Pressure Sensor

Overview: You've about to make an NO burglar alarm switch, which is similar to the Trip Wire Burglar Alarm, only this one is triggered by squeezing it. If you're using the special black foam without the hole, it works because the foam conducts more electricity when squished together, and less when it's at the normal shape.

What to Learn: Switches control the flow of electricity through a circuit. There are different kinds of switches. NC (normally closed) switches keep the current flowing until you engage the switch. The SPST and DPDT switches are NO (normally open) switches. Today's switch is also an NO switch.

Materials

- thin sponge or foam square (about 1″ square)
- AA battery case
- 2 AA batteries
- 3 alligator clip wires
- 2 large paper clips
- scissors
- aluminum foil
- LED

Lab Time

1. Make the Pressure Sensor:
    a. Cut the foil so it's slightly smaller than the foam square. You need two pieces.
    b. Carefully cut an open hole through the middle of your square. Make it bigger than you think you need.
    c. Place one piece of foil in the top of the sponge with the other piece on the bottom.
    d. Place a paperclip on top of each piece of foil. Point the paperclips in opposite directions so they don't touch when you're squeezing the sensor later.
    e. Wrap the whole thing in a single piece of tape.
2. Make the Pressure Sensor Circuit:
    a. Use your batteries, wires, and LED to make the LED light up. (No trip wire yet.)
    b. Remove one of the alligator wires from the LED and replace it with a third alligator wire.
    c. Attach one of the free alligator wire ends to one of the paperclips.
    d. Attach the remaining alligator wire to the other paperclip.
    e. Press *hard* on the sensor. *GOTCHA!*
3. When you squeeze the foam, the LED lights up! It's ideal for under a doormat or carpet rug where lots of weight will trigger it. You'll always know when mom's on her way into your room.

Troubleshooting: There are a few problem areas to watch out for when building this sensor. First, make sure the hole in your foam is big enough to stick a finger (or thumb) through easily. The foam keeps the foil apart until stepped on, then it squishes together to allow the foil to make contact through the hole. The second potential problem is if the switch doesn't turn the LED off. If this happens, it means you're bypassing the switch entirely and keeping the circuit in the constant ON position. Check the two foil squares, alligator clips, and paperclips – are they touching around the outside edges? Lastly, make sure your foam is the kind that pops back into shape when released.

Bonus Idea: Stick just the sensor under a rug and run longer wires from the sensor to your room. When someone comes down the hallway, they'll trigger the sensor and alert you before they get there!

Reading

By controlling how and when a circuit is triggered, you can easily turn a simple circuit into a burglar alarm – something that alerts you when something happens. By sensing light, movement, weight, liquids, even electric fields, you can trigger LEDs to light and buzzers to sound. Your room will never be the same.

The pressure sensor we're building is small, and it requires a fair amount of pressure to activate.

Now is a good time to introduce the idea of *pressure*. Pressure is force (like weight) over a given area (like a footprint). If you weighed 200 pounds, and your footprint averaged 10" long and 2" wide (so the area of your footprint is 10 x 2 = 20 square inches), you'd exert 200 / 20 = 10 psi (pounds per square inch) on the ground when standing on both feet. Or 5 psi per foot.

However, if you walked around on stilts instead of feet, and the "footprint" of each stilt averaged 1" by 1" square, you'd now exert 200 / (1 x 1) = 200 psi, or 100 psi per foot. Why such a difference?

The secret is in the area of the footprint. In our example, your foot is about 20 square inches, but the area of each stilt was only 1 square inch. Since you haven't changed your weight, you're still pushing down with 200 pounds. In the stilts' case, you're pressing the same weight into a much smaller spot… and hence the pressure applied to the smaller area shoots up by a factor of 20. Imagine how the floor feels under the spike of a high-heeled shoe.

So how do we use pressure in this experiment? You need to exert pressure on the sensor for it to activate. How much pressure is going to depend on how large or small your sensor is, how stiff your sponge is, how large the hole is, and so forth.

Bonus Idea: Stick just the sensor under a rug and run longer wires from the sensor to your room. When someone comes down the hallway, they'll trigger the sensor and alert you before they get there!

Exercises

1. How does this sensor work?
2. What makes this an NO switch?
3. How can you use both the trip wire and the pressure sensor in the same circuit? Draw it out here:

Answers to Exercises: Pressure Sensor

1. How does this sensor work? (When you squeeze it, you're getting the two foil squares to touch through the hole, which allows current to flow to your LED. When you release it, the foil spreads apart again because they are on opposite sides of the foam square, which insulates and interrupts the flow of electricity, and the LED goes dark.)
2. What makes this an NO switch? (A normally open switch doesn't allow current to flow when it's sitting there by itself. When you activate it (in our case, stepping on it), then it allows electricity to flow.)
3. How can you use both the trip wire and the pressure sensor in the same circuit? Draw it out here: