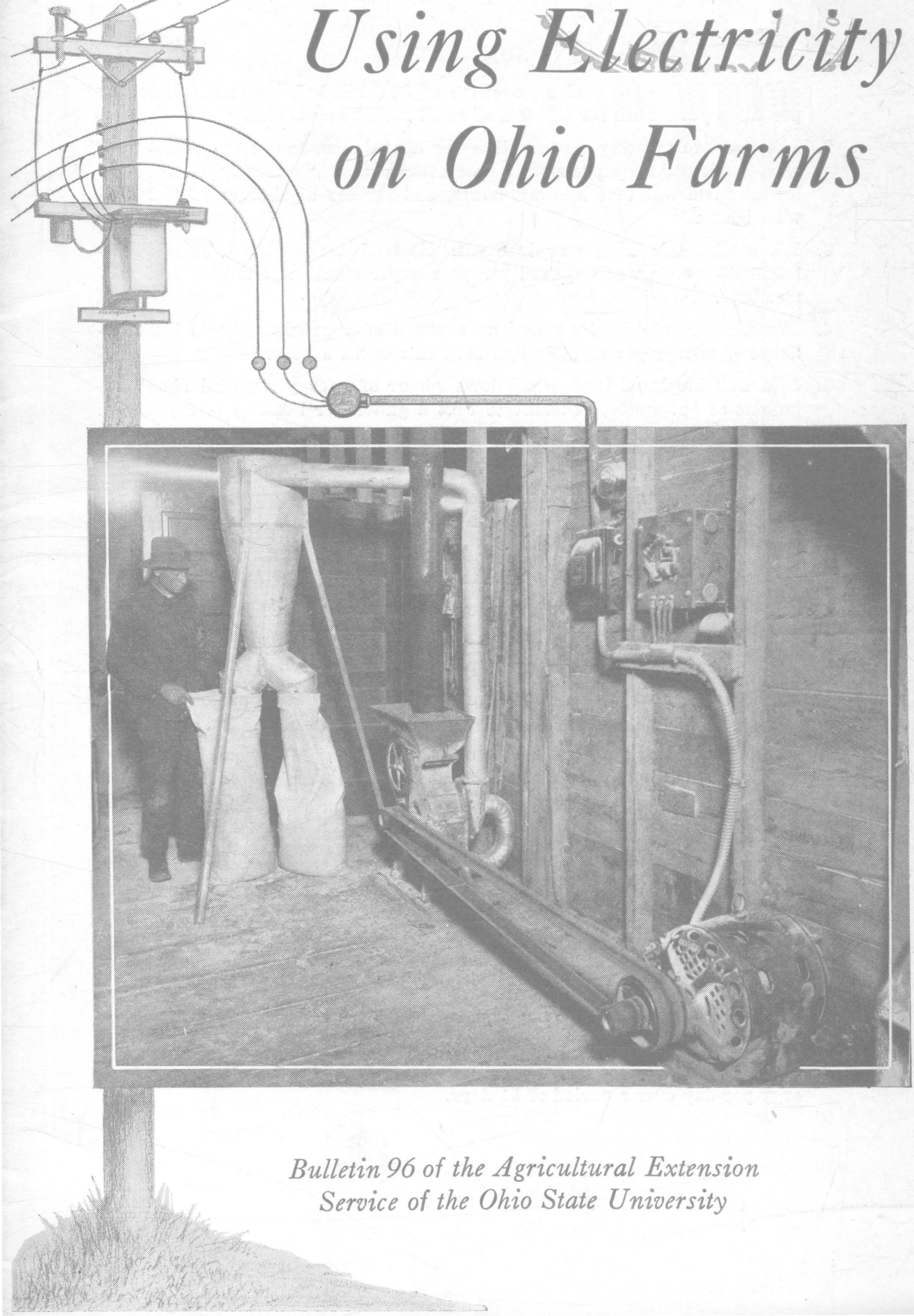
Using Electricity on Ohio Farms



Bulletin 96 of the Agricultural Extension Service of the Ohio State University

SUMMARY

1. The thirteen farms used an average of 38.3 kilowatt-hours of electricity per farm per month for lights and small socket appliances.

2. The average monthly consumption for all thirteen farms was 122.5 kilowatt-hours per farm per month. The average monthly consumption for the lowest farm was 56.3 kilowatt-hours, and for the highest was 304.2 kilowatt-hours.

3. When all the cooking was done with electricity, from 30 to 35 kilowatt-hours of energy was required per person per month in families of 5 to 7 members.

4. The electric refrigerators used an average of approximately 40 kilowatt-hours of energy per month when used 12 months a year.

5. In a well insulated tank, one kilowatt-hour of energy supplied about 3½ gallons of hot water, at about ⅓ cent a gallon for heating (see page 8).

6. An average of 2.4 kilowatt-hours of energy was used per month for washing clothes with an electric washing machine.

7. The electric hand iron used an average of 5 kilowatt-hours of energy per month, while the ironing machine used from 10 to 15 kilowatt-hours of energy per month.

8. One kilowatt-hour of energy operated a vacuum sweeper from 5 to 6 hours.

9. A 10-inch electric fan will operate in high speed for 20 hours on 1 kilowatt-hour of energy.

10. 1000 gallons of cistern water was pumped by 1.2 kilowatt-hours of energy.

11. 1000 gallons of well water was pumped by 1.63 kilowatt-hours of energy.

12. The milking machine reduced the time required for milking about 50 per cent. An average of 2 kilowatt-hours of energy per cow per month was used with the pipe line machine, or 3.26 kilowatt-hours per 1000 pounds of milk.

13. The energy used for grinding varied from 2 kilowatt-hours per 100 pounds for finely ground oats, to 0.1 kilowatt-hour per 100 pounds for coarsely cracked corn. The average for all grains ground medium fine was approximately 0.8 kilowatt-hours of energy per 100 pounds.

14. With the use of a 5-hp. electric motor and an 11-inch to a 16-inch ensilage cutter, silos as high as 40 feet were filled with an energy consumption of 1 kilowatt-hour per ton, using a ¼-inch cut.

15. A 1000-egg incubator averaged between 7 and 8 kilowatt-hours of energy per day.

16. A 56-inch 500-chick brooder used an average of 5.7 kilowatt-hours of energy per day over a period of 51 days.

Using Electricity on Ohio Farms

By

G. W. McCuen and I. P. Blauser

Department of Agricultural Engineering, The Ohio State University

What will it cost to use electricity on the farm and in the farm home, and how can it be secured? Those are among the first questions asked by anyone considering the use of electricity on the farm for light, heat, and power.

In order to secure information on the use of electricity on farms and in farm homes, your college of agriculture was instrumental in having an electric line built into a farm community that had not previously used electricity. The line served thirteen families on State route 31 southeast of Marysville. Records of the amount of electricity used on those thirteen farms for lights, for heat, and for power, both in the homes and on the farms, were carefully made for three years.

The power line was built. Everything was new. All costs are known. The data obtained during the three years on the construction, the operation, and the maintenance of the line for light, heat, and power used to operate numerous home conveniences and pieces of farm machinery are available. These data, if properly interpreted, should be helpful to both farmers and power companies. This bulletin is an attempt to present what was found about the use of electricity on those thirteen farms during the three years of study.

Throughout the bulletin, the amount of electricity used by the different pieces of equipment is given in kilowatt-hours. A *kilowatt-hour* is the unit by which electricity is measured and sold, just as a *gallon* is the unit in measuring and selling gasoline.

The cost of a kilowatt-hour of electricity varies. In some places, the average cost may be as low as 4 cents per kw-hr. (abbreviation for kilowatt-hour), while in other communities the cost may run as high as 15 or more cents per kw-hr. The actual cost in dollars and cents of operating the different pieces of equipment used on the thirteen farms is not given in the text of this bulletin. but the *amount* of electricity used is given. The relative cost of operating any particular piece of machinery or home appliance in any community can be obtained by multiplying the number of kilowatt-hours used by that piece of equipment by the local cost of a kilowatt-hour.

The use of electric lights in farm homes and farm buildings is just as desirable as is their use in city homes, in factories, and in stores. But, electricity used only for lights and for small household appliances, such as washers, irons, vacuum cleaners, and toasters would call for such a small amount of electricity, that, in most farm communities, a power company could not afford, except at prohibitive rates, to furnish electric current. Although more than 200 uses for electricity on farms have been reported, no one farm is going to use all of them. Many of those uses might prove highly profitable to farmers, other uses might be genuine labor savers, and still others might be classed as conveniences only.

