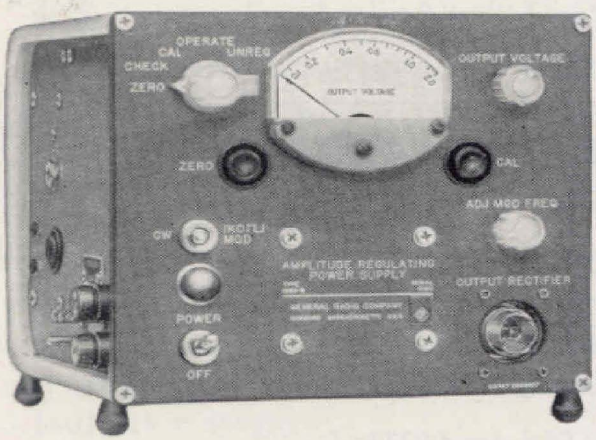
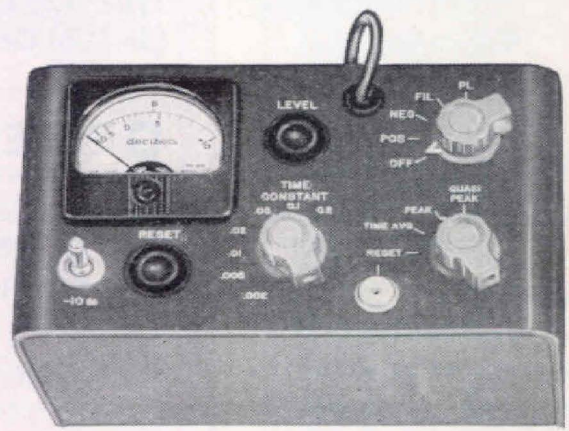
THE GENERAL RADIO

EXPERIMENTER

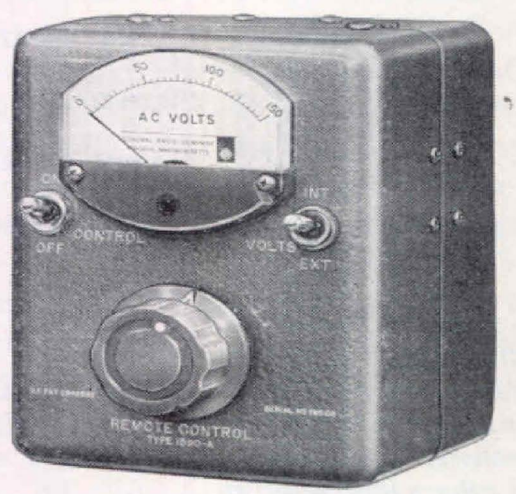
Type 1263–B
Amplitude-Regulating Power Supply



Type 1556–B
Impact Noise Analyzer



Type 1432–X
Decade Resistor



Type 1590–A Remote Control

VOLUME 35 No. 9 SEPTEMBER, 1961

THE GENERAL RADIO

EXPERIMENTER

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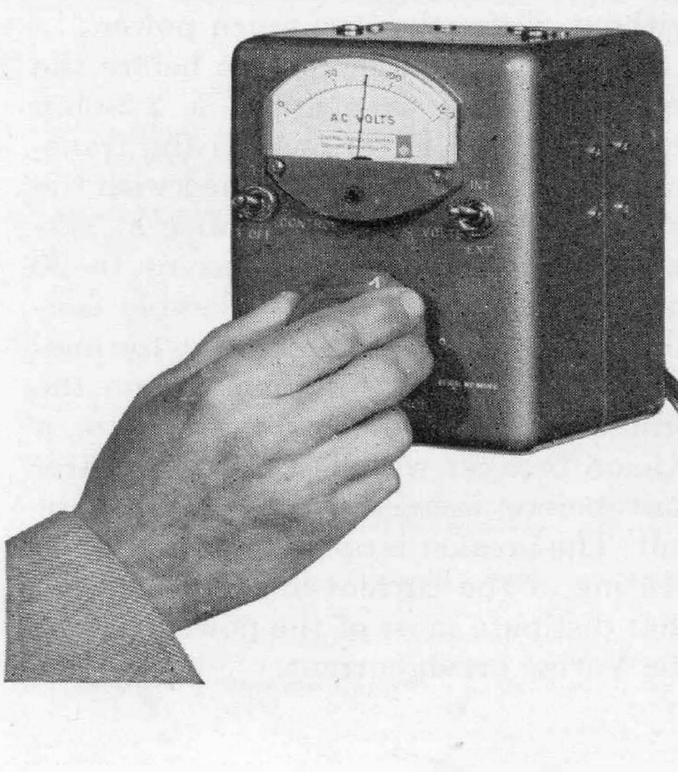
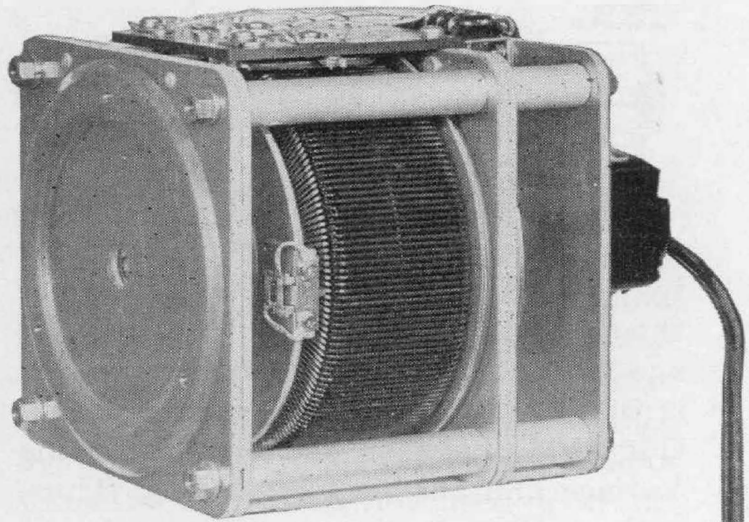
A REMOTE CONTROL FOR VARIAC® AUTOTRANSFORMERS

