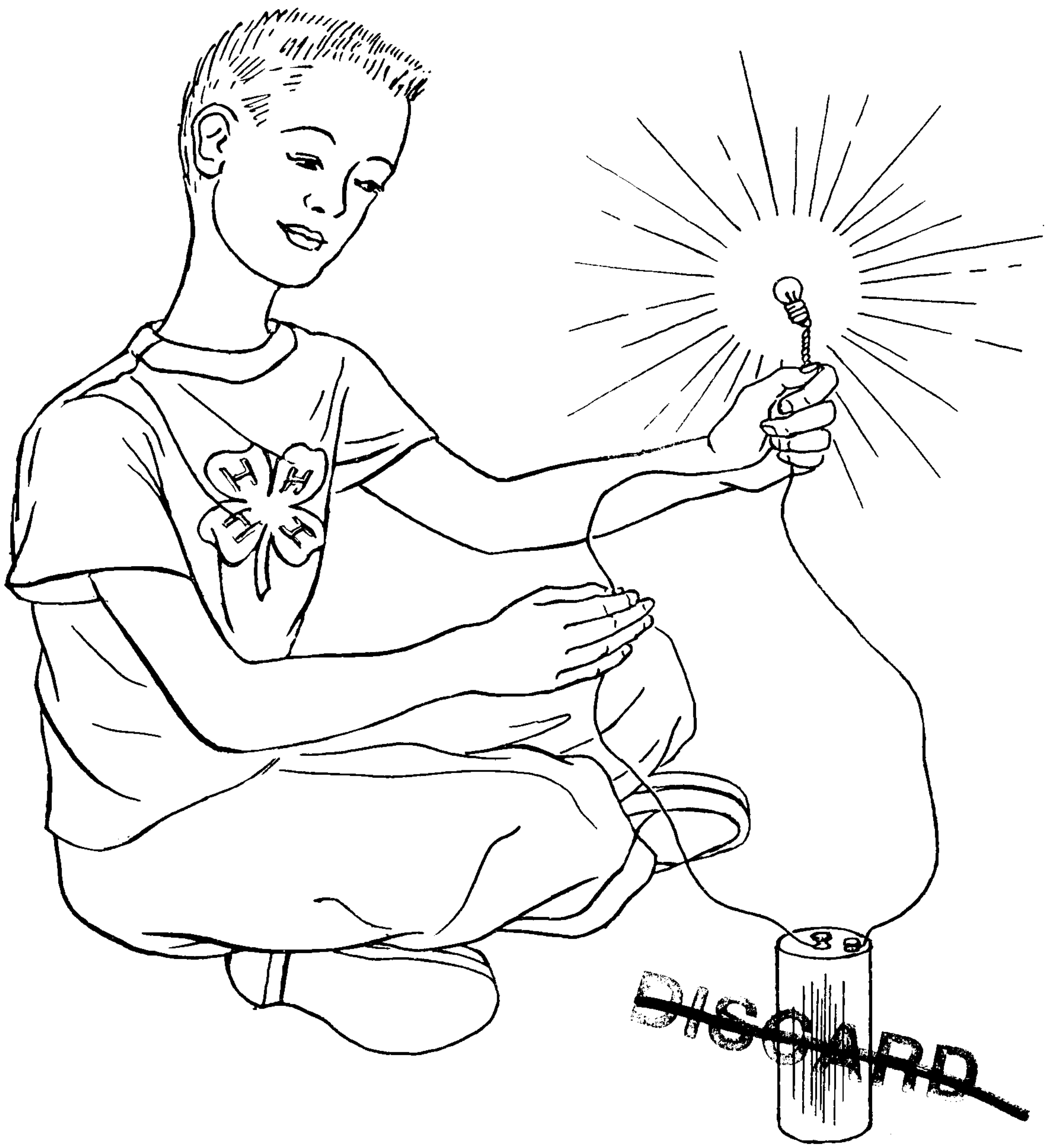
ELECTRIC MAGIC



FEDERAL COOPERATIVE EXTENSION SERVICE · OREGON STATE COLLEGE · CORVALLIS

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ELECTRIC MAGIC

Electric Magic is for boys and girls 9 to 12 years old who want to learn about electricity and belong to a 4-H Electricity Club.

In this project you will:

Do magic tricks with electricity.

Make magnets, switches, circuits, games, and gadgets.

Learn how electricity makes heat, light, and power.

Project Requirements

1. Learn how to do one or more of the electrical tricks included in the "Bag of Tricks" and explain how it works. . . . .
2. Make a flashlight . . . .
3. Make a switchboard with two-way and three-way switches, showing how electricity flows through a current and how switches work. . ...
4. Learn about magnets and magnetism. Magnetize bits of steel. Do at least one experiment on magnetism. . . . .
5. Make a compass that will point to the north magnetic pole . . ..
6. Make an electromagnet that will pick up tacks and similar items . ...
7. Working alone or with one or several other members, make a workable electric buzzer. . . . .
8. Complete this project book. Bring your Permanent 4-H Record up to date, write your 4-H story for the club year. Fill out a project completion card, have it signed by your club leader, and sent to your County 4-H Extension Agent when your project is completed . ...

Exhibits

You may exhibit:

One of the electrical games or gadgets you have made or a switchboard, which should include two three-way switches that control one light; it may include other switches, lights, or a buzzer you have made.

Your exhibit may not be more than 2 feet long, 12 inches wide, and 18 inches high. All parts should be clearly labeled to show what they are and how they work.

Learn Some Electrical Tricks

Organizing your club

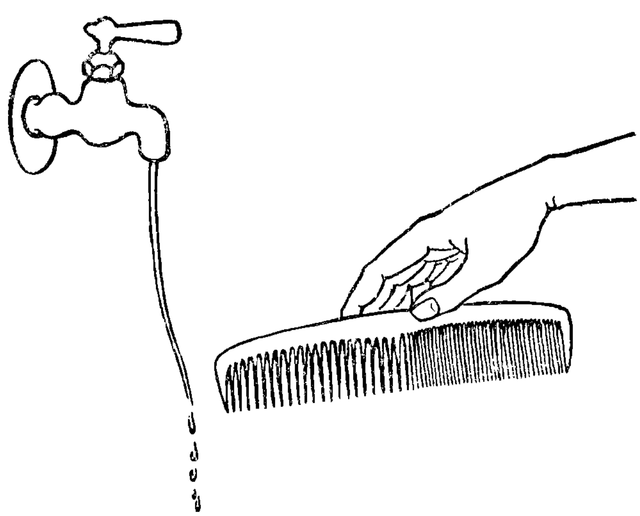
Learning about electricity is fun, particularly in a group such as a 4-H Club. At your first meeting, after each of you has signed a 4-H Club enrollment card, you may need to become better acquainted and then elect officers. One way to learn more about each other is to seat yourselves in a circle, have the leader introduce himself and tell something about his family, his hobbies, and what the club might do during the year. Then the person on one side of him can tell about himself—his name, where he lives, his hobbies, and any other 4-H Club work he may be doing. Continue around the circle this way, each person telling about himself.

Following the introductions, when all of you have become better acquainted, is the time to elect officers.

