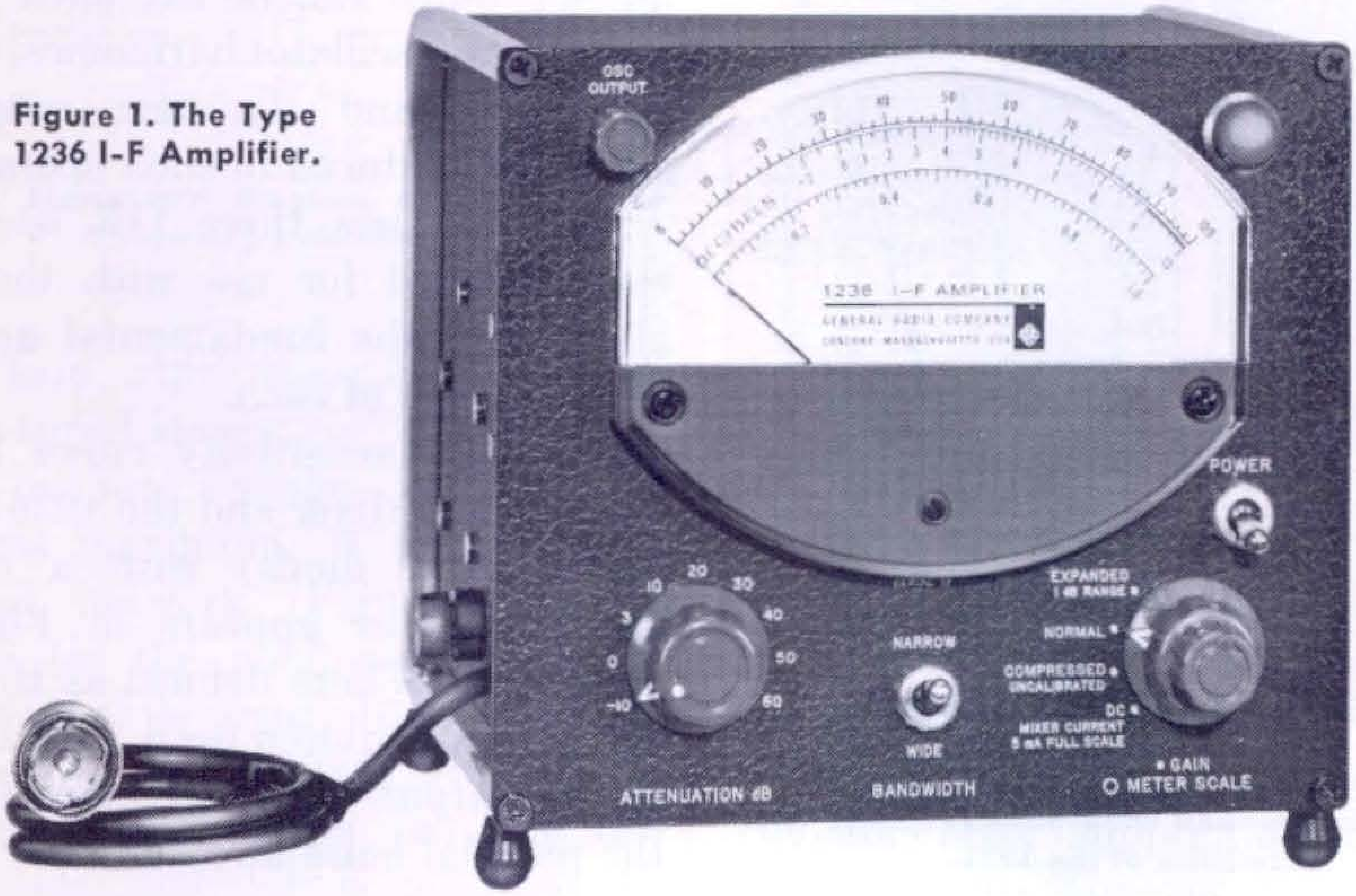
Figure 1. The Type 1236 I-F Amplifier.



