SPECIFICATIONS

Power Supply: Motor: 105–120 volts, 50–60 cycles, 3 watts. Potentiometer, see below.
Dimensions: 907-R, 4 (diameter) x 3⅞ (deep) inches.
908-R, 5¾ (diameter) x 3⅞ (deep) inches.
Weight: 907-R, one pound, 11 ounces.
908-R, two pounds.
Note: Data are for 60-cycle operation. Multiply speeds by ⅚ for 50-cycle operation.

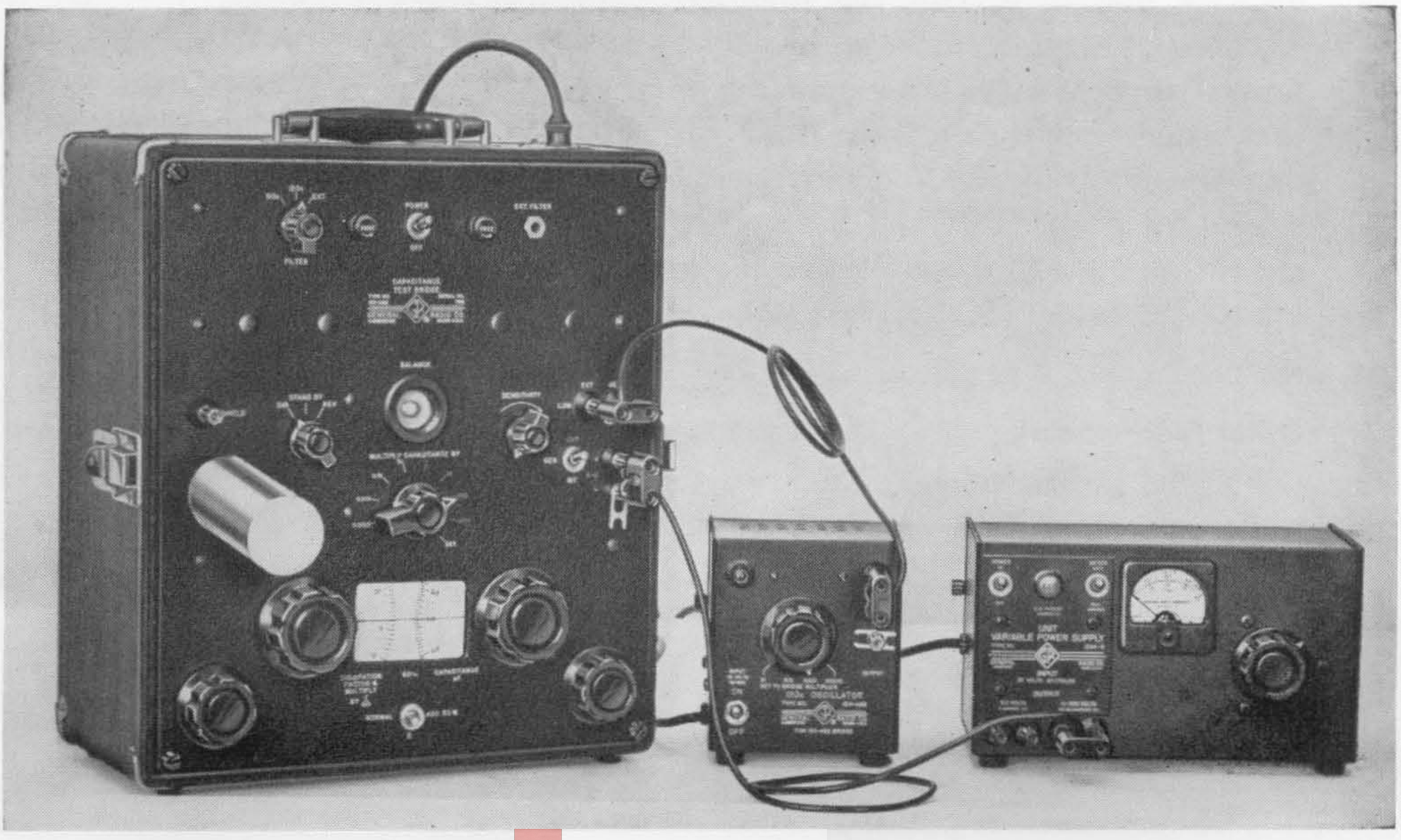
Type	*Dial*	*Pinion Speed*	*Dial Speed*	*Rotation*	*Center-tapped Potentiometer Resistance*	*Max Potentiometer Current*	*Resolution*
907-R18	907	½ RPM	18°/min	CCW	20 kΩ	10 ma	0.4°
907-R144	907	4 RPM	144°/min	Self-reversing	20 kΩ	10 ma	0.4°
908-R12	908	½ RPM	12°/min	CCW	50 kΩ	10 ma	0.2°
908-R96	908	4 RPM	96°/min	Self-reversing	50 kΩ	10 ma	0.2°

