Physics of Music Projects Final Report

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Abstract

The following project was begun in the spring of 2011 in an attempt to create plasma speakers and discover the range of frequencies for which the speakers sound best, and what may be modified to make the audibility of all tones the same, whether by adding mechanical improvements such as a horn or changing parts of the speaker circuit itself. Unfortunately the speakers were not completed at the time of this writing, and the project will hopefully be completed over the summer of 2011.

What are plasma speakers?

Plasma speakers are speakers that use a high-voltage, high frequency arc of electricity to make noise rather than using an electromagnet and a cone to push the air.

The noise made by the speakers is the same noise heard when static electricity builds up and a shock occurs. The noise is simply amplified and repeated at the right frequency to create notes.

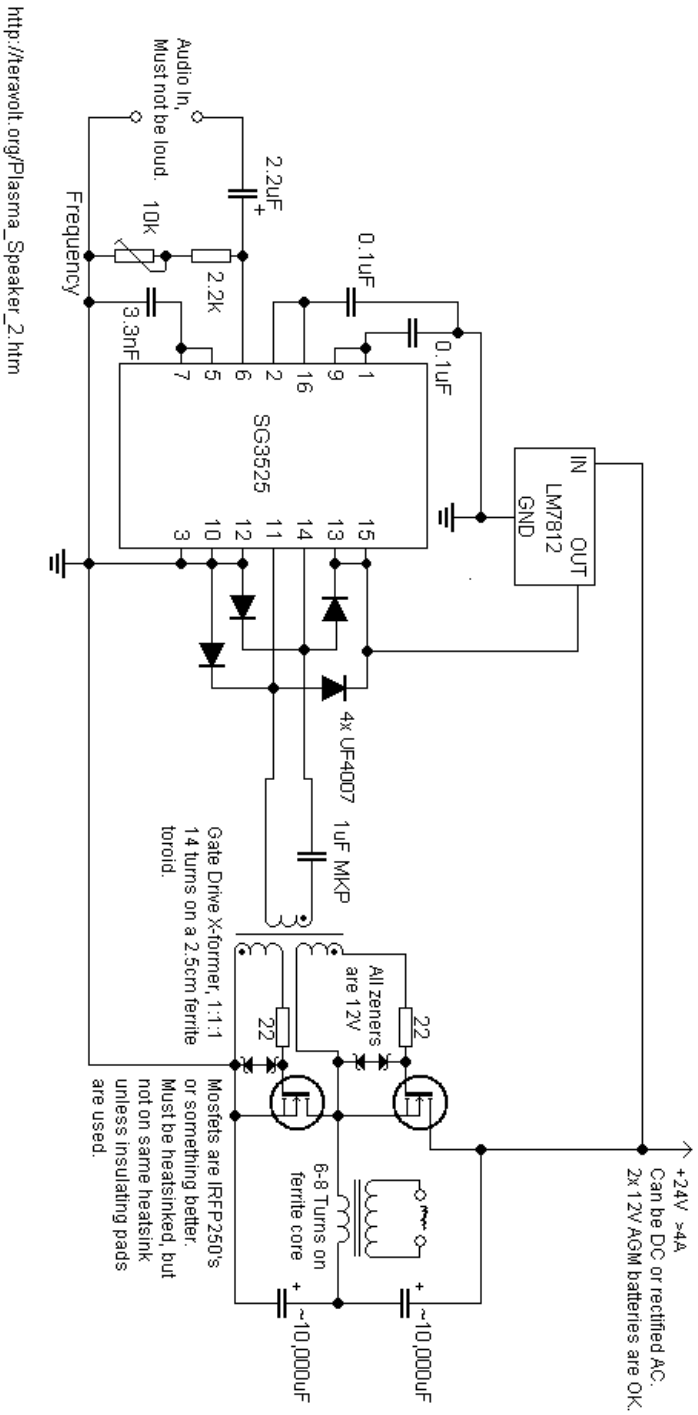
The arc of the plasma speaker actually runs at a frequency above 18,000 kHz, which is a higher pitch than the human ear is capable of registering. Notes are made by turning the input signal on and off at the note's frequency, and the resulting modulation results in a tone at the note's frequency for our listening pleasure.

The Circuit

The circuit design I chose (see schematic on following page) relies heavily on an integrated circuit to take in both the input voltage as well as the input noise signal, then sends the final signal to the flyback transformer, which will in turn increase the voltage of the signal and create the arc that makes the speaker sound.

The speaker takes a DC input voltage and relies on the integrated circuit to modulate that signal into an alternating current. Ideally a large battery is used to supply this voltage because the signal is completely flat and there is no background electromagnetic radiation from a power supply to disturb the signal. The audio signal is sent to the integrated circuit as well, and the audio signal is used as the reference voltage for the output, so the output signal from the IC turns on and off with the signal from the input audio.

