Electrostatic Motor Plans

SIMPLE, SENSITIVE VOLTAGE MOTOR USING 2-LITER SODA BOTTLES

- William J. Beaty, 1988 Museum of Science

Here's a simple electrostatic motor that's based on 2-liter soda bottles and aluminum foil. It's construction does not require access to a machine shop. It draws a fraction of a microamp during operation, and can run at unexpectedly high speeds (1000 RPM!) It runs on a minimum of 5000 volts DC, which can be had from several different low-current electrostatic energy sources.

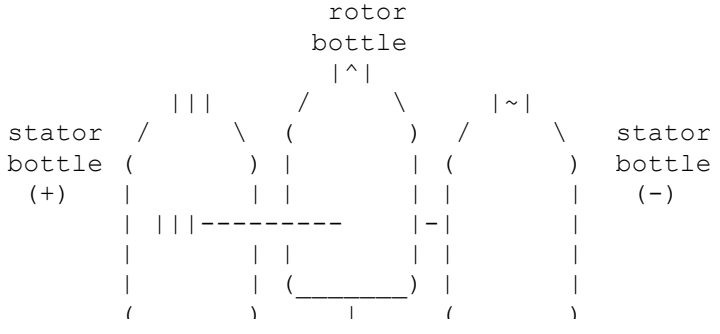
Any of the following can power this motor:

- Van de Graaff electrostatic generator (expensive unless home-built)
- Wimshurst electrostatic generator (expensive)
- Negative ion generator, try this one, it runs off a 9v batt.
- Aluminum foil on a TV screen (dangerous?)
- M. Foster's Cheap High Voltage
- Lenny R's PVC Pipe generator
- A very large electrophorus (low humidity required)
- "Kelvin's Thunderstorm" waterdrop machine (very feeble, barely works)
- High-voltage DC supply (dangerous, avoid it unless skilled with HV!)
- Jefimenko-style sky antenna (kite-lifted or balloon-lifted wire with needles at top)
- Or, with some practice, even with a balloon and a piece of fur can sometimes work.
- Batteries won't work, you need High Voltage

One of these motors is featured in the Electricity exhibit at the Museum of Science in Boston, powered by a hand-cranked Van de Graaff machine.

PARTS:

- three 2-liter pop bottles, at least one with a METAL cap
- roll of aluminum foil
- rubber cement
- silicone caulk
- 13" metal rod, 1/8" dia. (could use coathanger)
- Two 8" pieces of solid copper wire, or coathanger
- wood plank (or metal, or plastic) for the base
- duct tape
- hookup wire for attaching the power supply



Cut the rod so it's about 1 in. longer than the middle bottle. Sharpen the rod using a file. Drill a hole in the center of the plank using a drill bit slightly smaller than the sharpened rod. Carefully force the rod into the plank, unsharpened end first. (Note: coathanger wire will work as the center rod, sort of. But it's very wobbly. 1/8" welding rod works much better.)(Note: instead of filing a sharp point, try attaching a piece of a sharpened pencil to the top of the rod. The sharp graphite point makes a good bearing.)

"Rotor" Bottle

Find the exact center of the bottom of the middle bottle, and drill a hole there that's slightly larger than the rod diameter. When slid onto the sharpened rod, the bottle should spin very freely. If the hole is too big, the bottle will rattle around and make the brushes drag on its surface

If you can find a bottle with a metal cap, make a dimple in the center of the cap. The dimple is there so the point on the rod will have something to ride in to stay centered. Take care not to poke through the metal bottlecap with the sharp rod! If you can't find a metal cap, glue a hard object such as a small glass test tube into the bottle cap. If you use the pencil point mentioned above, a plastic bottle cap might work (I haven't tried this.) You'll still have to make a dimple in the plastic somehow.

Precisely cut three broad strips of aluminum foil so they are just wide enough to give a 1/2" spaces when attached to the center bottle. You want the middle bottle to have three regions of foil, with half-inch gaps between the regions. Trim the corners of the foil so they are round, and test-fit them on the bottle and trim as needed.

Glue the foil to the center bottle as shown in the drawing. (It doesn't matter if the shiney side of the foil faces out or in.) I used rubber cement to glue the foil strips. I coated the whole bottle with cement, coated one side of each pre-cut foil strip, allowed the glue to dry a couple of minutes, then CAREFULLY layed on the strips and burnished them down with a spoon as I went. The end result should look like an aluminum coating on the bottle, with three broad foil sections separated by 1/2in gaps running vertically. No part of each foil section should touch any other foil section. Bubbles in the foil don't hurt anything, and can be punctured with a pin and flattened with a spoon. Instead of glue and foil, you might instead try using a roll of adhesive aluminum foil tape available at some hardware stores.

Two "Stator" Bottles

Glue large sheets of foil around the entire center areas of both of the two 'stator' bottles, leaving a 2 in. foil-free space at the bottoms. The bottom must remain clear of foil, and no foil on these bottles should come close to touching the wooden base or close to any duct tape you might use to connect the stator bottles to the base.

