TM 11-5101

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

AF AMPLIFIER

AM-465/FR

DEPARTMENT OF THE ARMY • NOVEMBER 1954

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 250-volt plate and power supply circuits, or on the 115-volt ac and dc line connections.

DO NOT TAKE CHANCES!

TECHNICAL MANUAL
No. 11–5101

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *8 November 1954*

AF AMPLIFIER AM–465/FR

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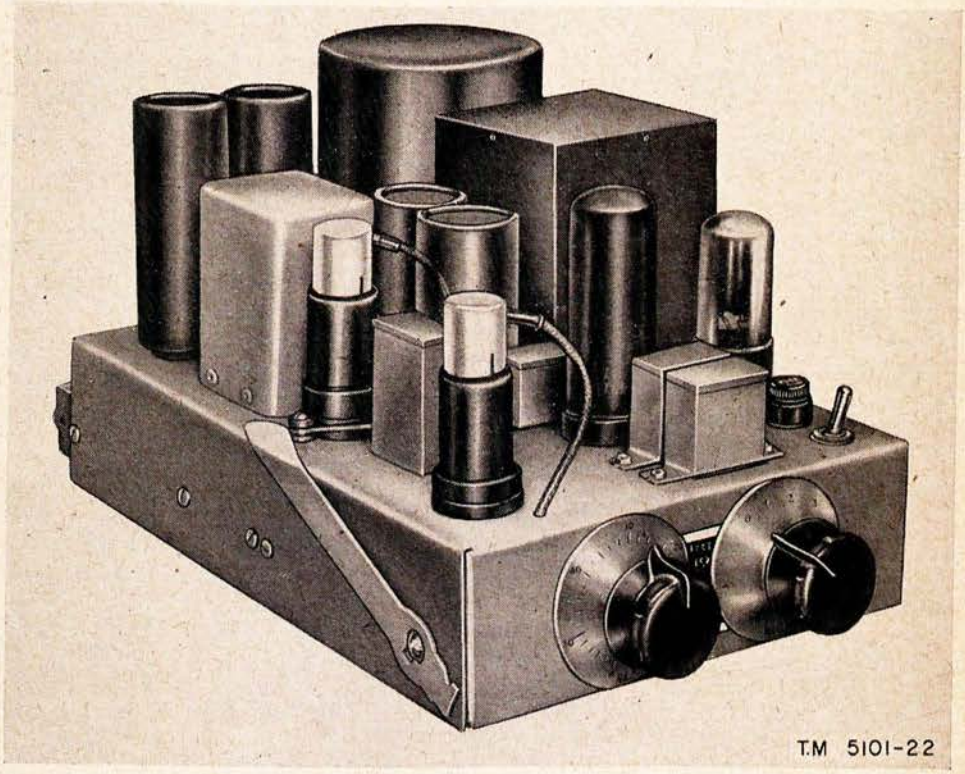


Figure 1. AF Amplifier AM–465/FR.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This manual contains complete instructions for the installation, operation, maintenance, and repair of AF Amplifier AM–465/FR (fig. 1). These instructions apply only to the audio-frequency (af) amplifier as a single unit.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and when performing preventive maintenance:

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 (Navy), 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. DA 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. 15).

d. DA 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. 16).

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

AF Amplifier AM–465/FR is a single channel, high fidelity, high gain, low distortion amplifier designed to raise the output of preamplifiers or mixers to a level suitable for feeding broadcast telephone lines or radio transmitter inputs. It may be used as a bridging amplifier for isolation or other applications where a 20,000-ohm amplifier input is desirable. The usefulness of AF Amplifier AM–465/FR as a single unit is limited to use as an emergency monitoring amplifier (2 watts output). The amplifier has a plug-in type chassis allowing easy removal from shelves or racks for servicing or interchanging units.

4. System Applications

a. AF Amplifier AM–465/FR is used to provide a signal level suitable for audio transmitter inputs. Terminal interconnecting plugs, supplied with the equipment as accessories, are used for interconnecting units. A simplified block diagram in figure 2 indicates the system set up. In

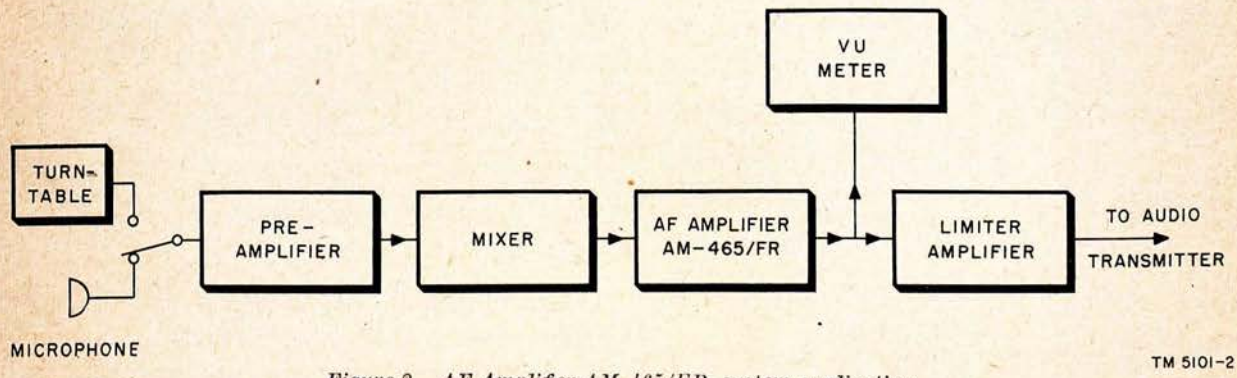


Figure 2. AF Amplifier AM–465/FR, system application.

this application the af amplifier is used to build up the output signal of a mixer to a level suitable for operation of a limiter prior to application to a transmitter.

b. The af amplifier may be used as a line matching amplifier. The amplifier may be used with amplifiers having provisions for 150- or 600-ohm balanced or unbalanced input.

c. If there is a loss of the high or low frequencies in the overall system application, the af amplifier can be altered to compensate for the loss.

5. Technical Characteristics

Power requirements—100 to 130 volts, 50 to 60 cps, 55 watts.
Fuse rating—1 ampere, type MDL.
Number of tubes—4.
Source impedance—600 or 150 ohms.
Input impedance:
  Matching—600 or 150 ohms (approx).
  Bridging—20,000 ohms (approx).
Maximum input level:
  Matching input—+11 dbm for 1% total rms distortion from 30 to 15,000 cps (output +30 dbm).
  Bridging input—+30 dbm for .5% total rms distortion from 30 to 15,000 cps (output +18 dbm).
Load impedance (tapped transformer)—600 ohms balanced (taps for 150, 15, 7.5, and 5 ohms).
Rated output level—+30 dbm with .5% total rms distortion from 50 to 15,000 cps; +30 dbm with less than 1% total rms distortion from 30 to 15,000 cps.
Gain:
  Matching input—65 db ±1 db, 600- or 150-ohm source to 600- or 150-ohm load.
  Bridging input—28 db from a 600-ohm terminated line to a 600- or 150-ohm load; measured at 1,000 cps with VA control in maximum position.
Frequency response—±1 db (referred to 1,000 cps) from 30 to 15,000 cps; measured from either 600-ohm or 150-ohm source to 600-ohm load with either bridging or matching inputs.
Noise level—Less than —48 dbm with VA control in maximum position and input and output circuits terminated in 600 ohms.
Isolation—90 db with matching input. 100 db with bridging input.
Connections—Two 10-prong plugs, mounted on rear panel of chassis, which engage with two receptacles provided with amplifier.

6. Packaging Data

a. When packaged for export shipment, the components of AF Amplifier AM–465/FR are packed in a moisture-vaporproof corrugated container which is placed in a wooden crate. An exploded view of a typical component packed for export is shown in figure 4. The size, weight, and volume of the container are indicated in the following chart:

	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Unit Weight (lb)
Wooden crate (export)	19⅛	12¼	14¾	2	50

b. The following list indicates the contents of the container. See the packing list attached to the container for exact contents.

Container dimensions (in.)	Contents	Notes
16⅛ x 10¾ x 13¼	1—AF Amplifier AM–465/FR chassis.	With tubes in place.

7. Table of Components

Component	Required No.	Height (in.)	Depth (in.)	Length (in.)	Unit weight (lb)
AF Amplifier AM–465/FR	1	6¾	12	8	18½
Input Receptacle for J1	1	⅞	⅞	2¼	¼
Output Receptacle for J2	1	⅞	⅞	2¼	¼
Set of mounting hardware	1 set	⅛	1	1¾	¼
Running spares	1 set	4	1½	1	1½
Technical Manual TM 11–5101, AF Amplifier AM–465/FR.	1				
Packing list					
Total					20¾

Note. This list for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

8. Description of AF Amplifier AM–465/FR

AF Amplifier AM–465/FR consists of a single chassis upon which are mounted three audio am-

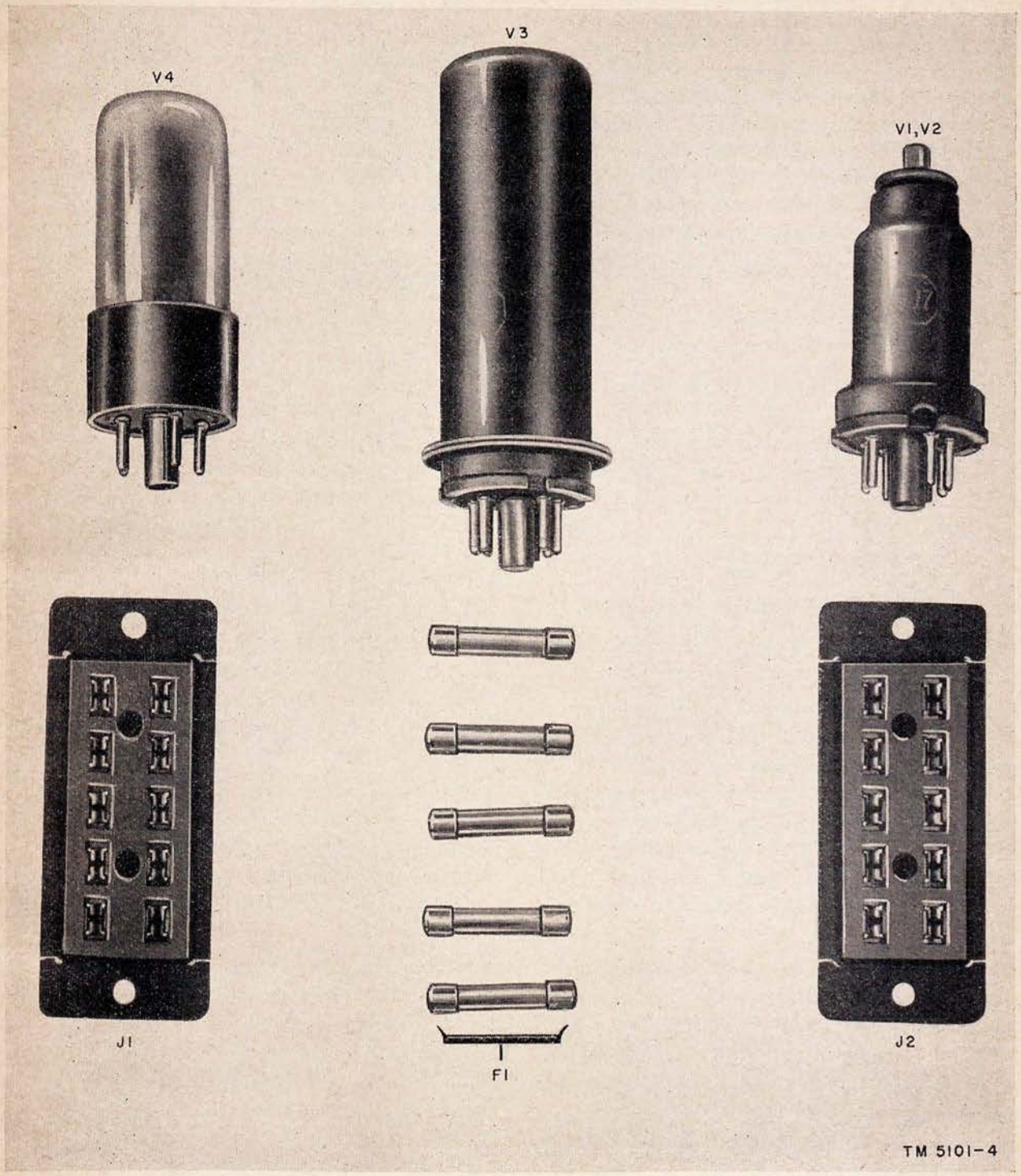


Figure 3. Running spares.

plifier stages and a power supply. A completely assembled amplifier is shown in figure 1. Provisions are made for controlling the gain of the amplifier, for adjusting the hum to a minimum, and for checking the operation of each tube. The VA (gain) control is mounted on the left side of the amplifier front panel and the METER switch on the right (fig. 14). The HUM adjustment potentiometer is mounted on top of the chassis in front of the output transformer (fig. 14). Connections to the amplifier are made directly to plugs located on the rear of the chassis. The plug marked J1 is the input and the plug marked J2 is the output (fig. 5).

9. Running Spares

A group of running spares (fig. 3), packed in the packing carton of AF Amplifier AM–465/FR, is supplied with each amplifier. Spares are provided for all normally expendable items such as tubes, receptacles, and fuses. The following is a list of running spares:

1—Tube 5Y3GT.
1—Tube –6J7.
1—Tube –6L6.
5—Fuses, 1 ampere, type MDL.
1—Receptacle, input.
1—Receptacle, output.

CHAPTER 2

INSTALLATION AND OPERATION

Note. This chapter illustrates and furnishes the operator sufficient information pertaining to the various controls and instruments provided for the proper operation of the equipment.

Section I. SERVICE UPON RECEIPT OF AF AMPLIFIER AM–465/FR

10. Unpacking and Checking New Equipment

Note. For used or reconditioned equipment refer to paragraph 14.

a. General. For domestic shipment, equipment is packed in corrugated fiberboard cartons (*c* below). For oversea shipment, the equipment is packed in double fiberboard cartons with a moisture-vaporproof barrier, packed in a wooden crate (*b* below). A packaging diagram for export and domestic shipment is shown in figure 4.

Caution: Be careful when unpacking and handling the equipment, it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment may be rendered useless.

b. Unpacking Equipment Packed for Oversea Shipment. Perform all the steps outlined below when unpacking equipment packaged for oversea shipment. When unpacking equipment packaged for domestic shipment, omit the steps described in (1) below.

(1) Remove the nails from the top and one side of the wooden case with a nail puller. Remove the top. Do not attempt to pry off the sides and top; the equipment may be damaged.

(2) Cut and fold back top of fiberboard container.

(3) Remove the moistureproof barrier.

(4) Cut and fold back top of inner fiberboard container.

(5) Remove the equipment from its inner container.

(6) Inspect the equipment for possible damage incurred in shipment.

(7) Check contents of packing case against master packing slip.

c. Unpacking Domestic Packing Cases. Follow *b*(2) through (7) above for unpacking domestic packing cases.

Note. Save the packing case and cartons. They can be used again when the equipment is repacked for storage.

11. Installation of Tubes and Capacitors

Instructions for checking the installation and location of tubes and capacitors are as follows:

a. Tubes. With the power OFF-ON switch in the OFF position, check to be sure that the tubes are in their proper sockets as shown in figure 5. The tube type for each socket is stenciled on the chassis near the socket. Mount the two grid caps and the grid cap shields on tubes V1 and V2 (type 6J7). Each shield must make a good electrical connection to the shell of the tube to insure noise-free operation.

b. Electrolytic Capacitors. The four electrolytic capacitors, C2, C9, C10, and C11, should be in the red sockets provided on the amplifier chassis (fig. 5). Carefully check each capacitor to be sure that the rating marked on the capacitor cover corresponds to the value stenciled on the chassis adjacent to the sockets.

