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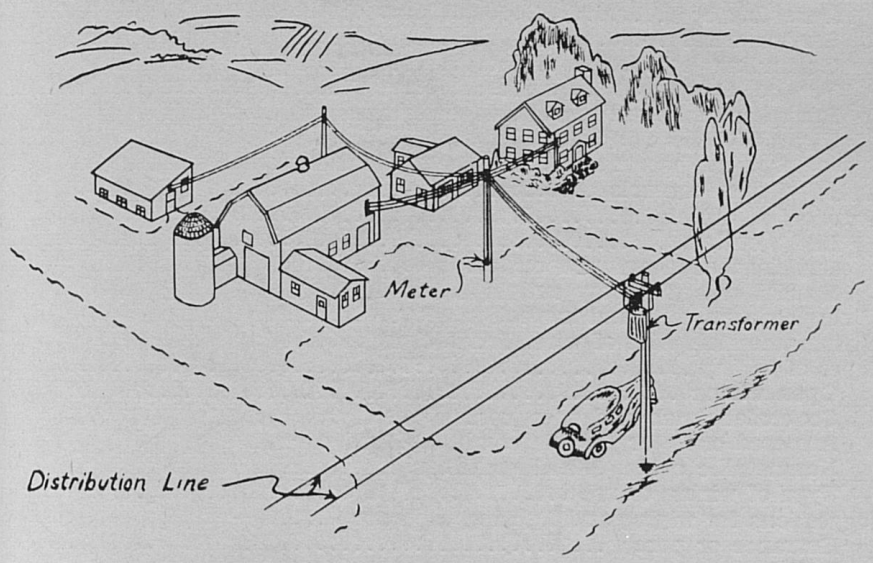
CIRCULAR NO. 311

ELECTRIC SERVICE FOR THE FARMSTEAD



Wiring system for the farmstead.

Lexington, Kentucky
June, 1938

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ELECTRIC SERVICE FOR THE FARMSTEAD

By J. B. KELLEY, IDA C. HAGMAN and EARL G. WELCH

USES OF ELECTRICITY ON THE FARM

The application of electricity to agriculture is a recent development. The use of electricity may not only provide better lighting, added conveniences, leisure time and improved living conditions for the rural family, but it may be a means of increasing the farm income. Electricity is used in the home for lighting, cooking, refrigeration, washing, ironing, and for operating the radio and other appliances. On the farm, it is used for pumping water, milking cows, cooling milk, separating cream, sterilizing milk utensils, churning, providing cold storage, increasing egg production, hatching eggs, brooding chicks, stimulating the growth of plants and animals, trapping insects, lighting yards and buildings, ringing burglar alarms on poultry houses, heating soil in hotbeds, drying fruits and vegetables, and operating all kinds of power-driven machines, such as saws, spraying machines, feed cutters, threshing machines and sheep shears. In fact, there are over 150 uses for electricity in agriculture.

SOURCES OF ELECTRICITY FOR THE FARM

There are two sources of electricity for the farm, the individual electric plant operated by a water wheel, windmill or gas engine, on the farm, and the central power plant operated by a utility company or cooperative association of farmers, which supplies current over high-voltage lines. Individual farm plants, altho satisfactory for lighting and for operating small appliances, limit the uses of electricity for power and heating and do not provide electricity as cheaply as it can be obtained from a central station.

STEPS IN PLANNING THE FARM WIRING SYSTEM

1. *Decide What Equipment Is to Be Used.* Make a careful study of the purchase prices, the operating costs and uses of electrical

equipment and reach a decision as to what fixtures, appliances and motors may be purchased and used profitably at present and in the future. Helpful assistance and information may be obtained from

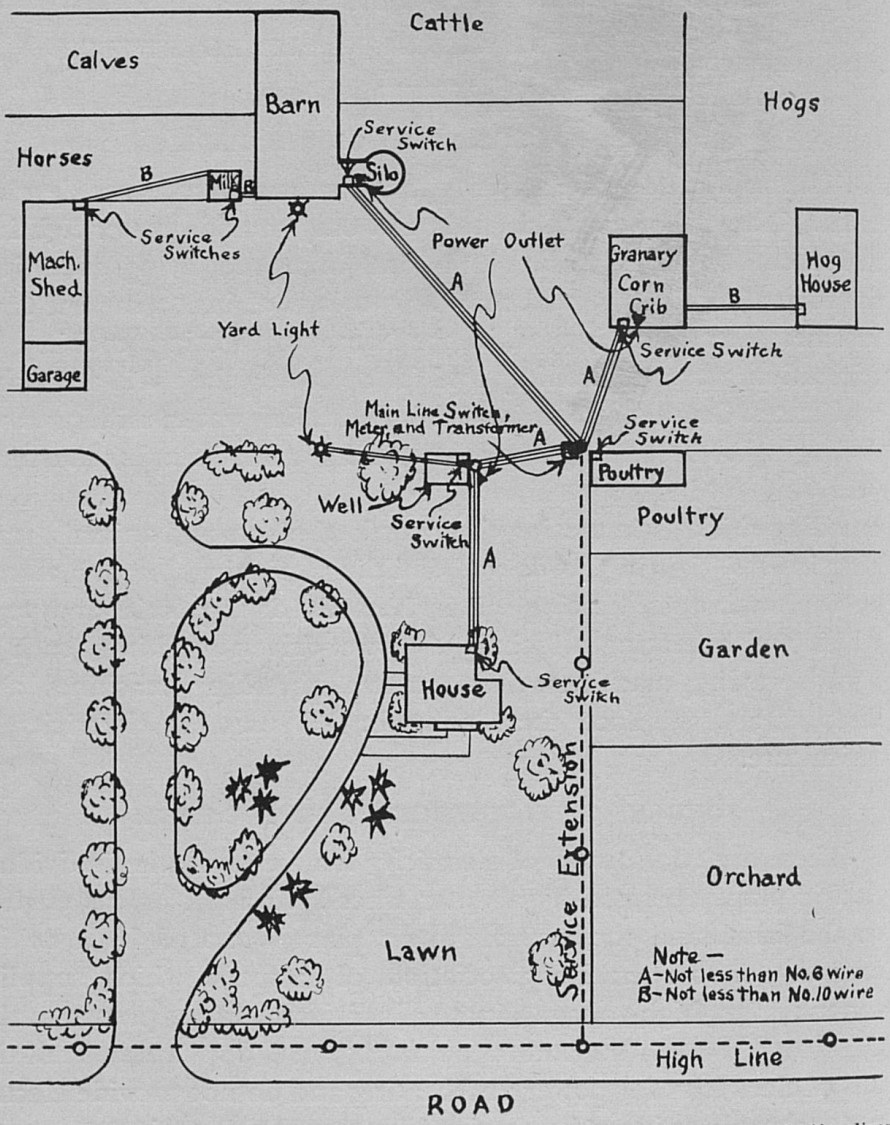


FIGURE 1. A farmstead showing location of buildings and the electrical distribution lines.

your county and home demonstration agents, from the trade literature of manufacturers, from the Rural Electrification Administration, Washington, D. C., from the Extension Division, University of

Kentucky, and from your local electrical contractors, dealers, and engineers of the utility company or rural electrification association.

2. *Make a Drawing of the Farmstead.* Prepare a simple sketch to scale of the farmstead,* and locate on it the various buildings. This sketch will aid in locating the transformer pole, the entrance service wires, meter, switches and entrance wires to the various buildings, and in determining the size of wires to use between buildings. See Figure 1.

3. *Sketch House Floor Plans.* Prepare simple sketches of the floor plans of the house, the barn and other buildings, and indicate on each the location of light outlets, switches, convenience outlets and heavy-duty outlets for water heaters, range and motors. This work should be done in consultation with a competent electrician. A copy of the wiring plans should be kept by the owner until the work is completed and accepted (see floor plans Figure 23, 24, 25).

4. *Employ an Electrician.* Furnish the above information to a competent electrician so that he may complete the wiring plans and specifications in accordance with the National Electric Code, or such state and local requirements as may be in force at the time the installation is made, determining the kind of wiring system, the size of service wires, switches and fuses, the number and size of branch circuits and kind of wiring materials and fixtures to use. The engineer of the Utility Company or Association furnishing the current should be consulted regarding the size and location of transformer.

5. *Get Bids.* After the plans and specifications have been completed, get bids from reliable contractors who have earned reputations for dependability and first-class workmanship.

6. *Provide for Inspection.* Require the contractor to get all necessary permits. After the work is completed have the wiring inspected and tested for grounds and short circuits, and have the contractor give you a certificate of final inspection and approval from the inspection bureau having jurisdiction. The contractor should guarantee his work and materials to be in accordance with National Electrical Code or prevailing code and agree in writing

* Meaning the part where the buildings are and any other part where electricity may be needed.

to replace without extra charge any material or work which develops defects (except from accident or misuse) within one year from date of completing the wiring.

7. *Use Good Material.* Use only equipment, wire, appliances or fixtures that have been listed or labeled as having been inspected or approved by the Fire Underwriters Laboratories (see Figure 2).

FIGURE 2. Labels that should be found on wiring equipment, indicating that the materials conform to the minimum requirements of the Underwriters Laboratories. They do not specify the exact quality of the product.

ELECTRICAL TERMS

A knowledge of the following electrical terms will be valuable in planning the farmstead wiring system and in the selection and operation of the electrical equipment.

1. *Direct Current* (DC). Current that flows in the same direction all the time. Batteries and direct-current generators produce direct current. Small community electric plants and home light plants usually produce direct current.

2. *Alternating Current* (AC). The direction of the current is reversed at a regular rate. The number of complete reversals, or cycles, occurring per second is the "frequency" of the current. A frequency of 60 cycles is common for lighting and power currents. Most rural electric transmission lines carry alternating current.

3. *Volt.* The unit of measure of electrical pressure. It corresponds to pound pressure in a water system. Electrical energy can be transmitted at high voltage more cheaply, over longer distances and with a smaller energy loss than when low voltages are used.

4. *Ampere.* The unit for measuring the rate of flow of electricity. It corresponds to gallons per minute of water flowing thru a pipe. It is used to designate the size of fuses, switches, the safe carrying capacities of wire and current used by electrical equipment.

5. *Watt.* The unit of electrical power. Watts = volts × amperes. A kilowatt = 1000 watts. A horsepower = 746 watts. The sizes of electric light bulbs and electrical appliances are stated in watts.

6. *Kilowatt-Hour.* The amount of energy consumed by an appliance working at the rate of one kilowatt for one hour.

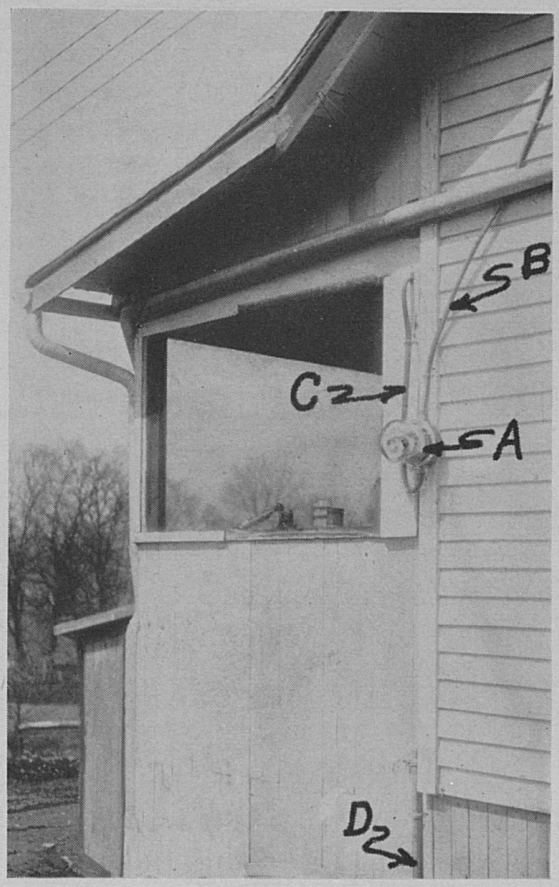


FIGURE 3. (A) Weather-proof glass-covered meter. (B) Nonmetallic cable service drop. (C) Service cable to branch circuit panel placed on back porch. (D) Driven ground.

Electricity is purchased at so much per kilowatt hour. The number of kilowatt-hours of electricity consumed is usually recorded by an instrument known as a watt-hour meter. (See Figure 3.)

7. *Resistance. Ohms.* Resistance is the property of a material

by virtue of which it opposes the flow of electric current. The unit of measurement of resistance is the ohm.

8. *Phase.* This word is used in stating the number of separate alternating currents acting together which a motor requires for operation or a generator produces. Thus, a three-phase motor requires three currents acting simultaneously, whereas a single-

FIGURE 4. Watt-hour meter housed in weather-proof metal box.

phase motor requires only one. A three-phase motor should be used where more than 5 horsepower is required. Of course its use implies access to a three-phase transmission system. Rural distribution lines are designed for single-phase or three-phase current.

