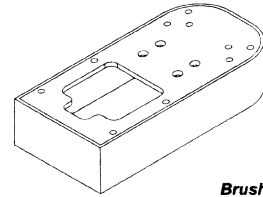


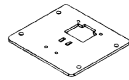
ASSEMBLING THE MOTOR

PART LIST

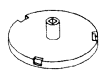
Plastic Frame & Paper Panel



Plastic Base



Rotating Plate*



Plastic Coil A



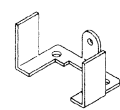
Plastic Coil C



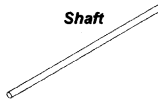
Plastic Coil D



Magnet Holder



Shaft



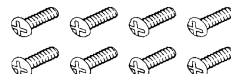
Tapping Screws (short)



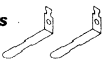
Axis Holder



Tapping Screws (long)



Brushes



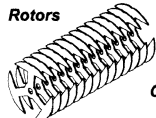
Screws



Nuts



Rotors



Color Paper Disk*



Magnet N Pole



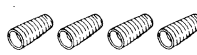
Magnet S Pole



Commutator



Spring Terminals



Fan*



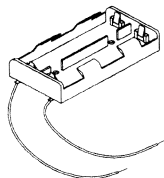
Double-Sided Tape



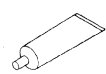
Sand Paper



Battery Case with Wires



Lubricant Grease

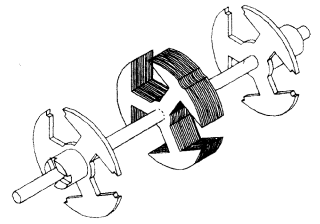


Enamel-Insulated Wire

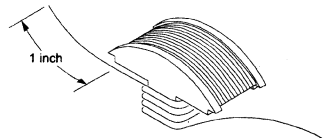


Note: parts marked with an asterisk are not required for assembly, but are used during experiments.

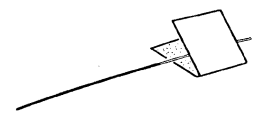
1. Insert coil A, the 14 rotors, and coil B through the shaft, with their grooves aligned.



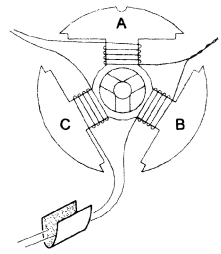
2. Carefully wind the enamel-insulated wire around each pole, leaving about 1 inch at each end. Be sure to wind the wire in the same direction around the poles.



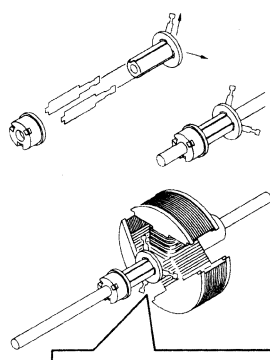
3. Use sandpaper to remove about 1 inch of insulation from both ends of three of the wires.



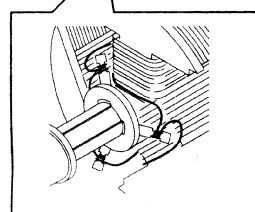
4. Twist the neighboring wire ends together.



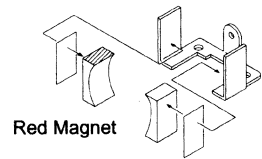
5. Insert the three commutators into coil C and attach coil D to hold in place. Then insert the coil with commutators attached onto the shaft. Then insert the assembled coil onto the shaft. You might need a pair of needle-nosed pliers to insert the assembly. Fold the commutator outward to secure the coil.



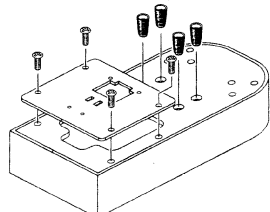
6. Wind the twisted end of a pair of enamel-insulated wires around each commutator. Make sure all the pieces are tightly connected.



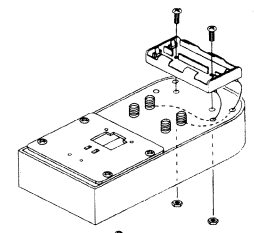
7. Use double-sided tape to attach the magnets to the inside of the magnet holder. Attach the white magnet to the holder's right side and red magnet to the holder's left side.



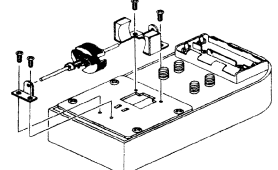
8. Attach the plastic base to the paper panel with four of the long tapping screws. Insert four spring terminals in the holes in the paper panel.



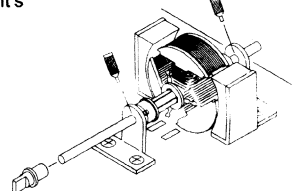
9. Insert two wires from the battery case through the holes in the paper panel. Attach the battery case to the paper panel with two screws and nuts. Connect the battery case's wires to the two spring terminals as shown. The red one to "+" terminal, the black one to "-" terminal.




10. Insert the coil D side of the shaft's end into axis holder and the coil B-side into the magnet holder. Fasten each holder to the base with two screws.

