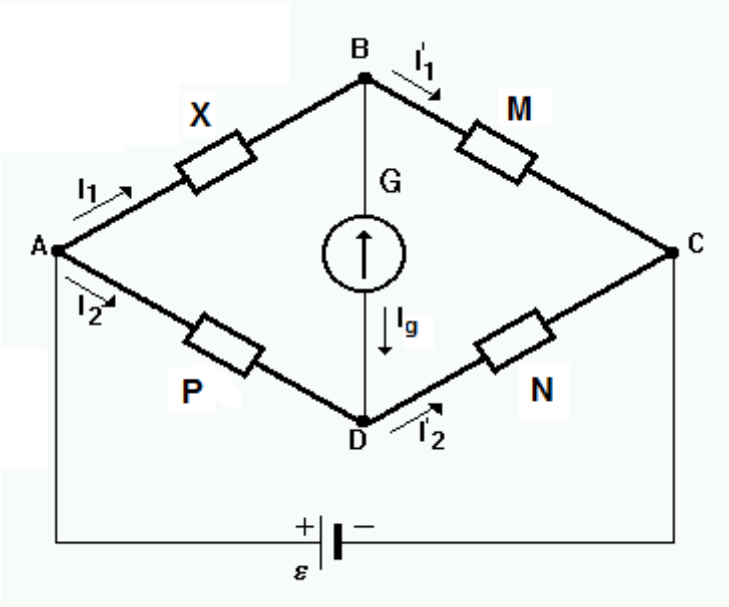
Answer on Question #85248 - Physics - Mechanics | Electric Circuits

The Wheatstone bridge. The circuit shown in Fig. P26.81. called a Wheatstone bridge, is used to determine the value of an unknown resistor X by comparison with three resistor M, N, and P whose resistances can be varied. For each setting, the resistance of each resistor is precisely known. With Switches K1 and K2 closed, these resistors are varied until the current in the galvanometer G is zero; the bridge is then said to be balanced. Show that under this condition the unknown resistance is given by X=MP/N. (This method permits very high precision in comparing resistors.) If the galvanometer G shows zero deflection when M=850.0 ohms, N=15.00 ohms and P=33.48 ohms, what is the unknown resistance X?

Solution:




According to the first Kirchhoff rule for node B:

$$I_1 - I_1' - I_g = 0.$$

According to the first Kirchhoff rule for node D:

$$I_2 - I_2' + I_g = 0.$$

For balanced bridge $I_g = 0$, so:

$$I_1 = I_1',$$

$$I_2 = I_2'.$$

According to the second Kirchhoff rule for circuit ABDA:

$$I_1 X + I_g R_g - I_2\ P = 0,$$

According to the second Kirchhoff rule for circuit BCDB:

$$I_1' M - I_2' N - I_g R_g = 0.$$

For balanced bridge:

$$I_1 X - I_2\ P = 0,$$

$$I_1\ M - I_2\ N = 0.$$

Solve this system of equations:

$$I_1 = \frac{I_2\ P}{X},$$

$$\frac{I_2\ P}{X} M = I_2\ N,$$

$$X = \frac{MP}{N} = \frac{850.00 \cdot 33.48}{15} = 1897.20\ Ohm.$$

Answer: Unknown resistance X equals 1897.20 Ohm.