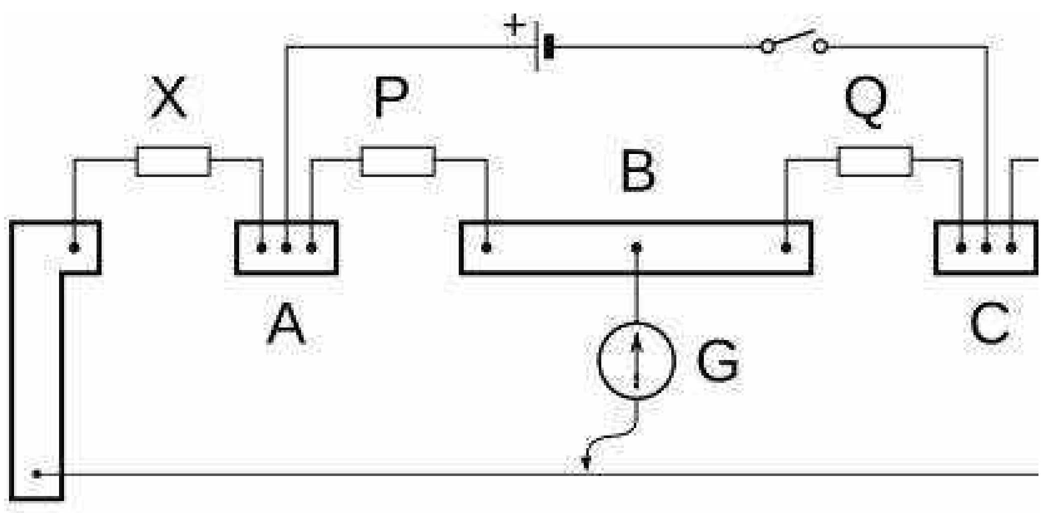
SUBJECT – APPLIED PHYSICS (LAB)

EXPERIMENT No – ----------

OBJECT – To determine the resistance per unit length of the wire of Carry Foster's Bridge and hence to determine a low resistance with its help.

APPARATUS REQUIRED – "E & E "make Carry Foster's bridge with inbuilt DC generated Power supply, Galvanometer, Unknown resistance / Resistive Wire, connecting wires and instruction manual.

THEORY - In electronics the carry foster bridge is the bridge used to measure low Resistances, or to measure small differences between two large resistances. It was invented by Carry Foster as a variant in Wheatstone bridge.



In the diagram, to the right X and Y are resistances to be compared. P and Q are Nearly equal resistances, forming the other half of the bridge. The bridge wire EF has a jockey contact D placed along it and is slide until the Galvanometer G measures zero. The thick bordered areas are thick copper bus bars of almost zero resistance.

1. Place a known resistance in position X.

2. Place an unknown resistance in position Y.

3. Adjust the contact D along the bridge wire EF so as to null the galvanometer. This position (as a percentage of distance from E to F) is $l1$.

4. Swap X and Y. Adjust to the new null point. This is $l2$.

If there is no deflection in Galvanometer then the bridge is in balanced condition that is the points B and D are at equal potential. In this condition,

$$\frac{P}{Q} = \frac{Resistance\ between\ A\ and\ D}{Resistance\ between\ D\ and\ C}$$

In the state of zero deflection, if the length of wire ED is L1 centimeter, then length of wire DF will be (100 – L1) cm if the cross sectional area of wire is uniform throughout. Then resistance per centimeter length of wire is ρ ohms per centimeter and the resistance of wire ED = L1ρ and resistance of wire DF = (100 – L1) ρ.

Let the resistance of the strip at the left end the α and at right and be β, then

$$\frac{P}{Q} = \frac{X+\alpha+l1\rho}{Y+\beta+(100-l1)\rho} \qquad \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(1)$$

Now, on interchanging the positions of X and Y. Let the balancing length obtained on wire be ED = L2 cm, then DF = (100 – L2) cm. Then

$$\frac{P}{Q} = \frac{Y+\alpha+l2\,\rho}{X+\beta+(100-l\ )\rho} \qquad \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(2)$$

From equation 1 and 2,

$$\frac{X+\alpha+l1\rho}{Y+\beta+(100-l\ )\rho} = \frac{Y+\alpha+l2\rho}{X+\beta+(100-l\ )\rho}$$

Adding 1 on both sides,

$$\frac{X+Y+\alpha+\beta+100}{Y+\beta+(100-l1)\rho} = \frac{X+Y+\alpha+\beta+100}{X+\beta+(100-l2)\rho}$$

