Date of Lab 3.5.2014 Date of Submission 3.12.2014

Physics Laboratory Report

Title 表題

Clip Motor Lab

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Summary

- We constructed a Clip Motor and applied Tohei's Right-hand Rule (Flemming's Left-hand rule), understanding the concepts behind the electrical current, the magnetic field, and the force (the way the coil turned).
- We also did several other side experiments which applied the Right-hand Thumb Rule, and also explained the basic functions of an electric motor.

Addition/Correction 追加／修正		

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words
・締切り守って ・論理的に ・わかりやすく ・自分のことばで

A great report with nice figures!

* Write your report in Japanese or in English * Use this form as a front cover.
* Submit your reports by the seventh day after your lab. You can add to or correct your report: note when you have done this.

Lab – Clip Motor
– Extra experiments for the Principles of the Electric Motor

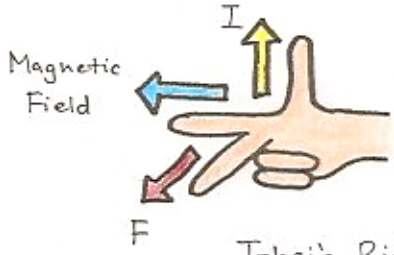
Introduction

Objective – Create a clip motor and identify the concepts (principles of an electric motor) that make it spin. Also, understand the concept of Tohei's Right-Hand Rule and the Magnetic Fields made from wires/coils and apply it in the experiment.

Theory

- **Tohei's Right-Hand Rule** (Developed from Fleming's Right-Hand Rule) – determines the different aspects (induced current, Magnetic Field, and force) within a motor/generator.

- **Principles of the Electric Motor** – Determines how an electric motor will function from the electric current direction and the direction of the Magnetic Field. The electric current direction determines the magnetic field by a coil (follows the Right-Hand Thumb Rule), and the direction of the magnetic field determines the direction the electric motor turns (Tohei's Right-Hand Rule).



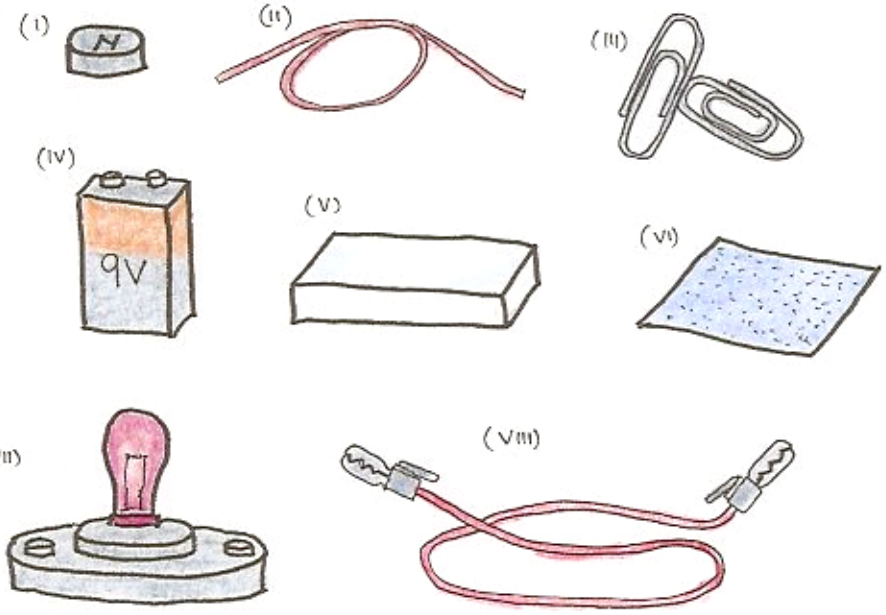
Tohei's Right-Hand Rule

Right-Hand Thumb Rule

Experimental

Experiment Apparatus:

(I) - Magnet
(II) - Enameled Wire (1m)
(III) - Metal paper clips 2x
(IV) - 9V Battery
(V) - Large eraser
(VI) - Sand paper
(VII) - 9V-Mini lights
(VIII) - Wire with crocodile clips