Motor-driven Variac® autotransformers are often positioned from a push-button control. The push buttons operate a two-phase motor to change the Variac setting and a voltmeter is used to indicate the output voltage. While this system provides the utmost in simplicity and reliability, the meter ballistics and the reaction time of the operator require that the motor drive be slow. Otherwise, considerable difficulty is experienced in adjusting to the desired output voltage.

A new device, the TYPE 1590-A Remote Control (shown in Figure 1), eliminates the requirement for slow-speed

Figure 1. The Remote Control makes possible precise voltage settings on voltage transformers from a remote point.





operation. The complete system is a simple, closed-loop servomechanism, as shown in Figure 2. This system automatically compensates for load regulation and if a low power regulated line is available to operate the remote control line-voltage fluctuations can also be corrected. By suitable switching many circuits can be sequentially adjusted from a single control. The system maintains the basic simplicity and reliability of the push-button control while offering the possibility of higher speed operation and greater flexibility. The correction rate depends upon the size of the driven Variac autotransformer and can be as high as 60 volts per second for small units.

The control Variac can be set to any desired voltage. If the remote Variac is not at the same voltage, the difference voltage will appear across the two-phase motor winding and cause the motor to rotate. The phase of this error voltage, and therefore the direction of rotation of the two-phase motor, depends upon whether the remote Variac output voltage is greater or less than that of the control Variac.

Since 10 volts or more is required to overcome friction and start the motor,

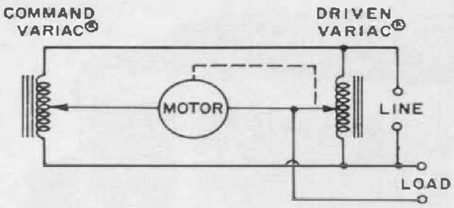


Figure 2. Elementary schematic of the servo system.

the remote Variac setting might differ by as much as ± 10 volts from that of the control Variac if the difference voltage were used directly. To decrease this error, a step-up transformer is used (Figure 3) between the brushes of the Variacs and the motor winding. Thus, with a 10-to-1 step-up ratio, a 1-volt error can cause the motor to operate.

While the use of a 10-to-1 step-up transformer decreases the required voltage difference between the Variacs by 10-to-1, it also creates the possibility of applying ten times the full line voltage or 1200 volts across the motor winding if the Variacs are momentarily set at opposite ends. For example, this high voltage could occur if the Variacs were set at opposite positions before power was applied or if the control unit is set very rapidly from zero to full output. To avoid this temporary high voltage the transformer is designed to saturate at 13 volts on the primary, limiting the motor voltage to about 130 volts.

The magnetizing current in the transformer increases rapidly as the core approaches saturation and means for limiting this current must be provided. A series resistor is not suitable since a

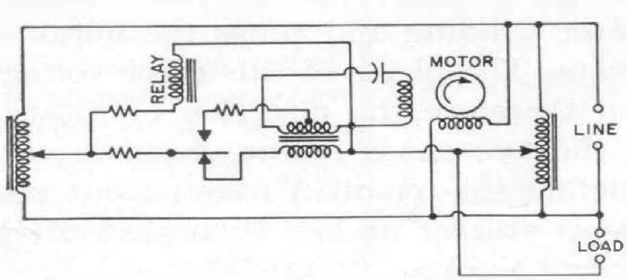


Figure 3. Schematic diagram showing the step-up transformer and protective relay.

value large enough to protect the Variac also contributes significant voltage drop and phase shift in the applied motor voltage, and therefore decreases the motor torque and increases the minimum error voltage to several volts. The use of a nonlinear resistor can provide adequate protection for momentary large error voltage and still contribute negligible voltage drop and phase shift as balance is approached. This technique has been used successfully in high-speed control units.

Since the Remote Control Unit must be a general-purpose device suitable for both slow- and high-speed applications, the peak power of 200 watts may have to be dissipated for considerable time, and, hence, the use of any resistive current-limiting device is not attractive. For this reason a protective relay is used to limit current. Whenever the error voltage is large enough to result in a transformer current greater than 2 amperes, the relay switches to a transformer primary winding with more turns. This maintains the motor voltage at a safe value and limits the transformer current without dissipating too much power.

To limit the surge current before the relay has time to operate, a 2 2-ohm resistor is used in series with the transformer. This resistor, combined with the transformer winding impedance at saturation, limits the surge current to 20 amperes under the worst possible condition. This surge current flows for one-half cycle only. If for some reason the protective relay should fail to operate, a Klixon breaker will shut off the control unit before excessive temperatures result. The breaker is operated both by the heating of the current-limiting resistors that dissipate most of the power and by the Variac brush current.

