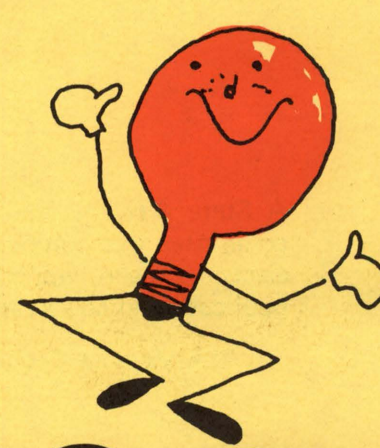

ELECTRO 2

4-H Electric Project • Record Book 69 • Reprint April 1979 • Extension Division • Virginia Polytechnic Institute and State University

Acknowledgments

A State 4-H Electric Program Literature Committee developed the outline for this project unit. The committee was composed of 6 members of the Cooperative Extension Service staff and 3 representatives of electric power suppliers. J. L. Calhoun, Extension Specialist, Agricultural Engineering, prepared this publication in cooperation with other members of the committee.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, and September 30, 1977, in cooperation with the U.S. Department of Agriculture. W. R. Van Dresser, Dean, Extension Division, Cooperative Extension Service, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061; M. C. Harding, Sr., Administrator, 1890 Extension Program, Virginia State College, Petersburg, Virginia 23803.

Table of Contents

Certain photographs used in this record book were furnished through courtesy of General Electric Company and Westinghouse Electric Corporation.

Welcome to Electro 2

In "Electro 1" you learned about power and how it generates electricity. You found out how electricity is used to give light, heat, and cold. You had fun with magnets. You learned some facts about electrical safety.

Now, you will begin to explore the why's and how's of electricity. Here are some of the things you can learn and do in this project:

1. How electricity can help you in other 4-H projects.
2. Electrical terms—what they mean and how to use them.
3. How fuses and circuit breakers work and what they do.
4. How to make electromagnets.
5. How to repair service cords.
6. About electric light bulbs and how to select them.
7. How to make your homework "lighter" with good lighting.
8. Ways to improve the use of electricity in your home.
9. Go on tours and trips.
10. Give demonstrations.
11. Make posters and exhibits.

WHAT YOU NEED TO DO

You will need a plan to guide you. This manual contains facts and ideas that will help you learn many exciting things about electricity. Your 4-H leader, parents, and Extension agent will help you plan and to achieve success in doing the items you include in your plan.

The more of the following completed by you, the higher your 4-H project score and the greater your learning and achievement of excellence. You will need to do the following things to complete this project (extra credit may be earned by doing more than the minimum required):

1. a. Learn how electricity helps in other 4-H projects.
   b. List the electrical equipment you have used in other 4-H projects.
2. a. List any equipment that was bought or made during this club year, and its cost.
   b. Discuss with your parents what additional equipment is needed most and list it.
3. Learn about electrical terms and how to use them.
4. Learn about fuses and circuit breakers.
5. Do 3 of the following or any other activities requiring equal skill or knowledge:
   a. Learn about electromagnets.
   b. Repair 4 service cords.
   c. Learn about light bulbs and how to select them.
   d. Remodel or make a lamp.
   e. Set up a study center.
6. Do 2 of the following:
   a. Show others something you have learned by giving one or more talks or demonstrations.
   b. Show others something you have learned by making one or more posters or exhibits.
   c. Visit one or more homes, farms, or industries where electricity is being used for many jobs. List the uses you observed on each visit.
7. Complete your project record beginning on page 1-R.

Services Electricity Provides

ELECTRICITY WORKS FOR US

Have you seen electricity? Of course you haven't. It's like the wind—you can't see it. You can see what the wind does. In the same way, you can see what electricity does. It can be used in many ways to give us light, heat, cold, power, and entertainment.

Electricity is like the "one-man track team," the track star who wins the high jump, broad jump, hurdles, and dashes. No other fuel or energy can do so many things for us in the home, on the farm, and in the community. Fuel oil will heat a home, but it won't run a food mixer. Gas will cool a refrigerator, but it won't run the washing machine. Coal will heat water, but it won't run a food freezer. Gasoline will drive a water pump, but it won't operate a television set. Electricity will do all of these jobs and hundreds more. Yes, there are more than 400 uses of electricity in the home and on the farm. Electricity does thousands of jobs in stores and factories. With its help, we have put man in space and sent men to the moon. You can now see color television. Other new ways to use electricity are being developed. Electricity is safe and low in cost. The things it does makes life easier and more fun.

WHERE IS IT USED?

Now, let's play a game. We learned that electricity does hundreds of jobs. We found that electricity can give us light, heat, cold, power, and entertainment. Listed below are several uses of electricity:

Percolator	Range
Window fan	Washing machine
Frypan	Floor polisher
Attic fan	Refrigerator
Table lamp	Floor lamp
Toaster	Food freezer
Food mixer	Clock
Ceiling fixture	Room air conditioner
Television	Portable drill
Hand iron	Radio

Write the above uses of electricity in the properspaces below:

Lighting	Heating	Cooling	Power	Entertainment
----------------	----------------	----------------	----------------	----------------
----------------	----------------	----------------	----------------	----------------
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HOW ELECTRICITY HELPS IN OTHER PROJECTS

Electricity is a partner in your other projects. They fit together like a hand and a glove. Electricity can help you in any 4-H project. For example, you will need to use a range for food preparation. In a house care project you will use many home electrical appliances. If you take a poultry project, you may need a brooder, egg candler, lighting, and other equipment. So, what you learn in the electric project can help you in other projects.

Now let's try your skill in another game. Listed below are a few of the many 4-H projects. On the right side of the page are several uses of electricity. These uses are numbered. Write opposite each project the numbers for the uses which would help you in the project. The numbers for the clothing project have been filled in to give you the idea. Let's see who can get the most of them right.

Name of Project	Uses Which Would help me in project (List uses by numbers)
Clothing	4, 7, 8, 10, 11, 13
Dairy	______________________
Foods and Nutrition	______________________
Home Improvement	______________________
House Care	______________________
Laundry	______________________
Poultry	______________________

Uses of Electricity

1. Range
2. Freezer
3. Refrigerator
4. Sewing machine
5. Vacuum cleaner
6. Study desk lighting
7. Clothes dryer
8. Washing machine
9. Egg candler
10. Hand iron
11. Water heater
12. Milking machine
13. Light for sewing center
14. Milk cooler
15. Floor polisher
16. Bedroom lighting
17. Food mixer

THINGS TO DO

Last year you made a list of the electrical equipment being used by your family. You found a lot of electrical helpers at work for you. Look at last year's list and turn to page 1-R. Ask your parents to help you:

1. List the electrical equipment you have used in other projects.
2. List the electrical equipment bought or made during the past year and the cost of each.
3. Decide what additional equipment is needed most and list it.

Let's explore Electricity

We use words to explain things. If someone says, "Mary cut her finger," you know what it means. You learned terms such as turbine, generator, and hydroelectric in the previous electric unit. We learn by getting to know the meaning of new words. In exploring electricity, you will find many different words, terms, and ideas. When you understand them, you can talk about and work with electricity. So, let's see if we can find out what electricity is and how it acts. Let's also learn some of the electrical terms used to talk "electricity."

WHAT IS ELECTRICITY?

No one knows exactly what electricity is. Don't let that bother you. Scientists have learned a lot about electricity. They have found that electricity always behaves in the same way under the same conditions. Knowledge of electricity has led to its great use.

All gases, liquids, and solids consist of tiny atoms. They contain even smaller particles called protons and electrons. These are electrical in nature. No one has ever seen a proton or an electron, so we don't know what they look like. Each proton has a positive (+) charge, and each electron has a negative (—) charge. Each neutral atom has the same number of protons and electrons. The number depends upon the material containing the atom. Things can happen to cause the protons and electrons to get out of balance.

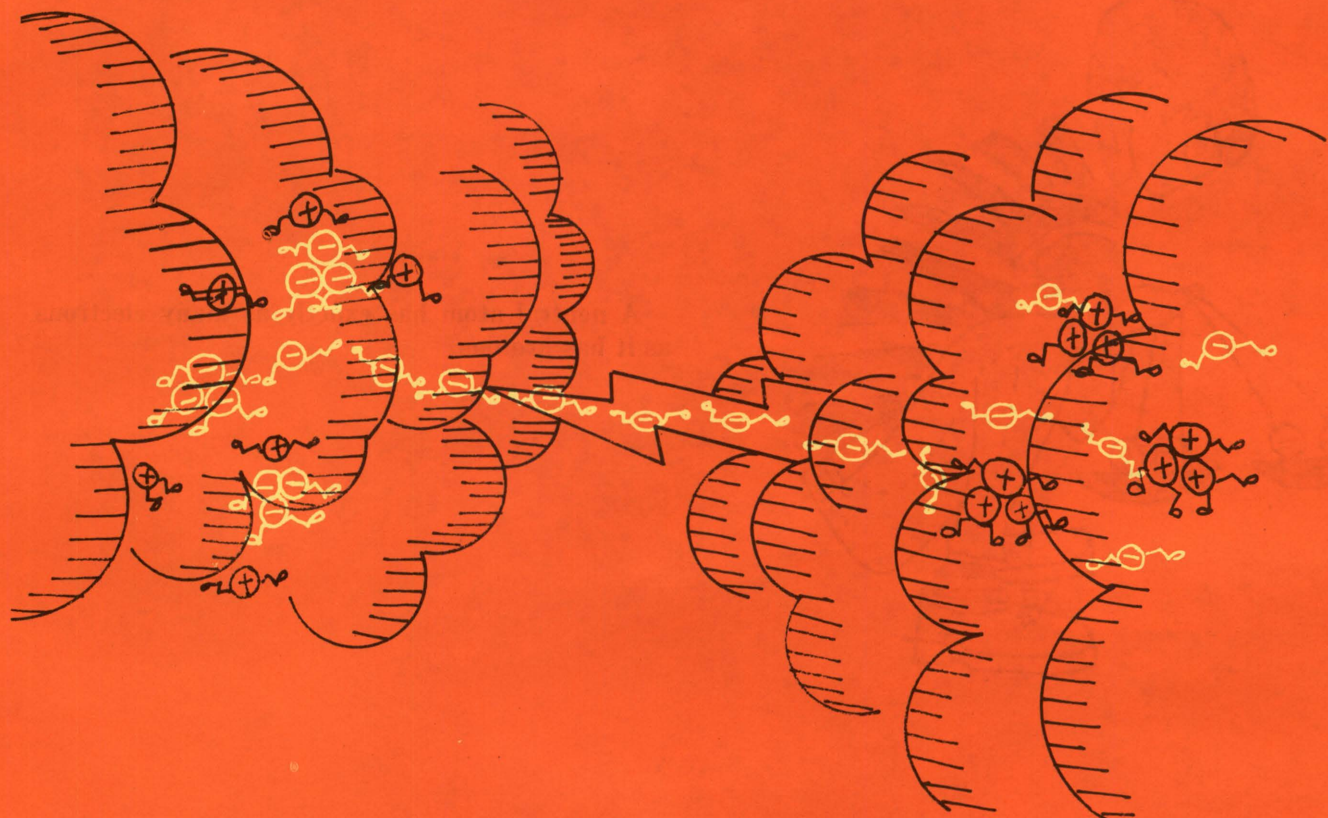
In some substances, the electrons are loosely held. They can move with ease from one atom to another. If an atom has too many electrons, the extras are attracted to another atom. When this happens, the two atoms are again in balance (neutral).

You may be wondering what all this has to do with electricity. Well, it's really important and here's why. Those loosely held electrons are what makes it possible for you to enjoy the services of electricity. You see, we can think of electricity as the flow of electrons. What would happen if we did not have materials in which the electrons are loosely held or free to move? You would not have electric lighting, TV, or any other electrical appliance.

Water can do great damage unless it is under control. The same is true of electricity. In using electricity we are simply controlling the flow of electrons.

A neutral atom has exactly as many electrons as it has protons.

Sometimes there are more electrons than protons, and the two get out of balance.



Lightning develops when excess electrons pass from negative portion of cloud to positive portion

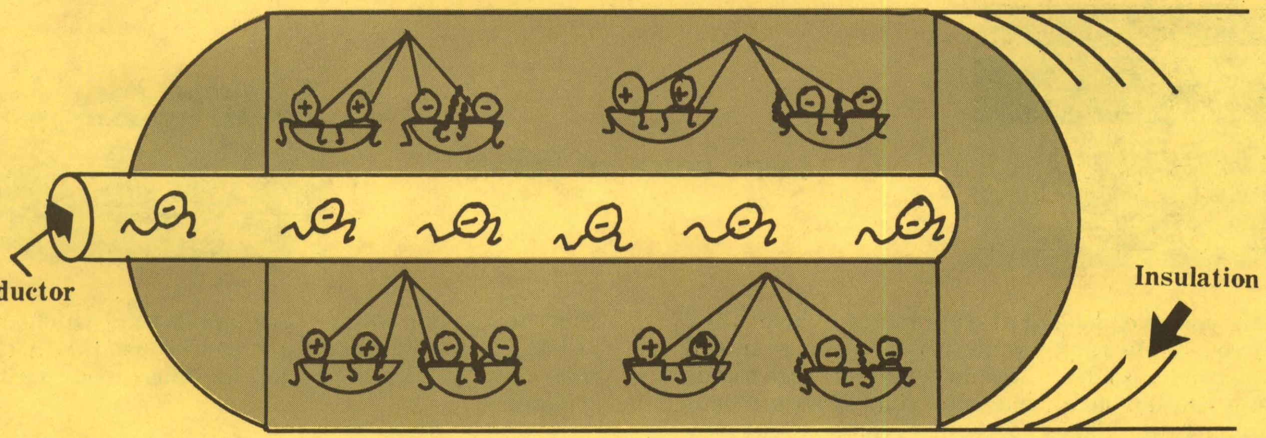
What happens when the movement of electrons is not controlled? Lightning is a good example. As a storm develops, there is a movement of electrons. The atoms in different parts of a cloud compete for electrons. The electrons become unbalanced and jump from positive to negative areas. When that happens, we have lightning. This uncontrolled flow of electrons can cause great damage. The electricity in homes, stores, and factories is supplied by the same kind of electrons. These electrons are under control. So, one way to explain electricity is to say it is a "flow of electrons."

