FLUX CAPACITOR (part of the STEAP system)

CAPACITORS

Inside most capacitors is a non-conductive dielectric material between the plates. Because the dielectric is non-conductive, all the electrons are bound in orbitals (until a breakdown voltage is reached). When one plate has a surplus of electrons, and the other plate has a deficit of electrons, an **electric field** is created. This causes the electron orbitals to become distorted. Each electron moves, on average, a short distance away from the negative plate and toward the positive plate. Any **net movement** of electrons in a direction is **current**, so there is a current inside of a capacitor with a **solid dielectric** when it is **charging or discharging**. Although the movement of any individual electron is small, **the number of electrons involved is very large**, so **large currents** can actually flow **within** a capacitor.

The above describes how most discrete capacitors work. Consequently, there is another process that is also called **"displacement current"**, even though there is nothing being displaced. This second kind of displacement current can't really be explained in terms of matter. It is simply a change in the electric field. **Whenever an electric field undergoes change, there is displacement current**. There really is not much more we can say to explain it, but it is there, and has an **associated magnetic field around it, just like current that consists of the motion of charges**.

Curl magnetic field:

In a capacitor that is **charging or discharging**, such as in an “LC” oscillator circuit, the **curl of the magnetic field** inside the capacitor plates is **non-zero**, driven by the **changing electric field**, a concept known as **Maxwell’s displacement current**.

If this capacitor is placed inside an inductor (a solenoid or similar coil), the magnetic field within the capacitor is a superposition of the **linear magnetic field generated by the inductor** and the **azimuthal (curl) magnetic field generated by the capacitor's changing electric field**.

1. Curl Inside the Capacitor Plates (Between Plates)

Even if no real current flows between the capacitor plates, a magnetic field is produced by the **time-varying electric field.**

2. Effect of the Surrounding Inductor

If a coil (inductor) surrounds the capacitor, the total magnetic field is the **sum of the fields**.

- **Inductor Field:** A uniform axial field parallel to the inductor's axis.
- **Capacitor Field:** A "curly" azimuthal field.

Resulting Curl: Because the inductor's magnetic field is generally uniform (low curl) and directed axially (along the plates), the **significant curl** of the total magnetic field inside the capacitor remains dominated by the displacement current of the capacitor.

3. Summary of Fields in a LC Circuit

- **Maximum Capacitor Field:** Occurs when the electric field is changing fastest, which is at the moment of charge and discharge is maximum.
- **Maximum Inductor Field:** Occurs when the current is at its maximum.
- **Combined Dynamics:** In a **fully integrated system** (**flux capacitor**), the changing electric field of the capacitor is **intertwined** with the **magnetic fields**, allowing for an enhanced energy storage density. If the capacitor is made by winding a bifilar coil, with like ends shorted, as the two plates of that capacitor, and the solenoid coil wound over the top, the electric and so the **magnetic fields will be perpendicular to one another.**
- **Perpendicular effects:** With a time changing (oscillating) current in both the capacitor and the solenoid coil, a **very fast** changing magnetic field will be created. This magnetic field will have the **appearance** of a sine wave due to the charging and discharging curve of the capacitor magnetic field. If another coil was intertwined, (bifilar), a high current would be induced into that coil from the magnetic field.
- **Compensation of low capacitance:** Where two coils are wound (bifilar) to create a capacitor, the very low capacitance is compensated by an external high value non polarised capacitor connected in parallel with the coil capacitance. The coil capacitor effectively takes on the value of the external high value capacitance, for example of a coil capacitance of 640pF and 20uF external capacitance, will be seen as +- 20uF of coil capacitance.
- **Heating effects of induction:** Where any over wound solenoid over the core capacitor, has a fast alternating current (forward and reverse), an induced current will be created into that metal core (the coil capacitor is copper) and so heat will be generated in that core (eddy currents).

Part of the above has been taken from a patent application for cooling the “Flux Capacitor” which uses two phase cooling with a high dielectric fluid such as, but not only, HFO-1234ze (hydro fluoro olefin). This application is in 3 names of which I am one of those people.