Bag of Tricks

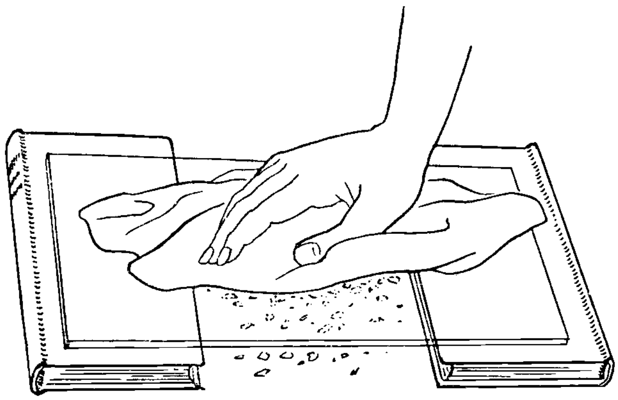
Your Electric Magic club might like to have a Bag of Tricks, and each of you might enjoy performing some of these tricks before other friends. Here are a few which will interest almost any audience.

Bending water: Run a hard rubber comb through your hair several times or rub the comb with a piece of woolen cloth. Hold the comb near a trickle of water and the water will bend toward the comb.

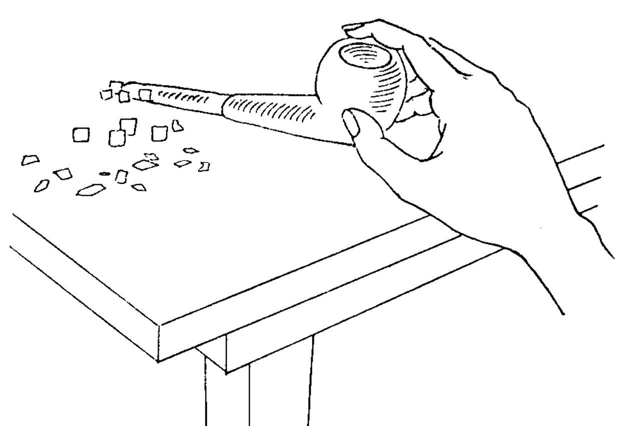


Paper the wall electrically: You can make paper stick to the wall electrically. Take a plain sheet of paper that is warm and dry. Brush it with a clothesbrush, then place the paper against the wall. It will stay in place.

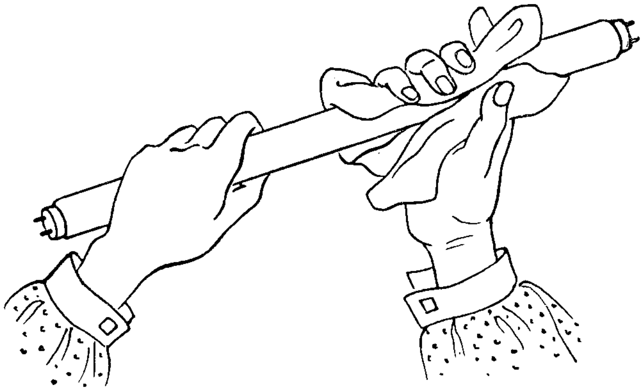
Dancing dolls: Support a piece of clean, dry, warm glass between two books. Cut some small dolls or animals from tissue paper. Rub the glass briskly with a piece of silk. The figures will jump up to the glass, then down to the table, up to the glass, and then down again.



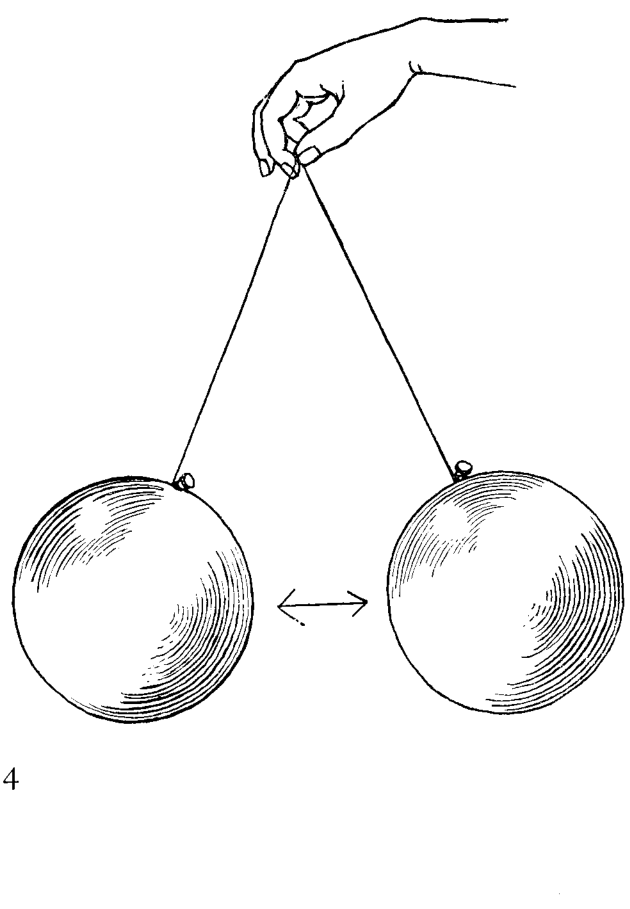
Dad's pipe picks up paper: Tear a piece of paper into pieces about one fourth of an inch square. Borrow a pipe that has a hard rubber stem. Show that the pipe will not pick up paper. Then rub the stem rapidly on woolen trousers, a woolen skirt, or with a piece of woolen cloth. When you hold the pipe stem near the small pieces of paper they will stand on end. If the pipe stem touches the pieces of paper they will cling to it for a few seconds.



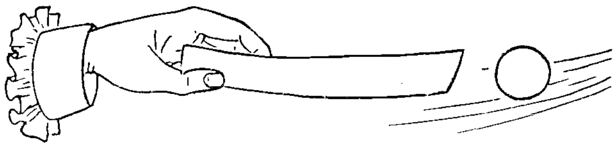
Light without wires: On a day when the air is dry you can light a fluorescent tube by electrical magic. The trick will work best in a darkened room. Grasp one end of the tube in your hand. Rub the tube lightly but rapidly with a piece of woolen cloth. In a few seconds the tube will light up.



Push-apart balloons: Inflate two rubber ballons. Tie them on the ends of a piece of string about three feet long. While you hold the string at a point midway between the balloons ask two friends each to rub a balloon with a piece of woolen cloth. Hold the two balloons up by the string and they will push apart.



Remote control: Brush a strip of paper with a clothesbrush. Then hold the paper near a ping-pong ball that is free to move. The ball follows the paper until the two touch, but after that the ball moves away when the paper is held close to it. A strip of paper that has been brushed also can be used to control a small cellulose duck floating in a pan of water.



It really isn't magic

When you run a comb through your hair, rub a comb or hard rubber pipe stem with woolen cloth, electrons are transferred from the hair or cloth to the hard rubber, and it becomes negatively charged. The charged hard rubber attracts water and paper.

Matter is composed of particles that are electrical in nature. One particle is the positively charged proton and one is the negatively charged electron. Unless disturbed the electrons stay put, but some can be made to move.

When glass is rubbed with silk, electrons are transferred from the glass to the silk. The glass becomes positively charged, causing the dancing dolls to hop about. When the paper sticks to the glass, the paper picks up a positive charge which causes the paper to jump away from the glass. The paper soon loses this positive charge, then hops up again.

The static electricity produced on the paper when it is brushed causes it to stick to the wall or to attract the ping-pong ball.

Static electricity can be produced any time of the year. Damp air, however, serves as a conductor to carry the static electricity away as fast as it is produced. That is why the tricks work best in dry weather.

The trick with the balloons shows how like charges push away from each other. The balloons are negatively charged after they are rubbed with the wool. As long as the balloons have similar charges they will push apart.