However, before the use of electricity becomes common on farms and in farm homes, the farmers must have electricity available at such cost and use it in such quantity that furnishing it will be profitable to the power company, and using it, profitable to the farmer.

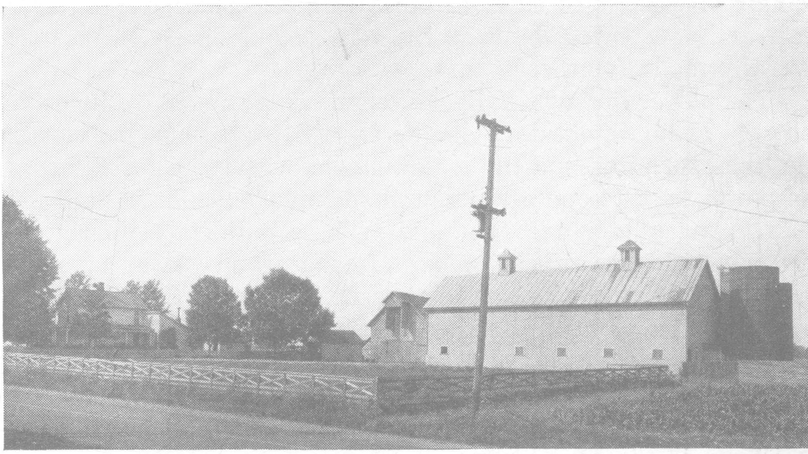


Figure 1.—Home of Leo Coleman, one of the largest users of electricity on the Marysville line. The transformer (box on the pole in the foreground) steps down the voltage from 6600 volts to 110-220 volts.

The Marysville Experimental Line

The length of the Marysville experimental line is 5.9 miles and it was built during the spring of 1926 at a cost of $1360 per mile. This figure includes the cost of the transformers but not that of the meters. Thirty-foot poles were used; they were spaced 175 feet apart and supplied with 3-foot cross arms. No. 4, stranded, bare copper wire was used. Single-phase, 60-cycle, 6600-volt current was carried on the primary line, while the three-wire secondary lines carried 110 to 220 volts. The thirteen master watt-hour meters were equipped with attachments which showed the highest kilowatt load over 15-minute intervals. There were also ninety individual watt-hour meters which measured the consumption of electricity by the different pieces of equipment.

The thirteen farmers served by the line are all cooperators in this rural electrification experiment. The east-central division of the National Electrical Light Association financed the management of the line, which is under the direct charge of the Department of Agricultural Engineering of the Ohio State University. Equipment manufacurers have loaned the equipment used on the line. The farmers were given the privilege to purchase any equipment used. Much of it has proved so satisfactory that it has been purchased and is now the property of the farmers.

The rate paid by the thirteen farmers for the electricity they used was as follows: 11 cents per kw-hr. for the first 15 kw-hr. per month; 8 cents per kw-hr. for the next 45 kw-hr. per month; and 3 cents per kw-hr. for all over 60 kw-hr. each month. Under this rate the minimum monthly bill was $5 per month—that is, each farmer paid a minimum of $5 per month even though he did not use that amount of electricity.

The above rate is not an experimental rate, even though it is used on the experimental line, for the same rate is used for the other rural lines in that territory. It appears now that the rate will be lowered in the near future.

Electric Service in the Thirteen Farm Homes

The experiences on the thirteen farms and in the farm homes on this electric line, during the period of the experiment, are briefly reviewed in the next few pages. The service rendered by each piece of equipment and the impressions of each farmer or farm wife have not been given, but an effort has been made to include such general statements as are typical of the service and experiences on the line as a whole.

Electric Lights.—Electric lights on the farm are convenient; where properly installed, safe; and they give good illumination.

If the most benefit is to be derived from any lighting system, it must be carefully planned. The lights must be properly placed and the switches conveniently located. Much thought was given to meet these demands in installing the lights in the thirteen farm homes. A statement common to many of the farm women is "lights over the sink and the kitchen table have made the kitchen work so much more pleasant and easy." It was generally agreed, also, that the lighting in the home had a remarkably good effect on the home and family life. That is one of the services of electricity in the farm home that cannot be measured in dollars and cents.

The amount of electricity used on the thirteen farms for lighting and for all small socket appliances, such as vacuum cleaners, percolators, glow heaters, heating pads, waffle irons, toasters, curling irons, fans, sewing machine motors, and immersion water heaters averaged 38.3 kw-hr. a farm a month for the three years.

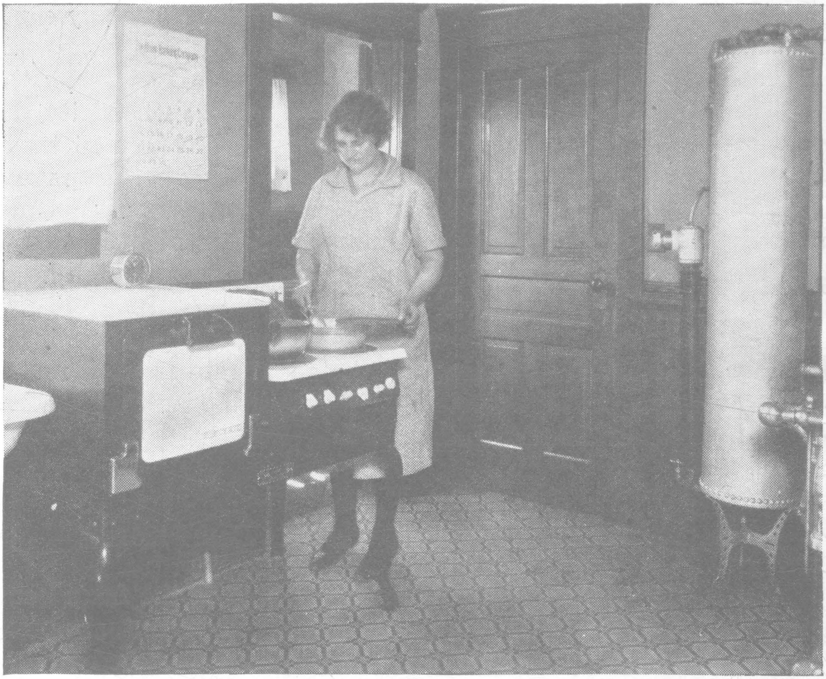


Figure 2.—Mrs. Henry Coleman does all of her cooking on the electric range during the months of May to October. The side-arm water heater on the water tank is used to supply hot water as needed. It is not economical to have a tank of water heated all the time, unless the tank is heavily insulated.

Cooking with Electricity.—The electric range was popular with the farm women. This was particularly true during the summer, when most farm kitchens are very hot. The electric ranges were used sparingly during the winter months, because a wood or coal range was used to heat the kitchen and the same fuel was used for cooking. The cost of cooking with electricity, unless the electric range is operated very efficiently, is higher than it is with other fuels. However, to compensate for the increased cost of operation, is the cleanliness, safety, convenience, cooler room temperature, and the automatic heat control of the electric range.

When all of the cooking was done on the electric range, the energy consumption varied from 30 to 35 kw-hr. per person per month with families of from five to seven members. For smaller families, the energy consumption per person would, doubtless, have been greater, and with larger families the energy consumption per person would have been less. Care and system in the operation

Figure 3.—Mrs. Lewis Nicol, after using an electric refrigerator for three years, feels that it is a necessity rather than a luxury.

of an electric range will account for differences in the cost of operation.

Electric Refrigerators.—Refrigeration is just as important in the farm home as it is in the city home. Farms in the community served by the Marysville experimental electric line, because of the inconvenience of getting ice, did not, as a rule, have any refrigeration until the electric refrigerator was made available. As a result of three years' experience, the electric refrigerator is no longer considered as a luxury only. It was especially appreciated by the women, because it saved them many trips to the basement, kept the food, furnished a supply of ice for cold drinks, and made easily possible many frozen desserts.

The energy consumption by refrigerators depends on the amount of food stored in them, the temperature of the food when placed in the refrigerator, the kind of food, the number of times the doors are opened, the length of time they are left open, and the location of the refrigerators. There were eight refrigerators used on the line, but some of them were not operated during the winter months, because they were located in cool pantries.

