Magnetic Levitation

University Physics II Honors Project

Austin Van Horn

ID: 010558943

Instructor: Dr. John Stewart

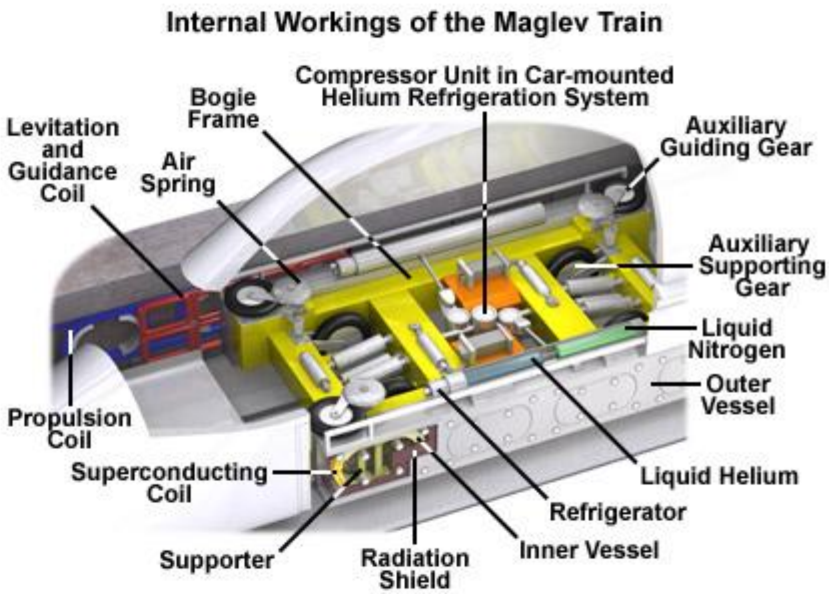
Lab Section: H1

Magnets have been around for a long time. The ideas and uses for magnets and electromagnetism have started to revolutionize the technologies of today. The first idea of magnetic levitation was developed in the early 1900's by Emile Bachelet (Maglev Transport 1). This idea was that we could levitate and propel objects using opposing magnetic forces created within a current. One of the most commonly known forms of this use is the Maglev Train. For a long time the Maglev train, was only an idea. We knew the physics behind it were true, but it was difficult to create substantial amounts magnetic force that could levitate objects that could potentially change our modes of transportation. In the 1960's researchers at Massachusetts Institute of Technology began putting these ideas into action with the discovery of super conductors. In 1966 these researchers brought us the first proposal for a magnetic levitation system. Since then technologies using magnetics have greatly improved and even started to be used. In Shanghai they have taken this technology and utilized it. They use a Maglev Train that sails 20 miles at speeds of around 260 mph which is quite impressive (Popular Science2).

Most maglev trains today use three simple things. Coils lined along the sides of the tracks which fire simultaneously and in synchronization as the train moves down the track. To oppose the force super conducting materials are lined along the train. The last part is a large source of current. Okay so maybe it isn't as simple as it sounds. There are many factors that go into actually making this work, such as making sure the forces align in the same direction, are of the same magnitude, coils fire at the right time (How it Works 3). Also the currents have to change sometimes to keep from throwing a train off. Special computers have been created to monitor the motions and keep the train right on track as well as propelling forward. Below are pictures that show what I'm trying to describe (Alex Landovskis 4).

Figure 1. (Real image of a track)

Figure 2. (Parts in the train system)

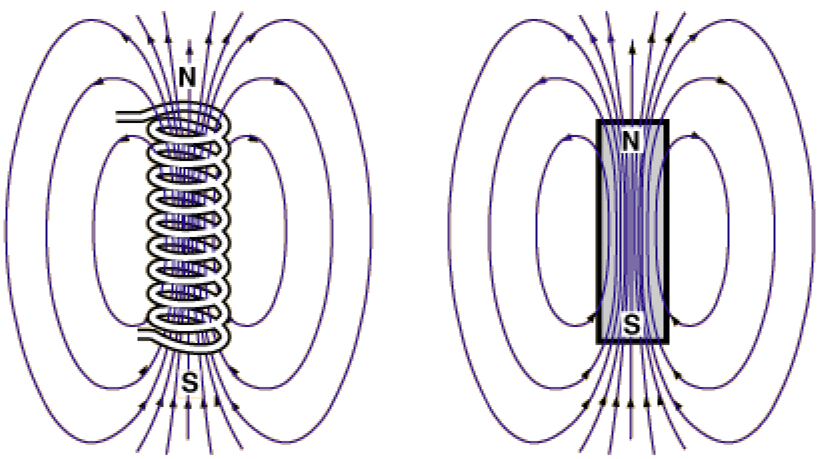


The goal of this project was to demonstrate how objects can be levitated as well as propelled by the use of magnetic forces. To show magnetic levitation I used the ideas of two permanent magnets repelling each other. First I laid down a piece of board about a foot and a half long and two inches wide. Then two strips of permanent magnets were laid down the lengths of the board. Two L- shaped pieces of plexy glass were then also laid down the lengths of the board. These pieces were placed so that you could see the magnets laid along the board and also serve as to guide another magnet being placed on top. To make the object which is supposed to simulate a levitated train, I used another piece of wood six inches in length and two in width. There are magnets with opposite poles from the one on the track attached to the piece facing down. The opposite poles repel each other making the object float. Now when the object has a force acting on it, the object should slide down the track with only the resistance of the friction caused by the walls guiding it.

