OPERATING INSTRUCTIONS

TYPE 1263-B
AMPLITUDE-REGULATING POWER SUPPLY

GENERAL RADIO COMPANY

D

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AMPLITUDE-REGULATING POWER SUPPLY

Form 1263-0110-D
July, 1962

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

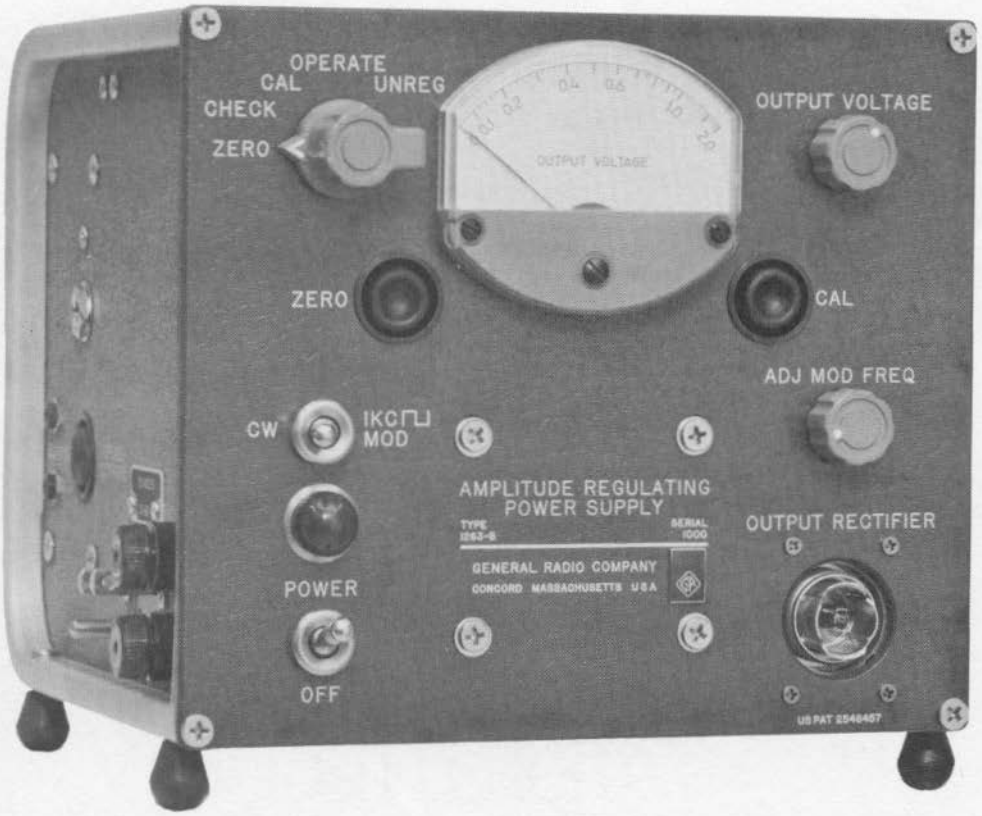

Figure 1. Panel view of Type 1263-B Amplitude-Regulating Power Supply.

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.

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 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, OA2.

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 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, adaptors, and relay-rack adaptor panels are available.

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).

Section 1
INTRODUCTION

1.1 PURPOSE.

The Type 1263-B Amplitude-Regulating Power Supply (Figure 1) is designed to operate General Radio Unit Oscillators or oscillators with similar power requirements. This power supply automatically adjusts the plate current supplied to an oscillator to maintain the rf output voltage at a constant preset level. This constant output is of great advantage in frequency-response measurements, and is particularly important when the oscillator frequency dial is mechanically swept for use with an oscilloscope or recorder. The oscillator must have suitable connections for application of a modulating voltage (as have General Radio Unit Oscillators). There must also be available an output rectifier to supply a negative dc potential proportional to the oscillator rf output. In Figure 2, a Type 1263-B Amplitude-Regulating Power Supply is shown with a Type 1750-A Sweep Drive, driving a Type 1209-B Unit Oscillator. The Type 1263-B Amplitude-Regulating Power Supply was designed especially for use with oscillators driven by the Type 1750-A. It is equally useful with the Types 907-R and 908-R Dial Drives (see paragraph 1.3.6) and with manually operated oscillators.

For most swept-frequency applications, cw operation is desirable because fast regulating action is possible. However, in this instrument,

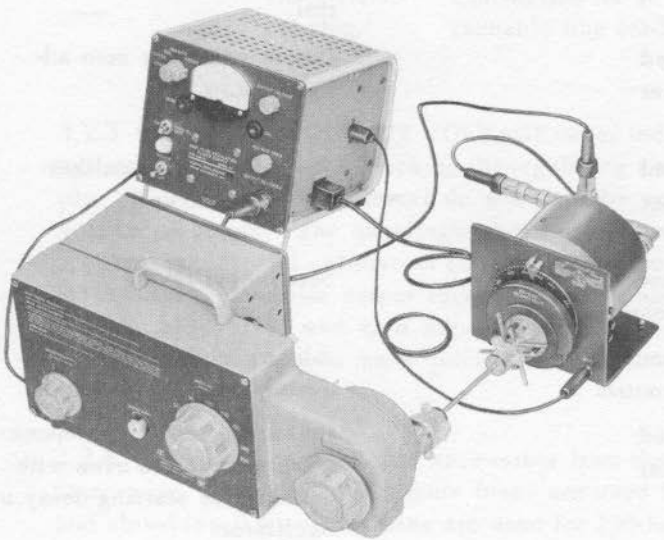

Figure 2. Type 1263-B Amplitude-Regulating Power Supply and Type 1750-A Sweep Drive shown driving a Type 1209-B Unit Oscillator.

internal 1-kc off-on modulation is provided for use with a sensitive detector such as an rf demodulating rectifier followed by a 1-kc selective amplifier.

The Type 1263-B also supplies heater voltage to the oscillator. Output voltage and current specifications are: plate supply, 0 to 300 volts at 30 ma; heater supply, 6 volts at 0.5 amp.

1.2 DESCRIPTION.

1.2.1 CONTROLS. The following controls are on the Type 1263-B Amplitude-Regulating Power Supply:

Name	Description	Positions	Function
POWER	Two-position toggle-switch with pilot light	POWER, OFF	Turns power on or off.
———	Two-position toggle-switch	CW-1 kc ⊓⊔ MOD	Selects cw or 1-kc square-wave modulation.
———	Five-position selector switch	ZERO, CHECK CAL, OPERATE UNREG	Permits output voltmeter to be checked and calibrated with output rectifier in use, without disturbing any connections to oscillator, and switches off amplitude control.
ZERO	Recessed thumb-set control		Output-voltmeter zero adjustment.
CAL	Recessed thumb-set control		Output-voltmeter calibration adjustment.
OUTPUT VOLTAGE	Continuous rotary control		Sets output level.
ADJ MOD FREQ	Continuous rotary control		Adjusts modulating frequency over narrow range.
INCREASE DUTY RATIO	Recessed thumb-set control		Permits symmetrical square-wave modulation even with appreciable starting delay in oscillator.

1.2.2 CONNECTORS. The following connectors are on the Type 1263-B Amplitude-Regulating Power Supply:

Name	Description	Function
POWER	Four-terminal socket	Direct plug-in connection for power cables of General Radio Unit Oscillators.
MODULATION	Two-terminal plug	Connection to modulation terminals of oscillator. For General Radio Unit Oscillators, connection is via patch cord with two-terminal socket on one end and telephone plug on other end.
OUTPUT RECTIFIER	Recessed Type 874 Coaxial Connector	Center conductor connects to output rectifier, shield connects to output-rectifier ground.
BLANKING	Telephone-tip jacks (two)	Connection for an external contactor to blank or cut off oscillator output. Used in sweep applications to eliminate return trace and provide a zero reference base line on sweep display.
GATE	Phone jack	Modulation-gate output for use with synchronous demodulator system.
—	Three-terminal plug.	Connection for ac power, through detachable line cord.

1.2.3 METER. The OUTPUT VOLTAGE meter indicates the output voltage, and is the means of checking the regulating action of the power supply. The meter is an internal dc vacuum-tube voltmeter, calibrated in volts of rf output. The quasilogarithmic scale covers a range from 0 to 2 volts. An internal calibration circuit permits the meter to be standardized with a particular output rectifier. By means of a panel selector switch, calibration and zero adjustments (thumb-set controls; refer to paragraph 1.2.1) can be made quickly without disturbing connections to the oscillator.

1.2.4 FUSES. Line fuses are accessible from the left-hand side of the instrument. Slow-blow 0.8-ampere fuses are used for 115-volt operation, and slow-blow 0.4-ampere fuses are used for 230-volt operation.