The average monthly energy consumption for three years for a 9-cubic foot box was 55.6 kw-hr. and for a 7-cubic-foot box of the same make, 42.6 kw-hr. per month. The summer monthly averages were 72.6 kw-hr. for the 9-cubic-foot box and 52.2 kw-hr. for the 7-cubic-foot box. The winter monthly averages were respectively, 38.6 and 33.1 kw-hr. These differences were not due entirely to the size of the boxes. Had the same size box been used in these two home there would still have been a considerable variation in the energy consumption, because of the different conditions under which the two boxes operated.

Water Heating.—The farm home has a need for an abundant supply of hot water the year around. During the winter months, the hot-water-back of the furnace or kitchen range furnishes plenty of hot water. However, some other source is needed during the summer, if an electric range is used for cooking. Electricity may be used quite successfully for heating water, but the tank must be thoroughly insulated to prevent radiation losses.

A storage type electric water heater was installed in one of the farm homes in May, 1929, and has been in operation since that time. It is operated on an off-peak schedule. That is, the water is heated at night and stored in a well insulated tank for use during the day. A time clock furnished by the electric power company turns the electricity on at 9:00 p. m. and off at 7:00 a. m. It is also turned on again for an hour between 11:30 a. m. and 12:30 p. m. The tank holds 60 gallons and it is well insulated. There are five members in the family, and the heater has furnished plenty of hot water even on wash days.

A very low rate is given for this off-peak service, because the current is used when very little current is used elsewhere. The rate is 1½¢ per kw-hr. for the first 100 kw-hr. per month, and 1¢

per kw-hr. for all over 100 kw-hr. each month. The cost for hot water has averaged $2.64 per month, or about one-third cent per gallon.

Washing Machines.—Washing, when done by hand, is probably the hardest task in the farm home. The electric washer is, therefore, one of the greatest labor-savers in the home. Not only does

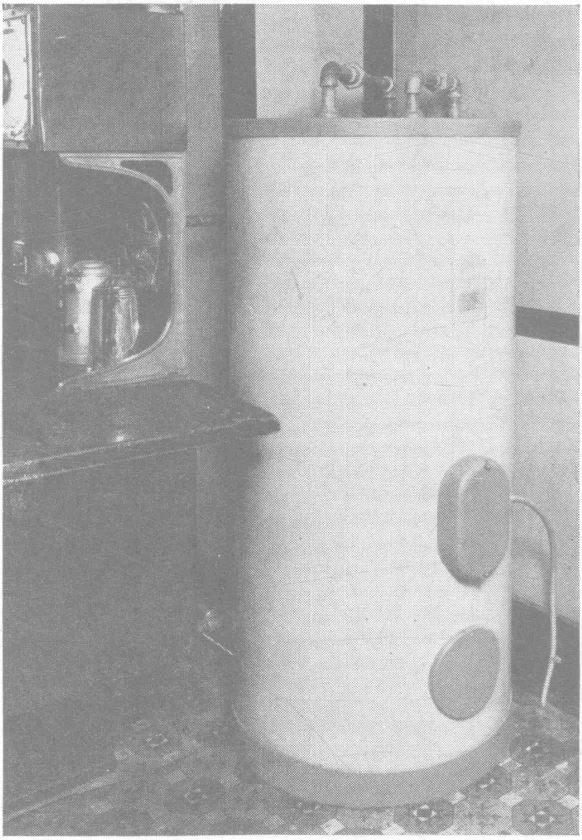


Figure 4.—This electric water-heater in the Lewis Nicol home, heats the water at night, and stores it in a well-insulated tank to be used during the day.

the electric washer save labor but it also saves from one-third to one-half the time usually required for washing.

The amount of energy used by the washing machine is very low. The average consumption for the thirteen washers on the line was 2.4 kw-hr. per month for the three years. The average washing consisted of about 30 pounds of dry clothes per week.

Ironing.—The electric hand-iron is probably one of the most widely used pieces of electrical equipment in the home. The investment is small. An electric iron saves much hard, hot work, compared with the old method of ironing.

Each of the thirteen farm homes used an electric iron. The energy consumption averaged about 5 kw-hr. per month. The average size electric hand-irons can be operated for one hour and 50 minutes on 1 kw-hr. of electricity. However, 1 kw-hr. will heat such an iron for a longer time if the ironing can be done with the current turned off part of the time.

Figure 5.—The electric washer saves time and energy. Two kw-hr. of current operates Mrs. Charles Nicol's washing machine for one month.

Figure 6.—Mrs. Henry Coleman has used her electric ironer for over two years. She does her ironing in about one-half the time required with the hand iron, and the work is much easier.

Where there is a large amount of ironing to do, an ironing machine is desirable. As soon as the user becomes familiar with the operation of the ironer, the time required for ironing is only about one-half as great as that required by the hand-iron, and the work is much easier.

The energy used by the ironing machines varied from 10 to 15 kw-hr. per month. The average for the three years was 14 kw-hr. per month.

Small Cooking Appliances.—Among the small electric appliances that add a great deal to the convenience of cooking are the percolator, toaster, waffle-iron, and small electric hot-plate. Any one of these of average size can be operated from 1½ to 2 hours on 1 kw-hr. of energy. These small appliances were not attached to separate meters and the amount of current used by them is not available.

Vacuum Sweepers.—The vacuum sweeper is another labor-saver for the housewife. The energy consumption of the vacuum cleaner is very low. It can be operated for five or six hours on 1 kw-hr. of electricity. The attachments available for the vacuum cleaner may be used for many purposes about the home in cleaning overstuffed furniture, draperies, and even clothing. Small jobs of spray painting can be done with the spraying attachment, which makes it possible to redecorate furniture very satisfactorily.

Figure 7.—Mrs. Peter Renner finds the vacuum cleaner a most useful piece of household equipment. The energy consumption is very low.

Portable Heaters.—The portable or glow heater is useful in taking the chill off bathrooms, or other rooms, during early fall and late spring. One kw-hr. will operate one for ½ to 2 hours, depending upon the size of the heater.

Glow heaters were put to various uses in the homes and about the farmsteads. Several farmers used them at lambing time to dry lambs born during the cold weather. One farmer used two heaters to protect his sheep against near-zero weather which occurred two days after the sheep had been shorn. Some used them to thaw out frozen pipes. Others found that when the heat was directed against the carburetors, the glow heaters helped in starting automobiles in zero weather.

Miscellaneous Household Appliances.—The electric fan, sewing-machine motor, immersion water heater, and curling iron were all found useful, and the cost of operation was low. A 10-inch fan, for instance, will operate in high speed for 20 hours on 1 kw-hr.

Figure 8.—The light on the granary illuminates the yard amply, and is controlled from the house, garage and barn. Mr. Leo Coleman finds the 150-watt light a great convenience when doing chores.

Use of Electricity About the Farmstead

Electric Lights.—Electric lights in the barn and other buildings not only give much better light than do lanterns, but are more convenient, and present a smaller fire hazard. Yard lights facilitate doing the chores after dark, and lighting the yard any time during the night when such is desired.

Pumping Water.—Running water under pressure in the house and about the farmstead was prized highly by the farmers, and the

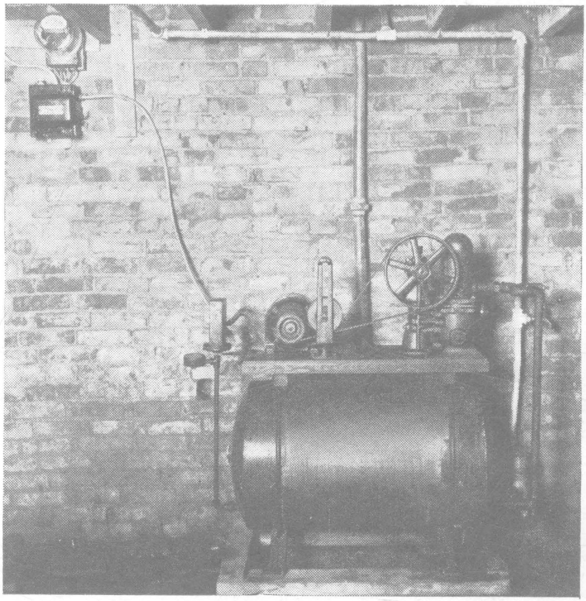


Figure 9.—This shallow-well system is used in Ernest Rausch's residence to supply soft water for household uses. One kw-hr. pumps 700 gallons of water.

