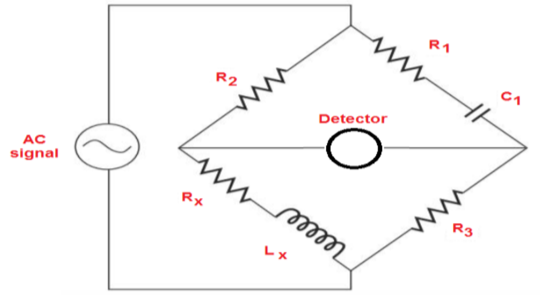
Hay bridge



$$R_x = \frac{R_2 R_3}{R_1[1+Q^2]}$$

$$L_x = \frac{C_1 R_2 R_3}{[1+\frac{1}{Q^2}]}$$

$$Q = \frac{1}{WC_1 R_1}$$

The Hay bridge differs from Maxwell's bridge by having a resistance R1 in series with a standard capacitor C1 instead of a parallel. The term W appears in the expression for both Lx and Rx. which indicates that the bridge is frequency sensitive.

- Used for inductance measurements of high Q (>10).
- Measure from 1 µH to 1000 H with an accuracy of ± 2 %.
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At balance $\quad Z_1 Z_x = Z_2 Z_3$, where

$$Z_1 = R_1 - j/\omega C_1$$
$$Z_2 = R_2$$
$$Z_3 = R_3$$
$$Z_x = R_x + j\omega L_x$$

Substituting these values in the balance equation we get

$$\left(R_1 - \frac{j}{\omega c_1}\right)(R_x + j\omega L_x) = R_2 R_3$$

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

Equating the real and imaginary terms we have

$$R_1 R_x + \frac{L_x}{C_1} = R_2 R_3 \quad (1) \quad \text{and} \quad \frac{R_x}{\omega C_1} = \omega L_x R_1 \quad (2)$$

Solving for L_x and R_x we have, $R_x = \omega^2 L_x C_1 R_1$.

Substituting for R_x in Eq. (1)

$$R_1(\omega^2 R_1 C_1 L_x) + \frac{L_x}{C_1} = R_2 R_3$$

$$\omega^2 R_1^2 C_1 L_x + \frac{L_x}{C_1} = R_2 R_3$$

Multiplying both sides by C_1 we get

$$\omega^2 R_1^2 C_1^2 L_x + L_x = R_2 R_3 C_1$$

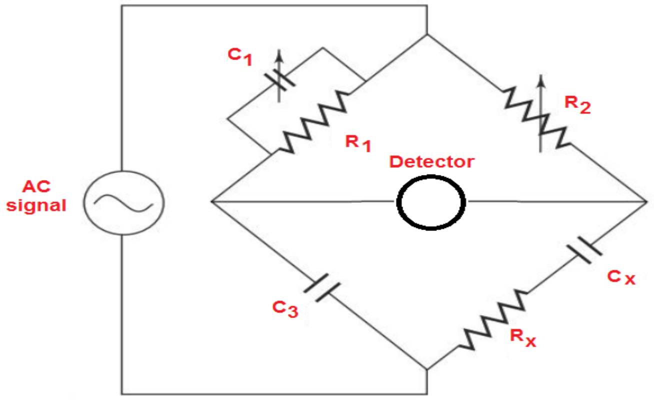
$$L_x = \frac{R_2 R_3 C_1}{1+\omega^2 R_1^2 C_1^2} \quad (3)$$

Substituting for L_x in Eq. (2)

$$R_x = \frac{\omega^2 C_1^2 R_1 R_2 R_3}{1+\omega^2 R_1^2 C_1^2} \quad (4)$$

The term ω appears in the expression for both L_x and R_x.
This indicates that the bridge is frequency sensitive.

SCHERING BRIDGE



$$R_x = \frac{R_2 C_1}{C_3}$$

$$C_x = \frac{C_3 R_1}{R_2}$$

Used for the measurement of capacitors.

- Used for bridge measurements in the range of 100pF -1µF with accuracy of ± 0.2 %.

For balance, the general equation is

$$Z_1 Z_x = Z_2 Z_3 \quad \textbf{(1)}$$

$$Z_x = \frac{Z_2 Z_3}{Z_1}, \; Z_x = Z_2 Z_3 Y_1$$

$$Z_x = R_x - j/\omega C_x$$

$$Z_2 = R_2$$

$$Z_3 = -j/\omega C_3$$

$$Y_1 = 1/R_1 + j\,\omega C_1$$

$$Z_x = Z_2 Z_3 Y_1$$

$$\left(R_x - \frac{j}{\omega C_x}\right) = R_2 \left(\frac{-j}{\omega C_3}\right) \times \left(\frac{1}{R_1} + j\omega C_1\right)$$

$$\left(R_x - \frac{j}{\omega C_x}\right) = \frac{R_2(-j)}{R_1(\omega C_3)} + \frac{R_2 C_1}{C_3}$$

Equating the real and imaginary terms, we get

$$R_x = \frac{R_2 C_1}{C_3} \quad \textbf{(2)} \qquad C_x = \frac{R_1}{R_2} C_3 \quad \textbf{(3)}$$