ALTERNATIVE ENERGY SOURCES

Experiments You Can Do

. . . from Edison

THOMAS ALVA EDISON SCIENCE EDUCATION SERIES

Science is a way of knowing about, understanding, interacting with, and appreciating the world around us. Science learning begins by probing, questioning, and discovering the wonders of the world in which we live.

The Thomas Alva Edison Science Education Series uses a "hands-on, minds-on" approach to help students use knowledge and skills obtained through activity-centered experiences to understand the past, present, and the future sources and uses of energy within the natural and social systems of our environment.

This Science Education Series will strengthen any science program by providing students with current information about science exploration and discovery. By developing an understanding of how persons relate to natural systems, the Edison Science Education Series will help students to discover how they can become energy literate and be effective managers of the natural environment in which they live.

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ALTERNATIVE ENERGY SOURCES

Experiments You Can Do . . . from Edison

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Edison Electric Institute gratefully acknowledges the Thomas Alva Edison Foundation as the creator of the first Edison experiments books. We at EEI are pleased to continue the Foundation's fine tradition of offering this service to the young people of America.

TO THE YOUNG PEOPLE OF AMERICA

A challenge unique in the history of our nation faces today's youth. The future well being of all citizens — particularly that of the young — depends upon our individual and collective abilities to make better use of existing sources of energy and to develop alternative sources. The problems involved are both immediate and long-range. Therefore, many of the solutions inevitably will have to come from the scientists and engineers of tomorrow . . . the youth of today.

The Edison Electric Institute, in cooperation with the investor-owned electric utilities all over America, is pleased to offer you this hands-on activity book. It is my hope that the experiments herein will spark greater interest and achievement in the areas of energy conservation and utilization. If so, then they will have indeed served a vital and lasting purpose.

As each of you thinks about a career, I urge you to consider science and engineering as rewarding paths to follow. They offer unlimited opportunities for both personal advancement and satisfaction.

Thomas R. Kuhn
President
Edison Electric Institute

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WHERE WILL TOMORROW'S ENERGY COME FROM?

Many concerned people are asking this question today . . . with good reason. Two of our most important sources of energy, oil and natural gas, are in short supply. We must find new sources of energy that can serve our needs in the years ahead.

The search for alternative energy sources is a worldwide effort. Scientists working in industry, at universities, and in government research laboratories are trying to unlock new supplies of energy. For although our planet has abundant reserves of energy, enough to last for countless years, much of this untapped energy is locked away beyond our present reach.

But we're learning more about alternative energy sources every day. In the not-too-distant future, scientists will probably discover practical and economical ways to employ these different forms of energy.

The eight experiments in this booklet will introduce you to several of the more promising alternative energy sources. A few of these include sunlight, wind, and geothermal energy. At the beginning of each experiment, you'll find a brief introductory section that discusses the promises and problems of the particular energy source. Be sure to read it before you begin the experiment.

Good Luck.

SOLAR ENERGY

Scientists estimate that the sunlight falling on the United States during a single summer day contains twice as much energy as our nation uses in an entire year! The problem is how to collect this "free" energy in an efficient, economical manner.

The two experiments that follow demonstrate two direct methods of capturing solar energy. In other words, these methods transform *sunlight itself* into useable forms of energy: heat (Experiment 1) and electricity (Experiment 2).

However, energy from the sun can also be collected indirectly. For example, "windmills" (Experiment 3) and ocean thermal energy systems (Experiment 4) convert the *effects of sunlight* into energy. The effects are wind and warm water. Sunlight provides the heat that makes the wind blow and warms the top layers of ocean waters.

Solar energy has many advantages:

- It is a clean, inexhaustible source of energy that will last as long as the sun itself.
- It is available in our own country. We don't have to "import" sunlight.
- In remote areas it is more practical and less costly than stringing transmission lines.

But solar energy also has serious disadvantages:

- Solar energy "turns off" at night and during cloudy weather.
- Solar energy is at its weakest during the winter months, when homes and factories need energy the most.
- It is expensive.

However, the potential benefits of solar energy outweigh its shortcomings. And major research programs are underway all over the world to make solar energy practical.

EXPERIMENT 1

A Model Solar Hot Water Heater

THINGS YOU NEED: About 10' of flexible black tubing. A shallow cardboard or wood box about 12" by 18". Flat black paint, paper, or cloth for the inside of the box. A piece of window glass to cover the box. Spring-type wooden clothespins. Tape. Two empty cans or buckets.

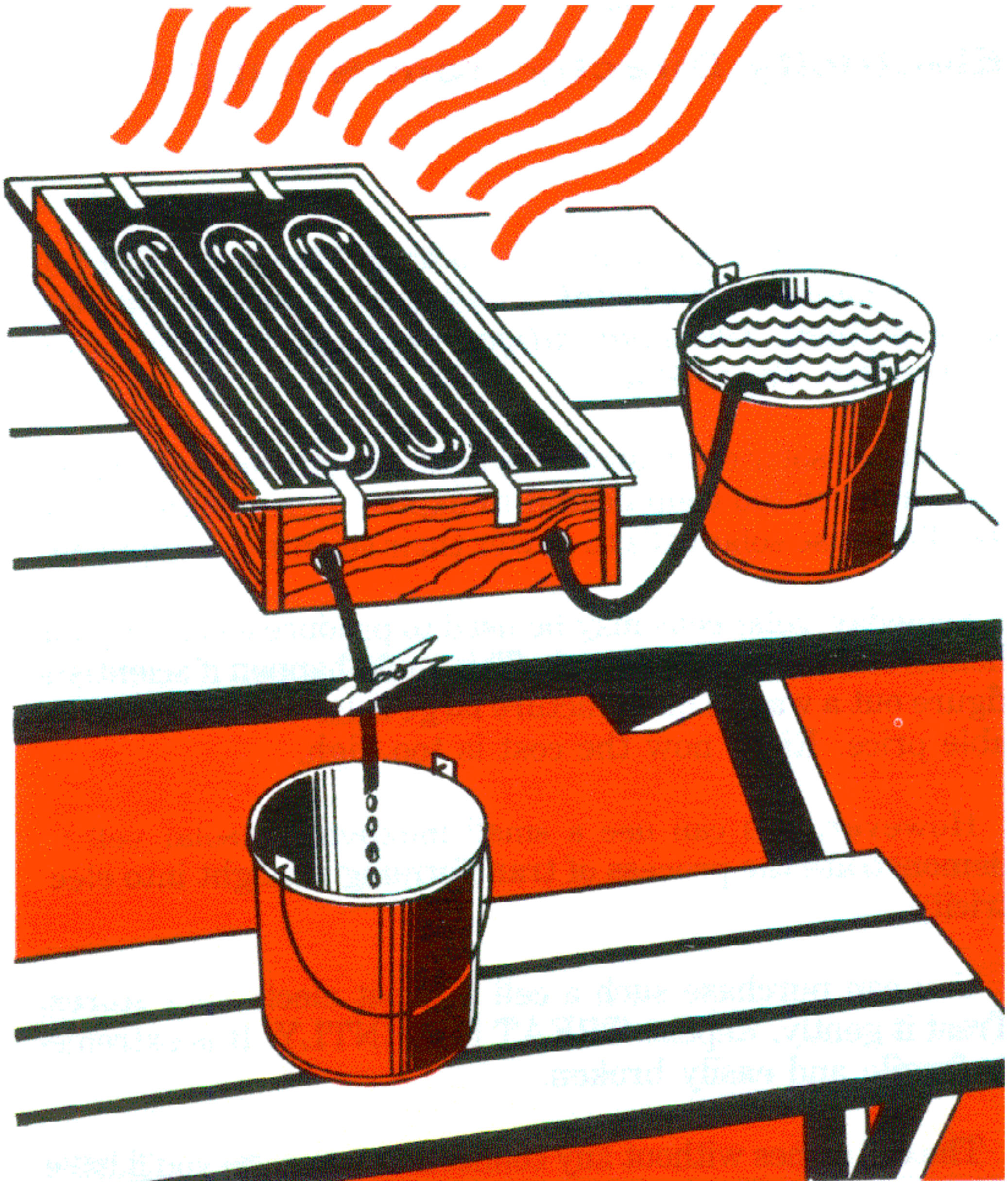
This experiment will help you understand how solar hot water heaters operate. Many people around the country are installing such systems in their homes. Perhaps someone in your neighborhood has done so.

The heart of a solar hot water heater is a device called a collector. It collects, or captures, solar energy and uses that energy to heat water. In a real solar hot water heater installation, the collector is large and is mounted on the roof of the house. The collector must be aimed toward the south so that it collects the maximum possible amount of sunlight during each day.

You can easily build a model solar energy collector. Start by covering the inside of the box with black paint, paper, cloth, or other dark material. Then loop the tubing back and forth inside the box. Arrange for both ends of the tubing to be sticking out of the sides of the box a couple of feet.

Next, place the glass cover on the box and secure it with tape. We're now ready for a test.

Wait for a sunny day and find an open area. Place the collector on a stand, with a can or bucket of water next to the collector. Put one of the tubing ends into the water. Suck gently on the other end to establish a siphon action. Once water starts to flow through the tubing, pinch the tubing partially with the clothespin to limit the flow of water to a small trickle.



Notice that after a while, the water trickling from the tubing will be warmer than the water siphoning into the collector. Why? You're right. Solar energy absorbed by the tubing is transferred to the water, thereby heating the water.