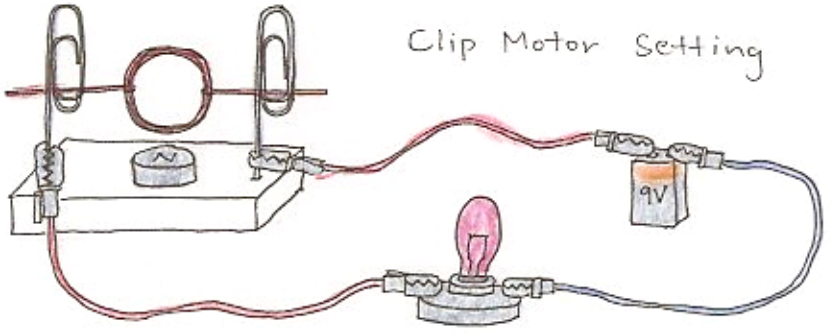
Experiments

Methods:

Construct an Electric Motor (Coil)

1) Construct a coil from the Enameled Wire.
2) Using the sand paper, remove the coating off one end. On the other end, remove only half of the coating.
3) Construct a stand for the coil by sticking the paper clips into the large eraser. Let the coil hang between the paper clips.
4) Connect the coil with the 9V battery, with the 9V-mini light with the crocodile-clip wires.
5) Place the magnet under the coil, between the paper clips without letting them touch.

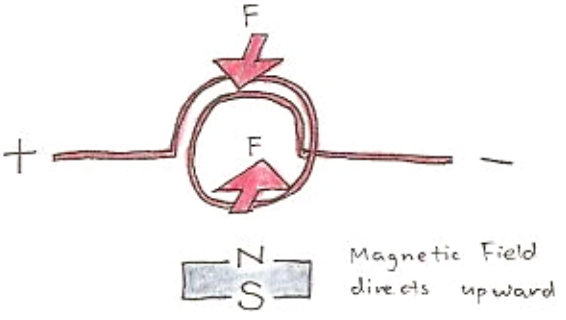
- Try reversing the + and – of the battery and observe
- Try reversing the magnetic field of the magnet and observe. (Determine the magnetic field using a compass).



Results:

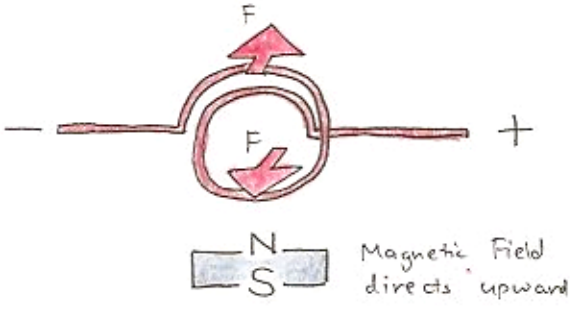
(i) With the Magnetic Field pointing upwards (North facing up), and the electric current from the left.

→ The top part spins outward, with the down part spinning inward. Light bulb blinks continuously.
(Based on Tohei's Right-Hand Rule)



(ii) With the Magnetic field pointing upwards (North facing up), and the electric current from the right.

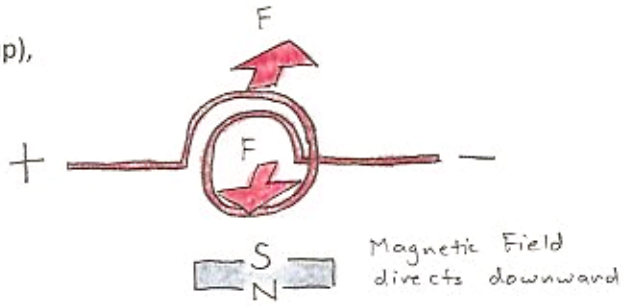
→ The top part spins inward, with the down part spinning outward. Light bulb blinks continuously.
(Based on Tohei's Right-Hand Rule)



nice figures!

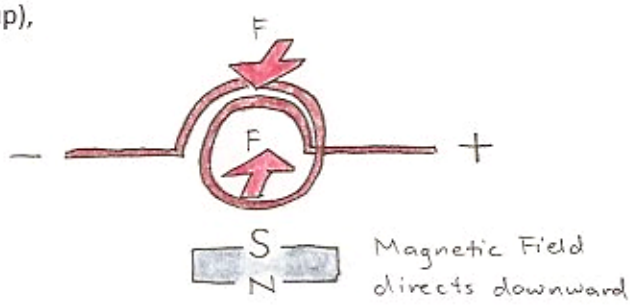
(iii) With the Magnetic field pointing downwards (South facing up), and the electric current from the left.

