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ELECTRICITY

for the 4-H scientist

Safety
Uses
Economy

DIVISION II
4-H ELECTRIC

TEACHING · RESEARCH · SERVICE

UNIVERSITY OF IDAHO
College of Agriculture

4-H Electric, Division II

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Name ....

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UNIVERSITY OF IDAHO
COLLEGE OF AGRICULTURE
AGRICULTURAL EXTENSION SERVICE

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MAKE A TEST LAMP

A handy addition to the electrician's tool kit of any 4-H member is a test lamp. When an electrical appliance doesn't work or there is trouble on a circuit, the test lamp can be used to find out where the trouble is. At least, the test lamp will show whether the circuit is alive or dead, "hot" or "cold."

There are many uses for a test lamp around the home and farm. With the lamp you can test appliance outlets, wall receptacles, trace electric circuits, check the main fuse or circuit-breaker box, and tell 115 from 230-volt lines.

WHAT TO DO: Make A Test Lamp

Materials Needed:

1. A 230-250-volt, low wattage bulb, rough service, if available.
2. At least two feet of No. 14 rubber-covered wire
3. A roll of plastic tape or a roll each of rubber and friction tape
4. A non-metallic, weatherproof lamp socket
5. Solder and flux

Tools Needed:

Your electrician's kit, or pliers, pocketknife and soldering iron

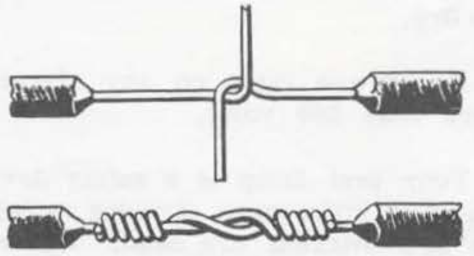


Figure 1

Figure 2

Steps to Take:

1. Cut the wire into two equal lengths. Strip two inches of insulation from one end of each piece and one inch from the opposite end.
2. Strip two inches of insulation from the wire leads of the weatherproof socket. Scrape the exposed wire ends clean.
3. Using a common wire splice join a length of wire to each of the socket leads, leaving the one-inch stripped end free (Figure 1).
4. Solder and tape each joint. If you use rubber tape, cover with an outer layer of the friction tape.
5. Bring the wire leads up against the sides of the base of socket, one on each side and tape securely. Cover any metal with tape.

6. Bend wires around the light bulb as shown.

7. Wrap at least two layers of tape around widest part of bulb and over the end, as in the picture (Figure 2).

Note: You can make a similar test lamp for use with battery-powered equipment such as your car or tractor. Use doorbell wire and a flashlight or auto light bulb, instead of the heavy wire and large bulb.

Demonstrations You Can Give

Show how to make a test lamp.

Show how to test a convenience outlet or a branch outlet to see whether it is "hot" (Figures 3 and 4). Tell how the test lamp glows brightly on 230-volt circuits and dimly on 115-volts.

Explain how to trace a branch circuit. You might even draw a diagram of a typical circuit with its outlets.

Using the battery-size, test lamp, trace a circuit on a tractor.

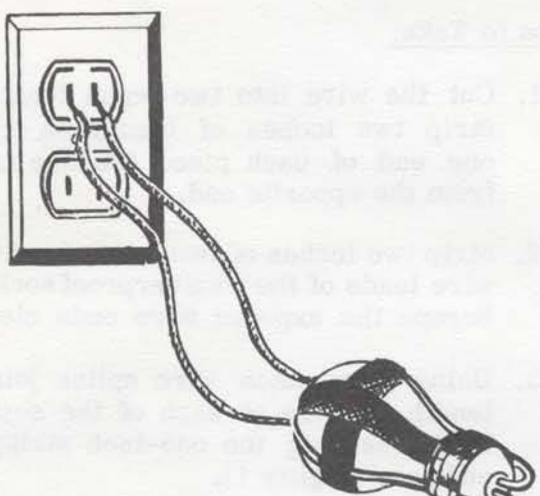


Figure 3

What Can You Exhibit?

A neatly made test lamp makes a good exhibit.

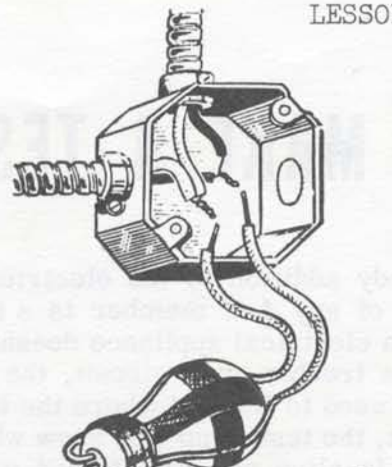


Figure 4

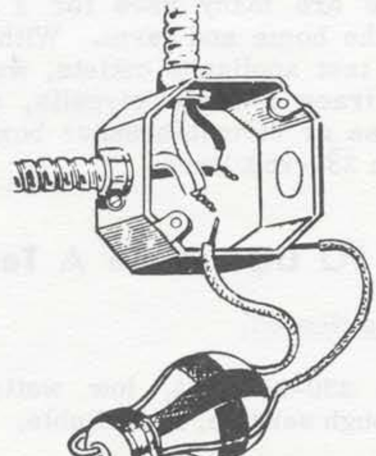


Figure 5

Test all metal boxes to make certain they are not "live".

SAFETY TIPS

Always grasp only the insulated portion of the test lamp. Use just one hand, if possible.

Never use test lamp when it is wet.

If surroundings are wet or damp, stand on a dry board when using test lamp. Better yet, wait until surroundings are dry.

Never use lamp on any circuit of more than 240 volts.

Your test lamp is a safety device. Use it to make sure circuits on which you are working are dead. Never be "fairly sure." Always be certain.

KNOW YOUR IRON

THE MODERN HAND IRON

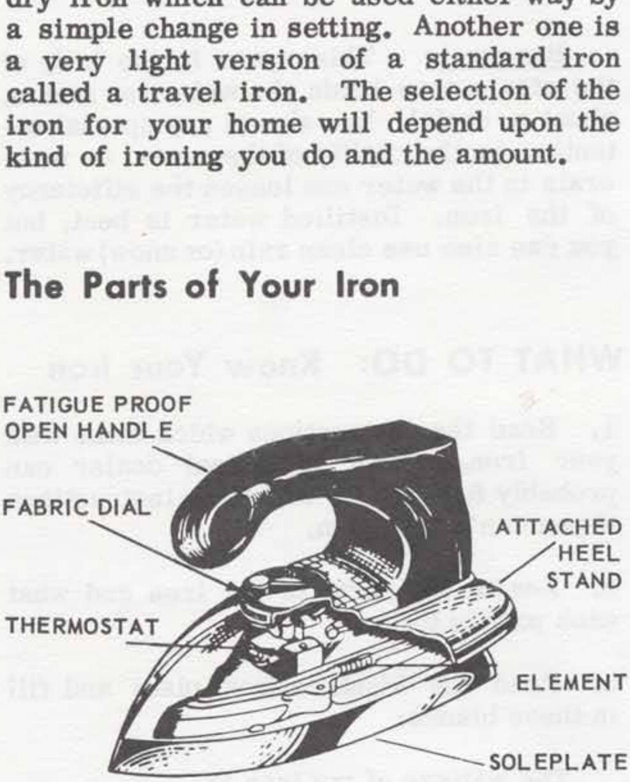
A long time ago, when ladies wore ruffles and bustles, ironing was a real chore. While great-grandmother pushed one heavy flatiron, others were heating on the stove. When the one she was using cooled, she put it on the stove and switched to one of the others.

Modern irons are a lot better - lighter, automatic, and designed to handle easily those corners, gathers and pleats. Ironing won't be a chore if you learn about your iron, its care and proper use. Let's take a good look at your iron and its parts.

Classes of Irons

You have probably seen many different kinds of irons displayed in stores. But there are two basic classes of irons - the dry iron and the steam iron. There are many different types of these basic classes. One of these is a combination steam and dry iron which can be used either way by a simple change in setting. Another one is a very light version of a standard iron called a travel iron. The selection of the iron for your home will depend upon the kind of ironing you do and the amount.

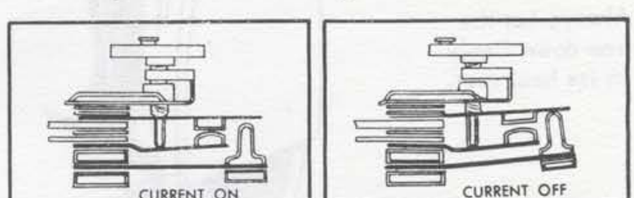
The Parts of Your Iron



The Sole Plate - Your iron slides over the material on its sole plate. For this reason, the sole plate should be smooth, well-polished, and, of course, rust resistant.

Heating Element - A heating unit is in the sole plate. This element works just like the heating element in an electric range. It resists the flow of electricity and gets hotter and hotter as electricity flows through it.

Thermostat - Most modern irons have a thermostat which turns the electricity on and off automatically so that the iron will not just get hotter and hotter. It is a strip of two different kinds of metal fastened together. One metal expands faster than the other when heated. This causes the strip to bend. As it bends, it opens the electric circuit, the electricity is cut off and the



iron stops heating. When the iron cools a little, the strip straightens out, the electricity is turned on and heating starts again.

Indicator Dial - The dial is used to set the thermostat so the iron will maintain the proper temperature for different materials. When you set the thermostat for a high

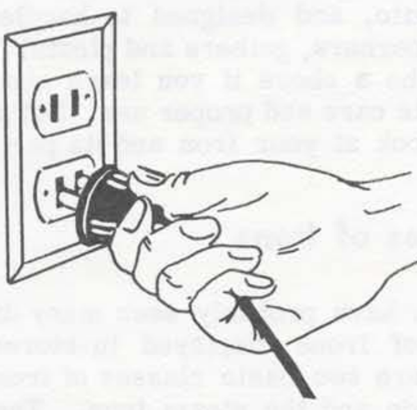
heat, you're simply fixing it so that it will have to bend farther before the current is cut off. The indicator is often marked in types of cloth instead of degrees of temperature.

Handle - Everyone knows what the handle is, but in an iron you'll probably want to know that it is heat-resistant and doesn't conduct heat from the iron to your hand. Also, handles come in different designs. Some homemakers prefer a handle that is open at the front so they can run the iron inside shirt-sleeves and pockets easily.

Rests - Older type irons usually had rests, trivets, on which the iron could be set while it was hot. The modern iron has a built-in rest, usually the back of the iron. The rest should be solid so the iron won't topple easily.

Always set the iron down firmly on its heel rest.

Cord - Cords are usually permanently attached to modern irons except on travel irons. Rubber or plastic sleeves at the point where the cord enters the iron are long enough to prevent the cord from being sharply bent at this point. Cords for irons are about six feet long. If a longer cord is needed, an extension cord can be used, provided it is of, at least, No. 16 asbestos insulated wire. Do not use a cord longer than 10 feet total (6 foot iron cord plus 4 foot extension). A longer extension cord, or one with smaller wire will not permit the iron to heat properly.



Take hold of the plug, not the cord, when you disconnect it from the outlet.

Reservoir - This space in the body of the steam iron holds the water for steam, about a cupful. You should pay special attention to the quality of the water, as minerals in the water can lessen the efficiency of the iron. Distilled water is best, but you can also use clean rain (or snow) water.

WHAT TO DO: Know Your Iron

1. Read the instructions which came with your iron. Your electrical dealer can probably furnish you with these instructions if you can't find them.

2. Learn the parts of the iron and what each part is for.

3. Read the identification plate and fill in these blanks:

The wattage of my iron is____________. It is a ____________-type iron. Does the thermostat cut off electricity promptly? No.__________ Yes.__________ What current does the iron work on? AC______ DC______. The manufacturer is____________________.

4. Be sure you have a proper electrical outlet in which to connect your iron.

5. For a month, iron your cotton and linen clothes. Learn to iron your father's or brother's work and sport shirts. Do all the small flatwork ironing for the family.

6. Make a chart similar to the one shown here and list the number and kinds of things you ironed. Specify on which you used a dry or steam iron. Keep the chart for two months.

7. Learn and practice proper care of your iron.

Demonstrations You Can Give

1. Explain types of irons and how to care for them. While explaining dry and steam types, combine explanation with the ironing of three garments of different fabrics, such as silk, wool, cotton, linen or man-made.

2. Tell and show how to set up an ironing center.

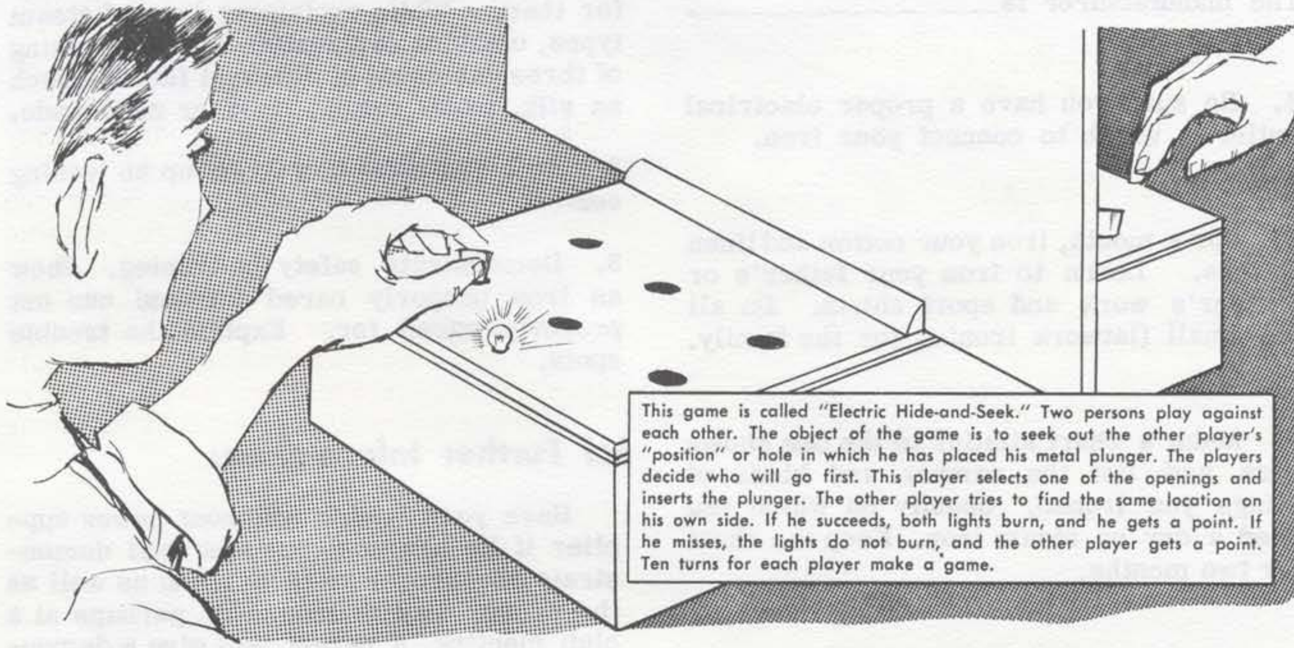
3. Demonstrate safety in ironing. Show an iron properly cared for and one not properly cared for. Explain the trouble spots.

For Further Information:

Have your leader ask your power supplier if he has someone who will demonstrate the proper care of irons as well as the proper way to iron. Or perhaps at a club meeting, a parent will give a demonstration of how to iron different articles using different kinds of irons.

Date	Articles	No. Ironed	Type of Fabric	Heat Setting Used	Care of Iron - (Clean, Inspect Cords, Store)

AN ELECTRIC GAME YOU CAN BUILD



This game is called "Electric Hide-and-Seek." Two persons play against each other. The object of the game is to seek out the other player's "position" or hole in which he has placed his metal plunger. The players decide who will go first. This player selects one of the openings and inserts the plunger. The other player tries to find the same location on his own side. If he succeeds, both lights burn, and he gets a point. If he misses, the lights do not burn, and the other player gets a point. Ten turns for each player make a game.

Do you know:
That you can make electrical games and puzzles that won't cost very much and that will give you and your friends a lot of fun?

That if you use a flashlight cell for a power supply, your game will be absolutely safe?

What a simple electrical circuit is?

That such a circuit may be used to detect the presence or position of certain things?

That there may be more than one switch in such a circuit?

That a circuit is not complete unless all switches in it are closed?

How to "read" a simple wiring diagram?

Where to get information on other electrical games?

You will learn these things, and more, if you make this electrical game.

What to Do

1. Learn what makes a simple electrical circuit.

2. Learn how a simple switch works.

3. Learn how to read a simple wiring diagram.

4. Make an electric hide-and-seek game, test it, and paint it.

Tools and Materials You'll Need

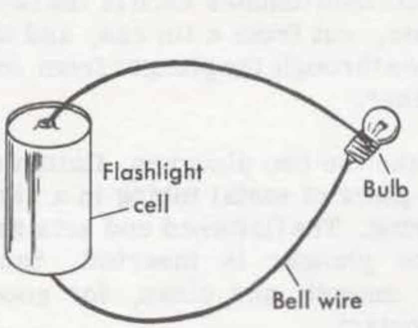
Hand saw (crosscut)
Try square or ruler
Tin shears
Pencil
Soldering iron or gun
Can opener
Drill with assorted bits
Screwdriver
Small hammer
A sharp 8d or 10d nail
Pliers
Pocket knife
Hack saw
Sandpaper
Paint brush
Cigar box
1 pc. 1/4" plywood, same size as cigar box top (usually about 9" x 5-1/2")
1 pc. 1/4" plywood or hardboard (1/8" or 3/16") 8 to 9 inches by 10 to 12 inches.
2 pcs. quarter round molding or 3/4" square wood 5-1/2" long
Two or three tin cans
2 pcs. 1/4" to 1/2" copper or aluminum tubing--2" long

24 carpet tacks
Wire brads (3/4")
7 ft. bell wire
1 flashlight cell
2 flashlight bulbs (type 112 or 123)
Solder and soldering paste
Enamel paint of a color you like

What Is A Circuit?

Electricity must flow through a wire before it will do any work, such as making a light bulb burn. It will not flow unless it is connected back to its source by means of a wire or the ground.

We could say, then, that an electrical current goes in a circle, but instead we use a similar word and say that it flows in a circuit.



Here's a diagram of a simple electrical circuit. The dry cell or battery is the source of electricity. The current flows through a wire leading from one terminal of the cell to one of the terminals of a lamp bulb. It then flows through the filament of the bulb, then out the other terminal and through another wire back to the second terminal of the dry cell.

The circuit is complete. Because there are no breaks in it, the electricity flows through it and makes light.

What Is A Switch?

If you were to disconnect one of the wires from the dry cell, the light would go out. The reason for this is simple--the current would no longer have a path over which to flow.

By breaking the circuit at that point, you would create a simple, but inconvenient switch. (If the voltage produced by the cell were as great as that in the wiring of your home, you would also have an unsafe switch, because it requires that you touch current-carrying parts.)

There are many types of switches, but they all have the same job--to "make" and "break" a circuit. In the walls of your home are many switches. They also are in portable lamps, appliances, power tools, and in farm and industrial equipment. Some are tiny, and others are very large. Some make contact only when you hold your finger on a button, others snap into position, and still others may be automatically controlled by some change, as in temperature.

There can be more than one switch in a circuit, but to have a flow of current, you can see that all of them must be closed. In other words, there must be a complete path for the current, or it will not flow. This is the principle of the electric hide-and-seek game.