1.3 ASSOCIATED EQUIPMENT.

1.3.1 UNIT OSCILLATOR. The following is a list of recommended General Radio Unit Oscillators:

Type No.	Frequency Range
1211-B*	0.5 to 5 Mc; 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

An earlier "A" model of the Type 1211, 1215, or 1209 Unit Oscillator will operate satisfactorily with the Type 1263-B Amplitude-Regulating Power Supply if the telephone plug is removed from the modulation cable or is adapted to connect to the screw-terminals on the oscillator. Types 1208-A and -B Unit Oscillators cannot be used with the Type 1263-B Amplitude-Regulating Power Supply. Other oscillators with suitable power requirements can be operated from this power supply if a dc connection can be made to the cathode circuit to apply plate-current control.

1.3.2 OUTPUT RECTIFIER. The General Radio Type 874-VR Voltmeter Rectifier is recommended for use as the output rectifier over the frequency range of 0.5 to 2000 Mc. It can be plugged directly into the output connector of General Radio Unit Oscillators, and provides a matched source for 50-ohm coaxial cable. The back resistance of the crystal diode should exceed 40,000 ohms. The ripple in the output of the rectifier must be less than 10 percent at frequencies above 0.5 Mc to prevent overloading the control amplifier; this condition is satisfied when a Type 874-VR with a good crystal diode is used. With the Type 874-VR Voltmeter Rectifier, the response time is essentially determined by the internal compensation in the power supply. The stability of the control system (freedom from hunting and oscillation) is established by this compensation.

1.3.3 OUTPUT FILTER. To minimize errors due to oscillator harmonics, a low-pass filter can be used between the oscillator output and the output rectifier (refer to Section 5). The following General Radio filters are recommended:

Type 874-F185	185-Mc Low-Pass Filter
Type 874-F500	500-Mc Low-Pass Filter
Type 874-F1000	1000-Mc Low-Pass Filter
Type 874-F2000	2000-Mc Low-Pass Filter

*Not recommended for modulated operation.

**For both cw and square-wave modulated operation with the Type 1263-B, set the Type 1218-A selector switch to CW.

1.3.4 MATCHED DETECTOR. In setups for measuring transmission or frequency characteristics of various elements and networks, a Type 874-VQ Voltmeter Detector, terminated in a Type 874-WM Termination Unit, can be used at the output of the unknown to measure the output signal. The Type 874-VQ Voltmeter Detector is similar to the Type 874-VR Voltmeter Rectifier (paragraph 1.3.2), except that it does not contain a series 50-ohm resistor and does contain compensating elements to minimize discontinuity produced by the shunt reactance of the crystal diode. A block diagram of the set-up for plotting frequency characteristics of a Type 874-F185 Low-Pass Filter is shown in Figure 3. In this diagram, the output of a Type 1215-B Unit Oscillator, regulated by the Type 1263-B Amplitude-Regulating Power Supply, is fed through the output rectifier (874-VR) to the device under test (874-F185). The output from the device under test is detected by the properly terminated Type 874-VQ Voltmeter Detector and the characteristics are plotted on an x-y plotter.

1.3.5 SWEEP DRIVE. The General Radio Type 1750-A Sweep Drive can be used with oscillators operating from the power supply to produce a sweeping frequency source with constant rf output over the sweep range. This sweep drive also has a blanking voltage and provides a cathode-ray-oscilloscope deflection voltage synchronized with the position of the driven dial.

1.3.6 DIAL DRIVE. For permanent, precise recording of data, a two-axis plotter is an invaluable accessory. The General Radio Types 907-R144 and 908-R96 Dial Drives are designed to sweep equipment using standard General Radio 4-inch (Type 907-R Drive) and 6-inch (Type 908-R Drive) dials. The Type 1263-B Amplitude-Regulating Power Supply, used with any of the oscillators listed in paragraph 1.3.1, will provide a

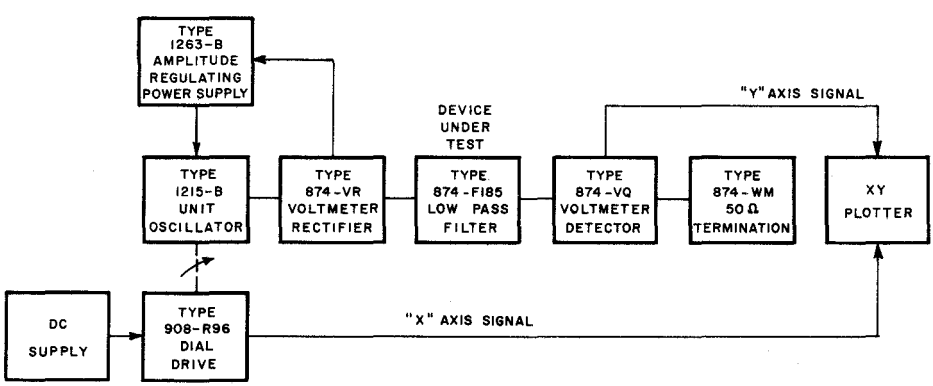

Figure 3. Typical setup for plotting frequency characteristics.

constant output voltage in order that the final recording will be a direct indication of relative response. In the block diagram of Figure 3, a Type 908-R96 Dial Drive is shown driving a Type 1215-B Unit Oscillator, with the detected output of a low-pass filter plotted by an x-y plotter.

1.3.7 SENSITIVE DETECTOR. A Type 874-VQ Voltmeter Detector followed by a Type 1232-A Tuned Amplifier and Null Detector tuned to 1 kc be used for increased detector sensitivity when 1-kc modulation from the Type 1263-B is applied to the oscillator.

Section 2

THEORY OF OPERATION

2.1 GENERAL.

In the cw mode of operation, the Type 1263-B Amplitude-Regulating Power Supply compares the dc potential developed by the oscillator output rectifier with a dc reference potential, and applies a correction to the oscillator plate supply to minimize the difference. The load resistance presented to the output rectifier is 100,000 ohms. A maximum of 300 volts at 30 milliamperes is available for the oscillator plate. The dc reference potential is adjustable from 0 to 2.5 volts, which corresponds to an rf output of 0 to 2 volts with the normal output rectifier. This power supply will maintain any preset level within 2 percent over the frequency range (subject to additional variations due to harmonics and possible errors of the output rectifier), provided that the oscillator produces at least 2 volts with a 300-volt, 30-milliampere plate supply at all frequencies within its range.

In the 1-kc modulated mode of operation, the regulating action is maintained and the carrier, or average rf, level is controlled. This level is one-half the "on" level of the rf-modulated output. Carrier output is limited to 1 volt with the recommended oscillators.

2.2 CIRCUIT.

The elementary schematic diagram (Figure 4) illustrates the principles of operations of the power supply. The output rectifier develops a negative dc potential proportional to the rf amplitude at the oscillator output. This potential is applied to the voltmeter amplifier and to one grid of the first difference amplifier. An adjustable negative reference potential is applied to the other grid of the first difference amplifier. An increase in the negative potential developed by the output rectifier, with respect to the reference potential, is amplified by the two difference amplifiers, and appears as an increased negative potential at the output-amplifier grid. This reduces the plate current supplied to the oscillator. Conversely, a decrease in output produces an increase in plate current applied. This closed-circuit feedback system holds the output close to a preset level. An external contactor shorts the reference potential to effect rf blanking.

With internal 1-kc square-wave modulation, the regulating action described above continues except that an RC filter is switched in to pass only the average dc from the output rectifier, and the plate supply is interrupted with a 1-kc square wave. Under these conditions, the average or carrier level of the oscillator output voltage is regulated. Variable resistors in the 1-kc multivibrator circuit permit adjustment of the frequency and duty ratio of the square-wave modulation over a narrow range. For cw operation, the multivibrator is biased to the "on" state and modulation ceases.

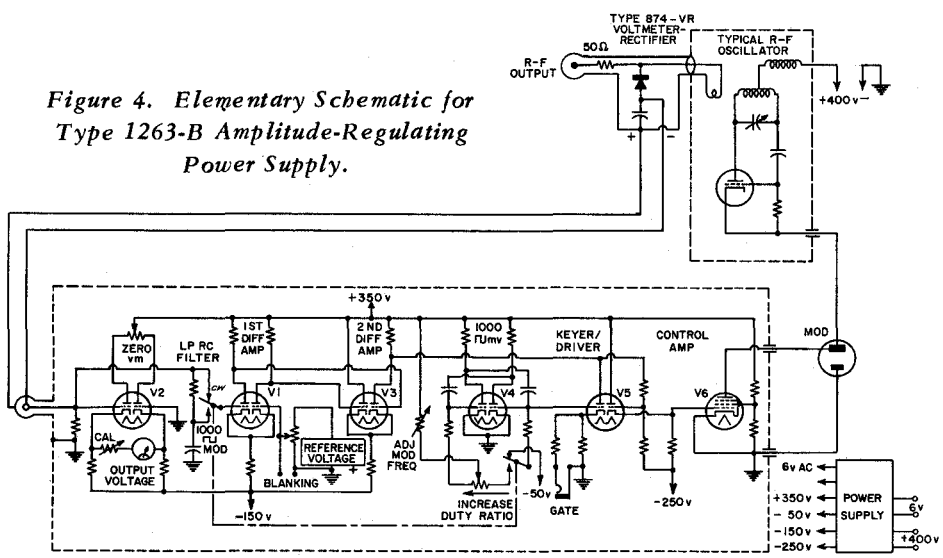

Figure 4. Elementary Schematic for Type 1263-B Amplitude-Regulating Power Supply.

