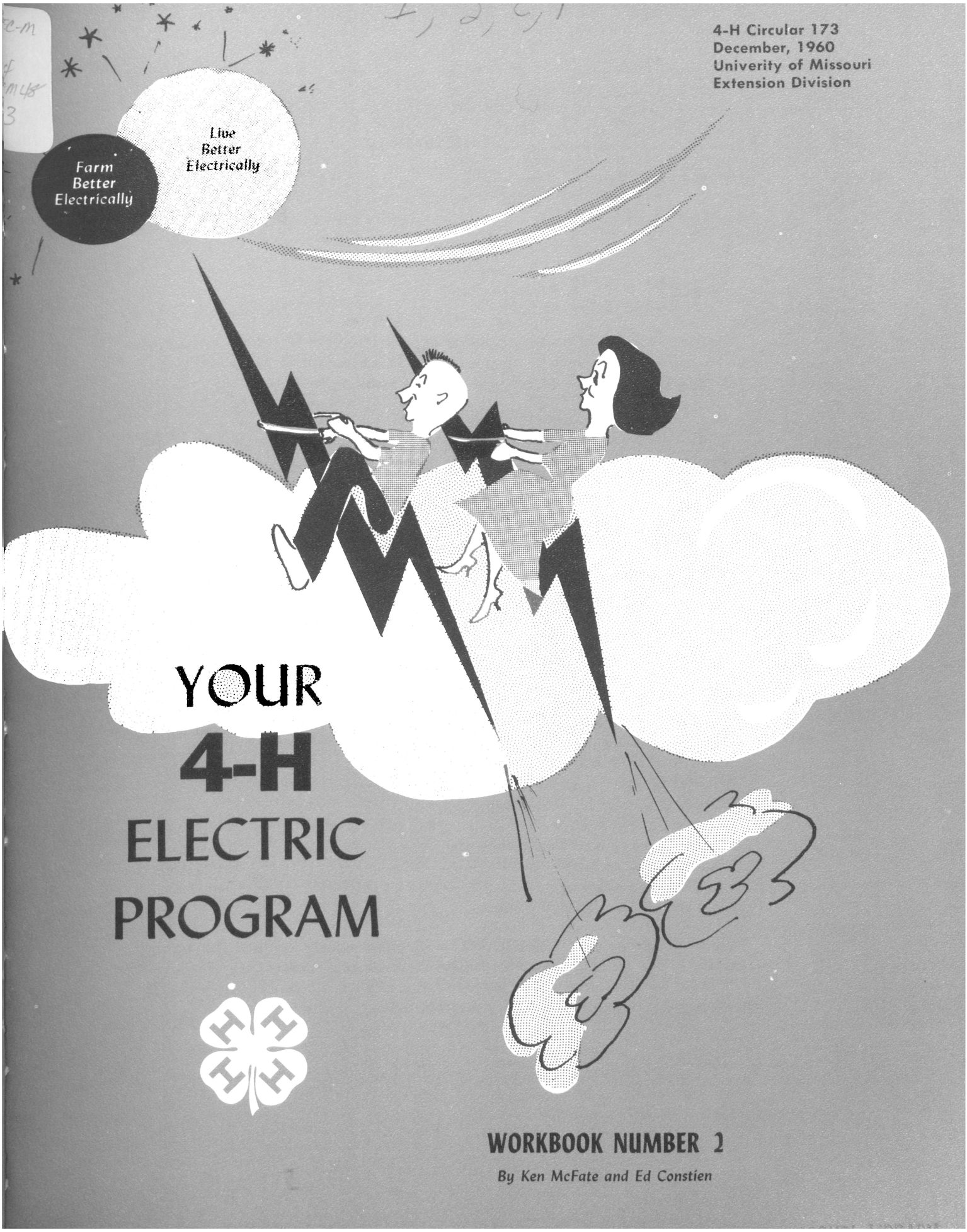
4-H Circular 173
December, 1960
Univerity of Missouri
Extension Division



YOUR 4-H ELECTRIC PROGRAM

WORKBOOK NUMBER 2

By Ken McFate and Ed Constien

NAME _____ Age _____

ADDRESS _____ PARENT'S NAME _____

NAME OF CLUB _____ CLUB LEADER _____

NAME OF LOCAL POWER SUPPLIER _____

Hi! 4-H'er

Workbook II contains a variety of new challenges in things to learn, things to build, and things to demonstrate. The information in Workbook No. I is background material for many of the units in Workbook II.

PROJECT REQUIREMENTS

If you enroll in this project, your club leader will expect you to complete the following:

1. Attend a majority of project meetings and six community meetings.
2. Make, build or repair at least three articles.
3. Complete at least two surveys at home or on the farm.
4. Study at least 6 units in this book. Complete the quizzes at the end of the same 6 units.
5. Perform at least one demonstration before a group of people.
6. Write a short story on "Things I Have Learned in 4-H Electricity This Year."
7. Turn in the project report to your leader by _____, 19___.

I hope you'll enjoy the units which you and your leader select from the following list:

1. Light for Better Living
2. Fluorescent Lamps and Fixtures
3. What Makes Motors Run
4. How to Select the Right Motor
5. Care and Use of Electric Motors
6. Make a Test Lamp
7. Simple Repairs and Replacements
8. Small Electrical Appliances
9. The Electric Skillet
10. Let's Learn About Heat Lamps

I'll try to keep you "ON GUARD" with more safety slogans this year. But safety is *your* primary responsibility. Don't take unnecessary chances. Play it safe. Respect electricity for what it is. Enjoy electricity for what it does—for you, your parents, and your community.

MR. E. LECTRON

Light for Better Living

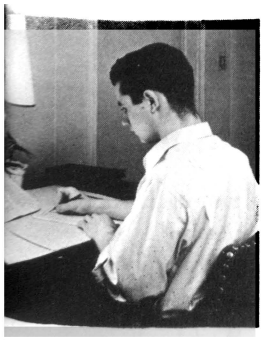
UNIT I

Almost 100 percent of the homes in the United States have electricity available today. But only a few of these homes have enough light for good, safe, comfortable reading and living.

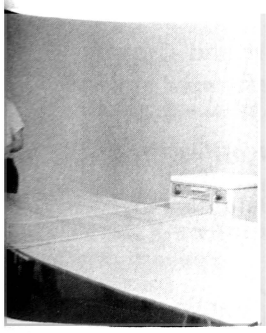
Did you ever stop to think how little *GOOD LIGHTING* really costs. Once the *proper* fixtures and bulbs are installed it costs just a few pennies a day. In fact, your study lamp can be operated for nearly 20 hours for only a nickel.

INCREASE YOUR KNOWLEDGE

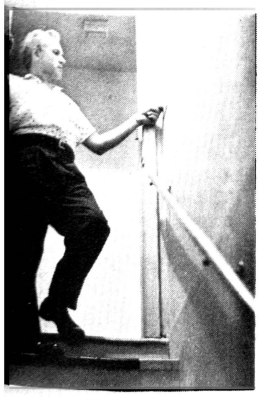
Light is used in and around our homes for many very important reasons. Some of these are:



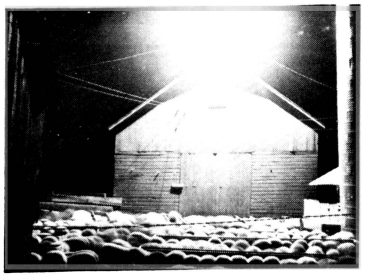
Light for Seeing—Better vision will result with better light. Better light will reduce eyestrain and headaches. It contributes to efficiency, personal comfort, and greater accomplishment.
Printers, machinists, draftsmen, stenographers, and others who work under artificial light during much of their working day generally have poorer vision than those who work little under artificial light.



Light for Convenience—Good lighting fixtures placed in a dark basement can make a cheerful game or recreation room. A portable outdoor light can extend your work and playtime hours. A closet light can help you find things more quickly.



Light for Safety—Lights over stairs, at steps, in work and play areas, in feedlots and in other dark areas make your home and grounds safer. Electric lights are the safest lights to use, especially in buildings where combustible materials are stored.



Light for Protection—Night lighting wards off prowlers, thieves and predatory animals that might otherwise account for large monetary losses. It gives a sense of security to members of the family who may be at home alone.

Light for Beauty—Good lighting can make your home beautiful inside and out. Proper lighting emphasizes the natural beauty of woods, paints and accessories.

In first year work, you learned that both the right quantity (amount) and the proper quality (lack of glare and contrast) were important for good lighting. You also heard about light measurement.

The *foot-candle* is one of the more common terms used in the study of light. It is the amount of light that is received from a standard candle at a distance of one foot. All levels of illumination are measured in foot-candles. Table 1 gives the recommended levels of illumination for several tasks. Ad-

TABLE 1-LEVELS OF ILLUMINATION FOR SPECIFIC WORK AREAS

Activity	Foot-Candle Required
Sewing (dark fabrics)	200
Sewing (light fabrics, prolonged periods)	100
Kitchen sink, workshop bench, desk study	70
Range, work surfaces, shaving, make-up center	50
Reading, simple music scores, table games, bathroom	
General lighting in Kitchen, laundry, hallways, & Stairways	10

ditional information on foot-candle requirements may be obtained from your power supplier.

To get the most benefit from your lighting system, it must be remembered that the *wall finishes* and *light* are partners in home lighting and good living. Light colors—or pastels—reflect light. Dark colors *absorb* light. Total amount of foot-candles available in a room depends on whether you have light or dark colored surroundings. In most cases, it is desirable to obtain a color combination that will "bounce" or reflect a large percentage of the light that strikes the walls and ceilings. Thus, the color of the surfaces *is* important.

A number of colors and their approximate reflectance values are listed in Table 2. Reflectance

TABLE 2-REFLECTANCE VALUES FOR A FEW SELECTED COLORS AND WOODS

Material Description	Relectance Value
Dark Gray	15%
Light Gray	65% - 82%
Dark Blue	8%
Light Blue or Green	62% - 69%
Deep Yellow	55%
Light Yellow	76% - 79%
Deep Red	22%
Light Pink	62% - 70%
Dark Wood	20% - 30%
Light Wood	50% - 60%

values are expressed as the percent of light reflected from that surface which it strikes. For instance, a light yellow wall reflects ¾ of the light that falls on it. Its reflectance value is 0.75 or 75%.

A good room color combination should have reflectance values in the following categories: ceiling, 60 to 90%; walls 35 to 60%, and floors, 15 to 35%. Because Table 2 does not show *specific* colors, it can be used as a guide only. For specific planning, obtain a color reflectance chart at your County Extension Office, major paint store, or from a major electrical lamp manufacturer representative.

The two most used sources of artificial light are filament or incandescent lamps and fluorescent lamps.

Filament or Incandescent lamps are essentially "a piece of wire in a bottle." The filament may be a straight wire, a coil, or a *coiled* coil surrounded by an inert gas. While the manufacturer must consider many factors in the design of each lamp, the user is mainly concerned about the size of bulb, type of base, light output and the "feeling" produced by specific electric lamps.

Most incandescent lamps are designed for an average of 750 hours of actual use. If you use them on poorly wired circuits with low voltage, however, you will not get the most efficient use of them.

Incandescent lamps produce light that is rich in red and relatively weak in blue. This emphasizes the warmer hues, creates a warm feeling and has been accepted for most lighting for many years.

All incandescent lamps—except the low wattage decorative types—must be shielded to prevent glare. This can be done by using a plastic or ceramic-enameled glass diffusing bowl or some other diffusing materials, and selecting the proper shades.

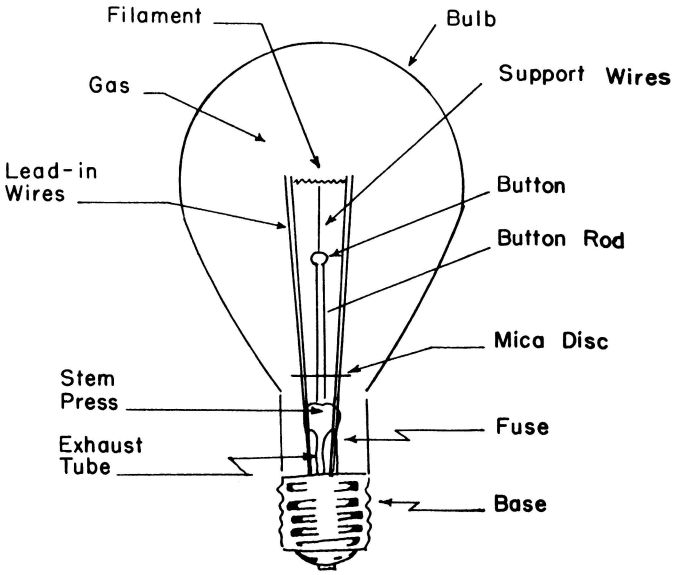
Fluorescent lamps and fixtures will be covered in Unit *2*. But if we are to have safe, adequate lighting in and around our homes, we must be sure that we have:

1. Adequate electrical circuits, properly protected.
2. Fixtures that provide the recommended quantity and quality of light.
3. Stairs, halls, ladders, playgrounds, yards and feedlots well lighted.
4. Lights equipped with multiple switching so "groping in the dark" is unnecessary.
5. Switches, fixtures and portable lamp cords replaced as soon as they become damaged.