→ The top part spins inward, with the down part spinning outward. Light bulb blinks continuously. (Based on Tohei's Right-Hand Rule)



(iv) With the Magnetic field pointing downwards (South facing up), and the electric current from the right.

→ The top part spins inward, with the down part spinning outward. Light bulb blinks continuously. (Based on Tohei's Right-Hand Rule)



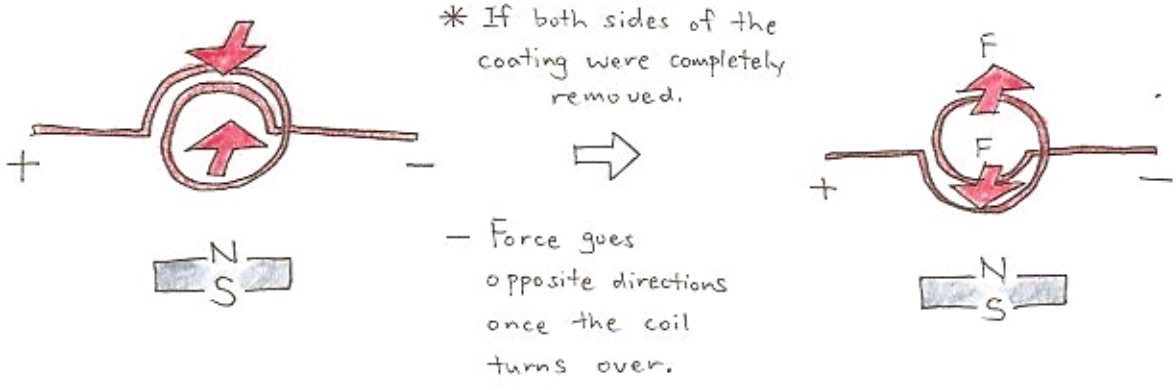
Discussion:

The spinning direction based on Tohei's Right-Hand Rule (Flemming's Left-Hand Law)

-Although there are different factors such as the direction of the electric current (being different based on which side the electric current flows from and whether it is the top or bottom of the coil) and the direction of the magnetic field (North facing up or down), the direction of the force, or the coil spinning will ultimately follow Tohei's Right-Hand Rule(Flemming's Left-hand Law).

Reason for the removal of only half the coating (How the coil continues spinning)

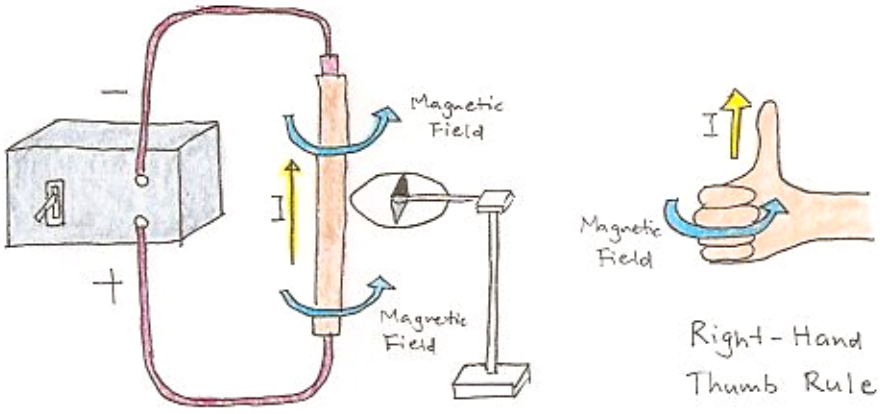
- The reason for the removal of only half the coating is the main reason for the continuous spinning of the coil. If both ends of the coating were fully removed, the coil would not, or have trouble spinning because of how the force (based on Tohei's Right-Hand Rule/Flemming's Left-Hand Law) goes against each other once the coil rotates and goes to the opposite of its original position. The removal of only half the coating leave's one side of the enamel wire a conductor, and one side an insulator. When the insulator touches the paper clips, the electric current stops, which is shown by the light bulb blinking on and off. But because of momentum, the coil continues to turn until the electric current is reconnected, and the original cycle/force continues, effectively skipping the phase with the opposite force.