2.3 RESPONSE TIME.

In swept-frequency applications, rapid variation of oscillator output is likely to occur, particularly in the uhf range. This variation can be nearly eliminated by the Type 1263-B Amplitude-Regulating Power Supply. Cw operation is recommended for most sweeping applications since the most rapid regulator response is obtained in this mode. With cw operation the Type 1263-B will correct a 2-to-1 step of oscillator output voltage in less than 0.5 millisecond. If blanking is applied by shorting contacts in the sweep-drive mechanism, regulation is restored within 2 milliseconds after blanking is removed. With internal 1-kc square-wave modulation the response and recovery times of the power supply are increased to about 50 and 200 milliseconds, respectively.

With cw operation the recommended General Radio Unit Oscillators can be swept through their entire ranges in less than one-half second with satisfactory regulation. To ensure complete regulation with modulation, the entire ranges of the oscillators should not be swept in less than 10 seconds, although good regulation can be obtained over most of the ranges with a sweep time as low as two seconds.

Section 3

INSTALLATION

3.1 CONNECTIONS. (Refer also to Section 1.3.)

3.1.1 POWER AND MODULATION CONNECTIONS. Plug the Unit Oscillator power cable into the multipoint connector on the right-hand side of the power supply. With the patch cord supplied, connect the MODULATION plug on the power supply to the modulation jack of the Unit Oscillator.

CAUTION

Excessive voltage, even if applied for a short time, can damage crystal diodes. Do not apply ac power to the power supply until all connections between oscillator, output rectifier, and power supply have been made. When using the Type 1211-B Unit Oscillator, turn the selector switch on the power supply to ZERO while changing frequency range.

3.1.2 OUTPUT-RECTIFIER CONNECTION. With a Type 874-R22 Patch Cord, connect the OUTPUT RECTIFIER connector of the Type 1263-B to the dc output (side connector) of the Type 874-VR Voltmeter Rectifier.

The Type 874-VR should be connected as close as possible to the output connector of the oscillator, either by direct plug-in or with an output filter interposed (refer to Section 5). The resistor end marked R should face the load to provide a matched source for a 50-ohm coaxial line. A Type 874-EL 90° Ell and Type 874-Z Stand are useful accessories for connecting and supporting the output filter and Type 874-VR. Adaptors are available for connectors other than Type 874. Refer to the table of Type 874 Accessories at the rear of this manual.

3.2 HEATER-SUPPLY VOLTAGE ADJUSTMENT.

There is a considerable variation in the heater-current requirements of the various Unit Oscillators. A compromise in voltage supplied permits satisfactory operation without adjustment. Output is 6 volts at 0.5 ampere with the nominal line-supply voltage. Heater-current requirements for oscillators are met as follows:

a. Types 1209-BL, 1209-B, and 1215-B: 6.3 volts at 0.3 to 0.4 ampere.

b. Type 1211-B: 5.4 volts at 0.7 ampere satisfactory (nominal requirement is 6 volts at 0.75 ampere).

c. Type 1218-A: has internal heater rectifier. Polarity of dc supplied by Type 1263-B Power Supply is chosen so that this rectifier conducts. Oscillator current requirement is less than 0.2 ampere. The drop in the rectifier and associated filter is such that proper voltage is supplied to the tube.

d. Type 1361-A: 7 volts at 135 ma. Voltage drop within the oscillator reduces the voltage at the tube to 6.7 volts, which is satisfactory for normal use. If the Type 1263-B Power Supply is to be used only with the Type 1361-A Oscillator, remove the jumper as described below.

e. Oscillators requiring less than 0.2 ampere at 6.3 volts: Remove the jumper that connects the terminals of the electrolytic capacitor at the top center of the Type 1263-B. This jumper is accessible from the rear after the dust cover and V2 are removed.

Section 4

OPERATING PROCEDURE

4.1 INITIAL ADJUSTMENT.

After the proper connections have been made to the oscillator and the output rectifier (refer to paragraphs 1.3 and 3.1), apply power, allow at least a 2-minute warm up, and check operation as follows:

a. Standardize the output voltmeter.

(1) With the selector switch in the ZERO position, turn the ZERO thumb-set control to zero the meter.

(2) Turn the selector switch to CHECK and observe the meter indication.

(3) Turn the selector switch to CAL and turn the CAL thumb control to produce the same indication as noted in (2).

b. Turn the selector switch to OPERATE.

c. Select CW or 1-KC ⊓⊔ MOD.

d. Set the OUTPUT VOLTAGE control so that the desired operating voltage is indicated on the meter. If it is impossible to reach this level by advancing the OUTPUT VOLTAGE control, the oscillator cannot supply this output. As the normal oscillator output coupling is reduced, the drop-out point of the regulator will occur abruptly, with no noticeable change in level down to this point, if the system is operating properly.

If, with normal plate supply, the output from the oscillator is much greater than desired, the control system may become unstable and break into oscillation. This condition can easily be observed by the action of the output meter as the oscillator output coupling is varied. As the coupling (control or loop on the oscillator itself) is increased from the minimum setting, the indicated voltage should rise to the desired output level, then remain constant over a part of the range of the oscillator output coupling. Then, if the coupling can be advanced far enough, the meter will suddenly jump up or down, indicating the unstable oscillating condition. All General Radio Unit Oscillators are equipped with an adjustable output coupling system, so that the above tests can be made. Once the adjustments have been made, it should be possible to turn the oscillator dial through the entire frequency range with no noticeable fluctuation in output voltage.

4.2 SWEEP APPLICATIONS.

If the oscillator is mechanically swept for automatic frequency response displays, the dynamic regulation of the output should be checked. A cathode-ray oscilloscope used to present the response is an excellent means of checking the operation of the power supply and of observing when optimum output-coupling setting is obtained. When the Type 1750-A Sweep Drive is used, connect the blanking cable to the BLANKING telephone-tip jacks on the Type 1263-B Amplitude-Regulating Power Supply to provide a zero-reference base line for the desired response display and for the checking display. The horizontal input to the oscilloscope should be supplied with the oscilloscope sweep voltage provided by the sweep drive. Temporarily insert a Type 874-T in the cable to the output rectifier and connect the vertical input of the oscilloscope to the connector thus made available. The oscilloscope should be set for dc response. Such changes in connection can be made without turning the power supply off, provided that the selector switch is set to ZERO. Return the selector switch to OPERATE. Drive the oscillator over the desired level. Adjust oscilloscope sensitivity to give a suitable horizontal and vertical deflection. For cw operation, the pattern should be approximately rectangular, with the horizontal portions straight lines. The negative voltage horizontal portion represents the oscillator output characteristic, and the positive portion the zero level.

With 1-kc internal modulation a similar pattern is obtained except that the horizontal portions are traced out by two bright spots connected by a vertical line. The flatness of the path traced by the lower spot is the indication of flatness of the oscillator output. Since the average value of the modulated output is regulated, variation in starting delay in the oscillator over its frequency range will cause variations in the duty ratio of the square wave and consequently show a variation from flatness. The use of a matched termination or resistance pad following the output rectifier will minimize variation of oscillator starting delay.

If the oscillator output characteristic is not shown as a horizontal straight line, adjust the oscillator output coupling, and, if necessary, reduce sweep speed. A broadening or burst of high-frequency voltage on this line indicates control-system oscillation; to eliminate this, reduce the output coupling. For best regulation, some readjustment of the oscillator output coupling is necessary with changes in the setting of the OUTPUT VOLTAGE control, particularly with internal 1-kc modulation.

Sharp discontinuities in the output characteristic of the oscillator, particularly when wide frequency ranges are swept, may require a reduction in sweep speed so that the control-system response time will permit complete correction of output voltage. With General Radio Unit Oscillators

and cw operation this reduction will not exceed the low-speed limit imposed by mechanical standards.

Once a flat horizontal line representing the oscillator output-voltage characteristic is obtained, the oscilloscope vertical input can be transferred to the device under test with the assurance that the output voltage is being regulated by the Type 1263-B.

