Electrical Projects for 4H Clubs
Michigan State University Cooperative Extension Service
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CLUB BULLETIN 53

ELECTRICAL PROJECTS *for* 4-H CLUBS

By R. L. MADDEX and P. G. LUNDIN

MICHIGAN STATE COLLEGE : : COOPERATIVE EXTENSION SERVICE
EAST LANSING

ACKNOWLEDGMENTS

Club Bulletin 53 covers material formerly issued in two separate publications, "Electrical Projects for 4-H Clubs" and "Farm Electricity for 4-H Clubs." The photograph in Fig. 46 is by L. M. Roehl, Cornell University. Background information on Exercise 3, directions for building the toy electric motor, and Figs. 9, 10 and 11 have been adapted from material published by the Westinghouse Electric Corporation. The 4-H Club Department wishes to express appreciation to both for their courtesy, and to all others who helped in the preparation of this revised edition.

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REQUIREMENTS FOR ELECTRICAL CLUB WORK

Electrical club members must be between the ages of 10 and 20 years. First-year members must be at least 10 years old by January 1.

FIRST YEAR

Members enrolling for the first year must complete Exercise 1, and two others listed for first year.

SECOND YEAR

Members enrolling for the second year must complete Exercise 14, and two others listed for second year.

THIRD YEAR

Members enrolling for the third year must complete any two articles listed for third year.

ADVANCED

Members enrolling for the advanced years must complete two exercises listed in the advanced group.

NOTE: *The club member is not limited to making only the articles listed in this bulletin. Changes in the plans may be made to fit individual needs. Articles selected should compare with those listed for the year enrolled. Stock lumber sizes may be used in building articles.*

BASIS OF AWARD

The work of the Electrical Club members will be judged on the score card shown below. Other factors in making awards are:

Interest and attitude as a club member.
Completeness and correctness of the report.

My 4-H Exhibit

ELECTRICAL

	Excellent	*Satisfactory*	*Should Improve*
A. QUALITY AND GENERAL APPEARANCE			
B. CHOICE AND SELECTION OF MATERIALS			
Practical electric device			
C. WORKMANSHIP Connections securely made			
Terminal connection free from strain			
Soldered and taped where required			
Will it operate?			
D. IS IT ELECTRICALLY SAFE?			
Free from fire hazard and electrical shock			
Insulation properly stripped			
Connector screws tightened			
Cords frayed, cracked, or broken			

REMARKS:

"MAKE THE BEST BETTER"

Save This Check List to Help You in Your Next Electrical Project

EXERCISES IN THIS BULLETIN

A. First Year Exercises

Extension Cord or Trouble Lamp, or Comparable (required)
Electric Cord Reel
Toy Electric Motor
Making a Motor Portable
Care of Electric Motors
Alarm Clock Time Switch
Repairing Appliance Cords
Swing Arm Lamp
Poultry Water Heater
Assemble Lamp Units, or Rewire Old Lamps
Electric Egg Candler
Making a Lamp Shade
Movable Spot or Flood Light

B. Second Year Exercises

Reading the Electric Meter and Computing Monthly Bill (required)
Wiring Panel
Movable Workbench Light
Home Lighting Survey
Making a Table Lamp
Installing a Door Bell or Chime
Mounting a Motor on a Seed Cleaner or Corn Sheller
Call Bell in the Barn
Belt Sander
Cost of Electricity for Operating Certain Equipment
Ice Cream Freezer Power Unit
Alarm Clock Time Switch
Poultry Water Heater
Making a Lamp Shade

C. Third Year Exercises

Installing a Yard Light
Switch Panel
Pig Brooder
Electric Chick Brooder
Infra-red Chick Brooder
Infra-red Heater
Infra-red Milkhouse Heater
Drill Press
Electric Fence Unit
Motor-driven Grindstone
Elevators for Handling Farm Products
Installation of Permanent Motor
Crystal Radio Set (plans furnished with kits)
Belt Sander
Call Bell in the Barn
Home Lighting Survey
Ice Cream Freezer Power Unit
Cost of Electricity for Operating Certain Equipment
Movable Work Bench Light

D. Advanced Exercises

Poultry House Light Dimmer
Wiring a Small Building
Electric Lawn Mower
Circular Saw
Changing Motor from 115 Volts to 230-Volt Operation
Installing Convenience Outlets
Drill Press
Motor-driven Grindstone
Elevators
Installation of a Permanent Motor
Installing a Yard or Additional Switch on Yard Light

SUGGESTED ARTICLES FOR ADVANCED YEARS

Plans for these articles are not included in this club bulletin. Some plans are available from the Agricultural Engineering Department, Michigan State College. Ask the advice of your club leader before writing, however.

Equipment Table
Pilot Lights
Cattle Trainer
Stock Watering Tank
Milk Can Hoist
Wagon Unloader
Seed Treater (motor driven)
Hot Bed (heating cable or lamps)
Electric Sewing Machine
Portable Air Compressor
Garage Door Opener
Lighted Picture Frame
Heated Dog House
Litter Carrier Hoist (motor driven)
Cow Prod
Weiner Roaster
Outdoor Christmas Decorations
Bug Killer
Paint Peeler
Milkhouse Heating Unit (heat lamps)
Ventilating Fan (attic)
Crystal Radio Set
Electronic Tube Radio (1 or 2 tube)

Electrical Projects for 4-H Clubs

By R. L. MADDEX[1] *and P. G. LUNDIN*[2]

Electricity is a servant of the farm family. Electricity is ready, at all times, to lighten the load and make it possible for the farmer and his family to have more of the comforts of life.

Savings are made in time, labor, and money on thousands of farms where the farmer lets electric power do work which he would otherwise have to do manually.

One kilowatt-hour, which is purchased for 3 cents or less, will do as much as a man working all day. You can readily see that it is not economical to permit the hired man to do any chores which can be done better by electricity.

The usefulness of electricity can be greatly extended. On the majority of farms now using electricity, the installation of additional lights, outlets, switches, and new circuits would add greatly to the convenience of the users. That is just as true in our city homes.

Approximately 98 percent of Michigan farms are supplied with electricity. More use should be made of electrical energy for farm production, because it will increase production and lower the cost of production—thereby increasing profits for the Michigan farmer. At the same time, it will reduce labor requirements and add to the convenience of farm operation.

This bulletin shows some of the equipment—reasonable in cost, and simple to construct—which can be used profitably on the farm and in the home.

ELECTRICAL TERMS DEFINED

AMPERE—The unit of measure for the rate of flow of an electric current.

VOLT—The unit of measure of the electrical pressure or "push" which causes a current to flow. A dry cell is approximately 1½ volts; a 3-cell storage battery about 6 volts. The power supplier furnishes 120 or 240 volts to the house or farmstead.

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[1]Extension Specialist in Agricultural Engineering.
[2]Assistant State 4-H Club Leader.

WATT—The unit of measure of the rate at which electric power is being used or developed. *(watts = amperes x volts)*

KILOWATT—1,000 watts = 1 kilowatt. $(Kw = \frac{amp. \times volts}{1,000})$

WATT-HOUR—The work done when one watt of electric power is used for 1 hour.

KILOWATT-HOUR—"Kilo" indicates "thousand," so 1,000 watt-hours = 1 kilowatt hour. $(Kw\text{-}hr. = \frac{amp. \times volts \times hrs.}{1,000})$

WATT-HOUR METER—Usually spoken of as "the meter." An electrical instrument, using no current itself, which records the electricity used in terms of kilowatt-hours. Each electrified house or farmstead is equipped with at least one watt-hour meter.

CIRCUIT—The path of an electirc current. It must be complete to permit the flow of a steady current. A complete circuit includes a device for production of electricity—that is, a power source, connecting wires, and the device being supplied with power. In the home the wires coming from the transformer are spoken of as "the source of power."

Branch Circuit—One circuit of a system made up of two or more circuits. The wiring in a building is usually made up of a system of circuits branching off from a main circuit. Each branch circuit supplies one part of the building, or one particular piece of equipment. Permissible wattage on a branch depends on wire-size of that particular circuit.

Closed Circuit—A continuous metal path through which electricity flows, as when a soldering iron is plugged into the circuit. It is sometimes referred to as a "live" or "hot" circuit.

Open Circuit—An intended or accidental opening of the metal pathway or circuit—as when a switch is opened, or when a fuse has burned out, or a circuit breaker has opened the circuit. Also referred to as a "dead" or "cold" circuit.

Short Circuit—Often caused by two wires touching, so that current does not flow through the lamp or appliance, but takes an improper short cut to the ground. When a short circuit occurs, a fuse "blows" and "opens" the circuit, which is one of the important reasons why all wiring should be carefully protected by fuses or circuit breakers.

INSULATION—A material which conducts electricity so poorly that the amount passing through it is negligible. Mica, glass, porcelain, and rubber are examples of insulating materials.

CONDUCTOR—A material through which electricity is readily transmitted. Metals such as silver, copper and aluminum are good conductors.

GROUND or GROUNDING—A safety device, which consists of an electrically tight connection to the earth, to dispose of surplus or overflow electricity by allowing it to leak to the ground. For example, a wire connected to a complete water system with approved ground clamps—or to a pipe or metal rod driven 4 to 8 feet into permanently moist ground—"grounds" the electrical system in an average house.

RESISTANCE—The characteristics of metal and other materials which tend to prevent, retard, or restrict electrical current flow. The property of resistance is desirable when used in the right way, as in electrical heating and lighting devices.

FUSE—The part of an electrical system purposely designed to melt and open the circuit when a specified current is exceeded.

CIRCUIT BREAKER—An automatic switch for opening a circuit, usually when a specified current is exceeded for a given time. Circuit breakers need only to be reset, while fuses must be replaced when "blown."

FUSETRON—A fuse with a built-in time delay, permitting the current to exceed the fusetron's rated capacity for short periods of time.

OUTLET—A point of entry into a circuit, at which the current is to be used or controlled. At this point a box is installed. The wires or cable are securely fastened to the box. All necessary connections are made within the box, and the convenience outlet, switch or lamp receptacle is attached to the box.

SAFETY SWITCH—A switch, usually of 30 amperes or more capacity, enclosed in a grounded metal box, and so arranged that door of box cannot be opened unless switch is off.

TRANSFORMER—A simple electrical device which changes the pressure or voltage. For example, a transformer serving a farm might "step-down" the voltage from 4,800 volts to 120 volts.

HORSEPOWER—A measurement of power. *One horsepower = 746 watts.* A one-horsepower (1 h-p.) motor requires approximately 1,000 watts to operate it at rated load, because it is only about 75 percent efficient. Thus, the "input" to the motor would be 1,000 watts, but the "output" would be 746 watts or the equivalent of 1 horsepower. Motors are rated on the output—not on the input.

ELECTRIC MOTORS FOR FARM USE

Types of Motors

There are three types of motors in general use on the farm. With all three—if the motor is of a good standard make—it is usually possible to reverse the direction of rotation, or change the line voltage, for greater convenience or operating efficiency. Certain conditions sometimes make that advisable. (See Exercise 41, page 87.)

SPLIT-PHASE MOTORS. The split-phase motor is available in several sizes, up to ½ h-p. This motor is the least expensive to purchase. The motor is limited to jobs that require only light starting loads. The starting current of this motor is high, being as much as 5 to 7 times full-load current. The motor is made for only one voltage, which can be either 110 or 220.

CAPACITOR MOTORS. Capacitor motors are a form of split-phase motor with a condenser connected in series to the starting-winding. They are easily identified by the condenser on the side, or on top. They are available in sizes from ¼ to 7½ h-p., but are seldom used in sizes over 1 to 2 h-p. The starting current is from 3 to 4 times full-load current, and their starting ability is about twice that of a similar size split-phase motor. They have no brushes and are designed to give no radio interference. This type of motor is desirable for equipment which requires frequent starting, such as the water system or furnace motor.

REPULSION-INDUCTION MOTORS. Repulsion-induction motors are the most widely used for starting heavy loads. They have a starting ability as much as 3 to 4 times their normal running power. The starting current, however, is relatively low as compared to the split-phase and capacitor motors. It is normally less than 3 times the full-load current. These are good general purpose motors in sizes of 1 h-p. or larger. You can buy them in sizes as large as 5, 7½ or 10 h-p. Most power companies are not able to handle single-phase motors in sizes larger than 5 h-p. on rural lines. Be sure to consult your power supplier before you buy a large motor.

The following table suggests the type of motor that should be used for various farm equipment.

TABLE 1—Types and capacity of motors for various tasks

Machine	Type of Motor	Capacity (h.p.)
Refrigerator (household)	Capacitor	¼
Tool grinder (emery wheel)	Split-phase or capacitor	¼– ½
Grindstone	Split-phase	¼
Washing machine	Split-phase	⅙– ¼
Corn sheller (single hole)	Capacitor	¼
Cream separator	Repulsion-induction or capacitor	⅙– ¼
Churn	Split-phase	⅙– ¼
Fanning mill	Split-phase	¼
Stoker (house furnace)	Capacitor	¼– ½
Water system (shallow-well)	Capacitor	¼– ½
Wood saw	Repulsion-induction	3 –7½
Sheep shearer	Split-phase or capacitor	¼– ½
Paint sprayer	Capacitor or repulsion-induction	½–2
Milking machine	Capacitor or repulsion-induction	¼–3
Meat grinder	Capacitor	¼
Ice-cream freezer	Capacitor	¼
Hay chopper	Repulsion-induction	5 –7½
Ensilage cutter	Repulsion-induction	5 –7½
Feed grinder	Repulsion-induction	½–7½
Concrete mixer	Capacitor	¼– ½
Grain elevator	Repulsion-induction	½–5
Hay hoist	Repulsion-induction	3 –5
Shop bench tools	Capacitor	¼– ½
Fruit and vegetable grader	Capacitor	¼– ½
Cider mill	Capacitor	¼

Selecting Proper Size Wire

It is highly important that the wire carrying electricity from the house or distribution pole to the barn, other outbuildings, and all motors be large enough to supply the power required without causing a high drop in voltage. By using any kind of a straightedge and the charts given here, you can determine the proper wire size for motor circuits (Fig. 1); 115-volt circuits (Fig. 2); and 230-volt circuits (Fig. 3).

For example, your poultry house is 130 feet from the house. The lights, water warmers, and feeders in the poultry house require a total of 2300 watts. Place a straightedge on the chart for a 115-volt current. (Fig. 2.) Align the straightedge, as shown, to read "2300 watts" on the left and "130 feet" on the right. It crosses the middle column between "6" and "8". Number 6 wire would be required for the installation.

The total load for any building should include all equipment which may be operating at any one given time. For approximate accuracy in figuring motor loads, allow: ¼ h-p. motor, 400 watts; ⅓ h-p. motor, 500 watts; ½ h-p. motor, 700 watts; ¾ h-p. motor, 900 watts; and 1 h-p. motor, 1200 watts. For motors larger than 1 h-p., allow 1000 watts per each additional horsepower.

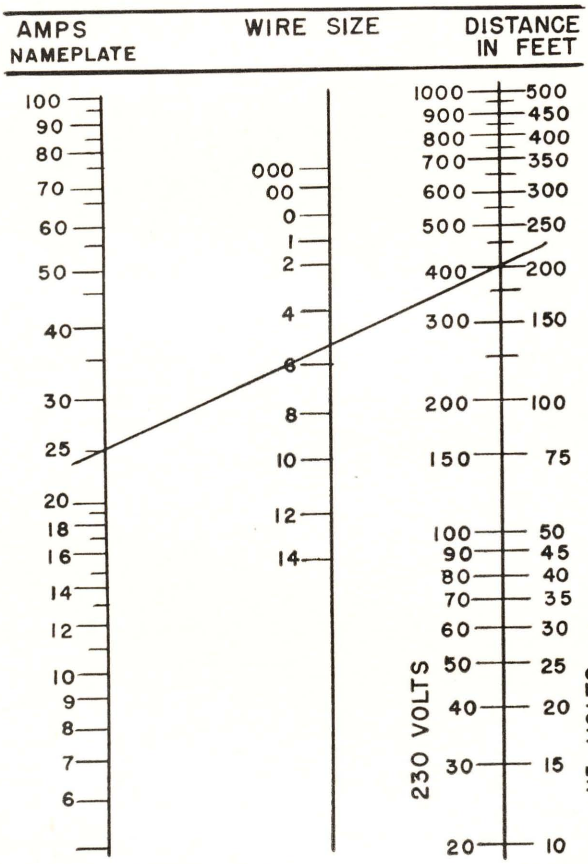


Fig. 1. MOTOR CIRCUITS. Using a straightedge, align the nameplate amperage on the left with the total one-way distance on the right. Use the left distance column for 230 volts and the right distance column for 115 volts. When the line falls between two wire sizes, use the larger one. Remember the smaller the number, the larger the wire size.

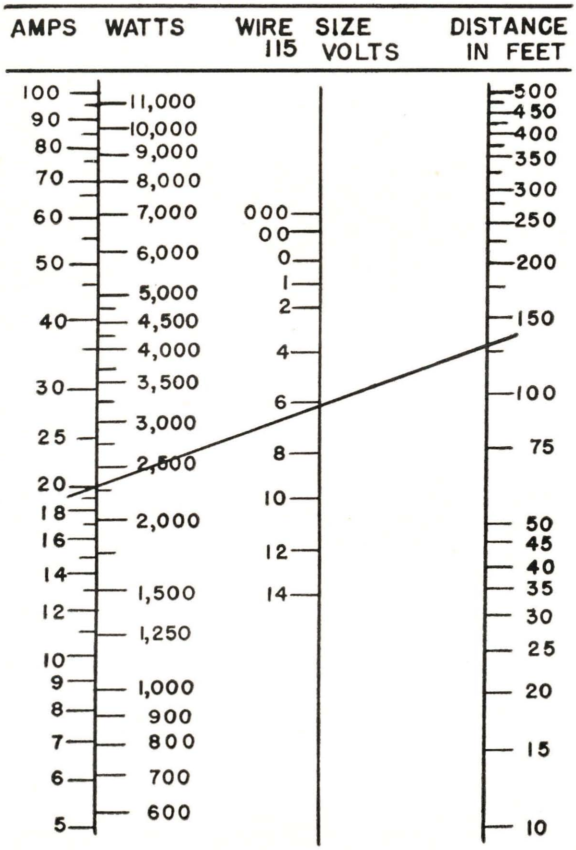


Fig. 2. 115 VOLTS. Using a straightedge, align the total wattage or amperage on the left with the one-way distance on the right. When the line falls between two wire sizes, use the larger size. Remember the smaller the number, the larger the wire size.

Figuring Pulley Sizes

Pulleys and belts transmit power from the motor to a machine, and adapt the speed of the motor to the correct speed for the machine. The belt must be large enough to transmit the power, and the pulley must be large enough to prevent slipping of the belt. The size of the small pulley is determined by the type and size of belt used, but should be large enough to prevent too much bending of the belt. Generally a

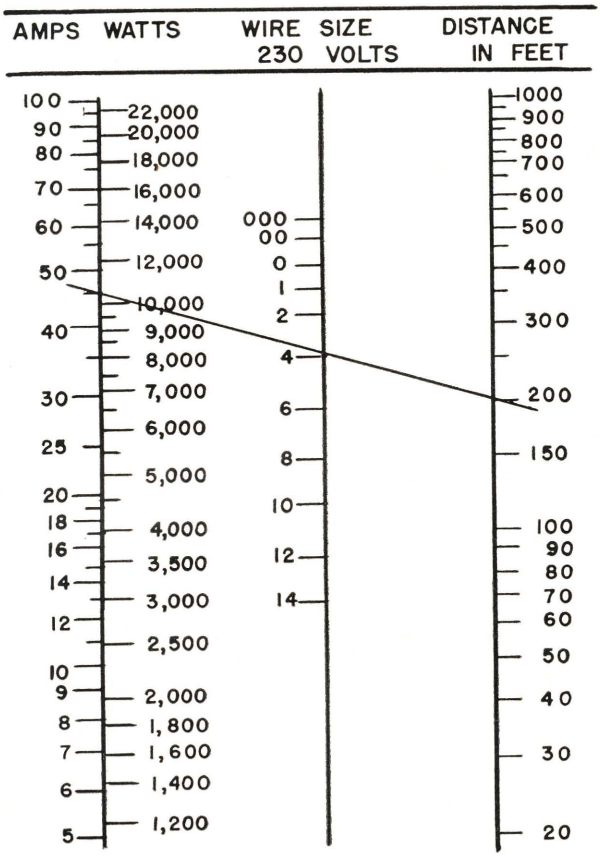


Fig. 3. 230 VOLTS. Using a straightedge, align the total amperage on the left with the one-way distance on the right. When the line falls between the two wire sizes, use the larger size. Remember the smaller the number, the larger the wire size.

2-inch pulley on the motor shaft is the smallest that should be used. The pulley selection chart (Fig. 4) gives the recommended speeds at which many appliances should be run. The chart can be used to determine pulley sizes also.

Pulley sizes can be determined by the following relation:

> *Motor r.p.m. x motor-pulley diameter = driven machine r.p.m. x driven machine-pulley diameter.*

Example: Suppose a corn sheller should be operated at 200 r.p.m. The motor speed is 1750 r.p.m. and there is a 2-inch diameter pulley on the motor shaft. What size pulley should be used on the corn sheller?

1750 r.p.m. x 2 in. = 200 x dia. of pulley on corn sheller

$$1750 \times 2 = 200 \times ? \quad 3500 = 200 \times ? \quad \frac{3500}{200} = 17.5$$

$$\text{dia. of pulley on corn sheller} = \frac{3500}{200} = 17.5\text{, or an 18'' pulley.}$$

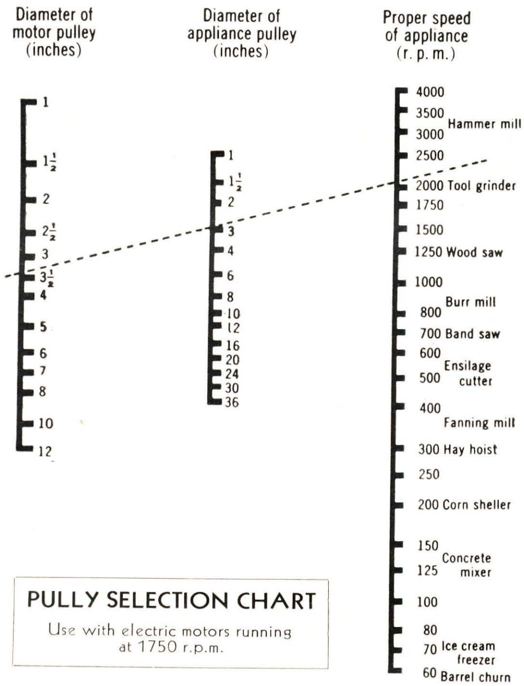


Fig. 4. PULLEY SELECTION CHART. Lay a straightedge across the chart between any two of the three factors represented by the vertical lines. Where the straightedge crosses the remaining line, read the information desired. Example: You have a 3½″ motor pulley and a tool grinder, a recommended operating speed of 2100 r.p.m. Your straightedge (dotted line) tells you that you should use a 3″ appliance pulley.

Or, you want to know what combination of pulleys will be required to obtain a specified machine speed (for any appliance). Put the right end of the straightedge across the righthand column at the specified number of r.p.m.'s. Then move the left end of the straightedge up or down to the first point where it crosses both of the other two columns. Read the combination of pulley sizes which will give you that speed.

NECESSARY TOOLS

To do satisfactory work in electrical projects, a good set of tools is necessary. The following list is a minimum to begin your project work. As you complete more projects new tools will be needed.

1. Hammer
2. Screwdriver
3. Side-cutter pliers
4. Jack knife
5. Soldering iron (either electric, or non-electric with blow torch)
6. Resin-core wire solder
7. Test lamp
8. Rubber tape
9. Friction tape.

It is also necessary to have available a copy of "Wiring Simplified," by H. P. Richter.

Fig. 5. Tools required to begin project work.

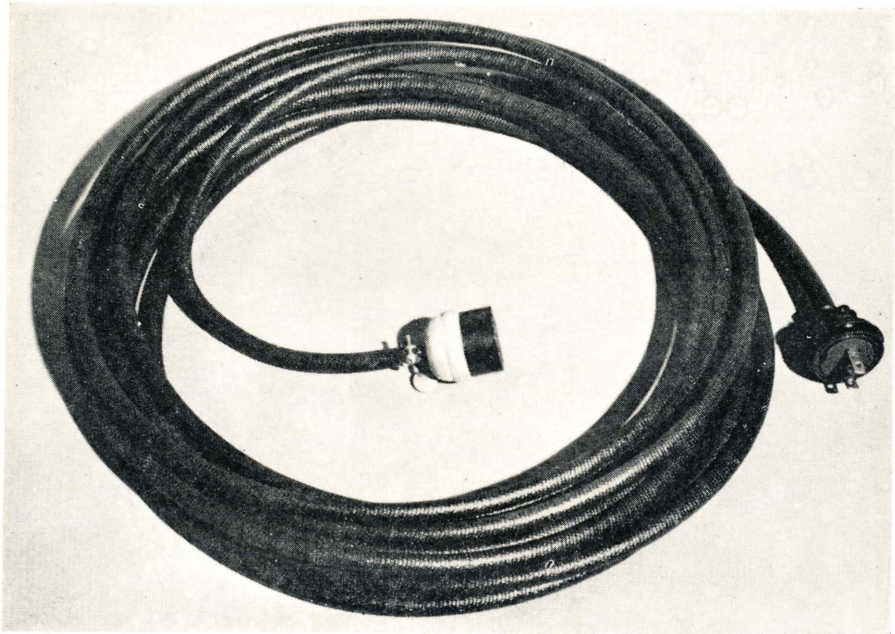


Fig. 6. A portable extension cord.

EXERCISE 1

EXTENSION CORD OR TROUBLE LAMP

There are many uses for both an extension cord and a trouble lamp on every electrified farm (Figs. 6 and 7).

The cord should be two-wire No. 16, heavy duty and rubber-covered, about 20 feet long. The trouble lamp will require a rubber handle and lamp guard, while the extension cord requires a connector body with a clamp grip. A good connector cap, preferably with a clamp grip, is required for either cord.

The cord should be connected in such a way that the tension will not be transmitted to the terminal screws. This may be done in the following ways: (1) by using a cap with a clamp grip, (2) if such a cap is not available, by tying an Underwriters knot, (3) if there is not room enough in the cap for a knot, the wire may be looped around the posts before fastening it under the terminal screws.

Any lamp or appliance cord may be substituted for above exercise.

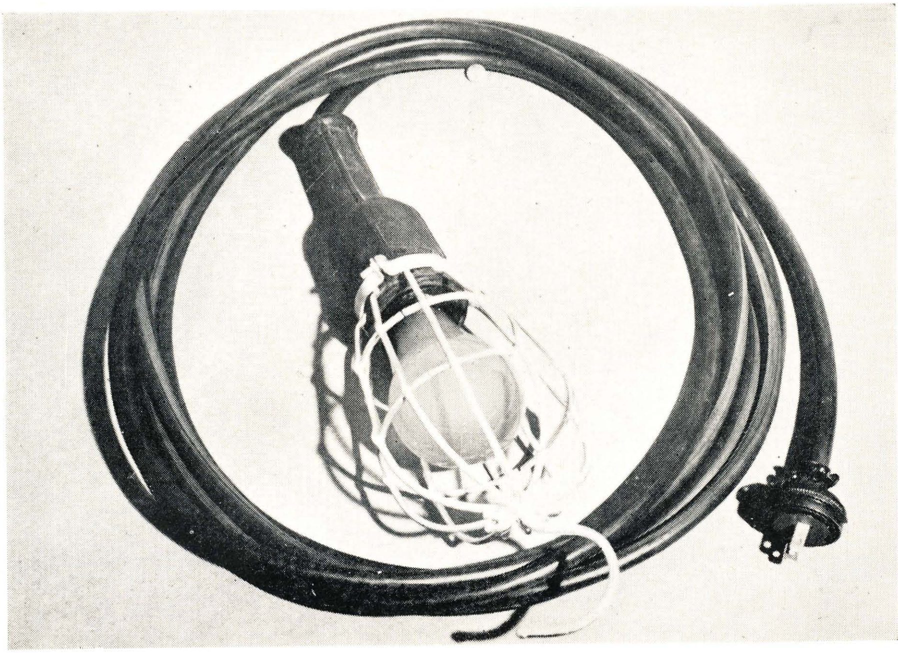


Fig. 7. A trouble lamp.

EXERCISE 2

ELECTRIC CORD REEL

The cord reel (Fig. 8) is a handy carrier for an extension cord, and will keep it in good condition when not in use. In the open position the cord reel keeps the convenience outlet off of the ground, making it easier and safer to connect to the outlet.

The hole on the back leg of the reel should be directly opposite that on the front leg where the cord goes into the convenience outlet. This permits the legs of the reel to fold together tightly.

Bill of Materials

2–½″ x 6″ x 12″ Southern Pine recommended
2–2″ strap hinges
1–convenience outlet
1–outlet box and cover
1–20′ of 2 wire No. 14 rubber covered cord

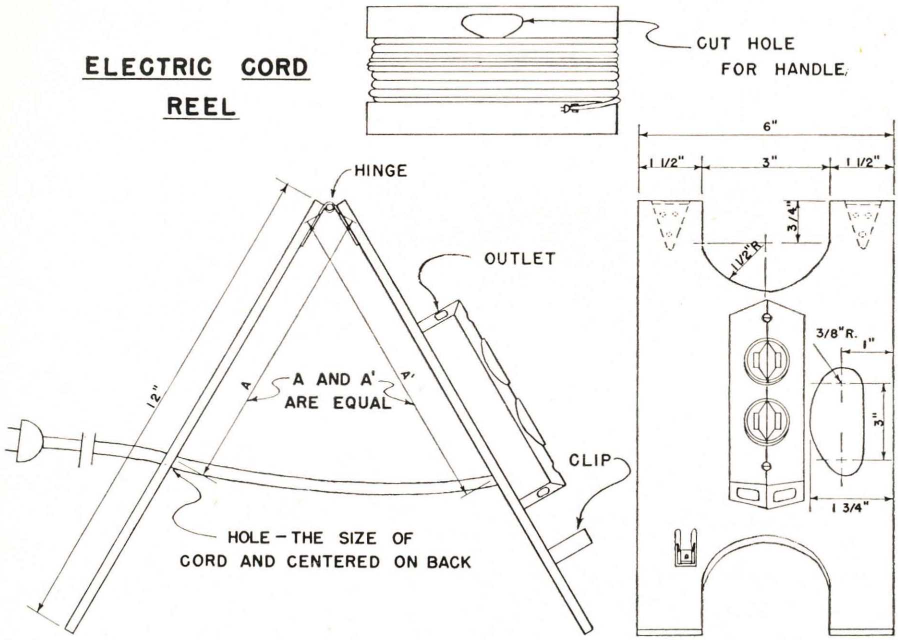


Fig. 8.

EXERCISE 3

TOY ELECTRIC MOTOR

The materials required, and the steps to follow in building your toy electric motor, are clearly shown in Fig. 11. Study it carefully, and follow the directions closely. Also remember that the motor, when finished, should never be left connected to the dry cell for any length of time when not running. A motor which is not running is almost a direct "short" on a dry cell. The same warning applies to such parts of the motor as the armature or the field, just as well as the entire motor.

Before beginning any construction from Fig. 11, read the section immediately following. Then build the motor. The other two sections on "things to do" show how you can make use of the finished toy motor so as to understand more clearly the principles of real motors.

How an Electric Motor Works

In a way, an electric motor is simply a spinning magnet. The earth itself is a huge magnet. We know the earth has magnetism because it causes a compass needle (which is itself a small magnet) to swing around. Ordinary horseshoe or bar magnets affect the compass needle in the same way.

Magnets act like that because they have *magnetic fields,* which are composed of *magnetic lines of force.* These concentrate at each end of a magnet to form two opposite *magnetic poles*—called, like those of the earth itself, the *North (N)* and *South (S)* poles. Like magnetic poles repel each other; opposite poles attract.

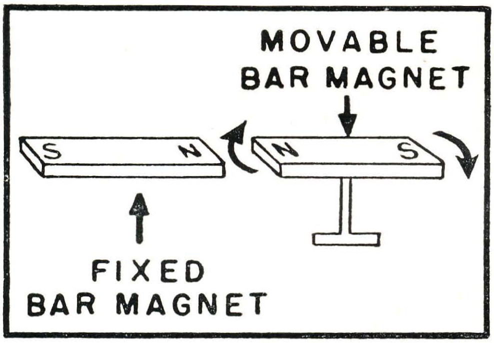


Fig. 9.

As shown in Fig. 9, the movable magnet swings around because it *N* pole is repelled by the *N* pole of the fixed magnet; but its *S* pole attracted. It stops swinging when its *S* pole is nearest the *N* pole of the fixed magnet.

Now suppose that just as the *S* pole of the moving magnet nears that *N* pole, you could suddenly reverse in some way the poles of the moving magnet. Then it would keep turning for another half turn. If you could change those poles every half turn, the moving magnet would spin around and around.

You can't reverse the poles of a *bar magnet* that way, but you can replace it with an *electromagnet,* which also has *N* and *S* poles. Made of a coil of wire wrapped around an iron core, the electromagnet can instantly change its *N* and *S* poles by *reversing the current in the coil of wire.* And that can be done automatically as the coil of wire spins around.

With the coil of wire replacing the moving bar magnet then, a *fixed electromagnet* —shaped to fit around the spinning coil—is likewise substituted for the fixed bar magnet. (Fig. 10.)

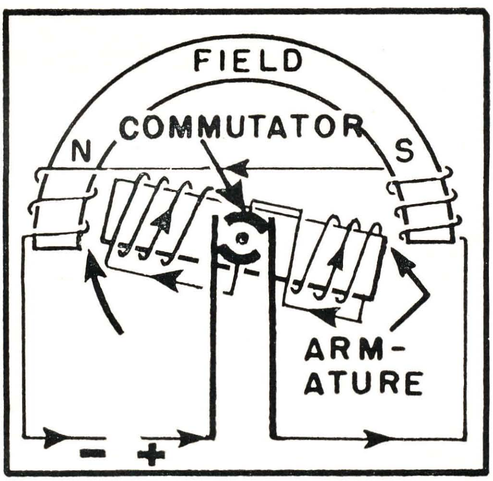


Fig. 10.

Now you have a simple direct-current motor. The fixed electromagnet is the *field,* and the spinning electromagnet is the *armature*. The arrangement for reversing the current in the spinning electromagnet—that is, in the armature—is called the *commutator*.

This is the kind of simple motor you will build (Fig. 11).

Things to Do With Your Motor

Lift out the armature of your motor. Connect the commutator wires to a dry cell. Test the polarity of each end of the armature with a compass needle. What do you find? Then reverse the battery connections and test with the compass needle again. What happens?

With the armature removed, connect the field coil of your motor to the dry cell. Test the polarity of each end of the field with a compass needle. How can you reverse the polarity of the field? Try it.

While your motor is running, push the field poles slightly out of alignment with the armature. What happens to the speed of the motor? Why?

Push the motor field completely out of the way and test the polarity of the armature as you slowly turn it around by hand. Can you explain what you find?

Try to reverse the direction of rotation of your motor by reversing the connections to the battery. What happens? Can you explain why?

Your motor is *series-wound*. Find out how to convert it to a *parallel-wound* motor. Then wire the motor this way and run it. Does the motor seem to run as well as before?

Try to reverse the direction of rotation of the parallel-wound motor by (1) reversing the battery connections, (2) reversing only the field connections, (3) reversing only the armature connections, (4) reversing both field and armature connections.

Which of these methods reverses the motor?

Other Things to Learn About Motors

Look around your home and make a list of all the devices you can find which are driven by electric motors.

Keep track of the number of things electric motors do for you in a single day. For example, they may start the car, run the streetcar you use, and so on.

Examine the toy motor from your electric train or an Erector set. Compare its essential parts to the same parts in the motor you have built.

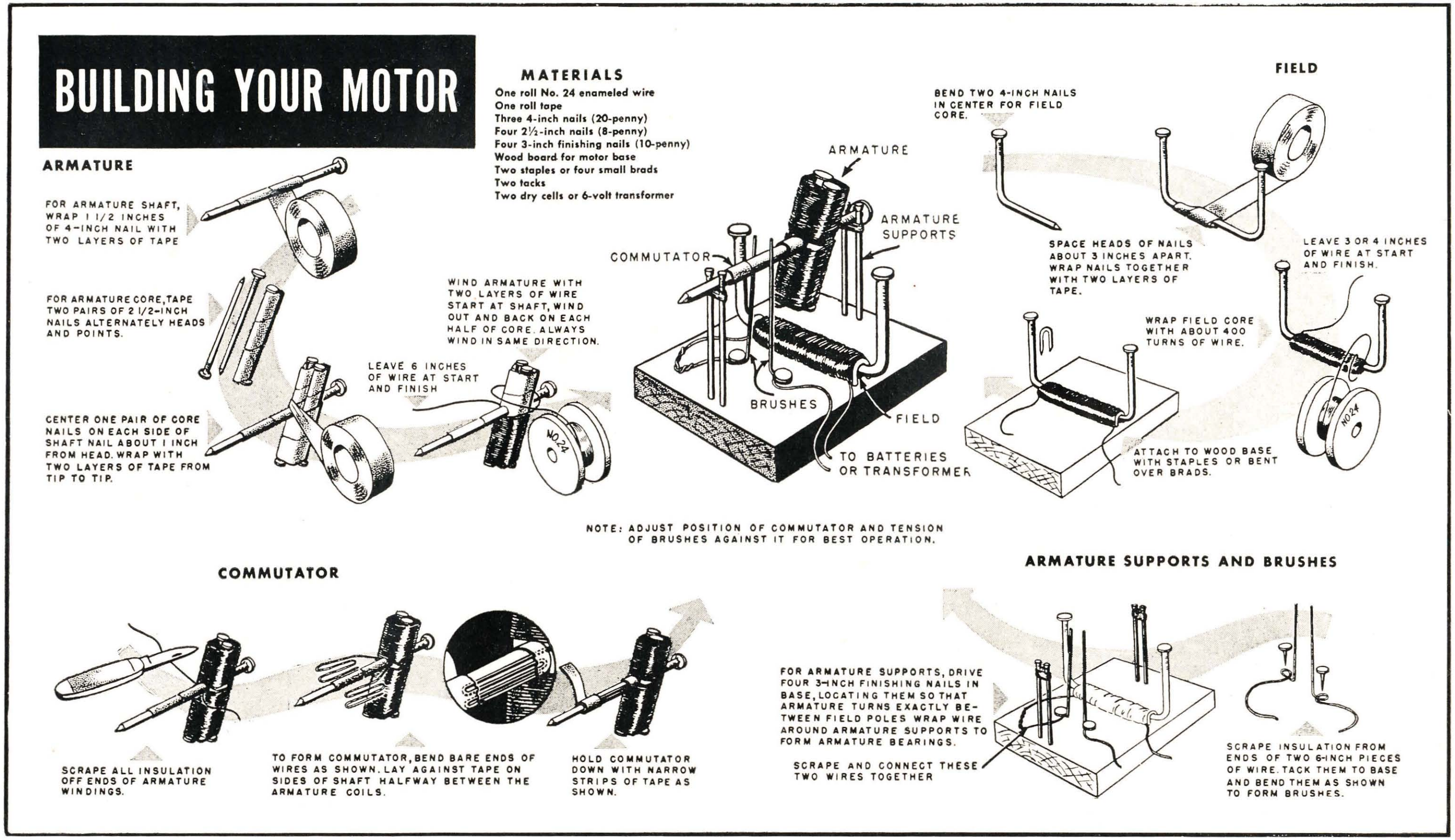


Fig. 11. This illustration gives all the materials required, and all the directions necessary, for building a toy electric motor (Exercise 3).

Examine the nameplate on a small alternating-current motor. Can you explain what all the information means?

Visit a shop where electric motors are repaired. Try to find out what usually happens to motors which need repairing. Learn how to prevent most motor breakdowns by proper oiling, cleaning, and care.

Learn about the various kinds of alternating-current motors. In what ways are they alike? How do they differ?

If possible, visit some factory or mill in your town. Learn all the ways in which it uses electric motors. Find out what kinds of motors are used and how they are controlled.

Find out how series-wound and parallel-wound motors differ in their characteristics of operation. What are some important uses of each type? Why?

Take apart an old electric motor which has been completely discarded and you are certain is no longer of use. Examine it carefully and try to determine what each part is for.

When an electric refrigerator starts you may see the lights in the kitchen dim for a second or two. Can you find out why this happens?

EXERCISE 4

MAKING A MOTOR PORTABLE

There are many machines on a farm which can be driven profitably with an electric motor. Some of them are: Elevators; pump jacks; seed cleaners; corn shellers; grinding wheels; egg cleaners; sausage grinders; and onion, potato or apple graders. Many are not used often enough to justify a separate motor for each machine, so it is desirable if the same motor can be used for several different purposes.

Figures 12, 13 and 14 show three common methods of making a motor portable, so that it can be conveniently changed from one job to another.

1. Figure 12 shows a commercial type, an iron rail motor mount with brackets that support the rail. When bolted to the iron rail, the motor can be held steady by the fixed brackets, or just as easily lifted clear of them. Extra brackets may be purchased so they do not have to be moved for each job.

2. Figure 13 shows the "C" clamp method. Mount the motor on a board slightly larger than the motor. The motor can then be clamped to almost any piece of equipment with two 5-inch "C" clamps. An advantage of this method is that the motor can be mounted in any position necessary for the job, provided the motor is of the right type of design.

3. Figure 14 shows the "broom handle method" of making a motor portable. Cut a large broom handle, or hoe handle, of approximately the same length as the motor shaft. Bolt the broom handle to the motor as shown, counter sinking the heads of the bolts. The slot in the wood mounting block is made by drilling two holes (the distance between the centers of these two holes should be equal to the length of the broom handle) in a board, and removing the wood between the holes with a keyhole saw.

The mounting in all cases should be installed so that the pulleys are properly lined up. Motors up to and including ⅓ h-p. may hang in the belt to keep it tight. Larger motors should be supported so

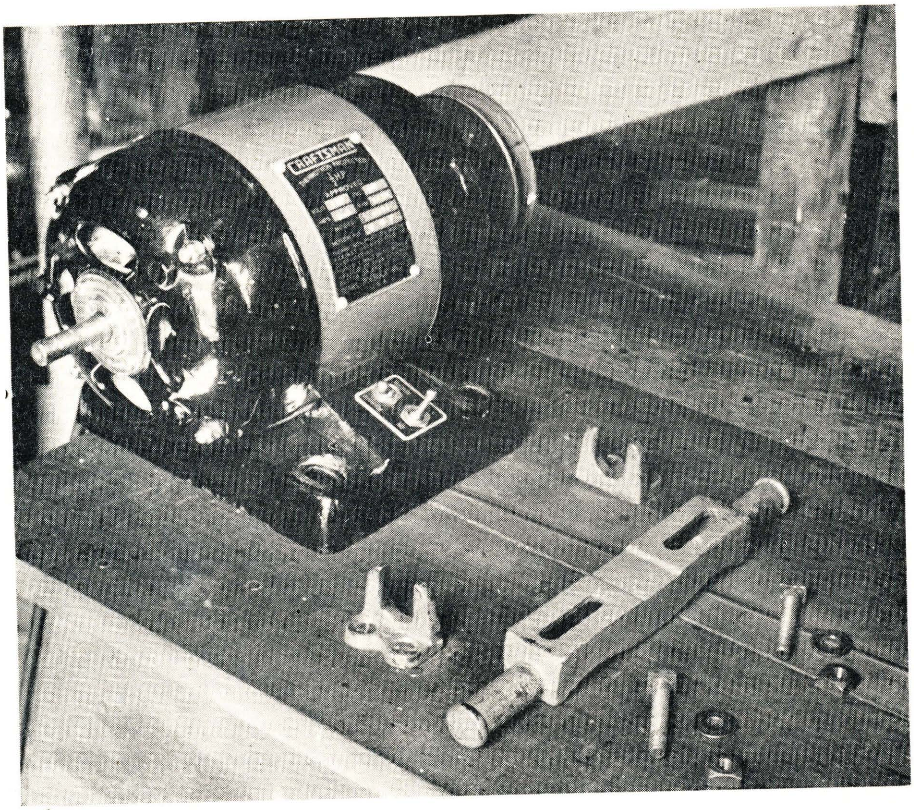


Fig. 12. A commercially made motor mount.

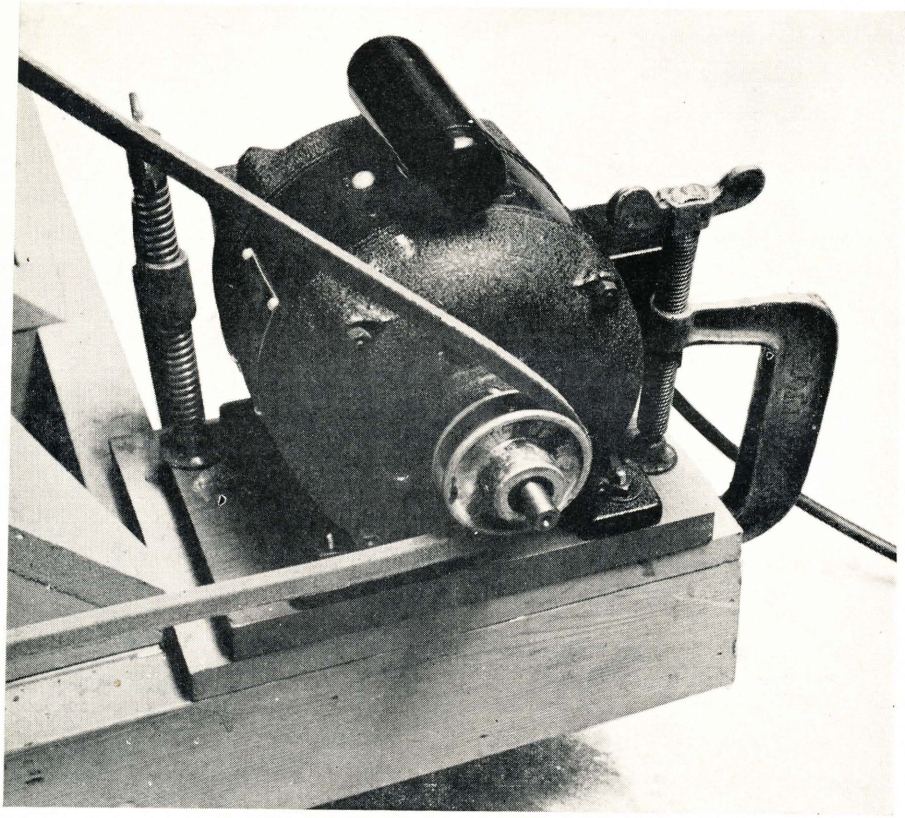


Fig. 13. The use of C-clamps in making a motor portable.

that the entire weight does not hang in the belt. The direction of rotation can be changed on most motors; that may be necessary when changing the motor from one machine to another.

Exercise 4 consists of making a motor portable, using these or similar methods, so that the motor can be used on at least two different pieces of equipment. Report the machines on which the motor is to be used, and the method by which it was made portable.

EXERCISE 5

CARE OF ELECTRIC MOTORS

Electric motors require a certain amount of regular care to assure trouble-free operation and long life. Occasional cleaning and oiling are necessary, as well as checking on the wearing parts such as brushes and bearings.

Electric motors should be cleaned regularly, to prevent overheating due to the insulating effect of the dirt and dust. Wipe the dirt off the outside with a rag. The dirt on the inside can usually be blown out with a tire pump. If grease and dirt have accumulated on the inside of a motor, it may be necessary to have an electric motor serviceman take it apart and wash the inside with *carbon-tetrachloride* in order to clean it thoroughly. Motors operated in a dusty or dirty location should be kept covered, and care should be taken to keep them from getting wet.

A little oil goes a long way on electric motors. The amount needed depends on the type of bearings, and how much the motor is used. The manufacturer's recommendations should always be followed. But in the absence of such instructions, the general rule for the common fractional horsepower motor is *3 or 4 drops* of oil every 3 or 4 months. Remember, there is a lot of difference between a *drop* and a *squirt* of oil, and that one of the common causes of motor failure is over-

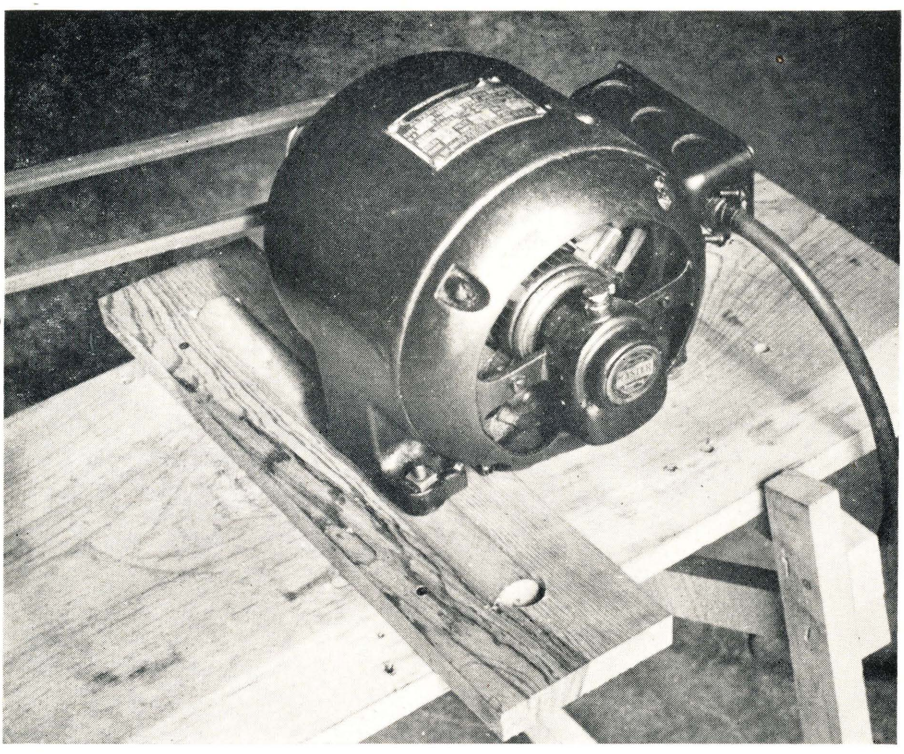


Fig. 14. The broom handle portable motor in operating position.

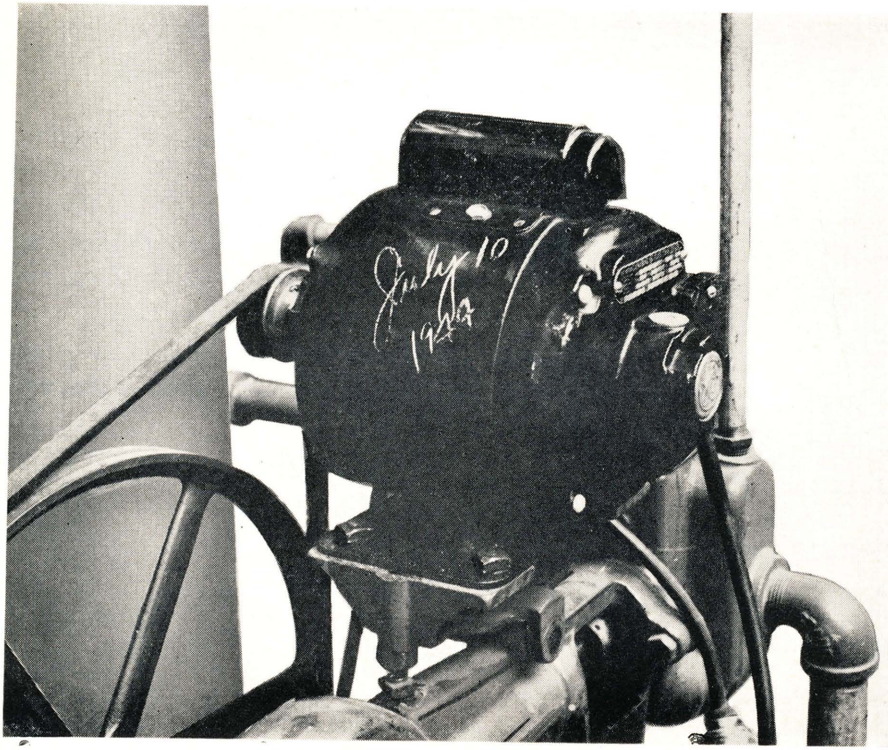


Fig. 15. A good clean motor, with record of the oiling date on the motor.

oiling. Motors with ball bearings require special lubrication about every two years by an electric motor serviceman.

The brushes will wear out in time, and should be replaced before they become so short that the brush spring no longer holds the brush on the commutator firmly. New brushes should have a curve on the end which fits the curve on the commutator. This curve can be ground on by wrapping a strip of fine sandpaper around the commutator and turning it a few turns by hand, with the brush held firmly against the sandpaper.

Bearings should be checked for looseness and endplay each time the motor is oiled. Replacing bearings is a job that should be done by an electric motor serviceman.

Overloading the motor will cause it to overheat and possibly burn out. A simple test for determining whether a motor is overloaded is to place the palm of your hand on the motor. If you can hold it there while you slowly count to 10 (10 seconds) it is probably not overloaded.

On machines where a certain speed is not required, the load can be decreased by using a smaller pulley on the motor, or a larger pulley on the machine.

The belt tension should be just tight enough to prevent slipping. If the belt is too tight, the bearings will wear faster. On the other hand, if the belt is too loose, it will slip and wear faster. Belts should be replaced when they become frayed or worn, and should be kept free of oil. It is important that the pulleys be properly lined up, and that the motor be fastened securely to prevent vibration.

Exercise 5 consists of caring for the motors on your farm (minimum of three motors), then reporting the oiling and cleaning dates, and all necessary repairs for one year.

EXERCISE 6

ALARM CLOCK TIME SWITCH

Materials Required

Wall shelf
Alarm clock
Wooden arm 1″ x 2″ x 4″ to 8″ (for use with snap switch)
Stove bolt ¼″ x 2¼″
Small pulley and cord (for use with toggle switch)

An ordinary spring-wound alarm clock makes a simple time switch, for automatically turning lights and small motors on or off at a certain time. For example, poultry house lights can be turned on automatically in the morning to stimulate winter egg production. Motors on pump jacks, feed grinders, and other appliances can also be started or stopped with this device.

Figure 16 shows the arrangement, for use with either a snap switch or a toggle switch. A lever arm is used with the snap switch; it must have enough weight so that it will drop and snap the switch when released from the alarm key.

A length of cord and a small pulley is needed to operate a toggle switch. The cord must be wound on the alarm key so that it will wind up and pull the switch when the alarm goes off. The clock should be securely fastened to the shelf.

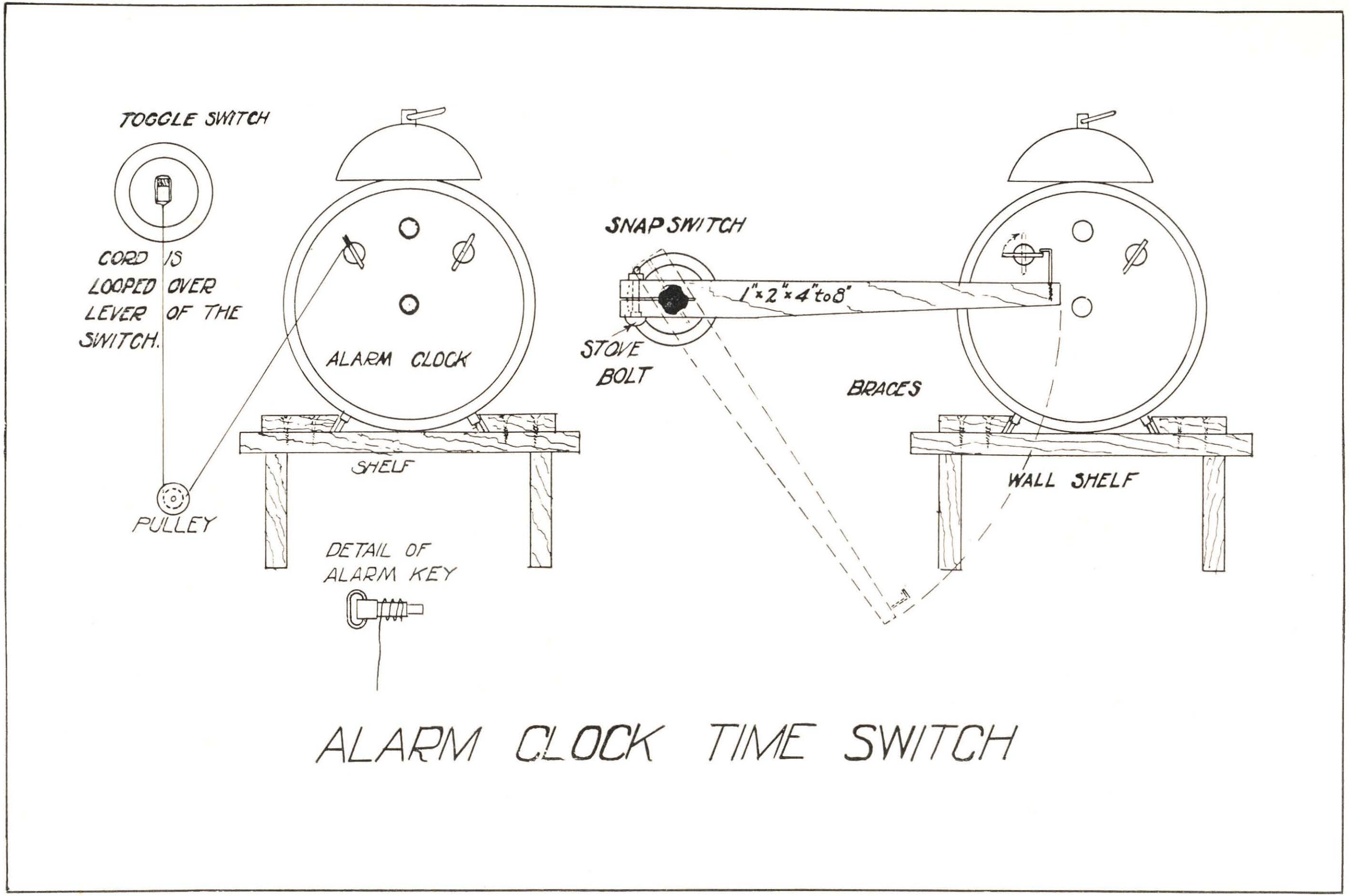

TOGGLE SWITCH
CORD IS LOOPED OVER LEVER OF THE SWITCH.
PULLEY
ALARM CLOCK
SHELF
DETAIL OF ALARM KEY
SNAP SWITCH
STOVE BOLT
1"×2"×4"to8"
BRACES
WALL SHELF
ALARM CLOCK TIME SWITCH

Fig. 16.

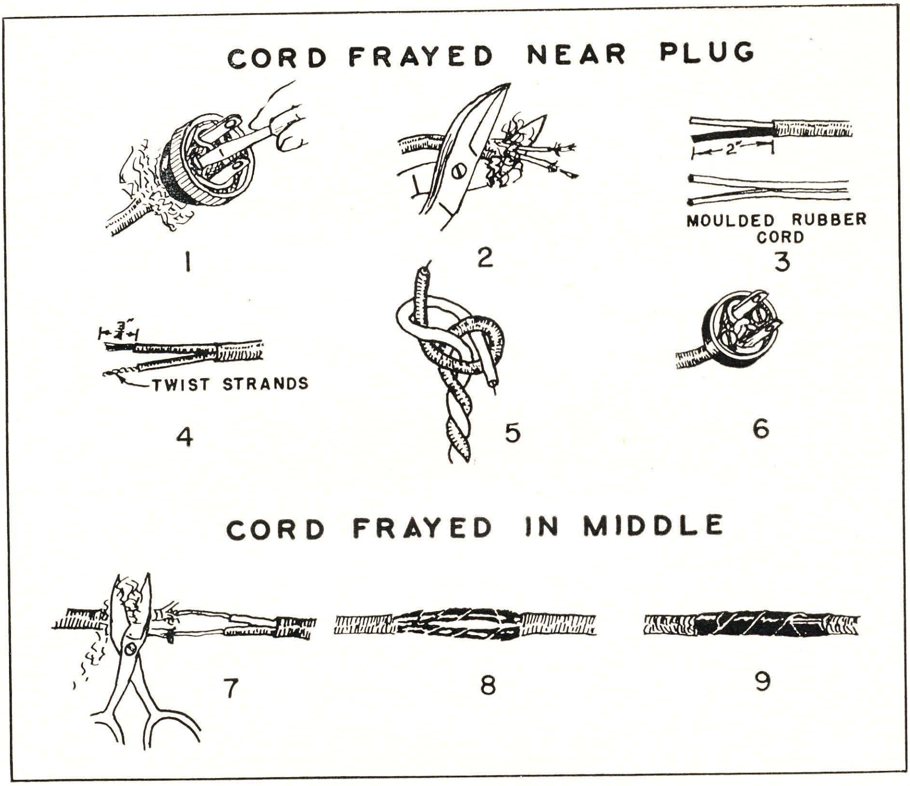


Fig. 17.

EXERCISE 7

REPAIRING APPLIANCE CORDS

Frayed and worn places on appliance cords, lamp cords and extension cords can be serious shock and fire hazards. All of these cords should be repaired immediately; or replaced if the damage is too extensive.

Repairing a Cord Frayed Near the Plug

(Steps 1 - 6, Fig. 17)

1. Release cord by loosening the screws inside plug.
2. Cut off frayed end of cord.
3. Strip 2″ of outer fabric covering from cord. Moulded rubber cord can be split back 2″ from the end. Be sure that when the cords are split no wires are exposed through the insulation.

4. Strip insulation from ends of cords to expose about ¾″ of bare wire. Twist strands together.

5. Slip cord through plug and tie cord ends in Underwriters knot. This keeps wires from being pulled away from under the screw posts. Pull knot down inside plug.

6. Wrap wires around prongs to form an S. Loop bare copper ends around the screw posts in clockwise direction. Hold in place and tighten screws firmly.

Repairing a Cord Frayed in the Middle

(Steps 7 - 9, Fig. 17)

7. Cut frayed edge clean.

8. With electrician's rubber tape, wrap each wire *separately* from end to end.

9. With friction tape (tire tape) binds the 2 wires together.

This exercise consists of inspecting and repairing all of the cords around your home and farm. Replace all broken plugs with new ones

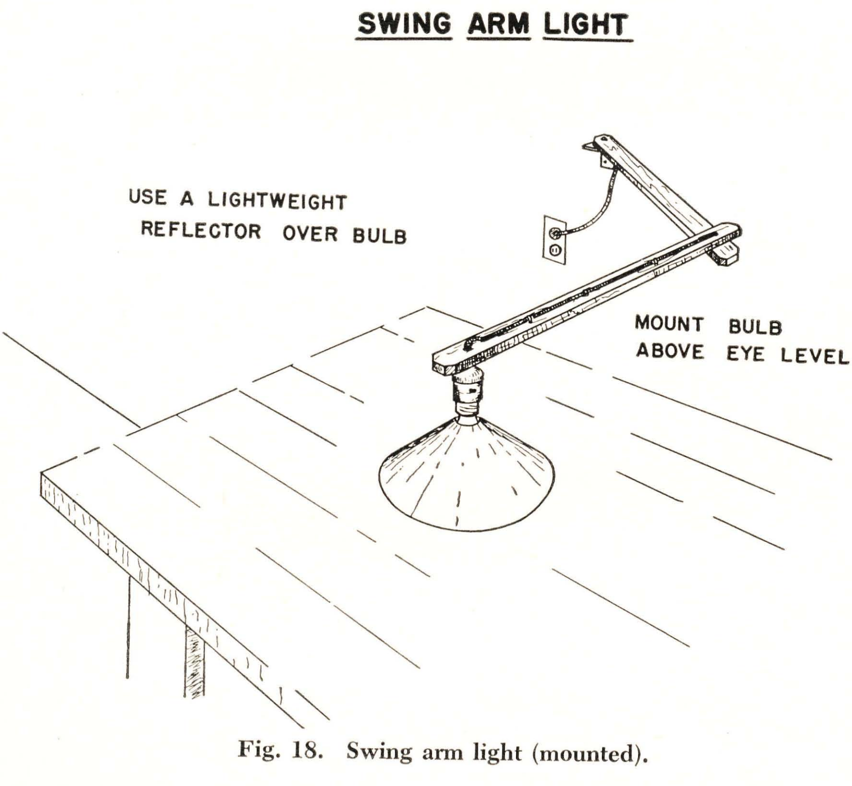


Fig. 18. Swing arm light (mounted).

of a type which will not break when dropped or stepped on. Report the number and types of cords you repaired.

EXERCISE 8

SWING ARM LIGHT

The swing arm light (Fig. 18) makes a very useful lamp for the workbench, work table, or study table.

Bill of Materials

1—1″ x 2″ x 4′ Southern Pine recommended
1—3″ x 3″ x 1″ x 1/8″ C bracket
1—1/4″ bolt with spring and winged nut
2—1/4″ pipe nipples—short
1—1/4″ pipe T and nut
1—shell socket
1—8′ of 2 wire No. 16 rubber covered cord
1—light weight reflector

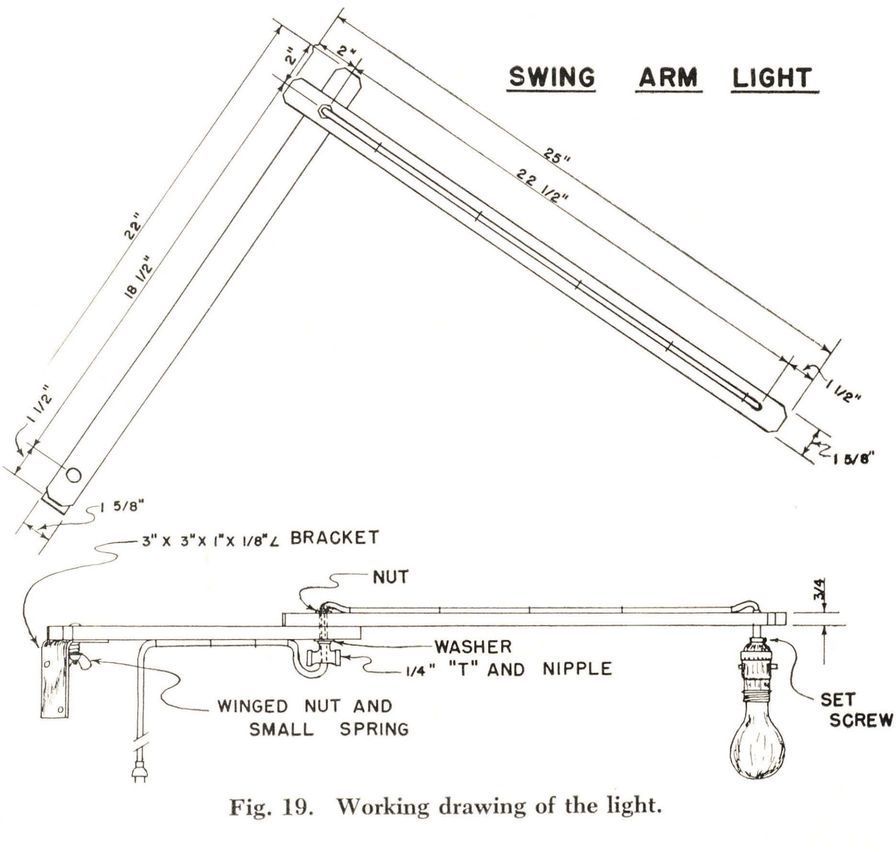


Fig. 19. Working drawing of the light.

Construction

Cut the 4′ board to the lengths shown in the working drawing (Fig. 19). Drill the holes just large enough to permit the cord to pass through, or the bolt for the winged nut.

Use one of the ¼″ pipe nipples as a hinge post for the swing arm. Clamp the shell light-socket to the other ¼″ nipple, using a set screw through the collar of the socket. Fit the pipe nipples snugly into the board.

Drill a hole through the bottom of the ¼″ pipe T to permit passage of the cord. Fasten the lamp to the wall by means of the right-angle steel bracket, and mount it so that the bulb is above eye level.

EXERCISE 9

POULTRY WATER HEATER

Water available at all times is essential for a flock of producing hens. Electric lights can be used to arouse the birds early in the morning, but unless water is available for them, much of the value of the lights may be lost.

An inexpensive poultry water heater to keep the water from freezing can be constructed from the accompanying diagram (Fig. 20). The hole in which the porcelain heater receptacle is mounted may be cut with a hammer and chisel, and should be just large enough to admit the receptacle. A round, or half-round file is handy for smoothing

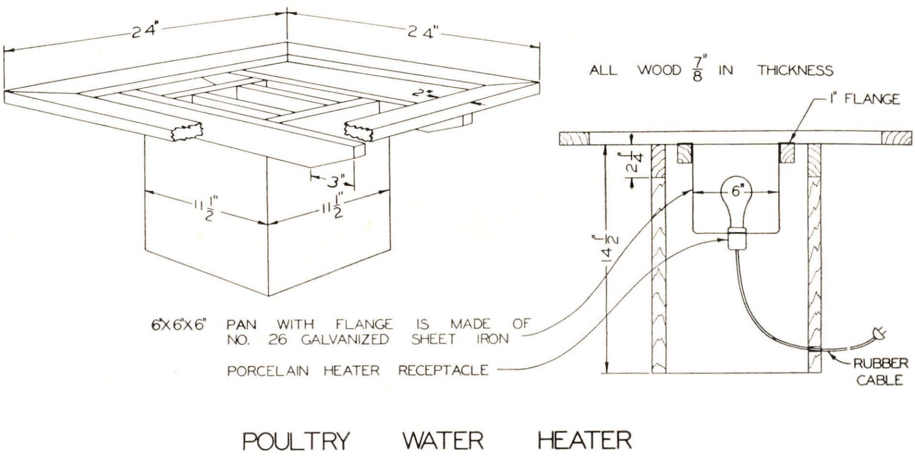


Fig. 20. Poultry water heater.

the edge to make a good fit. A hole should also be punched in the bottom of the pan near one corner, to drain any water which might spill into the pan.

The poultry waterer is placed on the stand over the lamp, which raises it about 14½ inches above the floor. Thus it is necessary for the hen to jump up on the framework of the stand to obtain water. This helps keep dirt out of the water and reduces spillage.

The size of lamp used for heating should be 25 watts or larger, depending on the amount of water to be warmed, and the air temperature. During cold weather the lamp should be left on continuously. For this reason a separate circuit, which does not turn off with the lights, should be provided. It is not necessary to heat the water appreciably; it needs only to be kept from freezing.

EXERCISE 10

ASSEMBLE LAMP UNITS

Many lamp kits are available at reasonable cost. These kits can be assembled by following plans included in the kits.

Lamp kits should be purchased for a definite use. Many small lamps do not provide enough light for reading, sewing or studying, but give enough light for general room lighting or decoration.

Consult the county 4-H agent, home demonstration agent or farm service advisor in selecting a lamp for a definite purpose. Height of lamp, type of lamp, type of bulb, size of bulb and type and size of shade should be considered in selecting a lamp kit.

(Or) REWIRE OLD LAMPS

Many oil burning lamps can be wired for electrical use, or old table lamps remodeled to make a desirable lamp for decoration or general seeing. Kits are available for this purpose. Consult your 4-H agent, home demonstration agent or farm advisor for recommendations as to the size and type of bulb and shade to be used on lamps that are remodeled.

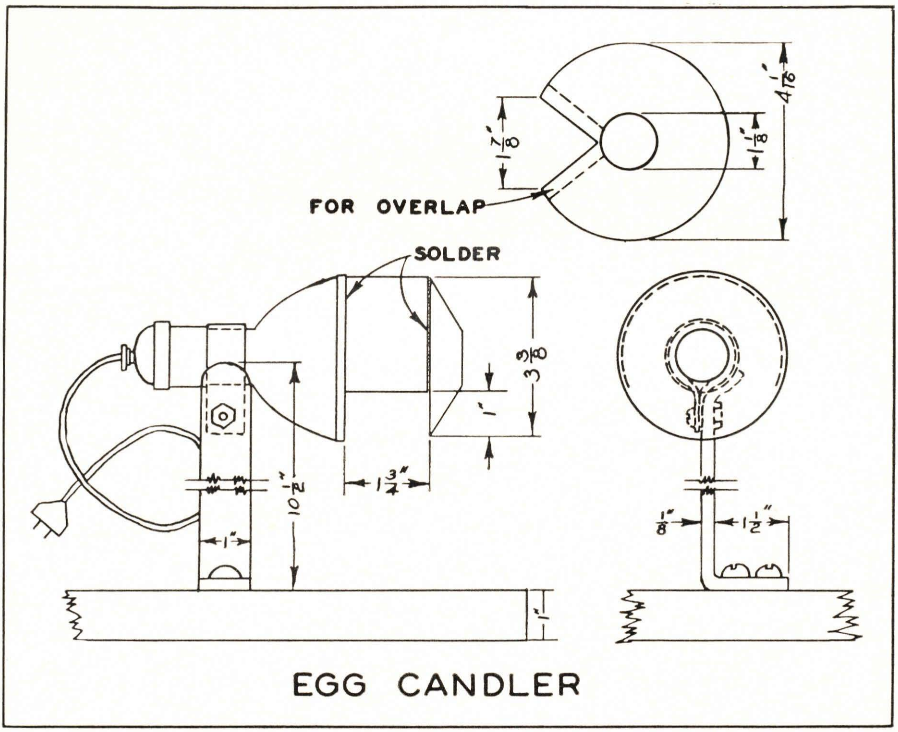


Fig. 21.

EXERCISE 11

ELECTRIC EGG CANDLER

By using an egg candler (Fig. 21) the farmer can determine the quality of his eggs before he markets them. The candler can also be used to demonstrate the necessity for frequent collection and prompt cooling of eggs in order to maintain a high quality product.

Materials Needed

1—Extension cord with lamp outlet
1—small dome-shaped oil can (base approx. 3⅜″ in diameter)
1—No. 2 tin can, 1¾″ long
1—1″ x ⅛″ x 12″ strap iron
1—¼″ x 1½″ machine bolt
1—flat piece of sheet metal 6″ x 8″
1—small can of aluminum paint
1—S11 Mazda 10-watt lamp

Procedure

Remove the bottom from the oil can with a can opener and attach the short No. 2 can with solder. Flatten the threads of the oil can and split the thread area on opposite sides with a hack saw to permit the socket to be forced into the opening. Secure with a pressure band as indicated.

Cut and shape the cone from the 6″ x 8″ sheet metal (another can will provide this material). Paint all inside surfaces with aluminum paint. When the paint is dry solder the cone to the barrel of the candler as shown. Mount on a 1″ x 12″ x 12″ block, using the strap iron that has been bent to form a foot and drilled for screws. Leave an opening large enough to allow a lamp to be placed in the socket. This opening provides illumination below the candler and keeps the candler cooler.

CAUTION—All sharp metal edges should be turned in to avoid cutting fingers.

EXERCISE 12

MAKING A LAMP SHADE

Lamp shades are not mere accessories in a room, but are as important a part of the furnishings as the chairs, tables, and other furniture. They should be of the proper size, shape, color and material to provide good lighting and harmonize with the rest of the room. You can easily make a new shade when it becomes necessary to replace an old one, or when you wish to give an old lamp a new look. Figure 22 shows you a layout for the lampshade pattern.

Shade-Size and Shape

Shades are always measured by the diameter across the bottom. On vanity lamps or dresser lamps the diameter should be 8 to 10 inches. Table lamps such as are used for reading, studying, and sewing should have shades with a bottom diameter of 14 inches to 18 inches. The flared shades permit a wider circle of light than the drum or square types and are generally best except when the design of the room calls for modern straight lines.

Shade-color

Shades should generally be a light color, at least on the inside, because dark colors soak up or absorb the light instead of reflecting it. White, off white, very light grey, yellow, or shell pink are good. The outside of the shade may be decorated with oil or water color paints.

Shade-materials

Paper shades are more common and are usually cheaper and easier to make than those covered with fabrics. The paper should be heavy enough to hold its shape and hide the imprint of the bare bulb, yet thin enough to let light come through. You can test the material, before cutting the pattern, by holding it over a lighted bulb.

Materials Needed

1. Old lamp shade or wire frame from one
2. Paper for lamp shade (one of the following)
    a. parchment paper
    b. drawing paper
    c. cover paper
    d. manila paper
    e. poly plastex
3. Household cement (transparent)
4. Scotch tape, clothes pins–pincer type (6 or 8)
5. Shears, pins, pencil, ruler
6. Oil or water color paints (optional)

NOTE: Heavy papers, such as manila can be made translucent (so that part of the light comes through) by oiling both sides with a mixture of equal parts of turpentine and linseed oil. When this is dry, a coat of clear shellac can be applied. This makes an imitation parchment.

Making the Shade

1. Remove old cover from the wire frame and save it for a pattern if suitable.

2. Clean wire frame using steel wool if necessary.

3. Paint or enamel frame white and dry 48 hours.

4. Cut out new shade using old covering as a pattern, or follow directions under "How to Make a Pattern for a Paper Shade" (below).

5. Attach shade to the frame by lacing or using gummed tape around the rims. To attach by lacing it is necessary to punch holes about ½-inch apart along top and bottom rim of paper. Leave a ½-inch margin from outside edges, and be sure to space evenly. Lace the paper onto the frame with an overhand stitch using heavy yarn, ribbon, colored twine, heavy cord, shoelaces, etc. The edge seam where the two ends meet may also be laced together, or glued.

How to Make a Pattern for a Paper Shade

Make your lampshade pattern by following these step-by-step directions. The capital letters refer to the points indicated on Fig. 22, which should be studied carefully before beginning any actual layout.

1. Measure diameter at top of wire frame.
2. Measure diameter at bottom.
3. Measure height through center of frame.

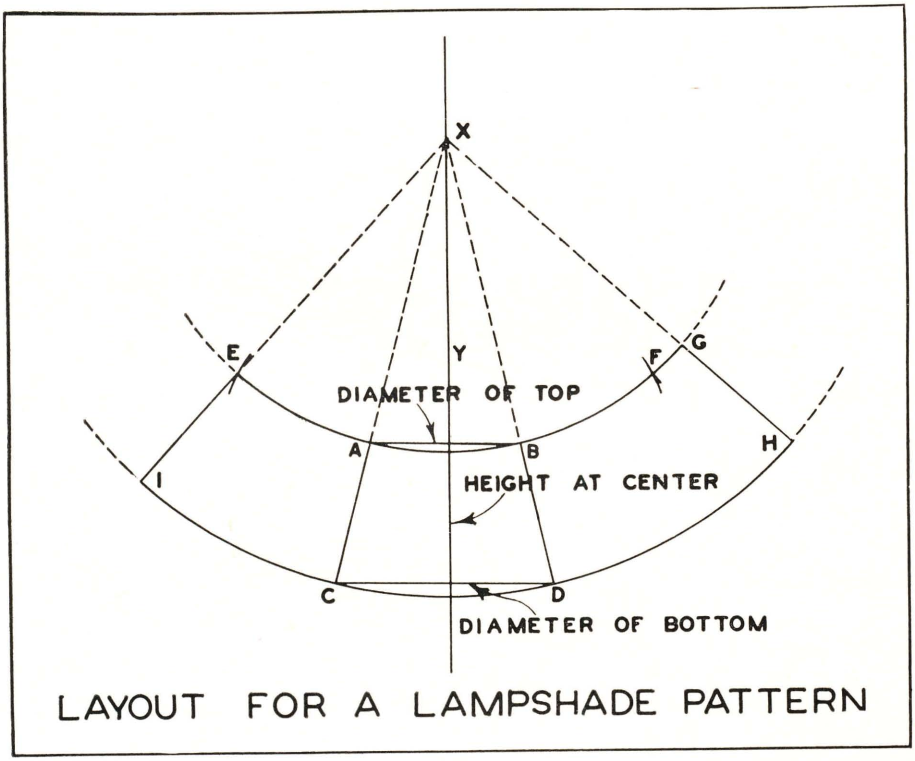


Fig. 22.

4. Draw diagram, full size, on wrapping paper.
5. Draw a line through center of pattern, extending well through top. Call this line "Y".
6. Extend line BD to meet line Y.
7. Extend line AC to meet line Y.
8. Mark X at point where all three lines meet.
9. Attach string and pencil to sturdy common pin.
10. Stick pin firmly into X.
11. With pencil swing an arc well around the AB line.
12. Swing another arc well around CD line.
13. With string, measure from A to B.
14. Put pin on A. Swing slight arc to E.
15. Put pin on B. Swing slight arc to F.
16. Measure about 2″ beyond F to G.
17. Draw line from X to H, through G.
18. Draw line from X to I, through E.
19. Cut out your pattern: E-I-G-H.

EXERCISE 13

MOVABLE SPOT OR FLOOD LIGHT

This lamp can be rolled under tractor or farm machinery for repair work at night. The unit can be used outdoors as well as indoors. The unit hung on a wall or on the machinery gives excellent light in the right spot. (Fig. 23.)

The unit can be used during cold weather to warm the tractor or car engine before starting. Replace the projector flood lamp with an infra-red heat lamp, adjust the lamp to shine on the motor pan, and roll the unit under the engine.

Bill of Material

1—1″ x 12″ x 18″ Southern Pine recommended
1—1″ dowling, 5½″ long
3—casters
1—adjustable lamp holder
1—outlet box and cover
1—convenience outlet
1—20′ of 2-wire rubber-covered No. 14 wire
1—attachment cap
1—150-watt hard glass reflector flood or spot lamp

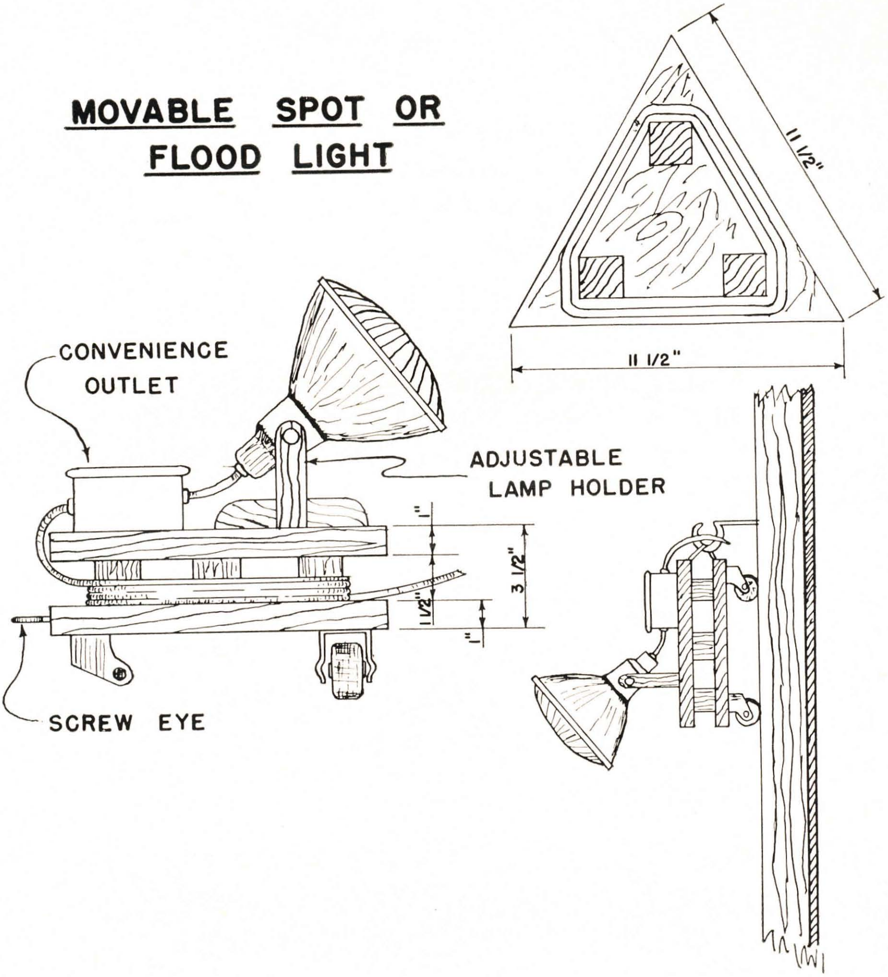


Fig. 23.

EXERCISE 14

READING THE ELECTRIC METER AND COMPUTING MONTHLY BILL

The electric meter measures the amount of electricity used. It is actually a small motor, which turns the dial pointers through a train of gears when electricity is being used.

The dials register in kilowatt-hours (KWH) the amount of electricity used. This is the unit of measure by which electricity is paid for—in the same way that gasoline is paid for by the gallon and sugar by the pound. A kilowatt-hour can be 1,000 watts used for an hour, 500 watts used for 2 hours, 100 watts used for 10 hours, or any other such combination. (See page 10.)

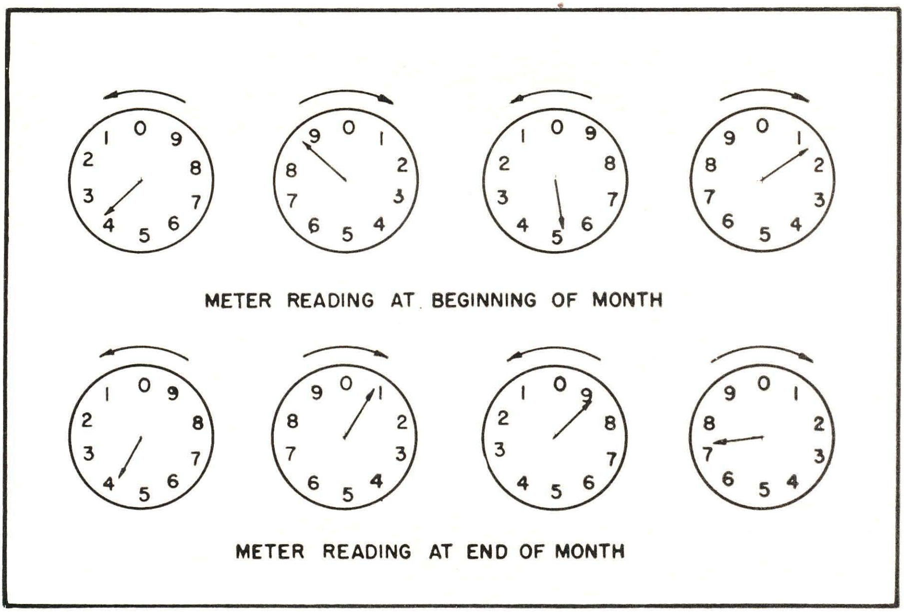


Fig. 24.

Two meter dials are shown in Fig. 24. One shows the reading at the beginning of the month, and the other shows the reading at the end of the month. Note that two of the hands on the dial turn in one direction, and the other two in the opposite direction.

To read the meter, write down the number each pointer has passed. Begin with the *right* hand dial—as your meterman does—and read to the *left*. The reason for this "backwards" reading is that the right hand dial must make one complete revolution before the next dial to its left moves a full division; and so on.

The reading at the beginning of the month in Fig. 24, is 3,851; the reading a month later is 4,087. Thus the number of kilowatt-hours used during the month is the difference between the two readings: *4,087 — 3,851 = 236 KWH.*

You can figure the monthly bill from that kind of a figure, if you know the electric rate. Most electrical rates are on a step-basis similar to the sample rate shown here—so that the more electricity you use per month, the lower the average cost per KWH.

FIRST	15 KWH —	6.0¢ per KWH
NEXT	15 KWH —	5.0¢ per KWH
NEXT	35 KWH —	4.0¢ per KWH
NEXT	155 KWH —	3.0¢ per KWH
	220 KWH	
OVER	220 KWH —	2.5¢ per KWH

MINIMUM BILL — $1.00
MICHIGAN SALES TAX — 3%

Using this sample rate for our 236 KWH, the bill for the month is figured as follows:

FIRST	15 KWH	@ 6.0¢ =	$ .90
NEXT	15 KWH	@ 5.0¢ =	.75
NEXT	35 KWH	@ 4.0¢ =	1.40
NEXT	155 KWH	@ 3.0¢ =	4.65
LAST	16 KWH	@ 2.5¢ =	.40
TOTAL	236 KWH		$8.10
Plus 3% sales tax			*.24*
NET BILL			$8.34

The average cost per KWH is obtained by dividing the *total monthly bill* by the *total KWH used during the month.*

NOTE: The sample rate used in this illustration does not apply to any particular area in Michigan. Obtain local rates from your power supplier to figure your own bill and average KWH cost monthly.

Requirements

1. Obtain your local electrical rate schedule; list it on a sheet of paper.

2. Read your electrical meter, writing down the meter reading and the date.

3. One month later, again read your electrical meter. Again write down the reading, and the date.

4. Determine the total number of kilowatt-hours used during the month.

5. Determine the amount of your monthly electrical bill, using your local rate.

6. Find the average cost-per-KWH, for the period covered by the bill.

This report should be attached to your electrical club report.

EXERCISE 15

WIRING PANEL

The purpose of this exercise is to teach some of the principles of wiring. You are required to do this exercise before attempting any others which involve wiring.

Exercise 15 consists of making a wiring panel, as shown in Fig. 26. The same panel, partly completed, is shown in Fig. 25. The wire which

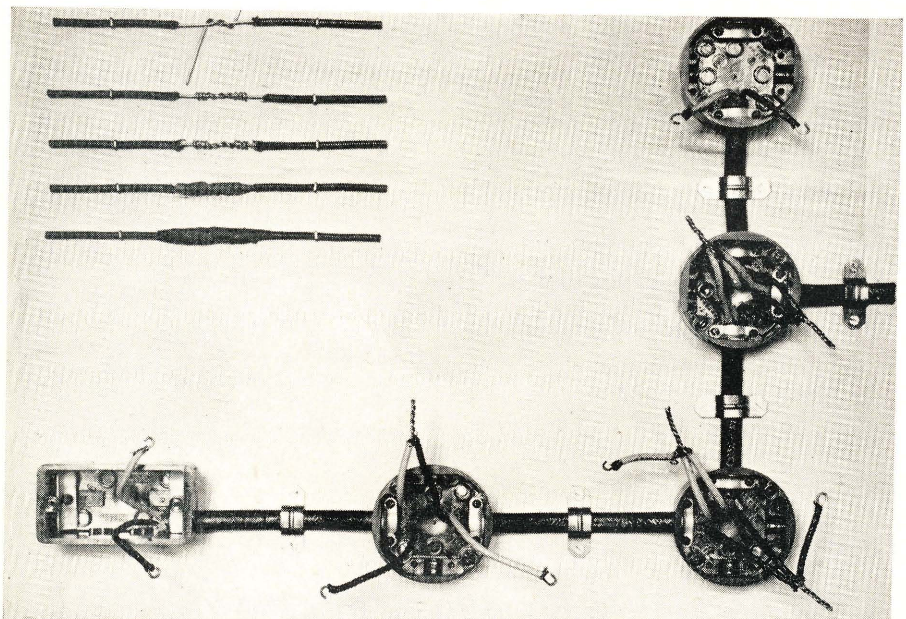


Fig. 25. Panel partly completed to show wiring connections. The wiring leading in from the right is the power source. The twisted connections on the indoor wiring should be bent, soldered, and taped before installing receptacles (as shown in Fig. 26.)

leads in from the right feeds the current to this group of outlets and can be considered the *source*. The switch at the left controls the outlet next to it, while the pull chain cover has a switch in the base. The outlet at the top is connected to the source in the junction box.

Study Chapters 4 and 5 in "Wiring Simplified" when you do this exercise.

The upper left hand-corner of the panel shows the five steps in making a "Western Union" splice:

1. Twisting the wires
2. Completed splice
3. Soldered
4. Rubber tape
5. Friction tape

This splice is used only for outdoor wiring.

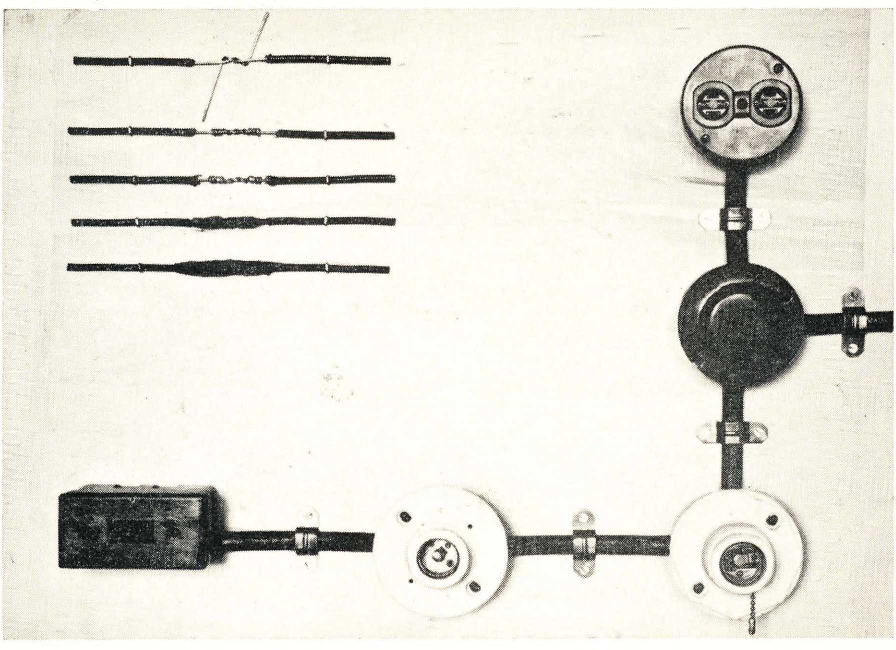


Fig. 26. The completed panel.

Materials Required for Panel

7 feet—No. 14 rubber covered wire
7 feet—2 wire No. 14 non-metallic cable
1—Rectangular or utility outlet box with clamps
1—Switch
1—Switch cover for rectangular outlet box
4—3¼″ outlet boxes
1—Duplex outlet for 3¼″ outlet box
1—Cover for 3¼″ outlet box
1—3¼″ lamp receptacle with pull chain
1—3¼″ lamp receptacle without pull chain
5—Cleats for 2 wire No. 14 non-metallic cable
20—⅝″ No. 8 round head screws

EXERCISE 16

MOVABLE WORK BENCH LIGHT

A movable lamp which can be used to provide ample light for any area of the work bench is a great convenience. The materials necessary for constructing this lamp are easily available.

Bill of Material

1 piece—1″ x 4″ x 24″
1 piece—1″ x 4″ x 14″
3 pieces—1″ x 4″ x 12″
1 piece—1″ x 2″ x 4″
1 piece—2″ x 2″ x 4″
1 piece—3″ x 3″ x 3″
1 piece—1″ x 2″ x 7″
1—3¼″ octagonal outlet box
1—3¼″ porcelain receptacle with appliance outlet (pull chain type if available)
1—No. 14 two wire rubber covered cable of length required
1—connector cap plug
1—½″ connector
1—14″ porcelain reflector
1—100 or 150 watt lamp

Procedure

Attach the 14″ piece of 1″ x 4″ to the 24″ piece. Attach the heel piece and brace boards as indicated (Fig. 27). Fasten the outlet box to the board and attach cable (using connector). Connect wires to receptacle and mount. Attach reflector.

Fastening a spool for extra wire on the upright, as indicated, is a very practical added feature. Or, a convenience outlet can be mounted

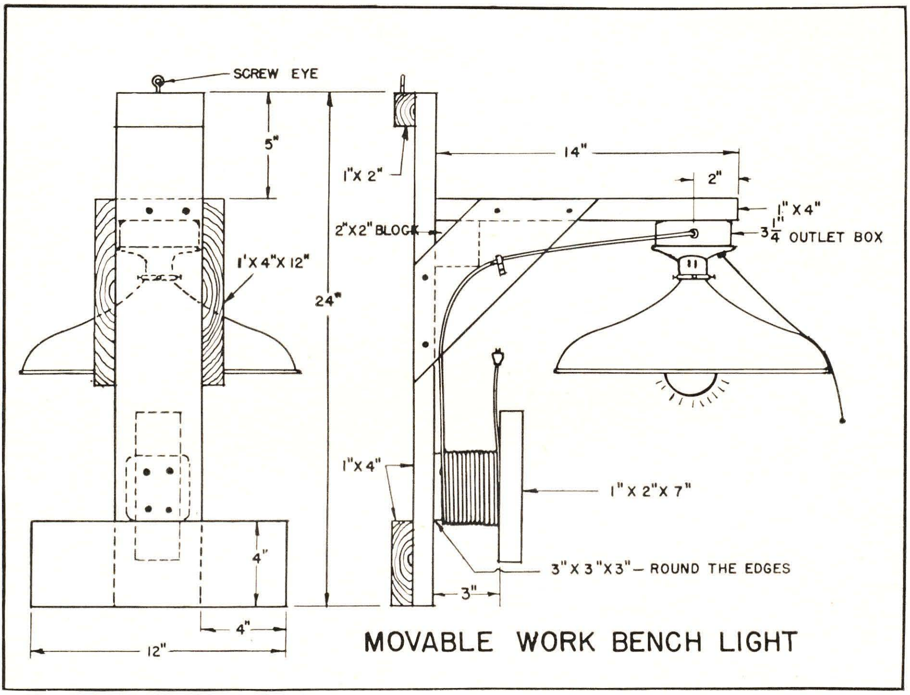


Fig. 27.

on the base, at the upright, for convenience in using small power tools. The same cable can be used to supply electricity to the convenience outlet and light.

Use a metal screw eye at the top of the upright, so the light can be suspended from a series of nails driven in at convenient places along the wall. The light should hang at such a level as to prevent glare in the worker's eyes.

EXERCISE 17

HOME LIGHTING SURVEY

Eyesight is probably the most precious and important of our five senses. And, good electrical lighting will help to preserve good vision.

The purpose of this exercise on home lighting is threefold:

1. To learn what "adequate lighting" is.
2. To measure the amount of light in various places.
3. To improve the effectiveness of your present lighting system.

Materials Needed

Light meter (may be borrowed from power company)
Rule or tape measure

Considerations in Determining Adequate Lighting

The amount of light is measured in *foot candles* (f.c.). One foot candle is "the amount of light a candle will cast on a surface placed one foot away." On a clear June day, there may be 10,000 f.c. of light available in the open. There may be 1,000 f.c. under a shade tree, and even 500 f.c. under a porch roof. Inside a room on a clear day, 200 f.c. may be available near the window—but 12 feet back from the window, there may be only 10 f.c. of light available. The average living room has less than 5 f.c. of artificial light supplied, which is considerably less than the eyes are accustomed to.

The following table gives the amount of light recommended for certain household tasks:

5 to 10 f.c.: for general lighting
10 to 20 f.c.: work areas in kitchen, laundry and ironing
20 to 50 f.c.: reading, sewing on light goods, shaving and make-up
50 to 100 f.c.: reading fine print, sewing on dark goods.

GENERAL LIGHTING refers to the light level throughout the room. This should be at least 1/10 the brightness of local lighting to avoid unpleasant and tiring contrasts of light and dark areas.

LOCAL LIGHTING is the light directly on your book, or other work.

The color of walls, ceilings, and floors has a marked effect on the amount of light available in a room. A light-colored room not only looks brighter, but actually *is* brighter—because the lighter colors reflect more light. This should be kept in mind when selecting the color scheme for a room.

Amount of Light Reflected by Different Colors

White (new)	82 – 89%	Blue	34 – 61%
Cream	62 – 80%	Pink	36 – 61%
Ivory	73 – 78%	Gray	17 – 63%
Green	48 – 75%	Tan (dark)	30 – 56%
Yellow	61 – 75%	Red (dark)	13 – 30%
Buff	49 – 66%	Green (dark)	11 – 25%

In addition to color, the following factors which depend mostly on the types of lamps, and their placement, should be considered.

1. *Direct Glare:* Proper shading of all bulbs will correct this serious lighting defect. Light is made to see by, not to be looked at.

2. *Reflected Glare:* Reflections from bright surfaces—such as a book page, desk top, etc.—are annoying. They can be eliminated by changing the position of the lamp or the work.

3. *Quality:* Light is of good quality when it is evenly distributed, and shadows are absent. The glass diffusing bowls on the better portable lamps distribute the light better, and soften the shadows.

4. *Intensity:* The foot-candle readings at each visual task should be in accordance with the recommendations.

5. *Contrast:* Unless the foot-candle reading throughout the room is at least 1/10 of the reading at the brightest spot in the room, there will be tiresome, unpleasant contrasts and a spotty lighting effect. The light meter readings are necessary to determine this important point.

6. *Adaptability:* There should be good lamps for every seeing purpose in the room, and enough of them so that all activities may go on simultaneously without having to move lamps about.

7. *Decorative Harmony:* This means that the lamp is pleasing to the eye from any location in the room, and is in keeping with sound decorative principles. There is a correct lamp for each table, desk, or furniture grouping.

Requirements

1. Select one room, preferably the kitchen or living room, and on a chart similar to Fig. 28, make a drawing of it. Show the size and shape, location of furniture, equipment and lights.

2. List the places where activities are carried on, giving the distance to lights and wattages of the lights.

3. Using the light meter, determine the amount of light available at each point listed under "2", above.

4. List all improvements needed.

5. Prepare another drawing and charts. Show the new arrange-

ROOM ____________________

(Let each dot represent 1 foot or 2 feet)

Activities Done Here:

Room Color:

WALLS *CEILING* *FLOOR*

Place of Activity	Distance to Light	Wattage	Min. f.c. Recom-mended	Reading in f.c.	Improvements Needed (or made)

Fig. 28.

ment of lights, furniture, equipment, color scheme, and any other changes which were made.

6. Write a short summary outlining the improvements in lighting made in your home and elsewhere, because of your interest in lighting.

Home Lighting References

"SEEING"—General Electric Company

"SEEING BEGINS WITH MEASURED LIGHT"—General Electric Company

"LIGHT UP AND LIVE ON THE FARM"—Westinghouse Electric Corporation.

EXERCISE 18

MAKING A TABLE LAMP

A properly designed table lamp makes reading, studying, and sewing easier, more comfortable—and conserves eyesight. In order to provide good lighting, a table lamp should have several important features. It should have an overall height of 26″ - 28″ and a flared shade with a bottom diameter of 16″ - 18″, to permit a good spread of light. The shade should be light enough to permit considerable of the light to pass through it. The lamp should have a diffusing bowl to soften the light and reflect some of it upward for general lighting. You can make such a lamp cheaply and easily with materials readily available.

In addition to the stem and base, which you will make, you will need the following materials:

1–lamp socket with switch, threaded for ⅛″ pipe)
1–⅛″ pipe nipple 1″ or1½″ long (to fit socket)
1–shade holder to fit socket (supports diffusing bowl)
1–diffusing bowl (8″ for 100 watt bulb)
1–shade (white lined with bottom diameter of 16″ to 18″)
1–100 watt bulb
1–lamp cord, 10-feet with rubber plug (U.L. approved) wood working tools, sandpaper, glue, etc.

Make one of the lamps shown in Fig. 29, or use any other plan which your leader thinks is suitable. The stem and base may be round, square, or octagonal. No definite measurements are required, except that the distance from the base to the socket should be 16″ - 18″.

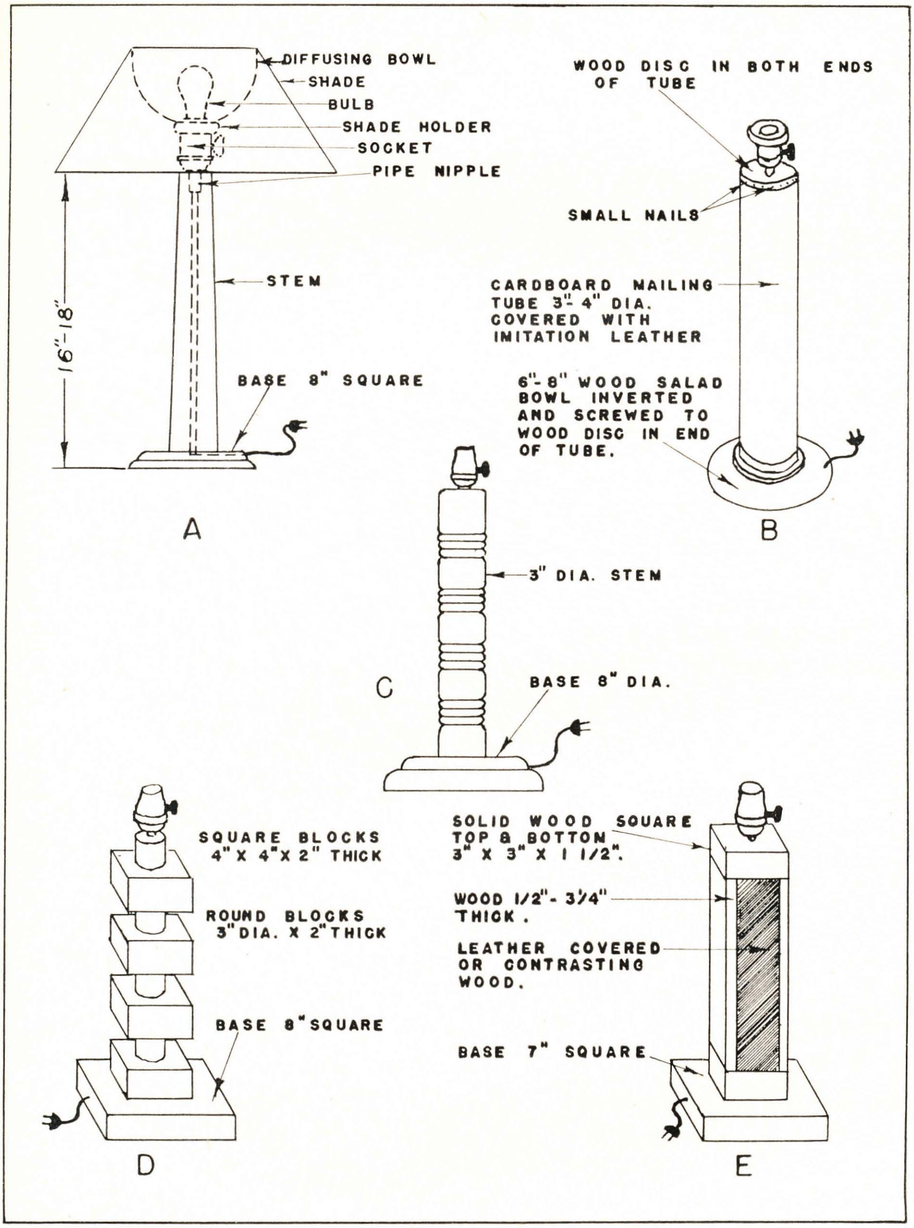


Fig. 29. Suggested table lamp designs.

Lamp "A": The stem is made by gluing together 2 pieces of wood 1″ x 2″ x 17″ and shaping them as shown in the sketch. Before gluing the pieces together, cut a "V" groove ¼″ deep lengthwise in each piece so that when they are fitted together the grooves match to form a hole through the center for the cord. The base is made of 2 pieces of wood 1″ thick. The lower piece is 8″ square and the upper one, 7½″ square. Make a groove on the under side of the top piece and drill a hole through the center of it to provide a place for the cord. Thread the cord through the hole and through the stem before gluing the base pieces together and fastening them to the stem.

Lamp "B": A cardboard mailing tube is used to make the stem for this lamp. A wood disk, 1″ thick, is fitted snugly in both ends and held in place with a few small nails. The base is a 6″ or 8″ wooden salad bowl, inverted and fastened to the bottom end with screws. The mailing tube may be covered with wallpaper or imitation leather.

Lamp "C": The stem and base for this lamp are to be turned on a lathe and a variety of turning patterns may be used. You will need a ⅜″ ships auger (which is longer than the ordinary wood auger) to drill the hole through the center for the cord.

Lamp "D": This stem is made by gluing together the required number of square and round blocks, as shown in the sketch, and fastening them on the base. A hole should be drilled through the center of all the blocks before assembling them.

Lamp "E": This stem is a hollow square tube with a solid square piece glued to both ends. Two or three different kinds of wood can be used in combination to make an attractive lamp.

The socket is fastened to each of the lamps by screwing it on the pipe nipple, which in turn is screwed into a ⅜″ hole in the top of the stem.

Rub the wood parts with fine sandpaper to make them smooth, and apply the desired finish to the wood. The shade holder is screwed on the socket and the diffusing bowl fastened in place. With the addition of the bulb and shade, you have a good lamp which is worth far more than it cost.

EXERCISE 19

INSTALLING A DOORBELL OR CHIME

Doorbells or chimes are convenient devices, simple to install, which make it easier for visitors to announce their arrival. A bell is usually installed for the front door, and a buzzer for the back door, in order to tell at which door the visitor is calling.

Musical chimes have a much more pleasant tone and are gradually replacing the doorbell. They are usually so arranged that when the front door button is pushed a different signal is sounded than when the back door button is pushed. Also an advantage is that no matter how long the button is held down, the chime does not repeat, or ring continuously.

The exercise consists of installing a doorbell or chimes. Refer to Chapter 12 of "Wiring Simplified" for instructions. The following materials are required:

1—bell transformer or 2 dry cells (1½ volt each)
1—chime or doorbell and buzzer
2—push button switches
bell wire as needed.

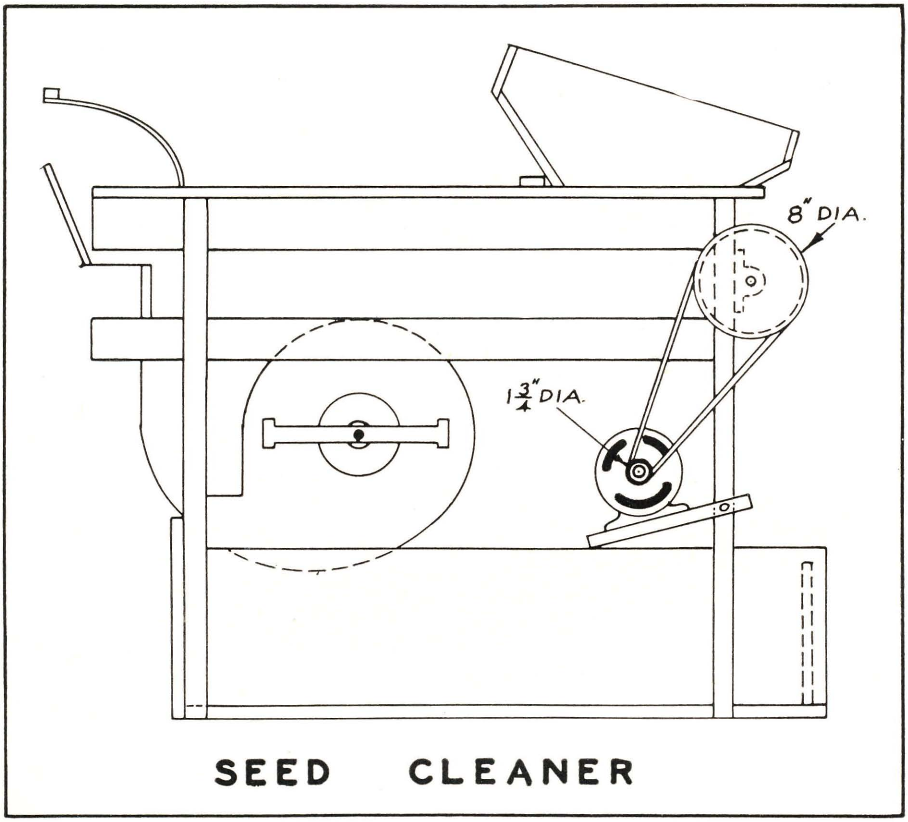


Fig. 30.

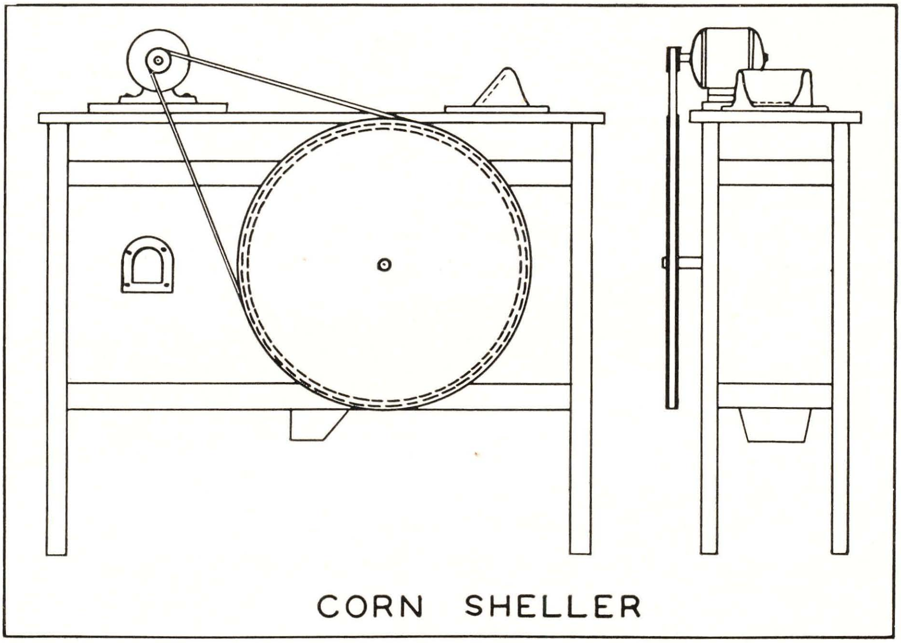


Fig. 31.

EXERCISE 20

MOUNTING A MOTOR ON A SEED CLEANER OR CORN SHELLER

The seed cleaner and the corn sheller are two machines which are easy to electrify. An electric motor will drive them all day for a few cents worth of electricity. This exercise requires that you mount a motor on a seed cleaner or corn sheller, and report which you did. (Figs. 30, 31.)

Attachment to Seed Cleaner

Attach the motor to a 9″ x 12″ board, 1″ thick, which is notched to fit the post of a fanning mill as indicated in Fig. 30. Drill a 3/8″ hole lengthwise through the board or attach 1″ x 2″ strips to the board and drill holes for the bolt through the strips. Also drill a 3/8″ hole through the post at a point 16 inches below the rack power shaft. A 3/8″ machine bolt, 13″ long is necessary to reach through the board. Use an 8″ pulley on the rack power shaft with a 1¾″ pulley on the motor to get a speed of 400 r.p.m. If necessary, reverse the motor to obtain the proper direction of rotation.

Attachment to Corn Sheller

To transfer the motor to a corn sheller simply mount the board on top of the sheller as indicated in Fig. 31, and reverse the direction of rotation of the motor if necessary. A capacitor or repulsion-induction (RI) motor should be used.

If the flywheel does not have a flat face on which to run the belt, a pulley can be made from ¾″ or 1″ plywood cut to size, and bolted to the flywheel. As a safety precaution replace the handle with a collar fitted with a flush set-screw.

EXERCISE 21

CALL BELL IN BARN

For convenience or emergency use, a call bell may be installed in the barn. Various signals may be prepared to summon each member of the family to the telephone, or to meals, or to call anyone in case of emergency.

A bell may be installed in the barn only, or one may be installed in the barn and one in the house, making it possible to signal from either place.

Materials Needed

1—push button switch—2 needed if bell is used in house and barn
1—call bell—2 needed if bell is used in house and barn
1—bell transformer or 2 dry cells
inside wire as needed (bell wire)
outside wire as needed (weatherproof)

Procedure

Install the call bell in the barn at a point where it can be heard in any part of the barn. The bell in the house is usually installed in the kitchen. The transformer or dry cells may be located either in the house or barn. Complete the installation to the source of either the bell transformer or two dry cells hooked in series, that is, center post of one battery to the outside post of the other battery. Connect the switches, and mount them in a convenient location.

The bell wire should be kept at least 6 inches from the power wires inside the building. The wiring system for this project is similar to that used in wiring a doorbell, as outlined in Chapter 12 of "Wiring

Simplified". The main difference is that outside wire is needed between the house and barn to complete the circuit. The outside wiring should be installed in the same way as ordinary electrical wiring, using proper size as indicated in the following table:

Spans up to 25 feet: No. 12 wire (Weatherproof)
Spans 25-50 feet: No. 10 wire
Spans 50 feet and over: No. 8 or larger

Wire smaller than recommended may be used, but breakage must be expected in case ice forms on the wire.

When the outside wires are mounted on the light pole, they should

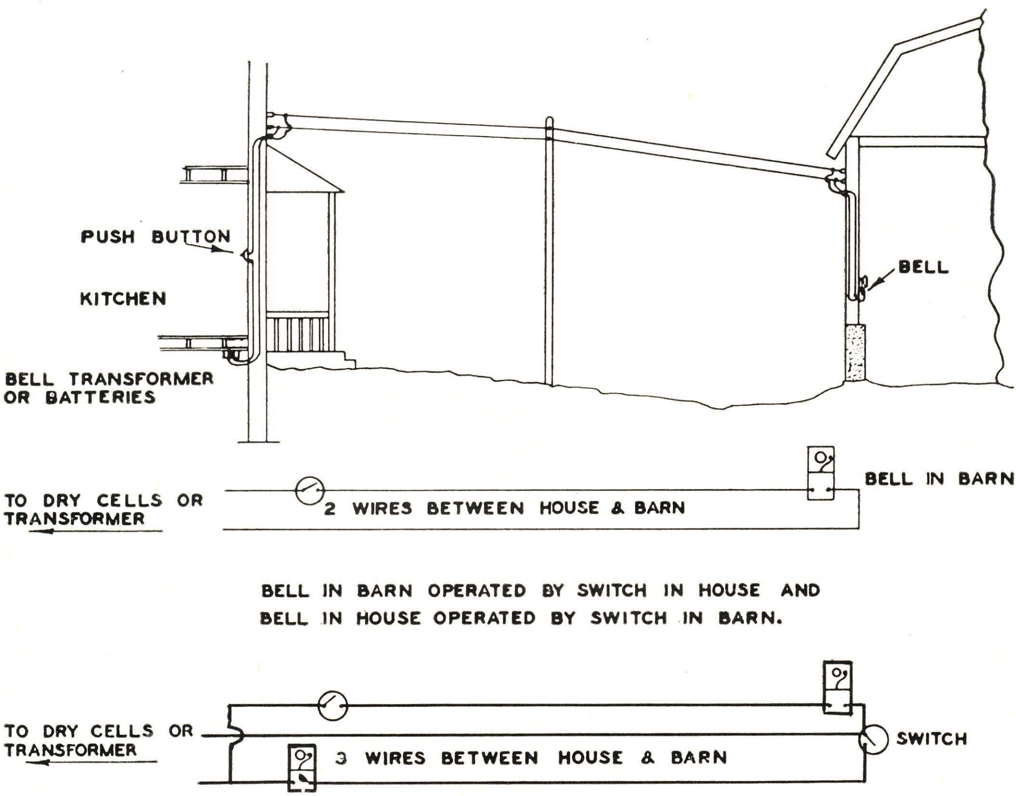


DIAGRAM OF CIRCUITS FOR CALL BELL IN BARN

Fig. 32.

be below the light wires, preferably at least a foot. All outside wires should be placed at sufficient height to clear traffic. The diagram (Fig. 32) shows how the circuits are connected. Consult "Wiring Simplified".

EXERCISE 22

BELT SANDER

A belt sander is a useful piece of equipment for the shop; you can easily make it by following the plan in Fig. 33.

Materials Needed

No.	Description	Size	Quan.	Material
1	Driver pulley shaft	½″ diam. x 6⅝″ long	1	Steel or iron
2	Single groove "V" type pulley, with set screw.	2″ diam. ½″ bore. For ½″ or ⅜″ wide belt.	1	Metal
3	Belt driven pulley and idler pulley.	2⅛″ diam. x 3⅛″ long	2	Hard wood
4	Common nail for key on driver pulley and shaft.	20d, approx. 3/16″ diam. by 4″ long.	1	Steel or iron
5	Flat head, wood screws	No. 9 x 1½″ long	7	Steel, brass or iron
6	Carriage bolts	¼″–20 N.C. x 5″ long	2	Iron or steel
7	Wing nuts	¼″–20 N.C.	2	Iron or steel
8	Idler pulley shaft	½″ diam. x 4¾″ long	1	Steel
9	Belt tension adjustment screws.	No. 10–24 N.C. machine screws, 2½″ long.	2	Steel
10	Siding plates	¾″ x 4″ x 12⅝″	2	Hard wood
11	Bottom plate	¾″ x 5″ x 20½″	1	Hard wood
12	Working top and spacer block	1¾″ x 3½″ x 7½″	1	Hard wood
13	Sandpaper belt	3″ Wide x 24″ grit to suit	1	
14	Tension adjustment straps	½″ x 3⅝″ x No. 16 Ga	2	Iron or brass
15	Wing nuts	No. 10–24 thread	2	
16	Thrust plates	½″ x 2″ x No. 16 Ga	2	Iron or steel
17	Wood screws	No. 8 x 1¼″, flat head	4	Iron or brass

Procedure

1. Prepare the wood parts by cutting to proper size and drilling the necessary holes as shown in the plan. The pulleys will need to be turned out on a lathe.

2. Assemble the wooden pulleys on the shafts and fasten the driver pulley to the shaft with a nail as indicated.

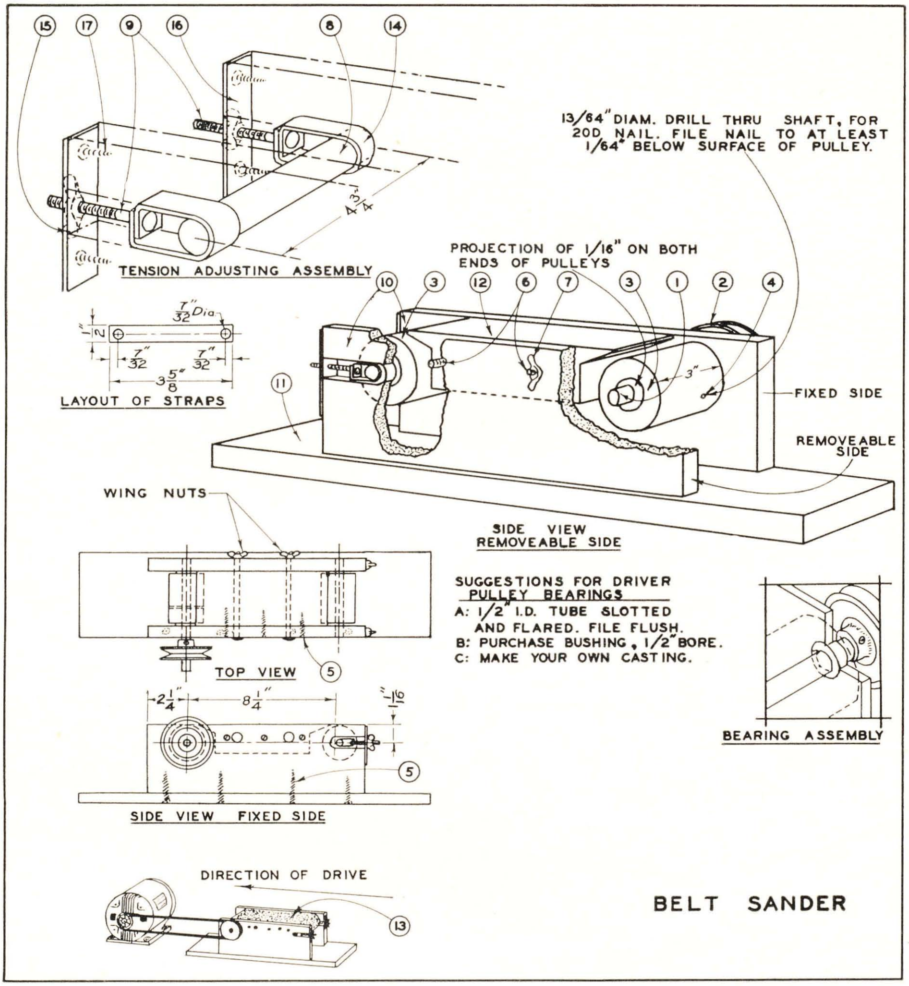


Fig. 33. Working drawing of the belt sander. Numerals refer to the descriptions in the "bill of materials" for Exercise 22.

3. Make the tension adjusting straps by bending as shown in the diagram (the holes should be drilled before bending).

4. Assemble the sander placing the pulley on the shaft last. Note that one side is removable, so that the sanding belt can easily be changed.

5. The sanding belt must run in the direction indicated in the plan.

EXERCISE 23

COST OF ELECTRICITY FOR OPERATING CERTAIN EQUIPMENT

The purpose of this exercise is to make each club member realize the economy of electricity as a source of power. Power companies have agreed to furnish an electric meter, if they are available, so that accurate results can be obtained on your farm.

Materials Needed

Local electric rate }
Electric meter } obtain from power company

Procedure

If the meter is available, attach it to the electrical equipment for 15 or 30 days. A representative of the power company will show you how to attach it. Where this is not possible, the operating cost can be estimated as outlined below. Compute the cost on a monthly basis.

Each motor on the farm has a name plate giving its rated horsepower. Because motors are not 100 percent efficient, a one-horsepower (1 h-p.) motor will use approximately 1 KWH of electricity for each hour of operation or a ½ h-p. motor will use about ½ KWH. So by multiplying the h-p. of the motor by the hours of operation during

TABLE 12—A typical 4-H club electrical cost report

Column No.	1	2	3	4	5
EQUIPMENT	H-P. OR KW. RATING OF APPLIANCE	HOURS IN USE PER MONTH	KWH USED PER MONTH—(Col. 1 x Col. 2)	COST PER MONTH (Col. 3 x Average cost per KWH)	REMARKS
Water pump	½	80	40	$0.96	Used meter 15 days
Washing machine	¼	12	3	0.07	
Water heater	2	60	120	2.89	
Milking machine	½	76	38	0.92	Used meter 10 days
TOTAL	....	....	301	$4.84	

Monthly bill—net $4.84
KWH used 201
Average cost per KWH .... 2.41 cents.

the month, you will have a close estimate of the number of KWH used. That estimate multiplied by the average cost-per-KWH, gives you the approximate cost of the electricity used by the motor.

The current requirement of heating equipment is given on the name plate. The cost of operation is figured by converting the watts to kilowatts, and multiplying that figure by the hours of operation and the average cost-per-KWH.

At least two pieces of equipment should be checked with the meter and accurate costs determined. If a meter is not available, estimate the costs. A report similar to Table 2 should be attached to your electrical club report.

EXERCISE 24

ICE CREAM FREEZER POWER UNIT

A simple power unit to turn an ice cream freezer with a motor is shown in Figs. 34 and 35. Other hand-operated machines, such as

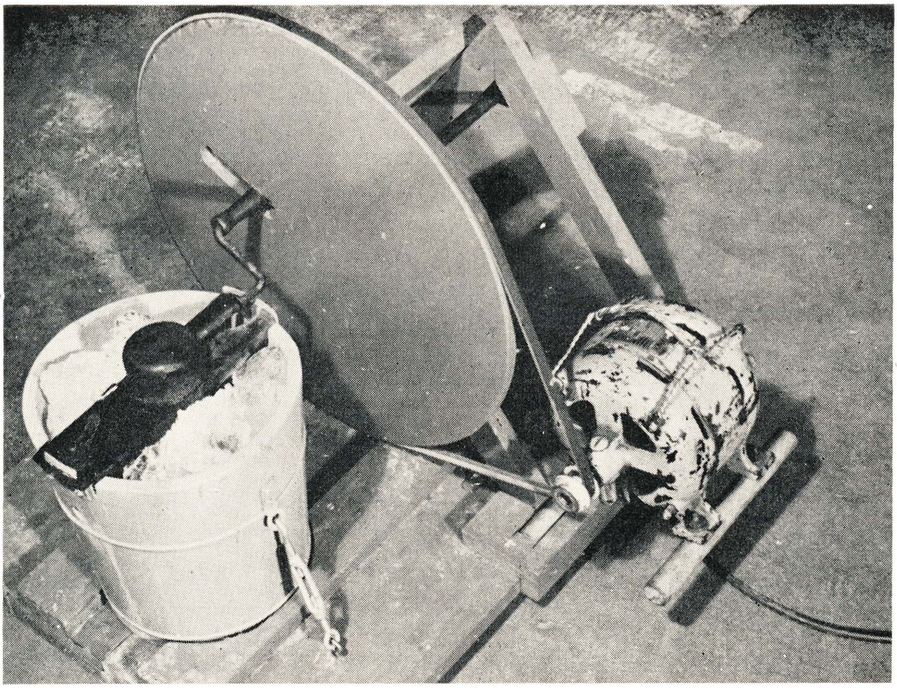


Fig. 34. View of an ice cream freezer, showing the construction. No dimensions are given since they will vary with different sizes of freezers.

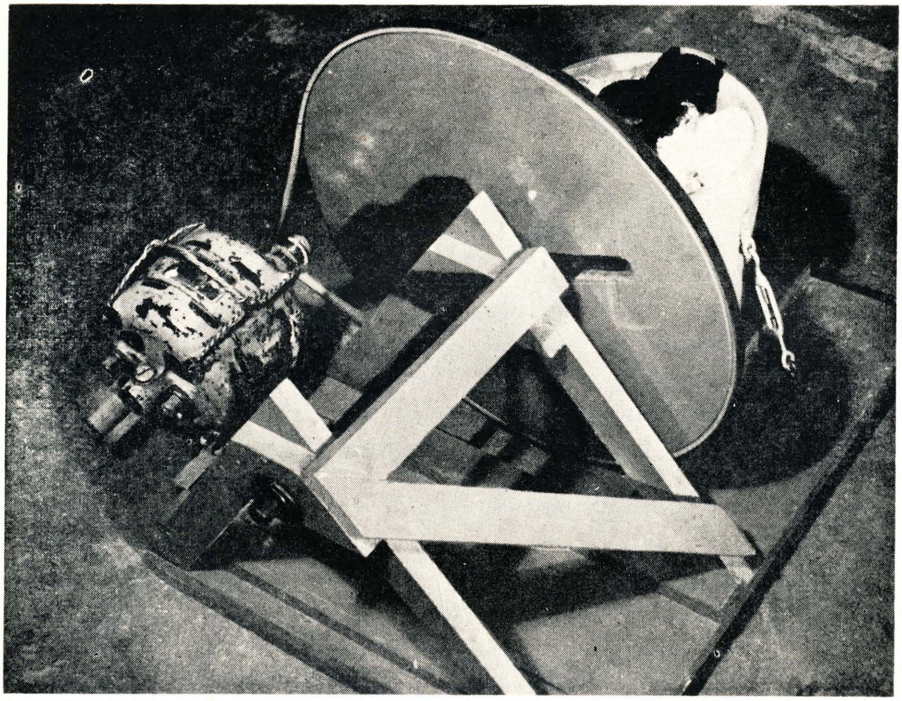


Fig. 35. Another view of ice cream freezer showing construction.

meat grinders and churns can be power-driven in the same way. This device is easy to construct, and it is not necessary to make any changes on the machine which is to be driven.

Materials Required

1—1″ x 6″ x 12′ for platform
1—2″ x 4″ x 10′ for frame
2—1″ x 4″ x 8′ for braces and cross pieces
1—¾″ x 17″ (or larger) plywood pulley
1—V-belt
1—¼″ x 18″ pipe threaded both ends
1—¼″ pipe flange
1—¼″ pipe cap
1—washer to fit over pipe
1—1½″ V-pulley to fit motor shaft
2—turn buckles of suitable size
1—portable motor and mounting
necessary nails and screws

NOTE: ⅜″ or ½″ pipe may be used if ¼″ fittings are not available.

Procedure

Make the platform about 2′ x 3′ in size by nailing the 6-inch boards on 3 cross pieces placed underneath. Assemble the frame out of 2″ x 4″ material, braced with 1″ x 4″ pieces, and nail to the platform. The pipe shaft passes through the short 2″ x 4″ pieces near the top, and must be mounted at exactly the same height as the crank shaft on the ice cream freezer. Cut a slot about 4-inches long in the pulley to admit the crank handle. Mount the pipe flange over the center of the plywood pulley and screw the pipe into the flange. The pipe cap and washer on the other end holds the pipe in place. The turnbuckles are used to fasten the freezer to the platform.

A 1½″ pulley should be used on the motor, which will give a freezer speed of about 160 r.p.m., when used with a 17″ pulley.

EXERCISE 25

INSTALLING A YARD LIGHT OR ADDITIONAL SWITCH ON A YARD LIGHT

The value of yard lights from the viewpoint of convenience and safety is immeasurable. An additional switch in the garage or granary can often pay for itself in a short period of time.

This exercise may be either the installation of the yard light with two switches, the installation of an additional switch, or the installation of a remote control lighting unit. In Fig. 36, Diagram *A* shows the "hook-up" when two switches are used. The letters *H* and *G* denote "hot" and "grounded" wires.

Inside wires should be non-metallic cable, and may be either No. 14 or No. 12 wire. Outside, use weatherproof wire—either No. 12, 10, or 8—depending on the distance between supports. All wiring must be done according to instructions given in "Wiring Simplified". Study chapters 4 and 15 before doing this project. The "Wiring Panel" should be completed before attempting this exercise.

Diagram B in Fig. 36 shows the hook-up for multiple switching using remote control mechanism for lighting.

Remote Control Lighting

In the metal box containing the remote control mechanism, there is a transformer and a relay or solenoid-operated switch. The transformer reduces the circuit voltage (115-125 volts AC) to 24 volts. The

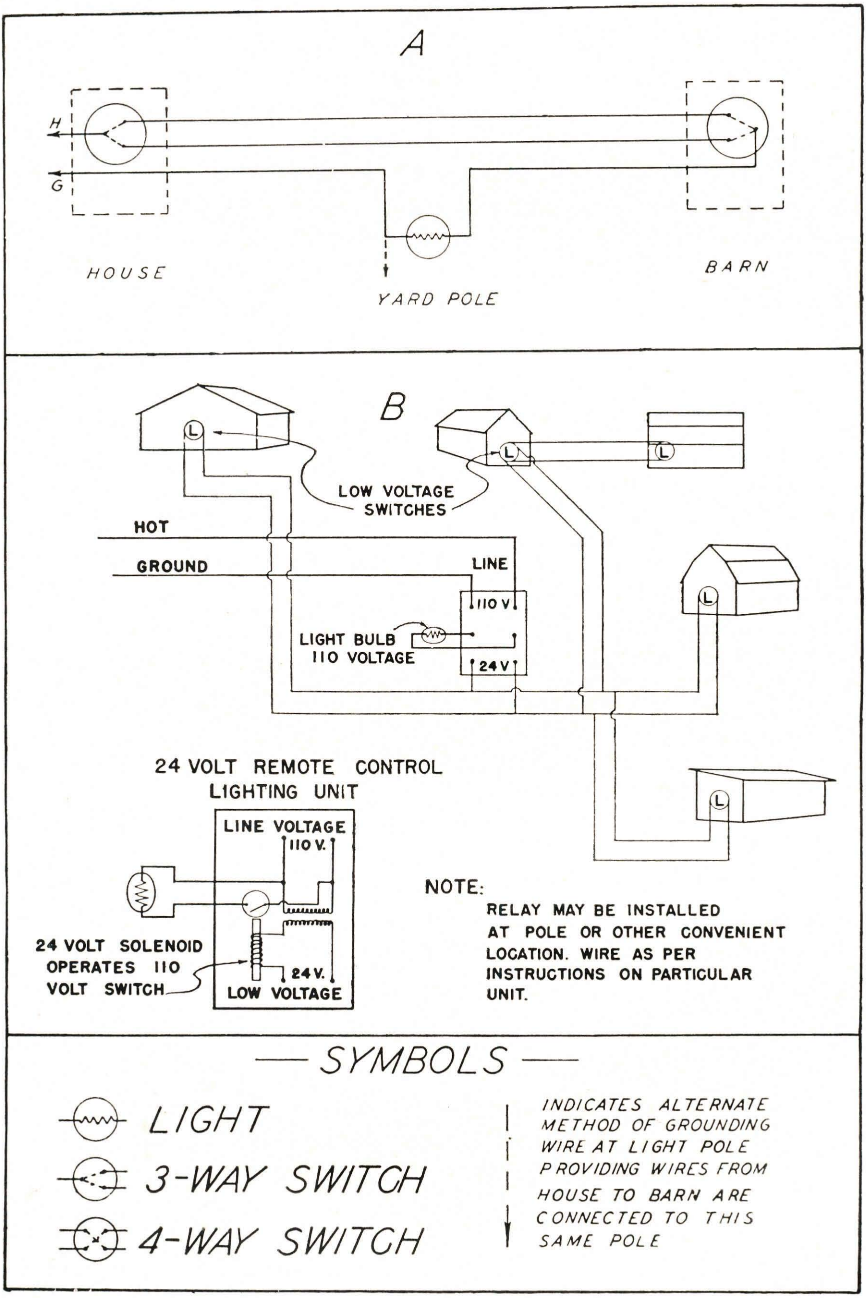


Fig. 36. Yard light wiring diagrams.

voltage of the circuits which run to the various remote control switches is 24 volts. Long runs of cable to barns and other farm buildings are often prohibitive when standard 115-125 volts wiring has to be used. This method of remote control is often an economical way to control a light from several locations.

The relay-operated switch opens or closes the circuit to the light as the remote switches are moved to "ON" or "OFF" position. More than one light can be operated through a single relay, provided the total load does not exceed ⅓ h-p., 15 amp., 125 volts AC.

The remote control system, using low voltage, is not subject to the same code restrictions as the conventional system. The low voltage system can be short circuited at any point without danger to the installation of excessive heat or fire or injury to the operator. Low cost 2 and 3-conductor wire may be used for underground, overhead, or inside wiring as designated.

EXERCISE 26

SWITCH PANEL

This is a good exercise to do before attempting the actual installation of a yard light, or an additional switch. It will help you understand how the circuits are wired for controlling a light from several points, and the switches can be used later in actual rewiring work.

The exercise consists of making a panel showing one or both of the typical yard light installations, as shown in Fig. 36. The type of wiring is the same as in the "Wiring Panel" exercise. (See page 45.)

Mount the switch boxes, and an outlet box for a lamp receptacle, on a panel. Use a 3-wire cable between the boxes, and connect the switches as shown in the diagram. Install a lamp receptacle on the outlet box. Attach a cord at one end of the system to supply current for the light. Before putting on the switch covers, operate the switches and trace the path of the current each time a switch is turned on.

EXERCISE 27

PIG BROODERS

The electrical pig brooder is a simple piece of equipment which helps to save more pigs per litter during early spring farrowing. By providing a warm area in one corner of the pen, it prevents loss by chilling after farrowing—and protects the little pigs from injury.

The little pigs should be placed under the brooder immediately after farrowing. Once they learn to stay there, little attention is needed to reduce the danger of the sow laying or stepping on them. The electric brooder should be used during farrowing, and for 7 to 10 days afterwards. Either of the two types in this exercise—incandescent lamp ("hover type") or infra-red lamp—can be used in any farrowing pen where electric current is available.

While it should go without saying, always use electric pig brooders in a safe manner. Costly losses have resulted, because of fire or the electrocution of valuable animals, when brooding equipment was not used properly. Be certain to protect the brooding equipment from the sow, or other farm animals, by a sturdy fence (Figs. 37 and 39). And connect the brooder directly to a convenience outlet; never run a long extension cord across the barn or brooder house.

Where the infra-red lamp type brooder is in use, connect *each lamp* directly to the convenience outlet. Don't use a 3-way plug, for example, to connect more than one infra-red type brooder to the same convenience outlet. Moreover, remember that the same safety rules against never overloading an electrical circuit always apply:

The total load in watts of infra-red type brooders, or incandescent lamp brooders, should not exceed the load allowable (in watts) for the size of the wire bringing service into the brooding areas.

HOVER TYPE PIG BROODER

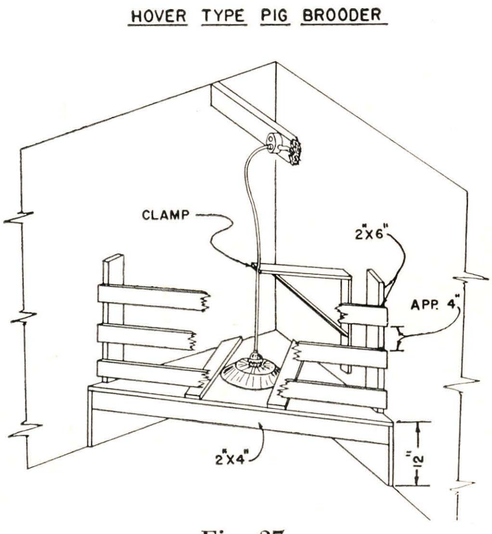


Fig. 37.

The hover-type brooder should be fastened securely in one corner of the house or pen, and a stout gate (2 x 6's are recommended) spiked in place across the corner above it.

Construction

Construct the brooder according to the plan shown in Fig. 37. The two sides can be made from either planks or boards 12″ wide, from 36″ to 42″ long. For use in a 6′ x 6′ farrowing house, use 36″ sides;

in larger houses, use 42″ sides. The hover top is made of boards, or from ¼″ to ⅜″ plywood if available. A horizontal 2 x 4 goes in place along the front edge, to give the structure more strength and to help hold the heat under the brooder.

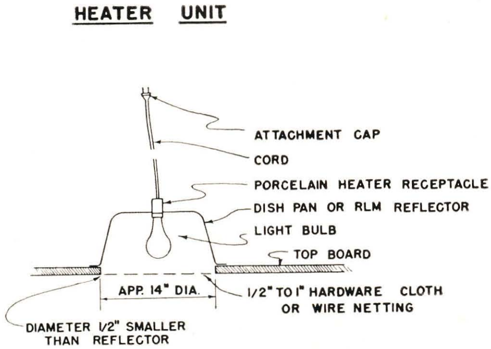


Fig. 38.

If an RLM reflector is not readily available for the incandescent heater unit, a dishpan with a bright inside surface can be substituted (Fig. 38). The pan should be 6″ or 7″ deep, and approximately 14″ in diameter. Use a hammer and cold chisel to make a hole in the bottom of the pan, large enough for a porcelain heater receptacle. Use only rubber-covered cord. (To facilitate use of the brooder, mount a convenience receptacle on the wall of the individual house, or near the farrowing pen in the central house. Wire from the receptacle in the individual house should extend to the outside through an approved weatherhead.)

Fasten the reflector with screws, to permit replacement of the light bulbs. Nail a piece of hardware cloth or fine chickenwire below the hole in the hover, as a safety measure. That will act as a guard to prevent straw or litter coming in contact with the bulb, and perhaps causing a costly fire.

The bulb in the incandescent lamp pig brooder has to be changed to meet the weather conditions. Use a 100-watt bulb during normal winter weather. Use a 150-watt bulb during severe weather. And during mild weather, use a 60-watt bulb.

INFRA RED LAMP PIG BROODER

In general, the construction of the infra-red type pig brooder is even simpler than that of the hover-type brooder. (Fig. 39.) Essentially, it consists only of the cord, lamp, lamp positioner, and the same kind of a stout gate spiked in place for the protection of the little pigs.

Use of the infra-red lamp eliminates the reflector necessary with an incandescent lamp, and the hover top needed to hold in the lesser amount of heat given off by an ordinary light bulb. Support of the lamp is very important, however, and it must be hung so that there is a minimum of 18″ between it and the level of the bedding. All of the same safety precautions as to overloading, use of rubber-covered cord, and proper wiring apply.

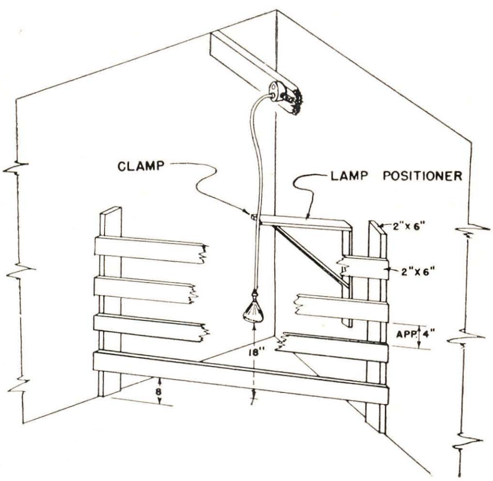


Fig. 39.

As to the infra-red lamp itself, either the red-ended or the white glass type can be used. Both will give the same amount of radiation (heat). The red-ended lamp is a hard glass type, and will not break if water splashes on it, or a pig rubs his nose against it. Moisture coming in contact with the white glass lamp when it is hot will cause the lamp to break.

EXERCISE 28

ELECTRIC CHICK BROODER

This home-built 4′ x 4′ brooder, equipped with 8 low-wattage lamps, will care for 250 chicks during normal brooding conditions. Three hundred and fifty chicks may be brooded in a 4′ x 6′ brooder of similar construction, using 12 low-wattage lamps. The cost of building materials should be about $15, and it will have a life comparable to that of a good commercial brooder.

Construction

The frame is 1″ x 4″ material. The top and sides are ¼″ building board of the hard type—such as plywood, fiber board, or studio board. The 4″ of space on top of the brooder should be filled with litter similar to that used on the floor.

Bill of Materials

3—1″ x 4″ x 12′ white pine recommended
1—¼″ x 4′ x 8′ building board of hard type
8—two-piece porcelain standard receptacle sockets with concealed terminals—such as Paulding 50721
20′—rubber-covered cord, No. 16
12—2″ No. 8 screws (fasten mounting strips to brooder)
½ pound—6d cement-coated nails
16—¾″ No. 6 screws (fasten receptacle to mounting strip)
1—handy utility box with cover for duplex outlet
2—½″ connectors
1—duplex receptacle—flush
3—connector caps (plugs)
8—60-watt electric lamps

Cut building materials into the following pieces (the lettered parts refer to those in Fig. 40):

PART NO.	REQ. NO.	SIZE	PIECE
A	4	1″ x 4″ x 16″	legs
B	2	1″ x 4″ x 48″	side supports
C	2	1″ x 4″ x 45½″	side supports (cut length to fit)
D	3	1″ x 4″ x 47″	mounting strips
E	1	¼″ x 47″ x 48″	top board
F	2	¼″ x 12″ x 48″	sides
G	2	¼″ x 12″ x 49″	sides

Wiring the Brooder

For wiring the brooder, 2-piece porcelain standard receptacle sockets, with concealed terminals, are satisfactory. The 8 sockets are arranged as shown in Fig. 40 (at the right). A duplex outlet on the side of the hover aids in making connections, and provides a simple way of turning lights on and off to control the temperature.

The center circuit of 2 lamps is attached directly to one pair of terminal screws on the duplex unit. It will remain "on" as long as the cord from the brooder is plugged in. The two outside circuits of the 3 lamps each, are provided with attachment plugs which are "ON" only when plugged into the duplex outlet. Rubber-covered No. 16 cord is satisfactory.

An alternate method of wiring is to connect all the lights in one circuit. This method eliminates the duplex outlet, but it is then necessary to loosen or tighten in the socket any lamp which is to be turned off or on.

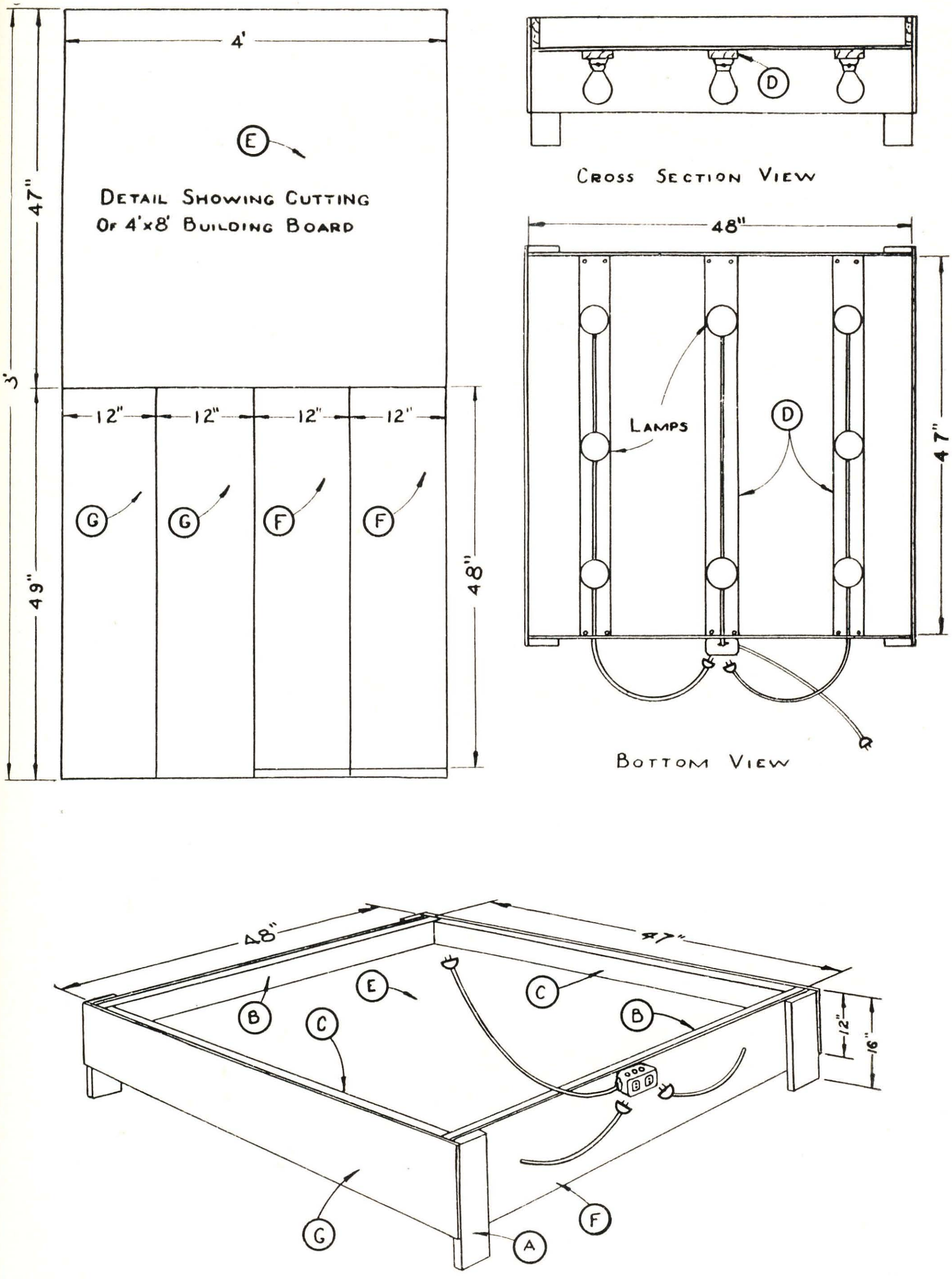


Fig. 40. Home-built brooder.

Controlling the Temperature

Use eight 60-watt standard lamps when starting the chicks. As the chicks grow older, their bodies will furnish more heat—and the temperature may be lowered by using fewer or smaller lamps. No thermostat or thermometers are necessary; just watch the chicks. They will huddle in a bunch if too cold; if it is too warm, none of them will stay under the brooder.

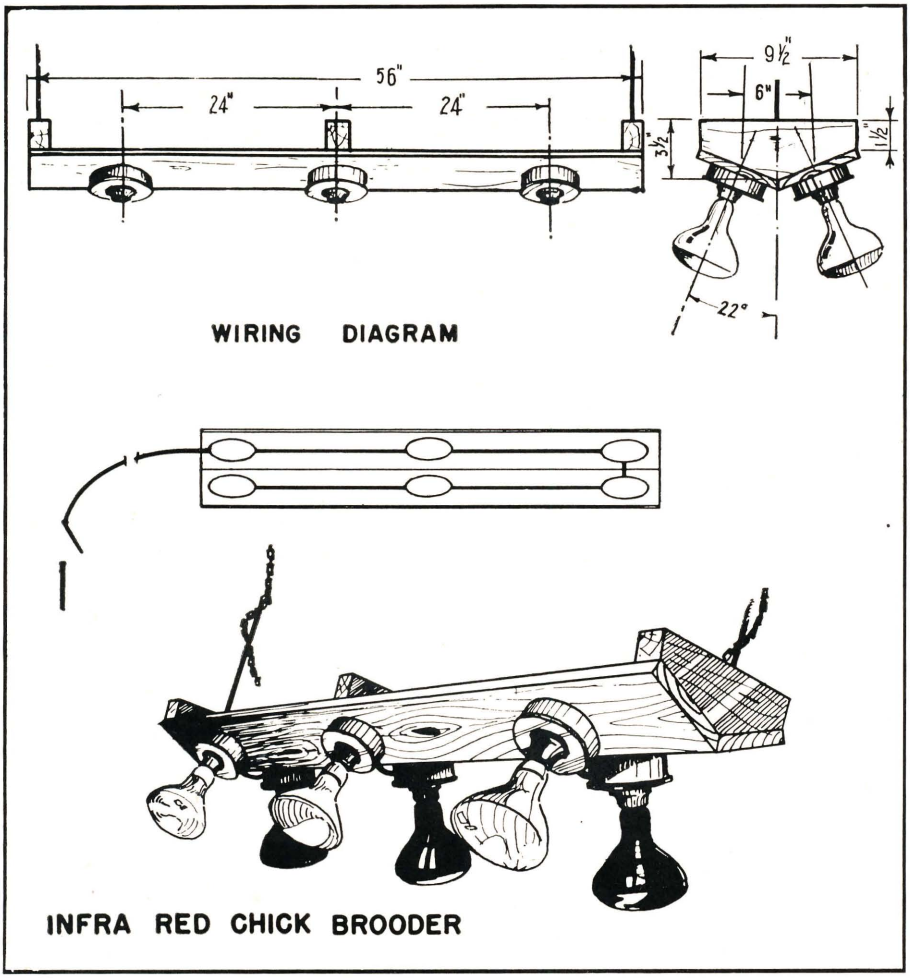


Fig. 41. Infra red brooding unit for chicks, with working drawing and wiring diagram.

Safety Precautions

Always leave a lamp in every socket to prevent danger from electrical shocks. Lamps should not be closer to the floor than shown in the drawing. All wiring to the brooder house, within the house, and in the brooder itself should be installed according to approved methods. It is important that the wires leading to the house be of proper size, since wires which are too small will greatly reduce the heat output of the lamps.

EXERCISE 29

INFRA RED CHICK BROODER

This 6-lamp brooder unit (Fig. 41, bottom) will care for 350 to 400 chicks during normal brooding conditions. The cost of materials for building the brooder should be about $10, and it will have a life comparable to that of a good commercial brooder.

Construction and Wiring

The brooding unit (Fig. 41, top) can be made from two 1″ x 6″ boards, cut 56 inches long. The 1 x 6's are fastened to the 2″ x 4″ crosspieces. The lamps are on 24″ centers.

Either porcelain sockets mounted on metal junction boxes, or heavy duty non-metallic junction boxes and outlets rated at 660 watts each, can be used. Two-wire, No. 12 non-metallic sheath cable should be used for wiring the lamps, and for connecting brooding unit to a disconnect switch (Fig. 41, center). Make all connections inside junction boxes; connect each lamp across the 115 volt line.

Either white glass or red-ended infra-red heat lamps can be used. Both lamps will give the same amount of heat. The red-ended lamp is made of hard glass, and will not break if water splashes on it. The white-ended lamp is made of regular glass, but has proved satisfactory for use in infra-red chick brooders.

Safety Precautions

Support infra-red brooder unit with light chain to rafters.

Do not place bottom of lamps closer than 18″ to litter.

Connect the brooding unit directly to the disconnect switch, or the fuse panel. The unit using six 250-watt lamps requires a separate circuit of 15-ampere capacity. The circuit should be fused in the brooder house.

Bill of Materials

2—1″ x 6″ x 52″white pine recommended
3—2″ x 4″ x 9½″
6—4″ outlet boxes
6—4″ keyless lamp
20′—2 wire No. 12 non-metallic cable
5—cleats for 2 wire No. 12 non-metallic cable
6—250-watt infra-red heat lamps

EXERCISE 30

INFRA-RED HEATER FOR THE OPERATOR

This milkhouse heater (Fig. 42) has the purpose of warming the operator while working in the milkhouse in cold weather. The unit should be mounted over, or just outside of the wash vat. (Fig. 43.) It

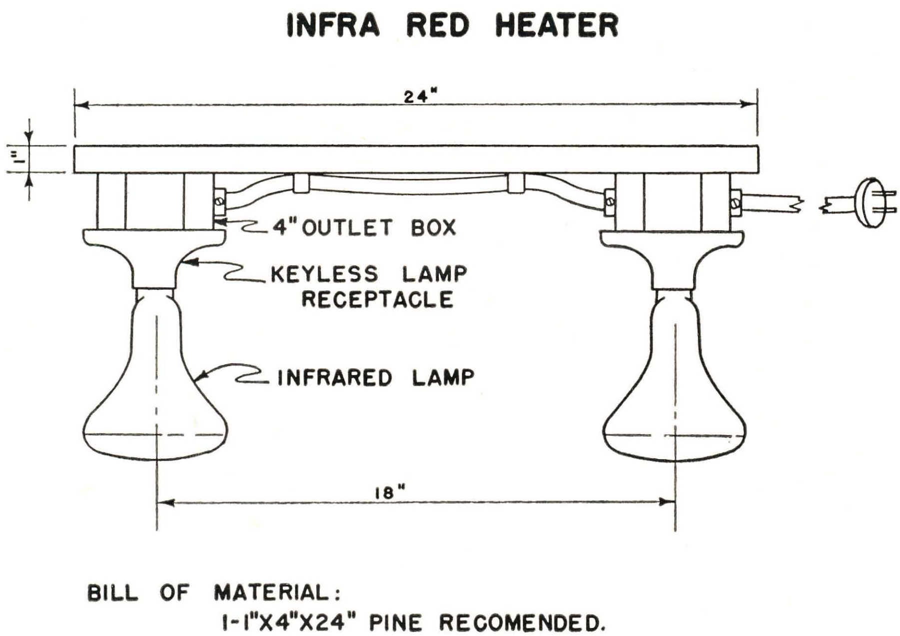


Fig. 42. Infra heater unit for the operator working in the milkhouse in cold weather. It will not warm the entire room.

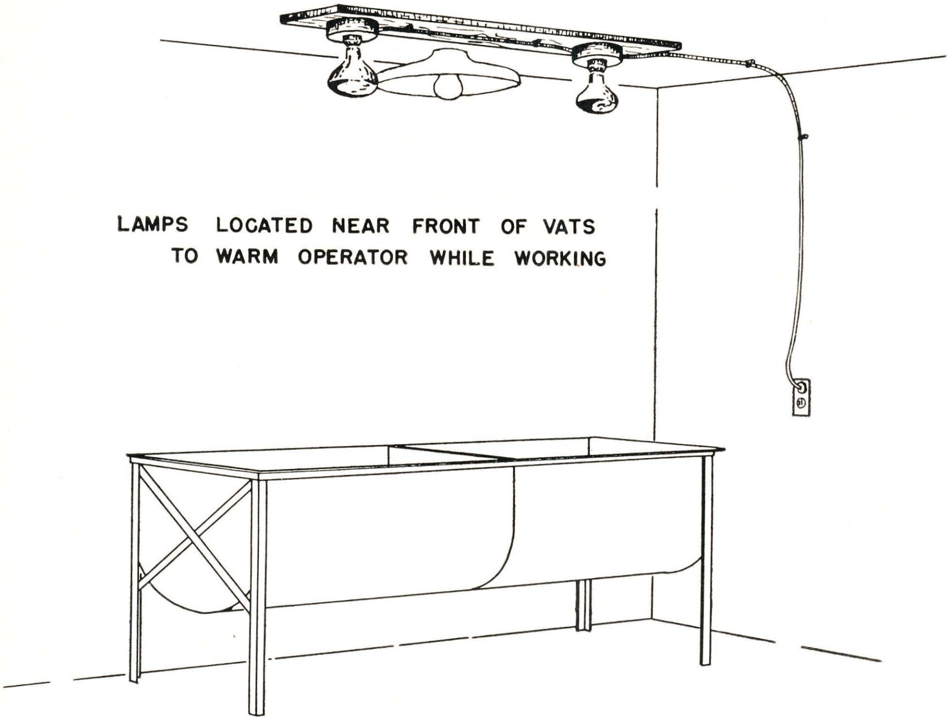


Fig. 43. How the heater unit shown in Fig. 42 is used in the milkhouse.

can be plugged into the outlet whenever it is needed. The unit is not large enough to warm the entire milkhouse. (See Exercise 31.)

Bill of Material

1—1″ x 6″ x 24″ pine recommended
2—4″ outlet boxes
2—4″ keyless porcelain or heavy duty non-metallic lamp receptacle
10′—2-wire, No. 14 rubber-covered wire (or enough to reach to a duplex outlet)
2—250-watt infra-red heat lamps

EXERCISE 31

INFRA-RED MILKHOUSE HEATER

The milkhouse can be kept at approximately 40° during the winter months, using infra-red lamps as a heat source.

One heat lamp is needed for each 120 square feet of floor space. The lamps should be arranged so that most of them are along the outside walls and over the water pipes. At least two of the infra-red lamps should be located so as to be just above anyone washing equipment in the wash vats.

The lamps over the wash vats should be controlled independently

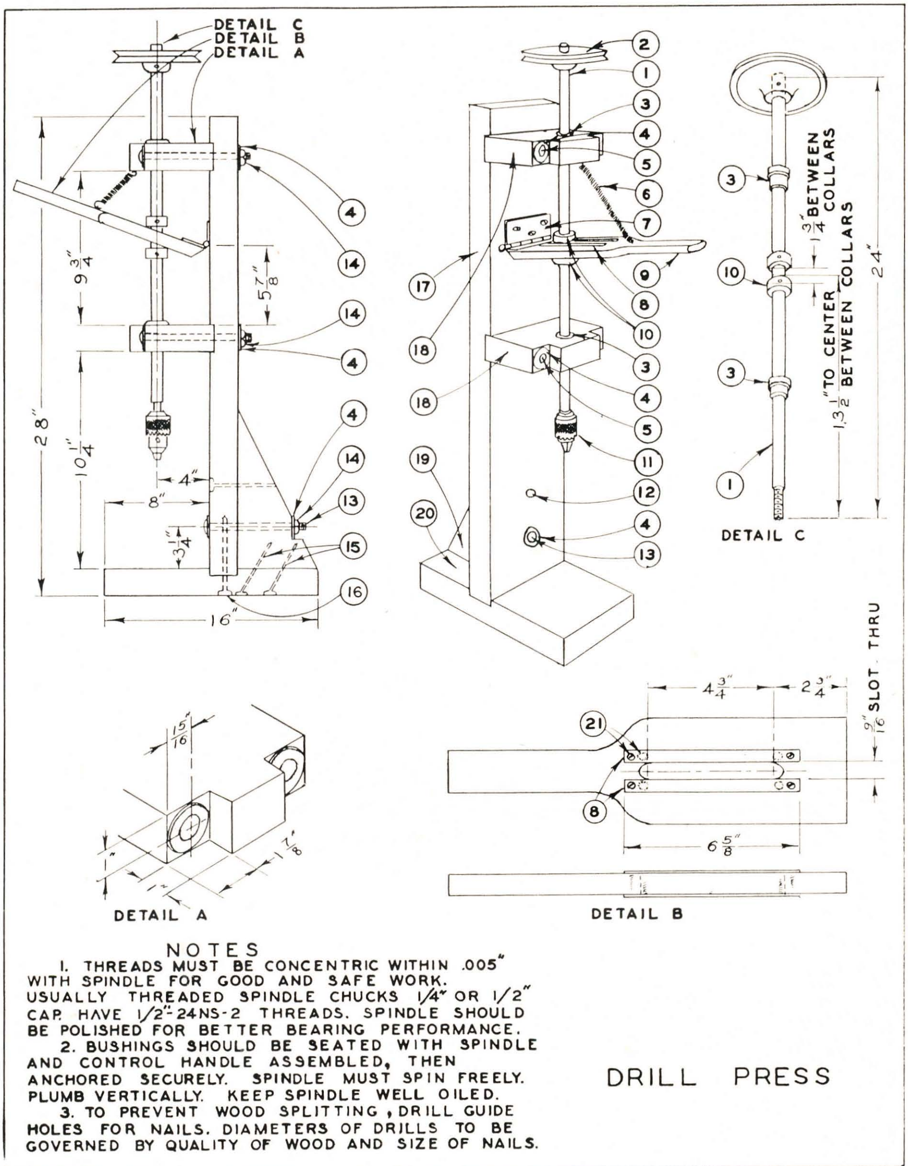


Fig. 44.

by a manual switch, so they can be turned on whenever anyone is working at the wash vats. The remaining lamps should be on a thermostat for automatic operation.

Each heating unit should be designed to fit the milkhouse in which it is to be used. Consult the local representative for your power supplier, for assistance in planning a complete milkhouse heating unit, using infra-red lamps.

EXERCISE 32

DRILL PRESS

An inexpensive drill press, which will do good work, can be made as shown in Fig. 44. This is a useful piece of equipment for any farm shop to speed up most drilling jobs.

Materials Required

No.	Description	Size	Quan.	Material
1	Spindle, ½″ dia. Steel line shafting.	24″ long	1	Cold fin. steel
2	Single groove "V" pulley with set screw.	6″ dia. ⅜″ to ½″ V-belt. Bore to suit spindle.	1	Metal
3	Spindle bushings, from a motor bearing or poured from babbitt.	Flanged to permit securing, ½″ bore.	2	Any bearing metals.
4	Round washers	For ½″ carriage bolt—1¾″ O.D.	10	
5	Carriage bolts, oil finished	½″ dia. x 8″	4	
6	Pull spring, coiled, with looped ends, and staples.	10 lb. pull, or greater	1	Steel
7	Butt hinges, with screws	4″ x 4″	1	(pr.) Metal
8	Bearing plates	½″ x 6⅝″, No. 16 U.S. Gage.	4	Steel strip stock.
9	Operating handle	1″ x 4″ x 15″	1	Hard wood
10	Line shaft collars with set screws	½″ bore	2	Steel
11	3 jaw drill chuck, threaded spindle type.	¼″ or ½″ capacity	1	
12	Common nail	40d, 5″ long	1	Steel
13	Carriage bolt, oil finished	½″ dia. x 7″	1	
14	Nuts, carriage bolt	For ½″ bolts	5	
15	Common nails	30d, 4½″ long	2	Steel
16	Common nails	60 d, 6″ long	2	Steel
17	Column	2″ x 6″ x 26½″	1	Hard wood
18	Head pieces	2″ x 6″ x 6½″	2	Hard wood
19	Column brace	2″ x 6″ x 12″	1	Hard wood
20	Table base	2″ x 6″ x 16″	1	Hard wood
21	Wood screws for bearing plates	No. 6 x ¾″ flat head	8	

Procedure

1. Prepare the wood pieces and assemble the stand, as shown in the plan.

2. The spindle shaft will have to be threaded to fit the threads in the spindle chuck. Most machine shops with a metal lathe can do this.

3. Assemble the spindle in the head pieces, putting on the shaft collars in the proper order, and screwing the drill chuck on last.

4. The motor for driving the drill press can be mounted either on the back of the stand, or on a separate shelf. In either case, the drill press should be fastened securely to a work bench. For vertical mounting on the back of the stand, only a ball-bearing motor should be used.

EXERCISE 33

ELECTRIC FENCE UNIT

Right from the start, it must be made unmistakably clear: *No home-made fence unit is safe to use on 110 volts.* And no such unit will be

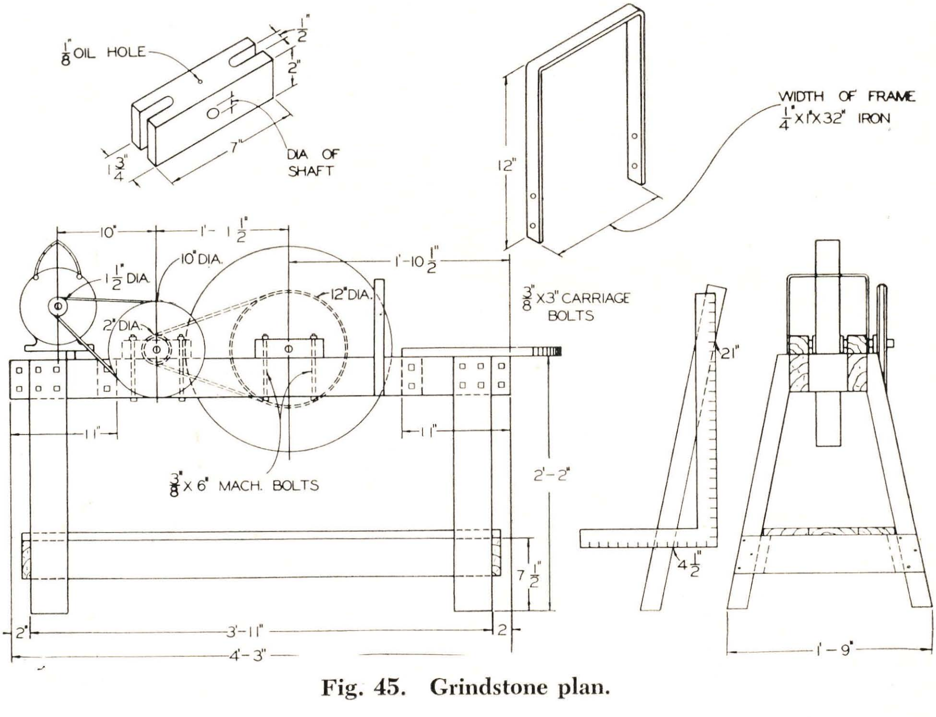


Fig. 45. Grindstone plan.

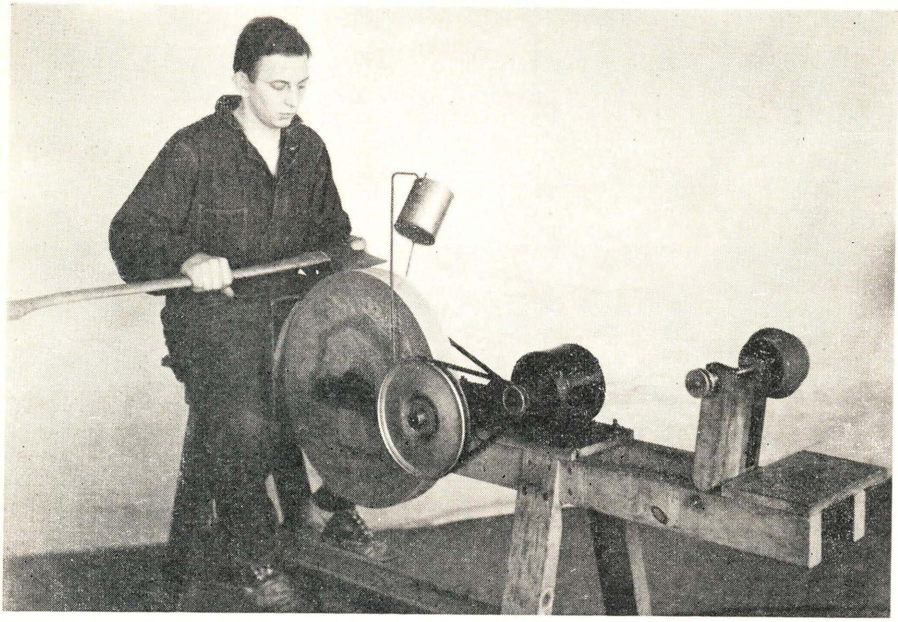


Fig. 46. An electric grindstone.

credited toward a 4-H project. Even with the battery type, it is better to buy rather than build, because of greater assurance of effective operation.

For those reasons, Exercise 33 consists of the installation of an electric fence—either the 110-volt or battery type—which must be a unit approved by the Underwriters Laboratory. Follow manufacturers' recommendations in the installation.

Report the length of electric fence installed, and for what purpose it was erected.

EXERCISE 34

MOTOR-DRIVEN GRINDSTONE

Faster and easier work can be done when a grindstone is driven by a motor. This exercise consists of mounting a grindstone, as shown in Figs. 45 and 46 (or installing a jack shaft on your present stone) to permit the use of an electric motor. Using pulleys of the sizes indicated will give a speed of about 45 r.p.m., on the grindstone.

EXERCISE 35

ELEVATORS FOR HANDLING FARM PRODUCTS

Many farm products can be more easily handled with elevating and conveying equipment, thus eliminating one of the hardest jobs on the farm. (Fig. 47.) Farmers can no longer afford to handle by hand

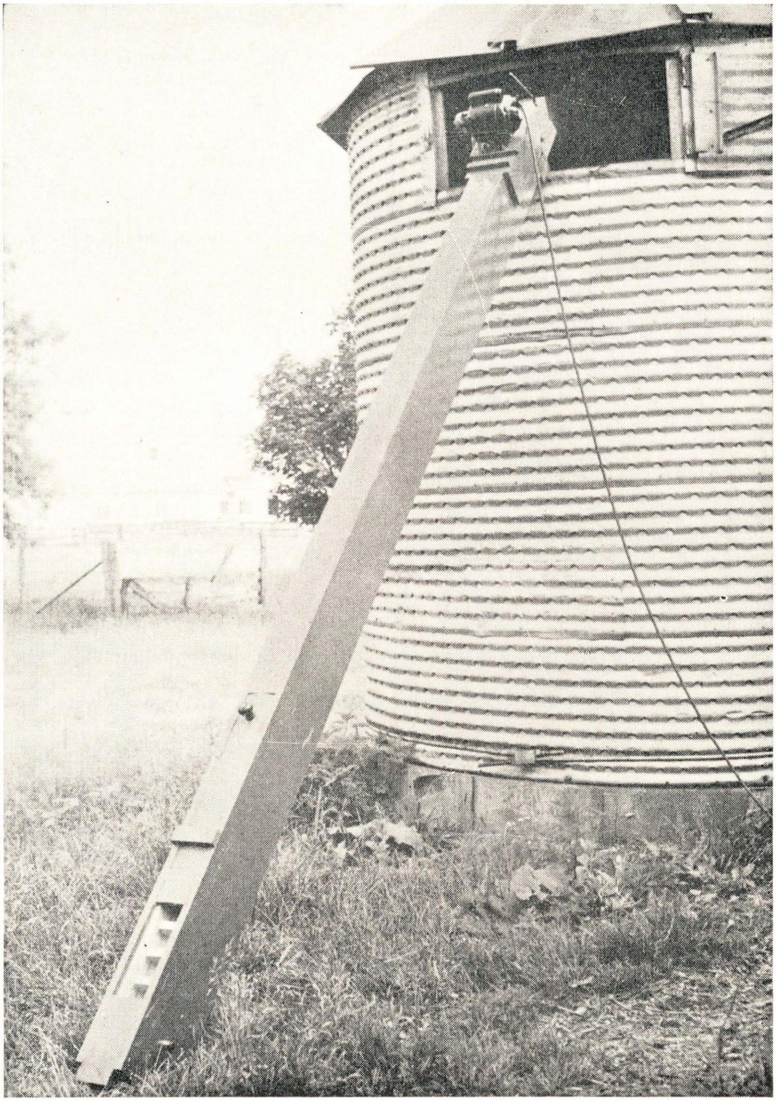


Fig. 47. The Michigan conveyor elevator for handling small grain, shown with hopper removed.

any products which can be handled mechanically. A ⅓ h-p. electric motor on a small home-built elevator, using a few cents worth of electricity, will bin more grain in a day than 3 or 4 men.

Ear corn, potatoes, sugar beets, baled hay and straw, bagged feed, crated produce, and many other farm products can be handled and elevated mechanically.

Building an elevator is an interesting and worthwhile exercise. There are three principal types of elevators for which plans are available at County Extension offices. These are: (1) The Michigan Vertical Cup-type Elevator for Small Grain, Circular Bulletin 193; (2) The Michigan Conveyor Elevator, Article 26-6, August 1943; (3) An Elevator for Ear Corn, Article 25-45, May 1943.

The first of these is considered a somewhat permanent type of installation, while Nos. 2 and 3 are portable types which can be moved from one job to another. One type is shown in Fig. 47.

In this exercise, build an elevator using one of these plans—or any comparable plan which your leader approves. Make a list of materials and farm products which can be elevated mechanically, and indicate the jobs which you plan to do with your elevator.

EXERCISE 36

INSTALLATION OF A PERMANENT MOTOR

For this exercise, there are 2 types of motor installations to choose from:

A. Installation of a motor and equipment, where the motor is not part of—nor attached to—the driven equipment.

B. Installation of a motor to drive equipment already in place.

The following steps are essential in making a type A installation. Type B installations will not require all of them. List the steps required according to your type of installation, and carry them out. (Study Chapter 16 in "Wiring Simplified".)

Steps in Motor Installation

1. Determine a suitable location for the motor and equipment. Some factors which determine location are:

   a) place where equipment can be used most efficiently
   b) accessibility to electrical outlet

c) convenience to install, service and maintain
d) conditions, such as dampness

2. Determine correct size of pulleys and belt, or inspect those already installed.

3. Line up the pulleys properly.

4. Set motor level. Ball-bearing motors are the only ones which may be mounted in any position.

5. Fasten securely, making sure there is provision for adjusting belt tension.

6. Complete the electrical connections after determining the following facts:

a) Is a separate circuit required? (Motors of ½ h-p., and larger should be connected to 240-volt circuits when possible.)
b) Is present outlet convenient, satisfactory and safe? See Chapter 4 in "Wiring Simplified".

7. Operate equipment to see if it functions properly.

Install at least one motor as outlined above. Prepare a report telling which type of installation was made; whether 120- or 240-volt current was connected, and how the motor is protected from overloading. List all of the steps which you did.

EXERCISE 37

POULTRY HOUSE LIGHT DIMMER

Extending the day in the poultry house, during the fall and winter, to approximately 13 hours by night-lighting is recommended for increased egg production. A light intensity of one watt for each 5 square feet of floor area will provide the illumination desired. Thus, a poultry house 30′ x 50′ (1,500 square feet), would require 300 watts of light. That can be supplied by using eight 40-watt lamps, or five 60-watt lamps. Better distribution of light can be obtained by using more lamps of smaller wattage, rather than fewer lamps of greater wattage. Do not use lamps larger than 60 watts, unless you find it necessary to have more light than is recommended.

Lights may be turned on either in the morning or in the evening. When evening lights are used, it is necessary that they be dimmed before turning them off completely, so as to allow the birds to get up on the perches.

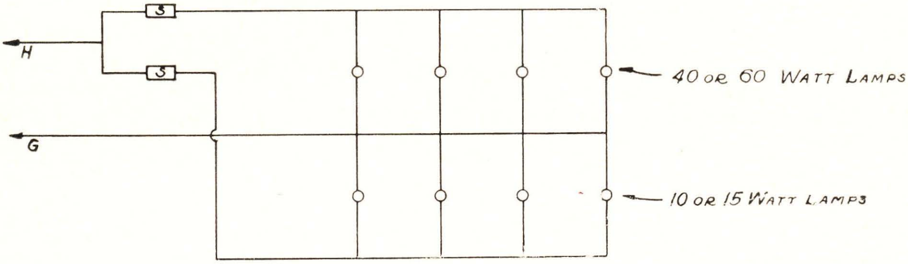


Fig. 48. Common ground system of dimming poultry lights.

That is easily done without any special dimming device, by using the *common ground system,* as shown in Fig. 48. The system consists of two circuits using the same ground wire. The large wattage lamps in one circuit provide the necessary light. When the lights are to be turned off, the low wattage lamps are turned on and the high wattage ones turned off. When the birds have gone to roost, the low wattage lamps are turned off.

Follow wiring instructions as given in "Wiring Simplified". Draw up a wiring diagram, and make a bill of materials covering all of the equipment needed. Include this with your report.

EXERCISE 38

WIRING A SMALL BUILDING

This exercise consists of furnishing electricity to some small building on the farm. At least one light receptacle, one duplex outlet, and one disconnect switch should be installed. Follow instructions given in "Wiring Simplified." Exercise 15 should be completed before attempting this exercise.

Before starting work, make a bill of material. List each item needed, the number or amount required, and the approximate cost of each item. From that you can figure the total cost. Submit the bill of material with your report.

EXERCISE 39

ELECTRIC LAWN MOWER

Mowing the lawn can be made an easier task by mounting an electric motor on a good lawn mower, as shown in Fig. 49.

Materials Required

A good lawn mower with proper size V-pulley
Capacitor or repulsion-induction motor, 1/3 h.p., 1750 r.p.m.
Mounting board, length and width to fit
Strap iron for motor support
V-pulley as large as distance between blade shaft and wheel axle shaft will permit
V-belt, A size, length to fit
Two-wire heavy duty rubber-covered extension cord
Snap switch
Reel for extension cord.

Procedure

Disassemble the mower and install the V-pulley on the blade shaft, cutting off the ends of the blades if necessary to make room for the pulley. (It may be also necessary to remove part of the blade shaft bearing on that end.)

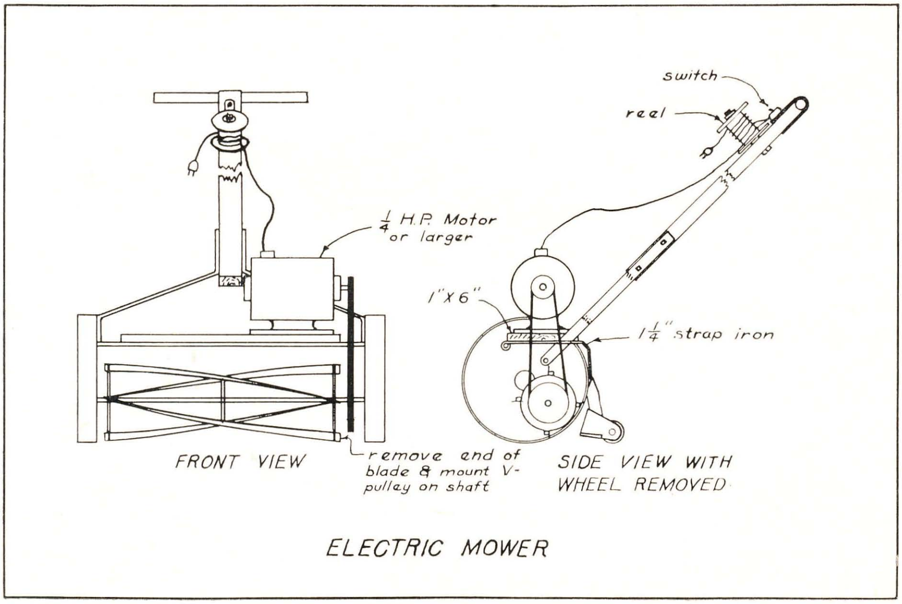


Fig. 49.

Mount the motor so that it will be located slightly to the rear of center for good balance. The strap iron support brackets must be fitted to the mower as required.

Install switch and wire reel as indicated. The motor revolves the blade, but the operator pushes the mower at whatever speed he desires. On some mowers it will be desirable to remove the driving "dogs" at the ends of the blade shaft.

The speed of the blade shaft should be approximately 500 r.p.m. (for a 5-blade mower), and not more than 650 r.p.m. (for a 4-blade mower). To determine the pulley size for the motor, use the following formulas.

$$\text{5-blade mower: } \frac{500 \text{ x pulley dia.}}{1750} = \text{motor pulley size}$$

$$\text{4-blade mower: } \frac{650 \text{ x pulley dia.}}{1750} = \text{motor pulley size}$$

EXERCISE 40

CIRCULAR SAW

A circular saw—such as that shown in Fig. 50—is a handy and useful piece of equipment, which is not very difficult to make. With it you can quickly rip a board to any desired width as well as cutting to length.

Materials Required

No.	Description	Size	Am't	Material
1	Table top	1″ boards	5½ bd. ft.	Hard wood
2	Side plates	1″ x 4″ x 34½″	4	White pine
3	End plates	1″ x 4″ x 20″	4	White pine
4	Legs	2″ x 4″ x 30½″	4	White pine
5	Adjustable power shelf	1″ boards	3⅞ bd. ft.	White pine
6	Bottom plates for above	1″ x 3″ x 16″	3	White pine
7	Adjusting handle	1″ x 2½″ x 23″	1	White pine
8	Adjustment board	1″ x 2″ x 24″	1	White pine
9	Fulcrum	2″ x 4″ x 20″	1	White pine
10	Butt hinges	4″ x 4″	2	Iron or steel
11	Wood screws	Dia. to fit above, 1″ long	3	Metal
12	Hex, head bolts for handle	½″–13 NC–5½″ long	2	Iron or steel
13	Washers, flat, round	⅝″ bolt	6	Iron or steel

No.	DESCRIPTION	SIZE	AM'T	MATERIAL
14	Nuts, hex	½″–13 NC	2	Iron or steel
15	Hex, head bolt	½″–13 NC–3″ long	1	Iron or steel
16	Nails	5d	55	Steel
17	Nails	6d	60	Steel
18	Nails	7d	30	Steel
19	Nails	9d	30	Steel
20	Combination circular saw	8″ bore to fit mandrel	1	Steel
21	Saw mandrel		1	Steel
22	"V" type belt	A	1	
23	Wood screws	Dia. same as Part No. 11 2″ long.	3	Iron or steel
24	Reinforcement plates	6″ x 6″ No. 16 U.S. Ga.	2	Iron or steel
25	Hex. head bolts	To fit mandrel and block	4	Iron or steel
26	Material for fence and guide			

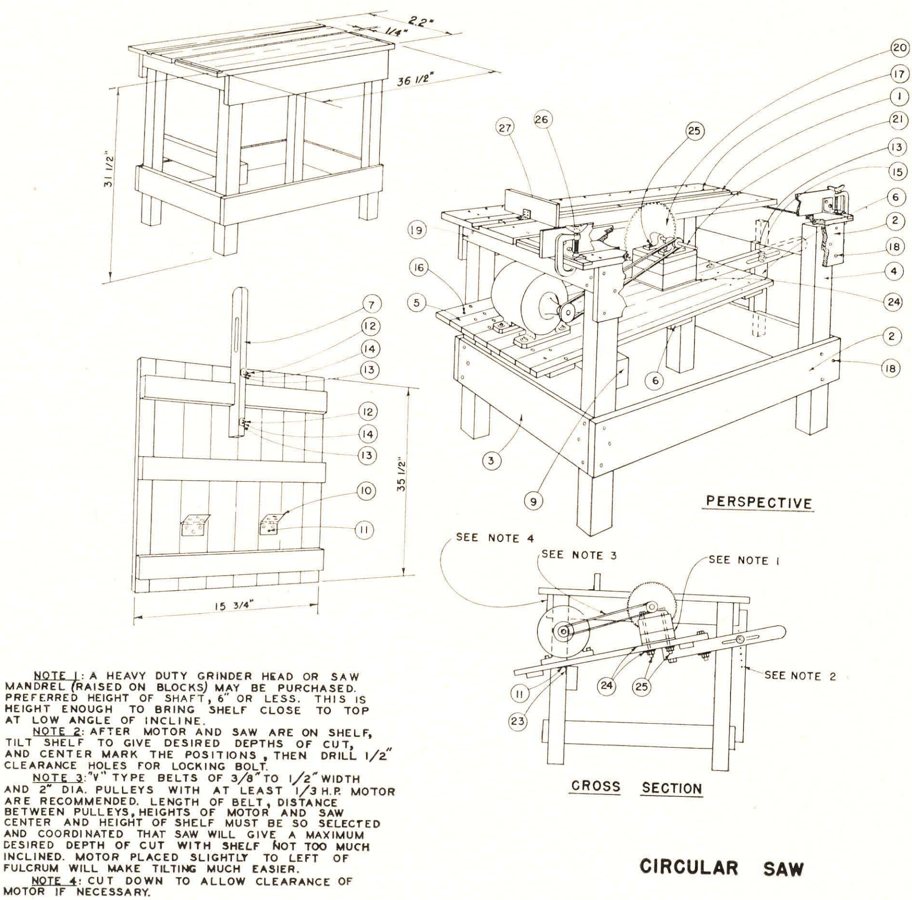


Fig. 50. Working drawing for building a circular saw. Numerals refer to the descriptions in the "bill of materials" for Exercise 40.

Procedure

1. Build the saw table and shelf as shown in the plan.

2. Mount the motor and saw mandrel on the shelf. (See Notes on the plan). The saw must be parallel to the table top boards.

3. For sawing lumber more than 1″ thick, the motor should be ½ h-p. or larger, with a 3″ diameter pulley.

Safe Operation

When sawing short pieces or narrow strips, always use a push stick. Always stand at one side of the saw, never directly behind it.

EXERCISE 41

CHANGING MOTOR FROM 115-VOLT TO 230-VOLT OPERATION

Many of the single-phase motors for farm use are designed to operate on either 115 volts or 230 volts; they are known as "dual voltage" motors. When 230 volts of service is available, it should be used—because 230-volt operation gives less power loss in the lines supplying the load, and it permits the use of smaller wire sizes and service equipment. Doubling the voltage cuts the line current required in half.

Where a low voltage condition exists in the barn or other buildings, changing all motors ½ h-p. or larger to 230 volts will greatly improve the operating performance and help to reduce overloading of the wiring system.

(However, before attempting any kind of a change in a motor, consult your electric power supplier to make certain that it is desirable to do so.)

Most manufacturers include instructions with their motors for changing from one voltage to another. For 115-volt operation the windings are in parallel, as illustrated in Fig. 51 (A). For 230-volt operation the windings are connected in series, as illustrated in the same figure (B).

Motor may have from 4 to 6 wires extending from the motor housing. If there are 5 wires, one wire is an end of the starting-winding. The other end of the starting-winding is connected inside the motor housing.

If there are 6 wires coming from the motor housing, then *both ends* of the starting-winding are inside. The starting-winding leads are generally of lighter wire than the running-winding leads.

Take a 1½-volt battery, or a battery buzzer system, and connect to one of the wires. To find the other end of the winding, touch each of the remaining leads to the battery or buzzer. If the wire sparks or buzzes, when touched to the other battery terminal, you have both ends of one of the motor windings. Mark those windings, and repeat the process to find the others.

Where the starting-winding is extended through the housing, it is not always possible to get a spark or buzz through it. Most farm motors have a capacitor in the starting-winding which will cause the circuit to act as an open circuit. However, eliminating the other winding leads which do spark or buzz will leave only the starting-winding.

When the windings have been determined, connect as illustrated in Fig. 52, for 230-volt operation. Connect the starting-winding across one of the motor windings. The starting-winding is always connected across 115 volt.

If the motor is running in the wrong direction after being connected to a 230 volt circuit, interchange the starting-winding leads for a "capacitor-type" motor to change the direction of rotation of the motor. In a "repulsion-induction" motor, shift the brushes to change the direction of rotation.

NOTE: When changing a motor from 115 volts to 230 volts, it is possible to get the windings connected so that they are working against each other. If the motor hums, but will not run, reverse one of the windings. Reverse it so that the winding lead which was brought out to the electrical outlet is now connected to the end of the second winding. Then bring the other lead out to the electrical outlet.

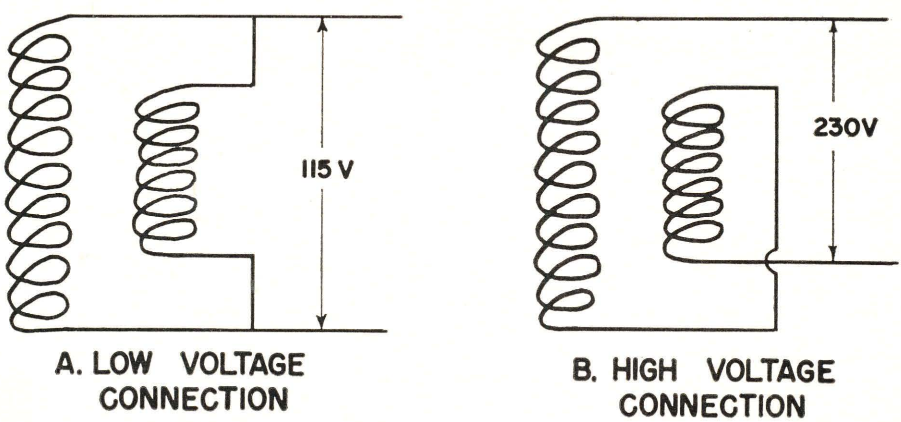
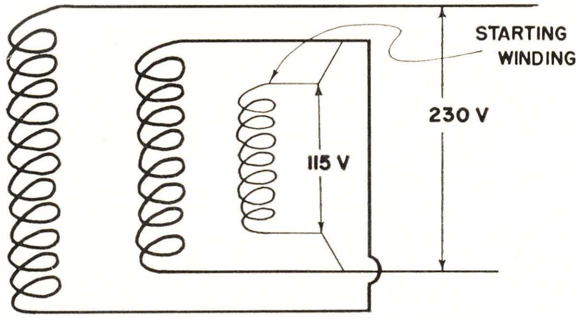


Fig. 51. Electric motor windings for 115 volts (A), or 230 volts (B).



MOTOR WINDINGS PLUS STARTING WINDING

Fig. 52.

EXERCISE 42

INSTALLING CONVENIENCE OUTLETS

Plenty of outlets and switches, located in the proper places, is the key to making the best use of electricity as a servant. Good lighting not only adds to your convenience and safety, but a barn is actually a more cheerful place to work in when it is well lighted. Switches should be so located that you can light the way ahead of you, and turn the lights off when you leave, without having to walk through any dark areas.

Outlets for plugging in motors, toasters, electric irons, etc., should be provided wherever needed to get the most satisfactory operation out of these appliances. Before an outlet is added to a circuit, the circuit should be checked for total load. If the circuit is fully loaded, run a new circuit for the outlet.

Motors and heating appliances should not be plugged in a light socket, because the wire is usually not heavy enough to carry the amount of current needed.

This exercise consists of installing two or more outlets—either a light receptacle or a duplex outlet—in your home, or in some other building on your farm. Use No. 12 non-metallic cable.

Study Chapters 5, 8 and 13 in "Wiring Simplified". Before attempting this exercise, you should have completed the Wiring Panel. (Exercise 15.)

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4-H CLUB MOTTO *"To Make the Best Better"*

4-H CLUB EMBLEM

4-H CLUB COLORS *Green and White*

4-H CLUB PLEDGE

I pledge
  My head to clearer thinking,
  My heart to greater loyalty,
  My hands to larger service, and
  My health to better living

For
  My Club
  My Community and
  My Country.

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