How warm the water gets will depend mostly on the time of year, how clear the skies are, and how slowly the water flows through the collector.

EXPERIMENT 2
Electricity Directly from Sunlight

THINGS YOU NEED: Silicon solar cell (see text). Block of wood. Compass. Cardboard. Small spool of magnet wire (#28 wire or finer). Two small alligator clamps. Soldering iron and solder. Tape. Glue.

A silicon solar cell transforms light directly into electricity (in a manner too complicated to explain here). Many space satellites use solar cells to power their scientific equipment.

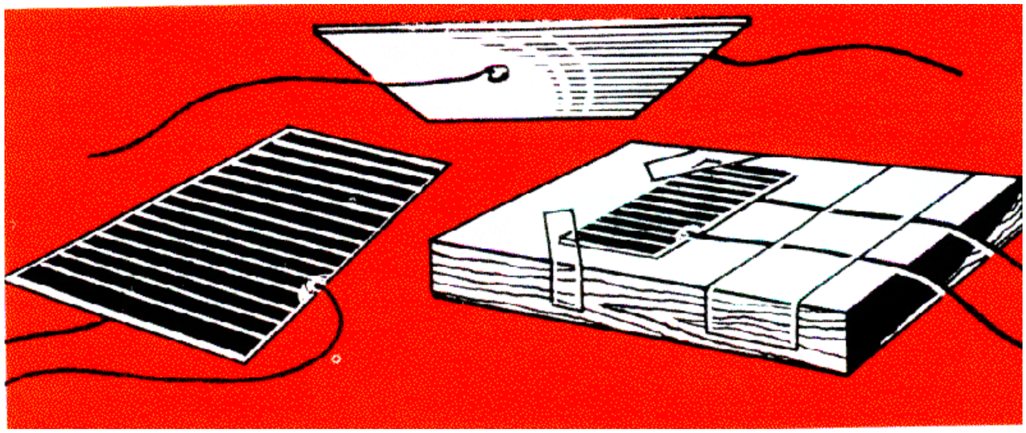
Someday, solar cells may be used to produce electricity for homes and factories on earth. This could happen if scientists figure out a way to manufacture large solar cells at a reasonable price. Right now the cost is too high.

However, you can use a small inexpensive solar cell to demonstrate the process of transforming sunlight into electricity.

You can purchase such a cell at most electronics stores. Treat it gently. Repeat: TREAT IT GENTLY. It is extremely fragile and easily broken.

The cell comes without any connecting wires. So you'll have to make a pair. Do this with two lengths of the magnet wire. Each connecting wire should be about 12" long. Carefully scrape ½" of the enamel insulation from both ends of both wires.

Now for the tricky part: Lay the solar cell on something soft, like an old towel. Solder one of the wires to the silver edge on the front of the cell. Do this very carefully. Then solder the other wire to the silver surface anywhere on the back of the cell.

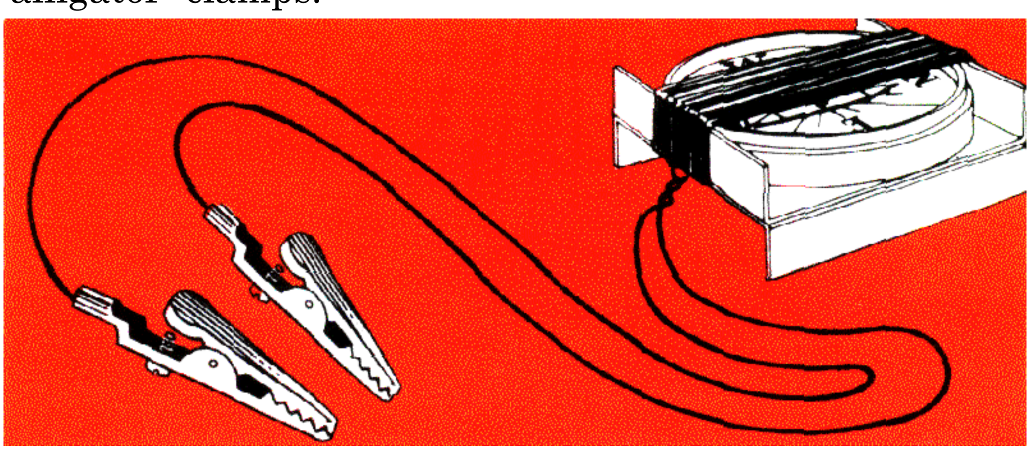


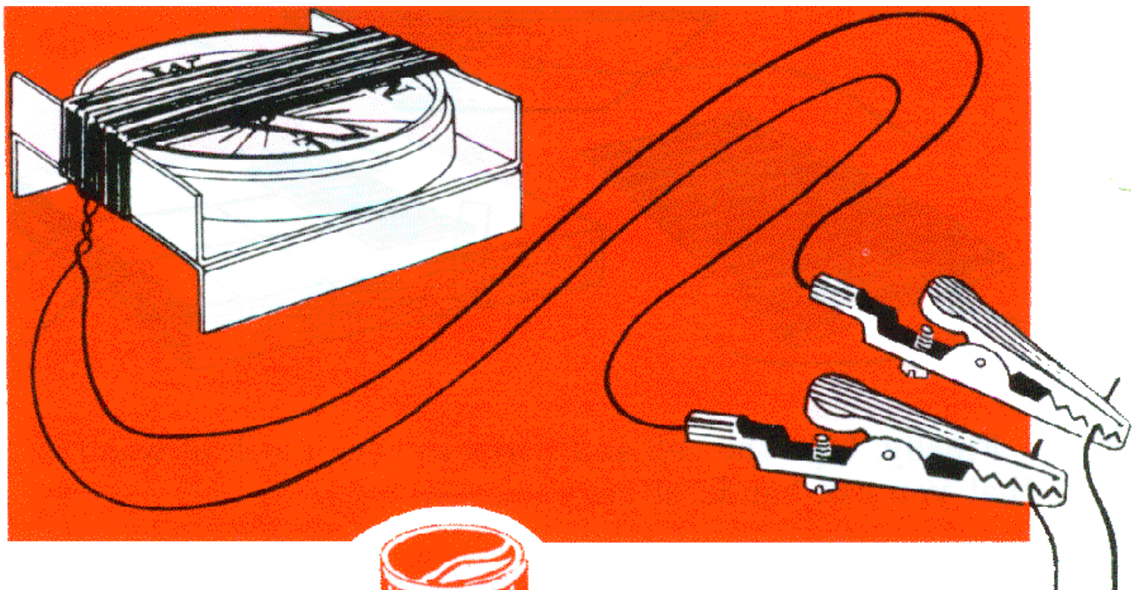
Finally, tape the cell and wires to your block of wood so that you can handle it conveniently.

Now set the cell aside. It's time to build a simple but very sensitive device – a galvanometer – to show that the cell can actually produce electricity. Making one is easy.

Cut and fold two pieces of cardboard and glue them back-to-back as shown in the drawing. Lay the compass inside this little "stand" so that the N and S markings are against the folded-up sides. Then wind about 100 turns of magnet wire around the compass and stand. Run the wires over the N-S markings, keeping them close to the center.

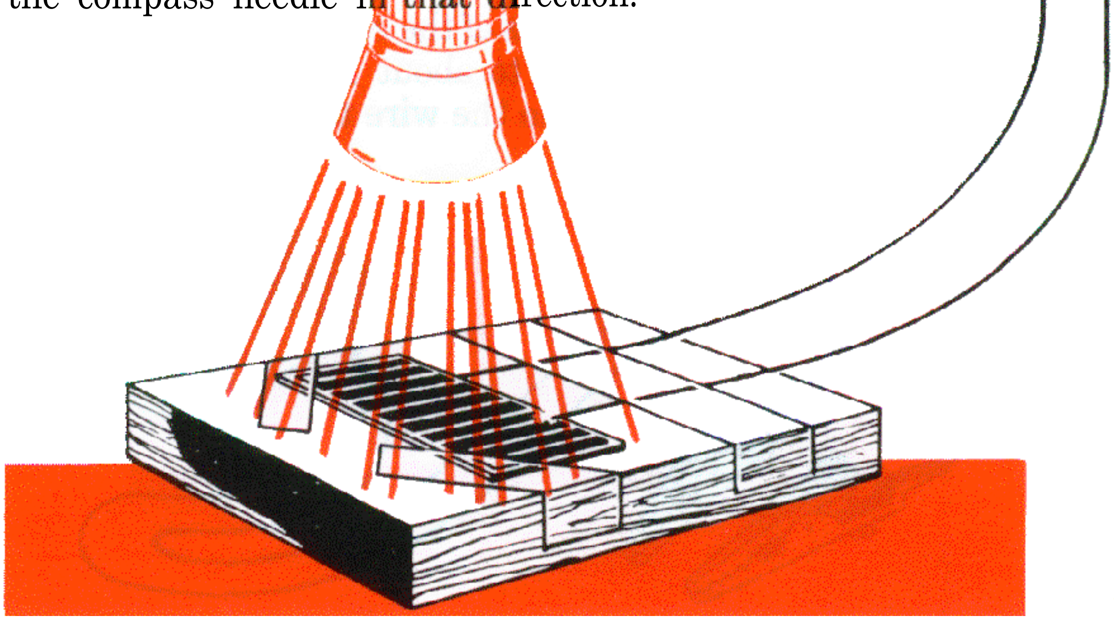
When finished, twist the ends of the coil to keep them from unwinding. Trim these ends to about 12" in length. Then scrape ½" of the enamel from the wire tips, and install the alligator clamps.