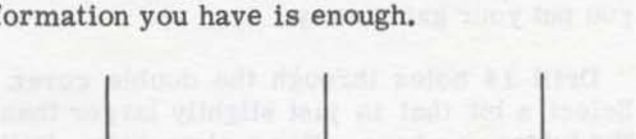
How To Read A Wiring Diagram

A wiring diagram tells you how to connect the electrical parts of something. Because this diagram is on a flat piece of paper, and because wires must often pass over each other, there must be a way to tell you whether they are to be joined or not.

If wires are to be joined at a crossover, the diagram will have a heavy dot there.

If wires are not to be joined at a crossover, then there will be no heavy dot, or there may be a U-shaped curve in one wire.

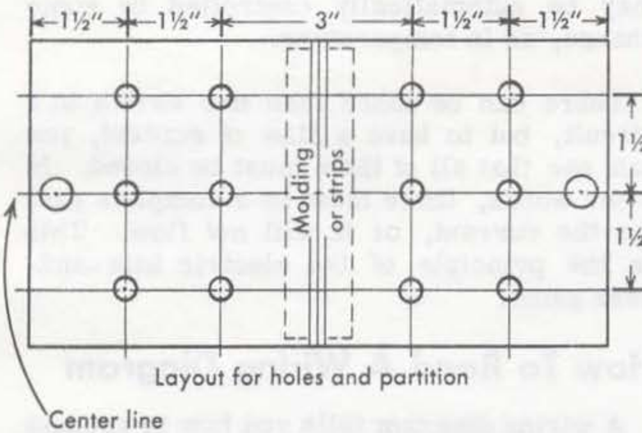
There are other things you should know about a wiring diagram, but for now, the information you have is enough.



Make The Large Parts

Cut a piece of 1/4" plywood the same size as the cigar box top, but long enough to be even with the very ends of the box. Sand the edges and corners. Tack it to the box top using a wire brad at each corner, clinched on the underside. See Page 6.

Make the partition, using the larger piece of plywood or hardboard. It can be as large as 9" x 12" or as small as 8" x 10".



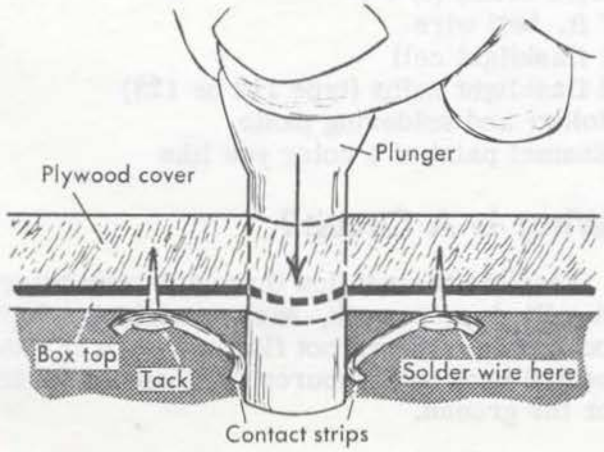
Layout for holes and partition

Lay out the location of the partition and the holes according to this drawing. Draw an additional line on each side of the partition center line, each line half the thickness of the partition away from the center line. If you are using 1/4" plywood for your partition, each of these lines would then be 1/8" away from the partition line, and 1/4" away from each other.

Have someone help you attach the strips of molding or 3/4" wood, driving the brads up from below. Your partition should fit snugly, but so that you can remove it when you put your game away.

Drill 14 holes through the double cover. Select a bit that is just slightly larger than the tubing you have. For a clean hole, drill from the top of the lid with the box open. Perhaps you can have someone help you hold it flat on a wood block. When you drill the holes for the light bulbs, select a drill that will let them fit snugly.

Make The Small Parts



The switches in your game will be like the cross-section drawing here. The circuit is normally open, and is closed only when you put one of the metal tubing plungers into the hole. This then touches each of the two strips of tinplate, cut from a tin can, and the current flows through the plunger from one strip to the other.

To make the two plungers, flatten one end of each piece of metal tubing in a vise or by hammering. The flattened end acts as a stop when the plunger is inserted. Sand each plunger smooth and clean, for good electrical contact.

Before you make the contact strips from tin can material, you should know that its edges can produce a severe cut. Be on guard against this, or protect yourself by wearing gloves for this part of the work.

Remove both ends from the cans you have by using a can opener. Split the resulting cylinders from top to bottom using the tin shears. Flatten this sheet, and with a sharp nail mark off 24 pieces 3/8" by 1-1/4". Cut them apart.

Using a sharp nail, punch a small hole about 5/16" in from one end of each strip. Bend the strips as shown, using the edge of a block of wood.

Make contact strips for the dry cell, using 1" strips of metal. Bend them so as to make good contact. Punch holes for attaching. Bend another piece to make a strap over the middle of the cell, with a hole in each end for a tack.

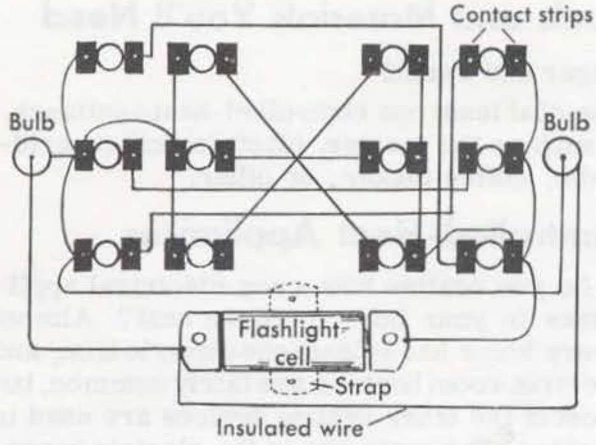
Assemble And Wire The Game

Everything must be in the right place for your game to work properly. If you use care in putting the electrical parts together, your game will last a long time and give you a lot of fun.

Before you mount the contact strips on the underside of the box cover, drill a practice hole in a piece of scrap wood and attach two of the strips to it using carpet tacks through the holes you made. There should be a gap between them. Try one of the plungers to see if you have the strips bent and attached so as to make contact with it. If not, make the necessary changes.

Then, attach the 12 pairs or strips in the proper position, using the tacks.

Attach the dry cell or battery, using the strap you made. Clinch-nail (from the bottom) a small piece of plywood inside the bottom of the cigar box first, so that the tacks you use to hold the strap will not come through. Then tack the contact strips in place.



Next, study the wiring diagram, making sure you understand it. Then, using the bell wire, attach it to the strips by soldering, following the diagram exactly. Also, solder the wires to the bases of the bulbs--one to the center contact, and the other to the threaded part. Then press bulbs down into their holes. Do not use any more solder than necessary.

Test Your Work

You may have noticed that the game is wired so that the left front hole on one side is connected to the left front hole on the other side of the partition, and so on.

To test it, then, you should put the two plungers in each pair of corresponding holes, and both lights should burn each time.

After you have completed a satisfactory test, paint the game. Paint the partition separately--the paint where it fits in the slot will serve to make it more snug. Make sure that paint does not drip down the holes onto your contact strips.

What Did You Learn? (True or False)

1. A break anywhere in an electrical circuit will prevent the current from flowing.

2. The only requirement for a switch is that it open and close the circuit.

3. If a wiring diagram shows a heavy dot at a crossover, it means the wires join.

4. You can safely touch parts carrying current from one flashlight cell.

5. Cleanliness and freedom from paint are not important on electrical contacts.

6. Safety is not important when you are building something.

Demonstrations You Can Give

Using a board on which you have mounted a dry cell, simple switch, and a light bulb, demonstrate the requirements for a simple circuit. Show why switches are designed for safety and located for convenience.

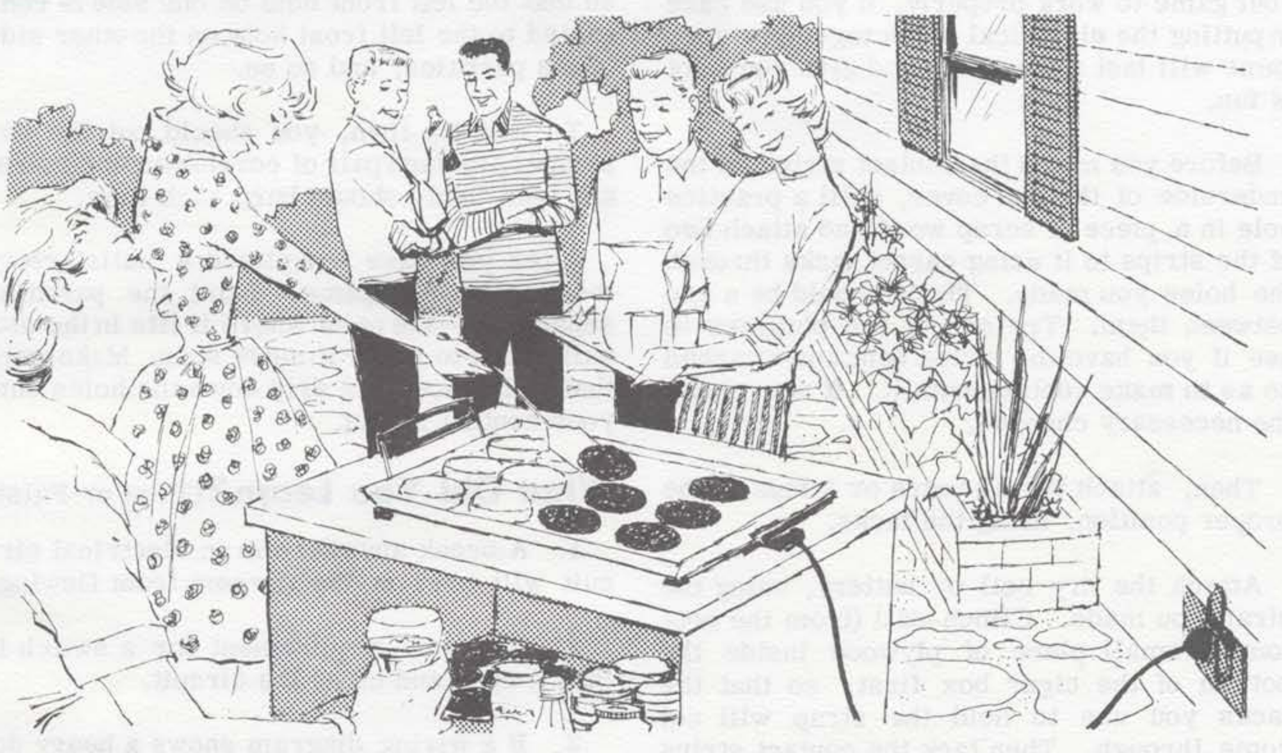
For More Information

See the paperback books "Electronic Puzzles and Games" and "Electronic Games and Toys."

Exhibit: Your finished Electrical Game makes a good exhibit.

LESSON NO. 24
Credit Points 4

FOOD HOT ON THE SPOT



One habit that almost everybody has is eating three meals a day. Most of the time you probably do this as a family, but also there are the times when guests are present.

Portable electric appliances can help us add variety to this routine, usually with greater convenience for the hostess. For example, it's easier to make and serve pancakes right at the table, using an electric griddle. They're better eating that way, too.

What to Do

1. List all the controlled-heat appliances in your home. Add to the list others you've seen advertised.

2. Make a chart for the appliances you have at home giving all the information on the name plate, whether you have an instruction book and where it's kept, special features, and uses.

3. Choose at least one of the above appliances to learn more about its regular and special uses, and learn the proper care in cleaning and storing.

4. Demonstrate or exhibit something you learned about one of the appliances you studied in detail.

Tools and Materials You'll Need

Paper and Pencil

Use of at least one controlled-heat appliance, such as the toaster, electric skillet, griddle, coffee maker, or other.

Controlled-Heat Appliances

Do you realize how many electrical appliances in your home produce heat? Almost every home has at least one electric iron, and electric room heaters are fairly common, but most of the other heating devices are used in cooking. The main one is the electric range. But for now, let's consider only the portable controlled-heat appliances. These include toaster, broiler, Dutch oven, corn popper, rotisserie, deep fat fryer, waffle baker, skillet, griddle, and trivet (table food warmer).

Roaster oven

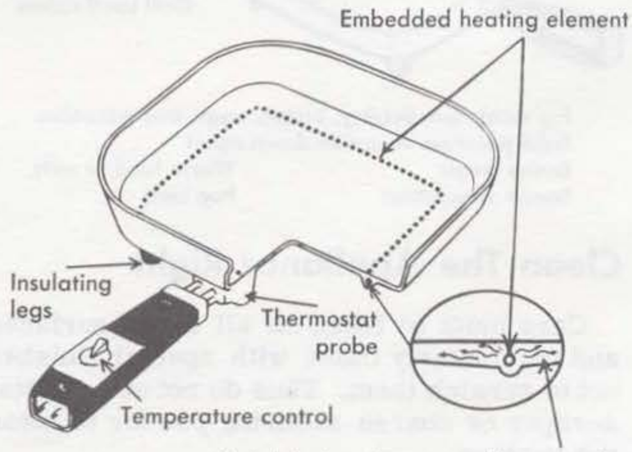
Broiler-fry pan

Dutch oven

How Do They Heat?

In all of these appliances there is a heating element which produces the heat. It consists of special wires made of a metal which resists the passage of the electric current and grows hot.

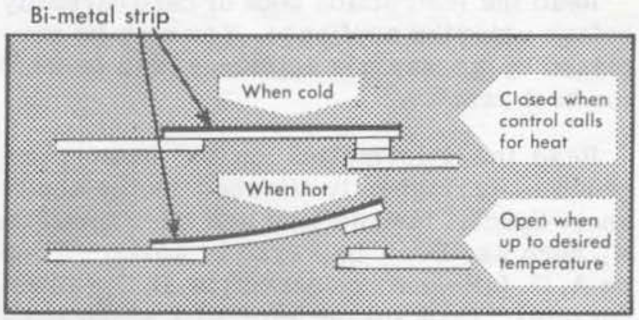
The cord which carries the current to the heating element does not get hot because it is made of wire which is a good conductor, that is, it offers little resistance to the flow of electricity. A small wire has more resistance than a large wire. Resistance also increases with the length of the wire. Therefore, the excessive warming of the cord supplying a heating appliance is a danger sign. This means that that cord is defective and should be replaced, or that it is too long, or that its wire size is too small. The latter two problems often occur when an extension cord is being used. An extension cord is not recommended for this purpose, but if used must be a heavy duty one.



Control Of Heat Is Necessary

Each food has a cooking temperature that is best. Controlled-heat appliances which have varied uses let you select this temperature, but beyond that they are automatic until the job is done. This controlled heating assures you that the food will not burn (unless you leave it too long), and that it will be done in a reasonable length of time.

The part that makes your heating appliance automatic is its thermostat. This device will keep the right temperature by shutting off and turning on the electric current.



Thermostat operation

This is accomplished by using two different kinds of metals welded together into one piece, for example, steel and brass. One metal expands more than the other when heated, causing the strip of metals to bend. When the heat reaches a certain point, the strip bends enough to make an opening which keeps the electric current from getting to the heating element. When the strip cools a bit, it straightens out and makes contact, the current again can flow, and heating resumes.

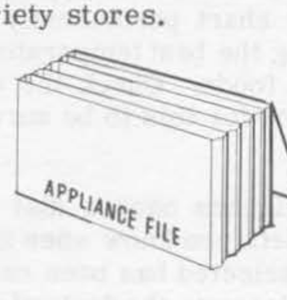
The thermostat is a delicate part of the appliance, and can be damaged easily. Therefore, be careful not to drop the appliance.

Read And File The Instructions

Each of these heating appliances is a valuable investment, and therefore should be properly cared for so that it will stay in good working order.

When the appliances in your home were first bought, they came with an instruction book or card telling how they should be used and cared for. In case you can't locate any information for some appliance, ask your dealer for it, or write to the manufacturer.

It's a good idea to have some special place to put information about all appliances in your home where any of your family can find it for easy reference. One suggestion for this is a multi-pocket file folder available at stationery and variety stores.



Read the instruction book or card carefully before using the appliance. You may be surprised by the way this appliance is to be used for best results.

Read the information on the name plate which is permanently attached to the appliance. Special instructions are often found on it, such as "Don't immerse in water," "Use on A. C. (alternating current) or D. C. (direct current)." Look for the letters UL which indicate that the appliance has been approved for electrical safety by Underwriters' Laboratories.

Heat Control On Detachable Cord?

Some appliances have the heat control attached to the cord which is detachable from the appliance. One reason for this is that the same special cord can be used on several of that manufacturer's appliances, thus saving the buyer the cost of one for each. Also, these appliances are the ones which can be put completely in water for ease in cleaning.

There are some rules which you should follow in handling such a cord. When through using the appliance, adjust the automatic heat control to OFF position, and then disconnect the cord from the wall outlet. Never remove the cord from the appliance if the cord is still plugged into the wall outlet. There is a long metal rod or probe extending from the control which gets extremely hot and should be cooled before handling to avoid burns.

Good Food Every Time

Controlled temperatures make for success in cooking. Some of the appliances have a temperature chart permanently attached to them showing the best temperature for cooking different foods. Check the chart or instruction book for this to be sure of best results.

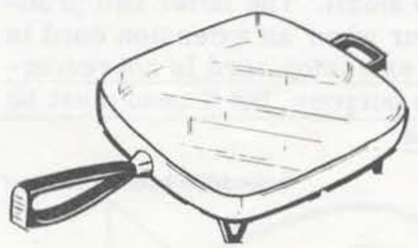
Most appliances have a dial indicator or light which lets you know when the temperature you've selected has been reached. Preheat the appliance to the desired temperature before starting to use it, unless the recipe says to do otherwise. This is one way to keep foods from sticking and making cleaning difficult.

Get Maximum Use

Few of us ever try all the recipes or suggestions given in the instruction book with a particular appliance. Take time now to find a new use for the appliance you are working with.

If it's a griddle, could you surprise your family with a different grilled sandwich, or could you use it to keep the serving dishes warm at the table? Maybe you could make use of an outdoor outlet and use the appliance for cooking supper there.

Use an electric skillet to do all these



Cook pot roast
Prepare stew
Simmer soups
Grill sandwiches

Fry meat, fish, poultry, bacon, eggs, and pancakes
Bake potatoes or upside down cakes
Braise meats
Steam vegetables
Warm food or rolls
Pop corn

Clean The Appliance Right

Care must be taken on all metal surfaces and particularly those with special finishes not to scratch them. Thus do not use a metal scraper or coarse scouring powder to clean the surface.

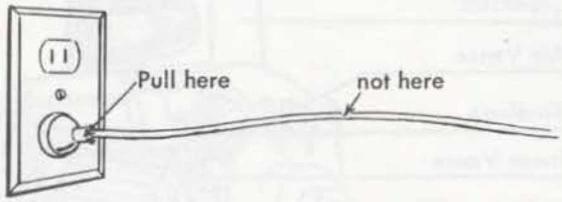
Check the instructions for cleaning carefully. Note if the appliance can be immersed in water. If the heat control is on the detachable cord, always remove it before putting the appliance in water.

Do not place the hot appliance in cold water or run cold water over it until it has cooled. A sudden change of temperature might cause the metal to warp. (You can add hot water tc the hot appliance to soak so that the pan will be ready for easy washing.)

Pretreated surfaces and special finishes require special care in use and in cleaning. Be sure you know what is right for the one you use.

Store Appliance And Cord Properly

Always disconnect the cord from the outlet by pulling on the plug, not on the cord.



After using, some of the appliances should be covered to keep them clean for use next time.

If the cord is permanently attached, wrap it around the appliance loosely without kinks and only after the appliance is cool.

