SPECIFICATIONS FOR TYPE 1141-A AUDIO-FREQUENCY METER

Frequency Range: 20 to 20,000 cycles in three ranges, 20 to 200 cycles, 200 to 2000 cycles, and 2000 to 20,000 cycles.

Accuracy: ±0.5% over the entire frequency range. The null point is sharp enough so that the dial can be set to 0.1% provided the waveform is reasonably pure and the supply voltage or detector sensitivity is sufficiently high to provide the necessary over-all sensitivity.

Dial: The 6-inch dial, which has a slow-motion drive, turns through an angle of about 320° giving a scale length of about 17 inches for each 10 to 1 frequency range. The total scale length is thus over 4 feet.

Input Impedance: 3 to 10 kilohms, the smaller value corresponding to the higher frequencies.

Input Voltage: 110 volts rms, maximum.

Output Impedance: 1 to 4 kilohms, the smaller value corresponding to the higher frequencies.

Controls: Frequency dial, range selector switch, and resistance-balance control.

Accessories Required: A null detector is needed to operate the meter. Head telephones, such as the Western Electric 1002-C, or an amplifier-meter combination, such as the TYPE 1231-B Amplifier and Null Detector, can be used. Even with head telephones an amplifier and filter section will prove useful.

Mounting: The instrument is mounted on an aluminum panel in a shielded cabinet.

Dimensions: (Length) 12 x (width) 8¾ x (height) 9 inches over-all.

Net Weight: 15¼ pounds.

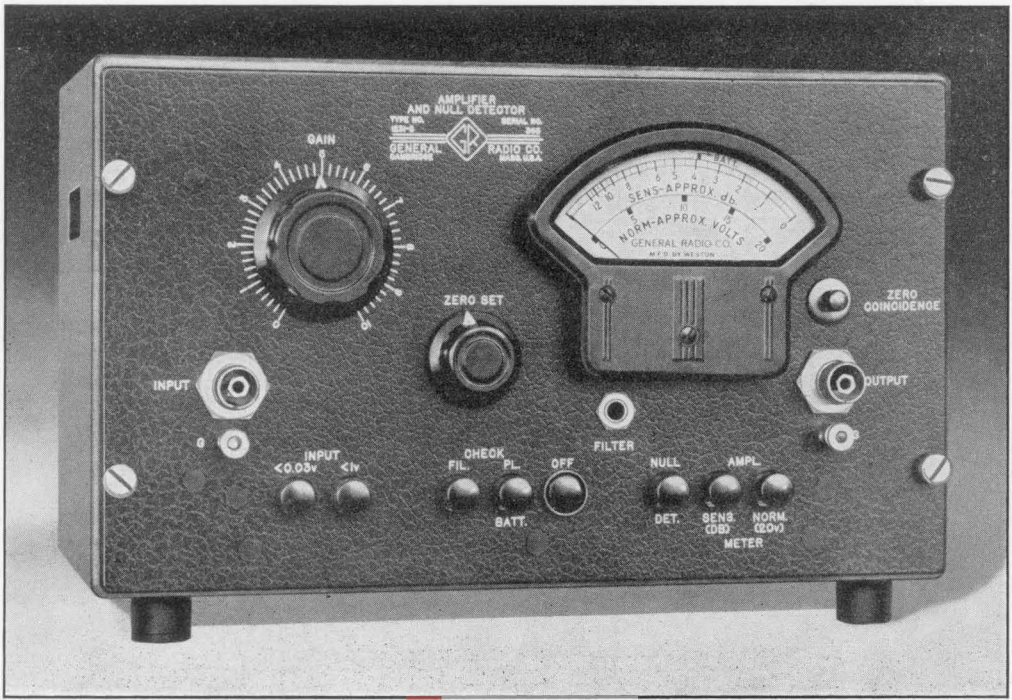
Type		*Code Word*	*Price*
1141-A	**Audio-Frequency Meter**	COLOR	**$215.00**

PATENT No. 1,983,447.

AN IMPROVED AMPLIFIER AND NULL DETECTOR

The TYPE 1231-B Amplifier and Null Detector is a battery-operated, resistance-coupled audio amplifier for use as a bridge detector, a standing-wave indicator, and a general-purpose laboratory amplifier. It has a built-in vacuum-tube voltmeter for measuring output voltage, and so for many applications no addi-

Figure 1. Panel view of the Type 1231-B Amplifier and Null Detector.



tional indicating device is needed. It can be operated either with the usual linear characteristic or with a semi-logarithmic characteristic to cover a wide range of voltage indication; during linear operation the voltmeter scale has two ranges, of 20 volts and about 2 volts respectively. A photograph of the instrument is shown in Figure 1.

The maximum open-circuit voltage gain is greater than 83 decibels at midband and has the frequency characteristic shown in Figure 2. Since the gain is greater than 70 decibels at 10 cycles and greater than 45 decibels at 100 kilocycles, the instrument is useful over this wide range for many bridge measurements. The input impedance is high, equivalent to 1 megohm in parallel with about 20 $\mu\mu$f, and the output impedance is about 50 kilohms resistive. Overloading of the last stage limits maximum output voltage to 20 volts for load impedances greater than 1 megohm and to 5 volts for a resistance load of 20 kilohms.

