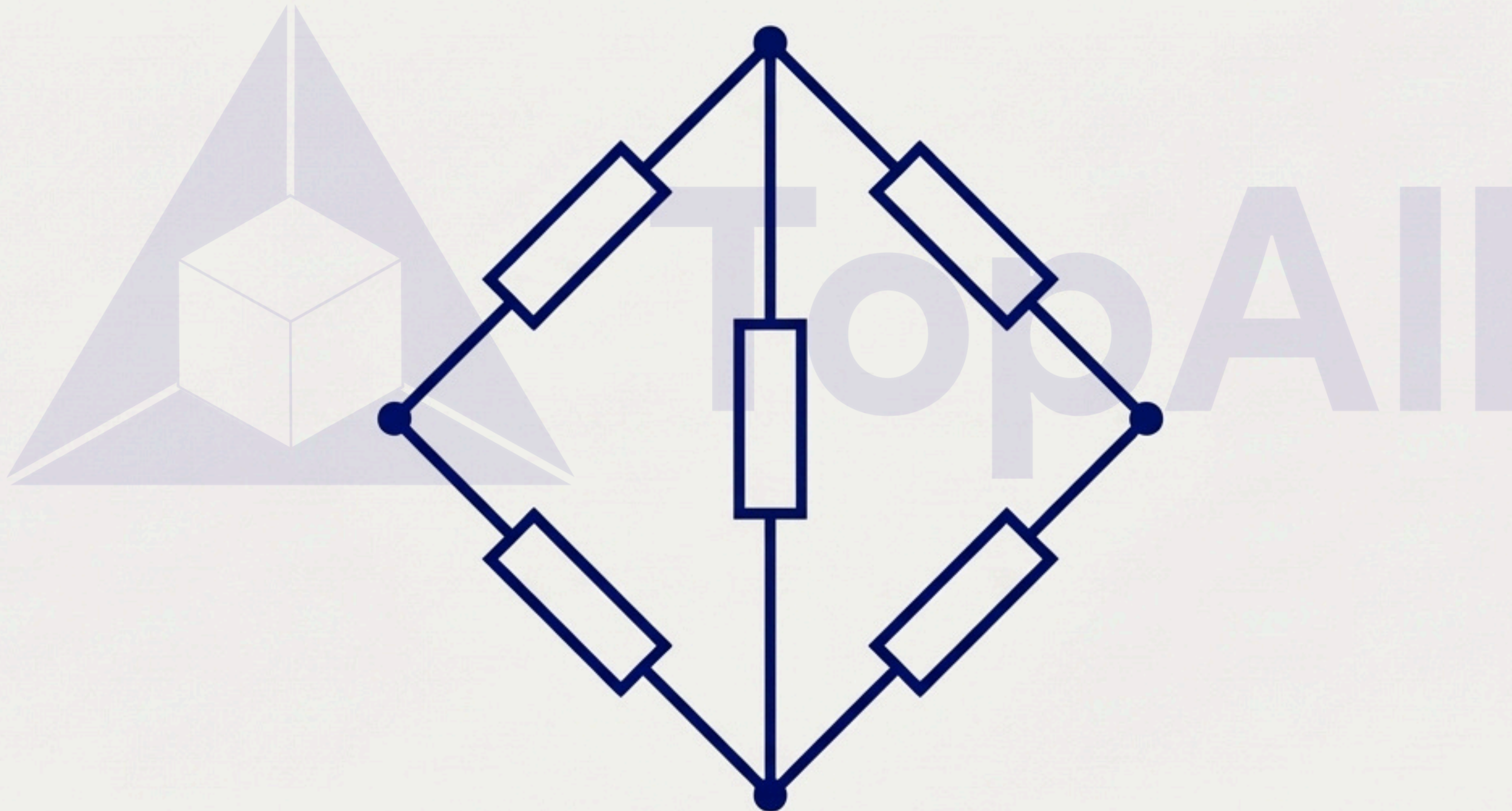


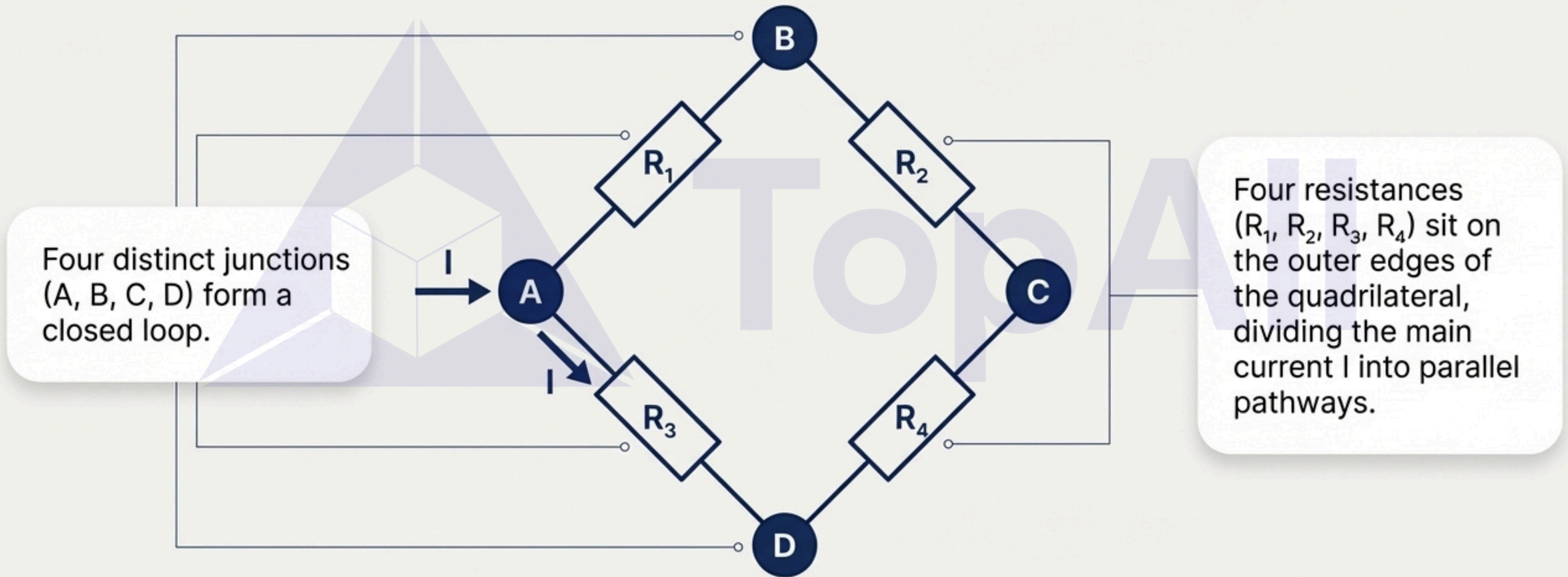
Wheatstone Bridge

An essential application of Kirchhoff's rules for precise resistance measurement.