Next, connect the silicon solar cell and the galvanometer as shown. Arrange the compass so that the coil lines up with the needle.

When you expose the solar cell to light (either sunlight or the light from a flashlight or table lamp), the compass needle will move. Here's why: The electric current produced by the solar cell flows through the coil and produces a weak magnetic field in the E-W direction. This magnetic field tries to pull the compass needle in that direction.



WIND ENERGY

Wind energy is really an offshoot of solar energy. Winds occur when different parts of the earth receive different amounts of energy from the sun.

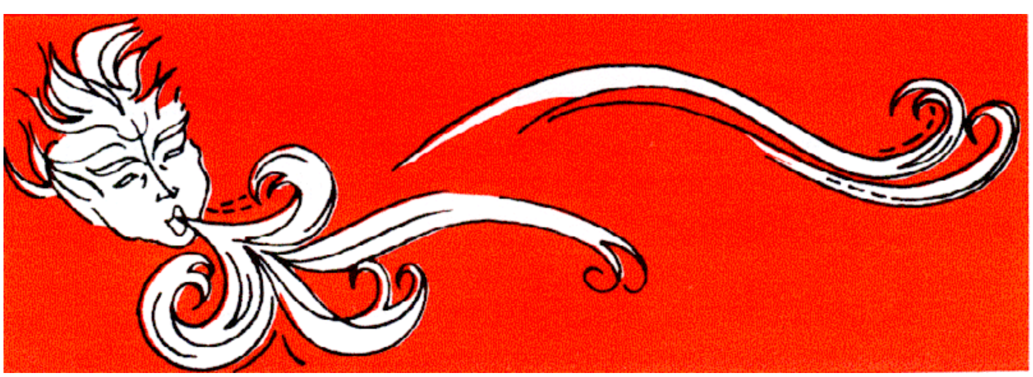
Today, many scientists feel that "windmills" designed to generate electricity can help meet future energy needs. Some say that homes will eventually have their own windmill generators.

Actually, the idea of harnessing wind energy is quite old. Wind was used many centuries ago to propel ships and to grind grain. American farmers pumped water with windmills in the 1920s and '30s.

Although wind energy is clean and appears to be free, there are many problems to be solved:

- The wind-powered generators available today are expensive.
- They are large.
- They don't generate electricity unless the wind is blowing, obviously.
- It is costly to store excess energy – that is, energy generated, but not immediately needed.

For these reasons, experts believe that wind generators will be useful only in limited situations.



EXPERIMENT 3

Converting Wind Energy into Electricity

THINGS YOU NEED: Model airplane propeller about 6" long. Two nails 1" long. Two nails 3" long. Four small nails. Small bar magnet 1" long. Two metals strips 1½" by 4", cut from a tin can. Magnet wire from Experiment 2. Germanium diode type 1N34A (most electronics stores carry this inexpensive part). Tape. Glue. Soldering iron and solder. Wood block about 3½" by 5". The galvanometer you made in Experiment 2.

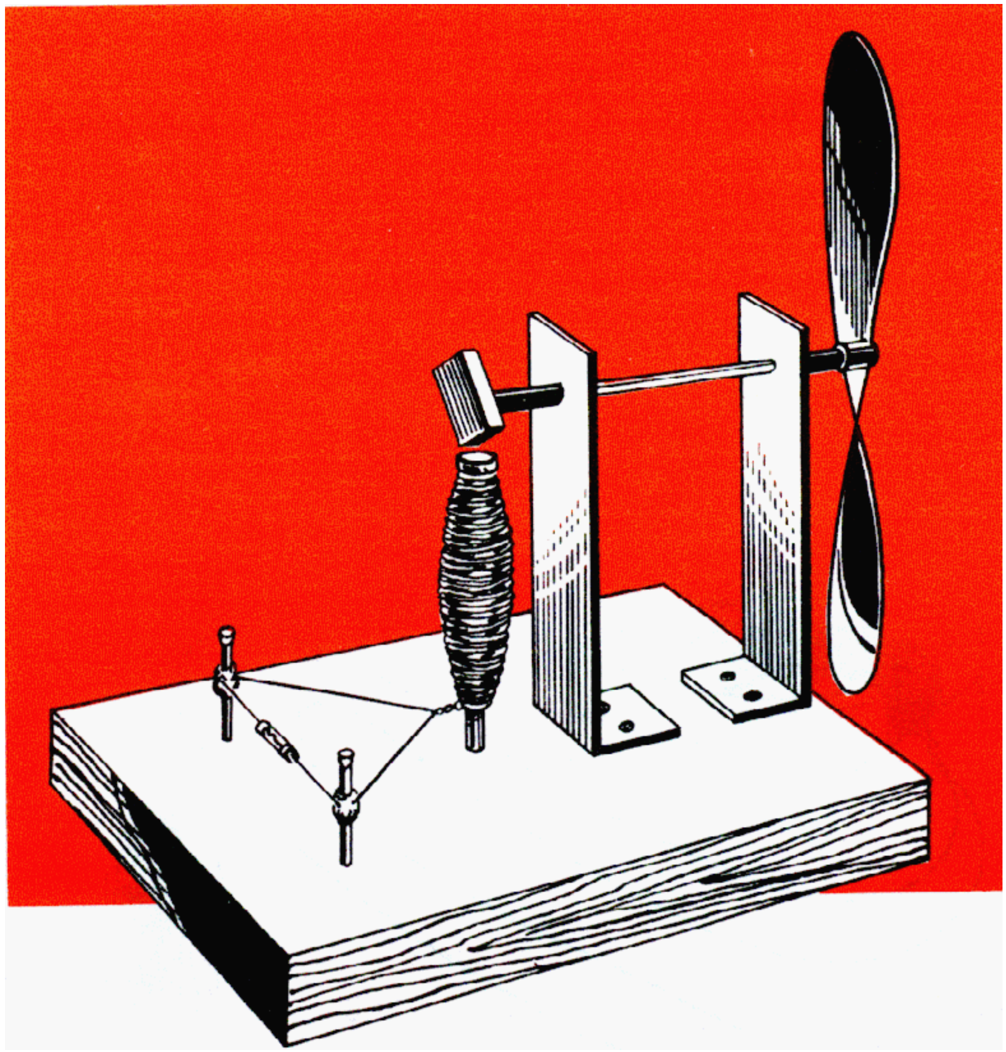
The model wind generator you're going to make works much like the new "wind turbines" for generating electricity. When the propeller spins, the magnet whizzing past the nail head generates a tiny alternating current (AC) in the coil around the nail. The small germanium diode connected across the two nail terminals converts the AC into DC (direct current), which is what we need in this experiment.

To make the wind generator, begin by wrapping 1000 turns of magnet wire around one of the large nails. The coil should be 2" long, measured from the head end. Leave a few inches of wire for connections. Twist them so they won't unravel.

Drive this nail into the center of the wood block. Also drive in the two smaller nails where shown.

After scraping the enamel insulation off the ends of the coil wires, wrap the bared ends around the nail heads. Then hook the diode across the nails, and make all connections secure by soldering.

Next, glue the bar magnet to the head of the other large nail. Be sure the magnet is centered on the head and the glue is given plenty of time to set. This will be our propeller shaft.



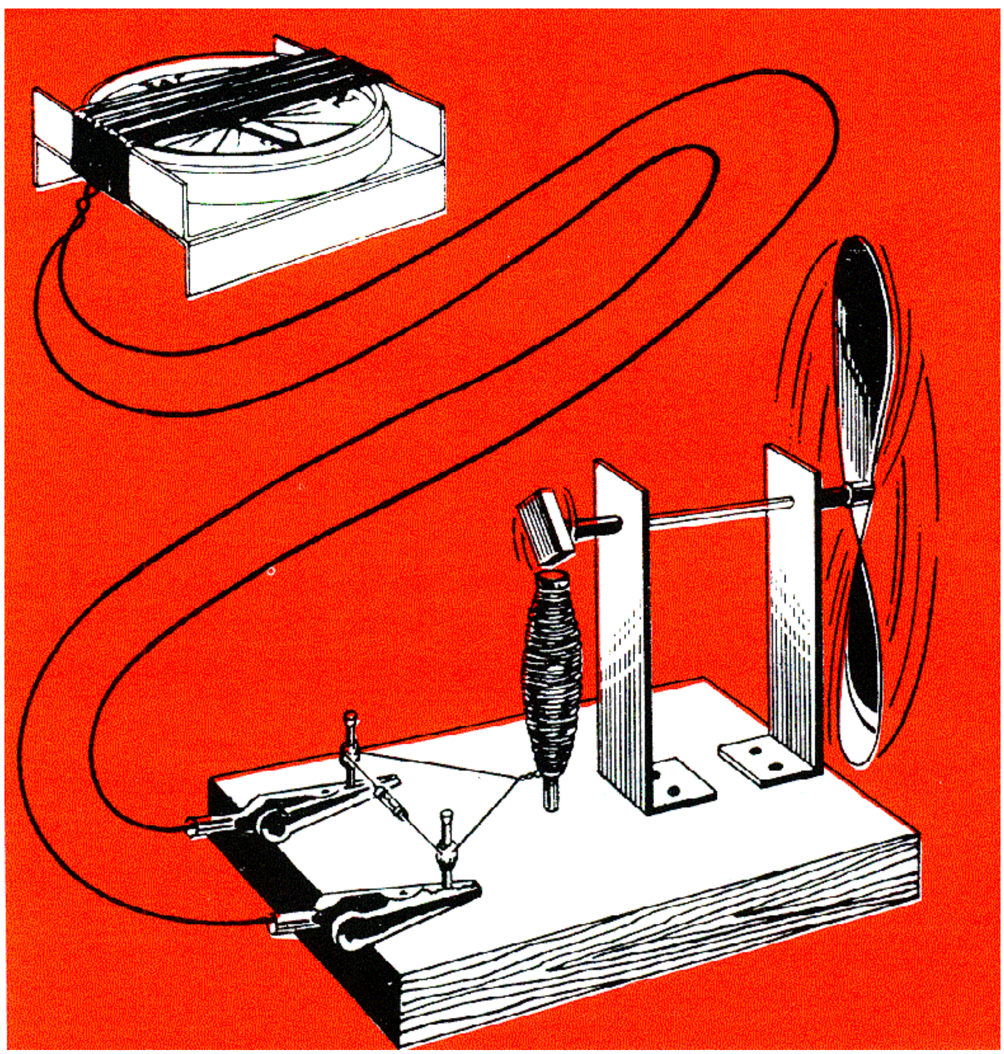
The shaft is supported by the two tin-can strips. Fold them in half lengthwise for added stiffness. Then bend about ¾" for the base. Nail them to the wood block, in line with the upright nail.

