

Final Report: 2008 Sigma Pi Sigma Undergraduate Research Award
Utah State University; June 4, 2009

Investigating the Effects of Atmospheric Composition on Sound Emitted by a Tesla Coil Speaker

Abstract: Plasma speakers (a.k.a. tesla coil speakers) have gained popularity over the past few years, but little scientific work has been performed on them as most are built by hobbyists. The USU Chapter of the Society of Physics Students will build a small tesla coil modeled after the coronaphone developed at Villanova University. Chapter members will record the sound propagating through four gases: air, nitrogen (N₂), carbon dioxide (CO₂), and argon (Ar). These spectra will be compared with one another to see if changes in sonic spectra reflect properties of the gases.

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Though plasma speakers are commercially available, they are expensive, large, and provide limited access to the flame for the experiment proposed. This project was predicated on constructing a low-cost, scaled-down, and experimentally useful variant of the commercial speaker. To do this, the USU team (initially consisting of 25 investigators) copied a circuit designed in 2002 by three Villanova electrical engineering undergraduates [1]. The stated goals of the Villanova design project were to produce an FET-based circuit, with low power consumption, and low construction cost, and a description of the circuitry was found on the internet.

The Villanova circuit consists of three coupled sub-systems. The USU team divided into three sub-system working groups, each responsible for producing one of the component circuits. By May 2008, the three sub-systems were all functional and successfully integrated to produce a flame a few centimeters in length. When the circuit was driven by an audio input source, the flame did indeed produce a weak but detectable audible output. In other words, the proposed project was well on its way to completion.

Then hubris struck. Wishing to show off the fruits of its labor in public, the team placed the circuit in an attractive box and enclosed the flame tip in a Faraday cage (for safety concerns). Essentially immediately thereafter the flame became intermittent. Unfortunately, extricating the circuitry and tip from their enclosures proved to be irreversible. Worse, efforts to troubleshoot the problems led to on-the-fly re-engineering of components (never a smart strategy), eventuating in a situation where blowing power transistors became a fairly dependable characteristic of the system.

By December 2008, the ongoing frustration of this foray into experimental science caused the USU team to shrink to about five remaining stalwarts. For a while, the team held out a hope that an anonymous tinkerer in the UK would produce—as promised on some YouTube postings—a cheap ion speaker kit that could be adapted for the proposed purpose. Regrettably, this hoped-for solution appears to have vaporized (probably along with the economy).

Conceding its need for assistance, the team consulted with a professional engineer who noted a number of ambiguities and flaws in the Villanova design. It is a distinct possibility that time pressure led the Villanova students to generate a provisional and incomplete project report. (This is yet another cautionary tale about web-based information.)

In any case, a series of redesigns by the USU team during the spring term 2009 has resulted in a system that, though hardly a “speaker,” is nonetheless reasonably functional. Now freed from academic demands, the team has embarked on an experimental protocol that should by summer’s end produce actual data relevant to the project’s original intent. When this eventuates a manuscript reporting the results will be prepared and a copy will be sent to the SPS national office.

Tangentially, the students participating in this saga have learned a number of potentially career-enhancing lessons having to do with the difficulty of developing practical electronic circuitry, the vagaries of experimentation, and the necessity for critical assessment of “published scholarship.”

1. Rob, Alejnikov, Mark Blattner, and Colin Joye, “Solid-State, FET-Based Ion Tweeter” (Villanova University, 2002). <http://www.ee.vill.edu/ion/>