Detachable cords should be stored in cool, dry places. Remember that if the heat control is attached to the cord, be especially careful not to drop it. One way to store it is to coil it loosely and put in a convenient drawer.

Heating Appliances Work Fine, If . .

Heating appliances put the biggest load on your wiring.

The wiring in most homes will handle one such appliance on each circuit (pair of wires leading from the main switch), but if you try to use two at once, you may be in trouble. A fuse can blow (or circuit breaker trip) or the voltage (electrical pressure) may drop so low that the appliances won't heat properly. In cooking this would mean that the food would not be cooked in the time given in the recipe and there would be insufficient browning.

If this happens, urge your parents to have an electrician come in to check your wiring.

What Did You Learn? True or False

1. A good conductor of electricity is used in a heating element.

2. A thermostat depends on the difference in expansion of two metals when heated.

3. All information about an appliance is usually found on the name plate.

4. Not all controlled-heat cooking appliances are immersible in water.

5. Coarse scouring pads or powder may damage the surface of the appliance.

6. Avoid storing cords with kinks or sharp bends.

7. Heating appliances require more electricity to operate than lights.

8. Low voltage slows down cooking.

Demonstrations You Can Give

Using a blackboard or large model made of cardboard, show how a thermostat works.

Using the appliance you chose to study, demonstrate some of the uses for it, and/or how to clean and store it.

For More Information

Ask your County Extension workers and power supplier representatives for bulletins and other information on appliance care. Clip articles from newspapers and magazines for your own reference.

Get THE-9 Household Equipment Its Care and Repair from your County Extension Office

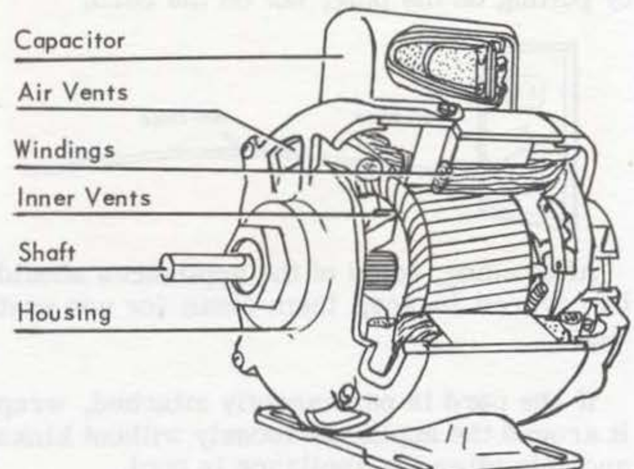
4-H ELECTRIC GUIDE SHEET

LESSON NO. 25
Credit Points 3

SELECTING THE RIGHT MOTOR

The first practical electric motor, back in 1850, weighed several hundred pounds and developed one horsepower. It wasn't exactly handy to carry around. But it had its points, many of the same important advantages found in modern motors, and it did the work for which it was designed.

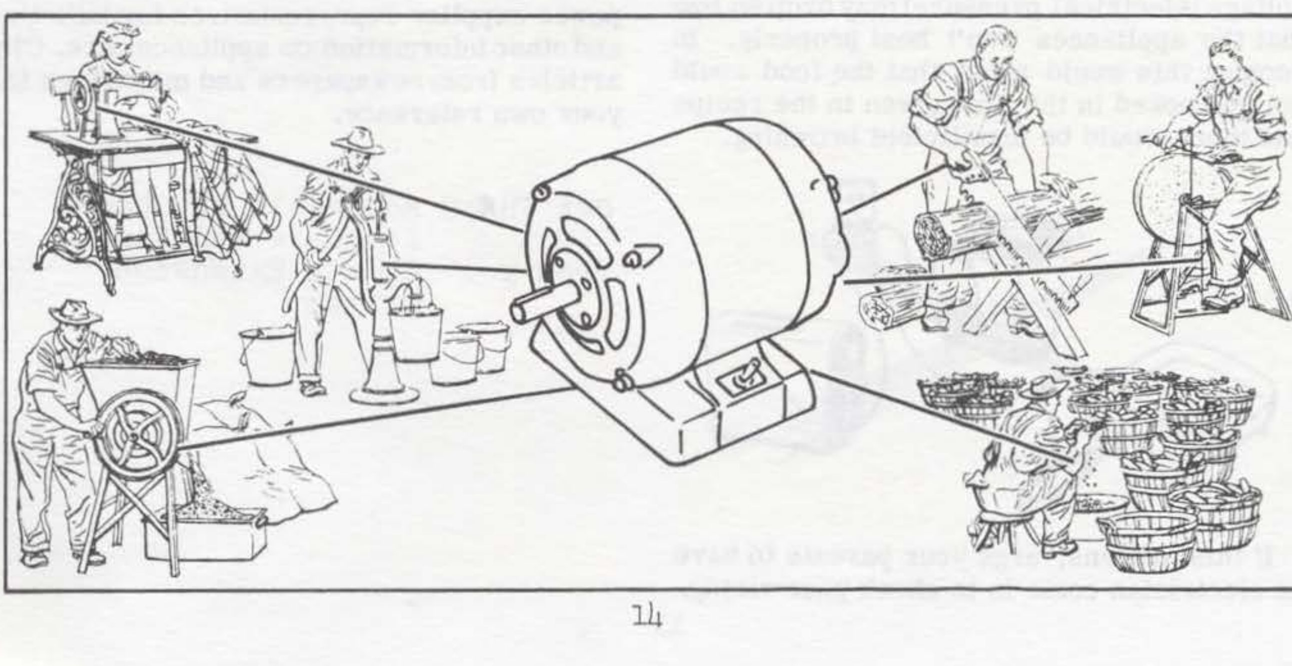
Today there are many types of motors, especially designed for different jobs. There are tiny motors that can fit in the palm of your hand, and tremendous motors that will drive heavy trains over the mountains and across the plains. There are motors for vacuum cleaners, refrigerators, and portable power tools. There are large motors for the heavy work of the farm - feed grinding, ensilage cutting, blower systems. You should know about these basic types of motors, and what you can do with them.

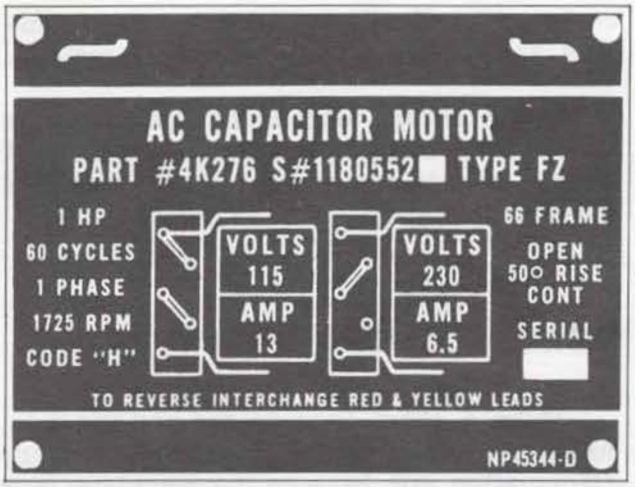


Types of Electric Motors

The Shaded Pole Motor is the smallest motor in the home, usually. It is used to operate small fans, electric toys, and stirring devices. It won't handle a load of any size without burning out. Shaded pole motors come in such sizes as 1/30 to 1/60th horsepower. They usually are not reversible.

The Universal Motor can usually be used on either alternating or direct current, but check the nameplate first. It is common equipment with hand drills, vacuum cleaners, food mixers, sewing machines and similar equipment. Its speed depends upon its load and it will run dangerously fast unless there is a load on it. That's one reason it is usually part of the equipment it runs. Remember, if you take a universal motor off an old appliance and try to use it for another purpose, it should not be run





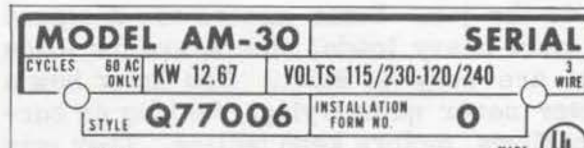
From the nameplate you can learn the motor's operating characteristics and power supply requirements. Always match the motor to your electric current supply.

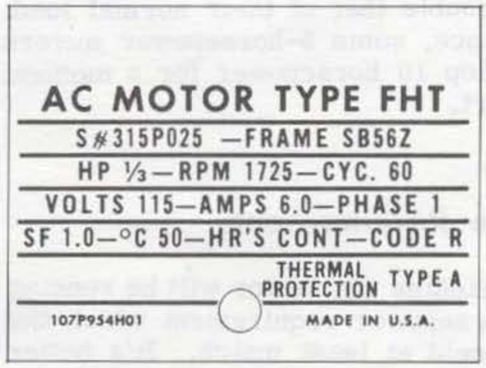
without a load on it. Universal motors come in smaller sizes, usually less than 1/3 horsepower, although some may run as high as 3/4 h.p. size.

The Split-Phase Motor will start light to medium loads and usually comes in sizes up to 1/3 horsepower. You'll find it powering fans, saws, drills, grindstones, bottle washers and that sort of equipment, operating on 110-120 volts. To change the direction of shaft rotation, the power leads to the starting winding need only be reversed. This is a convenience when the motor is used to power more than one appliance.

The Capacitor Motor is often recognizable by its capacitor, the little cylinder or box on the motor frame - although it may have the capacitor inside. This motor will start fairly heavy loads without difficulty and comes in sizes from 1/4 up to 5 , and even 10 horsepower. It is the most generally used, all-purpose farm motor, powering many pieces of equipment from refrigerators and freezers to water pumps, saws, grain and bag elevators, and ensilage cutters.

With capacitor motors no larger than 1/2 horsepower, 115 volts is sufficient for operation. Larger sizes work best on 230 volt connections, although they may be purchased for either 115 or 230 volts or both.





This motor can be reversed in the same way the split-phase motor is reversed, by changing the leads to the starting winding. For heavy loads it is more efficient than the split-phase motor, starting such loads with less current.

Selecting the Right Motor

Horsepower isn't everything when you are selecting the right motor to fit the job you want done. First, you have to match the motor to your electric current supply. From the nameplate of the motor you can learn its operating characteristics and the power supply requirements. These should match the voltage, phase and cycles of the electric circuit to which you'll connect the motor.

Current Right? Check the Type

Generally, motors of 1/4-horsepower and under are designed to operate on 115-volt current. Motors of 1/2-horsepower and up are usually operated on 230-volt current. But check the motor nameplate to make certain. If the motor is a dual voltage type, use the higher voltage if available.

If the power supply is right, the next thing to do is select the right type of motor to do the job. Some motors are designed to start heavy loads; others are for loads that are easy to start. You know how a motor never quits trying. As long as current flows, motors keep pulling. They may burn out if the load doesn't start moving. Some motors develop starting power (torque) double that of their normal load. For instance, some 5-horsepower motors will develop 10 horsepower for a moment at the start.

Machine Requirements

The machine the motor will be running has a horsepower requirement which the motor should at least match. It's better if the motor horsepower is a little higher than the equipment requires. You can learn the horsepower requirements of the machine from an equipment dealer, from the instructions which came with the machine, or, if you build the machine yourself the horsepower requirements or a specific motor will probably be recommended in the building instructions. In case the motor is already connected to a machine, observe whether there is any starting lag or whether the motor runs hot. If so, then the motor is probably too small or is improperly connected. Starting lag or overheating could also occur if the line voltage is too low, or the equipment improperly lubricated.

Speed Requirements

Motors differ in full load ratings. Check their speed on the nameplate. Speed can be regulated through the use of different sizes of pulleys on the motor shaft or equipment. You'll learn more about pulleys and belting in later work with motors.

Safety note: excessive speed can be harmful to equipment, and is a waste of power, so it's important to use a motor of the proper speed.

WHAT TO DO

Make a chart (see below) and fill it in, using the nameplates of the motors and any information you have on the machines they are supposed to run. Under "Comments" indicate whether all motors are the right type for the jobs they are being called on to do. If some motors are not being used correctly, show what motor would do the job better.

Demonstrations

Organize a group visit to a woodworking or fabricating shop or farm using many different types of motors. Examine the motor nameplates to see the current and horsepower requirements and type of motor. Notice the kind of motor that is matched to each job. Notice how pulleys are used to regulate speed of machinery, when this speed is different from the motor speed.

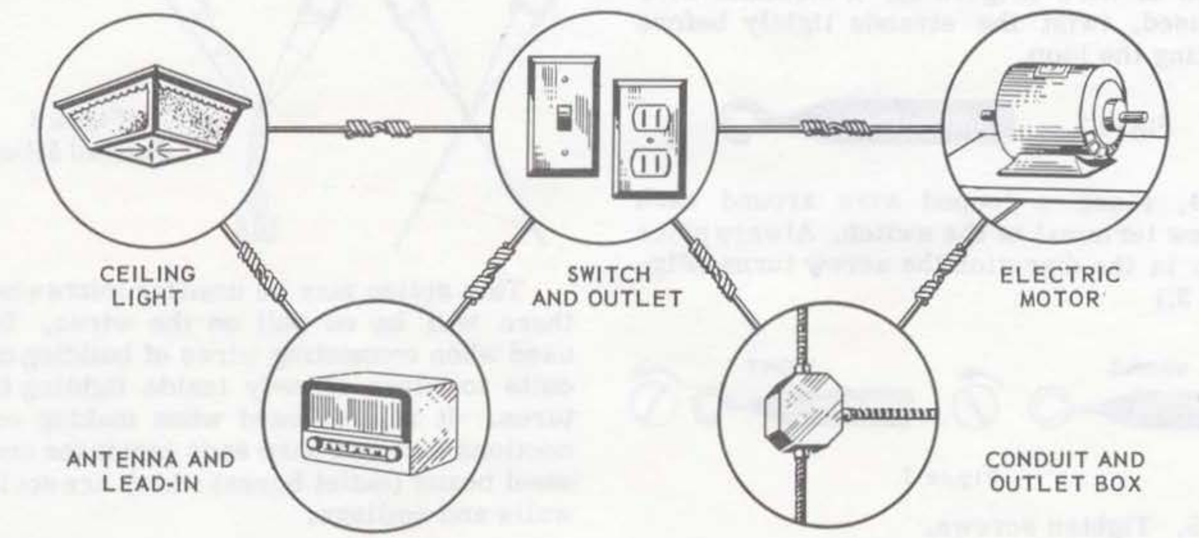
For Further Information

Ask your power supplier or an electrician to talk to your club on different uses of the electric motor, both portable and stationary types.

Motor Use	Location	HP	Voltage	Code Designation On Motor Nameplate	Comments
Grind-stone	Tool Shed	1/20	110	Split-Phase	Motor too light, heats up should be at least 1/3 hp

GOOD ELECTRICAL CONNECTIONS

Learn How to Splice and Solder



"Many live wires would be merely short circuits without proper connections."

Usually more electrical trouble is caused by loose connections than from all other faults. Loose fastenings at screw terminals, poor contact in connections and poorly made joints between two or more wires can completely stop the flow of electricity. Poor connections can also cause unsafe heating or cause an electrical current to flow and cease to flow at intervals, which is just as bad. You'll want all of your connections to be tight and dependable. In the wiring for buildings, safety codes allow splices only in junction boxes.

WHAT TO DO:
Make Some Electrical Connections

Tools Needed:

Your electricians' kit, or a knife, screwdriver, long nosed pliers, soldering iron and flux.

Materials Needed:

Eight pieces of No. 14 or No. 16 insulated wire, each about 18 inches long.

Two lengths of twin conductor wire, each about 2 feet long.

A single pole light switch, with screw terminals.

Resin core wire solder.

A roll of rubber tape
A roll of friction tape } Or better, 1 roll of electrician's plastic tape

Connect Wires to a Light Switch

1. Prepare two wires for connections by removing 1/2 inch of insulation from an end of each wire. Remove insulation by making a tapering cut, as when you sharpen a pencil (Figure 1). If you cut straight into

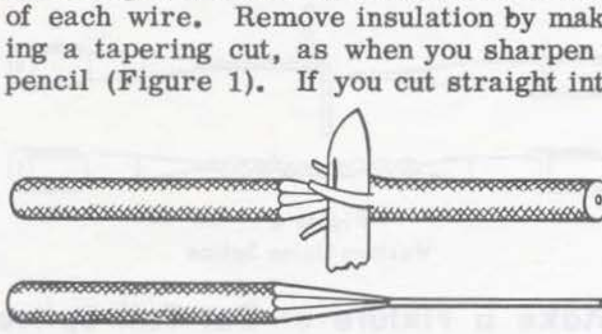


Figure 1
Removing the Insulation

the insulation, you are almost certain to nick the wire. This might cause it to break at a later time.

2. With a knife, scrape clean the exposed part of the metal wire.

3. With pliers, form a loop in each piece of wire (Figure 2). If stranded wire is used, twist the strands tightly before making the loop.

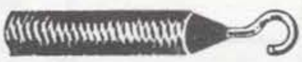


Figure 2

4. Place a looped wire around each screw terminal of the switch. Always place loop in the direction the screw turns (Figure 3.)

Figure 3

5. Tighten screws.

You will be using this procedure whenever you have to make connections to screw terminals.

Make a Common (or Western Union) Splice

1. With a knife, remove about 4 inches of insulation from the end of two pieces of wire. Cut the insulation as in Figure 1. Scrape or sandpaper exposed wire clean and place them together. Hold the wires securely with a pair of pliers and twist them in opposite directions. Wrap the ends of the wires as tightly as you can so the sharp points won't cut through the tape insulation which you will apply later (Figure 4). The common splice is used when there will be some pull on the wires.

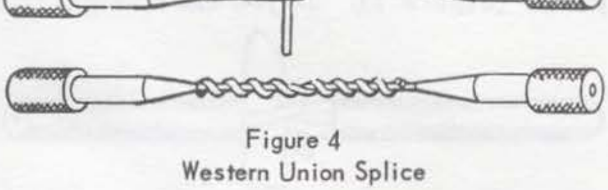


Figure 4
Western Union Splice

Make a Fixture or Rat-Tail Splice

1. Bare about 1 inch of the end of two wires, using the same method as before (refer to Figure 1). Clean exposed wires. Cross the wires and hold them securely with a pair of pliers and twist together. Loop ends back to prevent a sharp point (Figure 5).

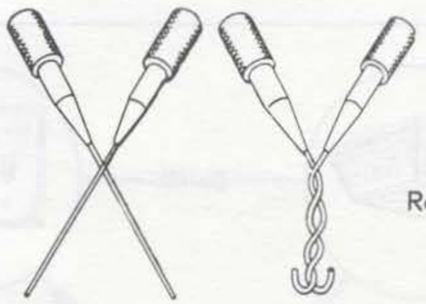


Figure 5
Rat-Tail Splice

This splice may be used for joints where there will be no pull on the wires. It is used when connecting wires of building circuits to wires already inside lighting fixtures. It is also used when making connections between wire ends inside the small steel boxes (outlet boxes) which are set into walls and ceilings.

Make a Tap or Center Splice

1. Bare a 1-inch section in the center of a piece of wire. Clean this section.

2. Bare and clean about 1-1/2 inches of the end of a second piece of wire. Remember the proper method for removing insulation. Cut on a taper, rather than straight down to the wire.

3. Cross the wires and hold them securely as the attached wire is wrapped tightly around the center section of the other piece of wire (Figure 6).