You'll have to decide how high the shaft holes should be. Locate the holes so the magnet ends are close to the upright nail head yet do not prevent the shaft from spinning freely.

Insert the shaft in the supports till the magnet is directly over the nail head. Two collars of electrical tape will keep the shaft in place. Finally, drill a hole in the propeller so that it fits snuggly on the nail.

Now for the test. Connect the galvanometer's alligator clamps to the two nail terminals. Keep the compass about a foot away from the magnet. Again, as in Experiment 2, have the galvanometer coil lined up with the compass needle.

Set the generator in the wind or in front of a fan. (Or wrap a couple feet of string around the shaft and pull upward, like trying to start a power lawn mower.) When the shaft turns, you'll see the compass needle deflect. This demonstrates that electricity can be produced from the wind.



OCEAN THERMAL ENERGY CONVERSION

Sunlight warms the top layers of the ocean. In some parts of the world, surface water temperature is 80°F or higher.

But the lower layers of water, hundreds of feet below the surface, are untouched by the sun's rays. Water at such depths usually has a temperature of about 40°F.

This difference in temperature can be used to drive a turbine-generator power plant. Here's how the process works, in simplified form: Let's say the power plant uses ammonia as the working medium (this is not the same as household "ammonia," which is really ammonium hydroxide). The process begins with the ammonia in liquid form, at a temperature of 40°F. (See diagram on page 16.)

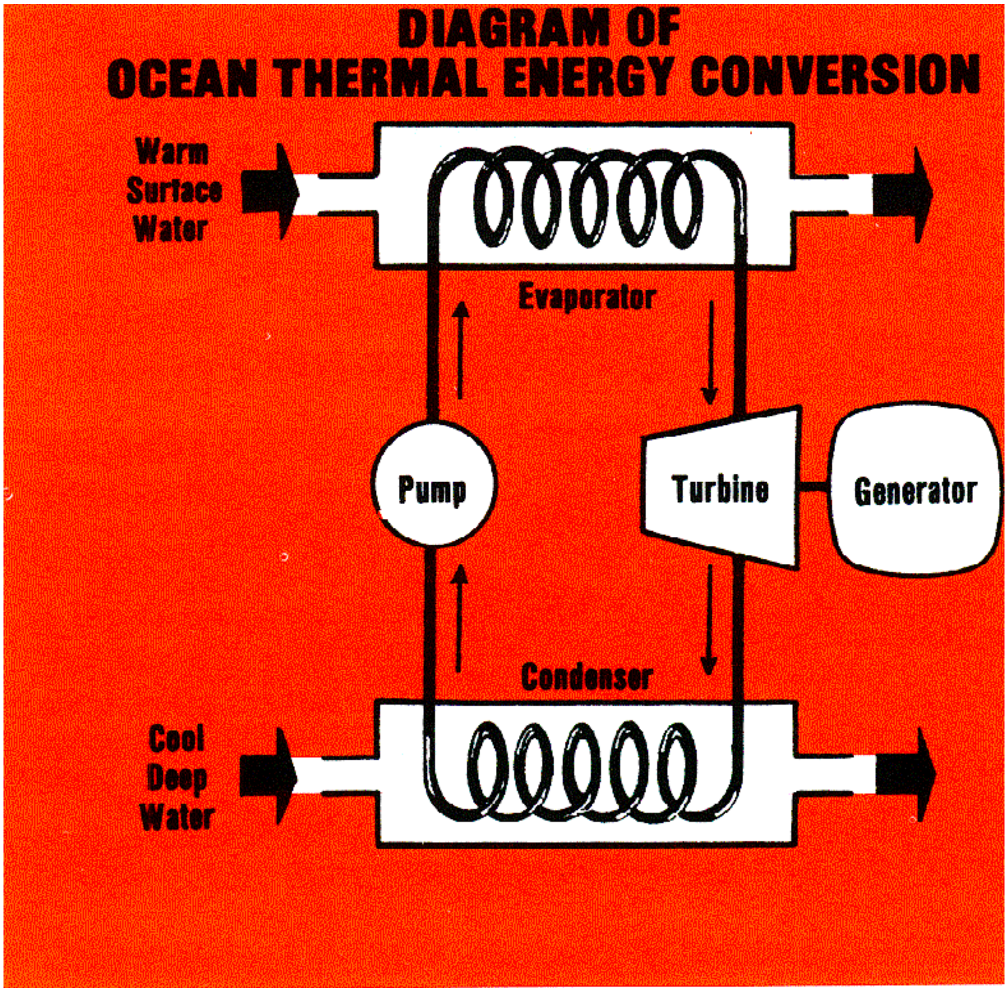
1. Warm seawater at the surface heats the liquid ammonia in the evaporator to a temperature of 80°F. This heating turns the ammonia into an expanding gas.

2. The expanding gas rushes through the turbine, making it spin. Since the turbine is connected to an electric generator, the generator also spins, thus producing electricity.

3. Cool seawater, from the deep, chills the ammonia gas in the condenser and turns it back into a liquid. The liquid ammonia is then pumped back to the surface.

4. Same as step 1 . . . the cycle starts all over again.

Although this process could generate much electricity, building a large ocean thermal energy conversion plant would be very difficult and expensive. Still, the concept holds promise in the warm parts of the world.



EXPERIMENT 4

The Idea Behind Ocean Thermal Energy Conversion

THINGS YOU NEED: An empty narrow-mouth plastic bottle. A balloon. A bucket filled with hot water. Another bucket filled with cold water.

This simple experiment uses air as the working medium to demonstrate the principle on which ocean thermal energy conversion is based. Here's what you do:

Put the empty bottle and balloon in your refrigerator. Leave them there for at least one hour. They both must be cold.

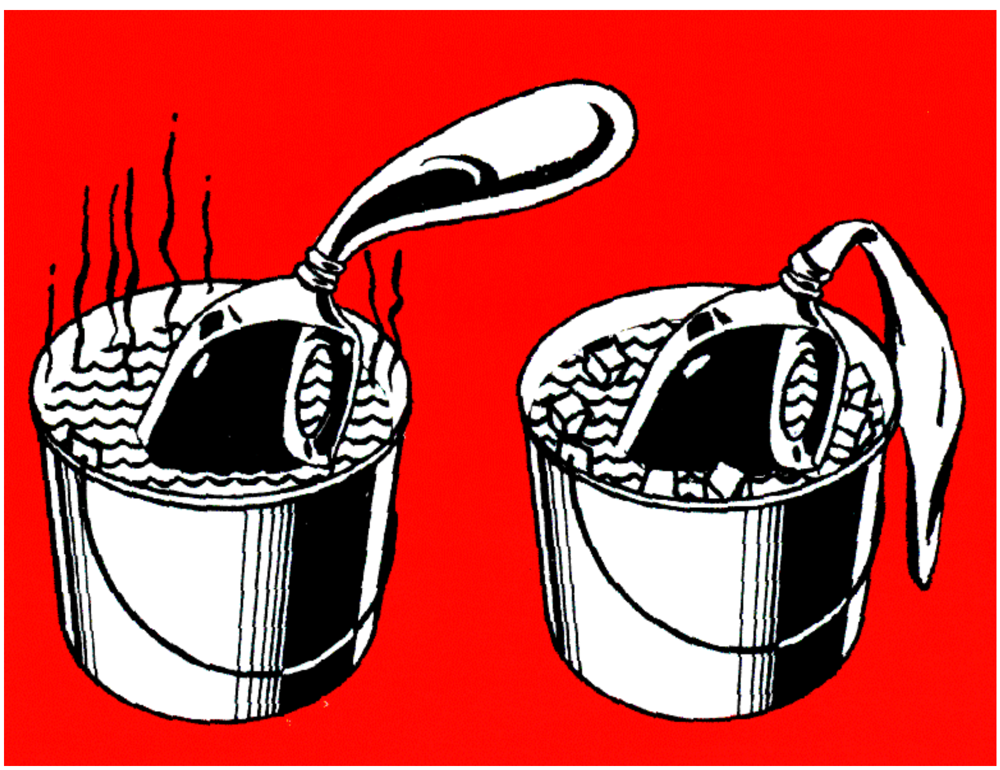
Before removing the bottle and balloon from the refrigerator, prepare the buckets of hot and cold water. Add a handful of ice cubes to the cold water to make it colder.

