

RADIO STATION KCBS  
140 Jessie Street  
San Francisco 5, Calif.

OPERATING INSTRUCTIONS  
FOR  
TYPE 732 DISTORTION AND  
NOISE METER  
TYPE 733-A OSCILLATOR  
AND  
TYPE 732-PI RANGE EXTENSION  
FILTERS  
FORM 518-C



GENERAL RADIO COMPANY  
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# OPERATING INSTRUCTIONS FOR TYPE 732-B DISTORTION AND NOISE METER

## 1.0 DESCRIPTION

### 1.1 FUNCTION

The Type 732-B Distortion and Noise Meter is intended for use in radio stations to measure the audio-frequency distortion and noise level in the transmitter output as well as in the audio-frequency portion of the transmitter equipment. It can also be used in distortion measurements on other types of audio-frequency equipment and in the production testing of radio receivers.

### 1.2 RANGE AND ACCURACY

**1.21 Distortion Range:** Distortion is read directly from a large meter. Full-scale values of 30%, 10%, 3%, and 1% are provided, and are selected by a multiplier switch. The range for carrier noise measurement is from 30 to 70 db below 100% modulation or 65 db below an audio-frequency signal of zero level.

**1.22 Audio-Frequency Range:** 380-420 cycles for distortion measurements; 30-24,000 cycles for noise or hum measurements. For extending the distortion measurements range, use Type 732-P1 Range Extension Filters with the Type 732-B Distortion and Noise Meter.

**1.23 Carrier Frequency Range:** The Type 732-B Distortion and Noise Meter is designed to operate at any carrier frequency between 0.5 and 60 megacycles. This range is covered by two coils.

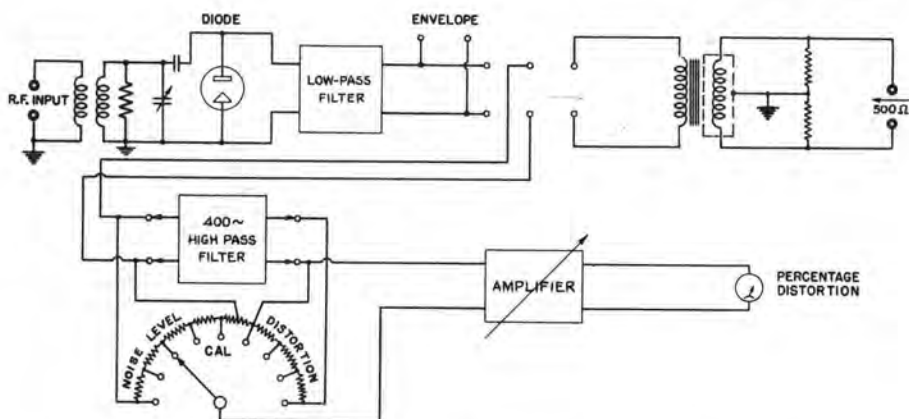


FIGURE 1. Schematic circuit diagram of Type 732-B Distortion and Noise Meter

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(either for the 0.5-8 Mc range or for the 3-60 Mc range) is supplied with the instrument unless both coils are specifically ordered. The coils are readily interchanged.

1.24 Accuracy: The over-all accuracy of measurement of each distortion range is better than  $\pm 5\%$  of full scale  $\pm 0.1\%$  distortion.

## 1.3 PRINCIPLE OF OPERATION

1.31 Schematic Circuit Diagram: The operation of the Type 732-B Distortion and Noise Meter is shown by Figure 1.

1.32 Radio-Frequency Circuit: A 400-cycle modulated radio-frequency voltage, applied to the input terminals, is coupled to a tuned circuit and to a diode rectifier. The carrier level is indicated on a d-c meter that can be switched in series with the diode rectifier. The positive half of the modulated radio-frequency wave is demodulated by the diode and passed through a filter which removes the radio-frequency components.

1.33 Audio-Frequency Circuit: The filter output voltage consists of an a-c component (corresponding to the varying envelope of the original modulated signal) superposed on a d-c component produced by rectification of the carrier.

For measurements of harmonic distortion, the output of this filter is passed through a 400-cycle high-pass filter, removing the 400-cycle fundamental of the audio frequency but leaving all its harmonics. The amplitude of the harmonic voltage is then indicated by the attenuator and the output meter. The attenuator dial is provided with a calibrating position which is used to standardize the meter scale in terms of the original 400-cycle amplitude, before making the measurement. This setting is made by adjusting the amplifier gain for a full-scale deflection on the meter, when a fraction of the envelope amplitude is applied to the amplifier.

