Kinetic Energy Converter and Charger

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ABSTRACT

The overall goal of this project was to create a system that could harvest human kinetic energy to provide power to small electronic devices. Primary research was conducted to determine the best method of energy production. Three options were examined; piezoelectricity, rotational magnetic induction through the use of a gyroscope, and linear electromagnetic induction. Ultimately, the later was chosen due to its energy production ability, portability, and diverse functionality.

By using a pair of induction coils with oscillating magnets, human motion is converted to an AC power source. This power is then converted into a DC power source that charges an internal battery. The internal battery is then used to charge a small external electronic device. A secondary design goal of this project was to be able to produce enough power to charge an iPhone battery. This proved to be impractical because the power produced from human motion would require an unrealistic amount of time to fully charge the battery. As a result, the design goals for this project were amended to focus on electronics smaller than an iPhone. Adding a wall charging feature for the internal battery was researched but not designed due to time constraints and the importance of developing the charging circuit. Another goal was to design and manufacture an enclosed, wearable housing for the system. The design was completed in Solidworks and 3D printed using ABS plastic to prevent magnetic field interactions. The overall goal to charge an internal battery by using solely kinetic energy was not met. Our coils were capable of producing the voltage necessary to charge the battery, however, the current produced through these coils was not large enough to charge the battery effectively. We were able to charge the battery using a waveform generator in place of the inductor coils, since it provided a large enough current. We considered using a series of transistors to increase the current, but that required using a separate DC power source to provide a supply voltage to the transistors. Overall, our goal to charge the internal battery with just kinetic energy was not met due to the insufficient power produced and the inability to boost the current without an external power source.

DESIGN GOALS

- Design a device capable of converting human kinetic energy into electric potential energy to charging external electronics
- Develop a compact, comfortable housing to hold the circuitry

SOURCES

[1] "Electromagnetic Induction Study Material for IIT JEE Exam." *Askiitians.com*, Askiitians, www.askiitians.com/iit-jee-electromagnetic-induction/.

THEORY

In electromagnetic induction, a change in magnetic flux induces a current. In this design, a coil of magnet wire was chosen to be the conductor. When a magnet travels through the coil, as shown below in Figure 1, the magnetic field emitted from the magnet propels the electrons within the coil, thereby creating a current. The induced voltage produced as a result of this movement is directly proportional to the rate at which the magnetic field is changing. As the speed and frequency of the internal magnet increase, more voltage will be induced. The power created by this motion can then be used to charge a small battery.

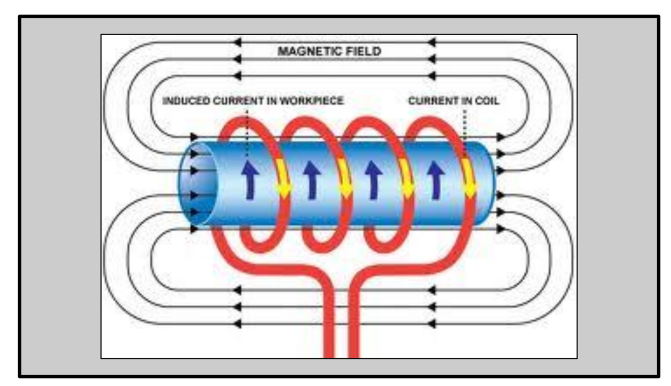


Figure 1: Electromagnetic Induction Theory [1]