4.3 INTERNAL AMPLITUDE MODULATION.

In addition to the toggle switch that selects either CW or 1-KC ⊓⊔ MOD, there are two controls for internal modulation. If a 1-kc fixed-frequency selective audio amplifier is used with a demodulating detector, adjust the modulating frequency for maximum response with the ADJ MOD FREQ control. For a symmetrical modulation waveform, monitor the demodulated output on an oscilloscope and adjust the duty ratio with the INCREASE DUTY RATIO thumb-set control on the left-hand side of the Type 1263-B. If a gate voltage is desired for keying a synchronous demodulator or for other synchronizing purposes, connect to the GATE output with a standard telephone plug.

4.4 EXTERNAL AMPLITUDE MODULATION.

Although the Type 1263-B Amplitude-Regulating Power Supply was designed to operate oscillators with cw or internal 1-kc square-wave modulated output only, a limited amount of amplitude-modulating voltage may be applied to the BLANKING terminals when the Type 1263-B is set for cw. Connect a blocking capacitor in series with the lead to the high (red) BLANKING terminal, and set the output voltage to 1 volt. At a 1-volt output, the input impedance is about 5000 ohms, and a 20-μf blocking capacitor is suitable at frequencies above 20 cps. If the blocking capacitor is an electrolytic, connect its negative terminal to the high (red) BLANKING terminal. At outputs smaller than 1 volt, the voltmeter diode nonlinearity causes greater modulation nonlinearity and lower input impedance. Therefore, it is recommended that if lower outputs are desired, the required attenuation be added at the output of the Type 874-VR.

Figure 5 shows the limit of the resulting modulation as a function of frequency. This is not a curve of over-all frequency response, but rather a curve representing the response-speed limitation of the Type 1263-B. Owing to the large amount of feedback in the system, the frequency response is flat below the overload points represented by the curve. To determine the maximum voltage that can safely be applied at any frequency, slowly increase the modulating voltage while observing the output-voltage meter on the Type 1263-B. Set the modulation voltage just below the point where the meter starts to drop, since this voltage

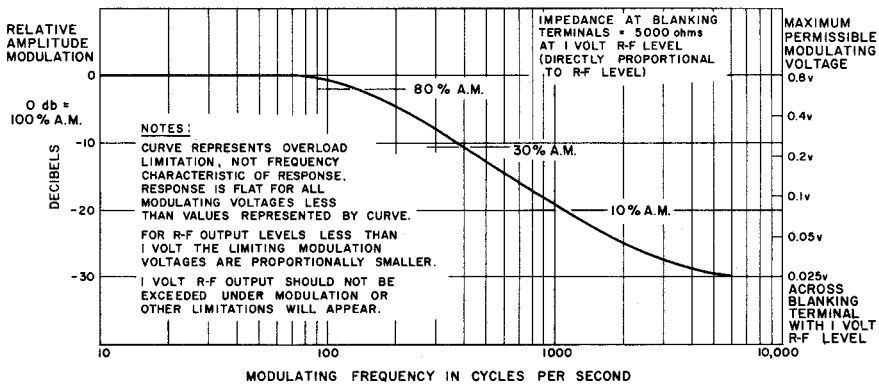

Figure 5. Typical external amplitude-modulation characteristics of the Type 1263-B

produces the maximum modulation that can be obtained without spoiling the output regulation. Connect a blocking capacitor in series with the lead to the high (red) BLANKING terminal, and set the output voltage to 1 volt. At a 1-volt output, the input impedance is about 5000 ohms, and a 20-μf blocking capacitor is suitable at frequencies above 20 cps. If the blocking capacitor is an electrolytic, connect its negative terminal to the high (red) BLANKING terminal. At outputs smaller than 1 volt, the voltmeter diode nonlinearity causes greater modulation nonlinearity and lower input impedance. Therefore, it is recommended that if lower outputs are desired, the required attenuation be added at the output of the Type 874-VR.

If necessary, equip the modulating source with a voltage divider to limit the voltage available to about 1 volt, so that the modulating voltage may more easily be set to the required value.

Section 5

OUTPUT RECTIFIER ERRORS

5.1 GENERAL.

The ability of the Type 1263-B Amplitude-Regulating Power Supply to maintain a constant oscillator output necessarily depends on the characteristics of the output rectifier. The power supply maintains within close limits the rectified dc produced by the output rectifier, but oscillator harmonics and frequency characteristics of the rectifier can cause errors.

5.2 OSCILLATOR HARMONICS.

The Type 874-VR Voltmeter Rectifier operates almost as a peak detector at the high rf voltages, as do most rf rectifiers covering a wide frequency range. This means that the rectifier can recognize only the peak value of the rf waveform and can produce a dc output proportional to it. The amount that the radio-frequency fundamental can vary depends on the percentage of harmonic voltage in the waveform. In addition, if the phase of the harmonic changes with frequency with respect to the fundamental, the variation can be twice the amplitude of the harmonic, even if the amount of harmonic does not change.

Unfortunately, this condition often exists in wide-range high-frequency oscillators. If the harmonic frequency approaches the resonant frequency of the voltmeter rectifier (refer to paragraph 5.3), the error is magnified.

Above about 300 Mc, a low-pass filter should be used between the oscillator output and the voltmeter rectifier to reduce errors due to harmonics. The frequency range over which such a filter is effective is limited to somewhat more than one-half the cutoff frequency up to the cutoff frequency. Thus, the 500-Mc low-pass filter can be used effectively between 300 and 500 Mc, the 1000-Mc low-pass filter between 600 and 1000 Mc, and the 2000-Mc low-pass filter between 1200 and 2000 Mc. To cover the gaps between these ranges, other filters with suitable cutoff frequencies are necessary. Usually there is no need to do anything below 300 Mc, but in the 500-to-600 Mc range, harmonics usually become a problem.

Another way of minimizing the effect of harmonics is to operate the output rectifier at a very low level where the characteristics approach square law. The minimum reliable control level is approximately 0.2

volt for the Type 1263-B Amplitude-Regulating Power Supply, and although this is above the region usually considered to be square law for the diode used in the Type 874-VR, quite noticeable reduction in the effect of harmonics can be obtained at output levels approaching this low limit.

When the polarity of the response detector at the output of the device under test is the same as that of the diode in the output rectifier (negative peak rectifier), some apparent cancellation of the effect of harmonics can take place. This is true where the phase of the harmonics of the oscillator with respect to the fundamental has not been appreciably altered in passing through the device under test. While this is not a true elimination of the effects of the harmonics (since the device under test is being measured for transmission of both fundamental and harmonics by such an arrangement), the resulting display is often a truer picture of the transmission characteristics than could be obtained with nonmatching diode polarities. For this reason, the recommended matched detector, Type 874-VQ, is supplied with a diode of the same type as is used in the Type 874-VR.

5.3 RECTIFIER FREQUENCY CHARACTERISTICS.

The resonant frequency of the Type 874-VR Voltmeter Rectifier is about 5400 Mc. The actual output voltage is down from the indicated or regulated level about 3 percent at 1000 Mc and 13 percent at 2000 Mc. Figure 6 illustrates the frequency characteristics of the Type 874-VR Voltmeter Rectifier or Type 874-VQ Voltmeter Detector with a typical crystal diode. When the Type 874-VQ Voltmeter Detector is used as the response detector, there is no need to apply a correction for frequency response, since the errors in the Types 874-VR and 874-VQ cancel.

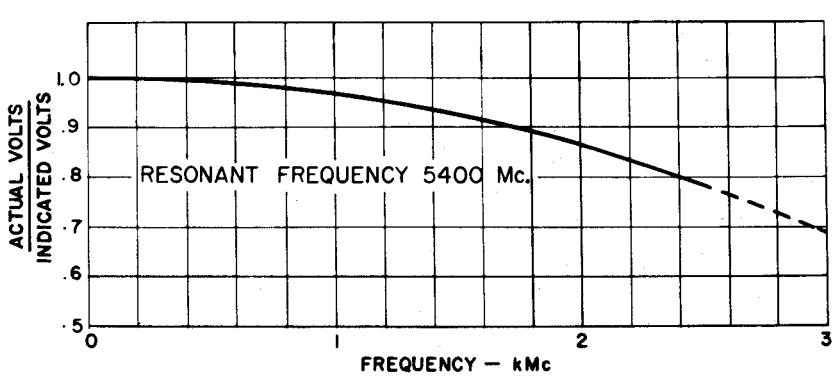

Figure 6. Resonance correction factors; Type 874-VR Voltmeter Rectifier.

5.4 RECTIFIER DIODE RESISTANCE.

In order to prevent excessive rf distortion from the output rectifier, it is important that the reverse resistance of the diode used be reasonably high. Diodes are easily damaged by excessive voltage (refer to paragraph 3.1.1), and the reverse resistance is usually decreased by such abuse. Since the normal calibration procedure does not show up this defect unless it is severe, ohmmeter checks of reverse resistance should be made frequently. For best performance, diodes whose reverse resistance is less than 40 kilohms should be replaced. Type 1N23B diodes are used in both the Type 874-VR Voltmeter Rectifier and the Type 874-VQ Voltmeter Detector.

