One interesting property of magnetic fields is that they can be created and destroyed by the application of an electric current through a loop of wire. This property can be used to construct a machine that might violate the Law of Conservation of Momentum.

Fundamental Experimental Device

Permanent magnets have two opposite poles, which will be referred to as north (n) and south (s) poles. A simple device using permanent magnets is shown in Figure 1.

Figure 1. A simple device using permanent magnets.

Two identical permanent magnets are fixed to a structure in Figure 1. Since like poles repel and unlike poles attract, the magnets shown will attract each other. The strength of all the poles will be assumed equal and the force each magnet feels is F, with the direction of the force shown in Figure 1. Since the magnets are fixed to the device, the device is in force equilibrium and no net force is causing it to accelerate.

Modified Device

The device of Figure 1 will now be changed so that the left magnet is now an electromagnet formed with a battery and loops of wire, as is shown in Figure 2.

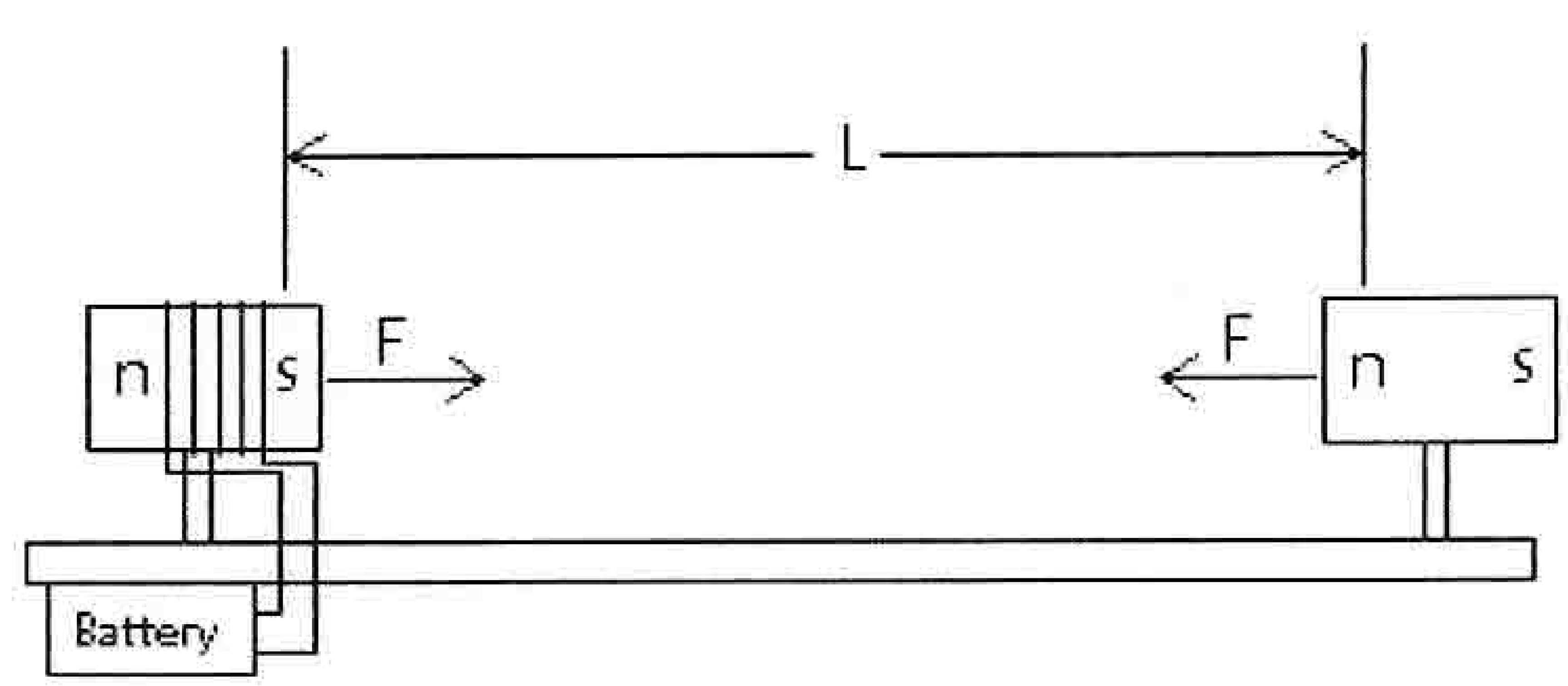

Figure 2. Device modified with an electromagnet on the left side.

The magnetic field of the electromagnet can be turned on and off whenever desired.

Special Relativity requires that nothing can travel faster than the speed of light. This would include the propagation of a newly created magnetic field across open space. If the speed of light is c, the electromagnetic field created in the left magnet would not be felt by the magnet on the right until a time period L/c had elapsed. The same situation would exist if the electromagnetic field were turned off. However, the right magnet is permanent. When the left magnet has it's field turned on, it immediately "feels" the magnetic force of the right magnet.

The Experiment

The experiment begins with the device stationary relative to our observing reference frame and the left electromagnet turned off. Suddenly, the left magnet is switched on and immediately feels the force from the right magnet. The signal of "creation of the electromagnetic field" has not yet reached the right magnet, so it does not have a corresponding force to oppose the force on the left magnet. The entire device accelerates to the right for a time period of L/c. Once the magnetic field signal reaches the right magnet, the resulting force on both magnets balances and the device continues at a constant velocity.

