

EXPERIMENT No. –

Aim: - To determine the **resistance per unit length of the bridge wire** of a Carey Foster's bridge, and to use it as the foundation for finding unknown small resistances or the specific resistance of a wire.

Resources required: -

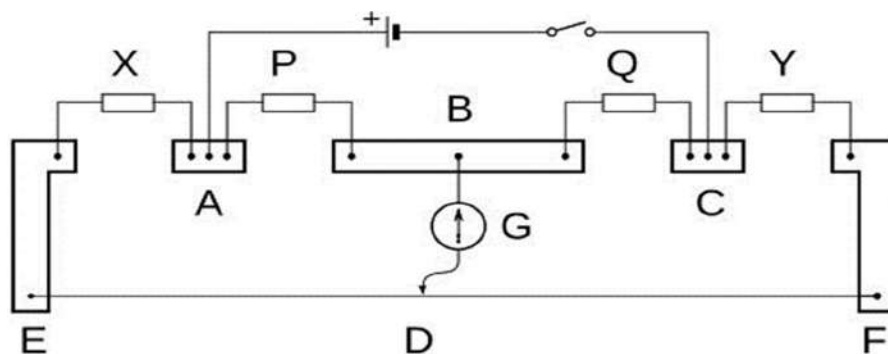
S. No.	Name of equipment	Specifications/Purpose	Quantity	Remark
1	Carey Foster Bridge	with a uniform 1 metre bridge wire mounted on a scale	1	
2	Standard resistance box		1	
3	Known resistance		1	
4	Unknown resistance		1	
5	Galvanometer		1	
6	Jockey		1	
7	Battery eliminator (or DC source)		1	
8	Plug key		1	
9	Connecting wires		1	

Theoretical Background: -

Carey Foster's bridge is a clever variation of the ordinary meter bridge. It was designed to overcome the biggest weakness of the meter bridge — the unavoidable *end resistances* at the copper strips and connecting terminals, which throw off any measurement of small resistances. In an ordinary meter bridge, these end errors are simply ignored, but when you're measuring resistances of just a fraction of an ohm, ignoring them is not an option.

The **Carey Foster bridge principle** is a direct modification of the classic Wheatstone bridge network. It consists of four resistance arms arranged in a loop.

In this specific bridge layout, two equal, steady resistances (P and Q) are placed in the inner gaps. The unknown resistance (X) and a known standard resistance (Y) occupy the outer gaps, connected directly across a uniform slide wire EF of length $L = 100$ cm.



When the bridge is perfectly balanced at a null point distance l_1 from the left end, the relation is given by:

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

Where:

- α and β are the end-resistances at the left and right copper strips respectively.
- ρ is the **resistance per unit length of Carey Foster bridge wire**.

By interchanging the positions of X and Y in the outer gaps, we shift the balance point to a new length l_2 :

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

Equating these two balance conditions allows us to completely cancel out the unknown end corrections (α and β). The final simplified formula yields:

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

If we intentionally make one side a perfect short-circuit ($Y = 0$) by using a thick copper strip, the equation simplifies beautifully to allow us to calculate ρ :

$$\rho = \frac{X}{l_2 - l_1}$$

FORMULA USED:

1. Resistance per unit length of wire of bridge;

$$\rho = \frac{X}{(l_2 - l_1)} \text{ ohms/cm}$$

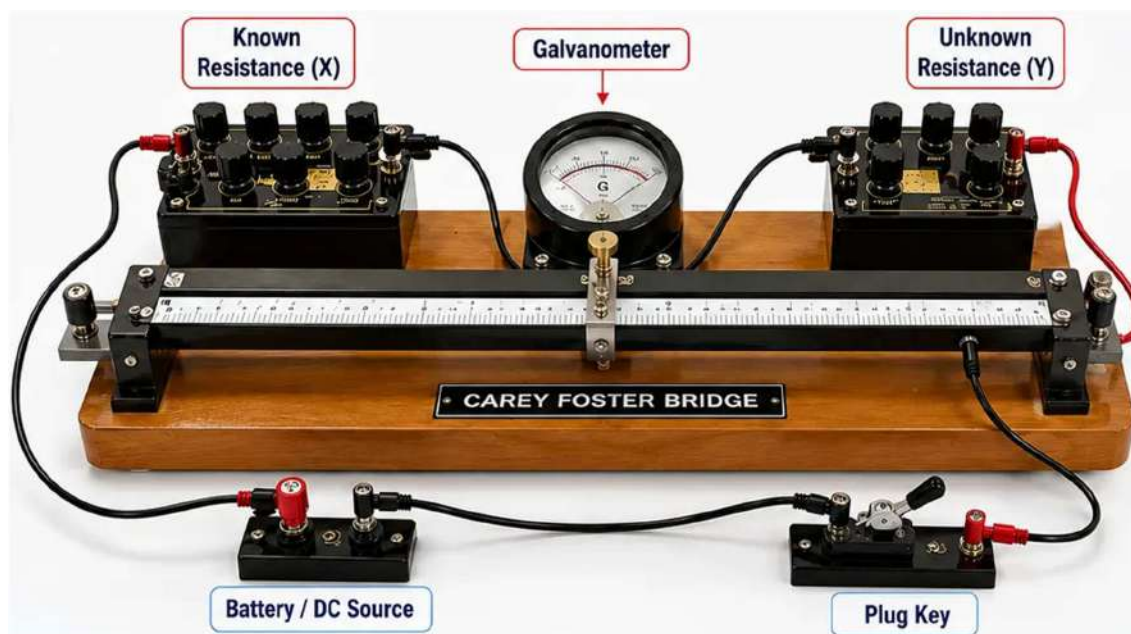
Where l_1 = balancing length on the bridge wire measured from the left and when known resistance X is connected in left gap of the bridge and zero resistance is connected in right gap of the bridge and l_2 = balancing length on the bridge wire measured from the left end on interchanging the position of X and Y .

