SPECIFICATIONS

Range: 0.05 to 3000 volts in seven ranges (3, 10, 30, 100, 300, 1000, 3000 volts, full scale).

Accuracy: Within ±3% of full scale for the lower voltage ranges (3, 10, 30 volts, full scale). Within ±5% of full scale for the higher voltage ranges (100, 300, 1000, 3000 volts, full scale). Battery aging may cause an additional error of 2% of full scale on the 3-volt range.

Input Resistance: 1000 megohms on the higher voltage ranges (100, 300, 1000, 3000 volts, full scale). Greater than 5000 megohms on the low voltage ranges.

Terminals: Two sets of input terminals are provided on the panel. One set is used for measurements at the low voltage end of the range (0 to 30 volts) and the other set is used for the higher voltage measurements (30 to 3000 volts).

Polarity: A reversing switch on the panel permits measurements with either the positive or the negative terminal of the source grounded to the panel of the instrument.

Effect of A-C: A superimposed a-c voltage of as high as 200 volts has a negligible effect on the meter indication.

Tube: The tube, a type 1E5-GP, is supplied.

Batteries: The batteries required are three Burgess W30BP or equivalent and one Burgess F2BP or equivalent. A compartment is provided in the case of the instrument for holding all batteries. A set of batteries is supplied with the instrument.

Mounting: The instrument is supplied in a walnut case with cover and is mounted on an engraved black crackle-finish aluminum panel.

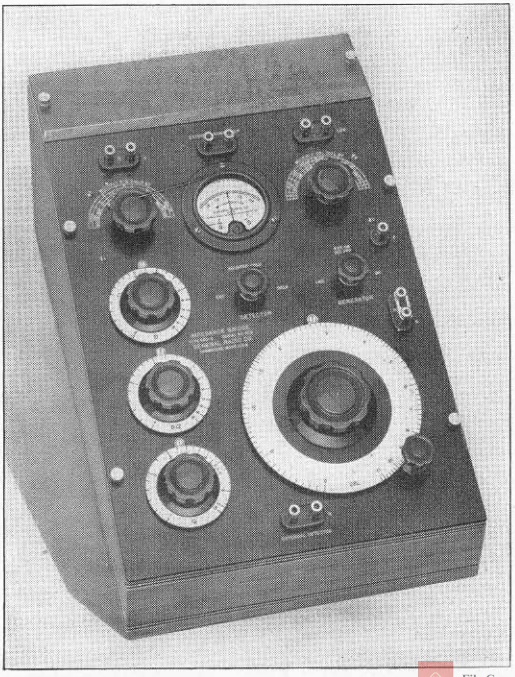
Dimensions: With cover closed, (length) 11 x (width) 6⅝ x (height) 5⅞ inches, over-all.

Net Weight: 9¾ pounds, including batteries.

Type		*Code Word*	*Price*
728-A	D-C Vacuum-Tube Voltmeter. .	PILOT	$110.00

MUTUAL INDUCTANCE MEASUREMENT WITH THE TYPE 650-A IMPEDANCE BRIDGE

● IN BOTH THE LABORATORY and the factory, the TYPE 650-A Impedance Bridge provides a rapid means of checking inductors, capacitors, and resistors with an accuracy sufficient for nearly all commercial requirements. In addition, this bridge can be adapted for many specialized measurements beyond the scope of its original design. A good example is furnished by a problem recently encountered in the measurement of the mutual inductance of automotive ignition coils and magnetos.



A TYPE 650-A Impedance Bridge was available for this measurement, and a consideration of the circuit showed that the instrument could easily be converted

FIGURE 1. View of the TYPE 650-A Impedance Bridge.