Section 6

SERVICE AND MAINTENANCE

6.1 GENERAL.

The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest District Office (see back cover), requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

6.2 TUBE REPLACEMENT.

Refer to the tube-location chart (Figure 7) inside the dust cover. Tube requirements are not particularly critical although some selection may be required. If the instrument fails to perform in accordance with the specifications, one or more tubes may require replacement. Failure to deliver rated output current is usually due to a defective V6 (6V6GT), although failure of V1, V3, V4, or V5 may also be indicated. Failure or poor performance of the voltmeter is usually due to a defective V2. Failure or poor performance of modulation is usually due to V4 or V5. If V1, V3, or V5 is replaced, check that the output of an oscillator operated on cw from the power supply is zero at the counterclockwise limit of the OUTPUT VOLTAGE control. If it is not, check that R2, accessible from the top of the instrument, is fully counterclockwise and measure the voltage from TP1 (pin 5 or V6) to GND. This voltage must be at least - 45 volts with a 20,000-ohm-per-volt meter and a line voltage of 125 (or 250) volts. Turn R3 clockwise slowly and note that the voltage remains at least -45 volts before decreasing rapidly to zero and beyond (checks margin of cutoff bias voltage). If the above test is not satisfactory, interchange V1 and V3 and, if necessary, replace one or both tubes. Return R2 to its counterclockwise limit. If the voltage from TP1 to GND is greater than -45 volts and the oscillator output is not zero, replace V6.

The usual defect found in replacement tubes for V1 and V2 is excessive dc drift with changes in line voltage. First, V2 should be checked as follows:

a. Set the selector switch to ZERO.

b. Adjust the ZERO control to obtain a meter indication between 0.1 and 0.2 volt.

c. Vary the line voltage from 105 to 125 (or 210 to 250) volts.

d. The total shift in indication should be less than one scale division.

e. Readjust for zero indication.

V1 can now be checked for drift as follows:

f. With an oscillator connected and adjusted for proper cw operation as described in Section 4, set the output voltage to 0.5 volt.

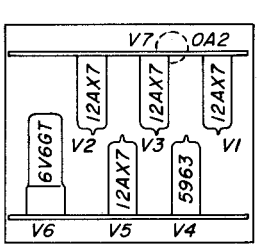

Figure 7. Tube Location Chart (rear view of the instrument) for Type 1263-B Amplitude-Regulating Power Supply.

g. Vary the line voltage from 105 to 125 (or 210 to 250) volts.

h. The total shift in meter indication should be less than one scale division.

Completely satisfactory performance can be obtained with tubes showing drifts greater than defined above if the line-voltage variations are not extreme.

6.3 CALIBRATION.

In addition to the normal operating adjustments described in the preceding sections, there are two internal controls. One of these is a factory-set, sealed control (R14, accessible from the bottom of the instrument) and will not require adjustment except with failure and replacement of RX1, R13, R14, R15, R27, or R75. After replacement of any of these, set the panel selector switch to the CHECK position and adjust R14 so that the ac potential at the OUTPUT RECTIFIER connector is the same as that indicated on the panel voltmeter. An accurate vacuum-tube voltmeter should be used.

The other internal control is R2, accessible from the top of the instrument. No adjustment of this control is necessary since it is set at its counterclockwise limit and is provided only for making the test described in paragraph 6.2.

6.4 TABLE OF VOLTAGES AND RESISTANCES.

Tube	Pin	Dc Volts to Ground	Res. to Ground	Tube	Pin	Dc Volts to Ground	Res. to Ground
V1 (12AX7)	1	+188 v	520 k	V4 (5963)	1	+65 v	220 k
	2	−.02 v	1.1 k		2	−43 v	780 k
	3	+2.05 v	300 k		3	0	0
	4, 5-9	6.7 v ac			4, 5-9	6.7 v ac	
	6	+200 v	320 k		6	+88 v	220 k
	7	−.02 v	100 k		7	−50 v	780 k
	8	+2.05 v	300 k		8	0	0
V2 (12AX7)	1	+325 v	51 k	V5 (12AX7)	1	+130 v	430 k
	2	0	3.4 M		2	−58 v	900 k
	3	+3.0 v	160 k		3	0	0
	4, 5-9	6.7 v ac			4, 5-9	6.7 v ac	
	6	+325 v	51 k		6	+350 v	1 k
	7	0	3.3 M		7	−59 v	1.25 M
	8	+3.0 v	160 k		8	0	200 k
V3 (12AX7)	1	+350 v	1 k	V6 (6V6GT)	2-7	6.7 v ac	
	2	+100 v	1 M		3	0	Open
	3	+102 v	100 k		4	+180 v	6 k
	4, 5-9	6.7 v ac			5	−55 v	200 k
	6	+130	430 k		8	0	0
	7	+101 v	920 k	V7 (OA2)	2, 7	−150 v	6.2 k
	8	+102 v	100 k				

1. Dc voltages are measured with a vacuum-tube voltmeter with 100-MΩ input resistance.

2. Resistance measurements are made with anchor terminals 21 and 23 connected to ground.

3. Except for V4, measurements are made with OUTPUT VOLTAGE control and R2 set completely counterclockwise and the CW-1 KC ⊓⊔ MOD switch set on CW. Measurements for V4 are made with the CW-1 kc ⊓⊔ MOD switch set on 1 KC ⊓⊔ MOD and the ADJ MOD FREQ and INCREASE DUTY RATIO controls set at maximum clockwise position.

TABLE OF TYPE 874 COMPONENTS

TYPE 874- CONNECTORS

TYPE	FOR CABLE TYPE: 874-A2 (50 Ω)	874-A3, RG-29/U, -55/U, -58/U, etc.	Rg-8/U, -9/U, -116/U, etc.	RG-59/U, -62/U, -116/U, etc.	single-wire lead
CABLE	-CA	-C58A	-C8A	-C62A	
CABLE, LOCKING	-CLA	-CL58A	-CL8A	-CL62A	
PANEL, FLANGED	-PBA	-PB58A	-PB8A	-PB62A	
PANEL, LOCKING	-PLA	-PL58A	-PL8A	-PL62A	-PLT
PANEL, LOCKING, RECESSED	-PRLA	-PRL58A	-PRL8A	-PRL62A	-PRLT

BASIC (AIR-LINE) 50 Ω CONNECTOR - 874-B

BASIC LOCKING CONNECTOR - 874-BL

TYPE 874- ADAPTORS

TO TYPE	874-	TO TYPE	874-
BNC plug	QBJA	TNC plug	QTNJ
plug	QBJL*	plug	QTNJL*
jack	QBPA	jack	QTNP
C plug	QCJA	UHF plug	QUJ
plug	QCJL*	(cable) plug	QUJL*
jack	QCP	jack	QUP
HN plug	QHJA	UHF 7/8 in.	QU1A
jack	QHPA	(air line) 1-5/8 in.	QU2
		3-1/8 in.	QU3A
LC plug	QLTJ	double plug or jack	Q2
jack	QLPA		
LT plug	QLTJ	binding post pair	Q9
jack	QLTP	274-NO patch cord	QN6
N plug	QNJA		
plug	QNJL*		
jack	QNP		
SC plug	QSCJ		
plug	QSCJL*		
jack	QSCP		

* Locking Type 874 Connector.

Example: To connect Type 874 to a Type N jack, order Type 874-QNP.

OTHER COAXIAL ELEMENTS

874-	
A2	50 Ω cable, 0.365" OD
A3	50 Ω cable, 0.206" OD
BM	300 Ω bal. termination
D20, D50	20-, 50-cm adjustable stubs
EL	90° ell
F185	185-Mc low-pass filter
F500	500-Mc low-pass filter
F1000	1000-Mc low-pass filter
F2000	2000-Mc low-pass filter
F4000	4000-Mc low-pass filter
G3, G6	3-, 6-, 10-, 20-db attenuators
G10, G20	
GA	adjustable attenuator
JR	rotary joint
K	coupling capacitor
L10, L20, L30	10-, 20-, 30-cm rigid air lines
LA	33-58 cm adjustable line
LK10, LK20	constant Z adjustable lines
LR	radiating line
LT	trombone constant Z line
M	component mount
MB	coupling probe
MR	mixer-rectifier
T	tee
UB	balun
VC	variable capacitor
VI	voltmeter indicator
VQ	voltmeter detector
VR	voltmeter rectifier
W50	50 Ω termination
W100	100 Ω termination
W200	200 Ω termination
WM	50 Ω termination
WN, WN3	short-circuit terminations
WO, WO3	open-circuit terminations
X	insertion unit
XL	series inductor
Y	cliplock
Z	stand

The above is a partial listing. For complete details, refer to the General Radio catalog.