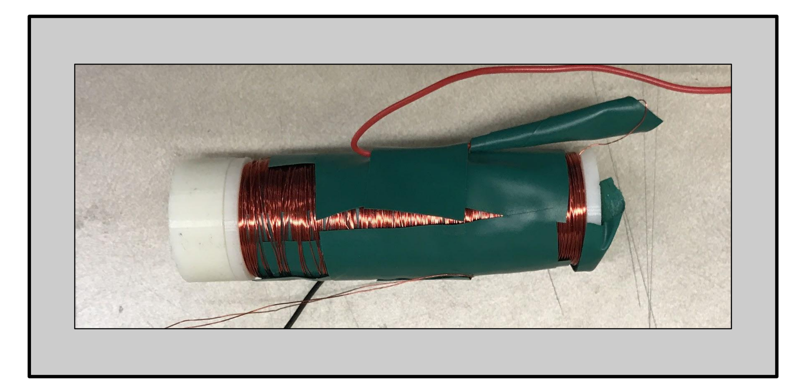
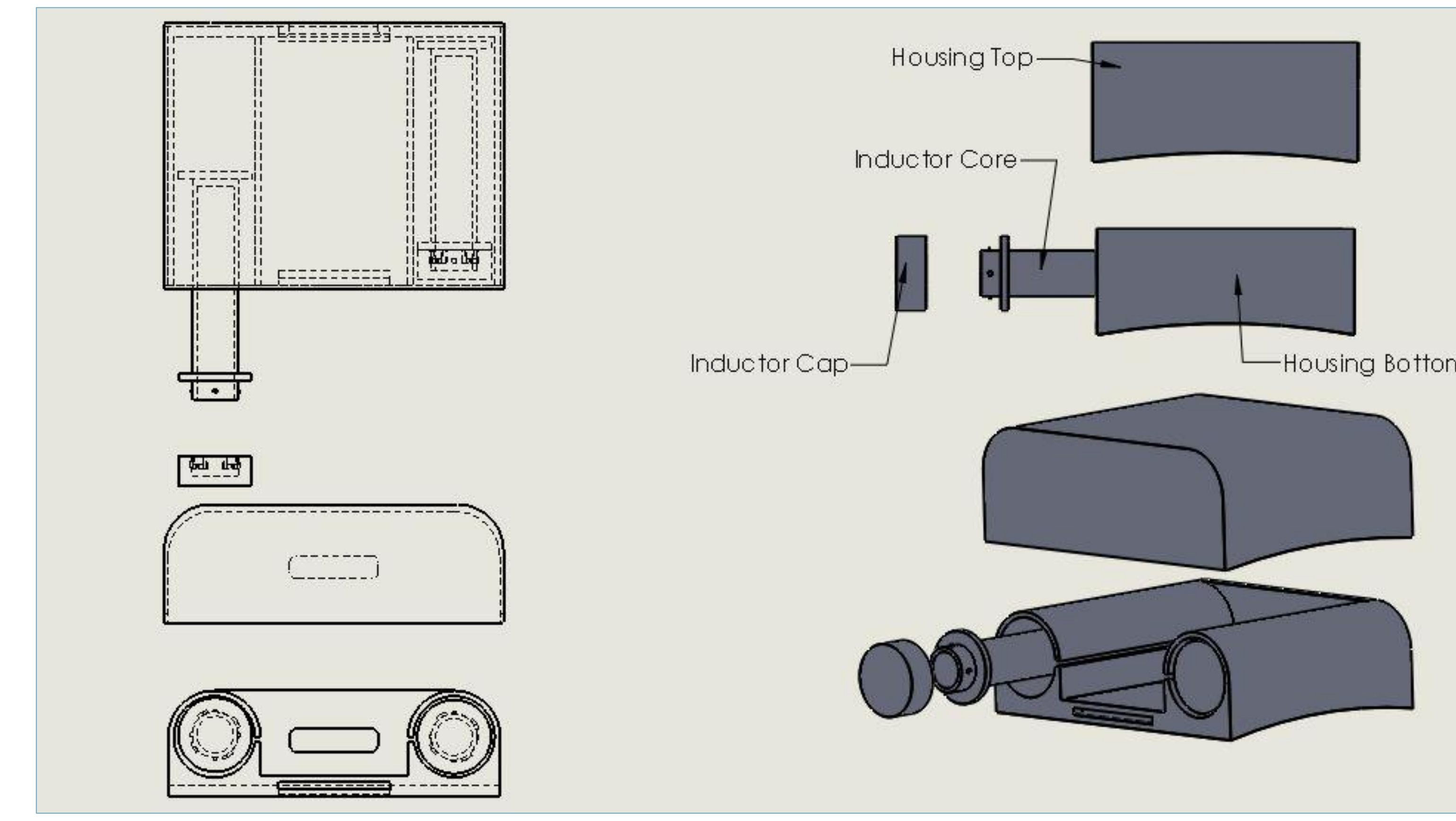


