capacitor as outlined in (4.1) and (6.1) above. The friction drive can be now removed from its bushing.

Subparagraph *b*(10), line 1. After "some," insert: TS-465B/U.

Add the following at the end of *b*(10):

In models TS-465A/U and TS-465C/U, switches S102 and S104 have shifts $4\frac{1}{16}$ inches long. For replacement procedures, refer to (a.1) and (b.1) below.

Page 48, paragraph 73*b*(10)(a), line 1. After "S104," add: (in TS-465/U and TS-465B/U).

(a.1) (Added) To replace FM-AM SELECTOR switch S104 (in TS-465A/U and TS-465C/U), proceed as follows:

1. Remove the control knob and unsolder and tag the leads to switch 104 and the leads to coils L108 and L111.

2. Remove the coils from the mounting bracket.
3. Remove the hexagonal mounting nut from the switch bushing.
4. Remove the switch from the chassis and bracket.
5. Mount the new switch and the bracket on the chassis and secure it with the hexagonal nut, and resolder the tagged leads in the proper positions on the new switch and coils L108 and L111.
6. Replace the control knob.

Subparagraph *b*(10)(*b*), line 1. After "S102," add: (in TS-465/U and TS-465B/U).

(*b*.1) (Added) To replace the OUTPUT SELECTOR switch S102 (in TS-465A/U and TS-465C/U), proceed as follows:

1. Remove the control knob, unsolder and tag the leads to S102, and remove the hexagonal mounting nut from the switch bushing.
2. Place the new switch in position and secure it with the hexagonal mounting nut.
3. Connect the tagged leads to the proper terminals of the new switch and solder the connections.

Page 50, paragraph 74. Add "(TS-465B/U)" to the paragraph heading. Subparagraph *a*, delete the last sentence.

74.1. Adjustment of Frequency Dial and Friction Drive (TS-465/U, TS-465A/U and TS-465C/U)

(Added)

a. Friction Drive. In Signal Generator TS-465/U, TS-465A/U, and TS-465C/U, the dial drive is operated through a friction-type drive which rotates a drum on the variable capacitor shaft. The friction drive consists of two disks which squeeze the edge of the drum on the variable capacitor. If the dial rotates too tightly or too freely, obtain a smooth drive by positioning the dial drive drum up or down as necessary on the variable capacitor driveshaft.

b. Zero Adjust of Dial Frequency. The variable capacitor should be set to the fully meshed position. The reference mark on the dial is the vertical black line which runs from the top to the bottom of the dial scale on the low-frequency end of the dial. It appears directly below the word

BAND which is printed in black. Aline the reference line on the dial with the red reference line on the transparent dial window.

Page 56, paragraph 76. Add: "(TS-465/U and TS-465B/U)" to the paragraph heading.

Line 3. Delete "Set SCR-211-(*)" and substitute: AN/URM-79.

Line 5. Delete "TS-174(*)/U" and substitute: AN/URM-80.

76.1. Calibration of Main RF Oscillator (TS-465A/U and TS-465C/U)

(Added)

Accurate calibration of the main RF oscillator requires the use of a frequency meter. Use Frequency Meter AN/URM-79 for all frequencies below 20 mc. and Frequency Meter AN/URM-80 for frequencies above 20 mc.

a. The RF oscillators in TS-465A/U are calibrated by adjusting the tank circuit constants of each band in such a manner that when the signal generator is tuned to its lowest or highest frequency on any given band, these frequency indications will be correct.

b. The low-frequency end is calibrated by varying the inductance of the coil. This is accomplished by the use of a powdered iron core. The high-frequency end of the band is adjusted by means of a trimmer capacitor. Some interaction between the low-frequency and high-frequency adjustments will be noted. The adjustments should be repeated until both the high and low ends of the band are properly calibrated. When adjusted in this manner, all intermediate points between the high- and low-frequency ends of the band will be in calibration.

c. The only exception to the above procedure is the *G* band. The *G* band is calibrated at 100 mc by physically changing the coil configuration. The circuit characteristics of TS-465A/U and TS-465C/U is such that when the frequency is accurately set at 100 mc, the calibration on the *G* band will be correct. Following is a step-by-step procedure of the calibration of the *A* band. This procedure should be repeated on all bands, except *G*.

- (1) Turn on the signal generator and frequency meter and allow them to warm up for at least 20 minutes.
- (2) Set Frequency Meter AN/URM-79 to 110 kc according to the instructions furnished with the frequency meter.
- (3) Set the BAND SELECTOR knob of the