12. Receptacle Connections

To place the equipment in operation, it is necessary to fabricate cables for the input and output receptacles that mate with the input and output

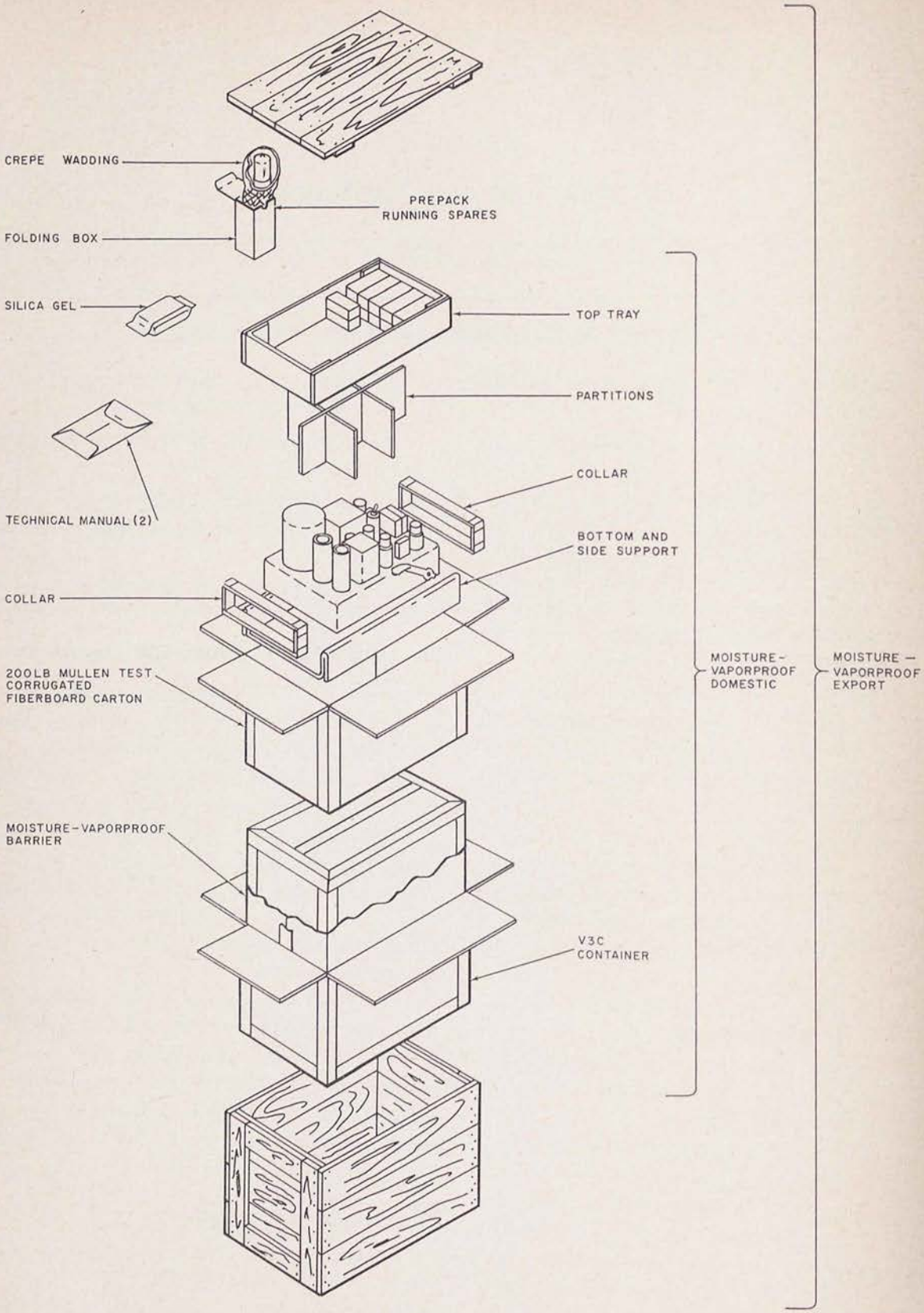


Figure 4. Packaging diagram.

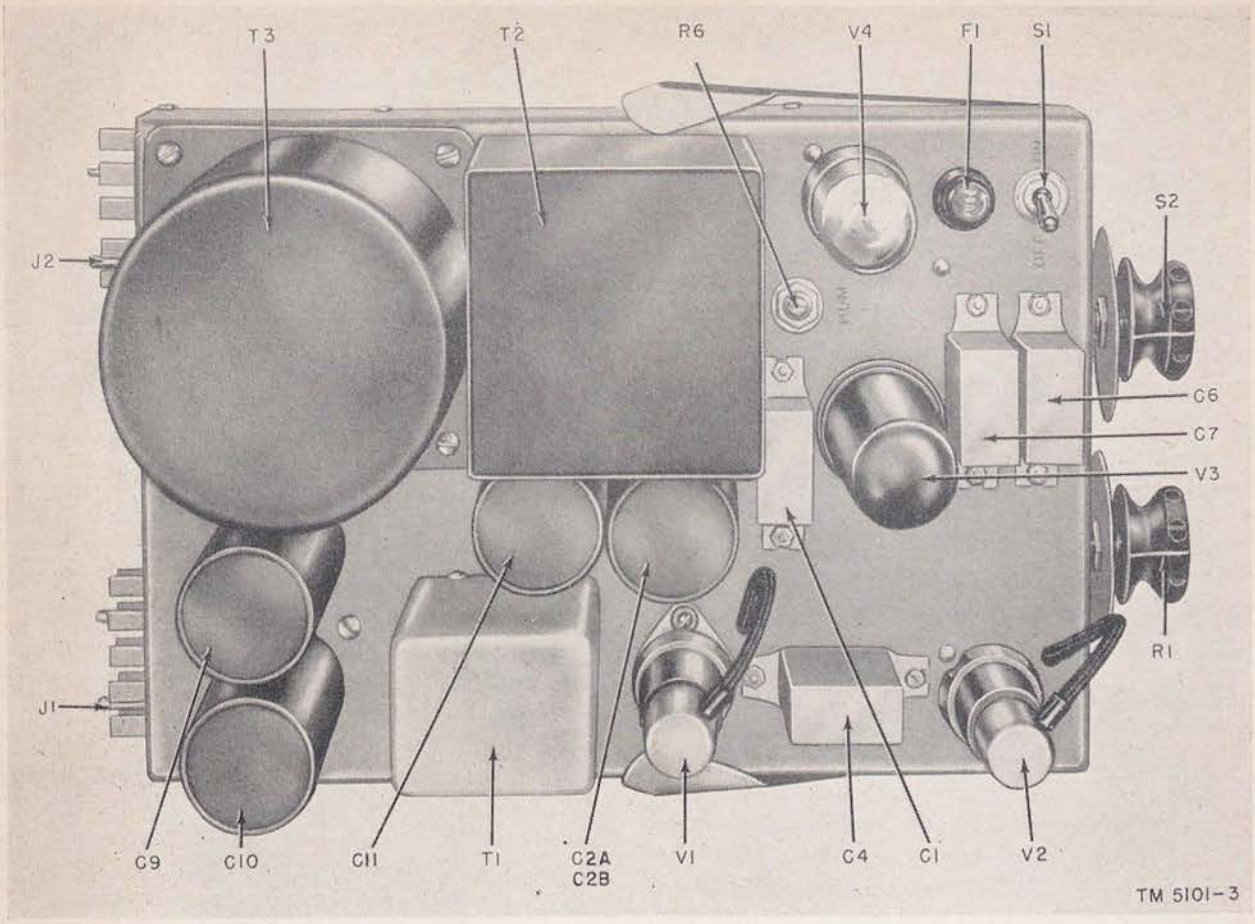


Figure 5. AF Amplifier AM–465/FR, chassis, top view.

plug mounted on the chassis. Paragraphs 17 and 18 contain the necessary information for proper termination of the input and output wiring. The connections to the two 10-prong receptacles that mate with the amplifier plugs mounted on the chassis are listed below.

Input Receptacle J1

Terminal No.	Connection
3	No connection.
4	No connection.
5	Bridging pad input.
6	Bridging pad input.
7	Output of bridging pad.
8	Test meter (+).
9	Output of bridging pad.
10	Amplifier ground.
11	Matching input (ground side).
12	Matching input.

Output Receptacle J2

Terminal No.	Connection
3	Output transformer, 5-ohm tap.
4	Output transformer, center tap.
5	Ac input to power transformer (to S1).
6	Ac input to power transformer.
7	Output transformer, 7.5-ohm tap.
8	Output transformer, center tap.
9	Output transformer, 15-ohm tap.
10	Output transformer, center tap.
11	Output transformer, 600 ohms.
12	Output transformer, 600 ohms.

13. Mounting

a. AF Amplifier AM–465/FR is designed for shelf mounting. Slide the amplifier chassis onto a shelf so that the plugs mounted on the chassis fit into the receptacles that have been mounted on the rear of the shelf.

b. The VA control shaft is on the left side of the amplifier (front view) and the METER switch is on the right side (fig. 14). Mount the dial plates furnished with the amplifier in positions corresponding to the respective shaft positions (VA dial to the left of the METER dial) securing them in place with the bushings, washers, and nuts supplied. Assemble the parts with the heads of the bushings on the inside of the panel to insure clearance.

c. Should it become necessary at any time to remove the amplifier for servicing, first remove the knobs and panel. Then, pull forward on the handles and slide out the amplifier.

14. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 10 for 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 change in this manual, preferably on the main schematic diagram (fig. 27).

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 30 through 32.

d. Install the equipment as outlined in paragraphs 11, 12, and 17.

Section II. INSTALLATION

15. Input Shielding

All audio leads should be shielded twisted pair copper wire, insulated for 200 volts, and need not be larger than No. 19 AWG. All joints should be of low resistance and soldered securely. If the circuits run in conduit or duct that may be subject to moisture, use a type of wiring that has a natural or synthetic rubber covering over the shield or lead. To minimize undesirable noise pickup and crosstalk on long input circuits, the shielding of the lines to the input terminals of the amplifier or rack should be covered with cotton braid or other suitable insulation and the shielding should be grounded only at the amplifier (point of lowest level such as a common ground bus bar). Be sure that the shields are electrically continuous and that the ground connections are perfect. Do not run the audio input leads adjacent to, or laced in with, alternating-current (ac) or high-level audio lines.

16. Metering Circuits

AF Amplifier AM–465/FR may be used with a system metering circuit. The four-position rotary switch mounted on the front panel of the amplifier chassis is designed for this purpose. The method described in *a* below is used when the af amplifier is used in a system. The hookup of the af amplifier, when metered as a single unit, is described in *b* below.

a. The overall system metering circuit must use a 20,000-ohms-per-volt meter having a direct-current (dc) range of 0 to 2.5 or 0 to 5 volts. The system also must have a metering switch with a blank position available. The blank position will be used for testing the af amplifier. The unused pin on the external metering circuit is connected to terminal 8 of the output receptacle J1. Terminal 10 of the same receptacle will be used as the meter return circuit. Label the new position of the external metering switch as AF Amplifier AM–465/FR. By placing the METER switch, located on the af amplifier, in position 1, 2, or 3, tubes V1, V2 and V3 can be checked on the system meter. The numbers on the METER dial plate indicate the tube being checked. With the tubes operating normally, the meter will read approximately 1 volt.

b. If no external metering circuit is available, wire terminals 8 and 10 of input receptacle J1 to two test jacks. Mount the jacks. Be sure that the mounting site selected is readily accessible. If possible, color code the jacks. Use a red test jack as the positive terminal (connected to pin 8) and a black test jack as the negative terminal (connected to terminal 10). Label these jacks. When checking the af amplifier, insert the test probes of Multimeter TS–352/U or equal into the test jacks.

17. Matching Input Connections

Connect the incoming lines to terminals 11 and 12 of the input receptacle of input plug J1. Connect the ground line of the incoming signal to terminal 11 of the input receptacle of input plug J1. Make impedance matching connections on the input transformer as follows:

a. 600-ohm Balanced Input. The amplifier is wired at the factory for 600-ohm balanced input

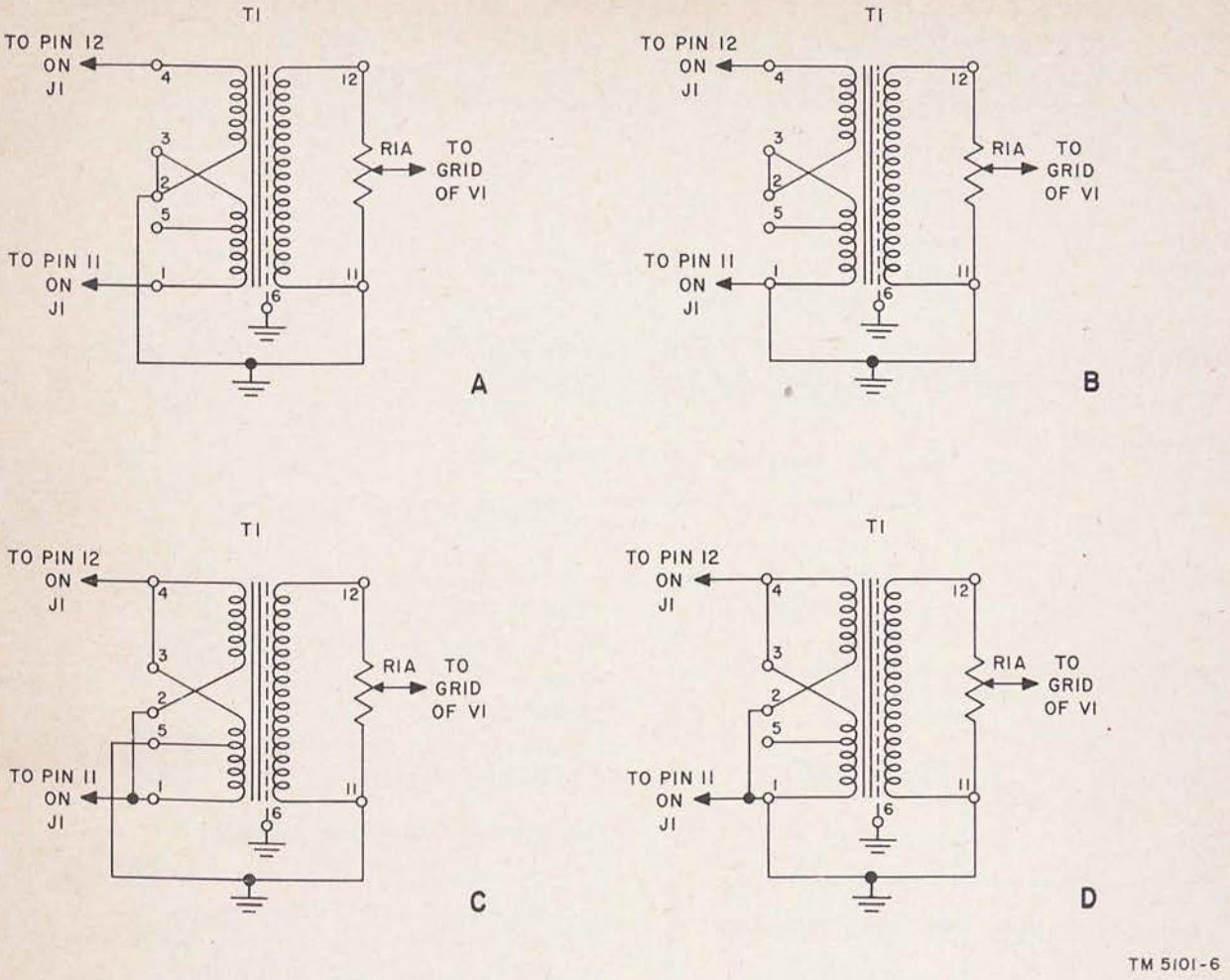


Figure 6. Matching input connections on input transformer T1.

operation. Terminal 2 on input transformer T1 is connected to terminals 3 and 11 (fig. 6Ⓐ and fig. 27).

b. 600-ohm Unbalanced Input. Transformer T1 is wired at the factory for 600-ohm balanced input operation (fig. 6Ⓐ). For 600-ohm unbalanced input operation, disconnect the wire connected to terminal 11 from terminal 2, and connect it to terminal 1. Figure 6B shows the proper wiring of transformer T1 for 600-ohm unbalanced input operation.

c. 150-Ohm Balanced Input. Transformer T1 is wired at the factory for 600-ohm balanced input operation (fig. 6Ⓐ). For 150-ohm balanced input operation, remove the wire connecting terminals 2 and 3. At terminal 2, disconnect the wire to terminal 11 and connect it to terminal 5. Connect a jumper between terminals 1 and 2, and connect a jumper between terminals 3 and 4. Figure 6Ⓒ shows the proper wiring for transformer T1 for 150-ohm balanced input operation.

d. 150-Ohm Unbalanced Input. Transformer T1 is wired at the factory for 600-ohm balanced input operation (fig. 6 Ⓐ). For 150-ohm unbalanced operation, remove the wire connecting terminals 2 and 3 on T1. At terminal 2, disconnect the wire connected to terminal 11 and connect it to terminal 1. Connect terminals 1 and 2 together and connect terminals 3 and 4 together. Figure 6 Ⓓ shows the proper wiring of transformer T1 for 150-ohm unbalanced input operation.

e. Balanced Bridging Input Connections. For balanced bridging input connections, wiring changes are made on the input plug. Input transformer T1 is connected for 600-ohm balanced input. Connect the incoming line to terminals 5 and 6 on the input receptacle for plug J1. On

the same receptacle connect terminals 7 and 12 together, and connect terminals 9 and 11 together. The solid lines on figure 7 show the proper wiring of input receptacle plug J1, if balanced bridging input operation is used.