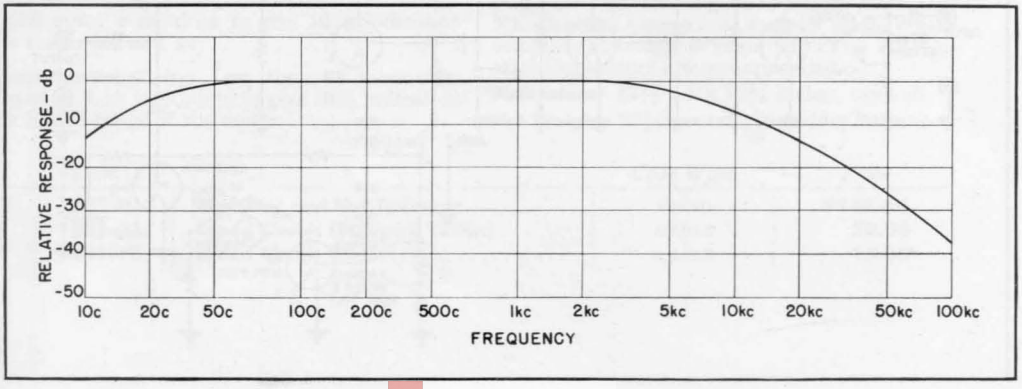
The simplified circuit diagram of Figure 3 shows that the amplifier has three stages and that the vacuum-tube voltmeter consists of a diode rectifier, a d-c amplifier, and the panel meter. A 30-decibel input attenuator selects a maximum input voltage rating of either 0.03 volt or 1 volt, and a tapered, wire-wound gain control allows continuous variation of gain over a wide range. During semi-logarithmic, null-detector operation, rectified d-c from the vacuum-tube voltmeter diode is applied as a gain-controlling bias to the last amplifier stage to produce the desired characteristic. An attenuator in the grid circuit of the d-c amplifier determines the scale range of the voltmeter, and a bridge-type plate circuit allows meter current to be zero with no signal at the instrument terminals.

The semi-logarithmic characteristic is intended primarily for null detector uses with bridges. Under this condition of operation less than 15 microvolts at the input terminals is required to produce a perceptible* movement of the meter needle at midband frequencies with the instrument set for maximum gain and no external filter. This input signal can then be increased by about 55 decibels before the meter reads full scale. Either the input attenuator or the gain control can be employed for higher input voltages. This sensitivity, combined with the wide range of voltage indication, means that the bridge balances can be made with precision and without gain adjustments in many instances.

In some situations, where the sensitivity of the null detector scale is not sufficient, the most sensitive range of the voltmeter can be used for a final

*"Perceptible" as used here means one-fifth of a one-sixteenth-inch division.

Figure 2. Frequency response characteristic of the amplifier.

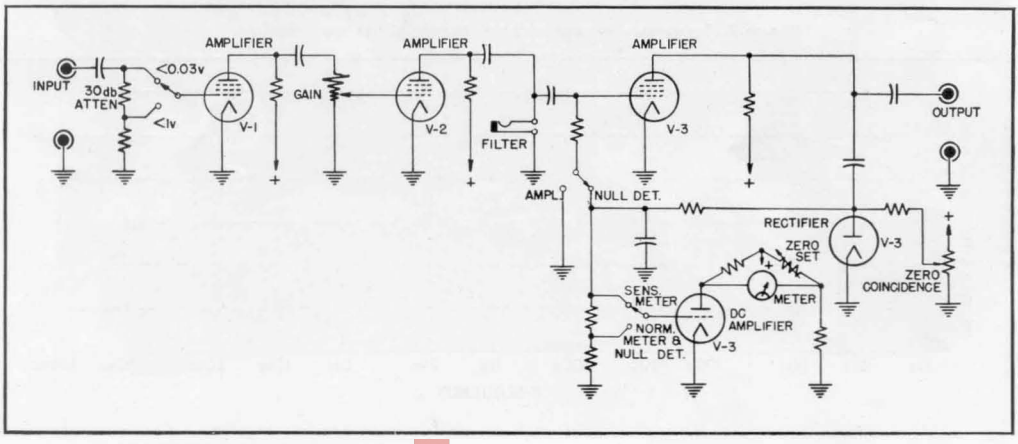


balance. The input signal required to produce a perceptible meter deflection is less than 5 microvolts for this range. For frequencies other than in the midband, sensitivity is less by the amounts shown in Figure 2. Head telephones can be used between 200 cycles and 10 kilocycles instead of the panel meter, according to individual preference, but there is no appreciable difference in sensitivity between the two methods.

