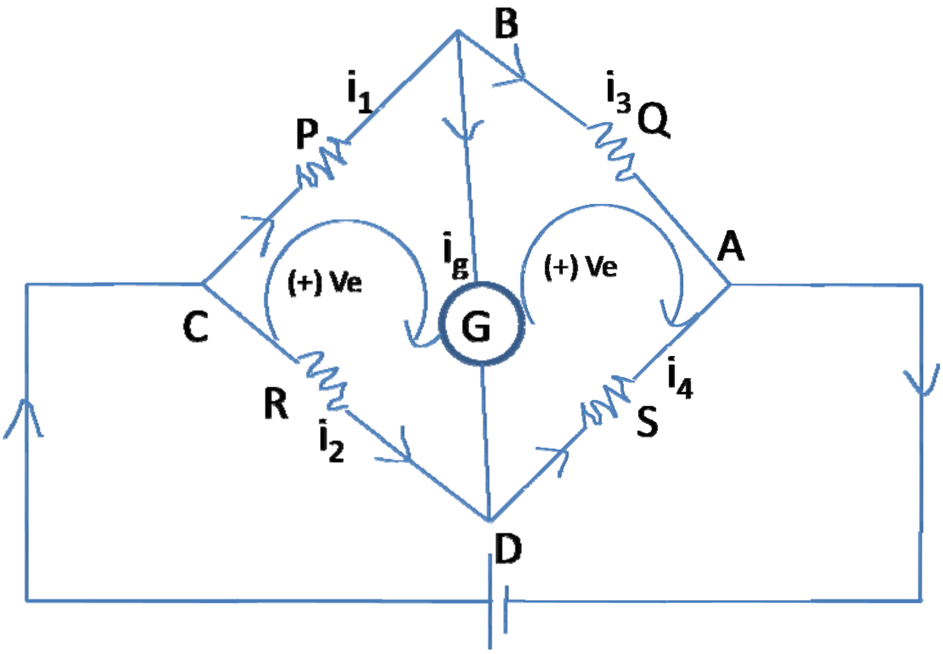
Using Kirchhoff's law we now find the condition for null deflection in a Wheatstone bridge

Four resistances P, Q, R and S are joined end to end to form a closed circuit. These close networks of conductors form a closed circuit. This close network of conductors is known as Wheatstone bridge. Between any pair of opposite junctions say A & C a battery is connected and between the other pair of opposite junctions a galvanometer is connected. We assigned the current flowing in the different branches from the logical consideration.



Given: G = The resistance of the galvanometer

Let i_1,i_2,i_3,i_4 & i_g be the current flowing through the branches of resistance P, R, Q, S and G respectively.

Applying Kirchhoff's first law :

(1) At the point C :

$\sum i = i - i_1 - i_2 = 0 \text{ or } i_2 = i - i_1 \rightarrow (1)$

(2) At the point B :

$\sum i = i_1 - i_3 - i_g = 0 \text{ or } i_3 = i_1 - i_g \rightarrow (2)$

(3) At the point D :

$\sum i = i_2 + i_g - i_4 = 0 \text{ or } i_4 = i - i_1 + i_g \rightarrow (3)$

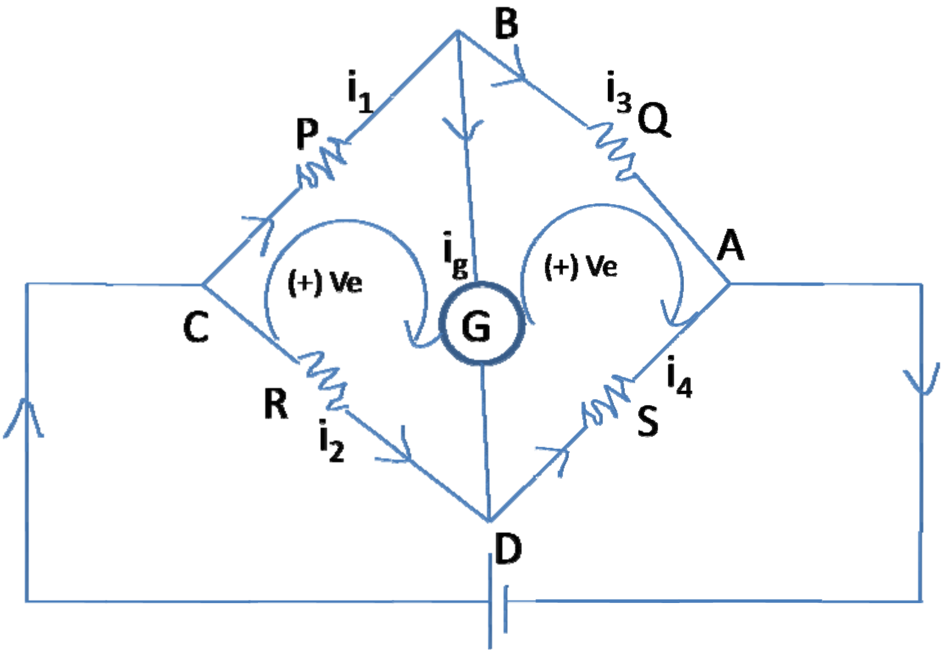
Applying Kirchhoff's second law :

In closed mesh CBDC :

$i_1 P + i_g G - i_2 R = 0$

Putting equation(1) : $i_1 P + i_g G - (i - i_1)R = 0$

$or\ (P + R)i_1 + i_g G - iR = 0 \rightarrow (4)$



(ii) In closed mesh BADB

$i_3Q - i_gG - i_4S = 0 \rightarrow (5)$

Putting equation(2) in equation (5)

$(i_1 - i_g)Q - i_gG - (i - i_1 + i_g)S = 0$

or $i_1(Q+S) - i_g(Q+G+S) - iS = 0 \rightarrow (6)$

To eliminate i_1 from the equations multiplying equation(4) by (Q + S) and (6) by (P + R) and substracting

$i_1(Q+S)(P+R) + i_gG(Q+S) - iR(Q+S) = 0$

$i_1(Q+S)(P+R) - i_g(P+R)(Q+G+S) - iS(P+R) = 0$

$i_g[G(Q+S) + (Q+S+G)(P+R)] - i[R(Q+S) - S(P+R)] = 0$

$$i_g = \frac{i(RQ - SP)}{G(Q+S) + (Q+S+G)(P+R)} \rightarrow (6)$$

From equation (6) we can find the current flowing the galvanometer. For null deflection ig=0 from equation (6) ig=0 only if (RQ-PS) = 0 or P/Q=R/S