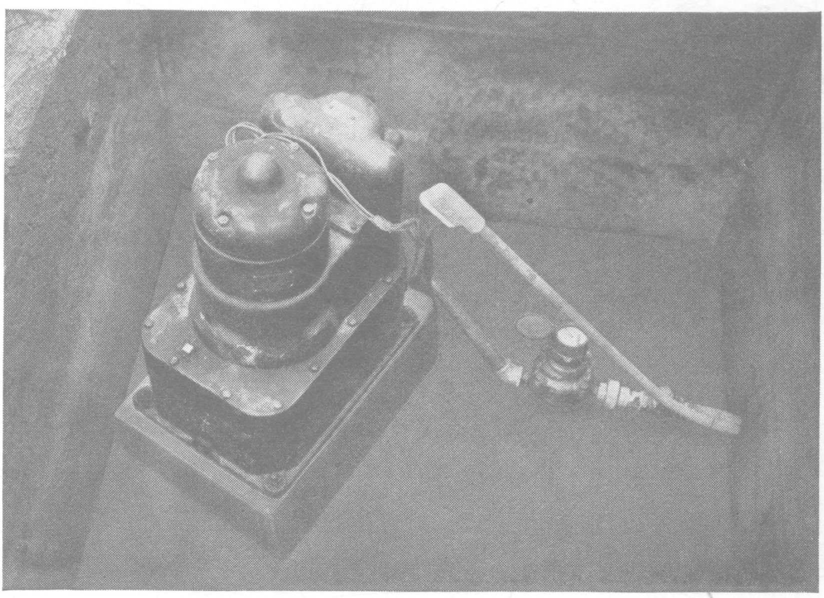


Figure 10.—All the well water for livestock and household uses is pumped by this deep-well system on George Rausch's farm. This outfit consumes 1 kw-hr. for every 575 gallons of water delivered.

water systems rank well toward the top of the list of desirable equipment used in connection with the experimental electric line. Most of the thirteen farms used both the cistern, or shallow-well, system for soft water, and the deep-well system for well water. Both systems are entirely automatic and need no attention except an occasional oiling of the pump and motor. A fresh-water valve was installed in most of the deep-well systems, so that fresh water could be secured at the kitchen sink and at the well, directly from the well, without the water having to go through the storage tank.

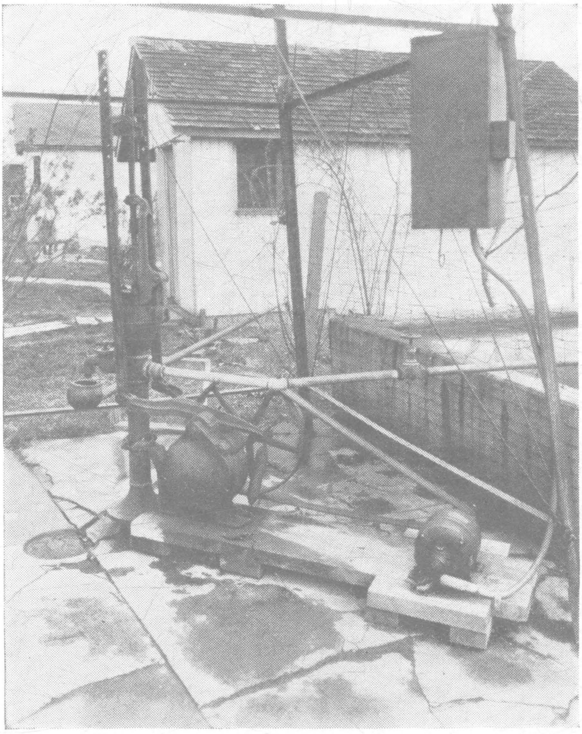


Figure 11.—A one-third hp. electric motor and a pump-jack, connected to pump formerly operated by wind power, furnishing an unfailing supply of well water on Edgar Rausch's farm.

Shallow-well systems were installed in cisterns and wells where the level of water was not more than 22 feet below the pump. Where the water was more than 22 feet below the pump, a deep-well pump was used, and the pump cylinder placed in the well so that it would never be more than 22 feet above the lowest level of the water.

Records kept on eight of the twelve shallow-well systems show that only 1.20 kw-hr. of energy were required per 1000 gallons of water pumped. The different systems varied from 0.90 kw-hr. for the lowest to 1.48 kw-hr. per 1000 gallons for the highest. The systems were set to start when the pressure fell to 20 to 23 pounds, and shut off when the pressure reached 40 to 43 pounds. The deep-well systems required a little more energy than the shallow-well systems, because they had to lift the water higher. Six of the twelve deep-well systems had both watt-hour meters and water meters on them. The range was from 1.42 kw-hr. to 1.74 kw-hr. per 1000 gallons of water pumped, the average for the six systems being 1.63 kw-hr. per 1000 gallons of water.

Professor Virgil Overholt, extension specialist in agricultural engineering, the Ohio State University, has done a great deal of work throughout the state in connection with farm water supply and sewage disposal. He has said, "If electricity does nothing else for the farmer except to put running water under pressure in the home, it is worth every cent it costs."

Milking Machines.—Milking by hand is, to many farmers, one of the most disagreeable tasks on the farm. Also, milking requires time that is often desired for field operations, especially during the rush season. Milking machines, properly installed, operated, and cared for, reduce the time required for milking about one-half. One

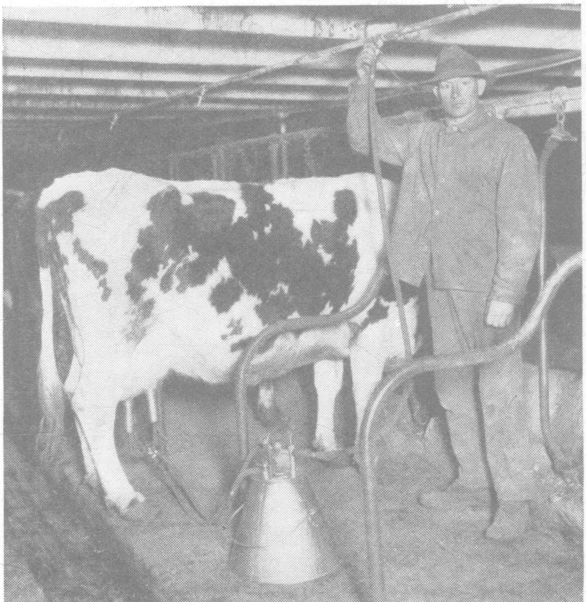


Figure 12.—Mr. Leo Coleman does the milking now in just one-half the time that it took him to do it by hand.

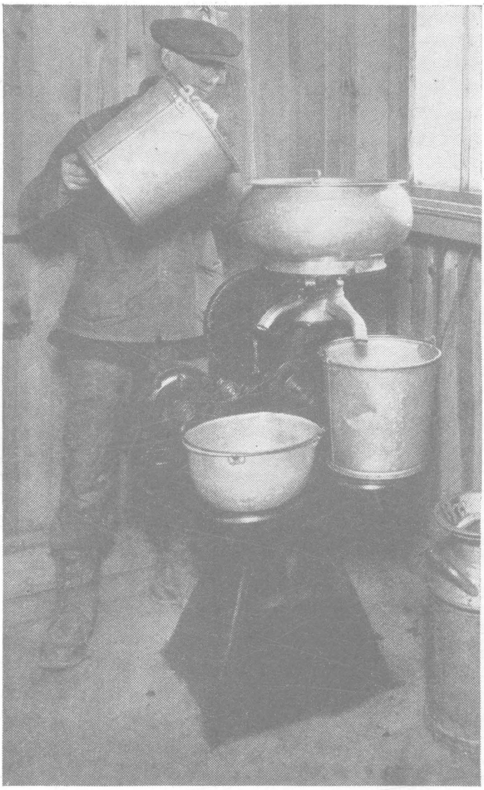


Figure 13.—A small motor on the cream separator does a good turn for the dairyman night and morning.

man and a milking-machine can take care of as many cows as two men without a milking machine.