1.34 For noise and hum measurements the output of the radio-frequency filter is applied directly to an attenuator. The calibration adjustment is made with the transmitter modulated at the level with which it is desired to compare noise. With the modulating voltage removed from the transmitter, the noise level in decibels below the modulated signal level is indicated on the meter.

## 2.0 INSTALLATION

### 2.1 VACUUM TUBES

All tubes are supplied with the instrument. Markers on the sockets indicate tube locations.

### 2.2 INPUT COUPLING COILS

2.21 Two coils are available to cover the carrier frequency range. The Type 732-P5 Coil covers the 0.5 to 8 Mc portion of the range. The Type 732-P6 Coil covers the 3 to 60 Mc portion of the range.

Each coil covers its portion of the range in four steps as selected by the orientation of the coil in its receptacle.

2.22 The coil provided with the distortion and noise meter can easily be removed and replaced with the coil for the other frequency range.

The coil is plugged into the receptacle provided for this purpose at the rear of the instrument. It must be so oriented that the desired

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portion of its frequency range is the portion indicated on the coil plate in the horizontal position. A cowl fastener holds the coil securely in place. The radio-frequency jack-top terminals are on the coil mounting. Be sure to ground the uninsulated terminal. This grounds panel and frame as well.

2.23 The Type 732-P5 Coupling Coil (0.5 to 8 Mc) is wound with 18 turns of wire on the input side with taps at 6 turns and at 2 turns. The coil is supplied with the insulated terminal connected to the full winding (18 turns) since this is the optimum connection for use at broadcast frequencies. If the coil is to be used at higher frequencies, the insulated terminal must be disconnected from the 18-turn terminal and connected to a tap of lower turns: 6 turns up to 4 Mc and 2 turns for the 4 to 8 Mc portion of the range, for example.

### 2.3 MOUNTING

When used with the other instruments in a Class 730 Transmission Monitoring Assembly, install panels in the following order: Type 733 Oscillator or Type 608-A Oscillator at the top, Type 731-B Modulation Monitor in the middle and Type 732-B Distortion and Noise Meter at the bottom. When the Type 732-P1 Range Extension Filters are used, they must be placed directly below the Type 732-B Distortion and Noise Meter.

### 2.4 CAUTION

The two connectors furnished with the Type 732-B Distortion and Noise Meter must be inserted at the rear of the instrument unless the Type 732-P1 Range Extension Filters are used in conjunction with the Distortion and Noise Meter.

### 2.5 POWER SUPPLY

Connect the instrument to the power line by means of the cord-and-plug assembly supplied. The power line frequency can be from 40 to 60 cycles. The power line voltage must be as indicated on the name plate near the power receptacle at the rear of the instrument (115 or 230 volts). The connections on the power transformer in the instrument can easily be changed for operation from either a 115-volt or a 230-volt line. For operation at 115 volts, connect #1 to #3 and #2 to #4. For operation at 230 volts, connect #2 to #3. The numbers refer to the terminals on the power transformer. When a change in transformer connections is made, the name plate must likewise be changed. The plate is stamped on one side for 115 volts, 40-60 cycles and on the other side for 230 volts, 40-60 cycles.

If any difficulty with a-c hum is encountered, reverse the line plug.

### 2.6 COUPLING TO TRANSMITTER

2.61 The most convenient way to couple the Type 732-B Distortion and Noise Meter to the transmitter is to install a small coil of a very few turns close to the antenna lead or to the tank circuit. This coil is then connected to the carrier input terminals. An ordinary rubber-insulated single-conductor concentric cable of around 75 ohms impedance has been found convenient. This forms a low-impedance link circuit with the coil mounted in the instrument.

2.62 Sufficient coupling must be provided so that when the instrument is turned on and the meter switch is at TUNE CARRIER, the meter

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will deflect at least to half scale after the signal has been tuned to exact resonance by means of the TUNE FOR MAXIMUM control.

The tuned circuit in the instrument is damped by two 6000-ohm resistors in parallel. If one of the resistors is removed, somewhat less power will be required to operate the instrument but side-band clipping will be increased, although not to a serious extent unless more than half the available tuning capacitance is in circuit.

