Experiment Using Electrostatic Motor

NaRiKa Corporation

1. Learning Outcome

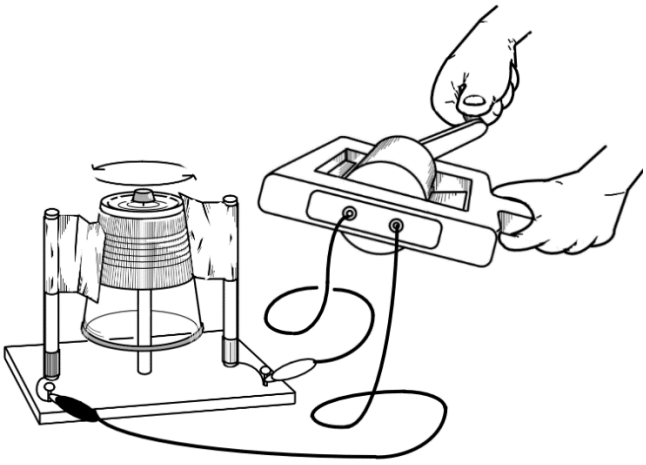
In this sub-unit, we will perform experiment related to the attractive and repulsive forces of static electricity (Coulomb force) using the Electrostatic Motor (Franklin Motor) and Static Genecon.

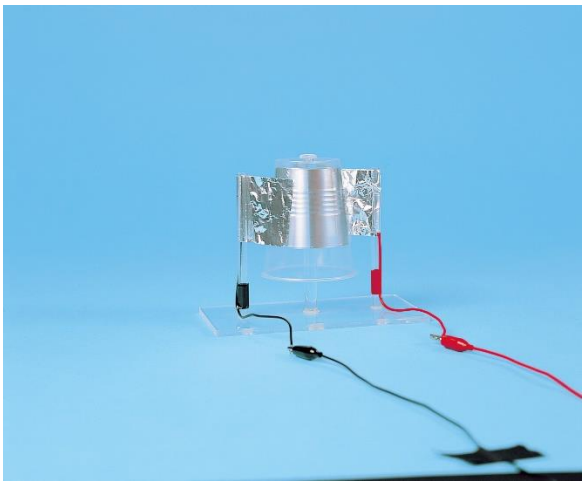
As the typical principle of static electricity, we will confirm the phenomena of electrostatic induction, attractive and repulsive forces. Let's start our experiment for the sake of analyzing this phenomenon.

2. Historical Background

In this sub-unit, we use an Electrostatic Motor, namely Franklin Motor, which was first invented by Benjamin Franklin and Andrew Gordon between 1740s and 1750s.

Electrostatic Motor is based on the principles of electrostatic induction, attractive and repulsive force. Electrostatic Motor feature is operation with high voltage and low current. On the contrary, other types of (normal) motors can be operated with low voltage and large current, because their principle is electromagnetic induction.





3. Electrostatic Generator: "Static Genecon"

We already know that if we rub piece of plastic with felt or different kind of cloth then static electricity will be generated. And we have in various ways confirmed properties of above mentioned way of generating static electricity. As a result, we have learned among other things as well, that electrostatic charge has two kinds. Furthermore, we can store static electricity because of the invention of Leyden jar and Electrophorus. By using them we can store greater

amount of static electricity, thus conducting experiments with large amount of static electricity. Because of that invention research about static electricity accelerated in the past.

In 1929, Robert J. Van de Graaff (1901-1967, USA), with purpose to invent particle accelerator, invented high voltage electrostatic generator, so called: "Van de Graaff generator". Van de Graaff generator can generate low electric current, but it can accumulate high amount of voltage. It is often used for demonstration experiments in schools.

Static Genecon
(Narika B10-1324)

In this unit, we will use "Static Genecon" that generates static electricity continuously in the same way as Van de Graaff generator to perform various experiments. For example: Charge & Discharge, or Repulsion and Attraction experiments, by analysis of the behavior during experiments, let's deepen our understanding of static electricity.