Commutator "brush" wires

The commutators (or "brushes") are pieces of heavy wire or coathanger 8in long, each attached to a stator bottle, and each extending sideways so their ends are very near (but not touching) the

rotor bottle surface. After attaching them to the bottles, bend the tips so they point towards the surface of the rotor bottle. See the diagram and photos.

I attached them to the stator bottles by bending the wire ends into an S-shape and embedding the S-shaped part in silicone caulk on the foil bottles. After the glue sets, the remaining short ends of each S-shape should be bent so they make solid contact with the bottle's foil. Don't let the silicone insulate the wire from the foil, because the stator foil and the commutator wire must both be electrically connected to one of the power supply terminals.

Attaching the Stator Bottles

Attach the two stator bottles to the plank so they are spaced about 1/2" from the rotor bottle. I used nuts and bolts through the bottoms, which allowed me to rotate the bottles a bit for easy adjustment of the spacing between the commutator wire tips and the center bottle. (Yes, it was really hard to position the bolts inside the bottles!)

If you use tape to attach the stator bottles, make sure it DOES NOT reach up to contact the foil. Duct tape, masking tape and wood are slightly conductive, and when the humidity is high, they can provide an unwanted leakage path to ground, preventing motor operation.

The Bearing

The metal-cap-with-dimple bearing is pretty crude. I improved it by obtaining a 1/4" diameter test tube, cutting the bottom 1/2" off it (by nicking with a file and snapping by hand with gloves.) This I glued into the exact center of the bottlecap. The sharpened rod spun nicely against the glass. Avoid dropping the center bottle suddenly down onto the metal rod, or the sharp point will shatter the glass bearing.

Mark Kinsler has a better suggestion: use a bottle with a plastic cap, and screw a short sheet-rock screw through it so the point of the screw extends downwards into the bottle. Now use a wooden rod instead of a metal one, and screw a small phillips-head screw into the end of the rod. Place the bottle on the wooden rod so that the point of the sheet-rock screw rides in the head of the screw at the top of the wooden rod. He mentions that the slightest air current will make this bottle turn.

RUNNING IT:

It takes more than 5,000 volts to operate this motor. This source of voltage is available from "static electric" sources. Try the generators linked at the top of this webpage, especially the Van de Graaff generator. If you don't have access to a Van de Graaff, try the "TV SCREEN" electrostatic generator.

Electrostatic Motor Debug/Repair

1. DON'T MAKE MAJOR CHANGES

First, did you build your motor to be somewhat like the one I described in the instructions? It can seem boring to simply copy someone else's idea exactly. It's easy to insert many improvements as you go. This makes the motor YOURS and no longer mine. But if your device doesn't work, what then? Maybe one of your improvements actually made the motor not work. If your motor isn't made from three 2-liter plastic pop bottles with aluminum foil glued to them, then I probably cannot help you debug it unless you hire me to come out to your house and take a look. The solution? First build a motor like mine, since we KNOW that this one works. Then, after you have a working motor, go and add all your alterations and improvements one at a time and see what happens. (In the electronics kit business, when the customers make additions to a device BEFORE making it work first, it's called "Ego Improvements.")

2. USE A RELIABLE POWER SUPPLY AT FIRST

Next, what are you using as a power supply? Before trying feeble power supplies like balloons/wool, electrophoruses (electrophori?), or Kelvin waterdroppers, try something fairly powerful such as a VandeGraaff machine, neg-ion gen, or the foil-on-TV-screen trick. Get the motor working with a known-good power supply before going off to try your own power supply ideas. This way you'll know to not blame the motor when the fault might be high humidity or a weak power supply. These motors need more than 5,000 volts DC to operate. This can be easily provided by a hefty "static electric" source.

3. BATTERIES WON'T WORK

This motor needs a "static electric" power supply (in other words, a power supply that puts out high voltage at low current.) Use a TV screen, or a VandeGraaff Generator, or a Negative Ion Generator. I found that my motor would not turn unless the voltage was at least 5,000 volts (and 7,000 volts was much better.) Batteries cannot run this motor unless you have about 4,000 of them hooked in series! (4000 times 1.5 volts is 6,000 volts)

4. TESLA COILS WON'T WORK (or will they?)

Tesla coils are no good because they are high-voltage AC and this motor requires high-voltage DC.

Maybe this is not true! mrgazebo@pacbell.net reports that his pop-bottle motor starts turning when the motor is placed near his large, floor-standing Tesla coil, while one bottle of the motor is connected to ground. Weird! Do Tesla Coils actually emit some microamperes of direct current into the air? Possibly. If so, then in theory a Tesla Coil could run this motor, but only if some corona-rectification is allowed to occur, and not if wires are used to connect the motor directly to the Tesla Coil terminals. But even that might be OK! Somebody with a TC should try it. (I tried it with a tiny solid-state tesla coil from a Plasma Sphere, but it would not run the motor.)

5. BOTTLE ROTATES EASILY, FRICTION MUST BE VERY LOW

Other possible problems: does the center bottle turn very freely? VERY VERY freely? It must. Here's a way to judge whether its friction is low enough. Get the bottle spinning slowly by hand, turning about once per second, then let go. It should keep turning for one or two revolutions or more. If not, friction is far too high. Check out the metal point bearing and make sure it hasn't drilled itself into the

Directions found at

http://amasci.com/