DEMONSTRATE

Using the lighting demonstration kit, show one or more of the following:

1. Effect of *Light Quality—Glare* and *Contrast.*
2. Effect of *Light Quantity, Reflectance* and *Absorption.*
3. Effect of colored bulbs on *Light Output.*



Incandescent Lamp Construction

THINGS TO DO

1. Plan and build a well lighted study center. (Refer to Extension Cir. 714—A Well Lighted Desk.)
2. Inspect all lamps in the home. Clean all dirty bulbs and soiled shades. Make a record of the work performed.
3. List the places where additional light switches should be added. Mark these on a floor plan of your home.
4. Study all different kinds of incandescent lamps. Obtain from your home or from your local stores, lamps and tubes of different wattages, shapes, bases, color characteristics, etc. Make a display board which shows the differences in lamp characteristics and show where each might be used in the home or on the farm.

MAKE A SURVEY

Note the color of walls, ceiling, floors and other objects and determine relative reflectance values. Determine the foot-candles of light now available in every room. This can be done with a foot-candle light meter, usually available at your County Extension Office or from your electric power supplier. Compare this with the minimum recommended amount of light and record your findings. Use the sample form below as a guide in developing your own record sheet.

COLOR - LIGHT REFLECTANCE SURVEY

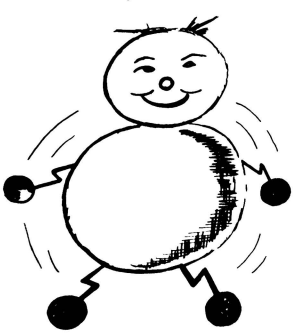
Room Studies	Walls	Color of Ceiling	Floors	Reflectance Value Walls	Ceiling	Floors	General Illumination	Recommended Illumination	How can light level Be Improved
				%	%	%	foot-candles	foot-candles	

UNIT 1 QUIZ—How Much Do I Know About Light?

1. A foot-candle is the amount of light from a standard candle measured at a distance of *(A—1) (B—10) (C—100)* foot or feet. ☐
2. Dark colored walls *(A—reflect) (B—absorb)* light. ☐
3. As a group, people who work outdoors have *(A—better) (B—poorer)* vision than draftsmen. ☐
4. A *(A—large) (B—small)* percentage of our homes have proper light for good living. ☐
5. Reflectance values are expressed as the percent of light *(A—absorbed) (B—reflected)* from the surface it strikes. ☐
6. Lights equipped with multiple switching are primarily for *(A—beauty) (B—safety and convenience).* ☐

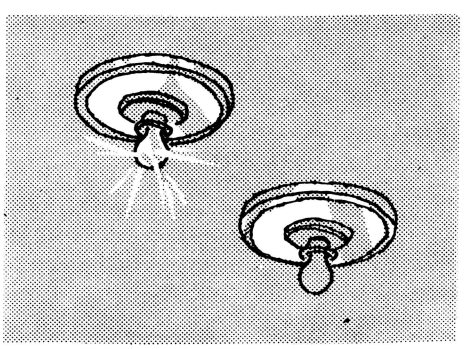
ADDITIONAL ACTIVITIES

Visit your local electric power supplier or County Extension Office and ask if you may obtain a copy of "See Your Home In a New Light" which gives many additional lighting suggestions and helpful ideas. If possible, have the local advisor talk with you about putting some of these ideas into practice and where the materials may be obtained.



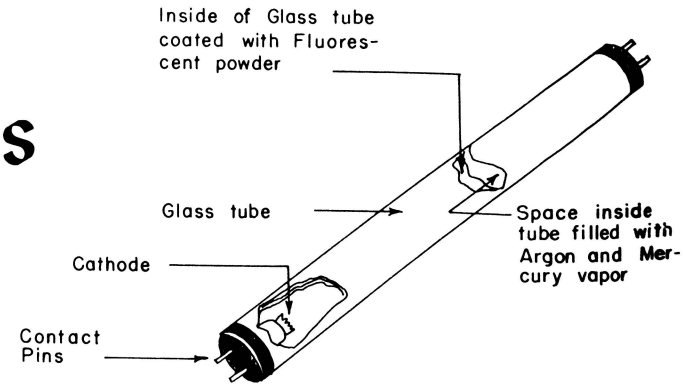
MR. E. LECTRON SEZ:

Clean lamps give more light



UNIT 2

Fluorescent Lamps and Fixtures



A moderate level of background lighting should be provided throughout the room for general lighting. Local lighting for all visual tasks such as reading, sewing, and study should then be added. This can be done in a number of ways and with different types of lights and light fixtures. The "workhorses" of electric lamps are the simple incandescent bulbs that are readily available in sizes of 7½ to 300 watts. Their general characteristics were discussed in Unit 1.

The fluorescent lamp is noted for its efficiency, which is nearly three times as great as that of the incandescent lamp. The average life of the fluorescent lamp is 7500 hours. However, excessive switching reduces life expectancy. They are made so that a wide range in colors can be obtained without loss of efficiency. Some fluorescent lamps create warm atmospheres; others create cool atmospheres. There are standard and deluxe lamps in each group.

Standard fluorescent lamps are designed for high efficiency and reasonable color rendition. *Deluxe* fluorescent lamps are designed for excellent color rendition and reasonable efficiency. When you desire to emphasize color, the deluxe warm (for reds, browns, etc.) or the deluxe cool (for blues, greens, etc.) fluorescent lamps should be considered. The home-line tube is often recommended for interior residential uses where fluorescent lighting is applied to provide *warm* light.

The "light" solution to dark room problems often involves the use of both incandescent and fluorescent lamps. The fluorescent lamps that are used as a part of cornice, valance, or wall bracket fixtures *wash* the walls with light. Rooms feel more spacious, become more beautiful, and are often more usable and useful. Incandescent lamps can be used to accent specific points of interest or specific colors in fabrics and for specific visual tasks. Good lighting is functional, attractive, and flexible when it *blends* with home and room decorating.

Assuming that interior wall surfaces reflect large amounts of light, basic requirements for minimum light for living standards include:

1. Shielding of all incandescent bulbs and most fluorescent tubes.
2. A minimum of one permanent lighting unit per room with switch control at room entrances.
3. Placement of fixtures to provide both *general* and *local* lighting at eye-work centers.
4. Portable lamps to supplement the above.

Table 1 shows minimum fixture requirements for general lighting of the living room, dining room, recreation area, bedroom, study and other living areas. The size of the room or area to be lighted determines the lighting and fixture requirement for each of two methods.

Structural fixtures like valance, cornice, and wall brackets (see pictures) are used primarily with fluorescent tubes. In dining areas, a ceiling fixture should direct most of the light down and onto the table. If recessed fixtures are used in any major living area,

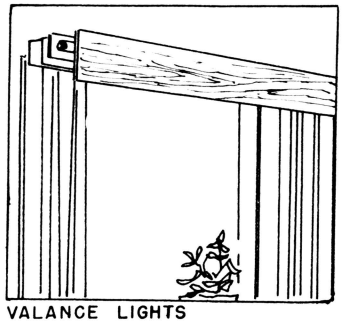
TABLE 1-MINIMUM REQUIREMENTS FOR GENERAL LIGHTING.

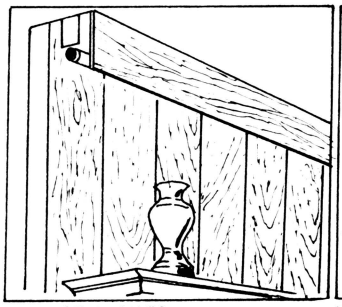
	A. Ceiling Fixtures		B. Structural Lighting
Room Size	Min. Size of Shield	Minimum Wattage	(Length of light source in cornice, bracket or valance)
Very Small (Up to 125 sq. ft.)	12"-15"	1-100w or 3- 40w	6 feet
Average (125-225 sq. ft.)	15"-17"	1-150w or 4- 40w	8-12 feet
Large (Over 225 sq. ft.)			16-20 feet

one 9″ or 12″ box that will accommodate a 100 to 150 watt bulb should be provided for each 40 to 50 square feet of floor area. A combination of recessed ceiling and wall fixtures adds flexibility to the lighting system.

Table 2 can be used as a guide for providing fixtures that will give the *minimum* amount of light for living. The recommendations made for kitchen areas meet requirements for other work areas such as the laundry, utility room, workshop, and basement. Additional information should be studied before installing these, however. You may wish to have *more* light with *more* control in your home. And the time to plan for it is *before* the lighting fixtures, circuits, and switches are installed.

Variable light controls or "dimmer switches" are available for adjusting lamps from full brightness to a soft low candlelight level for different occasions and effects. Limited light control can, however, be achieved by switching certain parts of the total room lighting system, individually.


VALANCE LIGHTS


CORNICE LIGHTS

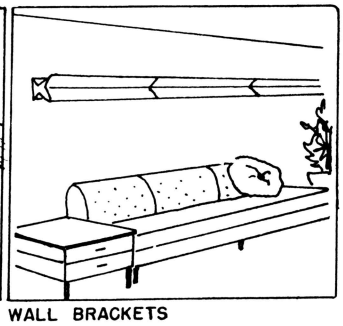

WALL BRACKETS

TABLE 2-FIXTURES REQUIRED FOR MINIMUM LIGHT IN SPECIFIC AREAS

Area	Type of Lighting	Type of Fixture To Use	Minimum No. Fixtures Required	Minimum size of Lamps for each Fixture*
Kitchen Area	General	Ceiling (12" dia.)	one	1 - 150w or 2 - 75w Inc. 2 - 40w or 4 - 20w Fl. or 2 circline Fl.
Kitchen Counters & Work Areas	Local	Wall Bracket or cornice	one for each 4 ft. counter	1 - 20w Fl. or 2 - 40w Inc.
Bathrooms & Lavatories	Local	Wall Bracket (vertical)	one each side grooming area	1 - 20w Fl. or 2 - 40w or 1 - 60w Inc.
Stairways	General	Wall or Ceiling	one at top & one at bottom, each flight	75w Inc.
Clothes Closet	General	Ceiling	one for each full-door closet	60w Inc.
Garage-Carport	General	Ceiling	one each side of parking area	100w Inc.
Halls	General	Ceiling Wall-bracket or recessed	one for each 10 feet	60w Inc.
Outside Residence	General	Post or Directional	one at each entrance (control from inside)	60w Inc.

* Fl = Fluorescent lamps
Inc. = Incandescent lamps

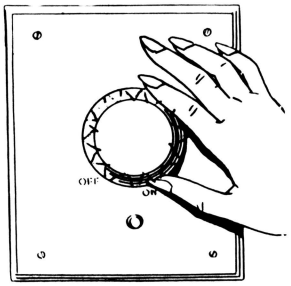
Outdoor lighting is a field of study in itself and can be covered by individual members if desired. Be sure to use equipment and wiring designed for outdoor use. Use proper circuit protection and control, and handle all wiring that can be reached from the ground with extreme care.

DEMONSTRATE

Using a structural lighting fixture, show the materials needed and construction of the unit. With this unit and/or a sketch, point out important structural dimensions for proper light direction and shielding. Use deluxe cool and deluxe warm lamps to show different lighting effects.

THINGS TO DO

1. In cooperation with your parents, plan and make changes necessary to meet the minimum lighting requirements in at least one room. Use at least one structural lighting fixture, if possible.
2. Make a plan for changing the lighting in the other parts of the home, if needed to meet minimum light standards.
3. Build a structural lighting fixture for use over sink, bed, or dresser as shown in your Members Idea Book.



Variable Light Controls

MAKE A SURVEY

Check the type of fixture and the size of lamp used for both general lighting and local lighting throughout your home. Show your findings in a form similar to that below. Indicate the type of fixture and bulb size required to meet minimum lighting standards.

LIGHT FIXTURE - BULB SURVEY

Room or Area	Type Lighting	Fixture		Size Lamp (watts)		Remarks
		Used	Required	Used	Required	

UNIT 2 QUIZ—How Much Do You Know About Fluorescents and Fixtures?

1. Local lighting *(A—is) (B—is not)* necessary for visual tasks if general lighting meets minimum lighting standards. ☐
2. Valance lighting is one of several *(A—good ceiling fixtures) (B—structural fixtures)* for modern homes. ☐
3. Table 2 can be used as a guide for selecting fixtures and lamps that give a *(A—maximum) (B—minimum)* amount of light for specific areas. ☐
4. Incandescent lamps are *(A—less) (B—more)* efficient than fluorescent lamps. ☐
5. The efficiency of standard fluorescent and deluxe fluorescent lamps is *(A—the same) (B—different).* ☐
6. Wall lighting *(A—is) (B—is not)* desirable when recessed ceiling fixtures are used in major living areas. ☐

ADDITIONAL ACTIVITIES

As a group, plan a scheduled trip to the office of your electric power supplier or lamp and fixture distributor where different types of lamps can be seen and demonstrated.