As the signal leaves the IC, it runs to a gate drive transformer, which is used to make two mosfets run at alternating times in order to keep heat to a minimum. One of the output windings on the transformer is anti-parallel to the input windings, so the signal is reversed. A capacitor is placed before the input to smooth out the signal, and resistors are placed at either output to regulate the current for the zener diodes used to protect the mosfets. Each mosfet runs to a large capacitor to also help smooth out the signal, and to prevent the the mosfets from affecting each other while on. The signal from the mosfets reaches the transformer, and the spark is formed. The potentiometer at the audio input is used to adjust the frequency for audio quality.


http://terawolt.org/Plasma_Speaker_2.htm
Audio In,
Must not be loud.
Frequency
10k
2.2uF
2.2k
3.3nF
0.1uF
0.1uF
SG3525
IN
LM7812
GND
OUT
+24V >4A
Can be DC or rectified AC.
2x 12V AGM batteries are OK.
4x UF4007
1uF MKP
Gate Drive X-former, 1:1:1
14 turns on a 2.5cm ferrite
toroid.
All zeners
are 12V
22
22
Mosfets are IRFP250's
or something better.
Must be heatsinked, but
not on same heatsink
unless insulating pads
are used.
6-8 Turns on
ferrite core
~10,000uF
~10,000uF

The Process

After finding a schematic I liked and testing it against other schematics found to be sure it would indeed do as it said, parts were ordered. The parts necessary are as follows:

4x UF4007 diodes

4x 12 volt zener diodes

2x IRFP250 mosfets.

1x LM7812

2x 22 ohm resistors

1x 2.2k resistor

1x 10k potentiometer

2x 0.1uF (104) capacitors

1x 3.3nF (332) capacitor

1x 1uF (105) MKP capacitor

1x 2.2uF electrolytic capacitor

2x 10,000uF electrolytic capacitors

flyback transformer

ferrite toroid

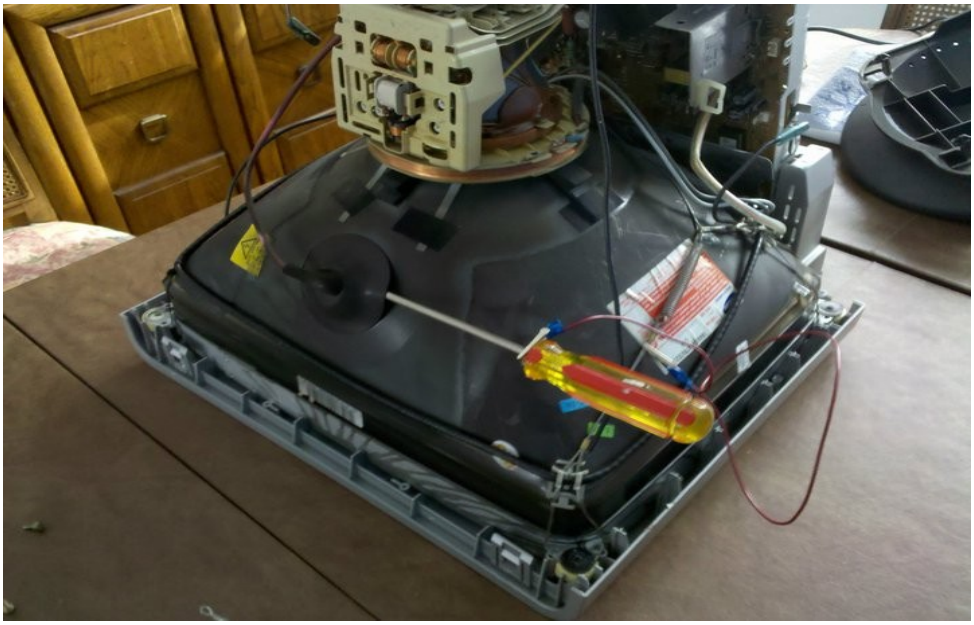
wire

When the project began there was no project kit to buy that had everything required, so each part had to be found and purchased separately. The one part that could

not be ordered quickly and easily was the flyback transformer, which had to be removed from an old cathode ray tube monitor or television.