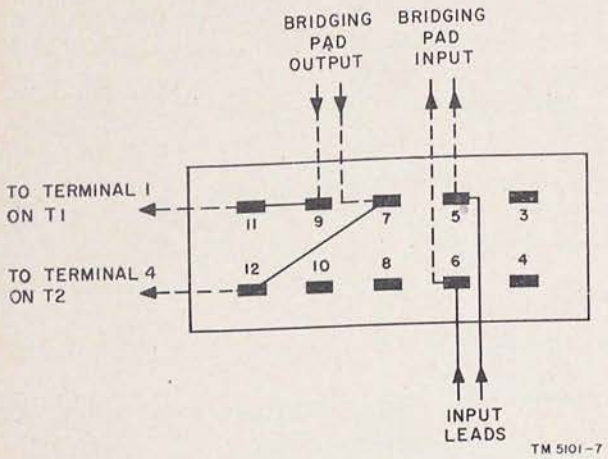


Figure 7. Balanced bridging input connections on input receptacle for plug J1.

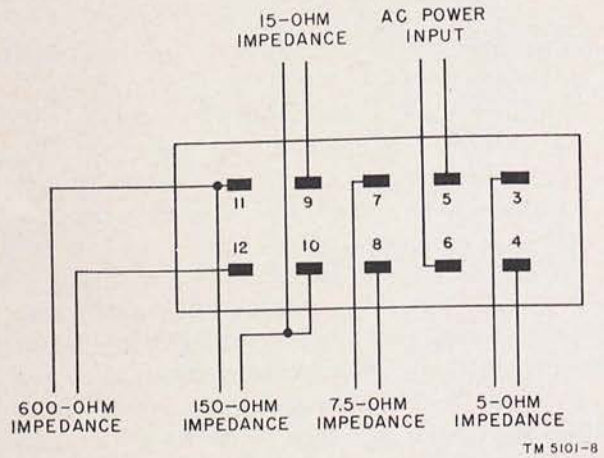


Figure 8. Output receptacle connections for plug J2.

18. Output Plug Connections

a. Output Connections. The amplifier is wired for operation into a variety of load impedances. The secondary winding of output transformer T2 is provided with a number of taps brought out to the terminals of output plug J2, mounted on the rear of the amplifier chassis (directly behind the power transformer). The center tap of the output transformer secondary winding (terminal 8 on the output transformer) is connected to terminals 4, 8, and 10 of connection plug J2 (fig. 27). Connection to the plug J2 is made by means of the receptacle supplied with each amplifier. Figure 8 shows the proper wiring of the output receptacle for plug J2 for the use of various load impedances. The following table gives the line connections for loads of various impedances.

Output connections for plug J2

Load impedance	Receptacle terminals
600 ohms*	11 and 12.
150 ohms	10 and 11.
15 ohms	9 and 10.
7.5 ohms	7 and 8.
5 ohms	3 and 4.

*600 ohms winding has a center tap (terminals 4, 8, and 10 on J2).

b. Ac Power Supply. The ac line is connected to terminals 5 and 6 of the output receptacle (on output plug J2). Figure 8 shows the proper connections of the ac power line to the output receptacle for plug J2. To insure a low hum level the ac supply circuit should be shielded and the shield grounded to a common ground bus bar.

19. Circuit Modifications

a. Ac Power Supply. Power transformer T3 is connected for operation from a 115-volt ac power line. If the line voltage is high (120 to 130 volts), disconnect the red and black wire from terminal 11 on transformer T3 and connect it to terminal 12. If the line voltage is low (100 to 110 volts), disconnect this same red and black wire and connect it to terminal 10 on transformer T3 (fig. 24).

b. Frequency Compensation. The normal frequency response of AF Amplifier AM–465/FR, shown by the curve in figure 9, is flat throughout the audio range. It may be desirable to increase the response at either the high-frenquency or low-frequency end of the range. If there is a partial loss of the low frequencies in the transmission of the incoming signal, there has to be an increase of gain or compensation at the lower frequency end of the amplifier response. If there is a partial loss of the high frequencies in the transmission of the incoming signal, there has to be an increase of gain at the higher frequencies to compensate for this loss. The curves in figures 10 and 11 show the increase in response that may be obtained by

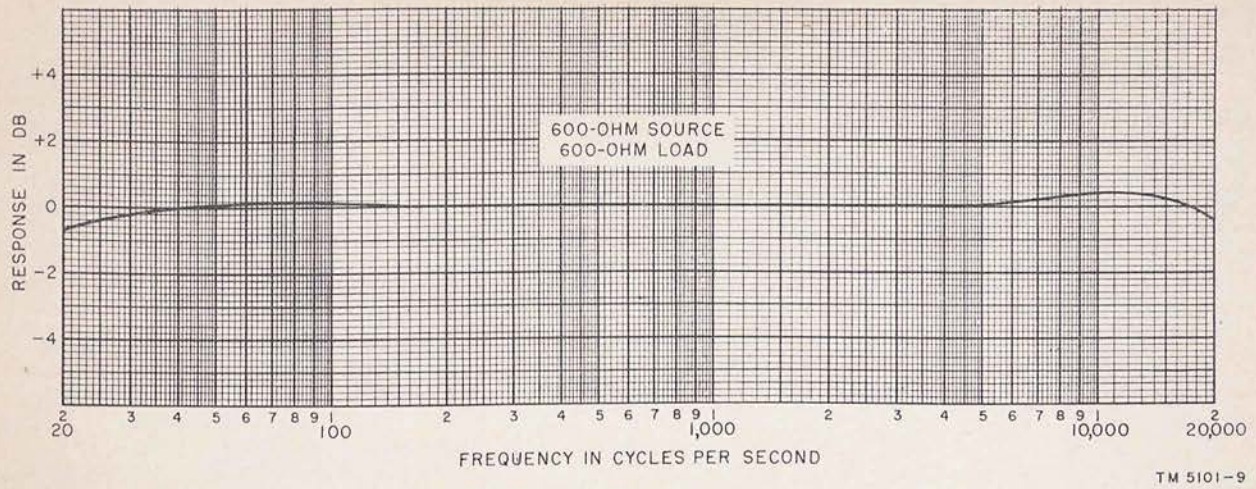


Figure 9. Normal frequency response of AF Amplifier AM–465/FR.

making compensation adjustments within the amplifier, according to the instructions in *c* and *d* below. If desired, both high- and low-frequency compensation may be applied.

Note. Because of slight differences in wiring and tolerances of component parts, it may be necessary to use capacitors differing in value from those given in the following tables to secure the desired response.

c. Increasing High-Frequency Response. Three curves, numbered 1, 2, and 3, are shown in figure 10. These curves illustrate the frequency characteristics of the amplifier after changes are made, in the circuit constants, to increase the high-frequency response of the amplifier by approximately 1, 2, and 3 decibels (db) at 10,000 cycles per second (cps). To obtain a frequency response corresponding to one on the three curves, replace the 3,900-micromicrofarad ($\mu\mu$f) capacitor, designated C5 in figures 12 and 27, with a capacitor having the value given, opposite the curve number, in the following table.

Capacitor values	
Response curve No.	C5 (200 vdcw) capacity in $\mu\mu$f
1	5, 600
2	8, 200
3	10, 000

d. Increasing Low-Frequency Response. The curves numbered 1, 2, and 3 in figure 11 show the frequency response of the amplifier after alterations have been made in the circuit to obtain greater low-frequency response. An increase of

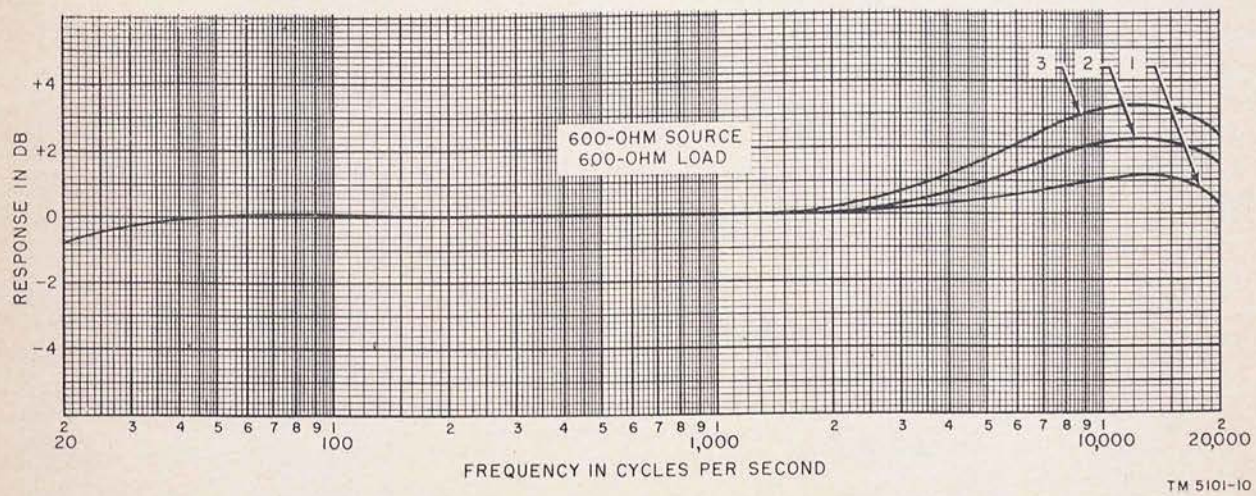


Figure 10. Frequency response with high-frequency compensation.

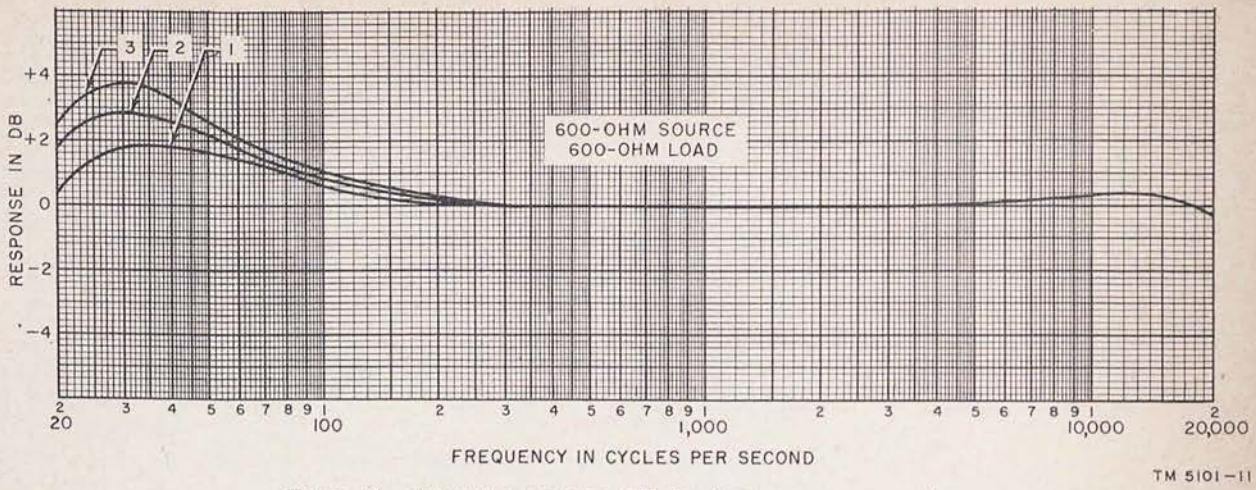
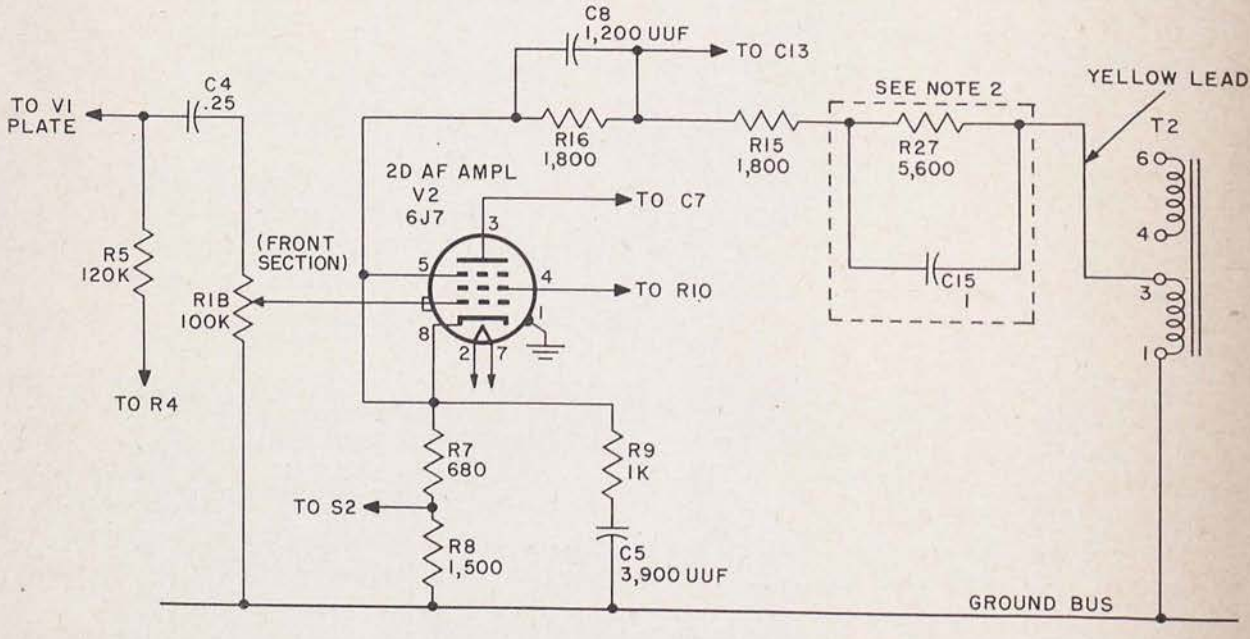


Figure 11. Frequency response with low-frequency compensation.