If you have a special interest in light, the following references will be helpful.

1. Primer of Lamps and Lighting, Willard Allphin, 1959, Chilton Publishing Company, New York, N. Y.
2. Laboratory Activities With Light, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. ($1.00 per copy)

What Makes Motors Run

UNIT 3

INCREASE YOUR KNOWLEDGE

Can you make an electric motor that will run? You certainly can and that's what we'll do in this unit. We'll learn what makes motors run by building one. Then you'll be ahead of all the millions of people who use motors every day but never know how they convert electrical energy into useful power.

Motors are Magnets

A compass needle always points to North. No matter how you turn the compass, the same end of the needle always swings to the North. The earth, like a small compass, is a magnet. Each has a North pole and a South pole. Around the poles of each are magnetic fields, invisible lines of force that attract and repel. (Fig. 1 & 2)

A North pole will repel another North pole. A South pole will repel another South pole. North and South poles are attracted to each other. In other words, like poles repel; unlike poles attract each other.

Lay two bar magnets on a table side-by-side. If both N poles are at one end, they'll repel each other and almost flip around until the N pole is lying next to the S pole. (Fig. 3)

Now then, let's place one of the bar magnets on the table. The other we'll fix on a pivot so it can spin around. This one we'll move so its N pole almost touches the fixed magnet's N pole. As soon as we release it, the movable magnet will spin around so its S pole will be near the N pole of the stationary magnet. That's an electric motor—almost.

It's not quite a motor because the magnet will rotate just far enough to get the opposite poles together. You might be able to cause the movable bar magnet to make turn after turn by turning the fixed magnet quickly end for end. This wouldn't be very practical as a motor, however.

If we could change the pole on one end of the rotating magnet just as soon as it reached the attracting pole it would be repelled by the stationary magnet and pushed away. And, as soon as the op-

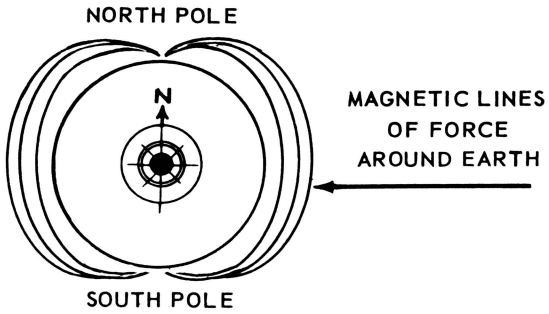


Fig. 1—The same end of the compass needle always points to the earth's magnetic North Pole.

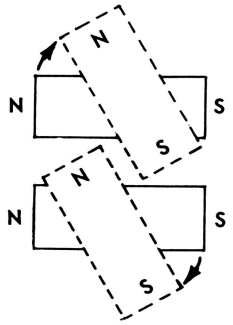


Fig. 2—Small bar magnets laid side by side move so that the North pole of one is near the South pole of the other.

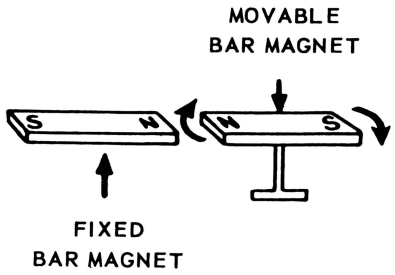


Fig. 3—A movable bar magnet pivots so its South pole is near the North pole of a stationary magnet.

posite end of the rotating magnet came into the magnetic field, it would be drawn to the stationary magnet. To keep the "motor" running, we would have to change the poles every half revolution.

Can Reverse Poles on Electromagnet

We cannot reverse the poles quickly on simple bar magnets, but we can on *electromagnets.* We can make an electromagnet by wrapping a wire several times around an iron core to form a coil. This magnet will also have a N and S pole when connected to an electric current. The big difference from a bar magnet is that the poles can be changed *instantly* by reversing the current in the wire. (Fig. 4)

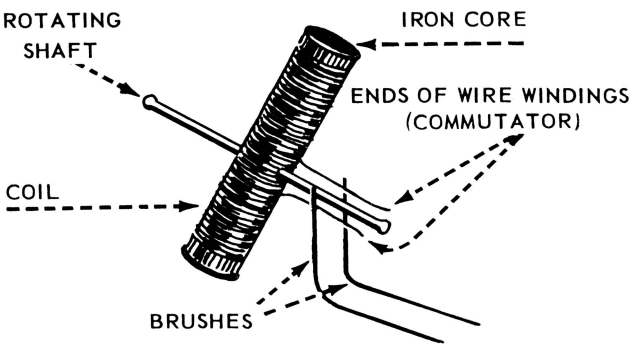


Fig. 4—A rotating electromagnet changes poles as contacts are made first one way and then the other.

Switching Poles Automatically

The rotating electromagnet will have to be connected to the two wires through which the current is passed. Since it is rotating on a center shaft, we cannot have a solid connection. Instead, we extend the wires from both ends of the coil out along the shaft and let the electric contact be made with "brushes" which touch or brush the wires *along* the shaft. As the magnet rotates, these wires trade places against the brushes and the electricity flows first one way and then the other through the coil. (See Fig. 4.) This is a simple way to reverse the current in the coil which, in turn, reverses the poles of the electromagnet.

Increasing Efficiency

Instead of using only one pole of a stationary magnet, we can use both. This is done by shaping the stationary magnet around the path of the rotating electromagnet. This way we have the benefit of the attracting and repelling forces from both poles. The rotation effect is doubled.

We can also wrap wires around this circular iron and make an electromagnet of it. But, when we wire this magnet we use no brushes because we want the current in it to flow in one direction only.

The stationary electromagnet is called the *field.* The rotating electromagnet is the *armature.*

DEMONSTRATE

Make a display board showing the parts of a simple electric motor and explain how each part works. Compare with the parts of a commercial motor which you can or have disassembled. Explain how and why the electric motor runs.

THINGS TO DO

After study of your Member's Idea Book, build a simple electric motor so you will better understand motor principles.

MAKE A SURVEY

Make a list of all farm and home chores that can be done with an electric motor. Put this information in a form similar to that below.

Farm chores that can be done with electric motors	Is a motor used now	Make an estimate of the amount of time and work saved if motor was used
Pumping water to livestock	No	Save one hour per day in hauling water

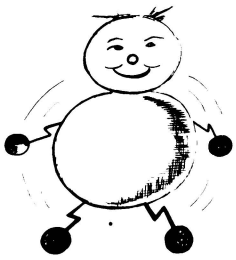
ADDITIONAL ACTIVITIES

Through your local power supplier, try to arrange group trips to a shop where electric motors are cleaned and repaired.

Ask your leader or power supplier to show and explain the parts of an actual motor using cut-away models.

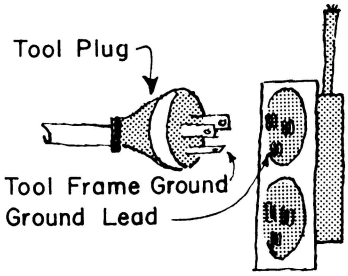
UNIT 3 QUIZ—What Makes Motors Run?

1. The North and South poles of magnets *(A—attract) (B—repel)* each other. ☐
2. The poles on *(A—a simple bar magnet) (B—an electromagnet)* can be reversed instantly. ☐
3. The compass needle always points to the *(A—earth's magnetic North pole) (B—South pole).* ☐
4. The rotating electromagnet is the motor *(A—field) (B—armature).* ☐
5. The commutator wires *(A—rotate) (B—do not rotate)* on the toy electric motor. ☐



MR. E. LECTRON SEZ:

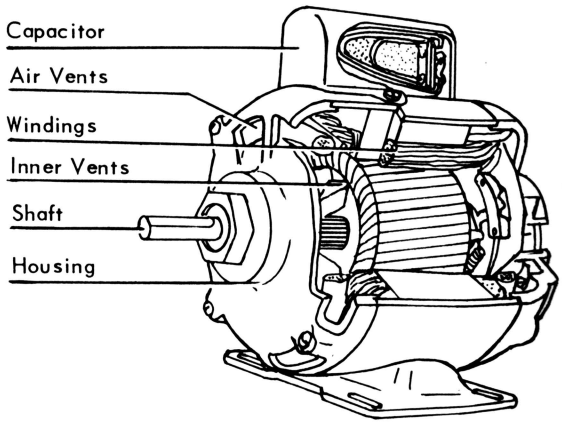
For safe use of tools, use grounded plugs and receptacles



UNIT 4

How to Select the

Right Motor



INCREASE YOUR KNOWLEDGE

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 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, designed specially 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 heavy work like feed grinding, ensilage cutting, and grain driers. 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 usually the smallest motor in the home. It is used to operate small fans, electric toys, and stirring devices. It won't handle large loads without burning out. Shaded pole motors come in such sizes as 1/30 to 1/6th horsepower. They are not often reversible.

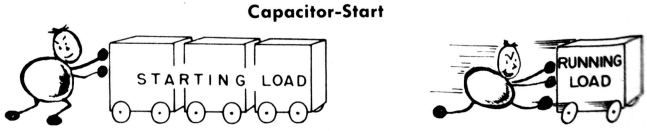
The Universal Motor can be used on either alternating or direct current, but check the nameplate first. It is common to find these used on hand drills, vacuum cleaners, food mixers, sewing machines and other similar equipment. Its speed depends upon its load. It will run *dangerously* fast unless there is a load on it. That's one reason it is usually built as a part of the equipment it runs. If you take a universal motor off an old appliance and try to use it for another purpose, it should *not* be run without a load attached to it. Universal motors come in small sizes, usually less than ⅓ horsepower, although a few may run as high as ¾ h.p.

Split Phase Motors will start light to medium loads and are available in sizes up to ⅓ horsepower. They drive fans, saws, drills, grindstones, bottle washers and other equipment usually operating on *120 volts.* They have two windings, a main or running winding and an auxillary or starting winding. To change the direction of shaft rotation, the leads to the starting winding need only be reversed. This is a real convenience when the motor is used to power more than one appliance.

Split Phase

The Capacitor Motor can often be recognized by its capacitor, the little cylinder or box on the motor frame; but some models now have the capacitor inside. Like the split-phase motors, it too has both a starting and a running winding. The capacitor (condenser) is placed in series with the starting winding to improve the starting characteristics of the motor. The motor will start fairly heavy loads without difficulty and comes in sizes from ¼ to 10 horsepower. It is the most generally used, all-purpose farm motor, being used to power equipment like refrigerators, freezers, water pumps, saws, and grain conveyors.

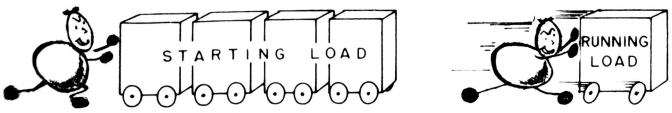
Capacitor-Start



With capacitor motors no larger than ⅓ horsepower, 120 volts is sufficient for operation. Larger sizes will work best on 240 volts, although they may be designed and purchased for either 120 or 240 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.

The Repulsion Start Motor is one designed to develop a large starting force with as little current as possible. It has more working parts (brushes, commutator, etc.) and requires more attention than the other types. The direction of rotation is easily changed by moving the position of the brushes. Cost of this motor, for 3 h.p. and less, is about 10 percent more than that of the capacitor motor. It is available in sizes ranging from 1/6 to 10 h.p.

Repulsion-Start



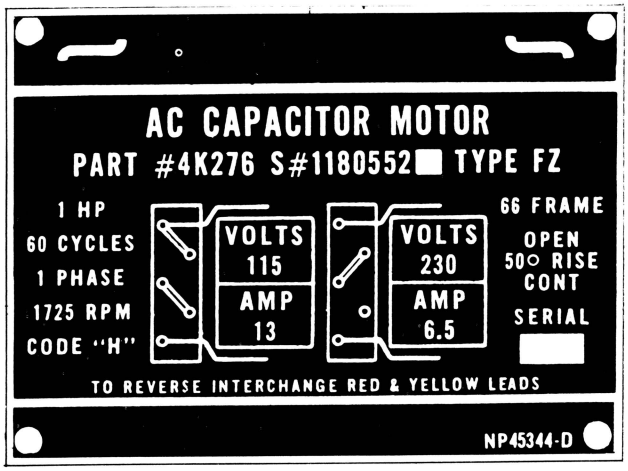
Selecting the Right Motor

Horsepower isn't everything when you are selecting the motor to fit the job you want done. First, the motor must be matched to your electric supply.

From the name plate 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. The requirements of the machine and the motor speed are also important.

Generally, motors of ¼ horsepower and under are designed to operate from 120 volt service. Motors of ½ horsepower and up are usually operated on 240 volts. But check the motor nameplate to make certain. If the motor can be operated on either 120 or 240 volts, use the higher voltage if available. There will be less voltage drop in the wire and the motor will draw less current.

Next, 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. A motor never quits trying. As long as current flows, motors keep pulling. They may burn out if the load doesn't start moving or if they aren't properly protected. When started, some 5 horsepower motors will develop 10 horsepower for a moment.