The energy consumption for the pipe-line milker used on one farm was 2 kw-hr. per cow per month. The energy consumption for milkers operated directly from individual motors is from 1 to 2 kw-hr. per cow per month.

Separating Milk.—The small electric motor is very well adapted for operating the cream separator, because of its steady, even power. The size of motor used is 1/8 to 1/4 hp. and the energy consumption is very low. One kw-hr. separated approximately 2000 pounds of milk.

Dairy Refrigeration.—Electricity makes cooling and storage of milk on the farm easy. The milk may be cooled by running it over an aerator through which is pumped the refrigerant (clear water or brine solution) used in the storage tank, or cold water from the well. The milk is then stored in cans in the storage tank.

A four-can size milk cooler was installed in the milk house on one of the farms. This milk cooler used an average of about 75 kw-hr. per month. It used as low as 4 kw-hr. per month during the winter and as high as 144 kw-hr. per month during the summer. A milk aerator and circulating pump was used in connection with the milk cooler.

Portable and Stationary General Purpose Motor.—There were twelve 5-hp. motors, and one 3-hp. motor on the experimental line. Three of the 5-hp. motors were portable, while all the others were stationary. However, a stationary motor can very easily be con-

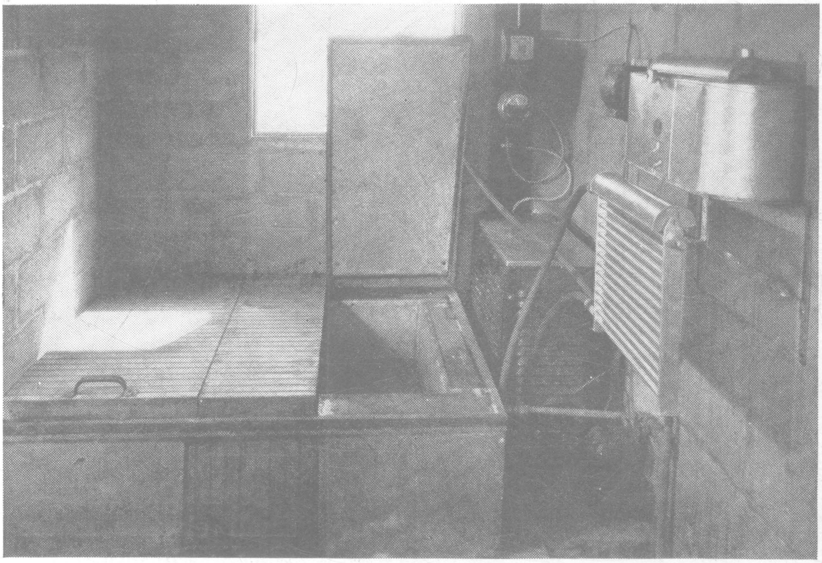


Figure 14.—The milk cooler is another piece of equipment on Mr. Leo Coleman's dairy farm that is paying its way. The milk is first run over the aerator through which is circulated the cold water from the cooling tank, by the small pump in front of the compressor cabinet. The milk is then stored in cans in the cooling tank. During the summer months an average of 130 kw-hr. per month are used.

verted into a portable motor by mounting it on skids, but cannot be moved so easily. These motors were used for the most part for grinding feed, although some of them were used for filling silos, sawing wood, and elevating grain.

Feed Grinding.—Using an electric motor to operate a feed grinder is one of the profitable uses to which electricity can be put on the farm. The most common size of burr grinder for a 5-hp. motor, is 6 inches. However, one of the 5-hp. motors operated an 8-inch burr grinder, but the grinder could not operate at full capacity. Two 5-hp. motors operated hammer mills designed for 5-hp. motors. The hammer mill lends itself to semi-automatic grinding very well, because no damage is done if the hopper becomes empty, or small pieces of metal or stones get into the grain. The amount of energy consumed and the capacity per hour depend mainly upon the kind of grain and the fineness of grinding, although other factors such as moisture content of grain, speed, and mechanical condition of the grinder have their effect. It is desirable to have the grinders operated semi-automatically.

The average energy consumed by all grinders on the line was approximately 0.8 kw-hr. per 100 pounds of all grain ground medium fine. The range was from 0.1 kw-hr. per 100 pounds of coarsely cracked shelled corn to 2 kw-hr. per 100 pounds of finely ground oats.

Several of the farmers stated that they saved enough by grinding their feed at home with the electric motor and grinder in place of taking it to town to a custom mill, to pay the cost of their entire electric bills, even though they were over $12 per month.

Ensilage Cutting.—The use of a 5-hp. electric motor on an 11-inch to 16-inch ensilage cutter gave very satisfactory results. With this size outfit the silo was filled by a crew of seven or eight men. The exchange of help was greatly reduced. The speed of the cutter varied from 400 to 500 revolutions per minute, according to the size of the cutter and the heights of the different silos filled. They were filled at the rate of 5 tons per hour, using 1 kw-hr. per ton. The corn was cut in ¼-inch lengths. It is important that the knives be kept sharp and the whole machine properly adjusted if best results are to be secured.

The silo-filling crew was reduced to four men by H. P. Miller & Son of Sunbury. They used a tractor to pull the binder and the

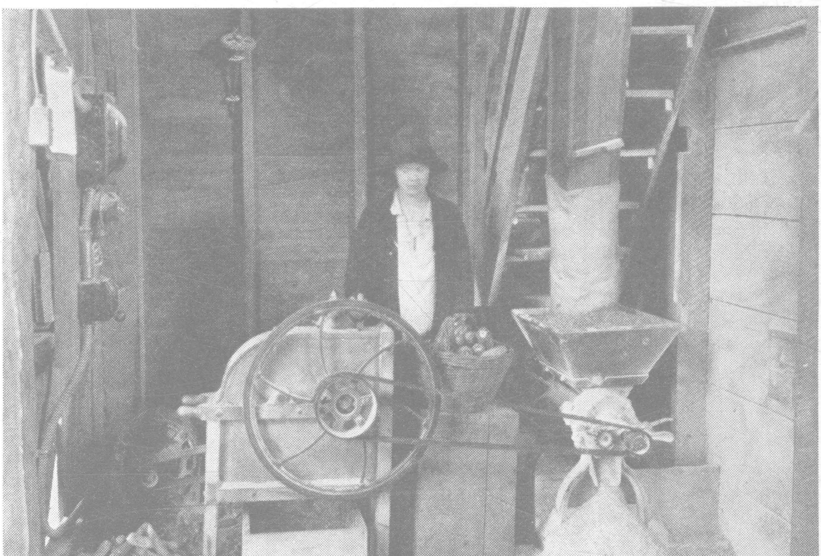


Figure 15.—The feed grinder and corn sheller on the Edgar Rausch farm are so arranged that when Mrs. Rausch shells corn for her chickens, she operates the feed grinder at the same time without extra effort, as the hopper is kept filled by an overhead bin.

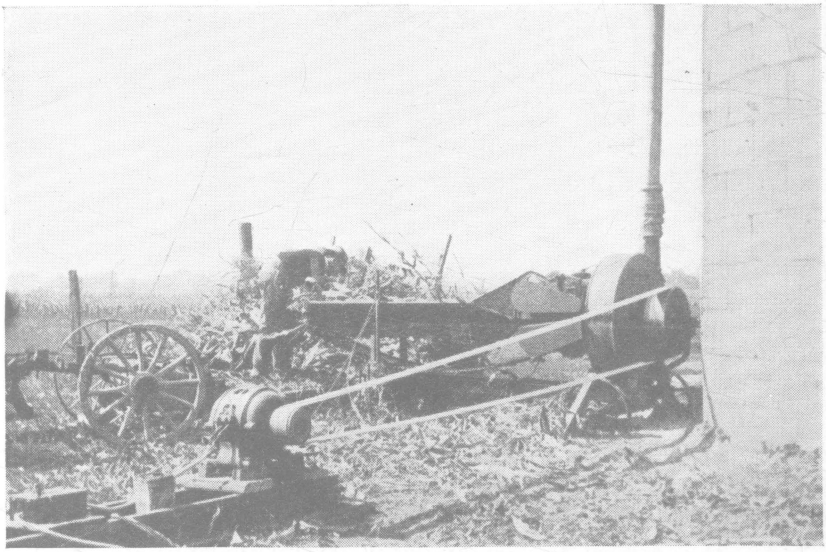


Figure 16.—A 5-hp. motor, mounted on skids, a 13-inch ensilage cutter, a tractor, a corn binder with conveyor type bundle carrier, three low down wagons, and a team of horses, made it possible for H. P. Miller & Son of Sunbury, Ohio, to fill the silos with a crew of four men.