Voltage Correction

The voltage fluctuations arising from load changes are automatically compensated, since at balance there can be no appreciable difference of voltage between the control and driven Variacs. If a regulated line is available to supply the small amount of power needed to operate the command Variac, corrections can also be automatically obtained for fluctuations in line voltage at the remote autotransformer. The regulated line must have low impedance at 60 cps and must have the same phase angle as the unregulated line to the remote unit. Such a combination can provide large amounts of power at a regulated voltage which is adjustable from zero to 140 volts. The addition of a buck-boost transformer, to limit the correction range to ±10% about the normal line voltage, will result in an increase of 5:1 in the power rating.

— M. C. Holtje

— C. A. Tashjian

Ordering

To order the proper motor-driven Variac autotransformer, use the same type-numbering system as for our standard motor-driven units. The motor capacitor and microswitches, specified by C and K in the type numbers for standard units, are not used with the Type 1590-A, except on 64-second models. For all others these letters should be omitted from the type numbers. Thus, for 2% positioning accuracy with a Type W10G2 Variac autotransformer, order Type W10G2D8.

SPECIFICATIONS

Tracking Accuracy: ±2% of input line voltage, when used with motor speed listed in the table.

Power: 105 to 125 volts, 50 to 60 cps.

Accessories Required: Standard motor-driven Variac autotransformer less capacitor and microswitches.

Connections: Knockouts and a terminal strip are provided in the case for the four leads necessary to connect the control unit to the remote Variac autotransformer.

Dimensions: Width 4⅞, height 6⅝, depth 5⅞ inches (124 by 169 by 149 mm) over-all.

Net Weight: 6½ pounds (3 kg).

TRAVERSE TIME AND CORRECTION RATE FOR 2% POSITIONING ERROR:

DRIVEN VARIAC AUTO-TRANSFORMER MODEL	SINGLE UNIT		TWO-GANG (G2)		THREE-GANG (G3)	
	Traverse Time* (Seconds)	Approximate Correction Rate (Volts/sec)	Traverse Time* (Seconds)	Approximate Correction Rate (Volts/sec)	Traverse Time* (Seconds)	Approximate Correction Rate (Volts/sec)
W2	2	60	2	60	4	30
W5	2	60	4	30	8	15
W10	4	30	8	15	16	8
W20	8	15	16	8	32	4
W30	16	8	32	4	32†	4
W50	32	4	64‡	2	64†‡	2

*If half the positioning error is desired, the traverse time can be doubled, giving half the correction rate. Traverse time greater than 64 seconds should not be used.

†3% positioning error.

‡Exception: microswitches necessary on 64-second models.

Type		*Code Word*	*Price*
1590-A	**Remote Control**	REMCO	**$95.00**

THE IMPACT NOISE ANALYZER

Measures Both Electrical and Acoustical Noise Peaks

Figure 1. The Type 1556-B Impact Noise Analyzer with the Type 1551-C Sound-Level Meter.

The revolution in business communication, brought about by the transmission of data over private wire circuits to and from computers and other business machines, has made necessary new methods of evaluating telephone-line noise to permit better rating of a line for its adequacy in this application. The noise on a line can introduce errors in the data transmitted. Since the transmitted signal is usually a series of pulses, a simple measurement of the rms value of the noise is not adequate. The measurement of noise peaks is a better approach, and the Type 1556-A Impact Noise Analyzer[1] has been extensively used for this purpose. In such tests many readings are taken, and the operations required can become tiresome. In order to make the instrument more convenient for this use, as well as for the measurement of acoustic impact noise, a new model, the Type 1556-B, shown in Figure 1, is now available.

[1]Arnold Peterson, "The Measurement of Impact Noise," *General Radio Experimenter*, 30, 9, February, 1956.

The new model has all the features of the earlier one. For instance it can measure the peak value of an impact or electrical pulse and store this value so that an indicating meter can be used to show this peak, even for a single pulse that has a duration of only tens of microseconds. Ordinarily, the stored signal must be erased before another pulse is measured, and one can do this by setting the rotary switch in a "Reset" position. This resetting, however, must be done many times in a short period when noise on data transmission lines is measured, and a more convenient means is desirable.

In the new model, at the suggestion of the Bell Telephone Laboratories, an auxiliary button that can be pressed to reset the circuits more easily and quickly has been added. This button can also be operated by a camera cable release. Since one length and type of cable release is unlikely to satisfy most customers and since cable releases are readily available, they are not furnished with the instrument.

Field experience with the analyzer in the measurement of acoustic noise has also indicated the desirability of this change. Although the original problem that led to the development of the impact noise analyzer was that of measuring the high-level sound from impacts in heavy machinery, the instrument has been widely applied to the measurement of relatively quiet impacts. Here, the impact noise from the detenting action while switching out of the "RESET" position could interfere with the desired measurements. In the new model it is possible to reset and release more quietly.

— ARNOLD PETERSON

SPECIFICATIONS

Input: Any voltage from 1 to 10 volts for normal range. Inputs below 1 volt reduce the range of reading.

Input Impedance: Between 25,000 and 100,000 ohms, depending on the setting of the LEVEL control.