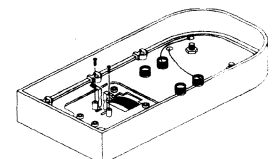


11. Attach the axis point to the shaft's end.

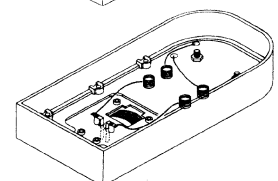


Note: When you use this unit in experiment, apply appropriate grease where  marks are indicated first.

12. Secure the brushes with screws through the back of the panel so they contact the commutator on the front of the panel.



13. Connect the remaining wire to the brushes and spring terminals. Make sure the wire is cut and the enamel is removed from both ends.

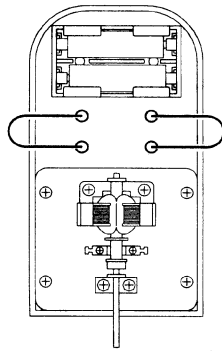


EXPERIMENT 1: Operating the Motor

You need:

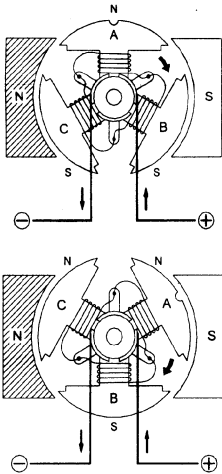
- Motor
- Wires
- Batteries

After wiring the experiment as shown, install the batteries. The circuit is charged with electricity and the motor starts spinning.

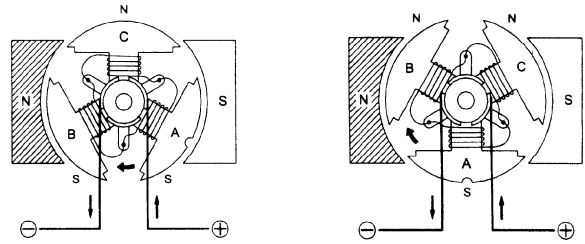


HOW DOES THIS WORK?

After the batteries installed, the coil in the motor becomes magnetized. The coil's magnetic field first repels, and then attracts the permanent magnets, and the coil spins. When the coil travels 1/3 of a circle, the first commutator breaks contact with the brush and electricity is cut off. Then the next commutator touches the brush, the next coil becomes magnetized, and the process repeats. When the commutator comes in contact with another brush, the motor receives repelling force from another magnet and keeps spinning until you remove the batteries or wires.



When you are through with the experiment, remove the batteries from the battery case to avoid the leakage from the battery.



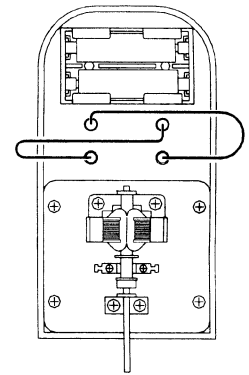
EXPERIMENT 2: Reversing the Motor's Direction

You need:

- Motor
- Wires
- Batteries

This is almost the same as the previous experiment, but you connect the battery in the opposite way to see what happens when + and - are swapped. When the electric current is reversed, the magnetic poles are also reversed.

When you are through with the experiment, remove the batteries from the battery case to avoid leakage from the battery.



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EXPERIMENT 3: Color Mixing with A Rotating Multicolored Disc

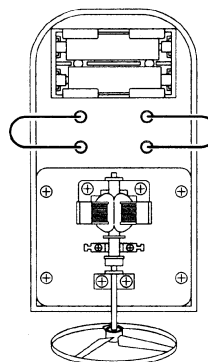
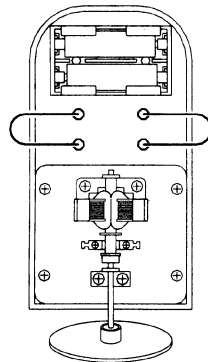
You need:

- Motor
- Wires
- Multicolored disc
- Rotating plate
- Batteries

This experiment shows how colors look when they are mixed, using the color-mixing disc. Snap the multicolored disc onto the rotating plate, and attach the plate to the motor's shaft. Then install the batteries and connect the wires as shown.

Blue, green and red are the three primary colors. See what happens when all three are mixed. Try taping white paper over part or all of a color to see what other color combinations look like.

When you are through with the experiment, remove the batteries from the battery case to avoid leakage from the battery.



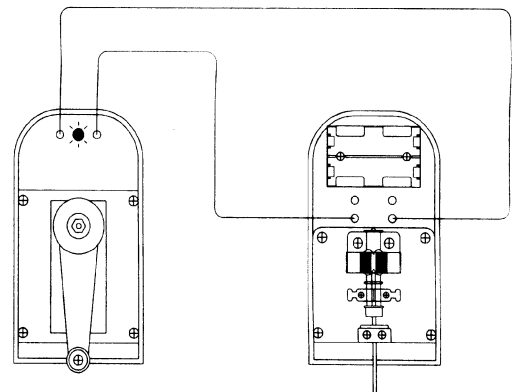
Attach the fan to the motor's shaft with the axis point at the end. Then install the batteries and connect the wires as shown.

EXPERIMENT 5: Operating the Motor using the Generator without Battery

You need:

- Generator
- Motor
- Wires

After wiring the experiment as shown, turning the handle and you will see the LED lights up and the motor starts to spin. The faster you turn the handle the faster the motor spins. You might need to turn the handle rapidly, as the motor requires much electricity to work.



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