Figure 17.—Mr. J. C. Rausch says that with his 5-hp. portable motor, he was able to "buzz" as much wood per hour as he did formerly with a tractor for power.

wagon. One man operated the tractor and one man loaded the wagon. Another man with a team took the wagons back and forth between the field and the silo, and a fourth man fed the ensilage cutter and took care of everything about the silo.

Sawing Wood.—The electric motor furnished a dependable source of power for the wood saw, and was not affected by temperature. From 1 to 3 kw-hr. were required per cord, depending upon the length of cut and the kind of wood sawed.

Figure 18.—A small motor (¼ hp.) takes the place of one man on such jobs as this. One kw-hr. of electricity will operate this size motor for 4 or 5 hours to run fanning mills, emery wheels, grindstones, and other small machines that may be turned by hand or driven by a small electric motor.

Elevating Grain.—The electric motor furnishes power to elevate grain at a very low cost. One farmer elevated 2500 bushels of oats 20 feet high with 5 kw-hr. of energy, or at a rate of 500 bushels per kw-hr., which made the power cost less than a cent per 100 bushels.

Small Utility Motors.—The common size of the small utility motor is ¼ hp. It is mounted on a three-legged base, with an extension rod to be placed against the driven machine or floor to keep the belt tight. It has a reducing gear and a number of different sized pulleys, so that a wide range in belt speeds is available. These motors may be easily shifted. They were used on several of the farms for fanning-mills, washing machines, water pumps, cream separators, corn shellers, and grindstones. One kw-hr. operated them from 4 to 5 hours.

Lights for Egg Production.—It has been known for some time that artificial lighting of poultry houses during the winter months has increased egg production during that period when prices are high. Other sources of lights have been used, but electric lights with suitable reflectors have been found the most satisfactory. The average consumption will vary from 3 to 5 kw-hr. per 100 hens per month.

Poultry Water Heaters.—If morning lights are used for egg production it is desirable that water be available at that time, and that it should not freeze during the night. If the weather is very cold or the house is not very tight the water will freeze and some method is necessary to prevent its freezing. An immersion type of water-heater of 50 to 75 watts was found satisfactory.

Figure 19.—Mr. Peter Renner is well pleased with the operation of his electric incubator. This is a 1000-egg size, and uses from 7 to 8 kw-hr. per day.

Incubators.—Electrically heated incubators are greatly appreciated by their users, because of their safety, convenience, saving of labor, cleanliness, and even temperature control. Two sizes of incubators were used on the line. The 160-egg size used about 1 kw-hr. per day, while the 1000-egg incubator used between 7 and 8 kw-hr. per day.

Brooders.—Electric brooders have proved satisfactory in Ohio, but if they are to be used during late winter or early spring, some form of supplementary heat is necessary, as the brooder will not heat the room satisfactorily in cold weather. Here again safety, even and accurate temperature control, convenience, and saving of labor are advantages of the electric brooder. The energy consumption varies, of course, with the conditions under which the brooder is operated. The average for a 56-inch, 500-chick brooder for 51 days of operation was 5.7 kw-hr. per day.

Monthly Consumption During 1929 of Different Pieces of Equipment on the Marysville Line

Equipment	No. farms using the equipment	Average kw-hr. used per farm per month			Lowest kw-hr. used in single month, any farm	Highest kw-hr. used in single month, any farm	Remarks
		Low farm	High farm	Average all farms			
Washing machines	13	1.5	4.2	2.4	1	5	Avg. washing 30 lbs.
Electric hand iron	12	1.8	6.5	4.2	1	9	
Ironing machine	1	...	...	12.9	8	17	
Refrigerators	8	21.5	48.5	35.1	0	77	Some of the refrigerators were turned off during the winter months
Ranges	9	7.8	75.2	27.7	0	160	Used mainly during summer months
Shallow well systems (cisterns)	12	0.7	2.5	1.4	0.5	4	Avg. of 1.2 kw-hr. per 1000 gallons
Deep well systems	6	6.0	37.5	20.4	3	48	Avg. of 1.63 kw-hr. per 1000 gallons
Pump jacks	4	3.8	11.1	7.8	2	21	
Milking machine	1	...	...	30.6	25	36	15 cows
Milk cooler	1	...	...	74.2	4	144	4-can size
Water heater 60 gal. off-peak	1	...	...	214.0	153	280	750-1000 gal. per mo.
Water heater Dairy, 5-gal.	1	...	...	73.7	57	101	150 gal. per mo.
5-hp. motor	12	3.0	75.6	21.0	0	97	Used mainly for feed grinding
3-hp. motor	1	...	...	17.8	4	32	Used for feed grinding
Lights and conveniences	13	14.7	106.1	36.8	9	143	For list of conveniences see pages 24-6
Total monthly consumption	13	60.6	507.2	150.3	42	797	High farm includes off-peak water heater

The tables on the next three pages show the electrical equipment used by each of the thirteen families on the Marysville line. The size of the farm, the type of farming, the number in each family, the number of buildings wired are all given for each family. There also is given the amount of current used on each farm for each of the three years, and the average yearly cost of electricity for each farm.

DATA CONCERNING THE THIRTEEN FARMS ON THE MARYSVILLE EXPERIMENTAL LINE

Cooperator	Farm		No. in family	No. bldgs. wired	Equipment	Yearly Consumption Kw-hr.				Average yearly cost
	Acres	Type				1927	1928	1929	3-year avg.	
Leo Coleman	195	Dairy	5	4	HOUSE—Range, refrigerator, water heater, washing machine, vacuum sweeper, percolator, iron, fan, toaster, heating pan, glow-heater, curling iron. WATER SUPPLY—Deep well system (½ hp.), shallow well system (⅛ hp.). DAIRY—Milk cooler (4-can), milk aerator with circulating pump, milking machine (½ hp.). BARN AND GRANARY—Feed grinder and corn sheller (5 hp.), utility motor (¼ hp.), emery grinder.	2209	2657	* 6087	3651	$141.39
Edgar Rausch	110	Livestock	4	7	HOUSE—Washing machine, vacuum sweeper, iron, cooker, percolator, heating pad, glow heater, fan, curling iron. WATER SUPPLY—Pump jack (⅓ hp.), shallow well system (¼ hp.). GRANARY—Corn sheller and feed grinder (5hp.).	856	806	727	796	$ 65.89
Lewis Nichol	140	Livestock	8	5	HOUSE—Range, refrigerator, water heater, washing machine, iron, vacuum sweeper, percolator, fan, glow heater, heating pad. WATER SUPPLY—Pump jack (¼ hp.), shallow well system (⅓ hp.), fresh water system (¼ hp.). BARN AND GRANARY—Feed grinder, ensilage cutter and corn sheller (5 hp.), utility motor (¼ hp.).	1160	1151	† 2011	1441	$ 81.99
Charles Nicol	106	General	2	6	HOUSE—Range, washing machine, iron, vacuum sweeper, waffle iron, percolator, fan, glow heater. WATER SUPPLY—Shallow well system (¼ hp.). BARN AND GRANARY—Feed grinder (3 hp.).	619	677	731	676	$ 62.82

* Includes current used by off-peak electric water heater which was installed in June, 1929.
† Includes current used by off-peak electric water heater for June and July, 1929.