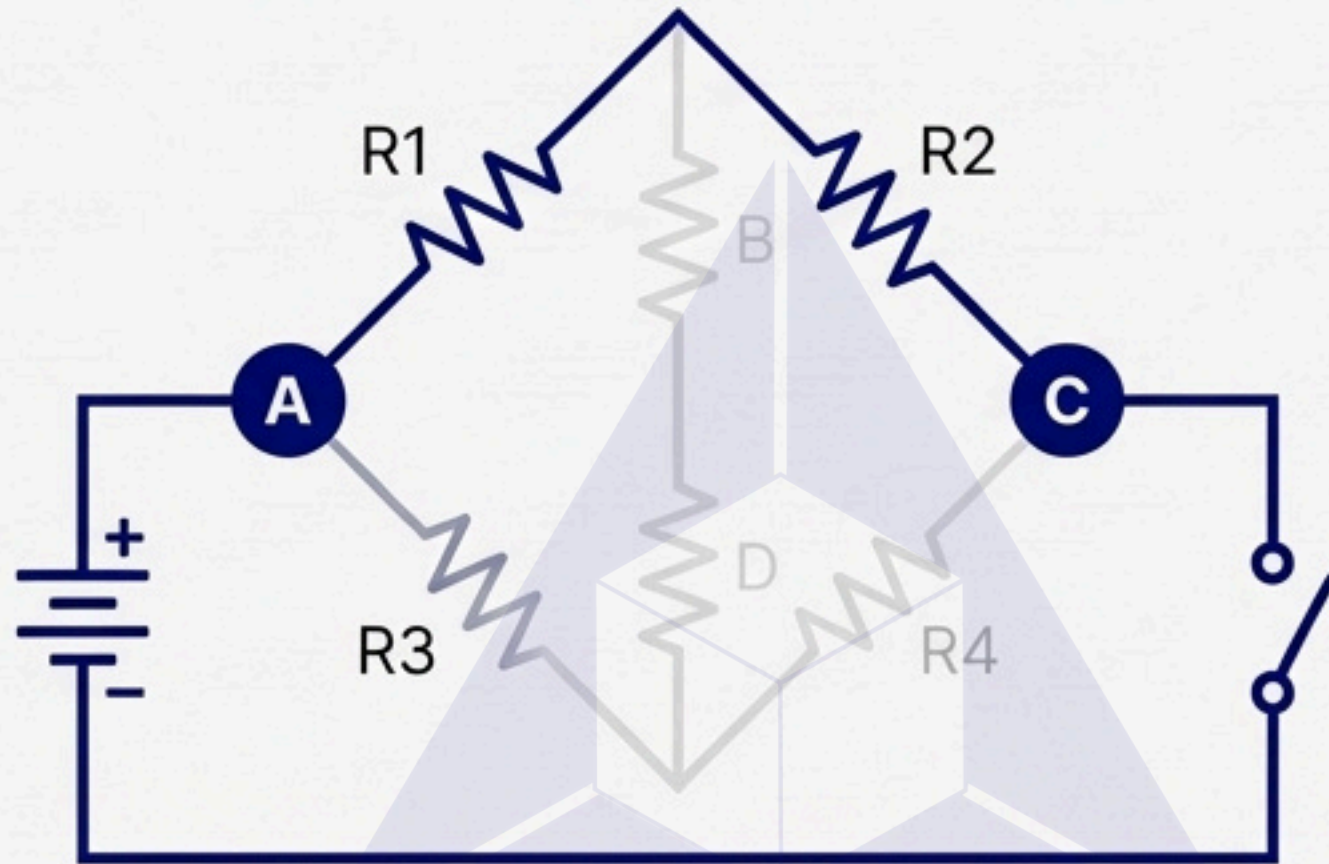


The Diamond Layout

A closed quadrilateral network of four resistors designed to precisely measure electrical resistance.