2, 3, and 4 db at 30 cps can be obtained by making suitable modifications in the circuit. To obtain a frequency response corresponding to one of the three curves make the following changes:

(1) Disconnect the yellow lead from R15 (on terminal 1 of terminal board 1) and connect this lead to a compensator composed of a 5,600-ohm resistor and a 1-microfarad (μf) capacitor (in parallel). Connect the other side of the compensator to R15 on terminal 1 of terminal board 1. The compensator may be supported by a small terminal board that can be mounted on the side wall of the chassis. The posi-

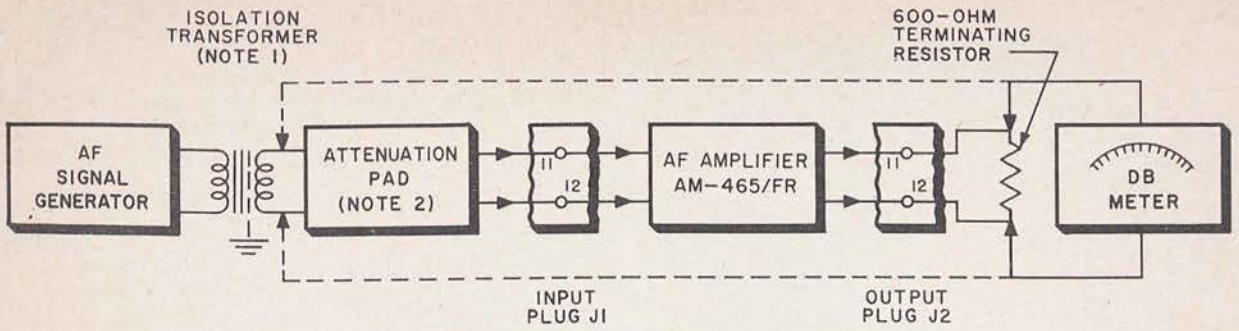


NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. RESISTOR R27 AND CAPACITOR C15 ARE ADDED TO CHANGE THE FREQUENCY RESPONSE OF THE AMPLIFIER.

TM 5101-12

Figure 12. Partial schematic diagram, showing changes for compensation.



NOTES:

1. MAY BE PART OF SIGNAL GENERATOR.
2. OUTPUT IMPEDANCE OF PAD MUST MATCH INPUT IMPEDANCE OF AMPLIFIER. BALANCED OR UNBALANCED DEPENDING ON CONNECTION OF AMPLIFIER. MINIMUM LOSS 20DB, PREFERABLY ADJUSTABLE TO EQUAL GAIN OF AMPLIFIER.

TM 5101-13

Figure 13. Frequency response test setup.

tion in the circuit of the resistor and capacitor, identified as R27 and C15, is shown in figure 12 (R27 should have a rating of 1 watt and C15 a rating of 200 direct-curent working voltage (vdcw).

(2) Replace the .25-μf capacitor, designated C4 in figures 12 and 27, with a capacitor that has the value given opposite the curved number in the following table.

Capacitor values	
Response curve No.	C4 (400 vdcw) capacity in μf
1	0.03
2	.05
3	.1

Note. Check the high-frequency response. If it is found too high, substitute a capacitor for C5 of the next lower standard value as required.

e. Increasing High- and Low-Frequency Response. In applications where system losses or other deficiencies require an increase in the response at both ends of the audio spectrum, some suitable combination of high- and low-frequency compensation can be selected and applied as described in *c* and *d* above.

20. Checking Frequency Response

After making the necessary component changes for either high- or low-frequency compensation, the frequency response must be tested to see whether the desired curve in either figure 10 or 11 is attained. Figure 13 shows the test setup that should be used when checking frequency response.

a. Test Equipment Required. The following test equipment is required to check the frequency response of the amplifier.

Item	Technical Manual
Decibel Meter ME–22/PCM or equal	TM 11–2096.
Audio Oscillator TS–382A/U or equal	TM 11–2684A.
Attenuator, Variable, TS–402/U	TM 11–2044.

b. Test Setup. Connect an attenuation pad with a minimum loss of 20 db (Variable Attenuator TS–402/U or equivalent) between the af signal generator and terminals 11 and 12 of input plug J1. The output impedance of the pad must match the input impedance of the amplifier. Connect a 600-ohm resistor to terminals 11 and 12 of output plug J2. Connect the db output meter (Decibel Meter ME–22/PCM or equal) across the 600-ohm resistor.

c. Test Procedure. The following procedure is used in checking the frequency response of the amplifier:

(1) Set the af signal generator to 1,000 cps.

(2) Turn the amplifier VA control to the maximum clockwise position.

(3) Adjust the output level of the af signal

generator and loss of attenuation pad for an amplifier output level of 0 dbm (0 dbm=1 mw). If the attenuation pad is adjustable set its loss to equal the gain of the amplifier, so that the input level to the attenuating pad equals the output level to the 600-ohm load resistor.

(4) Record the input and output levels.

(5) Keeping the input level to the pad constant, vary the frequency and record the output levels.

(6) The difference in levels from the 1,000-cps reference is the response of the amplifier. Convenient points to check are 30, 50, 100, 4,000, 7,000, 10K, 12K, and 15K cps.

(7) Check the readings obtained against the curves in figures 10 and 11.

Section III. OPERATION

21. Controls and Their Uses

(fig. 14)

The following table lists the controls of the af amplifier and lists their functions:

Control	Function
OFF-ON switch	In ON position, connects af amplifier to ac power source.
VA control	Gain of amplifier is increased as VA control is turned clockwise.
METER switch	Used in conjunction with any suitable voltmeter (20,000 ohms-per-volt or better). Number on METER dial plate indicates tube being checked. Normal operation of tubes is indicated by reading of 1 volt on meter.
HUM control	Adjustment of HUM control varies hum level of amplifier.

22. Operation of Af Amplifier

a. AF Amplifier AM–465/FR may be operated as a high fidelity, high gain, low distortion amplifier used to raise the output of preamplifiers or mixers. It also may be used as a bridging or isolation amplifier. The use of the amplifier as a single unit is limited to a monitoring amplifier of 2 watts output.

b. To operate the equipment, use the following procedure:

(1) Throw the OFF-ON switch to the ON position. Tube V4 should glow.

(2) Rotate the METER switch through positions 1, 2, and 3. The meter should read approximately 1 volt in each position. Set the switch to 0.

(3) Adjust the VA control to the desired volume level.

(4) Adjust the HUM control, with a screw driver, for minimum hum.

(5) To turn off the equipment throw the OFF-ON switch to the OFF position.

Note. If, during the operation of the equipment, an abnormal result is obtained, refer to equipment performance checklist (par. 36).

23. Operation Under Unusual Conditions

The operation of AF Amplifier AM–465/FR may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. Instructions are given below on procedures for minimizing the effects of these unusual operating conditions.

a. Operation in Arctic Climates. Subzero temperatures and climatic conditions with cold weather affect the efficient operation of the equipment. Instructions and precautions under such adverse conditions follow:

(1) Handle the equipment carefully.

(2) Keep the equipment warm and dry. Keep the filaments of vacuum tubes lighted constantly, unless this overtaxes the power supply.

(3) Locate the amplifier inside a heated inclosure where there is no danger of a cold draft striking the glass tube (V4) when a door is opened. A sudden draft of cold air is often sufficient to shatter the glass envelope of a heated tube. If the inclosure is so constructed that this precaution is impossible, place a blanket or some barrier between the source of the draft and the equipment.

(4) When an amplifier which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room tem-

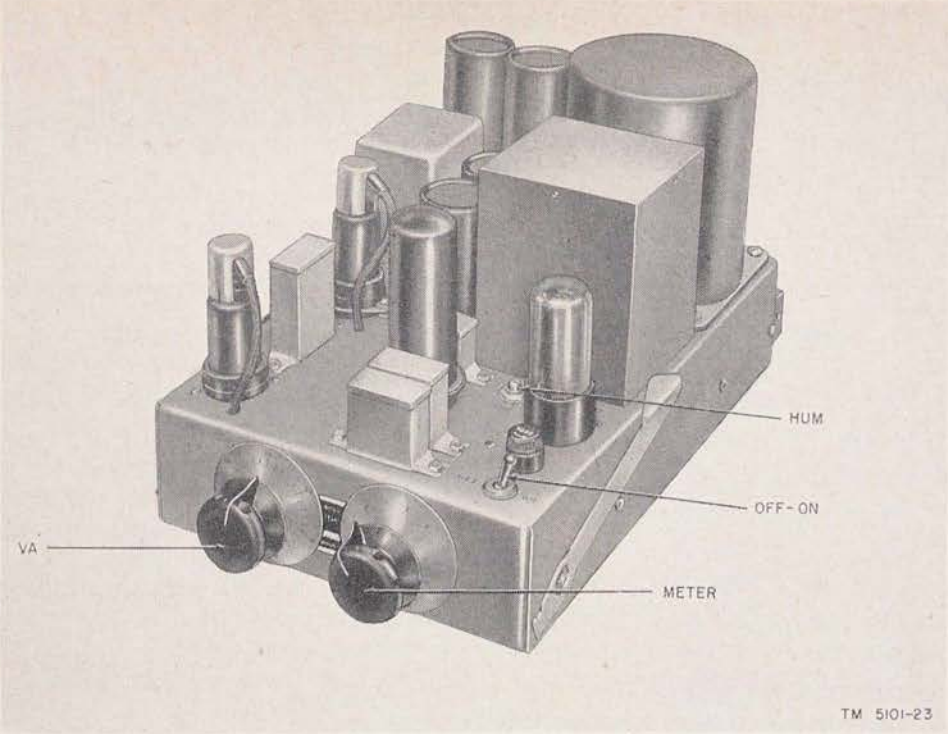


Figure 14. AF Amplifier AM-465/FR controls.

perature. When the amplifier has reached room temperature, dry it thoroughly. This condition may also arise when equipment warms up during the day after exposure during a cold night.

b. Operation in Tropical Climates. When operated in tropical climates, moisture conditions are more acute than normal. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. To minimize this condition, place lighted electric bulbs under the amplifier.

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

(1) The main problem arising with equipment operation in desert areas is the large amount of sand or dust and dirt which enters the moving parts of the amplifier, such as the step attenuators. The ideal preventive precaution is to house the amplifier 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 amplifier 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.

(2) Be sure to keep the amplifier as free from dust as possible. Make frequent preventive maintenance checks. Pay particular attention to the condition of the lubrication of the VA control (R1).

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

24. General

a. Usually a number of tools, materials, or tool equipment kits are furnished with the equipment or supplied to the organization for use with the equipment.

b. The actual allowable organizational maintenance that can be performed on AF Amplifier AM–465/FR is dependent to a large extent on the existing military regulations (Standard Operating Procedure), the existing tactical situation, and also on the tools and test equipment supplied or available.

25. Tools and Materials Supplied With AF Amplifier AM–465/FR

Tools and materials required for the organizational maintenance of the amplifier are listed in *a* and *b* below. Signal Corps stock numbers follow the materials used. Items contained in Tool Equipment TE–113 are listed in Department of the Army Supply Manual SIG 6 TE–113.

a. Tool.

1 Tool Equipment TE–113.

b. Materials

Orange stick (6Z7360).
Cheesecloth, bleached, lint-free (621989).
Carbon tetrachloride (6G 184).
Cleansing compound (6G236.2).
Paper, sand, flint No. 0000 (6Z7500–0000).

Section II. PREVENTIVE MAINTENANCE SERVICES

26. 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 will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring. Refer to AR 750–5.

27. General Preventive Maintenance Techniques

a. Use No. 0000 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 cleaning compound; then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

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

28. Use of Preventive Maintenance Forms (figs. 15 and 16).

a. The decision as to which items on DA 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 case of second and third echelon maintenance, by the individual making the inspection. In-

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; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 29a (1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 29a (3)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 29a (4)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 29 b (2)							
6	CHECK FOR NORMAL OPERATION. PAR. 29 a (2)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 29a (10)		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.		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 29b (4) AND 29b (5)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 29a (2)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR.29a (9)		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 FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 5101-24

Figure 15. DA 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; X Adjustment, repair or replacement required; ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 29a (1)	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 29a (3)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 29a (4)	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 29b (2)	
6	CHECK FOR NORMAL OPERATION. PAR. 29a (2)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 29a (10)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 29b (4) AND 29b (5)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 29a (9)	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 29a (2)	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
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. 29a (7)	
20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 29b (3)	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 29b (1)	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 29b (5)	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 29b (2)	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 29b (6)	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 29a(5) AND 29b (6)	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
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 FORM 1 MAY 51 11-239 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE. 48-16-6492-1

Figure 16. DA Form 11-239.

structions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 15 and 16 are partially or totally applicable to AF Amplifier AM–465/FR. References in the ITEM block refer to paragraphs in text that contain additional maintenance information.

29. Performing Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be broken or damaged. Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

a. Exterior Items.

(1) Check for completeness and satisfactory condition of the amplifier.

(2) Check meter readings (par. 21 and 22) for normal operation.

(3) Clean exterior of chassis and accessible parts.

(4) Inspect filter capacitors C2, C9, C10, and C11 for leakage of dielectric, for bulging, and for heating (fig. 5).

(5) Inspect power transformer T3 for excessive heating (fig. 5).

(6) Inspect fuse F1 and fuse holder for corrosion, cracks, and lack of tension sufficient to insure good contact.

(7) Check vacuum tubes, replace if necessary (fig. 5).

(8) Inspect capacitors C1, C4, C6, and C7 for leakage of oil (fig. 5).

(9) Check tube and filter capacitor sockets and pins for loose contacts, dirt, and corrosion.

(10) Check input and output plugs and receptacles J1 and J2 for dirt, corrosion, and loose contacts (fig. 5).

b. Interior Items.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

(1) Check resistors for blistering, discoloration, and other evidence of overheating (fig. 24).

(2) Check switches S1 and S2 for dirt, corrosion, loose contacts, and satisfactory mechanical action (fig. 24).

(3) Check all the fixed capacitors beneath chassis for bulges and discoloration (fig. 24).

(4) Check wires, cords, and cables for cracked, cut, and frayed insulation.

(5) Check terminal boards (TB1 and TB2) for cracks, dirt, and loose connections (fig. 24).

(6) Check dual potentiometer R1 (A and B) for satisfactory electrical and mechanical operation (fig. 24).

Section III. LUBRICATION AND WEATHERPROOFING

30. Lubrication of Dual Potentiometer R1 (VA Control)

a. Be sure that lubricants and points to be lubricated on R1 are clean and free from sand, grit, or dirt. Before lubrication, clean all surfaces to be lubricated.

b. Do not use excessive amounts of oil and do not allow connections to become greasy.

c. Press the catch nearest the rear end of R1 (fig. 17) turn the rear end cover sufficiently to release it, and pull the cover off R1. Clean exposed rear section contacts as instructed in *a* above with a light oil and rotate the shaft. If any dark streaks appear, wipe off the contacts with a lint-free cloth; and repeat this procedure until the contacts are clean, then apply a thin film of light oil. Press the catch nearest the front of R1 and remove the rear section exposing the front section contacts. Clean these contacts in the same manner. Replace the rear section and the end cover and lock in place.

31. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropic, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moisture- and fungiproofing treatment has been devised

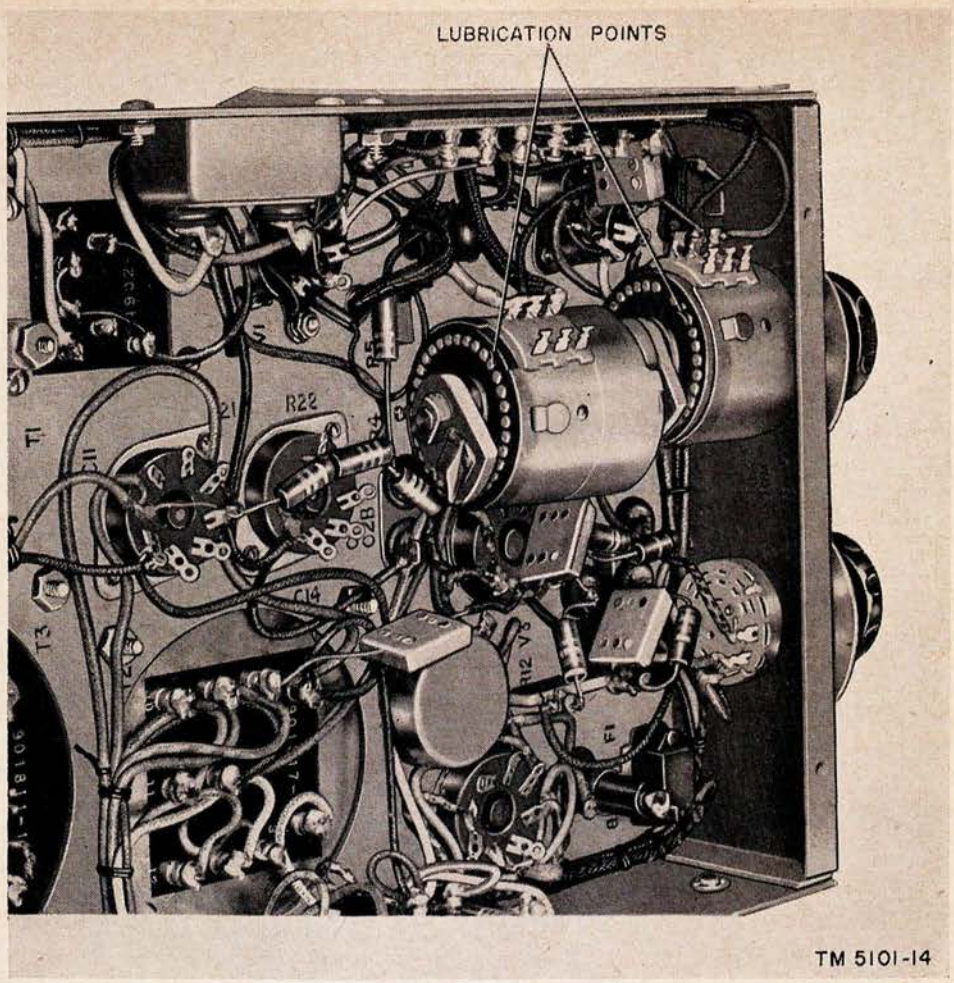


Figure 17. Lubrication points.

which, if properly applied, provides a reasonable degree of protection. This treatment is fully explained in TB SIG 13 and TB SIG 72.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are fully 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 fully explained in TB SIG 75.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to paragraph 30 for detailed instructions.