CONDUCTORS AND INSULATORS

These 2 words mean something. We use them in working with electricity. We need to understand them.

What is a conductor? Earlier we said some materials have electrons that are loosely held. These substances have electrons that move easily from one atom to another. In other words, they give up and accept electrons freely. The wires that bring electricity to points of use are made of these materials. They permit electrons to move with ease and are called *conductors*. They simply provide a path for the flow of electrons. Silver is a good conductor, but it is expensive. Copper and aluminum are not as good, but they cost less. That's why these 2 metals are so widely used for conductors.

Other materials hold their electrons like a miser keeps his money. They won't release the electrons in the atoms, nor allow free electrons to pass. These materials are known as insulators. Examples of good insulators are glass, plastic, rubber, bakelite, and porcelain. You can see that conductors and insulators are necessary for controlling the flow of electrons. Insulation around a conductor keeps the electron flow in the proper path. It keeps them from going where we don't want them. The service cords to your lamps and appliances are a good example. The conductors or wires, in the cord permit the free flow of electrons so a lamp can burn and a toaster can heat. The insulation on the cord keeps the electrons in the proper path. This control keeps you from getting shocked. It also keeps the wires in the cord separated so they can't get together and possibly start a fire. Insulators help to keep electrons from getting out of control.



Conductors let electrons flow with ease. Insulators won't let electrons move.

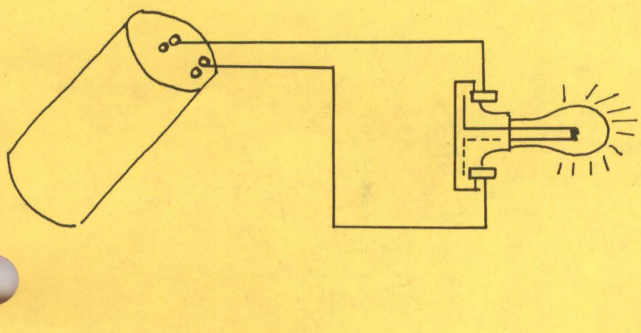
Listed below are several materials. Some are conductors and some are insulators. See if you can tell the difference. Place a check (√) mark by the ones that are conductors. Make an "X" by those that are insulators.

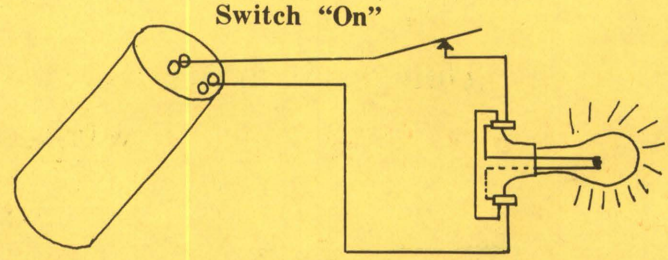
Paper _____	Glass _____
Brass _____	Copper _____
Air _____	Plastic _____
Wood _____	Rubber _____
Salt water _____	Aluminum _____
Cast iron _____	Bakelite _____
Steel _____	Porcelain _____
Mica _____	Silver _____

PATHS FOR ELECTRICITY

When you run around the house, you return to the starting point. To say it another way, you make a complete path or circuit around the house. The flow of electrons is similar. The electrons make a complete path, returning to the starting point. This path is called a circuit. The sketch below shows a circuit. The battery causes electrons to flow. In this case the lamp bulb is burning and electrons are flowing through the circuit. We call this a *closed circuit.*

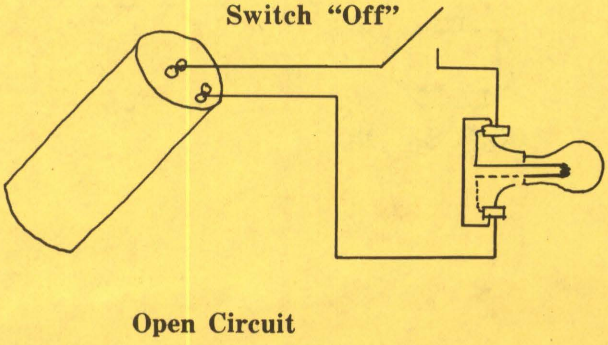
Now, let's disconnect one of the wires from the battery. The electron path has been broken. No electrons flow. The lamp goes out. We call this an *open circuit.* The next step is to install a switch in the circuit. This makes it easy to turn the light on and off.



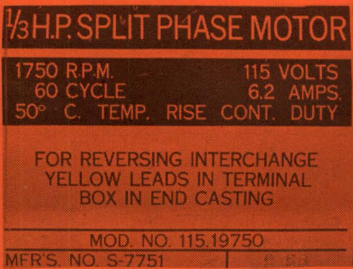


Closed Circuit

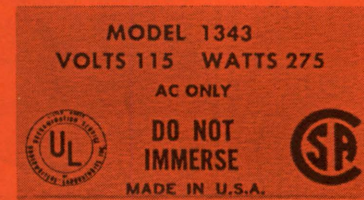
You turn lights on and off in your home in the same way. When you turn a switch "on", you make a closed circuit and the light burns. When you turn the switch "off", you make an open circuit and the light goes out. You have stopped the flow of electrons.



Open Circuit



LET'S COME TO TERMS



Have you ever looked at an appliance carefully? If so, you likely found some information stamped on it or on a plate. Maybe some of the words you saw did not mean much to you. Those words are important. They give you facts about the appliance. Some of these words are volts, amperes, and watts. You must know what these words mean to work with and talk about electricity. You will be using them a lot.

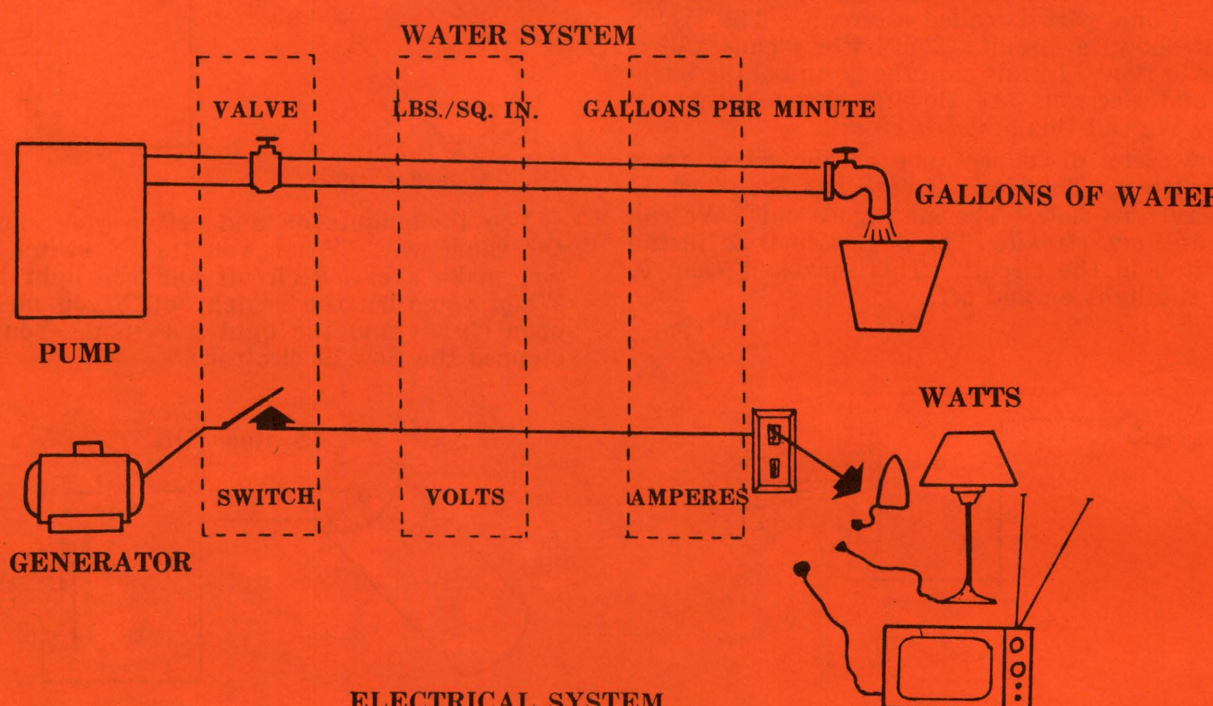
Volts.—First, let's go back to circuits. We mentioned that the battery forced the electrons to move. In your home wiring system, a generator instead of a battery causes electrons to flow. The generating station may be many miles away. The generator forces electrons to move along power lines to your home. This force or pressure in an electrical circuit is called volts. Then we can say that *volts are a measure of electrical pressure.* This pressure (voltage) is on your wiring circuits all the time. It is similar to the water system in your home. There is pressure in the lines regardless of whether you are using water or not. The same is true of electricity. Water can't flow without pressure and electrons can't flow without pressure (voltage).

The battery we used earlier provides a pressure of only 1-½ volts. Circuits used in your home for lighting and small appliances are supplied with 120 volts. An appliance which has 110-120 volts stamped on it can be used on a 120-volt circuit. Voltage can be measured with a *voltmeter.*

Amperes.—We said earlier that volts (electrical pressure) are what makes electrons flow or move. We compared it to water pressure. Water flows when you open a faucet. Electrons flow when you connect an appliance. We need a name for this flow of electrons in a circuit. The term "ampere" is used. What is an ampere? It's 6,300,000,000 electrons passing a point each second. This large figure shows why it's better to use the term "ampere" instead of electrons. Sometimes other terms are used to refer to the flow of electrons. These are "flow of electricity" and "electric current". They all mean about the same thing.

To sum up—*amperes is the rate of flow of electricity.* This compares to the number of gallons of water per minute that flows through a pipe. A 100-watt light bulb will cause almost one ampere to flow in a circuit. An electric iron will require a current flow of almost 10 amperes. The nameplates of many appliances show how many amperes they require. The rate of flow of electricity is measured with an instrument called an *ammeter.*

COMPARISON BETWEEN WATER AND ELECTRICAL SYSTEMS



What's Watt?—You learned that volts are electrical pressure, and amperes are the rate of flow of electricity. Volts and amperes work together to give us electric power. Neither volts nor amperes alone can give electric power for light, heat, and turning electric motors. For example, you can have 10,000 volts, but if there is no flow of electrons, there can be no power. Or, you can have a circuit which will allow a flow of 100 amperes, but it takes voltage to make the electrons flow.

The term "watts" is used to show the teamwork of volts and amperes. *Watts are the rate of using electricity or the rate of doing electrical work.* Let's see how volts and amperes work together to give us watts. You simply multiply volts by amperes as shown below:

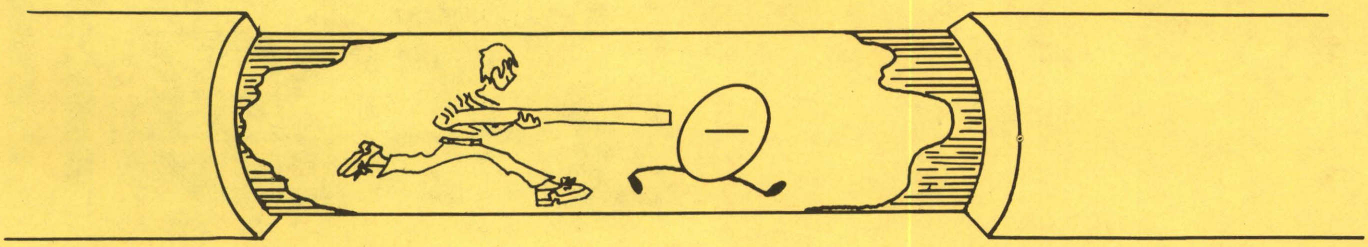
Volts x amperes = watts

(Pressure) x (rate of flow) = (power)

Suppose you have 120-volt circuit in which 1 ampere is flowing. Then 120 volts x 1 ampere = 120 watts. Here is another example. You have a toaster that uses 9 amperes on a 120-volt circuit. What is the wattage of the toaster?

120 volts x 9 amperes = 1,080 watts

A *wattmeter* is used to measure wattage. We can think of it as a meter which multiplies volts by amperes. You read the answer on the meter dial.



120 VOLTS x 1 AMPERE=120 WATTS (Power)

LET'S HAVE SOME FUN

Let's play "pick and choose". The member who does the best job of "picking and choosing" will be the winner.

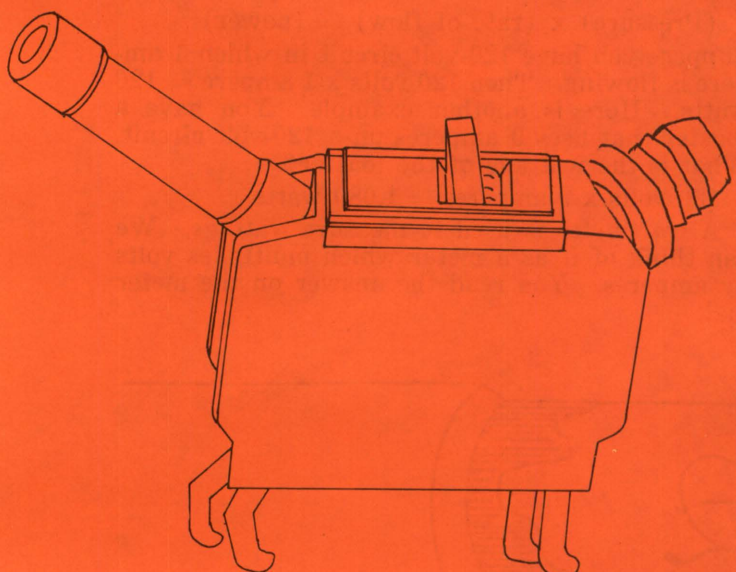
Some of the statements below are true and others are false. Beside each statement is a "T" and a "F". Pick the right answer. Then draw a circle around the "T" or "F" — "T" for true — "F" for false.