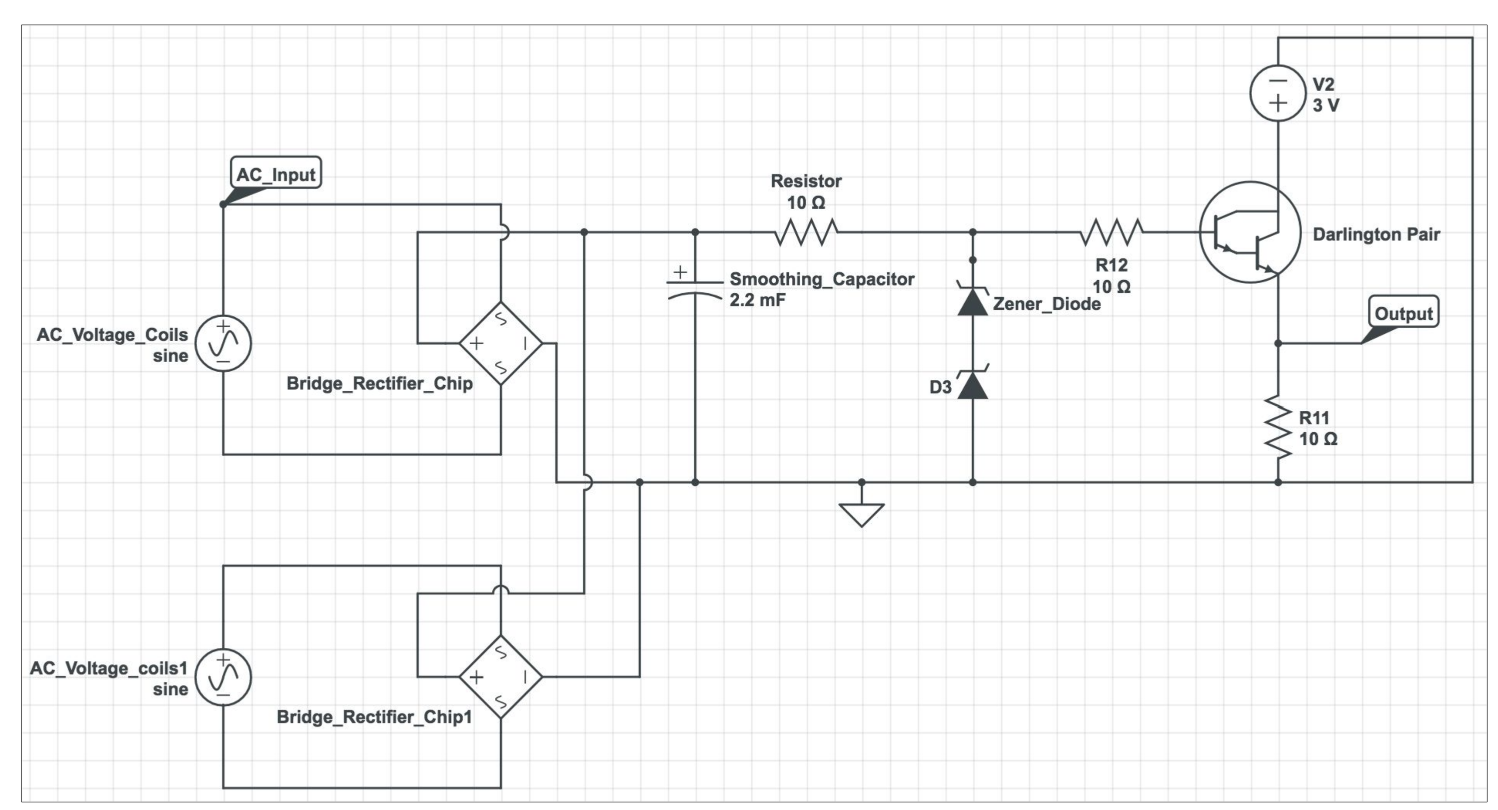
Figure 2: Inductor Coil

HOUSING



This housing system was 3D printed using ABS plastic for its low magnetic permeability and lightweight. The housing consists of a top piece and a bottom piece. The bottom holds the two inductor components, the circuitry, and the battery, while the top piece is secured with Nylon screws to contain the entire assembly. The housing is contoured on the bottom to fit better on the wearer's leg.

CIRCUITRY



In the schematic shown to the left, an AC voltage source is used to mimic the input produced by the induction coils. As these AC signals pass through the circuit, it first encounters a full-wave bridge rectifier chip that takes the input sine wave and outputs only positive signal ripples. In order to convert the signal to constant DC, the signal then passes through a smoothing capacitor that smooths out the ripples based on the charge and discharge time of the capacitor. From here, the output voltage is regulated in order to charge the battery. To do this, a series of Zener Diodes are used to hold the voltage at a threshold just below the max input charging voltage of the battery. After realizing the inductor coils were not producing enough current, a series of transistors called a Darlington Pair was used. This boosts the current high enough to charge the battery but, due to the saturation voltages of the two transistors, the output voltage is decreased significantly.

CONCLUSION

The average frequency of a person's leg as they are running is between 2-3Hz. This was the pace used to measure and calculate the maximum output voltage, current, and power ratings of our system. The maximum output voltage of the 3100 turn inductor coil is 8.08V at a max output current of 10.57mA. This gives a max power production of 0.085W. The maximum output voltage of the 3200 turn inductor coil is 8.4V at a max output current of 7.9mA. This results in 0.066W of power. Combining these two gives a max input power of 0.151W to the charging circuit. The maximum DC output voltage of the system at the same frequency produces 1.107V at a max output current of 114.2mA. This gives a final output power production of 0.126W. The power necessary to charge the internal battery of the system is 0.74W.