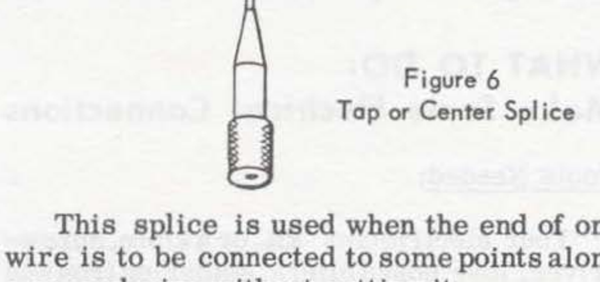


Figure 6
Tap or Center Splice

This splice is used when the end of one wire is to be connected to some points along a second wire without cutting it.

Splice Twin Conductors

1. Remove about 5 inches of outer insulation from an end of each of your two pieces of twin conductor wire.

2. Now make two common splices, one for each conductor. The splices must be staggered, so that each splice comes alongside unbroken insulation on the other conductor (Figure 7). If you put the splices side by side there will be danger of their shorting out, and your splice will be bulky. Do this by cutting one wire shorter than its twin. Do this on both pieces of twin conductor. In splicing, match the short end of one wire with the long end of the wire to be joined to it. On twin conductor, each splice is taped separately, then wrapped together with additional tape.

Figure 7
Two Conductor Cord Splice

Solder Your Splices

All connections must be soldered. The only time soldering is not used is when solderless connectors are used instead. Figure 8 shows some common types of solderless connectors. Wiring codes allow use of solderless connectors in certain instances - such as within junction boxes and other places where there is no strain on the connection.

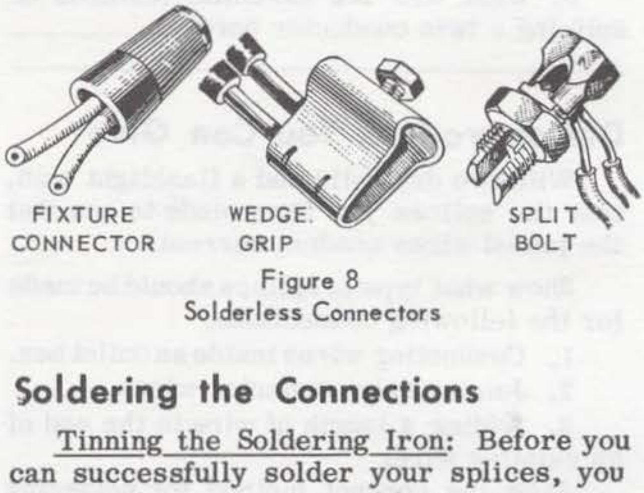


Figure 8
Solderless Connectors

Soldering the Connections

Tinning the Soldering Iron: Before you can successfully solder your splices, you must make sure your soldering iron is in condition. It is necessary that the four working surfaces of the soldering iron tip be covered with a thin film of solder. If the old film has burned off or has become corroded, it should be re-tinned. Check your soldering iron and go through the following steps:

1. If any of the four surfaces of the tip are not smooth and bright, heat the iron and place it in a vise with only enough pressure to hold it.

2. File the rough surfaces while keeping the file level with the surface. File only enough to make the surfaces smooth. Never hammer on a soldering iron tip. Use some sand paper or steel wool to help shine the tip.

3. Rub on some solid type sal amoniac for further cleaning of irons that are hard to tin. Immediately after cleaning and while still hot, melt and spread resin core solder over the tip.

4. Wipe the excess solder toward the point using a cloth. Be careful not to burn yourself or the cloth.

You will have to learn by experience how to keep a soldering iron at the right temperature. Getting it too hot is just as bad as not getting it hot enough. Instant heat soldering guns are increasing in popularity as a convenient way to solder.

Soldering Gun

Soldering the Wires

The splice joins the wires together but you need something more to give you a good electrical connection. This is where soldering comes in.

Solder needs a helper to attach itself to the copper wires. This material is called flux. Resin is a good flux for electrical soldering. Usually this flux is put inside thin solder tubes so you do not have to put it on separately. It is sold under the name of resin-core solder. Bar solder and a non-corrosive paste flux is sometimes used. Acid fluxes are also sold, but should never be used for electrical work.

Apply heat by placing the hot soldering iron directly to the joint you are soldering. Be patient until the joint is hot enough to melt the solder when the solder is put directly on the wire joint. Keep the wires above the iron so they'll heat faster (Figure 9). Always apply the solder from above.

Always allow solder to flow freely over splices. If it does not flow into every little crevice and opening between the turns of

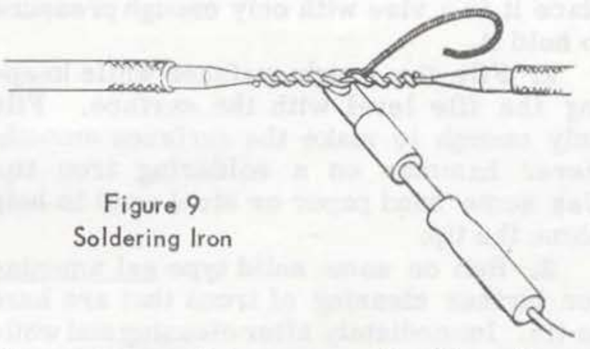


Figure 9
Soldering Iron

wire, you won't have a good soldered connection (Figure 10).

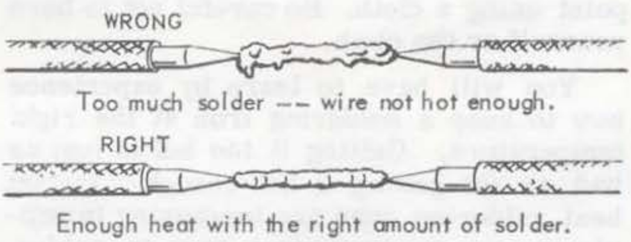


Figure 10

Tape the Splices

After the joint is made and soldered, you will have to replace the insulation. This protects the splice from mechanical injury and permits you to handle the wire without shock.

1. Rubber Tape - Any wire which has had rubber insulation must have a layer of rubber or plastic tape around the new joint. Place the tape over the tapered end of the rubber insulation. Wind spirally to the other end, letting the turns overlap a little. Keep the tape stretched so it will come together and seal out dirt and moisture. Put on as many layers as you need to build up the insulation to match what you took off. Be sure all the wire is covered where you have removed any insulation (Figure 11).

Figure 11
Rubber Tape

2. Friction Tape - Friction tape is used to replace the tough outer braid on the wire. It is made of cloth soaked in a sticky compound. Put it on the same way as the rubber tape, winding diagonally from one end to the other. Two layers are usually enough (Figure 12).

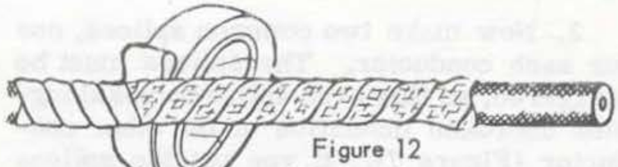


Figure 12
Friction Tape

3. Plastic Tape - This new type of tape has many uses. It is a very good insulator, stretches easily, sticks to most anything and the glossy backing does not gather dirt or lint. In covering splices, it can take the place of both rubber and friction tape. However, with plastic tape, extra care should be taken to protect pig-tail and center tape splices. Make sure enough material is around sharp points to prevent them from ever rubbing through the tape.

What Have You Learned?

1. Do you make splices in wires in conduit? ____________

2. What is the most practical tape for your tool kit? Rubber___Friction___Plastic___?

3. Where do you place the solder when soldering a joint? On the iron___on the wire___

4. What kind of flux must you use?____ ____________

5. What are the essential features of splicing a twin conductor cord?____________ ____________

Demonstrations You Can Give

With two dry cells and a flashlight bulb, test the splices you have made to see that the joined wires conduct current.

Show what type of splices should be made for the following connections:

1. Connecting wires inside an outlet box.
2. Joining twin conductor wires.
3. Adding a length of wire to the end of an existing wire.

Show the correct method for soldering splices.

Demonstrate different types of solderless connections and tell where they should be used.

For More Information

Have your leader ask your power supplier or an electrician to demonstrate different types of splices on different types and sizes of wire.

REPLACING SWITCHES AND OUTLETS

THESE ARE THE CULPRITS

Old convenience outlet – Loose contacts – Only One receptacle. Loose plate.

Old, worn switch. Doesn't always make contact. Cracked Plate.

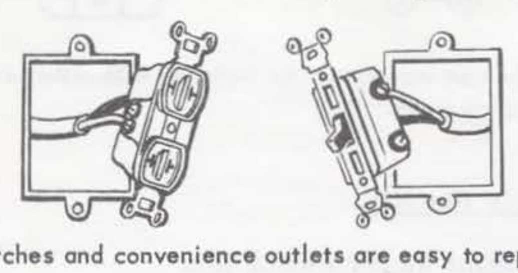
The wiring system of a home will usually last a long time, but the trouble is, some people try to make it last too long. Actually, a wiring system needs maintenance like anything else.

As appliances are added increasing the electrical load, the wiring may become overloaded, and have to be rewired. This job should be left to a trained electrician.

But you can do many of the ordinary repair jobs yourself -- such as replacing damaged switches or outlet boxes. The important thing is to know what you are doing and to know how to do it safely. Learn the necessary steps in safe electrical procedure before starting a job of this kind.

Switches have been improved in recent years. There is no longer any need for the loud "click" every time a light is turned on and off in a room. Why not install these new mercury switches at various locations and enjoy their silent action? Or look around and find switches which have been broken and replace them.

Maybe the convenience outlets have become worn over the years and don't hold the plugs properly anymore. Maybe you'd prefer a more modern style.



Switches and convenience outlets are easy to replace.

WHAT TO DO: Replace a Single-Pole Switch

Tools Needed:

Your electrician's kit and your test lamp will be needed. You will use the screwdriver, pocket knife, and electrician's pliers.

Materials Needed:

New single-pole switch of the kind you want to install, and possibly a new switch plate.

SAFE ELECTRICAL PROCEDURES

1. Work under the supervision of someone who knows.

2. Always turn the power off before changing a switch or outlet. Place a note by the power switch telling others not to turn it on until you have finished.

3. Use your test lamp to be sure power is off.

4. Use only underwriters approved material.

5. Be sure wires are correctly connected. Black "hot" wire goes to the brass screw and white (neutral) to the white colored screw. (on outlets)

Removing the Old Switch

1. Pull the main building switch on the branch circuit control to the off position to make sure no current can flow in the circuit.

2. Remove screws holding the switch plate.

3. Remove switch plate
   a. Check the circuit using a test lamp to make sure there is no voltage in the circuit.

4. Remove the screws holding the switch in place.

5. Pull the switch from the outlet box. Generally you will find plenty of slack wire in the outlet box.

6. Loosen the screw terminals and unhook the wires from the old switch.

Installing New Switch:

1. Scrape the bare ends of the wires to remove dirt and corrosion.

2. Loosen the screw terminals on the new switch. Do not remove them.

3. Set the switch so that the "off" and "on" markings will be right side up.

4. Connect the wires to the terminals. Either wire can be connected to either terminal on a single pole switch. If they are screw terminals, be sure the hook on each wire extends around the screw securely, clockwise. Tighten screws.

5. Fold the wires to get the slack back into the box, then push the switch into the outlet box.

6. Replace the screws that hold the switch in place. The holes in the switch mounting straps are slotted. This is so the switch may be adjusted to a straight up-and-down position even though the outlet box may be crooked.

7. Replace switch plate and screws. Don't tighten the screws too hard or the plate, if plastic, may crack.

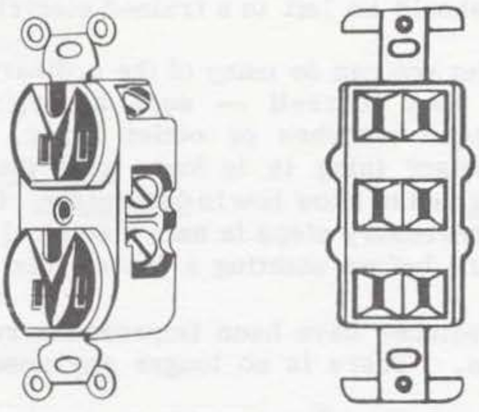
8. Replace the main switch to the "on" position.

9. Test the switch by moving it on and off several times, to see that it is working properly.

Replace a Convenience Outlet

When buying a new convenience outlet, see that it has double-sided contacts which usually can be seen by looking into one of the slots. This type of outlet will grip the attachment blades securely, preventing the plug from falling out. Double sided outlets generally provide more dependable contact and longer service.

The most common convenience outlet is the duplex type. Sometimes the triplex type is used, but be sure the appliances used won't overload the circuit.



Single type outlets can be replaced with either duplex or triplex types.

Tools Needed:

Same as for switch job.

Materials Needed:

New duplex type convenience outlet, and possibly a new plate.

Removing the Old Outlet:

Follow the same procedures as in removing the old switch.

Installing the New Convenience Outlet:

1. Hook the white wire on white colored terminal. If it is a screw terminal, be sure the wire hook turns in the same direction as the terminal screw tightens. If a second white wire was connected to the old convenience outlet, reconnect it to the second white colored terminal.

2. Hook the black wire to the other terminal on the opposite side of the outlet. If a second black wire was connected to the old convenience outlet, reconnect it to the second terminal on the same side.

3. Recheck your connections. An error in connecting the convenience outlet wiring may cause a short circuit.

4. Complete the installation. Follow the same procedures outlined for installing a new switch, steps 5 through 9.

Demonstrations You Can Give

Using an old switch you have replaced, show and tell its parts and trace the electrical circuit through it.

Show and tell with pictures or the real thing, about the different types of switches. Catalogs and brochures from your dealer can provide information and pictures.

Make a demonstration board showing how to replace a switch or outlet.

Make a board showing unsafe or faulty switches you have found.

For Further Information

Your power supplier or local electric supply dealer can provide information about the latest type switches and outlets.

LET'S LEARN ABOUT HEAT LAMPS

MAKE A PORTABLE HEAT LAMP

If you have ever used a prism to break up the rays of the sun, you saw a beautiful assortment of seven different colors. At one end of this assortment was red light. This red band of color was the start of an invisible band of light called infrared rays -- long, radiant heat waves.

Science learned how to produce these rays with electrical energy and now they work for us on many important jobs. In the home they are used as "heat lamps" on aching muscles, to dry paint, keep pipes from freezing, and other purposes where heat is needed.

On the farm they are used in brooders, to warm the crankcases of tractors and automobiles so cold weather starting will be easier, to warm water, to dry up wet areas and in locations where heat has to be directed. They can be used to provide quick comfort while washing dairy equipment or at a work bench.

The infrared lamp sends out invisible rays which heat only the surfaces they strike. Drafts and wind do not affect them and the rays are absorbed by the objects they strike and the objects then give off heat. Shine such a lamp across the room and the air will not be heated noticeably. However, it will be warm where the rays strike.

Safety and the Heat Lamp

The ordinary heat lamp does not give off much light; that isn't what it's for. You have to keep in mind that it is throwing out rays of heat. You can cook a baby chicken, start a fire in the litter, or burn yourself, if you use an infrared lamp too close to such things for too long a time. A thermometer won't give you an accurate recording of the heat that is being produced. Porcelain sockets are recommended if lamps are used for continuous or long burning periods. Brass, and most plastic sockets, will be

unable to stand the heat. In brooding, a heat lamp can never be supported by the cord. It must be supported by a wire or chain, so that it cannot fall.

Facts About Heat Lamps

Any infrared lamp bulb produces infrared rays whenever it is lighted. However, the lamps you use for brooding should have built-in reflectors. These types are much more efficient because they send all the infrared rays in the direction you want them to go. These lamps are usually "funnel shaped" in appearance. They come in 125-watt, 250-watt, and larger sizes. The 250-watt size is most common. There are two general types:

1. Soft Glass (white)
   a. Will not withstand water when hot.
   b. Costs much less.
   c. Just as efficient.
   d. Use where there is no danger of splashing water on bulb.

2. Hard Glass (red)
   a. Will withstand water splashes when hot.
   b. Cost more.
   c. Use where there is danger of water splashing on bulb.

Note: some red glass lamps are not hard glass, and will not withstand water splashes when hot. These are usually cheaper. Make sure you have the type you need. Make sure that all heat lamps have proper mechanical protection.

WHAT TO DO: Make a Portable Heat Lamp

Tools Needed:

Screwdriver, drill with 1/8" bit, carpenter's saw.

Materials Needed:

A swivel type outdoor socket with mounting hardware, cord and plug.

A 250-watt heat lamp.

A triangular piece of 1" lumber for base. Sides should be about 10" long. Sharp ends of triangle should be sawed off.

3 casters with mounting hardware.

1/2" or 3/4" screw eye.

Follow Figure 1 for assembly. Use the drill to start holes for screws and screw eye. Mount the casters and screw eye first, then the lamp socket.

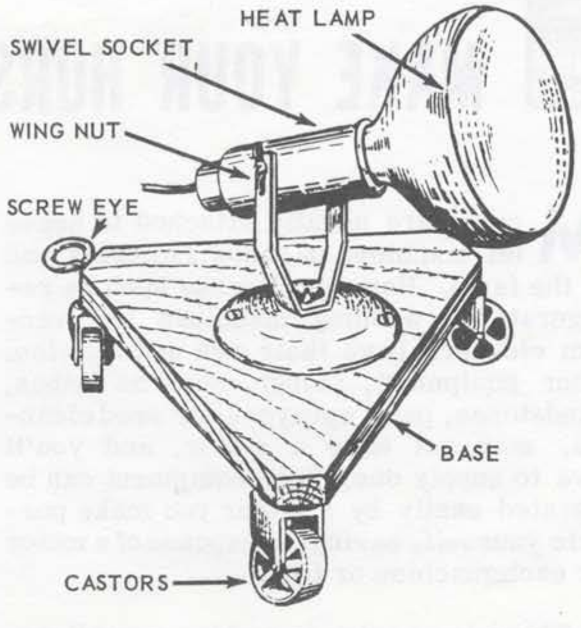


Fig. 1

Demonstrations You Can Give

Show how heat lamps are used in brooders, and give recommended distances from lamps to backs of animals or birds. (ASAE and college publications generally recommend at least 18" above animal or chick, and never less than 15" above litter).

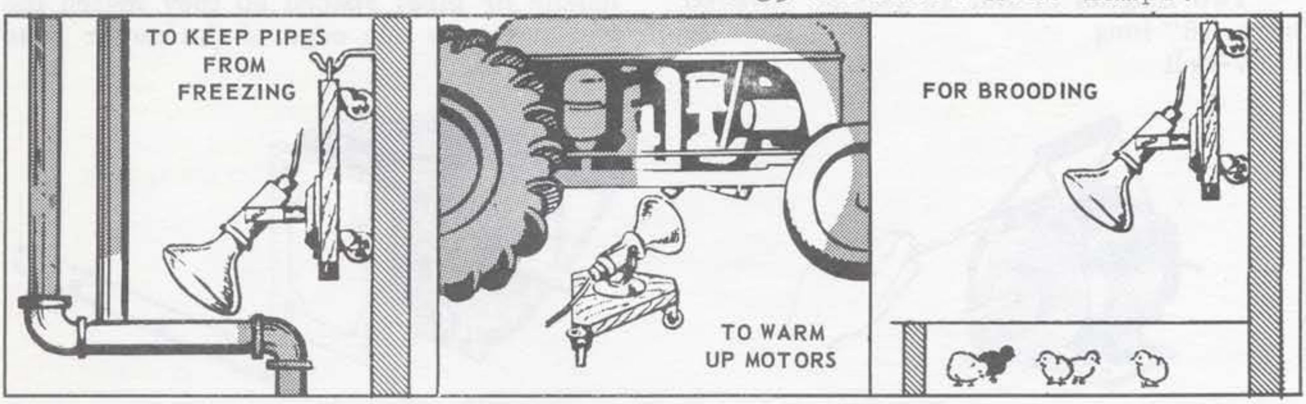
Demonstrate how it can be used to warm water, or protect water from freezing. Use a thermometer in water.

