

★
NAVSHIPS 91905

INSTRUCTION BOOK
for
AMPLIFIER, AF AM-413/G
and
DYNAMIC LOUDSPEAKER
LS-169/G

HARMAN-KARDON, INC.
52 West Houston St.
New York 12, N. Y.

BUREAU OF SHIPS

NAVY DEPARTMENT

Contract NObsr52352

★
Approved by BUShips: 10 April 1953

LIST OF EFFECTIVE PAGES

PAGE NUMBERS	CHANGE IN EFFECT	PAGE NUMBERS	CHANGE IN EFFECT
Title page	Original	to	Original
A to C	Original	to	Original
to	Original	to	Original
to	Original	to	Original
to	Original	to	Original
to	Original	to	Original



DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 993-100
10 April 1953

From: Chief, Bureau of Ships
To: All Activities Concerned with the
Installation, Operation and Main-
tenance of the Subject Equipment

Subj: Instruction Book for Audio Fre-
quency Amplifier AM-413/G and
Dynamic Loudspeaker LS-169/G
NAVSHIPS 91905

1. This is the instruction book for the subject equipment and is in effect upon receipt.
2. When superseded by a later edition, this publication shall be destroyed.
3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.
4. All Navy requests for NAVSHIPS Electronics publications should be directed to the nearest District Publications and Printing Office. When changes or revised books are distributed, notice will be included in the Bureau of Ships Journal and in the Index of Bureau of Ships General and Electronics Publications, NAVSHIPS 250-020.

H. N. WALLIN
Chief of Bureau

TABLE OF CONTENTS

<i>Paragraph</i>		<i>Page</i>
Section 1 — GENERAL DESCRIPTION		
1.	Introduction	1-1
2.	Audio Amplifier AM-413/G.....	1-1
3.	Dynamic Loudspeaker LS-169/G.....	1-1
4.	Equipment Supplied	1-1
5.	Equipment Required But Not Supplied.....	1-2
6.	Shipping Data	1-2
7.	Vacuum Tube Complement.....	1-2
8.	Reference Data	1-2
9.	Electrical Characteristics of Audio Amplifier AM-413/G.....	1-3
10.	Electrical Characteristics of Dynamic Loudspeaker LS-169/G.....	1-3
Section 2 — THEORY OF OPERATION		
1.	General Description of Circuits.....	2-1
2.	Theory of Negative Feedback.....	2-1
3.	The Cathode Follower.....	2-1
4.	The Differential Amplifier.....	2-1
5.	Volume Compression	2-3
6.	Triode Clipper	2-3
7.	Block Diagram	2-3
8.	Dynamic Loudspeaker LS-169/G.....	2-6
Section 3 — INSTALLATION		
1.	Installation	3-1
2.	Adjustment	3-1
Section 4 — OPERATION		
1.	Audio Amplifier AM-413/G.....	4-1
2.	Dynamic Loudspeaker LS-169/G.....	4-1
Section 5 — OPERATOR'S MAINTENANCE		
1.	Emergency Maintenance	5-0
Section 6 — PREVENTIVE MAINTENANCE		
1.	General	6-1
2.	Operation Test	6-1
Section 7 — CORRECTIVE MAINTENANCE		
1.	General Trouble Shooting Procedures.....	7-2
2.	Trouble Shooting Audio Amplifier AM-413/G.....	7-2
Section 8 — PARTS LISTS		

INDEX

LIST OF ILLUSTRATIONS

<i>Figure</i>	<i>Title</i>	<i>Page</i>
Section 1 — GENERAL DESCRIPTION		
1-1	Audio Amplifier AM-413/G and Dynamic Loudspeaker LS-169/G.....	1-0
Section 2 — THEORY OF OPERATION		
2-1	Simplified Block Diagram of Audio Amplifier AM-413/G.....	2-0
2-2	Amplification Without Negative Feedback.....	2-0
2-3	Use of Negative Feedback.....	2-0
2-4	Cathode Follower Circuit.....	2-2
2-5	Cathode Follower Circuit.....	2-2
2-6	Differential Amplifier Circuit.....	2-2
2-7	Cathode Follower and Differential Amplifier.....	2-2
2-8	Basic Principles of Compressor Circuit.....	2-4
2-9	Basic Compressor Circuit.....	2-4
2-10	A Triode Clipper Circuit.....	2-4
2-11	Block Diagram of Audio Amplifier AM-413/G.....	2-5
2-12	Schematic of Dynamic Loudspeaker LS-169/G.....	2-6
Section 3 — INSTALLATION		
3-1	Cable Connections for Audio Amplifier AM-413/G.....	3-0
3-2	Cable Connections for Dynamic Loudspeaker LS-169/G.....	3-0
Section 4 — OPERATION		
4-1	Operating Controls of Audio Amplifier AM-413/G.....	4-0
4-2	Operating Controls of Dynamic Loudspeaker LS-169/G.....	4-0
Section 5 — OPERATOR'S MAINTENANCE		
5-1	Location of Tubes, Fuses, and Electrolytic Capacitors.....	5-0
Section 7 — CORRECTIVE MAINTENANCE		
7-1	Failure Report, Sample Form.....	7-1
7-2	Audio Amplifier AM-413/G Chassis with Panel open	7-4
7-3	Terminal Board (TB101), Component Placement Diagram.....	7-5
7-4	Terminal Board (TB102), Component Placement Diagram.....	7-5
7-5	Voltage and Resistance Chart	7-5
7-6	Schematic of Audio Amplifier AM-413/G.....	7-11

LIST OF TABLES

<i>Table</i>	<i>Title</i>	<i>Page</i>
Section 1 — GENERAL DESCRIPTION		
1-1	Equipment Supplied for Amplifier AM-413/G.....	1-1
1-2	Equipment Supplied for Loudspeaker LS-169/G.....	1-2
1-3	Shipping Data	1-2
1-4	Vacuum Tube Complement.....	1-2
Section 5 — OPERATOR'S MAINTENANCE		
5-1	Emergency Maintenance Chart.....	5-0
Section 6 — PREVENTIVE MAINTENANCE		
6-1	Maintenance Test Schedule.....	6-1
6-2	Operation Check Procedure.....	6-2
Section 7 — CORRECTIVE MAINTENANCE		
7-1	Trouble Shooting Chart.....	7-3
7-2	Voltage and Resistance Data.....	7-6
7-3	Tube Ratings	7-8
7-4	Winding Data	7-9
Section 8 — PARTS LISTS		
8-1	List of Major Units.....	8-1
8-2	Table of Replaceable Parts.....	8-2
8-3	Cross Reference Parts List.....	8-12
8-4	Applicable Color Codes and Miscellaneous Data.....	8-13
8-5	List of Manufacturers.....	8-14

GUARANTEE

The equipment, including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten percent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred percent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

INSTALLATION RECORD

Contract Number: NObsr-52352	Date of Contract: 22 March 1951
Serial number of equipment.....	
Date of acceptance by the Navy.....	
Date of delivery to contract destination.....	
Date of completion of installation.....	
Date placed in service.....	
Blank spaces on this page shall be filled in at the time of installation.	

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations using form NAVSHIPS NBS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the *Bureau of Ships Manual* or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Federal stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of *Bureau of Ships Manual* or superseding instructions on the subject of radio-safety precautions to be observed.

WARNING

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

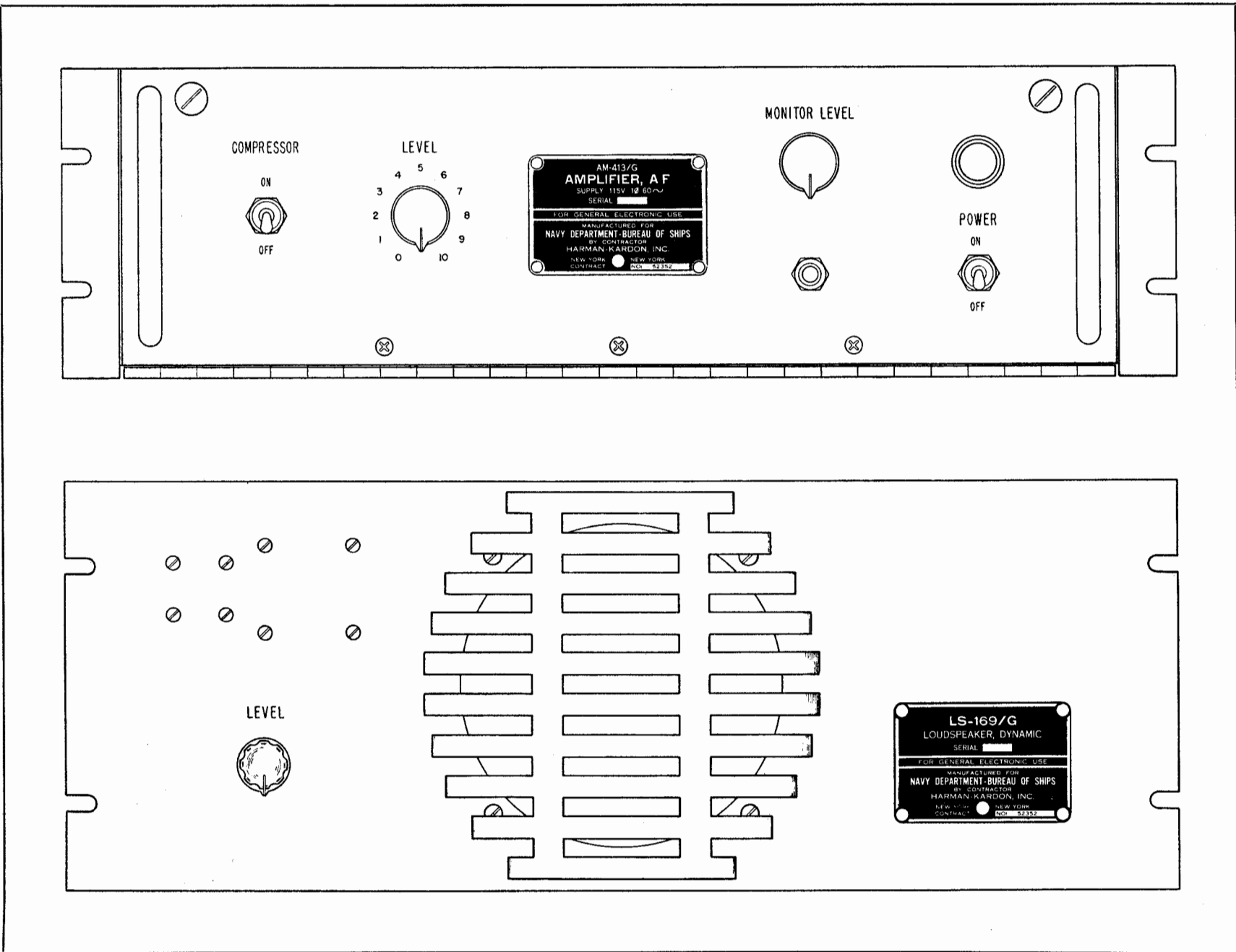


Figure 1-1. Audio Amplifier AM-413/G and Dynamic Loudspeaker LS-169/G

SECTION 1 GENERAL DESCRIPTION

1. INTRODUCTION

This instruction book contains information pertaining to the description, operation, and maintenance of Audio Amplifier AM-413/G and Dynamic Loudspeaker LS-169/G. This equipment is suitable for general communication purposes when operating in conjunction with Naval radio receiving sets and associated equipment.

2. A. F. AMPLIFIER AM-413/G (See figure 1-1)

- a. A. F. Amplifier AM-413/G consists of an audio amplifier and a volume compressor, and is designed for mounting in a standard 19 inch relay rack. Use of the volume compressor is optional, being determined by the position of a toggle switch.
- b. The amplifier provides power output of 2 watts with less than 7% harmonic distortion for input signals of from .001 to 6 milliwatts at frequencies between 200 and 5000 cps. The input signal is received through either or both of two receptacles, each individually connected to a 600 ohm balanced winding of the amplifier input transformer. The input receptacles are located at the rear of the amplifier.
- c. The Amplifier provides three 600 ohm outputs: a two watt balanced circuit for a loudspeaker, a 6 milliwatt balanced circuit for a 600 ohm line, and a 1 milliwatt unbalanced circuit for a headset. The receptacles for the balanced outputs are located at the rear of the amplifier. Connection to the headset output is achieved through a monitoring jack located on the front panel. In addition to the Level Control which varies the volume of all three outputs, there is a Monitor Level control which controls only the output of the monitoring jack.

- d. The volume compressor circuit maintains the variation in output volume within 3 db for an input variation of .001 to 6 milliwatts. The Compressor On-Off Switch is located on the front panel of the Amplifier.
- e. A built-in transformer-fed power supply, with primary taps for operation from 105/115/125 volts, 50-60 cycles, single phase AC, supplies all voltages required in the equipment. Total power consumption of the equipment at nominal line voltage is not more than 50 watts. The power Switch and the pilot lamp are located on the front panel. The fuses are located at the rear of the amplifier.
- f. The panel is so hinged to the amplifier that it forms the bottom cover of the chassis. Two quick-acting fasteners, when released, permit the panel to rotate downward, making the chassis interior available for inspection and servicing.

3. DYNAMIC LOUDSPEAKER LS-169/G

(See figure 1-1)

Dynamic Loudspeaker LS-169/G is capable of relatively faithful reproduction of the signal output of Audio Amplifier AM-413/G. Input signal is received through a receptacle available from the rear of the Loudspeaker panel, is adjusted in level by means of a constant impedance attenuator, and is then fed through a matching transformer to a permanent magnet type six inch Loudspeaker.

4. EQUIPMENT SUPPLIED (See figure 1-1)

The complete equipment supplied for A. F. Amplifier AM-413/G is listed in Table 1-1. The complete equipment supplied for Dynamic Loudspeaker LS-169/G is listed in Table 1-2. For additional information refer to Section 8 of this instruction book for a Combined Parts and Spare Parts List.

TABLE 1-1. A. F. AMPLIFIER AM-413/G EQUIPMENT SUPPLIED

Quantity per Equipment	Name of Unit	Navy Type Designation	Overall Dimensions			Volume	Weight
			Height	Width	Depth		
1	Audio Amplifier	AM-413/G	5 $\frac{1}{4}$	19	8 $\frac{3}{4}$	370	15 $\frac{1}{2}$
1	AC Power Plug	AN-3106-14S-7S	1-7/16	1 $\frac{1}{8}$	1 $\frac{1}{8}$	1.7	2 oz.
2	Audio Input Plug	AN-3106-14S-2S	1-7/16	1 $\frac{1}{8}$	1 $\frac{1}{8}$	1.7	2 oz.
2	Audio Output Plug	AN-3106-14S-2P	1-7/16	1 $\frac{1}{8}$	1 $\frac{1}{8}$	1.7	2 oz.
1	Cable Clamp with Ferrule to fit MCOS-2 cable	AN-3057-6	1-5/64	$\frac{7}{8}$	$\frac{7}{8}$	.8	1 oz.
4	Cable Clamp with Ferrule to fit RG-108/U cable	AN-3057-6	1-5/64	$\frac{7}{8}$	$\frac{7}{8}$	.8	1 oz.
2	Instruction Book	NAVSHIPS 91905	11 $\frac{1}{2}$	8 $\frac{3}{4}$	$\frac{1}{2}$	50	9 oz.

Unless otherwise stated, dimensions are in inches, volume cubic inches, weight pounds.

TABLE 1-2. LOUDSPEAKER LS-169/G EQUIPMENT SUPPLIED

Quantity per Equipment	Name of Unit	Navy Type Designation	Overall Dimensions			Volume	Weight
			Height	Width	Depth		
1	Dynamic Loudspeaker Plug	LS-169/G AN-3106-14S-2S	7	19	4	532	5 1/2
1			1 7/16	1 1/8	1 1/8	1.7	2 oz.
1	Cable Clamp with Ferrule to fit RG-108/U Cable Instruction Book	NAVSHIPS 91905	1 5/64	7/8	7/8	.8	1 oz.
2			1 1/2	8 3/4	1/2	50	9 oz.

Unless otherwise stated, dimensions are in inches, volume cubic inches, weight pounds.

5. EQUIPMENT REQUIRED BUT NOT SUPPLIED

None of the cables required for use with the equipment is supplied, nor are any of the auxiliary devices used in conjunction with the equipment, such as radio receiving sets.

6. SHIPPING DATA

A list of shipping boxes, their contents and their sizes is given in Table 1-3.

7. VACUUM TUBE COMPLEMENT

The vacuum tube complement of Audio Amplifier AM-413/G is given in Table 1-4. No vacuum tubes are used in Dynamic Loudspeaker LS-169/G.

TABLE 1-3. SHIPPING DATA

Shipping Box No.	Contents		Overall Dimensions			Volume	Weight
	Name	Designation	Height	Width	Depth		
1	AF Amplifier	AM-413/G	8 1/2	22	12	1.3	38
	AC Power Plug	AN-3106-14S-7S					
	Audio Input Plug	AN-3106-14S-2S					
	Audio Output Plug	AN-3106-14S-2P					
	Cable Clamp	AN-3057-6					
2	Instruction Book	NAVSHIPS 91905	10	22	7	0.89	21
	Loudspeaker*	LS-169/G					
	Instruction Book	NAVSHIPS 91905					

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

* When Supplied

TABLE 1-4. VACUUM TUBE COMPLEMENT

Jan Type	Tube Type	Quantity	Reference Symbols
12AT7WA	Twin Triode	5	V101 through V105
6005	Beam Power	1	V106
5Y3WGTB	Full-Wave Rectifier	1	V107

8. REFERENCE DATA

AF Amplifier AM-413/G

- a. Nomenclature.....A. F. Amplifier AM-413/G
- b. Contract Number and date
NObsr52352, 22 Mar. 1951
- c. Contractor.....Harman-Kardon, Inc.
52 West Houston St.
New York 12, N. Y.

- d. Cognizant Naval Inspector.....Inspector of Naval Material, U. S. N.
New York, New York
- e. Number of Packages per Equipment.....1
- f. Equipment Cubical Contents crated: 1.3 cubic feet
uncrated: .5 cubic feet
- g. Equipment Total Weight.....crated: 38 lbs.
uncrated: 17 lbs.

Dynamic Loudspeaker LS-169/G

- a. Nomenclature..Dynamic Loudspeaker LS-169/G
- b. Contract Number and date
NObsr52352, 22 Mar. 1951
- c. Contractor.....Harman-Kardon, Inc.
52 West Houston St.
New York 12, N. Y.
- d. Cognizant Naval Inspector..Inspector of Naval
Material, U. S. N.
New York, N. Y.
- e. Number of Packages per Equipment.....1
- f. Equipment Cubical Contents
crated: .89 cubic feet
uncrated: .3 cubic feet
- g. Equipment Total Weight.....crated: 21 lbs.
uncrated: 6 lbs.

