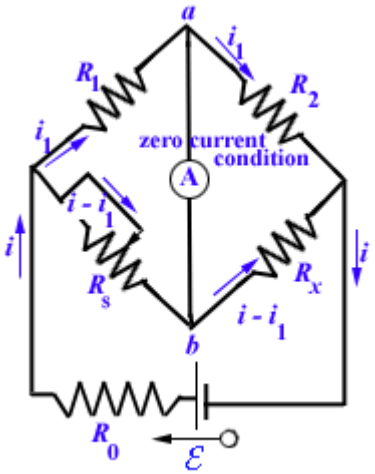
416.

Problem 33.46 (RHK)

In the circuit shown in the figure R_s *is to be adjusted in value until points a and b are brought to exactly the same potential* (*One test for this condition by momentarily connecting a sensitive ammeter between a and b; if these points are at the same potential, the ammeter will not deflect*.) *We have to show that when this adjustment is made, the following relation holds*

$$R_x = R_s\left(R_2/R_1\right).$$

An unknown resistance $\left(R_x\right)$ *can be measured in terms of a standard* $\left(R_s\right)$ *using this device, which is called a Wheatstone bridge.*



Solution:

We will analyse the circuit shown in the figure, called the Wheatstone bridge, at the condition when the points *a* and *b* in the circuit are at the same potential.

This condition is achieved by adjusting the sliding resistance R_s. This is called the null-condition, as then ammeter shows zero current.

At the null-condition, currents in the different branches of the circuit will be as shown in the diagram. We have required that at each junction sum of the currents that are entering is equal to the sum of the currents that are leaving.

As the points *a* and *b* are at the same potential, we have the equivalent conditions

$$i_1 R_1 = (i - i_1) R_s,$$

and

$$i_1 R_2 = (i - i_1) R_x.$$

From these equations, we get

$$\frac{R_x}{R_s} = \frac{R_2}{R_1},$$

or

$$R_x = R_s (R_2 / R_1).$$