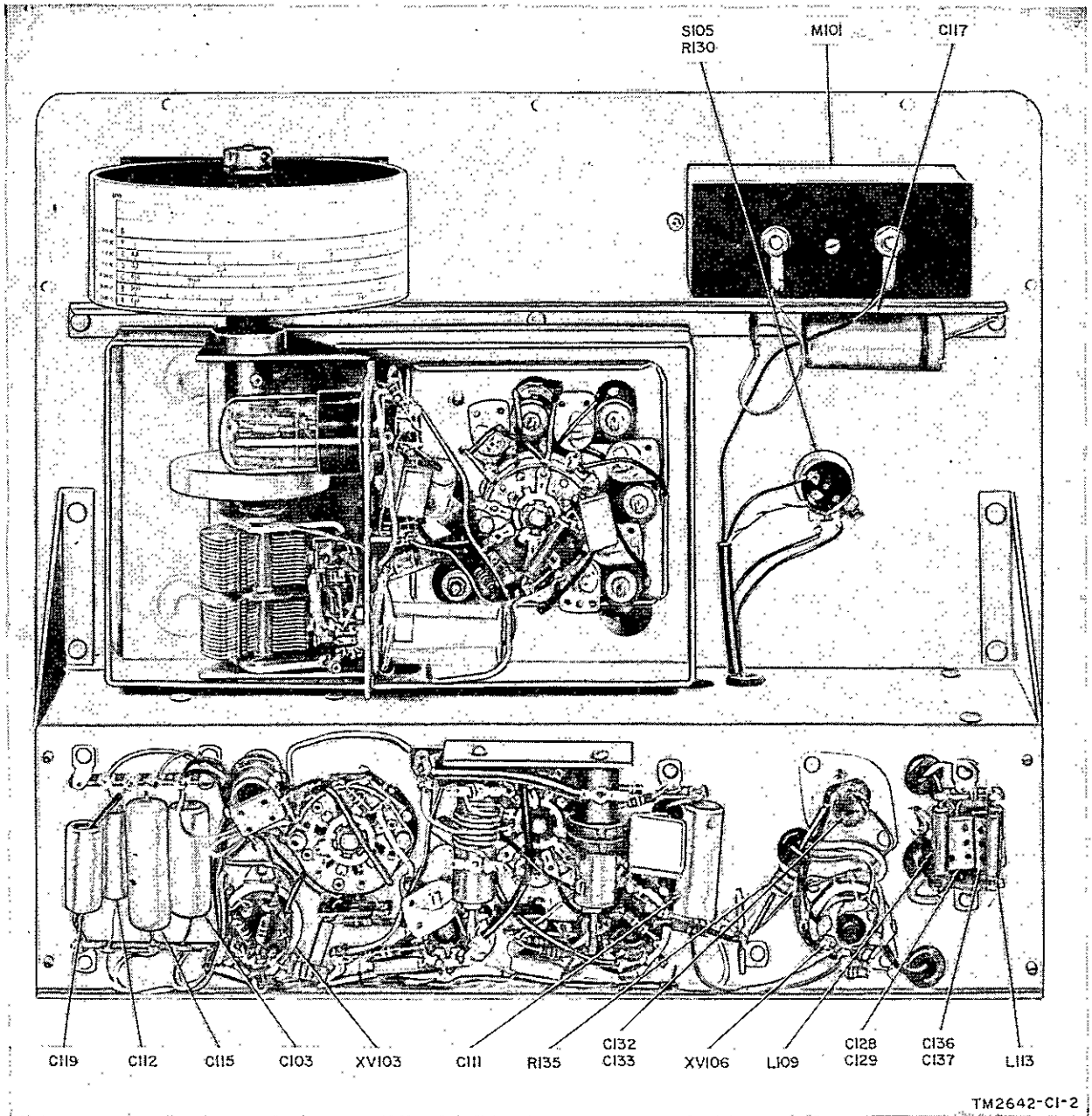


Figure 35.1. (Added) Signal Generator TS-465C/U, top rear view of chassis.

TS-465A/U or TS-465C/U to the *A* band position and the FREQUENCY ADJUSTMENT control to the low-frequency end of the *A* band (110 kc).

- (4) Adjust the core of L101 for zero beat in the headset connection to the frequency meter. Partially tighten the hexagonal locknut.
- (5) Set the FREQUENCY ADJUSTMENT control to the high-frequency (300 kc) end of the *A* band. Set the frequency

meter to 300 kc and adjust capacitor C105 for zero beat in the headset connected to the frequency meter.

- (6) Repeat the alinement ((4) and (5) above) until no further change in the settings is necessary. Tighten the hexagonal nut in coil L101. Repeat the above procedure for bands *B* through *F*.

Paragraph 78a, lines 6 and 7. Delete "Frequency Meter Set SCR-211-(*) or Frequency Meter TS-174(*)/U in the same manner as