A NEW 30-MHz AMPLIFIER WITH TWO BANDWITHS

The 30-MHz amplifier is a popular instrument that goes under a variety of names. It is an important element in a precision heterodyne receiver, and it is sometimes called, somewhat loosely, a receiver. Since it often serves, in combination with a local oscillator and mixer, as a detector for bridge measurements, it is also known as a null detector. No matter what its name, it is practically indispensable for a great many measurements.

The new GR 1236 is a low-noise, high-gain 30-MHz tuned amplifier with two switch-selected bandwidths, giving the user a choice of a "narrow" band of 0.5 MHz or a "wide" band of 4 MHz. One would typically use the narrow band for operation at lower frequencies, switching to the wide bandwidth at higher local-oscillator frequencies where frequency stability is often a problem. The narrow- and wide-band response characteristics are shown in Figure 2.

A six-inch taut-band meter with calibrated linear and decibel scales gives excellent resolution. The top 10 percent of the scale can be expanded to give a full-scale range of 1 dB with a resolution of 0.02 dB per small division. When the meter scale switch is set to COMPRESSED, the agc loop compresses the meter scale to about 50 dB. This feature is almost

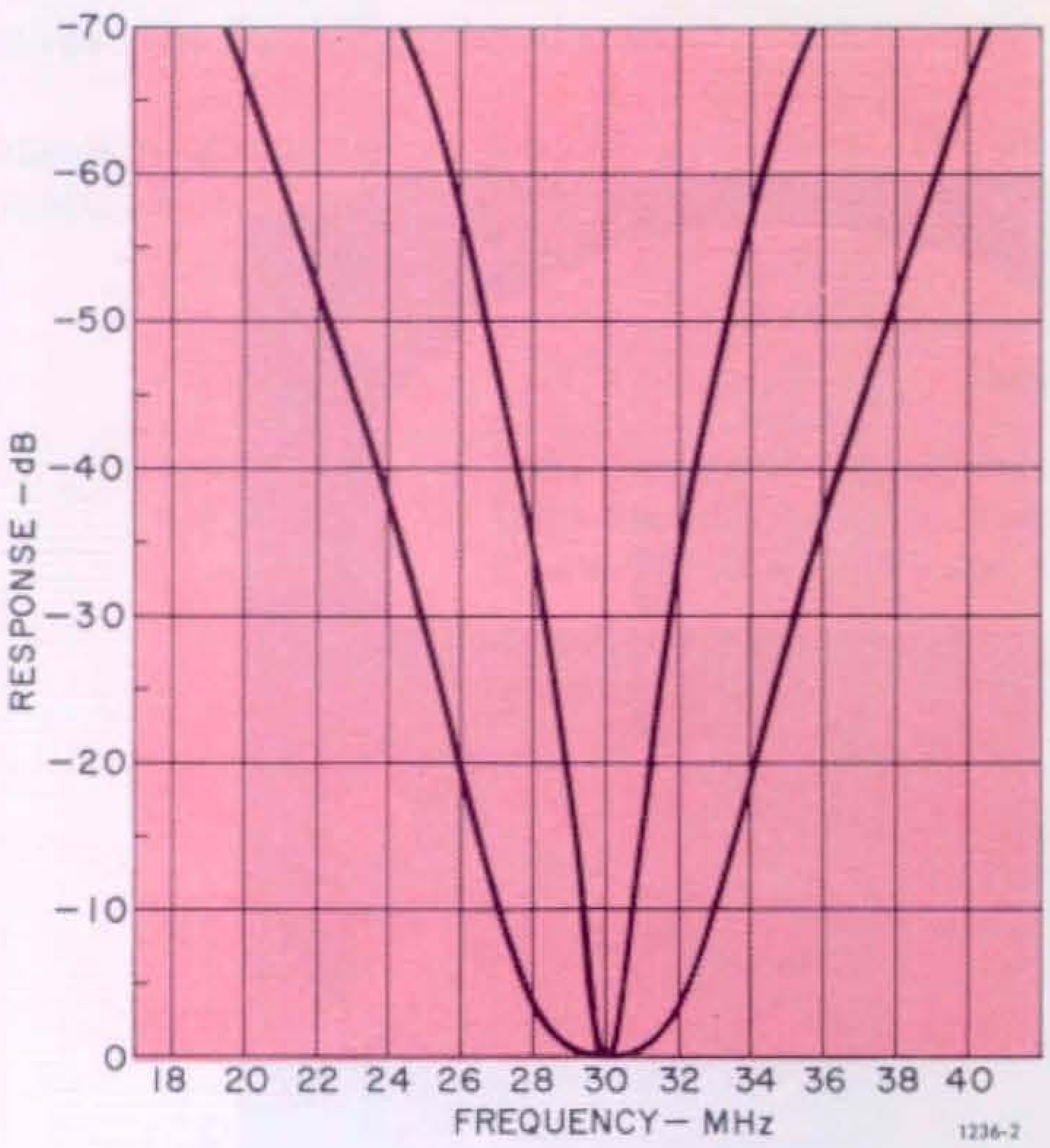


Figure 2. Narrow- and wide-band response characteristics of the 1236.

indispensable when the instrument is used as a null detector in a bridge measuring system.

The attenuator covers a range of 70 dB in 10-dB steps, with an accuracy of ± (0.1 dB + 0.1 dB/10 dB). The accumulated error will generally not exceed 0.3 dB. Because of the excellent repeatability of the attenuator, it is entirely practical to calibrate it against an external standard, thus reducing the attenuator error to that of the standard.