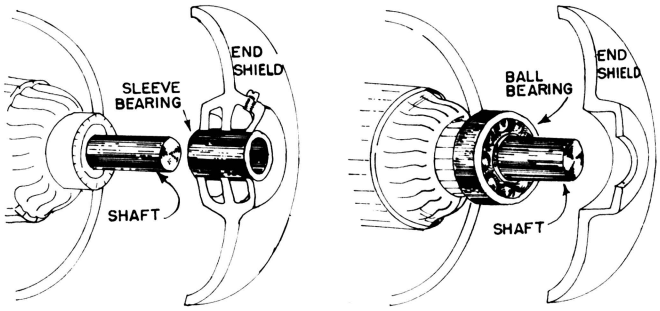


From the nameplate you can learn the motor's operating characteristics and power supply requirements. Always match the motor to your electric current supply.

Motor Bearings and Enclosures

If a motor is to be mounted in a horizontal position, either the sleeve bearing or ball bearing is satisfactory. For "upside-down" locations, the end shields on sleeve bearing motors can be loosened and rotated so oil reservoirs are *up*. If a motor must be mounted in a vertical or angular position or if it is to be moved frequently, the ball bearing motor is recommended.

Motors are available with a number or different cases or enclosures. The most common is the open type drip-proof case. But there are splash-proof enclosures for wet locations, total enclosures for dusty locations, and explosion-proof casings for use around combustible materials. Select the motor with the proper enclosure.



Types of electric motor bearings.

Machine Requirements

The machine which the motor will be driving has a horsepower requirement that the motor should match. It's even better if the motor horsepower is a little higher than that which the equipment requires. You can often obtain the horsepower requirements of a machine from an equipment dealer or from the machine instruction book. If you build a machine yourself, a specific size and type of motor may be recommended in the building instructions. When a motor is already connected to a machine, observe whether there is any starting lag or whether the motor runs too hot. If so, then the motor is probably too small or is improperly connected. Starting lag or overheating can also occur if the line voltage is too low, or the equipment improperly lubricated.

Speed requirements

Motors differ in full load ratings. Speed can be regulated through the use of different sizes of pulleys on the motor shaft or equipment.

The most common motor speed is 1750 RPM (revolutions per minute). Some crop drier motors run at 3450 RPM and some ventilating fan motors, at 1140 RPM. Check the nameplate to be sure.

The most common type of drive is the V-drive which consists of one or more V-belts and two V-pulleys. A simple way to determine the size of pulleys for the motor and machine is to use the following formula:

(RPM of Motor Pulley) x (its diameter) =
(RPM of machine pulley) x (its diameter)

For motors ⅓ h.p. or smaller, do not use less than a 2-inch pulley on the motor shaft.

NOTE: Excessive speed can be harmful to equipment and it wastes power; thus, proper motor and machine speed is important.

DEMONSTRATE

1. Obtain a sample of each type of motor studied in this unit. Explain the differences in these motors, including physical features, starting currents, relative starting torque, and typical jobs for which they are to be used.
2. Show how different types of motors are reversed.
3. Borrow a wiring Demonstration Board from the local vocational agricultural teacher or power supplier and:
   (a) show how split-phase and capacitor motors differ in starting ability and starting current.
   (b) compare the starting current and the running current of different types of motors.

CAUTION: Be sure the electric power supplier farm representative, qualified leader or the vo-ag teacher thoroughly explains the proper use of the demonstration board before you use it.

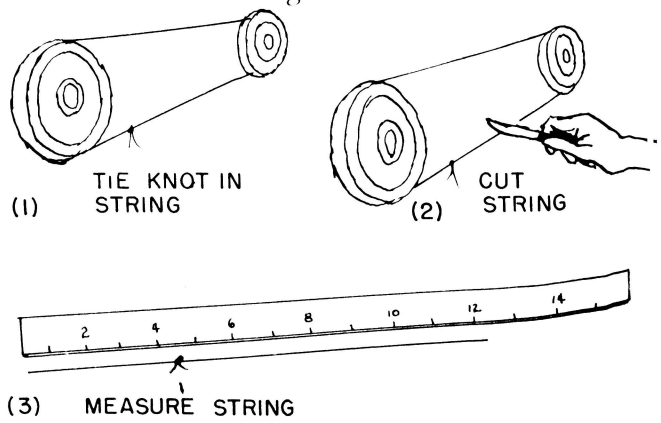
ADDITIONAL ACTIVITIES

1. Organize a group visit to a local factory, shop, or farm where many different types of motors are used. Examine the motor nameplates so that you may see the characteristics of motors performing different tasks or operating different machines. Notice how pulleys, gear reducers, and other types of drives are used to regulate the speed of machinery.
2. Ask your power supplier, an equipment salesman, engineer, or an electrician to talk to your club about the applications of different motors, motor controls, motor protection and the wiring needed for proper operation.

THINGS TO DO

1. Select a "Build-It" project from your Members Idea Book which requires the use of a motor. Write a report stating why you chose this project, show the cost, and tell how much good it has done. Give details on how you selected the machine speed and pulley size.
2. Select some hand-operated tool around your home and "motorize" it.
3. Purchase an inexpensive auger conveyor, if one can be used advantageously on your farm. Determine the rate at which feed is to be moved and select the proper motor and drive pulley.

To Determine Belt Length:



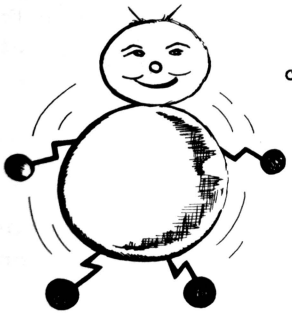
MAKE A SURVEY

Inspect all motors in your home or on your farm. Make a record of the machines they drive and other data shown in the sample form below:

Motor Use	Location	HP	Voltage	Code Designation On Motor Nameplate	Comments
Grindstone	Tool shed	1/20	120	Split-phase	Motor too small, heats up should be at least 1/3 horsepower

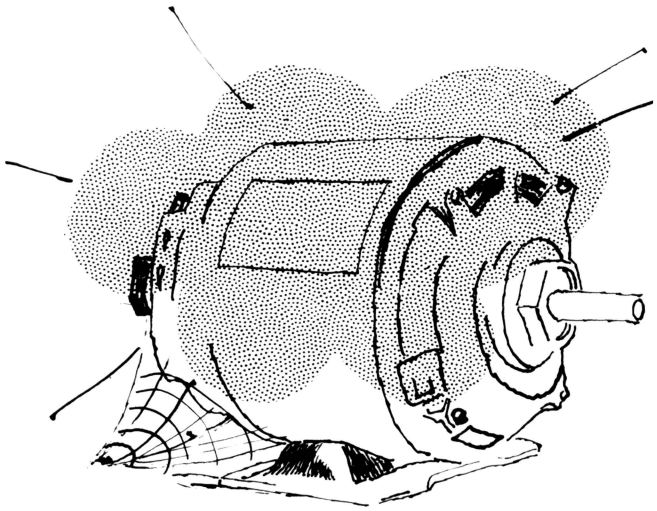
UNIT 4 QUIZ—What Do I Know About Motor Selection?

1. The *(A—universal) (B—shaded pole) (C—capacitor)* motor can be operated on either A.C. or D.C. electricity. ☐
2. *(A—Repulsion-Start) (B—split-phase)* motors have the ability to start heavy loads. ☐
3. To obtain the speed and voltage at which a motor operates, it would be best to *(A—call the dealer) (B—check the sales ticket) (C—check the nameplate).* ☐
4. Machine speed can be regulated by *(A—using different sized pulleys) (B—reversing the motor cord plug in the socket).* ☐
5. *(A—Split-phase) (B—shaded pole) (C—capacitor)* motors cannot usually be reversed. ☐
6. Motors with *(A—ball) (B—sleeve bearings)* are best for vertical positions. ☐



MR. E. LECTRON SEZ:

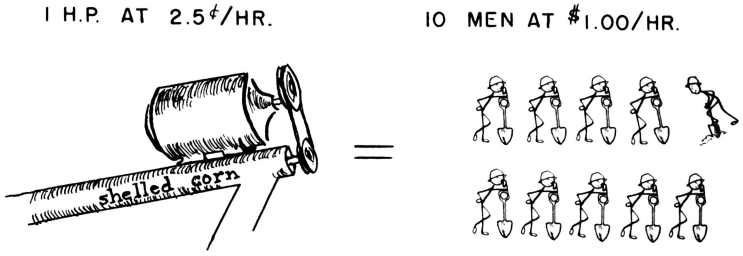
Avoid hazards. Use Dust proof motors in dusty places.



UNIT 5

Care and Use of

Electric Motors



INCREASE YOUR KNOWELDGE

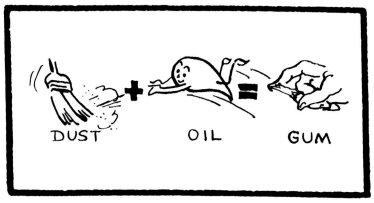
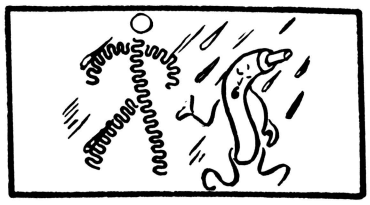
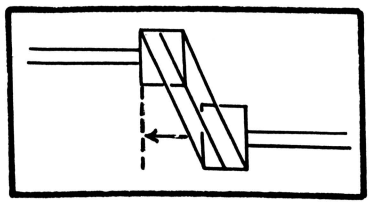
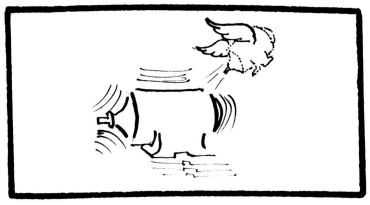
A one-horsepower electric motor can do almost as much work as ten men on certain tasks. Also, a motor will run continuously, if necessary, while a human can work at top speed for only a short time.

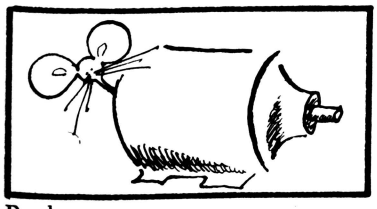
Electric motors are depenable, convenient, safe, quiet, and easy to control. They can be controlled manually or with switches which are actuated by changes in temperature, pressure, liquid level or relative humidity. Electric motors need very little attention. With proper care and protection electric motors last many, many years.

Fractional horsepower motors (those less than 1 horsepower in size) are light in weight and can easily be made portable so they can be moved from one chore to another.

Motor Enemies

Six common enemies of electric motors and their affects on motors are shown below, along with suggestions on how these can be overcome.

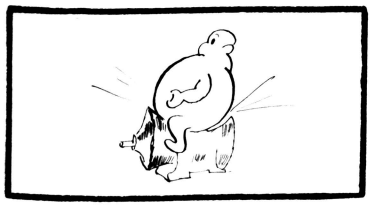
Enemy	How Motor is Affected	To Control the Enemy
 Too much oil (and dust)	Excessive oil catches stray dust and dirt which cuts off ventilation. It also destroys insulation. In either case, overheating occurs.	Use limited amount of oil. (Any motor that runs as much as a refrigerator motor should have 2 or 3 drops every three months) Wipe off excessive oil. Select motors with "sealed for-life" bearings which require no oil.
 Too much moisture	Damages insulation on motor windings	Dry in oven at 200° F or less and test for short circuits before putting back into use. Select drip-proof or splash-proof motors for wet locations.
 Misalignment	Causes burned out bearings.	Driving pulley on motor is not properly aligned with pulley on the driven machine. Align pulleys properly with string
 Too much vibration	Causes excessive wear and damaged bearings.	Check alignment and belt tension. Tension should be no more than adequate to handle the job.



Rodents

Mice make nests in windings, which cut off ventilation. They also chew insulation and cause short circuits.

Put 5/16″ mesh over motor vents. Select enclosed motors for use where rodents may be found.



Too much load

Overloads cause excessive heating and damaged windings.

Install proper overload protection. Select motor with built-in thermal overload device.

Motor Protection

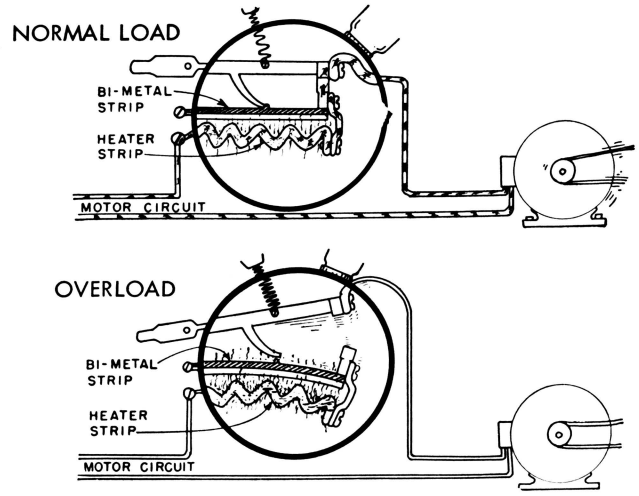
An electric motor takes more current (amperes) to start than it does to run under full load. To protect an electric motor properly against overload, then, a special type of fuse or other protective device must be used. A thermal breaker switch is such a device. This switch usually contains a breaker strip made of two different metals. When excessive current flows through this strip, one metal heats faster than another. This causes the strip to bend enough to release a latch and open the circuit. (See Sketch)

A time-delay fuse (fusestat or fusetron) will also carry the short-time overload of a motor when starting. If it is the right size it will protect the motor against a dangerous overload. The ordinary fuse and the time-delay fuse are shown below.

