"Demo" of parallel plate capacitor with variable plate separation

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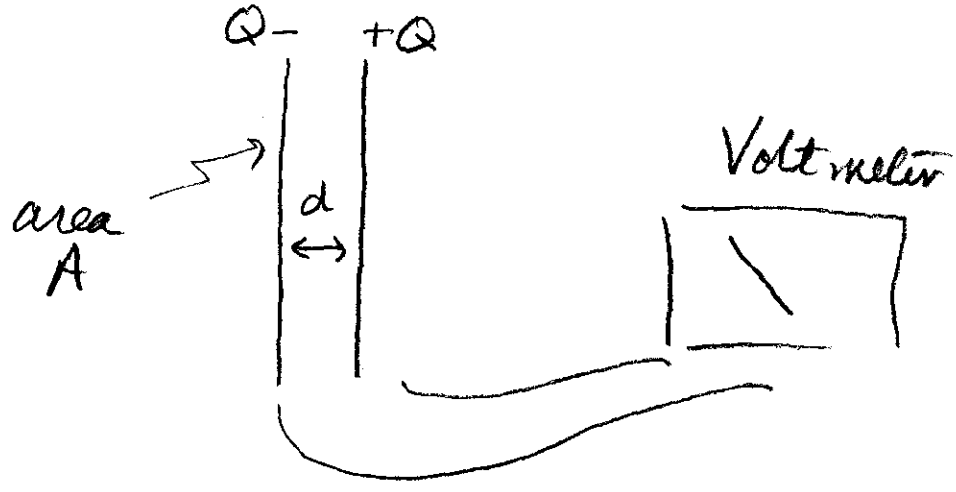
Recall:



Then $V = Ed$ $\qquad E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0}$

$= \frac{Qd}{A\varepsilon_0}$

And we observed that V increased from V_I (with plate separation $d = d_I$) to V_F (with plate separation $d = d_F > d_I$). Yes!

(1) Which is "amazing" as we did nothing electrical yet V changed!

(2) And the stored energy increased because: $PE_F = \frac{1}{2} Q V_F > PE_I = \frac{1}{2} Q V_I$

Thus we can explain.

$$PE_F - PE_I = \text{Work done (by "me")}$$

$$= F \times \text{distance}$$

$Q \times$ "E" ↑ , ↑ $d_F - d_I$

where "E" is the part of the E-field from the other (non moving) plate; but we know what that is: "E" $= \frac{\sigma}{2\varepsilon_0} = \frac{Q}{2A\varepsilon_0}$

$$\therefore PE_F - PE_I = \overbrace{Q \times \frac{Q}{2A\varepsilon_0} \times (d_F - d_I)}^{\text{Work done}}$$

$$= \frac{Q^2}{2A\varepsilon_0}(d_F - d_I)$$

using $V = \frac{Qd}{A\varepsilon_0}$

$$= \frac{Q}{2}(V_F - V_I)$$

= (yes) The change in the stored electrical energy!