One source of trouble in bridge measurements is the presence of unwanted voltages that obscure nulls. These voltages include random noise generated by the detector amplifier, power-frequency hum picked up by unshielded leads, and harmonics of the operating frequency that are produced either by non-linearity of the impedance being measured or by the generator itself. The noise level of the TYPE 1231-B is less than 15 microvolts referred to the input terminals, but this figure can, if necessary, effectively be reduced, along with hum and harmonics, by connection of an external filter through the panel jack provided. Filters thus connected are isolated by amplifier stages from the effects of varying input and output impedances and at the same time are at a high enough voltage level along the amplifying chain to be little affected by external fields. The TYPE 1231-P2 (400 and 1000 cycles) and TYPE 1231-P3 (60 cycles) Tuned Circuits are intended for use with the TYPE 1231-B. Any of these filters attenuates the second harmonic by about 20 decibels, and random noise by about 25 decibels; the TYPE 1231-P2 attenuates 60-cycle hum by about 35 decibels. The insertion loss of about 8 decibels caused by these filters is usually unimportant because of the high gain of the amplifier.

For measurements of impedance at ultra-high frequencies, a slotted, coaxial transmission line is often used with a traveling crystal detector to measure standing-wave ratios. If the u-h-f power source is pulsed, or otherwise amplitude modulated, at an audio-frequency rate, the rectified output of the crystal is an audio-frequency voltage. The TYPE 1231-B can be used to amplify and to indicate this voltage, and the sensitive range of the vacuum-tube voltmeter was incorporated into the instrument specifically for this application. The scale for this range has an approximate calibration in decibels. For more accurate measurements, a calibrated resistance attenuator can be inserted ahead of the TYPE 1231-B and the panel meter used only as a reference level indicator. Less than 100 microvolts is required at the amplifier input terminals to produce full-scale

Figure 3. Elementary schematic of the Type 1231-B Amplifier and Null Detector.



deflection on the sensitive meter range.

The TYPE 1231-B replaces the TYPE 1231-A and except for minor details is different only in the metering circuit. The use of a more sensitive, but still sturdy, 200 μa meter movement results in the high sensitivity of meter indication and makes the instrument suitable for standing-wave measurements, which is the application that initiated the redesign. However, the usefulness of the instrument as a bridge null detector has been greatly increased by the increased sensitivity, and an external indicating device is not needed.

The instrument is enclosed in a walnut cabinet, which also holds the battery. If desirable, the TYPE 1261-A Power Supply unit can be used to operate the TYPE 1231-B from 40 to 60-cycle lines and fits into the cabinet in place of the battery. Tubes are mounted on a shock-absorbing suspension to keep microphonic effects small. Push buttons are provided to operate the input attenuator, to set the condition of operation, and to select the meter-scale range. Other push buttons allow checking of the battery voltages on the panel meter. The input and output connections will take either General Radio TYPE 774-E Coaxial Connectors or the usual TYPE 274-M Plugs.

—W. R. THURSTON

SPECIFICATIONS

Input Impedance: 1 megohm in parallel with 20 micromicrofarads.

Maximum Gain: Greater than 83 db at 1 kc with 1 megohm load.

Meter Scales: NORM scale: This scale is the one normally used to monitor the amplifier output voltage. It is calibrated approximately in volts with an accuracy of reading of $\pm 5\%$ of full scale.

SENS scale: This scale is used for determining ratios of voltages successively applied to the input terminals, as in standing-wave measurements. It is calibrated approximately in decibels with an arbitrary zero. Thus a ratio expressed in decibels is obtained by subtracting one meter reading from another. Ratios so obtained are accurate within 30% of the correct value in decibels, provided at least one of the readings is above half scale on the meter.

No separate scale is provided for NULL DET operation, since actual readings are not needed.

Null Detector Sensitivity: Less than 100 microvolts input is required to give 10% indication on the meter at 1 kc.

Amplifier Sensitivity: Less than 25 microvolts input at 1 kc is required to give 10% indication on SENS range of the meter.

Output Impedance: Approximately 50,000 ohms.

Maximum Output Voltage: 5 volts into 20,000 ohms; 20 volts into 1 megohm.

Noise and Hum Level: The open circuit noise level is less than 0.5 volt at full gain. When the TYPE 1261-A Power Supply is used, the open circuit noise and hum level is less than 1 volt.

Frequency Response: See Figure 2.

Tubes: The instrument requires two type 1L4 and one type 1D8-GT tubes, which are supplied in the instrument.

Power Supply: Burgess 6TA60 (Signal Corps BA48) Battery Pack is supplied in place in the instrument. When a-c supply is desired, the TYPE 1261-A Power Supply can be used.

Battery Life: Between 200 and 250 hours at 8 hours per day.

Accessories Available: TYPE 1231-P2 (400 and 1000 cycles) and TYPE 1231-P3 (60 cycles) Tuned Circuits are available for providing selectivity (see below). For facilitating connections to the input and output, two TYPE 274-M Plugs are supplied. TYPE 274-NC or TYPE 274-NE Shielded Connectors may be used. Where complete shielding is required, TYPE 774 Coaxial Connectors are recommended.

Dimensions: 12¼ x 8 x 10¾ inches, over-all.

Net Weight: 23¾ pounds, including batteries.

Type		*Code Word*	*Price*
1231-B	**Amplifier and Null Detector**	VALID	**$195.00**
1231-P2	**Tuned Circuit (400 and 1000c)**	AMBLE	**20.00**
1231-P3	**Tuned Circuit (60c)**	AMPLE	**15.00**