The Wien bridge shown in Fig. 11.28 has a series RC combination in one arm and a parallel combination in the adjoining arm. Wien's bridge in its basic form, is designed to measure frequency. It can also be used for the measurement of an unknown capacitor with great accuracy.

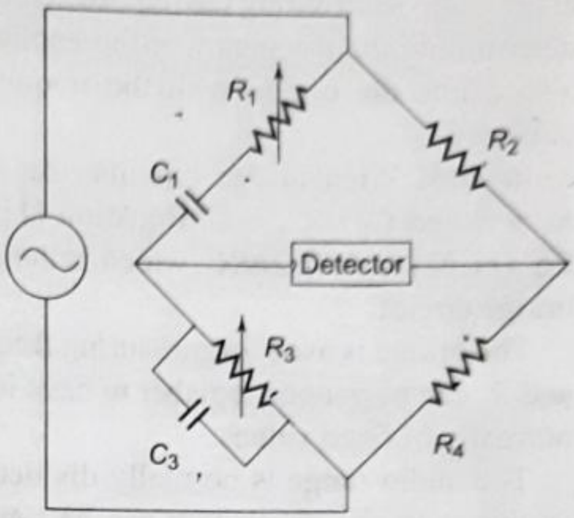

Fig. 11.28 Wein's bridge

The impedance of one arm is

$$Z_1 = R_1 - j/\omega C_1.$$

The admittance of the parallel arm is

$$Y_3 = 1/R_3 + j\,\omega\, C_3.$$

Using the bridge balance equation, we have $Z_1 Z_4 = Z_2 Z_3$.

Therefore, $Z_1 Z_4 = Z_2/Y_3$, i.e. $Z_2 = Z_1 Z_4 Y_3$.

$$\therefore \quad R_2 = R_4 \left(R_1 - \frac{j}{\omega C_1}\right)\left(\frac{1}{R_3} + j\omega C_3\right)$$

$$R_2 = \frac{R_1 R_4}{R_3} - \frac{j R_4}{\omega C_1 R_3} + j\,\omega\, C_3 R_1 R_4 + \frac{C_3 R_4}{C_1}$$

$$R_2 = \left(\frac{R_1 R_4}{R_3} + \frac{C_3 R_4}{C_1}\right) - j\left(\frac{R_4}{\omega C_1 R_3} - \omega C_3 R_1 R_4\right)$$

Equating the real and imaginary terms we have

$$R_2 = \frac{R_1 R_4}{R_3} + \frac{C_3 R_4}{C_1} \quad \text{and} \quad \frac{R_4}{\omega C_1 R_3} - \omega C_3 R_1 R_4 = 0$$

Therefore $$\frac{R_2}{R_4} = \frac{R_1}{R_3} + \frac{C_3}{C_1} \tag{11.21}$$

and $$\frac{1}{\omega C_1 R_3} = \omega C_3 R_1 \tag{11.22}$$

$$\therefore \quad \omega^2 = \frac{1}{C_1 R_1 R_3 C_3}$$

$$\omega = \frac{1}{\sqrt{C_1 R_1 C_3 R_3}}$$

as $$\omega = 2\pi f$$

$$\therefore \quad f = \frac{1}{2\pi\sqrt{C_1 R_1 C_3 R_3}} \tag{11.23}$$

The two conditions for bridge balance, (11.21) and (11.23), result in an expression determining the required resistance ratio R_2/R_4 and another expression determining the frequency of the applied voltage. If we satisfy Eq. (11.21) and also excite the bridge with the frequency of Eq. (11.23), the bridge will be balanced.

In most Wien bridge circuits, the components are chosen such that $R_1 = R_3 = R$ and $C_1 = C_3 = C$. Equation (11.21) therefore reduces to $R_2/R_4 = 2$ and Eq. (11.23) to $f = 1/2\pi RC$, which is the general equation for the frequency of the bridge circuit.