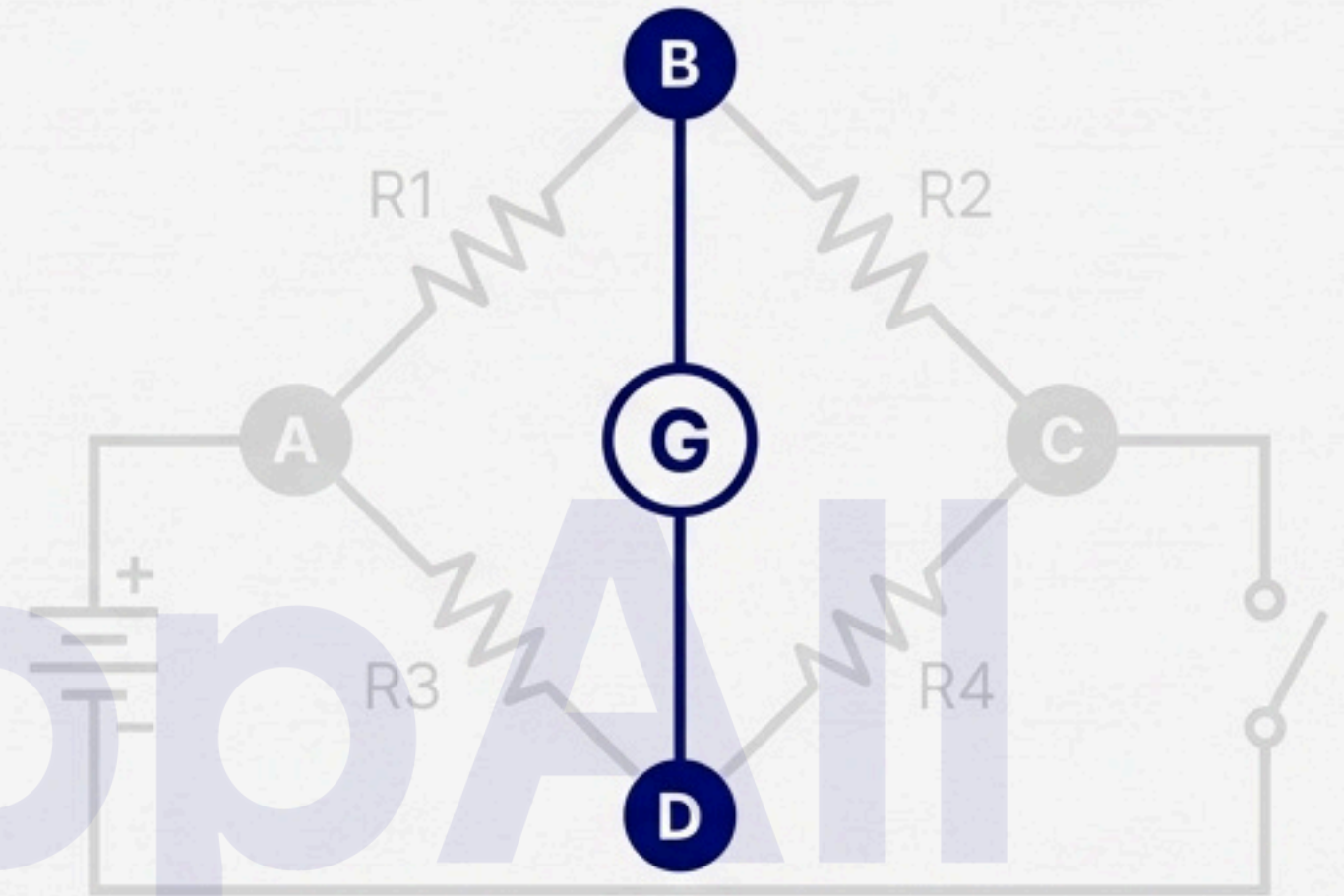


The Two Cross-Arms



Diagonal AC

Connected across diagonally opposite points A and C. This arm supplies the main current to the entire network.