Frequency Range: 5 cps to 20 kc.

Level Indication: Meter calibrated in db from −10 to +10. Attenuator switch increases range by 10 db.

Peak Reading: Rise time is less than 50 microseconds for a value within 1 db of peak value (for rectangular pulses). Storage time at normal room temperature is greater than 10 seconds for a 1-db change in value.

Quasi-Peak Reading: Rise time of less than 1/4 millisecond and decay time of 600 ±120 milliseconds for rectifier circuit.

Time-Average Reading: Charge time of rectifier circuit selected by seven-position switch, having times of .002, .005, .01, .02, .05, 0.1, and 0.2 second for the resistance-capacitance time constant. Storage time at normal room temperature is greater than 1 minute for a 1-db change in value.

Accessories Required: A sound-level meter or frequency analyzer to supply the analyzer input if it is to be used for acoustic measurements.

Input Terminals: Cord with phone plug at one end.

Batteries: One 1½-volt size D flashlight cell (Rayovac 2LP or equivalent) and one 45-volt B battery (Burgess XX30 or equivalent) are supplied. Typical battery life is 100 hours.

Transistors: Two 2N1372 and one 2N1374.

Tube Complement: One TYPE CK6418.

Cabinet: Aluminum; carrying case supplied. Case fastens directly to one end of TYPE 1551 Sound-Level Meter.

Dimensions: Height 4¼, width 7½, depth 6½ inches (110 by 195 by 165 mm).

Net Weight: 4½ lb (2.1 kg); carrying case, 1 lb (0.5 kg).

Type		*Code Word*	*Price*
1556-B	**Impact Noise Analyzer**	MEDAL	**$220.00**

TYPE 1263-B AMPLITUDE-REGULATING POWER SUPPLY

For most measurements it is desirable that the generator output amplitude be constant with frequency. The TYPE 1263-A Amplitude-Regulating Power Supply[1] has provided a convenient means of accomplishing this with General Radio Unit Oscillators and has been particularly useful in conjunction with the TYPE 1750-A Sweep Drive for sweep-frequency measurement techniques.

A new model is now available, TYPE 1263-B, which has similar characteristics to its predecessor. It can be used with the Sweep Drive as well in circuits where the oscillator frequency is changed manually or by means of the TYPE 907-R and 908-R Dial Drives.

A feature of the new model is provision

[1]W. F. Byers, "The Type 1263-A Amplitude-Regulating Power Supply," *General Radio Experimenter*, 29, 11, April, 1955.

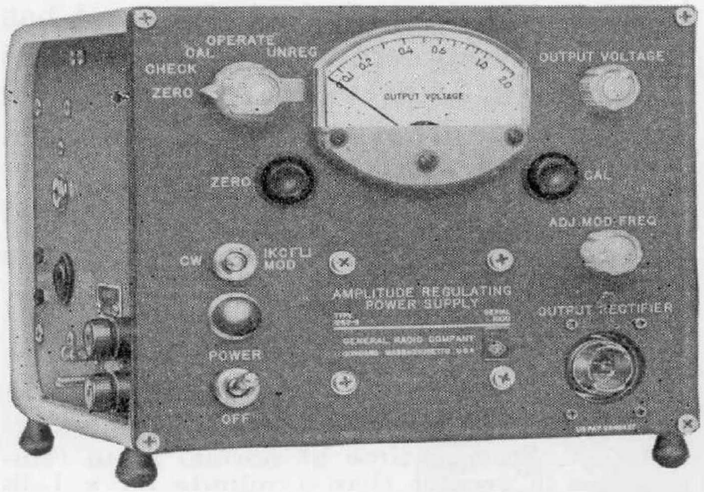


Figure 1. Panel view of the Type 1263-B Amplitude-Regulating Power Supply.

for square-wave modulation of the oscillator at 1,000 cps. This feature is particularly useful in frequency-response measurements because it permits the use of a tuned audio amplifier following the detector, thus achieving high sensitivity with simple equipment. The TYPE 1232-A Tuned Amplifier and Null Detector[2] is an excellent amplifier for this purpose. The square-wave modulation feature provides modulation free from incidental fm, a necessary condition for frequency-sensitive measurements.

The housing has been changed to the rack-bench type,[3] compatible with the TYPE 1361-A UHF Oscillator.[4] The two units can be attached to each other to form a rigid assembly.

Circuit

Figure 2 is a schematic of the power supply. With the controlled oscillator unmodulated, the dc potential developed by the oscillator output rectifier is compared with a dc reference potential, and the difference is brought to a minimum by a change in the oscillator plate voltage. When the oscillator is modulated by the internal 1-kc square-wave source, the average carrier level is controlled, which corresponds to one-half the maximum amplitude. Maximum oscillator output that can be controlled is 2 volts unmodulated and 1 volt modulated, corresponding to 2 volts at modulation peaks.

[2]A. E. Sanderson, "A Tuned Amplifier and Null Detector," *General Radio Experimenter*, 35, 7, July, 1961.

[3]H. C. Littlejohn, "The Case of the Well-Designed Instrument," *General Radio Experimenter*, 34, 3, March, 1960.

[4]G. P. McCouch, "A New UHF Signal Source," *General Radio Experimenter*, 35, 3, March, 1961.