Taking the balloon in your hand, squeeze it to drive out any air it may contain. Then quickly slip the neck of the balloon over the mouth of the cold bottle.

Immerse the bottle in the hot water (it's okay if the balloon is in the water too). In a few minutes, you'll see the limp balloon begin to inflate.

When the inflation stops, immerse the bottle in the cold water. The balloon will slowly shrink and become limp again.

Repeat the hot and cold immersion steps.



This experiment shows that heated water expands a working medium (the air inside the bottle) and makes it do "work" (blow up the balloon slightly). Cold water restores the medium to its original volume so that it can work again when reheated.

The experiment also demonstrates the principle of operation of a real ocean thermal energy conversion system: The heated liquid turns into an expanding gas, which "works" by turning the turbine. When cooled, the gas condenses back into a liquid, shrinking in volume.

TIDAL ENERGY

In some parts of the world, it's possible to harness the ocean's tides to make electricity. The idea is simple: First, build a dam across a bay. Then use the water that "piles up" against the dam to turn electric generators.

During high tide, the water builds up on the ocean side of the dam. It is allowed to flow into the bay by passing through turbines that turn electric generators.

During low tides, things are reversed. Now, the water trapped on the land side of the dam again passes through the turbines as it flows back to the ocean.

Two tidal energy conversion plants have been built overseas. They prove that the idea works. But not all bays are suitable for this kind of energy conversion process. In fact, there are only about a dozen places in the United States where this kind of power plant could be built. The tides must be high enough to create a worthwhile difference in water height. And the bay must be narrow enough for a practical dam to be built.

ENERGY FROM TRASH

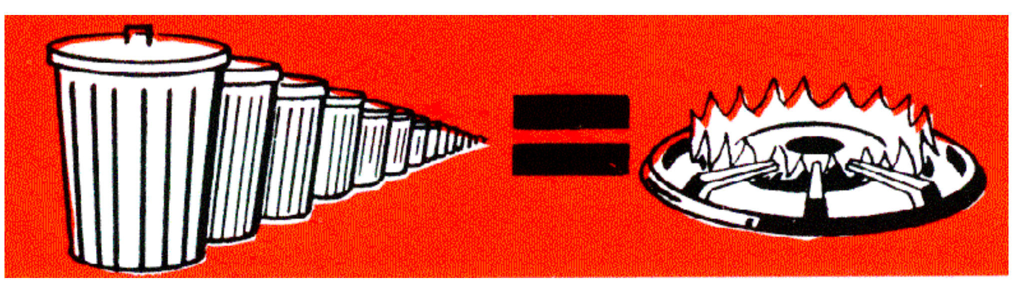
Turn trash into energy? Yes indeed. Many cities across the United States are doing just that. The idea makes good sense.

After you perform Experiment 5, you will see that much of the waste we discard every day can be burned to produce heat. In turn, this heat can be used to generate electricity in a power plant.

But combustible materials are only part of the story. We also discard organic wastes (such as food scraps) that can be transformed into methane gas, the chief component of natural gas. In this way, our garbage can help supplement America's natural gas supply.

According to the U.S. Environmental Protection Agency, over 6 billion tons of waste of all kinds are produced in America each year. Now a large portion of this mind-boggling heap contains recoverable energy that never gets recovered. That's a lot of energy going to waste . . . in waste.

As you might expect, converting waste products into energy is an expensive process, particularly when it is done on a large scale. However, waste conversion kills two birds with one stone: First, it provides us with needed energy. Second, it helps us dispose of waste materials. For both of these reasons, many experts predict that waste conversion will become very popular in the years ahead.



EXPERIMENT 5

Turning Trash into Useable Energy

THINGS YOU NEED: Household trash (see text). A shallow baking dish. Aluminum foil.

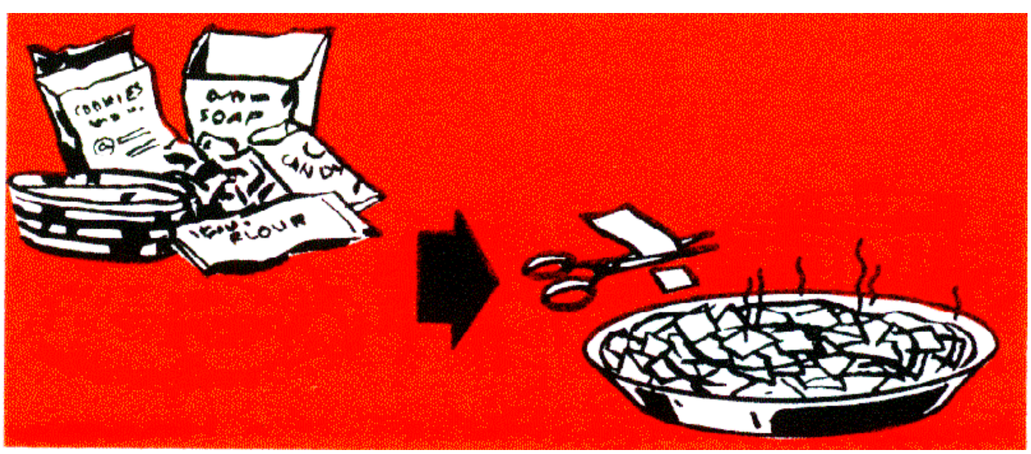
As we said earlier, many of the things we throw away every day can be burned to produce heat. They are a source of energy. This simple experiment proves the point. It shows one way of converting trash into fire fuel.

The first step is to put on a pair of gloves and rummage through your trash cans. Look for paper or cardboard items (that aren't too dirty or messy). For example:

- Can labels
- Cardboard boxes
- Paper cups or plates
- Toilet tissue wrappers
- Paper towels
- Flour or sugar bags

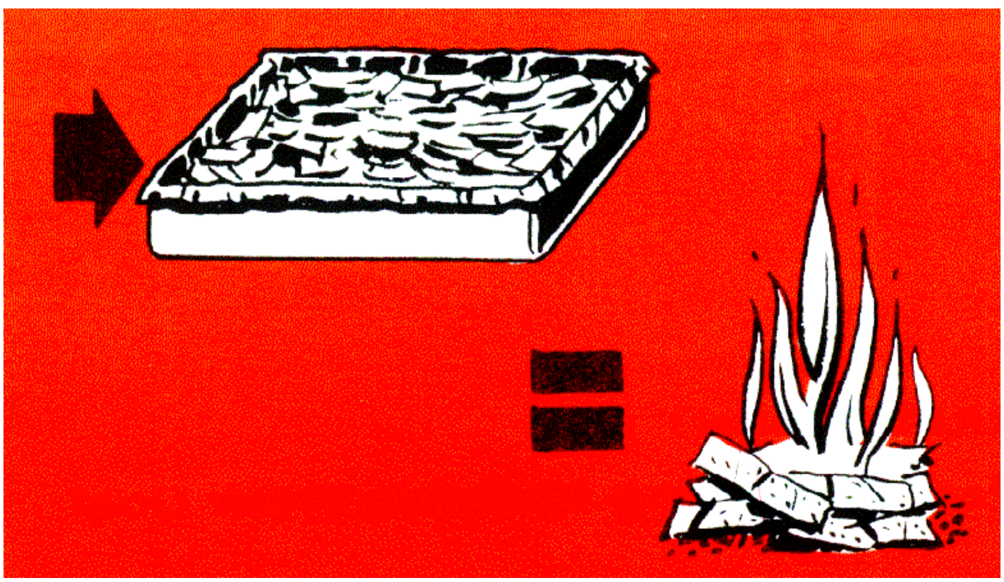
You get the idea . . . the list can go on and on.

Using scissors, cut these items into pieces that will fit neatly into the baking dish. But don't put them into the dish yet. First soak them in warm water until they are soggy. While the paper pieces are soaking, line the dish with aluminum foil to keep it clean.



Then place layer after layer of soggy paper into the dish. Use your fingers to press the layers together and to force the excess water out of the soggy mass. Pour this excess water out. Stop adding layers when you've built a pile that's about ¾" thick.

Now we want the compressed pile to dry out. For this demonstration only, let's speed up the drying process. Let's use an oven (better check to see if it's okay to use the oven for this purpose). Bake the pile for about an hour. Oven temperature should be around 200°F. DON'T USE A MICROWAVE OVEN. Because of the aluminum foil, the microwave tube inside the unit could be damaged.



After taking the dish out of the oven and after the contents have cooled down, lift the pile out of the dish. If it is still damp, set it aside until completely dry. When dry, chunks of this salvaged waste paper will burn like wood. You can use them in a fireplace, campfire, or whatever.

When making additional piles, skip the oven part. (You don't need the baking dish either; use something else.) Simply let the piles dry outside in the aluminum foil liner. It doesn't make sense to consume more energy using the oven than you get from the fire fuel.