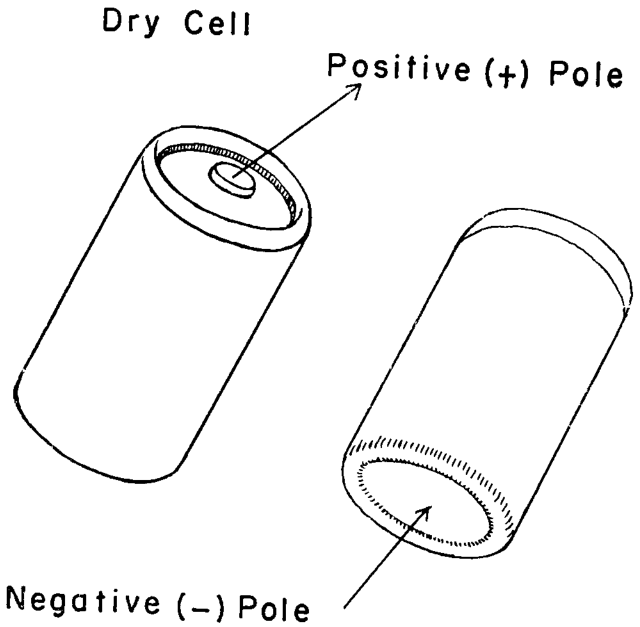
When you rub the fluorescent tube with wool, enough static electricity can be built up to cause gas in the tube to ionize and light up.

Make a Flashlight

Materials needed

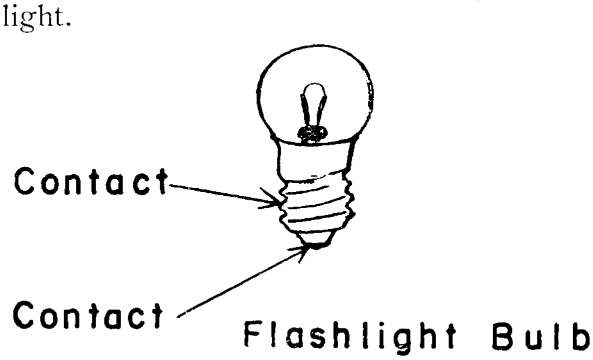
Each member should bring a flashlight battery and a screw-in type flashlight bulb. The club should get a coil (50 to 100 feet) of insulated bell wire and a roll of friction, adhesive, or plastic tape.

The club also should have pliers or wire cutters to cut the wire and pocket knives or wire strippers to remove the insulation. (All of this material will be used again at other meetings.)



Information necessary

In making this homemade flashlight you learn that a flashlight (dry cell) battery stores electrical energy, that electricity flows in a circuit (round trip) through wires or other conductors, and that electrical energy can make light.



Batteries have two poles (contacts). If a conductor (wire) is provided electricity will flow from the plus pole to the minus pole.

Light bulbs also have two contacts. To make a light, electricity must flow in one contact and out the other.

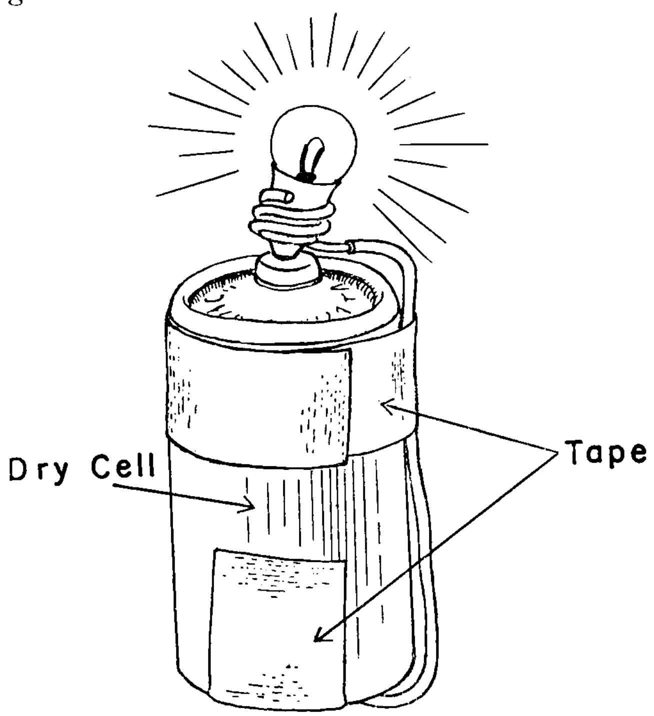
How to do it

In making a flashlight take 7 inches of insulated bell wire. Remove 3 inches of insulation from one end and 1 inch from the other. Make a screw-in socket by winding the three inches of bare wire around the threaded part of your bulb. Follow the threads. Make $2\frac{1}{2}$ or 3 loops around the base of the bulb.

Hold the bulb on the top pole of your battery with the wire sticking out at right angles. Bend this wire straight down along the side of the battery. Then bend the wire at a right angle again so it extends across the bottom of the battery. Now if the center pole of your bulb is in contact with the plus pole of your battery and the bare end of your wire in contact with the minus pole, your flashlight should light up. You may bend a circle in the wire at the bottom of the battery to give greater contact. Be sure and remove the insulation. Now fasten the wire to the battery with tape.

Your flashlight is complete. The bulb should not be in contact with the top pole unless you put a little pressure on the wire or bulb. Push the bulb down in contact with the top pole of your battery and watch it light up. This completes the circuit.

You may take this flashlight home to show your family. Try it in the dark. It makes a good light for your jack-o-lantern on Halloween. If you want to keep the light on without holding the wire down you can use a piece of tape but remember that your battery only holds so much electrical energy. As soon as it is all used your light will grow dim and finally go out.



How electricity makes light

Look carefully at your flashlight. Notice the tiny wire (filament) in the bulb. This filament becomes white-hot and makes light when an electrical current flows through it. The electricity goes in one contact, passes through the filament, and out the other contact. The circuit must be complete for the bulb to work. You may wonder why the tiny wires don't burn completely when they get so hot. They don't because there is a vacuum, or lack of oxygen, in the bulb and, of course, fire will not occur without oxygen.

You can compare what you have learned to the electrical system in your home. Light bulbs work the same way as the flashlight bulb. In the flashlight, electrical current passes from the plus pole through the bulb and wire to the negative pole of the battery. Electricity used in your home starts at a power plant, comes through many miles of wire, is conducted to all parts of the house by smaller wires, passes through the lights, heaters, motors, and other appliances and then goes back to the power house. This circuit also must be complete.

You should remember that the electricity from your battery flows one way only. It is called *direct current*. The electricity from power plants flows both ways. It alternates back and forth flowing one direction for an instant, then the other. It changes direction 60 times each second. It is called *alternating current*.

The electricity from your flashlight battery is of very low voltage (about 1.2 volts) and is not dangerous. The *electricity* in your home is of much *higher voltage* (110 volts or more). It can *kill* a person or start a *fire*. *You must handle it carefully.*

Questions

1. Which is the abbreviation for direct current? AC............ DC............

2. The electric current from a battery flows: In one direction only............ Both directions............

3. Does it make any difference which way the electric current flows through your light bulb?

   Yes............ No............ (Try it with your battery and bulb.)

4. Why does a light bulb make light when an electric current is passed through it? ....

   ....

   ....

5. Does an electric light bulb make heat as well as light? Yes............ No............

6. Why doesn't the filament in a light bulb burn? ....

....

7. What has happened when a light bulb is burned out? ....

....

8. What causes the light from a flashlight to get dimmer? ....

....

Make a Switchboard

You know that electric switches turn lights on or off. Some switches turn lights on or off at one place only; others turn lights on or off from two places; still others turn a light on or off from three or more different places.