9. *Fuses and Circuit Breakers.* A fuse is a safety device placed

in an electric circuit to protect lighting equipment, electrical appliances, and motors from damage caused by excessive current. A burned out fuse must be replaced with a new one. The size of a fuse is specified in amperes. There are three types of fuse; the

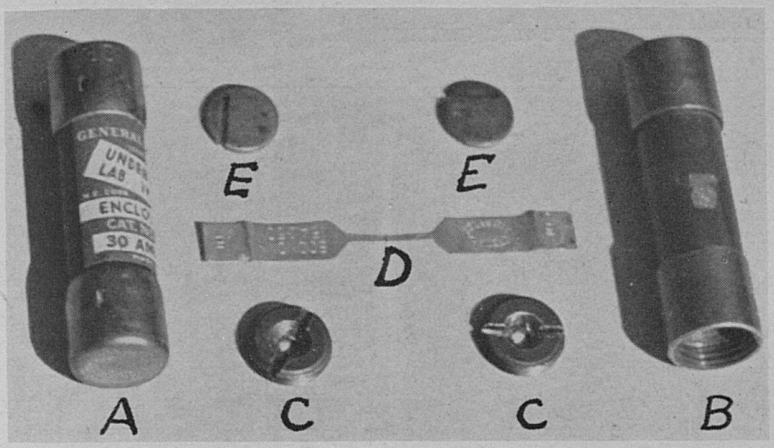


FIGURE 5. A, a cartridge fuse which has to be renewed when burned out. B, a cartridge fuse which may be taken apart and a new fuse element inserted. C, screw plugs for the end of the cartridge. D, the fuse element. E, the slotted disks for holding the fuse element in place.

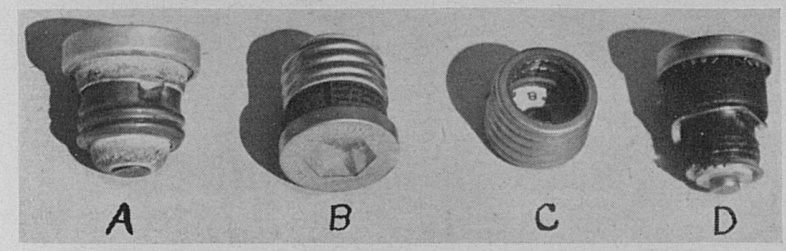


FIGURE 6. A and B, plug fuses. C, an adapter for a "nontamper" fuse. D, nontamper fuse which fits the adapter C. Only one size of fuse fits the adapter socket C, thus preventing the possibility of over or under fusing the circuit.

cartridge (Figure 5), the plug or screw socket, and the "non tamper" which helps to prevent overfusing because a fuse of a different ampere rating does not fit the socket (Figure 6).

The automatic circuit breaker for home wiring systems has been placed on the market recently (see Figure 7). It serves the same purpose as the fuse. This device avoids re-fusing branch circuits and prevents over fusing. When the circuit has been broken by an excessive current, service may be restored after correcting

the difficulty by throwing a lever down to the "off" position and then fully up to the "on" position. A circuit breaker acts both as a switch and a safety device. A fuse or circuit breaker should never be made inoperative by carrying the current around it, on a wire. Fuses or circuit breakers should never be placed in the grounded neutral wire of a circuit.

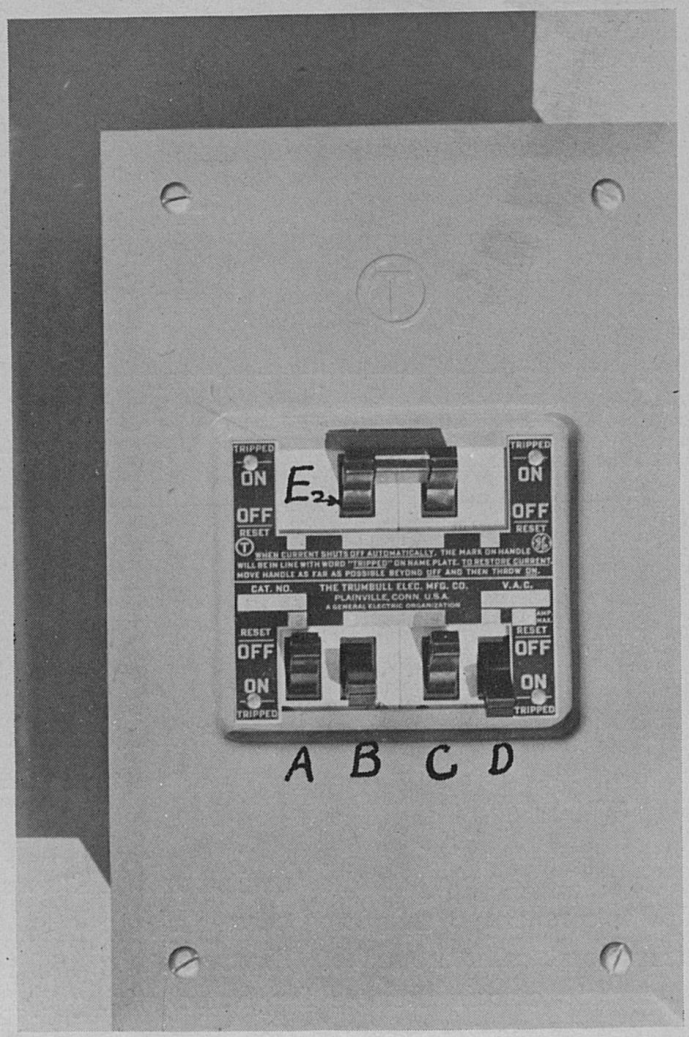


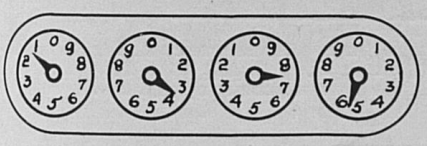
FIGURE 7. Automatic circuit breaker panel with switches for controlling four branch circuits and one range circuit. A, B, C and D, branch circuit controls for lights and small appliances. E, range circuit control. Controls A and C are shown in "off" position. Controls B and E are shown in "on" position. Control D is shown in a position indicating that the circuit breaker has automatically disconnected the circuit because of trouble on that line.

10. *Voltage Drop or Line Drop* is the drop in electrical pressure (volts) along any conductor carrying electric current. For motor operation the voltage drop should not exceed 5 percent of no-load voltage (5.75 volts on 115 volt circuit) and for light, heat, or appliance circuits it should not be greater than 2 percent or 2.2 volts on a 110 volt circuit. Where practical, the size of the feeder conductors should be such that the voltage drop up to the first distribution point for the load should not exceed 2 percent or 2.3 volts on a 115 volt circuit.

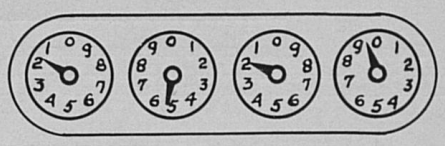
HOW CONSUMPTION OF ELECTRICITY IS MEASURED

The kilowatt-hour is the unit of measure by which electricity is purchased just as a bushel is the unit for measuring wheat and corn. For example, a 100-watt light bulb operating for 10 hours uses a kilowatt-hour of electrical energy. By dividing the number of watts required to operate any appliance into 1000, it is possible to determine the number of hours the appliance may operate on 1 kilowatt hour if the current flows continuously during the period of use. A 500-watt flatiron will operate a minimum of 2 hours (1000 divided by 500 = 2) on 1 kilowatt-hour of electrical energy. In actual practice the iron may be operated for more than 2 hours because the current is turned off either automatically or by operator when the iron heats above a certain temperature.

The number of kilowatt-hours of electricity consumed is usually recorded by an instrument known as a watt-hour meter. (See Figures 3 and 4.) It consists of a small motor operating clock-work at a speed depending upon the power that is being used. To read the meter, record the last number on each dial that the hand has passed, reading the dials right to left (see illustration).



This meter reading is 1375.



This meter reading is 1519.

The reading on the second dial from the right, altho the hand is at number 2 should be read as number one until the hand which moves clockwise on the first dial has passed zero. To determine

the amount of electricity used in one month, read the meter on the same day each month and subtract the preceding month's reading from the latter; 1519 — 1375 = 144 kilowatt-hours. The outside meter mounted on the house should preferably be placed on back porch or near the rear of the structure, where it will not detract from the appearance of the house but may be conveniently read.

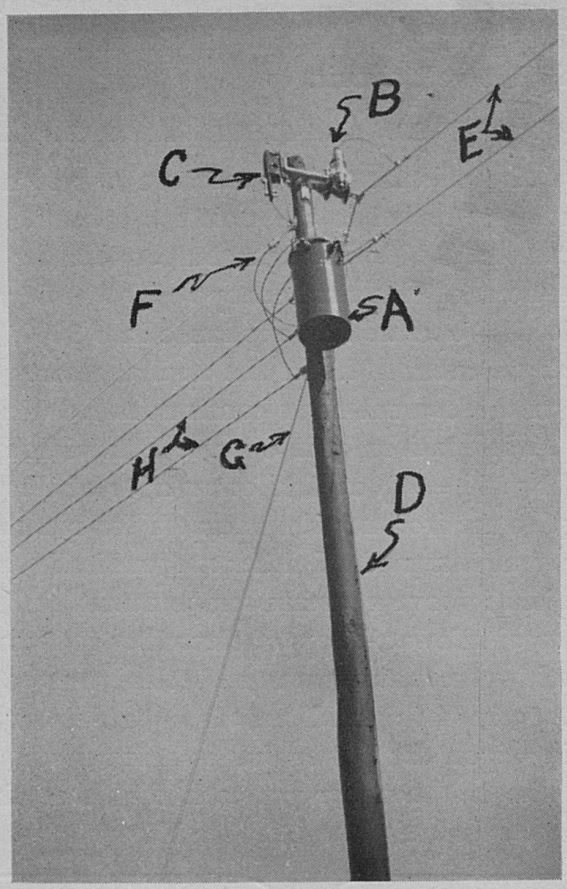


FIGURE 8. Arrangement at the entrance to a farm. Transformer, A. Lightning arrester, B. Overload protector, C. Pole, D. Distribution lines, E. Hot wire, F. A Guy wire used as Ground, G. Secondary service wires, H, from transformer to buildings.

WIRING EQUIPMENT

Transformer. Electricity for a power line is generated at some central station and transmitted over the rural distribution line at a high voltage. At the farm, the transformer reduces the high

voltage to a lower voltage (115 or 230 volts) suitable for operating the light and power equipment used (see Figures 8 and 9). The high-voltage wires connected to the transformer from the main line are known as the primary wires and those going from the

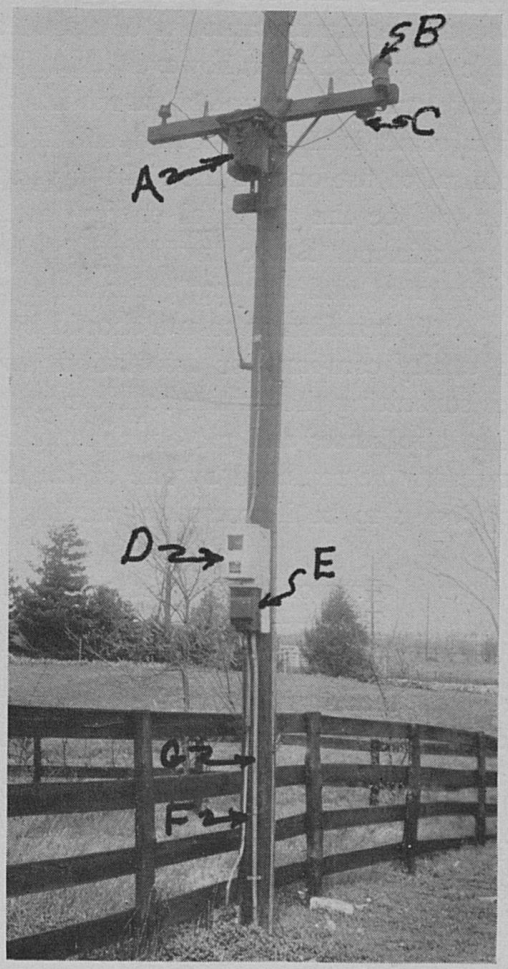


FIGURE 9. Transformer, A. Lightning arrester, B. Overload protector, C. Enclosed meter, D. Service switch, E. Ground, F. Cable for underground service, G. All mounted on the same pole.

transformer to the service wires on the farm are the secondary wires. (See Figure 10.) A two- or three-wire service may be provided from the transformer. A two-wire service makes available 115-volt current; a three-wire service, 115-volt and 230-volt current.