PARTS LIST

RESISTORS

R1	360 k	± 5%	1/2 w	REC-20BF(364B)
R2	250 k	±10%		POSC-11(254C)
R3	360 k	± 5%	1/2 w	REC-20BF(364B)
R4	1 k	± 5%	1/2 w	REC-20BF(102B)
R5	1 k	± 5%	1/2 w	REC-20BF(102B)
R6	300 k	± 5%	1/2 w	REC-20BF(304B)
R7	470 k	± 5%	1/2 w	REC-20BF(474B)
R8	10 k	±10%		POSC-25(103C)
R9	1 M	± 5%	1/2 w	REC-20BF(822B)
R10	1 M	± 5%	1 w	REC-30BF(105B)
R11	1 M	± 5%	1/2 w	REC-20BF(105B)
R12	100 k	± 5%	1/2 w	REC-20BF(104B)
R13	4.7	±10%	1 w	REC-30BF(047C)
R14	10	±10%		POSW-3(100C)
R15	47	±10%	1 w	REC-30BF(470C)
R16	3.3 M	± 5%	1/2 w	REC-20BF(335B)
R17	1 k	± 5%	1/2 w	REC-20BF(102B)
R18	100 k	± 5%	1/2 w	REC-20BF(104B)
R19	470 k	± 5%	1/2 w	REC-20BF(474B)
R20	4.7 k	± 5%	1/2 w	REC-20BF(472B)
R21	25 k	±10%		POSC-11(253C)
R22	300 k	± 5%	1/2 w	REC-20BF(304B)
R23	300 k	± 5%	1/2 w	REC-20BF(304B)
R24	100 k	±10%		POSC-11(104C)
R25	1 k	± 5%	1/2 w	REC-20BF(102B)
R26	3.3 M	± 5%	1/2 w	REC-20BF(335B)
R27	22	± 5%	1/2 w	REC-20BF(220B)
R28	100	± 5%	1/2 w	REC-20BF(101B)
R29	1 M	± 1%	1/8 w	REF-60(105A)
R30	2.74 M	± 1%	1/2 w	REF-70(2744A)
R31	1 M	± 1%	1/8 w	REF-60(105A)
R32	2.74 M	± 1%	1/2 w	REF-70(2744A)
R33	5.6 k	± 5%	1/2 w	REC-20BF(562B)
R34	1 k	± 5%	1/2 w	REC-20BF(102B)
R35	100 k	± 5%	1/2 w	REC-20BF(104B)
R36	56 k	± 5%	1/2 w	REC-20BF(563B)
R37	160 k	± 5%	1/2 w	REC-20BF(164B)
R38	160 k	± 5%	1/2 w	REC-20BF(164B)
R39	706k	±1/2%	1/8 w	REF-60(7063A)
R40	100 k	±10%		POSC-11(104C)
R41	100 k	±10%		POSC-25(104C)
R42	796k	±1/2%	1/8 w	REF-60(7963A)
R43	470 k	± 5%	1/2 w	REC-20BF(474B)
R44	1 k	± 5%	1/2 w	REC-20BF(102B)
R45	15 k	± 5%	1/2 w	REC-20BF(153B)
R46	6.2 k	± 5%	1/2 w	REC-20BF(622B)
R47	1 k	± 5%	1/2 w	REC-20BF(102B)
R48	2.2 M	± 5%	1/2 w	REC-20BF(225B)
R49	2.2 M	± 5%	1/2 w	REC-20BF(225B)
R50	200 k	± 5%	1/2 w	REC-20BF(204B)
R51	1 k	± 5%	1/2 w	REC-20BF(102B)
R52	3.9 k	± 5%	2 w	REC-41BF(392B)

RESISTORS (Cont)

R53	3.9 k	± 5%	2 w	REC-41BF(392B)
R54	3.9 k	± 5%	2 w	REC-41BF(392B)
R55	360 k	± 5%	1/2 w	REC-20BF(364B)
R56	100 k	± 5%	1/2 w	REC-20BF(104B)
R57	12 k	± 5%	10 w	REPO-22(123B)
R58	270	±10%	2 w	REC-41BF(271C)
R59	1.5 k	±10%	2 w	REC-41BF(152C)
R60	1.5 k	±10%	2 w	REC-41BF(152C)
R61	1.5 k	±10%	2 w	REC-41BF(152C)
R62	1 M	±10%	1 w	REC-30BF(105C)
R63	100 k	± 5%	1/2 w	REC-20BF(104B)
R64	3.3 k	±10%	2 w	REC-41BF(332C)
R65	3.3 k	±10%	2 w	REC-41BF(332C)
R66	3.3 k	±10%	2 w	REC-41BF(332C)
R67	4.7	± 5%	3 w	REPO-45(047B)
R68	75	± 5%	2 w	REC-41BF(750B)
R70	270	±10%	2 w	REC-41BF(271C)
R71	270	±10%	2 w	REC-41BF(271C)
R72	270	±10%	2 w	REC-41BF(271C)
R73	120 k	±10%	2 w	REC-41BF(124C)
R74	6.8	±10%	1/2 w	REW-3C(068C)
R75	91 k	± 5%	1/2 w	REC-20BF(913B)
R76	10 k	± 5%	1/2 w	REC-20BF(103B)

CAPACITORS

C1	10 µf		25 dcwv	COE-56
C2	.01 µf	±10%		COL-71(103C)
C3	.01 µf	±10%		COL-71(103C)
C4	.0068 µf	±10%		COM-1B(682C)
C5	.001 µf	± 1%		COM-5F(102A)
C6	.001 µf	± 1%		COM-5F(102A)
C7	.1 µf	±10%		COW-25(104C)
C8	1.0 µf	±10%		COW-17(105C)
C9	0.22 µf	±10%		COW-17(224C)
C10	0.1 µf	±10%	600 dcwv	COL-71(104C)
C11A	50 µf			
C11B	25 µf		450 dcwv	COE-10
C11C	25 µf			
C12A	10 µf			
C12B	10 µf		450 dcwv	COE-5
C13A	10 µf			
C13B	10 µf		450 dcwv	COE-5
C14A	1500 µf			
C14B	750 µf		10 dcwv	COE-9
C14C	750 µf			
C15A	90 µf			
C15B	30 µf		300 dcwv	COE-52
C15C	30 µf			
C16A	90 µf			
C16B	30 µf		300 dcwv	COE-52
C16C	30 µf			

CAPACITORS (Cont)

C17A	50 µf			
C17B	25 µf		450 dcwv	COE-10
C17C	25 µf			
C18	.0047 µf	±20%	500 dcwv	COC-62(472D)
C19	.0047 µf	±20%	500 dcwv	COC-62(472D)
C20	10 µf		25 dcwv	COE-56
C21	.01 µf	±20%	500 dcwv	COC-62(103D)
C22	.047 µf	±10%	400 dcwv	COW-25(473C)

RECTIFIERS

RX1	2RED-1008	RX6	2RE-1002	RX10	2RE-1002
RX2	2RE-1002	RX7	2RE-1002	RX11	2RE-1002
RX3	2RE-1002	RX8	2RE-41	RX12	2RE-1002
RX4	2RE-1002	RX9	2RE-41	RX13	2RE-1002
RX5	2RE-1002				

TUBES

V1	12AX7	V4	5963	V6	6V6GT
V2	12AX7	V5	12AX7	V7	OA2
V3	12AX7				

MISCELLANEOUS

L1	FILTER			745-414
F1	FUSE	0.8 a	115 volt	FUF-1
F2	FUSE	0.8 a	115 volt	FUF-1
F1	FUSE	0.4 a	230 volt	FUF-1
F2	FUSE	0.4 a	230 volt	FUF-1
J1	JACK ASSEMBLY			1263-B-200
J2	JACK			CDSJ-11R
J3	JACK			CDSJ-11B
J4	JACK			CDSJ-820
M1	METER			MEDS-100
P1	PILOT LAMP	Mazda #44		2LAP-939
	PILOT LAMP SOCKET			ZSOL-981
PL1	PLUG			CDPP-10
PL2	PLUG			CDMP-1264-2
SO1	SOCKET			CDMS-11-4
S1	SWITCH			SWRW-203
S2	SWITCH			SWT-333
S3	SWITCH			SWT-335
T1	TRANSFORMER			365-493

NOTE

Resistances are in ohms except as otherwise indicated by k (kilohms) or M (megohms). Capacitances are in picofarads except as otherwise indicated by µf (microfarads).

Type designations for resistors and capacitors are as follows:

POSC - Potentiometer, composition
POSW - Potentiometer, wire-wound
REC - Resistor, composition
REF - Resistor, film
REPO - Resistor, power
REW - Resistor, wire-wound

COC - Capacitor, ceramic
COE - Capacitor, electrolytic
COL - Capacitor, oil
COM - Capacitor, mica
COW - Capacitor, wax

Figure 13. Schematic Diagram of the Type 1263-B Amplitude-Regulating Power Supply.

