364.
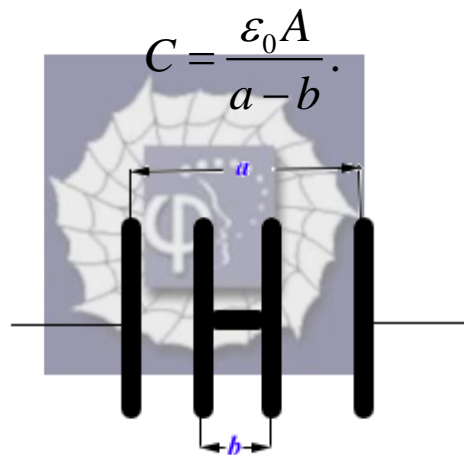
Problem 31.21 (RHK)

In the figure two capacitors in series have been shown. The rigid centre section of length b is movable horizontally. We have to show that the equivalent capacitance of the series combination is independent of the position of the central section and is given by
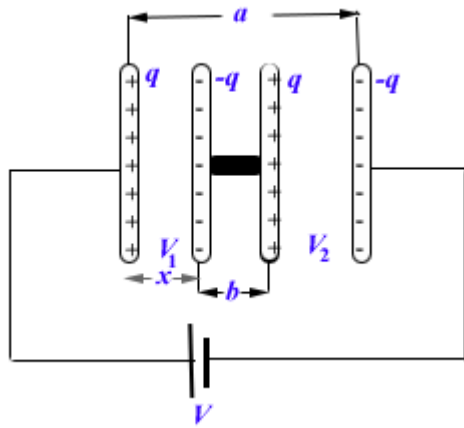
$$C = \frac{\varepsilon_0 A}{a - b}.$$

Solution:

For the configuration of the capacitor plates let the separation between the plates be x and $(a - b - x)$.

Electric field between the plates is

$$E = \frac{q}{\varepsilon_0 A}.$$

Therefore, potential differences between the pairs of plates are

$$V_1 = \frac{qx}{\varepsilon_0 A},$$

and

$$V_2 = \frac{q(a-b-x)}{\varepsilon_0 A}.$$

But as

$$V_1 + V_2 = V,$$

we have

$$V = \frac{qx}{\varepsilon_0 A} + \frac{q(a-b-x)}{\varepsilon_0 A} = \frac{q(a-b)}{\varepsilon_0 A}.$$

And

$$q = \frac{\varepsilon_0 A}{(a-b)}V.$$

As

$$q = CV,$$

$$C = \frac{\varepsilon_0 A}{a-b}.$$