VARIABLE INDUCTORS FOR BRIDGE MEASUREMENTS

IT is a peculiarity of bridge measurements practice that, while variable (continuously adjustable) capacitance standards are almost universally used in preference to fixed standards, a general preference for fixed inductance standards over variable standards has prevailed. There are, as a matter of fact, many cases where measurement methods can be improved by the use of a continuously adjustable inductor or variometer.

The use of such an instrument permits the use of equal arm bridges for inductance measurements. Equal arm bridges have very distinct advantages, particularly at higher frequencies, over bridges where adjustable bridge arms are relied upon for a bridge balance.

The whole technique of precision capacitance measurements has been developed around equal-arm bridge substitution methods. The same technique can be adapted for inductance measurements with advantage in many cases, although variable inductance standards have not been developed to as high a degree of precision as have variable standards of capacitance. The variometer balance is of particular value where repeated measurements are made on units of approximately the same size, as this type of standard is very well adapted to a limit bridge.

A variometer for laboratory bridge work should have an inductance which will remain constant to within narrow limits over a wide frequency range. The resistance should be low. In some applications ruggedness and ability to stand large currents are important.

Undoubtedly one of the reasons why the substitution method has not been more generally adopted for inductance measurements is the limitations of the available types of laboratory variometer. The General Radio line of laboratory variometers, TYPE 107, has recently been rather extensively redesigned and improved with this type of application in view. The new variometers are now available in stock.

One of the new TYPE 107-M Variable Inductors with rotor and stator connected in parallel

The new TYPE 107 Variable Inductors are wound with stranded wire having individual strands separately insulated from each other in order to keep down high-frequency resistance. The coils are impregnated and baked in a high-melting-point material so that the variometers can be run 40 degrees centigrade above room temperature without damage. The mechanical arrangement of windings has been changed so as to provide a more nearly linear calibration and a new type of slow-motion dial has been provided.

In order to provide the maximum inductance range for each variometer, provision is made for connecting the coils either in series or in parallel. The rotor and stator inductances are made equal so that there is no circulating current when the coils are connected in parallel. The parallel inductance at any setting is one quarter of the series inductance at the same setting. The inductance is nearly constant over a wide frequency range and is increased by only 2% at 1/10 the natural frequency of the coil.

Values of maximum and minimum inductance and d.-c. resistance for the series connection are marked on the nameplate of each instrument. Calibrations, accurate to 1%, for the entire range of the series connection at 1000 cycles per second may be obtained at a small additional charge.

The resistance is of course a function of frequency and varies approximately with the square root of frequency. The direct-current resistance which is substantially the same as the 1000-cycle resistance is measured for each variometer and this value is supplied with the instrument. The table here lists the value of Q[1] at that frequency for which it is a maximum for each coil. These values are for the coil at full inductance setting.

All of the new variometers have a 15-watt dissipation for a 40 degree centigrade rise. At this wattage and temperature there is a 16% increase in the direct-current resistance.

The table below lists new Type 107 Variable Inductors. Ranges have been generally readjusted and a new instrument has been added so that variometers are now available for inductances from 0.005 millihenrys to 500 millihenrys. The values listed below are average values for the several ranges of variometer. The resistance given is the direct current resistance measured at room temperature. The current value is that producing 40 degree temperature rise. Maximum and minimum inductances are given for the series connection. The natural frequency for maximum setting of each variometer is given. The maximum value of Q and the frequency at which it occurs are also listed for each coil at maximum inductance setting.

Qty.	R_0	I	Lmin.	Lmax.	f_0	Q at f	
Unit	Ω	a	mh	mh	kc		kc
107-J	0.17	8.5	0.005	0.05	5000	110	400
107-K	0.7	4.0	0.05	0.5	1500	140	200
107-L	4.0	1.7	0.5	5	500	125	60
107-M	40	.60	5	50	150	65	20
107-N	64	.14	50	500	30	20	7

The price of the new Types 107-J, K, L and M Inductors is $30; that of Type 107-N is $40.

— Charles T. Burke

[1] Q is the quantity, sometimes called dissipation factor, that expresses the excellence of a given inductor when used as a tuning element. It is the ratio of reactance to resistance $\left(\frac{\omega L}{R}\right)$ at the frequency in question.

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