The size of a transformer may be expressed in k. v. a. (kilo-volt amperes) or in kilowatts. Transformers of sizes ranging from 1½ to 5 k. v. a. (1500 to 5000 watts) will have a sufficient capacity for most farms in Kentucky, providing power for motors up to 5 hp. In some cases, a larger transformer will be needed. The size to use depends upon the maximum amount of electricity required at one time. A range or water heater, however, usually requires a 3 or a 5 kilo-volt ampere transformer and a three-wire service. As the efficiency of a transformer is highest when operated at its rated load, it is most economical to use one of the right capacity. If it is too large, the greater will be the electrical energy losses in the transformer. If the transformer is too small for the current requirements, it may be injured and the regulation voltage will vary excessively. The size of transformer to use should be decided by an engineer of the utility company or association that will furnish the current, after consulting the farmer regarding the total number and sizes of lights, appliances and motors that will be used. The transformer may easily be replaced by one of larger size when the current consumption is to be increased by adding more or larger equipment.

The transformer is commonly mounted on a pole of the main distribution line at the highway in front of the farmstead. Where the farm buildings to be served are scattered or are located at some distance back from the road, it is advisable to locate the transformer nearer the buildings, at the center of the electrical load, so that the service wires may be as short as possible to distribute the electricity to all the buildings with the least drop in voltage and loss of power. (See Figure 1.)

The pole to which the transformer is fastened should not be located where it will be used as a hitching post, where farm animals will rub against it, or where it may interfere with the movement of farm machinery. In most instances, one transformer should be installed for each farmstead. One transformer may serve two farmsteads if they are not too far apart, and the wire is properly sized to prevent an excessive voltage drop.

Service Wires. The service wires, commonly called the service drop, are the wires extending from the secondary, or low-voltage,

side of the transformer to the head of the service entrance conduit or cable at the building (see Figure 10). The service entrance conductors are those extending from the head to the main switch.

For an overhead service entrance, the National Electric Code permits the use of rigid metal conduit, electrical metallic tubing and service entrance cable. For underground entrance conductors, the code permits the use of lead-covered cable in rigid metal conduit, electrical metallic tubing, lead-covered cable in tile or fiber duct or any other underground cable designed to withstand action of the chemical agents in the soil.

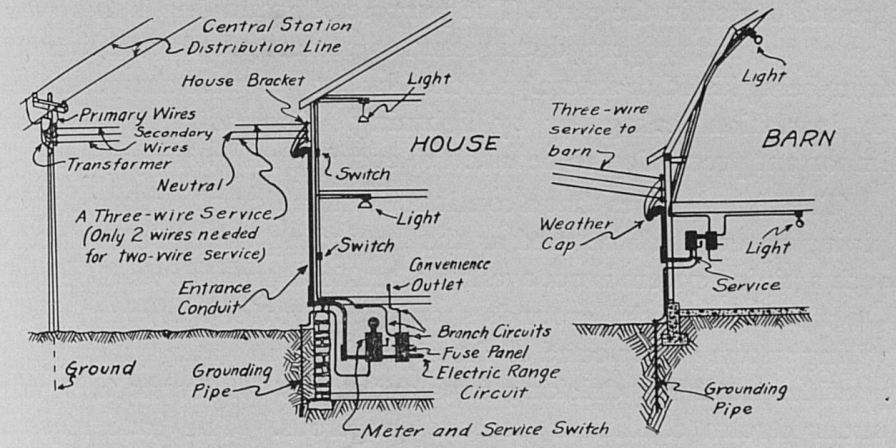


FIGURE 10. General plan of a wiring system for 115- and 120-volt, central-station current.

Two general types of service are used on the farm; the two-wire, used for a 115-volt system, and the three-wire, for the 115 and 230 volt system. The three-wire service is recommended for most farms. It provides for a wider range of possible uses of electricity than does the two-wire system. Almost an unlimited number of branch circuits and outlets may be installed on the three-wire service, if the proper sizes of wires, fuses and switches are used. It permits the use of both 115- and 230-volt equipment. If an electric range, a water heater or motors over $^1/_3$ horsepower are to be used, the three-wire system should be provided.

Service wires should be sized in accordance with the Code to carry the connected load, but in no case should they be smaller than No. 8 A.W.G. (American wire gage). Electrical equipment may

be operated more economically on a 230-volt circuit than on one of 115 volts.

One of the wires of the three-wire system, known as the neutral or grounded wire, should be connected to moist earth. Neutral wires should be white or bare, where permitted, for identification. Connecting an appliance to the neutral and one ungrounded (hot) wire provides current at 115 volts, but connecting across the two ungrounded wires (hot wires) provides 230 volts.

Grounding. The National Electric Code provides that all wiring systems carrying alternating current be connected to a metal ground buried in the earth. The purpose of grounding is to prevent loss of current, property damage and to protect people and livestock from being killed or severely shocked by stray electric charges caused by insulation leakage or by lightning. Grounding is the most important precaution to be taken to ensure a safe wiring system.

The code specifies that a continuous metallic underground water piping system shall be used as the grounding electrode but where such a piping system is not available, artificial grounds shall be used. On a farm, artificial grounds should be provided because, if the wiring system is connected to the pipe of a farm water system which provides water for drinking cups and tanks for livestock, it may under certain conditions become dangerous. The code requires (Article 250, 1937 Code) that, where artificial grounds are used, the electrodes be imbedded below permanent moisture level. Metal plates, iron or steel rods or pipes may be used for electrodes.

A common way to make an artificial ground is to drive a length of galvanized pipe not less than ¾" in diameter into the earth to a depth of 8 feet. Where rock lies close to the surface, drive two lengths of galvanized pipe not less than ¾" in diameter, at least 5 feet apart, to a depth of at least 6 feet. These two pipes then must be rigidly connected with pipe and fittings and connected to the grounding conductor of the wiring system. If the pipes can not be driven five feet into the earth, a ground can be made by burying a ¾" galvanized pipe 12 feet long, horizontally in a trench 3½ feet deep. About a bushel of wet charcoal should be put over the pipe before the trench is filled with soil. Artificial grounds made

of metal plates should present not less than two square feet of surface to the soil. Grounds made of plate copper should not be less than .06 inches thick and those of iron or steel not less than ¼ inch thick.

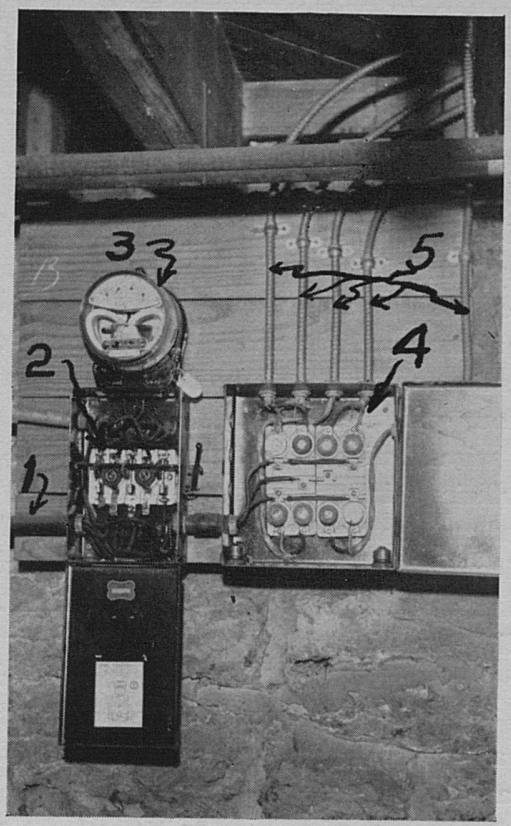


FIGURE 11. Service Equipment Panel in the basement of a house. 1. Metallic conduit for service entrance wires. 2. Meter service switch, plug and porcelain base housed in metal box. 3. Watt-hour meter. 4. Branch circuit panel, plug fuses and base mounted in metal box shown with door open. 5. Box conduits for four branch circuits for lights and convenience outlets.

At the main service entrance to the farmstead and the service entrance at each building, both wiring and conduit should be grounded. The ground is sometimes omitted at small outbuildings where the current is used only for lights and the wiring circuit is not more than 25 feet long. The proper grounding of a wiring system is of such importance that it should be done by a competent person.

Service Equipment. This usually consists of a meter, main switch and fuses or circuit breakers and their accessories to provide protection and serve as a means of cutting off the current for repairs, additions and in case of fire. On a farm, the location of the meter and main service switch requires some thought. They may be placed inside a building (see Figure 11) or outside under a porch (Figure 3) or on a conveniently located pole in the yard (see Figure 9). The advantage of the outside location is that meter and switch are readily accessible. The company supplying the current should be consulted as to the type of service equipment, method of mounting and provision for metering and as to where to place this equipment and the supply wires entering the buildings. In addition to the main service equipment, on some farms it may be advisable to provide each building with an entrance service switch and fuses or circuit breakers for one or more branch circuits distributing electricity to the various outlets in the building.

All service wires, switches and fuse or circuit-breaker panels should be of sufficient size or capacity to carry safely the maximum current required at one time for lights, range, water heater, refrigerator and all electrical appliances and motors that will be used at present, including a reasonable allowance for additional circuits and power that will be required in the future. The size of a switch is specified in amperes and volts. The main service switch on a farm may be 30, 60 or 100 amperes for the desired voltage, depending upon whether an electric range, water heater and 5 horsepower, or larger, motors are to be used.

Branch Circuits and Protective Equipment. Branch circuits for the home and outbuildings can be grouped under three classifications: (1) lighting, (2) small appliances both fixed and portable, (3) special heavy duty for ranges, water heaters and large motors. The number and capacity of the circuits should be based on all three classifications.

One branch circuit for supplying the lighting outlets in all rooms and all convenience outlets, except those in the dining room, breakfast room, kitchen, pantry and laundry, should be provided for every 500 square feet of floor space of the house. The outlets supplied by these circuits should be divided as equally as possible

among all such circuits. Even in small homes it is not advisable to connect all the light outlets on one circuit. If two circuits are provided lights on one can be used after the fuse in the other has burned out.

No wire smaller than No. 14 should be used for a lighting circuit protected with 15-ampere fuses or circuit breakers. Assuming a 1½ ampere connected load for each outlet, this circuit safely provides for 10 outlets. However, no single appliance having a rated capacity exceeding 1320 watts may be connected to such a circuit. Owing to the increasing desire in many homes for larger lights and a greater number of lights and appliances, many electricians are recommending nothing smaller than No. 12 wire for branch circuits.

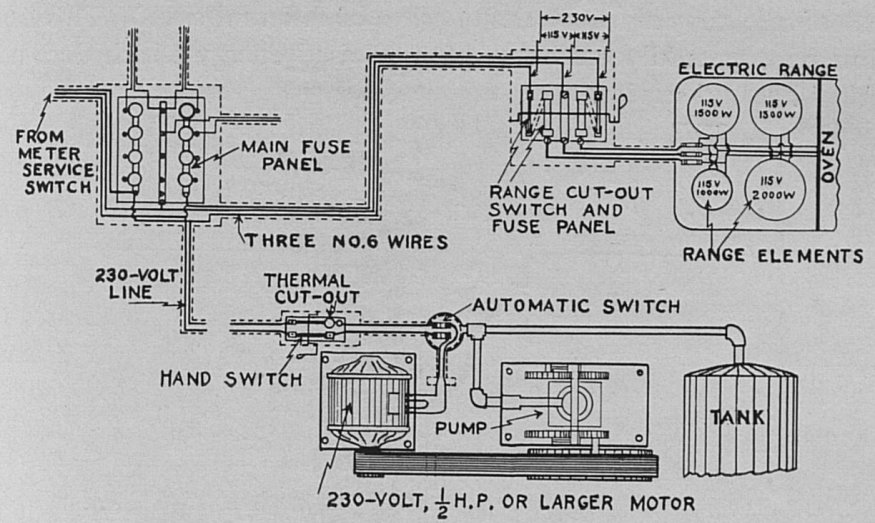


FIGURE 12. Wiring arrangement showing branch circuits for an electric range and electrically-operated water pump.

Appliance circuits are intended chiefly for supplying current to receptacle outlets and small fixed appliances. The appliance outlets in the kitchen, laundry, pantry and dining room should be supplied by at least one branch circuit of No. 12 wire and 20-ampere fuse protection. Most home appliances excepting the refrigerator, are used intermittently. As it is not likely that more than two or three appliances will be operated at any one time, one or two appliance branch circuits of No. 12 wire will probably be ample

for homes of medium size if confined to use in the kitchen, pantry, dining room, breakfast room and laundry. No appliance should be attached to a drop cord used for lights if the wire used for that purpose is No. 16 or No. 18, which is too small to safely provide current for appliances.