## 2.7 INITIAL ADJUSTMENT

Turn on the power switch and allow the tubes to warm up for a few minutes. With the radio-frequency terminals disconnected and no carrier input, throw the transfer switch to TUNE CARRIER and adjust the meter to zero by means of the knob on the case. Next, throw the switch to OPERATE and again set the meter to zero, using this time the screwdriver adjustment at the rear of the instrument. Make this adjustment with the dial set at CAL and the GAIN control at zero. When this adjustment has been made, the needle will remain at zero for either position of the switch.

## 2.8 CAUTION

It is important that no appreciable a-c hum from the assembly be picked up by the speech input equipment. This can be determined by listening to the output of the speech amplifier with phones and turning on and off the a-c supply to the transmission monitoring assembly. If the difference in level is large, the location of the assembly, or its orientation with respect to the speech input equipment, should be changed.

## 3.0 OPERATION

### 3.1 RADIO-FREQUENCY MEASUREMENTS

With the power on and the carrier connected to the radio-frequency terminals, throw switch to TUNE CARRIER and tune for an exact maximum reading of the meter. (See paragraph 2.62).

3.11 Throw the switch to OPERATE.

3.12 With the GAIN CONTROL set at zero, set the meter to zero by the knob on the meter. (This should not usually be necessary more frequently than once every hour or so). If the knob on the meter scale does not have sufficient range, adjust the control at the rear of the instrument. (See paragraph 2.7).

3.13 Set dial on CAL.

3.14 Modulate transmitter at desired level with the Type 733-A Oscillator or with the Type 608-A Oscillator set at 400 cycles; the level may be read on a Type 731-B Modulation Monitor.

3.15 Adjust GAIN for full scale on meter.

3.16 Harmonic distortion in percent can then be read directly on the meter in terms of the full scale value indicated by the dial position.

### 3.2 NOISE LEVEL MEASUREMENTS

These are made by removing the modulation from the transmitter and turning the dial to the NOISE LEVEL scale. For this measurement, dial reading and meter reading are added. The noise level is expressed in decibels below the modulation level at which the calibration adjustment is made (see paragraphs 3.14 and 3.15 above).



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## 3.3 AUDIO-FREQUENCY MEASUREMENTS

For measuring the distortion of an audio-frequency amplifier a filtered 400-cycle signal should be applied to the amplifier by the Type 733-A Oscillator or the Type 608-A Oscillator (set at 400 cycles) and the output level properly adjusted. The output should be connected to the audio-frequency input jacks, thereby automatically disconnecting the radio-frequency circuit.

3.31 The impedance at the AUDIO INPUT jacks is 500 to 600 ohms and is balanced to ground, as shown in Figure 1. The Type 732-B should not be used as a bridging device but as a dummy load. This is important because an amplifier which operates satisfactorily into a load of 500 ohms may not work properly into 250 ohms, the resultant impedance if bridged across the normal 500-ohm load.

3.32 The Type 732-B may be used as an unbalanced device (i.e. having one side grounded) of approximately 50,000 ohms impedance by using the envelope jacks for input and putting a wooden dummy plug in the left AUDIO INPUT jack.

3.33 In measuring audio-frequency distortion and noise the same procedure is used as at radio frequencies.

## 3.4 TELEPHONE LINE NOISE

For measuring telephone line noise terminate the line at the AUDIO INPUT jacks and apply a tone at the sending end for reference at the CAL. position. Remove tone and read directly residual noise in db below tone level. Noise as low as 65 db down from a 6-milliwatt reference can be accurately measured.

## 3.5 LINE-VOLTAGE VARIATIONS

Fluctuations in a-c power line supply will cause slight fluctuations of the indicating meters. This is normal and is not an indication of trouble.

## 3.6 CAUTION

When measuring audio-frequency noise or distortion do not use a tone reference level in excess of +26 decibels.

## 4.0 SUGGESTIONS FOR USE

### 4.1 TRANSMITTER PERFORMANCE TESTS

In making complete measurements on a transmitter, the recommended procedure is to measure, first, modulation; second, distortion; and finally, noise. In order to get a complete picture of transmitter performance, it is desirable to measure distortion at a number of modulation levels, including values below and above the normal operating levels, and to plot against percentage modulation on negative peaks. After readjustments have been made on the transmitter, new data can be referred to the plot for evidence of improvement. It is possible to make a complete run of this sort, through the range of audio-frequency input which the transmitter will handle, in less than 10 minutes. Type 731-B Modulation Monitor is recommended for measuring percentage modulation.