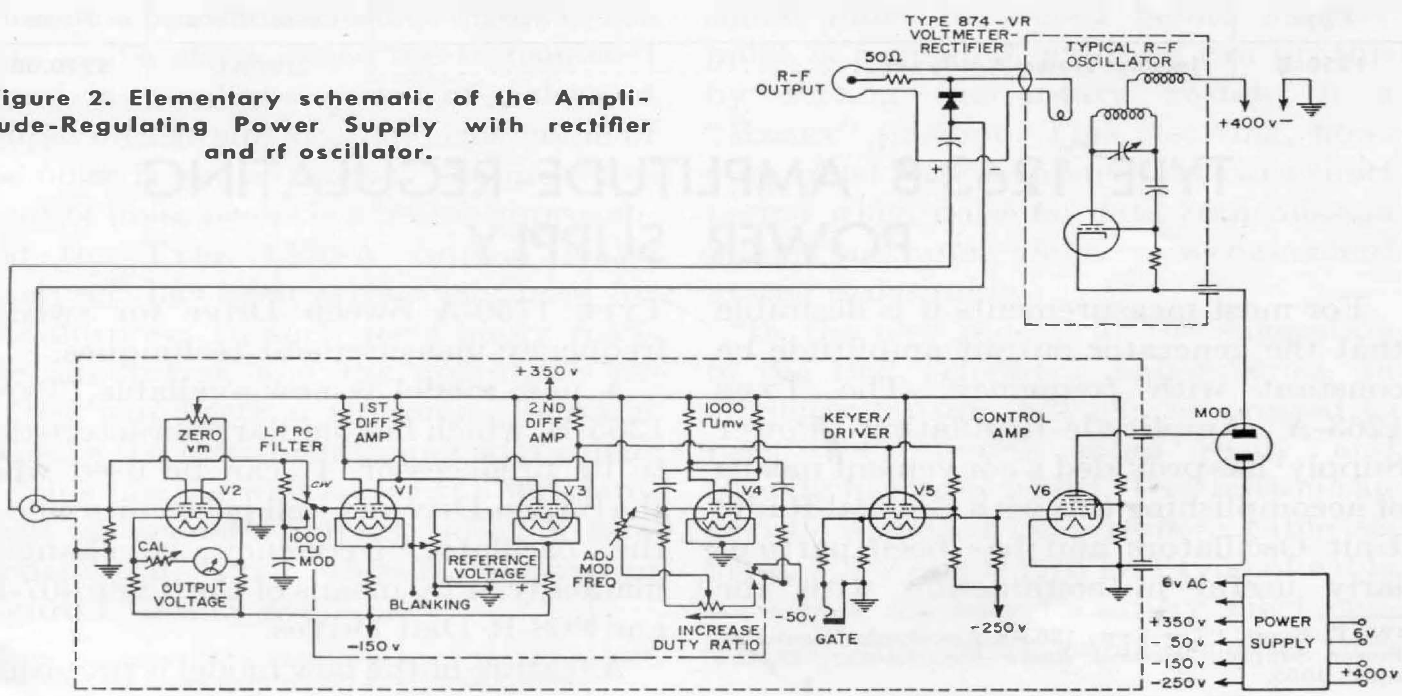


Figure 2. Elementary schematic of the Amplitude-Regulating Power Supply with rectifier and rf oscillator.

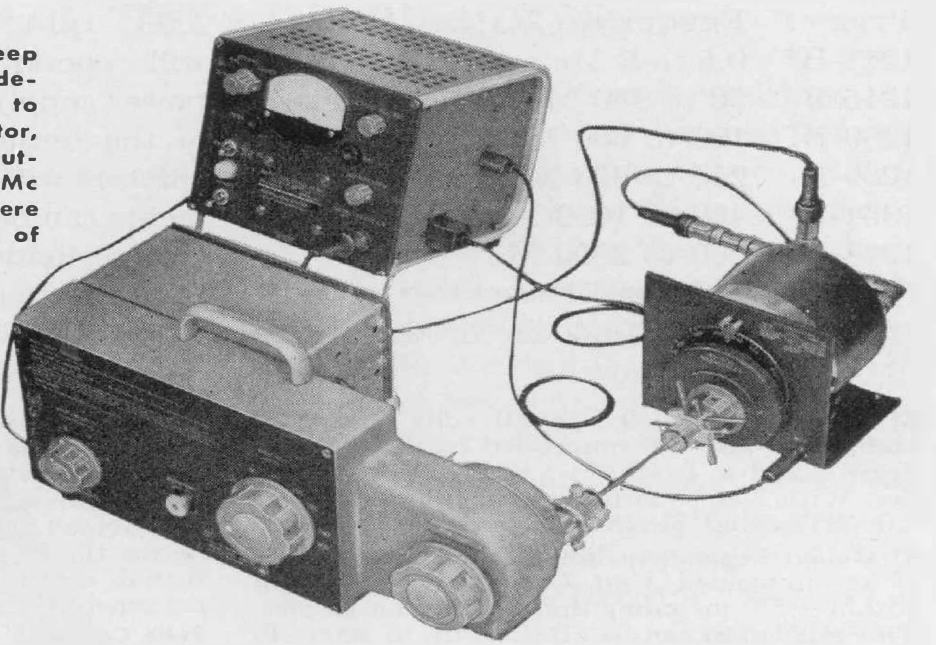


Figure 3. The Type 1750-A Sweep Drive and the Type 1263-B Amplitude-Regulating Power Supply set up to sweep a Type 1208-B Unit Oscillator, thus providing a constant sweep output over a frequency span of 250 Mc to 920 Mc. The equipment shown here is listed below, with the exception of the oscillator and sweep drive.