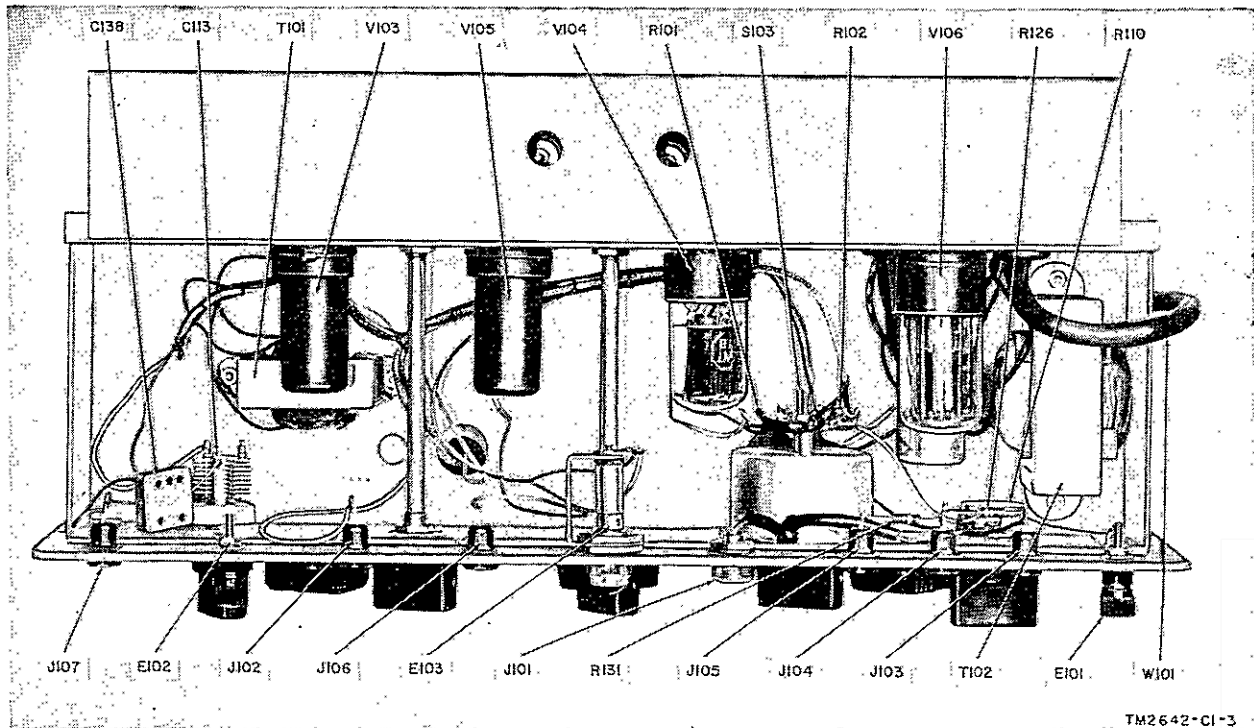


Figure 36.1. (Added) Signal Generator TS-465C/U, bottom rear view of chassis.

described in paragraph 75" and substitute: Frequency Meter AN/URM-79 or AN/URM-80 in the same manner as described in paragraph 76.

Page 57, paragraph 79. Make the following changes:

Delete the second sentence and substitute: Use Panoramic Indicator IP-173A/U in conjunction with Signal Generator TS-497A/U to measure the sweep width.

Delete subparagraph *a* and substitute:

a. Connect Signal Generator TS-497A/URR to the Panoramic Indicator as described in TM 11-5030.

Subparagraph *b*, line 2. Delete "the antenna terminals of the receiver" and substitute: J101 of the Panoramic Indicator.

Subparagraph *d*. Delete the first sentence and substitute: Set Signal Generator TS-497A/URR to 45 mc.

Subparagraph *d*, line 3. Change "adapter" to indicator.

Page 58, paragraph 82*a*. In the last line change "1 volt" to 2.5 volts or less.

Paragraph 83*a*, last line. Add: or to the input terminals of Voltmeter ME-30A/U.

Paragraph 84*a*, line 3. Delete "a standard

am receiver" and substitute: Radio Receiver R-389/URR.

Paragraph 85, line 4. After "TS-465(*)/U," add: or Voltmeter ME-30A/U.

Paragraph 86*a*, lines 1 and 2. Change "Frequency Meter Set SCR-211-(*) or Frequency Meter TS-174(*)/U" to: Frequency Meter AN/URM-79 or AN/URM-80.

Page 59, paragraph 87*a*, line 3. Change "standard am receiver" to: Radio Receiver R/389/URR.

Paragraph 88. Make the following changes:

Subparagraph *a*, line 2. Delete the first sentence and substitute:

Connect the OUTPUT cable of Signal Generator TS-465(*)/U to Radio Receiver R-220/URR (par. 79).

Subparagraph *b*, line 2. Change "60-cycle" to: 400-cycle. Delete subparagraph *c* and substitute:

c. The 400-cycle modulation should be heard in the loudspeaker of Radio Receiver R-220/URR.

Paragraphs 90*a* and 91*a*, line 3. After "am receiver," add: (Radio Receiver R-389/URR, R-390/URR or R-220/URR).

Paragraph 92*a*, line 1. Change "a standard am receiver" to: Radio Receiver R-390/URR.

Page 60. Delete paragraph 93.
 Page 62. Delete appendix I.
 Page 64. Delete appendix II.
 Figure 49 (fold-out). Make the following changes:

Caption. After "TS-465A/U," add: and TS-465C/U.
 Add the following to the notes:
 3. IN TS-465C/U, C109 IS 50 UUF, C112 IS .025 UF, AND C134 IS 47 UUF.

[AG 413.44 (14 Nov 58)]

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USAR: None.

For explanation of abbreviations used, see AR 320-50.

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