The big difference between the ordinary fuse and the time-delay fuse is the lump of metal in the base of the unit. If the current passing through this metal is too much for too long a time, this metal will "melt." When this *overload* condition occurs the spring pulls the wire out of the metal and interrupts the motor circuit. If, however, there is a *"short"* in the motor circuit (but no overload) the metallic link near the window breaks (or burns) just like the link in the ordinary fuse.

Sketch c shows how a time delay fuse fails when a motor is overloaded. Sketch d shows how the same fuse fails when a short circuit occurs.

The size of most overload protective devices should be not more than 1¼ times the current rating (amperes) of the motor. The current rating can be found on the motor name plate along with other motor data.

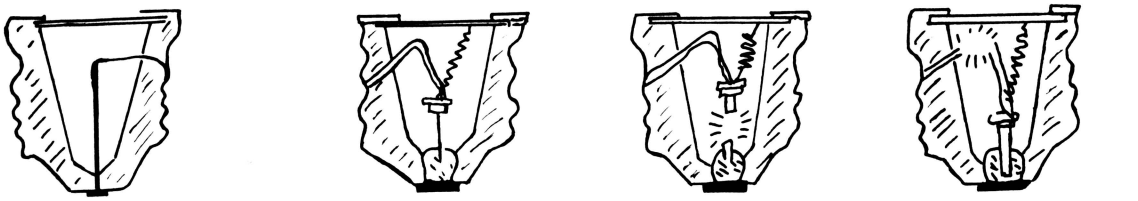


Thermal breaker switch.

Measuring Motor Operating Costs

In first year electricity work, you learned that you could multiply volts times amps to get the amount of electricity (in watts) used by heating and lighting loads. This is permissable because the *power factor* of these resistance loads is always one.

Because of "built-in" characteristics of motors, the power factor (ratio of real power to apparent power) is always less than one for motor loads. Thus, the real power drawn from a circuit by any motor must be measured with a *watt-meter.* When measur-



(a) Ordinary fuse

(b) normal (c) overload (d) Short cicuit

Time Delay Fuse

ing the electricity used for a certain period of *time,* a kilowatt-hour (KWH) meter is used. The KWH meter reading times the cost of *your* electricity rate gives the cost of operating an electric motor on a particular job. Such a KWH meter and instructions on its use can often be borrowed from your power supplier.

DEMONSTRATE

Select one of your motors for demonstration. Show how a motor should be properly cleaned and/or protected. Demonstrate how a fractional horsepower motor can be made portable.

With a vo-ag or power supplier wiring demonstration board, show how and why a time-delay fuse protects a motor when an ordinary fuse will not.

THINGS TO DO

1. If you installed an electric motor in Unit 4, add motor protection equipment, either a time-delay fuse or a thermal-breaker switch.
2. Install motor protective devices on at least two motors which need it most.
3. Check the motors on your survey (below) to see whether they are adapted to long hours of use (continuous running).

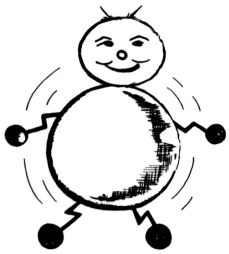
MAKE A SURVEY

List all motors around the home and the farm and determine whether they are clean and properly protected and lubricated. Use a form like the one below to report your results.

No.	Motor Use	Location	Motor Size (hp)	Voltage (volts)	Current (Amps)	Does It Require Oiling	Does It Require Cleaning	Is Motor Protected
	Refrig-erator	Kitchen	1/4	120	3.6	No	Yes	Yes

UNIT 5 QUIZ—Do I Know How to Protect and Care for Motors?

1. The *(A—ordinary fuse) (B—time delay)* fuse gives adequate protection for fractional horsepower motors. ☐
2. You *(A—do) (B—do not)* need to check the motor nameplate data to properly select overload protective devices for a particular motor. ☐
3. Electric motors require *(A—the same) (B—more) (C—less)* current to start than when running under full load. ☐
4. *(A—Few) (B—Most)* fractional horsepower motors need more than three drops of oil in each bearing at any one time. ☐
5. Improper pulley alignment and vibration *(A—are not) (B—can be)* enemies of many electric motors. ☐



MR. E. LECTRON SEZ:

Poor motor care brings excessive wear.

Make a Test Lamp

There are many uses for a test lamp around the home and farm. It's a handy addition to your electrical tool kit. When an electric appliance doesn't work or there is trouble on a circuit, the test lamp can be used to find out where the trouble is. The test lamp will at least show whether the circuit is "alive" or "dead," "hot" or "cold."

With the lamp, you can test appliance outlets, duplex convenience outlets, and electric circuits. You can also check the main fuse or circuit-breaker box and determine whether a circuit carries 120 or 240 volts.

Most test lamps use a 230 to 250 volt, low wattage rough-service bulb. But when these bulbs cannot easily be purchased in your town, the two lamp test unit shown in Fig. 2B can be used. In this case, two weatherproof sockets are wired in series and two rough-service 120 volt low wattage bulbs are used.

The procedure for using the test units is about the same. You and your leader can determine which of the two test units is best suited for your area. The tools needed include pliers, pocket knife, and soldering iron or gun.

The following tools will be needed:

1. One 230-250 volt *or* two 120 volt, low wattage, rough-service bulbs.
2. One *or* two rubber or plastic weatherproof 'pigtail' lamp sockets.
3. One roll of plastic tape or a roll each of rubber tape and friction tape.
4. At least two feet of No. 14 solid rubber covered copper wire.
5. Rosin core solder and flux.

To Make The Single Lamp Test Unit:

1. Cut the No. 14 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 until 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)

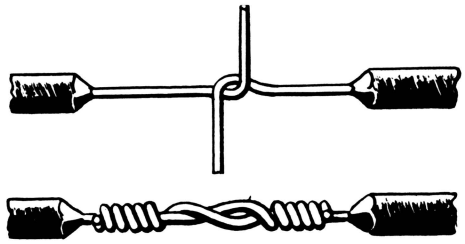


Fig. 1

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

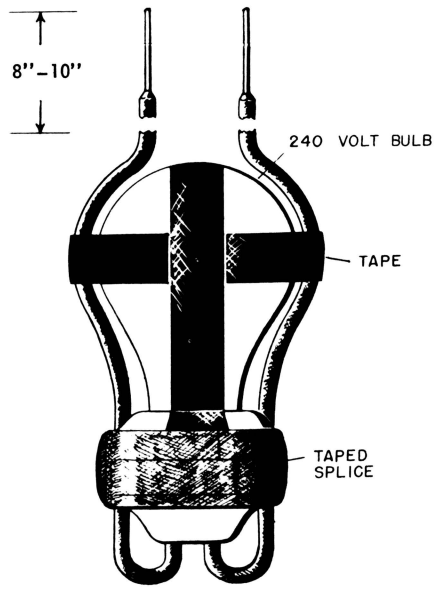


Fig. 2

NOTE: The two-lamp test unit can be made up in a similar manner with wires spliced as in Fig. 1.

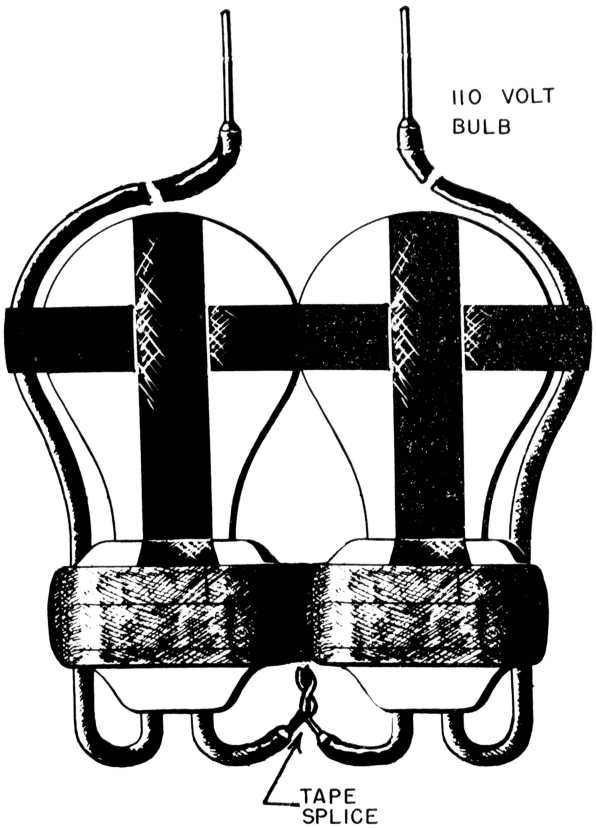


Fig. 2B

DEMONSTRATIONS

1. Show how to make a test lamp.
2. Show how to test a convenience outlet to see whether it is "hot" (Fig. 3 and 4). Tell how the test lamp glows brightly on 240-volt and dimly on 120-volt circuits.
3. Explain how to trace a branch circuit. Draw a diagram of a typical circuit with "safety valve" outlets, wire size, etc., shown.
4. Using the battery-size D.C. test lamps, trace a circuit on a tractor.

THINGS TO DO

1. Make a Test Lamp, as outlined.
2. Make a similar direct current (D.C.) 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 or bulbs.

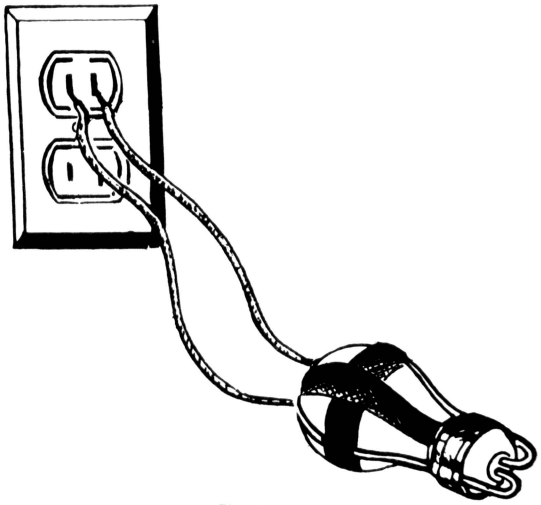


Fig. 3

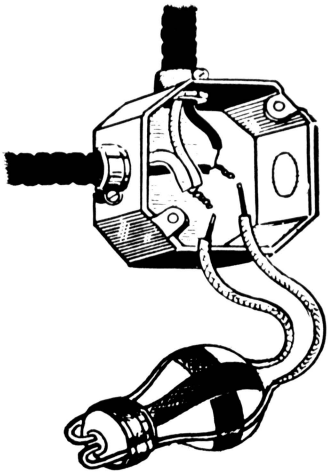


Fig. 4

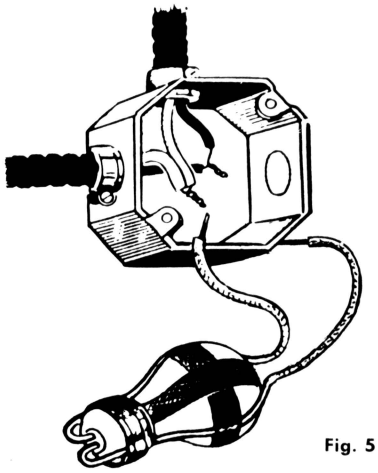


Fig. 5

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

SAFETY TIPS

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

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.

MAKE A SURVEY

1. Using your test lamp, check all outlets and determine whether these are 120 or 240 volt outlets. Note the location of all 240 volt outlets, their primary use and how the high voltage outlets are identified. Record your findings in a form similar to the one below:

SURVEY OF OUTLET VOLTAGE

240 volt Outlet Location	Primarily Used For	How Identified	Remarks
(Ex.) Living Room	Air Conditioner	240 volt outlet marked	

2. Using your test lamp, *check* all *exposed* metal boxes to determine whether they are "dead" or "alive." Record your findings in a form similar to the one below:

"HOT" BOX SURVEY

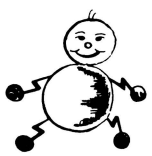
Exposed Metal Box Location	Condition		Was "Alive" Condition Corrected	Remarks
	"Dead"	"Alive"		
Shop Bench		X	Yes	

ADDITIONAL ACTIVITIES

Ask your power supplier or local electrician to talk to your club on test lamps and other safety equipment used in electrical work.

