CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35343

Project Title

Heat Pipe Cooled Thermoelectric Headlamp

Abstract

Objectives/Goals

This project seeks to create a dependable headlamp for use in emergency situations and remote locations. By employing the heat of the human body, this device would be more reliable than standard battery operated lights.

Methods/Materials

I created a headlamp that uses body heat to power a light emitting diode (LED). The headlamp uses Peltier devices to produce an electrical output. Each Peltier consists of multiple semiconductors, the sides of which are heated and cooled to different temperatures. By utilizing the Seebeck effect, this temperature difference induces a voltage in the device, which in turn creates a current that is used as an input to the flashlight.

Sustaining a bright light using Peltiers for a useful period of time requires maintaining a sufficient temperature difference between the plates of the Peltier. During experimentation, various heatsinks and heat pipe configurations were used to cool one side of the device.

The number of Peltiers employed in the system, wiring configuration, heatsinks, and differing heat pipe configurations were tested and optimized for the best results. The test cases were compared by calculating the total energy generated for each configuration during a 10 minute test period.

Results

The highest energy output was obtained when several Peltiers were mounted directly on the forehead. The low voltage output of the Peltiers required creating a step-up converter to power the LED. During experimentation, substantial variation in output current, voltage, and internal resistance of the Peltiers tiles was found. Fourteen different Peltiers were tested in various combinations of 1, 2, or 3 in series and parallel. The best results were obtained when the Peltiers were wired in series and were matched for lowest internal resistance and highest power output.

The output of the Peltiers dropped off rapidly because it was difficult to maintain a temperature difference between the two sides of the Peltiers. Various configurations of heatsinks were tested in order to improve performance. Several heat pipe variations were later tested in order to maximize the temperature differential and improve long-term Peltier output; an evacuated tube containing acetone transferred heat most efficiently.

Conclusions/Discussion

An LED headlamp powered by heat of the forehead was successfully constructed and ran for far over ten minutes.

Summary Statement

I created a headlamp powered by the heat of my forehead using Peltier thermoelectric generators and cooled with a heat pipe.

Help Received

Parents purchased supplies; Neighbor lent gas torch.