Type		*Code Word*	*Price*
907-R18	**X-Y Dial Drive**	EARLY	**$55.00**
907-R144	**X-Y Dial Drive**	EDUCE	**55.00**
908-R12	**X-Y Dial Drive**	EGRET	**55.00**
908-R96	**X-Y Dial Drive**	EJECT	**55.00**

A 120-CYCLE SOURCE FOR ELECTROLYTIC CAPACITOR TESTING WITH THE CAPACITANCE TEST BRIDGE

In most applications of electrolytic capacitors, a significant 120-cycle ripple component is superimposed on the applied unidirectional voltage. For this reason it has become widely accepted standard practice to test such capacitors at that frequency rather than at the more readily available 60 cycles. To meet this requirement, a modification of the 60-cycle TYPE 1611-A Capaci-

Figure 1. View of the Capacitance Test Bridge (left) with 120-cycle oscillator (center) and Unit Variable Power Supply (right) for furnishing the d-c polarizing voltage.



tance Test Bridge has been available for some time.[1] The modification as shown in the schematic diagram (Figure 2), consists primarily of the addition of terminals for connection of an external generator and of providing 120-cycle tuning for the internal detector. Switching is provided so that either the standard circuit or the special configuration can be used.

Because the input impedance to the bridge varies between 1 ohm and 1000 ohms, most available audio oscillators are not capable of delivering enough voltage directly to the bridge over its entire range for adequate sensitivity of balance. A multiwinding impedance-matching transformer is frequently required to deliver adequate energy to the bridge, particularly for the 1000 multiplier setting, and, in any event, a transformer is required to isolate the a-c source from the d-c polarizing voltage.

A recent modification of the TYPE 1214-A Unit Oscillator, the TYPE 1214-AS2 120-cycle Oscillator, has a power output approaching the maximum that the bridge arms will withstand. This inexpensive oscillator provides the 120-cycle source, the impedance matching, and the isolation. An output transformer is provided, tapped to provide optimum match to the bridge for each of the four applicable multipliers. A panel switch selects the proper tap, and the engraving corresponds to the multiplier markings of the bridge, X1, X10, X100, and X1000.

Other Frequencies

For the measurement of electrolytic capacitors over a range of low audio frequencies, it is convenient to make use of the impedance-matching transformer and switching provided in the new oscillator. Accordingly, a jack is provided on the panel of the oscillator by means of which an external source can be connected.

The bridge circuit is designed for optimum sensitivity at 60 cycles, and substantially the same performance is obtained at 120 cycles. As the measuring frequency is raised, however, the bridge sensitivity factor decreases and above about 400 cycles is inversely protional to frequency. Figure 3 shows the variation of the bridge sensitivity factor[2] S for the different settings of the CAPACITANCE dial. The sensitivity factor is independent of multiplier setting, but the voltage applied to the bridge varies with ratio arm setting, as