COAL CONVERSION

Coal is known as a *fossil fuel* because it is composed of the remains of trees and other plants that lived hundreds of millions of years ago. Oil and natural gas are also fossil fuels. All are available in America. But coal is, by far, the most plentiful of the three.

Coal has long been used as a fuel for electric power plants. Many years ago, coal was a popular fuel for heating homes. But coal is not as convenient a fuel as oil or natural gas. The furnaces needed to burn coal are more complicated. And special equipment is needed to control air-pollution in industry. For these reasons, scientists are searching for practical ways to convert coal into liquid fuel and gas.

Liquid fuel made from coal could be used in place of heating oil. It could also be made into gasoline for cars and kerosene for jet planes. Gas produced from coal could be mixed with natural gas for home heating and industrial use.

EXPERIMENT 6

Part A. Getting Methane from Coal

THINGS YOU NEED: Lump of soft (bituminous) coal about the size of a baseball. A two-pound coffee can. Funnel. Small glass bottle such as spices come in.

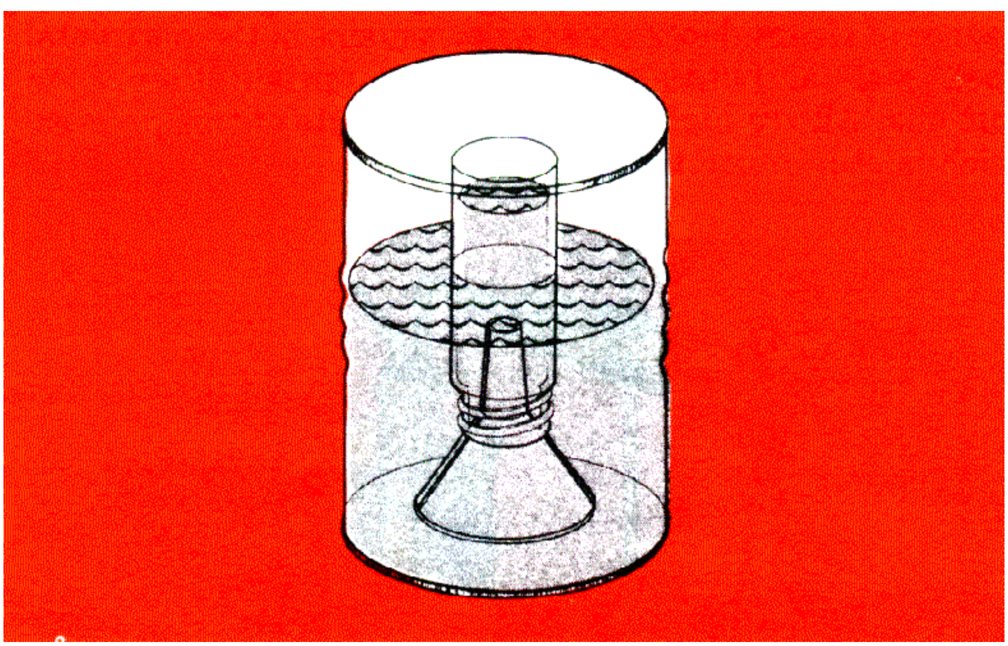
Fuel gas has been produced from coal for decades. The process requires high temperatures because chemical bonds must be broken to form the gas. (Part B of this experiment illustrates that process.)

But coal also contains a small amount of burnable gas trapped within its pores and cavities. This gas is not chemically linked in the coal and can be released rather easily. If you are able to find a piece of coal, you can prove this for yourself by doing the following simple experiment.

First wrap the coal lump in a sturdy rag and hammer it into a fine powder. With a wad of soft paper, plug the narrow end of the funnel and pour the coal powder into the other end. Holding the funnel upright, invert the coffee can over it. Then pressing the funnel against the bottom of the can, return the can to its original position. Remove the paper wad.

Now gently pour water into the can until the water is about an inch above the funnel (if it's a plastic funnel, you'll have to hold it down to keep it from floating). The water, of course, will enter the funnel. Next, take the small bottle and submerge it, open end up, in the water. After it fills completely, turn the bottle upside down, keeping it under water so that no air gets into it. Then carefully maneuver it over the funnel – again, staying under water. Finally, lower the bottle and let it rest on the funnel. That's all you have to do.

Put the can aside, and in a day or so you will see a large bubble at the upper part of the bottle. The bubble will contain



mostly methane. It is the same kind of gas that formed when decaying plant matter began turning into coal eons ago, back when dinosaurs plodded the earth. Just think, that methane could have been trapped for millions of years . . . until you released it.

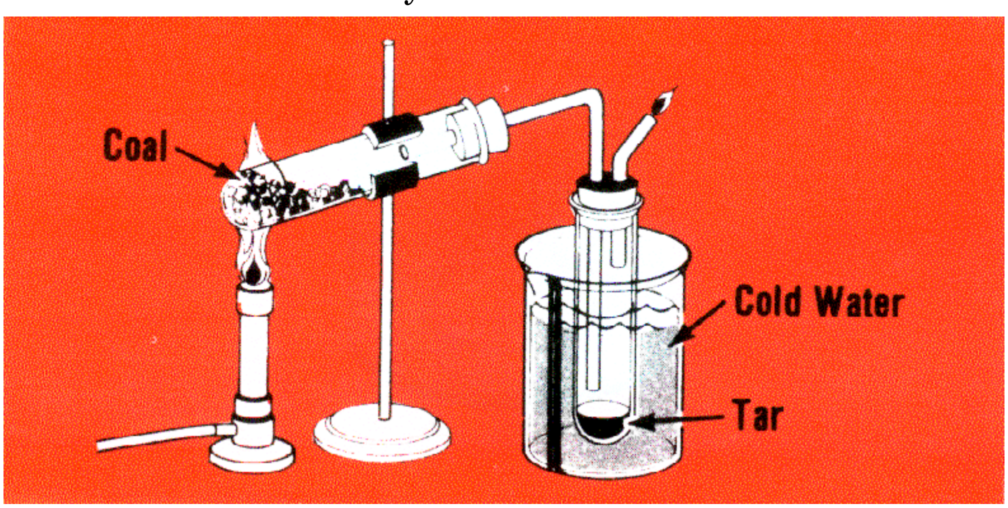
Part B. Converting Coal to Fuel Gas
(An optional classroom project requiring your teacher's supervision.)

THINGS YOU NEED: Everything shown in the drawing.

If you are given permission to try this experiment in the school chemistry lab, set up the equipment as shown in the drawing. Your teacher will guide you in the proper procedures.

When all is ready, heat the coal in the test tube for several minutes to drive out the air. Afterward, bring a flame to the opening of the outlet tubing. The emerging gas will burn. This gas is known, not surprisingly, as coal gas. It consists of a number of burnable gases.

Along with these fuel gases, the heating of coal in the absence of air produces coke (what remains in the horizontal tube), coal tar (what remains in the upright tube), and ammonia. All are highly useful by-products of this process, which is still in use today.



GEOTHERMAL ENERGY

Scientists believe that the core of our planet is a large mass of molten material. They call this material *magma*. It may have a temperature of 800° F.

In most places on earth, the magma is many miles below the ground. But at some locations, it comes close to the surface, and it creates hot spots. When ground water comes in contact with these hot spots, the water turns to steam. The geysers in Yellowstone National Park are well-known examples of this *geothermal energy* in action.

Incidentally, the name geothermal comes from *geo* (earth) and *therm* (heat). Geothermal means heat from the earth.

Where geothermal energy is available in the form of steam (at a suitable temperature and pressure), it is a practical source of energy. At the geysers geothermal field in Northern California, enough electricity is generated to serve a city nearly the size of San Francisco.

The steam is used to spin turbines that drive electric generators. The process is not complicated, particularly if the steam is hot and dry. Moist steam, though, may carry minerals from the water. And these minerals can clog and corrode the generating equipment.

The United States has 1.8 million acres of land where geothermal energy is known to exist in various forms. This leads to the belief that geothermal energy may eventually become an important source of electricity. Some estimates indicate that 30% of our electricity will come from geothermal energy by the 21st Century.

EXPERIMENT 7

A Model Geothermal Steam Engine

THINGS YOU NEED: An empty soup can. Heavy aluminum foil (frozen food tray, pie pan, etc.). Aluminum wrapping foil. Straight pin. An 8" length of stiff wire (coat hanger). Stick about 12" long. Small pot. Glue. Tape. Rubber band.

With a little imagination and a model turbine, you can get some idea how steam can produce electricity. First, you'll have to build the model. It's easy. Here's how:

1. If not already off, remove the lid from the soup can. Throw the lid away; rinse out the can.

2. Turn the can upside down and punch two 1/8" holes opposite one another in the bottom. Locate each hole about ¼" away from the rim.

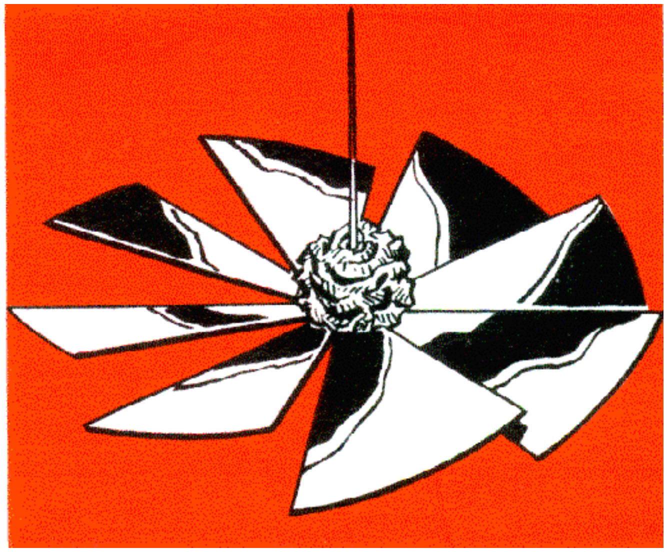
3. From your frozen food tray or pie pan, cut out a flat disk equal in diameter to that of the can. Pierce a hole in the center of this disk with a straight pin.