Henry Coleman	195	Dairy	7	6	HOUSE—Range, refrigerator, water heater, washing machine, iron, ironer, vacuum sweeper, toaster, fan, glow heater, heating-pad, curling iron, "B" eliminator. WATER SUPPLY—Deep well system (¾ hp.), shallow well system (⅛ hp.). DAIRY—Water heater. BARN AND GRANARY—Feed grinder and ensilage cutter (5 hp.), corn sheller (½ hp.).	2351	2925	4087	3121	$135.15
William Ell	100	Livestock	2	7	HOUSE—Range, washing machine, iron, vacuum sweeper, waffle iron, percolator, glow heater, heating pad, fan. WATER SUPPLY—Deep well pump jack (¼ hp.), shallow well system (¼ hp.). DAIRY—Cream separator. BARN AND GRANARY—Feed grinder (5 hp.), utility motor (¼ hp.).	516	652	956	708	$ 64.98
J. C. Rausch	155	Livestock	5	6	HOUSE—Range, refrigerator, cooker, washing machine, iron, vacuum sweeper, glow heater, heating pad, waffle iron, percolator, "B" battery eliminator, fan, sewing machine motor. WATER SUPPLY—Pump jack (½ hp.), shallow well system (¼ hp.). GRANARY AND SHOP—Corn sheller and feed grinder (5 hp.), ½ hp. motor.	738	1034	1361	1044	$ 73.04
Peter Renner	121	Livestock	7	7	HOUSE—Refrigerator, electric cooker, washing machine, iron, ironer, percolator, vacuum sweeper, curling iron, heating pad, toaster, glow heater, fan, immersion heater. WATER SUPPLY—Deep well system (½ hp.), shallow well system (¼ hp.). POULTRY—Time switch, brooder (500-chick), incubators (1000-egg) (160-egg). GRANARY—Corn sheller and feed grinder (5hp.).	1635	1363	1662	1553	$ 88.82

Martin Volrath	100	General	5	4	HOUSE—Range, washing machine, iron, percolator, vacuum sweeper, glow heater, heating pad, toaster, curling iron, fan. WATER SUPPLY—Pump jack (½ hp.), shallow well system (¼ hp.). DAIRY—Cream separator (⅙ hp.). BARN AND GRANARY—Corn sheller and feed grinder, and ensilage cutter (5 hp.).	646	701	751	699	$ 63.25
George Rausch	101	Dairy	3	6	HOUSE—Range, refrigerator, washing machine, iron, vacuum sweeper, toaster, heating pad, glow heater. WATER SUPPLY—Deep well system (½ hp.). GRANARY—Corn sheller and feed grinder, and ensilage cutter (5 hp).)	1115	1075	1279	1156	$ 76.19
Ernest Rausch	110	Livestock	5	5	HOUSE—Range, washing machine, iron, vacuum cleaner, percolator, curling iron, fan, toaster, heating pad. WATER SUPPLY—Deep well system (⅓ hp.), shallow well system (¼ hp.). GRANARY—Corn sheller and feed grinder (5 hp.), emery grinder.	993	1040	987	1007	$ 71.65
Homer Herd	162	Livestock	3	5	HOUSE—Refrigerator, washing machine, iron, vacuum sweeper, toaster, percolator, fan, waffle iron, curling iron, heating pad. WATER SUPPLY—Pump jack (½ hp.), shallow well system (¼ hp.). BARN—Corn sheller and feed grinder (5 hp.). DAIRY—Cream separator.	1350	1074	947	1124	$ 75.36
Leo Rausch	126	Livestock	9	6	HOUSE—Refrigerator, washing machine, iron, ironer, vacuum sweeper, percolator, glow heater, curling iron, heating pad, fan, battery charger. WATER SUPPLY—Deep well system (½ hp.), shallow well system (⅓ hp.). GRANARY—Corn sheller and feed grinder (5 hp.), utility motor (¼ hp.).	2062	2475	1863	2133	$104.68

Wiring for Electric Service

This bulletin is not a handbook on electric wiring. However, some of the more important points in wiring for electric service are mentioned. Any electric wiring should be done carefully.

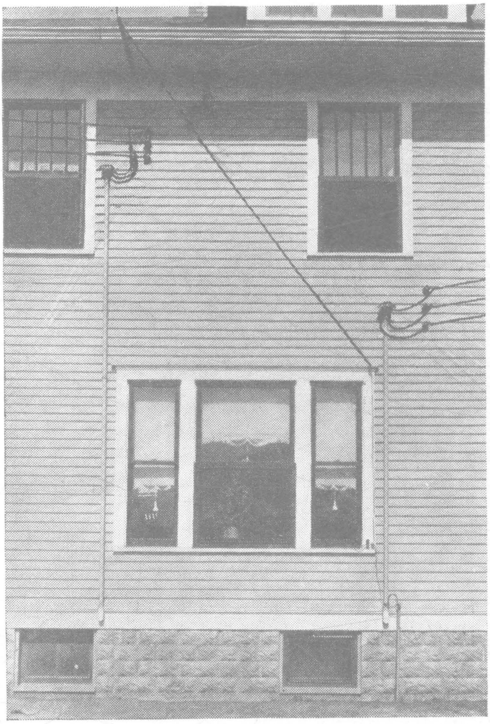


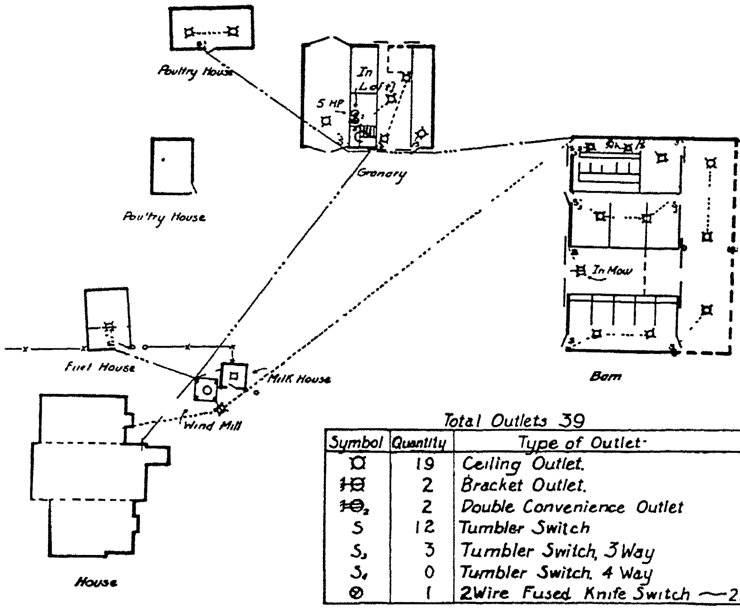
Figure 20.—A secondary (110-220 volt) service entrance through rigid conduit is shown at right to the service entrance switch in the basement and the same service leaving the house for the barn is shown at the left.

Safety.—Electricity at the present time furnishes the safest source of power known to man, if the installations are correctly made. Otherwise this source of power becomes a big hazard to life and property. Safety, then, is of prime importance in all electric wiring, whether it be for light, heat, or power. The electrical code for wiring should be followed.

Adequate Wiring.—Next in importance to safety is adequate wiring, if electricity is to be used to its fullest extent. In planning the wiring system the future needs should be considered along with the present needs. Many things enter into the cost of wiring for the farmstead, such as the number and size of buildings, number of yard lights, and the type of wiring used.

An especially high-class job of wiring was done on all the farms of the experimental line. The average number of outlets per farm is 81. The average cost of wiring these thirteen places was $141.23 for labor, and $248.47 for material, making average total costs of $389.70 per farm. That gives an average of $4.81 per outlet.

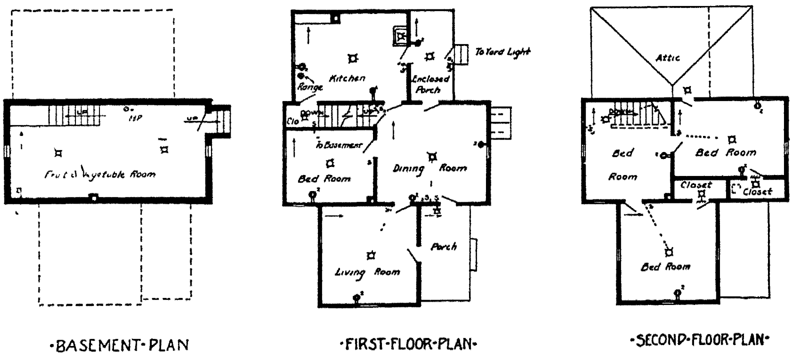
Figure 21 and figure 22 show a typical wiring diagram for one of the homes and farmsteads. The labor for this installation was $153.45, and the materials, exclusive of fixtures and equipment,



Total Outlets 39

Symbol	Quantity	Type of Outlet
⌑	19	Ceiling Outlet.
⊢⌑	2	Bracket Outlet.
⊢⊖₂	2	Double Convenience Outlet
S	12	Tumbler Switch
S_3	3	Tumbler Switch, 3 Way
S_4	0	Tumbler Switch. 4 Way
⊗	1	2 Wire Fused Knife Switch ~220 V

Figure 21.—Wiring diagram for the Charles Nicol farmstead.
——— .... ——— 3 wire 110-220 volts.
——— ——— ——— 2 wire 110-volt only.
.... Designates connection between outlets.