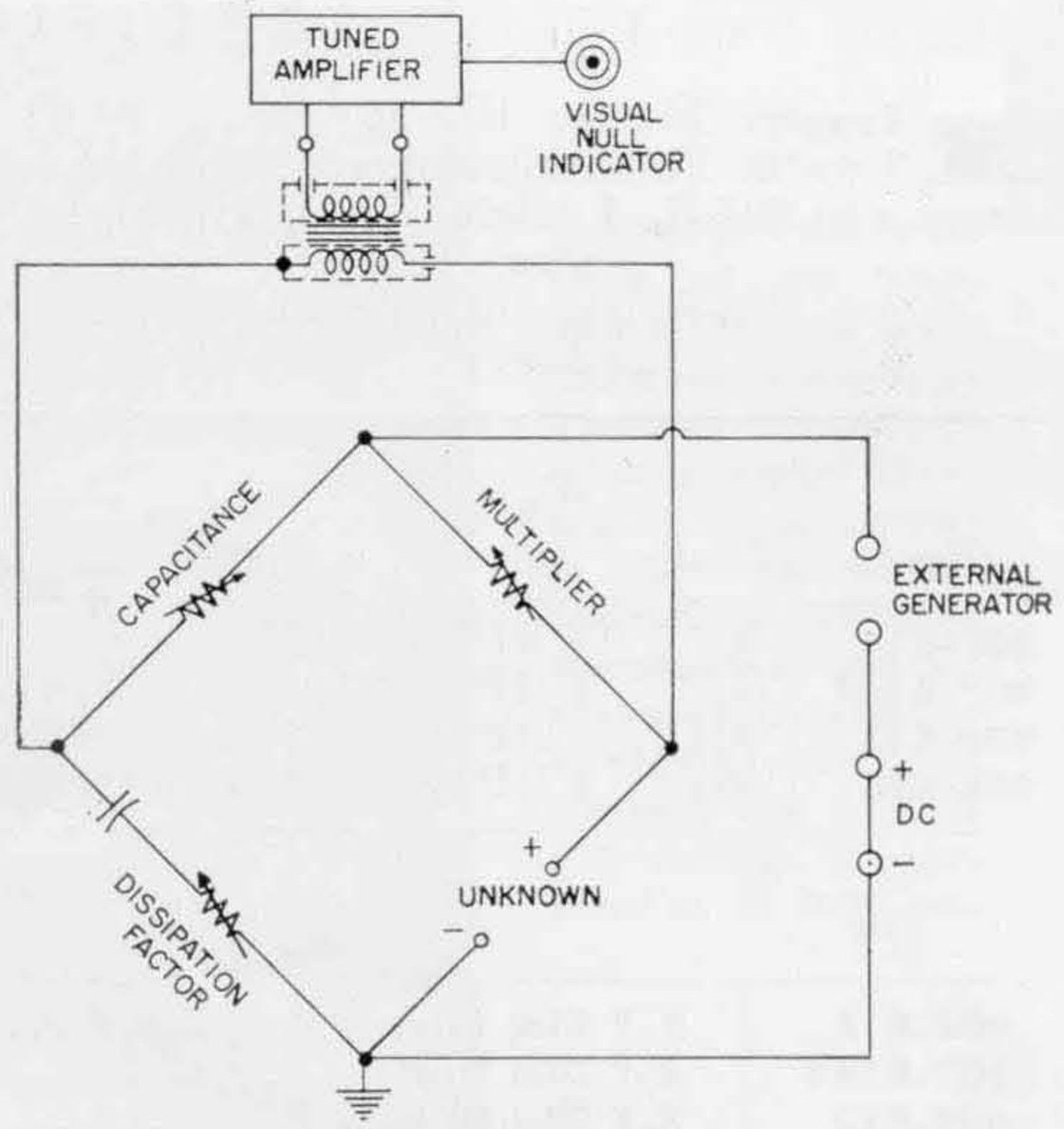


Figure 2. Elementary schematic of the bridge.

"Electrolytic Capacitor Testing at 120 Cycles", *General Radio Experimenter*, Vol. 28, No. 6, November, 1953, p. 8.

[2] Defined as $S = \dfrac{\dfrac{Za}{Zb}}{1+\dfrac{Za}{Zb}}\,d$, where d is the precision of setting of the reactive balance

shown in the following table.

Bridge Multiplier	*Approx. Voltage (rms) Applied to Bridge*
× 1	18
× 10	6
× 100	2
× 1000	0.6

The upper frequency limit for satisfactory operation is thus a function not only of available detector sensitivity and applied voltage but also of the magnitude of the capacitance being measured and of the accuracy of measurement desired. With the internal detector, measurements can be made at 1 kilocycle on even the highest multiplier with a resolution of about 1%. If higher resolution is desired, a more sensitive detector can be connected externally to the external-filter jack of the bridge. For best results the external detector should have a 20-db discrimination to harmonics and noise.

Dissipation Factor

The dissipation factor range of the bridge is directly proportional to frequency. At 60 cycles the range is 0.6 (60%), at 120 cycles 1.2 (120%) and at 400 cycles 4.0 (400%). This variation is compatible with the normal tendency of high-value electrolytic capacitors to show dissipation factors rising with frequency as a result of fixed series resistance.