4. Take some aluminum wrapping foil and wad it up into a little ball the size of a small cherry. Glue this ball to the disk, centered right over the hole. It will prevent the disk from wobbling badly.

5. After the glue has dried, put the pin in the disk hole and push it through the ball. Try to get the pin as perpendicular to the disk as you are able. Now enlarge this hole slightly with a thicker pin or needle. The idea is to have the disk and ball spin freely on the pin.

6. Make eight equally spaced "pie cuts" in the disk with a pair of scissors. Cut all the way to the ball.

7. Twist each "pie wedge" slightly to form the turbine wheel (see drawing).

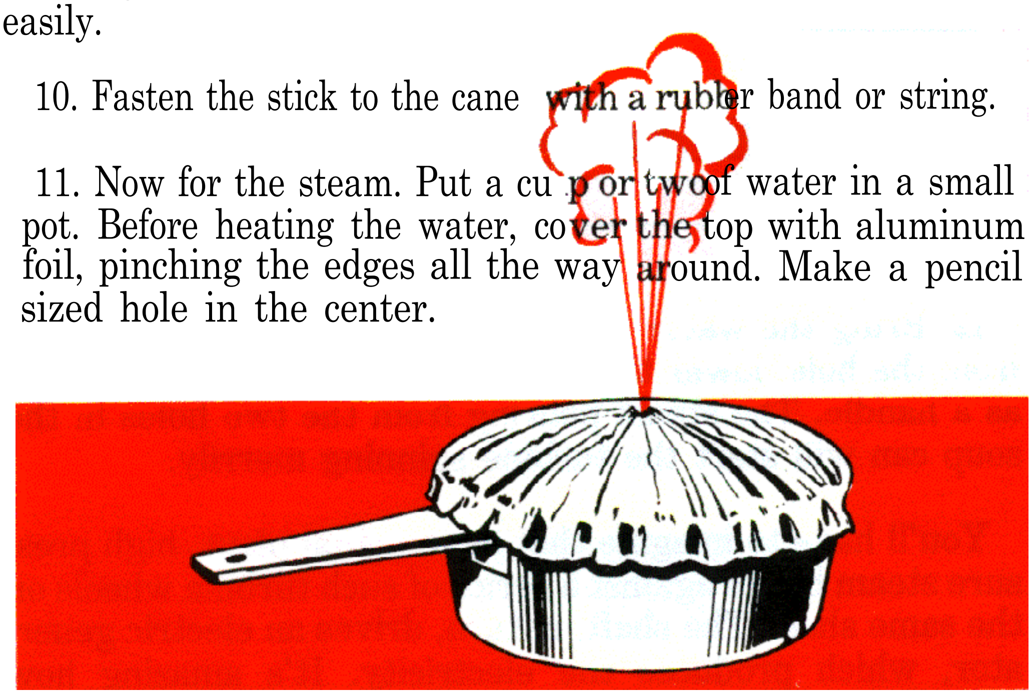


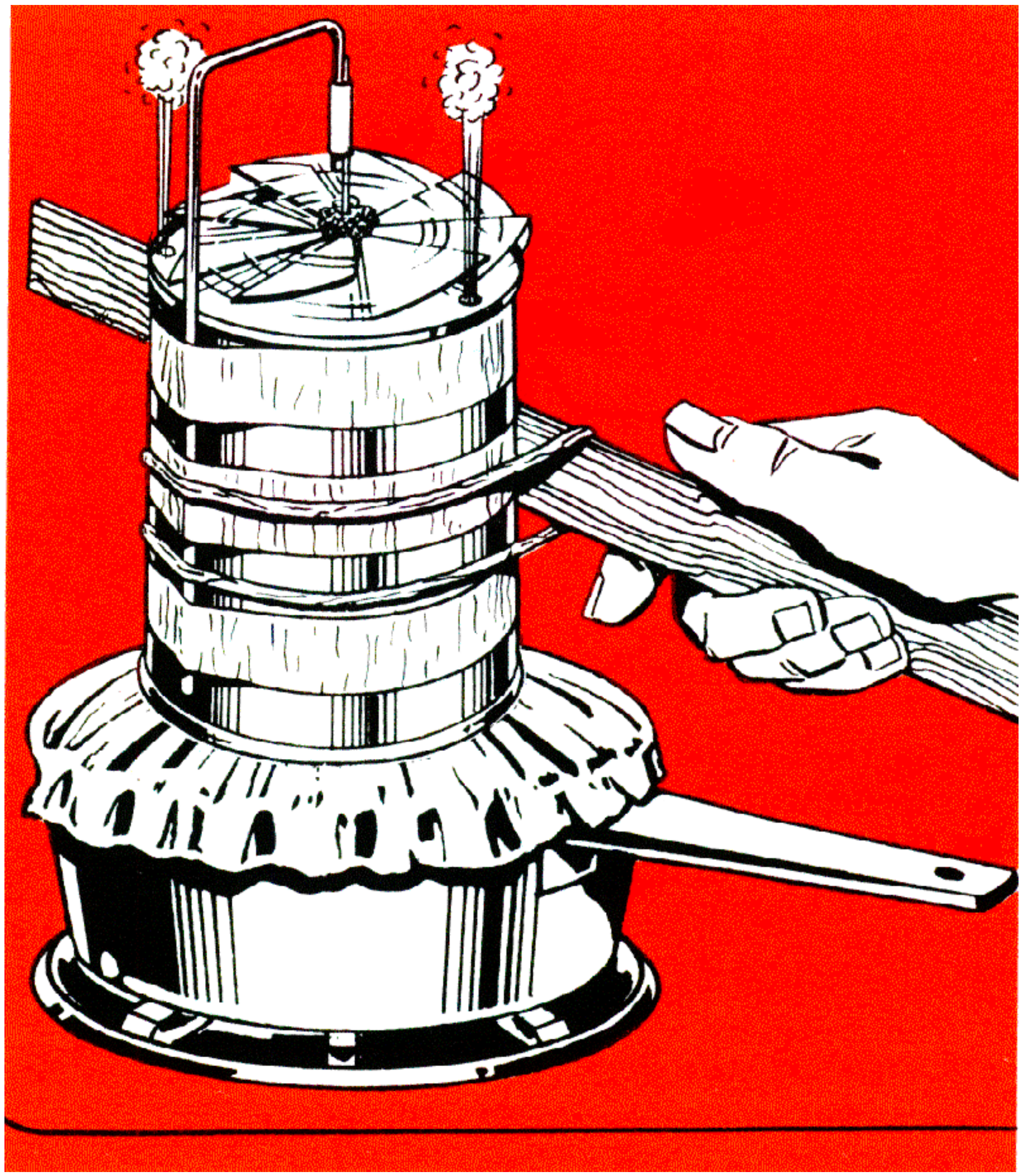
8. Bend the stiff wire, as shown. Make sure that when the wire is later attached to the can, the small downward segment will point to the can's center.

9. Slip the straight pin through the turbine and tape it to the support wire. Then tape the support wire to the can so that the turbine is as close as possible to the can without touching it. Blow on the turbine to test it. It should spin quite easily.

10. Fasten the stick to the cane with a rubber band or string.

11. Now for the steam. Put a cup or two of water in a small pot. Before heating the water, cover the top with aluminum foil, pinching the edges all the way around. Make a pencil sized hole in the center.





12. Bring the water to a boil. When steam starts jetting from the hole, lower the can over the hole, using the stick as a handle. The steam pouring from the two holes in the soup can will start the turbine spinning merrily.

You'll have to imagine that in an actual plant, high pressure steam blasts against a series of such turbine wheels on the same shaft. The shaft, in turn, drives an electric generator, which produces the electricity. It's amazing how powerful steam is.

THE FUEL CELL

What is a fuel cell? It is an electrochemical device for converting the chemical energy in fuels directly into electricity.

Why is it of high interest to scientists today? It can operate with two or three times the efficiency of other fuel-burning power producers. Thus the fuel cell, although not an energy source in itself, could help make our present fuel supply last years longer than expected.

Many scientists see the fuel cell playing a major role someday in providing electricity for automobiles and homes. Even now, large fuel cell systems are being developed for use as power plants for shopping centers and commuter trains. Small systems have already been used successfully in spacecraft.

In many ways, the fuel cell is like a battery. It contains no moving parts, is quiet, and wastes no energy as heat. Furthermore, it gives off no fumes. And like a battery, it has electrodes and an electrolyte.

But unlike a battery, the fuel cell will continue to produce electricity as long as fuel and an oxidant, such as air or oxygen, can be fed to the electrodes. In most batteries, one of the electrodes serves as the fuel and gets used up during operation. The fuel cell's electrodes never get used up. Only the fuel.