Show and tell how to use it in cold weather to make engines start easier.

Use a chart to show the different kinds of heat lamps, and the advantages and disadvantages of each.

For Further Information

See Farm Electrification Leaflet No. 9 Electric Brooding and No. 35 Infrared Heat Lamps.



A portable heat lamp has many handy uses.

Exhibit your portable Heat Lamp

MAKE YOUR HORSEPOWER PORTABLE

Motors are usually attached to heavier machines in shops, factories, and on the farm. Home appliances such as refrigerators, washing machines and vacuum cleaners have their own motors also. Other equipment, though, such as lathes, grindstones, paint sprayers, or seed cleaners, may not have a motor, and you'll have to supply one. Such equipment can be operated easily by a motor you make portable yourself, saving the expense of a motor for each machine or tool.

There is no trick to making a small motor portable. All you'll need is a motor, and a few simple parts.

WHAT TO DO:
Make a Small Motor Portable

Tools Needed:

Pliers, wrench, screwdriver, 1/4" drill, large rasp (file).

Materials Needed:

An electric motor, 1/4 to 1/2 Horsepower
A piece of 1" rounded rail, 10" long, or a broom handle, or 3/4" pipe
A two or three-step pulley for V-belt
Two 1/4" x 1-1/2" stove bolts, nuts, and flat iron washers
A piece of hose, 6" long
Two lengths of No. 10 rubber covered wire, 18" long
V-belt

Steps To Take:

1. Make a handle by slipping the two rubber covered lengths of wire through the rubber hose. Strip insulation from the ends of the wire and form hooks. Fasten the hooks under the top frame bolts of the motor (Figure 1). The wire may have to be flattened under the bolt heads. Check to see that the motor shaft turns freely after tightening the bolts.

2. Drill holes through the rail (broom handle or pipe) spaced so they match the two holes on one edge of the motor base (Figure 2).

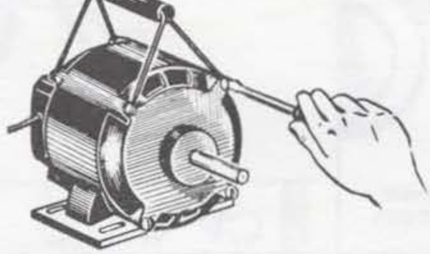


Figure 1

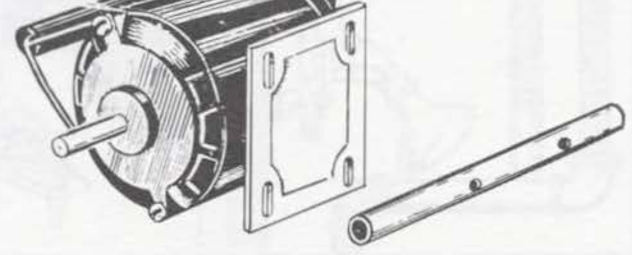


Figure 2

3. With a heavy file, notch the rail so the bolt heads will not protrude above the surface of the rail (Figure 3).

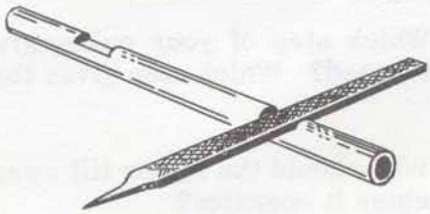


Figure 3

4. Bolt the rail to one edge of the motor base with stove bolts. Place a washer under each nut, then tighten securely with your wrench. (Figure 4).

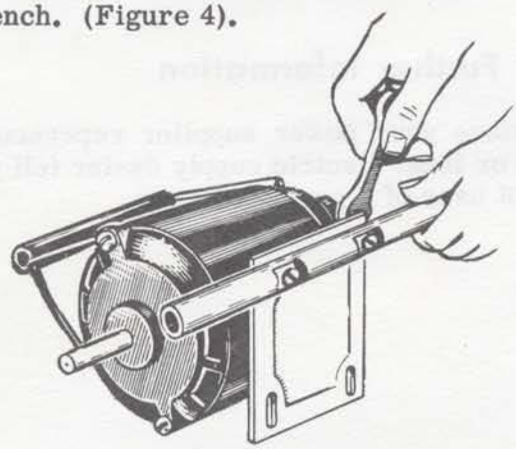


Figure 4

5. Fasten the step pulley to the motor shaft (Figure 5).

Figure 5

Attaching the Portable Motor

To use your motor, nail two wooden cleats next to the machine you're going to use it with. Place the cleats on the side of the equipment that allows motor to pull on bottom of pulley, with belt slack on top. Be sure the cleats are just far enough apart so the rail on your motor base will fit snugly between them (Figure 6).

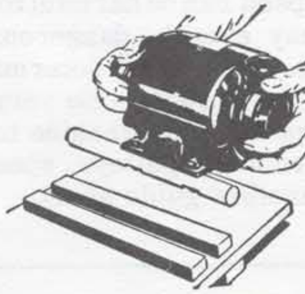


Figure 6

Place the cleats so that when the motor is hooked up with the V-belt, it will tilt away from the machine. This way, the weight of the motor keeps the belt tight (Figure 7). A three step pulley using a V-belt will operate most of your machines.

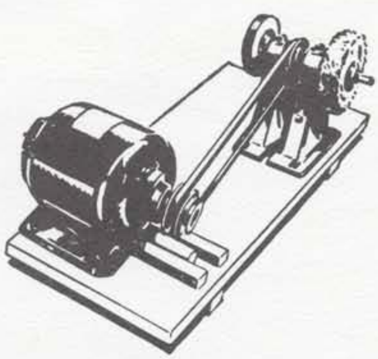


Figure 7

Make sure the belt alignment is right (Figure 8).

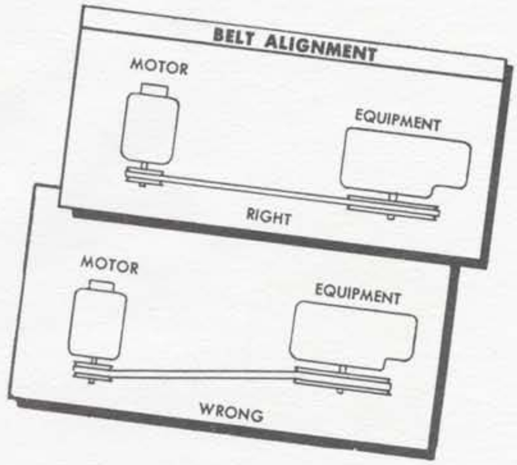


Figure 8

> **SAFETY NOTE:**
>
> Excessive speed can be harmful to equipment and may even be dangerous. The speed of the machine is determined by the size of the pulleys. Be very careful not to operate the machine too fast. You can learn about pulleys, speeds and belts from another guide sheet.

What Did You Learn?

1. List five pieces of equipment you can operate with a portable motor: ____________________

____

____

2. How did you find out which side of machine to place the motor on so that belt slack is on top of pulley?

3. Which step of your pulley gives the slowest speed? Which step gives the fastest?

4. Why should the motor tilt away from the machine it operates?

Demonstrations You Can Give

Show and tell how you made your motor portable.

For Further Information

Have your power supplier representative or local electric supply dealer tell you about uses of a portable motor.

SAVING STEPS WITH SWITCHES

How to Use 3-Way and 4-Way Switches

Have you ever walked up a dark flight of stairs or across a dark room and then had to fumble for a light switch? You won't have to if you have two or more convenient points of light control that use 3-way or 4-way switches.

The 3-way switch allows you to control a light or appliance from two different points. For example, you can turn a garage light on or off from either the house or garage. When 3-way and 4-way switches are combined you may control a light or appliance from 3 or more points. This would permit you, for instance, to turn a yard light on or off from either the house, garage or barn.

How 3-Way Switches Work

A 3-way switch has three terminals instead of only two such as are used on a single pole switch. A 3-way switch consists, actually, of two single-pole, single-throw switches so connected that one switch is "on" while the other is "off."

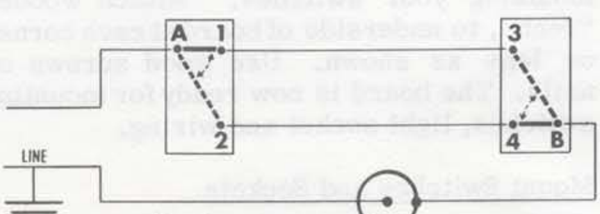


Figure 1

In Figure 1, you can see how a 3-way switch is connected to the line wire at A. Current may flow from A to (1) or from A to (2), depending on the position of the switch. The words "ON" and "OFF" do not appear on the switch. Either position of the switch handle will operate the light, depending on the position of the other 3-way switch at B operating the same light.

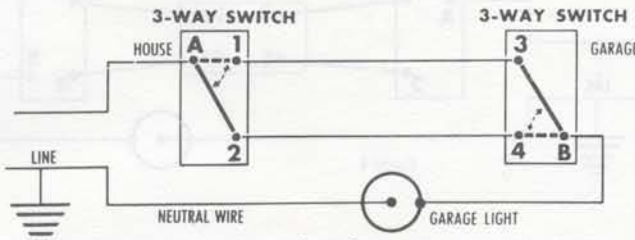


Figure 2

The principle of operation is shown in Figure 2. Let's say that the light is in a garage, and that it is controlled both from the house and the garage. The white (neutral) wire runs from the house to the garage light. Between the house and garage are two extra wires, marked 1-3 and 2-4. If the garage switch B is left turned to contact number 3, the light can be turned on from the house by turning switch A to contact number 1. If switch B is left turned to contact number 4, you can turn on the light by turning switch A to contact number 2.

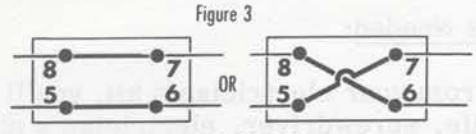
No matter in what position either switch is, the light can be turned on or off from either house or garage.

<u>You Can Control a Light from 3 Different Points</u>

Sometimes you may, for example, want to turn a yard light on or off from three different points like the house, the garage, or the barn. Such a circuit requires two 3-way switches at the extreme wiring points, with a 4-way switch wired in between.

How a 4-Way Switch Operates

Figure 3



A 4-way switch operates as shown in Figure 3. When the switch is turned one way, it connects terminal (5) to terminal (6), and terminal (8) to terminal (7). In its other position, (5) is connected to (7) and (6) to (8).

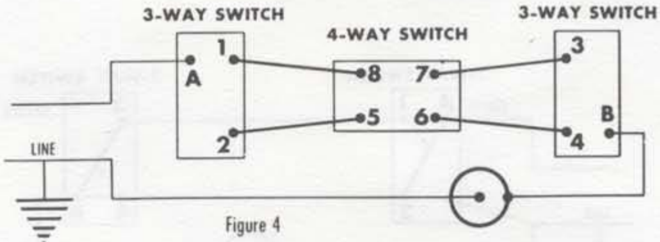


Figure 4

In Figure 4, draw light pencil lines on the 4-way switch, making connections (5)-(6) and (8)-(7). Now you can see that the circuit connects the two 3-way switches. Now, erase the pencil lines you made on the 4-way switch, and lightly draw in the other connections--(5)-(7) and (8)-(6). You can see that complete paths still exist between the 3-way switches. The light therefore can be turned on or off at either 3-way switch, or at the 4-way switch wired between the two.

You may operate a single lamp or outlet from as many control positions as you wish. Do this by adding a 4-way switch for each position. Always use a 3-way switch at the extreme electrical points of your wiring, with 4-way switches in between.

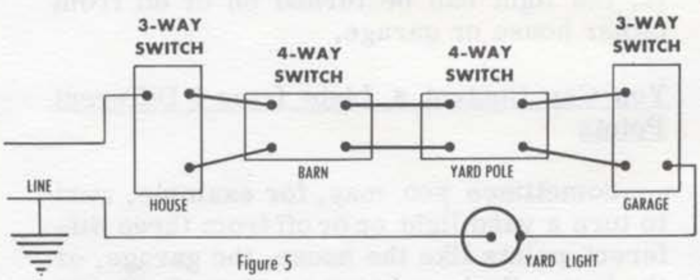


Figure 5

Figure 5 shows the wiring of a circuit control from any of four positions.

WHAT TO DO: Wire a Control Board

Tools Needed:

From your electrician's kit, you'll need a knife, screwdriver, electrician's pliers, and hammer.

Materials Needed:

Two 3-way switches with cover plates

One 4-way switch with cover plate

One incandescent lamp bulb

Two flush mount type sockets

One screw-in base plug or low watt light bulb

One male cord end plug

Five feet of No. 12 insulated copper wire

One board, about 15" or 18" square (at least 1/2" thick)

Four small wood blocks, at least 1/2" thick for "feet", if desired.

Two wooden strips about 1" square for legs

Two wooden cleats, about 10" long and 1" wide and two wooden blocks 1-1/4" square, all at least as deep as your switches.

Two hinges for swinging legs

Screws or nails long enough for mounting feet, legs and cleats to your board.

Friction tape, if desired.

Steps to Take:

Prepare your board as in Figure 6. The cleats should be about 3" shorter than the board is wide, and just far enough apart for mounting your switches. Attach wooden "feet", to underside of board at each corner or legs as shown. Use wood screws or nails. The board is now ready for mounting switches, light socket and wiring.

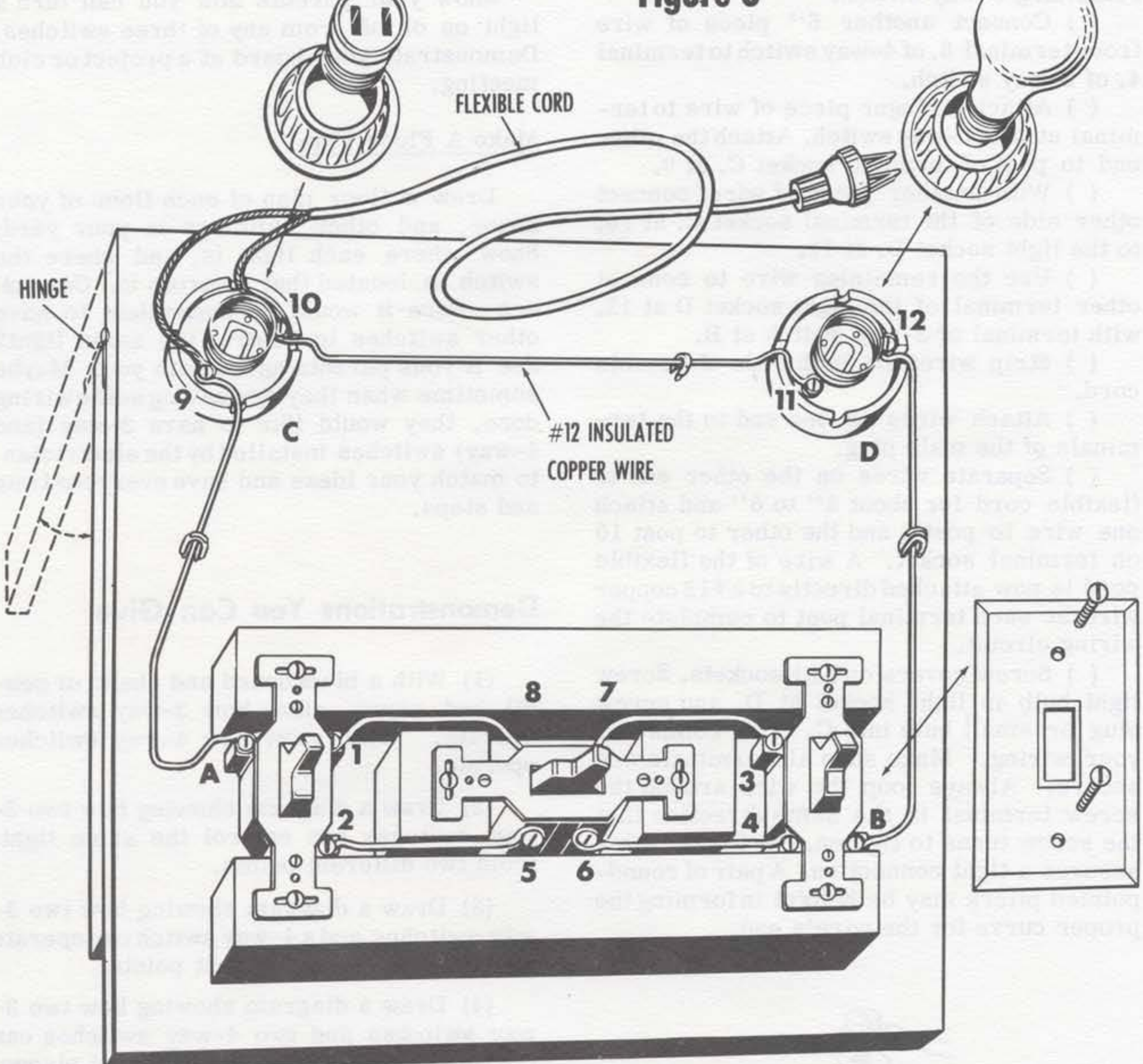
Mount Switches and Sockets

Mount switches as shown in Figure 6, with 4-way switch in the middle. Use mounting hardware that comes with switches and socket. (When wiring has been completed and checked, put the plates over the switches and screw covers on sockets, if they have them, to cover exposed terminals.) Mount light sockets as indicated

Now the wiring

1. Cut four pieces of #12 wire, each about 6" long, and strip an inch of insula-

Figure 6



DEMONSTRATION CONTROL BOARD

tion from each end. Use these to connect the 4-way switch to the 3-way switches. Due to the stiffness of the short connecting wires, it may be easier to connect the switches before mounting them on the wooden cleats.

2. Cut three other pieces of proper lengths to connect:

(a) terminal to 3-way switch

(b) terminal to lamp socket

(c) lamp socket to the other 3-way switch

3. Wire the board as shown in Figure 6. With a pencil, check off the corresponding wire in Figure 6 as you attach each wire to the circuit. In this way, you'll be sure you haven't omitted a wire. Check off (✓) each wiring step below as it is completed.

( ) Connect 6" piece of wire from terminal 1. of 3-way switch to terminal 8. of 4-way switch.

( ) Connect a 6" piece of wire from terminal 2. of 3-way switch to terminal 5. of 4-way switch.

( ) Connect 6" piece of wire from terminal 7. of 4-way switch to terminal 3. of remaining 3-way switch.

( ) Connect another 6" piece of wire from terminal 6. of 4-way switch to terminal 4. of 3-way switch.

( ) Attach a longer piece of wire to terminal at A of 3-way switch. Attach the other end to post of terminal socket C. at 9.

( ) With another piece of wire, connect other side of the terminal socket C. at 10. to the light socket D. at 11.

( ) Use the remaining wire to connect other terminal of the light socket D at 12. with terminal of 3-way switch at B.

( ) Strip wires on both ends of flexible cord.

( ) Attach wires on one end to the terminals of the male plug.

( ) Separate wires on the other end of flexible cord for about 4" to 6" and attach one wire to post 9 and the other to post 10 on terminal socket. A wire of the flexible cord is now attached directly to a #12 copper wire at each terminal post to complete the wiring circuit.