DC VOLTAGES MEASURED TO GROUND BY VTVM WITH S1 = "OPERATE" R2 = CCW, R8 = CCW, S3 = "CW" (NO EXTERNAL LOAD CONNECTIONS)

NOTES:

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 OHMS M = 1 MEGOHM

CAPACITANCE VALUES ONE AND OVER IN MICROMICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

⊘ SCREWDRIVER ADJUSTMENT
○ KNOB CONTROL

ANCHOR TERMINALS USED: 1 TO 19, 21 TO 38, 8

TEST POINT USED: T.P. 1

*JUMPER NORMALLY IN PLACE. REMOVE FOR OSC. HEATERS REQUIRING LESS THAN 0.2 AMP.

NOTE:
FOR 115V OPERATION CONNECT: 1 TO 3 AND 2 TO 4
F1 & F2 = 8/10 AMP SLO-BLO
FOR 230V OPERATION CONNECT: 2 TO 3
F1 & F2 = 4/10 AMP SLO-BLO

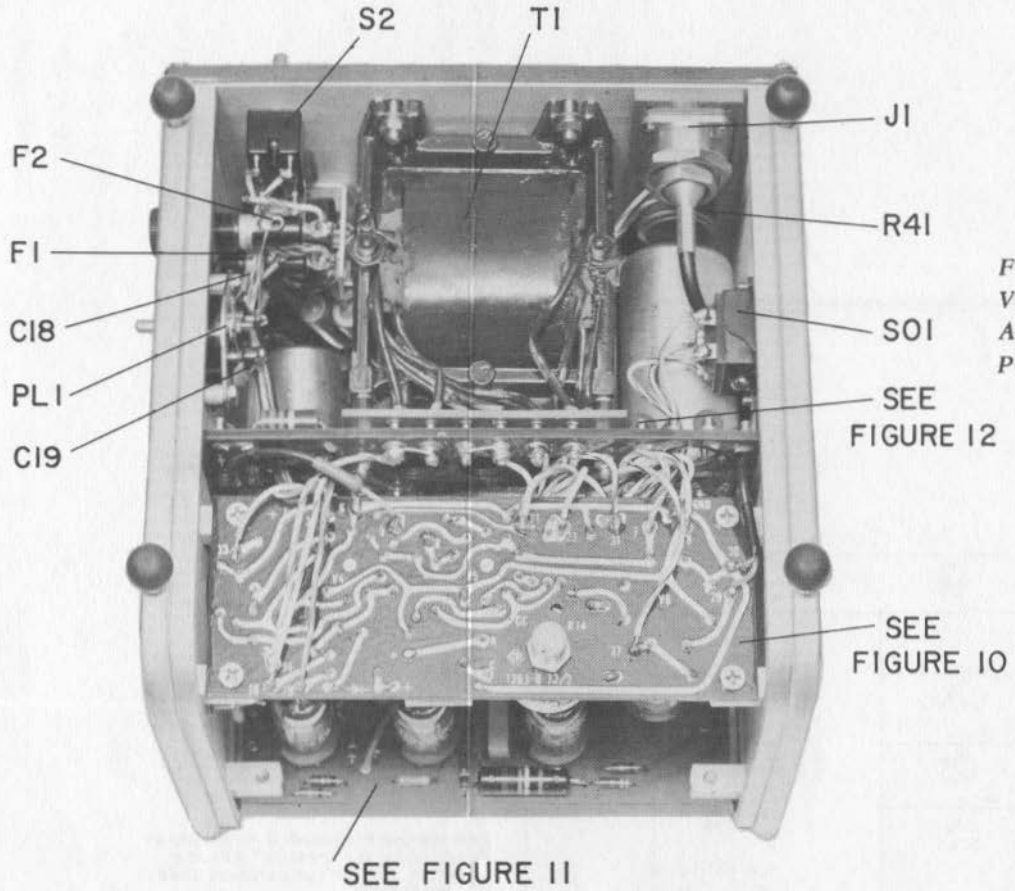

Figure 8. Bottom Interior View of the Type 1263-B Amplitude-Regulating Power Supply.

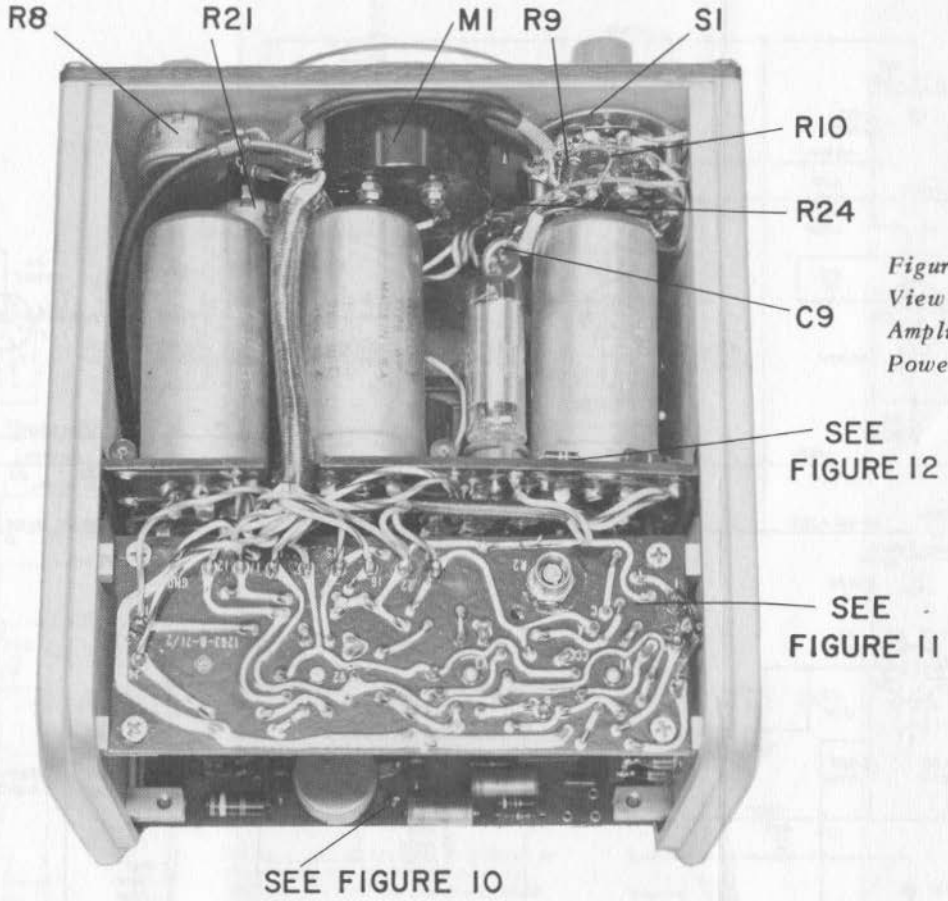

Figure 9. Top Interior View of the Type 1263-B Amplitude-Regulating Power Supply.

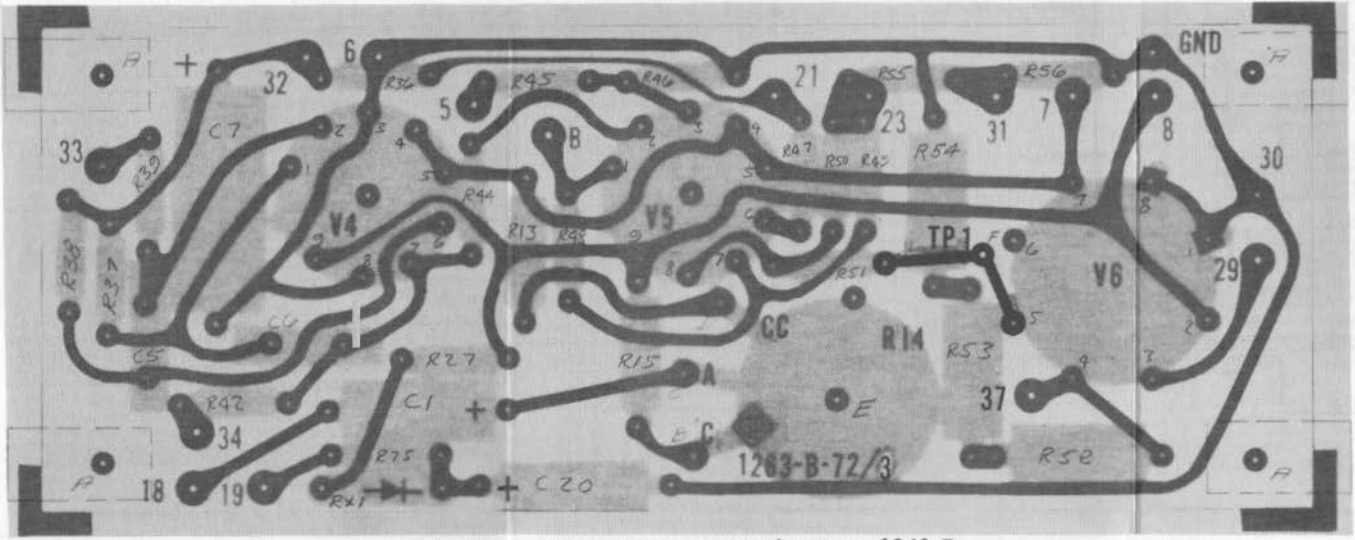

Figure 10. Etched-Board Layout for the Type 1263-B.