"Static Genecon", developed by NARIKA Corporation, is a smaller version of Van de Graaff generator. Below you can find a simple explanation of the operating principle. The basic principle is: by rubbing two things against each other, static electricity is generated.

In drawings below, we can see simplified internal structure of Static Genecon. Felt reinforced with metallic copper is in contact with drum made of PVC. Also, to collect electricity charge generated on the surface of the PVC drum, there is a collector made of metal (Figure 1).

If you rotate slowly the handle of Static Genecon, PVC drum will rotate, and rub felt. As a result of the friction, on the surface of PVC drum negative charge, and on the felt positive charge will be generated. On the surface of nonconductor static electricity will not move, therefore when PVC drum is rotated, negatively charged static electricity formed on the surface of PVC drum is transferred to the collecting plate.

Because collecting plate and PVC drum are not in contact, due to negative charge on the surface of PVC drum, collecting plate will be induced and negative electric charge on the surface of PVC drum will be neutralized. Because of the electrostatic induction of collecting plate, negative charge will easily move inside the conductor. On the other hand, positive charge generated on

the surface of felt will be supplied by negative charge from metallic copper plate inside of the felt, therefore it will be electrically neutralized (seemingly it looks like transference of positive charge. See Figure 2 and Figure 3.).

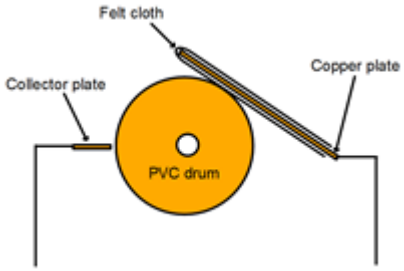


Figure1

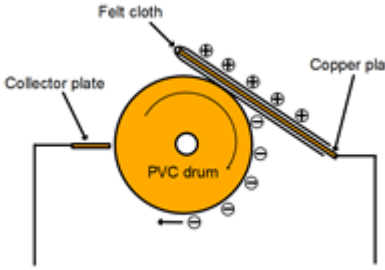


Figure2

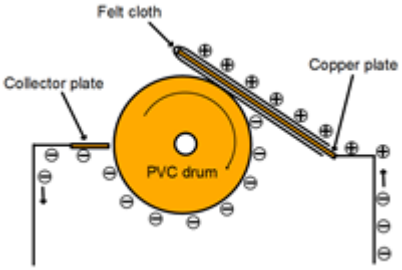


Figure3

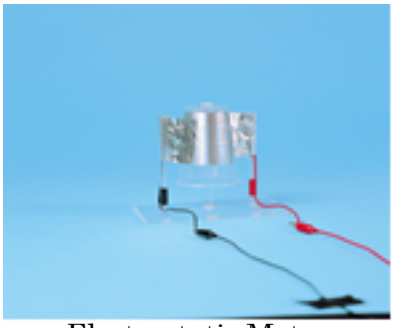
4. Experiment Using Electrostatic Motor

We will perform experiment related to the attractive and repulsive force of static electricity (Coulomb force) by using Electrostatic Motor (Franklin Motor) and Static Genecon. We will turn the motor by static electricity. From this experiment we will confirm basic theory of static electricity and let's became able to explain this phenomenon.

1. What to prepare

- Static Genecon: 1 pc (Narika B10-1324-W0)
- Electrostatic Motor (Franklin Motor): 1 pc (Narika B10-1324-06)

Static Genecon
(Narika B10-1324-W0)

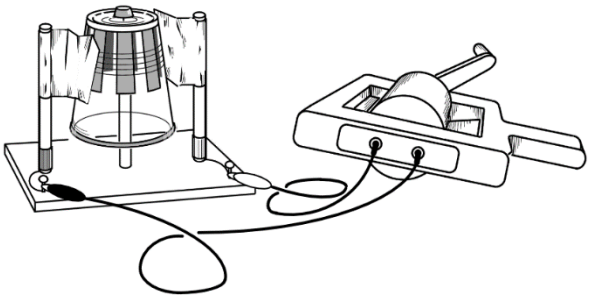


Electrostatic Motor
(Franklin Motor)
(Narika B10-1324-06)

2. Experiment procedure

1) Prepare completed Franklin motor.