**9. ELECTRICAL CHARACTERISTICS OF AUDIO
AMPLIFIER AM-413/G**

- (a) Frequency Response
 ± 1 db from 200 to 5000 cps
- (b) Input Impedance.....600 ohms $\pm 10\%$
- (c) Input Level......001 to 6 milliwatts

- (d) Outputs
 - (1) 2 watts, 600 ohms, balanced
 - (2) 6 milliwatts, 600 ohms, balanced
 - (3) 1 milliwatt, 600 ohms, unbalanced
- (e) Compression Range.....001 to 6 milliwatts
- (f) Output Variation of compressor
not more than 3db
- (g) Distortion.....not more than 7%
- (h) Signal Plus Noise to Noise Ratio
not less than 50db
- (i) AC Power Requirements:
 - (1) Voltage105/115/125
 - (2) Frequency50 to 60 cps
 - (3) PhaseSingle
 - (4) Power Consumption.....50 watts

**10. ELECTRICAL CHARACTERISTICS OF DYNAMIC
LOUDSPEAKER LS-169/G**

- (a) Frequency Response.....200 to 5000 cps
- (b) Input Impedance600 ohms
- (c) Maximum Power Input.....5 watts
- (d) Attenuation Control4db per division

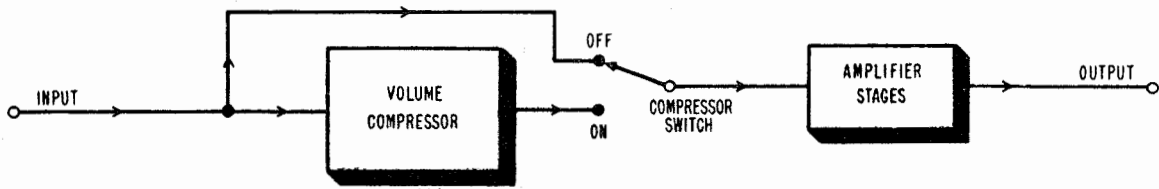


Figure 2-1. Simplified Block Diagram of Audio Amplifier AM-413/G

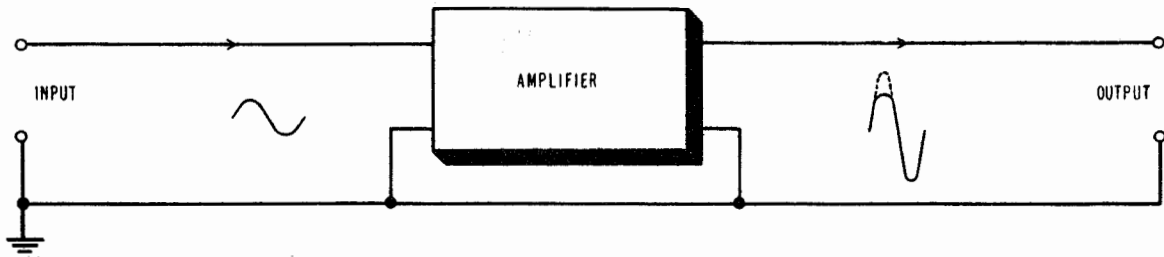


Figure 2-2. Amplification Without Negative Feedback

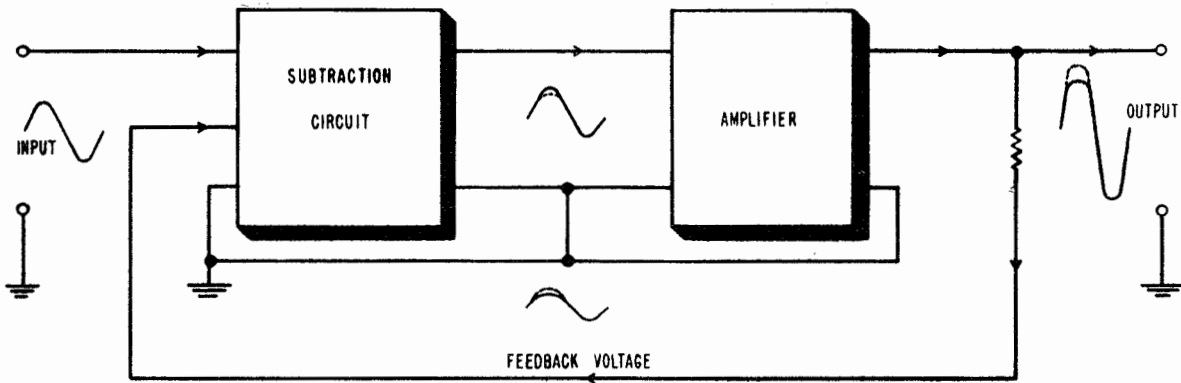


Figure 2-3. Use of Negative Feedback

SECTION 2

THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS

Audio Amplifier AM-413/G consists of an amplifier and a volume compressor. Figure 2-1 shows the basic functions of the circuit. As shown in the diagram, if the Compressor Switch is OFF, the signal is fed directly into the amplifier stages. If the Compressor Switch is ON, the signal is fed into the volume compressor and then into the amplifier stages.

2. THEORY OF NEGATIVE FEEDBACK

Negative feedback is used in the circuit of Audio Amplifier AM-413/G. The use of negative feedback is illustrated in figure 2-3. The arrangement without negative feedback is shown in figure 2-2 for comparison. A negative feedback (also called degeneration or inverse feedback) circuit is one in which a portion of the output voltage of an amplifier is applied to the input of the amplifier in opposite polarity to the signal applied to the amplifier. The amplifier may consist of one or more stages. In figure 2-3, the output of the amplifier has the same polarity as the input. In this case, the feedback voltage must be subtracted from the input. (If the output of the amplifier is of opposite polarity to the input signal, an adding circuit is used.)

An outstanding property of negative feedback is that it usually reduces the distortion produced by the amplifier in which it is used. Figure 2-2 shows an amplifier in which the positive peak has been flattened out due to distortion in the amplifier. In figure 2-3, negative feedback is used with the same amplifier. A portion of the distorted output voltage is subtracted from the input signal. As a result of the feedback voltage having a flattened positive half cycle, the output of the subtraction circuit has a peaked up positive half cycle. This peaked wave will partially compensate for the flattening produced by the amplifier. Therefore the output of the amplifier has less distortion than the output shown in figure 2-2. In a similar manner, negative feedback reduces noise, hum, and phase shift in the amplifier. Up to a certain point, the more feedback there is, the better will be the characteristics of the amplifier. However, due to the subtraction of a portion of the output voltage from the input signal, there is less signal actually applied to the input of the amplifier. Therefore, the output of the amplifier is reduced. In effect, the gain of the amplifier is reduced. The more feedback there is, the greater the reduction in effective gain. The loss in gain may be compensated for either by feeding the amplifier with a larger signal, or adding more stages to the amplifier.

Negative feedback tends to stabilize the characteristics of the amplifier. If the gain of the amplifier tends to decrease because a very high or very low frequency signal is applied, or because of line voltage variations or aging tubes, the feedback voltage becomes a smaller percentage of the input signal. As a result, after the subtraction, there is a larger portion of the input signal actually fed into the amplifier. This larger signal partially compensates for the loss in gain. Conversely, if the gain should increase, there will be more feedback, and consequently less signal entering the amplifier, tending to reduce the effective gain.

Negative feedback reduces the effect of loading on the output of an amplifier. If the feedback voltage is proportional to the output voltage, the circuit is called voltage feedback. Voltage feedback reduces variations in output voltage due to changes in load by feeding back more voltage if the output voltage should increase and feeding back less voltage if the output voltage should decrease. If the feedback voltage is proportional to the output current, the circuit is called current feedback. Current feedback reduces variations in output current due to changes in load.

3. THE CATHODE FOLLOWER

A cathode follower circuit is shown in figure 2-4. When the grid is driven positive, the current through the tube increases. Therefore, the voltage drop across the cathode resistor increases, and the output voltage goes in the positive direction. When the grid is negative, the current decreases, and the output voltage goes in the negative direction. Therefore, the output voltage of a cathode follower has the same polarity as the input. The tube current is determined by e_{gk} (see fig. 2-4) instead of e_s . However, $e_{gk} = e_s - e_k$. In other words, the actual voltage applied between grid and cathode equals the input voltage minus the output voltage. Therefore, the cathode follower is a negative voltage feedback circuit in which all of the output is fed back to the input. This circuit has a voltage gain of slightly less than unity. It can be used as a power amplifier. It can apply almost all the input signal across a very low impedance without loading down the input circuit. Figure 2-5 is a variation of the cathode follower circuit.

4. THE DIFFERENTIAL AMPLIFIER

A differential amplifier circuit is shown in figure 2-6. For signal e_1 , as the signal goes positive, the tube current increases. In other words, the current is in phase with e_1 . For signal e_2 , as the signal goes

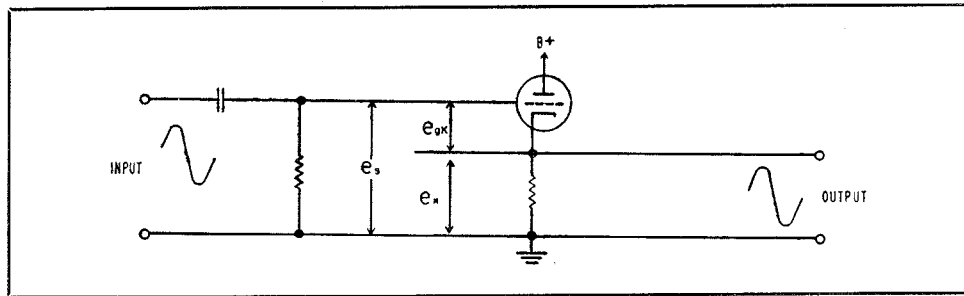


Figure 2-4. Cathode Follower Circuit

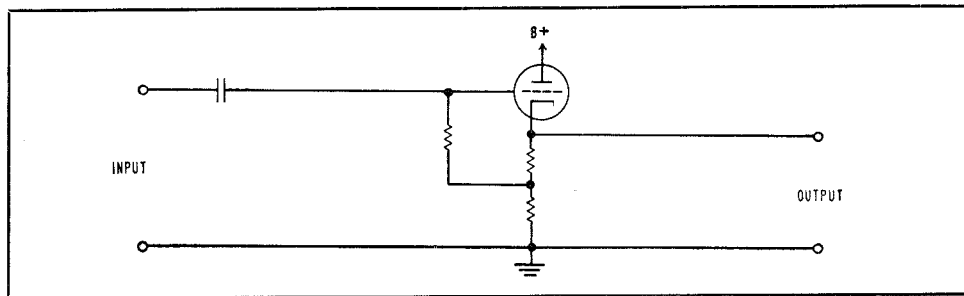


Figure 2-5. Cathode Follower Circuit

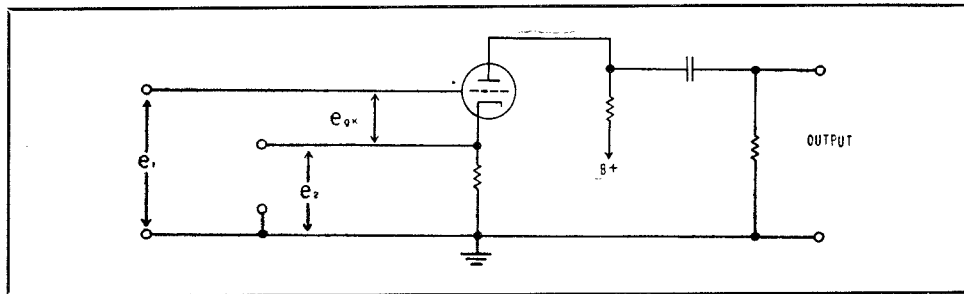


Figure 2-6. Differential Amplifier Circuit

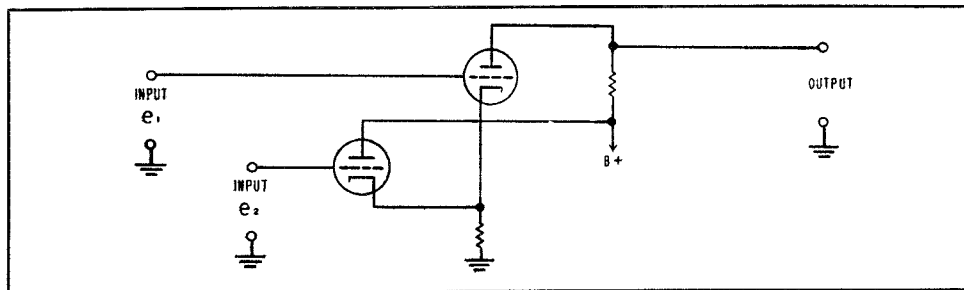


Figure 2-7. Cathode Follower and Differential Amplifier

positive, the cathode goes positive with respect to the grid, or the grid goes negative with respect to the cathode. Therefore, the current decreases. In other words, the current is in opposite phase to e_2 . Thus, the current depends on the difference between e_1 and e_2 . This can also be shown by the fact that (see figure 2-6) $e_{gk} = e_1 - e_2$. The differential amplifier is therefore used to obtain the difference between two signals. If e_1 and e_2 are equal and have the same polarity, there will be no signal between grid and cathode. The current flow through the tube will be constant and there will be no output. On the other hand, if e_1 and e_2 are of opposite polarity, the effective signal applied between grid and cathode equals the sum of the magnitudes of e_1 and e_2 . Figure 2-7 shows a cathode follower being used to drive the cathode of a differential amplifier.

5. VOLUME COMPRESSION

A volume compressor is an electronic circuit that attempts to keep the output voltage constant regardless of the magnitude of the input signal. The output of the volume compressor in Audio Amplifier AM-413/G varies less than 3 db (.001 to 6 milliwatts). The method of obtaining volume compression is shown in figure 2-8. R-2 represents a large fixed resistor. R-1 represents a variable resistance which can be adjusted to any value from infinity to one-hundredth of R-2. When the input signal is very small, R-1 is made practically infinite, and the output voltage equals the input voltage. As the input voltage is increased, R-1 is made smaller and smaller to hold the output constant: Figure 2-9 shows tube V-1 being used in place of R-1. When V-1 is cut-off, the AC resistance between plate and cathode equals R-3, which can be made much larger than R-2. When V-1 has zero bias, its dynamic resistance in the circuit shown becomes less than one-hundredth of R-2. Therefore, by varying the bias on V-1 between zero and cut-off, the output voltage can be controlled. In Audio Amplifier AM-413/G, V-1 is normally cut-off for very small signals. As the output of the compressor tends to increase, the grid of V-1 is made less negative, tending to hold the output constant.

6. TRIODE CLIPPER

A triode clipper circuit is shown in figure 2-10. For small signals, the circuit behaves like a conventional amplifier. For large signals, the bias is exceeded on the positive half cycle, and the cut-off voltage is exceeded on the negative half cycle. When the signal exceeds the bias, grid current flows. R-1 is made much larger than the resistance between cathode and grid. Therefore, almost all the voltage due to grid current flow is developed across R-1. Thus, whenever the signal exceeds the bias, the excess voltage appears across R-1, and the grid to

cathode voltage remains essentially zero. In this manner, the positive peaks of the signal are clipped. The negative peaks are clipped by driving the tube into cut-off. Once the tube is cut-off, any additional negative signal on the grid has no effect on the plate current, which remains zero. As a result, the circuit limits the magnitude of the output by clipping the positive and negative peaks of any signal exceeding a fixed limit.

7. BLOCK DIAGRAM

A block diagram of Audio Amplifier AM-413/G is shown in figure 2-11. With the Compressor Switch in OFF, the signal is fed through a transformer to the Level Control. From the Level Control the signal is amplified by V105 and V106 and is then coupled through the output transformer to the output receptacles. The monitoring jack has a Monitor Level Control which does not affect the magnitude of the speaker and line outputs. Negative feedback is applied to V105B from the plate of V106, and to V105A from the secondary of the output transformer.

The volume compressor has a balanced input circuit. Normally, V101A and V101B are cutoff. Half the input signal is fed to the grid of V102A. The other half is fed through the cathode follower V102B into the cathode of V102A. The output of V102A depends on the difference between the two signals. Any components of the two signals that are of opposite polarity will add in the output. Any components of the two signals that have the same polarity will tend to be cancelled out. Those signal components that were fed through the input transformer are of opposite polarity upon entering V102A and will receive almost twice the normal amplification of the stage. However, those signal components that originated in V104B enter V102A with the same polarity and are cancelled out of the output. The output of V102A is amplified by V103B and transferred through V104A to V104B. V104B rectifies the signal, producing a positive voltage which is fed to the grids of V101A and V101B. When no signal is present, V101A and V101B are cut-off. When signals below .001 milliwatts are fed into the compressor, the positive voltage produced by V104B is insufficient to allow V101A and V101B to conduct, and the output of the compressor is proportional to the input. When the input signal exceeds .001 milliwatts, V101A and V101B are allowed to conduct. As the output of the compressor starts to increase due to additional rise of input signal, more positive voltage is developed by V104B which cause V101A and V101B to present a lower resistance to the signal. Each slight increase in compressor output voltage is accompanied by a large increase in the positive voltage from V104B, resulting in a lower dynamic resistance of V101A and V101B, which has a greater shunting effect on the signal. In this manner, a 38 db variation in input

