

Fun with the Elihu Thomson Apparatus

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Abstract

The Elihu Thomson Apparatus was invented around 1900. The apparatus consists of a solenoid with an iron core that can be placed at different heights above the solenoid. This apparatus can be used to demonstrate magnetic induction by levitating rings, boiling water, vibrating a spring and lighting a light bulb.

Elihu Thomson

Elihu Thomson was an electrical engineer and an inventor. By the end of his life he had received 700 patents for his inventions. As well as being an inventor, Thomson also helped to create the Thomson-Houston Electric Company in 1879, which would later merge with the Edison General Electric Company to create General Electric.

Levitating Rings

When we put the copper ring on the solenoid it levitates. This happens because an alternating magnetic field is produced by the alternating current in the solenoid. This field induces an alternating current in the ring. Since the currents are located in a magnetic field they feel a magnetic force, which causes the ring to levitate. The aluminum ring also levitates when it is placed on the solenoid. As is shown by the pictures the aluminum ring levitates slightly higher than the copper ring when the same current is applied to both. The levitating rings are probably the most fun part of the apparatus. It is highly entertaining just to play with the apparatus and make the rings float on it, they can go to all different heights on the iron core, and can even fly off the end.

Split Ring

Compared with the full copper and aluminum rings the split ring really is not very much fun, but it demonstrates an important concept, so we'll include it anyways. When the split copper ring is placed on the solenoid, nothing happens. This ring is not a complete circuit, so it cannot carry a current.

Boiling Water

So maybe watching water boil does not seem like it would be all that fun, but with physics everything is fun! When the water tank is placed on the solenoid the induced currents cause the copper tank to heat up and this causes the water to boil. Well in theory that is what happens, when we did the experiment the tank only reached 80 degrees Celsius so the water did not boil. So I guess what they say is true, a watched pot never boils. This one may not seem as exciting as the levitating rings, but one can make it more fun. For example, I hear that if you sing "I'm a Little Tea Pot" the water will boil faster, or maybe you will just get your class to laugh at you, but either way laughter, and thus fun is involved. (I have a sneaking suspicion that had we sang I'm a little tea pot our water may have boiled.)



Magnetic Induction

Michael Faraday discovered that a changing magnetic field passing through a loop causes an induced current and an induced emf in the loop. According to Faraday, the magnitude of the induced emf in a conducting loop is equal to the rate at which magnetic flux through the loop is changing with time. Lenz's Law tells us that an induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.

Spring Coil

The spring coil is another fun and exciting object that interacts with the apparatus. We placed the spring coil over the iron core and it began to vibrate. The spring acts like a solenoid, and so the field created by the induced currents is alternating. This causes the spring to bounce up and down because half the time the field is repelled by the solenoid and half the time it is attracted. This picture of a spring may not be very exciting, but watching it vibrate sure is fun.

Light Bulb

So I know that turning on a light may not seem all that exciting, but when you use physics, everything just becomes more exciting. We started out with the light bulb resting on the solenoid, and of course it lit up. Then we lifted the light off of the solenoid and it remained lit up. It became dimmer as it was moved away from the solenoid and eventually went out. The light is caused by induced emf in the coil. The magnetic field that induces the emf also extends beyond the end of the solenoid, but it is weaker farther away from the solenoid, and so the induced emf is smaller, thus the light gets dimmer. There are several ways to have fun with this light bulb. First, it can be highly entertaining to move the light up and down, several times, and just watch it turn off and on. You could also use many parts of the apparatus to create an indoor campfire. The heat is generated by the copper ring, the light obviously from the light bulb, you could even make hot chocolate with the water tank, and you could use the rhythm of the spring vibrations to sing songs about how much fun physics is.



References

- [1] Physics 244H. University Physics for Honors
- [2] PHY 244. Honors Project 2 MAGNETISM lab handout
- [3] Walker, Halliday and Resnik, 2008. *Fundamentals of Physics*.