32. Rustproofing and Painting

a. When the finish on the chassis and the transformers (input, output, and power) have been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or 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 underneath the chassis of the amplifier 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 chassis or transformers by cleaning corroded metal with cleaning compound. In severe cases it may be necessary to use cleaning compound to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

33. General Troubleshooting Procedures

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

b. Paragraphs 34 through 36 help in determining which of the circuits is at fault and in localizing the fault to the defective stage or item, such as a burned-out tube or fuse.

34. Visual Inspection

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

(1) Burned-out fuse.
(2) Wires broken because of excessive vibration.
(3) Defective tubes.
(4) Worn, broken, or disconnected cords or plug.
(5) Leaky or bulged filter capacitors.
(6) Burned or discolored resistors.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

c. Inspect the input lead-in and circuit for obvious abnormalities.

35. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 36) will help the operator to locate trouble in the equipment. The list gives the items to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures the operator can take. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible 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 the operator can make without turning in the equipment for repairs. A reference to the troubleshooting chart (par. 49) indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

36. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Input receptacle	Plug into input Plug J1.		
	2	Output receptacle	Plug into output Plug J2.		
START	3	OFF-ON switch	Throw to ON position	5Y3GT tube filament lights.	Replace 5Y3GT tube. Replace fuse F1.
EQUIPMENT PERFORMANCE	4	METER switch	Check each tube as described in paragraph 23.	Meter reads 1 volt for each tube.	If one tube reads below 1 volt, replace defective tube. If all tubes read below 1 volt, replace 5Y3GT or plug-in filter capacitors.
	5	VA control	Check VA control	Gain of amplifier should increase as control is turned in clockwise direction.	Refer to paragraph 49.
	6	HUM control	Check HUM control	Hum reduced to minimum by adjustment of hum control.	Refer to paragraph 49.
STOP	7	OFF-ON switch	Throw to OFF position	5Y3GT tube heater goes out.	If still on, check OFF-ON switch. Refer to paragraph 49.

CHAPTER 4

THEORY

37. Block Diagram

(fig. 18)

AF Amplifier AM–465/FR is a four-tube high fidelity, high gain, low distortion amplifier designed to raise the output level of preamplifiers or mixers to a level suitable for feeding broadcast telephone lines or audio transmitter inputs. The signal path and block diagram are shown in figure 18. A complete schematic diagram is shown in figure 27.

a. Input Transformer. The audio signal from the mixer and/or preamplifier is fed into input transformer T1. The input transformer can be connected for 600-ohm balanced input, 600-ohm unbalanced input, 150-ohm balanced input, 150-ohm unbalanced input, or balanced bridge input (par. 17).

b. First Af Amplifier. The first af amplifier uses a pentode tube that amplifies the output of the input transformer (T1). The output is coupled to the input of second af amplifier (V2).

c. Second Af Amplifier. The second af amplifier uses a pentode tube that amplifies the output of the first af amplifier (V1) to a level sufficient to drive the power amplifier. A negative feedback voltage is fed to the cathode from the output transformer. This improves stage stability and reduces stage distortion.

d. Af Output Amplifier. Af output amplifier V3 is a conventional power amplifier that amplifies the output of the second af amplifier. The audio output of the af output amplifier is fed to output transformer T2. The secondary of the output transformer is tapped to provide impedance outputs of 5, 7.5, 15, 150, and 600 ohms. A tertiary winding in the primary of the output transformer provides the feedback signal to the second af amplifier (V2).

e. Power Supply. Power transformer T3 provides a filament voltage of 6.3 volts for amplifier tubes V1, V2, and V3. It also provides the proper voltage (5 volts) for the operation of plate supply rectifier (V4) filament and ac voltage for the plates of the plate supply rectifier (V4). Plate supply

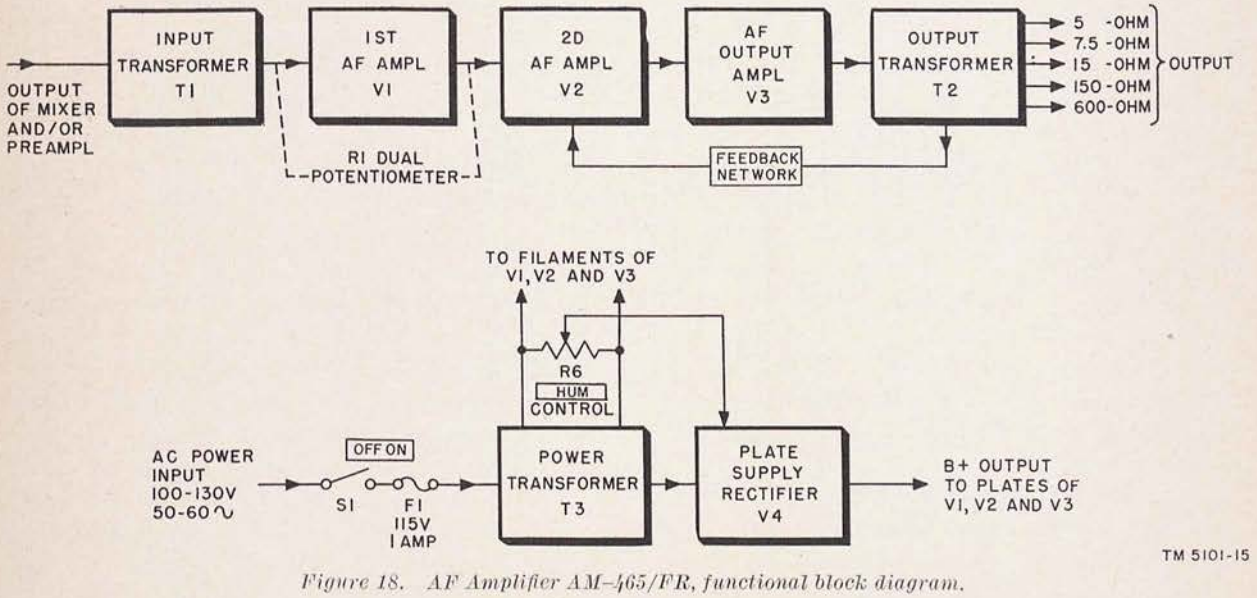


Figure 18. AF Amplifier AM–465/FR, functional block diagram.

rectifier V4 uses a duodiode tube as a conventional full-wave rectifier circuit. The filtered dc output of the rectifier supplies the dc plate and screen voltage for amplifier tubes V1, V2, and V3.

38. Input Circuit

a. The input circuit consists of input plug J1, the bridging network, and input transformer T1. Input plug J1 is wired at the factory as shown in the overall schematic (fig. 27). The input signal is fed to terminals 11 and 12 on J1. The grounded side of the input signal is connected to terminal 11 on J1.

b. Input transformer T1 is wired at the factory for 600-ohm balanced input, as shown in the overall schematic (fig. 27). Input transformer T1 can be connected for 600-ohm unbalanced input, 150-ohm balanced input, and 150-ohm unbalanced input, as described in paragraph 17.

c. When a balanced bridging input is used, the input signal is fed to terminals 5 and 6 on input plug J1. This feeds the input signal into the balanced bridge network, which consists of resistors R23, R24, and R25. Resistor R24 is required for the primary loading of input transformer T1. Resistors R23 and R25 are used as isolation resistors. These resistors prevent any change in line level from affecting the amplifier by isolating the amplifier from the line it is connected across. The output of the balanced bridge network is connected to terminals 7 and 9 on input plug J1. Refer to paragraph 17*e* for complete description of balanced bridging input connections.

d. Terminal 10 on input plug J1 is grounded. Terminal 8 on input plug J1 is connected to METER switch S2. With a 20,000 ohms-per-volt voltmeter connected to terminals 8 and 10, amplifier tubes V1, V2, and V3 can be checked by using METER switch S2 (par. 16).

39. First Af Amplifier

(fig. 19)

a. The first af amplifier V1 uses a pentode tube (type 6J7). Incoming signals from the input transformer develop a voltage across resistor R1A, one-half of the dual step attenuator. The signal voltage fed to the grid of this tube is dependent on the setting of the VA control. The resistor loads the secondary of the transformer effectively, isolating the input circuit from the grid circuit and controls the amount of signal applied to the amplifier control grid. The amplified signal developed in the plate of the amplifier is coupled to the second af amplifier. Resistor R5 and parallel combination C1 and R4 form the plate load. Cathode bias for this stage is provided by R26 and R2. To improve the frequency response and stage stability, these resistors are left unbypassed. Resistor R2 in addition to supplying a portion of the bias is used as a meter shunt. The junction of R26 and R2 is wired to METER switch S2. When the METER switch is placed in position 1, the voltage developed across R2 can be measured

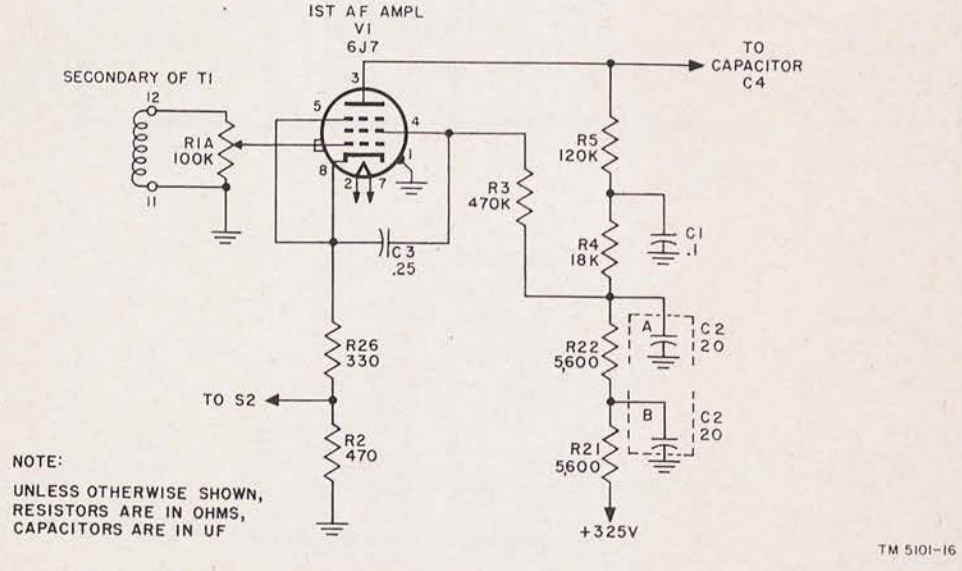


Figure 19. First AF Amplifier, schematic diagram.

on the system meter (par. 16). If the stage is operating normally, a potential of 1 volt will be read on the system meter.

b. Since conventional amplifiers have an inherent tendency to amplify the middle range of audio frequencies more than either the high or low frequencies, compensation is necessary. Resistor R4 and capacitor C1 form a low-frequency compensating network. At the low frequencies, the output voltage fed to the next stage is developed across R5 and R4. Capacitor C1 has a high reactance at the low frequencies and has little effect on the circuit. However, as the frequency increases the reactance of C1 decreases. This decreases the effectiveness of R4 as part of the plate load. Therefore, the output voltage developed at the higher frequencies is decreased. High-frequency compensation is accomplished in the next stage. Should it become necessary to increase the low-frequency response still further, refer to paragraph 19.

c. Resistors R22 and R21 bypassed by C2A and C2B form the plate decoupling network. Resistor R3 is the screen dropping resistor and capacitor C3 is the screen bypass capacitor.

40. Second Af Amplifier

(fig. 20)

a. The second af voltage amplifier V2 uses a type 6J7 pentode tube. The output of the first af amplifier is coupled through capacitor C4 to the control grid of V2. The signal voltage fed to the grid of this tube depends on the setting of the VA control (the second half of the dual step attenuator). Bias for the stage is provided by resistors R7 and R8. Resistor R8 in addition to supplying a portion of the bias provides a testing point for this stage. The junction of R7 and R8 is connected to the METER switch. When the METER switch is in position 2, a reading of 1 volt should be obtained on the system meter (par. 16).

b. The first af amplifier was compensated for losses at the lower end of the frequency spectrum. The second af stage compensates for losses occurring at the higher frequencies. Compensation is accomplished by a feedback circuit that decreases the amount of negative feedback as the frequency increases. Resistors R7 and R8 are paralleled by the series circuit of R9 and C5, a low-frequency compensating network. This combination receives a feedback signal developed across the output transformer tertiary winding. The feedback signal is fed from the tertiary winding through limiting resistors R15 and R16 to the cathode of V2. At low signal frequencies, capacitor C5 offers considerable reactance; therefore, resistor R7 and R8 form the effective impedance of the parallel circuit. However, as the signal frequency increases, the reactance of C5 decreases and the C5 and R9 combination is effectively placed in parallel with R7 and R8, thus reducing the percentage of negative feedback applied to the cathode of V2. The result of this high-frequency compensation plus the low-frequency compensation network in the first af amplifier is a flat frequency response over the entire audio range. Should it become necessary to further increase the high-frequency response, refer to paragraph 19.

c. Resistor R11 is the plate load resistor; the voltage developed across this resistor is fed to the power amplifier stage. Resistor R10 is the screen voltage dropping resistor and capacitor C10 is the screen bypass capacitor.