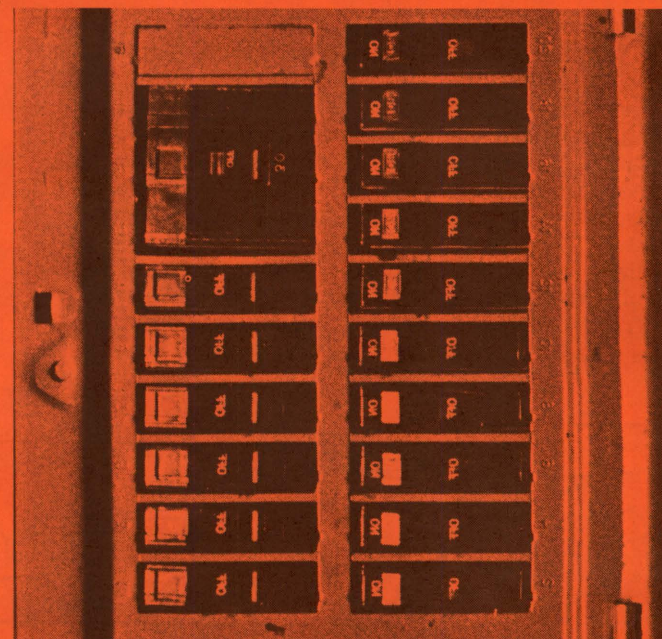
	Right	Wrong
1. The atom is the smallest particle in nature.	T	F
2. The neutral atoms of any material always have the same number of protons and electrons.	T	F
3. The protons in an atom are positively (+) charged.	T	F
4. Scientists have never seen protons and electrons.	T	F
5. No one knows exactly what electricity is.	T	F
6. Lightning is an example of electrons out of control.	T	F
7. Electrons cannot flow in a conductor.	T	F
8. Electrons can flow freely in an insulator.	T	F
9. There is always a flow of electrons in an open circuit.	T	F
10. You can't get shocked by touching a wire that is properly insulated.	T	F

Here is the "choose" part. The statements below give you a choice of answers. All of the answers are wrong except one. See if you can choose the correct answer. Draw a circle around the answer you choose.

1. A good conductor of electricity is: *wood, paper, copper, rubber.*
2. A good insulator for electricity is: *alumnum, salt water, cast iron, plastic, tin.*
3. To make an electric circuit, you need at least *1 wire, 2 wires, 3 wires, 4 wires.*
4. When a switch is in the open position you have a: *closed circuit, open circuit, short circuit, high-powered circuit.*
5. Voltage on a circuit: *changes protons to electrons, is a measure of electricity used causes the flow of electrons, causes the flow of protons.*
6. Voltage is: *the flow of electrons, the charge of an atom, electrical pressure, amount of electricity used.*
7. Amperes are: *the number of protons, the work done by electricity, the rate of flow of electricity, the size of a wire.*
8. Watts are: *a group of protons, what make electrons move, a measure of insulation, rate of using electricity.*
9. We can think of a wattmeter as a meter that *multiplies protons by electrons, measure electrical pressure, multiplies watts by amperes, multiplies volts by amperes.*
10. An electric heater uses 10 ampere when connected to a 120-volt circuit. The wattage of the heater is: *600, 800, 1,000, 1,200, 1,400, 1,600.*

Electric Watchdogs





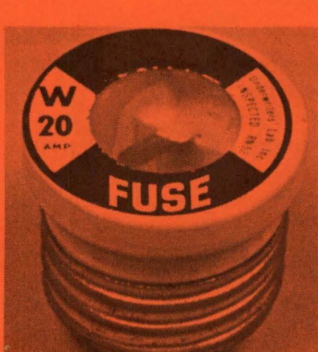
Dogs serve man in many ways. Some breeds can be trained to be "watchdogs". These dogs keep strangers away. In doing so, they protect people and property.

A wiring system brings electricity to points of use in your home. It is protected by what we might call "electric watchdogs". These watchdogs also protect people and property. They prevent fires which may be caused by short circuits and overloaded wiring. It is important for you to understand these "electric watchdogs" and how they work.

WHAT THEY ARE

There are 2 kinds of "electric watchdogs"—fuses and circuit breakers. Either type will give good protection. Overloaded wiring and short circuits cause too many amperes to flow in circuits. When this happens the wires get hot. They can get hot enough to start a fire. Fuses and circuit breakers are the "weak link" in your wiring. They open the circuit before wires can get hot enough to cause damage.

FUSES



Plug Fuse

Cartridge Fuse

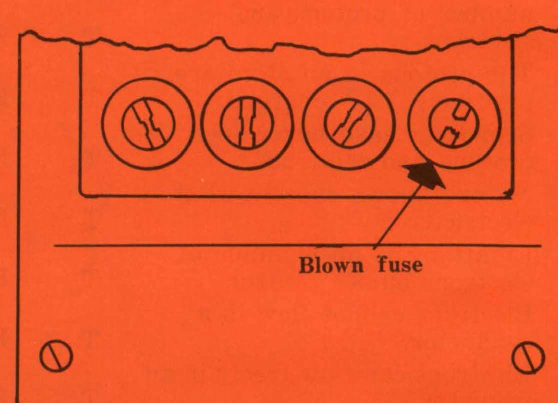
SIZE

The size of fuses and circuit breakers is stated in amperes. They are available in many different sizes. Look at a fuse or circuit breaker. You will find its size printed or stamped on it. Examples are 15, 20, 30, 60, 100, and 200 ampere sizes.

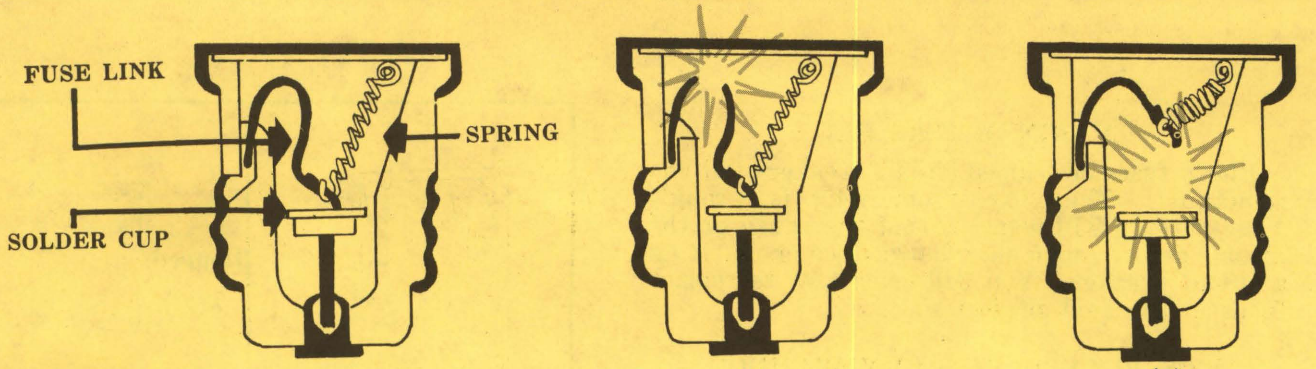
KINDS OF FUSES

There are two types of fuses, based upon the shape. They are plug and cartridge fuses. Notice how they look like either a plug or a cartridge. You can buy both types of fuses with a single element or 2 elements. Let's compare them.

Single element plug and cartridge fuses and often called "common" or "ordinary" fuses.

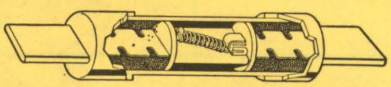


The inside of a single element cartridge fuse



(a) (b) (c)

A look inside a 2-element plug fuse: (a) parts of fuse, (b) a short circuit causes fuse link to melt, and (c) solder melts and spring pulls fuse link out of solder cup when circuit is overloaded.



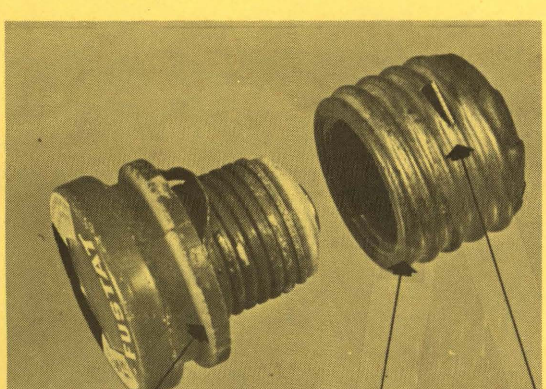
The inside of a cartridge fuse with 2 elements.

The element in these fuses is the weakest link in the wiring system. The element melts when a short circuit develops or when the circuit is overloaded. This condition is called a "blown" fuse. It stops the flow of electricity. Then the wires can't overheat and possibly start a fire.

Plug and cartridge fuses are also made with 2 elements. One element blows in case of a short circuit. The other element opens the circuit when it's overloaded. These fuses are better than single-element fuses. They give good circuit protection, and they have a "time delay" feature which helps. It takes a big surge of current to start an electric motor. This high current for just a few seconds may blow a single element fuse. A 2-element fuse won't blow when a motor starts. That's why it is best for circuits with electric motors.

Plug fuses are not made in sizes larger than 30 amperes. Single-element plug fuses have threads like those on an ordinary light bulb. They screw into the fuse socket. Some 2-element plug fuses have the same kind of threads.

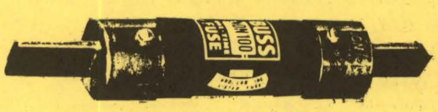
There's also a special kind of 2-element plug fuse. It has 2 parts—an adapter and the fuse. The adapter screws into the fuse socket. It has a wire prong on the side that locks the adapter in place. When you screw it into the socket, you can't take it out. Adapters have inside threads which differ in thread length and size. They are available for 15, 20, and 30 ampere fuses. When you put a 15 ampere adapter in a fuse socket, you cannot screw into it a 20 or 30 ampere 2-element fuse. The threads won't match. This type of 2-element fuse must be used in new wiring systems to be protected with fuses. The single element fuse can only be used for replacement in old wiring systems.



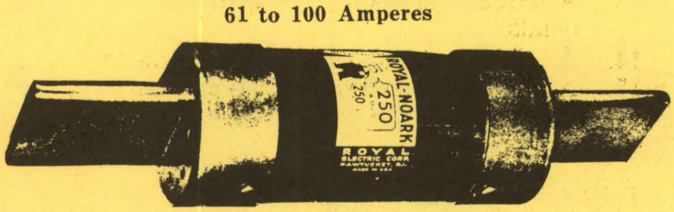
You can get cartridge fuses in sizes up to several hundred amperes. They are available with single and 2-elements. The 2-element cartridge fuse is a good choice for circuits with motors. It won't blow when a motor starts, and it gives good protection.

0 to 30 Amperes

31 to 60 Amperes



61 to 100 Amperes



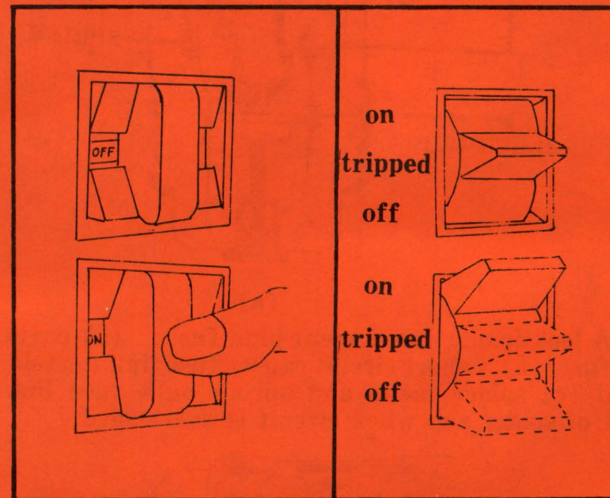
201 to 400 Amperes

CIRCUIT BREAKERS

What does a circuit breaker do? It does the same job as a 2-element fuse, including the time-delay feature. A circuit breaker has a metal strip that gets warm and bends when electricity flows through it. It gets hotter and bends more as the flow of electricity increases. The bending causes a trigger to release, which in turn opens the circuit. The metal strip straightens out as it cools. The circuit breaker can then be reset and it's ready to protect the circuit again. There's nothing to replace when a circuit breaker trips. You simply reset it after it cools. Like fuses, circuit breakers are available in many different sizes (ampere ratings).

A SIGN OF TROUBLE

Blown fuses or tripped circuit breakers tell you something. They say, "something is wrong". Your parents will want to find the cause of the trouble before replacing a blown fuse or resetting a circuit breaker. You will learn how to replace fuses in the next project unit.



LET'S PLAY ELECTRIC WATCHDOG!

On the left of the sheet are some statements about electric watchdogs. On the right side are several answers. Only one answer is right. See if you can pick the right one. Write the answer number in the space shown under "answer number". Let's see who can get the most of them right.

1. The two kinds of "electric watchdogs" are:
2. The purpose of fuses and circuit breakers is to prevent dangers caused by:
3. The size of fuses and circuit breakers is expressed in:
4. The two types of fuses, based upon their shape, are:
5. The element in a fuse is:
6. A blown fuse means:
7. Plug fuses are not made in sizes larger than:
8. Cartridge fuses are made in sizes up to:
9. The type of fuse which is best for circuits with electric motors is:
10. Plug fuses have threads on them like those:
11. You can't overfuse circuits if you use:
12. You can get 2-element plug fuses with adapters with ratings of:
13. A circuit breaker has a metal strip that bends:
14. A circuit breaker can be reset when:
15. A single-element plug fuse can only be used for:

Answer Number	
( )	1. Plug and cartridge
( )	2. The weakest link in the wiring system
( )	3. Two-element plug fuses with adapters
( )	4. When it gets hot
( )	5. Fuses and circuit breakers
( )	6. The fuse element has melted
( )	7. Amperes
( )	8. 15, 20, and 30 amperes
( )	9. 2-element fuse
( )	10. 30 amperes
( )	11. Several hundred amperes
( )	12. Short circuits and overloaded wiring
( )	13. A replacement in old wiring systems
( )	14. On a light bulb
( )	15. The metal strip cools

THINGS TO DO

Here are some things for you to do at home. Ask your parents to help you. Write the answers on Page 2-R.