– Extra experiments for the Principles of the Electric Motor

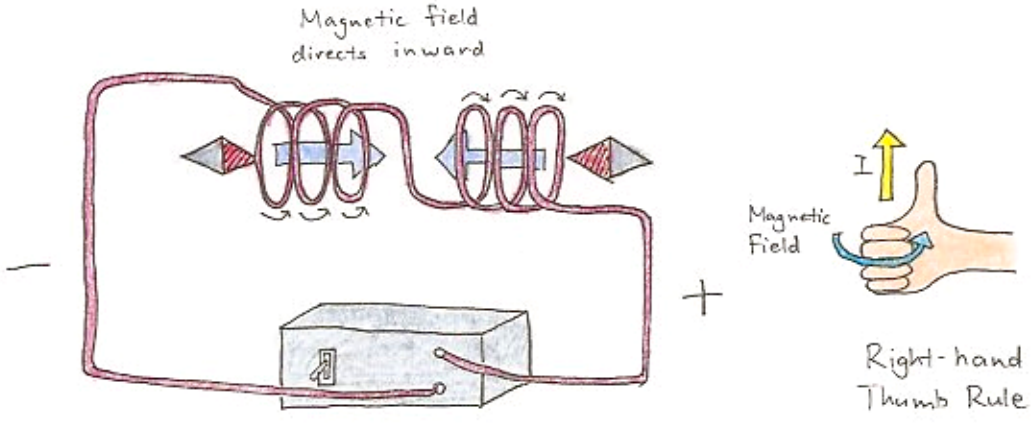
Experiment 1 – The Magnetic Field made by a Wire

- This experiment is based on the Right-Hand Thumb Rule. An electric current is passed through a wire, and a compass placed nearby the wire changes its direction based on the magnetic field formed around it. In our experiment, the electric current was going form bottom to the top, so the magnetic field that formed around was a counter-clockwise pattern, also proven by the compass.



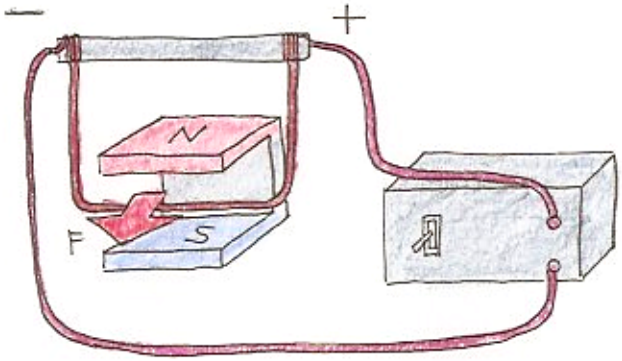
Experiment 2 – The Magnetic Field made by a Coil

- This experiment is based on the Right-Hand Thumb Rule. As an electric current is passed through the coil, and a compass is placed at both ends of the coil show the directions of the magnetic field, which is based on the electric current. In our experiment, the electric current was going from the left side, and the magnetic current formed can be showed by the compasses in the diagrams below. The opposite directions is caused by the different winding of the coil, as shown.

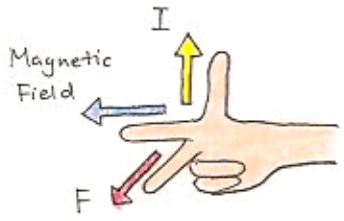


Experiment 3 – <u>The Force an Electric Current receives from a Magnetic Field (Wire)</u>

- This experiment is based on Tohei's Right-Hand Rule (Flemming's Left-Hand Rule). This shows how a magnetic field caused by an electric current (Right-Hand thumb rule) within a wire is affected when affected by another magnetic field, which follows Tohei's Right-hand Rule.