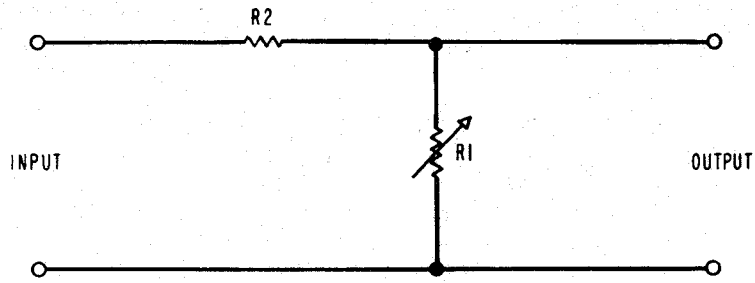


Figure 2-8. Basic Principle of Compressor Circuit

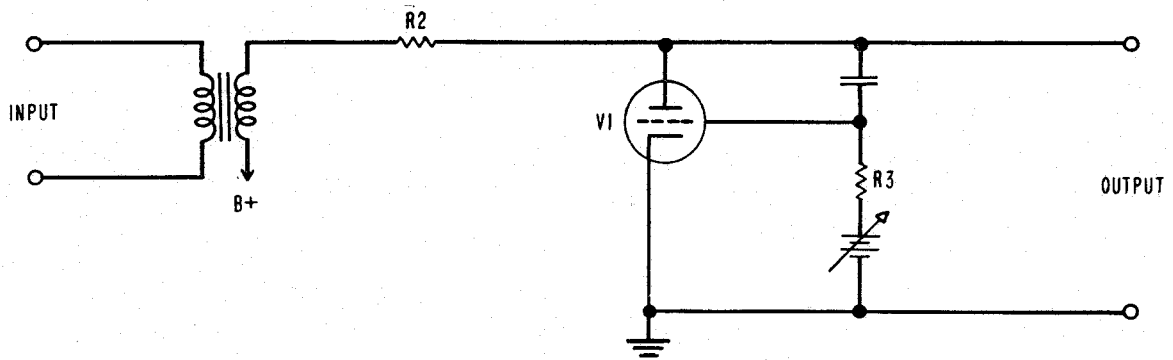


Figure 2-9. Basic Compressor Circuit

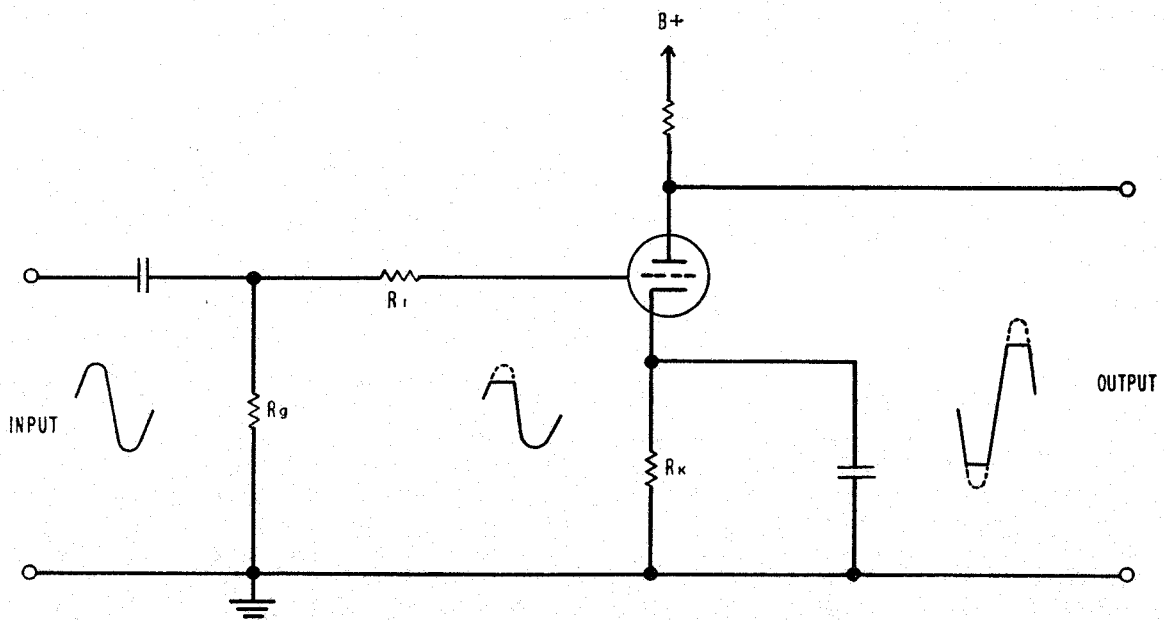


Figure 2-10. A Triode Clipper Circuit

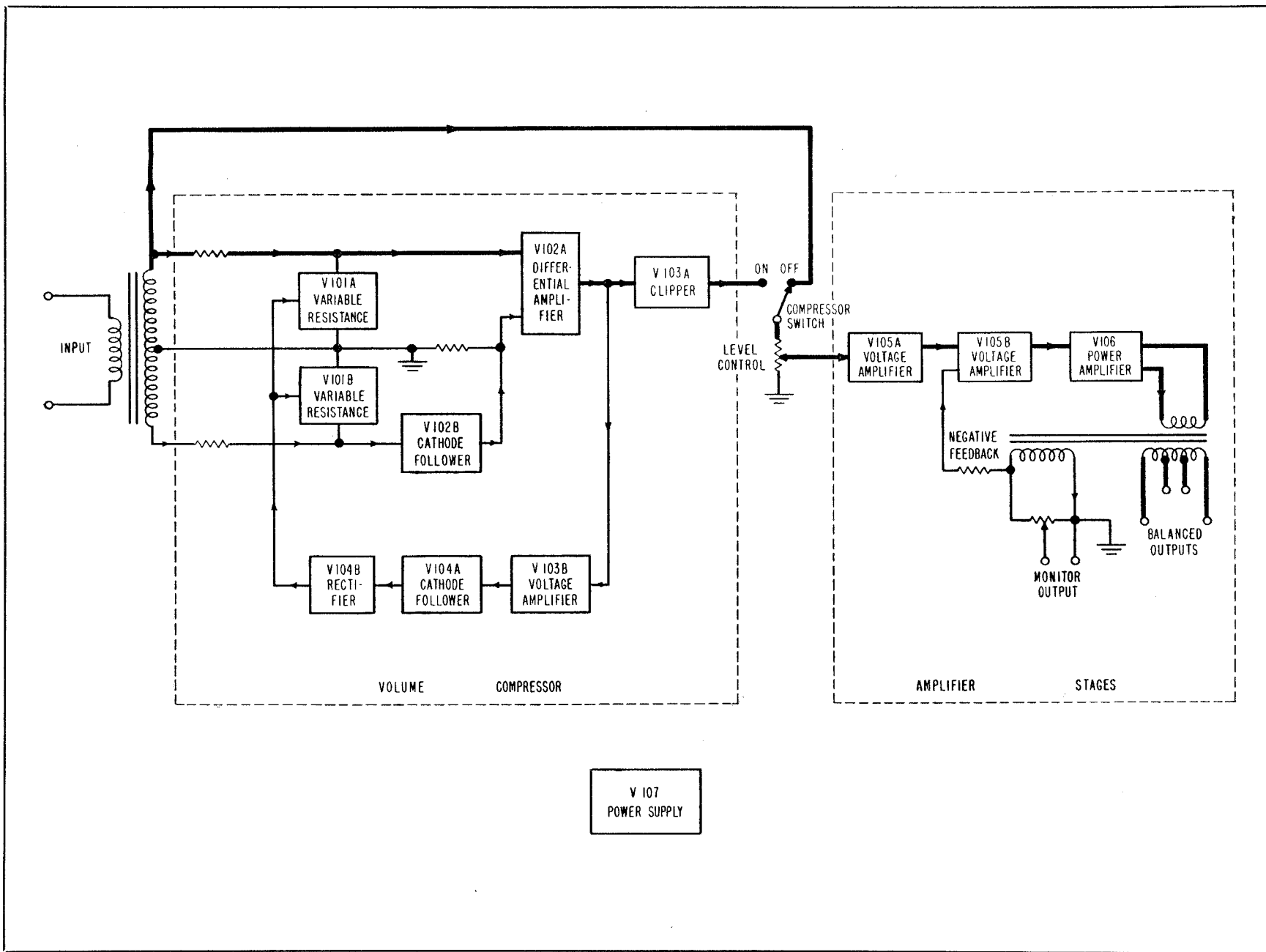


Figure 2-11. Block Diagram of Audio Amplifier AM-413/G

signal level is compressed into less than a 3 db variation in output level.

If the compressor input signal should suddenly change from very low level to very high level, V104B will produce a large surge of positive voltage to compress the signal. Due to the nature of the circuit, this surge of voltage, usually called a transient, is mixed with the signal. If this large transient is allowed to pass through the compressor and the amplifier into a loudspeaker or a headset, it can sound like a thump or click, or it may result in overdriving the amplifier stages and temporarily blocking the signal from passing through. However, this transient is fed into both inputs of V102A with the same polarity, and is therefore largely cancelled out of the output. The primary purpose of splitting the input signal and feeding each half separately into the differential amplifier (V102A) is to greatly reduce this transient.

If a very large signal is suddenly applied to the compressor, the compressor will reduce it to a much smaller magnitude. However, in order to compress the signal, a DC voltage must be produced by V104B, the rectifier stage. In order to convert a rectified AC voltage into DC, it must be filtered by a capacitor. The charging of a capacitor requires time; in this instance it requires a number of milliseconds. As a

result, for the first few milliseconds the compressor is unable to reduce the size of the signal, and the output of V102A will be excessive. To reduce the size of this excessively large pulse of signal, a clipper stage, V103A, is located between the output of V102A and the input to the amplifier stages. After the compressor has had sufficient time to reduce the signal to normal size, V103A will transmit the signal without clipping or distortion.

In order to obtain more efficient operation of the circuit, V103B is normally cut-off. When a signal is present, the positive peaks drive the tube into conduction, resulting in an output waveform consisting of negative pulses. Since the only application of the output of V103B is to produce a DC voltage, the quality of the compressor output is normally unaffected by the distortion produced in V103B.

8. DYNAMIC LOUDSPEAKER LS-169/G

The schematic of Dynamic Loudspeaker LS-169/G is shown in figure 2-12. The circuit consists of loudspeaker LS-201, impedance matching transformer T201, and step attenuator R201. The attenuator R201 is designed to provide Dynamic Loudspeaker LS-169/G with essentially a constant input impedance for all settings of the attenuator.

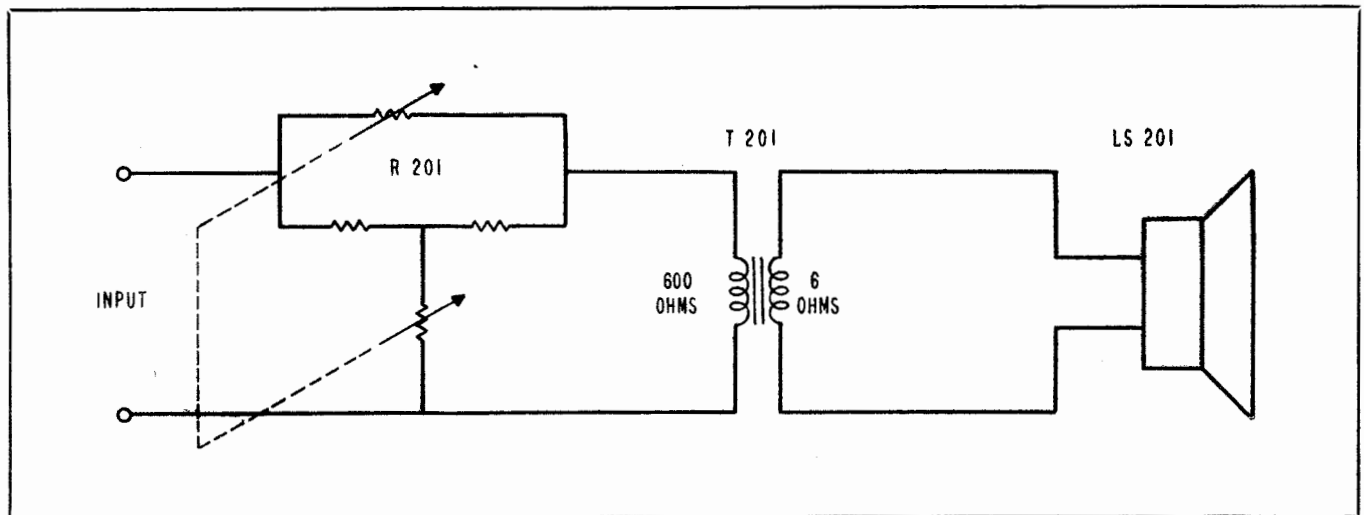
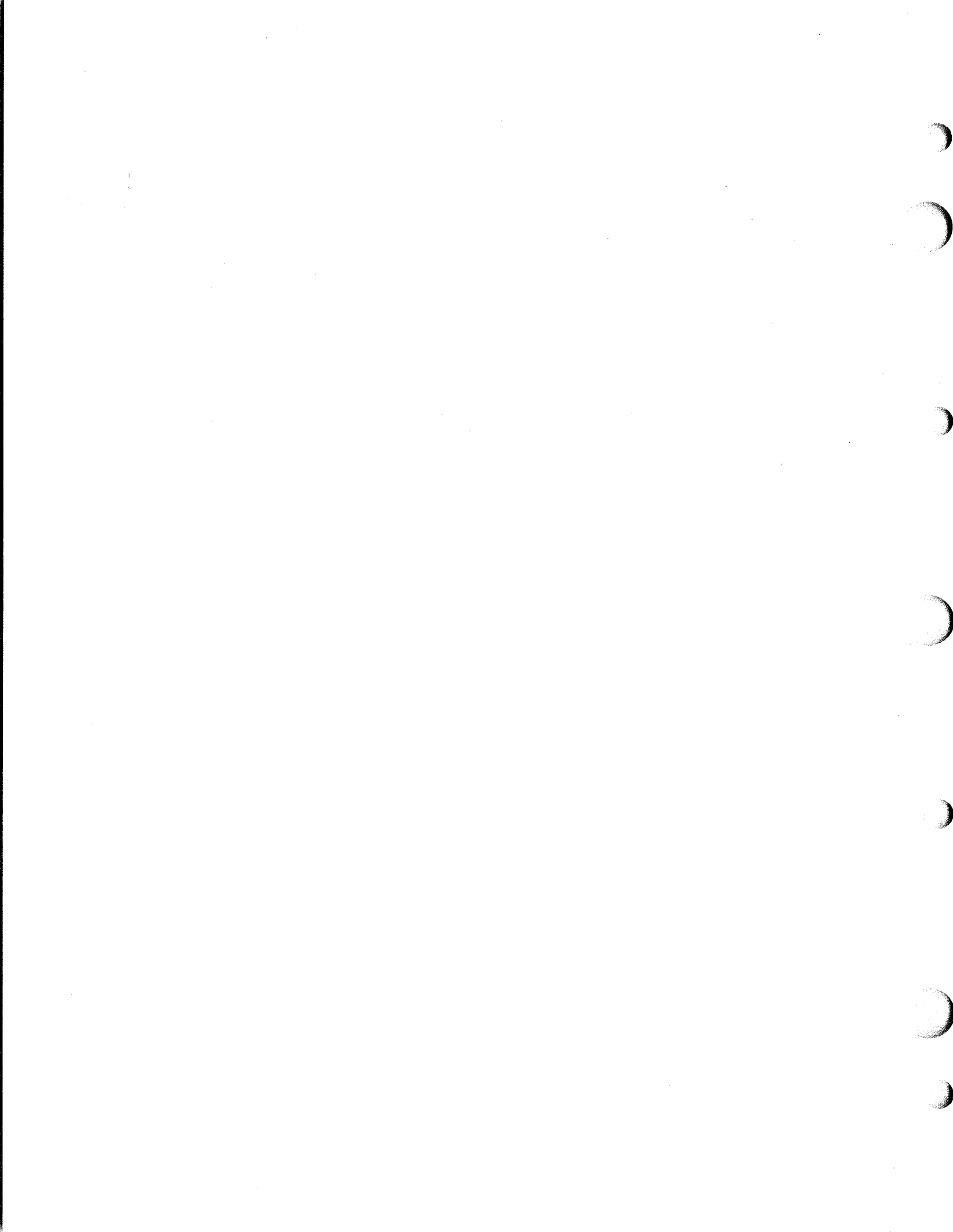


Figure 2-12. Schematic of Dynamic Loudspeaker LS-169/G



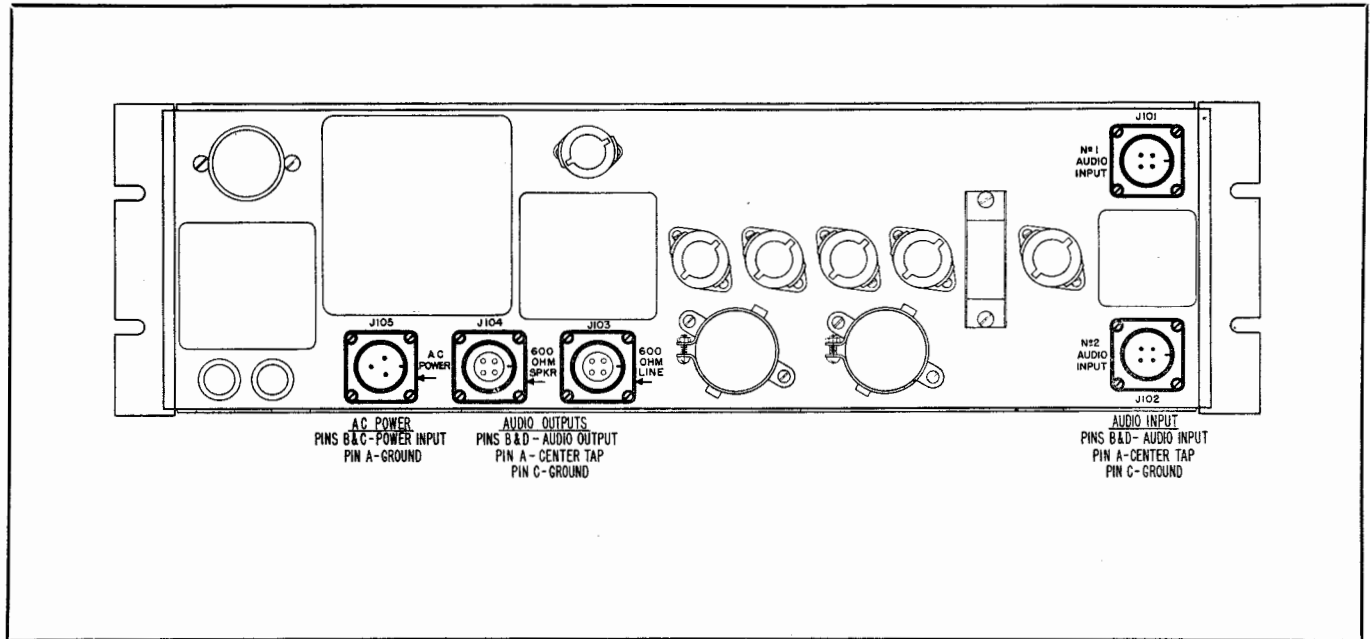


Figure 3-1. Cable Connections For Audio Amplifier AM-413/G

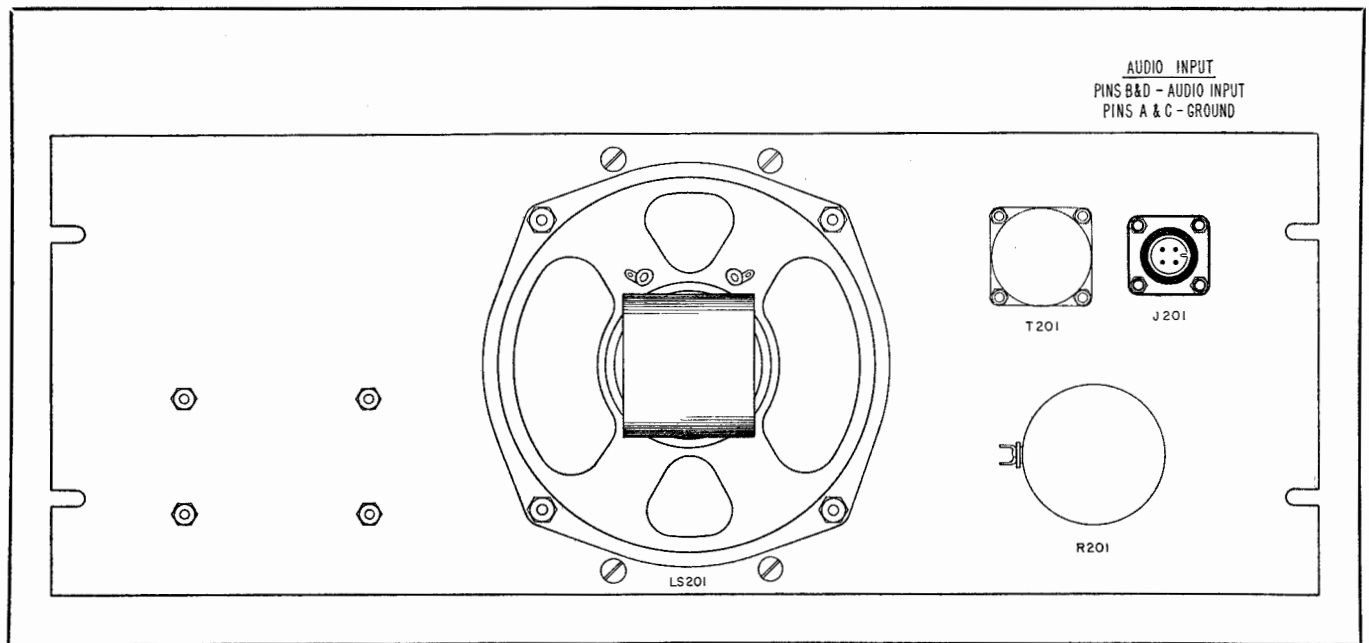


Figure 3-2. Cable Connections For Dynamic Loudspeaker LS-169/G

SECTION 3 INSTALLATION

1. INSTALLATION

Audio Amplifier AM-413/G and Dynamic Loudspeaker LS-169/G are designed for mounting in a standard 19 inch Navy type relay rack. The Audio Amplifier panel is a size C and the Dynamic Loudspeaker panel is a size D, in accordance with Navy drawing RE23F225D. No cables are furnished with either Audio Amplifier AM-413/G or Dynamic Loudspeaker LS-169/G. Cable connectors are furnished, however, and are installed in the appropriate receptacles for shipment. The power supply connector is intended for use with Navy type MCOS-2 cable, and the audio connectors are to be used with RG-108/U cable. See figures 3-1 and 3-2 for cable connections.