1. Find out whether your home wiring is protected with fuses or circuit breakers.
2. If fuses are used, find out how many of them have one element and how many have 2 elements.
3. See if you have on hand extra fuses of the proper size.
4. If circuit breakers are used, list the ampere rating of each.

Electromagnets

You learned about permanent magnets in Electro 1. They have a "north" and a "south" pole which never change. There is another type of magnet which has many uses. It makes electric motors run. It also makes possible dishwashers, buzzers, door chimes, and automatic washers. It is the electromagnet. "Electro" means electric. So, electricity is used to make an electromagnet. Permanent magnets are usually not very strong. Powerful electromagnets can be made.

An electromagnet is a temporary magnet. The "north" and "south" poles are not permanent. It is a magnet only when electricity is flowing through it. Soft iron is one part of an electromagnet. If won't hold magnetism. That's what we want in an electromagnet. It must lose its magnetism fast. Let's make a simple electromagnet and see how it works. You will need the following supplies:

10′ of No. 18 insulated copper wire
Two, 1-½ volt dry cell batteries, Size 6
One 20-penny nail (4″ long) or 5 or 6 pieces of soft iron wire taped together
Some small finishing nails or brads (½″ long)

Follow these steps:

1. Wrap about 10 turns of wire near the end of the nail. Leave 1′ of wire at one end.
2. Scrape 1″ of insulation from each end of the wire.
3. Connect the clean ends of the wire to the terminals of one battery as shown in Fig. 1.

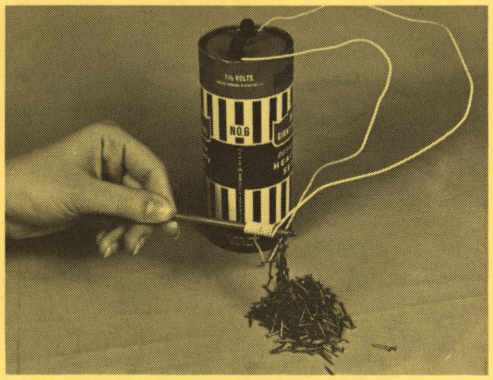


Figure 1.

Immediately touch the end of the nail to a pile of the small nails or brads. What happens? The nail is magnetized by the current flowing through the wire from the battery. Now, remove the wire from the battery. What happens and why? The nail may hold some of its magnetism because it is not made of "soft" iron. Pieces of soft iron wire in an electromagnet will lose their magnetism the instant you stop the current.

Let's try something else. Wrap about 50 turns of wire around the nail. Hook the two dry cells as shown in Fig. 2. This hook-up will give you 3 volts instead of 1½ volts. Attach one end of the wire wrapped around the nail to a battery terminal. Fasten the other end of the wire to the remaining battery terminal and quickly touch

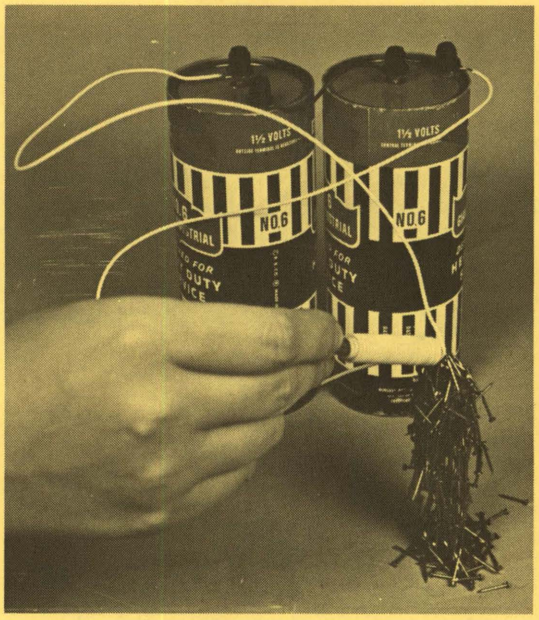


Figure 2.

the end of the nail to the small nails again. What happens this time?

1. Does it pick up more nails than the first electromagnet did?
   Yes_____ No_____
2. Is it a stronger magnet than the first one?
   Yes_____ No_____

Why was the second electromagnet stronger? The second magnet had 5 times as many turns of wire. It also had more current flowing in the wire because you doubled the voltage. Now we can get an idea of what makes a strong electromagnet. The more you increase the number of turns of wire and the amperage, the stronger the magnet becomes.

There are many uses for strong electromagnets. A crane with an electromagnet is used to move iron and steel. The crane operator turns on the magnet switch to pick up heavy loads. He opens the switch to drop the scrap metals. A permanament magnet would not do this job. It would not be strong enough and you could not turn it on and off.

There is something else worth knowing about electromagnets. They have "north" and "south" poles like permanent magnets. We can show this by using steel instead of iron in an electromagnet. The steel will then become a permanent magnet.

LET'S MAKE A PERMANENT MAGNET

Leave your batteries connected in series as in Fig. 3. Remove the insulated No. 18 wire from your nail electromagnet. Wrap the wire around the full length of a knitting needle. Connect the 2 ends of the wire to the battery terminals. Leave them connected for about 15 seconds. This should make the needle into a permanent bar magnet. Do the same thing with another steel knitting needle. You can magnetize a screwdriver in the same way. Don't do it unless you want your screwdriver to be magnetized.

Take one of the magnetized needles and hang it with a thread. Use a thread stirrup to keep the needle level as in Fig. 4. Keep it away from large pieces of steel. Watch the needle. Does it settle down and point in one direction? If it does, you have made a compass. The tip of the needle that points north is the north pole of the magnet. Mark the north pole with a red pencil. The other end is the south pole. Mark the south pole black. Do the same thing with the second needle. Leave the second needle hanging in the thread stirrup.

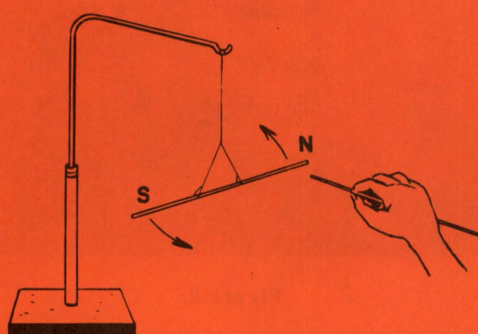
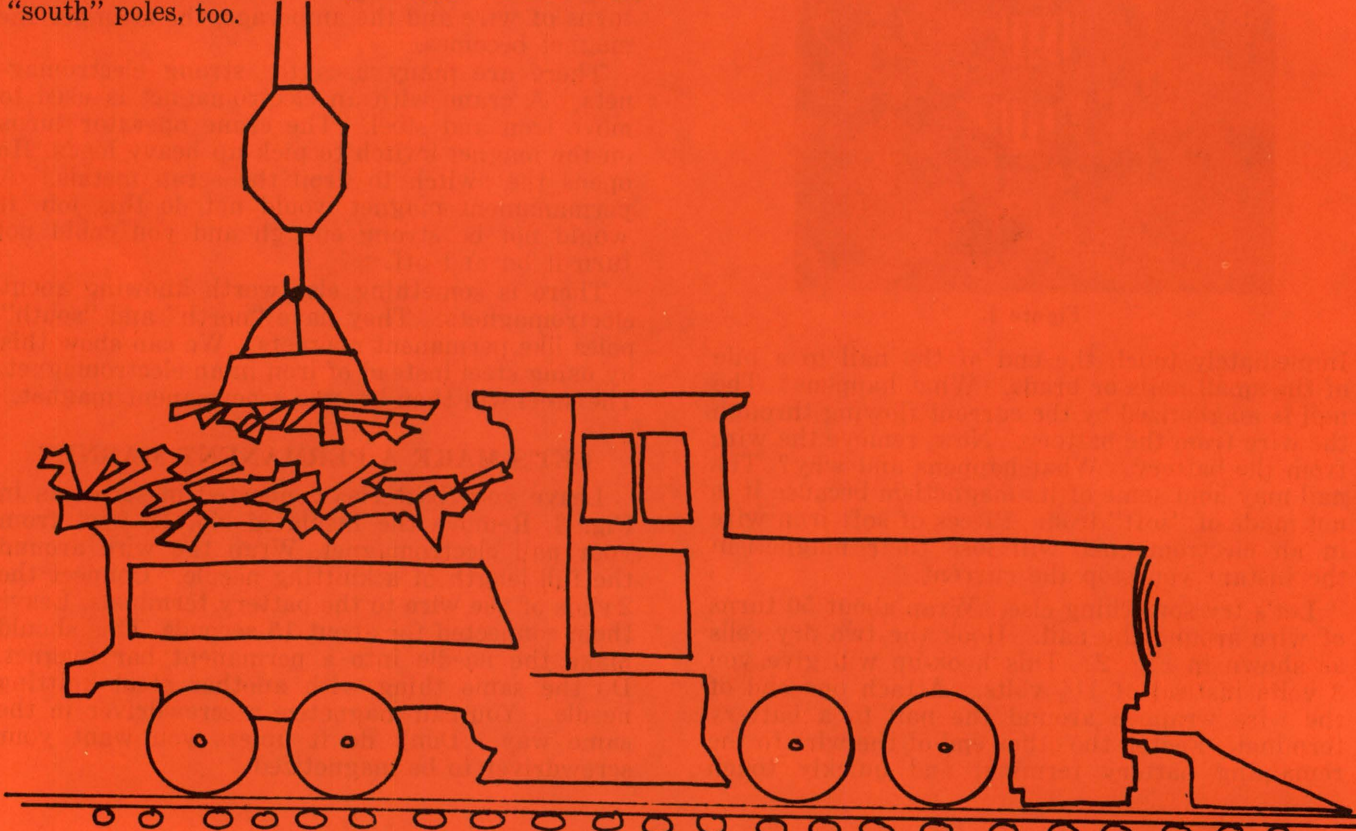


Figure 4.

Now bring the north (red) end of needle No. 1 near the north (red) end of needle No. 2. What happens? Now, bring the south (black) end of needle No. 1 near the north (red) end of needle No. 2. What happened this time? Needle No. 2 should swing away when the 2 north ends are near each other. They should be attracted when the south and north poles are near. If they worked that way, you have made permanent magnets. The poles were made with an electromagnet. That shows that an electromagnet has "north" and "south" poles, too.



Earlier we said electromagnets make it possible to have buzzers and door chimes. Let's make a buzzer and learn how it works. You will need the following supplies:

8′ no. 18 insulated wire
one, 1″ x 3″ x 6″ block of soft wood
1 strip of tin ½″ wide and 10″ long from a tin can
two, 10 penny nails
2 carpet tacks
one, 6-volt lantern battery or
four, 1½ volt dry cell batteries

Tools: Pocket knife, pliers, and hammer

Follow these steps:

1. Wind 100 turns of No. 18 wire around a 10-penny nail.
2. Drive above magnet nail into board as shown on sketch.
3. Bend the piece of tin into shape shown on sketch.
4. Remove 1″ of insulation from end of wire at top of magnet nail.
5. Place end of bare wire under tin strip. Use 2 carpet tacks to fasten tin strip and wire to board.
6. Cut a piece of No. 18 insulated wire 18″ long. Remove 1″ of insulation from each end of wire.
7. Drive one end of wire into the hole with contact nail. Be sure to drive nail at exactly the right place. Free end of tin strip must be under nail head, but not close enough so tin rubs the nail itself.
8. Check 2 things before connecting the battery. The tin strip must be close to the head of the magnet nail, but not touching it. The end of the tin strip must also be under the head of the contact nail. See that strip won't rub the contact nail as it moves up and down.
9. Remove 1″ of insulation from the end of wire coming from magnet nail.
10. Connect the 2 wires to the battery terminals. If you have done things right, your buzzer will make a noise.

WHAT MAKES YOUR BUZZER "BUZZ"?

It's easy to see what makes it buzz. Just follow the flow of electricity from the battery and back to it. Let's start at the battery and follow the wire to the contact nail. It goes up the nail, across the metal strip, through the wire of the magnet, and returns to the battery. This is a closed circuit and electrons are flowing.

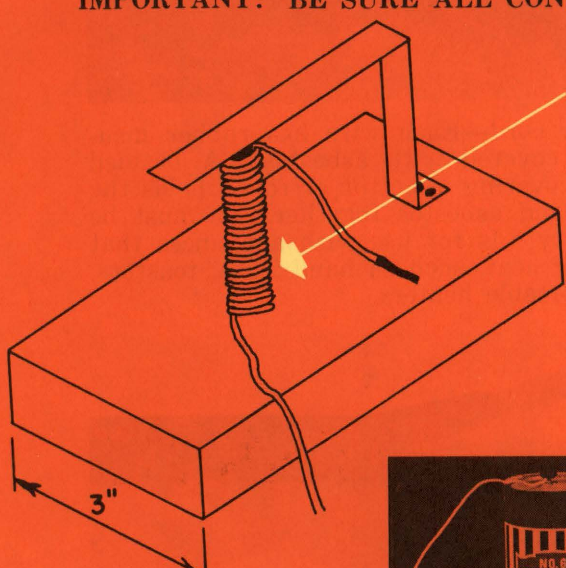
Your buzzer has a magnet similar to the one you made with a 20 penny nail. When electricity flows, it is a magnet. The moment the wires are connected to the battery, the circuit is closed, and magnetism pulls the strip down against the head of the magnet nail. Now, what happens? As the strip bends down, it moves away from the head of the contact nail. That causes an open circuit. The electromagnet is turned off. Its holding power is lost. The metal strip springs back up and touches the contact nail. Then the whole action starts all over again.

