Ph.D. Quals Question
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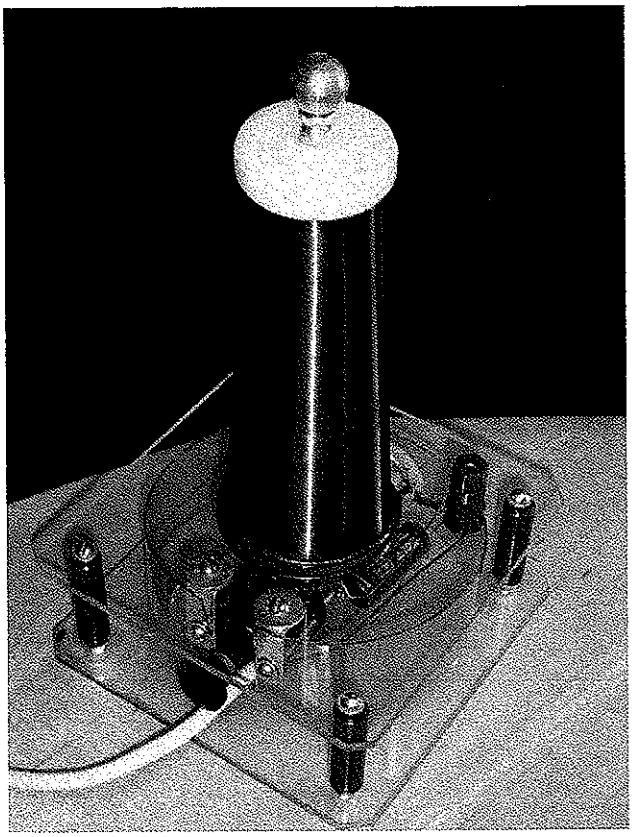
Compact Tesla Coil

The figure below shows the compact Tesla Coil that was shown to each student. The white cord at the bottom connects the coil to a 110 V power outlet and when the black knurled knob next to it is screwed in it moves two electrical contacts closer together and sparking takes place between them. At this time, if a coin held firmly in the fingers is brought toward the round aluminum ball at the top of the coil, sparks up to 1–2 inches long can be drawn out of the sphere. Obviously there is a very high voltage being generated on the sphere; this observation leads to the first question asked of the students: (1) what is the electrical engineering basis for the generation of this high voltage, given that the source voltage is 110 V?



Two hints were given: First, the students were told, or guided, to remember Faraday's law of electromagnetic induction and then, second, an AM radio was turned on while the coil was sparking and it was shown the coil was generating radio interference across the entire AM band (i.e., covering many hundreds of kHz).

The answer to this question usually involved two steps: (i) identification of the key components of the device, and then (ii) a hypothesis for how these components generated the high voltage.

Points for (i) were awarded for identifying the many turns making up the red colored part of Tesla coil as the secondary of a **transformer,** with the two thick black coils at its base making