2. ADJUSTMENT

The power transformer of Audio Amplifier AM-413/G has taps for line voltages of 105V, 115V, and 125V. Provision is made for connecting to these taps by means of a barrier strip. The equipment is shipped with the AC power connected to the 115 volt tap of the transformer. However, if the line voltage is closer to the rating of either of the other two taps, the appropriate connection should be made. Before supplying power to the amplifier, the AC line voltage should be measured, and, if necessary, the transformer connection should be modified. No further adjustments are required, other than to see that all tubes, cable connectors, fuses, and the pilot light are firmly fixed in their sockets and are making good contact. **BE SURE THAT ALL EQUIPMENTS ARE GROUNDED BEFORE APPLYING POWER.**

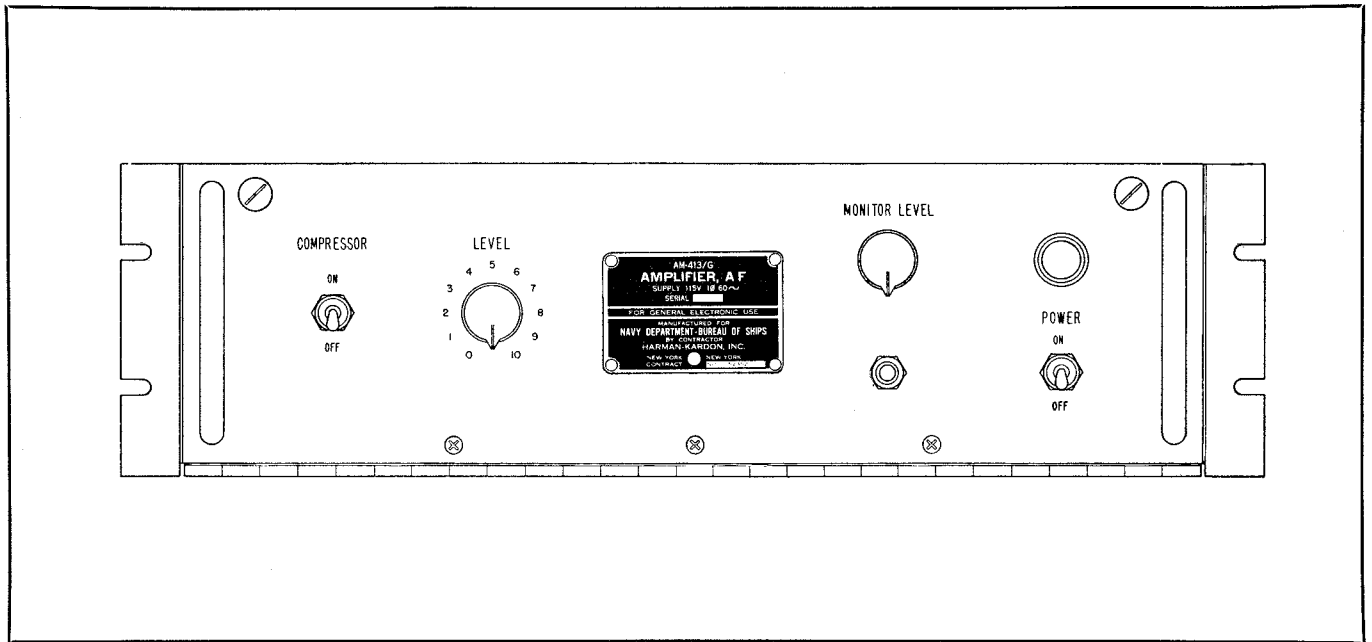


Figure 4-1. Operating Controls of Audio Amplifier AM-413/G

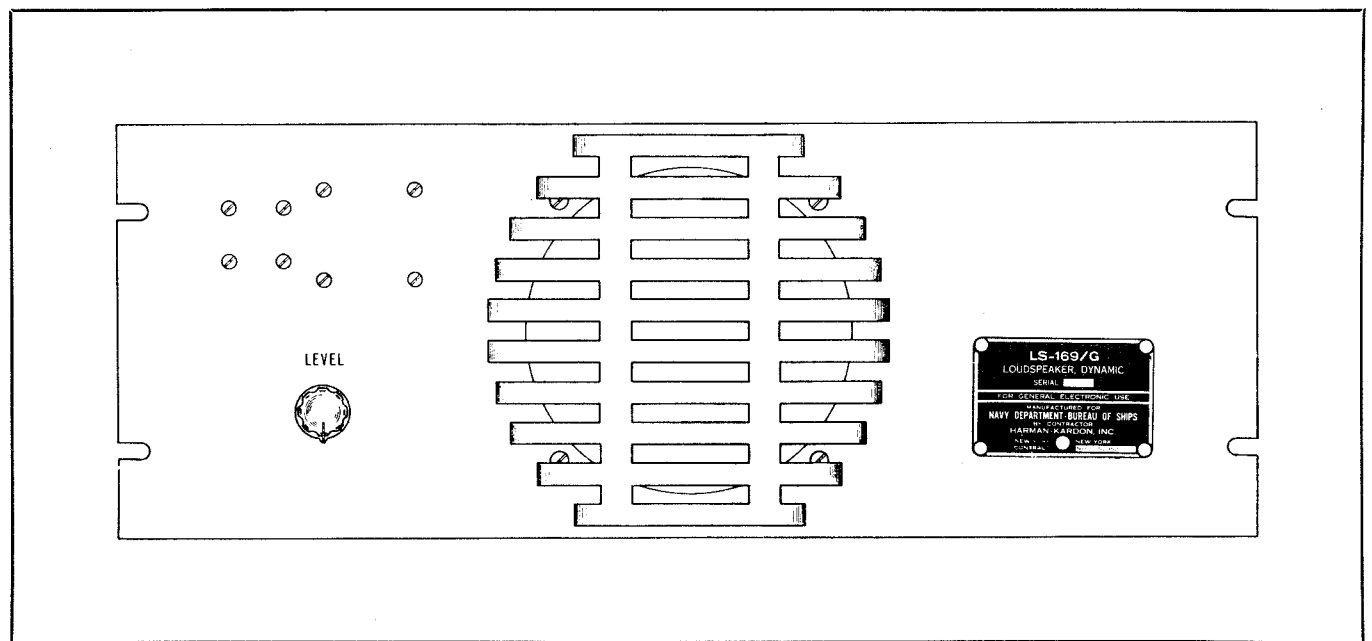


Figure 4-2. Operating Controls of Dynamic Loudspeaker LS-169/G

SECTION 4 OPERATION

1. AUDIO AMPLIFIER AM-413/G

The front panel of Audio Amplifier AM-413/G, where all the operating controls are located, is illustrated in figure 4-1. The "Power" Switch turns the equipment on; the pilot light indicates whether the equipment is on. The input signal should be within the limits of .001 to 6 milliwatts (.0245 to 1.9 volts). There are three outputs: speaker, line, and monitor. The speaker output is rated at two watts and the receptacle is located at the rear of the equipment. The line output is rated at six milliwatts and the receptacle is located at the rear of the equipment. The monitor output supplies one milliwatt to 600 ohm earphones through a monitor jack located on the front panel. The equipment contains a volume compressor, the use of which is determined by whether the "Compressor" Switch is "On" or "Off." When the "Compressor" Switch is "On," the equipment behaves like a normal amplifier. The "Level" control controls the gain of the amplifier for all outputs. In addition, the "Monitor Level" control provides control of the output at the monitor jack without affecting the speaker and line outputs. When using only the monitor output, best operation

can be obtained by placing the "Monitor Level" control in the maximum clockwise position and regulating the output with the "Level" control. When the "Compressor" Switch is "On," a volume compressor is placed into the circuit. The volume compressor will hold the signal level before the level control of the equipment essentially constant over the entire input range of .001 to 6 milliwatts. Thus, the "Level" control and the "Monitor Level" control act as volume controls instead of gain controls, since the magnitude of the output depends solely upon the settings of these controls, and not on the size of the input signal. However, the "Level" and the "Monitor Level" controls are used in the same manner as with the compressor off.

2. DYNAMIC LOUDSPEAKER LS-169/G

The front panel of Dynamic Loudspeaker LS-169/G is illustrated in figure 4-2. The only operating control is an attenuator, which is normally left in the maximum clockwise position. If this control is rotated counterclockwise, it will reduce the volume at the rate of 4 db for each position.

SECTION 5 OPERATOR'S MAINTENANCE

1. EMERGENCY MAINTENANCE

Operators shall not perform any of the following emergency maintenance procedures without proper authorization.

Table 5-1 lists emergency maintenance procedures that require neither special tools nor removal of the equipment from its mounting.

The location of tubes, fuses and electrolytic capacitors (plug-in types) is illustrated in figure 5-1.

WARNING

Never replace a fuse with one of higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been corrected.

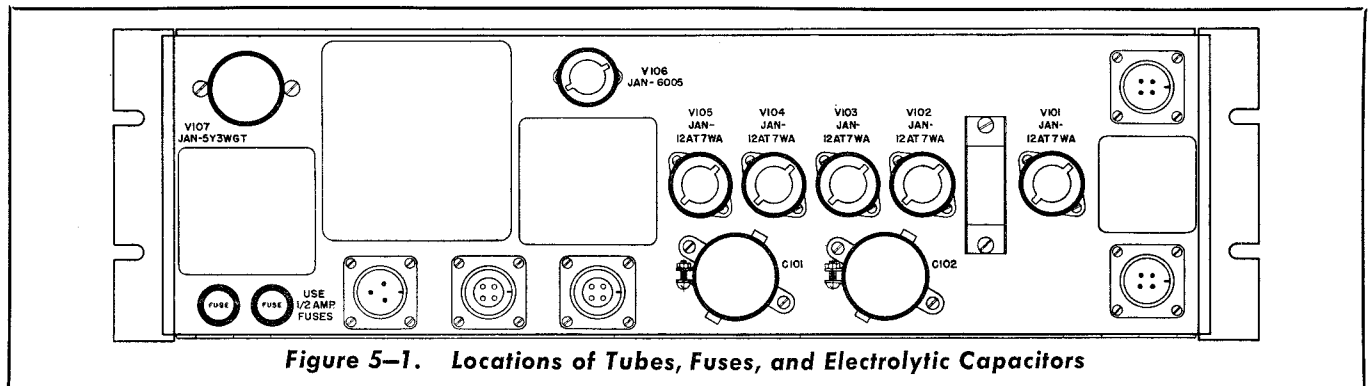


Figure 5-1. Locations of Tubes, Fuses, and Electrolytic Capacitors

TABLE 5-1. EMERGENCY MAINTENANCE CHART

STEP	SYMPTOM	PROBABLE TROUBLE	CORRECTION
1	Equipment does not operate — Pilot lamp and tubes do not light	Power Switch is in "OFF" position	Turn power switch on
		Fuse blown	Replace fuse
		Loose plug or defective cable	Check visually for damage; repair or replace
2	Equipment does not operate — Pilot lamp and tubes light	Defective tube	Replace any tubes that do not light; replace all others one at a time
		Shorted filter condenser	Replace all plug-in condensers
		Loose or defective input or output cable	Check visually for damage; repair or replace
3	Equipment operates poorly — low output, high distortion or excessive hum	Defective tube	Replace all tubes, one at a time
		Defective filter condenser	Replace all plug-in condensers

SECTION 6 PREVENTIVE MAINTENANCE

1. GENERAL

Preventive Maintenance consists of mechanical and electrical checks on the equipment at prescribed intervals in order to prevent any anticipated breakdowns. If potential failures are detected before actual breakdown occurs, the job of trouble shooting is lightened, and interruption of service is kept at a minimum. Table 6-1 lists a recommended Maintenance Test Schedule, under which the procedures given are to be performed at the intervals suggested.

The attention of Maintenance personnel is invited to the requirements of Chapter 67 of The Bureau of Ships Manual of the latest issue.

2. OPERATION TEST

The following procedure can be followed for checking the operation of Audio Amplifier AM-413/G.

The equipment required for the tests consists of an audio oscillator, two AC vacuum tube voltmeters, a distortion meter, and a 600 ohm 5 watt resistor. If a distortion meter is not available, the output waveform should be observed on an oscilloscope.

Connect the 600 ohm resistor, the distortion meter, and one voltmeter across the Speaker output of Amplifier AM-413/G. Connect the audio oscillator and the other voltmeter across one input of the amplifier. Throw the "Compressor" Switch to "Off." Set the "Monitor Level" control for maximum volume (maximum clockwise position) and the "Level" Control for minimum volume (maximum counter-clockwise position). Allow the equipment at least 15 minutes to warm up. Then follow the procedure in Table 6-2.

TABLE 6-1. MAINTENANCE TEST SCHEDULE

<i>WHAT TO CHECK</i>	<i>WHEN TO CHECK</i>	<i>HOW TO CHECK</i>
Pilot Lamp	Monthly	Check to see that lamp lights when power is applied to the unit.
Controls	Monthly	Check all control knobs and switches to see that they are mounted securely to their shafts or to the panel. Check gain control with power on for its effect on amplifier output.
Chassis	Semi-Annually	Remove the amplifier and the speaker from their housings and check for discoloration of components, indicating overheating. See that all connections are tight, well-soldered, and free from corrosion. Remove dust with a soft brush. See that tubes and capacitors are secure in their sockets.
Operation	Semi-Annually	Repeat the performance test of Section 6 Paragraph 2.
Tubes	Semi-Annually	Check all tubes on a tube checker, replacing any of them when it is indicated that transconductance has fallen off to any great degree.
Operating Voltage	Semi-Annually	Check all voltages (measured to ground) at all tube socket contacts, and compare results with voltages in Table 7-2. Small differences are not important, but major deviations should be investigated and remedied.
Resistance Measurements	Semi-Annually	Check values of resistance (measured to ground) at all tube socket contacts against values indicated in Table 7-2. Minor deviations from the resistances shown are to be expected, but large deviations should be corrected.

TABLE 6-2. OPERATION CHECK PROCEDURE

<i>Step</i>	<i>ADJUST</i>	<i>MEASURE</i>	<i>SHOULD BE</i>
1	Frequency to 100 cps. Input level to .025 volts. "Level" control for 35 volts output and do not readjust "level" control until step 5.	Distortion	Less than 7%
2	Frequency to 200 cps. Input level to .025 volts.	Output voltage	At least 25 volts
		Distortion	Less than 7%
3	Frequency to 5000 cps. Input level to .025 volts.	Output voltage	At least 25 volts
		Distortion	Less than 7%
4	Disconnect the oscillator, voltmeter, and all leads from the input circuit.	Output voltage	No more than .111 volts
5	Reconnect the oscillator and voltmeter across one input of the amplifier. Throw the "Compressor" Switch to "On". Set frequency to 1000 cps. Input level to 1.9 volts, "Level" control for 35 volts output, and do not readjust "Level" control until step 11.	Distortion	Less than 7%
6	Input level to .025 volts.	Output voltage	At least 25 volts
		Distortion	Less than 7%
7	Frequency to 200 cps. Input level to 1.9 volts.	Output voltage	At least 25 volts
		Distortion	Less than 7%
8	Input level to .025 volts.	Output voltage	At least 17.5 volts
		Distortion	Less than 7%
9	Frequency to 5000 cps. Input level to 1.9 volts.	Output voltage	At least 25 volts
		Distortion	Less than 7%
10	Input level to .025 volts.	Output voltage	At least 17.5 volts
		Distortion	Less than 7%
11	Frequency to 1000 cps. Input level to .025 volts. "Level" control for 35 volts output.	Distortion	Less than 7%
12	Disconnect the oscillator, voltmeter, and all leads from the input circuit.	Output voltage	No more than .111 volts

FAILURE REPORTS

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

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

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

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

Make certain you have a supply of Failure Report Cards and envelopes on board. They may be obtained from the nearest District Publications and Printing Office.

FAILURE REPORT—ELECTRONIC EQUIPMENT
NAVSHIPS (NBS) 383 (REV. 8-45)
(FORMERLY NAVSHIPS (NBS) 383 AND NAVSHIPS (NBS) 384)
SHIP NUMBER AND NAME OR STATION

CHECK ONE: RADIO
EQUIPMENT MODEL DESIGNATION
TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED
TUBE TYPE, INCLUDING PREFIX LETTERS
TUBE MANUFACTURER
FAILURE OCCURRED IN:
 STORAGE OPERATION
 HANDLING OTHER (SPECIFY)
 INSTALLING
NATURE OF FAILURE AND REMARKS

ELECTRONIC EQUIPMENT FAILURE REPORT (SIG)
NAVSHIPS (NBS) 383 (REV. 11-45)

NOTICE—Read notes on reverse side. Additional forms and envelopes may be obtained from nearest BWO.

DATE _____
NAME OF PERSON MAKING REPORT _____

NOTICE—Read notes on cover prior to preparing this form.