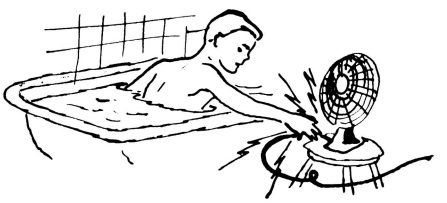
UNIT 6—QUIZ—Test Your Test Lamp Knowledge

1. You should always stand on *(A—wet) (B—dry)* ground when test lamps are used. ☐
2. If you are *(A—fairly sure) (B—uncertain) (C—certain)* that circuits are dead, you can work on them. ☐
3. Test lamps can be used on *(A—240) (B—440) (C—640)* volt circuits. ☐
4. *(A—Acid-core) (B—Rosin-core)* solder should be used in making any soldered electrical connection. ☐
5. For insulating bare wires the best tape to use is *(A—friction) (B—plastic).* ☐



MR. E. LECTRON SEZ:

Don't touch appliances or switches when in the bathtub.



UNIT 7

Simple Repairs and Replacements

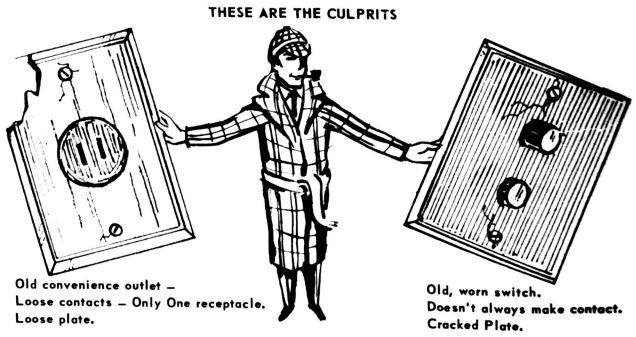


Fig. 1

INCREASE YOUR KNOWLEDGE

The wiring system of a home will usually last a long time. But some people try to make it last too long or use it too hard. A wiring system needs the home owners attention, care and maintenance just like other equipment.

As appliances are added, the electrical load increases. The wiring may become overloaded and have to be replaced. This job should be left to a trained electrician. But *you* can do some of the ordinary simple repair jobs yourself—jobs such as replacing damaged switches or duplex convenience outlets. The important thing is to know *what you are doing* and *how to do it safely.* So, 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 need for that loud "click" every time a light is turned on or off in a room. With the newer mercury switches, you can have silent action and silent service. Are there switches around *your* home that have been broken and need replacing? Are the duplex convenience outlets worn to the point where they don't always hold appliance plugs properly? If so, you can replace these with modern equipment and make your wiring system safer and more adequate.

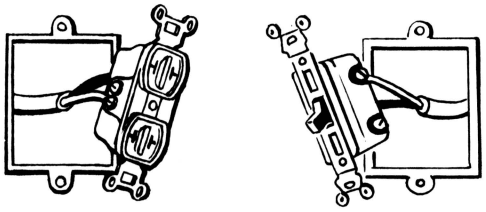


Fig. 2—Switches and convenience outlets are easy to replace.

Some manufacturers have omitted the screw terminals on wiring devices such as switches, outlets and lamp receptacles. Rather than bending the attachment wire around a screw, it is merely inserted into a hole in the back of the device. An example of such a device is shown in Fig. 3. An internal spring-loaded pressure connector holds the conductor in place.

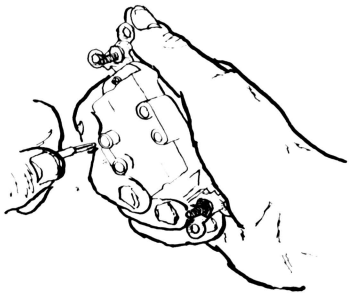


Fig. 3

Soldering and Splicing

The correct way to use the soldering iron is shown in your Members' Idea Book. The soldering gun may be used. In fact, for close work like radio construction or repair the soldering gun is almost a necessity. Remember, use rosin core solder or a rosin flux for your electrical soldering. Then wrap the joint with both rubber insulating and friction tape or with plastic electrical tape.

Splices in electrical conductors can also be made quickly and permanently with solderless connectors that use a compression sleeve covered by tough plastic insulating caps. You twist the copper wires and insert them in the copper sleeve. A compression tool crimps the sleeve which is then covered with the plastic cap. Fig. 4 shows two types of pressure connector tools and different types of lugs, sleeves and caps. Be sure to choose the right ones for your job.

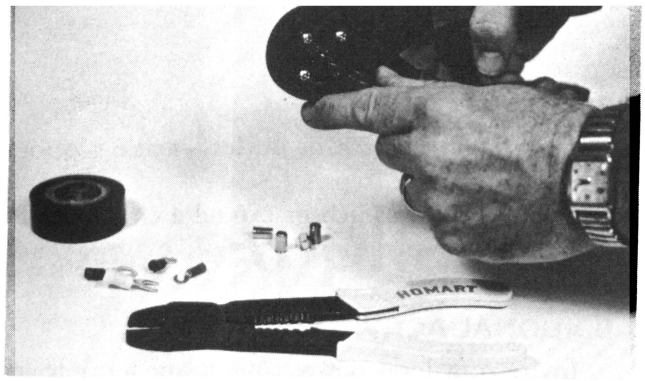


Fig. 4—Two types of pressure connector tools and different types of lugs, sleeves, and caps.

The screw-on wire nut is another means of making a solderless connection though it is not always as dependable as the pressure connector or soldered joint.

WHAT TO DO

Replace a Single-Pole Switch.

Tools Needed

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

Materials Needed

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

USE SAFE PROCEDURES WHEN WORKING WITH ELECTRICITY

1. Work under the supervision of someone who knows electricity and how to handle it.
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. Remove the fuse.
3. Use your test lamp to be sure power is off.
4. Use the proper materials—those approved by the Underwriter's Laboratories.
5. Be sure wires are connected correctly.

Removing The Old Switch

1. At the main building switch, turn the branch circuit control to the *off* position to make sure no current can flow in the circuit.
2. Remove the screws that hold the switch plate.
3. Remove the switch plate; check the circuit with a test lamp to make sure there is no electricity flowing through it.
4. Remove the screws holding the switch in place.
5. Pull the switch from the outlet box. There is generally plenty of slack wire in the outlet box.
6. Loosen the screw terminals and unhook the wires from the old switch.

Installing The New Switch

1. Scrape the bare ends of the wires to remove dirt and corrosion.
2. If there are screw terminals on the new switch, loosen them. Do not remove them completely.
3. Set the switch so that the "off" and "on" markings will read correctly after installation. Mercury switches *must* be mounted in a vertical position.
4. Connect the wires to the terminals. Either wire can be connected to either terminal on a single pole switch. Both switch wires are "hot." If terminals are of the screw type, be sure the hook on each wire goes around the screw in a clockwise direction. Tighten the screws. (For outlets of the type shown in Fig. 3, merely slip the wire into the proper hole. Be sure that no bare wire is exposed to cause short circuits.)
5. Bend and 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 slightly crooked.
7. Replace switch plate and screws. Don't tighten the screws too much as the plate, if plastic, may crack.
8. Turn the current on at the main switch.
9. Test the switch by moving it on and off several times, to see that it is working properly.

Replacing a Convenience Outlet

You can replace a convenience outlet in a manner similar to the switch replacement. Be sure to follow the same safety rules and wiring procedures. The black "hot" wire goes to the brass screw and the white wire (neutral) to the silver colored screw, with only one exception—in switch wiring both wires are "hot."

When buying a new convenience outlet, be sure that it has double sided contacts. This type will grip the attachment plug blades more securely, preventing the plug from falling out of the outlet. These double sided outlets generally provide more dependable contact and longer service. While they may be difficult to find in small towns, don't overlook the use of the newer wiring devices shown in Fig. 3.

The most common convenience outlet is of the duplex type. Single and triplex types are also available. In any case, be sure the appliances used will not overload the circuit.

DEMONSTRATIONS

1. Using an old switch you have replaced, show and tell about its parts. Trace the path over which electricity flows.
2. Show and tell about several different types of switches and convenience outlets now available. Catalogs and brochures from your dealer can provide information and pictures.
3. Make a demonstration board showing how to replace a switch or outlet.
4. Make a demonstration board which shows the unsafe or faulty switches that you have found.
5. Demonstrate how to use a soldering iron, soldering gun, and/or pressure connector tools. Show the many different fittings and the jobs that can be done with each.

THINGS TO DO

1. Replace a switch or outlet—make a photo display of important steps.
2. Add a light switch or extend a circuit under an electrician's supervision.

ADDITIONAL ACTIVITIES

Invite your local power supplier or local dealer to talk to your group. Learn who manufactures the newer tools and devices discussed in this unit. Write for their literature so that you will thoroughly understand how the equipment is to be used.

MAKE A SURVEY

1. Inspect all switches and outlets in and around your home. Look for broken plates, defective switches and outlets which will not hold a plug securely. Make up a form similar to the first one below for your record.
2. Make a survey of local electrical wiring shops. Determine whether new wiring devices and/or pressure connector tools are available. Report results in survey form. (See second form below.)

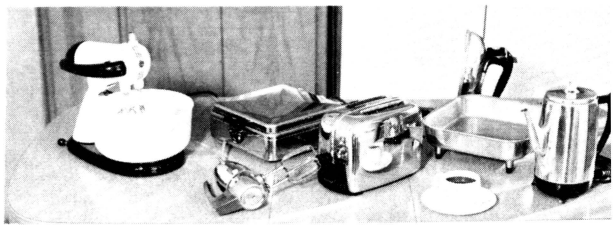
Device Checked	Condition	How Can Condition Be Improved	When Improved
Switch Plate	Cracked	Install New Plate	Dec. 23, 1960

Type Dealer	Does He Have New Type Outlets	Does He Handle Pressure Connectors	Why?	Will He Order Some For You

UNIT 7 QUIZ—How Much Do I Know About Electrical Repairs and Equipment Replacement?

1. If you are careful, you can change a switch when *(A—no one is present) (B—someone who knows supervises your work).* ☐
2. Before changing a convenience outlet, the power switch should be *(A—turned off) (B—turned off and tagged so no one will turn it on while you're working).* ☐
3. When a switch is replaced, the wires in the box *(A—usually) (B—seldom)* need to be spliced before the new unit can be installed. ☐
4. Mercury switches are *(A—noisy) (B—quiet) (C—dangerous).* ☐
5. If the power switch is off, your test lamp *(A—need never) (B—should still)* be used as a check just before starting your work. ☐
6. When an electrical splice or connection is made with a compression tool *(A—acid core) (B—rosin-core) (C—no)* solder is needed. ☐

Small Electrical Appliances



INCREASE YOUR KNOWLEDGE

Are you looking for a way to do household tasks in less time, with less energy? If so, small electrical appliances may be the answer. Manufacturers have a big assortment of these useful household tools that make for better, easier home making and family living. The list includes tools like the electric toaster, waffle iron, skillet, sauce pan, deep fat fryer, and coffee maker. All of these have one outstanding feature, "controlled heat" cooking, a topic covered more thoroughly in Unit 9. Other small home appliances include the electric mixer, portable fans, hand iron and vacuum sweeper, to name but a few. But, to get the most from your investment, you need to know how to select and care for small appliances.

Suggestions on Selecting Appliances

Some questions you should ask when selecting automatically controlled heating appliances are:

1. Are the appliance and cord UL approved for this use?
2. Is the appliance made of a non-tarnishable material—is it easy to keep clean?
3. Is the appliance constructed of a material that will conduct heat well? Aluminum is a good conductor.
4. Is the unit large enough for your family and expected guests?
5. Is the appliance equipped with sturdy legs or an insulated base to prevent heat from damaging tables and counter tops?

Care and Use of Small Appliances

A few simple but often overlooked *do's* and *don'ts* on the proper care and use of small appliances will lengthen their useful life. When using heating appliances you should *never* immerse the unit in water. Don't wrap the cord around the base until the appliance has cooled.

For the proper use of all appliances, these additional points should be studied and followed.

1. Be sure your wiring is adequate. A No. 12 wire appliance circuit is absolutely necessary.
2. Be sure the electrical cord plug makes good contact at the outlet. Extra heat is generated at loose connections.
3. Be sure to replace appliance cords when needed and with the right *type* of cord.
4. *Never* tamper with appliances when cords are plugged into circuits.
5. Always disconnect appliance cord from wall outlet first, rather than from the appliance. Remember, grasp the plug—not the cord.
6. On motor-operated appliances, use oil sparingly. Lubricate according to manufacturers' directions.
7. When appliances fail to function properly, first check for a blown fuse. If the appliance itself fails, quickest repair service can often be obtained by returning it directly to the manufacturer.

The electric toaster and mixer are covered in this unit to give a better understanding of small appliances. Because so many things can be done with the electric skillet, it is covered spearately in Unit 9.