The 1236 combines easily with the new, highly sensitive Type 874-MRAL Mixer (see page 19) and one of the GR line of oscillators to form a wide-range measuring receiver. The 1236 includes a separate adjustable regulated power supply for the local oscillator.

With a given oscillator, the frequency range can be extended by use of the local-oscillator harmonics, though sensitivity and dynamic range are somewhat reduced in such operation.

Table 1 lists three GR oscillators recommended for use with the 1236, along with the fundamental and harmonic ranges of each.

A typical sensitivity curve for the 874-MRAL Mixer and the 1236 (in the narrow-band mode) with a suitable local oscillator appears in Figure 3. Sensitivity is here defined as the input signal level required for a 3-dB increase in the output of the i-f amplifier over the residual noise level.

Circuit

A low-noise preamplifier uses two Nuvistors in cascode in the input stage and a third Nuvistor in the output stage. The heater supply of the Nuvistors is regulated to achieve high gain stability vs line-voltage changes.

The preamplifier output is fed to a ladder-type step attenuator, which covers 70 dB in 10-dB steps. The output meter is used for interpolation between steps.

The postamplifier consists of one untuned and three tuned stages. The gain of the untuned stage is controlled by a front-panel control, with coarse and fine adjustments.

When the METER SCALE switch is in the COMPRESSED position, it activates

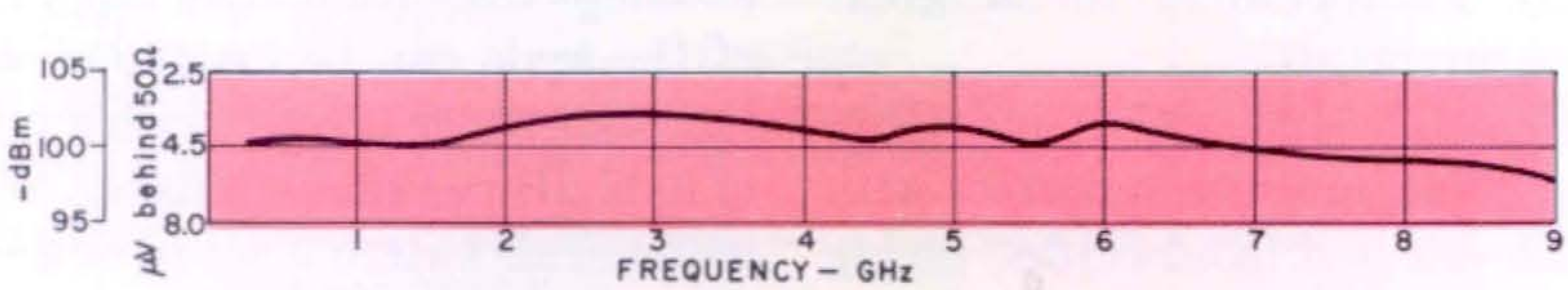


Figure 3. Typical sensitivity curve for receiver system comprising 1236, local oscillator, and Type 874-MRAL Mixer.

