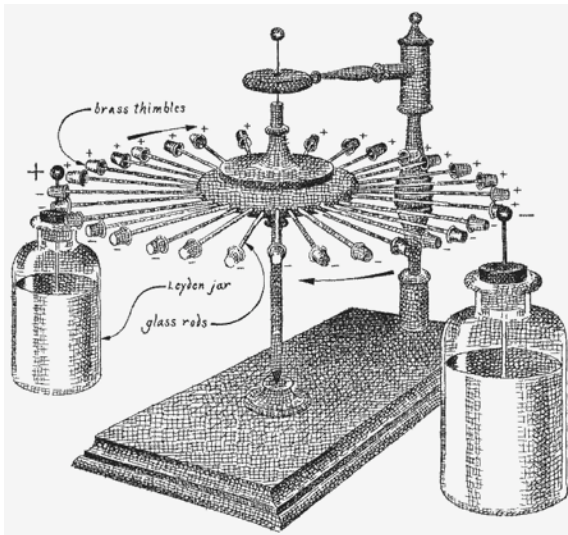


# Electrostatic Motor & Leyden Jar



Electrostatics is one of the most fascinating and possibly most overlooked fields of modern science. Electrostatic forces are the most powerful forces known in nature - much stronger than gravity or magnetism!



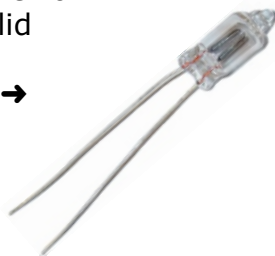
As Michael Faraday demonstrated in 1821, electric motors generate mechanical force as a result of strong magnetic fields that are produced with **high electric current** at low voltage. Electrostatic motors are of an opposite nature: they require **low direct current** at high voltage. Some can even be powered by the earth's natural electrical charge alone!

There are many different motor designs but all use the universal principle of attraction between unlike electrical charges and the repulsion of like charges.

## A. Electrostatic Motor

### Materials required

- Plastic test tube or 'pre-form'
- Plastic food cup with lid
- Pencil
- NE2 90V Neon lamp →
- Aluminium foil
- Blue-tack or clay
- Glue stick
- Scissors
- Drill bit



### Preparing the electrostatic motor

#### The base

1. Heat the back-end of a 7 mm diameter drill bit and melt a center hole through the bottom of the plastic cup.
2. Sharpen the pencil and stand it upright on the center of the plastic lid using the Blue-tack or clay. Both the lid and pencil should be pointing up.
3. Push the cup's hole over the pencil and press the cup onto the lid. Check that the pencil is vertical.



## The rotating armature

1. Cut a strip of aluminium foil, about 1 cm wide. Coat the dull-side of the foil with glue and then cut into 2 cm rectangles. You will need about 6.
2. Mark 80 mm from the closed end of the pre-form with a marker pen. Space the pre-glued rectangles, long-side up, evenly around the circumference at this mark. Leave about 5 mm spacing in between them.



## Running the motor

1. Find a wooden or plastic table top.
2. Invert the pre-form over the pencil tip. Ensure that it spins freely.
3. Bend one lead of the Neon lamp outward as depicted.
4. Turn down the lights. Simply start the FunFlyStick (FFS) and bring it close to the aluminium on one side of the armature.



5. Hold the lamp in your other hand (you will feel no discharge!) so that the bent lead of the lamp is close to the aluminium on the other side of the armature.
6. The armature should start running or you may need to start the motor with a gentle spin. As the motor spins, the lamp will flicker.

## Humidity & Static charges:

Any humidity is deadly to static electricity. It makes air more conductive and will drain charged objects. *When the relative air humidity is 20% or less charges of up to 30000 volts can be obtained by shuffling your feet across a carpet. If the humidity is raised to 60% then you can only obtain a mere 1500 volts!*

**Use a hairdryer to dry the test tube & cardboard tube of the FFS.**

## What is happening?

The FFS supplies a high voltage of up to 50 000 V and carries a positive charge so a tiny spark flies from the foil to the FFS. This leaves the aluminium with a net positive charge that is repelled from the positive charged FFS. The sideways electrostatic force causes the armature to rotate, which brings new foil pieces under the 'brushes' and the process repeats.

At the neon lead end, the electrons flow through the lamp towards the positive aluminium rectangles, jump to the closest piece of aluminium, get a free half-circular

ride and get dumped at the opposite FFS 'brush'. The flickering neon bulb indicates the irregular flow of electrons.

The rotor will keep on building speed as it experiences a continuous electrostatic force that will be limited by air resistance, friction and the instability of the rotor.

## B. Leyden Jar

A Leyden jar is simply a capacitor, that is, a device that stores electrical energy. Like all capacitors it consists of two conducting metal plates separated by an insulator or dielectric.

Our design will be a Water Capacitor or Water Leyden Jar. We will use water as an inner electrode and aluminium foil on the outside of a polypropylene cup. The polypropylene acts as the dielectricum.

### Materials required

- Metal paperclip
- Plastic food cup with lid
- Aluminium foil
- Glue stick & Scissors
- Water

### Preparing the Leyden Jar

1. Gently poke a hole through the centre of the plastic lid with the paperclip.
2. Straighten out one of the bends in the paperclip, forming a right angle or "L" shape.
3. Cut a piece of aluminium foil about 6 x 15 cm.
4. Glue the one side of the foil and then wrap it around the cup's base leaving a 1 cm gap between the edge of the foil and the open end of the cup.
5. Fold the excess foil neatly under the bottom end of the cup and smooth out.
6. Fill the cup about  $\frac{2}{3}$  with water and seal.
7. Insert the metal clip and ensure that it touches the water.



### Charging the jar

You may charge the jar using a rubber balloon rubbed on hair. We recommend the use of the FunFlyStick (FFS). Here is how:

Touch (ground) the foil at the bottom of the jar with your finger and bring the running FFS close to the paperclip. Charge for 20 seconds. First remove your finger and then the FFS. The clip now carries a net positive charge.

Now - bring the two leads of the neon lamp close to the clip and foil and see the spark.

### Safety

Be careful when handling the charged Leyden jar. It is a capacitor and therefore can store large quantities of electrical energy. Do not touch the foil and clip simultaneously - you will get a nasty shock! To discharge use an open scissors or the lamp.

### References

1. Presentation by Ken Byrne of Educational Innovations at NSTA, Philadelphia, March 2010
2. Noon, W; Secrets of building electrostatic lightning bolt generators, Lindsay Publications Inc., Bradley, 1989