DISTORTION AND NOISE METER

TYPE 69-C

COMMUNICATION PARTS
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PHONE: GLADSTONE 5-1994

TEST AND MEASURING EQUIPMENT SECTION

RADIO CORPORATION OF AMERICA

ENGINEERING PRODUCTS DEPARTMENT

Camden, New Jersey, U. S. A.

IB-32021-4

ERRATA
IN
INSTRUCTION BOOK
FOR
TYPE 69-C DISTORTION AND NOISE METER

Disposition: To be included with IB-32021-4

The following changes should be made in the parts list of instruction book IB-32021-4 for the Type 69-C Distortion and Noise Meter.

Pages 10,11 - Change the stock numbers for the following items to the new numbers listed:

Symbol No.	Present Stock No.	New Stock No.
C8-A	91727	39618
C23	70631	54858
C24	19802	54859
C25	54190	54860
C26	54204	54861
C33	68077	39628
C34	68738	47383
C35	68738	47383
R43	44294	19740
R44	44294	19740
R78	19746	19478
Shield,tube, top	4629	3683
Insulator	16767	16531
Connector	23225	47594
Binding post	4860	46907
Binding post	4606	30277
Binding post	4857	30277

RADIO CORPORATION OF AMERICA
ENGINEERING PRODUCTS DEPARTMENT
Camden, New Jersey, U. S. A.

8-25-58

DISTORTION AND NOISE METER

TYPE 69-C

MI-7512-H

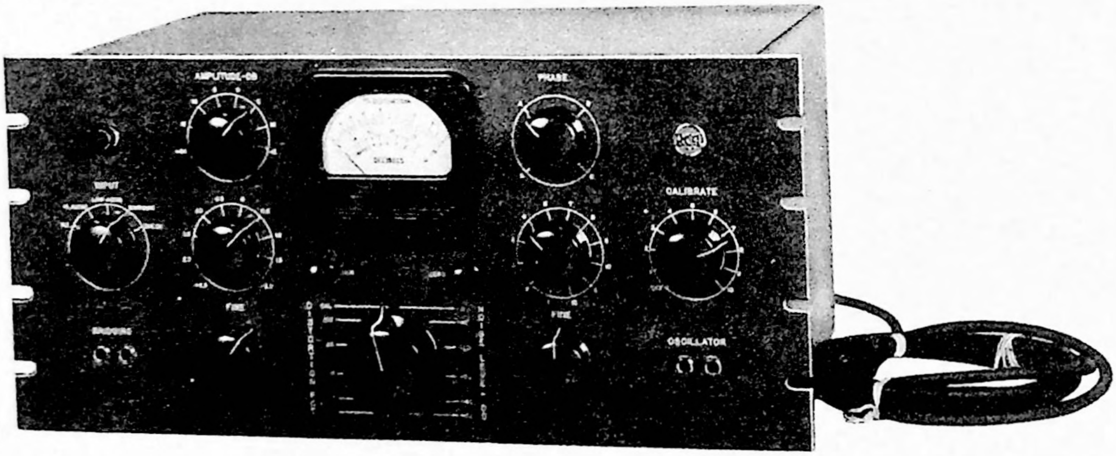
INSTRUCTIONS

TEST AND MEASURING EQUIPMENT SECTION

RADIO CORPORATION OF AMERICA

ENGINEERING PRODUCTS DEPARTMENT Camden, New Jersey, U. S. A.

Printed in U. S. A. IB-32021-4



PH-50329

DISTORTION AND NOISE METER

TECHNICAL SUMMARY

Electrical Characteristics

Frequency Range

1. High or low audio input—30 to 40,000 cycles, within ±0.5 db of 400 cycle response. Within 1.0 db down at 45,000 cycles.
2. Bridging input—30 to 15,000 cycles, within ±0.5 db of 400 cycle response. Within 1.5 db down at 30,000 cycles.

Distortion Range	0.3% to 100% r-m-s
Noise Level Range	0 to –75 db
Line Rating	110-120 volts, 25-60 cycles
Power Consumption	50 watts
Fuse Protection	1.5 amperes

Tube Complement

Voltage Amplifier	1 RCA-6C5
Voltage Amplifier	1 RCA-6C5 or 6C5GT/G
Voltage Amplifiers	2 RCA-6SJ7
R-F Rectifier	1 RCA-6X5GT/G
Power Rectifier	1 RCA-6X5GT/G
Voltage Amplifier and Vacuum Tube Voltmeter	1 RCA-6F8G
Voltage Regulator	RCA OD3/VR-150
Voltage Regulator	RCA OC3/VR-105
Ballast Tube	1 Amperite 6-8

Mechanical Specifications

Dimensions

Height	8¾ inches
Width	19 inches
Depth	13 inches
Weight (Net)	44 pounds
Panel Finish	Umber Gray.

DESCRIPTION

The Type 69-C Distortion and Noise Meter was developed to supply an accurate and reliable instrument for measuring the harmonic distortion and noise level in the output of radio transmitters, audio amplifiers, or modulated radio frequency equipment of any type. Distortion or noise measurements are read directly from the meter scale, which is calibrated for several ranges. When used with a low distortion oscillator, such as the Type-68-B, distortion measurements may be made at any frequency from 50 to 8,500 cycles per second. Higher frequency measurements can also be made with weighting of harmonics as indicated in the TECHNICAL SUMMARY under Frequency Range. Reliable readings as low as 0.3 percent may be made on any equipment having less than 180 degrees phase shift throughout its frequency range. Under these conditions, the inherent distortion in the oscillator approximates 0.1 percent r-m-s, which will have a negligible effect upon the distortion meter readings since design of the distortion meter is such that noise and distortion present in oscillator output is effectively cancelled out. Under the worst possible phase conditions, a residual reading of approximately 0.2 percent would be obtained.

Distortion measurements may be made at frequencies down to 20 cycles per second with reasonable accuracy if the amount of distortion to be measured is not too small. Using one mw in a 600-ohm line as a zero reference level, distortion can be measured at volume levels as low as –17 db and noise levels may be measured as low as –75 db.

The essential elements of the 69-C Distortion and Noise Meter are as follows:

1. An input circuit for the essentially sinusoidal signal from the audio signal generator, including a level control, marked "CALIBRATE," and a phase-shift network comprising three controls—coarse, medium and fine, as shown in Figure 1.