Since users may prefer to provide their own rectifier for the oscillator output, this is not supplied. The TYPE 874-VR Rectifier is recommended, however, and plugs directly into the coaxial output connectors of General Radio oscillators and is readily connected to the connector on the panel by a TYPE 874-R22 Patch Cord. The panel meter indicates the oscillator output voltage and, when a TYPE 874-VR Voltmeter Rectifier is used, indicates the equivalent zero-impedance generator voltage in series with 50 ohms.

Applications

For automatic sweep operation of the oscillator, as, for instance, in the display of amplitude-frequency characteristics on an oscilloscope, the TYPE 1750-A Sweep Drive is recommended. The complete assembly is shown in Figure 3. For this application, a blanking contact is provided in the sweep drive.

For slower-speed plotting, as with an X-Y plotter, TYPE 907-R and 908-R Dial Drives can be used. Figure 4 is a block diagram of a typical assembly.

Oscillator

The TYPE 1263-B Amplitude-Regulating Power Supply can be used with the following General Radio Oscillators:

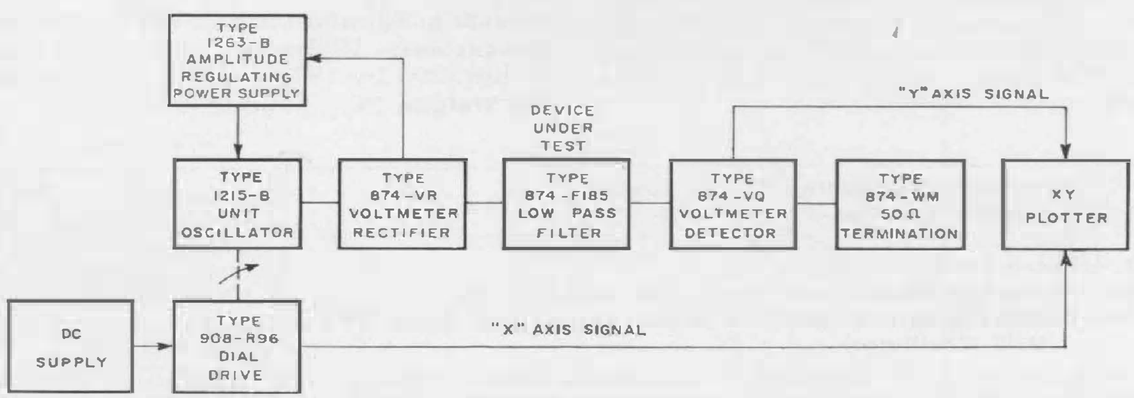


Figure 4. A typical setup for plotting frequency characteristics.

Type	Frequency Range
1211-B*	0.5 to 5 Mc and 5 to 50 Mc
1215-B	50 to 250 Mc
1209-BL	180 to 600 Mc
1209-B	250 to 920 Mc
1361-A	450 to 1050 Mc
1218-A	900 to 2000 Mc

*Not recommended for modulated operation

The earlier, A-models, of the Types 1211, 1215, and 1209 Unit Oscillators will operate satisfactorily with this power supply after a slight modification of the terminal connections. Other oscillators with compatible power requirements can be operated if a dc connection can be made to the cathode circuit to apply plate current control.

— W. F. Byers

SPECIFICATIONS

Rf Output Voltage: 0.2 to 2.0 volts behind 50 ohms for any recommended oscillator (see below), and a Type 874-VR Voltmeter Rectifier. With 1-kc square-wave modulation, 0.2 to 1.0 volt behind 50 ohms (average).

Rf Output Regulation: Below 500 Mc, rf output of recommended Unit Oscillators is held to within ±5% including the effects of harmonics. This regulation can be attained up to 2000 Mc if proper low-pass rf filters are used and a correction applied for the output-rectifier frequency characteristic.

Modulation

Frequency: 1-kc square-wave, adjustable ±5%, stable to within 5 cps over the rated range of line voltage.

Duty Ratio: 0.5 to 0.53, adjustable to compensate for oscillator starting delay.

Rise and Decay Times: 50 μsec each.

Overshoot: None.

Ramp-off: Less than 0.5%.

Gate Voltage: Synchronized with "off" interval of modulation, exceeds 1 volt into the recommended load of 30 kΩ shunted by 300 pf. Rise and decay times are less than 50 μsec each. Gate output during "on" interval of modulation is less than .01 volt.

Plate Supply Output: 0 to 300 volts at 30 ma.

Heater Supply Output: 6 v ±10% at 0.5 amp, 5.4 v ±10% at 0.7 amp.

Response Time: For a 2-to-1 step variation in oscillator output, correction is completed within 0.5 msec with cw operation, 50 msec with 1-kc modulation. Recovery time after blanking is less than 2 msec with cw operation, less than 200 msec with 1-kc square-wave modulation.