The sizes of wires and protective equipment to use for heavy-duty circuits must be based on the requirements of the electrical equipment to be connected. Separate circuits should be provided for electric ranges (see Figure 12), water heaters and the larger motors. The wire in all circuits should be of such a size that it will carry the electricity to the point where it will be used without an excessive voltage drop and without heating the wire to a temperature that would injure the insulation or cause a fire. (See table 1, page 46, of safe carrying capacities of wires of different sizes.) This heat loss represents kilowatt-hours of purchased energy which does not furnish useful service.

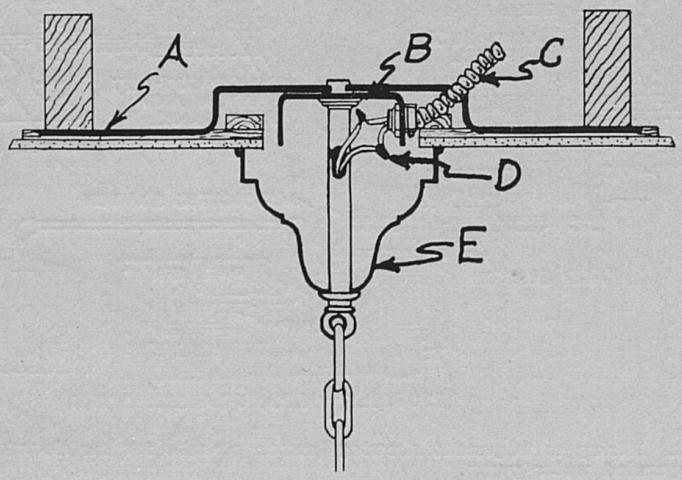


FIGURE 13. Cross section of a ceiling-light outlet. A. Mounting or metal strap fastened to ceiling joists. B. Outlet box. C. Flexible conduit. D. Soldered and taped wire splices. E. Canopy of pendant lamp fixture.

The voltage drop greatly reduces the light and power output for a given amount of current, increasing the operating cost. For motors, the voltage drop should not exceed 5 percent of the no-load voltage. A maximum of 3 percent is recommended. For lighting, heating and appliances, the voltage drop should not be greater than 2 percent. It is therefore important that if the wiring system for

light and power on the farm is to be adequate and safe, and if operating cost is to be kept at a minimum, the system must be correctly designed and installed by a competent person.

Types of Outlets. Outlets are of two general types: current-bearing outlets and switch outlets.

Current-bearing outlets are the openings in the circuit where the electric current is taken for use in lighting, heating and for driving motors. They are classed as light outlets, convenience outlets and special outlets for heavy-duty appliances. A light outlet is one at which a lighting fixture is permanently placed (see Figure 13). The convenience outlet is for plugging in a small appliance or lamp, at the convenience of the user (see Figure 14). A special or heavy-duty outlet is one of sturdy construction designed and wired

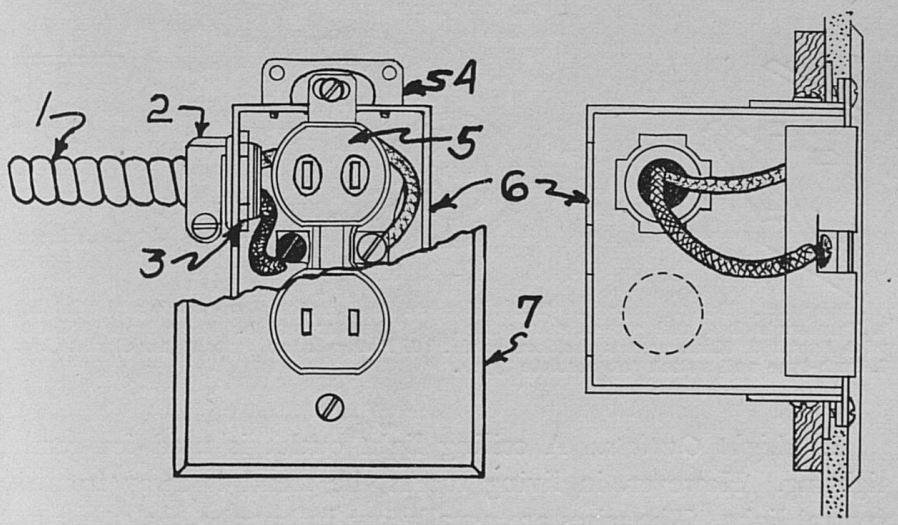


FIGURE 14. Details of a duplex convenience outlet. 1. Flexible conduit. 2. Connector. 3. Lock nut. 4. Mounting lug. 5. Flush receptacle. 6. Metal box. 7. Flush plate.

for use of heavy-duty appliances such as stoves, water heaters and large motors (see Figure 29).

A switch outlet is an opening in the circuit where a switch is inserted for the convenient control of the current (see Figure 15). It is placed where a switch is to be used for controlling the current to light or appliance outlets. A combination switch and convenience outlet or a convenience outlet in a bracket are economical

arrangements provided that they can be placed conveniently for the use of both. Switch outlets do not consume current.

Location of Outlets. The location and number of outlets in a home must be more or less an individual problem for each family. Following are some general suggestions:

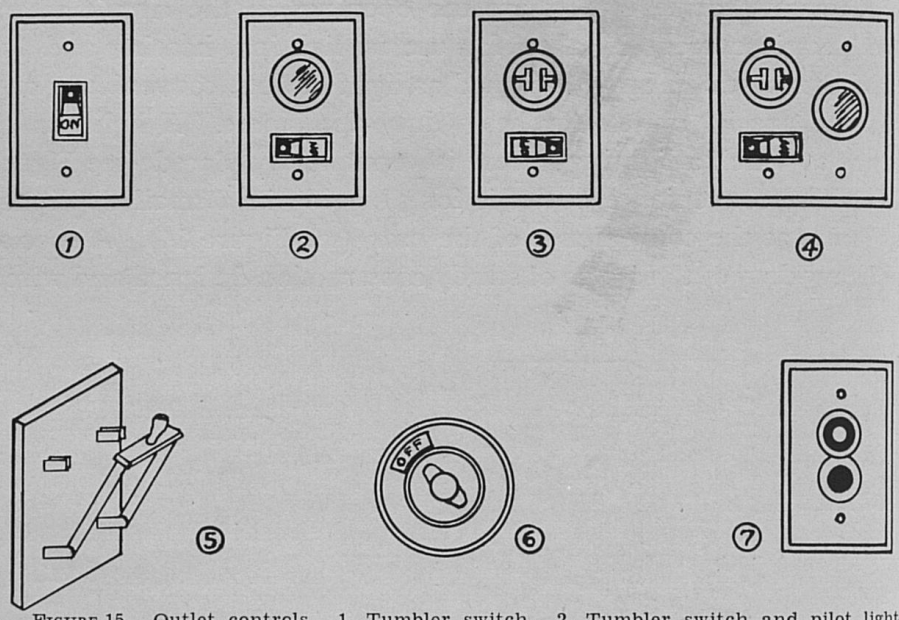


FIGURE 15. Outlet controls. 1. Tumbler switch. 2. Tumbler switch and pilot light. 3. Tumbler switch and convenience outlet. 4. Tumbler switch, convenience outlet and pilot light. 5. Knife switch (seldom used). 6. Rotary snap switch (an obsolete type). 7. Push-type wall switch (an obsolete type).

1. *Light Outlets.* A ceiling light outlet is used for general lighting. However, in living rooms the trend is away from the central light. The wires are usually put in but the outlet box may be covered with an inconspicuous plate until such time as a central fixture is desired. The ceiling light should be in the center of the ceiling and is most convenient if controlled by a wall switch near the door or doors where entry or exit is generally made. Large rooms sometimes require two ceiling outlets to give sufficient general lighting. Bracket fixture outlets are used where local lighting is required, as at a range, sink, ironing board, or mirror. In rooms such as living, dining and sun rooms, their uses are primarily decorative, tho too often they detract rather than add to the

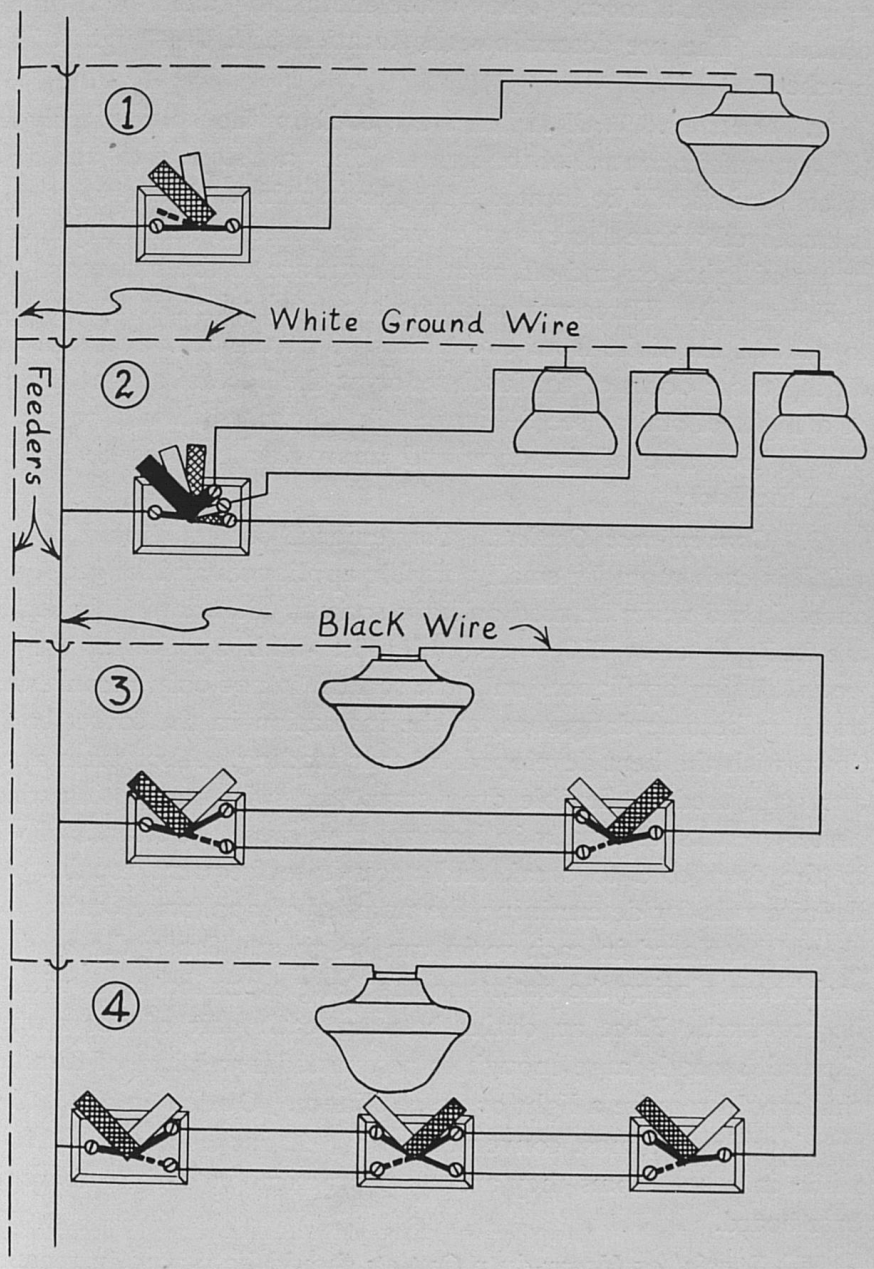


FIGURE 16. Methods of controlling lights. 1. Simple wall switch to control light from one point only. 2. Electrolier switch to control lights on several circuits. All lamps may be in one fixture. 3. Two three-way switches to control light from two points. 4. Two three-way switches and one four-way switch to control light from three points.

appearance of a room. They make the arrangement of furniture difficult. The use determines the location and the height of the brackets.

2. *Switches.* Wall switches are used in the home largely for the convenient control of the lights. They are step-savers and time-savers, and should be located with this in mind. A one-way switch is employed where there is only one best place to turn a light, or a group of lights, on and off, as at the entrance to the bathroom (see 1 Figure 16). Three-way switches are used when it is desirable to control the light from two places, as at the rear entrance and dining room doors of the kitchen, or at the bottom and at the top of a flight of stairs (see 3 Figure 16). Switches should be placed on the lock side of the door and approximately fifty-two inches from the floor.

3. *Convenience Outlets.* Convenience outlets should be provided in each room for small portable appliances and lamps. Appliances should never be used on light sockets. Standard light sockets are built to carry 250 watts and most small appliances use 660 watts. Using appliances on light sockets is not only inconvenient but may become dangerous, as the insulation in the socket breaks down with the heat developed by over loading. Also, when appliances are used on flexible drop cords, the swinging motion which usually results, especially in ironing, may cause the strands of wire in the drop cord to break and necessitate frequent repairs. No definite rule for determining the number of appliance outlets that should be placed in each room can be given. Study the needs of each room placing the outlets so that long extension cords will not be required. Place an outlet between each pair of doors where the wall space is large enough to accommodate a piece of furniture that would require a light or an appliance. Outlets in the kitchen and laundry are most convenient about 42 inches above the floor, while in other rooms they are more practical in or just above the base board.

