

EXPERIMENT NO. -

DATE:

TO MEASURE THE RESISTENCE PER UNIT LENGTH OF THE WIRE OF A METRE BRIDGE BY CAREY FOSTER’S METHOD AND HENCE DETERMINE THE VALUE OF AN UNKNOWN RESISTANCE



THEORY: In the arrangement as shown in Fig. **P** and **Q** are two nearly equal resistances inserted in gaps **1** and **2** of the metre bridge respectively. A resistance **R** is introduced in gap **4** from the fractional resistance box and another fixed resistance **S** is given in gap **3**. If now a null point be obtained at a distance **L** cm from the left end of the bridge wire, then by the principle of Wheatstone’s bridge.

$$\frac{P}{Q} = \frac{S + L \cdot \rho + \lambda}{R + (100 - L)\rho + \lambda'} \quad \text{----- (i)}$$

Where λ and λ' are the end resistance at the left and right ends of the metre bridge respectively) and ρ is the resistance per unit length of bridge wire.

Similarly, if the resistances **R** and **S** be interchanged and a null point obtained at **L'** cms from the left end of the bridge wire.

$$\frac{P}{Q} = \frac{R + L' \cdot \rho + \lambda}{S + (100 - L')\rho + \lambda'} \quad \text{----- (ii)}$$

From (i) and (ii), we have

$$\frac{P + Q}{Q} = \frac{R + S + 100 \cdot \rho + \lambda + \lambda'}{R + (100 - L)\rho + \lambda'} \quad \text{----- (iii)}$$

and
$$\frac{P + Q}{Q} = \frac{R + S + 100 \cdot \rho + \lambda + \lambda'}{S + (100 - L')\rho + \lambda'} \quad \text{----- (iv)}$$

Equating R.H.S. of equations (iii) and (iv), we have

$$R + (100 - L)\rho + \lambda' = S + (100 - L')\rho + \lambda'$$

Or,
$$\rho = (R - S)/(L - L') \quad \text{----- (v)}$$

Now if a copper strip is connected instead of resistance **S**, then equation (v) becomes,

$$\rho = R/(L - L')$$

----- (vi)

Thus measuring R, L and L', resistance per unit length (ρ) of the wire may be determined. We can also measure the value of an unknown resistance S, from equation (v),

$$S = R - (L - L')\rho$$

----- (vi)