( ) Screw covers on both sockets. Screw light bulb in light socket at D. and screw plug or small bulb into C. This completes your wiring. Make sure all terminals are secure. Always loop the wire around the screw terminal in the same direction that the screw turns to tighten. See Fig. 7. This assures a tight connection. A pair of round-pointed pliers may be helpful in forming the proper curve for the wire's end.

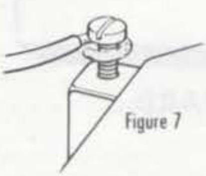


Figure 7

Test the Board

The board is wired, ready for testing. Plug it into a convenience outlet, or into an extension cord. The light bulb should turn on or off from any of the three switches. If it doesn't, pull the plug and check all of your wiring steps, one at a time, until you find the mistake. If your wiring is correct, mount the plates on the switches to cover exposed terminals.

Show Your Parents

Show your parents how you can turn a light on or off from any of three switches. Demonstrate your board at a project or club meeting.

Make A Floor Plan

Draw a floor plan of each floor of your house, and other buildings in your yard. Show where each light is, and where the switch is located that controls it. Can you see where it would be convenient to have other switches to control the same light? See if your parents agree with you. Maybe sometime when they are having some wiring done, they would like to have 3-way (and 4-way) switches installed by the electrician, to match your ideas and save everyone time and steps.

Demonstrations You Can Give

(1) With a blackboard and chalk, or pencil and paper, show how 3-way switches operate. Also show how 4-way switches operate.

(2) Draw a diagram showing how two 3-way switches can control the same light, from two different points.

(3) Draw a diagram showing how two 3-way switches and a 4-way switch can operate a light from three different points.

(4) Draw a diagram showing how two 3-way switches and two 4-way switches can operate a light from four different places.

Exhibit your Control Board

For Further Information

As your power supplier or an electrician to show you different types of light switches and wiring materials. Have him tell how actural wiring is done.

Note: Because the connections within a given 3-way or 4-way switch may vary with the manufacturer, the connections within each switch should be checked before the switches are connected on the board.

PROTECT YOUR MOTORS

What and How to Do It

It is amazing that an electric motor is such a willing worker. It always keeps right on trying, no matter how overloaded it might get. But, should a motor become overloaded, the wires in the motor windings will heat up and the insulation may burn off. If that occurs, you're in for trouble because your motor will be due either for an expensive repair job or the junk pile.

Even if you have the right motor for the job, accidental overloads are possible. So, don't abuse your motor--protect it by using the right fuse.

Ordinary Fuses Won't Do

Fuses are made to protect motors and you might think an ordinary fuse would do the job, but it won't. From two to seven times more current is used by an electric motor when it is started, than after it gains its normal speed. This produces an overload on the motor's wire windings. For that reason, fuses must be large enough to allow this extra current to flow while the motor is starting. This, however, will not protect the motor from an overload. Even during normal operation, a temporary overload or a low voltage condition can occur. Under those conditions, a motor will develop extra power and keep right on working. But, if the overload or low voltage continues, the motor will heat up and it won't be long before damage is done unless the fuse protects it.

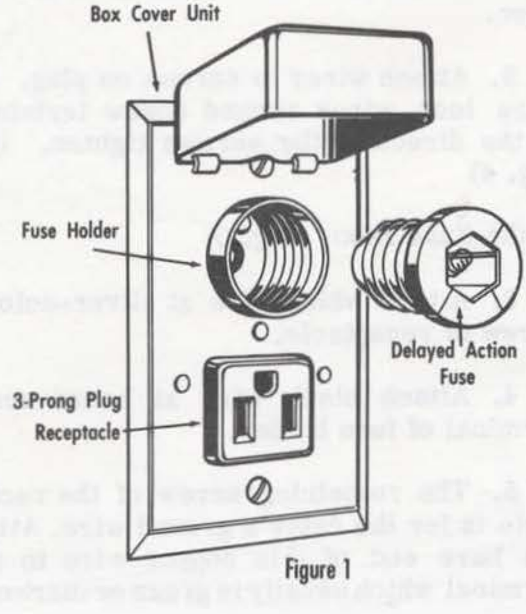


Figure 1

How Motors Are Protected

The type of fuse or circuit breaker needed to protect a motor must be able to handle the extra current at starting, yet protect the motor during the operation if overload conditions occur. You might think two fuses would be needed--one for starting and one for safe, normal operation. However, there is a type of fuse that might be considered as being two fuses in one. This is a delayed action or time delay fuse.

This kind of fuse is designed to handle the extra surge of current on starting as well as during temporary overloads. It will do this for a short time or until the heat is such that the motor's windings are in danger of burning. Then it will blow out, and stop the flow of current.

Normally, after starting, the motor will settle down quickly to a steady, low draw of current. Then the delayed action fuse will also cool off, continuing to protect the motor. A circuit breaker works in the same manner. A load, that is too heavy or prolonged, will trip the breaker and stop the flow of current. The breaker can again be reset for normal operation when the condition that causes the overload has been corrected. Plug caps with built-in breakers are also available at low cost to protect motors.

Select the Right Delayed Action Fuse

To find out the right size fuse needed for a given motor, simply read the amperage rating on the motor's nameplate. Then multiply the amperes by 1.1 and you'll get the fuse size for handling overloads allowable for most motors for reasonably short periods of time. For example: A motor is rated at 5 amp. (amperes) on 115 volt operation. Five multiplied by 1.1 equals 5.5 so take the next higher size delayed action fuse.

WHAT TO DO:

(A) Make a Motor-Protecting Fuse Block.

Make a fuse block for one motor, at least. You may want to make a fuse block for every motor that does not have built-in protection and that might be subjected to overloads. Motors that go on and off frequently, such as water pumps, should also be protected.

This fuse block will plug into the wall outlet and the motor plug can then be inserted in the fuse block.

Tools Needed:

Your electrician's kit or screwdriver, pocket knife, and electrician's pliers.

Materials Needed:

1 box cover unit with fuse holder and plug receptacle for a 3-prong plug (See Fig. 1)

1 delayed action fuse of proper amperage rating for the motor.

1 ordinary fuse

1 receptacle box or handy box. (See Fig. 5)

Male Plug

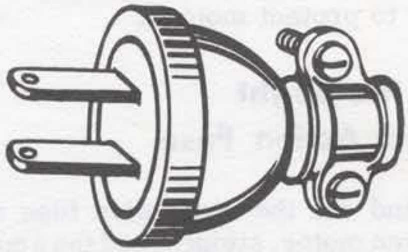


Figure 2

Figure 3

About two feet of No. 12-2 wire, nonmetallic cable with ground wire (See Fig. 3)

A piece of No. 12 copper wire for ground connections--as long as needed. (See Fig. 6)

1 male plug with cord grip. (See Fig. 2)

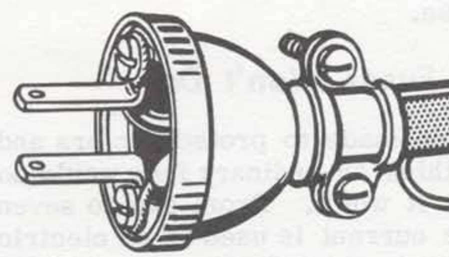


Figure 4

How to Assemble the Fuse Block

1. On one end of the cable, strip both wires back far enough to attach the plug. (See Fig. 3) Bring the ground wire out of the cable as shown. It will be connected later.

2. Attach wires to screws on plug. Always loop wires around screw terminals in the direction the screws tighten. (See Fig. 4)

In the Fuse Box: (Fig. 5)

3. Attach white wire at silver-colored screw of receptacle.

4. Attach black wire at brass screw terminal of fuse holder.

5. The remaining screw of the receptacle is for the cable's ground wire. Attach the bare end of this copper wire to this terminal which usually is green or marked G.

Make sure you have the right terminal. It will be found connected by a metal clamp or bar to the metal plate of the fuse box.

6. At plug end of wire, connect the bare copper ground wire (Fig. 5) to the electrical ground for the building. This may be done through either a ground wire, the armor of armored cable, or a conduit. If metal water pipes are connected to the electrical ground, you may connect the ground wire to a metal water pipe. (See Fig. 6) If none of these grounding conductors is available, you will need to run a ground wire to the electrical ground for the building.

7. Plug the fuse block into the wall outlet. (See Fig. 6) You can now see that when you insert the 3-prong motor plug into the fuse block the ground wire of your motor will be connected to the ground through the fuse-block ground wire. This is a safety precaution to protect from electric shock.

8. Insert the 3-prong motor plug into the fuse block.

Note: If your motor does not have a three-prong plug to fit the receptacle in the fuse block, you should get one. Install the plug and a length of 3-wire cable from your motor to the fuse block. The insulated or green (ground) wire of the cable should be attached securely to the frame of the motor at one end, and to the round prong of the three-prong plug at the other end. Make sure the "hot" lead from the motor is attached to the correct prong of the plug. This is the prong

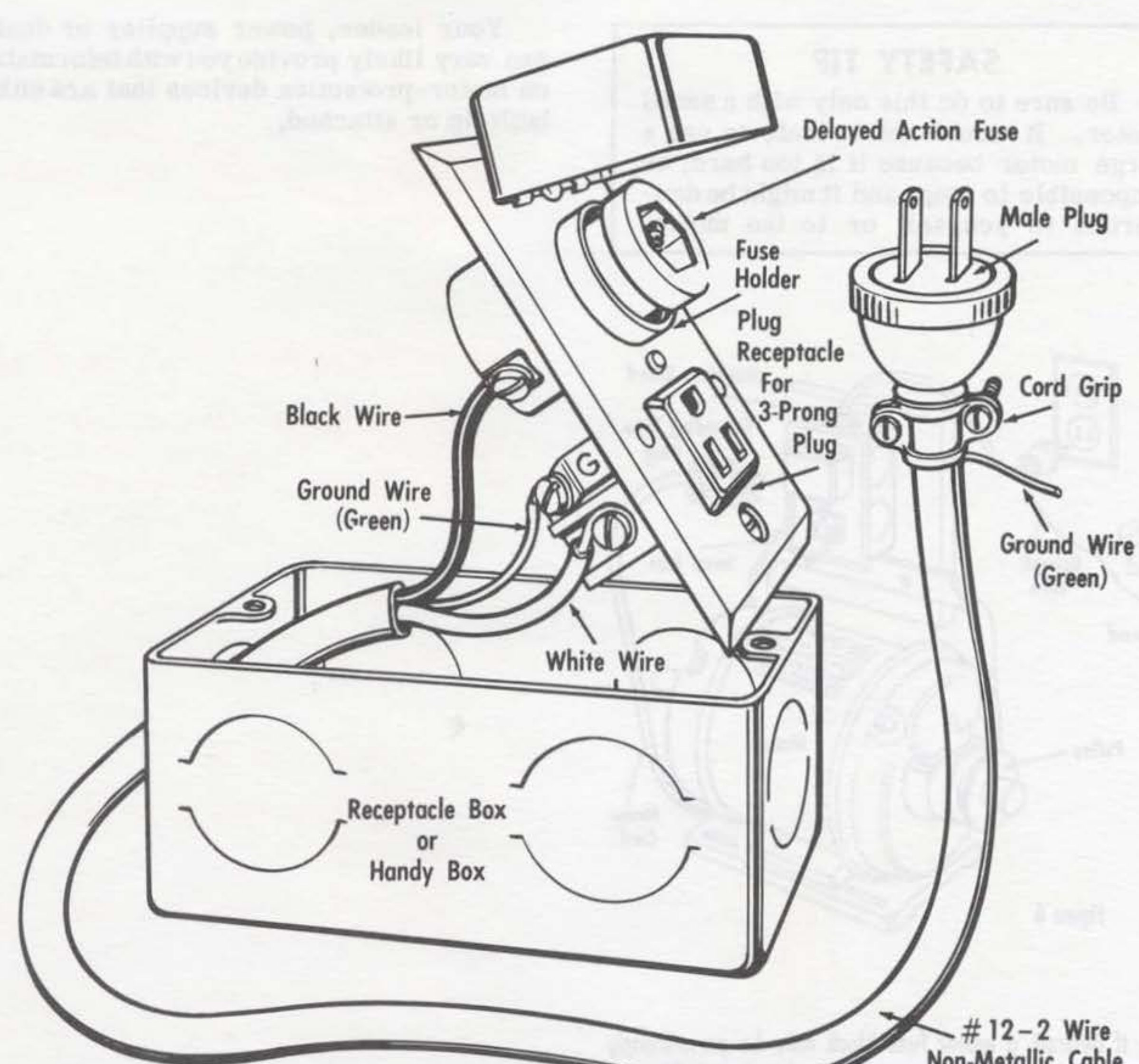


Figure 5

that will fit into the receptacle connection that has the brass screw--not the silver-colored screw.

(B) Demonstrate the Fuse Block.

Use a small motor. Mount the motor securely. Insert an ordinary fuse in the fuse block. Make a brake for the motor pulley. This could be merely a common wooden 2x4 about 3 feet long or longer placed under the pulley with one end on the floor or the mounting base and the other end raised by hand against the pulley.

Start the motor.

Apply the brake to the motor pulley using enough pressure to cause an overload. Keep applying pressure until the fuse blows.

SAFETY TIP

Be sure to do this only with a small motor. It would not be safe to use a large motor because it is too hard, or impossible to stop, and it might be dangerous to yourself or to the motor.

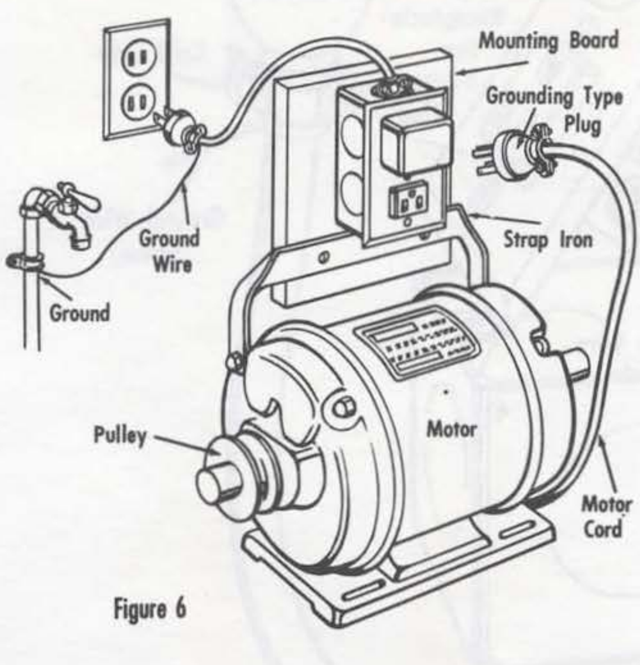


Figure 6

Note: If desired, a motor fuse block may be permanently mounted to a motor by providing a bracket holder as indicated in Fig. 6

Now replace the ordinary fuse with the proper size delayed action fuse and repeat the operation. Notice how the delayed action fuse carries the overload. However, this fuse will also blow if you keep applying pressure and after the motor is heated up to just below the danger point.

(C) With pictures or the real articles, show and tell about different fuses and how they work. Your dealer may be willing to loan you some samples of regular and delayed action fuses for your demonstration.

(D) Show how to make a fuse block.

For Further Information

Your leader, power supplier or dealer can very likely provide you with information on motor-protection devices that are either built-in or attached.

PORTABLE ELECTRICITY

4-H ELECTRIC GUIDE SHEET

LESSON NO. 32
Credit Points 3

Cells and Batteries-- How they Work, How to Care for Them

Cells and batteries are used by almost everybody everyday. They are used in flashlights, lanterns, hearing aids, bicycle lights, slide viewers, automobiles, tractors, trucks, aircraft, ships, and for many other uses.

Cells and batteries can be your handy helpful friends if you will use them properly and take good care of them or they can fail you just when you most want them if they are neglected, abused or improperly used.

If we understand how they work and how they should be used and cared for, we can keep them in good condition for immediate use whenever needed.

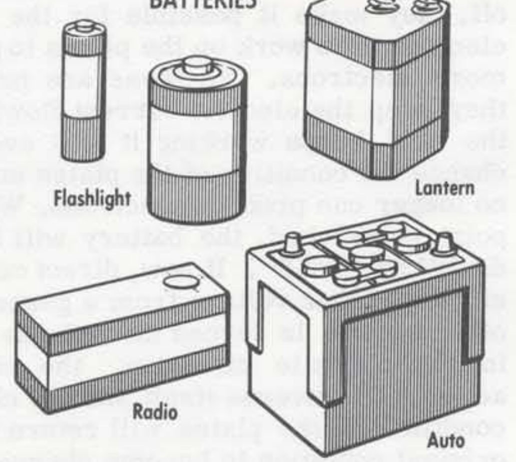


Figure 1

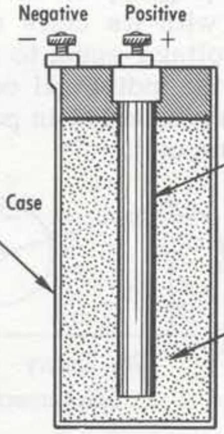
What You Can Do

Very likely there are, in your home or on your premises, several dry cells or dry batteries that are being used in flashlights, radios, etc. There likely are one or more storage batteries being used in cars, trucks or tractors. You can, therefore, learn how these batteries are made; how they work; the care they need; and what you can do to keep them in the best possible working condition.

Kinds of Cells

There are two kinds of electric cells. They both produce electricity by chemical action. One type is called a primary cell or dry cell. (See Fig. 2). It produces such chemical action in its materials that it cannot be recharged. As it is used, it slowly "runs down" and eventually becomes "dead," and must be thrown away.

Figure 2

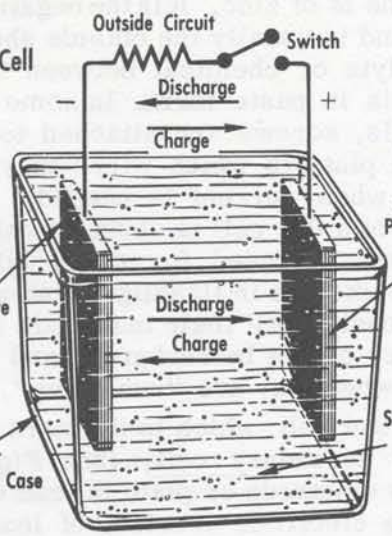


A "Dry" or Primary Cell

The other type is the secondary cell or wet cell. (See Fig. 3). It can be recharged or restored to its original condition, after it has been used, because the chemical action within the cell can be reversed. This is done by sending an electric current through the cell in the opposite direction from the discharge current.

Figure 3

A "Wet" or Secondary Cell



Kinds of Batteries

When two or more electric cells are connected they become a battery. A battery may be made either of dry cells to form a dry battery, or of wet cells to form a storage battery. Cells may be connected in series, (Fig. 4) or in parallel (Fig. 5). A battery with its cells connected in series has a voltage equal to the sum of the voltages of the individual cells. A battery with its cells connected in parallel has a voltage of but one cell.

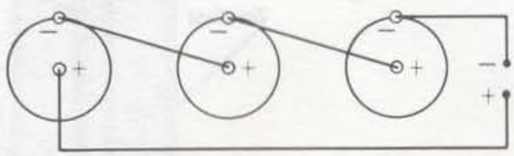


Figure 4 Dry Battery - Cells Connected in Series

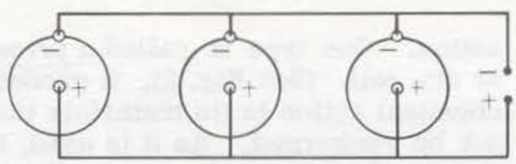


Figure 5 Dry Battery - Cells Connected in Parallel

How Cells are Made

An electric cell consists of two plates known as electrodes; a chemical called an electrolyte, and a case or container.