4. *Special or Heavy-duty Outlets* should be placed in rooms in which heavy-duty appliances such as range, large space heater or water heater are to be used.

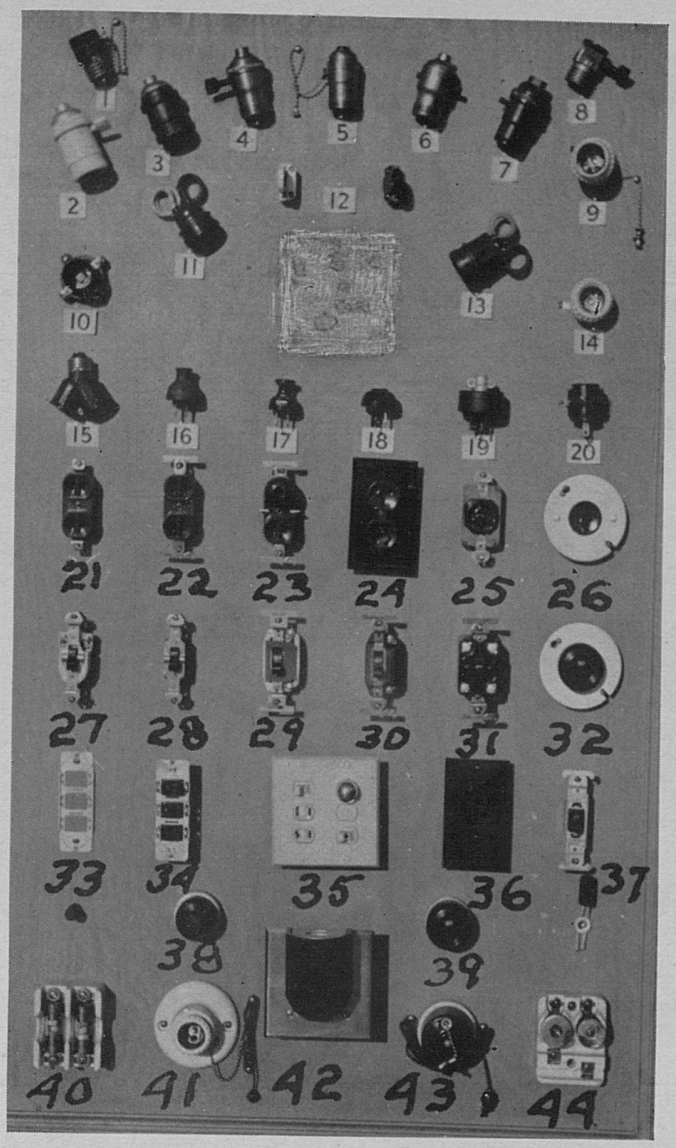


FIGURE 17. Panel of wiring equipment.

1. Body of pull socket
2. Porcelain, key light socket
3. Bakelite keyless light socket
4. Brass, key light socket
5. Brass, pull light socket
6. Brass, push-button light socket
7. Bakelite, push-button light socket
8. Body of key socket
9. Body of porcelain pull socket
10. Bakelite, screw-socket receptacle
11. Weatherproof socket
12. Lamp holders for tubular lamps
13. Weatherproof socket
14. Porcelain screw-socket receptacle
15. Double-socket attachment plug
16 to 20. Several styles of attachment-plug caps
21-26. Flush receptacles for lights or appliance outlets
27-32. Flush tumbler switches
33-34. Triplex convenience outlet and plates
35. Gang of receptacles, switches and pilot light
36. Triplex bakelite receptacle
37. Special receptacle
38. Snap switch
39. Tumbler switch
40. Cartridge fuses in porcelain base
41. Porcelain, pull light socket
42. Bracket socket
43. Pull switch, surface mounted
44. Plug fuses and two-pole porcelain base

WIRING CODE, PERMITS AND INSPECTION

All wiring installations should comply with the National Electric Code, with the laws applying to electrical installaton in effect in the local community, and with the regulations of the company furnishing the electricity. Copies of the National Electric Code may be obtained from the National Board of Fire Underwriters, 222 West Adams Street, Chicago, Illinois. The contractor should be instructed at the time the contract is let that he will be required to get all necessary permits and, after completing the work, have it inspected

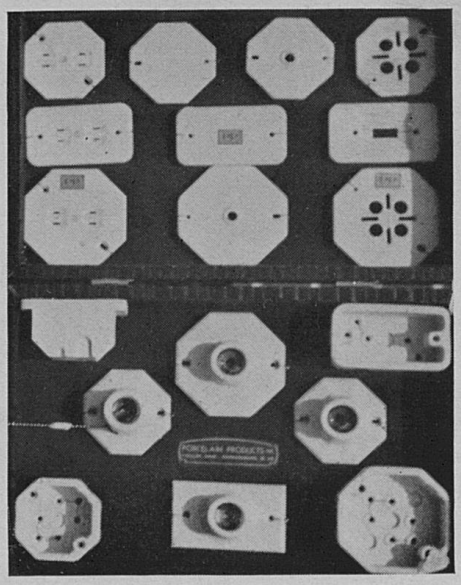


FIGURE 18. Receptacle covers and outlet boxes made of porcelain.

and tested for grounds and short circuits and furnish the owner a certificate of final inspection and approval from the inspection bureau having jurisdiction, before final payment is made. Inspection by a qualified person is a profitable investment or insurance against careless workmanship and use of inferior materials that do not meet the specifications and requirements of the code. It is also a safeguard against property damage by fire and injury or loss of life of persons or livestock.

WIRING MATERIAL

Many different sizes and kinds of bare and insulated wire are used in electrical work, each serving a particular purpose. Either bare or insulated wire may be used for main-line distribution wires and the service entrance wires. All wires for branch circuits inside of buildings, for lights, power and appliances, except the bare neutral for the range, should be insulated. The following is given so that one may easily recognize the various sizes and kinds.

Size of Wire. The size of wire is specified by a number. (See Figure 19.) The number decreases as the size increases. Sizes 16 and 18 are used in drop cords and for extension cords for lamps. Formerly, size 14 was commonly used for all branch lighting circuits in wiring houses, but the increasing use of more appliances

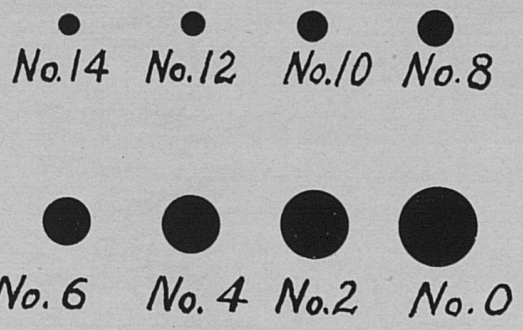


FIGURE 19. Wire sizes. The exact sizes of wires are shown by shaded circles.

and more adequate illuminaton causes current demands that may require the use of larger wires. For the main wires coming into the house and for heavy-duty circuits for ranges and heaters, sizes 8 and 6 or larger may be required. The size to use for large motors and long circuits should be determined by an electrician. The various sizes of wire are given in table 1. All diameters in the table refer to solid wire of the size mentioned. Stranded wires, made of a number of smaller wires twisted together, are used for extension cords where flexibility is required. Sixty-five strands of No. 34 wire are equivalent in cross-sectional area to No. 16 wire and this is known as No. 16 stranded wire.

Insulation. Wires carrying current must be kept apart or insulated to permit the electricity to flow where it is intended and to

prevent short circuits. The thickness of the insulation and the kind used depends upon the maximum voltage of the electricity to be carried, the amount of mechanical protection required, and the diameter of the wire.

Copper insulated wire is commonly used for the farmstead wiring system. A wire insulated with rubber, having a fiber covering over it for protection and to keep it in place is called a rubber-covered (RC) wire. If the metal conductor is stranded, it is called rubber-covered stranded wire (RCS). These kinds of wire are used inside of buildings.

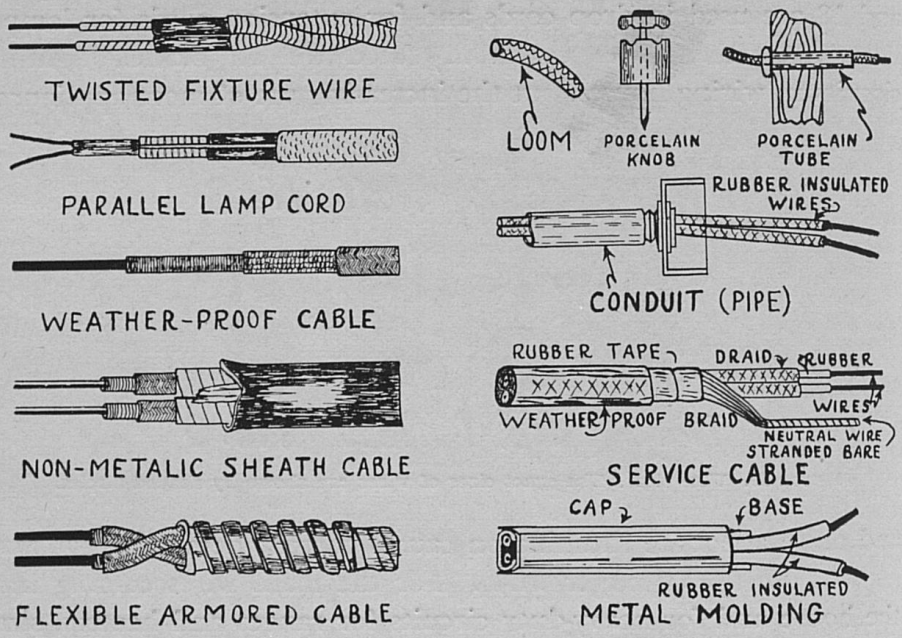


FIGURE 20. Wiring materials.

A wire insulated with a tough, fibrous weather-proof material is called weather-proof wire (WP) and is made to be used out-of-doors.

Some wires are insulated with slow-burning materials to eliminate the fire hazard and are used in hot, dry places, such as the interior of ranges and where wires are bunched together. This kind of wire is called slow-burning wire (SB).

Wire used on heating appliances such as flatirons, warming

pads and the like is commonly insulated with rubber and a thick layer of asbestos and is known as asbestos-covered wire (A).

One or more of these kinds of wire may be further mechanically protected by layers of steel, lead and fiber, depending upon the manner in which they are to be used.

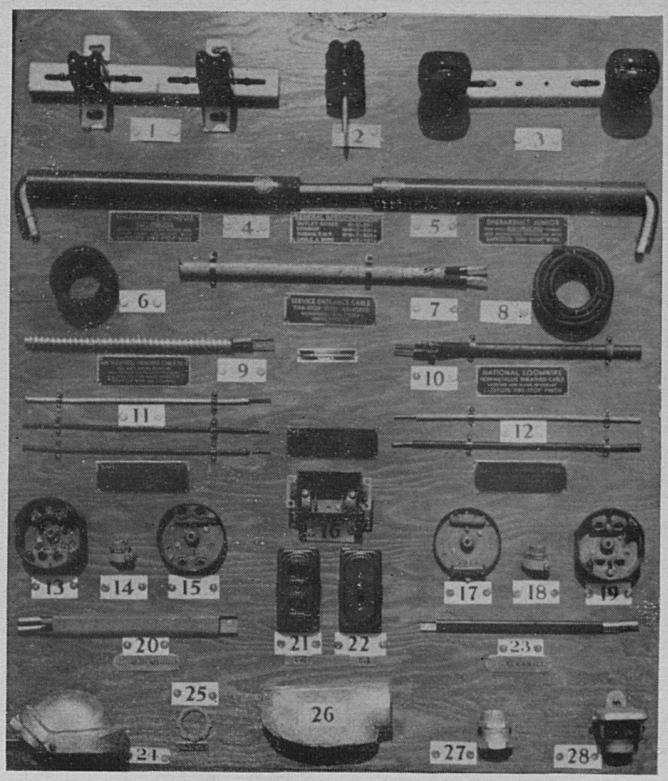


FIGURE 21. Wiring systems, fittings, wires and cables. 1-3. Service-line insulators and mountings. 4. Heavy metal conduit. 5. Light metal conduit. 6. Rubber-covered wire, flat twin. 7. Fire-stop steel armored entrance service cable. 8. Rubber-covered wire, round twin. 9. Flexible, steel armored cable. 10. Nonmetallic-sheathed cable. 11. White, black and red moisture-proof wire. 12. White, and black weather-proof wire. 13-19, inclusive. Metal outlet boxes and fittings. 20 and 23. Metal moldings. 21. Duplex receptacle. 22. Tumbler switch. 24. Service entrance conduit cap. 25. Lock nut for metal conduit. 26. Service entrance conduit elbow. 27. Metal adapter. 28. Service entrance conduit cap.

