Maxwell's Equation

Topic :- 2 "Displacement Current"
(2nd class of Maxwell's equⁿ)

$$\text{div}(\text{curl} B) = \mu_0\left[\text{div}(J) + \frac{\partial \rho}{\partial t}\right] \quad (9)$$

as $\text{div}(D) = \rho$

Maxwell called the added term in equⁿs the displacement current density.

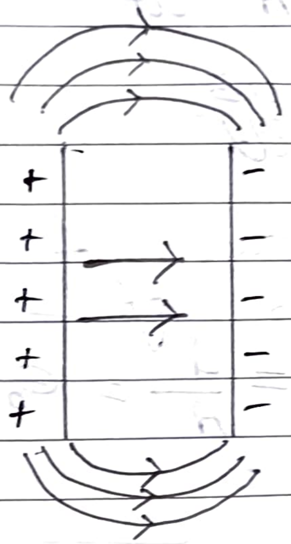

fig (1)

A physical situation which combines electric fields and currents in a straight forward way is shown in figure 1.
A current is enter the positive plate and leaves

the negative plate of a parallel plate condenser. This current cannot continue long and will become zero when the capacitor becomes fully charged. If q is the charge on the plates at any time t and A the plate area, then electric field in the gap $E = \frac{q}{\epsilon_0 A}$

$$\frac{dE}{dt} = \frac{1}{\epsilon_0 A} \frac{dq}{dt} = \frac{i}{\epsilon_0 A}$$

$$i = \epsilon_0 A \frac{dE}{dt} \quad \text{------} \quad (10)$$

Hence the current density in the gap of the plates $= \frac{i}{A} = \epsilon_0 \left(\frac{dE}{dt}\right)$

$$J_d = \frac{\epsilon_0 \, dE}{dt} \quad \text{------} \quad (11)$$

Thus the variation of E with time produces an additional current of current density J_d in space, called displacement current density.

$$\nabla \cdot E = \frac{\rho}{\epsilon_0}$$

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$$\nabla \cdot B = 0$$

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times B = \mu_0 \left(J + \epsilon_0 \frac{\partial E}{\partial t} \right)$$

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