The best way to identify switches is by the number of connections. A two-way switch has two electrical connections; a three-way has three; a four-way switch has four. A two-way switch turns a light on and off from one place only; three-way switches turn lights on or off from two different places; four-way switches used in combination with three-way switches turn lights on and off from any number of places.

First, make a demonstration switchboard to show how switches work.

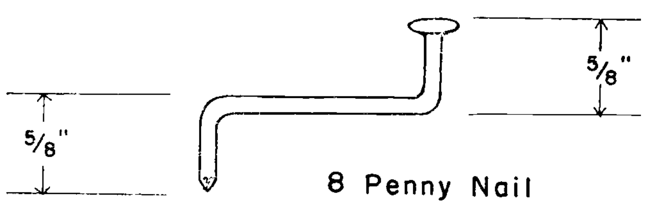
Materials and tools needed

You will need a dry cell or flashlight battery; a board about 8 x 12 inches; 3 eightpenny ($2\frac{1}{2}$ inch) nails; 9 threepenny shingle nails; 3 rubber bands; a screw type two-cell flashlight bulb; 6 feet of insulated bell wire; hammer; pliers or vice for bending nails; tape.

Two-way switch

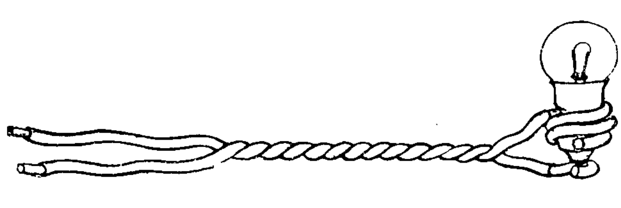
Now make a two-way switch, as shown in the upper right hand corner of the diagram on page 8. Drive threepenny nails at points marked C and A. Clip the points of the nails at both C's so they are only one-half inch high. The nail at A can be three-fourths of an inch high.

Now bend the eightpenny nail as shown. Drive the pointed end into the board at B. You can drill this hole or make it with another nail. It should have a snug fit but be free to turn. Connect the rubber band from the head of this nail to the nail at A. As you turn the switch from side to side, it should have a snap action. This is your two-way switch.

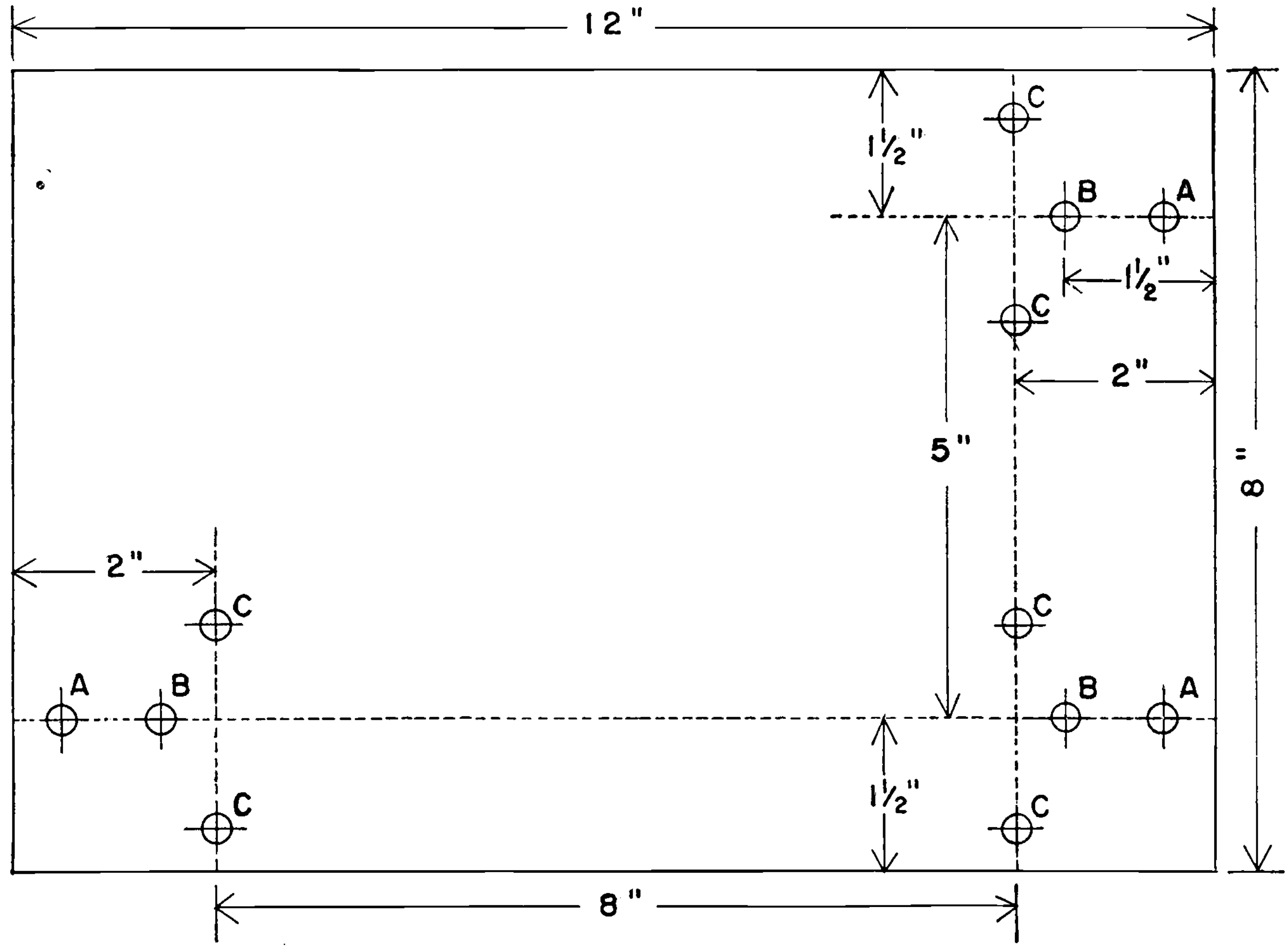


Light bulb socket

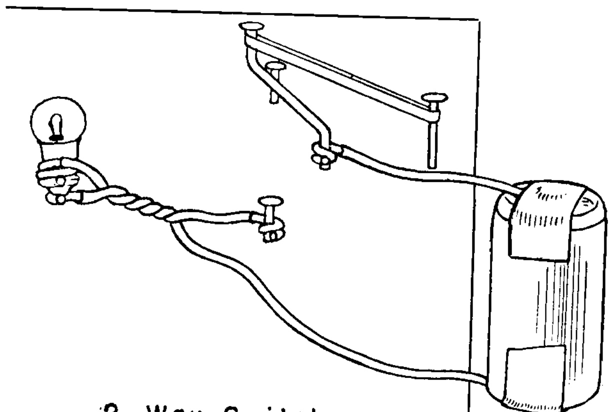
Make a light bulb socket somewhat like the one you made for your flashlight. Take 6 inches of bell wire, remove 3 inches of insulation and wrap bare wire around the base of the bulb starting at the top and following the grooves. Take another wire, $3\frac{1}{2}$ inches long.



Remove $\frac{1}{4}$ inch of insulation. Make a small loop or "eye" in this end. Then, hold this eye tight against the bottom connection of the bulb and



with the other hand twist the 2 wires together tightly for about 2 inches. This is your socket. If you have made it correctly the electricity can pass through a single wire to a connection of



2-Way Switch

the bulb, through the bulb, out the other connection and back through the other wire.