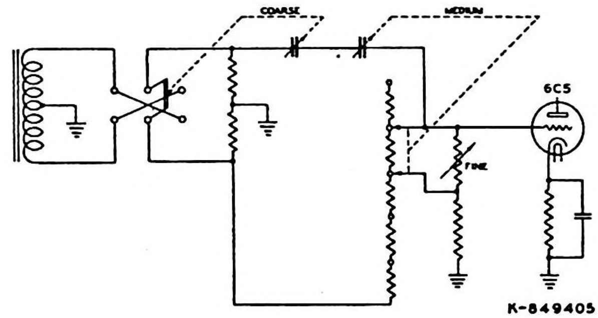


Figure 1—Phase Shifting Network
(Schematic K-849405)

2. An input circuit for the distorted signal from the equipment under test. This includes a rectifier for demodulating an r-f signal when desired, a selector switch marked "INPUT," a source of voltage for standardizing the gain of a voltage amplifier, and three level controls—coarse, medium and fine, as shown in Figures 2 and 3.

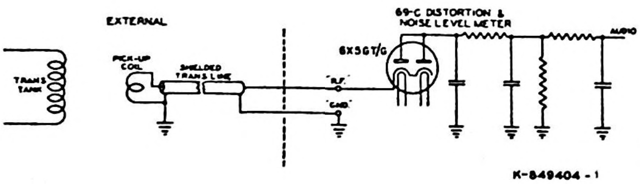


Figure 2—R-F Rectifier
(Schematic K-849404)

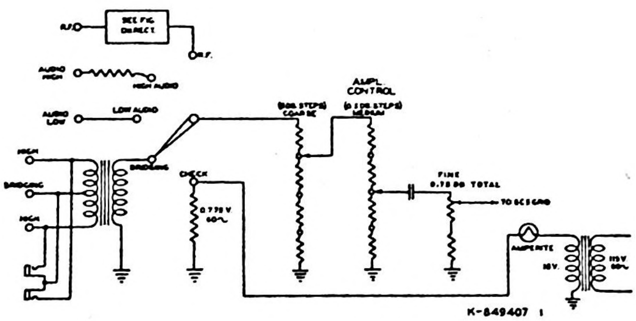


Figure 3—Input Circuit
(Schematic K-849407)

3. A push-pull amplifier stage which is used as a normal amplifier for noise level measurements, and as a cancellation stage for distortion measurements.

4. A "DISTORTION-NOISE LEVEL" switch, which is used for circuit switching and for controlling the attenuation between the push-pull amplifier stage (3 above) and the voltage amplifier.

5. A three-tube voltage amplifier with negative feedback. The "GAIN" control determines the gain of this amplifier by controlling the amount of feedback.

6. A detector and output meter, for measuring the r-m-s value of signal. A small amount of bucking current is fed through this meter to buck out the no-signal plate current of the detector. The amount of bucking current is controlled by the "ZERO" control. Figure 4 illustrates the distortion measurement circuit.

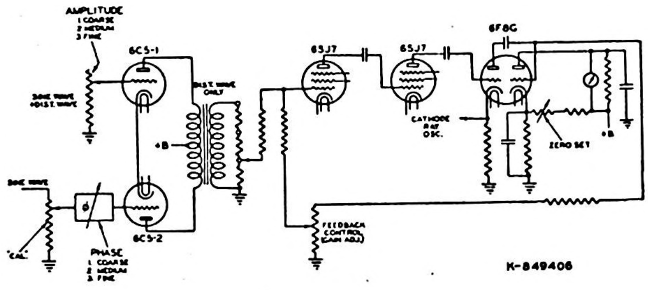


Figure 4—Distortion Measurement Circuit
(Schematic K-849406)

7. A power supply furnishing heater, plate, and screen voltages, and the standardizing voltage mentioned in 2 above.

In making distortion measurements, the meter indicates the distortion factor—i. e., the ratio of r-m-s total distortion to the fundamental amplitude. This is accomplished by suppressing the fundamental frequency component of the wave in question and measuring the r-m-s total of the remaining components. Elimination of the fundamental frequency component is accomplished by adding to the distorted wave a sine wave of the same frequency, equal in amplitude to the fundamental component, but 180 degrees displaced in phase. This voltage is secured from the same oscillator which supplies the signal to the equipment under test and is adjusted in amplitude and phase by the use of the controls on the panel of the Distortion and Noise Meter. Distortion readings directly in percent of the fundamental amplitude are obtained by first adjusting the meter to read full scale (100%) with only the sine wave input connected.

Measurements of noise levels are made by adjusting the meter for full scale deflection at the desired equipment output level and then removing the input signal from the equipment under test. The remaining noise and hum is amplified until a reliable meter deflection is obtained. The noise level is then read directly in decibels from the meter and attenuator scales.

INSTALLATION

The Type 69-C Distortion and Noise Meter is designed for mounting on a standard rack. The chassis is fully enclosed by an easily detachable dust cover. Terminals for connecting the meter with associated equipment are located on rear of chassis with parallel-connected jacks located on the front panel. Terminals are marked for easy identification. Typical methods of making connection with associated equipment for distortion and noise measurements are shown in Figures 5, 6 and 7.

The power cable should be connected between the a-c receptacle of the meter and a power supply outlet furnishing 105-125 volts, 25-60 cycles and delivering 50 watts. The power line fuse on the chassis should be in the proper position corresponding to the applied line voltage.

The pickup circuit used for modulated r-f signals must provide a low resistance d-c path between the r-f and ground terminals of the distortion meter as well as low audio frequency impedance.

These conditions will be met by the use of a small pickup coil consisting of several turns. Capacitative coupling or an antenna may be used if a radio frequency choke or a parallel resonant circuit is connected across the r-f and ground terminals. A low resistance, untuned coil is the most desirable for this purpose, as it is least likely to introduce hum into the circuit or to cause frequency discrimination. For high frequency r-f carriers, it is sometimes preferable to use a separate detector and tuned circuit.

The chassis of the Distortion and Noise Meter should be well grounded to minimize stray r-f pickup. This can be accomplished by the use of a heavy strap or braid, which should be kept as short as possible.