The other part of the project was to demonstrate magnetic propulsion. The ideas of propelling something by basic permanent magnets are fairly simple, so my goal was to demonstrate it by electromagnetic forces created in coils that would repel each other by firing them simultaneously. Forces in a coil are determined by $F = I(l \times nu_o I)\ or\ F = I(l \times B)$. This means that the more turns of the coil over the length the greater the force would be. Keeping this in mind I tried to create a coil that would create the greatest force possible with the space I had to work within. The greatest forces should also be at the end of the coils so the positioning in it was also a factor. To create these coils I used steel rods wrapped in tape and then coiled wire around that so that the steel would magnify the magnetic forces. One of these coils was laid along the track and the other was in the levitated object. In the diagram below is a picture of how the magnetic fields go. Forces are perpendicular to these fields. To get the magnetic forces to repel each other we would need to run the currents in opposite directions. Running currents in opposite directions would create forces that oppose each other and propel the free floating object down the track.

A more efficient way to generate force with the resources we had would be to use permanent magnets. It would also allow for a better visualization of how magnet forces would repel each other. These magnetic forces prove to be much more efficient and much stronger without the use of super conducting materials. In a wire opposite currents would repel each other. If we drew what the poles would look like for those in the form of a permanent magnet then we would have like poles faces each other. This same concept we used to float the simulated maglev train can also be used to move the object. To do this I put a magnet with a north pole on the end of the object or train that's being suspended in the air, and a magnet at the beginning of the track with its north pole also facing the train. Moving the train to the beginning of the track and letting it go we see the train float away from the other magnet. This is a demonstration of how the like poles will repel each other and also how we can generate energy and propulsion from magnetic forces.

Figure 3. (shows how magnetic fields move in a magnet and coil)



In this experiment there were many different factors that could tie in to not let us see the true physical effects of what was going on. The levitation was an all-around success. You could clearly see the levitation between the simulated train and the track. The only down fall is that in the different engineering of the track I used it need sides to guide it. These sides created friction which kept the train from being able to propel smoothely down the track.

In a real Maglev train coils are being used on both sides and superconducting materials in the train to propel the train. In my experiment I used two coils wrapped around steel rods to try and demonstrate the forces from the coils. One of the coils was placed in the train and another lining the track. To get the forces to repel each other I ran the currents in opposite directions. When fired up, this produced enough heat to melt through the track and produce a mere wobble in the train. When placing a compass along the coils you could easily see the theory behind it being proven, but I wouldn't call a wobble propelling an object.

With my second attempt at getting the object to propel down the track I used permanent magnets. I could show a much better description of the magnetic forces repelling each other by using like poles pointed towards each other. This is an easy concept to which just about everyone can relate to from their childhood playing with magnets. When constructing this I put a few magnets at the beginning of the track and some on the back of the train. The weights of the magnets through off the balance some, but this was easy to correct by using counter weights. When the simulation train was pulled next to the magnets and let go the train repelled down the track.

Over all, this project was definitely a success. If I were to do this project again, I would recommend maybe exploring with super conducting metals and using them. One of the things we tried was to see if just a coil and one simple steel rod would create some movement, but we saw none. In reality it should have some reaction, but it wasn't enough to move the train.

Citations

1.) "MAGLEV New Mode of Transport." *21st Century Home Page*. Web. 20 Apr. 2012. <http://www.21 "Super Trains: Plans to Fix U.S. Rail Could End Road & Sky Gridlock.

2.) " *Popular Mechanics*. Web. 21 Apr. 2012. <http://www.popularmechanics.com/technology/engineering/infrastructure/4232548>. stcenturysciencetech.com/articles/Summer03/maglev2.html>.

3.) "How Maglev Trains Work." *HowStuffWorks*. Web. 25 Apr. 2012. <http://science.howstuffworks.com/transport/engines-equipment/maglev-train.htm>.

4.) "Maglev Trains: How Maglev Trains Work? by Alex Landovskis & Veronique Rondeau." *301 Moved Permanently*. Web. 25 Apr. 2012. <http://ninpope-physics.comuv.com/maglev/howitworks.php>.