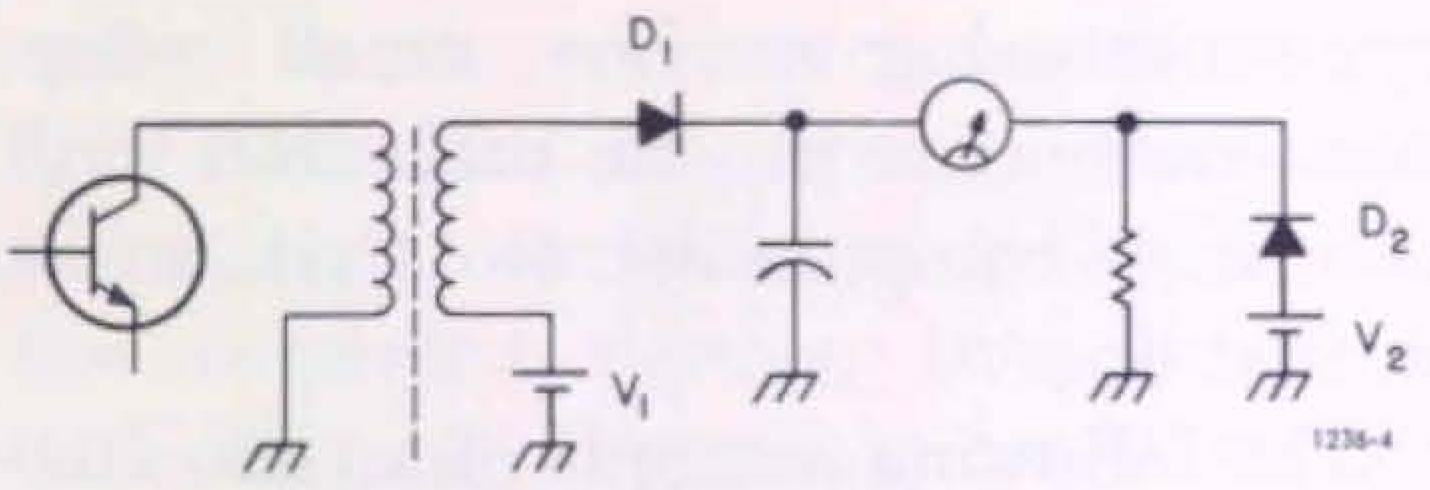


Figure 4. Elementary diagram of the detector linearizing network.

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the agc loop, which controls the gain of the two tuned stages.

The output voltage is about 2 volts rms maximum. A temperature-stabilized network (Figure 4) compensates for the nonlinear characteristics of the detector diode. In this network, *V1* is adjusted for a linear response in the upper part of the meter scale and *V2* is adjusted to optimize the lower part. Figure 5 shows the response with and without compensation.

The measured deviation from a linear response of a compensated detector circuit is plotted in Figure 6. A full-scale meter deflection corresponds to 2 volts rms rf voltage. Point *A* is the reference point, in this case 100% meter deflection, *B* and *C* are points of zero error; their positions are determined by *V1* and *V2*. The three points of zero error may be positioned for minimum error over either the whole range or part of the range.

The power supply consists of a Nuvistor plate supply, a supply for the transistors and for the Nuvistor heaters, and a local-oscillator plate and heater supply. All voltages except the local-oscillator heater supply are regulated.

Applications

The 1236 will be widely used with a local oscillator and mixer as a sensitive null detector for bridges, such as GR's 1602 UHF Admittance Meter and 1607 Transfer-Function and Immittance Bridge. Its excellent performance char-