Next, complete the circuit to the two-way switch. One wire from the battery goes directly to the bulb. The other wire can be connected to the switch at B. Be sure to wrap the wires tightly to the nails. There are two connections at the switch. This identifies a two-way switch.

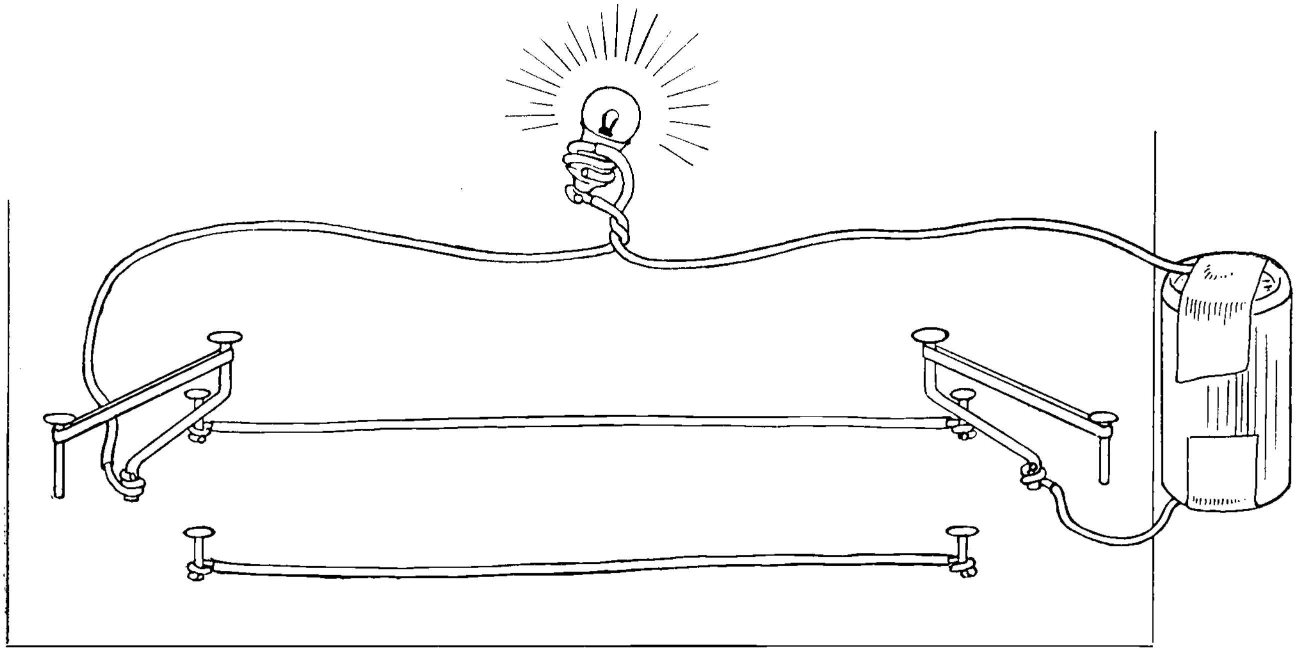
Three-way switch

The next job is to make two three-way switches. Make the three-way switches according to the diagram, the locations for nails the same as for the two-way switch.

There are 2 wires between the 2 switches, making 3 connections at each switch. That is why they are called three-way switches. These

2 wires make it possible to turn the lights on and off from 2 different places; for example, upstairs and downstairs or in the garage and in the house. One wire from the battery goes directly to the light bulb. The other goes to one switch. The other wire from the light bulb attaches to the second switch.

When the light is on, either switch will turn it off. When the light is off, either switch will turn it on.



3-Way Switch

Questions

1. What is the difference between an open and closed circuit? ....

....

....

2. How many contacts at the switch has a two-way switch?........ three-way?........ four-way?........

3. How many places can a two-way turn the lights on and off?...... three-way?...... four-way?......

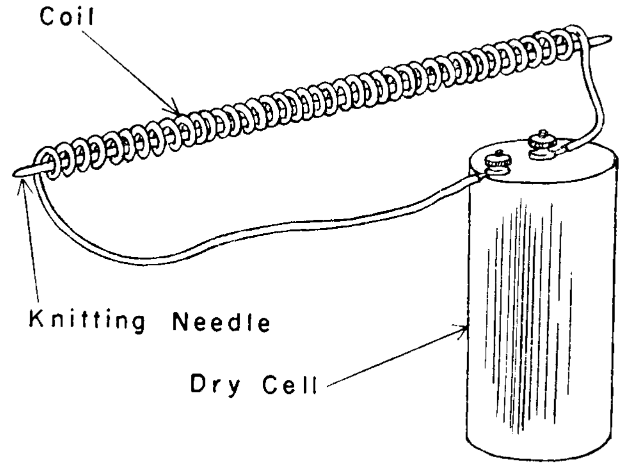
4. Where in your home or in other buildings do you use three-way switches?..............................

.... four-way switches? ....

Magnetism and Magnets

Magnetism attracts iron and steel. It is natural in certain iron ores. Many years ago the Greek people noticed that this strange ore could attract iron. Later it was learned that a long natural magnet hung by a thread would point to the North. This was called the lodestone or leading stone, and was the early compass.

An artificial magnet can be made by stroking or gently rubbing a piece of steel with a lodestone. This piece of steel then can be used to magnetize another piece of steel. This can be continued on and on. Lodestones are not always available but the same results can be obtained with an electric current.



Materials needed for club

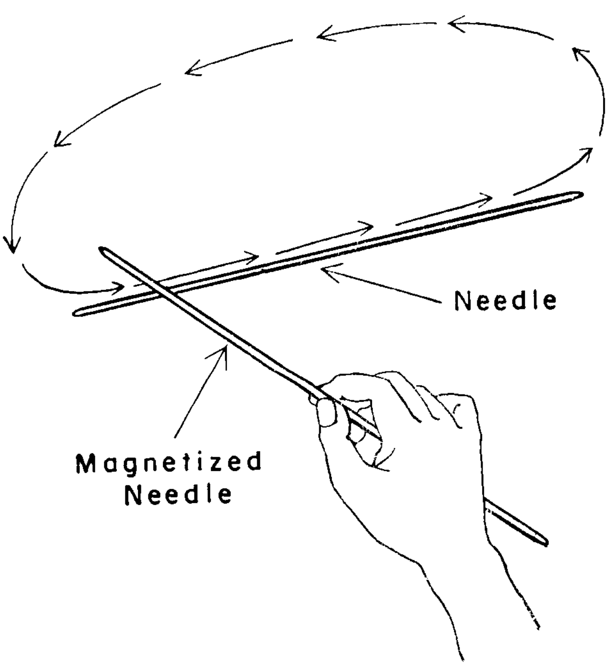
Your club will need a dry cell; bell wire; two steel knitting needles or similar steel; pliers; light thread; piece of paper; compass; iron filings.

If iron filings are not easily found, old or new scouring pads rubbed together will produce bits of iron that will do.

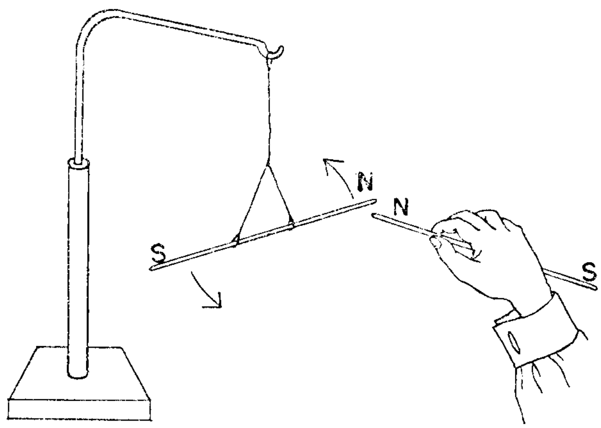
One set of materials can serve for the whole club, as these experiments can be done by the group. Each member, working alone or with another member, should do at least one of the experiments. All members should watch each experiment. If the club is large, additional materials should be provided.

