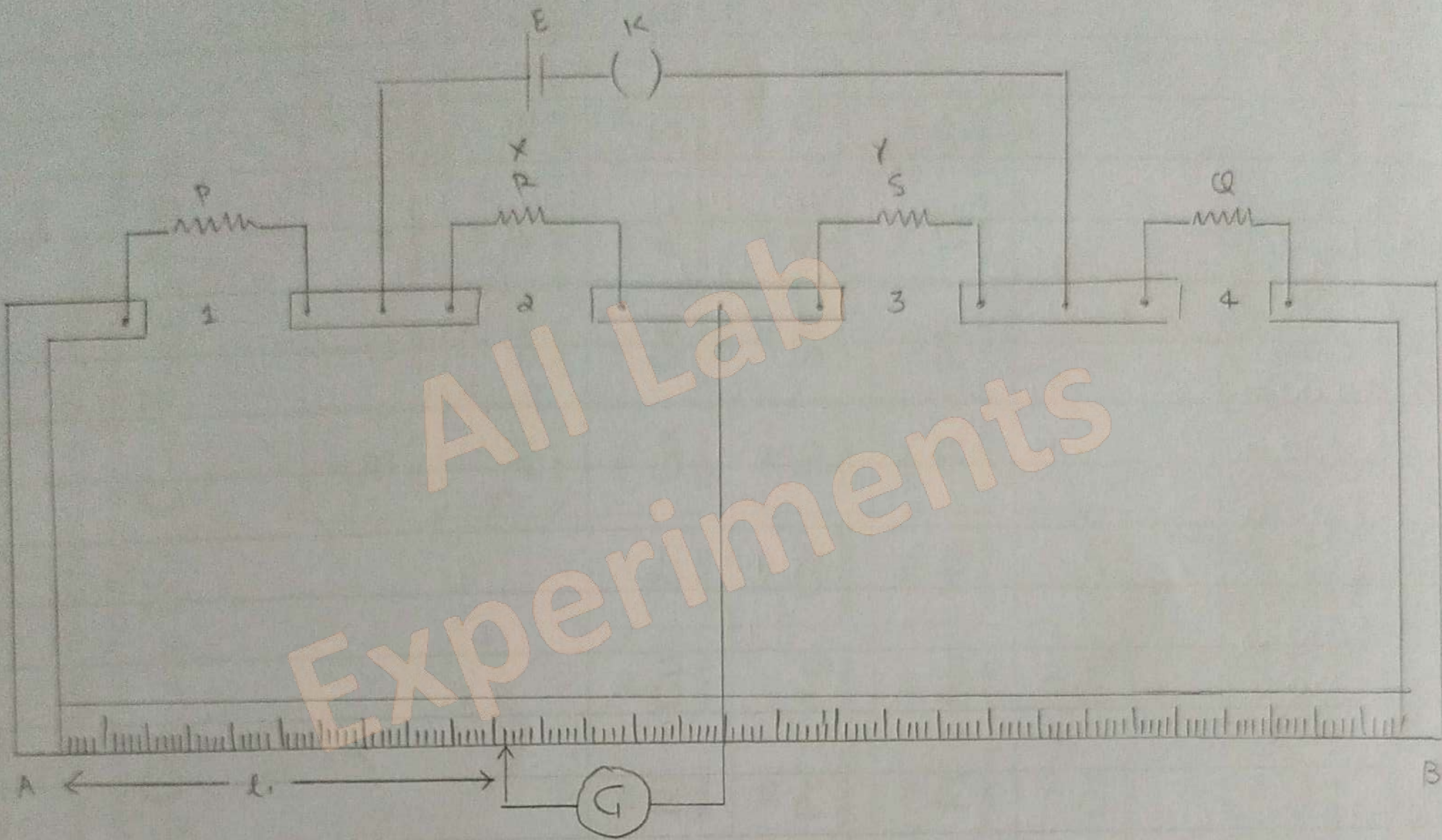
Diagram:



CAREY FOSTER'S BRIDGE

Aim: To determine the value of a given small resistance by using a Carey Foster Bridge.

Apparatus:

Carey Foster Bridge, two equal resistances, thick copper ~~wire~~ strip, fractional resistance box, unknown low resistance, battery, one way key, galvanometer, connecting wires.

Theory:

P & Q are two equal resistances, X is an unknown resistance, Y is fractional resistance box,

If D_1 is the balance point,

$$\frac{P}{Q} = \frac{X + L_1\rho + \alpha}{Y + (100 - L_1)\rho + \beta} \quad \text{--- (1)}$$

where, ρ = resistance per unit length of the wire.

α, β = end resistance at A & C respectively

L_1 = Distance AD_1.