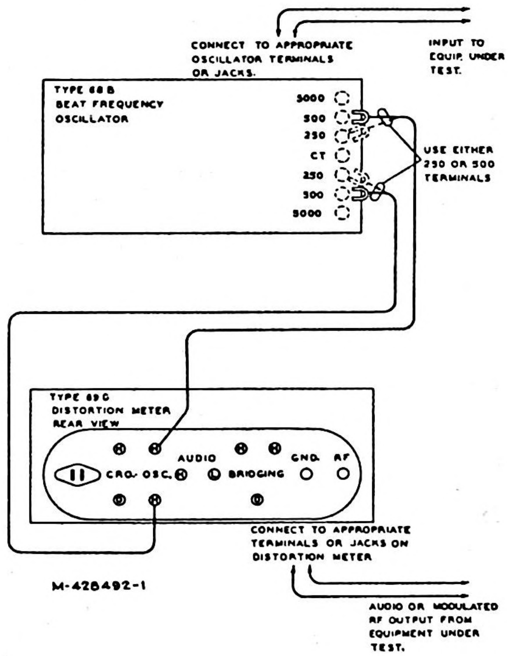


Figure 5—Distortion Meter Connections Using Direct Wiring

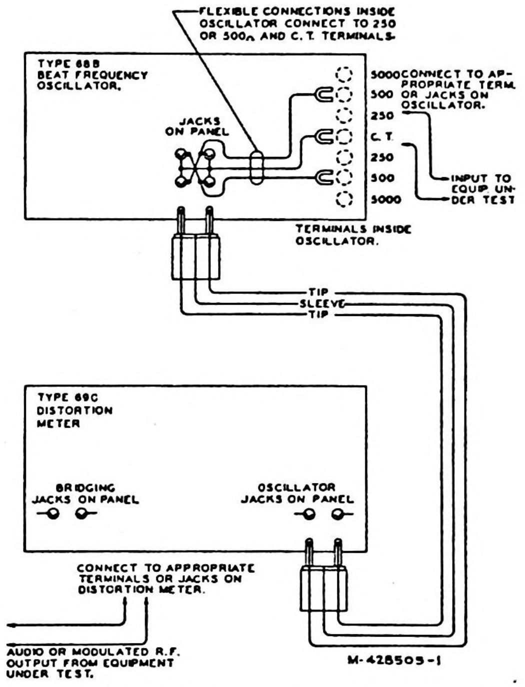


Figure 6—Distortion Meter Connections Using Patch Cords

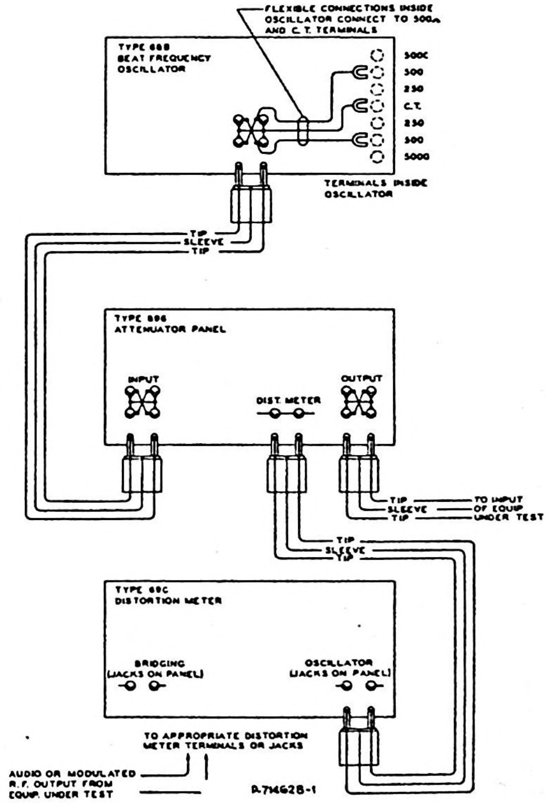


Figure 7—Distortion Meter Connections Using 89-C Attenuator Panel

OPERATION

Distortion and noise measurements are read from the same meter, which is calibrated to the following full scale readings:

Distortion	Noise Level
1%	–50
3%	–40
10%	–30
30%	–20
100%	–10
	0

The desired meter range is selected through the meter range switch, which is controlled by means of the large knob and scale. The desired distortion range may be selected by rotating the knobs over the left-half of the scale. The desired noise level range may be selected by rotating the knob over the right-half of the scale. By adjustment of the calibrated AMPLITUDE controls, the noise level range may be extended to –75 db.

INPUT LEVELS—For accurate distortion or noise measurements, the input levels to the instrument should be adjusted to within the following limits:

1. Modulated r-f—10 volts to 80 volts.

   Note—To determine the proper r-f input level modulate the transmitter approximately 100 percent. and set the "DISTORTION-NOISE LEVEL" switch at "0." Adjust the input level until full-scale meter reading is obtained with the "AMPLITUDE" control set between "0" and "+16."

2. Audio frequency from signal generator—2 volts to 4 volts.
3. Audio frequency from equipment under test—
   a. Bridging input terminals or jacks (balanced)
      Minimum—0.14 volt or 15 db below 1 mw on 600-ohm line.
      Maximum—9.0 volts or 22 db above 1 mw on 600-ohm line.
   b. Audio and ground input terminals
      (1) "Audio Low"—0.12 volt to 8.0 volts.
      (2) "Audio High"—1.2 volts to 80 volts.

COUPLING METHODS—Modulated radio frequency voltages to be measured are obtained through inductive coupling. The pickup coil should be designed with a low audio frequency impedance in order to eliminate any a-c hum component that may be picked up.

When the Distortion and Noise Meter is to be used in conjunction with a balanced audio line having an impedance of 600 ohms or less, a bridging transformer having an impedance of 20,000 ohms is provided. This impedance is sufficiently high to have no appreciable effect upon the low impedance line. The three transformer input connections terminate in three binding posts, marked "BRIDGING," located at the rear of the chassis, and a pair of parallel connected jacks located on the front panel. The center tap of the transformer winding is not grounded.

CONNECTIONS—Following are tabulated the correct connections to be made for distortion and noise measurements under various conditions:

1. For Modulated Radio Frequency Input
   a. Connect pickup coil between "R-F" and "GND" terminals at rear of instrument and remove all connections from "AUDIO" terminals.
   b. Set "INPUT" switch on "R-F" position.
2. For Audio Frequency Input—Balanced Lines up to 600 Ohms
   a. Connect audio line either to "BRIDGING" terminals at rear or to "BRIDGING" jacks on front panel. The center tap connection may be connected, left open or grounded as desired.
   b. Set "INPUT" switch to "BRIDGING" position.
3. For Unbalanced Audio Frequency Input—Below 4 Volts
   a. Connect audio line to "LOW AUDIO" and "GND" terminals.
   b. Set "INPUT" switch to "LOW AUDIO" position.
4. For Unbalanced Audio Frequency Input—Above 4 Volts
   a. Connect the audio line to "HIGH AUDIO" and "GND" terminals.
   b. Set "INPUT" switch to "HI AUDIO" position.

Conect 250 or 500 ohm terminals of audio signal generator to the two terminals at rear of distortion meter marked "OSC." or to the pair of jacks on front panel marked "OSCILLATOR."

A cathode-ray oscilloscope may be connected to the "CRO" binding posts to observe wave form of distortion or noise, or to assist in balancing out the fundamental. Any circuit connected across these binding posts should have an impedance of at least 100,000 ohms, and when an r-f field exists, such as around a transmitter, a shielded lead should be used.