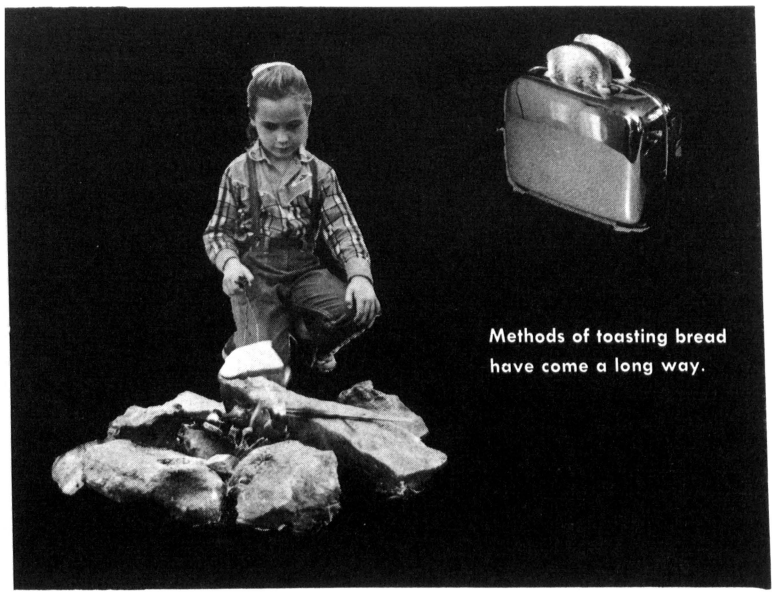
Toasters

If you've ever toasted a slice of bread over a camp fire, you know that it is difficult to toast it uniformly. And of course, only one side can be toasted at one time, just about like you might do with one of the first electric toasters that was ever made.

With automatic toasters of today, both sides are toasted uniformly at the same time. Some are equipped with a small oven to keep the first toasted bread warm and crisp until eaten.

The toasting of the bread is controlled in two ways. One is based on time. The darker the toast desired, the greater the time allowed. The other method of control is by radiant heat from the toast itself. As the bread is toasted, radiant heat is given off, much like the sun gives off radiant heat rays.

This radiant heat strikes a thermostat switch which shuts off electricity when that degree of heat is sufficient to toast the bread as the homemaker desires.



Toaster Care and Safety

Always disconnect the toaster from the electric outlets before cleaning it or removing crumbs or a lodged piece of toast.

Never use a fork to remove pieces of toast. This can damage the heating element and you could get shocked. This can happen whenever the toaster is connected to the source of power—even when the toaster switch is turned off.

After using a toaster, disconnect it from the outlet and allow it to cool before storing. Do not touch the shell as it may be as high as 200 degrees when it is in use. Only the non-metallic handles and controls have temperatures low enough to touch with your hands.

Remove crumbs and food particles from the toaster at least once a week. If there is no built-in crumb removal, use a soft brush, being careful of heating elements. Never shake a toaster.

Electric Food Mixers

Electric mixers save time and energy and make jobs in the kitchen such as mixing, beating, whipping, stirring, and creaming more pleasant.

Standard and portable mixers are available in several sizes.

Portable mixers consist only of a motor head and beaters. Wall hangers, brackets or stands can be purchased as an accessory. They are usually light, weighing between 1½ and 3½ pounds. Their small size means they can be stored in kitchen storage drawers. They do a good mixing job for most mixing tasks but are not recommended for mixing large amounts of food or extra thick mixtures.

Standard mixers are normally mounted in stands and are provided with several preparation bowls. Some may be removed from the stand and used as a portable mixer. Usually, standard mixer motor heads weigh about 3 pounds more than the portable mixer head.

Safety and Care of Mixers

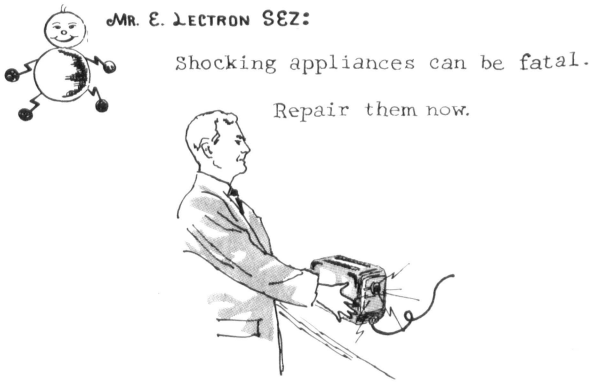
Although the mixer is a convenient tool in any kitchen, it can be the most dangerous of household appliances. To avoid serious accidents, such as finger amputations, by unintentional starting of a mixer, be sure to:

—disconnect the mixer from the outlet when not in use.
—take special precautions when more than one person is near the mixer.
—use only UL approved mixers.

The proper use of a mixer also includes making sure that beaters are lodged in place, the unit is started at a slow speed and that a rubber spatula is used to clean the beaters rather than using fingers or a spoon. All mixers get warm when used for a period of time. *But* a mixer should not be used so long at one time that it gets too hot.

DEMONSTRATE

1. Show the effect of good voltage and adequate wiring on the operation of a toaster and other heating appliances. This can best be done with two identical toasters on a wiring board equipped with 100 feet each of No. 12 wire and No. 16 wire. See your local club leader and/or power supplier for details in obtaining demonstration equipment.
2. Show the correct and safest methods of using, cleaning and storing both the portable and stationary types of food mixers. Point out the features which a person should look for in purchasing small electric appliances.



THINGS TO DO

1. With the help of an experienced person, learn how to use at least one or two small household appliances with skill. If at all possible let one unit be a heating appliance. For one month keep a record of the appliance's use, care and storage on a form similar to the first chart below.
2. Make a list of all other small electric home appliances used in and around your home. Learn all you can about each by studying the manufacturer's instruction booklet and your Member's Idea Book. List the manufacturer, the voltage, material used, cord features, and *at least* one important factor to consider in the care and use of each. Use a form like the second sample below.
3. Select a handy place to file electric home appliance instruction booklets. Be sure all that you have on hand or can obtain are stored there. Additional booklets can often be obtained from local dealers.

Date	Appliance	Used For	Used By	How Cleaned	Stored In	Comments re. Safe Use

Appliance	Make	Wattage	Material	Cord Features	Factors re. Care & Use
Toaster	Westinghouse	1650	Non-tarnish chrome plate	Type HPD	Clean by wiping with damp cloth

UNIT 8 QUIZ—What Do I Know About Small Appliances?

1. Of the small electric heating appliances on the market today *(A—a few) (B—nearly all)* are equipped with accurate temperature controls. ☐
2. When cleaning electric appliances you *(A—should) (B—should not)* immerse the entire unit in the wash water. ☐
3. When storing heating appliances equipped with asbestos cords, it *(A—is not good practice) (B—is all right)* to wrap the cord around the base before it is cool. ☐
4. You should not remove toast from a toaster with a fork because *(A—the shell is extremely hot) (B—you might get an electrical shock) (C—you might damage the toaster).* ☐
5. Electric mixers are good kitchen tools and are *(A—safe) (B—dangerous)* when handled in a somewhat careless manner. ☐

ADDITIONAL ACTIVITIES

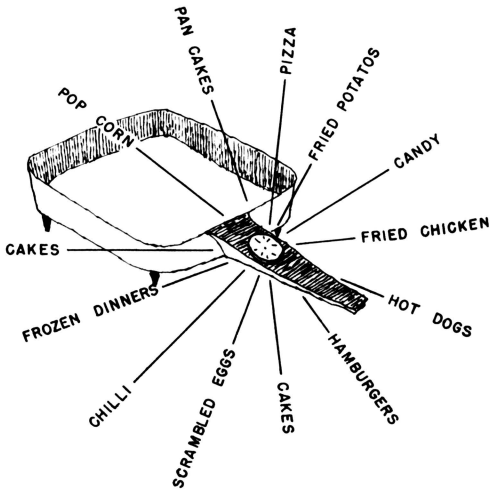
Ask your club leader to check with your local power supplier to see whether a tour of a small electric appliance factory can be arranged for your club and other electric project enrollees in your county. Several such factories do operate in Missouri. Perhaps your parents can arrange to go along.

Invite a small appliance dealer or repairman to talk to your club. Ask to have him disassemble one appliance and reassemble it. Have him point out some common points of trouble on a number of other small appliances.

Review the principals of electricity so that you are sure you know why heating appliances require good wiring, good cords and good connections.

UNIT 9

The Electric Skillet



INCREASE YOUR KNOWLEDGE

While manufacturers have supplied us with a variety of small electric heating appliances, the electric skillet is one of the most versatile. Homemakers can fry a few strips of bacon, pop some pop corn or cook a complete meal for the family, all in one unit. Skillets can be purchased in small, medium, and large sizes and in round, square or rectangular pan patterns. Most skillets show, near the control, the proper temperature at which to cook many different kinds of food. With such a skillet, even the novice can prepare a meal and stay out of trouble.

The *key* to easy cooking with the skillet is *controlled* temperature cooking. With *controlled* temperature you can fry, saute, stew, bake, pan broil or use as a chafing dish or warmer. On some models, the control is built permanently into the unit. On others the temperature control is detachable with the power cord. The latter has an advantage when the same control unit can be used on other heating appliances of the same make, like the sauce pan or deep fat fryer. Removable controls do not give desired temperatures as accurately as the best of the built-in thermostats. Electric skillets use an average of 1100 watts and a temperature range of from 140° F to about 400° F. Most have an indicator light to tell when the pan is at the temperature selected on the control dial.

Skillets are made of strong, light-weight, cast aluminum, or stainless steel on aluminum, with the heating element imbedded in the metal. The exterior of the pan is polished to simplify cleaning. The cover may be flat or dome shaped and is usually made of aluminum or pyrex glass. The latter enables you to see the foods while cooking but is more easily broken.

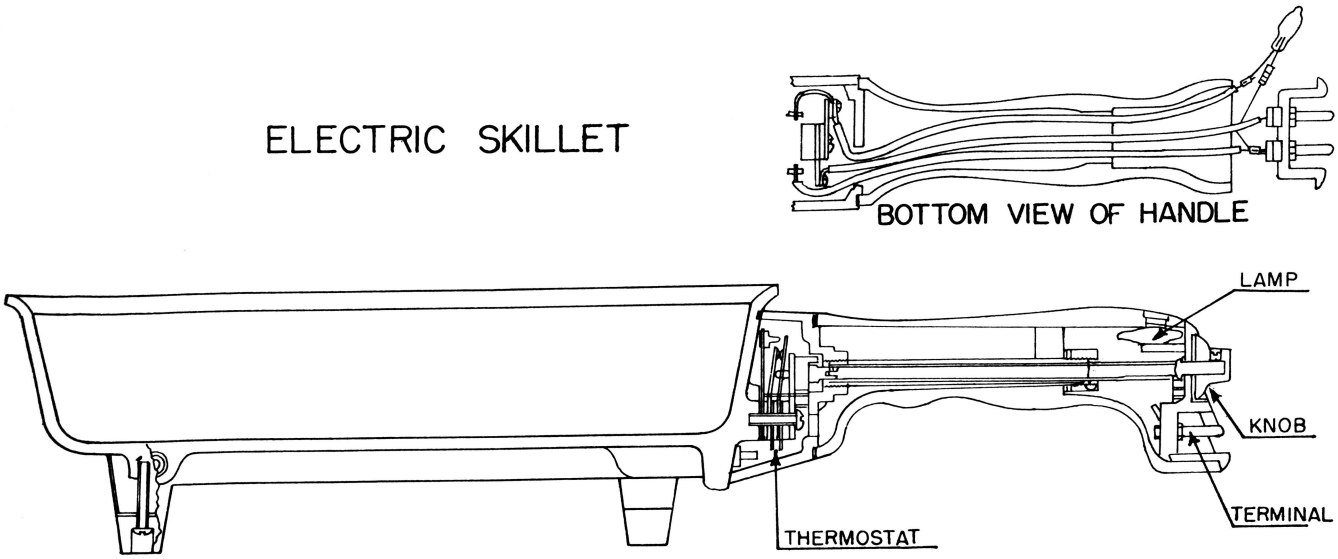
Using the Electric Skillet

Set the temperature control according to the recipe you are using. Preheat as the recipe requires. Follow the temperature guides—they are not the same for all models. Try suggested settings first; then adjust to higher or lower temperatures to meet your needs. Avoid over-heating or prolonged warming. Try a variety of foods to make the fullest use of the pan.

The fast, even heat of the electric skillet makes it popular as a kitchen tool. If one does not heat properly, the trouble could be caused by (1) thermostat set too low, (2) low voltage due to being connected to an extension cord or lamp socket, or (3) a warped or sprung cover. If it gets too hot, the thermostat is either set too high or it is not operating properly. When the latter is found to be the trouble, return the skillet or the detachable control to the manufacturer or appliance dealer.

Skillet Care and Operation

The best care of an electric skillet comes with frequent cleaning and attention. Clean the skillet after each use according to the manufacturer's recommendations. Never leave foods and grease in the pan for long periods of time. If food should stick to the pan, fill with water, heat to the simmering point



and loosen food particles with a rubber spatula or soft brush. Except on a chrome finish you can use a moistened, fine steel wood pad in circular motion for the final cleaning. Whiting* and soap may be used to remove grease spots.

