High Frequency Resonant Transformer

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The high frequency resonant transformer, more commonly known as the Tesla coil, is a device that combines different physical phenomena in the field of electromagnetism. The existing literature on the Tesla coil operation and construction is either incomplete or largely exceeds the high school level. This holds especially true for the dimensioning of the secondary coil. The aim of our project was to derive the relations between different parameters of the secondary coil taking into account its resonant nature and testing the derived relations by experiment. We derived a set of equations that describe the properties of single layer coils given their specific parameters. Our equations follow the special condition stated by Tesla himself, that the length of the wire from which the coil is made must be equal to one quarter of the resonant wavelength of the coil. A condition which is almost always overlooked when building such a device. One of the important outcomes of our work is a simple linear equation connecting the height H and radius R of the coil following the quarter wavelength condition: H/R = 1.265. Considering the complexness of the equations describing the resonant behavior of the coil, the simplicity of the derived relationship between H and R is astonishing and gives evidence of extreme elegance and beauty behind the operation of the device. To our best knowledge, this relation was not written in such a form before. We also designed and performed a series of experiments which confirmed our theoretical findings. By considering the derived relations we planned, constructed and tuned our own Tesla coil. The construction procedure is documented step-by-step with the aim of creating a friendly Tesla coil construction guide.

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