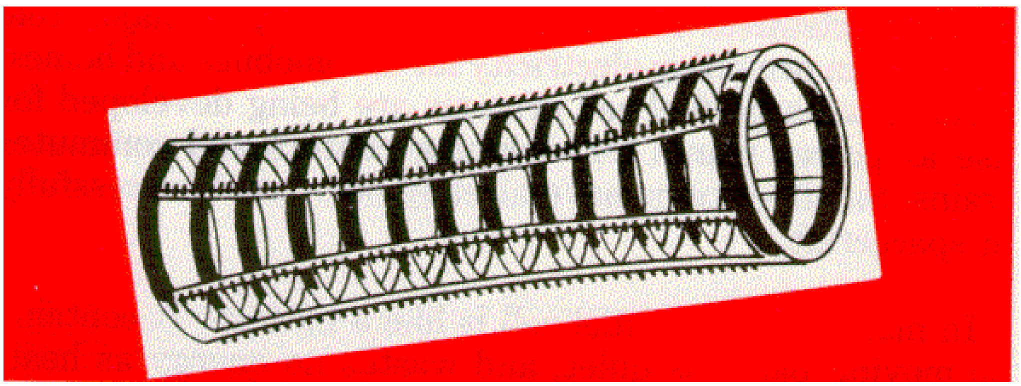
There are several types of fuel cells. Some use hydrogen as a fuel. Others use ammonia, alcohol, or various hydrocarbon fuels. But even though they may work differently, they all achieve the same result: They all produce electricity directly from fuels in an efficient manner.

Through research, fuel cell power plants could prove to be an environmentally safe yet competitive means of producing electricity in the future.

EXPERIMENT 8

Making a "Fuel Cell"*

THINGS YOU NEED: A nonmetallic mesh tube, such as a woman's plastic hair roller, measuring about 3" long by 1" in diameter (see drawing). Three small rubber bands or some string. Thin sheet of zinc or galvanized steel 3½ " by 2". A large gauze pad (see text). A tablespoon or so of natural powdered graphite (one tube of powdered graphite lubricant should do the trick). Flour. Salt. A saucer. Galvanometer from Experiment 2.

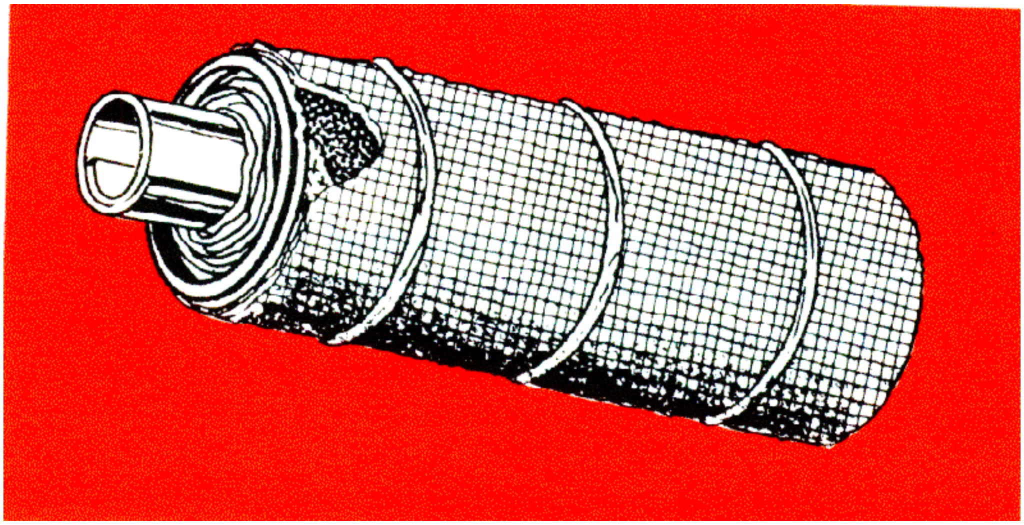


Making a fuel cell would be easy if we had the right materials. Trouble is, the right materials are either dangerous or difficult to get in small quantities. So let's take an easier path. Let's build a device that is considered to be a form of fuel cell. It uses zinc as the fuel (one electrode), air as the oxidant (the other electrode), and salt water as the electrolyte.

First pour all the graphite into a small mixing container. Next, in a separate container, prepare a binder of 1 part flour and 4 parts water. Then add the binder to the graphite, a little at a time, and stir. What we want to do is end up with a thick paste, like peanut butter.

Now from the gauze pad cut two strips as wide as the mesh tube (hair roller) and about 7" long. If you don't have gauze, try a paper towel; fold it in four layers and cut it to size.

* The device in this experiment was designed by research scientist Hiry West of the McGraw-Edison Co., Bloomfield, N.J.



On a portion of one of these strips, spread all the graphite paste (messy, isn't it?). You need cover only the first 3" of length, but cover the entire width of this 3" portion. Then place the mesh tube on the graphite and wrap the strip around the tube. The graphite will be facing the meshwork, of course.

Put the rubber bands or string around the gauze, and set the unit aside to dry (overnight, at least). That takes care of the air electrode for our "fuel cell." You may be wondering what part the graphite plays in the air electrode. Without getting too technical, it allows the oxygen in the air to enter the electrochemical reaction.

For the zinc electrode, roll the length of the zinc or galvanized steel into the tube small enough to fit inside the air electrode (but don't insert it yet). Then wrap the second gauze strip around the zinc.

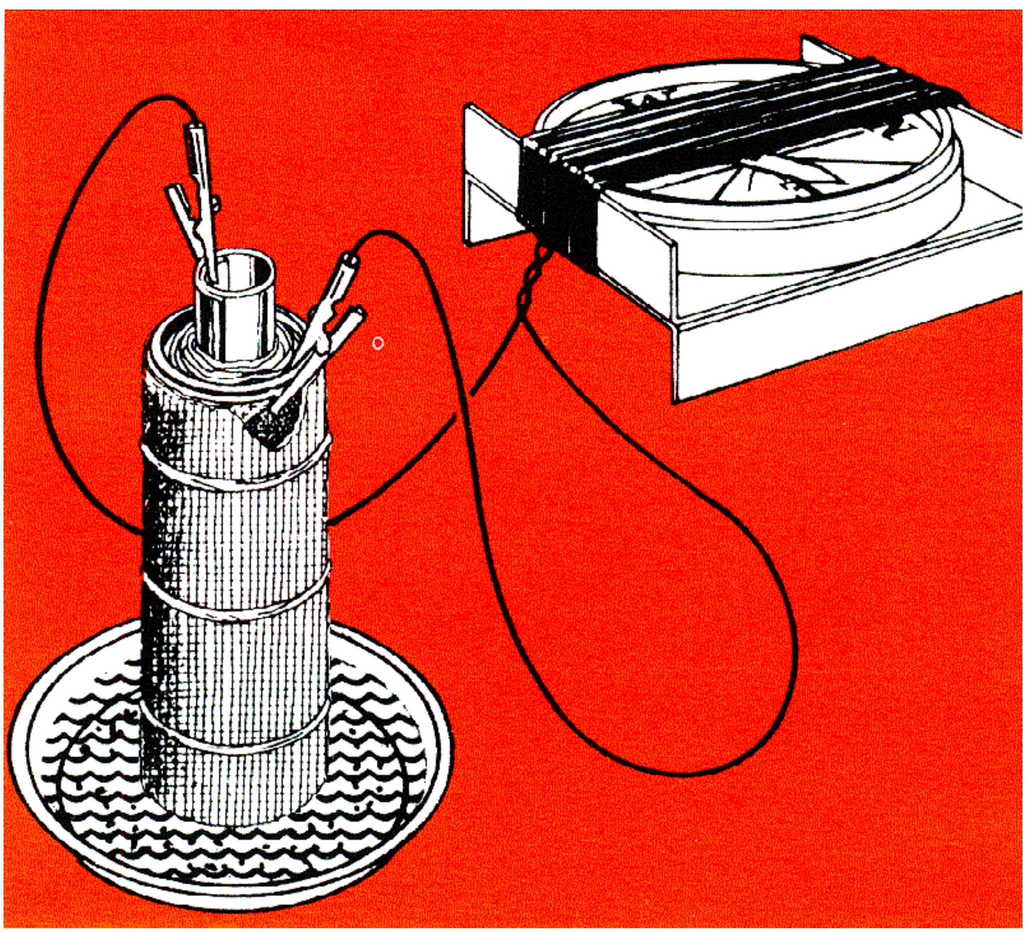
After the air electrode has had a chance to dry out, insert the wrapped zinc electrode into the tube core. It should be a snug fit.

We will need an electrolyte. So dissolve a tablespoon of salt in two or three tablespoons of hot water, and pour this electrolyte into a saucer. That completes all the preparations for the fuel cell. Now, will it work? Let's see.

Clip one of the alligator clamps from the galvanometer to the top of the zinc electrode. Clip the other clamp to the graphite on the air electrode. The clamp must contact the graphite. You may have to cut away some of the gauze to ensure such contact.

Arrange the galvanometer as indicated in Experiments 2 and 3. Then stand the fuel cell in the saucer. As the salt water soaks into the gauze, electrochemical action should start. It does! The deflecting galvanometer needle proves that electricity is being generated.

Depending on how you made the fuel cells, needle deflection may or may not be large. But any movement at all proves the point. Interchanging the galvanometer connections to the fuel cell may make the deflection more noticeable.



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