The effective accuracy of dissipation factor measurement decreases at the high frequencies. In addition to the problem of residual phase-angle errors within the bridge, the problem of making a satisfactorily low resistance connection to the capacitor under measurement is a serious one. For example, at 10,000 μf and 1000 cycles a series resistance of 0.001 ohm in lead or connection produces a dissipation factor of 0.6 (60%). For such an extreme case the limitation on accuracy is external to the bridge; for less extreme combinations of frequency and capacitance the accuracy of dissipation factor is ±2% of dial reading ±.0005 (f/60).

Applied Voltage

The a-c voltage applied to the capacitor under test is always somewhat lower than the voltage applied to the bridge, shown in the table above, since the ratio arm is in series with the unknown. The d-c polarizing voltage should normally be greater than the peak value of a-c test voltage. The voltages applied by the TYPE 1214-AS2 Oscillators are safely below ordinary voltage ratings for any given range. If, however, reduced test voltage is desired for capacitors of very low d-c rating or for any other reason, an adjustable resistor may be connected (in series or shunt) between the oscillator and the bridge to set to an arbitrarily specified level.

— I. G. EASTON

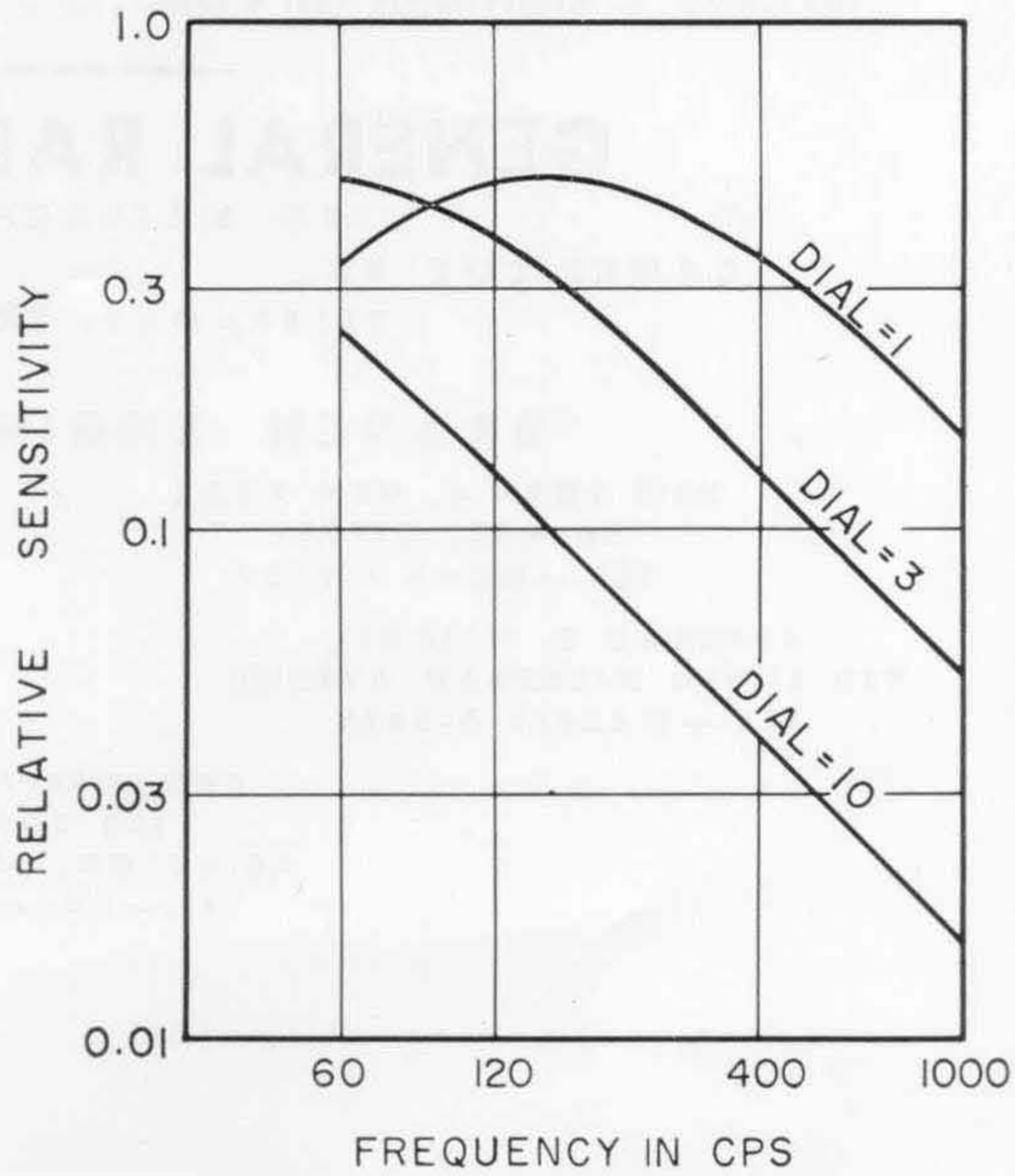


Figure 3. Variation of bridge sensitivity with frequency for different settings of the CAPACITANCE dial.