TYPES OF WIRING

Types of wiring used on the farm may be classified according to the kind of mechanical protection given to the wires.

Open Wiring. The open wiring "knob-and-tube" system is the cheapest as far as the materials are concerned, but affords the least

protection. In this system, insulated wires (RC) are supported on porcelain knobs and cleats placed at intervals on the surface of walls, ceilings, and thru joists and studding, boards being placed behind the wires where needed to provide some protection. Where a circuit passes thru a joist or wall, the wires are placed in porcelain tubes or a special weather-waterproof tubing known as "loom." In open wiring, the wires must be kept at least 3 inches apart and 1 inch from the surface over which they run, and a knob must be placed 6 inches from each tap or outlet.

Concealed Knob-and-Tube Wiring. In this system, the wires are supported by knobs, cleats and, in places, run thru tubes or loom as in the open wiring system, but they are concealed within the walls and ceiling of the structure. On straight runs, the knobs

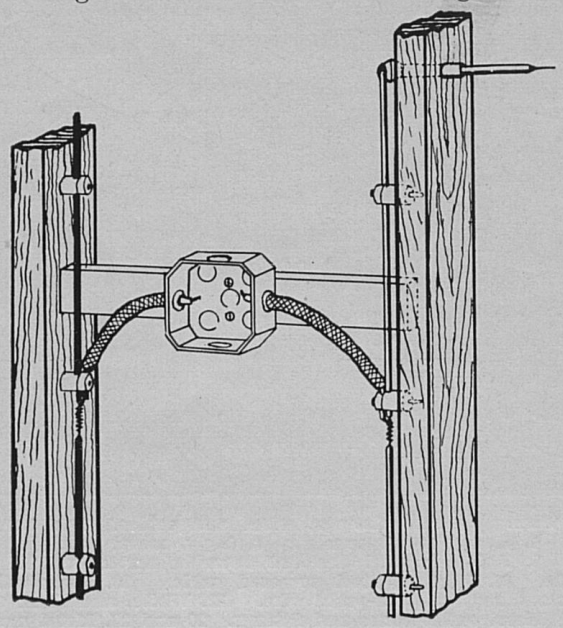


FIGURE 22. Metal outlet box for knob-and-tube wiring.

and cleats must not be more than 4½ feet apart. In the knob and tube system, outlet boxes and switch boxes are required by the Fire Underwriters and are mounted in exactly the same manner as for armored cable. See figure 22. Altho the knob-and-tube system, when properly installed, is safe and adequate, some city ordinances do not permit its use.

Concealed knob-and-tube wiring is usually installed before the ceilings and walls are covered. It should not be used in old buildings because it is difficult to provide adequate support for the outlet boxes. The cost of installing it in old buildings is greater than for armored cable or conduit wiring.

Armored Cable or Flexible Conduit. Armored cable is very extensively used (see figure 20). It is sold under a variety of trade names such as (BX), flaxsteel, etc. Type AC (armored cable) consists of two or more rubber-covered wires over which is a heavy layer of kraft paper, and over that a continuous ribbon wrapping of steel, each turn interlocking with the next, permitting the complete assembly to be flexible. Type ACL (armored cable lead) is made the same as type AC except that it has a lead sheath beneath the armor. Armored cable may be used for open or concealed work, but type ACL may be embedded in masonry or used in locations exposed to moisture. The cable may be drawn thru walls, partitions, floors and ceilings and may be held in place by pipe straps or staples. In armored cable work, all connections and joints are made inside of special approved boxes known as switch and outlet boxes and the steel boxes must be polarized or grounded to the neutral wire. All joints must be properly soldered and taped. In cutting the metal armor, care must be taken not to injure the insulation on the wires which may cause a "short" (a fire hazard).

Rigid-conduit. See items 4 and 5 figure 21. In conduit wiring, the pipe, or conduit, is installed when the building is erected and the wires are pulled thru it later. Rigid conduit is made of metal pipe and light metallic tubing (electric metallic tubing) that may be bent easily, and is especially smooth and enameled inside so as not to damage the wire. Black or green enameled conduit is commonly used, but in some localities galvanized is required. The conduit comes in 10-foot lengths. In locations where it is exposed to moisture or corrosive fumes, conduit and fittings of corrosion-resisting material suitable for the conditions should be used.

When the conduit is cut, the interior surface must be reamed to remove sharp edges or burrs. Whenever the conduit is attached to an outlet box, the end is threaded and securely fastened in place with locknut and bushing. Spliced wires are not permitted in con-

duit. All splices must be made at the outlet boxes and must be soldered and taped. This system offers maximum protection from mechanical injury.

Nonmetallic Cable. In the nonmetallic cable, each conductor wire is wrapped with an individual, spirally-wound layer of kraft paper (see Figure 20). Over all is placed a rubber sheathing or a tough outer layer of fabric impregnated in various solutions to make it water, fire and weather resistant. The cable is sold under various trade names, such as "Romex," "Cablex," "Cresflex," etc.

Every cable must be continuous, all connections must be inside approved boxes, as in armored cable. Like armored cable, it is more easily installed than pipe conduit in old buildings. It may be used as exposed or concealed wiring in dry locations, but should not be bedded in masonry, concrete or plaster. When used for exposed wiring, the latest National Electrical Code requires that it follow closely the surface of a joist or substantial running board $^{7}/_{8}''$ x $1^{3}/_{4}''$ and must be fastened to the surface at intervals of not over $3^{1}/_{2}$ feet. Where it passes thru or comes within seven feet of the floor, it must run inside of pipe or conduit. It must also be protected against mechanical injury, where necessary, by rigid conduit or substantial guard strips.

Metal Mouldings. Recently a number of metal-moulding conduits have been placed on the market to be used for protecting the wires on exposed surfaces of walls in structures already built (see Figure 20 and item 20 Figure 21). This type may be used in combination with other types of wiring.

Type of Wiring to Use. Choice of a wiring system may be limited by local regulations specifying the types of wiring approved by the National Code that are permitted locally.

The knob-and-tube system is the least costly for materials, but takes longer to install because of the holes that must be bored thru joists and studding. It requires protection from mechanical injury when the wires are exposed.

Armored cable provides practically all the advantages of a rigid conduit system and costs considerably less for both material and labor. Because of the ease with which it may be installed in

new or old buildings, and the protection which it affords, it is used extensively in wiring houses.

Nonmetallic cable is gaining in favor. It costs about the same as armored cable as far as material is concerned and requires less labor to install.

There seems to be no uniformity of opinion as to whether knob-and-tube, armored cable or rigid conduit is most suitable for barns and other farm buildings. On account of fumes and dampness in barns, nonmetallic cable is probably most suitable.

SUGGESTIONS FOR WIRING AND LIGHTING THE HOUSE

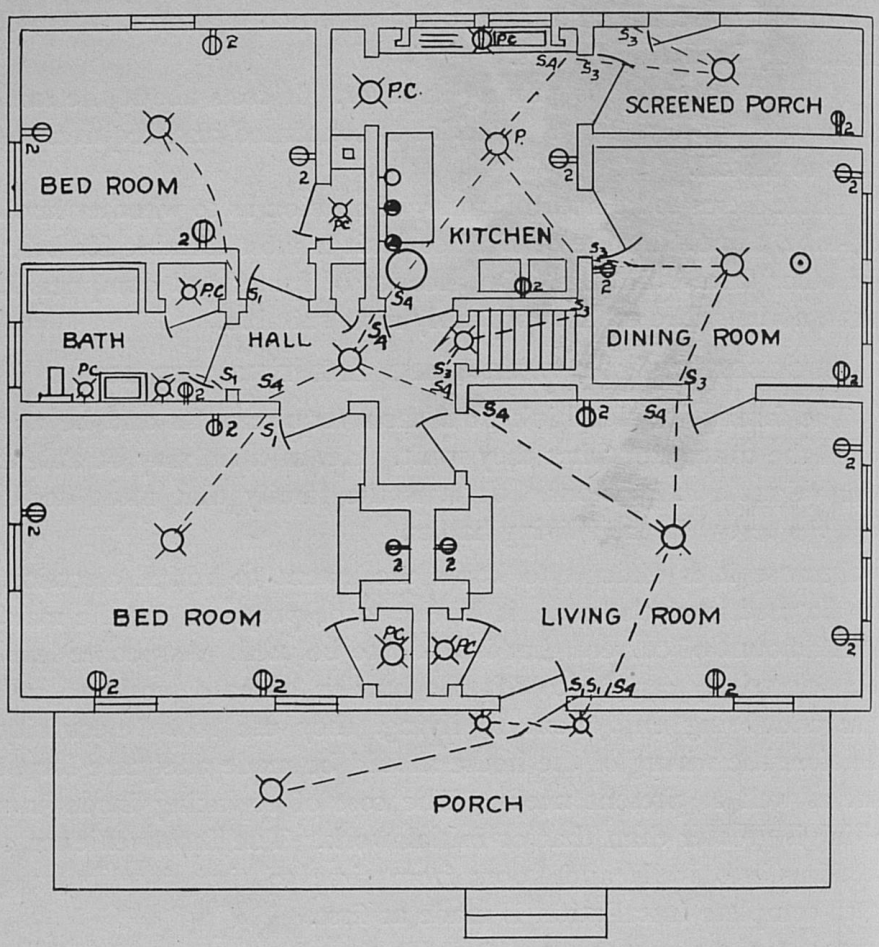
The family should think thru their requirements and be able to tell the contractor what they want. He, in turn, may be able to offer valuable suggestions, but it is the family that must decide what fits best with their living habits.

Because it is difficult to know the extent to which electricity will be used in one's home, it is wise to be prepared for the maximum amount of current that is likely to be used. As people learn what electricity can do to lift the burden of hard work, to save time and bring enjoyment to living, they use more electricity; therefore the wiring of the house should be made adequate for future as well as present needs. The cost of replacing inadequate wiring is greater than that of initial work. The inconvenience of breaking into walls and floors from time to time is eliminated when complete installation is made at first.

It is helpful to make floor plans of each floor in the house including attic and basement and to indicate upon the plans, by means of wiring symbols, the location and type of outlets desired. Wiring symbols to use on the floor plan are illustrated in figures 23, 24, and 25.

If, for reason of expense, all desired outlets and fixtures cannot be put in, either as many outlets as can be afforded may be put in, with allowance on the circuit for others to be added later; or put in all desired outlets and defer the purchase of fixtures in least-used rooms until money is available for the purpose.

The floor plans, figures 23, 24, and 25, illustrate the method of adapting the same floor plan to different cost levels. In figure 23,



WIRING SYMBOLS TO USE ON THE FLOOR PLAN

- Ceiling light outlet
- -P.C. With pull cord
- Wall light outlet
- -P.C. Wall outlet & pull cord
- Wall light outlet with convenience outlet
- Floor receptacle
- Single convenience outlet
- Double convenience outlet
- Single convenience outlet & switch
- Double convenience outlet & switch
- Heavy duty outlet (range, waterheater or motor)
- S_1 One-way switch. S_3 Three-way switch. S_4 Four-way switch.