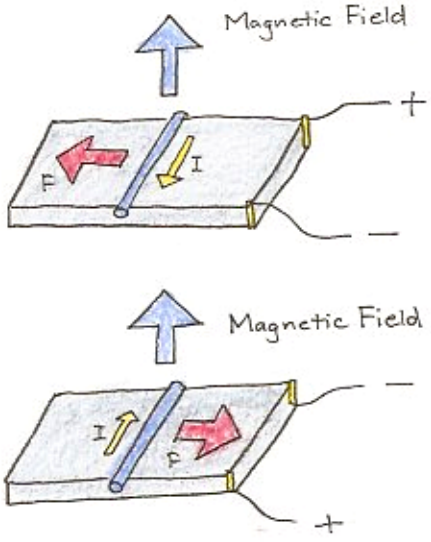
Force pushes the wire outwards

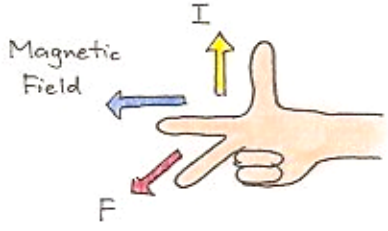


Tohei's Right-Hand Rule

Experiment 4 – <u>The Force an Electric Current receives from a Magnetic Field (Linear Motor)</u>

- This experiment is based on Tohei's Right-Hand Rule (Flemming's Left-Hand Rule). This shows how a metal rod (in which the electric current runs through) moves across a magnetic platform. Based on which end the electric current runs through, the metal rod can move in 2 ways: front or back. When the + and – of the electric current is exchanged, the direction the metal rod rolls in is reversed. This can all be predicted, as it follows Tohei's Right-hand rule.

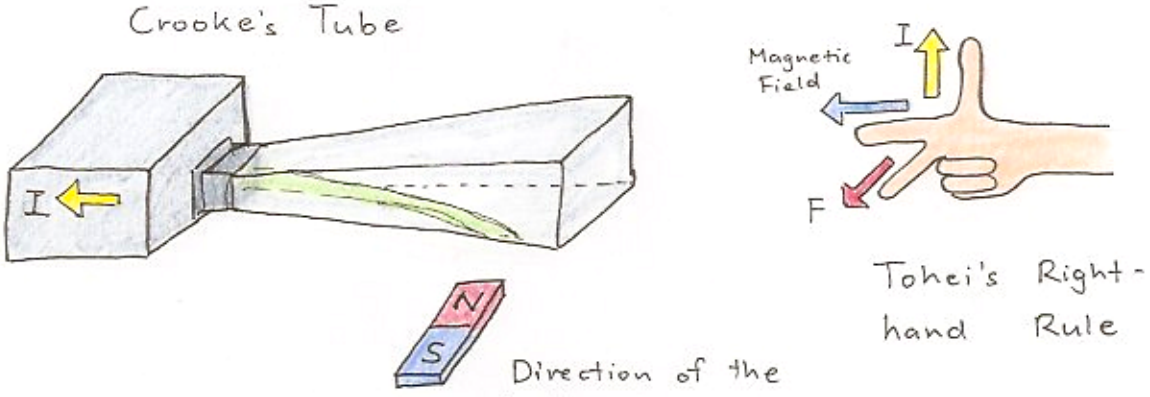




Tohei's Right-Hand Rule

Experiment 5 – <u>The Force an Electric Current receives form a Magnetic Field (Crookes Tube)</u>

- This experiment is based on Tohei's Right-Hand Rule (Flemming's Left-Hand Rule) and uses a Crookes Tube. In the Crooke's Tube, the direction of the electrical current is always opposite of the original direction of the electron beam. A magnet which is held close to the electron beam determines the surrounding magnetic field, and the direction the electron beam sways too is the force. The direction of the electron beam can change is many ways by the position of the magnet (close or far also included; the steeper the curve when put close), which can also be predetermined with Tohei's Right-hand rule.



Conclusion

- Although we did multiple experiments, most of them can be explained by the main 2 rules which are the Right-Hand Thumb Rule, and Tohei's Right-hand Rule (Flemming's Left-Hand Rule). The former describes how a magnetic field forms from an electric current, and the latter showing how the different aspects (the electrical current, the magnetic field, and the force) working with each within in an electric motor. We managed to make a simple clip motor using a coil that followed Tohei's Right-hand Rule, and we understood how it worked and kept spinning as it did.

Comments

- It was really pleasing, managing to finish the clip motor first in class, and generally, all the other experiments were interesting and fun to do. I had plenty of experience in implementing the Right-hand Thumb Rule and Tohei's Right-hand Rule in the many different experiments, and I'm sure that it helped me in further understanding its different applicable uses and conceptuality. I think that the experiments were fun and interesting, and very much worth doing.