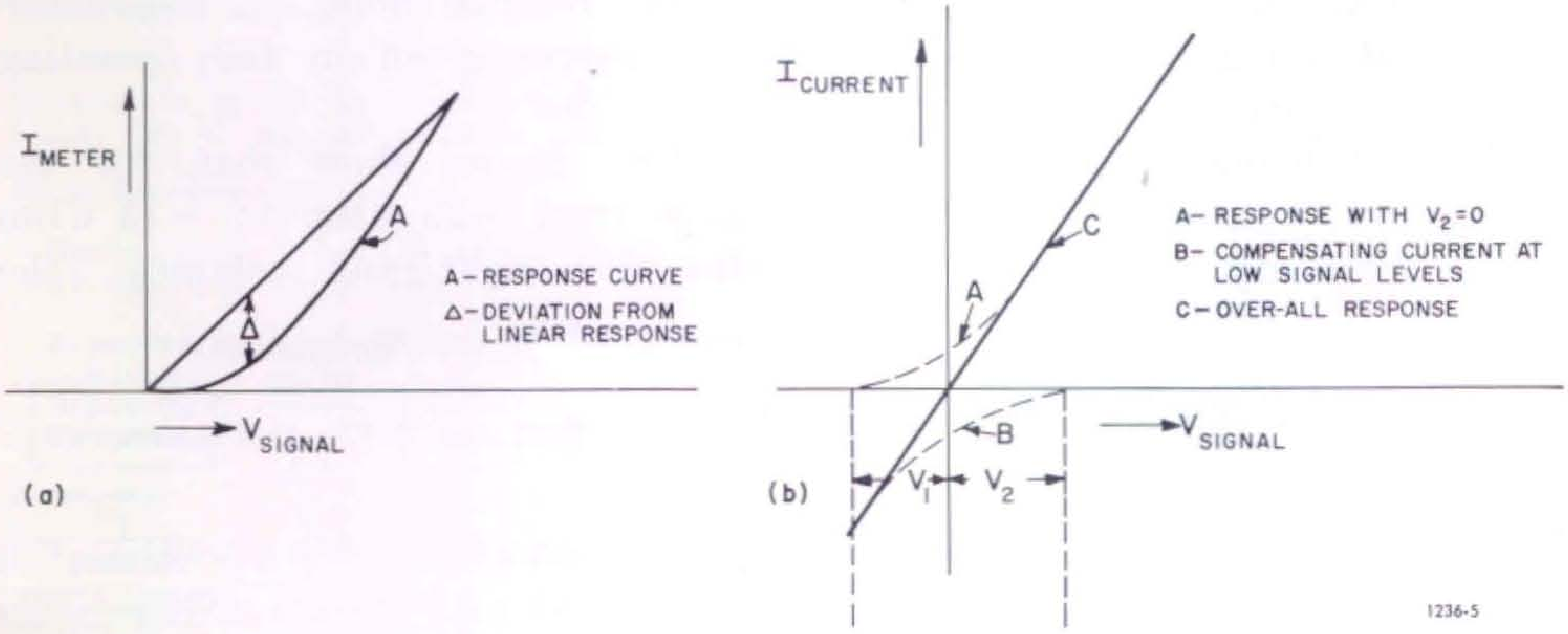

Figure 5. Uncompensated (*left*) and compensated (*right*) response of detector circuit.