CALIBRATION—Prior to making measurements, the instrument should be calibrated in the following manner:

1. Turn the power on by rotating the "CALIBRATE" control in a clockwise direction, and wait at least five minutes for voltages to stabilize.
2. With no input signal to the "OSC." binding posts or jacks and with the "DISTORTION-NOISE LEVEL" switch at the "CALIBRATE" position, adjust the "ZERO' control for a meter reading of zero percent. (not 0 db).
3. a. Set coarse and medium "AMPLITUDE" controls to "0" positions and "FINE" control with pointer approximately vertical.
   b. Set "DISTORTION-NOISE LEVEL" switch to the "0" position.
   c. Set "INPUT" switch on "CHECK" position.
   d. Adjust "GAIN" control for full-scale meter reading (0 db).

NOISE LEVEL MEASUREMENTS—

Noise levels may be measured in either of two ways. One method gives a result in terms of the standard zero level of the 69-C, which is one milliwatt in a 600 ohm line (0.775 volt ±1 db). The other method gives a result in decibels below some arbitrary output level of the equipment under test. The first method is accomplished as follows:

1. When using "LOW AUDIO" input, it is only necessary to remove input from equipment under test and adjust the "AMPLITUDE" controls and the "DISTORTION-NOISE LEVEL" switch until the meter reads on scale. The noise level (based on a 600-ohm line) is then read from the control settings and the meter readings.

   Caution—When input signal is removed from equipment under test, make sure that input circuit is still correctly loaded to avoid introduction of noise that is not present during normal operation.

2. When using "HI. AUDIO" input, a close approximation can be obtained by using the above procedure and adding −20 db to the result.
3. When using "BRIDGING" input, a close approximation can be obtained by using the above procedure and adding −1.5 db to the result.

The second method, which is the most accurate, is accomplished as follows:

1. Adjust the input to the device under test to obtain the output level below which it is desired to measure the noise level.
2. Adjust the "AMPLITUDE" and "DISTORTION-NOISE LEVEL" controls to obtain a meter reading of "0" db.
3. Remove the input signal from the device under test and readjust the "AMPLITUDE" and "DISTORTION-NOISE LEVEL" controls until the meter reads on the db scale. The sum of the amount that it was necessary to move the controls and the established meter reading denotes the noise level with respect to the original level.

DISTORTION MEASUREMENTS:

A— Audio measurements—

1. Apply input signal from the low-distortion oscillator to the "OSCILLATOR" input of the Distortion and Noise Meter.
2. Place "DISTORTION-NOISE LEVEL" switch on "CAL" position.
3. Adjust "CALIBRATE" control for a full-scale meter reading. (This setting should remain unchanged for remainder of measurement.)
4. Adjust input to equipment under test to desired level, remembering that its output must be within limits specified for input to Distorition and Noise meter.
5. Place "DISTORTION-NOISE LEVEL" switch on "0".
6. Place "INPUT" switch on appropriate position.
7. Adjust "AMPLITUDE" controls for full scale deflection of meter.
8. Place "DISTORTION-NOISE LEVEL" on "100" position.
9. Adjust "PHASE" controls until meter reading is below the calibrated position of the scale.
10. Turn "DISTORTION-NOISE LEVEL" switch to "30"
11. Adjust "PHASE" and "AMPLITUDE" controls for minimum meter reading, turning "DISTORTION-NOISE LEVEL" switch to lower percent for increased sensitivity if required.

B—Audio Measurements from R-F Envelope—

1. Apply the modulated R-F signal between the "R-F" terminal and "GND" on rear of distortion meter. The method of coupling is indicted under INSTALLATION and input level under OPERATION.
2. Place the input switch on the "R-F" position. This connects the rectifier output to the audio input of the coarse amplitude control.
3. Proceed to measure distortion and noise as indicated under Audio Measurements.

NOTE—For R-F frequencies considerably above broadcast band, a separate rectifier fed directly to the audio input may be desirable.

With the selector switch placed on "CAL" during distortion measurements, the meter reading may vary with the position of the "PHASE" controls. This is a normal characteristic resulting in an error of not more than 10 percent. on the "% DISTORTION" scale indication. In order to eliminate this error, place the selector switch on "CAL," after adjusting the phase controls for a balanced condition and readjust the "CALIBRATE" control for a full scale meter indiction. A slight readjustment of the "FINE" amplitude control will then be necessary for the final balance.

After obtaining an exact balance, the amount of total distortion is obtained by reading both the "meter" and "switch" scales. After a reading has been taken, the switch should be returned to the "CAL." position before making any adjustments to the equipment, in order to protect the meter.

CIRCUIT LOADING—The output of the Type 68-B Beat Frequency Oscillator should terminate in the correct impedance in order to secure minimum distortion of the oscillator signal. The correct terminating impedance is indicated at each pair of output terminals. To illustrate, an impedance of 500 ohms should be connected between the two terminals marked 500, or an impedance of 250 ohms between each terminal marked 500 and the center tap terminal. The Type 89-C Attenuator Panel will provide proper impedance loading. For sketch showing a typical attenuator and for connections when a Type 89-C Attenuator Panel is used, refer to Figures 8 and 5.

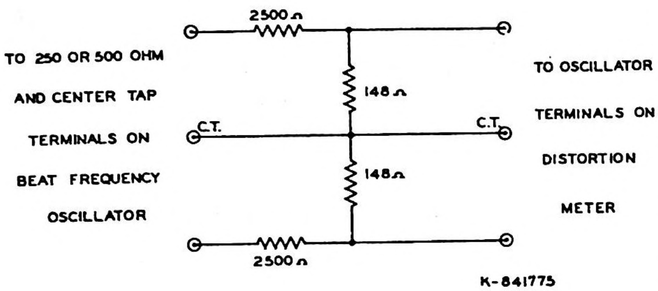


Figure 8—Typical Attenuator (Schematic K-841775)

EFFECT OF NOISE ON DISTORTION MEASUREMENTS—The Type 69-C Distortion and Noise Meter indicates the r-m-s total of all components of the input signal which fall within the limits of the frequency range. The exception is the fundamental frequency component, which is cancelled by the voltage taken directly from the oscillator. The reading of the meter will therefore include the following components:

Component	Frequencies for 1,000 cycle modulation (60-cycle power supply)
(1) Harmonics ...	2,000, 3,000, 4,000..20,000, etc.
(2) Modulation cross products between hum and fundamental	1,000 + 60 = 1,060 1,000 + 60 = 940 1,000 + 120 = 1,120 1,000 — 120 = 880 1,000 ± 180 = etc.
(3) Modulation cross products between hum and harmonics	2,000 ± 60 = 2,060 and 1,940 2,000 ± 120 = 2,120 and 1,880 2,000 ± etc. 3,000 ± 60 = 3,060 and 2,940 3,000 ± 120 = 3,000 ± etc. 4,000 ± etc.
(4) Hum components	60, 120, 180, etc.
(5) Noise components	All frequencies

The Distortion and Noise Meter sums all these quantities and thus indicates, as percent distortion, the ratio of the sum of all undesired components to the fundamental frequency component. If it is desired to determine the distortion due to the harmonic and cross product components alone, either of two methods may be used.