*REPORT NO. _____
DATE _____

ORGANIZATION PERFORMING MAINTENANCE _____ NAME AND RANK OF OFFICER ACCOUNTABLE FOR MAINTENANCE _____

EQUIPMENT INVOLVED
 Navy Army USMC JAN Commercial Other (Specify)
 Radio Radar Sonar Wire Tool Test Power Sound Other (Specify)

EQUIPMENT MODEL DESIGNATION _____ SERIAL NUMBER OF EQUIPMENT _____ NAME OF CONTRACTOR _____ CONTRACT NO. _____
TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED _____ SERIAL NUMBER OF UNIT _____ CONTRACT OR PO DATA OF UNIT _____ DATE EQUIPMENT RECEIVED _____

ITEM WHICH FAILED

THIS SIDE FOR TUBES		THIS SIDE FOR PARTS (NOTE 9)		
TUBE TYPE, INCLUDING PREFIX LETTERS	SERIAL NO. (NOTE 4)	NAME OF PART	CIRCUIT SYMBOL (EG R-134)	NAVY TYPE NO.
TUBE MANUFACTURER	CONTRACT NO. (NOTE 4)	SERIAL NO.	*CONTRACT DATA	*DATE RECD.
FAILURE OCCURRED IN	GUARANTEED HOURS (NOTE 8)	*CHECK-OFF OR TAG DATA (NOTE 9)		*MANUFACTURER'S DATA (NOTE 9)
<input type="checkbox"/> Storage <input type="checkbox"/> Operation	ACTUAL HOURS	BRIEF DESCRIPTION AND CAUSE OF FAILURE, INCLUDING APPROXIMATE LIFE (CONTINUE ON BACK)		
<input type="checkbox"/> Handling <input type="checkbox"/> Other (Specify in remarks)	DATE OF ACCEPTANCE (NOTE 8)			
<input type="checkbox"/> Installing	DATE OF FAILURE			
NATURE OF FAILURE AND REMARKS (NOTE 4) (CONTINUE ON BACK)	TYPE OF FAILURE (NOTE 7)	TUBE CIRCUIT SYMBOL Y-		

CONCLUSION:
 Normal replacement Shortage Modification Failure Transportation breakage Other (Specify)

*NOT REQUIRED FOR REPORTS SUBMITTED BY NAVAL ACTIVITIES.

16-46681-1 U. S. GOVERNMENT PRINTING OFFICE

Figure 7-1. Failure Report, Sample Form

SECTION 7

CORRECTIVE MAINTENANCE

1. GENERAL TROUBLE SHOOTING PROCEDURES

The general sequence of steps in servicing electronic equipment is:

1. *Sectionalization*: tracing the fault to a particular unit of the equipment being serviced.
2. *Localization*: tracing the defect to a specific stage or functionally related group of stages within the unit in which the fault seems to originate.
3. *Isolation*: tracing the fault to a particular circuit component specifically responsible for the defective operation of the equipment and then repairing or replacing the component.

When initially turning on defective equipment, the senses of smell, hearing, and sight should be used. Overheated components can sometimes be detected by their odors. Voltage arcs can usually be heard. Look for smoke or for small components such as resistors changing color due to overheating. If proper precautions are observed, it is sometimes feasible to detect overheated components by touching them. If any such indications are present, turn the equipment off immediately and do not attempt to turn it on again until the defect has been eliminated. Under these conditions resistance checks are generally used to isolate the trouble. Often the cause of the trouble is not with the overheated component itself. The symptoms may be due to a short developing in a capacitor or a tube, or to a resistor changing its resistance value. In addition to locating the actual cause of the trouble, it is necessary to check any overheated components for damage as a result of the excessive temperature.

If the equipment shows no evidence of becoming further damaged by being on, look for exterior signs of the trouble. Check all plug-in devices and both ends of all cables for good contact. Check all the fuses. See if all the tubes are lit. Check panel lamps, meters, and all other indicating devices for clues. See that all switches are in the proper position. If there are only a few tubes in the equipment, check them on a tube checker. If time is important, rather than checking the tubes, it may be quicker to replace them with new ones.

A method that can often quickly localize the trouble is called shock testing. If the tube filaments are in parallel, positive indication can be obtained by removing the tubes with the power on. Remove the output tube while observing the effect on the output device (earphones, meter, scope, etc.). If no response is observed, the trouble may be in the power supply, the output stage, the output device, or the connections between them. If a response is observed,

replace the output tube before it cools off, and remove the tube of the preceding stage. Continue this procedure until a tube is found that produces no indication on being removed. The trouble may be in that stage or the immediately preceding or the immediately following stages. Another method of shock testing is to ground the grids with a screwdriver, one at a time, starting from the output stage.

A more positive and more informative method of localizing the trouble is signal tracing. Connect a signal generator to the input of the equipment and adjust the signal frequency and amplitude to duplicate as closely as practical, actual operating conditions. Using an AC vacuum tube voltmeter and an oscilloscope, check the signal amplitude and waveform at the input and output of each stage, starting with the first stage. It is often possible to localize the trouble to two or three possible components.

After the trouble has been localized, DC voltage measurements are often effective in further localizing the trouble. After voltage measurements are made, the final isolation is generally achieved with an ohmmeter. Before using the ohmmeter, turn off the power and discharge the high voltage capacitors.

If signal tracing procedures fail to localize the trouble, DC voltage measurements of the equipment, starting with the power supply, should be made. If voltage measurements produce no results, turn the power off, discharge the high voltage capacitors, and make resistance checks with an ohmmeter.

After the equipment has been repaired, thorough performance tests should be made to insure that the equipment has been properly repaired and that no other defect exists.

2. TROUBLE SHOOTING AUDIO AMPLIFIER AM-413/G

Previous paragraphs which may aid the technician in servicing the equipment are as follows:

Section 4 par 1: Operation of Audio Amplifier AM-413/G.

Section 7 par 1: General Trouble Shooting Procedures.

Detailed information on the Amplifier theory and performance is provided in these paragraphs:

Section 1 par 9: Electrical Characteristics of Audio Amplifier AM-413/G.

Section 2: Theory of Operation.

Section 6 par 2: Operation Test (A procedure for checking the performance of the equipment).

Table 7-1 is a trouble shooting chart which may be useful in localizing the trouble. All tubes, fuses, and connectors are accessible from the rear of the

TABLE 7-1. TROUBLE SHOOTING CHART

CONDITIONS	SYMPTOMS	POSSIBLE CAUSE
	Pilot light fails to light.	Power Cable contact. Fuses. Pilot lamp. Power source.
	Fuse keeps blowing.	Filter capacitor shorted. Rectifier tube shorted. Short in power input circuit. Short circuit in power supply.
"Compressor" Switch "Off."	No output from amplifier. Inadequate amplification. Excessive distortion. Intermittent or unstable operation.	Power supply failure. V105 V106 Poor cable connections.
Satisfactory Operation without Compressor "Compressor" Switch then thrown to "On."	No Output. Insufficient Output. Excessive distortion with sufficient output. Intermittent or unstable operation.	V102 V103 C102 V101 V102 V103 V104

equipment, without disassembly. The location of tubes, fuses, and electrolytic capacitors is illustrated in Figure 5-1.

NOTE

ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

If trouble cannot be localized by exterior indications, an internal examination is in order. Access to the interior of Audio Amplifier AM-413/G may be had by releasing the two quick-fastening locks on the amplifier front panel. The amplifier panel will then drop down approximately 90 degrees, making available the interior wiring and components. Figures 7-2, 7-3, 7-4, and 7-5 show the locations of the electrical components. Figure 7-6 is a schematic of the Amplifier. Note that the power transformer T103 has a primary tapped for 105, 115, or 125 volt supply. The tap nearest to the average line voltage should be used.

Table 7-2 presents data for signal tracing, DC voltage measurements, and resistance measurements. The voltage data was taken with 115 volt 60 cps input to the 115 volt tap on T103. The input signal should be adjusted for .025 volts at 1000 cps. Adjust the "Level" control for 35 volts output across loaded "Speaker" terminals. The AC voltage measurements should be made with a vacuum tube voltmeter to avoid loading the circuit. If an oscilloscope and a DC vacuum tube voltmeter are connected in parallel with the AC vacuum tube voltmeter, then signal amplitude, waveform, and DC voltage can all be

measured simultaneously. Unless both points used in making the measurements are indicated in Table 7-2, measurements are made between the indicated points and ground. Slight variations between the measured values and the values given in the table may not be important. However, major deviations in readings should be investigated further.

WARNING

High voltages are dangerous and can be fatal. When making measurements at points having potentials of a few hundred volts or more, certain rules should be observed.

For potentials under 300 volts:

1. Connect the ground lead or the low potential lead.
2. Place one hand in a pocket.
3. Connect the other lead to the high potential point.
4. If both points are at high potentials above ground, place one hand in a pocket before connecting either lead.

For potentials above 300 volts:

1. Shut off the power.
2. Make the electrical connections.
3. Step away from the measuring instrument.
4. Turn on the power.
5. Do not touch the meter while the power is on, particularly if both points being measured are above ground.

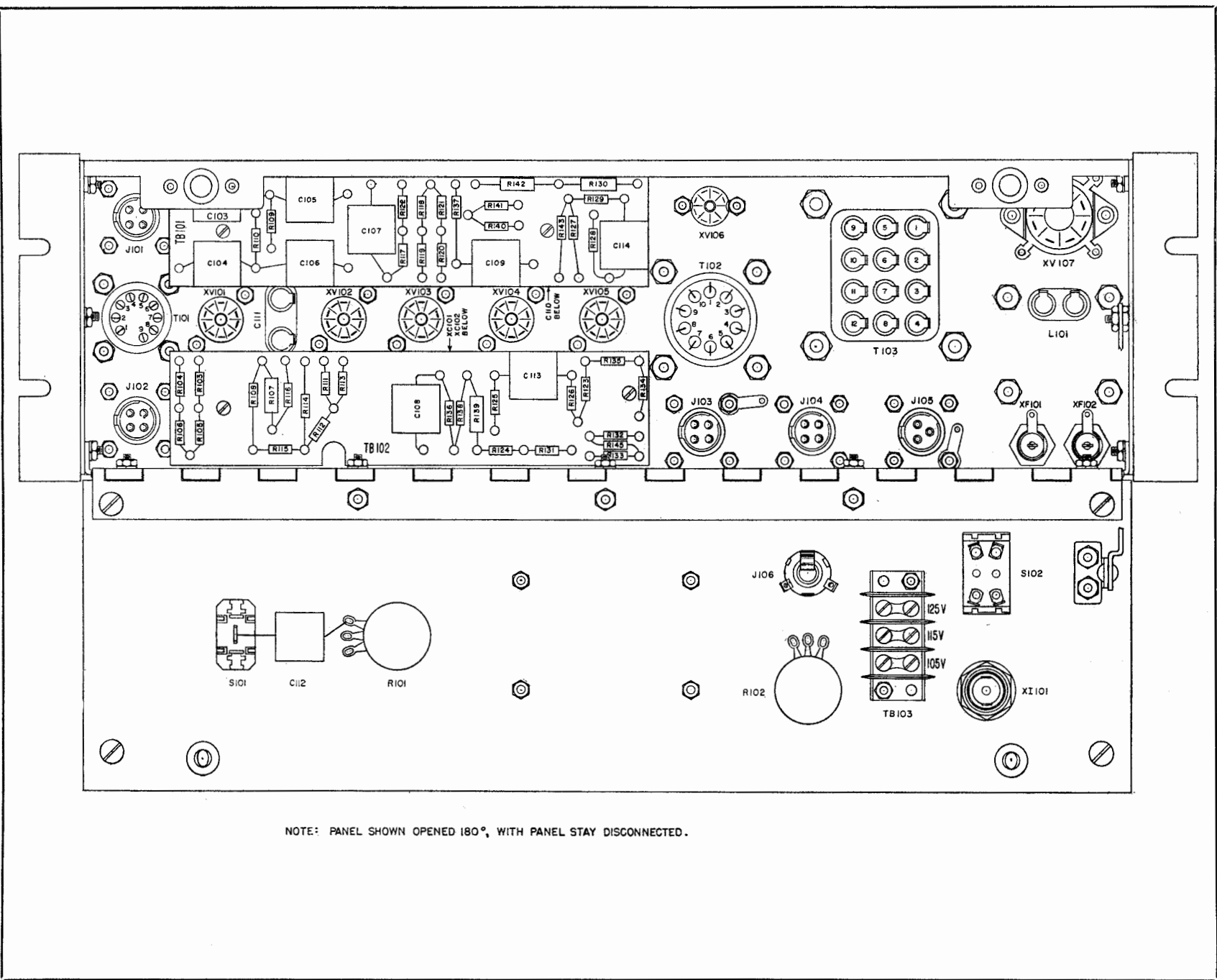


Figure 7-2. Audio Amplifier AM-413/G Chassis With Panel Open

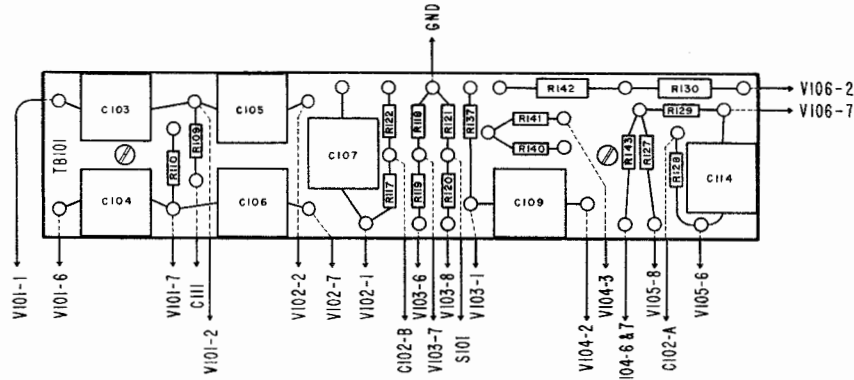


Figure 7-3. Terminal Board (TB-101), Component Placement Diagram

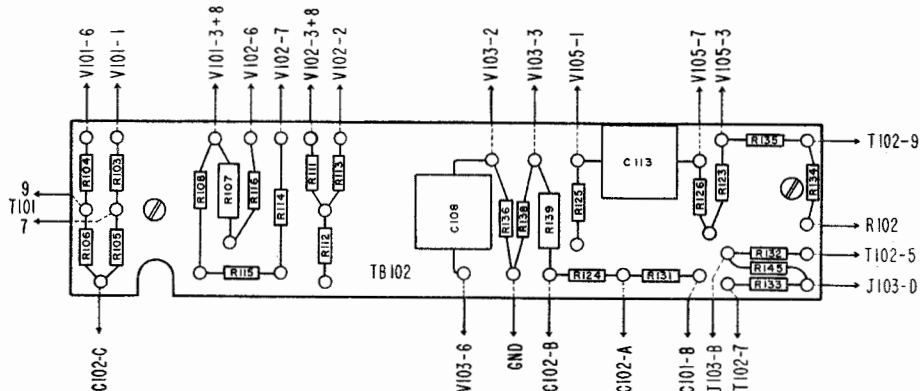


Figure 7-4. Terminal Board (TB-102), Component Placement Diagram

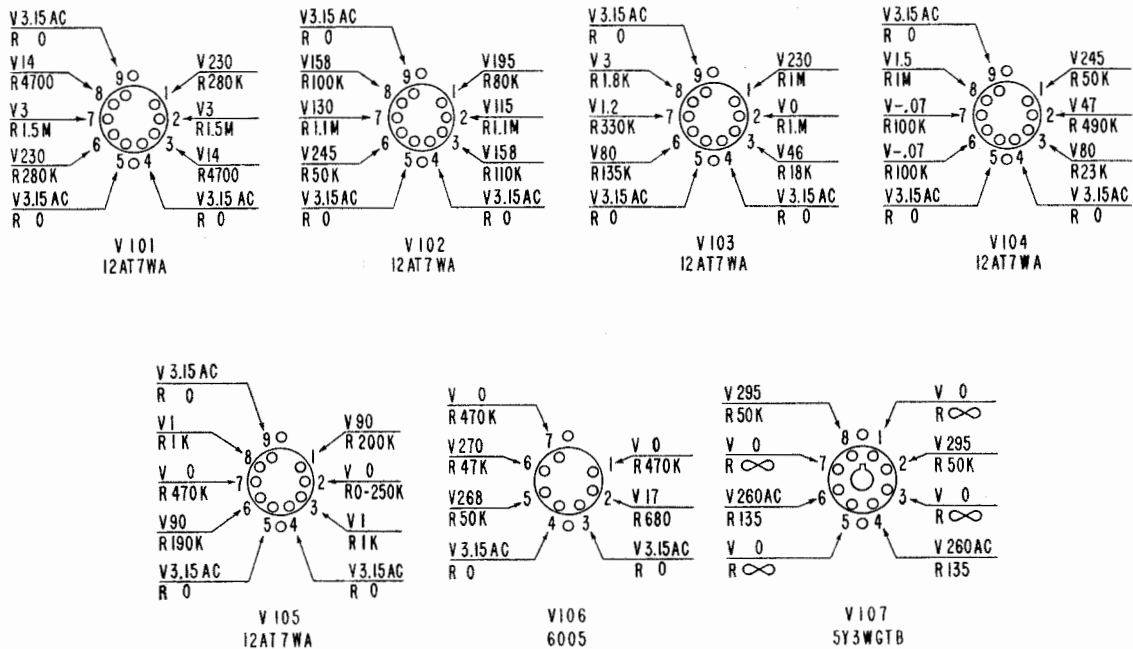


Figure 7-5. Voltage and Resistance Chart

TABLE 7-2. VOLTAGE AND RESISTANCE DATA

Stage	Element	* Pin	** AC Vol- age	Wave- Form S=Sine Wave	*** DC Voltage		Tube Cur- rent (MA)	Resist- ance (Ohms)
					With VTVM	With 1000 ohms per voltmeter		
V101A	Grid	2	.03	S	3	0	—	1.5M
	Cathode	3	—	—	14	13	—	4700
	Plate	1	.03	S	230	120	.15	280K
V101B	Grid	7	.03	S	3	0	—	1.5M
	Cathode	8	—	—	14	13	—	4700
	Plate	6	.03	S	230	120	.15	280K
V102A	Grid	2	.03	S	115	30	—	1.1M
	Cathode	3	.05	S	158	100	—	100K
	Plate	1	1.5	S	195	170	.75	80K
V102B	Grid	7	.03	S	130	30	—	1.1M
	Cathode	8	.05	S	170	100	—	100K
	Plate	6	0	—	245	245	.75	50K
V103A	Grid	7	1.5	S	1.2	0	—	330K
	Cathode	8	1.0	S	3	2.2	—	1.8K
	Plate	6	24	S	80	70	1.7	135K
V103B	Grid	2	23	S	0	0	—	1M
	Cathode	3	.02	— <u> </u> — <u> </u> —	46	34	—	18K
	Plate	1	1	— <u> </u> — <u> </u> —	230	60	0	1M
V104A	Grid	2	1.0	— <u> </u> — <u> </u> —	47	6	—	490K
	Cathode	3	1.5	— <u> </u> — <u> </u> —	80	75	—	23K
	Plate	1	0	—	245	245	3	50K
V104B	Grid	7	1.5	—	— .07	0	—	100K
	Cathode	8	.0005	—	1.25	0	—	1M
	Plate	6	3	—	— .07	0	.003	100K
V105A	Grid	2	.06	S	0	0	—	up to 250K
	Cathode	3	.04	S	1	.9	—	1K
	Plate	1	.8	S	90	70	1	200K

TABLE 7-2. VOLTAGE AND RESISTANCE DATA (Contd.)

