HOW A TESLA COIL WORKS

Working of Tesla Coil

A Tesla coil transformer operates in a significantly different fashion than a conventional (i.e., iron core) transformer. In a conventional transformer, the windings are very tightly coupled, and voltage gain is limited to the ratio of the numbers of turns in the windings.

However, unlike a conventional transformer, which may couple 97%+ of the magnetic fields between windings, a Tesla coil's windings are "loosely" coupled, with the primary and secondary typically sharing only 10–20% of their respective magnetic fields and instead the coil transfers energy (via loose coupling) from one oscillating resonant circuit (the primary) to the other (the secondary) over a number of RF cycles.

As the primary energy transfers to the secondary, the secondary's output voltage increases until all of the available primary energy has been transferred to the secondary (less losses). Even with significant spark gap losses, a well-designed.

Tesla coil can transfer over 85% of the energy initially stored in the primary capacitor to the secondary circuit. Thus the voltage gain of a Tesla coil can be significantly greater than a conventional transformer, since it is instead proportional to the square root of the ratio of secondary and primary inductances.

In addition, because of the large gap between the primary and secondary that loose coupling makes possible, the insulation between the two is far less likely to break down, and this permits coils to run extremely high voltages without damage.

Modern high voltage enthusiasts usually build Tesla coils that are similar to some of Tesla's "later" air core designs. These typically consist of a primary tank circuit, a series LC (inductance-capacitance) circuit composed of a high voltage capacitor, spark gap and primary coil, and the secondary LC circuit, a series resonant circuit consisting of the secondary coil plus a terminal capacitance or "top load." In Tesla's more advanced design, the secondary LC circuit is composed of an air-core transformer secondary coil placed in series with a helical resonator. The helical coil is then connected to the terminal capacitance. Most modern coils use only a single helical coil comprising both the secondary and primary resonator. The terminal capacitance actually forms one 'plate' of a capacitor, the other 'plate' being the Earth (or "ground").

The primary LC circuit is tuned so that it resonates at the same frequency as the secondary LC circuit. The primary and secondary coils are magnetically coupled, creating a dual-tuned resonant air-core transformer. Earlier oil insulated Tesla coils needed large and long insulators at their high-voltage terminals to prevent discharge in air. Later version Tesla coils spread their electric fields over large distances to prevent high electrical stresses in the first place, thereby allowing operation in free air.

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