### 4.2 AMPLIFIER AND RADIO RECEIVER TESTS

Distortion and noise in amplifiers or receivers are measured as outlined in paragraph 3.2 above. In addition, the audio-frequency

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characteristics of amplifiers and receivers are readily determined with the Type 732-B Distortion and Noise Meter since this instrument can function as a sensitive, wide-range voltmeter-frequency calibrated in decibels with no frequency error over the entire audio-frequency range.

## 5.0 SERVICING

### 5.1 TUBES

The calibration of the Type 732-B Distortion and Noise Meter is independent of the tubes used, with one exception. The Type 37 Tube used in the Type 732-B Distortion and Noise Meter to some extent affects the meter scale. It will be found necessary to discard about one tube in ten for failure of the 10 scale to agree with the 30 scale, etc.

### 5.2 FUSES

The fuses used in the Type 732-B Distortion and Noise Meter are Type 7AG or Type 8AG, one ampere.

### 5.3 AUXILIARY CONNECTORS

Should the Type 732-B Distortion and Noise Meter operate on all but the distortion ranges, make sure that the two auxiliary connectors are firmly in place at the rear of the instrument; if the Type 732-P1 Range Extension Filters are used, the auxiliary connectors are replaced by two cables to the filters.

### 5.4 SWITCH CONTACTS

If trouble occurs at the switch contacts, clean the contacts with carbon tetrachloride, then apply a thin film of high quality vaseline.

### 5.5 SPARE PARTS

The following spare parts are shipped with the instrument:

- 2 - Pilot Lamps, 6-volt, Mazda No. 40, G. R. No. 139-330.
- 1 - Box, 5 fuses, one ampere, Type 7AG or Type 8AG.

## 6.0 VACUUM TUBE DATA

These data were measured in the Calibration Laboratory of the General Radio Company using a Model 772 Weston Analyzer for all d-c and a-c voltages and currents.

Since this analyzer has a 20,000-ohms-per-volt meter, the values in the table below are useful in servicing the instrument but do not in all cases indicate the true operating condition.

Values as given were obtained from a standard Type 732-B Distortion and Noise Meter that was being calibrated for stock. Where voltages and currents are obviously not critical, variations of as much as 20% from these data should be expected.

### OPERATING CONDITIONS

No carrier input. Line voltage 115 volts, 60 cycles.  
Switch on OPERATE, GAIN at minimum, and attenuator at CAL.



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## Voltages and Currents for Vacuum Tubes

Tube Type	Heater (ac)	Plate to Cathode	Screen to Cathode	Control Grid to Cathode	Plate Current
T1	1V	6.3 v			
T2	6C6 #1	6.3 v	20 v dc	45 v dc	0.55 ma
T3	6C6 #2	6.3 v	58 v dc	105 v dc	1.08 ma
T4	37	6.3 v	92 v dc		0.47 ma
T5	84	6.3 v	178 v dc		
			178 v dc		

### PARTS LIST

#### RESISTORS

R-1 = 25 $\Omega$	R-22 = 250 K $\Omega$
R-2 = 293.5 $\Omega$	R-23 = 2 M $\Omega$
R-3 = 293.5 $\Omega$	R-24 = 1 K $\Omega$
R-4 = 200 K $\Omega$	R-25 = 2 M $\Omega$
R-5 = 13 K $\Omega$	R-26 = 3 K $\Omega$
R-6 = 20 K $\Omega$	R-27 = 20 K $\Omega$
R-7 = 28.5 K $\Omega$	R-28 = 2 M $\Omega$
R-8 = 2 M $\Omega$	R-29 = 6 K $\Omega$
R-9 = 200 K $\Omega$	R-30 = 6 K $\Omega$
R-10 = 100 K $\Omega$	R-31 = 25 K $\Omega$
R-11 = 130 K $\Omega$	R-32 = 50 K $\Omega$
R-12 = 2 M $\Omega$	R-33 = 50 K $\Omega$
R-13 = 100 K $\Omega$	R-34 = 15.81 K $\Omega$
R-14 = 200 K $\Omega$	R-35 = 5 K $\Omega$
R-15 = 2 M $\Omega$	R-36 = 2,239 $\Omega$
R-16 = 500 K $\Omega$	R-37 = 73.1 $\Omega$
R-17 = 30 K $\Omega$	R-38 = 5 K $\Omega$
R-18 = 1 K $\Omega$	R-39 = 10 K $\Omega$
R-19 = 20 K $\Omega$	R-40 = 35 K $\Omega$
R-20 = 15 K $\Omega$	R-41 = 100 K $\Omega$
R-21 = 100 K $\Omega$	