41. Power Amplifier

(fig. 20)

a. The signal from the second af amplifier V2 is applied to the grid of power amplifier V3 through coupling capacitor C7. The stage uses a type 6L6 beam-power pentode. Bias for the stage is developed across resistors R13 and R14. These resistors are unbypassed to secure a degenerative bias, which stabilizes the stage and decreases frequency distortion. In addition to supplying a portion of the bias, R14 acts as a meter shunt resistor. The voltage developed (1 volt) across R14 is supplied to the system meter (par. 16) when the METER switch is in position 3. Screen grid voltage is applied directly to the screen from the +270-volt supply. Resistor R12 is the grid return resistor.

b. Output transformer T2 has a dual primary and a tapped secondary. The tapped secondary provides a variety of impedance outputs that are wired to the output plug as shown in figure 27. The two feedback circuits connected from the output transformer to the cathode of the second af amplifier provides the following advantages: higher fidelity, improved stability, less harmonic, amplitude, frequency and phase distortion, and lower noise level ratio. The principal of the circuits (par. 40*b*) is to take a portion of the output

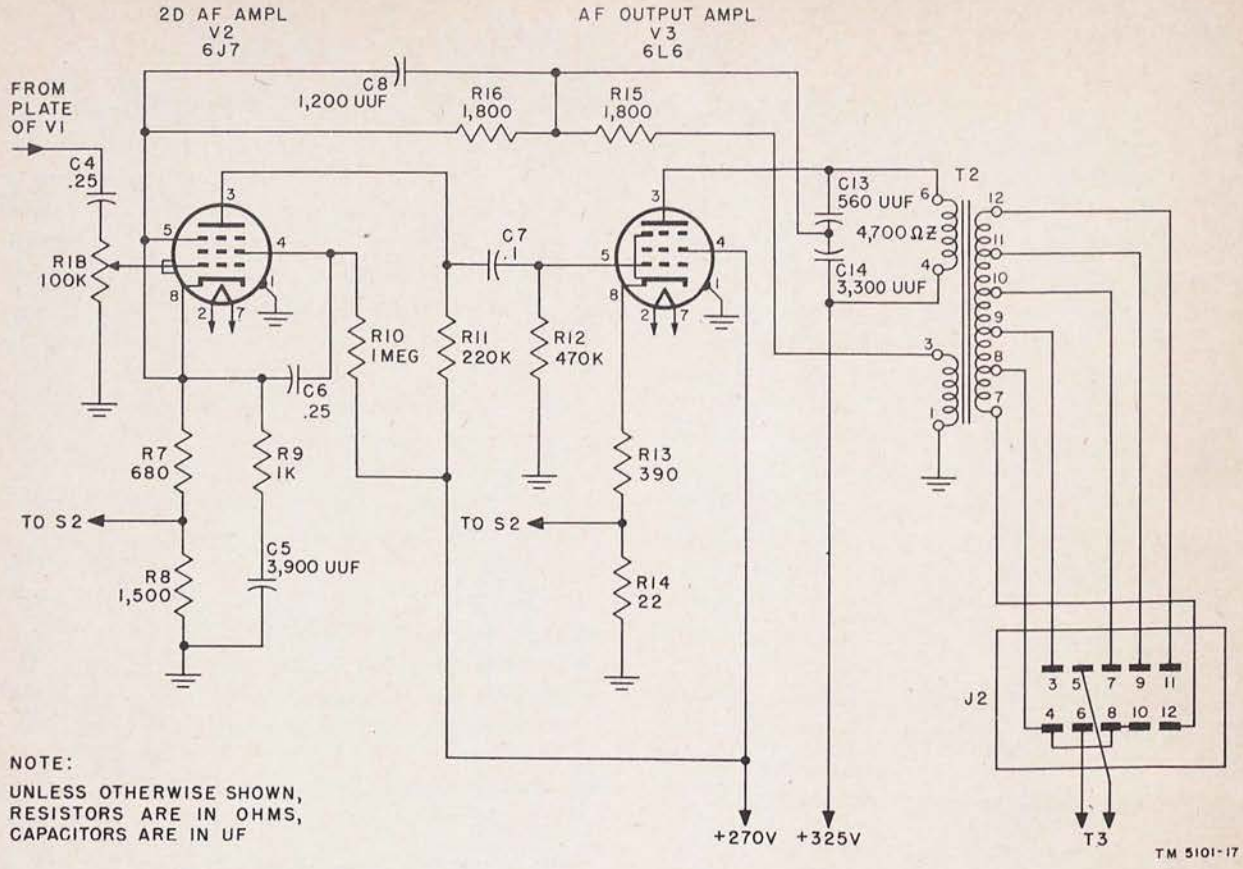


Figure 20. Second af and power output amplifier.

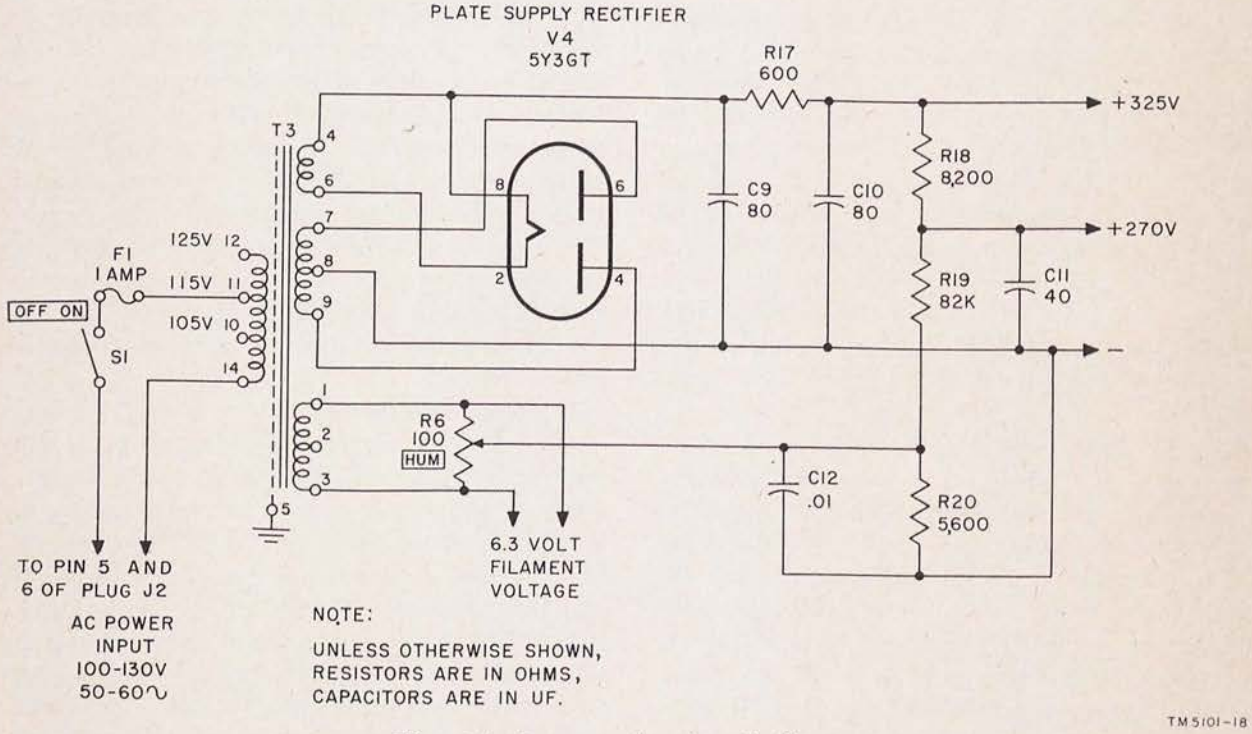


Figure 21. Power supply, schematic diagram.

voltage developed across the tertiary winding of T2 and feed it back to the cathode of V2. Capacitors C13 and C14 form a voltage divider network across the primary of T2, thus enabling a portion of the voltage developed across the primary of T2 to be fed back to the cathode of V2. This voltage is 180° out of phase with the tertiary winding feedback voltage. The two signals oppose each other, stabilizing the impedance of the tertiary winding at 8,000 cycles. Capacitor C8 is used to decrease the impedance of the feedback circuit above 8,000 cycles.

42. Power Supply

(fig. 21)

The amplifier will operate from an ac power source of 100 to 130 volts, 50 to 60 cps. Follow the instructions in paragraph 19*a* for proper termination of the power transformer to the ac line.

a. With the ac voltage applied to terminals 5 and 6 of the output receptacle, the line voltage is connected to the primary of transformer T3 through terminals 5 and 6 of the output plug, ON-OFF switch S1, and fuse F1. The primary of T3 is tapped to permit the use of input voltages ranging from 105 to 125 volts.

b. The high secondary voltage from taps 7 and 9 is applied to rectifier tube V4. The rectifier uses a 5Y3GT tube as a conventional full-wave rectifier that supplies the dc plate and screen voltages for all the amplifying tubes. A single section pi-type filter, consisting of capacitors C9 and C10 and resistor R17, supplies the necessary filtering of the rectified voltage for the plate of the output tube. Resistors R18, R19, and R20 form the power supply voltage dividing network. The +350-volt plate supply is obtained at the junction of R17 and R18; the +270-volt supply is obtained at the junction of R18 and R19. Capacitor C11 is an additional filter for the +270-volt supply.

c. The low-voltage secondary windings of transformers T3 provides 6.3 volts for the filament of the amplifier tubes and 5 volts for the filament of the rectifier tube. Shunted across the 6.3-volt filament winding of T3 is the HUM control. Adjustment of R6 will keep each end of the filament winding at an equal voltage with respect to the power supply (18 volts) and to ground, thus cancelling any ac hum or ripple in the heater circuits of V1, V2, and V3. The possibility of heater to cathode electron emission is eliminated by putting the heater at the +18 volt potential. Capacitor C12 provides additional filtering of the ac filament supply.

CHAPTER 5

FIELD MAINTENANCE

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. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: Certain points located throughout the chassis of the af amplifier operate at voltages above 250 volts. Do not touch these points while power is being applied to the amplifier. Be careful when handling or testing any part of the amplifier while it is connected to the power source.

43. Troubleshooting Procedures

a. General. The first step in servicing a defective amplifier is to sectionalize the fault. Sectionalization means tracing the fault to the major component or circuit responsible for the abnormal operation of the amplifier. The second step is to localize the fault. Localization means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults (such as burned-out resistors and shorted transformers) can be located by sight, smell, and hearing. The majority of faults however, must be localized by checking voltage and resistance.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. To be effective the procedure should be followed in the order given. Remember that servicing procedure should cause no further damage to the amplifier. First trouble should be localized to a single circuit. Then the trouble may be isolated within that circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 34) is to locate any visible trouble. Through this inspection alone, the repairman may frequently discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the amplifier that might occur through improper servicing methods and in forestalling future failures.

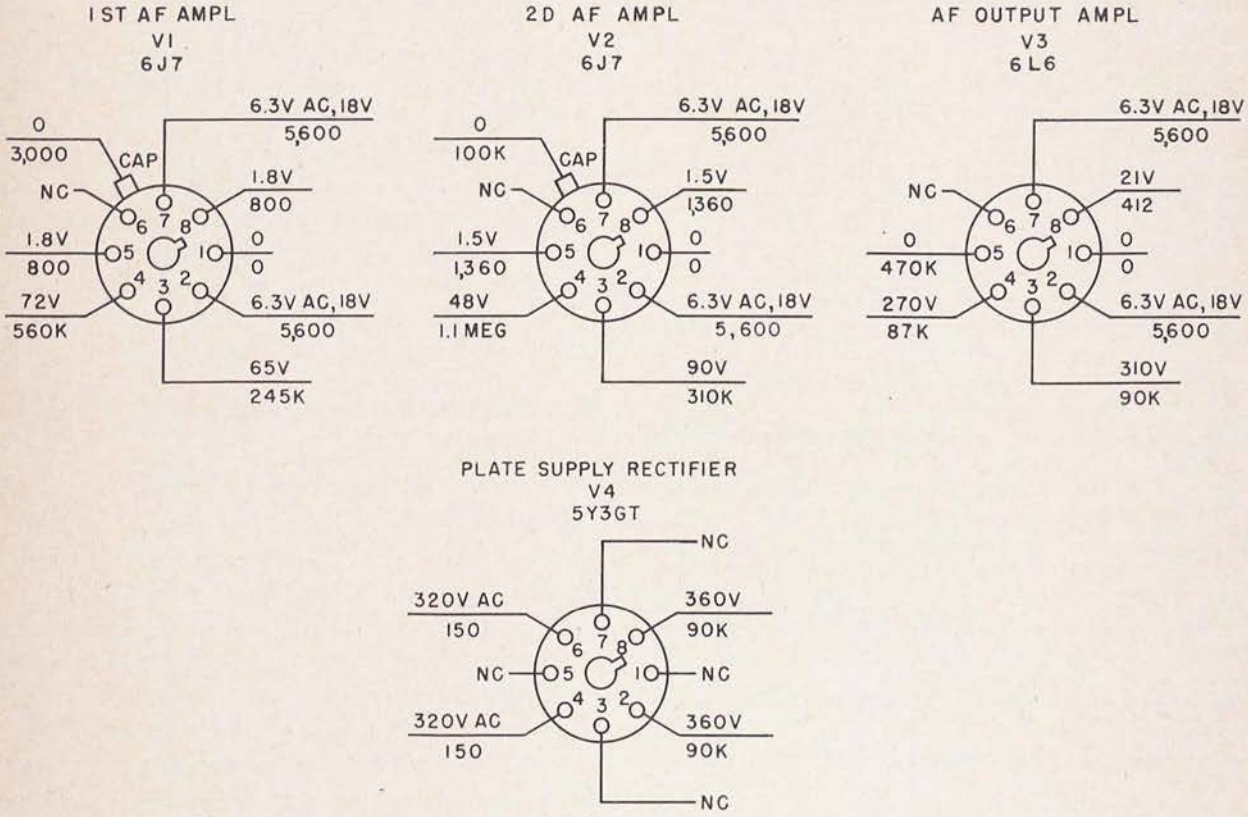
(2) *Input resistance measurements.* These measurements (par. 47) prevent further damage to the amplifier from possible short circuits. Since this test gives an indication of the condition of the filter circuits, its function is more than preventive.

(3) *Operational test.* The operational test (par. 48) is important because it frequently indicates the general location of trouble. In many instances the information gained will determine the exact nature of the fault. To use this information fully, all symptoms must be interpreted in relation to one another.

(4) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 49) will aid greatly in localizing trouble.

(5) *Signal substitution.* The simplicity of the amplifier circuit does not warrant the use of the signal substitution method of troubleshooting. Faulty component sectionalization and localization is accomplished more quickly and easily by taking the voltage and resistance measurements (fig. 22) and by referring to the troubleshooting chart (par. 49).

(6) *Intermittents.* In all these tests the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the am-



NOTES:

1. ALL VOLTAGES ARE DC POSITIVE WITH RESPECT TO GROUND, EXCEPT AS OTHERWISE NOTED.
2. 6.3V AC IS THE VOLTAGE MEASURED BETWEEN PINS 2 & 7 ON V1, V2 AND V3.
3. VALUES BELOW LINE ARE RESISTANCE MEASUREMENTS TO GROUND.
4. NC INDICATES NO CONNECTION.
5. USE MULTIMETER WITH SENSITIVITY OF 20,000 OHMS-PER-VOLT DC, 1,000 OHMS-PER-VOLT AC.
6. VA CONTROL R1 IN MAXIMUM CLOCKWISE POSITION.

TM 5101-19

Figure 22. Tube socket voltage and resistance diagram.

plifier itself but in the installation, or the trouble may be caused by external conditions. In this event, test the installation, if possible.

44. Troubleshooting Data

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

Fig.	Par.	Description
5		AF Amplifier AM–465/FR, chassis, top view.
6		Matching input connections on input transformer T1.
7		Balanced bridging input connections on input receptacle for plug J1.
8		Output receptacle connections for plug J2.
9		Normal frequency response of AF Amplifier AM–465/FR.
10		Frequency response with high-frequency compensation.
11		Frequency response with low-frequency compensation.
12		Partial schematic diagram, showing changes for compensation.
13		Frequency response test setup.
18		AF Amplifier AM–465/FR, functional block diagram.
22		Tube socket voltage and resistance diagram.
23		AF Amplifier AM–465/FR, B+ and filament distribution diagram.
24		AF Amplifier AM–465/FR chassis, bottom view.
27		AF Amplifier AM–465/FR, schematic diagram.
	5	Technical characteristics.
	15–20	Installation.

45. Test Equipment Required for Troubleshooting

The items of test equipment required for troubleshooting AF Amplifier AM–465/FR are listed below. The technical manuals associated with the test equipment also are listed.

Test equipment	Technical manual
Electron Tube Tester TV–7/U or equal	TM 11–5083.
Multimeter TS–352/U	TM 11–5527.
Decibel Meter ME–22/PCM	TM 11–2096.
Variable attenuator TS–402/U	TM 11–2044.

46. General Precautions

Whenever the amplifier is serviced, careless replacement of parts often will make new faults inevitable. Observe the following precautions.

a. Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads to it.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Do not allow drops of solder to fall into the set, since they may cause short circuits.

d. A carelessly soldered connection may create 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.

e. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring.