The above action takes place very fast. The electromagnet turns on and off in only a fraction of a second. This causes a clicking sound. The clicks happen so fast they sound like a buzz. So, you have used a buzzer to change electricity into noise.

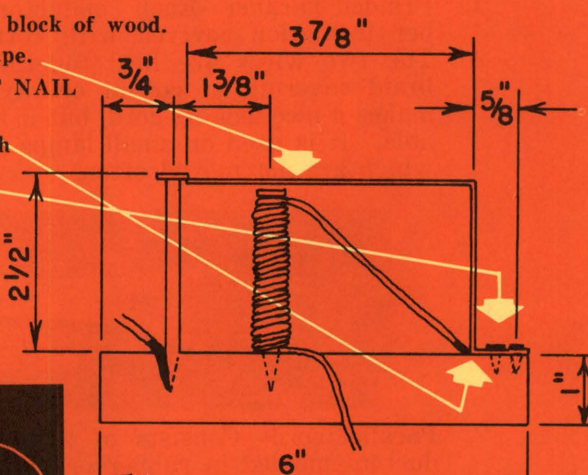
WHAT TO DO

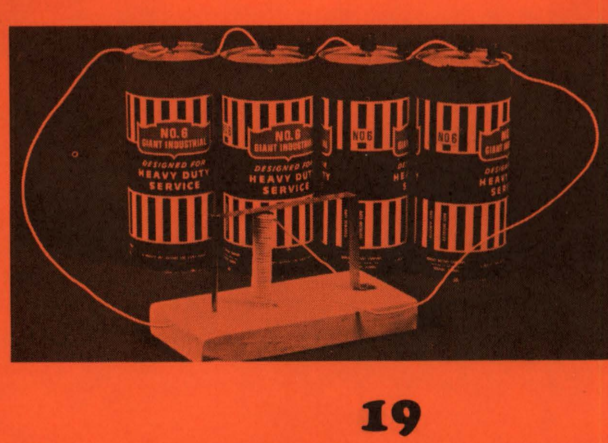
Turn to Page 2-R and report what you did with electromagnets.

IMPORTANT: BE SURE ALL CONTACT POINTS ON WIRES ARE SCRAPED WITH KNIFE



1. **Wind 100 turns doorbell wire on 10d nail to make MAGNET NAIL.**
2. **Drive MAGNET NAIL into block of wood.**
3. **Bend 7″ WINDER into shape.**
4. **Conect wire from MAGNET NAIL to WINDER as shown.**
5. **Using 2 carpet tacks, attach WINDER to block.**
6. **Drive wire into hole with CONTACT NAIL.**





Repair of Service Cords

What are service cords? They are all types of flexible cords that connect lamps and appliances to convenience outlets. They make it easy to connect lamps and appliances to a source of electricity. We couldn't do without them, but they can cause trouble. Worn or damaged service cords often cause appliances to be out of service. Let's learn how to repair them.

A LOOK AT SERVICE CORDS

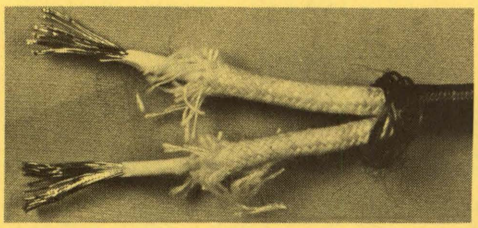
A service cord must be flexible—easy to bend. A stiff cord would be hard to use. A service cord has 2 or more wires separated from each other by insulation. We will learn how to repair cords with 2 wires. Each of these wires is made of many strands of small wire. It is called stranded wire. That makes the cord bend with ease. Solid wire would be stiff.

There are many kinds of service cords, but we can divide all of them into two general types:

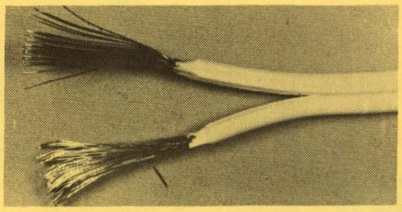
1. For lamps and non-heating appliances.
2. For appliances that cook or heat.

Let's learn about the types of service cords for use in and around the home.

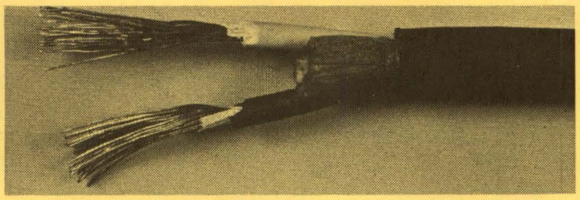
For Lamps and Non-Heating Appliances.—Several types of cords are used for lamps and appliances which **do not** cook or heat. Your family may be using the following types of cords.



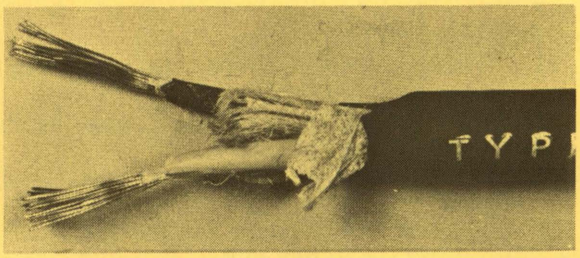
1. Braided parallel—Each conductor has rubber insulation covered with cotton braid. The two wires are held together with a braid covering of cotton or rayon. This makes a nice-looking cord, but it is not durable. It is used on small lamps and clocks which are not moved often.



2. Parallel cord—Consists of 2 parallel conductors molded in rubber or plastic. It is more durable than braided parallel cord. The covering is grooved so the two wires can be separated by simply pulling them apart.
This is a popular type of service cord. Used on portable lamps, radios, fans, and other non-heating appliances.

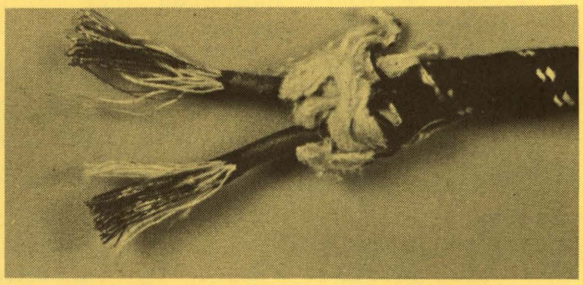


3. Junior hard service cord.—The insulated wires have a tough outer jacket of rubber or plastic. There is a hemp filler. Will stand hard usage. Can be used in damp places. Desirable for portable equipment in basements, shops, barns, milk houses, etc. A good type for general-use extension cords.

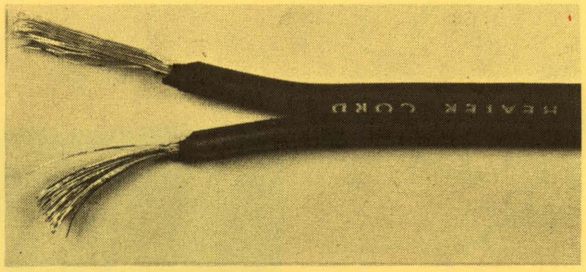


4. Hard-service cord—Same as junior hard service cord except rubber or plastic outer jacket is thicker and very tough. Will stand more abuse than other cords. Can be used in damp places. Desirable for portable equipment used outdoors.

For Appliances that Cook or Heat. These cords will stand more heat than those for non-heating uses.



1. Heater cord—Each wire has rubber insulation covered with asbestos. A braided outer covering of cotton or rayon holds the wires and asbestos together. It must be kept dry. Is for use with appliances that cook or heat, such as hand irons, toasters, and portable heaters.



2. Parallel heater cord—Consists of 2 parallel conductors molded in thermoplastic insulation. Can be used in damp places. Is for appliances that cook or heat, such as percolators, frypans, toasters, etc.

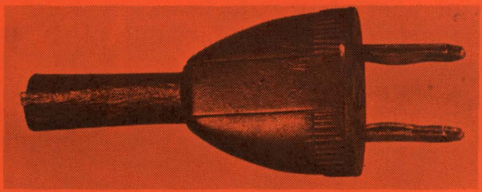
PLACES WHERE SERVICE CORDS SHOULD NOT BE USED

Flexible cord cannot:

1. Be used for fixed wiring.
2. Be run through holes in walls, ceilings, and floors.
3. Be run through windows and doors.
4. Be attached to building surfaces.
5. Be hidden behind building walls, floors, and ceilings.
6. Be spliced.

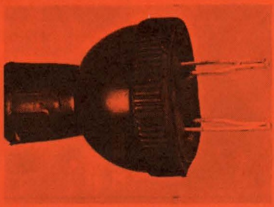
TYPES OF ATTACHMENT PLUGS

All service cords have a plug on the end called an "attachment plug". It fits into a convenience outlet—the source of electricity. There are many different kinds of attachment plugs.

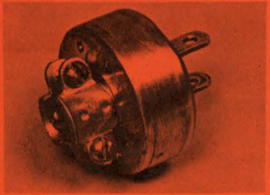


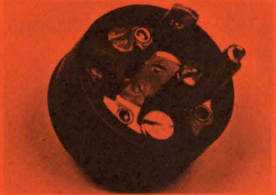
1. Molded. Prongs sealed in rubber or other material. Cannot be removed and reinstalled.

2. Flat. Made of rubber, plastic, or composition material. Is low in cost. Easily broken or crushed.
3. Quick-connecting. Made of plastic or bakelite. Fairly durable and easy to attach to cord. Used with parallel cord only. Satisfactory for small electrical loads.



4. Finger grip. Made of rubber or plastic. Easy to plug in and remove from convenience outlet. Rubber type very durable.

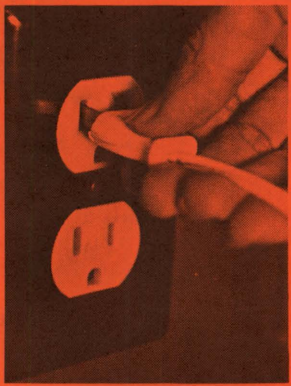




5. Heavy duty. For hard usage. Has metal protecting band and clamp for cord.
6. Grounding type. Long prong is for grounding purposes. You will learn about this attachment plug in another unit.

HOW TO REPLACE AN ATTACHMENT PLUG

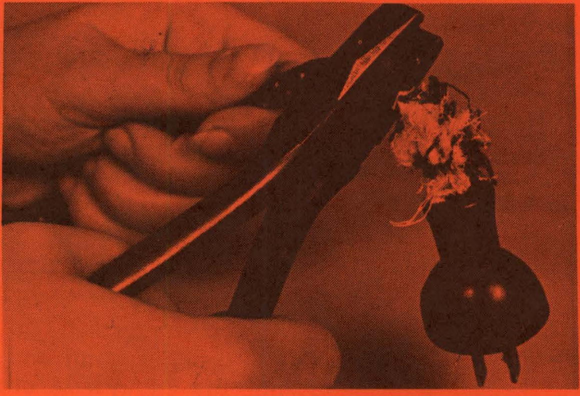
The first step is to **always remove** the attachment plug of the cord from the convenience outlet. Never inspect or work on a service cord until you have done this. Grasp the attachment plug between your thumb and finger to remove it from the outlet. Repeated jerking on the cord to disconnect an appliance may cause the wires



to pull loose in the attachment plug. It may also break or damage the cord. Even with proper care, cords take hard wear near the attachment plug. Some attachment plugs break easily. Bad cords and broken attachment plugs must be replaced at once for safety. Would you like to make these repairs yourself? You can if you learn and practice a few simple steps. It's easy and you can be the "cord repairman" at your home.

How to Remove Attachment Plug. — Follow these steps:

1. Remove attachment plug from convenience outlet.
2. Cut off plug and damaged cord with a knife or pliers.

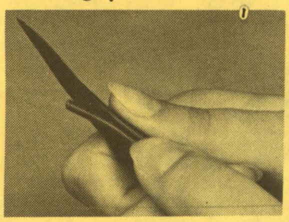
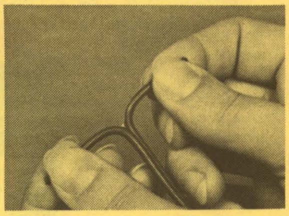


3. Throw plug away if broken or of molded type.
4. Do these things if attachment plug is still good and is not the molded type:
   a. Remove insulating disc.

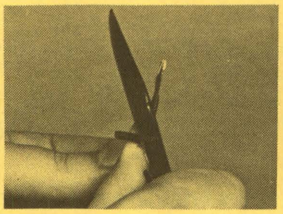
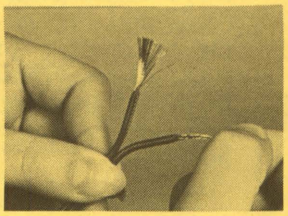
b. Loosen both screws. Do not remove them.
c. Pull wires out of plug and throw them away.

How to Remove Insulation from Wires.—Follow these steps:

1. If cord has an outer jacket, remove about 3″ of it. The jacket holds the wires together. Hard service cord is an example. Parallel cord has no outer jacket. In this case, pull insulated wires apart about 3″.

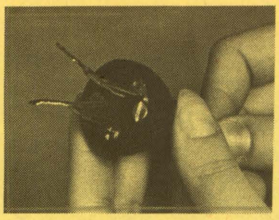
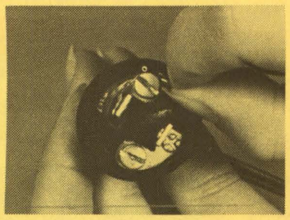



2. Remove ½″ of insulation from each wire. **Don't cut the small strands of wire.** Slope knife blade like you sharpen a pencil.
3. Unwrap fine thread from both wires and cut it off.
4. Scrape each wire clean with dull part of knife blade. Clean wires make a good electrical connection.
5. Twist strands of each wire together tightly. This binds the strands together so they won't give trouble when you install the attachment plug.