WBOUN

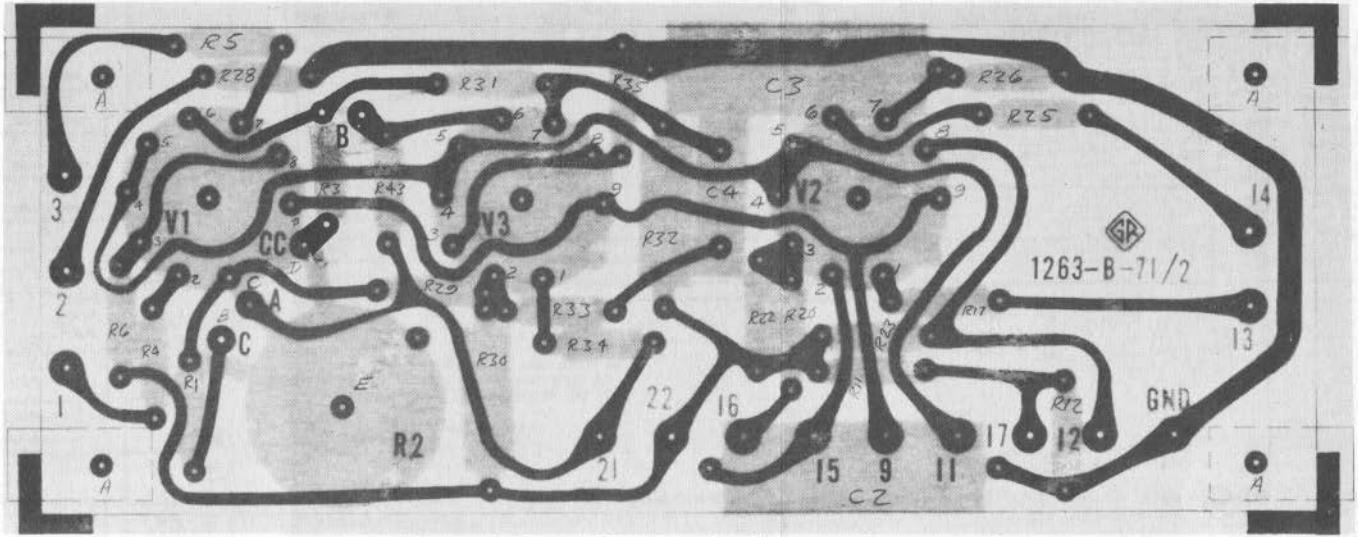

Figure 11. Etched-Board Layout for the Type 1263-B.

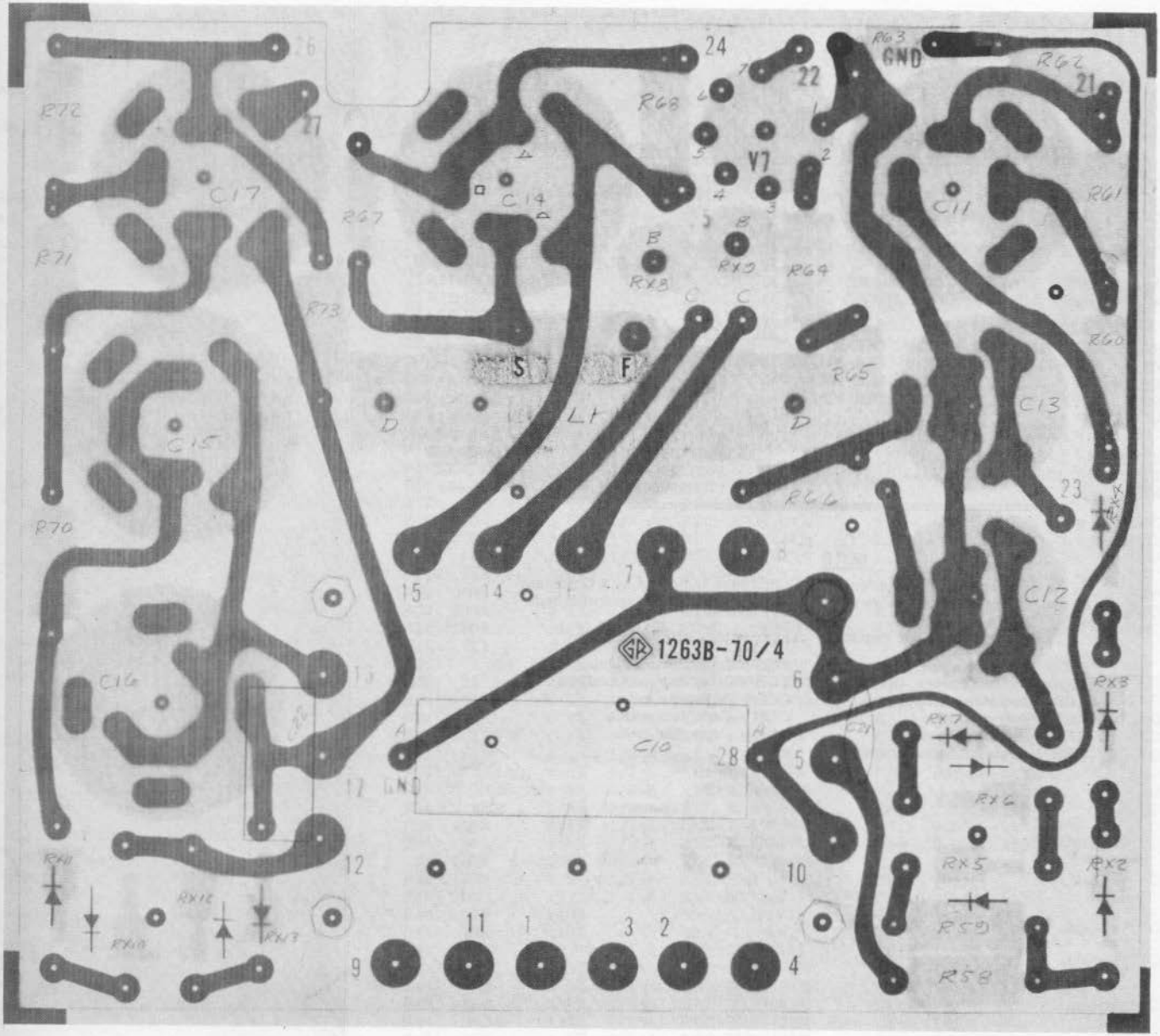

Figure 12. Etched-Board Layout for the Type 1263-B.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

EMerson 9-4400 Mission 6-7400

DISTRICT OFFICES

NEW YORK

Broad Ave. at Linden, Ridgefield, N. J.
Telephone N.Y. WOrth 4-2722
N.J. WHitney 3-3140

SYRACUSE

Pickard Bldg.
East Molloy Rd., Syracuse 11, N. Y.
Telephone GLenview 4-9323

PHILADELPHIA

1150 York Rd., Abington, Penna.
Telephone TUrner 7-8486
Phila., HAncock 4-7419

WASHINGTON

8055 13th St., Silver Spring, Md.
Telephone JUniper 5-1088

FLORIDA

113 East Colonial Drive, Orlando, Fla.
Telephone GArden 5-4671

CHICAGO

6605 West North Ave., Oak Park, Ill.
Telephone Village 8-9400

LOS ANGELES

1000 N. Seward St., Los Angeles 38, Calif.
Telephone HOllywood 9-6201

SAN FRANCISCO

1186 Los Altos Ave., Los Altos, Calif.
Telephone WHitecliff 8-8233

CANADA

99 Floral Pkwy., Toronto 15, Ont.
Telephone CHerry 6-2171

REPAIR SERVICES

EAST COAST

General Radio Company
Service Department
22 Baker Ave., W. Concord, Mass.
Telephone EMerson 9-4400

NEW YORK

General Radio Company
Service Department
Broad Ave. at Linden, Ridgefield, N. J.
Telephone N.Y. WOrth 4-2722
N.J. WHitney 3-3140

MIDWEST

General Radio Company
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Printed in U.S.A.