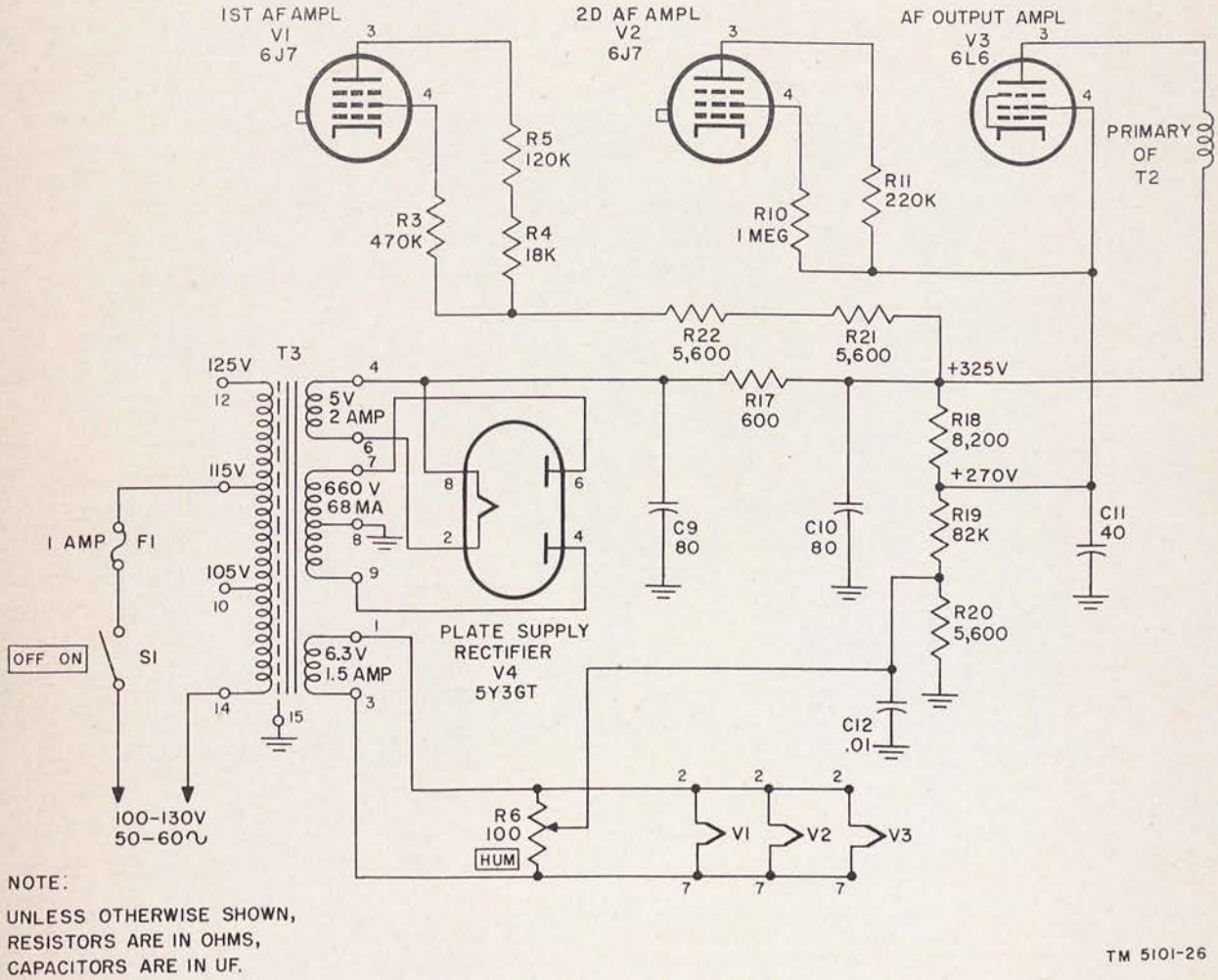
47. Checking Filament and B+ Circuits for Shorts

(fig. 23)

Trouble within the amplifier often may be detected and additional trouble avoided by checking the resistance of the filament and B+ circuits before applying power to the equipment. Make the following checks before attempting to put the amplifier in operation. With all the tubes removed the resistance between ground and the +325V point should read approximately 95,000 ohms, and the resistance between ground and the +270V point should read approximately 87,000 ohms. With the tubes (V1, V2, and V3 removed, the resistance of the filament winding (terminals 1 and 3 of transformer T3) should read approximately .1 ohm.

48. Operational Test

With the amplifier connected to its associated components for normal operation, operate the amplifier as described in the equipment performance checklist (par. 36). This checklist is important because it frequently indicates the general location of trouble. Also listen for crackling or buzzing noises that indicate voltage arcing. Check the amplifier for smoke and odor of burned or overheated parts.



NOTE:

UNLESS OTHERWISE SHOWN,
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UF.

TM 5101-26

Figure 23. AF Amplifier AM-465/FR, B+ and filament distribution diagram.

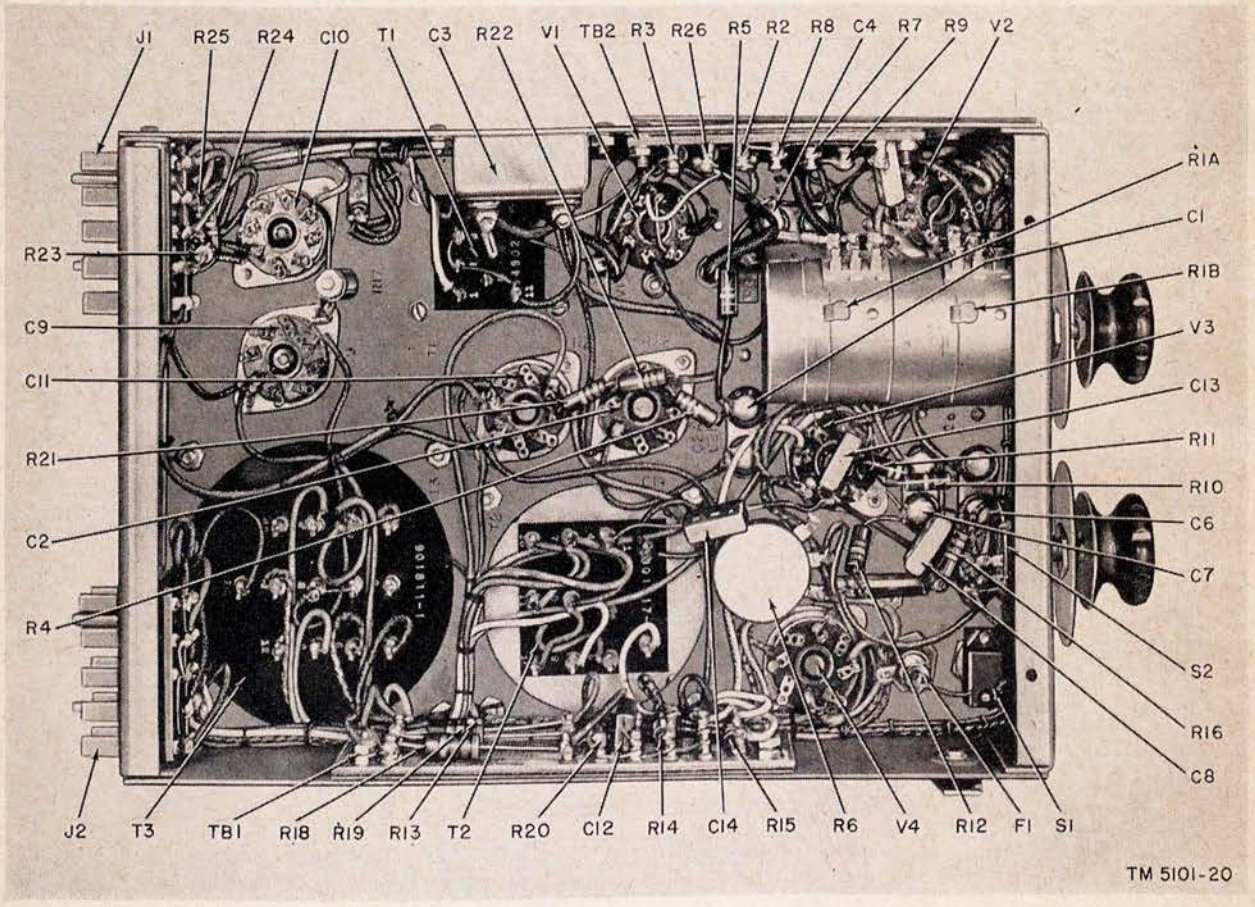


Figure 24. AF Amplifier AM–465/FR chassis, bottom view.

49. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the amplifier and associated power supply. This chart lists the symptoms that the repairman observes, either visually or audibly, while making a few simple tests. Once the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of this stage or circuit should be sufficient to isolate the defective part. Normal voltage and resistance readings are given in figure 22. The location of the under chassis components is shown in figure 24.

Symptom	Probable trouble	Correction
1. Rectifier tube 5Y3GT filament does not light.	Defective 5Y3GT	Check and replace 5Y3GT if defective.
	Defective switch S1	Check S1 with ohmmeter and replace if defective.
	Open fuse	Check continuity of fuse and replace if defective.
	Open power transformer T3	Check T3 with ohmmeter (see par. 50 for appropriate resistance values).
2. 5Y3GT plates show red	Shorted input filter capacitor C9	If filaments of V4 to ground checks as short circuit with ohmmeter; replace C9.
3. 5Y3GT overheats	Shorted output filter capacitor C10	If B+ voltage at junction of R17, and R18, checks zero, B+ checks shorted with ohmmeter; replace C10.
	Shorted plate filter capacitor C1	If B+ voltage at junction of R17 and R18 is low, plate voltage of V1 is zero; replace C1.
	Shorted +270v filter capacitor C11	If +270-volt terminal is low or zero, +250 volts terminal checks low with ohmmeter; replace C11.
	Shorted capacitor C2A or C2B	If plate and screen voltages are low junction of R17 and R18 reads 5,600 ohms or junction of R17 and R22 reads zero with an ohmmeter; replace C2A and C2B.
4. Hum	HUM control R6	Check R6 and replace if necessary.
	Open input filter C9	If B+ voltage is low, replace C9.
	Open output filter C10	If B+ voltage checks normal, check C10 and replace, if necessary.
	Loose shielding	Check all shielding.
5. Motor boating	Open filter C10. Open decoupling capacitors C2A or C2B.	If B+ voltage is normal or fluctuates with motorboat beats and screen voltages check normal, check C10, C2A, C2B. Replace defective component.
	Open grid or cathode circuit	Check all grid and cathode circuits. Replace defective component.
	Open capacitor between plate, cathode, of screen grid and ground.	Check all capacitors from ground to plate, cathode, and screen grid. Replace defective component.
6. No signal or weak signal	Tubes	Check tubes and replace defective tube.
	Coupling capacitor C4 or C7	Check and replace C4 or C7 if necessary.
	VA control	Check VA control with ohmmeter. Replace if necessary.
	Grid resistor R12	Check R12 with ohmmeter. Replace if necessary.
	Filter resistor R17	If B+ is zero, check R17 with ohmmeter. (***Caution:*** Discharge filter capacitors). Replace if necessary.
	Screen bypass capacitor C3 or C6	Check C3 or C6 and replace, if necessary.
	Voltage divider resistor R18	If B+ is zero, check R18. Replace if necessary.
	Voltage divider resistor R19 and filter capacitor C11.	If screen voltage of V3 is zero, check R19 and C11. Replace defective component.
	Open primary winding of output transformer T2.	Check T2 with ohmmeter. Replace if necessary.

Symptom	Probable trouble	Correction
7. Poor tone quality	Short-circuited or leaky coupling capacitor C4 or C7.	Check plate voltage of V1 and V2, and check C4 and C7. Replace defective component.
	Incorrect value of grid resistors	Check R1 and R12 Replace defective component.
	Open bypass cathode capacitor C5	If there is a large difference between normal plate and screen voltage, check C5. Replace if necessary.
8. Fading	Tubes	Check tubes and replace, if necessary.
	Coupling capacitors C4 and C7	Check C4, and C7 and replace, if necessary.
	VA control	Check R1A and R1B and replace, if necessary.
	Voltage divider resistors R18, R19, R20.	Check R18, R19, R20 and replace, if necessary.
9. Distortion	Tubes	Check tubes and replace, if necessary.
	Improper bias voltages	Check bias voltages and replace defective part.
	Coupling capacitors C4 and C7	Check C4 and C7 and replace if necessary.
10. Oscillation	Capacitor C13 or C14	Check C13, C14 and replace, if necessary.
	Open voltage divider R19	If V3 screen voltage is high, replace R19.
	Open output filter capacitor C10	Check C10 and replace, if necessary.
11. Amplification higher than normal.	Feedback circuit	Check C13, C14, C8, R15, and R16. Replace defective component.

50. Dc Resistances of Transformers

The dc resistances of the transformer windings in the amplifier are listed below:

Transformer	Terminals	Ohms
T1	1–4	43
	11–12	3,000
T2	1–3	50
	4–6	200
	7–8	20
	8–9	1
	8–10	1
T2	8–11	1
	8–12	18
	7–12	38
T3	10–14	5
	11–14	5
	12–14	6
	4–6	1
	7–9	300
	7–8	150
	8–9	150
	1–3	1

Section II. REPAIRS

51. Replacement of Parts

a. Most of the parts in AF Amplifier AM–465/FR are readily accessible and are easily replaced if found to be faulty. If VA control R1A or R1B, METER switch (S2), or OFF-ON switch S1 requires replacement, carefully mark the wires connected to the control or switches with tags or other devices to avoid misconnection when the new control or switch is installed. Follow this practice whenever replacement requires the disconnection of numerous wires.

b. To replace input transformer T1, output transformer T2, or power transformer T3, mark the wires connected to the transformer carefully with tags or other devices to avoid misconnection when the new transformer is installed.

52. Disassembly, Cleaning, Lubrication, and Reassembly of VA Control R1

Disassemble, clean, lubricate, and reassemble VA control R1 as instructed in paragraph 30*b*.

Section III. FINAL TESTING

53. Purpose

Equipment which has been repaired must meet definite minimum performance standards before it is returned to service. The tests outlined in this section are designed to measure the performance capabilities of AF Amplifier AM–465/FR and may be performed by maintenance personnel with adequate test equipment and the necessary skills. Equipment meeting the minimum requirements listed will furnish satisfactory operation.

54. Test Equipment Required for Final Testing

Test equipment of the type listed below is required for testing the repaired af amplifier:

a. Af Audio Oscillator. The af audio oscillator (Audio Oscillator TS–382A/U, or equal) must supply a constant output at frequencies ranging from 15 to 20,000 cycles.

b. Meters. Two output vacuum-tube voltmeters (vtvm), low range (Electronic Multimeter ME–6/U, Ballantine model 300, or equal) are needed. A noise end distortion analyzer (Distortion Analyzer TS–723/U or equal) is needed for distortion tests.

c. Load Impedances. Two 600-ohm resistors, 2 watts, are needed for proper loading of the amplifier.

55. Final Testing of AF Amplifier AM–465/FR

Input connections must be connected to 600-ohm balanced input (par. 17*a*).

a. Gain and Power Output.

(1) Connect the audio oscillator with a source impedance of 600 ohms to terminals 11 and 12 of input plug J1.

(2) Place a low range output vtvm directly across terminals 11 and 12 of input plug J1.

(3) Place a 600-ohm fixed composition resistor across terminals 11 and 12 of output plug J2.

(4) Place a low range output vtvm directly across terminals 11 and 12 of output plug J2 in parallel with the 600-ohm load.

(5) Set the VA control to the maximum clockwise position after the amplifier is in operation.

(6) Set the audio oscillator for an output frequency of 1,000 cycles.

(7) Adjust the audio oscillator so that the reading across terminals 11 and 12 of input plug J1 is .0044 microvolt. The output reading on the vtvm across the 600-ohm output load should be 7.75 volts. This is equivalent to a 65-dbm gain as compared to the .0044 microvolt input reading.

b. Frequency Response. The method described in paragraph 20 can be used for checking frequency response, but for completeness, an alternate method is discussed below—

(1) Connect the equipment as indicated in *a*(1) through (6) above.

(2) Vary the frequency of the audio oscillator from 30 to 15,000 cps. Keep the reading across terminals 11 and 12 of input plug J1 at .0044 microvolt over the entire range of frequencies.

(3) Read output on the vtvm across the 600-ohm output load at 30, 50, 100, 1,000, 4,000, 7,000, 10K, 12K and 15K cps. The reading should not be less than 7.75 volts (±1 db).

c. Distortion.