2. Unknown resistance of the given wire / resistance,

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

Where X = known resistance connected in the left gap. Y = the resistance of wire connected in the right gap. l_1 and l_2 respectively are the balancing length of the bridge wire measured from the left end, before and after interchanging positions of X and Y .

Experimental set-up: -



Experimental Procedure:

The experiment is carried out in two parts:

Part A: To Determine the Resistance per Unit Length of the Bridge Wire

1. Connect the circuit as shown in the experimental setup.
2. Connect the galvanometer to the bridge.
3. Select a known resistance X using the resistance box (band switches) on the left side. Set the resistance Y = 0 Ω on the right side.
4. The terminals P and Q are already connected internally; therefore, no additional connection is required.
5. Connect the bridge to the AC mains supply and switch it ON using the power switch.
6. Press the jockey key and slowly slide the jockey along the bridge wire to locate the position where the galvanometer shows zero (or minimum) deflection.
7. Note the balance length l_1 from the left end of the bridge wire using the meter scale.
8. Interchange the resistances by setting X = 0 Ω on the left side and selecting the same resistance value on the right side.
9. Again, slide the jockey to obtain the null point and note the new balance length l_2 .
10. Calculate the resistance per unit length of the bridge wire using

$$\rho = \frac{X}{(l_2 - l_1)} \Omega/\text{cm}$$

where, X = Known resistance (Ω), l_1 = First balance length (cm)

l_2 = Second balance length (cm)

11. Repeat the experiment for different values of X and calculate the average value of ρ .

Part B: To Determine the Resistance of the Given Wire (Unknown Resistance)

1. Connect the unknown resistance (or the given wire) to the Y terminal on the right side of the bridge.
2. Select a suitable known resistance X using the resistance box on the left side.
3. Switch ON the bridge and locate the null point by sliding the jockey while pressing the jockey key.
4. Record the first balance length L_1 .
5. Interchange the resistances and again locate the null point.
6. Record the second balance length L_2 .
7. Calculate the unknown resistance Y using

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

where, X= Known resistance (Ω), ρ = Resistance per unit length of the bridge wire (Ω/cm)

8. Repeat the experiment with different values of X and calculate the average value of Y for greater accuracy.

Observations Table: -

1. To determine the resistance per unit length of the bridge wire:

S. No.	Known Resistance X (in ohms)	Balance Length l_1 (cm)	Balance Length l_2 (cm)	$(l_2 - l_1)$ (In cm)	$\rho = \frac{X}{(l_2 - l_1)}$ in ohm/cm
1.					
2.					
3.					

2. For resistance of given wire / unknown resistance:

S. No.	Known Resistance X (in ohms)	Balance Length l_1 (cm)	Balance Length l_2 (cm)	$(l_2 - l_1)$ (In cm)	$Y = X - (l_2 - l_1)\rho$ ohms
1.					
2.					
3.					

Calculations:

Mean resistance per unit length:

$$\rho_{mean} = \frac{\rho_1 + \rho_2 + \rho_3}{3} = \dots \Omega/\text{cm}$$

Mean value of unknown resistance:

$$Y_{mean} = \frac{Y_1 + Y_2 + Y_3}{3} = \dots \Omega$$

Results:

1. The resistance per unit length of Carey foster's Bridge wire = _____ ohms
2. Resistance of the given resistance wire / unknown resistance = _____ ohms

Precautions: -

1. All plug connections must be clean, tight, and free of oxide layers.
2. The jockey should be tapped gently on the wire, never dragged or pressed hard — this can scratch the wire and change its uniform cross-section.
3. The key should be inserted only while taking a reading, to avoid unnecessary heating of the wire.
4. Try to keep the balance point between the 40 cm and 60 cm marks for maximum sensitivity.
5. Avoid parallax error while reading the position of the jockey on the scale.
6. Ensure the bridge wire has uniform cross-section along its entire length; a non-uniform wire introduces systematic error.