Experiment 1: Soft iron can be magnetized easily but loses its magnetism in a short time. Steel is harder to magnetize but holds its magnetism for long periods. Some steels hold their magnetism almost indefinitely. Long pieces of iron or steel can be magnetized by using an electric coil. This is done by wrapping insulated bell wire around a steel knitting needle. The wire should be wrapped the full length of the needle. The ends of the wire are then touched for just a few seconds to a dry cell. This will make the needle into a permanent bar magnet.

Experiment 2: Lay another needle on a table and stroke it with the magnetized needle. See diagram at right. Always stroke it in the same direction. Raise the magnetized needle at least two inches on each return stroke. Thus you can magnetize the second needle by using the first one.



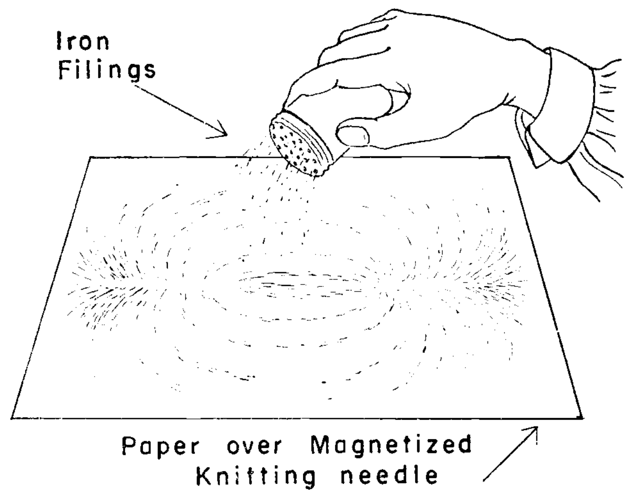
Experiment 3: Take one of the magnetized needles and hang it with a thread. A thread stirrup (see diagram) will help keep it level. Watch the needle. Does it point the same direction as a compass? A compass has a north and south pole. The needle also has a north and south pole. Hold the compass near the north pole; then, near the south pole of the



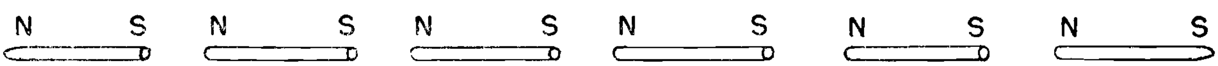
needle. What happens? Does the south pole of the needle attract the north or south pole of the compass? Try it with the second magnetized needle. Do like poles attract or repel (drive away)?

Experiment 4: Break one of the magnetized needles into short lengths. Pliers may be needed. Can you show by using the compass that each piece is a complete magnet—has a north and south pole? Hold one end, then the other of each piece to a compass. Does each piece have both a north pole and a south pole?

Experiment 5: Cover one of the magnets with a piece of paper. Sprinkle iron filings on the paper. Tap the paper and note the pattern formed. Strings or lines of filings pass from one pole of the magnet to the other. The space around a magnet is called the *magnetic field.* This experiment shows there is a magnetic field around your magnet. The filings teach us many things about the magnetic field. The magnetic field is one of the important things in our everyday life with electricity. If it were not



for the magnetic field we would not have electric motors. Telephones, radios, television, and many other things we use every day depend on this magnetic field.



Questions

1. What does magnetism do?..

2. Where are natural magnets obtained?..

3. How can an artificial magnet be made?...

4. What material is needed for a permanent magnet? ....

   For a temporary magnet?...

5. How can you find out which is the north pole of a magnet?...

6. Which magnetic poles attract each other?..

7. How many poles does a magnet have?...

Make a Compass

Each member makes a compass that points to the north magnetic pole.

You have your choice of several types. You may hang a magnetized needle from a thread as in *Experiment 3,* or float your needle on a cork, or balance it on the point of a pin or thumb tack. Your leader has instructions for making several types. Check with him.

When you have made a compass that works, have your leader initial Requirement 5.

Electromagnet

Each member makes an electromagnet that will pick up tacks, paper clips, and other small pieces of iron.

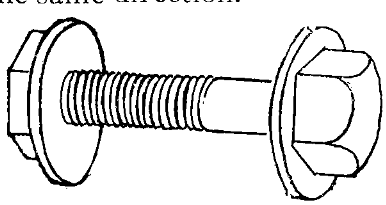
Materials needed

You will need a bolt and nut, about $\frac{1}{4}$ by $1\frac{1}{2}$ inches; enameled magnet wire or insulated bell wire; dry cell.

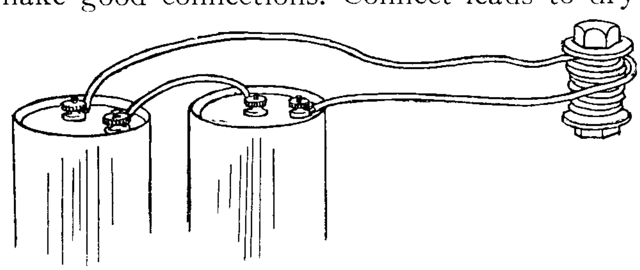
How to do it

Cut two washers from heavy cardboard to fit snugly on your bolt as pictured.

Wrap magnet or bell wire around the bolt until it is nearly full. Wind it neatly and always in the same direction.



Leave about a foot on both ends for leads. Scrape insulation off the ends of lead wires to make good connections. Connect leads to dry



cell and use your electromagnet to pick up tacks, and similar metal pieces.

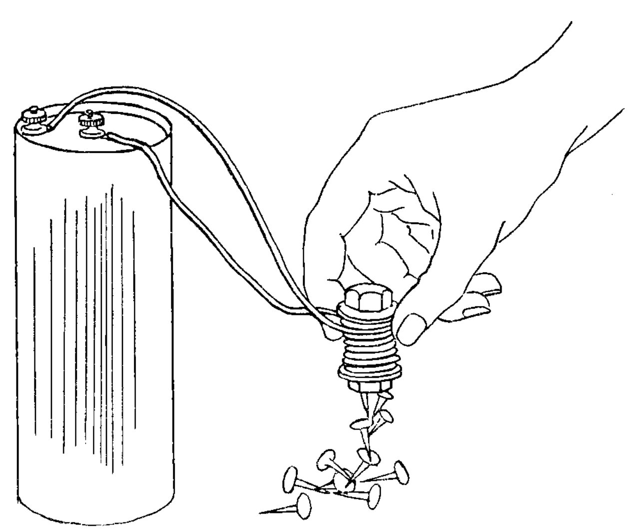
Do not have your electromagnet connected for more than a minute or so. It will weaken your battery very quickly.

You can make your electromagnet more powerful by using two dry cells. Connect them in a series as shown.

How it works

An electromagnet has a core of soft iron surrounded by a coil of wire. An electric current passing through the coil sets up a magnetic field which magnetizes the core. The iron core attracts iron. When the electric current is turned off the soft iron loses its magnetism rapidly.

Electromagnets are important. They are used to change electricity into power (motion).



