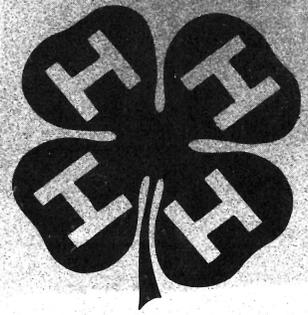
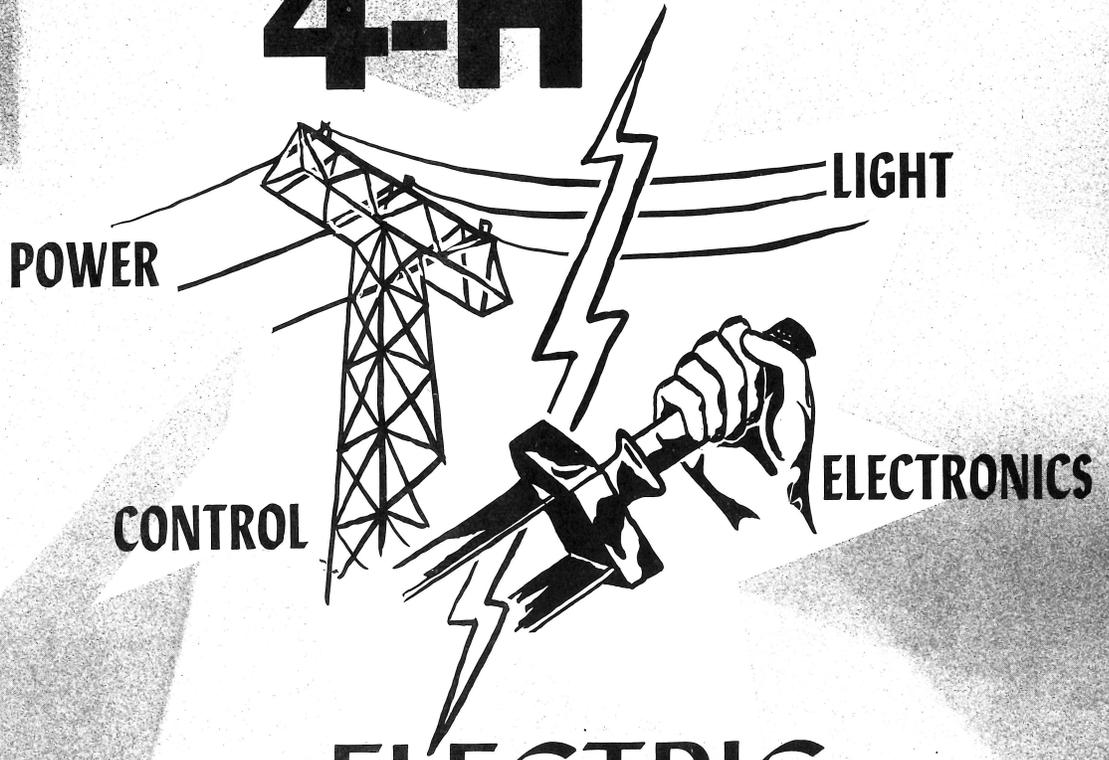


534  
m8m48  
20



# YOUR 4-H



# ELECTRIC PROGRAM



**WORKBOOK NUMBER 3**



University of Missouri  
Extension Division  
4-H Cir. 180 Reprint 7/66

## 4-H ELECTRICITY PROJECT

NAME \_\_\_\_\_ ADDRESS \_\_\_\_\_  
PARENTS NAME \_\_\_\_\_  
4-H Club \_\_\_\_\_ Leader \_\_\_\_\_  
Power Supplier \_\_\_\_\_ Location \_\_\_\_\_

### Welcome Back to the Electricity Project

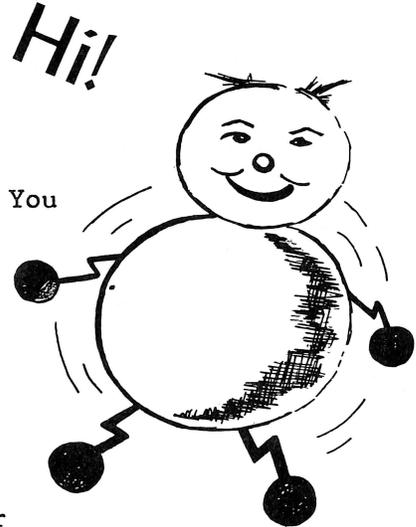
Workbook 3 has been developed a bit differently from No. 1 and No. 2. It has two groups of material, Group A and Group B.

#### Group A

1. Plan a Home Wiring System
2. Save Steps with Switches
3. Light up the Lot
4. Let Automatic Controls Work for You
5. Ground That Equipment
6. Electrons and Basic Electronics

#### Group B

7. Build a Radio for Your Own Use
8. Electronic Amplifiers
9. Inspiration Lighting - Outdoors
10. Inter-Communication Systems
11. Open - To be Developed by Member and Leader, with Agent or Power Supplier Assistance.



Units in Group A will be handled much like those of last year on a group study basis. Those in Group B can be handled on an individual basis. By doing this, we hope to have enough variety to meet the challenge and interest of all of you. In the special units of Group B, we hope that you may find the ones that you've been wanting to do. The information on these is abbreviated, however, and you'll need to talk with local technicians and consult the listed references if you are to do the best job with your project. You'll get a real thrill when you complete one of these units and see some of your electronic devices work.

Consult your local leader and power supplier for all possible sources of help. Make a note of these sources in your record book, along with good pictures, newspaper clippings, and demonstrations. A good story will let others know about you, your work, and your knowledge. It will also put you in a good position to compete for local, state, and national awards.

# UNIT I PLAN A HOME WIRING SYSTEM

You don't have to be a home builder, an electrician, or a professional interior decorator to appreciate the value of a good home wiring system. You may, in fact, already realize that some parts of your own home wiring system are adequate and some are inadequate. If you notice small appliances heating slowly or your lights dimming when refrigerator motors start, your wiring needs improvement. We must have the proper number of circuits and the right size of wire to handle our present and future electrical load to make the most efficient use of the electricity that we pay for.

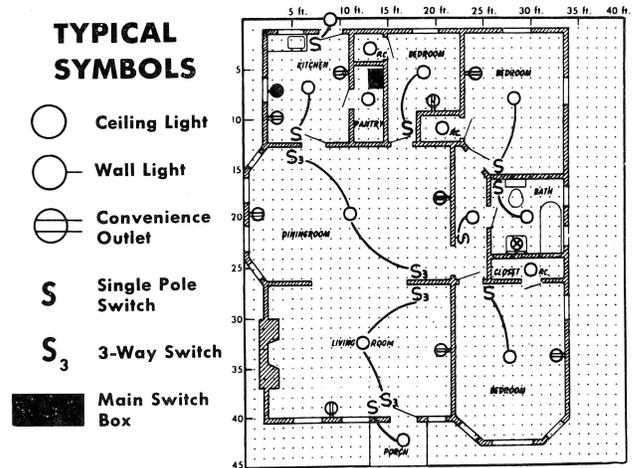
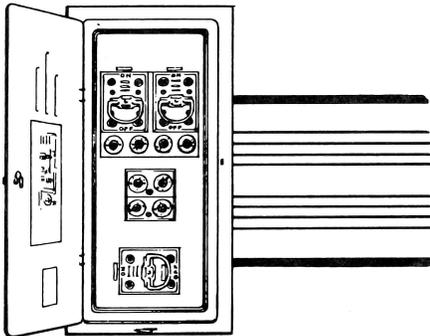


Figure 1.

Study the wiring section in your Members Idea Book. Understand how electricity is made, how it moves and how to use it properly.

## Parts of a Home Wiring System

A home owner's wiring system starts at the meter pole where separate wires often run to individual buildings. The three main parts are:



1. Service entrances (main power line and switches).
2. Branch circuits (general purpose, appliance and special).
3. Electrical outlets (lighting, switch, convenience and special purpose).

The main power lines must be quite large because they carry the load of all branch circuits.

While aluminum conductors are often used in outdoor wiring, copper is nearly always used indoors. It is a good electrical conductor, economical in first cost and easy to install. The different sizes used in the home are Nos. 6, 8, 10, 12, and 14, depending upon the load being served. The larger the number, the smaller the wire. This is shown in your Idea Book. A No. 12 gage wire is larger in diameter than a No. 14; a No. 10 is larger than a No. 12, etc.

The size of wire needed for branch circuits in a home depends much upon the type and number of electrical appliances used. Small overloaded wires become excessively hot and waste electricity. Although No. 14 wire will carry a 15 ampere load and is permissible for lighting circuits, according to the National Electrical Code, many peo-

ple now use No. 12 wire for both lighting and appliance circuits because of the small difference in the cost of the wire and its installation.

To avoid costly errors in wiring systems, a complete home wiring plan should be made before any work is done. You can start such a plan with a list of all present and anticipated electrical loads, recording their wattage and their location. You can then determine the number and kinds of branch circuits needed.

Actual Size					
Gauge Size	14	12	10	8	6
Fuse or Breaker	15	20	30	40	55
Max. Watts at 115 V.	1725	2300	3450	4600	6325
Max. Watts at 230 V.	3450	4600	6900	9200	12750

Wire sizes commonly used in homes

The three kinds of circuits that need to be considered are:

1. General purpose - serves the lighting needs and normal convenience outlet requirements.
2. Appliance - serves work areas where heavy portable appliances are used.
3. Special purpose - for large loads that normally require individual circuits. Examples: electric range, clothes dryer, automatic washer, water heater, and air-conditioner.

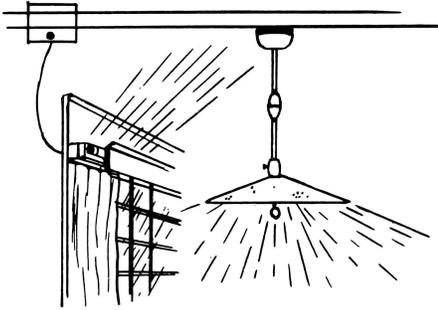
In planning general purpose circuits:

1. Divide lights and outlets into various branch circuits so that too much load will not be on at one time.
2. Never connect all of the lighting outlets located on one floor to a single circuit. (If a fuse blows, the whole floor would be darkened).
3. Allow at least one 20 ampere circuit for every 500 square feet of floor space or,
4. Allow at least one 15 ampere circuit for each 375 square feet of floor space.

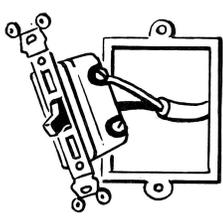
You should have at least two, and preferably three, appliance circuits for the kitchen, dining room, and laundry areas. These should be entirely separate from the lighting circuits.

Special purpose circuits should run direct to the outlet that serves the appliance, with no provision for connecting other equipment.

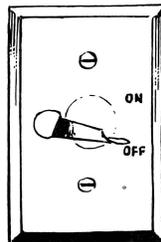
To make up your wiring plan, you should know that:



Lighting outlets

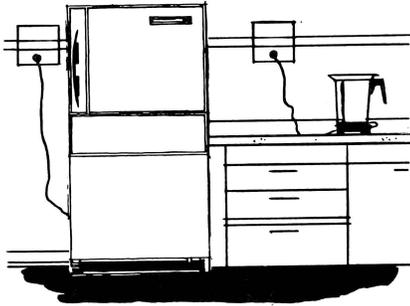


Light  
(indoors)

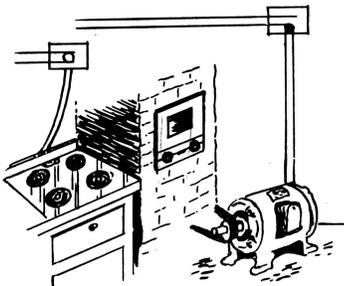


Weatherproof

Switches



Convenience outlets



Special purpose  
outlets

1. Lighting outlets are electrical boxes which provide a means for connecting branch circuits to fixtures used for lighting purposes. These will usually be of two different types, general lighting and special lighting. The general lighting fixtures in most rooms will be switch controlled. Special lighting includes fixtures and lamps used for inspiration or beauty. Units in Workbook 2 give information necessary for most lighting specifications that you may wish to consider.
2. Switches, as referred to in this unit are those mounted on the wall and not a part of any light fixture. These should be located at the latch side of the door or the traffic side of arches and within the room or area for which the control is used. Switches are normally located about 48 inches above the floor. All spaces for which wall switch controls are required and which have more than one entrance, should be equipped with multiple (more than one) switch control. These, of course, should be located at each main entrance or passageway. However, if these entrances are within ten feet of each other, multiple switching is not absolutely necessary.
3. Convenience outlets include the plug-in receptacle and the box in which it is housed. These may be of several types. While most have two receptacles, some have three, some only one. The number and locations of convenience outlets are generally regulated by the two major areas of the home- the work area, consisting of the kitchen, dining room, and laundry; and the living area, consisting of the living room, den, and bedrooms.

Convenience outlets in all living areas should be located near the end of the wall space so that they are less likely to be concealed behind large pieces of furniture.

4. Special purpose outlets are provided to serve specific electrical equipment. When used for permanently connected appliances, they are installed in or on the walls as a permanent part of the wiring system.

Recessed outlets for wall hanging clocks should be provided so that its cord can be concealed. Weather-proof outlets on the exterior side of the house for operating outdoor lights, power mowers, hedge trimmers, and other tools should be placed about 18 inches above the ground level.

It is impossible to cover all of the rules and regulations that must be considered. But some of the references at the end of this Unit will be most helpful in PLANNING a safe, practical and convenient home wiring system. When you make your wiring system plan, use the proper electrical symbols.

THINGS TO DO

1. Take a careful look at your main entrance switch. How many electrical circuits are there? \_\_\_\_\_ Are they marked? \_\_\_\_\_ If not, obtain someone's help and determine the number of outlets on each circuit: to do this, turn on all the lights in your home. Then trip one circuit breaker or remove one fuse at a time. Note the lights that went out and check outlets with your test lamp. Note on your switch box what each branch circuit serves and make a record of this for your 4-H report.
2. Make a Plan of a Wiring System for your home.
  - a. Check the appliances now in use and those which you and your parents expect to be using in about five years. Use the data chart below. If you plan to have electric heat, special wiring will be needed.

APPLIANCE	TYPICAL WATTAGE	NOW HAVE	WILL HAVE	APPLIANCE	TYPICAL WATTAGE	NOW HAVE	WILL HAVE
Air Conditioner	1100			Ironer	1650		
Attic Fan	400			Lamps, Each Bulb	40-100		
Automatic Toaster	1200			Mechanism for Fuel-Fired Heating Plant	800		
Automatic Washer	700			Mixer	100		
Broiler	1000			Oil Burner	250		
Built-in Ventilating Fan	400			Portable Fan	100		
Coffee Maker	1000			Portable Heater	1650		
Egg Cooker	600			Radio	100		
Deep Fryer	1320			Ranges, Electric	8000		
Dehumidifier	350			Refrigerator	200		
Dishwasher-Disposer	1500			Room Cooler	600		
Dry Iron or Steam Iron	1000			Rotisserie	1380		
Electric Blankets	200			Roaster	1380		
Electric Clock	2			Sandwich Grill	1320		
Clothes Dryer	4500			TV, Black and White	350		
Freezer	350			Vacuum Cleaner	300		
Fluorescent Lights (Each Tube)	15-40			Ventilating Fan	400		
Griddle	1000			Waffle Iron	1320		
Hair Dryer	100			Waste Disposer	500		
Heat or Sun Lamp	300			Water Heater	4500		
Hot Plate	1500			Water Pump	700		

- b. Make a scaled drawing of the floor plan of your home. Use a chart like that shown in Figure 1, only much larger in size.
- c. Show present outlets, switches, lights, etc. in blue. Add (in red) any outlets and/or switches needed to operate present or future equipment most efficiently.
- d. Make a list of electrical circuits that will need to be added. Will the service entrance box need to be changed? \_\_\_\_\_ Yes \_\_\_\_\_ No.

DEMONSTRATE

With a model home that you can construct from cardboard, show the proper number of outlets per circuit and the location of all outlets and switches. Show other wiring principles outlined in this book and in references.

UNIT 1 QUIZ

WHAT ABOUT WIRING  
(Check ✓ correct answer)

	<u>True</u>	<u>False</u>
1. Special purpose outlets are usually used for special lighting.	_____	_____
2. No. 12 wire will carry more load than No. 14.	_____	_____
3. Aluminum conductors must be larger in diameter than copper to carry a specific load.	_____	_____
4. Convenience outlets always accomodate two receptacles.	_____	_____
5. One appliance circuit is all that is ever needed for the kitchen-dining area.	_____	_____
6. Wires between the transformer pole and meter pole usually belong to the power supplier.	_____	_____

ADDITIONAL ACTIVITIES

If you find that you need extra circuits or extra switches in your home, draw up a plan for their installation. Check these with your parents, leader, local electrician, or power supplier. If installed, report it in your record blank.

HELPFUL REFERENCES FOR FURTHER FUN AND STUDY

- |   |  |
|---|--|
| 1. Practical Electrical Wiring (50¢)<br>H. P. Richter, Editor<br>McGraw-Hill Book Company, Inc.<br>New York, New York | 2. Remote - Control Wiring System<br>Manual for Residential Wiring<br>Design & Installation<br>General Electric Company<br>818 Olive Street<br>St. Louis 1, Missouri |
| 3. Simplified Electric Wiring<br>Handbook (50¢)<br>Sears, Roebuck and Company   |  |



MR. E. LECTRON S&Z:

PLANNED WIRING MEANS  
BETTER, SAFER LIVING.

# UNIT 2 SAVE STEPS WITH SWITCHES

## 3-Way, 4-Way and Low Voltage

Have you ever walked up a dark stairway or across a dark room before you could reach the light switch? You won't have to if you have two or more convenient points of light control that use 3-way and 4-way switches.

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

### How Three-Way Switches Work

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

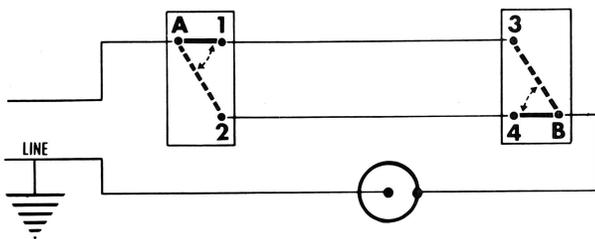


Figure 2

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

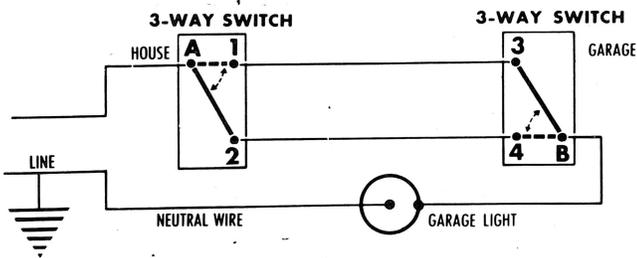


Figure 3

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

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

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



MR. E. LECTRON SEZ:

MULTIPLE SWITCHING  
SAVES STEPS -  
TEMPERS TOO.

## How A Four-Way Switch Operates

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

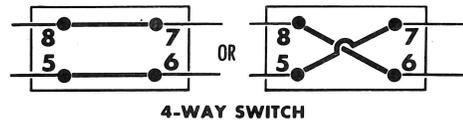


Figure 4

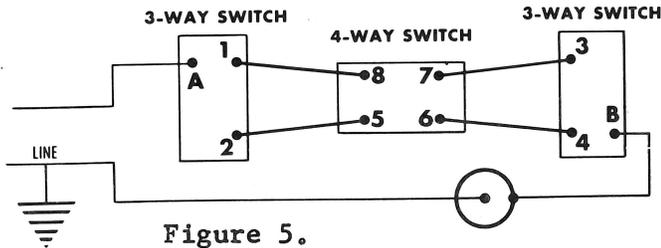


Figure 5.

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

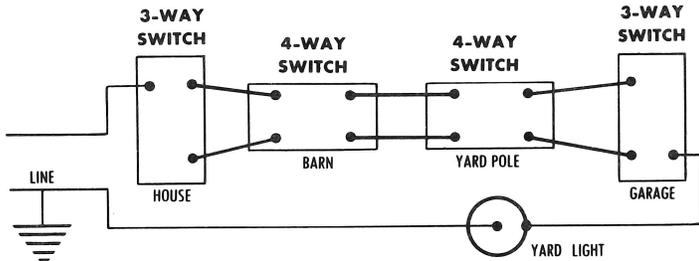


Figure 6.

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

Figure 6 shows the wiring of a circuit control from any of four positions.

Electric lights can also be controlled from several points with remote control wiring. Remote control wiring is a form of low-voltage wiring. (Low voltage refers to 25 volts or less.) When a light or another device is to be turned ON and OFF from three, four or more locations this has some advantages. Switching from several locations with regular wiring gets expensive because of the need for long runs and 3-way and 4-way switches. In the remote control system, the 120 volt wires are brought up to the light outlet that is to be controlled. Then an electrically operated switch (RELAY) is mounted in the outlet box for each fixture that will be controlled. Special push button switches are then mounted at the desired control points. The power circuit for operating the relays comes from a transformer that changes the 120 volts to 24 volts. Such transformers are constructed so that there is no danger of fire or shock.

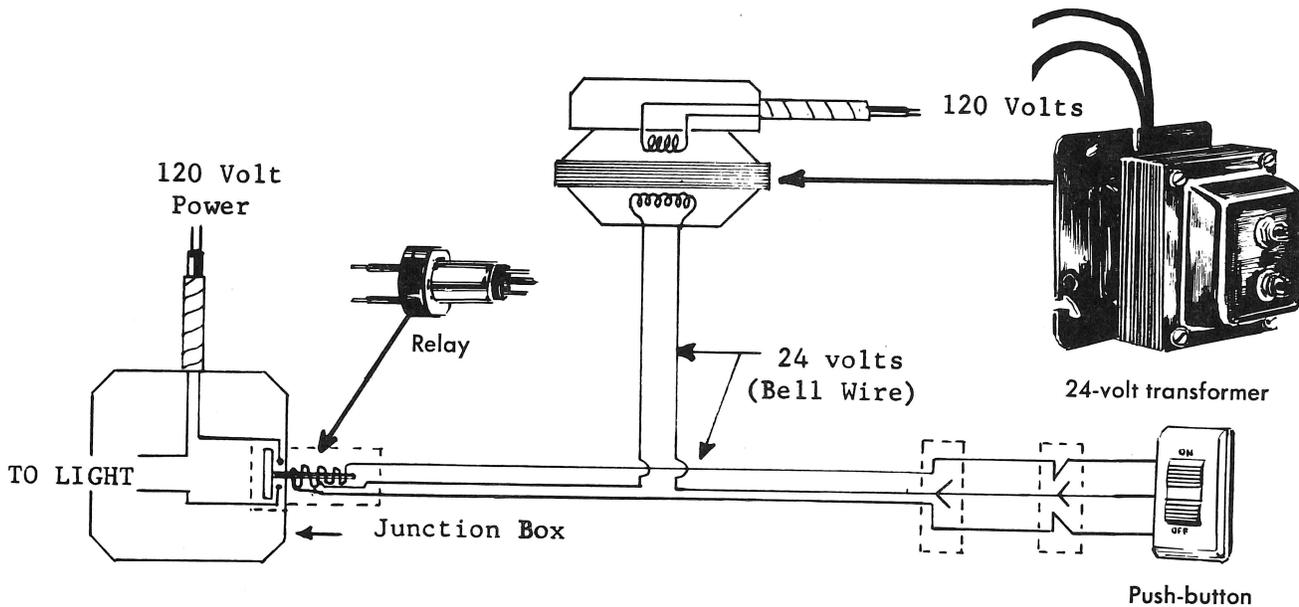


Figure 7. Low-Voltage Switch Control Circuit.

Electric wires used for low-voltage control have little insulation and should be kept at least two inches away from regular 120 volt (or higher) circuits. These conductors are often called Bell wire and are fastened with small insulated staples.

Low voltage wiring systems are also used for controlling the component parts of farm feed and material handling systems which must be operated in a certain sequence.

#### WHAT TO DO

Wire a Control Board

#### Tools Needed

From your electrician's kit, you'll need a knife, screwdriver, electrician's pliers and hammer. You might like to add a wire stripper to your tool kit this year. It will reduce the danger of cutting the metal conductor when stripping off the insulation.

## Materials Needed

Two 3-way switches with cover plates

One 4-way switch with cover plate

One incandescent lamp bulb

Two flush mount type sockets with screw-on covers

One screw-in base plug or low watt light bulb.

One male cord end plug.

Five feet of No. 12 insulated copper wire.

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

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

Two wooden strips about 1" square for legs, each about 10" long.

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

Two hinges for swinging legs.

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

Friction tape, if desired.

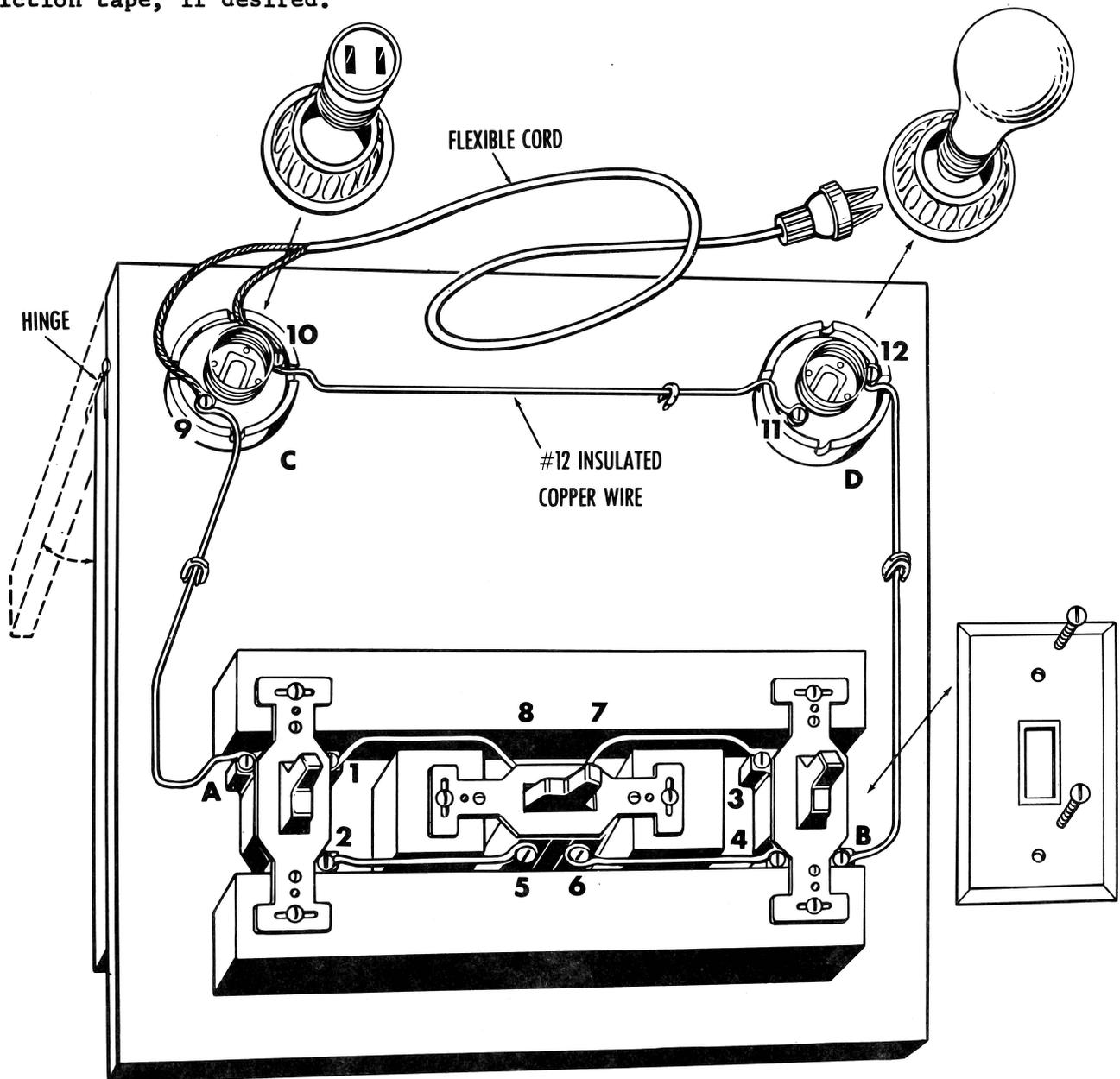


Figure 8 **DEMONSTRATION CONTROL BOARD**

## Steps to Take

Prepare your board as shown in Figure 8. The cleats should be about 3" shorter than the board is wide, and just far enough apart for mounting your switches. Attach wooden "feet" or legs to underside of board at corners as shown. Use wood screws or nails. The board is now ready for mounting switches, light socket and wiring.

## Mount Switches and Sockets

Mount switches as shown in Figure 8, with 4-way switch in the middle. Use mounting hardware that comes with switches and socket. (When wiring has been completed and checked, put the plates over the switches and screw covers on sockets to cover exposed terminals.) Mount light sockets as indicated.

## Now the Wiring

1. Cut four pieces of No. 12 wire, each about 6 inches long, and strip an inch of insulation from the ends of the pieces. Use these to connect the 4-way switch to the 3-way switches. Due to the stiffness of the short connecting wires, it may be easier to connect the switches before mounting them on the wooden cleats.
2. Cut three other pieces of proper lengths to connect:
  - a. terminal 9 to nearest 3-way switch.
  - b. terminal 10 to lamp socket.
  - c. lamp socket terminal 12 to the other 3-way switch.
3. Wire the board as shown in Figure 8. With a pencil, check off the corresponding wire in Figure 8 as you attach each wire to the circuit. In this way, you'll be sure you haven't omitted a wire. Check off (✓) each wiring step below as it is completed.
  - ( ) Connect 6 inch piece of wire from terminal 1 of 3-way switch to terminal 8 of 4-way switch.
  - ( ) Connect a 6 inch piece of wire from terminal 2 of 3-way switch to terminal 5 of 4-way switch.
  - ( ) Connect 6 inch piece of wire from terminal 7 of 4-way switch to terminal 3 of remaining 3-way switch.
  - ( ) Connect another 6 inch piece of wire from terminal 6 of 4-way switch to terminal 4 of 3-way switch.
  - ( ) Attach a longer piece of wire to terminal A of one 3-way switch. Attach the other end to terminal 9 of socket C.
  - ( ) With another piece of wire, connect terminal 10 of socket C to terminal 11 of light socket D.
  - ( ) Use the remaining wire to connect other terminal (12) of the light socket D with terminal B of the second 3-way switch.

- ( ) Strip wires on both ends of flexible cord.
- ( ) Attach wires on one end to the terminals of the male plug.
- ( ) Separate wires on the other end of flexible cord for about 4 to 6 inches and attach one wire to post 9 and the other to post 10 on socket C. A wire of the flexible cord is now attached directly to a No. 12 copper wire at each terminal post to complete the wiring circuit.
- ( ) Screw covers on both sockets. Screw light bulb in light socket at D and screw plug or small bulb into C. This completes your wiring. Make sure all terminals are secure. Always loop the wire around the screw terminal in the same direction that the screw turns to tighten. This assures a tight connection. A pair of round-pointed (long nose) pliers may be helpful in forming the proper curve for the wire's end.

Test the Board

The board is wired ready for testing. Be sure no one is near any exposed wires. Plug it into a convenience outlet, or into an extension cord. The light bulb should turn on or off from any of the three switches. If it doesn't, pull the plug and check all of your wiring steps, one at a time, until you find the mistake. If your wiring is correct, mount the plates on the switches to cover exposed terminals.

Make a Survey

Check around your home and farm for 3-way and 4-way switches. How many did you find? \_\_\_\_\_ Where were they located? \_\_\_\_\_ How many lights need to be controlled from additional points? \_\_\_\_\_

DEMONSTRATE

1. With a blackboard and chalk show how 3-way switches operate. Also show how 4-way switches operate.
2. Draw a diagram showing how two 3-way switches can control the same light from two different points; from three points; from four points.

UNIT 2 QUIZ FOR BETTER SIGHT, CONTROL THE LIGHT

	<u>True</u>	<u>False</u>
1. To control a light from 3 different points, two 3-way switches are needed.	_____	_____
2. To control a light from 4 different points only one 4-way switch is needed.	_____	_____
3. Low voltage wiring can be used to control lights from several points.	_____	_____
4. <u>Bell</u> wire can be used to carry 120 volts.	_____	_____

ADDITIONAL INFORMATION

If you wish additional information, talk with your electric power supplier, leader, county agent, University of Missouri agricultural engineer, or obtain the reference materials shown at the end of Unit 1.

## UNIT 3 LIGHT UP YOUR LOT

For Protection - Convenience - Beauty

It makes little difference whether you live on a lot in town or on a section of land in the country as far as the benefits of good outdoor lighting are concerned. Improved beauty, safety, convenience and protection achieved with additional light around your home may be limited only by your imagination and ingenuity. But while imagining how your home or farm will look with more and better light, be sure to consider good safe lighting principles.

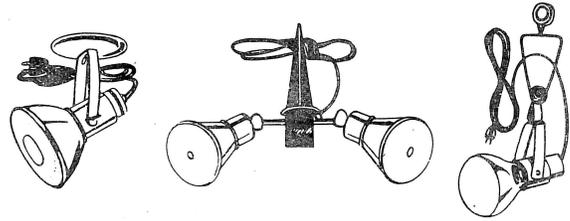


Figure 9.  
Adjustable Lamp Fixtures.

Principles of good indoor lighting that you've already learned also apply to outdoor lighting. You get GOOD LIGHTING when the right kind of light is used in the right place. The higher we place a fixture, the larger the area it will cover, but the higher the fixture the larger the bulb required. For lighting work and play areas, most lamps should be from 15 to 20 feet above ground level. The yard pole or building corner and gables provide good locations for many such lights. These lights need good control switches of the right type at the right locations, too.

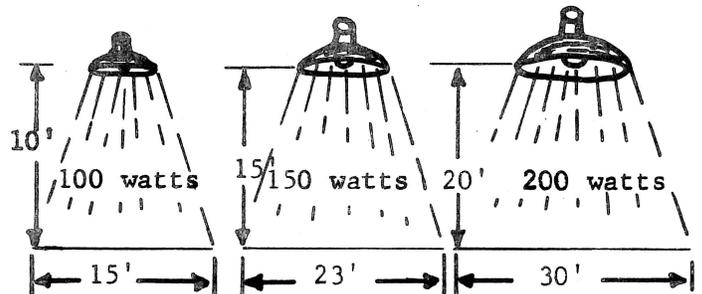


Figure 10. Lamp Height VS. Area Lighted  
(Shallow Dome Reflectors)

The wiring, type of lamp, type of reflector, lamp location, height, and cleanliness all contribute to overall lighting efficiency. The most common for outdoor use are reflector lamps and the incandescent lamps with metal reflectors.

Reflector lamps are excellent for yard lighting, protective lighting and emergency use. For outdoor use, they must be of the PAR-38 type which are made of heavy, molded glass that can be used without metal reflectors under any weather conditions. Though more expensive than incandescent bulbs, installation and upkeep costs on these are less. The reflector flood, with built-in reflector, should be used for lighting up large areas and the reflector spot for small areas where a concentrated beam of light is desired. The most common size, 150-watt, is available with blue, green, red and yellow lenses.

All-night lighting provides both protection and safety. Floodlights, like the PAR-38 lamps, have been found to keep human and animal thieves away from livestock and poultry. Flashing lights or moving lights are even more effective than stationary lights. The control switch for such protective lighting should be located in the home for fast action if prowlers are suspected. Many automatic pole-top fixtures that are used for farmstead and livestock protection use mercury vapor lamps. They are often installed and serviced by the power supplier for an annual fee and are turned on and off automatically by a photo-electric control switch near the top of the pole.

Mercury-vapor lamps are more expensive than incandescent lamps but they give over twice as much light as incandescent bulbs of the same wattage and they last several times as long.

Metal lamp reflectors serve two purposes. They direct more light onto the working area and they protect the lamp from rain and the accumulation of dust. Standard dome reflectors direct light down and shield the bulb. Shallow dome units do less shielding but give greater light distribution. Each of these types are made to match bulb sizes of 75, 100, 150, and 200 watts. The standard 12-inch diameter dome with a 150-watt lamp provides effective lighting in many farm buildings. The 12-inch diameter shallow dome reflector, with 100 watt lamp, is the most commonly used for indoor lighting. The deep bowl reflector is often used over work areas where the light is confined to a small pattern. Many different types of brackets and swivel sockets are available for holding these lamps and directing the light where needed.

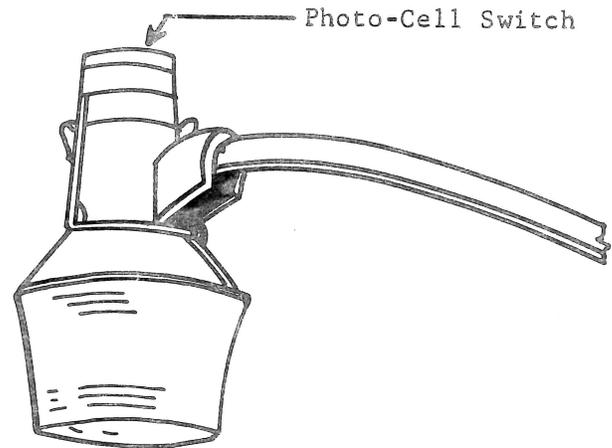
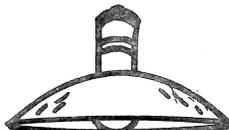


Figure 11. Automatic Yard Light

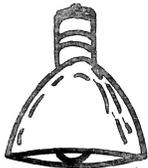
When providing light inside of farm buildings, direct most of the light onto work areas. Keep lamp fixtures and bulbs high enough so they will not be damaged with equipment. The greater height will also reduce glare. Mount the bulbs in a vertical position so that dust accumulation will be at a minimum. When lamps are used in dusty places like hay lofts, enclose them in dust-proof fixtures. Plan for plen-



Standard Dome



Shallow Dome



Deep Bowl

Figure 12. Types of Metal Reflectors

TABLE 1 SUGGESTED FIXTURE & INCANDESCENT LAMP SIZE FOR MINIMUM LIGHT					
Building	Area	Lamp Size (Watts)	Lamps per floor area listed	Reflector Type	Dia. In.
Garage	Storage	100	1/car	Shallow	12
Machine Shed	Storage	100	1/400 sq. ft.	Shallow	12
Beef Cattle Barn	Feeding & Loafing	100	1/300 sq. ft.	Shallow	12
Sheep Barn	Feeding & Loafing	100	1/300 sq. ft.	Shallow or Standard	12
Hog House	General	100	1/300 sq. ft.	Shallow or Standard	12
Dairy Barn	Feeding & Loafing	100	1/400 sq. ft.	Shallow	12
Poultry House	Laying House	60	1/100 sq. ft.	Shallow	10
Milkhouse	General	100	In Center of Building	Standard	12
Milk Parlor	Operator	150	One per cow	Standard	14
Haymow	Hay Storage	100	1/400 sq. ft.	USE DUST PROOF LAMP ENCLOSURES	
Feed Rooms	Feed Storage	100	1/400 sq. ft.	USE DUST PROOF LAMP ENCLOSURES	
Silo, Vertical	Storage	100		Deep	
Stairs	To loft	100	over stairs	Standard	12
Yardlight	PATHWAYS	200-300		Shallow	14

ty of light over stairways, loft ladders, hay chutes and dangerous walkways. Although Table 1 shows some general "guides" for minimum amounts of light in farm buildings, you will need more specific information if you are making a complete lighting system plan for a building or farmstead. (See your county agent or power supplier for more details on these.)

Switching the Lights. No matter how many fixtures you might have, they will do little good unless you provide adequate control. Around most homes and farm buildings you will need to use many three and four way switches to avoid "groping in the dark". Low-voltage controls may be desirable on new wiring systems.

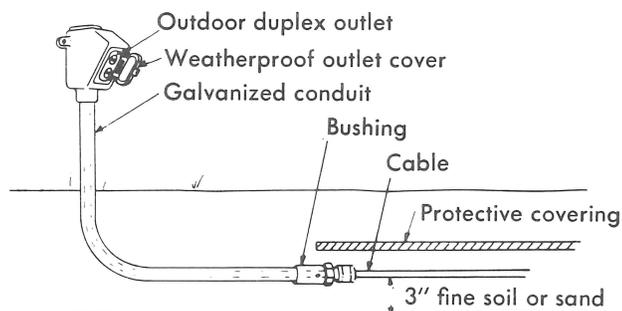


Figure 13.

Whether overhead or underground, good wiring is necessary for good light. Post lamps are normally served with underground wiring. This should be of the UF (underground feeder) type for direct burial in the earth. Protection against mechanical damage to this cable must be provided.

When outdoor overhead wiring is used in and around the farm court, consider the use of a three-wire cable called TRI-PLEX. It is made of aluminum and each of the three conductors must be larger

in diameter than copper wires carrying the same electrical load. The cost of this larger TRI-PLEX cable is often less than the cost of three single, smaller diameter, copper wires that would carry an equal load with the same voltage loss in the wires. The single cable looks better and it is usually safer. Greater clearance between the wires and the ground allows tall farm machines to pass under with less danger of personal injury and damage to the wires. It is always good practice to check your lighting and wiring plans with your power supplier before ordering the equipment.

THINGS TO DO (Under supervision of a technician)

1. Install a post lamp near your drive using underground cable and multiple switching. Or install a permanent outdoor electric outlet.
2. Install one or more reflector lamps to provide light for family fun beyond dusk. Use multiple switching for outdoor and indoor control.
3. Install metal lamp reflectors to improve efficiency of bare bulbs within buildings.

DEMONSTRATE

1. With the use of a light meter, show how light patterns (and how the amount of light within these patterns) change with the use of different types of metal reflectors. Reflectors can often be obtained from local dealers on a loan basis for demonstration.
2. Show the difference in light patterns made by reflector flood and reflector spot lamps. Show the different light patterns provided by post lamp diffusing bowls. Discuss where each type should be used.

MAKE A SURVEY

Make a list of places where you and your family could use more outdoor light. List the kind used for the area and the type of lamp best suited for illuminating this area.

Make a list of bare bulbs used inside of buildings where a metal reflector would improve the quality of light.

ADDITIONAL ACTIVITIES AND INFORMATION

Talk with your power supplier or local electric lamp dealer about other sources of information on lighting and inspect the different kinds of lamps he has in his store display. If you have the opportunity, visit special lighting displays. Observe safe and unsafe practices that are used.

UNIT 3 QUIZ

LOTS OF LIGHT TO LIGHT YOUR LOT

	<u>True</u>	<u>False</u>
1. Mercury vapor lamps are the most common electric lamps for outdoor lighting.	_____	_____
2. Flashing or moving lights are less effective than stationary lights for keeping animal and human thieves away from livestock.	_____	_____
3. When mounted at the same height, deep bowl reflectors provide a smaller light distribution pattern than the shallow dome reflectors.	_____	_____
4. One 150-watt lamp for each cow or stall is recommended for lighting milking parlors.	_____	_____
5. Metal lamp reflectors serve only one purpose - to direct light onto the work area.	_____	_____



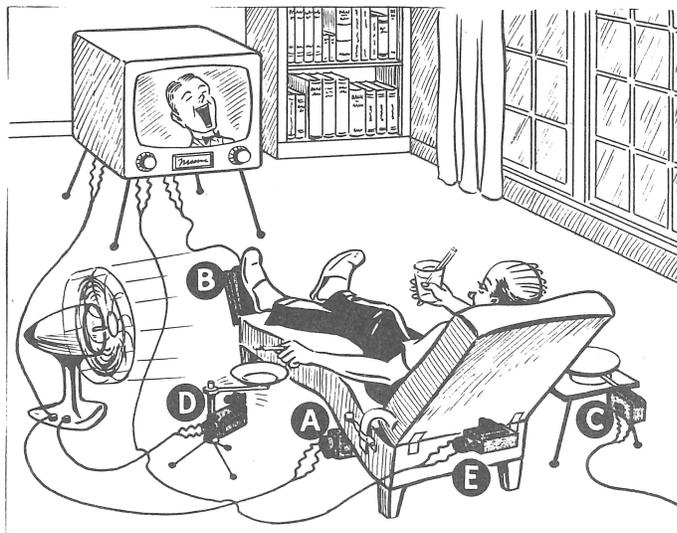
MR. E. LECTRON S&Z:

STRETCH YOUR DAY -  
LIGHT YOUR WAY -  
ENJOY YOUR PLAY.

## UNIT 4 LET AUTOMATIC CONTROLS WORK FOR YOU

You've already learned about manual controls-toggle switches for instance, that can be mounted on or near a machine within easy reach of the operator. But, did you ever stop to think how inconvenient it would be to stand by a refrigerator and turn on a switch whenever the inside temperature rose above a certain level and off again before the food inside was frozen?

There are many times when automatic controls are not only desirable, but are absolutely necessary. They will save a tremendous amount of time and labor. They can start and stop motors and electrical equipment automatically at specific time intervals and are, in general, more dependable than hired labor. Many of these controls are shown and discussed in your 4-H Electric Program Members Idea Book. Learn what they can do.



MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

SUMMER LUXURY AT ITS BEST

Electric motors are inexpensive to operate, easy to control, and have a long life. They can be put to excellent use in farm feed handling and processing systems. They power small hammer and roller mills, grain conveyors, bunk feeders, silo unloaders, and feed meters. The big job with most automatic system design lies in the selection of the right equipment with the proper control so that all components will operate together smoothly.

Any component, such as an auger conveyor or a feed meter, can be controlled with a simple manual switch. But, the proper use of an inexpensive cut-off switch can make this operation automatic. This, in turn, allows you to do other work. You don't need to stand around and wait until it is time to turn the manual switch off. (These cut-off switches are sometimes called pressure switches because it is the pressure, weight, or force of a material, like feed, that makes the switch operate.) They are sometimes called MICRO-switches because they need to move only a short distance to actuate a mechanism.

Cut-off switches may be simple snap-action switches or they may be of the mercury type. They can be purchased for as little as \$3.00. Those which are water tight and explosion-proof are more expensive.

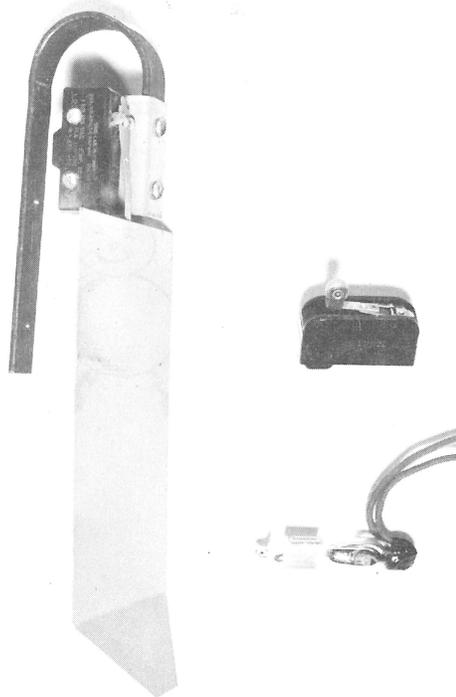


Figure 14. Cut-off Switches

The basic switches can be equipped with dozens of different actuating mechanisms and housings. Consequently, when selecting a switch for a specific application you should know the voltage, the motor horsepower, dimensions of the switch, the type of enclosure desired and if it is a mercury switch, the angle of the switch at which the circuit is opened or closed.

Automatic cut-off switches have lots of uses. They are used to stop automatic blender-grinders when enough feed has been ground to fill the storage bin. They can stop feed conveyors when hog, cattle, or poultry feeders become full or when the feed hoppers in the milking parlor are full. And these same switches will start them again when feed supplies in the bins are low. They can also be used to control the preparation and accuracy of a ration. For instance, if any one ingredient fails to flow into the proportioning hopper, the entire system will be shut off until the trouble is corrected.

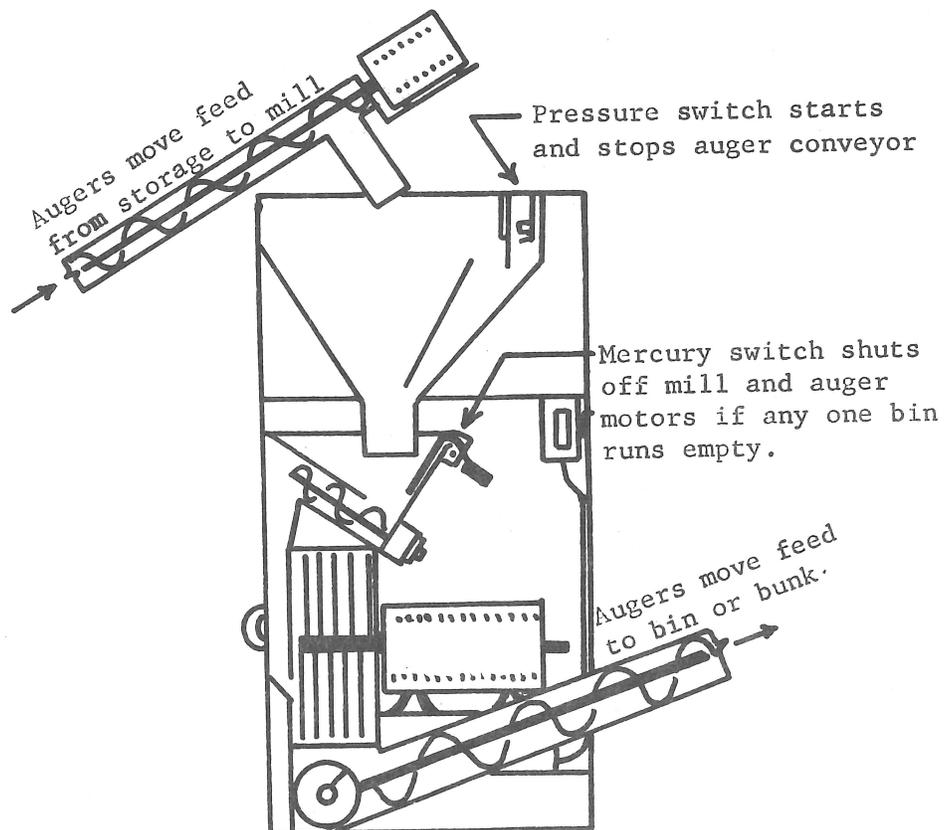


Figure 15. Cross Sectional View Automatic Electric Blender Grinder

#### THINGS TO DO

1. Make a model bin with cut-off switch as shown in Figure 16.

#### MATERIALS NEEDED:

- A 1-1/2 volt No. 6 dry cell battery.
- Miniature socket with solder terminal.
- A 1-1/2 volt flashlight bulb.
- 2 pieces of bell wire.
- One micro-switch BZ2RW22. ) - (Obtain from local electric supply company
- One switch bellows as shown.) - or power supplier)
- One piece of 5/16" plywood.

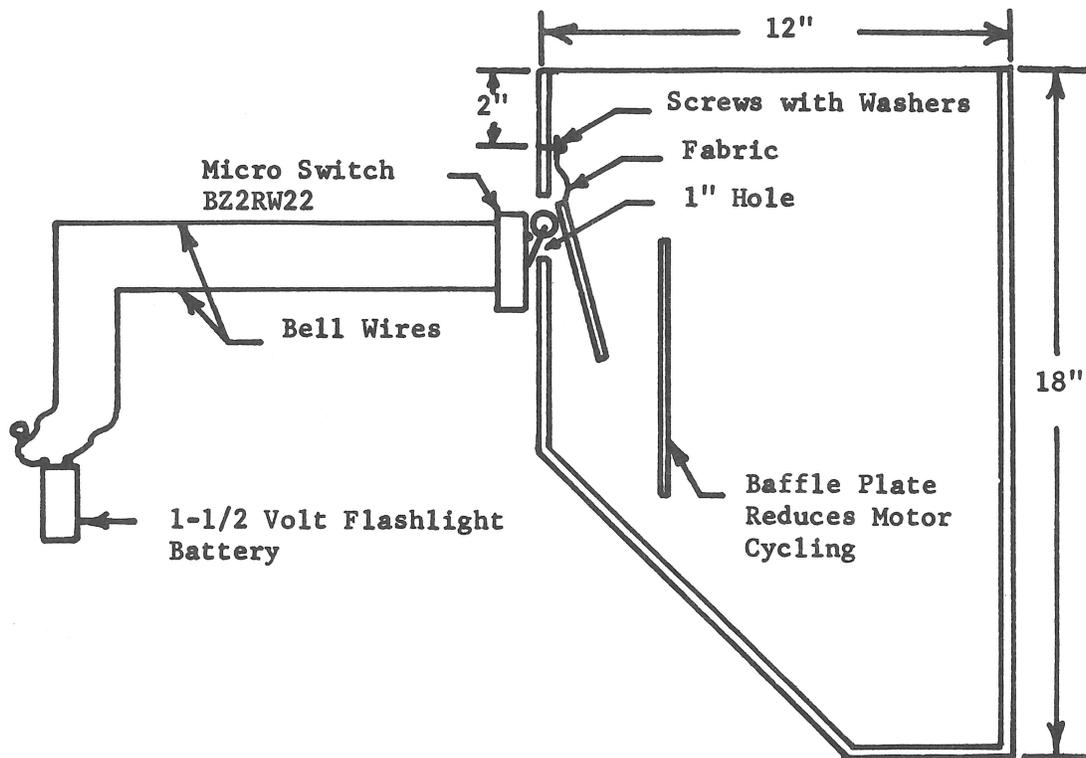


Figure 16 A. Model Feed Bin With Automatic Control

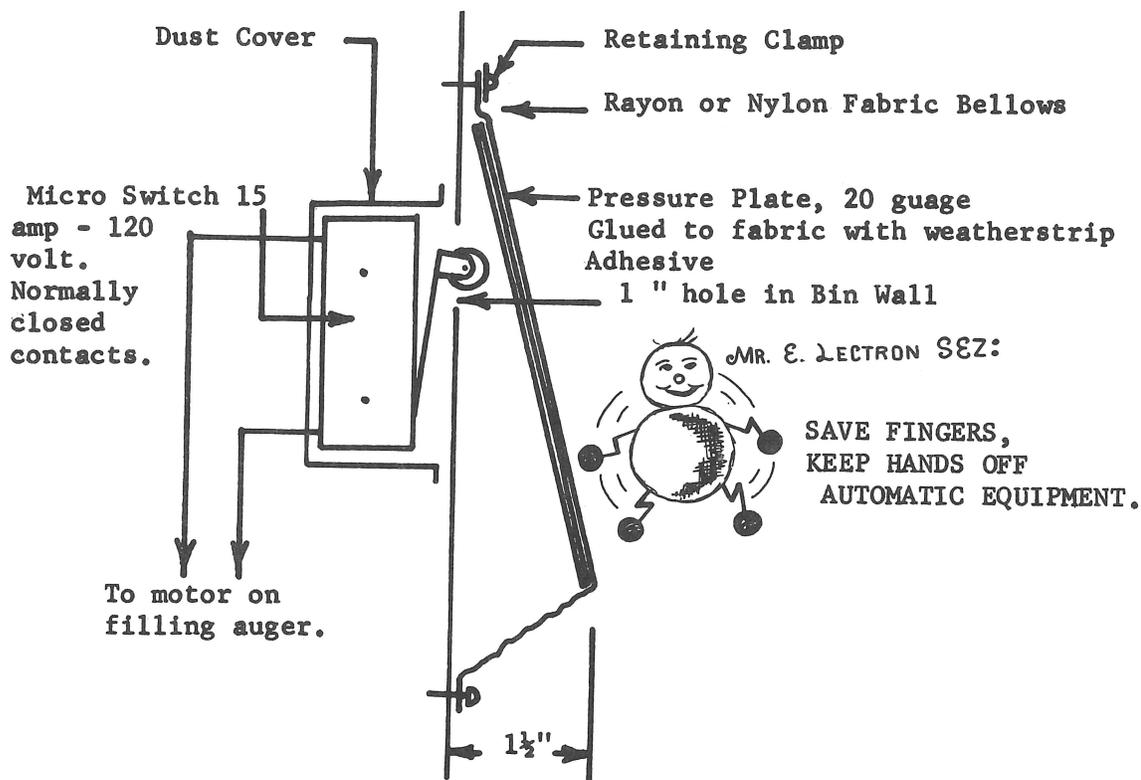


Figure 16 B. Cut-Off Switch - Installation Detail

2. Using the above principles, make a full size feed bin meter with switch control. Grain flow from feed meter is regulated by auger speed and area of intake opening. Adjust your meter for use as a proportioner to add grain into silage rations or as a way of injecting a concentrate or oil meal into your feed grinder. Because of automatic flow, the feed-meter hopper need not hold more than 150 lbs. at any one time. Be sure to keep hands away from all moving parts when operating.

DEMONSTRATE

1. Use your model bin to show how a simple pressure switch can be used to move grain automatically when and where needed. Shelled corn flows freely and can be used as the demonstration material. Make a comparison of the model and an actual installation. With the model, the light goes out when the switch shuts off as bin becomes full.

Purchase a Beef and Dairy Plan Book (MWPS - 2) or a Swine Equipment Plan Book (MWPS - 2) from your County Extension Office for ideas on the use of these switches. Make large line drawings of feed handling installations so you can better explain to others how these switches work to save time and labor.

2. With a ventilating fan and humidistat show how to obtain humidity control. Set the humidistat so that fan does not run. Then add vapor to the air surrounding the humidistat with an electric vaporizer or tea kettle. Explain the parts of a humidistat, how it works and where it is used. Explain why it is important to control moisture in a tightly constructed home or farm building.

MAKE A SURVEY

Make a survey of all automatic controls now in use in your home and on your farm. In tabular form, show the equipment controlled and the type of automatic control used.

UNIT 4 QUIZ

WHAT CONTROL FOR THE JOB

	<u>True</u>	<u>False</u>
1. Thermostats are switches that are used to control humidifiers and dehumidifiers.	_____	_____
2. Cut-off switches are often actuated by an increase or decrease in pressure caused by material flow.	_____	_____
3. Time switches are manual controls and cannot start and stop equipment automatically.	_____	_____
4. Pressure switches work on the principle of motor speed changes.	_____	_____
5. Basic cut-off or pressure switches are available with many different actuating devices.	_____	_____

ADDITIONAL INFORMATION AND ACTIVITIES

Study the Crop Drying and Materials Handling Sections of your Members Idea Book. Talk with your leader and power supplier about a tour of well mechanized farms in your area. Note the different types of controls and how they are used. Visit a local factory and see how they use controls to improve work efficiency.

# UNIT 5 BE SAFE - GROUND THAT EQUIPMENT

## Make a Path For Stray Electric Current.

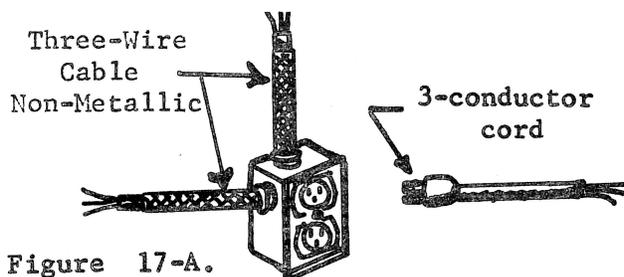
In many of your Electric Project activities you and your leader have discussed and worked with hot wires and cold wires. We hope that you've learned to respect electricity and to work with it safely. But, we must remember that electricity is always trying to flow to the ground or earth. It likes to take the shortest route possible. Under certain circumstances, you can provide the shortest route. If a hot wire inside of a portable tool breaks and touches the case, electricity can flow through the tool, your body, and into the ground. When this happens, you can get shocked - even killed. This can happen even if you aren't in direct contact with the earth. You might be touching a piece of metal that is in contact with the ground. Electricity would flow through you, through the metal, and then into the ground.

We can take many different steps to reduce or eliminate such electrical shocks and hazards. We can:

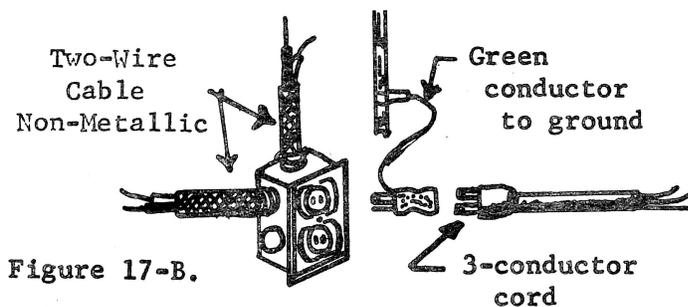
1. Purchase electrical equipment that has been approved by Underwriters' Laboratory.
2. Use the tool for the purpose designed and in the manner recommended by the manufacturer.
3. Provide 3-wire, 120-volt convenience outlets for portable equipment.
4. Keep electrical equipment in good repair.
5. Properly ground electrical equipment - provide a metallic path over which electricity will flow - from defective tool to the ground - without going through people or livestock.

There are several ways you can provide an adequate electrical ground - a path over which stray electricity will travel.

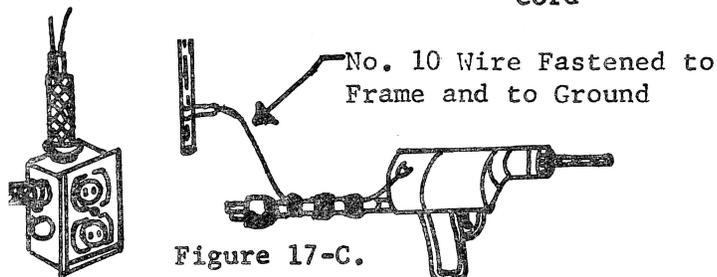
1. If you have tools and appliances with 3-conductor plugs, install 3-wire circuits with 3-conductor outlets as shown in Figure 17A. This is the best method of grounding such equipment.



2. If you have a tool with a 3-conductor plug and do not have a 3-conductor outlet, use an adapter as shown in Figure 17 B. Be sure the green wire (the ground wire) of the adapter is fastened to a water pipe or other grounded object.



3. If you have a 2-conductor cord on the tool and a 2-conductor convenience outlet, a separate ground conductor should be provided and connected as shown in Figure 17 C.



Permanently located equipment, like automatic electric livestock waterers, present considerable danger to livestock if they become defective. Animals standing in wet areas where good contact with the earth is assured may get shocked or electrocuted if electricity flows through them to the ground. Such hazards can be reduced by connecting this kind of equipment to a 1/2 inch copper rod or a 3/4 inch galvanized iron pipe driven into the ground. Attach a wire from the ground rod to the neutral wire of the circuit serving that equipment. Figure 18 shows the proper method of grounding livestock waterers.

An underground water system makes a good electrical ground, if all of the water pipe is metallic and if this system is "tied" to the main electrical system ground.

In many small towns, the water pipe serving the city is often used as a common ground. Frequently, however, water softeners and other equipment are installed so that they break this ground. If you live in a small town, you should make sure that there are no insulators in your water system. Rubber or leather washers found in water meters, gaskets between a water pump and its pipe and plastic fittings on water softener connections should be by-passed with a piece of No. 6 copper wire and proper ground clamps.

Plastic water pipe is an insulating material and is of no value as an electrical ground. When plastic water pipe is inserted in the line it is necessary to provide an electrical conductor that will tie both the neutral conductor and the frame of equipment to a suitable electrical ground. Even where metal water pipe is installed, this grounding procedure is recommended for electrical equipment like water pump motors, livestock waterers and water heaters.

During severe electrical storms, well grounded systems will not always protect your equipment from instantaneous lightning surges that give a sharp rise in voltage. Many grounding circuits will not carry these high voltages to the ground as fast as they are being built up. Therefore, to reduce equipment damage caused by such voltage increases, secondary lightning arrestors can be installed between the ungrounded wires and the grounded neutral wire. Such work should, of course, be done only by a qualified electrician.

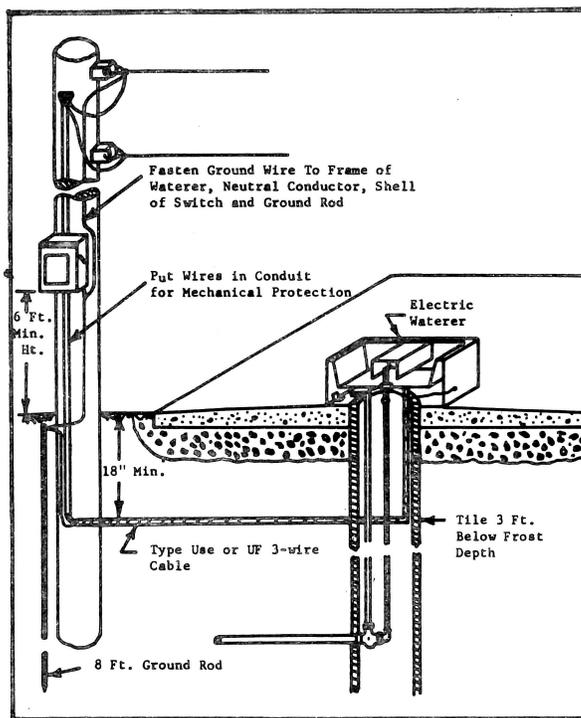


Figure 18. Waterer Installation

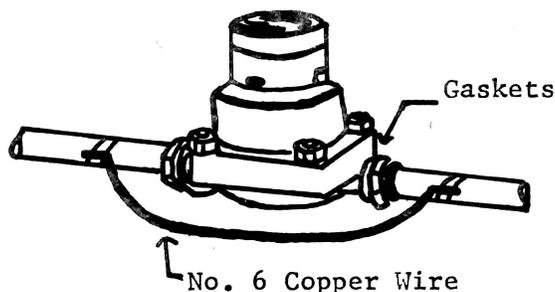
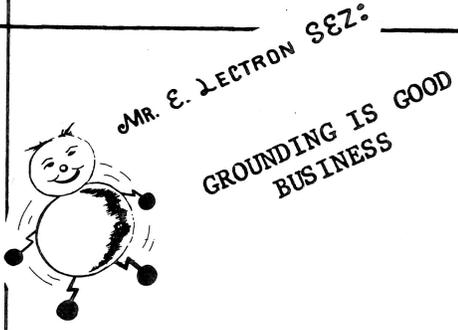


Figure 19. Water Meter

**MAKE A SURVEY**

Make a list of equipment (portable and permanent) in your home and on your farm that should be grounded. Then check to see whether that equipment is grounded. If it isn't, draw a diagram of how you think it should be grounded. Check this with your leader, electrician or power supplier.

Equipment Requiring A Ground	Equipment Voltage	Is This Properly Grounded		How can it be grounded properly
		Yes	No	
				

Check for insulated joints in your water system. Is there an electrical jumper tying the metal portions of the water line together?

**THINGS TO DO**

With counsel and supervision of a qualified person, provide some of those electrical grounds needed on your farm. Be sure all power is OFF before doing any work. Be sure to have your work inspected and approved by your electrician or power supplier.

**DEMONSTRATE**

Make up a wall section showing two 120-volt convenience outlets - one that will accommodate a 2-conductor plug and one that will accommodate a 3-conductor plug. Insert a piece of 3/4" pipe in this wall section. Show and discuss two ways of providing good electrical grounding circuits for portable tools. Tell why these are needed and required. Discuss methods of grounding major appliances like washing machines and water heaters.

**UNIT 5 QUIZ**

**GOOD GROUNDING PROVIDES PROTECTION**

- |  | <u>True</u> | <u>False</u> |
|--|-------------|--------------|
| 1. Water heaters never need a grounding conductor because they are connected to a water pipe | _____       | _____        |
| 2. The rounded conductor on a 120-volt portable tool plug serves as the grounding conductor. | _____       | _____        |
| 3. On older tools with 2-conductor plugs, electrical grounds are never needed.               | _____       | _____        |
| 4. Grounded appliances will <u>never</u> be damaged by surges of lightning.                  | _____       | _____        |

**ADDITIONAL ACTIVITIES**

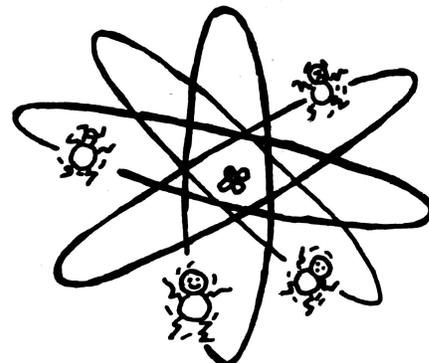
Ask your electric power supplier to talk with your club about experiences he has had with poorly-grounded and well-grounded electrical systems. Ask him to explain how lightning arrestors work.

## UNIT 6 ELECTRONS AND ELECTRONICS

This unit is about electrons and electronics. All things around you; this book, the air, and YOU are made of electrons. Electrons are very, very small and they move constantly. Sometimes we coax them to move in a definite direction to work for us.

### INCREASE YOUR KNOWLEDGE

The smallest bit of matter in any element is an atom. In the center of each atom is a nucleus. The nucleus is much like the sun and around it whirl electrons, like planets. The electron is somewhat like our world, only it is smaller than you can possibly imagine. It takes billions of atoms to make up the head of a pin. In fact, electrons are so small that over 100 of them may whirl in the orbits of some atoms. Much of an atom is made of space. Since we are made up of atoms, much of our bodies are space, too. If all the space were taken out of us and only solid matter were left, we would be no bigger than a vitamin tablet.



Electrons sometimes become detached from an atom and become free electrons. These electrons may exist by themselves or they may move from one atom to another. These free electrons are responsible for what we call electricity. Here are common methods by which electrons may be detached from their atoms and set free:

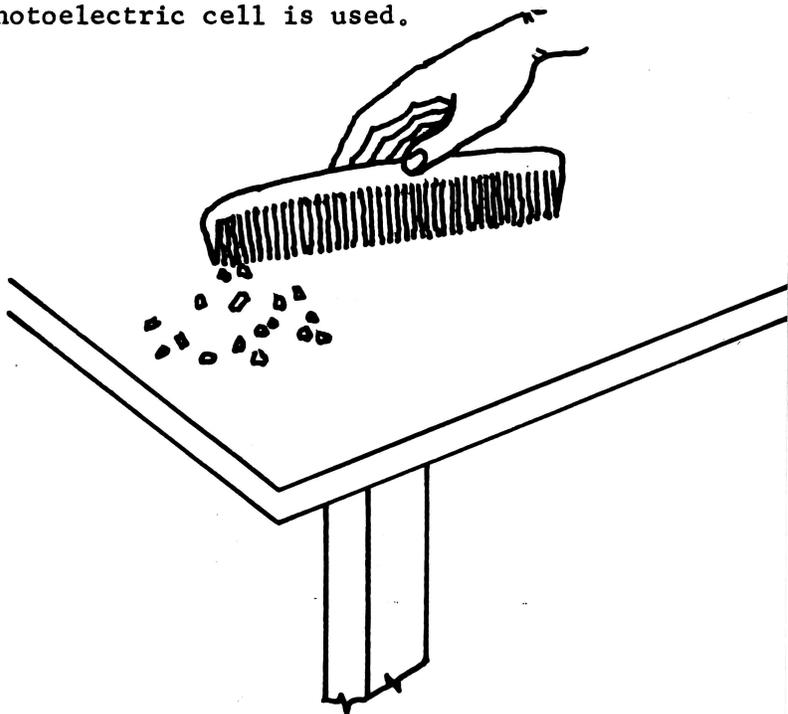
A flame may liberate electrons from the atoms of the air about it. When this happens, we say that the flame ionizes the air.

A body heated to incandescence emits electrons. The atoms of these white hot materials vibrate so rapidly that some of their electrons are shaken loose and ejected into the surrounding space. The hot filament of the radio vacuum tube, discussed in Unit 8, emits electrons for this reason.

Some materials show a distinct discharge of electrons when light falls upon them. Metals like sodium and potassium are particularly sensitive to light in this way. The discharge of electrons from materials by means of light is applied when the photoelectric cell is used.

Atoms have a positively charged nucleus. Electrons are negative. The positive charge of the nucleus exactly equals the number of negative electrons an atom has, if that atom is neutral. If the atom should lose one of its electrons, it will try desperately to regain another. It will attract or pull electrons toward itself.

You can see this attraction or pull of electrons by rubbing a comb with a piece of cloth. As you do this, you rub some of the electrons off of the comb. Now hold the comb over small bits of paper. Each tiny atom in the comb now has a positively charged nucleus, hungry for electrons to replace those it lost. As a result, the comb attracts the bits of

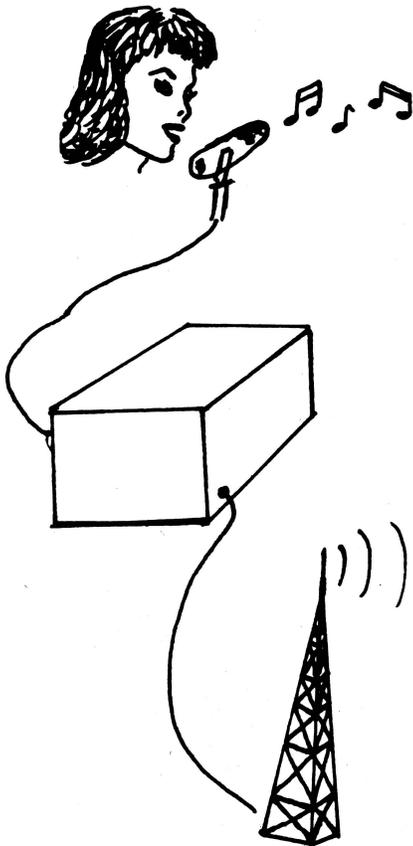


paper. All of the pieces of paper are attracted because the atoms in the paper are struggling to hold their electrons.

Many interesting things happen when we cause electrons to leave their normal orbits and travel into the orbits of other atoms. This business of freeing electrons from their atom and putting them to work is called electronics. In fact, the entire field of electronics is based on the flow of electrons. By using electronic tubes and transistors we can make electrons do many useful things for all of us.

One of the most common and more practical uses of electrons comes in radio work. Radio communication systems use electronics to send music and voice sounds from radio sending stations (transmitters) to your radio. Sound produced by vibration is carried by sound waves. But sound waves will travel only a limited distance. Radio waves - high frequency electromagnetic waves - will travel hundreds of miles. Radio communication systems use both sound waves and radio waves to send sounds around the world.

### HOW A RADIO WORKS

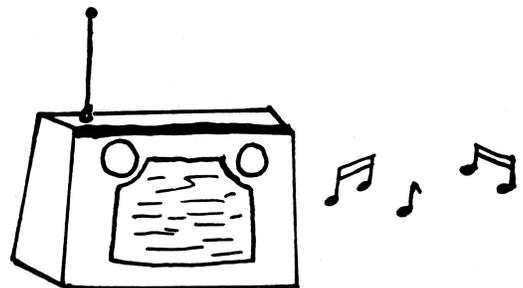


When sound waves go into a microphone they strike a very sensitive disk or diaphragm inside the microphone and make it vibrate. The microphone changes these vibrations into electrical waves similar to the sound waves. This vibrating electrical current is called the audio signal. The audio signal is then made stronger or amplified and sent to a transmitter.

The transmitter sends thousands of waves out each second. The number of these waves sent out each second is called the frequency or wave cycles per second. If your favorite radio station operates on a frequency of 720 kilocycles, this means it sends out 720,000 radio waves per second. The transmitter takes the audio signal and puts it with a radio wave which acts as a carrier wave. It carries the audio signal to your radio.

The sound waves that went into the microphone had a definite pattern. This same pattern is adopted by the audio signal. When the audio signal was placed with the radio or carrier waves the carrier waves were changed to keep this same form.

Radio waves travel through the air and some of them are picked up by your antenna. There are many radio stations sending out such waves and your radio must select the ones that you wish to hear. It does this by selecting the frequency or number of wave cycles per second sent out by that station.



When these waves come into your set they are very faint. The electric current that comes from your battery or electrical outlet, together with these faint radio waves, goes through a vacuum tube or a transistor. Here, the stronger current takes on the same pattern as the weak signals.

The stronger waves then go to a detector. At this time the audio signal and the carrier waves are still mixed together. The detector separates the carrier wave from the audio signal. The audio signal is amplified and sent to a loudspeaker. Here the audio signal vibrates a small disk. The vibrations send out waves which are just like the original sound waves that went into the microphone. Thus, we have the same sounds that were sent out by the radio station.

THINGS TO DO

1. Check your local library, newstand, or book store for paper back editions of books on basic electronics. Books on electronic and radio equipment can often be obtained from mail order and wholesale houses, too. Your leader, agent or power supplier can probably give you more specific information.
2. Build a 4-H crystal radio as discussed in Unit 7 or build a transistor set.

DEMONSTRATE

Using your crystal set, show and tell how sound waves and radio waves are carried from one point to another.

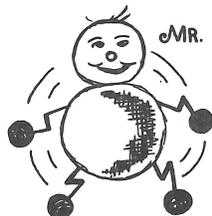
UNIT 6 QUIZ

ELECTRONS AND ELECTRONICS

	<u>True</u>	<u>False</u>
1. Atoms are mostly space.	_____	_____
2. Atoms make no effort to hold their electrons.	_____	_____
3. If you set your radio dial at 600 to receive your favorite radio station, that station sends out 600,000 wave cycles per second.	_____	_____
4. Radio stations change sound waves to audio waves and use radio waves to carry these to your radio.	_____	_____
5. Microphones change sound waves into electrical waves.	_____	_____

ADDITIONAL ACTIVITIES

Visit your local radio and television repairman and ask if he will tell you a bit about his work and equipment. Arrange for a group tour of your local radio or television station.



MR. E. LECTRON SEZ:

ELECTRONS, LIKE ME,  
HELP YOU LIVE BETTER  
ELECTRICALLY. DON'T  
LET OTHERS MISUSE US.

## UNIT 7 BUILD A RADIO FOR YOUR OWN USE

In Unit 6 you learned, in general terms, how a radio works. Now we can be more specific. You will find it both fun and educational to build a crystal radio, a transistor radio or a tube-type radio. Some of the parts for building these can often be obtained locally from radio shops, electric motor rewind shops, or from discarded radios lying around your own home. But you'll probably save time and money by purchasing the basic parts in a ready-made kit. Some common radio symbols are shown above.

The crystal radio will acquaint you with a simple receiver set. It is simple to build but not so easy to understand. It requires no power source. You merely connect the receiver to a good antenna and a good ground because the two act as a condenser for helping collect the signals.

The crystal acts as a "rectifier" for changing radio waves to electrical waves. The headphones, condensers and coils help "tune in" on the waves coming through the air so that you can hear the sound. The headphones are actually electric magnets. The electric current coming from the crystal causes the small metal wafer to vibrate. This, in turn, vibrates the hearing part of our ear. Most headphones are very sensitive and will respond to weak electric signals.

Figure 21 shows a crystal radio that was made from a \$3.00 kit. It has an adjustable crystal but a fixed crystal diode (type 1N64) was added for better reception. Some kits selling for about \$1.00 or more have pre-set crystals that do not require adjustment. These kits are sometimes equipped with a variable capacitor for smoother tuning.

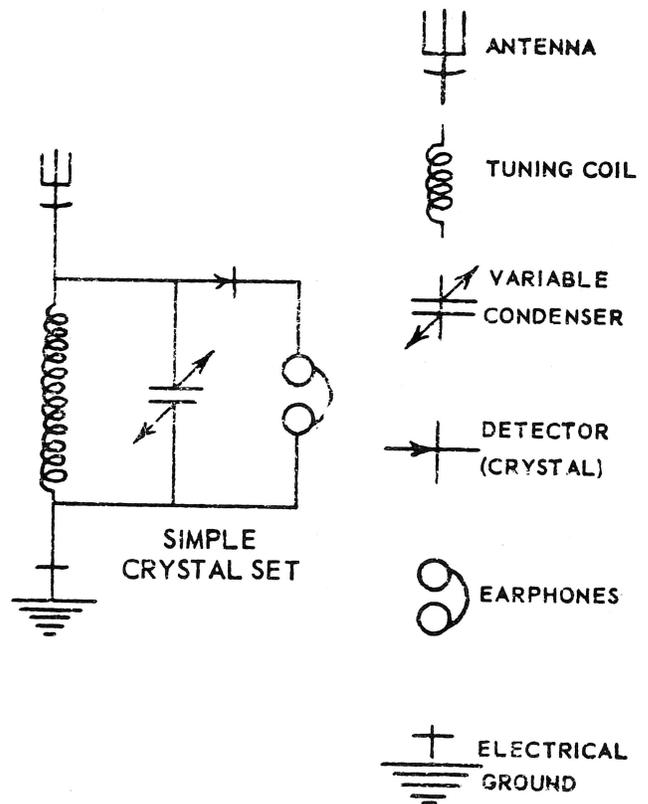


Figure 20. Radio Symbols

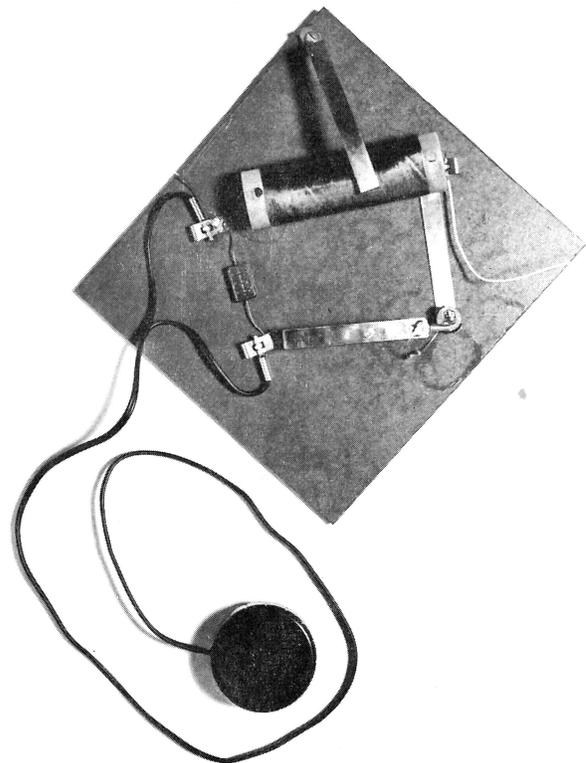


Figure 21. Crystal Set.

## Transistor Radios and Other Equipment

Transistor radio kits may have one or more transistors. The more transistors, the better the receiver and the greater the cost of the kit. Transistors not only amplify signals but also detect them. Transistor radios are battery powered. A small penlight battery may run a one-transistor radio for a period of from 4 to 6 months of normal operation.

All the kits have step-by-step procedures and instructions that must be followed closely. But before building your radio be sure that you understand what makes it work. You'll learn a lot more as you proceed with your "build it" project.

Transistors are fascinating devices and are used in many ways. If you enjoy putting the radio together, you might wish to get a more flexible transistor kit from your hobby shop. Many more practical electronic devices can be constructed from such a kit.

More skill and patience are required to put the transistor radio together. Be sure to understand each step as you go, and check it off of your instruction sheet as soon as it has been completed.

## Antennas and Grounds

On any radio set, the antenna is very important. It collects and transforms radio waves into very small quantities of pulsing electricity. High and long antennas are needed to operate crystal sets and one-transistor radios. If you live in the country, several miles from a broadcasting station, your antenna should be from 100 to 150 feet long. If you live in town near a station, a 50-foot antenna is usually adequate.

You must have the antenna insulated so that the small electric current it picks up does not detour to the ground instead of operating your radio. If the lead-in is separate from the antenna, it should be soldered at the junction as shown in Figure 22.

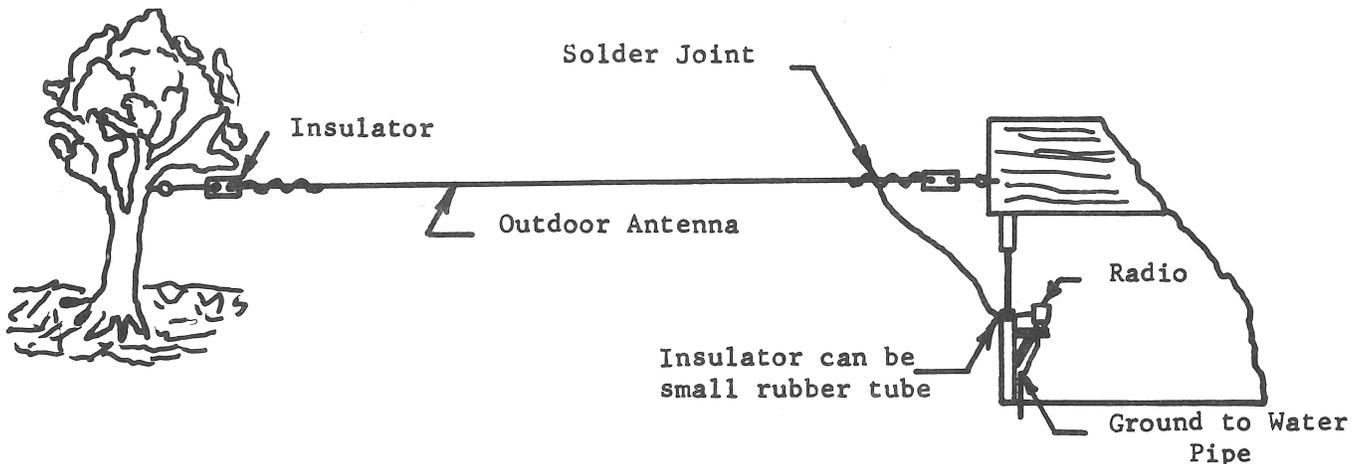


Figure 22. Antenna and Ground Installation

Your radio will not operate without a ground. You can make a good ground by running a piece of wire from the radio set to a cold water pipe or by driving a copper rod 8 feet into the earth. Be sure to clean off all paint or dirt before attaching the wire to the pipe or rod. A ground clamp, available at most hardware stores, will give the best connection.

## SAFETY FIRST

Never connect any part of the radio set to an electric light socket or to power equipment. This would destroy the set and injure the operator.

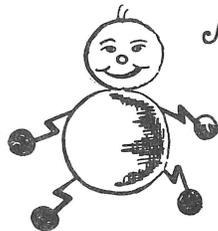
Never use a power or telephone pole to support your antenna.

During electrical storms, high and long outdoor antennas may pick up enough lightning static to damage your set. To avoid this, provide a single pole, double throw switch for grounding the antenna when your set is not in use. Antennas placed in the attic do not need disconnecting or grounding in this manner.

We hope you enjoy this unit and lots of good listening from your personal radio built by you.

You might want to obtain one or more of the following Radio Reference Books:

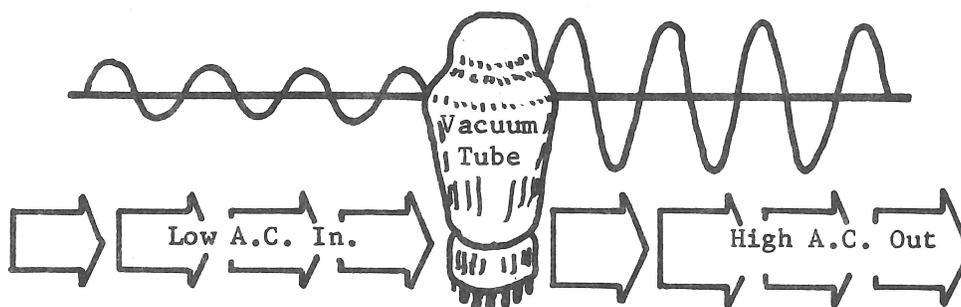
1. The Radio Amateurs Handbook  
American Radio Relay League  
West Hartford, Connecticut.
2. RCA Receiving Tube Manual  
Radio Corporation of America  
Harrison, New Jersey.
3. Understanding Radio  
Herbert Watson (Elementary)  
McGraw Hill Publishing Co.  
New York, New York
4. General Electric, ABC's of  
Radio  
General Electric Company  
Schenectady, New York



MR. E. LECTRON SAYS:

NEVER HANG ANTENNAS NEAR OR  
PARALLEL TO ELECTRIC POWER  
LINES.

## UNIT 8 ELECTRONIC AMPLIFIERS



In Unit 6, we said that audio signals are made stronger or are amplified. This is done with electronic amplifiers. And since radios, record players, hi-fi sets, and other devices which you might make all use amplifiers, it's a good idea to know what they are and how they work.

The purpose of any amplifier is to take a very small voltage change that cannot be used, make it many times stronger, and then use the amplified signal to run a pair of earphones, drive a loudspeaker, or operate a motor. A vacuum tube is an amplifier and one of the main jobs of a vacuum tube in your radio or T. V. set is to change small A.C. (alternating current) voltages into large A.C. voltages. And there are over 1200 different types of vacuum tubes available today.

Amplifiers are designed to amplify only those frequencies that their type of equipment requires. The three general groups are:

1. Audio Amplifiers: Used in radio and intercommunication systems. These amplify the voice currents in a band of frequencies from 15 cycles per second (cps) to 15,000 cps. - the range of frequencies which our ears can hear.
2. Video amplifiers: Used in television, radar, and similar equipment, they cover a wide band of frequencies. The expanded frequency band runs from 30 cps to 6,000,000 cps and higher.
3. Radio Frequency (R.F.) amplifiers: Used in radio receivers and transmitters, radar, fire control equipment, etc. R.F. units amplify only a narrow band of frequencies. But the narrow band may be found anywhere within a range of 30,000 cps. to several billion cps. They amplify the intensity of the current induced in the aerial before it is passed into a detector.

Some of the factors that must be considered in selecting the power or basic amplifier for a radio tuner, radio phonograph, or high fidelity system are:

1. Frequency range.
2. Variations in reproductions in level within this range.
3. Amount of distortion.
4. Power output.
5. Noise level (undesirable sounds coming from speaker system).

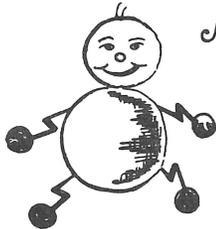
Most commercial radio and radio phonographs use a crystal pick-up that supplies enough voltage to drive the basic amplifier to its full output. Most hi-fi systems, on the other hand, have pickups with wider response and less distortion but which, unfortunately, have a lower power output. In fact, the output on magnetic types of pick-up - the kind used on many hi-fi sets - are only one-hundredth as great as the crystal pick-up. Therefore, high fidelity systems must use a preamplifier in conjunction with the basic amplifier. The preamplifier is used, of course, to provide additional amplification.

#### WHAT TO DO

Learn all you can about electronic amplifiers and other parts of a radio or hi-fi set. Then build one. The following references, available in paper back editions can be found at the many book stores:

Basic Electronics, Van Valkenburgh, Nooger & Neville, Inc., New York, New York, 1955, No. 170-2, \$2.50.

High Fidelity Simplified, Harold D. Weiler, 3rd Edition, John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, New York, No. 142, \$3.30.



MR. E. ELECTRON SEZ:

DON'T PLAY WITH RADIOS AND T.V.  
SETS WHEN ENERGIZED. AMPLIFIED  
CURRENT AND VOLTAGE CAN BE  
DANGEROUS.

## UNIT 9 LIVE WITH LIGHT - OUTDOORS

We emphasized the use of outdoor lighting for safety and protection around your home and farm buildings in Unit 3. Outdoor lighting can also be used to dramatize your home at night. Proper selection of fixtures and placement of lamps provide a warm welcome to visitors to your home.

Recessed lamps can light up steps, walks and doorways - some direct light horizontally; others direct light downward. Colored lamps in weather-proof fixtures can add much beauty to plantings, flower gardens, winding walks, patios, and terraces at night. Matching fixtures on the exterior walls near the home's entrance and at the garage, and possibly a friendly post lamp, can provide beauty in the daytime as well as at night. Reflect- or flood lights and spot lights are good for outdoor in- spiration lighting.

Outdoor cooking with barbecue units and ovens has become commonplace in everyday living. Light directed onto the fireplace or barbecue pit will help the cook prepare that delicious meal.

Most of the weather-proof lighting equipment is made of metal and reflects light down for illuminating a partic- ular setting or area. When selecting outdoor lighting fixtures, be sure to look for those that are approved by the Underwriters' Laboratory. Whenever possible, use underground wiring. But, if above-ground temporary wiring is used for nearby por- table lights, be sure the cords are out of the way. Use a weather-proof convenience outlet on the exterior wall. Such receptacles should be of the grounded 3-wire, 120- volt service type.

Manufacturers have a good assortment of portable outdoor lighting fixtures. Great care should be taken in using these on wet ground or around pools of water. All equipment should be well-grounded. During some seasons, like Christmas, people have a tendency to use large numbers of lights to beautify their homes. If this is a cus- tom in your home, check the load on the wiring so that you will not be guilty of over- loading it. Make sure that all circuits are properly fused.

### WHAT TO DO

You can use this unit to increase your knowledge on outdoor lighting and lighting practices. Additional information can be obtained from manufacturers of lamp bulbs, department stores, or local dealers. Your local electric power supplier will likely have information on lighting for special effects, both indoors and outdoors.

Pick an outside area around your home that you would like to see well lighted. Decide the purposes for which you would like to light it - for safety, play, work, or beauty.

Make a plan for lighting it. List the wiring materials, fixtures, lamp bulbs, and the cost.

Make one or more spike-pole outdoor lights similar to the one pictured here, or one or more garden lighting shields.

Use your imagination as you look around your home grounds. See how much good inspir- ation lighting you can add to improve the beauty and value of your home. Note the response you receive from such lighting by neighbors and relatives visiting your home.

Develop a well-lighted outdoor cooking center. Invite other 4-H club members in for a barbecue. Consult your leader, agent, or electric power supplier for additional ideas and activities pertaining to outdoor lighting.



For work



For play



For cooking  
and eating

# UNIT 10 INTER-COMMUNICATION SYSTEMS

Inter-communication systems are becoming more and more important in farm businesses and in home living.

Intercom systems are of several types - telephones; transceivers, and citizen's band radio. The latter is of the wireless type. Any of these types can speed repairs of farm machinery during the busy seasons or they can be used for the prompt filling of produce orders on truck farms and other specialized farms. They can also be used to guard against livestock disease by the prompt warning of unwary visitors, to keep away from lots and buildings.

In the home, intercom systems can supply music to all rooms. The homemaker can "listen-in" while the baby "sleeps" or while groups of children play outdoors. She can listen or talk to other parts of the home or other farm buildings.

Intercom systems need not be expensive. But before purchasing one, you need to be sure of what the system includes and how it is powered. Some units are operated by flashlight batteries, some by dry cells and others by regular 120 volt electric service. A two-station battery operated kit can be purchased for about \$15. A 5-station kit ("built in" type) may cost \$75 but this would include a master station and 5 single remote units.

In selecting an intercom system you should check on the following features.

1. Number of stations handled by the master unit.
2. Privacy and flexibility of inter-station control.
3. Type of power required.
4. Style and compactness of unit.
5. Cost of master and single stations.

## CITIZEN'S BAND RADIO SERVICE

If you live on a large farm or ranch where buildings or land might be separated by a few miles, you may want a private short distance radio communication system.

In 1958, the Federal Communications Commission (FCC) assigned 23 channels between 26.965 and 27.255 megacycles for citizen's radio service which require no operator's license or license examination. The radio equipment, itself, must be licensed by filing an application with the FCC.

The least expensive citizen's band communication set, including two transceivers, will cost about \$100. A transceiver, incidentally, is a unit that can be used as either a transmitter or a receiver. A reliable range between buildings and mobile equipment is from 5 to 10 miles.

Since there are certain rules and regulations on use of this means of communication, you should study all about it before purchasing any equipment. One good reference is:

Citizen's Band Radio, Allan Lytel, No. 273  
John F. Rider Publications, Inc., 116 West 14th Street  
New York 11, New York

Additional information on any inter-communication system can often be obtained from manufacturers of such equipment. Your local radio or television repairman, local electric dealer or local power supplier will help you get in touch with these companies.

# UNIT II YOUR CHOICE

## On County Agent Approval

This unit is included so any 4-H boy or girl enrolled in Electricity 3 may further develop knowledge in some specific phase of the broad field of electricity.

It is anticipated that some 4-H'ers will use Unit 11 as one of the four required for project completion. Consequently, we expect the club member to learn all he can about his particular subject. It is also expected that some type of equipment will be constructed, if at all possible. The quality of construction of the equipment will serve to show how much and how well the technical information has been studied by the 4-H club member.

As we do not expect every leader to be well versed in all topics in which third year Electric Project enrollees might be interested, it is important that the member know where he will obtain his technical information before he seeks the county agents approval of the choice.

Therefore, to receive credit for Unit 11, you must fill out the application form on the following page and have it approved by your county agent. Be sure to list all sources of information, what you intend to build, and what you have already completed in Electricity 1 and 2.

### ACKNOWLEDGEMENTS

Planning and organizational assistance was given by the Missouri State 4-H Electric Program Planning Committee:

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

William Spinabella, Sho-Me Power Corporation

T. Ray Wheeler, Missouri Power and Light Company

Carl Shubert, Kansas City Power and Light Company

Mrs. Jimmie Lou Cockriel, Platte-Clay Electric Cooperative

Alice Mae Alexander, Home Management Extension Specialist

Joe Mobley, Westinghouse Electric Corporation, Designed the cover and  
'Mr. E. Lectron'

Much material was contributed by the Westinghouse Educational Foundation, the National Committee on Boys and Girls 4-H Club Work, The National 4-H Electric Program Development Committee, and the Federal Extension Service.

Some information in the units pertaining to electronics and radio was developed by the California Extension Service; and some information in Unit 4, by the Iowa Agricultural Extension Service. The many helpful ideas obtained from other educational and commercial sources are very much appreciated.

The financial support of the University's Farm Electric Utilization Project, by the Missouri Farm Electric Utilization Council, made it possible for its director to serve as co-chairman of the 4-H Electric Program Planning Committee and to spend considerable time in developing this workbook.

# UNIT II - OPEN UNIT - APPROVAL FORM

I would like to study about \_\_\_\_\_

\_\_\_\_\_

I would, after investigation and study, be able to and would plan to build \_\_\_\_\_

\_\_\_\_\_

I would obtain my technical information from the following people, books and references:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

In Electricity 1 and 2, I built \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

In the following paragraph, I have outlined why I am particularly interested in this topic and why I feel I am capable of completing it.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Member \_\_\_\_\_ Address \_\_\_\_\_

Based on the information above and an understanding of the member's attitudes and aptitudes, I feel he (she) can follow Unit 11 through to completion. I, therefore, approve this Unit for credit in Electricity 3.

\_\_\_\_\_ Project Leader

\_\_\_\_\_ County Extension Agent

\_\_\_\_\_ Date

\_\_\_\_\_ Date \_\_\_\_\_, \_\_\_\_\_



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, Vice-President for Extension, Cooperative Extension Service, University of Missouri, Columbia, Mo. 65201.