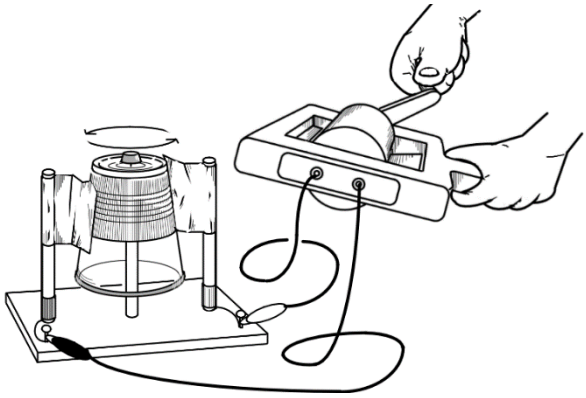
2) If Franklin motor is not completed, please assemble it beforehand.



3) Electrodes of Franklin motor are made of aluminum foil (strip). They are easy to tear, therefore please be careful when manipulating with them.

4) Connect Static Genecon with Franklin motor according to the drawing above.

5) Start turning slowly the handle of Static Genecon.



6) Franklin motor (plastic cup) starts rotating.

7) When the motor part does not rotate, keep the clearance of about 5 mm between the "motor" and the "brush electrode" avoiding they would touch each other.

*Always mind the clearance between the "motor" surface and the "brush electrode" (Aluminum "flag") avoiding they do not entirely touch each other.

5. Question

Please explain, with help of drawings below, the processes of rotation (principle of the process) of the Franklin motor.

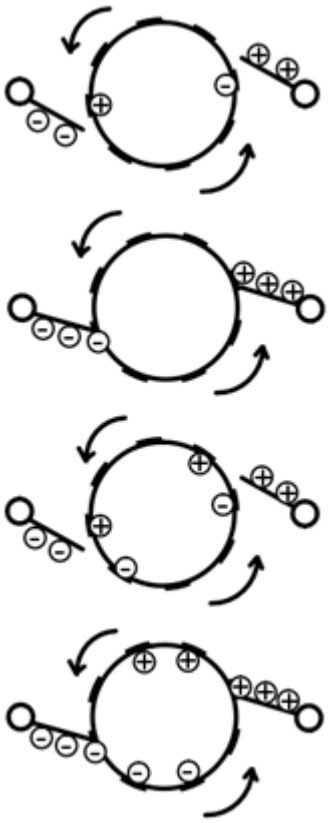
1. Negative (-) and positive (+) charge generated by Static Genecon is respectively transported to each of the two "brush electrodes" (two of the Aluminum flags) of Franklin Motor. Charge of the polarity opposite to that of transported charge is inducted on the Aluminum foil split surface (on the plastic cup) due to the electrostatic induction principle. Then, the motor (plastic cup) starts spinning, because of the attractive force occurred between different types of charge on the strip and "flag".

2. The polarity of charge on the strip is reversed once the flag touches the inducted strip, then the same type (polarity) of charge is transported to the strip from the flag.

3. Then, the motor (plastic cup) keeps spinning due to the repulsive force between the same types

of electrical charge. Simultaneously, the Aluminum strip next to the one mentioned above becomes attracted by the flag due to the different type (polarity) of the charge being affected by the electrostatic induction, which makes the rotation of the plastic cup even faster.

4. By repeating above 1. - 3. process, the Franklin Motor spins faster and faster.



If you observe the Franklin Motor carefully, you will know the flag ("brush electrode") and the strip on the plastic cup actually touch each other.

"Static Motor" is traditionally used as a different name of Franklin Motor. However, "Static Motor", which was still in the laboratory stage in 18th century, was expected to be more advanced version of Franklin Motor. Soon after that, it became commonly recognized that Static Motor needed high voltage to operate and the torque was relatively small, which meant Static Motor had little practical application.

However, around 1980, Micromachine based on the semiconductor manufacturing process became popular, because of which Static Motor began to receive attention again.