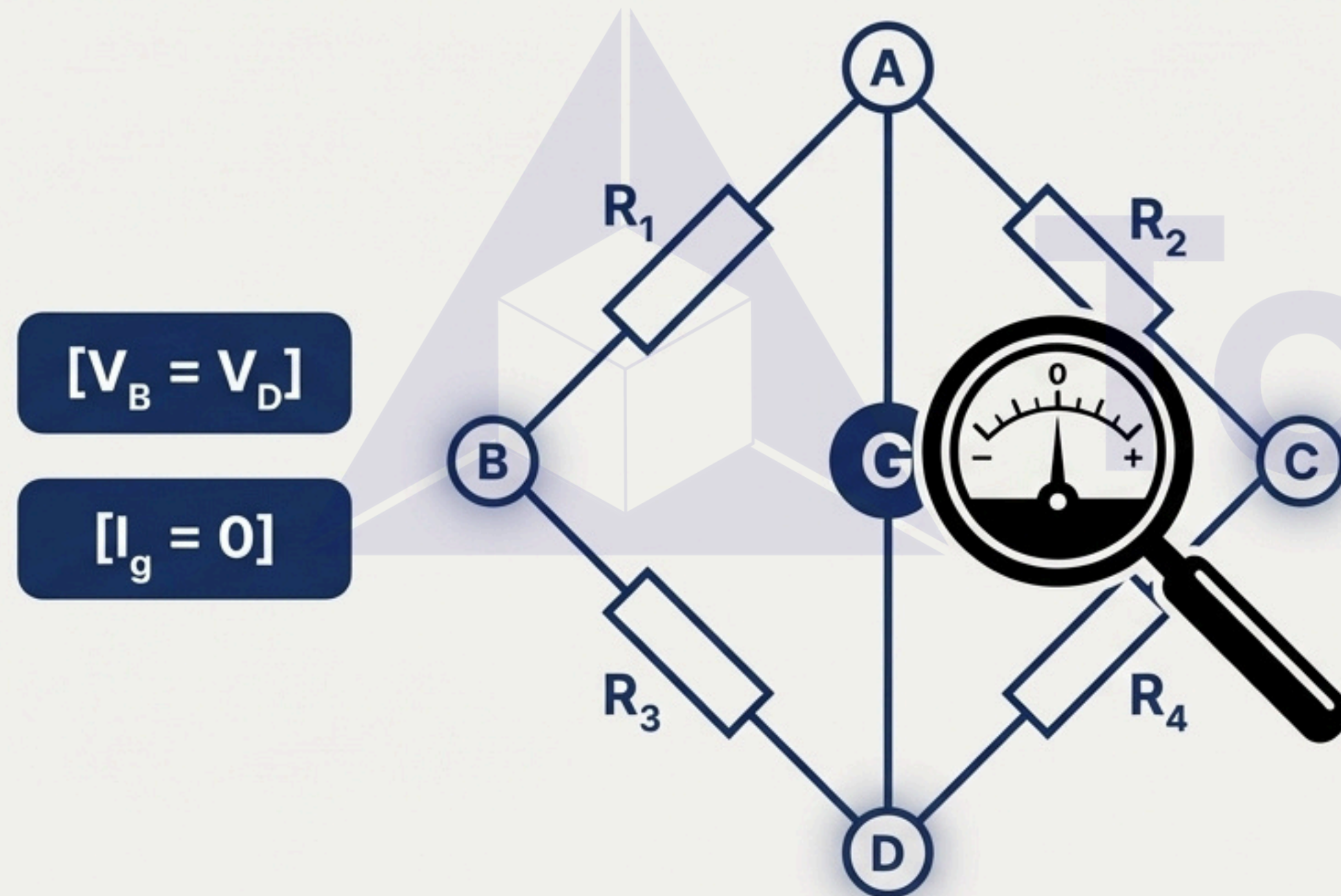


Diagonal BD

Connected across the remaining two vertices B and D. This arm contains a galvanometer to detect any any current flowing across the center of the bridge.

The Balanced State ($I_g = 0$)

By adjusting the resistor values, the bridge can reach a state of equilibrium where absolutely no current flows through the central galvanometer.