On interchanging X & Y, let D_2 be the balance point. Then,

$$\frac{P}{Q} = \frac{Y + l_2\rho + \alpha}{X + (100 - l_2)\rho + \beta} \quad \text{--- (2)}$$

where, l_2 = distance AD_2

comparing (1) & (2), adding 1 to both sides,

$$\frac{X + Y + 100\rho + \alpha + \beta}{Y + (100 - l_1)\rho + \beta} = \frac{X + Y + 100\rho + \alpha + \beta}{X + (100 - l_2)\rho + \beta}$$

$$\Rightarrow \quad Y + (100 - l_1)\rho + \beta = X + (100 - l_2)\rho + \beta$$

$$X - Y = (l_2 - l_1)\rho$$

Observation:

(a)

S.No	P(Ω)	POSITION OF BALANCE POINT WITH COPPER STRIP IN		$l_2 - l_1$ (cm)	$\rho = \frac{P}{(l_2 - l_1)}$ ohm/cm
		Right l_1 (cm)	Left l_2 (cm)		
1.	0.1	41.5	55.5	14	0.00714
2.	0.2	37	58	21	0.0095
3.	0.3	36.5	60	23.5	0.0128
4.	0.4	34	59.3	25.3	0.0158
5.	0.5	31.2	61.8	30.6	0.0163
6.	0.6	29.2	65	35.8	0.0167

Mean ρ = 0.013043 Ω/cm

(b) For unknown low resistance:

S.No	Known Resistance Q(Ω)	UNKNOWN RESISTANCE		$l_2' - l_1'$ (cm)	$P = Q + \rho(l_2' - l_1')$ (Ω)
		Left l_1' (cm)	Right l_2' (cm)		
1.	0.1	10	85	75	1.078223
2.	0.2	12.5	82.5	70	1.11301
3.	0.3	15.2	79.8	64.6	1.1425778
4.	0.4	17.7	77.2	59.5	1.1760585
5.	0.5	20.4	74.5	54.1	1.2056263
6.	0.6	22.8	72.2	49.4	1.2443242

Mean (P) = 1.159958 Ω

Determination of p:

Let, x' be a short thick copper strip of zero resistance and y' be a fraction of an Ω. Following the same procedure as above, let l_1 be the distance of the balance point from A when x' & y' are in the position of the diagram. When x' & y' are interchanged, let the balance point be at a distance l_2 from A, then

$$y' = (l_2' - l_1')\rho$$

$$\rho = \frac{y'}{l_2' - l_1'}$$

Calculation:

1. $P = 0.1\,\Omega$, $l_1 = 41.5$ cm, $l_2 = 55.5$ cm

$l_2 - l_1 = 14$ cm

$$\rho = \frac{0.1}{14} = 0.00714\ \Omega/\text{cm}$$

2. $P = 0.2\,\Omega$, $l_1 = 37$ cm, $l_2 = 58$ cm

$l_2 - l_1 = 21$ cm

$$\rho = \frac{0.2}{21} = 0.0095\ \Omega/\text{cm}$$

3. $P = 0.3\,\Omega$, $l_1 = 36.5$ cm, $l_2 = 60$ cm

$l_2 - l_1 = 23.5$ cm

$$\rho = \frac{0.3}{23.5} = 0.0128\ \Omega/\text{cm}$$

4. $P = 0.4\,\Omega$, $l_1 = 34$ cm, $l_2 = 59.3$ cm

$l_2 - l_1 = 25.3$ cm

$$\rho = \frac{0.4}{25.3} = 0.0158\ \Omega/\text{cm}$$

5. $\rho = \frac{0.5}{30.6} = 0.0163\ \Omega/cm$

6. $\rho = \frac{0.6}{35.8} = 0.0167\ \Omega/cm$

$$\text{Mean } \rho = \frac{0.00714 + 0.0095 + 0.0128 + 0.0152 + 0.0163 + 0.0167}{6}$$

$$= 0.013043\ \Omega/cm$$

Determination of low resistance X:

1. $P = Q + \rho(l_2 - l_1) = 0.1 + 0.013043(75) = 1.078223\ \Omega$
2. $P = 0.2 + 0.013043(70) = 1.11301\ \Omega$
3. $P = 0.3 + 0.013043(64.6) = 1.1425772\ \Omega$
4. $P = 0.4 + 0.013043(59.5) = 1.1760585\ \Omega$
5. $P = 0.5 + 0.013043(54.1) = 1.2056263\ \Omega$
6. $P = 0.6 + 0.013043(49.4) = 1.2443242\ \Omega$

Mean $= 1.159958\ \Omega$

Result: The value of the given unknown low resistance is $1.159958\ \Omega$ by Carey Foster's Bridge.

Precautions and Sources of error:

1. The ends of the connecting wires should be clean and all connections should be tight.
2. For bridge to have high sensitivity, the resistances of the four arms should be of the same order.