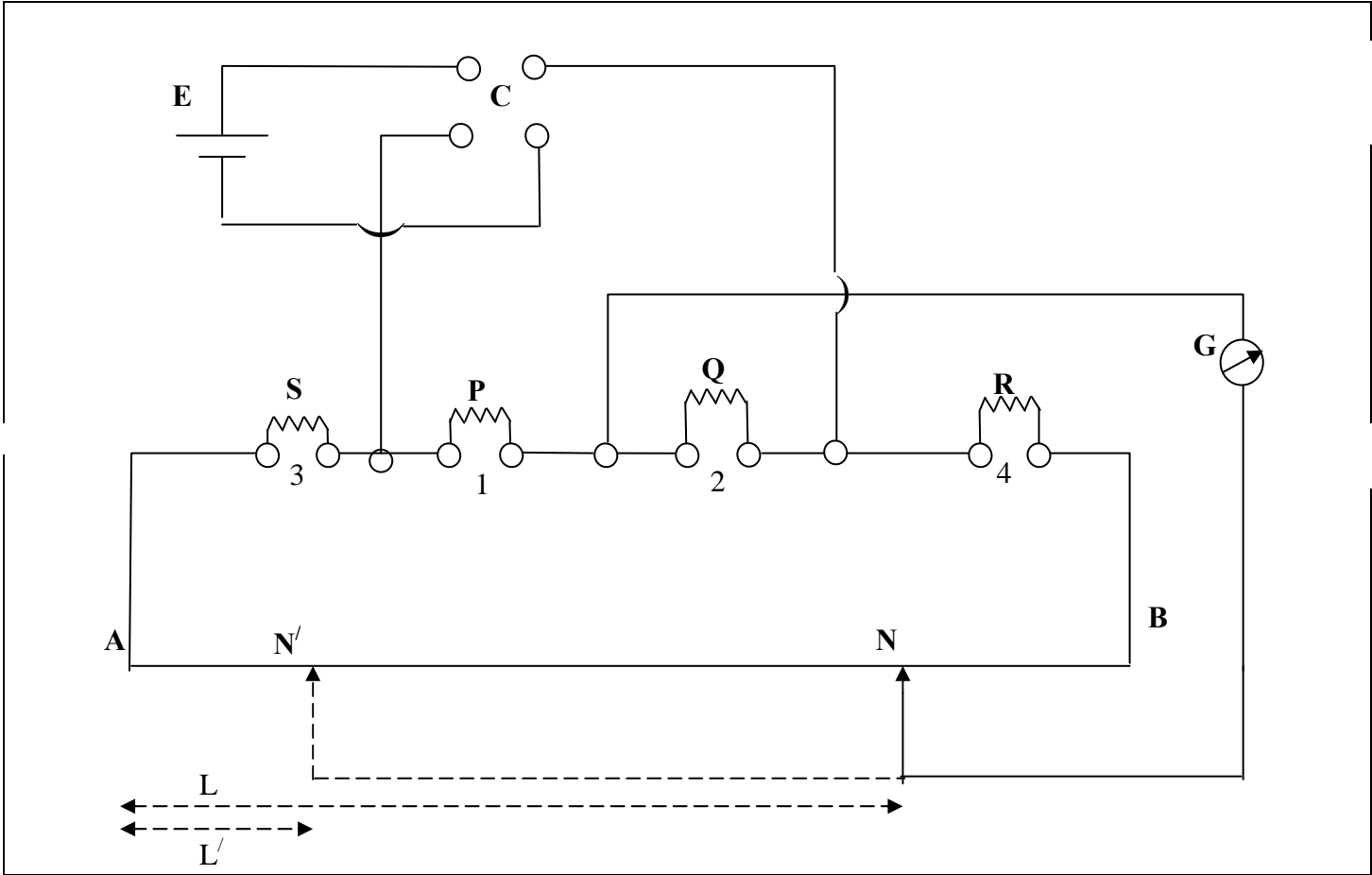


Fig. 1 : Circuit diagram for Carey Foster bridge

APPARATUS :

- | | |
|--|----------------------|
| 1. Metre bridge provided with four gaps (or Carey Foster's bridge) | 4. Galvanometer (G). |
| 2. Two nearly equal resistance. | 5. Cell (E). |
| 3. Resistance box provided with fractional ohm resistance. | 6. Commutator (C). |
| | 7. Connecting wires. |

PROCEDURE AND DATA TABLES :

[A] Steps for the measurement of resistance per unit length ρ

1. Keep the resistance(S) of the left gap (gap 3) zero by placing a copper strip in the gap.
2. Connect a fractional resistance box(R) on the right gap (gap 4).
3. Put a resistance 0.1 Ω in the fractional resistance box (R =0.1 Ω).
4. Adjust the position (N) of the jockey on the Carey foster bridge to get zero current (null point) in the galvanometer.
5. From the meter scale attached with the bridge, measure the exact distance (L) of the jockey from the extreme left end. Note this as direct reading in the table.

6. Place the commutator keys in the alternative gaps to reverse the direction of the current flow in the circuit and follow steps 4 and 5. This is the reverse reading of the null point. Now calculate the mean reading of L .
7. Repeat steps 4 to 6 for $R = 0.2 \Omega, 0.3 \Omega$ and 0.4Ω respectively.
8. Now connect the fractional resistance box on the left gap (gap 3) and the copper strip (zero resistance) on the right gap (gap 4).
9. Repeat steps 3 to 7 by changing the values of fractional resistance accordingly to get mean value of L' in each case.
10. Calculate $L - L'$ and hence resistance per unit length ρ in four observations. The final result will be the mean value of ρ .

Table1: Measurement of resistance per unit length ρ

Obs	Resistance in the (ohm)		Null point (cm)			$L-L'$ (cm.)	$\rho=R/(L-L')$ (ohm/cm)	Mean value of ρ (ohm/cm)
	Left gap	Right gap	Direct	Reversed	Mean			
1.	0.0 (S)	0.1 (R)			L			
	0.1 (R)	0.0 (S)			L'			
2.	0.0 (S)	0.2 (R)			L			
	0.2 (R)	0.0 (S)			L'			
3.	0.0 (S)	0.3(R)			L			
	0.3 (R)	0.0 (S)			L'			
4.	0.0 (S)	0.4 (R)			L			
	0.4 (R)	0.0 (S)			L'			

Mean $\rho = \text{----- ohm/cm}$

[B] Steps for the measurement of unknown resistance S:

1. Instead of copper strip (S=0), place the unknown resistance and follow steps 1 to 9 as before.
2. Calculate $L - L'$ and hence unknown resistance S in four observations. The final result will be the mean value of S.

Table 2: Measurement of unknown resistance S

Obs	Resistance in the (ohm)		Null point (cm)			L-L' (cm.)	S = R - ρ (L-L') (ohm)	Mean value of S (ohm)
	Left gap	Right gap	Direct	Reversed	Mean			
1.	S	0.1 (R)						
	0.1 (R)	S						
2.	S	0.2 (R)						
	0.2 (R)	S						
3.	S	0.3 (R)						
	0.3 (R)	S						
4.	S	0.4 (R)						
	0.4 (R)	S						

Mean value of the unknown resistance (S) isohm.

MAXIMUM PERCENTAGE ERROR:

We have, $\rho = \frac{R}{L - L'}$

Therefore, $\left(\frac{\delta\rho}{\rho}\right)_{\max} = \frac{\delta(L - L')}{L - L'} = \frac{2 \delta L}{L - L'}$; Assuming R to be corrected.(viii)

Where $\delta L = 0.1$ cm (1 division of the metre scale)

Using a typical observed values of $L - L'$, we can calculate the maximum percentage error in ρ as,

$$\left(\frac{\delta\rho}{\rho}\right)_{\max} \times 100\% =$$

$$\text{Now } S = R - (L - L')\rho$$

$$\text{Or, } (\delta S)_{\max} = (L - L')\delta\rho + \rho \cdot 2\delta L, \text{ assuming } \delta R = 0$$

$$= \rho \left[(L - L') \frac{\delta\rho}{\rho} + 2\delta L \right]$$

$$\boxed{\left(\frac{\delta S}{S}\right)_{\max} = \frac{\rho}{S} \left[(L - L') \frac{\delta\rho}{\rho} + 2\delta L \right]}$$

Putting the value of $\frac{\delta\rho}{\rho}$ from (viii) and taking a typical set of observed data we can calculate

$$\text{maximum percentage error, } \left(\frac{\delta S}{S}\right)_{\max} \times 100\% =$$

DISCUSSIONS: