Marwari college Darbhanga

Subject---physics (Hons)

Class--- B. Sc. Part 2

Paper---04 , Group—A

Topic--- Wheatstone Bridge (Electricity)

Lecture series 59

By:-. Dr. Sony Kumari,

Assistant professor

Marwari college Darbhanga

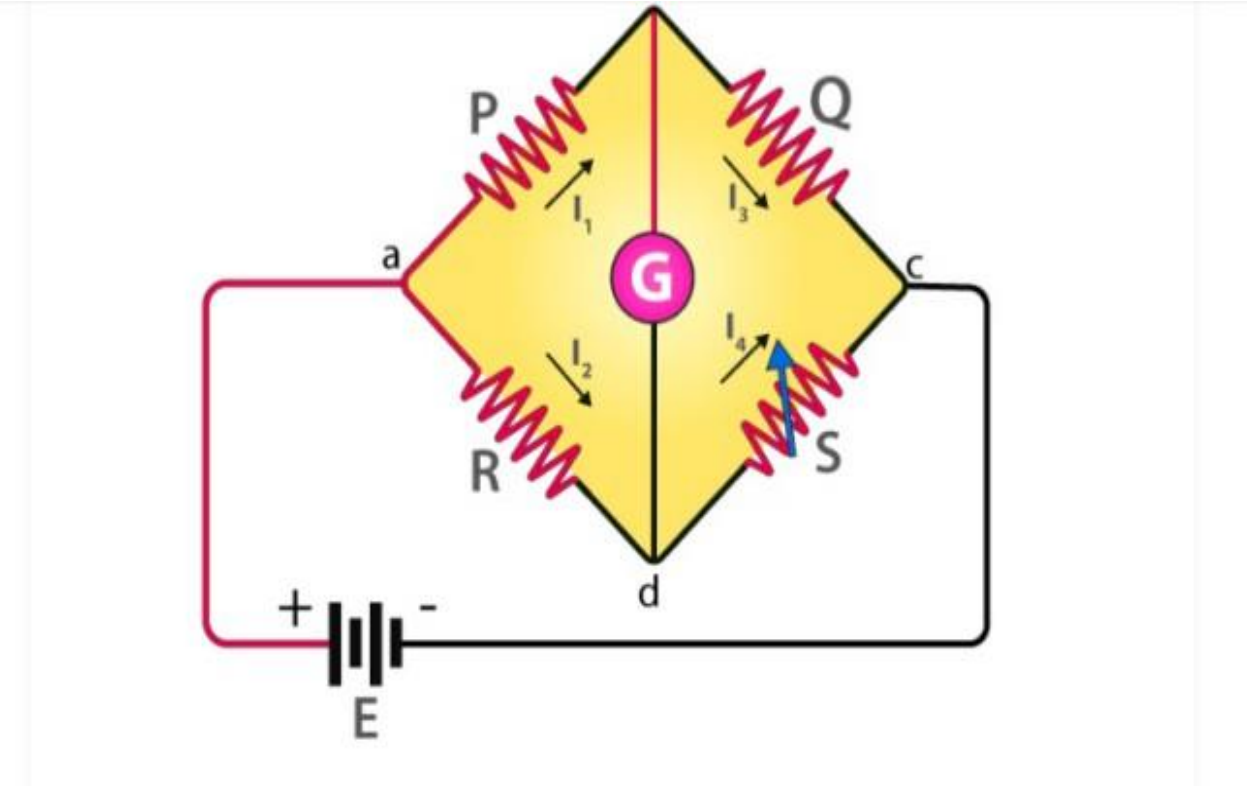
Wheatstone Bridge

Wheatstone bridge, also known as the resistance bridge, is used to calculate the unknown resistance by balancing two legs of the bridge circuit, of which one leg includes the component of unknown resistance. It was invented by Samuel Hunter Christie in the year 1833, which was later popularized by Sir Charles Wheatstone in 1843.

The circuit is composed of two known resistors, one unknown resistor and one variable resistor connected in the form of a bridge. This bridge is very reliable as it gives accurate measurements.

Construction of Wheaton bridge

The Wheatstone bridge works on the principle of null deflection, i.e. the ratio of their resistances are equal and no current flows through the circuit. Under normal conditions, the bridge is in the unbalanced condition where current flows through the galvanometer. The bridge is said to be in a balanced condition when no current flows through the galvanometer. This condition can be achieved by adjusting the known resistance and variable resistance.



Derivation

The current enters the galvanometer and divides into two equal magnitude currents as I_1 and I_2. The following condition exists when the current through a galvanometer is zero,

$$I_1 P = I_2 R \text{ (1)}$$

The currents in the bridge, in a balanced condition, is expressed as follows:

$$I_1 = I_3 = \frac{E}{P+Q} \; I_2 = I_4 = \frac{E}{R+S}$$

Here, E is the emf of the battery.

By substituting the value of I_1 and I_2in equation (1), we get

$$I_1 = I_3 = \frac{E}{P+Q} \; I_2 = I_4 = \frac{E}{R+S}$$

Here, E is the emf of the battery.

By substituting the value of I_1 and I_2 in equation (1), we get

$$\frac{PE}{P+Q} = \frac{RE}{R+S} \; \frac{P}{P+Q} = \frac{R}{R+S}$$

$$P(R+S) = R(P+Q)$$

$$PR + PS = RP + RQ$$

$$PS = RQ \text{ (2)}$$

Wheatstone Bridge Application

1. * The Wheatstone bridge is used for the precise measurement of low resistance.
2. * Wheatstone bridge along with operational amplifier is used to measure physical parameters such as temperature, light, and strain.
3. * Quantities such as impedance, inductance, and capacitance can be measured using variations on the Wheatstone bridge.

$$R = \frac{P}{Q} \times S \quad (3)$$

Equation (2) shows the balanced condition of the bridge while (3) determines the value of the unknown resistance.

In the figure, R is the unknown resistance, and the S is the standard arm of the bridge and the P and Q are the ratio arm of the bridge.

Wheatstone Bridge Limitations

1. For low resistance measurement, the resistance of the leads and contacts becomes significant and introduces an error.

2. For high resistance measurement, the measurement presented by the bridge is so large that the galvanometer is insensitive to imbalance.

3. The other drawback is the change in the resistance due to the heating effect of the current through the resistance. Excessive current may even cause a permanent change in the value of resistance.