SPECIFICATIONS FOR TYPE 1214-AS2 UNIT OSCILLATOR

Frequency: 120 cycles ±2%.
Output Impedance: Four impedances to match the impedance of the TYPE 1611-AS2 Capacitance Test Bridge at four multiplier positions.
Output: At least 200 milliwatts into matched load.
Controls: Output impedance switch and power switch.
Distortion: Less than 3% into a matched load.
Terminals: The output terminals are jack-top binding posts with standard ¾-inch spacing; a ground terminal is provided, adjacent to one of the output terminals. Jack is provided for connecting external oscillator.
Power Supply: Unlike most instruments of the Unit line, the power supply is built into the instrument; 115 volts, 40–60 cycles; power consumption is about 16 watts.
Accessories Supplied: Spare fuses; the power cord is integral with the unit.
Tube: One 117N7-GT, which is supplied with the instrument.
Mounting: Aluminum panel and sides finished in black-crackle lacquer. Aluminum dust cover finished in clear lacquer. Relay-rack adaptor panel available.
Dimensions: (Height) 5¾ x (width) 5 x (depth) 6¼ inches, over-all, not including power-line connector cord.
Net Weight: 4½ pounds.

SPECIFICATIONS FOR TYPE 1611-AS2 CAPACITANCE TEST BRIDGE

Capacitance Range: 0 to 11,000 μf at 60 cycles. 1 μf to 11,000 μf at 120 cycles or other external frequency.
Dissipation-Factor Range: 0 to 60% at 60 cycles. Range proportional to frequency. (0 to 120% at 120 cycles.) Dial readings must be multiplied by the ratio $\frac{f}{60}$ for frequencies other than 60 cycles.
Accuracy: Capacitance ±1%. Dissipation factor ±(2% of dial reading +0.05% x $\frac{f}{60}$ dissipation factor).
Detector Filter: Tuned to 60 or 120 cycles, selected by switch. Jack provided for use of an external filter for other frequencies.
External Generator: Required for frequencies other than 60 cycles. TYPE 1214-AS2 Oscillator described below is recommended for 120-cycle measurements.
Polarizing Voltage: Terminals are provided for connecting an external d-c polarizing voltage. The maximum voltage that should be impressed is 500 volts.

One of the terminals is grounded so that any a-c operated power supply with grounded output can be used. The terminal capacitances of the power supply do not affect the bridge circuit.

Power Supply Voltage: 105 to 125 (or 210 to 250) volts, 60 cycles. **Power Input:** 15 watts.
Accessories Supplied: TYPE CAP-35 Power Cord and spare fuses.
Mounting: Portable carrying case of luggage-type construction. Case is completely shielded to insure freedom from electrostatic pickup.
Tube Complement: One each 6X5-GT/G, 6SJ7, and 6U5.
Net Weight: 30½ pounds.
Dimensions: (Width) 14½ x (depth) 16 x (height) 10 inches, over-all, including cover and handles.

Type		*Code Word*	*Price*
1214-AS2	Unit Oscillator (including power supply).....	ABBOT	$95.00
1611-AS2	Capacitance Test Bridge.....	FAVOR	$545.00

GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE
CAMBRIDGE 39 MASSACHUSETTS
TELEPHONE: TRowbridge 6-4400

BRANCH ENGINEERING OFFICES

NEW YORK 6, NEW YORK
90 WEST STREET
TEL.—WOrth 4-2722

LOS ANGELES 38, CALIFORNIA
1000 NORTH SEWARD STREET
TEL.—HOllywood 9-6201

CHICAGO 5, ILLINOIS
920 SOUTH MICHIGAN AVENUE
TEL.—WAbash 2-3820

SILVER SPRING, MARYLAND
8055 13th STREET
TEL.—JUniper 5-1088

PHILADELPHIA OFFICE
1150 YORK ROAD
ABINGTON, PENNSYLVANIA
TEL.—HAncock 4-7419

PRINTED IN U.S.A.