Since the numerators of both sides are equal. Hence their denominators will also be equal. So, Y + β + (100 – *l*1) ρ = X + β + (100- *l*2) ρ

Y = X – (*l2* – *l1*) ρ _____________________ (3)

If Y = 0 then the resistance per unit length of wire of Carey Foster's Bridge will be:

$$P = \frac{X}{(l2 - l1)}\ ohms/cm \quad \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(4)$$

FORMULA USED:

1. Resistance per unit length of wire of bridge ;

$$\rho = \frac{X}{(l2 - l1)}\ \text{ohms/cm}$$

Where *l1* = 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 *l2* = 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,**

$$Y = X - (l2 - l1)\ \rho$$

Where X = known resistance connected in the left gap. Y = the resistance of wire connected in the right gap. *L1 and L2* respectively are the balancing length of the bridge wire measured from the left end, before and after interchanging positions of X and Y.

PROCEDURE:

The experiment is performed in the following Two Steps;

1. To determine the resistance per unit length of the bridge wire.
2. To determine the resistance of the given wire / unknown resistance.

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

1. First connect the circuit as shown in figure 1 for which just connect the Galvanometer as given in the figure and select any resistance X with the

help of bands which is given in the left end and select the resistance Y to zero with the help of band switch given on the right end.

2. As you can see P and Q are already connected in the bridge so no need to connect anything over there.

3. Now connect the bridge to 220 volt using mains chord connected in the bridge and switch on the bridge using on / off switch connected at front side of the bridge and slide the Jockey on the wire from left to right end and check the deflection of galvanometer and try to make the deflection zero or minimized by sliding the Jockey and pressing the push to connect key given on the Jockey.

4. When you get the zero deflection / minimum deflection on wire note down the reading / length L1 of wire from left hand with the help of meter scale and pointer given on the bridge and Jockey.

5. Now interchange the resistance X and Y that is select the zero resistance at the left end and select the same resistance at right end which we take value of X in first reading with the help of bands which is given at both the ends.

6. Now again slide the Jockey on wire from left to right with pressing push to connect key and set the Galvanometer to zero / minimum deflection and not the reading / length L2 of wire from the left hand with the help of meter scale and pointer given on the bridge and Jockey.

7. Now we have the value of L1 and L2 and we have the value of X also so we can calculate the resistance per unit length of wire of bridge by given formula $\rho = \frac{X}{(l2 - l1)}$ ohms/cm

8. Now you can repeat the step from 1 to 7 by taking different values of X using band switches and resistivity will be calculated for each observation and its mean will be calculated.

2. **To determine the resistance of a given wire/ resistance.**

1. As we used Y = 0 in previous part but to determine the resistance of a given wire / unknown resistance we have to select any value of resistance to be calculated using band switch or to connect the given wire of which we have to calculate the resistance at the terminal given for Y at right end initially.

2. Now select any value of X using band switch on left end and select the unknown resistance using given band switch on right end or connect any wire at its terminal.

3. Now follow the steps 3, 4, 5, 6 to find the values of L1 and L2.

4. As we know the value of X so by using the relation given below we can calculate the value of Y.

$$Y = X - (l2 - l1)\rho$$

5. You can calculate the value of Y by taking different values of X and take the mean value of Y for more accurate result.

OBSERVATIONS:

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

S. No.	Resistance connected Left end using switch X (in ohms)	Position of zero/minimum Deflection when X is connected		(***l2 – l1***) (In cm)	ρ=$\frac{X}{(l2-l1)}$ (in ohm/cm)
		In left gap ***L1*** (in cm)	In right gap ***L2*** (in cm)		
1.					
2.					
3.					

Mean ρ=____________ohm/cm

2. For resistance of given wire / unknown resistance:

S .No.	Resistance connected At left end using band switch, X	Position of zero/minimum Deflection when X is connected	(***l2 – l1***)	Y=X-(l2-l1)ρ (in cm)

	(in ohms)	In left gap ***L1***(in cm)	In right gap ***L2*** (in cm)	(in cm)	
1.					
2.					
3.					

Mean Y = __________cm

RESULT:

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 the terminals should be properly tightly connected for better results.
2. Never allow the flow of current in the circuit for a long duration otherwise resistance wire will get heated which in turn increases its resistance. So plug the key only while taking observations.
3. Don't move the Jockey or the bridge wire by rubbing; otherwise thickness of wire will not remain uniform.
4. Operate the band switches and Galvanometer gently.