Total Outlets - 43

Symbol	Quantity	Type of Outlet
⌑	12	Ceiling Outlet
H⌑	4	Wall Outlet
⊢⊖₂	11	Double Convenience Outlet
S	7	Tumbler Switch
S_3	7	Tumbler Switch 3 Way
S_4	0	Tumbler Switch-4 Way
⊗	1	3 Wire Fused Switch 110-220 Volts
⊘	1	2 Wire Fused Switch 110 Volts only

Figure 22.—Wiring diagram for the Charles Nicol farm home.
.... Designates connection between outlets.

cost $247.81, giving a total cost of $401.26. There are 82 outlets which makes an average cost of $4.89 per outlet. Rigid conduit and B X cable were used for this installation.

Service Entrance Switch.—The service wires from the transformer end at the service entrance-switch. This makes it possible to cut off all the current from the distribution system. A safety-type of switch should be used because all the live parts, including the fuses, are enclosed in a self-locking metal box which prevents fire and electric shock hazards at that point.

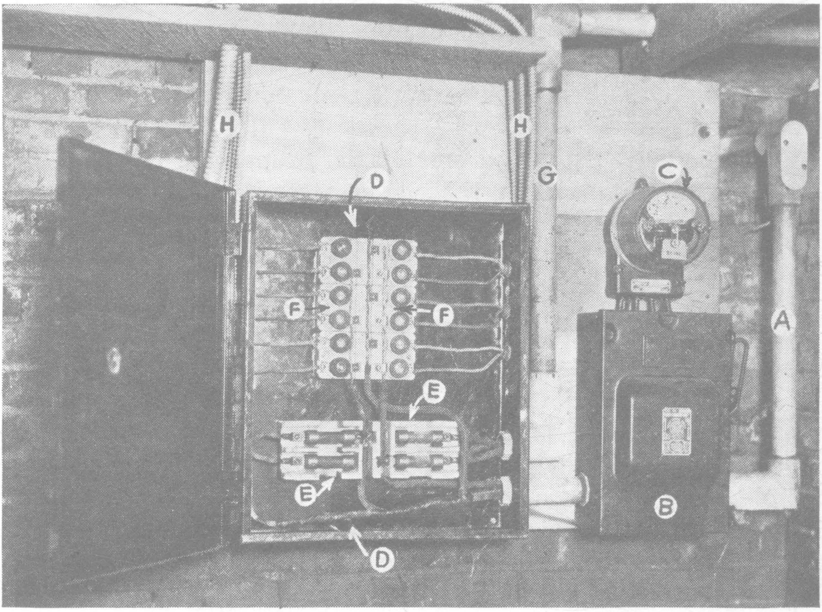


Figure 23.—A typical service entrance-switch and distribution panel.
A. Rigid conduit entrance.
B. Service entrance switch box.
C. Watt-hour meter.
D. Main distribution panel.
E. 220 volt service fuse blocks.
F. 110 volt service fuse blocks.
G. 110-220 volt service for farmstead.
H. Flexible conduit and BX cables for house circuits.

Either a 60-ampere, 250-volt, or a 100-ampere, 250-volt switch should be used. A 60-ampere service entrance-switch is the minimum size that should be installed, and in case a 7½ hp. motor, range, water heater, and other equipment generally found on the farm, are used, a 100-ampere switch should be used. If there are possibilities of the load increasing in a few years so that a 100-ampere switch would be needed, it would probably be cheaper and more satisfactory to install the 100-ampere switch at the start rather than installing the 60-ampere switch and then later changing to the 100-ampere switch.

Farmstead Distribution System.—The farmstead distribution system is made up of all the distribution panels and their circuits from the meter to the loads. The system should carry the electrical energy from the meter to the load in a safe, economical, and convenient manner. The following suggestions may help to secure such a system:

1. The system must be intelligently planned before it is constructed; it should care for the immediate and future needs; it must be adequate, useful, economical; and the outlets, switches, and fuses correctly placed.
2. Select the best type of wiring for conditions and capital to be invested.
3. Use only "approved" materials, properly installed.
4. Carefully maintain the system after it is put into service.

Rural Line Extension Plan

The Public Utilities Commission of Ohio on April 8, 1930, established Administrative Order No. 110, which pertains to rural line extensions.

According to this order the electric company pays the entire cost of building the line, but is entitled to a guaranteed minimum monthly payment, by the customers of the line, of an amount not to exceed 2 per cent of the total "construction cost" of the line extension. However, in no case is the electric company forced to accept a minimum monthly payment guarantee of less than the minimum called for by the Tariff applicable to the customer's service.

If it costs the electric company $1200 a mile to build a power line to serve rural customers, then the electric company may set the minimum monthly payment per mile of line at $24, which is 2 per cent of $1200. For the state as a whole, there is an average of about four customers per mile of line. Each one of the four customers would have to guarantee a minimum monthly bill of $6, assuming that all have the same class of service. If the line averaged six customers per mile then the minimum monthly bill would be $4. If there are one or more customers on the line that are large users of electricity, they may assume more than their pro-rata share and thereby reduce the minimum monthly guarantee for the smaller consumers.

In case additional customers are added to a line extension already established, they must guarantee a minimum monthly payment the same as that paid by the other customers for the same class of service. The plans state that the minimum monthly guarantee shall be reapportioned at least annually.

A new line extension may be connected to a line extension already built and the two considered as a single line extension, provided the new extension will not increase the minimum monthly payment guarantee for the existing line extension. In case of an increased guarantee the new line extension is treated as a separate and distinct extension.

The initial contract is for a term of four years. The minimum monthly payment guarantee cannot be raised, but may be lowered yearly if new customers come on the line.

The order also provides for the filing of optional plans for rural line extensions by the electric companies in the manner prescribed by law.

The rates that electric companies charge for electricity cannot be greater than the rates on file with the Commission and approved by it.

Copies of the Order may be secured from the Public Utilities Commission of Ohio, Columbus, Ohio.

Securing Rural Service

The data secured on the Marysville line are based on actual farm conditions and are applicable to farms operated similarly. If a farm community desires to secure electric service, the following suggestions may be of assistance:

1. Call a meeting of those in the community who are interested and select a committee to represent the community in a conference with the utility company which may serve the territory.

2. Arrange for a conference with the utility company.

3. Following the conference a utility company representative will visit the territory to study conditions, secure promise of right-of-way, and prepare an estimate of line construction cost.

4. Call a second meeting, inviting the utility company representative to explain the details of the company policy and rates as applied to rural line extensions.

5. If everything relative to the policy and rates is satisfactory and understood, the next step is signing the contract.

This order of procedure may or may not be strictly adhered to. However, it is well for both the farmers and utility company to have a clear understanding as to all details before proceeding. Misunderstandings are often embarrassing and sometimes costly.

Agricultural Extension Service

Extends Agricultural Engineering to Ohio Farms

If you have problems in soil drainage (well drained soil produces more economically than poorly drained soil), in soil erosion, in new or remodeled buildings for poultry or farm animals, or with balky field machinery, the extension specialists in agricultural engineering will assist you. All sewing machines that give the housewife exasperating trouble are not necessarily ready for the junk man or the sewing machine agent. A sewing machine clinic may show just what to do with the old machine to make it work perfectly. This service may be secured through your county agricultural agent.

The bulletins of the Agricultural College Extension Service are available to any resident of Ohio. They also may be secured from the local county agent, or by writing to Agricultural Extension Service, the Ohio State University, Columbus, Ohio.

Other agricultural engineering bulletins available are:

- Binder Head and Knotter Head Troubles
- Grading of Earth Roads
- Hog Farrowing House
- Hog Houses and Equipment
- Plows and Good Plowing
- Sewage Disposal for Rural Dwellings
- Use of Rope on the Farm

BULLETIN 96—Reprinted March, 1931

THE OHIO STATE UNIVERSITY AND THE UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING
AGRICULTURAL EXTENSION SERVICE, H C RAMSOWER, Director, Columbus
FREE—Cooperative Agricultural Extension Work—Acts of May 8 and June 30, 1914