FIGURE 23. Planned for full equipment.

all desirable outlets and switches for light, heat and energy are shown; figure 24 omits some of the conveniences but it is quite adequate for comfort; in figure 25 minimum allowance of outlets for

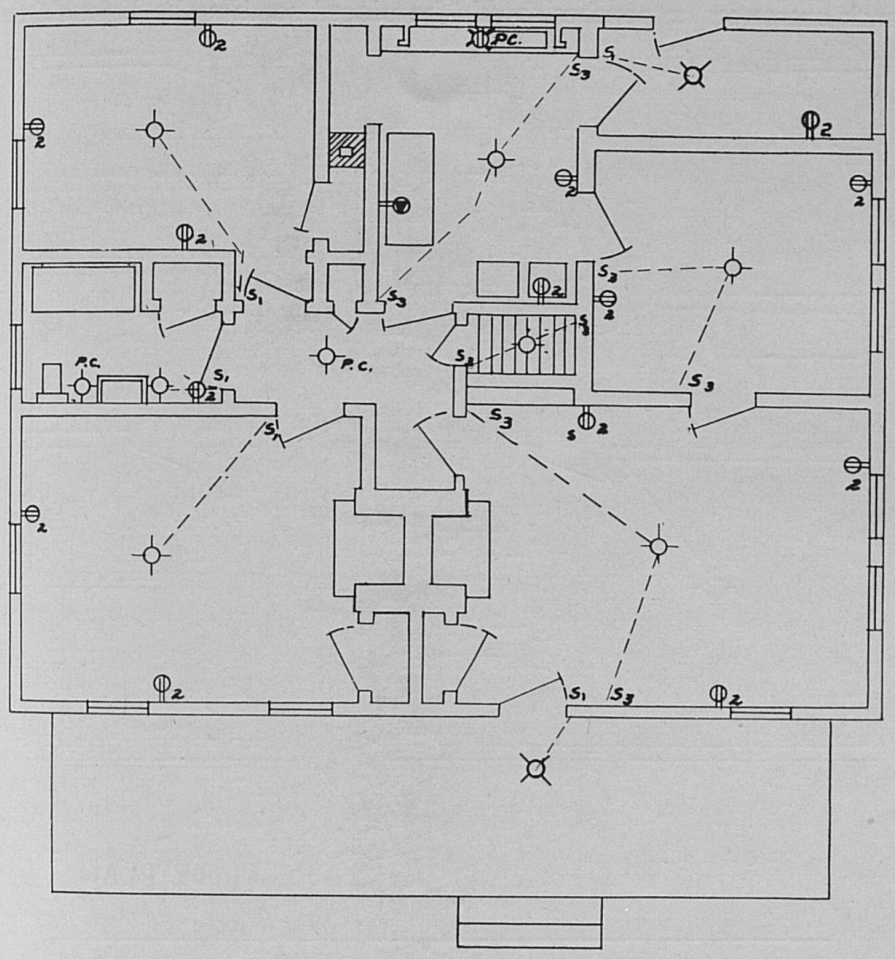


FIGURE 24. Planned for the most important equipment.

lights and small equipment is made. This plan permits the use of an automatic refrigerator but prohibits the use of a range, water heater or motors larger than one-third horse power. A three-wire entrance is required for the first and second plans while a two-wire entrance may be used for the third, provided one is sure that a range or large motor will not be used in the near future.

The various rooms in the house are considered room by room

in the following text. Types of lighting fixtures are illustrated in figures 26 and 27.

Entrance or Porch. The lighting fixtures for the front and back entrances or porches should be placed so that the light shines

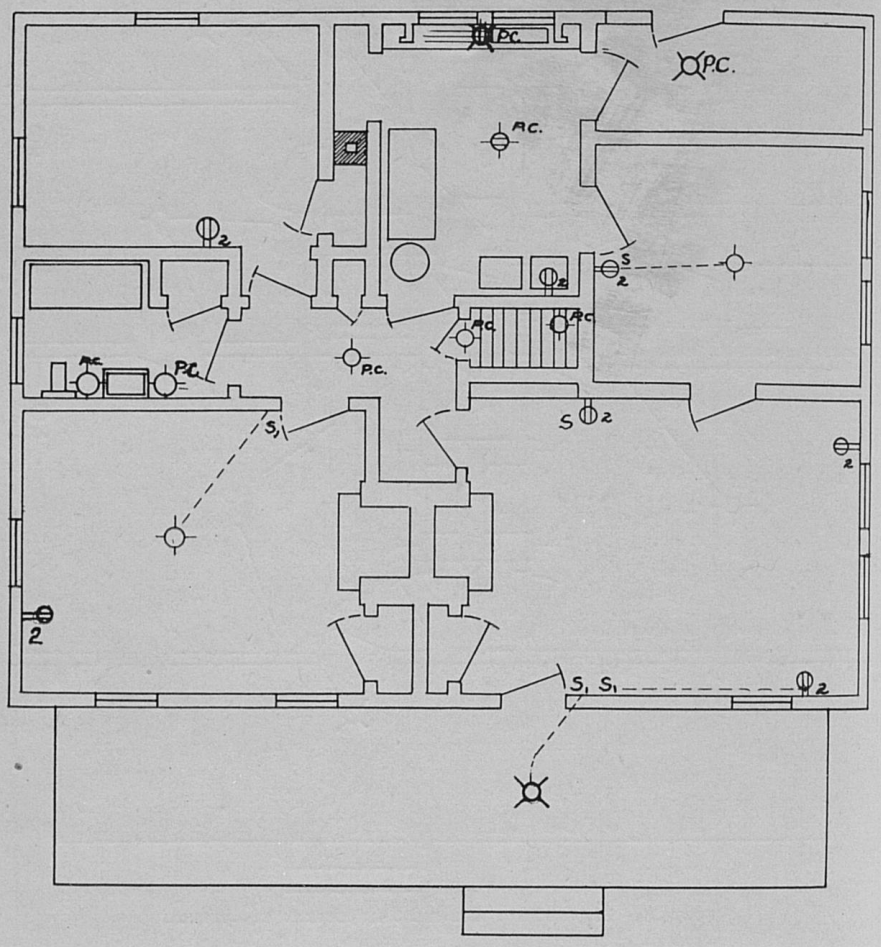


FIGURE 25. Planned for minimum equipment.

on steps, doorway and walk. Porch lights should be operated by a switch inside the door. A weather-proof fixture with a plain globe of white glass, placed at the ceiling, is suitable for both front and back porches. Lanterns may be placed on each side of the front door. Other wall-bracket fixtures are used at entrances without porches.

A screened or glassed living porch should be equipped with the same well-distributed wiring arrangement as the living room. At least one double convenience outlet is desirable for the back porch

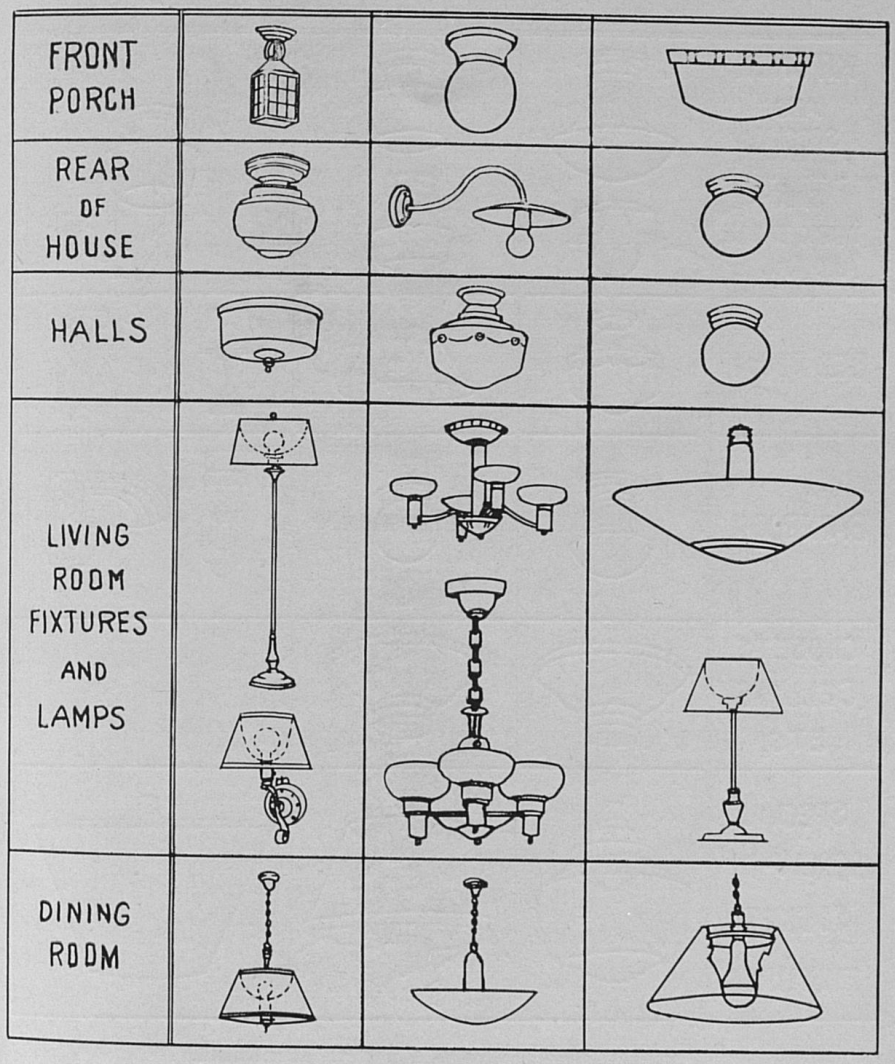


FIGURE 26. A selection of fixtures.

that is used as a workroom or for dining. A bell at the front door and a buzzer at the rear door are convenient.

Halls. For general lighting in the front hall one may use a pendant-type fixture if the room has a high ceiling or a close-to-the-

ceiling type for a low ceiling. As in all lighting arrangements, the globes should be of a character that transmits a soft, pleasant light free from glare.

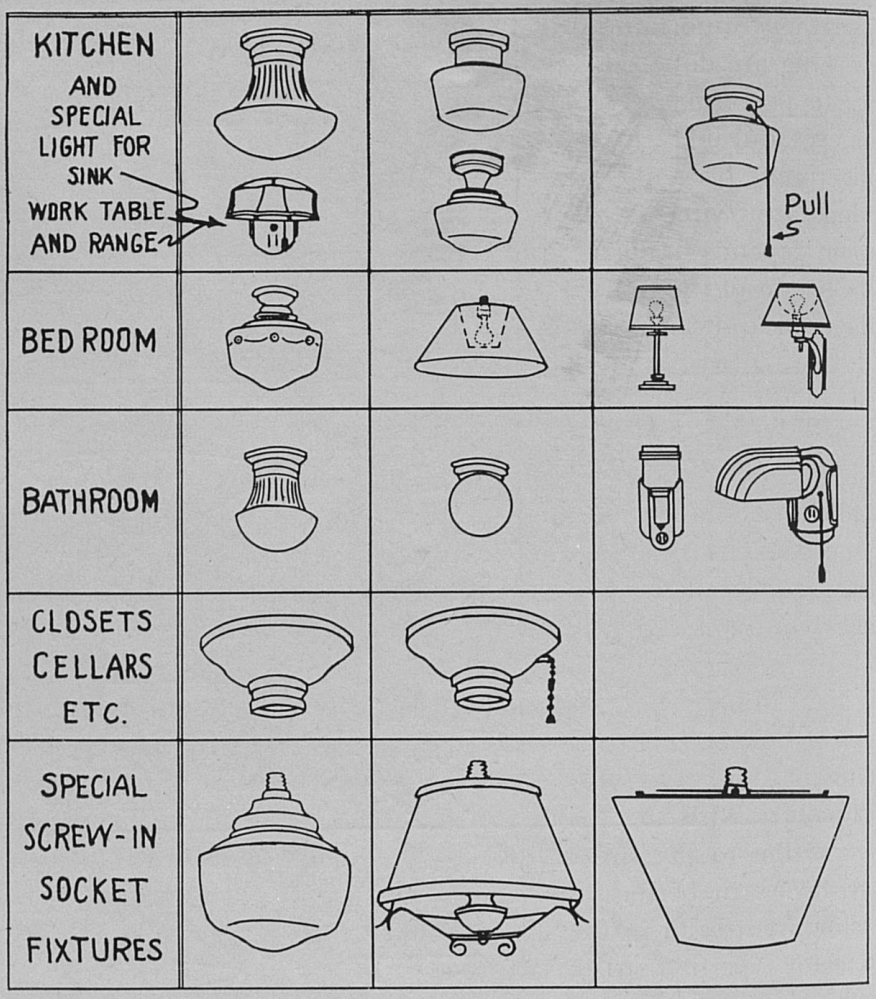


FIGURE 27. A Selection of Fixtures. (Continued.)

In the upper hall, a simple fixture with a plain enclosing globe placed where it lights the head of the stairs is sufficient for a small hall. In larger halls and irregular shaped ones more ceiling lights may be needed. It is recommended that switches be placed at entrance doors to the hall, at the foot and head of the stairs so that

they can be controlled at either place and adjacent to room doors. In a large hall it may be desirable to have a double convenience outlet for attaching portable lamps or vacuum cleaner.

Living Room. Safe-seeing, sight-saving, convenient lighting is extremely important in the living room where reading, studying and working are done. Every occupant of the room should be able to see to perform any desired activity with the least possible strain on eyes and body. A sufficient amount of light, well distributed in the room, prevents the sharp contrasts of dark and light areas which are trying on the eyes. The quantity of light needed in the room depends upon the number of people using the room, its uses, the height of the ceiling, the shape of the room and the character of the walls and ceiling, such as color, texture and finish.

Ceiling fixtures and portable table, floor and pin-up lamps which give a safely-diffused light are obtainable. For utilitarian local lighting better-sight lamps are recommended. They are equipped with diffusing bowls that soften and distribute the light; with white-lined shades that increase the amount of local light, and with proper height of lamp and spread of shade to shed the light over a large area. In a room of average size and shape, two or more better-sight lamps placed convenient to centers of activity will provide adequate general and local lighting. However, where the ceiling is high and the background and furnishings dark, it is advisable to supplement them with ceiling fixtures to provide more general illumination. The ceiling fixtures and lamps should be chosen to harmonize with the home and furnishings and to be in pleasing proportion to the size of the room. Simple, unobtrusive fixtures are always in better taste than ornate, showy ones. Close-to-the-ceiling fixtures fit in best in a room having a low ceiling while the pendant type of fixture is more satisfactory for high ceilings. All bulbs should be shaded to prevent glare.