They are used in motors. Large electromagnets are used to pick up and move pieces of iron. The magnets are on large cranes. The iron is dropped when the electricity is turned off.

Question

1. Can you change the poles on your electromagnet?.................. How? ....

Make a Buzzer

Electric Magic members can work alone or with one or more buddies to make a buzzer, but if you want to include the buzzer in your exhibit, you must make it by yourself.

You may use the following plan, one your leader may have, or others. When you understand how a buzzer works, you can make your own plan.

A buzzer will show how you get power and motion from an electric current.

Materials and tools needed

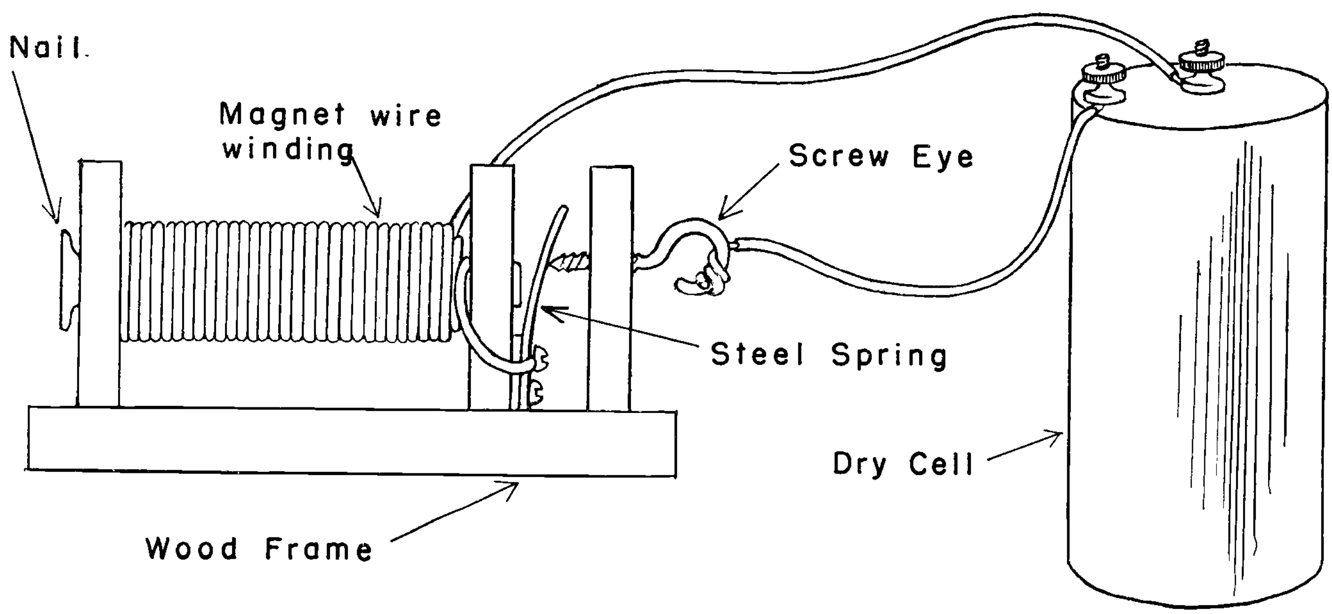
You will need a wood base about 4 by 8 inches; 3 pieces of wood, ½ by 2 by 3 inches; a brass screw eye with a 1-inch shank; a thirtypenny spike; enameled magnet wire or insulated bell wire; a No. 7 wood bit; a hacksaw; small nails; tin snips; 2 round headed screws, ½ inch long; screw driver; thin, flat piece of steel spring or a tin can.

How to do it

Make the buzzer look like the diagram. Cut about an inch from the pointed end of the spike with the hacksaw. The thirtypenny spike is seven-sixteenths of an inch in diameter. Use the No. 7 wood bit to drill holes for the spike. Push the spike through the hole in one piece of wood, then wrap the spike with magnet wire It is much easier to wind the coil before the spike is secured in place. Leave room for the second piece of wood at the small end. About four layers of winding should be enough.

If a steel spring is used, it will be necessary to drill holes through the spring for the screws. If a piece of tin from a can is used, the holes can be punched with a nail though drilling will do a neater job. If tin is used, it should be about one quarter inch wide.

The screw eye should not be mounted directly in line with the iron core or spike. It should be to one side as shown. A brass screw eye is best, an iron screw will work but it may become magnetized and interfere with the operation of the buzzer. Wire your buzzer so the path of the electric current will flow from the battery through the winding of the coil of the electromagnet, through the spring, through the screw eye, and back to the battery.



How the buzzer works

When the circuit is closed the current flows through the electromagnet which pulls the spring toward the end of the spike or iron core. When it leaves the screw eye, the electric eye is broken. When no current flows there is no magnet, so the spring bounces back to make contact with the screw eye. This closes the circuit making the operation repeat itself. It does this rapidly causing the spring to bounce back and forth making the buzzing sound. That is why it is called a buzzer.

It may be necessary to do a little adjusting to get your buzzer to work properly. Turn the screw eye in or out or adjust the spring.

You can use your buzzer in one of the games you will make later or to send signals in code.

Questions

1. Explain in your own words how your buzzer works. ....

....

....

2. Why is enameled magnet wire preferred for electromagnets and motors rather than rubber or plastic insulated bell wire? ....

....

....

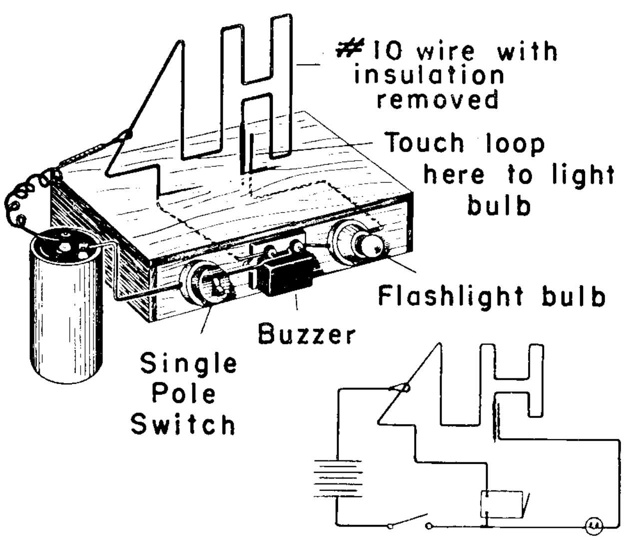
3. How many places in your home do you have electromagnets? .... Name some of them.

....

....

Games and Gadgets

You may build a steady hand tester, a quiz board, or some other electrical game or gadget. This job may be done in cooperation with other club members but if you exhibit the game or gadget, it should be made by yourself. Make several if you wish.

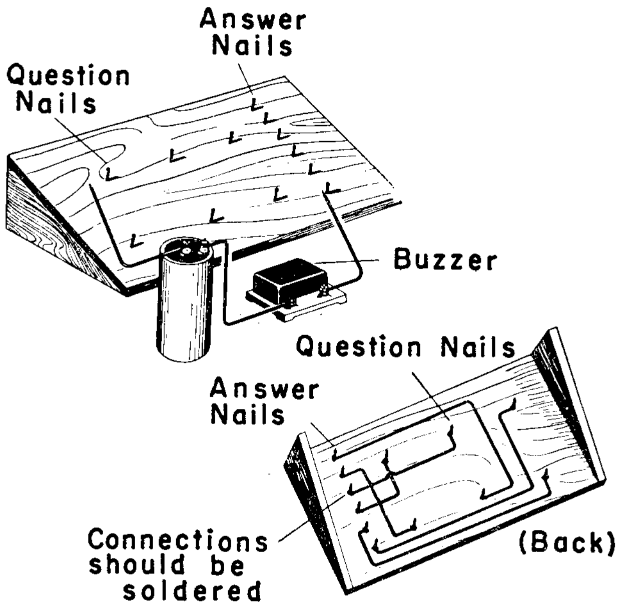


A steady hand tester

Is your hand steady? A steady hand tester is easy to make and can be entertaining. If you are successful in moving the loop from the beginning of the "4" to the end of the "H," the bulb will light. A buzzer will sound if you touch the "4-H."