One method is to operate the equipment under test at a high output level, which results in making the hum and noise components negligible compared to the other components. Another method is as follows:

1. Measure distortion in the normal manner at the desired output level.
2. Measure the noise level in decibels, using the same output level as a reference level.
3. Convert the reading in decibels to percent; for example, –40 db = 1%, –60 db = 0.1%.
4. These values may then be substituted in the following equation:

$$H = \sqrt{D^2 - N^2}$$

Where H = total harmonic and cross section distortion in percent.
D = distortion percent obtained as per (1).
N = noise (in percent) obtained as per (2) and (3).

When making distortion measurements, it should be kept in mind that the noise level in the output of the beat frequency oscillator approximates 50 db below 1 milliwatt and is substantially independent of the actual oscillator output voltage. While the design of the distortion meter is such that the effects of noise and distortion present in the oscillator output tend to be cancelled out, in most cases the cancellation will be more complete for the distortion than for the noise components.

Therefore, it is desirable to operate the oscillator at as high an output as practicable, thus improving the signal to noise ratio to the point where the noise output of the oscillator (expressed in percent of signal) is small compared to the percent distortion being measured. High oscillator output may not always be consistent with the input voltage requirements of the meter, but this difficulty can readily be overcome by the use of one or two attenuator pads or the 89-C Attenuator Panel.

When operating the Noise and Distortion Meter at a point remote from the oscillator, the effect of noise and distortion in the line may be great enough to seriously affect the accuracy of the measurements. Hence this type of operation is not recommended.

Normally, when taking measurements near 0 or 180 degrees phase shift, a balance cannot be obtained at frequencies which are transmitted through the equipment under test with phase shifts which fall within these narrow limits. This, however, can be overcome by inserting a capacitor in series with one of the two outside terminal connections (not the center tap) between the distortion meter and oscillator. The value of the capacitor and the choice of which connection to use is best decided by trial.

MAINTENANCE

Service generally consists of replacing tubes which have become defective through usage. All tubes should be tested at regular intervals in a tube tester.

The Distortion and Noise Meter is protected by a 1.5 ampere fuse. Should the clips holding this fuse become unduly heated through improper contact, the fuse will blow. Hence the holding contacts should be free from foreign matter and hold the fuse firmly in place.

Figures 9 and 10 show respectively the top and bottom view of the chassis, with the components comprising the circuit identified by numerals corresponding to like values on the list of spare parts. This facilitates replacement of circuit elements which have developed a breakdown. Schematic circuit and connection diagrams are shown in Figures 11 and 12.

Resistance elements through constant usage, sometimes become altered in value. This change, if sufficiently great, will affect operation in that portion of the circuit in which the resistance element is located.

Check tube socket voltages against the values in the table below. In event that the check on the tubes does not remove the cause of fault, disconnect the Distortion and Noise Meter from its source of power. With an ohmmeter, check through the entire equipment for continuity.

If such procedure shows the circuit to be intact, then check each element therein with the ohmmeter and compare the resistance readings of the resistors against the corresponding resistor given in the spare parts list.

In the event that R55A, C8 or T2 require replacement, it will be necessary to readjust R-55A so that the Audio Low response is flat within ±0.5 db from 20 cycles to 40,000 cycles, and down not more that 1 db at 45,000 cycles. Potentiometer R-55A is located underneath the chassis, on the shield.

In testing capacitors for open, short and leaky circuits, it is necessary to remove one side of the capacitor under test from the circuit in which it is connected. The probes of the ohmmeter are then placed across the terminals of the capacitor under inspection and from the nature of the ohmmeter deflection, the condition of the capacitor can readily be ascertained. a point remote from the oscillator, the effect of noise

REPLACEMENT OF ATTENUATOR RESISTORS—In replacing the close tolerance precision resistors on the selector switches, great care should be taken to prevent overheating them while soldering. A clean, hot iron should be used and the resistor lead grasped with pliers between the body of the resistor and the point to be soldered. Do not cut the lead too short as overheating may occur in the soldering process. Make the soldered joint as quickly as possible to avoid prolonged heating.

TUBE SOCKET VOLTAGES

(120-volt line, fuse in 120-volt position)

All voltages except filament are d-c to ground, measured with a 20,000-ohm-per-volt voltmeter.

Tube	E_f a-c	E_p	E_{sg}	E_k	E_p#2	E_k#2
6X5G R-F Diode	6.3					
6C5 or 6C5GT/G	6.3	120	—	3.7	—	—
6C5	6.3	120	—	3.5	—	—
6SJ7	6.3	152	112	3.8	—	—
6SJ7	6.3	152	112	3.8	—	—
6F8-G	6.0	105	—	3.6	250	11.5
6X5-GT/G	6.3	d-c out = 357, a-c pl. to pl. 600 volts r-m-s				
OC3/VR-105		105				
OD3/VR-150		255				
Amperite 6-8	12.0					