Switches placed at the most used entrances to the room are a great convenience. Double convenience outlets should be placed where they are most accessible for attaching portable lamps, the radio and other appliances. Avoid placing outlets in the center of large, unbroken wall spaces which might make it necessary to move a large piece of furniture to reach the outlet. Have a sufficient

number of outlets so that fixture cords will not have to be stretched about the room.

Wall brackets are sometimes installed in the living-room for decorative lighting. As they are not a practical means of illuminating the living-room and often interfere with the arrangement of the furniture, the expense of installing them might better be diverted to a more practical purpose. When used, wall brackets should be placed symmetrically and where they will not detract from the appearance of the room nor interfere with the furniture placing.

A double convenience outlet mounted in the top and flush with the mantel board is useful for attaching a portable lamp, a fan, the electric clock, Christmas decorations, etc.

Dining Room. A ceiling fixture is needed in the dining room for general illumination and for lighting the top of the table; one of the most practical is a better-sight lamp hung about 30″ above the table. With a 100-watt or larger lamp bulb it provides soft, diffused light at meals or for study, sewing and recreation; the well-directed light makes seeing easy for reading, playing games and working. Switches at doors leading from the kitchen and adjoining rooms control the light conveniently.

If wall brackets are used for decorative lighting, they should be placed so that they do not interfere with the arrangement of the furniture. They should be 5 to 5½ feet above the floor and equipped with low wattage, inside-frosted bulbs and with shades. One or more double convenience outlets should be provided for attaching portable decorative lights, fan, vacuum cleaner, sewing machine and table appliances, such as the toaster, percolator, waffle iron, etc. If a floor outlet is used for the table appliances, it should be water proof and flush with the floor. The cord may be brought thru the seam or an eye in the rug. In the small dining room the appliances may be attached to a base outlet. The outlet for the fan should be near the small shelf upon which the fan is placed.

Kitchen. A ceiling light is essential in the kitchen. A simple fixture with a ten-inch enclosing, plain white globe with a 100-watt

or larger lamp bulb provides adequate general illumination for most kitchens. Two units may be needed in a large or unusually long kitchen. It is convenient to control the ceiling lights with switches at the most used doors. In addition to the ceiling light, it is desirable to have local lighting at sink, work cabinets and range. White porcelain wall brackets with white glass globes directing the light downward, with 40- to 60-watt lamp bulbs, placed so that the light shines on the working area but not in the eyes of the worker, are easily cleaned and convenient. An extra outlet in the fixture permits attachment of small appliances. In the home not wired for brackets, pin-up lamps may be connected to convenience outlets.

Before planning the placing of convenience outlets in the kitchen, the best possible arrangement of the kitchen should be made. Outlets may be desired for attaching a toaster, percolator, mechanical beater, flat iron and fan. Other possible needs for outlets may be for attaching clock, dishwasher, egg beater, extractor, hot plate, roaster, washing machine, ironer, etc. Heavy-duty outlets are needed for a range and a water heater.

Breakfast Nook. Local light for the breakfast table may be provided by a pendant ceiling fixture equipped with a diffusing globe hung about 2 to 2½ feet above the table, or by a wall bracket with a shade which directs the light downward or by a pin-up lamp placed above the table. A double convenience outlet should be placed so that appliances can be attached conveniently.

Bedrooms. A ceiling fixture and wall or portable lamps are required in the much used room. Two or more double convenience outlets may be useful for attaching the alarm clock, fan, health lamp, night lamp, heating pad, milk warmer, portable lamps and the vacuum cleaner.

At dressing units it is recommended that a light be placed on each side of the mirror on a level with the face of the person dressing. A pair of shaded wall-bracket lights or pin-up lamps, one on each side of the dresser or a pair of tall lamps on the dresser are serviceable when equippd with 60-watt bulbs and shaded with white or light shades.

For reading in bed, a wall-type better-sight lamp placed slightly

to one side and just above the head of the person reading permits comfortable reading. One central fixture, bracket wall fixture or a convenience outlet for a pin-up or other portable lamp may be adequate for a little-used bedroom. Where only one outlet is provided it may be more practical to omit the ceiling fixture as the double convenience outlet permits the use of portable lamps and small appliances. A light may be desirable in the deep clothes closet or the one inefficiently lighted by the general illumination in the room. This light should be mounted so that clothing cannot be placed in contact with it, as a protection from fire. The light may be controlled by a pull cord or automatically as the door opens.

Bathroom. Adequate illumination may be provided in all but large bathrooms by a pair of upturned wall brackets with diffusing glass shades, placed 5 feet to 5 feet 3 inches from the floor, on each side of the mirror, preferably 30″ apart. A fixture is procurable with a convenience outlet for attaching curling iron, hair drier or fan. No fixture should be so placed that one while in the bath can reach it and be injured by electric shock. A satisfactory ceiling fixture, in addition to the bracket lights, in a large bathroom is one with an enclosing glass globe. If a ceiling fixture is used it should be mounted over the wash basin.

Attic. A light at the head of the stairs and one or more convenience outlets to which an extension cord may be attached will serve to light all parts of the attic.

Basement. A light at the foot of the stairs, controlled at the head of the stairs, will light stairs and furnace if the latter is close to the stairs. Shaded lights with pull cords will be needed in storage rooms, coal bin and near electric service. If the room is used as a workshop each work area should be adequately lighted and provided with appliance outlets.

SUGGESTIONS FOR WIRING OUTBUILDINGS

Wiring Between Buildings. Use weather-proof or rubber-covered wire outside or between buildings. The wire must be of sufficient size to carry the connected load, but in no case less than No. 10 A.W.G. (American Wire Gage). The National Safety Code

requires that no wire smaller than No. 8 be used on spans longer than 50 feet, as the wire must be strong enough to withstand wind and weight of ice on the wire. If larger wire is required, the exact size to use will depend upon the length, allowable voltage drop and the total amount of current required at one instant. The wires should be placed not less than 12 feet above the ground and at a sufficient height to provide clearance for a threshing machine, load of hay, or large truck.

Yard Lights. One or more yard lights will be found convenient, particularly if they are wired with a pair of 3-way switches to control them from two convenient points. Yard lights should be mounted 15 or more feet above the ground, on goose-neck bracket arms fastened to poles or buildings. They should be provided with

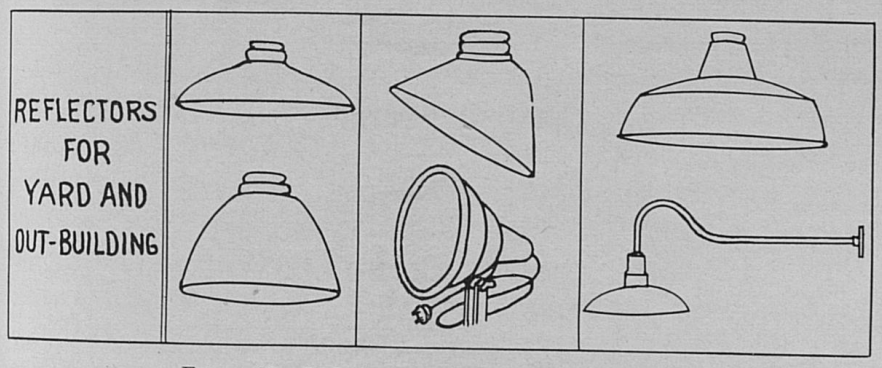


FIGURE 28. Reflectors for yard and outbuildings.

100- to 150-watt Mazda lamps and yard reflectors and should be so located as to illuminate the barnyard and entrances to the buildings. All outdoor lights should have weather-proof sockets and wiring and be substantially mounted to withstand storms.

Other Farm Buildings. Garage, machinery shed, shop, hog houses and milk house should be wired with lights and reflectors (see Figure 28). Care should be taken to provide convenient outlets for portable motors (see Figure 29) and to see that the wires, switches and fuses or circuit breakers are of the proper sizes and installed according to the Code.

Barns. The same care must be taken in planning and wiring the barn and other outbuildings as in wiring the house, in order

to provide a convenient, adequate, safe system. Lights controlled by conveniently located switches should be used in every part of the barn. Three-way switches placed so that the lights can be turned off and on from either end of the barn, near entrances, save time. Use tumbler switches placed at a convenient height and so located or protected that animals cannot injure them. Cover

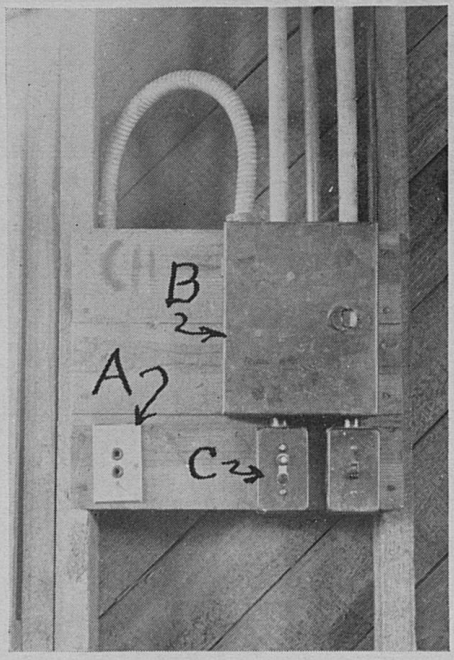


FIGURE 29. A, a power outlet for plugging in a portable motor. Outlets of this type should be conveniently placed in the outbuildings wherever it may be desirable to operate a portable motor. B, Circuit fuse panel. C, a lighting circuit switch.

the switches with galvanized, porcelain or heavy bakelite cover plates.

The wiring and service outlets must be protected from mechanical injury by animals and feed stored and should be moisture and acid proof. All receptacles and lamp sockets should be porcelain or bakelite. The use of brass fixtures of any kind in barns and outbuildings is not permitted by the National Electric Code. Lights should have wire guards and reflectors. The open-bottom guard is better than the enclosed type, as it does not have to be removed to replace a lamp. If the lamp sockets

are suspended on heavy-duty cord, the lamps swing and are not so easily broken if accidentally struck.

In the milking quarters of the dairy barn, which should be well lighted, there should be at least one light behind every five cows. When the cows "face in," there should be one convenience outlet for every 30 feet of length of wall on both sides of the barn. If the cows "face out," provide only one outlet per 30 feet of length of stable in the cleaning alley.

A couple of lights with reflectors should be placed in the hay loft, mounted as high as possible. The switch for operating these lights should be on the first floor, at the foot of the stairway or ladder. Wiring in the hay loft should be run in conduit for protection against fire and mechanical injury.

Poultry Houses. Plans should be made to provide electricity for the poultry houses. Electric lights not only add to the convenience of feeding and caring for the flock but, under proper management, provide a means of increasing egg production during the winter, when prices are high. Electricity may also be used for operating burglar alarms, water heaters, incubators, brooding equipment and for ultra-violet ray lighting. The following recommendations regarding lighting laying houses should be followed:

1. Have the house wired by a competent electrician.

2. Use as the lighting unit a 40-watt frosted Mazda lamp with a cone-shaped, aluminum-painted reflector sixteen inches in diameter and four inches deep.

3. Use one 40-watt bulb per 200 square feet of floor space. A 20 x 20 Kentucky poultry house requires two 40-watt bulbs.

4. Place the lighting units 5 to 6 feet from the floor and 10 feet apart, on the center roof support or on a line midway between the front of the house and the roosts. The roosts as well as the floor must be lighted or some of the hens will stay in the dark roosts.

5. Provide an automatic alarm-clock switch for operating the lights.

6. Use porcelain or bakelite receptacles, and switch plates, and the same wiring materials as recommended for barns.

If the reader desires additional informaton on wiring materials,

the cost of wiring and equipment and the cost of operating various kinds of electrical equipment, write to the Extension Division of the College of Agriculture, Lexington, Ky. Also write for Kentucky Extension Circular No. 305 "The Cost of Rural Electric Service."

Table 1. Safe carrying capacity of insulated copper wire, for electric current, in amperes.*

Size of wire American wire gage	Rubber insulation	Varnished cloth insulation	Other insulation and bare wire
	amps.	amps.	amps.
18	3	—	5†
16	6	—	10†
14	15	18	20
12	20	25	30
10	25	30	35
8	35	40	50
6	50	60	70
4	70	85	90
3	80	95	100
2	90	110	125
1	100	120	150
0	125	150	200
00	150	180	225
000	175	210	275
0000	225	270	325

* From National Board of Fire Underwriters' code.

† The allowable carrying capacities of Nos. 18 and 16 wire, when in cords for portable heaters, are 10 and 15 amperes, respectively.