Hum and Noise: Peak residual hum and noise modulation is less than ±0.3% on cw; less than ±3% with 1-kc square-wave modulation.

Output Voltmeter: Internal standardizing circuit is provided. Accuracy after standardization is better than ±10% of indication when a correction is applied for rectifier characteristic at extremely high frequencies.

Tube Complement: Four 12AX7, one each 5963, 6V6GT, 0A2.

Power Input: 105 to 125 (or 210 to 250) volts, 50 to 60 cps, 55 watts maximum, at full load.

Accessories Supplied: Type CAP-22 Three-Wire Power Cord, connector cable for modulation jack on oscillator, spare fuses.

Other Accessories Required: Type 874-VR Voltmeter Rectifier, Type 874-R22 Patch Cord for connecting output rectifier, and Type 874-T Tee for monitoring oscilloscope connection in sweeping applications.

Recommended Oscillators: Type 1215-B (50 to 250 Mc), Type 1209-BL (180 to 600 Mc), Type 1209-B (250 to 920 Mc), Type 1361-A (450 to 1050 Mc), Type 1218-A (900 to 2000 Mc), and for cw operation only, Type 1211-B (0.5 to 50 Mc).

Other Accessories Available: The Type 1750-A Sweep Drive is recommended for automatic operation; coaxial cables, connectors, attenuators, filters, and adaptors; Type 480-P408 Panel Extensions for relay-rack mounting; Type 480-P416 Panel Extensions for rack mounting with the Type 1361-A UHF Oscillator.

Mounting: Aluminum panel and cabinet.

Dimensions: Width 8, height 7, depth 9¼ inches (205 by 180 by 235 mm), over-all.

Net Weight: 14½ pounds (6.6 kg).

Type		*Code Word*	*Price*
1263-B	Amplitude-Regulating Power Supply	GAVOT	$355.00
874-VR	Voltmeter Rectifier	COAXRECTOR	30.00
874-T	Tee	COAXTOGGER	11.00
874-R22	Patch Cord	COAXTANNER	7.60
480-P408	Panel Extensions (pair, for power supply only)	EXPANELJAG	8.00 Pair
480-P416	Panel Extensions (pair, for power supply and Type 1361-A UHF Oscillator)	EXPANELNIT	6.00 Pair

The previous model of the Amplitude-Regulating Power Supply, Type 1263-A, is still available. This model does not provide 1-kc square-wave modulation. The Type 1263-A is priced at $305.00; code word is SALON.

SIX-DIAL DECADE RESISTOR

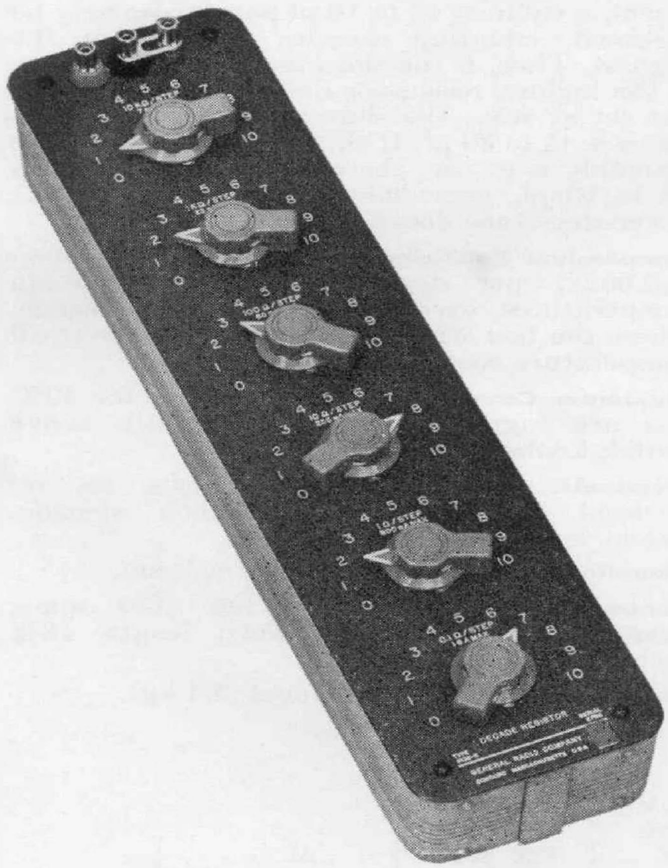


Figure 1. View of the Type 1432-X Decade Resistor.

General Radio decade resistors are stable, accurate units designed for use at audio and radio frequencies as well as at dc. Available in single decades or in multi-dial boxes, they have been manufactured continuously since 1915. The design and construction of the resistors are constantly being improved, as new materials and production methods become available, and new combinations of decade units in the Type 1432 assemblies are made available as demand becomes evident. The latest is the Type 1432-X Decade Resistor, shown in Figure 1, a six-dial box with a total resistance of 111,111 ohms, adjustable in steps of 0.1 ohm.

Mechanical protection, as well as electrical shielding, is provided by the aluminum cabinet and panel, which completely enclose both the resistors and the switch contacts. The resistance elements have no electrical connection to the cabinet, for which a separate shield terminal is provided.

SPECIFICATIONS

Accuracy of Adjustment: All resistors are adjusted at dc within $\pm 0.05\%$ of the stated value at their terminals, except the 1-ohm units, which are adjusted within $\pm 0.15\%$, and the 0.1-ohm units, which are adjusted within $\pm 0.5\%$.

