MAXWELL'S BRIDGE 11.11

Maxwell's bridge, shown in Fig. 11.22, measures an unknown inductance in terms of a known capacitor. The use of standard arm offers the advantage of compactness and easy shielding. The capacitor is almost a loss-less component. One arm has a resistance R_1 in parallel with C_1, and hence it is easier to write the balance equation using the admittance of arm 1 instead of the impedance.

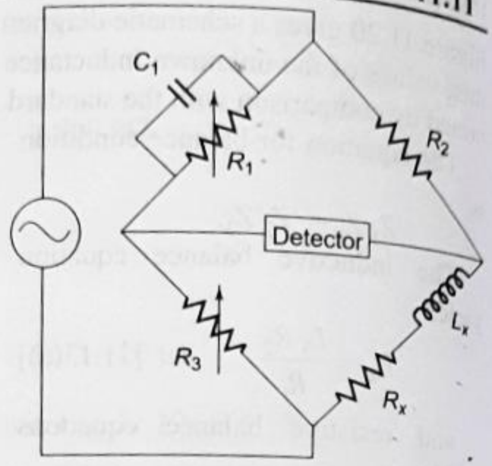

Fig. 11.22 Maxwell's bridge

The general equation for bridge balance is

$$Z_1 Z_x = Z_2 Z_3$$

i.e.

$$Z_x = \frac{Z_2 Z_3}{Z_1} = Z_2 Z_3 Y_1 \tag{11.14}$$

Where $Z_1 = R_1$ in parallel with C_1 i.e. $Y_1 = \frac{1}{Z_1}$

$$Y_1 = \frac{1}{R_1} + j\omega C_1$$

$$Z_2 = R_2$$

$$Z_3 = R_3$$

$Z_x = R_x$ in series with $L_x = R_x + j\omega L_x$

From Eq. (11.14) we have

$$R_x + j\omega L_x = R_2 R_3 \left(\frac{1}{R_1} + j\omega C_1 \right)$$

$$R_x + j\omega L_x = \frac{R_2 R_3}{R_1} + j\omega C_1 R_2 R_3$$

Equating real terms and imaginary terms we have

$$R_x = \frac{R_2 R_3}{R_1} \text{ and } L_x = C_1 R_2 R_3 \tag{11.15}$$

Also

$$Q = \frac{\omega L_x}{R_x} = \frac{\omega C_1 \cancel{R_2} \cancel{R_3} \times R_1}{\cancel{R_2} \cancel{R_3}} = \omega C_1 R_1$$

Maxwell's bridge is limited to the measurement of low Q values (1 – 10). The measurement is independent of the excitation frequency. The scale of the resistance can be calibrated to read inductance directly.

The Maxwell bridge using a fixed capacitor has the disadvantage that there is an interaction between the resistance and reactance balances. This can be avoided by varying the capacitances, instead of R_2 and R_3, to obtain a reactance balance. However, the bridge can be made to read directly in Q.