PARTS LIST

SYMBOL No.	DESCRIPTION	Stock No.
	DISTORTION AND NOISE METER TYPE 69-C MI-7512H	
C-4	Capacitor—.25 mfd., 300 V.	70618
C-5, C-6	Capacitor—15-15-40 mfd., 450-450-25 V.	34150
C-7	Capacitor—10-10-40 mfd., 450-450-25 V.	33865
C-8	Capacitor—560 mmf., 500 V.	39646
C-8A	Capacitor—39 mmf., 500 V.	91727
C-9	Capacitor—.25 mfd., 400 V.	70618
C-10	Same as C-4	
C-11, C-12	Part of 33865 (C-7)	
C-13	Same as 33865 (C-7)	
C-14	Same as C-9	
C-15	Part of 33865 (C-13)	
C-16	Same as C-9	
C-17	Part of 33865 (C-13)	
C-18	Capacitor—.025 mfd., 1000 V.	70654
C-19, C-20	Same as 33865 (C-7)	
C-21	Capacitor—40-40-40 mfd., 300-25-25 V.	19805
C-22	Same as C-4	
C-23	Capacitor—.01 mfd., 500 V.	70631
C-24	Capacitor—.05 mfd., 300 V.	19802
C-25	Capacitor—.25 mfd., 300 V.	54190
C-26	Capacitor—1.0 mfd., 150 V.	54204
C-27, C-28, C-29	Capacitor—15-15-5 mfd., 450-450-450 V.	19806
C-30	Part of 34150 (C-5, C-6)	
C-31	Capacitor—40 mfd., 25 V.	19807
C-32	Part of 33865 (C-19, C-20)	
C-34, C-35	Capacitor—3900 mmfd., 500 V.	68738
C-36, C-37	Capacitor—3300 mmfd., 500 V.	39664
F-1	Fuse—2 Amps.	3883
L-2, L-3	Reactor—Filter, XT-2016	19812
M-1	Meter—Percent of distortion	44311
R-1	Resistor—180,000 ohms, 2 watt	19734
R-36	Resistor—13,500 ohms, ±1%, ½ watt	54199
R-37	Resistor—100,000 ohms, ½ watt	3252
R-38	Resistor—91,000 ohms, ½ watt	71624
R-39	Resistor—11,000 ohms, ½ watt	19738
R-40	Potentiometer—25,000 ohms	54202
R-41, R-42	Resistor—1,000 ohms, ½ watt	34766
R-43, R-44	Resistor—10,000 ohms, 2 watt	44294
R-45	Resistor—47.5 ohms, ½ watt	19741
R-53	Resistor—100,000 ohms, ½ watt	3252
R-54	Resistor—470,000 ohms, ½ watt	30648
R-55	Potentiometer—2000 ohms	19799
R55A	Potentiometer—50,000 ohms	54203
R-58	Resistor—22,000 ohms, ½ watt	30492
R-61	Resistor—220,000 ohms, ½ watt	14583
R-64	Resistor—22,000 ohms, 1 watt	71989
R-67	Same as R-61	
R-68	Resistor—1800 ohms, ½ watt	30930
R-69	Resistor—27,000 ohms, 1 watt	71990
R-72	Resistor—470,000 ohms, ½ watt	30648
R-73	Resistor—1800 ohms	19742
R-74	Potentiometer—12,000 ohms	19800
R-75	Resistor—40,000 ohms	44313
R-76	Resistor—1000 ohms	19744
R-77	Resistor—3700 ohms	19745
R-78	Resistor—470 ohms, 2 watt	19746
R-79	Resistor—3300 ohms, 1 watt	71986
R-80 & S-7	Potentiometer—7000 ohms	54200
R-81, R-82	Same as R-58	
R-89	Resistor—680 ohms, ½ watt	12262
R-104	Resistor—1600 ohms, ½ watt	3560
R-109	Potentiometer—100,000 ohms	54201
R-110	Resistor—82,000 ohms, ½ watt	8064
R-112, R-113	Resistor—68 ohms, ½ watt	34763
R-114	Resistor—330 ohms, ½ watt	8063
R-115	Resistor—56,000 ohms, ½ watt	30650
S-1	Switch—Wafer, 1 section, 5 position	19818
S-5	Switch—Wafer, 2 section, 4 position, without stop	19817
S-7	Switch—Power, On-Off (Included with R-80)	
T-1	Transformer—Bridging XT-4849-B	19809
T-2	Transformer—Balancing XT-3103	19810
T-4	Transformer—Input, XT-3118	19811
T-5	Transformer—Power, XT-3150	19808
V-3	Ballast—Voltage regulator tube, amperite 6-8B	63893
	MISCELLANEOUS	
	Binding Post—(Marked "O")	4860
	Binding Post—(Marked "LOW")	4606
	Binding Post—(Marked "HIGH")	4857
	Connector—A.C. 2 prong male	23225
	Cover—Insulating for Capacitor C-21	28451
	Fuse Mounting—Fuse F-1	4774
	Grid Cap	30314
	Insulator Assembly	16767
	Jack Assembly	30079
	Knob—(Small size)	4323
	Knob Assembly—(Medium size)	17268
	Knob Assembly—(Large size)	17269
	Mounting Plate—for capacitor	19820
	Mounting Plate—for capacitor	28452
	Pilot Light Assembly	
	A-1 Jewel	43735
	B-1 Socket	43737
	Shield—Tube, top	4629
	Shield—Tube	4452
	Shield—Tube	3950
	Socket—Tube, octal	48998
	Socket—Tube, 4 contact	19448
	Lamp	11891
	SWITCH ASSEMBLY S-2 FOR DISTORTION AND NOISE METER TYPE 69-C	
R-6	Resistor—8750 ohms, ±1%, ½ watt	54172
R-7	Resistor—2270 ohms, ±1%, ½ watt	54182
R-8	Resistor—2165 ohms, ±1%, ½ watt	54183
R-9	Resistor—544 ohms, ±1%, ½ watt	54184
R-10	Resistor—170 ohms, matched pair, ½ watt	19747
R-11	Resistor—10,800 ohms, ±1%, ½ watt	54185
R-12	Resistor—4930 ohms, ±1%, ½ watt	54186
R-13	Resistor—2100 ohms, ±1%, ½ watt	54187
R-14	Resistor—1030 ohms, ±1%, ½ watt	54173
R-15	Resistor—538 ohms, ±1%, ½ watt	54174
R-16	Resistor—290 ohms, matched pair, ½ watt	19748
R-17	Resistor—360 ohms, matched pair, ½ watt	19749
S-2	Switch—Wafer, 2 section, 8 position	19813