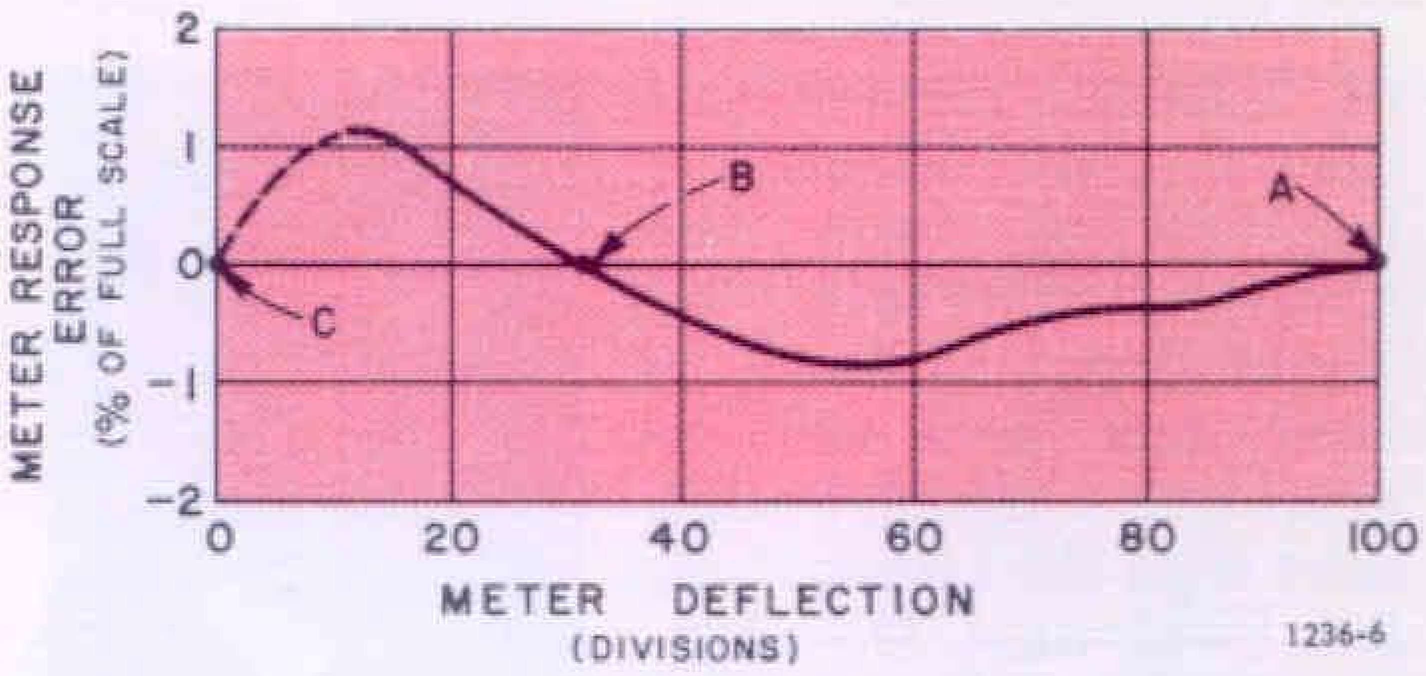

Figure 6. Measured deviation of compensated detector circuit from linear response.

acteristics suggest that it will also be a popular relative-signal-level meter in attenuation measurements, SWR measurements at low signal levels with slotted lines, reflection-coefficient measurements with hybrids or directional couplers, etc. SWR meters consisting of a tuned detector and a high-gain low-frequency amplifier often require a signal level that is too high for measurements on nonlinear devices. The heterodyne detector, with its much higher sensitivity, is the preferred SWR meter in such instances, and it is also recommended in general for precision measurements of both high and low SWR.

Measurements of small reflection coefficients with a directional coupler or a hybrid reflectometer are restricted by the directivity of the coupler or the balance of the hybrid and by the dynamic range and sensitivity of the detector. By the use of precision tuners and such terminations as those available in the GR900 line, the directivity or balance can be made almost perfect at any one frequency. Then, with a heterodyne-measuring receiver, small reflection coefficients can be measured with accuracy comparable to that of a slotted line.

The following example of an attenuation measurement using the i-f series substitution method indicates the accuracy and dynamic range attainable with this system.

The measurement setup is shown in Figure 7. The receiver consists of a 1236 I-F Amplifier, a 1208 Oscillator (40–530 MHz), and an 874-MRAL Mixer. The measuring frequency is 500 MHz.

The 1236 output reading (attenuator setting plus meter indication) is noted with and without the unknown attenuator in the circuit. The difference of the two readings is the measured attenuation. These measurements are repeated at different signal levels to determine the useful dynamic range of the system.

The results appear in Table 2. The top two rows give the 500-MHz signal level at the detector. The third row gives the attenuator values as measured, while in the fourth row the numbers are corrected for the 1236 attenuator errors. The numbers in the fifth row are corrected for the error caused by the residual noise, in accordance with curves given in the operating instructions.

These figures show that, for the range from −73 dBm to −13 dBm (the five right-hand columns), the