In a dry cell, the most common type of primary cell (See Fig. 2), one electrode is of carbon. This is the positive electrode and is usually the center post. The other electrode is of zinc. It is the negative electrode and is usually the outside shell. The electrolyte or chemical between the electrodes is in paste form. In some types of dry cells, screws are attached to the top of each plate to which wires may be connected when current is needed. The top voltage of a dry cell is about 1.5 volts. Dry cells are intended for short off-and-on service like use in flashlights but will work continuously until their materials are used up. They cannot be recharged and are discarded when they are "run-down".

In a wet cell, which is the more common type of secondary cell, (See Fig. 3) the positive electrode or plate is lead while the negative electrode consists of lead oxide. The electrolyte or chemical which surrounds the plates is dilute sulphuric acid. The two electrodes or plates are separated or insulated from each other by a porous material that does not conduct electricity. These separators may be made of such materials as wood, spun glass or sponge rubber. The greatest voltage of such cells, is about 2.2 volts. The voltage depends on the strength of the acid and the condition of the plates. The current which a secondary cell can produce depends on the area or size of the plates that is exposed to the acid.

How a Storage Battery Works

When a battery is fully charged, the terminals are filled or charged with electrons, which stop the acid from working on the plates. When, however, the terminals are connected through an outside circuit, the pressure or charge on the plates forces a current of electrons or electricity to flow from the positive terminal to the negative terminal. As these electrons are drawn off, they make it possible for the acid or electrolyte to work on the plates to produce more electrons. As these are produced, they keep the electric current flowing. As the acid keeps working it will eventually change the condition of the plates until they no longer can produce electrons. When that point is reached, the battery will be "run down" or "dead". If now, direct current of slightly higher voltage from a generator or other source is forced through the battery in the opposite direction, the chemical action will reverse itself and the chemcial condition of the plates will return to their original condition to become charged again. The battery is now ready for use. In normal usage, however, a battery is never allowed to become "run-down" or "dead" before recharging. For instance, when you start your car, you connect the terminals of your battery through your starter circuit. As the current flows, it begins to discharge the battery. The discharge continues until the car engine starts. At that point, the engine takes the load off the starter thus stopping the discharge. At the same time the engine turns the generator which then starts forcing current through the battery in the opposite direction. This reverses the chemical action in the battery and starts it to recharge. If, however, your car engine fails to start and you keep running the starter long enough, your battery will continue to discharge until it is "run-down" or "dead". Dead batteries are slow to recharge and if left dead long enough, it may be impossible to recharge them to their original condition.

As they are used, batteries eventually wear out. Hydrogen and water escape and evaporate from the electrolyte or acid. This lowers the acid level and if not brought up to proper level, leaves the plates exposed to the air. Even when plates are fully covered, metal gradually drops from the plates and settles to the bottom of the battery case. This metal is permanently lost and cannot be returned to the plates by recharging. The life of a battery on such things as quality, size for the job, kind of use, rate of discharge and charge, and its care and service. Batteries are usually guaranteed for a limited time only. When worn out they must be replaced.

What to Do

A. Make a list of the dry cells or dry batteries used by your family and check their condition as well as that of their containers.

B. Inspect regularly and care for your storage batteries.

C. Keep a battery service record.

D. Give a demonstration on battery care and service.

How to Do It

(A) Dry Cells and Dry Batteries

Even though these cannot be recharged, they will last longest if properly cared for. Make a list of the dry cells and batteries used in your home. Examine them and their containers. They should be kept dry and cool. When not in use they should be kept on "open circuit" or "shut off". Run-down cells, if left in flashlights or other equipment, may leak and corrode the connections or the case in which they are used. So, check your dry cells from time to time and replace any that are "dead". If contacts in flashlights or other equipment are corroded, clean them before installing new batteries.

(B) Inspect Regularly and Care For Your Storage Battery

Storage batteries, to give their best service, should be inspected frequently. Check the following for each battery:

1. Top: Keep clean and dry. If acid has spilled, clean off with soda water.

2. Terminals: Keep clean and free from sulphate. If crusted, remove sulphate and apply film of vaseline.

3. Nuts and bolts: Keep clean, same as for terminals. If they are badly eaten by acid, replace with new ones.

4. Electrolyte: Level: Check the level in each cell. If low, add distilled water to proper level. If a cell tends to stay low, examine the case for cracks and leaks. The specific gravity of the electrolyte enables you to determine whether the battery is charged, partially charged, or discharged.

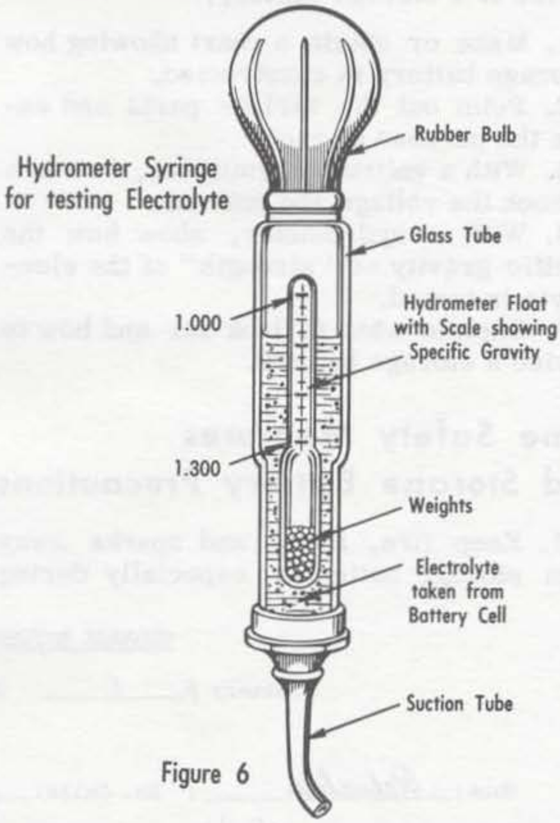


Figure 6

Strength: So, with the use of a hydrometer syringe, (See Fig. 6), draw enough electrolyte to make the hydrometer float freely in the syringe glass tube. Read the scale on the hydrometer. This specific gravity reading will tell you whether the battery is charged or discharged. If the reading at the surface of the electrolyte is 1.150 or lower, the battery is discharged. If below 1.25 the battery should be recharged without delay. If the reading is around 1.275 to 1.350, the battery is probably sufficiently charged to do its work.

If, after charging, the voltage is low or the battery is weak, test the strength or specific gravity again with a hydrometer. If the reading is still low, the battery may need to be replaced.

Note: If you do not have a hydrometer, see your service station attendant. Ask him to explain its use as he tests each cell in your battery.

(C) Keep a Battery Service Record

Rule a sheet like Fig. 7 or make a similar form on which to keep your record. Keep a record for a year--or for the life of the battery.

(D) Give a demonstration on The Care and Service of a Storage Battery.

1. Make or obtain a chart showing how a storage battery is constructed.
2. Point out the various parts and explain the purpose of each.
3. With a voltmeter-ammeter, show how to check the voltage and current.
4. With a hydrometer, show how the specific gravity or "strength" of the electrolyte is tested.
5. Explain what to look for and how to service a storage battery.

Some Safety Measures and Storage Battery Precautions

1. Keep fire, flame and sparks away from storage batteries, especially during re-charging when hydrogen gas is given off. Hydrogen gas is explosive.
2. Safety glasses should be worn when working with storage batteries.
3. Keep battery in upright position to avoid spilling the acid or electrolyte when carrying or handling.
4. Use proper tools to remove terminal clamps from the battery posts.
5. Use a battery-carrying strap when lifting and carrying a battery.
6. Battery clamps should not be hammered onto battery posts as they may cause breakage: a light tapping should do.

Some Battery Precautions

1. Vents in all filter caps should be kept open to allow gas to escape.
2. Only distilled water should be used for refilling.
3. Electrolyte or acid should cover the plates but should not be kept above the recommended level.
4. If gravity of electrolyte is less than 1.25, the battery should be re-charged.
5. Avoid a quick charging rate, it may be damaging.
6. Battery temperatures during charging should never be allowed above 125°F. If temperature is high, reduce the charging current.

STORAGE BATTERY SERVICE RECORD

Battery # 1 Used in: Family Car

Make: Reliable ; No. Cells: 3 ; Guaranteed for: 36 Mos.

Date Purchased: 3/10/59. Dealer: Hopewell ; Purchase Price: ______

Date Replaced: ______ Total Months Used ______; Service Costs ______

Average Cost per month service: ______ ; Total Cost: ______

Record Conditions Found and What was Done

Date Inspected	Case		Post or Terminals	Bolts, Nuts Clamps	Electrolyte		Volts	Current	Remarks
	Top	Sides			Level	Gravity			
4/18/59	soiled	O.K.	slightly coated	slightly coated	down slightly	1.290	2.1	not checked	cleaned top and bolts added water

Figure 7

4-H ELECTRIC GUIDE SHEET

LESSON NO. 33
Credit Points 4

a bright idea — MAKE A STUDY LAMP

How much does light have to do with seeing? Everything! In complete darkness, the eyes receive no image to transmit to the brain, so we cannot see a thing. In dim light objects can be seen, but not clearly, and it's hard to separate the object from its background.

Nature designed our eyes for outdoor living. But as civilization progressed, man moved indoors. His eyes were called on for many new seeing tasks. And he had to create light indoors to see by.

There are many, many kinds of lamps and lighting fixtures, but there are only two eyes per person. So it is important to take care of your eyes, and have the right kind of lighting, whether for reading, work, or play.

The Facts of Light

Light without glare or harsh shadows is the best kind to see by. The amount of light (intensity) is important, too. Light intensity is measured in "footcandles". Different conditions of work, reading, or play require different footcandles of light intensity. The general trend in lighting is toward greater light intensity for all seeing activities.

Good lighting may be obtained from either incandescent bulbs or fluorescent tubes. Since the lamp we're going to build uses an incandescent bulb, we'll concern ourselves with fluorescent lighting at another time.

Good lighting is of two types: general lighting for general seeing, and localized lighting for close seeing such as reading, sewing, games, and shopwork. General lighting may be provided by ceiling fixtures and lamps with open-top shades. A study lamp provides localized lighting and sometimes supplements the general lighting.

Diffusers are devices used to make a light source larger--so that light coming from any given square inch is less intense. There's less glare. They spread out the light by making it travel in several directions. Shadows are softer.

Diffusers make for more eye comfort, less eye strain.

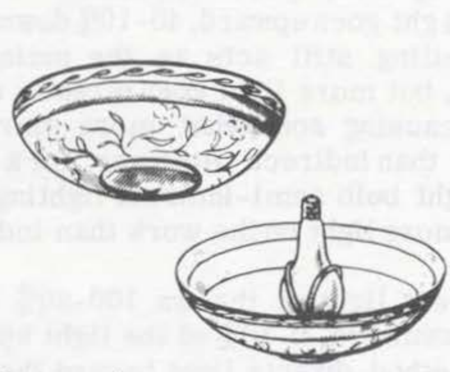
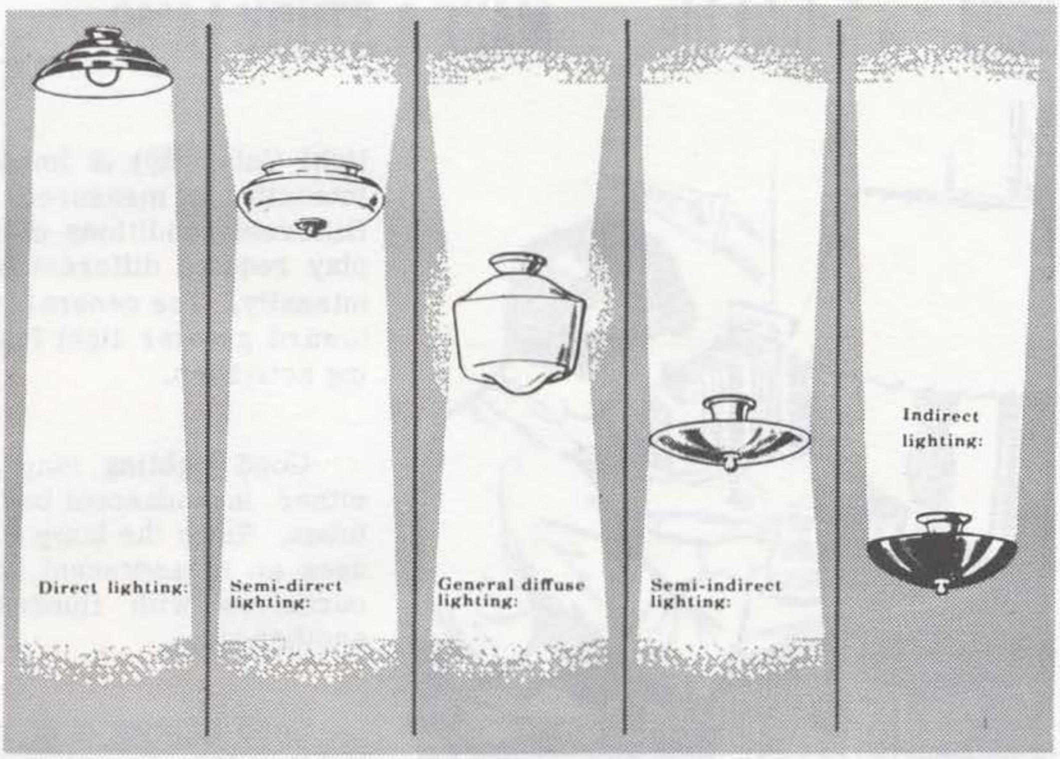


Figure 1

Types of Lighting



With indirect lighting, 90-100% of light is directed upward, and 10-0% downward. Indirect lighting gives little glare and practically eliminates shadows. The ceiling acts as the light source; if it is light in color, it reflects light downward into the room. The larger the light source for a given wattage, the less bright and more comfortable it is. Also, when light reaches any one point from several sources or parts of a large source, shadows are less dense.

Semi-indirect lighting is similar to indirect lighting, except that less light is directed upward, more downward. 60-90% of the light goes upward, 40-10% downward. The ceiling still acts as the main light source, but more light goes directly downward, causing somewhat more glare and shadow than indirect. However, for a given size light bulb semi-indirect lighting produces more light on the work than indirect.

Direct lighting throws 100-90% of the light downward, 0-10% of the light upward. This method directs light toward the work surface, giving maximum light there but causing excessive contrast of light and shadow, and reflected glare from shiny surfaces, including printing in books.

General diffuse lighting throws light in all directions--40-60% of the light goes upward, 60-40% downward.

Semi-direct lighting throws light both up and down, with 90-60% going downward, 10-40% upward. Most light is directly on the work surface, with glare and shadows as a result.

A ceiling fixture with a glaring bare bulb that throws light directly downward can usually be changed to a less glaring, more comfortable fixture simply by installing a clip-on diffuser. How many ceiling lights are there in your home? Is their light completely direct? You may want to purchase some clip-on diffusers for use in your home. Be sure to get white or ivory, because colored ones give very little light and distort the appearance of furnishings and people. (figure 1).

WHAT TO DO:
Build A Study Lamp

With just a few materials and tools you can build a lamp with a diffusing bowl that directs some light upward, and distributes light gently downward with a minimum of glare and shadow.

This lamp is designed (15" from desk to bottom of the shade) so that you cannot see the diffusing bowl as you sit at your work. The 16" shade is wide enough to permit spreading the light over your study area.

Materials You'll Need:

Two pieces of wood 1" x 2" x 13" for stem

One piece of wood 7-1/2" x 7-1/2" x 3/4" for upper half of base

One piece of wood 8" x 8" x 3/4" for lower half of base

Lamp socket with 3-position switch for 3-light bulb. Socket should be threaded for 1/8" pipe

14-1/2" length of 1/8" pipe, threaded at both ends

Lock washer and nut to fit threaded pipe

Shade holder to fit socket. This will support the diffusing bowl. (Shade holder not needed if bowl is threaded plastic.)

White lined shade with 16" bottom diameter

9-3/8" diffusing bowl

3-light bulb (50-100-150-watt)

9-foot lamp cord with plug. Not smaller than No. 18 AWG UL approved conductor

Six-1-1/4" No. 10 flat-head wood screws

Wood glue   Fine sandpaper

Carpenter's tools

Steps To Take

1. Prepare the base. Drill a 1/2" diameter hole in the center of the upper half of base. (This is the 7-1/2" x 7-1/2" x 3/4" piece.)

2. Drill a 1-1/4" diameter hole in the lower half of the base. (This is the 8" x 8" x 3/4" piece.)

3. In this same piece, drill a 1/4" hole from an edge to the center hole.

4. If you wish, round the upper edges of both pieces with a wood rasp and sand to a smooth finish. This gives you a base with a slightly different style.

Make The Stem

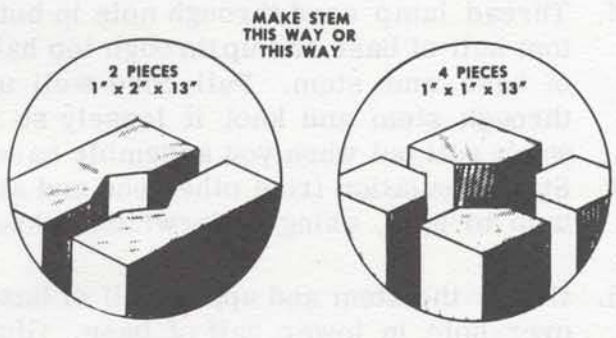


Figure 2   Figure 3

1. Cut a "V" groove the length of each stem piece. Make sure the grooves match (figure 2). Make grooves 7/16" wide and 1/4" deep.

(Note: another way to make the stem is to take 4 pieces of wood 1" x 1" x 13", and bevel a corner the length of each piece. Then join the 4 pieces (figure 3). Either method provides a channel for the pipe which will carry the wire up the stem.)

2. Match the grooves and glue the stem pieces together. Follow instructions on the glue container so you'll clamp the stem properly and let it dry long enough.

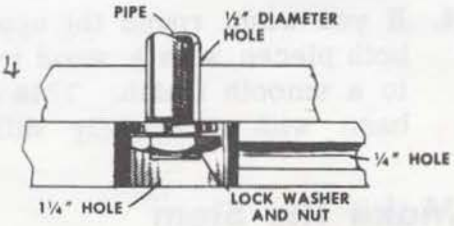
Now Assemble The Lamp

1. Center the stem over the hole in the upper half of the base and secure it from underneath with two wood screws. Countersink the screws.

2. Insert the pipe into stem and top half of base. Remove the socket cap from light socket and screw it onto the pipe at top of stem .

3. At bottom of stem, place lock washer and nut on pipe. Tighten nut (figure 4).

Figure 4



4. Thread lamp cord through hole in bottom half of base and up through top half of base and stem. Pull cord well up through stem and knot it loosely so it won't pull out when you assemble base. Strip insulation from other end and attach to plug, using Underwriters' knot.

5. Center the stem and upper half of base over hole in lower half of base. Glue the base together. When dry, secure from underside using one wood screw at each corner. Counter sink the screws.

6. Now untie loose knot in cord at top of stem. Strip insulation from ends of each wire and tie Underwriters' knot again here. Fasten to screw terminals of light socket.

7. Assemble socket, and screw the shade holder onto socket.

8. Fit the diffusing bowl on the shade holder. If you use a threaded plastic diffusing bowl, the shade holder will not be needed.