To make a steady hand tester you need a single pole switch, a buzzer, a flashlight bulb and socket, a battery, some bell wire, some No. 10 or larger wire to make the "4-H," and some lumber. You have already learned how to make a switch, light bulb socket, and a buzzer. If you wish, you can paint the light green and use a red light in place of the buzzer.

The "4-H" is made from the heavy wire with all insulation removed. Drill holes in the top of the box. Mount the "4-H" through these holes and fasten securely. Use bell wire to connect one end of the "4-H" to the buzzer. The other terminal of the buzzer is connected through the switch to the battery. The end of the "H" leg is taped to keep the wire leading to the signal light from touching the "4-H" wire.



One side of the light is connected to the wire extending up beside the leg of the "H." The other side of the light is connected through the switch to the battery. Use one terminal of the buzzer as a common connector for the buzzer and the light.

The loop is made from bell wire. To make a handle for the loop, split a wooden pencil, run the wire through between the two pieces of wood, then tape the pencil together again. Be sure the wire from the loop to the battery is long enough to reach all parts of the "4-H" easily.

The steady hand tester can be fun at meetings and can be used at fairs.

A quiz board

You can make an interesting quiz board with a few materials and a little imagination. You will need a battery, a doorbell buzzer, a dozen small finishing nails, bell wire, and some light lumber. You can use the buzzer you have made, or you can use a flashlight bulb in place of the buzzer and make the socket yourself.

Each of the six question nails at the left are wired to answer nails on the right of the board. The battery buzzer circuit is completed when one wire from the battery is touched to a question nail and the other wire to the correct answer nail. The question and answer nails are connected on the back of the board.

You can make a larger quiz board and you can make it any shape you wish.

Choose any subject for a quiz sheet. The quiz sheet is made from light cardboard or heavy paper, the same size as the quiz board. Punch holes at the right locations for the nails to stick through.

If your subject is birds, cut out small bird pictures. Cut out the names of the birds too. Paste the picture of a bird on the quiz sheet above one of the holes for a question nail. Paste the name of the bird beside the hole for the answer nail. Do the same for each picture and name. Be careful to match questions and answers to nails that are wired together.

Fit the quiz sheet on the quiz board. You are ready to check your friends on how well they know birds.

When they touch the nail under a bird with one lead wire and the nail beside the correct name with the other wire the buzzer sounds, or the light lights.

You can make extra quiz sheets on insects, animals, trees, cars, flowers.

Other games and gadgets

Any game or gadget that uses low voltage electricity or magnets will qualify for a game or gadget. You may use plans from other sources or you can invent your own. Your game or gadget should be interesting, show how electricity works, and should be well made. Make it neat and attractive. If it is to be your electric magic exhibit, it must be less than 18 inches long, 12 inches wide, and 18 inches high.

Electric Magic Exhibit

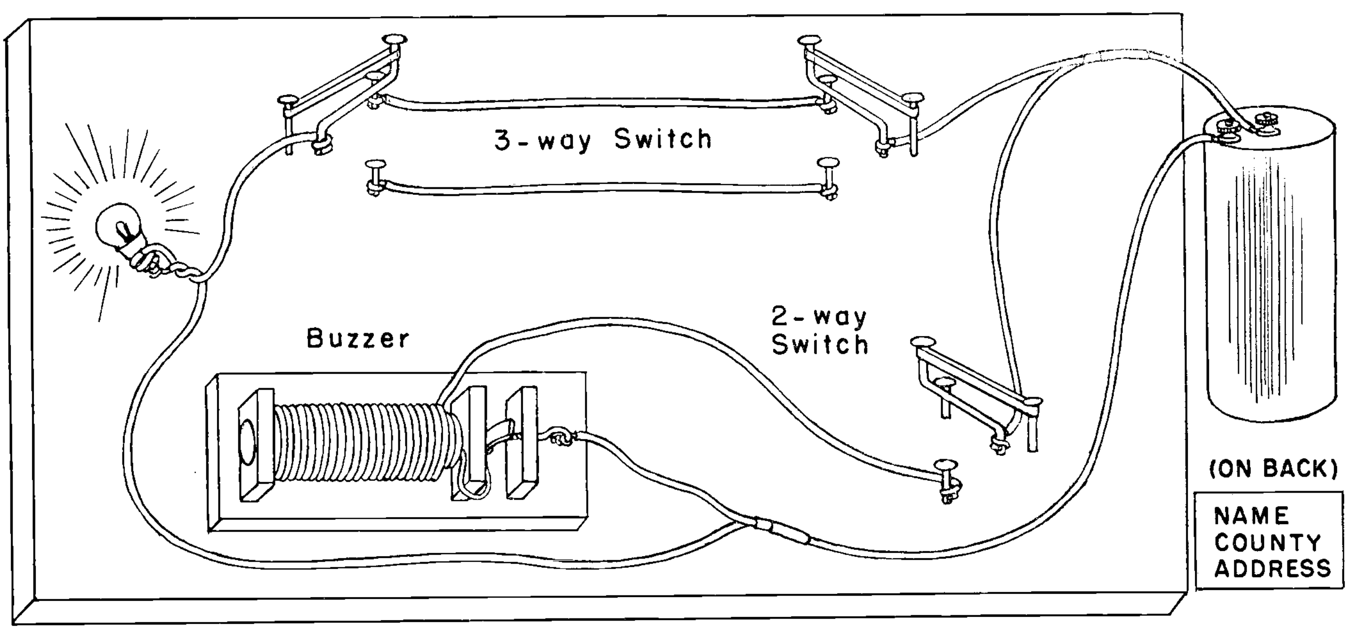
When you have completed all of the requirements of this project, you may exhibit at your 4-H community or county fair some of the things you have made. You have your choice of exhibiting:

1. An electrical game or gadget that you have made or
2. A switchboard which should include a two-way switch, two three-way switches that control one light and may include other switches, buzzers, motors, etc., you have made.

The total size of your exhibit may not be more than 24 inches long, 12 inches wide, and 18 inches high. All of the articles included in your exhibit must be things you have made by yourself.

Your exhibit may or may not include an electric battery, but it should be set up so it will work when a battery is attached. Labels and instructions should be attached to show how and why it works.

The exhibit will be judged on appearance (25), workmanship (25), how well it works (25), and what it shows or teaches (25) points.



Summary

In this first-year 4-H electricity project, you have learned many things about electricity. You have learned how switches work and how electricity flows in a circuit; how electricity makes light and heat; how electrical energy can be transformed into mechanical power; the strength of electricity and some of the many things it can do to make our lives more enjoyable; and that electricity can be dangerous.

In advanced 4-H electricity projects, you can learn more about electricity and its use. Fun With Low Volts is the next division. You continue to work with safe, low voltage electricity. When you are 12 or older, you can take Let Electricity Do It. In this division you learn about (ac) alternating current and how to use it in your home, shop, or farm. You make a lamp and learn about lighting. You can make electrical equipment to use in your home, shop, or on your farm.