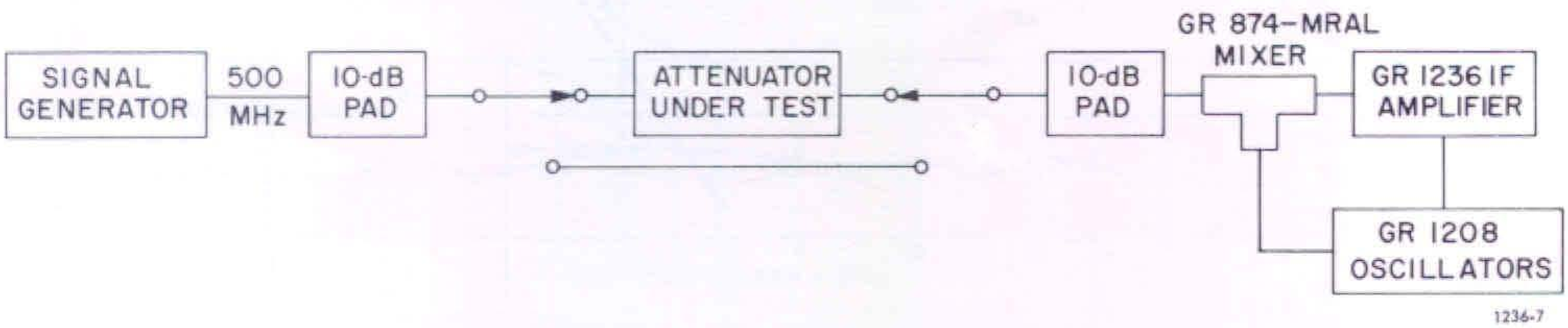

Figure 7. Setup for attenuation measurement described in text.

spread in the uncorrected attenuation figures is 0.19 dB, with a maximum deviation from mean of 0.11 dB. For the corrected figures, the spread is 0.04 dB and the maximum deviation from mean 0.02 dB. With the corrections for residual noise applied, the spread over the range from −83 to −13 dBm is again 0.04 dB, with a maximum deviation from the mean of 0.02 dB. Here the accuracy is perchance considerably better than that given in the specifications.

— M. KHAZAM

TABLE 1

Local Oscillator Type	*Frequency Range, MHz*			
	Fundamental	*2nd harmonic*	*3rd harmonic*	*4th harmonic*
1208-C	40-530	100-1030	165-1530	230-2030
1209-C	220-950	470-1870	720-2790	970-3710
1218-B	870-2030	1770-4030	2670-6030	3570-8030

TABLE 2

Min signal level at detector in dBm	−95	−83	−73	−63	−53	−43	−33
Max signal level at detector in dBm	−73	−63	−53	−43	−33	−23	−13
Measured attenuation in dB	17.2	19.05	19.73	19.69	19.61	19.75	19.80
Measured attenuation corrected for attenuator error in dB	17.4	19.25	19.78	19.76	19.76	19.80	19.79
Measured attenuation corrected for attenuator error and residual noise in dB	20.1	19.8	(noise not a factor)				

SPECIFICATIONS

Center Frequency: 30 MHz.

Bandwidth: Wide band, approx 4 MHz; narrow band, approx 0.5 MHz, selectable by panel switch.

Noise Figure: Typically 2 dB.

Sensitivity: From a 400-Ω source, for a 3-dB increase in meter deflection, < 9 μV (wide band) or < 3.5 μV (narrow band).

Meter Characteristics

Normal Scale: −2 to 10 dB. Linearity ±0.2 dB over 0 to 10-dB range.

Expanded Scale: 1-dB full scale. Linearity ±0.03 dB.

Compressed Scale: 40-dB min range.

Attenuator

Range: 0 to 70 dB in 10-dB steps.

Accuracy: ± (0.1 dB + 0.1 dB/10 dB) at 30 MHz.

Continuous Gain Control: 10-dB min range.

Video Output (Modulation): 1.5 V max; 1-MHz bandwidth.

I-F Output: 0.5 V max into 50 Ω.

Power-Supply Output: 150 to 300 V dc, adjustable, at 30 mA, regulated; 6.3 V ac at 1 A.

Power Required: 105 to 125, 195 to 235, or 210 to 250 V, 50 to 60 Hz, 22 W (without oscillator).

Accessories Supplied: Power cord, spare fuse.

Accessories Available: As local oscillator, GR 1208, 1209-C, 1209-CL, 1215, 1218, and 1361; 874-MRAL Mixer; GR874 low-pass filters, attenuators, adaptors, etc.

Mounting: Convertible-bench cabinet.

Dimensions (width x height x depth): 8 by 7⅜ by 8 in. (205 x 190 x 205 mm).

Weight: Net, 12½ lb (6 kg); **shipping,** 14¾ lb (7 kg).

Catalog Number	*Description*	*Price in USA*
1236-9701	**1236 I-F Amplifier**	**$675.00**