Our Readers Write ...

Comments on
"Understanding Vanishing Energy During Charging of Capacitor Level"

I read the above article in the Classroom Section of the March 2006 issue of *Resonance* with great interest, but was disappointed at the end. The problem investigated is an age-old one and has been very widely written about. That an ideal charged capacitor, when connected across an ideal inductor, gives rise to steady sinusoidal oscillations is well known and is a standard tutorial problem in the first circuit theory course. The real problem is to explain the loss of energy when an ideal charged capacitor is connected across another uncharged ideal capacitor, by ideal connecting wires whose resistance and inductance are both zero. An impulsive current flows to charge the second capacitor instantly to a value determined by the ratio of the capacitors. However, there is loss of energy in the process and the most accepted explanation is that this energy is radiated. It is indeed a reasonable answer because the impulsive current has a flat spectrum from zero to infinite frequencies. Hence the system will radiate, like an antenna system, irrespective of the dimensions of the circuit. However, why is this radiated energy independent of the size and shape of the capacitors and the connecting wires ? This, in my opinion, is the real problem, which has not even found a mention in the literature, not to speak of a solution.

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Author's Reply to comments on
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The problem discussed in the article mentioned above is of two capacitors, in which one capacitor is charged and connected to the other one through a resistance. In such case, both capacitors share the charge on first capacitor, but during this process, a part of energy is lost through the resistance. Even when the resistance value tends to zero, it appears that the same energy is vanishing. In our article, we have shown that the approach in solving of this problem is not correct. In a typical RC circuit, value of inductance is taken as zero, effect of inductance is negligible, $\frac{R^2C}{4} > L$. However, for very low values of R, this statement is no longer valid and the circuit will become underdamped and oscillatory. When R is zero, the circuit will oscillate without any decay of amplitude. An analogous mechanical system will have zero friction.

Finally, the popular explanation that this energy is radiated is not correct. After all, radiation is a form energy transfer by electromagnetic waves. If there is radiation from LC circuit, then it has to be represented as a resistance in a tank circuit, corresponding to the loss of energy. (An LC circuit with zero resistance should oscillate without any decay just as a pendulum would oscillate indefinitely if there were no friction. So if such circuit radiates, it will lose energy causing decay of amplitude, which in turn would mean that its resistance is not zero. This is against original hypothesis.)

The reason of apparent vanishing energy in this problem arises mainly due to the habit of ignoring effect of inductance in the circuit when resistance tends to zero. As soon as that element is included in the analysis, there is no mystery left and problem is solved.

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Some readers have pointed out that the cover picture depicted on the May 06 issue is unlikely to be that of bromeliads and is more likely to be that of Agave sp. We regret that the picture was published without confirming the identity of the plant.