Peltier Effect

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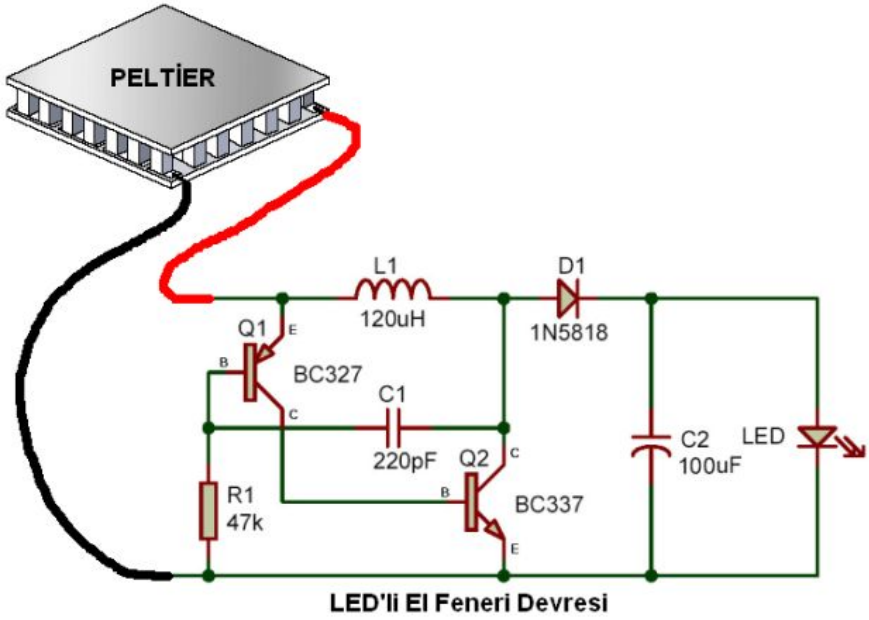
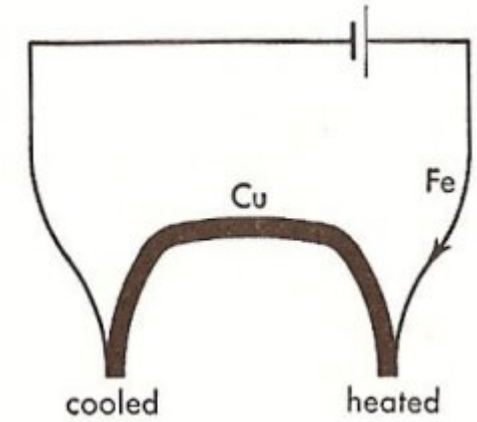
Introduction to the Peltier Effect



Two fundamental principles in the relationship between heat and electricity are the Peltier andSeebeck effects. Both relate temperature to voltage intensity and current direction and have been essential in many cooling / heating applications.

What is the Peltier effect?



Jean-Charles Peltier found that when two metal wires of different materials were joined to form an electrical circuit and a direct electrical current was made to flow through the circuit, one junction would become cold and the other junction would become hot;

when the current direction was reversed, the cold junction would get hot while the hot junction would get cold. Since Peltier's discovery, there have been constant efforts to make use of this principle.

Heat generated by a current flowing in one direction would be absorbed if the current was reversed. (Note that the effect always involves pairs of junctions, whether the junctions are explicit or just implied in the balance of the circuit.) Unlike the irreversible generation of heat caused by resistance throughout the circuit, the Peltier effect is found to be proportional to the first power of the current, not to its square.

As an example of the Peltier effect, consider the circuit shown here. Under these conditions, it is observed, as indicated in the diagram, that the right-hand junction is heated. It shows, in other words, that electrical energy is being transformed into heat energy. Meanwhile, heat energy is transformed into electrical energy at the left junction, thereby causing it to be cooled. When the current is reversed, heat is absorbed at the right junction and produced at the left one.

Principle of the Peltier effect

The Peltier effect is a creation of a heat difference from electric voltage

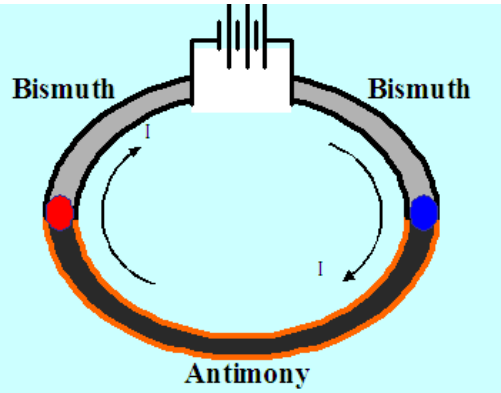


Figure 2. The peltier effect between Bismuth and Antimony.

When a current flows across the junction of two metals, it gives rise to an absorption or liberation of heat, depending on the direction of the current. If the current happens to flow in the same direction as the current that is produced by the Seebeck Effect at the hot junction (Tz), heat will be absorbed, whereas at the cold junction (T,) heat will be liberated.

$$\text{Magnitude of Peltier Effect} = \left[\text{Junction Temp. in } ^\circ\text{K}\right] \times \left|\text{Rate of emf Change at Junction Temp.}\right|$$

The Peltier effect is given as the product of the absolute temperature ("K") of the junction and the rate of change of the thermal EMF of the junction at that temperature. (Fig. 3) If a complete analysis were done, one would find that the Peltier effect produces no measurable change in the temperature of the junction when the only current through it is that due to the thermal EMF.

Applications

Thermoelectric cooling/heating modules are used in an ever-increasing range of applications from everyday consumer goods to high-tech laboratory, military, medical, scientific, and telecommunications markets.

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