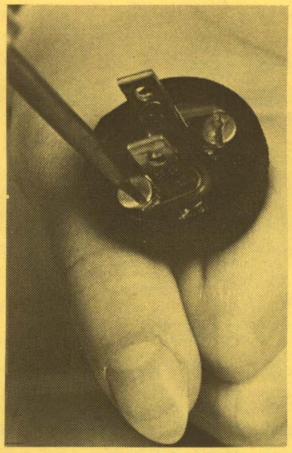
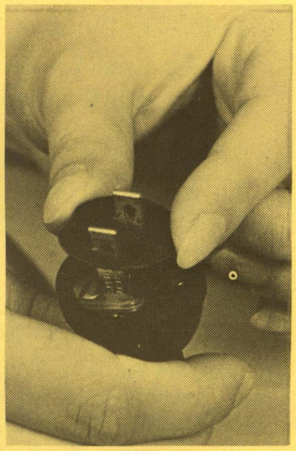



Install Attachment Plug. Follow these steps:

1. Push the 2 wires you have just prepared through hole in back of attachment plug.

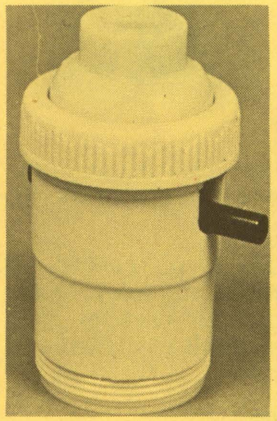
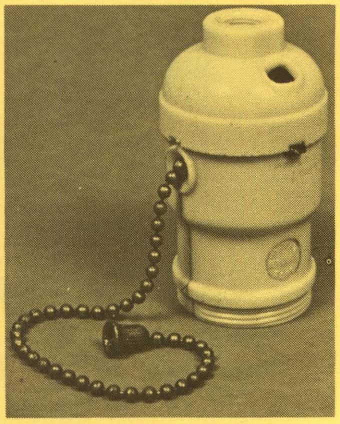
2. Take end of either wire and swing it clockwise around one of the prongs.
3. Continue same wire clockwise around and under screwhead. Let insulation come to screwhead, but not under it.
4. End of wire should reach around and under screwhead but not far enough to cross insulation.

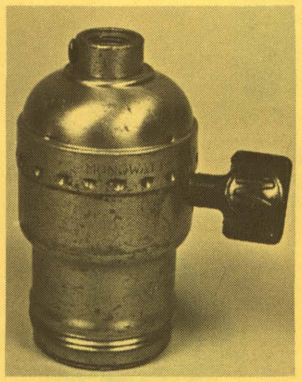
5. Tighten screw securely. Be sure no strands of wire stick out.
6. Place other wire around other prong in the same way.
7. Look at end of attachment plug. The wires make an "S" if you have done the job right.
8. Put the insulating disc over the prongs.

A LOOK AT LAMP SOCKETS

All portable lamps have one or more sockets. Lamp bulbs screw into them. Sockets often get worn, broken, or damaged. When that happens, they must be replaced. Let's learn how to do this repair job.

Plastic




Metal

Types of sockets.—There are several kinds of lamp sockets. They are made of materials such as metal, plastic, and porcelain. You can get them with or without switches. Most lamps have metal sockets with pushbutton, key, or pull-chain switches. So, let's learn how to replace a metal lamp socket.

How to Remove Socket.—Follow these steps:

1. Don't do anything until you unplug the attachment plug from the convenience outlet.
2. Cut off socket and damaged cord near it with knife or pliers.
3. Hold socket in your right hand and press hard at point marked "press."
4. Hold cap steady with left hand while you press and apply a twisting action on shell with right hand.

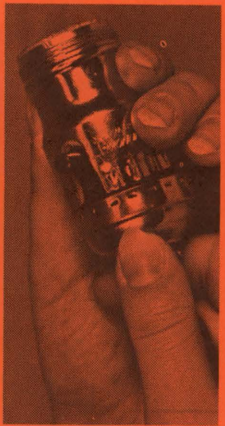
5. Remove outer shell and insulating shell.
6. Look at the 2 screws on socket body. Are both wires held firmly by the screws? If so, chances are the socket is defective and should be replaced.

7. See if insulating shell is black and charred. If so, throw the socket away.
8. If socket appears to be good, loosen screws and remove wires. Don't remove screws.

HOW TO REPLACE A SOCKET—Follow these steps:

1. Push cord through hole in cap. Be sure open end of cap is toward end of wires. See that insulating liner is in cap.
2. Prepare ends of wires like you did for attachment plug.
3. Tie the two wires into a holding (Underwriter's) knot.

4. Fasten prepared ends of wires to socket body by placing one wire under each screwhead. Wrap wires clockwise around screws.
5. Be sure insulating shell is in outer shell. Then put socket back together. A click or snap tells you the cap and outer shell are locked together.



THINGS TO DO

1. Look at all service cords on lamps and applicances in your home. List below the service cords that should be repaired or replaced:

   ----

2. Repair at least 4 service cords. Report the repairs you make on Page 2-R.

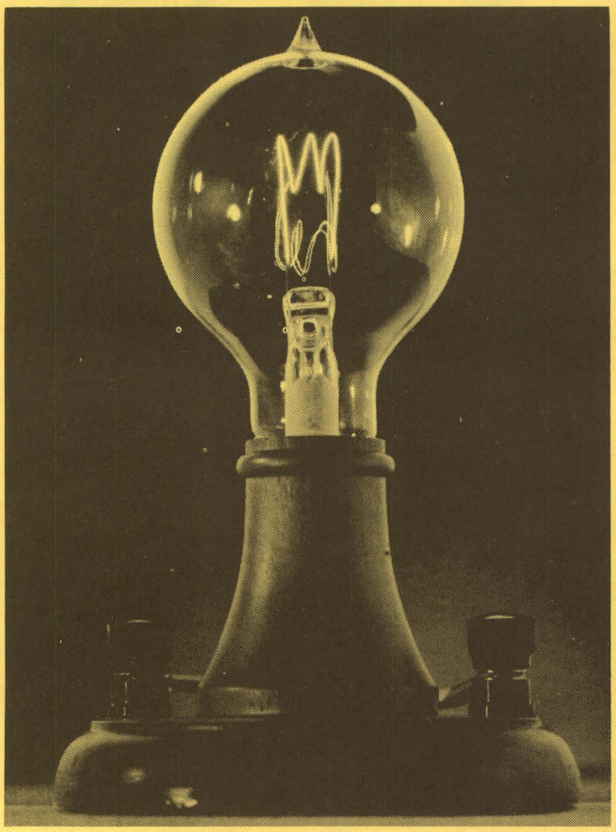
The MAGIC of Light

Light and sight are partners. You couldn't see without light. The sun floods the outdoors with light during the day. In homes, stores, and factories, we must bring light indoors. The magic of electric light does it.

Over 80% of what you learn comes through your eyes. So, lighting helps us learn. Electricity can give us the best kind of lighting for work, study, and play. Yet, we often misuse lighting and overwork our eyes. Have you noticed that when your eyes are tired, you feel tired all over? So, we need to know about lighting and how to use it.

HOW IT BEGAN

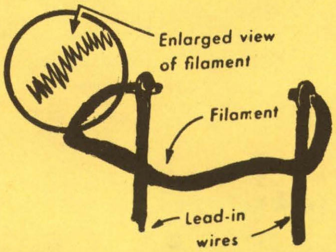
Man first used fires for light at night. Then came candles, next fuel lamps, and finally electric lamps. Thomas A. Edison made the first successful light bulb in 1879. It was crude compared to our present bulbs. His main problem was to find a material that would glow brightly and not melt. Edison experimented with hundreds of materials. He finally decided carbon was best. Carbon was used for the filament in light bulbs for many years. A material called tungsten was used in light bulbs for the first time in 1911. It is found in most light bulbs today. Tungsten has a high melting point (6120°F). That's almost 14 times greater than oven temperatures for baking biscuits.



Edison's First Lamp

HOW A LIGHT BULB WORKS

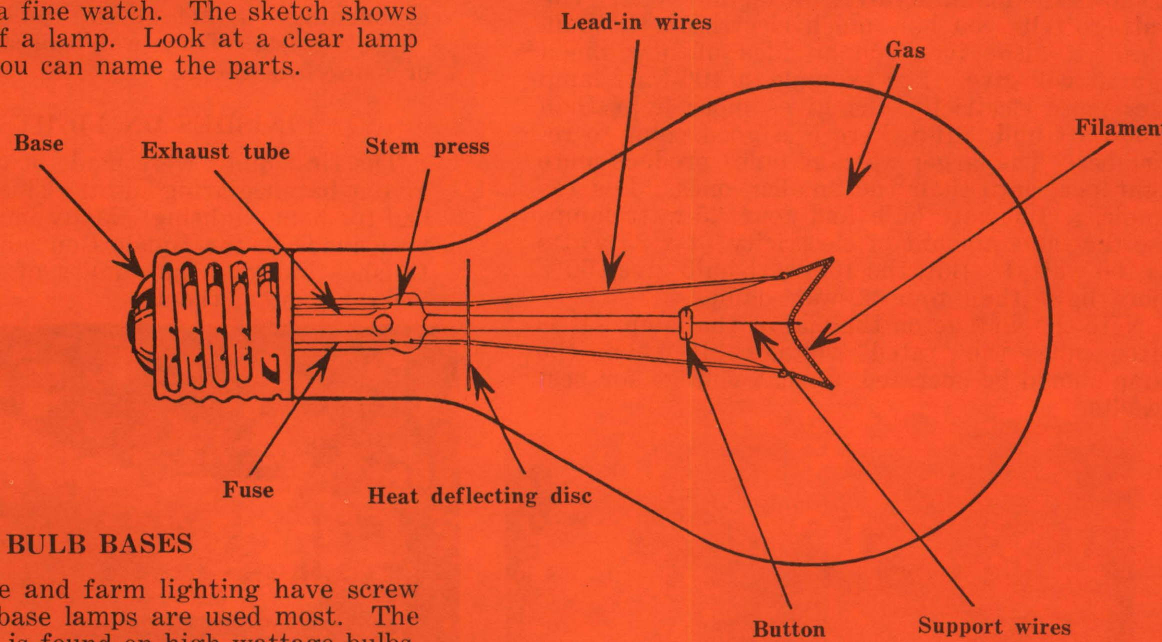
It's fun to learn how a bulb makes light. Let's see how it happens. Have you seen the element glow when an electric heater is turned on? It gives some light, but its purpose is to heat. The element would melt before it got bright enough to give much light. The filament in a light bulb works in the same way. The main difference is that the filament in a bulb gets "white hot" without melting. Tungsten has a high melting point, as we said earlier. The filament in small lamps is sealed in a glass bulb from which the air has been pumped. Without oxygen, the filament can be operated at a higher temperature without burning up. Larger light bulbs contain a nonflammable gas instead of a vacuum. These gases allow the filament to operate at still higher temperatures.



The filament may not appear to be over 1" long. Did you know it may be 24" long? The reason is the filament is usually made of coiled wire. If enlarged, it would look like a screen door spring. The filament temperature of many lamps is above 4500°F. The white glow from this high temperature is known as incandescence. So, the name given to this type of light source is "incandescent lamp." Manufacturers use the word lamp instead of light bulb.

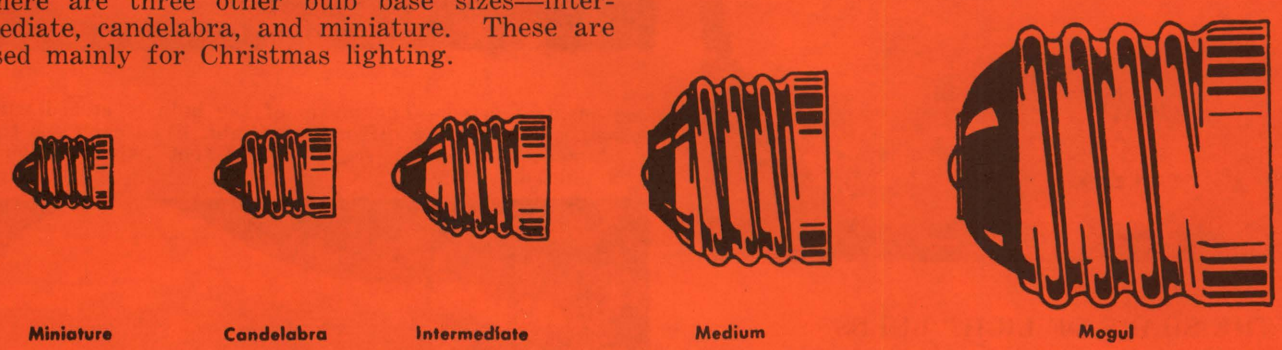
PARTS OF A LIGHT BULB

Now, let's look inside the bulb. There are many parts. Some of these parts are made with as much care as a fine watch. The sketch shows the main parts of a lamp. Look at a clear lamp bulb and see if you can name the parts.



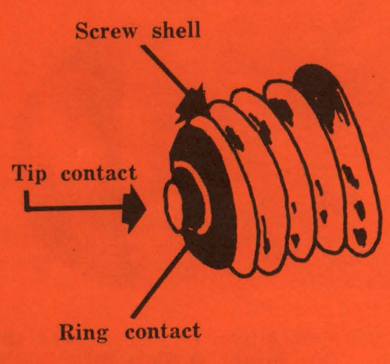
BULB BASES

Bulbs for home and farm lighting have screw bases. Medium base lamps are used most. The large mogul base is found on high wattage bulbs. There are three other bulb base sizes—intermediate, candelabra, and miniature. These are used mainly for Christmas lighting.

