Building a Fixed Magnet DC Motor

Participants in this activity will build a simple electric motor. The purpose of this activity is to understand the operation of a FM DC motor.

Materials

Pencils and Paper
Small Magnets (4-6 per motor)
Enameled Magnet Wire 24-18 gage, Approximately 2 ft per motor
Alligator clip Test Leads (2 per motor)
D Size Battery Holder (Optional)
1 x 1/2 x 1 Styrofoam Blockinch (1 per motor)
Clear Tape
Duct Tape
Toilet Paper Rolls (4 per class)
Exacto Knives
Wire Cutters
Stop Watch
Needle Nose Pliers
Wooden Block approximately 3/4 x 4 x 4 inches
D Sized Alkaline Dry Cell
Large Paper Clips (2 per motor)
Dark Marker
100-200 Grit Sand Paper
Electric Drill
1/16 inch drill bit
Drawing Compass

Procedure

1.) Review the DC Motor Fundamentals slide show.
2.) Carefully review and make a sketch of the motor construction diagrams.
3.) Obtain the materials listed above.
4.) Create the motor armature: Wrap approximately 10-15 turns of wire around the toilet paper roll. Be careful to leave approximately 1-2" at the beginning and end of the wrap. Use small pieces of clear tape to hold the wire wraps in place. Refer o the construction diagrams.
5.) Using an Exacto knife and sandpaper, carefully remove ALL the enamel insulation from **one** end of the armature lead. Refer to the construction diagrams and remove only HALF the enamel insulation from the other end of the armature lead. (note: removing only half the material is an important step. The motor will not operate properly if more than ½ the insulation is removed.
6.) Draw a line on the wooden block Drill two 1/16"holes, 3" apart in the wood block. Use a 6" try square to keep the holes parallel.
7.) Bend the two paper clips (as shown) to accommodate the armature. Set the bent paper clips in the 1/16" holes.
8.) Balance the armature on the paper clips. Be certain that the armature leads are level and that the armature can spin freely. Make any adjustments necessary in order to insure a smooth balanced spinning of the armature. Be certain that the contact areas between the armature and paper clips is clean and free of dirt, oil or insulating material.

9.) Place the battery and battery holder on the wooden block and attach the test leads to the battery terminals. Do not complete the circuit at this time.
10.) Stack the the magnets under the armature.
11.) Connect the circuit. The armature should move slightly, in a rocking motion each time the circuit is completed. *(If the armature does not move, this indicates a poor electrical connection somewhere in the circuit or a dead battery. Check the battery voltage with a meter. Clean each connection and try again.)*
12.) Spin the armature gently. The armature should continue to spin.

If the armature does not continue to spin then:
Be certain that the armature is as lightweight as possible
Increase the voltage (Add more batteries in series)
Increase the magnetic field. (Obtain stronger magnets or add more magnets)
Check for shorts and poor connections in the circuit.
Twist the ½ insulated end of the wire
Reverse the test lead polarity

Short Description of How The Motor Works

1. When the un-insulated ends of the armature are in contact with the paper clip, current flows through the armature.
2. Current flowing through the armature induces a magnetic field in the armature that is in opposition to the fixed magnetic field of the magnets.
3. The opposing fields create force strong enough to create a torque on the armature causing it to rotate.
4. The armature begins to rotate.
5. This would serve to rotate the opposite (attractive) magnetic field of the armature into the fixed magnetic field of the magnets.
6. The motor would come to a complete stop if it were not for the fact that one armature lead has 180 degrees of insulation left on it.
7. The insulated portion of the armature lead effectively turns off the current through the armature, allowing the momentum of the armature to carry itself through a turn of 360 degrees. This starts the whole process over again.
8. This motor is in fact operating on a magnetic “Push” that lasts through approximately half the time the armature is rotating.