Department of Electrical Engineering

DEC1707

SENIOR DESIGN

The Electromagnetic Train

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Electrical Engineering EE492

Problem statement

To make an electromagnetic train and explain it using in-depth knowledge of electromagnetism by studying the basic principles behind how it works. We need to compare how many turns per inch in order for a train to finish the track with the optimum speed. We need to understand the principle behind of the electromagnetic train, which is the Gradient of Dipole Potential Energy.

Design Requirements

Functional requirements

- Electromagnetic train will move at high speed through the tracks (coil) until the battery is insufficient to complete the track (22 cycles)
- Electromagnetic train should be able to be observed clearly when it speeds through the tracks.
- Magnet should stay intact on the battery

Non-functional requirements

- No external power source required aside from the “train” itself.

Operating environment

- Operates on a flat surface

Design Approach

- Understand all the materials and conclude the most suitable type that will be used in the design.
- Construct the circuit and make sure that the “train” is visible when it is operating.
- Test and calculate all the variables.
- Provide a total rundown of how the systems works including all the theories such as the Faraday's law, Biot Savart's law, as well as more mechanical aspects like friction and gravity.

Audience & Usage

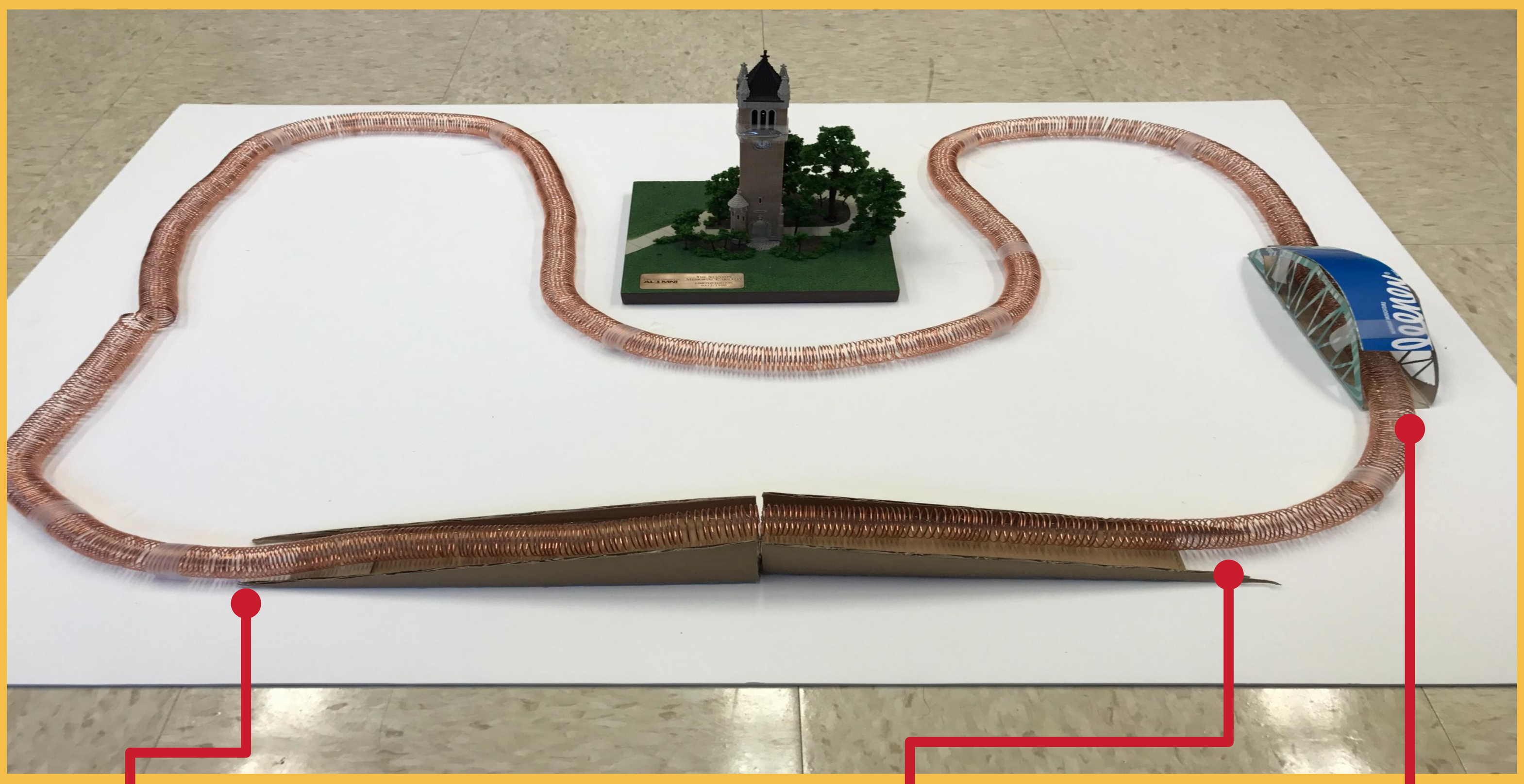
Users:

Faculty advisors and students who are interest in electromagnetic train.

Intended use:

Understand the theories behind the electromagnetic train.

Electromagnetic Train Coil Design



Materials of train

Battery

- Rechargeable AA Nickel-Cadmium.

Magnets

- N52 Neodymium Permanent Magnets

Materials of the coil

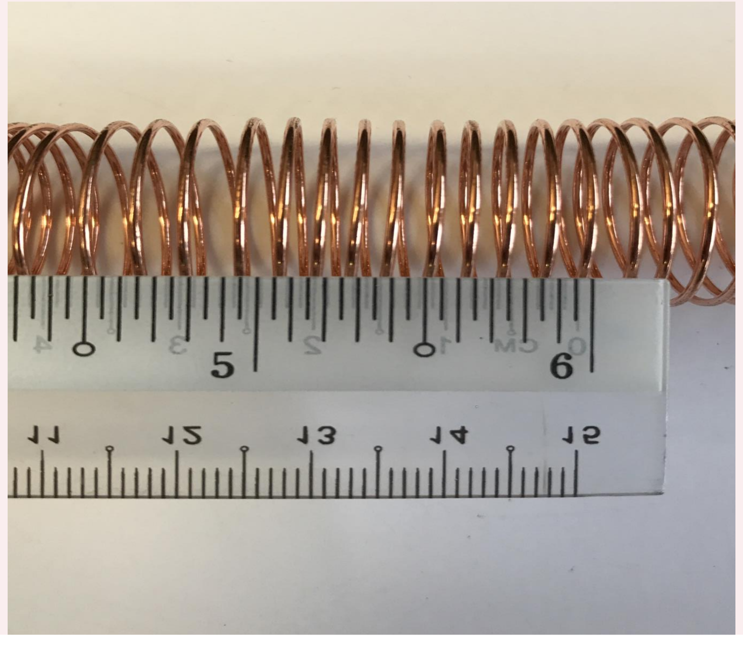
- Size 18 AWG wires,
- Resistance 0.2095mΩ/cm to limit the current.

Length of the coil

- For the testing the length of the coil is 1 meter
- Slope at 12.6%

No of turns of coil

- The optimum number of turns is 9 turns per inch
- Spaced evenly in between.



Technical details

- The Lorentz force which acts upon the coils
- The Gradient Dipole Potential Energy, which acts upon the system
- Lorentz Force = - (Gradient Dipole Force)
- From the Dipole force calculations:

$$F = CI,$$

where

$$C = \frac{\mu_0 m N}{L}\left[\frac{1}{R} - \frac{R^2}{(L^2+R^2)^{3/2}}\right].$$

- L is the distance between the two magnets and battery system.
- N is the number of turns within L
- R is the average radius of the coil

Project Testing

- Measuring the mass of the whole system (the magnets + the battery)
- Calculating the force on the battery (which causes it to move)
- Recording a video so that we can measure the acceleration of the battery by using 30 fps format.
- Testing the train with several different “turns ratios” to see the impact on the train speed.
- Testing the train with different number of magnets which best suits the needs of our track.
- Test the minimum voltage required for the battery to run a full course.