Group Project One: Tesla Coil

MCEN 5228: Flow Visualization

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Context & Purpose

For our first group project we decided to contact the physics department to let us image their tesla coil in action. The intent was to capture the stunning beauty of the machine in use. The phenomenon seen in the videos are the beams of electricity flowing from the coil into the air. As a group we combined our knowledge of physics and photography, as well as imaging hardware to display the phenomenon. With our collaborative efforts, we successfully created different types of images and videos to show the class how interesting and unique of a machine this really is.

Apparatus

A tesla coil is a type of transformer circuit. Its purpose is to create high voltage, low current, and high frequency AC electricity. Since voltage is equal to the current times the resistance, it is possible to create high voltages with low current by greatly increasing the overall resistance of the circuit. Nikola Tesla invented the device in 1891 [1]. The device has been modified and used commercially. The medical and lighting industries have used the design with some changes in some frequency. However, recently, the coil is mostly used for its fantastic effect and for educational purposes. The coil, imaged below, is about two feet tall with a rounded disk-like metal top.

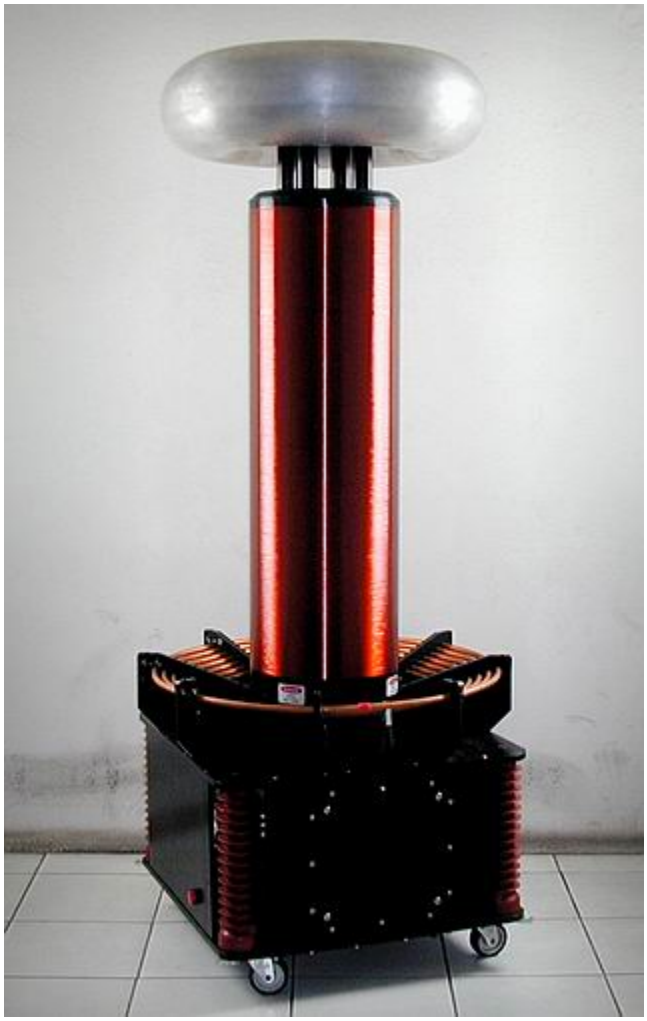

Figure 1: Image of similar tesla coil

The top part has a diameter of about one foot and is constructed of two metallic hemispheres. The beams of electricity shot out two to three feet from the surface. The flow pattern was completely random, except for when we used the grounding rod which concentrated the electricity to the rod at close distances. This is not a 'traditional' flow and therefore there are no Reynolds or Grashof numbers to be calculated. Engineering and mathematical analysis of the coil is not well known and not relevant to the scope of this project.

Filming Technique

I used my Sony HD Camcorder to create the videos. The lighting in the room was dimmed to enhance the contrast between the electric beams and the dark background. I stood about six feet from the coil in all three videos and used the automatic focus option. The field of view ranges from a maximum of about six feet to only one foot when zoomed in. The model number is HDR-HC5. It was somewhat difficult for the automatic white balance setting to capture the video because the beam was extremely bright while the background was dark. This is probably why the black backdrop appears grainy. The first video shows the grounding rod absorbing the electrical discharge almost completely due to its close proximity to the coil. In the second film the rod is moved away from the coil and the random scattering of electricity starts to dominate the overall flow. The final film was shot without the grounding rod and thus the electrical energy was dispersed evenly in every direction. There was not any video editing or processing done, besides clipping the desired sections.

Impact of Film

The three short videos reveal the beauty of the physics that Tesla mastered over one hundred years ago. I like how bright the beams appeared in the video and also how moving the grounding rod impacted the overall dispersion of the electrical field. I would have liked to use a completely black background with no distracting elements. The lighting could maybe have been darker to eliminate the grey affect in the back. If I would have filmed again I would have tried to adjust the white balance because the grainy background is somewhat distracting. Another main problem is that the coil could only be turned on for ten seconds at a time to prevent over-heating. Therefore all the videos are very short. This tesla coil idea could be developed further by using more than one grounding rod and also measuring the distances between the rod and coil to see exactly where the dispersion takes place.

Reference

1. "Tesla Coil." Wikipedia.org Available at http://en.wikipedia.org/wiki/Tesla_coil