PARTS LIST—Continued

SYMBOL No.	DESCRIPTION	Stock No.
	SWITCH ASSEMBLY S-3 FOR DISTORTION AND NOISE METER TYPE 69-C	
R-18	Resistor—1120 ohms, ±1%, ½ watt	54188
R-19	Resistor—1700 ohms, ±1%, ½ watt	54189
R-20	Resistor—2165 ohms, ±1%, ½ watt	54183
R-21	Resistor—1600 ohms, ±1%, ½ watt	54191
R-22	Resistor—1500 ohms, ±1%, ½ watt	54192
R-23	Resistor—360 ohms, ±1%, matched pair	19749
R-24	Resistor—412 ohms, ±1%, ½ watt	54193
R-25	Resistor—260 ohms, ±1%, matched pair	19764
R-26	Resistor—308 ohms, ±1%, matched pair	19765
R-27	Resistor—154 ohms, ±1%, matched pair	19766
R-28	Resistor—290 ohms, ±1%, matched pair	19748
R-29	Resistor—1390 ohms, ±1%, ½ watt	54194
R-30, R-31	Resistor—1300 ohms, ±1%, ½ watt	54195
R-32, R-33	Resistor—1100 ohms, ±1%, ½ watt	54196
R-34	Resistor—900 ohms, ±1%, ½ watt	54197
R-35	Resistor—1000 ohms, ±1%, ½ watt	54198
S-3	Switch—Wafer, 2 section, 10 position	19814
	SWITCH ASSEMBLY S-4 FOR DISTORTION AND NOISE METER TYPE 69-C	
R-46	Resistor—103 ohms, ±1%, matched pair	19772
R-47	Resistor—8.1 ohms, ±1%, matched pair	19773
R-48	Resistor—316 ohms, ±1%, matched pair	19774
R-49	Resistor—1030 ohms, ±1%, ½ watt	54173
R-50	Resistor—81 ohms, ±1%, matched pair	19775
R-51	Resistor—3160 ohms, ±1%, ½ watt	54180
R-52	Resistor—10,300 ohms, ±1%, ½ watt	54181
S-4	Switch—Wafer, 3 section, 12 position	19815
	SWITCH ASSEMBLY S-6 FOR DISTORTION AND NOISE METER TYPE 69-C	
R-83	Resistor—430 ohms, ±5%, ½ watt	19781
R-84	Resistor—470 ohms, ±5%, ½ watt	30499
R-85	Resistor—560 ohms, ±5%, ½ watt	5164
R-86	Resistor—620 ohms, ±5%, ½ watt	11485
R-87	Resistor—910 ohms, ±5%, ½ watt	12531
R-88	Resistor—1300 ohms, ±5%, ½ watt	33572
R-90	Resistor—300 ohms, ±5%, ½ watt	3792
R-91	Same as R-84	
R-92	Same as R-85	
R-93	Resistor—1000 ohms, ±5%, ½ watt	34766
R-94	Resistor—1200 ohms, ±5%, ½ watt	30731
R-95	Resistor—1800 ohms, ±5%, ½ watt	30930
R-96	Same as R-83	
R-97	Same as R-87	
R-98	Resistor—750 ohms, ±5%, ½ watt	19785
R-99	Resistor—820 ohms, ±5%, ½ watt	30158
R-100	Same as R-94	
R-101	Same as R-95	
R-102	Resistor—2700 ohms, ±5%, ½ watt	30730
R-103	Same as R-99	
R-105	Resistor—1100 ohms, ±5%, ½ watt	34019
R-106	Resistor—1600 ohms, ±5%, ½ watt	3560
R-107	Resistor—3000 ohms, ±5%, ½ watt	19794
R-108	Resistor—9100 ohms, ±5%, ½ watt	30671
S-6	Switch—Wafer, 6 section, 12 position, without stop	19816
	TERMINAL BOARD ASSEMBLY TB-1 DISTORTION AND NOISE METER TYPE 69-C	
R-3	Resistor—1.29 ohms, matched pair, ½ watt	19778
R-56	Resistor—1000 ohms, ½ watt	34766
R-57	Resistor—120,000 ohms, ½ watt	30180
R-59, R-60	Resistor—6800 ohms, ½ watt	14659
R-62	Same as R-56	
R-63	Same as R-57	
R-65, R-66	Same as R-59	
R-70, R-71	Resistor—27,000 ohms, ½ watt	30409
	TERMINAL BOARD TB-2 DISTORTION AND NOISE METER TYPE 69-C	
C-2	Capacitor—47 mmfd., 500 V.	68737
C-3	Capacitor—56 mmfd., 500 V.	50399
C-33	Capacitor—100 mmfd., 500 V.	68077
R-2	Resistor—10,000 ohms, 1 watt	71914
R-4	Resistor—3300 ohms, 1 watt	71986
R-5	Resistor—18,000 ohms, 2 watt	39158