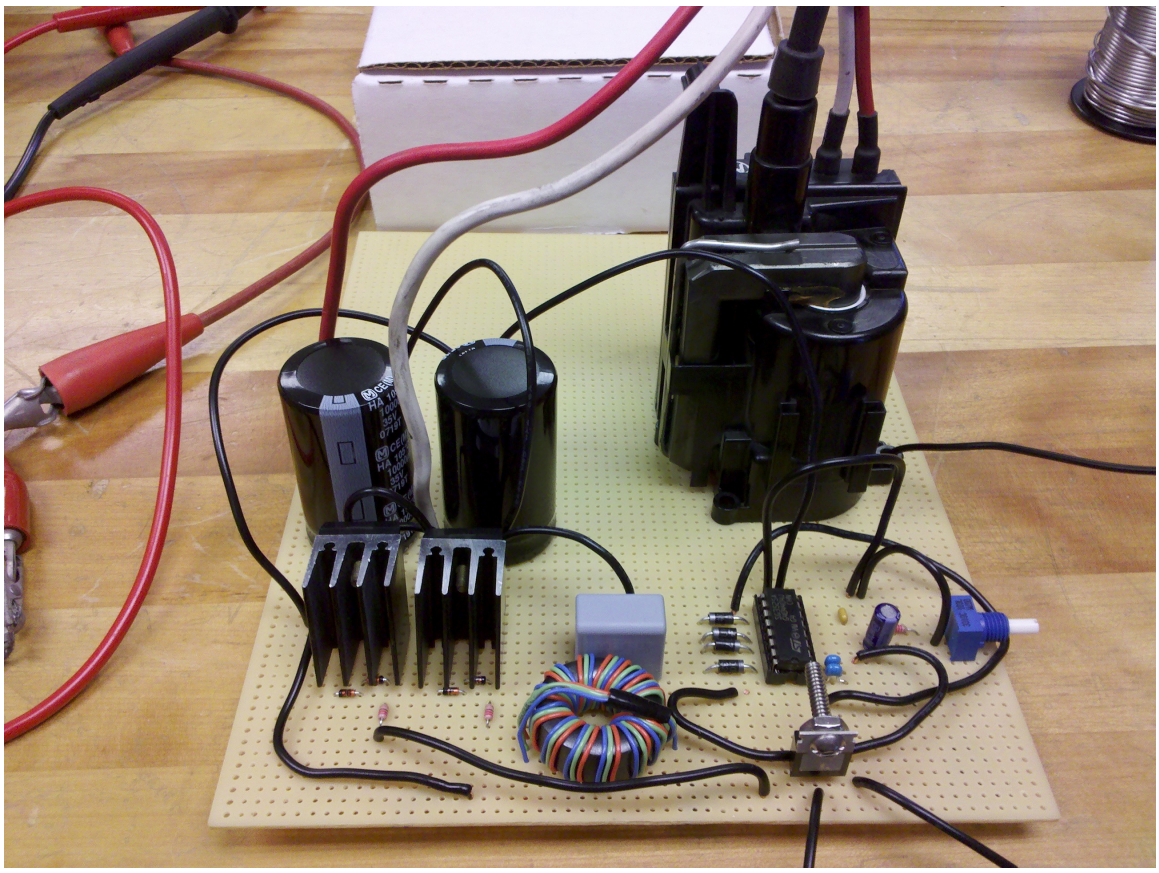
In order to remove the flyback transformer, first the case needs to be opened. Opening the case is simple, all that is required is removing all of the screws around the plastic shell and the case lifts right off.

The next step is potentially dangerous, because the capacitor on the flyback transformer must be discharged before removing it from the tube. This is done with a screwdriver and a wire with alligator clips on either end. First clip the wire to the ground cable running around the front of the tube, and clip the other end to the screwdriver. Carefully insert the tip of the screwdriver under the suction cup. A loud spark may be heard, do not remove the screwdriver. Leave the screwdriver under the cap for several minutes, then carefully remove it. The capacitor will be fully discharged, and the suction cup may be removed from the monitor.



After the suction cup has been taken off, remove the motherboard from the rest of the monitor and desolder the flyback transformer from the motherboard.

All that remains is to assemble the circuit, either solder free on a breadboard or on a perfboard for a more permanent circuit. I had the circuit assembled on a perfboard so that I could have the components more spread out and not be restricted by the preset nodes.



This is the final construction of the circuit. Not shown is the gap for the arc, which leads from the large wire on top of the transformer to the gap, then the black wire connected to

the bottom of the transformer.

Problems

Unfortunately, the circuit as of right now does not work. After testing each part of the circuit with a power supply and multimeter, it has been determined that the issue lies in the integrated circuit. Either by improper wiring or accidentally shorting the circuit, the IC does not allow current to flow through it to the remainder of the circuit, leaving the speakers unfinished and silent.

Conclusion

While ultimately the project did not work, I still learned much from working on it. I discovered the basics of how all electronic speakers work, and learned a great deal about signals and how they may be processed to create different results. I plan to continue working on the speakers throughout the summer, and continue to learn more about acoustics and sound as I do so. Once these speakers are completed, if I have time I will make an effort to create another speaker and get plasma in stereo.