#### CONDENSERS

C-1 = 139-1207  
 C-2 = 100  $\mu$ f  
 C-3 = 10  $\mu$ f  
 C-5 = 100  $\mu$ f  
 C-6 = 0.02  $\mu$ f  
 C-7 = 0.5  $\mu$ f  
 C-8 = 0.02  $\mu$ f  
 C-9 = 0.02  $\mu$ f  
 C-10 = 0.1  $\mu$ f  
 C-11 = 2  $\mu$ f  
 C-12 = 0.25  $\mu$ f  
 C-13 = 4.0  $\mu$ f  
 C-14 = 2.0  $\mu$ f  
 C-15 = 0.25  $\mu$ f  
 C-16 = 2.0  $\mu$ f  
 C-17 = 2.0  $\mu$ f  
 C-18 = 2.0  $\mu$ f  
 C-19 = 0.02  $\mu$ f  
 C-20 = 0.02  $\mu$ f  
 C-21 = 50  $\mu$ f

#### INDUCTORS

L-1 = 125 mh  
 L-2 = 125 mh  
 L-3 = 250 mh  
 L-4 = 2.5 mh  
 L-5 = 732-P5 or  
       732-P6

#### TUBES

V-1 = RCA 1V  
 V-2 = RCA 6C6  
 V-3 = RCA 6C6  
 V-4 = RCA 37  
 V-5 = RCA 84

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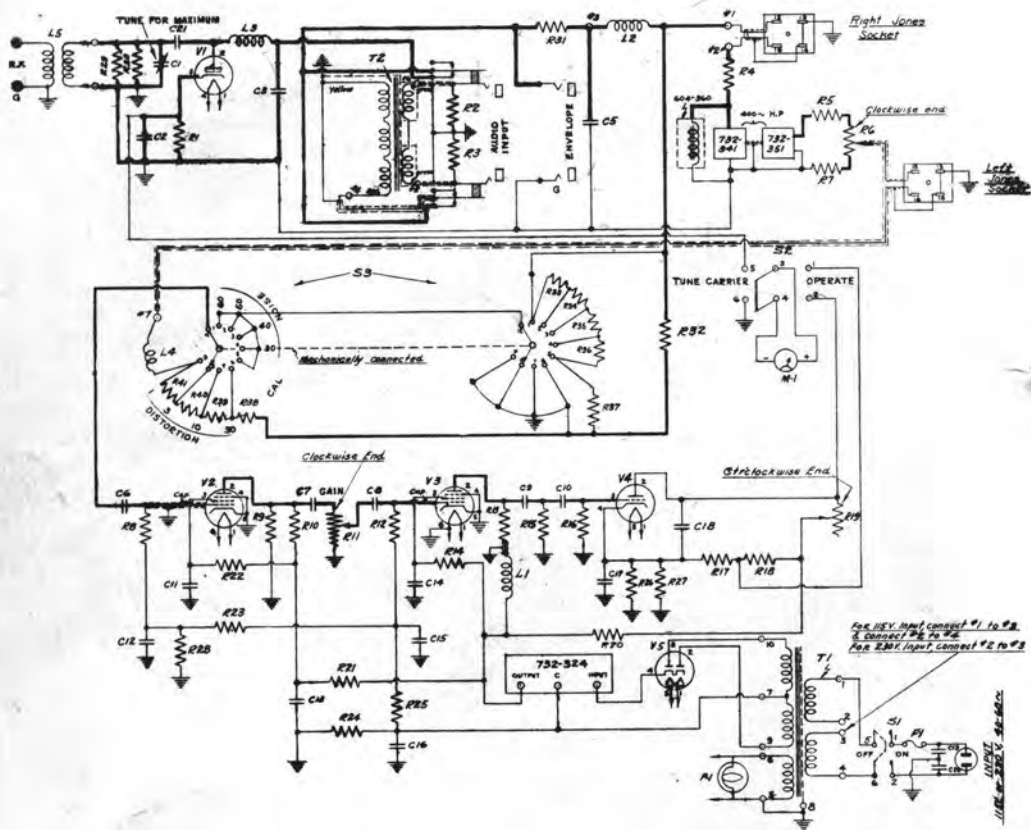