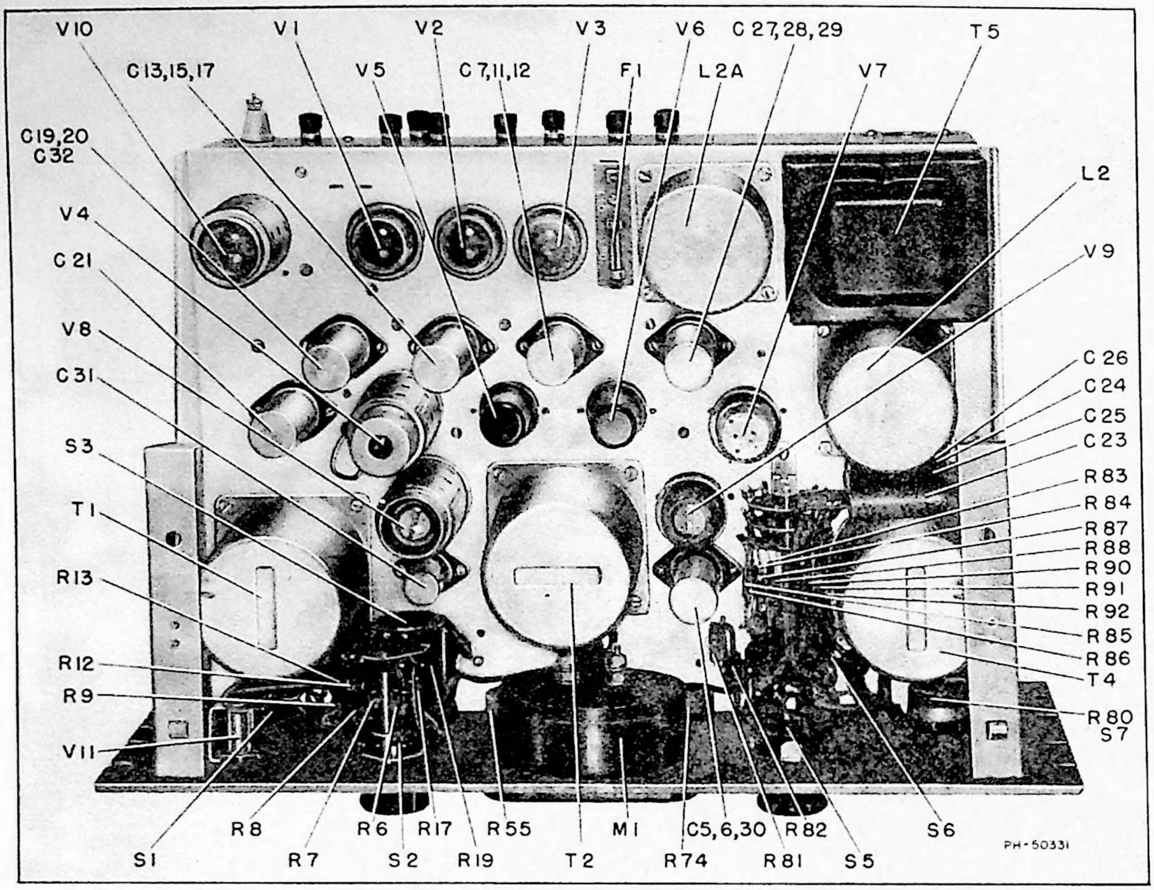


Figure 9—Chassis and Panel Assembly, Top View

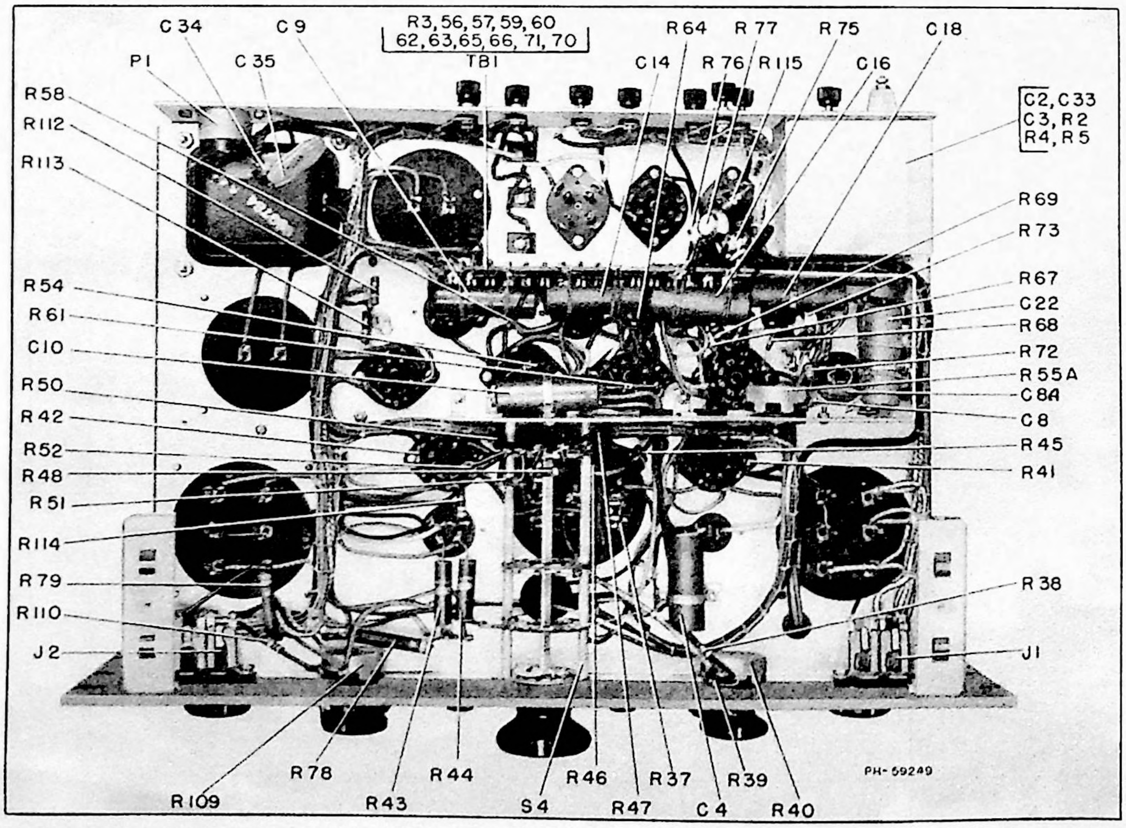


Figure 10—Chassis and Panel Assembly, Bottom View

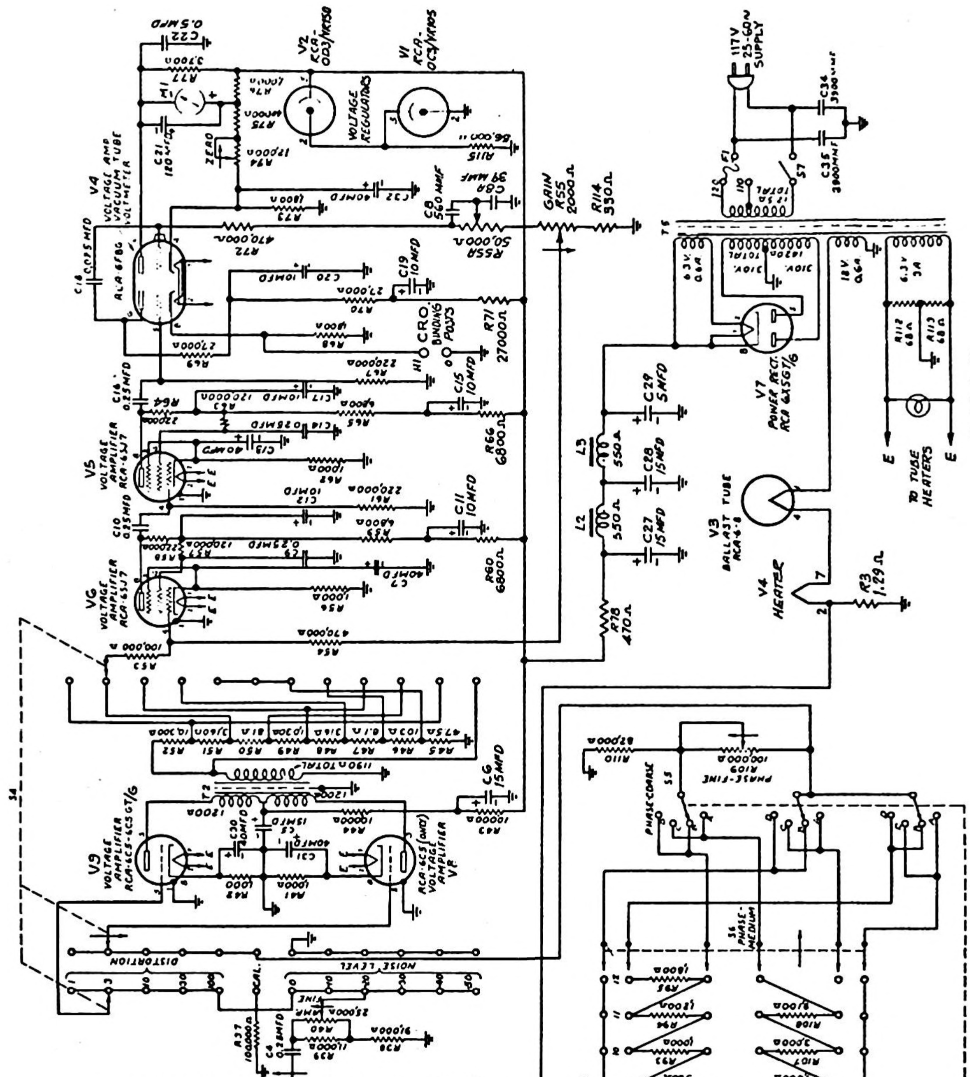


Figure 11—Distortion and Noise Meter (Schematic T-601763—Sub. 12)