When the left electromagnetic field is turned off, the force on this magnet immediately stops. This signal of "no magnetic field" does not reach the right magnet for a time period L/c. During this time period, the right magnet continues to feel a force, bringing the velocity of the device back to zero. The device has moved to the right (shifted it's center of mass location) with no external forces having been applied.

Another Experiment

For the next experiment, the device of Figure 2 will be further modified. Both magnets will now be electromagnets, each powered by its own battery. The device begins the experiment stationary relative to our observing reference frame. As before, the experiment begins with the right magnet turned on and the left magnet turned off. Then, the left magnet is switched on and immediately feels the force from the right magnet. The signal of "creation of the left magnetic field" must travel to the right magnet, so the right magnet does not have a corresponding force to balance the left magnet force. The entire device accelerates to the right for a time period up to L/c.

In this experiment, just before the signal of "creation of the left magnetic field" reaches the right magnet, the right magnet is turned off. The right magnet then will not produce a force balancing the force on the left magnet. The signal of "no magnetic field" of the right magnet travels toward the left magnet but does not reach the left magnet for an additional time period L/c. After this additional time is up, the device has a velocity to the right. The left magnet can be turned off and the cycle repeated.

A Further Modification

The device of Figure 2 may be modified to produce another version of the experiment.

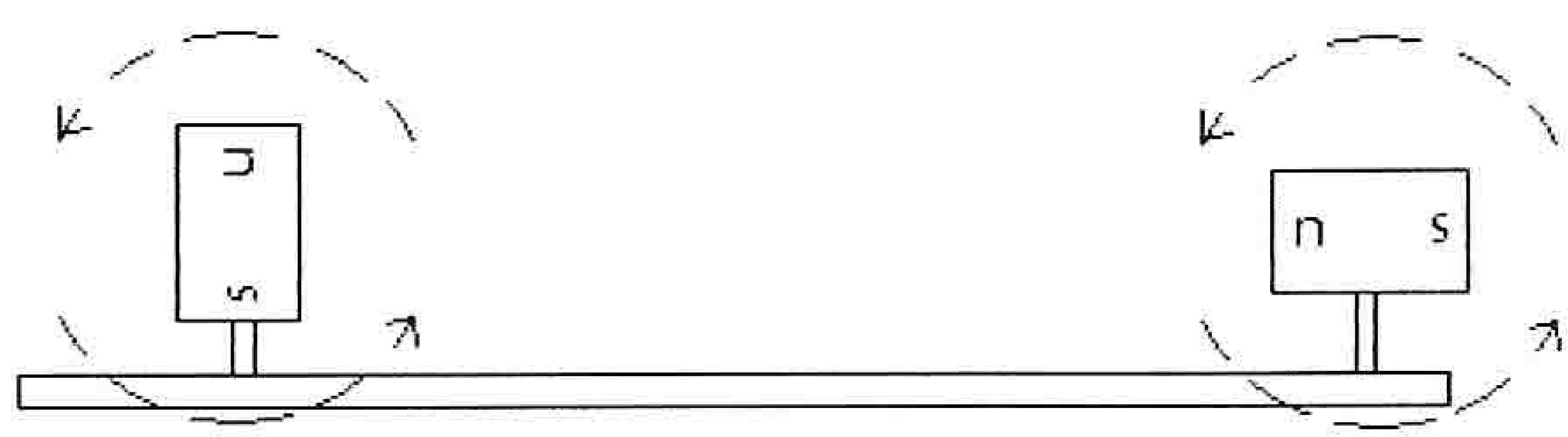

Figure 3. The device contains two rotating permanent magnets.

Figure 3 shows an alternate device composed of two permanent magnets which are constructed to rotate about their centers as shown. The experiment for this device is similar to the one with the two electromagnets except that the "off" condition of the electromagnets is replaced by the vertical position of these magnets.

The experiment begins with the left magnet positioned vertically as shown. In this position, there is no net force on it from the right magnet, which is horizontal as shown. When the left magnet is quickly rotated to a level position, such as shown in Figure 1, it will immediately have a force directed to the right on it. The signal of "horizontal position of the left magnet" does not reach the right magnet for a time period of L/c. Just before this signal arrives, the right magnet is flipped into the vertical position. When the signal does arrive, the right magnet does not produce a force that balances the left magnet force. The left magnet continues to feel the force from the right magnet for an additional time period L/c. Then, the signal of "vertical position of the right magnet" arrives at the left magnet.

The force on the left magnet has given the device a velocity to the right. The two magnets can then be rotated to their original positions and the experiment can be repeated until any desired velocity is achieved. The only energy expended is that used to rotate the magnets. This magnet rotation energy is internal energy stored within the device. This internal energy is converted into kinetic energy of the platform, allowing for the possibility that the Law of Conservation of Energy is observed even though the Law of Conservation of Momentum is not.

Summary

There are a number of possible explanations for these paradoxes.

1. The Special Theory of Relativity has a flaw affecting the description of the device or its elements.
2. The Special Theory does not have a flaw, but the individual device elements have a flaw in their description.
3. The grouping of the individual device elements into the device has a flaw.
4. There is a new, previously unknown phenomenon being described by this experiment.
5. The Law of Conservation of Momentum can be broken by such a device.

These paradoxes exist because so little is known about fields in general and magnetic fields in particular. There are not enough tools to evaluate what could be wrong with this analysis (or what could be right?). Discovering the tools to properly evaluate magnetic fields and the above devices is the future challenge.

Thought experiments are the foundation for relativity theory. New discoveries are dependent on the development of new and revealing thought experiments.