Stage	Element	* Pin	** AC Voltage	Wave- Form S=Sine Wave	*** DC Voltage		Tube Cur- rent (MA)	Resist- ance (Ohms)
					With VTVM	With 1000 ohms per voltmeter		
V105B	Grid	7	.57	S	0	0	—	470K
	Cathode	8	.17	S	1	.9	—	1K
	Plate	6	16	S	90	70	1	190K
V106	Grid	7	16	S	0	0	—	470K
	Cathode	2	0	—	17	17	25	680
	Screen	6	90	S	270	270	1.5	47K
	Plate	5	143	S	268	268	23.5	50K
T102	Primary	1 to 3	143	S	12	12	—	300
	Secondary	9 to 10	15	S	0	0	—	1.1
Output	J103	B to D	4	S	0	0	—	600
	J104	B to D	35	S	0	0	—	40
T103	Primary	1 to 2	105	S	0	0	—	6.5
		1 to 3	115	S	0	0	—	7.1
		1 to 4	125	S	0	0	—	7.7
	Secondary	9 to 11	6.3	S	0	0	—	.05
V107	Plate	4	260	S	— .8	—	22	135
	Plate	6	260	S	— .8	—	22	135
	Cathode	2	1.5	—	295	295	45	50K
	Filament	2 to 8	5	S	—	—	2000	—
Filter	L101	1 to 2	1.5	—	9	9	—	220
	C101B	5	.07	—	285	285	—	50K
	C102A	3	—	—	267	267	—	50K
	C102C	7	—	—	240	240	—	43K

*If only one point is indicated, measurements are to ground.

**Use 1000 cps .025 volt input signal. Adjust "Level" control for 35 volts output across unloaded "Speaker" terminals.

***Use 115 volt, 60 cps input to 115 volt tap on T103.

If the voltmeter resistance is low enough to be comparable in magnitude to the circuit resistance, the voltmeter will "load" the circuit, and will indicate a lower voltage than is actually present when the voltmeter is not connected to the circuit. For this reason, a vacuum tube voltmeter is preferred for making measurements to ground. For those cases in which measurements are taken between two points above ground, or when a vacuum tube voltmeter is not available, a column of DC voltage readings taken with a 1000 ohms per volt meter is included in Table 7-2. Voltage readings taken with a 1000 ohms per volt meter can sometimes be misleading. For example, if a resistor having a very high value of resistance should burn-out, when the low impedance voltmeter is connected across the resistor, the voltmeter will complete the circuit and show a normal reading. To protect the meter from damage due to excessive voltage, set the meter to the highest range before making each measurement.

When the defective component is not a plug-in item, the final isolation of the defect is commonly achieved with an ohmmeter. Before making any resistance measurements, turn off the power and discharge the high voltage capacitors. If any resistance measurements are to be made in the primary circuit of the power transformer or of the switch or fuses, be sure to disconnect the power cable from the power source. Values of resistance between tube socket pins and ground and across inductances are listed in Table 7-2. Detailed data on the transformers is given in Table 7-4. For all other values of resistance consult the schematic (Figure 7-6).

After the trouble has been isolated and the equipment has been repaired, the test described in Section 6, par. 2 should be performed to insure that the equipment is operating properly.

**3. TROUBLE SHOOTING DYNAMIC LOUDSPEAKER
LS-169/G**

Dynamic Loudspeaker LS-169/G consists of only four electrical components: an input receptacle (J201), a bridged-T constant impedance ten step attenuator (R201), an impedance matching transformer (T201), and a loudspeaker (LS201). Figure 2-12 is a schematic of Dynamic Loudspeaker LS-169/G. If the unit fails to operate properly, the following procedure can be followed:

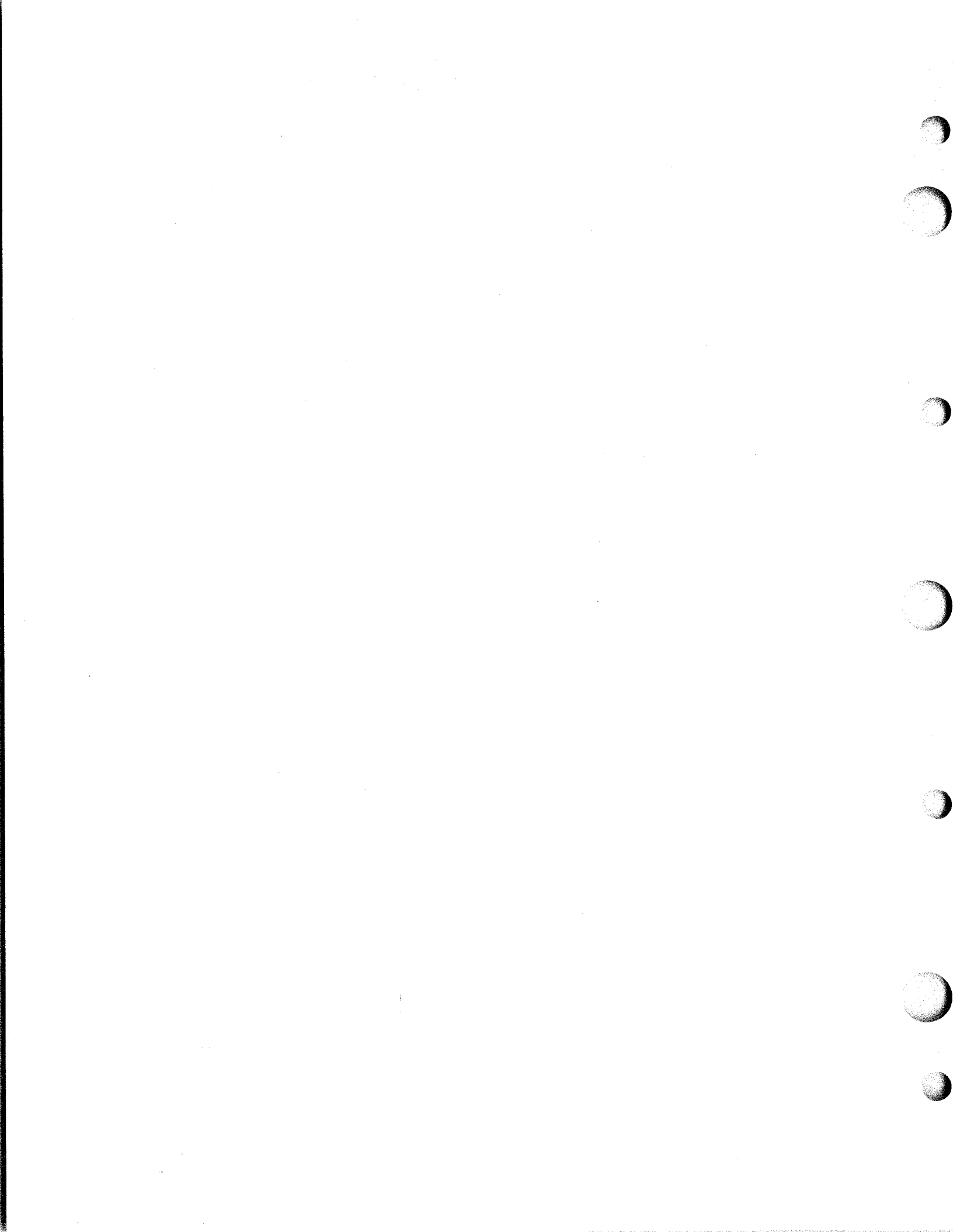
- a) Check the position of R 201, the attenuator control. For maximum volume it should be in the maximum clockwise position.
- b) Check both ends of the audio cable for good contact.
- c) Trace the signal with an AC voltmeter or an oscilloscope.
- d) Check the wiring for opens or shorts.
- e) Disconnect one lead from the loudspeaker, and check the voice coil for continuity.
- f) Check the transformer (T 201). Data on the transformer is given in Table 7-4.
- g) Check the attenuator (R 201).
- h) Substitute a new component for any component that is suspected of being defective.

TABLE 7-3. TUBE RATINGS

Characteristics	Tube Type		
	12AT7WA	6005	5Y3WGTB
Filament Voltage (V)	6.3	6.3	5.0
Filament Current (A)	.3	.45	2.0
Plate Voltage (V)	250	250	
Grid Bias (V)	0	-12.5	
Screen Voltage (V)		250	
Plate Current (MA)	10.5	45	
Screen Current (MA)		3.75	
A-C Plate Resistance (Ohms)	9500	52,000	
Voltage Amplification Factor (MU)	60	270	
Transconductance (Micromhos)	Normal Minimum	6500 4500	5200 3000
Emission I (MA)	50	100	120
Test Volt	10	30	75

TABLE 7-4. WINDING DATA

Symbol Description	Harman Kardon Part. No.	Schematic Diagram	Winding	Wire Size	Turns	D.C. Resistance (ohms)	Remarks
L101	NT512	<p>10 HENRYS 70ma</p>		33 PE	3210	240	Filter Choke
T101	NT509		Primary 1 Primary 2 Secondary	35 PE 35 PE 42 PE	400 CT 400 CT 3800 CT	28 26 1100	Input Transformer Maximum Input level — .006 W ± 2db from 100 to 10,000 CPS
T102	NT510		Primary Secondary 1 Secondary 2	35 PE 31 PE 35 PE	2480 Tapped at 1610 680 Tapped at 255, 340 & 425 88	495 99 10.8	Output Transformer Output level — 2 W ± 2db from 100 to 10,000 CPS Primary DC — 35 ma
T103	NT511		Primary Secondary 1 Secondary 2 Secondary 3	25 PE 2 #22 PE 33 PE 19 PE	510 Tapped at 428 & 469 22 2200 CT 28 CT	8.0 .14 280 .17	Power Transformer
T201	NT506		Primary Secondary	33 PE 22 PE	900 90	50 1.0	Matching Transformer for Dynamic Loudspeaker LS-159/G



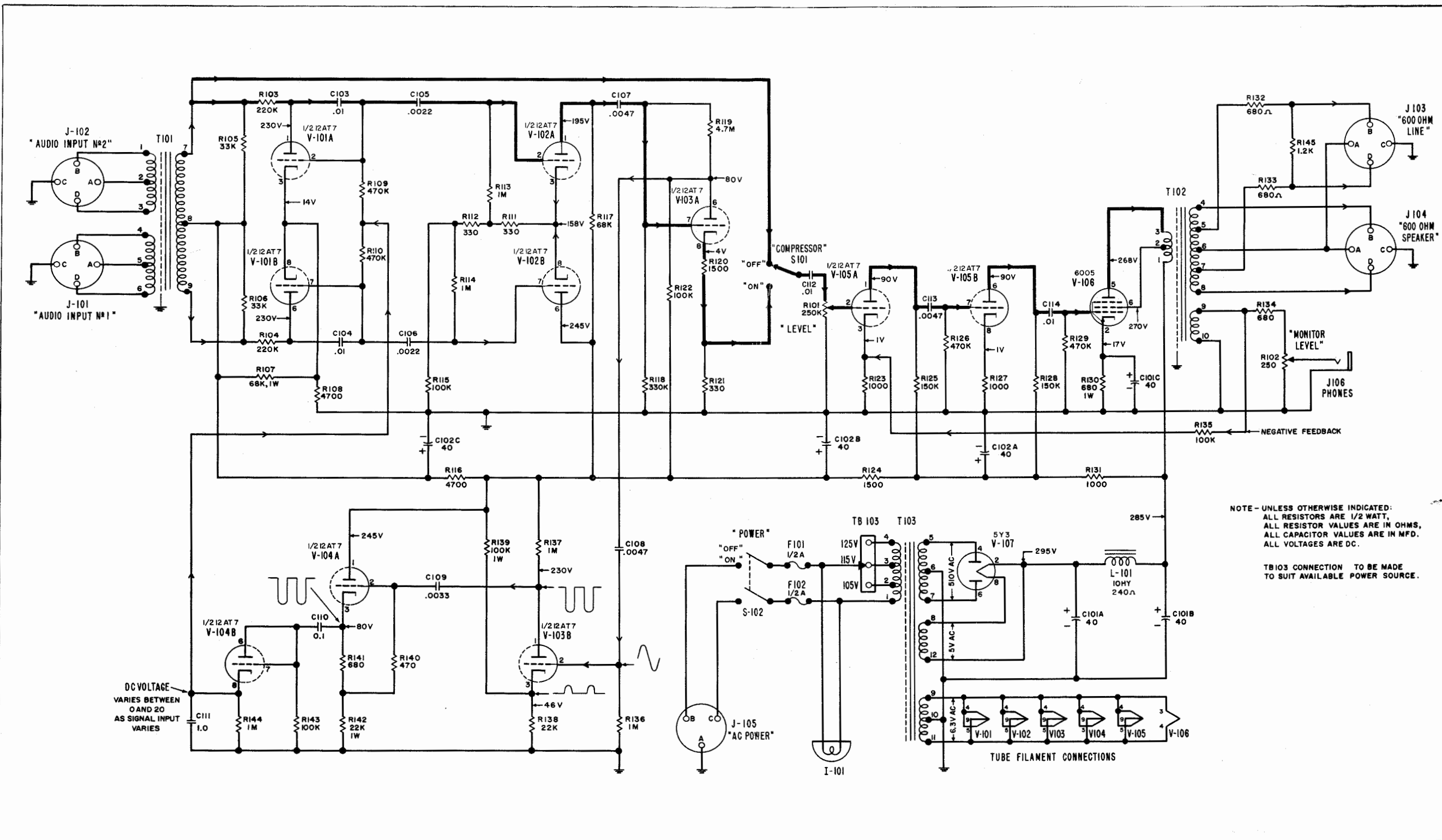


Figure 7-6. Schematic of A. F. Amplifier AM-413/G

SECTION 8
PARTS LISTS

Table 8-2, the Table of Replaceable Parts, constitutes the major portion of this section. The items are listed according to their reference symbols in alphabetical and numerical sequence. The compo-

nents of AF Amplifier AM-413/G are of the series 101-199, and the Dynamic Loudspeaker components are of the series 201-299.

TABLE 8-1. LIST OF MAJOR UNITS

<i>Symbol Group</i>	<i>Quantity</i>	<i>Name of Major Unit</i>	<i>Navy Type</i>	<i>Designation</i>
100-199	1	AF Amplifier	—	AM-413/G
200-299	1	Dynamic Loudspeaker	—	LS-169/G

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE SYMBOL	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTIONS
A-101	Shop Manufacture	PANEL CONTROL: Not enclosed. Overall Dimensions: 17 in long; 5 in wide; 3/16 in thick; aluminum Type III, Class 2 Spec MIL-E-15090. Contains provision for mounting of 1 hinge, 2 handles, 2 quick acting fasteners, 1 nameplate, 2 volume controls, 2 toggle switches, 1 indicator light, 1 telephone jack. Provides mounting facilities for controls of Amplifier AM-413/G. PAR METAL PRODUCTS CORP., LONG ISLAND CITY, N. Y.	Control Panel for Amplifier
A-102	*	HINGE: Mounts panel to chassis. Overall Dimensions: 16-23/32 in lg; 1-1/2 in wide; .062 in thick. Mounted by 8 holes: .144 in diam, 3-3/4 in apart and 2 holes .228 in diam, 4 in apart. HARMAN-KARDON, INC., N. Y., N. Y.	Hinges Chassis to Control Panel
A-103	Shop Manufacture	ANGLE MOUNTING: Provides facilities to permit amplifier to be mounted in standard 19 in relay rack. Overall Dimensions: 5-7/32 in lg, 1 in wide, 1 in high, 3/16 in thick. Mounted to amplifier by 3 holes for #8 Fl Hd M.S. on 2-1/8 in centers; mounts to rack by 2 slots, 1/4 in wide x 3/8 in deep. HARMAN-KARDON, INC., N. Y., N. Y.	Mounted to each side of Amplifier Chassis
A-104		Same as A-103	
A-105	*	HANDLE, for carrying amplifier. Overall Dimensions: 4-3/8 in lg, 3/8 in diam, 1-7/8 in high. Mounted by two No. 12-24 screws on 4 in centers. CAMBRIDGE THERMIONIC CORP., CAMBRIDGE, MASS.	Mounted to side of Control Panel
A-106		Same as A-105	
A-107	Shop Manufacture	CHASSIS, AMPLIFIER: Provides mounting facilities for electronic components and housing for electronic circuit. Overall Dimensions: 17 in lg, 5 in wide, 2-3/16 in high. Mounted by six 8-32 screws, three on each side, to mounting angle on 2-1/8 in centers. PAR-METAL PRODUCTS CORP., LONG ISLAND CITY, N. Y.	Chassis Assembly of Amplifier
A-201	Shop Manufacture	PANEL, CONTROL, not enclosed. Overall Dimensions: 19 in lg, 7 in wide, 3/16 in thick. Aluminum Type III Class 2 Spec MIL-E-15090. Contains provision for mounting 1 dynamic loudspeaker, 1 attenuator, 1 transformer, 1 cable connector. Provides mounting facilities for electrical components of Dynamic Loudspeaker LS-169/G. PAR METAL PRODUCTS CORP., LONG ISLAND CITY, N. Y.	Control Panel for Loudspeaker
A-202	Shop Manufacture	GRILLE, for Loudspeaker LS-169/G used as grille for P6-T speaker. Stainless Steel, Oval Shape, slotted 6-7/8 in wide, 6-9/16 in lg. Mounts with four steel inserts 11/32 in x .249 in diam on 2-1/4 in x 6-3/16 in centers. Ten rows of cut slots, 3/8 in high, arranged in series of vertical rows. PREMIER INSTR. CO., N. Y., N. Y.	Mounts to Loudspeaker Control Panel
C-101	N16-C-99999-0004	CAPACITOR, FIXED, ELECTROLYTIC. Case style No. 13 MBCA, Ref Dwg Group 1. 3 sections, 40 mf capacity per section. 300 v dc working voltage. Temp range -40°C to +85°C. Cylindrical metal case 4-29/32 in lg, 1-1/2 in diam. 4 pin type terminals located on bottom, spaced equally around .687 in circle, phenolic. Terminals insulated from can. Plug-in mounting fits standard medium octal socket. Spec No JAN-C-62 Spec Type No CE53C400N	Consists of C-101A, C101B, C-101C