9. Insert bulb, and place shade on completed lamp.

Variations You Can Make

You can finish your wood lamp with colored enamel, shellac, stain, or varnish. Or you may want to cover it with imitation leather. You can vary the stem and base of your lamp to achieve different pleasing designs. Or perhaps you would like to make your own lamp design, using the same length stem and same size shade, diffusing bowl and bulb. Work your design out in detail and show it to your leader before starting work.

Demonstrations You Can Give

Display your lamp and tell how you built it.

Explain the purpose of the diffusing bowl, and the importance of selecting the proper height and diameter of the shade.

Explain which type of lighting is best: direct, semi-indirect, general diffuse lighting, semi-direct, indirect lighting. Why?

With totally direct lighting and a magazine with shiny paper show how the light can reflect at one angle so that the print seems to fade into the background.

Chart Your Lighting

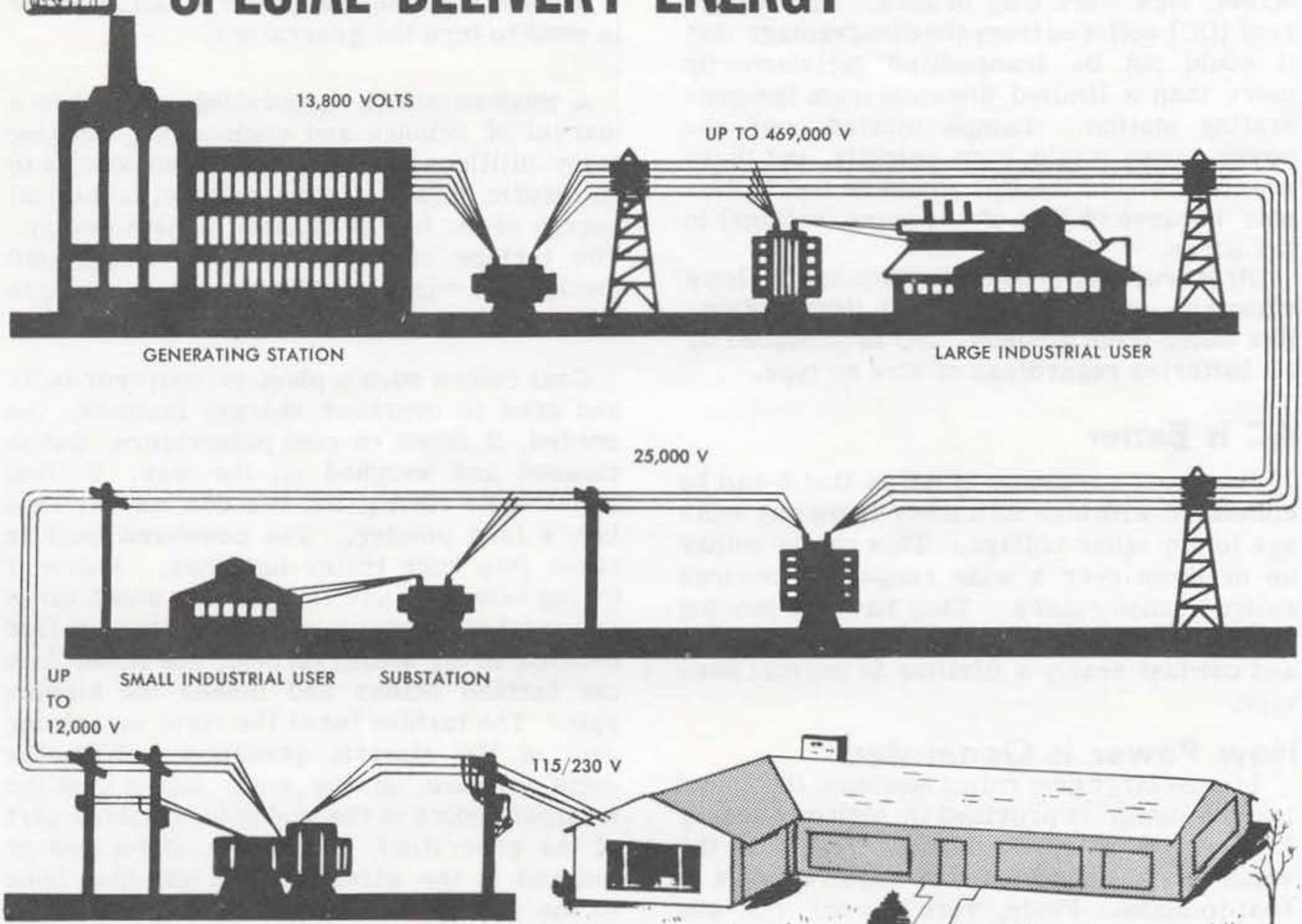
Make an information chart of the lights and lamps in your home. Name the locations, and whether the lighting is good or poor. What did you do to improve poor lighting? Mention it on your chart.

EXHIBIT the lamp you have made.

For Further Information

Get a book or a bulletin and read up on it --use your study lamp! Ask your leader to arrange a talk on lighting by your power supplier representative.

SPECIAL DELIVERY ENERGY



How are most of the things you use in your home delivered to you? Do they come by truck, or do you go and get them in the family car?

How about the limitless supply of electrical energy--how is it delivered?

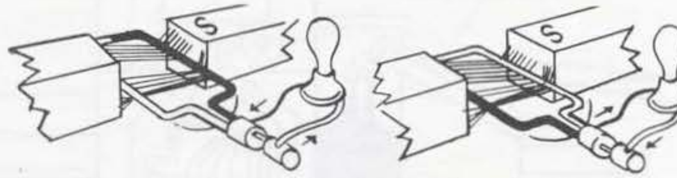
Today most people take for granted the system that brings power to their homes. They know that all they have to do is flip a switch and a mysterious, almost magical force provides light when it's dark, heat when it's cold, and "cold" when it's hot. You'll find it interesting to know how electricity is made and how it is delivered to you. You'll find it valuable to know what to do if the supply ever should fail.

What to Do

1. Get to know the system that delivers electrical energy to your home.
2. Learn what to do if your power supply is interrupted.

How Our "AC" is Made

Practically all electricity produced for sale in the United States is now "alternating current." This is usually abbreviated AC so that it can be spoken and written easily.



When a loop of wire spins between the poles of a magnet, it cuts magnetic lines of force. This produces an electric current in the wire. The current reverses direction each half turn and is therefore called alternating current. The first alternating current system lighted the town of Great Barrington, Massachusetts on March 20, 1886 and was developed by George Westinghouse.

DC is Older

Previously, a direct current generator had been installed by Thomas Edison at Pearl Street, New York City in 1882. Direct current (DC) suffered from the disadvantage that it could not be transmitted satisfactorily more than a limited distance from the generating station. Lamps located near the power house would burn brightly, but those near the end of the line would be much dimmer because of loss of pressure (voltage) in the wires.

Direct current is so called because it flows smoothly, evenly, and without interruption, like water from a faucet. DC is produced by all batteries regardless of size or type.

AC is Better

The great advantage of AC is that it can be converted with high efficiency from any voltage to any other voltage. This can be either up or down over a wide range, by devices called transformers. They have no moving parts, require only very minor maintenance, and can last nearly a lifetime in normal service.

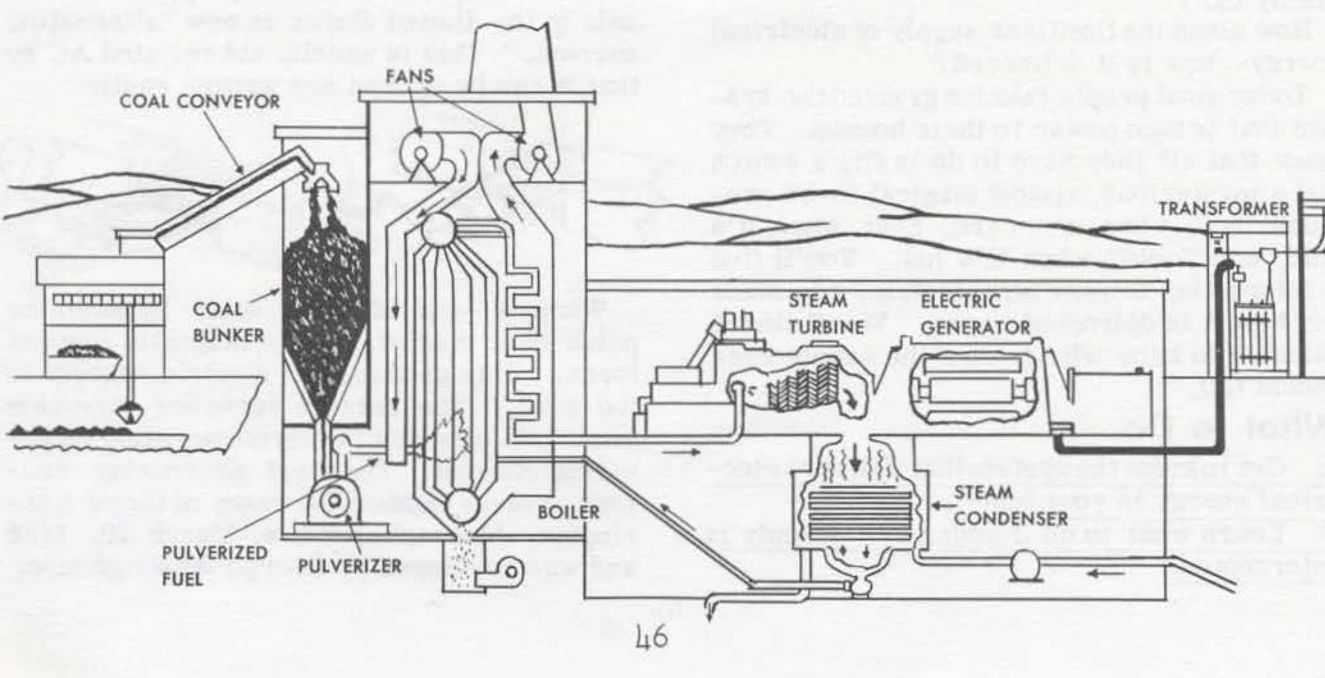
How Power is Generated

In most large generating stations, the actual turning power is provided by high-pressure, high speed steam turbines. Steam is the vapor of boiling water and requires a lot of heat to make. Fuels, such as coal, oil, and gas, are used to keep huge boilers steaming 24 hours a day. Already atomic power is starting to replace these fuels.

In other stations, the power of falling water is used to turn the generators.

A modern steam generating station is a marvel of science and engineering, costing many millions of dollars. Its purpose is to transform energy. In the boilers, chemical energy of the fuel is changed to heat energy. The turbine changes the heat energy into mechanical energy. The generator changes this into electrical energy.

Coal enters such a plant on conveyor belts and goes to overhead storage bunkers. As needed, it flows to coal pulverizers, and is cleaned and weighed on the way. Rolling metal balls then grind the coal as fine as a lady's face powder. The powdered coal is blown into huge boiler-furnaces. Miles of tubing in the furnace carry water which turns to superheated steam. Rushing through fine nozzles in the steam turbine, the steam hits the turbine blades and makes the turbine spin. The turbine turns the rotor or moving part of the electric generator. When the coils of wire on the rotor sweep past the magnetic poles of the stator (motionless part of the generator), electricity is formed or induced in the wires. Steam now goes back to the condenser. Here the steam changes back to water and returns to the boiler to start its trip once more.



Transforming Power

Electricity must be used the instant it is made. In other words, we have not as yet learned how to store it for future use. (The one exception to this is the storage battery.) Electricity speeds over a vast distribution system to all the places near and far where it does its work. Heart of the distribution system is the transformer. It raises the voltage of electricity for long-distance transmission or lowers it for many uses.

High Voltage Highway

Power is generated in modern stations at voltages between 11,000 and 14,000 volts. By means of the transformer, it is boosted to voltages up to as high as 460,000 volts. The higher voltages are used for the longest high-tension transmission lines.

The higher the voltage, the less the current flow (amperes) for a given power load. This means smaller wires can handle the same load. This is an important consideration. Large diameter wire is more costly, difficult to handle, accumulates dangerous quantities of ice, and is buffeted around by strong winds. All these effects are reduced with smaller wire.

Stepping Down to "Safe" Voltages

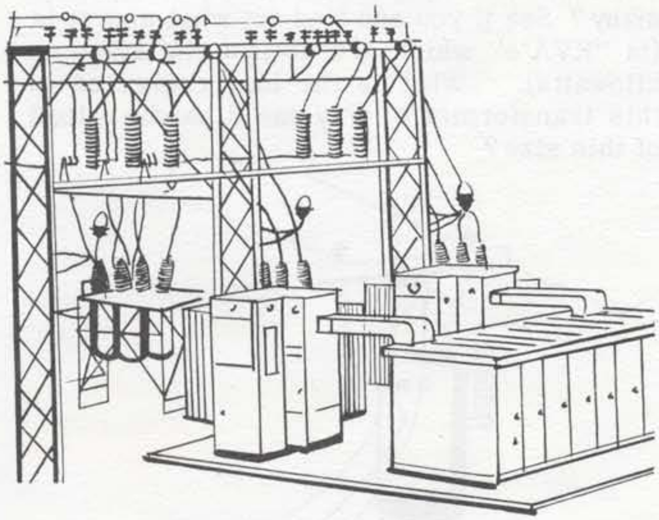
Very high voltage is much like a jet airliner. Such a plane is fine for long distances, but you can't land it in your backyard. You have to "step down" from the plane at a big airport, either to a smaller plane or to an automobile, to complete your trip.

Electricity, on its way to you, does the same thing. It steps down at least twice from the high voltage of the transmission line.

The first step-down takes place at a substation, where there are transformers, circuit breakers, and lightning arresters. From here the electricity goes over distribution lines to the surrounding area at a voltage that, although still high, is much safer to "have around" than that used for transmission.

The circuit breakers are giant automatic switches which turn off the electricity in case of an emergency. They turn it on again when the emergency is over.

Lightning arresters protect electrical equipment when lightning hits the line. They



bypass the extra current harmlessly into the ground.

The final step-down in the distribution system is near your home. Here another transformer, much smaller than the one at the substation, brings electricity down to 115 and 230 volts. These voltages, while still deadly if mishandled, can safely be handled with the protection afforded by flexible and economical insulation found on cords and in our appliances.

Now, Take a Tour

Ask your leader to organize a tour of a local power supplier's generating plant or substation. Arrange to have a power supplier representative explain the purpose of the various pieces of equipment.

Get the Answers

Try to find the answers to these questions:

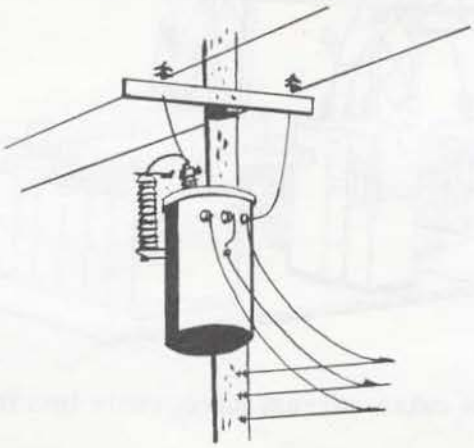
Where is the power you use generated? How is it made (steam or water power)?

What about the power line past your home --what is its voltage?

Where is the substation from which your line is fed?

Is there more than one way that the line past your home can get electricity? Why?

Where is the transformer that serves you? Does it serve other customers, too? How many? See if you can find out what size it is (in "KVA's" which are almost the same as kilowatts). What is the load connected to this transformer? Why can it handle a load of this size?



When the Power Goes Off

The power system has yet to be operated that does not stop delivering electricity at some time or other. Power suppliers take every possible precaution against this, yet they are prepared to act quickly, if necessary, to restore service at any hour of the day or night.

When and if yours does, there will always be a good reason. Some of these are:

1. "Planned" interruptions. Your power supplier from time to time has to shut off certain customers because of necessary repairs and improvements to the line. Most power suppliers attempt to protect their customers from loss or inconvenience from such interruption by scheduling them at times when power use is down. They also try to notify users by telephone, in person, or by newspaper and radio.

2. Weather. Thunderstorms, ice storms, and windstorms can cause plenty of damage to even the best-protected lines.

3. Accidents. A car can shear off a pole, or a careless woodsman can fell a tree across a power line. Other accidents can produce the same effect.

WARNING: If you see a fallen wire or any other evidence of an accident, call the police or power supplier immediately.

4. Equipment failure. Despite every precaution, somewhere along the line a piece of equipment may break down and put you out of power.

Your Responsibility

If some day your power supply fails, here is what you should do:

1. Make sure that the interruption is not just caused by the blowing of your own main fuse.

2. Telephone your power supplier immediately. Give them your name and location, and information as to when the interruption occurred. (IMPORTANT--Some people who have depended on the "other fellow" to do this have waited for days and wondered why their service was not restored. Power suppliers depend on you for this--they have no other way of knowing whether all their customers are "in service.")

Make sure you know where to call to get in touch with your power supplier--day and night.

What Did You Learn?

True or False

1. Practically all commercially produced electricity in the United States is generated as direct current and converted to AC.
2. Direct current can be transmitted greater distances than AC.
3. Planned interruptions, weather, accidents, and equipment failure are the main causes of power failure.
4. Coal is pulverized to a fine powder before it is fired in large steam boilers.
5. Electricity can not be stored except chemically in a storage battery.
6. Power is usually generated in voltages up to 138,000 volts.
7. The purpose of a circuit breaker is to protect electrical equipment when lightning strikes.
8. A transformer has no moving parts and requires little maintenance.
9. The first commercial electric generator was a direct current type.
10. If your lights go out, always assume that someone else has reported it to your power supplier.

HOW TO USE THIS BOOK IN FULFILLING THE GOALS OF THE 4-H ELECTRIC PROJECT FOR THE FIRST AND SUCCEEDING YEARS

The minimum goals for credit in the 4-H Electric project vary according to the 4-H member's age and the number of years he or she has taken the electric project. For example, if you are a 4-H member beginning the 4-H Electric project at the age of 10, you will not be required to earn as many credit points as a 14-year-old 4-H member beginning the 4-H Electric project. However, if you are a 12-year-old in your second year of electricity you must earn as many credit points in that year as a 14-year-old does in his or her first year.

Each lesson or goal has been designated a certain number of credit points. These are shown near the title of each lesson or goal. You decide on the lessons you want to study, list them, and add up the credit points.

For a full year's 4-H project credit, the total of your credit points should be at least as many as shown in the following table:

Examples of reading the table below are as follows: (a) An 11-year-old member is required to complete 13 credit points the first year. (b) A 14-year-old is required to complete 17 credit points his first year. (c) A 14-year-old taking the electric project for the third year must complete 21 credit points that year.

There are enough lessons in this book to give you credit for two or more years in the 4-H Electric Project. Do at least all of the lessons that interest you. If you wish, and your leader approves, you may combine any of the lessons in this Division with those in other Divisions to earn credits for a year's work.

Minimum Number of Credit Points
Required for Each Year's Work in the 4-H Electric Project

4-H Member's Age	4-H Member's Year in 4-H Electric Project			
	1st Year	2nd Year	3rd Year	4th or Later Years
10 - 11	13	15		
12 - 13	15	17	19	20
14 - 15	17	19	21	21
16 & over	19	21	21	21

This system of credit points makes it possible for you to do the things you want to do with electricity and get credit for them in the 4-H Electric project.

Supplemental Information Available

T-5 Leaders Idea Book
T-21 Members Idea Book

See your County Extension Office concerning the availability of electrical kits, films and other information.