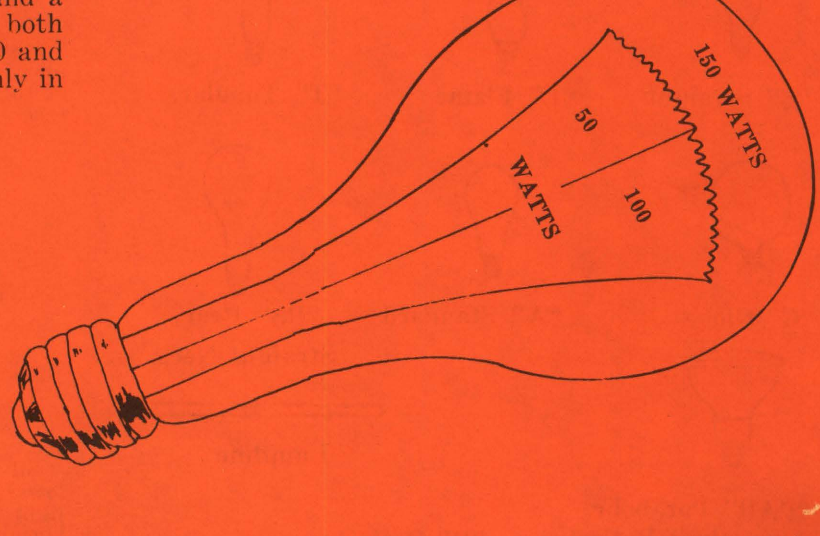


THREE-WAY BULBS

These have 2 filaments instead of one. They give you 3 levels of light from a single bulb. For example, a 50-100-150 watt bulb has a 50 and a 100 watt filament. The wattage is 150 when both filaments are on. Other sizes are 50-200-250 and 100-200-300. Three-way bulbs are used mainly in table and floor lamps.



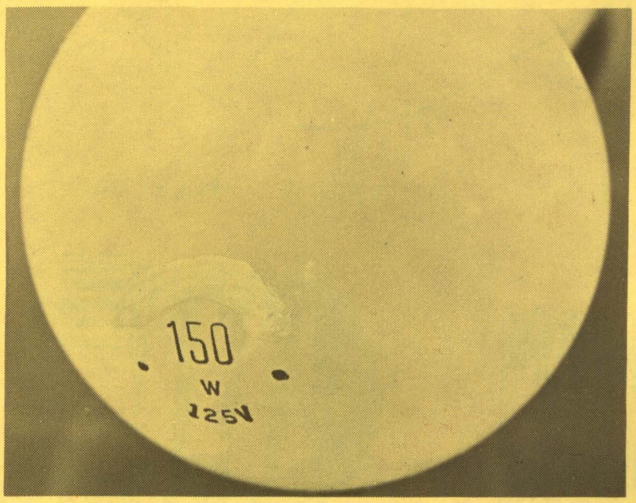
Base of 3-way bulb



THE END OF A LIGHT BULB

The end of a bulb has some important facts. It shows the manufacturer, watts, and volts. The wattage tells you how much electricity the bulb uses. It also gives you an idea of how much light it will give. For example, a 100-watt lamp uses more electricity and gives more light than a 60-watt bulb. But, here is a good point to remember. The larger wattage bulbs produce more light per watt than the smaller ones. For example, a 100-watt bulb and four 25-watt lamps use the same amount of electricity (4 x 25 watts = 100 watts). But, the 100-watt bulb gives 50% more light than four 25-watt lamps.

Note the voltage on the end of the lamp. It is often called the "rated" voltage. It means the lamp should be operated on that voltage for best results.



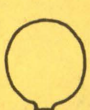
THE SHAPE OF LIGHT BULBS

Let's learn about bulb shapes used in and around the home. The sketches below show the most common ones.

"S" Straight

"F" Flame

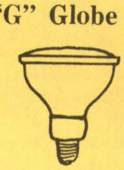
"T" Tubular



"G" Globe

"A" Standard

"PS" Pear, Straight Neck



"PAR" Parabolic Aluminized Reflector

"R" Reflector

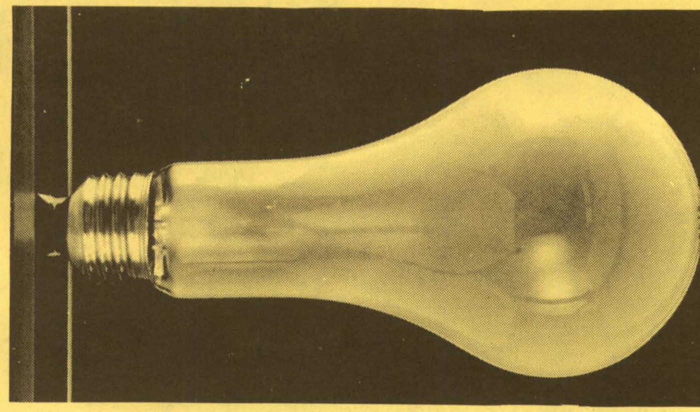
Lumiline

THE GLASS IN LIGHT BULBS

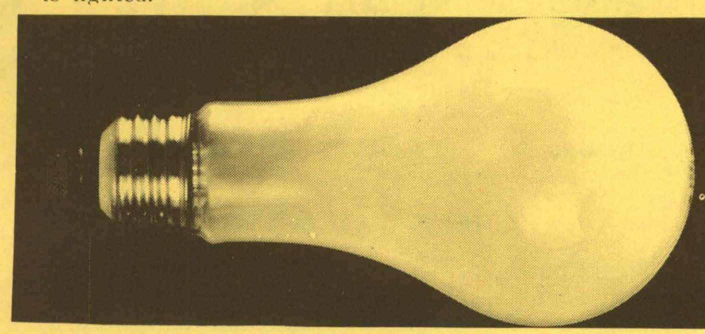
Most light bulbs are made of soft glass. They often break if water touches them while the bulb is burning. Some special bulbs are made of "hard" glass. They won't break if rain, sleet, or snow hits them.

FINISHES ON LIGHT BULBS

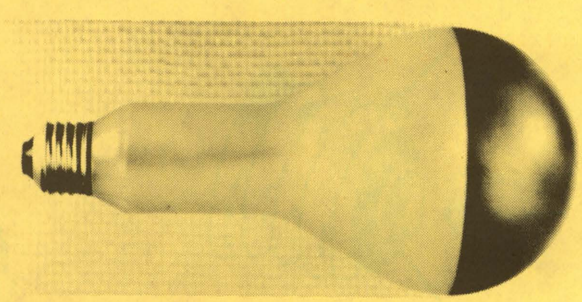
The first bulbs were made of clear glass. They give a harsh glaring light. This type of bulb is bad for home lighting. Many improvements have been made in the finishes on lamp bulbs. These finishes improve the quality of the light. Let's look at some of them.



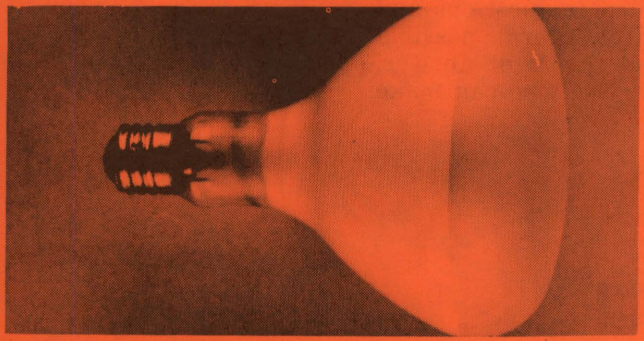
Inside frosted.—The inside of the bulb is etched with acid. This frosting diffuses the light. You can't see the filament but you can see a "bright spot" when the bulb is lighted.



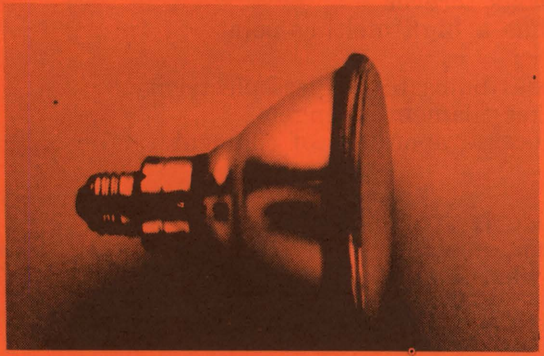
Inside Coated.—A thin coating of white powder is applied on the inside of the bulb. It gives good diffusion of the light. The light spreads over all of the bulb surface. There is no "bright spot" near the center.



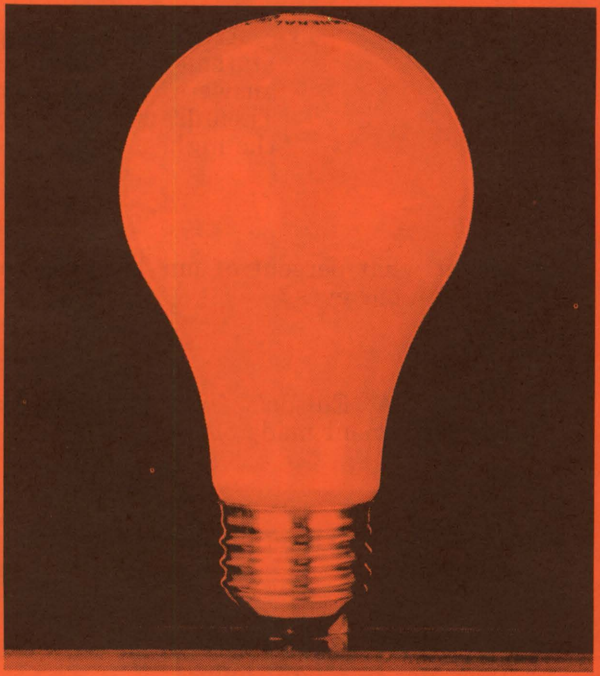
Silver Bowl.—A coating of silver is placed over the lower half of the bulb. This bright surface reflects the light upward. The silver coating prevents seeing the "bright spot" in the bulb. It is burned base up.



Reflector Bulb.—The upper portion of this bulb has an interior coating of silver. This directs the light in a beam. One type is the "R" bulb. It is available in "flood" (wide beam) and "spot" (narrow beam) models. This bulb is made of soft glass and must be protected from rain and snow if used outdoors.



PAR Bulbs.—This bulb is for outdoor use. It is made of "hard" glass and won't break when hit by rain or snow. The PAR bulb is available in 'flood" and "spot" types.



Bug Lamp.—Many night-flying insects are attracted by light. Yellow "bug lamps" will keep them away. These bulbs don't repel insects. We just pull a trick on them. Insects can't see yellow light.

WHY LAMPS GET DARK

Have you noticed how a bulb darkens after it has burned a long time? The filament slowly evaporates and makes a black deposit inside the bulb. Darkened bulbs don't give as much light as new ones. Evaporation of the filament finally causes it to break. Then you have a "burned out" bulb.

Light Magic

LET'S PLAY LIGHT MAGIC

At the left of the page are some questions and statements. Beside each are several possible answers. See if you can find the right answer. Then draw a circle around it. See who can make the highest score.

1. About what percent of our learning comes through our eyes?	50% 60% 80% 95%
2. Thomas A. Edison's first successful lamp had a filament made of:	copper steel carbon aluminum
3. One reason why tungsten is so good for lamp filaments is:	it has a low melting point it doesn't use much electricity it lasts forever it has a high melting point
4. Inert gas in a light bulb:	causes bulbs to use less electricity makes filament stronger reduces evaporation of filament
5. The proper name for the lamps we have studied is:	inside frosted bulb incandescent lamp all-white bulb
6. Which size of bulb base is used most in light bulbs used in the home?	intermediate miniature medium mogul
7. Compare the light given off by a 200-watt bulb and 4, 50-watt bulbs.	same amount 200-watt bulb gives more light 4, 50-watt bulbs give more light
8. A three-way light bulb has:	1 filament 2 filaments 3 filaments 4 filaments
9. You can't see the "bright spot" when this bulb is burning.	inside frosted bulb inside coated bulb clear bulb
10. Which one of these bulbs won't break in rain?	clear bulb inside frosted bulb reflector bulb PAR bulb
11. Bug lamps keep insects away because:	yellow light frightens insects insects don't like yellow light insects can't see yellow light
12. Lamp bulb darkening is caused by:	high voltage evaporation of filament low voltage turning bulb on and off

Lighter Homework

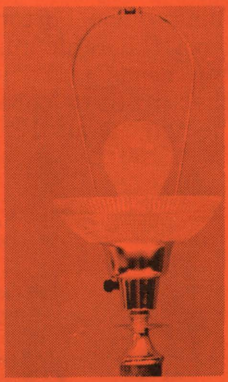
There's homework to do! You must study your lessons. Have your parents ever mentioned these things to you? They know study goes along with learning. Each boy and girl needs a good place to study—one you can call your own. It needs to have good lighting, too. Don't study just any place with any kind of light. Bad lighting causes you to get tired sooner—your work takes more time. So, good lighting can help you do homework faster and easier. You may make better grades, too. Let's find out how you can have a well-lighted study center.

A "Better Light Better Sight" table lamp is best for lighting a study center.

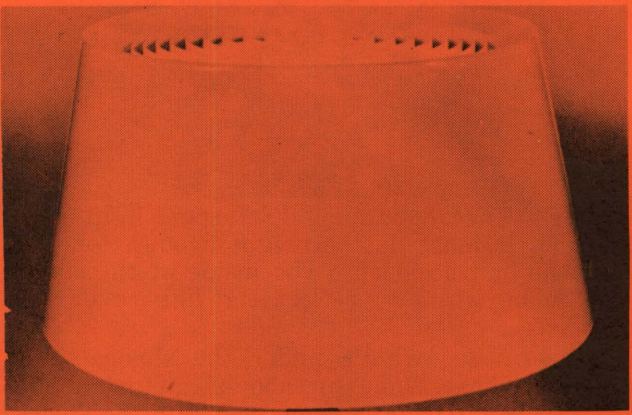
A table lamp can give good lighting for your study center. It must have features which provide enough light. It must also reduce glare and shadows. The best table lamps for a study center will have a "Better Light Better Sight" tag on them. Look for the tag — it tells you the lamp meets the needs for your study center.