FIGURE 2. Circuit diagram of Type 732-B Distortion and Noise Meter

# OPERATING INSTRUCTIONS FOR TYPE 733-A OSCILLATOR

## 1.0 DESCRIPTION

This oscillator is a source of audio-frequency voltage of good waveform at a frequency of 400 cycles per second. It is intended for use in modulating the radio transmitter when 400-cycle distortion measurements are to be made with the Type 732-B Distortion and Noise Meter.

### 1.1 CIRCUIT

A complete circuit diagram is shown in Figure 1. The oscillator is of the Hartley type. A filter is used in the output to eliminate harmonic voltages. Output terminals for load impedances of 50, 500 and 5000 ohms are provided. Negligible distortion and mismatch occur when a 600-ohm load is connected to the 500-ohm tap.

### 1.2 OUTPUT

The output is available at jacks on the panel and at binding posts at rear.

### 1.3

A potentiometer is provided for controlling the output.

## 2.0 INSTALLATION AND OPERATION

### 2.1 INSTALL VACUUM TUBES

All tubes are supplied with the instrument.

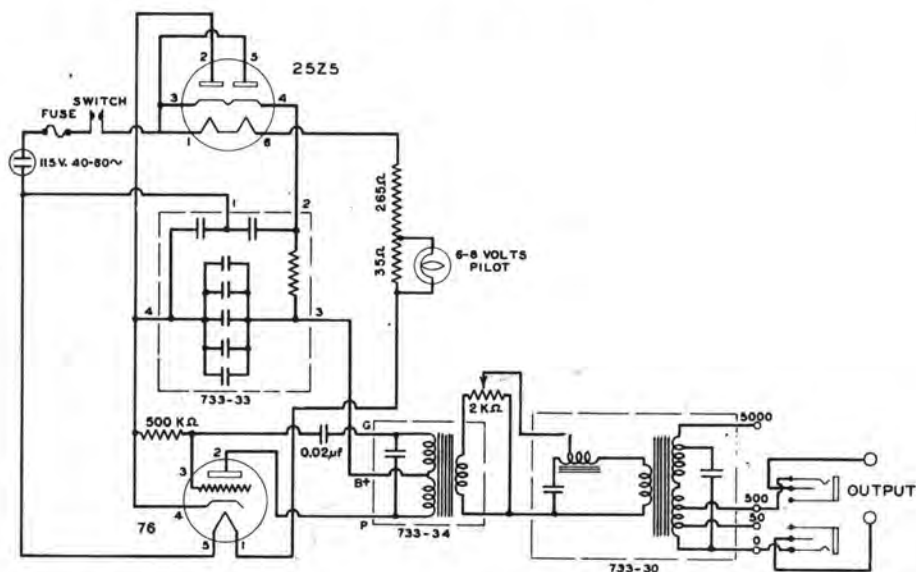


FIGURE 1. Complete circuit diagram of Type 733-A Oscillator



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### 2.2 POWER SUPPLY

Connect the oscillator to 115-volt, 40-to-60 cycle line by means of cord-and-plug combination supplied.

### 2.3

To operate the Type 733-A Oscillator it is only necessary to throw the power switch to the ON position.

### 2.4

The output of the oscillator should be plugged, as desired, into the speech input portion of the transmitter. The maximum level obtainable from the Type 733-A Oscillator is about +7.5 db above a 6-milliwatt reference, and an output control is provided. The output can therefore be applied to the speech amplifier at the point where lines from the studios normally terminate. The output transformer has a tapped secondary and the output impedance is selected by connecting the lead from the output jack to the terminal engraved with the desired impedance.

# OPERATING INSTRUCTIONS FOR TYPE 732-P1 RANGE EXTENSION FILTERS

## 1.0 DESCRIPTION

### 1.1 FUNCTION

The Type 732-P1 Range Extension Filters are designed specifically for use with the Type 732-B Distortion and Noise Meter to extend the audio frequency range over which distortion measurements can be made.

The instrument consists of five filters and a selector switch mounted behind a relay rack panel.

