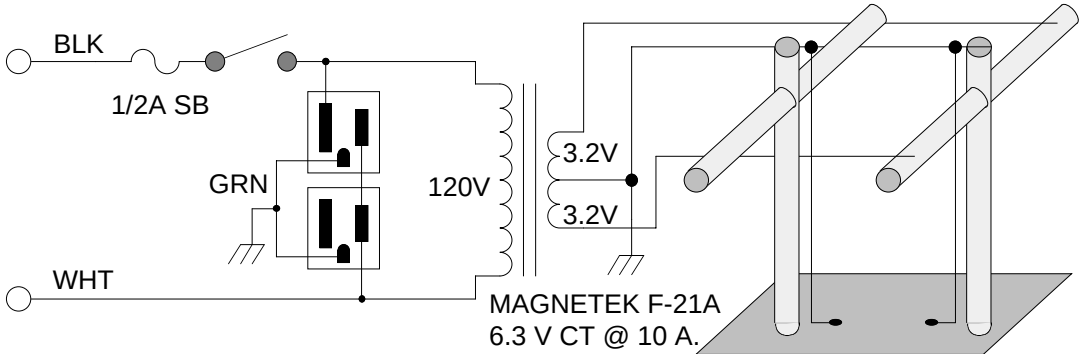
Bird-On-A-Wire: A Demonstration of Potential Difference

In this demonstration the concept of potential difference (and electrical safety) is explored with the aid of a "bird" whose body is made of nitrocellulose. Most students have observed a bird perched on a single power line. Ask the students why the bird survives. Discuss the concept of potential difference, and what would occur if the bird's body or wings bridged two of the power line wires. Discuss the bird's fate in terms of its body resistance and the resulting current that would flow through its heart muscle. Show the class the 4 cm length of 20 gauge nichrome wire that fastened to a support rod. Insert the nichrome wire deep into the nitrocellulose bird and draw the analogy with a real bird's body resistance.

Plug the line cord of the apparatus (see the schematic diagram) into a 120 VAC receptacle. A "night light" should be plugged into one of the grounded receptacles on the front of the apparatus. Turn on the apparatus using the power switch at the rear of the unit. The night light should be illuminated. Point out the upper ground wire on the "utility poles" and discuss its use. Trace the ground wires on each pole to their earth connection at the base of each pole. Discuss the purpose of the ground wires. Point out the other two "hot" wires on the utility poles and discuss their use. The potential difference between these wires is twice the potential difference between either wire and the ground wire.



Grasp the support rod by its insulated handle and touch the electrical connections to the nichrome wire in the bird's body to the upper ground wire. Repeat with each of the hot wires. Nothing will happen because no potential difference appears across the nichrome wire. Touch the aluminum sections of the support rod to the upper ground wire and either of the two hot wires. A potential difference will appear across the nichrome wire. In a few seconds the nichrome wire will heat and ignite the nitrocellulose. The bird will disappear in a spectacular display of flame and smoke. Wear dark safety glasses when presenting this demonstration!

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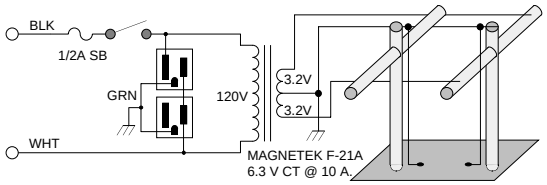

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Prepare the Bird's Body

Prepare the bird's body several days before the demonstration. The body is made from a nitrocellulose pad available commercially from magic supply companies as "flash cotton." Flash cotton is available in Albuquerque from Magic Avenue, 110 Morningside N.E. (505-262-2155). The nitrocellulose is packaged wet. Add a few drops of yellow food coloring to several ounces of water. Remove the nitrocellulose from its packaging. Soak and press the nitrocellulose in the water until the nitrocellulose is saturated with water and uniformly colored. A bird mold is supplied with the apparatus. Place the mold on several layers of paper towels. Place the water soaked nitrocellulose into the mold. Place a paper towel on top of the mold. Use a screwdriver or similar tool to press the towel into the mold and force the nitrocellulose into the mold contours. Replace the water soaked towels with dry towels and repeat the process until most of the water has been adsorbed. Carefully place the mold on its edge and allow the nitrocellulose to dry completely. When the nitrocellulose is thoroughly dry remove the bird from the mold. The nitrocellulose will expand to several times its original size. See the figure. For long term storage, wet the bird with water and store in a Ziplock bag.

Caution: Dry nitrocellulose is extremely flammable. Store carefully in an open, fireproof container.

Nitrocellulose (cellulose nitrate) is commonly called "guncotton" or "flash cotton". It is more stable than black powder, and it produces a much greater volume of hot gas. It also burns much faster than black powder when in a confined space. Nitrocellulose is extremely flammable and has the potential to self-ignite when dry. Although self ignition is highly unlikely when using commercial flash cotton, always take proper safety precautions when storing the dry material. There are actually three forms of nitrocellulose, only one of which is useful for this demonstration. The mononitrate and dinitrate are not explosive, and are produced by incomplete nitration. The explosive trinitrate is only formed when nitration is allowed to proceed to completion.

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