C-102		Same as C-101	Consists of C-102A, C-102B, C-102C
C-103	N16-C-99999-0005	CAPACITOR, FIXED MICA DIELECTRIC. Case Style No 22 MBCA. Ref Dwng Group 1. 10,000 mmf $\pm 10\%$ tolerance. 500 v DC working voltage. Molded low loss bakelite case 53/64 in lg, 53/64 in wide, 11/32 in high. 2 terminals, wire lead type, one located on each end. Terminal Mounted Spec No JAN-C-5 Spec Type No CM35B103K	V-101A Plate Coupling
C-104		Same as C-103	V-101B Plate Coupling
C-105	N16-C-31908-1564	CAPACITOR, FIXED MICA DIELECTRIC. Case Style No 22 MBCA. Ref Dwng Group 1. 2200 mmf $\pm 10\%$ tolerance. 500 v DC working voltage. Molded low loss bakelite case 53/64 in lg, 9/32 in wide, 53/64 high. 2 terminals wire lead type, one located on each end. Terminal Mounted Spec No JAN-C-5 Spec Type No CM30B222K	V-102A Grid Coupling
C-106		Same as C-105	V-102B Grid Coupling
C-107	For replacement, use N16-C-32646-6940	CAPACITOR, FIXED MICA DIELECTRIC. Case style No 22 MBCA. Ref Dwng Group 1. 4700 mmf $\pm 10\%$ tolerance. 500 v DC working voltage. Molded low loss bakelite case 53/64 in lg, 53/64 in wide, 11/32 in high. Two terminals, wire lead type, located one on each end. Terminal Mounted Spec No JAN-C-5 Spec Type No. CM35B472K	V-102A Plate Coupling
C-108		Same as C-107	V-103B Grid Coupling
C-109	N16-C-32250-9764	CAPACITOR, FIXED MICA DIELECTRIC. Case Style No 22 MBCA. Ref Dwng Group 1. 3300 mmf $\pm 10\%$ tolerance. 500 v DC working voltage. Molded low loss bakelite case 53/64 in lg, 9/32 in wide, 53/64 in high. 2 terminals wire lead type, one located on each end. Terminal Mounted Spec No JAN-C-5 Spec Type No CM30B332K	V-103B Plate Coupling
C-110		CAPACITOR, FIXED, PAPER DIELECTRIC, 1 section. Case style No 18 MBCA. Ref Dwng Group 1. 100,000 mmf, $\pm 20,000$ mmf tolerance. 100 v DC working voltage. Hermetically sealed insulated metal case. Dimensions excluding terminations 2-1/16 in lg, 3/8 in diam. 2 terminals wire lead type, located one on each end. Wax impregnation, wax filling. No internal ground connections. Spec No JAN-C-25 Spec Type No CP16A1HB104M	V-104A Cathode Coupling
C-111	For replacement, use N16-C-48813-7462	CAPACITOR, FIXED PAPER DIELECTRIC, 1 section case. Style No 41, MBCA. Ref Dwng Group 1, 1 mf $\pm 400,000$ mmf, $-200,000$ mmf. 400 v DC working voltage hermetically sealed metal can. Case Dimensions excluding terminals 2-5/16 in lg, 49/64 in wide, 2-1/2 in high. 2 solder lug type terminals 3/4 in high, located on bottom, spaced 5/8 in center to center, mounted on phenolic pillars. Mineral oil impregnation, mineral oil filling. No internal ground connections. 2 mounting slots, .156 in wide, spaced 1-15/16 in center to center. Spec No JAN-C-25, Spec Type No CP65BIEE105X	V-104B Cathode By-Pass
C-112		Same as C-103	S-101 Coupling
C-113		Same as C-107	V-105A Plate Coupling
C-114		Same as C-103	V-105B Plate Coupling

*If failure occurs, requisition from ESO, referencing NAVSHIPS 900.180A as authority.

TABLE 8-2. TABLE OF REPLACEABLE PARTS (Contd.)

REFERENCE SYMBOL	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTIONS
E-101	N16-S-34676-6514	SHIELD, ELECTRON TUBE, brass, cylindrical shape. Overall Dimensions: 1-5/16 in lg, 1.065 in dia; bayonet mounted, includes compression music wire coil spring 1-1/2 in lg. Spec JAN-S-28A, Spec Type No TS103402	V-101 Tube Shield
E-102		Same as E-101	V-102 Tube Shield
E-103		Same as E-101	V-103 Tube Shield
E-104		Same as E-101	V-104 Tube Shield
E-105		Same as E-101	V-105 Tube Shield
E-106	N16-S-34607-6039	SHIELD, ELECTRON TUBE, brass cylindrical shape. Overall Dimensions: 2-1/4 in lg, .930 in dia. Bayonet mounted. Includes compression music wire coil spring 1-1/2 in lg. JAN Spec JAN-S-28A. Spec Type No. TS102U03	V-106 Tube Shield
E-107	N16-K-700302-611	KNOB, rd phenolic black, designed to accommodate rd shaft. 1/4 in dia, 1/2 in deep brass insert, groove filled with white lacquer. 1-5/32 in lg, 1-1/16 in dia, 5/8 in high. Navy Dwg RE10F479F	Control Knob for R-101
E-108		Same as E-107	Control Knob for R-102
E-109	For replacement, use N17-C-781366-251	CLAMP, ELECTRICAL, aluminum anodized, 2 screw type fastening devices. Overall Dimensions: 1-5/64 in lg, 7/8 in dia, threaded end for mounting. Designed to hold material 1/4 in dia. Used as cable clamp MIL Dwg AN3057	Clamps Cable to Plug
E-110		Same as E-109	
E-111		Same as E-109	
E-112		Same as E-109	
E-113		Same as E-109	
F-101	G17-F-16302-80	FUSE, CARTRIDGE, .5 amp 250 v, time delay 135% for 1 hour, 200% for 2 min. Ferrule type 1/4 in lg, 1/4 in dia glass envelope enclosed type, non indicating. Cartridge Fuse Type 28032-1. Spec 17F2, Type 3AG1/2	
F-102		Same as F-101	
H-101	*	FASTENER, spring lock type. Tensile strength averages 1425 lbs. Locking torque 8.1 in lbs, unlocking torque 5.9 in lbs. Overall Dimensions: Stud .805 in lg, Spring 1.49 in lg, .562 in wide, .295 in high, Grommet .094 in lg, .500 in dia. Mounted by two No 4-40 screws on 1 in centers. LION FASTENER, INC., HONEOYE FALLS, N. Y.	Fastens Panel to Chassis

I-101	G17-L-6806-130	LAMP, GLOW, 105-125 v, .04 w, .3 ma. AC striking voltage 65 v. DC striking voltage 90 v MBCA. Ref Dwg Group 7. Miniature bayonet base, T3-1/4 bulb, clear, white, 1-3/16 in lg overall. Rated life over 25 hrs. GENERAL ELECTRIC CO. NE-51	Pilot Lamp
J-101	N17-C-72610-5434	CONNECTOR, RECEPTACLE, 4 contacts, male polarized straight type. Overall Dimensions: 1.25 in lg, 1-3/16 in wide, 1-3/16 in high, 7/8 in dia; 20 amp at 21 mv. Cylindrical shape with square mtg flange, anodized aluminum, melamine insert, 4 mtg holes 1/8 in dia, 15/16 in mtg centers. MIL C-5015, AN-3102-14S-2P.	Audio Input
J-102		Same as J-101	
J-103	N17-72246-5434	CONNECTOR, RECEPTACLE, 4 contacts, female polarized straight type. Overall Dimensions: 1.25 in lg, 1-3/16 in wide, 1-3/16 high; 7/8 in dia. 20 amp at 21 mv. Cylindrical shape with square mtg flange anodized aluminum melamine insert, 4 mtg holes 1/8 in dia, 15/16 in mtg centers. AN-3102A-14S-2S	Line Output
J-104		Same as J-103	Speaker Output
J-105	N17-C-72604-1522	CONNECTOR, RECEPTACLE, 3 contacts, male, round polarized, straight type. Overall Dimensions: 1.25 in lg, 1-3/16 in wide, 1-3/16 in high, 7/8 in dia. Current rating 20 amp at 21 mv. Cylindrical shape with square mtg flange, anodized aluminum melamine insert, 4 mtg holes, 1/8 in dia, 15/16 in mtg centers. AN-3102-14S-7P	Power Input
J-106	N17-J-39248-4418	JACK, TELEPHONE. For 2 conductor plug. Shank dim: 3/8 in dia, 7/32 in lg. Contact arrangement J-1/MBCA. Ref Dwg Group 4. No circular spring. Overall Dimensions: 1-1/4 in lg, 49/64 in wide, 15/16 in high; 3/8 in dia mtg hole. Moisture and fungus proofed. JAN-J-641, JJ-034	Phone Output
L-101	N16-R-29234-8629	REACTOR, FILTER CHOKE, 1 section, 10 hy overall inductance, 60 ma DC, 240 ohms DC resistance, 1500 v rms test voltage, hermetically sealed case, steel grey finish. Overall Dimensions: 2-1/4 in lg, 2-1/8 in wide, 2-3/4 in high, mounted on four #8-32 thd mtg studs, 15/32 in high on 1-5/8 in and 1-1/2 in cent. 2 terminals, neoprene steatite comp seal located on bottom. Sprayed with moisture and fungus resistant lacquer. FREED TRANSFORMER CO., INC., BROOKLYN, N. Y.	Power Filter
LS-201	N17-L-91319-6645	LOUDSPEAKER, DYNAMIC, Permanent Field Magnet, 3-4 ohm voice coil impedance 6 w average input wattage, 6 in dia cone. Overall Dimensions: 6-11/16 in OD, 3-3/16 in deep. Four #10-32 x 5/8 FHMS for mtg on 4-3/8 in mtg centers. Navy Dynamic Loudspeaker Dwg #RE49J590. JENSEN MFG. CO., CHICAGO, ILL. P6-T	Loudspeaker
N-101	For reference only	PLATE, IDENTIFICATION, aluminum, anodized finish white etched inscription, dull black background, inscribed Amplifier AF AM-413/G. Overall Dimensions: 3 in lg, 2 in wide, 1/16 in thick. Four 1/8 in dia mtg holes on 1-3/4 in by 2-3/4 in centers. Navy Spec No RE13A516C	AM-413/G Plate
N-201	For reference only	PLATE, IDENTIFICATION, aluminum, anodized finish, white etched inscription, dull black background, inscribed Loudspeaker, Dynamic LS-169/G. Overall Dimensions: 3 in lg, 2 in wide, 1/16 in thick. Four 1/8 in dia mtg holes on 1-3/4 in by 2-3/4 in mtg centers. Navy Spec No RE13A516C	LS-169/G Plate

*If failure occurs, requisition from ESO, referencing NAVSHIPS 900.180A as authority.

TABLE 8-2. TABLE OF REPLACEABLE PARTS (Contd.)

REFERENCE SYMBOL	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY 'AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTIONS
P-101	N17-C-70334-5473	CONNECTOR, PLUG, 4 contacts, female, round polarized, straight type. Overall Dimensions: 1-7/16 in lg, 1-1/8 in dia. 20 amp at 21 mv. Cylindrical body, aluminum, anodized, melamine insert. Navy Spec MIL-C-5015. Spec Type No AN3106A-14S-2S	Audio Input
P-102		Same as P-101	
P-103	N17-C-70594-5434	CONNECTOR, PLUG, 4 contact, male, round polarized, straight type. Overall Dimensions: 1-7/16 in lg, 1-1/8 in dia. 20 amperes 200 v DC. Cylindrical shaped body, anodized aluminum, melamine insert. Spec MIL-C-5015. Spec Type No AN-3106A-14S-2P	Line Output
P-104		Same as P-103	Speaker Output
P-105	N17-C-70328-1524	CONNECTOR, PLUG, 3 contact, female, round polarized, straight type. Overall Dimensions: 1-1/16 in lg, 1-5/32 in dia. 20 amp at 21 mv. Cylindrical body shape, aluminum anodized, melamine insert. Spec No MIL-C-5015. Spec Type No AN-3106A-14S-7S	Power Input
R-101	N16-R-99999-0003	RESISTOR, VARIABLE, COMPOSITION; 1 section, 250,000 ohms $\pm 10\%$; 2 w; C taper; 3 solder lug term; metal case, enclosed, 1-17/32 in lg by 1-5/32 in dia; 1/4 in dia round metal shaft 7/8 in lg from mtg surface; mtd by bushing 3/8 in lg w 3 #8-32 thread; Allen-Bradley type J	Level Control
R-102	N16-R-99999-0004	RESISTOR, VARIABLE, COMPOSITION; 1 section, 250 ohms $\pm 10\%$; 2 w; C taper; 3 solder lug term; metal case, enclosed, 1-17/32 in lg by 1-5/32 in dia; 1/4 in dia round metal shaft 7/8 in lg from mtg surface; mtd by bushing 3/8 in lg w 3 #8-32 thread; Allen-Bradley type J	Monitor Level Control
R-103	N16-R-50714-0811	RESISTOR, FIXED, COMPOSITION; 220,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF224K per JAN-R-11	V-101A Plate Load
R-104		Same as R-103	V-101B Plate Load
R-105	N16-R-50417-0811	RESISTOR, FIXED, COMPOSITION; 33,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF333K per JAN-R-11	V-101A Plate Decoupling
R-106		Same as R-105	V-101B Plate Decoupling
R-107	N16-R-50553-0811	RESISTOR, FIXED, COMPOSITION; 68,000 ohms $\pm 10\%$; 1 w; .750 in lg by .280 in OD; 2 axial wire lead term; RC30BF683K per JAN-R-11	V-101 Cathode Bias
R-108	N16-R-50129-811	RESISTOR, FIXED, COMPOSITION; 4700 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF472K per JAN-R-11	V-101 Cathode Bias
R-109	N16-R-50822-0811	RESISTOR, FIXED, COMPOSITION; 470,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF474K per JAN-R-11	V-101A Grid Return

R-110		Same as R-109	V-101A Grid Return
R-111	N16-R-49706-0811	RESISTOR, FIXED, COMPOSITION; 330 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF331K per JAN-R-11	V-102 Cathode Bias
R-112		Same as R-111	V-102 Cathode Bias
R-113	N16-R-50975-0811	RESISTOR, FIXED, COMPOSITION; 1 megohm $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF105K per JAN-R-11	V-102A Grid Return
R-114		Same as R-113	V-102B Grid Return
R-115	N16-R-50633-0811	RESISTOR, FIXED, COMPOSITION; 100,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF104K per JAN-R-11	V-102 Cathode Load
R-116		Same as R-108	V-101 Plate Decoupling
R-117	N16-R-50552-0811	RESISTOR, FIXED, COMPOSITION; 68,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF683K per JAN-R-11	V-102A Plate Load
R-118	N16-R-50759-0811	RESISTOR, FIXED, COMPOSITION; 330,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF334K per JAN-R-11	V-103A Grid Return
R-119	N16-R-51173-811	RESISTOR, FIXED, COMPOSITION; 4.7 megohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF475K per JAN-R-11	V-103A Feedback
R-120	N16-R-49961-0811	RESISTOR, FIXED, COMPOSITION; 1500 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF152K per JAN-R-11	V-103A Cathode Load
R-121		Same as R-111	V-103A Cathode Load
R-122		Same as R-115	V-103A Plate Load
R-123	N16-R-49922-0811	RESISTOR, FIXED, COMPOSITION; 1000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF102K per JAN-R-11	V-105A Cathode Bias
R-124		Same as R-120	V-103 Plate Decoupling
R-125	N16-R-50678-0811	RESISTOR, FIXED, COMPOSITION; 150,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF154K per JAN-R-11	V-105A Plate Load
R-126		Same as R-109	V-105B Grid Return
R-127		Same as R-123	V-105B Cathode Bias
R-128		Same as R-125	V-105B Plate Load
R-129		Same as R-109	V-106 Grid Return

*If failure occurs, requisition from ESO, referencing NAVSHIPS 900.180A as authority.

TABLE 8-2. TABLE OF REPLACEABLE PARTS (Contd.)

REFERENCE SYMBOL	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTIONS
R-130	N16-R-49842-231	RESISTOR, FIXED, COMPOSITION; 680 ohms $\pm 10\%$; 1 w; .750 in lg by .280 in OD; 2 axial wire lead term; RC30BF681K per JAN-R-11	V-106 Cathode Bias
R-131		Same as R-123	V-105B Plate Decoupling
R-132	N16-R-49841-0811	RESISTOR, FIXED, COMPOSITION; 680 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF681K per JAN-R-11	J-103 Isolation
R-133		Same as R-132	J-103 Isolation
R-134		Same as R-132	J-106 Dropping
R-135		Same as R-115	Inverse Feedback
R-136		Same as R-113	V-103B Grid Return
R-137		Same as R-113	V-103B Plate Load
R-138	N16-R-50336-0811	RESISTOR, FIXED, COMPOSITION; 15,000 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire term; RC20BF153K per JAN-R-11	V-103B Cathode Bias
R-139	N16-R-50634-0231	RESISTOR, FIXED, COMPOSITION; 100,000 ohms $\pm 10\%$; 1 w; .750 in lg by .280 OD; 2 axial wire term; RC30BF104K per JJAN-R-11	V-103B Cathode Bias
R-140		Same as R-109	V-104A Grid Return
R-141		Same as R-132	V-104A Cathode Bias
R-142	N16-R-50373-0231	RESISTOR, FIXED, COMPOSITION; 22,000 ohms $\pm 10\%$; 1 w; .750 in lg by .280 in OD; 2 axial wire lead term; RC30BF223K per JAN-R-11	V-104A Cathode Load
R-143		Same as R-115	V-104B Plate Return
R-144		Same as R-113	V-104B Cathode Load
R-145	N16-R-49941-231	RESISTOR, FIXED, COMPOSITION; 1200 ohms $\pm 10\%$; 1/2 w; .468 in lg by .249 in OD; 2 axial wire lead term; RC20BF122K per JAN-R-11	J-103 Shunt
S-101	N17-S-72828-2605	SWITCH, TOGGLE; DPST; 30 amp, 250 v; phenolic body 1-21/64 in lg by 49/64 in wide by 1-1/16 in deep; bat type handle 11/16 in lg; 4 solder lug term; mtd by bushing 15/32 in lg w 15/32-32 thread; ST52K per JANS-S-23; mfd by CUTLER-HAMMER, MILWAUKEE, WIS.	Power Switch

S-102	N17-S-71894-1544	SWITCH, TOGGLE; SPDT; 20 amp, 24 v; phenolic body 1-1/8 in lg by 5/8 in wide by 5/8 in deep; bat type handle 11/16 in lg; 3 solder lug term; mtd by bushing 15/32 lg w 15/32-32 thread; SF42D per JANS-S-23; mfd by CUTLER-HAMMER, MILWAUKEE, WIS.	Compressor Switch
T-101	N17-T-99999-0001	TRANSFORMER, AUDIO FREQUENCY, INPUT; Primary 1-600 ohms CT, Primary 2-600 ohms CT; Secondary—60,000 ohms CT; 500 v test; hermetically sealed steel case 1-19/32 in lg by 1-19/32 in wide by 2-11/32 high; .012 w max audio operating level; turns ratio 1 to 10 each primary to secondary; ± 2 db from 100 to 10,000 CPS; 9 term glass header; mtd by four 6-32 studs on 1-1/16 in by 1-1/16 in mtg centers; mfd by FREED TRANS. CO., BROOKLYN, N. Y.; Freed No 24758; Harman-Kardon No NT510; TFIA10AJ per MIL-T-27	Amplifier Input
T-102	N17-T-99999-0002	TRANSFORMER, AUDIO FREQUENCY, PLATE COUPLING; Primary 8000 ohms total, tapped at 3260 ohms; Secondary 1-600 ohms CT and 38 ohms CT. Secondary 2-10 ohms; primary rated 35 ma DC, no secondary DC; primary 1000 v test, secondaries 500 v test; hermetically sealed steel case 2-1/4 in lg by 2-1/8 wide by 4 in high; 2 w max audio operating level; turns ratio, primary to secondary 1-3.6, to secondary 2-28; ± 2 db from 100 to 10,000 CPS; 10 term glass header; mtd by four 8-32 studs on 1-1/2 in by 1-5/8 in centers; mfd by FREED TRANS. CO., BROOKLYN, N. Y.; Freed No 24759; Harman-Kardon No NT510; TFIA13YY per MIL-T-27	Amplifier Output
T-103	N17-T-99999-0003	TRANSFORMER, POWER, STEP-DOWN AND STEP-UP; Primary 105/115/125 v 50 to 60 CPS single phase; Secondary 1-510 VCT @ .070A; Secondary 2-6.3 v CT @ 2A; Secondary 3.5 v @ 2A; 1500 v test; hermetically sealed steel case 3-3/8 in lg by 3-1/8 in wide by 4-1/4 in high; 12 steatite term w neoprene compression seal; mtd by four 10-32 studs on 2-1/4 in by 2-1/4 in centers; mfd by FREED TRANS. CO., BROOKLYN, N. Y.; Freed No 24760; Harman-Kardon No NT511; TFIA03YY per MIL-T-27	Amplifier Power
TB-101	Shop Manufacture	TERMINAL BOARD. LTS-E4 phenolic board includes 32 terminals, turret lug type without barriers. Overall Dimensions: 7-3/4 in lg, 1-13/16 in wide, 3/32 in thick. 2-5/32 in dia mounting holes on 5-1/ in mounting centers. HARMAN-KARDON, INC. Dwg #C-05078	Mounts Condensers and Resistors
TB-102	Shop Manufacture	TERMINAL BOARD. LTS-E4 phenolic board includes 33 turret type terminals; without barriers. Overall Dimensions: 7-3/4 in lg, 1-13/16 in wide, 3/32 in thick. 2 5/32 in dia mounting holes on 6-5/8 in mounting centers. HARMAN-KARDON, INC. Dwg #C-05079	Mounts Condensers and Resistors
V-101	N16-T-58240-14	ELECTRON TUBE, Twn Triode, glass envelope, 9 terminations, pin type, located on bottom. Receiving Tube JAN Type 12AT7WA Spec No MILE-1B. GENERAL ELECTRIC CO., SCHENECTADY, N. Y.	Compressor Tube
V-102		Same as V-101	Subtraction Amplifier
V-103		Same as V-101	Compressor Amplifier
V-104		Same as V-101	Compressor Rectifier
V-105		Same as V-101	Voltage Amplifier

*If failure occurs, requisition from ESO, referencing NAVSHIPS 900.180A as authority.

TABLE 8-2. TABLE OF REPLACEABLE PARTS (Contd.)

REFERENCE SYMBOL	STOCK NUMBERS SIGNAL CORPS STANDARD NAVY AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTIONS
V-106	N16-T-76005	ELECTRON TUBE, beam power, glass envelope, 9 terminations, pin type, located on bottom. Receiving Tube JAN Type 6005. Spec No MIL-E-1B. GENERAL ELECTRIC CO., SCHENECTADY, N. Y.	Power Amplifier
V-107	N16-T-99999-0004	ELECTRON TUBE, Twin Diode, glass envelope, 4 terminations, pin type, located on bottom. Receiving Tube JAN Type 5Y3WGTB. Spec MIL-E-1B. GENERAL ELECTRIC CO., SCHENECTADY, N. Y.	Power Rectifier
XF-101	N17-F-74266-9231	FUSE HOLDER, Retainer Type, extractor post 250 v 15 amp, accommodates one cartridge type fuse. Overall Fuse Dimensions: 1-1/8 in lg, 1/4 in dia. Bakelite Body. Brass contacts, pressure type. Overall Holder Dimensions: 2-9/64 in lg, 1-1/16 in dia. 2 terminals, solder lug type. Inserted thru 1/2 in hole in panel and held in place with nut. Has test hole 0.103 in-0.108 in dia in center of cap. BUSSMAN MFG. CO., ST. LOUIS, MO. Type HKP-H	Houses Fuse
XI-101	N17-L-99999-0002	LIGHT, INDICATOR. Supplied with lens 3/4 in dia, smooth clear red. Threaded cap lens holder. MBCA Ref Dwg Group 7. Accommodates miniature T3-1/4 lamp bayonet base. 110 v 2 mil. Brass shell, bakelite housing, black nickel finish, enclosed. Overall Dimensions: 2-1/16 in lg, 7/8 in dia. One mtg hole required 11/16 in dia. Accommodates up to 3/8 in thick panel. Horizontally mounted. Lamp replaceable from front of panel. Two terminals, solder lug type, located at rear, both insulated from shell. Contains 47,000 ohms resistance. DIALIGHT CORP., BROOKLYN, N. Y. No 852208-831 Indicator Light	Houses Pilot Lamp
XV-101	N16-S-64063-6713	SOCKET, ELECTRON TUBE, 9 contacts. Phosphor bronze, silver plated, tin dip finish. Miniature. Includes center shield .125 in round. Overall dimensions, excluding terminals: 1-3/8 in lg, .940 in wide, 25/32 in high. Molded plastic body Type MFE per MIL-P-14. One piece saddle mounting. Mounting dim: 3/4 in dia chassis hole required. 2 mounting holes .125 in dia, spaced 1-1/8 in C to C. Spec No JAN-S-28A, Type TS103P01	Socket for V-101
XV-102		Same as XV-101	Socket for V-102
XV-103		Same as XV-101	Socket for V-103
XV-104		Same as XV-101	Socket for V-104
XV-105		Same as XV-101	Socket for V-105
XV-106	N16-S-62603-6702	SOCKET, ELECTRON TUBE, 7 contacts. Phosphor bronze, silver plated, tin dip finish. Miniature. Includes center shield .18 in round. Overall dimensions, excluding terminals: 1-1/8 in lg, .8 in dia, 25/32 in high. Molded plastic body Type MFE per MIL-P-14. One piece saddle mounting. Mounting dim: 5/8 in dia chassis hole required. 2 mounting holes .125 in dia, spaced .875 in C to C. Spec No JAN-S-28A, Type TS102P01	Socket for V-106

XV-107	N16-S-99999-0001	SOCKET, ELECTRON TUBE, 8 contacts. Phosphor bronze, silver plate tin dip finish, medium oval shape. Overall Dimensions excluding terminals: 1-7/8 in lg, 1-3/8 in wide, 11/16 in high. Molded plastic body. One piece saddle mounting. Mounting Dimensions: 1-1/8 in chassis hole required, 2 mounting holes .156 in dia, spaced 1-1/2 in C to C. Spec JAN-S-28A. Type TS101P02	Socket for V-107
XC-101		Same as XV-107	Socket for C-101
XC-102		Same as XV-107	Socket for C-102

*If failure occurs, requisition from ESO, referencing NAVSHIPS 900.180A as authority.

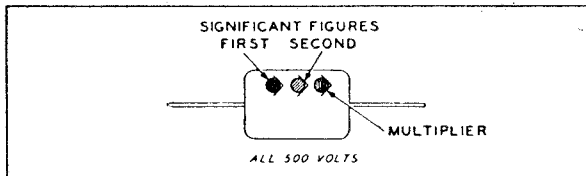
TABLE 8-3. CROSS REFERENCE PARTS LIST

JAN DESIGNATION	KEY SYMBOL	JAN DESIGNATION	KEY SYMBOL	JAN DESIGNATION	KEY SYMBOL	ARMY-NAVY TYPE DESIGNATION	KEY SYMBOL
CE53C400N	C-101	RC20BF472K	R-108	TS103P01	XV-101	AN-3057-6	E-109
CM35B103K	C-103	RC20BF333K	R-105	TS102P01	XV-106	AN-3102A-14S-2P	J-101
CM30B222K	C-105	RC20BF683K	R-117	TS101P02	XV-107	AN-3102A-14S-2S	J-103
CM35B472K	C-107	RC20BF104K	R-115			AN-3102A-14S-7P	J-105
CM30B332K	C-109	RC20BF154K	R-125			AN-3106A-14S-2S	P-101
CP16A1HB104M	C-110	RC20BF224K	R-103			AN-3106A-14S-2P	P-103
CP65B1EE105X	C-111	RC20BF334K	R-118			AN-3106A-14S-7S	P-105
TS103U02	E-101	RC20BF474K	R-109	TF1A04YY	L-101		
TS102U03	E-106	RC20BF105K	R-113	TF1A10AJ	T-101		
JJ-034	J-106	RC20BF122K	R-145	TF1A13YY	T-102		
RV4ATRD254C	R-101	RC20BF153K	R-138	TF1A03YY	T-103		
RV4ATRD251C	R-102	RC30BF683K	R-107	RE10F479F	E-107		
RC30BF331K	R-142	RC20BF475K	R-119	3AG ¹ / ₂	F-101		
RC30BF104K	R-139	RC30BF681K	R-130	P6T-C5257	LS-201		
RC20BF221K	R-112	ST42D	S-101	410-4B1	R-201		
RC20BF331K	R-111	ST52K	S-102	B-3616	T-201		
RC20BF681K	R-132	12AT7WA	V-101				
RC20BF102K	R-123	6005	V-106				
RC20BF152K	R-120	5Y3WGTB	V-107				

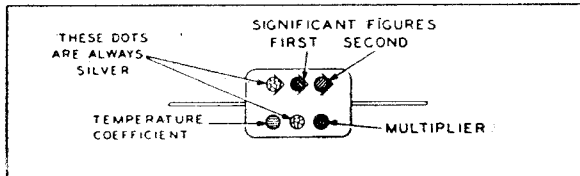
TABLE 8-4. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODES

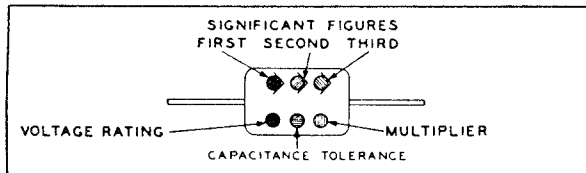
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



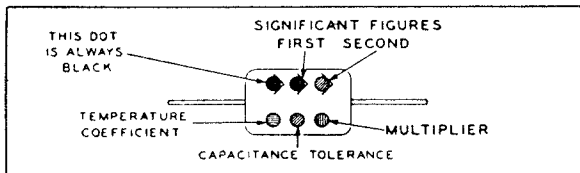
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



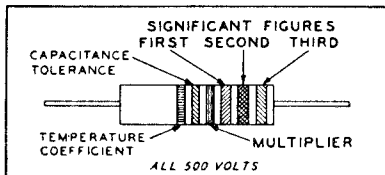
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



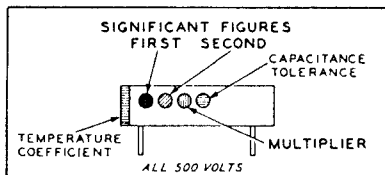
JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



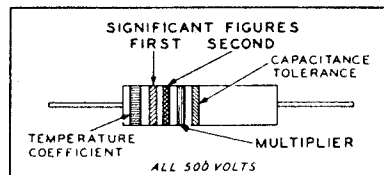
RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS



AXIAL TYPE INSULATED

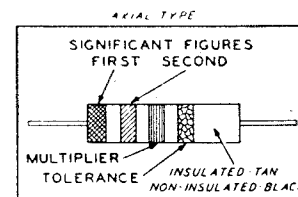


RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

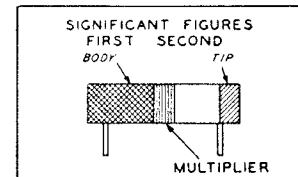
RESISTORS				CAPACITORS				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	MULTIPLIER			VOLTAGE RATING	TEMPERATURE COEFFICIENT
				RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC		
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1000	3	ORANGE	1000	1000	1000	300	D
	10000	4	YELLOW	10000			400	E
	100000	5	GREEN	100000			500	F
	1000000	6	BLUE	1000000			600	G
	10000000	7	VIOLET	10000000			700	
	100000000	8	GRAY	100000000		0.01	800	
	1000000000	9	WHITE	1000000000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

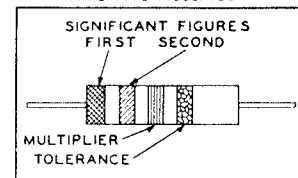


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

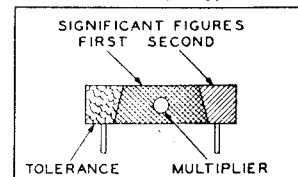


TABLE 8-5. LIST OF MANUFACTURERS

<i>Abbreviation</i>	<i>Prefix</i>	<i>Name</i>	<i>Address</i>
AB	CBZ	Allen-Bradley Co.	118 W. Greenfield Ave. Milwaukee 4, Wis.
Amphenol	CPH	American Phenolic Corp.	1830 So. 54th Ave. Chicago, Ill.
Buss	CFA	Bussman Mfg. Co.	Jefferson & University Sts. St. Louis 7, Mo.
CTC	CAMQ	Cambridge Thermionic Corp.	445 Concord Ave. Cambridge 38, Mass.
Cinch	CMG	Cinch Mfg. Co.	2334 W. Van Buren St. Chicago 12, Ill.
C-D	CD	Cornell-Dubilier Electric Corp.	1000 Hamilton Blvd. So. Plainfield, N. J.
C-H	CAE	Cutler-Hammer, Inc.	Milwaukee 1, Wis.
Dialco	CAYZ	Dialight Corp.	60 Stewart Ave. Brooklyn, N. Y.
Elco		Elco Corporation	190 W. Glenwood Ave. Phila. 40, Pa.
Freed	CFX	Freed Transformer Corp.	1718 Weirfield St. Brooklyn 27, N. Y.
GE	CG	General Electric Co.	1 River Road Schenectady 5, N. Y.
IRC	CIR	International Resistance Corp.	401 N. Broad St. Phila., Pa.
Jensen	CJS	Jensen Radio Mfg. Co.	6601 S. Laramie Ave. Chicago 38, Ill.
Lion		Lion Fastener Inc.	Honeoye Falls, N. Y.
Molded	CMI	Molded Insulation Co., Inc.	335 E. Price St. Phila., Pa.
Par Met	CQP	Par Metal Products Corp.	49th & Northern Blvd. Long Island City, N. Y.
Shallcross	CSM	Shallcross Mfg. Co.	Fusey & Jackson Ave. Collingdale, Mass.
Switchcraft	CBIM	Switchcraft Co.	1328-30 N. Halsted St. Chicago, Ill.
UTC	CUT	United Transformer Corp.	148 Varick St. N. Y., N. Y.

INDEX

SUBJECT	FIGURE OR TABLE	PARAGRAPH
A		
Adjustments, AM-413/G .....	.....	3-2
B		
Block Diagram, Overall	2-11	.....
Block Diagram, Simplified	2-1	.....
C		
Cable Connections, AM-413/G	3-1	.....
Cable Connections, LS-169/G	3-2	.....
Cathode Follower	2-4	2-3
	2-5	.....
Chassis With Panel Open	7-2	.....
Clipper, Triode	2-10	2-6
Color Codes and Miscellaneous Data	8-4	.....
Component Placement Diagram	7-3	.....
Terminal Board	7-4	.....
Compression, Volume	2-8	2-5
	2-9	.....
Cross Reference Parts List	8-3	.....
Corrective Maintenance .....	.....	7-1
D		
Description of Circuits, General .....	.....	2-1
Differential Amplifier	2-6	2-4
	2-7	.....
Dynamic Loudspeaker	2-12	2-8
E		
Electrical Characteristics of AM-413/G .....	.....	1-9
Electrical Characteristics of LS-169/G .....	.....	1-10
Emergency Maintenance	5-1	5-1
Equipment Required but not supplied .....	.....	1-5
Equipment Supplied, Table of	1-1	.....
	1-2	.....
F		
Failure Report	7-1	7-1
Feedback, Negative, Theory of	2-2	2-2
	2-3	.....
Follower, Cathode	2-4	2-3
	2-5	.....
G		
General Description .....	.....	1-1
Guarantee .....	.....	(Page IV)

SUBJECT	FIGURE OR TABLE	PARAGRAPH
I		
Installation .....	.....	3-1
Installation Record .....	.....	(Page IV)
L		
List of Effective Pages .....	.....	(Page A)
List of Illustrations .....	.....	(Page II)
List of Major Units	8-1	.....
List of Manufacturers	8-5	.....
List of Tables .....	.....	(Page III)
Location of Tubes, Fuses, Electrolytic Capacitors	5-1	.....
Loudspeaker, Dynamic	2-12	.....
M		
Maintenance Test Schedules	6-1	6-1
Manufacturers, List of	8-5	.....
N		
Negative Feedback, Theory of	2-2	2-2
	2-3	.....
O		
Operation, AM-413/G	4-1	(Page 4-2)
Operation Check Procedure	6-2	.....
Operation, LS-169/G	4-2	4-1
Operation Test, AM-413/G .....	.....	6-2
Ordering Parts .....	.....	(Page V)
P		
Preventive Maintenance .....	.....	6-1
R		
Reference Data .....	.....	1-8
Report of Failure	7-1	7-1
S		
Safety Notice .....	.....	(Page V)
Schematic Diagram, AM-413/G	7-6	.....
Schematic Diagram, LS-169/G	2-12	.....
Shipping Data	1-3	.....
T		
Table of Contents .....	.....	(Page I)
Table of Replaceable Parts	8-2	.....
Triode Clipper	2-10	2-6
Trouble Shooting, AM-413/G	7-1	7-2
Trouble Shooting, LS-169/G .....	.....	7-3
Trouble Shooting Procedure .....	.....	7-1
Tube Characteristics	7-3	.....

INDEX

NAVSHIPS 91905
AM-413/G and LS-169/G

SUBJECT	FIGURE OR TABLE	PARAGRAPH
V		
Vacuum Tube Complement	1-4	.....
Voltage and Resistance Chart	7-5	.....
Voltage and Resistance Data	7-2	.....
Volume Compression	2-8	2-5
W		
Warning Notice .....	.....	5-1
Winding Data	7-4	7-2
	