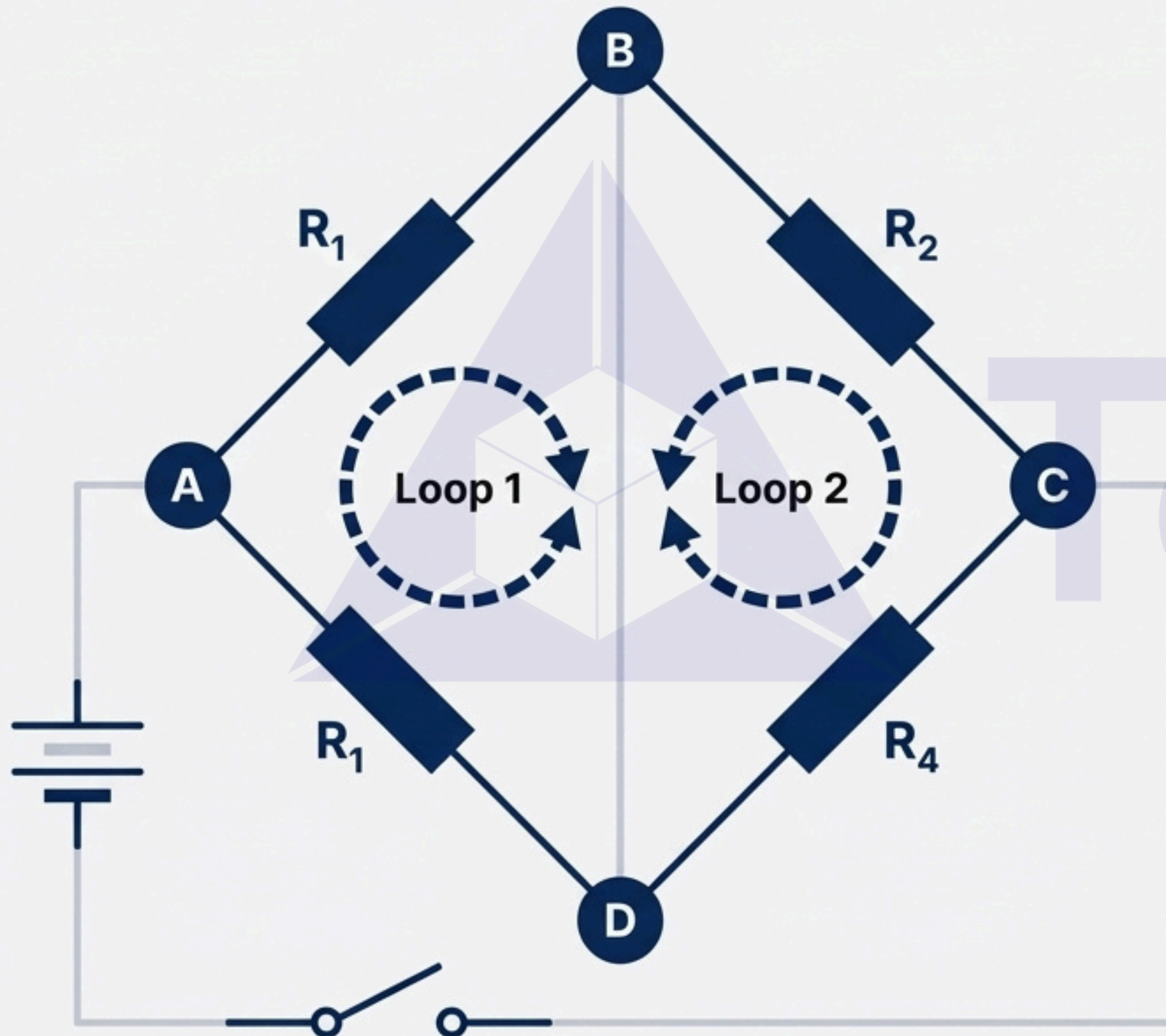


Because the electrical potential at node B equals the potential at node D, no charge is pushed across the center.

Consequently:

- Current I_1 flows entirely into I_3 ($I_1 = I_3$).
- Current I_2 flows entirely into I_4 ($I_2 = I_4$).

Deriving the Null Condition



Loop ADBA:

Applying Kirchhoff's loop rule:

$$-I_1 R_1 + 0 + I_2 R_2 = 0 \Rightarrow I_1 R_1 = I_2 R_2$$

Loop CBDC:

Applying Kirchhoff's loop rule:

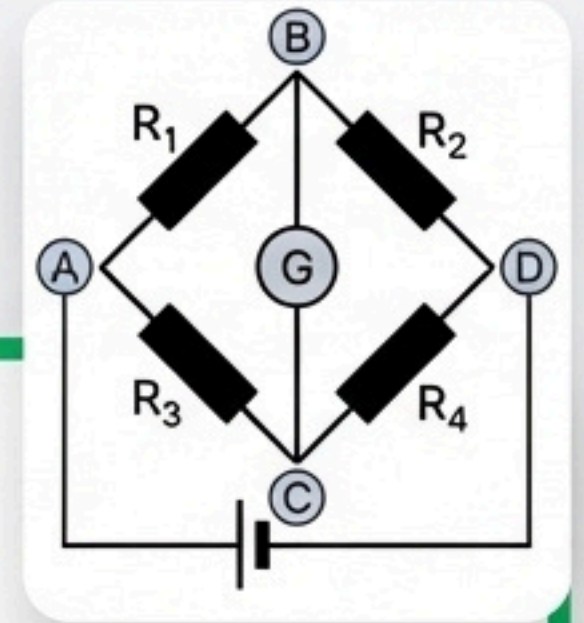
$$-I_1 R_3 + 0 + I_2 R_4 = 0 \Rightarrow I_1 R_3 = I_2 R_4$$

Dividing the two loop equations yields the balance condition:

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

This ratio is used to calculate an unknown resistance (e.g., R_4) when the other three resistances are known.

Key Takeaways



- Structure: A 4-resistor network featuring 1 battery arm (diagonal AC) and 1 galvanometer arm (diagonal BD).
- Balance Condition: Equilibrium occurs strictly when node potentials are equal ($V_B = V_D$), resulting in zero central current ($I_g = 0$).
- The Core Formula: $R_2 / R_1 = R_4 / R_3$ (valid only when $I_g = 0$).
- Application: The foundational principle for precisely calculating unknown resistances, directly applied in practical laboratory devices like the Meter Bridge.