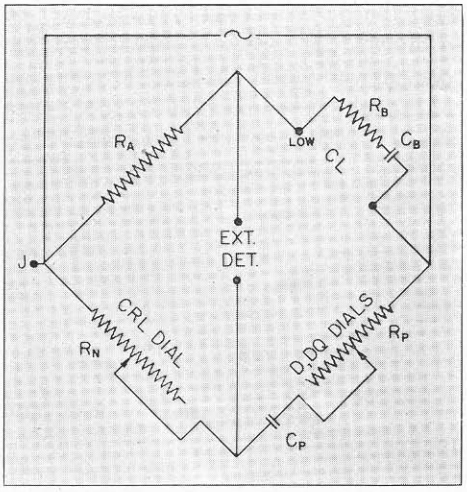


FIGURE 2. Schematic circuit diagram for the TYPE 650-A Impedance Bridge as used for capacitance measurements.

to a Carey-Foster type of mutual inductance bridge.*

The schematic bridge circuit for *capacitance* measurements is shown in Figure 2. To convert to a Carey-Foster bridge, the A-arm is shorted, and the unknown inductor and an external resistor are connected as shown in Figure 3. Shorting of the A-arm is accomplished by connecting the junction J to the high EXT DET terminal or to the low CL terminal. One winding of the ignition coil is connected to the CL terminals in series with the external resistor. The other winding is placed in series with the head telephones. The external resistor may, for convenience, be a decade resistance box of 100,000 ohms maximum setting. A known fixed resistor of suitable magnitude is equally satisfactory.

Balance is obtained by varying the CRL dial and either the D or the DQ dial. The mutual inductance, M, is then given by

$$M = R_N(R_B + R_L)C_P$$

*Other methods of measuring mutual inductance were discussed in an article by R. F. Field, "The Measurement of Mutual Inductance," General Radio *Experimenter*, January, 1937.

where R_N is the reading of the CRL dial multiplied by 1000, R_B is the external resistor in the B-arm, R_L is the effective resistance of the inductor, and C_P is the capacitance of the standard mica condenser in the P-arm, 10^{-8} farads.

The inductance of the winding connected in the P-arm can be determined from the expression

$$L = (R_N + R_P)(R_B + R_L)C_P.$$

The resistance R_P depends upon the setting of the D or DQ dial at balance. The choice of the dial to be used is determined by the resistance needed for balance. The maximum resistance of the D dial is 1650 ohms, while that of the DQ dial is 16,500 ohms. The magnitude of R_P is calculated from the expression

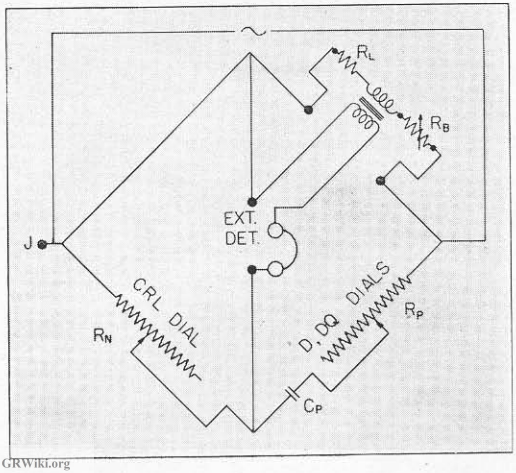
$$R_P = \frac{D}{6.28 \times 10^{-5}}$$

where D is the dial reading multiplied by the factor indicated by the multiplier switch setting.

The resistance, R_B, of the decade box should be large compared to R_L, the effective resistance of the coil under measurement, so that R_L can be neglected. For this condition,

$$M = R_N R_B C_P$$

FIGURE 3. Modification of the circuit of Figure 2 for measurements of mutual inductance.



and

$$L = (R_N + R_P)(R_B C_P).$$

When R_L is not negligible compared to R_B, the inductance and storage factor Q of the coil can be first measured with the bridge connected for inductance measurement, and the value R_L then calculated.

In the particular application referred to above, the measurement of ignition coils, it was found that the low tension coil should be connected to the P-arm of the bridge in order that balance be within range of the bridge controls.

— L. E. PACKARD

CHICAGO DISTRICT OFFICE
920 South Michigan Avenue

● AS MANY OF OUR READERS in the Chicago area know, the General Radio Company has been operating an Engineering and Sales Office since December 1, 1943, on South Michigan Avenue. Mr. L. E. Packard from our Cambridge engineering staff is in charge, and is already well known to many of our Chicago friends. Mr. Packard is thoroughly acquainted with the uses and applications of General Radio products, and is always glad to pass along technical information gained through his experience in the measurement field. The facilities of the office are available not only to our customers in greater Chicago, but to all in the Mid-West area who find it more convenient to communicate with

View of the interior of the General Radio Company's Chicago Office.