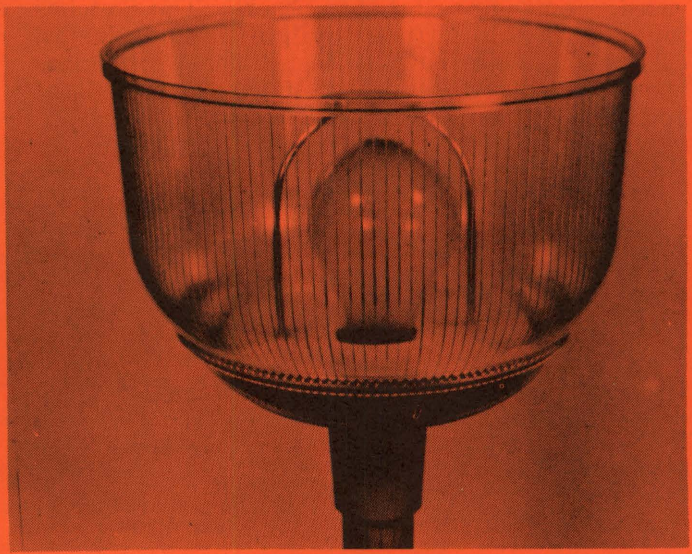
You will find either a prismatic refractor or a prismatic lens bowl on "B-L-B-S" lamps. They also have a perforated metal disc near the top of the shade. These two parts help spread light evenly over the study area. These lamps use a 200-watt inside frosted bulb. They provide light of good quality.

Look for a lamp with this tag.



(a)





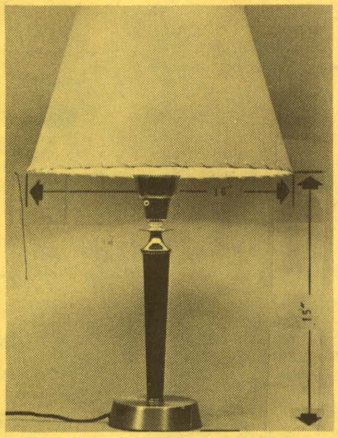
(b)

You can buy BLBS lamps with: (a) prismatic refractor and (b) prismatic lens bowl.

OTHER LAMPS

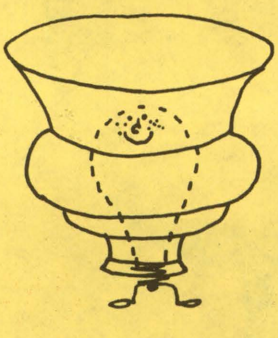
Other types of lamps can be used for a study center. They aren't as good as the "Better Light Better Sight" lamp. They are often much better than those boys and girls are now using. What should we look for when buying a lamp which does not have the "Better Light Better Sight" tag?

Dimensions.—The bottom of the shade should be 15″ above the table top. The overall height of the lamp needs to be about 25″. The shade can be either drum or cone shaped. It should be open at the top, about 10″ deep and 16″ wide at the bottom.

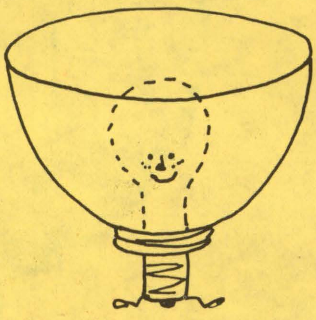


Shade.—The shade should let some light pass through. It must not be bright enough for you to see the bulb location. The inside of the shade needs to be white to reflect the light over the study area.

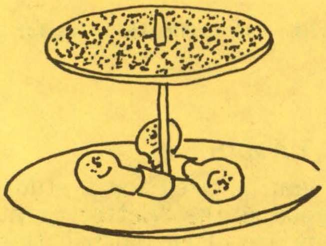
Diffuser.—See what's under the shade. The lamp must have some method of diffusing the light. This diffusion softens the light—reduces glare and shadows. Several types of diffusers are used. Some are better than others. The sketches show 3 ways to diffuse the light in study lamps. The CLM white bowl is best. The white glass bowl-shaped diffuser is better than one made of plastic. A plastic disc is a low cost diffuser.



A. CLM glass diffuser



B. Bowl-shaped glass diffuser



C. Plastic diffusing disc

What Size Bulb is Needed?—Don't use a bulb smaller than 150 watts in a study lamp. At least 200 watts is recommended if the lamp has diffuser A or B. Some study lamps with A or B diffusers have 3-way sockets. If yours has one, select a 50-200-250 watt bulb for your lamp.

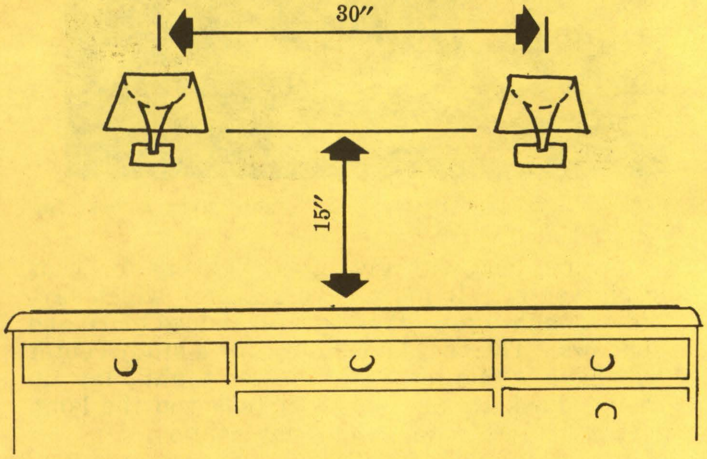
A PAIR OF LAMPS FOR STUDY

Two lamps give good light for study. They spread the light over the whole desk top. Either table or wall-hung lamps will do the job. A large desk is needed if 2 table lamps are used. Wall lamps don't require any desk space.

Shade.—The shade on each lamp should be at least 6″ wide at the top, 7″ deep, and 10″ wide at the bottom. The shade should let some light pass through. It must not be bright enough for you to see the bulb location. The inside of the shade should be white.

Diffusers.—The lamp needs some kind of diffuser. It can be a glass or plastic diffusing bowl or a plastic disc.

Bulbs.—Use a 100 watt or larger bulb in each lamp.

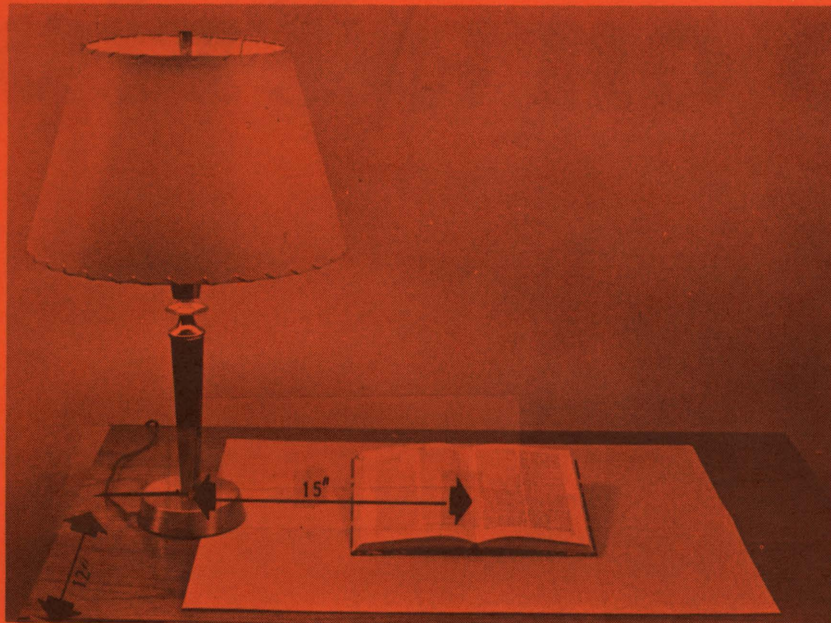


WHAT MAKES A GOOD STUDY CENTER

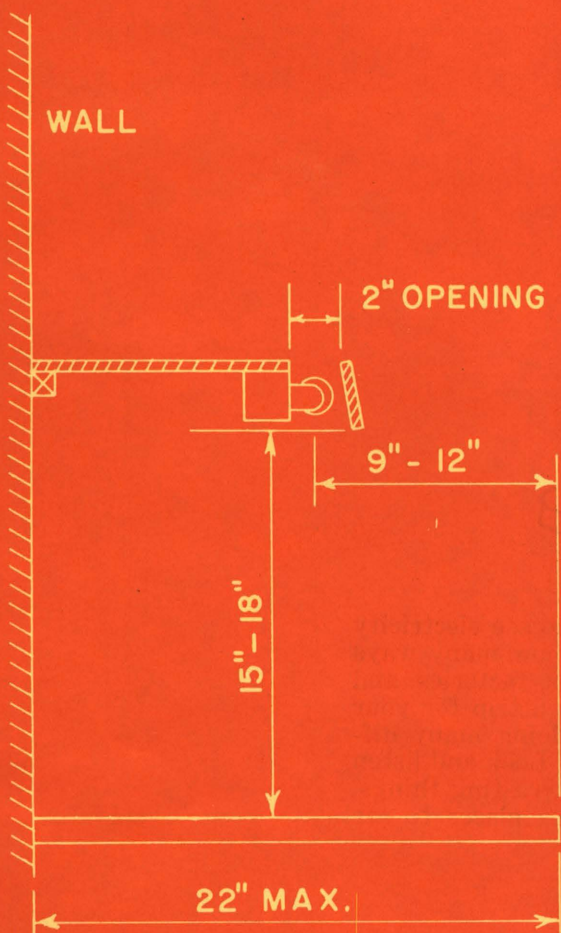
Good lighting is a must. Your study center must have other features too. You will need a flat-top table or desk about 26 x 46″ in size and 28-29″ high. The surface should be non-glossy and light in color. If the top is dark, cover it with a large light-colored blotter or other material. Place the desk against the wall—never in front of a window. You need a light-colored wall in back of your desk. If the wall is dark, cover it with light-colored pegboard or tackboard. Use a straight chair. Your eyes should be at least 14″ above the work surface.

WHERE TO PLACE A TABLE LAMP

You can't have a good study center unless the lamp is in the right spot. Let's see how to place a lamp to get the best lighting on the work area. The following photograph shows exactly where to spot the lamp. Follow the dimensions shown



in setting up your study center. Should the lamp be 15″ to the right or left of the center of your work? That depends upon your writing hand. If you are right-handed, place the lamp to the left. Put it on the right side if you are left-handed. Then your hand won't cast a shadow on your work.



LIGHTED SHELF

Here is another way to light a study center. It is simple and you and your Dad can build it. It uses a fluorescent tube instead of an incandescent light bulb. You will learn more about fluorescent lighting in another unit. Note the fluorescent tube under a shelf. You can keep books on top of the shelf. Follow the dimensions in the sketch in building it. The 2-inch opening above the tube lets light go upward for general lighting. Paint the interior of the shelf white for good light reflection. Use a deluxe warm white fluorescent tube not smaller than 30 watts.

THINGS TO DO

Turn to page 2-R and explain what you did on home lighting.

Let's go on a Trip

It's a lot of fun to go on trips to see electricity at work. You just can't believe how many ways electricity is used in homes, stores, factories, and on farms. Your leaders will plan a trip for your group. You will see electricity doing many different jobs. Be sure to go along. Look and listen carefully. You will learn many interesting things. Your parents may take you other places to see electricity at work.

THINGS TO DO

Write on Page 3-R the names of homes, farms, stores, and factories you visited to see the ways electricity is being used.

My 4-H Electric Project Record

Electro 2

Year____________

Name ____ Age ______________

Address ______________________________ County or City ______________________________

Name of Club ____

Fill in this record and turn it in when your leader asks for it. That is the way to complete project Requirement No. 7.

1. a. Did you learn how electricity helps in other projects? (check √ one) Yes_____ No_____
   b. List the electrical equipment you have used in other projects:

Name of Project	Equipment Used
______________________________	______________________________
	______________________________
______________________________	______________________________
	______________________________
______________________________	______________________________
	______________________________

cut along this line

2. a. List the electrical equipment that was bought or made during the year and the cost of each.

Equipment bought or made	Cost	Equipment bought or made	Cost
______________________	________	______________________	________
______________________	________	______________________	________
______________________	________	______________________	________
______________________	________	______________________	________

   b. Discuss with your parents what additional electrical equipment is needed most and list it below:

____

____

3. Did you learn about electrical terms and how to use them? Yes _____ No_____. If so, define the following terms:

   a. Volt ____

   b. Ampere ____

   c. Watt ____

4. Did you learn about fuses and circuit breakers? Yes_____ No_____. If so, answer the following questions:

   a. Is your home wiring protected with fuses or circuit breakers? ______________________________

   b. If fuses are used, how many of them have one element? ______________________________________

      How many have 2 elements? ______ Do you have on hand extra fuses of the proper size? Yes_____ No_____.

   c. If circuit breakers are used, list the ampere rating of each breaker __________________________

____

5. Check below the activities you did during this year (3 required):

   a. Learned about electromagnets ____________ b. Repaired 4 service cords ____________

   c. Learned about light bulbs and how to select them ____________

   d. Remodeled or made a lamp ________

   e. Set up a study center ____________

   f. ____________________________ __________

   g. ____________________________ __________

   h. ____________________________ __________

   i. ____________________________ __________

Explain below what you learned by doing the activities you checked above. (Use additional sheets if needed)

____

____

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6. Check below what you did this year (2 required):

a. Gave talk or demonstration ________________

b. Made poster or exhibit ____________________

c. Visited electrified home, farm, or industry ____________

List what you did in the proper space below:

a. Talks and demonstrations given. ___________

Date	Subject	Talk or demonstration	Kind of meeting	Attendance

b. Posters and exhibits

Name of Posters or Exhibit	Where it was shown

c. List names and addresses of electrified homes, farms, or industries visited and uses of electricity observed at each place. (Use space below, and additional sheets if needed.)

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