(1) Connect the equipment as indicated in *a* (1) through (6) above.

(2) Place the distortion analyzer across the 600-ohm output load.

(3) Adjust the audio oscillator so that the output reading on the vtvm across the 600-ohm output load is 24.5 volts.

(4) Set the audio oscillator at the following frequencies: 30, 50, 100, 1,000, 4,000, 7,000, 10K, 12K, and 15K cps, and measure distortion. The distortion should not exceed 1 percent at 30 cps and .5 percent at 50 to 15K cps.

d. Noise Level.

(1) Place a 600-ohm resistor and a noise analyzer across terminals 11 and 12 of output plug J2.

(2) Place a 600-ohm resistor across terminals 11 and 12 of input plug J1.

(3) Set the amplifier VA control to the maximum clockwise position after the amplifier is in operation. The noise level reading on the noise analyzer should be less than .00195 volt.

e. VA Control. Rotating the VA control in a counterclockwise position in the above tests should lower the output voltage.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

56. Disassembly

The following instructions are recommended as a guide for preparing the amplifier for transportation and storage.

a. Disconnection of Cables. Disconnect input and output receptacles with cables from plugs J1 and J2.

b. Removal of Unit. Slide the amplifier from the shelf by pushing back on the ejector handles.

57. Repacking for Shipment or Limited Storage

Note. As far as possible, use the original packaging materials that were saved at the time the equipment was unpacked.

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.

b. Whenever practicable, place a dehydrating agent such as silica gel inside the carton. Protect the carton with a waterproof sealing compound or tape.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

58. General

The demolition procedures outlined in paragraph 59 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.

59. Methods of Destruction

a. Smash. Smash the tubes, switches, capacitors, transformers, and resistors, using sledges, axes, handaxes, pickaxes, crowbars, or heavy tools.

b. Cut. Cut cables and wiring, using axes, handaxes, or machetes.

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

d. Bend. Bend chassis.

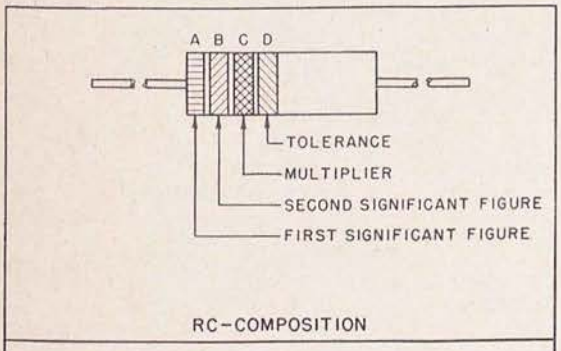
e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

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

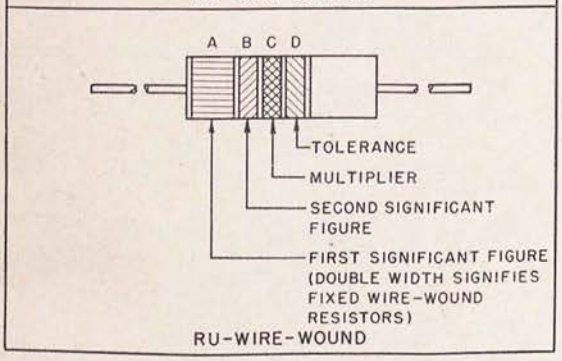
g. Destroy. Destroy everything.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

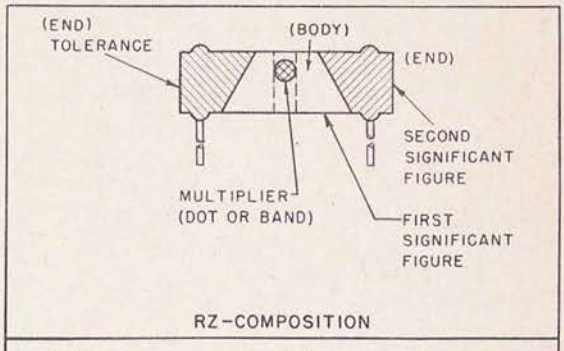


RC-COMPOSITION

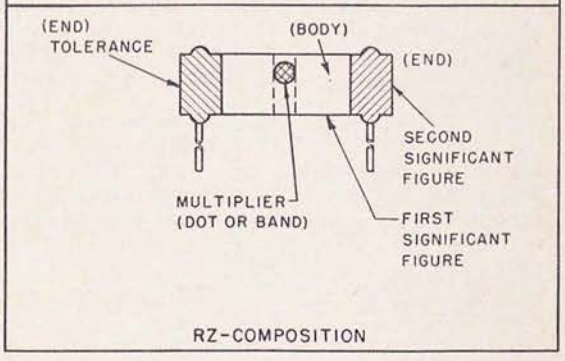


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

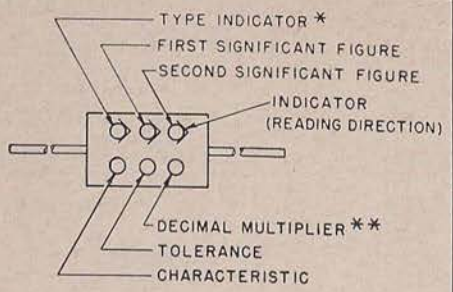
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

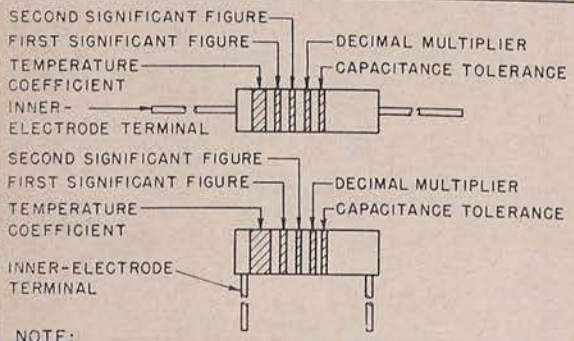
Figure 25. Resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



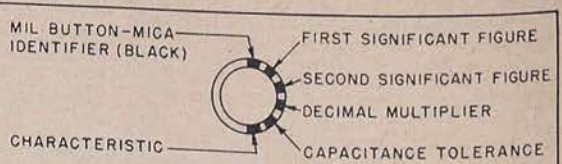
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

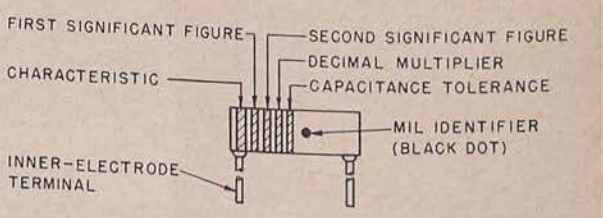


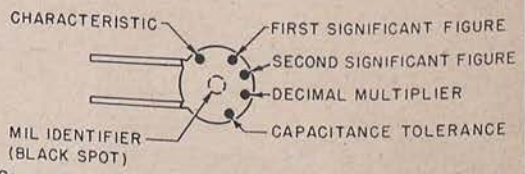
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS, TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE 2					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 26. Capacitor color codes.

INPUT	CONNECT ON T1	CT
600 OHM	2-3	2
150 OHM	1-2, 3-4	5

DUAL POTENTIOMETER

T1

R1A 100K 100 KΩ VA

R1B 100K VA

1ST AF AMPL V1 6J7

2D AF AMPL V2 6J7

AF OUTPUT AMPL V3 6L6

C1 .1

C2 20

C3 .25

C4 .25

C5 3,900UUF

C6 .25

C7 .1

C8 1,200 UUF

C13 560 UUF

C14 3,300UUF

R2 470

R3 470K

R4 18K

R5 120K

R7 680

R8 1,500

R9 1K

R10 1 MEG

R11 220K

R12 470K

R13 390

R14 22

R15 1,800

R16 1,800

R21 5,600

R22 5,600

R23 10K

R24 560

R25 10K

R26 330

S2

METER

T2

4,700 ΩZ

600 OHMS

ZERO OHMS

J1

J2

T3

125V 115V 105V

5V 2 AMP

660V 68MA

6.3V 1.5AMP

S1 OFF ON

F1 1 AMP

100-130V 50-60~

PLATE SUPPLY RECTIFIER V4 5Y3-GT

R6 100 HUM

R17 600

R18 8,200

R19 82K

R20 5,600

C9 80

C10 80

C11 40

C12 .01

OUTPUT	TERMINALS ON J2
5 OHM	3-4
7.5 OHM	7-8
15 OHM	9-10
150 OHM	10-11
600 OHM	11-12

NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. ▭ INDICATES EQUIPMENT MARKING.

TM5101-21

Figure 27. AF Amplifier AM-465/FR, schematic diagram.

INDEX

[413.47 (14 Oct 54)]

BY ORDER OF THE SECRETARY OF THE ARMY:

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Chief of Staff.

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11–597A, Sig Base Depot Co (2)

NG: Same as Active Army except allowance is one copy for each unit.
USAR: None.
Unless otherwise noted, distribution applies to ConUS and overseas.
For explanation of abbreviations used, see SR 320–50–1.

U. S. GOVERNMENT PRINTING OFFICE: 1954

AF AMPLIFIER AM–465/FR

CHANGE
No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *9 October 1963*

TM 11–5101, 8 November 1954, is changed as follows:

Page 3. Add paragraph 1.1 after paragraph 1.

1.1. Index of Publications

Refer to the latest issue of DA Pam 310–4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. Department of the Army Pamphlet No. 310–4 is an index of current technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders available through publications supply channels. The index lists the individual parts (–10, –20, –35P, etc.) and the latest changes to and revisions of each equipment publication.

Delete paragraph 2 and substitute:

2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38–750.

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), NAVSANDA Publication 378 (Navy), and AFR 71–4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting by the individual user of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended changes to DA technical manual parts lists or supply manuals 7, 8, or 9) will be used for reporting these improvements. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to: Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS–MP, Fort Monmouth, N.J., 07703. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc.).

Page 18. Delete chapter 3 heading and substitute: MAINTENANCE INSTRUCTIONS.

Delete sections I and II and substitute:

Section I. OPERATOR'S MAINTENANCE

24. Scope of Operator's Maintenance

The maintenance duties assigned to the operator of the equipment are listed below together with a reference to the paragraphs covering the specific maintenance function.

a. Daily preventive maintenance checks and services (par. 27).

b. Weekly preventive maintenance checks and services (par. 28).

c. Cleaning (par. 29).

25. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 27 through 29 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

Copy 1/2

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (pars. 27 and 28) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are; the *References* column lists the paragraphs or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective actions listed, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38–750.

26. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily and weekly. Paragraphs 27 and 28 specify the items to be checked and serviced. In addition to the routine daily and weekly checks and services, the equipment should be rechecked and serviced immediately before going on a mission and as soon after completion of the mission as possible.

27. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	See that the equipment is complete (SIG 7&8 AM–465/FR).	
2	Cleanliness	Clean the exterior surfaces (par. 29). During cleaning operation, inspect for damaged, missing, or loose hardware and controls.	
3	Operation	During operation be alert for any unusual performance or condition.	

28. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Exterior	Inspect all exposed surfaces for chips, cracks, rust, corrosion, and mildew.	None.
2	Controls	Inspect all operating controls for binding, scraping, and excessive looseness.	None.

29. Cleaning

Inspect the exterior of the equipment. The exterior surfaces should be clean, and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

***Warning:* Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. *Do not* use near a flame.**

b. Remove grease, fungus, and ground-in dirt from the case; use a cloth dampened (not wet) with Cleaning Compound (Federal stock No. 7930–395–9542).

c. Remove dust or dirt from plugs and jacks with a brush.

d. Clean the front panel and control knobs; use a soft clean cloth. If necessary, dampen the cloth with water; mild soap may be used for more effective cleaning.

Section II. ORGANIZATIONAL MAINTENANCE

29.1. Scope of Organizational Maintenance

a. This section contains instructions covering second echelon maintenance of the equipment. It includes instructions for performing preventive and periodic maintenance services, and repair functions to be accomplished by the organizational repairman.

b. Second echelon maintenance of the equipment includes:

(1) Replacement of defective tubes and fuse (fig. 5).

(2) Preventive maintenance (pars. 29.2 through 29.5).

(3) Lubrication (par. 30).

(4) Troubleshooting (pars. 35 and 36).

29.2. Preventive Maintenance

a. Preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent breakdown, and assure maximum operation capability. Preventive maintenance is the responsibility of all echelons concerned with the equipment and includes the inspection, testing, and repair or replacement of parts, subassemblies, or units that inspection and tests indicate would probably fail before the next scheduled periodic service. Preventive maintenance checks and services of the equipment at the second echelon level are made at quarterly intervals unless otherwise directed by the commanding officer.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38-750.

29.3. Quarterly Maintenance

Quarterly preventive maintenance checks and services on the equipment are required. All deficiencies or shortcomings will be recorded in accordance with the requirements of TM 38-750. Perform all the checks and services listed in the quarterly preventive maintenance checks and services chart (par. 29.4) in the sequence listed. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have quarterly preventive maintenance checks and services performed on it. Equipment in limited storage (requires service before operation) does not require quarterly preventive maintenance.

29.4. Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	See that the equipment is complete (SIG 7&8, AM-465/FR).	
2	Cleanliness	Clean the exterior and interior of the equipment (par. 29). During cleaning operations, replace or tighten damaged, missing, or loose hardware and controls.	
3	Exterior	Inspect all exposed surfaces for chips, cracks, rust, corrosion, and mildew. Touchup paint as required (par. 29.5).	
4	Lubrication	Lubricate the equipment (par. 30 and fig. 17).	
5	Pluckout items	Inspect seating of pluckout items. Make sure that tube clamps grip tube bases tightly.	
6	Transformer terminals	Inspect the terminals on the power transformer. All nuts must be tight. There should be no evidence of dirt or corrosion.	
7	Terminal blocks	Inspect terminal blocks for loose connections and cracked or broken insulation.	

29.4. Quarterly Preventive Maintenance Checks and Services Chart — Continued

Sequence No.	Item	Procedure	References
8	Resistors and capacitors	Inspect the resistors and capacitors for cracks, blistering, or other detrimental defects.	
9	Operation	Operate the equipment according to paragraph 36.	Paragraph 36.
10	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310–4.
11	Modifications	Check DA Pam 310–4 to determine if new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	TM 38–750 and DA Pam 310–4.
12	Spare parts	Check all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	SIG 7&8 AM–465/FR.

29.5. Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9–213.

Page 19. Delete figure 15.

Page 20. Delete figure 16.

Page 21. Delete paragraph 31.

Page 24, item 4, action or condition column. Change "23" to "16".

Page 32, paragraph 45, chart. Delete first item and substitute: Test Set, Electron Tube TV–7/U; TM 11–6625–274–12.

Page 36, paragraph 52. Change "paragraph 30*b*" to paragraph "30".

Page 37, paragraph 54*b*. Delete "ME–6/U, Ballantine model 300, or equal" and substitute: ME–30A/U.

Page 38. Add the following appendix after chapter 6.

APPENDIX

REFERENCES

DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9–213	Painting Instructions for Field Use.
TM 11–2044	Attenuators TS–403/U and TS–402A/U.
TM 11–2096	Test Set TS–140/PCM; Signal Generators SG–15/PCM and SG–15A/PCM; and Decibel Meters ME–22/PCM and ME–22A/PCM.
TM 11–5097	Spectrum Analyzers TS–723A/U, TS–723B/U, and TS–723C/U.
TM 11–5527	Multimeters TS–352/U, TS–352A/U, and TS–352B/U.
TM 11–6625–261–12	Operator's and Organizational Maintenance Manual: Audio Oscillators TS–382A/U, TS–382B/U, TS–382D/U, TS–382E/U, and TS–382F/U.
TM 11–6625–274–12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV–7/U, TB–7A/U, TV–7B/U, and TV–7D/U.
TM 11–6625–320–12	Operator's and Organizational Maintenance Manual: Voltmeter, Meter ME–30A/U and Voltmeters, Electronic ME–30B/U and ME–30C/U.
TM 38–750	The Army Equipment Record System and Procedures.

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NG: None.

USAR: None.

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

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