Do not use soda, strong alkaline soap, or cleaning powder on aluminum and never scrape aluminum with a metal object. Use a wooden spoon or other wooden object. Always clean the outside of the skillet with a damp cloth. When cleaning, do not place the unit which holds the thermostat in water.

Always connect the skillet cord directly to a wall outlet. Do not connect to an extension cord or lamp socket as the wires are too small for satisfactory heating. Avoid using other heating appliances on the same circuit when the skillet is in use. Store the skillet in a dry place where it will be handy to reach when preparing that complete meal or snack. Leave the cover off the pan so it will air out.

Calculating the Cost of Skillet Use

With electric heating equipment that has *no* control, you can easily calculate its cost of operation if you know the wattage, the length of operating time and the cost of your electricity. Let's say that the 1100 watt heating element in your skillet operated *continuously* for 2 hours and electricity costs were 2 cents per kilowatt hour (see Workbook I, page 5 for definition of terms.) Then 1100 watts x 2 hours x 2 cents ÷ 1000 watt-hours is equal to 4.4 cents. *BUT,* all name brand skillets have a thermostat that uses just the right amount of heat at all times. With this thermostatic control the heating element is ON *only a part of the time,* always operating at maximum efficiency. Consequently, the only accurate method of determining the operating cost of controlled heat appliances is with a kilowatt-hour meter.

*Whiting is an inexpensive fine chalk which cleans without scratching or injuring the surface. It can usually be purchased at drugstores, hardware and paint stores. Whiting can also be used dry as a powder for cleaning.

DEMONSTRATE

1. Show others how to prepare a meal for three or four people using the electric skillet. Select the appropriate foods and sufficient accessories to make an attractive "dish" when the demonstration is completed. During the demonstration, point out specific features and advantages of the skillet and discuss the nutritional value of such a meal prepared by "controlled" heat cooking utensils.
2. Show how you can use the skillet as a corn popper, deep fat fryer, etc.
3. Show how to clean and care for the skillet.

THINGS TO DO

Check with your local leader or home demonstration agent about the differences in electric skillets and the many different uses which can be made of them. Obtain recipes for meals that can be prepared in them. Cook at least your first three meals

under the supervision of an experienced homemaker so that you will become well acquainted with the advantages of controlled heat cooking.

In outline form (sample below), keep a record of different foods prepared in your skillet. Indicate the type of food cooked, how many people were served, how long the skillet was used, etc. You might obtain an electric meter from your power supplier so that you can tell exactly how many kilowatt-hours of electricity are used by the skillet during the month.

Date	Food Prepared	No. Served	Time of Skillet Use	Skillet Temp.	KWH Used	Cleaning Agent	Remarks
3/1/61	Beef, Potatoes Carrots, Onion	2 adults 2 children	1 hour & 10 minutes	275-300	75	Mild Soap	

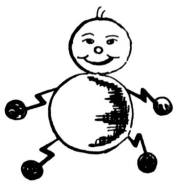
UNIT 9 QUIZ—What Have I Learned About the Electric Skillet?

1. A good material for cleaning grease spots from aluminum skillets is *(A—pure white baking soda) (B—an inexpensive fine chalky substance called Whiting).* ☐
2. One material that should *not* be used for cleaning aluminum skillets is a *(A—fine steel wool pad) (B—wooden spoon) (C—sharp metal knife).* ☐
3. Electric skillets with the "built-in" thermostat control *(A—can be) (B—should not be)* submerged in the wash water when being cleaned. ☐
4. If an electric skillet does not heat up properly, it may be due to the *(A—large wire size of circuit) (B—thermostat set too high) (C—low voltage at the skillet).* ☐
5. The cost of operating an electric skillet can best be determined by *(A—multiplying the wattage x operating time x the electricity rate) (B—using a kilowatt-hour meter).* ☐

ADDITIONAL ACTIVITIES

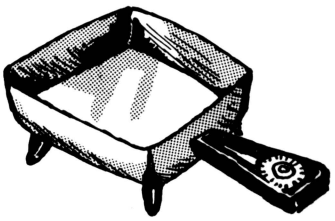
Visit a factory where electric skillets or other small appliances are made. Do this as a group project with your local leader or local electric power supplier representative in charge.

After you understand and have learned to operate an electric skillet, have two or three members bring their skillets to a combined member-parent meeting. Put on a "popcorn" party. *Note:* Be sure you know how to pop corn in the skillet or you might be embarrassed. Don't put more than one skillet on a circuit. Thus, the building in which you hold such a "party" will need to have an extra good wiring system.



MR. E. LECTRON SEZ:

Controlled heat units mean clean, cool kitchens



UNIT 10

Lets Learn About

Heat Lamps

INCREASE YOUR KNOWLEDGE

If you use a prism to break up the rays of the sun, you will see a beautiful assortment of seven different and distinct colors. At one end of this assortment is red light. This red band of color is the start of an invisible band of light called infrared rays—long, radiant heat waves.

Science has learned how to produce these rays with electrical energy so that they work for us on many important jobs. In the home they are used for soothing aching muscles, for drying paint, for keeping water pipes from freezing, and for 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 wet areas, and to supply heat in locations where heat has to be directed. They can be used to provide quick comfort while milking, washing dairy equipment, or at your work bench.

The infrared heat 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. These objects then give off heat. Shine such a lamp across the room and the air will not be heated noticeably. But it will be warm where the rays strike.

Heat Lamp Facts

Infrared lamp bulbs produce infrared rays whenever they are lighted. The lamps you use for brooding should have built-in reflectors. These types are more efficient than ordinary lamps of the same wattage because they send all the infrared rays in the direction you want them to go. These lamps are usually "funnel shaped." 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 Lamps (usually white in color).
   a. Will not withstand water when hot.
   b. Cost less.
   c. Are just as efficient as hard glass.
   d. Are used where there is no danger of splashing water on bulb.
2. Hard Glass Lamps (usually red in color).
   a. *Will* withstand water splashes when hot.
   b. Cost more.
   c. Are used where there is danger of water splashing on bulb.

The red bowl heat lamp avoids glare by reducing the visible light output. But, *not all red bowl lamps are of the hard glass type.* A simple indicator of soft vs. hard glass is first cost. Soft glass lamps cost about ⅓ as much as hard glass lamps. Be sure to purchase the one that best fits your needs.

Heat Lamp Safety

The ordinary heat lamp does not give off much light; that isn't what it's for. 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 these things for too long a time. A thermometer *will not* give you an accurate recording of the heat that is being produced. The metal on the thermometer will be at a different temperature than the surrounding air. Porcelain sockets are recommended if lamps are used for continuous or long burning periods. Brass, and most plastic sockets, will not withstand the high temperatures that occur at the lamp base. When used for brooding, the metal reflector surrounding the lamp must be placed at the proper height and supported by a chain, wire or bracket—*never* by the current-conducting cord. Use no more than seven 250-watt lamps per circuit with No. 12 wire.

When properly used and cared for, heat lamps should have a life expectancy of 5000 hours or more.

DEMONSTRATE:

1. How heat lamps are properly used for brooding. Show specific recommendations regarding equipment, minimum heights, etc. as recommended by the University of Missouri or the American Society of Agricultural Engineers.
2. Different kinds of heat lamps, and the advantages and disadvantages of each. Use a chart and actual equipment (loaned to you by a local dealer).

THINGS TO DO

1. Make a portable heat lamp unit as shown in Figure 3 or in your Member's Idea Book.

2. Install a thermostatically controlled heat lamp in your pump house to protect water pipes and equipment from freezing.
3. Install a battery of heat lamps in your milking parlor or over wash-up areas in the milkhouse. Check your wiring before adding these, however.
4. Make a *safe* pig brooder unit.

MAKE A SURVEY

If you use any heat lamps around your home or farm, check the fixtures, size and type of lamps, number of lamps, and how they are used. Use a form similar to the one below to record what you find.

Lamp Used For	Protective Fixture	Type Socket	Type of Hanger	Lamp Height	No. Lamps per Circuit	Circuit Wire Size	Circuit Fuse Size	Recommended Changes
Chick Brooding	Metal Refl.	Porce-lain	Electric Cord	18"	7	#12	20	Hang with Chain (wire)

UNIT 10 QUIZ—How Well Can I Handle Heat Lamps?

1. *(A—Brass) (B—Porcelain)* lamp receptacles are recommended for heat lamp use.
2. Heat lamps with *(A—red) (B—white)* bowls are *usually soft glass lamps.*
3. The rays from an infrared chick brooder may *(A—penetrate the birds but will never start a fire) (B—start a fire when placed too close to the litter).*
4. The *(A—red) (B—white)* bowl infrared lamp reduces visible light output and glare.
5. The *(A—soft) (B—hard)* glass lamp is the most expensive to buy and it will withstand water splashes.

ADDITIONAL ACTIVITIES

Study all of the sections in your 4-H Member's Idea Book that relate to heat lamps and heat lamp units. Obtain and study a copy of Farm Electrification Leaflet No. 6, using infra-red heat lamps safely from your County Agent or Workbook II authors.

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Kenneth L. McFate, Assistant Professor, Agricultural Engineering and Co-Chairman of Committee

Nelson Trickey, State 4-H Club Agent and Co-Chairman of Committee

Edward J. Constien, Extension Agricultural Engineer

Dave Earle, Westinghouse Electric Corporation

Tommy Smith, American Electric Company

William Spinabella, Sho-Me Power Corporation

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Issued in furtherance of cooperative extension work, acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. C. B. Ratchford, Director, Cooperative Extension Service, University of Missouri, Columbia, Mo.

ELECTRICITY PROJECT II

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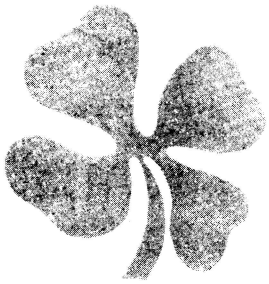

Name _____ Address _____

Age _____ Club _____

Years Enrolled In Electricity _____ Leader _____

Parents Name _____

Who Furnishes Electricity to Your Home? _____

My Participation:

Club meetings attended during year___. Project meetings held___. Project meetings attended____.
Number of demonstrations given at: project meetings____, community club meetings____, county meetings____, district meetings____, and state meetings____.
Number of times participated in judging work in: project meetings____, county____, district____, state____, interstate____.
Number of exhibits made in: community____, county____, district____, state____, interstate____.

Participated In:
County Achievement Day____, District Achievement Day____, State Achievement Day____, national contests____, county fair or show____, district fair____, State Fair____, Interstate Show____, marketing days____, county camp____, district camp____, State Club Week____, National Club Congress or National 4-H Conference____.
Number of news stories published____. Number of radio and T.V. programs participated in____.
Number of public speeches made____.

Served on _____ standing committee in club.

-- PROJECT REQUIREMENTS --

If you enroll in this project, your club leader will expect you to complete the following:

1. Attend a majority of project meetings held and six community meetings.
2. Make, build or repair at least three pieces of equipment.
3. Complete at least two surveys at home or on the farm.
4. Study at least 6 units in this book. Complete the quizzes at the end of the same 6 units.
5. Perform at least one demonstration before a group of people.
6. Write a short story on "How Electricity Has Benefited Me This Year."
7. Complete workbook and project report and turn in to your club leader by _____, 19____.

I certify that _____ has met the requirements of this 4-H .
Member's Name
project as outlined.

Signed _____
Project Leader

SUMMARY OF ACHIEVEMENT

Number of project meetings held by club leader _____.

Number of project meetings attended by you _____.

Number of surveys completed _____.
(attach all survey sheets to the back of this report)

Number of demonstrations performed _____. List these and related information below:

Title	For Whom Given	When Given	Number in attendance

List pieces of equipment built and exhibited:

Item	Value	How Obtained	How Used	When Exhibited

What additional activities, where electricity was used, did you and/or your club engage in during the year: (be specific)

_____

_____

_____

_____

_____

_____

_____

_____

In your own words write a short story telling how electricity has benefited you this year. Include such things as the amount of time and labor that one or more pieces of equipment have saved, the cost of operation, safety, health and other factors, if they apply to your particular situation. You can think of many other advantages and you'll want to report these ideas in a concise manner. Use pictures if they are available.

-- ACHIEVEMENT AWARDS AVAILABLE --

Ribbons are presented to electric project members who demonstrate or exhibit at County Achievement Days. Top demonstrators represent their county at district and state achievement days where additional ribbons are presented.

Be a 4-H Star! Each year about thirty 4-H boys and girls will be chosen to give an electrical demonstration in the 4-H Electric Theatre at the Missouri State Fair. Details may be obtained from your County Extension Agent.

County Achievement Pin. Awarded for completion of project requirements.

-- NATIONAL AWARDS PROGRAM --

County Medal: Awarded to the top four boys and girls in each county who fill out and turn in the standard report forms.

State Award: One boy or girl is selected from county electric program medal winners for an all expense paid trip to the National 4-H Club Congress in Chicago each year.

National Awards: Six $400 scholarships to state trip winners in blue award group.

Your county will be awarded a handsome plaque if it reports the most outstanding Electric Program in the state. You can help your county win this award by doing more than just the requirements in your project.

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