Total Resistance at Terminals: Sum of dial settings plus the zero resistance given below.

Frequency Characteristics: Similar to those of individual decade resistance units, modified by the increased series inductance, L_0, and shunt capacitance, C, due to the wiring and the presence of more than one decade in the assembly. At total resistance settings of approximately 1000 ohms or less, the frequency characteristic is substantially the same as those shown in Figure 2. At higher settings, shunt capacitance

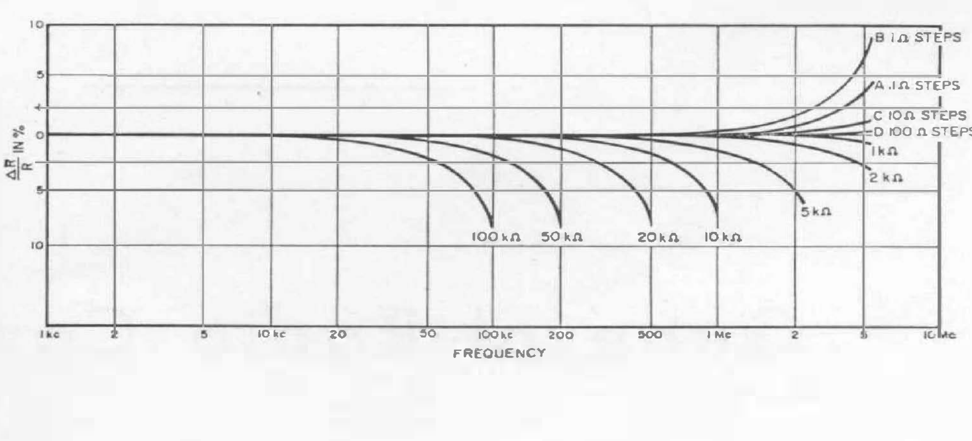


Figure 2. Maximum percentage change in series resistance as a function of frequency for decade-resistance units in Type 1432-X Decade Resistor.

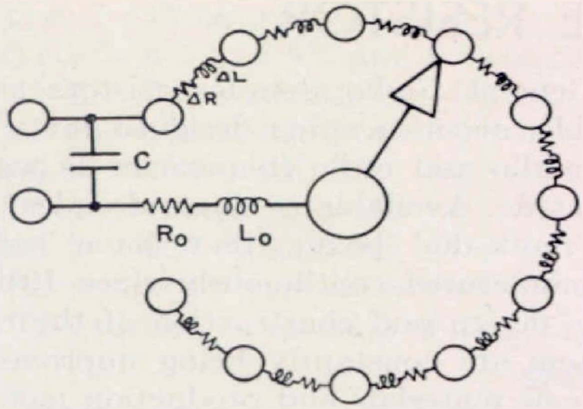


Figure 3. Equivalent circuit of a resistance decade, showing location and nature of residual impedances.

becomes the controlling factor, and the effective value of this capacitance depends upon the settings of the individual decades. See Residual Impedances below, and Figure 3.

Residual Impedances:

Zero Resistance (R_0): .001 ohm or less per dial at dc; 0.04 ohm per dial at 1 Mc; proportional to square root of frequency at all frequencies above 100 kc.

Zero Inductance (L_0): 0.10 μh per dial.

Effective Shunt Capacitance (C): This value is determined largely by the highest decade in use. With the LOW terminal connected to shield, a value of 15 to 10 pf per decade may be assumed, counting decades down from the highest. Thus, if the third decade from the top is the highest resistance decade in circuit (i.e., not set at zero) the shunting terminal capacitance is 45 to 30 pf. If the highest decade in the assembly is in use, the effective capacitance is 15 to 10 pf, regardless of the settings of the lower-resistance decades.

Temperature Coefficient of Resistance: Less than ±0.002% per degree Centigrade at room temperatures, except for the 0.1-ohm decade, where the box wiring will increase the over-all temperature coefficient.

Maximum Current: See Table. Values for 40°C rise are engraved on panels directly above switch knobs.

Terminals: Jack-top binding posts set on General Radio standard ¾-inch spacing. Shield terminal is provided.

Mounting: Aluminum panel and cabinet.

Dimensions: Width 4⁵⁄₁₆ inches (110 mm); height 4¾ inches (120 mm); length 18¼ inches (470 mm).

Net Weight: 7 pounds, 8 ounces (3.4 kg).

TABLE I

RESISTANCE PER STEP (ΔR) OHMS	ACCURACY OF RESISTANCE INCREMENTS	MAXIMUM CURRENT 40°C RISE	POWER PER STEP WATTS	ΔL μh
0.1	±0.5%	1.6 amp	.25	0.014
1	±0.15%	800 ma	.6	0.056
10	±0.05%	250 ma	.6	0.11
100	±0.05%	80 ma	.6	0.29
1,000	±0.05%	23 ma	.5	3.3
10,000	±0.05%	7 ma	.5	9.5

TYPE		RESISTANCE TOTAL	RESISTANCE MULTIPLE OF	NO. OF DIALS	CODE WORD	PRICE
1432-X	Decade Resistor	111,111	0.1	6	DOGMA	$160.00

General Radio Company

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