

Piezoelectric One-way Remote

A piezoelectric igniter, such as the small ones found in butane-fueled barbecue lighters (Figure 1), or the larger ones found in propane grills (Figure 2), can be used as a “remote control” of sorts. The good news is that it works as an “on” switch – the bad news is that it won’t work as an “off” switch!



Figure 1



Figure 2

To Do and Notice

1. Make several small loosely crumpled balls of aluminum foil, with diameters of about 1 cm. (See Figure 3; pencil is to show scale.)
2. Cut two strips of aluminum foil, and tape them to the sides of a plastic film can so that they do not touch each other. (See Figures 3, 4 and 5.)
3. Drop the aluminum foil balls into the film can so that they rest loosely on each other and bridge the gap between the foil strips. (See Figure 5.)

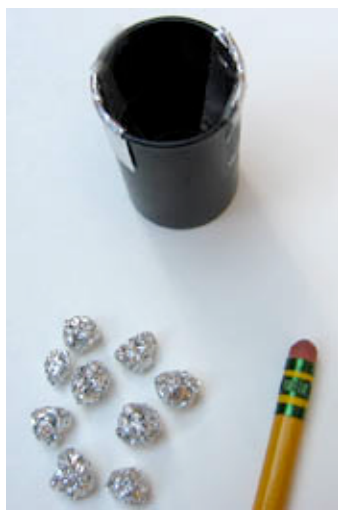


Figure 3



Figure 4



Figure 5

4. Set up a simple series circuit such as the one shown in upper right portion of Figure 6. It should contain a circuit element that gives a visible indication when it is “on” (e.g., the motor and propeller used in the circuit shown, or a flashlight bulb or Christmas tree bulb), one or more batteries as applicable, and the film can with aluminum balls.

5. In the circuit shown, the motor does not turn when only one D-cell is used. But when the piezoelectric igniter is snapped near the film can, the motor starts, and the propeller rotates. To turn the motor off, either disconnect a wire for a couple of seconds, or shake the film can so that the aluminum balls reposition themselves. When the igniter is snapped again, the motor will restart.

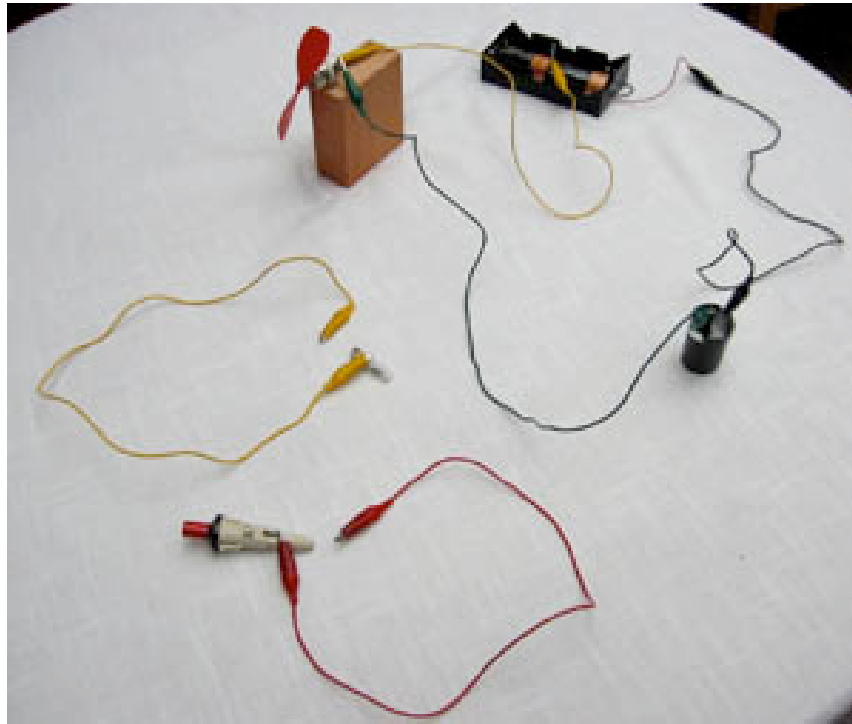


Figure 6

6. Try moving the igniter farther from the film can to see how far away the “remote control” will work. Also, try hooking a wire to one of the igniter contacts, and holding the other end of the wire close enough to the other contact to generate a visible spark (see lower center igniter in Figure 6 – be careful not to shock yourself!!). See how this affects the distance over which the “remote” will work. You can also hook both ends of a wire to the contacts, forming an antenna, and see how this affects the distance.

What’s Going On

Aluminum is normally covered with a thin oxide film. When the irregularly crumpled aluminum balls are lightly resting against each other, and against the metal strips in the film can, the oxide is effective in blocking current. Snapping the igniter creates a large radiating electric field, which allows current to penetrate the oxide film; once the current starts flowing, it continues until turned off.

Acknowledgement

This effect was demonstrated at the Exploratorium by a member of the Galileo Circle group of Japanese physics teachers.