### 1.2 AUDIO-FREQUENCY RANGE

When these filters are used with a Type 732-B Distortion and Noise Meter, distortion can be measured at the following frequencies: 50, 100, 400, 1000, 5000, and 7500 cycles  $\pm 5\%$ .

### 1.3 ACCURACY

The over-all accuracy of measurement of each distortion range at 400 cycles is better than  $\pm 5\%$  of full scale  $\pm 0.1\%$  distortion. For this frequency, the Range Extension Filters panel merely supplies the necessary switching since the 400-cycle filter is in the Type 732-B Distortion and Noise Meter.

At the other audio frequencies (50, 100, 1000, 5000 and 7500 cycles), and at distortions greater than 0.5%, the error is less than  $\pm 10\%$  of the true value  $\pm 0.15\%$  distortion.

### 1.4 PRINCIPLE OF OPERATION

The block diagram of Figure 1 indicates how the Type 732-P1 Range Extension Filters operate in conjunction with the Type 732-B Distortion and Noise Meter.

With the selector switch of the Type 732-P1 Filters set at 400 cycles, the operation of the Type 732-B Distortion and Noise Meter is not affected in any way.

With the selector switch at any of the other frequencies, the distortion and noise meter will indicate the harmonic content of the selected fundamental. The transmitter must of course be modulated at this new frequency. It is suggested that a Type 608-A Oscillator be used for this purpose. Noise measurements can be made at any setting of the selector switch.

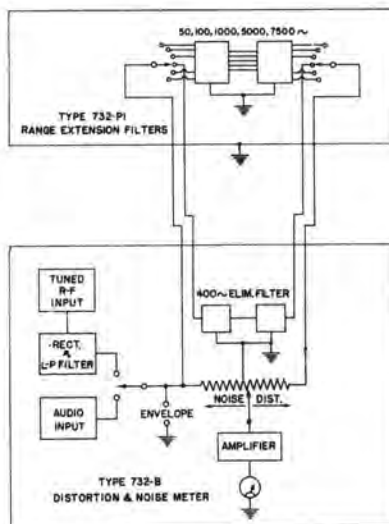


FIGURE 1. Diagram showing connections between Distortion Meter and Filter Panel

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## 2.0 INSTALLATION

### 2.1

The Type 732-P1 Range Extension Filters must be mounted directly below the Type 732-B Distortion and Noise Meter. The two instruments must be connected together by means of the two short cables provided for this purpose. The cables plug into the receptacle at the rear of the instruments.

### 2.2

There are no tubes, fuses, pilot lamps or other accessories and no adjustments of the Type 732-P1 Filters need be made.

### 2.3

Since the third harmonic of the highest modulating frequency is 22,500 cycles, it becomes very important to set carefully the TUNE FOR MAXIMUM control of the Type 732-B Meter to exact resonance. Otherwise, side-band clipping and phase distortion may introduce a serious error in the results. See paragraph 2.62 in the Operating Instructions for the Type 732-B Distortion and Noise Meter.

Side-band clipping varies directly with tuning capacitance. While side-band clipping will in any event be less than 0.5 db for modulating frequencies and their harmonics below 25 kc, it is advantageous to select the r-f coil position in the Type 732-B Distortion and Noise Meter for the lower frequency range when there is a choice due to overlap of frequency ranges, since the tuning capacitance will then be lower. For example, if the carrier frequency is 1 Mc, set the 732-P5 coil for the 0.5 - 1 Mc position.

## 3.0 OPERATION

### 3.1

The operation of the Type 732-B Distortion and Noise Meter is not affected. See Section 3.0 of the Operating Instructions for the Type 732-B Meter. In transmitter measurements and in audio-frequency amplifier measurements, the fundamental frequency must of course correspond to the filter frequency selected by the switch on the Type 732-P1 Range Extension Filters panel.

### 3.2

Since the Type 733-A Oscillator supplies 400 cycles only, the Type 608-A Oscillator is recommended as an adequate audio-frequency supply of low harmonic content.

## 4.0 SUGGESTIONS FOR USE

### 4.1

The extended frequency range for distortion measurements should prove useful in the adjustment of degenerative audio amplifiers where distortion is introduced at either end of the audio range.



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FIGURE 1. Type 732-B Distortion and Noise Meter



FIGURE 2. Type 732-P1 Range Extension Filters



FIGURE 3. Type 733-A Oscillator





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